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Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss



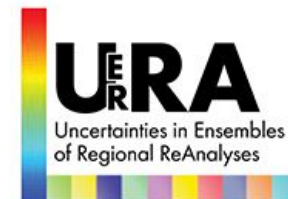
Meteorologisk
institutt
150 år

Evaluation of reanalyses for precipitation in the Alps and in Fennoscandia: Concepts and early results (WP3)

Francesco Isotta¹, Cristian Lussana²,
Christoph Frei¹, and Ole Einar Tveito²
22nd November 2016



- (1) Federal Office of Meteorology and Climatology MeteoSwiss, Zurich, Switzerland
- (2) Norwegian Meteorological Institute, Oslo, Norway



UERRA Reanalysis datasets (in prep.)

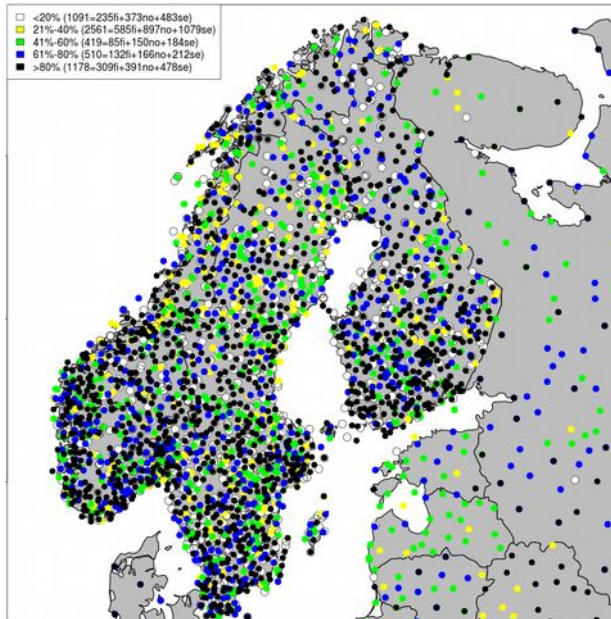
Dataset	Grid spacing	Period	Information
→ UK MetOffice Reanalysis	24 km	1978-	20 members (1 mean and spread) Static 4DVAR
UK MetOffice Reanalysis	12 km	1978-	deterministic uses ensemble reanalysis uncertainty in the assimilation
HARMONIE reanalysis SHMI, Météo-France	11 km	1961-2014	deterministic
COSMO-REA6 University of Bonn	6 km	20 years	deterministic COSMO + nudging
COSMO-EU reanalysis University of Bonn reanalysis	12 km	2006-2010	21 members, ensemble-nudging data assimilation (probabilistic observations)
→ MESCAN Météo-France	5.5 km	1961-2010	MESCAN-SURFEX-TRIP-HR Model: HARMONIE 11 km 6-8 members (different physics) 2006-2010

+ E-Obs, ERA-Interim, ERA20C

January-May 2008, UKMO 24km grid

MESCAN only 1 member

Reference Datasets Fennoscandia I



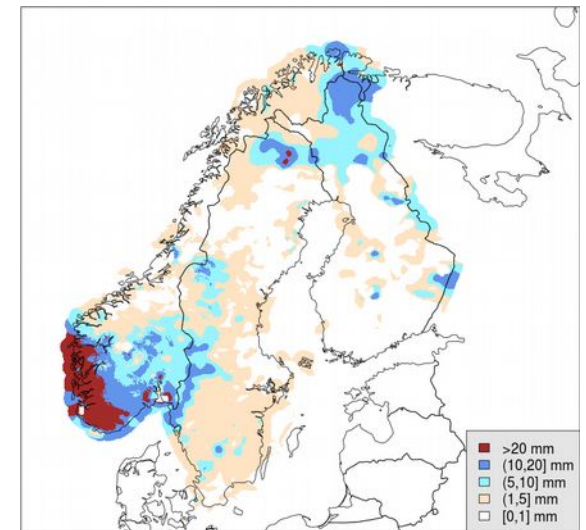
Nordic Gridded Climate dataset (NGCD)

Variable	Precipitation
Δx	1km
t	1981-2010, daily
x	Finland, Norway, Sweden (mainland)
Stations	~3850
Source	ECA&D, eklima.met.no, SMHI + FMI

EU-FP7 UERRA project



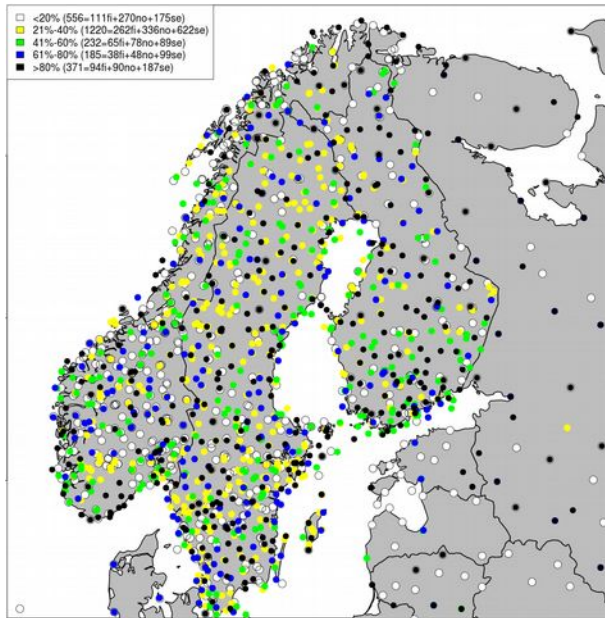
Experimental release available (free):
MET Norway Thredds Service



Evaluation of reanalyses for precipitation in the Alps and in Fennoscandia: Concepts and early results (WP3).

F. Isotta, C. Lussana, C. Frei, O. E. Tveito

Reference Datasets Fennoscandia II



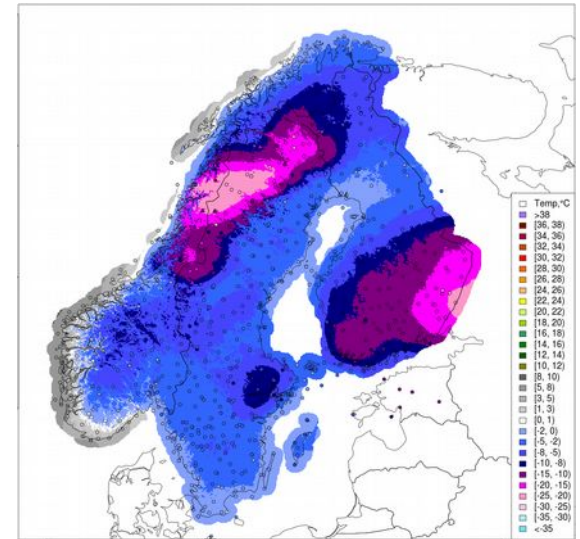
Nordic Gridded Climate dataset (NGCD)

Variable	Temperature
Δx	1km
t	1981-2010, daily
x	Finland, Norway, Sweden (mainland)
Stations	~1800
Source	ECA&D, klima.met.no, SMHI + FMI

EU-FP7 UERRA project



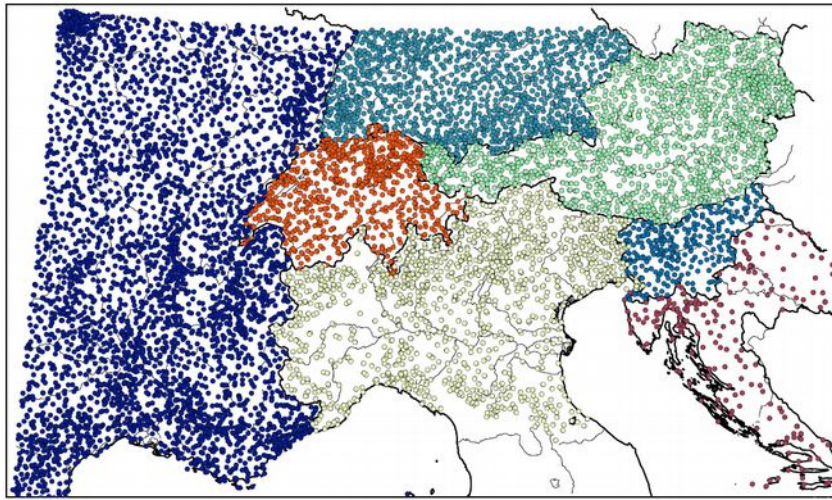
Experimental release available (free):
MET Norway Thredds Service
Two versions based on different spatial interpolation methods: Residual Kriging, Optimal Interpolation



Evaluation of reanalyses for precipitation in the Alps and in Fennoscandia: Concepts and early results (WP3).

