Seasonal forecast from CMCC

MedCOF5- Climate outlook for winter 2015-16

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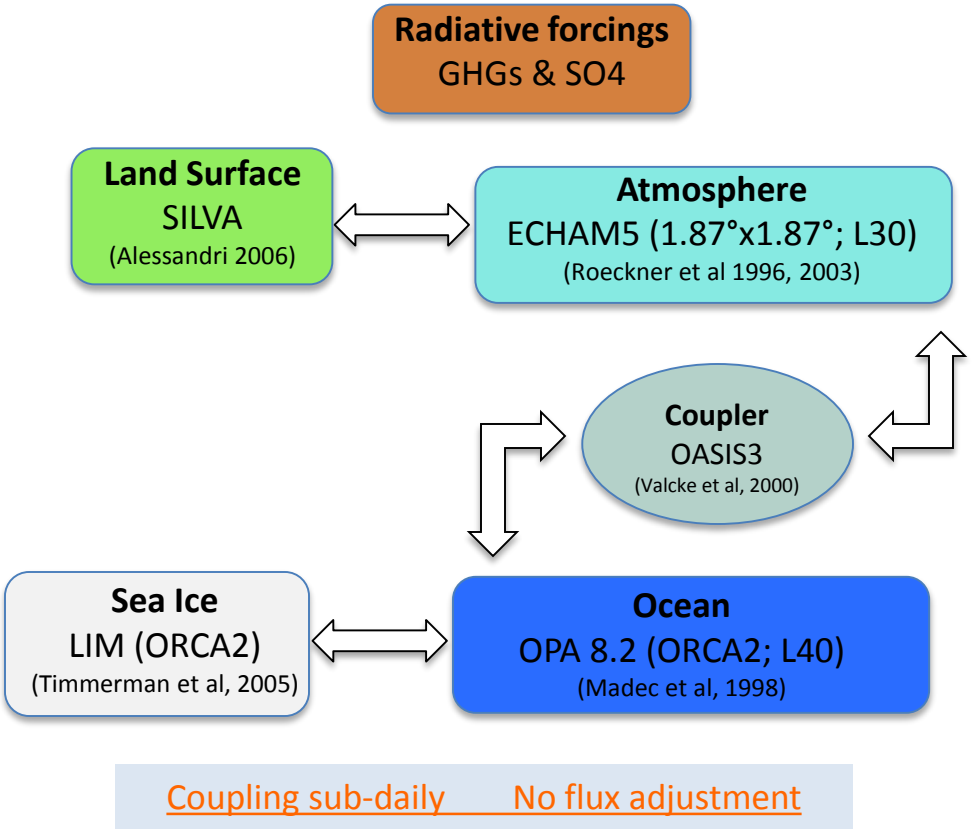
MEDCOF-05
23-24 November 2015
Kenzi Farah Hotel, Marrakech, Morocco

cmcc
Centro Euro-Mediterraneo sui Cambiamenti Climatici

The CMCC Seasonal Prediction System

CMCC-SPSv2

THE CLIMATE MODEL



Coupling sub-daily No flux adjustment

Off line Initialization Tools

Atmospheric and Land Surface IC from **ECMWF Analyses**

Spectral & Time interpolation INTERA
(Kirchner, 2001)

CMCC Ocean Analyses

T & S - OI assimilation SOFA 3.0
(De Mey and Benkiran 2002)
CIGODAS

Bellucci, Masina, Di Pietro & Navarra, 2007. MWR

Sea ice: initial condition is given by the ocean analysis on the basis of SST, with a climatological thickness
Aerosol and GHGs: observation up to 2005, afterwards RCP8.5 scenario values are used
Ozone: climatological

The CMCC Seasonal Prediction System

CMCC-SPSv2: **the initialization strategy**

Atmosphere and Land:

Atmosphere and land initialised with ECMWF operational analyse; re-forecasts 1981-2010 → initial conditions generated using the ERA-Interim re-analyses.

- atmospheric fields interpolated from the ECMWF grid to the grid of the CMCC model;
- land fields interpolated from the HTESSEL to the two soil reservoirs implemented in SILVA;

Ocean and Sea-Ice:

Ocean initialization with full-values from a global analysis (or reanalysis) performed with the CMCC Global Ocean Data Assimilation System (CIGODAS; Bellucci et al. Cim. Dyn. 2007) implemented in the OPA8.2 dynamical ocean model, used with the same configuration and spatial resolution as in the seasonal forecast system.

- **Assimilated profiles of temperature and salinity** data from the CORA data set (Cabanes, et al. 2013) and **relaxation towards observed SSTs** (from ECMWF) with a 12-day restoring time scale.

- **initial sea-ice cover diagnosed from the analyzed SST**; sea ice thickness and snow depth over ice are set to a monthly climatology diagnosed from a 1960-2008 climate simulation

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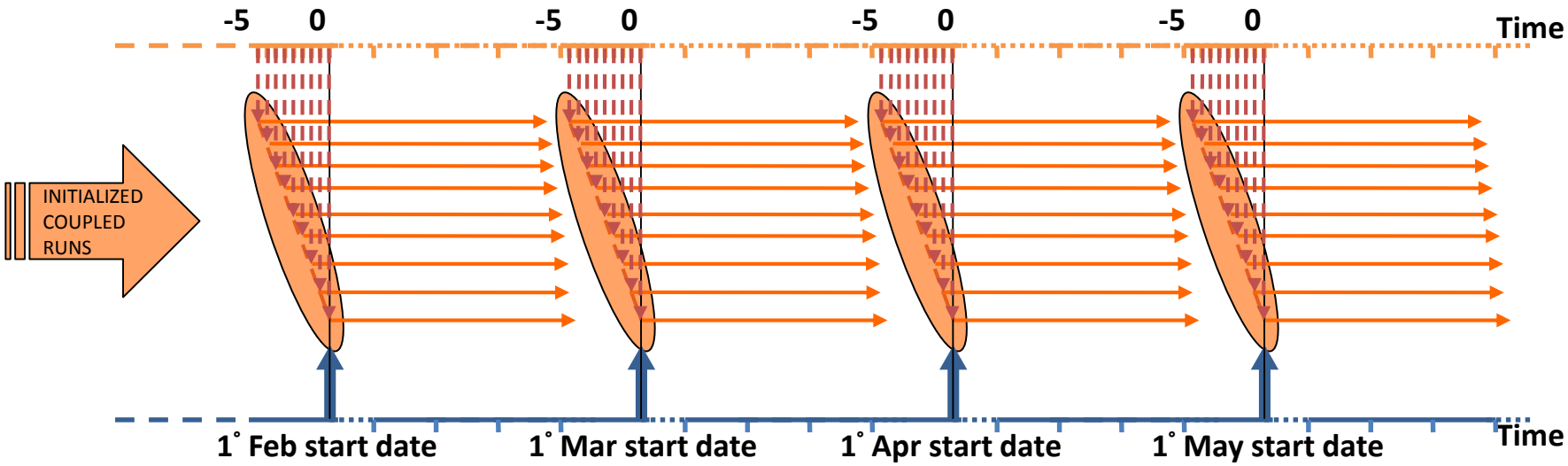
The experimental setup: forecast and re-forecasts for validation

OFF LINE interpolated
Land-Atmosphere IC from
Operational analysis
9 ICs from a lagged time initialization

Day lag every 12 hours



OFF LINE assimilated
OCEAN ANALYSES

- start date **every month**
- **7-month**-integrations
- **12 start dates** per year (once a month)
- **9 ensemble members** for each start date
- **reforecast** for calibration 1989-2010

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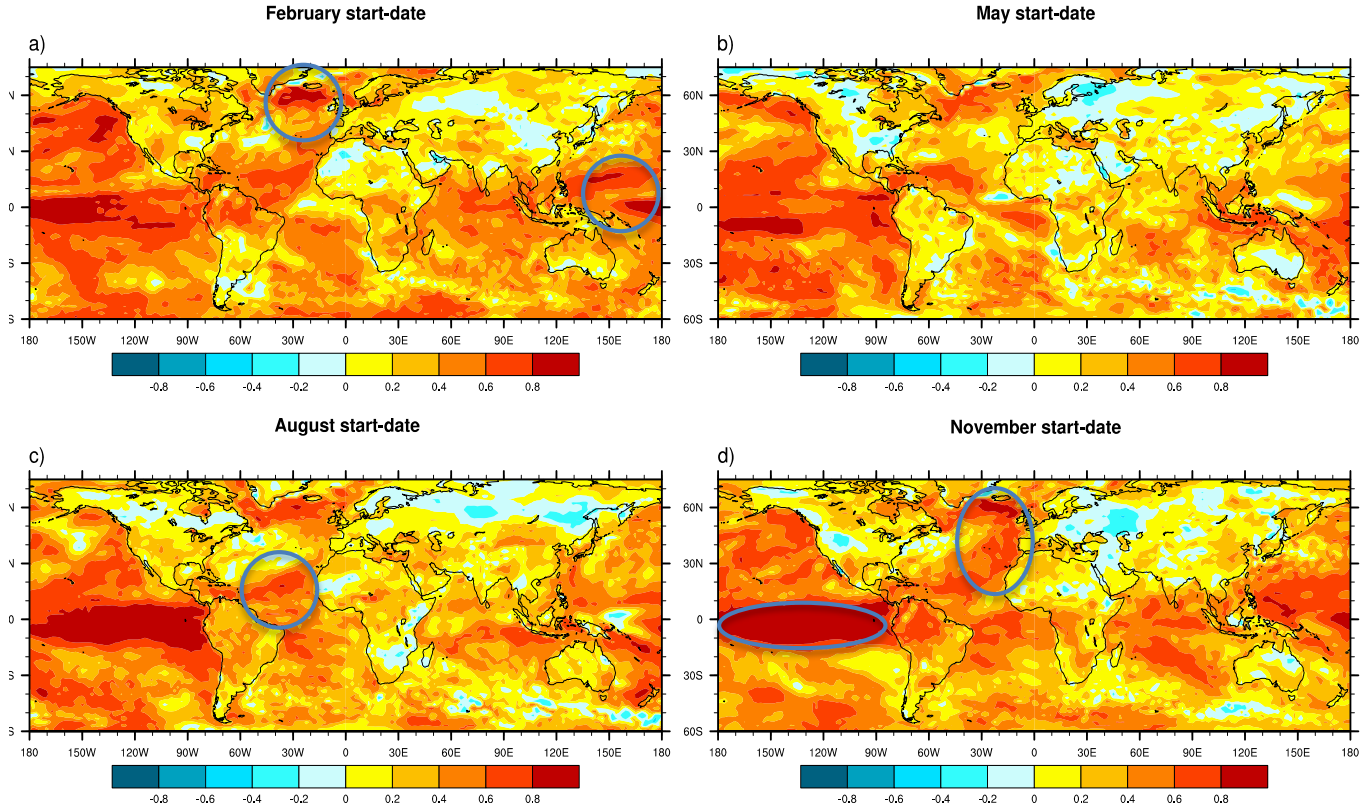
Surface Temperature ACC between forecast (Lead 1) and ERA-Interim reanalyses, for the 1989-2010 period (re-forecasts)

