

Seasonal forecast from System 4

European Centre for Medium-Range Weather Forecasts

Outline

- **Overview of System 4**
- **System 4 forecasts for DJF 2015/2016**
- **Plans for System 5**

System 4 - Overview

System 4 seasonal forecast model

● IFS (atmosphere)

- T_L255L91 Cy36r4, 0.7 deg grid for physics (operational in Dec 2010)
- Full stratosphere, enhanced stratospheric physics
- Singular vectors from EPS system to perturb atmosphere initial conditions
- Ocean currents coupled to atmosphere boundary layer calculations

● NEMO (ocean)

- Global ocean model, 1x1 resolution, 0.3 meridional near equator
- NEMOVAR (3D-Var) analyses, newly developed.

● Coupling

- Fully coupled, no flux adjustments
- Sea-ice based on sampling previous five years

System 4 configuration

- **Real time forecasts:**

- **51 member ensemble forecast to 7 months**
- SST and atmos. perturbations added to each member

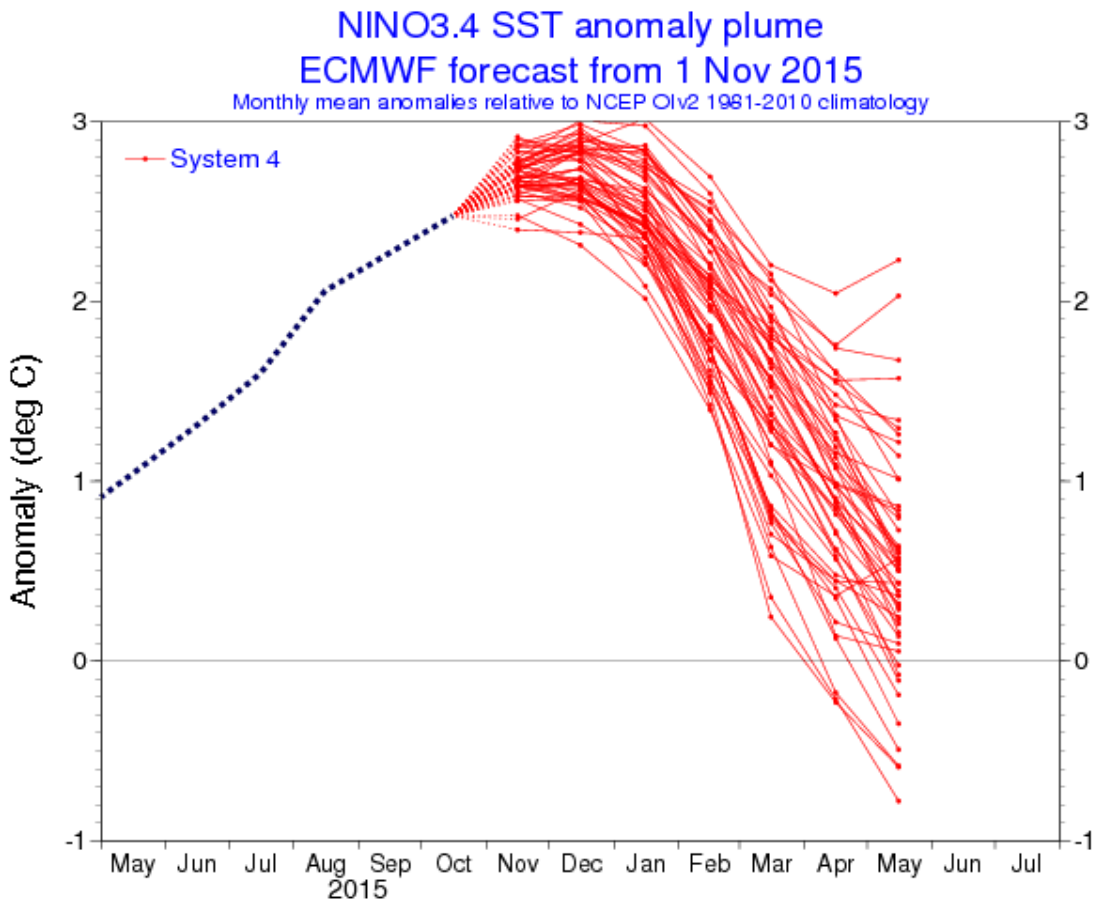
- **15 member ensemble forecast to 13 months**
- Designed to give an 'outlook' for ENSO
- Only once per quarter (Feb, May, Aug and Nov starts)

- **Back integrations from 1981-2010 (30 years)**

- 15 member ensemble every month
- 15 members extended to 13 months once per quarter

