On the Usage of Recalibrated Radiance in Reanalysis Experiments

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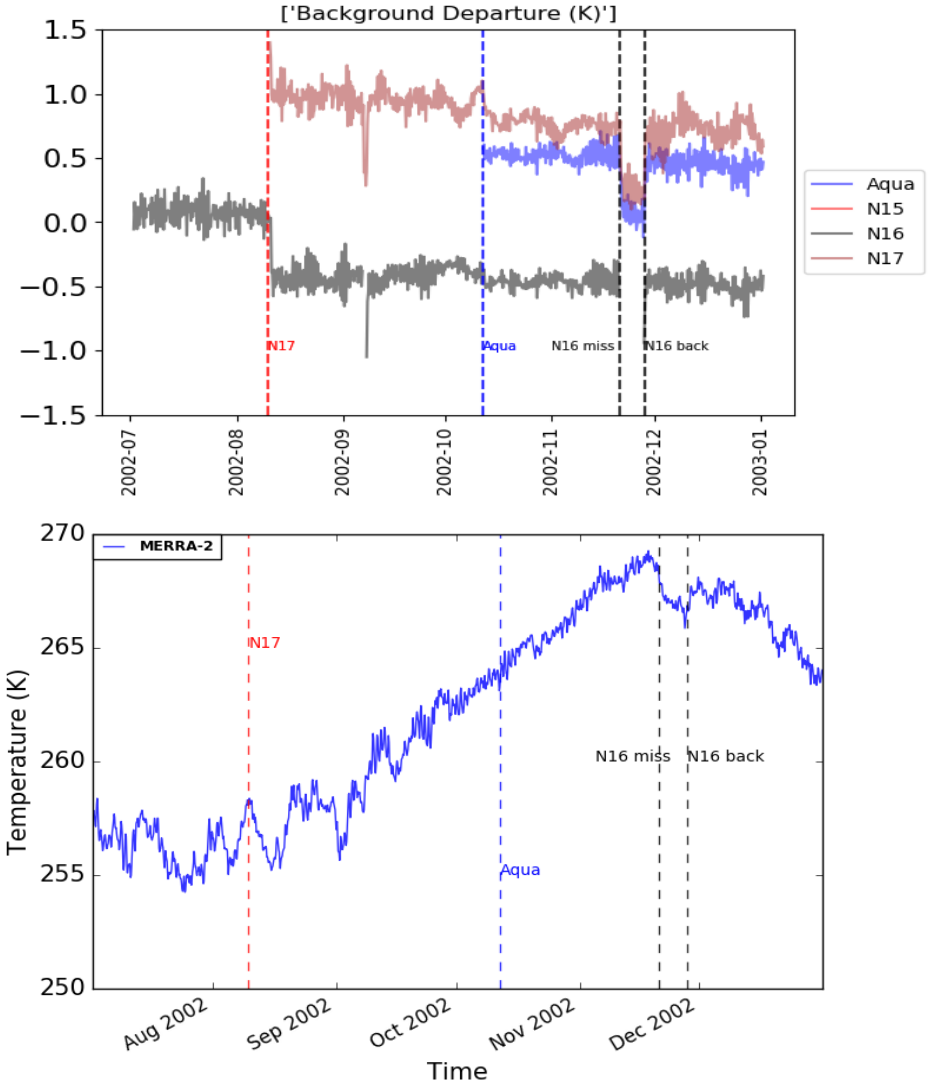
Motivation



- Sudden changes in background departure of Channel 14 in MERRA-2
  - Introduction of NOAA-17 AMSU-A
  - Introduction of AQUA AMSU-A
  - Data gap of NOAA16 AMSU-A on 19-28 November 2002
- Loss of NOAA-16 AMSU-A reflected in upper stratosphere temperature
  - Mean T shown at 2hPa and between 20-50^{o} S

Motivation

This effort aims to explore the impact of alternate data-source/inter-calibrated radiance on a similar system by:

- Conducting experiments using inter-calibrated radiance to test the sensitivity of the system
- Study if these new data sets can successfully alleviate sensitivity of temperature in upper stratosphere.

