AI4S
BSC AI4Science Fellowships

Earth Sciences Department

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Exploring windows of opportunity at sub-seasonal time scales for extreme precipitation events

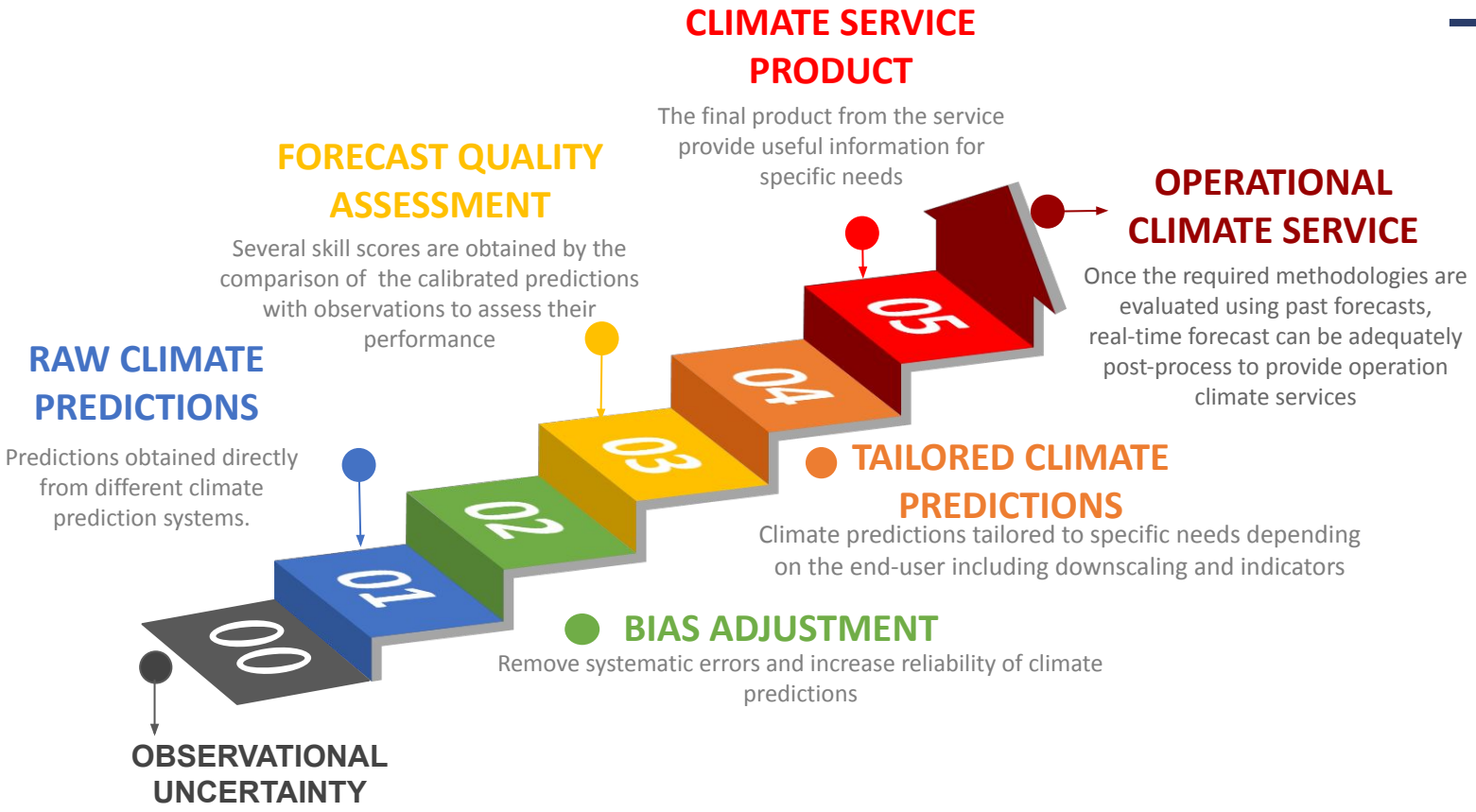
The Valencia DANA case study

15th of May 2025
6th Summer School

The Abdus Salam International Centre for Theoretical Physics

Núria Pérez-Zanón, Francisco Doblas-Reyes & Albert Soret

Climate Services based on Climate Predictions



Set of tools

from evaluation to operational

Parallelization in multiple nodes: **startR**

Parallelization in multiple cores: **multiApply**

Calibration: **CSTools**

Verification: **s2dv**

Downscaling: **CSDownscale**

Indicators: **CSIndicators**

Job scheduler: **Autosubmit**

https://earth.bsc.es/gitlab/es/startR

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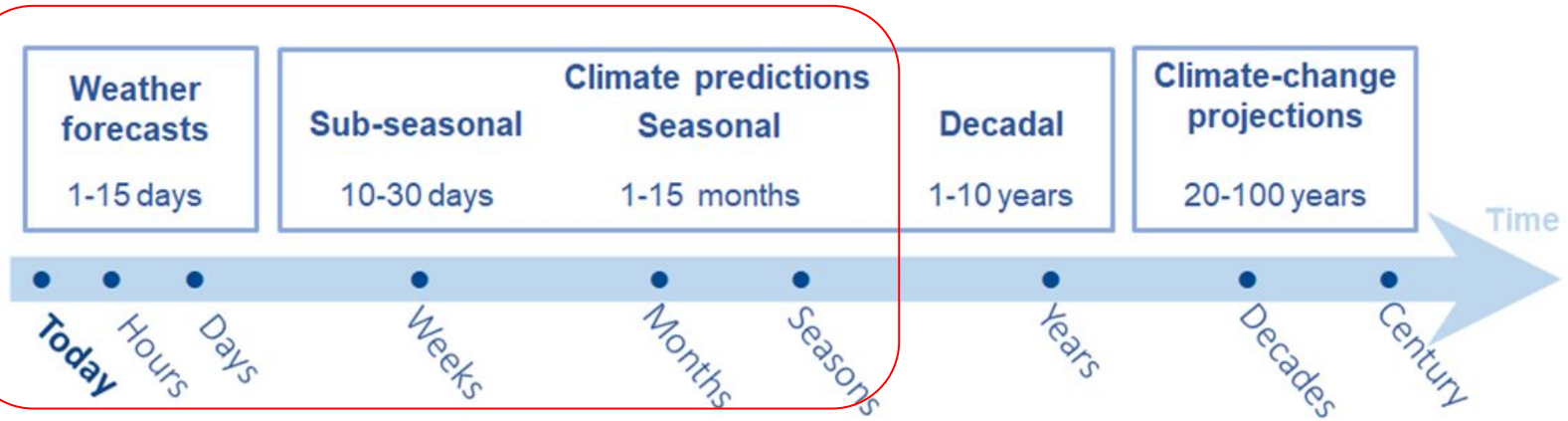
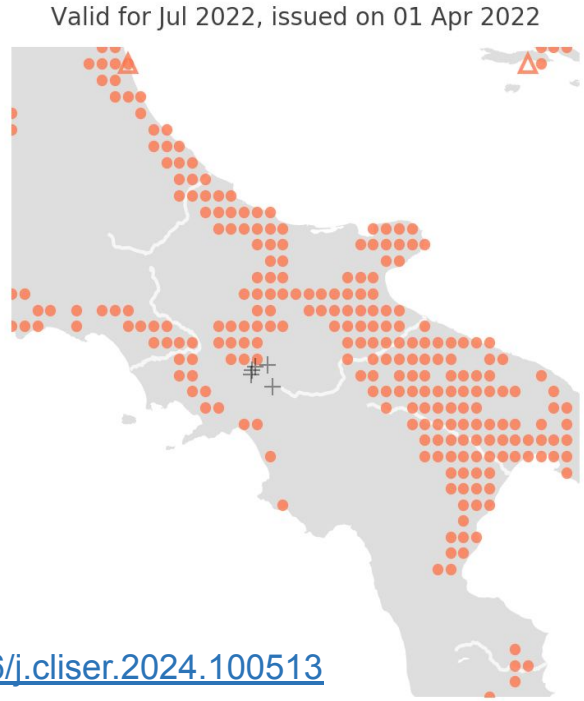
Manubens et al., 2018 doi:10.1016/j.envsoft.2018.01.018; Pérez-Zanón et al. 2022 doi:10.5194/GMD-15-6115-2022; Pérez-Zanón et al., 2023 https://doi.org/10.1016/j.cliser.2023.100393

