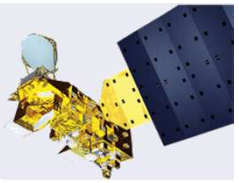

AIRS (obs-calc) trends in window channels

Hartmut H. Aumann

Jet Propulsion Laboratory
California Institute of Technology

April 3, 2019

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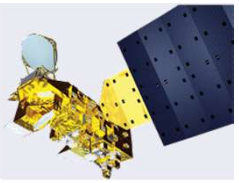

For climate applications of AIRS data, trend artifacts should be much less than the 10 mK/yr global warming.

At a minimum, trend artifacts in the data should be quantified.

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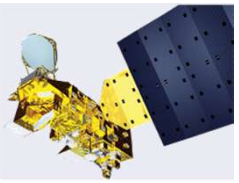

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Trends are measured using the time series of the difference between the observations (obs) and the calculated (calc) values based on a truth with unquestioned stability. We use the RTGSST from NOAA in the tropical oceans. These data are stabilize on floating buoys.

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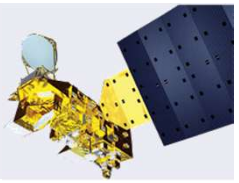

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We show trends for 7 atmospheric window channel.

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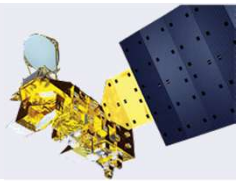
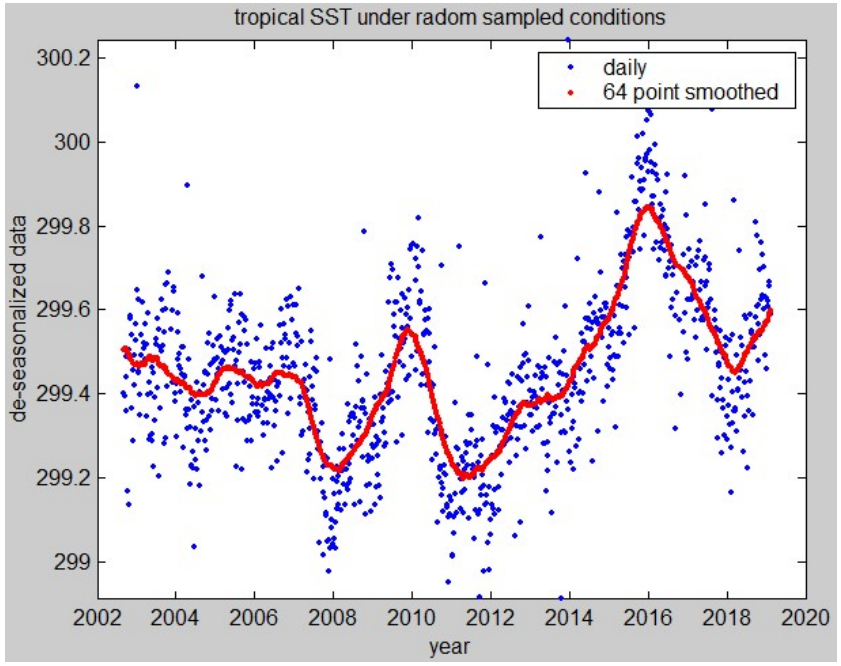
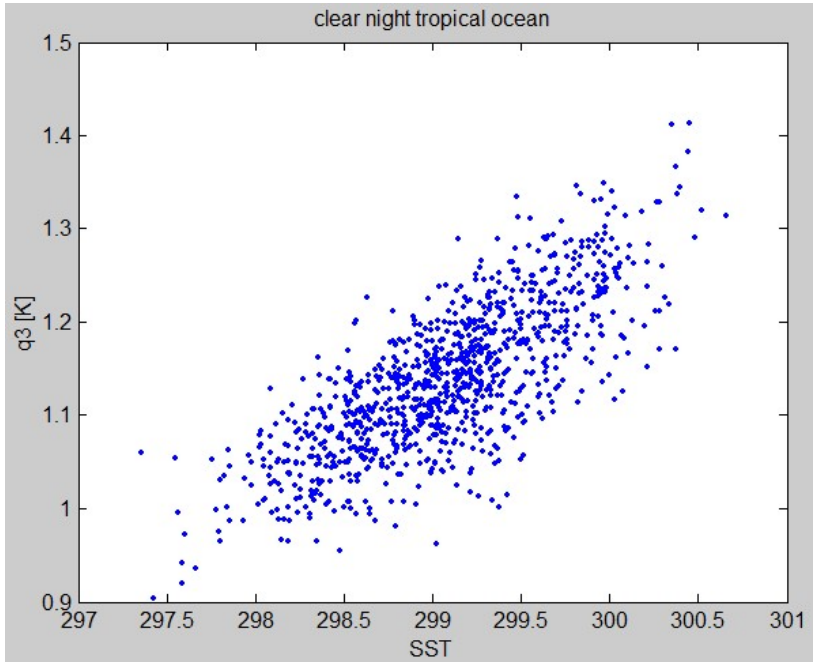
The trends are measured relative to the RTGSST from NOAA in the tropical oceans in terms of (obs-calc) under clear conditions.







