

Seasonal forecast from System 4

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Outline

- **Overview of System 4**
- **Some recent research results**
- **System 4 forecasts for DJF 2014**
- **FP7 EUPORIAS / SPECS projects & C3S**

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)

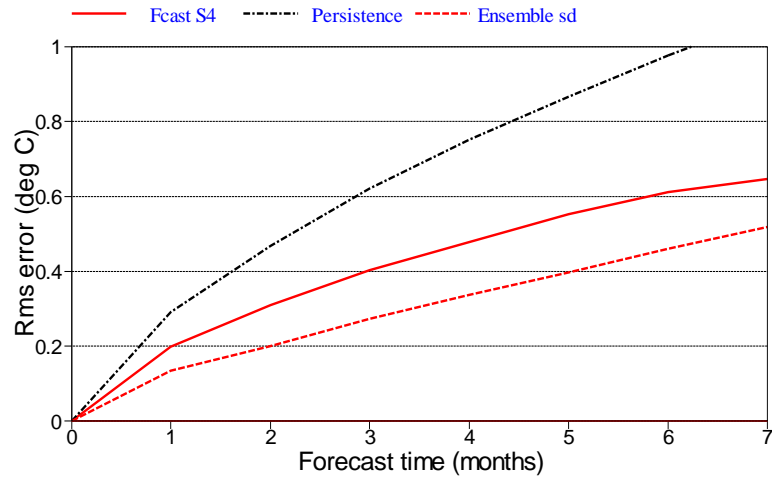
- 15 member ensemble every month
- 15 members extended to 13 months once per quarter

Recent Research

More recent ENSO forecasts are better

NINO3.4 SST rms errors

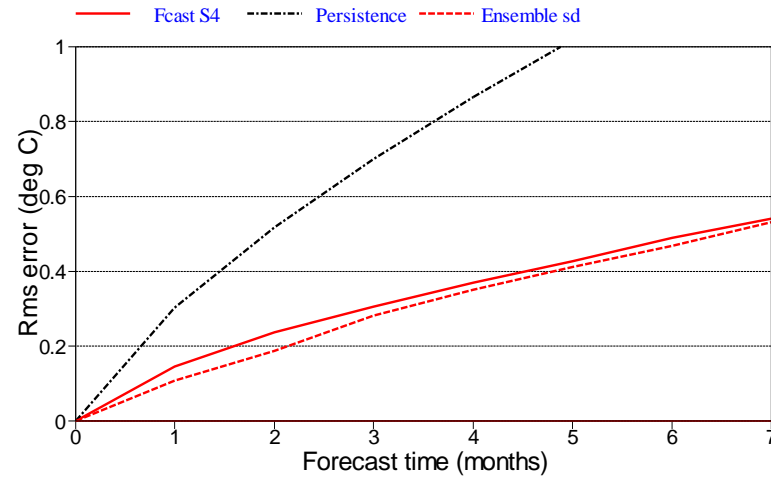
180 start dates from 19810101 to 19951201, amplitude scaled
Ensemble size is 15
95% confidence interval for 0001, for given set of start dates



1981-1995

NINO3.4 SST rms errors

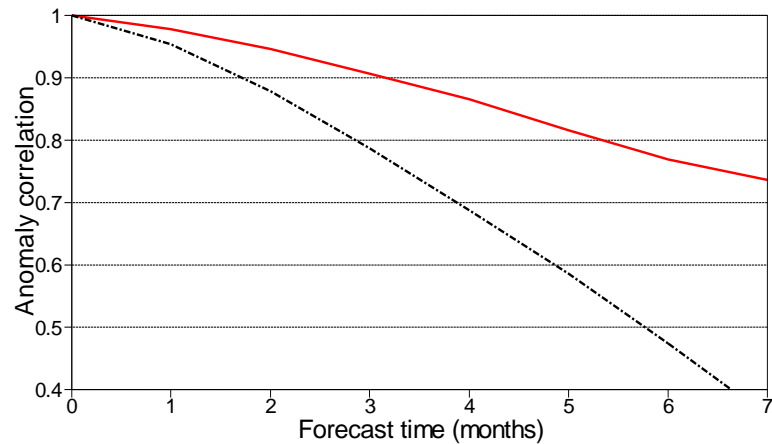
180 start dates from 19960101 to 20101201, amplitude scaled
Ensemble size is 15
95% confidence interval for 0001, for given set of start dates



1996-2010

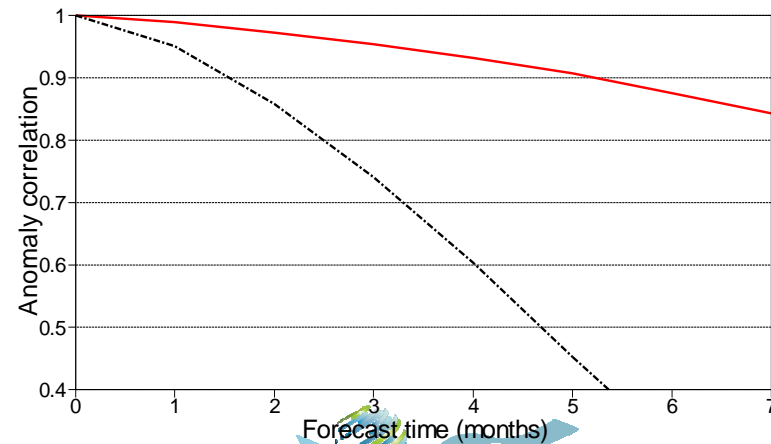
NINO3.4 SST anomaly correlation

wrt NCEP adjusted Qv2 1971-2000 climatology



NINO3.4 SST anomaly correlation

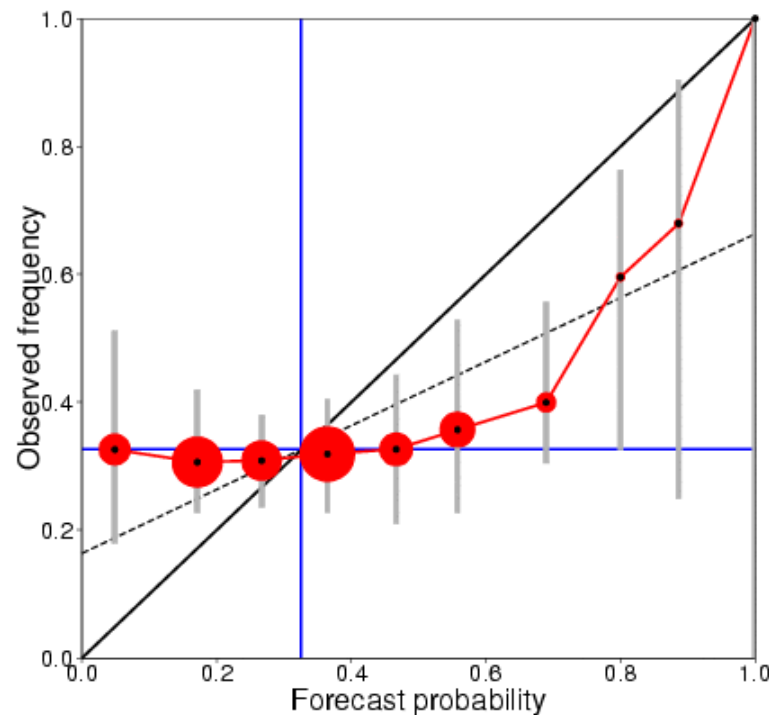
wrt NCEP adjusted Qv2 1971-2000 climatology



S4 extended hindcast set

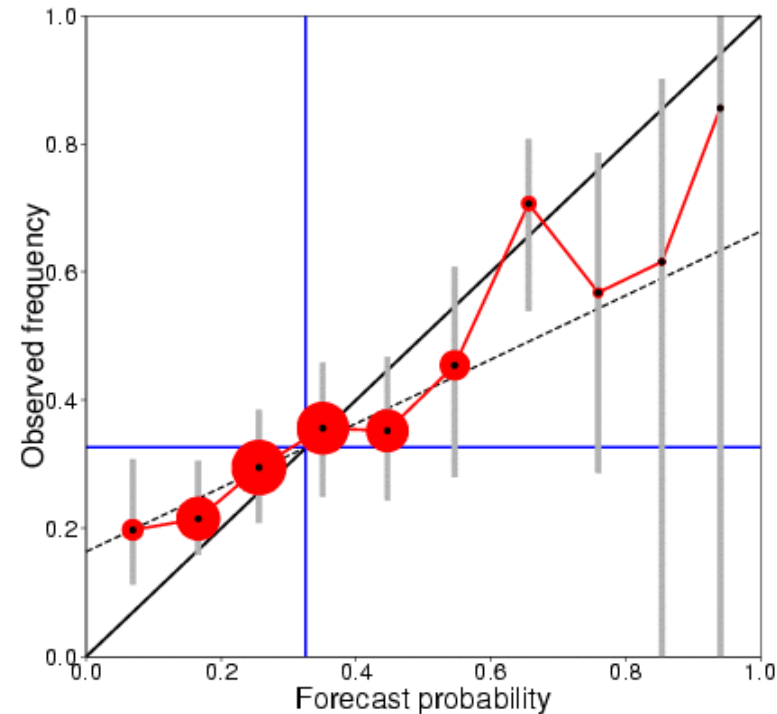
15 members

DJF Europe T2m > upper tercile
Re-forecasts from 1 Nov, 1981-2010
Reliability score: 0.902
ROC skill score: 0.06



51 members

DJF Europe T2m > upper tercile
Re-forecasts from 1 Nov, 1981-2010
Reliability score: 0.981
ROC skill score: 0.22



(Figures from Susanna Corti)