Lead time 1 refers to the season starting one month after the start date (e.g. Feb lead 1 = MAM)



- Skill is higher in the Tropical oceans (ENSO and teleconnections)
- Good skill in the northern Atlantic region, particularly in the winter and the spring

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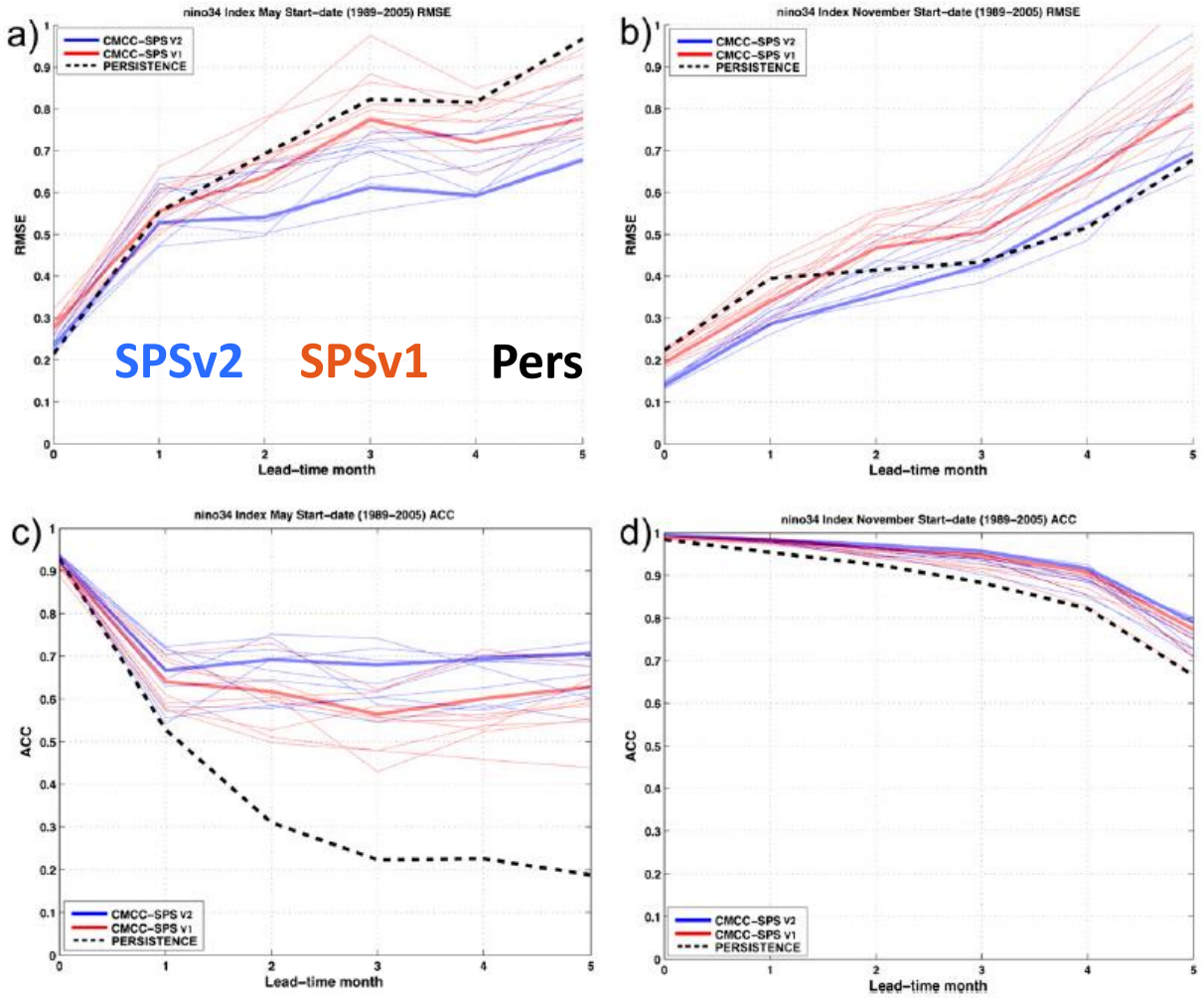
SST - NINO3.4

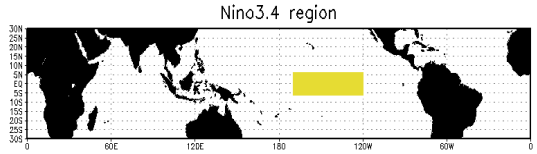
May

November



Inclusion of a land-atmosphere initialization

SST anomalies in the NINO 3.4 region



The **inclusion of land-atmosphere initial conditions** demonstrates an important impact on the forecasts of equatorial Pacific SST, either as a result of the intra-seasonal stochastic component of the atmospheric initial state (Shi et al., 2011), or for the amplification of initial condition error in such a coupled system (Hudson et al., 2011).

