Wind Lidar OSSEs in the Joint Center for Satellite Data Assimilation

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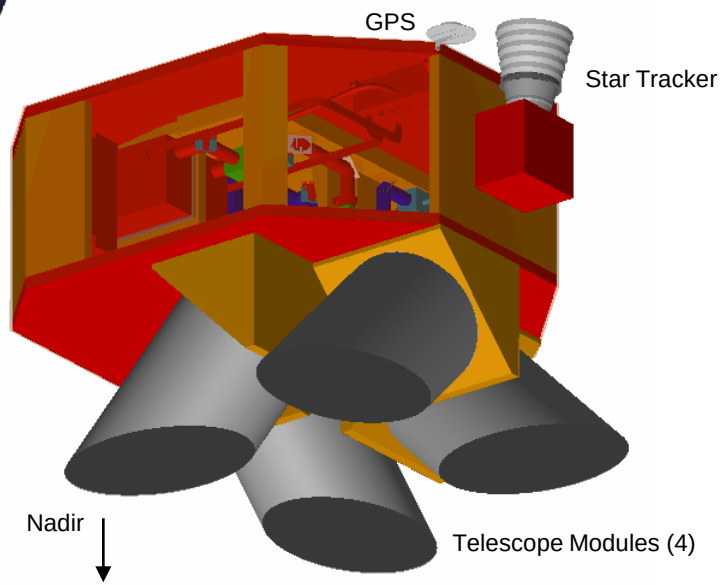
Wind Lidar OSSEs

- Impact experiments for GWOS mission concept
  - NASA Tier-3 Decadal Survey mission concept
  - Four telescopes, full vector winds on either side of spacecraft
  - Two technologies, direct and coherent detection
- Experiments funded under Wind Lidar Science element of NASA's ROSES 2007
- GWOS observations simulated by Simpson Weather Associates using DLSM

GWOS ISAL Instrument Quad Chart



Features of the Instrument Concept

- Utilizes Doppler lidar detection method
  - Coherent (aerosol) detection @ 2 µm
  - Direct (molecular) detection @ 355 nm
- Direct channel laser based on GLAS;
- Direct channel receiver based on TWiLiTE IIP
- Coherent channel laser and receiver based on DAWN IIP
- Telescopes are shared among all lasers
- Pointing and knowledge requirements met with co-located star tracker and GPS

