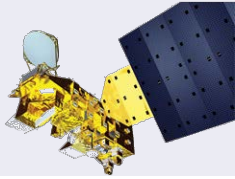

Comparison of the AIRS and CrIS Radiometry using Random Nadir Sampling

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Jet Propulsion Laboratory, California Institute of Technology,

AIRS Team Meeting. Greenbelt, MD
September 14, 2016

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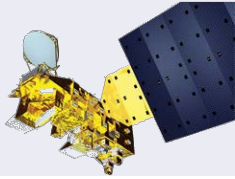
Outline



- Motivation
- Data
- Results
- Summary and Conclusions

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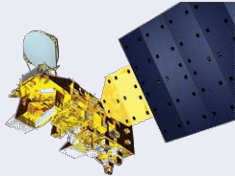
A seamless continuation of AIRS data with CrIS requires radiance agreement at the better than 100 mK level



AIRS has produced data since 2002, but the AIRS climate data record will eventually end. The climate data record established with AIRS is intended to be continued by CrIS with data starting in 2012.

AIRS and CrIS are in polar orbit with 1:30 AM ascending node, have similar specifications and measurement objectives.

The only credible way of establishing a seamless transition from AIRS to CrIS is with the direct comparison of radiances.

100mK far exceeds any AIRS or CrIS absolute accuracy specification, but

- **100 mK is the equivalent of 10 years of global warming.**
- **100 mK is important for climate change analysis (Ohring et al. 2007 BAMS)**
- **A 100 mK shift at 210K to 210.1K increases the DCC count by 1% (Aumann et al. ACP 2013)**

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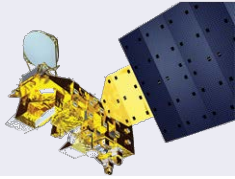
We use Random Nadir Sampling (RNS) to compare the AIRS and CrIS radiometry



AIRS on EOS-Aqua and CrIS on NPP are in 1:30 PM ascending node orbits.
The Sun is 1.5 degree (tropics) 0.7 degree (global) higher in the sky (closer to noon) for CrIS than AIRS.

The FOV of AIRS and CrIS are of the same size.
Both instruments sample a 45 km diameter with a 3x3 pattern.

Based on various tests using clear non-frozen night (obs-calc) and Simultaneous Nadir Overpasses (SNO) the AIRS and CrIS calibration is consistent at the 0.1K level.
Neither method is globally representative.

Differences of the order of 100 mK in the mean and temperature sensitivity of the difference have previously been reported based on the comparison of southern and northern hemisphere Simultaneous Nadir Overpasses of AIRS/IASI (Tobin et al. 2016) and for AIRS/CrIS (Wang et al. 2015).

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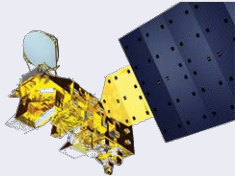
Data



In order to eliminate differences due to spectral sampling and spectral resolution we limit the analysis to the broad atmospheric window centered at 900 cm-1.

For the period between May 2012 and March 2016 we collected all AIRS and CrIS Random Nadir Spectra (RNS) in the AIRS and CrIS Calibration Data Subsets (ACDS, CCDS).

Each day we typically collect 22,000 RNS from each instrument. The data are sampled to be area representative (i.e. 50% from the tropical zone).

We calculate the daily mean for all data or large area subsets and analyze the time series of the daily means.

All data are filtered by the AIRS and CrIS QC, The mean is calculated using 5 sigma editing (to eliminate bad outliers);

