Universidade Vigo

EPhysLab

Asociación Meteorológica Española

Effects of the Western Mediterranean Oscillation in the moisture transport from the Mediterranean Sea and the North Atlantic Ocean: implications on precipitation patterns over the Iberian Peninsula

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Sala 1. Sesión: Estrecho de Gibraltar

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1. Introduction

1.1. Motive

Deepening the knowledge of the WeMO(+/-) influence on the climatological moisture transport that contributes to precipitation over Europe, and particularly, the IP.

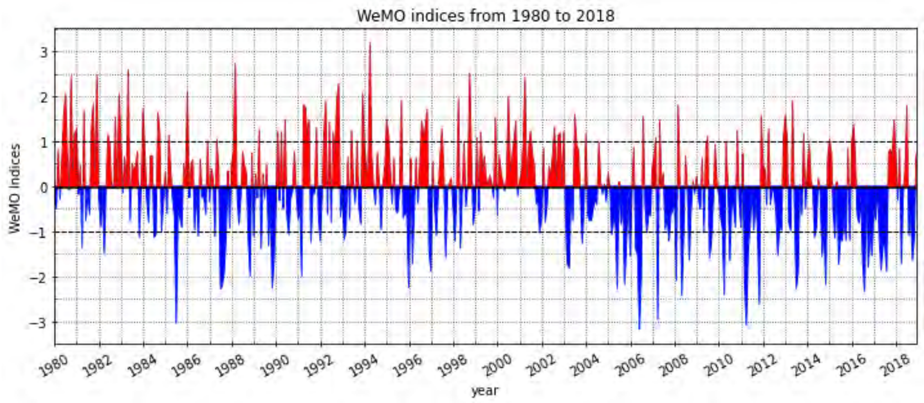
1.2. Objectives

Determine the role of WeMO(+/-) on precipitation patterns and moisture contribution to precipitation from the Mediterranean Sea (MEDT) and the North Atlantic Ocean (NATL).

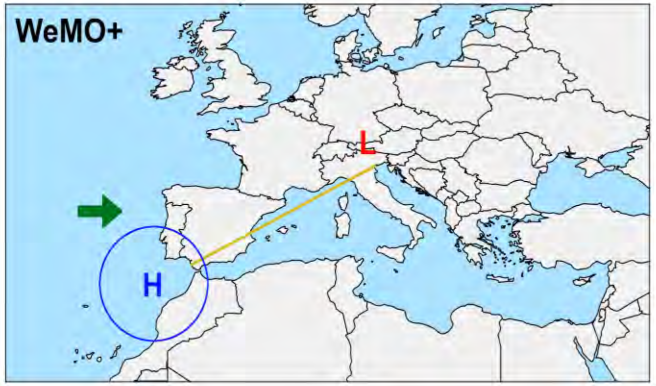
Investigate differences of EP during WeMO(+/-) and no WeMO conditions

1.3. WeMOi [1]

Pressure difference
Po plain (Padua) – gulf of
Cádiz (San Fernando)

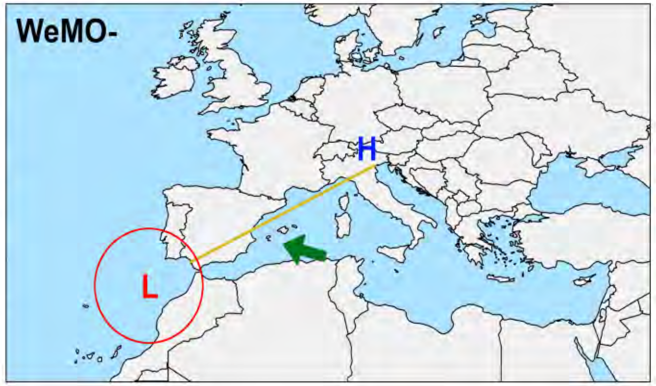


WeMOi(+) ≥ 1



North westerly
flow

WeMOi(-) ≤ -1



South easterly
flow

2. Material & Methods

2.1. Data

Precipitation

E-OBS
(monthly: 1980-2018) [2]

Iberia01
(daily: 1980-2015) [3]

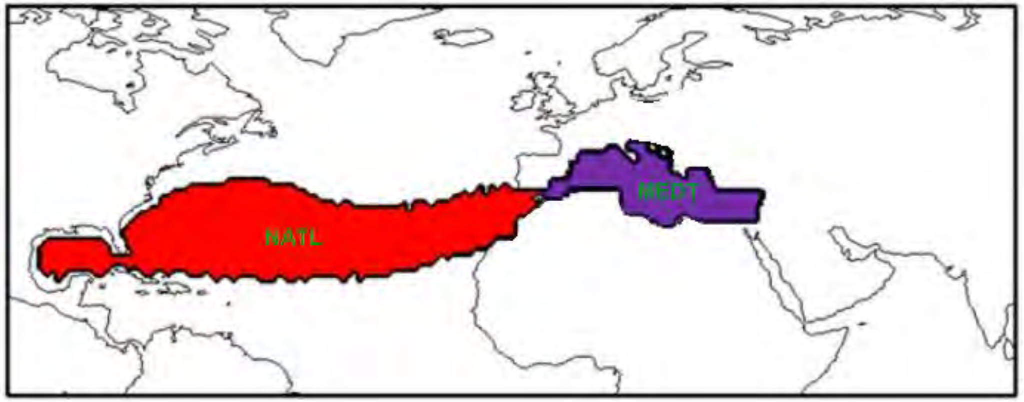
WeMOi
(monthly: 1980-2018) [1]

Moisture contribution
(|(E-P)<0|)
- Flexpart
(daily & monthly:
1980-2018)

2.2. Flexpart

Flexpart v9.0 [4] + ERA-Interim Project (1980-2018)

Forward analysis from the NATL and MEDT



Calculate humidity changes in each parcel (~2 million) through the budget of evaporation (e) and precipitation (p) along 10 days considering a constant mass (m).

$$(e - p) = m\frac{dq}{dt}$$

Integrating the (e-p) along the vertical column (61 levels) to estimate freshwater balance at surface.

