Assimilation of Suomi-NPP and NOAA-20 ATMS data at ECMWF

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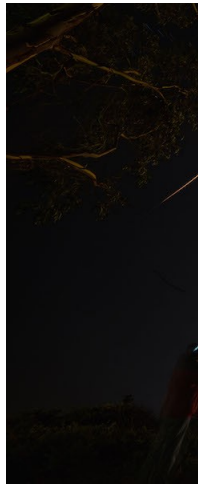
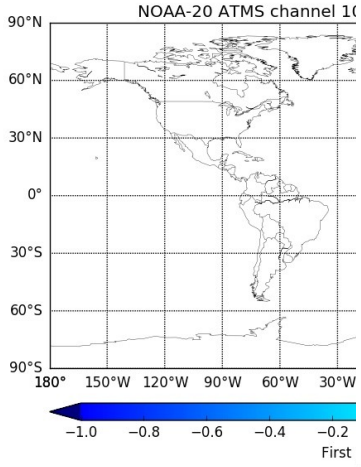
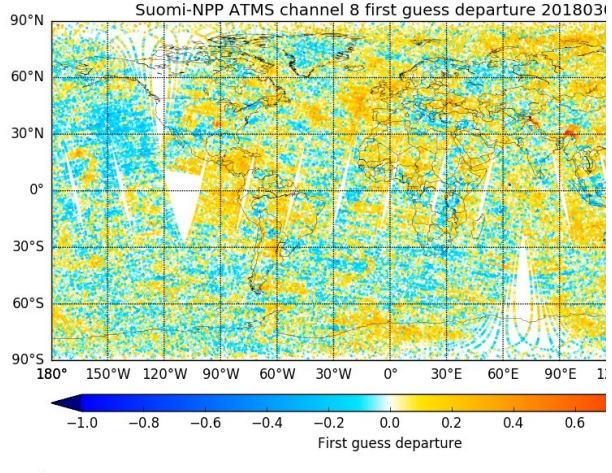
ECMWF

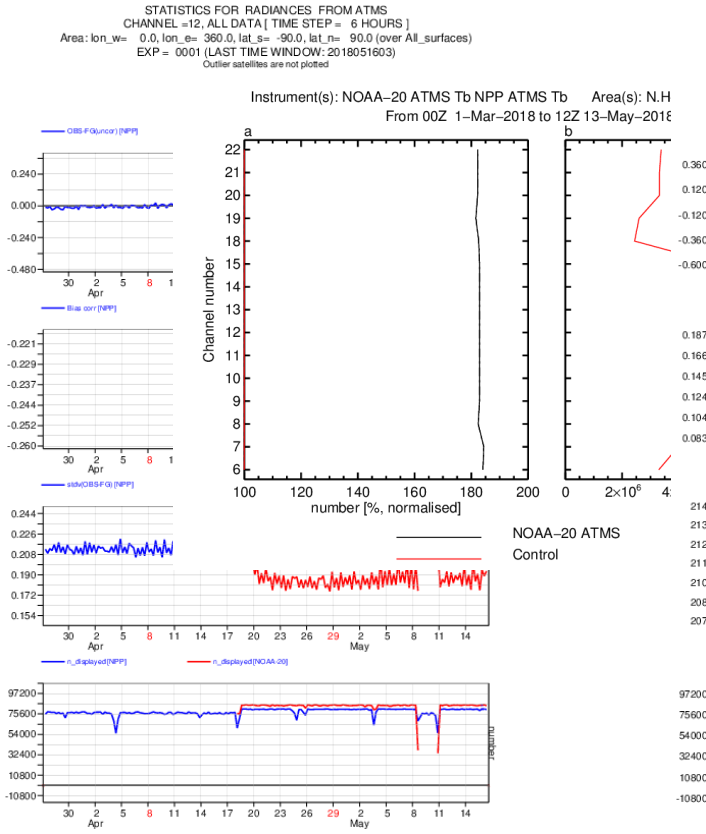
NOAA-20 ATMS timeline (an ECMWF perspective)

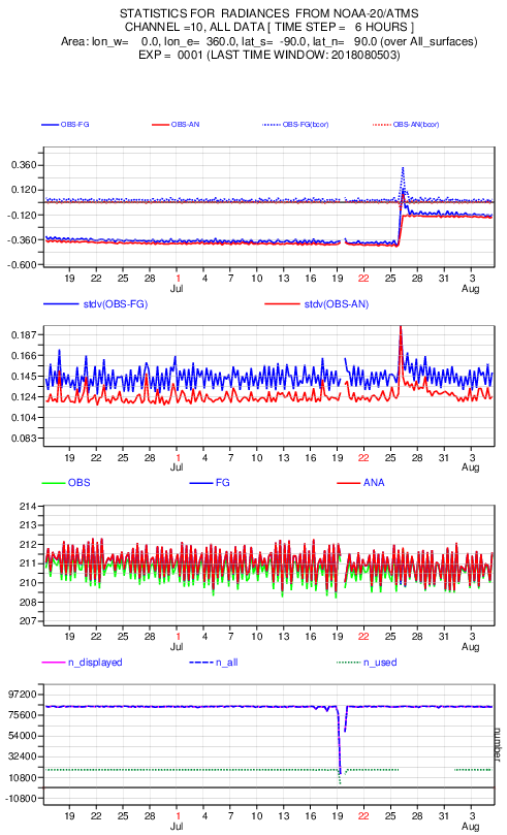
18/11/2017	19/12/2017	25/02/2018	18/04/2018	22/05/2018	01/08/2018
Launch	First sample data	NRT stream	Passive monitoring	Active assimilation	Switch to SDRs









