Intersatellite Calibrated HIRS Upper Tropospheric Water Vapor

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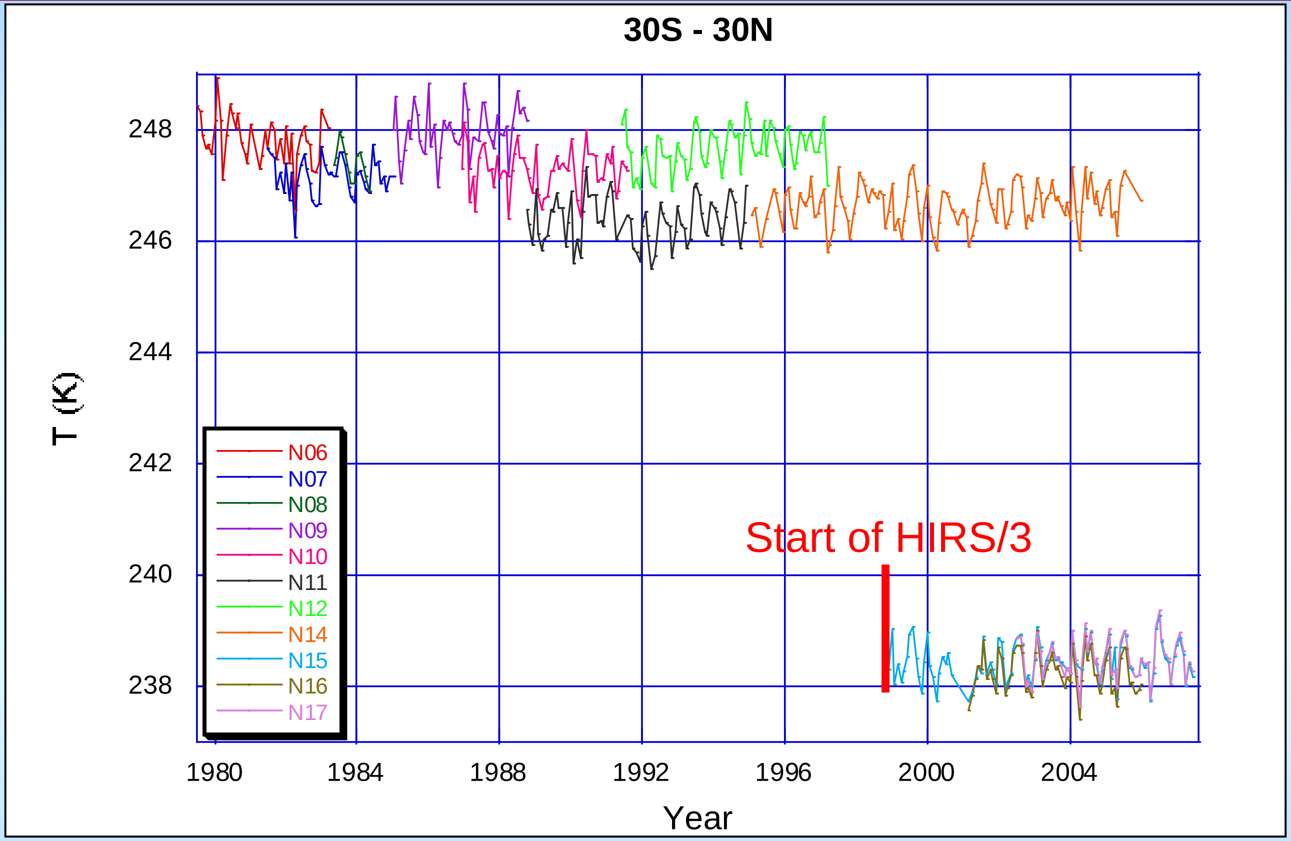
Outline

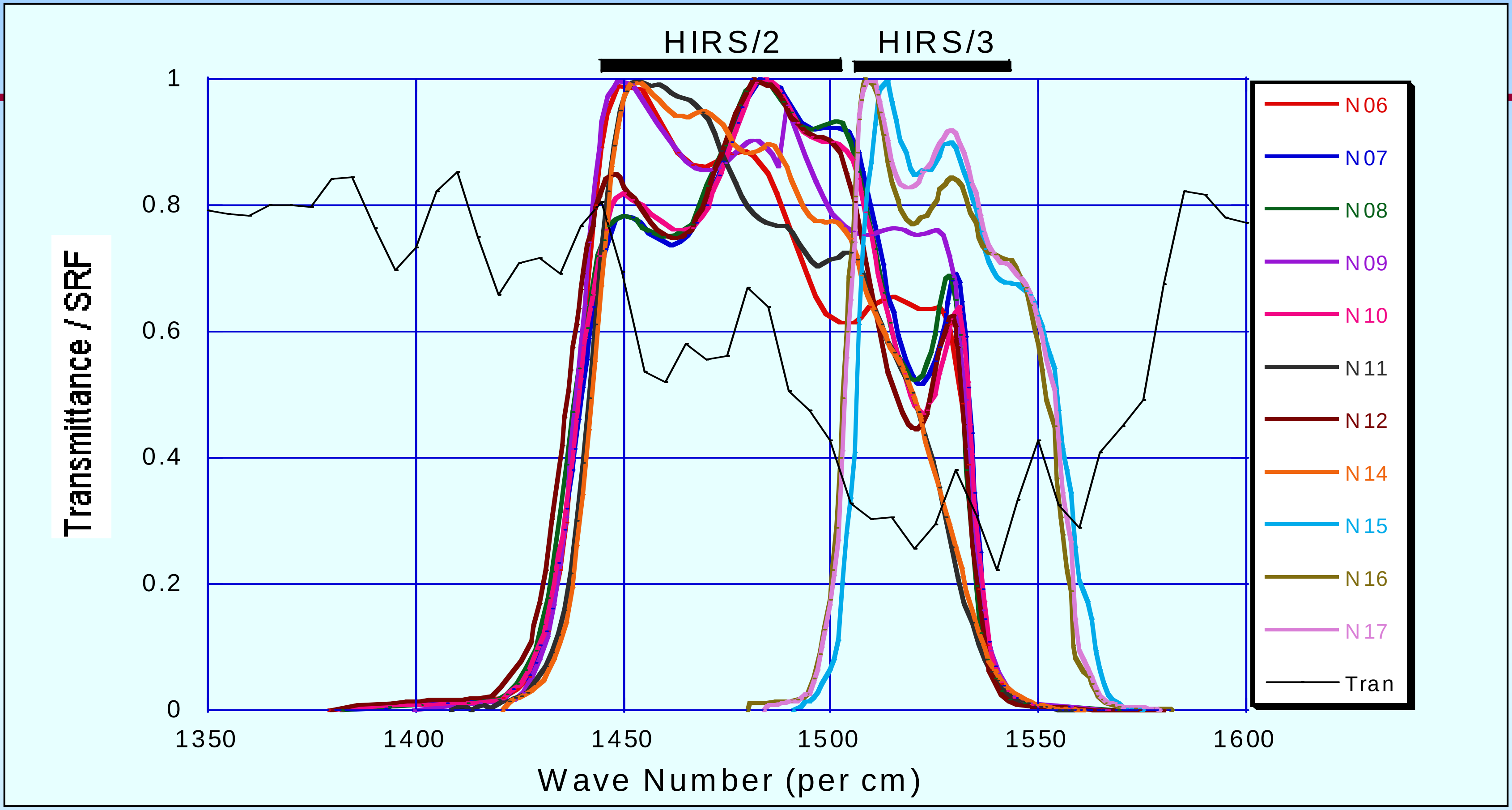
- Motivation
  - Time series discontinuity from satellite to satellite, particularly from TOVS to ATOVS
  - Upper tropospheric water vapor (UTWV) is an important fundamental climate data record (CDR)
  - UTWV is key to water vapor feedback
- Approach
  - New and improved intersatellite calibration based 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.

