Estimation of the model climate (reforecasts)

Linus Magnusson
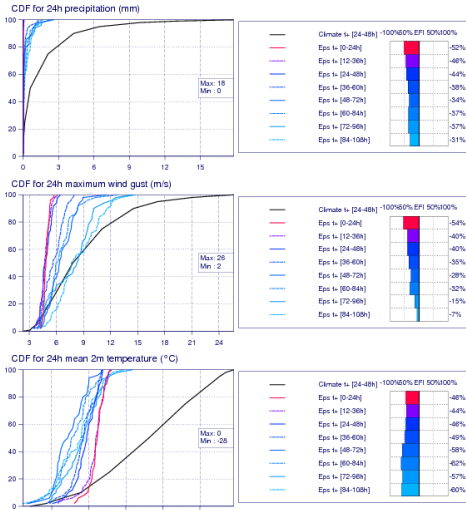
ECMWF

Model climate from reforecasts

Why do we need reforecasts?

Motivation 1:

Tarfala   **Nikkaloukta**
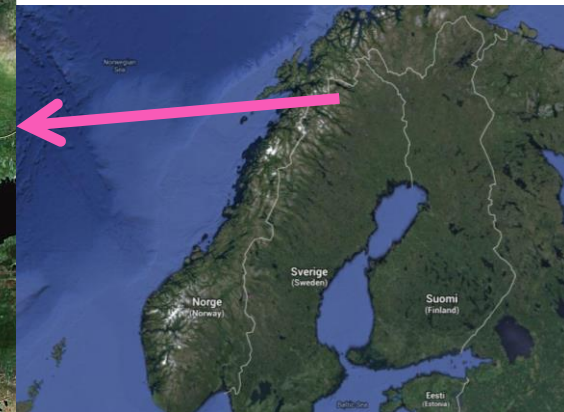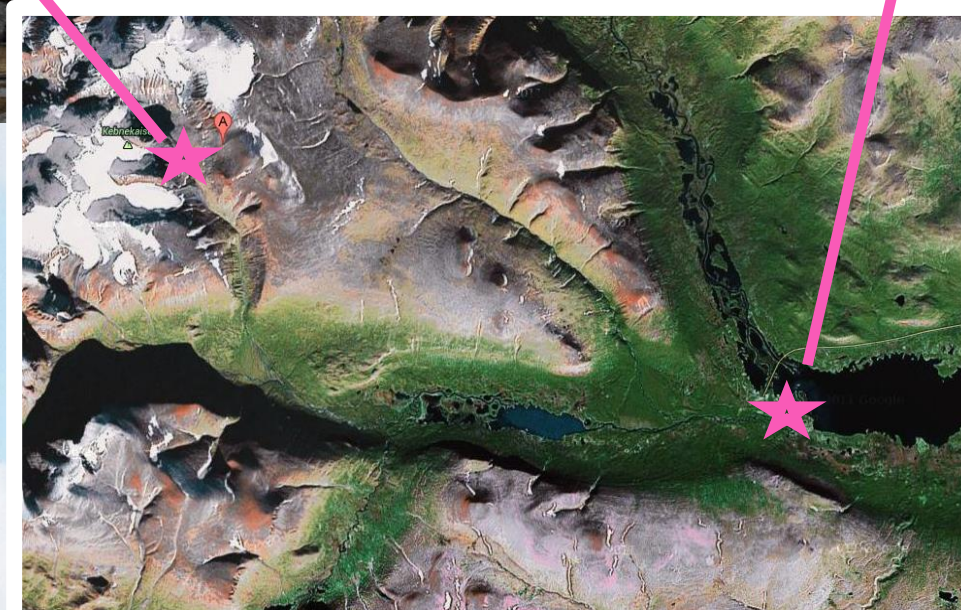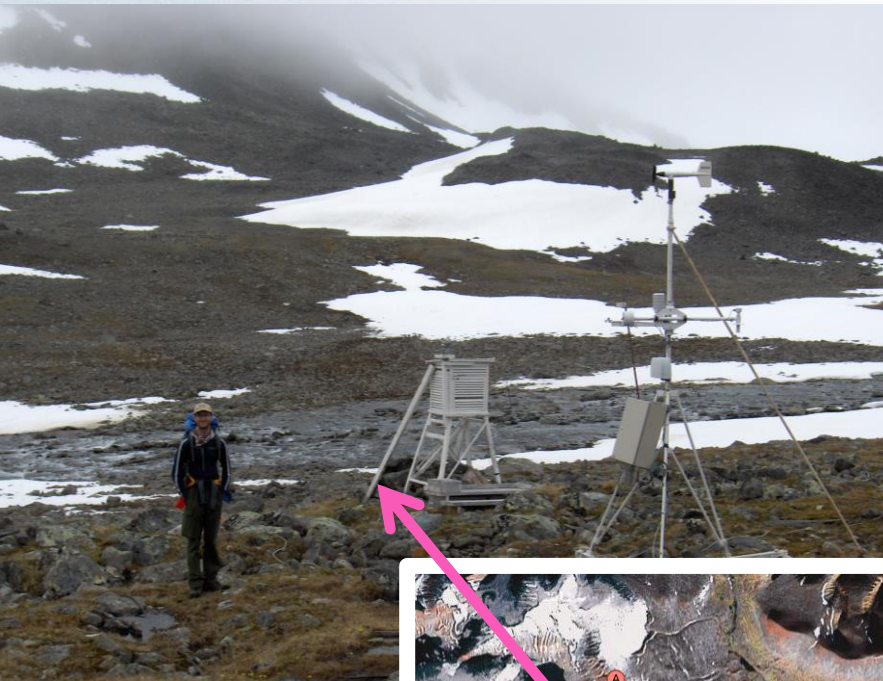
17 km between the stations, ENS resolution 18 km..

Motivation 2:

28 November 2013 00 UTC T+120 VT:Tuesday 3 December 2013 00 UTC
ontrol run (bottom legend, 2C contour interval near extrema).
50% only). climatological sea ice cover in magenta (>= 50%).

+120h

y 28 November 2013 00 UTC T+240 VT:Sunday 8 December 2013 00 UTC
ontrol run (bottom legend, 2C contour interval near extrema).
50% only). climatological sea ice cover in magenta (>= 50%).

+240h
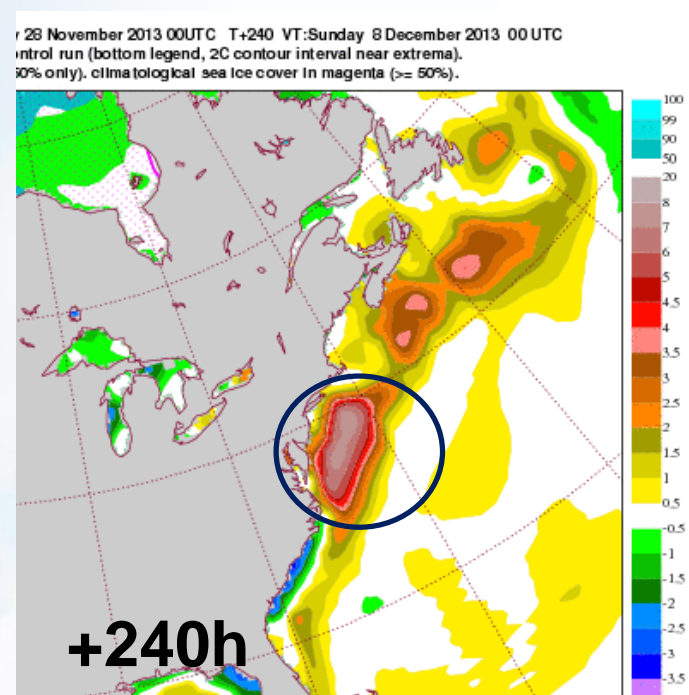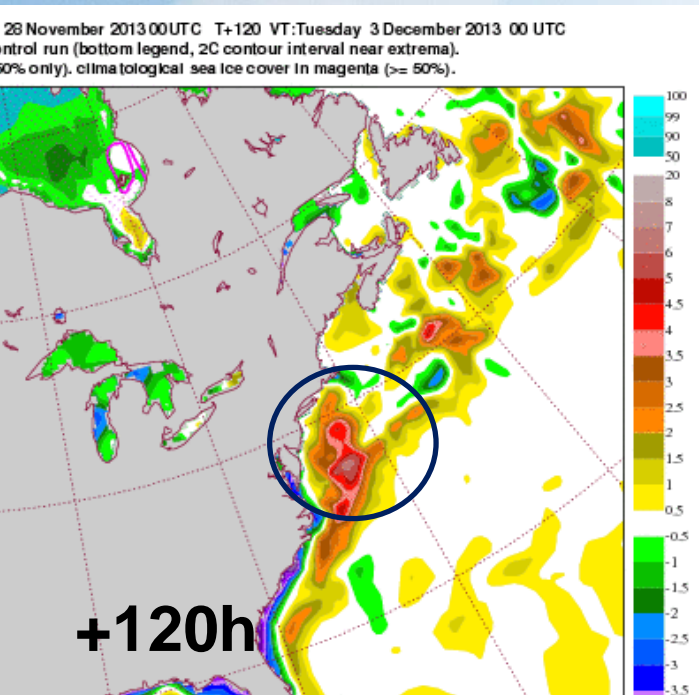
SST anomaly
(from the obs.
climatology)

Forecasts from 28
Nov 0 UTC

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Model bias day 10
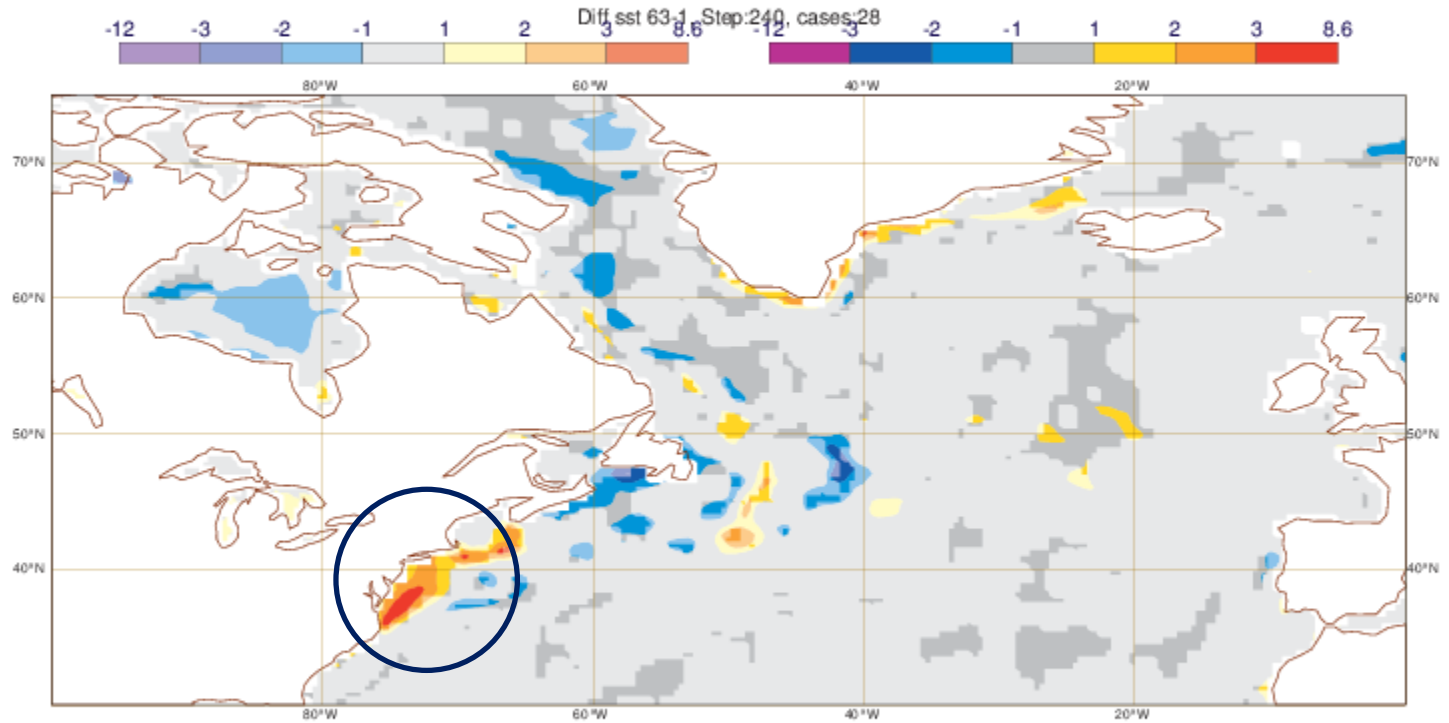
Anomaly in respect to model climate (weekly mean)
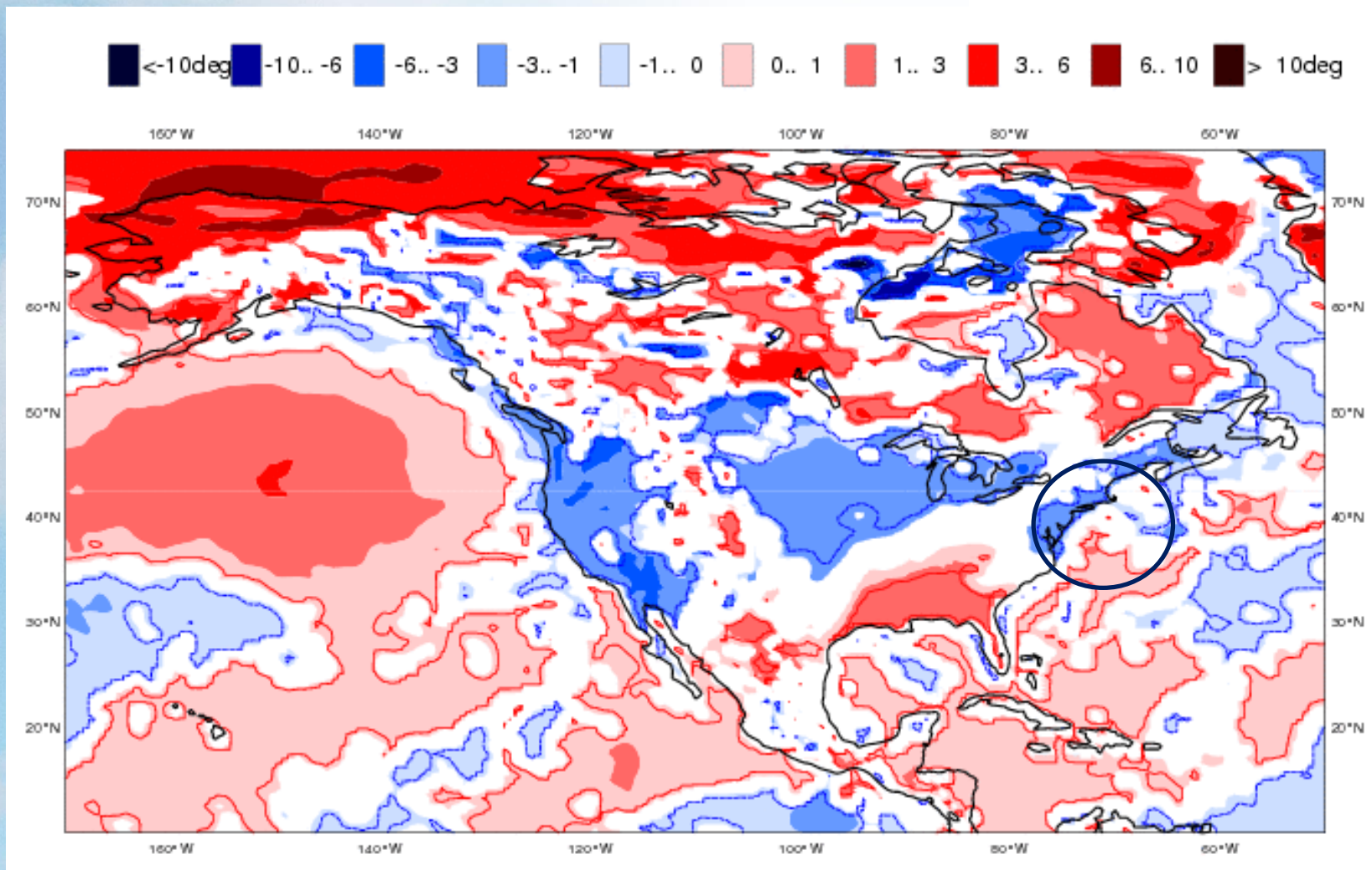
Why do we need reforecasts?

