ISCCP calibration: Operational and Research results

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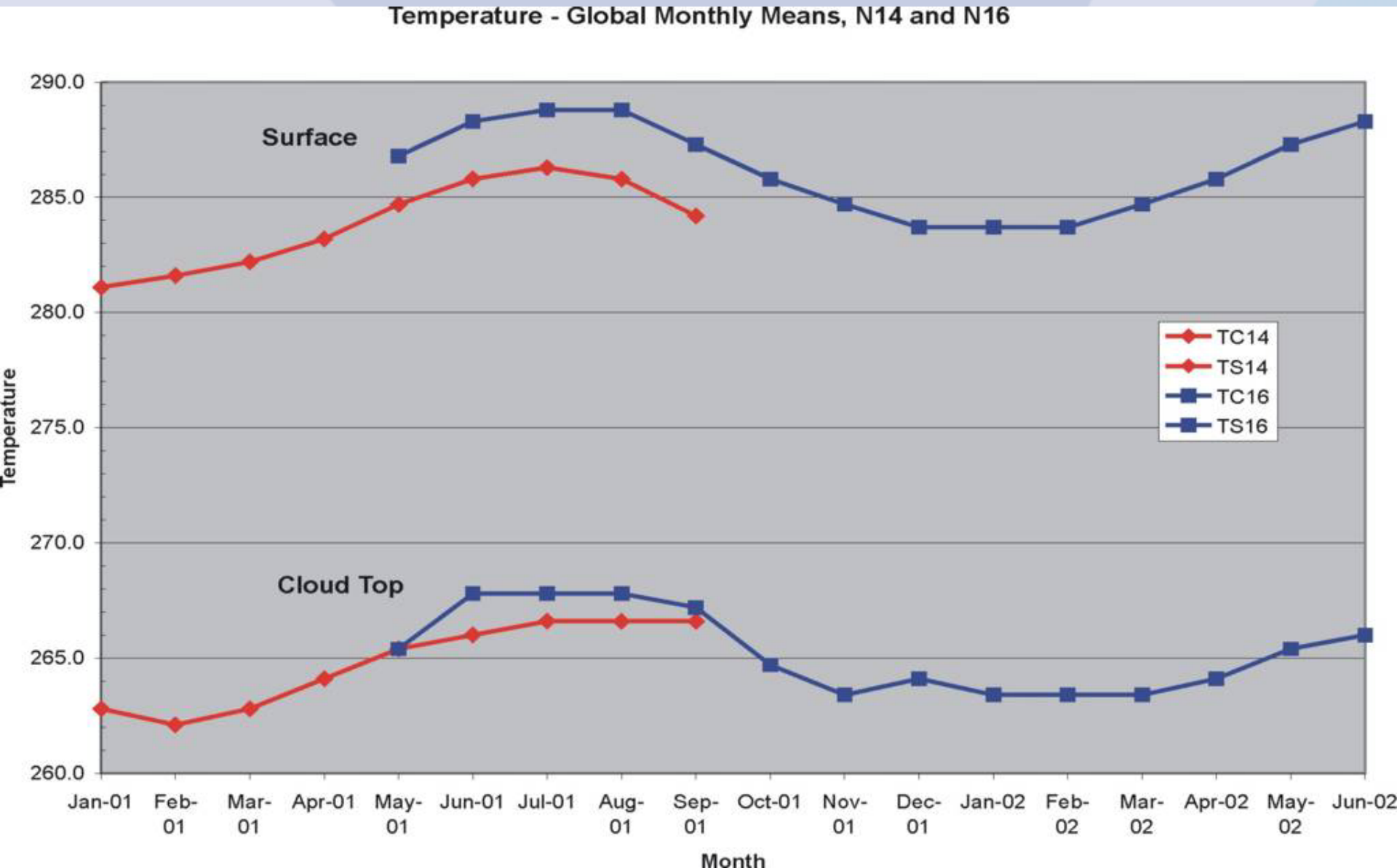
Outline

- ISCCP operational calibration method
- NCDC ISCCP Calibration Analysis
  - Purpose
  - Calibration check
  - Errors found
  - Correction

