

# MedCOF Mediterranean Climate Outlook Forum

WMO Northern Africa





MedCOF training Workshop in OSF: Additional sources of seasonal climate information

WMO RA VI

## Overview:

-WMO Lead Centre for Long Range forecasting
-Mediterranean Seasonal Climate update
-IRI seasonal forecast resources
-Empirical forecasts

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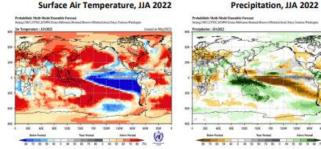
### Global Seasonal climate Update

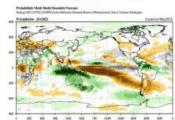
#### Summary

During February-April 2022, all four Pacific Niño sea-surface temperature (SST) indices in the central and eastern Pacific were below-normal. The observed SST conditions in the equatorial Pacific were characterized by a weak La Niña state. The Indian Ocean Dipole (IOD) over the observed period was weakly negative. The North Tropical Atlantic (NTA) SST index was near-zero, and the South Tropical Atlantic (STA) SST index was positive.

For the June-August 2022 season, below-normal sea-surface temperature anomalies in the Niño 3.4 and Niño 3 regions with values of approximately -0.5° C (Niño 3.4) and -0.5° C (Niño 3) are predicted indicating a return toward nearnormal conditions.

Although a tendency towards near-normal ENSO conditions is predicted for the equatorial central and eastern Pacific, negative sea-surface temperature anomalies are still expected through much of this region. The widespread warmerthan-average sea-surface temperatures elsewhere are predicted to dominate the forecast of air temperatures for June-August 2022, although the extent and strength of predicted warming is less than during March-May 2022. Positive temperature anomalies are expected over most of the land areas in the Northern Hemisphere, with the exceptions being a band running from southern Central America and Caribbean, through the Sahelian belt, the southern Arabian Peninsula, and the Indian subcontinent. Of these exceptions, it is only over part of the Indian subcontinent where below normal temperatures are predicted with high probability and model-to-model consistency. The largest land air-temperature anomalies are expected over the far northern and north-eastern parts of Asia at around 90 °E, and in patchy areas at about 40 °N including parts of North America, through much of Europe, and small areas in southwestern, central and eastern Asia extending far to the east of Japan. The probabilities for above-normal temperatures are most increased immediately to the northeast of the Indian subcontinent, to the east of Japan, and over much of southeast Asia and the Maritime continent, but model-to-model consistency in predictions of positive temperature anomalies is high over most of the Northern Hemisphere landmasses. Exceptions include the Indian subcontinent, the southern half of the Arabian Peninsula, Africa south of about 20 °N, and the northern part of South America extending along the Pacific coast of North America. In the Southern Hemisphere, positive temperature anomalies are predicted over the southern Maritime continent, extending to the southeast as far as about 90 °W. There is also a fork of predicted positive temperature anomalies that extends over New Zealand and Tasmania. Probability for above-normal





#### Figure 1. Probabilistic forecasts of surface air temperature and precipitation for the season June-August 2022. The tercile category with the highest forecast probability is indicated by shaded areas. The most likely category for below-normal, above-normal and near-normal is depicted in blue, red and grey shadings respectively for temperature, and orange, green and grey shadings respectively for precipitation. White areas indicate equal chances for all categories in both cases. The baseline period is 1993-2009.

#### Observations: February-April 2022 1.

In the following sections, observed temperature and precipitation patterns for the previous season are briefly discussed. For more detailed information about regional and local climate anomalies, the reader is referred to the concerned WMO Regional Climate Centres (RCCs) or RCC Networks, listed in Section 5.

#### Large-scale sea surface temperature (SST) indices 1.1

During February-April 2022, all four Pacific Niño sea-surface temperature (SST) indices in the central and eastern Pacific were below-normal. The observed SST conditions in the equatorial Pacific were characterized by a weak La Niña state. The Indian Ocean Dipole (IOD) over the observed period was weakly negative. The North Tropical Atlantic (NTA) SST index was near-zero, and the South Tropical Atlantic (STA) SST index was positive.

Month	Niño 1+2	Niño 3	Niño 4	Niño 3.4	IOD	NTA	STA	I
February 2022	-1.4	-1.1	-0.2	-0.7	-0.4	0.5	0.7	
March 2022	-0.7	-0.7	-0.7	0.9	-0.1	0.1	0.4	
April 2022	-1.4	-0.9	-0.7	-1.0	-0.4	0.1	0.3	
February-April 2022	-1.2	-0.9	-0.5	-0.3	-0.3	0.2	0.5	

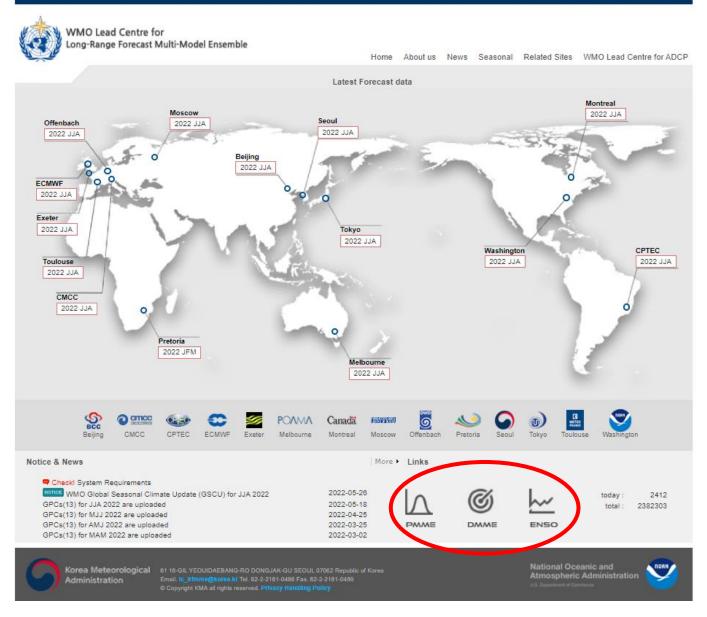
Table 1. Large-scale oceanic indices (°C). Anomalies are with respect to the 1981-2010 average. (Source: U.S. Climate Prediction Center)

#### 2. Potential evolution of the state of the climate over the next three months (June-August 2022)

#### 2.1 Large-scale SST-based indices, June-August 2022

Month	Nino 1+2	Nino 3	Nino 4	Nino3.4	IOD	NTA	STA
June 2022	-0.9±0.3	-0.5±0.2	-0.7±0.3	-0.7±0.2	-0.8±0.2	0.1±0.1	0.0±0.1
July 2022	-0.8±0.3	-0.4±0.2	-0.7±0.3	-0.5±0.2	-1.1±0.3	0.2±0.1	0.0±0.1
August 2022	-0.7±0.3	-0.4±0.2	-0.6±0.3	-0.5±0.3	-1.3±0.4	0.2±0.1	0.0±0.1
June-August 2022	-0.8±0.3	-0.4±0.2	-0.7±0.3	-0.5±0.2	-1.1±0.4	0.2±0.1	0.0±0.1

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Home > Seasonal > Forecast > Probabilistic MME

#### Probabilistic MME Seasonal Information O Definition of Probabilistic MME » Probabilistic MME » Deterministic MME » References Map Type Forecast Combined O Below Normal O Near Normal O Above Normal » Probabilistic MME » Deterministic MME Select Period » Individual Forecast » Indices Issued date 2022 V MAY V Period 2022 JUN 2022 AUG $\sim$ ~ Verification » Hindcast » Forecast Select Model Data Exchange 🗹 All » Search/Download 🗹 СМСС CPTEC ECMWF Exeter 🗹 Beijing » Direct Download Melbourne Montreal Moscow Offenbach Seoul » Report Download 🗹 Tokyo Toulouse Washington » Mailing List System Configuration Information Select Parameters **Global Seasonal Climate** Precipitation ○ 500hPa GPH O Mean Sea Level Pressure Update O 2m Temperature O 850hPa Temperature O Sea Surface Temperature O 850hPa Zonal Wind O 850hPa Meridional Wind Select Region 360 Latitude -90 90 Global Longitude 0 ~ → Plot



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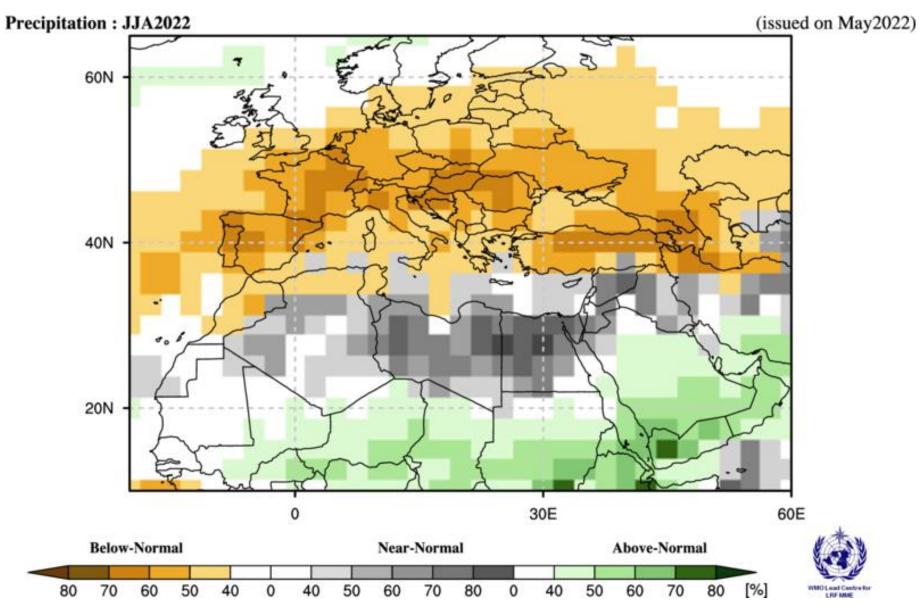
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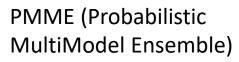
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Probabilistic Multi-Model Ensemble Forecast