- Local conditions that is not covered by the model grid (look at anomalies to the model climate)
- Account for systematic errors in the model
- Account for model drift (change in systematic error with lead time)

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Aim of reforecasts:
Sampling the climatology of the current model version

Configuration of reforecasts

Example: Thursday 28 January 2016:

28 January 2016 :   28 January 1997 :   28 January 2015:

20 years x 11 forecasts = 220 forecasts
Present model version
Ensemble configuration to 45 days
Initialised from ERA Interim

Twice a week + 5 weeks window for EFI
= 1980 forecasts

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Example: 2-metre temperature values for 132-hour reforecasts

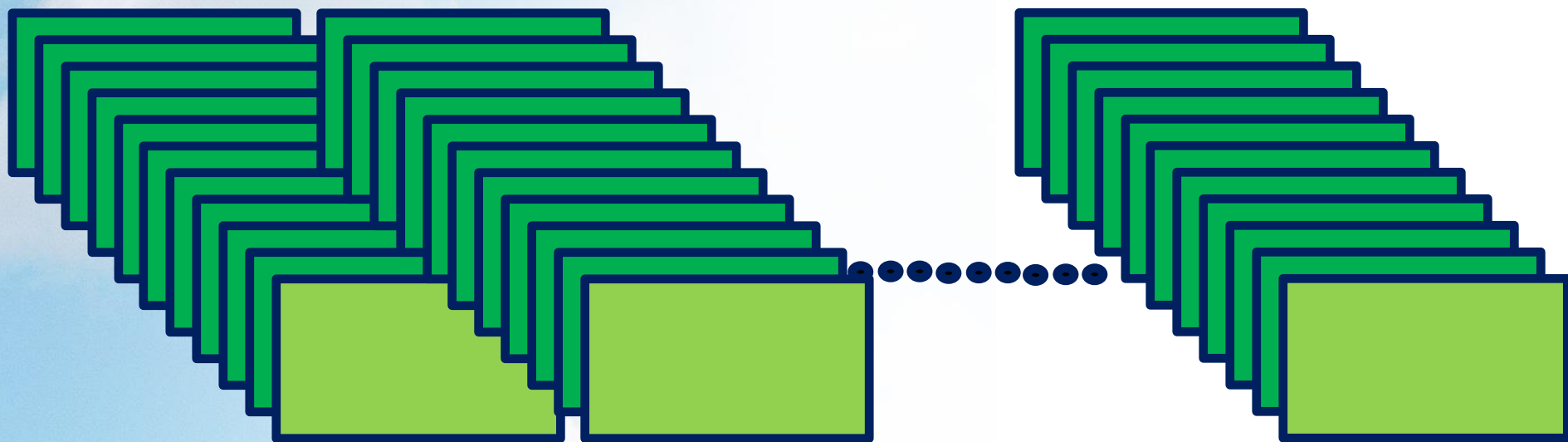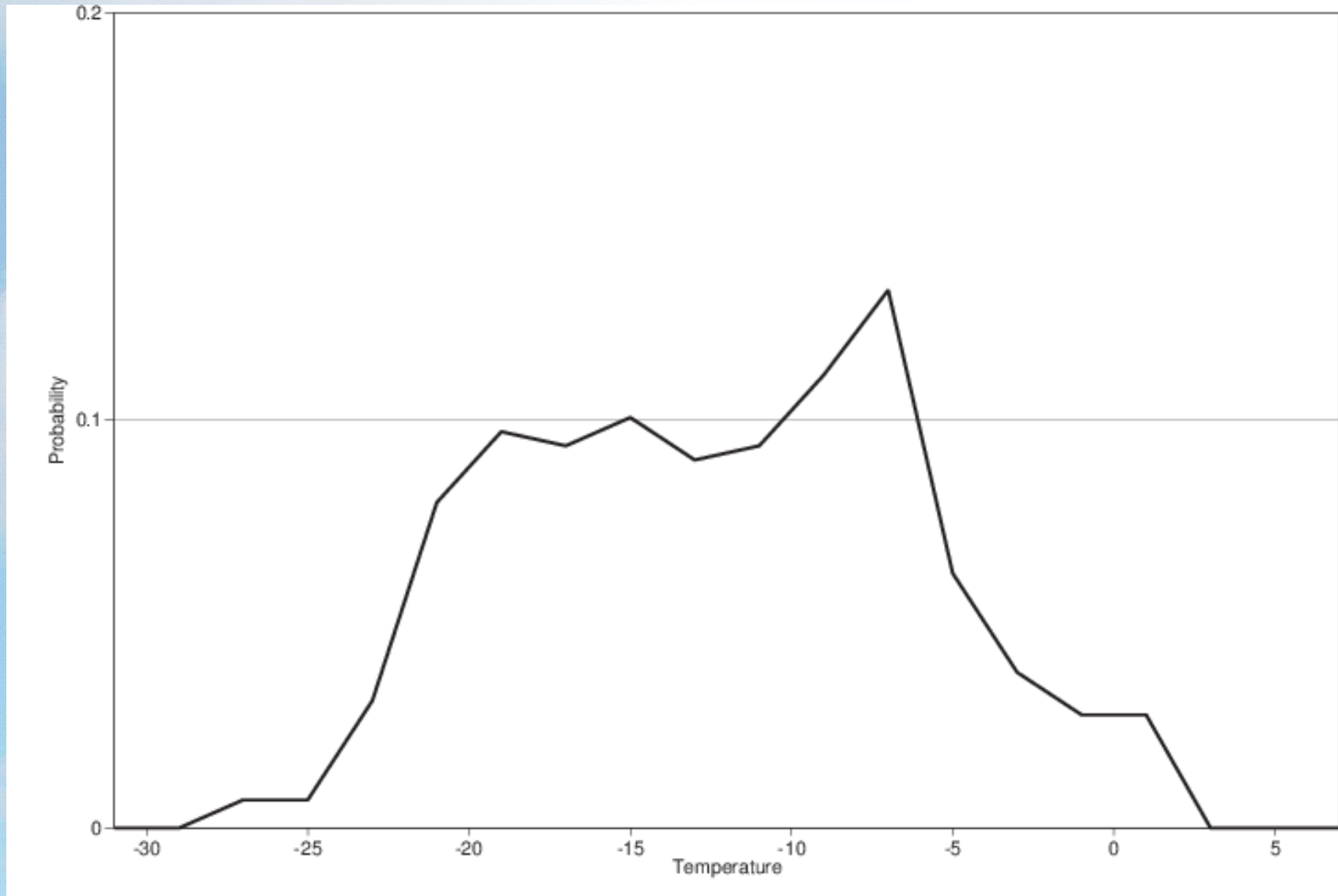|							
-11	-16	-16	-23	-22	-19	-19	-12
-17	-11	-13	-18	-18	-21	-18	-20
-12	-17	-22	-22	-21	-19	-7.6	-6.2
-8.9	-6.7	-24	-21	-26	-18	-8.2	-8.4
-11	-13	-19	-11	-13	-9.7	-24	-18
-20	-25	-6.8	-9.1	-6.9	-6.9	-15	-15
-15	-16	-21	-11	-15	-19	-24	-21
-26	-22	-15	-15	-17	-15	-18	-21
-5.4	-20	-3	-5.7	-8.8	-5.4	-21	-12
-9.4	-17	-8.6	-7.3	-9	-10	-17	-21
-16	-19	-19	-23	-16	-18	-22	-21
-20	-24	-15	-16	-13	-21	-17	-20
-21	-19	-4.6	-3.7	-6.8	-5.9	-8.1	-11
-7.7	-9.6	-10	-9.9	-12	-12	-12	-7.1
-20	-15	-9.5	-19	-12	-14		

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Probability distribution function (PDF)

Cumulative distribution function (CDF)

