Satellite Data Assimilation Upgrades to the Global Forecasting System

The EMC Satellite Data Assimilation Team

Overview

- GFS v15.1 FV3 implementation
- July 2019 Data Upgrade: GFS V15.2
- Expected improvements in the v16 implementation

- See also talks and posters by Yanqiu Zhu, Haixia Liu, Cory Martin, Emily Liu

GFS v15.1: FV3 Upgrade

- ATMS modified for all-sky assimilation
- Switch to GFDL microphysics necessitated that the cloud water increment not be fed back to the model
  - Spin down issues are reduced
- Near Sea-Surface Temperature correlation lengths more reasonable (100km). Introduction of climatological updates (useful for observation-poor regions)
- TAC2BUFR conversion for drifting buoys.
- Replace SBUV with OMPS-N (S-NPP).
- Switch on Meteosat-11 SEVIRI.
- CrIS FSR (S-NPP) including additional humidity channels; IASI humidity; channels; Saphir; MetOp-B ASCAT

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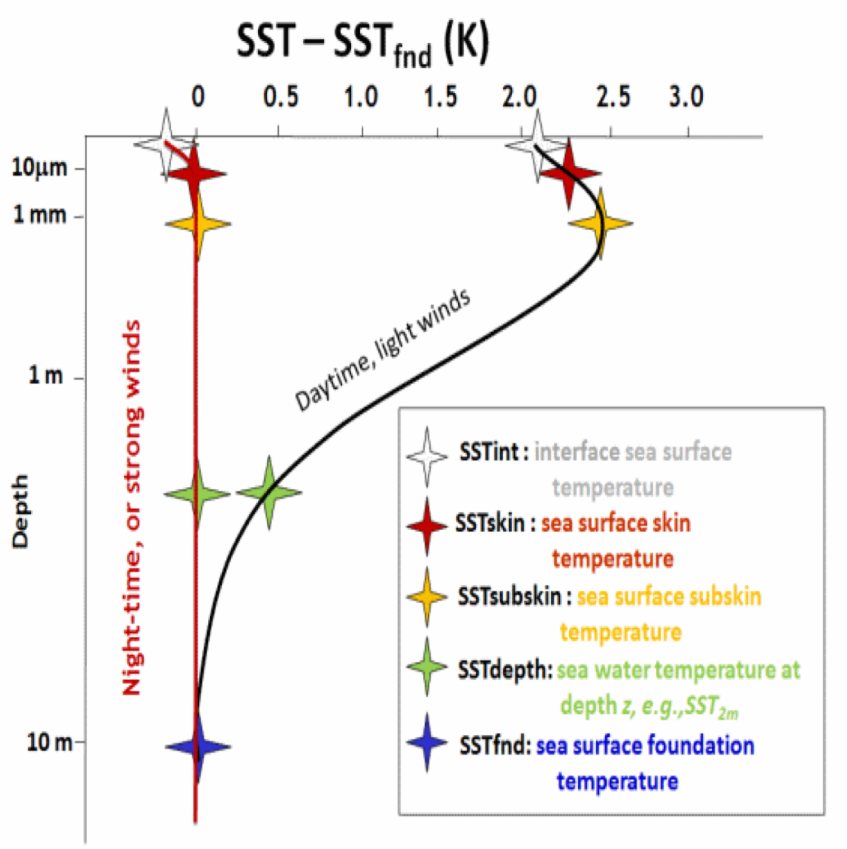
SST definition (GHRSST)



IR:

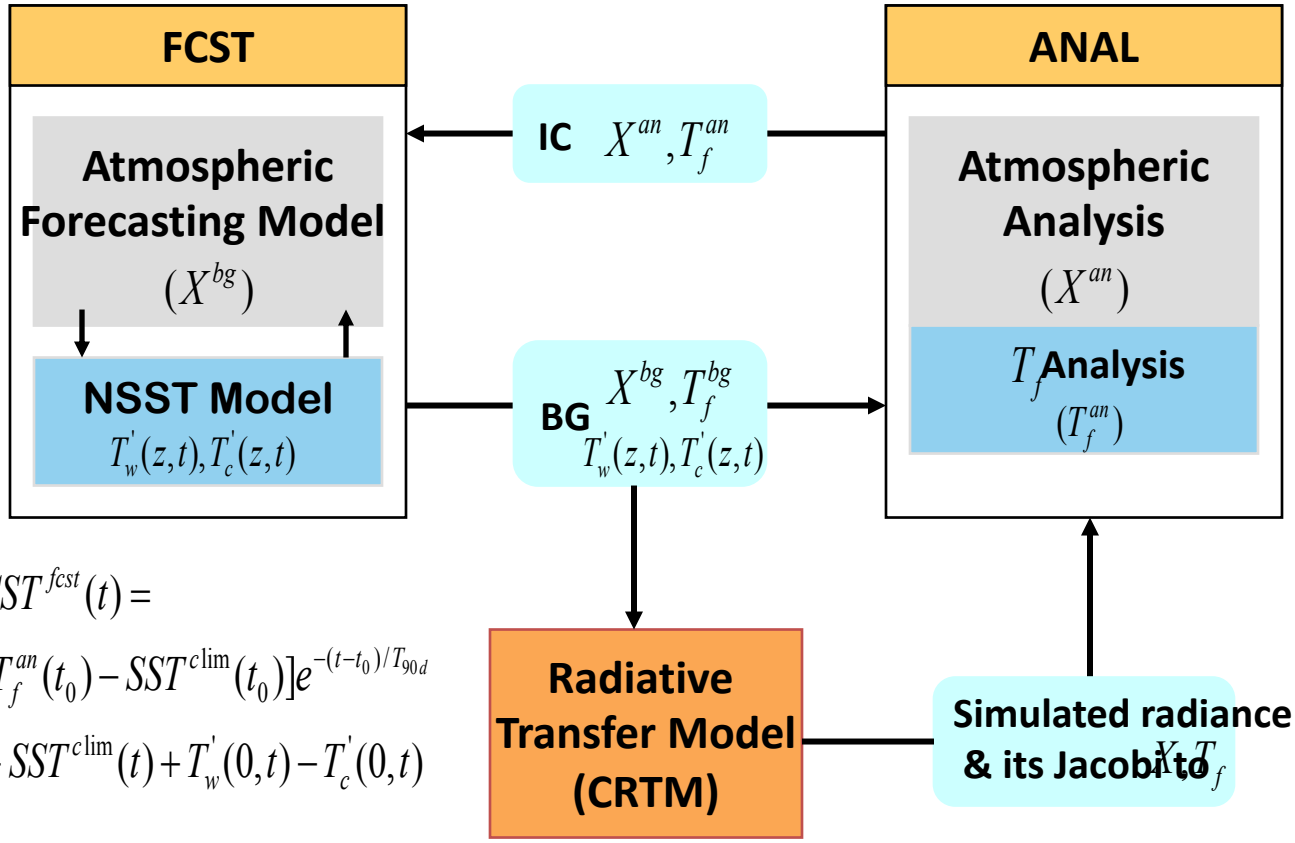
MW:

In situ :
20

Hypothetical vertical profiles of temperature for the upper 10m of the ocean surface in high wind speed conditions or during the **night** (red) and for low wind speed during the **day** (black).

