CMCC Seasonal Outlook

Winter 2018-19

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Stefano Materia, Enrico Minguzzi, Antonio Navarra,
Stefano Tibaldi
+ contribution from the ODA Division

The new CMCC operational seasonal prediction system
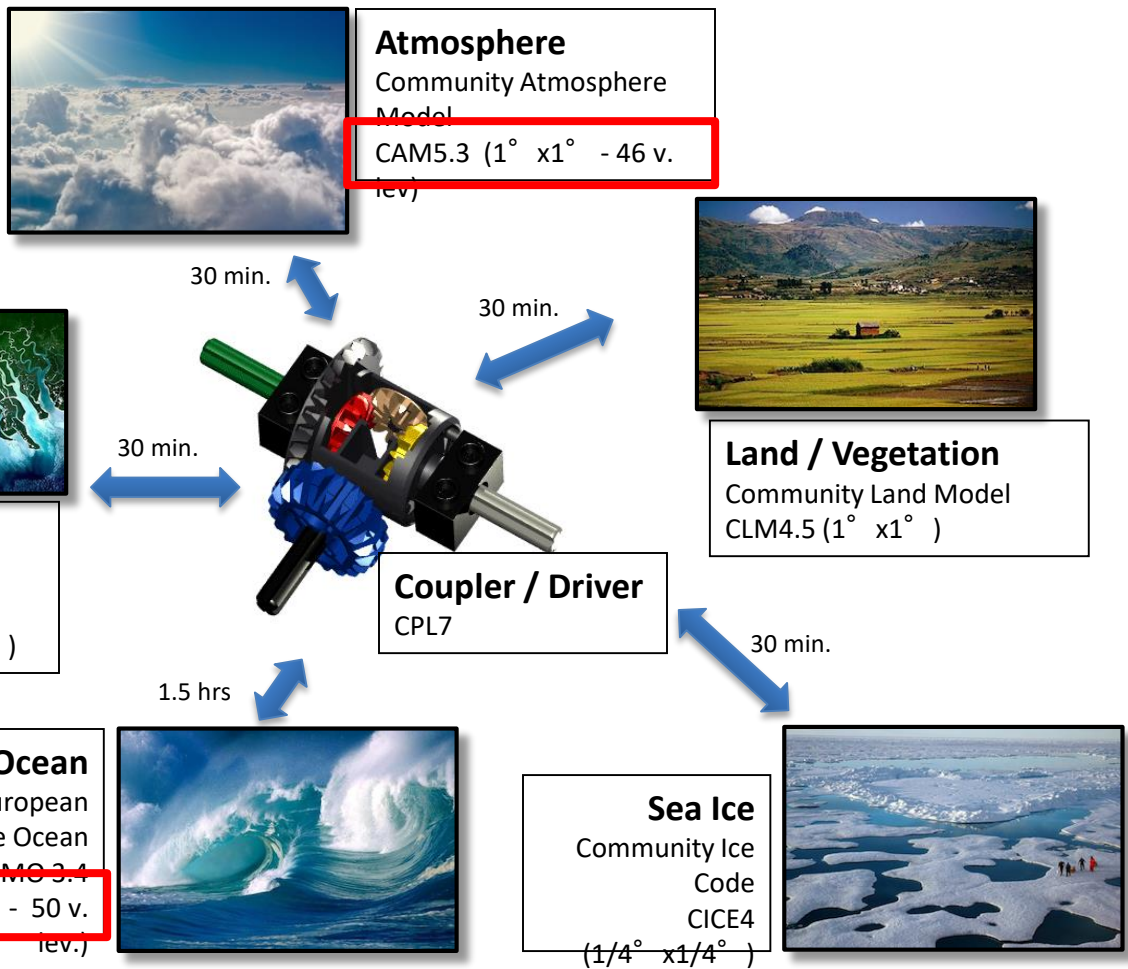
From the CMCC SPSv2 to the SPSv3

1. Improving the climate model

2. Improving the initialization strategy

3. Increasing the size of the forecast ensembles

The new SPS.v3

Improving the climate model

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

30 min.

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

30 min.

30 min.

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

Coupler / Driver
CPL7

1.5 hrs

30 min.

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)

The new SPS.v3

Improving the climate model

Ocean: OPA → NEMO and 2° → 1/4°

OLD system

New system

Ocean Surface Currents
ORCA2 – 201501 Monthly Mean

Ocean Surface Currents
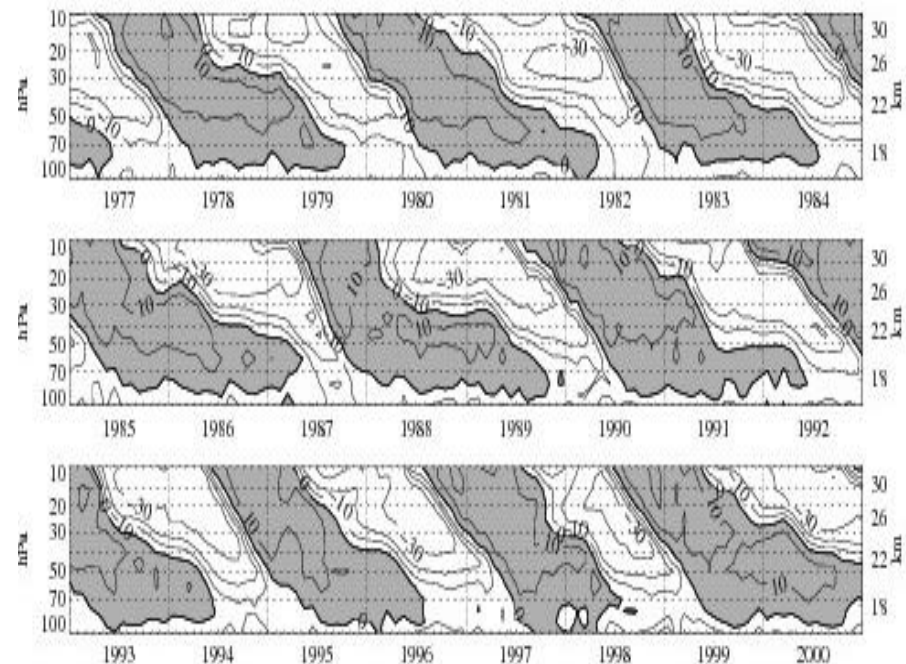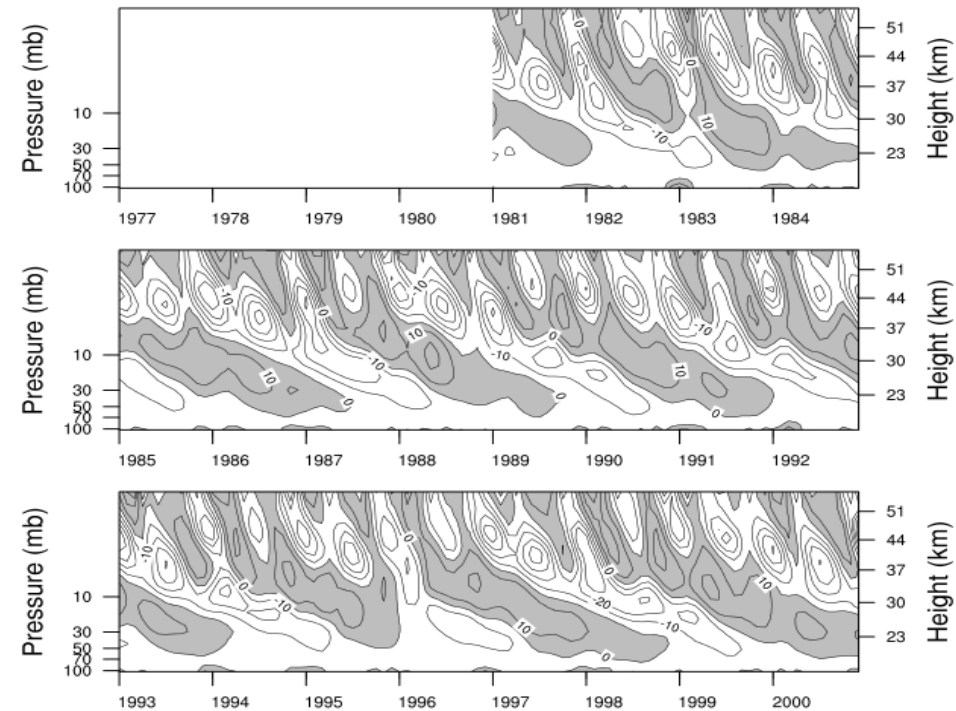ORCA025 – 201501 Monthly Mean
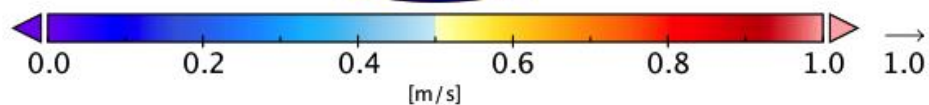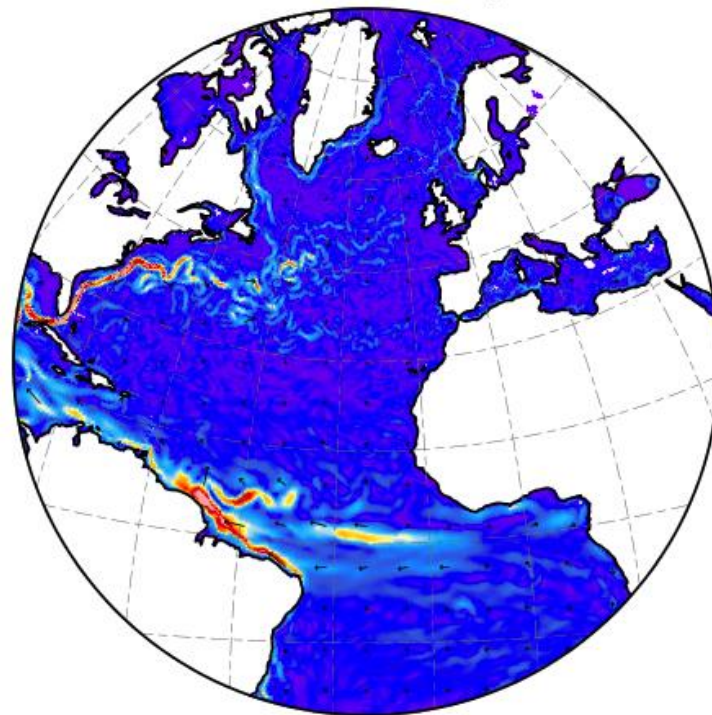
The new SPS.v3

Improving the climate model

Atmosphere: CAM5 version used has a modified vertical grid with 46 levels and a model top at 0.3 hPa, producing a **QBO period similar to observations in the lower stratosphere**.

Model

Observations

The new SPS.v3

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 → **9 atmospheric I.C.**.

