MEDSCOPE
MEDiterranean Services Chain based On climate PrEdictions

Mediterranean Seasonal Climate Update

Nov 15, 2023

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

- 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).

- 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	0.5^o x 0.5^o / 46 levels
DWD	50	T127 / 95 levels
ECCC3	10	1.1^o / 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 1^ox1^o grid and interpolated here to 0.5^ox0.5^o 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	1.1^o x 1.4^o / 85 levels
GFDL-SPEAR	30	C18 / 32 levels
NCAR-CCSM4	10	0.9^o x 1.25^o / 26 levels
NCAR-GEOS5v2	12	0.5^o / 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 1^ox1^o grid and interpolated here to 0.5^ox0.5^o 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	$1^o \times 1^o$

3. Seasonal Forecast:

3.1 Start date and Leadtime:

Start date M0	Nov
Leadtime L1	DJF

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.

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:

3.3 ENSO:

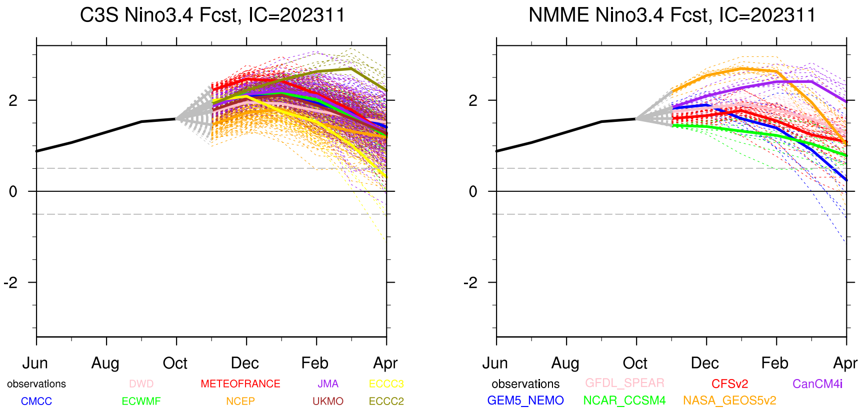


Figure 1: Niño3.4 prediction from all the ensemble members of the C3S multi-system (a) and the NMME multi-system (b), for the start-date of Nov.

3. Seasonal Forecast:

3.4 Mediterranean Maps:

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

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:

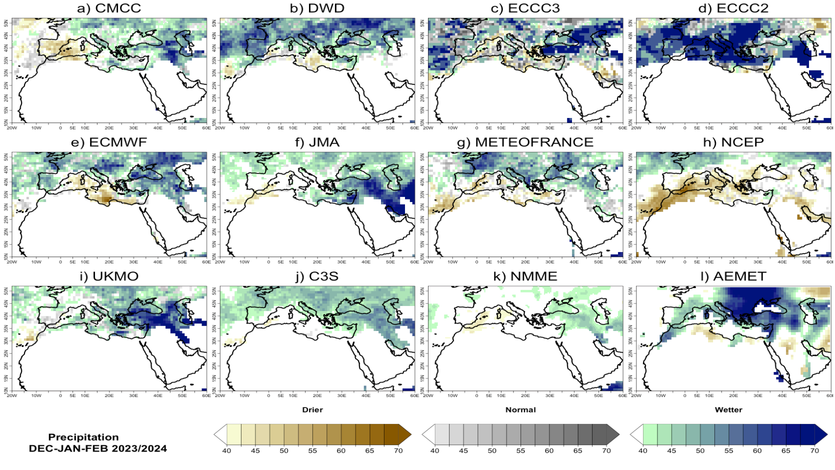


Figure 2: Most likely tercile of Precipitation in the three seasonal forecast systems C3S (j), NMME (k) and AEMET(l) in L1 forecast. From (a) to (i) models of the C3S ensemble.

b) Precipitation Skill (RPSS) L1:

