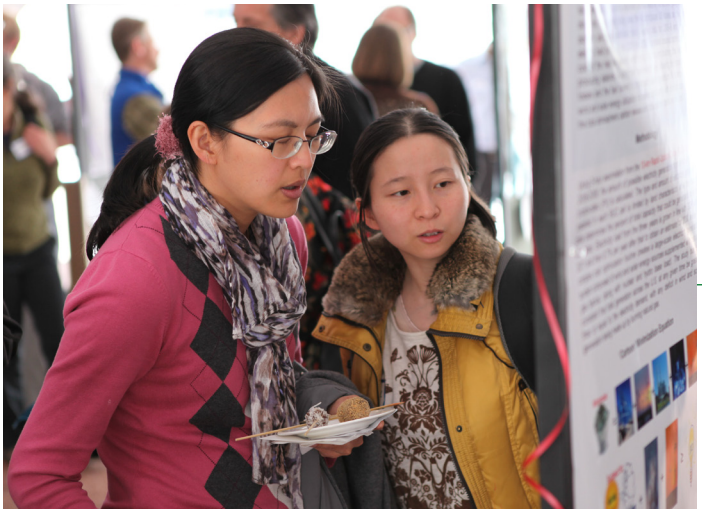
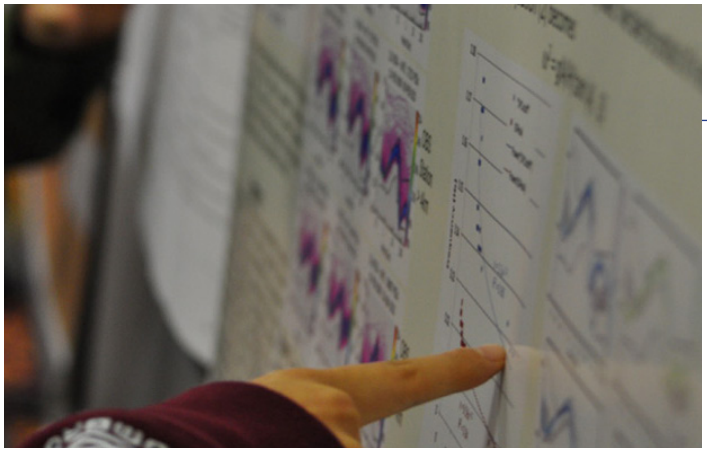
CIRES

Rendezvous 2014

Glenn Miller Ballroom, UMC • Friday, May 2 • 11:30 a.m.





CIRES Annual Science Symposium

Hosted by

CMC
CIRES MEMBERS' COUNCIL

email: memberscouncil@cires.colorado.edu

Come celebrate innovation, performance, and outstanding science with your CIRES colleagues!

CIRES Rendezvous 2014

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May 2, 2014
University Memorial Center (UMC)
PROGRAM

POSTER PRESENTERS:
This year there are two options for hanging your posters: (UMC Terrace & Aspen Rooms)

- Thursday, May 1st between 3:30 pm – 5:00 pm
- Friday, May 2nd between 7:30 am – 11:00 am

ALL OTHER ATTENDEES:
Arrivals between 11:00 am – 11:25 am

Luncheon: 11:30 am – 1:30 pm (UMC Glenn Miller Ballroom)

- Director's State of the Institute Address
- Awards
- Q & A Session

Poster Session: 1:30 pm – 4:30 pm (UMC Terrace & Aspen Rooms)

Center for Science and Technology Policy Research (Light Blue)
Cryospheric and Polar Processes Division (Purple)
Ecosystem Science Division (Pink)
Education Outreach Program (Yellow)
CIRES Communications Group (Yellow)
Solid Earth Sciences Division (Orange)
Weather and Climate Dynamics Division (Blue)
Environmental Chemistry Division (Green)
Environmental Observations, Modeling and Forecasting Division (Red), (Aspen Rooms)

From the Director

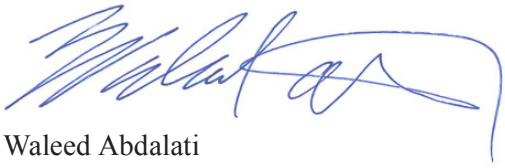
Dear CIRES Colleagues,

I am pleased to welcome you to Rendezvous 2014, CIRES' annual science symposium, hosted by our CIRES Members Council. This is one of my favorite CIRES events, as it showcases the diversity and excellence of your research, and represents an opportunity take stock of how much we have accomplished over the year, and continue to accomplish year after year. It is an opportunity to come together and celebrate our achievements, celebrate the achievements of our colleagues, learn about the great work that we do at CIRES, and build bridges to colleagues who may be down the hall or down the street.

CIRES is a leading research organization, on the CU-Boulder campus, in the state of Colorado, and in the nation. We can show impressive statistics with regard to our funding, publications, citations, etc., but at the end of the day, CIRES is about people. It is about talented people doing important research that ultimately benefits humankind. I encourage you to take this opportunity to learn about the work your colleagues are doing and to step back and appreciate the fact that we are so much more than a research institute; the work we do makes lives better, and we should all be proud of that.

So I invite you to enjoy Rendezvous, socialize with friends, make new friends, and celebrate all we do.

Sincerely,



Waleed Abdalati
Director

2013 Career Track Promotions

Promoted to:

Associate Scientist II
Eric Gordon
Jessica Henley
Julien Lynge
Benjamin Moore

Research Scientist II
Curtis Alexander
Jeffrey Deems
Kelly Mahoney
Andrew Rollins
Nicholas Wagner

Associate Scientist III
Ludovic Bariteau
Andrew Barrett
Christopher Bond
Robert Burris
Kelly Carignan
Timothy Coleman
Jennifer Jencks
Jonathan Kovarik
Justin Mabie
Ellen Parrish

Senior Associate Scientist
Kenneth Aikin
David Costa
David Gallaher
John Holloway
Doug Young

Research Scientist III
Daniel Lack
Yelena Pichugina
Alysha Reinard
Kevin Schaefer

Senior Research Scientist
Dale Hurst
John Miller
Julienne Stroeve

Adminstrative Associate II
Sarah McCoy

2013 Years of Service

5 Years of Service
Waleed Abdalati
Curtis Alexander
Kristen Averyt
Brendan Billingsley
Terry Bullett
David Carter
Tim Coleman
Sean Davis
Barbara Ervens
Tilo Ghosh
Evelyn Grell
Emrys Hall
Jennifer Jencks
Jan Kazil
Siri Jodha Khalsa
Elliot Lim
Ben Miller
David Neufeld
Mel Nicholls
Melissa Nigro
Yehor Novikov
Ilana Pollack
J. Reeves
Matt Richardson
Nick Zabotin

10 Years of Service
Laura Bianco
Bill Dúbe
Doug Fowler
David Kingsmill
Brian Lerner
Allison McComiskey
Donald Neff
David Noone
Frank Schaffer
Joshua Schwarz
Anju Shah
Drew Slater
Troy Thornberry
Gregory Tucker
Anthony Veale

15 Years of Service
David N. Anderson
Gary Bates
Antonietta Capotondi
Gilbert Compo
Xiangbao Jing
Rich Lutes
Sara Michelson
Debra Mondeel
Xiaowei Quan
Eric Ray
Donna Scott
Kenneth Smith
James Vickroy
Doug Young

20 Years of Service
Wayne Angevine
Mary Jo Brodzik
Julia Collins
Patrick Disterhoft
Christine Ennis
Edward Gille
Joan Hart
Leslie Hartten
Michael Jones
Barry McInnes
Andrew Pomper
Ted Scambos
Anne Sheehan
Donna Sueper
Betsy Weatherhead

25 Years of Service
Shelley Copley
Jeffrey Weil
Klaus Wolter

30 Years of Service
Richard Armstrong
Eirh-yu Hsie
Gerhard Hübler

2014 CIRES Outstanding Performance Awards

SCIENCE AND ENGINEERING AWARDS

CRITERIA 1: *Develop new scientific, engineering, and/or software tools that facilitate and encourage novel research, both within and external of CIRES;*

CRITERIA 2: *Participate in collaborative and/or multi-disciplinary research that engages a broader cross-section than the nominee's typical scientific or engineering community;*

CRITERIA 3: *Demonstrate uncommon initiative, resourcefulness, and/or scientific creativity conducting research with potential to expand or change the direction of a particular field or discipline.*

To Yelena Pichugina, for her groundbreaking research focusing on dynamic atmospheric processes at the heights of modern wind turbine rotors. Her work has revolutionized the measurement, characterization, and visualization of atmospheric phenomena, turbulence, and boundary layers, all of which will be important for a growing wind energy industry.

During her distinguished career, Pichugina has helped pioneer the application of lidar measurements for wind energy purposes, has developed innovative software to estimate nighttime boundary layers, and has created a new scientific pathway to obtain high-quality data for the characterization of wind and turbulence processes important for successful wind farm operations. At the same time, she has planned and led research programs to study low-level jets, the major wind resource in the Great Plains, and to assess velocity deficit and turbulence associated with operational wind turbines. Pichugina's work has earned her respect in both the scientific community and the renewable energy industry.

To Ligia Bernardet, for outstanding leadership to the Hurricane Task of the Developmental Testbed Center, an organization dedicated to supporting the growing use of the Hurricane Weather Research and Forecasting model (HWRF). Bernardet and her team's greatest accomplishment was unifying the several distinct versions of the HWRF model, allowing all users to use the same code base.

Bernardet's communication skills were instrumental in achieving the long-term goals of her team. She was responsible for the planning and execution of her team's work and for maintaining key partnerships, which include operational forecast centers, government research laboratories, academic researchers, and international collaborators.

The unification of the HWRF code greatly expedites the transition of new developments to the NOAA Environmental Modeling Center, facilitates greater collaboration within NOAA, and provides access for users across the globe. This was a large undertaking that required advanced technical skills and the ability to understand the perspectives, missions, and procedures of the various groups that use HWRF. Bernardet's leadership was outstanding.

To Carsten Warneke, for coordinating and leading the instrumentation of NOAA's WP-3D research aircraft for the very successful SENEX 2013 field study. The aircraft hosted 25 instruments, which represented 50 principal investigators (PIs) from multiple government agencies and universities. Thanks to Warneke's excellent planning, the project was ahead of schedule at all times and resulted in tremendously exciting results pertaining to the formation and movement of secondary pollutants in the U.S. Southeast. During the SENEX 2013 field study, Warneke also acted as flight scientist on approximately half of the research flights and was co-PI on one of the aircraft's instruments.

In the long term, Warneke's 12 years of research concerning the role of volatile organic compounds (VOCs) in the atmosphere has helped provide the foundation for the creation of the CIRES Energy and Environment Initiative, and he has been a major contributor to its development from its inception. Warneke's own research on the roles of VOCs in the atmosphere, as well as knowledge gained from the SENEX project, has and will continue to profoundly influence the way scientists think about air quality and climate change.

2014 CIRES Outstanding Performance Awards

SERVICE AWARDS

CRITERIA 1: *The service increases the efficiency and/or quality of research performed at CIRES;*
CRITERIA 2: *Implementation of a creative/innovative idea, device, process, or system that enhances CIRES research or assists in accomplishing the CIRES mission;*
CRITERIA 3: *The service promotes or inspires excellence and dedication to the science and research performed at CIRES.*

To Patrick Cullis, for his stunning training and outreach videos. Cullis' videos not only help CIRES achieve excellence in Earth science research through improved data collection, but they also foster public interest and awareness of our work.

Cullis' training videos for NOAA's Global Monitoring Division show, rather than tell, the intricate steps associated with atmospheric science data collection, providing technicians and trainees with visually appealing, easy-to-follow methodologies. These videos make data collection at CIRES better and more efficient.

In order to tell a compelling visual story about CIRES science, Cullis has also documented field work, including some ozonesonde releases that were part of two seasons of atmospheric science research in Utah's Uintah Basin. His vivid video work inspires interest in science among all viewers—collaborators, funders, students, and the lay public.

To Brian Meyer and Jennifer Jencks, CIRES data managers at NOAA's National Geophysical Data Center, for their innovative ideas and outstanding teamwork, which have resulted in the creation of a web interface that allows scientists across the world to easily access more than 30 years of foundational marine research data.

This project's success was largely due to Meyer's and Jencks' ability to effectively communicate their vision with the software engineers and work with a diverse team. Their final design has allowed 1 million annual users to easily search, subset, and filter available data, using both web map and text-based criteria.

Noting the success of the web interface, other groups within NGDC are now copying the layout of the discovery web pages. Improved access to geophysical data—a result of the vastly improved interface and underlying data stewardship—will impact geophysical research and continue to uphold NGDC's reputation for providing efficient and reliable access to foundational geophysical data.

To Linda Pendergrass, for her superb work planning, coordinating, and managing the many events staged by CIRES. Pendergrass' never-ending enthusiasm for helping CIRES put its best foot forward leaves both CIRES members and our visiting colleagues excitedly awaiting the next CIRES event.

The 'Cooperative' portion of our name, CIRES, has real-world implications—a staggering number of local, national, and international conferences, meetings, workshops, and parties. As the event planner for CIRES, Pendergrass helps define our institute through elegant orchestration of CIRES' events. Her attention to detail and superb management of day-to-day issues generate pleasant environments conducive to a free exchange among participants. In fact, many colleagues want CIRES to take the lead on future projects and workshops due, in large part, to Pendergrass' excellent event planning. Pendergrass' mastery of event planning helps maintain CIRES' reputation as a world-class organization, and she does it all with an ever-present, optimistic smile.

CIRES Medals

CIRES scientists are often integral to NOAA award-winning science and engineering teams but cannot be given certain federal awards, such as the prestigious Department of Commerce Silver and Bronze medals. The CIRES director recognizes the extraordinary achievements of CIRES scientists working in partnership with federal colleagues.

CIRES Silver Medal – in collaboration with NOAA colleagues in the Earth System Research Laboratory's Global Monitoring Division

CIRES scientists **Betsy Andrews, Derek Hageman, and Anne Jefferson** were part of a NOAA Silver Medal team lauded "for establishing an international, cooperative network to make coordinated, long-term measurements of aerosol climate-forcing properties." NOAA's recipients were John Ogren and Patrick Sheridan of the Earth System Research Laboratory's Global Monitoring Division.

"The group is honored for its vision in recognizing that NOAA's network of six baseline stations is inadequate to characterize the diverse nature of aerosols around the globe, its creativity and strategic thinking in developing an approach to export NOAA's monitoring methods to external partners, and its leadership in implementing these methods in a cooperative network of 24 stations in 10 countries (as of late 2012)," according to the Department of Commerce citation. "The end result is a standardized data set to assess the ability of global climate models to represent trends and variations of aerosol climate-forcing properties around the globe."

The Department of Commerce Silver Medal is the second highest honor granted by the U.S. Secretary of Commerce. Awards are given for "exceptional performance characterized by noteworthy or superlative contributions that have a direct and lasting impact within the Department."

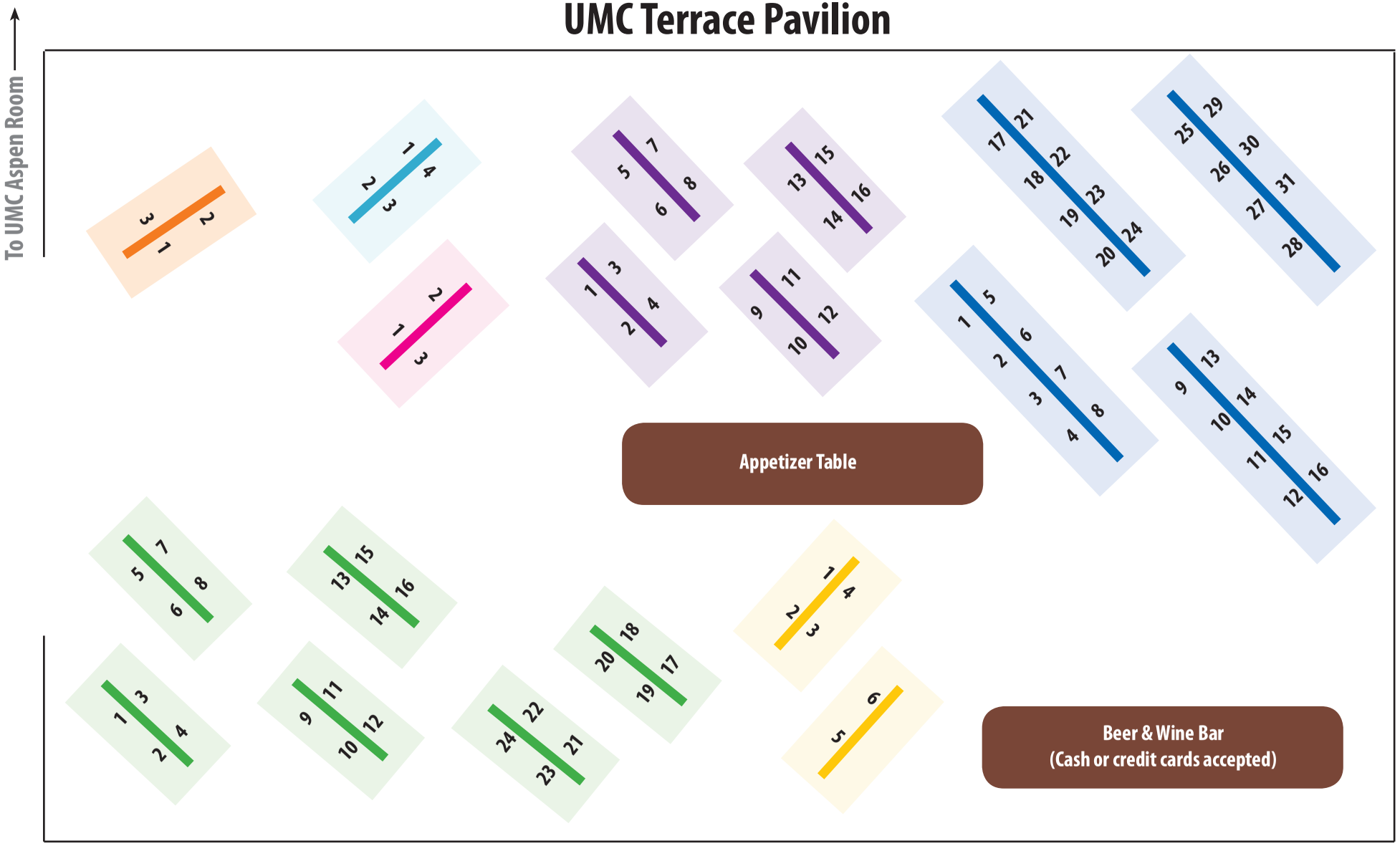
CIRES Bronze Medal – in collaboration with NOAA colleagues in the National Geophysical Data Center

Jennifer Jencks, a CIRES employee in NOAA's National Geophysical Data Center, was part of a NOAA Bronze Medal team lauded "for superior leadership and interagency collaboration in creating the comprehensive digital information publication, Gulf of Mexico Data Atlas."

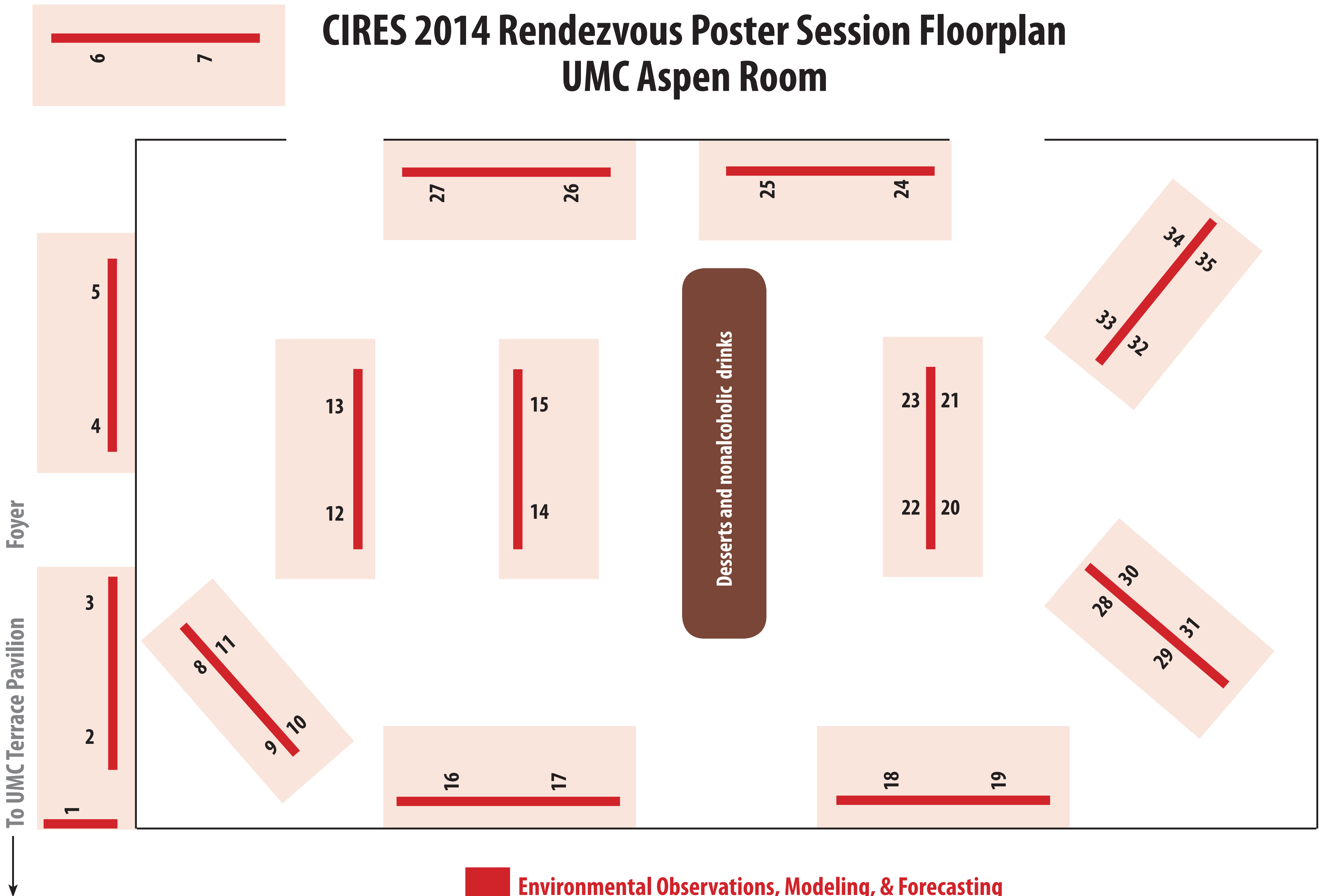
Following the 2010 Deepwater Horizon Oil Disaster in the Gulf of Mexico, many people recognized the need for a detailed regional atlas to assist in planning and restoration efforts. Federal and state agencies looked to NOAA to compile data and information on all aspects of the Gulf, including the physical environment, marine resources, and economic activity. Experts from several NOAA line offices, state agencies, and universities partnered together to develop the digital atlas. Jencks' expertise with NGDC data and data services helped ensure the atlas incorporated critical components, such as bathymetry and coastal relief data. The atlas is a successful example of interagency collaboration improving the quality and utility of information.

The Department of Commerce Bronze Medal is the highest award granted by the Under Secretary of Commerce for Oceans and Atmosphere, and recognizes exceptional work that furthers NOAA's goals or missions.

CIRES 2014 Rendezvous Poster Session Floorplan
UMC Terrace Pavilion



CIRES 2014 Rendezvous Poster Session Floorplan
UMC Aspen Room



PRESENTING:

Joanna Boehnert (Poster **CSTPR 3**)

Aditya Choulkulkar (Poster **EOMF 10**)

Marin Clark (Poster **SES 3**)

Christopher Cox (Poster **EOMF 30**)

Nathan Niemi (Poster **SES 1**)

NOT PRESENTING:

Michelle Betsill

Andrew Dessler

Louise Gall

Anne Monod

Robert Rhew

Volker Wulfmeyer

PROJECT: Visualizing Climate Discourses and the Green Economy

SPONSOR: Max Boykoff

Joanna Boehnert

Postdoctoral

Ph.D., University of Brighton, United Kingdom

Joanna Boehnert is conducting two research projects focused on the visual communication of complex ecological and socio-political systems. Her first project will map the organizations, individuals, discourses, methods, and funders that contribute to climate communication, using network visualizations, timelines, and system maps. Her second project will visualize proposals for valuing nature, especially the United Nations Environment Programme's Green Economy initiative, using a variety of analytical perspectives. This work will communicate proposed methodologies and practices for addressing the accelerating biodiversity crisis. Boehnert sees her work as a means of supporting ecological literacy. "Working on making environmental information meaningful and relevant to more people is enormously satisfying for me," she says. "Images are a powerful means of communicating ecological concepts since images are so effective at displaying context, relationships, and dynamics in complex systems." Boehnert is working with Max Boykoff and CU-Boulder's International Collective on Environment, Culture and Politics (ICE CaPs) and also is looking for new collaborators in the environmental research community.

POSTER ABSTRACT: Mapping Climate Communication

This poster presents the first iteration of a project mapping organizations, individuals, discourses, methods and funders that contribute to climate communication. The work visualizes research by Professor Max Boykoff (and others) on climate communication using network visualizations, timelines and a strategy map. Using these tools to illustrate the relationships between climate discourses, prominent actors and major organizations participating in climate communication (including science institutions, academic institutions, media organizations, think tanks and government agencies, along with the interests and funders linked to these organizations) the work maps complex communication processes. Network visualization illustrates relationships between individual and organizational actors including dynamics between nodes. The timeline illustrates the temporal growth of climate discourses illustrating the historical processes that have lead to the growth of various ways of communicating climate change. The strategy map displays methods used by different groups. The design of new visualizations is both a method (useful for both analysis) and outcome (useful for dissemination) of the research illustrated by this poster. Systems and network visualization communicates context, connections and causality in complex systems, providing an overview for wide variety of applications. Images in this poster will be developed into a series of posters to be presented next at the 'Changing Climate Change Communication' conference in Amsterdam in July 2014 and completed in final versions September 2014.

PROJECT: Quantitative Analysis of Mass Flux Parameterization Using Observations From the DYNAMO (Dynamics of the Madden Julian Oscillation) Field Program

SPONSOR: Mike Hardesty

Aditya Choukulkar

Postdoctoral
Ph.D., Arizona State University

Aditya Choukulkar is working with NOAA's Atmospheric Remote Sensing Group and the Physical Sciences Division. Using measurements from the DYNAMO field program on the equatorial Indian Ocean, Choukulkar is investigating mass flux transport in shallow convection cases, which is expected to be an important mechanism in the transport of moisture from the boundary layer into the lower troposphere.

"Weather forecast models are challenged to capture this process in cumulus parameterization schemes due to unavailability of sufficient data sets studying this process," he says. "Our work will enable, for the first time, characterization of mass flux profiles from close to the surface up to the cloud top. This will allow us to understand the role of shallow convection in the transport of moisture." In addition, by directly observing the governing variables, this study will also help gain insights on commonly used boundary layer parameterizations.

POSTER ABSTRACT: Ship-based Observations of Turbulence and Mass Flux Transport in the Indian Ocean from the DYNAMO Field Program

The Dynamics of the Madden Julian Oscillation (DYNAMO) field program involved deployment of several measurement systems based on ships, islands and aircraft over the Indian Ocean. The R/V Revelle was the primary platform for surface based measurements which included the High Resolution Doppler Lidar (HRDL) and the 94-GHz cloud Doppler radar (W-band radar). In this paper, the data from the HRDL and the W-band radar will be used to study the updraft/downdraft structure and mass flux transport in the context of shallow convection cases. Time series of turbulence profiles from the HRDL will be combined with those from the W-band radar to allow, for the first time, the study of the updraft/downdraft structure from clear air to well within the cloud layer. This allows a unique opportunity to study the turbulence profiles for clear versus cloudy elements independently. The time series of the combined updraft/downdraft profiles are plotted as a function of velocity threshold. In addition variables important for convective mass flux parameterization in models, such as updraft fractional coverage (σ) and convective mass flux velocity (M*) are computed. This will allow comparison of directly measured σ and M* values to those derived from model parameterizations.

PROJECT: Boundary Layer Meteorology and Cloud Physics Over Ice Sheets and the Reconstruction of Paleotemperatures from Ice Cores.

SPONSOR: Bill Neff and David Noone

Christopher Cox

Postdoctoral
Ph.D., University of Idaho Moscow

Christopher Cox will be collaborating with David Noone's Climate Processes Research Group and the ICECAPS team (The Integrated Characterization of Energy, Clouds, Atmospheric state and Precipitation at Summit); these projects have neighboring observatories at Summit Station, Greenland. Cox will be researching the relationship clouds and fogs at Summit have with the meteorology near the surface of the ice sheet, including isotope ratios in precipitation that will become part of the ice sheet. Scientists estimate paleotemperatures from the isotope ratios trapped in the ice, and Cox hopes to gain a better understanding of the influence of clouds on these isotope ratios as they are poorly understood. "Understanding the relationship that clouds, fogs, and precipitation have with the ice sheet is important for understanding the influence that clouds have on the ice sheet, including its mass balance," says Cox.

Not only is Cox excited to explore the trails around Boulder, but he also is eager to join Boulder's large scientific community and jump into his project because, as Cox says, "Research provides new puzzles to solve every day."

POSTER ABSTRACT: Microphysical properties of diamond dust, fog, and blowing snow over the central Greenland Ice Sheet

The surface mass balance of the Greenland Ice Sheet (GIS) is a combination of accumulation and runoff rates and is very sensitive to changes in these components. Clouds modulate the surface mass balance because they play a role in both the hydrologic cycle and surface energy balance. Furthermore, cloud and post-depositional processes influence the isotopic composition of the ice, which is used for paleoclimate reconstructions. Despite the importance of clouds, relatively little is known of the properties of clouds over the GIS. This work focuses on observations of surface-based clouds from Summit, Greenland (72N 38W 3200m), including supercooled liquid radiation fogs, ice fogs, diamond dust, and blowing snow. Surface-based cloud microphysics are presented from measurements made by Droplet Measurement Technologies (DMT) Meteorological Particle Spectrometers (MPS) and Fog Monitors (FM100) positioned at 2 m and 10 m above the surface. The period of study is June 2012 through October 2013 (17 months). MPS and FM100 data, in combination with meteorology and observations from a co-located radar and infrared spectrometer, are used to identify the types of observed clouds. The following questions are then addressed: 1) what is the prevalence of the various types of surface-based clouds?, 2) what are their microphysical properties?, and 3) what are the meteorological conditions under which they occur? Using this baseline characterization, this study will next quantify the influence that surface-based clouds have on the surface energy and hydrologic budgets of the ice sheet, and constrain the influence of cloud processes on the isotopic ratio of surface accumulation. It is anticipated that the different types of surface-based clouds exhibit a range of radiative, dynamic, and hydrologic interactions with the surface.

PROJECT: Paleotopography of the Basin and Range and the Geodynamics of Intracontinental Extension

SPONSOR: Craig Jones

Nathan Niemi

Sabbatical

Ph.D., California Institute of Technology

As an Associate Professor of Earth and Environmental Sciences at the University of Michigan, Nathan Niemi studies continental deformation, specifically actively deforming tectonic systems. Niemi has travelled west to study the tectonic activity in the Great Basin region. "Every year, the distance between Salt Lake City and Reno increases by ~1 cm. This process has been ongoing for millions of years creating the Great Basin," says Niemi. "In most places, this kind of stretching of the Earth's crust leads to it breaking in two and forming a new ocean. Here, the Earth's crust appears to continually stretch instead of breaking."

By studying the deformation of the Earth in the Basin, Niemi hopes to uncover the processes that accommodate plate tectonic motions around the globe. Niemi and his collaborators in the Geodynamics Group in the Department of Geological Sciences also hope to identify any implications the study has for seismic hazards in the western United States.

Through fieldwork in Colorado, Utah, Nevada, and California, including geological mapping and sample collection, Niemi will have plenty of opportunities to explore the rugged west. Niemi says, "For a geologist from Michigan, having mountains right in your backyard is a wonderful change of scenery! Years in rainy England, I'm really happy to see the sun again almost every day!"

POSTER ABSTRACT: A Paleoelevation History of the Basin and Range and Its Relation to Cenozoic Extensional Tectonism

The Basin and Range Province of the western United States is one of the premier examples of diffuse continental extension in the world. Estimates of extension across the Basin and Range during the Cenozoic range from 200% province-wide to locally as great as 400%. However, crustal thicknesses across this region, as derived from a variety of geophysical methods, are remarkably uniform and, at ~35 km thick, are similar to global averages. Reconciling large-magnitude crustal extension with observed crustal thicknesses is difficult without calling on one of three possible alternatives: (1) an Andean-plateau crustal thickness of ~60 km at the termination of the Sevier Orogeny and prior to extension; (2) substantial addition of material to the crust by syn-extensional magmatism or (3) mobilization and redistribution of fluid lower crust during extension. Quantitative paleoelevation histories can help discriminate between these competing mechanisms for widespread Cenozoic extension. New estimates of pre-extensional paleoelevations for the northern and central Basin and Range are presented using clumped isotope ($\Delta 47$) thermometry of lacustrine carbonates that suggest modest (~2-3 km) pre-extensional elevations for the northern Basin and Range and quite low (< 1 km) elevations for the southern Basin and Range. These paleoelevations are incompatible with mass balance considerations based on the observed magnitude of crustal extension and modern crustal thicknesses, and imply that crustal mass was added to the Basin and Range during extension, either from magmatism or crustal flow.

