Initial Impact Assessment of ADM-Aeolus Wind Observations on NCEP Global Analysis and Forecast

Hui Liu[1], K. Ide[1], K. Garrett[2], R. N. Hoffman[1], W. McCarty[3], A. Kliewer[4], T. C. Wu[4], H. Cronk[4], K. Apodaca[5], J. Dunion[5], L. Bucci[5], and L. Cucurull[5]

[1]University of Maryland/CICESS; [2]NOAA/NESDIS/STAR; [3]NASA/GSFC; [4]CIRA/CSU; [5]NOAA/AOML

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Objective of NESDIS/STAR

- Assess impact of Aeolus horizontal-line-of-sight (HLOS) wind on NOAA operational global data assimilation system (GDAS)

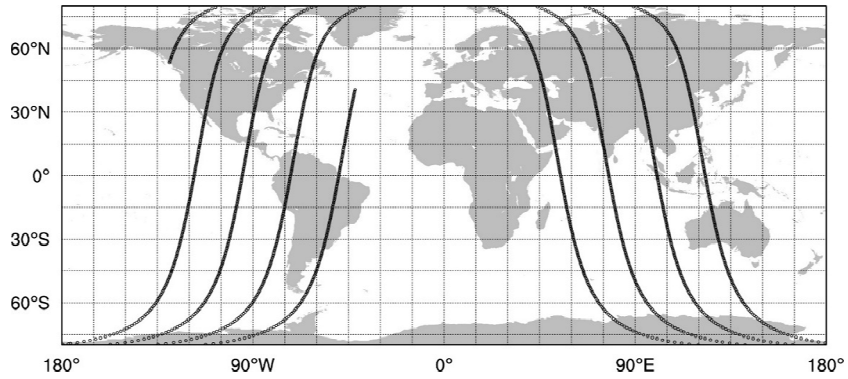
Outline

- Comparison of Aeolus wind to operational NOAA global forecast system (GFS) 6-h forecast
- Offline-bias correction and observation error variance estimation of Aeolus winds for NOAA GDAS
- Observation System Experiment (OSE) setup
- Impact assessment of Aeolus wind on forecast skill

Comparison of Aeolus Wind to GFS 6-h Forecast

- Aeolus Level-2B (L2B) HLOS wind:
  - Sep 6 – Oct 16, 2018
  - 0-24km altitude range
  - Horizontal resolution: 90km
  - Vertical resolution: 1-2km
  - ~ 4 orbits and 1800 profiles per 6-hourly cycle
  - Rayleigh wind in clear-sky and Mie wind in cloudy-sky
- Comparison to GFS winds:
  - GFS wind at C384 (~0.25 degree) horizontal resolution and 64 vertical levels (0-60km)
  - Interpolate GFS wind to the time and location of Aeolus wind, and transform to HLOS wind component

Aeolus profile locations, Oct 16, 12UTC cycle, 2018



Quality Controls and Evaluation of Aeolus Wind

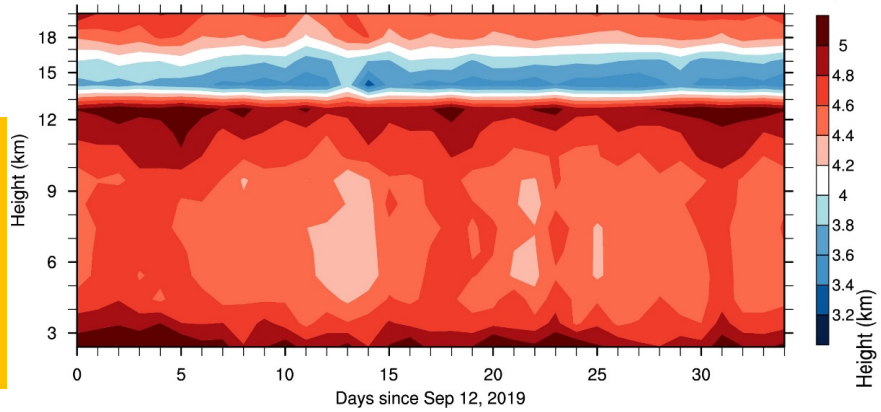
QC 1 Check: Remove Blacklisted Data

QC 2 Remove: Rayleigh wind: > 4 m/s uncertainty

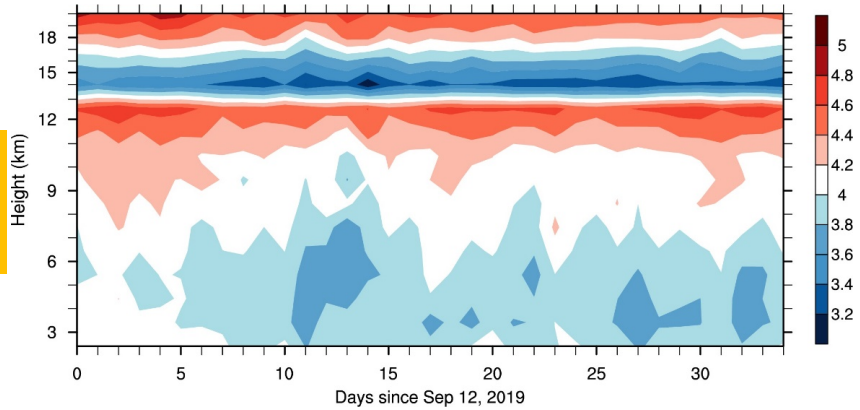
QC 3 remove: GFS vertical shear > 5 m/s/km