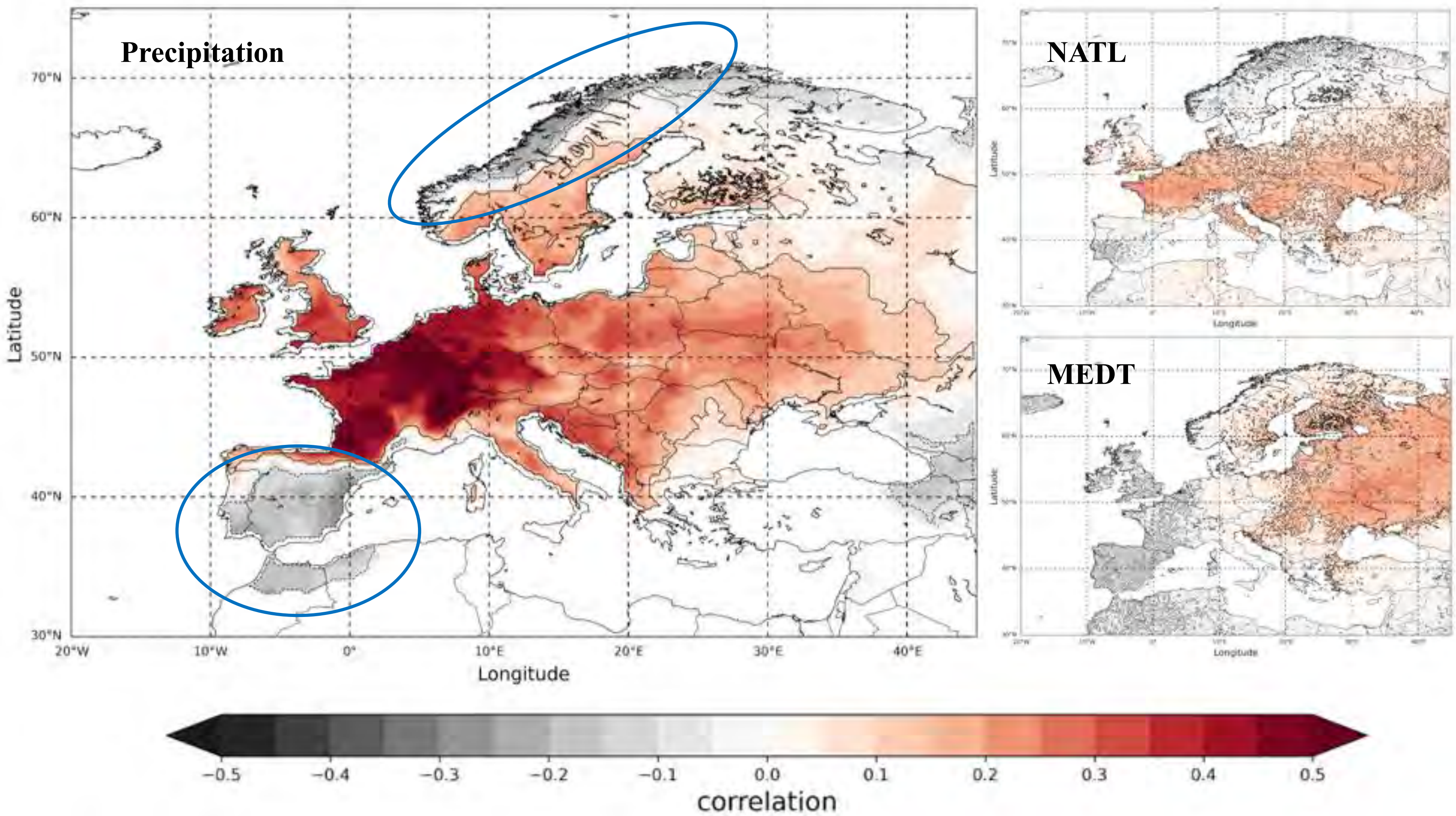
$$E - P \approx \frac{\sum_{i=1}^{K}(e - p)_i}{A}$$

3.1. Correlation

great part of Europe significant correlation

positive

negative



Correlation between WeMOi and precipitation (EOBS), contribution of the NATL/MEDT (1980-2018); black line significant ($p < 0.05$) correlation (solid: positive/dashed: negative)

