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Estimation of the sampling Error of a CHAMP Radio Occultation Temperature Climatology based on an empirical Approach using ECMWF Analyses

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The CHallenging Minisatellite Payload (CHAMP) satellite has been recording radio occultation (RO) measurements since September 2001 almost continuously. Based on this dataset about 150 globally distributed temperatures profiles per day were retrieved at WegCenter/Univ. of Graz using its CHAMPCLIM Retrieval Version 2.3 (CCRv23). This way the CHAMP data provided the first opportunity to create RO based temperature climatologies for meanwhile more than five years. Systematic differences compared to climatologies from operational analyses of the European Centre for Medium Range Weather Forecasts (ECMWF) amount to less than ś0.5 K most of the time between about 8 km to 35 km and from pole to pole. The standard deviation varies between about 1 K and 2.5 K, depending on height.

At WegCenter/Univ. of Graz an observational empirical error model was developed (Steiner and Kirchengast, J. Geophys. Res., 110, D15307, doi: 10.1029/2004JD005251, 2005), which estimates the observational error of CHAMP temperature profiles. In this study we extend this model and add empirical modeling of the sampling error, which is of particular interest in a single-satellite mission such as CHAMP. The sampling error stems from an uneven and sparse sampling of the spatio-temporal variability of the atmosphere. It is estimated in form of the difference between climatologies from ECMWF analysis temperature profiles co-located with RO events and corresponding climatologies averaged from the complete ECMWF analysis fields. The latter, available four times daily at a spatial resolution matching the RO measurement resolution, approximate the “true” atmospheric state reasonably well in terms of spatio-temporal variability. The co-located profiles are computed by spatially

interpolating to the CHAMP RO event locations using the nearest time layer of the six-hourly analyses.

The results show that at high latitudes of seasonal-mean CHAMP temperature climatologies the sampling error exhibits strongly varying error features of up to ś3 K. The most pronounced features stem typically from insufficient sampling of the polar vortex in the northern and southern hemispheric spring season. These irregularly time-varying sampling errors at high latitudes rule them out for modeling by a simple static or regular-seasonal-cycle model. However, for the climatologies at low and middle latitudes (within ś60° latitude), the sampling error amounts to less than ś0.3-0.5 K in the height range from middle/upper troposphere (4-8 km) to 35 km. It somewhat varies with height, latitude and season, the amount of which is investigated in this study. The results are in particular discussed for the empirically modeled sampling error in latitude bands ranging from 60°S to 60°N. Complementing the empirical observational error model, the empirical sampling error model serves as vital auxiliary information for adequate use and interpretation of the multi-year RO temperature climatology itself.