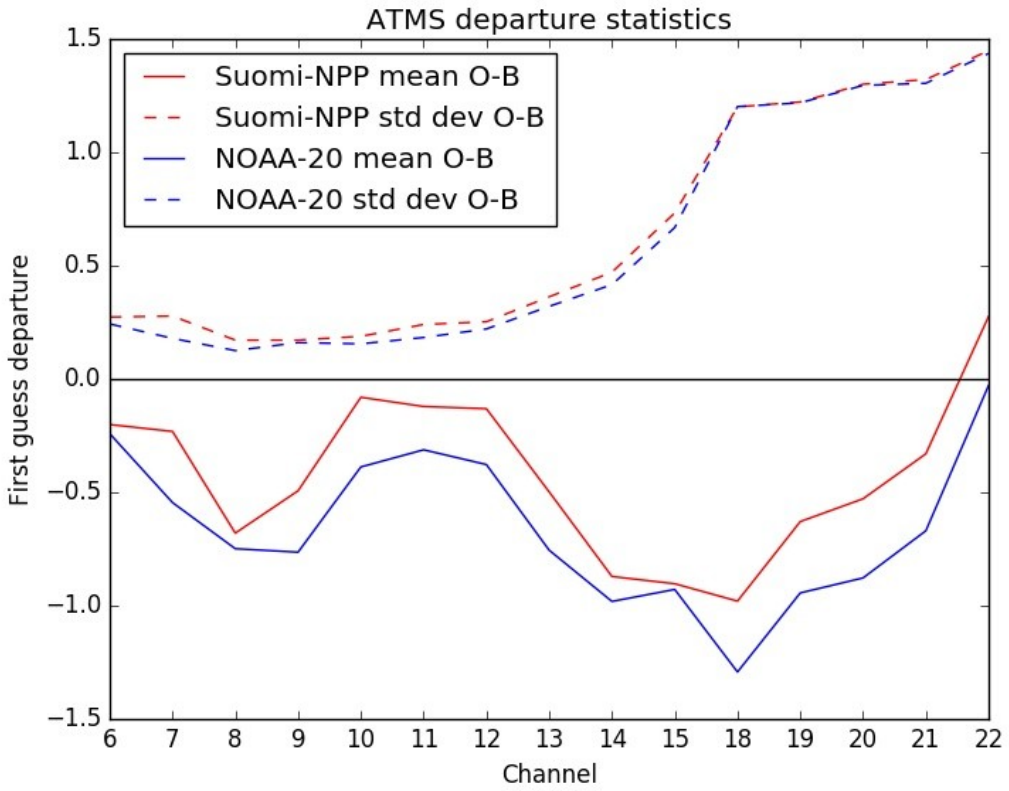


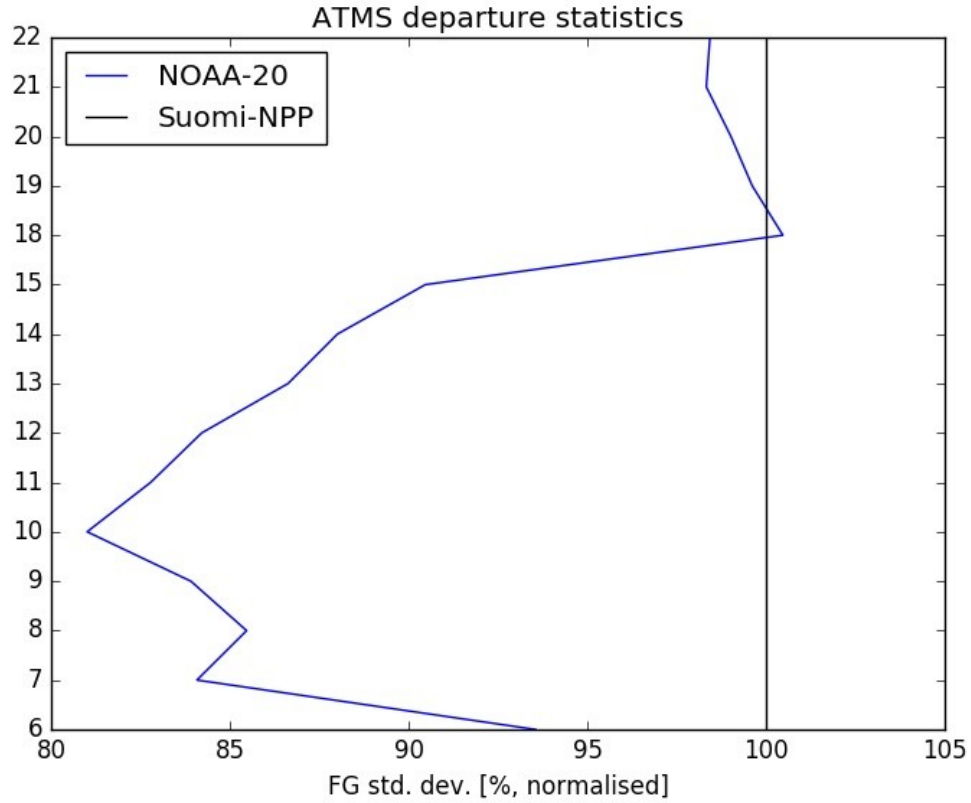
Pre-processing

- Most data presented are TDRs (before antenna pattern correction) but more on SDRs later
- 3x3 averaging makes data characteristics more similar to AMSU-A (spatial resolution, noise)
- Clear sky radiative transfer and retrieved emissivity over land and sea ice to calculate model equivalents in observation space
- Quality control includes cloud screening based on window channel first guess departures

Global first guess departure statistics: NOAA-20 v Suomi-NPP ATMS

- Biases are similar between the instruments
- Standard deviations of first guess departures are significantly smaller (>15% for some channels) for NOAA-20 than Suomi-NPP due to lower instrument noise