Data/Experiment Design

Ferraro et al. (2016) :

- channels 1, 2, 3 and 15 which have 23, 31, 50, 89 GHz frequency
- Corrections: Viewing angle, location dependent bias and many more

Zou and Wang (2013):

- Simultaneous Nadir Overpass (SNO) CH6 from NOAA-18 and CH(4-7) and CH(8-14) from NOAA-15 as reference
- Integrated Microwave Inter-Calibration Approach (IMICA) method to obtain a long-term data product
- Correction derived from the global ocean differences between Aqua and the reference satellite.

Data Source	Reference	Description
M2	N/A	Antenna Temperature bufr stream used in MERRA-2
FERRARO	Ferraro et al. 2016	Inter-calibrated AMSU-A measurements for Channels 1-3, 15
Z&W	Zou and Wang 2013	Inter-calibrated AMSU-A measurements for Channels 3-14
NOAA	NOAA KLM User's Guide, 1999	Antenna Temperature acquired from Z&W based on NOAA CLASS

Experiment Design

Assimilation (3DVar) and the model configurations are similar to MERRA-2 specification

Horizontal Resolution C90 ~100km (MERRA-2 C180 ~50km)

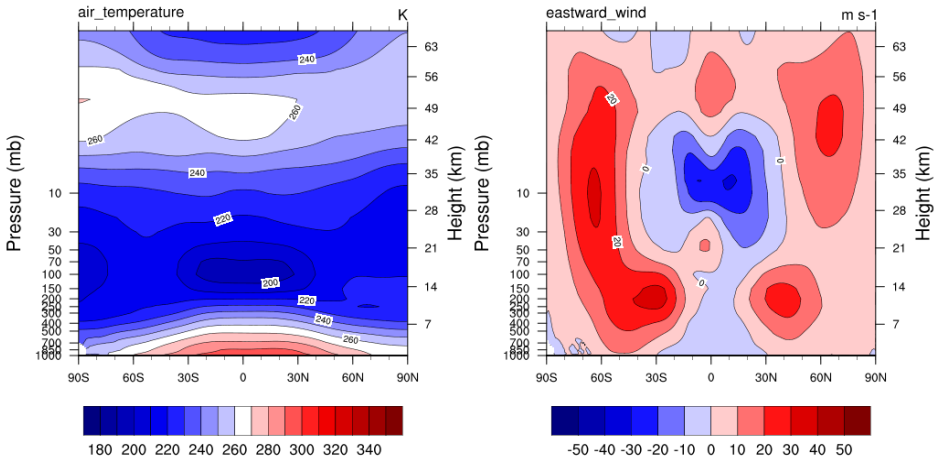
72 vertical levels to 0.1 hPa

Study period: 2 July – 31 December 2002

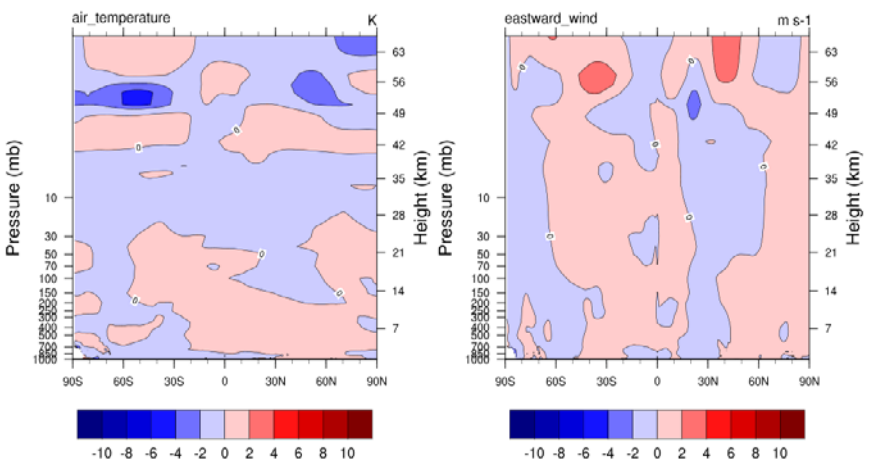
Experiment	AMSU-A Data Source		
	CH: 1-3, 15	CH: 4-13	CH: 14
CTL	M2	M2	M2
EXP_TANT	NOAA	NOAA	NOAA
EXP_IC	FERRARO	Z&W	Z&W
EXP_IC14	NOAA	NOAA	Z&W
MERRA-2	M2	M2	M2

