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The Role of Latent Heating in a North-Atlantic Baroclinic Environment Conducive to Extratropical Cyclone Clustering

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A cluster of severe extratropical cyclones (Dudley, Eunice and Franklin) hit North-Western Europe within one week in February 2022, and caused widespread damage and fatalities by strong wind gusts and high accumulated precipitation amounts. These cyclones developed over the North-Atlantic within a baroclinic environment with strong jet streams accompanied by atmospheric rivers. Extratropical cyclone clustering is counterintuitive because individiual cyclones reduce large-scale temperature gradients and baroclinicity that are essential for their growth. We hypothesise that diabatic heating through latent heat release enhances the baroclinic environment favourable for secondary cyclogenesis. To quantify the influence of latent heat release on this baroclinic environment, we performed idealised model experiments with the Open Integrated Forecast System (OpenIFS) from the European Center for Medium Range Weather Forecastst (ECMWF). The latent heat of vaporisation constant was enhanced and reduced by 50 percent respectively.

The control experiment captured the location, speed and direction of the jet stream, and the path and intensities of the individual cyclones well. The model results show that reduced latent heating weakens the jet stream strength, while enhanced latent heating strengthens the jet stream strength. The baroclinic environment responds similarly — i.e., the meridional temperature gradient decreases with reduced latent heating and increases with enhanced latent heating. We plan to apply the isentropic slope diagnostic for baroclinicity to quantify the diabatic contributions of latent heating to the baroclinic environment. We also plan to discuss the effects of latent heating on the individual cyclones. With this case-study we explore diabatic heating as a pathway for extratropical cyclone clustering.

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