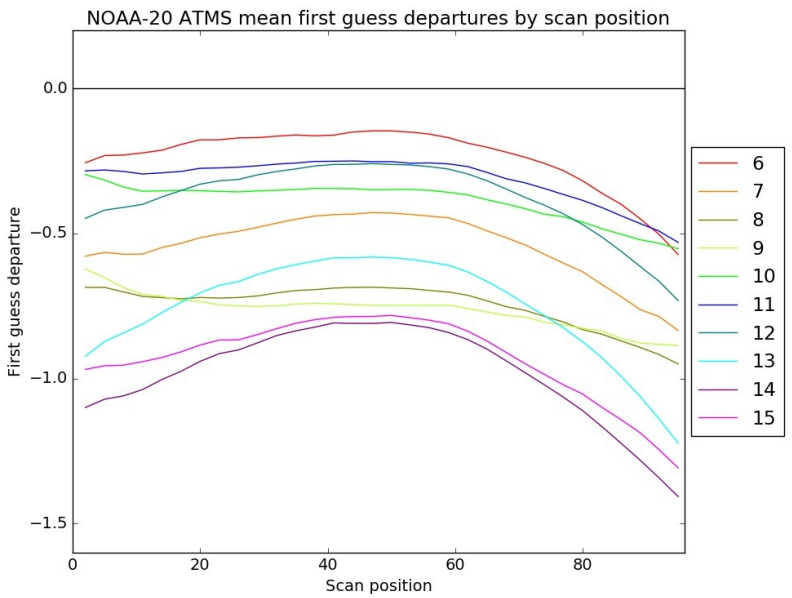


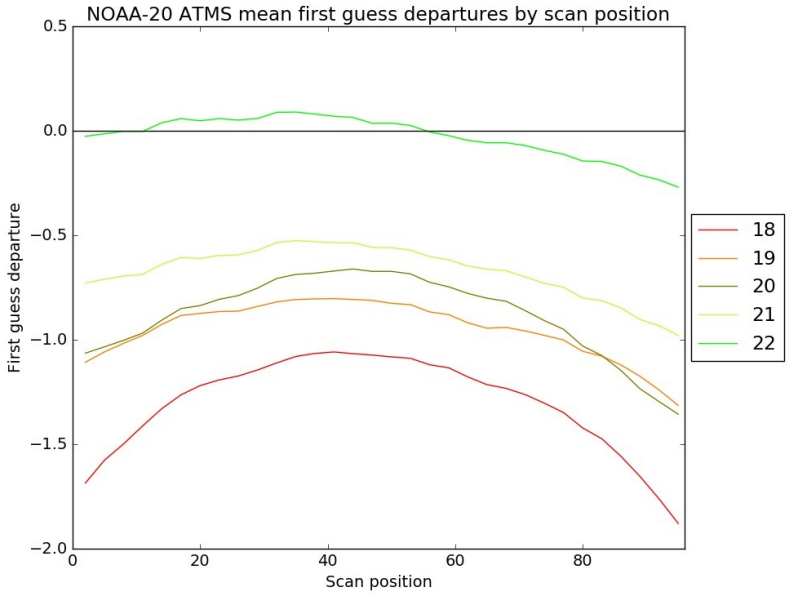


Scan dependent biases

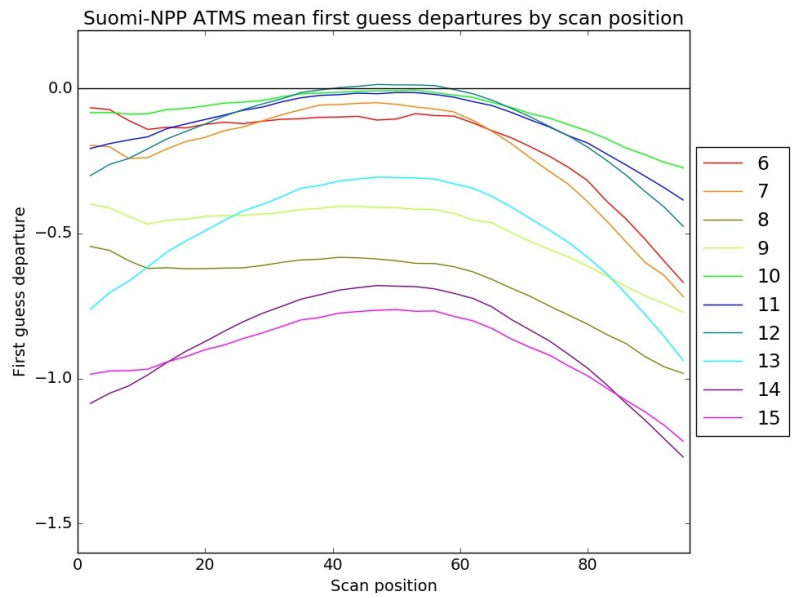
- Scan dependent biases are similarly symmetric for NOAA-20 and Suomi-NPP TDRs
- Magnitude of biases is slightly larger for NOAA-20

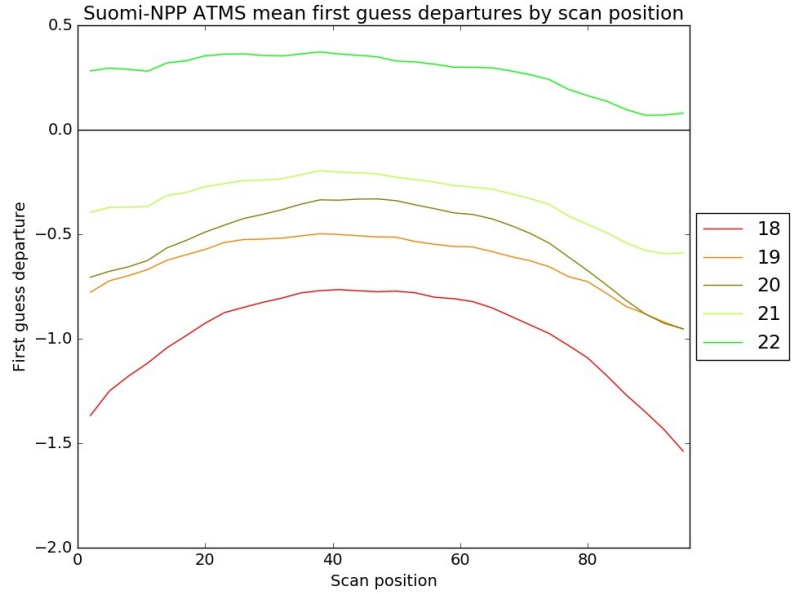
NOAA-20





Suomi-NPP

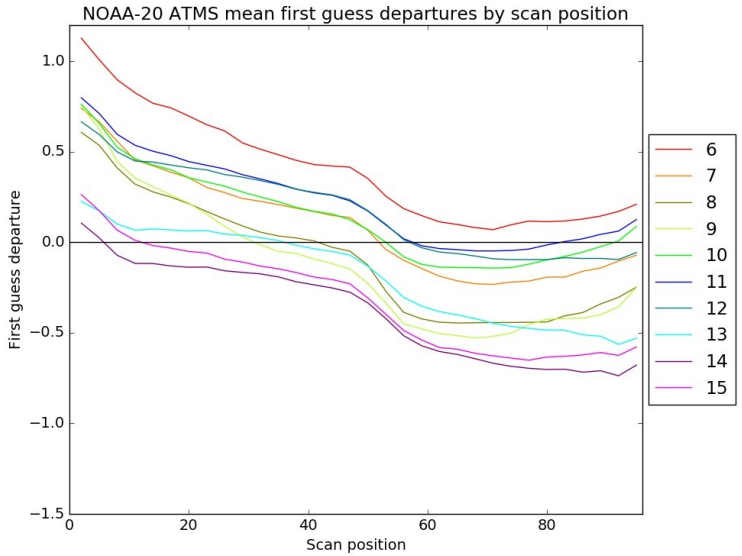




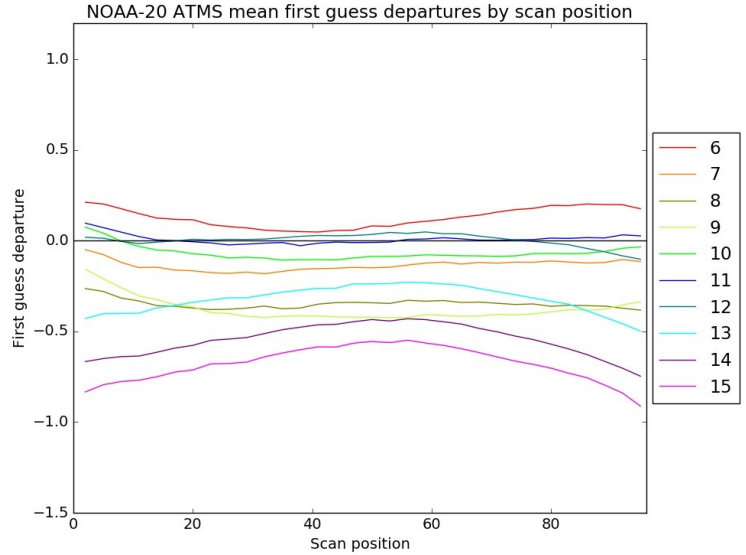
NOAA-20 ATMS TDR & SDR scan biases

- NOAA-20 updated SDRs have much more symmetric scan biases than NOAA-20 original SDRs
- NOAA-20 updated SDRs have more symmetric and smaller magnitude scan biases than NOAA-20 TDRs
- NOAA-20 updated SDRs have more symmetric and smaller magnitude scan biases than Suomi-NPP SDRs