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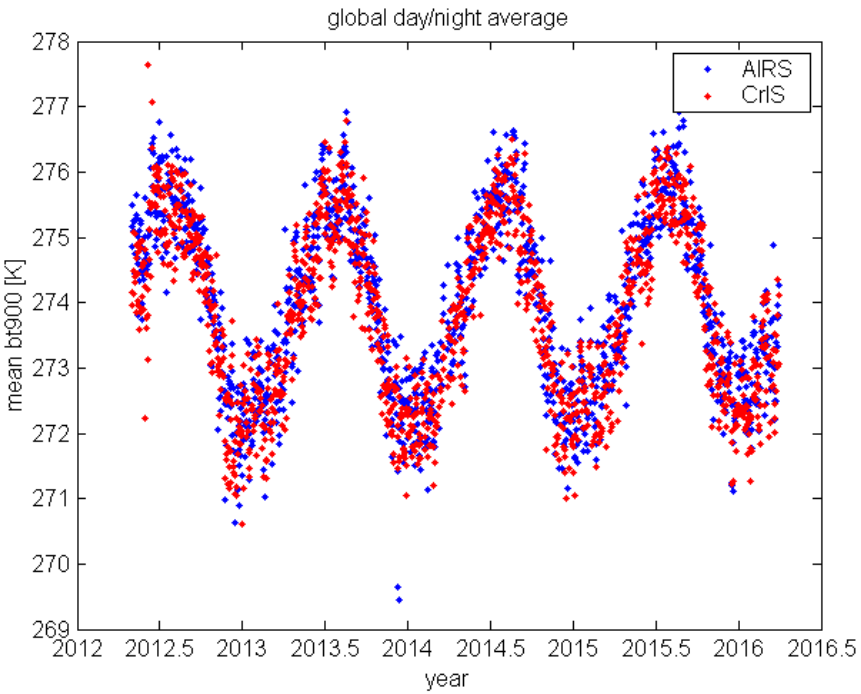
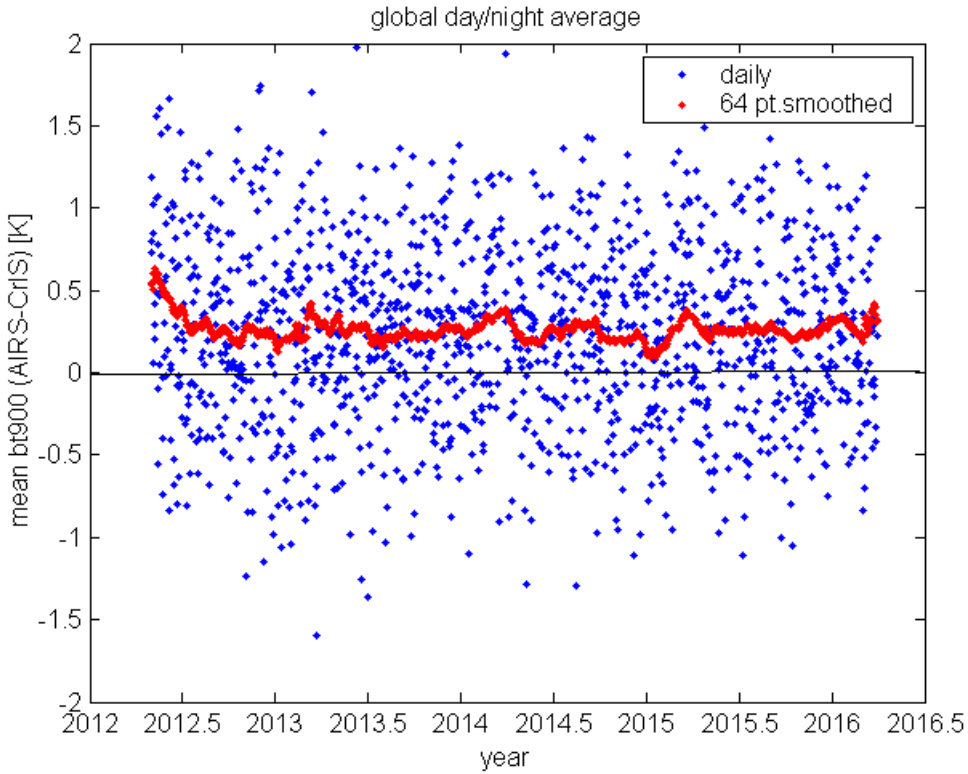
AIRS-CrIS for the 900 cm-1 window region shows seasonal variability for the global data





The daily mean difference between AIRS and CrIS at 900 cm-1 shows no obvious seasonal variability, but AIRS is biased 250+-16 mK warm.

In the following we show all data smoothed by a 64 point running mean.