CDF T2M 12

mod 67.9 19
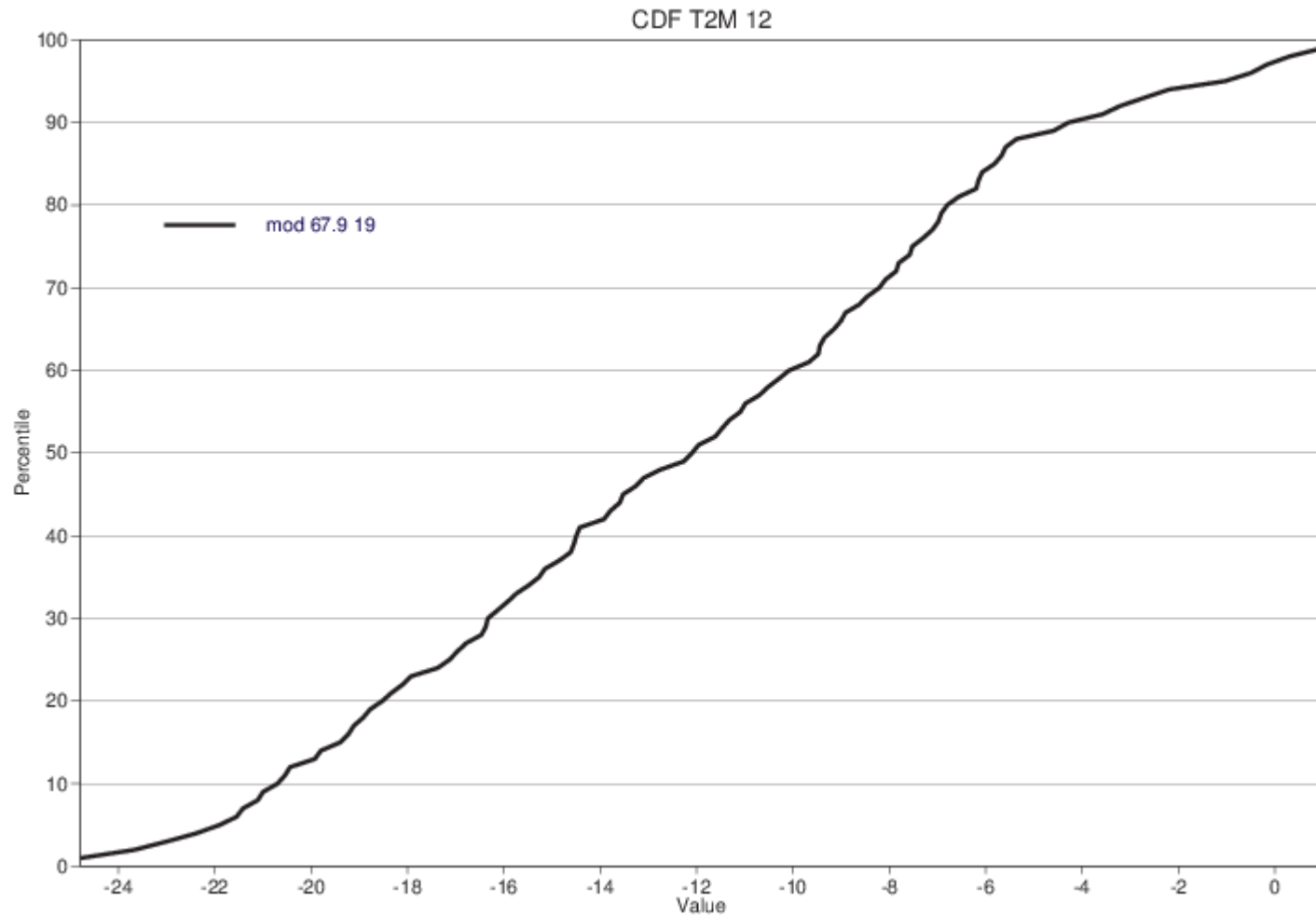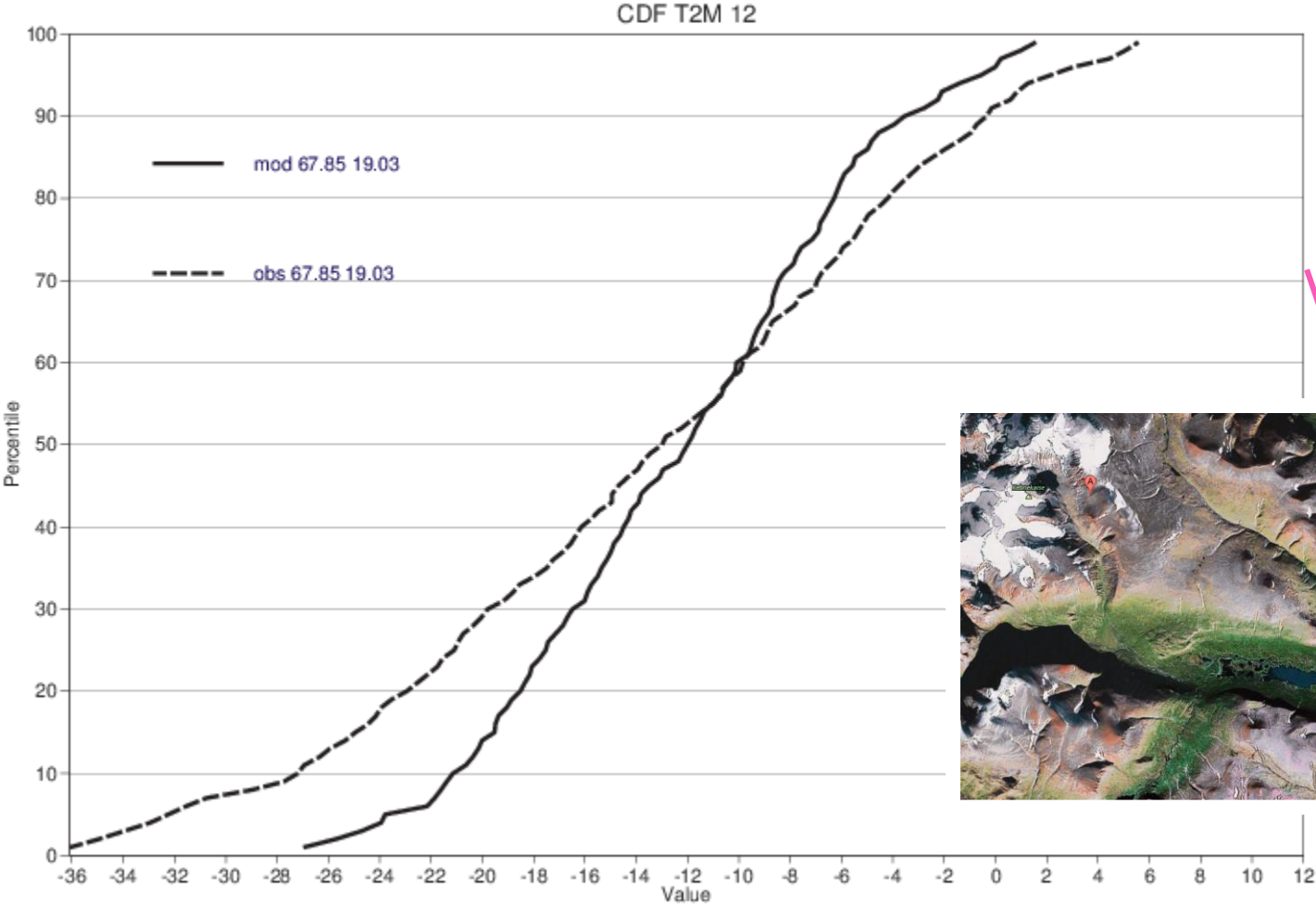
What is the probability for temperature < -10 ?
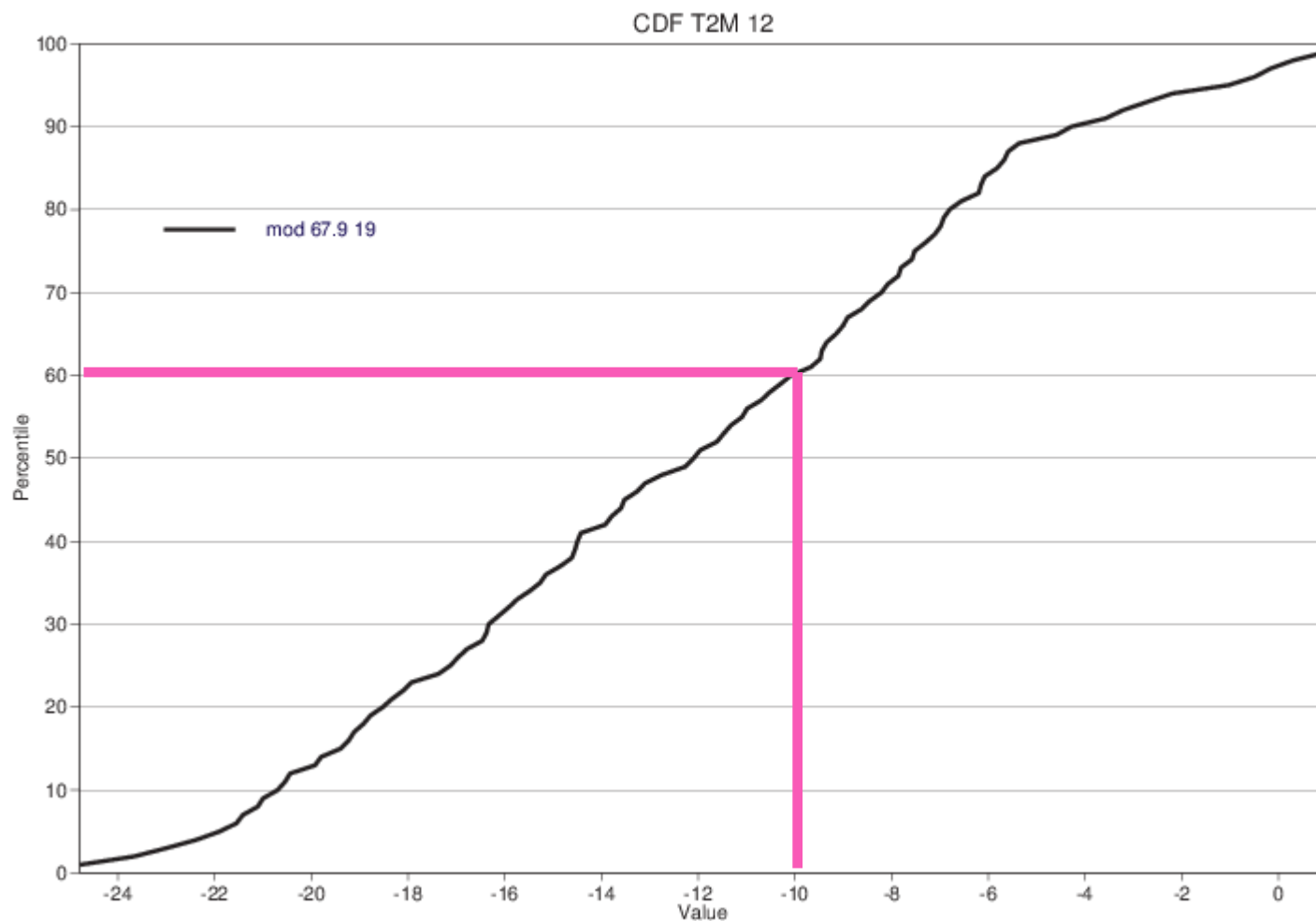
Cumulative distribution function
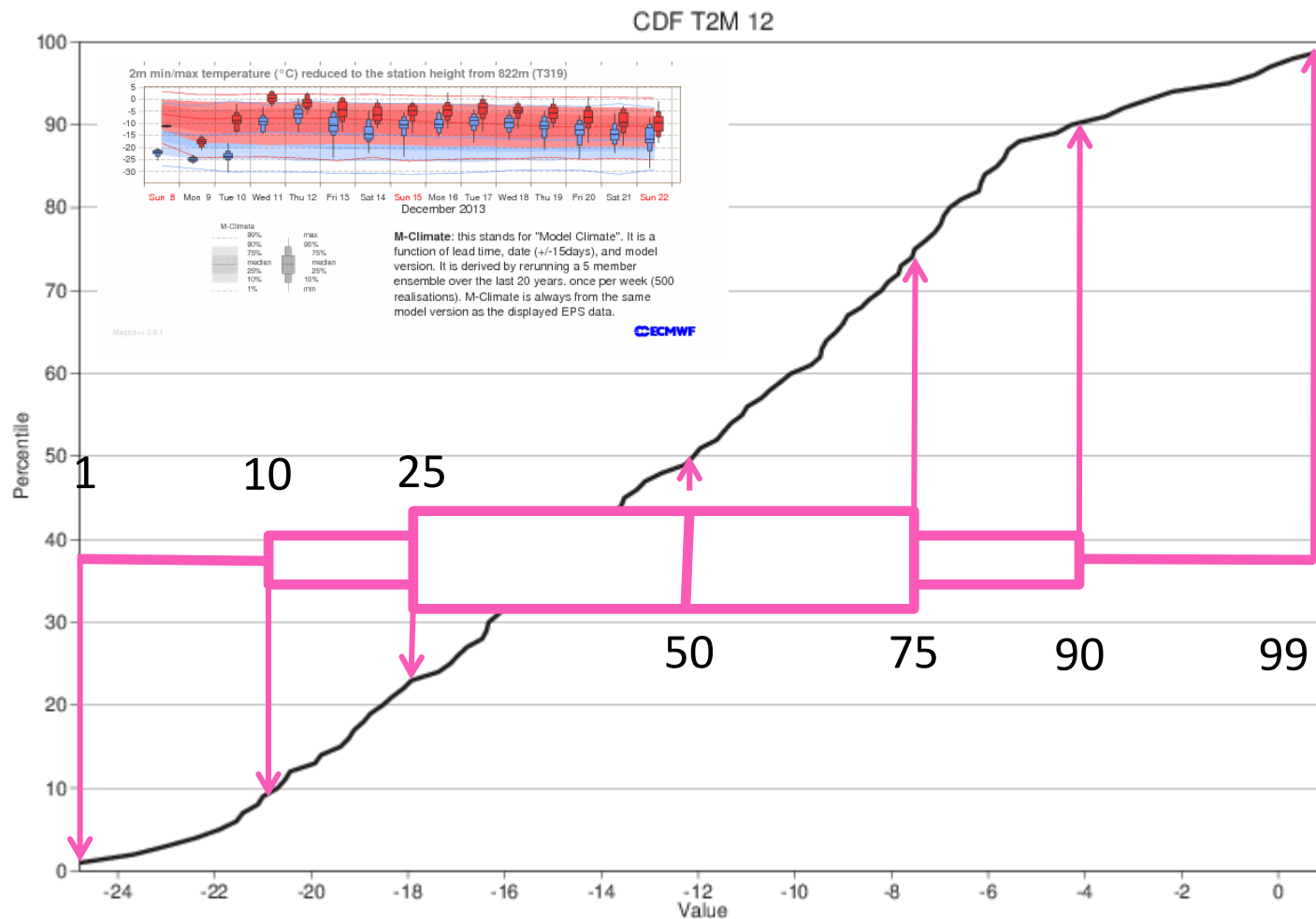
Model climate and observed climate (Nikkaloukta)
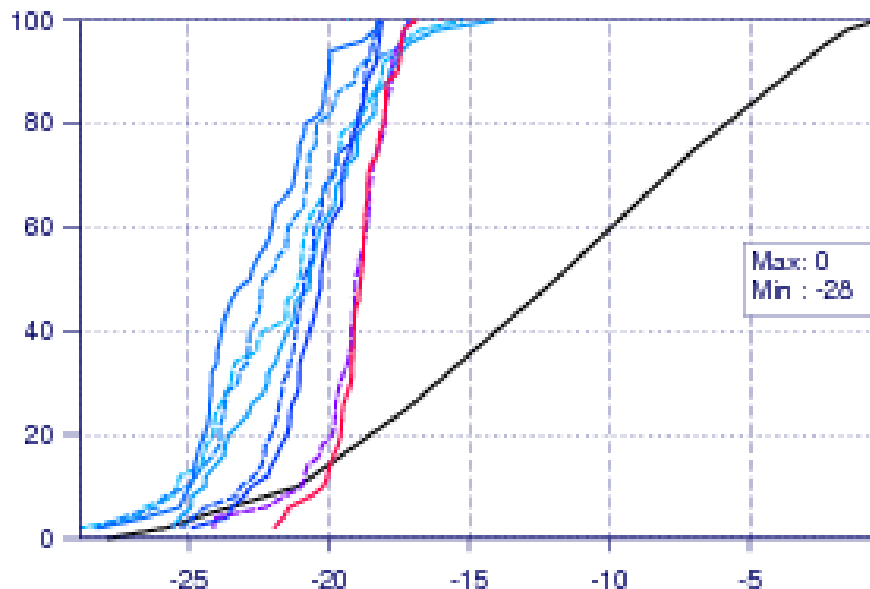