ECMWF,Offenbach,Toulouse







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Home > Seasonal > Forecast > Probabilistic MME

Seasonal	Probabilistic MME
> Information	
<ul> <li>» Probabilistic MME</li> <li>» Deterministic MME</li> <li>» References</li> </ul>	<ul> <li>Definition of Probabilistic MME</li> <li>Map Type</li> </ul>
> Forecast	
<ul> <li>» Probabilistic MME</li> <li>» Deterministic MME</li> <li>» Individual Forecast</li> <li>» Indices</li> </ul>	Combined O Below Normal O Near Normal O Above Normal      Select Period
Verification	Issued date 2022 V MAY V Period 2022 JUN V 2022 OCT V
» Hindcast » Forecast	Select Model
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<ul> <li>» Search/Download</li> <li>» Direct Download</li> <li>» Report Download</li> <li>» Mailing List</li> </ul>	□ All         □ Beijing       □ CMCC       □ CPTEC       ♥ ECMWF       □ Exeter         □ Melbourne       □ Montreal       ♥ Offenbach       □ Seoul       □ Tokyo         ☑ Toulouse       □ Washington
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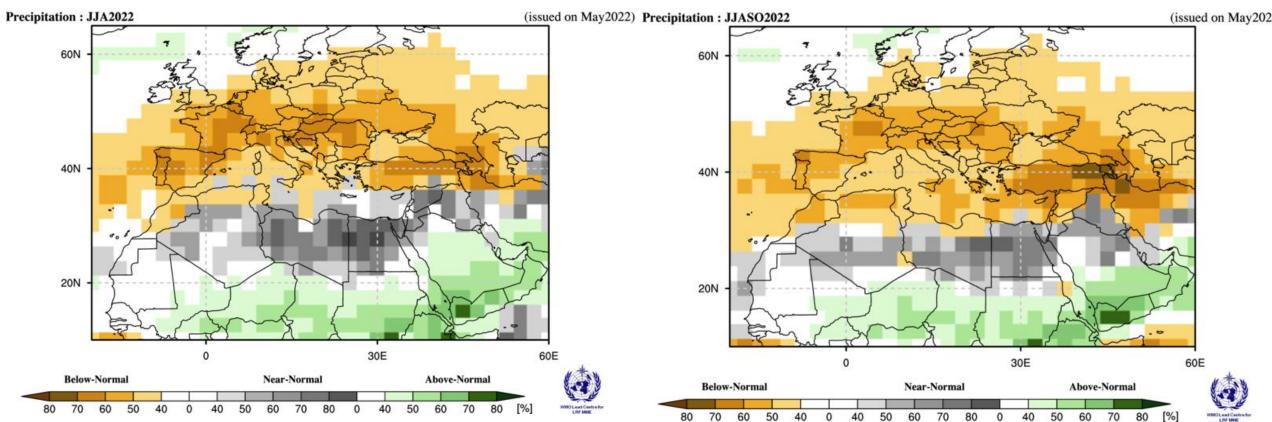
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Probabilistic Multi-Model Ensemble Forecast

ECMWF,Offenbach,Toulouse



Probabilistic Multi-Model Ensemble Forecast ECMWF,Offenbach,Toulouse



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Home > Seasonal > Forecast > Probabilistic MME

Seasonal	Probabilistic MME
> Information	O Definition of Probabilistic MME
<ul> <li>» Probabilistic MME</li> <li>» Deterministic MME</li> <li>» References</li> </ul>	Map Type
> Forecast	
» Probabilistic MME » Deterministic MME	Combined     O Below Normal     O Near Normal     O Above Normal
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<ul> <li>» Search/Download</li> <li>» Direct Download</li> <li>» Report Download</li> <li>» Mailing List</li> </ul>	□ All         □ Beijing       □ CMCC       □ CPTEC       ✓ ECMWF       □ Exeter         □ Melbourne       □ Montreal       □ Moscow       ✓ Offenbach       □ Seoul         □ Tokyo       ✓ Toulouse       □ Washington
System Configuration Information	Select Parameters
> Global Seasonal Climate Update	<ul> <li>Precipitation</li> <li>S00hPa GPH</li> <li>Mean Sea Level Pressure</li> <li>Sea Surface Temperature</li> <li>Sea Surface Temperature</li> <li>Sea Surface Temperature</li> </ul>
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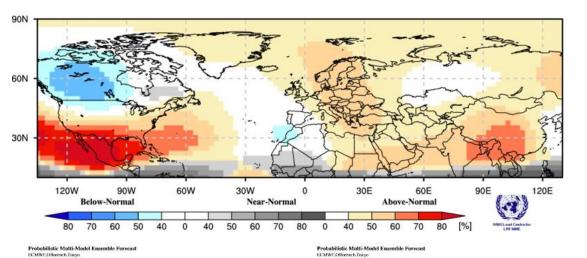


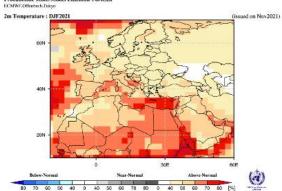
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Probabilistic Multi-Model Ensemble Forecast Probabilistic Multi-Model Ensemble Forecast ECMWF,Offenbach,Tokyo

500hPa GPH : DJF2021

(issued on Nov2021)



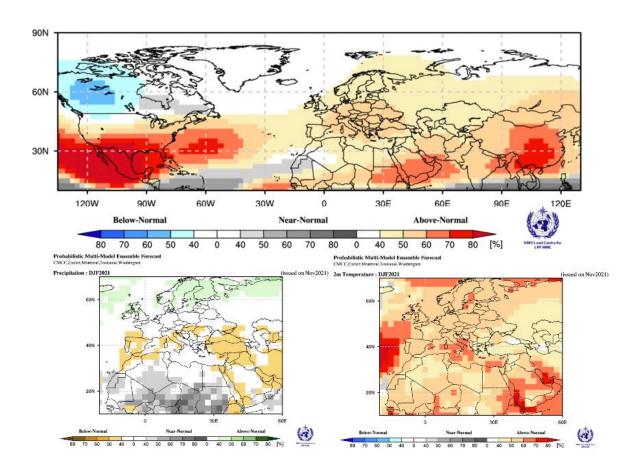


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CMCC, Exeter, Montreal, Toulouse, Washington

500hPa GPH : DJF2021

(issued on Nov2021)



ECMWF,Offenbach,Tokyo

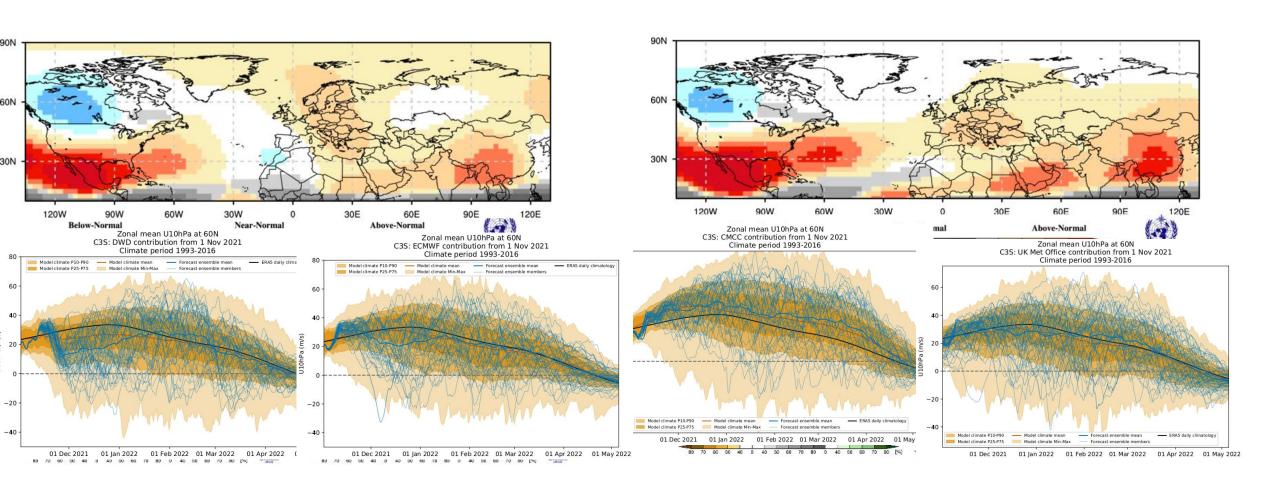
#### 500hPa GPH : DJF2021

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•obabilistic Multi-Model Ensemble Forecast CMCC,Exeter,Montreal,Toulouse,Washington

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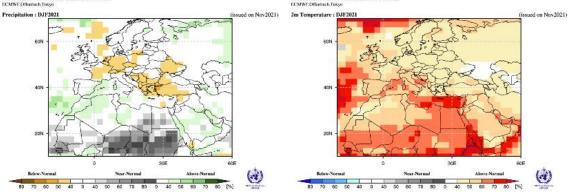


ECMWF,Offenbach,Tokyo

#### 500hPa GPH : DJF2021

(issued on Nov2021)