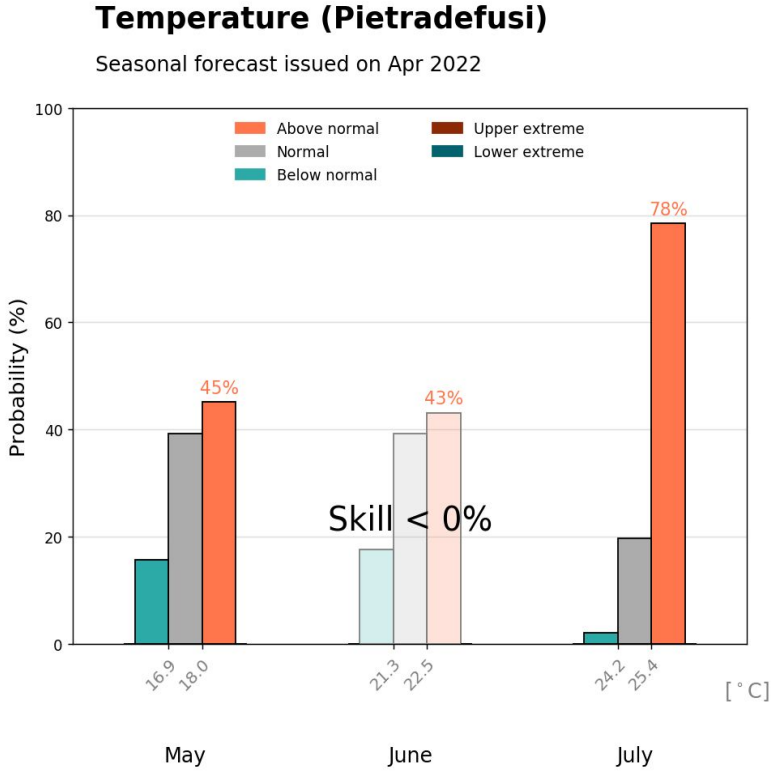
Climate Services based on Climate Predictions



Agriculture

VITIGEOSS





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Pérez-Zanón et al., 2024 doi:10.1016/j.cliser.2024.100513

Showcase the Climate Services potential or limitations

Case study

S2S4E Climate Services for Clean Energy

https://s2s4e.eu/climate-services/case-studies

- Case Study #1 Factsheet: Cold Spell and Wind Drought in Europe
- Case Study #4 Factsheet: Combined snowmelt and high precipitation in Sweden
- Case Study #5 Factsheet: Icing Event in Romania
- Case Study #6 Factsheet: Wind drought in USA
- Case Study #7 Factsheet: The "Beast of the East" Cold Spell in Europe
- Deliverable 4.1: Detailed information about the case studies from the factsheets is presented in this deliverable, under Chapter 6.
- Factsheets Guide: A guide to help understand the factsheets presented

Manrique-Suñé et al., 2023 doi:10.1016/j.cliser.2023.100359.