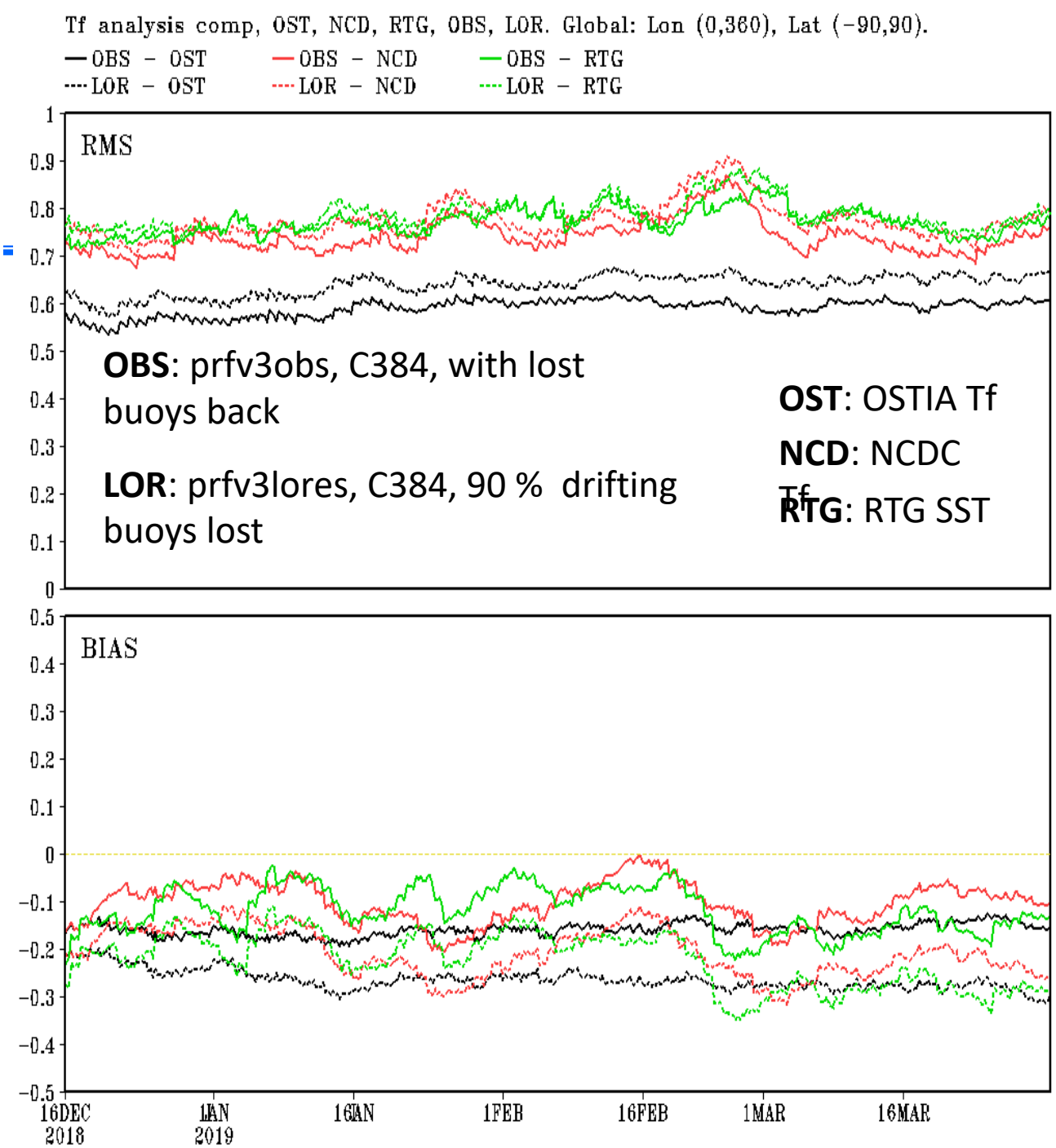
Xu Li

The NCEP GFS with the NSST



$$T_{crtm}(z_{ch},t) = T^{fcst}(z_{ch},t)$$

$$T^{fcst}(z,t) = T_f^{bg}(z_w,t) + T_w^{'}(z,t) - T_c^{'}(z,t)$$



OBS: prfv3obs, C384, with lost buoys back

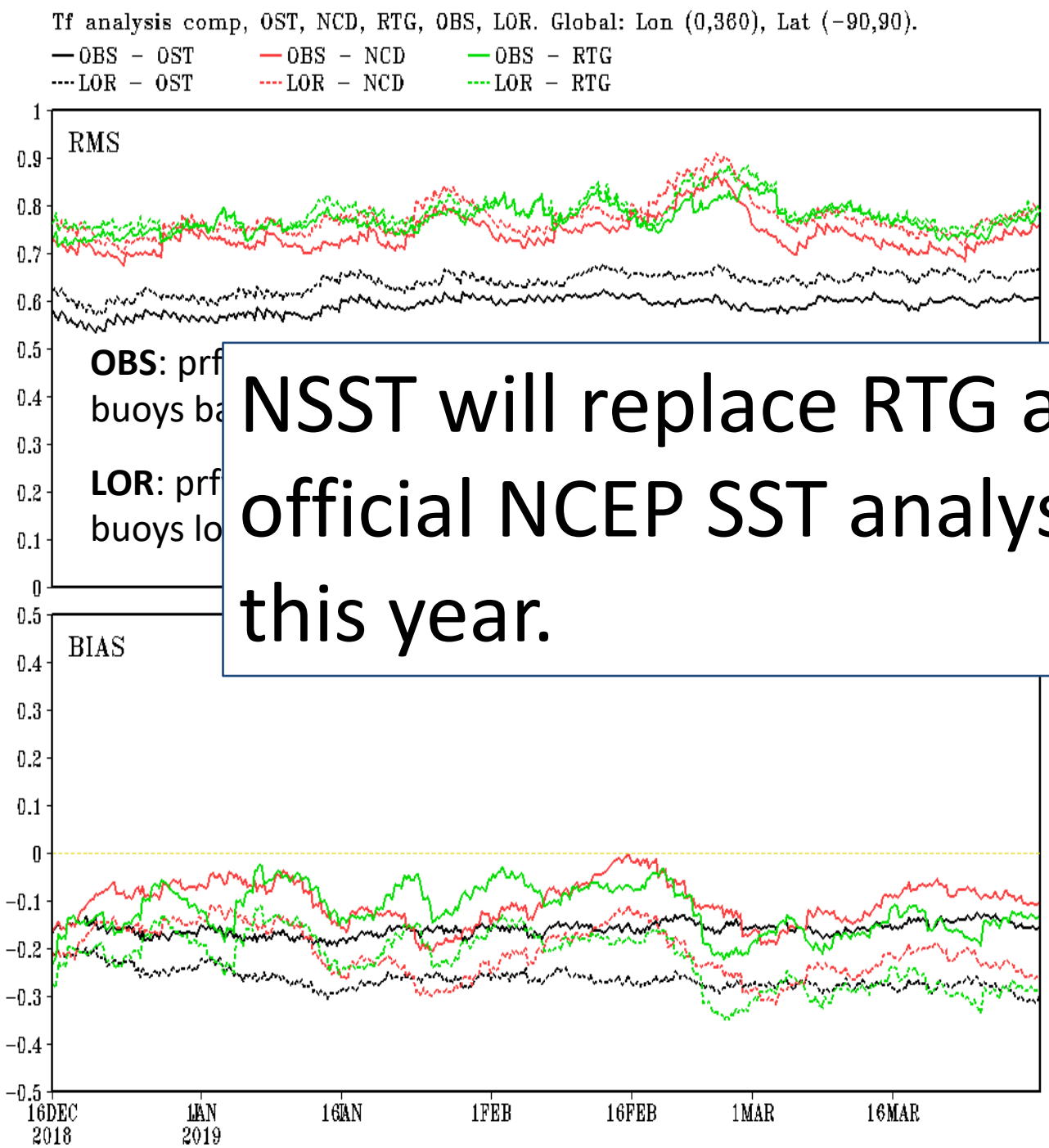
LOR: prfv3lores, C384, 90 % drifting buoys lost

OST: OSTIA Tf

NCD: NCDC Tf

RTG: RTG SST

SST with missing buoy data diverges away from OSTIA



OBS: prf
buoys ba

LOR: prf
buoys lo

NSST will replace RTG as the official NCEP SST analysis later this year.

