

# Influence of the North Atlantic Oscillation on the Atmospheric Levels of Benzo[a]pyrene Over Europe

Pedro Jimenez-Guerrero (✉ [pedro.jimenezguerrero@um.es](mailto:pedro.jimenezguerrero@um.es))

Universidad de Murcia <https://orcid.org/0000-0002-3156-0671>

Nuno Ratola

Universidade Do Porto

---

## Research Article

**Keywords:** North Atlantic Oscillation, benzo[a]pyrene, chemistry/climate20 modelling, chemical transport21

**Posted Date:** March 31st, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-369970/v1>

**License:** © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

**Version of Record:** A version of this preprint was published at Climate Dynamics on April 16th, 2021. See the published version at <https://doi.org/10.1007/s00382-021-05766-0>.

# Abstract

The atmospheric concentration of persistent organic pollutants (and of polycyclic aromatic hydrocarbons, PAHs, in particular) is closely related to climate change and climatic fluctuations, which are likely to influence contaminant transport pathways and transfer processes. Predicting how climate variability alters PAHs concentrations in the atmosphere still poses an exceptional challenge. In this sense, the main objective of this contribution is to assess the relationship between the North Atlantic Oscillation (NAO) index and the mean concentration of benzo[a]pyrene (BaP, the most studied PAH congener) in a domain covering Europe, with an emphasis on the effect of regional-scale processes. A numerical simulation for a present climate period of 30 years was performed using a regional chemistry transport model with a 25 km spatial resolution (horizontal), higher than those commonly applied. The results show an important seasonal behaviour, with a remarkable spatial pattern of difference between the north and the south of the domain. In winter, higher BaP ground levels are found during the NAO+ phase for the Mediterranean basin, while the spatial pattern of this feature (higher BaP levels during NAO+ phases) moves northwards in summer. These results show deviations up to and sometimes over 100% in the BaP mean concentrations, but statistically significant signals ( $p < 0.1$ ) of lower changes (20 to 40% variations in the signal) are found for the north of the domain in winter and for the south in summer.

## Full Text

This preprint is available for [download as a PDF](#).