PROJECT: Lithosphere Deformation and the Effect of Earthquakes on Erosion Budgets of Actively Deforming Mountain Belts

SPONSOR: Roger Bilham

Marin Clark

Sabbatical

Ph.D., Massachusetts Institute of Technology

Marin Clark is an associate professor in the field of geomorphology, geodynamics, tectonics, and thermochronology in the Department of Earth and Environmental Science at the University of Michigan. Her research involves the study of topography and how it relates to lithospheric deformation. Clark looks at the evolution of rivers and other landforms; these systems are a sensitive record of the vertical movement of Earth's surface caused by deformation. Sometimes this deformation occurs very deep in Earth's crust or upper mantle, making direct observation an impossible task. To study these deep processes, Clark has developed ways of using topography as a proxy for motion at great depths beneath the continents. She uses a variety of tools including field geology, GIS modeling, geodynamic modeling, and thermochronology.

POSTER ABSTRACT: Determining Hillslope-Scale Material Strength from Seismically-Triggered Landslide Events

Natural hillslope "strength" or stability, relevant for landscape evolution and hazard assessment, falls far short of laboratory measurements of rock strength on hand-sized samples. This limitation stems from the fact that laboratory shear tests are performed on intact rock, yet it is fracture density, aperture and size that set the limit on hillslope-scale (102–103 m^2) rock strength. In this study, we exploit large earthquakes in high relief settings to quantify hillslope strength because an earthquake imparts a measurable forcing (strong ground motion) and a quantifiable landscape response (landsliding). Here we apply an infinite-slope stability model developed by the hazard community from which we can assess slope stability given known topographic slope, as a function of landslide thickness and shear-strength properties (cohesion and internal angle of friction) for a particular seismic event given measured peak ground acceleration (PGA). Using the 2008 M7.9 Wenchuan earthquake in China as a test case, we demonstrate how PGA and observed landslides can be inverted to quantify hillslope-scape rock strength.

Center for Science and Technology Policy Research Research

CSTPR 1. Risk Perceptions, Management Regimes, and Wildfire Mitigation Behavior in Wildland-Urban Interface Zones: A Cross-Case Analysis

Elizabeth Koebele, Deserai A. Crow, Lydia Dixon, Adrianne Kroepsch, Rebecca Schild, and Katherine Clifford
(1) Center for Science & Technology Policy Research, (2) Environmental Studies Program

CSTPR 2. The Inevitability of and Responsibility for Catastrophic Sea Level Rise

Jordan Kincaid
CSTPR

CSTPR 3. Mapping Climate Communication

Dr. Joanna Boehnert
Center for Science and Technology Policy Research Research, CIRES

CSTPR 4. Cooking Up Clean Air: Demand for Improved Cookstoves and Implications for Air Quality and Health in Ghana

Katherine Dickinson (1, 2), Christine Wiedinmyer (2), Mary Hayden (2), Andrew Monaghan (2), Mike Hannigan (3), Vanja Dukic (4), Abraham Oduro (5), Ernest Kanyomse (5)
(1) CIRES, (2) National Center for Atmospheric Research, (3) CU-Boulder Engineering, (4) CU-Boulder Applied Math, (5) Navrongo Health Research Centre

Cryospheric and Polar Processes Division

CPP 1. A New Normal For The Sea Ice Index

Fetterer, Florence (1) ; Windnagel, Ann (1) ; Meier, Walter N. (2)
(1) CIRES NSIDC (2) NASA-Goddard

CPP 2. Bridging the work of field scientists and the needs of data re-users

Antonia Rosati (1), Lynn Yarmey (2)
(1) CIRES, (2) NSIDC, (3) ACADIS, (4) NCAR, (5) UCAR

CPP 3. The Coldest Place On Earth: -90°C and Below in East Antarctica from Landsat-8 and other Thermal Sensors

G. Garrett Campbell (1), Allen Pope (1), Matthew Anthony Lazzara (2), Theodore A Scambos (1)
1. NSIDC, CIRES, CU 2. SSEC, U. of Wisconsin.

CPP 4. Climate Change in the Presence of Climate Variability – Implications for the future surface mass balance of Greenland

J. E. Kay (1), C. Deser (2), M. Vizcaino (3)
(1) CIRES (2) NCAR CGD (3) TU-Delft

CPP 5. Analysis of wintertime mesoscale winds and turbulent fluxes around southeastern Greenland

Alice K. DuVivier(1,2) and John J. Cassano (2,2)
(1) Cooperative Institute for Research in Environmental Sciences
(2) Department of Atmospheric and Oceanic Sciences, University of Colorado, Boulder, Colorado

CPP 6. Relationship between large-scale circulation and ice core data from the McCall Glacier, Alaska

Elizabeth Cassano, John Cassano, Joe McConnell, Matt Nolan
(1) CIRES (2) CIRES, ATOC (3) DRI (4) UAF

CPP 7. Distinguishing ice from snow for melt modeling using daily observations from MODIS
Karl Rittger (1) Anne C. Bryant (2), Mary J. Brodzik (1), Evan Burgess (3), Thomas H. Painter (2), Richard Armstrong (1)
(1) CU Boulder/CIRES/NSIDC
(2) NASA Jet Propulsion Laboratory
(3) University of Alaska, Geophysical Institute

CPP 8. What is the Permafrost Carbon Feedback?
Elchin Jafarov (1), Kevin Schaefer(1)
(1) CIRES

CPP 9. CHARIS: the contribution to High Asia runoff from ice and snow: Preliminary results from Upper Indus Basin, Pakistan
R. L. Armstrong (1), A. P. Barrett (1), M. J. Brodzik (1), F. Fetterer (1), D. Hashmey (2), U. Horodyskyj (1), S. J. S. Khalsa (1), A. Khan (3), A. Racoviteanu (4), B. H. Raup (1), K. E. Rittger (1), M. W. Williams (3), A. M. Wilson (3)
(1) CIRES
(2) Water and Power Development Authority, Pakistan
(3) INSTAAR
(4) Laboratoire de Glaciologie et Geophysique de l'Environnement, St. Martin d'Heres, France

CPP 10. The annual cycle of snowfall and accumulation at the top of the Greenland Ice Sheet
Benjamin B. Castellani (1,2,3), Matthew. D. Shupe (1,2,3), David. R. Hudak (4), Brian E. Sheppard (4)
(1) CIRES, (2) NOAA ESRL, (3) University of Colorado, (4) Environment Canada

CPP 11. Exchange for Local Observations and Knowledge of the Arctic: An Infrastructure for the Collection, Preservation, and Sharing of Local and Traditional Knowledge
Julia Collins, Peter Pulsifer, Betsy Sheffield
National Snow and Ice Data Center

CPP 12. A New Look at the Summer Arctic Frontal Zone
Alex Crawford (1), Mark Serreze (1)
(1) NSIDC

CPP 13. Surge of a Complex Glacier System - The Current Surge of the Bering-Bagley Glacier System, Alaska
Ute Herzfeld (1,2, 3), Brian McDonald (2), Thomas Trantow (3), Robert Griffin Hale (4), Maciej Stachura (5), Alexander Weltman (1,6) and Tyler Sears (1,2)
(1) CIRES, (2) Department of Electrical, Computer and Energy Engineering, (3) Department of Applied Mathematics,
(4) Department of Aerospace Engineering Sciences,
(5) Black Swift Technologies, (6) Department of Computer Sciences

CPP 14. Using the self-organizing map algorithm to characterize widespread extreme temperature events over Alaska
Cody Phillips(1), Elizabeth Cassano(1), John Cassano(1), Mark Seefeldt(1), William Gutowski(2), and Justin Glisan(2)
(1) CIRES, (2) Iowa State University

CPP 15. International collaboration and capacity-building: The unique opportunities of USAID-funded research science
Alana Wilson (1, 2), Mark Williams (2), Richard Armstrong (1), Rijan Kayastha (3), Andrew Barrett (1), Mary Jo Brodzik (1), Florence Fetterer (1), Siri Jodha Singh Khalsa (1), Adina Racoviteanu, Bruce Raup (1)
(1) CIRES, (2) INSTAAR and Department of Geography, (3) Kathmandu University

CPP 16. Comparison and validation of Arctic precipitation fields from three atmospheric reanalyses: CFSR, MERRA, ERA-Interim.
Allison Hurley (1), Mark Serreze (2)
(1) CIRES, Department of Geography; (2) NSIDC, CIRES, Department of Geography

Ecosystem Science Division

ES 1. The effects of fire severity on black carbon additions to forest soils – 10 years post fire
Rebecca Poore (1), Carol Wessman (2), Brian Buma (3)
(1) CIRES (2) Ecology and Evolutionary Biology

ES 2. A Multi-Catchment Investigation into Hydrologic Disturbance from Beetle-kill and Dust in the Upper Colorado River Basin.
Ben Livneh1, Jeffrey S. Deems1,2, Brian Buma3, Joseph, J. Barsugli1., Dominik Schneider4, Noah P. Molotch4,5, Klaus Wolter1, and Carol Wessman1.
(1. CIRES Western Water Assessment, University of Colorado
2. National Snow and Ice Data Center, University of Colorado
3. Department of Natural Sciences, University of Alaska Southeast
4. NOAA Earth System Research Laboratory Physical Sciences Division
5. Institute of Arctic and Alpine Research (INSTAAR), University of Colorado
6. Jet Propulsion Laboratory, California Institute of Technology

ES 3. Changes to zooplankton community structure in lakes perpetuates in streams below lakes
Thomas M. Detmer (1,2), James H. McCutchan (1), William M. Lewis (1,2)
(1) CIRES, (2) Biology Department

Education Outreach Program

EO 1. CIRES Communications Group: What We Can Do for You
Kristin Bjornsen (1), Katy Human (1), David Oonk (1), Robin Strelow (1)
(1) CIRES

EO 2. Lens on Climate Change (LOCC) – Engaging Secondary Students in Climate Science through Videography
David Oonk, Anne Gold, Lesley Smith, Susan Buhr-Sullivan, Max Boykoff, Beth Osnes, Amanda Morton
CIRES

EO 3. Water Spotters: A Student Citizen Science Project to Help Develop the Water Budget of the Colorado Front Range
David Noone, Lesley Smith, Michael O'Neill, Adriana Bailey, Max Berkelhammer, Aleya Kaushik and Emily Kellagher
CIRES

EO 4. Making More Impact with the CIRES Education Outreach Group
Susan Buhr Sullivan (1), Anne Gold (1), Susan Lynds (1), Amanda Morton (1), David Oonk (1), Lesley Smith (1), Jennifer Taylor (1)
(1) CIRES

EO 5. SDO Project Suite: Student-Scientists Exploring Solar Science

Jennifer Taylor (1), Susan Buhr (1), Erin Wood (2), Deborah Scherrer (3), Martha Wawro (4), Wendy Van Norden (4) Emily Kellagher
(1) CIRES EO
(2) University of Colorado Laboratory for Atmospheric and Space Physics
(3) Stanford Solar Center
(4) NASA Goddard Space Flight Center

EO 6. Arctic Climate Data in the Classroom - A Broader Impacts Effort

Anne Gold (1); Karin Kirk (2); Deb Morrison (3); Andrey Grachev (1); Ola Persson (4);
Susan Lynds (1)
(1)CIRES
(2)Education Consultant
(3)CU School of Education
(4) NOAA

Environmental Chemistry Division

EC 1. The International Global Atmospheric Chemistry (IGAC) Project

Megan L. Melamed and Jeff Jennings

EC 2. Measurements of Fluorescent Bioaerosol Particles in the Colorado Front Range

A.E. Perring (1)(2), J.B. Emerson (1), N. Fierer (1)(3), J.P. Schwarz (1)(2) and D.W. Fahey (2)
(1) CIRES
(2) NOAA ESRL
(3) Department of Ecology and Evolutionary Biology, UC Boulder, Boulder CO

EC 3. Global distribution and trends of tropospheric ozone: An observation-based review

Owen R. Cooper (1,2), D. D. Parrish (2), J. Ziemke (3), N. V. Balashov (15), M. Cupeiro (4), I. E. Galbally (5), S. Gilge (6), L. Horowitz (7), N. R. Jensen (8), J.-F. Lamarque (9), V. Naik (7,10), S. J. Oltmans (1,2), J. Schwab (11), D. T. Shindell (12), A. M. Thompson (15,16), V. Thouret (17), Y. Wang (13), R. M. Zbinden (17,14)
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(9) National Center for Atmospheric Research, Boulder, Colorado, USA
(10) University Corporation for Atmospheric Research, Boulder, Colorado, USA
(11) Atmospheric Sciences Research Center, University at Albany - State University of New York, Albany
(12) Goddard Institute for Space Studies, National Aeronautics and Space Agency, New York, USA
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(17) Laboratoire d'Aérologie, UMR 5560, CNRS and Université de Toulouse, Toulouse, France

EC 4. Key parameters controlling the OH-initiated formation of secondary organic aerosol in the aqueous phase (aqSOA)

Barbara Ervens (1,2), Armin Sorooshian (3,4), Yong B. Lim (5), and Barbara J. Turpin (5)
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(3) Department of Chemical and Environmental Engineering, University of Arizona, Tucson, AZ.
(4) Department of Atmospheric Sciences, University of Arizona, Tucson, AZ.
(5) Department of Environmental Sciences, Rutgers University, New Brunswick, NJ

EC 5. Characterizing emissions of volatile organic compounds (VOCs) from oil and natural gas operations in Haynesville, Fayetteville, and Marcellus shale regions via aircraft observations during SENEX 2013

Jessica B. Gilman(1,2), Brian M. Lerner(1,2), Megan Dumas(3), Dagen Hughes(4), Alyssa Jaksich(4), Courtney D. Hatch(4), Martin Graus(1,2), Jeff Peischl(1,2), Ilana B. Pollack(1,2), Thomas B. Ryerson(2), John S. Holloway(1,2), Michael K. Trainer(2), Kenneth C. Aikin(1,2), Carsten Warneke(1,2), and Joost de Gouw(1,2)
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(3)Department of Chemistry, Stonehill College, Easton, MA, USA
(4)Department of Chemistry, Hendrix College, Conway, AR, USA

EC 6. Retrievals of the Refractive Indices of Absorbing Aerosol

Kyle J. Zarzana (1,2), Christopher D. Cappa (3), Margaret A. Tolbert (1, 2)
(1) CIRES, (2) Department of Chemistry and Biochemistry, University of Colorado Boulder, (3) Department of Civil and Environmental Engineering, University of California, Davis

EC 7. SI2N Overview Paper - Measurements Or Where Do I Find the Perfect Ozone Profile Data?

B. Hassler (1,2), I. Petropavlovskikh (1,3), J. Staehelin (4), N.R.P. Harris (5), M.J. Kurylo (6), J.-C. Lambert (7), K.H. Rosenlof (2), R.S. Stolarski (8,9)
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(7) Belgium Institute for Space Aeronomy (IASB-BIRA), Brussels, Belgium;
(8) NASA, Goddard Space Flight Ctr, Greenbelt, Maryland, USA;
(9) Johns Hopkins University, Dept Earth & Planetary Sci, Baltimore, Maryland, USA

EC 8. Separating the stratospheric and tropospheric pathways of El Nino-Southern Oscillation teleconnections

Amy H. Butler (1), Lorenzo M. Polvani (2,3), and Clara Deser (4)
(1) CIRES, (2) Columbia University, (3) Lamont-Doherty Earth Observatory, (4) NCAR

EC 9. Effects of Water on Sulfur Chemistry in Planetary Atmospheres: Using Venus as a Natural Laboratory

Jay A. Kroll and Veronica Vaida
Department of Chemistry and Biochemistry - University of Colorado Boulder, CIRES

EC 10. Field intercomparison of the gas/particle partitioning of oxygenated organics during the Southern Oxidant and Aerosol Study (SOAS)

Samantha Thompson(1), Reddy Yatavelli(1), Harald Stark(1,3), Joel Kimmel(3,7), Jordan Krechmer(1), Douglas Day(1), Gabriel Isaacman(4), Allen H. Goldstein(4,5), Anwar Khan(6), Rupert Holzinger(6), Felipe Lopez-Hilfiker(2), Claudia Mohr(2), Joel Thornton(2), John Jayne(3), Douglas Worsnop(3), Jose L. Jimenez(1)
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EC 11.Reactive Nitrogen Partitioning and its Relationship to Winter Ozone Events in Utah

Robert Wild (1,2), Peter Edwards (1,2), William Dube (1,2), Ronald Cohen (4,5), John Holloway (1,2), James Kercher (7), Lance Lee (4), Robert McLaren (3), James Roberts (1), Jochen Stutz (6), Patrick Veres (1), Carsten Warneke (1,2), Eric Williams (1), Bin Yuan (1,2), Steven Brown (1)
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EC 12. Aircraft measurement of glyoxal (CHOCHO) and nitrous acid (HONO) during SENEX 2013

Kyung-Eun Min(1,2), William. P. Dube(1,2), Peter M. Edwards(1,2), Rebecca. A. Washenfelder(1,2), Andrew. O. Langford(2), Steve. S. Brown(2)
(1) CIRES, (2)NOAA ESRL

EC 13. Changes in Visibility and Local Radiative Forcing in the Southeast U.S. Linked to Decreased Aerosol Sulfate Mass

Alexis Attwood (1,2), Rebecca Washenfelder (1,2), Weiwei Hu (1,3), Nick Wagner (1,2), Allison McComiskey (1,2), Pedro Campuzano-Jost (1,3), Douglas Day (1,3), Brett Palm (1,3), Suzane Simoes de Sa (4), Charles Brock (2), Eric Edgerton (5), Karsten Baumann (5), Jose-Luis Jimenez (1,3), Steven Brown (2)
((1) CIRES, (2) NOAA ESRL, (3) University of Colorado, (4) Harvard University, (5) Atmospheric Research and Analysis

EC 14. GEIA's Vision for Improved Emissions Information

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(4) Max Planck Institute for Meteorology, Hamburg, Germany
(5) Norwegian Institute for Air Research, Kjeller, Norway
(6) Panorama Pathways, Boulder, Colorado, USA

EC 15. Top-down constraint on hydrocarbon emissions in the Denver-Julesburg oil and natural gas basin

Gabrielle Pétron1,2, Anna Karion1,2, Colm Sweeney1,2, Benjamin R. Miller1,2, Stephen A. Montzka2, Gregory Frost1,2, Michael Trainer2, Pieter Tans2, Arlyn Andrews2, Jonathan Kofler1,2, Detlev Helmig3, Douglas Guenther1,2, Ed Dlugokencky2, Patricia Lang2, Tim Newberger1,2, Sonja Wolter1,2, Bradley Hall2, Paul Novelli2, Alan Brewer2, Stephen Conley4, Mike Hardesty1, Robert Banta2, Allen White2, David Noone1,5, Dan Wolfe1 and Russell Schnell
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EC 16. Measurements of VOCs by GC-MS in rural Alabama

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EC 17. Secondary Organic Aerosol Formation and Aging in a Flow Reactor in the Forested Southeast US during SOAS

Weiwei Hu(1), Brett B Palm(1), Lina Hacker(2), Pedro Campuzano Jost(1), Douglas A Day(1), Suzane Simoes de Sa(3), Juliane Fry(4), Benjamin R Ayres(4), Danielle C Draper(4), Amber M Ortega(1), Astrid Kiendler-Scharr(2), Aki Pajunoja(5), Annele Virtanen(5), Jordan Krechmer(1,6), manjula R Canagaratna(6), Samantha Thompson(1), Laxminarasimha R Yatavelli(1), Harald Stark(1,6), Douglas R Worsnop(6), Michael Lechner(1), Abigail Koss(1,8), Joost de Gouw(1,8), Scot T Martin(3), Delphine Farmer(7), Steven S Brown(8), W.H. Brune(9), Jose L Jimenez(1)
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EC 18. Aerosol and Particle Engineering Research Aimed at Improving Global Health

Jessica M.H. Thrall (1,4), Stephen P. Cape (1,4), Nisha K. Shah (1,4), C. Andy Pelzmann (4), Jane Duplantis (2), David H. McAdams (1,2), Scott Winston (4), and Robert E. Sievers (1,2,3,4)
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EC 19. VOCs Flux Measurements over Haynesville Shale Gas Play

Bin Yuan1,2,*, Lisa Kaser3, Thomas Karl4, Martin Graus1,2,4, Jeff Peischl1,2, Terasa L. Campos3, Steve Shertz3, Eric C. Apel3, Rebecca S. Hornbrook3, Alan Hills3, Daniel Riemer3, Jessica B. Gilman1,2, Brian M. Lerner1,2, Carsten Warneke1,2, Andrew J. Weinheimer3, Frank M. Flocke3, Roy L. Mauldin III5, Chris A. Cantrell5, Thomas B. Ryerson1, Alex B. Guenther3,6, Joost A. de Gouw1,2,*
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EC 20. Anthropogenic Triggers of Multiphase Chemistry of Glyoxal

E. Waxman (1), A. Laskin (2), J. Laskin (2), T. Koenig (1), C. Kampf (1), U. Baltensperger (3), J. Dommen (3), A. Prevot (3), J. Slowik (3), B. Noziere (4), S. Wang (1, 5, 6), R. Volkamer (1,6)
(1) University of Colorado Department of Chemistry, (2) EMSL, PNNL, (3), Paul Scherrer Institut, (4) IRCELYON, (5) HKUST, (6) CIRES

EC 21. Observational evidence for incomplete dehydration in the TTL

Andrew Rollins (1,2), Troy Thornberry (1,2), Ru-Shan Gao (1), Sarah Woods (3), ThaoPaul Bui (4), David Fahey (1,2)
(1) NOAA ESRL CSD, (2) CIRES, (3) SPEC, Inc., (4) NASA Ames Research Center

EC 22. Vertical Profiles of Aerosol Extinction over the Southeastern US during the Summer

Nicholas L. Wagner(1)(2), Charles A. Brock (1), Timothy Gordon (1)(2), Daniel Lack (1)(2), Mathews Richardson(1)(2), Daniel Law (1)(2), Andre Welti (1)(2)(3), Ann M. Middlebrook (1), Jin Liao(1)(2), John Holloway(1)(2), Jeff Peischl(1)(2),Ilana Pollack(1)(2)
Tom Ryerson, Martin Graus, Carsten Warneke
(1) NOAA, Earth Systems Research Laboratory
(2) CIRES, University of Colorado
(3) ETH, Zürich, Switzerland

EC 23. Single particles measured by a time-of-flight AMS coupled with a light scattering module onboard NOAA P3 during SENEX

Jin Liao(1,2), Ann Middlebrook (2), Andre Welti (3), Donna Sueper(4), Daniel Murphy (2) et al.
(1)CIRES, (2)NOAA ESRL, (3)ETH Zurich, (4)Aerodyne Research

EC 24. Optical Properties of Organic Aerosol in the Southeastern U.S.

R. A. Washenfelder (1, 2), A. R. Attwood (1,2), C. A. Brock (2), and S. S. Brown (2)
(1) CIRES, (2) NOAA ESRL

Environmental Observations, Modeling and Forecasting Division

EOMF 1. Geomagnetic Field Modeling with DMSP

P. Alken (1), S. Maus (1), H. Luehr (2), R. J. Redmon (1), F. Rich (3), B. Bowman (4), S. M. O'Malley (5)
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(3) Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts, USA
(4) Space Environment Technologies, Pacific Palisades, CA, USA
(5) Atmospheric and Environmental Research, Inc., Lexington, Massachusetts, USA

EOMF 2. Dynamical origins of Total Ozone extremes in historic records across the US

Irina Petropavlovskikh (1,2) (irina.petro@noaa.gov), Robert Evans (1), Bryan J. Johnson (1), Gloria L. Manney (3,4), Harald E. Rieder (5,6)
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EOMF 3. L-band Soil Moisture Mapping using UAS for Validation and Calibration of SMAP

Albin J. Gasiewski(1), Maciej Stachura(1,2), Jack Elston(1,2), Eric M. McIntyre(1), and Eryan Dai(1)
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EOMF 4. The Role of Soil Moisture and SSTs in Decadal Drought in Western North America

Sally Langford (1), Yoshimitsu Chikamoto (2) and David Noone (1)
(1) CIRES/ATOC, University of Colorado, Boulder CO (2) IPRC, University of Hawaii, Honolulu HI

EOMF 5. What lies beneath: Using water column sonar data to map fish schools and more

Carrie C. Wall (1), Charles Anderson (1), Rick Towler (2), John Cartwright (3), Jesse Varner (1), Anna Milan (3), Danielle Austin (1), and Susan J. McLean (3)
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(3) NOAA National Geophysical Data Center, Boulder, CO 80305

EOMF 6. Enhanced Management of and Access to Hurricane Sandy Ocean & Coastal Mapping Data

Barry Eakins (1), Dave Neufeld (1), Dan Price (2), and Susan McLean (2)
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EOMF 7. Smart Post-Processing of a Global Numerical Weather Prediction Ensemble

Scott Gregory (1), Isidora Jankov (2), Timothy Schneider (3), Alexander McDonald (4)
(1) CIRES/NOAA/GSD, (2)CIRA/NOAA/GSD, (3)NOAA/GSD, (4)NOAA/GSD

EOMF 8. Ionospheric Assimilation of Radio Occultation and Ground-based GPS data using Non-stationary Background Model Error Covariance

C. Y. Lin (1,2,3), T. Matsuo(2,3), J. Y. Liu(1,4), C. H. Lin(5), H. F. Tsai(6), and E. A. Araujo-Pradere(2)
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(4) National Space Organization, HsinChu, Taiwan.
(5) Department of Earth Science, National Cheng Kung University, Tainan, Taiwan.
(6) GPS Science and Application Research Center, National Central University, Chungli, Taiwan

EOMF 9. Prolonged Duration and Frequency of Springtime Ozone Depletion events in the Arctic

Audra McClure-Begley 1,2 , Irina Petropavlovskikh 1,2, Samuel J. Oltmans 1,2, Taneil Uttal 2, Sara Crepensik 1,2
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2 National Oceanic and Atmospheric Administration, Earth Systems Research Laboratory

EOMF 10. Ship-based Observations of Turbulence and Mass Flux Transport in the Indian Ocean from the DYNAMO Field Program

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(2) Chemical Sciences Division, National Oceanic and Atmospheric Administration
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EOMF 11. Potential for Geographic Diversity to Smooth Wind Electricity Generation

Mark A. Handschy(1)(2), Jay Apt(3), Julie Lundquist(4)(5), Stephen Rose(3), Clara St. Martin(4)
(1) CIRES, (2) Enduring Energy, LLC, (3) Carnegie Mellon University, Tepper School of Business, Department of Engineering and Public Policy, (4) University of Colorado, Department of Atmospheric and Oceanic Sciences (5) National Renewable Energy Laboratory

EOMF 12. Build Your Own Metadata Editor! Easier than an IKEA bookshelf!

Richard Fozzard (1), Marty Aubrey (1), Anna Milan (2), Anju Shah (1), Dan Price (3), Marcus Cole (2), Travis Pence (1)
(1) CIRES, (2) NOAA NGDC, (3) NOAA Corps

EOMF 13. Observed and Projected Ocean Wind Speed Trends and Marine Boundary Layer Clouds

Jan Kazil (1,2) Graham Feingold (2)
(1) CIRES (2) NOAA ESRL

EOMF 14. NOAA tsunami water levels archive – scientific perspectives and discoveries

George Mungov(1), Marie Eble(2), Susan McLean(3)
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(2) NOAA Center for Tsunami Research, Seattle, Washington
(3) NOAA National Geophysical Data Center, Boulder, Colorado

EOMF 15. Assimilative Neutral Wind Bias Correction Scheme for Global Ionospheric Modeling at Midlatitude

Yang-Yi Sun (1,2,3), Tomoko Matsuo (1,2), Naomi Maruyama (1,2), and Jann-Yenq Liu (3)
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(2) Space Weather Prediction Center, National Oceanic and Atmospheric Administration, Boulder, Colorado, USA.
(3) Institute of Space Science, National Central University, Chung-Li, Taiwan.

EOMF 16. Detecting Moisture Convergence Signals in a Madden-Julian Oscillation Event: A Feasibility Study Combining Scatterometer and Thermal Emissions Spectrometer Data
Lesley L. Smith (1), David C. Noone (1)(2), Max Berkelhammer (3), Ralph F. Milliff (1)
(1) CIRES, (2) ATOC University of Colorado, (3) Dept. Earth and Environmental Sciences, University of Illinois, Chicago

EOMF 17. High-resolution coastal DEMs of the Nation: A Hurricane Sandy test case
Luke Beasley(1), Michael Sutherland(1), Barry Eakins(1), Matthew Love(1), Kelly Carignan(1), and Susan McLean(2)
(1) CIRES
(2)NOAA NGDC

EOMF 18. The Implications of Background 03 Affecting the Setting and Attainment of the NAAQS for Surface 03
Samuel J. Oltmans (1,2), Allen S. Lefohn (3)
(1) CIRES, (2) NOAA ESRL Global Monitoring Division, (3) A.S.L. & Associates

EOMF 19. How much can we learn about nitrous oxide emissions from background sites and simple box models?
J.David Nance (1,2), James W.Elkins (2), Geoffrey S. Dutton (1,2), Bradley D. Hall (2), Debra. J. Mondeel (1,2), James H. Butler (2), Edward J. Dlugokencky (2), Steven C. Wofsy (3), and Matthew Rigby (4)
(1) CIRES, (2) NOAA ESRL GMD, (3) Harvard University, (4) University of Bristol

EOMF 20. Long-Range Correlations of Underwater Pressure Fluctuations
Justin S. Ball (1), Oleg A. Godin (1,2), Läslo G. Evers (3) and Cheng Lv (1)
(1) CIRES, University of Colorado at Boulder, (2) NOAA Earth System Research Laboratory, Physical Sciences Division, Boulder, CO, (3) Seismology Division, Royal Netherlands Meteorological Institute, De Bilt, The Netherlands

EOMF 21. Update to the Mauna Loa Clear-sky Apparent Solar Transmission 1958 - 2013
K. Lantz (1,2), D. Longenecker (1,2), E. Hall (1,2), J. Wendell (2)
(1) CIRES, (2) NOAA/ESRL

EOMF 22. The Many Uses of Multibeam Echosounder Data
Evan Robertson (1), Chuck Anderson (1), Jesse Varner (1), Daniel Price (2)
(1) Cooperative Institute for Research in Environmental Sciences (CIRES)
(2) NOAA National Geophysical Data Center (NGDC)

EOMF 23. Towards the Goal of Modular Climate Data Services: An Overview of NCPP Applications and Software
Ben Koziol, Luca Cinquini, Allyn Treshansky, Sylvia Murphy, Cecelia DeLuca, Richard Rood
CIRES, NOAA-ESRL, NESII, NASA-JPL, University of Michigan-Ann Arbor

EOMF 24. Winter temperature tides from 30 to 110 km at McMurdo (77.8S, 166.7E), Antarctica: Lidar observations and mechanism study of fast amplitude growth above 100 km by CTIPe model.
Weichun Fong (1,2), Xian Lu (1), Xinzhao Chu (1,2), Cao Chen (1,2), Tim Fuller-Rowell (1,3), Mihail Codrescu (3), Zhibin Yu (1,2), Brendan Roberts (1,2), Chester S. Gardner (4), Adrian J. McDonald (5)
(1)CIRES, (2)ASEN, CU Boulder (3)SWPC, NOAA (4)EE, UIUC,(5)Physics and Astronomy, U of Canterbury, New Zealand

EOMF 25. Vertical evolution of gravity wave potential energy and wavenumber spectrum from 30 to 110 km observed by an Fe liar at McMurdo (77.8S, 166.7E), Antarctica
Xian Lu(1), Xinzhao Chu(1,2), Zhibin Yu(1,2), Weichun Fong(1,2), Cao Chen (1,2)
(1)CIRES (2) Aerospace Department

EOMF 26. Applications of Atomic Filters in Na Doppler Lidar
Ian F. Barry (1), Wentao Huang (1), John A. Smith (1), Weichun Fong (1), and Xinzhao Chu (1)
(1) CIRES

EOMF 27.CIRES/NOAA-GMD HIPPO data set for transport and chemistry in the global troposphere.
F.L. Moore(1,2), E. Ray(1,2), J.W. Elkins(1), E.J. Hintsa(1,2), J.D. Nance(1,2), G.S. Dutton(1,2), B.D. Hall(1), B.R. Miller(1,2), S.A. Montzka(1), D.F. Hurst(1,2), C. Sweeney(1,2), E. Atlas(3), and S.C. Wofsy(4)
(1)NOAA ESRL, (2)CIRES CU, (3)U of Miami, (4)Harvard University.

EOMF 28. NGDC Data Management Supporting the Extended Continental Shelf Project
E Lim(1), J Jencks(1), R Warnken(2), S McLean(2), J Varner(1), J LaRocque(2), E McQuinn(1)
(1) Cooperative Institute for Research in Environmental Sciences (CIRES), at University of Colorado at Boulder, (2) NOAA/NESDIS/National Geophysical Data Center, Boulder, Colorado.