Materia et al. 2014, J. Climate

The CMCC Seasonal Prediction System

ROC SCORE

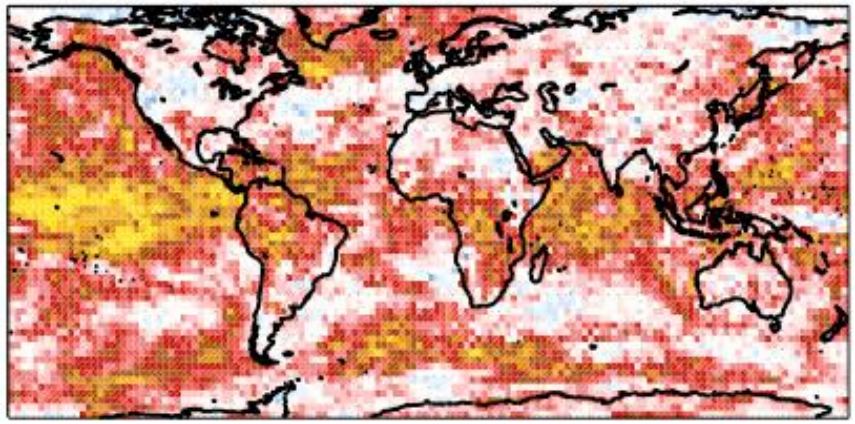
Lead 1 - DJF Forecasts

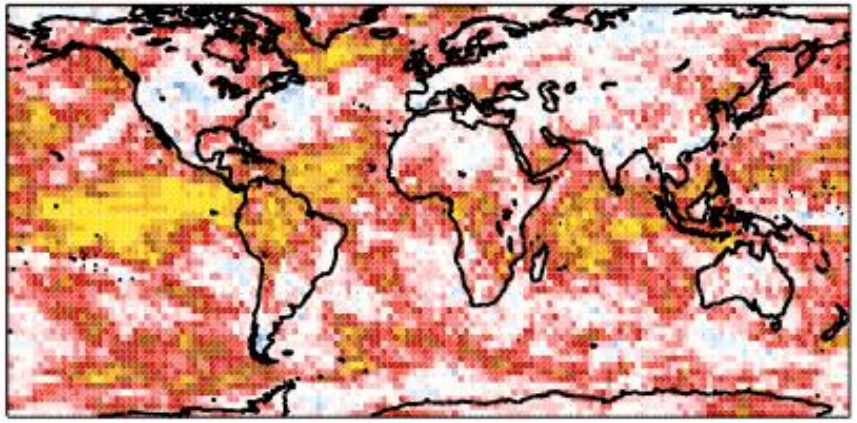
Below lower tercile

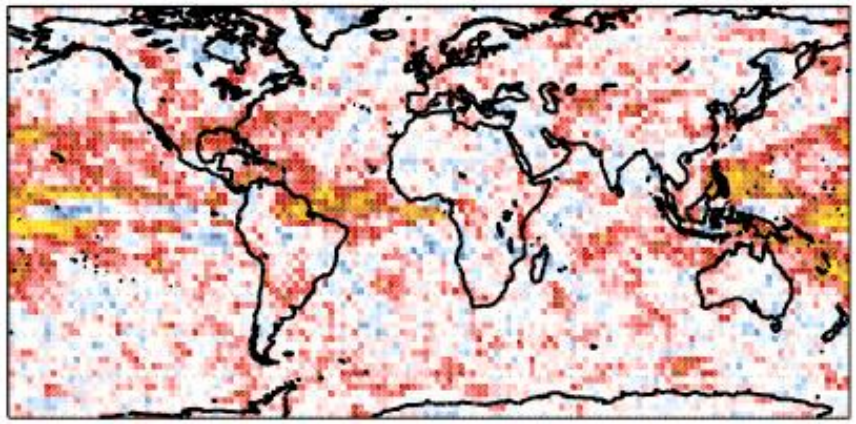
Above upper tercile

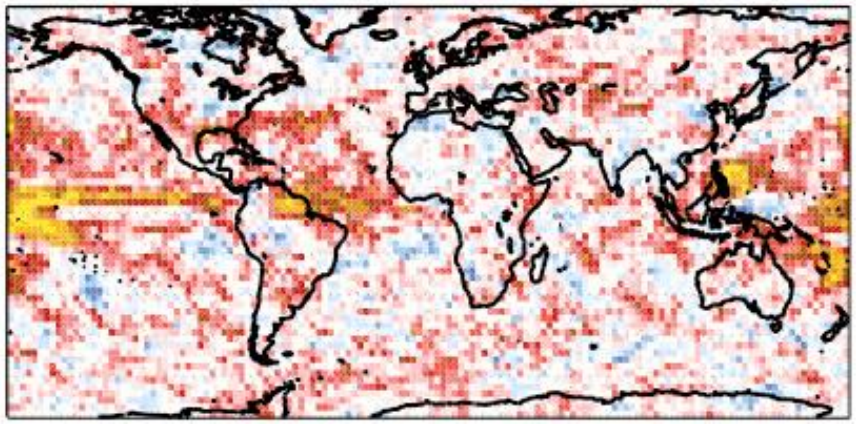
2m temperature

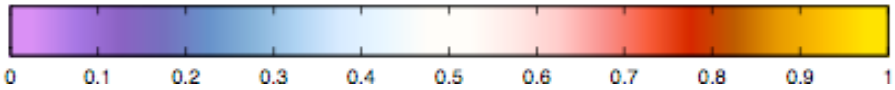
Precipitation





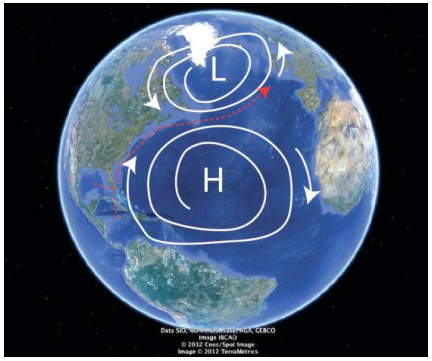




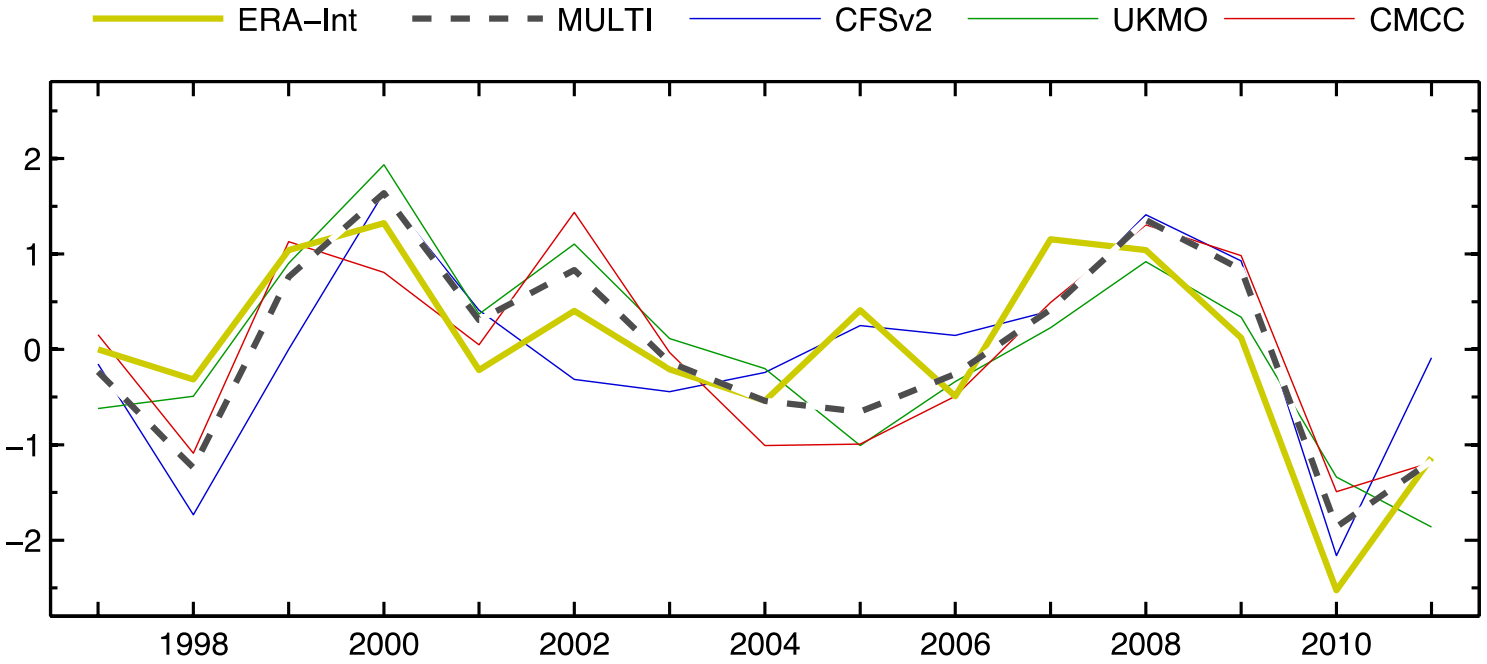


The CMCC Seasonal Prediction System

Skill for winter NAO



Despite its low-resolution and relatively small ensemble size, the CMCC-SPS exhibits significant skill (0.57), comparable to that of the UKMO and CFSv2 prediction systems.



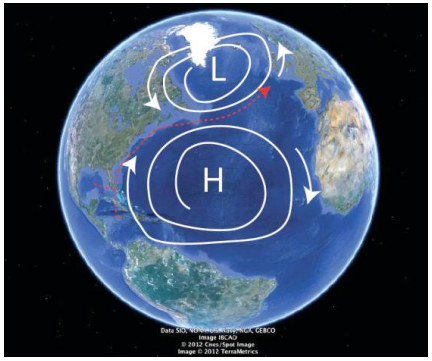
Mean-winter NAO for the three prediction systems, ERA-Interim and the multi-system mean. Ensemble sizes: UKMO=24, CFSv2=24, CMCC=9, MULTI=57.

Athanasiadis et al. (2015)

The CMCC Seasonal Prediction System

Skill for winter NAO

ACC for three NAO-related teleconnection indices.
These are computed from winter-mean MSLP anomalies.



NAO Wallace and Gutzler (1981) index

	CFSv2	UKMO	CMCC	MULTI
1982–2010	0.54	—	0.48	0.62
1997–2010	0.72	0.64	0.57	0.74

AO index

	CFSv2	UKMO	CMCC	MULTI
1982–2010	0.61	—	0.54	0.68
1997–2010	0.74	0.65	0.74	0.85

NAOI Lie and Wang (2003) index

	CFSv2	UKMO	CMCC	MULTI
1982–2010	0.57	—	0.56	0.65
1997–2010	0.74	0.76	0.76	0.85

The correlations between different hindcast periods and teleconnection indices vary, however they are always high enough to ensure a high level of statistical significance.

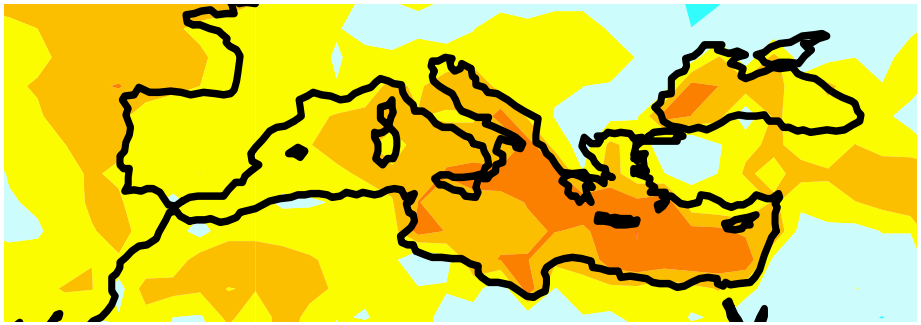
Athanasiadis et al. (2015)

The CMCC Seasonal Prediction System

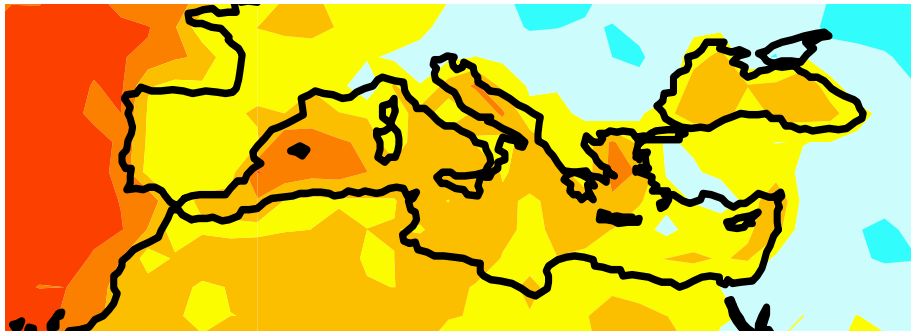
Focus on the Mediterranean area

Tsurf Anomaly Correlation (ACC) lead time 1

May



November



Skill is higher in the eastern basin during the summer, while in the winter the good skill over North Atlantic favors good quality of the forecast over the western basin.