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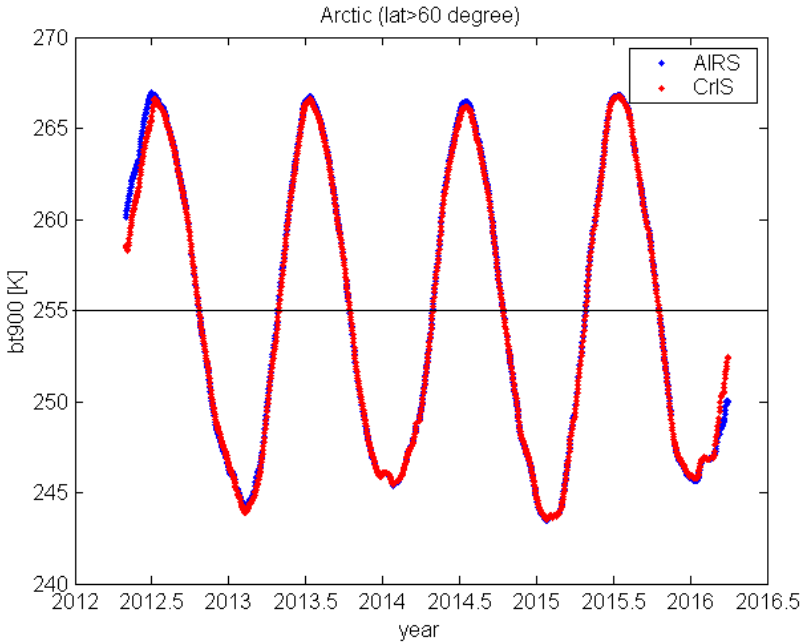
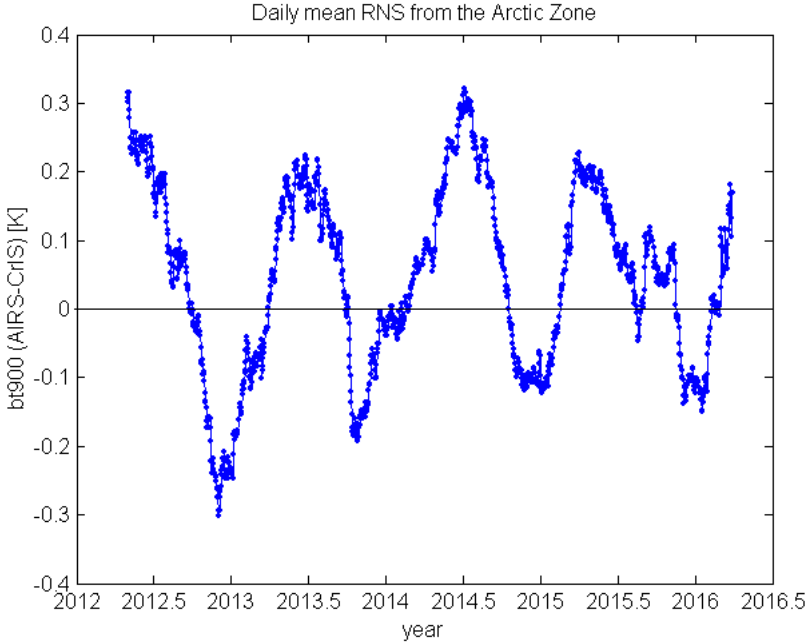
AIRS-CrIS shows considerable scene temperature dependent bias in the Arctic zone (6% of the area of the globe).





At 245K CrIS is bias about 100mK warm, at 265K CrIS is bias 200 mK cold compared to AIRS. The daily mean difference between AIRS and CrIS at 1232 cm-1 looks very similar to the difference at 900 cm-1.