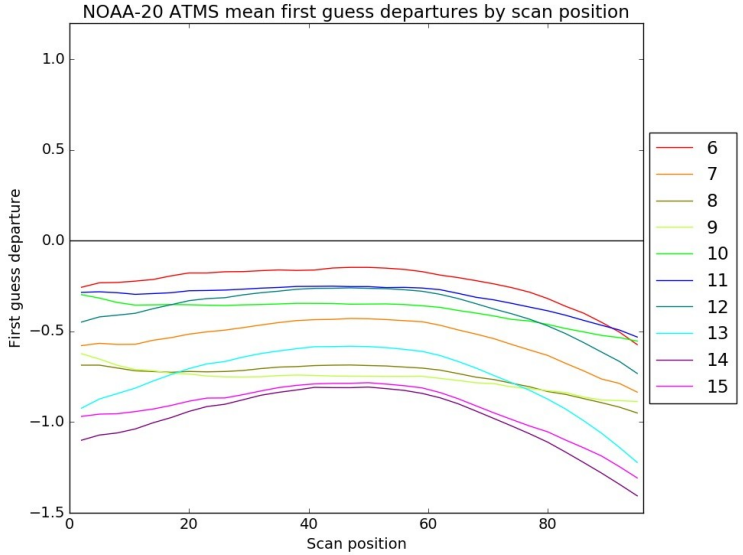
NOAA-20 original SDRs



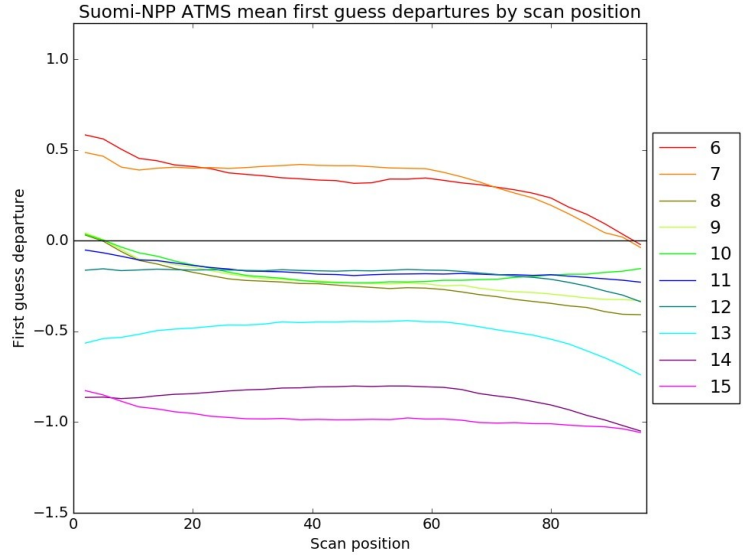
NOAA-20 updated SDRs



NOAA-20 TDRs



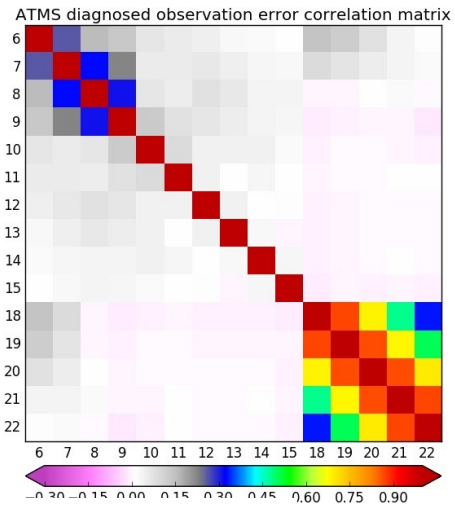
Suomi-NPP SDRs



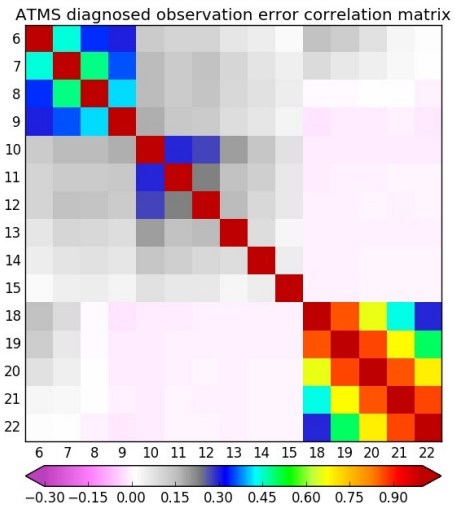
Striping and correlated instrument noise

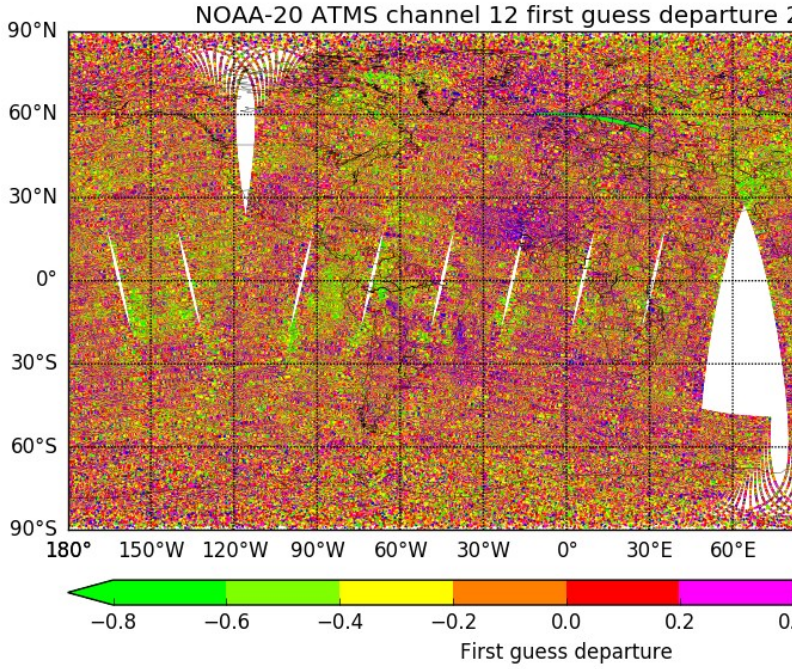
- Diagnosed inter-channel error correlations appear to be significantly weaker for NOAA-20 ATMS
- Striping is also reduced but not completely removed

