Update in Joint OSSE System
- Control data in 2012 observing system -

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NOAA/NWS/NCEP/EMC, JCSDA, Wyle IS

Contribution from
Jack Woollen [2], Sean Casey [5], *Zaizhong Ma* [5], Tong Zhu, *Lars Peter Riishojgaard* [4], *Steven Greco* [3], *Sidney Wood* [3], *David Emmitt* [3],
CRTM developers, GSI developers

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[4] JCSDA, UMCP[5] JCSDA, UCAR, UMCP

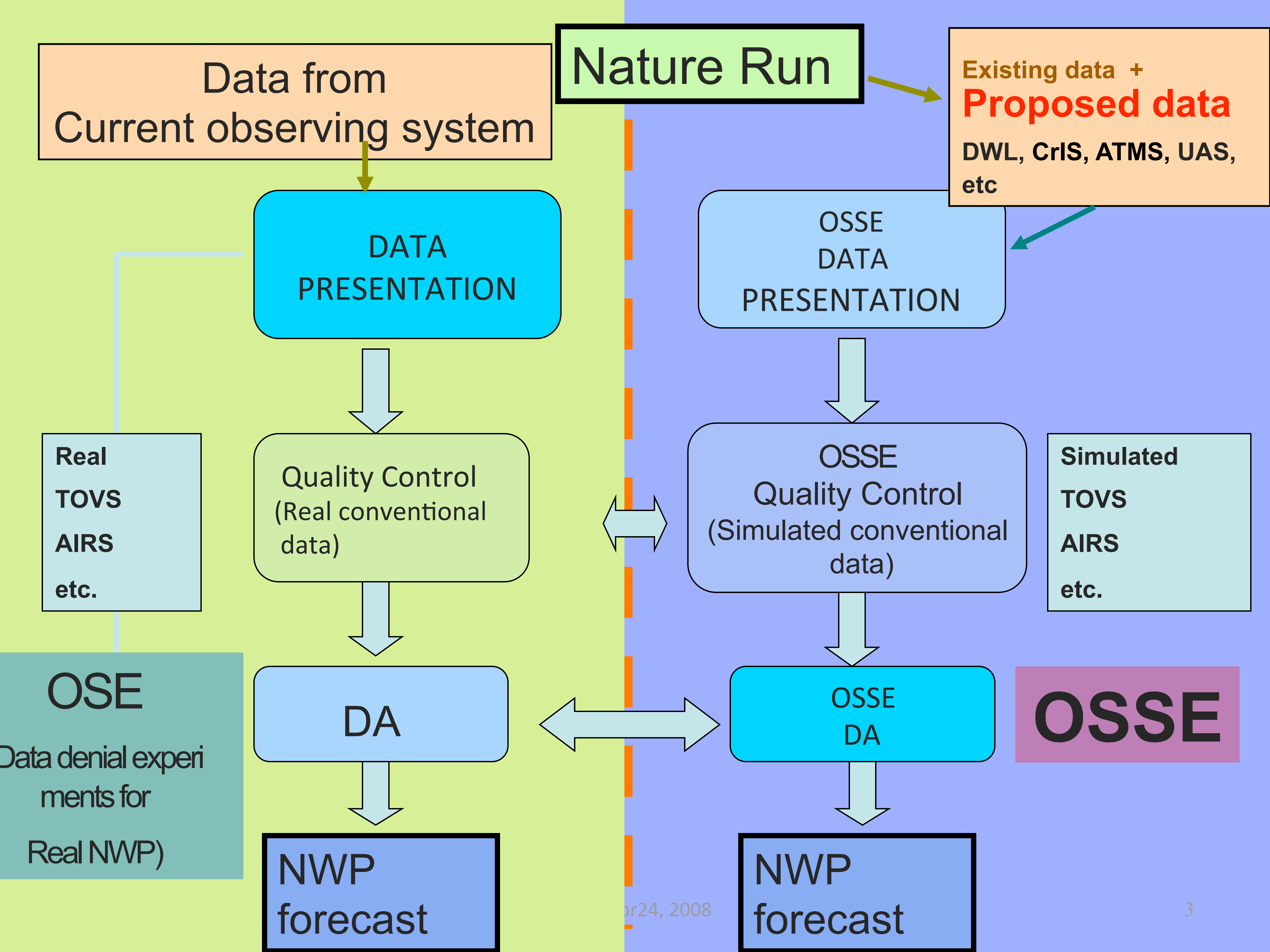
Observing Systems Simulation Experiments (OSSEs)

OSSE
Evaluate observing systems and data assimilation systems using simulation experiments.

OSSE can provide quantitative estimate of data impact of future instruments

Potentially save large amount of expense.

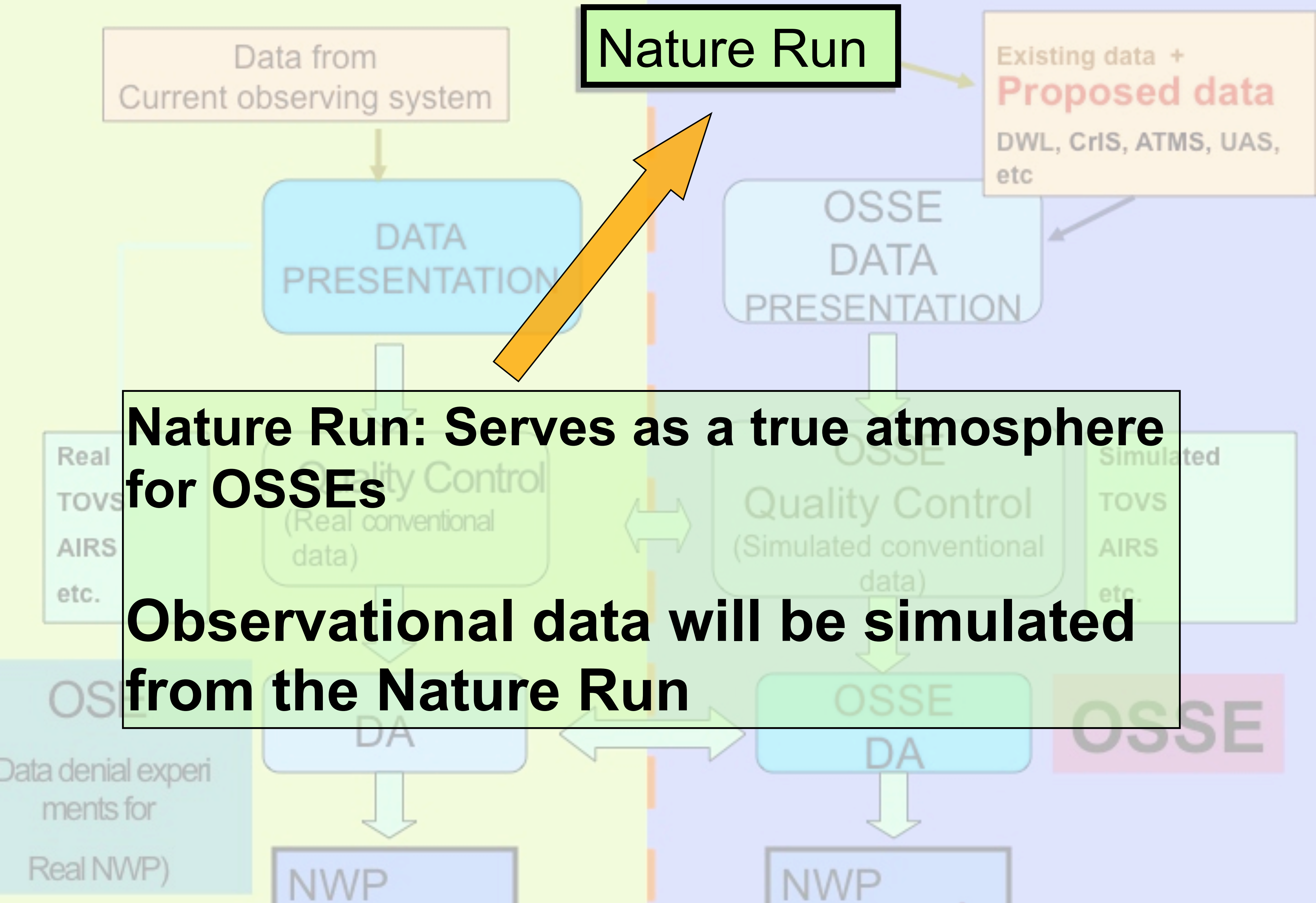
OSSE can be used to evaluate data assimilation system