g buoy
way from

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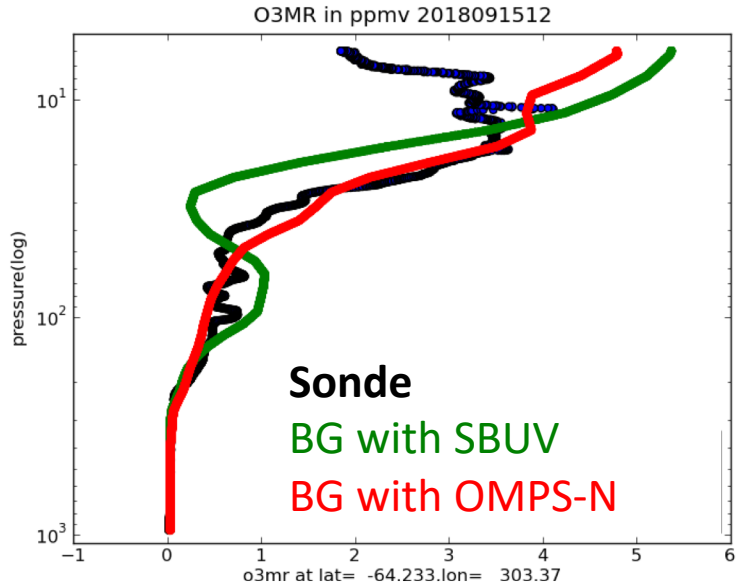
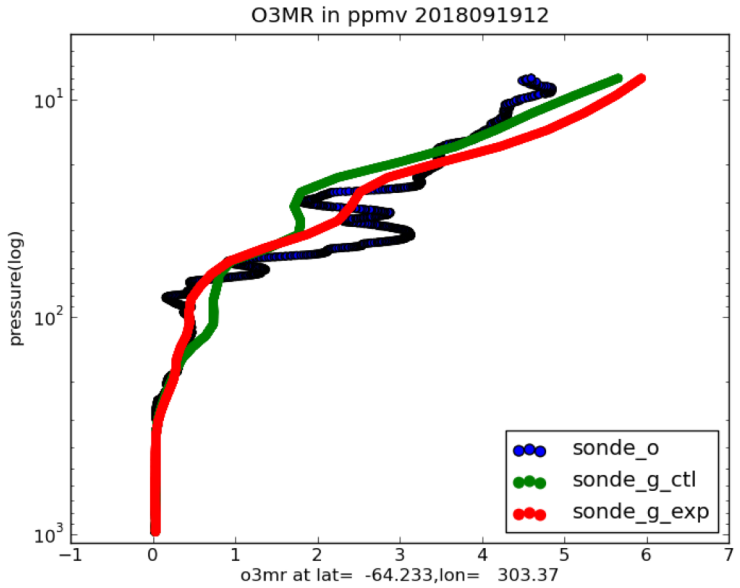
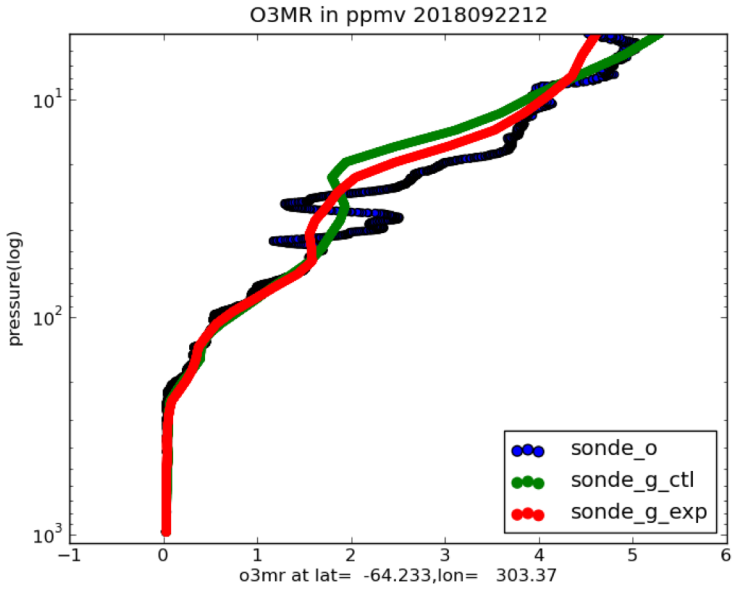
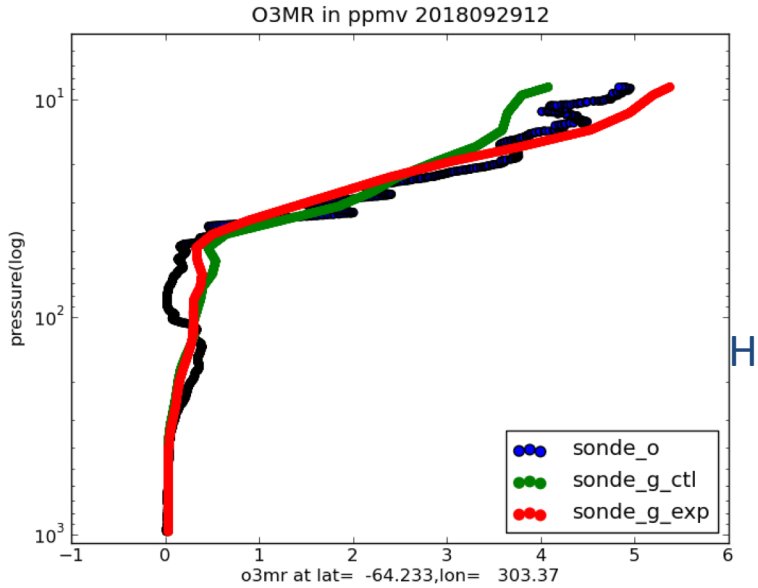
Sonde fits improved on switching from SBUV to OMPS-N retrievals