Between 2002 and 2019 the SST varied by 0.6K

"obs" are the radiances measured under clear conditions. "calc" are the radiances expected based on the known SST and emissivity and water vapor corrections.

The column water vapor increases 8%/K of the SST increase. (Clausius-Clapeyron).

The water vapor correction is based on the water vapor derived from two AIRS channels. q3=bt1231-bt1227. The required transmission correction for water vapor is based on synthetic regression training using Hitran2016.

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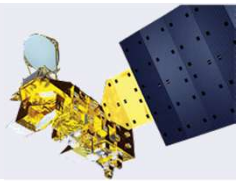
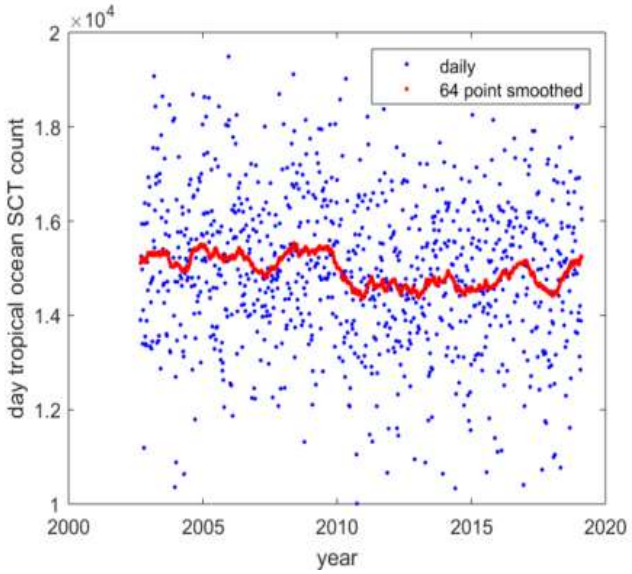
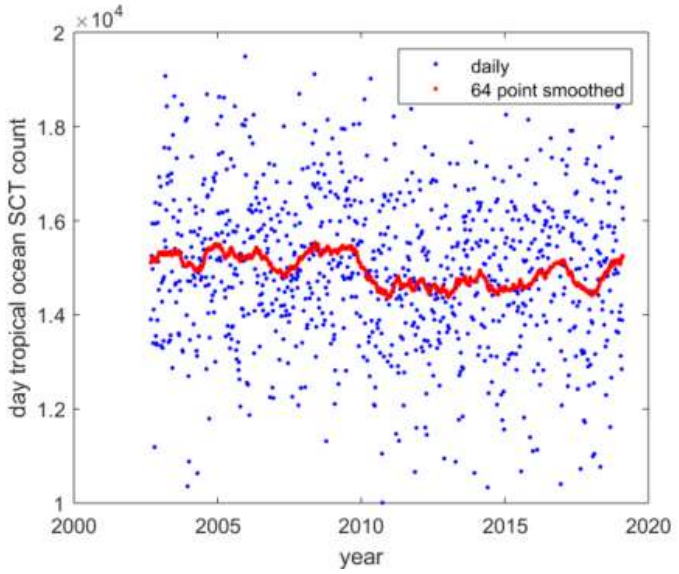
Typically 20,000 clear tropical ocean spectra are identified and collected in the ACDS.