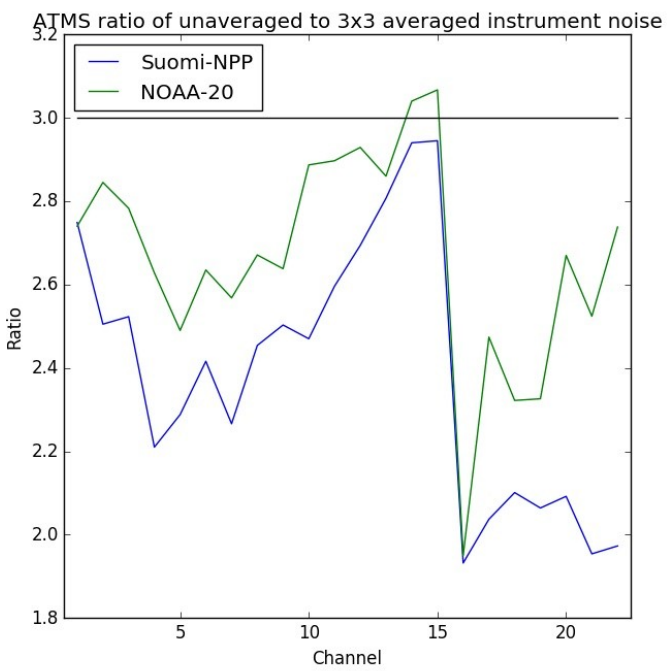
NOAA-20

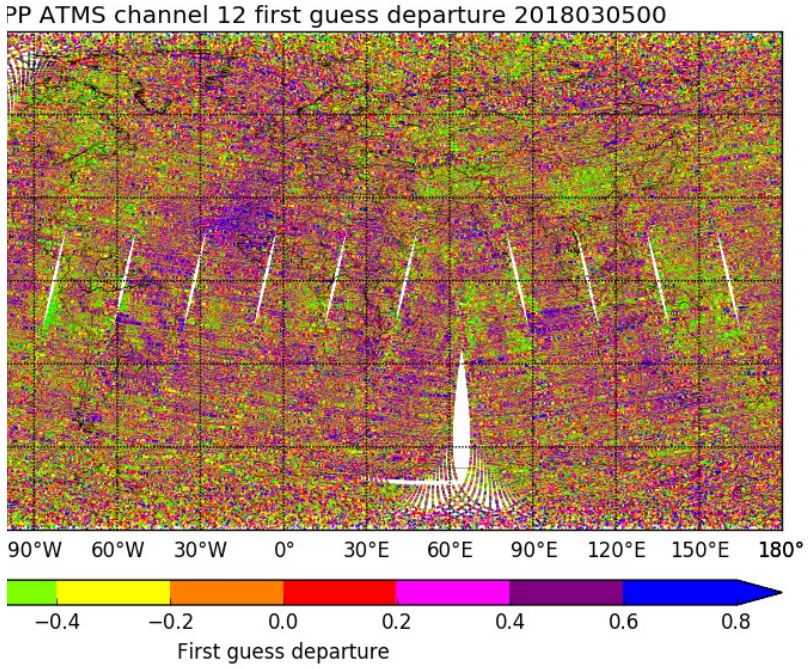


Suomi-NPP





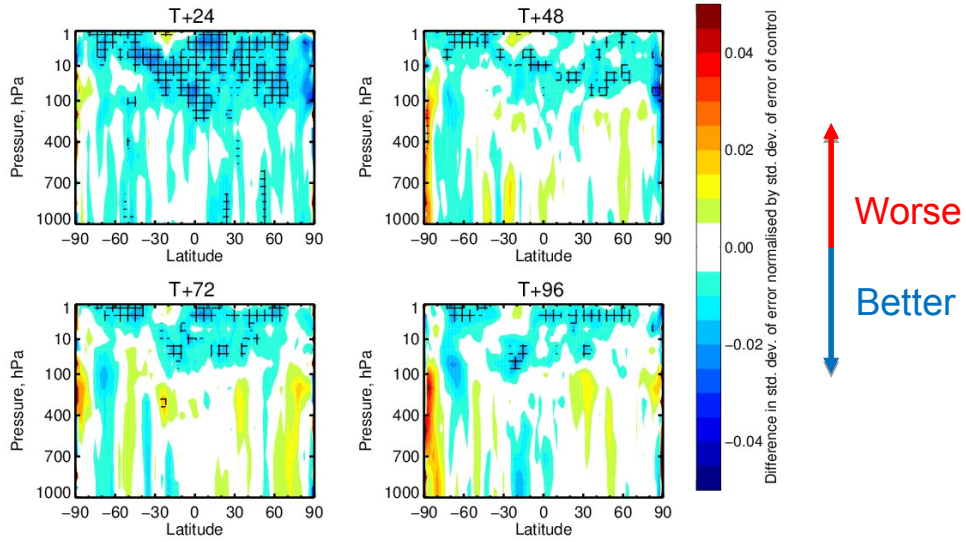




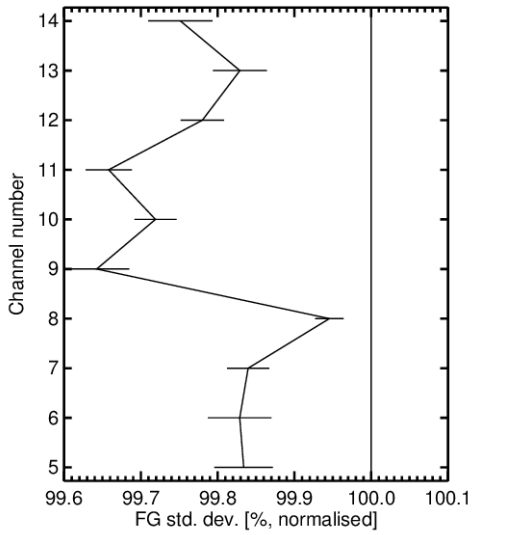
Assimilation experiment results – From three and half months

- Improved first guess fits to:
  - Temperature observations (AMSU-A, CrIS, GPSRO)
  - Humidity observations (MHS, GEO CSRs)
- Neutral to slightly positive forecast scores:
  - Improved geopotential height forecasts, particularly in the stratosphere

