The effect of GPS radio occultation data on radiometric profile retrievals

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Introduction

Current IR/MW remote sensing systems have limited skill for inferring temperature and moisture profiles in the vicinity of the tropopause area and in the stratosphere. However, the Global Positioning System (GPS) radio occultation (RO) provides very accurate upper tropospheric and stratospheric refractivity profiles that are related to temperature and humidity. This study investigates the use of RO measurements to improve radiometric retrievals in the vicinity of the tropopause region.

First, the results of a simulation study are presented to illustrate the impact of the GPS data on the temperature and humidity retrievals near the tropopause. A statistical regression based on the NOAAM8 radiocross dataset is used to obtain temperature and humidity retrievals from the combination of the radiometric and geosynchronous systems. The simulation study uses brightness temperatures from the 39 channels Advanced TIROS Operational Vertical Sounder (ATOV5) on the NOAAM8 satellite.

Second, the study is repeated with real data. Preliminary results are shown: the CHAMP data is sorted according to the horizontal motion of the tangent points, and the number of collocations between CHAMP, ATOVS, and NWP data is determined. Validation of CHAMP refractivity profiles are also presented. Finally, we show preliminary results of temperature retrieval using ATOVS and GPS data.

Simulation approach

Simulating observations based on:
- the NOAAM8 radiocross dataset: 7547 profiles global in time and space
- HIRS and MW brightness temperatures: Tb (represent HIRS, CrIS and AMU data)
- surface temperature and humidity data
- GPS refractivity profiles at 16 pressure levels between 5 and 30 km.
- GPS simulation is based on Healy and Eyre (2000) and Kursinski et al. (1997).

Temperature and humidity retrievals:
- Both linear and quadratic terms for Tb (HIRS, AMSU), SFC obs and refractivities (GPS) are included in the regression.
- Results for ocean and land are combined in this analysis.
- Regression coefficients derived from 90% of all profiles, testing is performed with remaining 10%.

Results of the simulation study

This study yields improved tropospheric and moisture profiles when compared to those inferred from either system alone.

- In the Troposphere GPS improves:
  - HIRS temperature profile retrievals near the tropopause by 1 K and at pressure levels below 570 hPa by 3 K
  - CrIS temperature profile retrievals near the tropopause by 0.6 K
  - CrIS moisture profile retrievals from 400 hPa to 700 hPa by about 25%
  - ATOVS moisture profile retrievals from 570 to 700 hPa by 5 K
  - ATOVS temperature profile retrievals by about 0.2 K from profile improvement by about 0.2 K from profile improvement by about 0.2 K
  - ATOVS temperature profile improvement by about 0.2 K from profile improvement by about 0.2 K

- In the stratosphere GPS improves:
  - ATOVS temperature profile retrievals between 15 hPa and the tropopause by about 0.5 K.
  - CrIS temperature profile retrievals near the tropopause and the tropopause by about 0.4 K.

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