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Reference Datasets Alpine Region



Alpine Precipitation Grid Dataset (APGD)

Variable	Precipitation
Δx	5km
t	1971-2008, daily
x	Alpine Region (2-17.5E, 43-49N)
Stations	>8500 (~6000 per day)
Quality	Quality checked

EU-FP7 EURO4M project

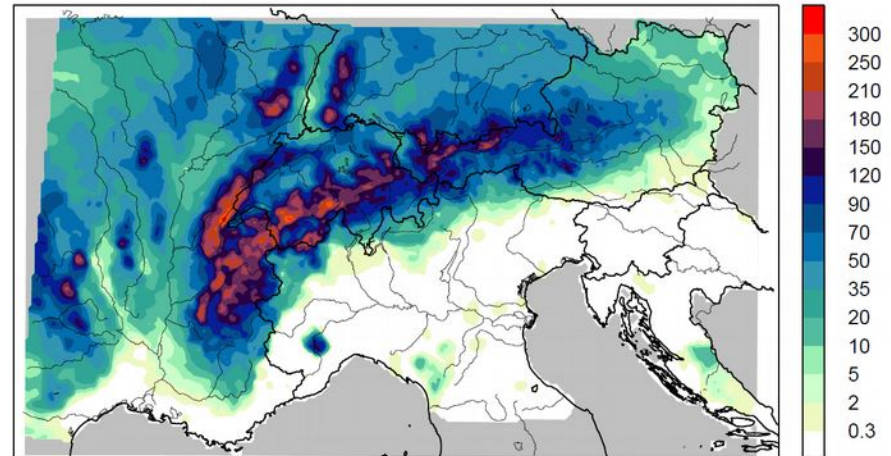


Isotta et al. (2014)
Int. J. Climatol.

Available at: www.meteoswiss.ch
Search for «Alpine precipitation»

APGD

Precipitation sum (mm) from 1990-02-13 to 1990-02-14



Pan-Alpine Probabilistic Dataset

2008.11.04

Area-mean precipitation over
hydrological units in the Alps

Same data as for APGD

100 ensemble members

534 hydrological units,

- at four hierarchical scales
- 325 elementary units (EEA)

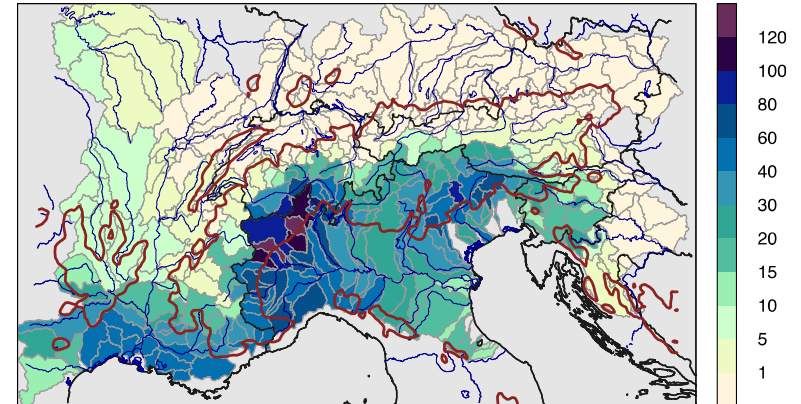
consistent within 68 super-units

daily, 1971-2008 (in process)

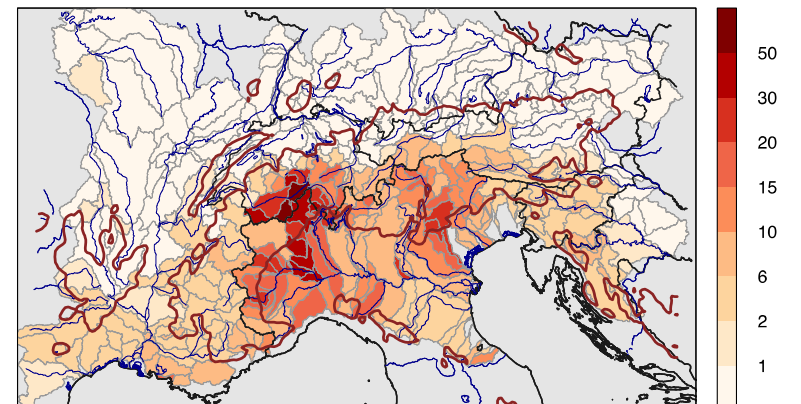
2002-2008 processed so far

■ **APGD_ens**

ensemble median (mm)

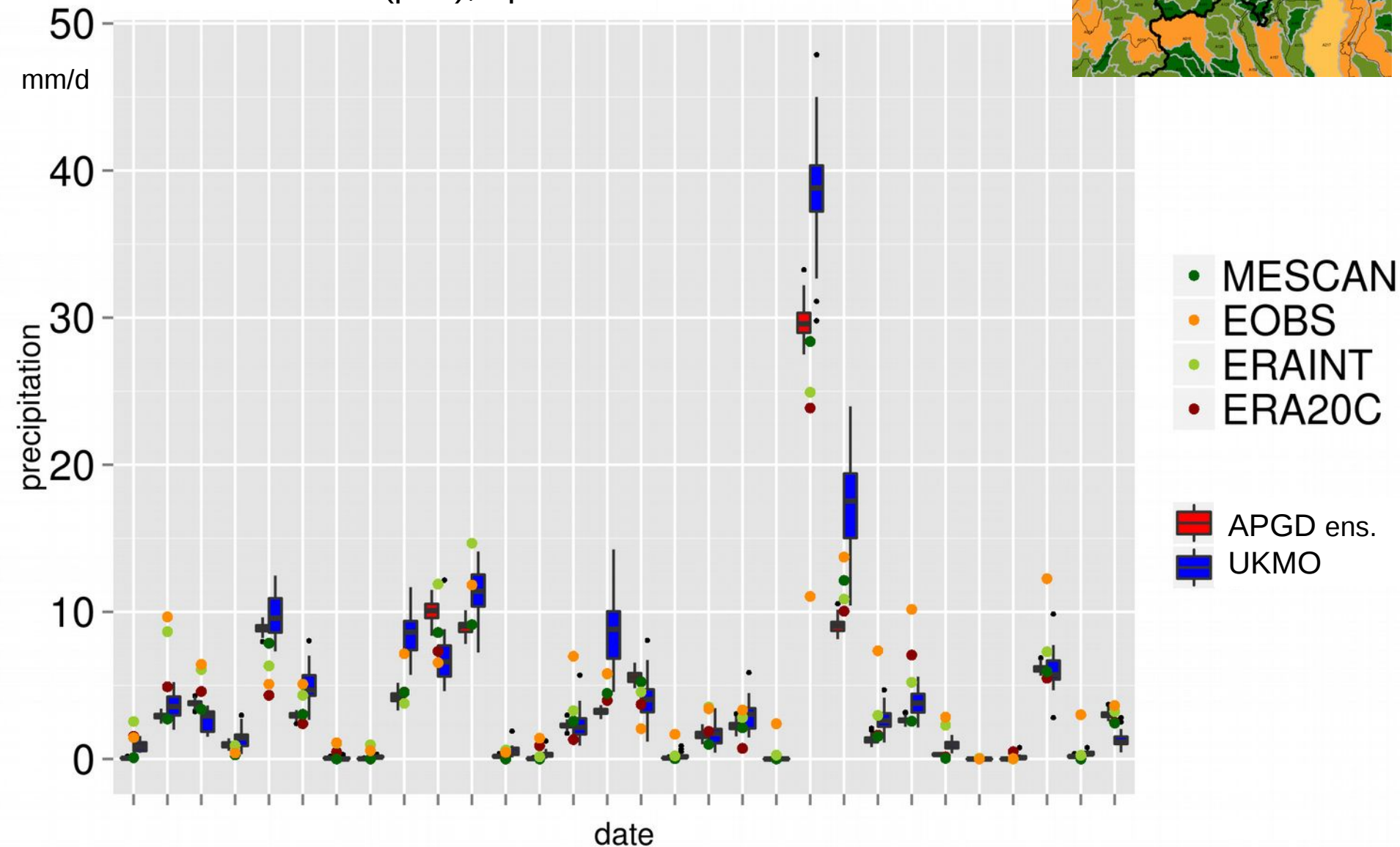
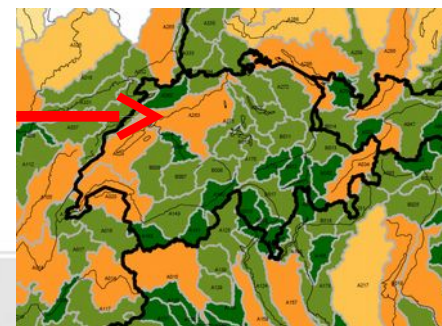


