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The dynamical link between surface cyclogenesis, upper-tropospheric Rossby wave breaking and the life cycle of the Scandinavian blocking

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The Scandinavian blocking is a well-known quasi-stationary state of the atmospheric flow and one of the four main weather regimes over the Euro-Atlantic domain in winter. It has a major impact on the European climate leading to long-lived cold periods in winter whose triggering and decay phases are still difficult to forecast. Furthermore, their dynamics are still a matter of debate. The aim of our study is to analyze the link between surface cyclogenesis, upper-tropospheric Rossby wave breaking (RWB) and the life cycle of the Scandinavian blocking (SB) using ERA40 reanalysis (1958-2001) from mid-October to mid-April. One of the preferential path between weather regimes in which the SB is involved is hereafter analyzed. It is characterized by the transitions from the zonal to blocking regimes and from the blocking to Greenland anticyclone regimes. Surface cyclogenesis is automatically detected by a tracking algorithm based on maxima of relative vorticity and Rossby wave breaking by local reversal of the potential vorticity (PV) gradient.

During the onset of blocking, Atlantic cyclones have straight trajectories that extend toward the north of Scandinavia where they are strongly deepened. These surface cyclones are connected to anticyclonic wave breakings (AWBs) in the upper troposphere over Europe. These AWBs advect low-PV air toward Northern Europe creating the blocking characteristic anticyclone over Scandinavia.
During the destruction of the blocking, cyclones are much less present in the eastern part of the Atlantic and most of them present curved trajectories in mid-Atlantic. They are shown to be linked to cyclonic wave breakings (CWBs) to the south of Greenland. These CWBs destroy the strong zonal PV gradient of the blocking over the Atlantic ocean and advect low-PV air toward the Greenland therefore creating the Greenland anticyclone weather regime or the negative phase of the North Atlantic Oscillation.

To conclude, our study shows that distinct wave breaking events participate in the onset and decay of the SB and are related to different behaviours in surface cyclones over the Atlantic.