Spectral Filter Functions



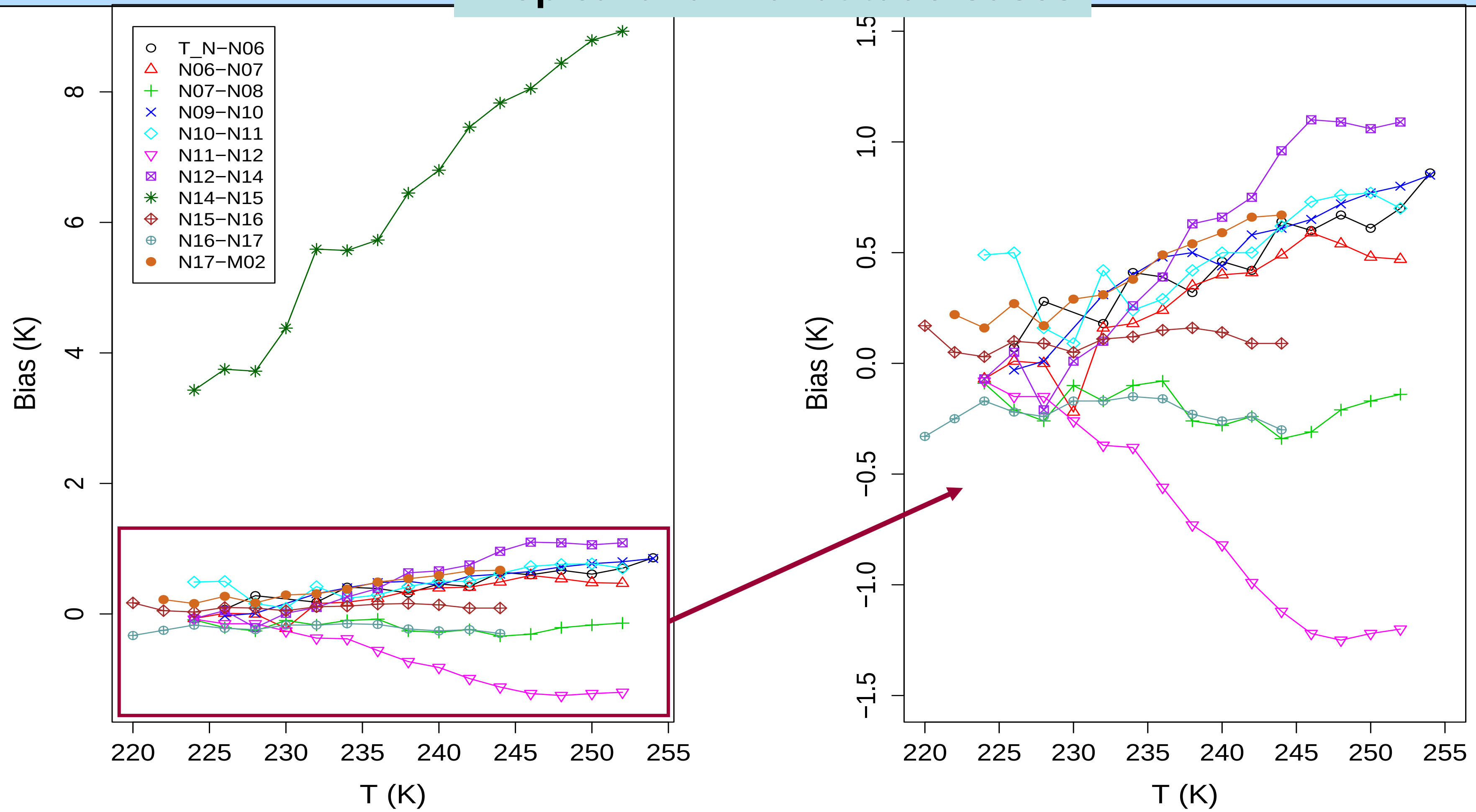
- Differences between HIRS/2 and HIRS/3 are expected due to different filter functions.
- In-orbit performance still has biases unexplained by filter functions.
- Thus empirical approach is considered.