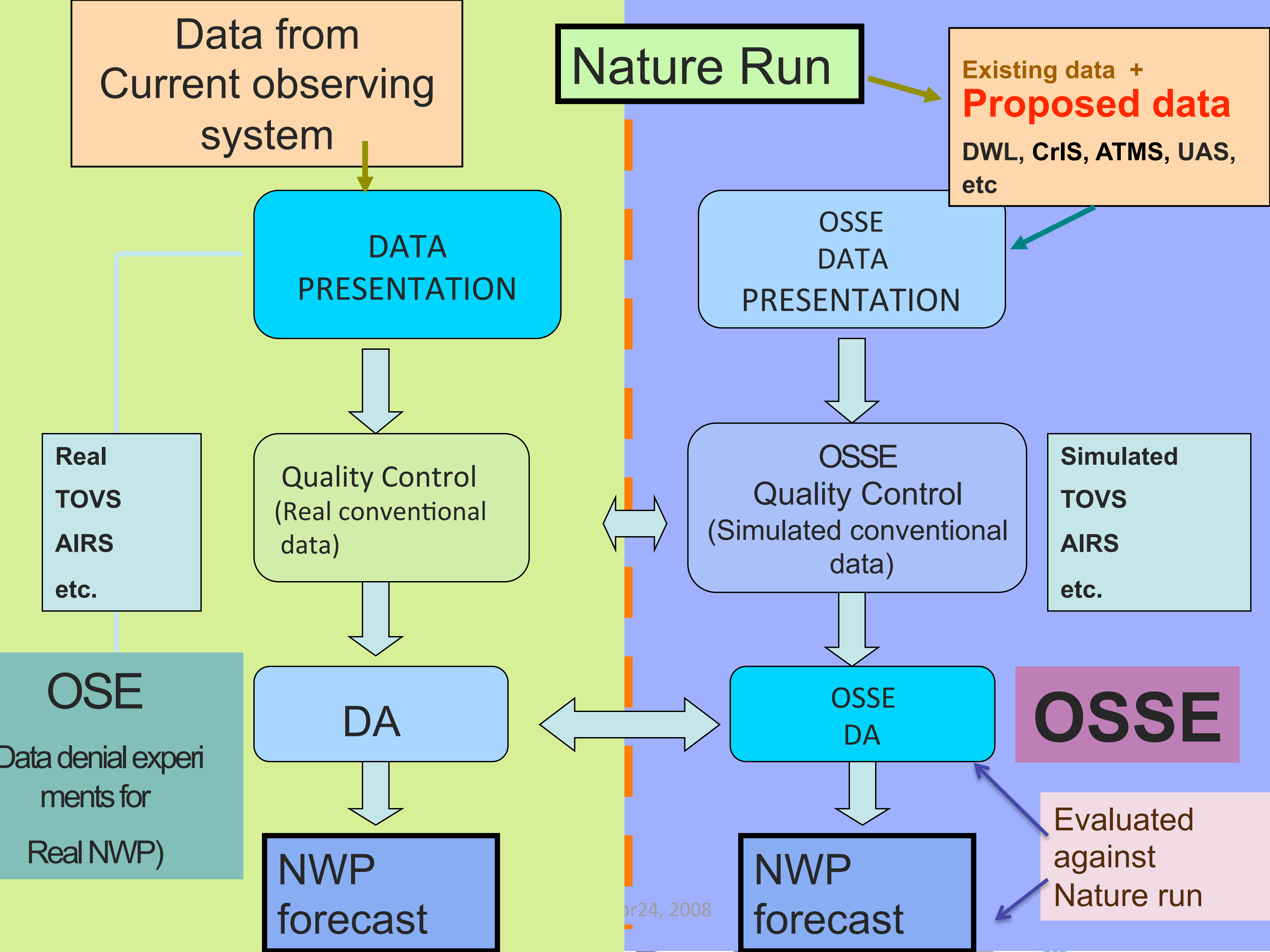

Data from
Current observing system
Nature Run
Existing data +
Proposed data
DWL, CrIS, ATMS, UAS, etc
DATA PRESENTATION
OSSE DATA PRESENTATION
Real
TOVS
AIRS
etc.
Quality Control
(Real conventional data)
OSSE
Quality Control
(Simulated conventional data)
Simulated
TOVS
AIRS
etc.
OSE
Data denial experiments for
Real NWP)
DA
OSSE DA
OSSE
NWP forecast
NWP forecast

Nature Run

Nature Run: Serves as a true atmosphere for OSSEs

Observational data will be simulated from the Nature Run





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DA
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OSSE
Evaluated against Nature run
NWP forecast
NWP forecast
r24, 2008

International Joint OSSE capability

- Full OSSEs are expensive
  - Sharing one Nature Run and simulated observations saves on cost
  - Allow sharing diverse resources

- OSSE-based decisions have international stakeholders
  - Decisions on major space systems have important scientific, technical, financial and political ramifications
  - Community ownership and oversight of OSSE capability is important for maintaining credibility

- Independent but related data assimilation systems allow us to test robustness of answers

Joint OSSE Nature Run Data

Joint OSSE Nature Run by ECMWF
Spectral resolution : T511, Vertical levels: L91, 3 hourly dump

13 month long. Starting at 12Z May 1, 2005
Daily SST and ICE: provided by NCEP

Andersson, Erik and Michiko Masutani 2010: Collaboration on Observing System Simulation Experiments (Joint OSSE), ECMWF News Letter No. 123, Spring 2010, 14-16.

