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Improving the management of extreme weather events using teleconnection-based seasonal hydroclimatic forecasts

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Increasingly uncertain hydrologic regimes combined with more frequent and intense extreme events are challenging water systems management worldwide, emphasizing the need of accurate medium- to long-term predictions to timely prompt anticipatory operations. Despite modern forecasts are skillful over short lead time (from hours to days), predictability generally tends to decrease on longer lead times. Global climate teleconnection, such as El Niño Southern Oscillation (ENSO), may contribute in extending forecast lead times. However, ENSO teleconnection is well defined in some locations, such as Western USA and Australia, while there is no consensus on how it can be detected and used in other regions, particularly in Europe, Africa, and Asia.

In this work, we employ the Multi Variate Niño Index Phase Analysis (MV-NIPA), which allows capturing the state of multiple large-scale climate signals (i.e. ENSO, North Atlantic Oscillation, Pacific Decadal Oscillation, Atlantic Multi-decadal Oscillation, Indian Ocean Dipole) to forecast hydroclimatic variables on a seasonal time scale. For each phase of the considered climate signals, our approach identifies relevant anomalies in Sea Surface Temperature (SST) that influence the local hydrologic conditions.

The potential of the MV-NIPA framework is demonstrated through an application to the Lake Como system, a regulated lake in northern Italy which is mainly operated for flood control and irrigation supply. MV-NIPA results showed high correlation between seasonal SST values and one season-ahead precipitation in the Lake Como basin, allowing the construction of skillful forecasts of precipitation and, through a basin hydrological model, lake inflow. Such forecasts are then used for directly conditioning the lake operations, and prove to be an asset for early informing the system management on upcoming extreme weather events, e.g., the accurately predicted 2003 and 2005 summer droughts. The lake regulation benefits from such information by timely activating appropriate hedging strategies in anticipation of extreme weather events, ultimately resulting in a more reliable water supply, especially in critical years.