Land surface:

• **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. Both for the forecasts and for the re-forecasts (1993-2016) → **3 land I.C.**

Ocean (sea-ice)

• eddy-permitting **global ocean analyses system developed and produced at CMCC**, C-GLORS (Storto et al. 2015), with NEMO at ¼ degree resolution, with 50 vertical levels with partial steps and coupled to the LIM2 sea-ice model → **8 oceanic I.C.**

A set of 216 (= 8*9*3) initial states generated and **50 ICs randomly selected from this set**

Increasing the forecast ensemble size

Day lag every 12 hours

OFF LINE interpolated Atmosphere IC from ECMWF (ERA interim) operational analysis

OFF LINE CLM4.5 forced with **ECMWF** and **NCEP** atmospheric forcing to Land Surface

-5   0   -5   0   -5   0   **Time**

1° Feb start date   1° Mar start date   1° Apr start date   **Time**

OFF LINE assimilated OCEAN ANALYSIS
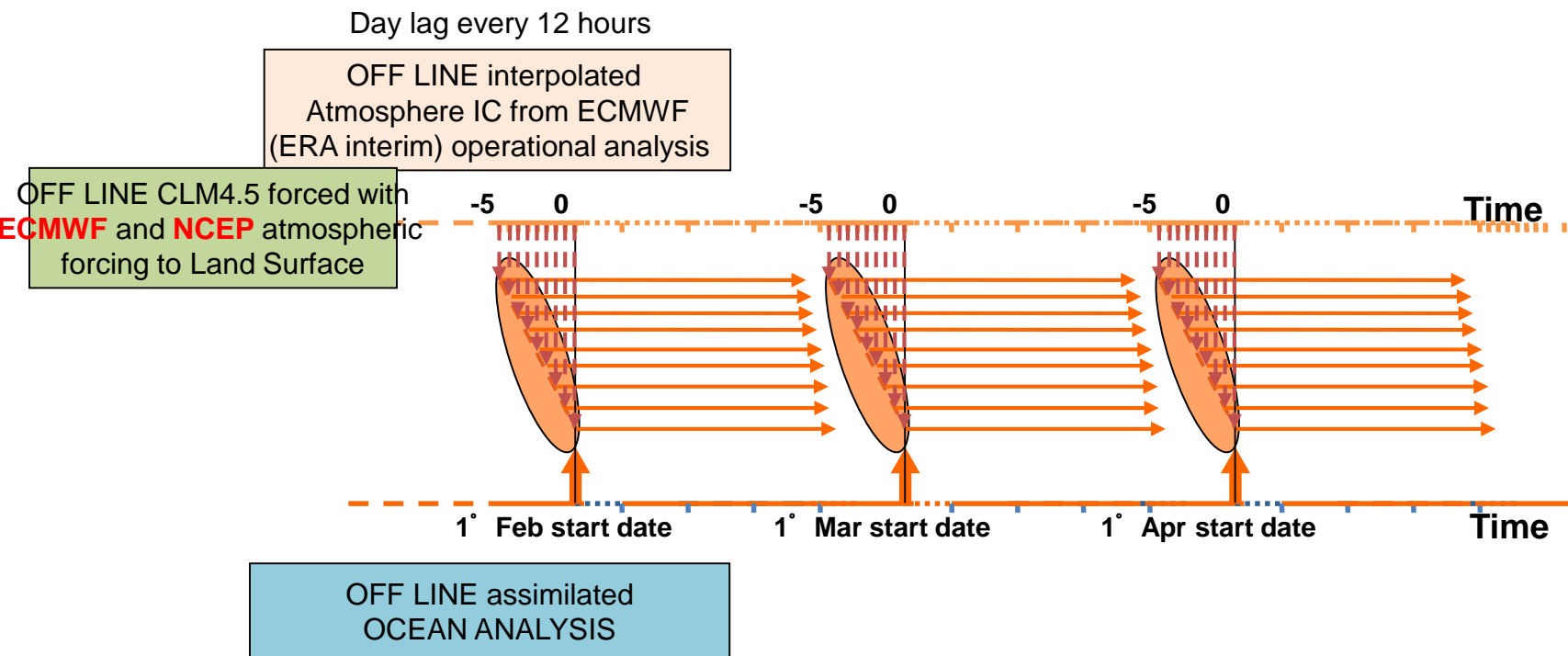
- 3 perturbations for the land surface
- 9 perturbations for the atmosphere
- 8 perturbations for the ocean

216 ICs ➡

50 forecast members

40 re–forecast members

The new SPS.v3

T2m **Anomaly Correlation** (predicted and observed anomalies 1993–2016)
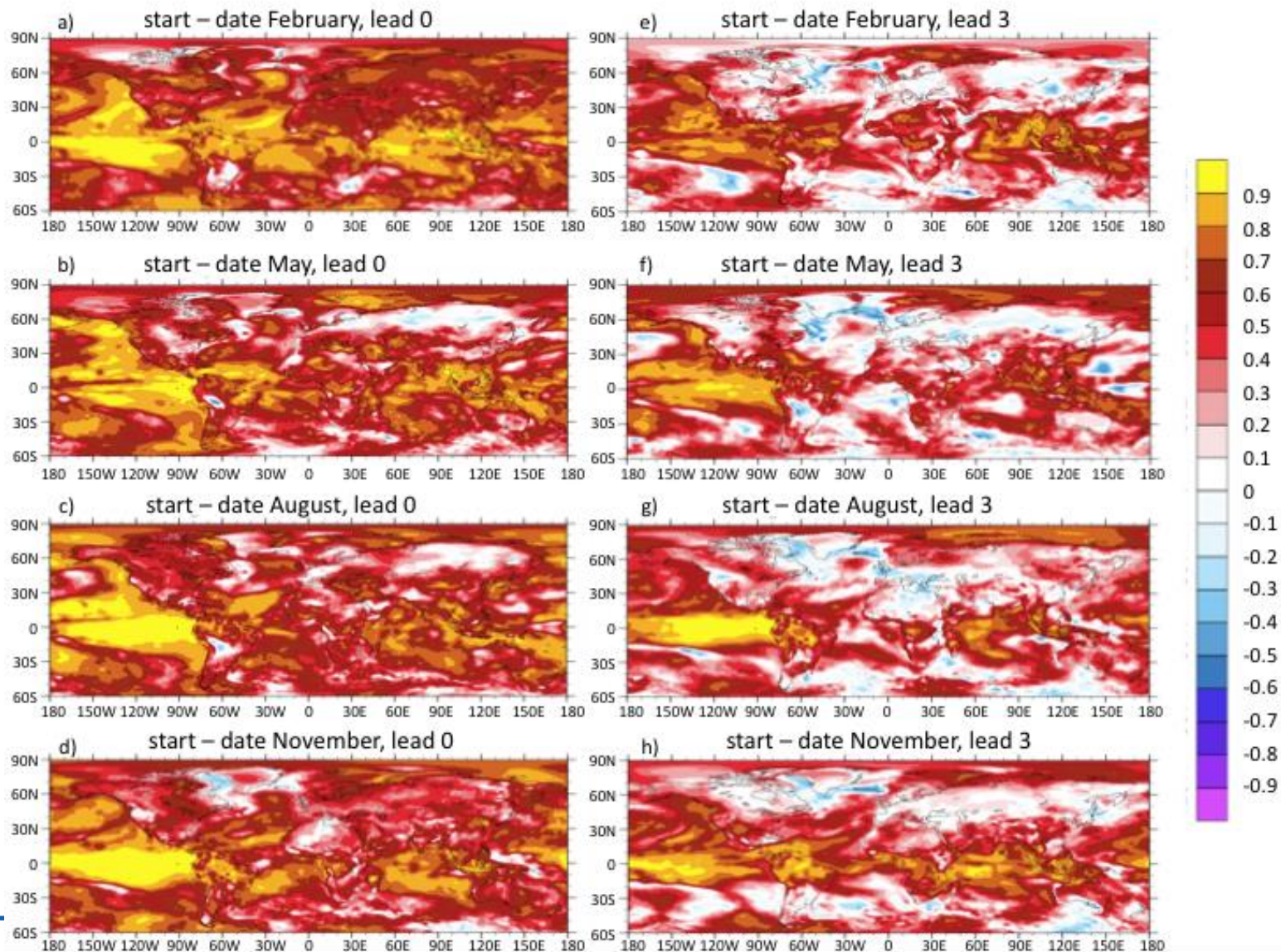
The new SPS.v3

Prec Anomaly Correlation (predicted and observed anomalies 1993–2016))
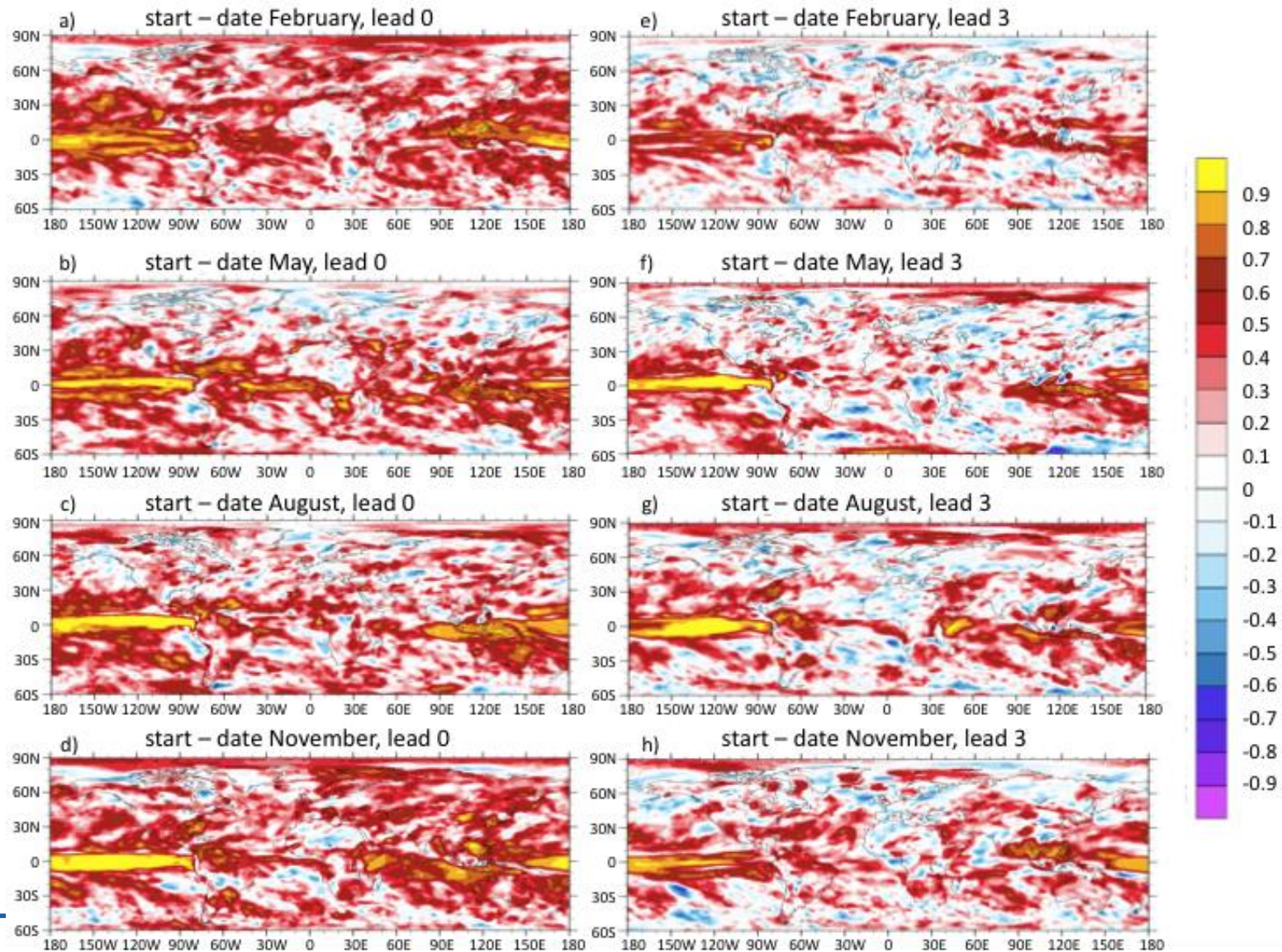
The new SPS.v3