EOMF 29. Evaluation of NWP forecast model skill at simulating offshore winds by comparing to ship-based Doppler lidar measurements.
Pichugina Yelena (1, 2), Robert Banta (2), Alan Brewer (2), Joseph Olson (1, 2), Melinda Marquis (2),James Wilczak (2), Irina Djalalova (1, 2), Laura Bianco (1, 2), Stan Benjamin (2), and Mike Hardesty (1,2)
(1) CIRES
(2) NOAA/Earth Systems Research Laboratory

EOMF 30. Microphysical properties of diamond dust, fog, and blowing snow over the central Greenland Ice Sheet
Christopher J. Cox (1,2,3), David Noone (1,2), Michael O'Neill (2,4), Von P. Walden (5), Matthew D. Shupe (2,3), Max Berkelhammer (6)
(1) Dept. of Atmospheric and Ocean Sciences, University of Colorado, Boulder, (2) Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, (3) NOAA Earth System Research Laboratory, Physical Sciences Division, Boulder, (4) NOAA Earth System Research Laboratory, Global Monitoring Division, Boulder, (5) Dept. of Civil and Environmental Engineering, Washington State University, Pullman, WA, (6) Dept. of Earth Sciences, University of Illinois, Chicago

EOMF 31. Improvements to the Data Dissemination Website and Additions to Trackline Archive at NGDC
Brian Meyer (1), Jennifer Jencks (1), John Campagnoli (2), Dan Metzger (1), Udo Barckhausen (3), Takemi Ishihara (4)
(1) CIRES, (2) NOAA NGDC, (3) BGR, Germany, (4) AIST, Japan

EOMF 32. Image Services and Mosaic Datasets Providing Access to Bathymetry Data at NGDC
Jesse Varner (1, 2), John Cartwright (2), Barry Eakins (1, 2), David Rodziewicz (2, 3), Marcus Cole (2, 4)
(1) CIRES, (2) NOAA National Geophysical Data Center, (3) NOAA Corps, (4) NOAA National Ocean Service, Hydrographic Surveys Division

EOMF 33. Exploration of novel whole atmosphere lidar for whole atmosphere wave dynamics
John Smith, Xinzhao Chu, Wentao Huang
CIRES

EOMF 34. Geodesy for Evaluating the Impact of Sea Level Rise on NASA Centers and Facilities
Lynda Bell(1), R. Steven Nerem(1), Dallas Masters(1), Charles Meertens(2)
(1) University of Colorado/Boulder, Colorado Center for Astrodynamics Research, CIRES
(2)UNAVCO, Boulder, Colorado

EOMF 35. Automated Estimation of Boundary Layer Height Using Doppler Lidar
Thomas Rieutord (1), R. Michael Hardesty (2), W. Alan Brewer (3)
(1) Meteo France, (2) CIRES, (3) NOAA ESRL/CSD

Solid Earth Sciences Division

SES 1. A Paleoelevation History of the Basin and Range and Its Relation to Cenozoic Extensional Tectonism
Nathan Niemi (1)
(1) CIRES and the University of Michigan

SES 2. Investigating Mechanisms of Lithospheric Shortening via Ocean Bottom Seismometers: South Island, New Zealand
Daniel W. Zietlow (1) and Anne F. Sheehan (1)
(1) CIRES and Department of Geological Sciences

SES 3. Determining Hillslope-Scale Material Strength from Seismically-Triggered Landslide Events
Marin Clark (1)(2), Sean Gallen (2), Johnathan Godt (3)
(1) CIRES Visiting Fellow, (2) Dept. of Earth and Environmental Sciences, University of Michigan, (3) Geologic Hazards Center, USGS, Golden, CO

Weather and Climate Dynamics Division

WCD 1. First forecast of a sudden stratospheric warming with a coupled whole-atmosphere/ionosphere model IDEA
H. Wang (1,2), R. A. Akmaev (2) T.-W. Fang (1,2), T. J. Fuller-Rowell (1,2), F. Wu (1,2), N. Maruyama (1,2), and M. D. Iredell (3)
(1) CIRES, (2) NOAA, SWPC, (3) NOAA, EMC.

WCD 2. Stochastic Forcings Associated with MJO Initiation during DYNAMO
Leslie M. Hartten (1, 2) and Cécile Penland (2)
(1) CIRES, Univ. of Colorado, 216 UCB, Boulder CO 80309-0216, USA
(2) NOAA/ESRL/Physical Sciences Division, 325 Broadway, Boulder CO 80305-3328, USA

WCD 3. The Sensitivity of Springtime Arctic Mixed-Phase Stratocumulus Clouds to Surface Layer and Cloud-Top Inversion Layer Moisture and Ice Nuclei Sources
Amy Solomon (12), Matt Shupe (12), Ola Persson (12), Hugh Morrison (3), Takanobu Yamaguchi (12), Peter M. Caldwell (4), Gijs de Boer (12), Graham Feingold (1), Barbara Ervens (12)
(1) NOAA/Earth System Research Laboratory, Boulder, Colorado, (2) CIRES/University of Colorado, Boulder, Colorado,(3) National Center for Atmospheric Research, Boulder, Colorado, (4) Lawrence Livermore National Laboratory, Livermore, California

WCD 4. Global Coupled Atmosphere/Ocean Model for Seasonal and Climate Forecast Applications at NOAA/ESRL
Shan Sun (1,2), Georg Grell (2), Rainer Bleck (1,2,3), Stan Benjamin (2)
(1) CIRES, (2) NOAA ESRL, (3) NASA GISS

WCD 5. Improving CTIPe neutral density response and recovery during geomagnetic storms.
M. Fedrizzi (1), T. Fuller-Rowell (1), M. Codrescu (2), M. G. Mlynczak (3), D. R. Marsh (4)
(1)University of Colorado/CIRES - NOAA/SWPC, (2)NOAA/SWPC, (3)NASA Langley Research Center, (4) Atmospheric Chemistry Division, NCAR

WCD 6. Upper Atmospheric Data Assimilation with an Ensemble Kalman Filter
Tomoko Matsuo (1,2), I-Te Lee (3), and Jeffrey L. Anderson (4)
(1) CIRES, (2) NOAA SWPC, (3) National Central University, Taiwan, (4) NCAR IMAGe

WCD 7. Amplified Warming Projections For High Elevation Regions From CMIP5 Models

Imtiaz Rangwala(1,2), Eric Sinsky(2) and James R. Miller (2)
(1) Western Water Assessment, CIRES
(2) Dept. of Marine Sciences, Rutgers University, NJ

WCD 8. Evaluation of Routine Atmospheric Sounding Measurements using Unmanned Systems (ERASMUS): Campaign objectives and planned operations

Gijs de Boer(1,2), Brian Argrow(3), Dale Lawrence(3), Scott Palo(3), Geoffrey Bland(4), James Maslanik(3), Jack Elston(3), James Mack(3)
(1) CIRES, (2) NOAA ESRL, (3) Department of Aerospace Engineering, University of Colorado - Boulder, (4) NASA Goddard Space Flight Center

WCD 9. The Developmental Testbed Center's Involvement with the Hurricane WRF: An Overview of Community Support , Testing, and Evaluation

Christina R. Holt (1,2,3), Ligia R. Bernardet (1,2,3), T. Brown (1,2,3), M.K. Biswas (4), D. Stark (4), L. Carson (4), V. Tallapragada (5), and S. Trahan (5)
(1) CIRES, (2) NOAA ESRL/GSD, (3) Developmental Testbed Center, (4) NCAR, (5) NCEP Environmental Modeling Center

WCD 10. High-Resolution Rapid Refresh Prediction of Tornadic Supercells in the U.S. Southern Plains During May 2013

Curtis Alexander (1), David Dowell (2), Steve Weygandt (2), Eric James (1), Stan Benjamin (2)
(1) CIRES, (2) NOAA ESRL

WCD 11. Adaptation at the municipal scale in the US Mountain West: What drives action in the face of weather and climate-related hazards?

Lisa Dilling (1)(2), Krister Andersson (1)(3), John Berggren (1)(2), Ashwin Ravikumar (1)(4)
(1) Western Water Assessment, (2) Center for Science and Technology Policy Research Research, CIRES, Environmental Studies
(3) Political Science and Environmental Studies
(4) CIFOR (Center for International Forestry Research)

WCD 12. Evaluation of operational weather radar rainfall estimates in flood-prone areas of California

Sergey Matrosov (1), Marty Ralph (2), Paul Neiman (3), Allen White (3)
(1) CIRES, (2) Scripps Institution of Oceanography, (3) NOAA ESRL

WCD 13. El Niño-Southern Oscillation (ENSO) Interdecadal Modulation: A Linear Inverse Modeling Perspective

Antonietta Capotondi, Prashant Sardeshmukh
CIRES and NOAA ESRL

WCD 14. Co-Producing Future Climate Scenarios for Adaptation and Management in the Gunnison Basin: An Integrative Framework for Developing Usable Climate Information

Katherine Clifford(1)(2), Imtiaz Rangwala(1), William Travis(1)(2), Eric Gordon(1)
(1) Western Water Assessment, (2) Department of Geography, University of Colorado Boulder

WCD 15. A Ramp Tool and Metric to Measure the Skill of Numerical Weather Prediction Models at Forecasting Wind Ramp Events

Laura Bianco (1), Irina V. Djalalova (1), James M. Wilczak (2)
(1) University of Colorado/CIRES, (2) NOAA ESRL

WCD 16. The climatological distribution of extreme Arctic winds, and implications for ocean and sea ice processes.

Mimi Hughes (1), John Cassano (1)
(1) CIRES

WCD 17. The characteristic patterns of Arctic cyclones from 1979 to 2013
Tomoko Koyama (1), Julienne Stroeve (2)
(1)ATOC, (2)CIRES NSIDC

WCD 18. Relative Roles of Gravity and Planetary Waves in Vortex Preconditioning Prior to Sudden Stratospheric Warmings
John R. Albers (1), Thomas Birner (2)
(1) CIRES, NOAA ESRL (2) Colorado State University

WCD 19. Leading modes of synoptic scale convective activity over the central Pacific
Juliana Dias (1), George Kiladis (2) and Maria Gehne (1)
(1) CIRES, (2) NOAA ESRL PSD

WCD 20. Wind Resource Assessments from Two Years of Short-Range High-Resolution Rapid Refresh Forecasts
Eric James (1), Curtis Alexander (1), Brian Jamison (2), and Stan Benjamin (3)
(1) CIRES, (2) CIRA, (3) NOAA ESRL

WCD 21. A diagnostic of MJO predictability estimates using observational power spectra
Maria Gehne (1), Juliana Dias (1), George Kiladis (2)
(1) CIRES, (2) NOAA ESRL PSD

WCD 22. Terrain-blocked airflow and orographic precipitation along the coast of northern California
Raul Valenzuela(1,2) and David Kingsmill (2,3)
(1) University of Colorado, ATOC, Boulder, CO
(2) University of Colorado, CIRES, Boulder, CO
(3) NOAA/ESRL/PSD, Boulder, CO

WCD 23. Rapid core magnetic field variations over the past decade
Arnaud Chulliat (1), Stefan Maus (2)
(1) CIRES and NOAA/NGDC

WCD 24. Planning for an Uncertain Future: Climate Change and the Salt Lake City Water Supply
Tim Bardsley(1), Andy Wood(2), Mike Hobbins(3), Tracie Kirkham(4),Laura Briefer(4), Jeff Niermeyer(4), Steve Burrian(5), Erfan Goharian(5)
(1) CIRES Western Water Assessment, (2) NCAR, (3)NOAA PSD,ESRL (4) Salt Lake City Department of Public Utilities, (5) University of Utah Department of Civil Engineering

WCD 25. Understanding the Climate Science Needs of Natural Resource Managers in the Prairie Pothole Region
Heather M. Yocum, Andrea J. Ray
CIRES, NOAA/ESRL Physical Sciences Division

WCD 26. Ensemble Modeling of the July 23, 2012 CME Event
M. D. Cash(1,2), D. A. Biesecker(1), G. Millward(1,2), C. N. Arge(3), and C. J. Henney(3)
(1)NOAA Space Weather Prediction Center, Boulder, CO
(2)Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO
(3)Space Vehicles Directorate, AFRL, Kirtland Air Force Base, NM

WCD 27. Cyclostationary Empirical Orthogonal Function Representations of the Evolution of the Southern Oscillation Leading to El Nino-Southern Oscillation Warm Events

Benjamin D. Hamlington (1), Ralph F. Milliff (1), Harry van Loon (2) and K-Y Kim (3)
(1) CIRES, (2) NCAR, (3) Seoul National University

WCD 28. Using REST-like URLs to create an interactive interface to a custom set of web products

Catherine Smith(1), Donald Murray(2) and Don Hooper(3)
(1) NOAA ESRL,(2) NOAA ESRL,(3) NOAA ESRL

WCD 29. Impact of Small Scale E-field Variability and Lower Atmospheric Forcing on Thermospheric O/N2 Column Density

Jack Olsen, Mariangel Fedrizzi, Mihail Codrescu, Tim Fuller-Rowell
NOAA SWPC, CIRES

WCD 30. The Experimental Regional Ensemble Forecast System (ExREF)

Ligia Bernardet1*, Isidora Jankov1&, Steve Albers1&, Kirk Holub1, David Reynolds2, T. Workoff3%, F. Barthold3@, W. Hogsett3, and J. Du4
1 NOAA ESRL Global Systems Division, Boulder, CO
2 NOAA ESRL Physical Science Division, Boulder, CO
3 NOAA NCEP – Weather Prediction Center, College Park, MD
4 NOAA NCEP – Environmental Prediction Center, College Park, MD
* Cooperative Institute for Research in the Atmospheric Sciences, CU, Boulder, CO
& Cooperative Institute for Research in the Atmosphere, CSU, Fort Collins, CO
% Systems Research Group, Inc., Colorado Springs, CO
@ I.M. Systems Group, Inc., Rockville, MD

WCD 31. Ionosphere Plasmasphere Electrodynamics (IPE) model development for understanding connection between terrestrial and space weather

N. Maruyama(1,2), P.G. Richards(3), Y.-Y. Sun(1,2), J. Middlecoff(4,5), T.-W. Fang(1,2), T.J. Fuller-Rowell(1,2), A. Richmond(6), A. Maute(6)
(1) CIRES, (2) NOAA SWPC, (3) George Mason University (4) CSU (5) NOAA GSD, (6) NCAR/HAO

Center for Science and Technology Policy Research

CSTPR 1. Risk Perceptions, Management Regimes, and Wildfire Mitigation Behavior in Wildland-Urban Interface Zones: A Cross-Case Analysis

Elizabeth Koebele, Deserai A. Crow, Lydia Dixon, Adrianne Kroepsch, Rebecca Schild, and Katherine Clifford
(1) Center for Science & Technology Policy Research, (2) Environmental Studies Program

In recent years, wildfires affecting communities located in the wildland-urban interface (WUI) have grown in size and become more destructive, substantially impacting life and property across the West. Regional demographic and climate trends are working to exacerbate wildfire conditions, as the West's human population continues to grow rapidly and drought conditions persist. Understanding residents' perceptions of wildfire risk and responsibility for fire mitigation on private lands, as well as wildfire management options in the WUI, is important for shaping policy and land management decisions that reduce risk to life and property. Although this is an increasingly urgent topic, little research has been conducted to investigate the nexus between residents' wildfire mitigation behavior and the role of information in promoting knowledge about and responsibility for mitigation. This study uses two in-depth cases of recent catastrophic wildfires in Colorado to analyze such connections. Using data from interviews with fire managers, focus groups with residents, as well as fire mitigation planning documents, this research investigates the connections between information, local management regimes, and homeowner decisions regarding property mitigation in the face of wildfire risk. These findings indicate that fire management agencies can best encourage mitigation by local residents by supporting and incentivizing mitigation activities, disseminating risk and mitigation information through personal channels, and seizing post-fire windows of heightened community interest.

CSTPR 2. The Inevitability of and Responsibility for Catastrophic Sea Level Rise

Jordan Kincaid
CSTPR

Sea level rise is often lumped together with other aspects of climate change when determining moral justification for action. This paper argues that addressing sea level rise, by virtue of its exceptionally long-term, inter-generational nature, requires justification over and above justification for addressing the more immediate, intra-generational implications of climate change. Moreover, with regard to adaptation, there is a stark practical and theoretical difference between adapting to climate change and adapting specifically to sea level rise.

CSTPR 3. Mapping Climate Communication

Joanna Boehnert
Center for Science and Technology Policy Research, CIRES

This poster presents the first iteration of a project mapping organizations, individuals, discourses, methods and funders that contribute to climate communication. The work visualizes research by Professor Max Boykoff (and others) on climate communication using network visualizations, timelines and a strategy map. Using these tools to illustrate the relationships between climate discourses, prominent actors and major organizations participating in climate communication (including science institutions, academic institutions, media organizations, think tanks and government agencies, along with the interests and funders linked to these organizations) the work maps complex communication processes. Network visualization illustrates relationships between individual and organizational actors including dynamics between nodes. The timeline illustrates the temporal growth of climate discourses illustrating the historical processes that have lead to the growth of various ways of communicating climate change. The strategy map displays methods used by different groups. The design of new visualizations is both a method (useful for both analysis) and outcome (useful for dissemination) of the research illustrated by this poster. Systems and network visualization communicates context, connections and causality in complex systems, providing an overview for wide variety of applications. Images in this poster will be developed into a series of posters to be presented next at the 'Changing Climate Change Communication' conference in Amsterdam in July 2014 and completed in final versions September 2014.

CSTPR 4. Cooking Up Clean Air: Demand for Improved Cookstoves and Implications for Air Quality and Health in Ghana

Katherine Dickinson (1, 2), Christine Wiedinmyer (2), Mary Hayden (2), Andrew Monaghan (2), Mike Hannigan (3), Vanja Dukic (4), Abraham Oduro (5), Ernest Kanyomse (5)
(1) CIRES, (2) National Center for Atmospheric Research, (3) CU-Boulder Engineering, (4) CU-Boulder Applied Math, (5) Navrongo Health Research Centre

Nearly 3 billion people cook over open flames on a daily basis. This behavior impacts local and regional air quality, global climate, and human health. Two hundred households in the Kassena-Nankana district of Northern Ghana were randomly selected to participate in a randomized field trial of two types of improved biomass-burning cookstoves. Social surveys have been deployed to measure cooking behaviors and willingness to pay for these technologies. Personal exposure to pollutants, in-home air quality measurements, and health outcomes will be monitored over two years to assess the stoves' impacts. Results will be used to generate coupled natural-human system models of the impacts of scaled-up stove use on social, health, and air quality outcomes.

Cryospheric and Polar Processes

CPP 1. A New Normal for the Sea Ice Index

Fetterer, Florence (1) ; Windnagel, Ann (1) ; Meier, Walter N. (2)
(1) CIRES NSIDC (2) NASA-Goddard

The NSIDC Sea Ice Index is a popular data product that shows users how ice extent and concentration have changed since the beginning of the passive microwave satellite record in 1978. It shows time series of monthly ice extent anomalies rather than actual extent values, in order to emphasize the information the data are carrying. Along with the time series, an image of average extent for the previous month is shown as a white field, with a pink line showing the median extent for that month. These are updated monthly; corresponding daily products are updated daily.

The Sea Ice Index was first published online in 2002. A baseline period of 1979-2000 was used for calculating means and medians. In July 2013, we changed the product to use a 30-year baseline period (1981-2010). This new normal, by including the first decade of the 21st century with its record low extent years, changed the scale on the extent trend plots so the overall loss of ice looked less anomalous than before the change, and each month's median extent line generally moved further north in the Arctic (in Antarctica, the position of the median extent line did not change much).

A 30-year period is the standard used by organizations like the World Meteorological Organization (WMO) and NOAA for climatologies and climate normals. Thirty years is used because it is deemed a sufficiently long time to average out most interannual variability but short enough to clearly show longer-term climate trends. These maxims about climate normals come from the world of weather and climate. Sea ice responds to climate forcing differently, and the assumptions behind the use of 30-year normals for meteorology may not hold true for sea ice.

We moved to a longer baseline, but with reservations.
Should we have changed the baseline? If the baseline includes periods of significant change, the resulting means or medians do not necessarily represent "normal" conditions for comparisons. In other words, ideally the baseline period should be relatively stable with small or no trend. This is not the case for sea ice in the Arctic, particularly since 2000. The loss of Arctic sea ice may now appear less significant to casual users of the product.

Another consideration is that features that were once common may be lost in updated climatologies. The most notable example is the Odden ice tongue (Figure 1) that once routinely formed off the east coast of Greenland during winter. Associated with outbreaks of cold air temperatures along with the interplay of bathymetric features and ocean currents, the Odden has not formed frequently enough in the first decade of the 21st century to show up in the new monthly median extent line at all. The recent absence of the Odden illustrates an important change in the sea ice system, but without a median extent line from a "more-normal" normal period, information about the loss of the Odden is not carried by the Sea Ice Index data product as obviously as was the case before.

At the Rendezvous, we have an opportunity to hear and gather opinions, suggestions and ideas about how to better understand and explain the use of a "normal" in a sea ice product intended for a wide audience. The poster was also presented at the INSTAAR 44th Arctic Workshop.

CPP 2. Bridging the work of field scientists and the needs of data re-users

Antonia Rosati (1), Lynn Yarmey (2)
(1) CIRES, (2) NSIDC, (3) ACADIS, (4) NCAR, (5) UCAR

The National Science Foundation requires Principal Investigators to make the data they collect and create publically available. To assist PIs with this requirement, NSF funded the Advanced Cooperative Arctic Data and Information Service (ACADIS).

ACADIS houses data from the Division of Polar Programs (PLR), provides data management assistance to PIs, and advances search and data discovery tools. In short, ACADIS exists for NSF Arctic researchers by providing a safe home for data and encouraging data reuse. ACADIS is a group of specialist organizations comprised to create a repository of Arctic data that encompasses spatial, temporal, and attribute granularity of data so that "big science" and "small science" may better integrate. The ACADIS project fosters scientific synthesis and discovery by providing services that make data from multiple disciplines freely available for access and analysis. ACADIS provides the arctic research community with data archival and data management services as well as value-added products to make the data more useful to more people. Essentially, the goal is to improve the usability and interdisciplinary re-use of arctic data.

But just putting a data file online is not useful enough. Many researchers and data providers understand their own data so intimately that it may seem that all the necessary information is contained in the file structure itself. This is clearly not the case with re-use. Placing the data and research in the greater scientific context is vital.

ACADIS is a far-reaching program that provides assistance with data submission, data preservation and data sharing services. This poster discusses the various tools and services available through ACADIS. These include pieces from each step of the research process – from proposal writing to meeting NSF requirements to maximizing citations.

ACADIS, funded by NSF, is a joint effort by the National Center for Atmospheric Research (NCAR), University Corporation for Atmospheric Research (UCAR), and the National Snow and Ice Data Center (NSIDC). For more information about ACADIS; to send feedback; or to submit, retrieve and search data; please visit their website <http://www.aoncadis.org>, contact support@aoncadis.org, or call 720-443-1409.

CPP 3. The Coldest Place On Earth: -90°C and Below in East Antarctica from Landsat-8 and Other Thermal Sensors

G. Garrett Campbell (1), Allen Pope (1), Matthew Anthony Lazzara (2), Theodore A Scambos (1)
1. NSIDC, CIRES, CU 2. SSEC, U. of Wisconsin.

Using daily land surface skin temperature data sets from AVHRR and MODIS spanning 1983 to 2013 for July and August (day of year 182 to 243), we identify several sites along the East Antarctic ice divide crest with multiple cold events of <-90° C surface skin temperature (<183.15 K, <-130°F). The pattern of MODIS Land Surface Temperature (LST) annual temperature minima maps are similar to a DEM-derived surface slope map for the region above ~2500 m, indicating that extreme low temperature events occur under clear-sky conditions and are colder than any observed clouds.

The extreme cold event regions lie along the highest section of the East Antarctic ice divide between Dome F (Dome Fuji), Dome A (Kunlun Station) and Dome B, above 3800m. Local topography of the coldest temperatures showed three types of locations: within 50 km of a dome summit; on the ice sheet surface above large subglacial lakes, and within small (~100 km2) topographic basins near the divide crest.

Our coldest measured temperature using the MOD11 MODIS Land Surface Temperature data set wa -93.2°C (179.98 K, or -136° F) and occurred on 10 August, 2010 at 81.794°S, 59.317°E.

We will also present plans to install an instrument platform in this area to further study these cold situations. This will address questions about the difference between air and radiative temperature in the cold events.

CPP 4. Climate Change in the Presence of Climate Variability – Implications for the Future Surface Mass Balance of Greenland

J. E. Kay (1), C. Deser (2), M. Vizcaino (3)
(1) CIRES (2) NCAR CGD (3) TU-Delft

While climate variability is known to have important effects on climate change projections, especially at regional spatial scales, its influence is often underappreciated and confused with model error. Why? In general, modeling centers contribute a small number of realizations to international climate change projection assessments (e.g., Coupled Model Intercomparison Project 5 (CMIP5)). As a result, model error and climate variability are difficult, and at times impossible, to disentangle. In response, we designed the CESM Large Ensemble with the explicit goal of enabling assessment of climate change in the presence of climate variability. The core simulations replay the 20-21st century (1920-2080) 30+ times using a single CMIP5 model (CESM with the Community Atmosphere Model version 5) under historical Representative Concentration Pathway 8.5 external forcing. Companion pre-industrial control simulations (1000+ years) allow assessment of natural climate variability in the absence of climate change. Comprehensive easily accessible model outputs, including many daily outputs, are available as single-variable timeseries in netcdf format for any interested scientist or stakeholder. Initial results demonstrate the surprisingly important influence of climate variability on 20-21st century climate change projections. Global warming hiatus decades occur. Climate variability alone produces projection spread comparable to that in CMIP5. In our poster, we will highlight the influence of internal variability and forced climate change on climate variables controlling the future surface mass balance of the Greenland Ice Sheet.

CPP 5. Analysis of Wintertime Mesoscale Winds and Turbulent Fluxes around Southeastern Greenland

Alice K. DuVivier(1,2) and John J. Cassano (2,2)
(1) Cooperative Institute for Research in Environmental Sciences
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The strong, mesoscale tip jets and barrier winds that occur over the oceans near southern Greenland have the potential for strongly impacting ocean circulation, particularly deep convection. However, the variability in known wind patterns and how this variability might be important for driving an ice-ocean model has not been investigated. Analysis using the self-organizing map (SOM) technique was performed using winter (NDJFM) 10 m wind data from the European Center for Medium Range Weather Forecasts Interim Reanalysis (ERA-I) and from two regional simulations using the Weather Research and Forecasting (WRF) model at 50km and 10km resolutions. Previously identified wind patterns were found to span a range of possible manifestations with different implications for ocean forcing. WRF50 simulated patterns with strong barrier-parallel flow more frequently than ERA-I and WRF50 also had faster coastal winds than ERA-I. The two WRF simulations had little significant difference in mean wind speed, but larger differences were found for extreme events, though the sign and magnitude of the difference varies spatially and across the different types of wind patterns. The complex air-sea interactions for particular wind patterns and the resulting impact of the interactions on the ocean are not generalizable. The largest differences in turbulent fluxes were found over the marginal ice zone between all datasets and are likely related to treatment of sea ice in WRF at different resolutions.

CPP 6. Relationship Between Large-scale Circulation and Ice Core data from the McCall Glacier, Alaska

Elizabeth Cassano, John Cassano, Joe McConnell, Matt Nolan

Ice cores have often been used to reconstruct paleoclimate based on proxies contained in the cores. Using an ice core from McCall Glacier, in the eastern Brooks Range of Alaska, we attempt to determine relationships between ice core proxies and synoptic weather patterns influencing McCall Glacier. Relationships between ice core data and large-scale weather patterns are determined using correlation analyses and the method of self-organizing maps. Results presented in this poster will focus on relationships between ice core proxies and synoptic weather patterns for the past 60 years, when reliable atmospheric reanalysis data are available. This analysis has explored links between annual ice core proxy data and large-scale synoptic weather patterns on both an annual and seasonal basis to determine if the weather at particular times of year is primarily responsible for certain ice core proxies.

CPP 7. Distinguishing Ice from Snow for Melt Modeling Using Daily Observations from MODIS

Karl Rittger (1) Anne C. Bryant (2), Mary J. Brodzik (1), Evan Burgess (3), Thomas H. Painter (2), Richard Armstrong (1)
(1) CU Boulder/CIRES/NSIDC, (2) NASA Jet Propulsion Laboratory, (3) University of Alaska, Geophysical Institute

In high mountainous regions of the Earth during melt periods, both seasonal snow and glacier ice melt may contribute to surface water and ground water feeding streams. In these regions there are often few in-situ observations that can help distinguish between the two components of melt, particularly across large mountain ranges. Understanding the contribution of melt water from the seasonal snow and glacier ice sources informs us about the current state of the water cycle and how a changing climate may alter the water cycle. In this study, we analyze daily time series of MODIS data products to distinguish ice from snow as the seasonal snowpack recedes, revealing melt over glacier ice surfaces.

Broadband albedo increases as ice is exposed because of larger grain sizes and dust/debris on the glacier surface. To investigate the grain sizes we use estimates from the MODIS Snow Covered Area and Grain Size Model (MODSCAG) and MODIS Dust Radiative Forcing in Snow (MODDRFS) derived from MODIS surface reflectance (MOD09GA). MODSCAG uses the shape of the spectrum selected by a spectral mixture analysis model while MODDRFS uses the Normalized Difference Grain Size Index (NDGSI). Comparison of the grain sizes with grain sizes derived from the Airborne Visible/Infrared Imaging Spectrometer have demonstrated higher accuracy for the NDGSI approach. In addition to analysis of grain sizes, we use 2 standard albedo products from the MODIS, the Terra Daily Snow Cover algorithm (MOD10A1) that uses a narrow-to-broadband conversion scheme to create an integrated broadband albedo and Surface Reflectance BRDF/Albedo (MCD43) product that provides albedo in three broad bands. We focus on the Hunza River basin, in the Upper Indus located in Northern Pakistan. We use the annual minimum ice and snow from the MODICE Persistent Ice and Snow (MODICE) algorithm to identify glaciated regions for analysis. The 4 methods (MODSCAG, MODDRFS, MCD43, and MOD10A1) all show sensitivity to exposed glacier surfaces. Further work will use a time series of melt modeling in this region to determine the contributions from seasonal snow versus glacier ice melt.

CPP 8. What is the Permafrost Carbon Feedback?

Elchin Jafarov (1), Kevin Schaefer(1)
(1) CIRES

The Permafrost Carbon Feedback (PCF) is an amplification of surface warming due to the release of carbon and methane from thawing permafrost. To improve estimates of the PCF we added prognostic organic layer to the Simple Bioshpere/Carnegie-Ames-Stanford (SIBCASA) Terrestrial Carbon Cycle Model and quantified carbon and methane fluxes resulting from changes in terrestrial carbon storage in permafrost affected soils. Model simulations spanning 1901 to 2010 were driven using Climatic Research Unit-National Centers for Environmental Prediction (CRUNCEP) reanalysis, atmospheric CO2, and land use change information as modified by the Multi-Scale Terrestrial Model Intercomparison Project (MsTMIP). From 2011 to 2300, multiple projections of CO2 and methane emissions and changes in PCF were evaluated by scaling the CRUNCEP data using trends in weather data derived from the Fifth Coupled Model Intercomparison Project (CMIP5) for 4.5 and 8.5 Representative Concentration Pathway (RCP) scenarios (Figure 1,2). Implementation of the dynamic organic layer into the model lowered the effective thermal conductivity between the soil and the atmosphere and increased the resilience of permafrost to climate warming and decreased permafrost seasonal thawing depth. The ensemble mean for each RCP is our best estimate of CO2 and methane emissions from degrading permafrost and the standard deviation is a measure of uncertainty.

CPP 9. CHARIS: the Contribution to High Asia Runoff from Ice and Snow: Preliminary Results from Upper Indus Basin, Pakistan

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(1) CIRES, (2) Water and Power Development Authority, Pakistan, (3) INSTAAR,
(4) Laboratoire de Glaciologie et Geophysique de l'Environnement, St. Martin d'Heres, France

The Contribution to High Asia Runoff from Ice and Snow (CHARIS) project is systematically assessing the role of glacier ice melt and seasonal snow melt in the freshwater resources of High Asia. This assessment is crucial for accurate forecasting of availability and vulnerability of water resources in this region. In collaboration with Asian partner organizations, we are deriving critical regional-scale information for planning downstream irrigation, hydropower generation and general consumption. Realistic forecasts of water resources in these regions are not possible until we better understand the current hydrologic regime. We are applying a suite of satellite remote sensing, reanalysis and ground-based data as input to snow and ice melt models. Gridded maps of snow and glacier area/elevation are input to a temperature-index melt model. Runoff from snow-covered grid cells is the product of cell area and melt depth from the melt model. Glacier melt is estimated similarly, once snow has disappeared from glacierized grid cells.