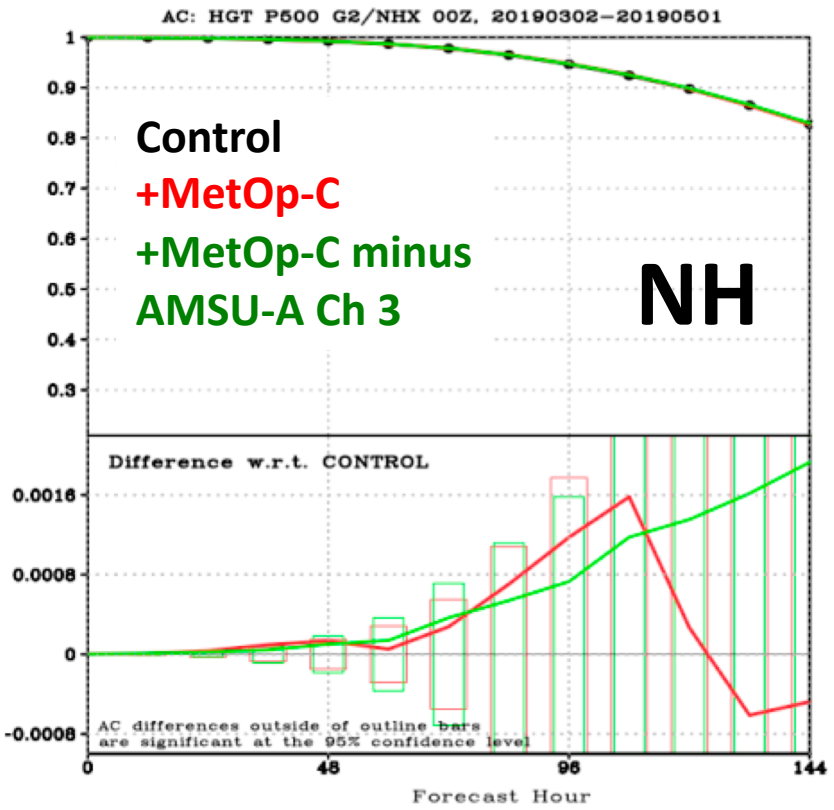


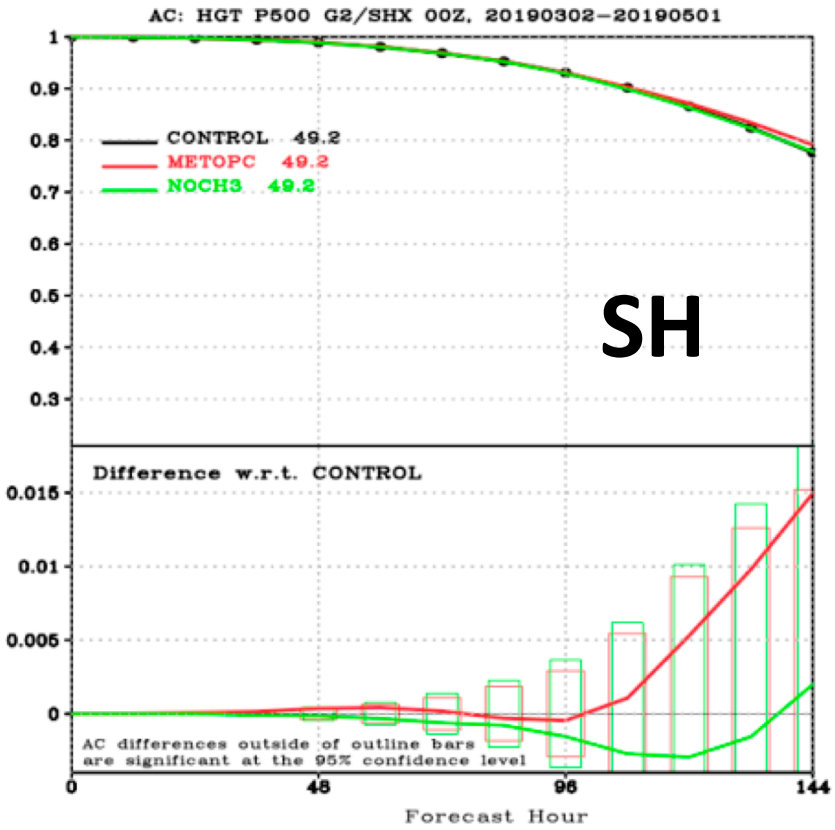
Haixia Liu

July 2019 Data Upgrade

- Implement GOES-17 AMVs before GOES-15 is retired (possibly in July)
  - Test the impact of losing significant amounts of data at certain times of the year.
- Implement AMSU-A and MHS from MetOp-C (other instruments not available in time)