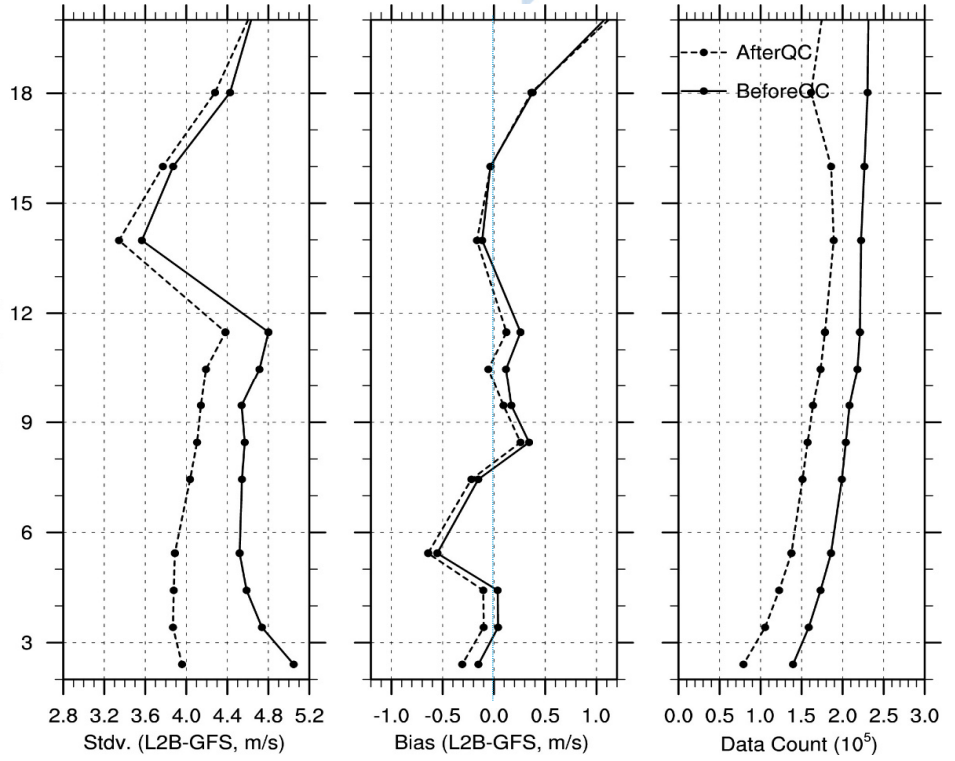
Rayleigh Stdv (Aeolus-GFS) Before QC

(Sep 12-Oct 16, global)



