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Montgomery Potential and Wind Fields on Isentropic Surfaces from GPS Radio Occultation

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Atmospheric profiles from Global Positioning System (GPS) radio occultation (RO) measurements provide precise and accurate information on the thermal structure of the troposphere and lower stratosphere. Since altitude (and also geopotential height) is based on accurate knowledge of the position and velocity vectors of the transmitter and receiver satellites involved, it is possible to obtain highly resolved and accurate vertical information from RO.

In this study we use observational data from 2007 to 2013 from the RO missions CHAMP, SAC-C, GRACE-A, and Formosat-3/COSMIC. Using potential temperature as the vertical coordinate we calculate monthly means of the Montgomery potential on isentropic surfaces from 300 K to 600 K (approximately 12 km to 24 km in altitude) with a horizontal resolution of 5° in latitude and 5° in longitude. Contours of the Montgomery potential on isentropic surfaces correspond to a stream-function for adiabatic, geostrophic flow. Subsequently we derive monthly mean geostrophic wind fields (outside the tropics) from sampling error-corrected fields of the Montgomery potential on isentropic surfaces.

We find that these climatological RO wind fields clearly capture all of the main wind features with departures from analysis winds being, in general, smaller than 2 $\mathrm{m\ s^{-1}}$. Larger biases close to the subtropical jet and at high latitudes—biases rarely exceed 10 %—are caused by the geostrophic approximation. We present monthly mean wind fields, their annual cycle as well as inter-annual variability related to the El Niño–Southern Oscillation. This three-dimensional information of high quality from RO data can subsequently be utilized to investigate atmospheric dynamics close to the tropopause.