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Causal effects of teleconnection patterns on soil moisture through different climate paths over the Greater Horn of Africa

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Soil moisture is undoubtably a vital variable of the climate system. Understanding the interactions among atmosphere, climate, and soil is necessary for water resource management, drought monitoring, and disaster prevention. However, evaluation of those interactions so far primarily focused on typical correlation analysis which often fail to imply causal relationship due to autocorrelation and high dimensionality within time series variables. Here, we used a data driven causal inference method called PCMCI+ to discover causal relationships among teleconnection patterns (El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD)), climate variables (precipitation and temperature) and soil moisture during 1980-2022 over Great Horn of Africa (GHOA), where is a susceptible region to suffer from severe drought. Further, we quantitative calculated the causal effects of teleconnection patterns on SM through different climate paths. Results suggest that IOD generally presents higher causal effects on climate variables (temperature and precipitation) or on soil moisture through both precipitation and temperature paths than ENSO over most parts of GHOA. Moreover, precipitation performs shorter lag effect and greater causal effect on soil moisture in GHOA. Our study provides the first attempt to quantitatively analyze the causal effects of teleconnection patterns on SM through both precipitation path and temperature path, and it highlights the causal relationships within atmosphere-climate-soil interactions, which could help for better understanding of climate change impact on drought over GHOA.