Rayleigh Stdv (Aeolus-GFS) After QC

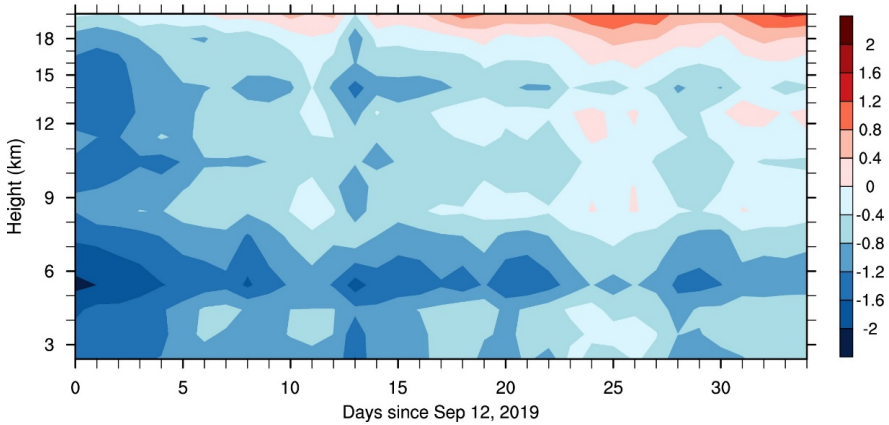




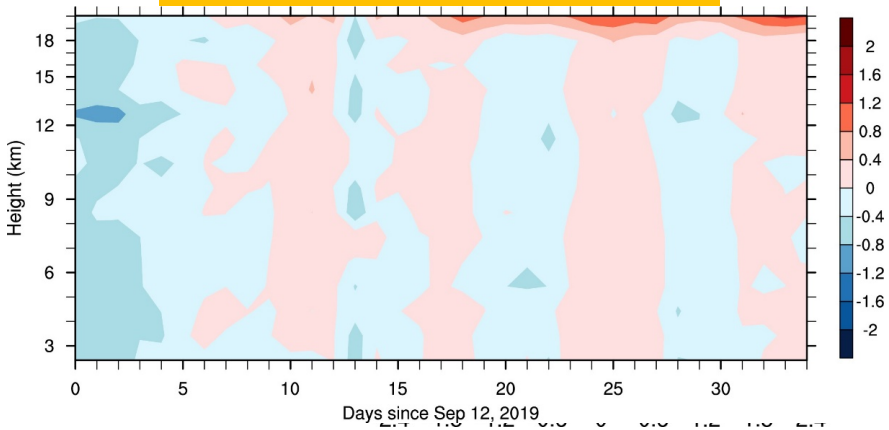
Rayleigh global STDV: 4.6 m/s (before QX), 4.1 m/s (after QC)

Offline Bias Correction of Aeolus Wind

Rayleigh wind bias (L2B-GFS, ascending)

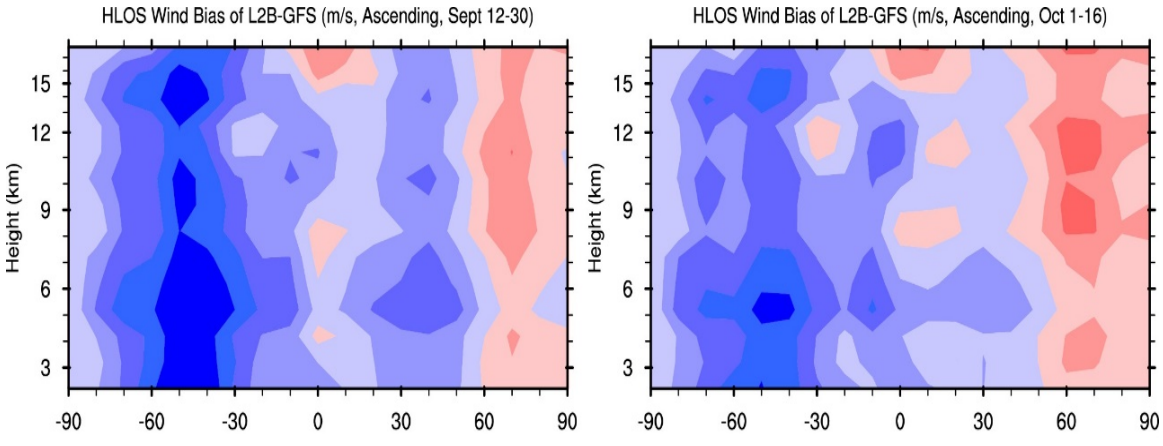


Rayleigh wind bias after correction

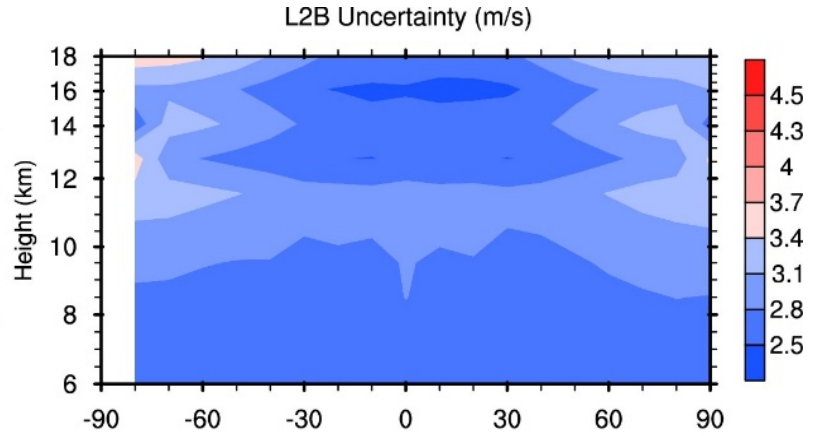


- Bias correction as function of orbits, latitude, height, and time
- (shown below averaged in Sep 12-30 and Oct 1-16)