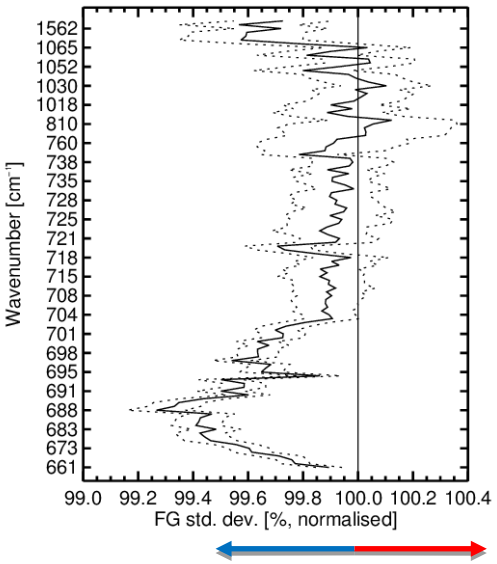
Change in RMSE of geopotential height forecasts



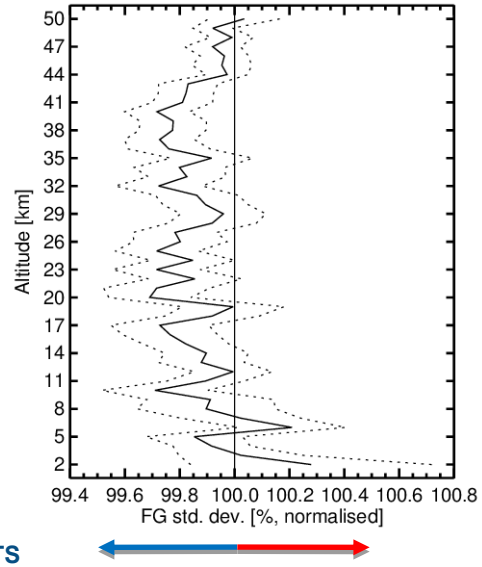
AMSU-A



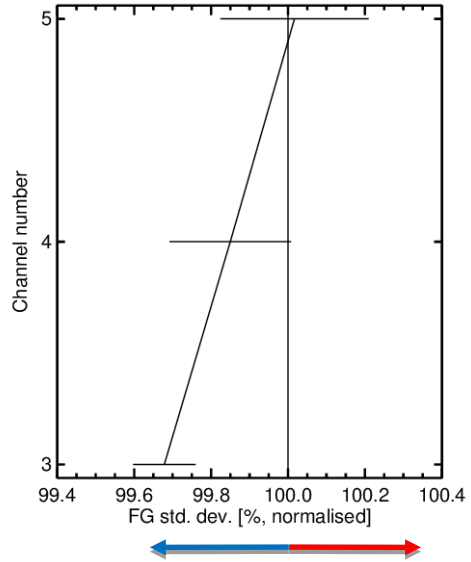
CrIS



GPSRO

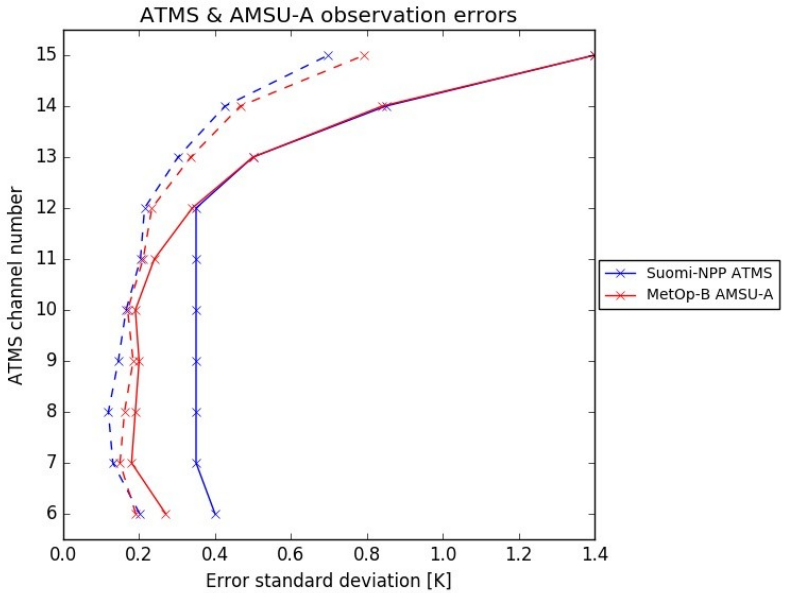


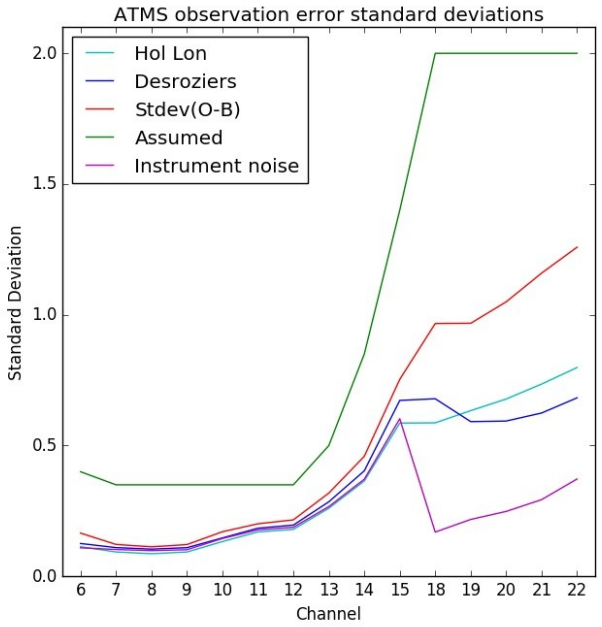
MHS

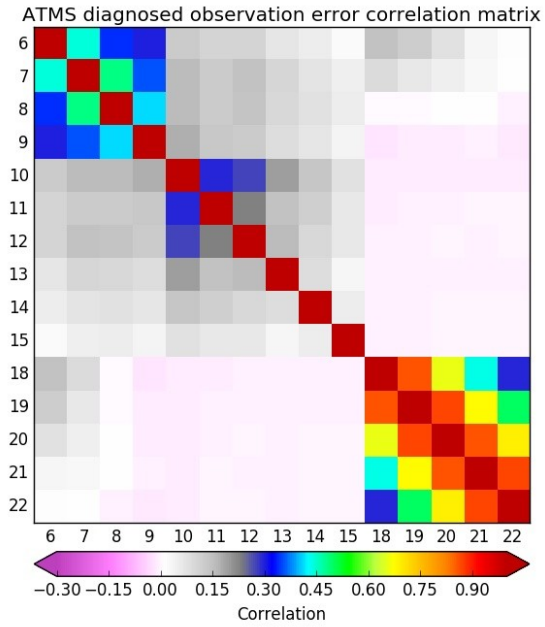


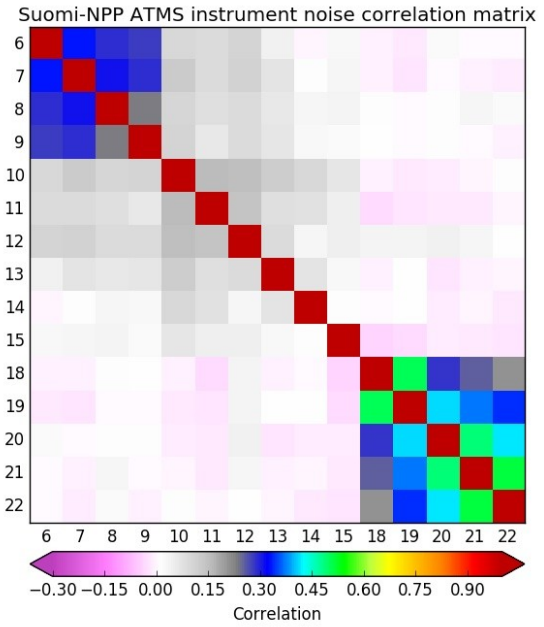
Suomi-NPP ATMS correlated errors