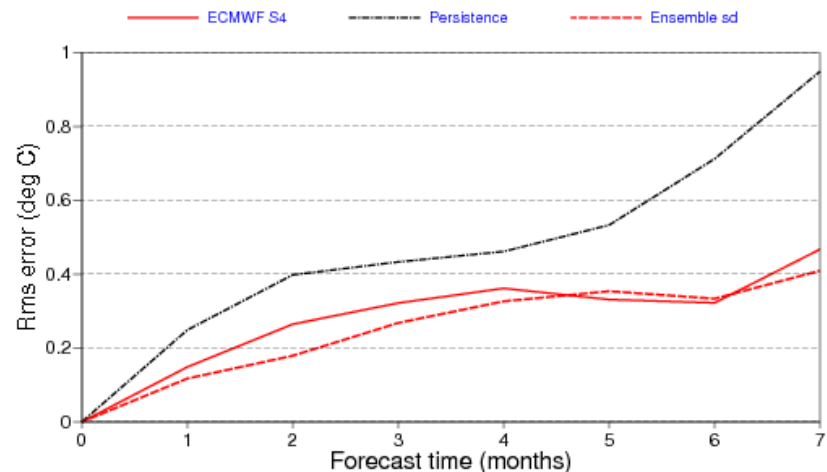
Forecasts for DJF 2015/2016

ECMWF forecast: ENSO

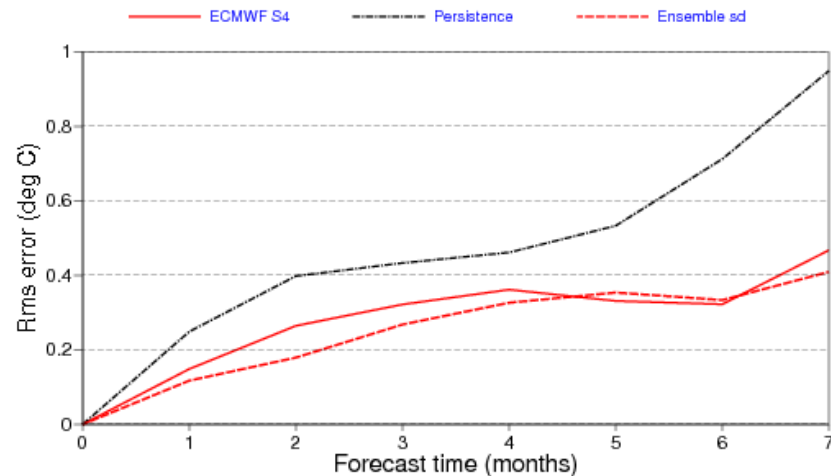


ECMWF

NINO3.4 SST rms errors
34 start dates from 19811101 to 20141101, amplitude scaled
Ensemble size is 15



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34 start dates from 19811101 to 20141101, amplitude scaled
Ensemble size is 15

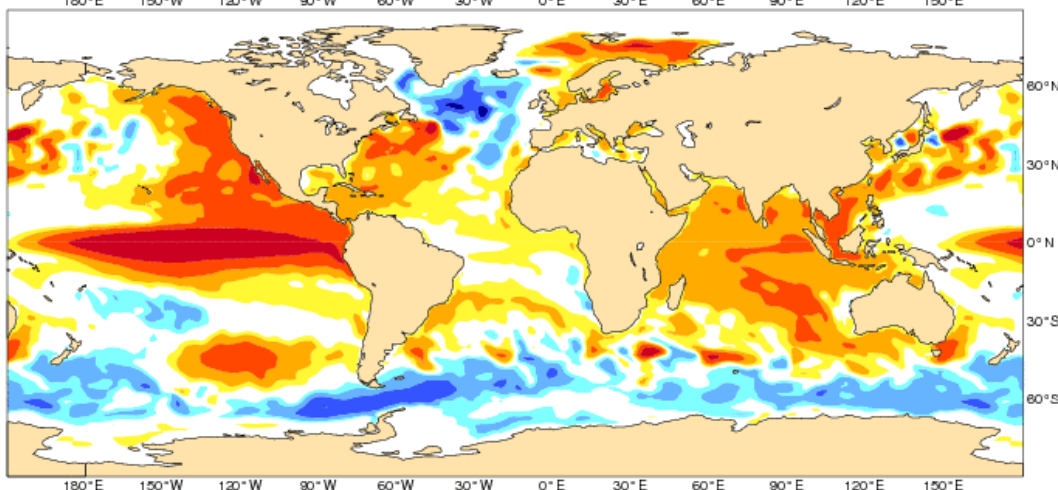


ECMWF forecast: DJF sst

ECMWF Seasonal Forecast
 Mean forecast SST anomaly
 Forecast start reference is 01/11/15
 Ensemble size = 51, climate size = 450

System 4
 DJF 2015/16

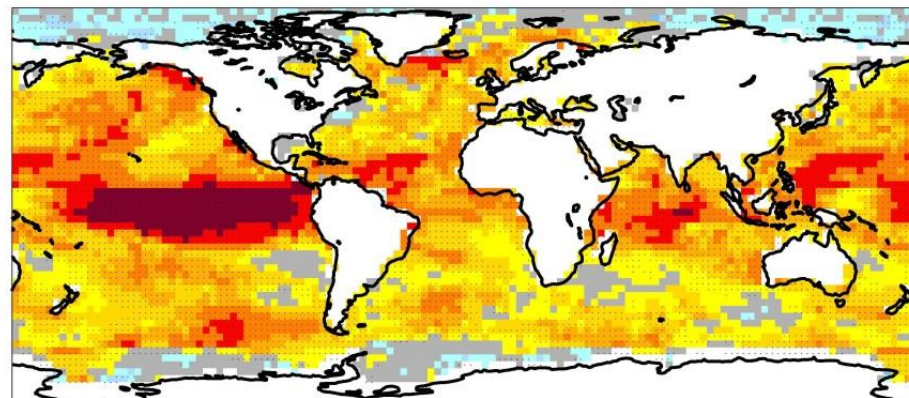
■ <-2.0
■ -2.0..-1.0
■ -1.0..-0.5
■ -0.5..-0.2
■ -0.2..0.2
■ 0.2..0.5
■ 0.5..1.0
■ 1.0..2.0
■ > 2.0°C



**Ensemble
 mean**

Anomaly Correlation Coefficient for ECMWF with 15 ensemble members
 Sea Surface temperature
 Hindcast period 1981-2010 with start in November average over months 2 to 4
 Black dots for values significantly different from zero with 95% confidence (1000 samples)

■ -1
■ -0.9
■ -0.8
■ -0.7
■ -0.6
■ -0.4
■ -0.2
■ 0.2
■ 0.4
■ 0.6
■ 0.7
■ 0.8
■ 0.9



