Building OSSE at JCSDA

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Observing System Simulation Experiment

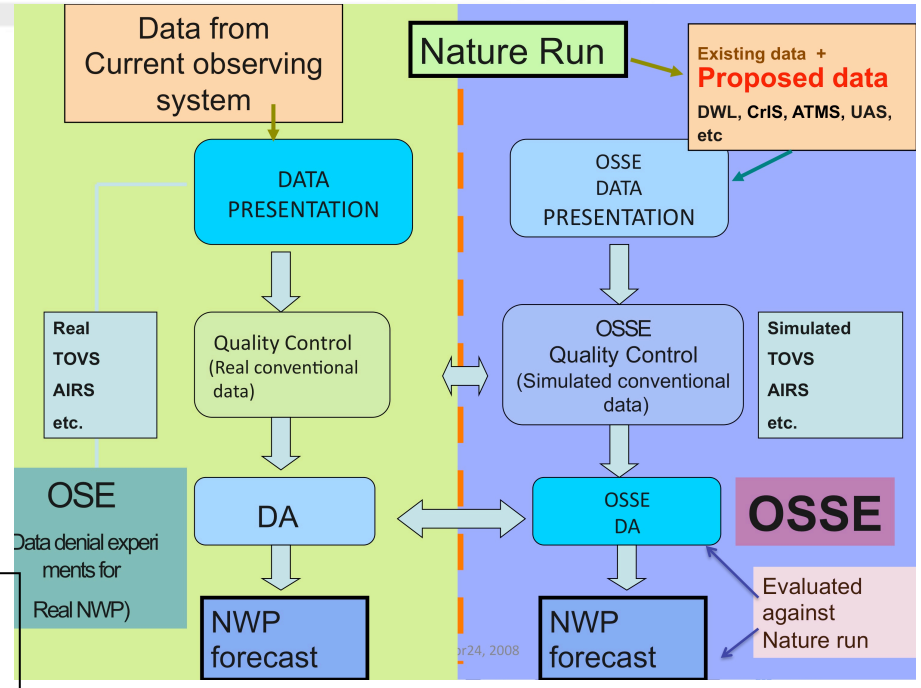
➢A Nature Run (NR, proxy true atmosphere) is produced from a free forecast run using the highest resolution operational model which is significantly different from the NWP model used in Data Assimilation Systems.

➢Calibrations is performed to provide quantitative data impact assessment.

➢Data impact on analysis and forecast will be evaluated.

➢A Full OSSE can provide detailed quantitative evaluations of the configuration of observing systems.

➢A Full OSSE can use an existing operational system and help the development of an operational system



Advantage of Collaboration

- Full OSSEs are expensive
  - Sharing one Nature Run and simulated observation saves costs
  - 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 the robustness of answers

Various OSSEs conducted in Past

TOVS (Atlas 1987)
WiNDSAT (Hoffman 1990)
LAWS DWL (Rohaly and Krishnamurti 1992)
SWIFT OSSE (Lahoz 2005, Keil 2004)
ADM Aeolos (Stoffellen 2006)
Doppler Wind Lidar (Masutani et al 2006, 2009)
GWOS DWL (Riishojgaard et al 2012)
DWL Configuration(Ma et al 2014)

Review articles about OSSE

Arnold, C.P., Jr. and C.H. Dey, 1986: Observing-systems simulation experiments: Past, present, and future. *Bull. Amer. Meteorol. Soc.,* **67**, 687-695.

Masutani, M., *et al.*, 2010a: Observing System Simulation ExperimenBaker, ts. In *Data Assimilation: Making sense of observations*, Eds. W.A. Lahoz, B. Khattatov and R. Ménard, Springer, 647-679.

