Geophysical Research Abstracts
Vol. 19, EGU2017-5344, 2017
EGU General Assembly 2017

Extracting climate signals from large hydrological data cubes using multivariate statistics - an example for the Mediterranean basin

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Global warming is expected to change ocean-atmosphere oscillation patterns, e.g. the El Nino Southern Oscillation, and may thus have a substantial impact on water resources over land. Yet, the link between climate oscillations and terrestrial hydrology has large uncertainties. In particular, the climate in the Mediterranean basin is expected to be sensitive to global warming as it may increase insufficient and irregular water supply and lead to more frequent and intense droughts and heavy precipitation events. The ever increasing need for water in tourism and agriculture reinforce the problem. Therefore, the monitoring and better understanding of the hydrological cycle are crucial for this area.
This study seeks to quantify the effect of regional climate modes, e.g. the Northern Atlantic Oscillation (NAO) on the hydrological cycle in the Mediterranean. We apply Empirical Orthogonal Functions (EOF) to a wide range of hydrological datasets to extract the major modes of variation over the study period. We use more than ten datasets describing precipitation, soil moisture, evapotranspiration, and changes in water mass with study periods ranging from one to three decades depending on the dataset. The resulting EOFs are then examined for correlations with regional climate modes using Spearman rank correlation analysis. This is done for the entire time span of the EOFs and for monthly and seasonally sampled data. We find relationships between the hydrological datasets and the climate modes NAO, Arctic Oscillation (AO), Eastern Atlantic (EA), and Tropical Northern Atlantic (TNA). Analyses of monthly and seasonally sampled data reveal high correlations especially in the winter months. However, the spatial extent of the data cube considered for the analyses have a large impact on the results.
Our statistical analyses suggest an impact of regional climate modes on the hydrological cycle in the Mediterranean area and may provide valuable input for evaluating process-oriented climate models. The study is supported by WACMOS-MED project of the European Space Agency.