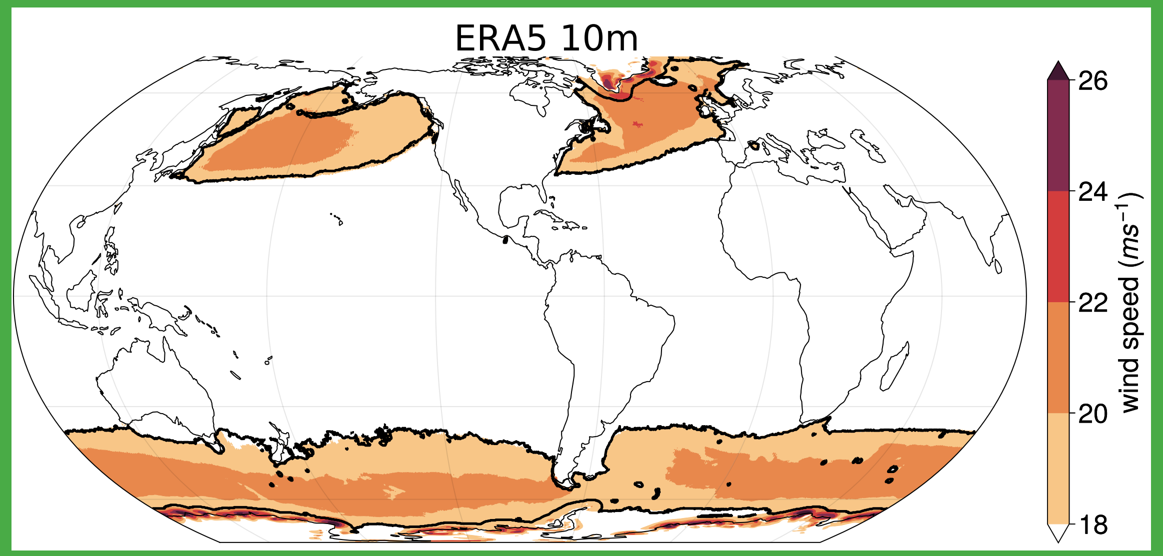

Annual 98th percentile of daily-mean 10 m windspeed

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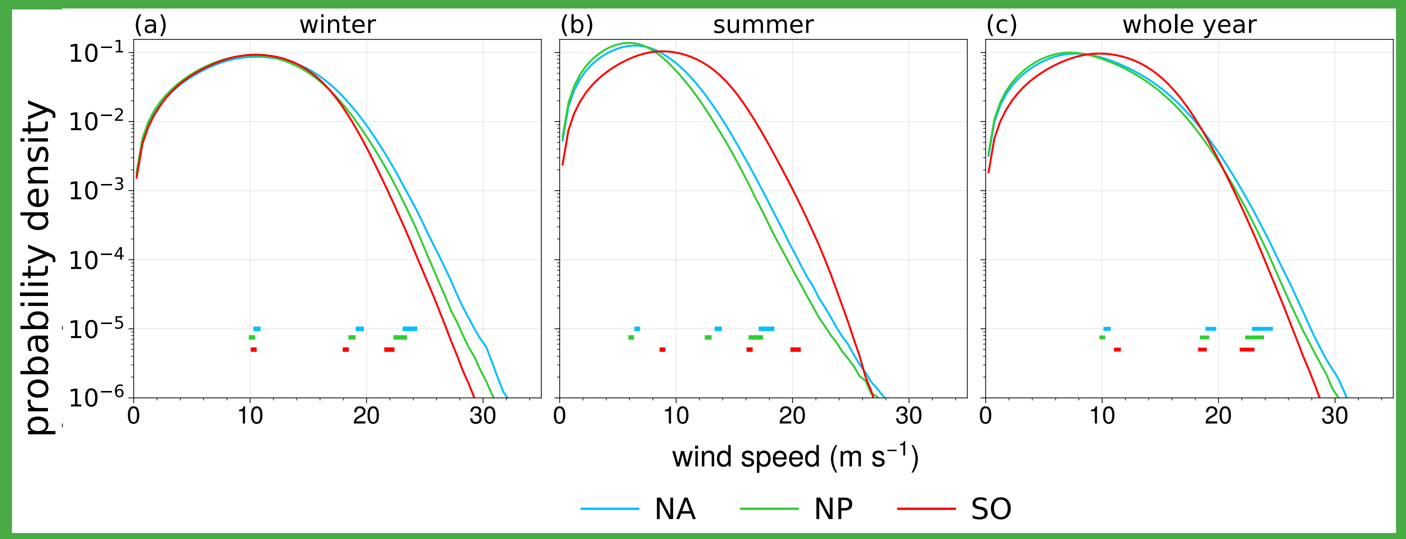

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Extreme annual quantiles are higher in the Northern Hemisphere, with the highest values in the North Atlantic. Annual extreme quantiles mainly reflect winter statistics.

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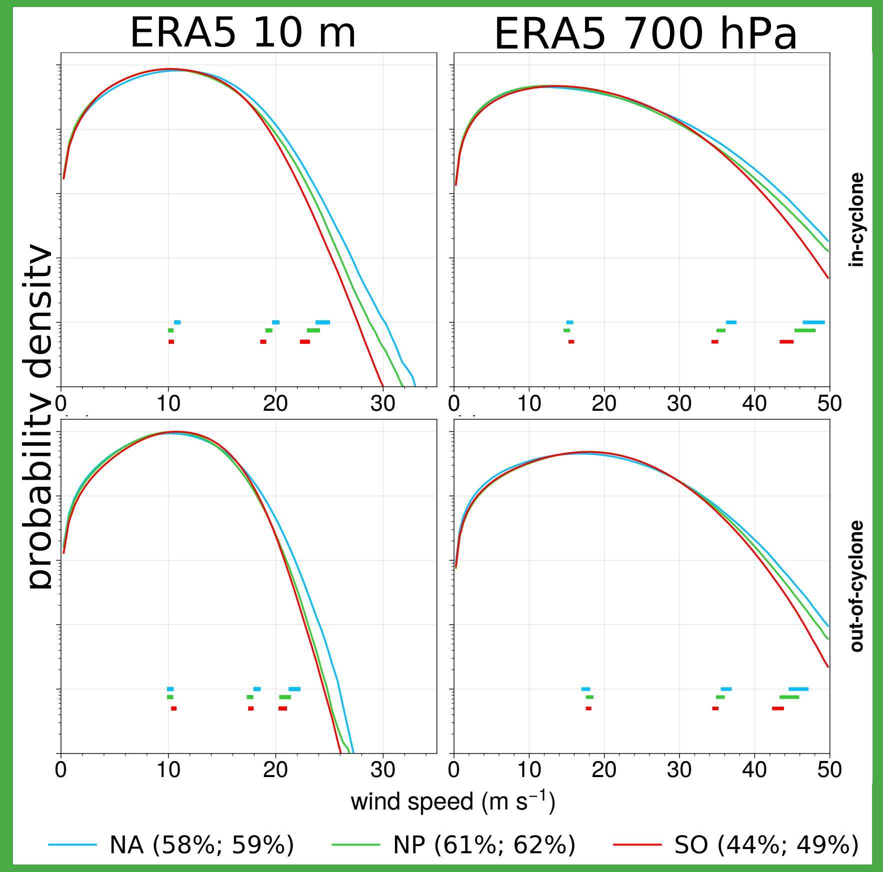