T2m Relative Operating Characteristics (ROC) Score 1993–2016
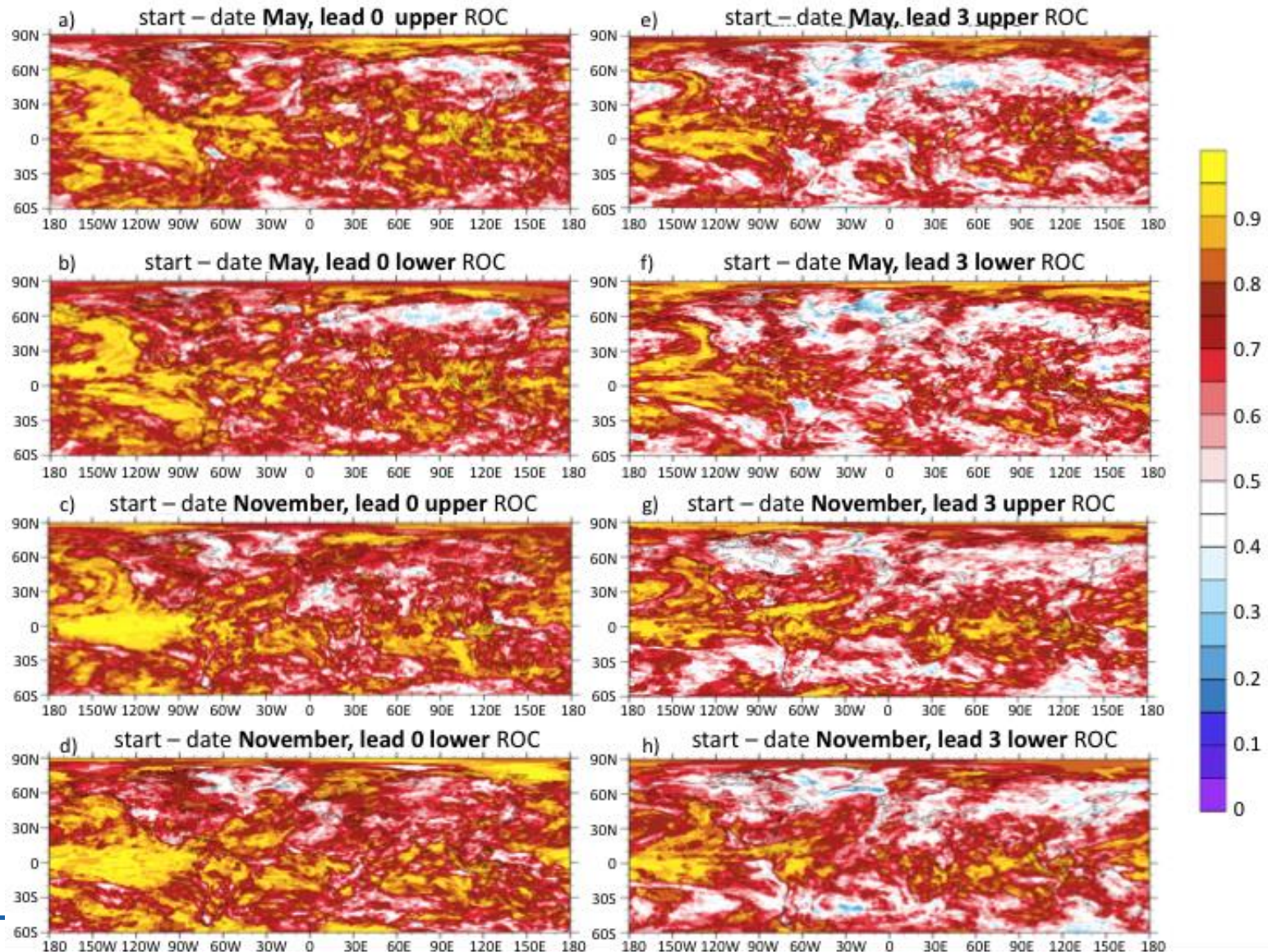
The new SPS.v3

Prec Relative Operating Characteristics **(ROC) Score** <u>1993–2016</u>
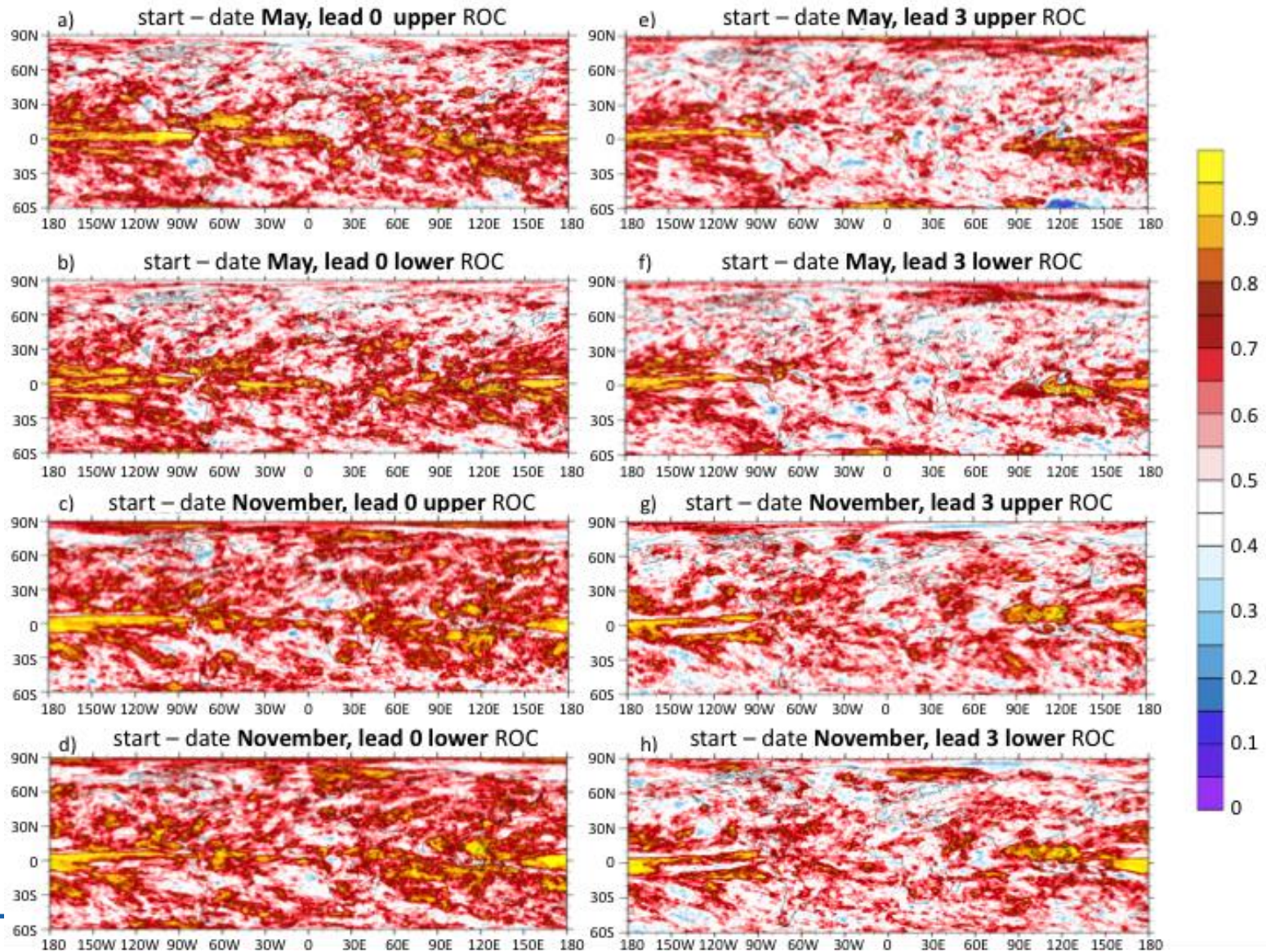
The new SPS.v3