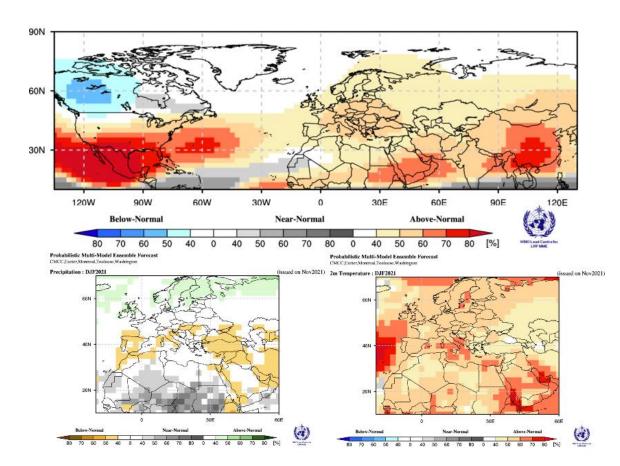
90N 60N 30N 90W 60W 30W 30E 60E 90E 120E 120W 0 **Below-Normal** Near-Normal Above-Normal 80 70 60 50 40 0 40 50 60 70 80 0 40 50 60 70 80 [%] LRF MME Probabilistic Multi-Model Easemble Forecast Probabilistic Multi-Model Ensemble Forecast



**'obabilistic Multi-Model Ensemble Forecast** CMCC, Exeter, Montreal, Toulouse, Washington

500hPa GPH : DJF2021

(issued on Nov2021)

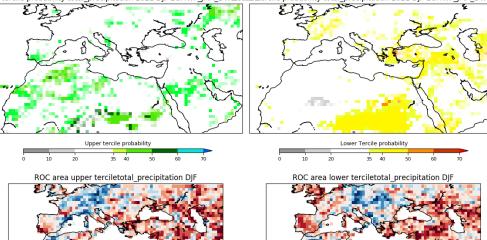


ECMWF,Offenbach,Tokyo

#### 500hPa GPH : DJF2021

(issued on Nov2021)

Upper tercile probability total\_precipitation 2021 DJF ECMWF\_JMA\_DWD.dexed?tercile probability total\_precipitation 2021 DJF ECMWF\_JMA\_DWD lead1



0.2

0.3

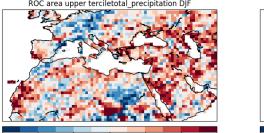
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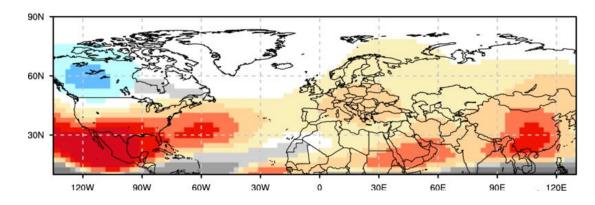
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**'obabilistic Multi-Model Ensemble Forecast** CMCC, Exeter, Montreal, Toulouse, Washington

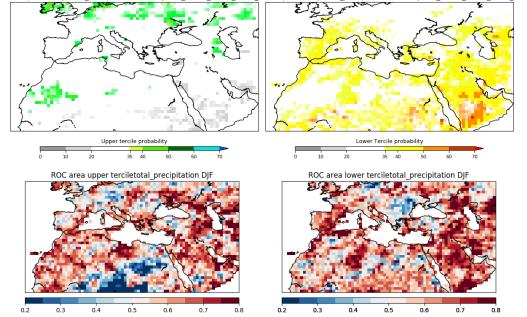
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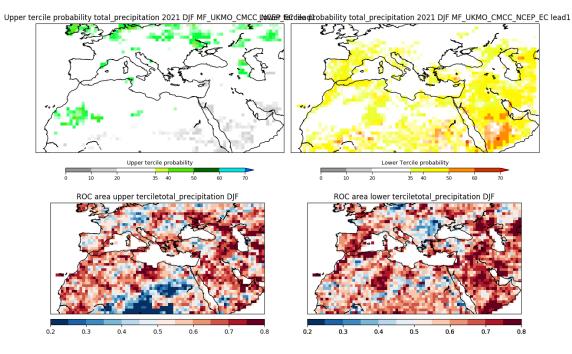
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### Importance of verification:

Guidance on Operational Practices for Objective Seasonal Forecasting, chapter 4.9:

"In summary, hindcast and real-time forecast quality should be published, regularly reported and made available alongside operational forecasts so that this information can be used when preparing seasonal forecasts"





Long-Range Forecast Multi-Model Ensemble

Home About us News Seasonal Related Sites WMO Lead Centre for ADCP

Home > Seasonal > Forecast > Probabilistic MME

#### Seasonal

#### Information

- » Probabilistic MME
- » Deterministic MME
- » References

#### Forecast

- » Probabilistic MME
- » Deterministic MME
- » Individual Forecast
- » Indices
- Verification
- » Hindcast » Forecast
- Data Exchange
- » Search/Download » Direct Download
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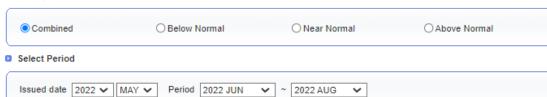
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- System Configuration
- Global Seasonal Climate Update

#### O Definition of Probabilistic MME

Probabilistic MME

#### Map Type



#### Select Model

🖌 All				
🗹 Beijing	CMCC	CPTEC	ECMWF	🗹 Exeter
Melbourne	🗹 Montreal	Moscow	🗹 Offenbach	🗹 Seoul
Tokyo	Toulouse	Vashington		

#### Select Parameters

Precipitation ○ 500hPa GPH O Mean Sea Level Pressure O 2m Temperature O 850hPa Temperature O Sea Surface Temperature O 850hPa Zonal Wind O 850hPa Meridional Wind

#### Select Region

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	Global 🗸	Longitude	0	~ 360	,	Latitude	-90	~	90	





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» Forecast Data Exchange » Search/Download » Direct Download » Report Download » Mailing List

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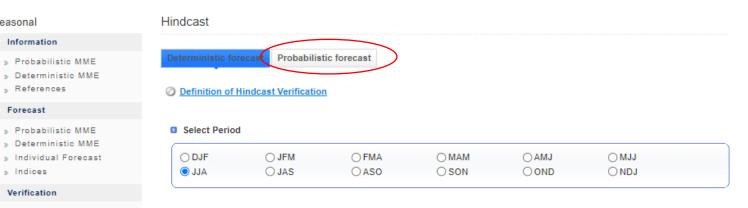
**Global Seasonal Climate** 

Information

Update

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Home > Seasonal > Verification > Hindcast



#### Select Model

MME				
🔾 Beijing	OCMCC	○ CPTEC	CECMWF	OExeter
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Seoul	○ Tokyo	O Toulouse	O Washington	

#### Select Measure

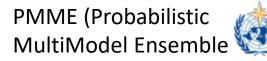
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#### Select Parameters

Precipitation	O Mean Sea Level Pressure	◯ 2m Temperature
○ 850hPa Temperature	⊖ 500hPa GPH	Sea surface Temperature

#### Select Region

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Home About us News Seasonal Related Sites WMO Lead Centre for ADCP

Home > Seasonal > Verification > Hindcast

Seasonal	Hindcast					
> Information						
<ul> <li>» Probabilistic MME</li> <li>» Deterministic MME</li> <li>» References</li> </ul>	Deterministic foreca		orecast			
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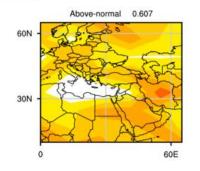
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Global	$\sim$	Longitude 0	~	360	,	Latitude	-90	~	90	

#### Relative Operating Characteristic(ROC) map

Beijing, CPTEC, ECMWF, Exeter, Melbourne, Montreal, Moscow, Seoul, Tokyo, Toulouse, Washington