CPP 10. The Annual Cycle of Snowfall and Accumulation at the Top of the Greenland Ice Sheet

Benjamin B. Castellani (1,2,3), Matthew. D. Shupe (1,2,3), David. R. Hudak (4), Brian E. Sheppard (4)
(1) CIRES, (2) NOAA ESRL, (3) University of Colorado, (4) Environment Canada

Under the current warming trend of the Earth's climate, the Greenland Ice Sheet (GIS) has been melting on its fringes and experiencing a net loss of mass. However, the mass balance of the GIS as a whole is not well understood due to a dearth of knowledge of the interior region. Central to understanding this mass balance is precipitation, of which non-satellite derived observations over the central GIS are sparse. Recently, a Precipitation Occurrence Sensor System (POSS) was deployed at Summit, Greenland, a research site located near the apex of the GIS in a region where the mass balance is thought to be near equilibrium or slightly positive. POSS reflectivity and snowfall measurements are compared with a co-located vertical-pointing Ka-band cloud radar to evaluate uncertainty. Providing a broader perspective, this radar-based precipitation data is analyzed alongside weekly surface height change measurements from an accumulation forest. The annual cycle of snowfall at Summit is presented showing a clear summertime maximum and a smaller, late-winter maximum as well. The annual mean liquid equivalent snowfall was found to be 83mm, which is similar to estimates provided by reanalysis products by a factor of 2. A comparison to the seasonal cycle of accumulation showed comparable seasonal patterns, though the seasonal amplitude is damped. While accumulation increases at a relatively steady rate throughout the year, snowfall occurs in two distinct and repeating regimes. The relatively low correlation (0.39) between snowfall and accumulation indicates that other factors like compaction and the redistribution of snow by wind are also important contributors to the seasonal variability of solid accumulation. The reduced amplitude of the accumulation seasonal cycle can be reasoned based on seasonal variations in latent heat flux and compaction, which help to provide a relatively consistent rate of accumulation throughout the year in lieu of the large variations in snowfall. The density of the snow implied by the latent heat flux, solid accumulation, and liquid equivalent snowfall is far too low when compared to actual vertical density observations at Summit. Since the in-situ accumulation data is quite reliable, a large portion of this discrepancy is likely due to underestimates of the total snowfall by the POSS. However, this uncertainty alone cannot fully explain the rather large disagreement in mass. It is hypothesized that the only other source of mass, the deposition of snow by wind, contributes a sizable amount of mass to complete the balance.

CPP 11. Exchange for Local Observations and Knowledge of the Arctic: An Infrastructure for the Collection, Preservation, and Sharing of Local and Traditional Knowledge

Julia Collins, Peter Pulsifer, Betsy Sheffield
National Snow and Ice Data Center

The Exchange for Local Observations and Knowledge of the Arctic (ELOKA) is working to build a community that facilitates international knowledge exchange, development of resources, and collaboration focused on Arctic communities and stewardship of their data, information, and knowledge. Over the last decade, Arctic residents and Indigenous peoples have been increasingly involved in all aspects of Earth system research. Through the communication of local and traditional knowledge (LTK) and the results of community-based monitoring (CBM), Arctic communities have made, and continue to make, significant contributions to understanding recent environmental change. To reap the full benefits of these contributions, a means of recording, preserving, and sharing the data and research outcomes must be available. ELOKA is a growing infrastructure focused on the data management concerns associated with LTK and CBM data. These data are a valuable complement to quantitative results collected via satellite or other sensor networks, and our data management challenge includes supporting the use of LTK and CBM data in the broader data analysis context. ELOKA operates on the principle that all knowledge should be treated ethically, and intellectual property rights should be respected.

CPP 12. A New Look at the Summer Arctic Frontal Zone

Alex Crawford (1), Mark Serreze (1)
(1) NSIDC

The Arctic frontal zone (AFZ) is a narrow band of steep horizontal temperature gradients spanning the coastline of Siberia, Alaska, and western Canada along the Arctic Ocean during summer. Past research has associated the AFZ with surface heating contrasts between the Arctic Ocean and snow-free land, with its regional strength strongly influenced by topography. The AFZ has significant impacts on summer precipitation patterns in the Arctic. Cyclones forming along the Siberian sector of the AFZ often contribute to the summer cyclone maximum in the Arctic Ocean, which in turn has strong impacts on sea ice conditions. Despite the importance of the AFZ to the regional climate system, it has been examined in only a handful of focused studies. Furthermore, past research has largely considered the AFZ as a static feature; variations in the strength of the AFZ and the implications of these variations are yet unknown.

This study incorporates data from three atmospheric reanalyses to describe the characteristics of the AFZ at higher resolution than previously possible: The European Reanalysis (ERA-Interim) from the European Centre for Medium-range Weather Forecasting (ECMWF), the Modern-Era Retrospective Analysis for Research and Applications (MERRA) from NASA, and the Climate Forecast System Reanalysis (CFSR) from the National Center for Environmental Prediction (NCEP). Additionally, processes that lead to the annual development of the AFZ are considered by examining annual variation of temperature gradient strength in association with large-scale circulation, surface wind fields, sea ice concentration, and snow cover extent.

CPP 13. Surge of a Complex Glacier System - The Current Surge of the Bering-Bagley Glacier System, Alaska

Ute Herzfeld (1,2, 3), Brian McDonald (2), Thomas Trantow (3), Robert Griffin Hale (4), Maciej Stachura (5), Alexander Weltman (1,6) and Tyler Sears (1,2)
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(4) Department of Aerospace Engineering Sciences,
(5) Black Swift Technologies, (6) Department of Computer Sciences

Understanding fast glacier flow and glacial accelerations is important for understanding changes in the cryosphere and ultimately in sea level. Surge-type glaciers are one of four types of fast-flowing glaciers --- the other three being continuously fast-flowing glaciers, fjord glaciers and ice streams --- and the one that has seen the least amount of research. The Bering-Bagley Glacier System, Alaska, the largest glacier system in North America, surged in 2011 and 2012.

Velocities decreased towards the end of 2011, while the surge kinematics continued to expand. A new surge phase started in summer and fall 2012.

In this paper, we report results from airborne observations collected in September 2011, June/July and September/October 2012 and in 2013. Airborne observations include simultaneously collected laser altimeter data, videographic data, GPS data and photographic data and are complemented by satellite data analysis. Methods range from classic interpretation of imagery to analysis and classification of laser altimeter data and connectionist (neural-net) geostatistical classification of concurrent airborne imagery. Results focus on the characteristics of surge progression in a large and complex glacier system (as opposed to a small glacier with relatively simple geometry). We evaluate changes in surface elevations including mass transfer and sudden drawdowns, crevasse types, accelerations and changes in the supra-glacial and englacial hydrologic system.

CPP 14. Using the Self-organizing Map Algorithm to Characterize Widespread Extreme Temperature Events Over Alaska

Cody Phillips(1), Elizabeth Cassano(1), John Cassano(1), Mark Seefeldt(1), William Gutowski(2), and Justin Glisan(2)
(1) CIRES, (2) Iowa State University

The spatial resolution of global climate models is such that localized extreme weather events and the processes that trigger them are difficult to simulate. Thus, relating the large-scale synoptic conditions (a feature that global climate models reproduce well) to widespread extreme events may be useful for understanding the physical process, which lead to such events. This study focuses on widespread cold temperature extremes (defined as the coldest 1% of all temperatures occurring on at least 25 grid points on a given day) within two domains in Alaska divided by the Brooks Range. The synoptic climatology for Alaska is defined using daily sea level pressure (SLP) data from the ERA-Interim reanalysis, which is categorized into 35 patterns using the self-organizing map (SOM) algorithm. The SOM classification is used to relate these large-scale SLP circulation patterns to widespread extreme temperature events. In order to understand the temporal evolution of extreme events, the preceding five days leading up to said events are examined through the SOM classification. Extreme events may be related to synoptic blocking patterns, leading to high or low temperatures caused by advection or radiative cooling. Observing the days preceding extreme temperature events sheds light on the influence of particular patterns that lead to extremes.

CPP 15. International Collaboration and Capacity-Building: The Unique Opportunities of USAID-funded Research Science

Alana Wilson (1, 2), Mark Williams (2), Richard Armstrong (1), Rijan Kayastha (3), Andrew Barrett (1), Mary Jo Brodzik (1), Florence Fetterer (1), Siri Jodha Singh Khalsa (1), Adina Racoviteanu, Bruce Raup (1)

(1) CIRES, (2) INSTAAR and Department of Geography, (3) Kathmandu University

The Contribution to High Asia Runoff from Ice and Snow (CHARIS) project is led primarily by a team at NSIDC and is mandated by its funder, the US Agency for International Development (USAID), to combine research activities and capacity building. The scientific objectives are to enhance understanding of the role of ice and snow in High Asian hydrology, and the capacity-building component engages academic or government research partners in eight countries of High Asia whose water resources are intricately linked to the presence of ice and snow. This funding structure creates unique opportunities to prioritize international collaboration with: 1. Non-academic scientists, as demonstrated by CHARIS' collaboration with government hydrometeorological and water management agencies in three countries, and 2. Research scientists with limited training or experience in a field of interest, as demonstrated by CHARIS' facilitation of graduate education for Kabul University (Afghanistan) faculty and the initiation of glaciological and hydrological field studies by faculty at Sherubtse College, Bhutan.

CHARIS accomplishments to-date include knowledge-exchange about regional hydrology (both partner - NSIDC and partner – partner), funding of Afghan students for M. S. by Research in Glaciology at Kathmandu University, and training of partners in water sampling techniques for hydrochemistry based mixing model work. Water sampling and hydrochemistry interpretation has offered the best opportunity to engage students and young researchers in the project. An overview of these accomplishments and on-going objectives will be presented.

CPP 16. Comparison and Validation of Arctic Precipitation Fields from Three Atmospheric Reanalyses: CFSR, MERRA, ERA-Interim

Allison Hurley (1), Mark Serreze (2)

(1) CIRES, Department of Geography; (2) NSIDC, CIRES, Department of Geography

While the observed sharp decline in end-of-summer sea ice extent is in part a response to Arctic warming, it also contributes to the warming in autumn and winter. This is because extra heat gained by the open ocean waters in summer is released back to the atmosphere once the midnight sun sets. Ice loss can also influence precipitation; while extensive open water represents a moisture source, a changing sea ice distribution can affect horizontal temperature gradients, and hence storm formation and tracks.

As part of assessing such links, , we present results from a statistical comparison of Arctic temperature (2-meter temperature) and precipitation from three modern atmospheric reanalyses, MERRA, CFSR and ERA-Interim, with monthly observations from 755 stations from the Global Historical Climatology Network (GHCN). We focus on the 32-year period from 1979-2010. GHCN station observations were then used to validate the reanalyses. Bias, correlations, root mean-squared error (RMSE), and mean absolute error (MAE) were also calculated. The largest inconsistencies between the reanalyses and the observations existed in summer; smaller biases and errors existed in winter. Overall, it appears that all three of the reanalyses are overestimating precipitation, with MERRA yielding smaller biases and errors across all seasons compared to NCEP-CFSR and ERA-Interim; making MERRA a viable choice to utilize in studies focused on Arctic precipitation or hydrology.

The ability to reproduce known seasonal trends in Arctic precipitation as well as their correlation with station data is emphasized in this study. Overall, MERRA, CFSR, and ERA-Interim capture major known features of Arctic precipitation, including: 1) peak annual totals over the Atlantic side of the Arctic linked to the Icelandic Low and the North Atlantic storm track, 2) low annual totals over the Canadian Arctic Archipelago, eastern Siberia and the central Arctic Ocean, 3) contrasting seasonal cycles over land (summer maximum, winter minimum) and the Atlantic sector (winter maximum, summer minimum). Precipitation trends and anomalies were investigated. In general, there was agreement between each of the reanalyses for all months across land areas. Results showed strong positive trends over the majority of land areas during the autumn months; with continued positive trends in precipitation present across much of Eurasia persisting into winter. One notable disagreement between the reanalyses is the much different pattern of trends and recent anomalies over the North Atlantic in ERA-Interim.

Ecosystem Science Division

ES 1. The Effects of Fire Severity on Black Carbon Additions to Forest Soils – 10 Years Post Fire

Rebecca Poore (1), Carol Wessman (2), Brian Buma (3)
(1) CIRES (2) Ecology and Evolutionary Biology

Soil carbon is the largest pool of terrestrial organic carbon. Black carbon (BC) is the most recalcitrant portion of that pool. During a forest fire, while large amounts of forest carbon are released as carbon dioxide, a small fraction of the biomass consumed by the fire is only partially combusted, yielding soot and charcoal. These products, also called black carbon (BC), make up only 1-5% of the biomass burnt, yet they can have a disproportionate effect on both the atmosphere and fluxes in long-term carbon pools.

Although debated, most studies indicate a turnover time of BC on the order of 500-1,000 years in warm, wet, aerobic soils. As such, charcoal may function as a long-term carbon sink, however its overall significance depends on its rate of formation and loss. At the landscape level, fire characteristics are one of the major factors controlling charcoal production.

In northern Colorado in 2002, a large fire swept through a subalpine spruce, fir and lodgepole pine forest. Over the last three years we have sampled BC soil pools in 44 sites across a range of fire severities from unburned to severe crown fire. This poster presents the results of this study, and the unexpected finding of no clear effect of fire or fire severity on BC totals.

ES 2. A Multi-Catchment Investigation into Hydrologic Disturbance from Beetle-kill and Dust in the Upper Colorado River Basin

Ben Livneh1, Jeffrey S. Deems1,2, Brian Buma3, Joseph, J. Barsugli1., Dominik Schneider4, Noah P. Molotch4,5, Klaus Wolter1, and Carol Wessman1.
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Since 2002, the headwaters of the Colorado River Basin have experienced changes in land cover, occurring at sub-annual timescales. Widespread tree mortality from bark beetle infestation has taken place across a range of forest types, elevation, and latitude. Extent and severity of forest structure alteration have been observed through a combination of aerial survey data, MODIS-derived leaf area index (LAI), and in situ measurements. Additional disturbance has resulted from deposition of dust from regional dryland sources on mountain snowpacks that strongly alter the snow surface albedo, driving earlier and faster snowmelt runoff. Severity of dust-on-snow events have been estimated via satellite, field, and in-situ observations. In this study, we explore the combined impacts of forest disturbance and dust on snow within a hydrologic modeling framework. We force the Distributed Hydrology and Vegetation Model (DHSVM) with observed meteorology, time-varying maps of forest properties to emulate bark beetle impacts, and variable parameterizations of snow albedo based on dust events. Results from beetle-killed canopy alteration suggest slightly greater snow accumulation as a result of less snow interception and reduced canopy sublimation, which outweigh increases in sub-canopy snow ablation fluxes, contributing to overall increases in annual water yield on the order of 10 %. However, understory regeneration roughly halves the changes in water yield. The primary hydrologic control of dust-on-snow events is on the rate of snowmelt, with more rapid melt rates associated with more extreme dust deposition, producing earlier peak streamflow rates for snowmelt dominated catchments on the order of 2 – 4 weeks.

ES 3. Changes to Zooplankton Community Structure in Lakes Perpetuates in Streams Below Lakes

Thomas M. Detmer (1,2), James H. McCutchan (1), William M. Lewis (1,2)
(1) CIRES, (2) Biology Department

Historically, most lakes at high elevation in the western United States were fishless. Stocking programs have decreased the percentage of large, deep lakes that are fishless from 95% to 5%. Fish, in formerly fishless lakes, alter zooplankton community composition and suppress zooplankton body size and biomass per unit volume. A change in zooplankton community structure in lakes is important to streams below lakes because of the close relationship between the two. Suppression of zooplankton export from lakes to streams is important because zooplankton are a high-quality food source and are thought to subsidize stream consumers. The primary goal of this study was to quantify the effect of fish on zooplankton export and to characterize the subsidy that zooplankton provide to streams below lakes. In addition, this study identified several important physical and biological factors that control zooplankton export to streams below lakes at high elevation.

Education Outreach Program

EO 1. CIRES Communications Group: What We Can Do for You

Kristin Bjornsen (1), Katy Human (1), David Oonk (1), Robin Strelow (1)
(1) CIRES

Who do you want to reach? The general public? Journalists? Your funders? Potential collaborators? The CIRES communication group can help you communicate, to diverse audiences, the value and importance of your work. We use clear writing, photos and short videos, branded design and social media to help members of your target audience understand and value your research.

EO 2. Lens on Climate Change (LOCC) – Engaging Secondary Students in Climate Science through Videography

David Oonk, Anne Gold, Lesley Smith, Susan Buhr-Sullivan, Max Boykoff, Beth Osnes, Amanda Morton
CIRES

Climate change is often discussed with examples from the polar regions but there are significant changes happening to local climates around the world. Learning about climate change is more tangible for students when it addresses effects they can observe close to their home than thinking about decreasing polar bear populations. LOCC engaged Colorado middle and high school students in producing videos about climate change topics in Colorado, specifically ones that are impacting students' lives and their local community. Participating schools were located in rural, suburban and urban Colorado many of which have diverse student populations and high Free and Reduced Lunch rates. Outreach staff recruited university graduate and undergraduate student to mentor the students in their research and video production. With the help of these mentors, ten student groups selected and researched climate topics, interviewed experts (CIRES, NOAA, NSIDC, CU scientists), and produced their videos. In addition, the LOCC middle and high school student groups provided prompts of their topic (a sketch and brief synopsis) for Max Boykoff and Beth Osnes' "Inside the Greenhouse (ITG)" undergraduate class in which participating students produced short companion films. The videos from the LOCC and ITG groups were screened at a final event on campus in February 2014. The student groups spent the day at CU touring the campus, eating at in the Center for Community cafeteria and learnt about college life. The films produced by Boulder Valley School District students are being aired on their public access channel, Channel 22.

The LOCC project's goal was to connect secondary students with CU and the scientific community that would otherwise not have the opportunity. Our evaluation showed that the process of video production was a powerful tool for the students to explore and understand climate change topics. Students and teachers appreciated the unique approach to learning.

EO 3. Water Spotters: A Student Citizen Science Project to Help Develop the Water Budget of the Colorado Front Range

David Noone, Lesley Smith, Michael O'Neill, Adriana Bailey, Max Berkelhammer, Aleya Kaushik and Emily Kellagher
CIRES

Water is at the core of many issues in environmental change from local to global scales, and learning about the water cycle offers students an opportunity to explore core scientific concepts and their local environment. In climate research, there are significant uncertainties in the role water plays in the climate system. Water also acts as a central theme that provides opportunities for experiential science education at all levels. The "Water Spotters" program underway at University of Colorado exploits the synergy between the need for enrichment of science education and the need for water sample collection to provide primary data for climate research. The program takes advantage of the prominent agricultural landscape of the region in eastern Colorado, which is a poignant example of how society influences the climate through irrigation, evaporation/transpiration and run-off and whose productivity is influenced by the climate system. Ten schools in the St. Vrain Valley School District MESA (Math Engineering Science Achievement) program are participating in the program. CU personnel have installed automated weather stations at each school, as well as precipitation collectors. Elementary and middle school lessons have been developed in coordination with science teachers that emphasize both Colorado State Scientific Standards and inquiry-based learning about the water cycle and weather. In the spring of 2014, students began collecting precipitation samples that are being analyzed at CU and used as a core component of our research goals. Water Spotters highlights the value of student citizen science in obtaining needed research quality data while also meeting national needs to improve science education.

EO 4. Making More Impact with the CIRES Education Outreach Group

Susan Buhr Sullivan (1), Anne Gold (1), Susan Lynds (1), Amanda Morton (1), David Oonk (1), Lesley Smith (1), Jennifer Taylor (1)
(1) CIRES

The CIRES Education Outreach group engages CIRES and NOAA researchers to get geoscience out into the community. We are available to help with proposals, provide training for scientists on outreach, and discuss any engagement and outreach questions. We always have needs for expert reviewers, volunteers, presenters, and partners. We often collaborate with researchers on broader impacts activities associated with a proposed project, which may make the difference in a competitive funding environment. CIRES EO staff work at no-cost to proposers to develop these proposed activities, which are then funded through the successful request. These broader impacts projects benefit from the longer-term infrastructure developed through our own external funding.

This poster details some current CIRES EO projects and describes the capabilities CIRES EO can bring to your project. These include:

- community building and user engagement through virtual and face to face means
- delivery of online courses and webinars;
- evaluation and needs assessment support including use of surveys, webstatistics, focus groups and interviews;
- development of digital learning resources and collections; and
- videography.

Example projects include the Climate Literacy and Energy Awareness Network (CLEAN) collection of learning resources for secondary and college-level faculty, professional development, curriculum development, and stakeholder assessments, Summer projects include education associated with DISCOVER AQ and FRAPPE air quality campaigns, partnership with City of Boulder Clean Water Program associated with research into Boulder flooding, a water-focused research experience for diverse community college students, and launch of new space weather curriculum. For more about CIRES EO projects and how to work with CIRES EO see http://cires.colorado.edu/education/outreach/ or contact Susan Buhr Sullivan at susan.buhr@colorado.edu.

EO 5. SDO Project Suite: Student-Scientists Exploring Solar Science

Jennifer Taylor (1), Susan Buhr (1), Erin Wood (2), Deborah Scherrer (3), Martha Wawro (4), Wendy Van Norden (4) Emily Kellagher
(1) CIRES EO, (2) University of Colorado Laboratory for Atmospheric and Space Physics, (3) Stanford Solar Center
(4) NASA Goddard Space Flight Center

About the SDO Project Suite:
The SDO (Solar Dynamics Observatory) Project Suite is a NASA-funded project done in conjunction with the University of Colorado's Laboratory for Atmospheric and Space Physics Extreme Ultraviolet Variability Experiment (EVE) project as part of the SDO mission. The goal of the SDO Project Suite is to promote education and public outreach of the Solar Dynamics Observatory's cutting-edge research and groundbreaking data. Imagine a classroom of "student-scientists" that master standards-based STEM content through an interdisciplinary curriculum. Picture motivated, student-directed teams actively engaging in an authentic exploration of our nearest star, the Sun that are

• Using actual SDO imagery and data to predict a space weather forecast
• Creating solar activity movies from near real-time SDO solar imges
• Producing a digital public service announcement to educate the local community about the impacts of solar activity on Earth's life and society.
• Designing and presenting an interactive solar exhibit to an audience that demonstrates and educates people about solar science concepts.
Not only do students master content standards but they also develop 21st century skills related to digital literacy, media literacy, critical thinking, problem solving, and collaboration with peers-just what scientists experience everyday in the "real world" to research these scientific questions:
• What are some natural effects of the Sun-Earth relationship?
• What are the causes and effects of solar activity?
• Why is understanding and predicting solar activity important?
• How is the Sun and solar activity researched by scientists?
• How are Earth and its societies impacted by space weather?
• Can space weather be accurately forecasted?

The SDO Project Suite is designed as a comprehensive curriculum that integrates new and adapts existing solar science lessons into a series of coherent lessons and projects with real-life application. The series of four Solar Modules in the SDO Project Suite lead students through an interactive exploration of solar science:
• Module 1: Provides an understanding of the structure of the Sun.
• Module 2: Investigates how and why the Sun is studied via the electromagnetic spectrum and magnetism.
• Module 3: Explores the significance of solar activity on Earth's habitability and the affects of space weather on Earth.
• Module 4: Student collaboration to design, produce, and curate a 3-D Solar Exhibit summative assessment:

Middle school grades (6-8) are the target audience for the SDO Project Suite. In 2014, students from Estes Park Middle School's Galaxy Gazers Astronomy Club are testing curriculum resources including a magnetometer, spectroscope, and pinhole camera. Additional education outreach activities are planned for 2014.

The Science of SDO:
SDO is the first mission to be launched for NASA's Living With a Star (LWS) Program, a program designed to improve our understanding of the physics behind the activity displayed by the Sun's atmosphere, which drives space weather that impacts life and society on Earth. Solar activity and variability are key concerns of our modern, increasingly technological society. Solar flares and coronal mass ejections can disable satellites, cause power grid failure, and disrupt communication and navigation systems. And because the Sun is so powerful, even small changes in its output could have effects on Earth's climate.

The SDO satellite, launched in February 2010, contains a suite of three key instruments – the University of Colorado's LASP EVE instrument, Stanford University's Helioseimic Magnetic Imager (HMI), and Lockheed Martin Solar and Astrophysics Laboratory's Atmospheric Imaging Assembly (AIA). EVE measures changes in the Sun's output of extreme ultraviolet radiation, which has a direct and strong effect on Earth's upper atmosphere that can impact radio communications and GPS navigation. HMI maps solar magnetic fields and can look inside the sun to determine how the Sun's magnetic field is generated, which drives space weather. AIA's four telescopes take full-disc images of the Sun's surface and atmosphere in different wavelength every 10 seconds.

EO 6. Arctic Climate Data in the Classroom - A Broader Impacts Effort

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The broad goal of science education is for students to develop a scientific habit of mind and become familiar with the nature of the scientific process. Understanding and analyzing scientific data are key steps towards becoming a critical thinker. Bringing scientific data into the classroom and having students work and explore data were the goals of this curriculum development project – Arctic Climate Connections.

This three-module curriculum focuses students' attention on current scientific research going on in the Arctic and how work done in the Arctic is relevant to their own lives and the global climate. Students learn about the geographic extent of the Arctic and explore its physical setting using a combination of Google Earth and video resources. Students then collect their own climate data to learn the basics of data collection, reporting, and analyzing. Students engage in description and interpretation of climate data before they analyze existing datasets from the NOAA meteorological tower in Eureka, Nunavut, Canada from 2010. Students have to navigate a real scientific dataset, which includes some measurement artifacts and data discontinuities due to tower service. Students are repeatedly asked to relate the results from Arctic research to the mid-latitudes and their own physical environment.

The curriculum was presented to 26 Colorado educators in a professional development workshop. These educators from elementary schools through community colleges have expressed their excitement for the data-rich curriculum and are in the process of implementing the curriculum in their classrooms. Because of the modular design of the curriculum, the inquiry-based approach to teaching the curriculum can be used from elementary school through college level with small modifications by the educators. We will present data from pre- and post-workshop skill tests that demonstrate teacher learning in terms of science content, scientific process skills, and the understanding of the scientific method. We will also present qualitative survey data about the workshop and initial results from classroom implementations. This is a Broader Impacts Effort to a NSF science research award.

Environmental Chemistry Division

EC 1. The International Global Atmospheric Chemistry (IGAC) Project

Megan L. Melamed and Jeff Jennings

The International Global Atmospheric Chemistry (IGAC) project is a Core Project under the umbrella of the International Geosphere Biosphere Programme (IGBP) and co-sponsored by the international Commission on Atmospheric Composition and Global Pollution (iCACGP). IGAC's mission is to coordinate and foster atmospheric chemistry research towards a sustainable world by integrating, synthesizing, guiding, and adding value to research undertaken by individual scientists through initiating new activities, acting as a hub of communication for the international atmospheric chemistry research community, and through building scientific capacity. IGAC accepts there is a need to develop an integrated approach to address global sustainability and embraces that challenge by integrating IGAC's core activities that focus on emissions, atmospheric processes, and atmospheric composition with sustainability issues such as climate, human health, ecosystems, and how individual and societal responses feedback onto the core IGAC research-led activities.

EC 2. Measurements of Fluorescent Bioaerosol Particles in the Colorado Front Range

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Bioaerosols are of atmospheric interest due to their potential importance as cloud condensation and heterogeneous ice nuclei and because they represent a sizeable fraction of coarse mode aerosol in some locations. Relatively little data exists, however, regarding diurnal, seasonal and annual cycles of bioaerosols and the meteorological processes that control them. Newly developed real-time instrumentation allows for sensitive, high time resolution detection of fluorescent bioaerosols and is uniquely suited to address key uncertainties in the sources, distributions and behavior of these particles in the atmosphere. Here we present observations of ambient fluorescent biological aerosol made on the Front Range of Colorado using a custom-modified Wideband Integrated Bioaerosol Sensor (WIBS) during the summer and fall of 2013. The summertime measurements were made from the roof of the NOAA ESRL David Skaggs Research Center in Boulder and the fall measurements were made both at the surface and aloft at the Boulder Atmospheric Observatory Tall Tower. We examine diurnal variations in loading and size distribution of fluorescent bioaerosol at the two locations. We also investigate the relationship between meteorological events and fluorescent bioaerosol. For example, we observe higher concentrations and markedly different number distributions associated with precipitation events. Simultaneous filter samples were collected for fluorescence microscopy and DNA sequencing. To our knowledge this represents the first such comparison for the WIBS under ambient conditions. This data set will provide useful insight into the sources, loadings and properties of fluorescent bioaerosol and the local and regional processes that drive them.

EC 3. Global Distribution and Trends of Tropospheric ozone: An observation-based review

Owen R. Cooper (1,2), D. D. Parrish (2), J. Ziemke (3), N. V. Balashov (15), M. Cupeiro (4), I. E. Galbally (5), S. Gilge (6), L. Horowitz (7), N. R. Jensen (8), J.-F. Lamarque (9), V. Naik (7,10), S. J. Oltmans (1,2), J. Schwab (11), D. T. Shindell (12), A. M. Thompson (15,16), V. Thouret (17), Y. Wang (13), R. M. Zbinden (17,14)

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A comprehensive understanding of global surface ozone trends has eluded the scientific community due to limited long-term in situ observations and relatively few ozone monitors in regionally representative rural or oceanic regions. Furthermore, satellite records of lower tropospheric ozone mixing ratios are presently too short to yield robust results. However, in recent years several studies have provided updates to ozone trends at long-established sites, or reported trends at many newer sites that now have lengthy records sufficient for trend analysis. To pull all these new findings together into a single reference, many colleagues and I have produced a review article on the global distribution and trends of tropospheric ozone [Cooper et al., 2014]. Relying upon the highlights of this synthesis I will use a condensed graphical format to review all of the current ozone trend analyses in the peer-reviewed literature, focusing on rural rather than urban monitoring sites to facilitate understanding of ozone changes across broad regions. Trends at rural sites are also more easily compared to global chemistry-climate models. The earliest reliable ozone records began in the 1950s and 1970s with more and more sites becoming available in the 1980s and 1990s. The ozone rate of change has varied in magnitude and even sign over the decades with the strongest changes occurring in East Asia, eastern North America and Western Europe where changes in domestic ozone precursor emissions have been greatest. Ozone trends since the 1990s will be compared to global images of satellite-detected tropospheric column NO2 to identify regions where ozone trends are consistent, or inconsistent with observed ozone precursor changes and our general understanding of tropospheric chemistry. In addition I will present a new global analysis of 9-years of tropospheric column ozone as detected by the polar orbiting OMI and MLS instruments on the NASA AURA satellite, contrasting interannual ozone variability in the northern and southern hemispheres. The poster will conclude with a brief introduction to a new interdisciplinary and international effort to produce the first Tropospheric Ozone Assessment Report (TOAR).

Cooper, O. R., D. D. Parrish, J. Ziemke, N. V. Balashov, M. Cupeiro, I. E. Galbally, S. Gilge, L. Horowitz, N. R. Jensen, J.-F. Lamarque, V. Naik, S. J. Oltmans, J. Schwab, D. T. Shindell, A. M. Thompson, V. Thouret, Y. Wang and R. M. Zbinden (2014), Global distribution and trends of tropospheric ozone: An observation-based review, Elementa, submitted.

EC 4. Key Parameters Controlling the OH-initiated Formation of Secondary Organic Aerosol in the Aqueous Phase (aqSOA)

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Secondary organic aerosol formation in the aqueous phase of cloud (fog) droplets and aerosol particles (aqSOA) might contribute significantly to the total SOA burden and can help to explain the discrepancies in observed and predicted SOA properties. Ambient SOA often comprises highly oxidized material (high O/C ratio) composed of oligomers and dicarboxylic acids that do not have any known efficient gas phase sources.

In order to implement aqSOA formation in models, the most important processes within the multiphase system have to be identified. We explore parameter ranges of physical key processes and aqSOA formation rates as a function of oxidant (OH) availability. The processes include (1) phase transfer of both SOA precursors and oxidants from the gas to the aqueous phase, (2) diffusion within the aqueous phase, and (3) aqueous phase reactions that result in aqSOA formation within the aqueous particles or droplets, respectively.

Model results suggest that cloud aqSOA formation is oxidant-limited even if aqueous sources of the OH radical are taken into account. This limitation manifests itself as an apparent surface-dependence of aqSOA formation. Comparison to ambient data on organic mass (oxalate) formation in clouds as a function of cloud properties (drop surface area) exhibits similar trends. These findings imply that future cloud aqSOA parameterizations

EC 5. Characterizing Emissions of Volatile Organic Compounds (VOCs) from Oil and Natural Gas Operations in Haynesville, Fayetteville, and Marcellus Shale Regions via Aircraft Observations During SENEX 2013

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The 2013 SENEX (Southeast Nexus) field campaign took place in June and July 2013 with to ascertain how the interaction of natural and anthropogenic emissions influence climate change and air quality throughout the southeastern United States. Five of the research flights utilizing the NOAA WP-3D aircraft focused on areas of intensive oil and natural gas production from various shale plays. These areas included the Haynesville shale in eastern Texas and western Louisiana, the Fayetteville shale in northern Arkansas, and the Marcellus shale in western Pennsylvania. According to the U.S. Energy Information Administration's (EIA) Annual Energy Outlook 2013 report, (1) the Haynesville, Fayetteville, and Marcellus shale collectively account for approximately 75% of the dry shale gas produced in the U.S., and (2) shale gas is expected to provide the largest source of growth in the U.S. natural gas supply over the next few decades. Depending on the particular shale formation, raw natural gas can contain significant amounts of non-methane hydrocarbons in the form of natural gas liquids (e.g., ethane, propane, butanes) and natural gas condensate (e.g., pentanes, cycloalkanes, and aromatics).