- Initial assumed observation errors for Suomi-NPP ATMS were uncorrelated and inflated due to correlated instrument noise
- Since then forecast improvements have been attained by accounting for correlated errors directly (e.g. for IASI, CrIS)
- Diagnose error standard deviations and correlations using Hollingsworth-Lönnberg and Desroziers' methods







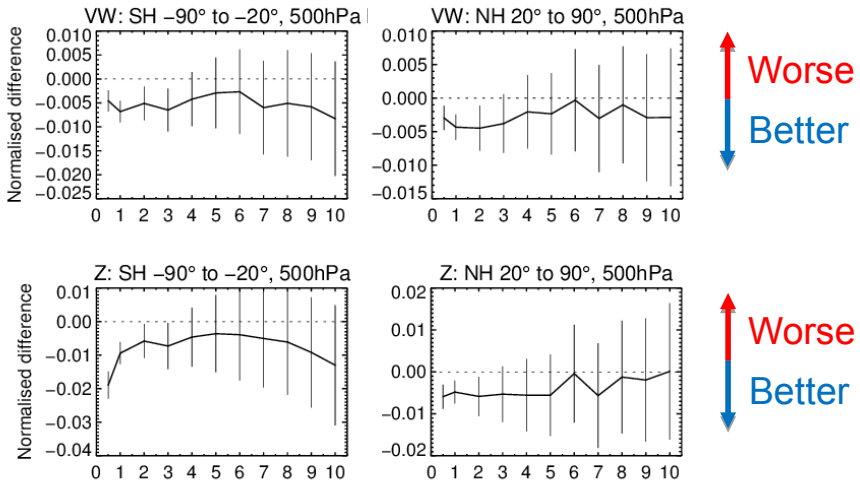


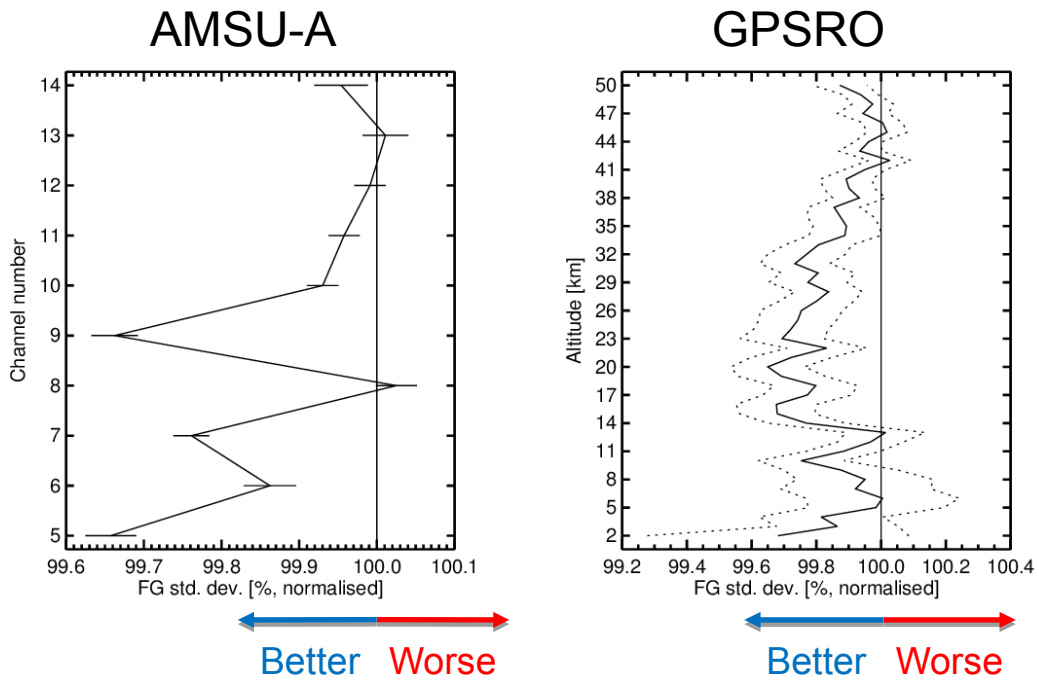
Thanks to Vince Leslie for the instrument noise correlation matrix

