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Assessment of bi-modality in global soil moisture datasets

Luis Vilasa (1), Han Dolman (1), Diego Miralles (1,2), and Richard de Jeu ()
(1) Vrije Universiteit van Amsterdam, (2) Ghent University

Surface soil-moisture is a critical variable in the interaction between land and atmosphere. It plays an important role in the occurrence of climate extremes due its role in the surface radiation budget and energy balance, can affect average temperature and precipitation at climatological scales and propagate its influence to the atmospheric boundary layers.

During the last decades a wide range of global soil moisture datasets were developed from a variety of sources. These datasets are in need for validation. Several metrics such as correlation coefficients, bias RMSE, triple collocation, R metric and others were used for this purpose. All these metrics assess the quality of the estimates in either time or space, but rarely capturing both. In this article we perform an analysis of soil-moisture datasets using a new metric based on the concept of soil moisture bi-modality that combines both spatial and temporal aspects.

Bi-modality can be recognized, when the soil moisture data probability density function has the shape of a bimodal distribution, that is, a continuous probability distribution with two different modes that can appear as distinct peaks. A variety of geophysical processes can cause the soil moisture probability density function to present a bimodal behaviour. This fact gives us the opportunity to create a new metric based on the presence of a bimodal behaviour; a new tool that we can use to analyse soil moisture datasets for its application in climate studies.

This new tool based on the bi-modality metric is used to analyse both a satellite global soil moisture dataset (from the AMSR-E sensor retrieved with the LPRM algorithm) and climate model datasets from the Atmospheric Model Intercomparison Project (AMIP) experiment of the Coupled Model Intercomparison Project (CMIP5). Comparing the results of both datasets we observe a clear discrepancy between climate models and satellite observations, with climate models bringing distinctly higher bi-modality values. The magnitude and distribution of this discrepancy is explored and some hypothesis for this discrepancy are put forward for discussion.