Mediterranean Seasonal Climate Update

Workshop on objective seasonal forecasts (OSF) production over MedCOF region

Carmen Álvarez-Castro[1,2]

[1] Pablo de Olavide University, Seville, Spain

[2] Fondazione Centro EuroMediterraneo Sui Cambiamenti Climatici, Bologna, Italy.

02/07/2024

Introduction

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

The **Mediterranean Seasonal Climate Update (MSCU)** is a monthly Seasonal Forecast update for a large region encompassing the Mediterranean basin, which presents forecasts of Precipitation and Temperature, for the upcoming season, using:

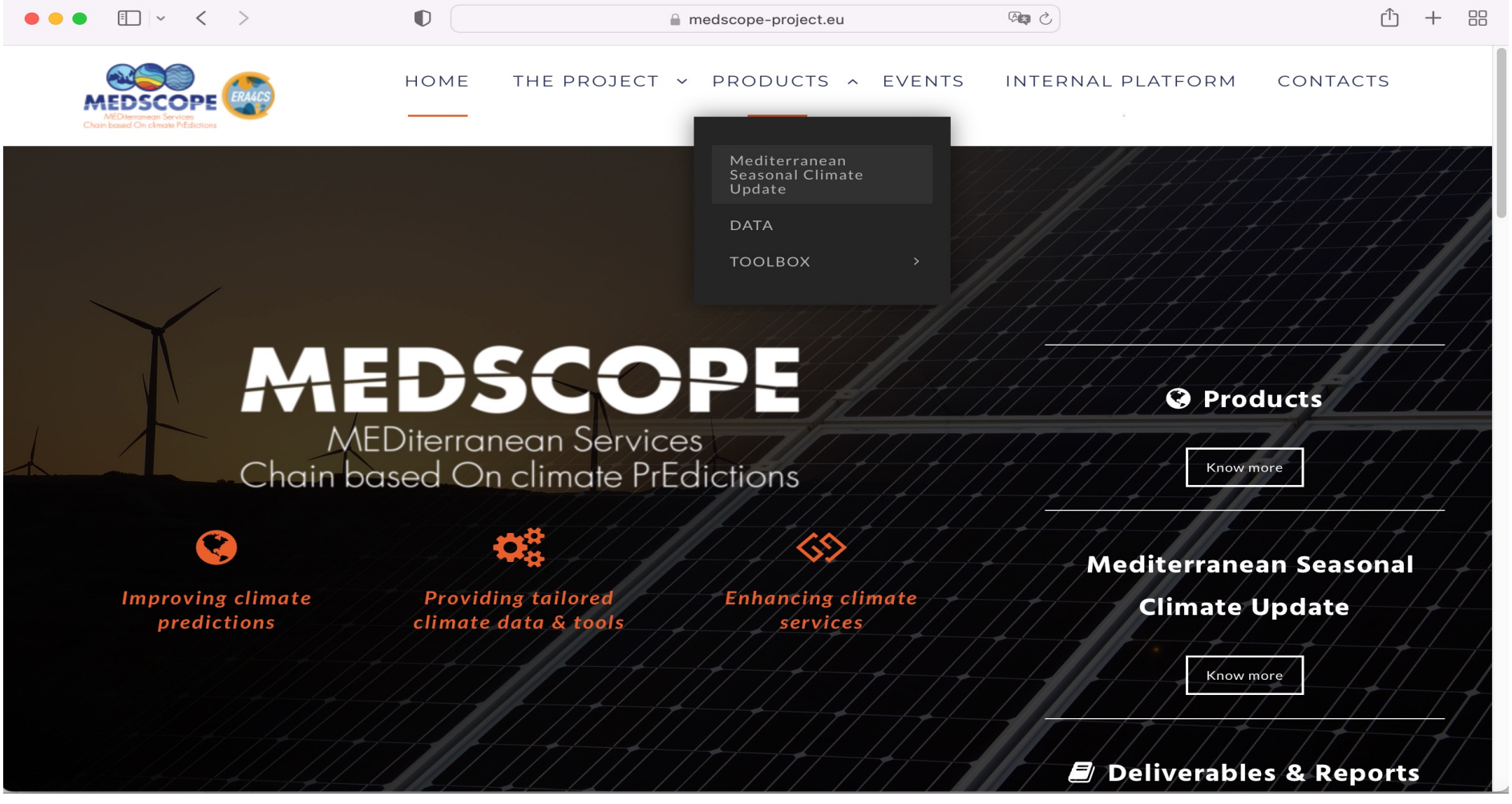
- The **North American Multi-Model Ensemble (NMME)** seasonal prediction system (Kirtman et al, 2014, Becker et al, 2014),
- The **Copernicus Climate Change (C3S)** seasonal prediction system (https://climate.copernicus.eu/seasonalforecasts) and,
- The **AEMET empirical model** developed within the MEDSCOPE framework (Rodriguez-Guisado et al, 2019).

The MSCU is principally addressed to the MedCOF community and more generally, to users and stakeholders who may benefit from having at hands a summary, in graphical homogeneous form, of the seasonal predictions produced by some of the main international and well–documented multi–model systems.

Introduction

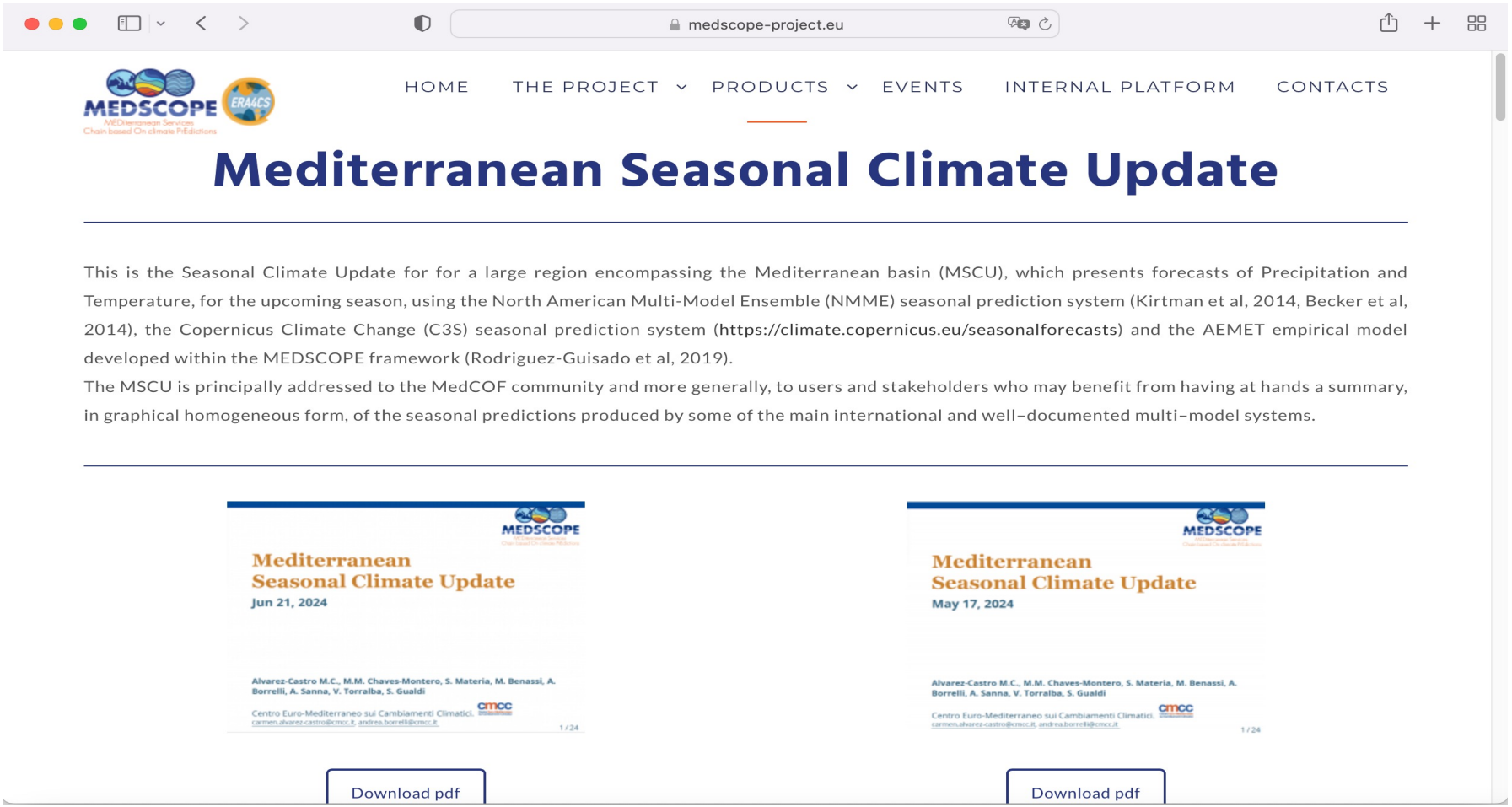
MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

Available at the MEDSCOPE website: www.medscope-project.eu



Introduction

Available at the MEDSCOPE website:
https://www.medscope-project.eu/products/mediterranean-seasonal-climate-update/



Example: Last Mediterranean Seasonal Climate Update

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

Mediterranean Seasonal Climate Update

Jun 18, 2024

Alvarez-Castro M.C., M.M. Chaves-Montero, S. Materia, M. Benassi, A. Borrelli, A. Sanna, V. Torralba, S. Gualdi

Centro Euro-Mediterraneo sui Cambiamenti Climatici.
carmen.alvarez-castro@cmcc.it, andrea.borrelli@cmcc.it

Outline

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

1. Introduction
2. Data:
   a) C3S ensemble
   b) NMME ensemble
   c) AEMET empirical model
3. Seasonal Forecast:
   1. Start date and Leadtime
   2. Terciles
   3. ENSO:
   4. Mediterranean Maps:
      a) Most likely Tercile in the three forecast systems (L1): Precipitation
      b) Skill (L1): Precipitation
      c) Most likely Tercile in the three forecast systems (L1): Temperature
      d) Skill (L1): Temperature
4. References

Supplementary Material

1.Introduction

MEDSCOPE
MEDiterranean Services Chain based On climate PrEdictions

- This is a Seasonal Climate Update for a large region encompassing the Mediterranean basin (hereafter, MSCU) and is principally addressed to the MedCOF community and more generally, to users and stakeholders who may benefit from having at hands a summary, in graphical homogeneous form, of the seasonal predictions produced by some of the main international and well-documented multi-model systems.
- Seasonal forecasts are essential to offer data and information for the development of early-warning decision support systems (Troccoli et al,2008), which can help to reduce the socio-economics related risk associated with anomalous events.
- Characteristics of the climate system and links among remote regions make seasonal prediction systems capable of forecasting the probability of occurrence of future anomalies. The skill of these forecasts depends on the considered meteo-climatic variable, on the lead time and on the target area (Balmaseda et al, 2009). The evolution of anomalous conditions over the oceans and in tropical regions is, in general, more predictable than over continental areas in mid-latitudes. Thus, the models' predictive skill is generally higher in the Tropics. Also, variables like precipitation, featured by a more stochastic nature, are less predictable than temperature, and thus forecasts show higher predictive skill for temperature than for rainfall (Becker et al, 2014).