The CMCC Seasonal Prediction System

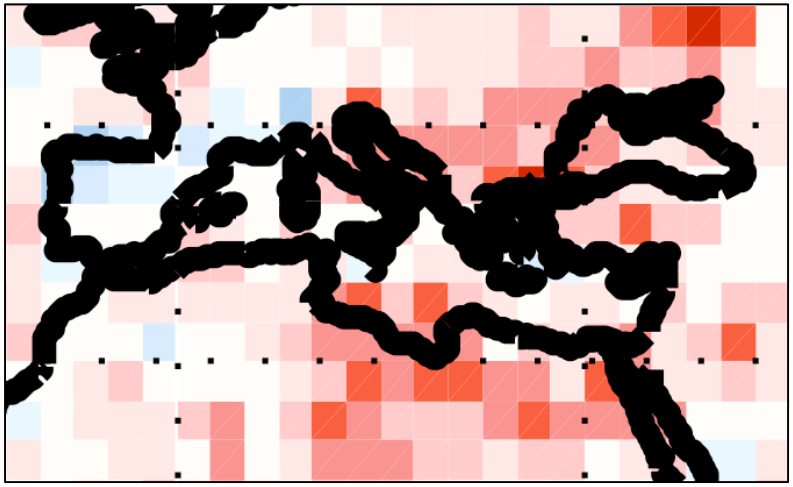
ROC SCORE

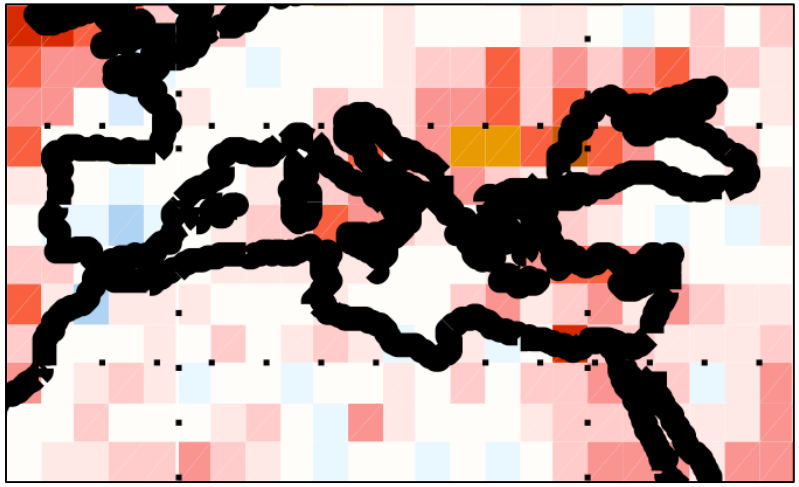
Lead 1 - DJF Forecasts

Below lower tercile

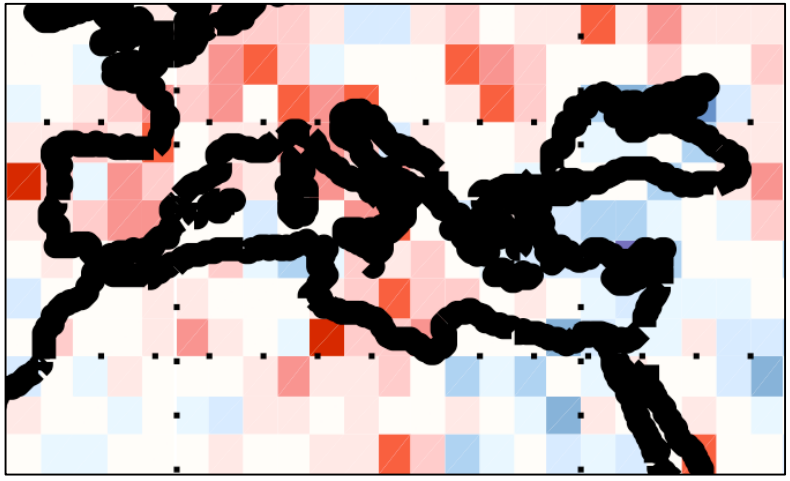
Above upper tercile

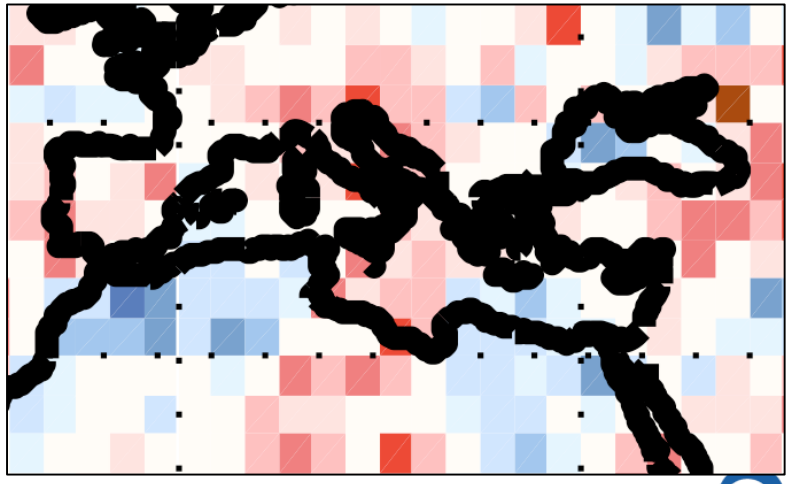
2m temperature

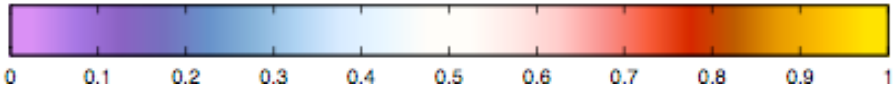




Precipitation



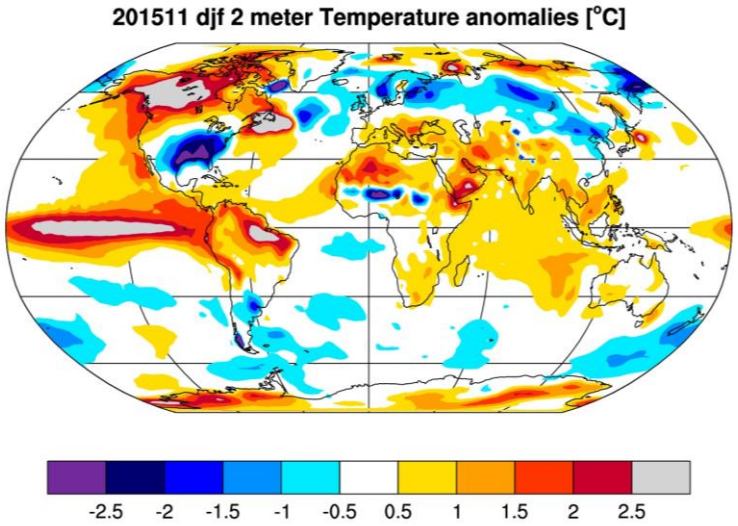


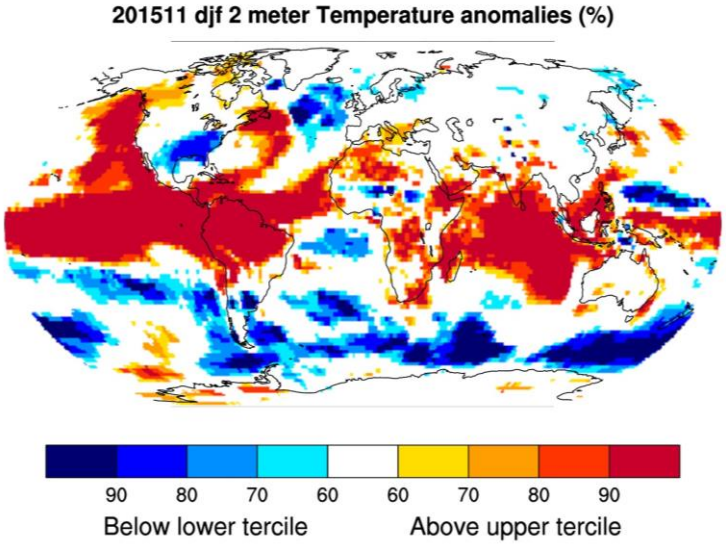


CMCC Forecast: next winter

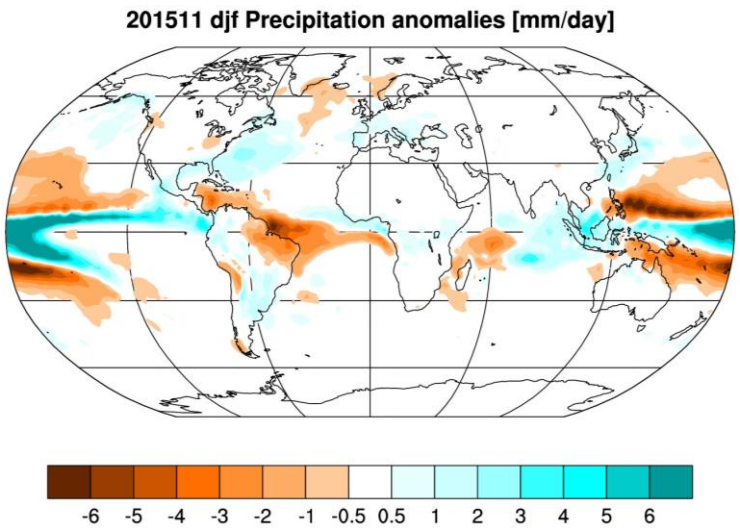
November start date - Lead 1 (DJF)