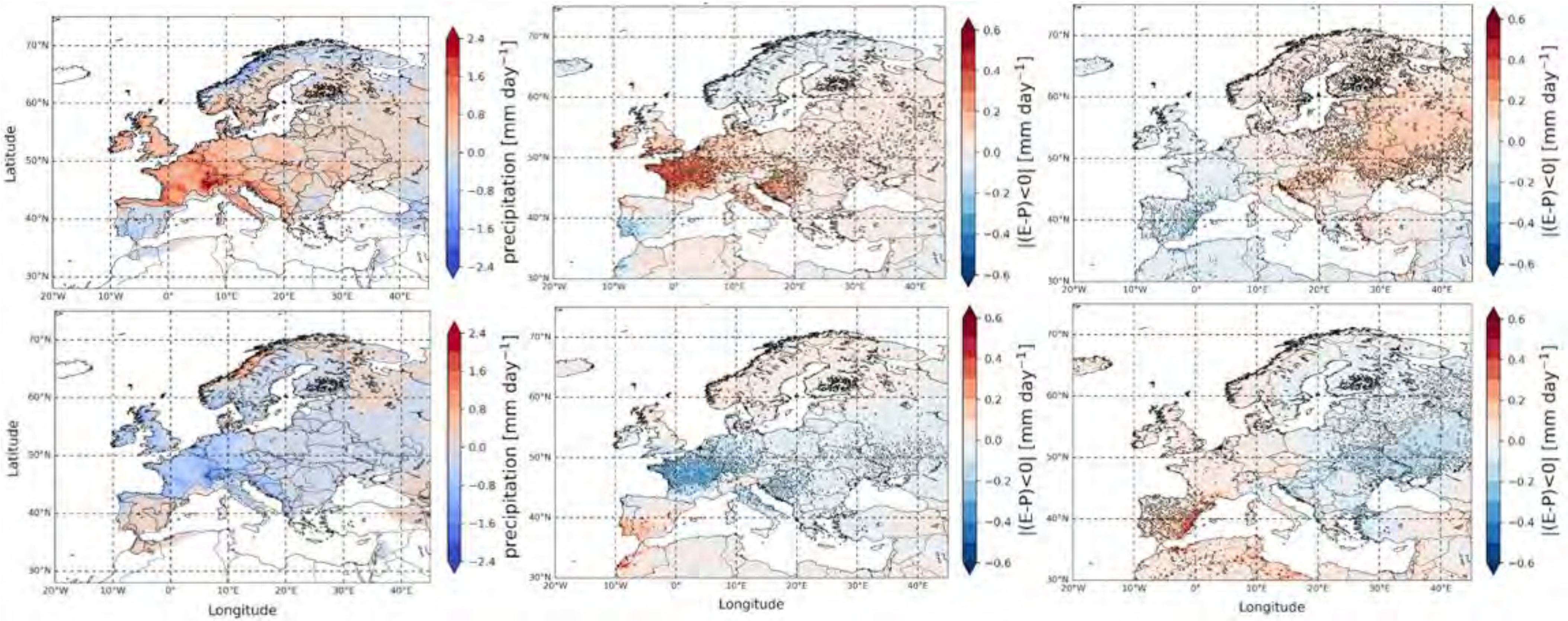
3.2. Anomaly - annual

Patterns vice versa during WeMOi(+/-)

Precipitation | **NATL |(E-P)|<0** | **MEDT |(E-P)|<0**

WeMOi(+)

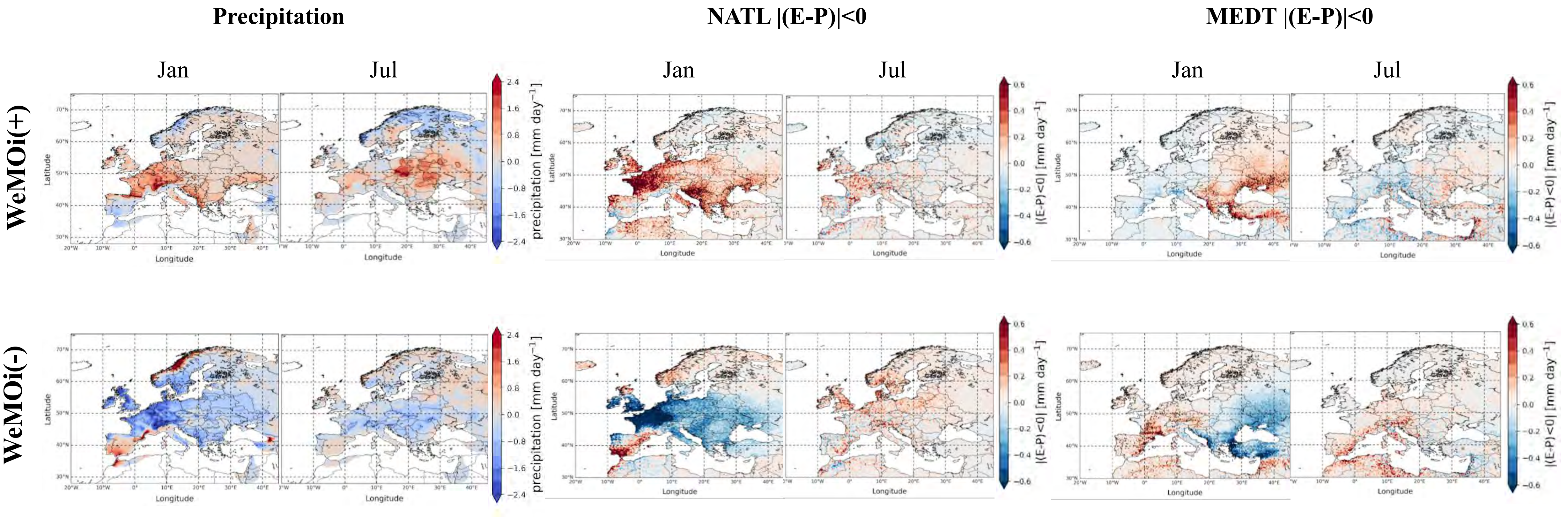
WeMOi(-)



Anomalies of precipitation and moisture contribution from the NATL/MEDT under WeMOi(+) and WeMOi(-) months. Climatology 1980-2018.