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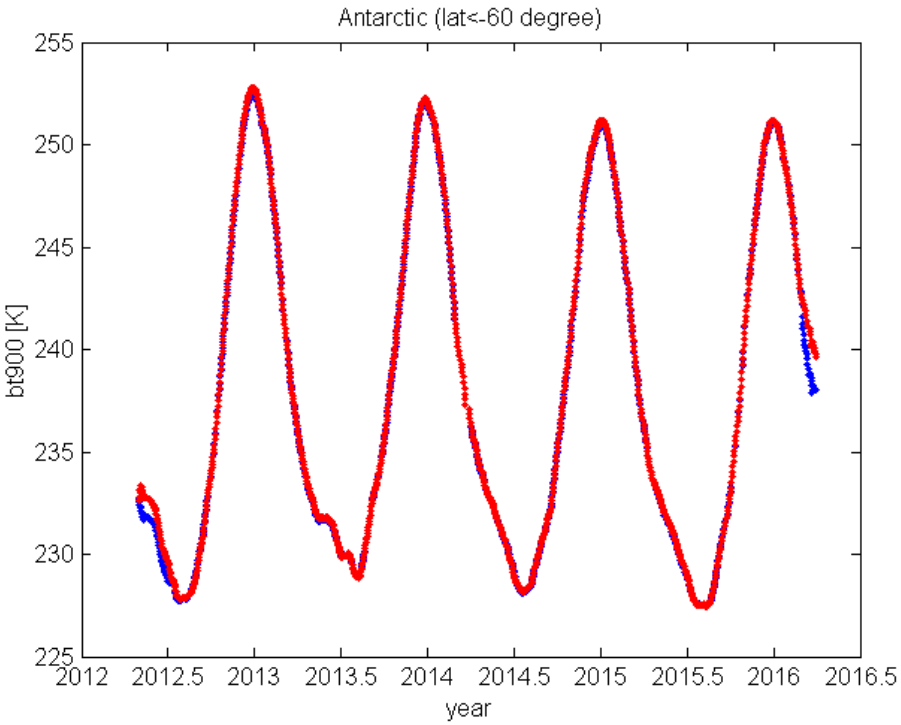
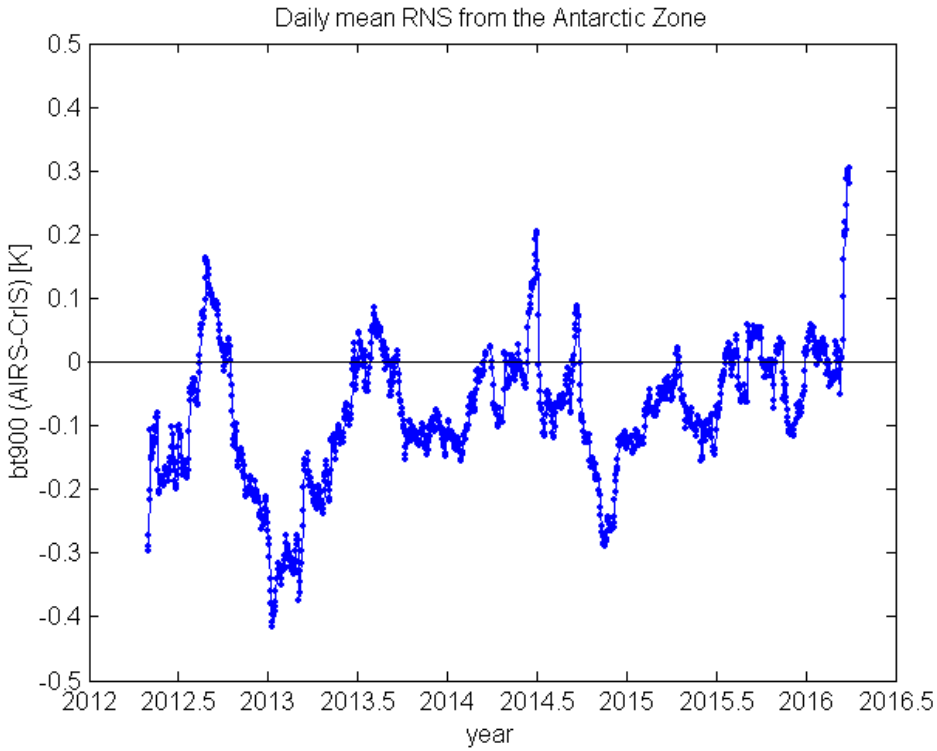
The scene temperature sensitivity of AIRS-CrIS is less obvious for the colder Antarctic data





At 230 K CrIS is bias about 100mK warm (consistent with the result for the Arctic)