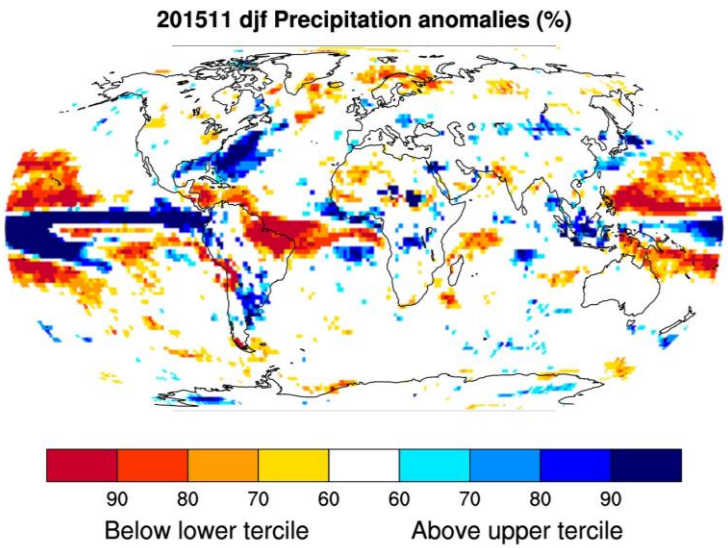
2-m Temperature



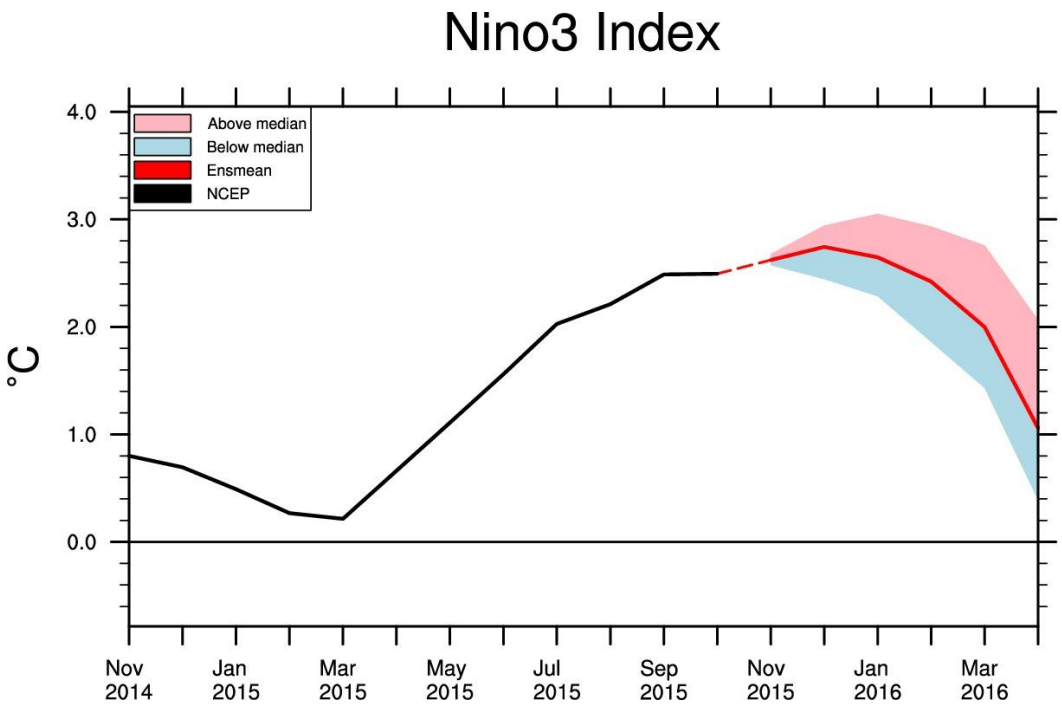


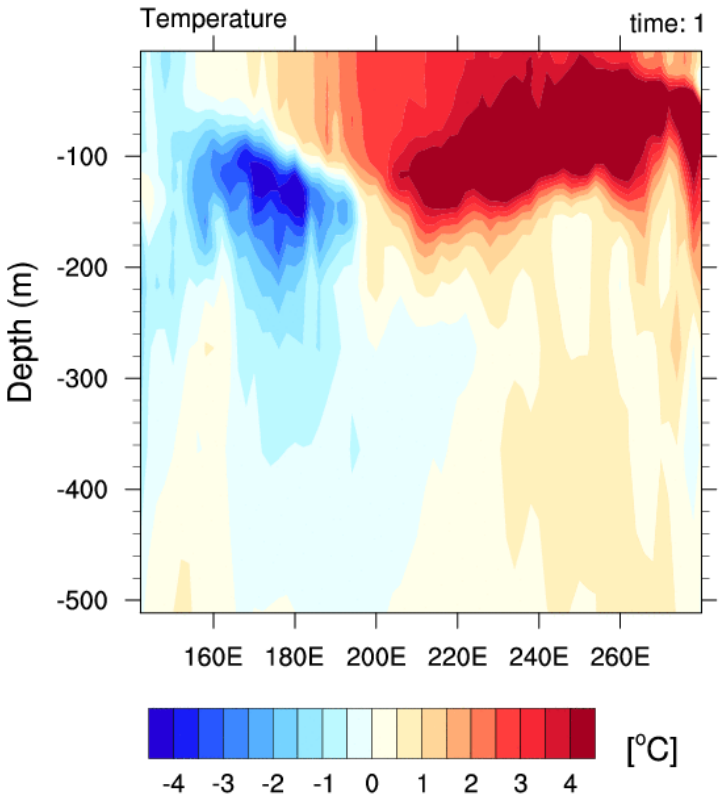
Precipitation

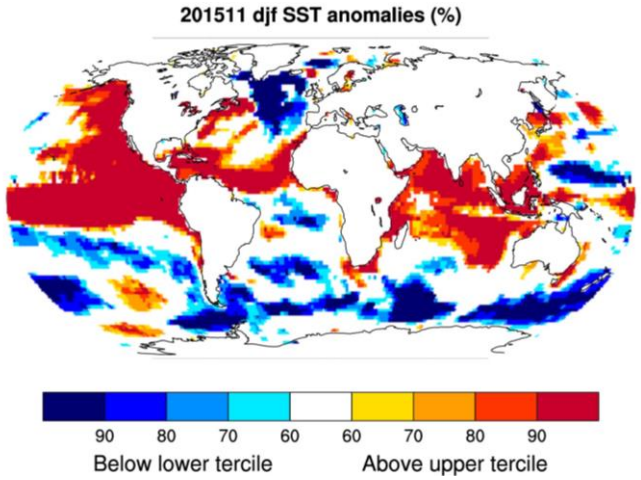




CMCC Forecast: next winter





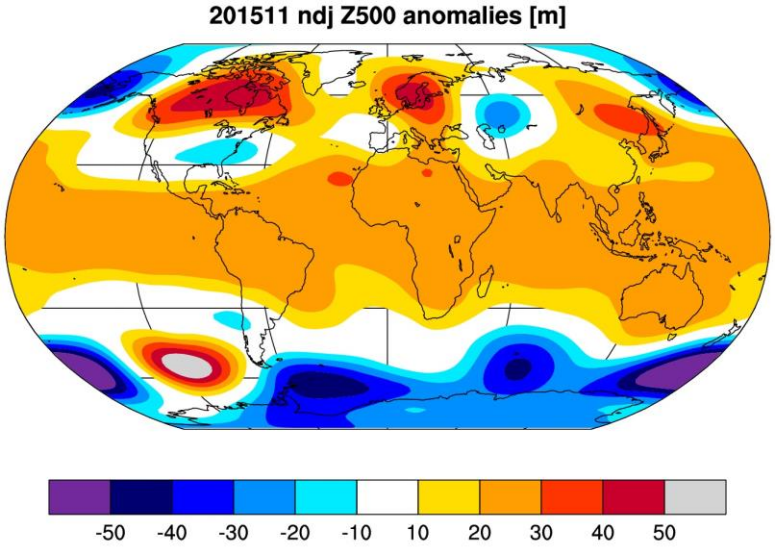


Strong El Niño conditions will persist, with a decay starting after the maximum of December (between 2.5°C-3°C). Most likely, the warm anomalies over Indian Ocean and W Tropical Atlantic will persist, as well as the cold anomaly in the north Atlantic sector. Equatorial Atlantic will be colder than usual too.

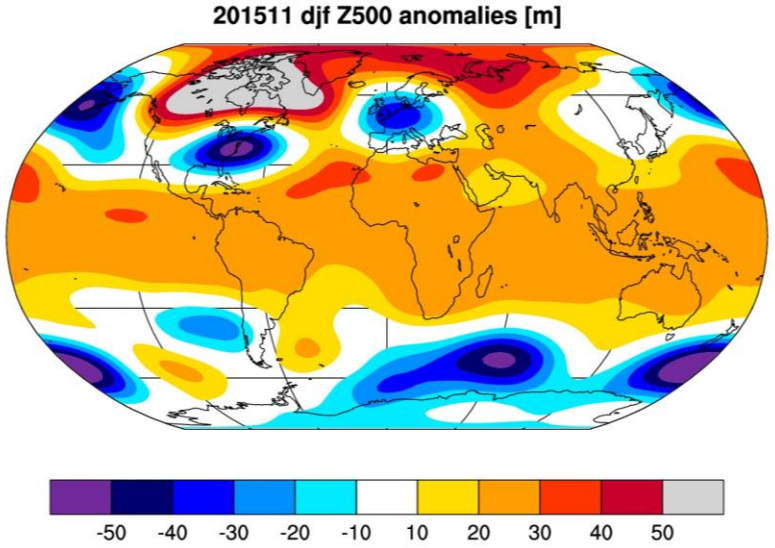
CMCC Forecast: next winter

November start date – Z500

Lead 0 (NDJ)



Lead 1 (DJF)

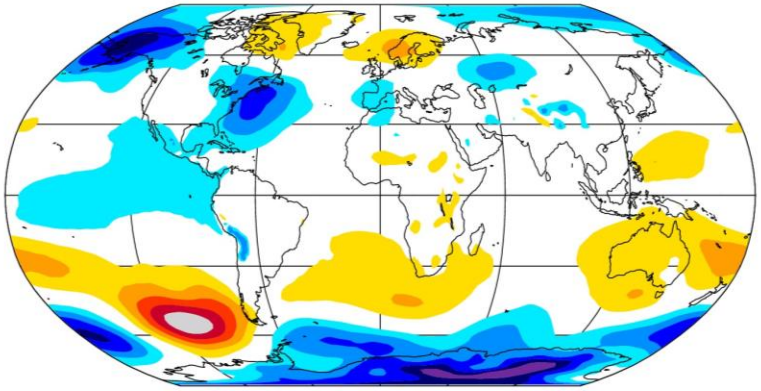


CMCC Forecast: next winter

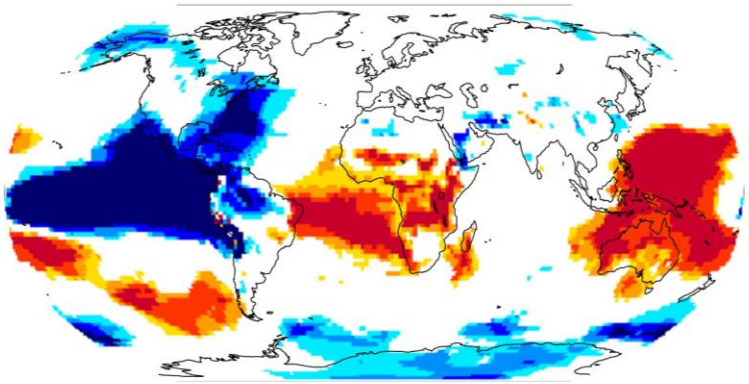
November start date – SLP

Lead 0 (NDJ)