CDF T2M 12

mod 67.85 19.03

obs 67.85 19.03

Nearby stations (Nikkaloukta –black, Tarfala – green)
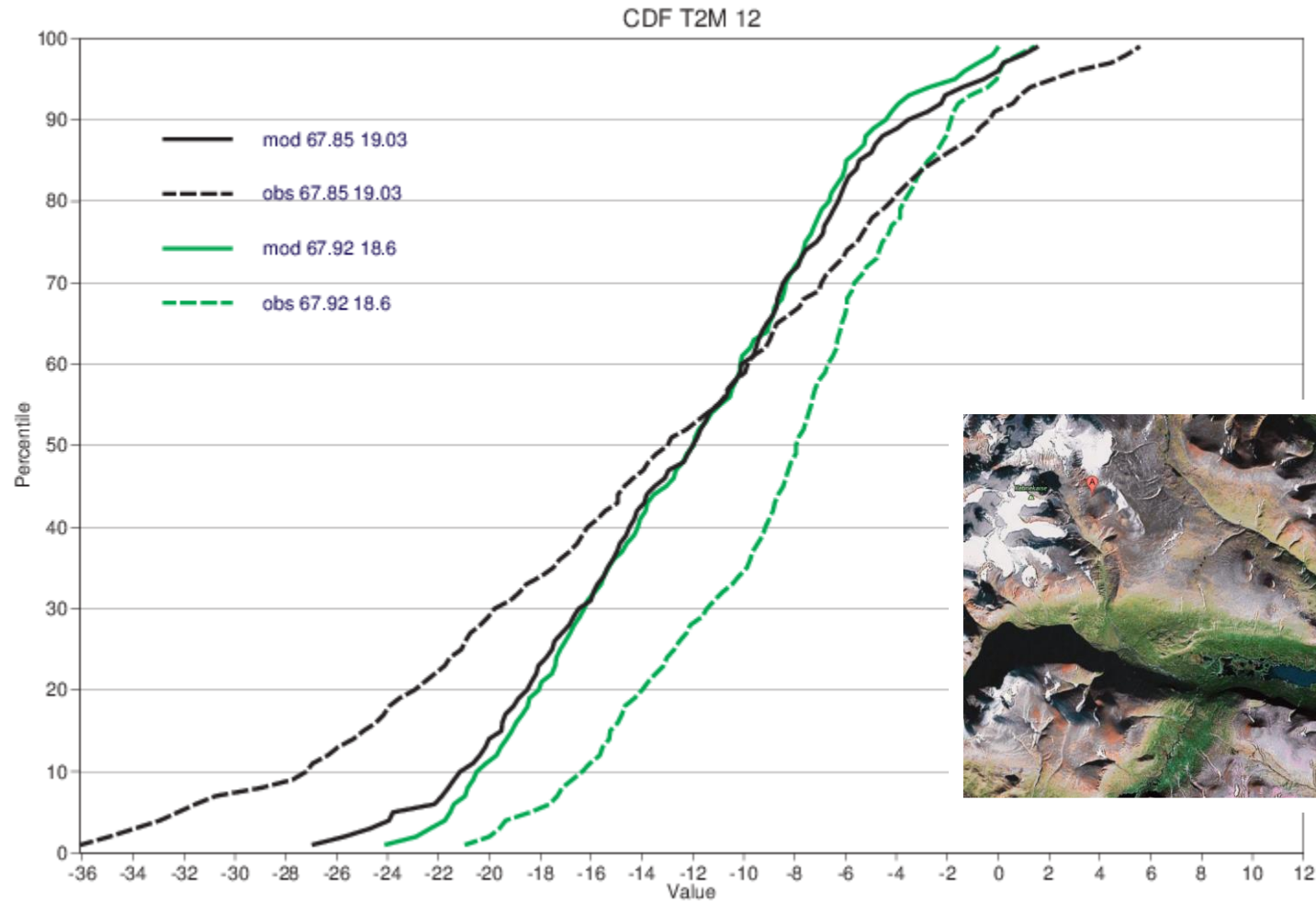
How to use the reforecast data set?

CDF for 24h mean 2m temperature (°C)

	Climate t+ [24-48h]	-100%50% EFI 50%100%
Eps t+ [0-24h]		-46%
Eps t+ [12-36h]		-44%
Eps t+ [24-48h]		-46%
Eps t+ [36-60h]		-49%
Eps t+ [48-72h]		-58%
Eps t+ [60-84h]		-62%
Eps t+ [72-96h]		-57%
Eps t+ [84-108h]		-60%

Max: 0
Min : -28

Max:
Min: 24-48h M-Climate extrema
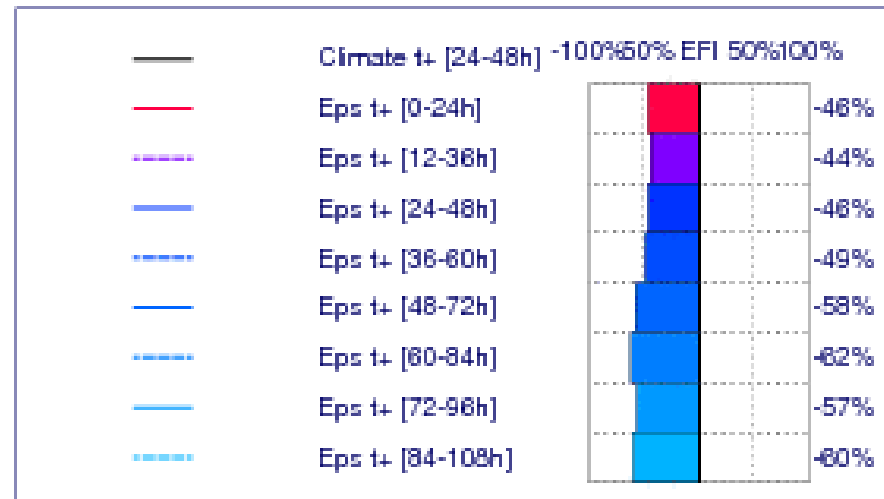
M-Climate: this stands for "Model Climate". It is a function of lead time, date (+/- ~15 days), and model version. It is derived by rerunning a 5 member ensemble, over the last 20 years, once a week (500 realisations). M-Climate is always from the same model version as the displayed EPS data. On this page only the 24-48h lead M-Climate is displayed.

Magics++ 2.8.1

# Sampling issues: Extreme forecasts (example from old configuration – motivation for the new)

- Need to sample the tails of the distribution
- Focus on short to medium range
- Problems with correlated forecasts (members, steps)

2013
28 November

5 December

12 December

19 December

26 December

5 x 5 x 20 = 500 fields
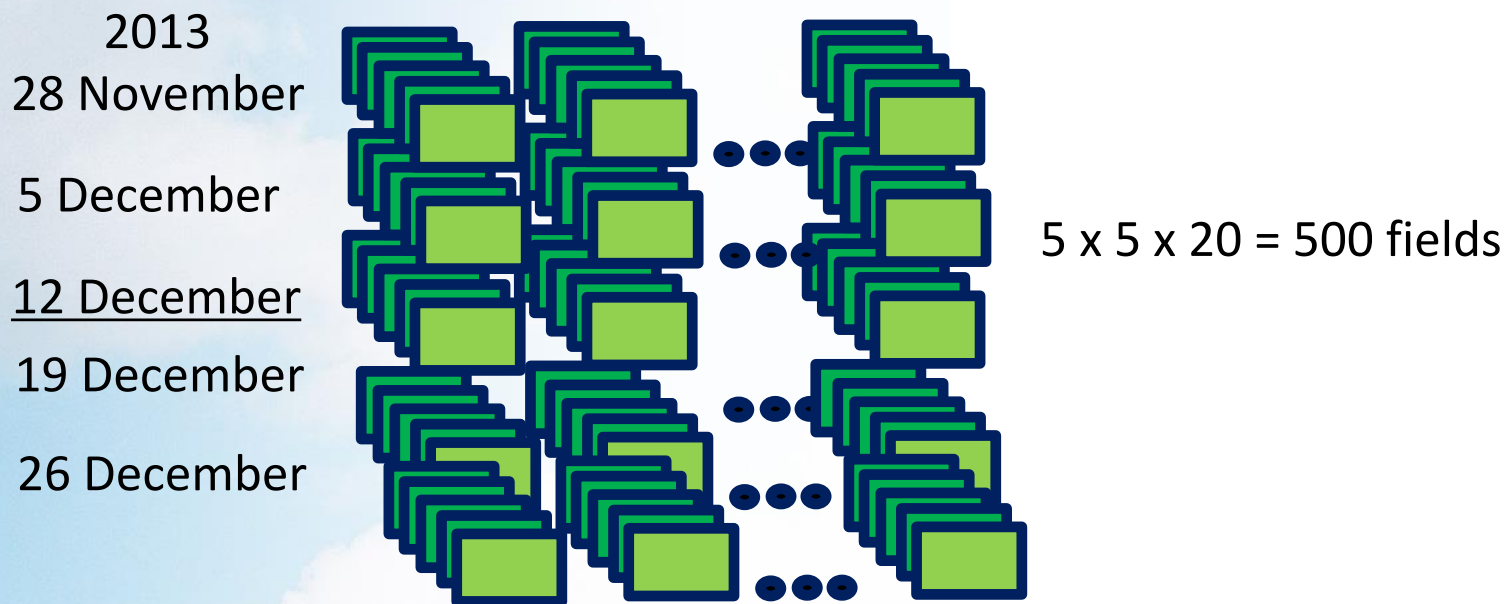
# 99th percentile of climate (24-hour max. wind gusts)

