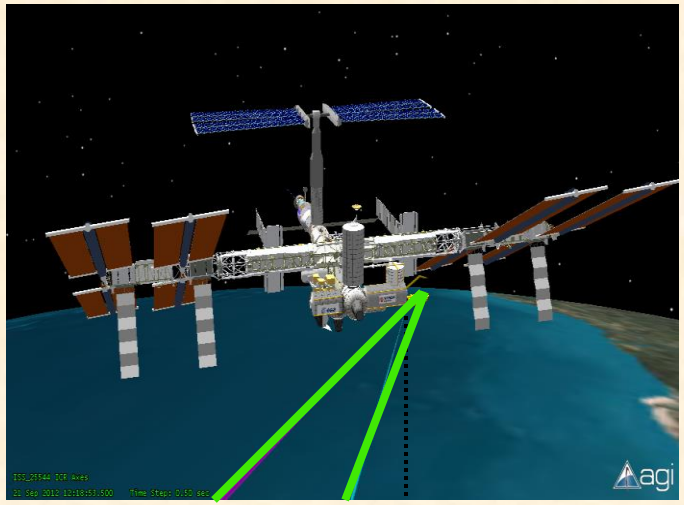
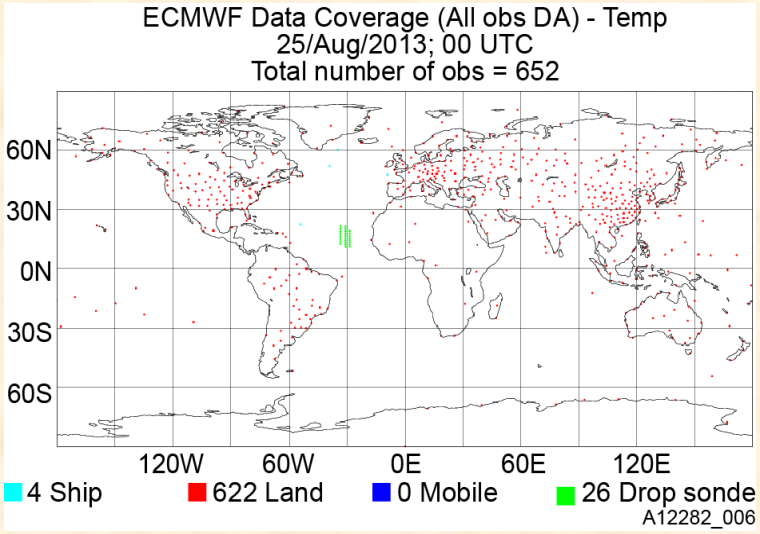
The ATHENA-OAWL Science Investigation

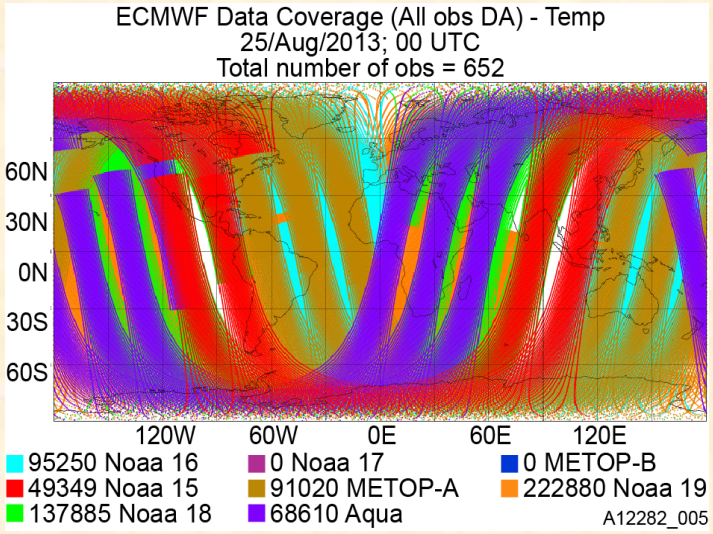


Mike Hardesty, Lars Peter Riishojgaard, Wayman Baker, Robert Atlas, Nancy Baker, Andrew Collard, Arlindo da Silva, Dave Emmitt, Mary Forsythe, Ron Gelaro, Yongxiang Hu, Shoba Kondragunta, Rolf Langland, Frank Marks, Oreste Reale, Oliver Reitebuch, Sara Tucker and Carl Weimer