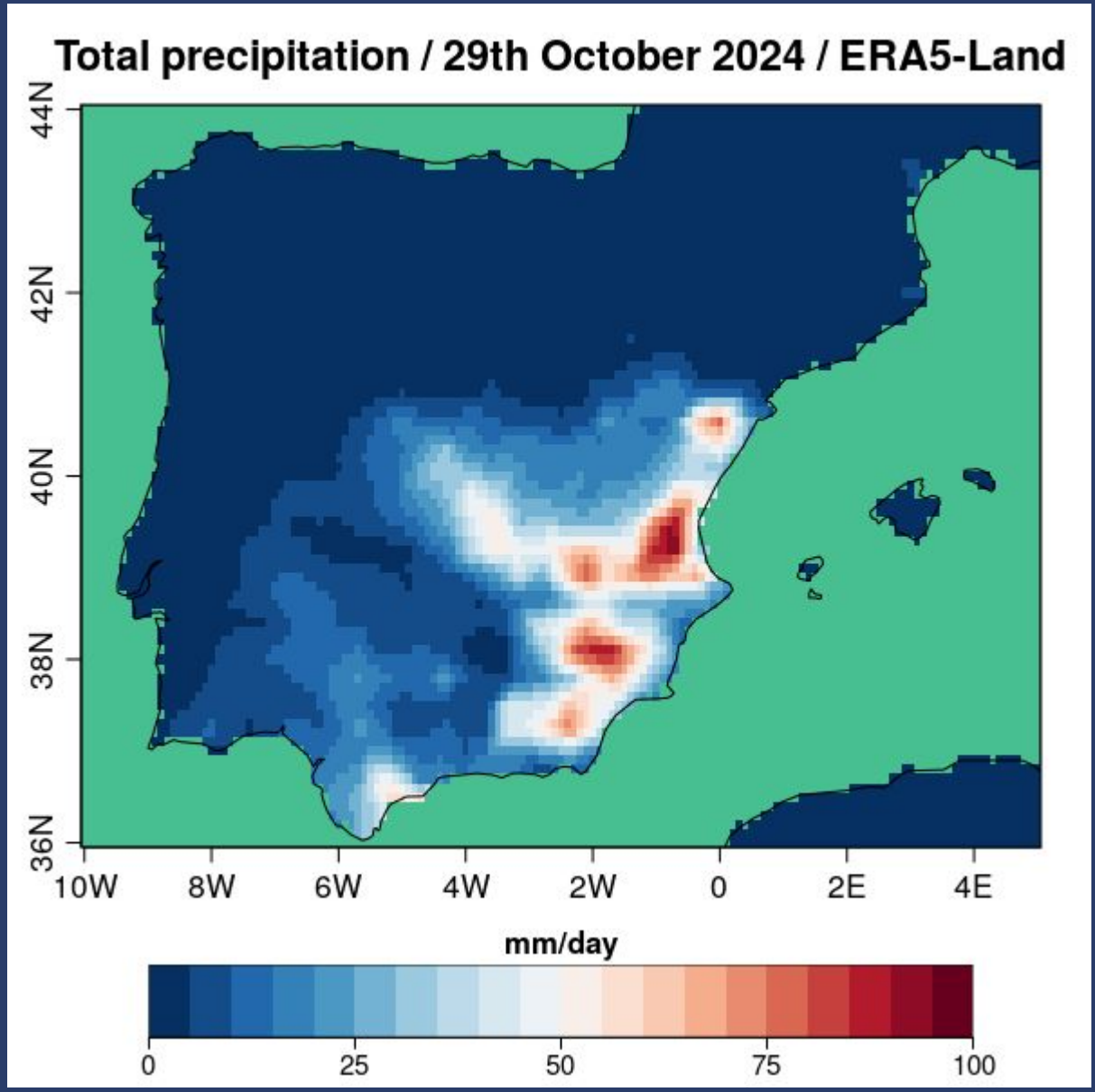
Showcase the Climate Services potential or limitations

Case study

ERA5 Land

AEMET in-situ weather station, in Turís (Valencia), recorded 185 mm in 1 hour and 621 mm in 6 hours.

https://www.aemet.es/documentos/es/conocermas/recursos_en_linea/publicaciones_y_estudios/estudios/informe_episodio_dana_29_oct_2024_.pdf