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

- The MSCU presents forecasts of Precipitation and Temperature, for the upcoming season, using the North American Multi-Model Ensemble (NMME) seasonal prediction system (Kirtman et al, 2014, Becker et al, 2014), the Copernicus Climate Change (C3S) seasonal prediction system (https://climate.copernicus.eu/seasonalforecasts) and the AEMET empirical model developed within the MEDSCOPE framework (Rodriguez-Guisado e tal, 2019). These systems have been chosen as they include large super-ensembles produced with well-documented state-of-the-art seasonal prediction systems. The different reference hindcast periods considered by the different multi-model systems (see Tables 1 and 2), may have some influence on both their predictions and predicting skills.

- The MSCU will be continuously updated and improved through interactions with users and collected feedback and, progressively, more systems will be considered and included in the Update.

2. Data
a) C3S models

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

C3S Models	Members	Model horizontal/vertical resolution (atmosphere)*
CMCC	50	0.5º x 0.5º / 46 levels
DWD	50	T127 / 95 levels
ECCC3	10	1.1º / 85 levels
ECCC2	10	T63 / 35 levels
ECMWF	51	TCO319 / 91 levels
JMA	78	TL159 / 6o levels
MF	51	TL359 / 91 levels
NCEP	120	T128 / 64 levels
UKMO	60	N216 / 85 levels
TOTAL*	**460**	
Hindcast period**	**1993-2016**	

Table 1: C3S Models, number of members and Hindcast reference period in the ensemble.

* C3S models are provided in 1ºx1º grid and interpolated here to 0.5ºx0.5º grid.

** Number of Members of the Forecast. The total number of members vary among start dates due to NCEP, JMA and UKMO models.

2. Data
b) NMME models

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

NMME Models	Members	Model horizontal/vertical resolution (atmosphere)*
CFSv2	24	T126 / 24 levels
CanCM4i	10	T63 / 31 levels
GEM-NEMO	10	1.1º x 1.4º / 85 levels
GFDL-SPEAR	30	C18 / 32 levels
NCAR-CCSM4	10	0.9º x 1.25º / 26 levels
NCAR-GEOS5v2	12	0.5º / 72 levels
TOTAL**	**96**	
Hindcast period	**1982-2010**	

Table 2: NMME Models, number of members and Hindcast reference period in the ensemble.

* NMME are provided in 1ºx1º grid and interpolated here to 0.5ºx0.5º grid.
** Number of Members of the Forecast. The total number of members vary among start dates due to NASA and CFSv2 models.

2. Data
c) AEMET Empirical model

MEDSCOPE
MEDiterranean Services Chain based On climate PrEdictions

The AEMET empirical model (Rodriguez-Guisado et al, 2019) is based on multiple linear regression, using global climate indices (mainly global teleconnection patterns and indices based on sea surface temperatures, as well as sea-ice and snow cover) as predictors. The model is implemented in a way that allows easy modifications to include new information from other predictors that will come as result of the ongoing sensitivity experiments within the MEDSCOPE project.

The AEMET empirical model makes use of different sets of predictors for every season and every sub region. Starting from a collection of 25 global climate indices, a few predictors are selected for every season and every sub region, checking linear correlation between predictands (temperature and precipitation) and global indices up to one year in advance and using moving averages from two to six months. Special attention has also been payed to the selection of predictors in order to guaranty smooth transitions between neighbor sub regions and consecutive seasons. The model runs a three-month forecast every month with a one-month lead time.

AEMET Empirical Model	Horizontal Resolution
AEMET	1^o x 1^o

3. Seasonal Forecast:

3.1 Start date and Leadtime:

Start date M0	Jun
Leadtime L1	JAS

Table 3: Mediterranean figures for Precipitation and Temperature Figures at leadtime 1 (L1)

Notes:
There is a mask in the forecasts in regions that have climatologically very little precipitation in the target months. These regions correspond to the **white** areas in precipitation maps. Forecast of the temperature maps are not affected by this mask.
ECMWF and JMA data were interpolated to common C3S 1x1 grid.

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

3. Seasonal Forecast:

3.2 Terciles:

Seasonal forecasts for precipitation and temperature are expressed in form of probability (Doblas-Reyes et al, 2005, Palmer et al, 2008), meaning that the areas of interest are assigned a likelihood of being wetter (warmer), drier (colder) or within the norm:

- The probability of being above the norm is given by the percentage of ensemble members predicting an anomaly higher than the 66th percentile,
- The probability of being below the norm is given by the percentage of ensemble members predicting an anomaly lower than the 33rd percentile.
- The forecast representing predicted anomalies within the norm (between 33rd and 66th percentile) is displayed as well.

3. Seasonal Forecast:

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

3.3 ENSO:

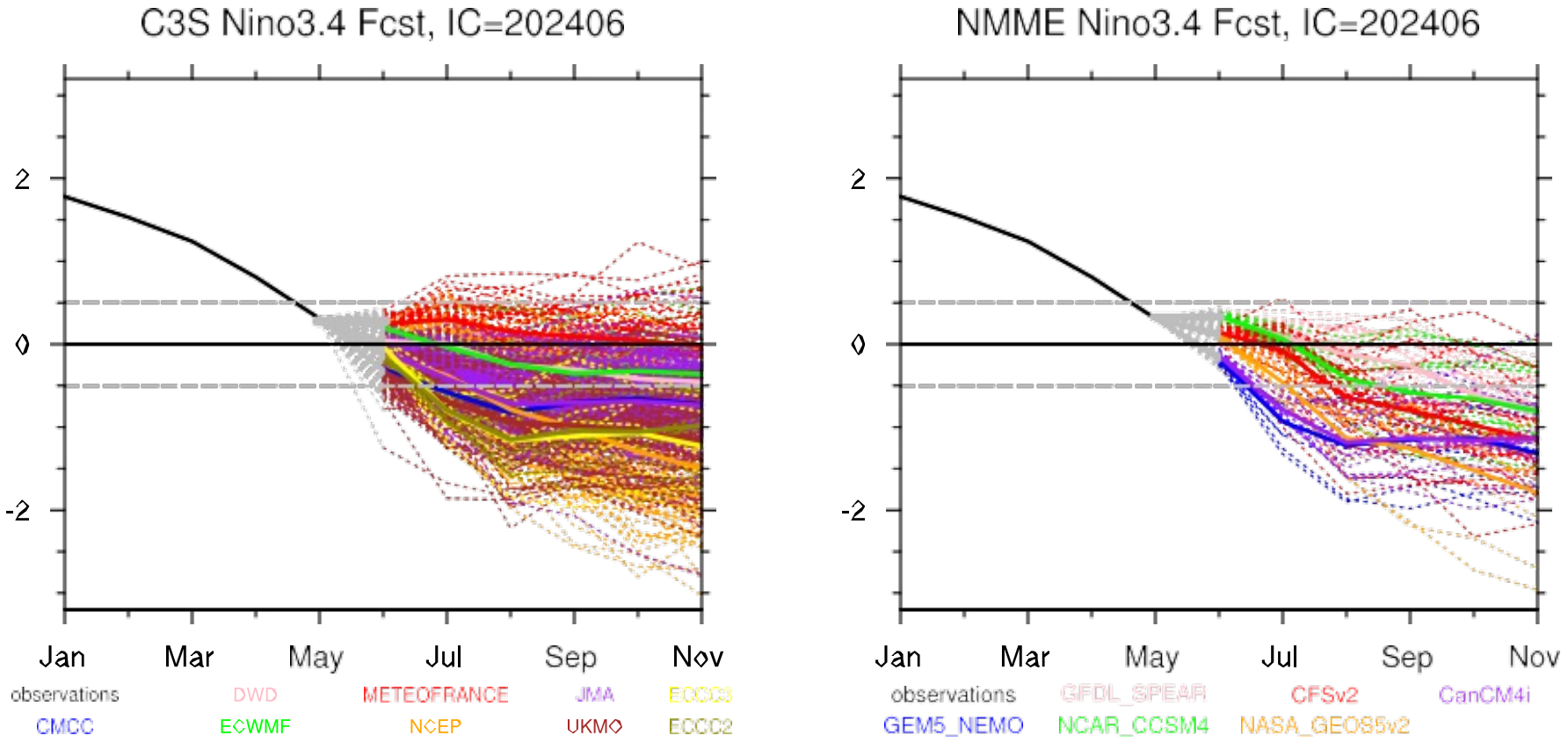


Figure 1: Niño3.4 prediction from all the ensemble members of the C3S multi-system (a) and the NMME multi-system (b), for the start-date of Jun.