ACC=0.61

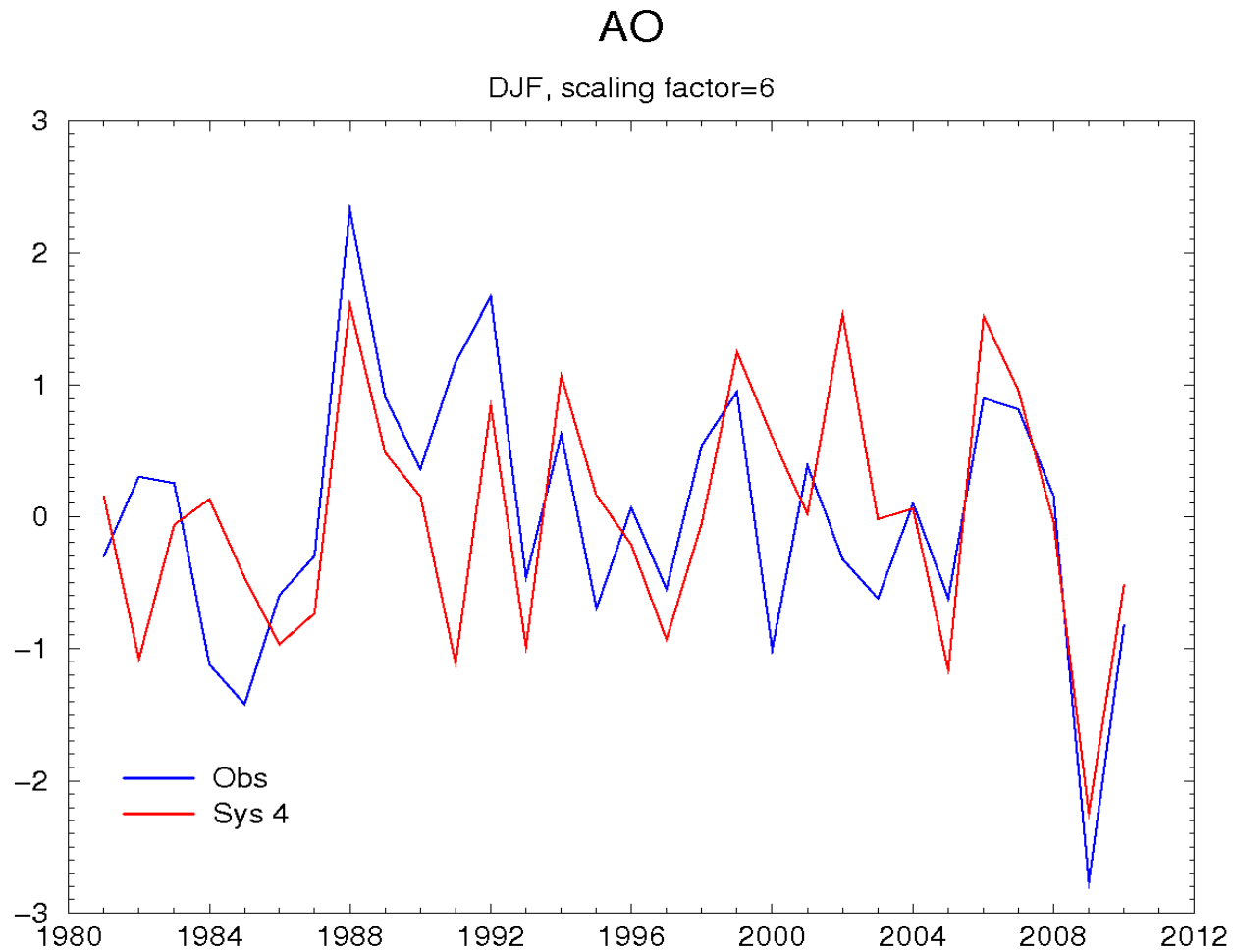
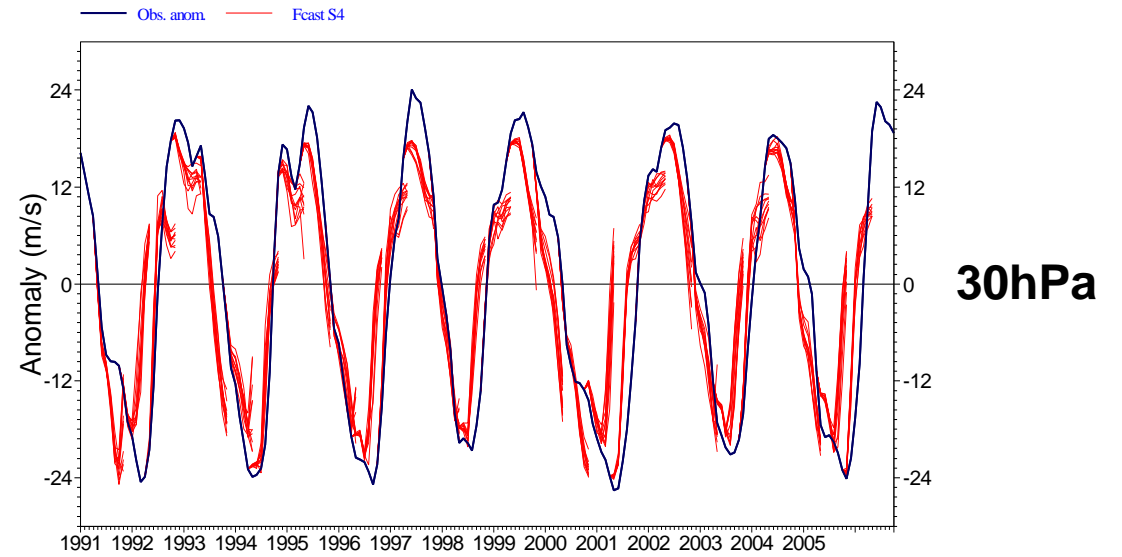
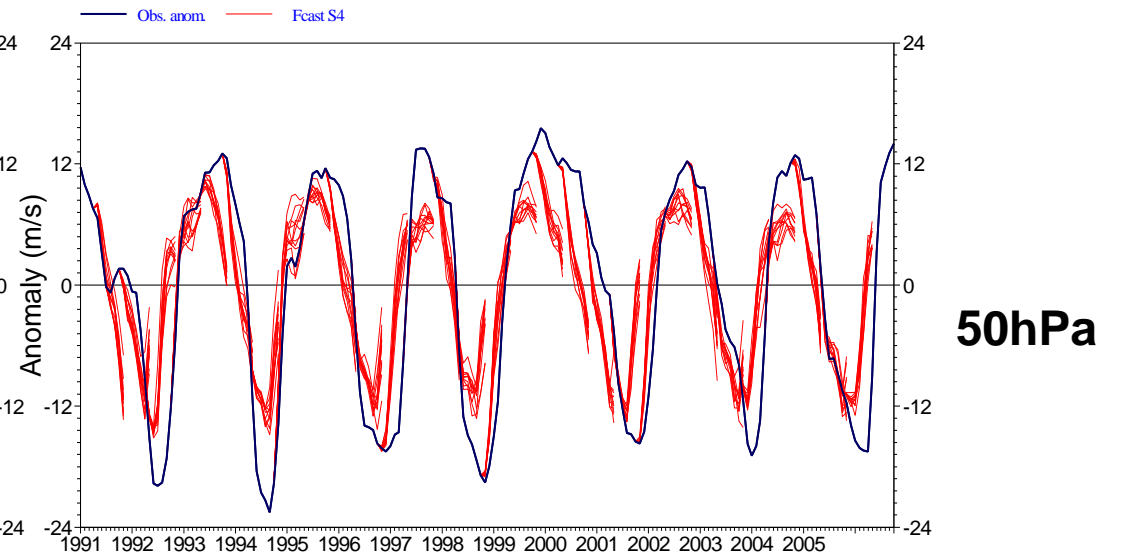
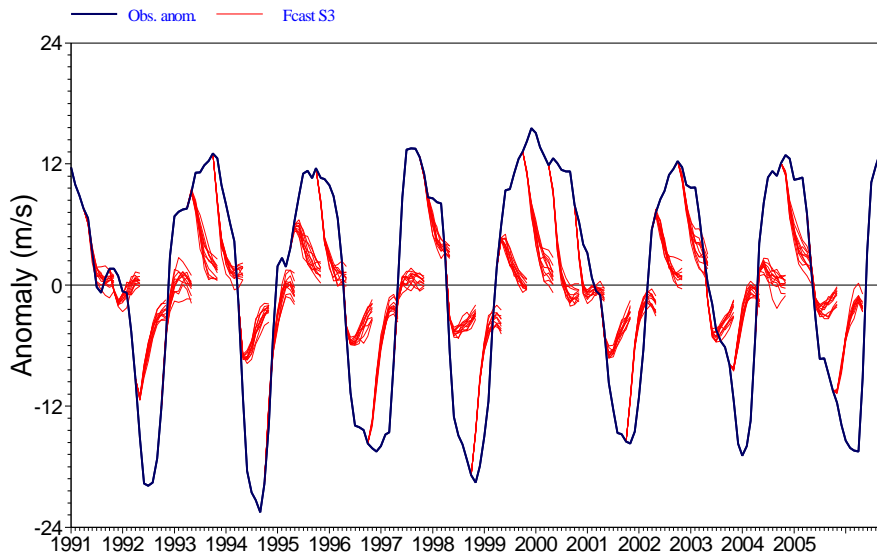


Fig. 1. The Arctic Oscillation Index for DJF, as analysed from ERAI (blue) and as predicted by the S4 ensemble mean from the 1st November (red). The S4 ensemble mean is **scaled by a factor of 6** to be of comparable amplitude to the observed index.

