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Baseline climatology of extremely high vertical wind shears' values over Europe based on ERA-Interim reanalysis

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The dominant role in the development of deep convection is played by kinematic and thermodynamic conditions, as well as atmospheric circulation, land cover and local relief. Severe thunderstorms are considerably more likely to form in environments with large values of convective available potential energy (CAPE) and significant magnitude of vertical wind shears (VWSs). According to the most recent research, the tropospheric wind shears have an important influence on intensity, longevity and organisation of the primary convective systems – bow echoes, squall lines and supercell thunderstorms. This study, in turn, examines the role of wind structure in controlling the spatial and temporal variability of VWSs over Europe. Considering the importance of the kinematic conditions for the convective systems formation, research is limited exclusively to 0-1 km, 0-3 km and 0-6 km wind shears.

In order to compute the VWS' values, the data derived from ERA-Interim reanalysis for the period 1981-2015 was applied. It consisted of U and V wind components with 12-hourly sampling and horizontal resolution of $0.75\times0.75°$. The VWS' values were calculated as wind difference between two levels – this entails that the hodograph's shape was not considered (e.g. Clark 2013, Pucik et. al 2015). We have analysed both VWS' mean values (MN) and frequency of VWSs exceeding assumed thresholds (FQ). Taking into account previous studies (e.g. Rasmussen & Blanchard 1998, Schneider et al. 2006, Schaumann & Przybylinski 2012), the thresholds for extremely high values of vertical wind shears were set at 10 m/s for 0-1 km shear, 15 m/s for 0-3 km shear and 18 m/s for 0-6 km shear.

Both MN and FQ values were characterised by strong temporal variability, as well as significant spatial differentiation over the research area. A clear diurnal cycle was identified in the case of 0-1 km shear, while seasonal variability was typical for 0-3 km and 0-6 km shears. Regardless of the season, 0-1 km shear reached higher MN and FQ values at 00 UTC than at 12 UTC. Moreover, its spatial distribution showed distinct differences linked to the underlying surface type. Surface energy budget seems to be an important factor contributing to the diurnal and spatial variability of VWSs – it generates the formation of local air circulation leading to modification of the wind direction and speed in the boundary layer. For 0-3 km and 0-6 km shears, a noticeable spatial differentiation between land and sea areas was not recognised. The significantly higher MN and FQ values over the land were found exclusively in the case of 0-3 km shear during the winter, particularly over the Mediterranean region. In the middle troposphere, the VWS' fluctuations (0-3 and 0-6 km shears) are primarily determined by the seasonal changes in atmospheric circulation patterns over the research area.