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

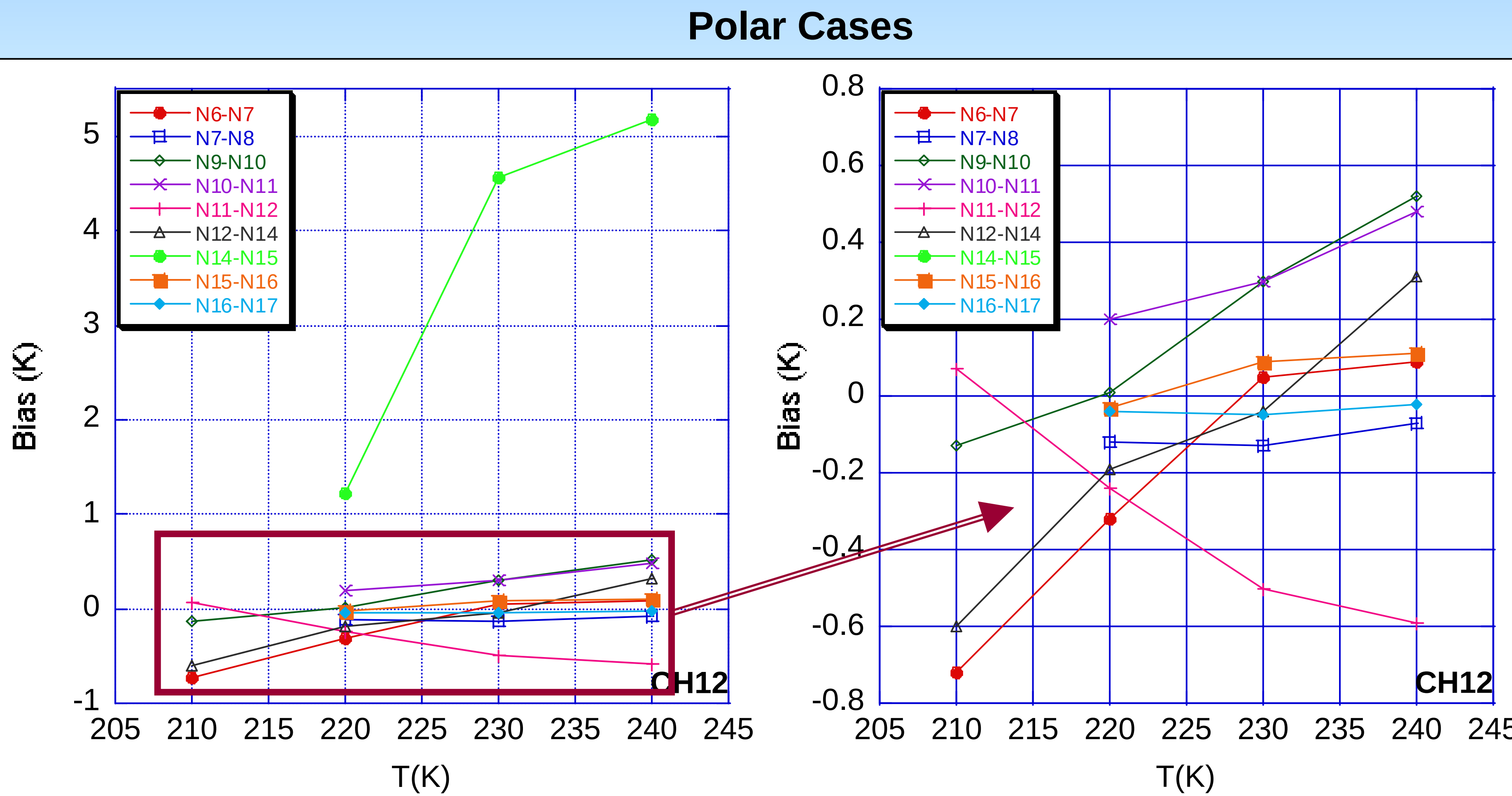
Temperature-dependent Intersatellite Differences from Zonal Mean Approach

Tropical and Mid-latitude Cases



- More than half of satellites have bias variations larger than 0.5 K.

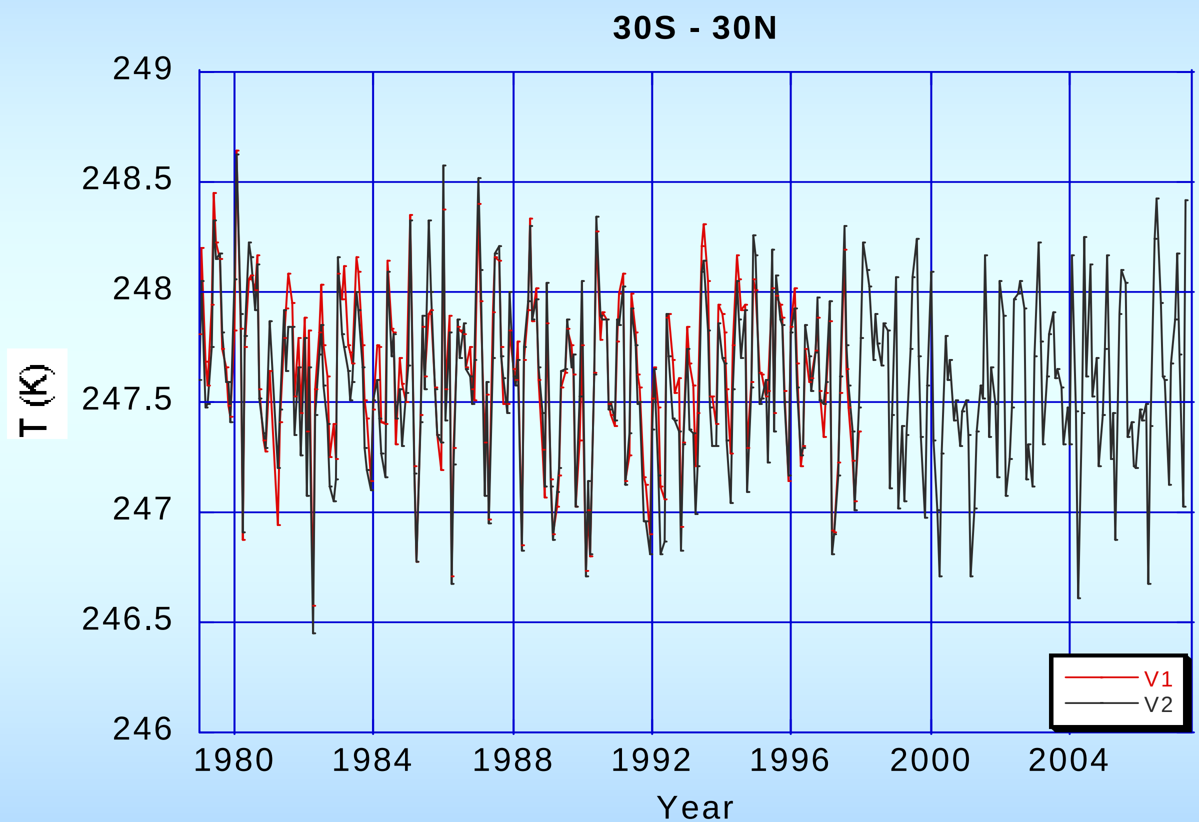
Temperature-dependent Intersatellite Differences from SNO Approach



