Linking the variability of PM_{10} in Europe to the position of the extratropical jet

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1. Introduction

Previous studies have shown that the variability of the extratropical jet modulates the evolution of the near-surface ozone concentrations in the US [Barnes & Fiore, 2013; Shen et al., 2015], but so far there were no studies linking the variability of air pollutants in Europe to that of the jet. Here we have assessed the impact of the jet on the surface concentrations of winter PM_{10} in Europe [Ordóñez et al., 2019].

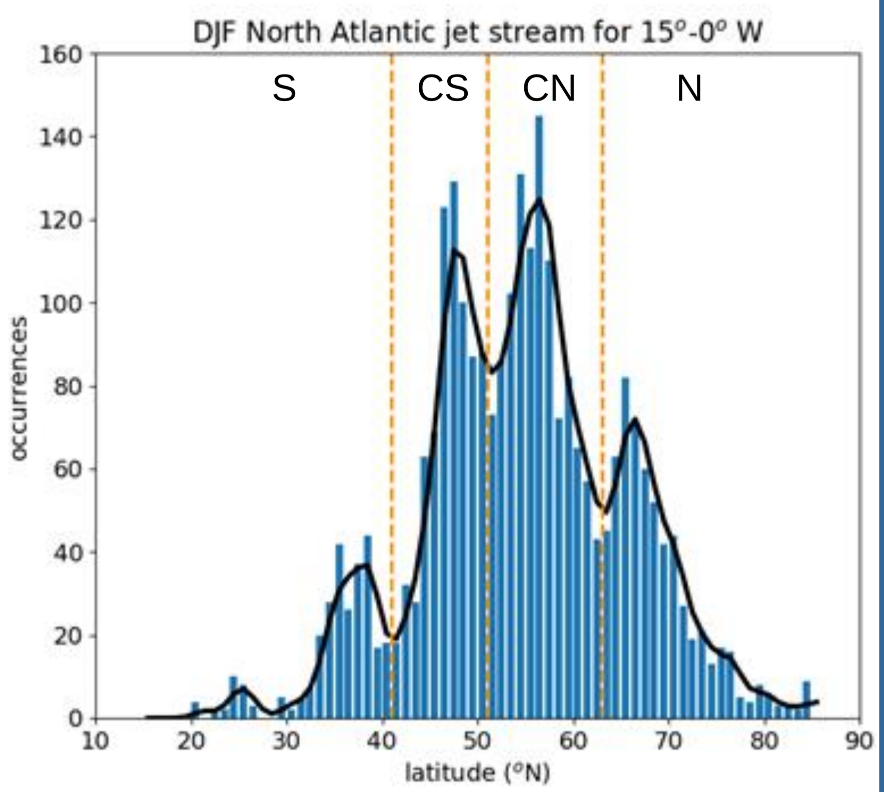
2. Detection of the eddy-driven jet stream

The daily latitude and strength of the jet stream over the eastern North Atlantic [0°–15° W] are identified from the NCEP/NCAR reanalysis during a 30-year period by adapting the algorithm by Woollings et al. [2010].

We have classified the daily jet latitudes in **four preferred positions:**

- **Southern (S):** south of 41° N
- **Central-Southern (CS):** 41° N – 51° N
- **Central-Northern (CN):** 51° N – 63° N
- **Northern (N):** north of 63° N

Distribution of the daily jet latitude in winter (DJF)

