



First results from the GPS atmospheric remote sensing experiment TOR aboard TerraSAR-X

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The TerraSAR-X satellite was launched on 15 June 2007 into a sun-synchronous orbit at an altitude of about 514 km and about 98° orbit inclination. In addition to synthetic aperture radar and laser communication payloads, TerraSAR-X accommodates the Tracking, Occultation and Ranging (TOR) experiment. TOR's hardware consists of the Integrated Geodetic and Occultation Receiver (IGOR) and a laser retro-reflector for Satellite Laser Ranging (SLR). IGOR, a dual frequency, geodetic-grade GPS receiver instrument, provides signal-to-noise ratios, pseudo-range and carrier phase observations of an occulting and a reference satellite at sampling rates of up to 50 Hz for remote sensing of atmospheric refractivity using the radio occultation (RO) technique. For precise orbit determination pseudorange and carrier phase data from all satellites in view are sampled at 0.1 Hz.

Three brief RO tests were conducted with TOR in 2007; a 32-day campaign was performed in January/February 2008 and from 25 July to 17 November 2008 occultation events were recorded continuously for 117 days. We describe first results from an analysis of about 19.000 setting radio occultation events observed during that last campaign. Atmospheric refractivity profiles derived from TOR data are intercompared with ECMWF analyses; ECMWF analysis data are interpolated to the time and location of the RO measurement. At altitudes of about 2–25 km the mean fractional refractivity bias with respect to ECMWF is less than $\pm 0.5\%$, its standard deviation varies between 0.5% and 1% in the altitude range 5–20 km increasing to about 2% at altitudes below 5 km and above 20 km. Unlike the RO receivers aboard the CHAMP and GRACE satellites the IGOR aboard TerraSAR-X employs an open-loop tracking technique to improve L1 carrier phase tracking at altitudes below 5 to 6 km. Consistent with earlier findings from the COSMIC constellation, open-loop tracking significantly reduces the 50%-altitude, the tangent point altitude which is reached by 50% of all setting observations. During the same time period (25 July 2008 to 17 November 2008) the RO experiment aboard GRACE-A recorded fewer events (about 16.000). While GRACE-A results exhibit a significantly smaller standard deviation in the stratosphere, their 50%-altitude is about 2.3 km higher than the corresponding TerraSAR-X result underlining the improved tracking behavior of TOR in the lower troposphere.