Climatology : MERRA-2 and CTL

(a) MERRA-2 Climatology

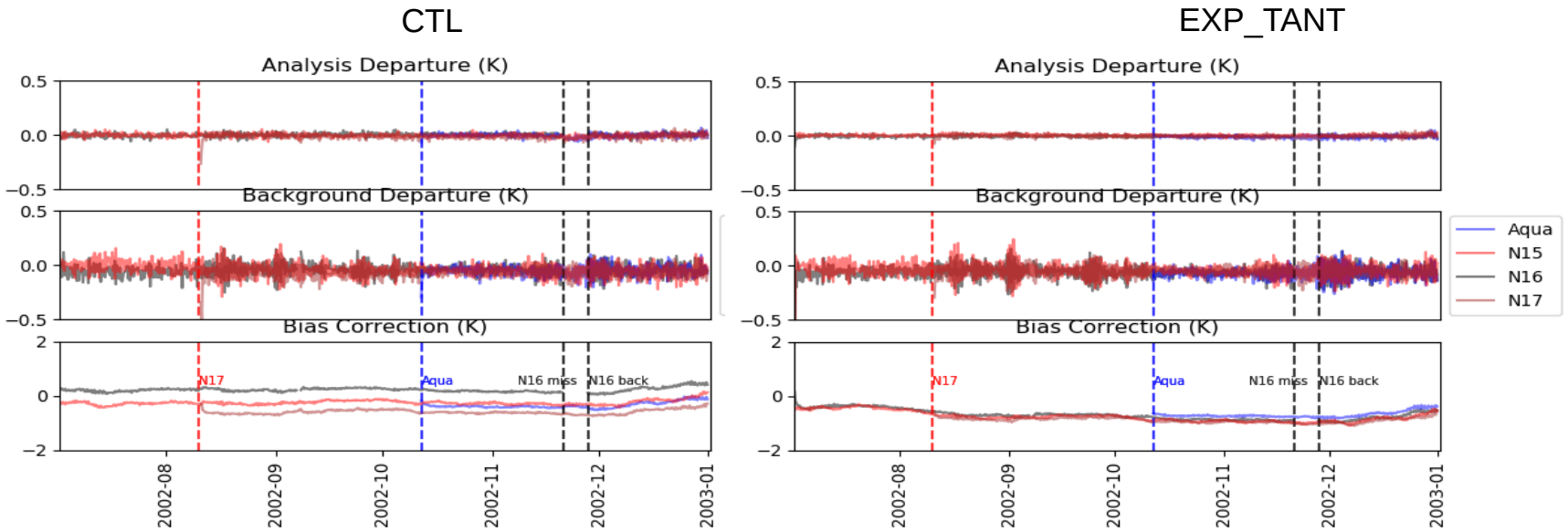


(b) MERRA-2-CTL Climatology



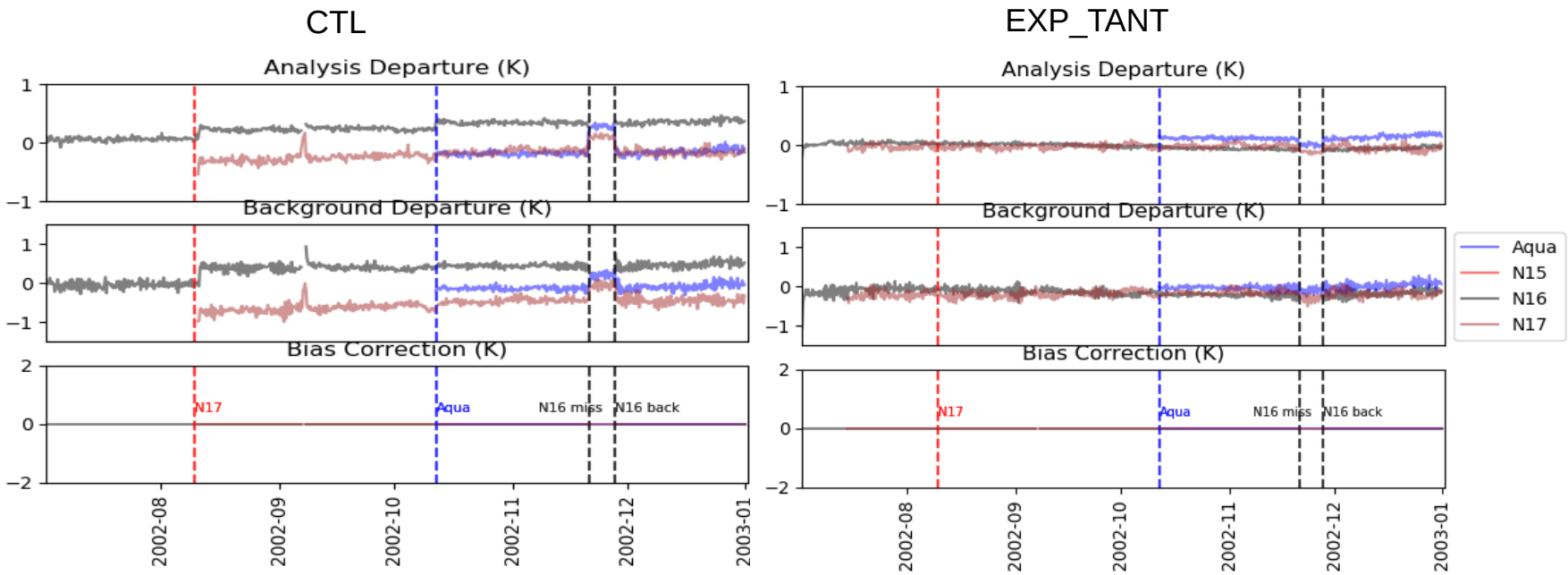
- (a) Zonal mean temperature and zonal mean zonal wind for MERRA-2 from 2 July to 31 December 2002 is shown
- (b) Minimal differences between MERRA-2 and CTL
- This confirms that results from experiments at C90 can be translated to MERRA-2 at C180