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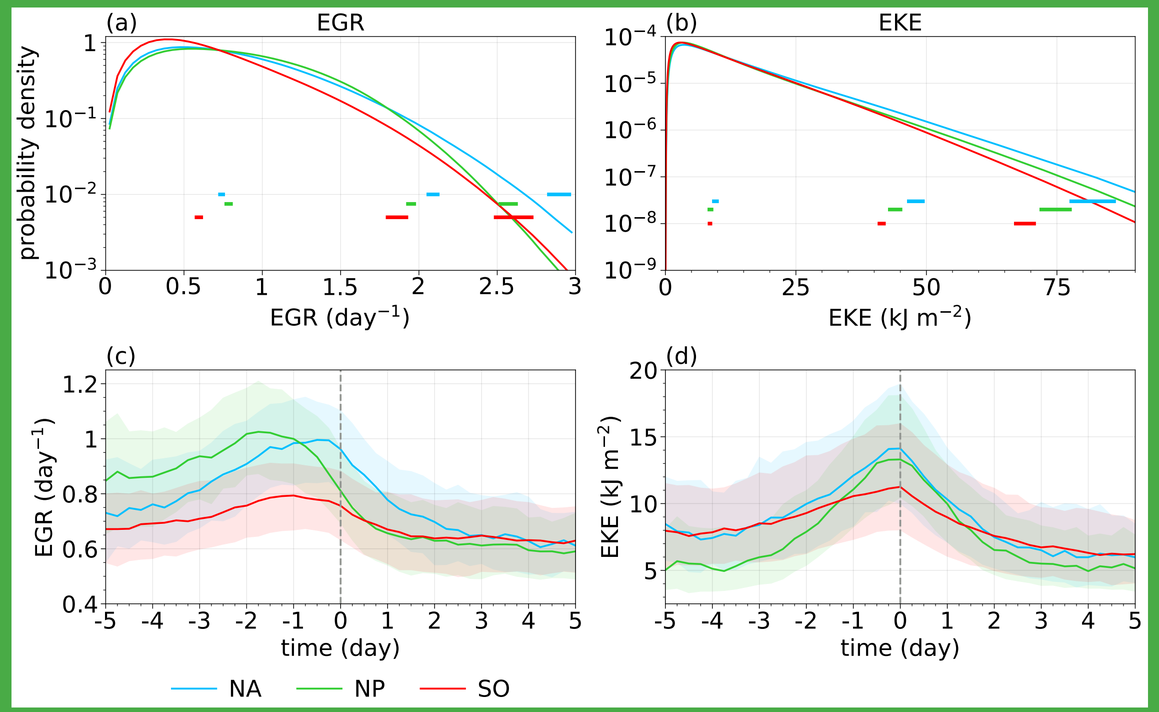

PDFs and time-series following extreme cyclones of eady growth rate and eddy kinetic energy

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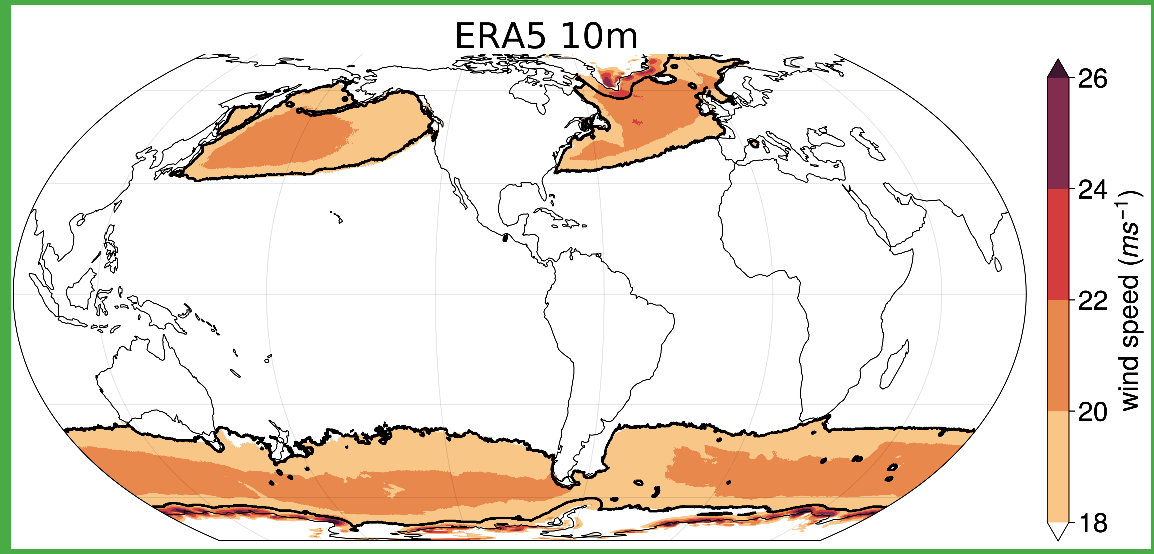

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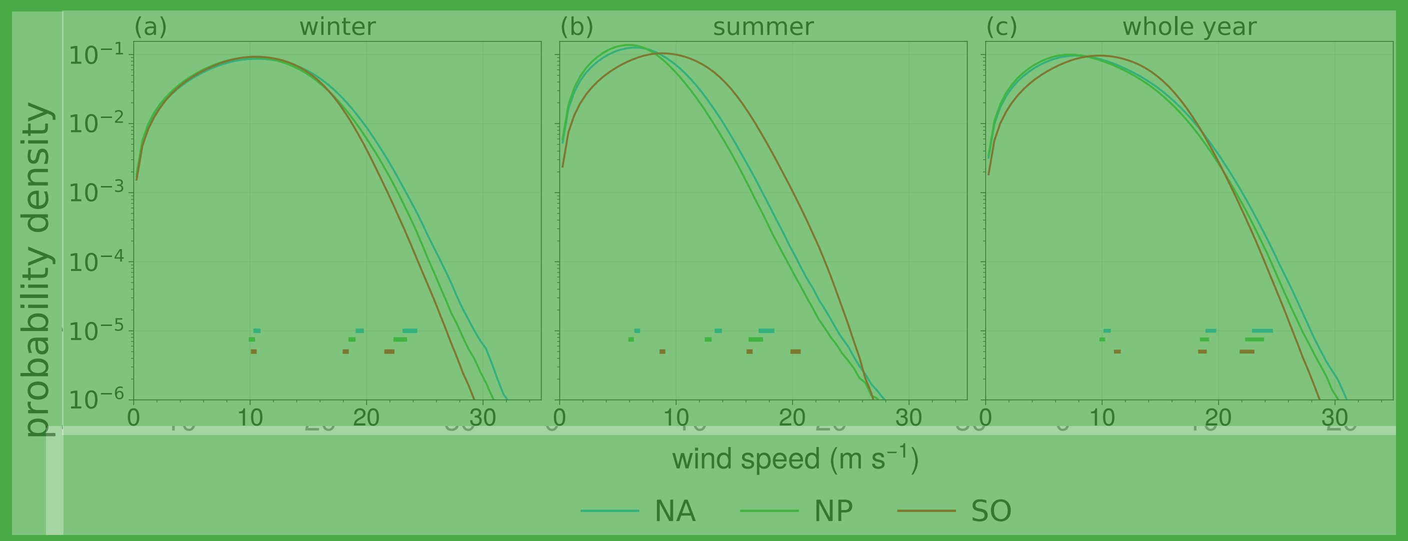

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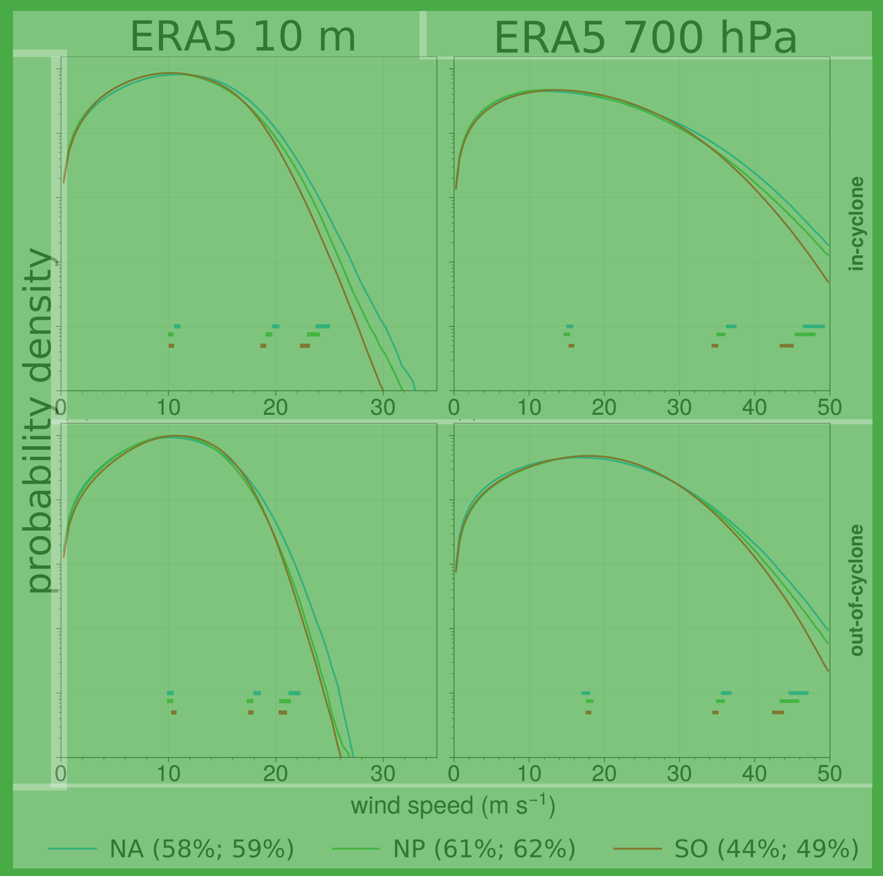