Bias correction for Rayleigh ascending orbits



Observation Error Variance Estimation of Aeolus Wind

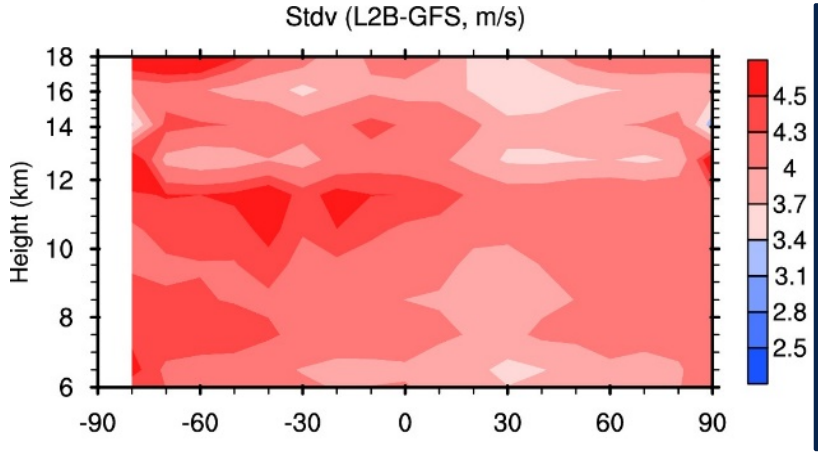


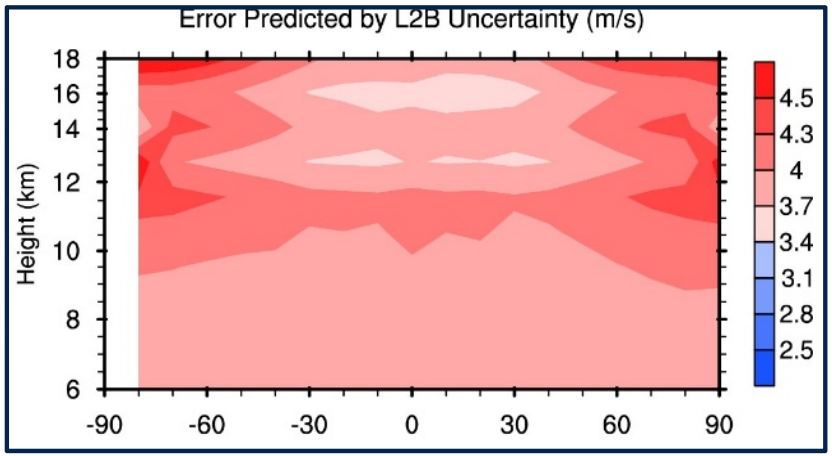
Assume:

$$\sigma_o = a(orbit) * L2Buncertainty + b(orbit)$$

Then, linear regression of Stdv (L2B-GFS) to L2B uncertainty to get the coefficients.

	Rayleigh clear	Mie cloudy
Ascending	1.00 * L2Buncertainty + 1.16	3 m/s
Descending	0.94 * L2Buncertainty + 1.25	3 m/s





Aeolus Observing System Experiment (OSE)

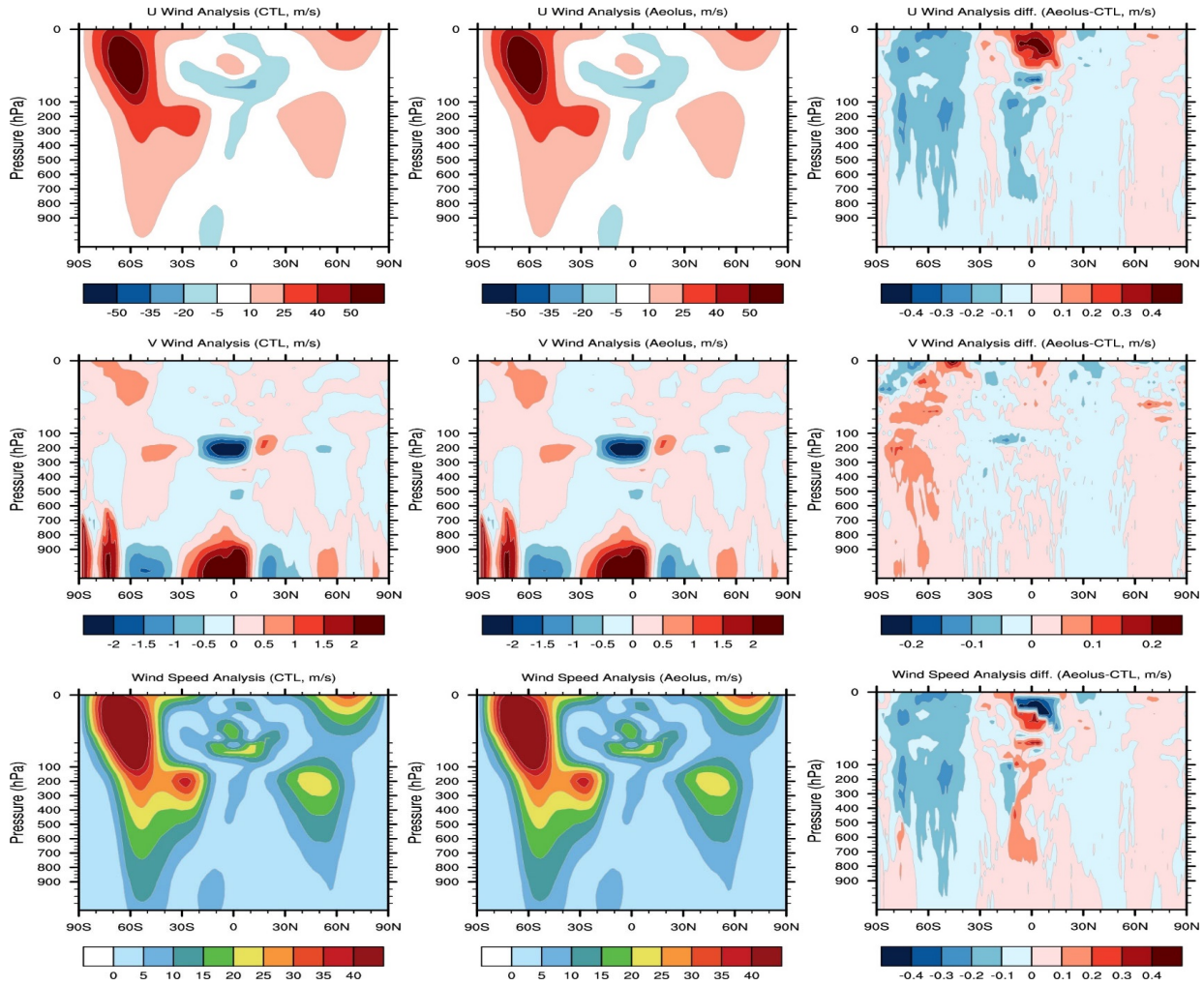
- Assimilate Aeolus L2B HLOS wind in NOAA FV3GFS 4DEnVar
- Experiments at C384/C192/L64 research resolution