Overview of the Science Mission

"Athena-OAWL is a breakthrough mission designed to advance the understanding and prediction of atmospheric dynamics in the mid-latitudes, and especially in the tropics."





A Different Concept….

- ATHENA-OAWL is a "design to cost" mission aimed specifically at the recent EV Instrument opportunity
- Requirements on both horizontal and vertical coverage are relaxed relative to the 3D-Winds Decadal Survey Mission
- However, requirement for full vector winds is maintained
- Deployment on the ISS enables the mission to retain most science from a free-flyer mission at reduced cost

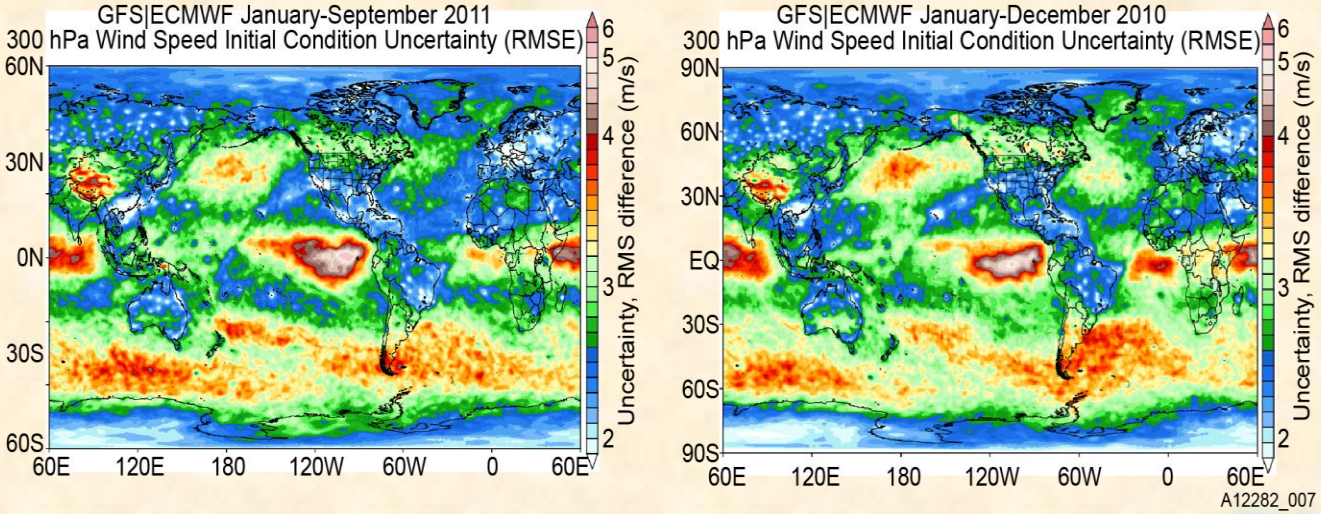
What will the mission provide?

