# CONTRASTING PRECIPITATION TRENDS IN EUROPE: AN ATTRIBUTION FROM MOISTURE TRANSPORT ANOMALIES

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## SUMMARY

**Precipitation trends in Europe have revealed opposing trends between different regions. The causes have been attributed to the influence of teleconnection patterns and the increasing influence of persistent high-pressure systems. In this paper we investigate these changes from another perspective, taking into account the variability of atmospheric moisture transport from the climatological sources of moisture in each region. To carry out this study, regions with statistically significant trends of opposite sign were determined using precipitation data from various products. For each region, its oceanic and terrestrial moisture sources that contributed to precipitation were determined. The results confirm the agreement in the representation of positive precipitation trends in southeastern Europe and the western half of the Iberian Peninsula, as well as negative trend values in some parts of central and western Europe. The North Atlantic Ocean and the western Mediterranean Sea acted as the most important oceanic sources from where the moisture contribution increased. However, the positive trend terrestrial origin precipitation seems to play a crucial role on the modulation of precipitation trends.**

## 1. STUDY AREA

**Figure 1**

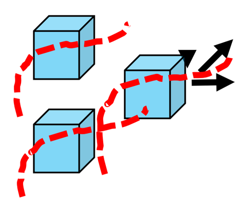
## 2. DATA AND METHODOLOGY

### 2.1 Data

- Precipitation data from EOBS, MSWEP and ERA5. Period: 1980-2018.
- Global outputs of the budget of (E-P) from the Lagrangian Particle Dispersion Model (FLEXPART) [1].

### 2.2 Methodology

FLEXPART v9.0 model + Meteorological reanalysis data from ERA-Interim Project [2]. Period 1980-2018.



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

Calculating for all parcel residing in the atmospheric column over a target area, we obtain (E-P). Integration in 't optimum' days.

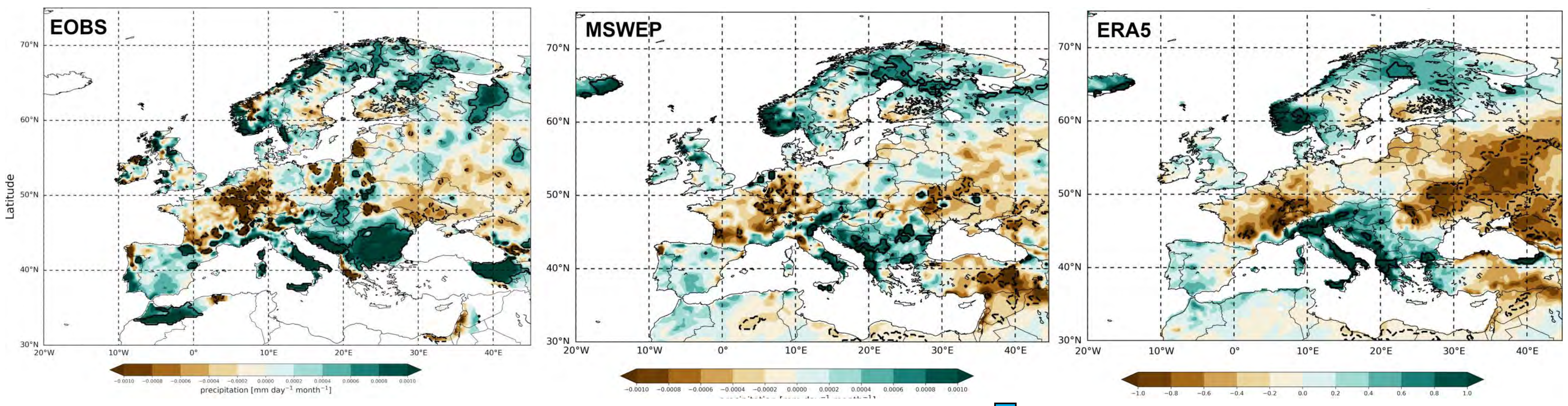
Backward analysis: For each tracked parcel (~2 million, with the same mass *m*) are calculated changes of Specific humidity (*q*) through differences of evaporation (*e*) and precipitation (*p*) every 6 hours. Were tracked parcels losing at least, 1 mm/day.

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

**E** → evaporation **P** → precipitation
**K** → No parcels **A** → Area

## 3. RESULTS AND DISCUSSION

**Figure 2.** Figure 2 shows the precipitation trends according to EOBS, MSWEP and ERA5 data for the period 1980-2018.




The EOBS precipitation trend pattern shows opposite values between well-defined areas of Europe. Positive values are observed over most of the Iberian Peninsula, with the exception of the extreme northwest. In addition, other well-defined areas with positive trend values are found in southern and south-eastern Europe as well as in the north-east. MSWEP and ERA5 precipitation data show a very similar spatial trend to EOBS in terms of geographic regions with decreasing and increasing sign, although they differ visibly in magnitude, particularly over the Iberian Peninsula.

Figure 3 left shows in brown and light blue those regions where the three precipitation products coincide in positive and negative sign for the trend, respectively. Figure 3 right illustrates the regions considered for this study, two with positive trends: Iberian Peninsula (IP) and South-East Europe (SEE), and two with negative trends: Central-West Europe (CWE) and Eastern Europe (EU).