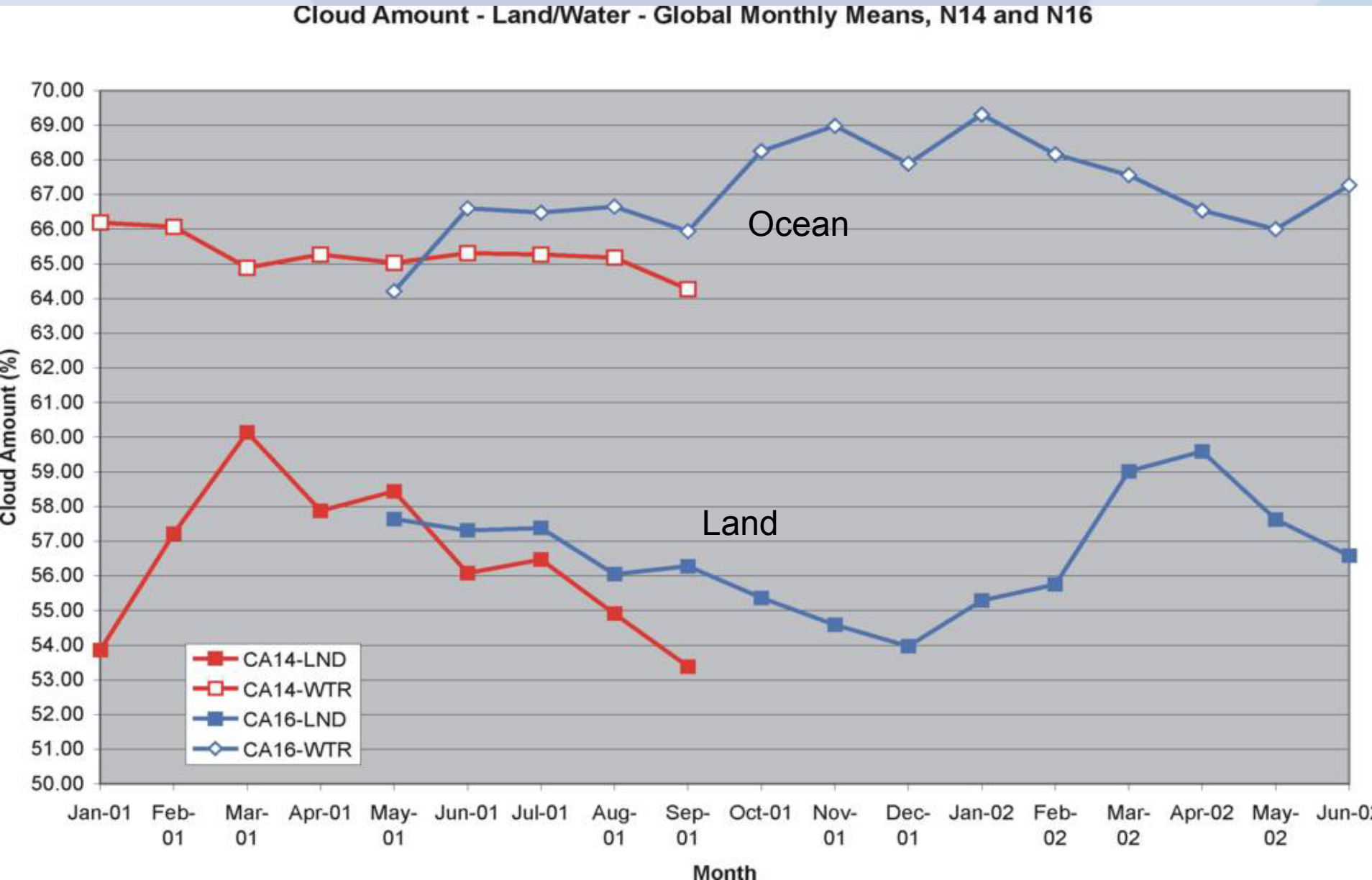
ISCCP calibration overview

- Collect visible and IR data from radiometers onboard NOAA Polar Orbiter, GOES, METEOSAT, GMS, etc
- Normalize all geostationary satellites to the afternoon polar orbiter
- Monitor/correct polar orbiter for drift over time
- Normalize succeeding instruments to the original standard
- Tie the relative standard to an absolute standard using aircraft campaigns