- Equivalent of over 200 wind profiles per day
- Quasi-uniformly distributed between 54 degrees N and 50 degrees S
- Data will be available to operational NWP users within 30 minutes of the time of measurement
  - Unprecedented latency
  - Meets the most stringent data cut-off criterion for operational use
- Goal is to at least double the ~1200 daily wind profiles provided by the radiosonde system, with more uniform coverage

ATHENA-OAWL Societal Benefits

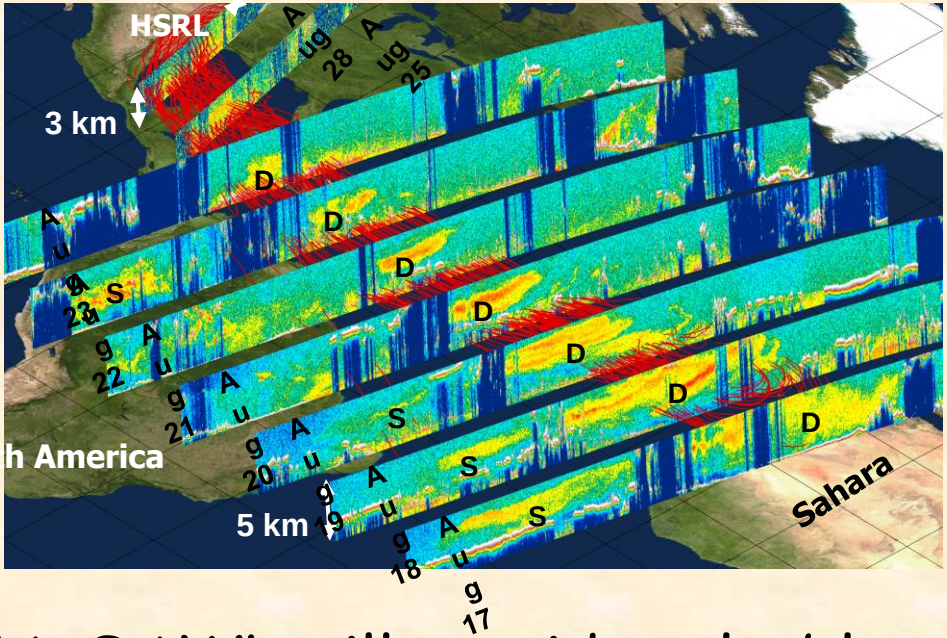
- Extension of the operational NWP forecast range by at least 6 hr, providing direct economic benefits to the US economy in the range of $1B - $2B per year

- Demonstration of improved reanalysis data sets to support process studies and climate research



Societal benefits (2)

- ATHENA-OAWL will increase understanding of transport and distribution of aerosols and their role in the climate system



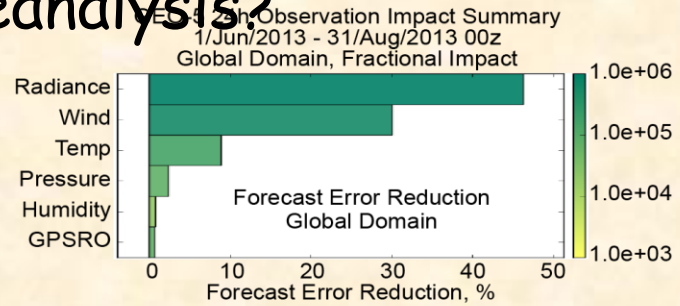
- ATHENA-OAWL will provide valuable scientific and technical risk reduction for a future 3-D Winds Mission