3.2. Anomaly - January July

Stronger differences in winter

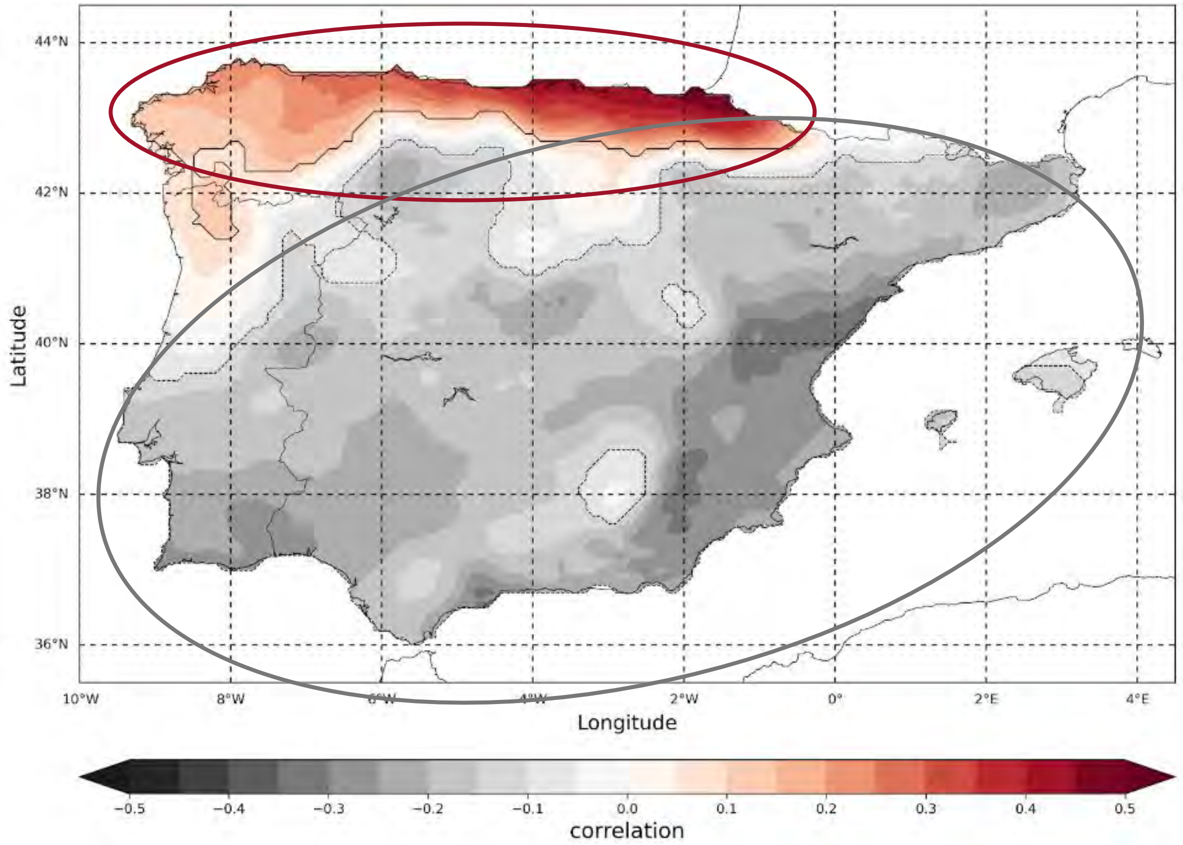


Anomalies of precipitation and moisture contribution from the NATL/MEDT for January and July under WeMOi(+) and WeMOi(-) months. Climatology 1980-2018.

3.3. Correlation IP

Positive
Northern Area

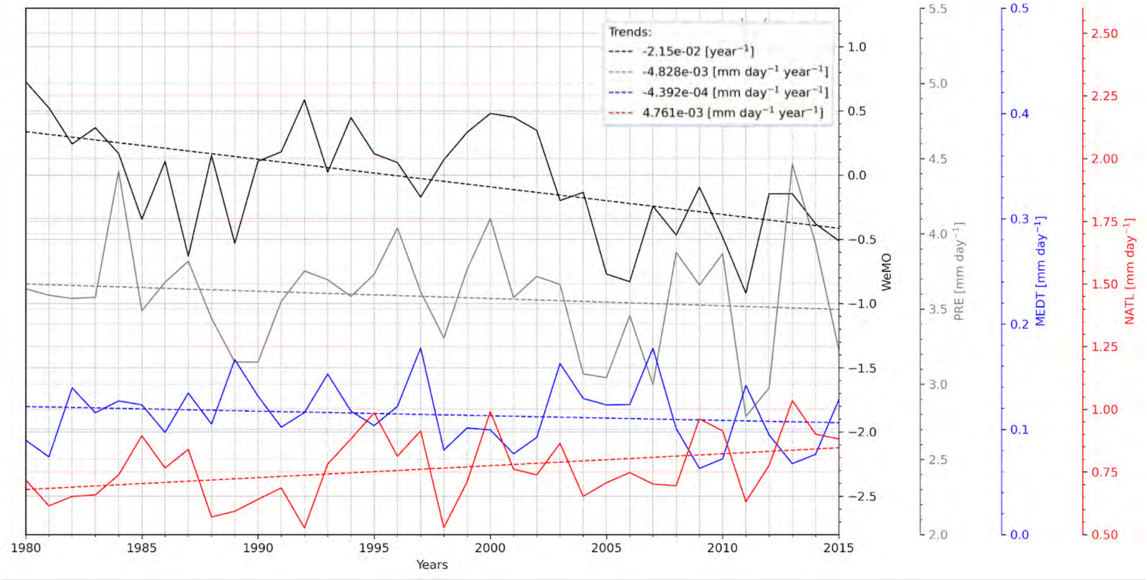
Negative
Southern Area



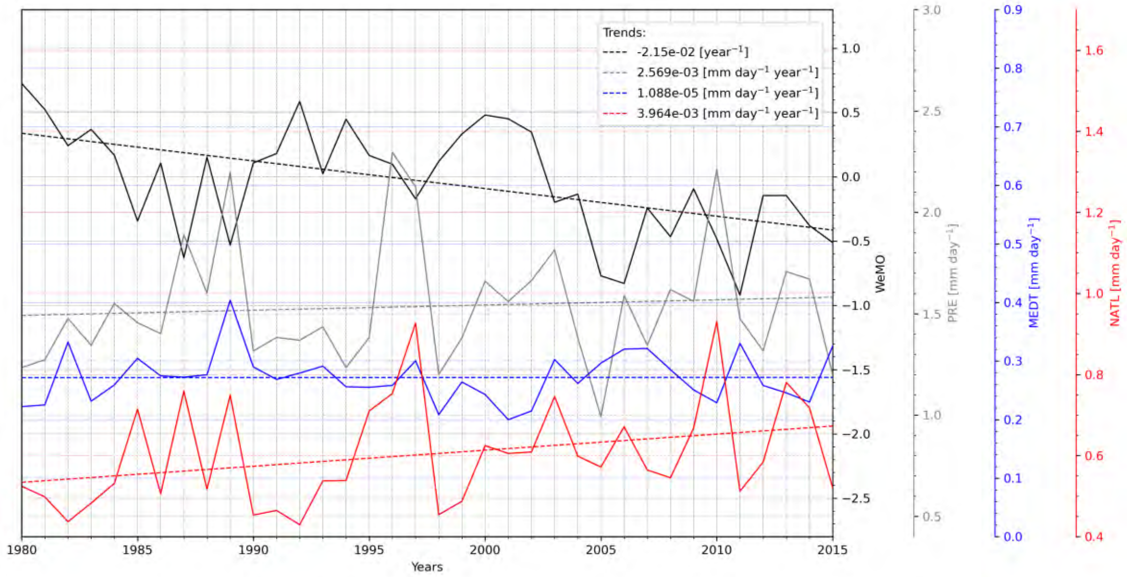
Correlation between WeMOi and precipitation (Iberia01) (1980-2015); black line significant ($p < 0.05$) correlation (solid: positive/dashed: negative)