	Control run (CTL)	Aeolus Experiment
All operational observation types	Yes	Yes
Aeolus L2B HLOS wind	No	Yes Rayleigh clear + Mie cloudy wind

- Initialized at Sep 5 00Z, 2018 for spin-up of a week
- Assessment period is Sep 12 – Oct 16, 2018
- Forecast verification to independent observation types and ECMWF analysis
- Summary Assessment Metrics (SAM, Hoffman et al., 2018)

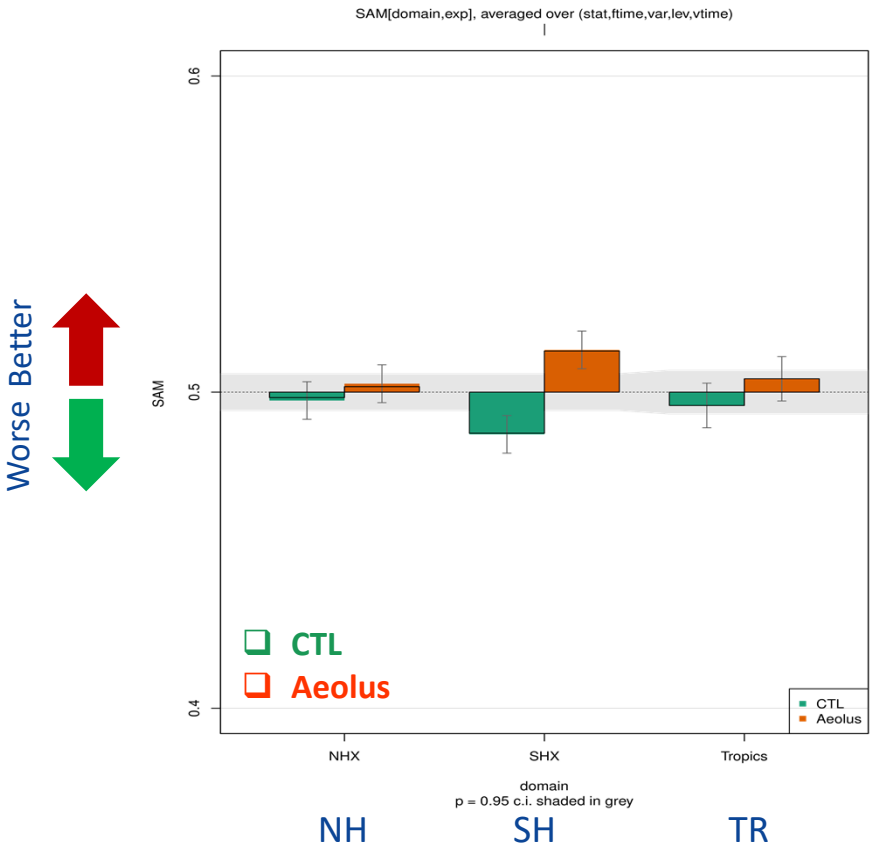
Impact on Zonal Mean of Wind Analyses

(Sep 12–Oct 16, 2018)