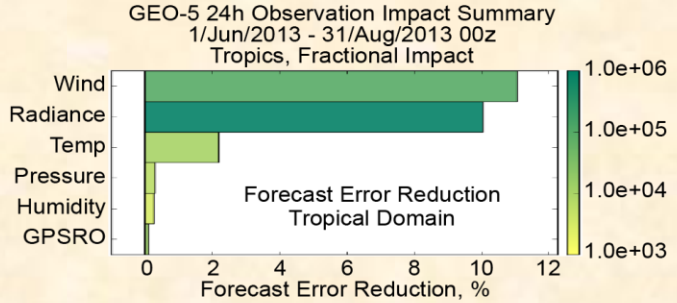
ATHENA/OAWL Science Team

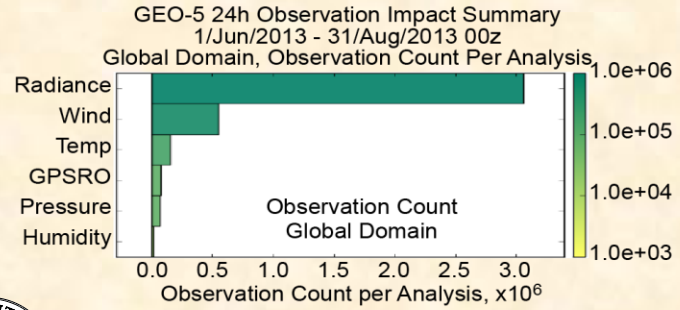
- PI: Dr. Lars Peter Riishojgaard, University of MD
- Dr. Robert Atlas, NOAA/OAR
- Dr. Nancy Baker, Navy/NRL
- Dr. Andrew Collard, IMSG@NOAA/NCEP/EMC
- Dr. Arlindo da Silva, NASA/GMAO
- Dr. Dave Emmitt, Simpson Weather Assoc.
- Dr. Mary Forsythe, UKMO
- Dr. Ron Gelaro, NASA/GMAO
- Dr. R. Michael Hardesty, U. of CO, CIRES
- Dr. Yongxiang Hu, NASA/LaRC
- Dr. Shobha Kondragunta, NOAA/NESDIS
- Dr. Rolf Langland, Navy/NRL
- Dr. Frank Marks, NOAA/GMAO
- Dr. Oreste Reale, USRA/GESTAR
- Dr. Oliver Reitebuch, DLR
- Dr. Sara Tucker, Ball Aerospace
- Dr. Carl Weimer, Ball Aerospace
- Dr. Wayman Baker

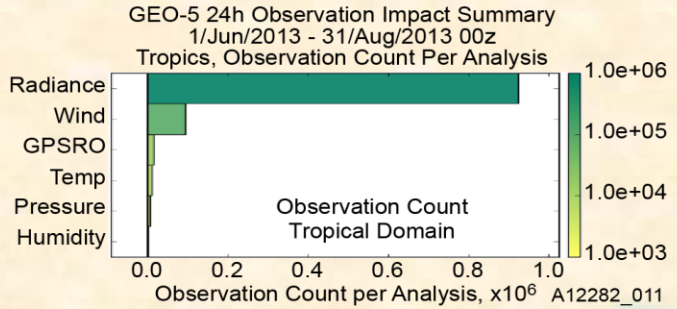
Science Questions: Forecasting

- How much can forecast skill be improved in the tropics and mid-latitudes with accurate, uniformly-spaced wind profiles?
- How can improved sampling, coverage, and precision of tropical and-latitude winds impact numerical weather prediction forecast skill and climate reanalysis?









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Science Objectives: Forecasting

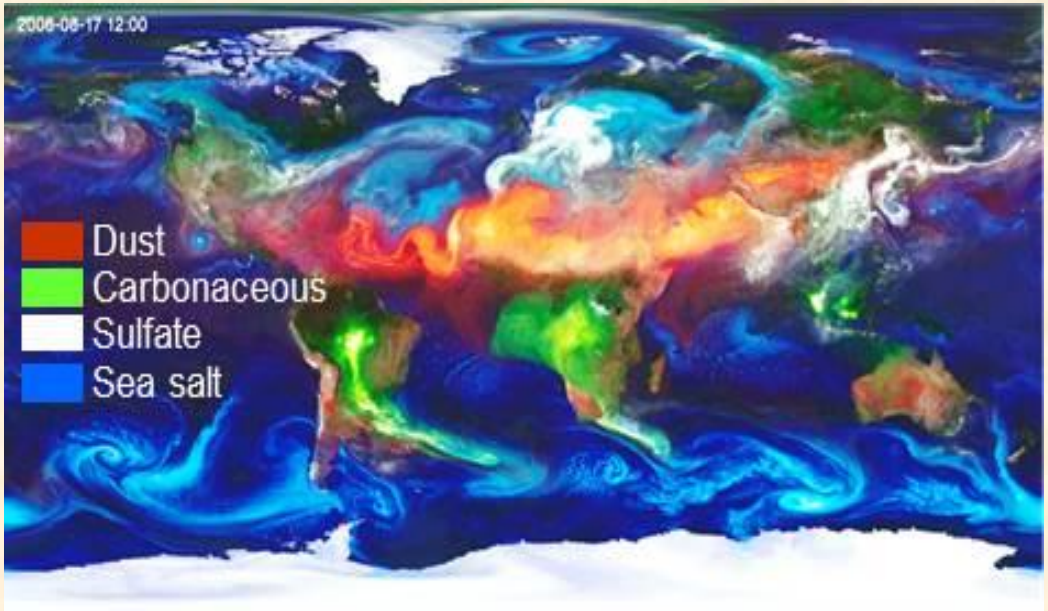
- Measure and assimilate wind profiles to extend medium-range NWP forecast skill by at least 6 h in the mid-latitudes and reduce the tropical RMS wind error by 10-20% in the 24-48 hr forecast