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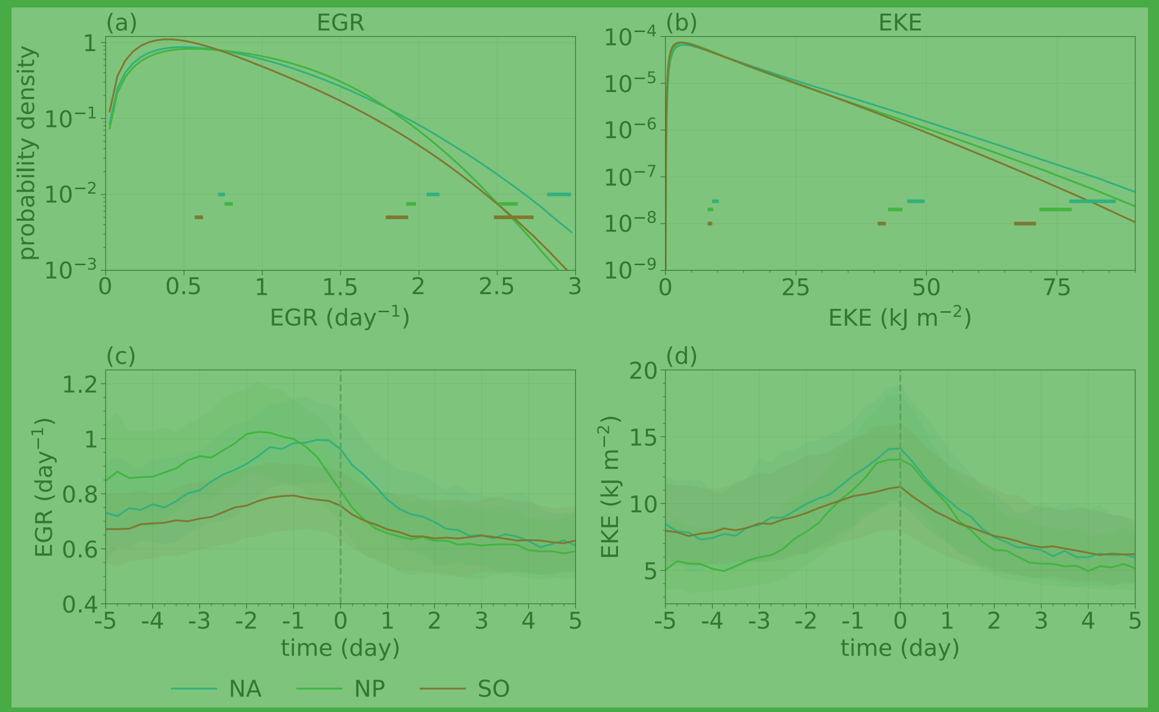

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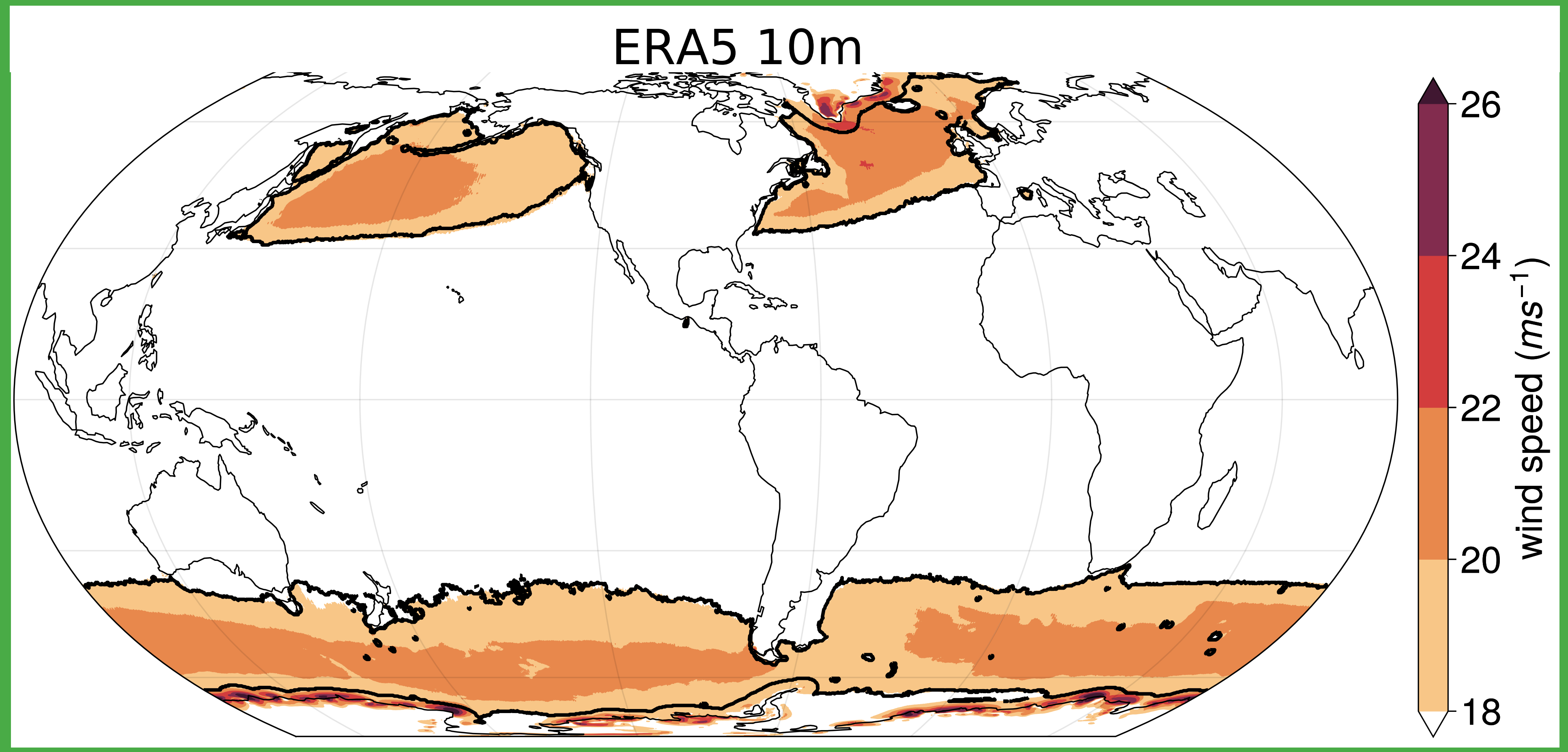

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1 A well-known feature of the observed climate is that the annual-mean surface winds are stronger over the storm track regions in the Southern Hemisphere. Whether the same is true when it comes to surface wind ***extremes*** is currently unclear. Given the hemispheric asymmetry in the mean, we might expect surface wind extremes to follow the same asymmetry.

Here we show that the opposite is true and that the surface wind extremes are stronger in the Northern Hemisphere. To show this, we select the data from the main storm track regions (see the Figure) in ERA5 reanalysis from 1979-2020. Using this data, we calculate various area-weighted empirical probability density functions (PDFs).