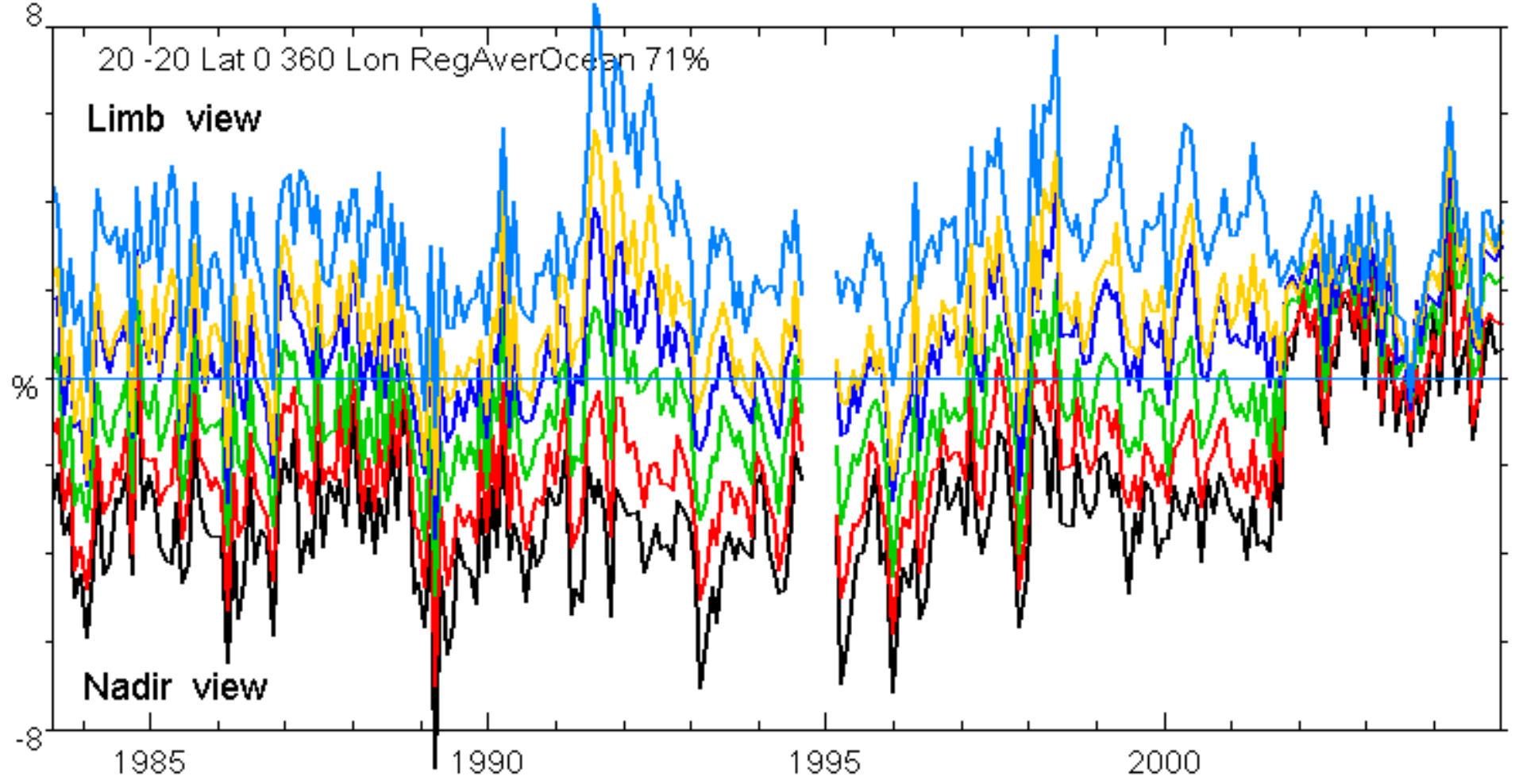
NOA14 to NOA16 Temperatures



NOA14 to NOA16 Cloud Amounts



Limb to Nadir Cloud Amount Anomalies for Afternoon Polar Orbiters over Oceans

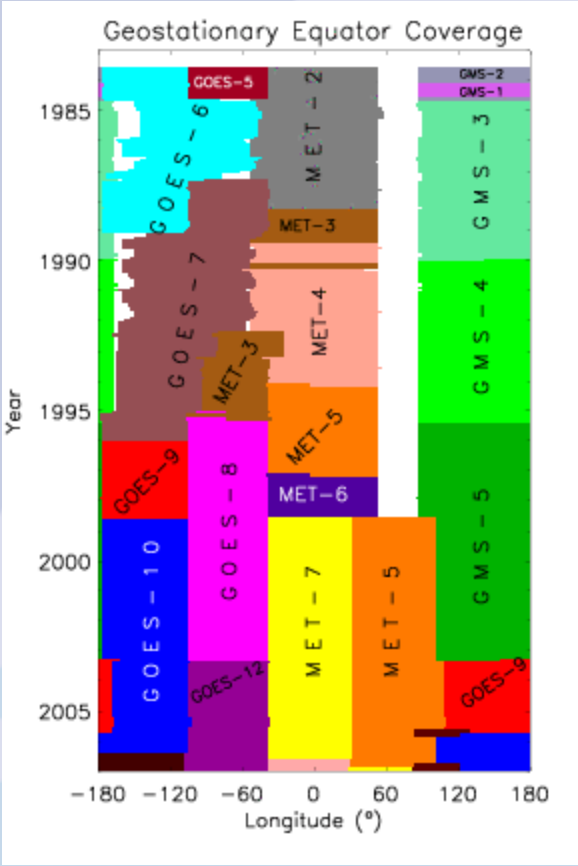


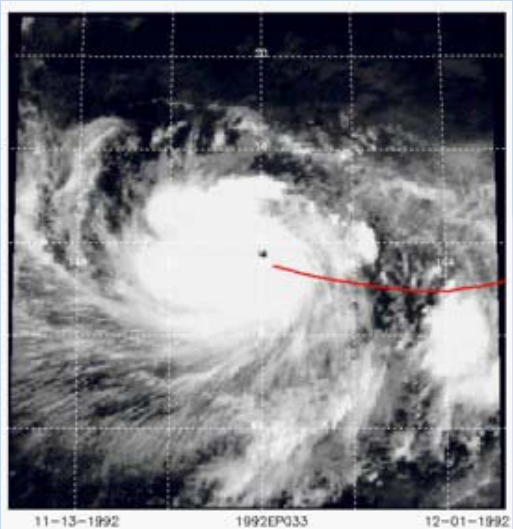
Future considerations

- **Mean properties of Earth are more nearly constant over decadal time scale than the calibration of the radiometers**
- **Relative calibration uncertainties of radiances used in ISCCP**
  - **Vis: +/- .01-.02 absolute, +/- 3-5% relative**
  - **IR: +/- 2K absolute, +/- .3-1.0% relative**
- **Estimate the absolute calibration uncertainty to be about 10% for VIS and 2% for IR**
- **Lessons learned:**
  - **Real decadal scale changes of Earth much smaller than uncertainties in calibration and cannot be reliably detected without significant improvement of instrument calibration**
  - **Given infrequent aircraft campaigns it is difficult to distinguish real inter-annual variability from short-tem calibration changes**
  - **need onboard calibration for all channels**
    - **Still may not be sufficient (IR differences of 1K)**
    - **Vicarious target calibration procedures still needed as backup/confirmation**
  - **Need to plan transition from one instrument to the next**

NCDC ISCCP Calibration analysis

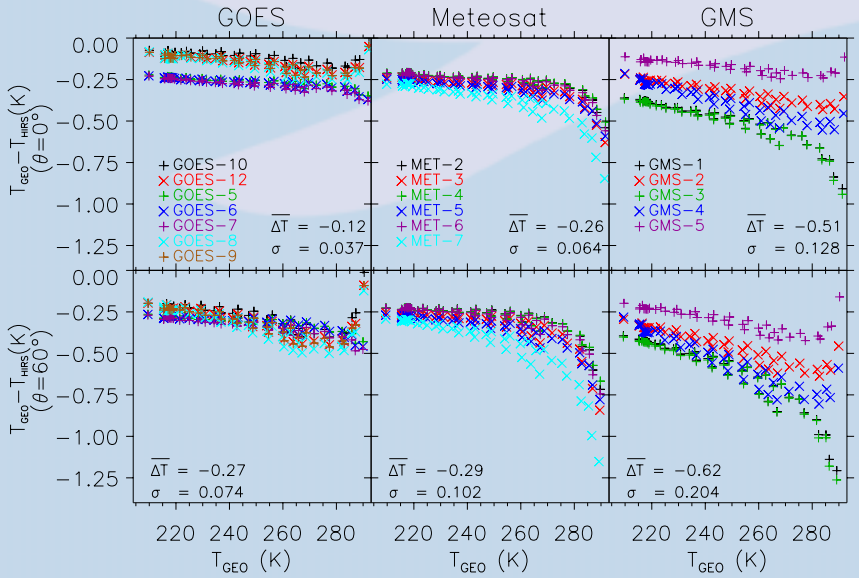
- Independent check of ISCCP results
- Climate applications
  - Hurricanes
  - Clouds
  - Precipitation





NCDC approach

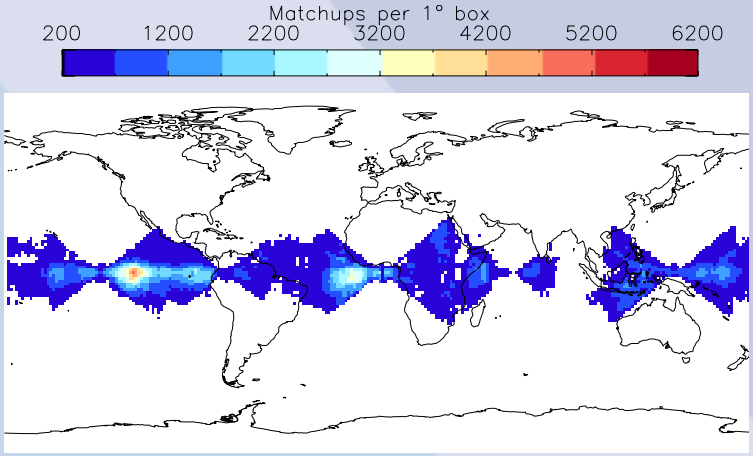
- Goal – independent review of geostationary calibration
- Reference – HIRS Pathfinder Data
- Theoretical HIRS/GEO differences