- Biases are also temperature dependent.

Extension of Time Series

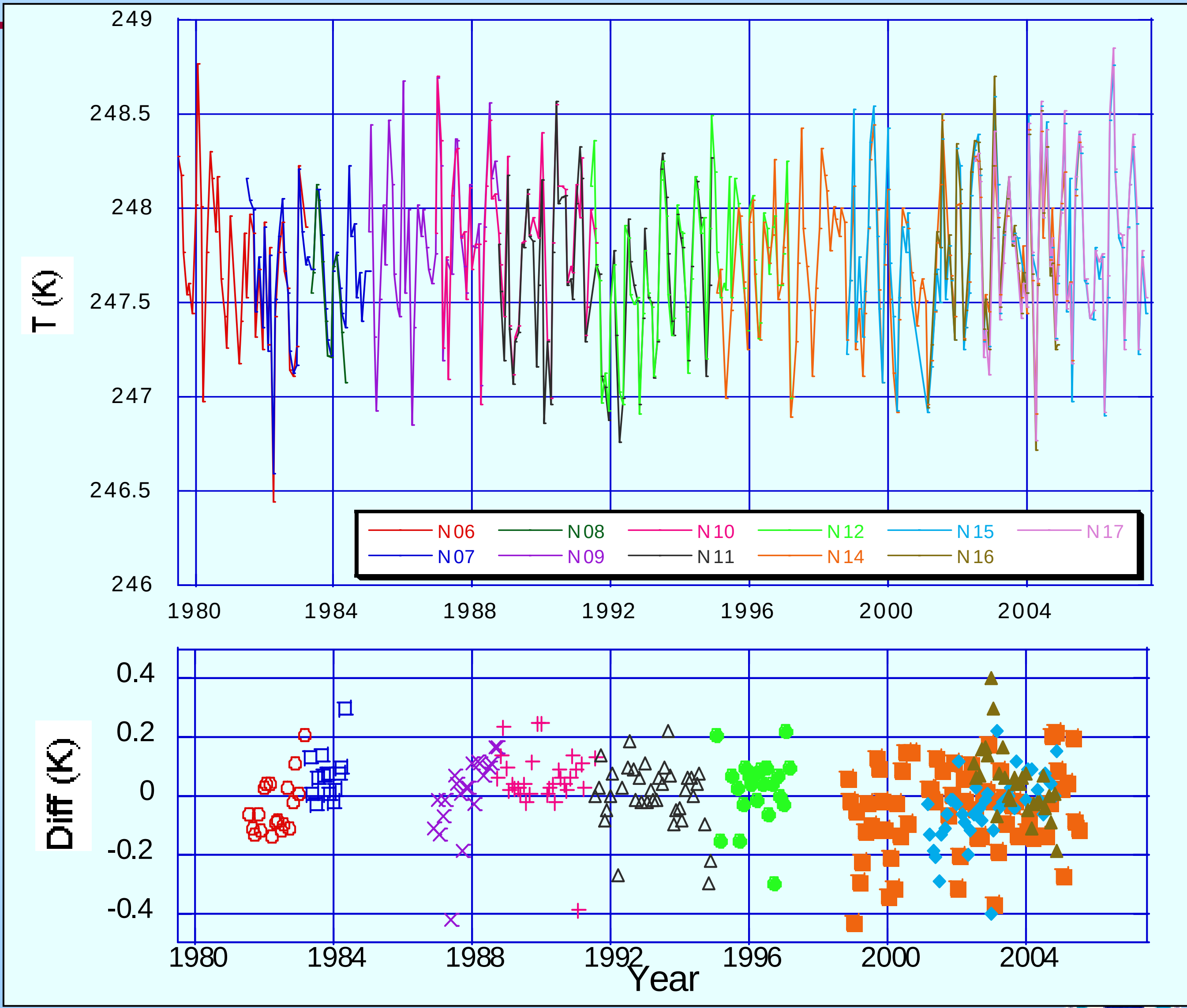
- Orbital, daily, and monthly, 1979-present
- At both pixel resolution and 2.5x2.5 lat/lon grids
- Intersatellite-calibrated