System 4



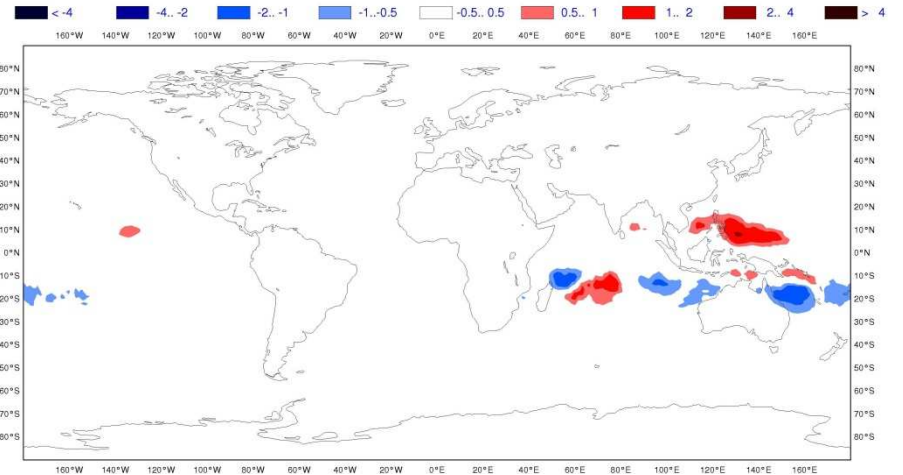
System 3



Tropical storm forecasts

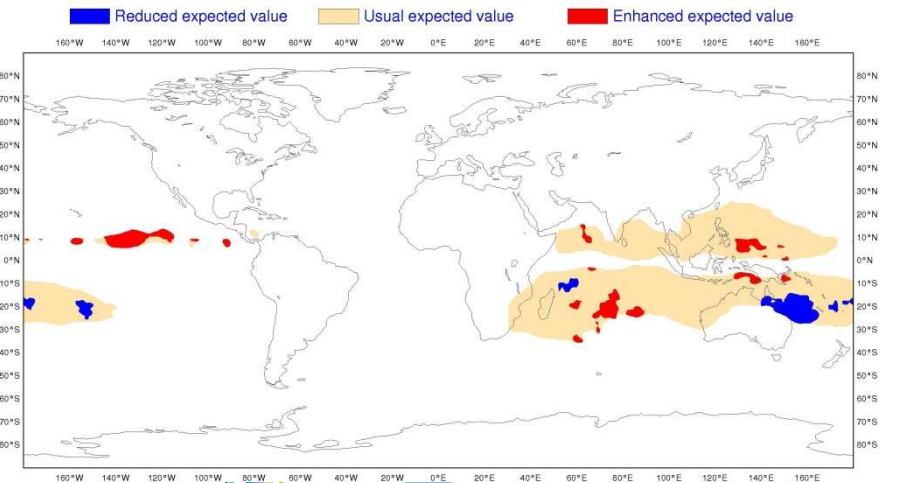
ECMWF Seasonal Forecast
Tropical Storm Density Anomaly
Forecast start reference is 01/10/2014
Ensemble size = 51, climate size = 300

System 4
NDJFMA 2014/15
Climate (initial dates) = 1990-2009



ECMWF Seasonal Forecast
Standardized Tropical Storm Density
Forecast start reference is 01/10/2014
Ensemble size = 51, climate size = 300

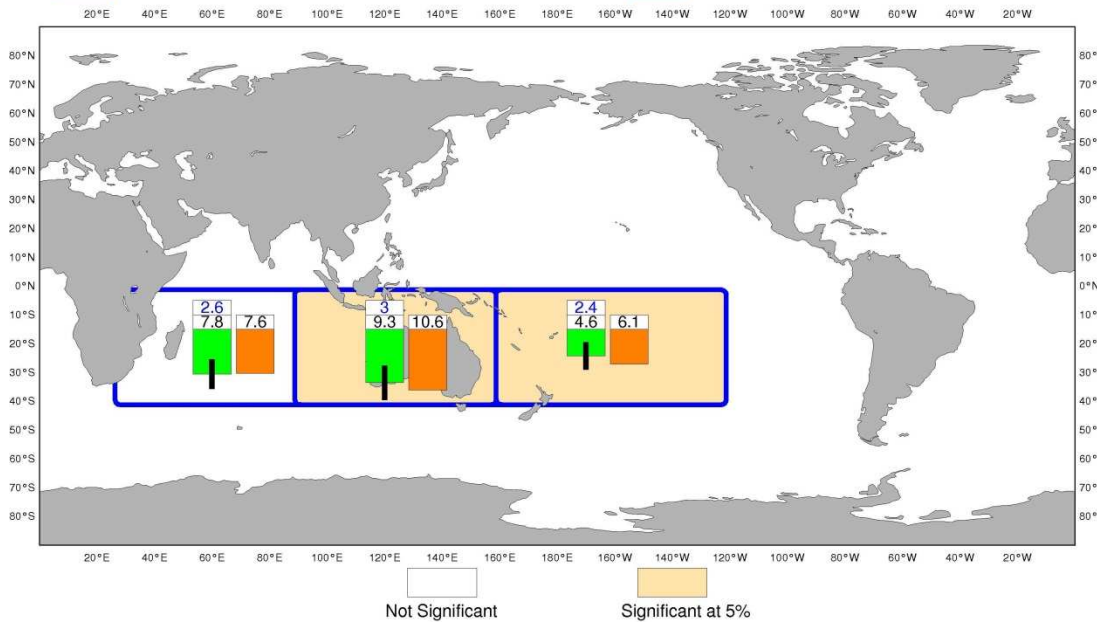
System 4
NDJFMA 2014/15
Climate (initial dates) = 1990-2009



ECMWF Seasonal Forecast
Tropical Storm Frequency
Forecast start reference is 01/10/2014
Ensemble size = 51, climate size = 300

System 4
NDJFMA 2014/15
Climate (initial dates) = 1990-2009

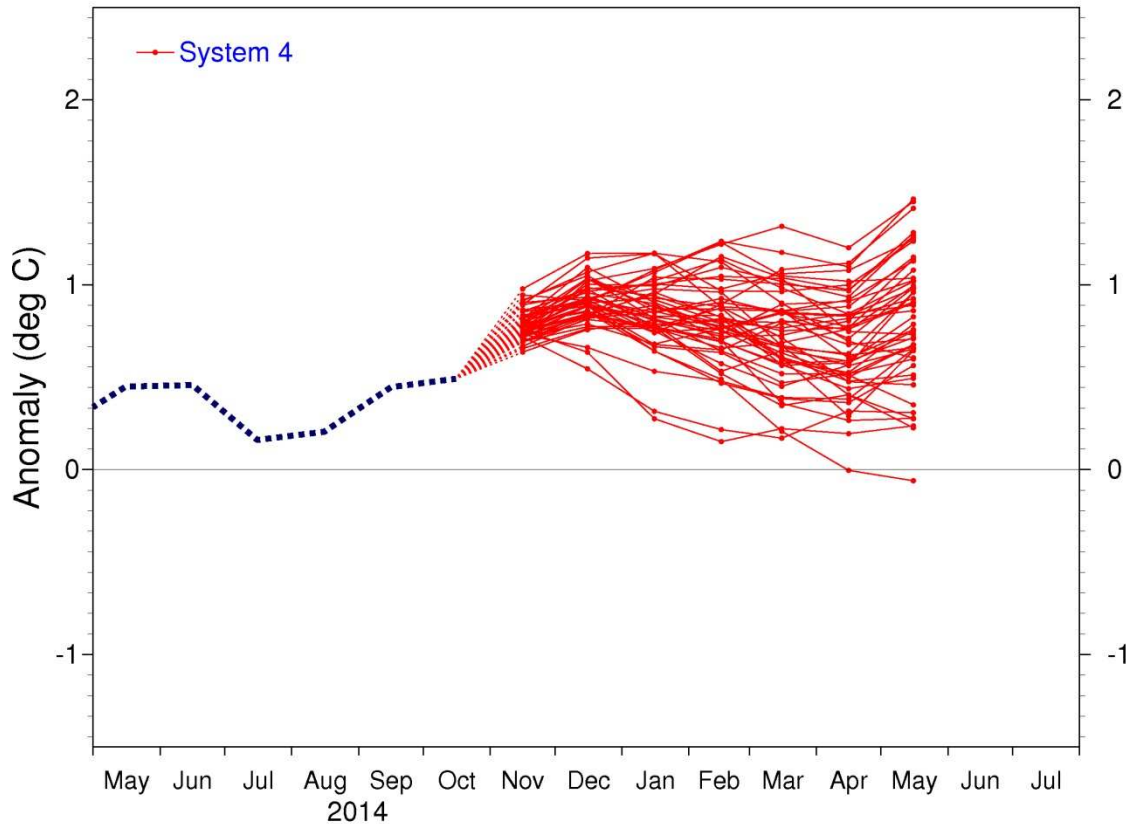
Forecast mean Standard deviation Climate mean



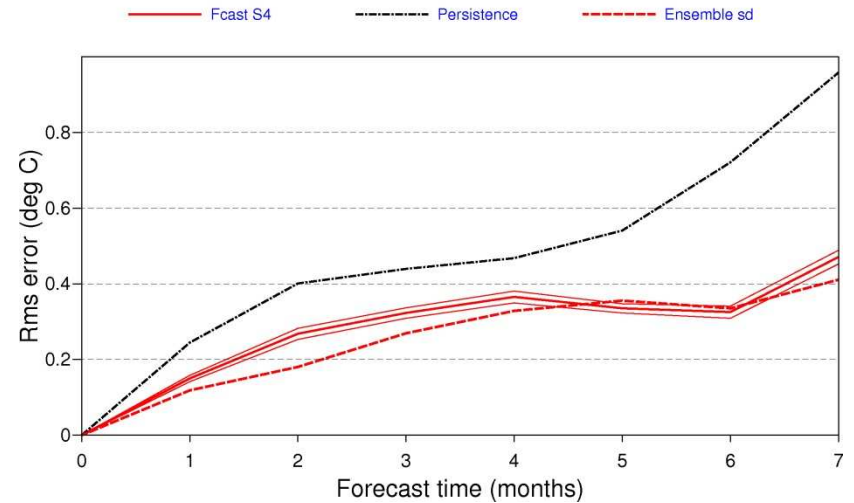
Forecasts for DJF 2014

ECMWF forecast: ENSO

NINO3.4 SST anomaly plume
 ECMWF forecast from 1 Nov 2014
 Monthly mean anomalies relative to NCEP Olv2 1981-2010 climatology