0.7

### Precipitation : JJA Lat : 10~65, Lon : 0~65



Near-normal 0.506

60N ·

30N

0.8

0

0.9

Below-normal 0.564 60N 30N 60E 0

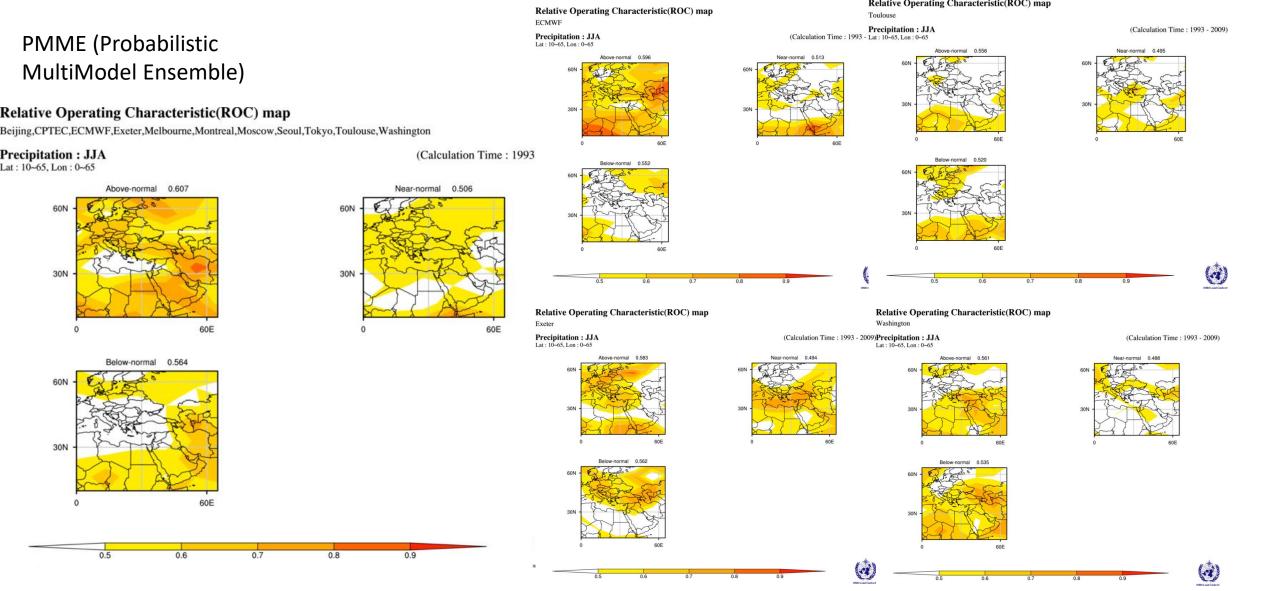
0.6

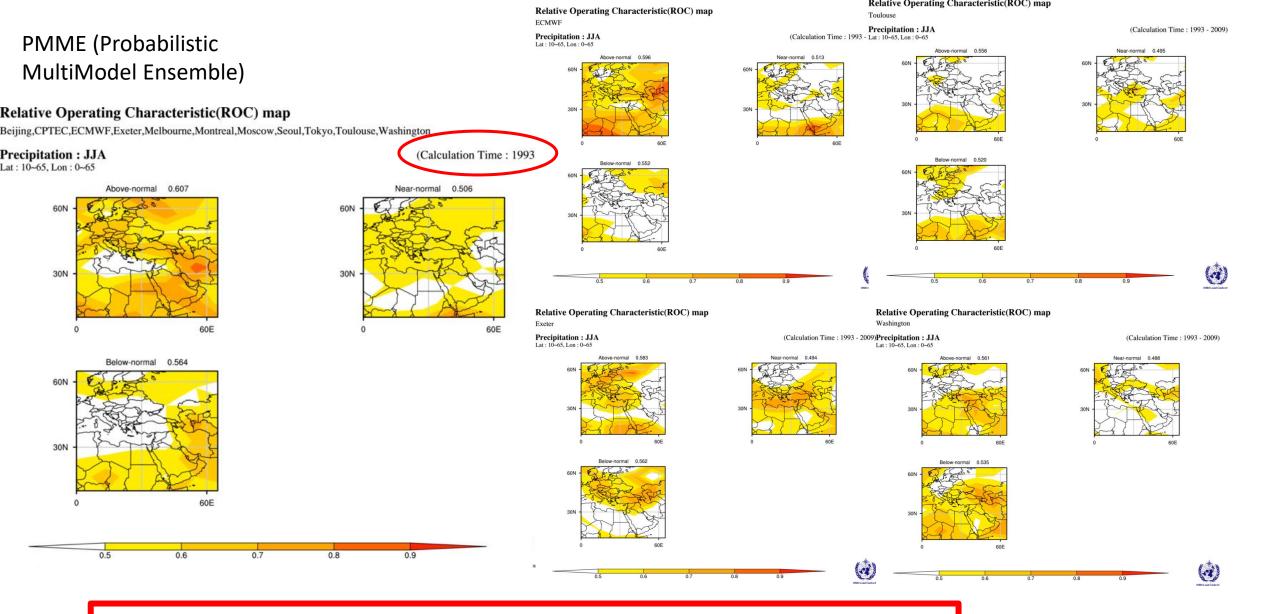
0.5



(Calculation Time: 1993 - 2009)

60E





Caution interpreting these maps: short hindcast implies high uncertainty in skill-scores

Mediterranean Seasonal Climate Update https://www.medscope-project.eu/products/mediterranean-seasonal-climate-update/



# Mediterranean Seasonal Climate Update May 17, 2022

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.

1/24



# Mediterranean Seasonal Climate Update May 17, 2022

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.

1/24

-Focused on Mediterranean Basin (aimed at MedCOF community)

-Seasonal predictions from C3S, NMME and AEMET empirical model presented in graphical homogeneous form

-Skill information available to help interpreting forecast maps

-More prediction systems and features to be incorporated.

Mediterranean Seasonal Climate Update



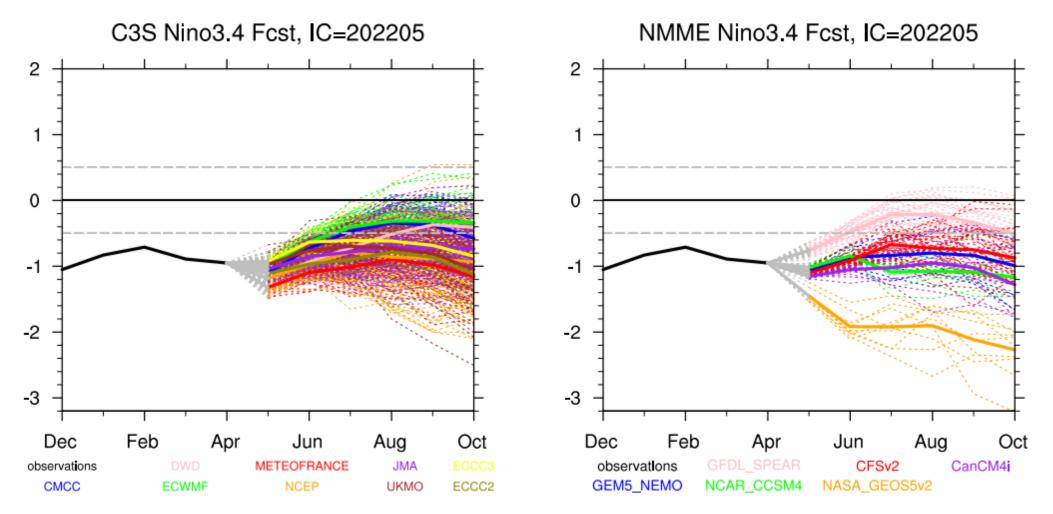
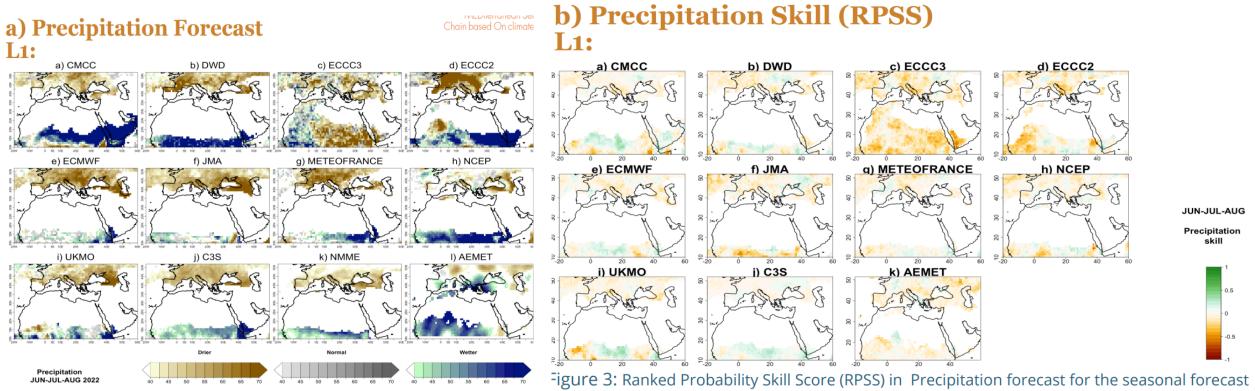


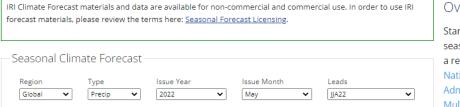
Figure 1: Niño3.4 prediction from all the ensemble members of the C3S multi-system

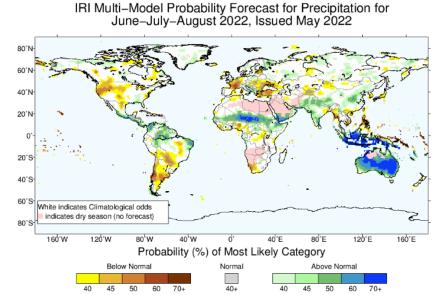
### Mediterranean Seasonal Climate Update



systems. Higher values indicate better model predictive skill. From (a) to (i) models of the C3S ensemble. (j) for AEMET.







#### Overview

Starting in April 2017, the IRI probabilistic seasonal climate forecast product is based on a re-calibration of model output from the U.S. National Oceanographic and Atmospheric Administration (NOAA)'s North American Multi-Model Ensemble Project (NMME). This includes the ensemble seasonal prediction systems of NOAA's National Centers for Environmental Prediction, Environment and Climate Change Canada, NOAA/Geophysical Fluid Dynamics Laboratory, NASA, NCAR and COLA/University of Miami. The output from each NMME model is re-calibrated prior to multi-model ensembling to form reliable probability forecasts. The forecasts are now presented on a 1-degree latitude-longitude grid.

**Disclaimer**: The IRI seasonal forecast is a research product. Please see the NOAA CPC forecast for the official seasonal forecast over the U.S. Please consult your country's national meteorological service for the official forecast for your country.

Please see the 'Discussion' item for an

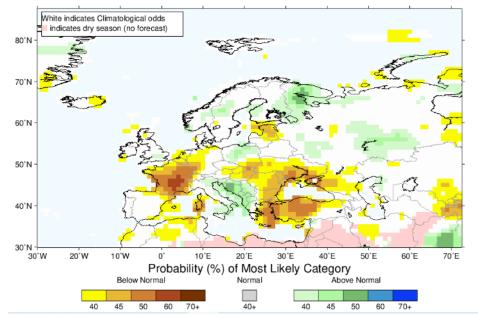
Based on NMME models. Probabilities for every model are calculated training logistic regression using observations (1990-2020). Probabilities then are averaged to built the multimodel.



IRI Climate Forecast materials and data are available for non-commercial and commercial use. In order to use IRI forecast materials, please review the terms here: <u>Seasonal Forecast Licensing</u>.



#### IRI Multi–Model Probability Forecast for Precipitation for June–July–August 2022, Issued May 2022



#### Overview

Starting in April 2017, the IRI probabilistic seasonal climate forecast product is based on a re-calibration of model output from the U.S. National Oceanographic and Atmospheric Administration (NOAA)'s North American Multi-Model Ensemble Project (NMME). This includes the ensemble seasonal prediction systems of NOAA's National Centers for Environmental Prediction, Environment and Climate Change Canada, NOAA/Geophysical Fluid Dynamics Laboratory, NASA, NCAR and COLA/University of Miami. The output from each NMME model is re-calibrated prior to multi-model ensembling to form reliable probability forecasts. The forecasts are now presented on a 1-degree latitude-longitude grid.

