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Drought Persistence in Models and Observations

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Many regions of the world have experienced drought events that persisted several years and caused substantial economic and ecological impacts in the 20th century. However, it remains unclear whether there are significant trends in the frequency or severity of these prolonged drought events. In particular, an important issue is linked to systematic biases in the representation of persistent drought events in climate models, which impedes analysis related to the detection and attribution of drought trends.
This study assesses drought persistence errors in global climate model (GCM) simulations from the 5th phase of Coupled Model Intercomparison Project (CMIP5), in the period of 1901-2010. The model simulations are compared with five gridded observational data products. The analysis focuses on two aspects: the identification of systematic biases in the models and the partitioning of the spread of drought-persistence-error into four possible sources of uncertainty: model uncertainty, observation uncertainty, internal climate variability and the estimation error of drought persistence. We use monthly and yearly dry-to-dry transition probabilities as estimates for drought persistence with drought conditions defined as negative precipitation anomalies. For both time scales we find that most model simulations consistently underestimated drought persistence except in a few regions such as India and Eastern South America. Partitioning the spread of the drought-persistence-error shows that at the monthly time scale model uncertainty and observation uncertainty are dominant, while the contribution from internal variability does play a minor role in most cases. At the yearly scale, the spread of the drought-persistence-error is dominated by the estimation error, indicating that the partitioning is not statistically significant, due to a limited number of considered time steps. These findings reveal systematic errors in the representation of drought persistence in current climate models and highlight the main contributors of uncertainty of drought-persistence-error.
Future analyses will focus on investigating the temporal propagation of drought persistence to better understand the causes for the identified errors in the representation of drought persistence in state-of-the-art climate models.