Homogenization of GNSS IWV time series

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Long records of observational data are essential to climate research for understanding the condition of environmental evolution on the planet. Ground-based networks of Global Navigation Satellite System (GNSS) receivers provide observations of tropospheric delay and integrated water vapor (IWV) for more than 20 years.

However, GNSS time series show breakpoints due to changes in the instruments, in measurement conditions, or in processing software. Such artificial shifts can introduce spurious trends which can be erroneously interpreted as climate variations.

The purpose of the present study is to detect these changes or breakpoints in the time series of the difference between IWV from GNSS and IWV from ERA-Interim reanalysis. Two problems have been observed in the data: a month-dependence variability and if the ERA model allows to correct the physical periodic signal there is still a time-varying bias.

We propose here a segmentation model to detect abrupt changes in the mean in which the variance is supposed to be month-dependent and a functional is added to the model to take into account for a time-varying bias in the data (i.e. a systematic difference between GNSS and ERA-Interim IWV data).

The estimation proposed procedure consists in 2 steps. First, obtain the estimation of the breaks and the functional with the number of breaks being fixed. Second, choose the number of breaks using one or several adapted model selection criteria. For the first step, an iterative procedure is proposed that alternates the estimation of the breaks and the estimation of the functional model (here we chose a Fourier series of order 4). For the second step, three different criteria for selecting model were tested and intercompared.

This work presents the results of the developed method applied on daily synthetic data available from 120 GNSS stations globally distributed. The period of study is from January 1995 to December 2010. The synthetic data are from the benchmark simulations elaborated in the framework of the COST Action ES1206(GNSS4SWEC).