Climatology of moisture sources associated with extratropical cyclones reaching the western Mediterranean: a Lagrangian approach

José Carlos Fernández-Alvarez[1,2], Patricia Coll-Hidalgo[2], Gleisis Alvarez-Socorro[2], Albenis Pérez-Alarcón[2,3,4], Raquel Nieto[2] and Luis Gimeno[2]
[1] Galician Supercomputing Center (CESGA), Santiago de Compostela, Spain
[2] Environmental Physics Laboratory (EPhyslab), Centro de Investigación Mariña, Universidad de Vigo
[3] Departamento de Meteorología, Instituto Superior de Tecnologías y Ciencias Aplicadas, Universidad de La Habana
[4] Instituto Dom Luiz (IDL), Facutad de Ciências, Universidad de Lisboa

Poster 6

Introduction

- Despite the singularity of its geographic conditions, the Mediterranean basin is considered one of the main cyclogenesis regions in the world.
- The extratropical cyclones (ECs) that affect it often become intense, causing high-impact climatic conditions and severe socio-economic and environmental damage throughout the region.
- For this reason, it is essential to carry out in-depth analysis and research related to these systems to minimize the impacts and disasters they may cause.

General objetive: *To carry out a climatology of moisture sources associated with ECs arriving in the Western Mediterranean (WestMED).*

Data and methodology

- **Models used:** WRF-ARWv.3.81 and FLEXPART-WRFv3.3.2.
- **Data used:** ERA5 reanalysis (spatial resolution: 0.25º).
- **Results processing:** Python and TROVAv1.1 software.
- **EC detection and tracking:** MSLP minima/1000 km radius
- for paring centres in continuous 6h time steps.
- **Period used**: 1985-2022.

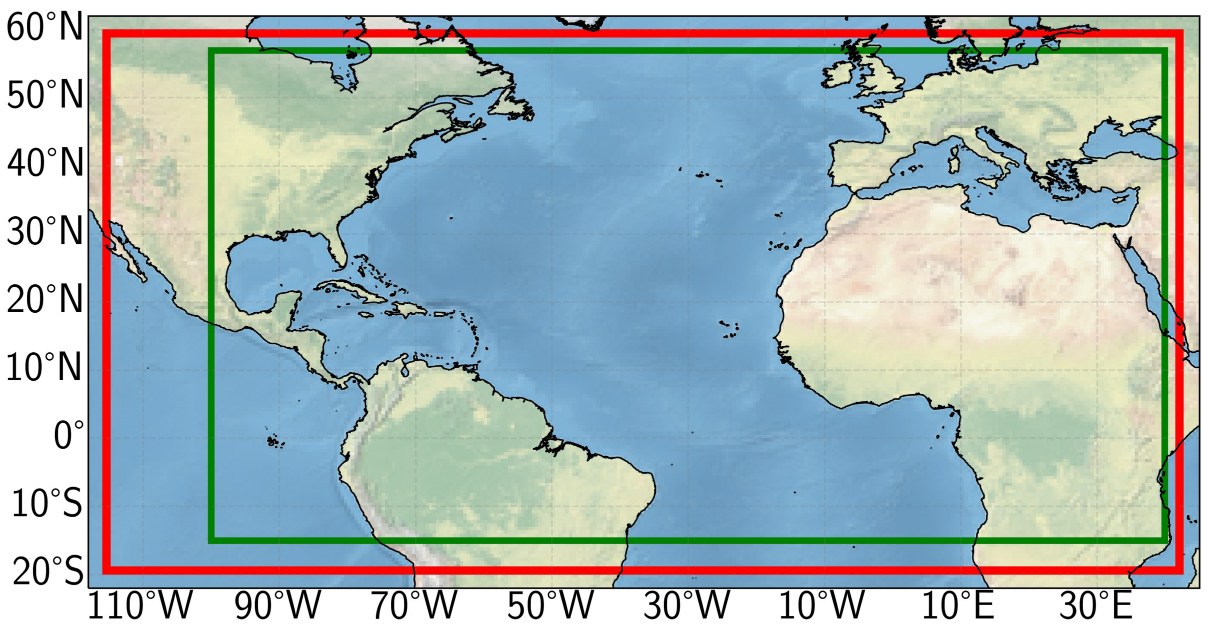
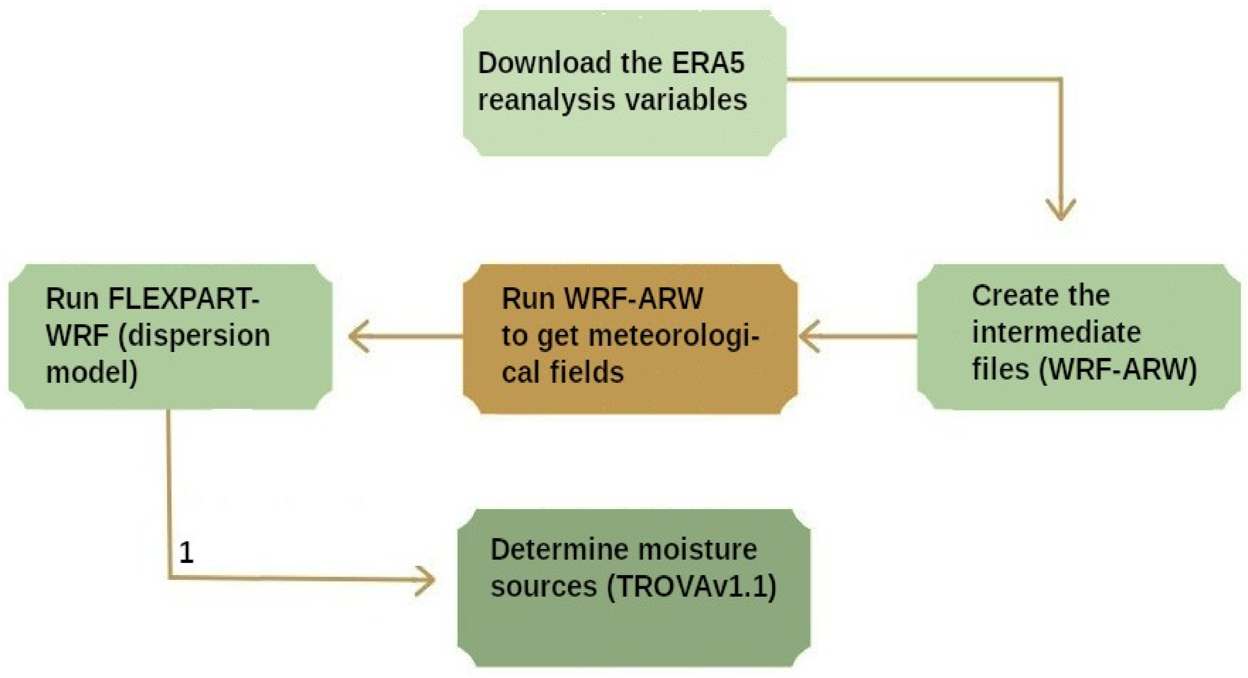