The clear spectra are selected using a Spatial Coherence Test (Aumann et al. 2006). In this test a spectrum is defined as SCT clear if the maximum difference between the nearest neighbor is less than 0.5K. About 4.2% of the day, 2.4% of the night tropical ocean data in the past 16 years pass this test.





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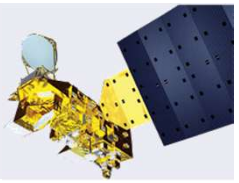
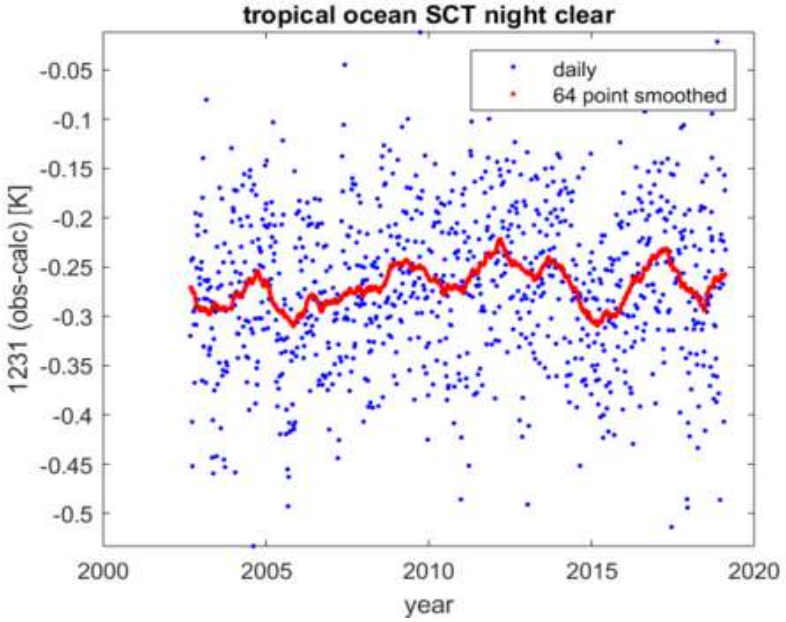
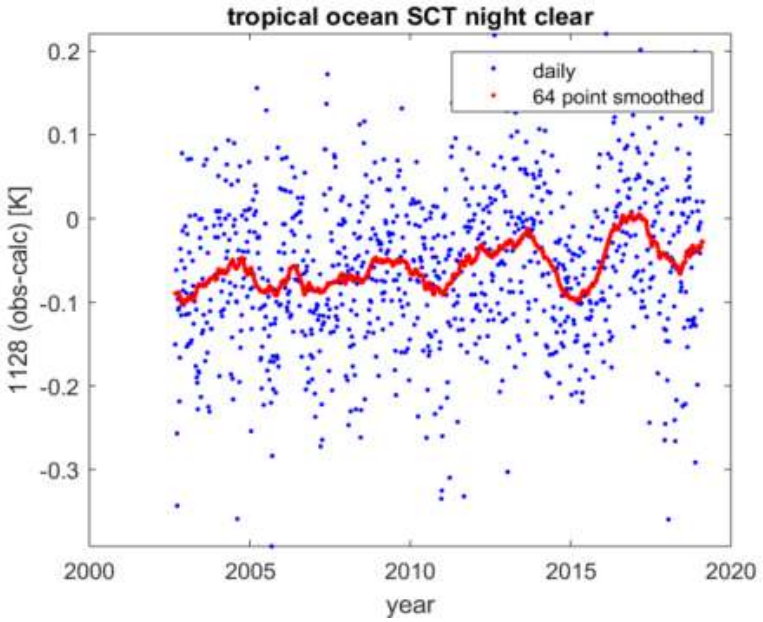
The 1231 and 1128 cm-1 channels have a small trend.