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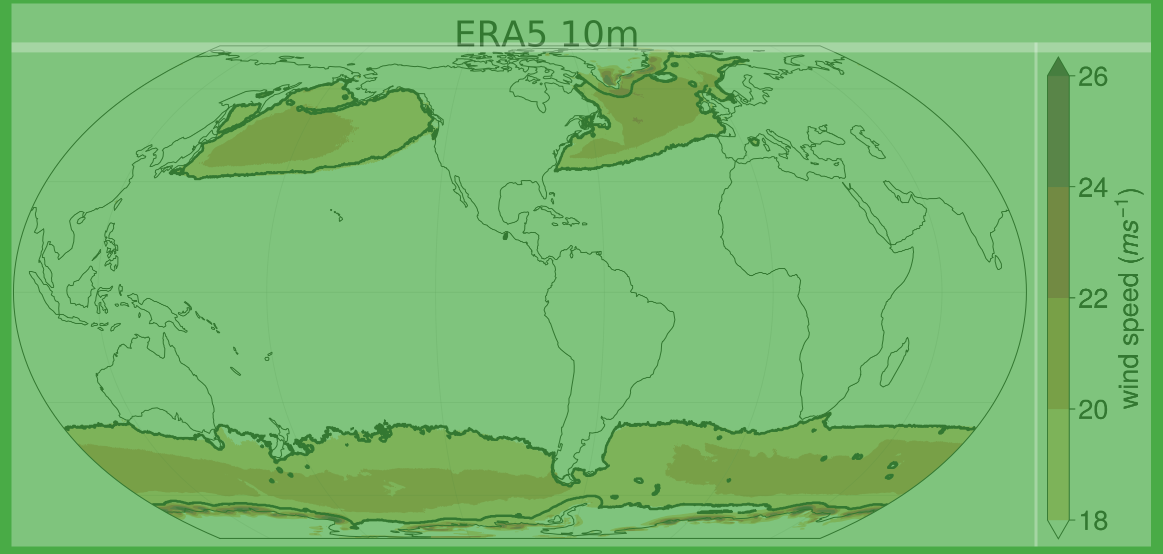

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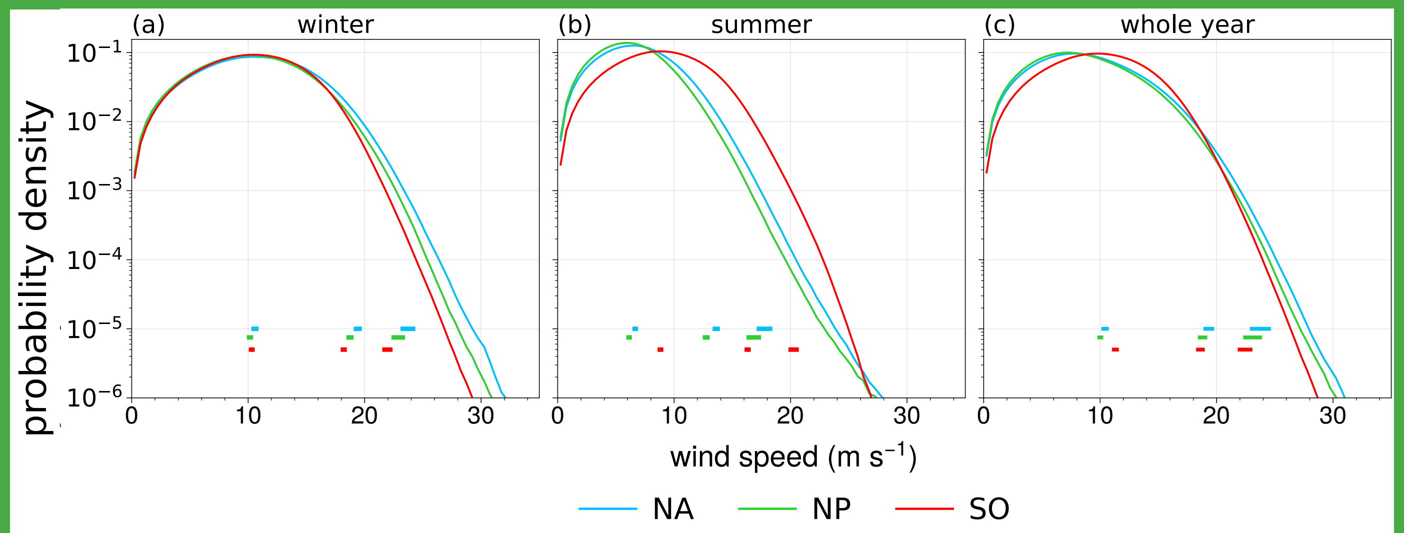

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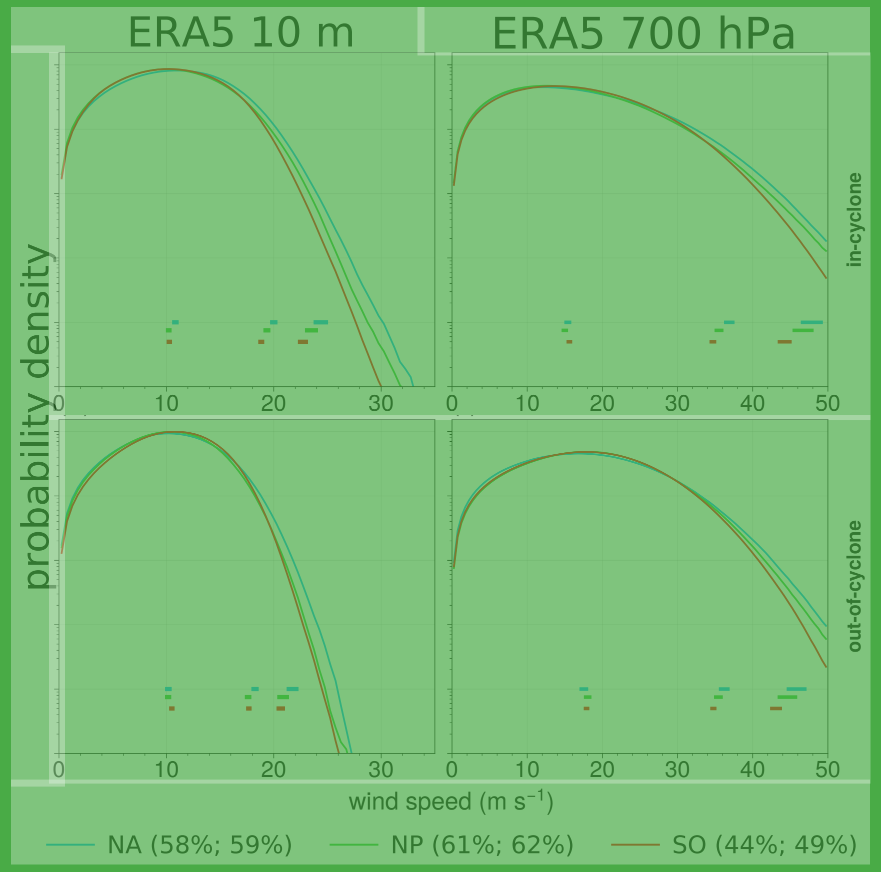

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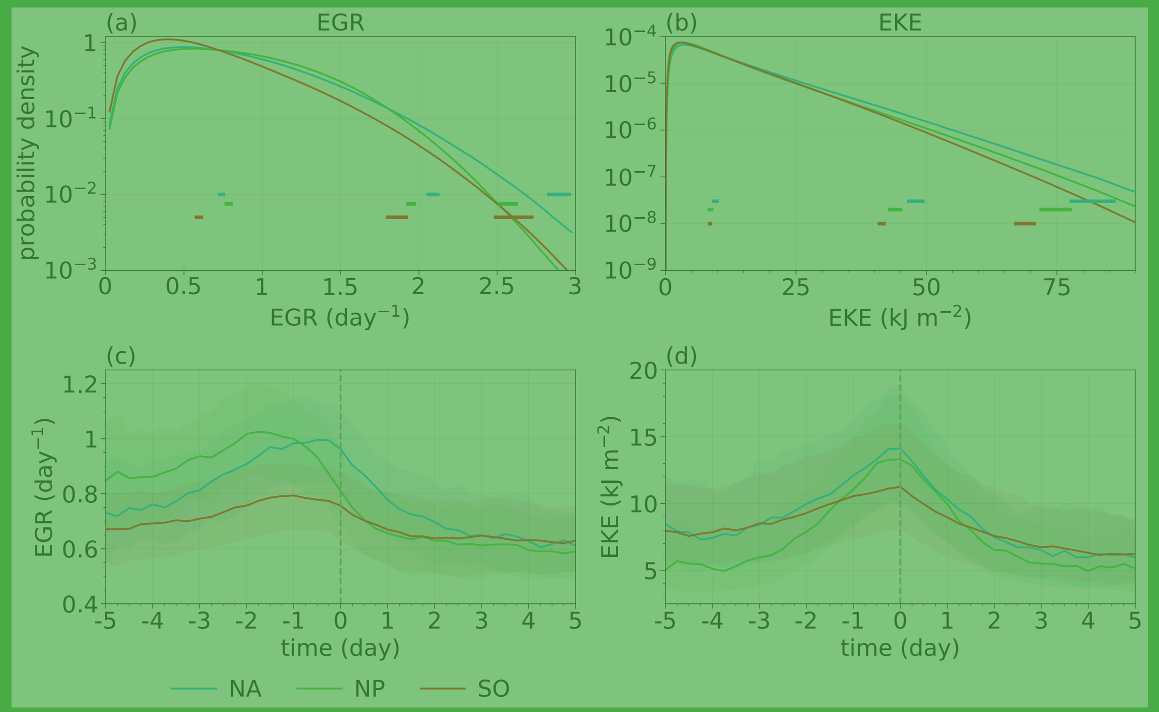