Day 1

Day 7

Thu 19 Dec 2013 00UTC ©ECMWF VT: Fri 20 Dec 2013 00UTC - Sat 21 Dec 2013 00UTC 0-24h
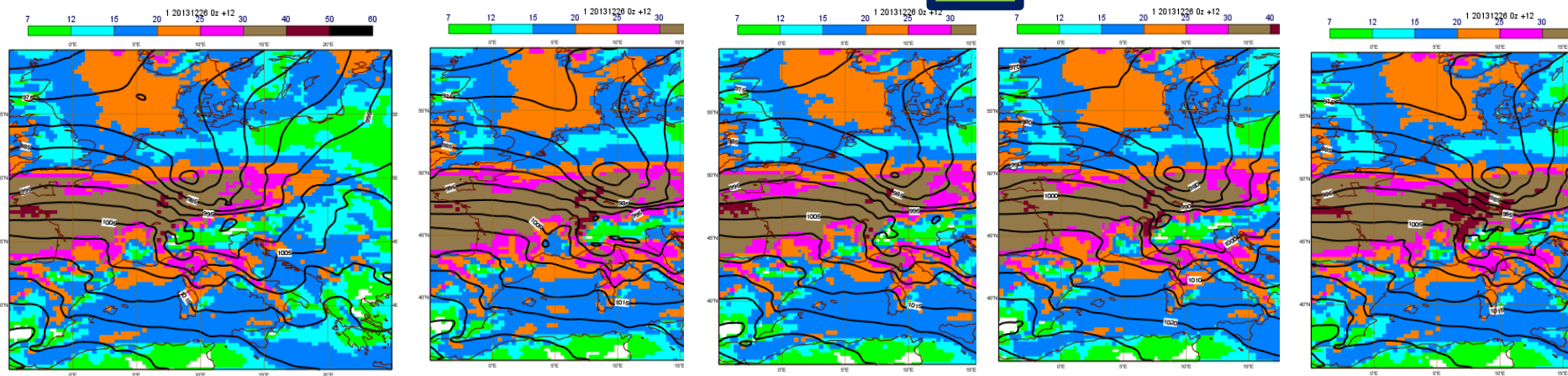10m wind gusts (in m/s) Model climate Q99 (one in 100 occasions realises more than value shown)
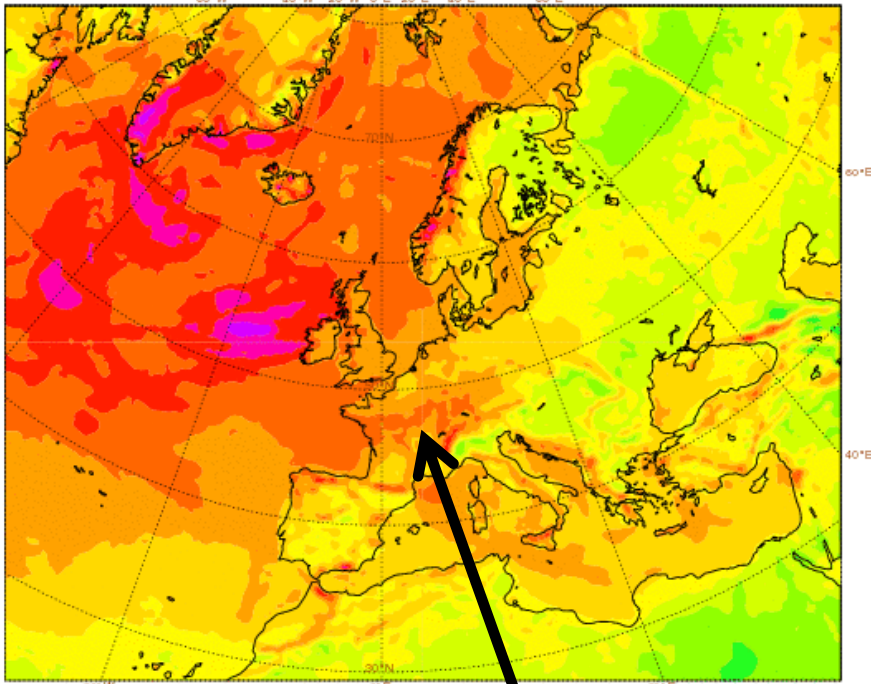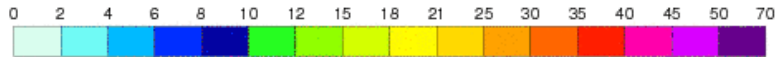
Thu 19 Dec 2013 00UTC ©ECMWF VT: Thu 26 Dec 2013 00UTC - Fri 27 Dec 2013 00UTC 144-168h
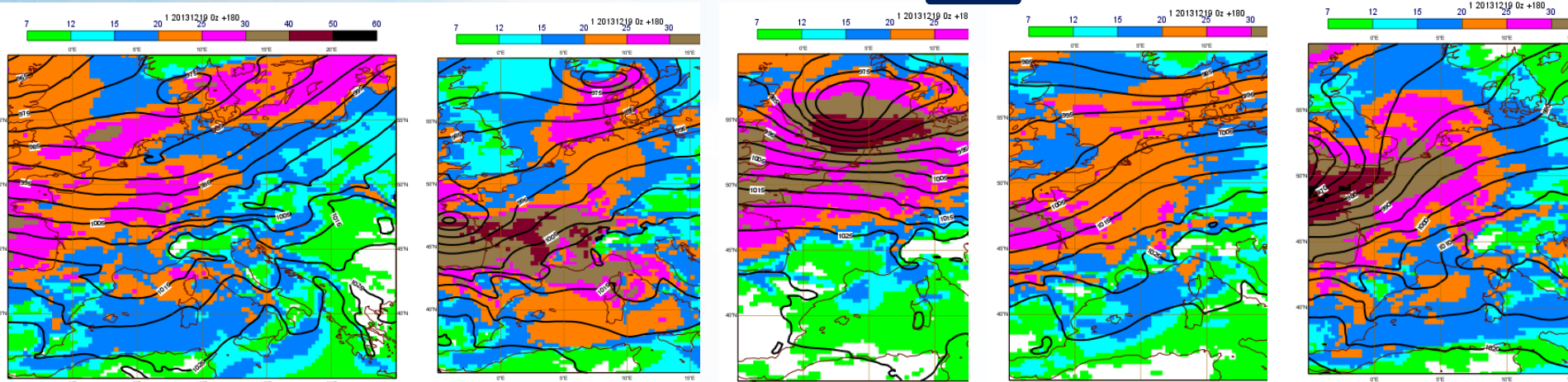10m wind gusts (in m/s) Model climate Q99 (one in 100 occasions realises more than value shown)

30-35 m/s
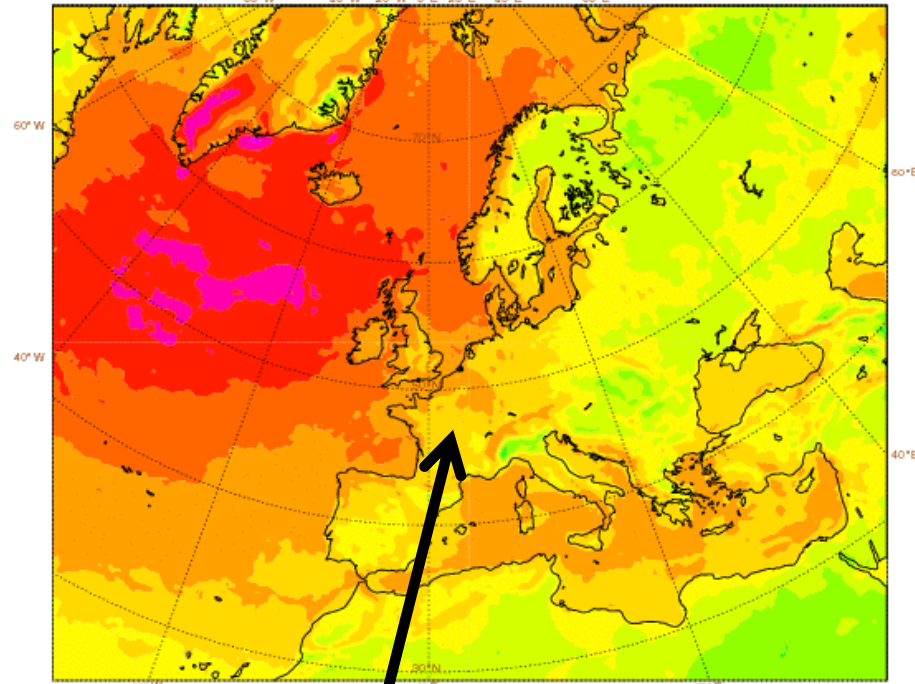
21-25 m/s

Reforecasts valid 26 December 1999 (Max. wind gusts and MSLP)
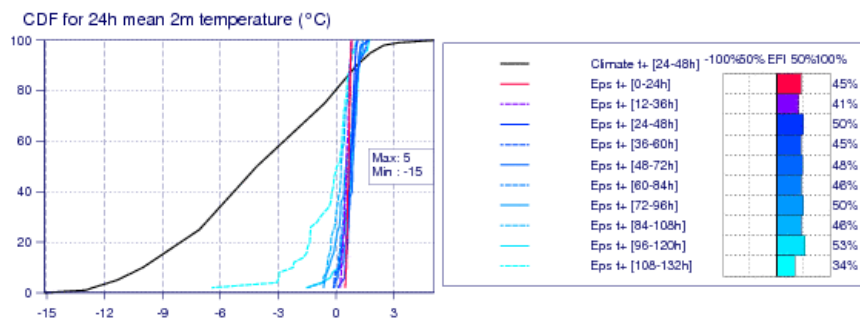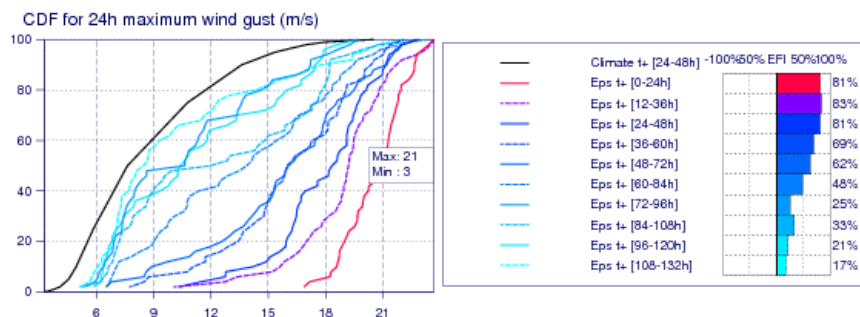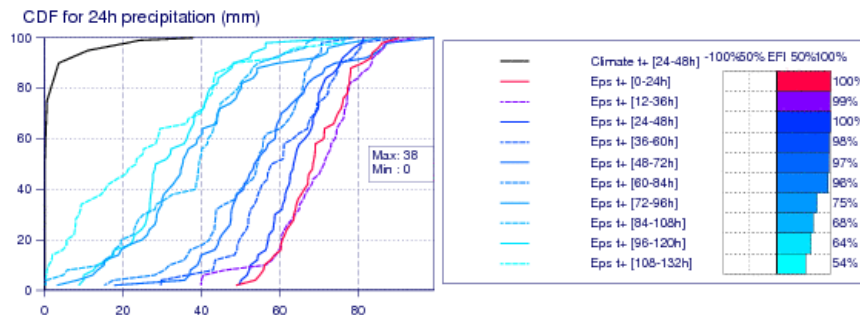
From 26 December 1999 +12h

From 19 December 1999 +180h

ECMWF

Forecast outside the model climate:

Forecast and M-Climate cumulative distribution functions with EFI values at 46.33°N/12.48°E valid for 24 hours from Friday 31 January 2014 00 UTC to Saturday 1 February 2014 00 UTC
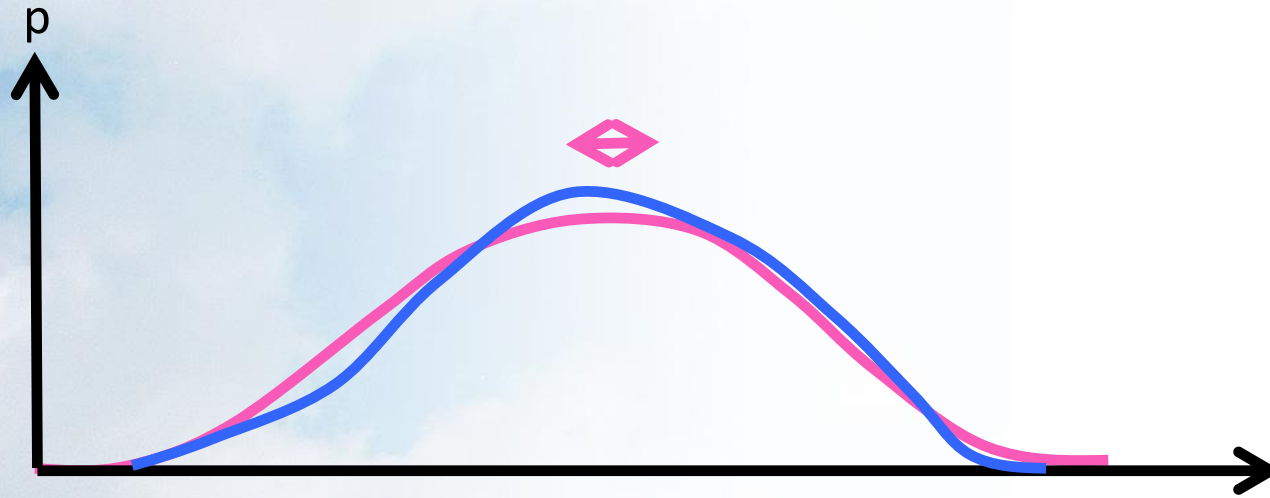
M-Climate: this stands for "Model Climate". It is a function of lead time, date (+/- ~15 days), and model version. It is derived by rerunning a 5 member ensemble, over the last 20 years, once a week (500 realisations). M-Climate is always from the same model version as the displayed EPS data. On this page only the 24-48h lead M-Climate is displayed.
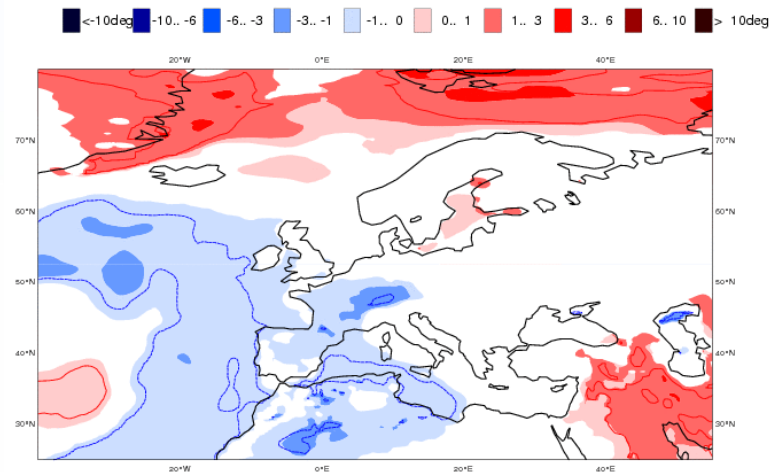
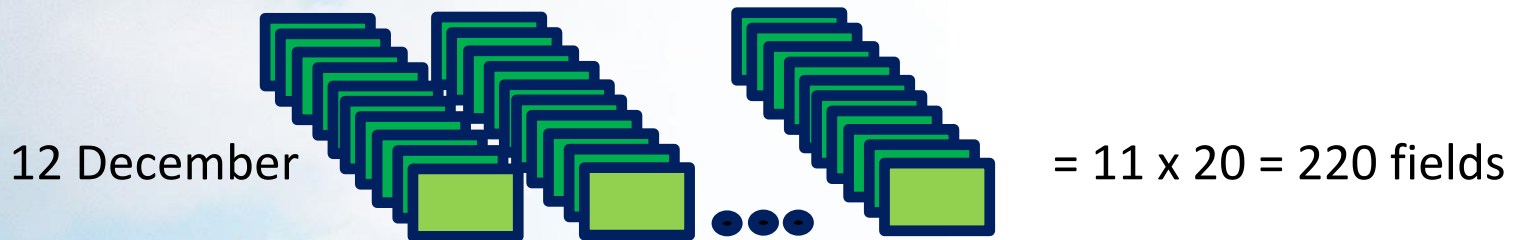# Long forecast (monthly, seasonal)

p

Normally weak signals

ECMWF EPS-Monthly Forecasting System
2-meter Temperature anomaly
Forecast start reference is 22-01-2015
ensemble size = 51 ;climate size = 200

Day 26-32
16-02-2015 TO/22-02-2015
Shaded areas significant at 10% level
Contours at 1% level

Sampling issues: Monthly forecasts

- Need to sample the mean
- Model drift
- Sensitive to subtile difference between real time forecast and reforecast configuration

12 December = 11 x 20 = 220 fields

Monthly forecast anomalies

Monday Thursday Monday
★★★

20 years x 11 forecasts x 3 dates = 660 forecasts

ECMWF

Difficulties in constructing reforecasts

Aim: Simulate climate of the real time forecasts…
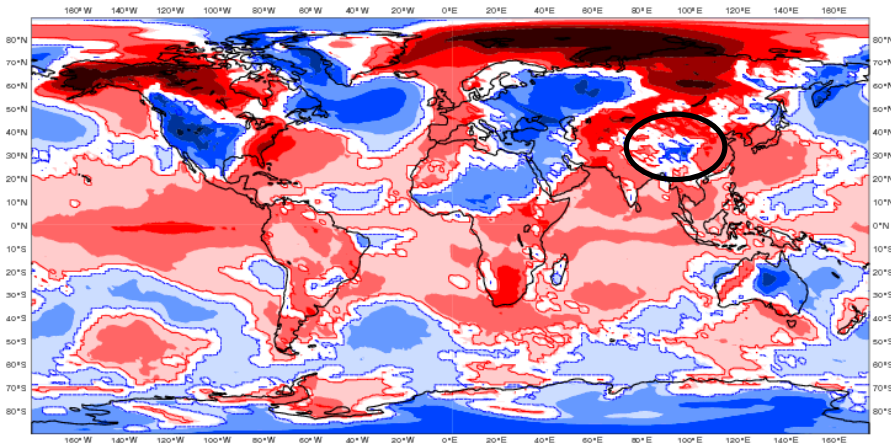

ECMWF EPS-Monthly Forecasting System
2-meter Temperature anomaly
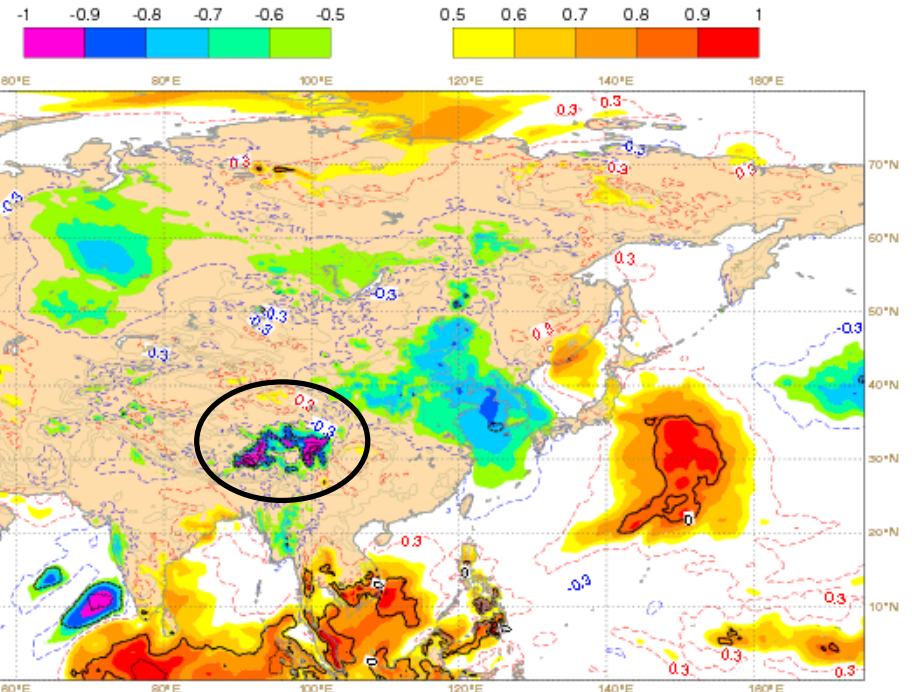Forecast start reference is 28-12-2015
ensemble size = 51, climate size = 660

Day 1-7
28-12-2015/TO/03-01-2016
Shaded areas significant at 10% level
Contours at 1% level

Sun 17 Jan 2016 12UTC ©ECMWF t+12-36h VT: Mon 18 Jan 2016 00UTC - Tue 19 Jan 2016 00UTC
Extreme forecast index and Shift of Tails (black contours 0,1,2,5,8) for 2m mean temperature
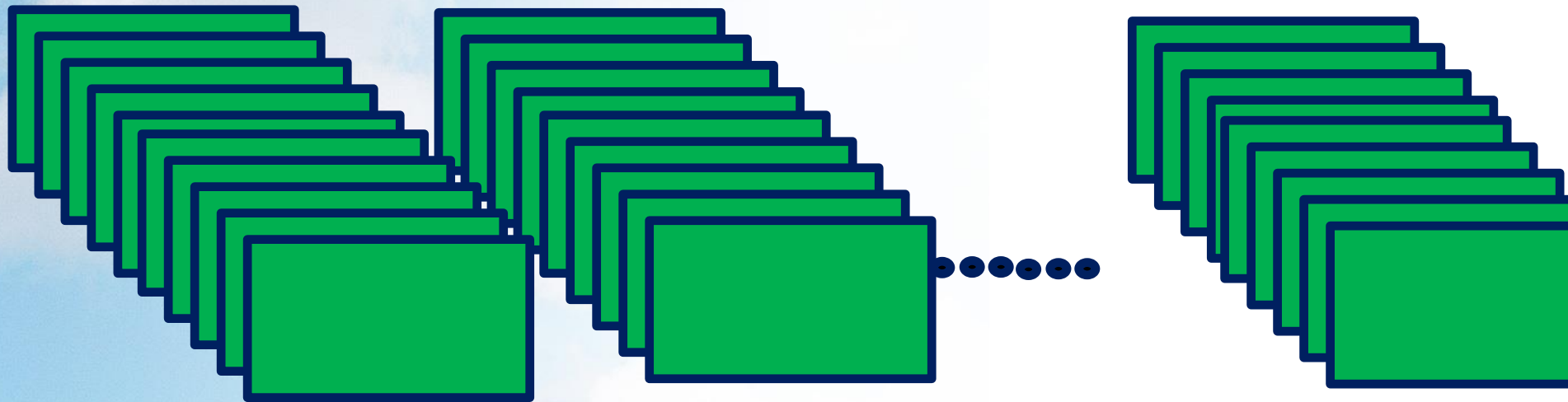
ECMWF

Configuration of reforecasts for seasonal forecasts

Example: 1 November

1 November 1981:   1 November 1982:   1 November 2010:

30 years x 15 forecasts = 450 forecasts
Run once for System 4, Initialised from ERA Interim