3.3. Trend

Area north



Area south



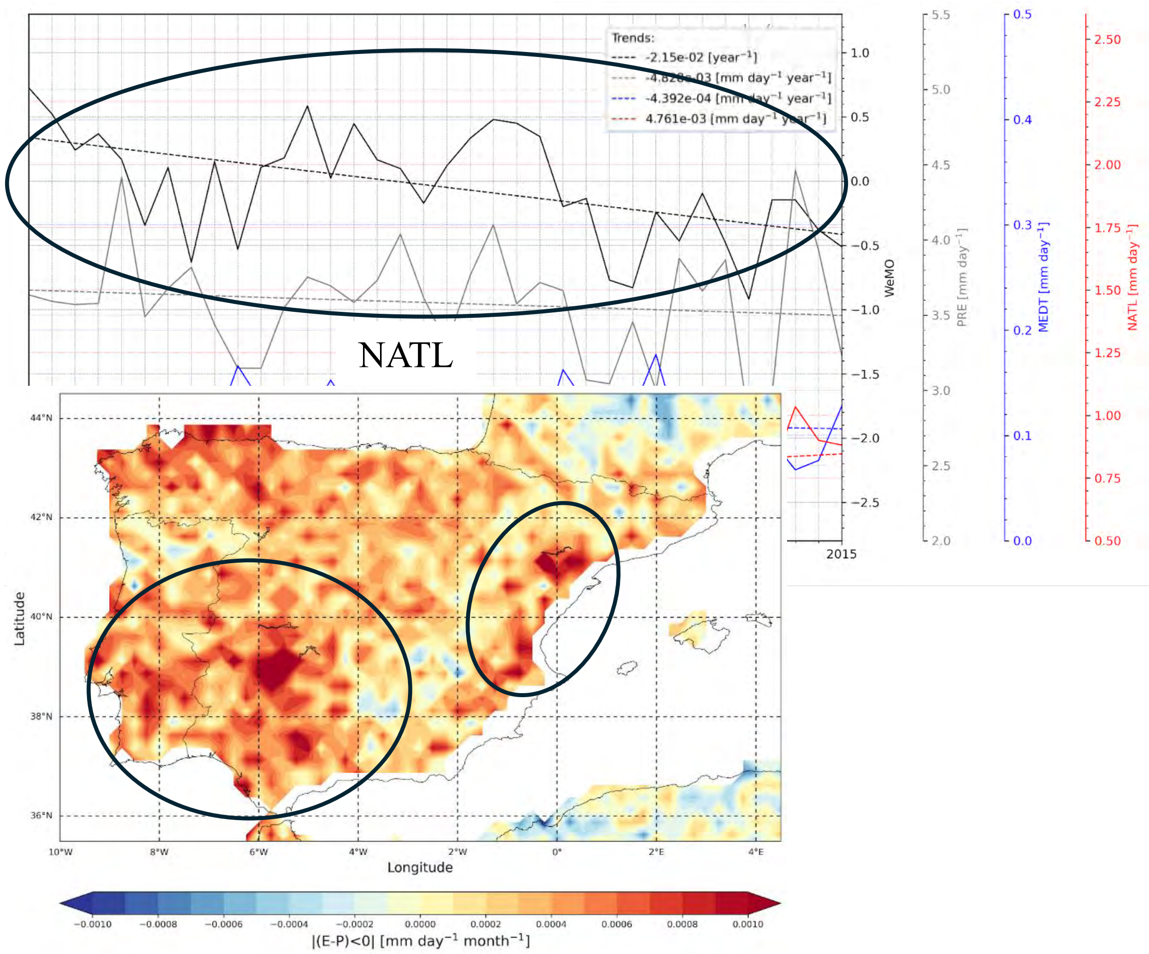
Area north	
Pre:	negative trend
MEDT:	negative trend
NATL:	positive trend

