Using HIRS Observations to Construct Long-term Global Temperature and Water Vapor Time Series

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Outline of the Study

- To develop temperature and water vapor retrieval schemes using a neural network technique.
- To construct long-term time series of temperature and water vapor in the troposphere.
- To better understand the variability of temperature and water vapor.

Training Data

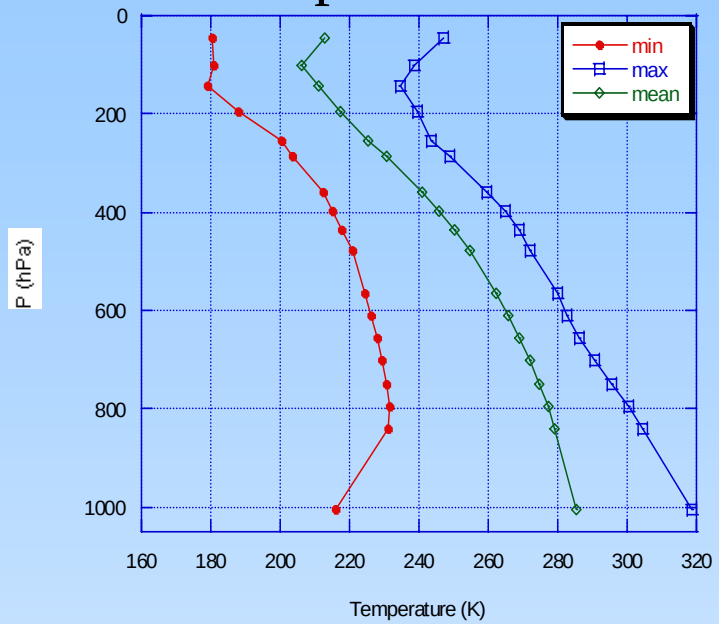
- A diverse sample of atmospheric profiles selected from ECMWF ERA-40 analyses.
- RTTOV-8 is used to simulate HIRS channel brightness temperatures
- The sample profiles and corresponding HIRS brightness temperatures are randomly divided into three data sets:
  - 60% training set
  - 20% testing set
  - 20% independent validation set

Neural Network

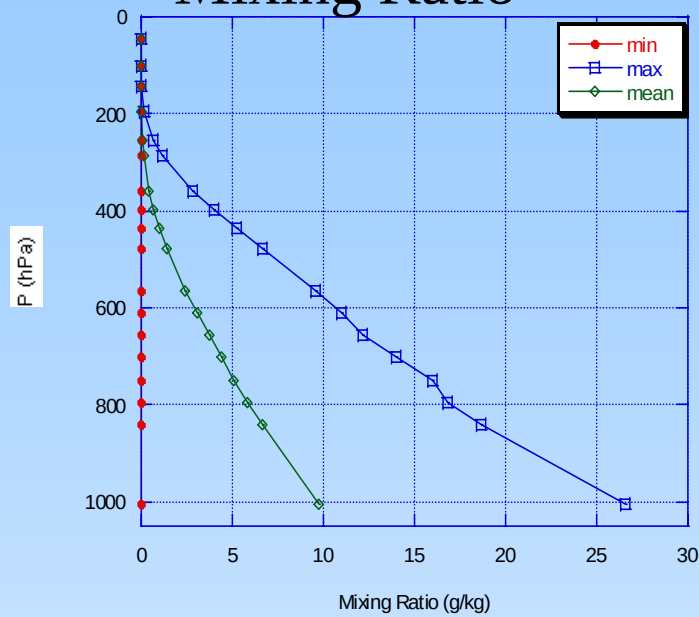
- Five layers (three hidden layers), back propagation.
- Separate neural networks for temperature and water vapor.
- Input: HIRS channels 1-12 and CO_2 concentration.
- Output: Temperature profiles from 1005 to 50 hPa and water vapor profiles from 1005 to 300 hPa.