Payload Data

Dimensions	1.5m x 2m x 1.8m
Mass	567 Kg
Power	1,500 W
Data Rate	4 Mbps

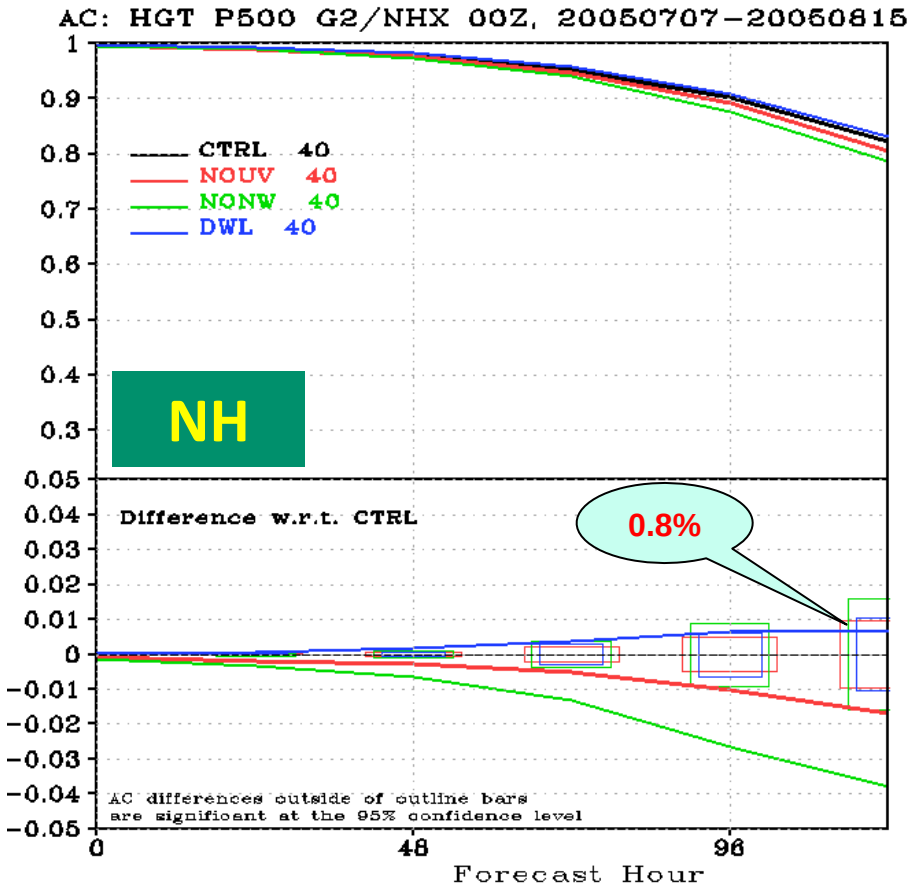
Technology Development Needs

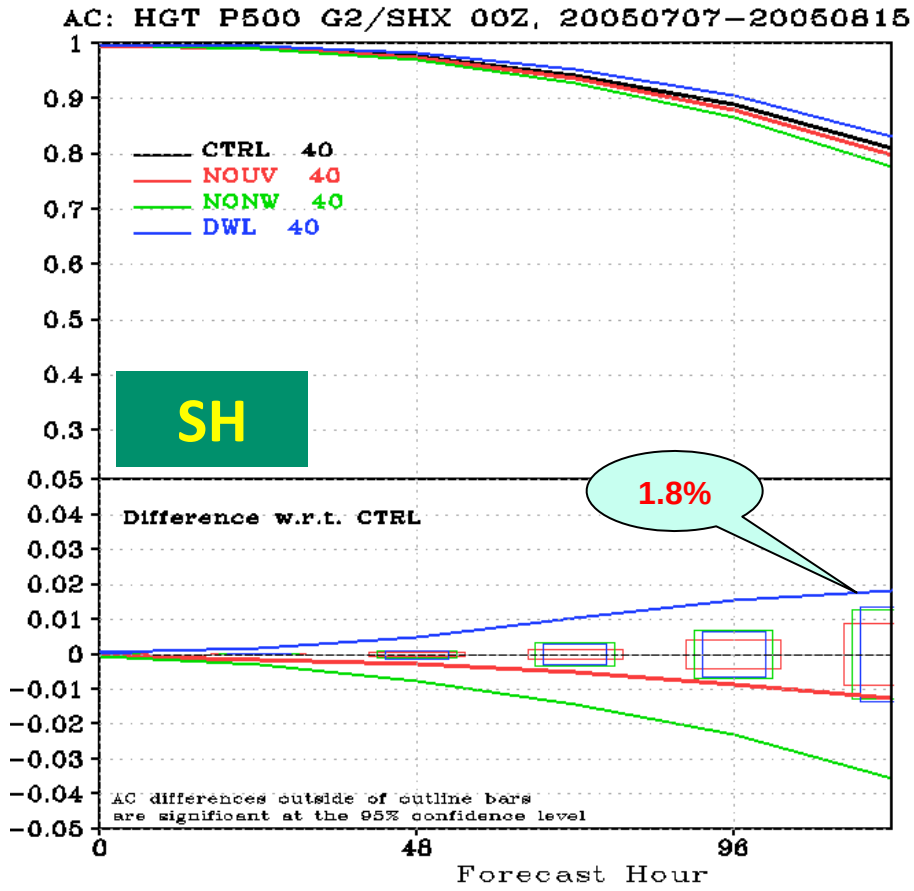
- Direct detection system requires 6 billion shots for mission lifetime (2 years)
  - Direct channel baseline is 3 lasers + 1 backup
  - Demonstration of reliable performance at higher or lower lifetimes will determine number of lasers for direct detection channel, impacting mission cost
- Coherent detection system requires demonstration of the 316M shot lifetime in a fully conductively cooled laser
- Both Lidar technologies require aircraft validation flights

Experimental setup

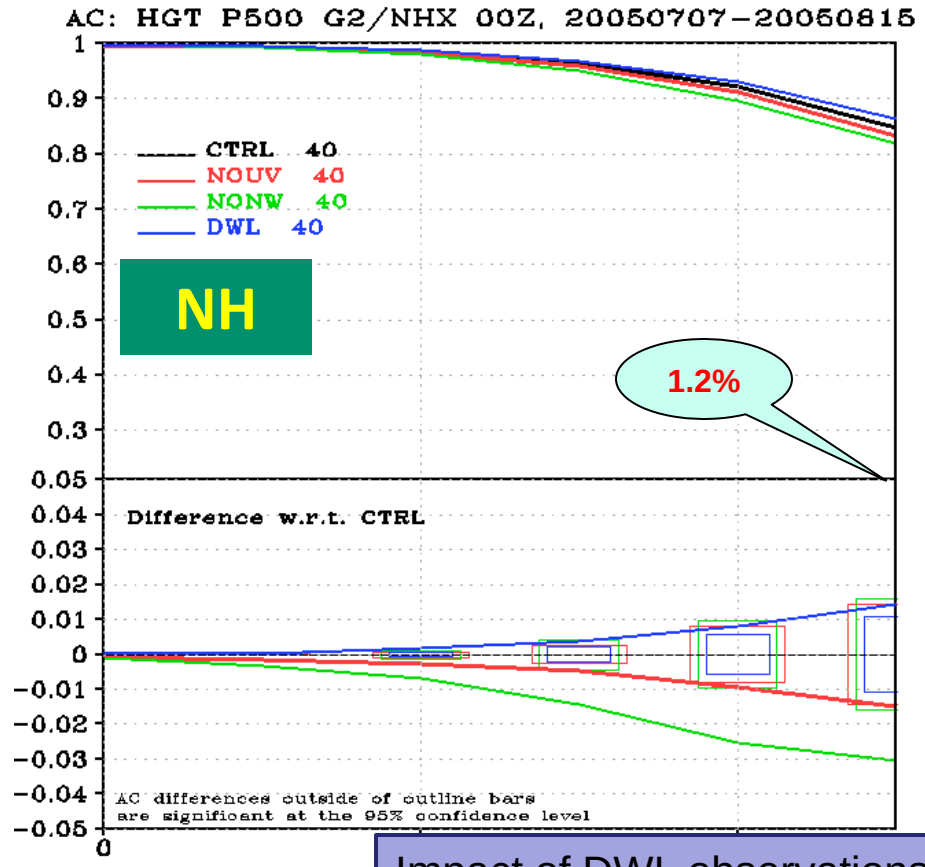
- NCEP GFS at horizontal resolutions T-126 and T-382
- "OSSE period": July 01-Aug 15, 2005 (simulated)
  - Five-day forecast launched every day at 00Z
  - Most observing systems used for routine operational NWP included, except GPSRO and IASI (will be corrected once we simulate 2010/11 GOS)
- Four experiments, all verified against Nature Run
  - CRTL: Observations as assimilated operationally by NCEP
  - NOUV: as CTRL, but without RAOBS (220, 221 and 232)
  - NONW: as CTRL, but without any wind observations
  - DWL : as CTRL, plus simulated GWOS lidar wind data