Adding MetOp-C MHS and AMSU-A

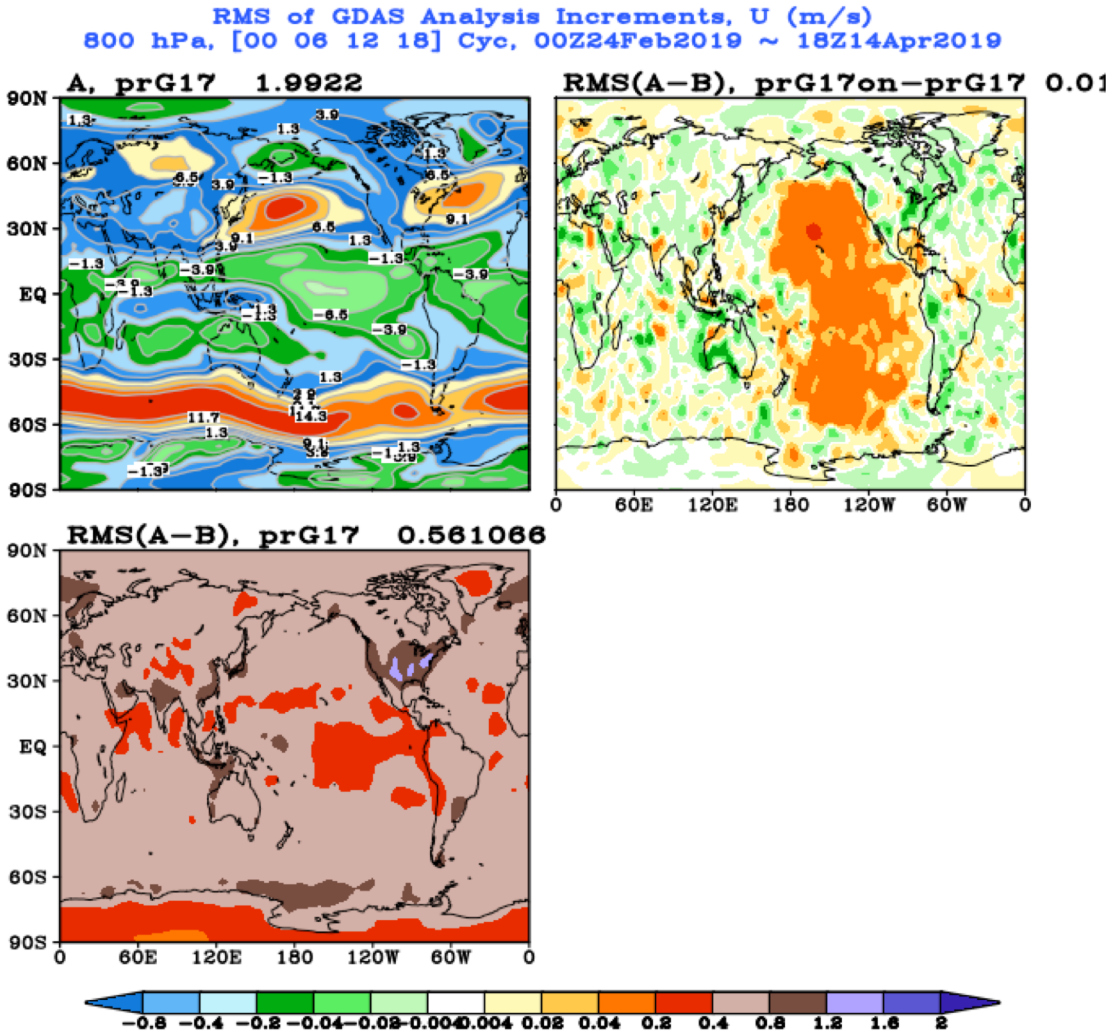




500hPa Geopotential Height AC Scores

Mostly Neutral

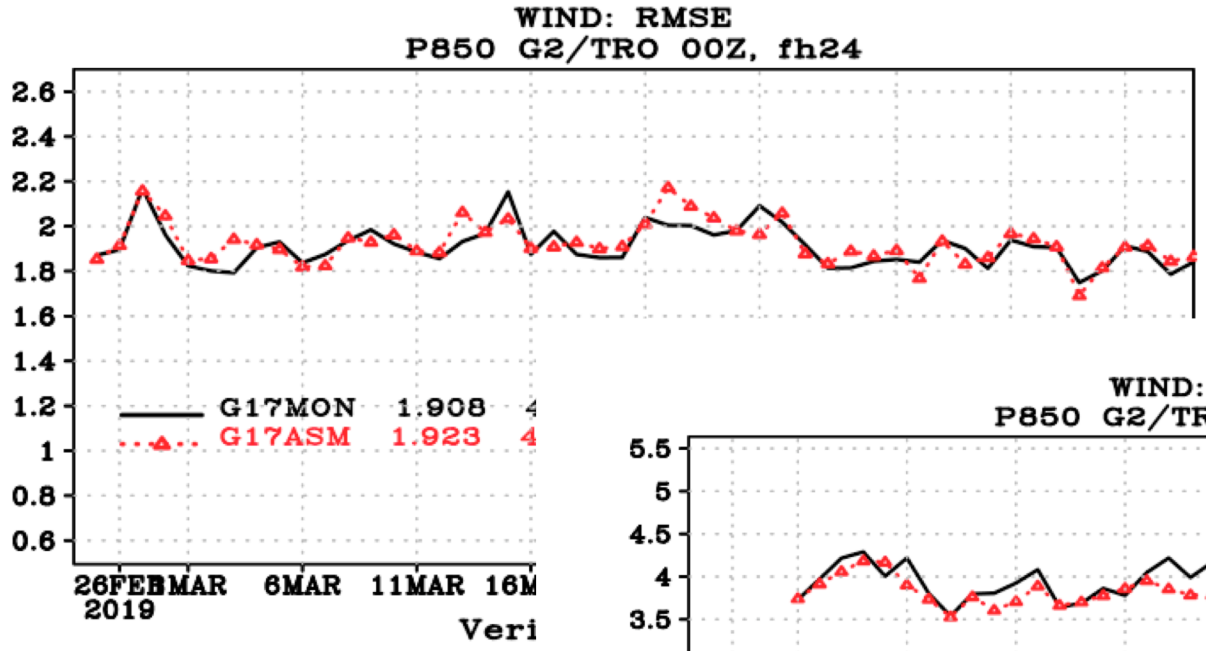
Replacing GOES-15 with GOES-17



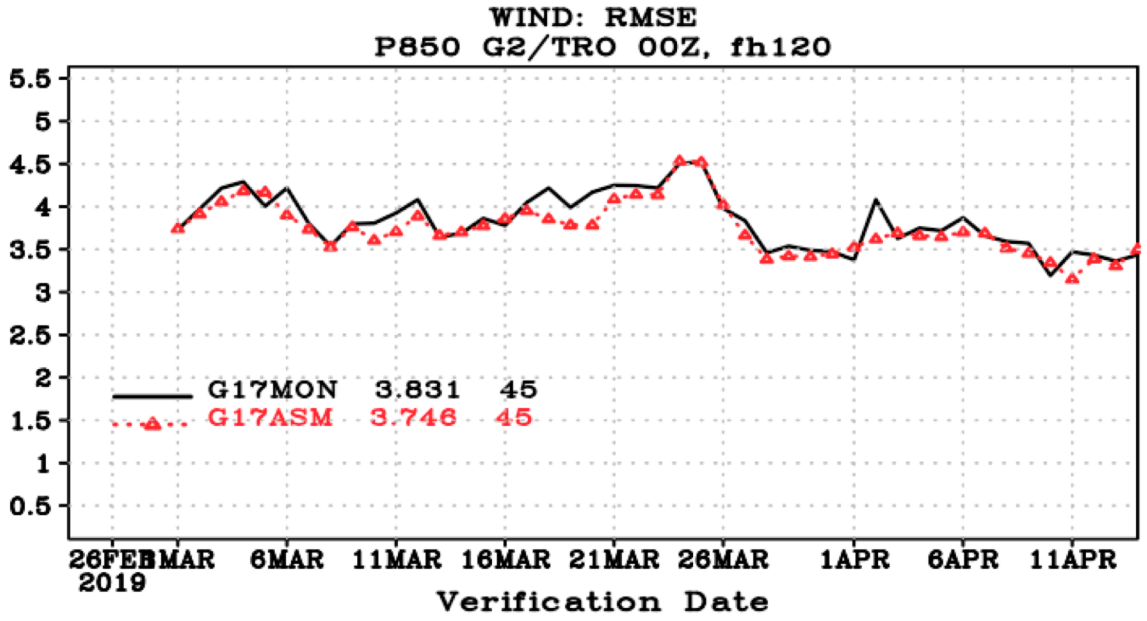
Iliana Genkova

Analysis increments imply this is helpful

Replacing GOES-15 with GOES-17



850hPa Tropical Wind RMS is mixed.



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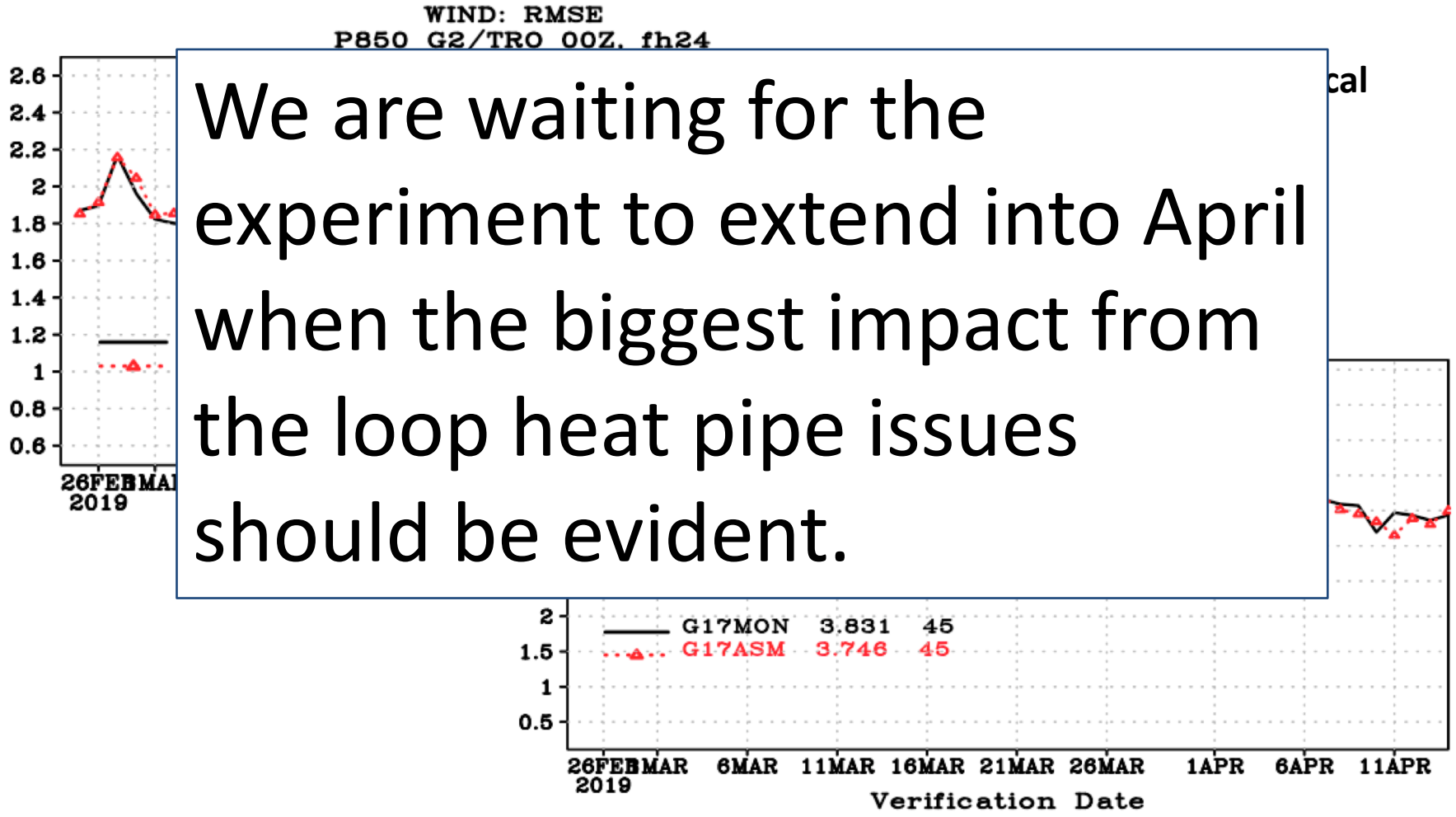
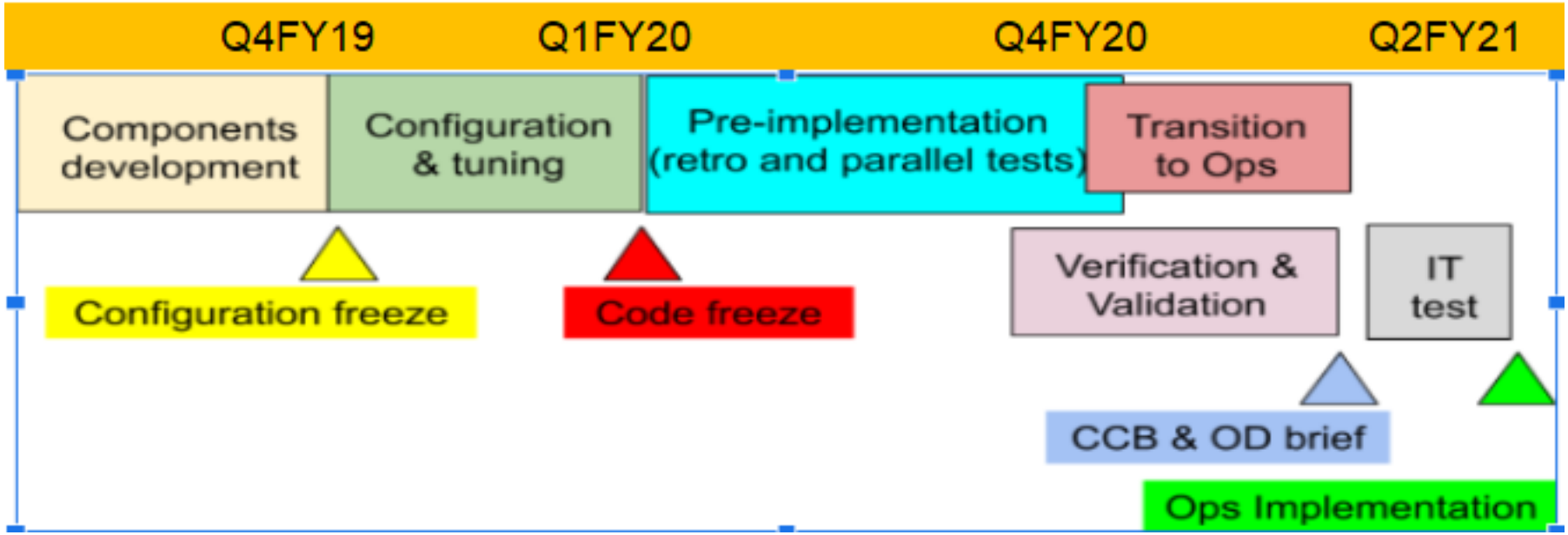


We are waiting for the experiment to extend into April when the biggest impact from the loop heat pipe issues should be evident.