Each dot in the figures below is the mean(obs-calc) from one day





The trend and trend uncertainty are calculated as the linear fit through the daily data.

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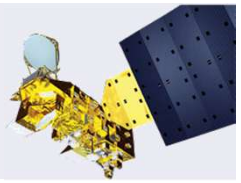
The 2616 and 2508 cm-1 channels have a somewhat larger trend



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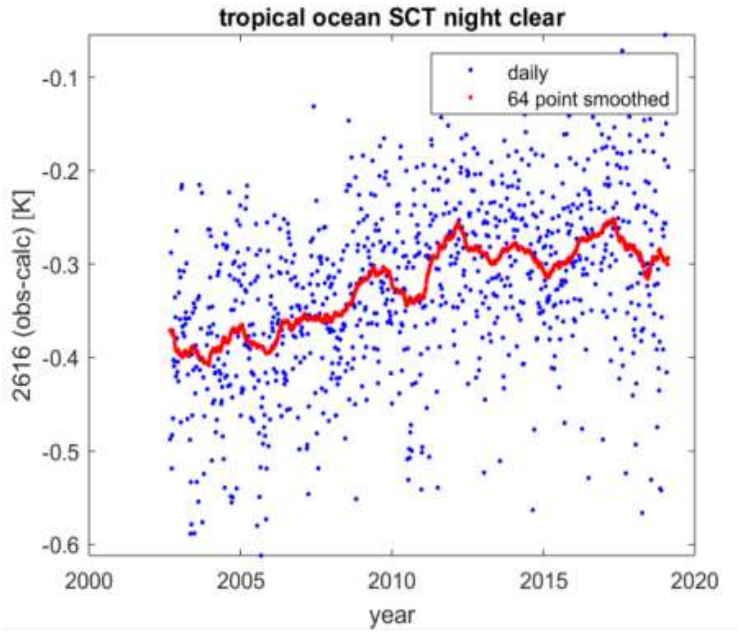

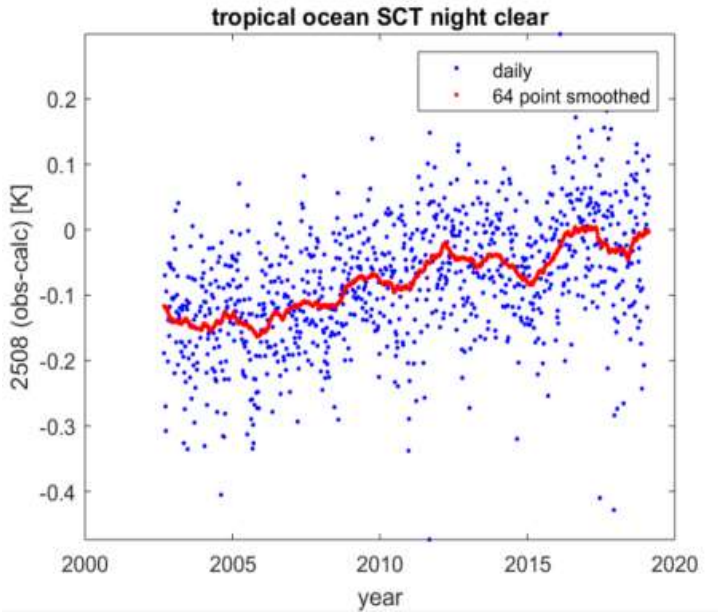

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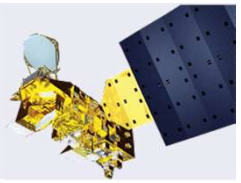
We show results for 7 atmospheric window channel in 7 of 12 detector modules in terms of the mean bias and the bias trend..