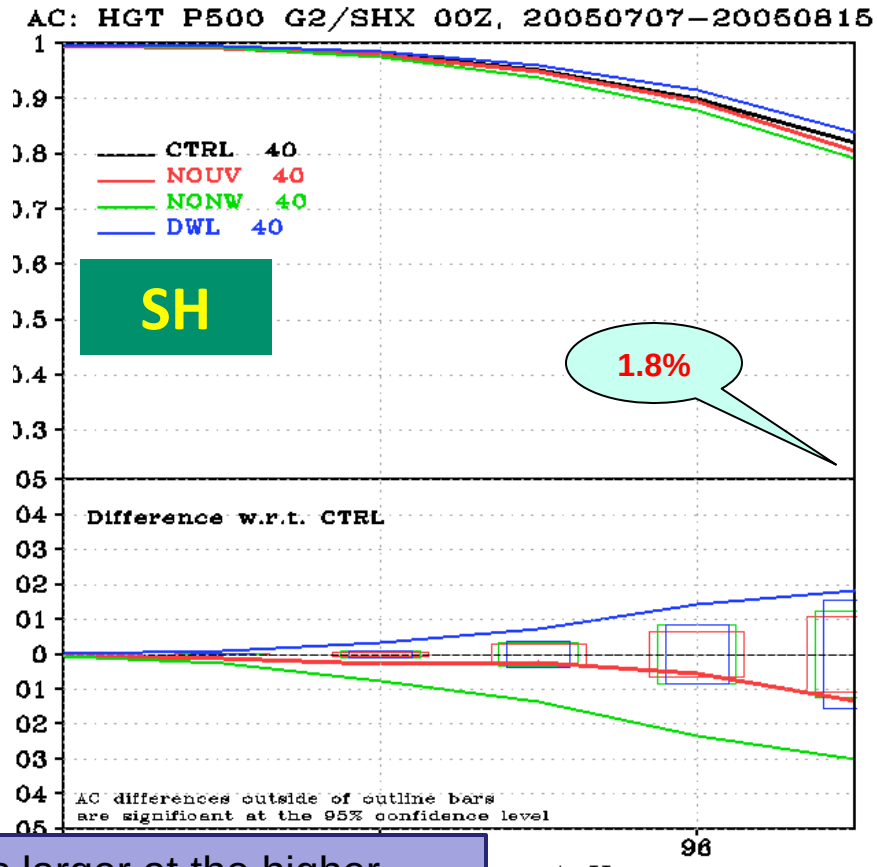
500hPa HGT anomaly correlation coefficients (T126)





500hPa HGT anomaly correlation coefficients (T382)





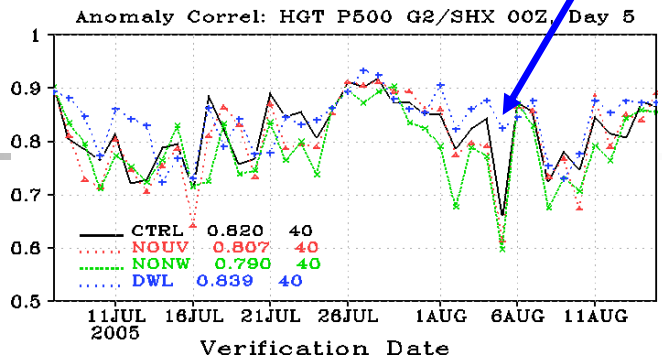
Impact of DWL observations is larger at the higher resolution (T382), even though skill of control is higher

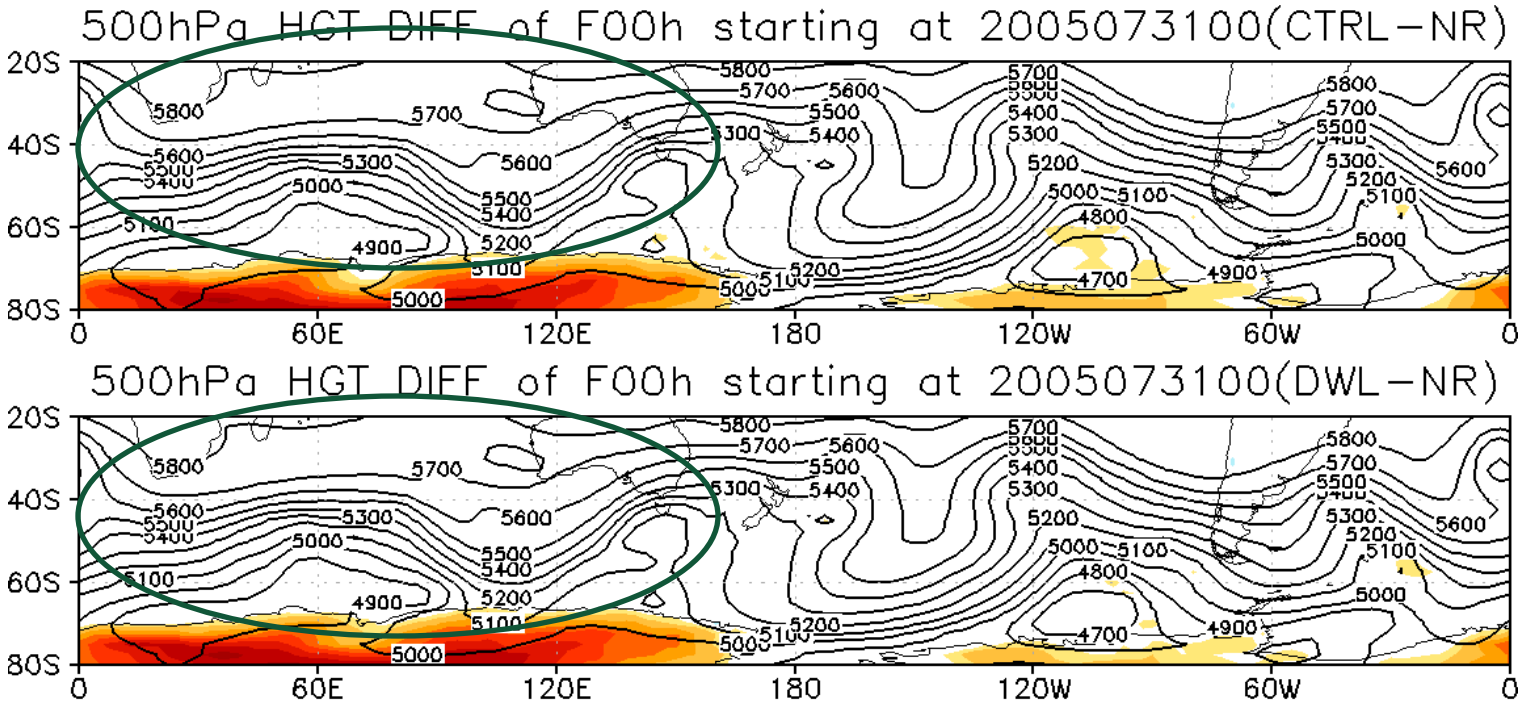
Special Case Study (T-382)