Copies are available to designated users for research purposes & to users known to ECMWF
User list is maintained by Michiko Masutani (NOAA/NCEP)
contact: michiko.masutani@noaa.gov

Complete Nature Run data set is posted at NASA/NCCS portal
http://portal.nccs.nasa.gov/osse/index.pl
Password protected. Accounts are arranged by **Ellen Salmon (Ellen.M.Salmon@NASA.gov)**
Limited data set is available from NCAR
http://dss.ucar.edu/datasets/ds621.0/matrix.html
Contact: Chi-Fan Shih chifan@ucar.edu and Steven Worley worley@ucar.edu

OSSEs Conducted and in Progress

Early Morning Orbit Satellite (JCSDA,EMC,NESDIS,AOML,DOD)

OAWL OSSE (JCSDA, NCEP, SWA,AOML)

Simulation of DWL planned from NASA (SWA)

GWOS OSSE NASA (JCSDA, NCEP/EMC, SWA)

Simulation of radiance data for control experiments and made available to Joint OSSE, NCEP/EMC, NESDIS, NASA/NCCS, NCAR

PREMIER by ESA/ESTEC Environment of Canada

Polar Communications and Weather mission (PCW) Environment of Canada

ADM-Aeolus and follow up mission KNMI, NASA/GSFC/GMAO

Research on observational Error (NASA/GSFC/GMAO)

Evaluation of Hybrid Data assimilation system NCEP, UMD

Evaluation of Unmanned Aircraft System AOML, NOAA/ESRL

Evaluation of results, IITM

WISDOM OSSE (NOAA/ESRL)

Regional OSSE to Evaluate DWL data on Hurricane forecast, Univ Utah

Rigional OSSE on severe storm, Mississippi State University

Simulation of observation for control experiments is a initial investment for OSSE

Upgrade in Simulated observation for Control experiments at JCSDA

Radiance data

Only Clear Sky radiance are posted
(Cloudy radiance are also simulated. Radiance with mask based on GSI usage is also simulated. But these data are not posted.)
Saved in BUFR format
No observational error added

Set A
Entire Nature run period
Type of radiance data and location used for reanalysis from May 2005-May2006
Simulated using CRTM1.2.2 (OPTRAN)

Set B
Type of radiance data location used in 2012
July, August, January and February (July and August completed)
CRTM 2.0.5 (RTTOV) are used.

Type of data simulated

Set A

AIRS (Aqua),
AMSU-A (Aqua, NOAA-15, 16, 18),
AMSU-B (NOAA-15, 16, 17),
HIRS2 (NOAA 14),
HIRS-3 (NOAA 15, 16, 17),
HIRS-4 (NOAA-18),
MSU (NOAA-14),
MHS (NOAA-18)
GOES sounder (GOES-10, 12)

All conventional data available in 2005-2006

Set B

IASI(METOP-A), AIRS(AQUA),
ATMS(NPP), CrIS(NPP)
HIRS-2(NOAA14),
HIRS-3(NOAA 15, 16,17),
HIRS-4(NOAA 18, 19, METOP-A),
AMSUA(NOAA 15, 16, 17,18,19, AQUA, METOP-A),
AMSUB(NOAA 15, 16, 17),
MSU(NOAA 14), HSB(AQUA),
MHS(METOP-A,NOAA18,19),
SSMIS(DMSP F16), SEVIRI(MSG)
GOES sounder (10,12, and 13)

GPSRO,
Addition to set A ASCAT and WINDSAT

DWL OSSE presented used Set A
Set A are posted from NASA/NCCS portal and NCAR

OSSE for Early-Morning-Orbit Observation uses Set B

Next Step
Up grade to CRTM 2.2 or above (improved surface)
Simulation with Cloudy radiance
Cloud track wind is based on Nature Run cloud (SWA)
Observational error to be added

Potential exchange in control observation with other Joint OSSE group

Evaluation of simulated GOES and AMSUA at the 1st step (12hr fcst) of the Nature Run simulated with 2005 template

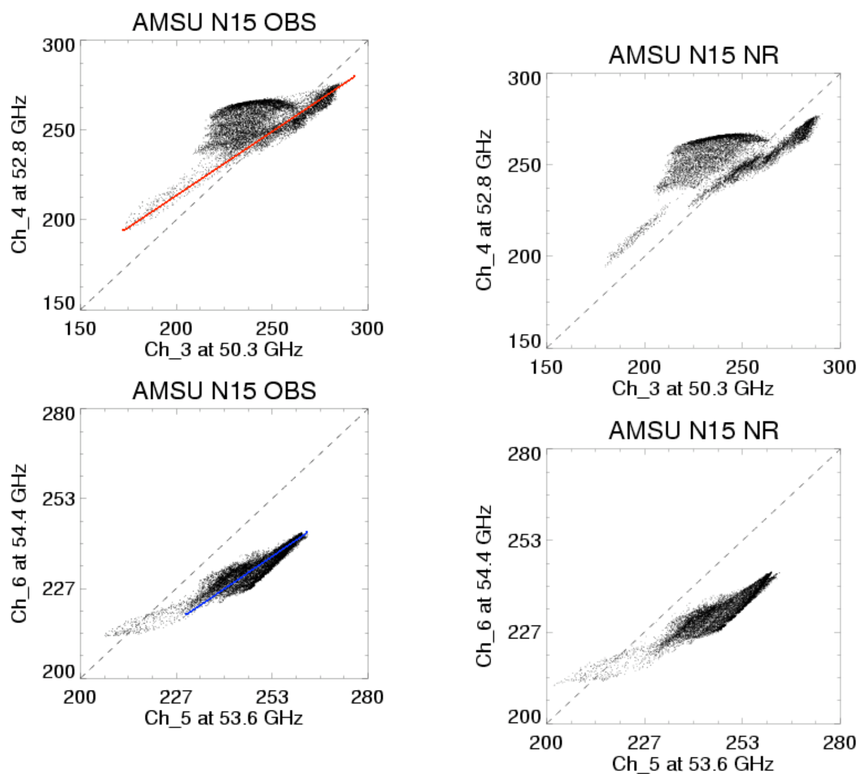


Fig. 3 Scatter plots of the inter-channel relation between brightness temperatures of (a) channel-3 and channel-4 from observation, (b) channel-3 and channel-4 from NR simulation, (c) channel-6 and channel-7 from observation, and (d) channel-6 and channel-7 from NR simulation at 0000 UTC May 2, 2011.

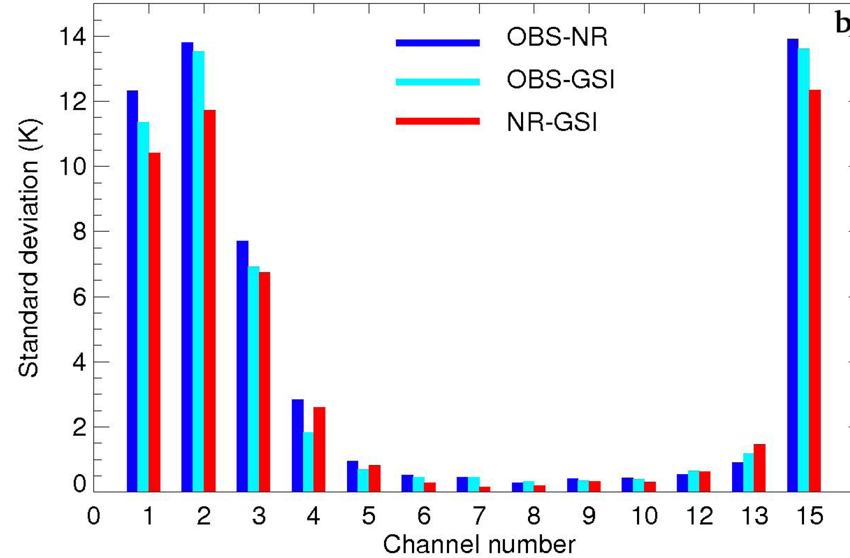


Fig. 2 Comparisons of the standard deviations (STD) for observation-minus-630 simulation (OBS-NR), observation-minus-background (OBS-GFS), and simulation-minus-631 background (NR-GFS) for NOAA-15 AMSU-A brightness temperatures at 0000 UTC on 2 May 632 2005

Zhu T., F. Weng, M. Masutani, J. S.Woollen 2012: Synthetic radiance simulation and evaluation for a Joint OSSE. Submitted to Jour. Geophysical. Res.