MEDSCOPE
MEDiterranean Services Chain based On climate PrEdictions

3. Seasonal Forecast:

3.4 Mediterranean Maps:

Mediterranean temperature and precipitation (forecast and skill) in Leadtime L1: **JAS**

a) Precipitation Forecast

b) Precipitation Skill

c) Temperature Forecast

d) Temperature Skill

Models: C3S models (CMCC, DWD, ECCC3, ECCC2,ECMWF, JMA, NCEP, MF, UKMO), NMME ensemble and Empirical Model AEMET

Note: Figures 2 (Precipitation Forecast) and 4 (Temperature Forecast), can be reproduced using 'PlotMostLikelyQuantileMap' function within the CSTools R package (Perez-Zanon et al, 2021)

a) Precipitation Forecast L1:

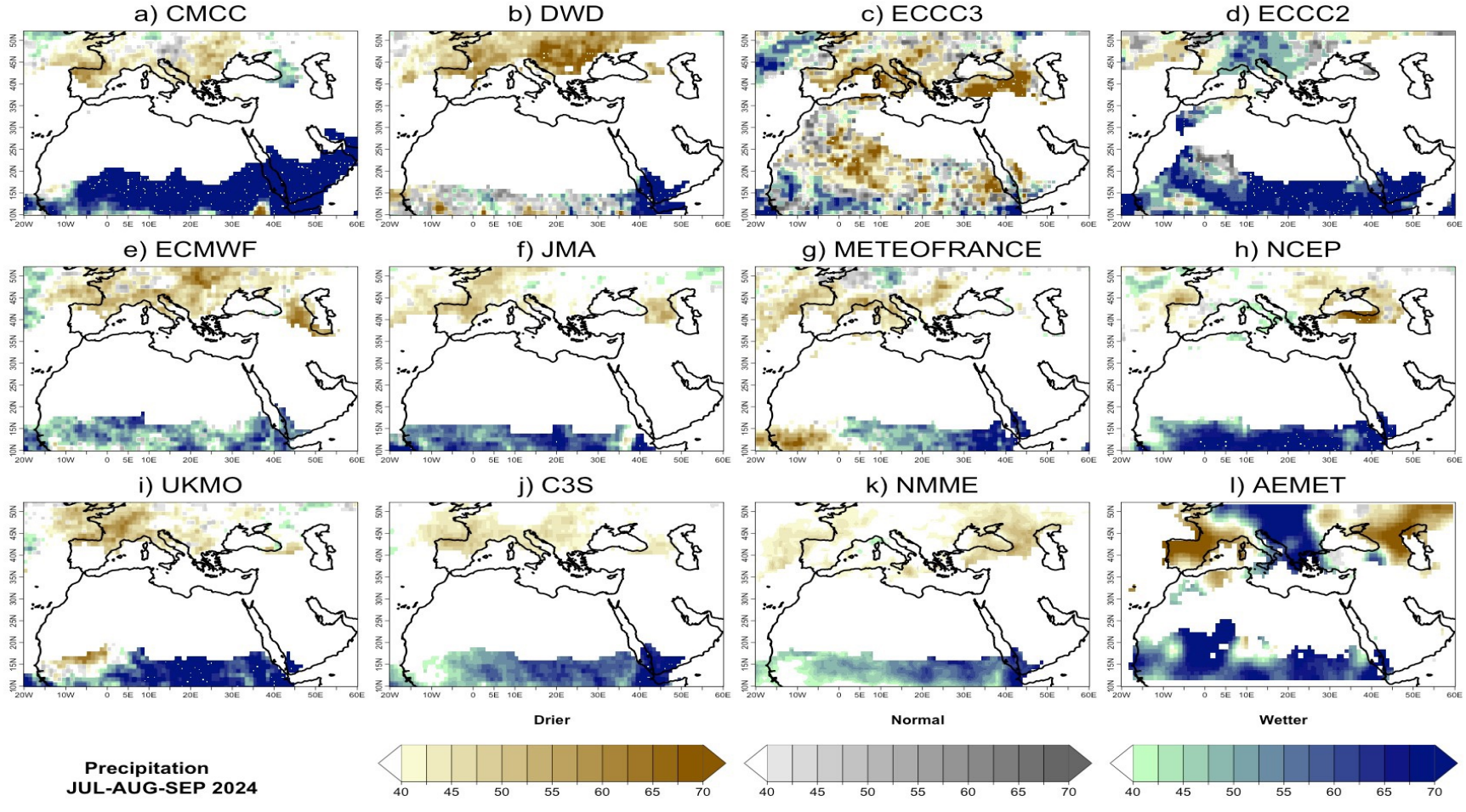


Figure 2: Most likely tercile of Precipitation in the three seasonal forecast systems C3S (j), NMME (k) and AEMET(l) in L1 forecast. From (a) to (i) models of the C3S ensemble.

b) Precipitation Skill (RPSS) L1:

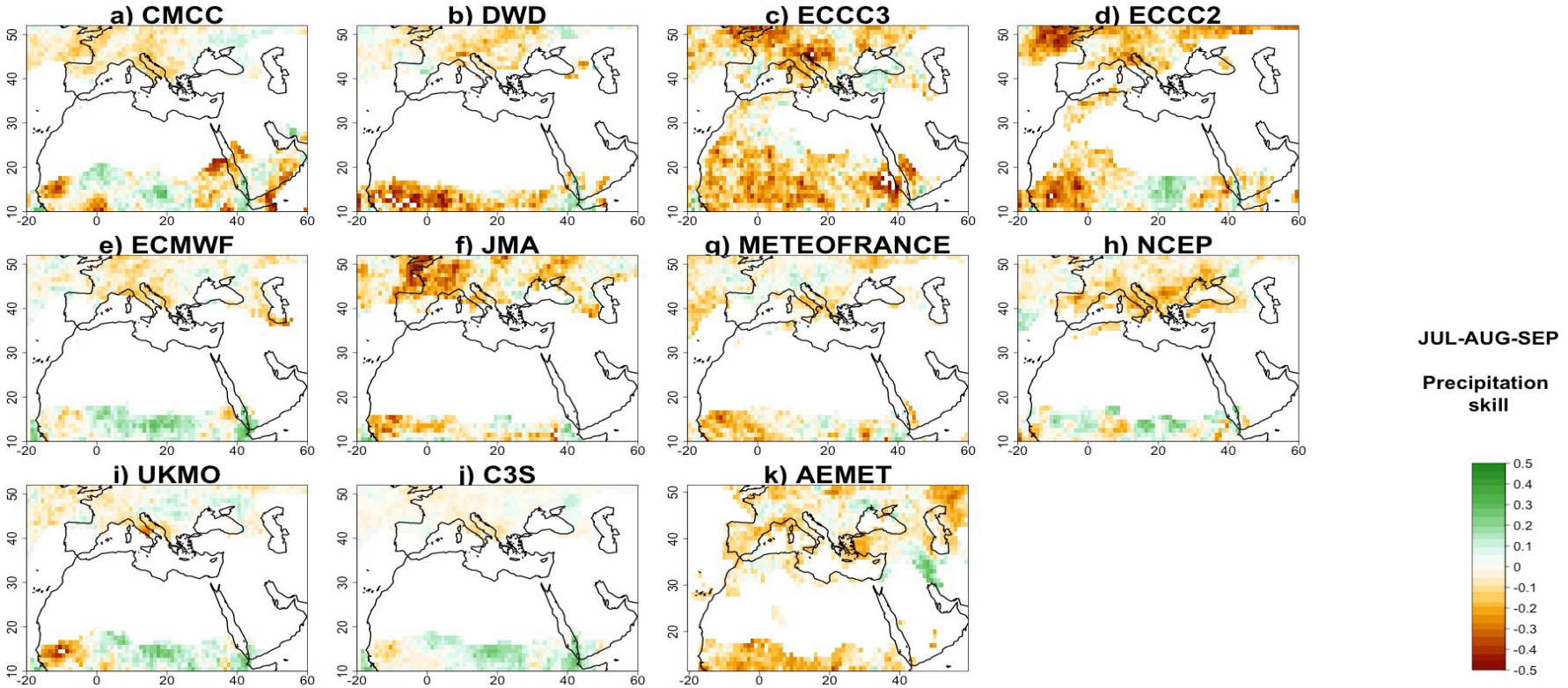


Figure 3: Ranked Probability Skill Score (RPSS) in JAS Precipitation forecast for the seasonal forecast systems. Higher values indicate better model predictive skill. From (a) to (i) models of the C3S ensemble. (j) for AEMET.