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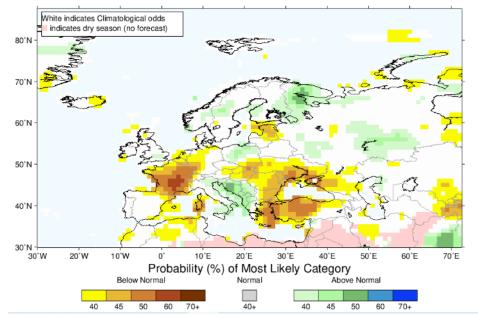
Please see the 'Discussion' item for an overview of the individual forecasts.



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#### IRI Multi–Model Probability Forecast for Precipitation for June–July–August 2022, Issued May 2022

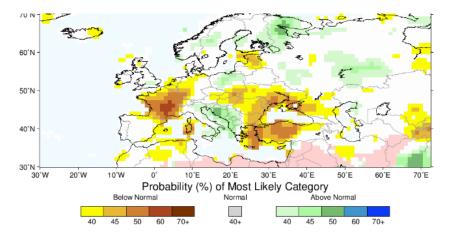


#### Overview

Starting in April 2017, the IRI probabilistic seasonal climate forecast product is based on a re-calibration of model output from the U.S. National Oceanographic and Atmospheric Administration (NOAA)'s North American Multi-Model Ensemble Project (NMME). This includes the ensemble seasonal prediction systems of NOAA's National Centers for Environmental Prediction, Environment and Climate Change Canada, NOAA/Geophysical Fluid Dynamics Laboratory, NASA, NCAR and COLA/University of Miami. The output from each NMME model is re-calibrated prior to multi-model ensembling to form reliable probability forecasts. The forecasts are now presented on a 1-degree latitude-longitude grid.

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Please see the 'Discussion' item for an overview of the individual forecasts.



#### Discussion

# May 2022 Climate forecast Discussion for Jun-Aug through Sep-Nov 2022

**Note:** The IRI seasonal forecasts of precipitation and temperature issued this month are based on an objective calibration procedure that combines the NCEP-CFSv2, CanSIPS-IC3, COLA-RSMAS-CCSM4, and GFDL-SPEAR, and NASA-GEOSS2S models. The climatological base period for normal is 1991-2020.

In April 2022, the equatorial sea surface temperatures (SSTs) in the central-eastern tropical Pacific Ocean were below average, and tropical Pacific atmosphere remained consistent with La Niña conditions. The CPC/IRI ENSO forecast from early-May indicates that La Niña is likely to persist during summer and fall in the Northern Hemisphere with 69% chance in Jun-Aug 2022, weakening during Jul-Sep and Aug-Oct, while strengthening slightly thereafter. Four out of the five models used in IRI's seasonal climate forecast, predict cooler than average SSTs over the eastern tropical Pacific and a continuation of the current La Niña episode. GFDL-SPEAR, one of the five models used here, indicates ENSO-neutral conditions for the next few months, before reverting back to La Niña later in the forecast. This has significant impacts on the seasonal forecasts of precipitation and temperature across the globe. The tropical Atlantic Ocean does not exhibit significant SST anomalies, while a gradually strengthening negative dipole in the Indian Ocean is evident during the forecast period.

The forecasts show moderate probabilities of below-normal precipitation in the Northwest United States, southern South America, and Turkey in Jun-Aug, weakening during rest of the forecast period. Increasing probabilities of below-average precipitation are forecast for the ensembling to form reliable probability forecasts. The forecasts are now presented on a 1-degree latitude-longitude grid.

**Disclaimer**: The IRI seasonal forecast is a research product. Please see the NOAA CPC forecast for the official seasonal forecast over the U.S. Please consult your country's national meteorological service for the official forecast for your country.

Please see the 'Discussion' item for an overview of the individual forecasts.

The climatological base period currently used is 1991-2020. Details of the forecast system, post-processing, and recommended references for citation can be found here. Forecasts from the individual NMME models are shown on NOAA CPC's website. Verifications of IRI's real-time forecasts issued since 1998 can be found on the Seasonal Climate Verifications pages.

To aid in interpretation of the forecast probabilities, maps of the observed precipitation and temperature percentiles are plotted in physical units here: Climatological Percentiles Maproom.

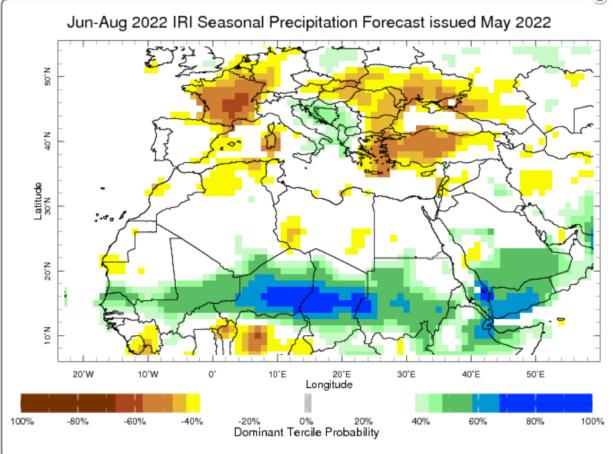
The IRI forecasts are also available as a flexible probabilistic format, providing the probability of exceedance (or nonexceedance) of a user-specified percentile of the climatological distribution: Go to IRI Flexible Forecasts

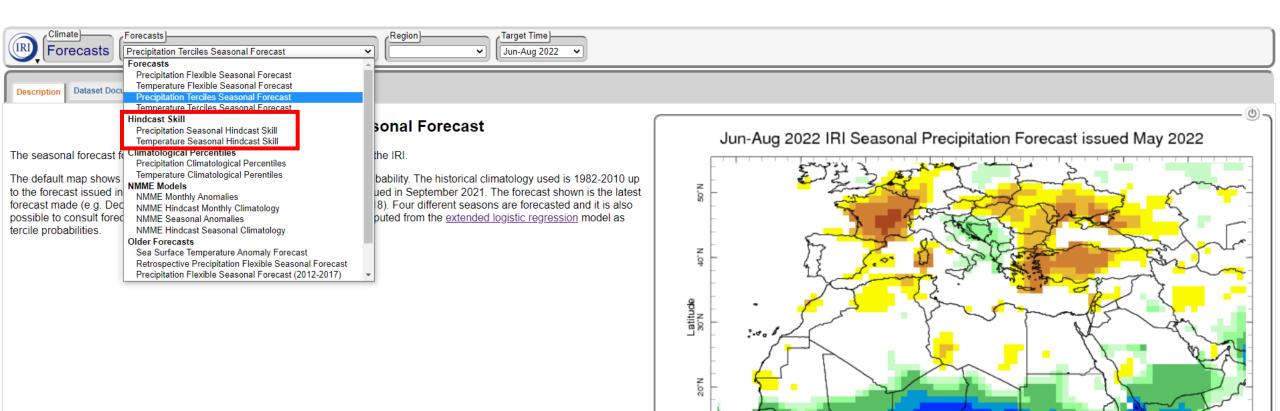




The seasonal forecast for above-, below- and near-normal precipitation from the IRI.

The default map shows globally the seasonal precipitation forecast tercile probability. The historical climatology used is 1982-2010 up to the forecast issued in August 2021, and is 1991-2020 from the forecast issued in September 2021. The forecast shown is the latest forecast made (e.g. Dec 2017) for the next season to come (e.g. Jan-Mar 2018). Four different seasons are forecasted and it is also possible to consult forecasts made previously. The forecasts are directly computed from the <u>extended logistic regression</u> model as tercile probabilities.





z

100%

20'W

-80%

10'W

-60%

0'