ROC score – November start date

Below lower tercile
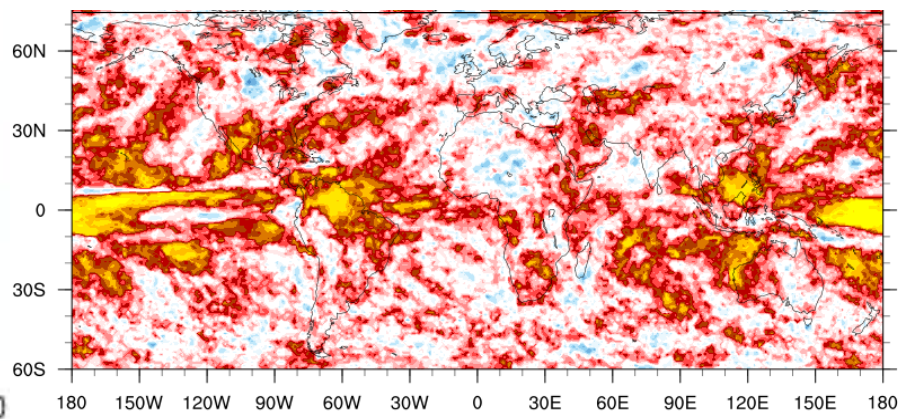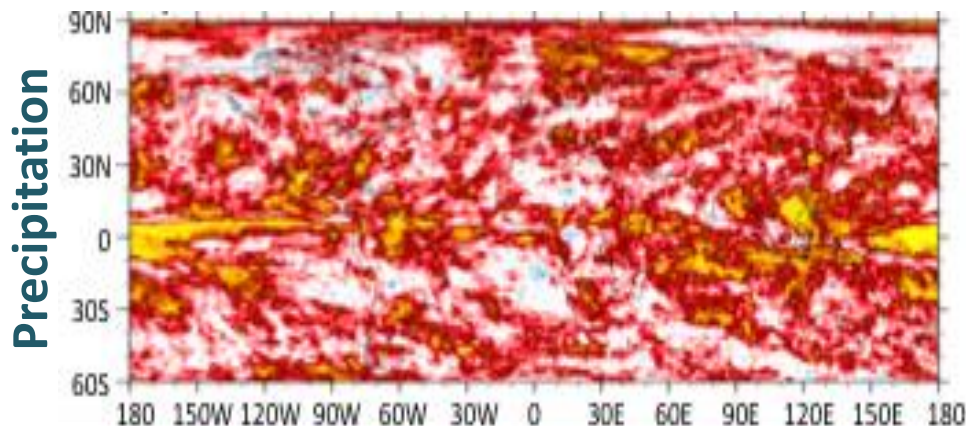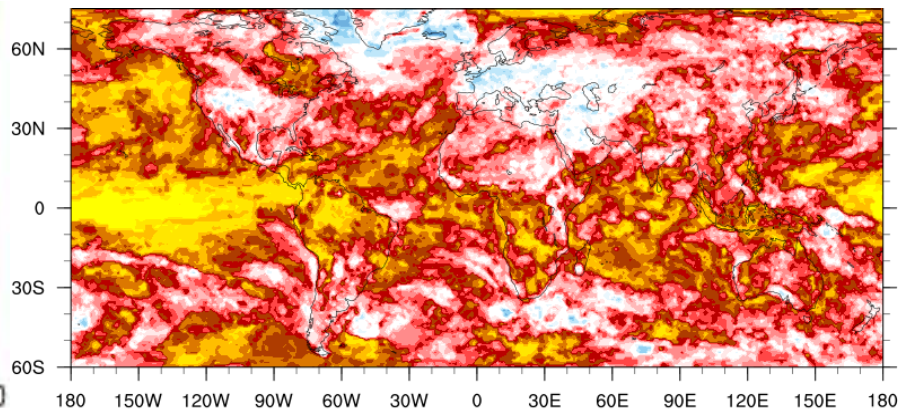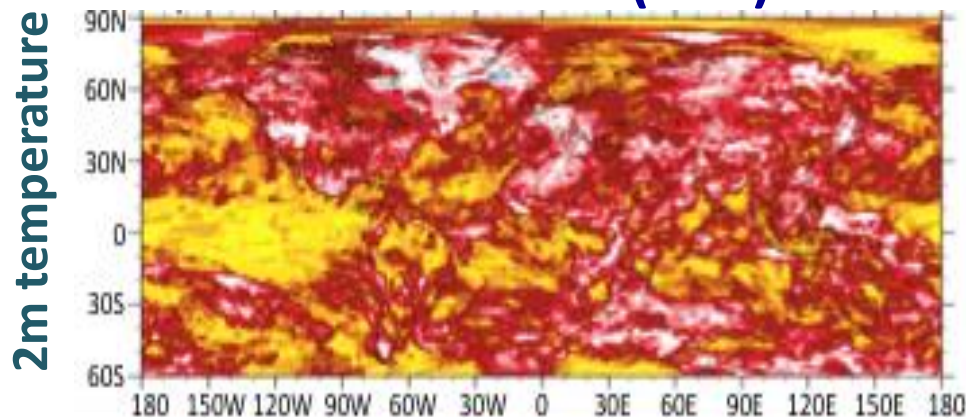
The new SPS.v3

ROC score – November start date

Above upper tercile
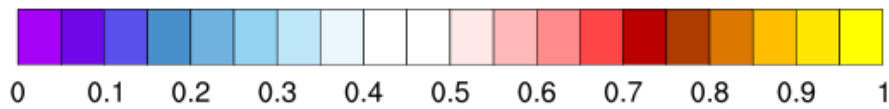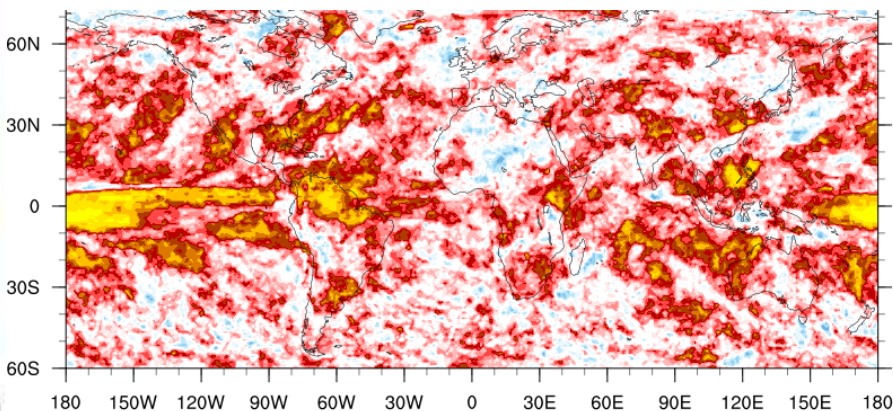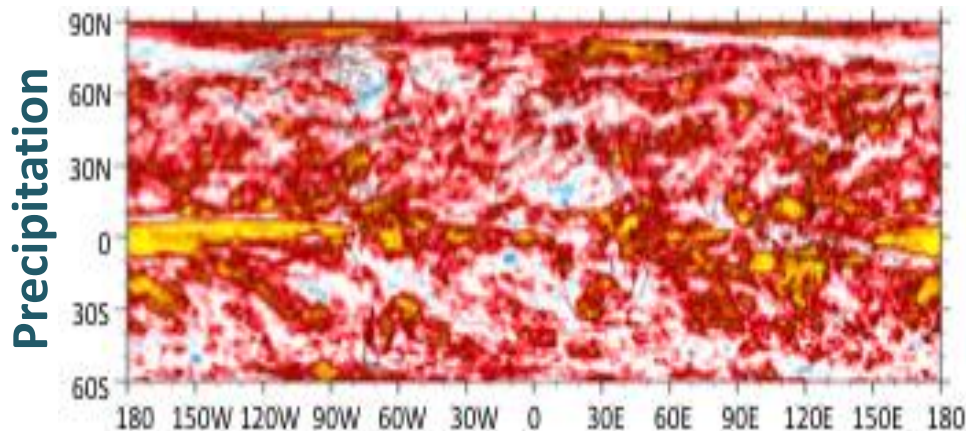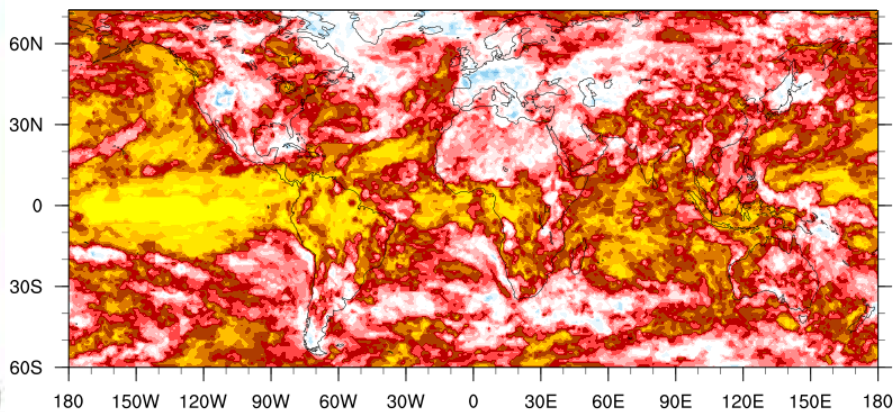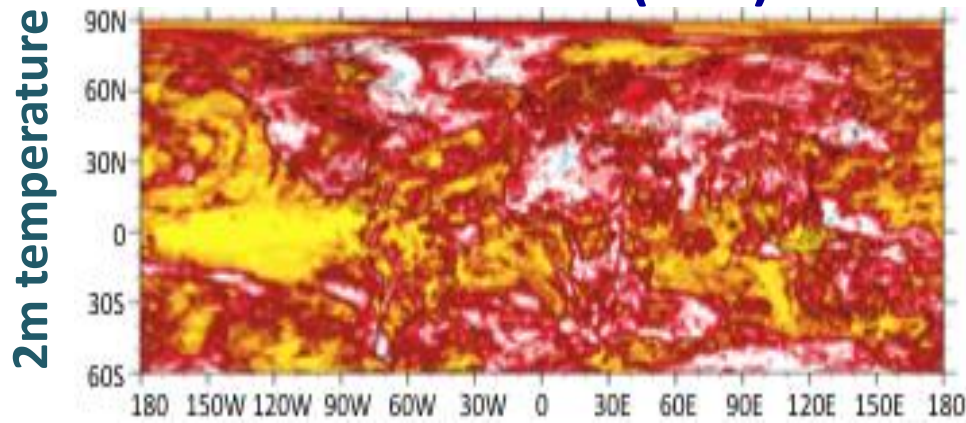
The new SPS.v3

Hindcasts (**1993–2016**) of the **SST–NINO3.4** index against observed index (ERA-Interim)
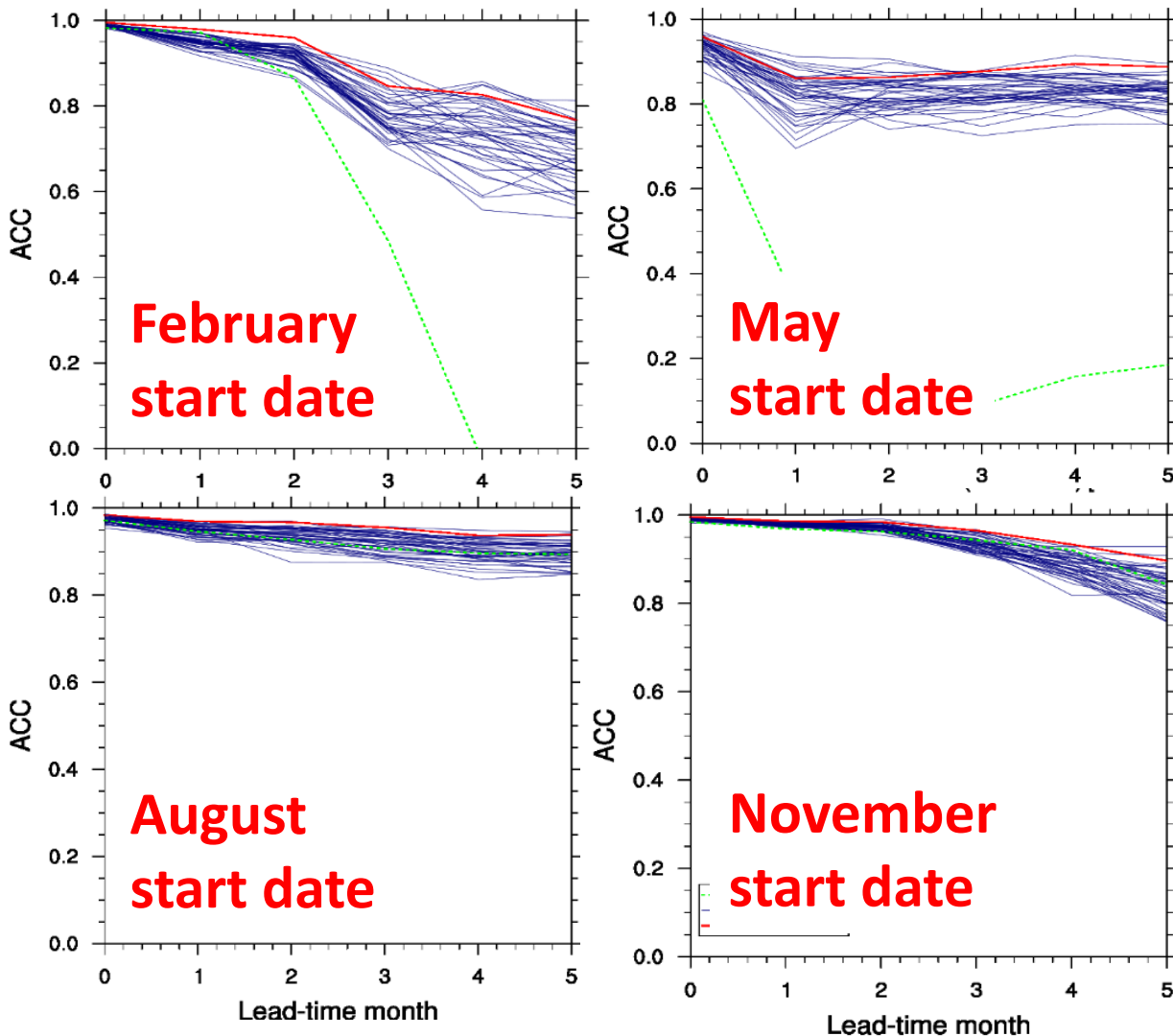
SST anomalies in the NINO 3.4 region
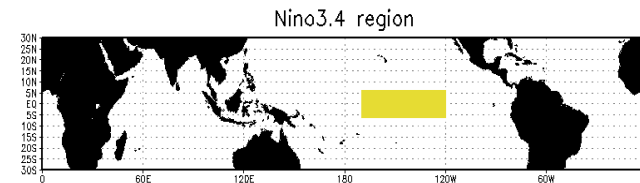
Persistence
SPS3
SPS3 ens. mean