(Obs-calc)	Day bias	Day Trend K/yr	Night bias	Night trend K/yr
2616 (51)	+4.2100	0.0103± 0.0034	-0.3805	0.0083± 0.0009
2508 (19)	+2.3263	0.0099± 0.0020	-0.1596	0.0090± 0.0010
1231 (3)	-0.2208	0.0020± 0.0006	-0.2648	0.0013± 0.0006
1128 (151)	-0.0434	0.0033± 0.0007	-0.0913	0.0026± 0.0008
961 (17)	-0.0046	0.0031± 0.0007	-0.0481	0.0022± 0.0007
901 (53)	+0.0047	0.0058± 0.0007	-0.0417	0.0046± 0.0007
790 (55)	+0.1100	0.0049± 0.0007	+0.0519	0.0044± 0.0007

For most channels the bias is less than 100 mK and slightly negative.

It is not clear if this bias is related to the absolute calibration, the RTA or to a small cloud leak into the “clear” data.

The trend in the bias is less than 5 mK/year for 8-13 micron the window channels, close to 10 mK for the 4 micron window channels.

The observed trends are likely the trends in all channels in a detector module.

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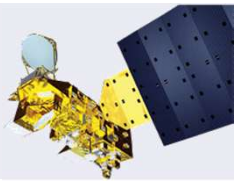
A 5 mK/year trend is small, but it is large in the context of a 10 mK/yr global warming.



The likely cause of the warming trend is the increasing contamination of the scan mirror, which is not accounted for in the 2 point calibration.

When the instrument looks at the OBC, the calibration assumes that OBC radiates as a 308.3K BB. Due to contamination of the scan mirror the OBC signal will be less, and the gain will be erroneously increased. This results in a warming trend under warm conditions.

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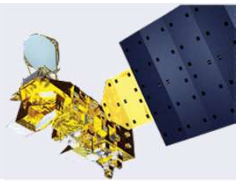
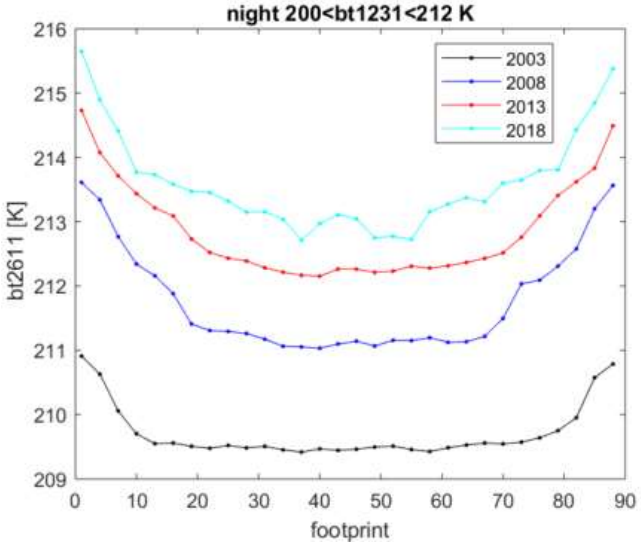
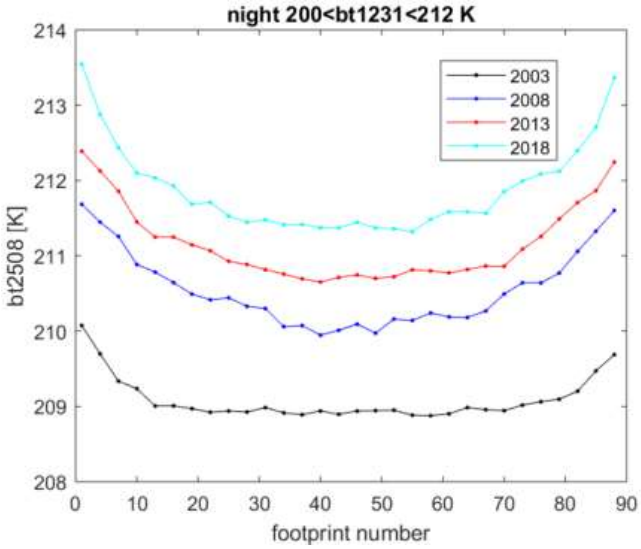
There is clear evidence of increasing contamination of the scan mirror using SW channels for DCC at night



pge#2328 Module M2b



pge#2204 Module M1b



Between 2003 and 2018 bt2611 at the center increased from 209.5 K, 211.1 K, 212.2 K to 212.8 K. The edge brightening increased from 1.5K to 2.6K, 2.8K to 3K.