GFSv16 Schedule



GFS v16

- 127 Levels
- IAU; LETKF; Early cycle EnKF; Stochastic physics changes
- Turn on AMSU-A Ch 14/ATMS Ch 15
- Fix excessive stratospheric humidity increments
- Use of Jacobians to produce linearized perturbations in EnKF
- NSST changes
  - Improved climatological updates (especially for lakes)
  - Possible extra observations from GMI; VIIRS and/or AMSR-2

GFS v16 contd.

- Correlated observation error for IASI
- COSMIC-2
- Use of GOES-16 and Himawari clear sky radiances
- NOAA-20 VIIRS AMVs
- Detection of super-cooled water clouds; use of convective clouds
- Higher weighting for ASCAT data
- Addition of TAMDAR, Canadian AMDAR and LATEM aircraft observations

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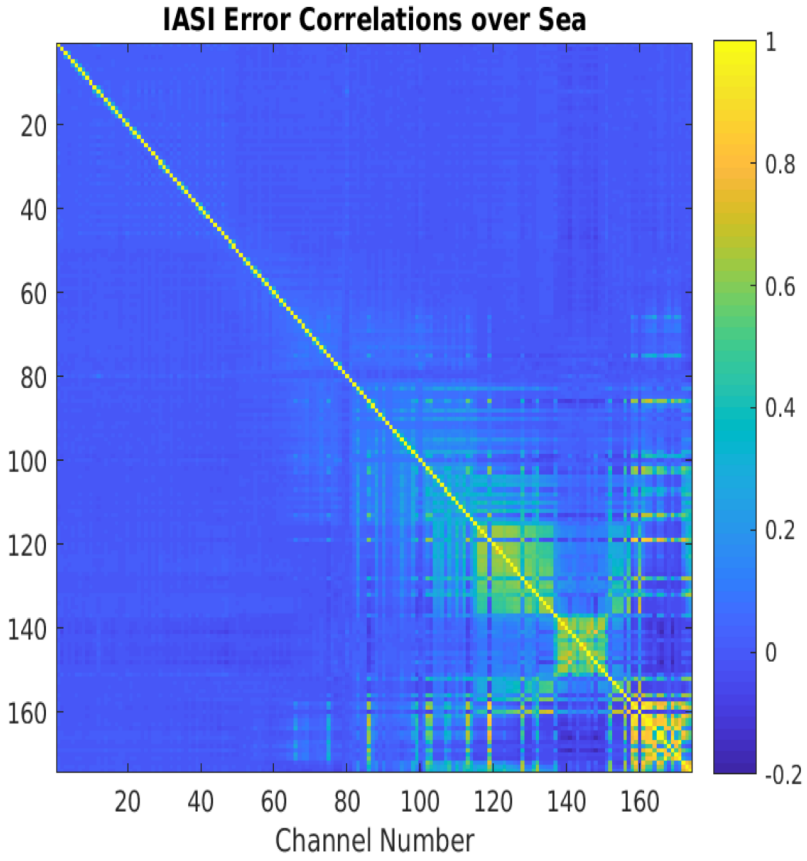
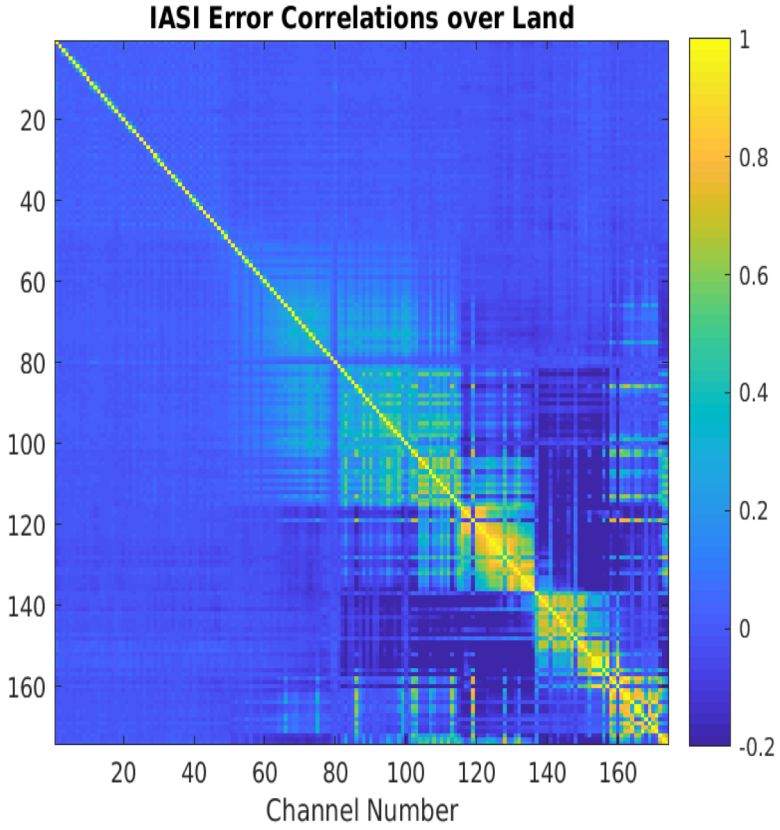
Correlated Observation Error: IASI over Sea and Land