The new SPS.v3

Hindcasts (**1993–2016**) of the <u>**DJF NAO**</u> index (<u>**Nov.**</u> start date) against the respective observed index (ERA-Interim).

NAO

r(1993-2016) = 0.30   r(1997-2011) = 0.50

— ERA-Interim
— CMCC-SPS3
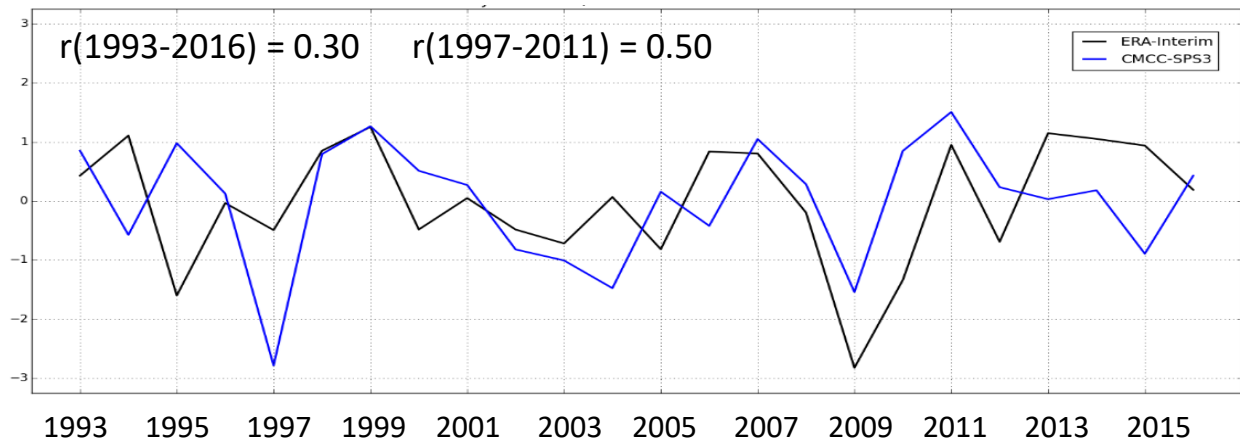
$ERA - Interim$

$CMCC - SPS3$

Hindcasts (**1993–2016**) of the <u>**DJF PNA**</u> index (<u>**Nov.**</u> start date) against the respective observed index (ERA-Interim).
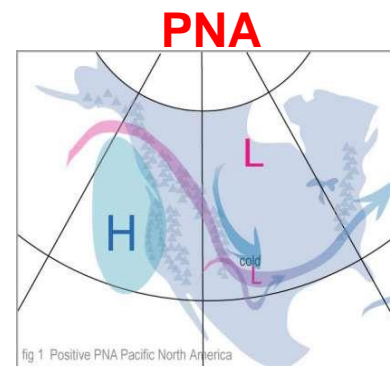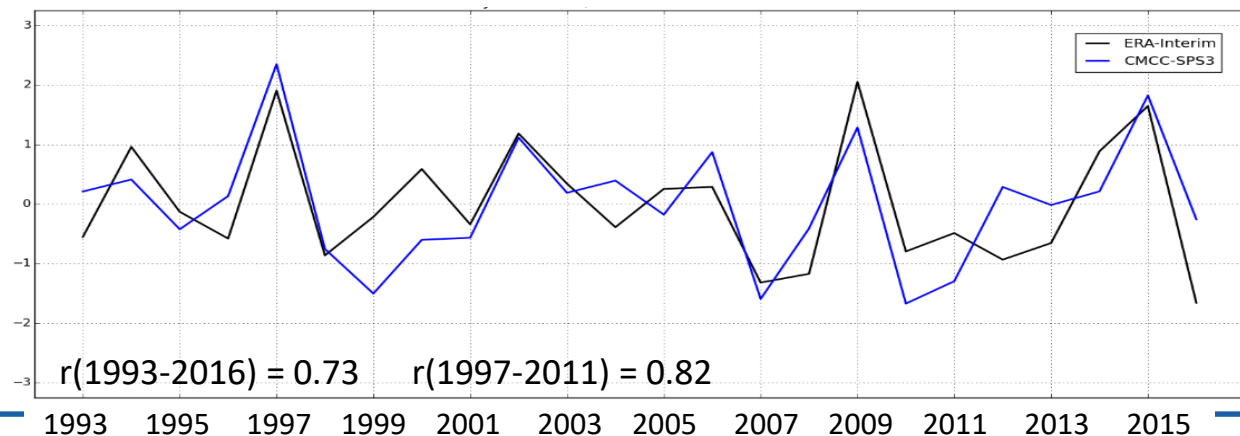
PNA

— ERA-Interim
— CMCC-SPS3

r(1993-2016) = 0.73   r(1997-2011) = 0.82

fig 1 Positive PNA Pacific North America
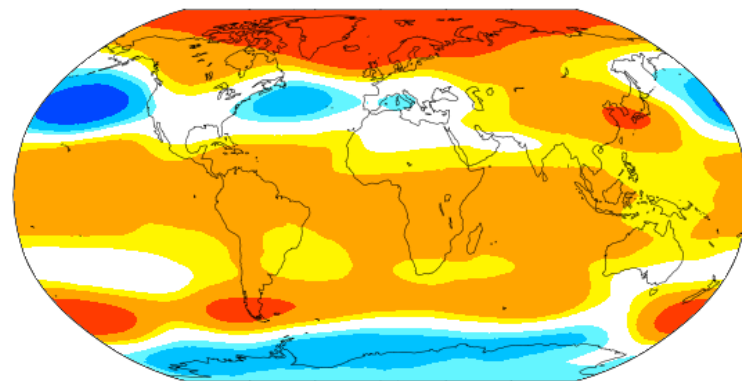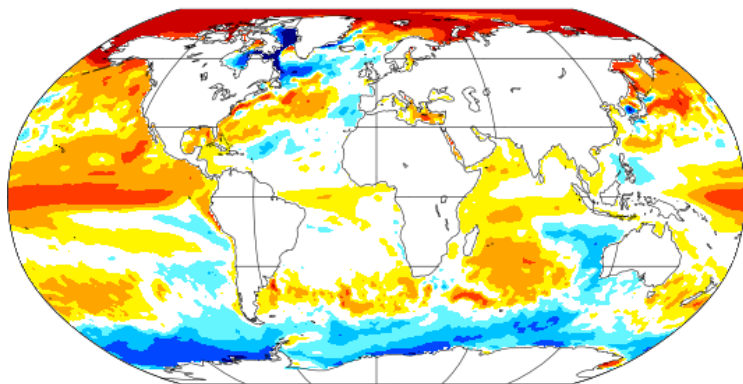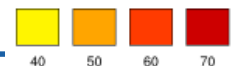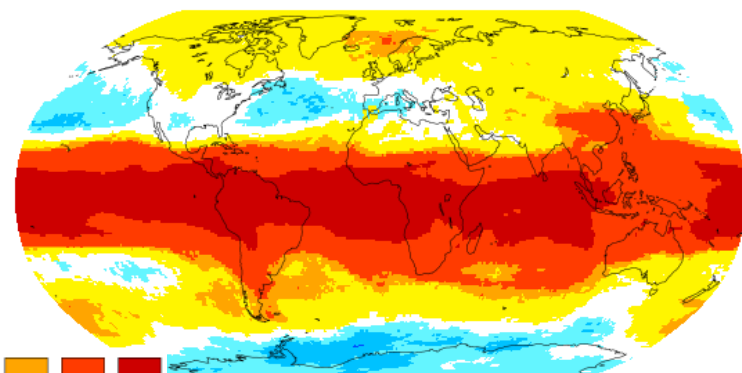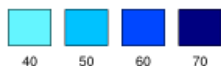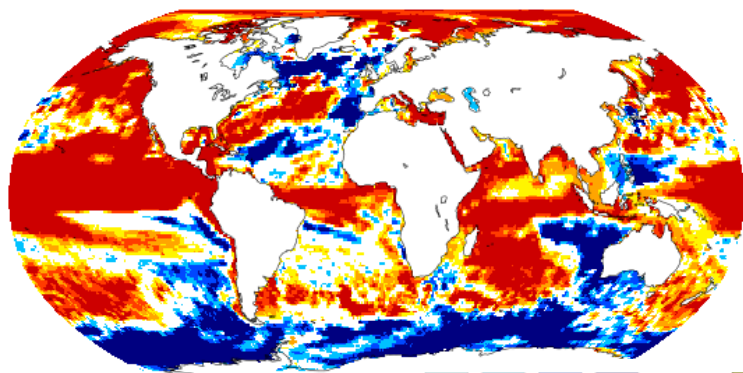
CMCC Seasonal Outlook – winter 2018-19