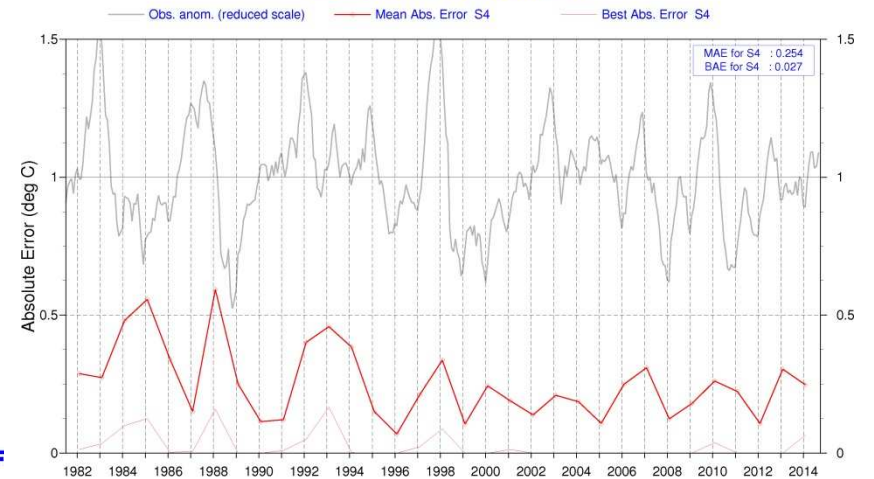


NINO3.4 SST rms errors
 33 start dates from 19811101 to 20131101, amplitude scaled
 Ensemble size is 15
 95% confidence interval for 0001, for given set of start dates



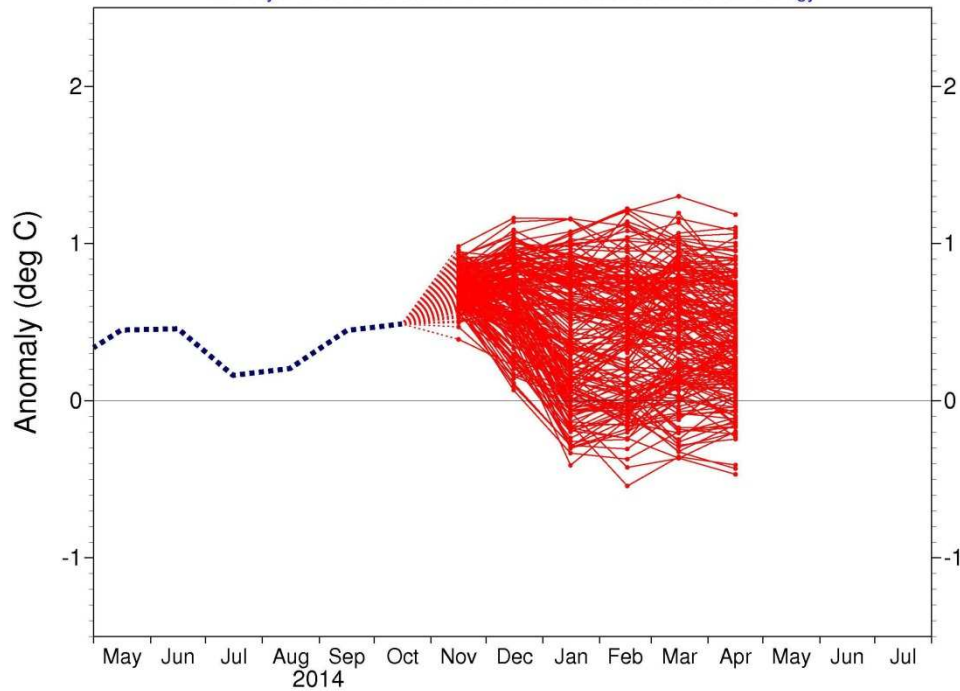
NINO3.4 SST absolute error scores
 November starts

ECMWF amplitude scaled forecasts (mean during 7 months, plotted at centre of verification period)
 Ensemble size is 15 SST obs: HadSST1/Olv2



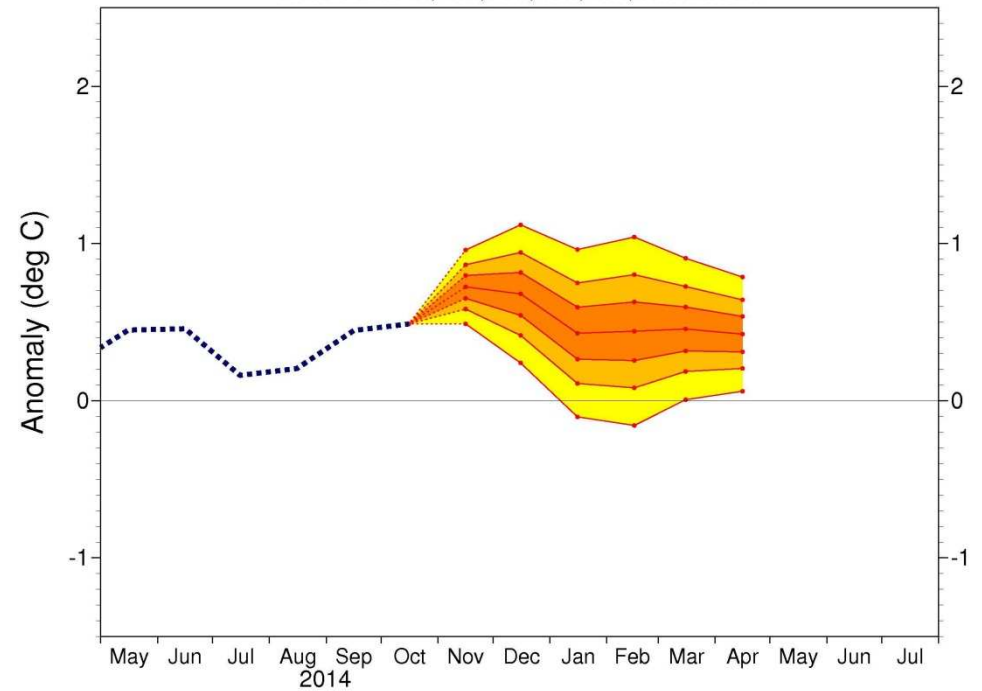
Nino 3.4 plume and p.d.f.

NINO3.4 SST anomaly plume
EUROSIP multi-model forecast from 1 Nov 2014
ECMWF, Met Office, Météo-France, NCEP
Monthly mean anomalies relative to NCEP Olv2 1981-2010 climatology



ECMWF

NINO3.4 SST calibrated pdf
EUROSIP multi-model forecast from 1 Nov 2014
ECMWF, Met Office, Météo-France, NCEP
Percentiles at 2%, 10%, 25%, 50%, 75%, 90% and 98%



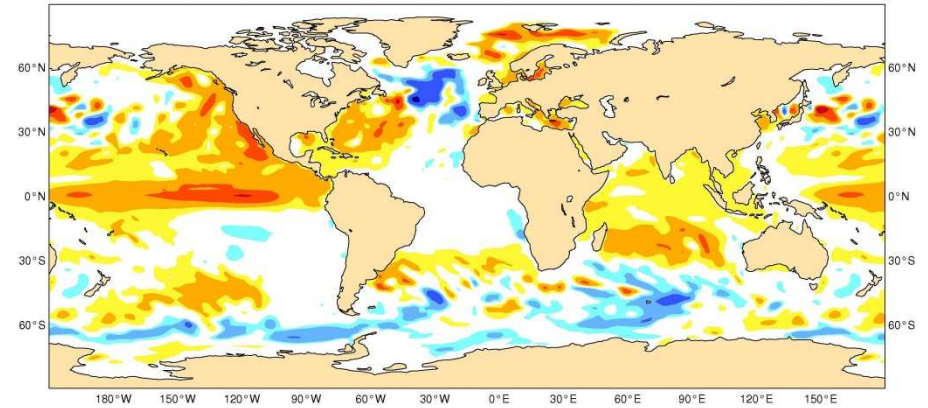
ECMWF

ECMWF forecast: DJF sst

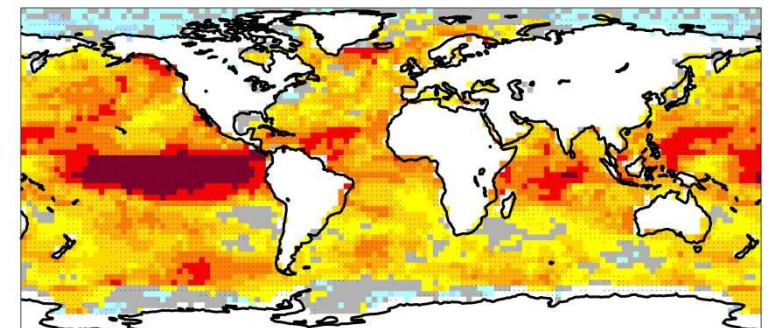
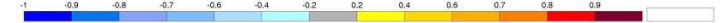
Ensemble mean

System 4
DJF 2014/15

ECMWF Seasonal Forecast
Mean forecast SST anomaly
Forecast start reference is 01/11/14
Ensemble size = 51, climate size = 450



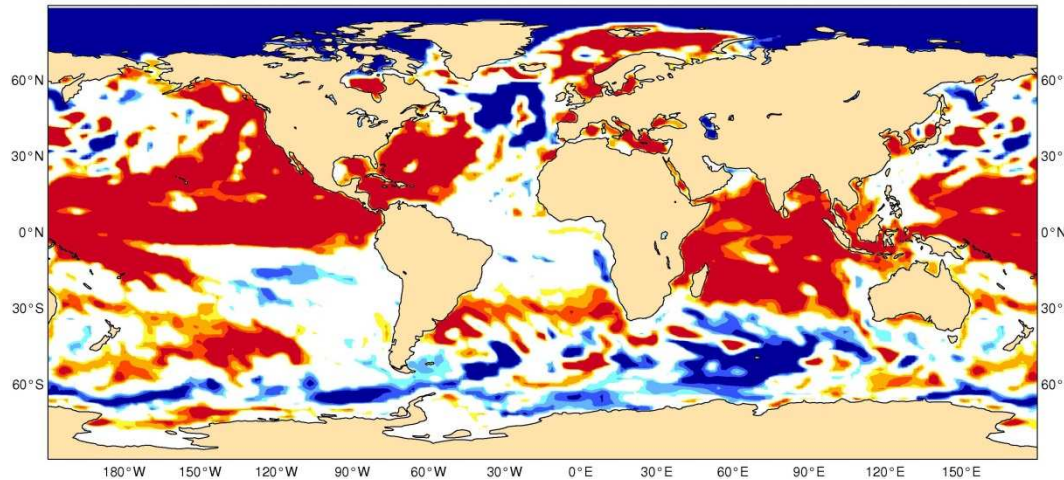
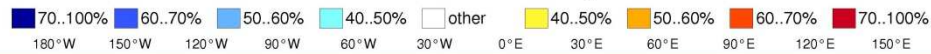
Anomaly Correlation Coefficient for ECMWF with 15 ensemble members
Sea Surface temperature
Hindcast period 1981-2010 with start in November average over months 2 to 4
Black dots for values significantly different from zero with 95% confidence (1000 samples)



