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Upper Tropospheric and Lower Stratospheric Diurnal Tides of Temperature Derived from Radio Occultation Measurements

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We investigate the diurnal tide of temperature derived from Global Positioning System (GPS) radio occultation (RO) data of the Formosat-3/COSMIC (Constellation Observing System for Meteorology Ionosphere and Climate) satellite constellation. The constellation consists of six satellites, which were launched in April 2006. Since mid-2007 local time coverage is sufficient to allow the observation of the diurnal tide typical for one month at almost all latitudes. Only at high latitudes (beyond 70°), where ascending and descending branch of the satellite orbit move together (in terms of local time), local time sampling is insufficient and irregular within one month.

We use retrieved dry temperature profiles of Formosat-3/COSMIC RO measurements provided by UCAR/CDAAC (University Corporation for Atmospheric Research/COSMIC Data Analysis and Archive Center). We estimate the diurnal tide of temperature in 5° zonal bands between an altitude of 4 km and 35 km on a monthly scale. We compare the diurnal tides for northern hemispheric summer months June, July, and August 2007 and 2008 and show also results from the northern hemispheric winter months December, January, and February 2007/08.

At low latitudes, where seasonal variability is negligible, we find a downward propagating phase in all months. It is most pronounced between 15°N and 15°S and may be attributed to an upward propagating diurnal tide. Amplitude and phase observations are in excellent agreement with the tropical diurnal tide determined from ECMWF (European Centre for Medium-Range Weather Forecasts) short-term forecast fields (24 h to 48 h forecasts, temporal resolution of 3 hours).

Comparing the diurnal tides from ECMWF forecasts and Formosat-3/COSMIC measurements at latitudes beyond 20°, similarities become smaller and turn into disparities. On the one hand, the diurnal tide of the ECMWF model is very weakly pronounced and maximum temperatures are always observed in the afternoon. Formosat-3/COSMIC data, on the other hand, show a more strongly pronounced diurnal tide at mid- and high latitudes and the local time of maximum temperatures varies with latitude, height, and season. The measurement results are consistent between the northern hemispheric summer months of 2007 and 2008.

We also discuss results of space-time spectral analysis performed to specify the characteristics of the diurnal tides—the zonal wavenumbers, the directions (east or west), and the periods of the waves.