## Figures

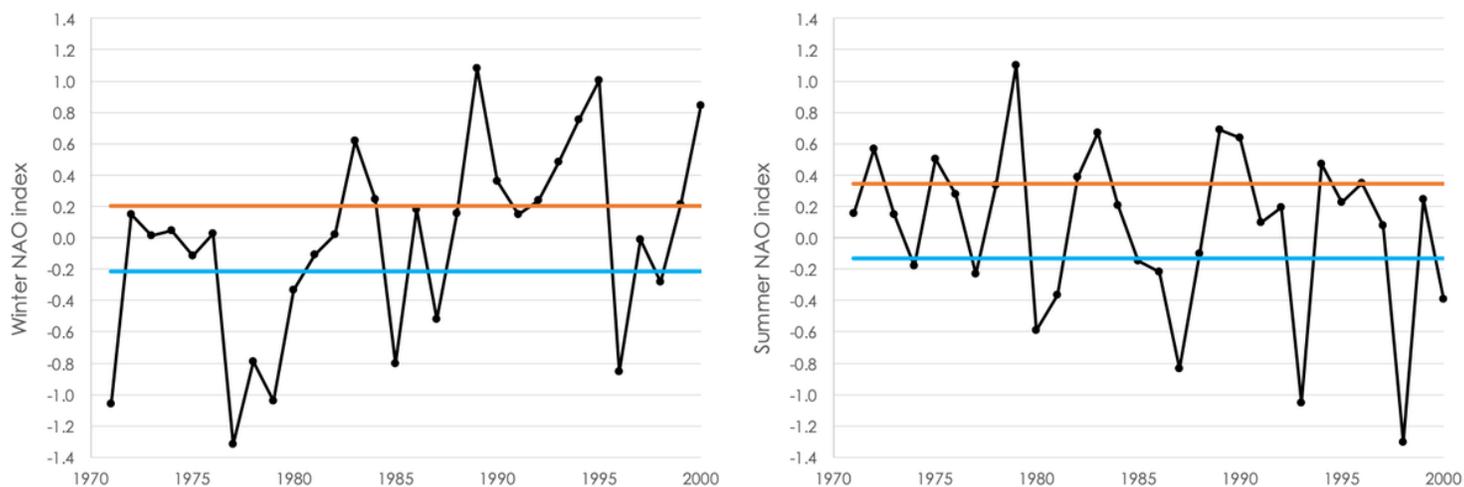
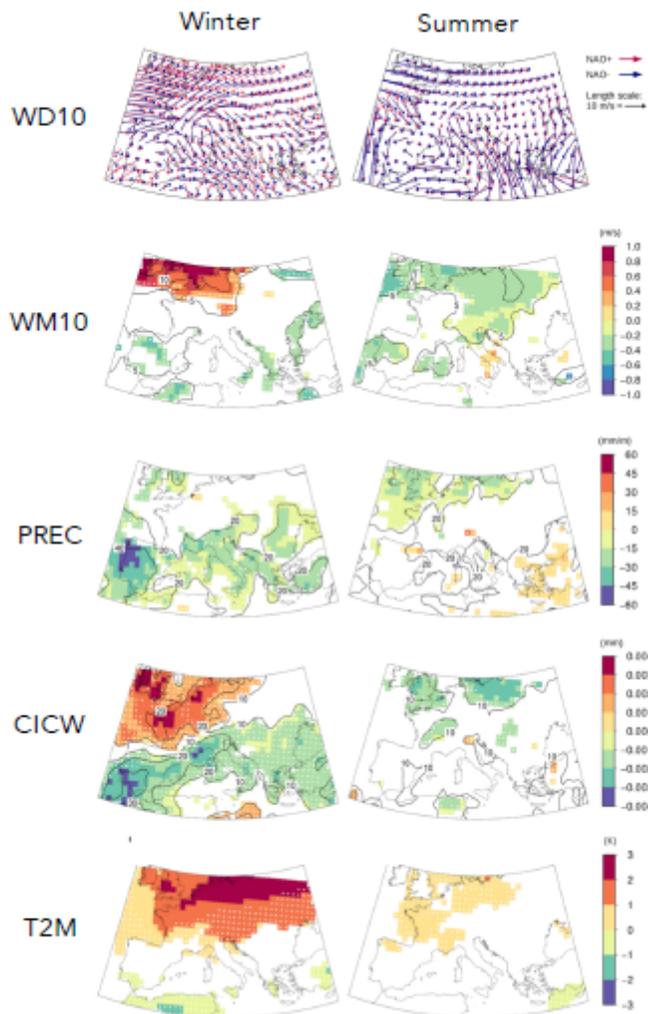


Figure 1

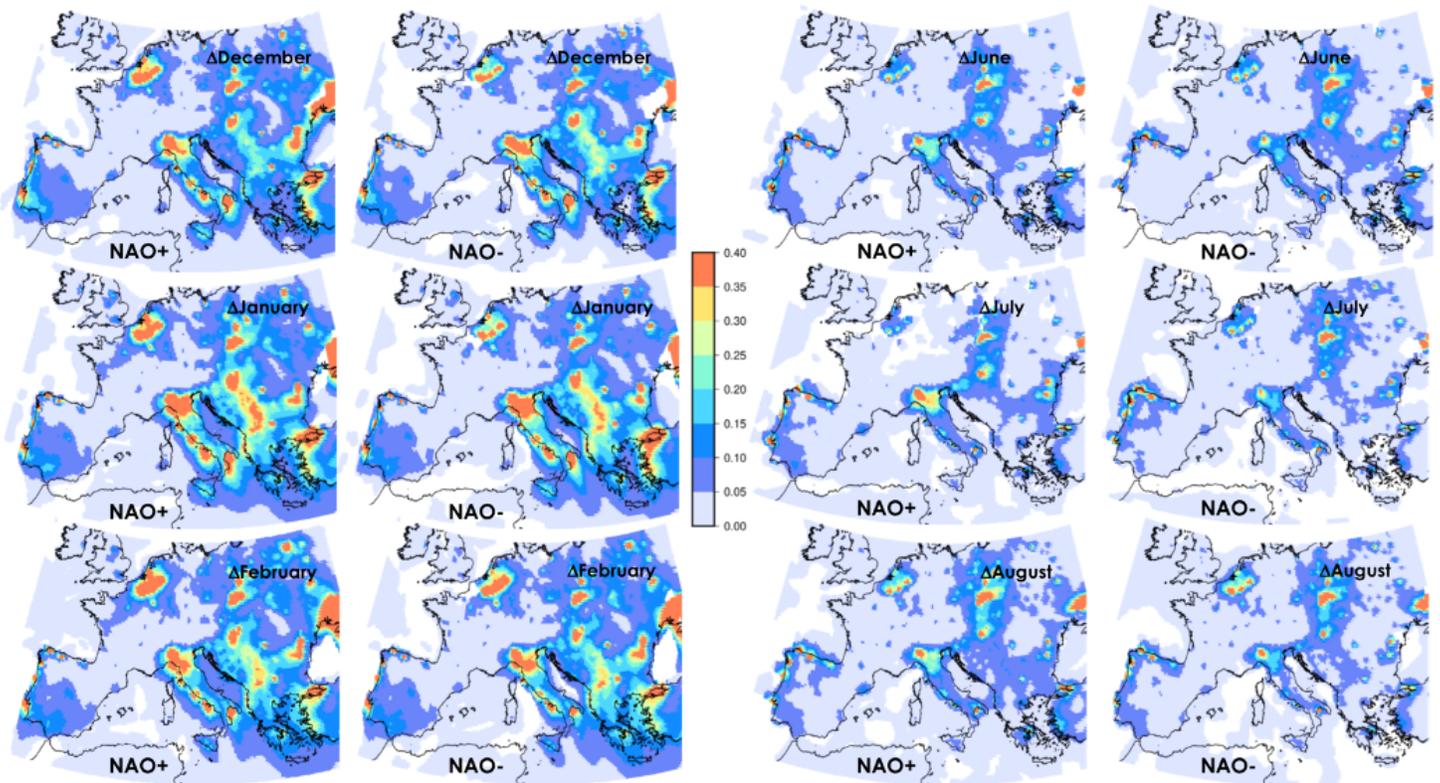
Winter (top) and summer (bottom) original CPC/NOAA NAO index series for the period 1971- 2000. The former are December-January-February averages and the latter are June-July-August averages. The red