Wind analysis differences (Aeolus-CTL) evident in SH and TR regions

Overall Impact on Forecast (Global Average)
(Sep 12–Oct 16, 2018)

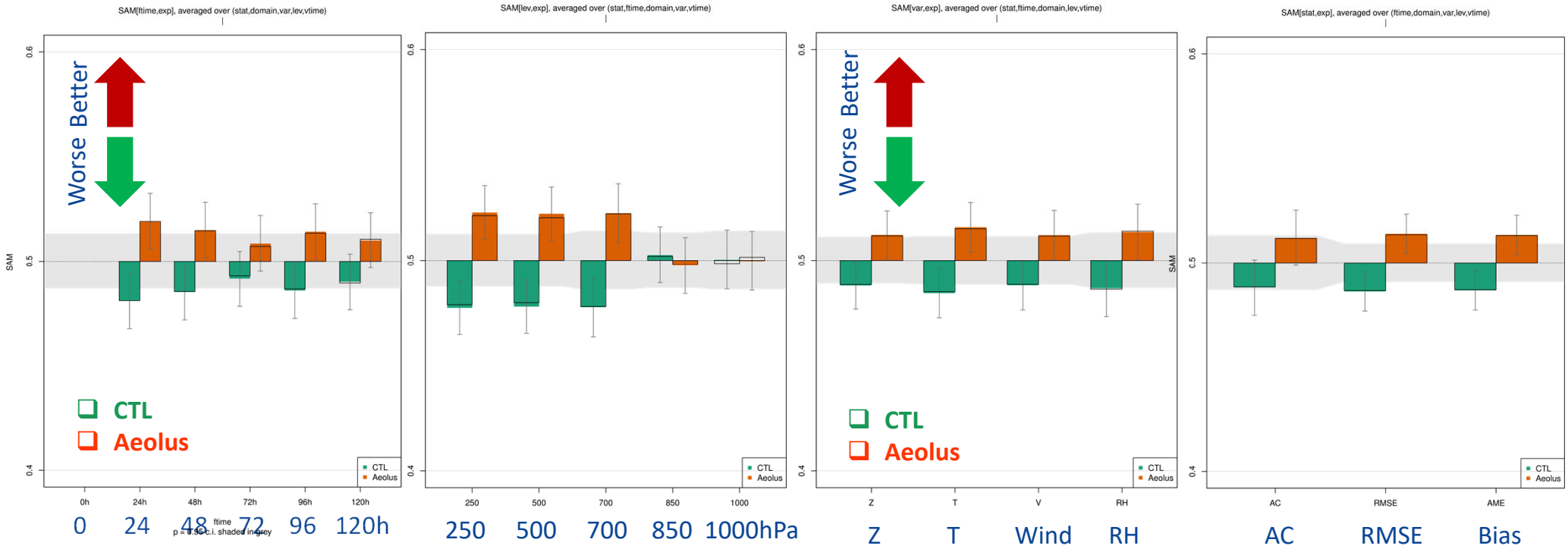


Summary Assessment Metrics (SAM, Hoffman et al., 2018)

The SAM score of forecast verifications of wind, temperature, height, and moisture to ECMWF analysis

Improvement in Southern hemisphere is statistically significant

Overall Impact on Forecast (Southern Hemisphere)
(Sep 12–Oct 16, 2018)