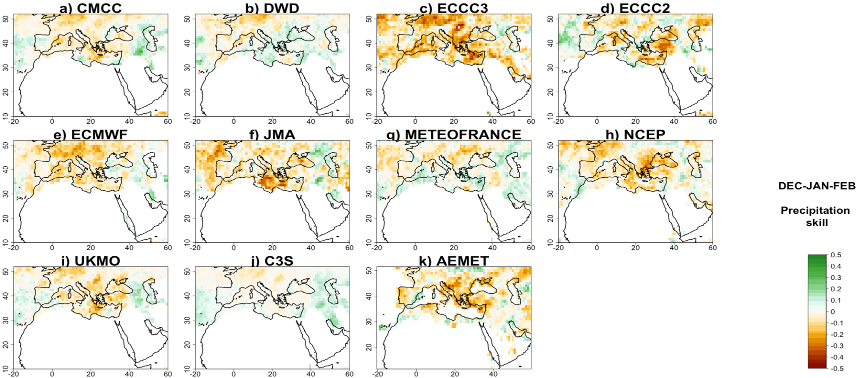


Figure 3: Ranked Probability Skill Score (RPSS) in DJF Precipitation forecast for the seasonal forecast systems. Higher values indicate better model predictive skill. From (a) to (i) models of the C3S ensemble. (j) for AEMET.

c) Temperature Forecast, L1: DJF

MEDSCOPE
MEDiterranean Services Chain based On climate PrEdictions

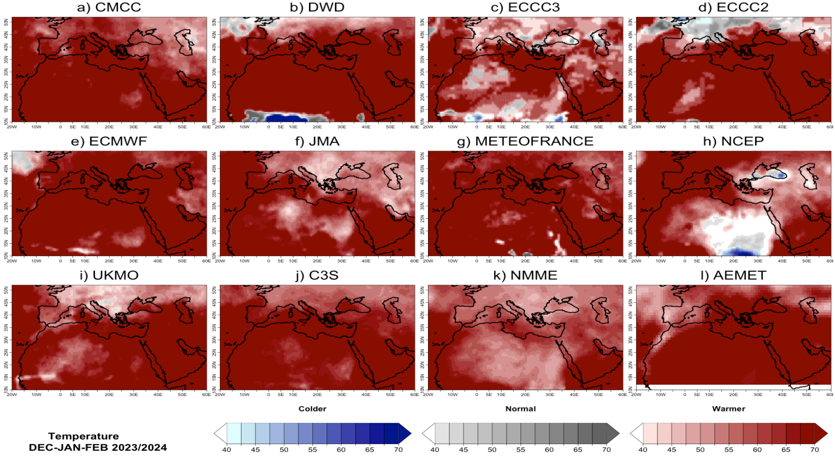


Figure 4: Most likely tercile of Temperature in the three seasonal forecast systems C3S (j), NMME (k) and AEMET(l) in L1 forecast. From (a) to (i) models of the C3S ensemble

d) Temperature Skill (RPSS) L1:

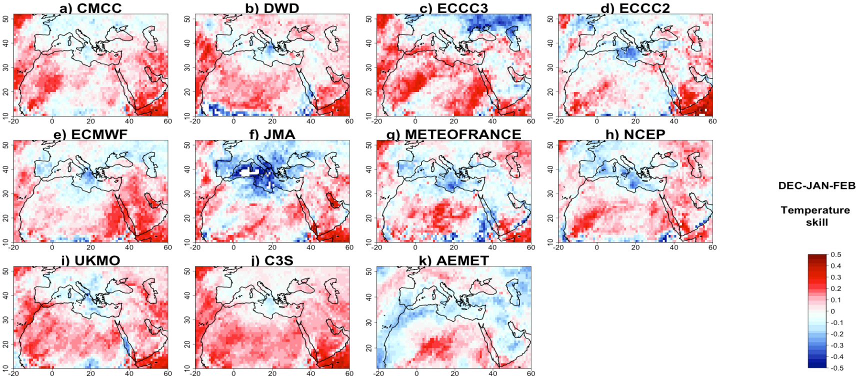


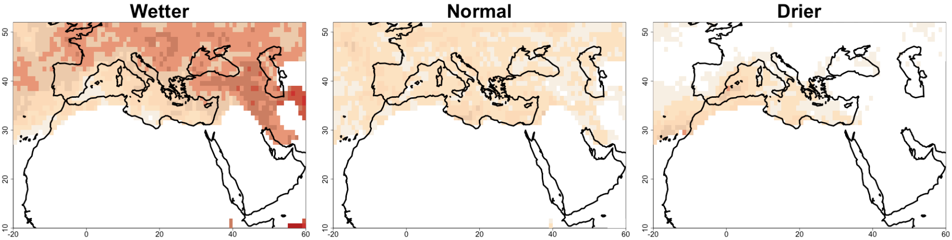
Figure 5: Ranked Probability Skill Score (RPSS) in DJF Temperature forecast for the seasonal forecast systems. Higher values indicate better model predictive skill. From (a) to (i) models of the C3S ensemble. (j) for AEMET.

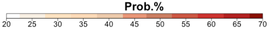
4. References:

- 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: DJF

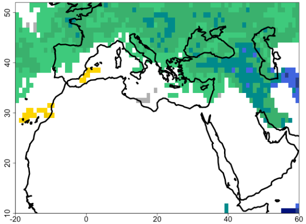


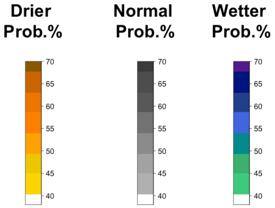


Precipitation Mediterranean

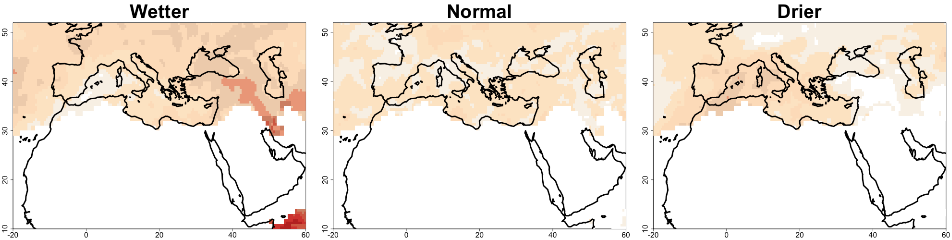
DEC-JAN-FEB 2023/2024

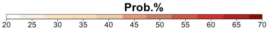
Probability of occurrence for the most likely category of events





S2. NMME Precipitation Forecast L1: DJF

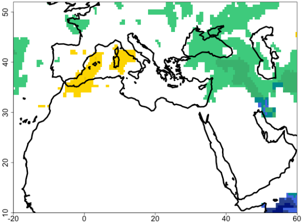


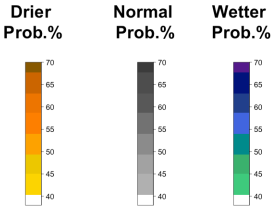


Precipitation Mediterranean

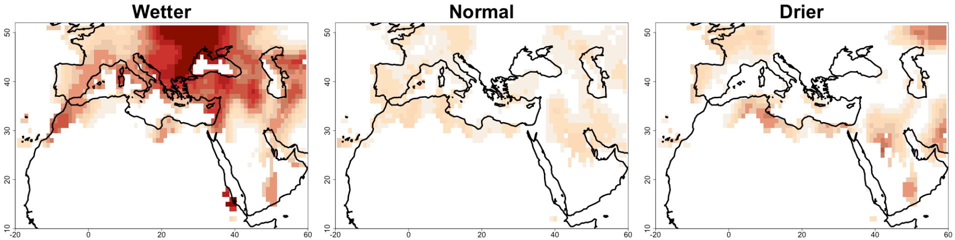
DEC-JAN-FEB 2023/2024

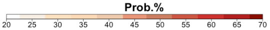
Probability of occurrence for the most likely category of events