ECMWF Seasonal Forecast
Prob(most likely category of forecast SST)
Forecast start reference is 01/11/14
Ensemble size = 51, climate size = 450

System 4
DJF 2014/15

<---- below lower tercile above upper tercile ---->



Tercile probabilities

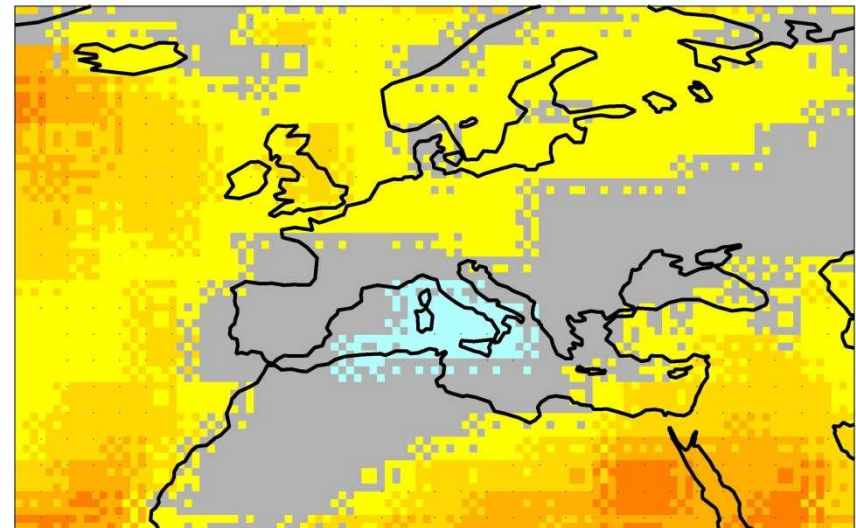
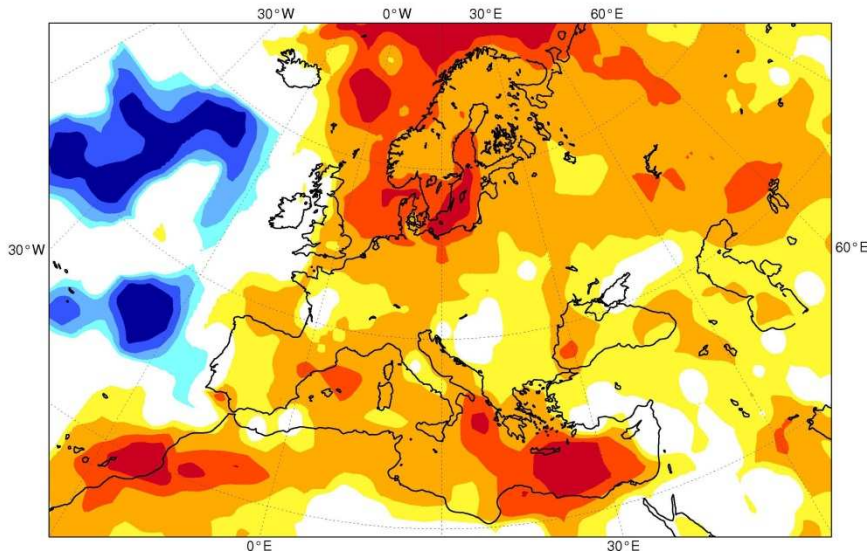
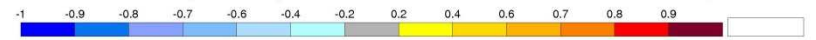
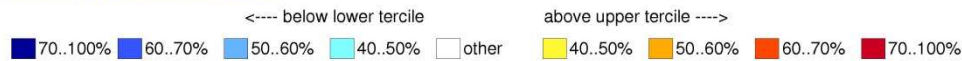
ACC skill (1981-2010)

ECMWF forecast: DJF 2mT

ECMWF Seasonal Forecast
 Prob(most likely category of 2m temperature)
 Forecast start reference is 01/11/14
 Ensemble size = 51, climate size = 450

System 4
 DJF 2014/15

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)



Tercile probabilities

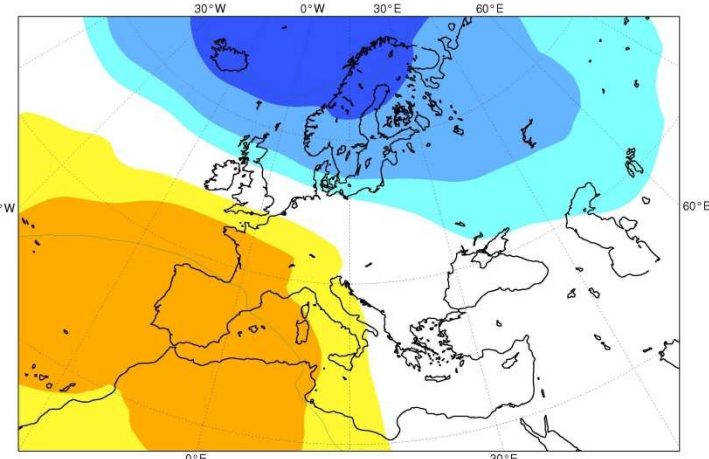
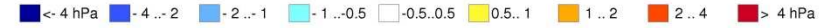
ACC skill (1981-2010)

ECMWF forecast: DJF mslp

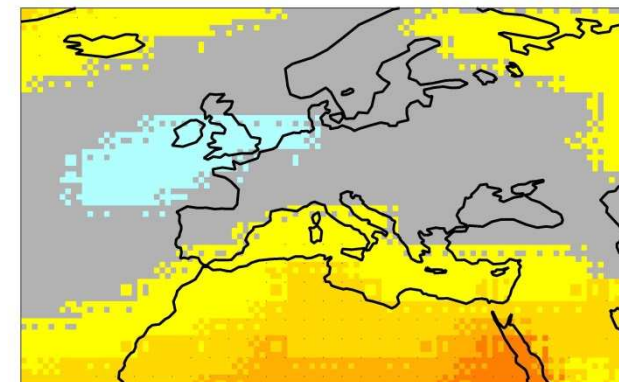
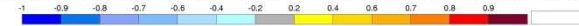
Ensemble mean

ECMWF Seasonal Forecast
 Mean MSLP anomaly
 Forecast start reference is 01/11/14
 Ensemble size = 51, climate size = 450

System 4
 DJF 2014/15
 Solid contour at 1% significance level

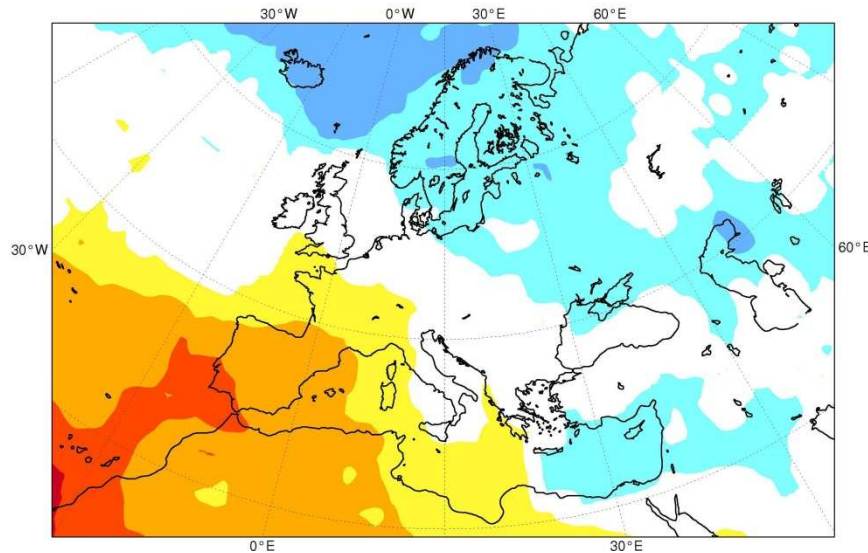
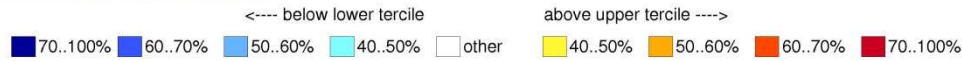


Anomaly Correlation Coefficient for ECMWF with 15 ensemble members
 Mean sea level pressure
 Hindcast period 1981-2010 with start in November average over months 2 to 4
 Black dots for values significantly different from zero with 95% confidence (1000 samples)



System 4
 DJF 2014/15

ECMWF Seasonal Forecast
 Prob(most likely category of MSLP)
 Forecast start reference is 01/11/14
 Ensemble size = 51, climate size = 450



