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)
CO₂ Increase

CO$_2$ Impact

HIRS Differences between 370 and 330 ppmv of CO2, Derived by RTTOV-8
Monthly Mean Temperature

30S-30N, 0-3UTC

-10.5
-10
-9.5
-9
-8.5
-8
-7.5
-7

-10.5
-10
-9.5
-9
-8.5
-8
-7.5
-7


year

monthly
smooth
• 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.
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.