Intersatellite Calibrated HIRS Upper Tropospheric Water Vapor

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Outline

• Motivation
  – Time series discontinuity from satellite to satellite, particularly from TOVS to ATOVS
  – Upper tropospheric water vapor (UTWV) is an important fundamental climate data record (CDR)
  – UTWV is key to water vapor feedback

• Approach
  – New and improved intersatellite calibration based on two datasets
    • Overlaps of zonal means
    • Simultaneous nadir overpass (SNO)

• Result
  – Extended time series of the fundamental CDR to present
Motivation – Uncorrected Intersatellite Differences of UTWV (Channel 12)

- Due to the independence of individual HIRS instrument’s calibration, biases exist from satellite to satellite.
- These intersatellite biases have become a common source of uncertainty faced by long-term studies.
Differences between HIRS/2 and HIRS/3 are expected due to different filter functions.

In-orbit performance still has biases unexplained by filter functions.

Thus empirical approach is considered.
Approach – Two Datasets for Intersatellite Calibration to Cover Diverse Atmospheres

- Overlaps of zonal means for tropical and mid-latitude atmosphere cases
  - Zonal means of channel 12 (UTWV) are computed for every 10-degree latitude belt.
  - Differences are derived from overlapping satellites.

- Simultaneous nadir overpass (SNO) observations for polar cases
  - SNOs occur when two satellites cross each other
  - Data taken at the same location at the satellite nadir within a few seconds
  - In the regions 70-80N and 70-80S
Temperature-dependent Intersatellite Differences from Zonal Mean Approach

Tropical and Mid-latitude Cases

- More than half of satellites have bias variations larger than 0.5 K.
- Biases are also temperature dependent.
Extension of Time Series

- Orbital, daily, and monthly, 1979-present
- At both pixel resolution and 2.5x2.5 lat/lon grids
- Intersatellite-calibrated

Intersatellite Calibrated to N-12
(showing 30S – 30N)

- Biases minimized.
- Temperature dependent biases accounted for.
- Similar overall variances between HIRS/2 and HIRS/3.
- Time series can be extended as variance preserved.
Seasonal Variation

- Within tropics, drier atmosphere produces a higher value of UTWV (channel 12 “sees” lower atmosphere).
- Minima in the tropics indicate moist upper troposphere caused by convection.
- Maxima in northern tropics in January move to southern tropics in July, indicating the move of dry regions in upper troposphere from north to south.
- Zones of low values indicate positions of ITCZ.
UTWV Time Series (showing 30S – 30N)

UTWV anomaly
Long-term UTWV Anomaly Dataset

7.5S-7.5N
UTWV Has Good Coverage for Tropical Convections

Conclusions

• Improved intersatellite calibration.
  – Temperature dependent inter-calibration
• Extension of time series to current.
  – HIRS/2 and HIRS/3 series connected
• The HIRS UTWV anomaly data are useful in monitoring Madden-Julian oscillation and various equatorial waves.