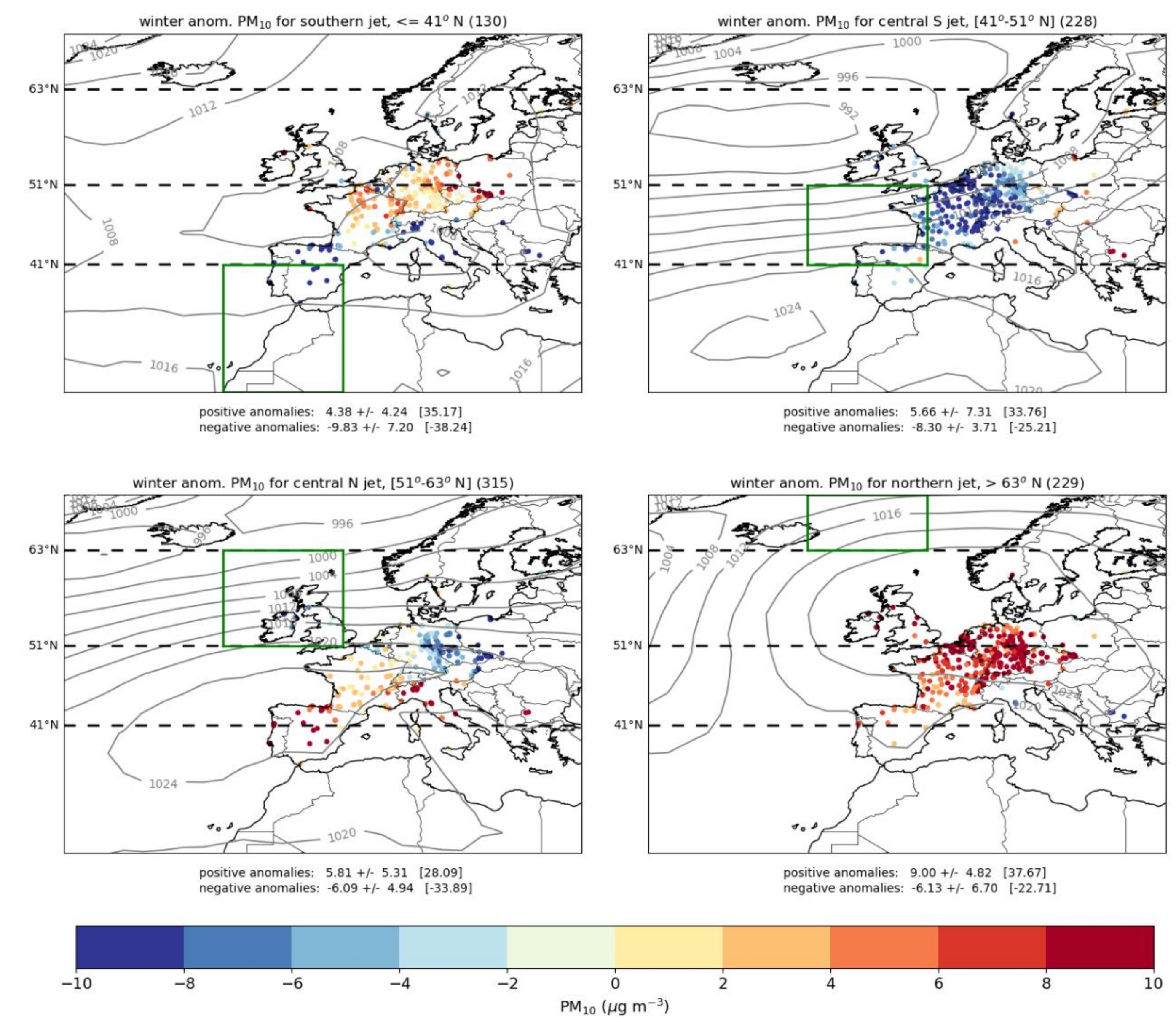


3. Impact of the jet on European winter PM_{10} concentrations

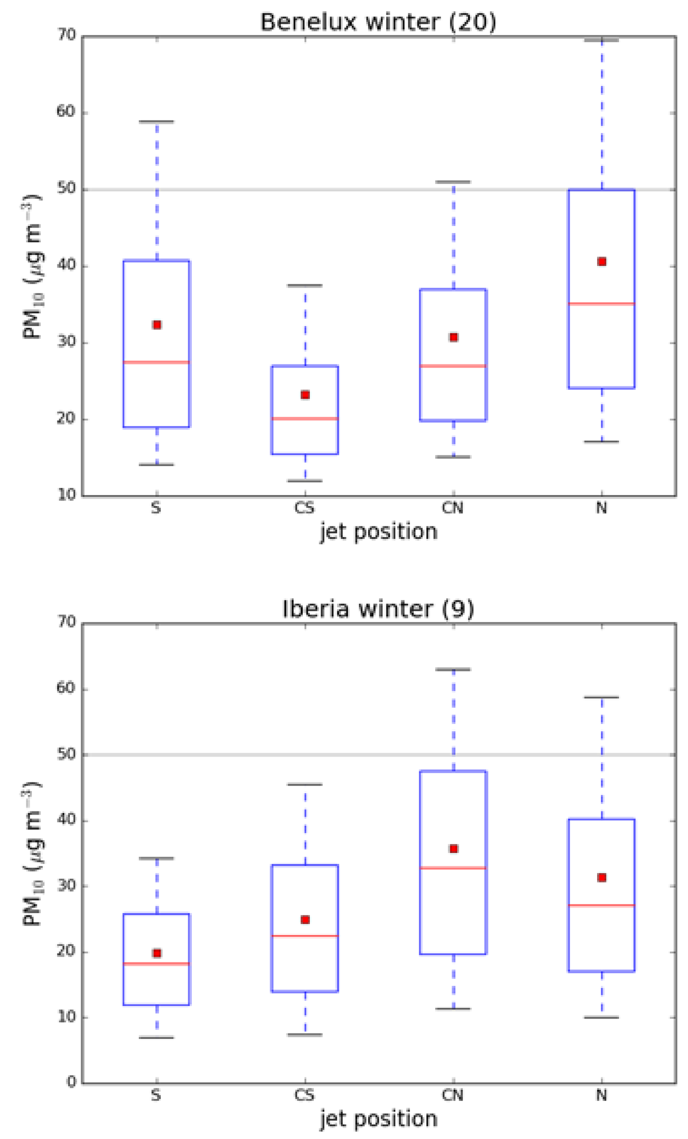
We have assessed the impact of the jet parameters on daily average PM_{10} in winter (DJF) 2001–2010 from EMEP & AirBase.