Training Data

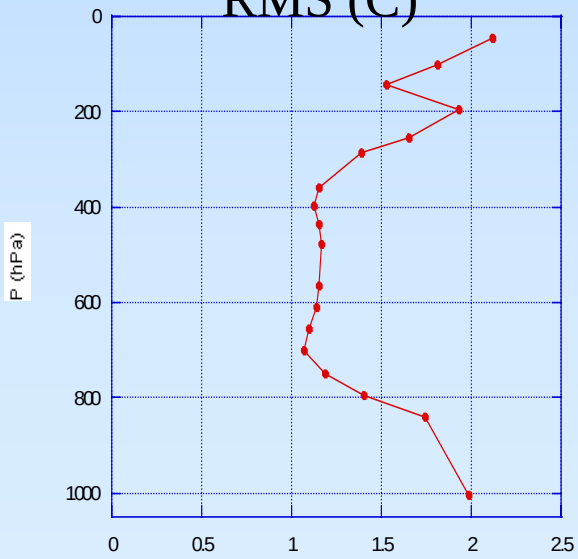
Temperature



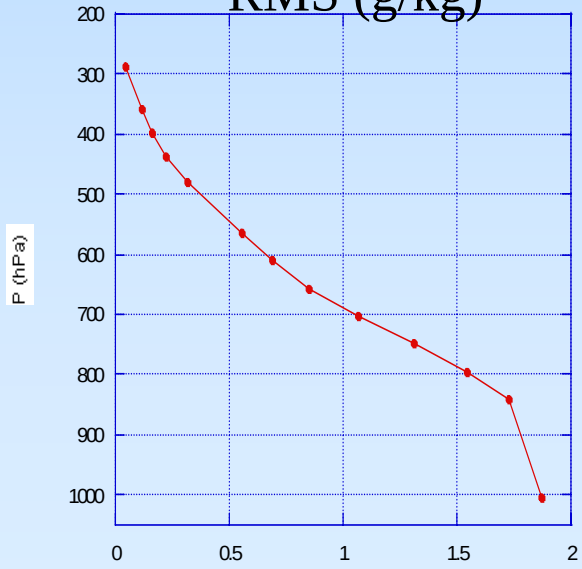
Mixing Ratio



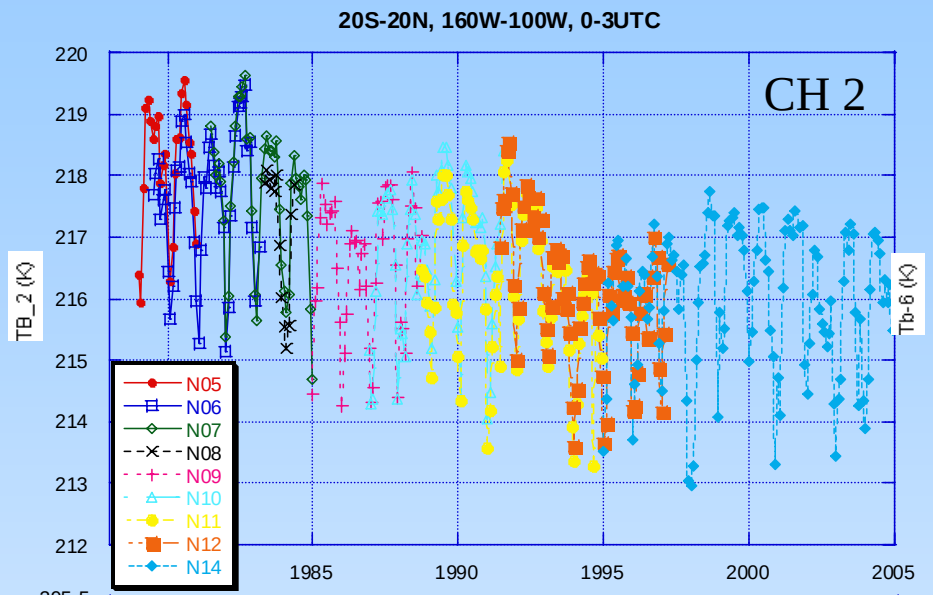
RMS (C)

