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A comparison of lower stratospheric temperatures from the 2001–2006 CHAMP radio occultation and MSU/AMSU climate records

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Long-term upper air temperature records have been established by different groups with considerable effort from radiosonde data and from satellite based (Advanced) Microwave Sounding Unit (MSU/AMSU) measurements, the latter providing information on layer-average stratospheric and tropospheric brightness temperatures. Comparisons of the temperature series show discrepancies not only with respect to radiosonde data but also between MSU data sets stemming from different retrievals. In this context the Global Navigation Satellite System radio occultation (RO) technique offers new possibilities by providing high quality observations of the atmosphere in an active limb sounding mode. Besides high accuracy and vertical resolution in the upper troposphere and lower stratosphere region, one of the most important properties regarding climate studies is the long-term stability due to intrinsic self-calibration.

Based on RO observations of the CHAllenging Minisatellite Payload for geoscientific research (CHAMP) satellite since late 2001, CHAMP RO temperature climatologies have been constructed at the WegCenter/Univ. of Graz. Focusing on the MSU lower stratosphere channel (TLS), synthetic TLS temperatures were calculated by applying global weighting functions to zonal-mean monthly-mean RO temperature climatology profiles for the years 2001–2006. These synthetic CHAMP TLS temperatures were compared to recent MSU TLS records from the University of Alabama in Huntsville (UAH, USA) and from Remote Sensing Systems (RSS, USA), as well as to synthetic TLS temperatures from HadAT2 radiosonde data (Hadley Centre/MetOffice, UK) and ECMWF (European Centre for Medium-Range Weather Forecasts) analyses. Further-

more, some available additional RO data from other satellites, processed for a number of months with the same processing system as used for CHAMP, were used as "quality-check anchor points" for the 2001–2006 RO record: SAC-C RO climatologies of JJA 2002 (three months), GRACE RO of July 2006, and COSMIC RO of December 2006, respectively.

In terms of absolute temperature we found that CHAMP TLS temperatures globally agree better with UAH temperatures outside the summer season and with RSS within summer, whilst ECMWF temperatures generally agree better with RSS temperatures. In terms of TLS temperature anomalies, overall very good agreement of CHAMP temperature anomalies with UAH, RSS, and ECMWF anomalies was found for intra-annual variability (RMS difference < 0.1 K globally and in the tropics, < 0.2 K in the extratropics), whilst HadAT2 anomalies show significantly larger differences (factor of two globally and more in the extratropics) as well as a systematic cold offset of near -0.4 K. Regarding 2001–2006 trends, UAH, RSS, and ECMWF anomalies exhibit a statistically significant cooling trend difference to CHAMP in the tropics (~ -0.45 K/5yrs) and globally (~ -0.35 K/5yrs). In view of the global homogeneity and long-term stability characteristics of RO climatologies this indicates that the MSU/AMSU TLS temperature record overestimates the early 21^{st} century cooling trend, especially in the tropical upper troposphere/lower stratosphere region but also globally.