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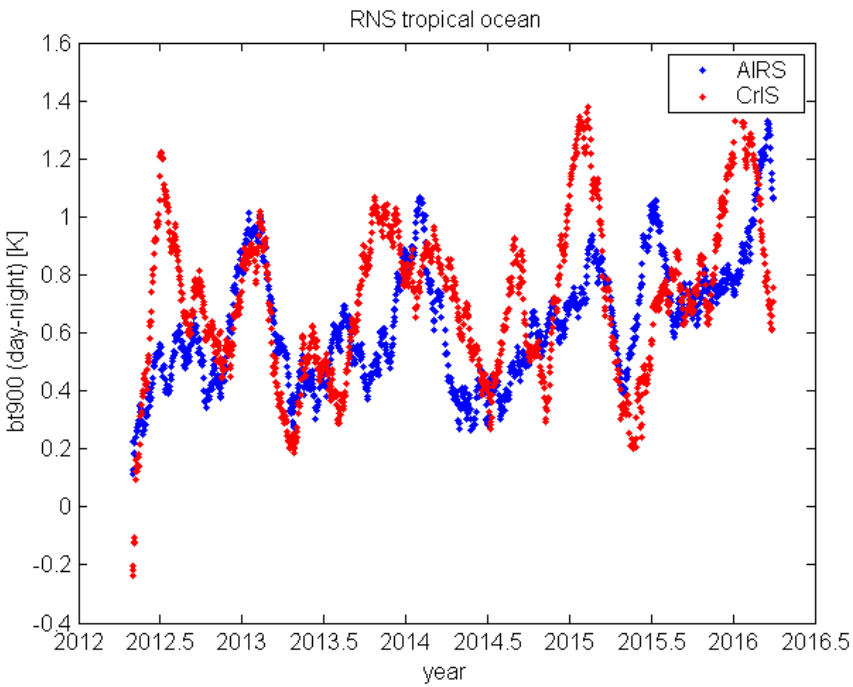
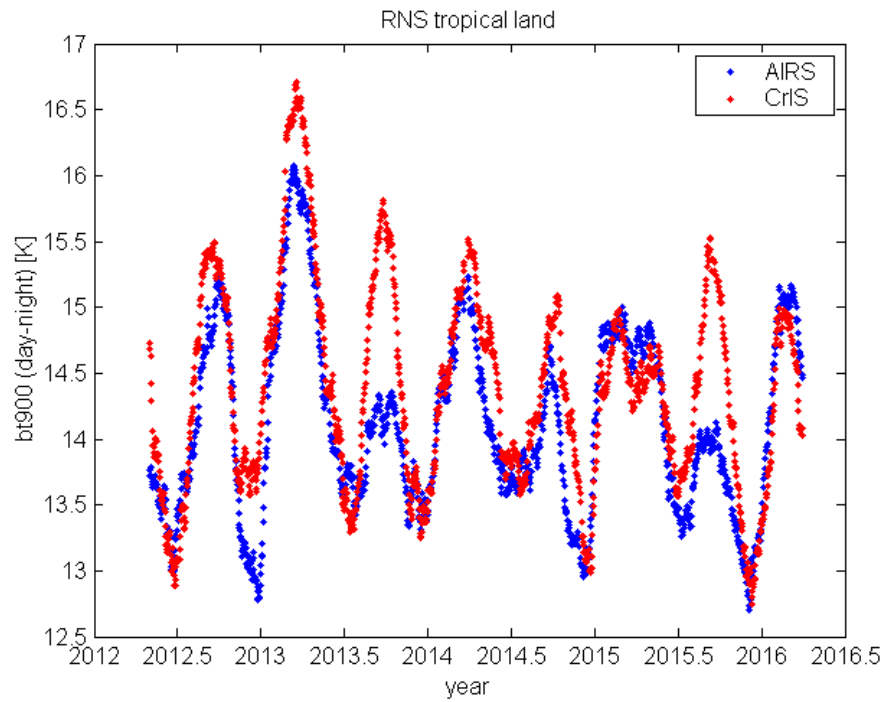
Other examples: Day-night difference



AIRS day-night = 0.62K+/-0.041K
CrIS 0.68+/-0.042K
The difference of -0.11+/-0.06K is not 2 sigma significant



AIRS +14.15K
CrIS + 14.47K
The CrIS land day/night difference is 0.3+/-0.12K larger than for AIRS

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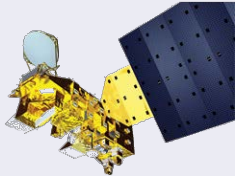
Summary



RNS are useful for the comparison of the radiometric performance of polar orbiting radiometers.