Candidates for additional study

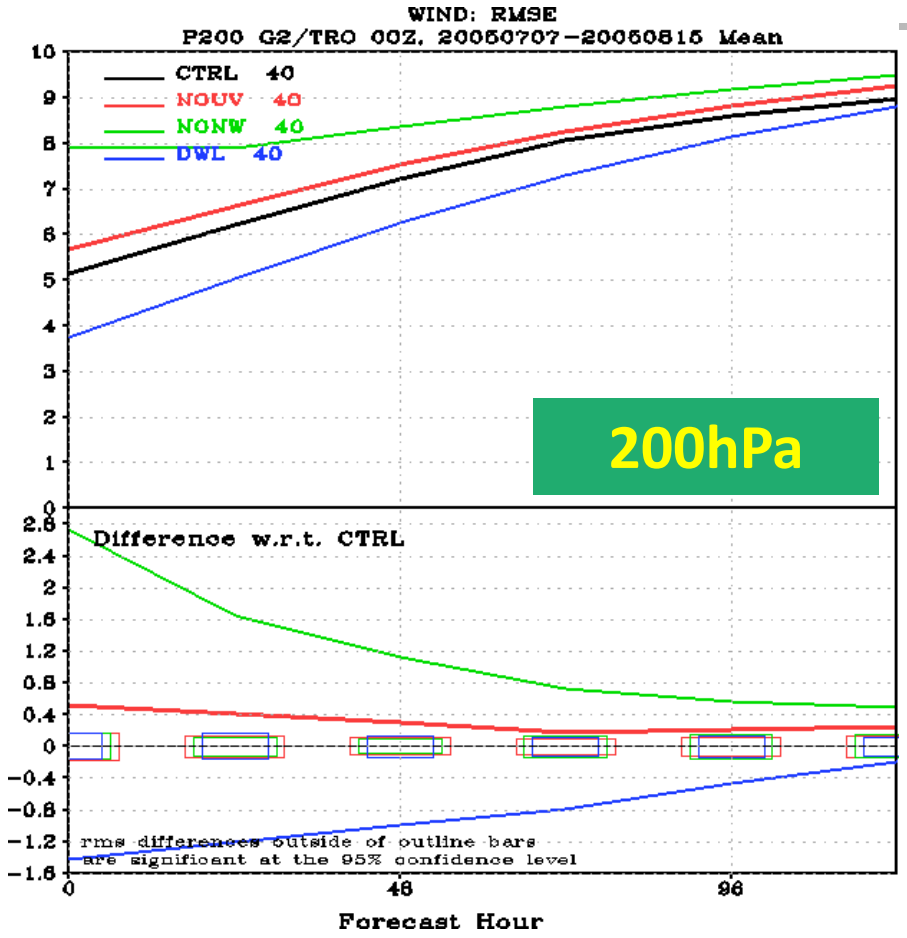
Date: Aug 5th , 2005

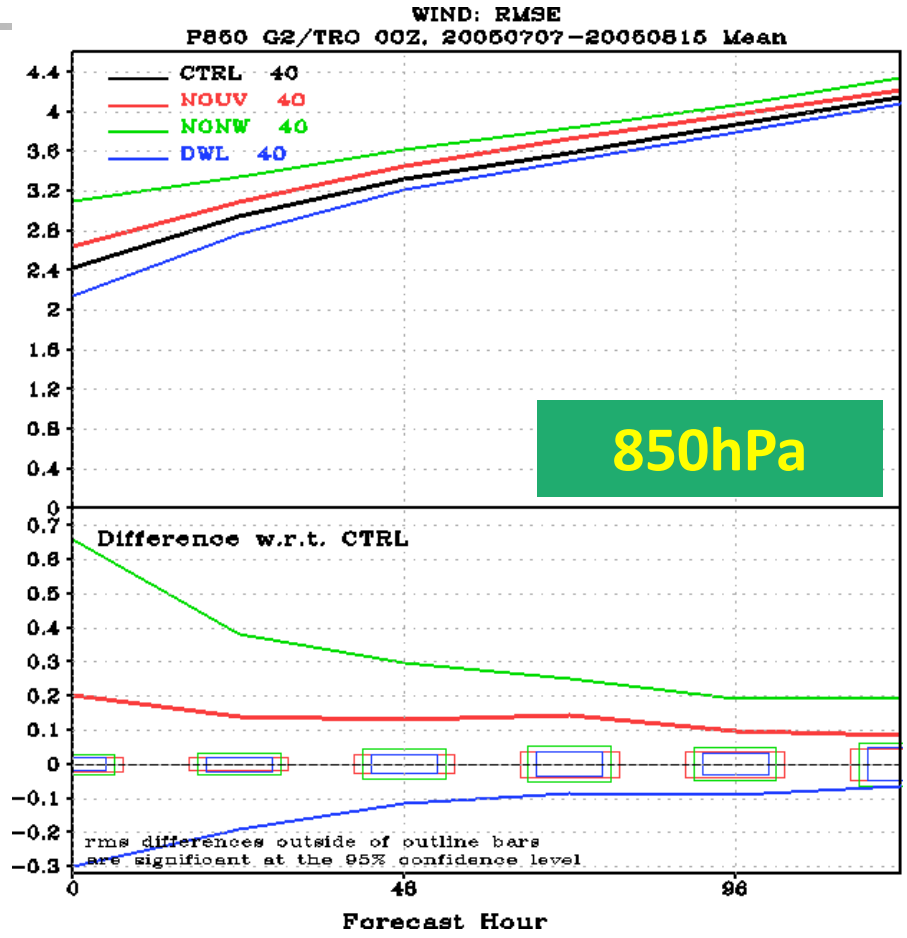
SH: (20° ~80° S)





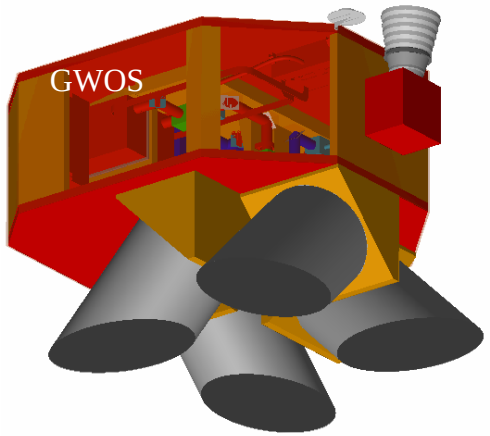
RMSE: 200, 850hPa Wind error in tropics (T382)