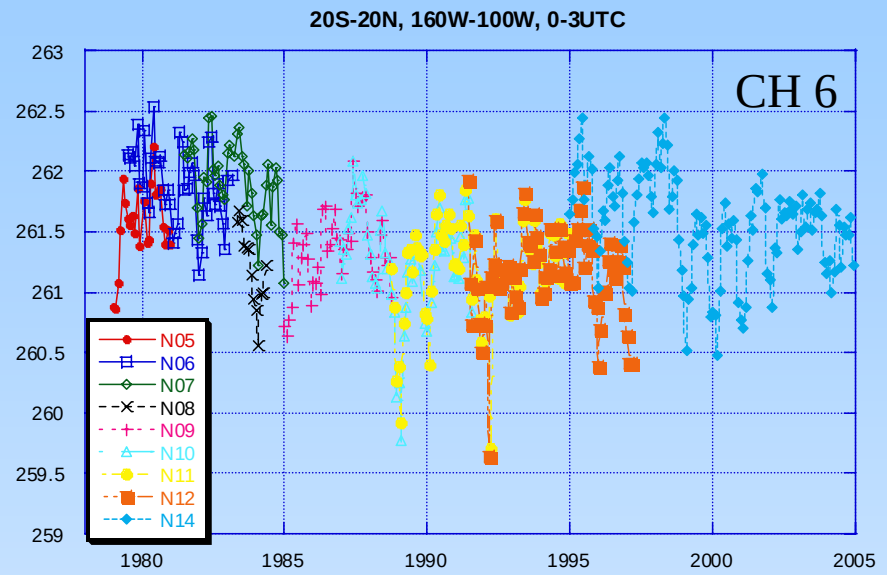


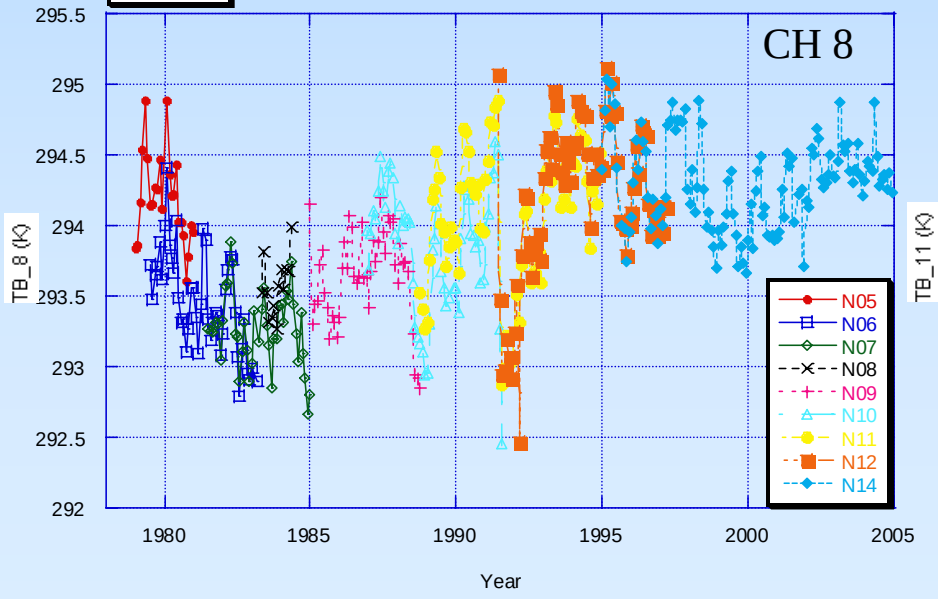
RMS (g/kg)