Area south	
Pre:	positive trend
MEDT:	positive trend
NATL:	positive trend

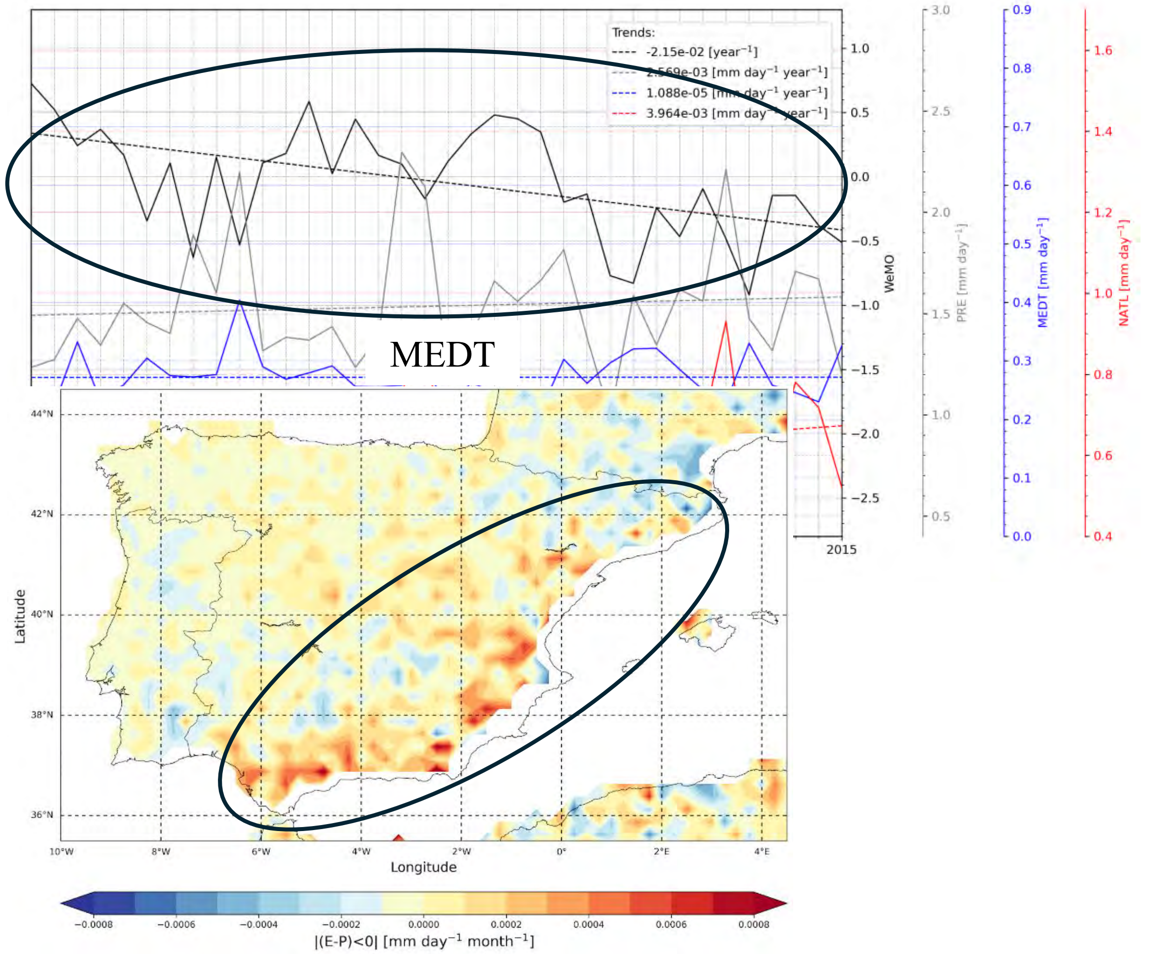
Annual timeseries with linear trends for WeMOi, precipitation, contribution from the MEDT and NAT (1980-2015); for positive (north) and negative (south) correlation area; trends of the contribution from the NATL and the MEDT [mm day-1 month-1] (1980-2015)

3.3. Trend

Area north

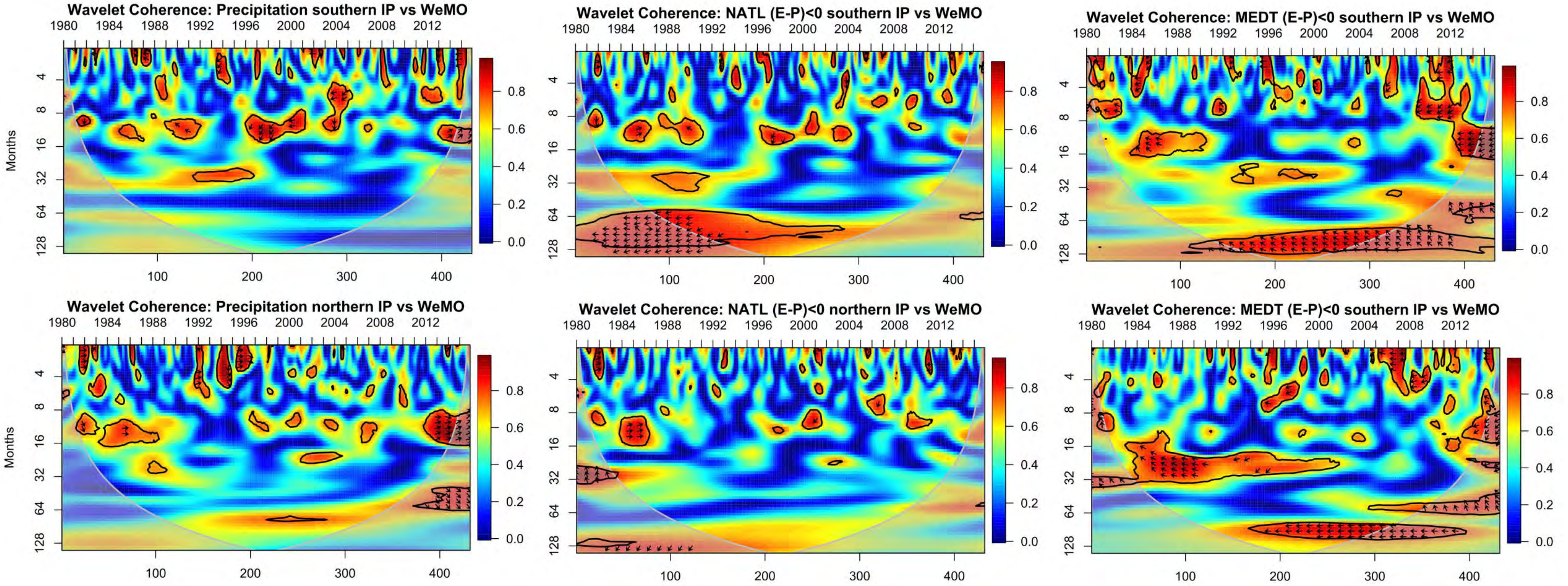


Area south



Annual timeseries with linear trends for WeMOi, precipitation, contribution from the MEDT and NAT (1980-2015); for positive (north) and negative (south) correlation area; trends of the contribution from the NATL and the MEDT [mm day-1 month-1] (1980-2015)