PM_{10} concentrations are very sensitive to the jet latitude, while the impact of the jet strength is relatively weak.

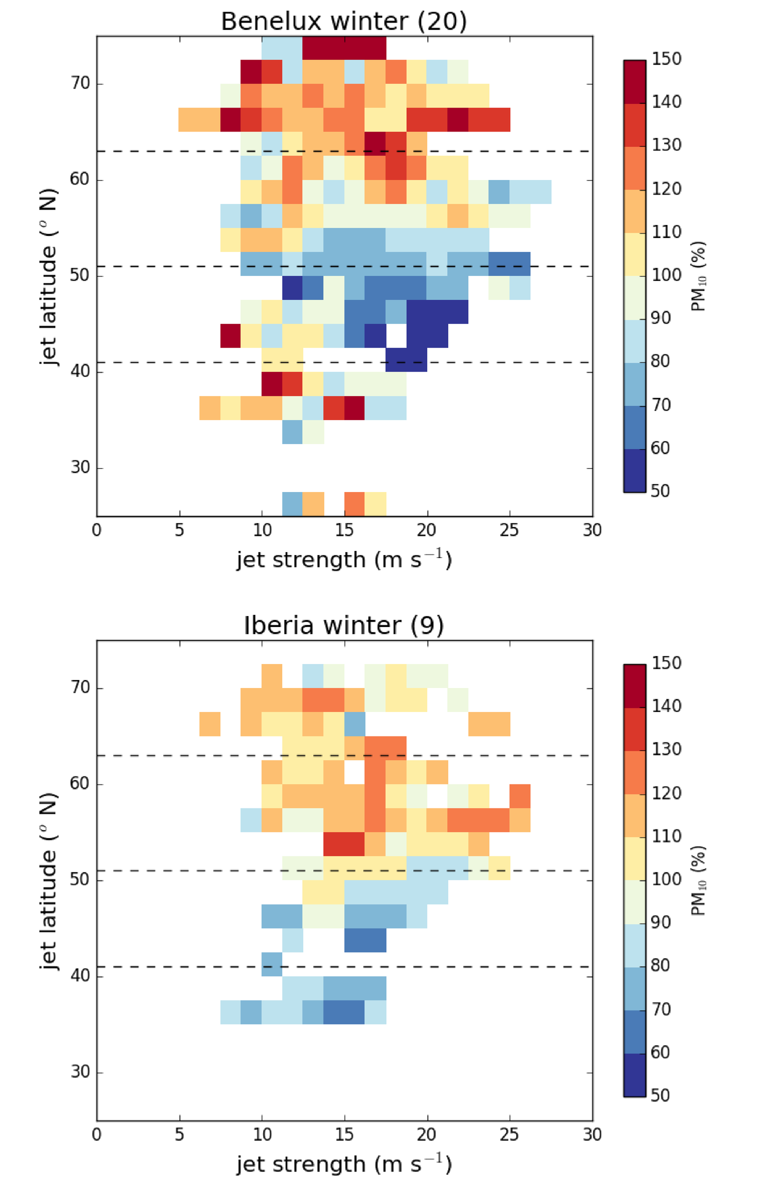
PM_{10} concentration anomalies for the 4 jet positions



PM_{10} distributions for the 4 jet positions



Dependence of normalised PM_{10} on the jet strength and latitude



4. Impact of the jet on the odds of extreme PM_{10} days

We have examined the impact of the jet positions on the odds of **PM_{10} extremes** (**exceedances of the winter 95th percentiles** of the detrended daily PM_{10} anomalies at each location).