90% ensemble inter-quantile (mm)

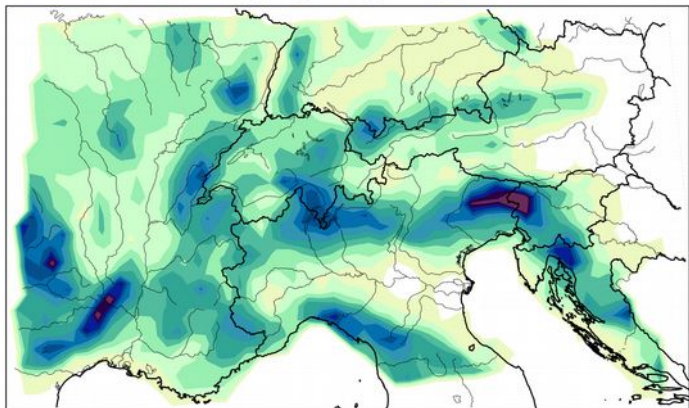


Daily precipitation

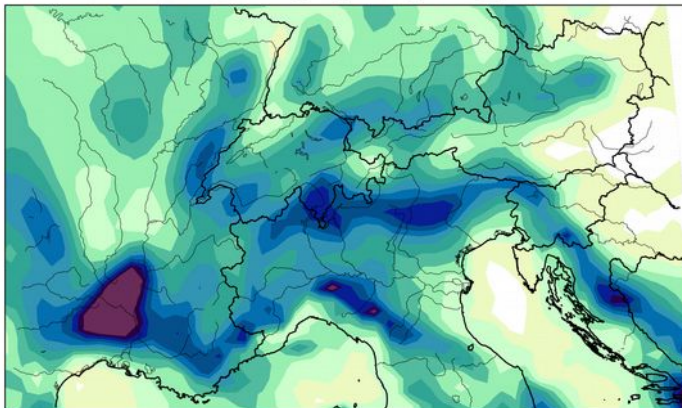
Aare catchment (part), April 2008



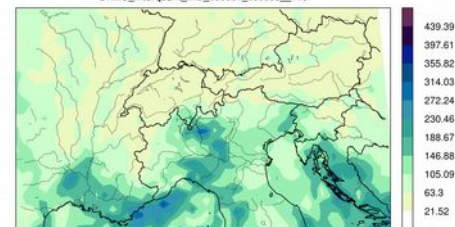
APGD



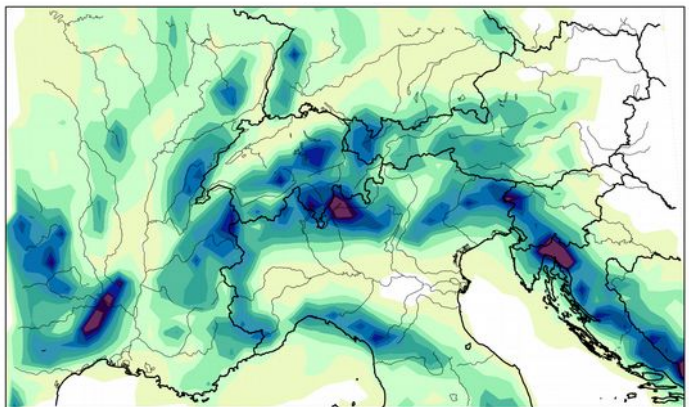
UKMO (median)



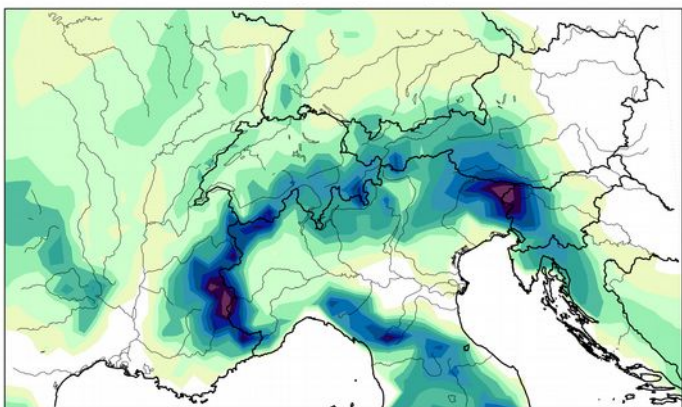
UKMO interquantile (90%-10%)



MESCAN



E-Obs



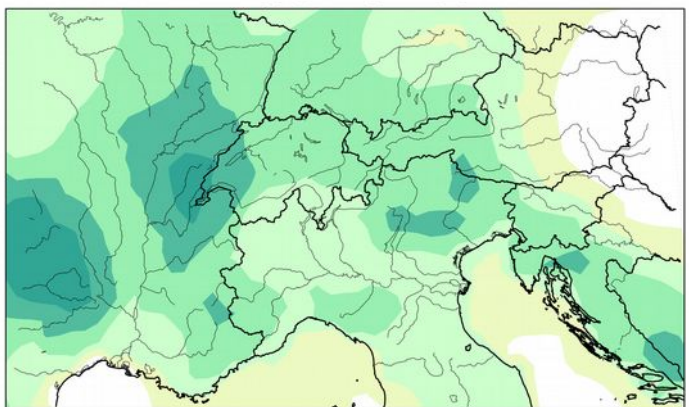
1000
924
848
772
696
620
544
468
392
316
240