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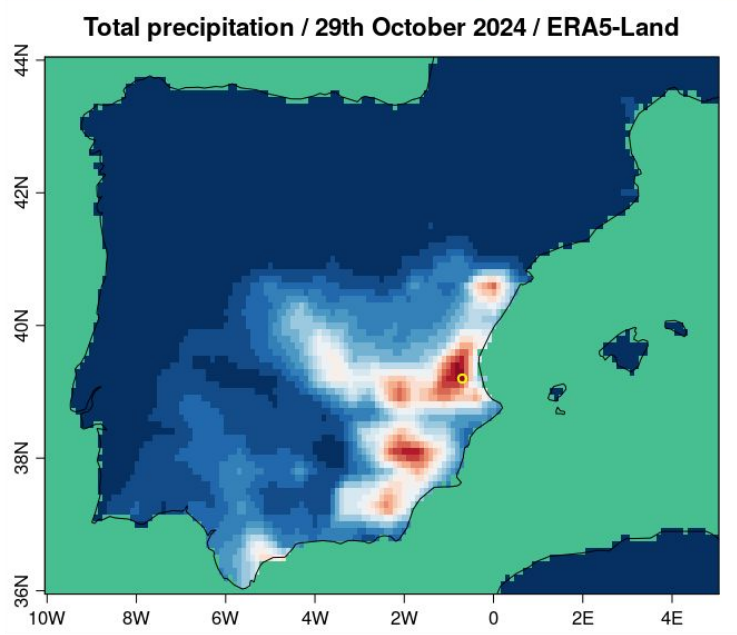
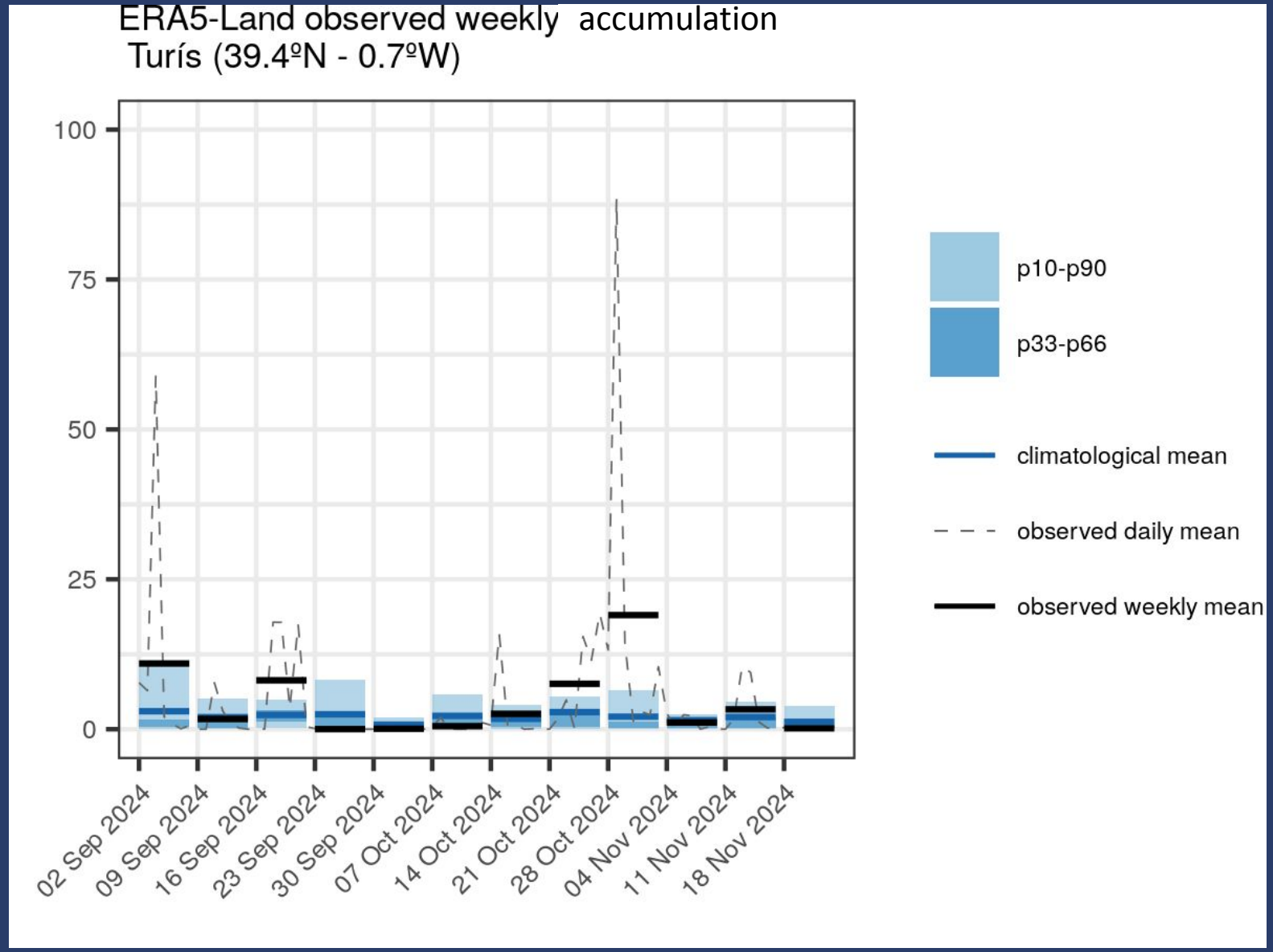
ERA5 Land

Was this event impacting weekly precipitation?





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Sub-seasonal forecast

Was sub-seasonal forecast able to capture the event?

Forecast system: NCEP-CFSv2

Reference: ERA5 interpolated to NCEP-CFSv2 gaussian grid using CDO conservative method

Nominal initialization dates (Thursdays): 03-10-2024, 10-10-2024, 17-10-2024, 24-10-2024.

- For the hindcast (1999-2016), these nominal start dates contain 12 ensemble members generated by merging the 4 daily initializations for the nominal initialization date plus 2 days before.
- For the forecast, these nominal start dates contain 48 ensemble members built in the same way.

The target week is from Monday 28th of October to the 3rd of November 2024.