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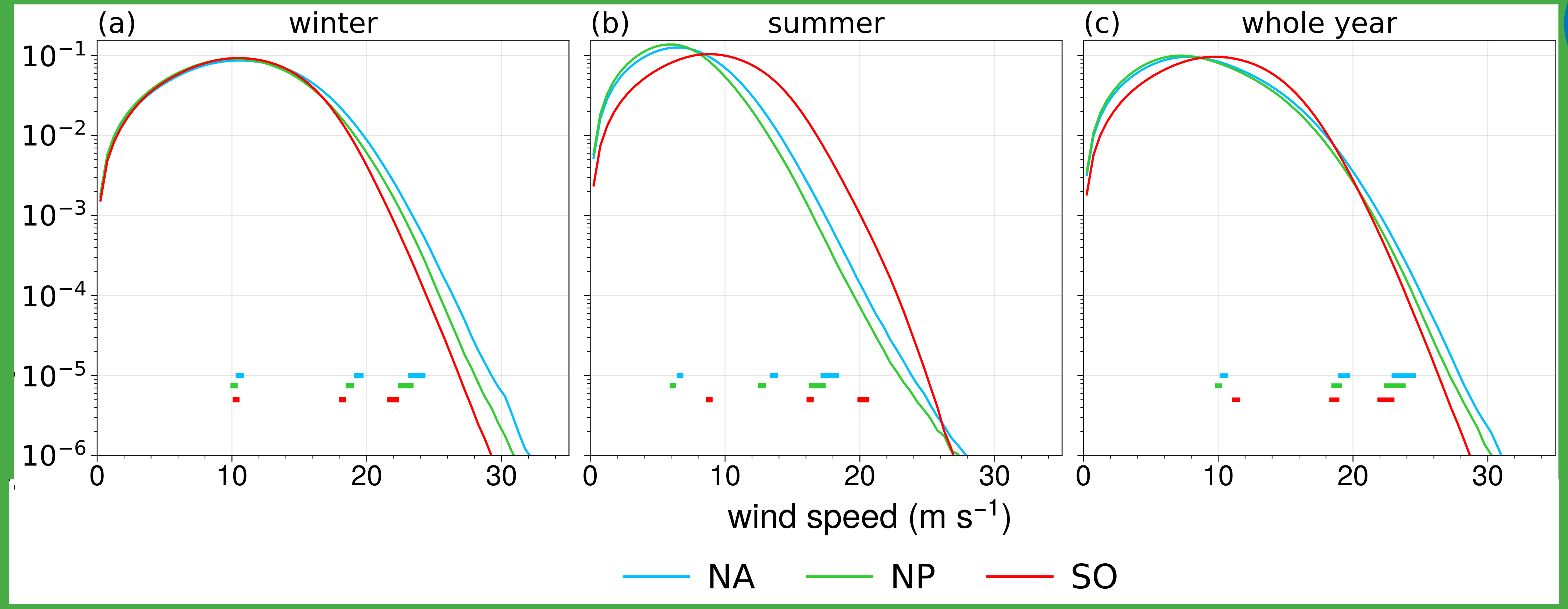

Seasonal PDFs of 10 m windspeed in the storm track regions

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This Figure shows empirical PDFs of surface windspeed for the North Atlantic (blue), the North Pacific (green) and the Southern Ocean (red). Values of 50th, 98th and 99.9th percentiles (horizontal lines, going from left to right, respectively) alongside their uncertainty ranges are shown for each PDF and in each basin.

During the respective winter seasons (Fig a), cores of the PDFs are very similar. However, basins in the Northern Hemisphere have thicker right-hand tails of distributions and significantly higher values of 98th and 99.9th percentiles. Basins in the Northern Hemisphere have stronger seasonality (see summers at Fig b), which makes the median of the annual distributions (Fig c) significantly higher in the Southern Hemisphere. However, the annual extremes are mostly reflecting the winter extremes and are, therefore, higher in the Northern Hemisphere.

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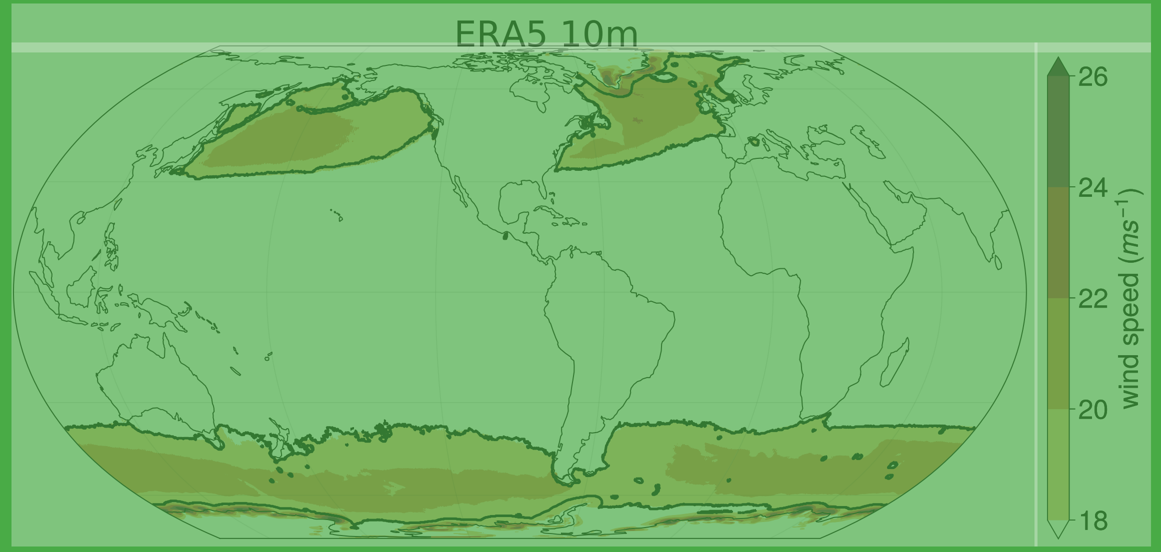

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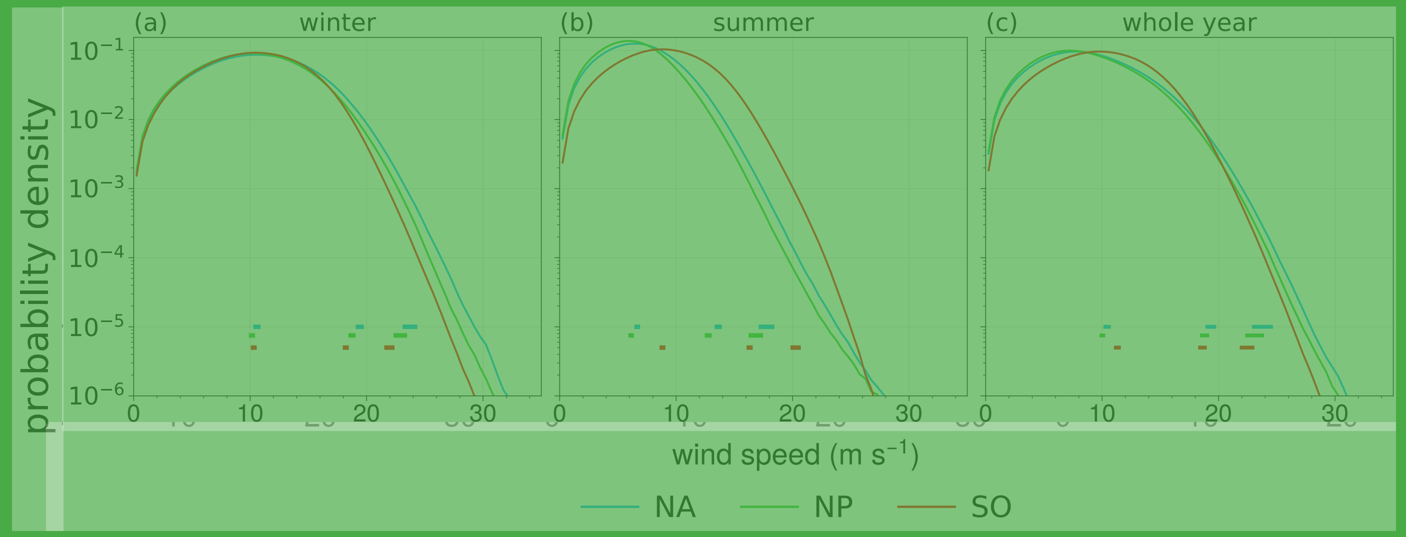