Figure 1: Domain configuration for WRF-ARW (red) and FLEXPART-WRF (green) simulations. Spatial resolution: 0.18º.



1- Determination of position and variables associated with the ECs

Figure 2: Flowchart implemented in this study.

Methodology to determine moisture sources

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

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

m: particle mass
e – p: increase or decrease in the water vapor ratio along the trajectory every 6 hours
E: Evaporation
P: Precipitation
N: total number of particles over the area of grid A
E – P > 0: Moisture source region
Residence time of water vapor: 10 days (van der Ent and Tuinenburg, 2017)
Methodology: Stohl and James (2005) considering precipitating particles according to Läderach and Sodemann (2016).

Results: ECs climatology

Number of ECs: 273

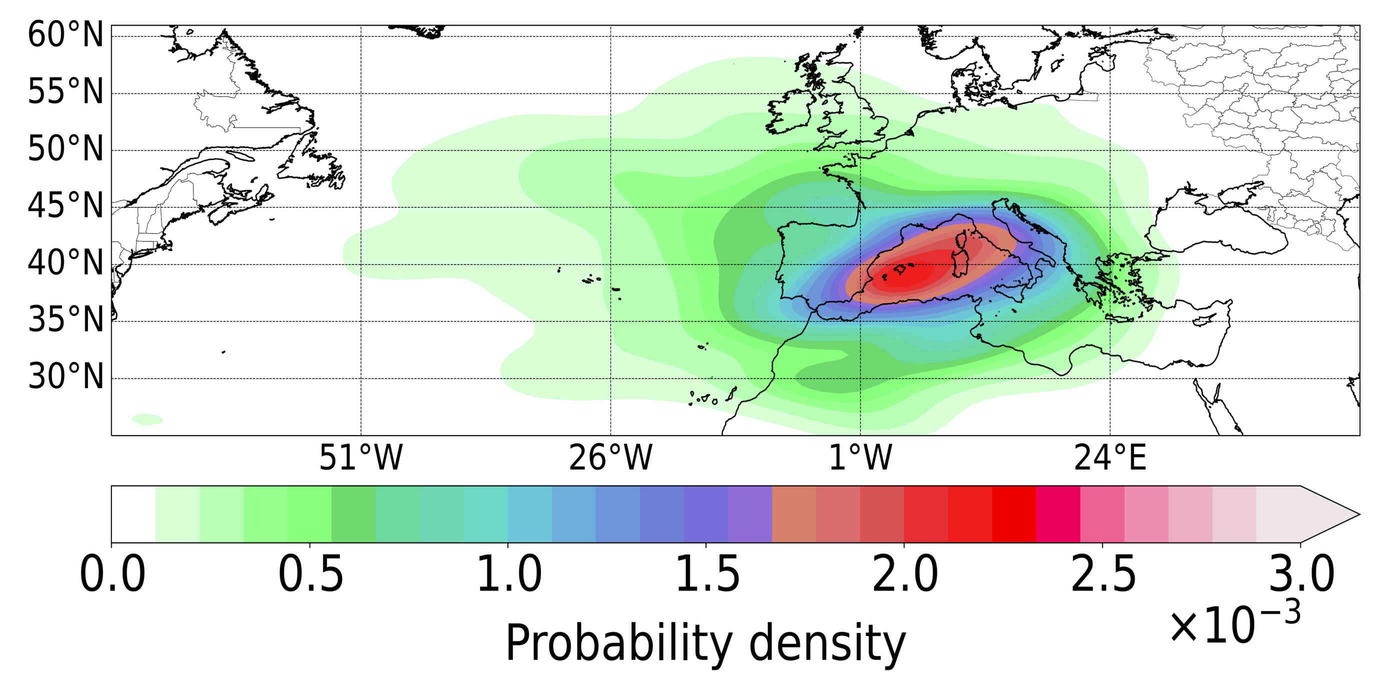


Figure 3: The probability density of ECs tracks in the period used: 1985-2022.

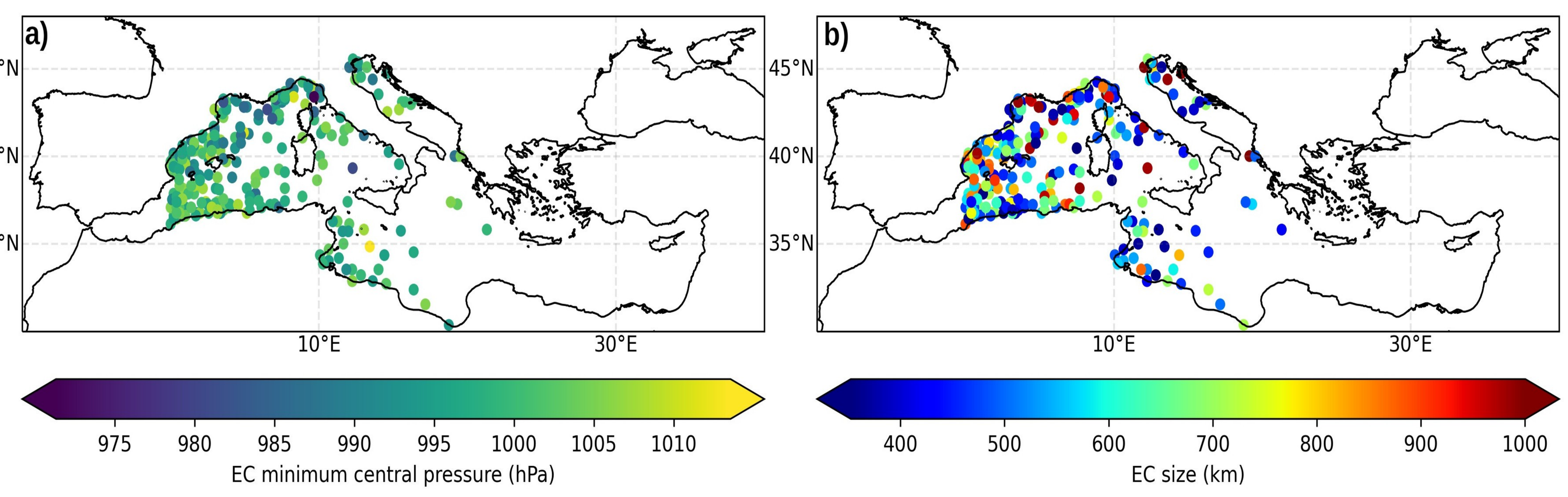


Figure 4: EC minimum central pressure (hPa, a) and EC size (km, b) for all ECs detected in the period: 1985-2022