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

c) Temperature Forecast, L1: JAS

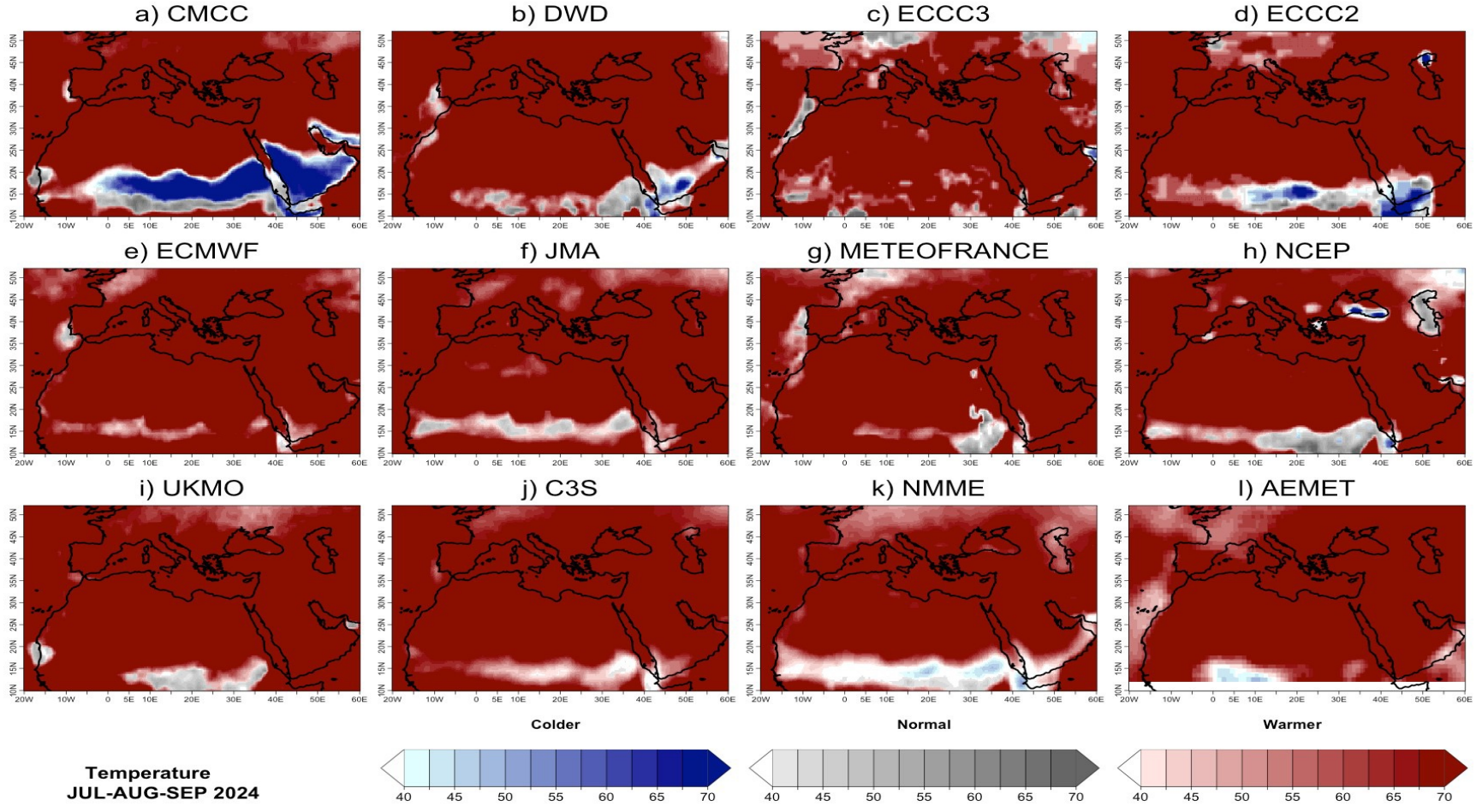


Figure 4: Most likely tercile of Temperature in the three seasonal forecast systems C3S (j), NMME (k) and AEMET(l) in L1 forecast. From (a) to (i) models of the C3S ensemble

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

d) Temperature Skill (RPSS) L1:

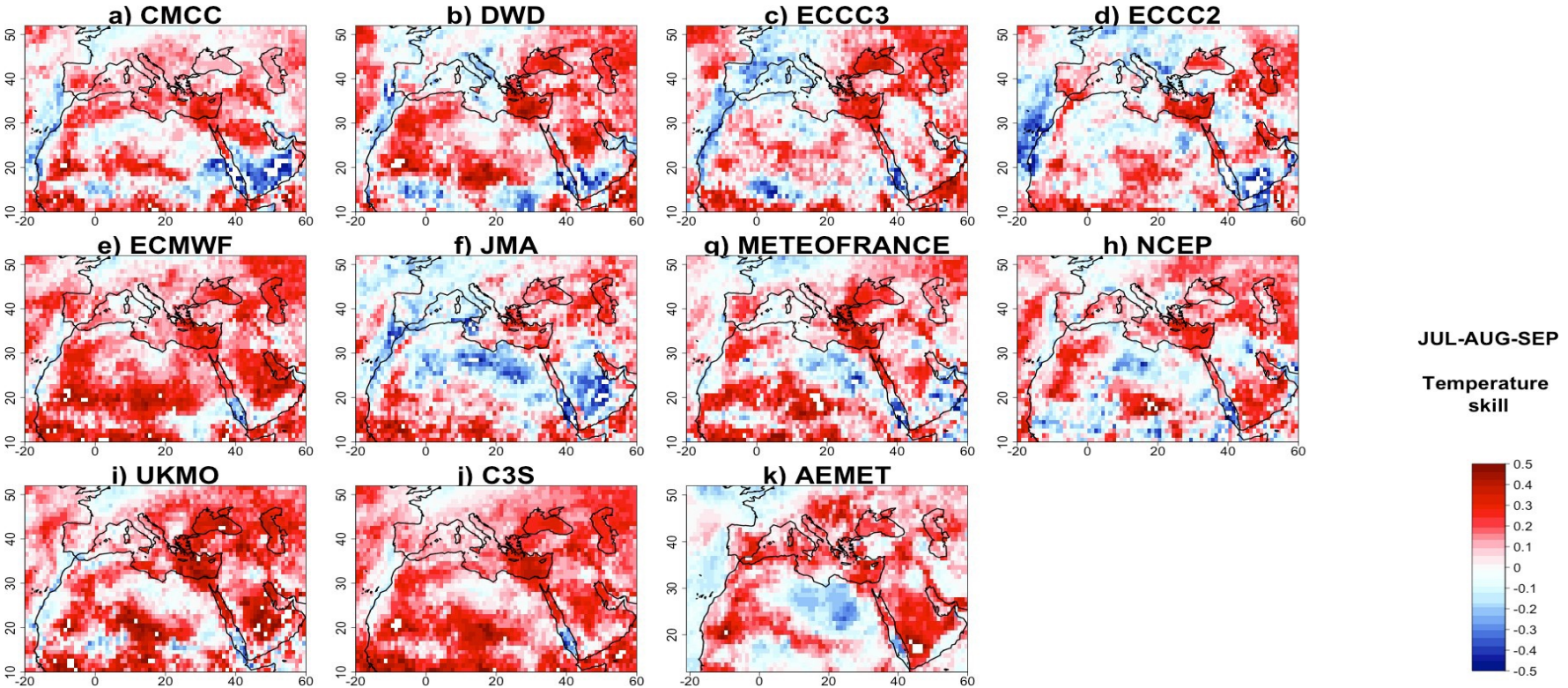


Figure 5: Ranked Probability Skill Score (RPSS) in JAS Temperature forecast for the seasonal forecast systems. Higher values indicate better model predictive skill. From (a) to (i) models of the C3S ensemble. (j) for AEMET.

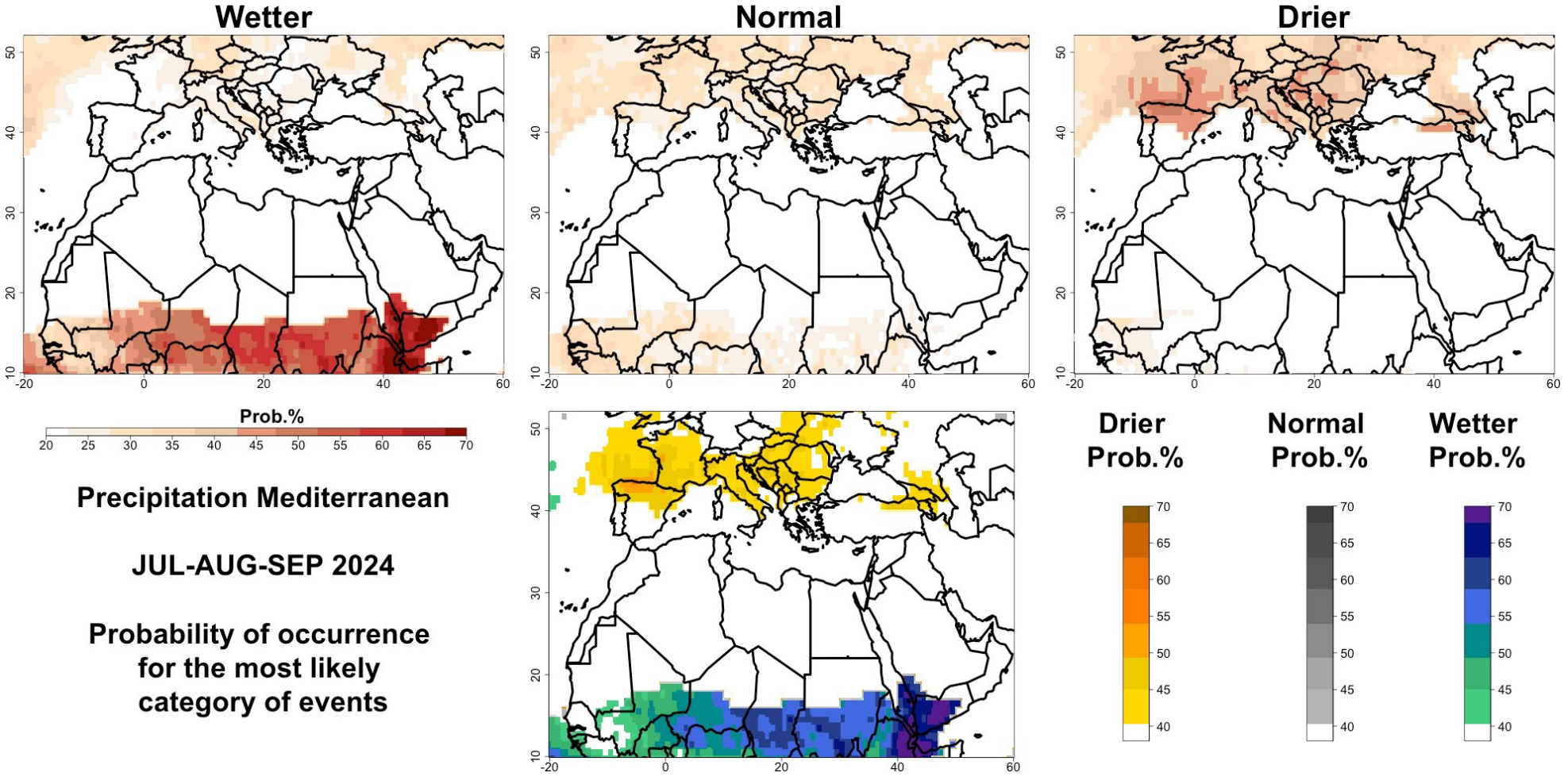
4. References:

MEDSCOPE
MEDiterranean Services Chain based On climate PrEdictions

- Balmaseda, M., and D. Anderson. "Impact of initialization strategies and observations on seasonal forecast skill." Geophys. Res. Lett. 36.1 (2009).
- Becker, E., H. V. den Dool, and Q. Zhang, 2014: Predictability and Forecast Skill in NMME. J. Climate, 27, 5891–5906, https://doi.org/10.1175/JCLI-D-13-00597.1.
- Doblas-Reyes, F. J., R.Hagedorn, and T. N.Palmer, 2005: The rationale behind the success of multi-model ensembles in seasonal forecasting—II. Calibration and combination. Tellus, 57A, 234–252, doi:10.1111/j.1600-0870.2005.00104.x.
- Kirtman, B. P., and Coauthors, 2014: The North American Multimodel Ensemble: Phase-1 Seasonal-to-Interannual Prediction; Phase-2 toward Developing Intraseasonal Prediction. Bull. Amer. Meteor. Soc., 95, 585–601, https://doi.org/10.1175/BAMS-D-12-00050.1.
- Palmer, T. N., F. J.Doblas-Reyes, A.Weisheimer, and M. J.Rodwell, 2008: Toward seamless prediction: Calibration of climate change projections using seasonal forecast. Bull. Amer. Meteor. Soc., 89, 459–470.
- Pérez-Zanón, N., Caron L.-P., Alvarez-Castro C., Batte L. et al. (2021). CSTools: Assessing skill of climate forecasts on seasonal-to-decadal timescales. R package version 4.0.0. https://CRAN.R-project.org/package=CSTools
- Rodríguez-Guisado, E., Serrano-de la Torre, A. Á., Sánchez-García, E., Domínguez-Alonso, M., and Rodríguez-Camino, E.: Development of an empirical model for seasonal forecasting over the Mediterranean, Adv. Sci. Res., 16, 191–199, https://doi.org/10.5194/asr-16-191-2019, 2019.
- Troccoli A., Harrison M., Coughlan M., Williams J.B. (2008) Seasonal Forecasts in Decision Making. In: Troccoli A., Harrison M., Anderson D.L.T., Mason S.J. (eds) Seasonal Climate: Forecasting and Managing Risk. NATO Science Series, vol 82. Springer, Dordrecht

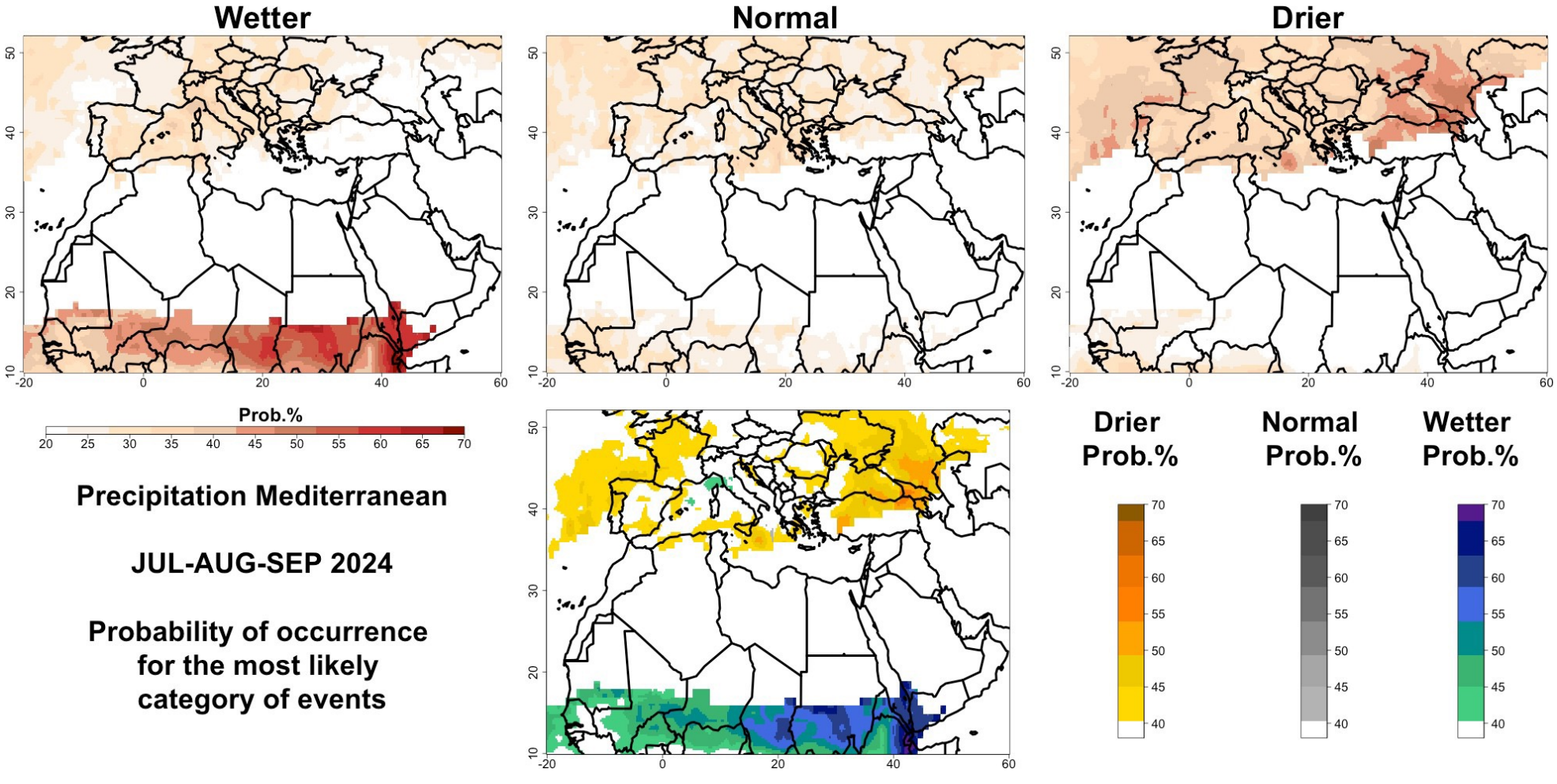
MEDSCOPE
MEDiterranean Services Chain based On climate PrEdictions

S1. C3S Precipitation Forecast L1: JAS



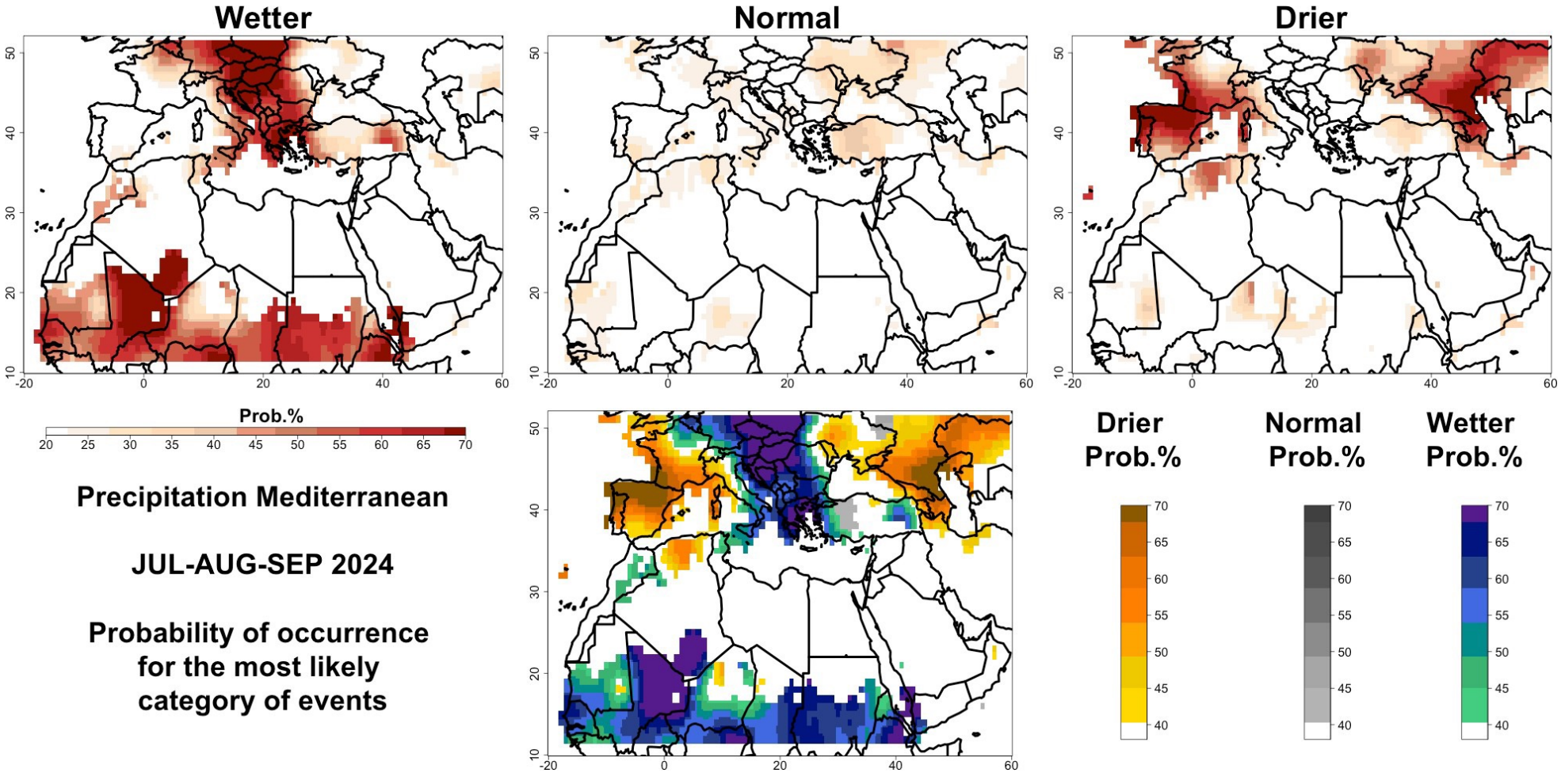
MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