3.4. Nonlinear relationships



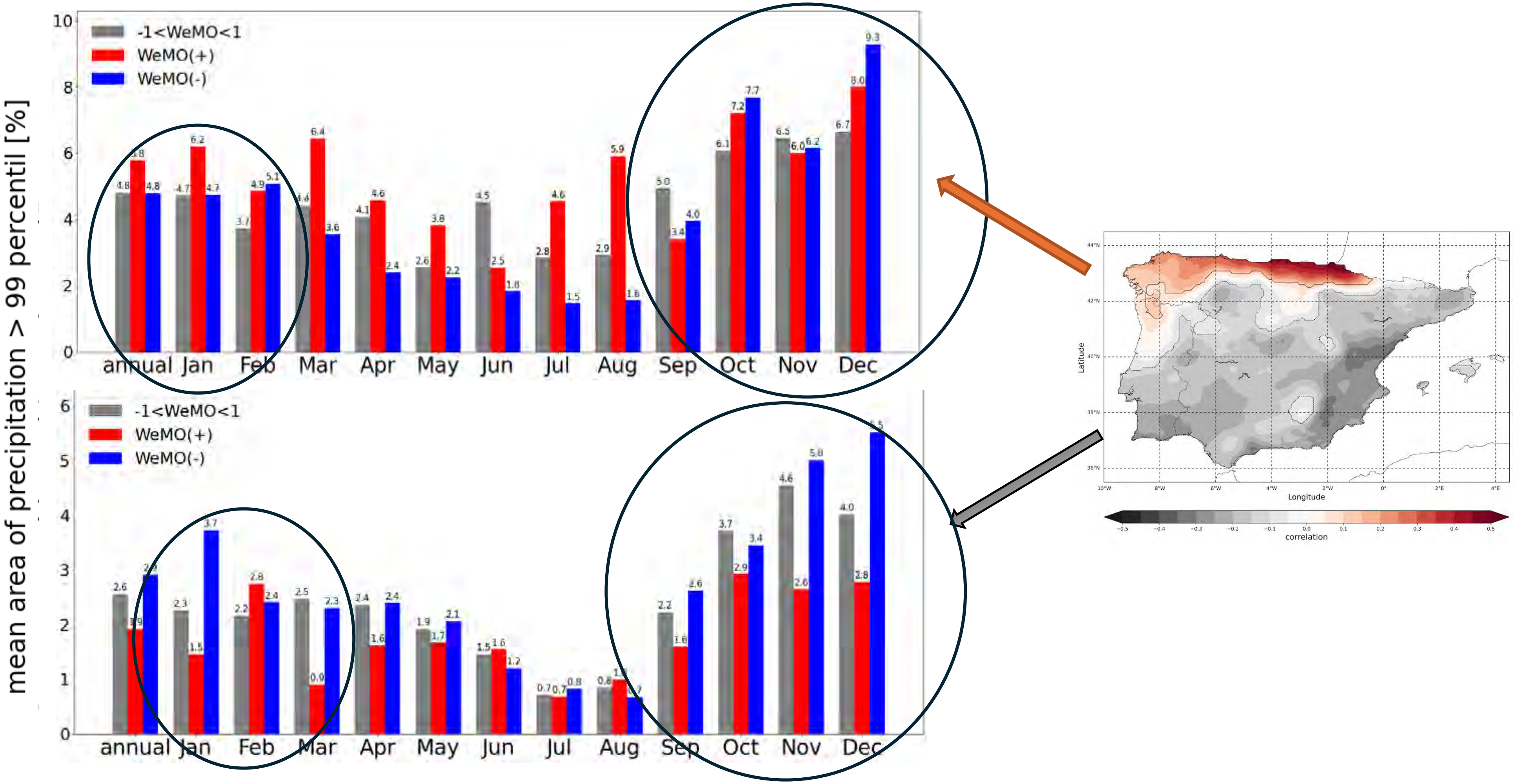
Warmer colors (red) variables are correlated; black line significance line; arrows point to the right (left) when the time series are in phase (anti-phase); arrows pointing to the right-down or left-up indicate that the first variable is leading, while arrows pointing to the right-up or left-down show that the second variable is leading.