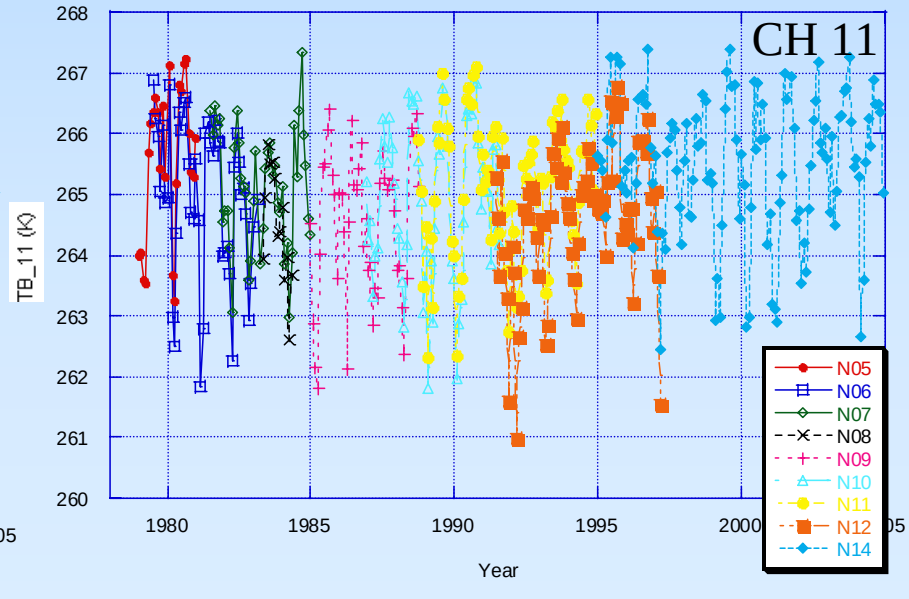


Clear-sky HIRS Channel Brightness Temperatures

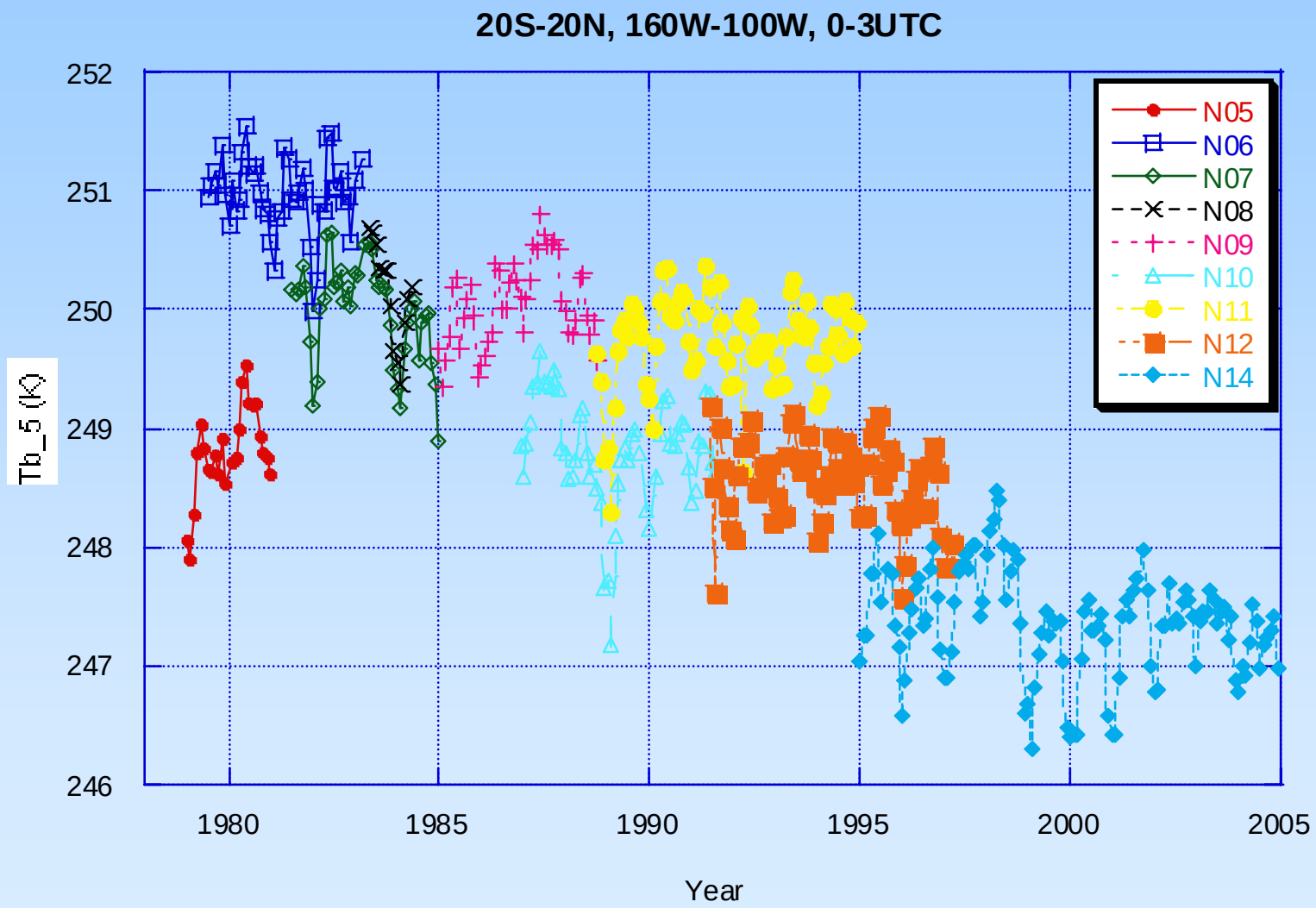