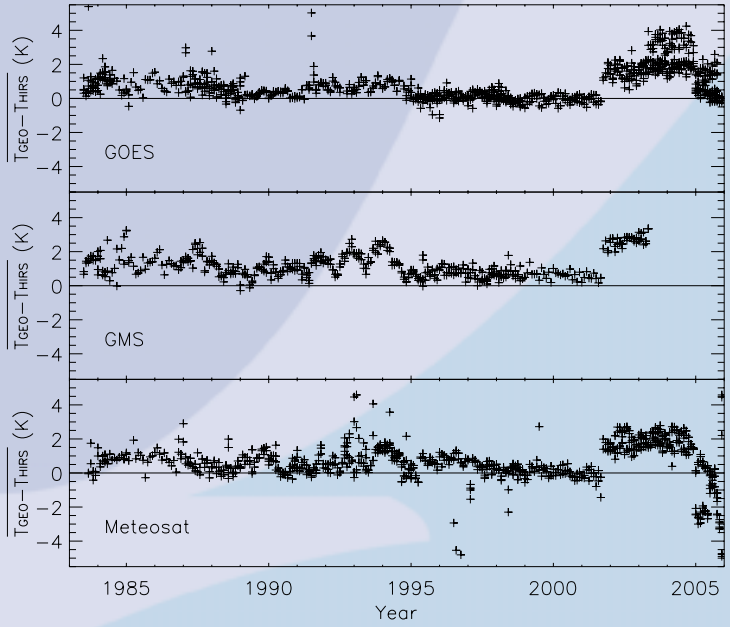
GEO/HIRS colocation

- Footprint matching
  - Average observations of GEO within HIRS footprint
- Calibration
  - ISCCP – used the absolute calibration temperatures
  - HIRS – Pathfinder data (D. Jackson, L. Shi)
- Initial matchup filter (Followed Wu et al. [from Tian et al. 2004])
  - ΔTime < 15 min
  - $\sigma(T_{GEO}) < 1$ K
  - $\Delta[(\cos\theta)^{-1}] < 0.05$
  - $\Delta\varphi < 30°$

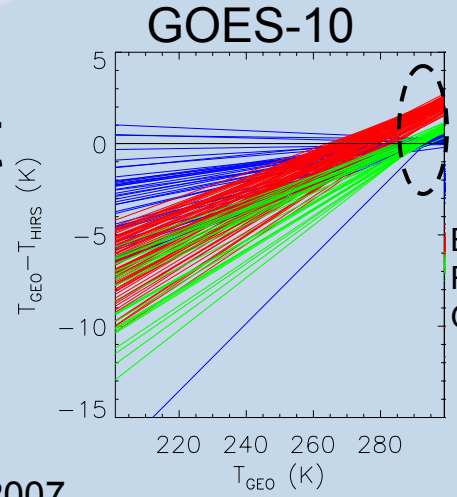
Initial matchup filter - results



All matchups – 1983-2005

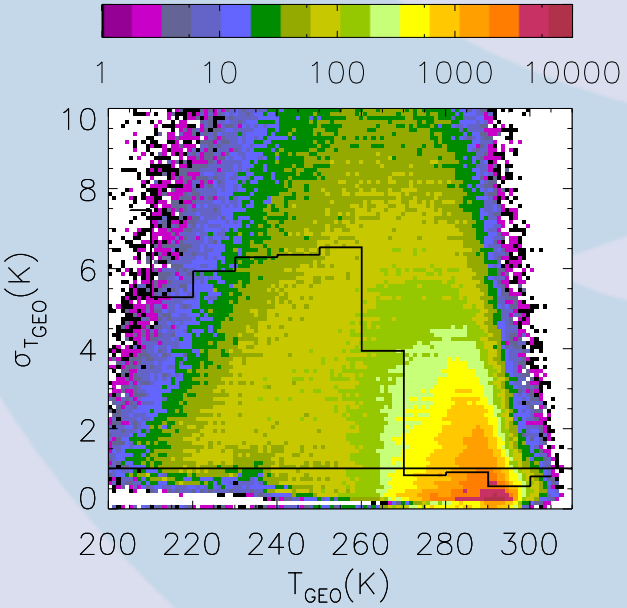


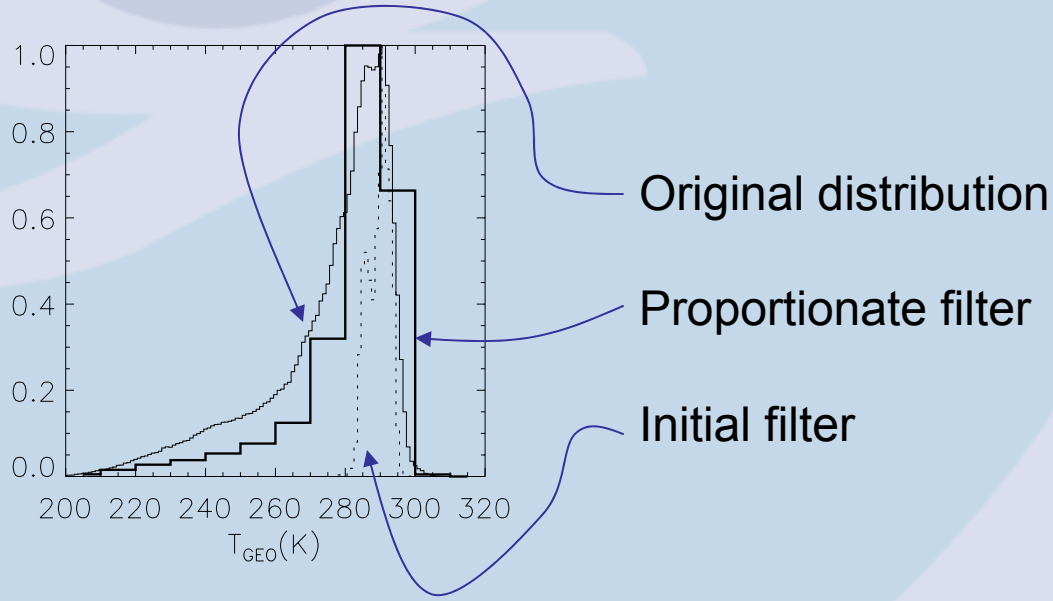
- Effect of calibration shift at coldest temperatures not discernable