List of references are available at

http://www.emc.ncep.noaa.gov/research/JointOSSEs/references

International Joint OSSE

Since 2006

Joint OSSE Nature Run by ECMWF

ECMWF Nature run used at NOAA
Spectral resolution : T511
13 month long. Starting May 1st,2005
Vertical levels: L91, 3 hourly dump

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

Joint OSSEs at JCSDA and collaborators

Evaluation of Infrared sounders on the geostationary Hyperspectral Environmental Suite (HES)
Evaluation of Future configuration of GNSS-RO
Evaluation of OAWL and WISCCR DWL
Evaluation of DWSS and JPSS
Simulation of DWL planned from NASA (GWOS, ISS)
Simulation and assimilation of Cloud Motion Vector, ASCAT
Evaluation of Wind Lidar (GWOS, ISS) impact and configuration experiments for NASA
Evaluation of Impact of GWOS on monsoon,

Simulated observation for Control experiments are available from NASA/NCCS and NCAR

Data distribution
NASA/NCCS
Contact:
Ellen Salmon Ellen.M.Salmon@NASA.gov
Bill McHale wmchale@nccs.nasa.gov

NCAR
Currently saved in HPSS Data ID: ds621.0
Contact:
Chi-Fan Shih chifan@ucar.edu Steven Worley worley@ucar.edu

Joint OSSEs conducted by other organizations

PREMIER InfraRed and MicroWave Limb Sounder measurements 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)
Studies of Observational errors (NASA/GSFC/GMAO)
Regional OSSE to Evaluate DWL data on Hurricane forecast (Univ Utah)
Rigional OSSE on severe storm (Mississippi State University)
Global OSSE forUnmanned Aircraft System (NOAA/AOML, NOAA/ESRL)
Evaluation of Hybrid Data assimilation system (NOAA/EMC, UMD)
Global OSSE for WISDOM balloons (NOAA/ESRL, NOAA/AOML)
Evaluation of RAOB over India (National Centre for Medium Range Weather Forecasting (NCMRWF))
Analysis and Evaluation of Observing System Simulation Experiments (OSSEs) forecast data for Indian Summer Monsoon (ISM), Indian Institute of Tropical Meteorology

OSSE with New Nature runs at JCSDA

GOES-5 Nature Run By NASA/GSFC/GMAO (G5NR)

GOCART model with full aerosol, full chemistry
Global, 7 km from May 16, 2005-June2007
3km run for selected periods are planned
Data are available in 0.5deg and model resolution with30min write up.
Pressure level data are provided in 0.5 deg
Various time mean data are also provided
Data are available through OPeNDAP to registered users.

For more detail visit:

http://gmao.gsfc.nasa.gov/projects/G5NR/

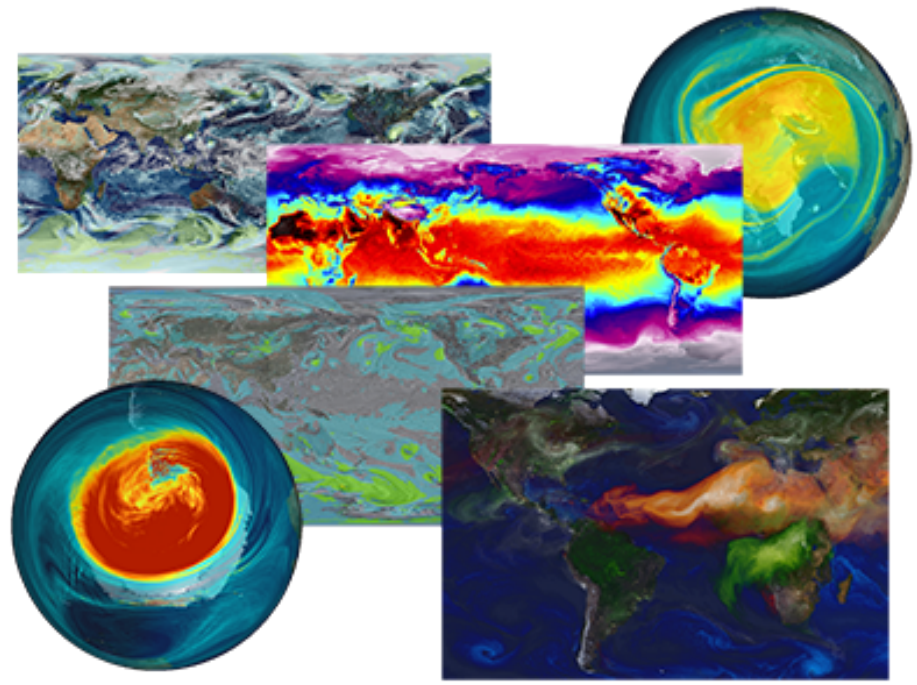
ECMWF Nature Run

ECMWF IFS T1279 91 Level
March 1st, 2005- April 30th, 2006
Sample data provided for hurricane period and midlatitude storm period.