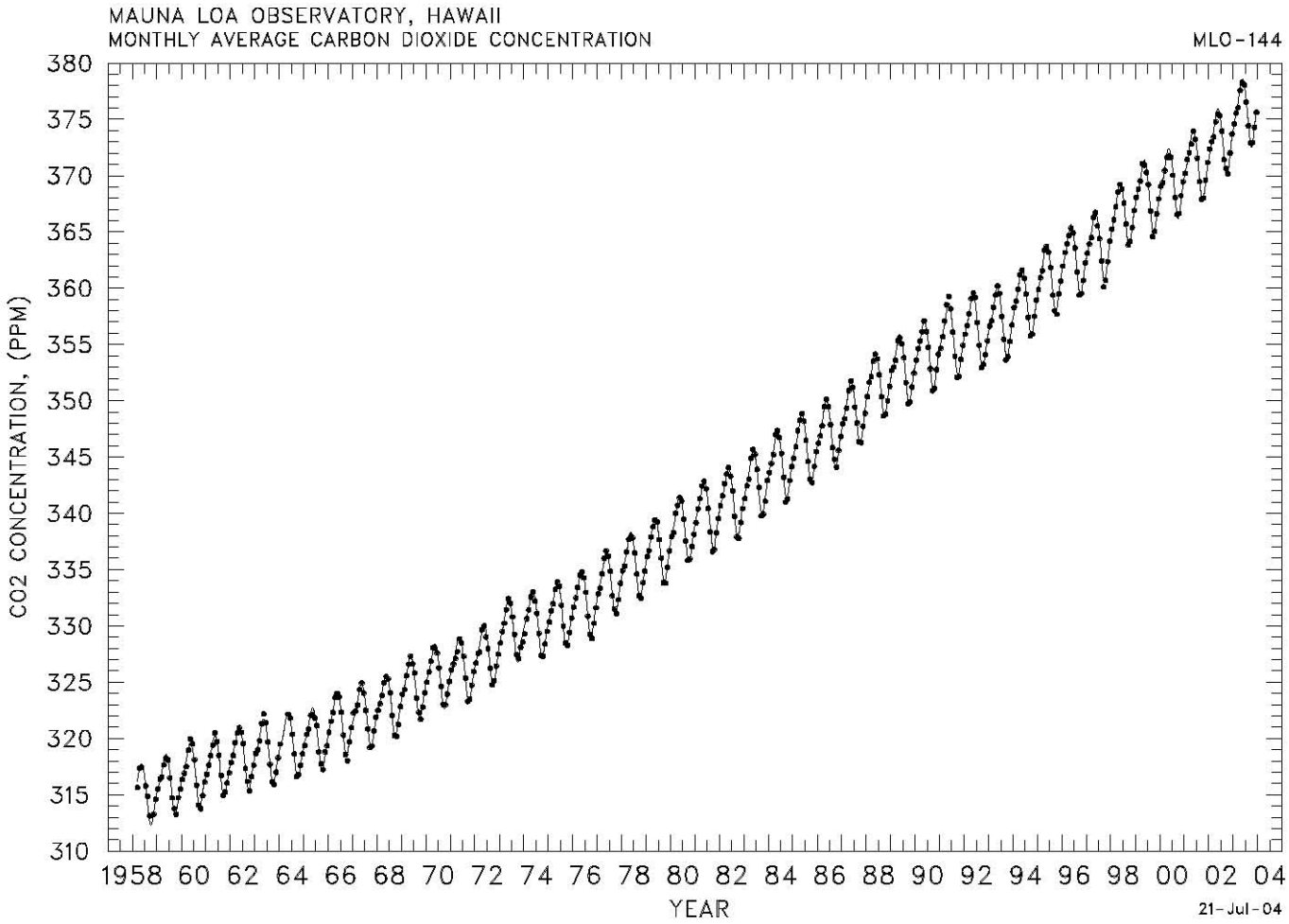




Clear-sky HIRS Channel-5 Brightness Temperatures

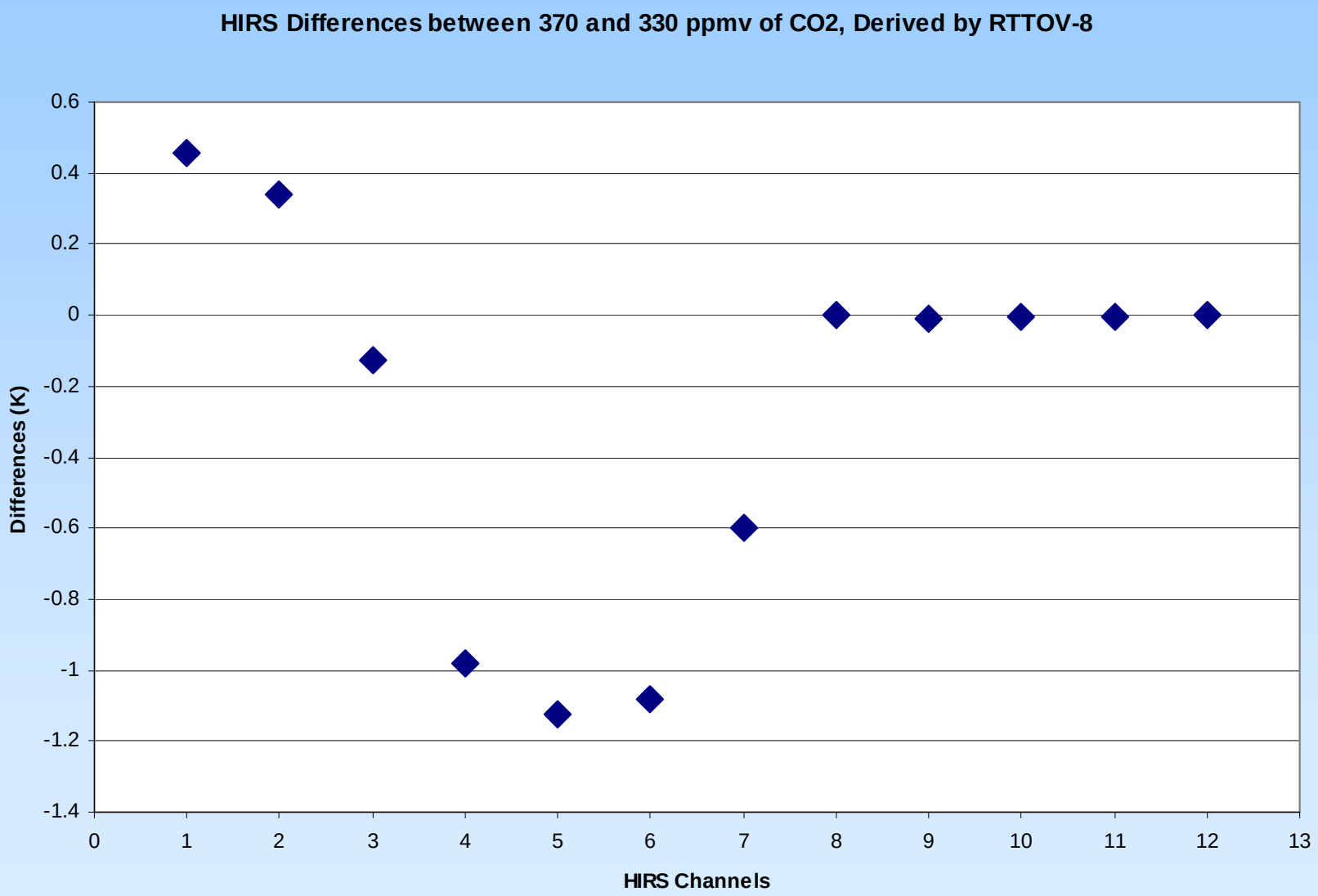


CO_2 Increase

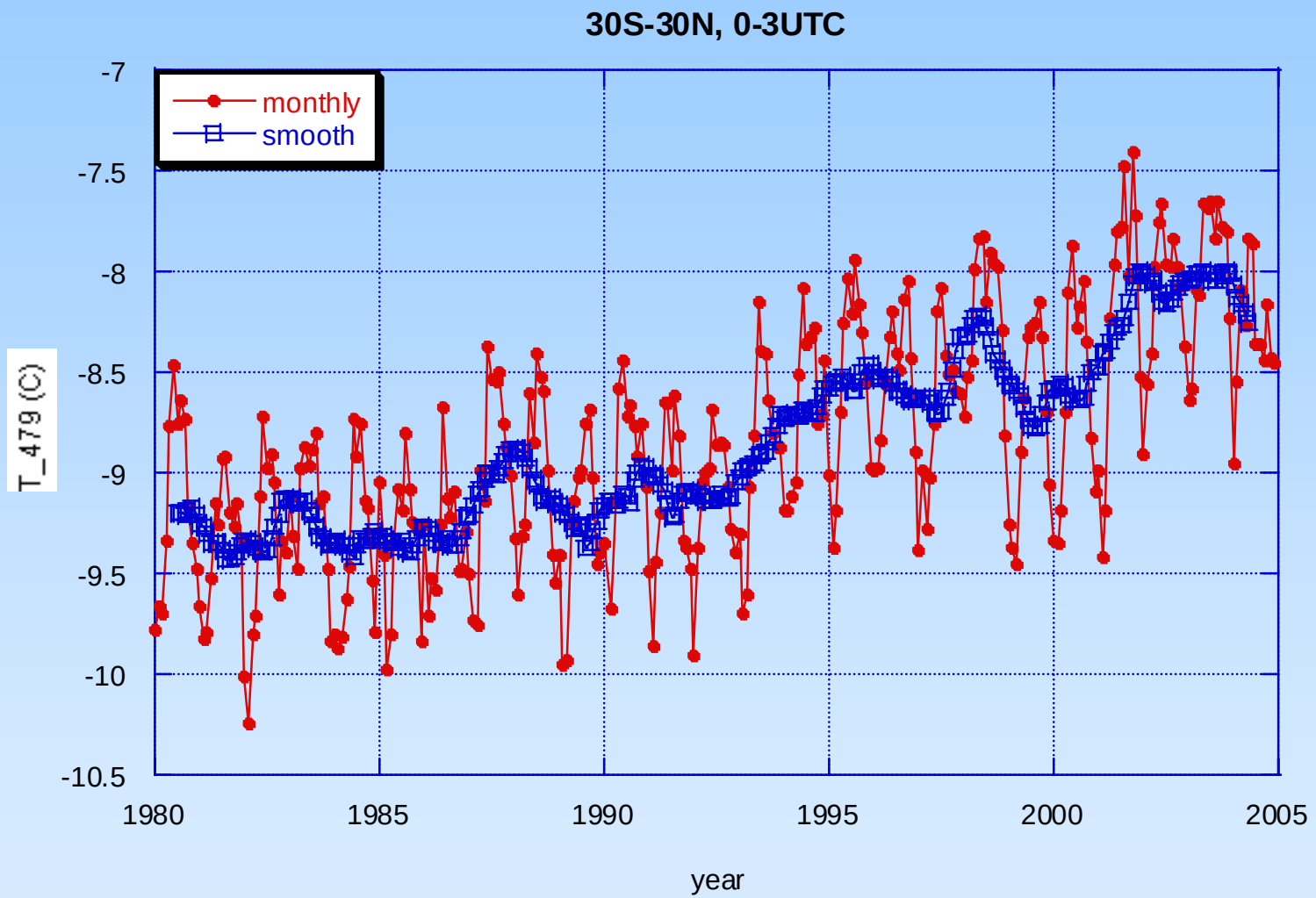


