Geophysical Research Abstracts
Vol. 18, EGU2016-3177-1, 2016
EGU General Assembly 2016

Century-scale causal relationships between global drought conditions and the state of the Pacific and Atlantic Oceans

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Drought is one of the costliest and least understood natural hazards. The El Niño Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and North Atlantic Oscillation (NAO) are atmosphere–ocean coupled modes of climate variability that occur in the Pacific and Atlantic Oceans. In this study, the Granger causality test is used to examine the effects of ENSO, PDO, and NAO on global drought conditions. The results show robust relationships between drought conditions and the ocean states, as assessed through a multi-index (SPEI and SPI) and multiscalar (3-month and 12-month) evaluation. The influence of ENSO events is widespread, dominating about 40% of the global land droughts. Southern and western North America, northern South America, and eastern Russia are more influenced by PDO. Results show that NAO influence on drought is not restricted to Europe and includes northern Africa. The role of NAO is most evident at 3-month time scale. Moreover, the results provide evidence that drought conditions can be affected by multiple factors. ENSO and PDO may reinforce each other to dominate climate variability over North America and northern South America. Climate variability in southern Europe and northern Africa may be forced by the concurrence of ENSO and NAO. The spatial patterns of the influence of ocean states on global droughts provide valuable information for improving drought forecasting.