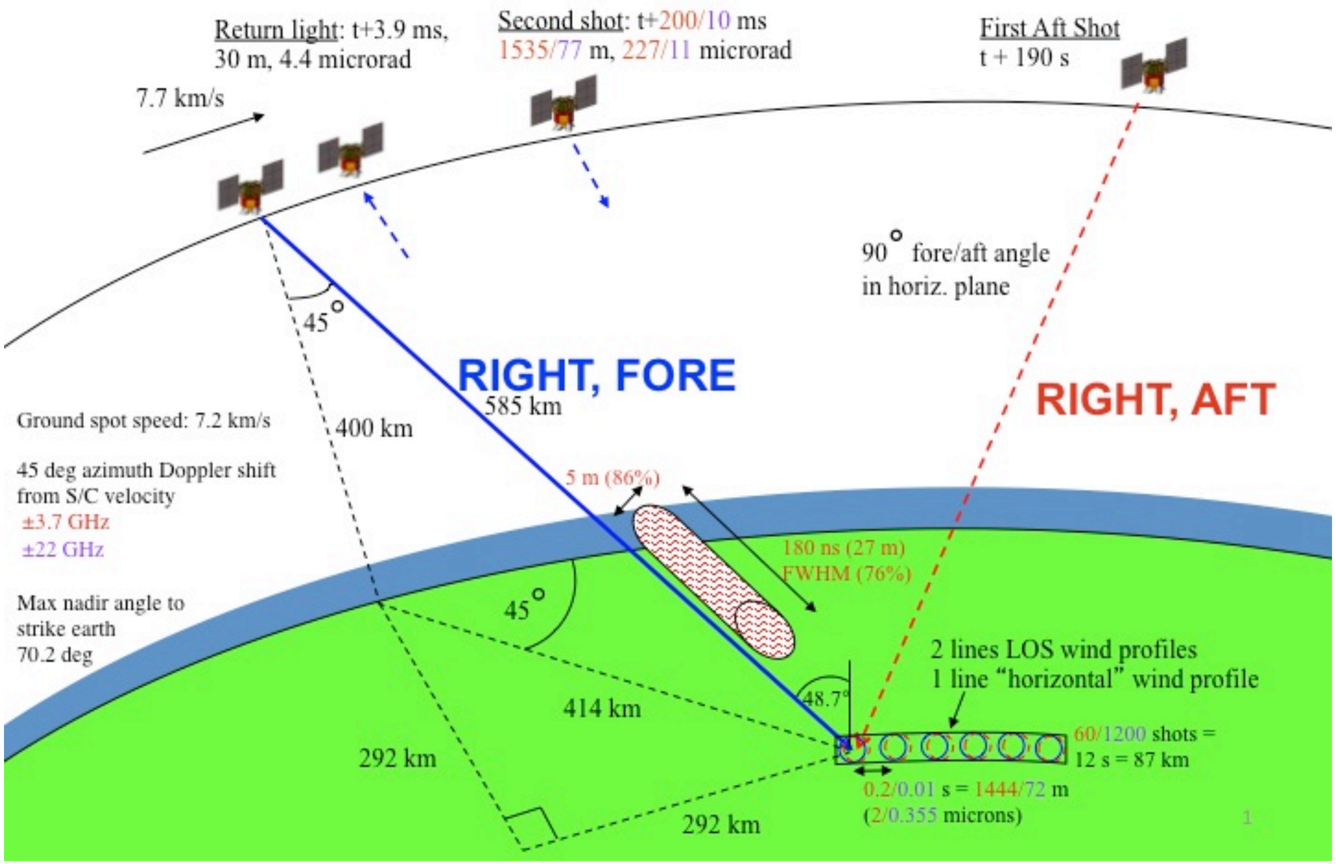
GWOS OSSEs

- Numerical weather prediction requires independent and global observations of the **mass** (temperature) and **wind** fields
- The global three-dimensional mass field is well observed from space
- Impact experiments for GWOS mission concept
  - Four telescopes, full vector winds on either side of spacecraft
  - Two technologies, direct and coherent detection
- GWOS observations simulated by Simpson Weather Associates using DLSM

Published:

Riishojgaard, L. P., Z. Ma, M. Masutani, J. S. Woollen, G. D. Emmitt, S. A. Wood, and S. Greco (2012), Observation System Simulation Experiments for a Global Wind Observing Sounder, *Geophys. Res. Lett.*, **39,** L17805, doi: 10.1029/2012GL051814

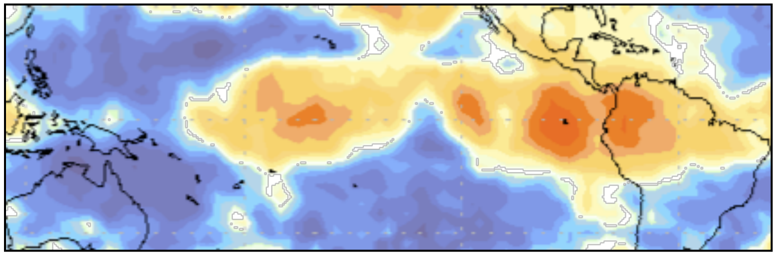
Hybrid Doppler Wind Lidar Measurement Geometry: 400 km



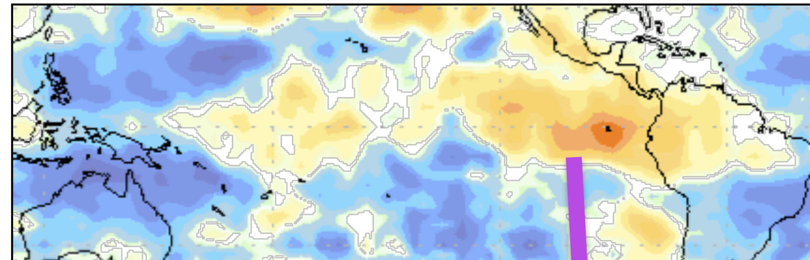
Auxiliary material of Riishojgaard et al (2012), contains complete description of GWOS including above diagram originally produced by Michael Kavaya.

Reduction of RMSE from NR in H500 Analysis (Averaged between July 7-August 15)

Four Looks



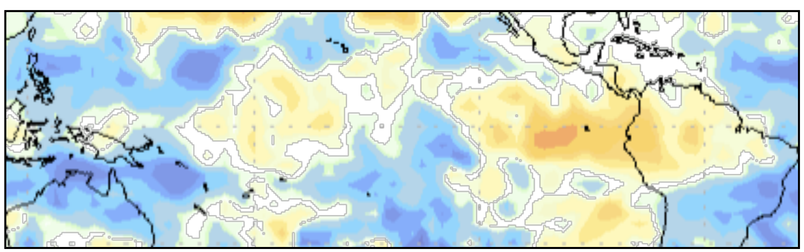
Two front looks
(righr fore and left fore)



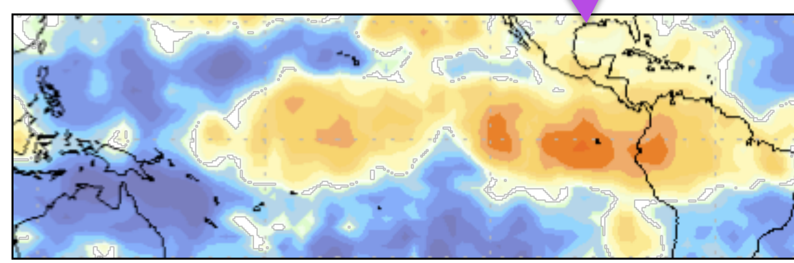
Four time more observation

Same number of observation

One Look
(right fore only)