The presentation pm G5NR
19th IOAS-AOLS
3.1 A 7-km Non-Hydrostatic Global Mesoscale Simulation for OSSES with GEOS-5

William M. Putman, NASA, Greenbelt, MD; and A. Darmenov, A. Da Silva, R. Gelaro, A. Molod, L. Ott, and M. J. Suarez

Validation available at:
http://gmao.gsfc.nasa.gov/global_mesoscale/G5NR/report_master_5DecwithDRAFTmark.pdf



G5NR image by NASA/NCCS

Simulation of observation at JCSDA

Conventional observation

- Conventional observation based on operational usage.
- Satellite wind is still simulated based on real observation. Considering to simulate at Nature run cloud location.

GPSRO

- GPSRO has simulated for refractivity. Being simulated for bending angle. Plan to upgrade forward model in 2015.

Current GPS, Add 6 sat over equator, Additional 6 satellite in polar orbit, GPSRO by PlanetiQ are being simulated and tested.

Simulation of Radiance

- Clear sky radiance has been simulated with CRTM 2.0.5 (RTTOV) are used. Being upgraded to CRTM 2.1.3
- Type of radiance data location used operation in
- Using CRTM 2.0.5 Type of radiance data location used operation in July –August2012, January February 2013 for T511NR in 2005 and 2006
- Using CRTM 2.1.3 Type and distribution July –August2012, January-Februrary 2013 for T511 NR in 2005 in 2006
- Using CRTM 2.1.3 Type and distribution August-September 2014 from G5NR 2006
- Random error was added. Plan to use NESDIS statistics.
- Bias was added based on bias in real observation
- Accommodate new variable from new nature runs
- Plan to test cloudy simulation of radiance
- Coefficients for hyperspectral infrared radiances from geostationary orbit were generated. JCSDA will simulate with CRTM. (SSEC will simulate with SARTA)

Plan to use two Polar satellite scenario as control configuration

Control	3polar	2polar (PM Gap)	1polar (Mid-AM Only)	Orbit
F16 (SSMI/S)	F16	F16	F16	Early-AM
F17 (SSMI/S)	F17	F17	F17	Early-AM
F18 (SSMI/S)	F18	F18	F18	Early-AM
Metop-A (AMSU/MHS/IASI/HIRS)	Metop-A	Metop-A	Metop-A	Mid-AM
Metop-B (AMSU/MHS/IASI)	Metop-B	Metop-B	Metop-B	Mid-AM
N15 (AMSU)	N15	N15	N15	Late PM
N18 (AMSU/MHS)	N18	N18	N18	PM
N19 (AMSU/MHS)	N19	N19	N19	PM
SNPP (ATMS/CrIS)	SNPP	SNPP	SNPP	PM
Aqua MODIS IR Winds	Aqua MODIS IR*	Aqua MODIS IR	Aqua MODIS IR	PM
Aqua AIRS	Aqua AIRS	Aqua AIRS	Aqua AIRS	PM
Aqua MODIS WV Winds	Aqua MODIS WV	Aqua MODIS WV	Aqua MODIS WV	PM
Terra MODIS IR/WV Winds	Terra MODIS	Terra MODIS	Terra MODIS	AM
WindSat	WindSat	WindSat	WindSat	Early-AM
GOES Sounder, AMVs	GOES	GOES	GOES	GEO
JMA AMVs	JMA AMVs	JMA AMVs	JMA AMVs	GEO
METEOSAT AMVs	METEOSAT AMVs	METEOSAT AMVs	METEOSAT AMVs	GEO

Fewer repetitive obs, less to simulate and add correlated errors to

By NOAA/NESDIS

Evaluation of Simulated Radiance
At the beginning of the Nature run

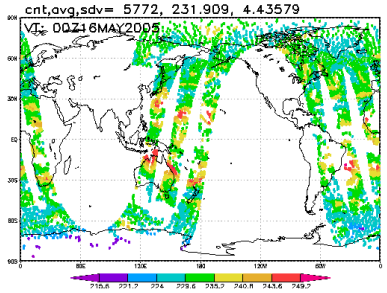
Compare simulated radiance an d real radiance at initial time of the Nature Run 00z May 16, 2005, the GMAO analysis is very close to real atmosphere. After a few steps Nature run will diverge from real atmosphere. Observations are assimilated by NCEP GSI at 00Z May 16 with same guess fields.