**ACC skill
 (1981-2010)**

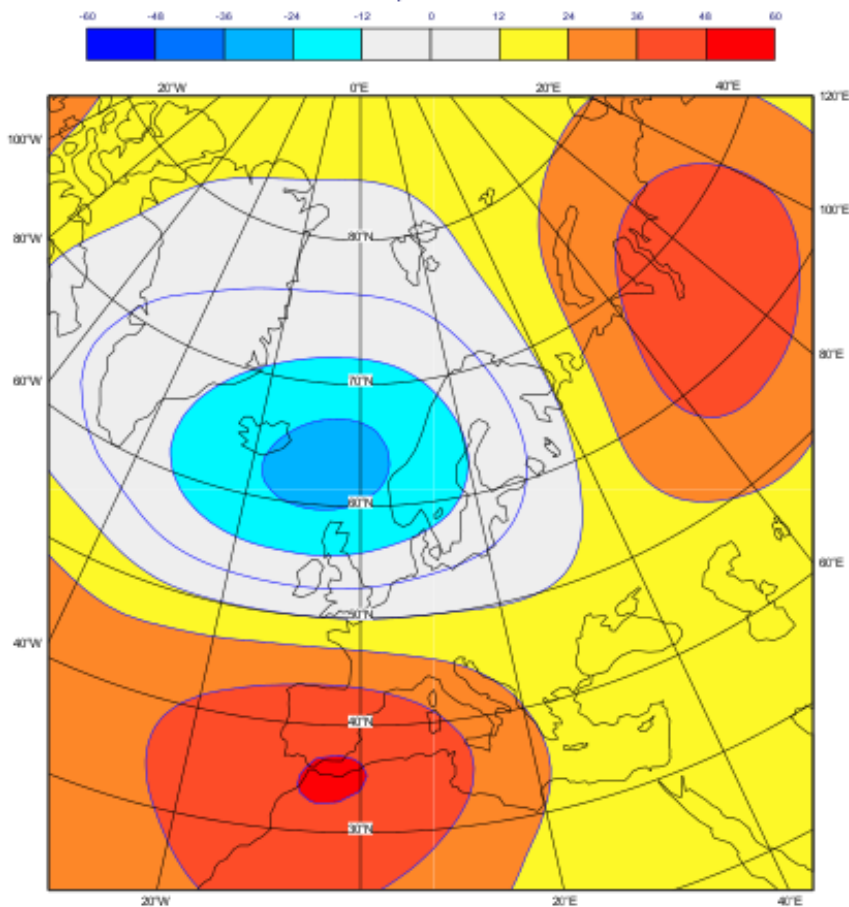
ECMWF forecast: DJF z500

ECMWF Seasonal Forecast System 4

Mean Z500 anomaly - DJF 2015/2016

Forecast start reference is 01/11/2015

Ensemble size = 51, climate size = 450

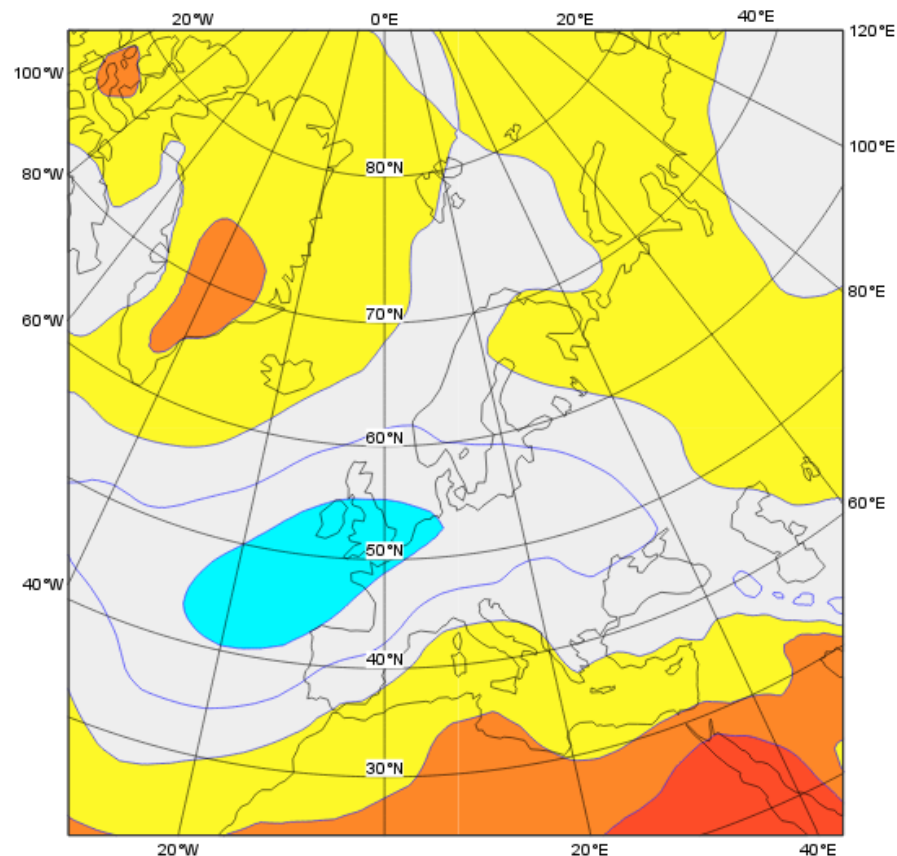


**Ensemble
Mean anomaly**

ACC skill

ACC for ECMWF S4 with 15 ensemble members
500hPa geopotential height

Hindcast period 1981-2010 - Nov start - DJF avg



**ACC skill
(1981-2010)**

ECMWF forecast: DJF mslp

Ensemble Mean anomaly

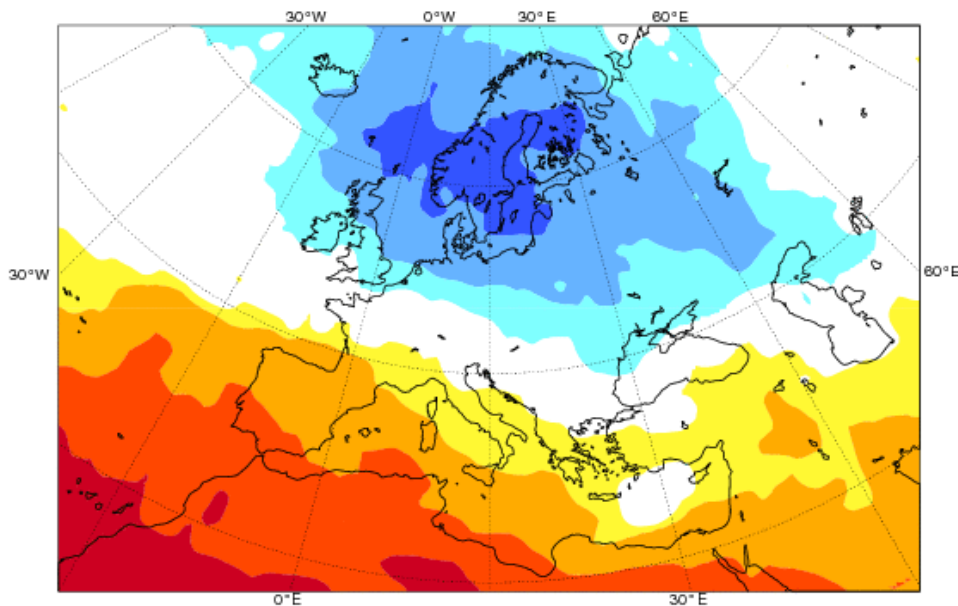
System 4
DJF 2015/16
Solid contour at 1% significance level