Two one side looks
(right fore and right aft deg)
To produce vector wind



Two synchronized one side looks right fore and right aft look which provide vector winds show advantage in tropics compare with two left and right fore look. To be published in *Masutani et al (2012), proceeding for SPIE Asia-Pacific Remote Sensing 2012.*

OSSE to evaluate Early Morning Orbit Satellite at JCSDA (Presented by Sean Casey)

Planned Experiments

A control run in which all relevant observations from systems other than DWSS are assimilated

Same as 1., but without early morning orbit coverage (no NOAA-16/DMSP-F17)

Same as 2., but with JPSS (i.e. CrIS and ATMS) added in the early morning orbit

Same as 2., but with VIIRS in the early morning orbit (i.e., polar winds)

Same as 2., but with VIIRS and ATMS in the early morning orbit

OSSE System

Moving from Vapor(IBM) to JIBB(Linux cluster)

Period of experiments proposed (distribution of existing observation)

(July2012-August2012, January2012-February2012)

Impact of DWL vs model resolution

Hurricane Case period

Quick study to investigate design for OSSE experiments.

Experiments comparison between model resolution and GWOS data to find out the best resolution for the WLS OSSE

Assimilation start on 9/20 end on 10/10.

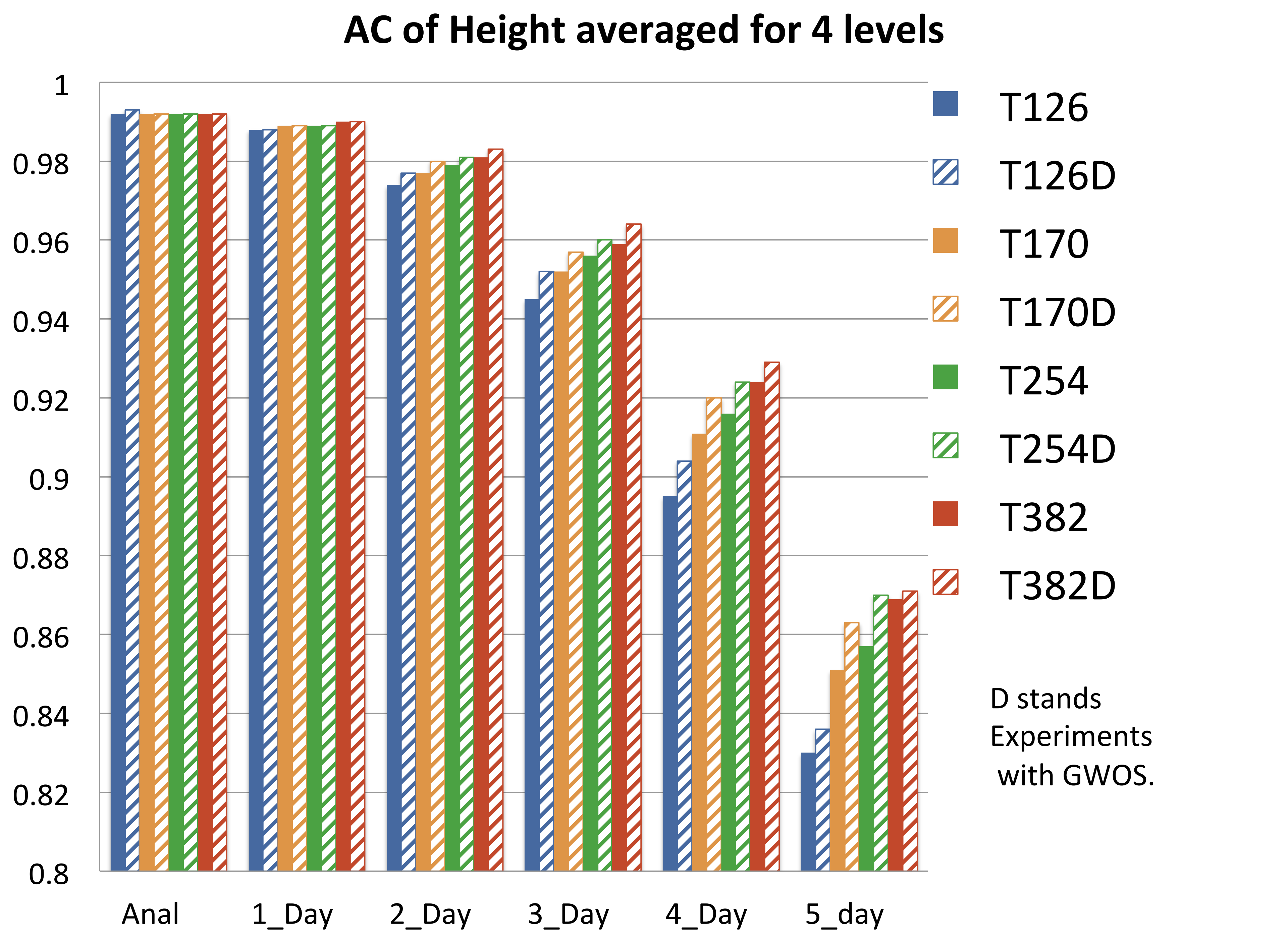
Forecast from10/1-10/10 are used for evaluated against Nature run. This is the poriod with a major hurricane in the Nature Run.

T126, T170, T254, and T382 horizontal resolution are compared.

Since the period is short a nomaly correlation of Height fields are average of 250hPa, 500hPa, 700hPa, and 1000hPa, NH and SH, 00Z and 12Z.