Problem with the initial filter

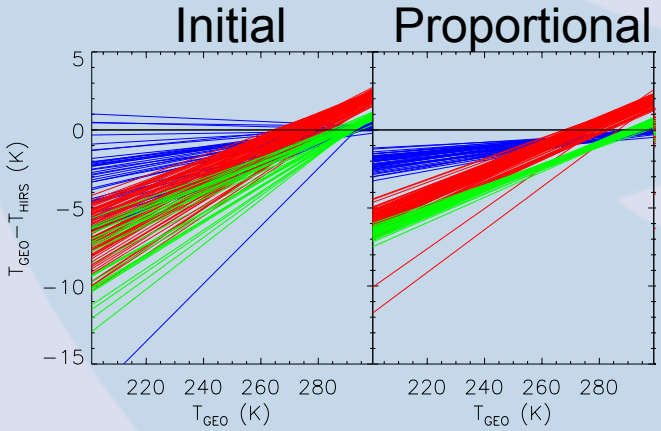
- Limited targets
- Limited dynamic range
- Limited applicable temperatures
- Replace with proportionate noise filter





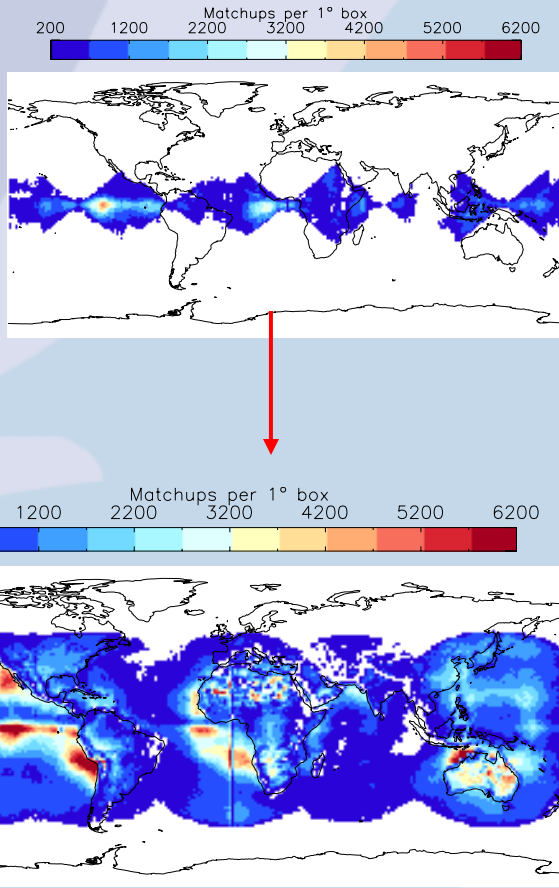
New proportionate filter

- Proportionate filter
  - ΔTime < ~~15 min~~ → 30 min
  - $\sigma(T_{GEO})$ < ~~1 K~~ → 10^{th} $\%^{ile}$ per 10K bin in T_{GEO}
  - $\Delta[(\cos\theta)^{-1}] < 0.05$
  - $\Delta\varphi$ < ~~30°~~ → none



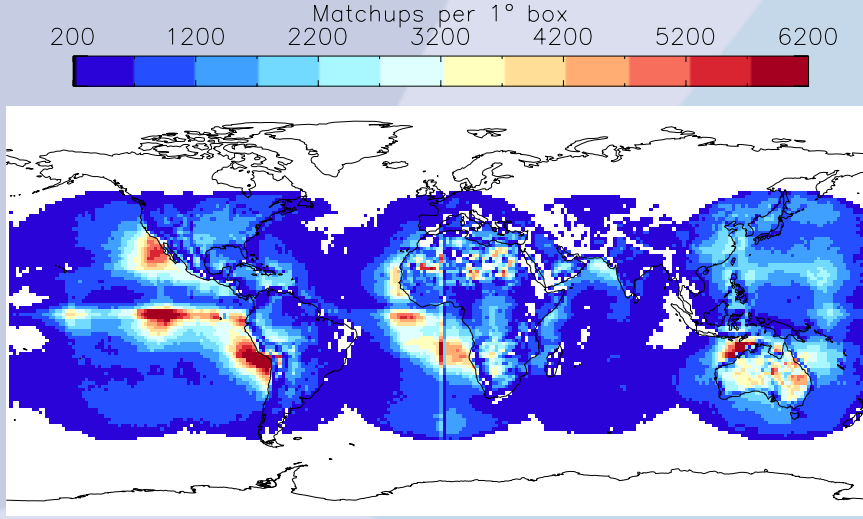
Effect at colder temperatures evident!