S3. AEMET Precipitation Forecast
L1: DJF

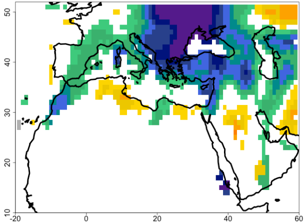


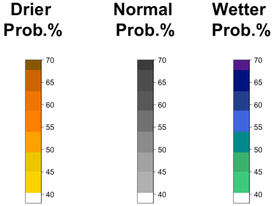


Precipitation Mediterranean

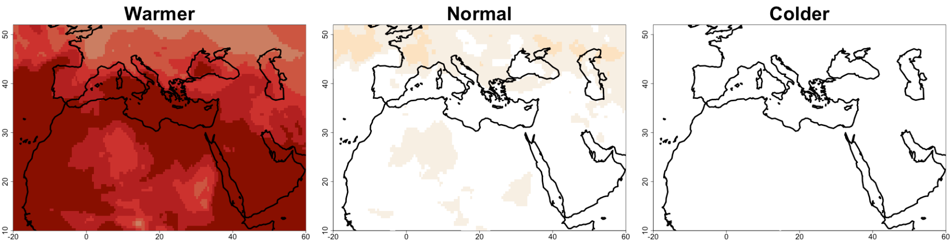
DEC-JAN-FEB 2023/2024

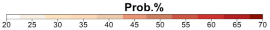
Probability of occurrence for the most likely category of events





S4. C3S Temperature Forecast
L1: DJF

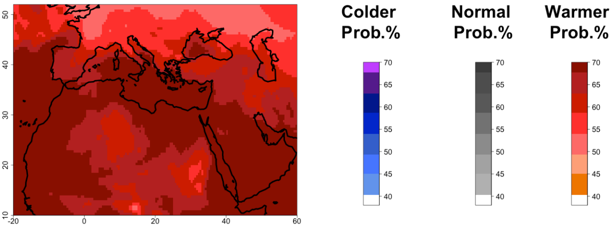




Temperature (2m) Mediterranean

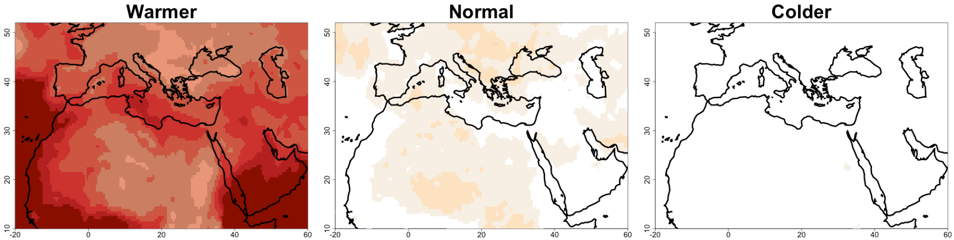
DEC-JAN-FEB 2023/2024

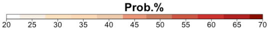
Probability of occurrence for the most likely category of events