November start date   **Lead 1 (DJF)**

CMCC Seasonal Outlook – winter 2018-19

November start date   **Lead 1 (DJF)**
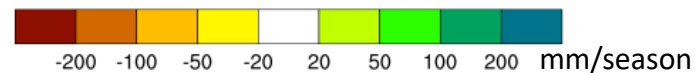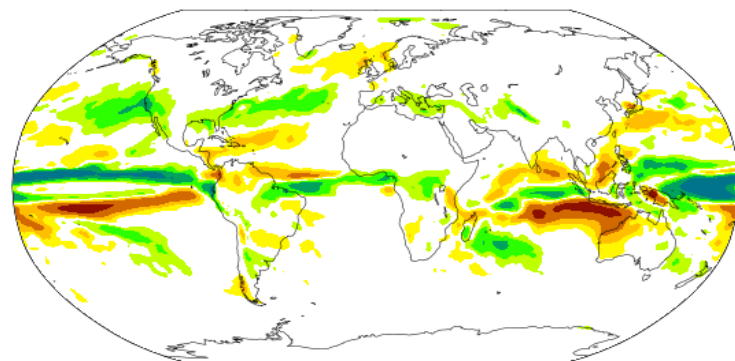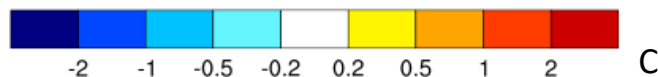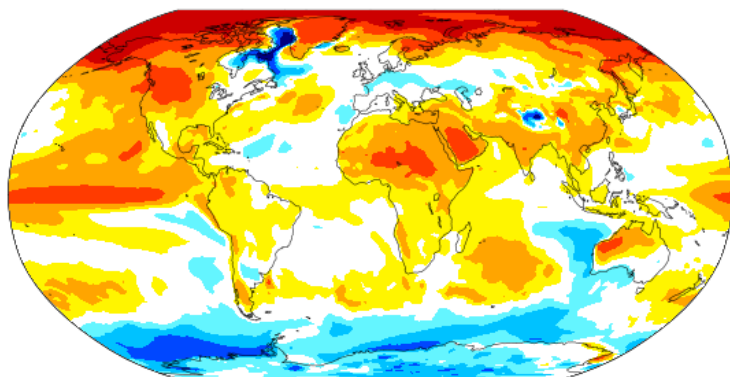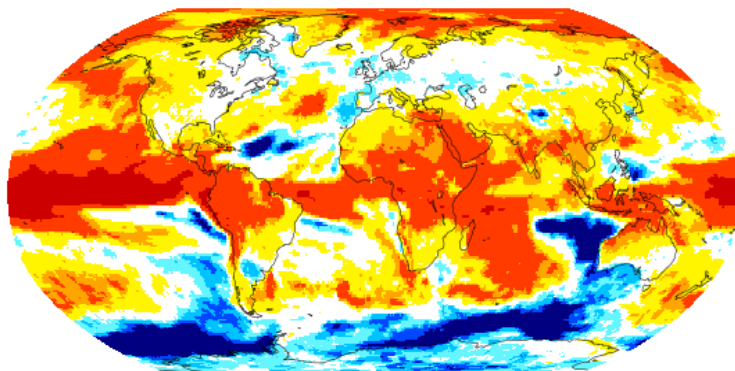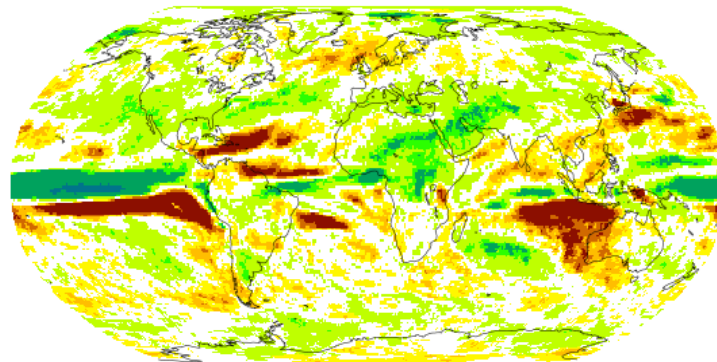
CMCC Seasonal Outlook – winter 2018-19
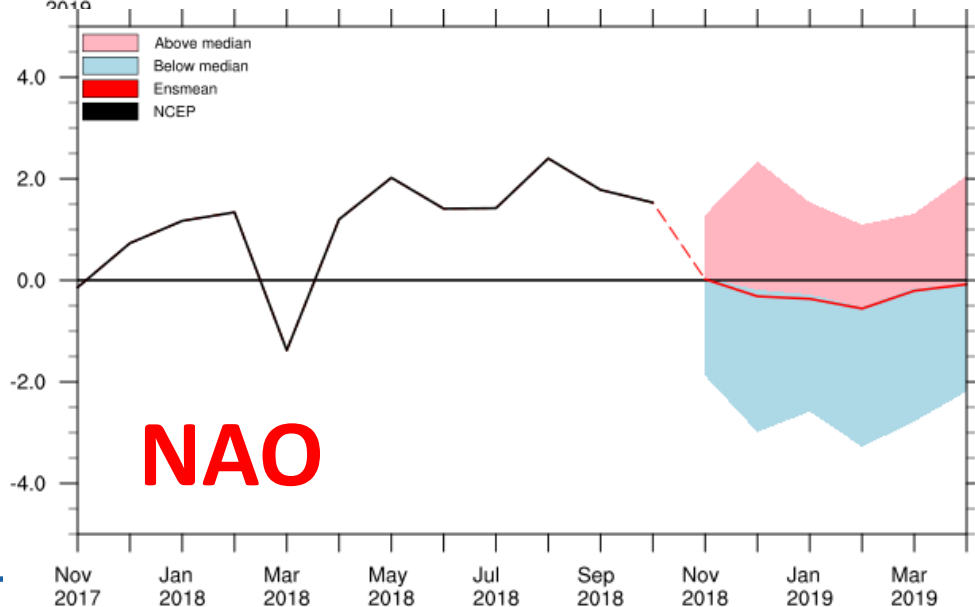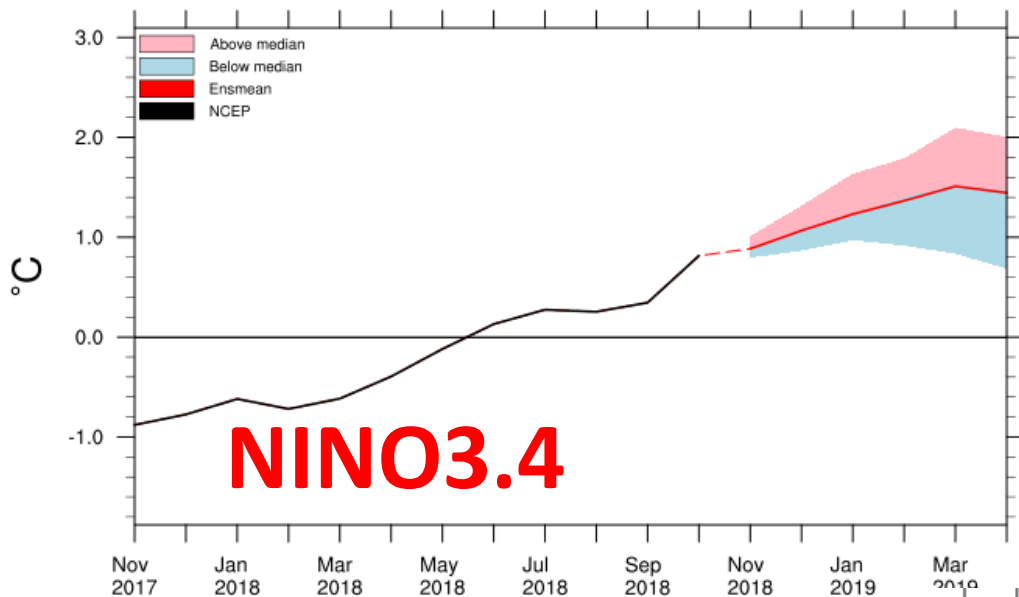
CMCC Seasonal Outlook – winter 2018-19

start date November   NDJ Lead 0

Z500

T2m

Precip
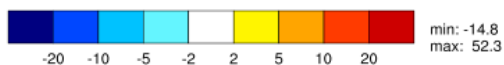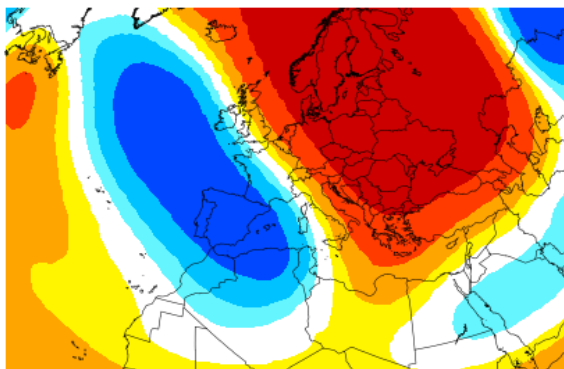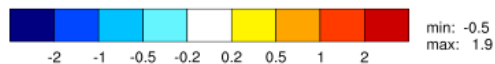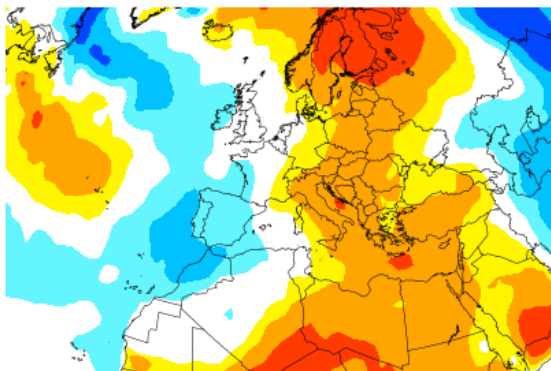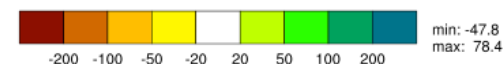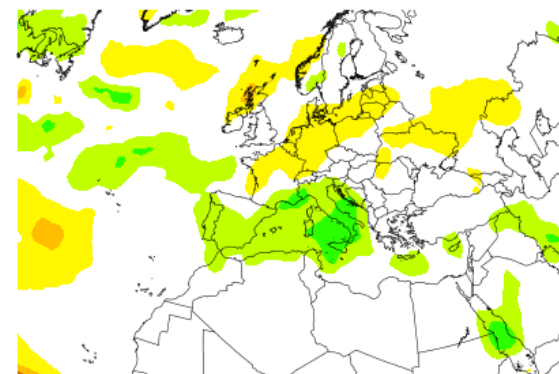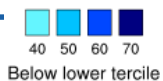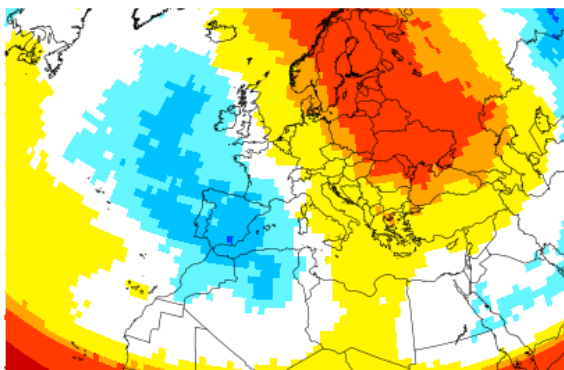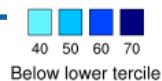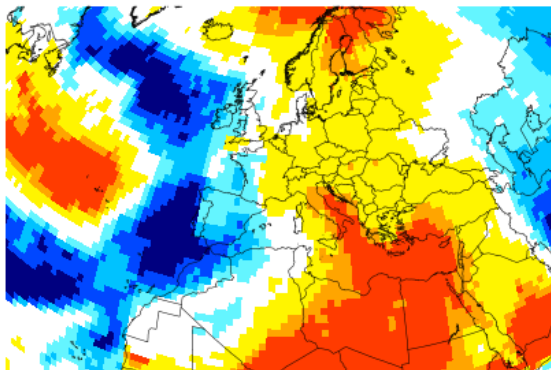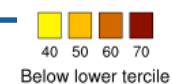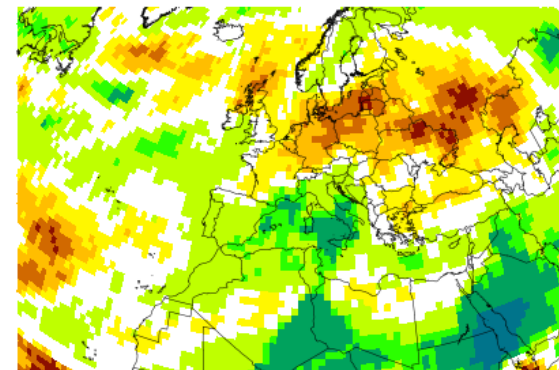
CMCC Seasonal Outlook – winter 2018-19
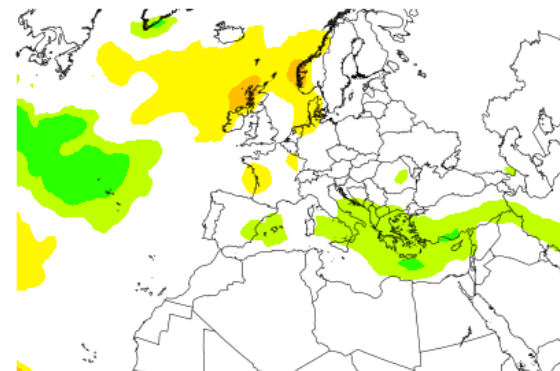
start date November — **DJF Lead 1**
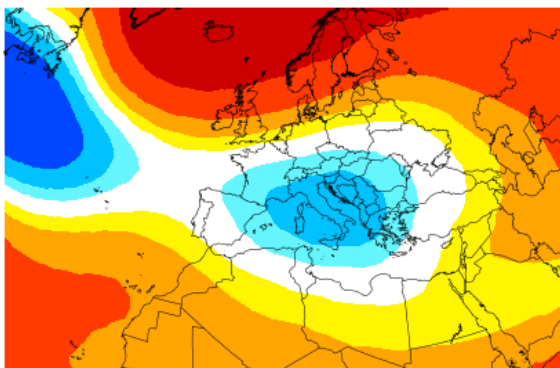
Z500   T2m   Precip
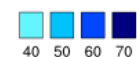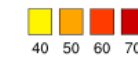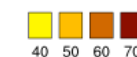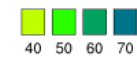
CMCC Seasonal Outlook – winter 2018-19

