



Winds development and use in the NCEP GFS data assimilation system

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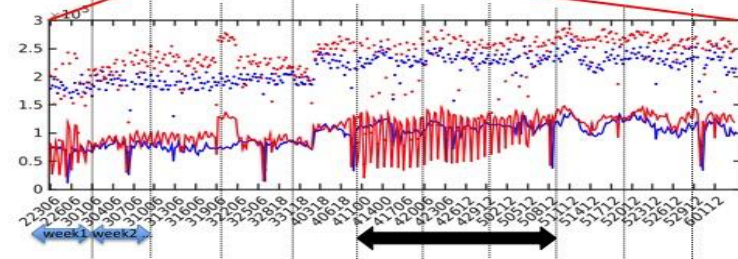
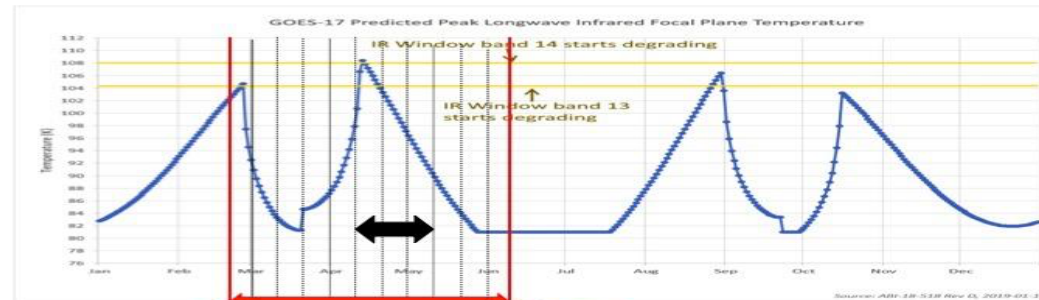
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University of Miami, ⁶CIMSS/University of Wisconsin–Madison

INTRODUCTION

GOES-17 and NOAA-20 VIIRS were recently added to the Global Observing System upper-air observations. Now all geostationary satellites carry on board Advanced Baseline Imager (ABI)-class imagers with surpassing spatial and spectral capabilities. These technological advancements led to improved Atmospheric Motion Vectors (AMVs) data products from EUMETSAT, JMA and NOAA NESDIS.

NCEP's GFS Data Assimilation system transitioned from GOES-15 to GOES-17 and added NOAA-20 VIIRS winds in 2019. Leo-Geo winds were evaluated for inclusion soon (TBD) and new products, Aeolus wind profiles and GOES-GOES Stereo winds, are currently evaluated for DA

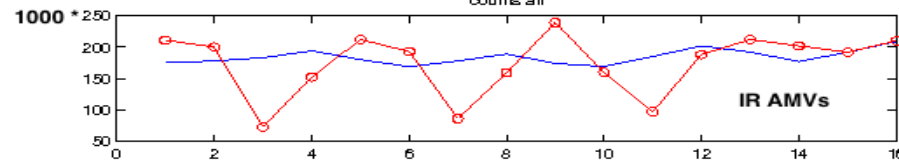
GOES-17 AMVs Loop Heat Pipe (LHP) anomaly impact on IR winds count