Results: Climatology of moisture sources

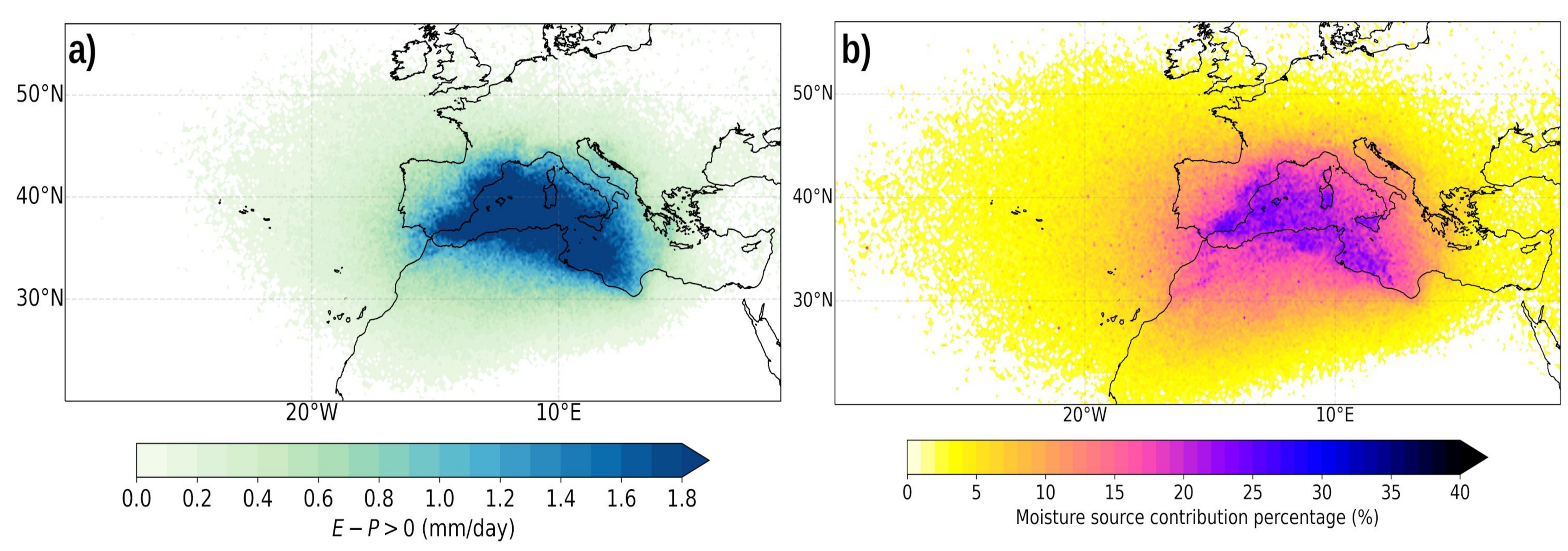


Figure 5: Climatology of moisture sources (a) and moisture sources contribution percentage (b) for all ECs detected in the period: 1985-2022.

Conclusions

- It was obtained that the regions with the highest density of probability of occurrence were the east of the Iberian Peninsula, southern Europe, and the WestMED.
- In addition, 273 EC cases that arrived at WestMED during this study period were determined.
- The moisture source regions with the greatest contribution to these ECs were the Western and Central Mediterranean with values greater than 1.8 mm/day, and then the Eastern Atlantic.
- Values of moisture sources contribution percentage greater than 20% were observed in the Mediterranean region and in the rest of the areas values oscillating in the range of 5-20%.

Acknowledgements

- José C. Fernández-Alvarez acknowledge the support from the postdoctoral contract funded by the Xunta de Galicia with grant No. IN606B2024/016.
- Gleisis Alvarez-Socorro acknowledge the support from ESMORGA project (TED2021-129152B-C43).
- Patricia Coll-Hidalgo acknowledge support from the Xunta de Galicia (Consellería de Cultura, Educación e Universidade) under PhD grant No. ED481A2022/128.
- This work was supported by the SETESTRELO project (PID2021-122314OB-I00), funded by the Ministerio de Ciencia, Innovación y Universidades, Spain.
- This work has been possible thanks to the computing resources and technical support provided by CESGA (Centro de Supercomputación de Galicia) and Red Española de Supercomputación.

References

1. Stohl, A.; James, P.A. A Lagrangian analysis of the atmospheric branch of the global water cycle: Part II: Earth's river catchments ocean basins, and moisture transports between them. J. Hydrometeorol. 2005, 6, 961–984.
2. van der Ent, R.J.; Tuinenburg, O. A The residence time of water in the atmosphere revisited. Hydrol. Earth Syst. Sci.
3. Läderach, A.; Sodemann, H. A revised picture of the atmospheric moisture residence time. Geophys. Res. Lett. 2016, 43, 924–933
4. Fernández-Alvarez, J.C.; Pérez-Alarcón, A.; Nieto, R.; Gimeno, L. TROVA: TRansport Of water VApor. SoftwareX 2022, 20, 101228.

Universidade Vigo
EPhysLab
CESGA GALICIA SUPERCOMPUTING CENTER
XUNTA DE GALICIA