Bias correction and estimate of skill

ECMWF

Reforecast used to calculate scores for seasonal forecasts

Anomaly Correlation Coefficient for 0001 with 25 ensemble members
Near-surface air temperature
Hindcast period 1981-2016 with start in November average over months 2 to 4
Black dots for values significantly different from zero with 95% confidence (1000 samples)
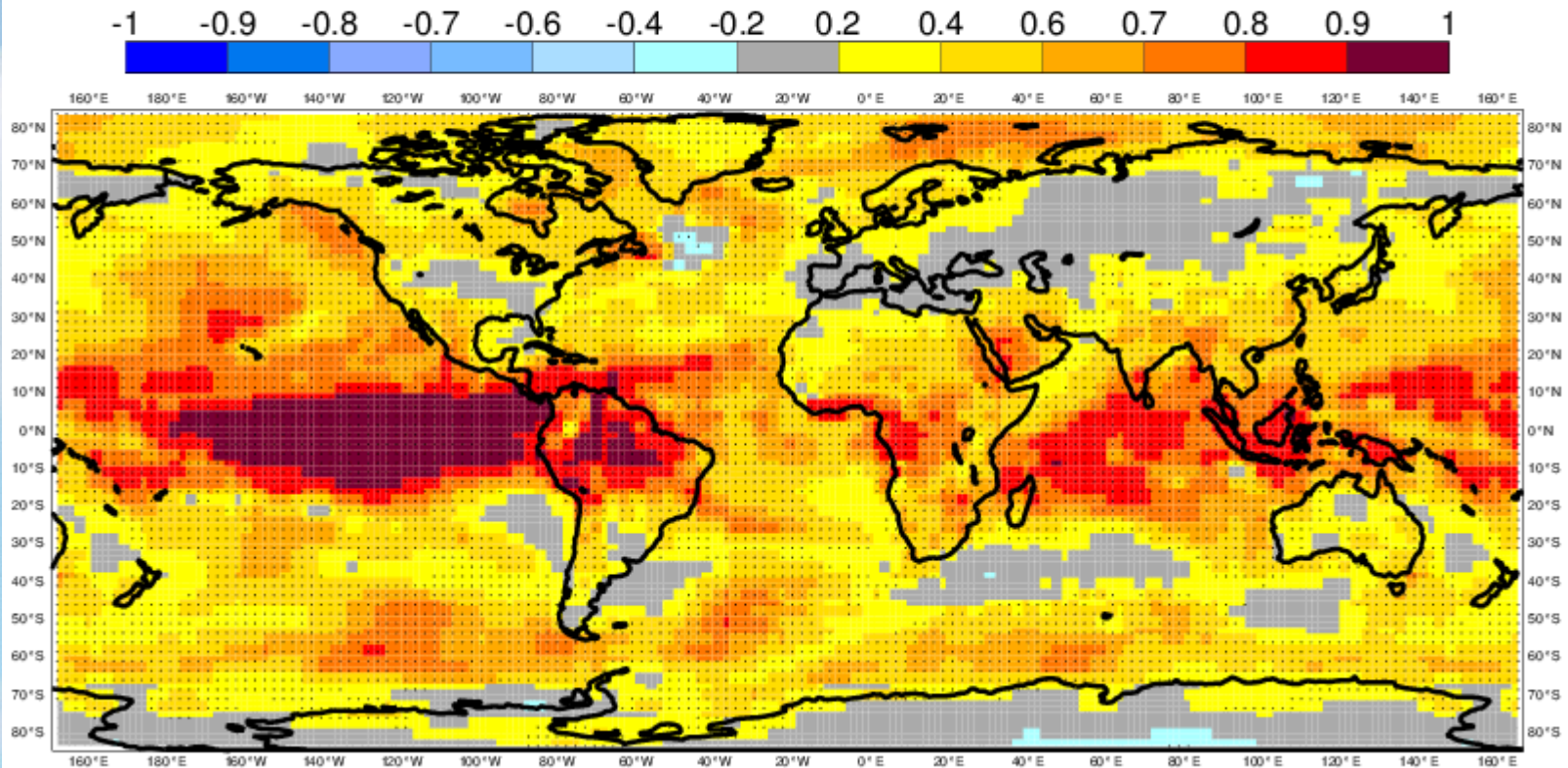
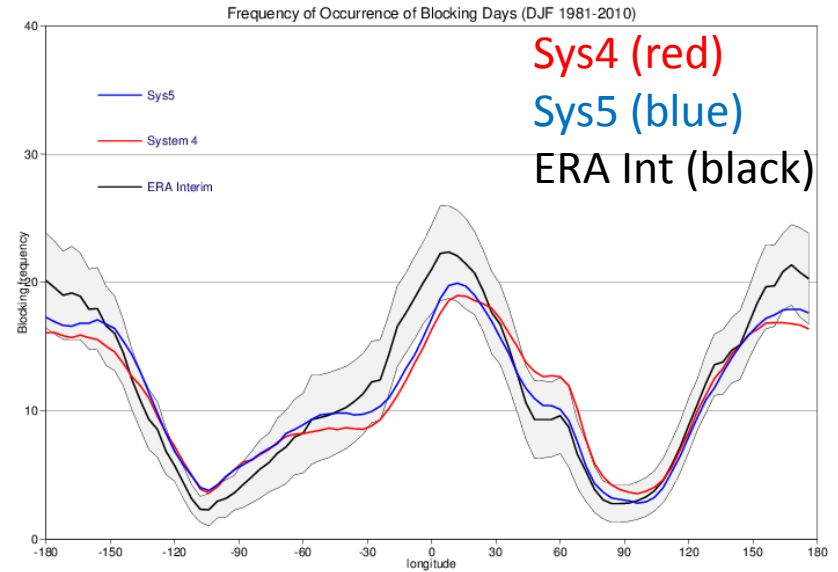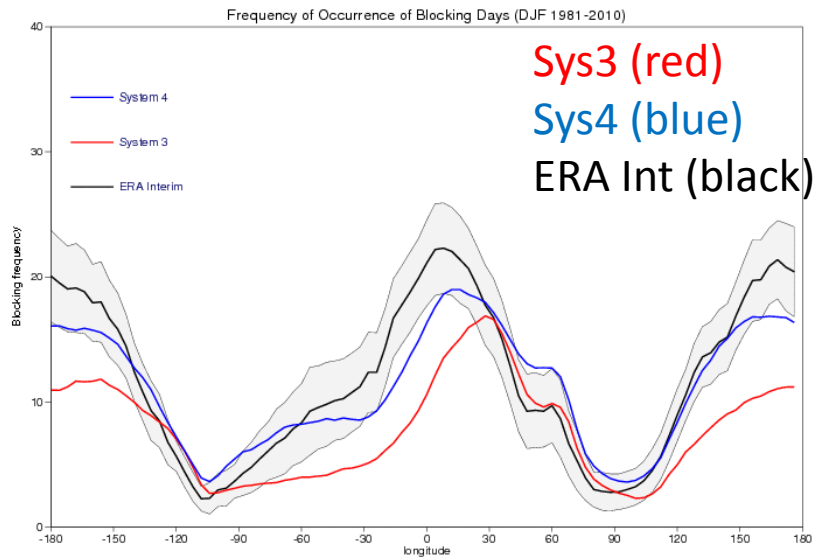# Example of diagnostics from reforecasts: Blocking index
Tribaldi and Molteni (1990)

Friday 4 May 2012 00UTC ©ECMWF Analysis t+000 VT: Friday 4 May 2012 00UTC
850 hPa Temperature / 500 hPa Geopotential

dz/dlat< -5 (North)
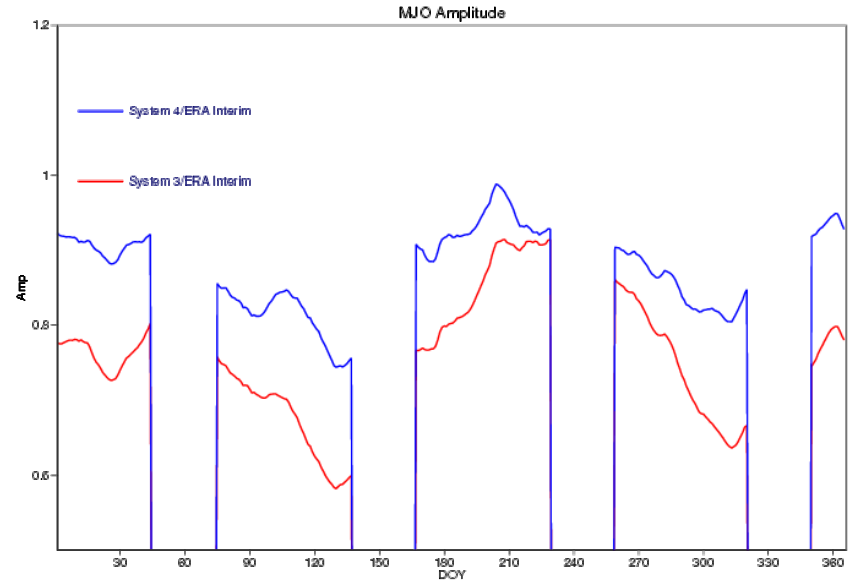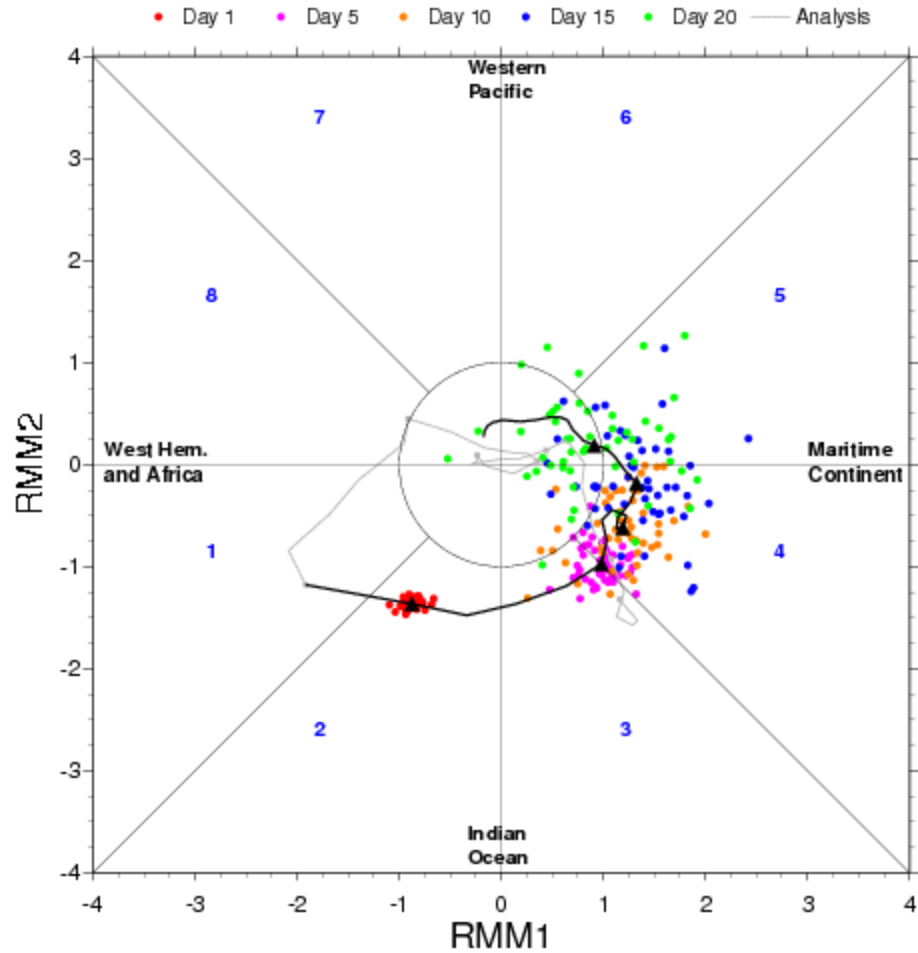**dz/dlat > 0 (South)**
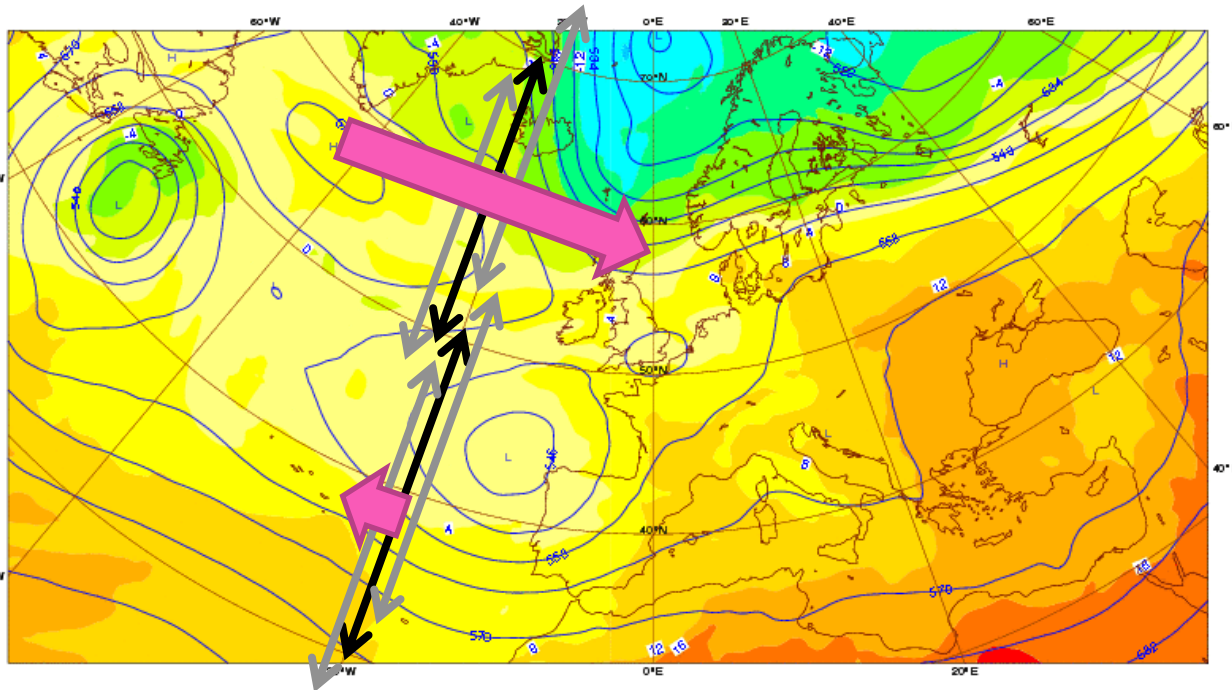
Blocking cont.