S5. NMME Temperature Forecast
L1: DJF

MEDSCOPE
MEDiterranean Services
Chain based On climate PrEdictions

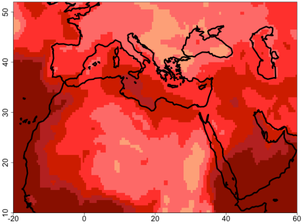


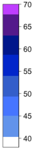


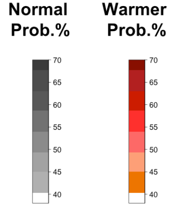
Temperature (2m) Mediterranean

DEC-JAN-FEB 2023/2024

Probability of occurrence for the most likely category of events



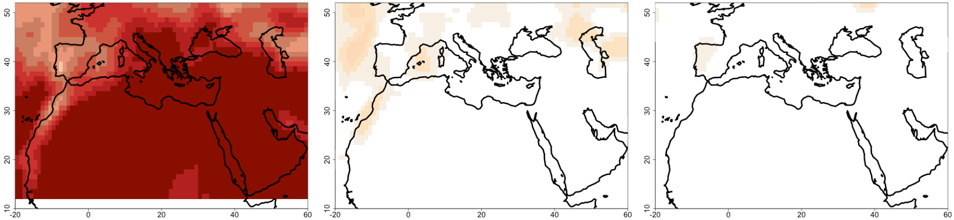




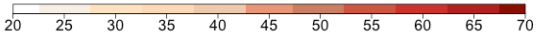
S6. AEMET Temperature Forecast L1: DJF

MEDSCOPE
MEDiterranean Services Chain based On climate PrEdictions

Warmer | Normal | Colder



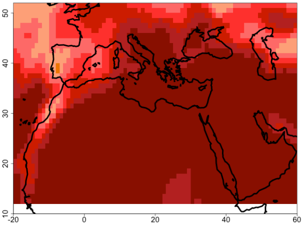
Prob.%



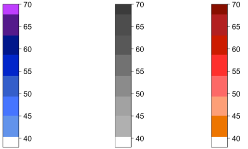
Temperature (2m) Mediterranean

DEC-JAN-FEB 2023/2024

Probability of occurrence for the most likely category of events



Colder Prob.% | **Normal Prob.%** | **Warmer Prob.%**



S7.) Precipitation Skill (ACC) L1:

MEDSCOPE
MEDiterranean Services Chain based On climate PrEdictions

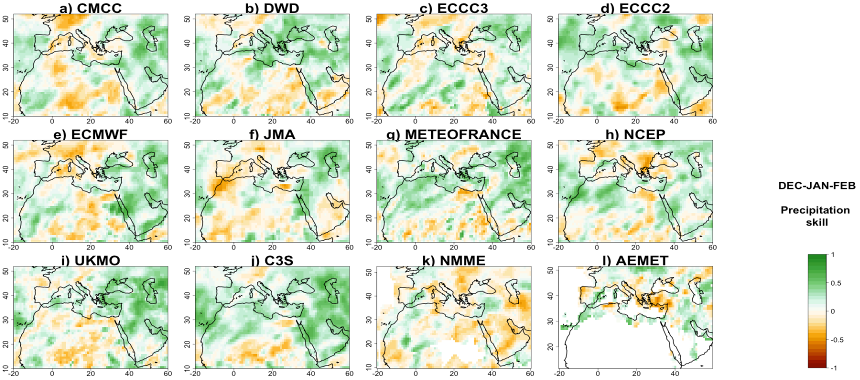


Figure 6: Precipitation correlations in DJF forecast, compared to observations, for the three seasonal forecast systems C3S (j), NMME (k) and AEMET(l). Higher values indicate better model predictive skill. From (a) to (i) models of the C3S ensemble.

S8.) Temperature Skill (ACC) L1:

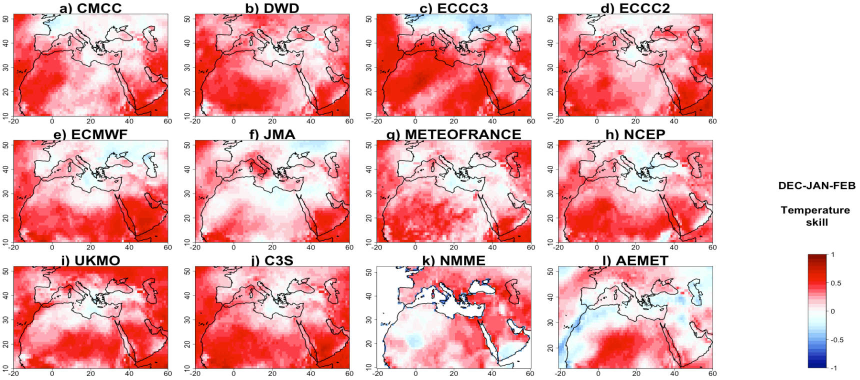


Figure 7: Temperature correlations in DJF forecast, compared to observations, for the three seasonal forecast systems C3S (j) and NMME (k) and AEMET(l). Higher values indicate better model predictive skill. From (a) to (i) models of the C3S ensemble