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Dynamical mechanisms of the North Atlantic circulation and precipitation in Portugal

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The precipitation regime over Portugal is characterized by a strong seasonal behavior with a marked peak occurring during the winter season (December-February). Furthermore, the large interannual variability leads to a relatively high recurrence of extremely wet and extremely dry winters, which produce strong impacts in river flow and water resources. Due to the high economical and social vulnerability, a better understanding of the large-scale mechanisms that are linked to the occurrence of these extremes is of utmost relevance. Aiming at the identification of the main differences between the atmospheric flow during dry and wet conditions, a representative area-mean winter precipitation time series was computed for Portugal and six extremely dry and six extremely wet winters were selected for the analysis. Winter precipitation variability in Portugal is largely governed by large-scale modes of the atmospheric circulation over the North Atlantic. In fact, this study shows that a well-defined North Atlantic ridge yields mostly dry conditions over Portugal by controlling the preferred location of the storm track paths over the North Atlantic. The transient low pressure systems associated with the storm track constitute the main source of winter precipitation in Portugal and, consequently, clear differences between the storm track in the wet and dry winters were identified. During dry winters, a clear maximum extends from the eastern coast of North America towards the British Islands, following a southwest-northeast tilted path. Conversely, during wet winters, a much more zonal path characterizes the storm track. This shift in the trajectory is also present both in the transient enthalpy fluxes and in the momentum fluxes. With the purpose of isolating the dynamical forcing mechanisms that contribute to these contrasting conditions, the patterns of the Empirical Forcing Function (EFF) are discussed. For the dry winters, the EEF pattern depicts a clear dipolar structure over the North Atlantic; cyclonic (anticyclonic) generation of potential vorticity is found upstream (downstream) of the anomalously strong ridge, while a much smoother, weaker and zonal pattern is depicted over the North Atlantic for the wet winters. The identification of these dynamical differences between the two contrasting conditions is therefore essential to understand the large-scale mechanisms that commonly trigger the occurrence of drought episodes in Portugal.