ECMWF Seasonal Forecast
Mean MSLP anomaly
Forecast start reference is 01/11/15
Ensemble size = 51, climate size = 450

ECMWF Seasonal Forecast
Prob(most likely category of MSLP)
Forecast start reference is 01/11/15
Ensemble size = 51, climate size = 450

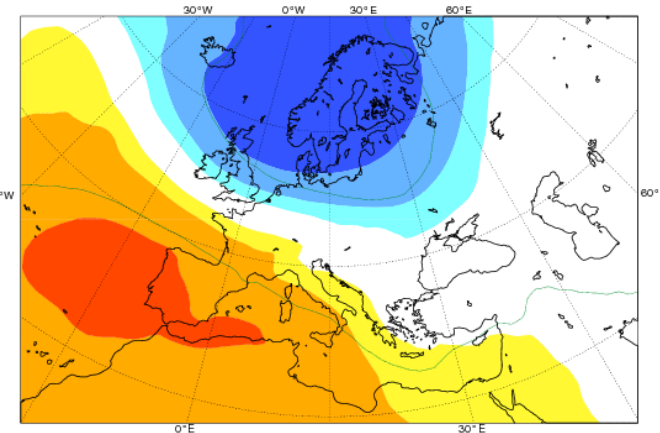
System 4
DJF 2015/16

<--- below lower tercile above upper tercile --->
 ■ 70..100% ■ 60..70% ■ 50..60% ■ 40..50% □ other ■ 40..50% ■ 50..60% ■ 60..70% ■ 70..100%



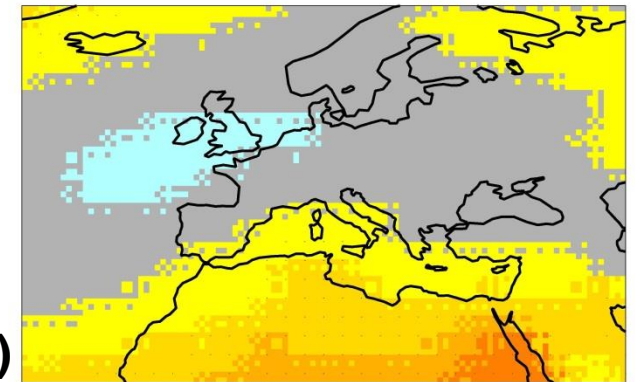
Tercile probabilities

■ < -4 hPa ■ -4 .. -2 ■ -2 .. -1 ■ -1 .. -0.5 □ -0.5..0.5 ■ 0.5..1 ■ 1 .. 2 ■ 2 .. 4 ■ > 4 hPa



Anomaly Correlation Coefficient for ECMWF with 15 ensemble members
Mean sea level pressure
Hindcast period 1981-2010 with start in November average over months 2 to 4
Black dots for values significantly different from zero with 95% confidence (1000 samples)

■ -1 ■ -0.9 ■ -0.8 ■ -0.7 ■ -0.6 ■ -0.4 ■ -0.2 ■ 0.2 ■ 0.4 ■ 0.6 ■ 0.7 ■ 0.8 ■ 0.9 □



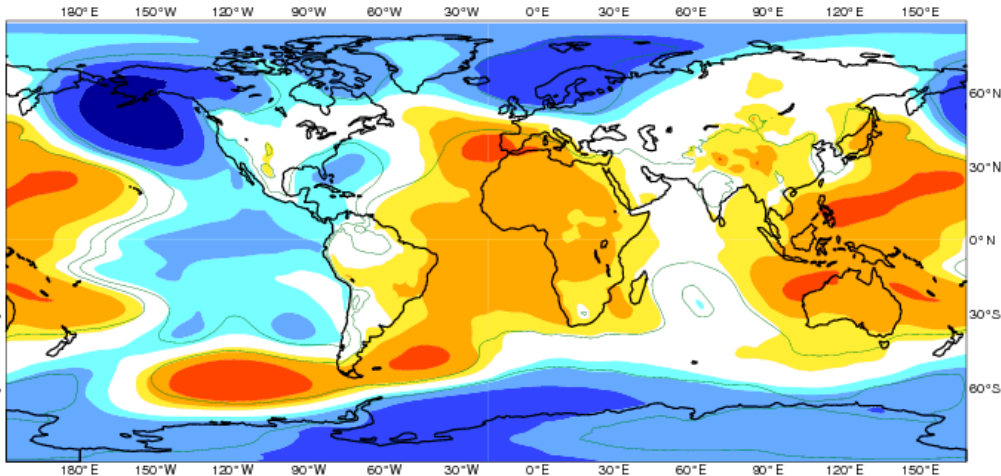
ACC skill
(1981-2010)

Evolution of mslp after winter

ECMWF Seasonal Forecast
 Mean MSLP anomaly
 Forecast start reference is 01/11/15
 Ensemble size - 51, climate size - 450

System 4
 DJF 2015/16
 Solid contour at 1% significance level

■ <- 4 hPa
 ■ -4 .. -2
 ■ -2 .. -1
 ■ -1 .. -0.5
 ■ -0.5..0.5
 ■ 0.5.. 1
 ■ 1 .. 2
 ■ 2 .. 4
 ■ > 4 hPa



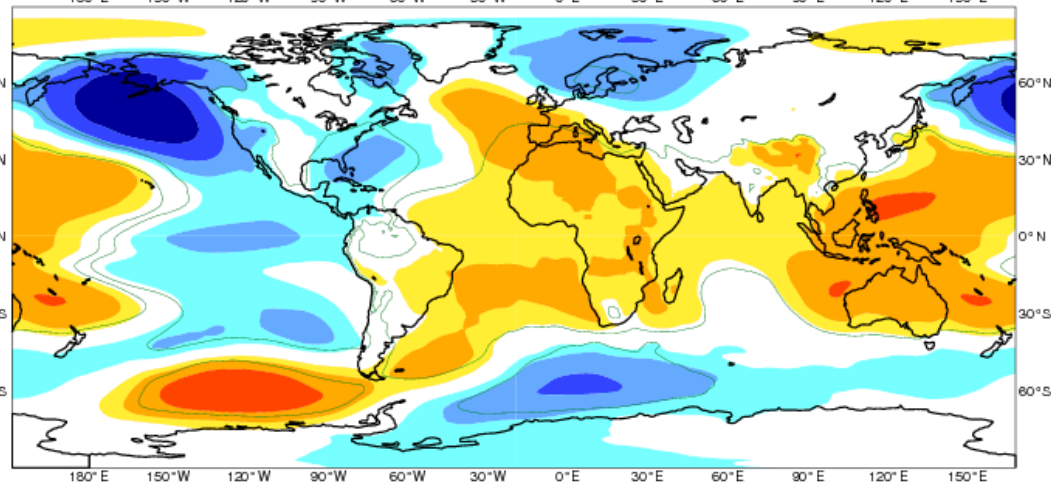
MSLP in DJF

MSLP in JFM

ECMWF Seasonal Forecast
 Mean MSLP anomaly
 Forecast start reference is 01/11/15
 Ensemble size - 51, climate size - 450

