Ground based water vapor retrieval in Antarctica

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Water vapor is the most abundant greenhouse gas and plays a central role in global warming. It creates a self-generating cycle where its concentration and air temperature increase one another. A quantification of the abundance and variability of atmospheric water vapor still requires longer and consistent time series of data, possibly recorded by different and independent sensors to overcome technique-specific systematic errors and obtain accurate results.

Although representing a few percentages of the total atmospheric content, Antarctic water vapor variations impact local temperature variations and plays an important role in snowfall accumulation and surface mass balance. Thus, accurate long time series of water vapor content in Antarctica are crucial to better understand the current climate variations and to assess the reliability of global climate models predictions.

The propagation of the GPS radio signal through the atmosphere impacts the radio wave velocity according to the atmospheric media composition. Particularly, the interaction with the neutral atmosphere bends and delays the electromagnetic wave introducing an error into the satellite slant range. Originally considered as an observation nuisance, it is now more than two decades that the delay is used to reckon the atmospheric water vapor content and its variability.

Over the Antarctic coast, we selected a set of five GPS permanent stations whose data were used to compute the local integrated Precipitable Water vapor (PW). The GPS station selection was driven by the presence of radiosounding (RS) data locally performed using Barocap, Thermocap and Humicap-A sensors mounted on Vaisala radiosondes. The 12-year data sets of RS and GPS observations at Casey, Davis, Mawson, McMurdo and Mario Zucchelli stations were processed with the purpose of computing the PW time series and determine their trends. For both techniques, the processing strategy was specifically developed to ensure a homogeneous and up-to-date data analysis, implementing models and parameters capable to minimize known observation or instrumental biases to a minimum.

We compared GPS and RS time series and highlighted a general good agreement and the presence of systematic differences. Despite these biases, the PW seasonal variations that were detected with the two techniques are rather consistent, as confirmed by the scatter plots and the related correlation coefficients, shown in the paper.