3. Results (Ongoing analysis)

3.5. Extreme precipitation area

Northern area greater EP area in WeMOi(+) phases

Southern area greater EP area in WeMOi(-) phases

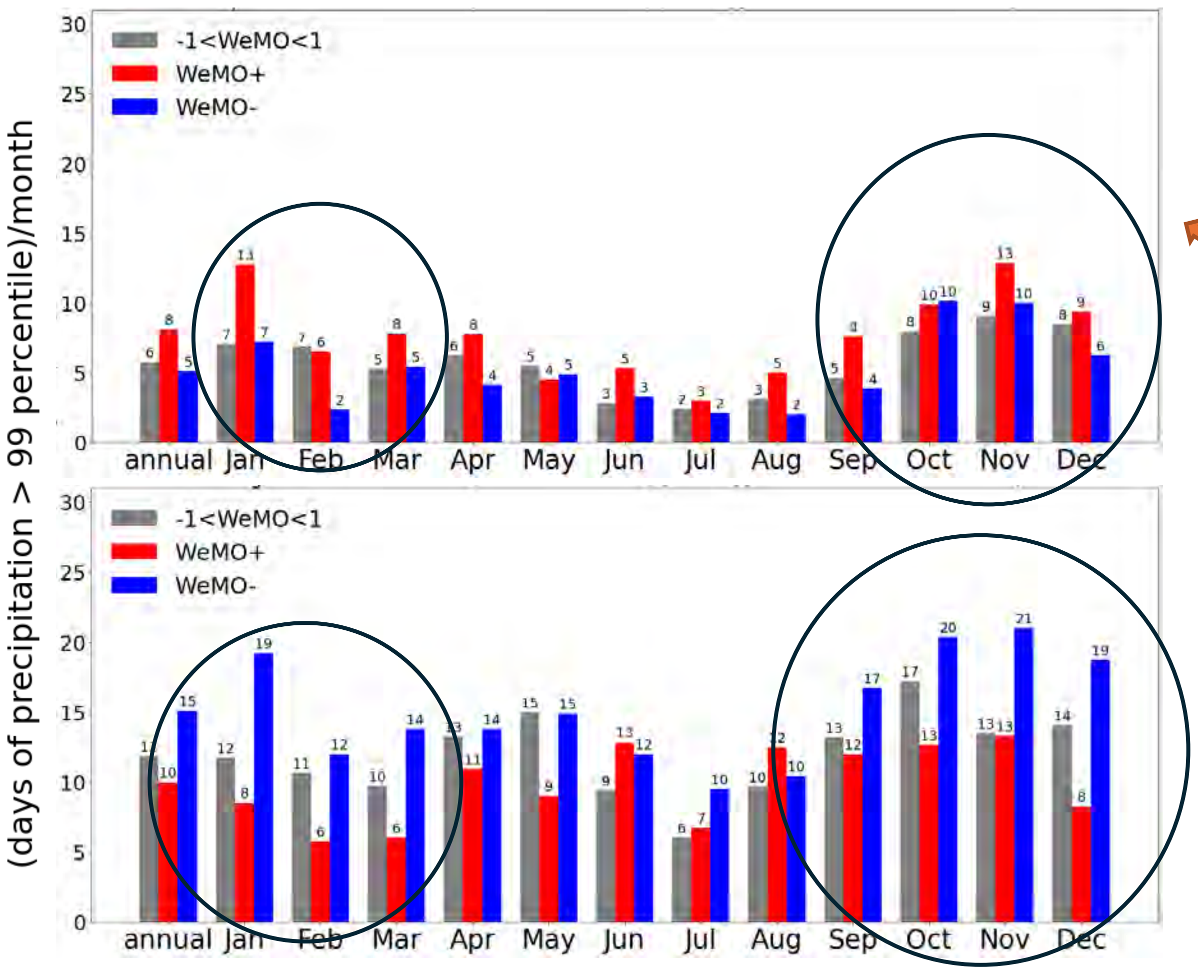


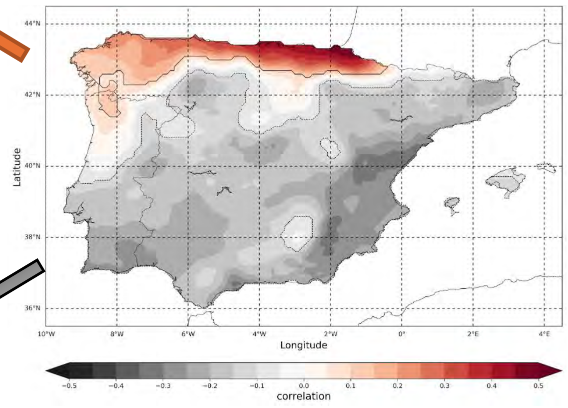
Percent of extreme precipitation area (>99 percentile), in respect to the significant (p<0.05) positive (above) and negative (bellow) correlation area (WeMOi-precipitation); during WeMOi(+/-) phases and other months; Iberia (1980-2015)

3.6. Extreme precipitation days

Northern area more EP days in WeMOi(+) phases

Southern area more EP days in WeMOi(-) phases





Days of extreme precipitation (> 99 percentile) per month; in the significant positive (above) and negitive (bellow) correlation area; during WeMOi(+/-) phases and other months; Iberia (1980-2015)

4. Conclusions and ongoing research

- In this study we confirmed that WeMO influences the precipitation patterns over the Iberian Peninsula but also over Europe, been negatively (positively) correlated with the half southern (northern) part of the Iberian Peninsula.
- Different phases of the WeMO also modulates the moisture contribution to precipitation from the NATL and MEDT over Europe and the Iberian Peninsula, particularly during winter months.
- During WeMOi(-) the southern part of the IP, the north-east Maghreb and the mediterranean coast of France receive more moisture than in the longtime mean.
- During WeMOi(+) the northern part of the IP, France and the Balkans receive more moisture than in the longtime mean.
- In the IP the extreme precipitation (EP) is influenced by the WeMO regime, which results in larger areas occupied by EP and more days with EP in the southern part under WeMOi(-) conditions and in the northern part under WeMOi(+) conditions.
- The influence of the WeMO is stronger in autumn- and winter-months.

➡ Nowadays we are computing the role of the NATL, MEDT and IP as sources of moisture for EP events under WeMOi(-/+) in the southern and northern IP.

References

[1] Martin-Vide, J. and Lopez-Bustins, J.-A. (2006), The Western Mediterranean Oscillation and rainfall in the Iberian Peninsula. Int. J. Climatol., 26: 1455-1475. https://doi.org/10.1002/joc.1388.

[2] Cornes, R., G. van der Schrier, E.J.M. van den Besselaar, and P.D. Jones. 2018: An Ensemble Version of the E-OBS Temperature and Precipitation Datasets, J. Geophys. Res. Atmos., **123**. doi:10.1029/2017JD028200; version 28.0e.

[3] Herrera, S.; Cardoso, Rita M.; Soares, Pedro M. M.; Espírio-Santo, F.; Viterbo, P.; Gutiérrez, J.M.; 2019; "Iberia01: Daily gridded (0.1º resolution) dataset of precipitation and temperatures over the Iberian Peninsula" [Dataset]; DIGITAL.CSIC; http://dx.doi.org/10.20350/digitalCSIC/8641.

[4] Stohl, A., and James, P. (2005). A Lagrangian analysis of the atmospheric branch of the global water cycle. Part II: Moisture transports between the Earth's ocean basins and river catchments. J. Hydrometeorol. 6, 961–984, doi:10.1175/JHM470.1.