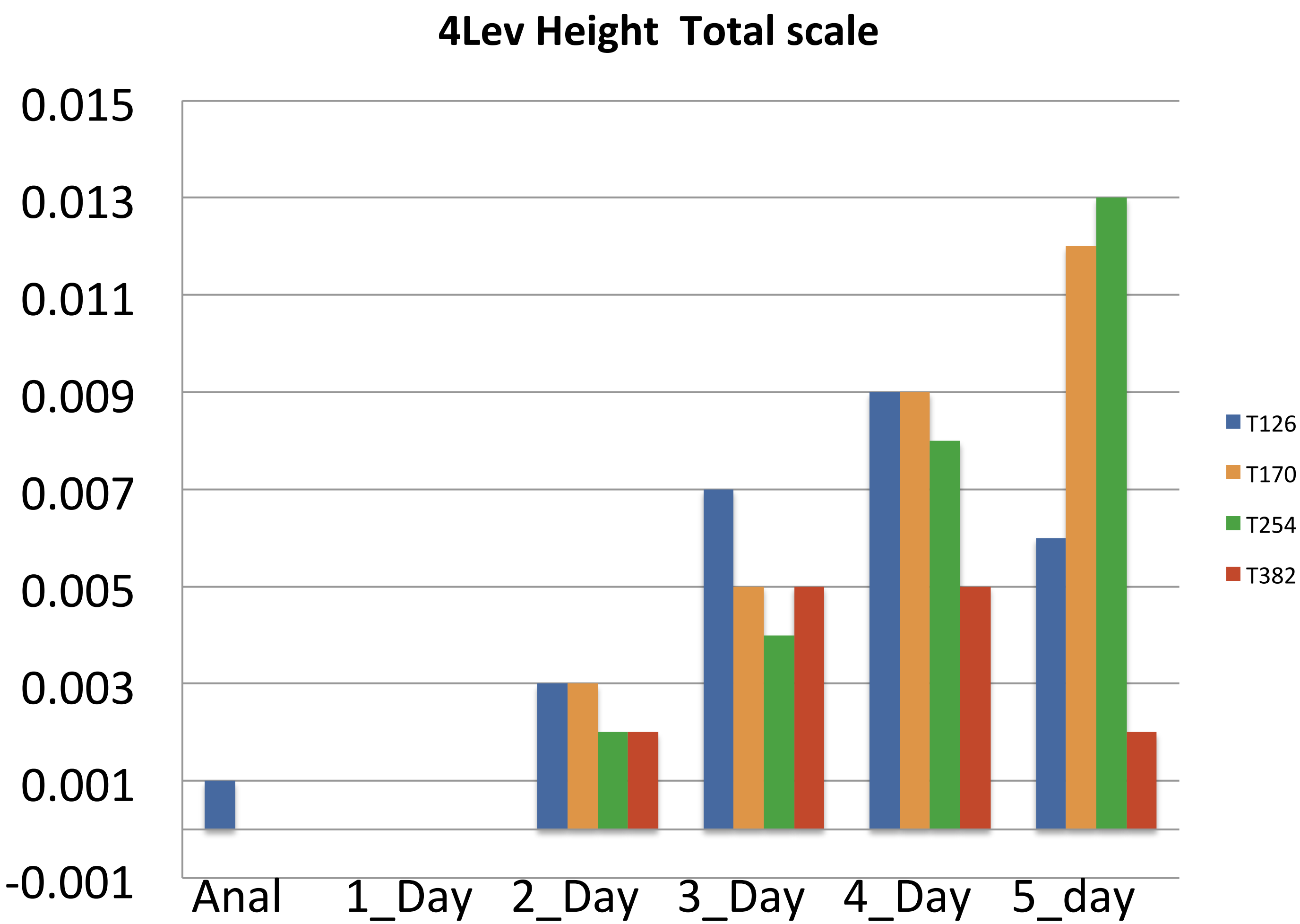
Wind fields include both U and V. NH and SH, 00Z and 12Z, but only at 250hPa.

(Evaluation is done using EMC package by Fanling Yang)



AC of Height averaged for 4 levels
1
0.98
0.96
0.94
0.92
0.9
0.88
0.86
0.84
0.82
0.8
Anal
1_Day
2_Day
3_Day
4_Day
5_day
T126
T126D
T170
T170D
T254
T254D
T382
T382D
D stands Experiments with GWOS.

Improvement in Anomaly correlation by adding GWOS



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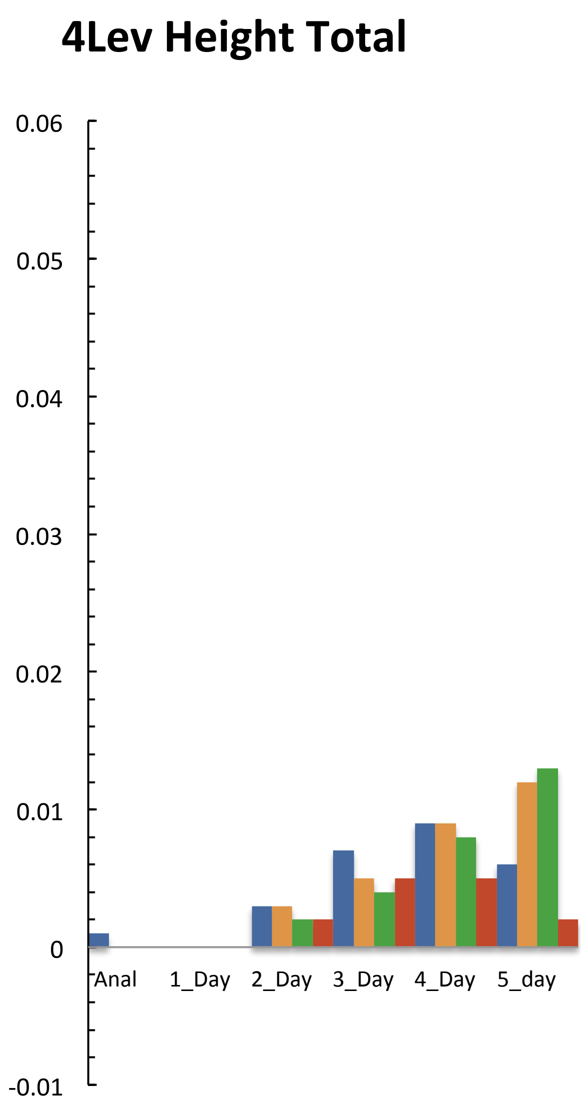

