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Detecting drought conditions related to vegetation at west continental Europe based on variations from the North and Caspian Seas

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Teleconnections relate regional pressure patterns to local climate anomalies, influencing the variation of vegetation patterns. Over west continental Europe, droughts have been widely investigated with persistent low-frequency atmospheric circulation patterns (e.g. the North Atlantic Oscillation, NAO) with the centers over the Atlantic based on the 500mb height anomalies of the Northern Hemisphere. However, the effects of teleconnection patterns with the centers of active variability over the North and Caspian Seas is largely unexplored for droughts related to vegetation patterns. In this study, we explored the impact of the North Sea-Caspian Pattern (NCP) on regional ecohydrologic conditions in the Greater Region of Luxembourg in Western Europe. Using a Principal Component Analysis (PCA), we first decomposed the annual Normalized Difference Vegetation Index (NDVI) from the Global Inventory Monitoring and Modeling System (GIMMS) between 1981 and 2015. In the first PCA component, a distinctive greening trend of NDVI is detected since the late 1980s. However, the corresponding station observations and the ERA5 reanalysis data show that the region in west continental Europe became increasingly drier based on the difference between precipitation and evaporation. We explain the above paradoxical greening but drying patterns by the mechanism of NCP over the region. During the positive phase of NCP, the high pressure over the North Sea weakens circulation over the region and leads to warmer conditions in west continental Europe. These conditions are good for vegetation growth because the region was mainly energy-limited during the observed period at the annual scale based on a Budyko analysis. However, the positive phase of NCP also promotes divergent conditions at the lower troposphere and it reduces moisture flux over the region. In the Budyko space, the persistent positive phase of NCP would lead the energy-limited region to be water-limited. As the positive phase of NCP is expected to be more frequent along with the increasing global temperatures, the region may start to experience increasing water stress on vegetation. These results suggest that unforeseen droughts related to vegetation may be emerging in the region. New drought monitoring and management measures related to vegetation should be developed at west continental Europe, especially during the positive phase of NCP.