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Future changes in North Atlantic winter cyclones in CESM-LENS: cyclone intensity and horizontal wind speed

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Strong low-level winds are among the most impactful effects of extratropical cyclones on society. The wind intensity and the spatial distribution of wind maxima may change in a warming climate, however, the dynamics involved are not clear. Here, structural and dynamical changes of North Atlantic cyclones in a warmer climate close to the end of the current century are investigated with storm-relative composites based on Community Earth System Model Large Ensemble (CESM-LE) simulations. Furthermore, a piecewise potential vorticity inversion is applied, to attribute such changes in low-level winds to changes in PV anomalies at different levels.

We identify an extended wind footprint southeast of the cyclone centre, where the wind speed tends to intensify in a warmer climate. Both an amplified low-level PV anomaly driven by enhanced diabatic heating and a dipole change in upper-level PV anomalies contribute to this wind intensification. On the contrary, wind changes associated with lower- and upper-level PV anomalies mostly compensate each other upstream of the cyclone center. Wind changes at upper levels are dominated by changes in upper-level PV anomalies and the background flow. All together, our results indicate that a complex interation of enhanced diabatic heating and altered upper-tropospheric wave dynamics shape future changes in near-surface winds in North Atlantic cyclones.