←ALL

←ASSIMILATED

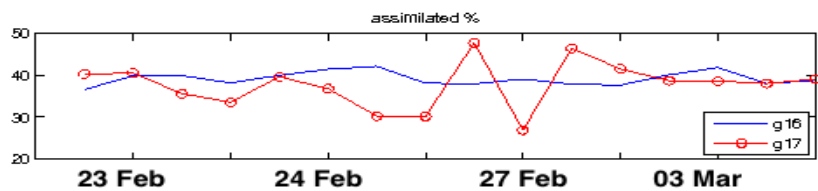
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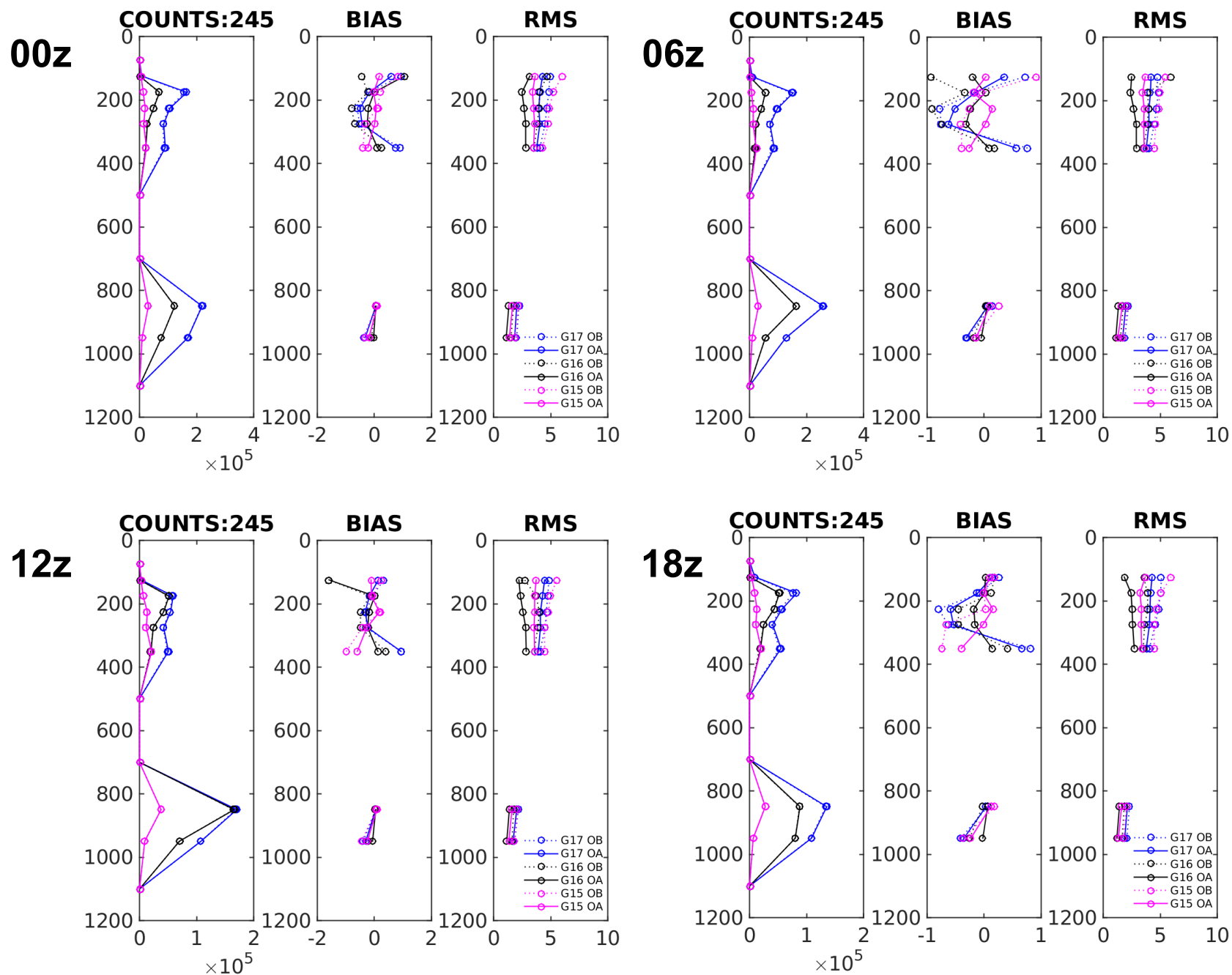
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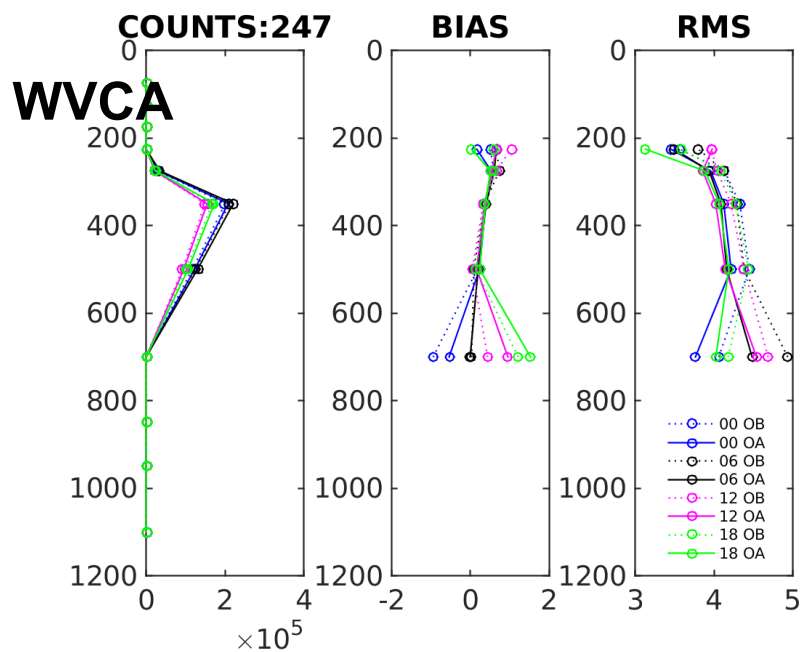