(blue) lines denotes the 70th (30th) percentile value of each series. The years/values with a NAO index above (below) that percentile are selected as NAO+ (NAO-) events for the composites analysis.



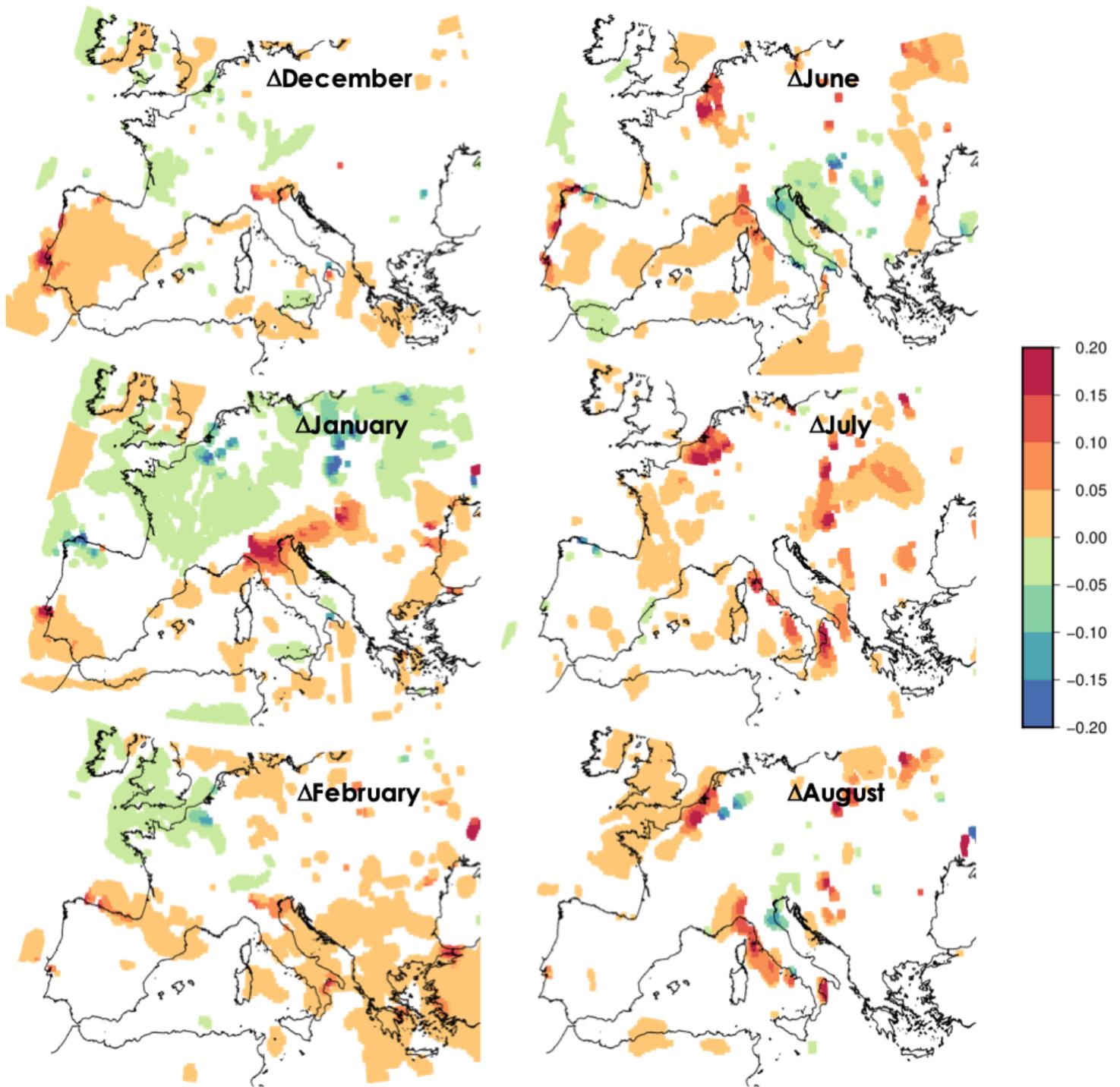
**Figure 2**

NAO impact in winter (left) and summer (right) on atmospheric conditions. (First to bottom rows) 10-m wind direction (WD10) during NAO+ (red) and NAO- (blue) phases (arrow proportional to the wind speed); NAO+ minus NAO- for the mean 10 m-wind module (WM10) (m s<sup>-1</sup>), precipitation (PREC) (mm month<sup>-1</sup>), column integrated cloud water (CICW) (mm) and 2-m temperature (T2M) (K). Results are only represented only if significant ( $p < 0.1$ ). Dots blur the values not representing a S/N ratio  $> 1$ , and contours depict differences expressed as percentage (adapted from Jerez et al. (2013b)). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.