start date November   JFM Lead 2

Z500   T2m   Precip
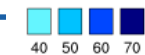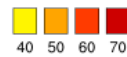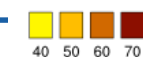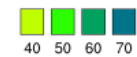
CMCC Seasonal Outlook – winter 2018-19
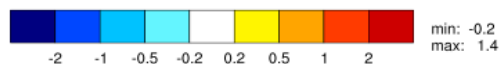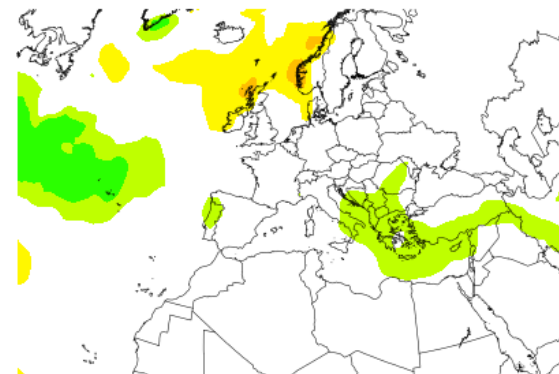
start date November SST DJF Lead 1
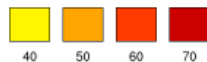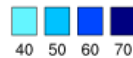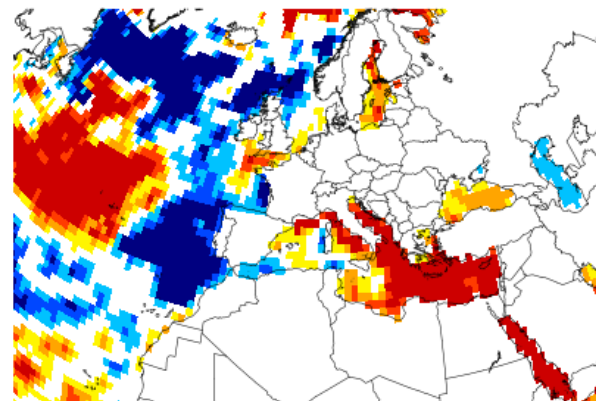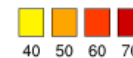
Thanks

Summary 1

➢ The **new CMCC seasonal prediction system** (SPS) has been illustrated.

➢ The new CMCC seasonal prediction system is part of the **Copernicus C3S pre-operational multi – model system** and it will become **operational very soon** (next few weeks).
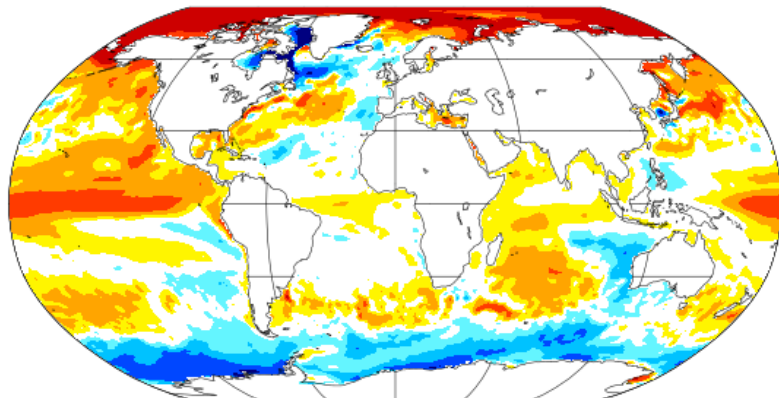
➢ An extensive **analysis of the performance of the new SPS is on going**.

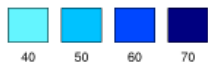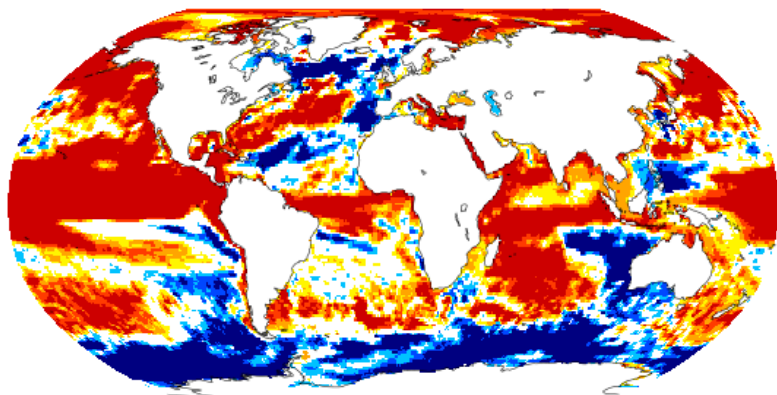➢ Very preliminary results indicate that **improving** the model components and their **resolution, the initialization and the ensemble size lead to better predictions**.

➢ There is **room for improvement, especially for the land–surface model and its initialization**