http://cdiac.esd.ornl.gov/trends/co2/sio-mlo.htm

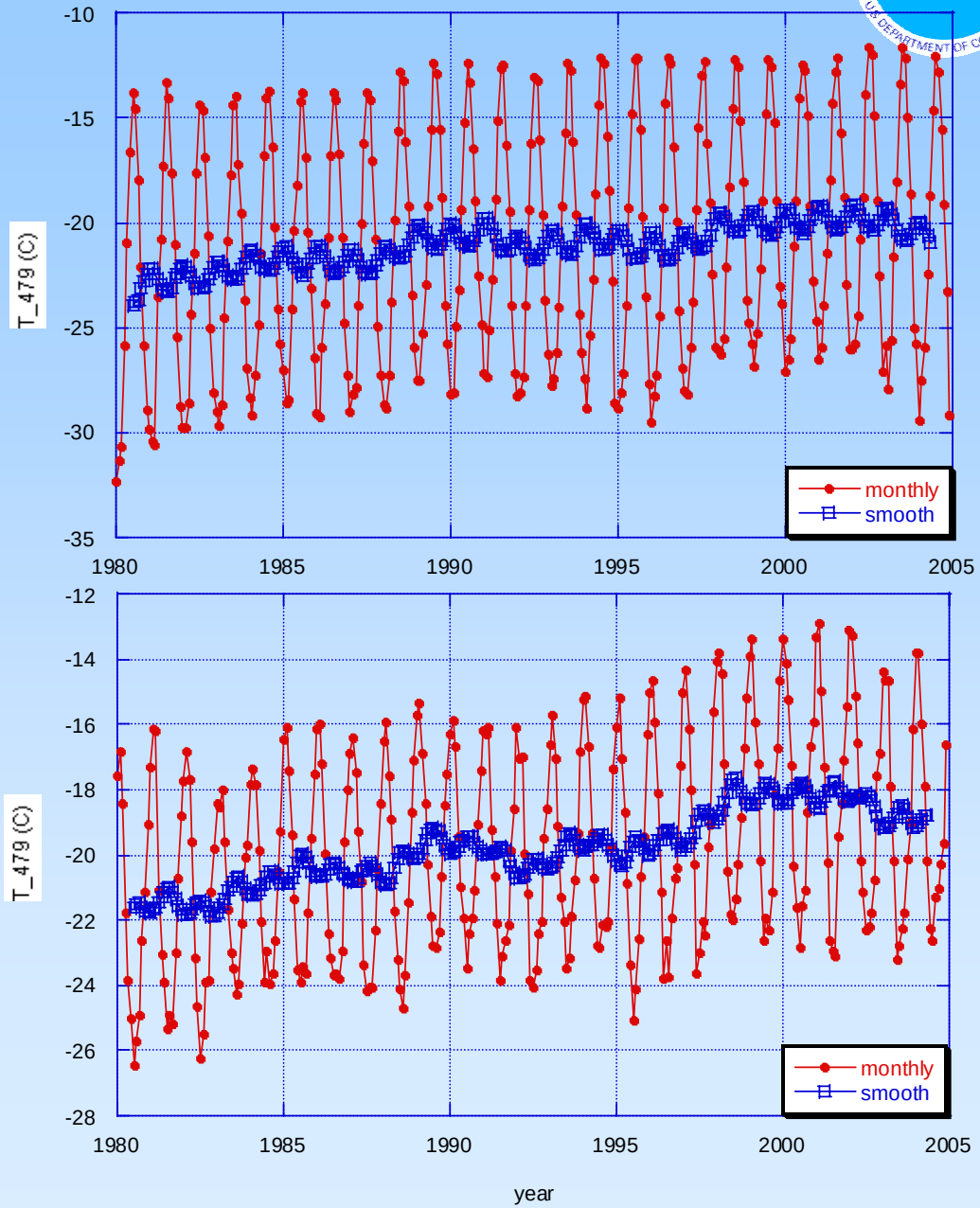
CO_2 Impact


HIRS Differences between 370 and 330 ppmv of CO2, Derived by RTTOV-8
Differences (K)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
0
1
2
3
4
5
6
7
8
9
10
11
12
13
HIRS Channels