EC 6. Retrievals of the Refractive Indices of Absorbing Aerosol

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Aerosol particles can affect climate by either scattering or absorbing incoming solar radiation, which causes either a cooling or warming effect, respectively. The complex refractive index can be used to quantify the amount of light that is scattered and absorbed, but accurate values for many types of aerosol particles are not known. Previous work in our group and elsewhere have utilized extinction measurements made with cavity ring-down spectroscopy to retrieve refractive indices, but these methods may not be sufficient to accurately and precisely quantify the refractive index. We present model results for retrievals using only extinction data and also results for retrievals with both extinction and absorption data, which show significant improvements in both accuracy and precision. Possible reasons for the improvements observed are explored.

EC 7. SI2N Overview Paper - Measurements Or Where Do I Find the Perfect Ozone Profile Data?

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The peak of chlorofluorocarbon (CFC) concentrations in the stratosphere was reached in the mid to late 1990s. Since then the detection and attribution of the ozone layer recovery and evolution in measurement time series is one of the main focal points of stratospheric ozone research. Answering these questions requires a critical examination of the pattern and time sequence of ozone change with an accurate knowledge of the spatial (geographical and vertical) and temporal ozone response. For such examination, it is critical that the quality of the measurements used be as high as possible and that the measurement uncertainties are well quantified.

In preparation for the 2014 United Nations Environment Programme (UNEP)/World Meteorological Organization (WMO) Scientific Assessment of Ozone Depletion the SI2N initiative was created to evaluate the available long-term ozone profile data sets for measurement stability, uncertainty characteristics, and ultimately their suitability for ozone recovery studies. Some of the data sets have been improved based on the findings of this initiative, with updated data versions now being available.

This summary presents an overview of these stratospheric ozone profile measurement data sets (ground- and satellite-based) that are available for ozone recovery studies, the measurement techniques employed in obtaining them, their geographical and vertical coverage, layer density, the length of their time series, their native units and their overall measurement uncertainties. In addition, the latest data versions are briefly described (including changes to previous data versions as well as different retrievals available for measurements from the same satellite instrument).

EC 8. Separating the Stratospheric and Tropospheric Pathways of El Nino-Southern Oscillation Teleconnections

Amy H. Butler (1), Lorenzo M. Polvani (2,3), and Clara Deser (4)
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The El Niño-Southern Oscillation (ENSO) is a major driver of Northern Hemisphere wintertime variability and, generally, the key ingredient used in seasonal forecasts of wintertime surface climate. Modeling studies have recently suggested that ENSO teleconnections might involve both a tropospheric and a stratospheric pathway. Here, using reanalysis data, we carefully distinguish between the two. We first note that the temperature and circulation anomalies associated with the tropospheric pathway are nearly equal and opposite during the warm (El Niño) and cold (La Niña) phases of ENSO, whereas those associated with the stratospheric pathway are of the same sign, irrespective of ENSO phase. We then exploit this fact to isolate the two pathways. Our decomposition reveals that ENSO's climate impacts over North America are largely associated with the tropospheric pathway, whereas ENSO's climate impacts over the North Atlantic and Eurasia are greatly affected by the stratospheric pathway. The stratospheric pathway, which we here define based on the occurrence of one or more sudden stratospheric warmings in a given winter, and whose signature projects very strongly on the North Atlantic Oscillation, is found to be present 60% of the time during ENSO winters (of either phase): it therefore likely plays an important role in improving seasonal forecasts, notably over the North Atlantic and the Eurasian continent.

EC 9. Effects of Water on Sulfur Chemistry in Planetary Atmospheres: Using Venus as a Natural Laboratory

Jay A. Kroll and Veronica Vaida

Department of Chemistry and Biochemistry - University of Colorado Boulder, CIRES

Sulfur compounds have been observed in the atmospheres of a number of planetary bodies in our solar system including Venus, Earth, Mars, Io, Europa, and Callisto. The global cloud cover on Venus located at an altitude between 50 and 80 kilometers is composed primarily of sulfuric acid (H2SO4) and water. Planetary photochemical models have attempted to explain observations of sulfuric acid and sulfur oxides with significant discrepancies remaining between models and observation. In particular, high (SO2) mixing ratios are observed above 90 km which exceed model predictions by orders of magnitude. These studies are particularly important given recent suggestions of using SO2 injections in the stratosphere to generate sulfate aerosol for solar radiation management. Using Venus as natural laboratory we can test our knowledge of fundamental sulfur chemistry in order to fully understand the chemical fates of sulfur species in planetary atmospheres.

Work recently done in the Vaida lab has shown red light can drive photochemistry through OH stretch overtone pumping in acids like H2SO4 and has been successful in explaining much of the sulfur chemistry in Earth's atmosphere. Water can have a number of interesting effects such as catalysis, suppression, and anti-catalysis of thermal and photochemical processes. We are investigating the role of water complexes in the dehydration of sulfur acids and the hydration of sulfur oxide. We are investigating these reactions using FTIR and UV/Vis spectroscopy and will report on our findings.

EC 10. Field Intercomparison of the Gas/Particle Partitioning of Oxygenated Organics During the Southern Oxidant and Aerosol Study (SOAS)

Samantha Thompson(1), Reddy Yatavelli(1), Harald Stark(1,3), Joel Kimmel(3,7), Jordan Krechmer(1), Douglas Day(1), Gabriel Isaacman(4), Allen H. Goldstein(4,5), Anwar Khan(6), Rupert Holzinger(6), Felipe Lopez-Hilfiker(2), Claudia Mohr(2), Joel Thornton(2), John Jayne(3), Douglas Worsnop(3), Jose L. Jimenez(1)

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Four new instruments that directly measure gas-to-particle partitioning in near-real time were deployed at the Centreville, AL Supersite of the Southern Oxidant Aerosol Study (SOAS) in the southeastern United States in the summer of 2013: two Filter Inlet for Gases and AEROsols High-Resolution Chemical Ionization Mass Spectrometer (FIGAERO-CIMS), a Thermal Desorption Aerosol GC-MS (TAG), and a Thermal Desorption Proton-Transfer Reaction Mass Spectrometer (TD-PTRMS). Signals from these instruments corresponding to elemental compositions of several organic acids were chosen for comparison of the measured gas/particle partitioning. The results show good correlation between the two CIMS instruments and the TAG on average, with varying agreement on the time series, while the PTRMS instrument shows lower partitioning to the particle phase compared to the two other instruments

We will also present a comparison between gas/partitioning at the SOAS ground site (Centreville, AL 2013) and BEACHON-RoMBAS site (Manitou Springs, CO 2011). These different campaigns represent very different environments in terms of VOC emission profiles and absolute humidity. We will investigate the effect of these changing parameters on the gas/particle partitioning of both alkanoics acids and bulk averaged acids.

EC 11.Reactive Nitrogen Partitioning and its Relationship to Winter Ozone Events in Utah

Robert Wild (1,2), Peter Edwards (1,2), William Dube (1,2), Ronald Cohen (4,5), John Holloway (1,2), James Kercher (7), Lance Lee (4), Robert McLaren (3), James Roberts (1), Jochen Stutz (6), Patrick Veres (1), Carsten Warneke (1,2), Eric Williams (1), Bin Yuan (1,2), Steven Brown (1)

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Recent air quality measurements have shown anomalously large concentrations of wintertime ozone in Utah's Uintah Basin, host to intensive oil and gas operations. As part of the Uintah Basin Winter Ozone Studies (UBWOS) in January-February of 2012, 2013, and 2014, a variety of instruments were deployed to measure speciated reactive nitrogen and ozone. Here we present an analysis and comparison of reactive nitrogen data for the two years with the most significant difference in ozone levels, 2012 and 2013. We also describe a recently developed measurement of total reactive nitrogen (NOy) by cavity ring-down spectroscopy, which was deployed for the first time in 2013. Compared to 2012, which had very different meteorological conditions, ozone production rates in 2013 were roughly three times faster, leading to numerous and substantial exceedances of national air quality standards. Furthermore, despite considerably higher NOy levels in 2013 compared to 2012, levels of photochemically active NOx was remarkably similar between the two years. Much of the reactive nitrogen oxidation occurred at night, suggesting that nighttime processes played an important role in defining the conditions for daytime photochemistry. Our findings regarding the reactive nitrogen budget help us understand the role of different NOx oxidation processes in O3 photochemistry, as well as the overall sensitivity of O3 production to nitrogen oxides in this environment.

EC 12. Aircraft Measurement of Glyoxal (CHOCHO) and Nitrous Acid (HONO) During SENEX 2013

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Glyoxal (CHOCHO) is an indicator of the oxidation processes of volatile organic compounds (VOCs) in the atmosphere. It has been proposed to play an important role in secondary organic aerosol formation (SOA) due to its high water solubility and oligomer forming ability. However the knowledge of underlying mechanisms is still limited. In addition, the enhanced CHOCHO signal observed by satellite instruments in equatorial regions indicates our insufficient understanding on source processes of CHOCHO. To date, no previous in situ CHOCHO observations have been available from aircraft owing to the difficulties in ambient levels of detection.

In support of the scientific goals of SENEX 2013 (Southeast Nexus) to investigate the role of anthropogenic and natural emissions in ozone and aerosol formation and their climate impact, we developed the Airborne Cavity Enhanced Spectrometer, ACES. This instrument provides rapid, sensitive in situ measurements of CHOCHO and other trace gases important in tropospheric oxidation chemistry, such as NO2 and HONO. The presentation will include a brief description of the working principle and performance of the new ACES instrument.

We present the first in situ CHOCHO map over southeast US. The region is strongly influenced by emissions of isoprene, whose oxidation is a major CHOCHO source. The region also has large anthropogenic emissions from urban and power plant plumes that may influence isoprene oxidation and glyoxal formation. Finally, we sampled several air masses heavily influenced by emissions from shale gas extraction. We examine the geographical distribution of glyoxal across a range of different air masses. The contrast between these air masses, together with 0-D box modeling calculations using explicit VOC degradation mechanisms (MCM3.2v), allow us to assess CHOCHO formation processes from oxidation of different VOCs together with CHOCHO sink mechanisms, including photochemical degradation and aerosol uptake. The results will be compared with recent results from similar measurements in other regions, such as urban area (Los Angeles, CA) and a remote oil and gas producing area in Utah. Vertical profiles of CHOCHO, which are useful for satellite validation, as well as yields of CHOCHO from pyrogenic emission from biomass burning plumes will be presented.

EC 13. Changes in Visibility and Local Radiative Forcing in the Southeast U.S. Linked to Decreased Aerosol Sulfate Mass

Alexis Attwood (1,2), Rebecca Washenfelder (1,2), Weiwei Hu (1,3), Nick Wagner (1,2), Allison McComiskey (1,2), Pedro Campuzano-Jost (1,3), Douglas Day (1,3), Brett Palm (1,3), Suzane Simoes de Sa (4), Charles Brock (2), Eric Edgerton (5), Karsten Baumann (5), Jose-Luis Jimenez (1,3), Steven Brown (2)
(1) CIRES, (2) NOAA ESRL, (3) University of Colorado, (4) Harvard University, (5) Atmospheric Research and Analysis

Sulfate aerosol is a major contributor to PM2.5 mass in the United States and impacts direct and indirect aerosol radiative forcing, visibility and health. The mass concentration of aerosol sulfate has decreased in the southeast U.S. by 3.9(±0.8)% yr-1 between 1992 – 2013, consistent with the 60% reduction in nationwide SO2 emissions from 1990 – 2010 following the Clean Air Act Amendment. During the Southeastern Oxidant and Aerosol Study (SOAS), which took place in the summer of 2013, we deployed a novel, broadband cavity enhanced spectrometer (BBCES) to measure relative humidity dependent aerosol extinction in the ultraviolet as a function of wavelength. The aerosol composition in this region is dominated by ammonium sulfate, which along with organics contributes 60 - 90% of surface PM2.5. Using submicron aerosol optical extinction and composition data, we determine a relationship between the enhancement in aerosol extinction at elevated relative humidity, γext, and the mass fraction of organics, which shows decreased water uptake and reduced optical extinction at lower sulfate and higher organic mass fraction. We calculate that the reduction in particle hygroscopicity has caused a -1.6(±0.3)% yr-1 change in aerosol optical extinction from 1998-2013 based on changes in chemical composition alone. This change in ambient extinction is separate and in addition to the change in extinction of -3.1(±0.8)% yr-1 that we calculate as a direct result of decreased aerosol mass over the same period. Direct measurements of visibility show an improvement between 1998 – 2013, which is consistent with these expectations. Radiative forcing calculations of the decreased aerosol extinction and resulting increased surface solar irradiance will also be presented.

EC 14. GEIA's Vision for Improved Emissions Information

Gregory Frost (1,2), Claire Granier (1,2,3,4), Leonor Tarrasón (5), Paulette Middleton (6)
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Accurate, timely, and accessible emissions information is critical for understanding and making predictions about the atmosphere. We will present recent progress of the Global Emissions InitiAtive (GEIA, http://www.geiacenter.org/), a community-driven joint activity of IGAC, iLEAPS, and AIMES within the International Geosphere-Biosphere Programme. Since 1990, GEIA has served as a forum for the exchange of expertise and information on anthropogenic and natural emissions of trace gases and aerosols. GEIA supports a worldwide network of emissions data developers and users, providing a solid scientific foundation for atmospheric chemistry research. By the year 2020, GEIA envisions being a bridge between the environmental science, regulatory, assessment, policy, and operational communities. GEIA's core activities include 1) facilitating analysis that improves the scientific basis for emissions data, 2) enhancing access to emissions information, and 3) strengthening linkages within the international emissions community. We will highlight GEIA's current work distributing emissions data, organizing the development of new emissions datasets, facilitating regional emissions studies, and initiating analyses aimed at improving emissions information. GEIA welcomes new partnerships that advance emissions knowledge for the future.

EC 15. Top-down constraint on hydrocarbon emissions in the Denver-Julesburg oil and natural gas basin

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NOAA ESRL conducted an intensive measurement campaign in Colorado's NE Front Range in May 2012 to investigate hydrocarbon emissions from oil and gas operations. The study region was centered on the most densely drilled region (> 24,000 active wells) of the Denver-Julesburg basin. Total methane (CH4) emissions for the region were estimated using a mass-balance approach with in-situ CH4 data from flights conducted on two different days and ground-based measurements of wind direction and speed. CH4 and over 40 different species were also analyzed in a total of 118 discrete air samples collected by the airplane on 12 flights. Here we present data for CH4, propane, n-butane, i-pentane, n-pentane, benzene, acetylene and carbon monoxide. Top-down emission estimates were calculated for the non-methane hydrocarbon measured based on the total CH4 emission top-down estimate and hydrocarbon correlation slopes for the airborne discrete air samples. The aircraft data are compared with the NOAA GMD long-term measurements of air samples collected since 2007 at the Boulder Atmospheric Observatory tower, north of Denver. We also compare the atmospheric measurements with raw natural gas and flashing emissions from oil tanks composition data provided by the Colorado Oil and Gas Conservation Commission and the Colorado Department of Public Health and the Environment.

EC 16. Measurements of VOCs by GC-MS in Rural Alabama

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Volatile organic compounds (VOCs) are a large class of chemicals that are emitted into the atmosphere by both human and natural biological activity. VOCs are comprised of both precursor compounds that drive oxidation chemistry and oxidation products. Extensive measurements of VOCs can help determine the relationships between precursor and secondary compounds, and the relative effects of anthropogenic and biogenic emissions on climate and air quality.
The Southeastern US is a region of particular research interest, as it is strongly affected by both anthropogenic and biogenic VOCs. As part of the 2013 Southern Oxidant and Aerosol intensive study (SOAS), an in-situ gas-chromatograph mass spectrometer (GC-MS) was deployed at a forested site in rural Alabama. This site was dominated by biogenic emissions, but was also subject to anthropogenic influence. The GC-MS measured a large number of primary and secondary anthropogenic and biogenic VOCs in the C2 to C11 range, with a time resolution of 30 minutes. Measured compounds of particular interest include isoprene, speciated monoterpenes, methylvinylketone (MVK), methacrolein, C2 to C11 alkanes, lightweight unsaturated hydrocarbons including ethene, propene, and acetylene, C6 to C9 aromatics, C1 to C7 oxygenated VOCS (alcohols, ketones, aldehydes), halogenated VOCs, acetonitrile, and several sulfur-containing compounds. A summary of these measurements will be presented. This summary will include characterization of various anthropogenic and biogenic sources sampled at the site, discussion of oxidation chemistry, OH reactivity, and SOA potential. These GCMS measurements provide key information for constraints in models and to aid in the interpretation of data from other instruments.

EC 17. Secondary Organic Aerosol Formation and Aging in a Flow Reactor in the Forested Southeast US During SOAS

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A major field campaign (Southern Oxidant and Aerosol Study, SOAS) was conducted in summer 2013 in a forested area (Centreville Supersite) in the southeast U.S. To investigate secondary organic aerosol (SOA) formation from biogenic volatile organic compounds (BVOCs), 3 flow reactors (potential aerosol mass, PAM) were used to expose ambient air to oxidants and their output was analyzed by state-of-art gas and aerosol instruments including a High-Resolution Aerosol Mass Spectrometer (HR-AMS), a High-Resolution Proton-Transfer Reaction Time-of-Flight Mass Spectrometer (PTR-TOFMS), and for the first time, two different High-Resolution Time-of-Flight Chemical Ionization Mass Spectrometers (HRToF-CIMS), and an SMPS. Ambient air was exposed 24/7 to variable concentrations of each of the 3 main atmospheric oxidants (OH, O3 and NO3) to investigate SOA formation and aging. The OH exposure was estimated by 3 different methods (empirical parameterization, carbon monoxide consumption, and chemical box model). Effective OH exposures up to 7e12 molec cm-3 s were achieved, which is equivalent to over a month of aging in the atmosphere. High SOA formation of up to 12 µg m-3 above ambient concentrations of 5 µg m-3 was observed under intermediate OH exposures, while very high OH exposures led to destruction of ambient OA by ≈ 30%, indicating shifting contributions of functionalization vs. fragmentation, which is similar to previous results from urban and terpene-dominated environments. The highest SOA enhancements were 3-4 times higher than the ambient OA. More SOA is typically formed during nighttime when terpenes are higher and lower during daytime when isoprene is higher. SOA formation is also observed after exposure of ambient air to O3 or NO3, although the amount and oxidation was lower than for OH exposure. Formation of organic nitrates in the NO3 reaction will be discussed. High SOA formation (above 40 µg/m3) and a large number of CIMS ions, indicating many different compounds were observed when a pine branch was placed in front of the PAM, while oak and kudzu branches resulted in lower enhancement. Processing of ambient air by OH led to significant reductions in the bounce of ambient particles, indicating an effect on their phase.

EC 18. Aerosol and Particle Engineering Research Aimed at Improving Global Health

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As the Global Health Group of CIRES, our objective is to develop safe and effective vaccine delivery systems, specifically those that take advantage of dry powder microparticles to enhance vaccine safety and stability. We are currently exploring potential administration by needle-free active dry powder aerosol inhalers; unit-dose, all-in-one auto-reconstitution syringe devices; and sublingual solid formulations. To create stable dry microparticles of vaccines and pharmaceuticals, we utilize our patented CO2-Assisted Nebulization with a Bubble Dryer® (CAN-BD) system. We have also developed a human-powered, active dry powder inhaler called the PuffHaler® for the intrapulmonary delivery of these dry powder vaccines and pharmaceuticals. A Phase I clinical safety trial of intrapulmonary mucosal membrane delivery of our CAN-BD processed measles vaccine dry powder aerosols has shown efficacious immune response and no serious adverse events after administration to 60 adult males in India.

Our success in CAN-BD processing of vaccines and pharmaceuticals may be extended to improve vaccine stability and delivery methods for other vaccines, antibiotics (e.g., tuberculosis), and antivirals (e.g., influenza).

EC 19. VOCs Flux Measurements Over Haynesville Shale Gas Play

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VOCs measurements were made over Haynesville shale gas play using instruments onboard NCAR C130 and NOAA WP-3D during the broad Southeast Atmosphere Study (SAS). Using the datasets, several different methods, including eddy covariance, were used to calculate benzene and toluene flux from oil&gas extraction activities. This study may help to understand the effects of shale gas extraction to regional air quality and climate change.

EC 20. Anthropogenic Triggers of Multiphase Chemistry of Glyoxal

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Glyoxal (C2H2O2) is a ubiquitous small molecule that is observed in the terrestrial biogenic, urban, marine and arctic atmosphere. It forms secondary organic aerosol (SOA) as a result of multiphase chemical reactions in water. The rate of these reactions is controlled by the effective Henry's law partitioning coefficient (Heff) which is enhanced in the presence of inorganic salts by up to 3 orders of magnitude (Kampf et al., 2013, ES&T). Aerosol particles are among the most concentrated salt solutions on Earth and the SOA formation rate in aerosol water is strongly modified by this 'salting-in' mechanism. We have studied the effect of gas-phase ammonia on the rate of SOA formation in real particles composed of different inorganic salts (sulfate, nitrate, chloride). A series of simulation chamber experiments were conducted at the Paul Scherrer Institut in Switzerland during Summer 2013. The SOA formation rate in experiments with added gas-phase ammonia (NH3) was found to be greatly accelerated compared to experiments without added NH3. Product analysis of particles included online HR-ToF-AMS and offline nano-DESI and LC-MS. We find that imidazole-like oligomer compounds dominate the observed products, rather than high-O/C oligomers containing solely C, H, and O. We further employed isotopically labelled di-substituted 13C glyoxal experiments in order to unambiguously link product formation to glyoxal (and separate it from chamber wall contamination). We present a molecular perspective on the reaction pathways and evaluate the effect of environmental parameters (RH, particle pH, seed chemical composition) on the formation of these imidazole-like oligomer compounds. The implications for SOA formation from photosensitized oxidation chemistry is discussed.

EC 21. Observational Evidence for Incomplete Dehydration in the TTL

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The tropical tropopause layer (TTL), especially above the western Pacific, is the primary gateway for entry of air into the stratosphere from the troposphere. Dehydration of stratosphere-bound air parcels by deposition of water vapor to ice particles in the TTL is therefore a key process controlling the humidity of the stratospheric overworld. Strong correlations between large-scale stratospheric humidity and TTL temperatures on intra-annual and interannual timescales have demonstrated that this mechanism is largely correct.

What remains uncertain is how efficiently air is dehydrated on its passage through the TTL and therefore the absolute value of water vapor entering the stratosphere. In the absence of appropriate particles to act as nuclei for ice crystal formation, relative humidity with respect to ice (RHi) exceeding 160% at TTL temperatures is required for clouds to form and remove water from the gas phase. If ice crystal concentrations are low (~100 / liter or less), the time for thermodynamic gas-particle equilibrium to be achieved can be on the order of hours following the formation of ice crystals. It is also possible that ice crystals, once formed, may evaporate before they are removed from the TTL by sedimentation. These mechanisms suggest the likelihood that air parcels with RHi exceeding 100% may frequently pass the through the cold point and enter the stratosphere.

Here we present measurements made from the NASA Global Hawk UAS during the Airborne Tropical Tropopause Experiment (ATTREX) of relative humidity, ice water content, and ice crystal concentrations in the central and eastern Pacific TTL in winter 2013 (ATTREX-2) and in the western Pacific TTL in winter 2014 (ATTREX-3). This dataset provides unprecedented high-quality observations of the key parameters required to test theoretical descriptions of dehydration in the TTL. During ATTREX, the cirrus clouds encountered most frequently had low ice crystal concentrations. While those clouds encountered with high ice crystal concentrations exhibited RHi very close to 100%, the more common thin clouds exhibited higher average and more variable RHi. A number of observations show supersaturated air or air with residual ice crystals at the potential temperature of the cold-point tropopause.

ATTREX achieved a significant number of flight hours sampling air in this key region of the atmosphere. These observations provide evidence that suggest that the average entry value of water into the stratosphere is somewhat supersaturated due to incomplete dehydration to 100% RHi at the cold point.

EC 22. Vertical Profiles of Aerosol Extinction Over the Southeastern US During the Summer

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Recent studies have shown that during the summertime aerosol loading in the southeastern United States measured in situ at surface is not enhanced as much as the AOD measured by satellites and AERONET. Regional modeling is able to reproduce the extinction at the surface, however not the higher extinction above ground. An enhanced source of secondary organic aerosol above the surface layer has been proposed as a possible explanation for the discrepancy. During summer 2013, in situ measurements of aerosol extinction, hygroscopicity, and particle size distributions were collected from the NOAA WP-3 aircraft and the NASA DC-8 aircraft as part of the Southeast Atmosphere Study and SEAC4RS. We present an analysis of aerosol extinction profiles and compare these with ground-based measurements and previous studies. Measurements of aerosol composition and trace gases aboard the aircraft are used to determine if secondary organic aerosol production is enhanced above the surface.

EC 23. Single Particles Measured by a tTime-of-Flight AMS Coupled with a Light Scattering Module Onboard NOAA P3 During SENEX

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(1)CIRES, (2)NOAA ESRL, (3)ETH Zurich, (4)Aerodyne Research

Single particles were measured by a time-of-flight AMS coupled with a light scattering module onboard NOAA P3 during SENEX. The fraction of the optically triggered particles with mass spectra signals above detection limit was about 40% on average. The detection efficiency varied depending on the particle size and chemical composition. The detection efficiency decreased at smaller (<250 nm) and larger (>400 nm) sizes. The detection efficiency was significantly higher when more acidic particles were sampled during the flight to Pennsylvania nature gas wells. The size and chemical dependence of the detection efficiency will be further discussed. The particles that had mass spectra appear much later than the predicted time will also be discussed. This might provide in situ information to help narrow down the uncertainty of the collection efficiency that were widely used in the AMS community.

EC 24. Optical Properties of Organic Aerosol in the Southeastern U.S.

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Optical properties of aerosols vary as a function of wavelength, but few measurements have reported the wavelength-dependence of aerosol extinction cross sections and complex refractive indices. In the case of brown-carbon, its wavelength-dependent absorption in the ultraviolet spectral region has been suggested as an important component of aerosol radiative forcing. During the Southern Oxidant and Aerosol Study in summer 2013, we deployed a new field instrument to measure aerosol optical extinction as a function of wavelength, using cavity enhanced spectroscopy with a broadband light source. The instrument consists of two broadband channels which span the 360–390 and 385–420 nm spectral regions using two light emitting diodes (LED) and a grating spectrometer with charge-coupled device (CCD) detector. We analyze this data to characterize the optical properties of organic aerosol from biomass burning and biogenic sources.

Environmental Observations, Modeling & Forecasting Division

EOMF 1. Geomagnetic Field Modeling with DMSP

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The Defense Meteorological Satellite Program (DMSP) launches and maintains a network of satellites to monitor the meteorological, oceanographic, and solar-terrestrial physics environments. In the past decade, geomagnetic field modelers have focused much attention on magnetic measurements from missions such as CHAMP, Oersted and SAC-C. With the completion of the CHAMP mission in 2010, there have been limited satellite-based vector and scalar magnetic field measurements available for main field modeling. In this study, we investigate the feasibility of using the Special Sensor Magnetometer (SSM) instrument onboard DMSP for main field modeling. These vector field measurements are calibrated to compute instrument timing shifts, scale factors, offsets, and non-orthogonalities in the fluxgate magnetometer cores. Euler angles are then computed to determine the orientation of the vector magnetometer with respect to a local coordinate system. We fit a degree 15 main field model to the dataset and compare with similar models such as the World Magnetic Model (WMM) and IGRF. Results indicate that the DMSP dataset will be a valuable source for main field modeling for the years between CHAMP and the Swarm mission.

EOMF 2. Dynamical Origins of Total Ozone Extremes in Historic Records Across the US

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Dobson ozone column time series have been collected in the US at five stations since 1960s. Half century of data contain valuable information about inter-annual variability in atmospheric ozone field related to the natural and anthropogenic processes. In addition to total ozone column measurements Umkehr ozone profiles are derived on every clear, sunny day. The long-term time series of Umkehr ozone measurements are available in Boulder, CO since 1978. The vertical distribution of ozone above Boulder allows attributing total column ozone variability to the processes that can be of tropospheric or stratospheric origin. Ozone in the free troposphere and lower stratosphere is greatly influenced by atmospheric dynamics. Equivalent Latitude and the position of station with respect to the subtropical and polar jets can be used to relate variability of total ozone to transport processes. We use five Dobson stations across the US to correlate Total ozone variability with NAO (Northern Atlantic Oscillation), AO (Arctic Oscillation) and ENSO (El Nino Southern Oscillation) to attribute differences in the regional interannual variability to dynamical variability. In addition to standard evaluation techniques we utilize a STL-decomposition method to address temporal variability and trends in the Dobson data, as well as synoptic-scale meteorological (i.e subtropical jets) and climate variability. We find that ozone depleting substances (EESC) and the 11-year solar cycle are the main modulating forces for both extremes and mean values. However, dynamical features such as QBO, ENSO and NAO contribute significantly to ozone variability and trends at 5 US Dobson stations. 'Fingerprints' are better captured in the tails (extremes) than in the bulk of the record. Further, we apply a statistical modeling approach to the ozone data set to attribute ozone variability to individual driving forces associated with natural and anthropogenic causes. The extreme event detection is applied to analyze total ozone records at all 5 Dobson stations. We find significant changes in trends derived with and without extreme events, which is consistent with previous analysis of 5 European Dobson stations. We also test the sampling limitation of the Umkehr dataset for detection of dynamical "fingerprints". We find that sampling affects the magnitude of the variability, but not the variability itself.

EOMF 3. L-Band Soil Moisture Mapping Using UAS for Validation and Calibration of SMAP

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Due to long electrical wavelengths and aperture size limitations the scaling of passive microwave remote sensing of soil moisture from spaceborne low-resolution applications to high-resolution applications suitable for precision agriculture requires use of low flying aircraft. This poster summarizes a project to develop a commercial Unmanned Aircraft System (UAS) hosting a precision microwave radiometer for mapping of soil moisture in high-value shallow root-zone crops and validation of NASA SMAP soil retrieval moisture algorithms. The project is based on the use of the Tempest electric-powered UAS and a compact digital L-band (1400-1427 MHz) passive microwave radiometer developed specifically for extremely small and lightweight aerial platforms or man-portable, tractor, or tower-based applications. Notable in this combination are a highly integrated UAS/radiometer antenna design and use of both the upwelling emitted signal from the surface and downwelling cold space signal for precise calibration using a lobe-correlating radiometer architecture. The system achieves a spatial resolution comparable to the altitude of the UAS above the ground while referencing upwelling measurements to the constant and well-known background temperature of cold space. The radiometer incorporates digital sampling and radio frequency interference mitigation along with infrared, near-infrared, and visible (red) sensors for surface temperature and vegetation biomass correction. This NASA-sponsored project is being developed both for commercial application in cropland water management, L-band satellite validation, hydrological scaling studies, and estuary and coastal salinity plume studies.

EOMF 4. The Role of Soil Moisture and SSTs in Decadal Drought in Western North America

Sally Langford (1), Yoshimitsu Chikamoto (2) and David Noone (1)
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Western North America is susceptible to severe impacts of decadal to multi-decadal droughts, as evidenced by treecore or lake sediment records. Future predictions suggest that this region will become more arid, with further consequences for water resources. Understanding the mechanisms of drought variability and persistence in western North America is critical for the eventual development of effective forecasting methods. The ocean is expected to be the main source of potential predictable decadal memory in the system as the atmosphere varies on a much shorter timescale. However, low frequency precipitation anomalies in western North America can occur in the absence of ocean feedbacks. Sea surface temperature anomalies in the north Pacific Ocean associated with around 20 per cent of the low frequency winter precipitation in California in the CMIP5 historical runs. This is not sufficient to use the skill of global coupled models in predicting ocean conditions ahead of time to successfully forecast the possibility of long-term drought in western North America. Megadroughts may be generated by unpredictable atmospheric noise, or persisted by other sources of low frequency variability such as land processes and feedbacks. Water storage and related variables which integrate precipitation are more predictable on longer timescales, as measured by anomaly correlation for hindcasts compared to a 'perfect model' control run with CESM1.0.3. The importance of SST anomalies or antecedent land conditions in initiating and persisting megadroughts in western North America is explored with ensemble simulations of CESM1.0.3, where the atmosphere is perturbed at the start and peak of megadroughts in the control run. The model results confirm the importance of internal variability, SST forcing and land processes in projections of future decadal hydroclimate; the relative role of each process differs for droughts with varying characteristics.

EOMF 5. What Lies Beneath: Using Water Column Sonar Data to Map Fish Schools and More

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Active acoustic technology is of increasing importance for studies examining fish populations and biological abundance in the water column. Multibeam echosounders are employed routinely on NOAA fishery vessels to estimate biomass, conduct trophic- and species-level identification, measure school morphology and behavior, and characterize habitat for commercially important species. These surveys deliver valuable information for ecosystem-based fisheries management but they also produce massive amounts of data that are costly and difficult to maintain. With its ability to store and preserve large datasets, NOAA's National Geophysical Data Center is acquiring and archiving acoustic data collected from NOAA and academic fleets. Through these efforts, an accessible archive of acoustic water column data will be made available to researchers and the public around the world. A web-based search engine will allow anyone to identify where data were collected, what instrument was used, and access the raw data and associated products. Years of decreasing funding for the sciences have necessitated our ability to get more information and more users out of data currently collected. This globally-accessible archive is a large step in that direction. Of most importance is identifying how best to tap the archive to benefit current and future fisheries research and management.