S2. NMME Precipitation Forecast
L1: JAS



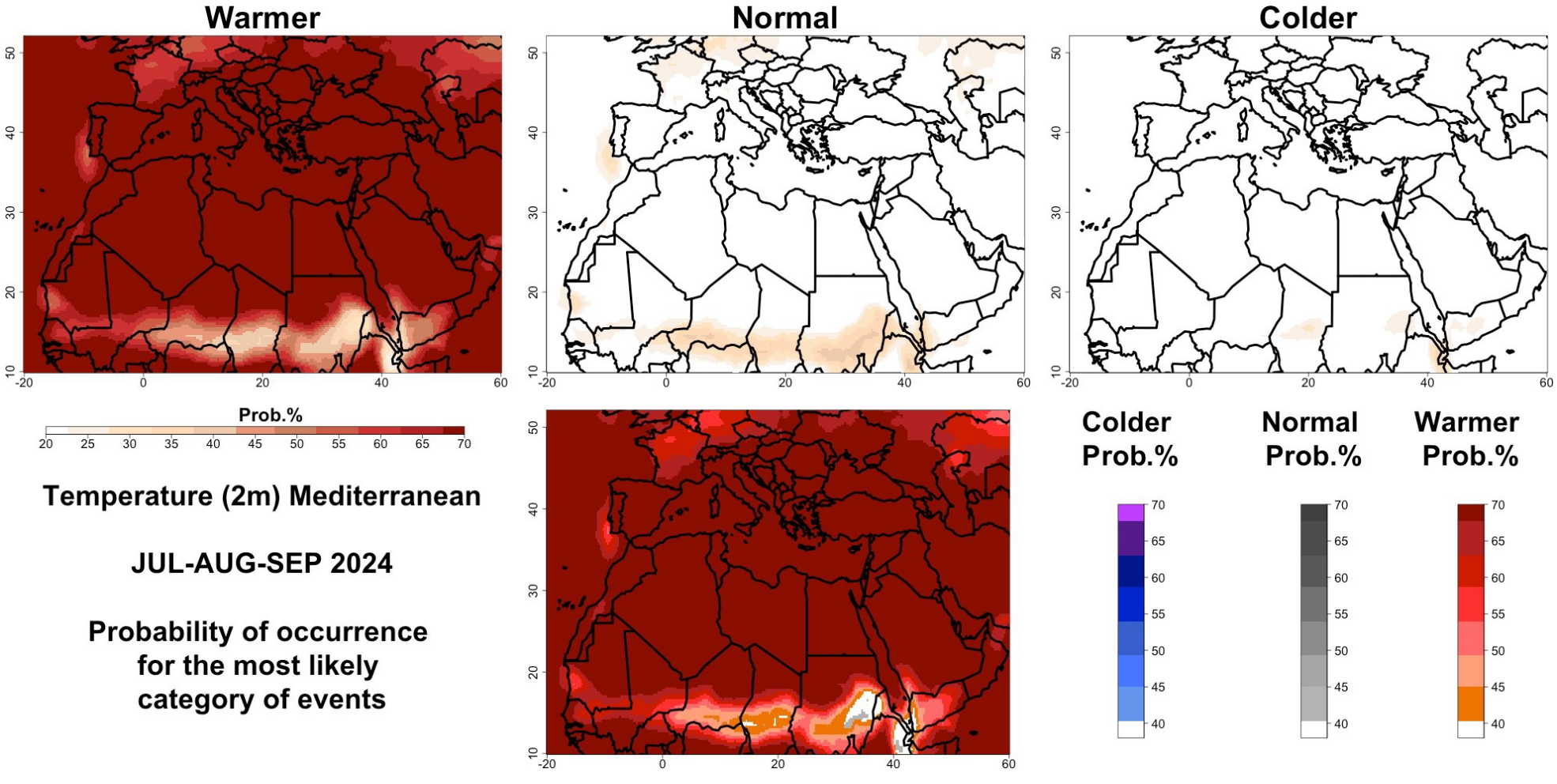
MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

S3. AEMET Precipitation Forecast
L1: JAS



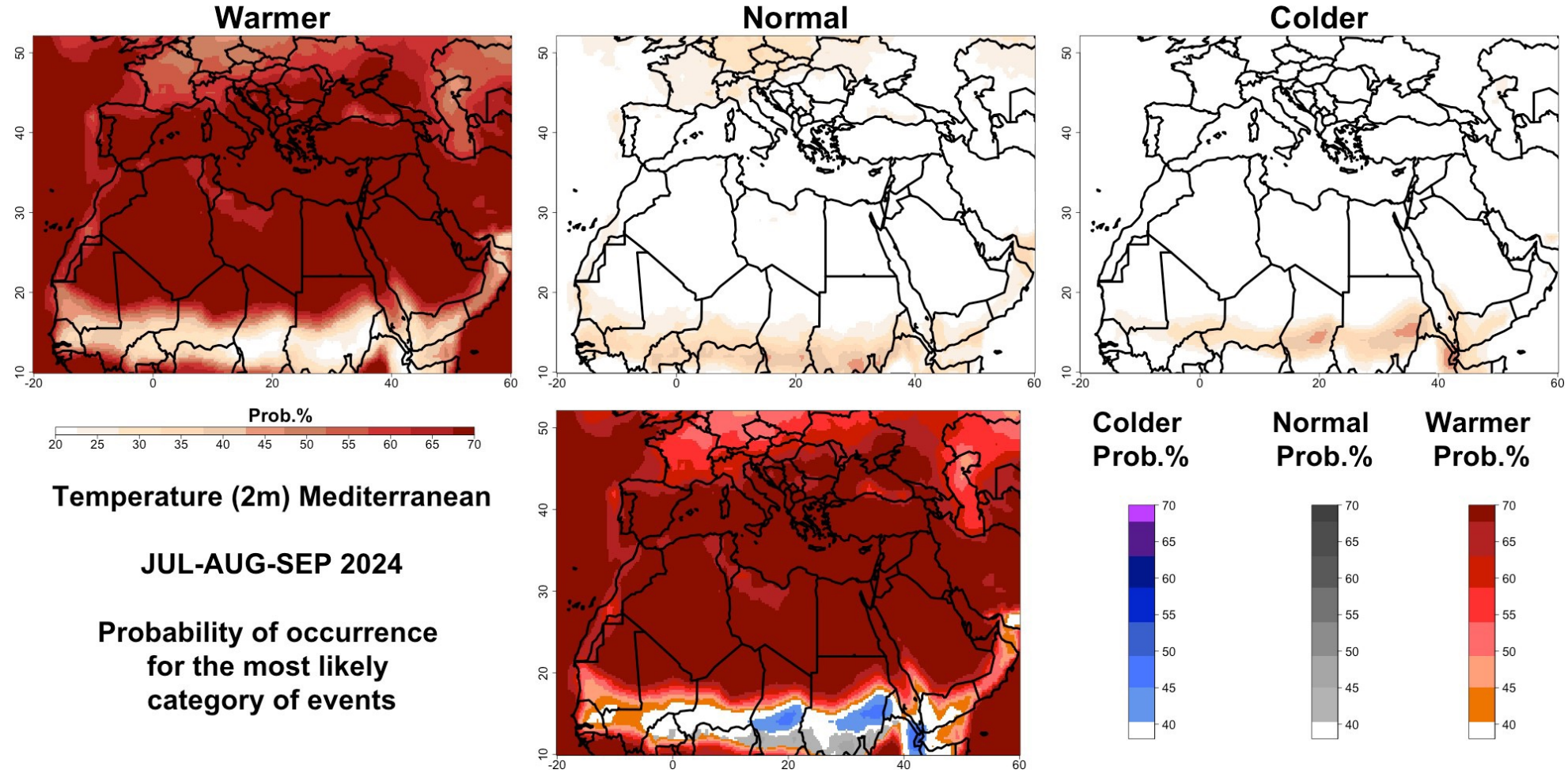
MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

S4. C3S Temperature Forecast
L1: JAS

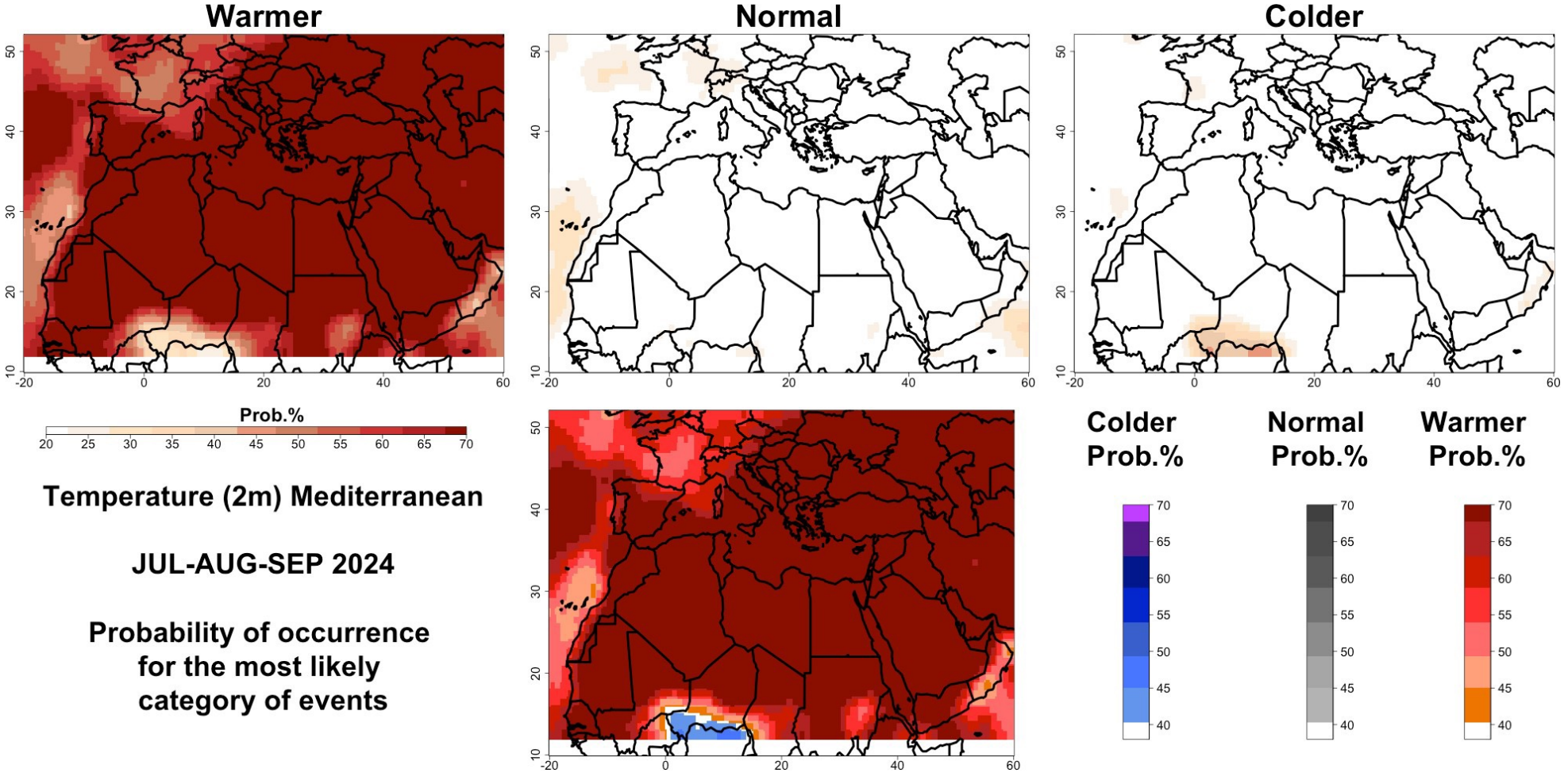


MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

S5. NMME Temperature Forecast
L1: JAS



S6. AEMET Temperature Forecast L1: JAS



MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

S7.) Precipitation Skill (ACC) L1:

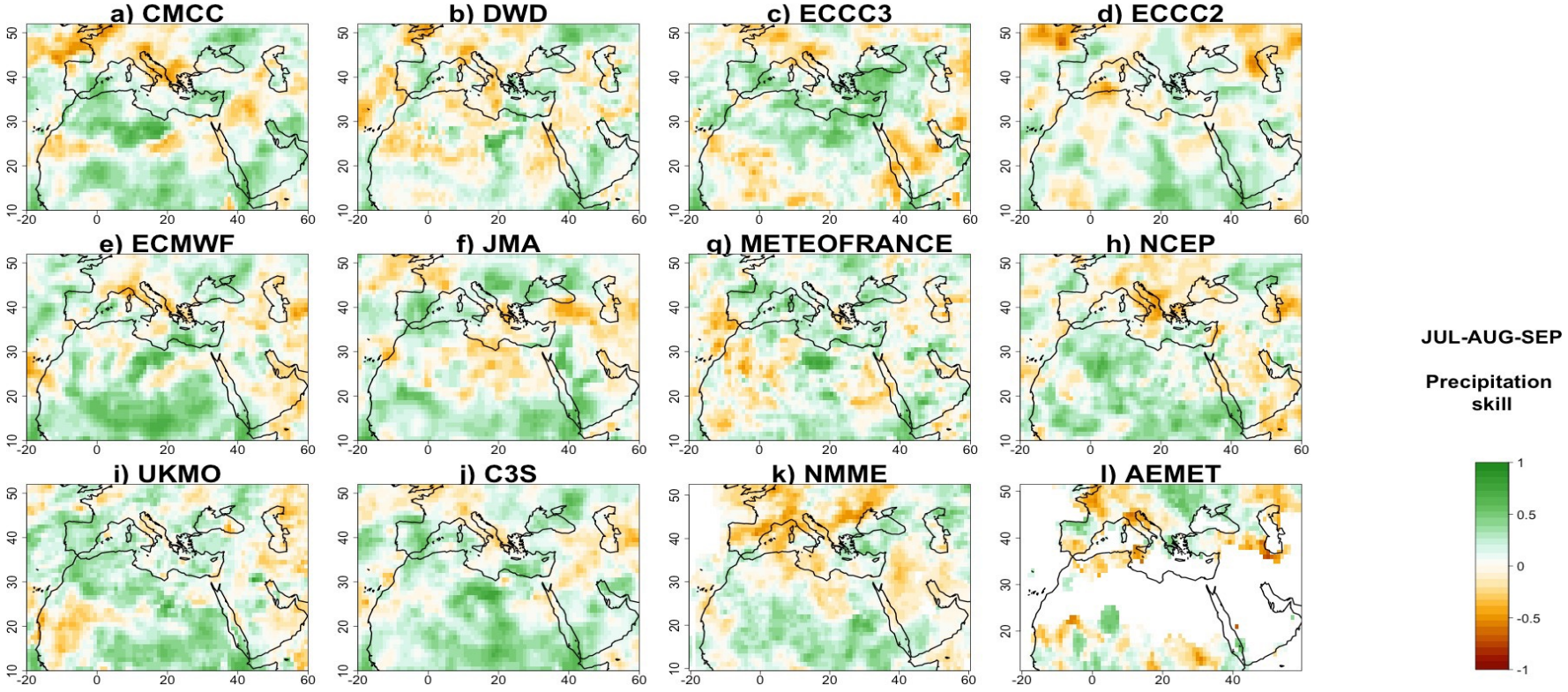


Figure 6: Precipitation correlations in JAS forecast, compared to observations, for the three seasonal forecast systems C3S (j), NMME (k) and AEMET(l). Higher values indicate better model predictive skill. From (a) to (i) models of the C3S ensemble.

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

S8.) Temperature Skill (ACC) L1:

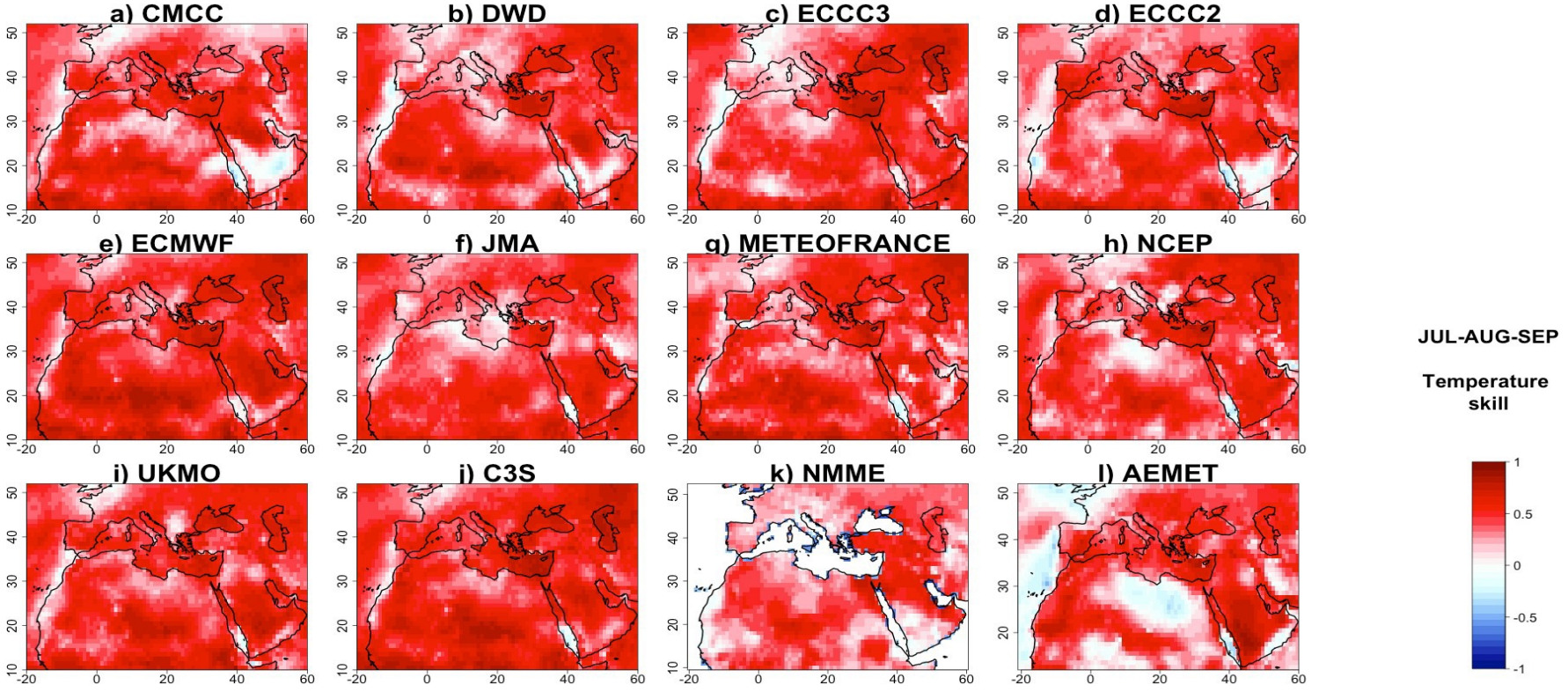
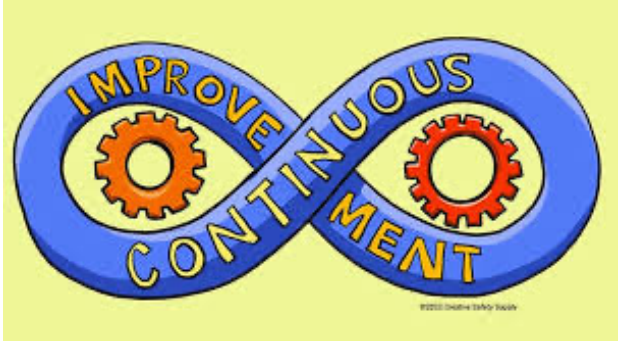


Figure 7: Temperature correlations in JAS forecast, compared to observations, for the three seasonal forecast systems C3S (j) and NMME (k) and AEMET(l). Higher values indicate better model predictive skill. From (a) to (i) models of the C3S ensemble

Improving the Mediterranean Seasonal Climate Update



Improving the MSCU: New

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

- Improvements in the operational chain to **release the update each 15th of the month**.

- **ASC: Andalusian Seasonal Climate Update** (with info for Andalusia/Spain) -> available from September in vareclim website (within www.upo.es)

- Increase the horizontal resolution with a **Downscaling available by January 2025** (at least 25 km, but exploring the possibility to reach up to 1 km)

Improving the MSCU: Feedback

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

- Specific region of interest for an update?
- Additional variables? SST, SLP, z500?
- Include another leadtime?
- Verification?
- Changes in design/format/content???
- Changes in observation dataset for skill scores??

https://www.cost.eu/actions/CA23108/#tabs+Name:Description

CA23108 - Seasonal-to-decadal climate predictability in the Mediterranean: process understanding and services (MEDUSSE)

Downloads

Description

Climate forecasting has enormous potential influence in different socio-economic sectors, such as agriculture, health, water management, and energy. Actionable climate information is particularly relevant at seasonal-to-decadal timescales, where predictability is linked to slow fluctuations of the system such as those in the ocean, sea-ice and land-surface, thus bridging weather/sub-seasonal predictions (mainly relying on atmospheric initial condition) with future projections (mainly based on atmospheric radiative forcing). Seasonal-to-decadal climate forecasting has progressed considerably in recent years, but prediction skill over the Mediterranean is still limited. Better understanding the drivers of regional climate anomalies as well as exploring untapped sources of predictability constitute a much-needed and timely effort.