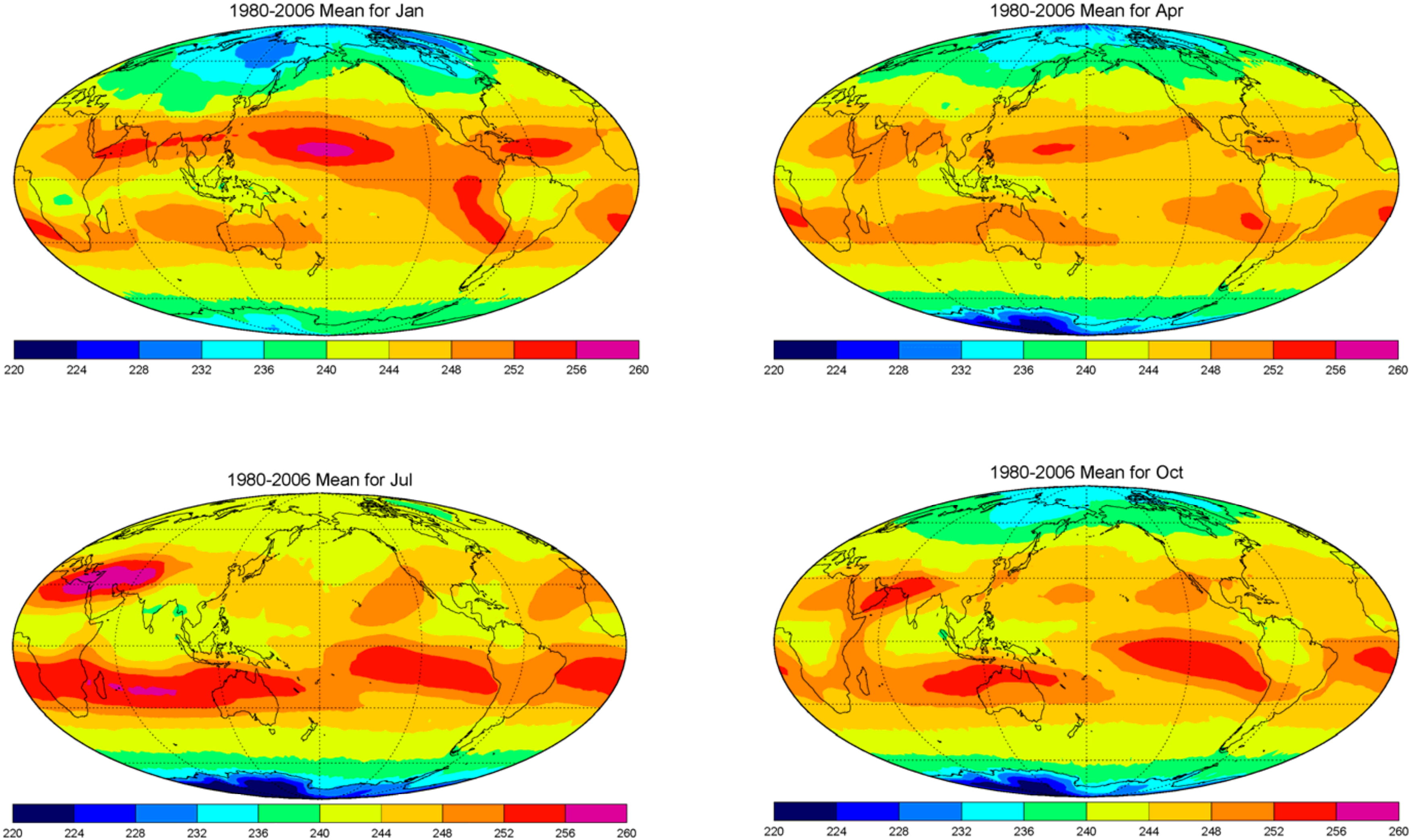
* V1 is derived based on methods discussed in Bates, J. J., X. Wu, and D. L. Jackson, (1996) Interannual variability of upper-troposphere water vapor band brightness temperatures. J. Climate, **9**, 428-438.

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.



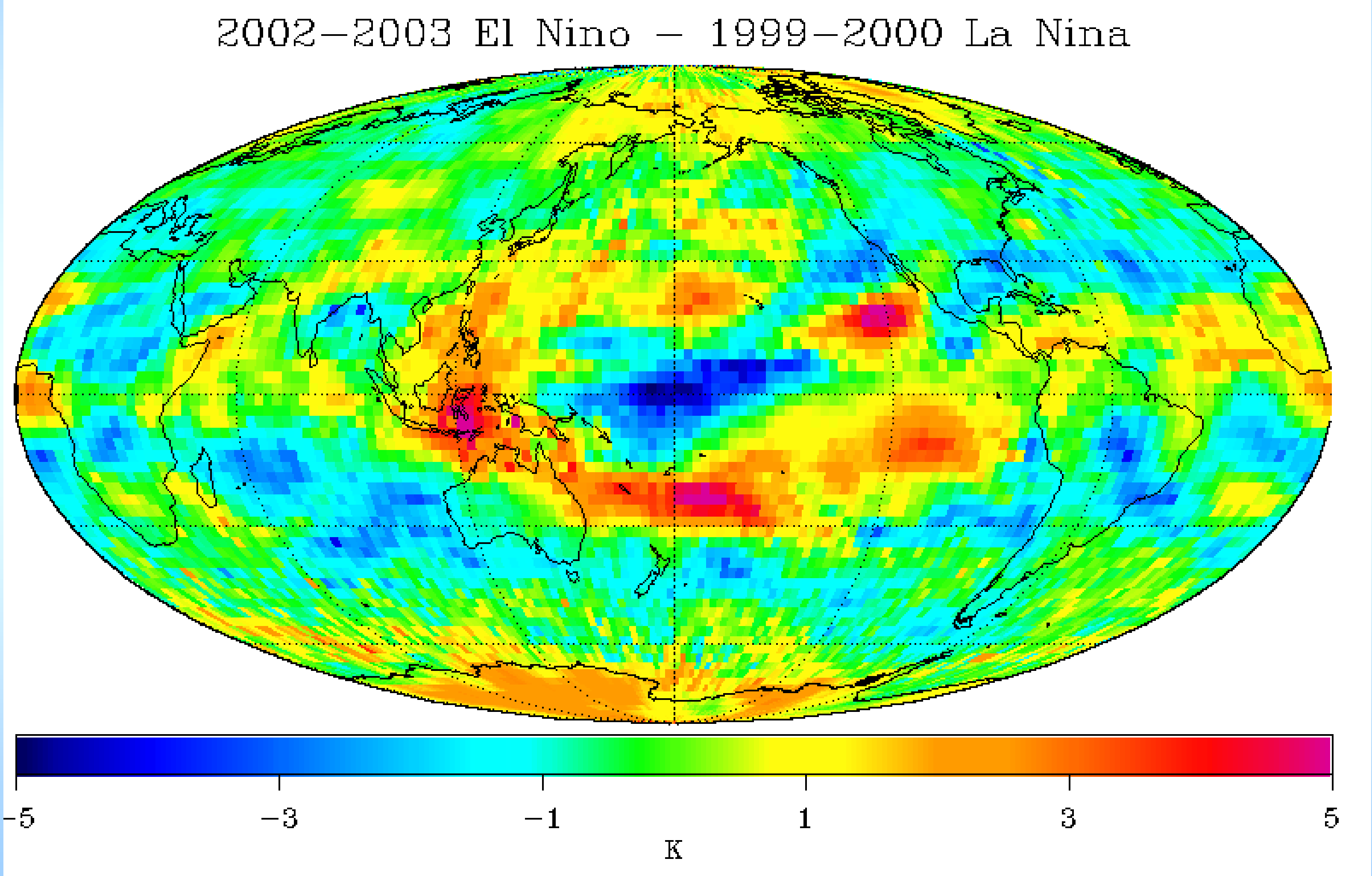
Climatologic Mean for Jan, Apr, Jul, and Oct