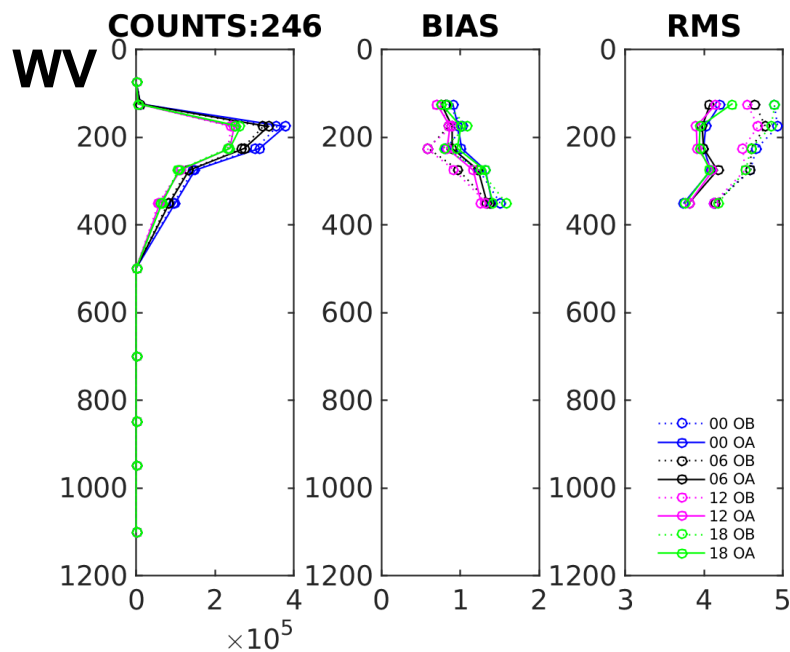
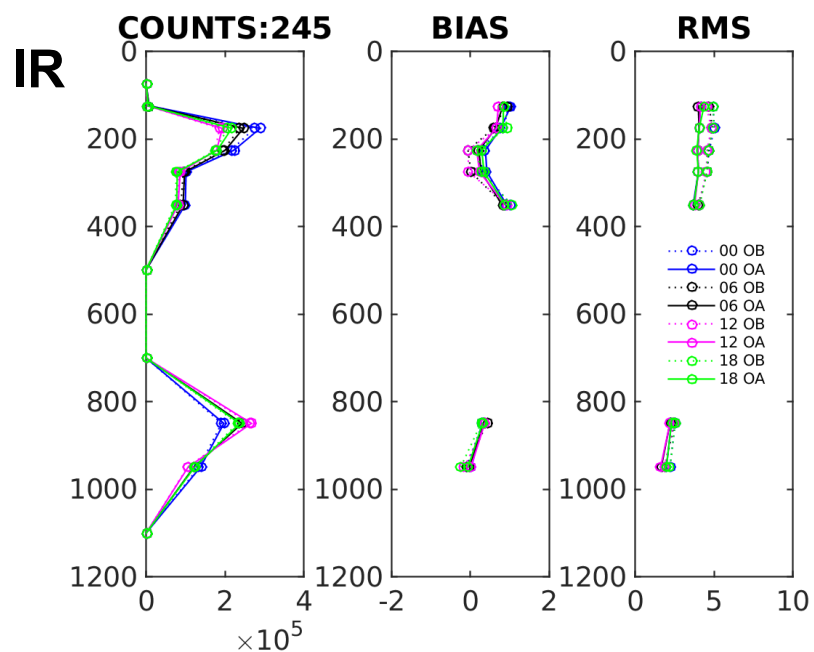
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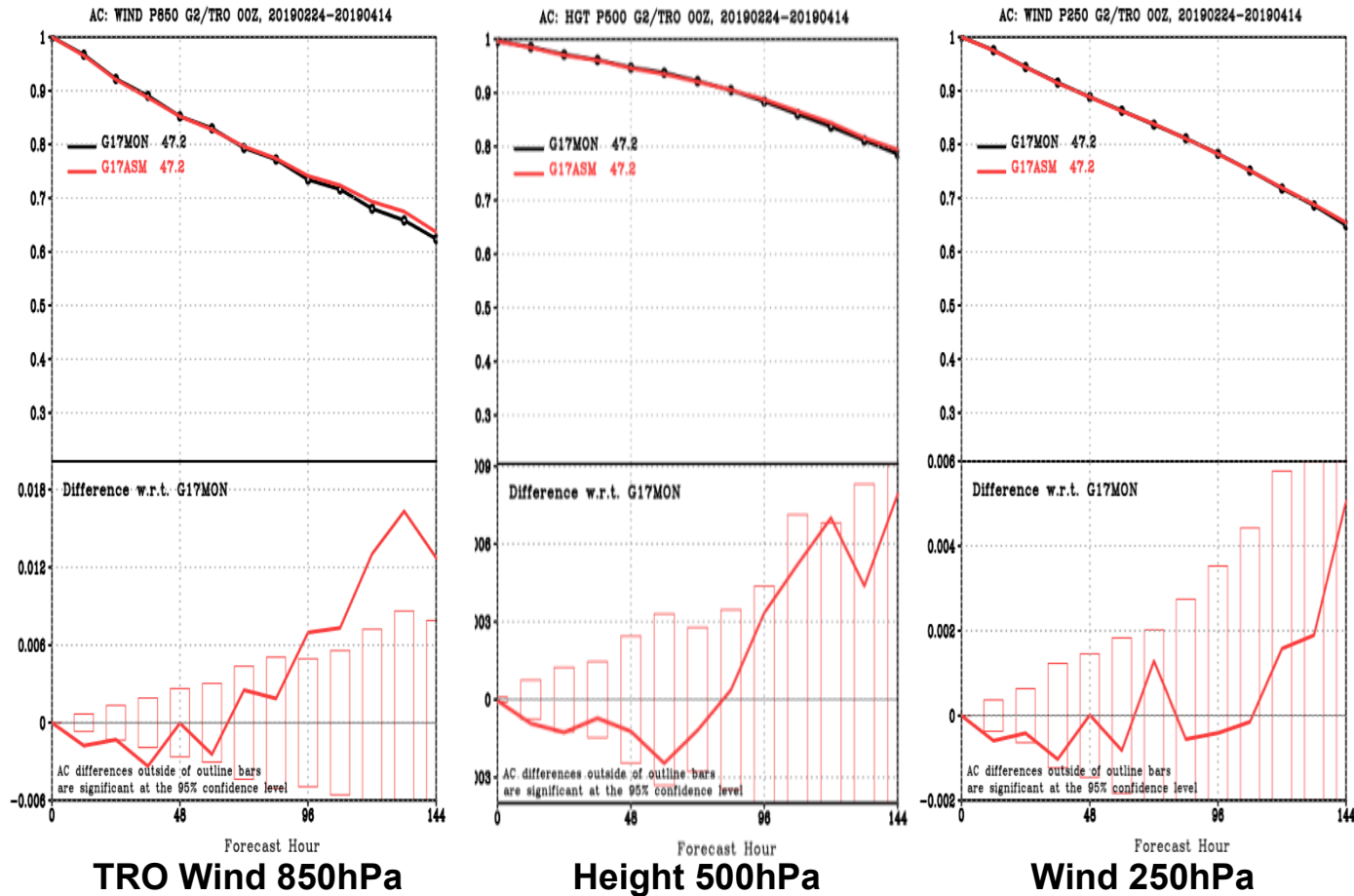
BLUE:GOES-16 RED: GOES-17