0 24 48 96 120h

250 500 700 850 1000hPa

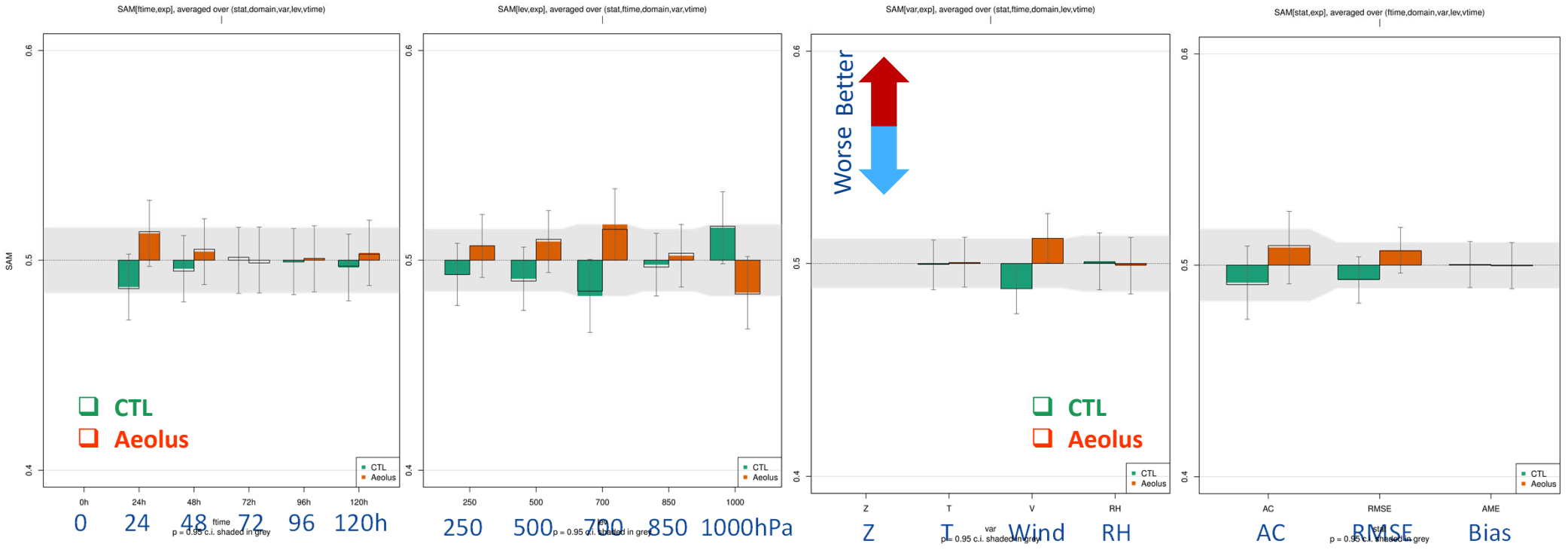
Z T Wind RH

AC RMSE Bias

Improvement at upper levels (250-700 hPa) is statistically significant

Overall Impact on GFS Forecast (Tropics)

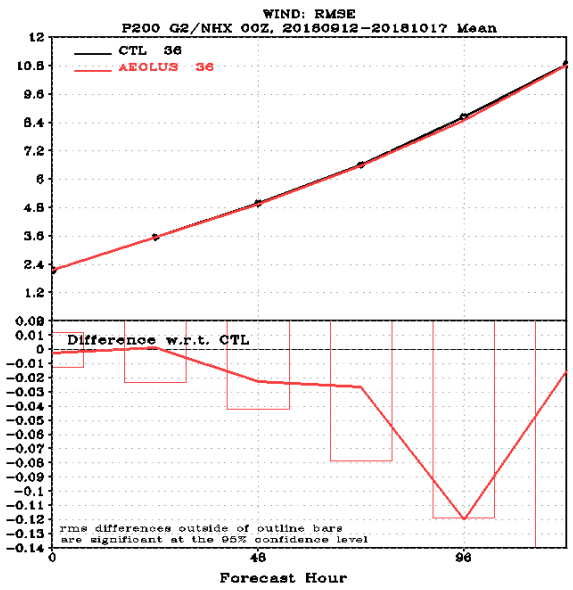
(Sep 12–Oct 16, 2018)



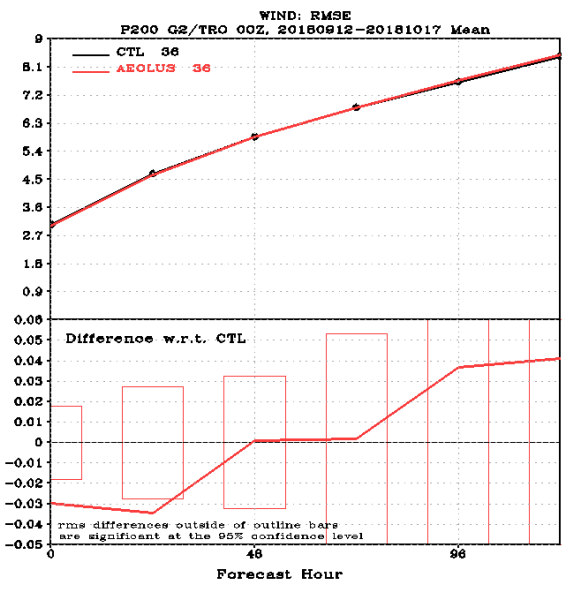
RMSE of Wind Forecast vs. ECMWF Analysis