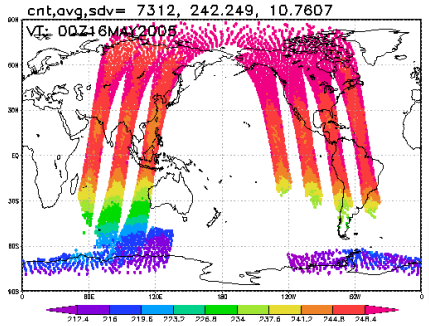
For this evaluation only instrument available in May 2005 can be evaluated.

HIRS3 NOAA17
Ch 12

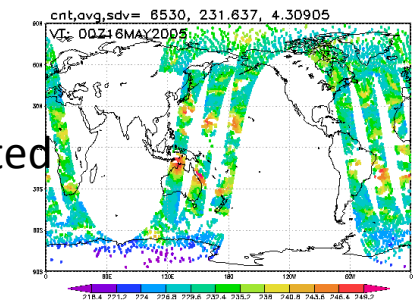
AMSUA NOAA 15
Ch 13

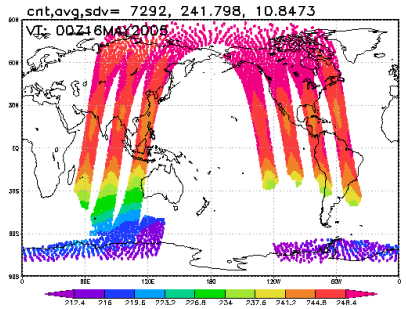
Real





Simulated



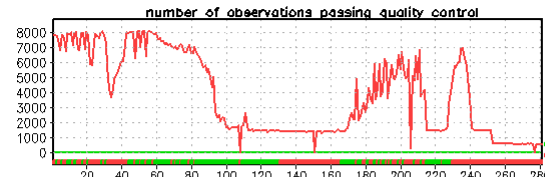


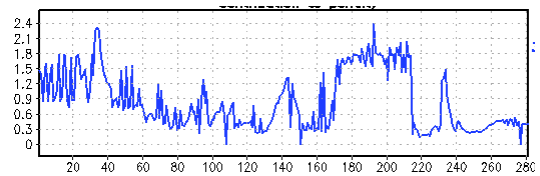
Number of observations passing quality control