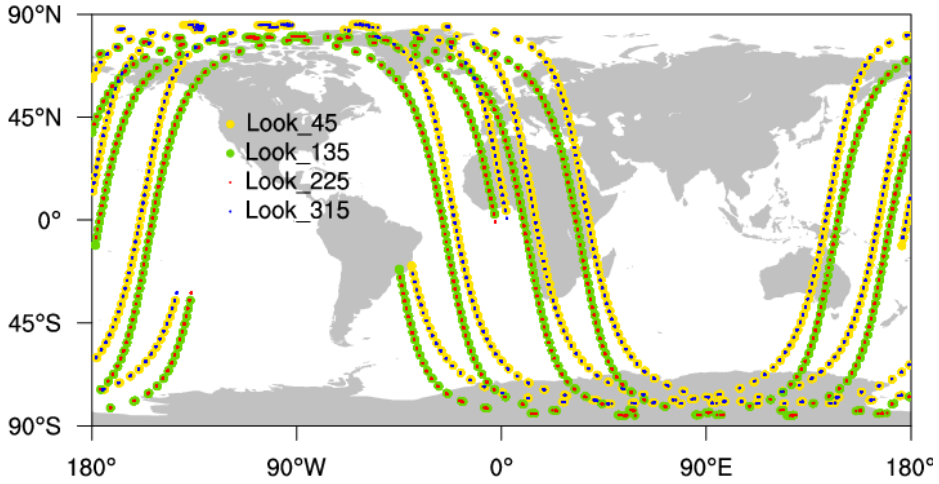
Single LOS or Vector Winds?

- Important configuration issue for GWOS (impact vs. cost)
- Experiments performed with variable number of perspectives:
  - One; single line of sight, similar to ADM/Aeolus
  - Two; full horizontal wind vectors, left or right side of satellite track
  - Four; full GWOS coverage; wind vectors on both sides of satellite track



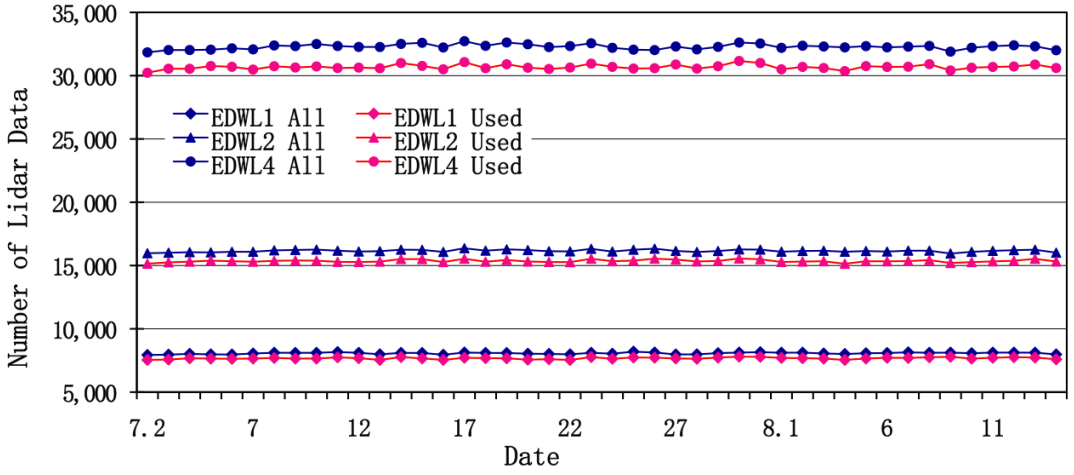
Impact of Different Wind Lidar Configurations on NCEP Forecast Skill.

GWOS Lidar Wind obs

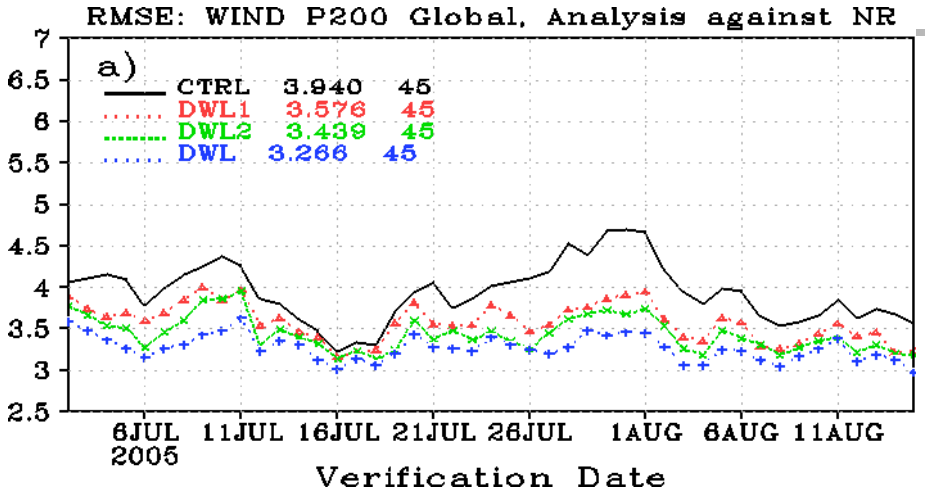


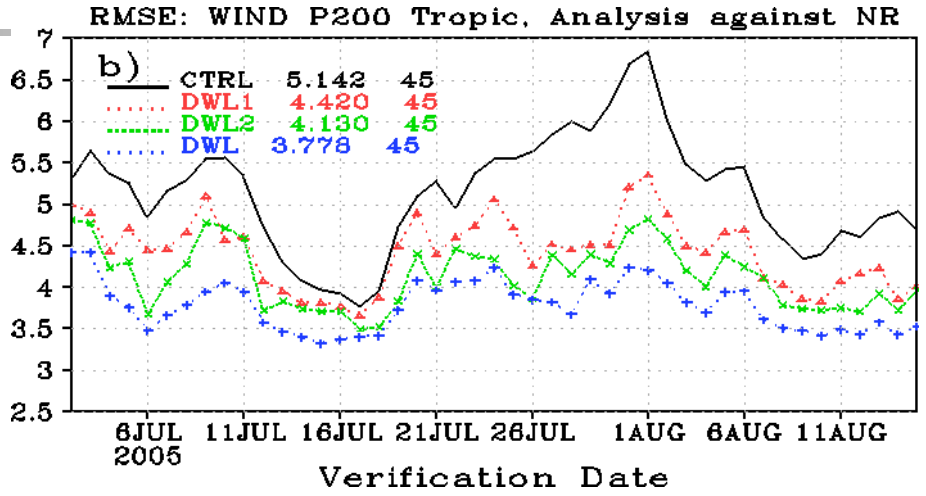
Distribution of Lidar observations for one analysis cycle (July 7 2005, 00Z)