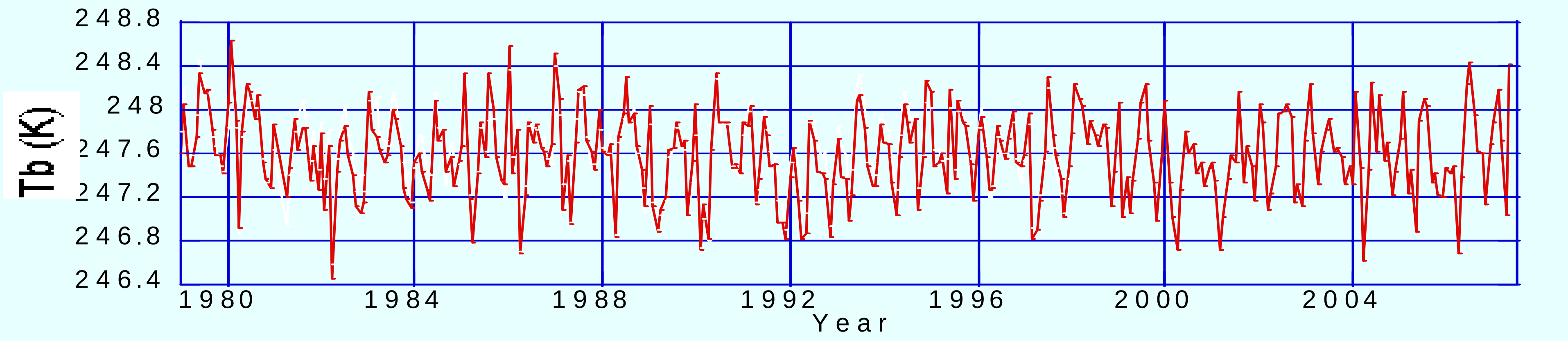
Seasonal Variation

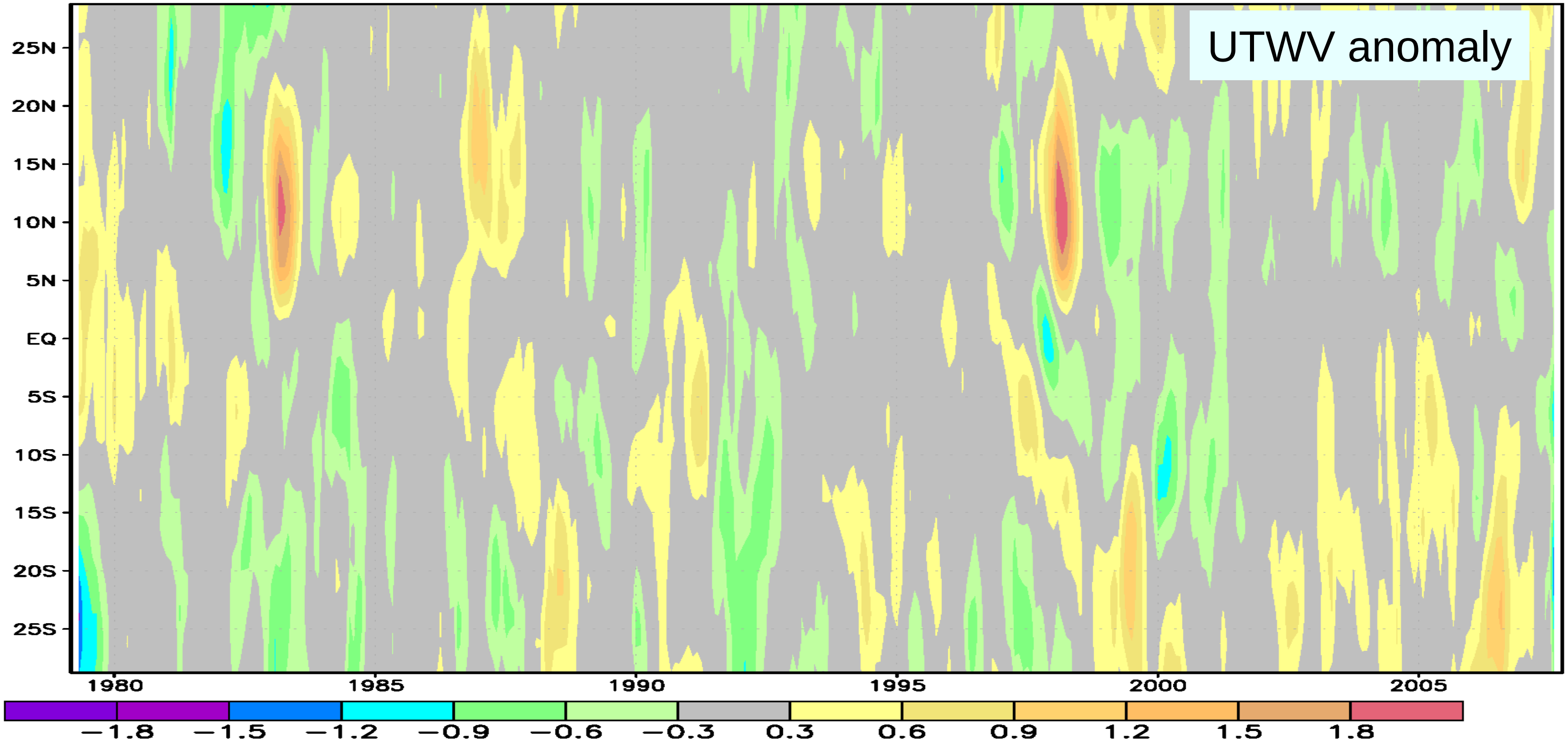
- Within tropics, drier atmosphere produces a higher value of UTWV (channel 12 “sees” lower atmosphere).
- Minima in the tropics indicate moist upper troposphere caused by convection.
- Maxima in northern tropics in January move to southern tropics in July, indicating the move of dry regions in upper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