- Measure wind profiles at regular intervals with sufficient precision to reduce current uncertainty between operational analyses and reanalyses

- Measure the wind field in the vicinity of tropical jets

Science Question: Tropical Cyclone

- What is the influence of the tropical wind field and the aerosol radiative effects in the genesis and lifecycle of tropical cyclones?



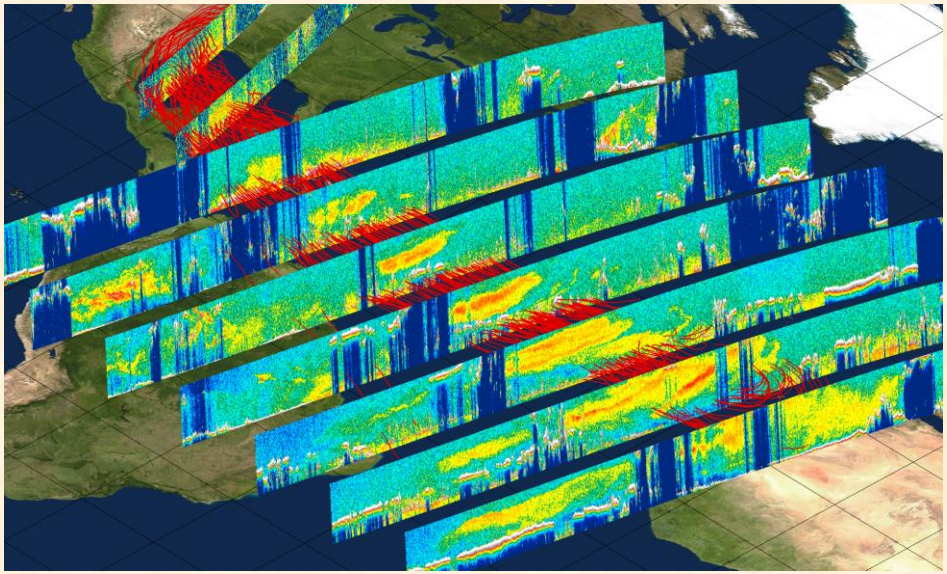
Credit NASA GSFC

Science Objectives: Tropical Cyclones

- Measure regularly-spaced tropical wind profiles to advance understanding and prediction of tropical cyclones
- Reduce the tropical cyclone track error by 25% at 96 h lead time for forecasts with a steering current uncertainty
- Evaluate the role of the boundary layer in the spin up of the hurricane inner core and in storm intensification
- Advance the knowledge of aerosol radiative effects on tropical cyclone genesis and development

Science Questions: Aerosol transport

- What is the role of long range dust transport in the global energy and water cycle?
- What is the role of global transport and distribution of aerosols and pollution on air quality and climate



Science Objectives: Aerosol Transport

- Measure wind and aerosol backscatter profiles to improve understanding of of long-range transport and its impact on energy and water cycles