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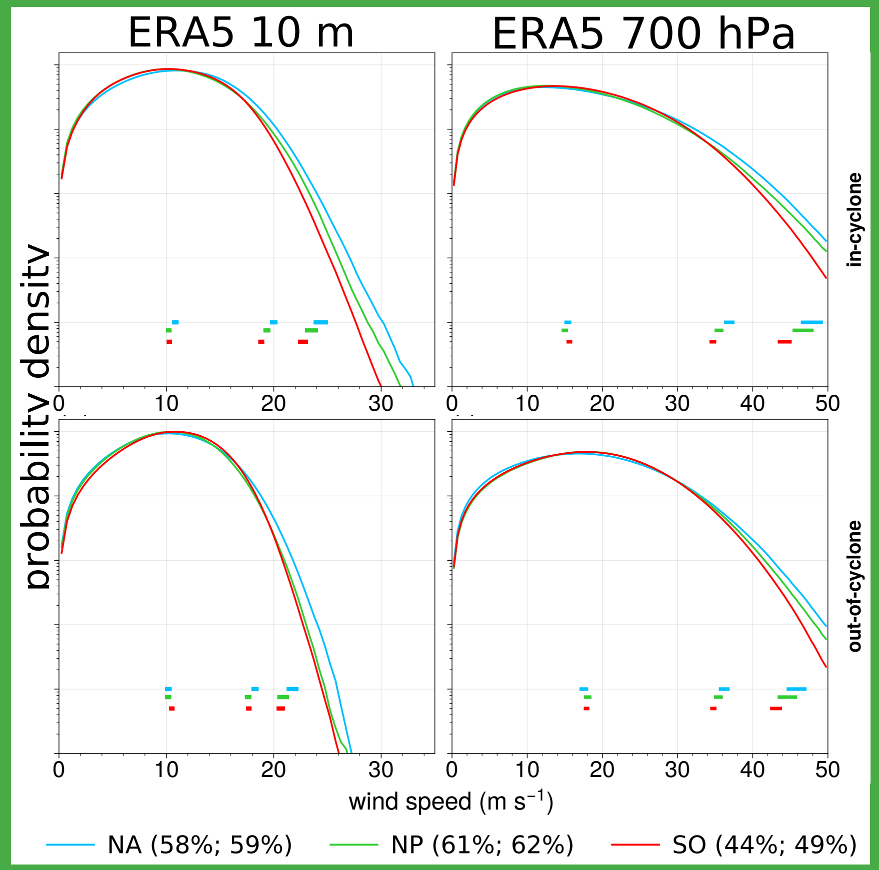

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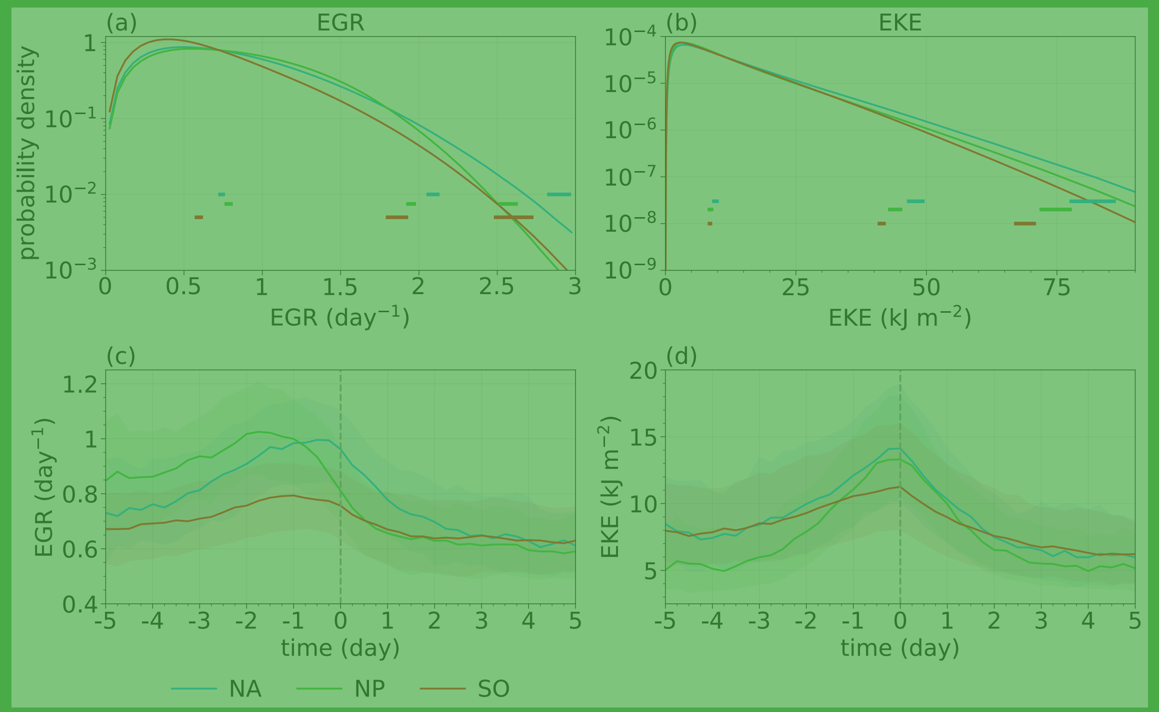

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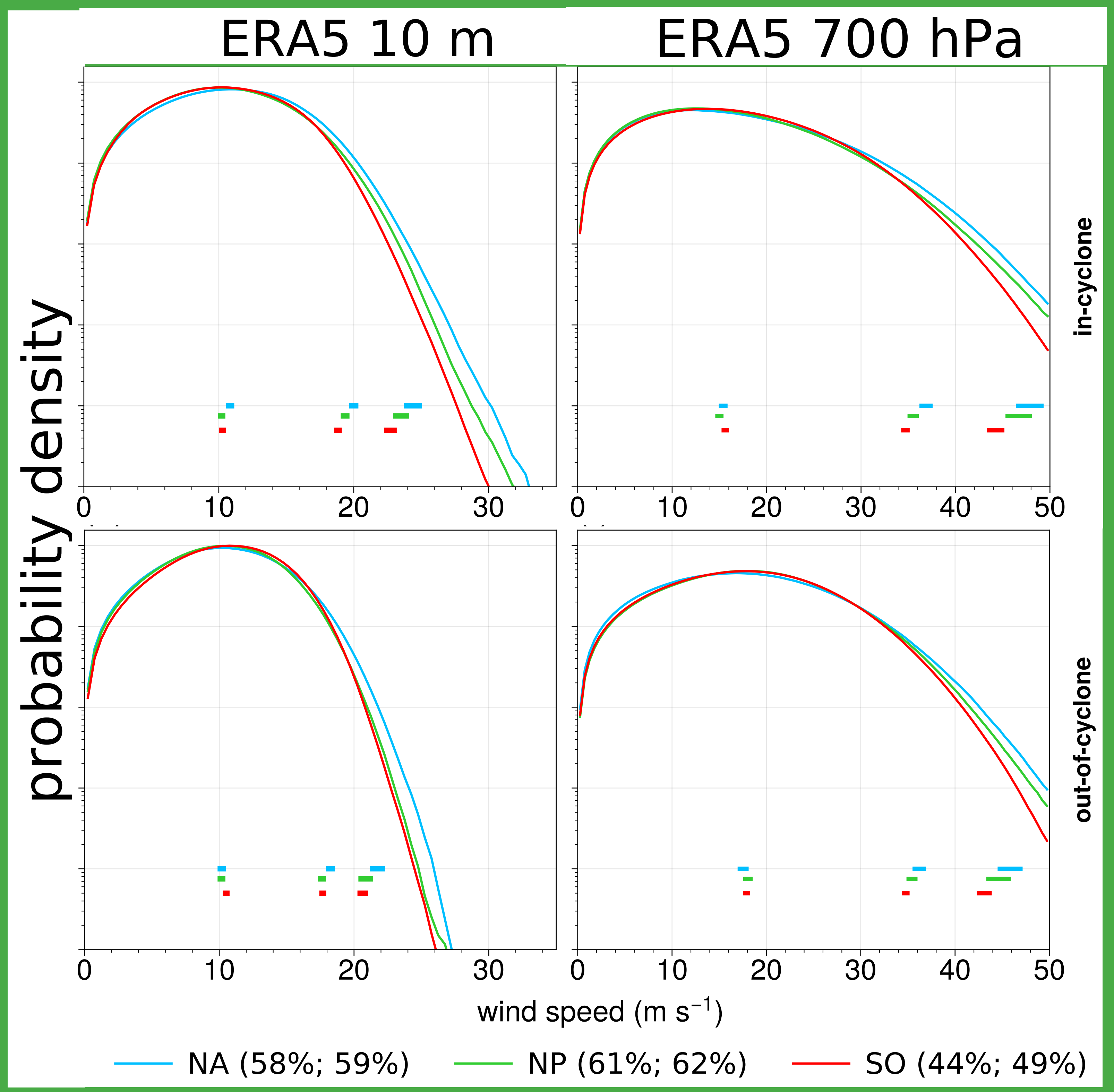