EOMF 6. Enhanced Management of and Access to Hurricane Sandy Ocean & Coastal Mapping Data

Barry Eakins (1), Dave Neufeld (1), Dan Price (2), and Susan McLean (2)
(1) CIRES, (2) NOAA NGDC

CIRES staff at NOAA's National Geophysical Data Center (NGDC) are working collaboratively with other NOAA offices and partners that acquire ocean and coastal mapping (OCM) data to ingest, describe, archive, and deliver mapping data in the Sandy-impacted region to support improved response and restoration. Specific data include airborne topography and topographic-bathymetric lidar data, bathymetric sonar data, and associated data streams such as side scan sonar, backscatter, and bottom samples. NGDC will also work with NOAA partners to improve discovery of, and access to, archived OCM data. Finally, NGDC will develop robust and sustainable capabilities for the web-based discovery of and access to coastal digital elevation models (DEMs) that provide seamless topo-bathy depictions of Sandy-impacted coasts. This two-year, funded project supports a variety of NOAA mission requirements, from safe navigation to coastal flood forecasting and habitat characterization.

EOMF 7. Smart Post-Processing of a Global Numerical Weather Prediction Ensemble

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The High Impact Weather Prediction Project (HIWPP) is funded to accelerate and enhance the development of new and improved global numerical weather prediction (NWP) models. One of the tasks of HIWPP is the statistical post processing of an ensemble of global NWP models to determine the most probable weather outcome.

Using multiple numerical weather prediction models in an ensemble that spans the range of realistic weather outcomes adds value to weather forecasts and is now commonplace. The precise way that the information from an ensemble of numerical weather models is used depends on the user and the purpose, but an ensemble mean is a common and obvious choice if one has no prior knowledge of the ensemble members' skill. The ensemble members may have seasonally or situationally varying skill, or perhaps better than average skill for certain variables while having worse skill for others. Clearly, the interpretation of an ensemble can be enhanced knowing the history of the members' successes and failures at predicting reality. This ensemble post processing project is a step toward the distillation of an ensemble of global weather forecasts to yield a single 'best' estimate of temperature, precipitation and wind forecast over the globe, better than an ensemble mean. Although the project demonstration is for a global result, the methodologies being developed apply to purposes where a user may want a best forecast on a limited region such as for solar and wind energy.

Statistically post processing the results from the ensemble to target improvement in accuracy of weather forecasts can be done in many ways, ranging from relatively simplistic to very sophisticated. The initial, simplistic, steps in creating a statistical post processing routine for a global ensemble forecast have been performed and the results show notable improvement over the ensemble mean. The plan for performing the next steps, including development of probability distributions and use of more sophisticated post processing including Bayesian model averaging, is discussed.

EOMF 8. Ionospheric Assimilation of Radio Occultation and Ground-Based GPS Data Using Non-stationary Background Model Error Covariance

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Ionospheric data assimilation is a powerful approach to reconstruct the 3D distribution of the ionospheric electron density from various types of observations. We present a data assimilation model for the ionosphere, based on the Gauss-Markov Kalman filter with the International Reference Ionosphere (IRI) as the background model, to assimilate two different types of total electron content (TEC) observations from ground-based GPS and space-based FORMOSAT-3/COSMIC (F3/C) radio occultation. Covariance models for the background model error and observational error play important roles in data assimilation. The objective of this study is to investigate impacts of stationary (location-independent) and non-stationary (location-dependent) classes of the background model error covariance on the quality of assimilation analyses. Location-dependent correlations are modeled using empirical orthogonal functions computed from an ensemble of the IRI outputs, while location-independent correlations are modeled using a Gaussian function. Observing System Simulation Experiments suggest that assimilation of TEC data facilitated by the location-dependent background model error covariance yields considerably higher quality assimilation analyses. Results from assimilation of real ground-based GPS and F3/C radio occultation observations over the continental United States are presented as TEC and electron density profiles. Validation with the Millstone Hill incoherent scatter radar data and comparison with the Abel inversion results are also presented. Our new ionospheric data assimilation model that employs the location-dependent background model error covariance outperforms the earlier assimilation model with the location-independent background model error covariance, and can reconstruct the 3D ionospheric electron density distribution satisfactorily from both ground- and space-based GPS observations.

EOMF 9. Prolonged Duration and Frequency of Springtime Ozone Depletion events in the Arctic

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Surface ozone measurements have been maintained in Barrow, Alaska since the mid-1970's, this long term data set allows for analysis and research regarding the year to year variability and long term trends of tropospheric ozone in this region. Since the discovery of ozone depletion events (ODE's) in the 1980's [Oltmans , 1981] evidence has shown that there is a direct correlation between sea ice age, wind direction, and ozone depletions. As the climate continues to change, the characteristics and chemistry of the sea ice, and in turn atmosphere, will change as well. With first year sea ice now making up the majority of Arctic ice cover, younger and saltier ice is being melted each spring. Bromine and other halogens are released into the atmosphere from brine depositions on the ice surface resulting in photo chemical reactions depleting ozone at the surface. It must be considered that wind direction of air masses moving into the measurement location play a great role on the intensity and frequency of events each year. When air masses have dominant land based direction, then the depletion events are not seen. These ODE's have been steadily increasing over time, with a remarkable amount of depletion detected in 2012. Data collected from Thermo Scientific Model 49c Ozone monitors in Barrow, Alaska and Tiksi, Russia (located at 71.6 N and 71.3 N respectively to minimize solar angle differences) can be correlated with dominant wind direction, Hybrid Single Particle Langrangian Integrated Trajectory (HYSPLIT) modeling, and ice age to form an association between ODE's and winds passing over the halogen rich arctic ice. 2013 data from both arctic locations is analyzed to determine the dynamics of ozone depletions with regard to changing ice conditions and wind patterns as compared to 2012 and historical data. The data must be scrutinized with regard to the confounding variables to determine the mechanism behind the extended duration and severity of depletion events in the arctic.

EOMF 10. Ship-Based Observations of Turbulence and Mass Flux Transport in the Indian Ocean from the DYNAMO Field Program

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The Dynamics of the Madden Julian Oscillation (DYNAMO) field program involved deployment of several measurement systems based on ships, islands and aircraft over the Indian Ocean. The R/V Revelle was the primary platform for surface based measurements which included the High Resolution Doppler Lidar (HRDL) and the 94-GHz cloud Doppler radar (W-band radar). In this paper, the data from the HRDL and the W-band radar will be used to study the updraft/downdraft structure and mass flux transport in the context of shallow convection cases. Time series of turbulence profiles from the HRDL will be combined with those from the W-band radar to allow, for the first time, the study of the updraft/downdraft structure from clear air to well within the cloud layer. This allows a unique opportunity to study the turbulence profiles for clear versus cloudy elements independently. The time series of the combined updraft/downdraft profiles are plotted as a function of velocity threshold. In addition variables important for convective mass flux parameterization in models, such as updraft fractional coverage (σ) and convective mass flux velocity (M*) are computed. This will allow comparison of directly measured σ and M* values to those derived from model parameterizations.

EOMF 11. Potential for Geographic Diversity to Smooth Wind Electricity Generation

Mark A. Handschy(1)(2), Jay Apt(3), Julie Lundquist(4)(5), Stephen Rose(3), Clara St. Martin(4)
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We investigate how effectively geographic aggregation can smooth electric generation from wind power. To quantify variability, we model the fraction of time aggregated generation falls below a specified power threshold. This metric has more bearing on grid reliability than do conventional measures derived from the standard deviation σ of generation level. In Monte Carlo simulations this variability metric declines exponentially as e^(-HN) with increasing number N of uncorrelated generators, consistent with the statistics of large deviations and in contrast to the slower $1/\sqrt{N}$ dependence of σ. Generation-duration curves we calculate using wind-speed datasets from U.S. tall towers also exhibit exponential decline in low-power durations. Sites further than 1000 km apart are consistently uncorrelated according to our analysis of 54-year hourly wind-speed records from 117 stations with 20–5000 km separations across Canada (after removal of diurnal cycles and trends slower than 90 days).

EOMF 12. Build Your Own Metadata Editor! Easier Than an IKEA bookshelf!

Richard Fozzard (1), Marty Aubrey (1), Anna Milan (2), Anju Shah (1), Dan Price (3), Marcus Cole (2), Travis Pence (1)
(1) CIRES, (2) NOAA NGDC, (3) NOAA Corps

Every scientist recognizes the critical role that dataset metadata plays in the access, understanding, exploitation and archiving of their data for future generations (or should by now)!

But modern metadata standards are managed in XML, a cryptic language that scientists don't always speak. This inhibits even the savviest scientist or data manager from documenting their data. Not to mention the folks in the field who are so busy collecting the data that they hardly want to spend time learning XML.

Until now, building a customized metadata editor that's easy to use required hiring an (expensive) programmer. Even after it was done, making the slightest change required pleading for indulgence from your programmers, followed by waiting a week while the change was deployed to your production environment, sigh!

So for the EMMA Enterprise Metadata Management Architecture we use in NOAA (see our poster from last year's CIRES Rendezvous), we decided to eschew the programmers. Now all you need to build your own custom metadata editor(s) is basic knowledge of XML and HTML (and optionally Javascript). Our builder is implemented using XSLT, a kind of XML template language, that's fast and easy to learn for the purposes of this editor builder. Changes to your editor are instantly visible, requiring no tedious deployment process.

For this poster, we'll demonstrate a couple of metadata editors our users have created, Cruise-Level Metadata and Hydrographic Surveys. We'll also peek into how the builder framework is implemented for those who like to look under the hood.

EOMF 13. Observed and Projected Ocean Wind Speed Trends and Marine Boundary Layer Clouds

Jan Kazil (1,2), Graham Feingold (2)
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An uncharted feedback mechanism of marine low clouds to anthropogenic climate forcing is their response to wind speed. This mechanism proceeds, inter alia, via the effect of wind speed on the surface fluxes of heat, moisture, and sea spray aerosol. Satellite observations have shown a general trend towards higher ocean wind speeds in the period 1991-2008, with increases by at least 5-10 %, depending on region. This observed trend is not necessarily related to anthropogenic climate forcing, but could arise from decadal internal variability of the climate system. Climate simulations project ocean wind speed trends for the 21st century in the range of -10% to 10% at the locations of large marine stratocumulus decks, and an increase in excess of 10% in the Southern Ocean in response to anthropogenic climate forcing. This presentation investigates the response of marine stratocumulus clouds to wind speed changes and the associated effect on radiative forcing. Results of cloud-system-resolving simulations of marine stratocumulus clouds are presented.

EOMF 14. A NOAA Tsunami Water Levels Archive – Scientific Perspectives and Discoveries

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(3) NOAA National Geophysical Data Center, Boulder, Colorado

The National Environmental Satellite, Data, and Information Service (NESDIS) National Geophysical Data Center (NGDC) and co-located World Data Service for Geophysics (WDS) provides long-term archive, data management, and access to national and global tsunami data. Currently, NGDC archives and processes high-resolution data recorded by each system in the Deep-ocean Assessment and Reporting of Tsunami (DART®) network, coastal-tide-gauge data from the National Ocean Service (NOS) network as well as tide-gauge data recorded by all gauges in the two National Weather Service (NWS) Tsunami Warning Centers (TWCs) regional networks. The challenge in processing these observational data is that the observations from the deep-ocean, Pacific Islands, Alaska region, and United States West and East Coasts display commonalities, but, at the same time, differ significantly, especially when extreme events are considered. The focus of this work is on how time integration of raw observations (10 seconds and 15 seconds for the TWCs regional networks, 15 seconds for DARTs and some upgraded tide-gauges, and 1-minute for all tide gauges) could mask extreme water levels. Analysis of the statistical and spectral characteristics obtained from records with different time step of integration will be presented. Results show the need to precisely calibrate the despiking procedure against raw data due to the significant differences in the variability of deep-ocean and coastal tide-gauge observations. It is shown that special attention should be shown to the very strong water level declines associated with the passage of the moving North deep Atlantic cyclones. Strong changes for the deep ocean and for the West coast have implications for data quality but these same features are typical for the East Coast regime.

EOMF 15.Assimilative Neutral Wind Bias Correction Scheme for Global Ionospheric Modeling at Midlatitude

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This study demonstrates the usage of a robust data assimilative procedure, which is applied to correct the model wind biases to enhance the capability of the global physics-based Ionosphere Plasmasphere Electrodynamics (IPE) model. The hmF2 observed by the FORMOSAT-3/COSMIC (F3/C) radio occultation (RO) technique is utilized to adjust global thermospheric field-aligned neutral winds (i.e., a component of the thermospheric neutral wind parallel to the magnetic field) at midlatitudes according to a linear relationship between time differentials of the field-aligned wind and hmF2. The adjusted winds are further applied to drive the IPE model, which is built upon the Field Line Interhemispheric Plasma (FLIP) model with a realistic geomagnetic field model and empirical model drivers. The comparison of the modeled electron density with the observations of F3/C and ground-based GPS receivers at the 2012 March Equinox suggests that the modeled electron density can be significantly improved, especially in the midlatitudes of the Southern Hemisphere. Moreover, the F3/C observation, the IPE model, and the wind bias correction scheme are applied to study the 2012 Southern Hemisphere Midlatitude Summer Nighttime Anomaly (southern MSNA)/Weddell Sea Anomaly (WSA) event at the December Solstice for examining the role of the neutral winds in controlling southern MSNA/WSA behavior over different longitudes. With the help of the wind bias correction scheme, the IPE model comprehensively reproduced the F3/C observed southern MSNA/WSA features. The apparent eastward movement of the southern MSNA/WSA features in the local time coordinate is primarily caused by the longitudinal variation in declination angle of the geomagnetic field that controls the field-aligned projection of both geographic meridional and zonal neutral winds.

EOMF 16. Detecting Moisture Convergence Signals in a Madden-Julian Oscillation Event: A Feasibility Study Combining Scatterometer and Thermal Emissions Spectrometer Data

Lesley L. Smith (1), David C. Noone (1)(2), Max Berkelhammer (3), Ralph F. Milliff (1)
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The moisture convergence process, especially prior to the onset of deep convection, is a difficult-to-observe phase in the life-cycle of an active Madden-Julian Oscillation (MJO) event. Nonetheless, moisture convergence in the atmospheric planetary boundary layer is thought to play a key role in energy transfers that drive MJO evolution with implications for MJO propagation mechanisms and processes of convective organization. We examine the feasibility of detecting moisture convergence signals associated with a single MJO event, Dec 2007 - Jan 2008, in the tropical Indian and western Pacific oceans. Surface vector wind retrievals from the NASA QuikSCAT scatterometer are combined with paired water-isotope/water vapor retrievals from the Tropospheric Emissions Spectrometer (TES) aboard the NASA Aura platform. Preliminary results correlating surface zonal wind and surface convergence with HDO/H2O ratios in the planetary boundary layer at various stages of the MJO life-cycle are described.

EOMF 17. High-Resolution Coastal DEMs of the Nation: A Hurricane Sandy Test Case

Luke Beasley(1), Michael Sutherland(1), Barry Eakins(1), Matthew Love(1), Kelly Carignan(1), and Susan McLean(2)
(1) CIRES, (2)NOAA NGDC

CIRES staff at NOAA's National Geophysical Data Center (NGDC) are working collaboratively with USGS's Earth Resources Observation & Science (EROS) Center to develop robust, sustainable procedures for building seamless bathymetric-topographic digital elevation models (DEMs) of the Nation. These procedures will be tested and implemented by building a suite of DEMs of the New York-New Jersey shoreline that were impacted by storm surge from Hurricane Sandy in 2012. We will describe these coastal DEM development procedures (including how to ensure cell alignment between models, and update models as new elevation data are acquired), the resulting suite of nested, telescoping coastal DEMs (currently in progress), and our long-range plans for extending this effort to all U.S. coasts. NOAA develops and uses digital elevation models to support a variety of mission requirements. These include coastal flood forecast and warning due to tsunami, hurricane, and storm surge as well as research into fish habitat, sea-level changes, and off-shore energy.

EOMF 18. The Implications of Background O3 Affecting the Setting and Attainment of the NAAQS for Surface O3

Samuel J. Oltmans (1,2), Allen S. Lefohn (3)
(1) CIRES, (2) NOAA ESRL Global Monitoring Division, (3) A.S.L. & Associates

Under the Clean Air Act, the U.S. EPA periodically reviews National Ambient Air Quality Standards (NAAQS) for pollutants identified as criteria pollutants. Among the criteria pollutants is surface O3, for which the current standard is under review to determine if the level should be maintained or modified. The Clean Air Act requires that the primary NAAQS be set on the basis of protection of human health with an adequate margin of safety. The current standard is that the 3-year average of the annual 4th highest maximum daily 8-hour average O3 (MDA8) not exceed 75 parts per billion (ppb). Recent EPA staff recommendations and deliberations by the EPA Clean Air Scientific Advisory Committee (CASAC) Ozone Panel suggest that the standard should be in the range 60-70 ppb. Recent work (Lefohn et al., 2014a; 2014b) has shown that during the spring and early summer U.S. background O3 (O3 not contributed by U.S. pollutant emissions) over the western U.S. is a large fraction of measured ambient O3 at levels <70 ppb. In addition much of the health risk associated with surface O3 estimated by the EPA is associated with O3 in the 25-55 ppb range and background O3 contributes a large percentage in this range. Because of the large contribution of background O3 to measured O3 at a number of locations, the ability to meet a standard with a threshold <70 ppb by controlling local or regional emissions will be severely limited.

EOMF 19. How Much Can We Learn About Nitrous Oxide Emissions from Background Sites and Simple Box Models?

J.David Nance (1,2), James W.Elkins (2), Geoffrey S. Dutton (1,2), Bradley D. Hall (2), Debra. J. Mondeel (1,2), James H. Butler (2), Edward J. Dlugokencky (2), Steven C. Wofsy (3), and Matthew Rigby (4)

(1) CIRES, (2) NOAA ESRL GMD, (3) Harvard University, (4) University of Bristol

Atmospheric nitrous oxide (N2O) is an important ozone-depleting gas that continues to rise in concentration even as CFC emissions have virtually ceased. It is also a potent greenhouse gas with a global warming potential of 298 times per molecule that of carbon dioxide with 100 years time horizon. NOAA has been monitoring background concentrations of N2O from weekly flask sampling since 1977, starting with five remote stations over a broad latitudinal coverage from Pt. Barrow, Alaska to South Pole, Antarctica. This network has expanded to thirteen flask sites and six in situ instrument sites. We have combined data from the collocated, ground-based sites using three different independent instruments all linked to the WMO N2O calibration scale, primarily to assist in quantifying the global burden of atmospheric N2O for international assessments of the state of the science in climate and stratospheric ozone depletion. The growth rate of atmospheric N2O has been constant at 0.78±0.01(3σ) parts per billion (ppb) per year over the period, but with important deviations related to ENSO, transport, and changes in patterns of emissions. Recent studies used a combination of multiple atmospheric networks and different Global Climate Models (GCMs) to calculate emissions, even down to emission values for individual countries and sources. Slight calibration differences between networks of a few tenths of a ppb can have significant effects on the emissions calculated by these methods. Our approach is to use one calibration scale for our flask and in situ networks within different GMD groups with simple box models to examine the locations of the emissions.

EOMF 20. Long-Range Correlations of Underwater Pressure Fluctuations

Justin S. Ball (1), Oleg A. Godin (1,2), Läslo G. Evers (3) and Cheng Lv (1)

(1) CIRES, University of Colorado at Boulder, (2) NOAA Earth System Research Laboratory, Physical Sciences Division, Boulder, CO, (3) Seismology Division, Royal Netherlands Meteorological Institute, De Bilt, The Netherlands

We investigate the spatial coherence of underwater ambient noise using a year-long time series of measurements by two hydrophones located at depths close to the SOFAR axis off the Ascension Island. Qualitative agreement with observed cross-correlations is achieved within a simple environmental model consisting of a fluid layer overlying a homogeneous solid half-space. In particular, the model correctly predicts the existence of two normal modes in the microseism frequency range, with the group speed of one of the normal modes being smaller than the sound speed in water. Bathymetry makes the propagation environment strongly range-dependent. Accounting for the range dependence proves necessary to achieve quantitative agreement between observations and modeling within constraints provided by earlier, active tomographic studies in the area. The agreement justifies our interpretation of the peaks of the measured cross-correlation function of ambient noise as modal arrivals and demonstrates the feasibility of acoustic noise interferometry in the ocean at record-large ranges in excess of 120 km.

EOMF 21. Update to the Mauna Loa Clear-Sky Apparent Solar Transmission 1958 - 2013

K. Lantz (1,2), D. Longenecker (1,2), E. Hall (1,2), J. Wendell (2)
(1) CIRES, (2) NOAA/ESRL

The apparent solar transmission has been measured for five and a half decades by the Global Monitoring Division (GMD) of the National Atmospheric and Oceanic Administration (NOAA) at the Mauna Loa Observatory (MLO). Mauna Loa Observatory's remote location and high altitude makes it well suited for studying atmospheric changes in the free troposphere with limited local influences. A clear-sky 'apparent' solar transmission (AT) is calculated using the ratio of direct-beam broadband pyrheliometer measurements at fixed atmospheric paths (airmass) [Ellis and Pueschel, 1971]. The MLO AT is particularly sensitive to changes in background stratospheric aerosols and the influence of volcanic eruptions.

The updated clear-sky AT from 1958 to 2013 monthly record is computed from daily morning values to remove boundary layer influences due to upslope winds . The aerosol signal from the eruptions of Agung, El Chichon, and Mt Pinatubo in 1964, 1982, and 1991, respectively are clearly visible in the record. A 6-month running smoothed fit is applied to the monthly values and highlights the seasonal trends in the data that have been attributed primarily to Asian aerosol transport in the spring [Bodhaine et al., 1981]. This seasonal variability of the clear-sky AT has an amplitude of ~0.007. A 24-month running smoothed fit highlights the longer term changes. The cleanest background is observed from 1958-1962 in the record except for a brief period in 1978. A comparison of the average clear-sky AT in 2013 with the cleanest background observed between 1958 and 1962 gives a decrease in the clear-sky AT of 0.004.

After the eruption of Mount Pinatubo in 1991, the clear-sky AT reached a maximum in 1998 and a subsequent slow decrease through 2010 that was attributed to smaller volcanic eruptions [Vernier et al., 2011; Solomon et al., 2011]. The last few years show the AT has begun to level off or shows a slight increase. Annual clear-sky AT averages of the 10 cleanest days are useful for viewing stratospheric background air while limiting the influence of local pollution events and interference from cirrus clouds. Annual averages of Aerosol Optical Depth (AOD) from a Precision Filter Radiometer (PFR) of the 10 cleanest days is also calculated as a proxy for stratospheric aerosol optical depth at this site. Annual averaged AT from 1996 to 2013 alongside the annual averaged AOD from 2000 to 2013 from the 10 cleanest days at MLO are presented. The additional years in the annual MLO AT and AOD (PFR) record continue to show a persistently variable background. The background stratospheric aerosol load has implications for understanding global climate change and changes in surface temperatures [Solomon et al., 2011].

EOMF 22. The Many Uses of Multibeam Echosounder Data

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Multibeam echosounders (MBES) are scientific instruments that use sound navigation and ranging (SONAR) techniques to determine the depth of water and the nature of the seabed. MBES are typically mounted to the hull of a ship and have a single transducer emit a broad fan-shaped sound wave perpendicular to the ship's track. A receiver array then forms the sound return into multiple beams that record the two-way travel time, return angle, and sound intensity values. This information provides the opportunity for a variety of applications and research, some of which are highlighted here.

The original - and still primary - use of MBES data is mapping the bathymetry of the seafloor. Bathymetric maps can be employed for nautical charting, port monitoring, and pre/post dredge assessment. They also provide site analyses for engineering projects such as pipelines, wind farms, and tidal energy studies. Gridded bathymetry data provide high-resolution support for tsunami modeling, coastal inundation studies, and ocean current modeling and forecasts. The intensity, or backscatter, values recorded by multibeam systems are also quite valuable. These data are used to classify sediment types and delineate different underwater habitats. Backscatter returns aid researchers in locating coral, rocky, sandy, and other environments used in biological diversity studies. More recently, researchers have configured MBES systems to collect data within the water column itself. These data are utilized by fisheries scientists to find, track, and determine biomass of fish populations. Additionally, the water column data have the ability to detect perturbations in the water column and track gas seeps. The latter of which are in high demand following events such as the Deepwater Horizon incident in 2010.

The National Geophysical Data Center (NGDC) is one of three federal data archives and is tasked with maintaining, archiving, and making publicly accessible the nation's geophysical data, including MBES data. Currently the multibeam database contains 2348 published cruises and hosts over 700,000 data files. These data combine to provide approximately 19 million kilometers of ship track data. Proper data stewardship by NGDC provides a mechanism for public reuse of these multibeam data for a variety of purposes beyond the original intent of the data collection effort. This not only allows unrelated projects to use the same data but also provides huge cost benefits to those who use the data. Following the Integrated Ocean and Coastal Mapping Program policy of "Map Once, Use Many Times", we are observing many benefits from the reuse of MBES data.

EOMF 23. Towards the Goal of Modular Climate Data Services: An Overview of NCPP Applications and Software

Ben Koziol, Luca Cinquini, Allyn Treshansky, Sylvia Murphy, Cecelia DeLuca, Richard Rood
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In August 2013, the National Climate Predictions and Projections Platform (NCPP) organized a workshop focusing on the quantitative evaluation of downscaled climate data products (QED-2013). The QED-2013 workshop focused on real-world application problems drawn from several sectors (e.g. hydrology, ecology, environmental health, agriculture), and required that downscaled downscaled data products be dynamically accessed, generated, manipulated, annotated, and evaluated. The cyberinfrastructure elements that were integrated to support the workshop included:

(1) a wiki-based project hosting environment (Earth System CoG) with an interface to data services provided by an Earth System Grid Federation (ESGF) data node;
(2) metadata tools provided by the Earth System Documentation (ES-DOC) collaboration;
(3) a Python-based library OpenClimateGIS (OCGIS) for subsetting and converting NetCDF-based climate data to GIS and tabular formats.

Collectively, this toolset represents a first deployment of a "ClimateTranslator" that enables users to access, interpret, and apply climate information at local and regional scales.

EOMF 24. Winter Temperature Tides from 30 to 110 km at McMurdo (77.8S, 166.7E), Antarctica: Lidar Observations and Mechanism Study of Fast Amplitude Growth Above 100 km by CTIPe Model.

Weichun Fong (1,2), Xian Lu (1), Xinzhao Chu (1,2), Cao Chen (1,2), Tim Fuller-Rowell (1,3), Mihail Codrescu (3), Zhibin Yu (1,2), Brendan Roberts (1,2), Chester S. Gardner (4), Adrian J. McDonald (5)
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We provide the first characterization of diurnal and semidiurnal thermal tides in temperature from 30 to 110 km in the winter season (May through August) at McMurdo (77.8°S, 166.7°E), Antarctica. The observations were made with an Fe Boltzmann temperature lidar in 2011 and 2012. Over 330 h of winter data are compiled into a composite day of temperature perturbations that significantly reduce the incoherent wave effects while preserving the coherent tidal signatures. Both diurnal and semidiurnal tides have small amplitudes (less than 3 K) below 100 km with vertical wavelengths of ~29 and ~23 km, respectively. An interesting new finding of this study is that the diurnal and semidiurnal tidal amplitudes grow fast above 100 km and can reach at least 15 K near 110 km, which are exceeding that of the freely propagating tides originating from the lower atmosphere. Such fast growth exists for all Kp index cases and diurnal amplitude increases to 15−30 K at 110 km with larger Kp indices corresponding to larger tidal amplitudes and faster growth rates. In addition, the slopes of diurnal tidal phases become steeper above 100 km and the tidal phases barely change with altitude from 100 to 106 km. Combining with the significant amplitude increases, it implies that there may exist additional tidal sources near or above 100 km.
Geomagnetic activity appears to be a dominant tidal source above 100 km but may not be the only one. Since the fast amplitude growth exists for quiet ($Kp \leq 1$) condition as well, it indicates that geomagnetic activity may cause an enhancement of temperature tides but other additional contributions are still needed, such as direct solar heating and chemical heating. In this paper, we utilize the coupled thermosphere ionosphere plasmasphere electrodynamics (CTIPe) model to investigate the possible sources/mechanisms that lead to the fast amplitude growth of tides as observed by lidar in the polar winter region.

EOMF 25. Vertical Evolution of Gravity Wave Potential Energy and Wavenumber Spectrum from 30 to 110 km Observed by an Fe Lidar at McMurdo (77.8S, 166.7E), Antarctica

Xian Lu(1), Xinzhao Chu(1,2), Zhibin Yu(1,2), Weichun Fong(1,2), Cao Chen (1,2)
(1)CIRES (2) Aerospace Department

We provide the first report on the vertical evolution of gravity wave potential energy and vertical wavenumber spectrum from 30 to 110 km in the Antarctic winter seasons from 2011 to 2013. These wave properties were derived from temperature observations made with an Fe Boltzmann lidar at McMurdo (77.8◦S,166.7◦E), Antarctica. The potential energy density per unit mass (Epm) grows exponentially with a scale height of 13 km in the Rayleigh region (30–70 km), where waves are partially dissipated or saturated. However, the vertical variation of Epm is not uniformly exponential in the MLT region. An unusually rapid increase of Epm is observed from 86 to 94 km with a scale height close to freely propagating waves (6km), suggestive of very small dissipations; while above 94 km, Epm barely increases with altitude implying that gravity waves dissipate severely. A new finding of this study is that the shape of vertical wavenumber spectra possesses two distinctive ranges. From 1 to 4 km, its yearly mean slope is close to the canonical value of -3, as predicted by various theories. From 4 to 12 km, its mean value is only about -1.5. This may suggest that waves are saturated more for wavelengths of 1–4 km than for longer ones. The characteristic vertical wavelengths increase from 12 –18 km in the Rayleigh region to >20 km in the MLT region. It is intriguing that the slopes and shapes of wavenumber spectra do not evolve considerably with altitude, whereas spectral power densities increase by 5–10 times. The mechanisms for the vertical evolution of gravity wave Epm and spectra deserve further investigations.

EOMF 26. Applications of Atomic Filters in Na Doppler Lidar

Ian F. Barry (1), Wentao Huang (1), John A. Smith (1), Weichun Fong (1), and Xinzhao Chu (1)
(1) CIRES

Designs of Na atomic filters are revisited in conjunction with recent improvements in the quality and resolution of Na Doppler lidars to achieve two scientific goals in atmospheric measurements of wind and temperature: downward extension of the range of these lidars into the lower atmosphere and useful daytime observation capability. In the past, Faraday filters have demonstrated increased SNR in daytime observations, allowing for the study of diurnal cycles and other atmospheric effects of solar radiation that would be impossible with only nighttime measurements. The application of double-edge filters in recent years to measurements in the lower atmosphere has hinted at the observation of gravity wave generation by convective processes and topography, in addition to the propagation of these waves upward to the more extensively studied Mesosphere and Lower Thermosphere (MLT) region. However, the results of daytime and lower-atmosphere observation attempts have to date included noise levels prohibiting useful scientific interpretation. To increase the SNR of these observations, the Faraday filter design has been optimized for adjustable magnetic field strength, and the unique double-edge filter design replaces the tuned FPI in previous designs with an atomic filter for absolute frequency calibration with simultaneous wind and temperature measurements. In both cases, improved temperature control for the Na atomic filters has led to greater stability and control over the respective filter functions. The improved optical efficiency of the Na lidar receiver system has extended the range of nighttime measurements up to 110 km with significantly higher SNR than many other lidar systems, and has resulted in measurements of Rayleigh scattering up to 60 km using the atomic double-edge filter, with greater temporal and spatial resolution than demonstrated ever before. Results have so far demonstrated higher accuracy of measurements in the lower atmosphere using the new double-edge filter design in conjunction with the STAR Na Doppler lidar system developed by the Chu Research Group out of CIRES, which will also be used to obtain daytime observations with higher signal levels and less noise. The expansion of the scientific capabilities of the Na Doppler lidar system into the lower atmosphere and daytime observations will allow for more complete characterization of the atmosphere over a wider range of times and altitudes, prompting new areas of research related to gravity wave generation in the lower atmosphere, the effects of solar radiation during the day, and phenomena with longer periods requiring continuous observation spanning multiple days.