Episodes lasting >1 day

Frequency of Occurrence of Blocking Days (DJF 1981-2010)

Sys3 (red)
Sys4 (blue)
ERA Int (black)

Frequency of Occurrence of Blocking Days (DJF 1981-2010)

Sys4 (red)
Sys5 (blue)
ERA Int (black)

Madden-Julian oscillation

ECMWF MONTHLY FORECASTS
FORECAST BASED 06/05/2013 00UTC

MJO Amplitude

Sys3 (red)
Sys4 (blue)
ERA Int (black)
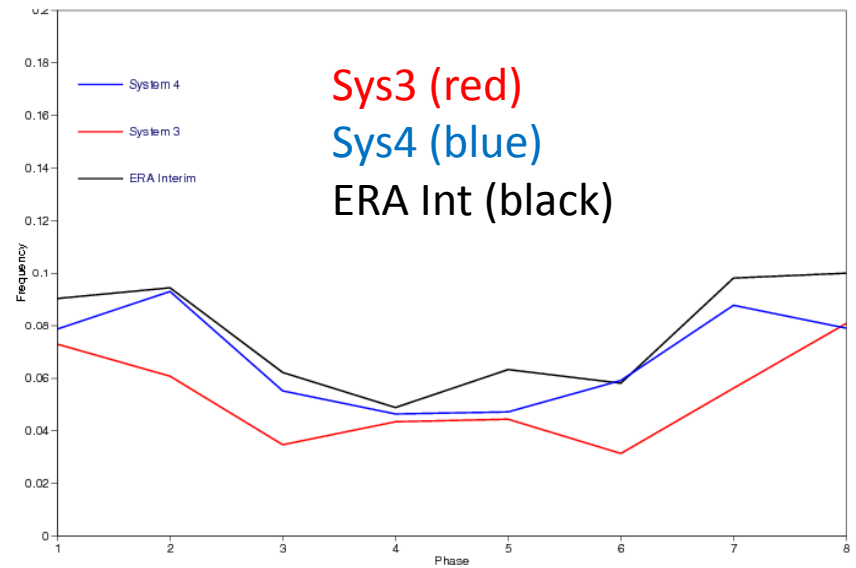
Teleconnections – linear regression

T2m in a grid point

$$y=ax+b$$
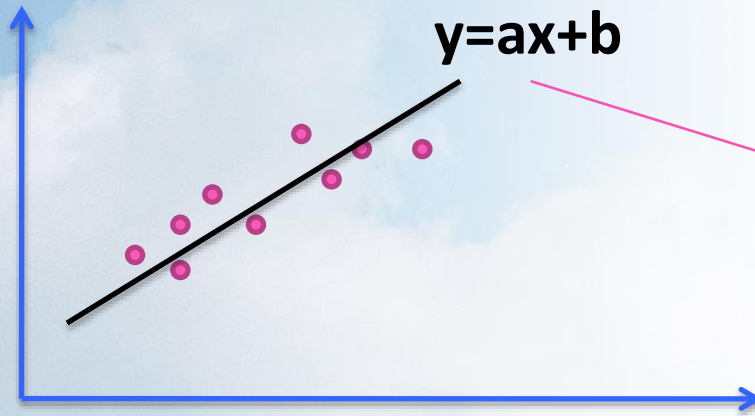
Nino3.4 SST
(190E-240E,10N-10S)

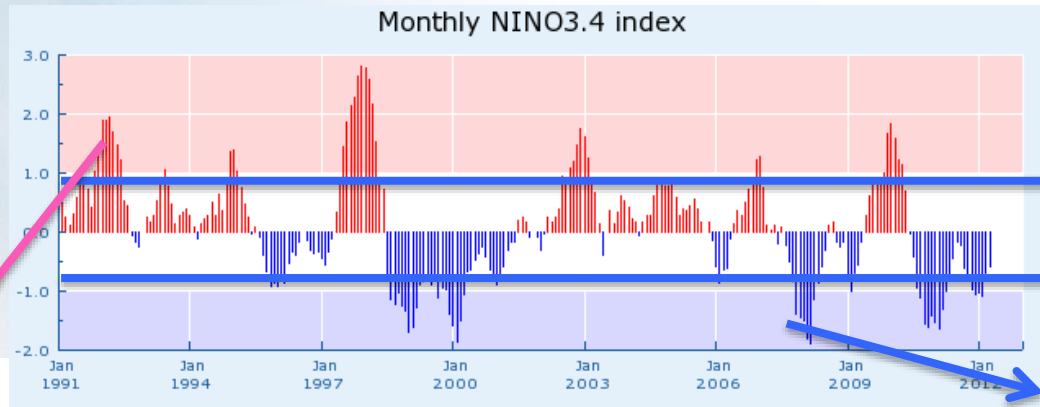**Regression ERA Interim Nino34 SST DJF 2T**
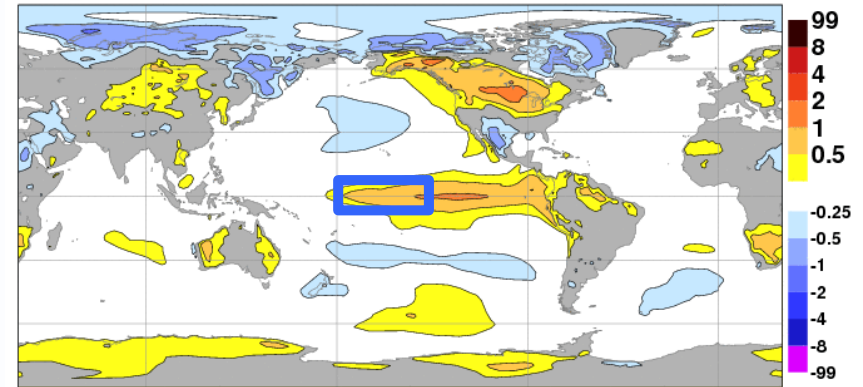
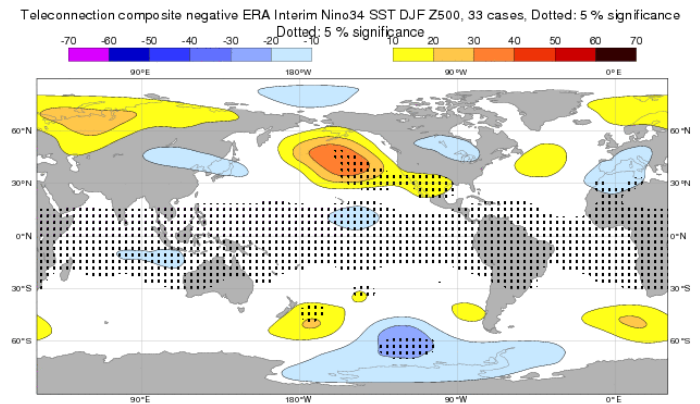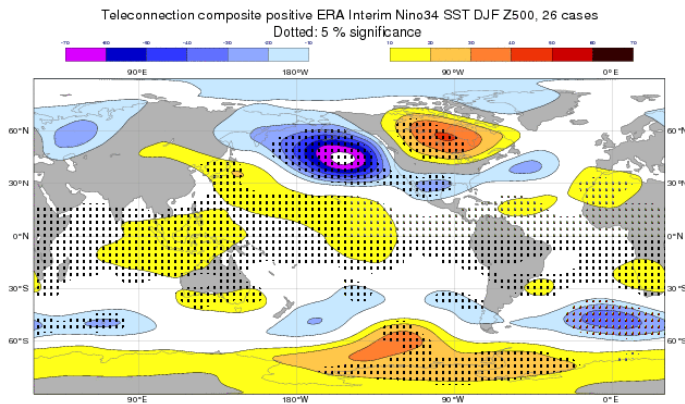**(logarithmic scale)**
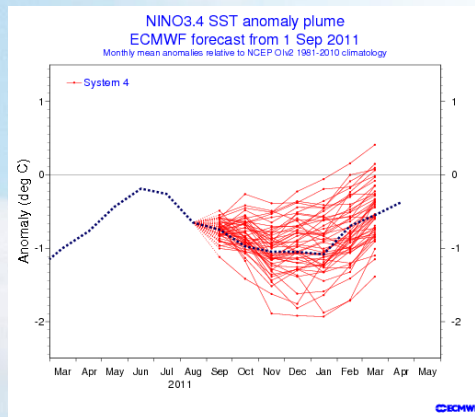
Example for seasonal for Nino3.4

Teleconnections - composites

Monthly NINO3.4 index

+/- 0.5 stdev

Positive composite

Negative composite

Teleconnection composite positive ERA Interim Nino34 SST DJF Z500, 26 cases
Dotted: 5 % significance

Teleconnection composite negative ERA Interim Nino34 SST DJF Z500, 33 cases, Dotted: 5 % significance
Dotted: 5 % significance

Composite of MSLP 10- days after MJO phase 3

ECMWF MONTHLY FORECASTS
FORECAST BASED 06/05/2013 00UTC

+ 10 days =

Reanalysis

MJO Composite MSL0 ERA Interim 1981 - 2010 season DJF Phase: 3, Lag:10
N. Fields: 240
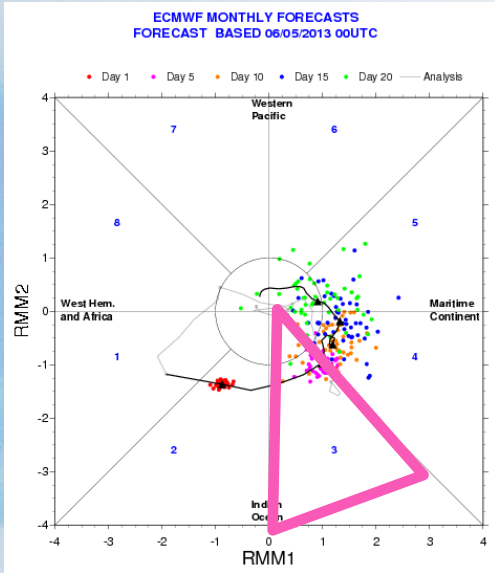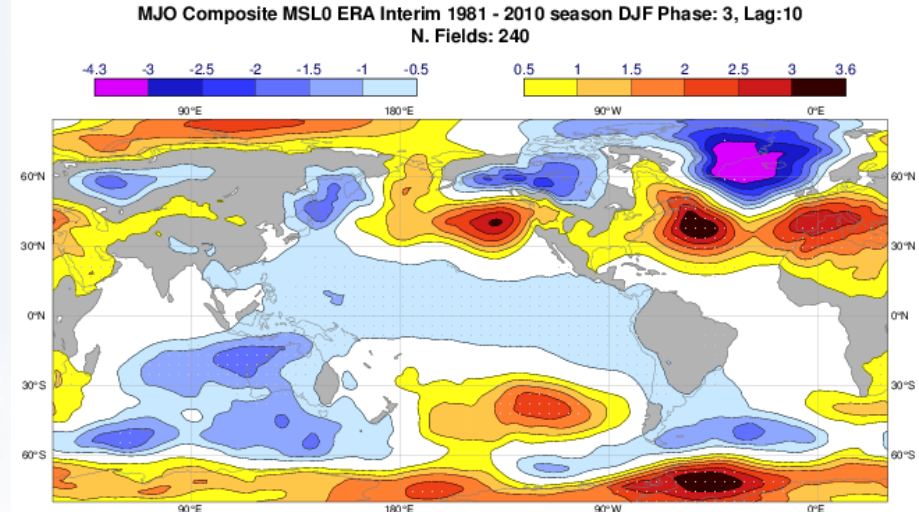
Composite of Outgoing long-wave radiation lag 0 days

MJO Composite TTR0 ERA Interim 1981 - 2010 season DJF Phase: 3, Lag:0
N. Fields: 265

Seasonal forecasts

MJO Composite MSL0 Sys5 1981 - 2010 season DJF Phase: 3, Lag:10
N. Fields: 2223

ECMWF
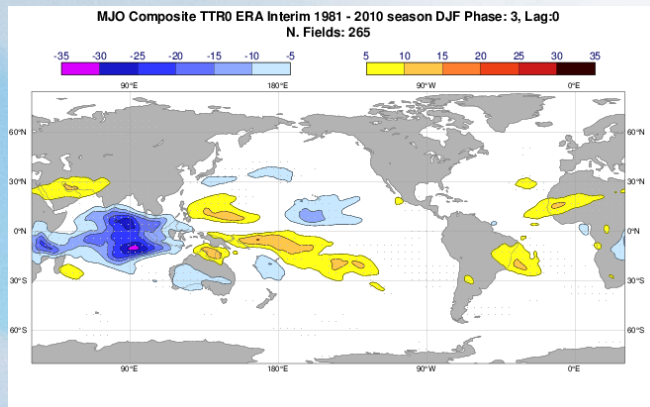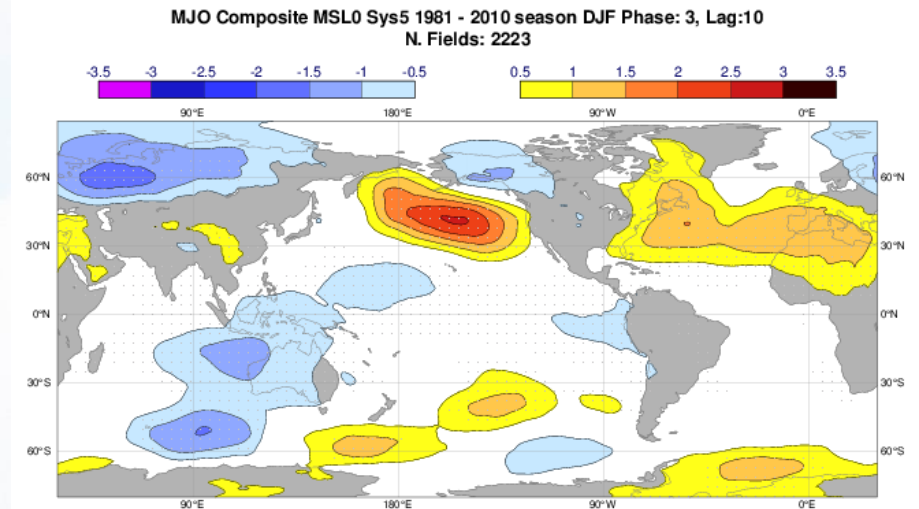
Summary

- The model climate can be different from the observed climate
- We need the model climate to determine whether the forecast is anomalous
- Twice a week, forecasts for the 20 last years are rerun to build up the model climate
- Used for several forecast products

- Used for score calculation and diagnostics

ECMWF

Configuration of reforecasts

Example: Thursday 12 December 2013:

12 December 1993:   12 December 1994:   12 December 2012:

20 years x 5 forecasts = 100 forecasts
Present model version
Ensemble configuration to 32 days
Initialised from ERA Interim

Model climate from reforecasts