-40%

<sup>20°E</sup> Longitude

20%

0%

Dominant Tercile Probability

30°E

40%

50'E

80%

100%

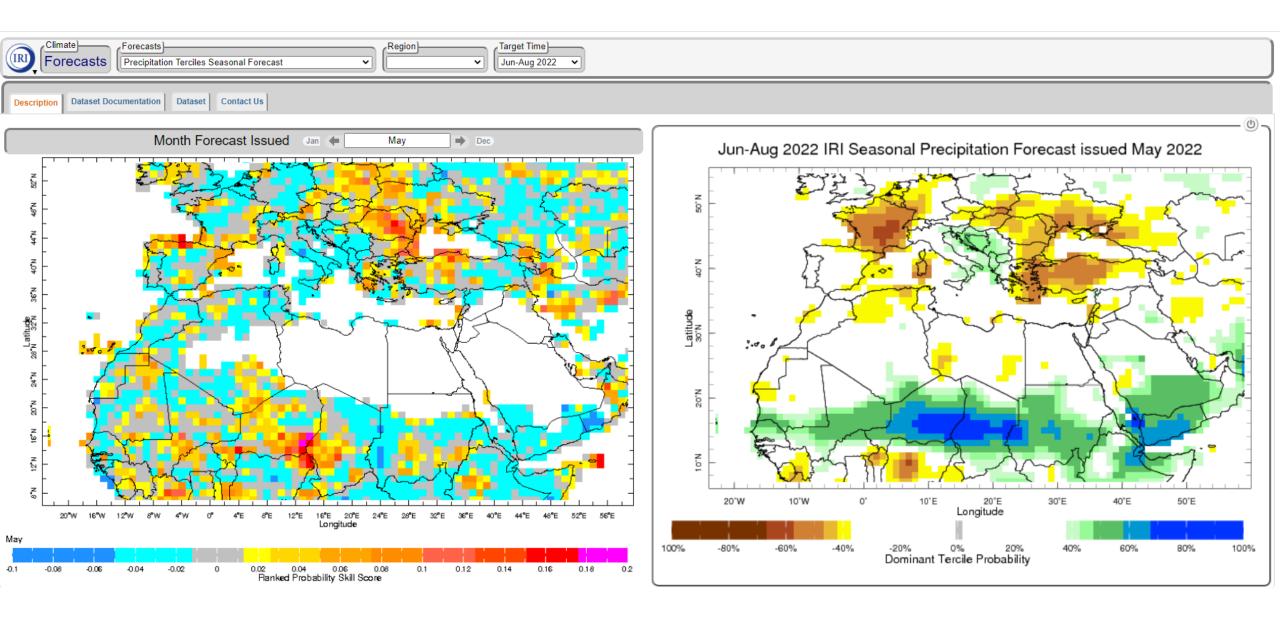
40°E

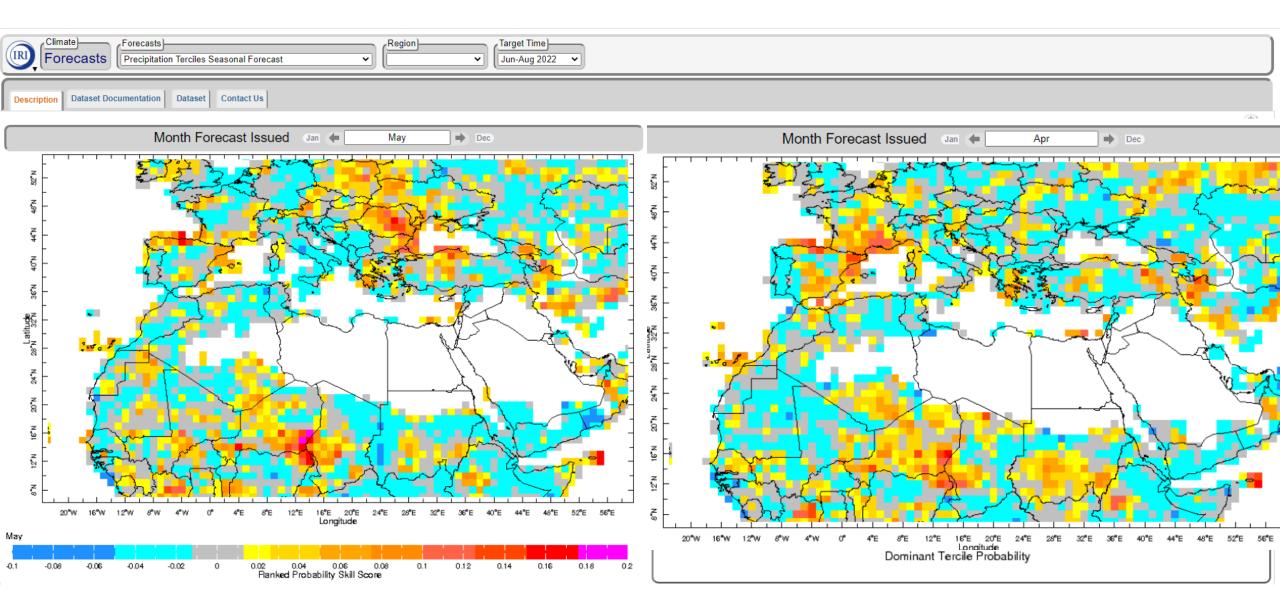
60%

10°E

-20%

<ul> <li>Skill is mapped by calendar month for seasonal lead times. Lead 1 = months 2.4, Lead 2 = months 3.5, Lead 3 = months 4.6, Lead 4 = months 5.7 after the forecast is issued. Forecasts skill scores combine start times by calendar month and across years 1982 to 2010. The observational reference datasets are CMAN-LAD for precipitation and GHCN-CAMS for themperature. The models included in the sasessment are: the Center for Ocean-Land-Atmosphere StudesUniversity of Miami (COLA-RSMAS-CSMI), one from the National Aeronautics and Space Administration (NBS-GAIGA0-052012), three from the Geophysical Fluid Dynamics Laboratory (GFDL-CM2p5-FLOR-ABG, GFDL-CM2p5-FLOR-ABG, GFDL-CM2p5-FLOR-ABG, GFDL-CM2p5-FLOR-ABG, GFDL-CM2p5-FLOR-ABG, Second Prediction, NCEP- CFSv2) and one from the National Center for Atmospheric Research (NCAR-CSSMI).</li> <li>These skill scores diagnostics maps give a sense of where and when (issued which months of the year and for which seasonal lead times) the probability Skill Scores (RPSS; Epstein (1969); Murphy (1969, 1971); Weigel et al. (2007)) are used to quantify the exient to which the calibrated tercile-category predictions are improved compared to climatological frequencies. RPSS values tend to be small, even for skillul forecasts. The approximate relationship between RPS5 and correlation being such that a RPS5 values tend to be small, even for skillul forecasts of Ranked Categories. J Appl. Meteor., 8, 985–987</li> <li>Murphy A.H., 1997 A.Mcen on the Ranked Probability Score: J Appl. Meteor., 8, 985–989</li> <li>Murphy A.H., 1997 L. Andeen on the Ranked Probability Score. J Appl. Meteor., 8, 985–987</li> <li>Murphy A.H., 1997 L. Mcen on the Ranked Probability Score. J Appl. Meteor., 8, 985–987</li> <li>Murphy A.H., 1997 L. Mcen on the Ranked Probability Score. J Appl. Meteor., 8, 985–989</li> <li>Murphy A.H., 1997 L. Andeen Orbability Group Compared to Comp</li></ul>	Climate Seasonal Forecasts Hindcast Skill Precipitation Seasonal Hindcast Skill	Skill Score RPSS V
Precipitation Seasonal Hindcast Skill Seasonal skill score based on the historical performance of each calibrated NMME model and their multimodel ensemble (1982-2010). Skill is mapped by calendar month for seasonal lead times. Lead 1 = months 2.4, Lead 2 = months 5.5, Lead 3 = months 4.6, Lead 4 = months 5.5, Lead 3 = months 4.6, Lead 4 = months 5.5, Lead 3 = months 4.6, Lead 4 = months 5.7, Lead 3 = months 4.6, Lead 4 = months 4.6, Lead 4 = months 5.7, Lead 3 = months 4.6, Lead 4 = months 5.7, Lead 3 = months 4.6, Lead 4 = mont	Description Dataset Documentation Instructions Contact Us	
Weigel, A.P., M.A. Liniger, and C. Appenzeller, 2007: The Discrete Brier and Ranked Probability Skill Scores. Mon. Wea. Rev., 135, 118–124  May  O.1 -0.08 -0.04 -0.02 O 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18 0.2  Ranked Probability Skill Score	<ul> <li>Seasonal skill score based on the historical performance of each calibrated NMME model and their multimodel ensemble (1982-2010).</li> <li>Skill is mapped by calendar month for seasonal lead times. Lead 1 = months 2-4, Lead 2 = months 3-5, Lead 3 = months 4-6, Lead 4 = months 5-7 after the forecast is issued. Forecasts skill scores combine start times by calendar month and across years 1982 to 2010. The observational reference datasets are CMAP-URD for precipitation and GHCN-CAMS for temperature. The models included in the assessment are: the Center for Ocean-Land-Atmosphere Studies/University of Miami (COLA-RSMAS-CCSM4), one from the National Aeronautics and Space Administration (NASA-GMAO-062012), three from the Geophysical Fluid Dynamics Laboratory (GFDL-CM2p1-ea04, GFDL-CM2p5-FLOR-B01), two from the Canadian Meteorological Center (CMC1-CanCM3, CMC2-CanCM4), one from NOAA's Centers for Environmental Prediction (NCEP- CFSv2) and one from the National Center for Atmospheric Research (NCAR-CESM1).</li> <li>These skill scores diagnostics maps give a sense of where and when (issued which months of the year and for which seasonal lead times) the probabilistic seasonal forecasts have the potential to provide useful information, based on hindcasting.</li> <li>Skill scores definitions:</li> <li>RPSS: Ranked Probability Skill Scores (RPSS; Epstein (1969); Murphy (1969, 1971); Weigel et al. (2007)) are used to quantify the extent to which the calibrated fercile-category predictions are improved compared to climatological frequencies. RPSS values tend to be small, even for skillful forecasts. The approximate relationship between RPSS and correlation being such that a RPSS value of 0.1 corresponds to a correlation of about 0.44 (Tippett et al. 2010).</li> <li>References:         <ul> <li>Epstein, E.S., 1969: A Scoring System for Probability Forecasts of Ranked Categories, J. Appl. Meteor., 8, 985–987</li> <li>Murphy, A.H., 1969: On the "Ranked Probability Score". J</li></ul></li></ul>	

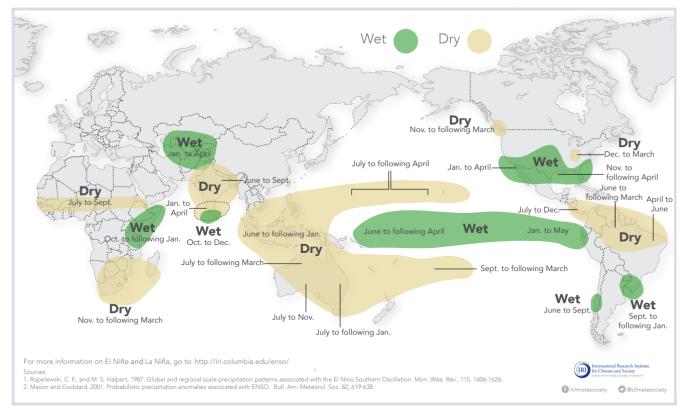




-Based on relationships among different elements of the climate system.