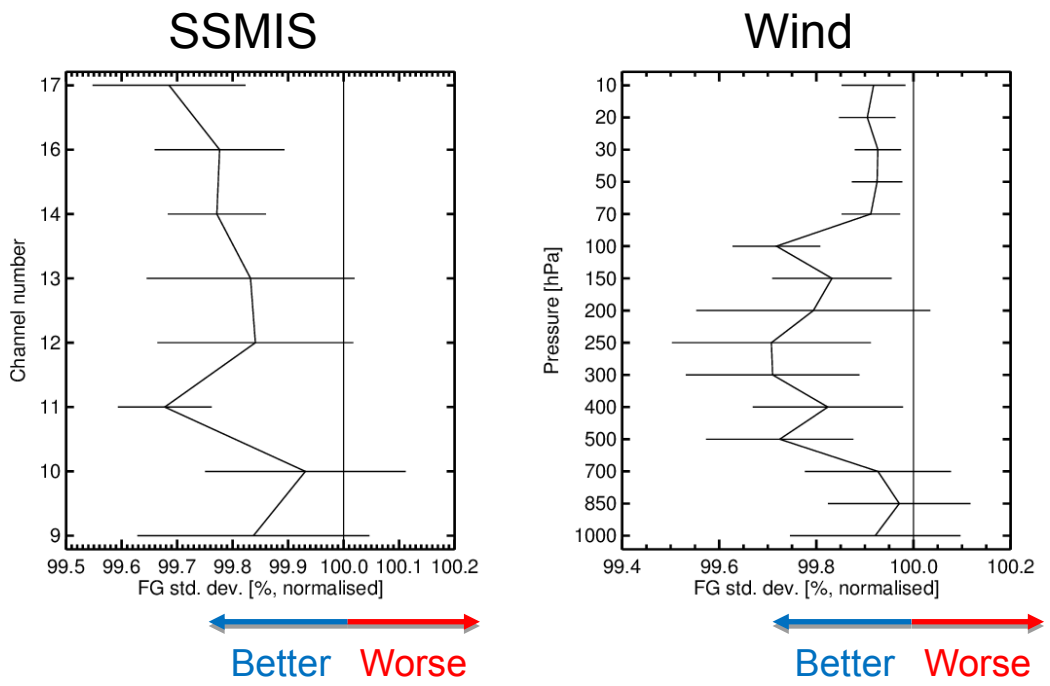
Results

- Several inflation factors were tested, x1.75 gave optimal results
- Improved first guess fits to temperature, humidity and wind observations
- Improved extra-tropical forecasts of geopotential height, temperature and vector wind to day 3

Change in RMSE of vector wind (top) and geopotential height (bottom) forecasts

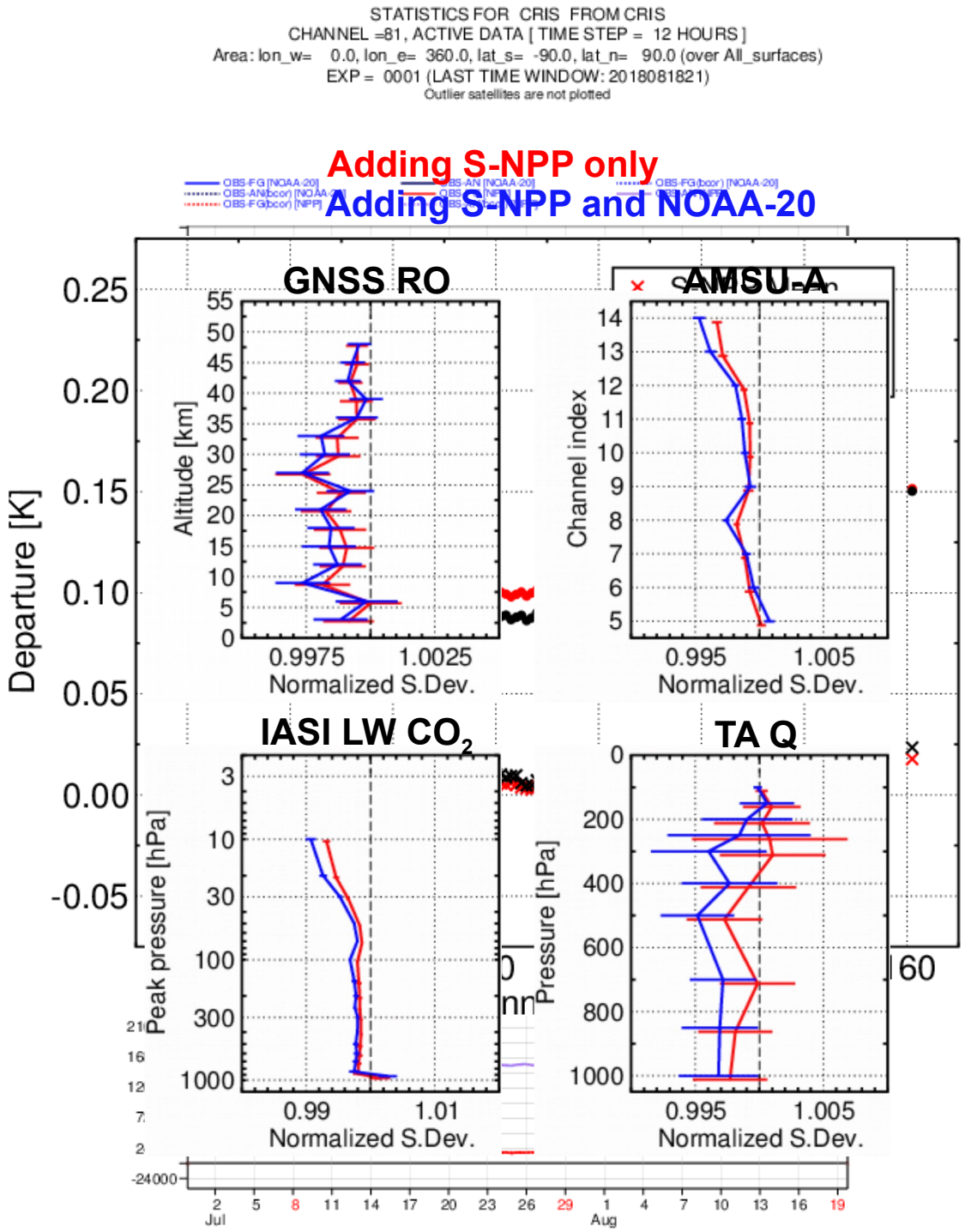






NOAA-20 CrIS update (Reima Eresmaa)

- Using 111 LWIR channels (We use 118 Suomi-NPP CrIS channels)
  - No humidity sounding channels or aerosol detection
  - Due to ongoing performance issues with new RTTOV coefficients
- Operational monitoring from 1st August 2018
  - Slightly different biases to Suomi-NPP CrIS
  - Lower noise than Suomi-NPP CrIS
- Research experiments from 1st May 2018
  - Incrementally improved first guess fits
  - Neutral forecast scores so far
- Operational assimilation to be introduced soon



Conclusions and future work

- NOAA-20 ATMS:
  - Data are of very good quality with comparable biases to Suomi-NPP and significantly lower and less correlated noise
  - Assimilation experiments lead to improved forecasts of geopotential height, temperature, humidity and wind particularly in the stratosphere
- Suomi-NPP ATMS correlated errors:
  - Correlated instrument noise and representation errors can be taken account of directly allowing more weight to be given to the data
  - Results show significant improvements to short-range temperature, humidity and wind forecasts as well as medium-range wind and geopotential height forecasts
- Ongoing work includes:
  - The use of correlated errors for NOAA-20 ATMS
  - Implementation of operational assimilation of NOAA-20 CrIS
  - Investigation of benefits of increased temporal frequency of ATMS observations e.g. for tropical cyclones

ATMS and AMSU-A biases (after antenna pattern correction)

- NOAA-20 ATMS biases consistent with Suomi-NPP ATMS biases at cold end of AMSU-A “pack”
- Grey points and uncertainty bars indicate GRUAN estimated IFS model biases