System 4
 JFM 2016
 Solid contour at 1% significance level

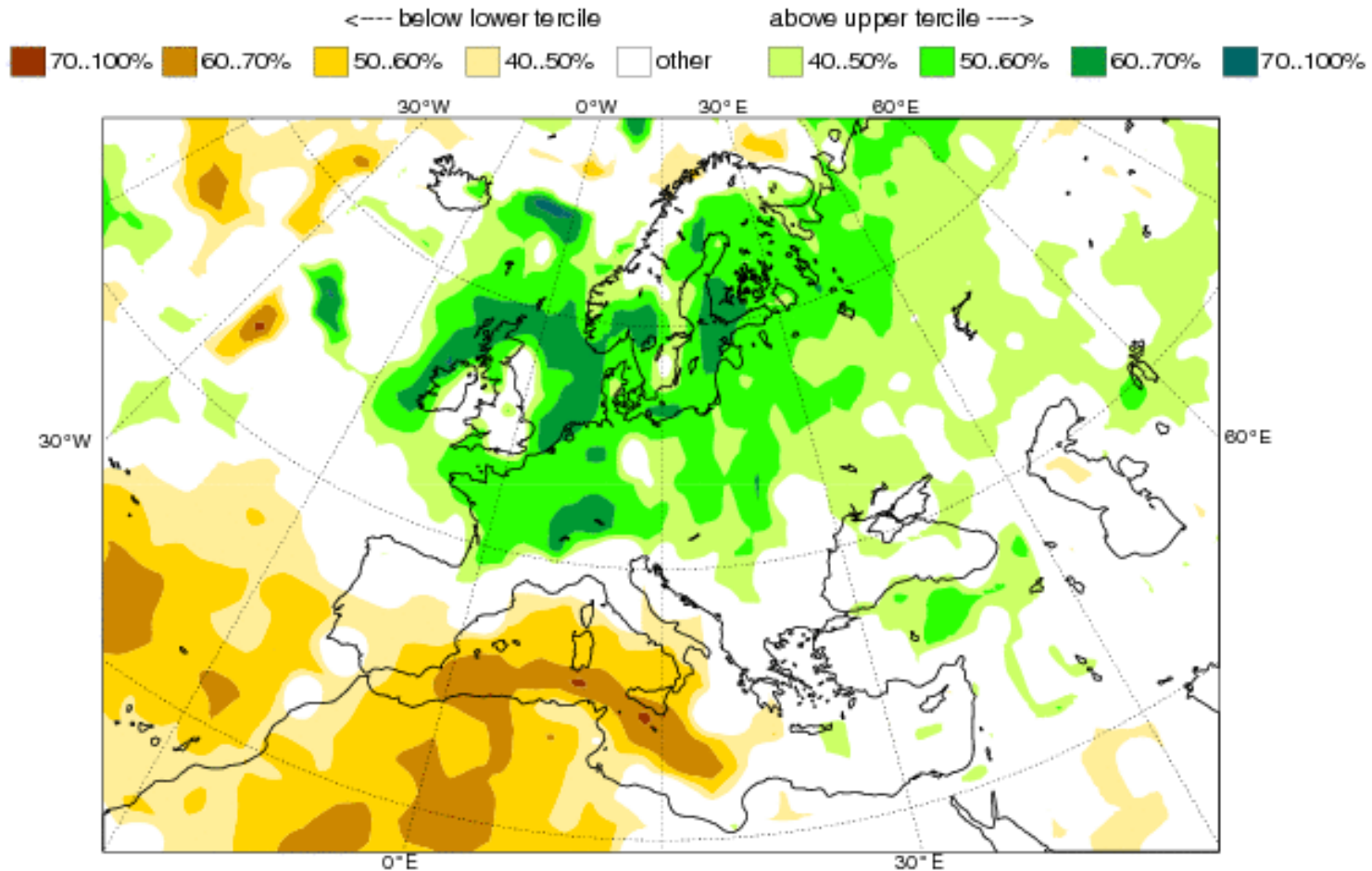
■ <- 4 hPa
 ■ -4 .. -2
 ■ -2 .. -1
 ■ -1 .. -0.5
 ■ -0.5..0.5
 ■ 0.5.. 1
 ■ 1 .. 2
 ■ 2 .. 4
 ■ > 4 hPa



ECMWF forecast: DJF precip

ECMWF Seasonal Forecast
Prob(most likely category of precipitation)
Forecast start reference is 01/11/15
Ensemble size = 51, climate size = 450