The region selected is the iberian peninsula 36°N - 44°N, 10°W - 5°E

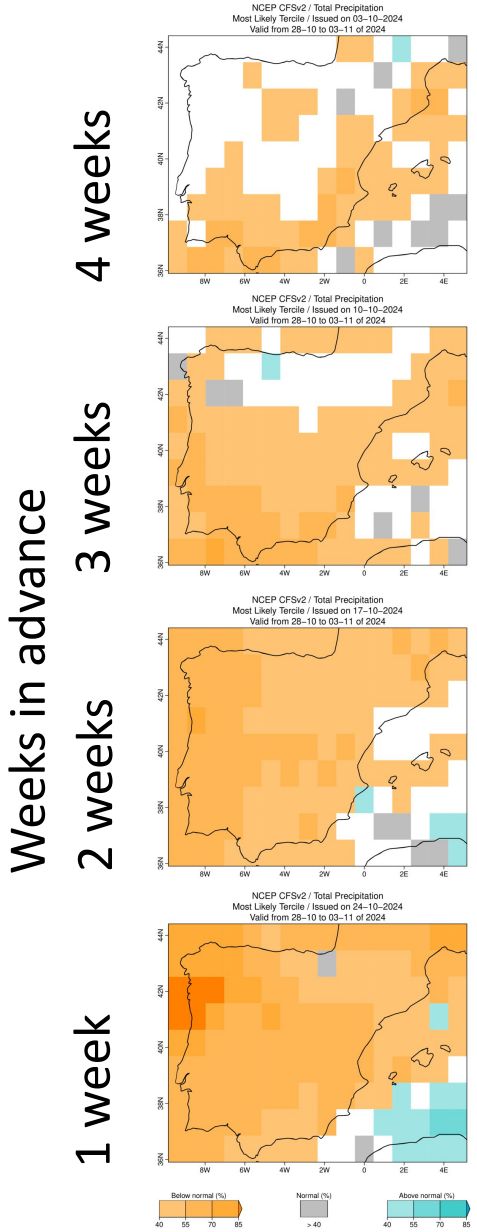
Sub-seasonal forecast

Was sub-seasonal forecast able to capture the event?

Calibration methods

- ❏ bias (corrects only the bias),
- ❏ evmos (Leung et al., 1999),
- ❏ mse_min (Doblas-Reyes et al., 2005),
- ❏ crps_min (Van Schaeybroeck and Vannitsem, 2015),
- ❏ rpc-based (Eade et al., 2014),
- ❏ quantile mapping (Gudmundsson et al., 2012)

Bias method



What we see:

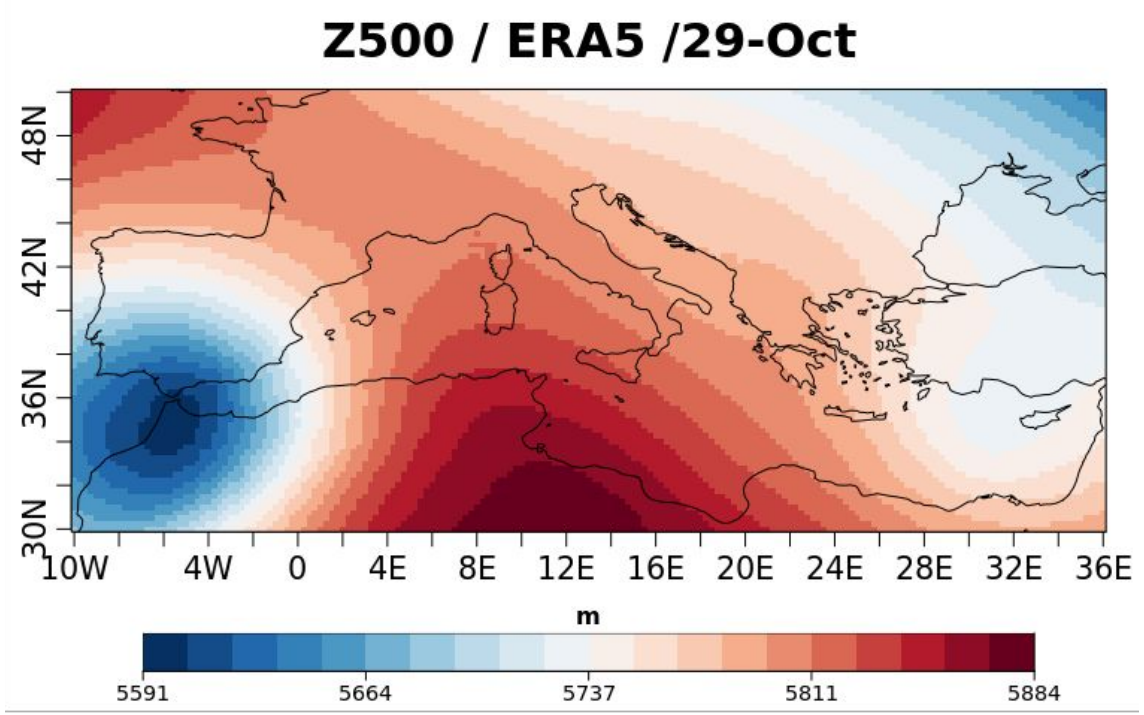
The probability of the most probable tercile category for the weekly accumulated precipitation for the target week (Monday 28th of October to the 3rd of November 2024)

