Observing System Simulation Experiments for Space-based Doppler Wind Lidar Observations

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1. Introduction

The three-dimensional global wind field is the most important remaining measurement needed to accurately assess the dynamics of the atmosphere. Wind information in the tropics, high latitudes, and stratosphere, is particularly deficient. Furthermore, only a small fraction of the atmosphere is sampled in terms of wind profiles. This limits our ability to optimally specify initial conditions for numerical weather prediction (NWP) models and our understanding of several key climate change issues.

Because of its extensive wind-measurement heritage and especially the rapid recent technology advances, Doppler wind LIght Detection And Ranging (Lidar) has reached a level of maturity required for a space-based mission. The Doppler Wind Lidar (DWL) mission is expected to provide global wind profile observations with high vertical resolution, precision, and accuracy. The assimilation of space-based Doppler wind Lidar planned by NASA is being conducted in the Observing System Simulation Experiments (OSSEs)

2. Nature Run and Obs. Simulation

NR: A 13-month (May 2005 ~ June 2006) long free run was provided by ECMWF using cycle 30r1 of their Integrated Forecast System (IFS) model with triangular truncation T511.

Simulated OBS: "2012 observing system". Simulated equivalents of all observing systems used in NCEP operations in 2012.

Set (2011-12 period)
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 **(refractivity)**
ASCAT **(290)**
WINDSAT **(289)**
All conventional data available in 2011-12

3. DWL Instrument Description

Parameter/ Configuration	OAWL (aerosol only)	WISSCRcoh (Coherent)
Laser Wavelength(s)	532 nm	2μm
Laser PRF	150	10
Laser Pulse Energy (at output wavelength)	260 mJ	250 mJ
Laser Power (@ output wavelength)	39 W	2.5 W
Telescopes	2 x 0.7 m diameter	2 x 0.5 m diameter
Two views/looks	No switching, continuous at 150 Hz (enabled by OAWL)	12 second dwell with 1.3 second switching time between looks
Viewing Angle	40 off nadir	40 off nadir

Here we describe the two DWL subsystems that remained invariant in our testbed site. While the original plan was to only simulate the Optical Autocovariance Wind Lidar (OAWL, aerosol) subsystem, the team decided that in order to provide NASA with a "cleaner" comparison between the DWL options, all the subsystems would need to be simulated for a common orbit and using common rules for clouds, subgrid scale wind variability and aerosol distributions.

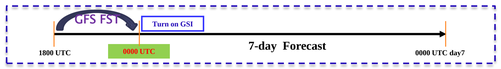
4. Obs. Error Assignment

$$\sigma_{ob}^2 = \sigma_m^2 + \sigma_s^2$$

- In the early OSSEs for space-based Doppler Wind Lidars (DWLs), the σ_{ob} was set to a single value for all altitudes, all instrument configurations, and all instrument measurement precisions…just one value. These simplicities are not appropriate nor necessary in assessing the potential impact of an active optical remote sensor.
- Now, we adopt a methodology for assimilating space-based DWL winds into NWMs that recognizes the a priori knowledge of the LOS measurement precision and uses the published σ_{obs} for rawinsonde wind observations utilized by the NCEP global model runs.

5. Experiment Setup

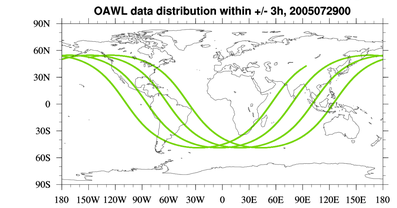
The analysis and forecast model used for the observing system simulation experiments reported on here is a Linux version of the operational NCEP Global Data Assimilation/Forecast System (GDAS/GFS) implemented in 2012.