Psum

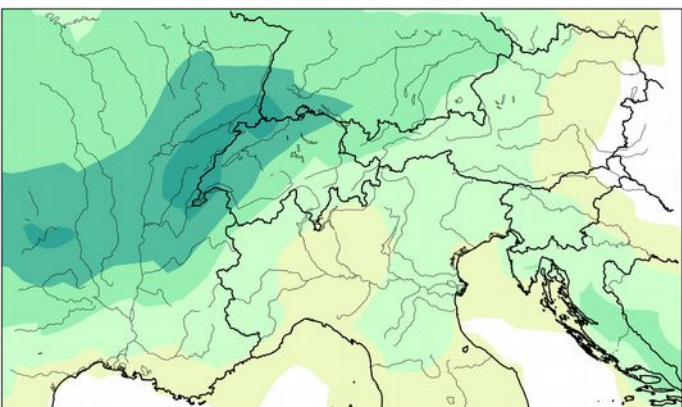
1.2008-5.2008

UKMO 24km grid

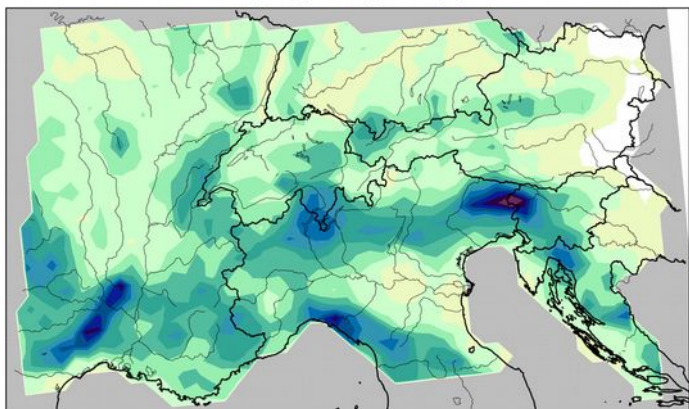
ERA-Interim



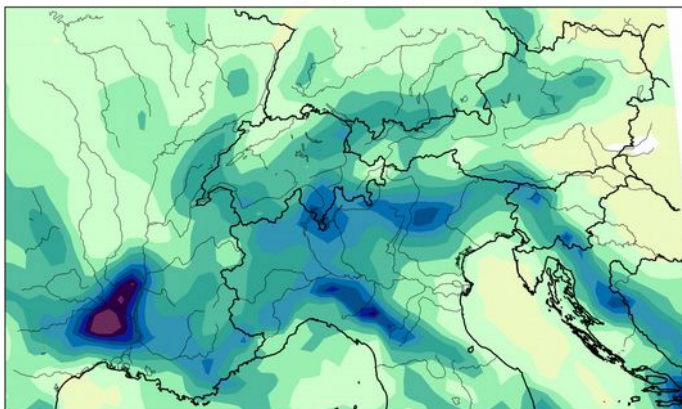
ERA20C



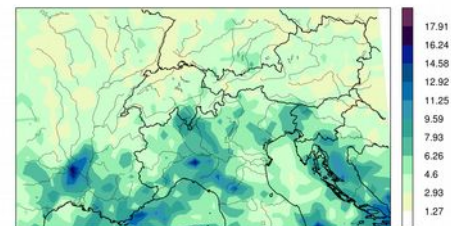
APGD



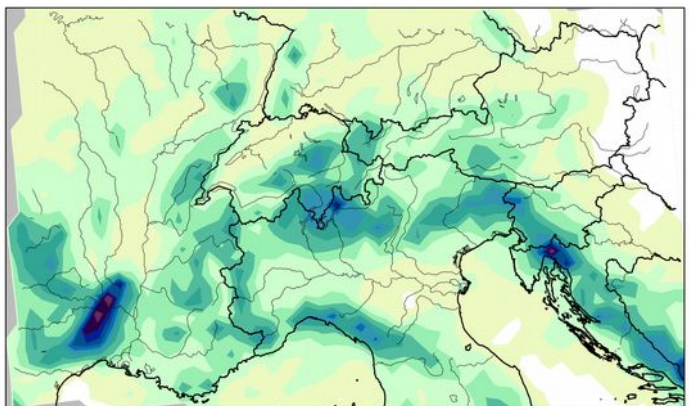
UKMO (median)



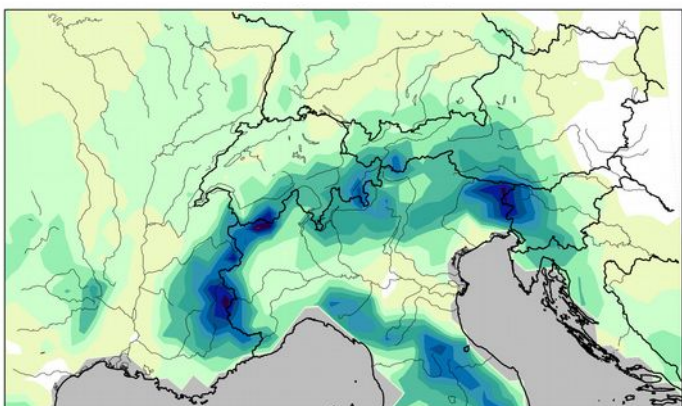
UKMO interquantile (90%-10%)



MESCAN



E-Obs



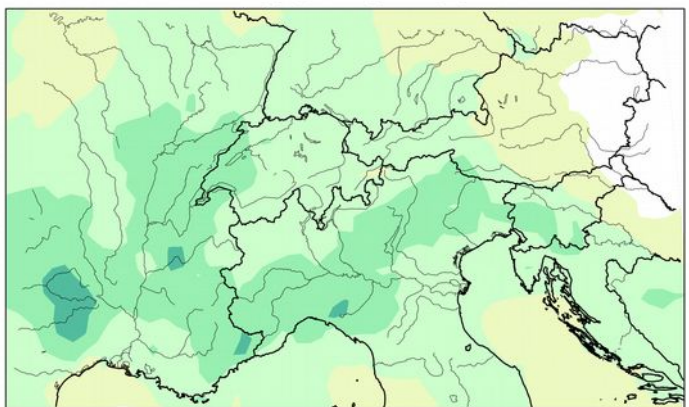
40
36.6
33.2
29.8
26.4
23
19.6
16.2
12.8
9.4
6

Q95

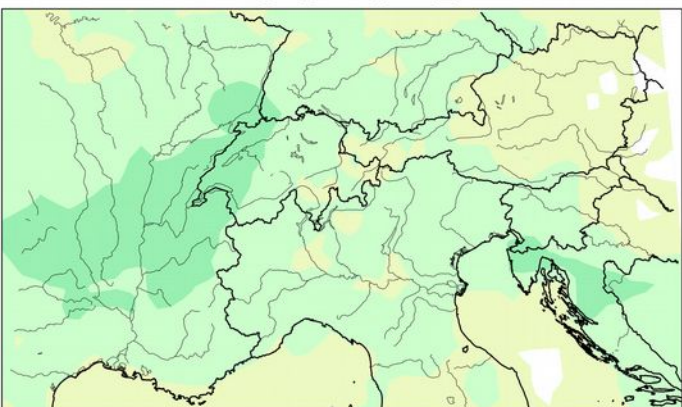
1.2008-5.2008

UKMO 24km grid

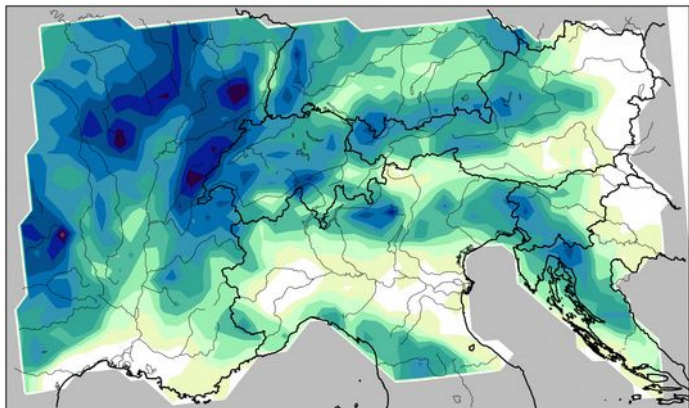
ERA-Interim



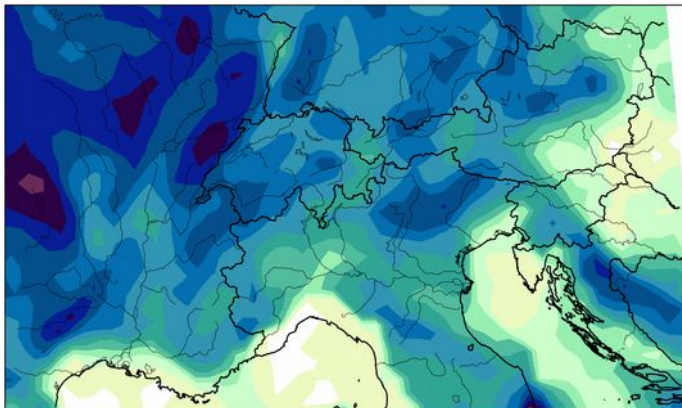
ERA20C



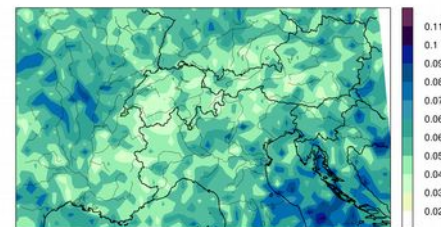
APGD



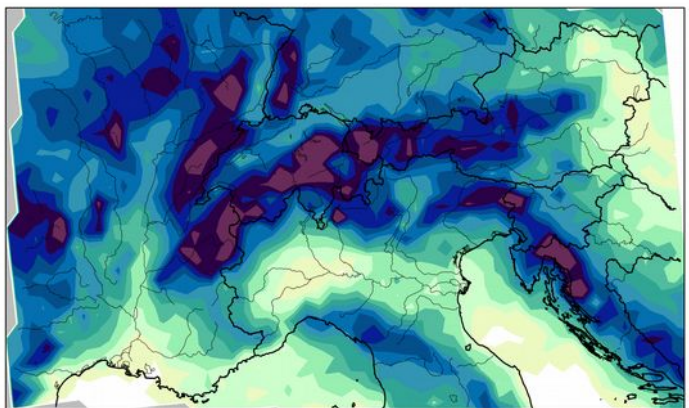
UKMO (median)