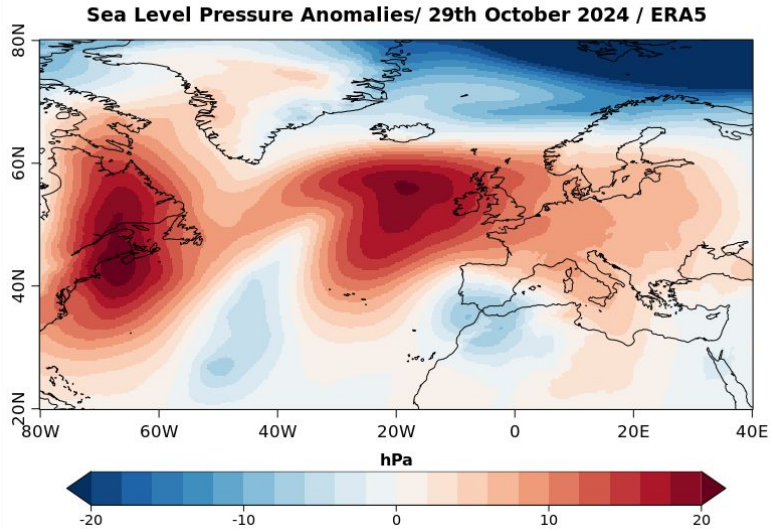
The forecast 1 and 2 weeks in advance show above normal conditions to be the most probable category in the Alboran sea.

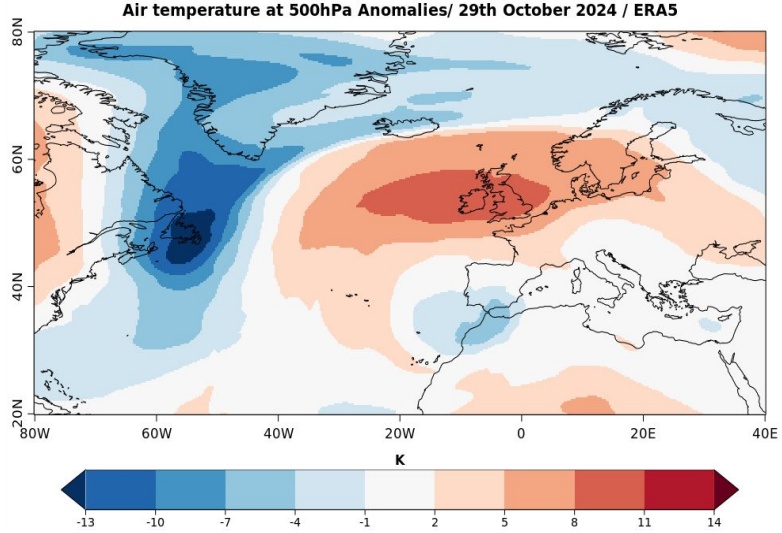
Is it a problem of predicting the correct location of precipitation? If so, could I apply any AI technique to correct the location of the predicted precipitation?

Questions

Atmosphere


Z500 / ERA5 /29-Oct
48N
42N
36N
30N
10W
4W
0
4E
8E
12E
16E
20E
24E
28E
32E
36E
m
5591
5664
5737
5811
5884

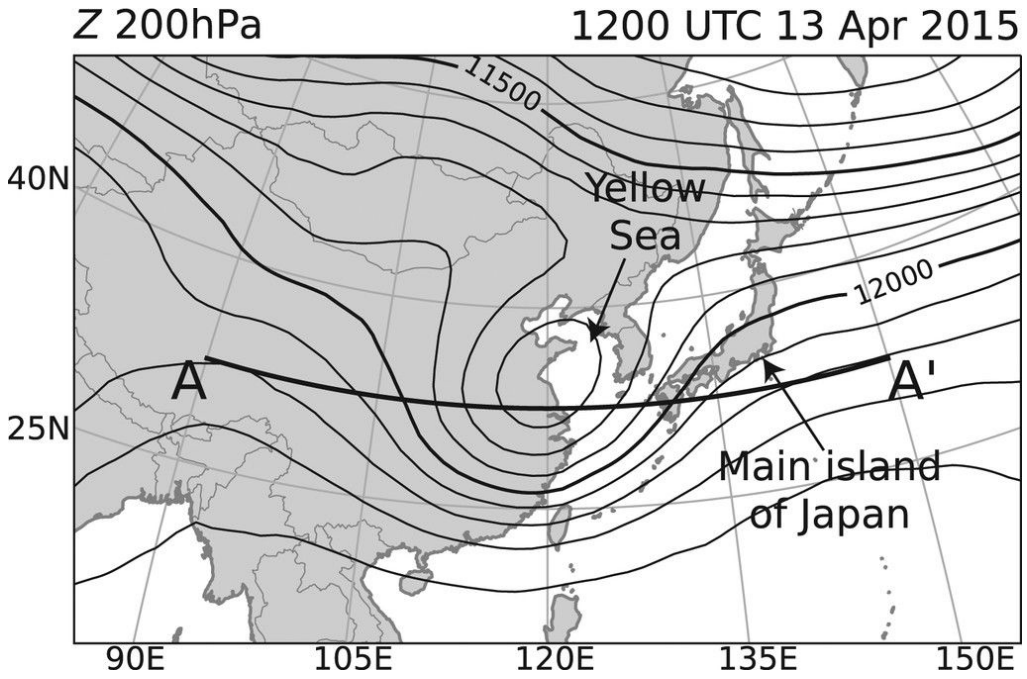

Sea Level Pressure Anomalies/ 29th October 2024 / ERA5
80N
60N
40N
20N
80W
60W
40W
20W
0
20E
40E
hPa
-20
-10
0
10
20

