

## **Upper tropospheric and lower stratospheric variability observed with GPS radio occultation data since 2001: Results from CHAMP, GRACE, TerraSAR-X, and FORMOSAT-3/COSMIC**

**T. Schmidt**, S. Heise, G. Michalak, G. Beyerle, F. Zus, J. Wickert, A. Faber  
*GFZ German Research Centre for Geosciences, Potsdam, Germany*

A. de la Torre, *Austral University, Buenos Aires, Argentina*

P. Alexander, *University of Buenos Aires, Buenos Aires, Argentina*

tschmidt@gfz-potsdam.de

The radio occultation (RO) technique uses GPS signals received aboard low Earth orbiting satellites for atmospheric limb sounding. Temperature profiles are derived with high vertical resolution. Due to its long-term stability, all-weather capability and global coverage the GPS RO technique offers the possibility for global monitoring of tropopause parameters and the temperature structure in the upper troposphere and lower stratosphere (UTLS) region. The German CHAMP (2001-2008), the US/German GRACE (since 2006), the Taiwan/US FORMOSAT-3/COSMIC (since 2006), and the German TerraSAR-X (since 2007) missions provide occultation measurements since more than one decade. An overview of recent results from the application of RO data in the UTLS region is given with respect to

(1) tropopause and UTLS temperature trends: A global increase of the tropopause height is observed combined with mostly upper tropospheric warming and lower stratospheric cooling.

(2) global gravity wave activity in the UTLS: The specific potential energy as a measure of GW activity is deduced from the temperature profile for each occultation event. To separate gravity waves from the background and planetary waves different methods are applied and finally horizontal wave parameters are determined that are the basis for momentum flux estimates.

(3) the tropopause inversion layer: Global features and seasonal variability of the tropopause inversion layer are analyzed. For the characterization of the northern hemispheric extra-tropical tropopause region complementary trace gas measurements (O<sub>3</sub>, CO) from the MOZAIC program onboard commercial aircrafts are used.