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Linking the variability of PM10 in Europe to the position of the extratropical jet

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We have investigated the impact of the polar jet on the winter PM_{10} (particulate matter with aerodynamic diameter ≤ 10 μm) concentrations in Europe during a 10-year period. For this purpose, we have computed the daily latitude and strength of the jet by using reanalysis wind fields in the lower troposphere over the eastern North Atlantic (0°–15° W). Then we have extracted daily average surface PM_{10} observations at ~440 sites from the European air quality database (AirBase).

Four preferred jet positions have been identified over the 0°–15° W sector in winter: southern (south of 41° N), central-southern (between 41° N and 51° N), central-northern (between 51° N and 63° N) and northern (north of 63° N). They exert a stronger influence than the jet strength on the mean PM_{10} levels. Consequently, we have examined whether the full distribution of PM_{10} and the occurrence of PM_{10} extremes (exceedances of the local winter 95th percentiles) are also linked to the jet position.

The northern position is associated with enhanced PM_{10} concentrations (on average ~9 μg m^{-3} above the mean values) and threefold increases in the odds of PM_{10} extremes over northwestern / central Europe. Comparable increases have been found in southern Europe when the jet is in its central-northern position. In both cases, the rise in the PM_{10} concentrations is associated with blocking of the zonal flow over those regions and the impact on PM_{10} extremes is maximised for time lags of around 1–2 days. On the other hand, the mean sea level pressure (SLP) patterns of the central-southern jet position resemble a positive phase of the winter North Atlantic Oscillation (NAO), yielding large PM_{10} decreases (on average around −9 μg m^{-3}) in northwestern / central Europe. Similarly, the southern jet position results in low PM_{10} concentrations in southern Europe.

These results demonstrate that winter near-surface PM_{10} concentrations in Europe are strongly sensitive to the jet latitude, with implications for future projections of air pollution. As there is no consensus on the future evolution of the North Atlantic jet in a warming climate, different responses among model simulations could be relevant to understand discrepancies in their climate change projections of PM_{10} and other pollutants.