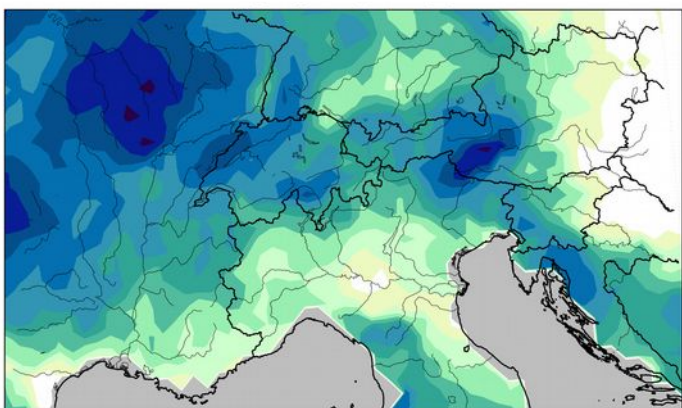
UKMO interquantile (90%-10%)



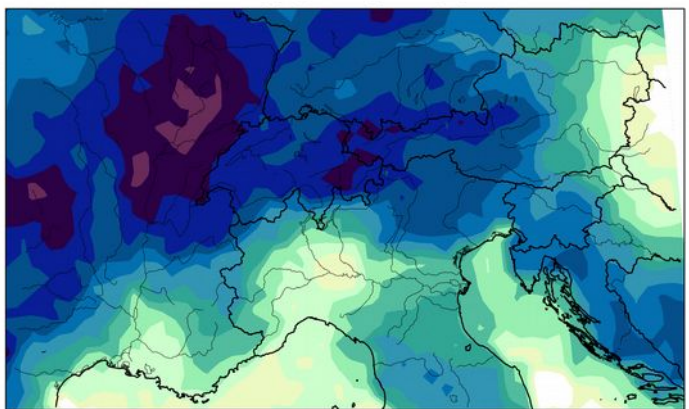
MESCAN



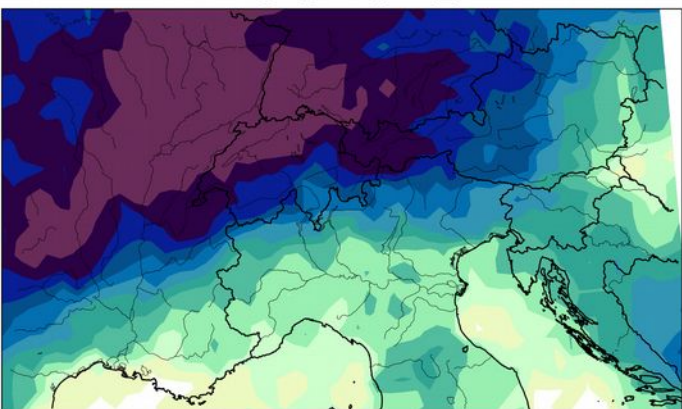
E-Obs



ERA-Interim



ERA20C



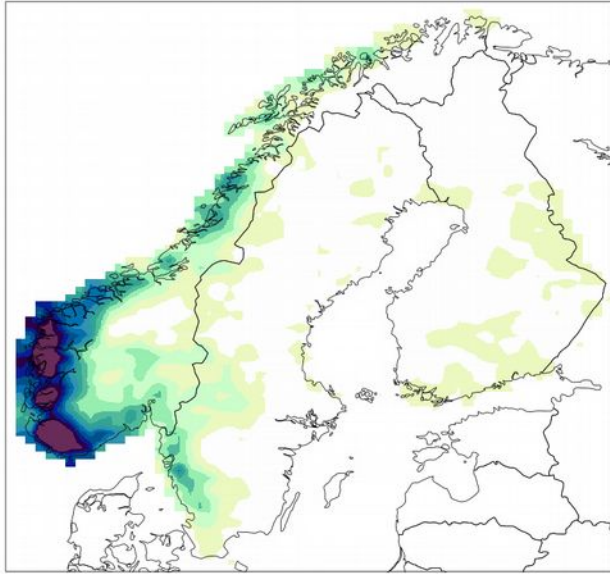
0.55
0.52
0.49
0.46
0.43
0.4
0.37
0.34
0.31
0.28
0.25

**Freq.
wet
days
(1mm/d)**

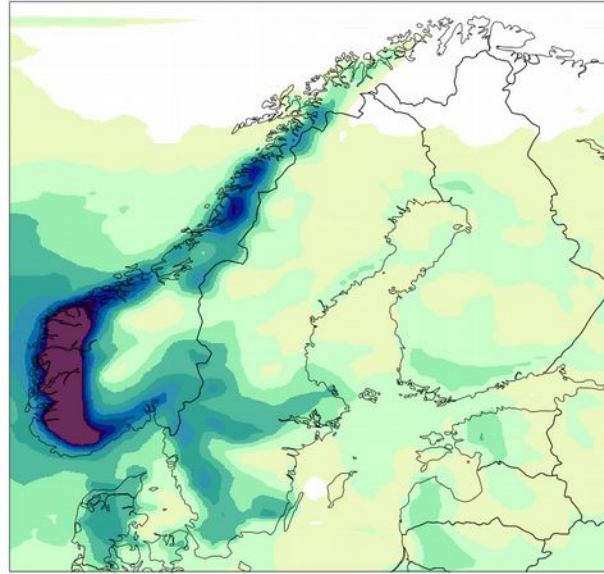
1.2008-5.2008

UKMO 24km grid

NGCD



UKMO (median)

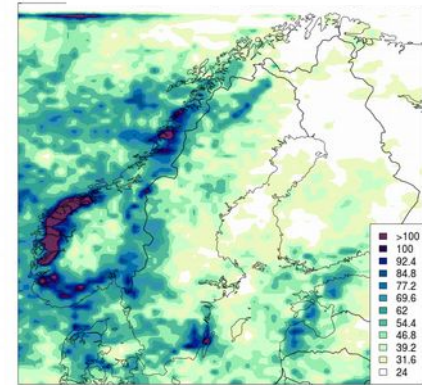


Psum

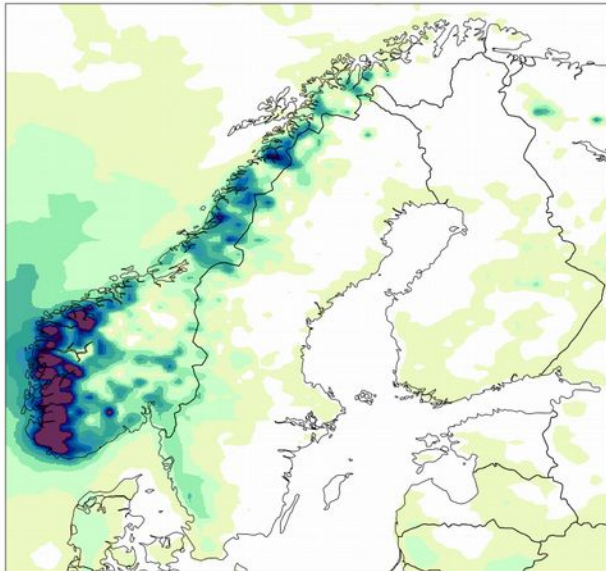
1.2008-5.2008

UKMO 24km grid

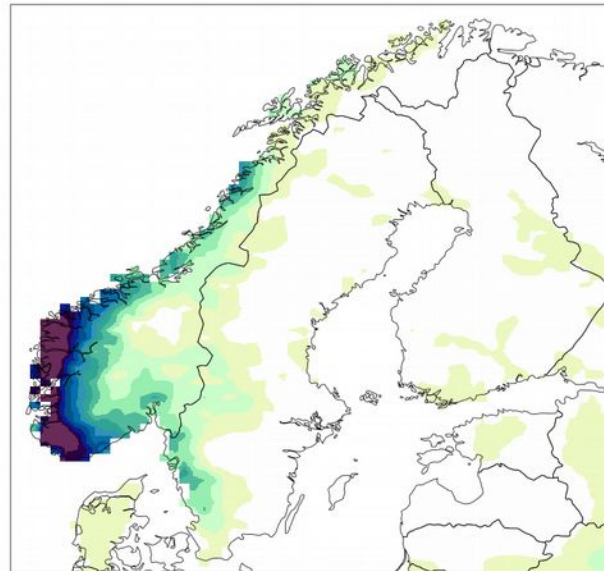
UKMO interquantile (90%-10%)