Comparison of GOES-15, GOES-16 and GOES-17 IR AMVs by AN hour



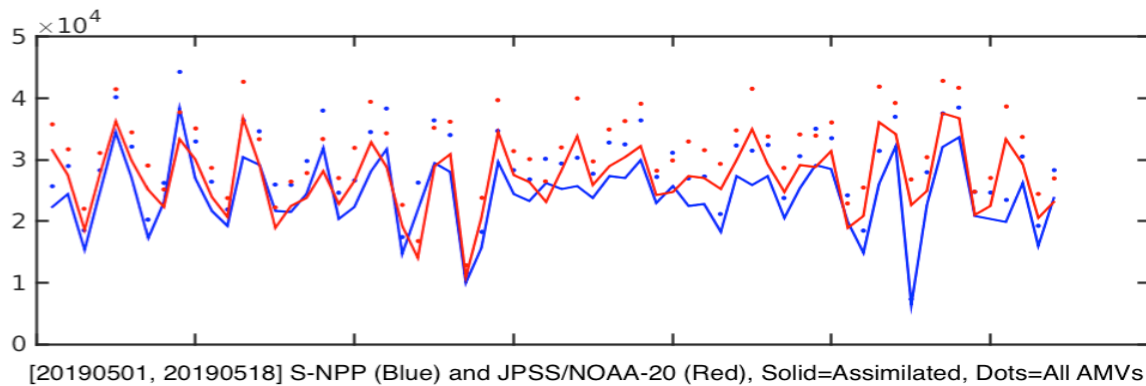
Comparison of GOES-17 IR AMVs split by Spectral type and AN hour