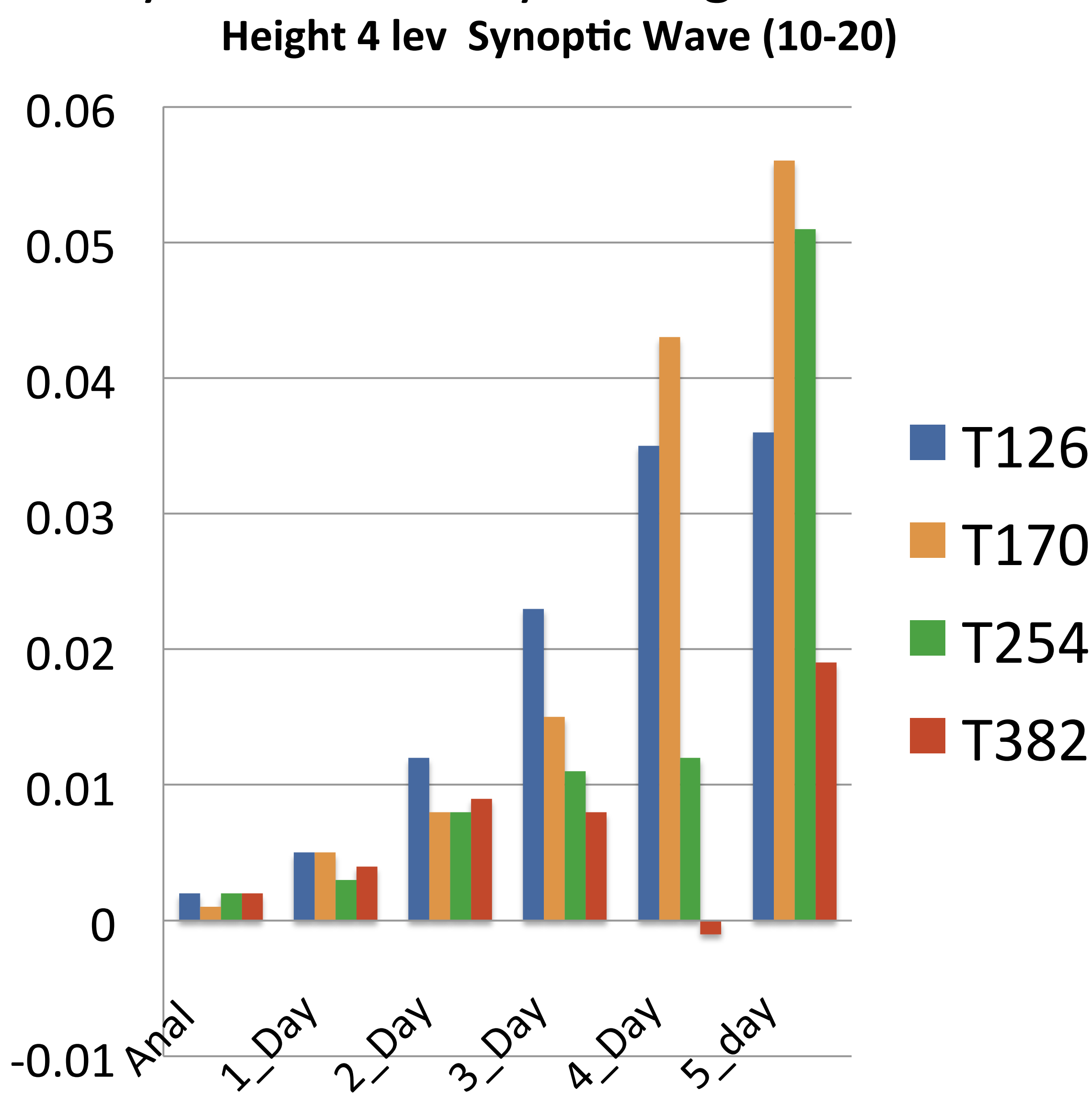

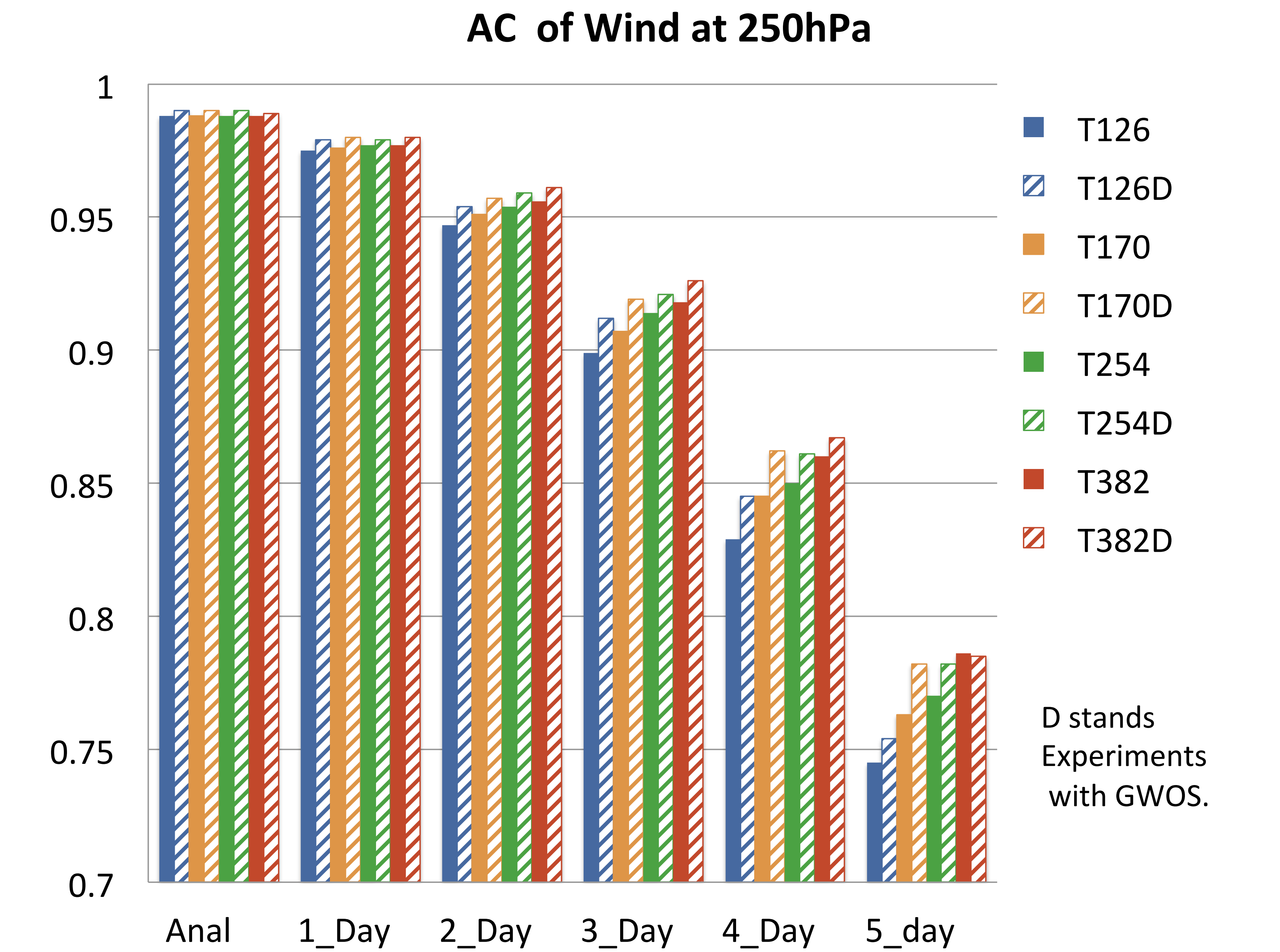

AC of Wind at 250hPa
1
0.95
0.9
0.85
0.8
0.75
0.7
Anal
1_Day
2_Day
3_Day
4_Day
5_day
T126
T126D
T170
T170D
T254
T254D
T382
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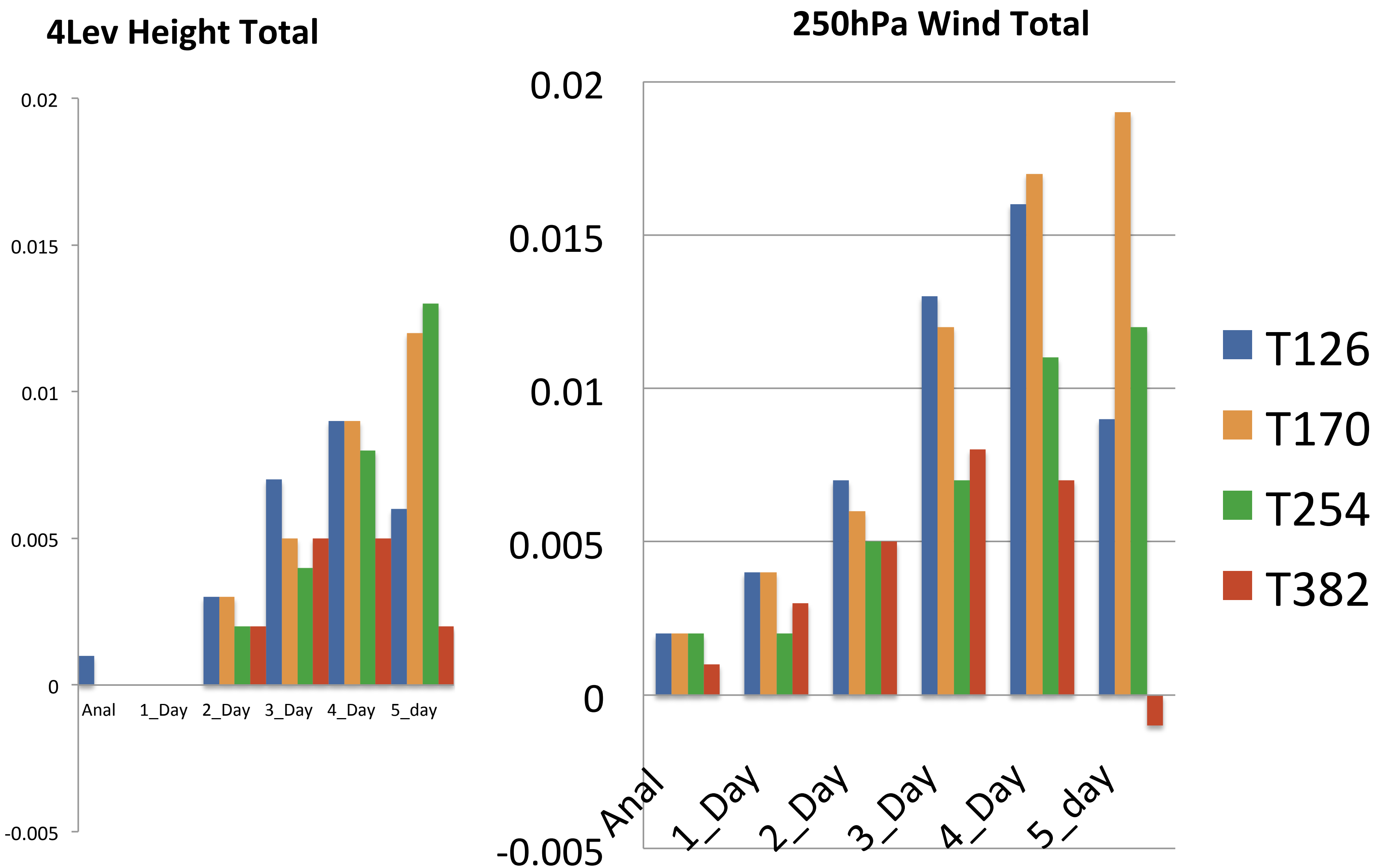