201511 ndj Mean sea level pressure anomalies [hPa]

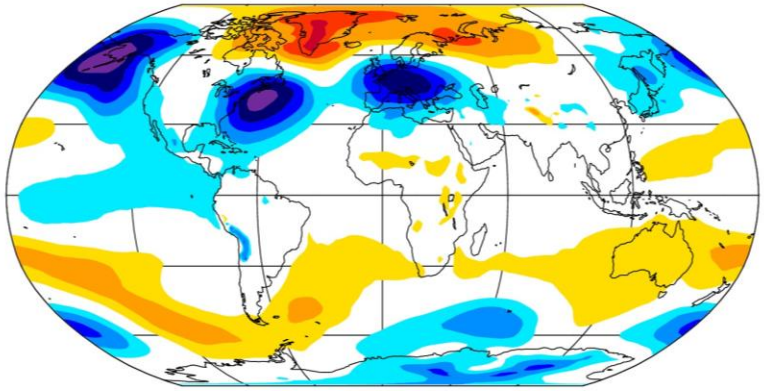


201511 ndj Mean sea level pressure anomalies (%)

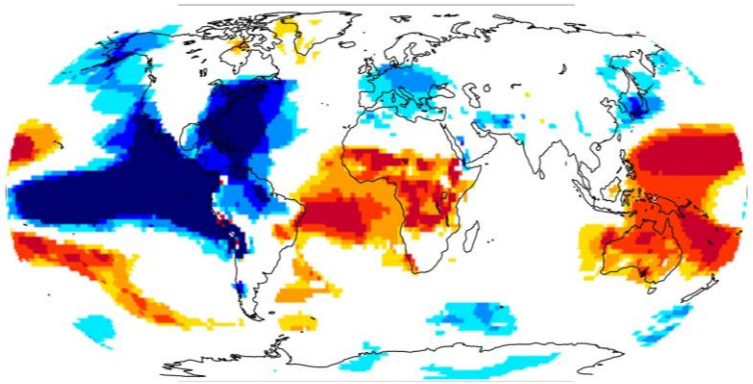


Lead 1 (DJF)

201511 djf Mean sea level pressure anomalies [hPa]

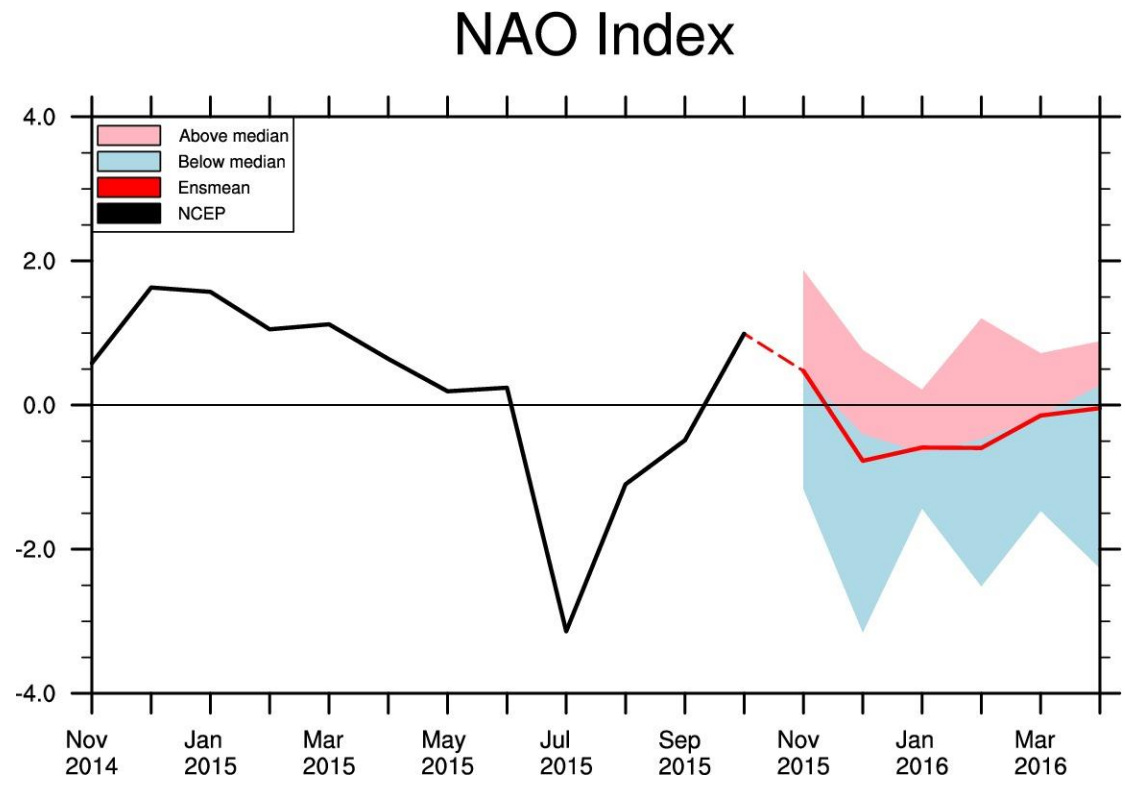


201511 djf Mean sea level pressure anomalies (%)

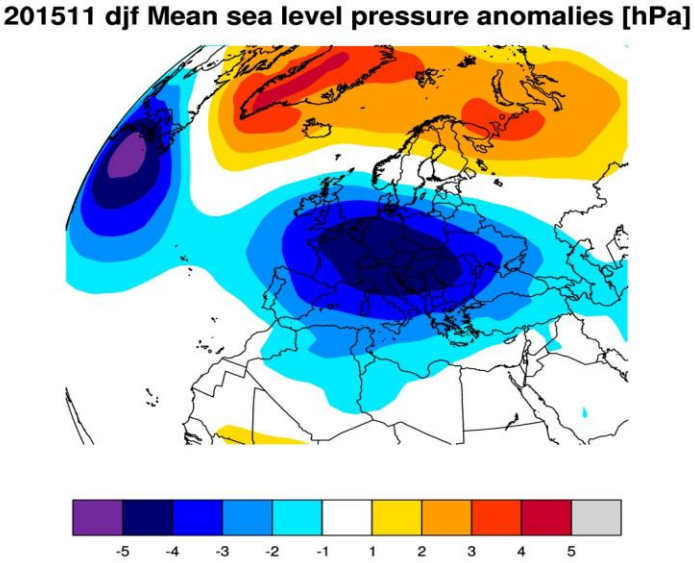


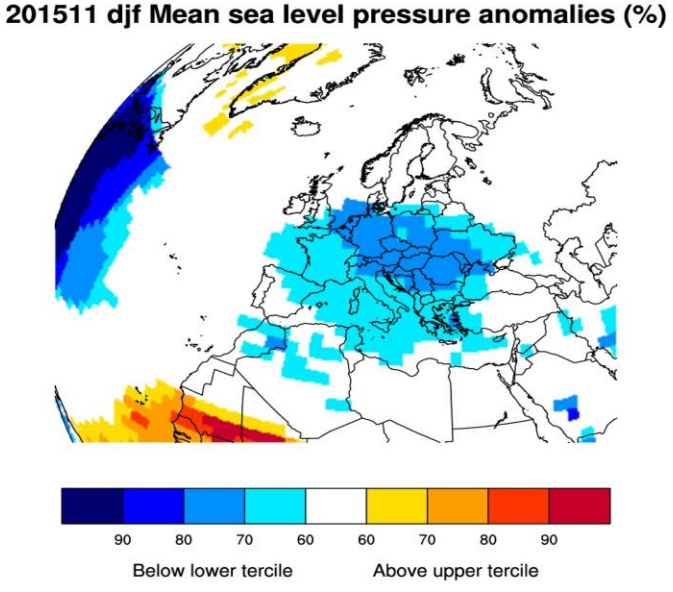
CMCC Forecast: next winter

Predicted NAO index
(Wallace and Gutzler)



Predicted SLP anomaly



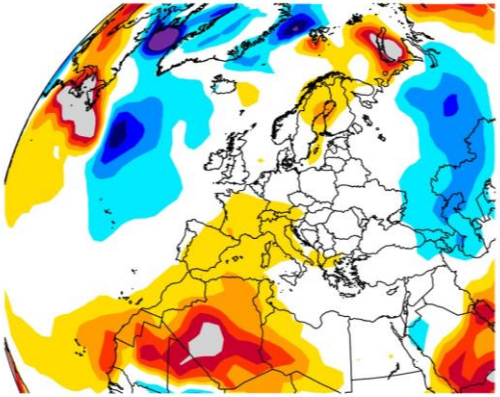


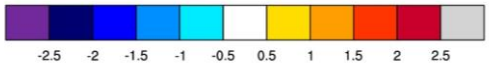
Forecast next winter

2-meter Temperature – start date 1 November

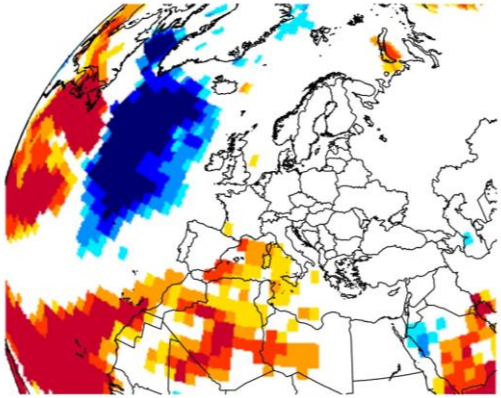
Lead 0

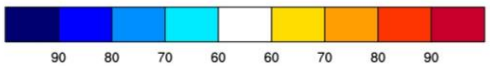
201511 ndj 2 meter Temperature anomalies [°C]