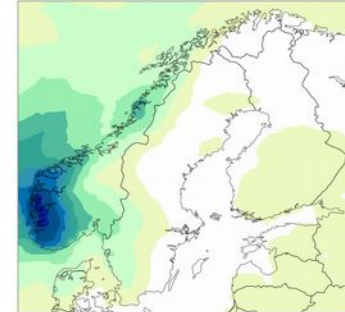
MESCAN



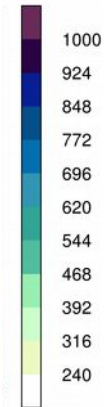
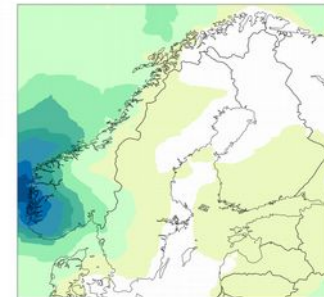
E-Obs



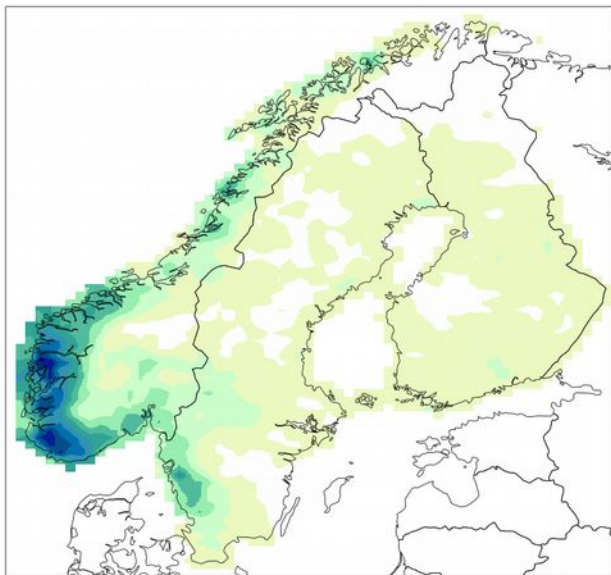
ERA-Interim



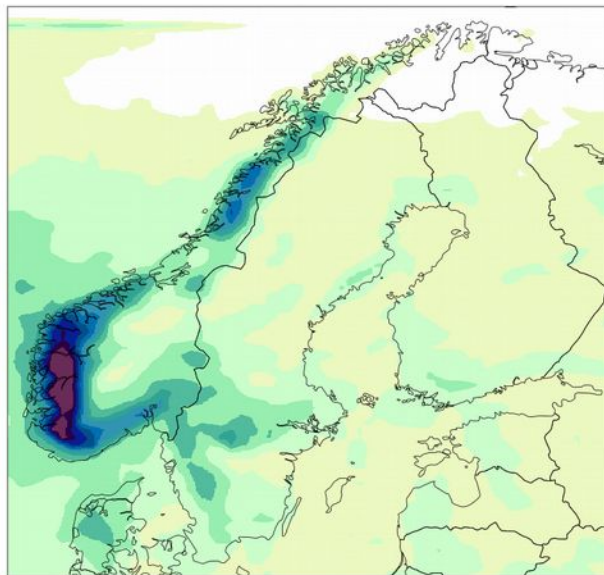
ERA20C



NGCD

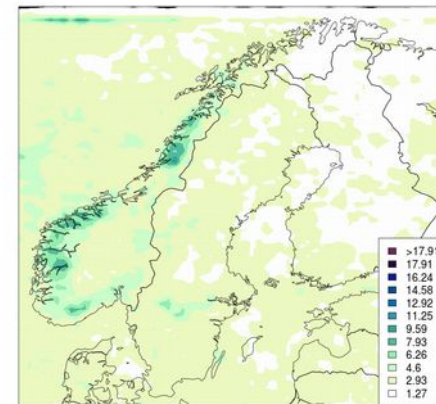


UKMO (median)

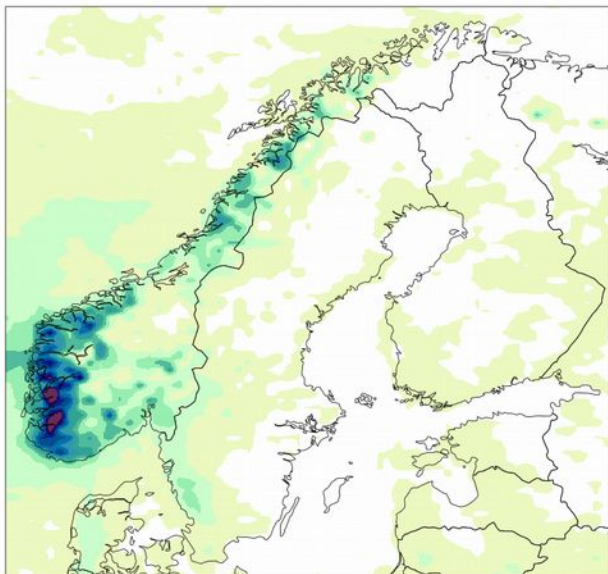


Q95, 1.2008-5.2008
UKMO 24km grid

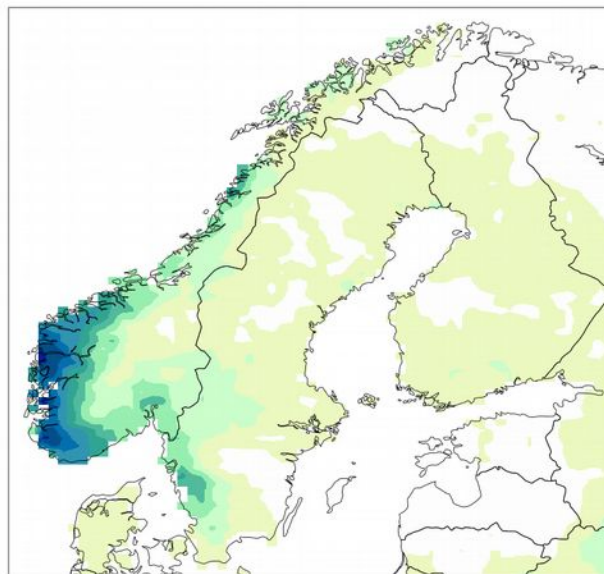
UKMO interquantile (90%-10%)



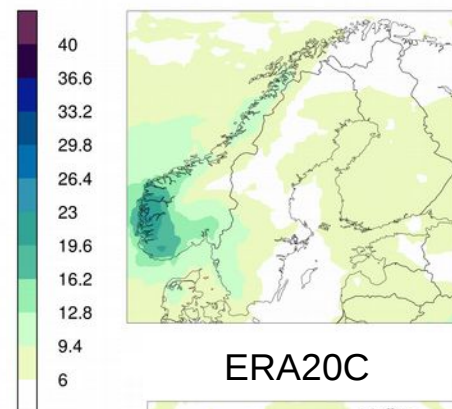
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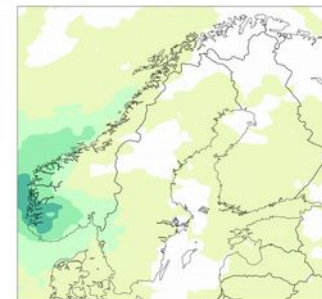
E-Obs