Contribution to the penalty

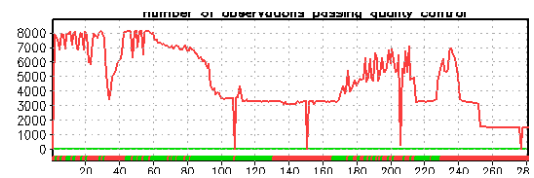
AIRS AQUA

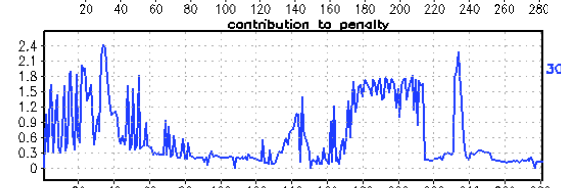
Real





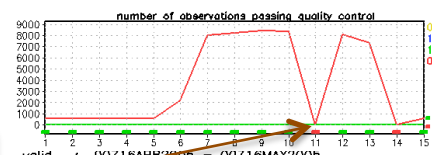
Simulated

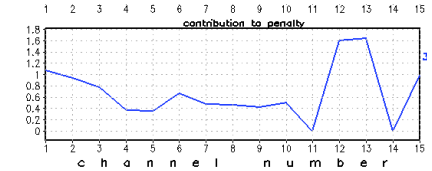




AMSUA NOAA 15

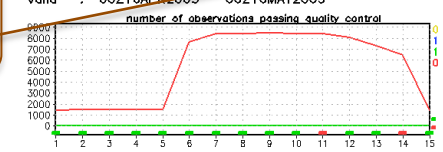
Real

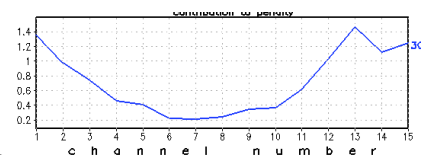




Large bias in real observation but no bias in simulated observation

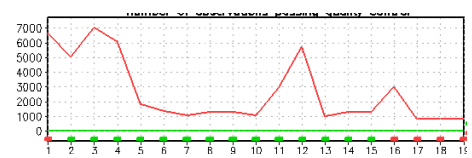
Simulated

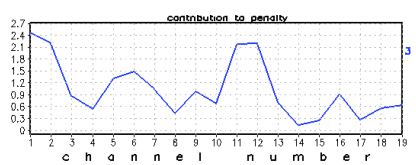




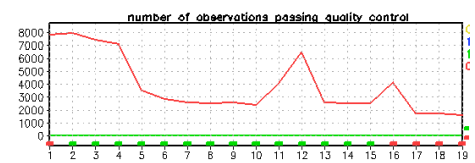
HIRS3 NOAA17

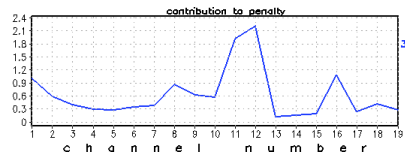
Real





Simulated

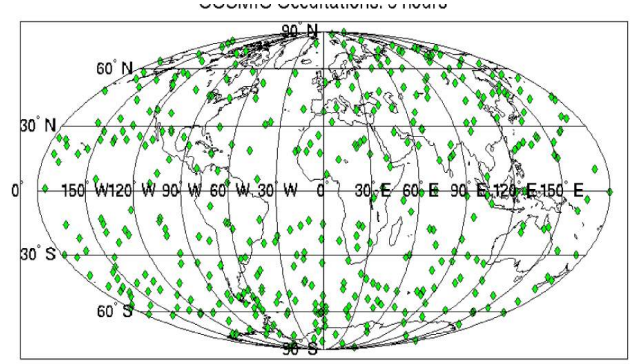




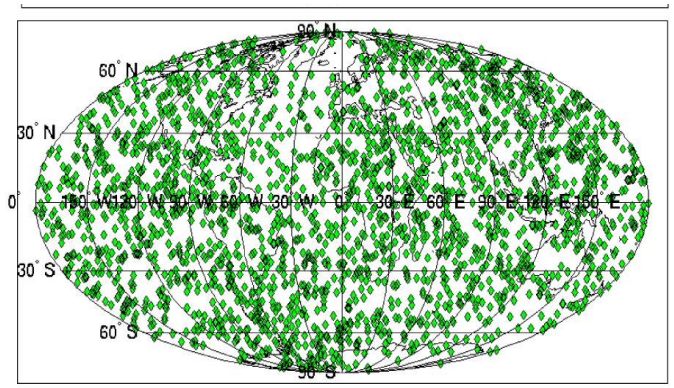
OSSE being conducted at JCSDA

- Conduct OSSE to Evaluate of Infrared sounders on the geostationary Hyper-spectral Environmental Suite (HES).
- Collaborating with ESRL and NOAA/AOML, JCSDA plan to conduct a series of global OSSE experiments to assess the impact of additional future Global Navigation Satellite Systems (GNSS) Radio Occultation constellations.
- Add various observational errors to control observations and study data sensitivity to the data impact. Use template from real observation.
- Upgrade OSSE system to current operational data assimilation and beyond.
- OSSE for further more instruments are being considered
- JCSDA is putting together the state of the art OSSE package together based on the different existing tools.

COSMIC



COSMIC-2



Related Presentations

19th IOAS-AOLS 2.3 Preliminary OSSE with GNSS RO observation, L. Cucurull, *et al.*

19th IOAS-AOLS 3.2 Initial Validation of a New OSSE Capability. S.P.F. Casey *et al.*

Possible Future OSSEs

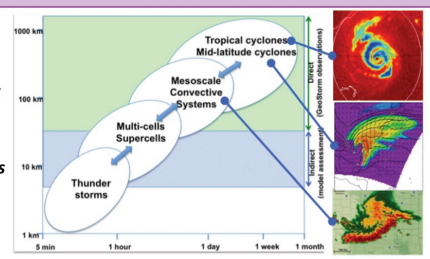
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