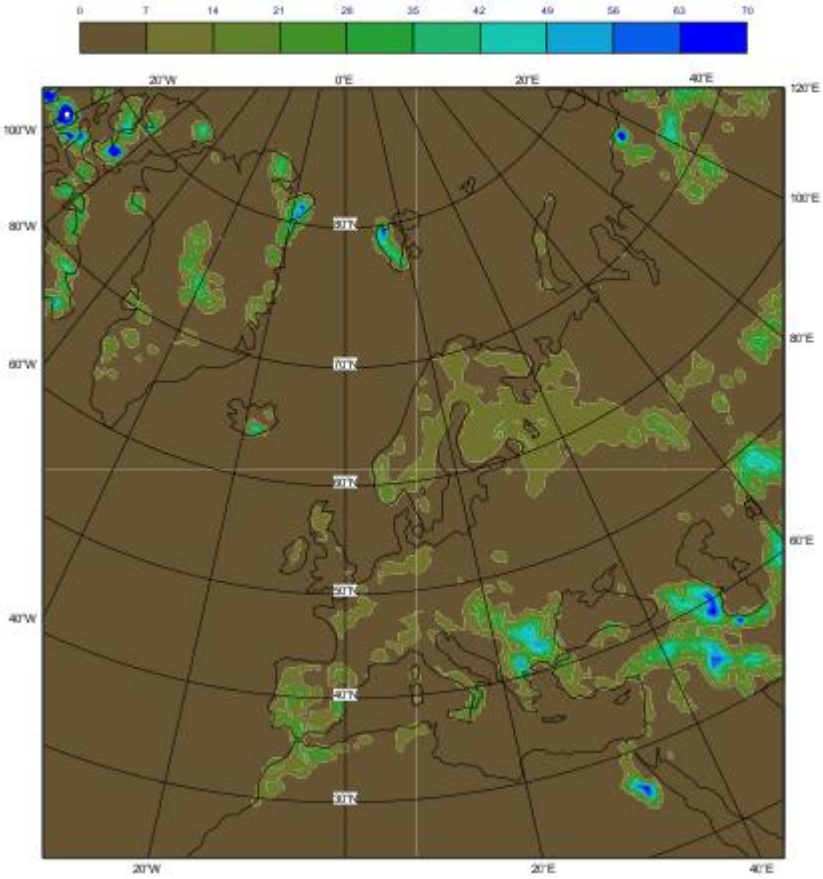
System 4
DJF 2015/16



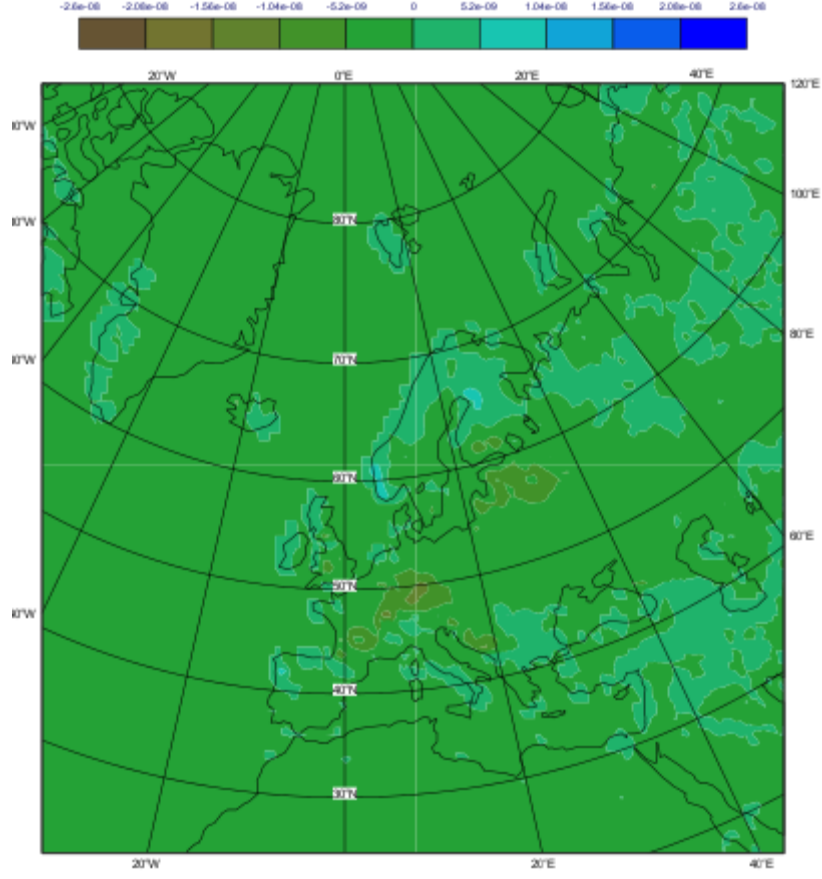
Tercile probabilities

ECMWF forecast: DJF soil moisture & runoff

ECMWF Seasonal Forecast System 4
Mean soil moisture anomaly (l/m^2) - DJF 2015/2016
Forecast start reference is 01/11/2015
Ensemble size = 51, climate size = 450



ECMWF Seasonal Forecast System 4
Mean runoff anomaly (m/s) - DJF 2015/2016
Forecast start reference is 01/11/2015
Ensemble size = 51, climate size = 450

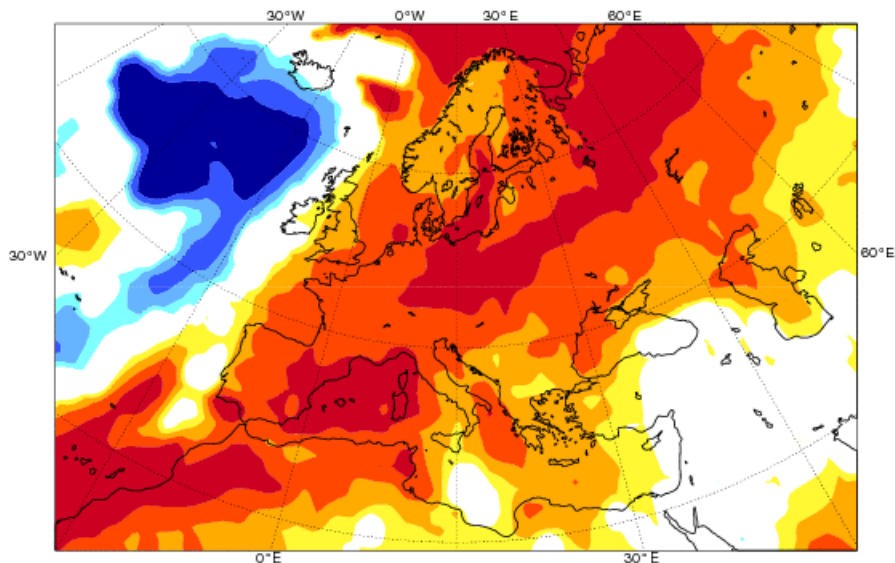


Ensemble mean anomalies

ECMWF forecast: DJF 2mT

ECMWF Seasonal Forecast
 Prob(most likely category of 2m temperature)
 Forecast start reference is 01/11/15
 Ensemble size = 51, climate size = 450

<--- below lower tercile above upper tercile --->
 70..100% 60..70% 50..60% 40..50% other 40..50% 50..60% 60..70% 70..100%