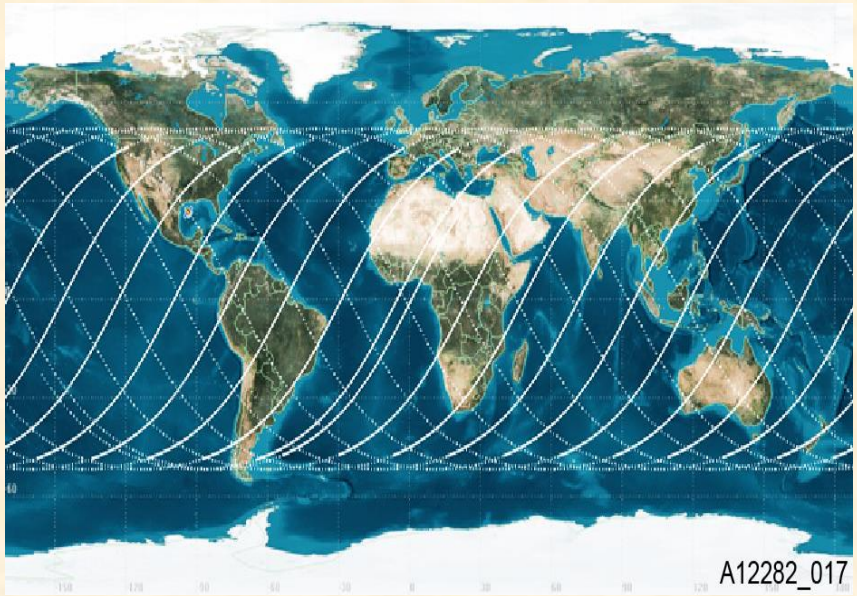
- Combine wind aerosol profiles with existing passive measurements to improve understanding of global transport and distribution of biogenic and anthropogenic aerosols

Instrument Functional Requirements

Instrument Functional Requirements			
Parameter			Requirement
Number of LOS looks			2
Wind Profile Temporal Resolution			≤12 s
Global coverage rate (based on ISS orbit)			24 hrs
# profile measurement attempts per 24 h*			7200
HLOS wind speed precision threshold			≤3 m/s
Globally distributed PEPs per 24 h			≥1200
Accuracy (wind speed bias)			≤0.5 m/s
Altitude/Backscatter-Dependent Wind Measuremer			
Vertical Resolution (km)	Altitudes (km MSL)		Requirement
	0-2	-	1 km
	2-25	-	1 km
HLOS wind speed measurements with < 3 m/s precision	Altitudes (km MSL)	Day or Night	% measurements above threshold
	0-2	Day	30%
		Night	43%
	2-10	Day	15%
		Night	35%
	10-15	Day	25%
		Night	55%
	15-25	Day	12%
		Night	45%
$SNR_{\sigma N}$ for aerosol backscatter products (Parallel polarizat			
Clear sky $SNR_{\sigma N}$ (Rayleigh backscatter, no aerosol). Aerosols and/or additional averaging (N) increases $SNR_{\sigma N}$	Altitude		CALIOP Requirement (5 km/250 m)
	1 km	Day	1.9
		Night	NA
	15 km	Day	NA
		Night	NA

Threshold Investigation

- The threshold investigation provides two orthogonal HLOS wind speed data products at 100 km horizontal and 1 km vertical resolution during nighttime portions of the ISS orbit where aerosol concentrations provide adequate signal for at least one year



Summary

- ATHENA-OAWL is a design-to-cost mission that will provide breakthrough information on dynamics and transport in the tropics and mid-latitudes
- Operation on the ISS enables a mission with high science content at reduced cost
- Science investigations aimed at improving NWP forecast skill and climate reanalysis, understanding influence of winds and aerosols on tropical cyclones, and characterizing the role of aerosol transport on energy/water cycles and air quality
- Threshold mission (nighttime only) still provides major science returns