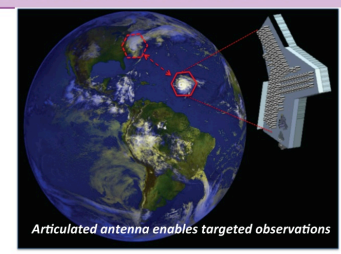
"GeoStorm": A pre-PATH mission

A GEOSTATIONARY MICROWAVE SOUNDER MISSION FOCUSED ON THE EVOLUTION OF SEVERE STORMS

Improve our understanding of sudden and unpredicted change in intensification and motion of destructive storms:

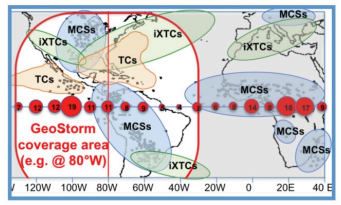
- *hurricanes*
- *severe thunderstorms and mesoscale convective systems*
- *mid-latitude cyclones and winter storms*





Low cost as a hosted payload

Many hosting opportunities in GEO:



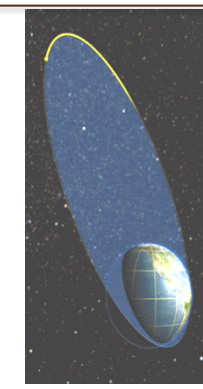
There are more than 80 GEO comm-sats that provides a view of the Americas, being replaced at a rate of 5-6 per year

GeoStorm Highlights	
Targeted observations	Life cycle storm tracking
Time-continuous	Capture dynamic processes; diurnal cycle fully resolved
Multiple simultaneous key parameters	Temperature, humidity, precipitation, wind
All-weather	Cloud/rain-penetrating
3-D observations	1000 km dia x 15 km vert. (volume); 25 km dia x 3 km vert. (resolution)
Wide coverage	All storms visible from GEO

GeoStorm covers a substantial subset of the PATH science objectives at a greatly reduced cost (~ $100M vs. ~ $500M), using all key PATH technologies and flying as a hosted payload.
Proposed as a Venture EV-I hosted-payload mission

Figure produced by NASA/JPL

The impact of PCW satellite winds filling the gap at high latitudes



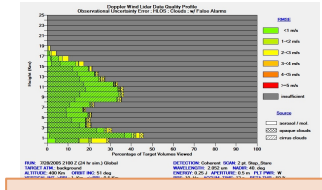
Masutani, M., L. Garand, W. Lahoz, L.-P. Riishojgaard, E. Andersson, Y. Rochon, M. Tsyrulnikov, J. McConnell, L. Cucurull, Y. Xie, S. Ishii, R. Grumbine, G. Brunet, J. S. Woollen, and Y. Sato, 2013: Observing System Simulation Experiments: Justifying new Arctic Observation Capabilities, White paper on OSSE Optimized Modelling, National Centers for Environmental Prediction Office Notes No 473. http://www.lib.ncep.noaa.gov/ncepofficenotes/files/on473.pdf

Improve assimilation of DWL on ISS orbit

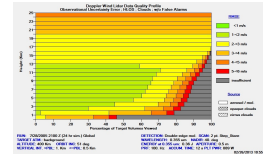
Space based Doppler Wind Lidar (DWL)

◆A space-based Doppler wind lidar (DWL) would provide accurate, global tropospheric wind data for both climate studies and weather forecasting.
◆DWL require large telescope and fine tuning reduction of weight is a challenge .
◆Extra power means more accuracy but more weight and eye safety issue
◆Further Evaluation of OAWL DWL.

Aerosol return
Possibly light weighted

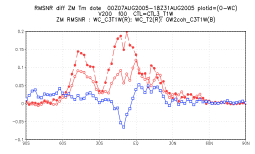


Molecular return
Tends to be large and heavy

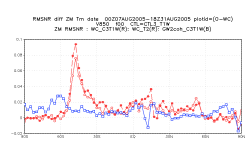


ISS allow heavier instruments but just more data to area to data rich area.
Current interests are focused on ISS orbit only.
AOS could promote Lightweight Coherent Lidar to measure aerosol return in polar orbit

V 200 hPa



V 850 hPa



Analysis impact (reduction of RMS Diff from NR, compared to control experiment (existing obs only). Only results from coherent Lidar are presented.
DWL with two looks to produce vector wind measurement.
Red, Solid line,open circle:ISS orbit T126 experiment
Red, Dashed line, closed circle: ISS orbit T254 experiment
Blue, Solid line, open circle: Polar orbit T126 experiment