EOMF 27. CIRES/NOAA-GMD HIPPO Data Set for Transport and Chemistry in the Global Troposphere

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During the four-year NSF sponsored HIPPO and START-08 campaigns, CIRES staff within NOAA/ESRL/GMD maintained and took data from three basic instruments: NWAS (the NOAA Whole Air Sampler), UCATS (the UAS Chromatograph for Atmospheric Trace Species), and PANTHER (PAN and other Trace Hydrohalocarbon ExpeRiment). The vertical and temporal coverage provided by ten Pole to Pole transits over the Pacific is unique to the HIPPO data set. The measured trace gases within the HIPPO data set have lifetimes that span the time scales of transport within and across the bounder layer, free troposphere, and stratosphere. Within each of these regions, multiple trace gases were measured with either their major source or sink being contained within that region. Vertical and horizontal gradients are evident in the data that are consistent with variances in the source and sink regions, coupled with the dominant transport features such as inter-hemispheric exchange, upwelling and mixing, boundary layer trapping, stratospheric down welling and intrusions, and transport of polluted air. The HIPPO project focused on longer lived trace gas measurements and in this presentation we highlight the coupling of trace gases with a predominantly northern boundary layer source region, to the global troposphere via the inter hemispheric exchange process. We discuss how correlated measurements of trace gases in these air parcels maintain information about a common transport history and common OH chemical fields (the dominate loss mechanism).

EOMF 28. NGDC Data Management Supporting the Extended Continental Shelf Project

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The Extended Continental Shelf (ECS) Project is a multi-agency collaboration led by the Department of State whose mission is to establish the full extent of the continental shelf of the United States consistent with international law, thus ensuring management of the resources on and below the seabed. NGDC is one of 3 NOAA Line Offices active in the inter-agency U.S. Extended Continental Shelf Project. NGDC has primary responsibility to manage all of the digital data and derived products associated with the ECS.

One of the key challenges in the project is the stringent requirement to track the provenance of data and derived products. Final regional analyses will result in hundreds of points that define a new maritime boundary that is our extended continental shelf. These points will be developed in a rigorous process of analysis encompassing potentially thousands of raw datasets and derived products. NGDC's Information Management System (IMS), keeps track of these data, and the ways in which they relate to one another. The IMS enables scientists performing ECS analyses to contribute data and derived products to NGDC's archive, and to discover and retrieve these data during future stages of the project. The IMS is populated with primary data, derivative data and products, associated metadata, and analyses. The ECS Catalog, a central component of the IMS, is a web-based application running on a Java platform and built with the Grails application framework. It uses a relational database to persist entries and relationships for all the data and products in the project. It also stores geospatial information about each entry, which is used to populate a dynamic, interactive map built using ESRI's ArcGIS Server and JavaScript API. The map displays all ECS-related data and products in the Catalog, exposed in the form of a RESTful web service - a simple, consistent way of publishing resources and enabling create, read, update, and delete capabilities. This enables multiple team members to participate in managing ECS data, track the provenance of data and derived products used in the analyses, and display analyses using a dynamic web-map service.

This project has long-term international impact, including stewardship of areas potentially worth billions of dollars in resources and rich in research opportunities. This poster focuses on NGDC's continuing efforts in creating and maintaining a robust relational database of all digital data and derived products associated with the ECS, to provide scientific, technical, and data expertise to enable the analysis and final determination of a new maritime boundary for the U.S.

EOMF 29. Evaluation of NWP Forecast Model Kkill at Simulating Offshore Winds by Comparing to Ship-Based Doppler Lidar Measurements

Pichugina Yelena (1, 2), Robert Banta (2), Alan Brewer (2), Joseph Olson (1, 2), Melinda Marquis (2),James Wilczak (2), Irina Djalalova (1, 2), Laura Bianco (1, 2), Stan Benjamin (2), and Mike Hardesty (1,2)
(1) CIRES, (2) NOAA/Earth Systems Research Laboratory

Evaluation of model skill in predicting winds over the ocean was performed by comparing retrospective runs of NWP forecast models to lidar measurements in the Gulf of Maine, a potential U.S. coastal region for offshore wind farm development.

Deployed on board of the Research Vessel Ronald H. Brown during the NEAQS 2004 field campaign, the NOAA High Resolution Doppler lidar (HRDL) provided accurate, motion compensated wind measurements from water surface up to several hundred meters aloft. The precision and high vertical resolution of lidar profile measurements through the turbine rotor layer make it ideal for verifying NWP output for wind energy use.

The study presents validations of two modeling systems; the hourly-updated NOAA/ESRL Rapid Refresh (RAP) system and a new hourly-updated version of the NOAA/NWS/NCEP North America Mesoscale (NAMRR) forecast system. These models were run at both normal resolution (RAP 12 km, NAMRR 13 km) and nested down to high-resolution versions: the High-Resolution Rapid Refresh (HRRR 3 km) and the NAMRR CONUSNEST (4km).

Lidar data also were used to estimate the impact of additional data assimilation from 11 Wind Profiling Radars located along the East Coast by comparing model runs with and without WPR data assimilated.

The results demonstrate the importance of observational data to validate, calibrate and improve NWP models and decrease uncertainty of wind resource assessment in one of the US offshore areas projected for wind plant development.

EOMF 30. Microphysical Properties of Diamond Dust, Fog, and Blowing Snow Over the Central Greenland Ice Sheet

Christopher J. Cox (1,2,3), David Noone (1,2), Michael O'Neill (2,4), Von P. Walden (5), Matthew D. Shupe (2,3), Max Berkelhammer (6)
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The surface mass balance of the Greenland Ice Sheet (GIS) is a combination of accumulation and runoff rates and is very sensitive to changes in these components. Clouds modulate the surface mass balance because they play a role in both the hydrologic cycle and surface energy balance. Furthermore, cloud and post-depositional processes influence the isotopic composition of the ice, which is used for paleoclimate reconstructions. Despite the importance of clouds, relatively little is known of the properties of clouds over the GIS. This work focuses on observations of surface-based clouds from Summit, Greenland (72N 38W 3200m), including supercooled liquid radiation fogs, ice fogs, diamond dust, and blowing snow. Surface-based cloud microphysics are presented from measurements made by Droplet Measurement Technologies (DMT) Meteorological Particle Spectrometers (MPS) and Fog Monitors (FM100) positioned at 2 m and 10 m above the surface. The period of study is June 2012 through October 2013 (17 months). MPS and FM100 data, in combination with meteorology and observations from a collocated radar and infrared spectrometer, are used to identify the types of observed clouds. The following questions are then addressed: 1) what is the prevalence of the various types of surface-based clouds?, 2) what are their microphysical properties?, and 3) what are the meteorological conditions under which they occur? Using this baseline characterization, this study will next quantify the influence that surface-based clouds have on the surface energy and hydrologic budgets of the ice sheet, and constrain the influence of cloud processes on the isotopic ratio of surface accumulation. It is anticipated that the different types of surface-based clouds exhibit a range of radiative, dynamic, and hydrologic interactions with the surface.

EOMF 31. Improvements to the Data Dissemination Website and Additions to Trackline Archive at NGDC

Brian Meyer (1), Jennifer Jencks (1), John Campagnoli (2), Dan Metzger (1), Udo Barckhausen (3), Takemi Ishihara (4)
(1) CIRES, (2) NOAA NGDC, (3) BGR, Germany, (4) AIST, Japan

Public trackline geophysical data (magnetic, gravity, seismic, and bathymetric) play a key role in many research and environmental model efforts. The National Geophysical Data Center is the primary archive of these data worldwide. However, obtaining these data could be time consuming, requiring navigating multiple pages of prompts before finally obtaining the desired data. Moreover, much of the data existed in non-digital form that was not discoverable on-line. This process was bulky, out-dated, and non-flexible. A new interface has been created by CIRES and NOAA scientist and programmers have worked together to create a new interface which allows the user to view, refine, and obtain trackline data in an efficient, user friendly manner. At the same time NGDC / CIRES has made a concerted effort to identify, ingest, and archive all available global marine and aeromagnetic trackline data for access via this new interface. The result is over 2 million miles of geophysical data, along with the pre-existing analog and digital data, are now available via a vastly improved user interface, allowing the geoscience community has unprecedented access to global geophysical trackline data. This poster will focus on the changes in data discovery and delivery, while highlighting some of the key new data.

There has also been a concerted effort to archive and ingest all available global marine and aeromagnetic trackline data to be distributed by NGDC. Hundreds of surveys and millions of data observations, including many which had only been available via analogue medium (paper, microfilm, etc.), have been added to our database and are now available to the public.

In combination with the new interface, the geoscience community has unprecedented access to global geophysical trackline data.

EOMF 32. Image Services and Mosaic Datasets Providing Access to Bathymetry Data at NGDC

Jesse Varner (1, 2), John Cartwright (2), Barry Eakins (1, 2), David Rodziewicz (2, 3), Marcus Cole (2, 4)
(1) CIRES, (2) NOAA National Geophysical Data Center, (3) NOAA Corps, (4) NOAA National Ocean Service, Hydrographic Surveys Division

NOAA's National Geophysical Data Center (NGDC) stewards a large amount of gridded bathymetry data, including bathymetric attributed grids (BAGs) for National Ocean Service (NOS) hydrographic surveys, bathymetric/topographic digital elevation models (DEMs), and associated color shaded relief visualization products. These data are in a wide range of different resolutions, are often overlapping when superseded by newer data, have various spatial reference systems/vertical datums, and may have irregular boundaries. NGDC has begun utilizing ArcGIS mosaic datasets to organize and manage these data, and has published a set of ArcGIS image services providing data discovery and access to the public. These image services can be utilized in desktop GIS software, or used as "building blocks" for the development of web-based mapping applications (such as NGDC's Bathymetry Data Viewer). The services are also available via Open Geospatial Consortium (OGC) Web Map Service (WMS) and Web Coverage Service (WCS) standards. The services are readily discoverable and useable on the new centralized NOAA GeoPlatform and ArcGIS Online repositories. The services provide access to the underlying data (i.e. depths in meters), and to derived color shaded-relief imagery useful for visualization and data quality assessment. All original raster data and associated attributes are retained, regardless of whether data is overlapping. Seamless views provide the "best-available" data at each location as a continuous mosaic. Alternatively, by applying filter criteria, a user can control exactly what subset of data to show. For example, bathymetry can be isolated from a single survey, project, or a range of dates. "On-the-fly" processing can be performed to generate additional products without requiring extra storage, such as various colorized visualizations, slope, aspect, elevation profile graphs, and (potentially) vertical datum transformations. Overviews (reduced-resolution images) are pregenerated to improve the speed at which the mosaic is displayed. Mosaic datasets and image services will be used for management and dissemination of data and products related to ongoing DEM development in areas affected by Hurricane Sandy.

EOMF 33. Exploration of Novel Whole Atmosphere Lidar for Whole Atmosphere Wave Dynamics

John Smith, Xinzhao Chu, Wentao Huang
CIRES

Studies of wave propagation and atmospheric dynamics from the lower to upper atmospheres have been limited by the elusive and fragmented nature of measurements in these regions. Recent discoveries at McMurdo using an Fe-Boltzmann lidar system have revealed not only the viability, but also the importance for measurements at 30-150+ km in deepening our understanding of the space-atmosphere interaction region (SAIR). Although the mechanisms are yet to be fully understood, the SAIR is known to be essential for sustaining life, absorbing harmful solar radiation, ablating meteoric material, regulating gaseous escape, dissipating energetic particles and fields from space and balancing influences from the planet itself. Since the SAIR is a highly coupled region which is influenced by both events in space and disturbances in the lower atmosphere, we assert that measurement coverage is essential to a more complete understanding of this region. To address this measurement challenge, a "whole atmosphere" lidar concept is proposed. The wind and temperature measurement range and precision of this lidar will cover waves, turbulence and the mean state from 20-170+ km. A detailed description of the system architecture is presented along with the measurement capability and potential avenues of research.

EOMF 34. Geodesy for Evaluating the Impact of Sea Level Rise on NASA Centers and Facilities

Lynda Bell(1), R. Steven Nerem(1), Dallas Masters(1), Charles Meertens(2)
(1) University of Colorado/Boulder, Colorado Center for Astrodynamics Research, CIRES
(2)UNAVCO, Boulder, Colorado

Sea level is rising in response to climate change. Currently this rate is a little over 3 mm/year, but it is expected to accelerate significantly over this century, with a total sea level change by 2100 of approximately 1 ± 0.5 meters. This will have a profound impact on coastal populations and infrastructure, including NASA centers and facilities. A detailed study proposed by the University of Colorado's Center for Astrodynamics Research on the impact of sea level rise on a few of NASA's most vulnerable facilities was recently funded by NASA. Individual surveys at several high-risk NASA centers have been conducted from May to November 2013 and used as case studies for a broader investigation for coastal infrastructure around the country. The first year of the study included implementing and conducting a terrestrial laser scanning (TLS) and GPS survey at Kennedy Space Center, Cape Canaveral, Florida, Wallops Flight Facility, Wallops Island, Virginia, and Langley Research Center, Hampton, Virginia. We are using a broad array of geodetic tools to perform this study – much of which has been developed over the last few decades by NASA and its investigators. We will use airborne lidar data and terrestrial laser scanning (TLS) data to construct detailed digital elevation models (DEMs) of the facilities that we assess. We will use GPS data to assess the rate of vertical land movement at the facilities and to tie the DEM to tide gauges and other reference points. We will use satellite altimeter data from TOPEX, Jason-1, and Jason-2 to assess the sea level changes observed near these NASA facilities over the last 20 years to see if it offers clues for the future. We will also use GRACE satellite gravity observations to predict the regional changes in sea level caused by the melting of ice complexes around the world. We will use these datasets along with sea level projections from global climate models (GCMs) and semi-empirical projections to make detailed maps of sea level inundation for the years 2050 and 2100 for varying amounts of sea level rise. We will also work with other selected investigators to assess the effects of tidal variations and storm surge when coupled with changes in mean sea level, as storm surge is likely when initial damage due to sea level rise will occur.

EOMF 35. Automated Estimation of Boundary Layer Height Using Doppler Lidar

Thomas Rieutord (1), R. Michael Hardesty (2), W. Alan Brewer (3)
(1) Meteo France, (2) CIRES, (3) NOAA ESRL/CSD

Boundary layer height is an essential parameter for several areas of research (air quality, atmospheric modeling, and more...). Doppler lidar provides continuous information such as average profiles of wind speed and direction, turbulence, and backscatter intensity (proportional to aerosol concentration). These data can be used to develop a good estimator of boundary layer height. The purpose of this work is to find an algorithm able to deal with all these data products in order to detect automatically the top of the boundary layer. Two methods will be presented : one based on peak detection in the relevant signals, one based on data clustering.

Solid Earth Sciences Division

SES 1. A Paleoelevation History of the Basin and Range and Its Relation to Cenozoic Extensional Tectonism

Nathan Niemi (1)

(1) CIRES and the University of Michigan

The Basin and Range Province of the western United States is one of the premier examples of diffuse continental extension in the world. Estimates of extension across the Basin and Range during the Cenozoic range from 200% province-wide to locally as great as 400%. However, crustal thicknesses across this region, as derived from a variety of geophysical methods, are remarkably uniform and, at ~35 km thick, are similar to global averages. Reconciling large-magnitude crustal extension with observed crustal thicknesses is difficult without calling on one of three possible alternatives: (1) an Andean-plateau crustal thickness of ~60 km at the termination of the Sevier Orogeny and prior to extension; (2) substantial addition of material to the crust by syn-extensional magmatism or (3) mobilization and redistribution of fluid lower crust during extension. Quantitative paleoelevation histories can help discriminate between these competing mechanisms for widespread Cenozoic extension. New estimates of pre-extensional paleoelevations for the northern and central Basin and Range are presented using clumped isotope ($\Delta 47$) thermometry of lacustrine carbonates that suggest modest (~2-3 km) pre-extensional elevations for the northern Basin and Range and quite low (< 1 km) elevations for the southern Basin and Range. These paleoelevations are incompatible with mass balance considerations based on the observed magnitude of crustal extension and modern crustal thicknesses, and imply that crustal mass was added to the Basin and Range during extension, either from magmatism or crustal flow.

SES 2. Investigating Mechanisms of Lithospheric Shortening via Ocean Bottom Seismometers: South Island, New Zealand

Daniel W. Zietlow (1) and Anne F. Sheehan (1)

(1) CIRES and Department of Geological Sciences

We use teleseismic body wave tomography to image variations in P-wave speed in the upper mantle underneath the South Island of New Zealand. By combining data from the permanent network of seismometers in New Zealand (GeoNet) with ocean bottom seismic data (from the MOANA experiment), we are equipped to better investigate the mechanisms by which the mantle lithosphere accommodates tectonic convergence. Does it occur via intracontinental subduction or does mantle lithosphere simply thicken similar to the overlying thickening crust? If the latter is true, at what point does the thickened lithosphere become gravitationally unstable and sink into the mantle? Hypothesis and checkerboards tests show that incorporating the ocean bottom seismometers with the existing New Zealand National Seismograph Network yields a depth resolution of around 250-300 km, deeper than previously possible. We made P-wave traveltime picks via cross-correlation of waveforms on 55 teleseismic events for a total of 2525 P-wave arrival times. To ensure even ray coverage, we binned the earthquakes in 5° backazimuth and 10° distance bins, yielding 34 teleseismic events and 1645 P-wave arrival times. Compared to a standard Earth model with the mean values of each event removed and stations corrected for elevation, preliminary analysis of teleseismic P-wave traveltime residuals suggests a distinct pattern on- and offshore the South Island.

SES 3. Determining Hillslope-Scale Material Strength from Seismically-Triggered Landslide Events

Marin Clark (1)(2), Sean Gallen (2), Johnathan Godt (3)

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Natural hillslope "strength" or stability, relevant for landscape evolution and hazard assessment, falls far short of laboratory measurements of rock strength on hand-sized samples. This limitation stems from the fact that laboratory shear tests are performed on intact rock, yet it is fracture density, aperture and size that set the limit on hillslope-scale (102 – 103 m2) rock strength. In this study, we exploit large earthquakes in high relief settings to quantify hillslope strength because an earthquake imparts a measurable forcing (strong ground motion) and a quantifiable landscape response (landsliding). Here we apply an infinite-slope stability model developed by the hazard community from which we can assess slope stability given known topographic slope, as a function of landslide thickness and shear-strength properties (cohesion and internal angle of friction) for a particular seismic event given measured peak ground acceleration (PGA). Using the 2008 M7.9 Wenchuan earthquake in China as a test case, we demonstrate how PGA and observed landslides can be inverted to quantify hillslope-scape rock strength.

Weather and Climate Dynamics Division

WCD 1. First Forecast of a Sudden Stratospheric Warming with a Coupled Whole-Atmosphere/Ionosphere Model IDEA

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(1) CIRES, (2) NOAA, SWPC, (3) NOAA, EMC.

We present the first "weather forecast" with a coupled whole-atmosphere/ionosphere model of Integrated Dynamics in Earth's Atmosphere (IDEA) for the January 2009 Sudden Stratospheric Warming (SSW). IDEA consists of the Whole Atmosphere Model (WAM) and Global Ionosphere-Plasmasphere (GIP) model. A 30-day forecast is performed using the IDEA model initialized at 00 UT on January 13, 2009, ten days prior to the peak of the SSW. IDEA successfully predicts both the time and amplitude of the peak warming in the polar cap. This is about two days earlier than the National Centers for Environmental Prediction (NCEP) operational Global Forecast System (GFS) terrestrial weather model forecast. The forecast of the semidiurnal, westward propagating, zonal wave number 2 (SW2) tide in zonal wind also shows an increase in the amplitude and a phase shift to earlier hours in the equatorial dynamo region during and after the peak warming, before recovering to their prior values about 15 days later. The SW2 amplitude and phase changes are shown to be likely due to the stratospheric ozone and/or circulation changes. The daytime upward plasma drift and total electron content (TEC) in the equatorial American sector show a clear shift to earlier hours and enhancement during and after the peak warming, before returning to their prior conditions. These ionospheric responses compare well with other observational studies. Therefore, the predicted ionospheric response to the January 2009 SSW can be largely explained in simple terms of the amplitude and phase changes of the SW2 zonal wind in the equatorial E region.

WCD 2. Stochastic Forcings Associated with MJO Initiation During DYNAMO

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Numerical forecast models have difficulty simulating and forecasting the MJO, especially in its "initiation" phase in the Indian Ocean, due in part to model deficiencies such as incorrectly tuned parameterizations or inadequate subgrid parameterizations. Data collected during the DYNAMO field campaign captured frequent episodes in which a "cold pool" of air was laid down on the ocean surface during convective rain events. The dramatic changes in air temperature and winds led to large changes in sensible and latent heat fluxes. Clearly, such events are sub-grid scale to global forecast models. Stochastic forcing might be employed in global models to incorporate the effects of these subgrid events. Linear Inverse Modeling (LIM) can provide an estimate of the geographical covariance statistics and time series of stochastic forcing. Covarying time series of LIM-derived stochastic forcing during the DYNAMO field campaign (October 2011 – March 2012), obtained from global gridded analyses, will be presented. These will be compared with SST and surface heat flux observed by the R/V Revelle during DYNAMO IOP (October 2011 – January 2012). Particular emphasis will be placed on the evolution of these variables during the initial phases of the MJO.

WCD 3. The Sensitivity of Springtime Arctic Mixed-Phase Stratocumulus Clouds to Surface Layer and Cloud-Top Inversion Layer Moisture and Ice Nuclei Sources

Amy Solomon (12), Matt Shupe (12), Ola Persson (12), Hugh Morrison (3), Takanobu Yamaguchi (12), Peter M. Caldwell (4), Gijs de Boer (12), Graham Feingold (1), Barbara Ervens (12)

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Observations indicate that the processes that maintain subtropical and Arctic stratocumulus (Sc) differ, due to the different environments in which they occur. For example, specific humidity inversions (specific humidity increasing with height) are frequently observed to occur coincident with temperature inversions in the Arctic (e.g., Curry et al. 1996, Tjernström et al. 2004, Sedlar and Tjernström 2009). In a recent study, Sedlar et al. (2011) surveyed data from SHEBA, ASCOS and at Barrow, Alaska, to find that specific humidity inversions occurred 75-80% of the time when low-level clouds were present. In addition, this study found a significant relationship between the existence of specific humidity inversions and Arctic Mixed-Phase Stratocumulus (AMPS) that extended into the temperature inversion, highlighting the difference between AMPS and subtropical stratocumulus where the entrainment of dry air aloft prevents cloud liquid water from forming in the temperature inversion. Other important differences between warm Sc and AMPS are more effective cloud top radiative cooling due to cold, dry overlying Arctic free troposphere, and vapor diffusion onto ice (Bergeron process) which acts as a potentially large sink of water vapor for AMPS even when there is limited liquid water. In warm Sc drizzle grows by collision-coalescence of droplets, so as liquid water in warm Sc decreases, drizzle will shut off.

In this study we focus on quantifying the relative impact of cloud-top and sub-cloud layer sources of moisture and ice nuclei on the microphysical-radiative-dynamical feedbacks in an AMPS cloud system in LESs of the Department of Energy Atmospheric System Research Indirect and Semi-Direct Aerosol Campaign (ISDAC) "Golden Day" 8 April 2008.

WCD 4. Global Coupled Atmosphere/Ocean Model for Seasonal and Climate Forecast Applications at NOAA/ESRL

Shan Sun (1,2), Georg Grell (2), Rainer Bleck (1,2,3), Stan Benjamin (2)

(1) CIRES, (2) NOAA ESRL, (3) NASA GISS

A coupled global model aimed at intra-seasonal and interannual prediction is under development at NOAA's Earth System Research Laboratory. It uses the FIM atmospheric model and an ocean model based on HYCOM ('iHYCOM'). Both FIM and iHYCOM are 3-dimensional grid point models, laid out on a common icosahedral horizontal grid and using an adaptive hybrid-isentropic/isopycnic vertical coordinate. The fact that FIM and iHYCOM shares horizontal grid allows us to couple the atmosphere and ocean model directly without the need for an interpolating flux coupler.

The atmospheric model shares column physics with GFS. Initial results showed that regional biases in cloud cover, and hence shortwave radiation flux, are large in both coupled and uncoupled (FIM-only) global simulations, and needed to be reduced in many geographic regions. For this reason, we have developed and tested modifications for shallow and deep convection schemes and vertical discretization and conducted several 1-year AMIP tests on sensitivity to these changes/parameters.

Results of these tests and optimal configuration so far of the FIM-iHYCOM coupled model and its latest simulations compared to CFSv2 and NASA CERES satellites data will be presented.

WCD 5. Improving CTIPe Neutral Density Response and Recovery During Geomagnetic Storms

M. Fedrizzi (1), T. Fuller-Rowell (1), M. Codrescu (2), M. G. Mlynczak (3), D. R. Marsh (4)

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The temperature of the Earth's thermosphere can be substantially increased during geomagnetic storms mainly due to high-latitude Joule heating induced by magnetospheric convection and auroral particle precipitation. Thermospheric heating increases atmospheric density and the drag on low-Earth orbiting satellites. The main cooling mechanism controlling the recovery of neutral temperature and density following geomagnetic activity is infrared emission from nitric oxide (NO) at 5.3 micrometers. NO is produced by both solar and auroral activity, the first due to solar EUV and X-rays the second due to dissociation of N2 by particle precipitation, and has a typical lifetime of 12 to 24 hours in the mid and lower thermosphere. NO cooling in the thermosphere peaks between 150 and 200 km altitude. In this study, a global, three-dimensional, time-dependent, non-linear coupled model of the thermosphere, ionosphere, plasmasphere, and electrodynamics (CTIPe) is used to simulate the response and recovery timescales of the upper atmosphere following geomagnetic activity. CTIPe uses time-dependent estimates of NO obtained from Marsh et al. [2004] empirical model based on Student Nitric Oxide Explorer (SNOE) satellite data rather than solving for minor species photochemistry self-consistently. This empirical model is based solely on SNOE observations, when Kp rarely exceeded 5. During conditions between Kp 5 and 9, a linear extrapolation has been used. In order to improve the accuracy of the extrapolation algorithm, CTIPe model estimates of global NO cooling have been compared with the NASA TIMED/SABER satellite measurements of radiative power at 5.3 micrometers. The comparisons have enabled improvement in the timescale for neutral density response and recovery during geomagnetic storms. CTIPe neutral density response and recovery rates are verified by comparison CHAMP satellite observations.

WCD 6. Upper Atmospheric Data Assimilation with an Ensemble Kalman Filter

Tomoko Matsuo (1,2), I-Te Lee (3), and Jeffrey L. Anderson (4)

(1) CIRES, (2) NOAA SWPC, (3) National Central University, Taiwan, (4) NCAR IMAGe

Recent availability of global observations of ionospheric parameters, especially from GPS receivers on low Earth orbiting platforms, has motivated a number of attempts at assimilating ionospheric data. However, assimilation of sparse, irregularly distributed thermosphere observations to global models remains a daunting task. In this presentation we demonstrate the utility of ensemble Kalman filtering (EnKF) techniques to effectively assimilate a realistic set of space- and ground-based observations of the thermosphere and ionosphere into a general circulation model. An EnKF assimilation procedure has been constructed using the Data Assimilation Research Testbed (DART) and the Thermoshere-Ionosphere-Electrodynamics General Circulation Model (TIEGCM), two sets of community software offered by NCAR. An important attribute of this procedure is that the thermosphere-ionosphere coupling is self-consistently treated both in a forecast model as well as in assimilation schemes. It effectively facilitates solving the inverse problem of inferring unobserved variables from observed ones, for instance, thermospheric states from better observed ionospheric states. We demonstrate this point using specific observations including (i) neutral mass densities obtained from the accelerometer experiment on board the CHAMP satellite, and (ii) electron density profiles obtained from the COSMIC/FORMOSAT-3 mission. Furthermore, we discuss some of the issues specific to upper atmospheric EnKF applications and the roles of auxiliary filtering algorithms, such as adaptive covariance inflation and localization of covariance, to cope with these issues.

WCD 7. Amplified Warming Projections for High Elevation Regions from CMIP5 Models

Imtiaz Rangwala(1,2), Eric Sinsky(2) and James R. Miller (2)

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We analyze output from global climate models available from the Coupled Model Intercomparison Project Phase 5 (CMIP5) to determine whether the projected warming in mountains by the end of the 21st century is significantly different than in low elevation regions. We focus on seasonal changes in temperature in the northern hemisphere mid-latitudes for three different greenhouse gas emission scenarios. The multi-model ensemble indicates that warming rates will be enhanced at high elevations relative to their lower elevation counterparts at the same latitude. This effect is most pronounced for daily minimum temperatures during the cold season, particularly in the Tibetan Plateau/Himalayan region for which the climate models get realistic elevation fields. Furthermore, the amplification of warming with elevation is greater for a higher emission scenario. We discuss factors that cause the elevation dependent warming to be more pronounced in some global climate models than in others.

WCD 8. Evaluation of Routine Atmospheric Sounding Measurements Using Unmanned Systems (ERASMUS): Campaign objectives and Planned Operations

Gijs de Boer(1,2), Brian Argrow(3), Dale Lawrence(3), Scott Palo(3), Geoffrey Bland(4), James Maslanik(3), Jack Elston(3), James Mack(3)
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A field campaign recently funded by the United States Department of Energy (US DOE) will feature the use of unmanned aircraft systems (UAS) to obtain atmospheric measurements over the DOE Atmospheric Radiation Measurement (ARM) program's Oliktok Point facility. As a part of this work, six 'micro-class', low-cost, unmanned aircraft will be constructed and instrumented by University of Colorado scientists and engineers working together with specialists from NASA Goddard Space Flight Center. These aircraft will feature instrumentation to measure basic atmospheric quantities such as temperature, humidity, winds and pressure, along with instrumentation to obtain slightly more exotic quantities related to atmospheric radiation and aerosols.

These aircraft will be deployed to the DOE Oliktok Point facility for a two-week field campaign aimed at obtaining measurements designed to help address the following scientific questions:
- How do profiles of temperature and humidity evolve during transitions between clear and cloudy atmospheric states?
- How do aerosol properties vary with height at high latitude locations?
- What role do moisture inversions play in the lifecycle of Arctic mixed-phase clouds, and how does their structure evolve in space and time?
- How well do current remote-sensing retrievals perform in the Arctic environment?
- What is the spatial variability of heat and moisture fluxes over ice and land surfaces?

In addition to obtaining measurements to address these questions, ERASMUS will serve as a test case to evaluate the potential for future atmosphere measurements using UAS at the Oliktok Point facility. This facility is unique in that it is associated with FAA Restricted Area R-2204, which can be activated by Sandia National Laboratory to allow for UAS operations. Additionally, this facility will host the third ARM mobile facility (ARM AMF3), an extensive suite of ground-based instrumentation measuring atmospheric quantities ranging from aerosols to cloud microphysics and lower atmospheric structure.

This poster will provide an overview of activities planned as a part of ERASMUS, including information on the DOE Oliktok Point facility, UAS development for this campaign, an overview of instrument systems to be deployed, anticipated flight patterns, and an overview of the scientific objectives listed above.

WCD 9. The Developmental Testbed Center's Involvement with the Hurricane WRF: An Overview of Community Support, Testing, and Evaluation

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To expedite the transition of research to operations and to aid in the improvement of hurricane models, the DTC provides user support and rigorously tests new experimental configurations of the Community Hurricane Weather Research and Forecasting (HWRF) system. The DTC provides full support for the August 2013 Community version of HWRF (v3.5a), which not only included all of the 2013 operational capabilities, but expansions that made it possible to cover all of the Northern Hemisphere basins, and perform idealized simulations. The code, its documentation, and extensive datasets for the Community release of HWRF can be downloaded from the DTC website (www.dtcenter.org) and, since its original debut in the community, has been made available for more than 700 individual users worldwide.

The DTC facilitates HWRF developers from multiple government institutions and universities (e.g. NOAA/NCEP, NOAA/ESRL, UCLA, OU) by providing the infrastructure that makes collaboration and exchanging code more efficient, and allows the DTC to rigorously test new advances in hurricane modeling originating from a variety of sources.

This presentation will cover the mechanisms that aid in the transition of research advancements to operations, and the testing activities and procedures at DTC.

WCD 10. High-Resolution Rapid Refresh Prediction of Tornadic Supercells in the U.S. Southern Plains During May 2013

Curtis Alexander (1), David Dowell (2), Steve Weygandt (2), Eric James (1), Stan Benjamin (2)
(1) CIRES, (2) NOAA ESRL

The 13-km Rapid Refresh (RAP) and 3-km convective-allowing High-Resolution Rapid Refresh (HRRR) are hourly updating weather forecast models that use a specially configured version of the Advanced Research WRF (ARW) model (including Thompson microphysics, MYNN PBL, and RUC LSM) and assimilate many novel and most conventional observation types on an hourly basis using Gridpoint Statistical Interpolation (GSI). Included in this assimilation is a procedure for initializing ongoing precipitation systems from observed radar reflectivity data, a cloud analysis to initialize stable layer clouds from METAR and satellite observations, and special techniques to enhance retention of surface observation information.

The HRRR is run hourly out to fifteen forecast hours over a domain covering the entire conterminous United States using initial and boundary conditions from the hourly-cycled RAP and is available in real-time to operational forecasters in both the private and public sectors. The hourly updating HRRR forecasts provide a measure of forecast likelihood in the form of run-to-run consistency that can be translated into probabilities of a particular weather hazard using a time-lagged ensemble with neighborhood spatial and temporal filters of diagnostic fields.