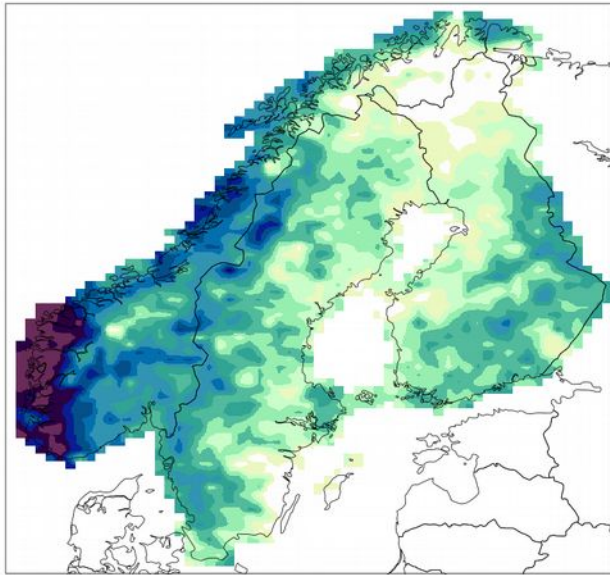
ERA-Interim



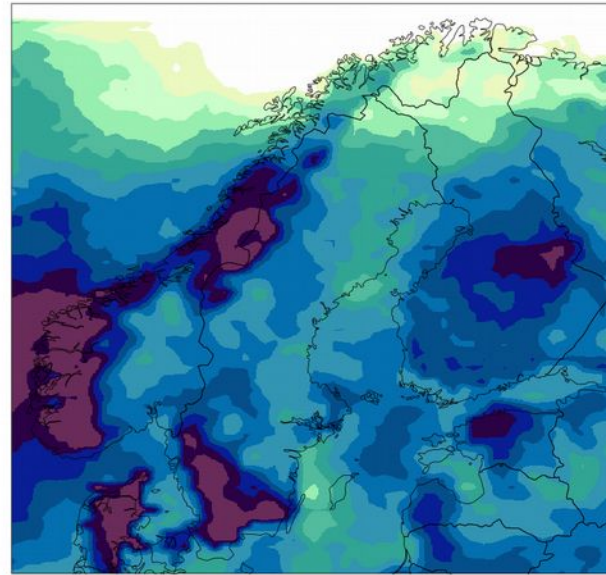
ERA20C



NGCD

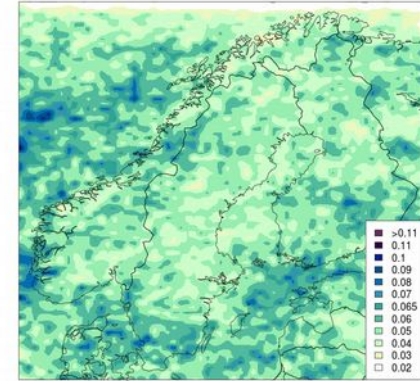


UKMO (median)

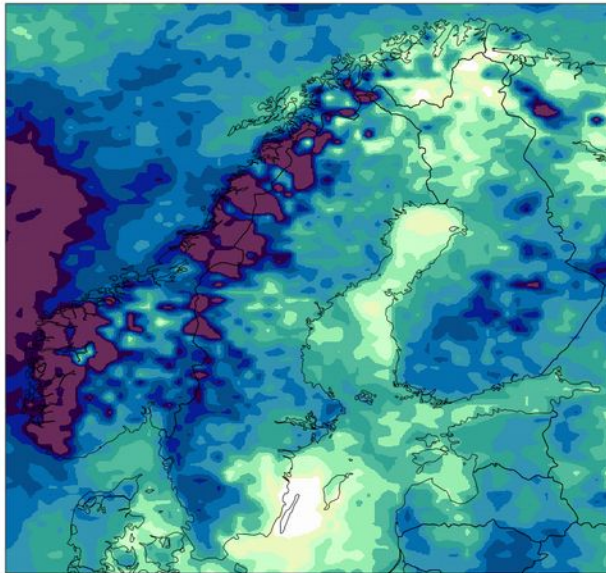


**Freq. wet days
(1mm/d)**
1.2008-5.2008
UKMO 24km grid

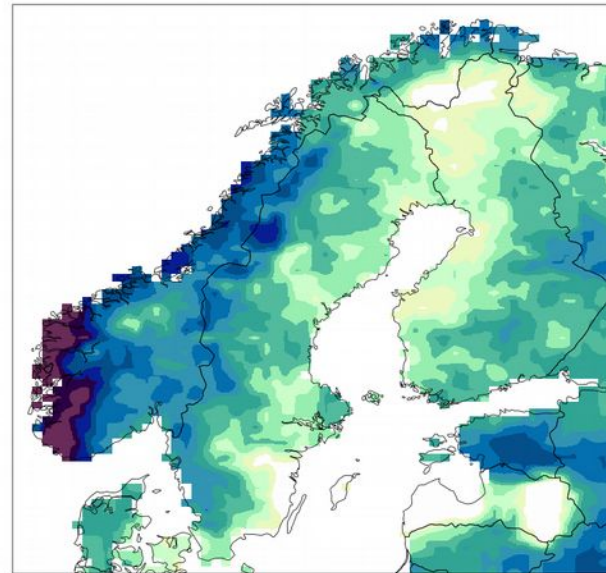
UKMO interquantile (90%-10%)



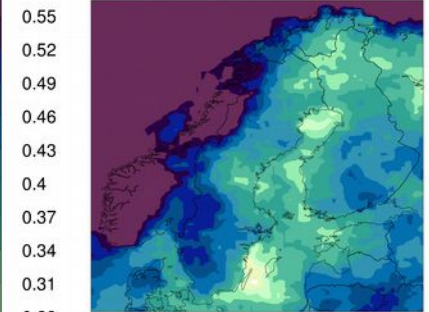
MESCAN



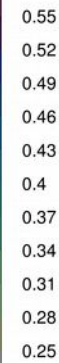
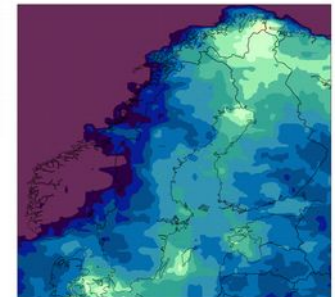
E-Obs



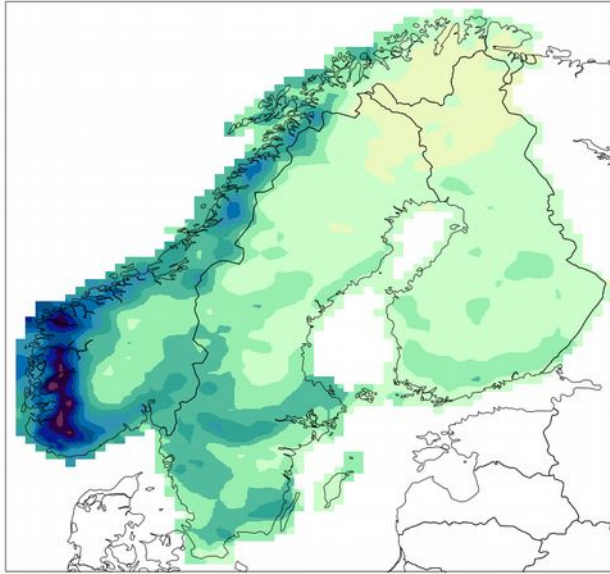
ERA-Interim



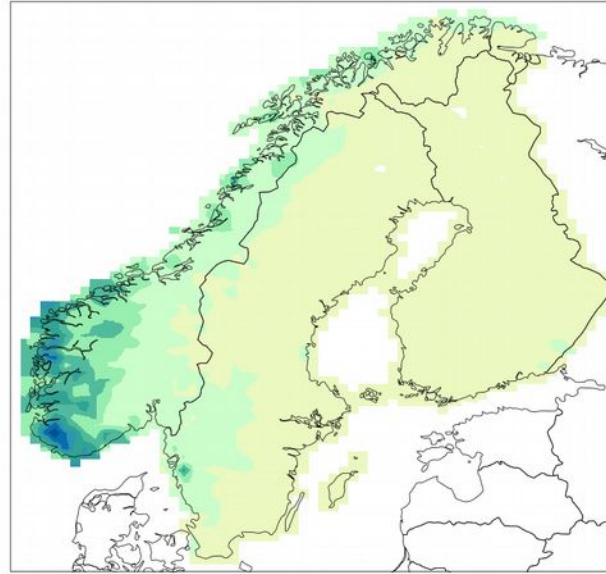
ERA20C



UKMO (median)



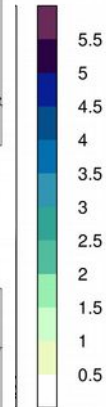
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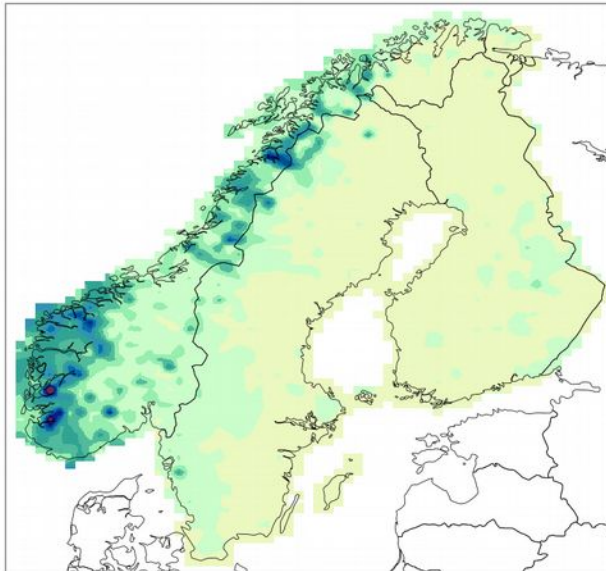
MAE