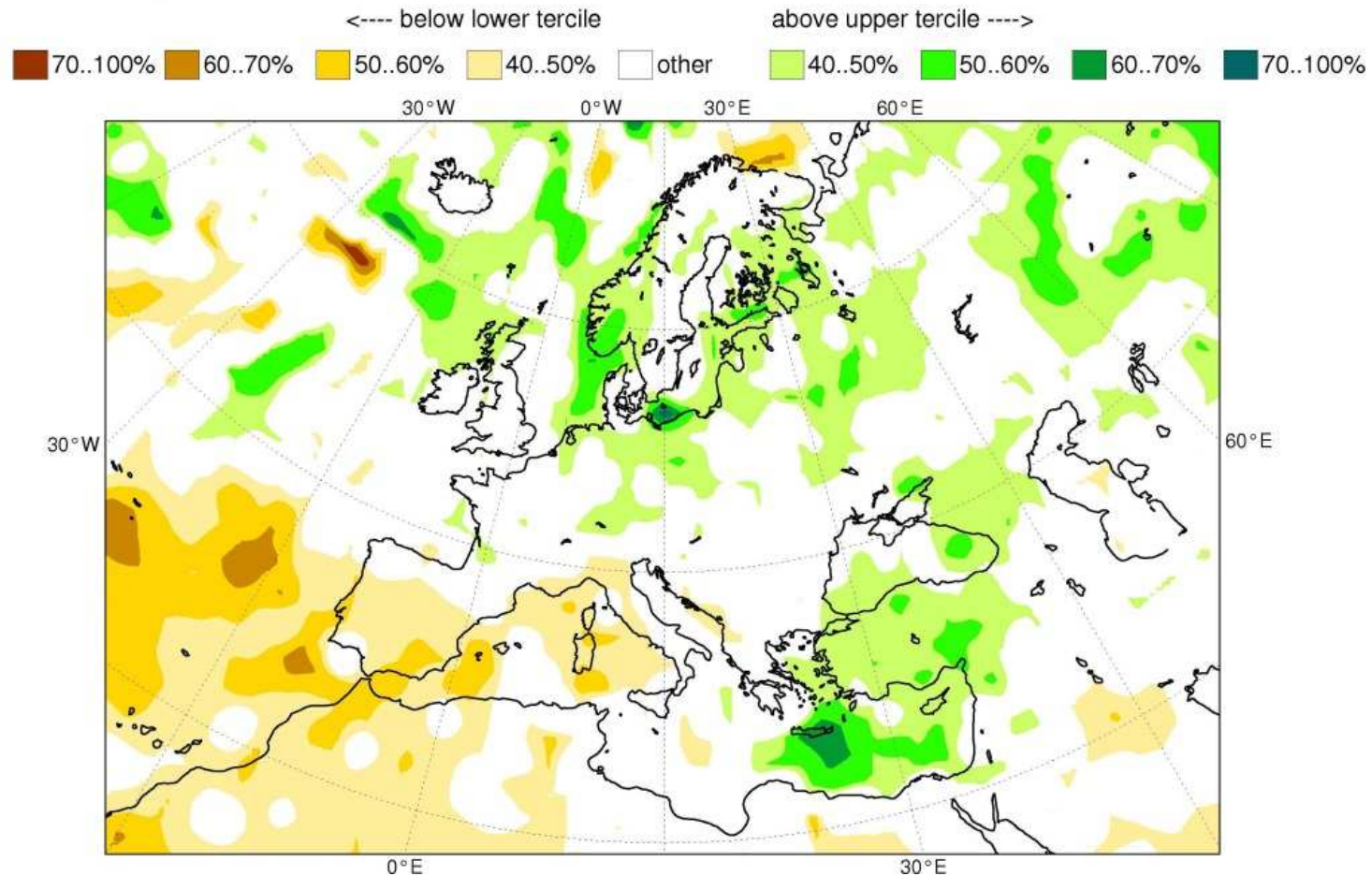
Tercile probabilities

ACC skill
 (1981-2010)

ECMWF forecast: DJF precip

ECMWF Seasonal Forecast
Prob(most likely category of precipitation)
Forecast start reference is 01/11/14
Ensemble size = 51, climate size = 450

System 4
DJF 2014/15



Tercile probabilities

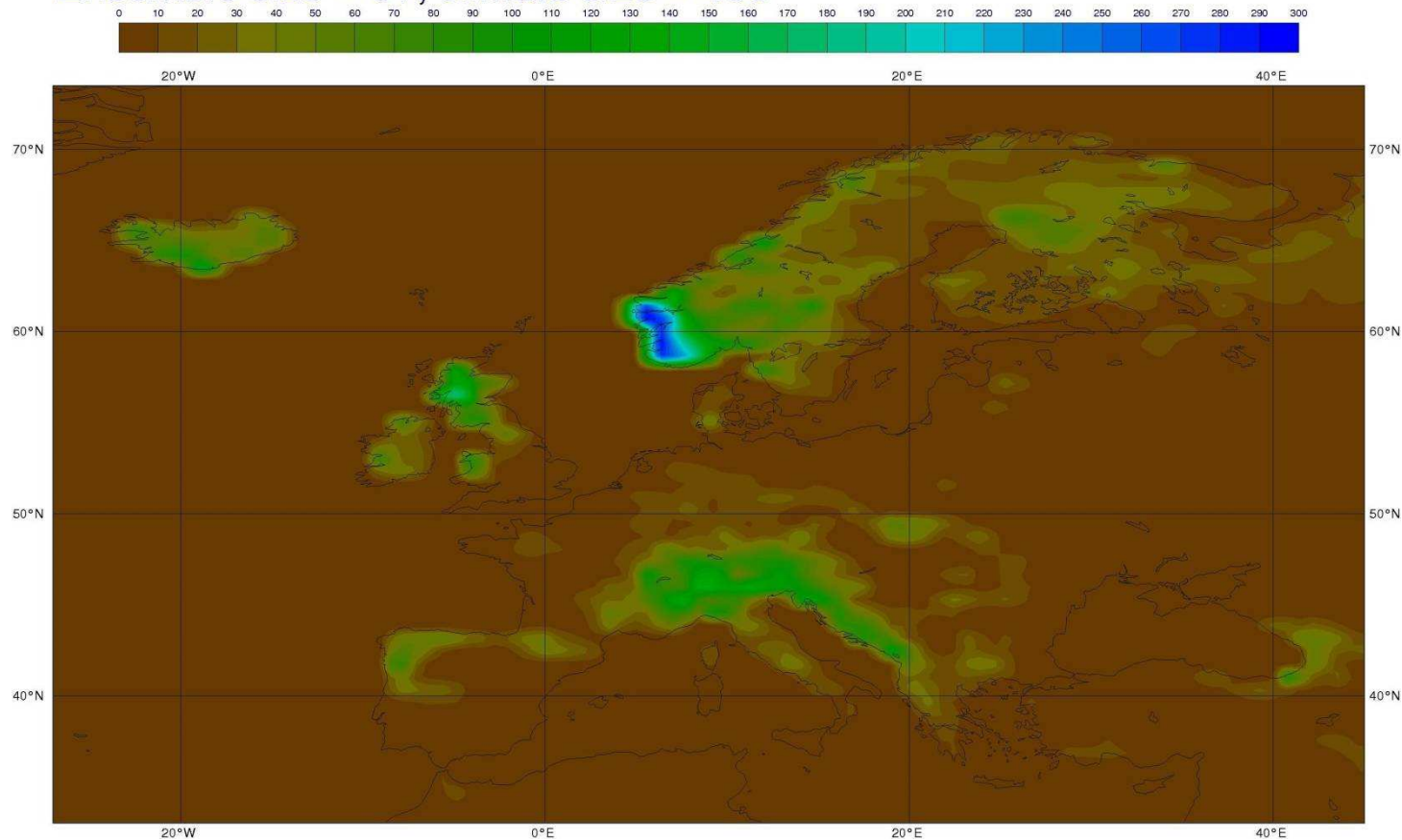
ECMWF forecast: DJF runoff

ECMWF Seasonal Forecast

Ensemble Mean, Accumulated runoff (mm) - DJF 2014

Forecast start reference is 01/11/2014

Ensemble size = 51, climate size = 450



Ensemble mean

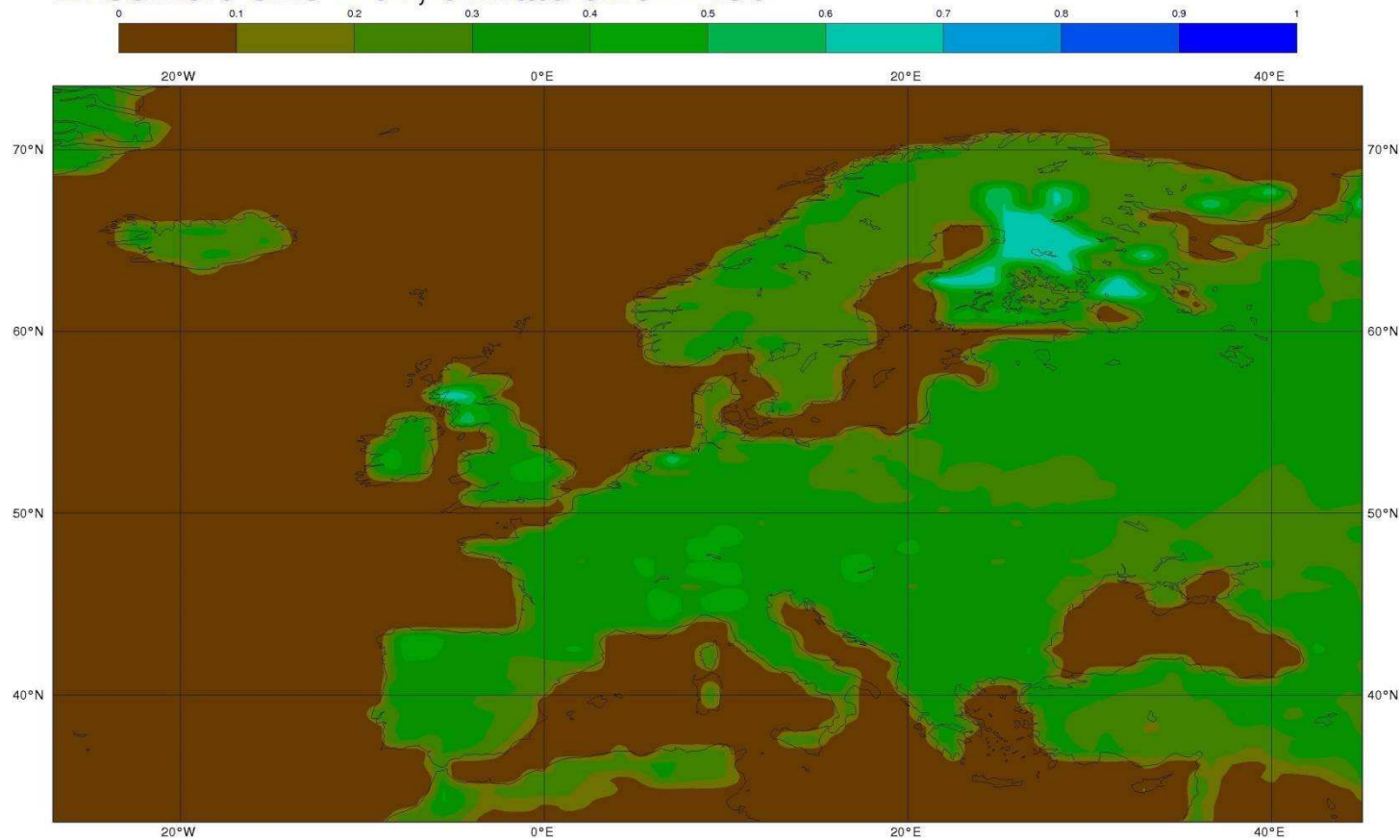
ECMWF forecast: DJF soil moisture

ECMWF Seasonal Forecast

Ensemble Mean, Volumetric Soil Water - L1 ($\text{m}^3 \text{m}^{-3}$) - DJF 2014