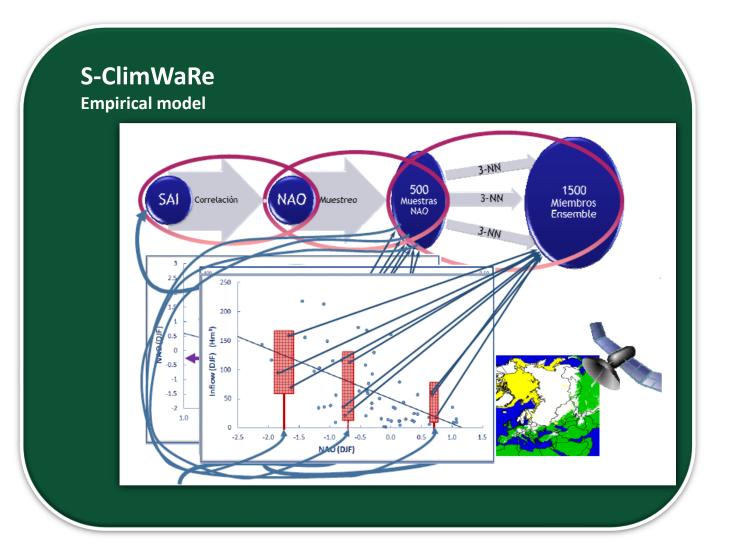
### **El Niño and Rainfall**

El Niño conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one El Niño to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.



-Assume statinary relationship among driver and target-Usually linear methodologies

-Based on relationships among different elements of the climate system.



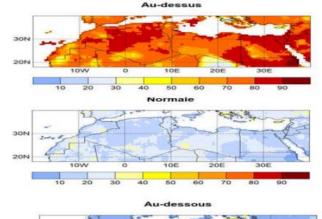
-Assume stationary relationship among driver and target-Usually linear methodologies

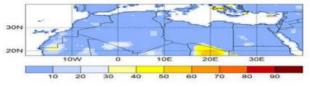
-Example of snow cover-NAO linear regression

### **II. Statistical Forecast**

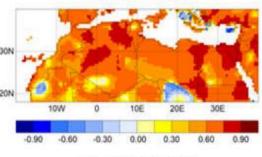
Statistical forecasts of 2m temperature anomalies are produced by Canonical Correlation Analysis method using as predictors North Atlantic April SST (NOAA NCDC ERSST version4) and as predictand North Africa T2m(CPC /GHCN\_CAMS).

Statistical forecast is represented by probabilities of 3 categories above normal, normal and below normal.

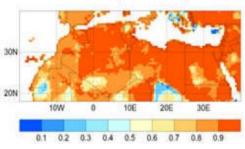




Pearson's Correlation







-Assume stationary relationship among driver and target

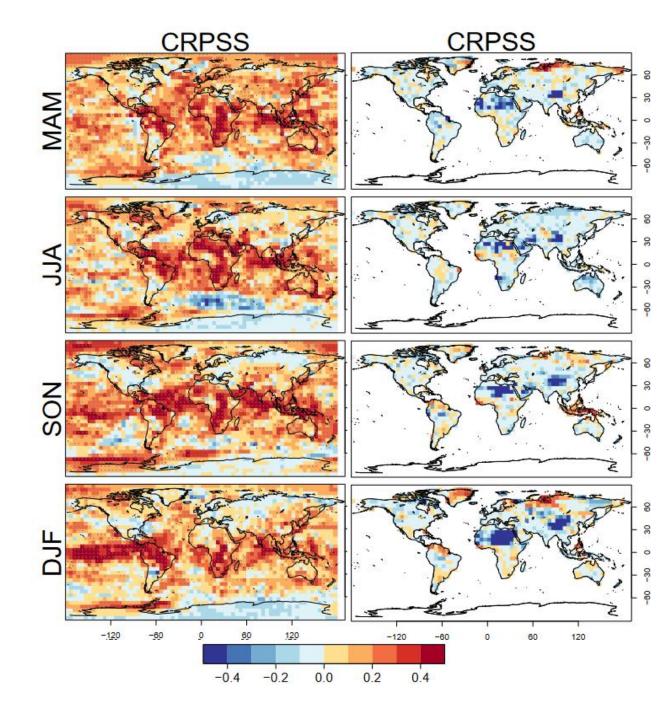
-Usually linear methodologies

-Use of spatial information (CCA) in empirical model for temperatura in RA I RCC-LRF

# A global empirical system for probabilistic seasonal climate prediction

J. M. Eden<sup>1</sup>, G. J. van Oldenborgh<sup>1</sup>, E. Hawkins<sup>2</sup>, and E. B. Suckling<sup>2</sup>

<sup>1</sup>Royal Netherlands Meteorological Institute (KNMI), De Bilt, the Netherlands
<sup>2</sup>NCAS-Climate, Department of Meteorology, University of Reading, Reading, UK



Predictor	Source		
CO2EQV	CO <sub>2</sub> -equivalent concentrations (Meinshausen et al., 2011)		
NINO3.4	Calculated from SST fields from HadISST (Rayner et al., 2003)		
PDO	University of Washington (http://research.jisao.washington.edu/pdo/)		
QBO	At 30 hPa from the reconstruction of Brönnimann et al. (2007)		
AMO	Calculated by van Oldenborgh et al. (2009); based on HadSST (Kennedy et al., 2011a, b)		
IOD	Calculated from SST fields from HadISST (Rayner et al., 2003)		
LSST	HadSST3 (Kennedy et al., 2011a, b)		
CPREC	GPCC Full Data Reanalysis version 6 (Schneider et al., 2011)		



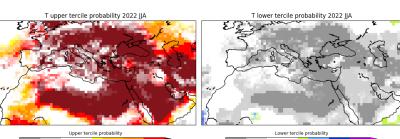
Deliverable D2.3

#### Final version of the empirical forecasting system

	Acronym	Index name	Source
	AAO AO	Antartic Oscillation	https://psl.noaa.gov/data/correlation/aao.data
	EA	Artic Oscillation East Atlantic	https://psl.noaa.gov/data/correlation/ao.data ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/
	EA/WR	East Asia/West	a index.tim https://psl.noaa.gov/data/correlation/ea.data
(su		Russia	
attern	EP/NP	East Pacific/North Pacific	https://psl.noaa.gov/data/correlation/epo.data
eleconnections z500 patterns)	NAO	North Atlantic Oscillation	https://psl.noaa.gov/data/correlation/nao.data
S2 6	NP	North Pacific	https://psl.noaa.gov/data/correlation/np.data
-	PNA	Pacific North American	https://psl.noaa.gov/data/correlation/pna.data
	SCAND	Scandinavian	ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/ cand_index.tim
	WP	West Pacific	https://psl.noaa.gov/data/correlation/wp.data
Stratosp here	QBO	Quasi Biennial Oscillation	Averaged u wind (10S-10N at 10hPa)
	u10n	Northern u at 10hPa	Averaged u wind (60N-85N at 10 hPa)
	u10s	Southern u at10hPa	Averaged u wind (85S-60S at 10 hPa)
ENSO	MEIv2	Multivariate ENSO index	https://psl.noaa.gov/enso/mei/data/meiv2.data
	SOI	Southern Oscillation index	https://psl.noaa.gov/data/correlation/soi.data
-	WTIO	Western Tropical Indian Ocean	Averaged (50E-70E,10S-10N)
DCeal and 00m	SWIO	South Western Indian Ocean	Averaged (31E-45E,32S-25S)
Indian Ocean SST and Tave200m	SETIO	South Eastern Tropical Indian Ocean	Averaged (90E-110E,10S-0)
-	DMI	Dipole Mode Index	Calculated (WTIO-SETIO)
	Nino12	Nino12	Averaged (90W-80W,10S-0)
	Nino3	Nino3	Averaged (150W-90W,5S-5N)
2 a a li	Nino4	Nino4	Averaged (160E-150W,5S-5N)
ve 10 ac	Nino34	Nino34	Averaged (170E-120W,5S-5N)
Pacific Ocean SST and Tave200m	Nino34- Nino12	Nino34 - Nino12	Calculated
oans	TNA	Tropical Northern Atlantic	Averaged (57.5W-15W, 5.5N-23.5N)
	TSA	Tropical Southern Atlantic	Averaged (30W-10E, 20S-0)
ano	NAT	North Atlantic Tropical	Averaged (40W-20W, 5N-20N)
editerrane SST and Tave200m	SAT	South Tropical Atlantic	Averaged (15W-5E, 20S-5N)
19 J	TASI	NAT - SAT	Calculated
a s a	Atl1	Locally derived	Averaged (40W-10W, 50N-60N)
₹	Med1	Locally derived	Averaged (0-8E, 33N-46N)
Atlantic+Mediterranean Oceans SST and Tave200m	Med2	Locally derived	Averaged (10E-22E, 33N-46N)
	Med3	Locally derived	Averaged (25E-40E,30N-40N)
	WHWP	Western Hemisphere Warm Pool	https://psl.noaa.gov/data/correlation/whwp.data
Snow extent	SnNH	Snow extent (N.	https://climexp.knmi.nl/getindices.cgi?WMO=Rut
		Hemisphere)	ersData/nh_snow&STATION=NH_snow_cover& YPE=i&id=someone@somewhere
	SnNA	Snow extent(North	https://climexp.knmi.nl/getindices.cgi?WMO=Ru
		America)	ersData/namerica_snow&STATION=North_Ame ca_snow_cover&TYPE=i&id=someone@somew
	0-54	Constant	ere
	SnEA	Snow extent (Eurasia)	https://climexp.knmi.nl/getindices.cgi?WMO=Ru ersData/eurasia_snow&STATION=Eurasia_sno
	Snow1	Locally derived	_cover&TYPE=i&id=someone@somewhere Averaged (10E-20E, 58N-67N)
	Snow2	Locally derived	Averaged (10E-20E, 50N-67N) Averaged (110W-85W, 38N-50N)
	Snow2 Snow3	Locally derived	Averaged (110W-05W, 30N-50N) Averaged (38E-67E, 38N-54N)
	Snow4	Locally derived	Averaged (302-072, 3010-3410) Averaged (75E-145E, 25N-55N)
	Snow3- Snow4	Locally derived	Calculated locally (Snow3-Snow4)
	Soil weth	Variability modes	Rotated PCA from monthly anomalies (calculate

