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The role of SST gradients in the development of North Atlantic maritime storms

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Windstorms are clusters of extremely high surface wind speeds, and are a major natural hazard associated with the highest loss potentials in Europe. Over the North Atlantic, some windstorms owe their existence to explosive extra-tropical cyclones. Strong sea-surface temperature (SST) gradients over the eastern North American coast can assist in the growth of these cyclones by increasing lower-tropospheric baroclinicity, such that they produce destructive winds at the surface. This study explores the relationship between cyclone and windstorm growth, as well as the SST gradients and Eady Growth Rates which precede these extreme cyclones.

Using 6-hourly ERA-interim data from 1979-2000, maritime windstorms which reside in the North Atlantic basin (80-15W, 30-60N) are tracked by tracking clusters of anomalously high surface wind speeds in time, and cyclones are tracked by identifying maxima in MSLP vorticity. Then, the two systems are matched subject to lifetime and distance criteria.

We found that windstorms are first detected, on average, around the time of maximum intensification of cyclones. In addition, over 95% of the windstorms appear after the occurrence of the cyclone. There is also a significant correlation ($p < 0.01$) between the the maximum intensification rates of both systems.

Then, considering only cyclones which are followed by a windstorm, we construct Lagrangian composites of Eady Growth Rates (850-500 hPa) and SST gradients centered on the cyclones. Stronger and zonally extended SST gradients can be found on the Southern quadrant of the cyclones, and higher Eady Growth Rates are situated directly next to the center of the cyclone. The highest density of anomalous points (values greater than the local mean plus standard deviation) included in both the composites are located around the North Atlantic Current region.