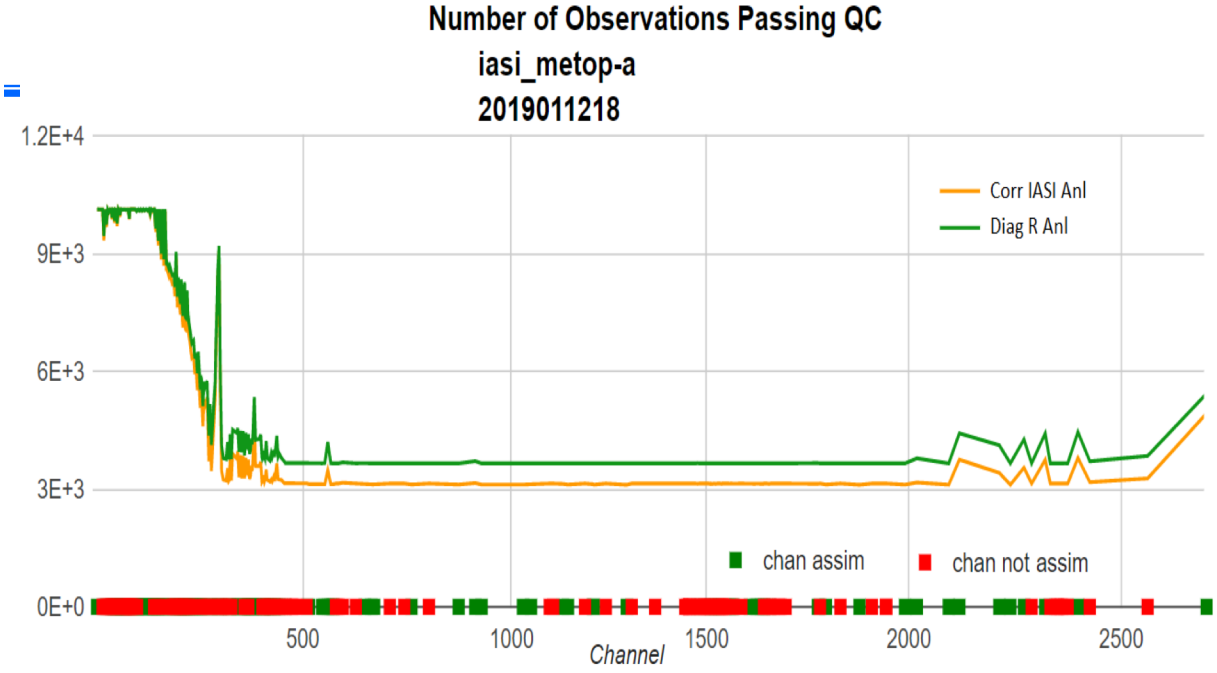


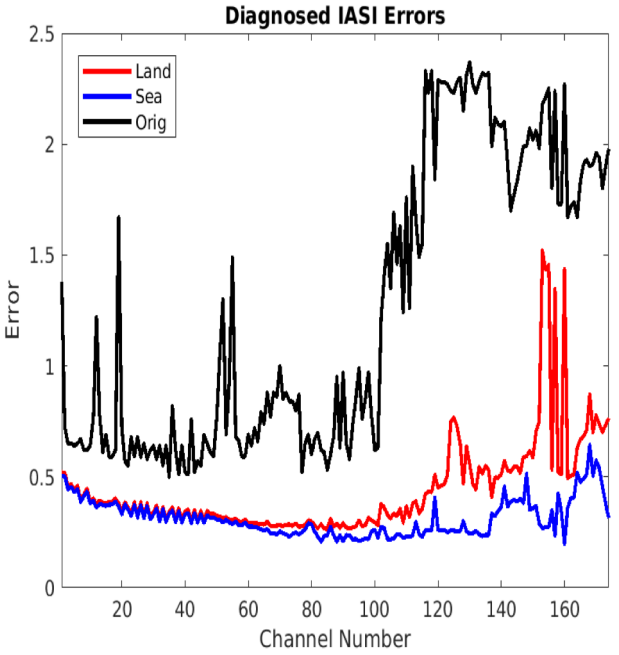


The use of correlated IASI error is currently being tested in the FV3 framework

Kristen Bathmann

Correlated Observation Error with Stricter Cloud Detection

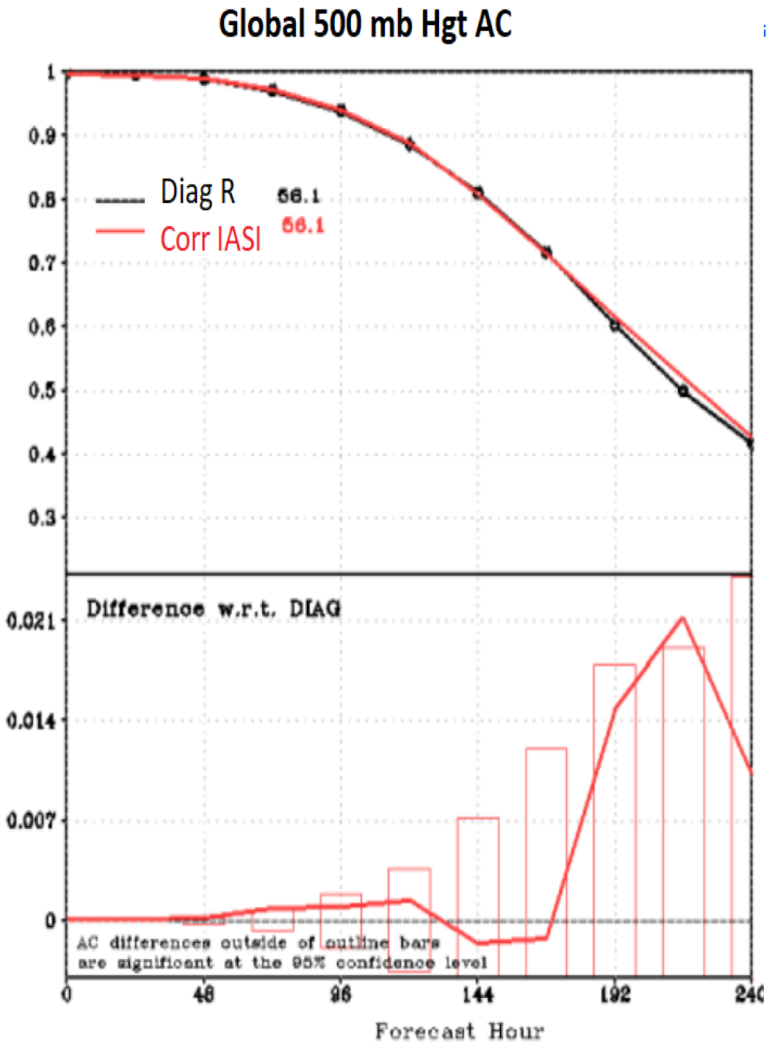


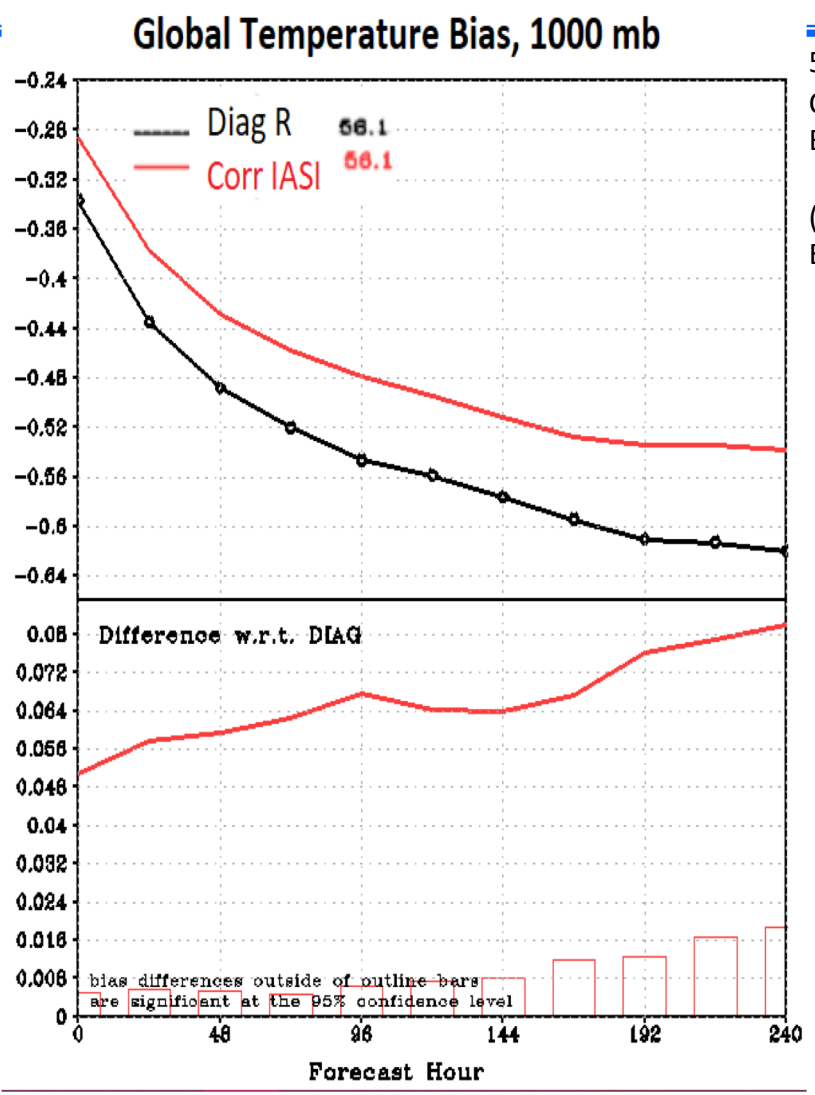


Smaller observation errors (diagnosed from Desroziers) are used in quality control.

Stricter cloud detection rejects potentially cloud contaminated data.