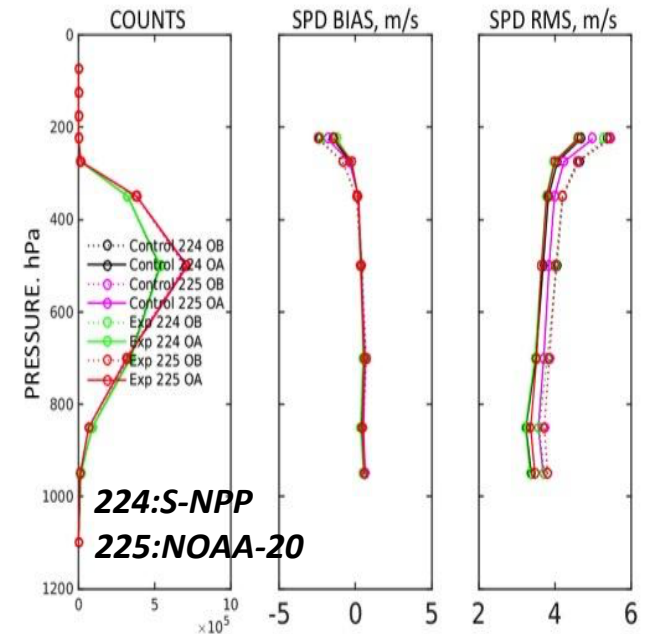


Due to the LHP issue less GOES-17 winds are assimilated at 12z and 18z. However the background departures and AN increments are consistent across all analysis hours, and comparable to these from GOES-15 and GOES-16. The forecast impact is mostly neutral aside from a slight improvement in the 120-144h FC in the tropics at 850hPa.

JPSS/NOAA-20 VIIRS AMVs



S-NPP and NOAA-20 VIIRS AMVs comparison

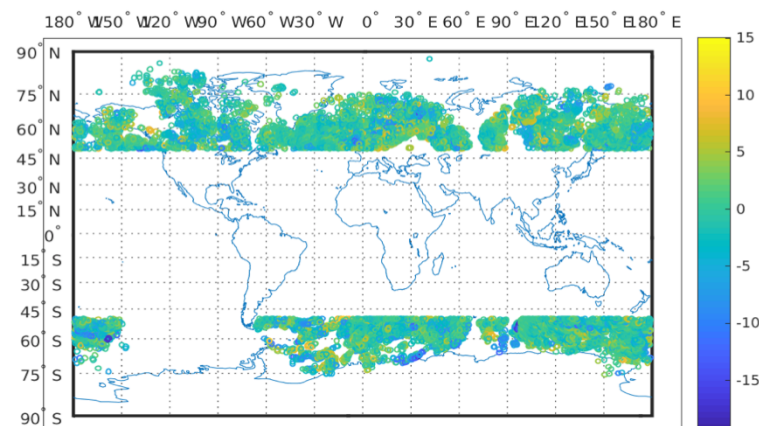


NCEP began assimilating S-NPP VIIRS winds in 2016. NOAA-20 nearly doubled the VIIRS winds while quality remained good. For a while winds from both instruments were actively assimilated with neutral to positive forecast impact. The VIIRS winds BUFR table was recently updated and the winds temporarily set to monitoring mode but assimilation will resume in 2021.

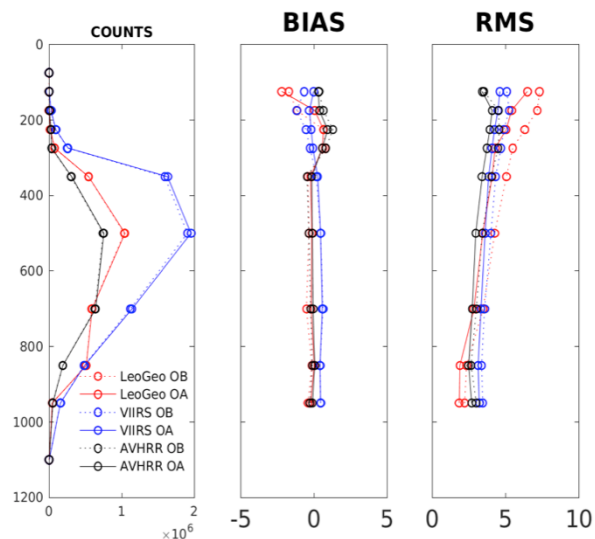
LEO-GEO AMVs

Leo-Geo winds cover the observation sparse zones between geo- and polar winds. They show steady positive forecast impact across the SH and hold strong potential as the next wind product being assimilated.