A significant scene temperature sensitivity of the bias is seen in the analysis of Artic and Antarctic data, qualitatively confirming previous reports based on the comparison of southern and northern hemisphere Simultaneous Nadir Overpasses for AIRS/IASI (Tobin et al. 2016) and for AIRS/CrIS (Wang et al. 2015)

Differences between AIRS and CrIS are also seen in the day-night differences for tropical land.

The Arctic and Antarctic data cover a temperature range seen in clouds in the tropical and extratropical area.

Scene temperature dependent bias complicates the comparison of clouds and cloud properties from AIRS and CrIS.

For climate change analysis 100 mK differences and their temperature sensitivity are a problem for the continuity of the data record.

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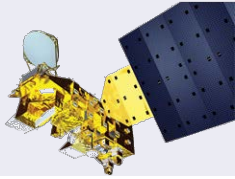

Questions/Comments?

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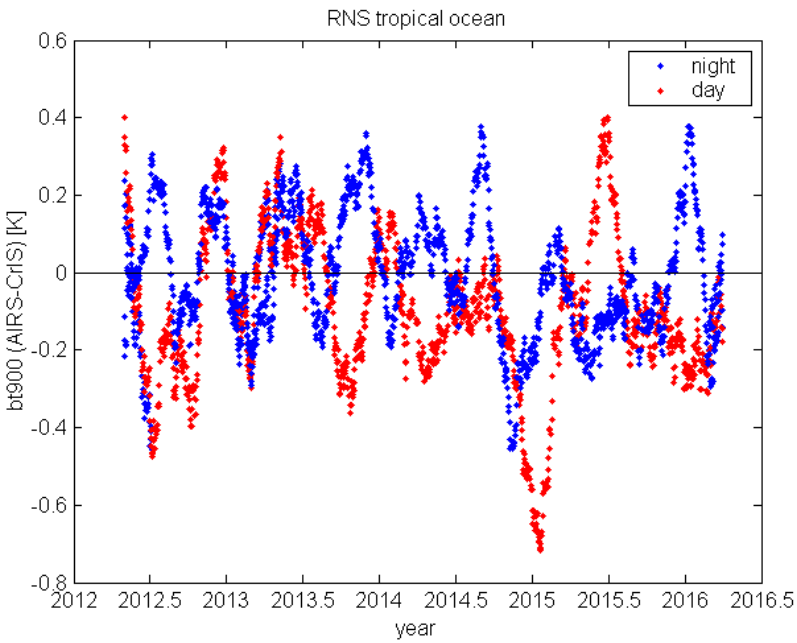
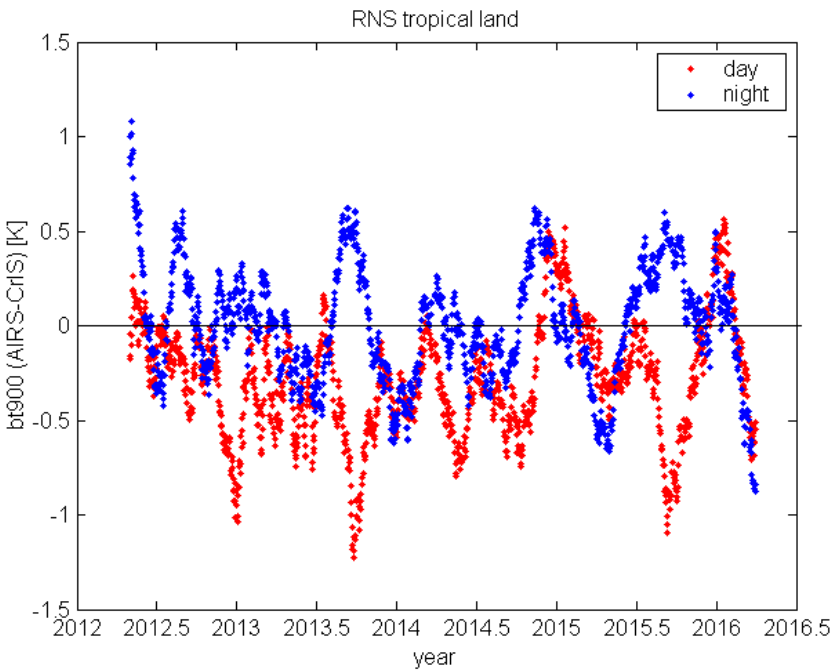
Other examples: tropical ocean and land





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