Summary of Study on Model Resolution for OSSE

- ◆GWOS show consistent impact in all resolution up to 3days.
- ◆More impact in wind fields compared to height fields.
- ◆3-4 time more impact in synoptic scale scale event compared to global scale event.
- ◆Impact in low resolution models can represent impact in high resolution model up to 3 days.

- T126 does not resolve small scale data impact sufficiently
- Impact on T382 model is less than T170 and T254 model and drops after 3days. The reason may be that T511 Nature run does not have small scale feature which cannot be resolved by T382 model. No space for improvement beyond 4day.
- With T511 Nature run T170 and T254 are appropriate to demonstrate impact of GWOS in unresolved scale but T382 model can be used to study of impact up to 3days.
- Need higher resolution Nature run to investigate data impact in current NCEP operational model in T574.

High resolution Nature Nun
Personal view

A. Requirement
- Good tropics with MJO like oscillation
- 3D Turbulence spectrum
- Good Forecast skill
- Cloud resolving model

B. Length of NR
- Run NR for 13month and save restart file for every few days.

A few basic fields ever 6 hourly 500H, 250 wind, MSLP, Precip

- For selected period,

1hourly archive
Complete model fields (could be in low resolution
Diagnostics 2D file
Pressure level regular lat lon data for diagnostics.

Need to coordinate the request.

First: NOAA, JCSDA, Environment of Canara,
Second: NASA, NCAR and universities
Third: JOSSE community

B. Currently many candidate models but no model is satisfactory.

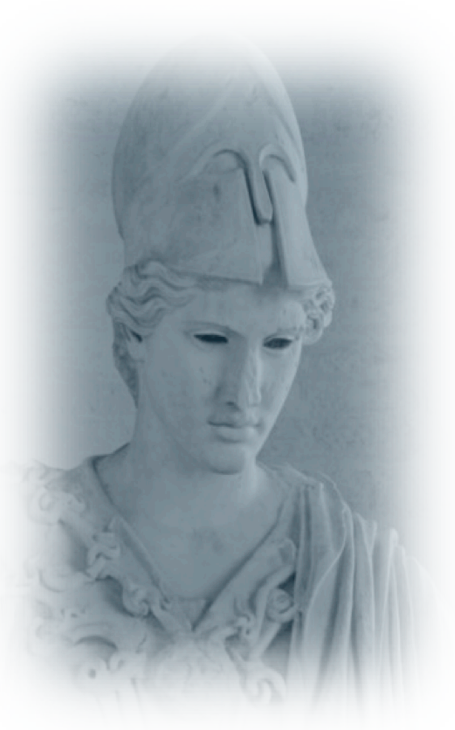
Athena project compared ECMWF model (IFS) and NICAM model. The results are made available to public.

Kinter,J.L. and co authors (2012):Revolutionizing Climate Modeling – Project Athena: A Multi-Institutional, International Collaboration, BAMS, *9*3.

Any other candidate for NR must prove better performances.

Proposal for Intermediate step:

- T2047 ECMWF model for 2.5 month length in winter and summer season.
- Initial condition from T511 NR or recent analysis on 6/15 and 12/15.
- Archive can be done in reduced resolution. (Need to study power spectrum of model)
- IFS has proved performance. (From the experience in Athena project, NICAM may be good for the next stage.)
- IFS has a familiar archive to Joint OSSE community



Project Athena: Collaborating Groups

COLA - Center for Ocean-Land-Atmosphere Studies, USA (NSF-funded)

ECMWF - European Center for Medium-range Weather Forecasts, UK

JAMSTEC - Japan Agency for Marine-Earth Science and Technology, Research Institute for Global Change, Japan

University of Tokyo, Japan

NICS - National Institute for Computational Sciences, USA (NSF-funded)

Cray Inc.

Codes

NICAM: Nonhydrostatic Icosahedral Atmospheric Model

IFS: ECMWF Integrated Forecast System

Supercomputers

Athena: Cray XT4 - 4512 quad-core Opteron nodes (18048)

#30 on Top500 list (November 2009) – dedicated Oct'09 – Mar'10

Kraken: Cray XT5 - 8256 dual hex-core Opteron nodes (99072)

#3 on Top500 list (November 2009) replaced Athena – allocation of 5M SUs

Athena Experiments

	Resolution	Grid Size	# Cases	Time Period	Data Volume	Comments
NICAM		7 km	8*	103 days	639 TB	21 May - 31 Aug 2001-2009 * unable to complete 2003
IFS 13-month Hindcasts	T159	125 km	48	395 days	0.7 TB	1 Nov - 30 Nov (next year) 1960 - 2007
	T511	39 km			7 TB	
	T1279	15 km			41 TB	
	T2047	10 km	20		51 TB	
IFS 103-day Hindcasts	T159	125 km	9	102 days	0.03 TB	21 May - 30 Aug 2001 - 2009 (a la NICAM)
	T511	39 km			0.3 TB	
	T1279	15 km			2 TB	
	T2047	10 km			6 TB	
IFS 10-Member Ensembles (Summers)	T511	39 km	6	132 days	2.7 TB	Selected years
	T1279	15 km			17 TB	
IFS 10-Member Ensembles (Winters)	T511	39 km	6	151 days	3.2 TB	1 Nov - 31 Mar Selected years
	T1279	15 km			20 TB	
IFS AMIP	T159	125 km	1	47 years	0.6 TB	1961 - 2007
	T1279	15 km			38 TB	
IFS Time Slice	T159	125 km	1	47 years	0.6 TB	2071 - 2117
	T1279	15 km			38 TB	
Total					874 TB	

http://wxmaps.org/athena/home/