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We also employ an objective storm-tracking algorithm to compare winter PDFs of surface windspeed in- and out-of-cyclones. We focus on winter seasons, whose extremes contribute the most to the annual extremes, and when extratropical cyclones are the strongest.

We find that extreme percentiles in each basin are higher within cyclones. There are also discernible hemispheric differences within in-cyclone distributions, with the Norther Hemisphere (and the North Atlantic in particular) having stronger extremes inside of cyclones.

Cyclones are also more frequent in the Northern Hemisphere (percentages in the legend), but the higher frequency has significantly lower impact on the total (Fig 2) distributions.

Inter-hemispheric differences persist even beyond the boundary layer (at 700 hPa) which points to the influence on large-scale processes in the observed hemispheric differences.

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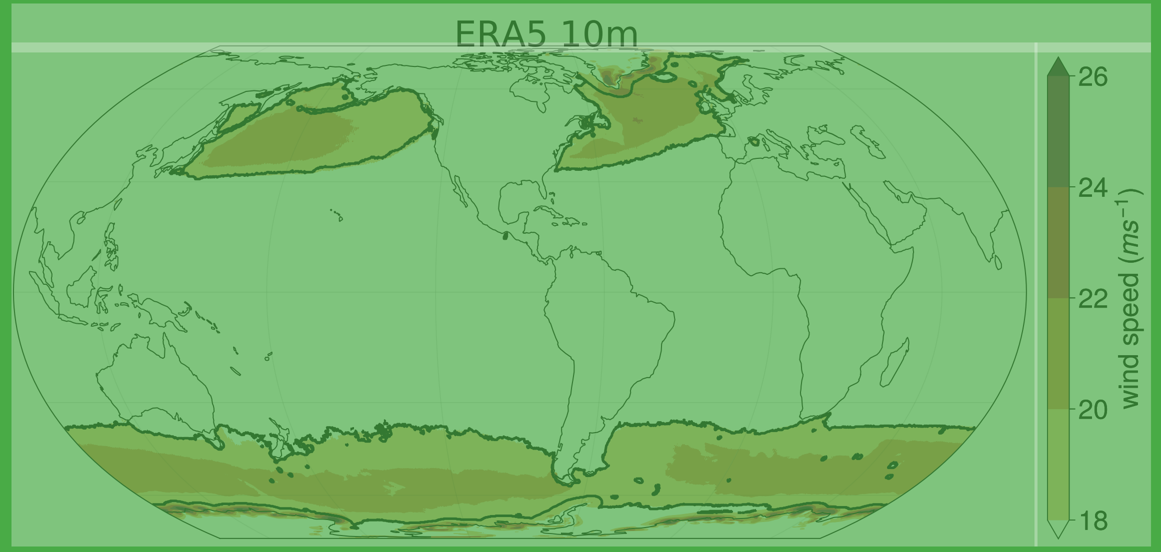

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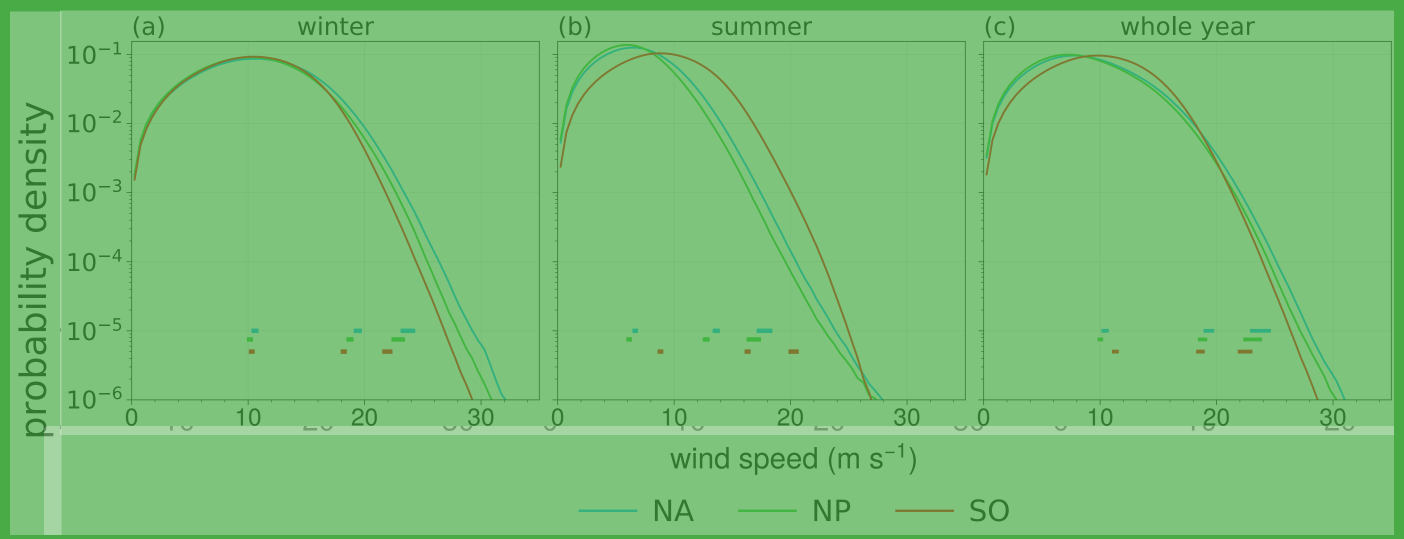

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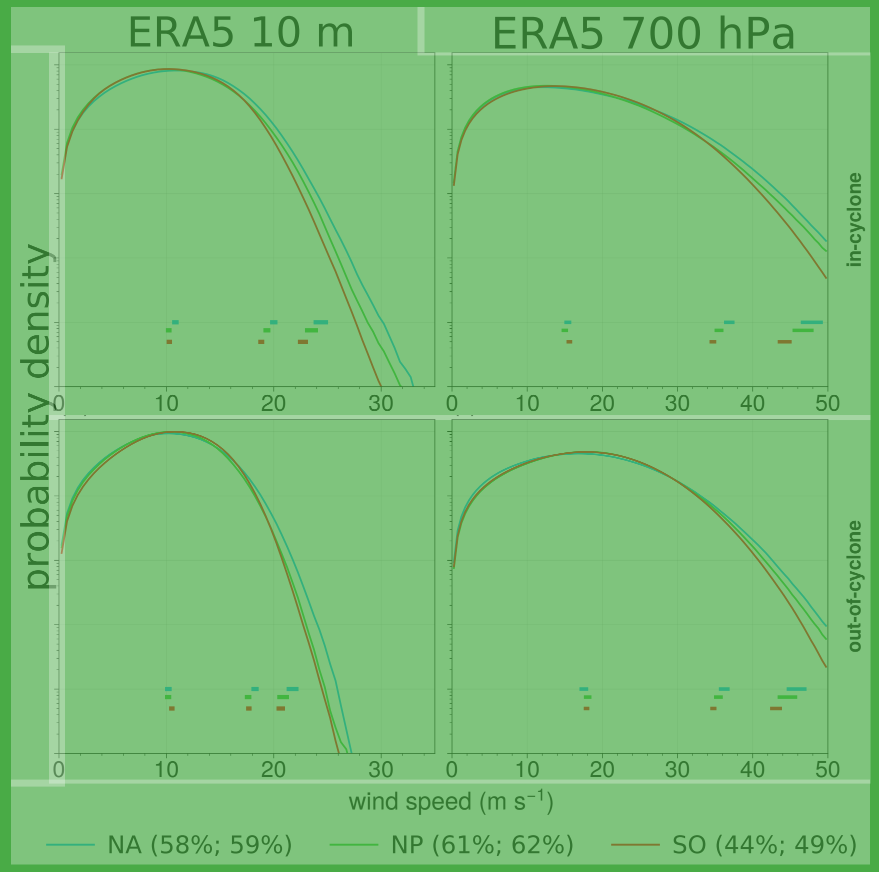

