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Near-surface wind speeds in ERA5: Climatology, decadal variability and long-term trends

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The knowledge of long-term climate and variability of near-surface wind speeds is essential and widely used among meteorologists, climate scientists and in industries such as wind energy and forestry. The new high-resolution ERA5 reanalysis from the European Centre for Medium-Range Weather Forecasts (ECMWF) will likely be used as a reference in future climate projections and in many wind-related applications. Hence, it is important to know what is the mean climate and variability of wind speeds in ERA5.

We present the monthly 10-m wind speed climate and decadal variability in the North Atlantic and Europe during the 40-year period (1979-2018) based on ERA5. In addition, we examine temporal time series and possible trends in three locations: the central North Atlantic, Finland and Iberian Peninsula. Moreover, we investigate what are the physical reasons for the decadal changes in 10-m wind speeds.

The 40-year mean and the 98th percentile wind speeds show a distinct contrast between land and sea with the strongest winds over the ocean and a seasonal variation with the strongest winds during winter time. The winds have the highest values and variabilities associated with storm tracks and local wind phenomena such as the mistral. To investigate the extremeness of the winds, we defined an extreme find factor (EWF) which is the ratio between the 98th percentile and mean wind speeds. The EWF is higher in southern Europe than in northern Europe during all months. Mostly no statistically significant linear trends of 10-m wind speeds were found in the 40-year period in the three locations and the annual and decadal variability was large.

The windiest decade in northern Europe was the 1990s and in southern Europe the 1980s and 2010s. The decadal changes in 10-m wind speeds were largely explained by the position of the jet stream and storm tracks and the strength of the north-south pressure gradient over the North Atlantic. In addition, we investigated the correlation between the North Atlantic Oscillation (NAO) and the Atlantic Multi-decadal Oscillation (AMO) in the three locations. The NAO has a positive correlation in the central North Atlantic and Finland and a negative correlation in Iberian Peninsula. The AMO correlates moderately with the winds in the central North Atlantic but no correlation was found in Finland or the Iberian Peninsula. Overall, our study highlights that rather than just using long-term linear trends in wind speeds it is more informative to consider inter-annual or decadal variability.