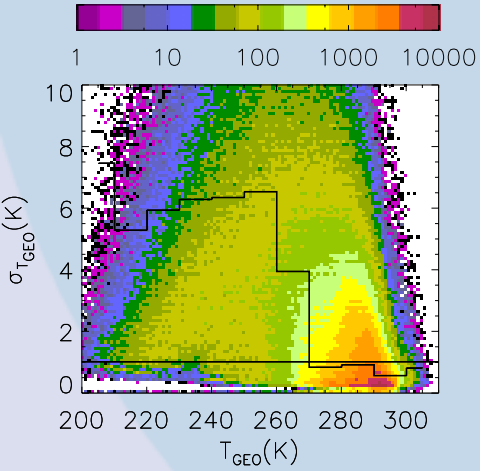
All matchups – 1983-2005

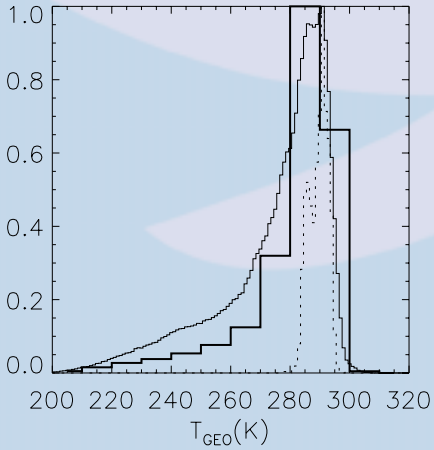


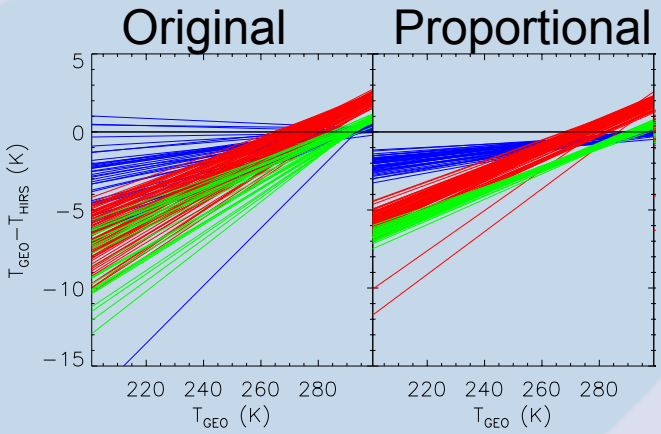
Proportionate filter

- Problem
  - Simple spatial noise filter limits locations
- Solution
  - Filter out noise proportionally