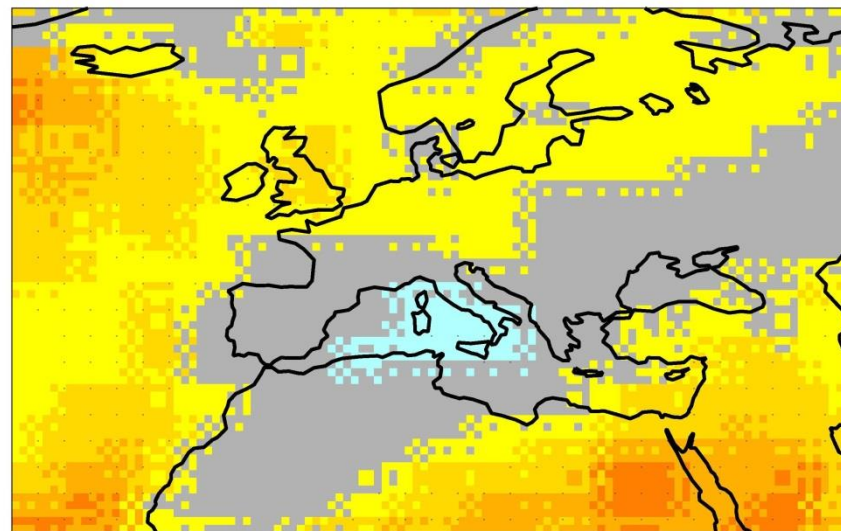


Tercile probabilities

System 4
 DJF 2015/16

Anomaly Correlation Coefficient for ECMWF with 15 ensemble members
 Near-surface air temperature
 Hindcast period 1981-2010 with start in November average over months 2 to 4
 Black dots for values significantly different from zero with 95% confidence (1000 samples)

-1 -0.9 -0.8 -0.7 -0.6 -0.4 -0.2 0.2 0.4 0.6 0.7 0.8 0.9



ACC skill (1981-2010)

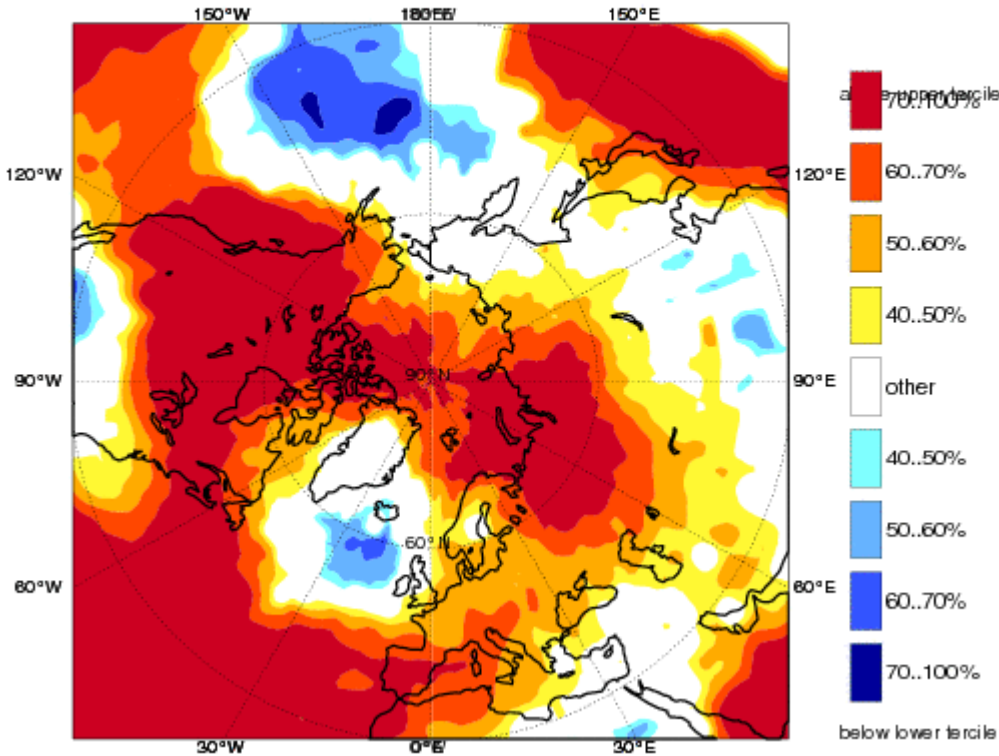
ECMWF forecast: DJF T850hPa

ECMWF Seasonal Forecast
 Prob(most likely category of T850)
 Forecast start reference is 01/11/15
 Ensemble size = 51, climate size = 450

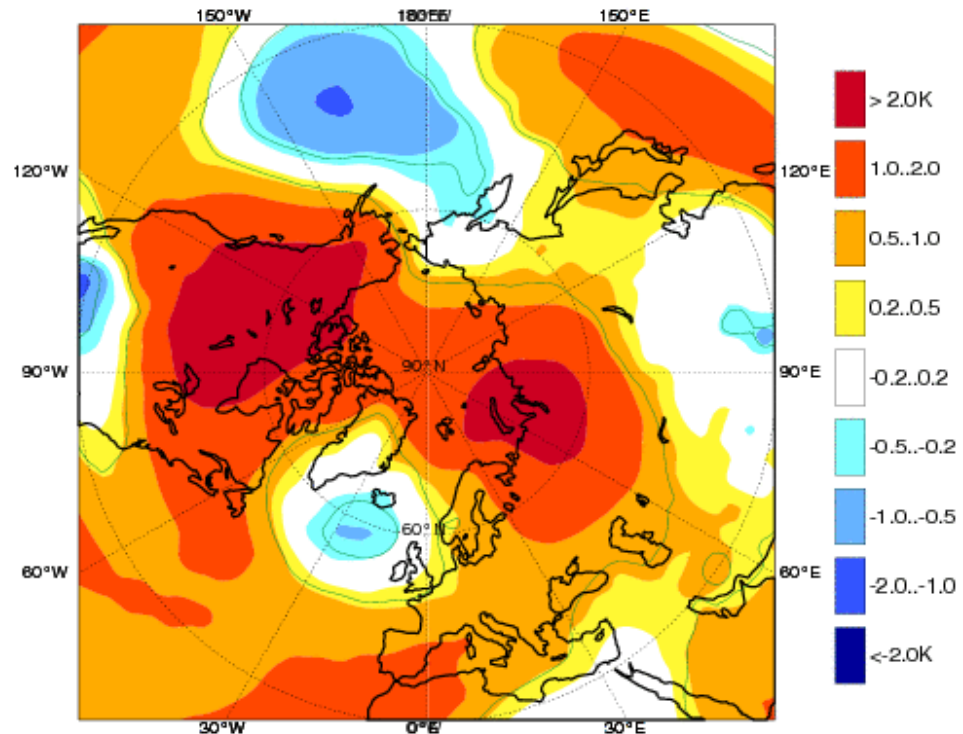
System 4
 DJF 2015/16

ECMWF Seasonal Forecast
 Mean T850 anomaly
 Forecast start reference is 01/11/15
 Ensemble size = 51, climate size = 450