Between 2002 and 2018 the difference between the center and the end changed from 1.1K to 2.2 K. The difference in the frequency does not explain the difference in the change.

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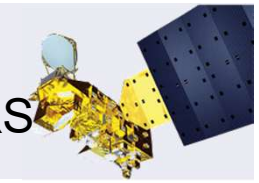
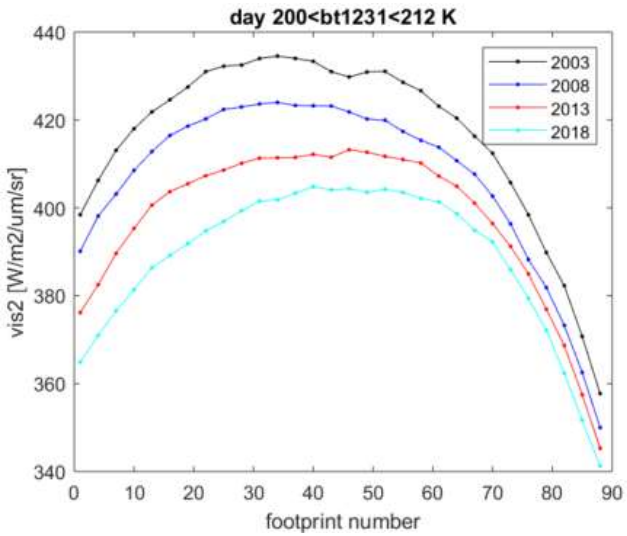
There is clear evidence of increasing contamination of the scan mirror using the visible light channels from AIRS



AIRS vis2 (0.58-0.68 micron

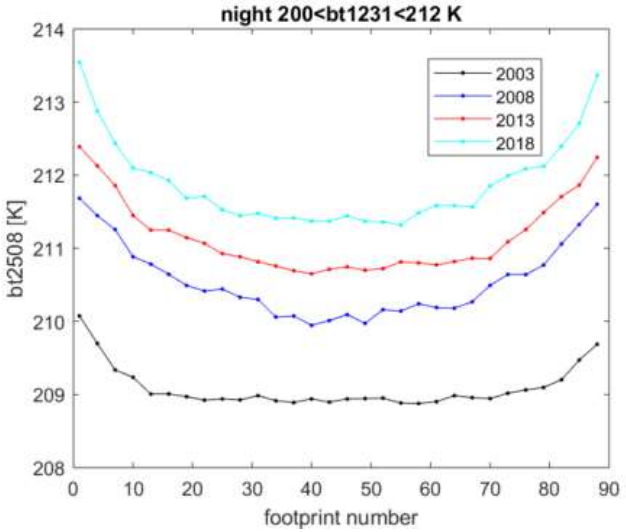


In 2003 vis2 was 398 at footprint #1, 358 at footprint#90

In 2018 vis2 was 364 at footprint#1, 340 at fottprint#90

The signal decreased faster on the Sun side.

pge#2204 Module M1b



The shape and the level of the bt2508 footprint profiles changed. The difference between the center and the end was 1.1K (2003) and 2.2 K (2018).