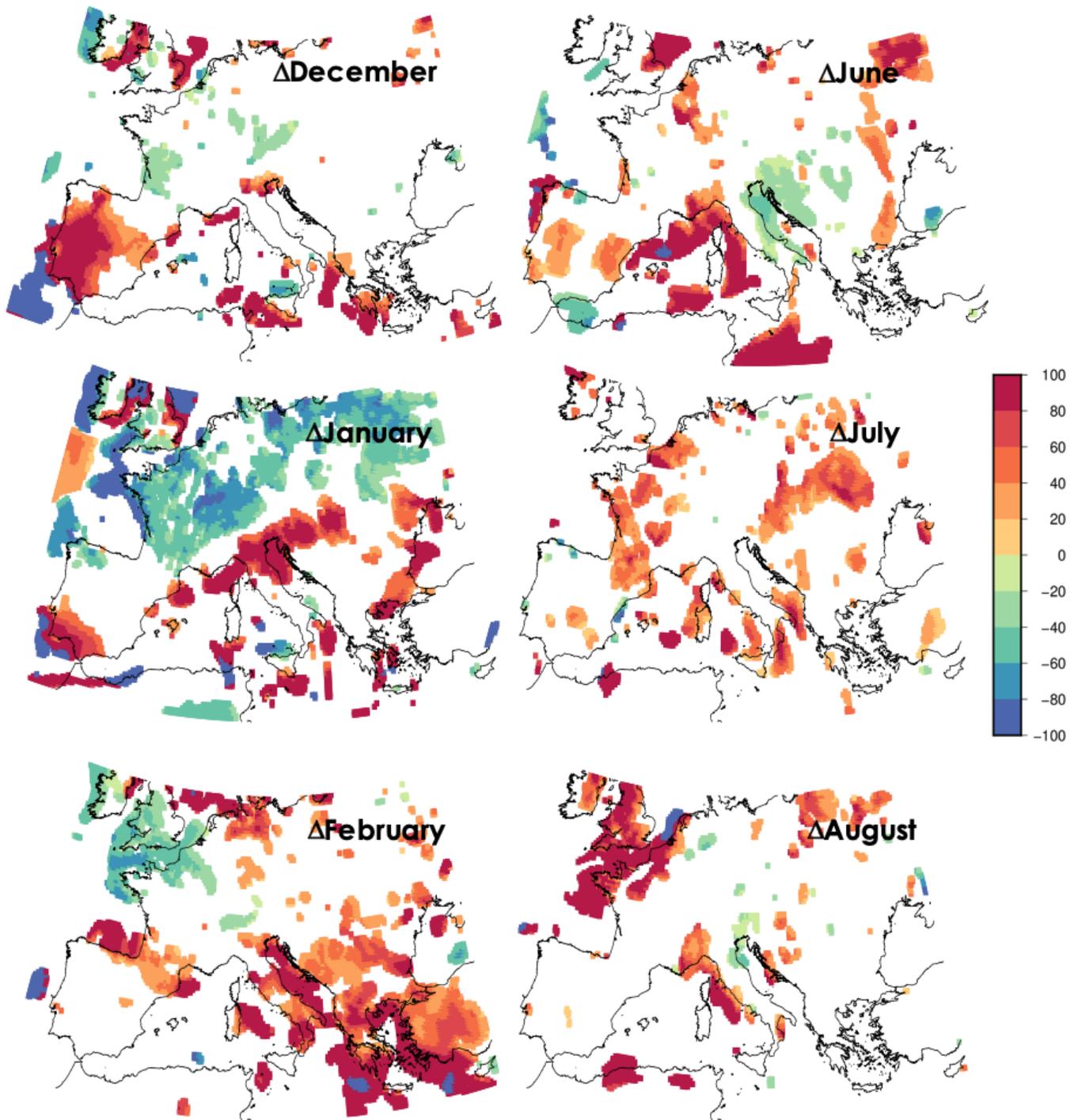
**Figure 3**

Absolute ground-level concentrations (ng m<sup>-3</sup>) of BaP averaged during periods with NAO+ and NAO- phases for winter (left) and summer (right) months; 1971-2000. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.



**Figure 4**

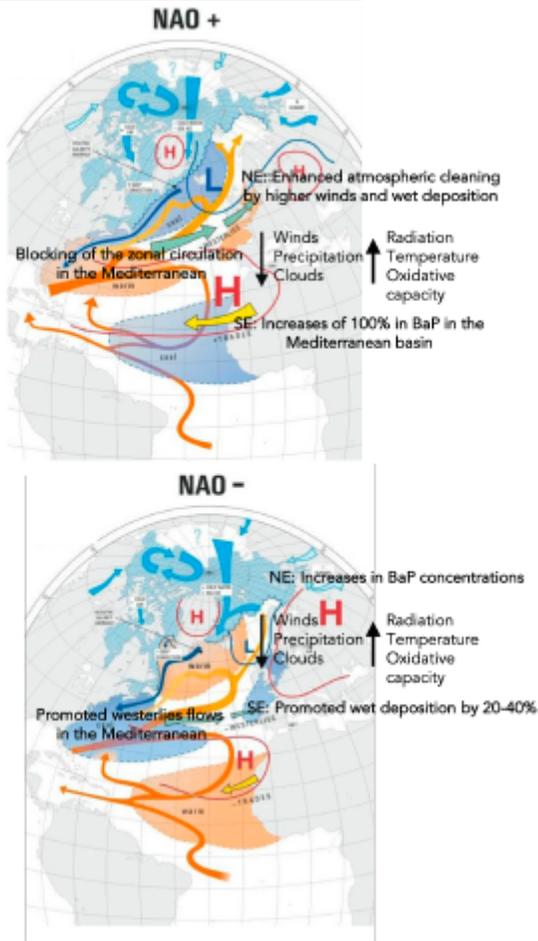
Absolute ground-level differences (ng m<sup>-3</sup>) in BaP concentrations between NAO+ and NAO phases for winter (left) and summer (right) months; 1971-2000. Results are only shown where statistically significant ( $p < 0.1$ ). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.



**Figure 5**

Differences (%) in ground-level BaP concentrations between NAO+ and NAO- phases for winter (left) and summer (right) months; 1971-2000. Results are only shown where statistically significant ( $p < 0.1$ ). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country,

territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.



**Figure 6**

Summary of the processes involved in the NAO impacts on the concentration of BaP during (top) NAO+ phase and (bottom) NAO- phase (base image adapted from Wanner et al. (2001)). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [supplemental.pdf](#)