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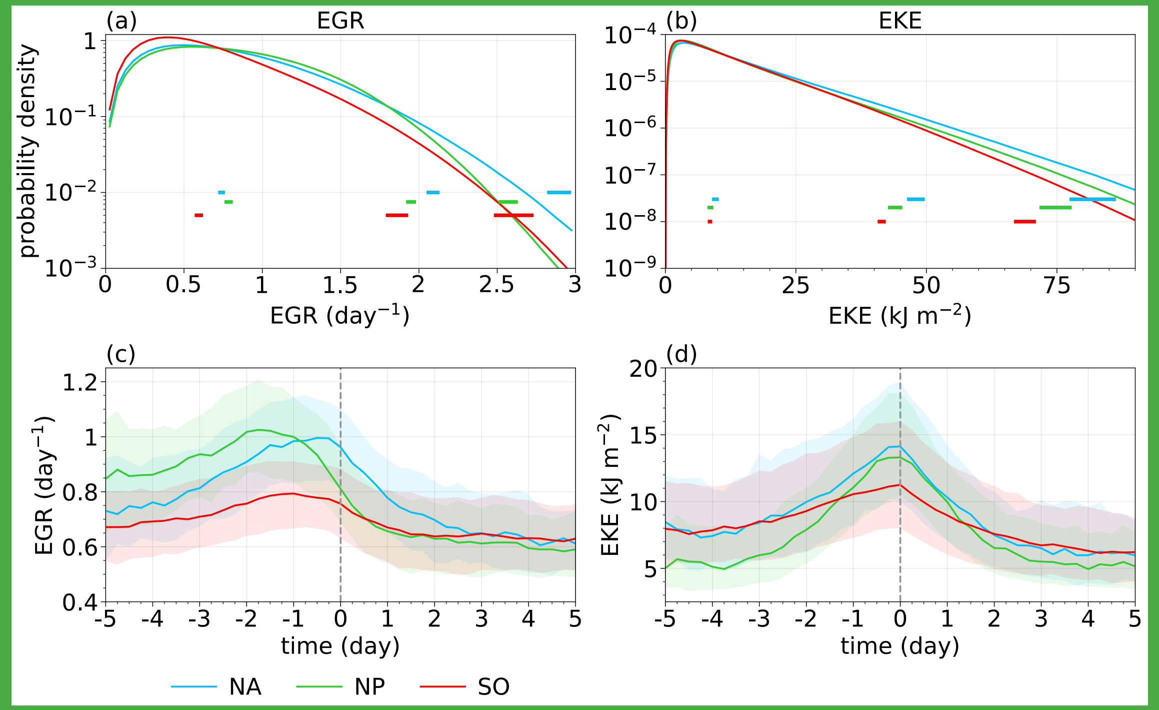

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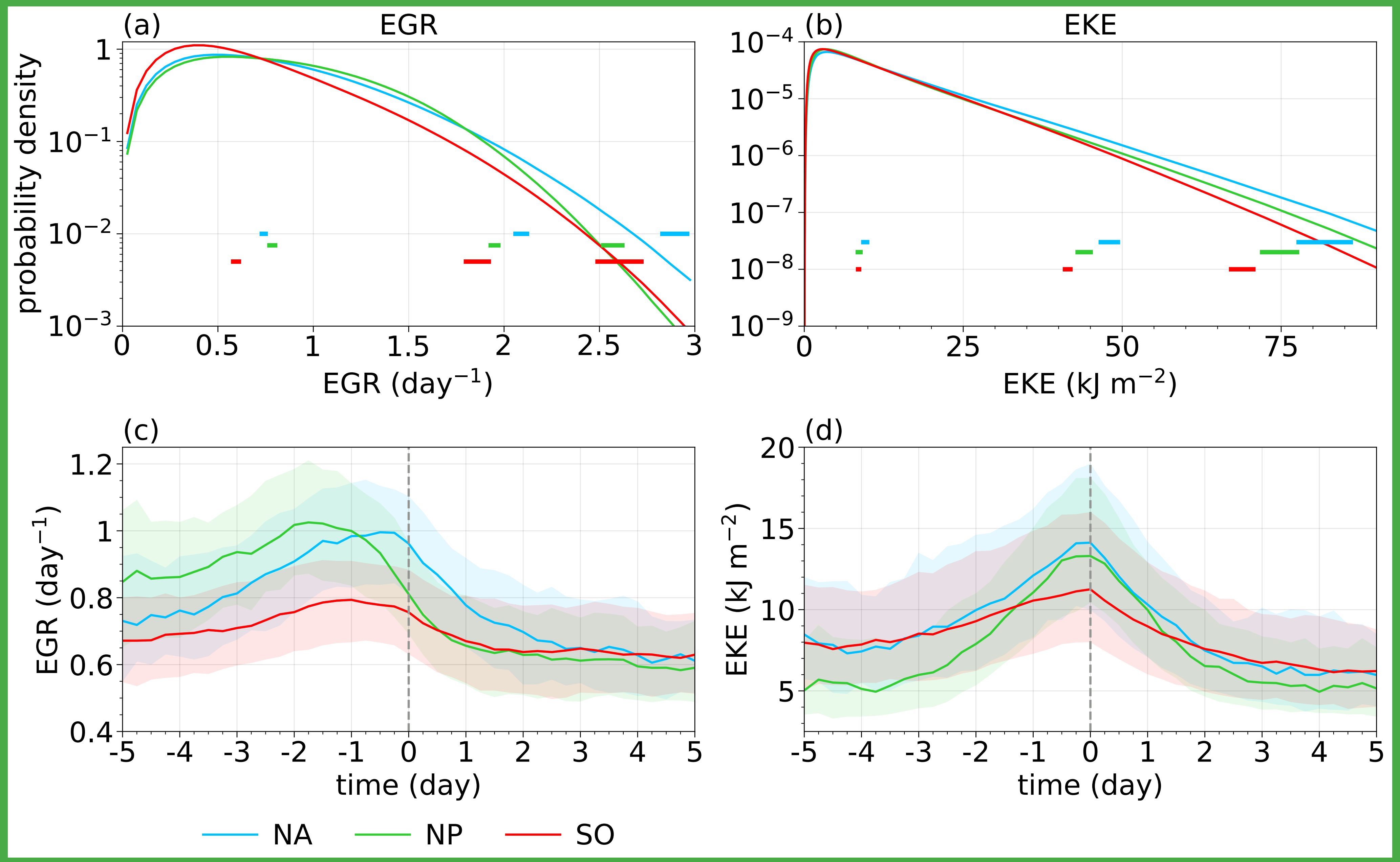

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4 Hemispheric differences in extreme surface windspeed are consistent with higher values of mid-tropospheric baroclinicity (eady growth rate, Fig a) and vertically integrated eddy kinetic energy (Fig b) in the Northern Hemisphere.

If we focus on the most extreme winter cyclones in each basin (those that cause exceedances of basin-wide 98th percentiles in areas greater than 2.5×10^5 km^2) and follow them along their tracks, we can see hemispheric differences in the areas surrounding the cyclone centers. Namely, baroclinicity is much higher in the Northern Hemisphere (Fig c), which causes stronger eddies (Fig d) - in line with the linear baroclinic instability theory. Within the Northern Hemisphere, the North Pacific has the highest values of baroclinicity (Fig c) and the growth of the eddies (Fig d). However, eddies in the North Pacific start weaker than the eddies in the North Atlantic and do not surpass maximum eddy kinetic energy of eddies in the North Atlantic during their lifetime.

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