Observation statistics: AMSU-A Channel 13



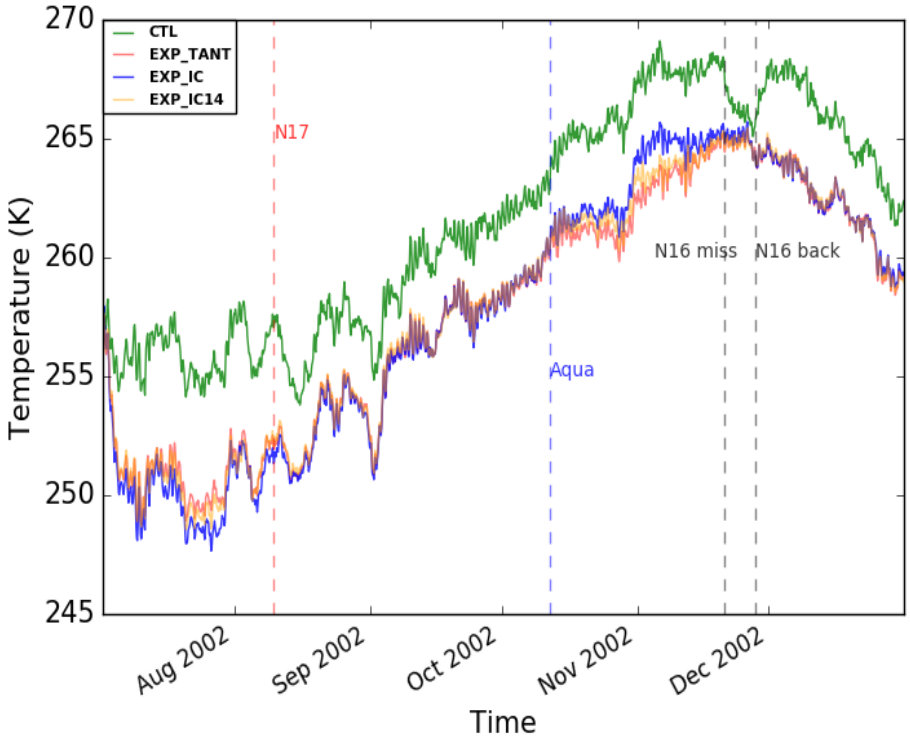
- AMSU-A channel 13 is bias corrected
- CTL bias correction values vary between instruments
- Implies difference in AMSU-A radiance between instruments in CTL
- Similar bias correction values in MERRA-2
- Values of bias correction are more consistent across sensors in EXP_TANT