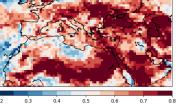
# -Comprehensive list of global and regional predictors

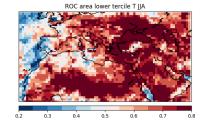
- -Use of PLS regression
- -Multiple runs with different configurations to try to isolate signal
- -Generation of hindcast to evaluate skill with a particular configuration

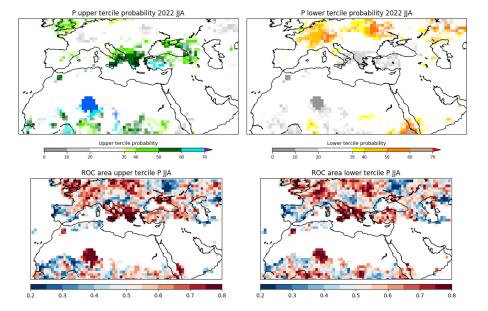


IS 40 50 60 70

ROC area upper tercile T JJA









Deliverable D2.3

#### Final version of the empirical forecasting system

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	AAO	Antartic Oscillation	https://psl.noaa.gov/data/correlation/aao.data
1	AO	Artic Oscillation	https://psl.noaa.gov/data/correlation/ao.data
1	FA	East Atlantic	ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/e
eleconnections (2500 patterns)			a_index.tim
	EA/WR	East Asia/West Russia	https://psl.noaa.gov/data/correlation/ea.data
	EP/NP	East Pacific/North Pacific	https://psl.noaa.gov/data/correlation/epo.data
00 pc	NAO	North Atlantic Oscillation	https://psl.noaa.gov/data/correlation/nao.data
82	NP	North Pacific	https://psl.noaa.gov/data/correlation/np.data
F	PNA	Pacific North	https://psl.noaa.gov/data/correlation/pna.data
		American	
	SCAND	Scandinavian	ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/s cand_index.tim
	WP	West Pacific	https://psl.noaa.gov/data/correlation/wp.data
Stratosp here	QBO	Quasi Biennial Oscillation	Averaged u wind (10S-10N at 10hPa)
liere	u10n	Northern u at 10hPa	Averaged u wind (60N-85N at 10 hPa)
	u10s	Southern u	Averaged u wind (85S-60S at 10 hPa)
ENSO	MEIv2	at10hPa Multivariate ENSO	https://psl.noaa.gov/enso/mei/data/meiv2.data
ENSO		index	
	SOI	Southern Oscillation index	https://psl.noaa.gov/data/correlation/soi.data
5	WTIO	Western Tropical Indian Ocean	Averaged (50E-70E,10S-10N)
ndian Ocea SST and Tave200m	SWIO	South Western Indian Ocean	Averaged (31E-45E,32S-25S)
Indian Ocean SST and Tave200m	SETIO	South Eastern Tropical Indian Ocean	Averaged (90E-110E,10S-0)
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	Nino3	Nino3	Averaged (150W-90W,5S-5N)
e e e e e	Nino4	Nino4	Averaged (160E-150W,5S-5N)
Pacific Ocean SST and Tave200m	Nino34	Nino34	Averaged (170E-120W,5S-5N)
	Nino34- Nino12	Nino34 - Nino12	Calculated
	TNA	Tropical Northern Atlantic	Averaged (57.5W-15W, 5.5N-23.5N)
eans	TSA	Tropical Southern Atlantic	Averaged (30W-10E, 20S-0)
0 u	NAT	North Atlantic Tropical	Averaged (40W-20W, 5N-20N)
editerrane SST and Tave200m	SAT	South Tropical Atlantic	Averaged (15W-5E, 20S-5N)
9 H G	TASI	NAT - SAT	Calculated
a S di	Atl1	Locally derived	Averaged (40W-10W, 50N-60N)
Atlantic+Mediterranean Oceans SST and Tave200m	Med1	Locally derived	Averaged (0-8E, 33N-46N) Averaged (10E-22E, 33N-46N) Averaged (25E-40E,30N-40N)
	Med2	Locally derived	Averaged (10E-22E, 33N-46N)
Ĕ	Med3	Locally derived	Averaged (25E-40E,30N-40N)
Atla	WHWP	Western Hemisphere Warm	https://psl.noaa.gov/data/correlation/whwp.data
	SnNH	Pool Snow extent (N.	https://climexp.knmi.nl/getindices.cgi?WMO=Rutg
Snow extent	SnNH	Snow extent (N. Hemisphere)	https://climexp.knmi.nl/getindices.cgi?WMO=Rutg ersData/nh_snow&STATION=NH_snow_cover&T YPE=i&id=someone@somewhere
	SnNA	Snow extent(North	https://climexp.knmi.nl/getindices.cgi?WMO=Rutg
	SHINA	America)	ersData/namerica_snow&STATION=North_Ameri
		America)	ca_snow_cover&TYPE=i&id=someone@somewh ere
	SnEA	Snow extent	https://climexp.knmi.nl/aetindices.cgi?WMO=Rutg
	SILA	(Eurasia)	ersData/eurasia_snow&STATION=Eurasia_snow cover&TYPE=i&id=someone@somewhere
	Snow1	Locally derived	_covers I YPE=ISId=someone@somewhere Averaged (10E-20E, 58N-67N)
	Snow2	Locally derived	Averaged (10E-20E, 56N-67N) Averaged (110W-85W, 38N-50N)
	Snow2 Snow3	Locally derived	Averaged (110W-85W, 38N-50N) Averaged (38E-67E, 38N-54N)
			Averaged (38E-67E, 38N-54N) Averaged(75E-145E, 25N-55N)
	Snow4	Locally derived	
	Snow3- Snow4	Locally derived	Calculated locally (Snow3-Snow4)
	Soil weth	Variability modes	Rotated PCA from monthly anomalies (calculated
	ess	variability modes	10W-40E, 30N-60N box)
1	030		Torritole, ourroute boxy

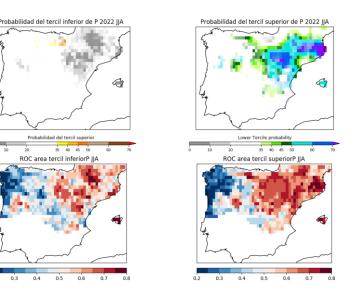
- -Comprehensive list of global and regional predictors
- -Use of PLS regression

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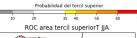
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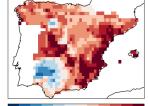
35 40 45 50

- -Multiple runs with different configurations to try to isolate signal
- -Generation of hindcast to evaluate skill with a particular configuration

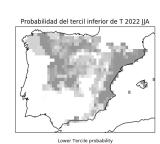


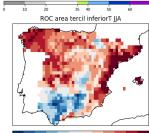












0.3 0.4 0.5 0.6 0.7 0.2 0.8



Deliverable D2.3

#### Final version of the empirical forecasting system

Snow extent (N

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ersData/namerica\_snow&STATION=North\_Amer ca\_snow\_cover&TYPE=i&id=someone@somewh

Rotated PCA from monthly anomalies (calc 10W-40E, 30N-60N box)

over&TYPE=i&

ttps://climexp.knmi.nl/getindices.cgi?WMO=Rutg rsData/eurasia\_snow&STATION=Eurasia\_snow

E=i&id=someone@somewh

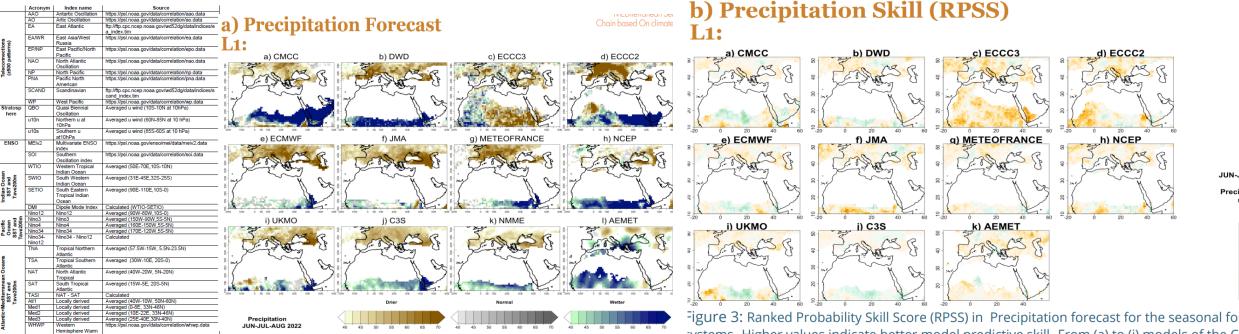
nl/getindices cgi?WMO=Rute

-Comprehensive list of global and regional predictors

- -Use of PLS regression
- -Multiple runs with different configurations to try to isolate signal

-Generation of hindcast to evaluate skill with a particular configuration

### Monthly delivered as part of MSCU:



systems. Higher values indicate better model predictive skill. From (a) to (i) models of the C ensemble. (j) for AEMET.

### http://seasonal.meteo.fr/content/bienvenue



### **Final remarks:**

-Several sources of seasonal climate information have been presented -Importance of verification, both for dynamical and empirical models

Future steps:

-Diagnosis products (variability patterns, weather regimes..). Some of them already available at RAVI RCC-LRF.

-Dore analysis representation of sources of predictability in the models

-Exploring ways of combining information.