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Climatology, dynamics and regional impacts of Euro-Atlantic blockings and sub-tropical ridges

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Blocking high pressure systems are large-scale atmospheric circulation patterns with meteorological impacts that vary across regions and seasons, depending on the blocking location, spatial characteristics and temporal length. Blocking episodes are an important component of the intra-seasonal and inter-annual variability at mid-latitudes. We performed a thorough characterization of Euro-Atlantic blocking occurrence within different longitudinal sectors (Atlantic, European and Russian), and a comprehensive analysis of their seasonal and regional impacts in temperature and in precipitation regimes. In order to distinguish high-latitude blocking from other common high pressure systems affecting Europe, namely sub-tropical ridges, a novel ridge detection scheme was developed. Ridges do not require a wave-breaking occurrence as blockings do, although they are frequent precursors of wave-breaking and subsequent blockings. Thus, a novel characterization of the distinctive seasonal impacts associated with sub-tropical ridges occurring in different longitudinal sectors of the Euro-Atlantic region was performed. Finally, an assessment of the dynamical mechanisms behind the temperature and precipitation responses to blocking was performed. This includes for precipitation the role of cyclonic activity (storm-tracks and cut-off lows), moisture transport, and large-scale atmospheric instability, while for temperature the focus was on the role played by horizontal advection, subsidence and imbalances in various radiation budgets.

This distinction clarifies that most extreme heat episodes in southern Europe and Mediterranean areas should not be attributed to blockings, but rather to ridges. In central and northern European areas, both regimes are responsible for warm conditions in summer, due to enhanced radiative heating and increased subsidence. During winter, blocking and ridges lead to opposite temperature responses. Blocks reinforce cold northerly advection in their eastern flank, promoting cold winter spells, especially those centered in the eastern Atlantic and western Europe, while mild Atlantic flows associated to ridge patterns result in warmer conditions – in Sousa et al., 2017b, Climate Dynamics.

Blocking and ridges are associated with a marked north-south dipole in precipitation anomalies. While blocks force a split of the storm-track, ridges are associated with a stronger zonal flow at higher latitudes. Thus, negative (positive) precipitation anomalies during blocks occur at higher (lower) latitudes. Enhanced atmospheric instability and cyclonic activity south of blocking centers relate with increased rainfall in southern Europe, where torrential regimes significantly contribute to precipitation totals. This dipole reverses during ridges, which lead to dry conditions in southern Europe, and increase moderate rainfall classes northwards under enhanced zonal flow conditions – in Sousa et al., 2017a, Climate Dynamics.

Sousa PM, Trigo RM, Barriopedro D, et al., Clim. Dyn. 2017a. doi: 10.1007/s00382-016-3132-5
Sousa PM, Trigo RM, Barriopedro D, et al., Clim. Dyn. 2017b. doi: 10.1007/s00382-017-3620-2

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