Observation Statistics : AMSU-A Channel 14



- AMSU-A Channel 14 is not bias corrected
- Shows discontinuities in analysis and background departure with the change in observing system in CTL
- EXP_TINT has a smoother analysis and background departure response compared to CTL
- EXP_IC and EXP_IC14 show response similar to EXP_TINT
- Issues with AMSU-A data used in MERRA-2

Upper Troposphere Temperature: July to December 2002

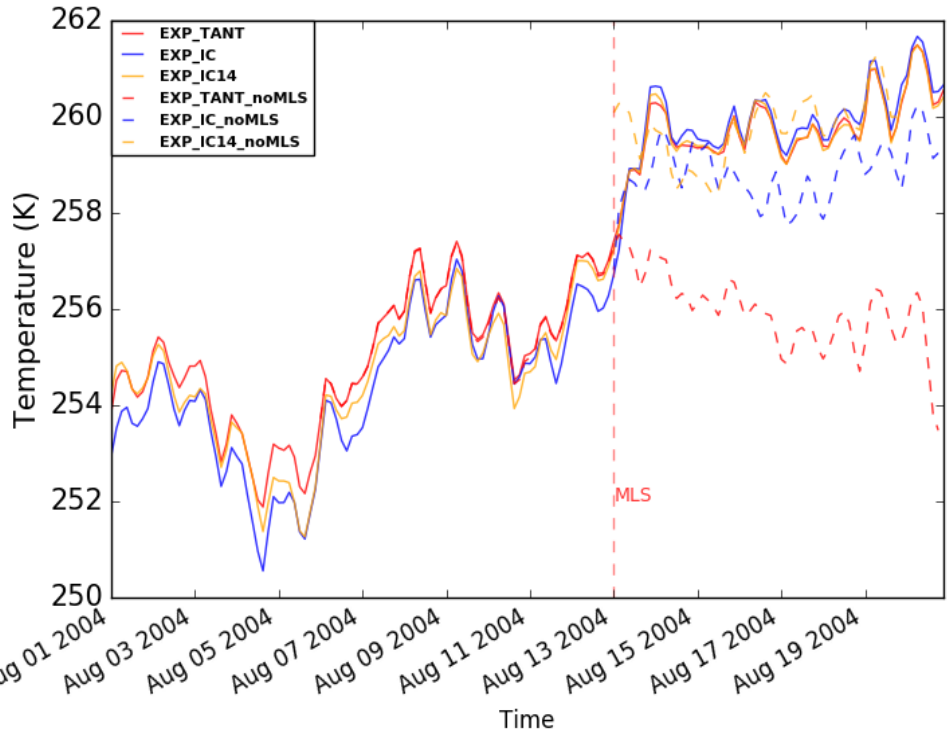


Time-series: Zonal Mean Temp at 2hPa/mean of 50º S and 20º S Lat

- A bias of average 4 K is noted between CTL and the other experiments
- CTL shows a drop in upper stratospheric temperature with absence of NOAA-16 in assimilation
- EXP_TANT and EXP_IC14 have very similar temperature profile than EXP_IC due to corrections applied to CH14 in Z&W radiance

Upper Stratosphere Temperature : August 2004

Mean Temperature at 2 hPa between 20- 50^{o}S



- EXP_TANT, EXP_IC and EXP_IC14 simulated in 2004 to test stability
- MLS temperature assimilation from 5hPa and above commenced on 13 August 2004
- Negligible stratosphere temperature difference between experiments after MLS temperature assimilation
- MLS temperature acts as an anchor in upper stratosphere

Conclusion

Established that MERRA-2 data stream needs to be reprocessed for future reanalyses.

- The MERRA-2 AMSU-A data prior to 2005 was the same as MERRA

At minimum, the early AMSU-A record needs to be reprocessed to be consistent with the base NOAA antenna temperature data record

Using NOAA data-stream for AMSU-A will partially alleviate the upper stratosphere temperature sensitivity, but more considerations on the recalibrated radiances are underway

Upper stratosphere temperature achieves stability with the introduction of MLS temperature assimilation

- MLS temperatures anchor to the upper stratospheric temperature
- Prior to MLS, this is primarily done by assimilation CH14 without bias correction, but that data record was questionable in previous GMAO reanalyses
- MLS has no follow-on, and it has yet to be studied how much GNSSRO acts to anchor the radiances in the context of the upper stratosphere