Difference of UTWV between 2002-2003 El Niño and 1999-2000 La Niña

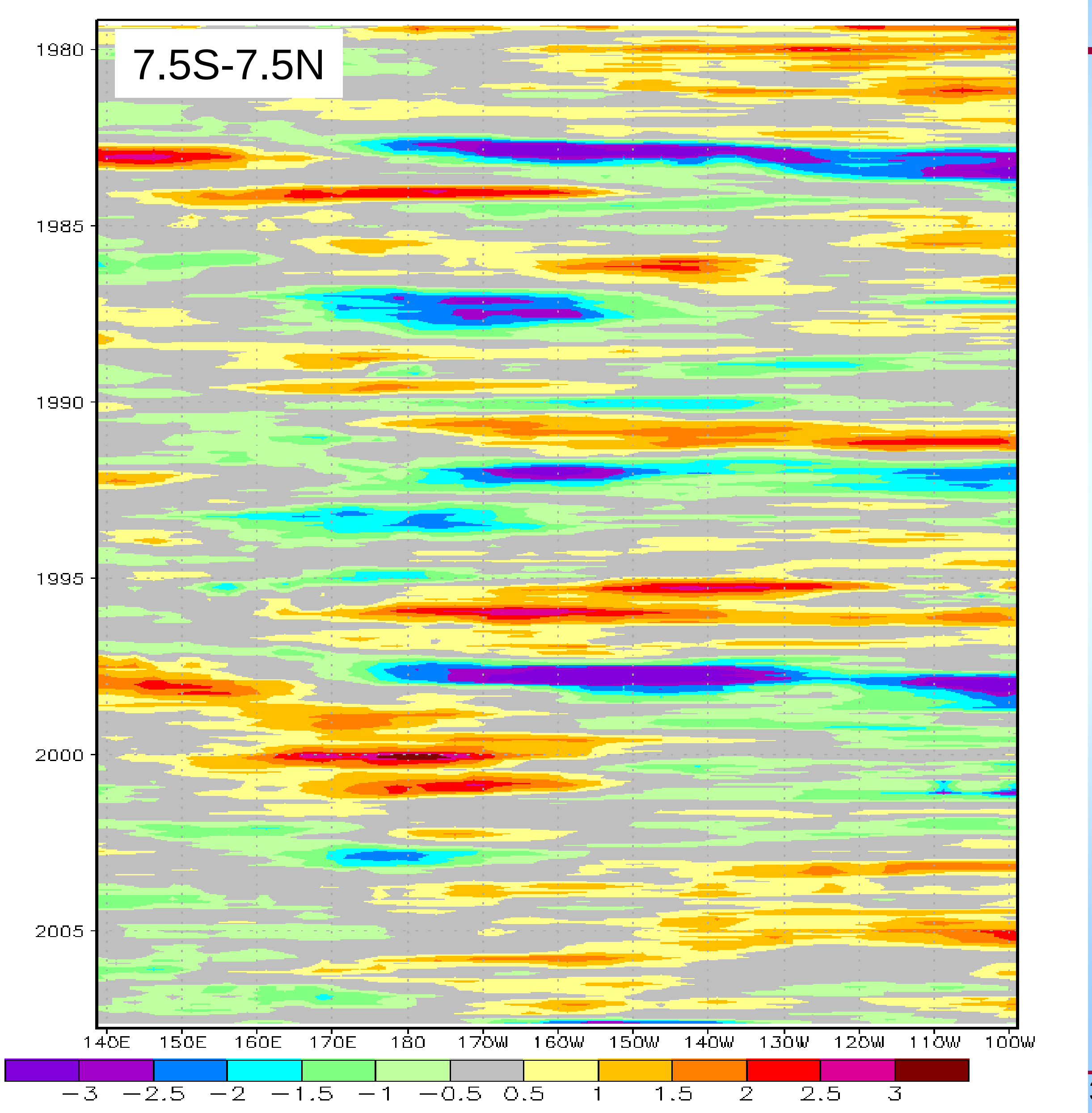


UTWV Time Series (showing 30S – 30N)