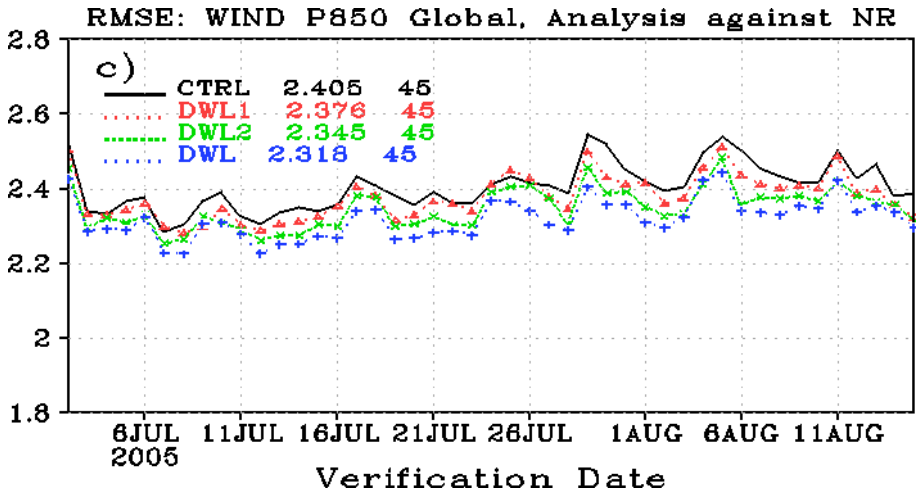
Number of Lidar obs per analysis cycle, before and after QC (shown only for 00Z)