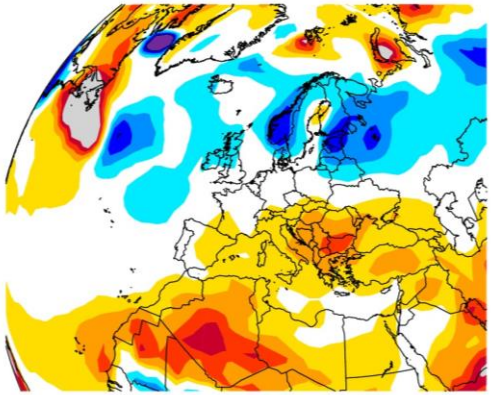
201511 ndj 2 meter Temperature anomalies (%)

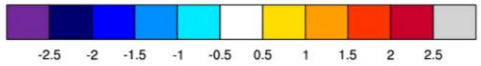




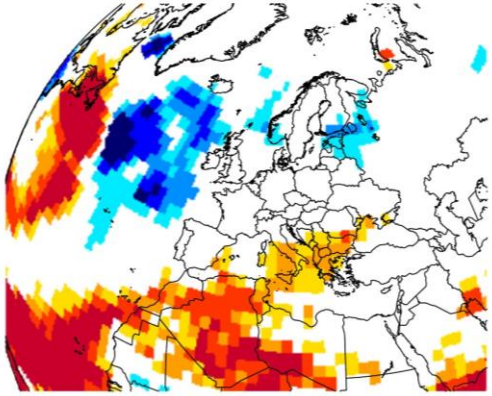
Lead 1

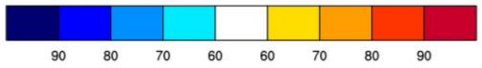
201511 djf 2 meter Temperature anomalies [°C]





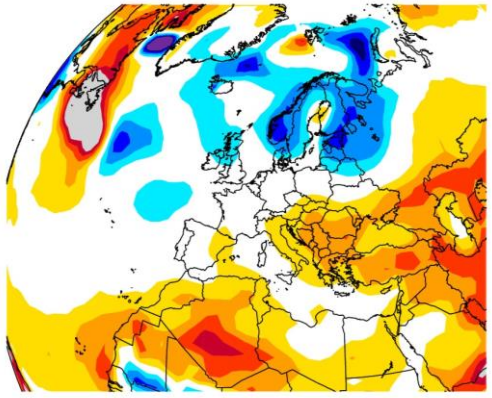
201511 djf 2 meter Temperature anomalies (%)

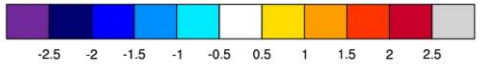




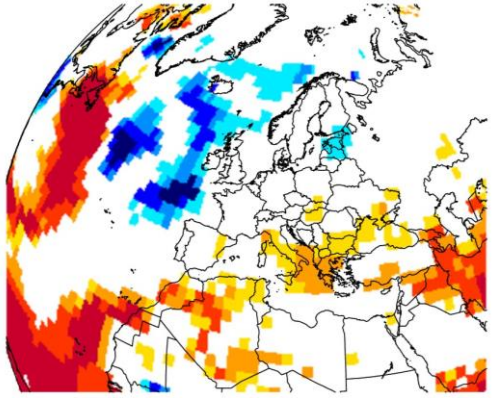
Lead 2

201511 jfm 2 meter Temperature anomalies [°C]





201511 jfm 2 meter Temperature anomalies (%)

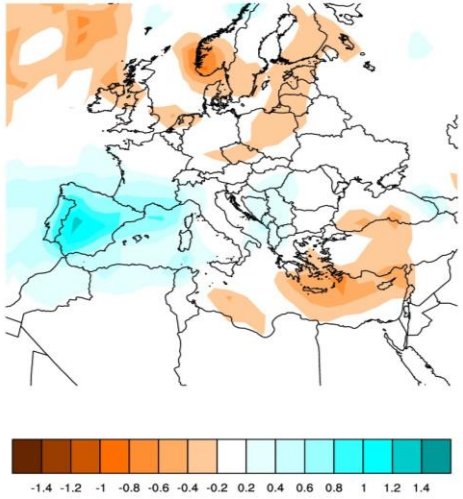


Forecast next winter

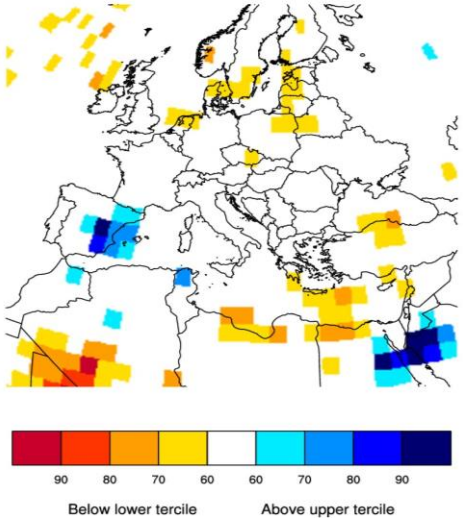
Precipitation – start date 1 November

Lead 0

201511 ndj Precipitation anomalies [mm/day]

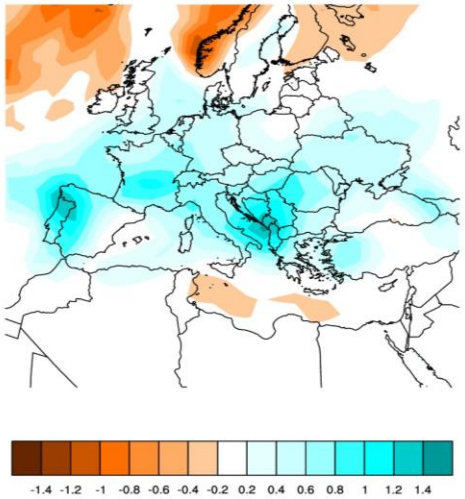


201511 ndj Precipitation anomalies (%)

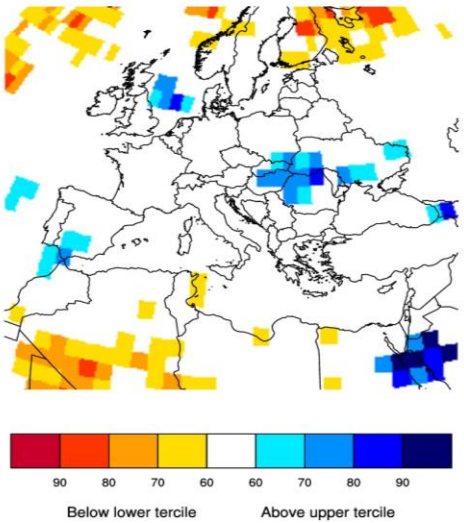


Lead 1

201511 djf Precipitation anomalies [mm/day]

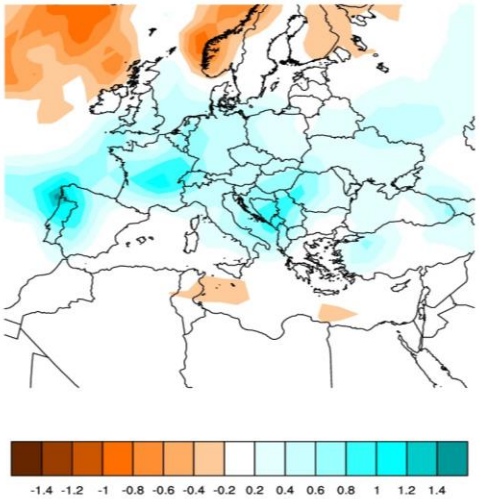


201511 djf Precipitation anomalies (%)