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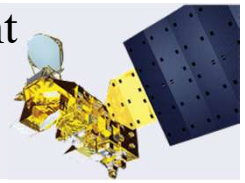
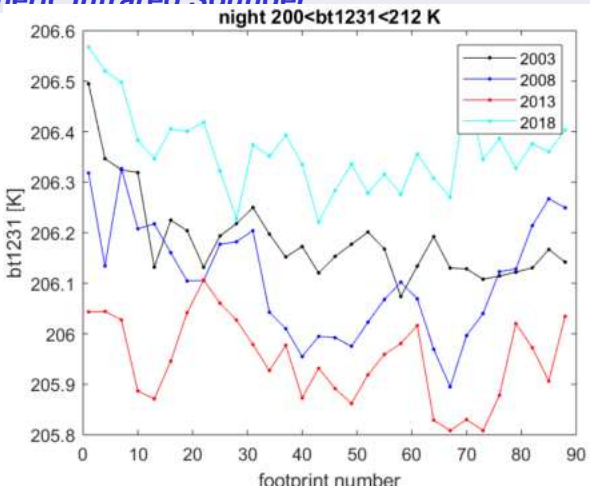
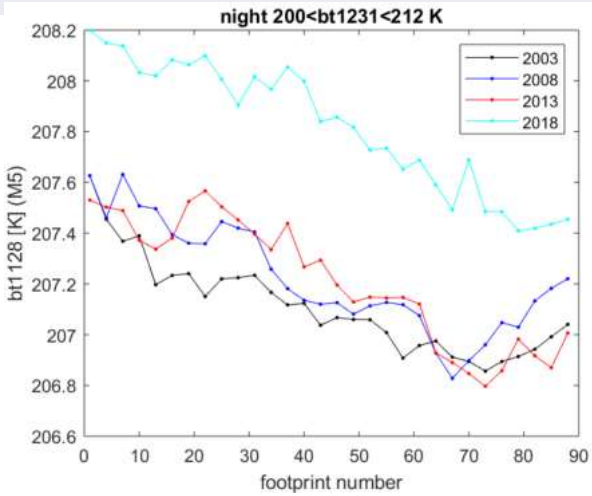
The 8-13 micron window channels also show time dependent Scan angle effects at cold temperatures

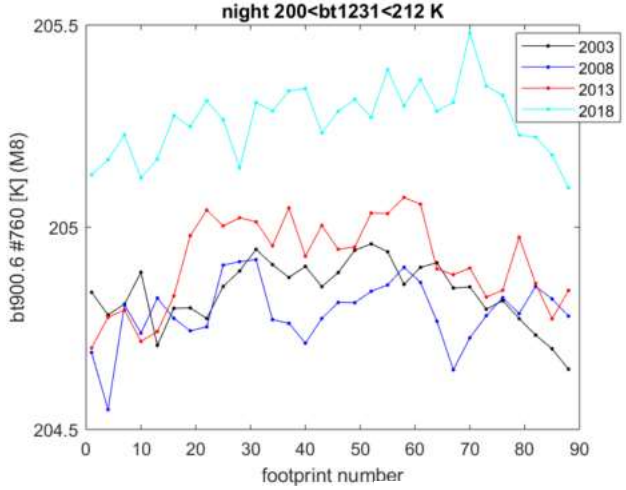




At 1231 cm-1 (M4d) contamination effects are weak



At 1128 cm-1 (M5) the contamination and polarization related effects may be combined.



Left: At 900 cm-1 (M8) the contamination effect is different than at 1231,
including a different curvature

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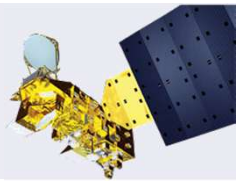

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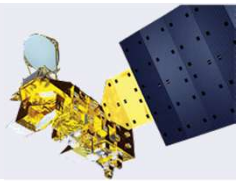

Trends in the AIRS window channels under clear tropical ocean conditions are between 2 and 5 mK/year in the 8-13 micron window channels, 10 mK/yr in the 4 micron window channels.

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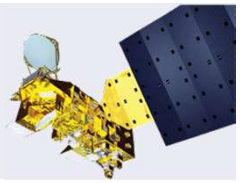

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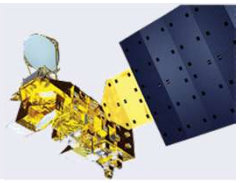

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This effect may be corrected with refinements of the calibration equation.

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