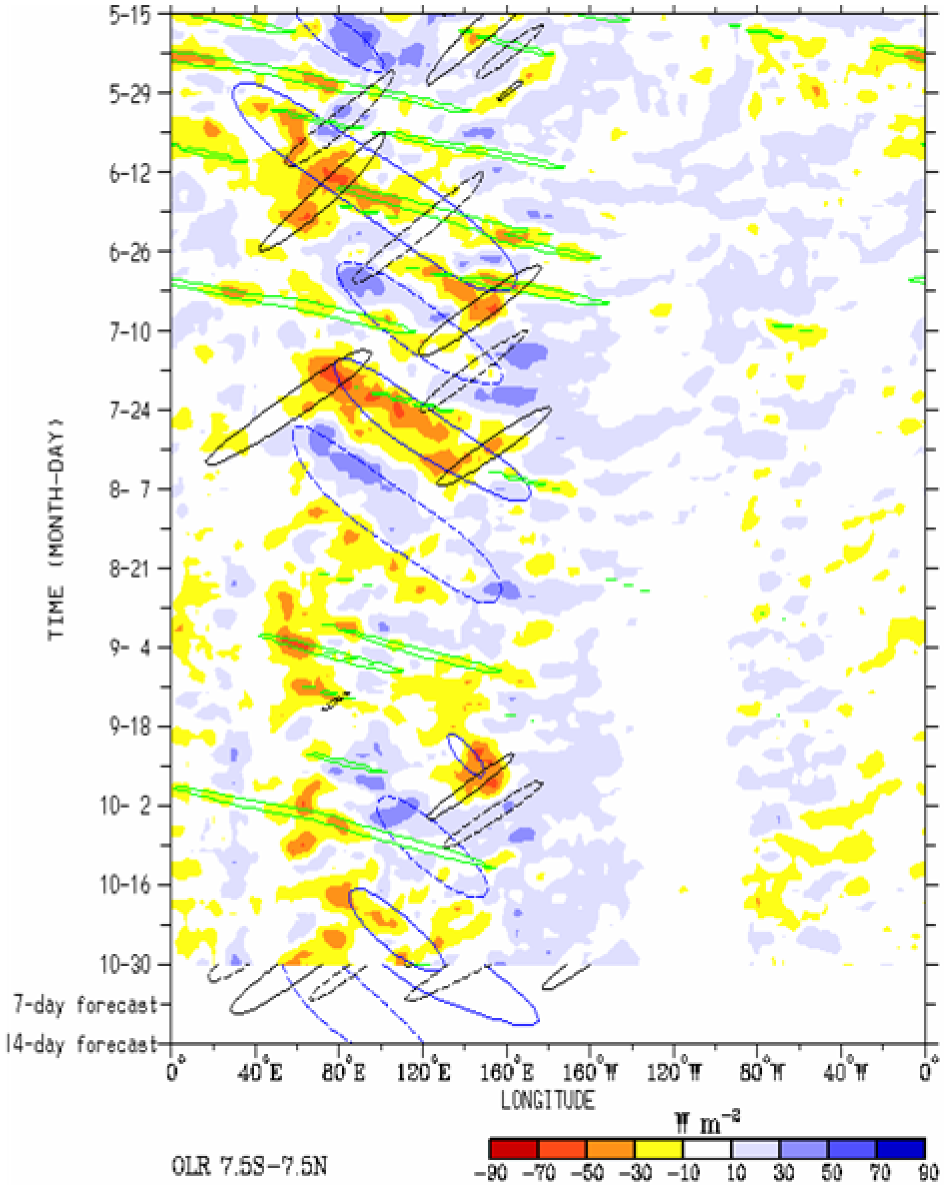


Long-term UTWV Anomaly Dataset

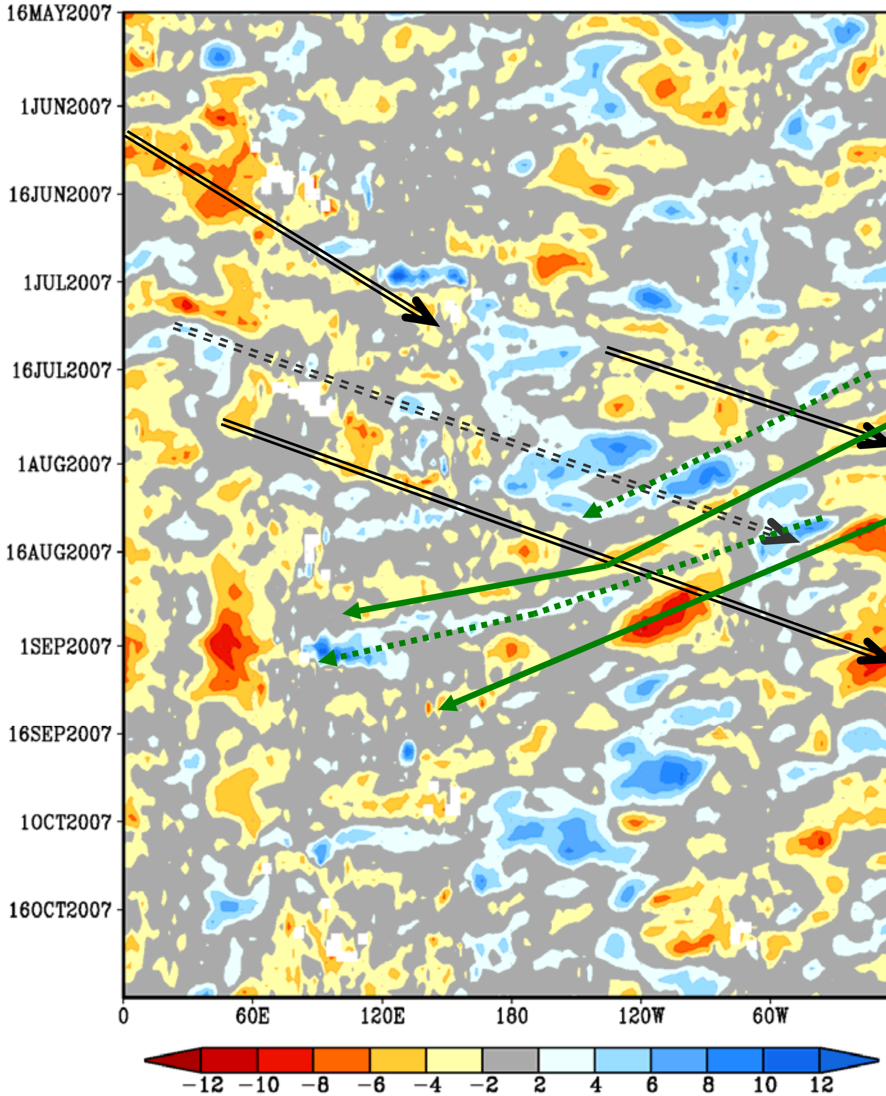


UTWV Has Good Coverage for Tropical Convections

OLR



HIRS Upper Tropospheric Water Vapor



← Obtained from http://www.cdc.noaa.gov/map/clim/olr_modes/hovEa.html

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.

International TOVS Study Conference, 16th, ITSC-16, Angra dos Reis, Brazil, 7-13 May 2008. Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2008.