System 4
 DJF 2015/16
 Solid contour at 1% significance level



Tercile probabilities



Ensemble mean anomaly

Conclusions for DJF 2015/2016

- **NAO+ conditions, but weakening North-Atlantic mslp anomaly could weaken effect of NAO on Europe**
- **Westerlies hitting northern Europe in early winter, but possibly also reaching south Caucasus in later winter**
- **Higher than normal precip in northern Europe, dryer in the western Mediterranean region. Wet anomaly over south of Caucasus**
- **Overall hotter than usual over all of Europe, especially over a dry western Mediterranean**

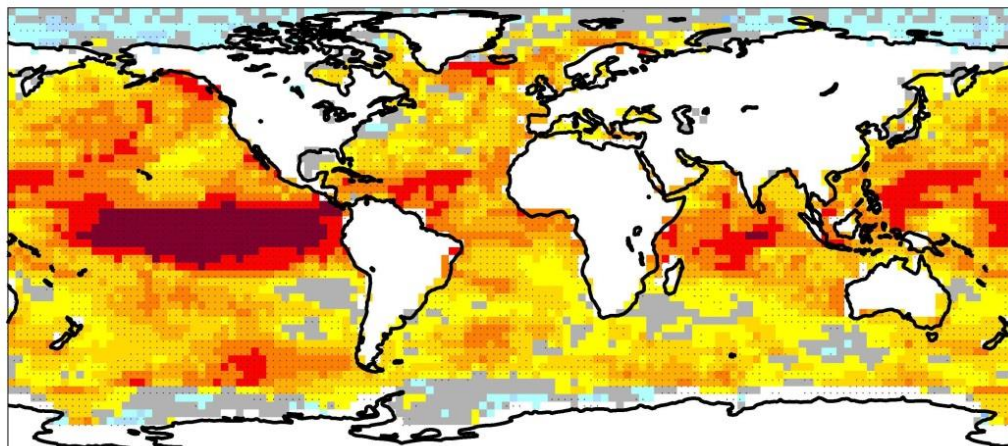
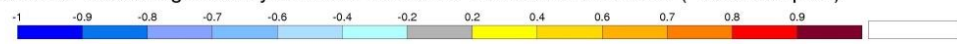
System 5 - Review

Plans for System 5

- **Higher horizontal and possibly vertical resolution:**
 - T_L511 or T_{CO}319
 - L137
- **Increased hindcast ensemble size to 25**
- **0.25° Ocean (Nemo 3.4.1)**
- **Improvements in atmosphere and land surface:**
 - LIM2 sea-ice model
 - New ozone scheme (Monge-Sanz 2011 [doi: 10.5194/acp-11-1227-2011](https://doi.org/10.5194/acp-11-1227-2011))
 - Accuracy of ENSO similar, but will have better QBO
 - Improved land surface initialisation: LAI, soil moisture, lakes, etc.
- **Target is early 2017**

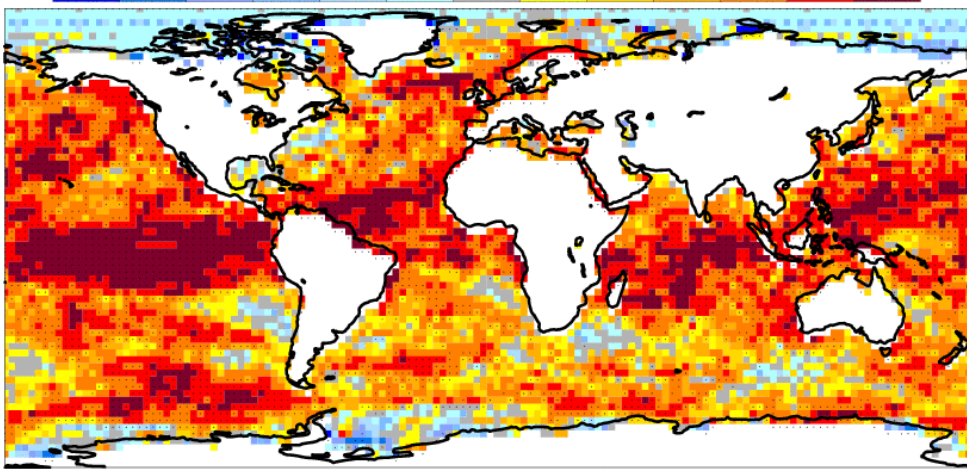
ECMWF forecast: DJF sst

Anomaly Correlation Coefficient for ECMWF with 15 ensemble members
 Sea Surface temperature
 Hindcast period 1981-2010 with start in November average over months 2 to 4
 Black dots for values significantly different from zero with 95% confidence (1000 samples)

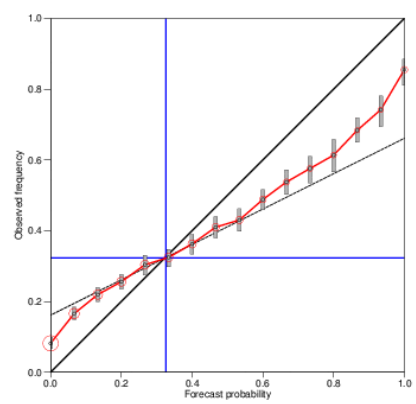


**ACC skill
(1981-2010)**

ROC Skill Score for CodOecmfE0001S004M001 with 15 ensemble members and 16 bins
 Sea Surface temperature anomalies above the upper tercile
 Hindcast period 1981-2010 with start in November and averaging period 2 to 4
 Threshold estimated with a kernel method for the PDF
 Black dots for values significantly different from zero with 95% confidence (1000 samples)



ROC skill scores



reliability