Correlated Observation Error Impact: IASI over Sea





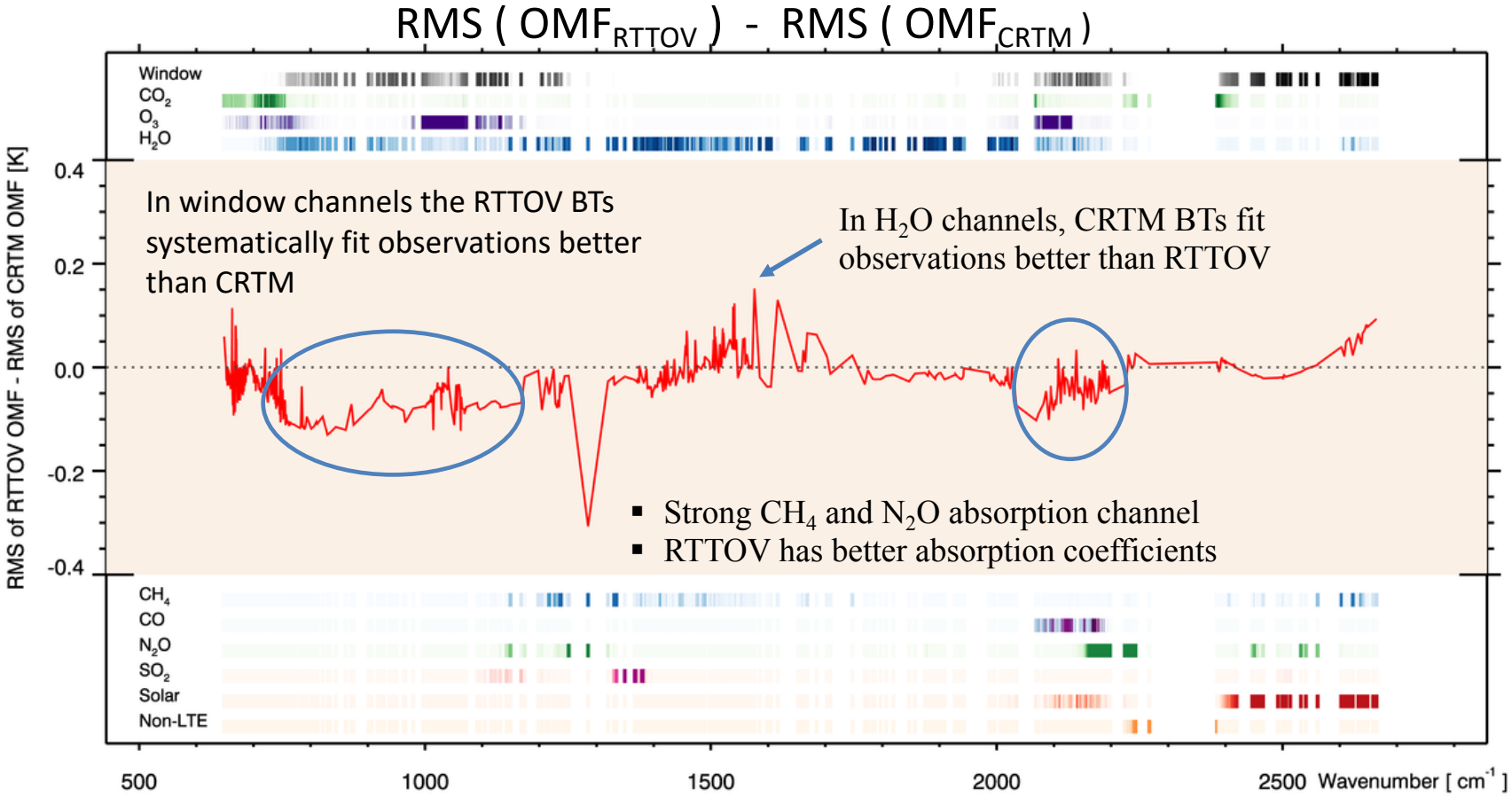
500 mb Hgt Anomaly Corr and 1000 mb T Bias

(verfied against EMCWF analyses)

Speed up of Correlated Error Code

- Various code optimisations including the use of Cholesky decomposition for linear calculations involving the matrix inverse have resulted in extra run times begin reduced from minutes to seconds making the operational implementation feasible.

RTTOV-CRTM Comparisons



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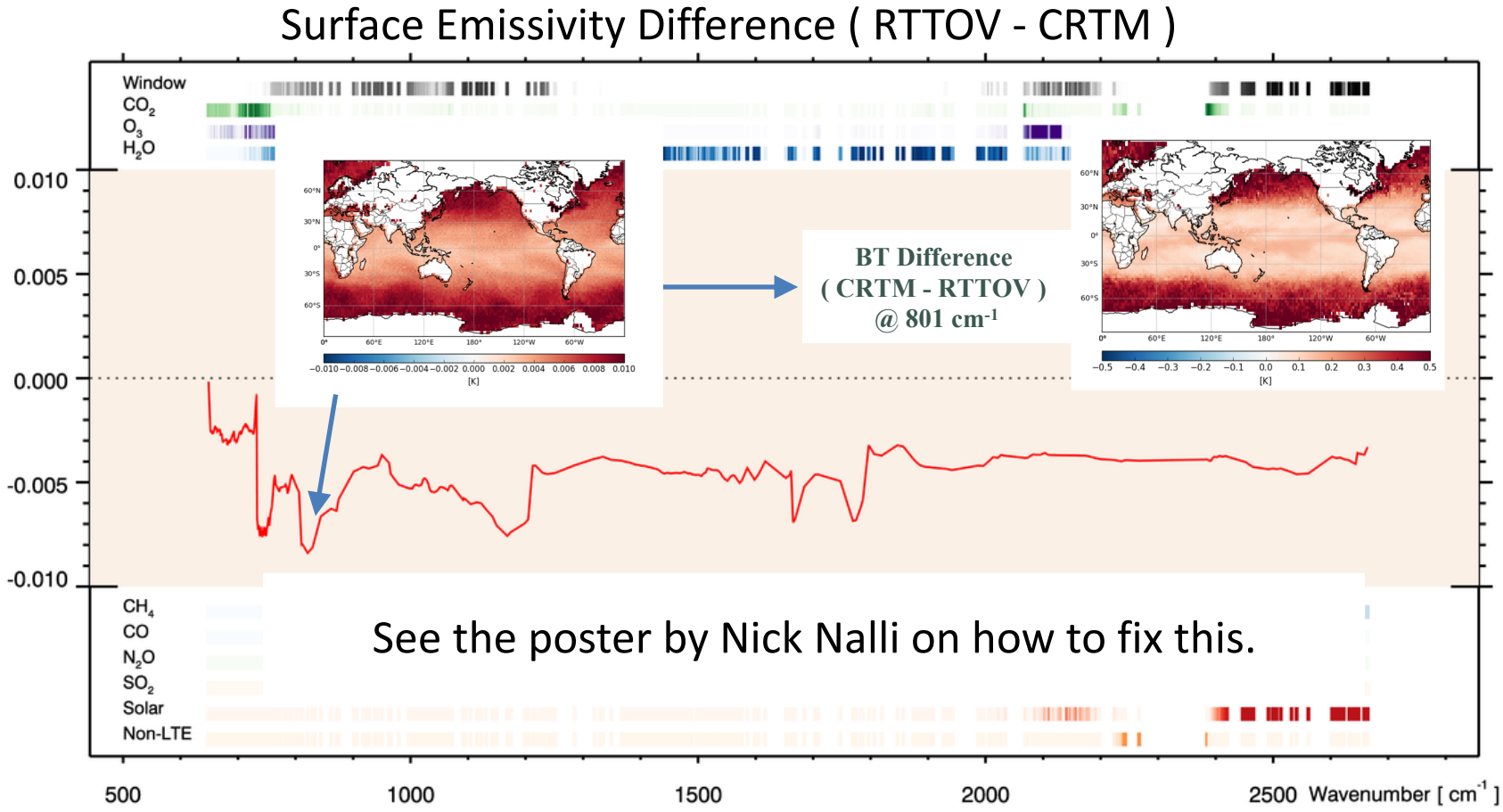


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Thankyou