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Surface wind storms in relation to mid-tropospheric baroclinicity

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Severe surface wind storms are substantially influenced by mid- and upper-tropospheric growth factors. Some of the main factors include divergence and vorticity advection in the upper troposphere, latent heat release, low static stability and baroclinic waves in the mid troposphere.
In this study we examine this baroclinicity as an example of potential growth factors for extra-tropical cyclones.

Previous analysis have shown a link between baroclinicity over the Northern Atlantic and major wind storms related to extreme cyclones over Europe. In our study we extend these works by a comparison of spatial coherence and temporal variability between surface wind storms and mid-tropospheric baroclinicity. We investigate the question whether a trend of storminess at the surface resembles the development of growth factors such as baroclinicity.

For this purpose we make use of the 20th Century Reanalysis dataset because of its temporal coverage from 1871 to 2008 and its sample size of 56 ensemble members. The Eady Growth Rate is used as a measure of baroclinicity. For cyclone identification and tracking we apply an algorithm based on the laplacian of mean sea level pressure which was firstly developed by Murray and Simmonds (1991) and further make use of a wind tracking algorithm developed by Leckebusch et al. (2008).

The spatial coherence between the horizontal distribution of baroclinicity and surface storminess is analyzed. We investigate local wind storm occurrence over Europe in relation to regions with an increase in mid-tropospheric baroclinicity over the Northern Atlantic on different spatial scales. We estimate the necessity of baroclinicity over a certain area over the Atlantic for a track of an extreme cyclone affecting a specific region. In addition the magnitude of Northern Atlantic baroclinicity could be used as an indicator of cyclone intensity and further as an indicator of the maximum possible intensity of a cyclone. In this study we will assess this hypothesis.

Further we examine the variability of the relation of baroclinicity and storminess on different time scales. Such a comparison of the variability of baroclinicity in the mid troposphere with the surface winds signal might help to gain a better understanding of decadal variability and long-term trends in storminess.