Forecast start reference is 01/11/2014

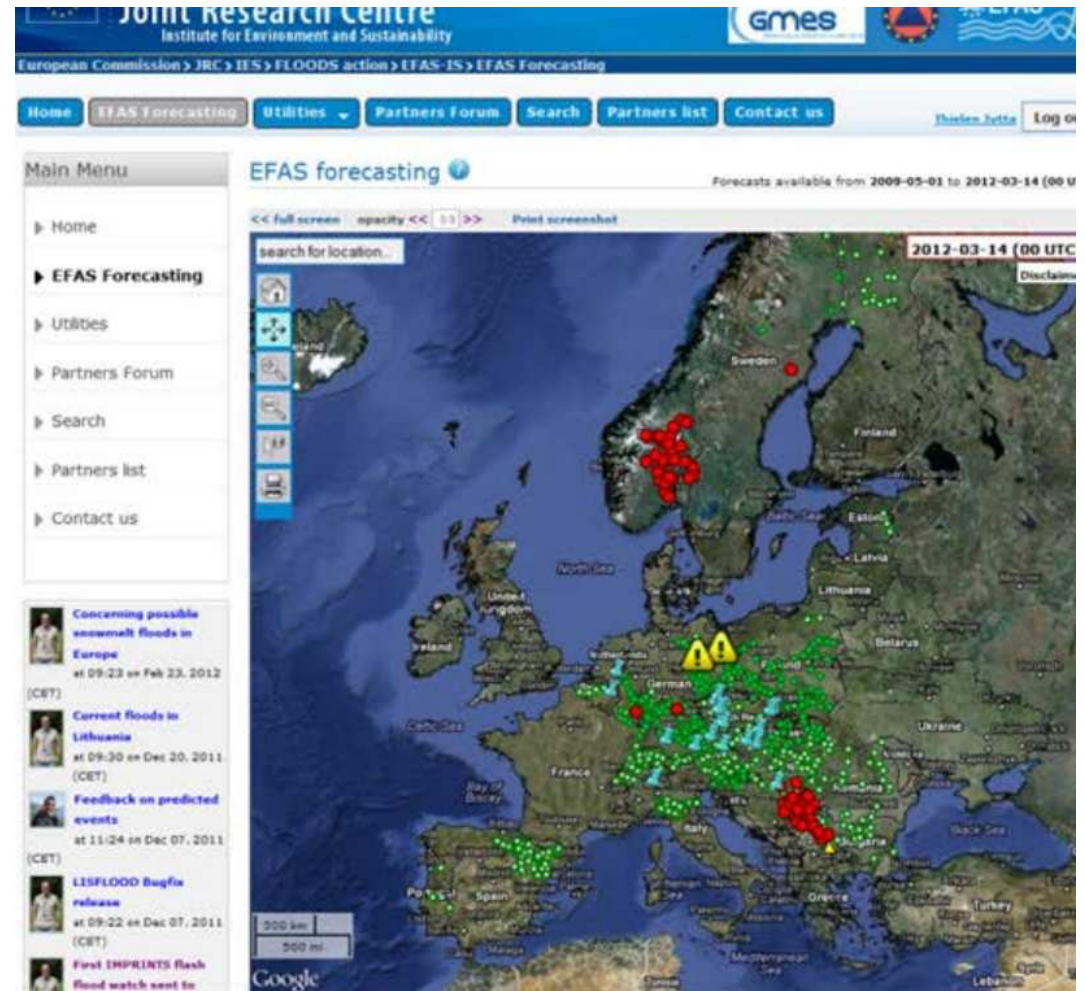
Ensemble size = 51, climate size = 450



Ensemble mean

European Flood Awareness System (EFAS)

- <http://www.ecmwf.int/en/research/projects/efas>
- <https://www.efas.eu/>



SPECS / EUPORIAS / C3S

EUPORIAS



SPECS

Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

Project runs from Nov 2012 until Jan 2017



UNIVERSITY OF LEEDS



© ECMWF MedCOF3 - Antalya - 17th ~ 18th November 2014



Euporias

- **What: “Prototypes” of stakeholder projects representing possible uses of seasonal forecasts (SFs)**
- **Why: To understand appreciation and use of SFs across Europe**
- **How: Extensive user survey (face-to-face interviews, web, etc.):**
 - Relatively few people/companies use SFs
exceptions: energy, water, transport and health, larger companies
 - SFs mostly used as qualitative information/ background
 - **Main problems: Low skill, low resolution, lack of accessibility**
 - Wanted are T, precip, wind, solar radiation, humidity

→ **See EUPORIAS report soon to come**

SPECS

Goal is to improve on seasonal forecasting by looking at

Horizontal resolution

Stochastic representations

Empirical predictions

Forecast visualisation & Outreach

Forecast quality

Calibration & combination

Climate-vegetation representation

Ensemble generation

Pilot applications (cf. Euporias)

Stratosphere & radiative forcing

Land-surface initialisations

Local predictions (statistical & dynamical downscaling)

Sources of skill

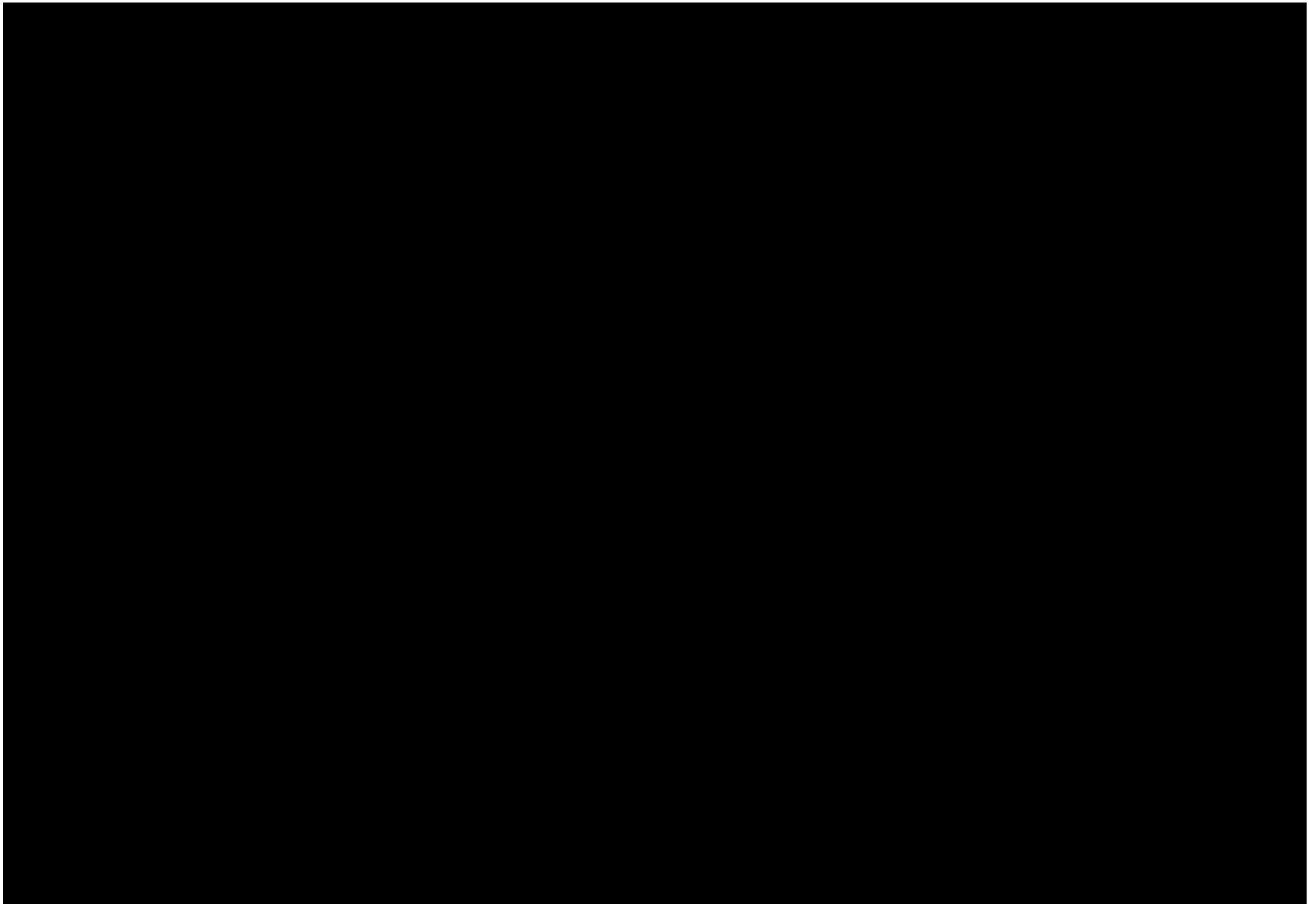
Copernicus Climate Change Service (C3S)

Goals:

- informing policy development to protect citizens from climate-related hazards such as high-impact weather events;
- improving planning of mitigation and adaptation practices for key human and societal activities;
- promoting the development of new services for the benefit of society.