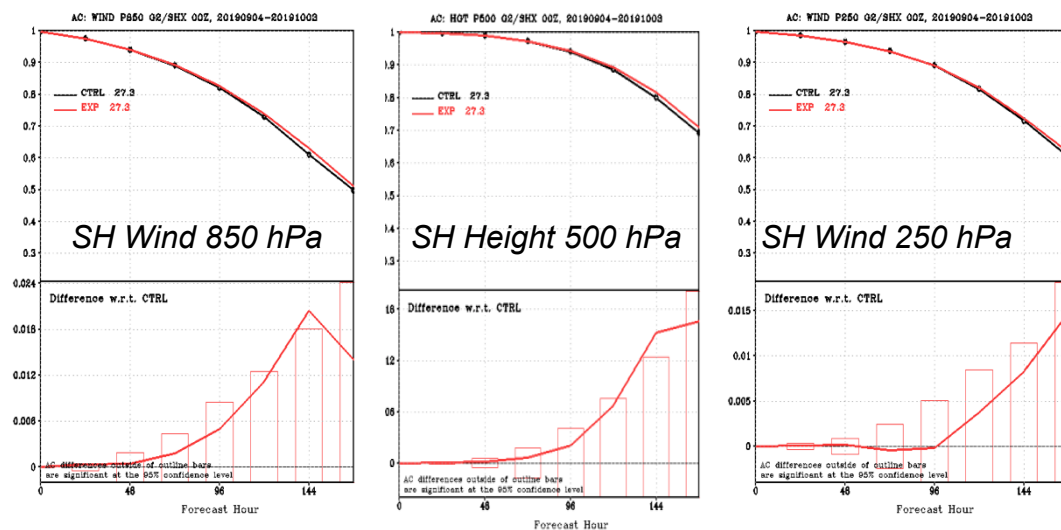
Leo-Geo AMVs spatial distribution



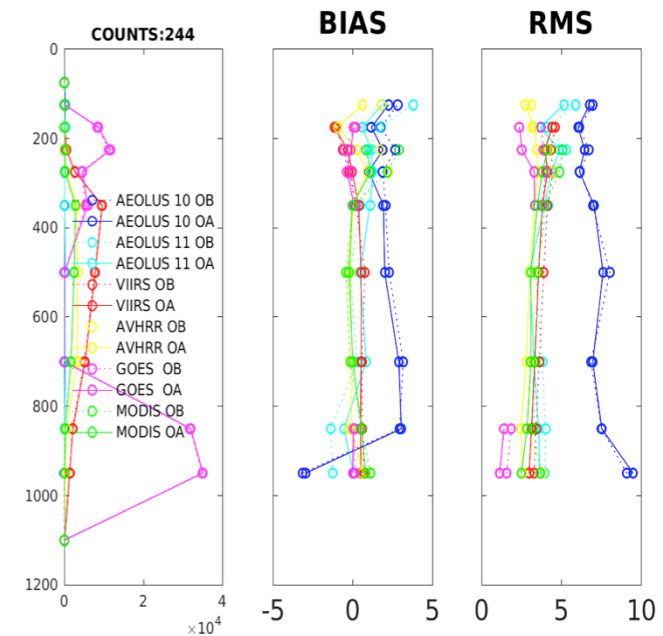
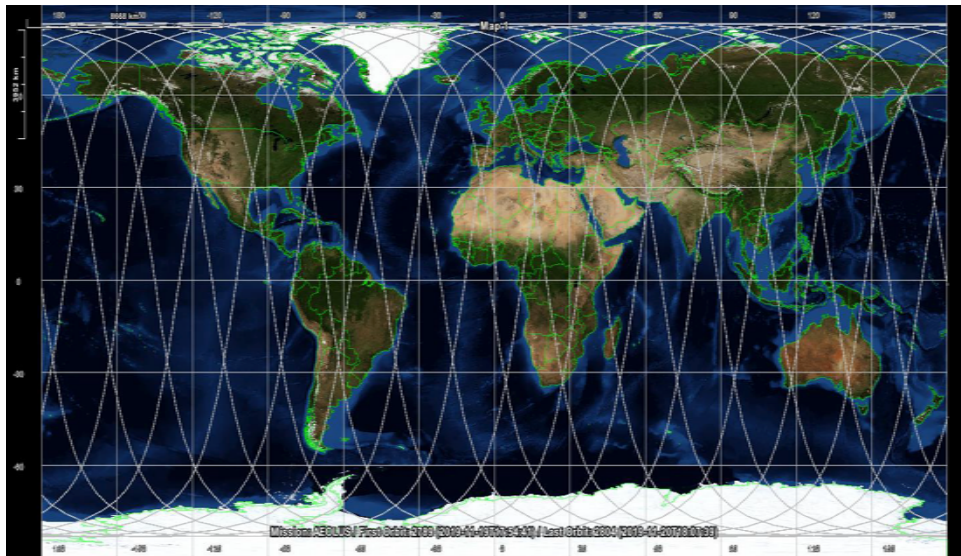
Leo-Geo and polar AMVs comparison