This is done through a **logistic regression model** which considers the effect of the persistence of extremes and different time lags for the jet position:

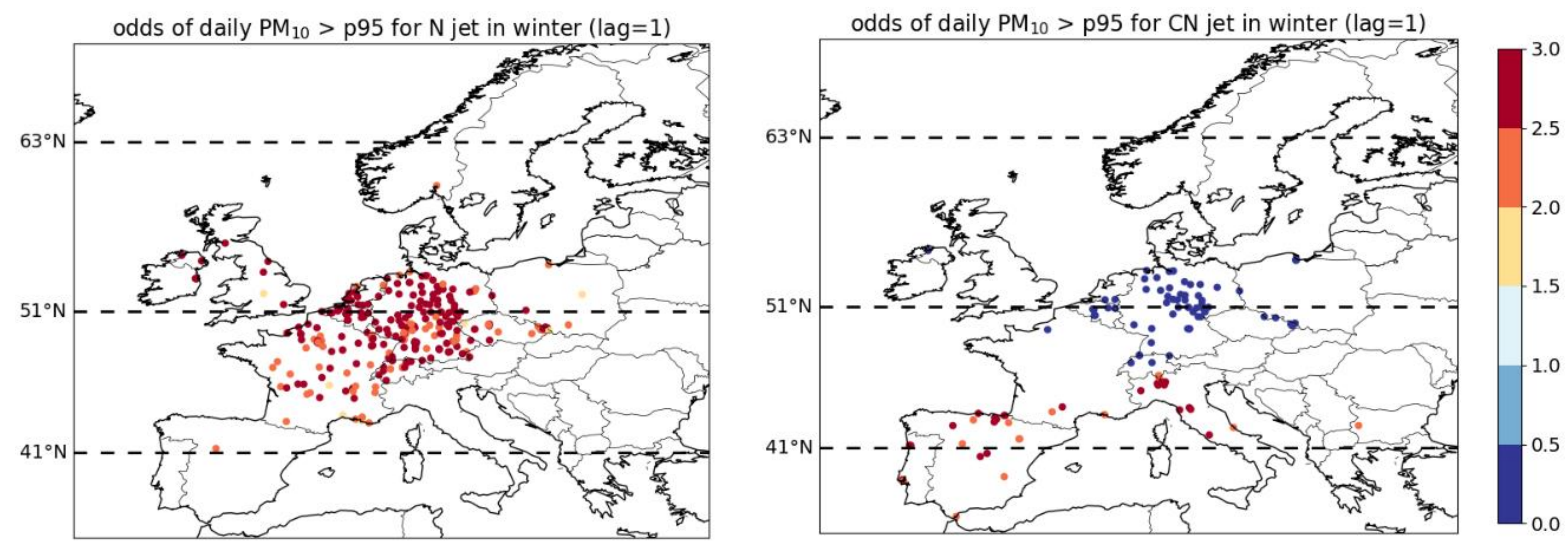
$$logit\,(p(d)) = log\,(P(d)/(1-P(d))$$

$$logit\,(p(d)) = b_0 + b_1 \cdot X(d-1) + b_2 \cdot Jet(d-1)$$

Where:

- P(d): probability of extremes on the given day
- p(d) = P(d)/(1–P(d)): odds of extremes
- X (d – 1): binary sequence indicating whether an extreme PM_{10} event occurred or not on the previous day
- Jet (d – 1): binary sequence indicating whether the jet was in a given position or not on the previous day

Threefold increases in the odds of PM_{10} extremes over the north / south of the continent **for the Northern / Central-Northern jet position (left / right)**



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5. Summary and relevance

- Winter PM_{10} concentrations more sensitive to the jet latitude than to the jet strength.
- Enhanced PM_{10} (on average ~9 µg m^{-3}) and threefold increase in the odds of PM_{10} extremes in northwestern /central Europe for the northern jet position.
- Similar results for PM_{10} in southern Europe when the jet is in the central-northern position.
- Differences in the location of mid-latitude jets among Earth system model simulations may be relevant to understand discrepancies in their climate change projections of PM_{10} and other pollutants.

References

Barnes & Fiore, 2013, https://doi.org/10.1002/grl.50411.

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Shen et al., 2015, https://doi.org/10.5194/acp-15-10925-2015.

Woollings et al., 2010, https://doi.org/10.1002/qj.625.