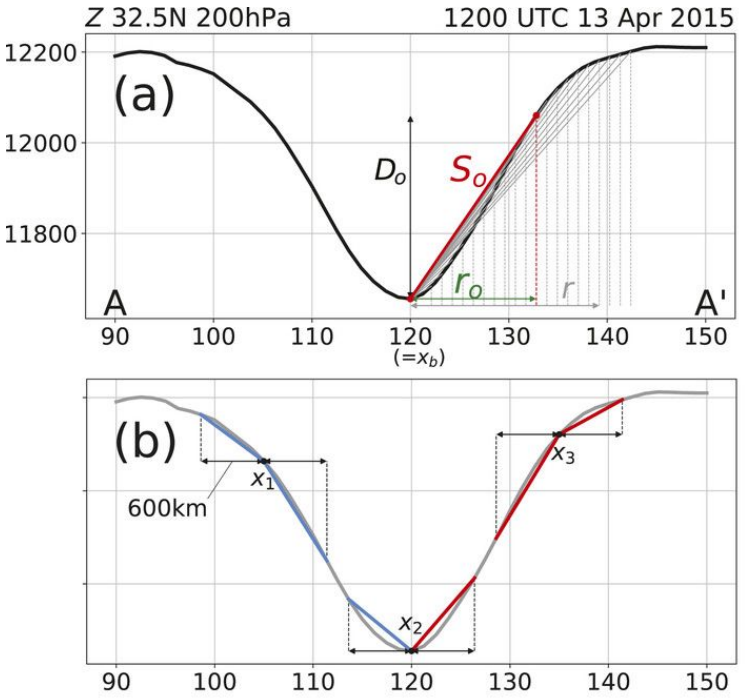

Air temperature at 500hPa Anomalies/ 29th October 2024 / ERA5
80N
60N
40N
20N
80W
60W
40W
20W
0
20E
40E
K
-13
-10
-7
-4
-1
2
5
8
11
14

Strategy

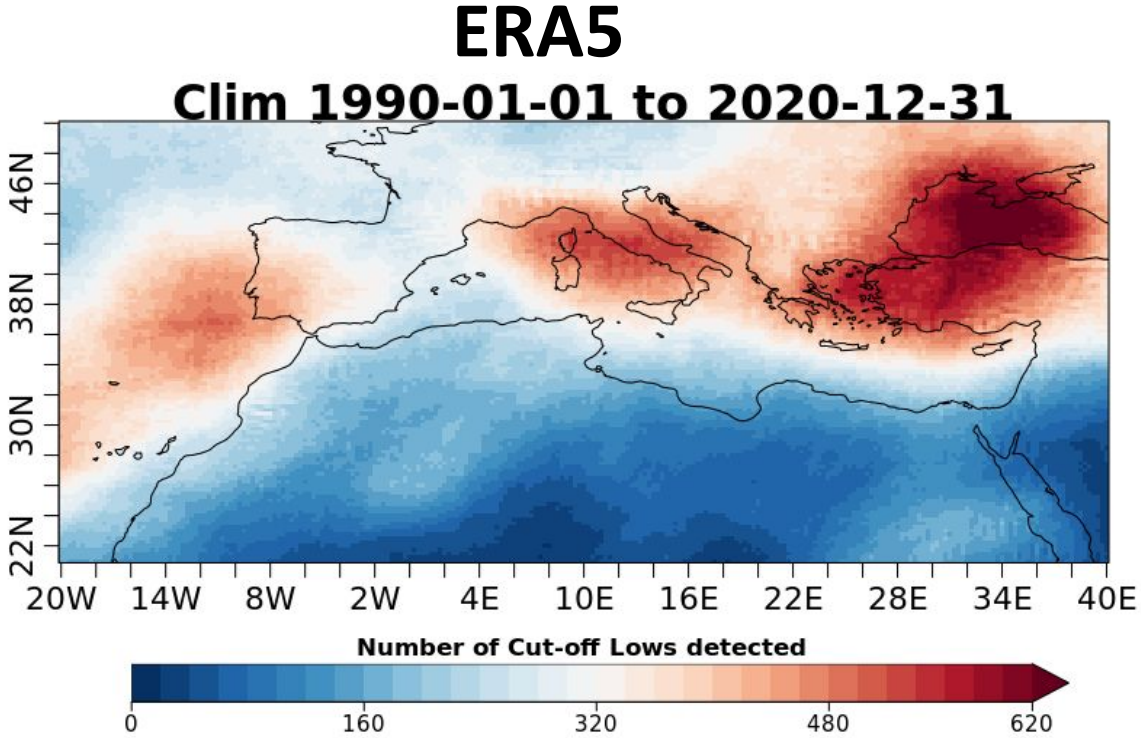
Cut-off lows detection algorithm
→ I can apply it at forecast, hindcast and reference datasets to get a probability to occur as well as to perform the forecast verification.