Anomaly Correlation



AEOLUS Wind Profiles



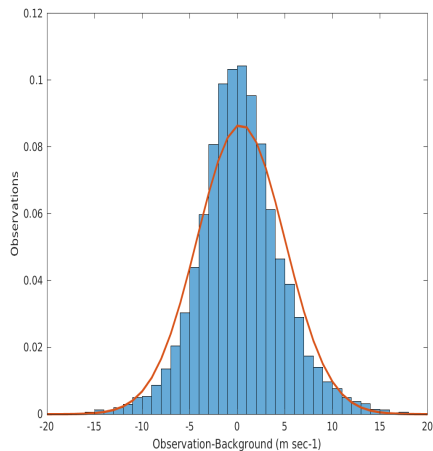
*Early Aeolus Mie Clear (10) and
Mie Cloudy (11) winds O-B vs
VIIRS, AVHRR, MODIS and GOES
O-B/O-A*

Aeolus provides global high accuracy DWL wind profiles in two channels, Mie and Rayleigh. Initial experiments show the Mie Cloudy and Rayleigh Clear winds first guess departures are lower or comparable to these from AMVs. We have developed bias correction, observation error regression and variational quality control (VarQC) schemes for Aeolus data and DA experiments are ongoing.

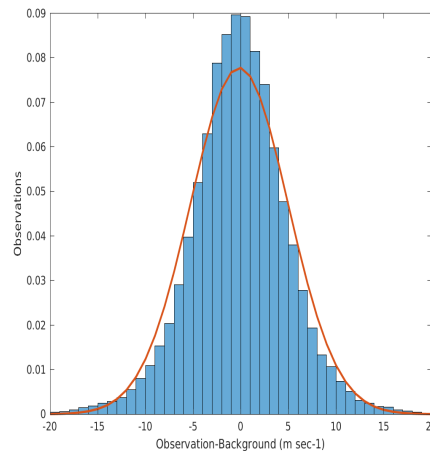
- Developed an accurate probability model for Aeolus observations from (O-B) statistics
- Observed departures from the pure Gaussian form

Innovation Statistics: valid: 2019082018

Mie cloudy



Rayleigh clear

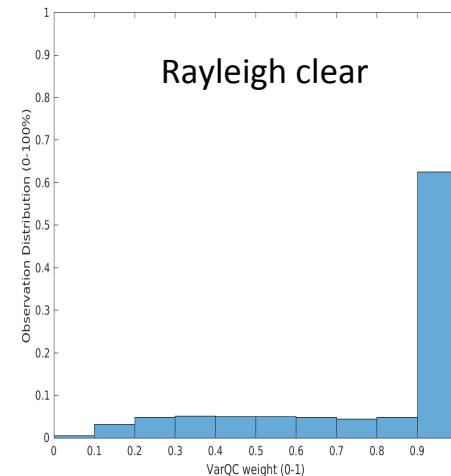
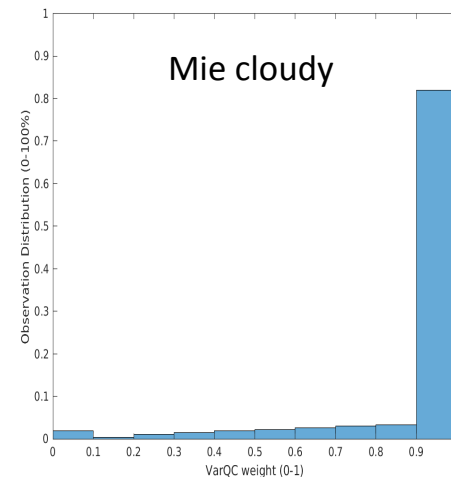