**Regions where positive (brown) and negative (light blue) trends coincide.**

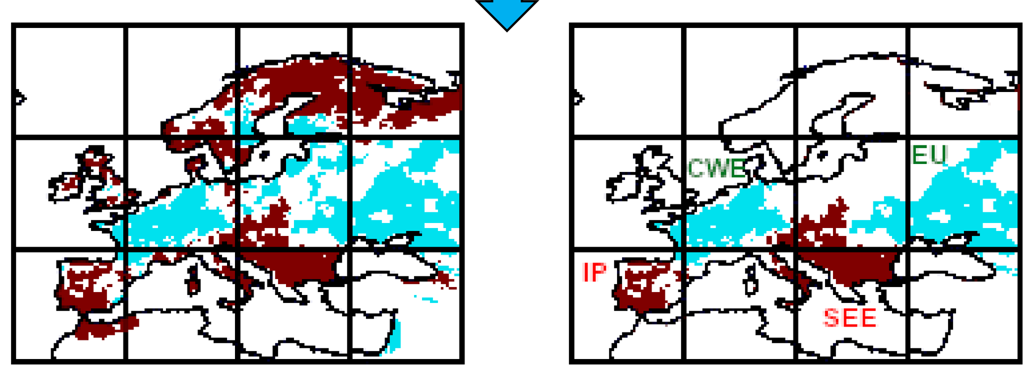



**Figure 3**

**Study regions**

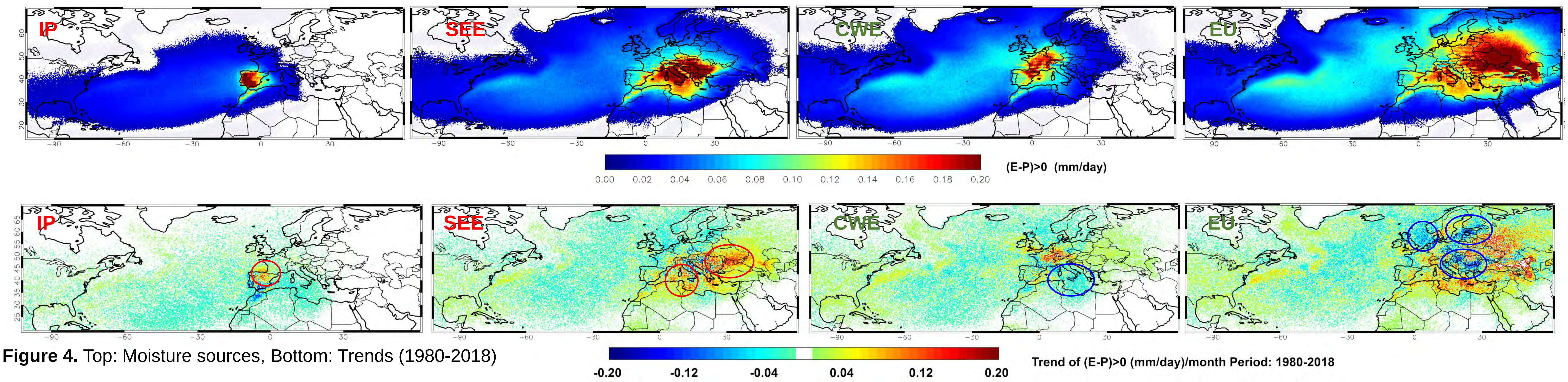



**Figure 4.** Top: Moisture sources, Bottom: Trends (1980-2018)

Figure 4 top shows the spatial pattern of (E-P)>0 (moisture sources) obtained after tracking backward in time the air masses residing over IP, SEE, CWE and EU. Positive trends (Fig. 4 bottom) (reddish colors) represents those areas from where air masses have increased the moisture uptake that later precipitates over the target regions. Negative areas indicate the contrary, regions from where the moisture supply to precipitation over the target regions decreased along the study period.

Moisture lose over the IP, and consequently the precipitation trend increase, have been supported by the increase on moisture uptake from western North Atlantic Ocean (NATL), but particularly from the central and north east IP and the Gulf of Vizcaya. For the Southeast Europe region (SSE), a region characterized by the precipitation increase, was found that major positive trends on moisture contribution for precipitation occur from the central and western Mediterranean Ocean, as well as from the region itself and western Europe. It also confirms the importance of recycling on local precipitation, which has been also highlighted by previous studies.

The spatial pattern of moisture uptake that contributes to precipitation over CWE, reveals a positive trend from oceanic regions like the western NATL, and the western Mediterranean and the surrounding waters southwest of England. Positives trends highlight over the region itself, also confirming that recycling has been increasing the terrestrial origin precipitation. It was also confirming for the EU region, which precipitation negative trend is related with the terrestrial origin precipitation decrease over southeast, central and northeast Europe. Besides the moisture uptake have decreased from the Baltic and Northern Sea.

## 4. CONCLUSIONS

In this study we initially investigated the moisture sources and the precipitation trends over Europe for the period 1980-2018, confirming that extent areas match precipitation trends in three datasets. For each target regions was determined the origin of precipitation. A trend analysis of moisture supply that precipitates over the target regions revealed the important role of the climatological oceanic sources of moisture, but particularly the modulated role of terrestrial origin as recycling and moisture exports within the continent on the precipitation trends.

### REFERENCES

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