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Relationships between extra-tropical cyclone intensity measures

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Extra-Tropical Cyclones (ETC) cause the most variability in weather and a significant portion of total insured losses in Europe. Their impacts are caused by high wind speeds, heavy precipitation and large ocean waves. The intensity of ETCs can be quantified with multiple different measures such as Mean Sea Level Pressure (MSLP), relative vorticity or storm severity indices. Currently, it is not known how the various measures of ETC intensity relate to each other. The aim of this study is to determine relationships between different intensity measures, their dependence on geographical region, and on the structure and evolution of the ETCs.

ERA5 reanalysis data from 1979 to 2021 was used to study the relationships. The analysis was restricted to the cold season (from October to March) which is when the strongest ETCs most often occur. ETCs were tracked using feature tracking software TRACK with values of 850-hPa relative vorticity every three hours as input. To focus on the most relevant ETCs affecting Europe, only tracks in the North Atlantic were chosen and stationary and short-lived systems were excluded. The intensity measures were calculated by combining the ETC tracks with parameters from ERA5 reanalysis. The intensity measures analysed include the maximum 850-hPa relative vorticity, minimum MSLP, maximum wind gusts, and a storm severity index which is based on extreme 10-metre winds and their occurrence probability. Relationships between different intensity measures were analysed for land and sea areas separately using mutual information and density heatmaps.

The initial results shows that there is a correlation between maximum 850-hPa vorticity and minimum MSLP, and that this correlation is stronger over sea than land areas. However, this relationship is non-linear, with considerable spread associated with it. Additional results concerning the other measures of intensity will also be presented.