- Adopted a new VarQC scheme implemented in the 2021 operational NCEP/GFS (Purser et al., 2019) to improve the assimilation of Aeolus
- VarQC assigns adaptive weights as a function of observation increment and the probability of gross error

$$W_i(z_i) = \begin{cases} 1 & : z_i = 0 \\ \frac{-1}{z_i} \frac{dg_i(\alpha_i \beta_i x_i; z_i)}{dz_i} & : z_i \neq 0 \end{cases}$$

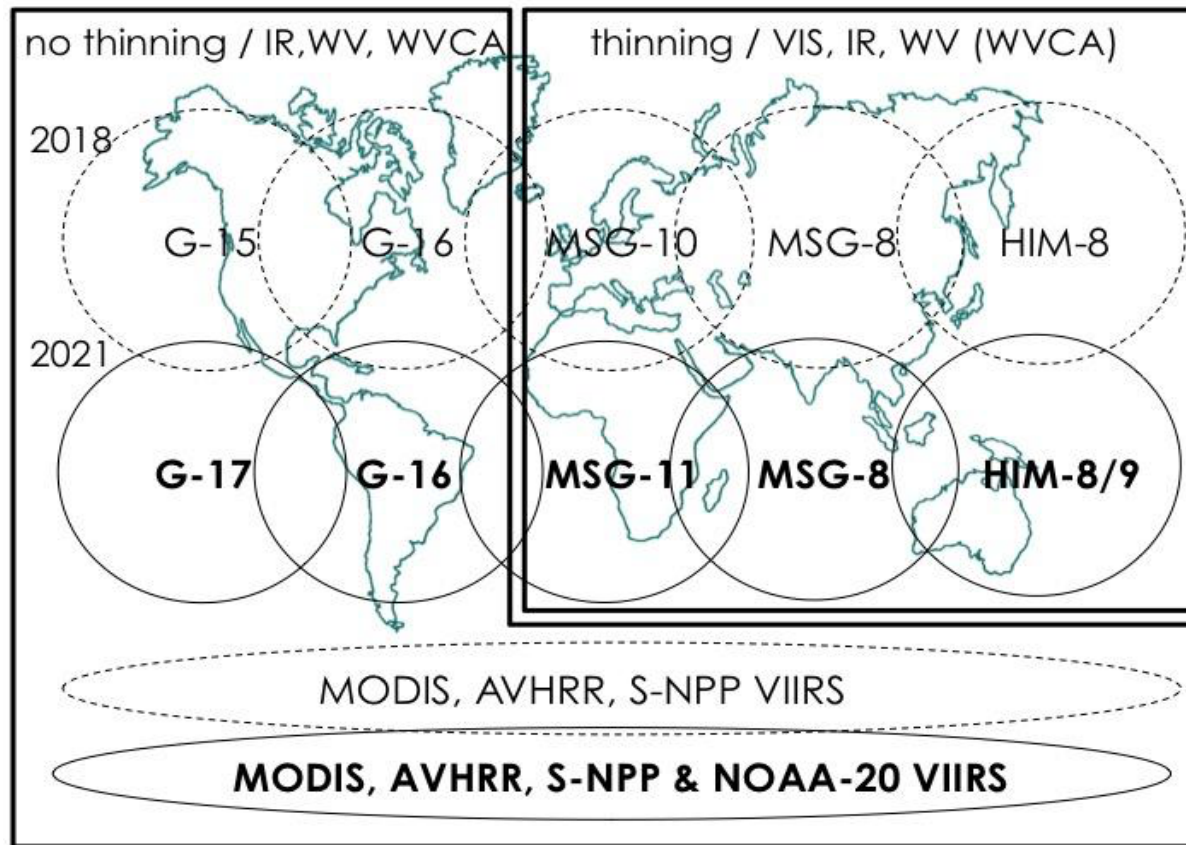
- VarQC deals with rejection limits outside of the Gaussian
- Not discarding observations that lead to large departures, but assigning less weight during the final

Adaptive weight distribution valid: 2019082018



VarQC adaptive weights 0 to 1 range

- 0 least impact to the analysis
- 1 most impact to the analysis



SUMMARY

NCEP GFS Data Assimilation system continuously updates the assimilated products and expands to include new and promising winds data sets. With all geostationary winds derived from ABI-like instruments the quality of the winds is more consistent than ever before, thus allowing for more coherent treatment and quality control.

Additionally, LeoGeo and Aeolus winds will soon improve the winds observing system coverage horizontally and vertically.