200 hPa, Sep 12-Oct 16 2018

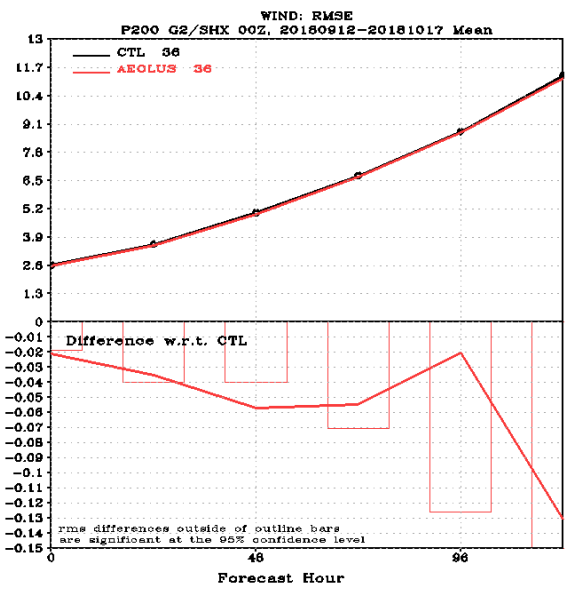
NH



TRO



SH



Better

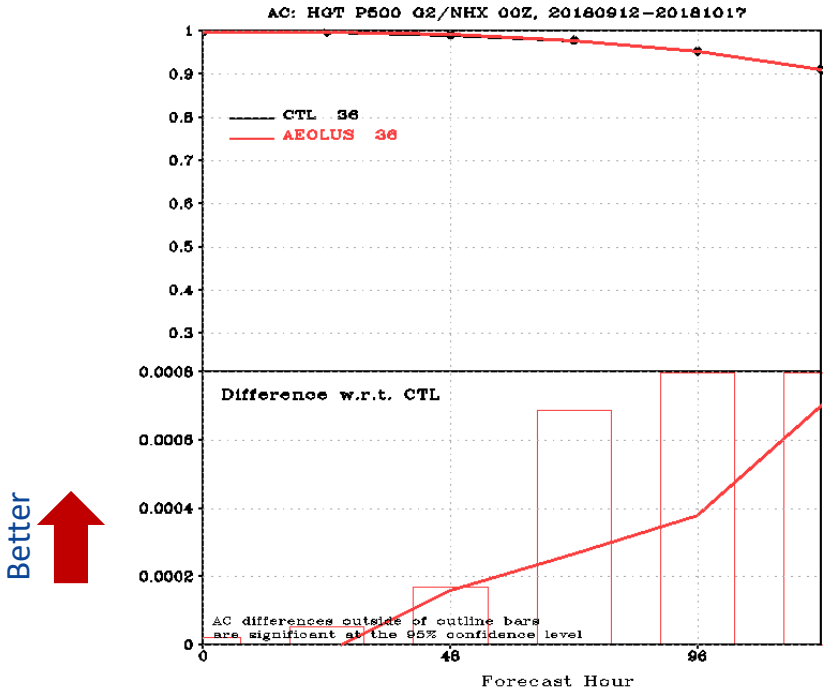
- Vector wind RMSE vs. Forecast Length (top)
- Difference of Aeolus Experiment w.r.t. CTL experiment (Bottom).
- Bars represent 95% confidence interval for null hypothesis

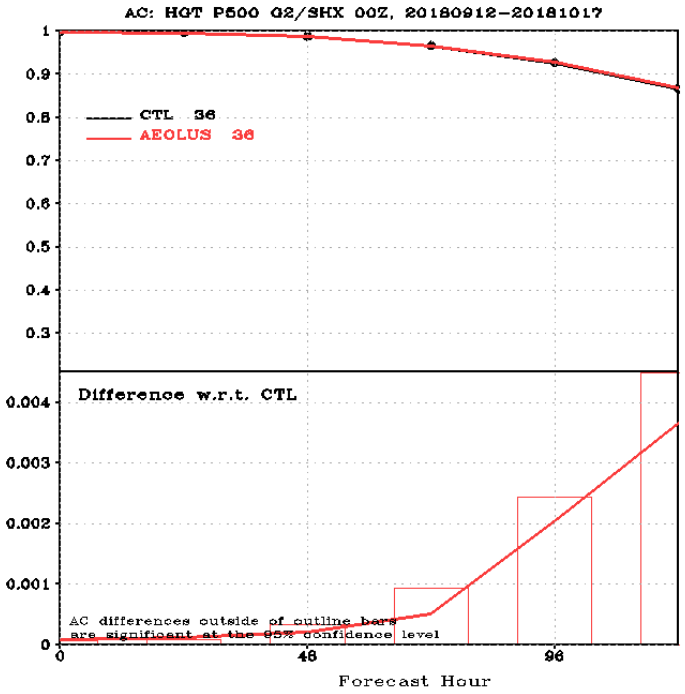
Anomaly Correlation of 500 hPa Height Forecast

Sep 12-Oct 16, 2018

NH

SH





Summary

- Aeolus winds have been assimilated in NOAA/GDAS (at research resolutions)
- Initial results are encouraging:
  - Positive impact on forecast in the Southern Hemisphere (and Tropics)
  - Neutral impact in the Northern Hemisphere
- Further refinements for Aeolus wind assimilation with NOAA/GDAS:
  - Quality controls
  - Bias corrections
  - Observational error quantification
- Next impact assessment:
  - Aug 2 – Sep 16, 2019