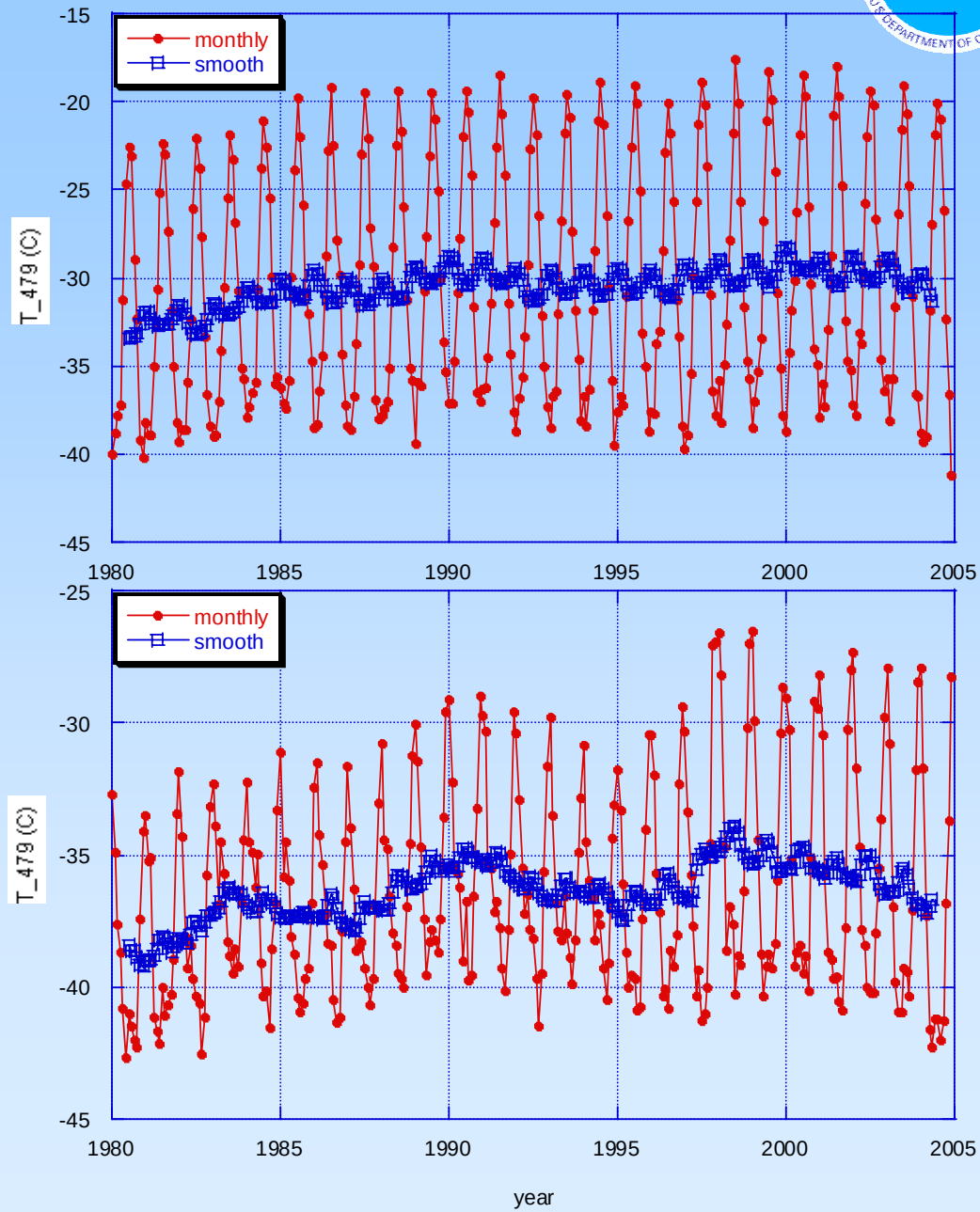
Monthly Mean Temperature



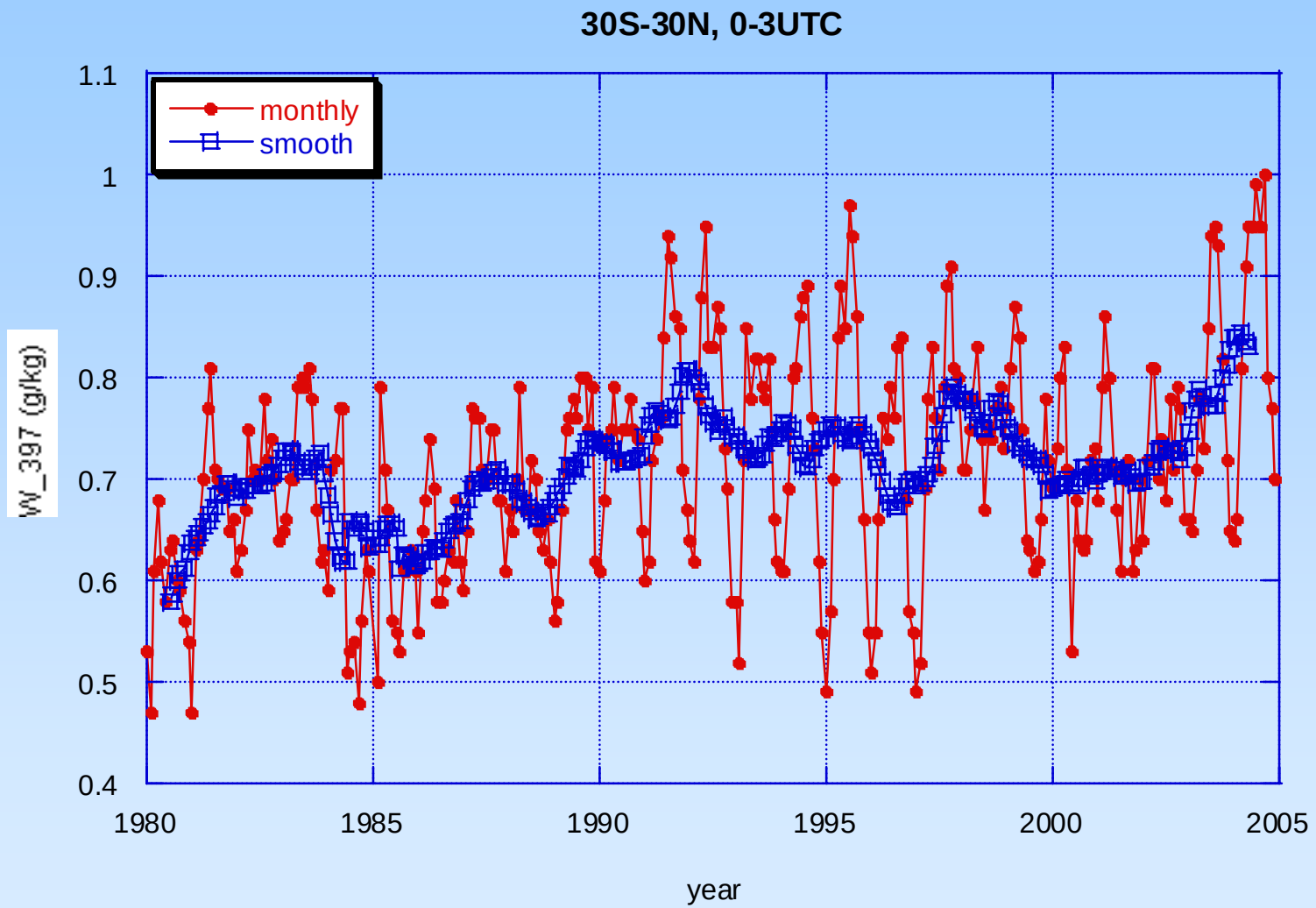
- Monthly mean 479hPa temperature for 30-60N (upper panel) and 30-60S (lower panel), 0-3UTC.
- Both northern and southern mid-latitudes show warming trends.



- Monthly mean 479hPa temperature for 60-90N (upper panel) and 60-90S (lower panel), 0-3UTC.
- Through the last twenty-five years, summer mean temperature rose significantly over both north and south poles.



Monthly Mean Mixing Ratio



Summary and Conclusion

- A neural network technique is applied to the retrievals. The training dataset is constructed with sampled profiles from ECMWF ERA-40 representing the global atmospheric conditions and RTTOV-8 simulated HIRS brightness temperatures.
- Carbon dioxide is included in the retrievals.
- The time series shows increases of temperatures in all the latitudes. However, the patterns of the temperature increase are different in different latitude zones.
- This work is in the early stage of the study. Better inter-satellite calibration and validation are planned.

Next Steps

- Apply a better inter-satellite calibration algorithm.
- Continue the work to include recent satellites.
- Extend the time series back in time by using VTPR data (1972-1979) to construct temperature and water vapor profiles.
- Validate the retrievals using other independent data sources.

International TOVS Study Conference, 14th, ITSC-14, Beijing, China, 25-31 May 2005. Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2005.