Action Details

MoU - 021/24

CSO Approval date - 17/05/2024

How can I participate?

- Read the Action Description MoU
- Inform the Main Proposer/Chair of your

CA23108 - Seasonal-to-decadal climate predictability in the Mediterranean: process understanding and services (MEDUSSE)

Downloads

Working Groups

Number	Title	Leader
1	Climate Variability and Predictability	*TBA*
2	Climate Prediction	*TBA*
3	Climate Services	*TBA*

Express your interest to join any of the working groups by applying below.

It is required to have an e-COST profile to submit your application. If needed, create it first and then click 'Apply'.

Apply

Action Details

MoU - 021/24

CSO Approval date - 17/05/2024

How can I participate?

- Read the Action Description MoU
- Inform the Main Proposer/Chair of your interest (email)
- Apply to join your Working Groups of interest
- Please note, Management Committee nominations are carried out through the COST National Coordinators

CA23108 - Seasonal-to-decadal climate predictability in the Mediterranean: process understanding and services (MEDUSSE)

Downloads

Management Committee

Country	MC Member
Croatia	Dr Ivana HERCEG BULIC
Croatia	Ms Petra SVILICIC
Cyprus	Dr Georgios ZITTIS
Greece	Prof Panagiotis NASTOS
Italy	Dr Silvio GUALDI
Slovakia	Dr Anna KRAKOVSKA
Spain	Dr Carmen ALVAREZ-CASTRO
Spain	Prof Javier GARCÍA-SERRANO
Switzerland	Prof Angela MEYER
Türkiye	Dr Hudaverdi GURKAN

Action Details

MoU - 021/24

CSO Approval date - 17/05/2024

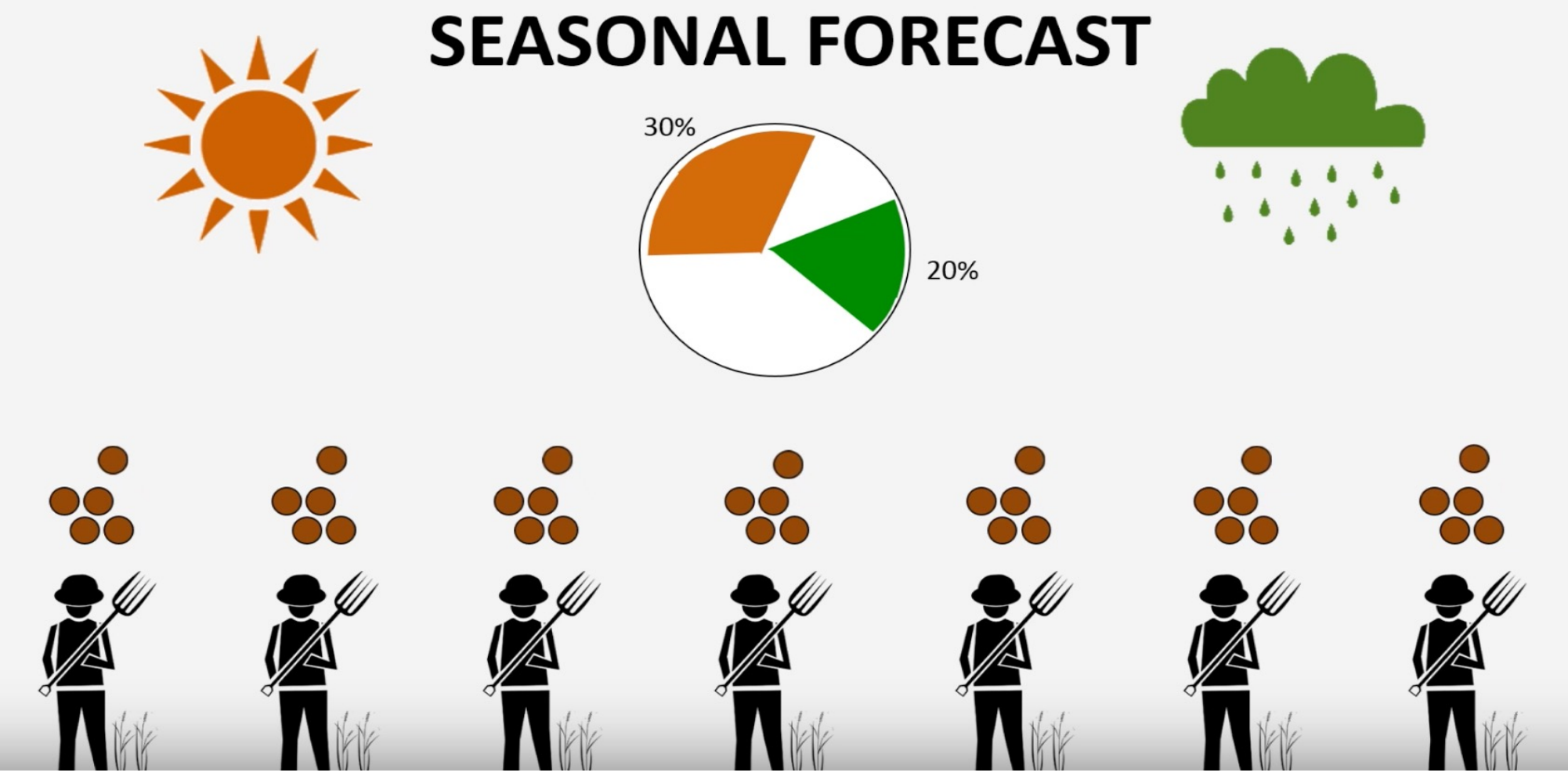
How can I participate?

- Read the Action Description MoU
- Inform the Main Proposer/Chair of your interest (email)
- Apply to join your Working Groups of interest
- Please note, Management Committee nominations are carried out through the COST National Coordinators

Improving the MSCU: Feedback

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

- Specific region of interest for an update?
- Additional variables?
- Include another leadtime?
- Verification?
- Changes in current format???



Thanks for your attention!!

Thanks to:

Esteban Rodriguez-Guisado, Verónica Torralba, Andrea Borrelli, Antonella Sanna, Silvio Gualdi, Marianna Benassi, Maria Chaves-Montero, Stefano Materia, David Gallego, Cristina Peña-Ortiz.

Forecast Skill: RPSS

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

The ranked probability skill score (RPSS), also computed with a CSTools function, is based on the comparison of the cumulative squared probability and the reference cumulative probability:

$$\mathbf{RPSS = 1 - RPS_{forecast}/RPS_{reforecast}}$$

where RPS is the sum of the squared difference between cumulative forecast and reference probabilities.

RPSS = 1 the forecast has perfect skill compared to the reference (observations, analyses or climatology) - **forecast beneficial**;

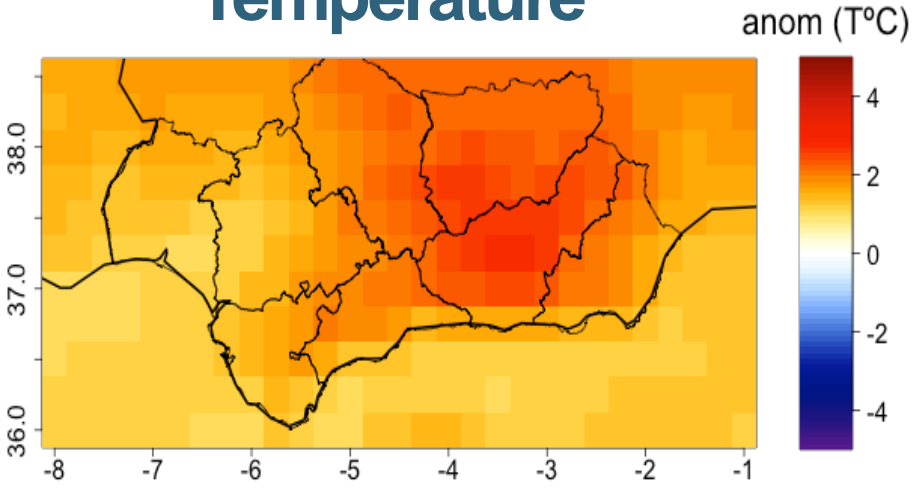
RPSS = 0 the forecast has no skill compared to the reference (observations, analyses or climatology) - **forecast has no benefit over climatology**;

RPSS = a negative value the forecast is less accurate than the reference (observations, analyses or climatology) - **forecast misleading**.

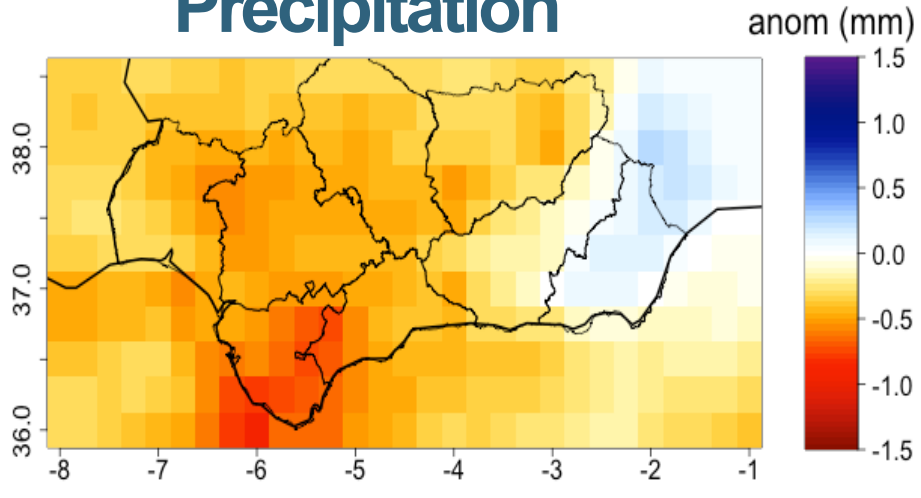
Andalusian Seasonal Climate Update

September 15, 2024

Temperature



Precipitation



Downscaling

- Increase the horizontal resolution with a **Downscaling available by January 2025** (at least 25 km)

- Exploring the possibility to reach up to 1 km with MSWX dataset