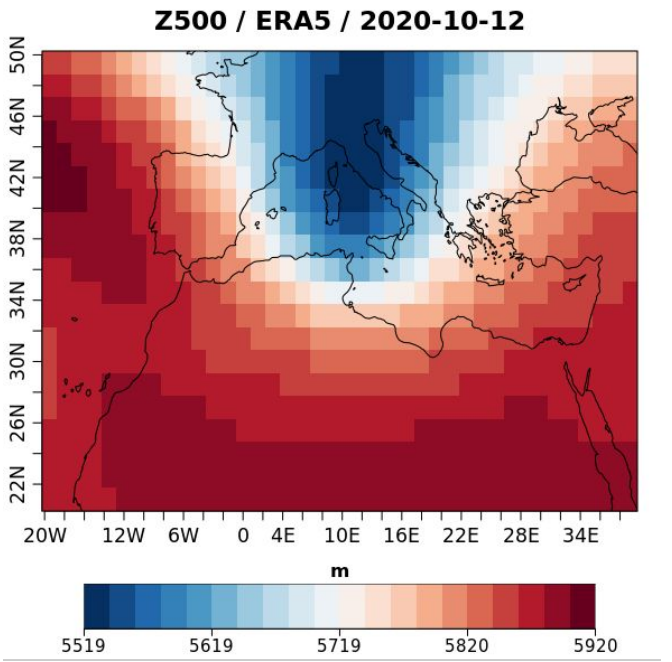
Kasuga et al., 2021 https://doi.org/10.1175/MWR-D-20-0255.1

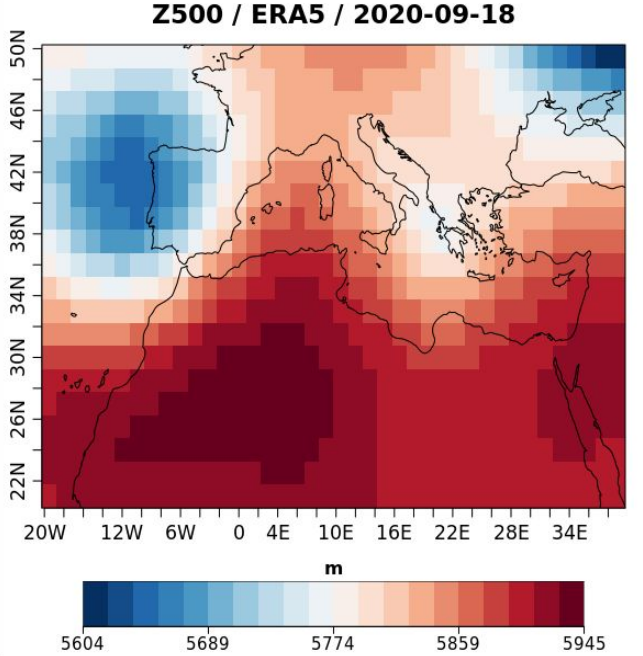


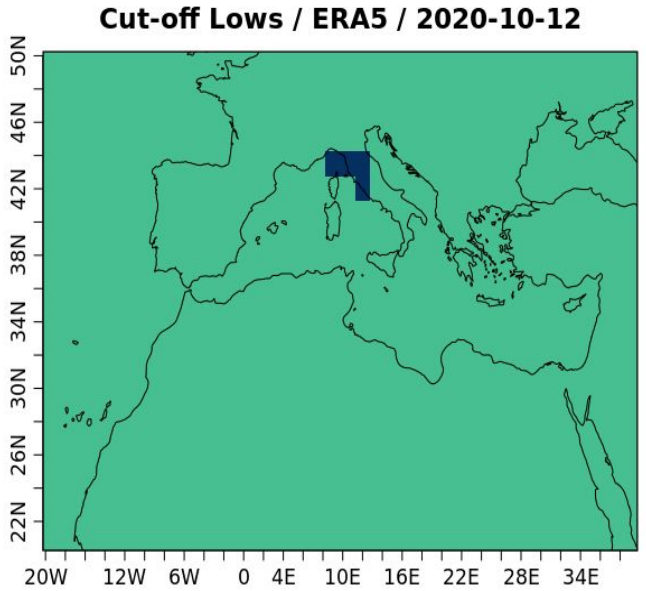


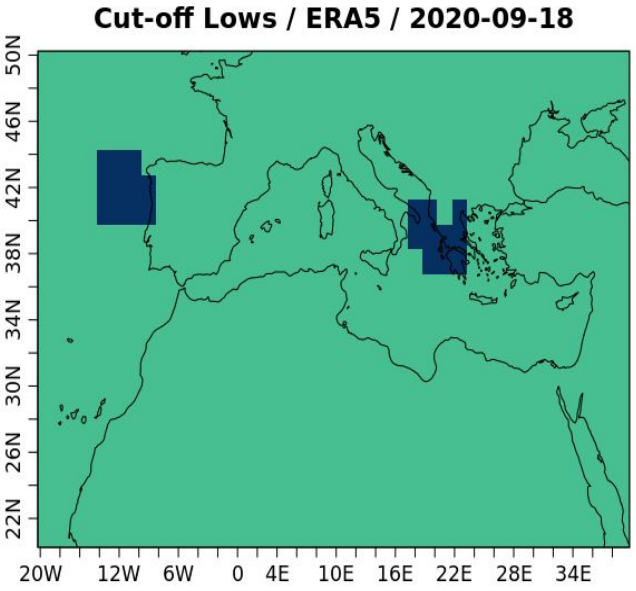
Cut-off low detection











Next steps

> Analyse precipitation forecast from ECMWF sub-seasonal forecast

> Apply the cut-off low detection algorithm and perform the forecast verification

❖ Could I apply an AI technique to calibrate the forecast system precipitation?

Suggestions are welcome

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Thanks for your attention

Núria Pérez-Zanón acknowledges her AI4S fellowship within the “Generación D” initiative by Red.es, Ministerio para la Transformación Digital y de la Función Pública, for talent attraction (C005/24-ED CV1), funded by NextGenerationEU through PRTR.

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