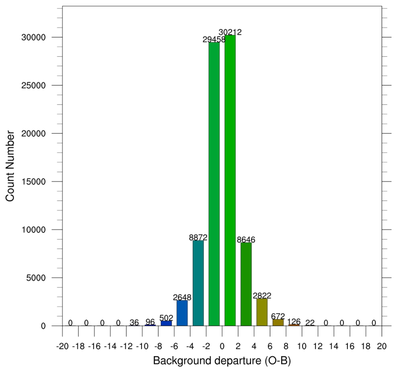


Time Period: **30 days** (07/28 18z ~ 08/27 00z, 2005)
Three experiments have been carried out in each set:

1. **CTRL**: A control run in which all the simulated equivalents of observations (both conventional and space-based) used operationally by NCEP in 2012;
2. **OAWL**: Same as CTRL, but adding OAWL lidar wind data;
3. **WISSCRCOH**: Same as CTRL, but adding WISSCR coherent lidar wind data;

6. Quality Control: First-guess Departure Check



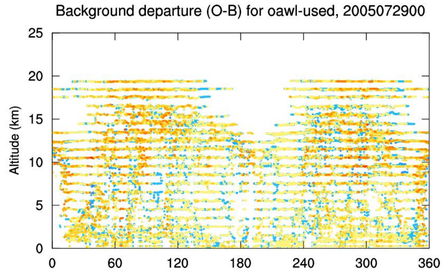


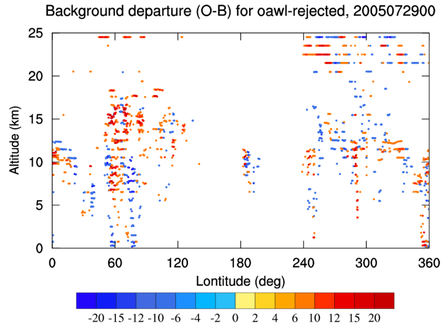
ratio = (Observation-Background)/max(***ermin***.min(***ermax***,*observor*))

If ratio > ***gross***, then this observation fails in gross check and will be listed as a rejection in the fit files.

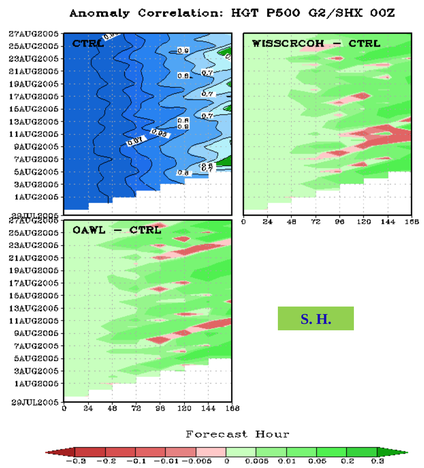
DATE: 2005072900, +/- 3h

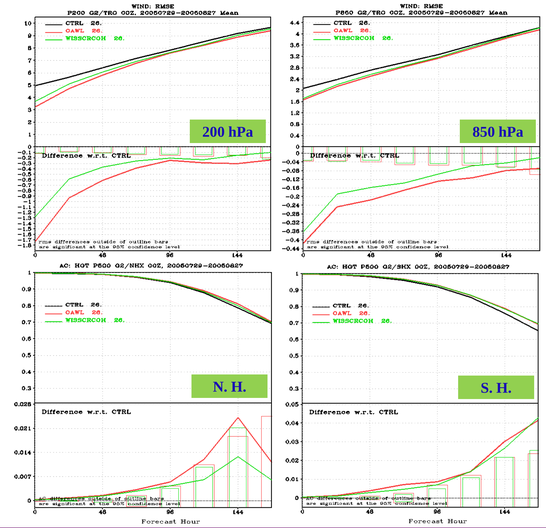
Obs. Types	DWL gross 2.5 (New)		
Data Counts	95,897		
	Used 42,056	Rejected 3,804	Monitor 50,037





7. One-month Statistics Results





8. Summary

A full global OSSE was conducted to assess the relative impact of OAWL and 3DWINDS on global atmospheric analyses and numerical weather prediction, which would utilize the ECMWF T511 NR and the OSSE system , and the GDAS used by the JCSDA for OSSE work. Our current preliminary results will depend on observational error assignment and future data assimilation system.