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Relationship between atmospheric blocking and thunderstorm activity over western and central Europe

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Severe thunderstorms and associated hazardous weather events frequently cause considerable damage to buildings, crops, and automobiles, resulting in large monetary costs in many parts of Europe and the world. Despite the high relevance for questions regarding trends of such events caused by climate change, the role of natural variability and large-scale mechanisms on the persistence behind that are not well understood. In this work, we established a relationship between the occurrence of atmospheric blocking over the eastern North Atlantic and northern Europe and the incidence of thunderstorm activity in western and central Europe. This includes a discussion of how blocking modulates the relevant atmospheric processes that support or suppress the development of convective storms. To analyze the link between both, lightning data from 2001 to 2014 were compared with blocking events based on the ERA-Interim reanalysis using the odds ratio to determine the strength of association.

Two relevant blocking areas over the eastern part of the North Atlantic and over the Baltic Sea or southern parts of Scandinavia can be identified, which influence the occurrence of deep moist convection in parts of western and central Europe statistically significant (far-field effect). Based on the mean ambient conditions on days with blocking, we discovered relevant dynamic and thermodynamic processes supporting or suppressing the development of thunderstorms. We found that the anticyclonic circulation of a block over the eastern part of the North Atlantic leads to a northerly to northwesterly advection of drier and more stable air masses at the eastern flank of the block (*convection-inhibiting conditions*). In addition, the environmental conditions tend to cause on average a large-scale subsidence of air masses above the investigation area. In contrast, the southerly to southwesterly advection of warm, moist and unstable air masses from the Mediterranean on the western flank of a block over the Baltic Sea results in *convection-favouring conditions* over Europe. It is interesting to note that both blocking situation are on average associated with weak wind speeds at mid-troposphere levels or weak wind shear, respectively. As a consequence, thunderstorms related to atmospheric blocking over the Baltic Sea are on average probably less organized.