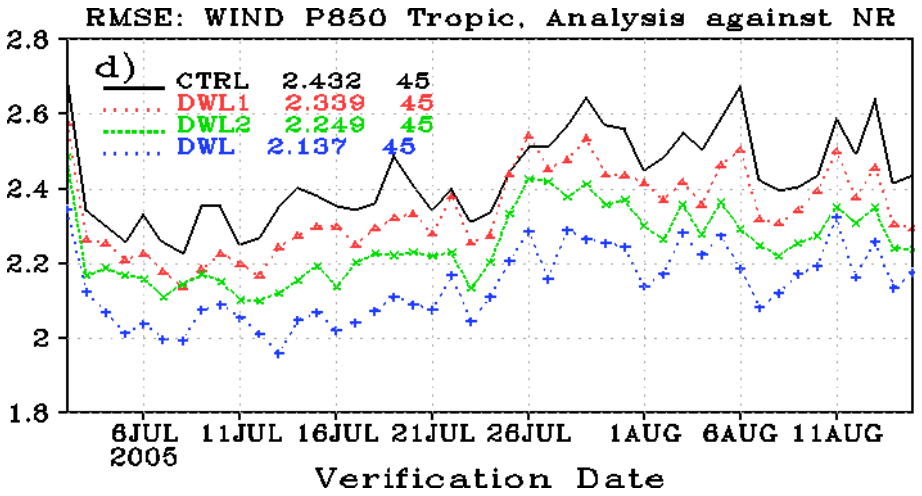


Analysis Impact: Wind



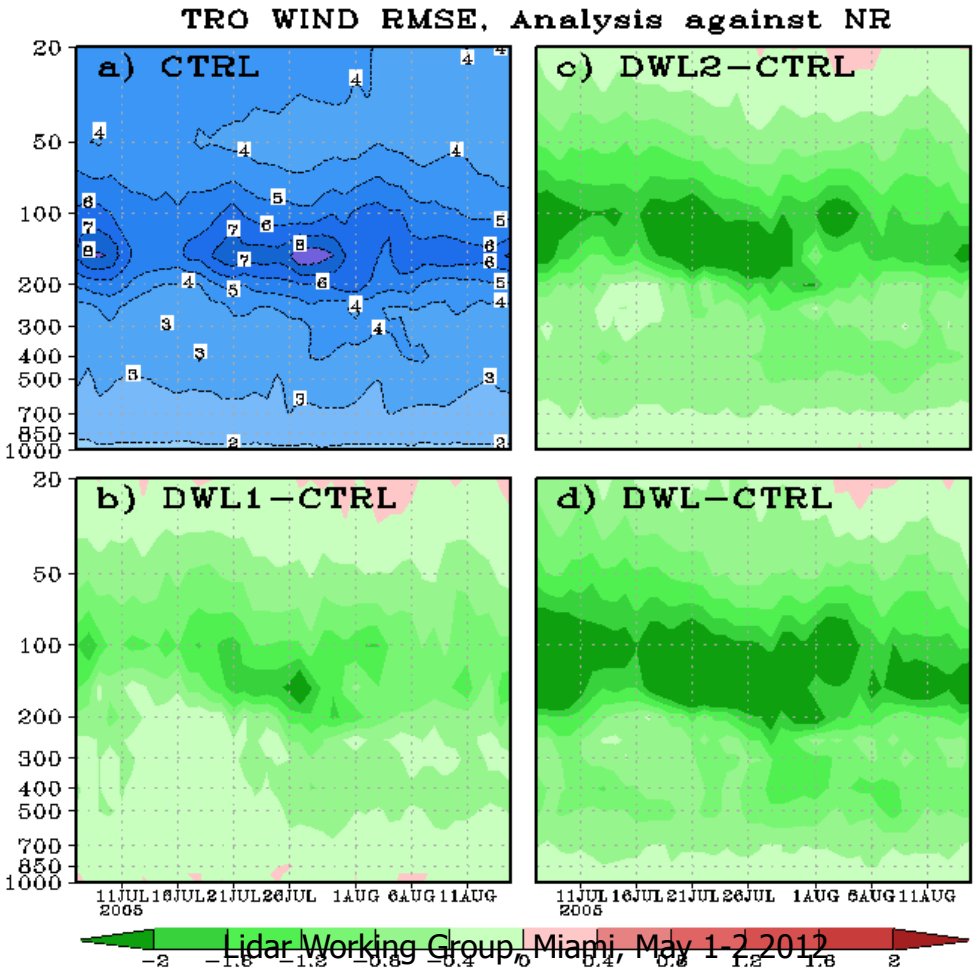






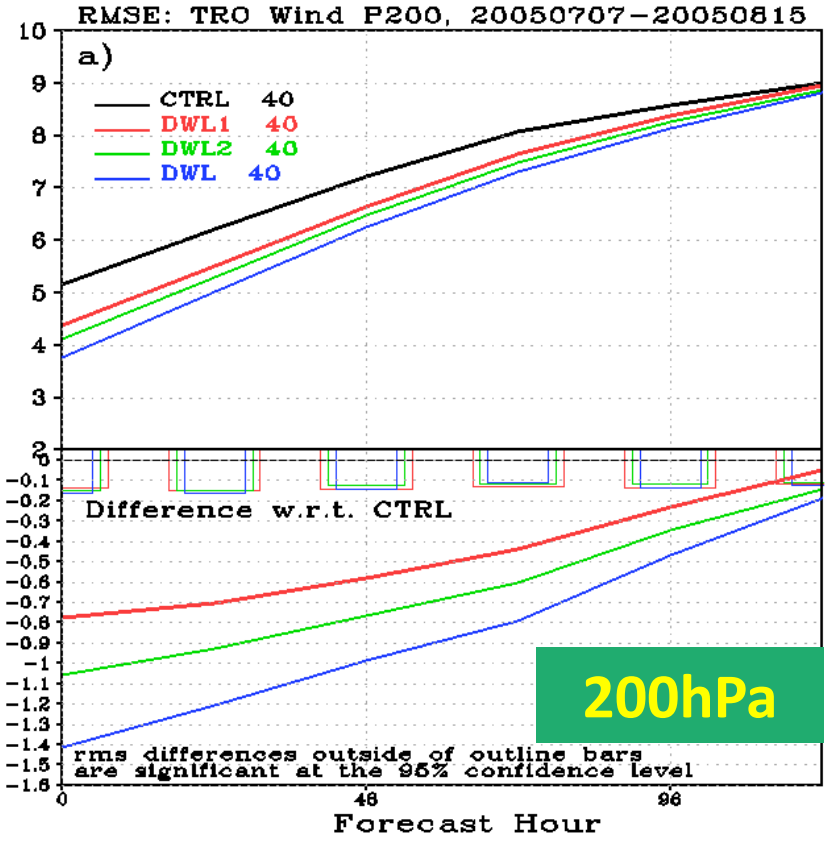
Analysis Impact:

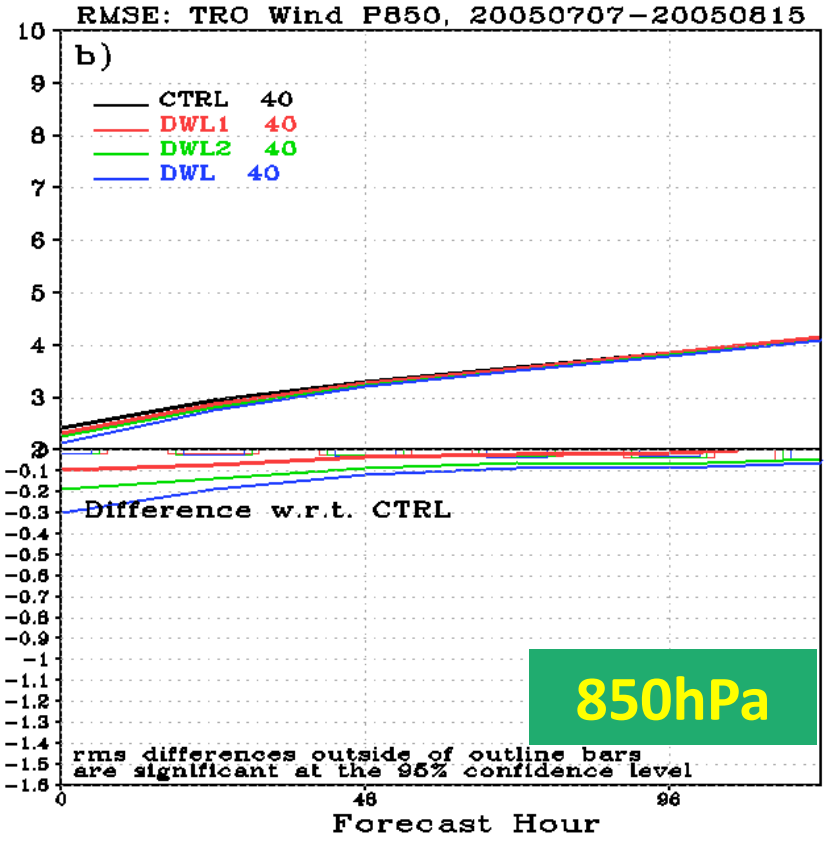
Tropical winds



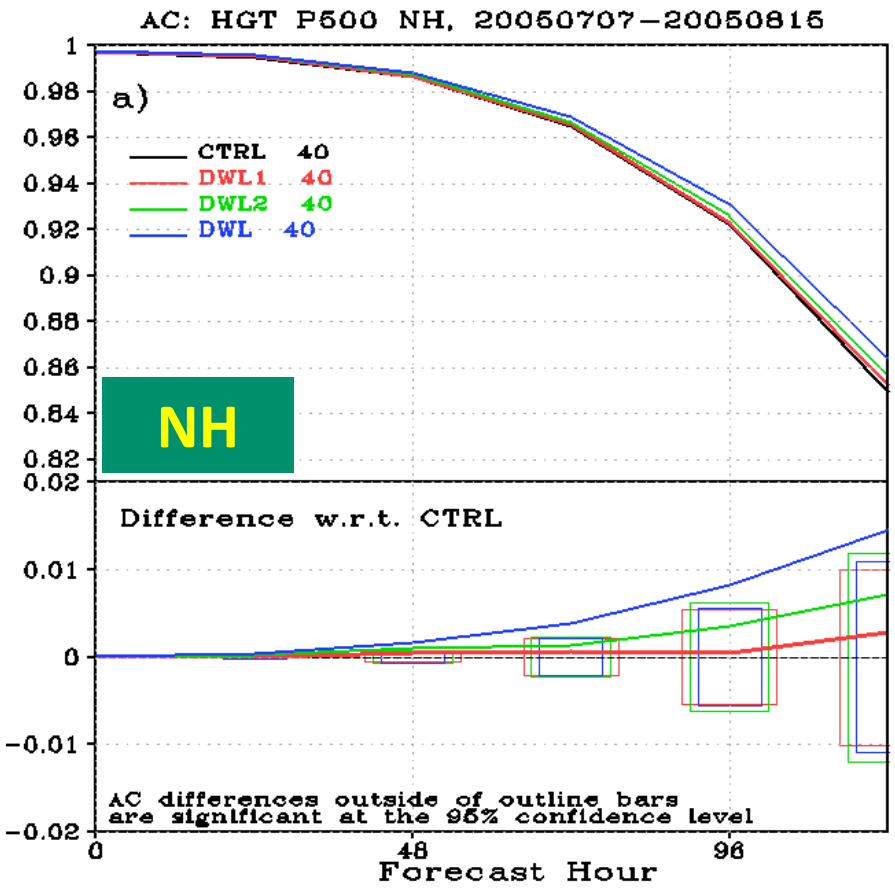
Forecast: Tropical Wind

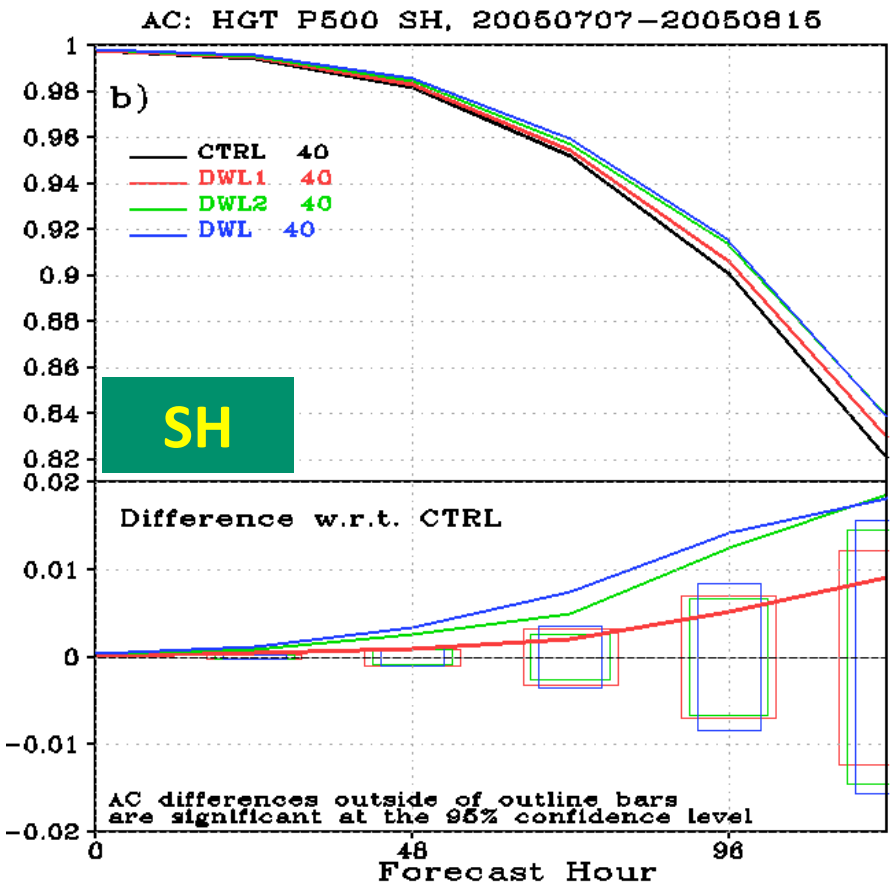
(RMS error at 200, 850hPa)





Forecast skill: 500 hPa height AC





Summary and conclusions

- A comprehensive OSSE system has been developed under the Joint OSSE collaboration
- Initial results simulating expected impact of GWOS observations on NCEP GFS system are encouraging
  - Small positive impact in NH extratropics (summer)
  - Larger positive impact in SH extratropics (winter)
  - Very large positive impact in tropics; implications for hurricane forecasting
  - Two perspectives, more coverage lead to larger impact

WLS OSSE outlook (wish list)

- Experiment in opposite season (NH winter/SH summer)
- Increased horizontal resolution (T-574 and higher; requires new Nature Run)
- Detailed case studies
- Separate assessments of the impacts of Direct Detection and Coherent Detection
- Other orbits, e.g. different altitude, lower inclination
- Impact on applications other than NWP, e.g. chemical transport models

Acknowledgments: Study funded primarily through Wind Lidar Science Element of NASA ROSES 2007 (Kakar). Additional resources including computing made available by NCEP/EMC.

Project status

- Original ROSES-funded project scheduled to end by May 2011
  - Due to hiring difficulties, the project got off to a slow start, and no-cost extension through May 2012 was therefore approved by NASA
  - Funding is now exhausted and work has been completed

Project status (II)

- Zaizhong Ma has transitioned to other work within NESDIS/STAR
- OSSE work now proceeding for DWSS under DoD funding, in collaboration with AOML (Bob Atlas)
  - JCSDA team consists of LPR, Michiko Masutani, Sean Casey
- Hope for new NASA-funded Wind Lidar OSSE project

General status of Joint OSSE system/collaboration (more in presentation by Michiko)

- ECMWF-provided T511 Nature Run nearing the end of its shelf life
- Several candidates for replacement
  - ECMWF
  - GMAO
  - ESRL
  - …
- Community decision is needed
- OSSEs are gaining visibility within NOAA
  - Funding to follow?