In this presentation we will evaluate HRRR forecasts of several tornadic supercell events that occurred in the southern plains of the U.S. in May of 2013 with significant impacts to communities such as Granbury, Texas on 15 May; Shawnee, Oklahoma on 19 May; Moore, Oklahoma on 20 May; and El Reno, Oklahoma on 31 May. In this evaluation we will focus on both deterministic and probabilistic HRRR forecasts. We will present both HRRR reflectivity and updraft-helicity fields as measures of forecasted convective structure to highlight the skill of the deterministic forecasts in accurately identifying regions of observed supercells.

We will also evaluate the model-forecasted local environmental kinematic and thermodynamic parameters including vertical wind shear in the lowest kilometer, low-level storm-relative helicity, most unstable parcel level, lifting condensation level and CAPE/CIN to determine the potential to discriminate between non-tornadic and tornadic supercells in the HRRR forecasts. We will synthesize both the explicitly forecasted supercell structures and the forecasted local environmental information in a time-lagged ensemble to produce an hourly probabilistic estimate of the tornado potential across regions containing numerous supercells. These probabilistic estimates will be compared with the observed tornado reports to determine the accuracy of the hazard estimation in both location and time.

WCD 11. Adaptation at the Municipal Scale in the US Mountain West: What Drives Action in the Face of Weather and Climate-Related Hazards?

Lisa Dilling (1)(2), Krister Andersson (1)(3), John Berggren (1)(2), Ashwin Ravikumar (1)(4)
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(3) Political Science and Environmental Studies, (4) CIFOR (Center for International Forestry Research)

As adaptation to climate change emerges, it is clear that much of the action necessary to prepare for and respond to climate change impacts lies with decision makers at the local scale. While there have been pockets of activity and some substantial progress in areas, many barriers to climate change adaptation have been described. Barriers to climate change adaptation include lack of resources, lack of information, incompatible attitudes and perceptions, fear of political ramifications, etc. However many cities are well used to responding to weather and climate hazards, and have proactively prepared for such hazards, even if they are not particularly frequent. As a complement to studies that examine barriers to adaptation, we chose to conduct a study of the drivers that lead to planning for and adapting to weather and climate-related hazards at the municipal scale, as a proxy for understanding what might drive adaptive behavior towards climate change. Climate change impacts will also partially be expressed through such extremes, so we suggest that behavior toward extremes may provide key insights into drivers of adaptation in the future. We studied U.S. municipalities in the intermountain west states of Colorado, Wyoming and Utah. These municipalities experience extreme climate events such as flooding, droughts, wildfire, blizzards, hailstorms, and tornadoes on a regular basis, some more recent examples being the Black Forest Fire and the 2013 Front Range Floods. To assess responses and planning to natural hazards and extreme events in the region, we conducted face-to-face and phone interviews with multiple key informants in a randomly selected sample of 60 municipalities with populations over 10,000. The goal of these interviews was to ask about the risks of weather and climate-related hazards, past events, responses taken (if any), planning activities, and the role of informal community groups, state and national policies, and other influences on municipal actions. One of our goals with this initial phase was to understand the range of possible responses and to generate hypotheses to explain the differences in responses (i.e. the drivers of adaptive actions). We find that many municipalities have implemented policies that are adaptive to climate-related hazards, although there are significant differences in responses between municipalities, and suggest a role for multiple drivers of adaptive responses.

WCD 12. Evaluation of Operational Weather Radar Rainfall Estimates in Flood-Prone areas of California

Sergey Matrosov (1), Marty Ralph (2), Paul Neiman (3), Allen White (3)
(1) CIRES, (2) Scripps Institution of Oceanography, (3) NOAA ESRL

The flood-prone river basins in many of the mountainous regions of California's coastal areas are believed to lack adequate operational radar coverage. This study evaluates quantitative precipitation estimation (QPE) from operational WSR-88D radar measurements in the vicinity of the Russian River basin, which sometimes floods during severe precipitation events caused by landfilling atmospheric rivers. A vertical profile of reflectivity (VPR) correction was devised for use with the WSR-88D data to improve QPE results. The QPE assessment was performed using multi-year observations from a ground-based site operated by the NOAA's Hydrometeorology Testbed (HMT) Program. HMT data included high resolution gauge measurements and S-band profiler observations, which provided high-resolution information on the vertical structure of precipitation. It is shown that the WSR-88 measurements detect most of the bright band (BB) rainfall, which contributed over half of the total precipitation. For this rain type the VPR corrected hourly QPE results showed relatively small mean absolute biases (<10-15%) and errors of about 50-60%. About one third of the total rainy hours with mostly shallow non-bright-band (NBB) rain, which generally was lighter than BB rain and provided approximately 15% of total precipitation, were not detected by the operational radar. The accuracy of radar-based QPE for the detected fraction of NBB rain was rather poor with biases of approximately -50% - -60% and characteristic errors around 80%. On some occasions, the radar provided false rain accumulations when detecting high clouds, which did not precipitate at the ground or coexisted with shallow rain (~ 6% of total accumulation). For heavier rainfall with significant total accumulations, which provided significant flood hazards, radar-based QPE results for precipitation event totals showed relatively good agreement with gauge data.

WCD 13. El Niño-Southern Oscillation (ENSO) Interdecadal Modulation: A Linear Inverse Modeling Perspective

Antonietta Capotondi, Prashant Sardeshmukh
CIRES and NOAA ESRL

ENSO characteristics, including amplitude, temporal evolution, and spatial pattern, vary on decadal/inter-decadal timescales, as revealed by observations, long ocean reanalysis, and climate model simulations. It is still unclear whether these low-frequency changes in ENSO properties can be associated with changes in the system dynamics (for example changes in the mean state), with differences in the statistics of the atmospheric forcing, with anthropogenic forcing, or merely due to sampling. In this study we use Linear Inverse Modeling (LIM) to examine interdecadal ENSO variations in a 1200 years pre-industrial control integration of the National Center for Atmospheric Research (NCAR) Community Climate System Model version 4 (CCSM4). A pre-industrial control integration is chosen because of its millennial duration, as well as to examine ENSO diversity in the context of natural variability. LIM describes the evolution of a dynamical system in terms of a linear operator, encapsulating the system dynamics, and noise. Thus, it is an ideal framework for identifying the relative roles of changes in dynamics, changes in the noise statistics, and sampling in ENSO low-frequency variations. Our results indicate that even variations in amplitude as large as 50% may be entirely due to sampling. These results have important implications for the detection of anthropogenic signals in the tropical Pacific Ocean.

WCD 14. Co-Producing Future Climate Scenarios for Adaptation and Management in the Gunnison Basin: An Integrative Framework for Developing Usable Climate Information

Katherine Clifford(1)(2), Imtiaz Rangwala(1), William Travis(1)(2), Eric Gordon(1)
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This research aims to develop usable climate information for decision making at local scales using an integrative framework, involving interactions between scientists and stakeholders, that facilitates a better understanding of the stakeholder's climate needs and sensitivities. We present a study from the Gunnison Basin, located in southwestern Colorado, that uses this framework to understand the climate needs of a diverse group of stakeholders, which includes ranchers, recreationalists, scientists, and public land managers, and how this local knowledge can be effectively utilized in creating usable future climate narratives for community level decision-making. We present an analysis based on detailed interviews of stakeholders which examine how elements of (1) spatial (e.g., region, watershed, slope) and temporal (e.g., seasonal, generational) scales, (2) features (e.g., snowpack, monsoon, avalanches, dust on snow, frost, storms), (3) processes (e.g., precipitation, runoff, evapotranspiration, fire, population dynamics, pest invasions), and (4) outcomes (e.g., harvest, income, user-days) can be incorporated with physical models and scientific understanding to identify the stakeholder's climate needs, and develop effective climate scenarios for decision making.

WCD 15. A Ramp Tool and Metric to Measure the Skill of Numerical Weather Prediction Models at Forecasting Wind Ramp Events

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We present a Ramp Tool and Metric. This tool was developed out of recognition that relatively rare ramp events (large changes of power – Δp – in a short period of time – Δt) have a greater impact on grid integration costs for wind energy than do the quiescent periods between ramp events. A standard metric (such as MAE or RMSE) that does not give special consideration to ramp events may not give an adequate representation of model skill or model skill improvement. To test the Ramp Tool and Metric we used the NOAA/ESRL Rapid Refresh Numerical Model (RAP) which runs at 13km horizontal resolution.

This ramp tool has three components:
1) The first is a process to identify ramp events in the time series of power. Three different ramp identification methods were developed to see if a consistent best method can be identified.
2) The second component is a method for matching in time each forecast ramp event with the most appropriate observed ramp event.
3) The third and last component of the ramp tool is a process through which a skill score of the forecast model is determined. The skill score is calculated from a utility operator's perspective, incorporates both phase (timing) and amplitude errors, and recognizes that up and down ramps can have significantly different impacts on grid operation.

Since no single pair of power and time thresholds defines a ramp, and in fact some utilities may be interested in several different Δp, Δt definitions of a ramp at the same time, the ramp skill metric integrates skill over a range of Δp, Δt values.

WCD 16. The Climatological Distribution of Extreme Arctic winds, and Implications for Ocean and Sea Ice Processes

Mimi Hughes (1), John Cassano (1)
(1) CIRES

Some of the strongest near-surface winds on Earth form in the Arctic due to mesoscale processes such as polar lows and barrier jets. The strong surface winds in the arctic have important impacts on ocean and sea ice circulation. We examine the climatological distribution of over-ocean, near-surface wind speeds within a pan-Arctic domain in five gridded datasets: the ECMWF Interim reanalysis (ERA-I), the Climate Forecast System Reanalysis (CFSR), version 2 of the common ocean-ice reference experiment dataset (COREv2), and two regional climate simulations generated using the Weather, Research, and Forecast (WRF) model run at 50 km (WRF50) and 10 km (WRF10) horizontal resolutions with ERA Interim as lateral boundary conditions. To examine the influence of spatial resolution on near surface wind speeds, we estimate probability density functions of the four lower-resolution (i.e., ERA-I, CFSR, COREv2, and WRF50) dataset's 10m wind speed for an 18-year (1990-2007) period. We also show the annual cycle and long-term maps of the 90th, 95th, and 99th percentiles and maximum wind speeds. Despite having lateral boundary conditions from ERA-I, WRF50's wind statistics are more similar to CFSR, suggesting that the similar horizontal resolution of the two datasets is playing a strong role in determining wind statistics.

We then perform the same statistical analysis of winds on all five datasets for two years when 10km data are available (June 2005 to May 2007); despite the much shorter time period, the Pan-Arctic statistics are very similar to those from the 18-year analysis. WRF10 differs from WRF50 in only the most extreme percentiles, which are hypothesized to be near coastal Greenland during strong downslope wind events. We repeat the wind speed statistical analysis within a subdomain surrounding Greenland and find that WRF10 has consistently larger maximum wind speeds, but this difference only appears at wind speed percentiles higher than 99 percent, and further differences in the 99th percentile wind speeds are spatially heterogeneous.

To tie these results to their implications for ocean and sea ice processes, we perform a similar analysis on surface fluxes within the Greenland subdomain using the WRF50 and WRF10 datasets. We find unrealistically large sensible heat fluxes along the sea ice edge, and the geographic distribution and magnitude of these fluxes is shown to be sensitive to sea ice representation in WRF. The results from these atmospheric-only WRF simulations will be useful for estimating the sensitivity of coupled models to atmospheric resolution.

WCD 17. The Characteristic Patterns of Arctic Cyclones from 1979 to 2013

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According to IPCC AR5, the Greenland ice sheet (GrIS) has been losing mass over the last two decades and it is very likely that the average ice loss rate over the period 2002 to 2013 has substantially increased compared to the previous period 1992-2001. At the same time, the Arctic Ocean has seen dramatic reductions in its sea ice cover. While trends in both the sea ice cover and Greenland mass loss may be linked to general Arctic warming and/or shifts in synoptic-scale atmospheric circulation patterns, the relative importance of expanding open water areas on the Greenland surface mass balance (SMB) remain unknown. The GrIS SMB is influenced by the net balance between ablation and precipitation. This study aims to understand how cyclone activity affects the GrIS SMB and if there is a connection between sea ice loss and changes cyclone frequency and intensity. Towards this end, we studied the characteristic patterns of Arctic cyclones using NCEP/NCAR Reanalysis data from 1979 to 2013. We present the results for six continuous pentads considering seasonal variations as well as for composites of high and low sea ice years.

WCD 18. Relative Roles of Gravity and Planetary Waves in Vortex Preconditioning Prior to Sudden Stratospheric Warmings

John R. Albers (1), Thomas Birner (2)
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Recent observational research has suggested that large disruptions of the stratospheric polar vortex – such as those that occur during a major sudden stratospheric warming (SSW) – may modulate deep convection by injecting intrusions of high potential vorticity air into the deep tropical upper troposphere. In particular, because SSWs occur over very particular geographic regions, they provide an interesting opportunity to use knowledge of the state of the stratosphere to help predict where and when convection may be triggered in the deep tropics. However, taking advantage of such a predictive capability will require forecast skill in predicting the occurrence of SSWs themselves. Unfortunately, predicting when a SSW will occur is not yet possible given our current knowledge on how warmings are actually triggered. We make progress on this front as follows.

We conduct a composite analysis using reanalysis data to evaluate the evolution of polar vortex geometry prior to the onset of two distinct categories of SSWs: vortex splitting events versus vortex displacements events. Using the composite analysis as a guide, we conduct a case study of the 2009 SSW in order to evaluate the roles of planetary and gravity waves for preconditioning the polar vortex in terms of two SSW triggering scenarios: anomalous planetary wave forcing from the troposphere, and resonance due to either internal or external Rossby waves. The results support the view that split SSWs are caused by resonance rather than anomalously large wave forcing. Given these findings, we suggest that vortex preconditioning – which is traditionally defined in terms of vortex geometries that increase poleward wave focusing – may be better described by wave events that 'tune' the geometry of the vortex towards its resonant excitation points.

WCD 19. Leading Modes of Synoptic Scale Convective Activity Over the Central Pacific

Juliana Dias (1), George Kiladis (2) and Maria Gehne (1)
(1) CIRES, (2) NOAA ESRL PSD

The Pacific Intertropical Convergence Zone (ITCZ) and South Pacific Convergence Zone (SPCZ) are characterized by a broad spectrum of synoptic convective activity. An Empirical Orthogonal Function (EOF) analysis of global tropical (20S-20N) brightness temperature (Tb) data filtered to retain fluctuations from 2-6 days reveals out of phase variations in convection on either side of the equator within the Pacific, with a period of around 4 days. This antisymmetric pattern of convection is consistent with zonally propagating disturbances such as mixed Rossby-gravity (Yanai) and eastward inertio gravity waves. However, a lag-regression analysis of the EOF pattern shows that this convective signal propagates poleward in both hemispheres over time, with little zonal propagation evident. On the other hand, projection of the circulation data onto this convective pattern reveals westward propagation that is consisted with Yanai modes. In addition, spectral analyses of the EOF signal as well as long space-time series of Tb suggest that Yanai and EIG waves form a continuum, which should not necessarily be separated into westward versus eastward components. Theoretical shallow water modes are used to interpret the 2-6 days convective and associated circulation pattern, where it shown that an interference signal between Yanai and EIG waves results in EOF patterns similar to the observations.

WCD 20. Wind Resource Assessments from Two Years of Short-Range High-Resolution Rapid Refresh Forecasts

Eric James (1), Curtis Alexander (1), Brian Jamison (2), and Stan Benjamin (3)
(1) CIRES, (2) CIRA, (3) NOAA ESRL

The High-Resolution Rapid Refresh (HRRR) model is being run hourly in real-time at the Global Systems Division (GSD) of the Earth System Research Laboratory (ESRL). The model is run out to fifteen forecast hours over a domain covering the entire conterminous United States (CONUS) at a spatial resolution of three kilometers, allowing the use of explicit convection. Initial and boundary conditions are obtained from the operational Rapid Refresh (RAP), and three-dimensional variational data assimilation including radar reflectivity observations was implemented in April 2013 within the 3-km HRRR.

The three kilometer scale and hourly updating of the HRRR lends itself to forecasts of small-scale weather variability. Renewable energy forecasting is one of many meteorological applications in which accurate depiction of small-scale spatial and temporal variability of sensible weather elements is critical. Low-level winds, for example, are highly dependent on small-scale orographic and coastal effects, especially in regions of complex terrain, and the HRRR can provide high-resolution forecasts in these regions. The high resolution also permits an accurate depiction of convective-scale structures and their local impacts on wind speeds.

In this study, we analyze long-term averages of HRRR two-hour forecasts of 80-m wind speed in order to estimate renewable energy resource potential in different regions of the country. The short-term (two hour) forecasts allow sufficient time for model spin-up at the smallest resolvable scales while minimizing forecast error inherent in longer forecast lengths.

We will present the methodology and some preliminary results including various measures of the model low-level wind field averages and variability during 2012-13, with a focus on thresholding winds speeds to identify regions of high potential for wind energy development. We will also describe the diurnal cycle of winds, both within the central plains wind corridor and in some regions under consideration for offshore wind farm development. The wind resource availability in each season will be compared between the two years in the context of the relatively dry 2012 and wet 2013 over much of the CONUS.

WCD 21.A Diagnostic of MJO Predictability Estimates Using Observational Power Spectra

Maria Gehne (1), Juliana Dias (1), George Kiladis (2)
(1) CIRES, (2) NOAA ESRL PSD

Understanding of the convection associated with the Madden-Julian oscillation (MJO) and its multiscale variability remains a challenge. There is need for simple diagnostics applicable to both observations and model output to improve understanding and aid with model evaluation. Here, a diagnostic based on a two dimensional linear damped oscillator with white noise stochastic forcing and observed power spectra is presented to diagnose decay time, period and stochastic forcing statistics for the MJO.

To assess the MJO multiscale variability an index of the intraseasonal MJO is defined that retains low and high frequency variability of tropical convection associated with the MJO. The index is based on the first two empirical orthogonal functions (EOFs) of latitudinally averaged (15S-15N) and band pass filtered (20-100 days) brightness temperature (Tb), but retains the low frequencies by projecting the full daily Tb anomalies onto the EOF patterns. The variance of the first and second EOF is 23% and 17% respectively.

Spectral analysis of the two principal components (PC1,2) reveals very different characteristics for PC1 and PC2. Both show a distinct spectral peak at the mean MJO frequency of 0.02cpd with more power in the PC1spectrum. The PC2 spectrum has a substantial amount of power at low frequencies (<0.01cpd), dominating the PC1 spectrum and even the MJO peak power. The diagnostic yields a period of 49 days and a decay time of 10-13 days, which is close to previous estimates of the prediction limits for the MJO, although slightly on the low side. In addition, there is less forcing variance on the PC2 time series as estimated by the diagnostic. Both, the increased low frequency power and the lower forcing variance of PC2, are related to the spatial pattern associated with PC2. The main loading of EOF2 is located between 90E-150E in the western Pacific warm pool, where generally the warmest sea surface temperatures (SSTs) are found. Due to this PC2 has a much stronger El Ni~no - Southern Oscillation (ENSO) signal (also visible in the time series) than PC1, and convection in this region can be initiated by small perturbations on the warm SST background state. ENSO appears to have only a minor influence on PC1 variability.

Estimates of period and decay time depend on the index used in the diagnostic. Convection based MJO indeces and indeces that include information about the circulation (RMM) are compared. Seasonal variability of the estimated period and decay time is assessed.

WCD 22. Terrain-Blocked Airflow and Orographic Precipitation Along the Coast of Northern California

Raul Valenzuela(1,2) and David Kingsmill (2,3)
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Several past studies have addressed the role of terrain-blocked airflow on orographic precipitation (OP) over relatively large orographic barriers, such as The Olympics, The Sierra Nevada, and The Alps, just to name a few. In a broad sense, terrain-blocked flow acts as a virtual barrier, lifting an incoming airflow before the orographic barrier's windward side so OP can be initiated in advance of the windward slope, complicating classical mechanisms like upslope ascent and seeder-feeder.

An accurate understanding of the OP forcing is needed where complex terrain is directly exposed to strong upslope winds carrying large amounts of water vapor because the hydrological consequences can be devastating for nearby populated areas. For example, past studies show large hydrological impacts associated with atmospheric rivers (AR) making landfall along the mountainous west coast of the U.S. Here we analyze a terrain-blocked flow case where an AR made landfall along northern California, focusing on a relatively small-scale barrier such as the coastal ranges. Some of the questions we try to answer are: do terrain-blocked flows along the coastal range manifest similarly to their large-scale counterparts? Is the terrain-blocked flow able to force or modify precipitation along and offshore of the northern California coast? The primary observing asset is a scanning X-band Doppler radar that allows the three-dimensional airflow and precipitation structure analysis along and up to 50 km offshore of the coastline. Additional observational context is provided by a 915 MHz wind profiler.

One unique result is the documentation of the terrain-blocked airflow interface moving toward and with a skewed orientation relative to the coast. In addition, we have applied a countered frequency by distance diagram (CFDD) to attenuation-corrected reflectivity, allowing the documentation of horizontal effects of terrain-blocked flow on orographic precipitation.

WCD 23. Rapid Core Magnetic Field Variations Over the Past Decade

Arnaud Chulliat (1), Stefan Maus (2)
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It has long been observed that the geomagnetic secular acceleration (defined as the second order time derivative of the field) at ground observatories undergoes some sudden changes of polarity, referred to as geomagnetic jerks. The better space-time data coverage and overall data precision provided by the Oersted and CHAMP satellites recently made it possible to model the secular acceleration on the global scale. Unlike measurements at isolated observatories, secular acceleration spherical harmonic models can be downward continued to the core-mantle boundary, thus providing new information on rapid core dynamics. We calculated secular acceleration models from CHAMP data every 30 days from 2002 to 2009.5 on a three-year sliding window. We found that the secular acceleration underwent two large 'pulses' at the core-mantle boundary, one centered in 2006 and the other centered in 2009. These two pulses are separated by a geomagnetic jerk near 2007, and delimited by two other jerks near 2003 and 2010.5. Their spatial structures at the core-mantle boundary are highly anti-correlated and suggest the existence of a localized standing wave at the core surface, of period 5 to 6 years, in the low-latitude Atlantic sector. Possible interpretations of this wave in terms of core processes will be discussed, as well as relationships with other rapid core field variations observed in geomagnetic data.

WCD 24. Planning for an Uncertain Future: Climate Change and the Salt Lake City Water Supply

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Assessing climate change risk to municipal water supplies is often conducted by hydrologic modeling specific to local watersheds and infrastructure to ensure that outputs are compatible with existing planning frameworks and processes. This study, lead by the CIRES Western Water Assessment, leverages the modeling capacity of an operational National Weather Service River Forecast Center to explore the potential impacts of future climate-driven hydrologic changes on factors important to planning at the Salt Lake City Department of Public Utilities (SLC). Hydrologic modeling results for the study area align with prior research in showing that temperature changes alone will lead to earlier runoff and reduced runoff volume. The sensitivity of average annual flow to temperature varies significantly between watersheds, averaging -3.8% /°F and ranging from -1.8% to -6.5% flow reduction per degree Fahrenheit of warming. The largest flow reductions occur during the high water demand months of May through September. Precipitation drives hydrologic response more strongly than temperature, with each 1% precipitation change producing an average 1.9% runoff change of the same sign. We explore the consequences of climate change for the reliability of SLC's water supply system using scenarios that include hydrologic changes in average conditions, severe drought scenarios, and future water demand test cases. The most significant water management impacts will be earlier and reduced runoff volume, which threaten the system's ability to maintain adequate streamflow and storage to meet late-summer water demands. Ongoing work utilizing an integrated water system model in development will broaden the scenario planning capacity to include changes in climate, hydrology, infrastructure, management and growth.

WCD 25. Understanding the Climate Science Needs of Natural Resource Managers in the Prairie Pothole Region

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In the face of increasing risks from climate change, natural resource managers and decision-makers have growing needs for actionable information about these risks to inform management outcomes and policies. At the same time, physical scientists and earth system modelers face increasing pressure to provide appropriate climate information to inform policy discussions and decision-making. In the Prairie Pothole Region (PPR), the need to make wildlife conservation and land management decisions in the context of a changing climate is complicated by socio-economic factors, including the expansion of oil and natural gas development, increased incentives for the conversion of prairie and native grassland to agricultural production, and declining Federal support for existing conservation programs on private lands. This project will combine quantitative and qualitative research methods to understand how different state and Federal management institutions leverage climate knowledge and climate science in the context of the PPR. Specifically, we seek to identify the climate science needs of natural resource managers, how those users receive climate knowledge, and how and when climate science is used during decision-making process on annual to decadal time scales.

WCD 26. Ensemble Modeling of the July 23, 2012 CME Event

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On July 23, 2012 a large and very fast coronal mass ejection (CME) was observed by STEREO A. This CME was unusual in that the estimates of the speed of the CME ranged from 2125 km/s to 2780 km/s based on dividing the distance of STEREO A from the Sun by the transit time of the CME. Modeling of this CME event with the WSA-Enlil model has also suggested that a very fast speed is required in order to obtain the correct arrival time at 1 AU. We present a systematic study of parameter space for the July 23, 2012 CME event through an ensemble study using the WSA-Enlil model to predict the arrival time of the CME at STEREO A. We investigate how variations in the initial speed, angular width, and direction affect the predicted arrival time. We also explore how variations in the background solar wind influence CME arrival time by using varying ADAPT maps within our ensemble study. Factors involved in the fast transit time of this large CME are discussed and the optimal CME parameters are presented.

WCD 27. Cyclostationary Empirical Orthogonal Function Representations of the Evolution of the Southern Oscillation Leading to El Nino-Southern Oscillation Warm Events

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A description, due to van Loon and co-workers, of large-scale sea-level pressure (SLP) variations on the Southern Hemisphere (SH) documents the evolution toward El Nino- Southern Oscillation (ENSO) warm events. Particular SLP variations in May-June are strong predictors for the peak warming of tropical eastern Pacific sea-surface temperatures (SST) that mark the mature phase of an ENSO warm event in December- January of the following year. SH SLP evolution has been demonstrated in earlier works, beginning with point-to-point indices (e.g., the Southern Oscillation Index or SOI), and later in seasonal time series of regional averages of SLP reconstructions and reanalyses. Similar averages of ancillary datasets, including SST and surface winds, support various phases in the SLP evolution description. Cyclostationary empirical orthogonal functions (CSEOFs) are used here to consolidate and confirm this description of SLP evolution leading to ENSO warm events. A CSEOF loading vector, given an annual nested period and monthly SLP data, consists of 12 SLP patterns per mode. The second leading CSEOF mode loading vector isolates and provides a clear hemispheric picture of the SLP evolution in warm event years. Monthly SLP data from NCEP-NCAR reanalyses were treated for the period 1950 to present, for the Pacific Ocean basin from 50°N to 50°S. The principal component time series associated with CSEOF mode 2 compares well with the Multivariate ENSO Index and with monthly-regional average SLP on the SH for the multi-decadal period in question. CSEOF mode 2 comparisons with SST and surface winds are also examined.

WCD 28. Using REST-Like URLs to Create an Interactive Interface to a Custom Set of Web Products

Catherine Smith(1), Donald Murray(2) and Don Hooper(3)
(1) NOAA ESRL,(2) NOAA ESRL,(3) NOAA ESRL

NOAA/ESRL PSD has a large suite of climate and weather web tools where users can interactively create maps and other plots from our large data holdings. The tools are largely specific as to the type of product they can generate (maps, time-series plots, vertical cross-sections, Hovmollers, daily vs monthly data) though they are flexible in terms of date and region selection. In order to examine meteorological details of a specific climate or weather event, users often have to go to separate web pages to generate the different types of plots or select multiple variables, one at a time on a particular page. To make this process easier, we have created a web page http://www.esrl.noaa.gov/psd./data/multiplot/ where users can generate a predefined set of plots for a particular type of weather/climate event. The user simply selects a date, region and a type of product (for example, 'flooding' or 'Arctic annular mode') and a set of images is returned. For example, selecting 'Arctic annual mode' returns recent AO and NAO time series, a temperature anomaly map, a correlation map of the AO with SLP, and a vertical cross section of zonal wind. Users can step forward or backward through time to see the time evolution of the variables being plotted. The webpage code generates a unique URL for each image using the region, date and type. The code returns a table containing the images which are defined by URLs needed to generate each plot. This style of generating web products is similar to the REpresentational State Transfer (REST) style in that a unique URL with a specific syntax generates an image directly and the user doesn't need to know anything about the underlying data structure to obtain a product. By using this approach, we were able to leverage all of our already ready existing web pages. The set of plots returned for each weather/climate type are being defined by scientists and more will be added in the future. A link for each page that generates the plot is provided so users can explore a particular product in more depth.

WCD 29. Impact of Small Scale E-Field Variability and Lower Atmospheric Forcing on Thermospheric O/N2 Column Density

Jack Olsen, Mariangel Fedrizzi, Mihail Codrescu, Tim Fuller-Rowell
NOAA SWPC, CIRES

Over the past few decades, physical models have greatly enhanced the scientific knowledge of the complex Sun-Earth system. The creation of these models has been a steady process of developing numerical simulations and comparing their output with reliable observations of the real systems being modeled. The value of these physical models and the knowledge we gain from them is highly dependent on the validity of said models. This study aims to quantitatively assess the global, three-dimensional, time-dependent, non-linear coupled model of the thermosphere, ionosphere, plasmasphere, and electrodynamics (CTIPe). We explore the CTIPe model's calculations of the O/N2 ratios, using observations from the TIMED-GUVI satellite. A comparison-by-visualization tool contrasts the daily global averages and the monthly longitudinal cross-sections of the composition. The daily global averaging helps to gain a 'big picture' sense of seasonal variations. The month-by-month comparison across latitudes, with all longitudes averaged, displays the finer details of the distribution of the O/N2 composition. These visualizations are accompanied by statistical variation calculations and together are used on various simulations of the CTIPe model, with slight changes made to the small scale electric field variability and tidal forcing.

Poster Abstracts

WCD 30. The Experimental Regional Ensemble Forecast System (ExREF)

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The Experimental Regional Ensemble Forecast (ExREF) system has been a component of the Hydrometeorology Testbed (HMT) numerical weather prediction suite in the past two winters. Its results are distributed to the Sacramento, CA National Weather Service (NWS) Weather Forecast Office and River Forecast Center, where they are ingested in the Advanced Weather Interactive Processing System (AWIPS) to provide guidance on the forecasting of extreme precipitation events. ExREF has also been used as experimental guidance for the NWS Weather Prediction Center Flash Flood and Intense Rainfall (FFaIR) and Winter Weather experiments. Finally, ExREF is being ingested and tested by a private company as guidance for winter precipitation events that can bring down power lines or disrupt reliability of power to customers.

ExREF is run in near-realtime by the Global Systems Division (GSD) of the NOAA Earth System Research Laboratory (ESRL). Currently the eight-member ExREF domain covers most of North America in order to make results applicable to a variety of weather regimes and NOAA programmatic needs. In spite of all its realtime applications, ExREF is not an operational system or a system planned for operational transition as is. Instead, ExREF is a tool for the development and testing of new Numerical Weather Prediction (NWP) methodologies. It employs 9-km grid spacing so tests are conducted with higher resolution than the current NCEP operational Short-Range Ensemble Forecast (SREF) system. At this time, the realtime ExREF has representation of model uncertainty (through diversity of microphysics parameterizations) and initial condition uncertainty (through dynamically-downscaled Global Ensemble Forecast System (GEFS) analyses).

In this presentation we will provide an ExREF overview, along with examples of its use in a testbed context and as a platform for testing new techniques that can lead to improvement of operational ensemble forecasting.

WCD 31. Ionosphere Plasmasphere Electrodynamics (IPE) Model Development for Understanding Connection Between Terrestrial and Space Weather

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IPE model has been developed by collaboration between CU CIRES, NOAA SWPC and GSD, in order to improve our specification of ionosphere and plasmasphere in response to external forcing from both above and below, and to be coupled to whole atmosphere models for understanding an impact of the terrestrial weather to space weather. The model describes the time dependent, three-dimensional, global density of nine ion species, electron density, temperatures of electron and ions in the ionosphere and plasmasphere. The parallel plasma transport is based on Field Line Interhemispheric Plasma (FLIP) Model [Richards et al., 1990]. A realistic model of Earth's magnetic field is implemented by using the APEX coordinate system [Richmond, 1995]. Global, seamless plasma transport perpendicular to the magnetic field has been included all the way from the equator to the poles. The electrodynamics solver is based on the TIEGCM [Richmond and Maute 2013]. It self-consistently calculates the electric field as one of the main driver for the Ionosphere-Plasmasphere module. The code has been parallelized using MPI/Scalable Modeling System (SMS) [Govett et al., 2003], in order to speed up the code to meet so that its run speed will be comparable to that of the whole atmosphere model. The code scales reasonably well, and runs up to 640 processors, by decomposing both latitude and longitude direction in a flexible manner determined at run time. The recent developments will be updated in this presentation.

In this presentation we will provide an ExREF overview, along with examples of its use in a testbed context and as a platform for testing new techniques that can lead to improvement of operational ensemble forecasting.

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DAVID OONK/CIRES

Back row, left to right: Anne Perring, Robin Strelow, Ben Livneh, Joe Olson, Chris Clack
Front row, left to right: Kiki Holl, Gloria Hicks, Doug Fowler, Lucia Harrop, Barry Eakins, Richard Tisinai
Not pictured: Deann Miller, David Stone

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