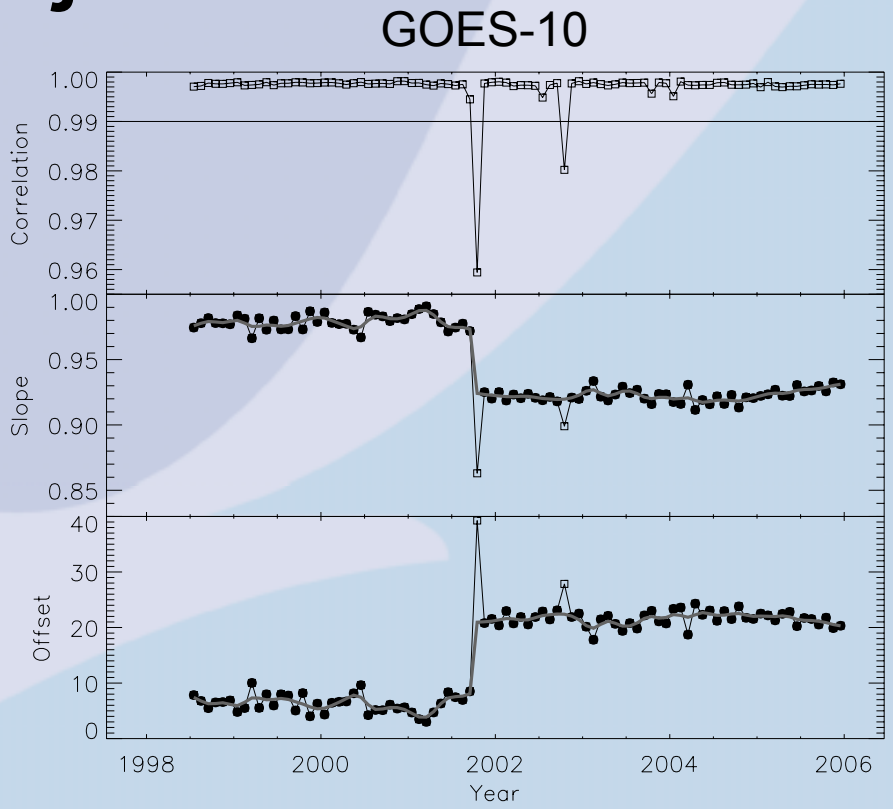




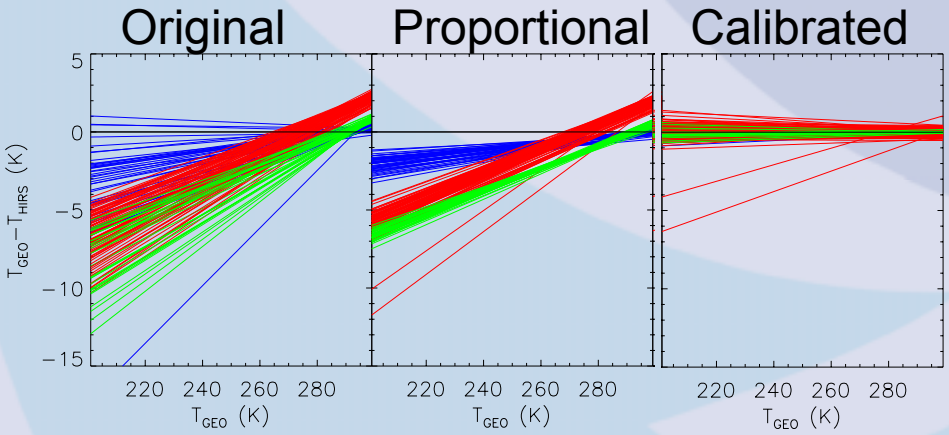


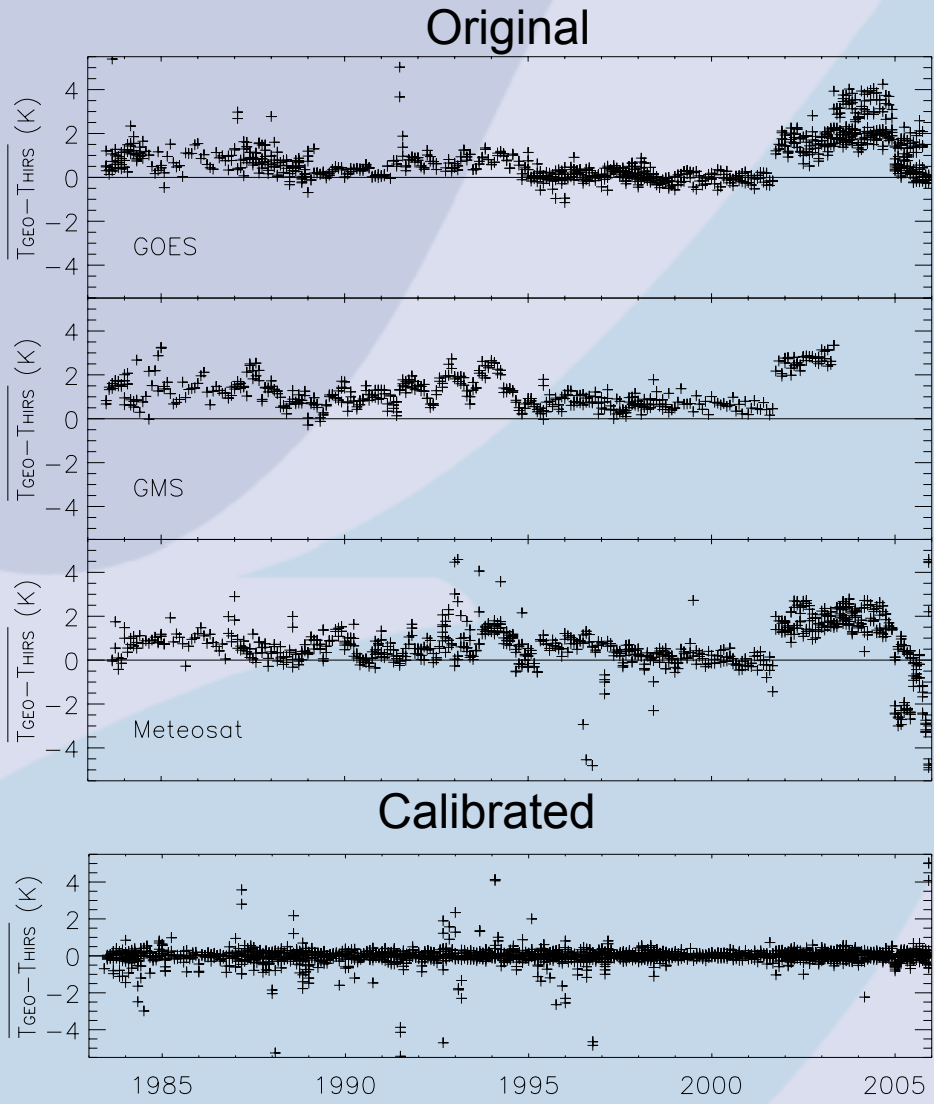
Calibration adjustments

- Monthly comparisons
- Remove low correlation points
- Replace missing with smoothed data
- Calibration shift evident
- Shift caused by error in new instrument
  - AVHRR nonlinear calibration truncation
  - Not accounted for by ISCCP



