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The sensitivity of atmospheric blocking to changes in upstream latent heating

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Recent climatological studies based on trajectory calculations have pointed to an important role of latent heating during cloud formation for the dynamics of blocking anti-cyclones. However, the causal relationship between latent heating and blocking formation has not yet been fully elucidated. To explicitly study this causal relationship, we perform sensitivity simulations of selected blocking events with a global weather prediction model in which we artificially eliminate latent heating in clouds upstream of the blocking anti-cyclones. This elimination has substantial effects on the upper-tropospheric circulation in all case studies, but there is also significant case-to-case variability: some blocking systems do not develop at all without upstream latent heating, while for others the amplitude of the blocking anticyclones is merely reduced. This strong influence of latent heating on the upper-level circulation is due to a combination of two effects: the direct injection of air masses with low potential vorticity (PV) into the upper troposphere in strongly ascending “warm conveyor belt” airstreams, and the indirect effect owing to the interaction of the associated divergent outflow with the upper-level PV structure. The important influence of diabatic heating demonstrated with these experiments suggests that an accurate parameterization of microphysical processes in weather prediction and climate models is crucial for adequately representing blocking dynamics.