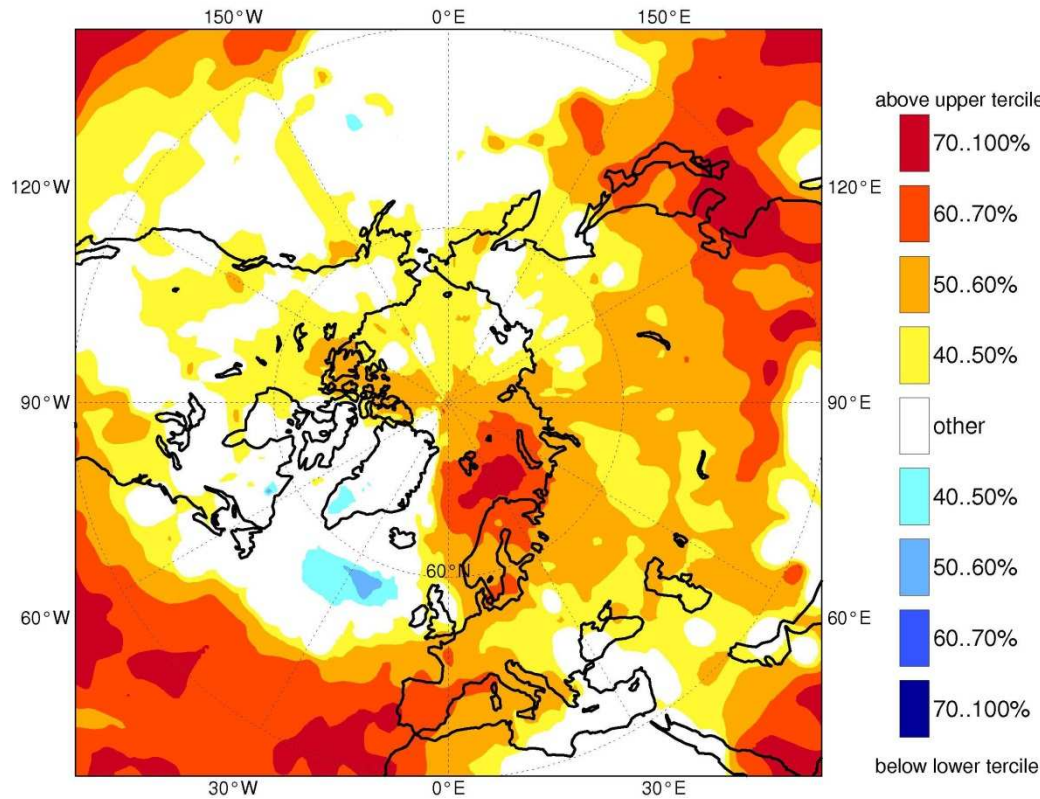
•More info:

<http://www.ecmwf.int/en/about/what-we-do/copernicus/copernicus-climate-change-service>



ECMWF forecast: DJF T850hPa

ECMWF Seasonal Forecast
 Prob(most likely category of T850)
 Forecast start reference is 01/11/14
 Ensemble size = 51, climate size = 450

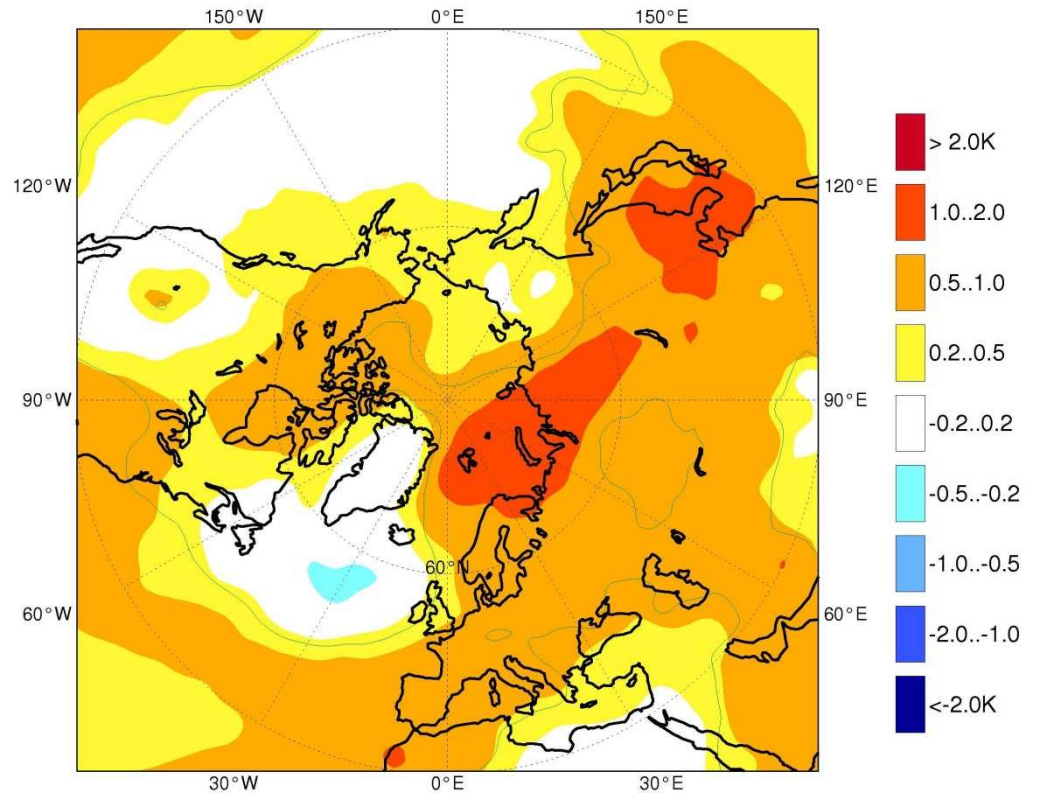


Tercile probabilities

System 4
 DJF 2014/15

ECMWF Seasonal Forecast
 Mean T850 anomaly
 Forecast start reference is 01/11/14
 Ensemble size = 51, climate size = 450

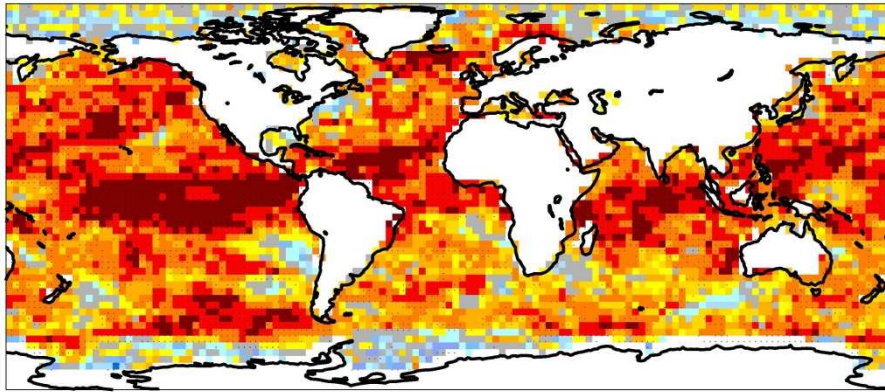
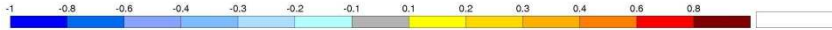
System 4
 DJF 2014/15
 Solid contour at 1% significance level



Ensemble mean anomaly

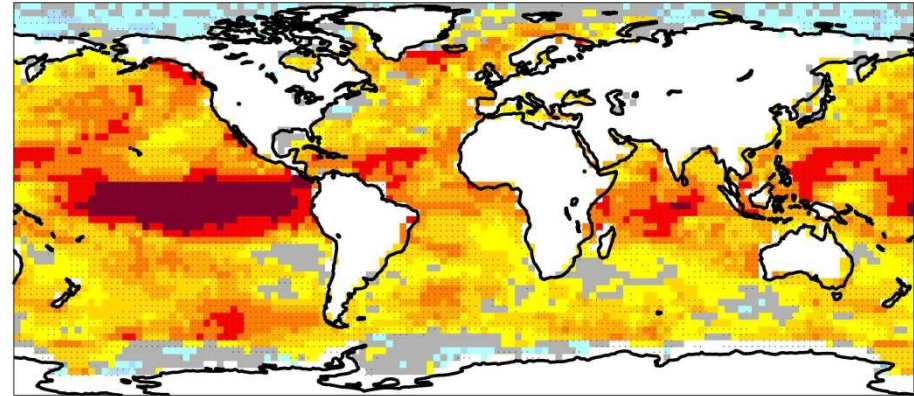
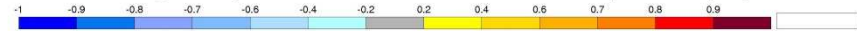
ECMWF forecast: DJF sst

ROC Skill Score for OFecmIEXys4SY00M1 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 computed ranking the sample
 Black dots for values significantly different from zero with 95% confidence (1000 samples)

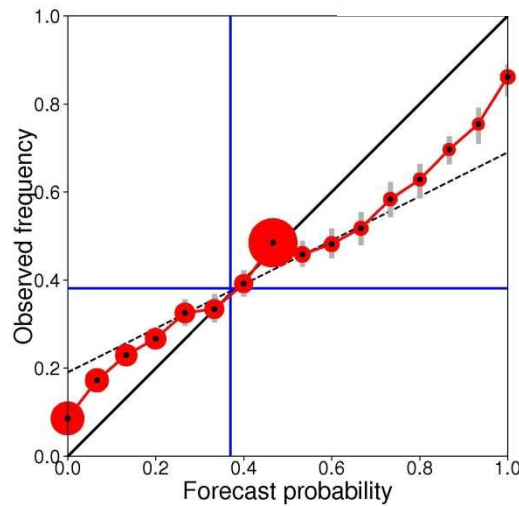


ROC skill scores

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)



reliability