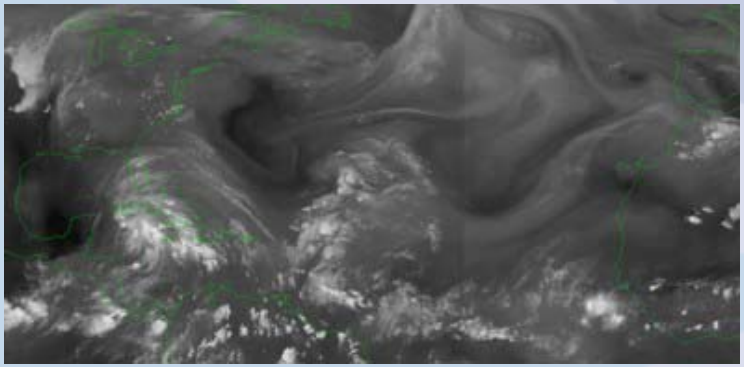
Calibration results



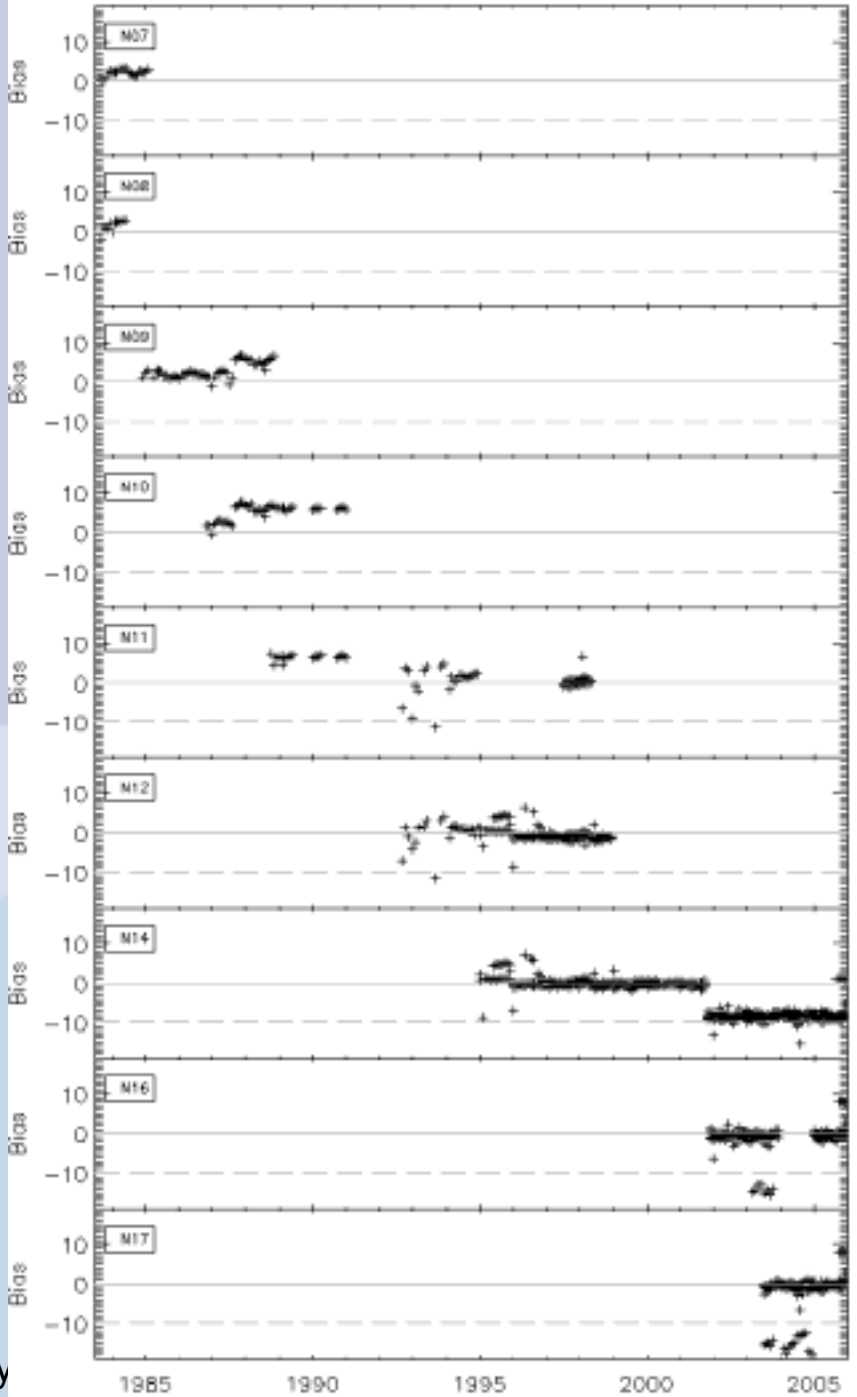


ISCCP IR Water Vapor channel

- Also showed calibration problem

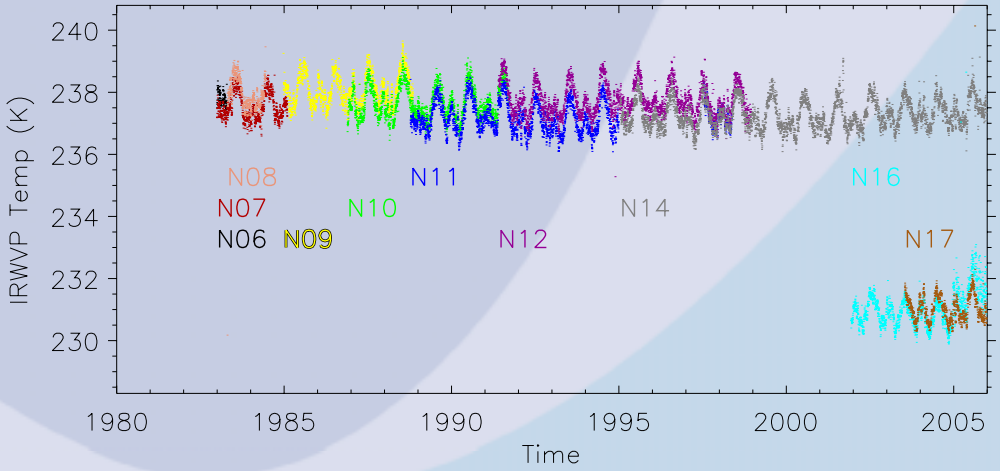


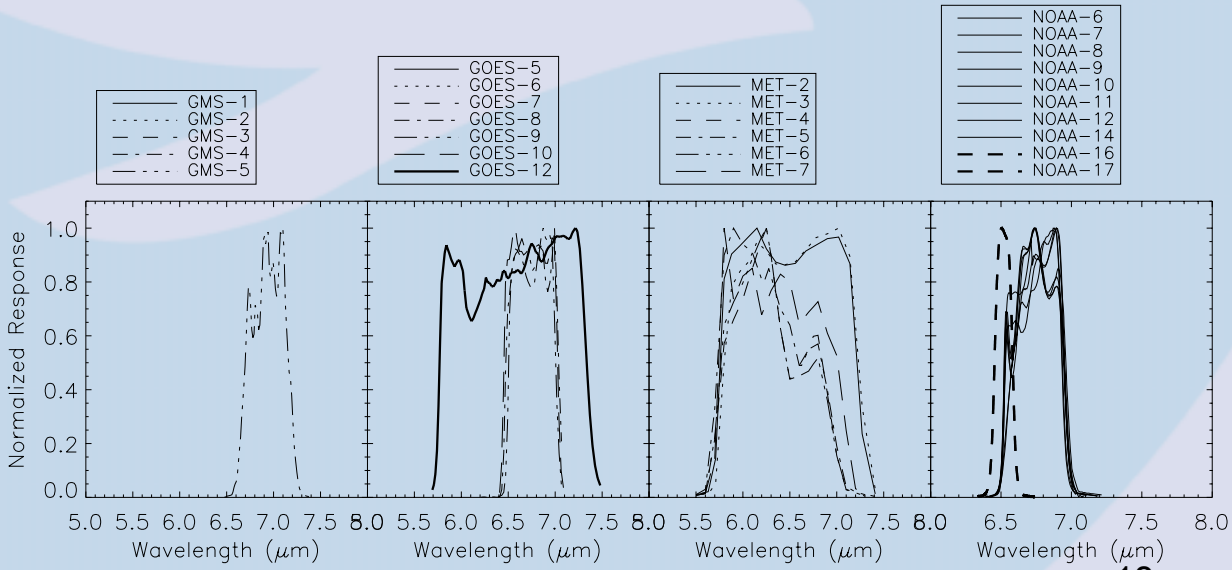
- Same cause?



Water vapor channel problem

- Same cause?
  - No
- New problem
  - Reference instrument changed
  - But, ISCCP continued to use it as a reference





Summary

- Independent checks are necessary
  - Here, we found an error in ISCCP calibration due to mistake in calibration of reference instrument
- One point calibrations not enough
  - Needed comparisons across range of observations
- Change in HIRS water vapor means loss of calibration reference
- Calibrated infrared window channel provides temporally-consistent observations