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Systematic Residual Ionospheric Error in the Radio Occultation Data

J. Danzer, B. Scherllin-Pirscher, and U. Foelsche
Austria (julia.danzer@uni-graz.at)

The Radio Occultation (RO) method is used to study the Earth's atmosphere in the troposphere and lower stratosphere. The path of a transmitted electromagnetic signal from a GPS satellite changes when passing through the ionosphere and neutral atmosphere. The altered signal is detected at a receiving Low Earth Orbit satellite and provides information about atmospheric parameters such as the refractivity of the Earth's atmosphere and in a further processing step, e.g., pressure or temperature.

The processing of the RO data has been done at the Wegener Center for Climate and Global Change. Different corrections are applied on the data, such as a kinematic Doppler correction, induced by the moving satellites, and an ionospheric correction due to the ionosphere dispersive nature. The standard ionospheric correction enters via a series expansion, which is truncated after first order and the correction term is proportional to the inverse square of the carrier frequency. Due to this approximation we conjecture there to be still an ionospheric residual error in the RO data, which does not fully address the change of ionization in the day to night time, and at times of high and low solar activity.

This residual ionospheric error is studied by analyzing the bending angle bias (and noise). It is obtained by comparing the bending angle profiles to Mass Spectrometer and Incoherent Scatter Radar (MSIS) climatology in an altitude between 65 km and 80 km. In order to detect the residual ionospheric induced error we investigate the bias over a time period from 2001 to 2010, using CHAMP and COSMIC RO data. The day to night time bias and noise are compared for different latitudinal zones. We focus on zones between 20°N to 60°N, 20°S to 20°N and 60°S to 20°S.

Our analysis shows a difference between the day and night time bias. While the night time bias is roughly constant over time, the day time bias increases in the years of high solar activity, and decreases in the years of low solar activity. The aim of our analysis is to quantify this systematic residual error in order to perform an advanced ionospheric correction in the processing of the RO data.