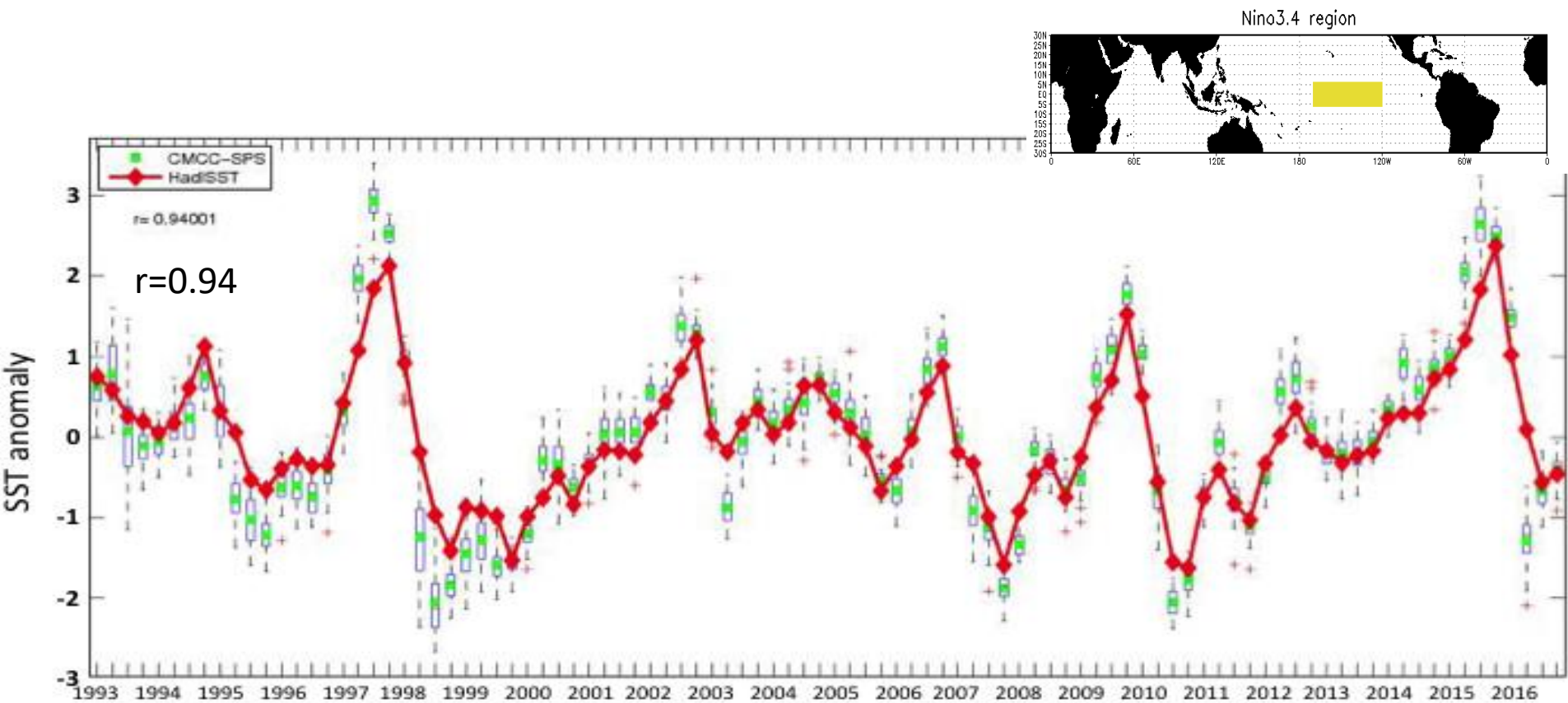➢ We are designing sensitivity experiments and targeted analysis aimed at improving understanding of sources of predictability and how to provide better information and data on climate variability at seasonal to multiannual timescales.
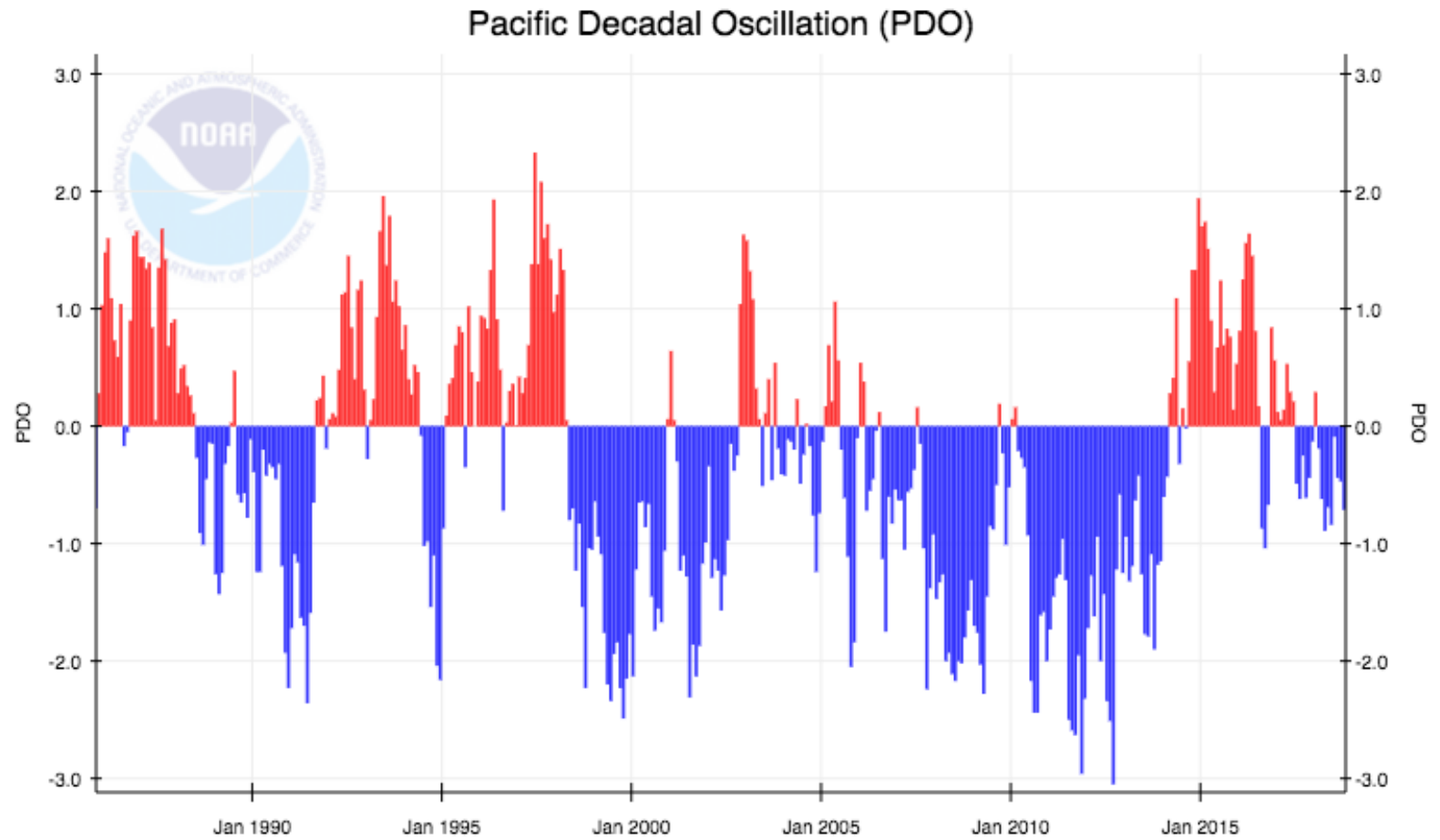
SST anomalies in the NINO 3.4 region

CMCC Seasonal Outlook – winter 2018-19

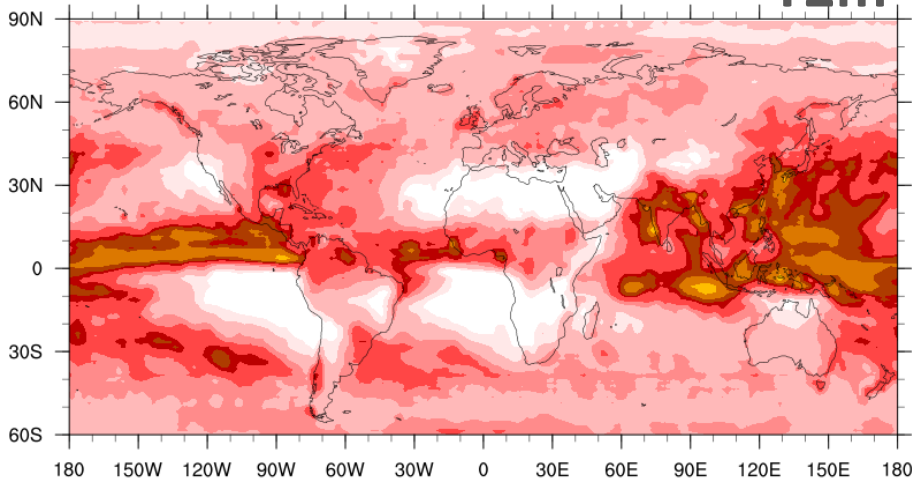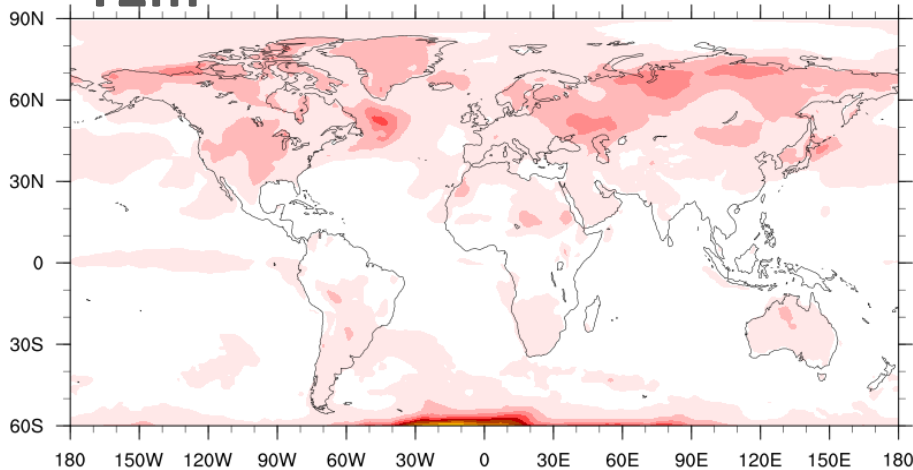Pacific Decadal Oscillation (PDO)

The new SPS.v3

RMSE (1993-2016) – lead season 1 (DJF) – Forecasts vs ERA-Interim

May start date

November start date
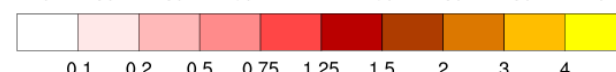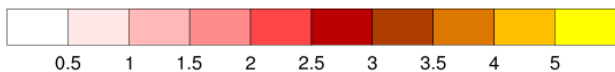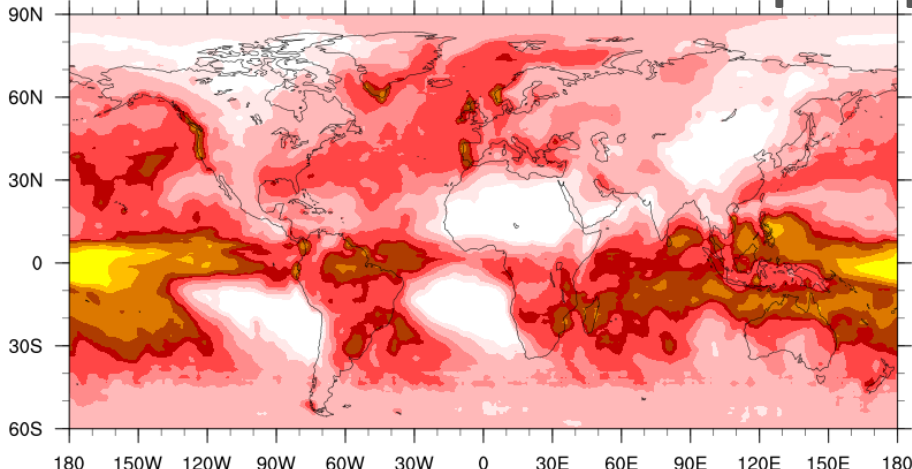
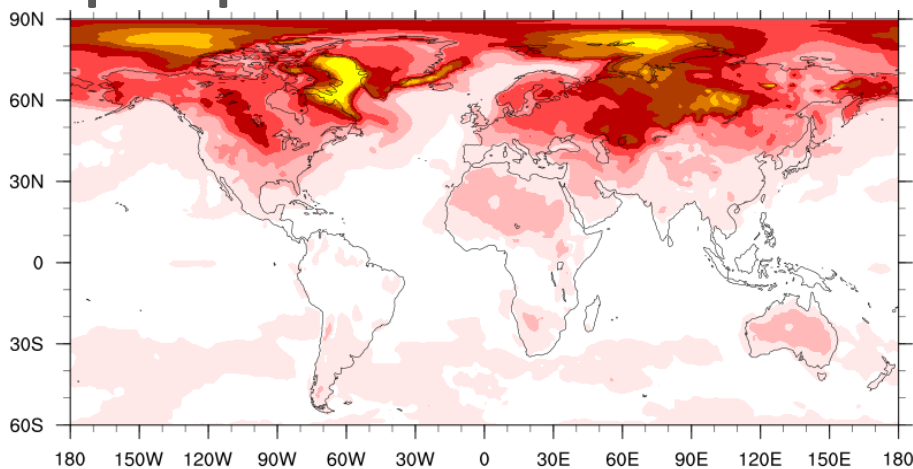# Evolution of the CMCC-SPS

	Currently operational system	**New operational system (next few weeks)**
	SPS.v2 2012 (CLIMAFIRCA)	**SPS.v3** 2016 (Copernicus)
Ocean	OPA-ORCA2 2°x2° − 30 levs	NEMO 1/4° x 1/4° − 50 levs
Atmosph.	ECHAM-5 2°x2° − 19 levs no stratosph.	CAM5 1°x1° − 46 levs with stratosph.
Land	SILVA model	CLM + River routing scheme
Ensemble size	9	50
Initial Conditions	Ocean Analyses Atmosphere Analyses	Ocean Analyses Atmosphere Analyses