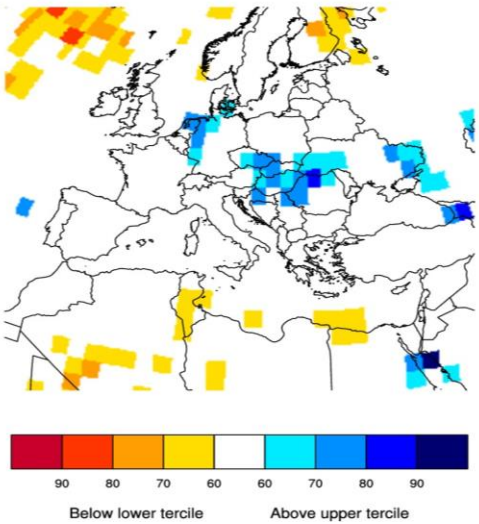


Lead 2

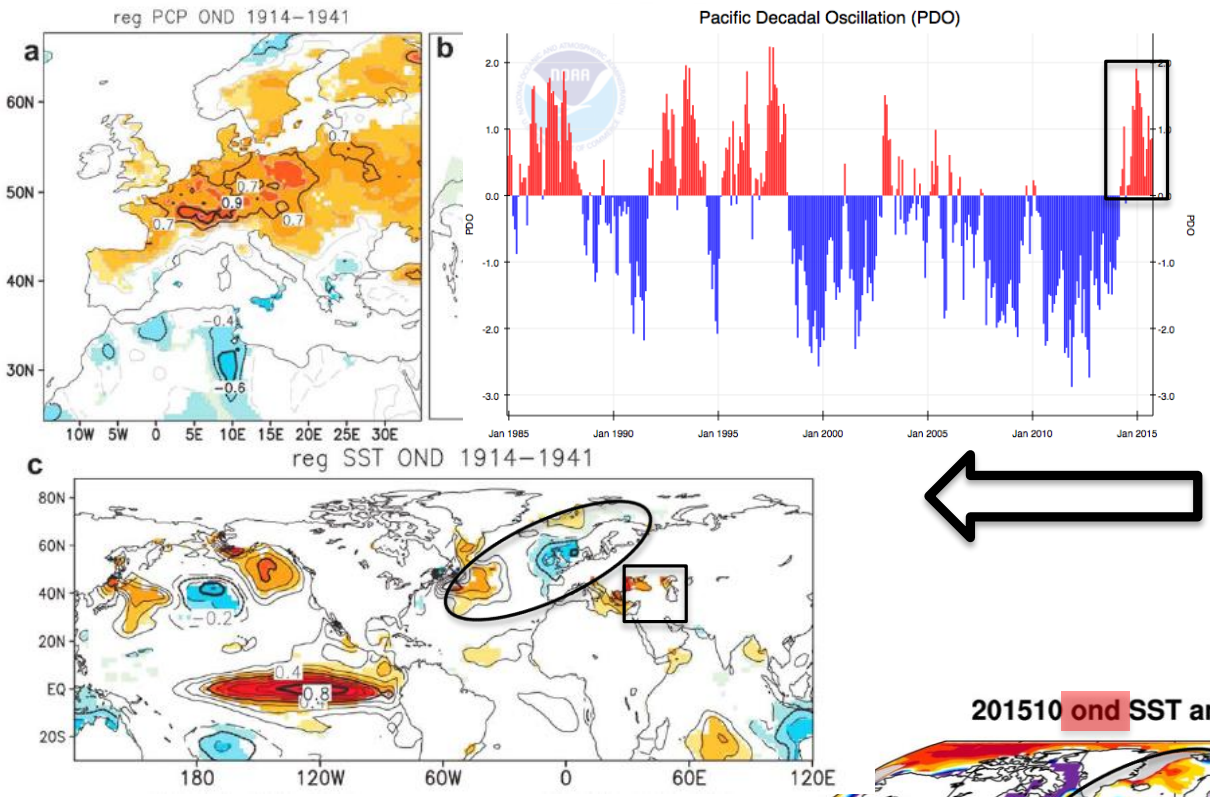
201511 jfm Precipitation anomalies [mm/day]



201511 jfm Precipitation anomalies (%)



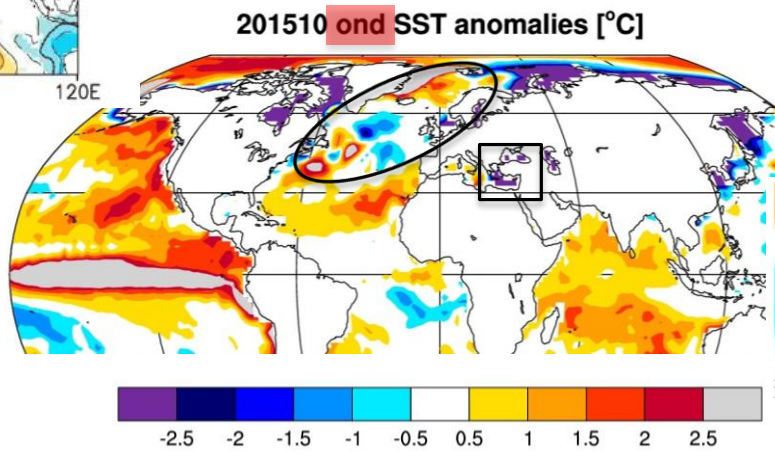
Teleconnection El Niño-Mediterranean

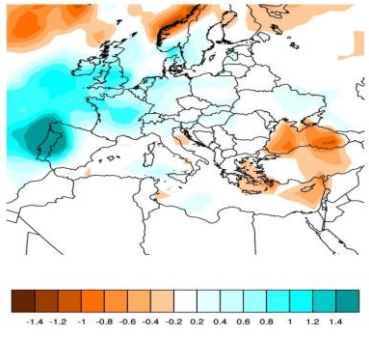


(Parages and Rodriguez, 2012)

Regression of precipitation PC1 in the Euro-Mediterranean area (the domain is shown in panel a. In a PDO+ phase like the current, negative (positive) anomalies of precipitation in Southern (Northern) Europe are linked to a central-east El Nino event and a SST tripole in the Atlantic

A positive precipitation anomaly associated with the El Nino signal was forecasted for the OND season. The CMCC-SPSv2 has predicted a SST structure in the Atlantic similar to that expected in a PDO+ phase, while an opposite anomaly was forecasted for the Eastern Mediterranean.





The new CMCC Seasonal Prediction System

From the CMCC SPSv2 to the SPSv3:
How we do plan to improve our SPS:

1. **Improving the climate model**
2. **Improving the initialization strategy**
3. **Increasing the size of the forecast ensembles**

The new CMCC-SPSv3: **improving the climate model**

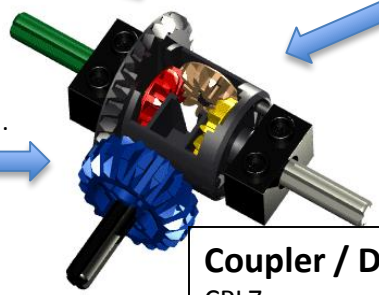
Atmosphere
Community Atmosphere Model
CAM5.3 (1°x1° - 46 v. lev)

30 min.

30 min.

Land / Vegetation
Community Land Model
CLM4.5 (1°x1°)

30 min.



River routing
River Transport Model
RTM (0.5°x0.5°)

Coupler / Driver
CPL7

30 min.

1.5 hrs

Ocean
Nucleus for European Modelling of the Ocean
NEMO 3.4
(1/4°x1/4° - 50 v. lev.)

Sea Ice
Community Ice Code
CICE4 (1/4°x1/4°)

Main novelties:

- **New model components**

- **Increased atmospheric resolution** (both horizontal and vertical)

- **Increased oceanic resolution** (both horizontal and vertical)

Proposed Scientific and Technical Solutions

The new CMCC-SPSv3: **improving the initialization strategy**

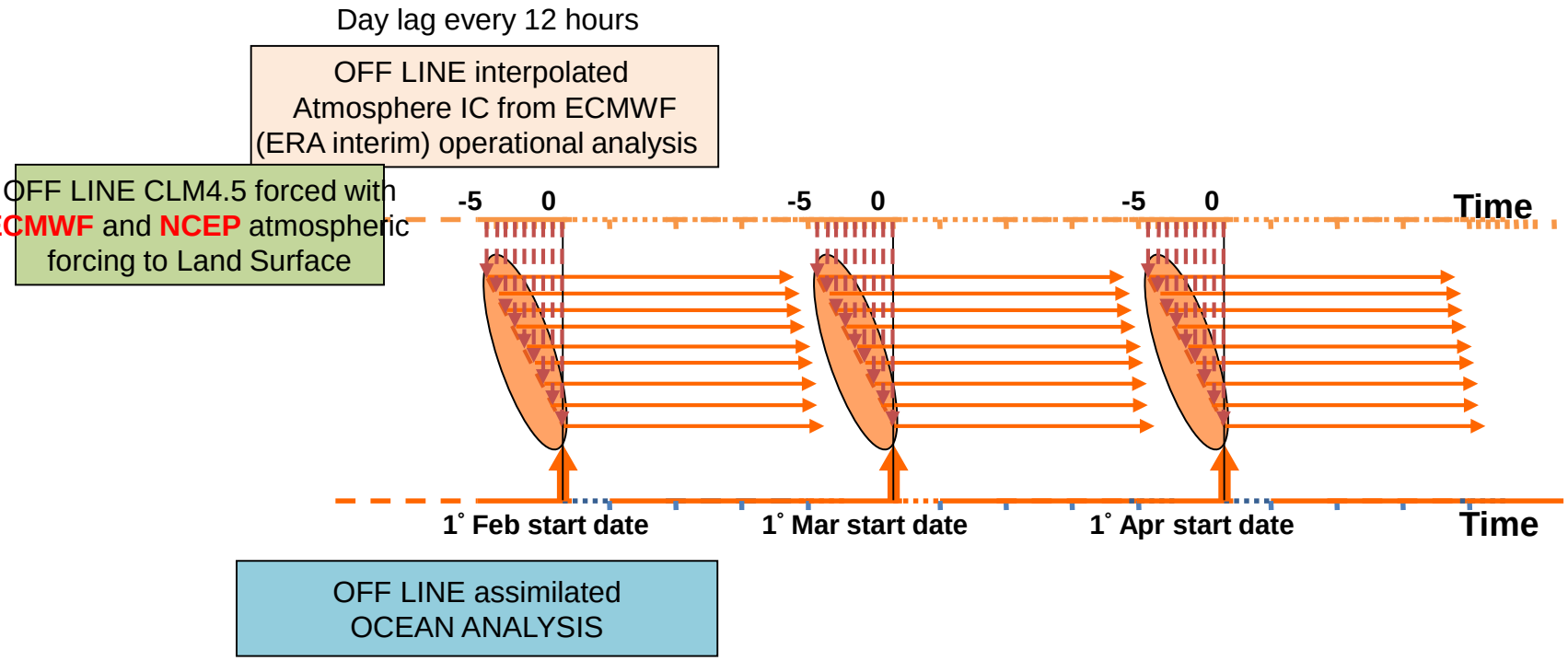
Atmosphere: initialized with **ECMWF operational analyses**, whereas in the re-forecasts (1993-2016) atmospheric initial conditions are generated using the ERA-Interim re-analyses.

Land surface: Land Data Assimilation System approach (Koster, R. D , J. Climate 2009), i.e. **initialization from land analyses performed with the land-surface model forced with meteorological fields** (four times a day) from NCEP/NCAR and ECMWF analyses. Restart of the first day of the month used as initial condition for the forecast.

Ocean (sea-ice): ocean and sea-ice initial conditions provided by the eddy-permitting **global ocean analyses system developed and produced at CMCC**, C-GLORS (Storto et al. QJRMS 2015), with NEMO at ¼ degree resolution, with 50 vertical levels with partial steps and coupled to the LIM2 sea-ice model.

Proposed Scientific and Technical Solutions

The new CMCC-SPSv3: **increasing the forecast ensemble size**



- 3 perturbations for the land surface
- 9 perturbations for the atmosphere
- 8 perturbations for the ocean

216 ICs → **80 forecast members**

Thank you

Some references of the CMCC Seasonal Prediction System:

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