1.2008-5.2008

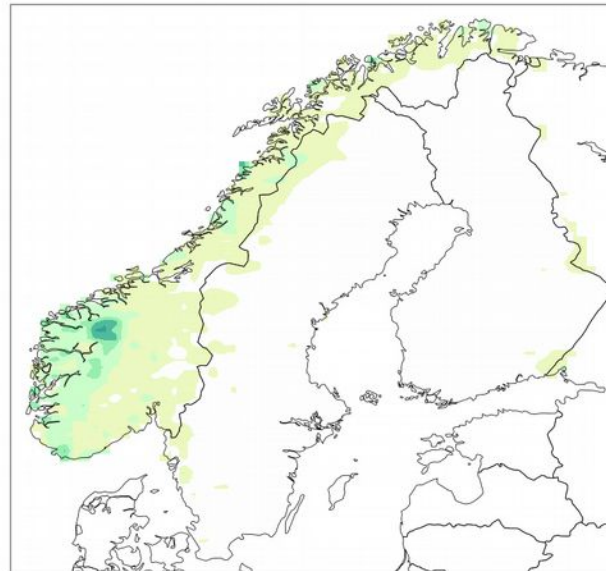
UKMO 24km grid



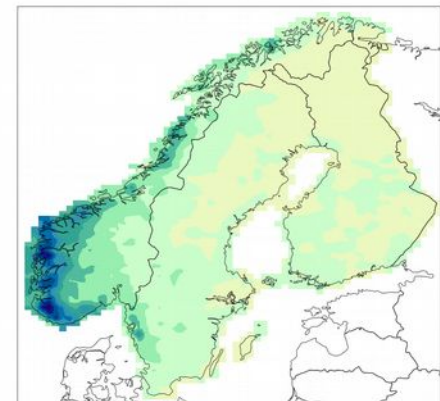
MESCAN



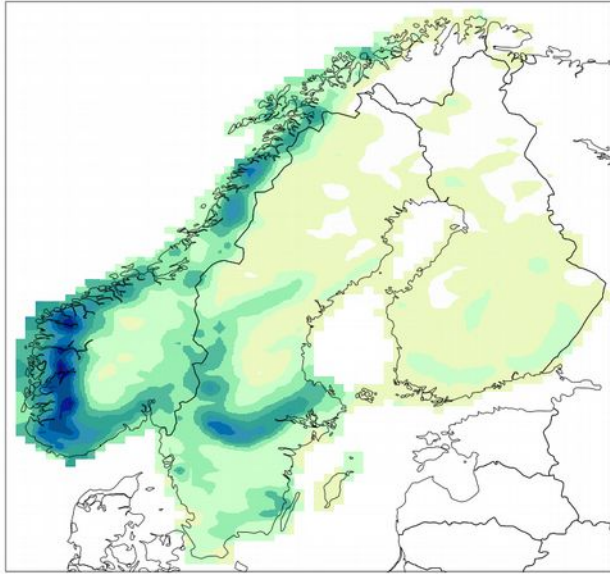
E-Obs



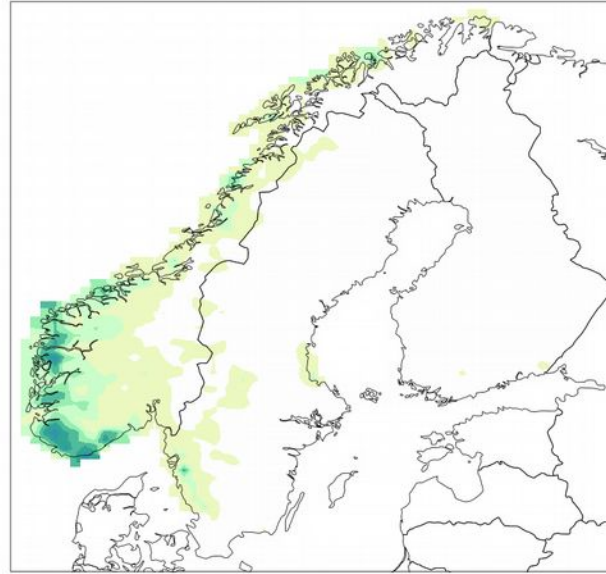
ERA20C



UKMO (median)



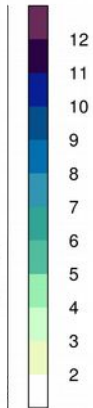
ERA-Interim



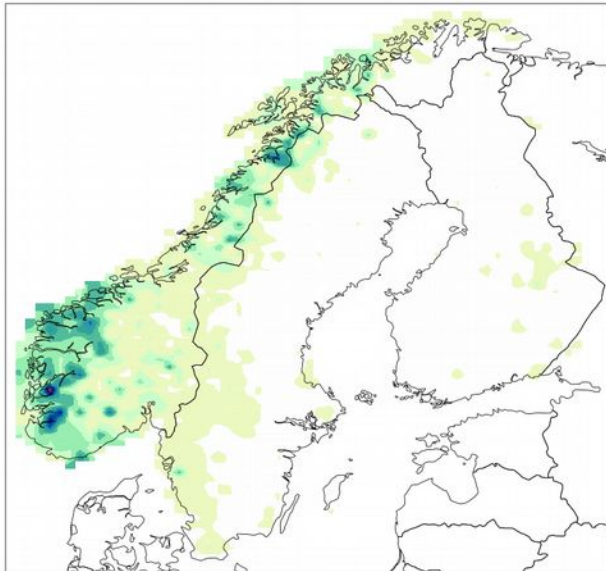
RMSE

1.2008-5.2008

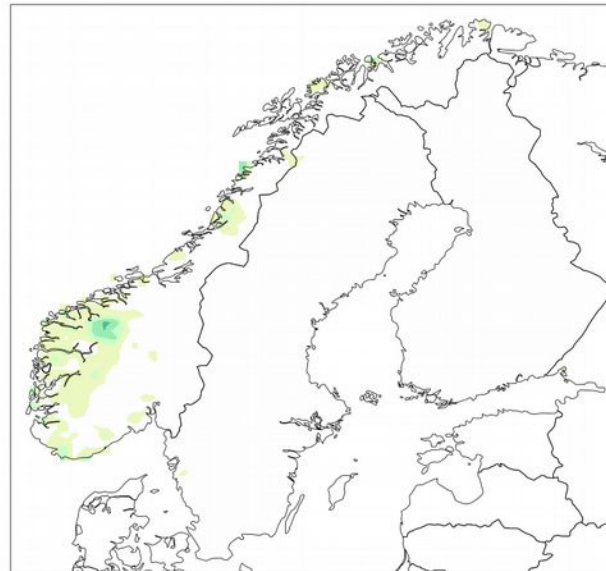
UKMO 24km grid



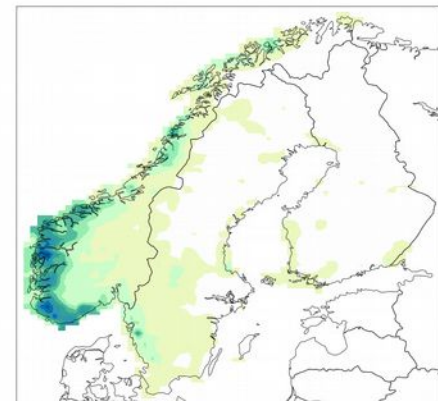
MESCAN



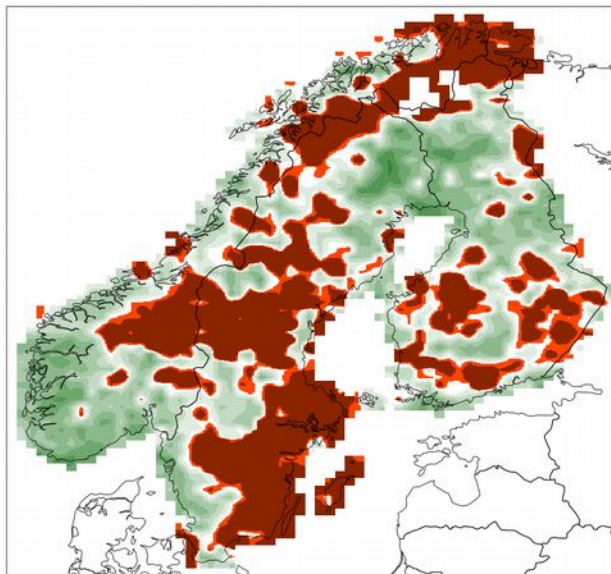
E-Obs



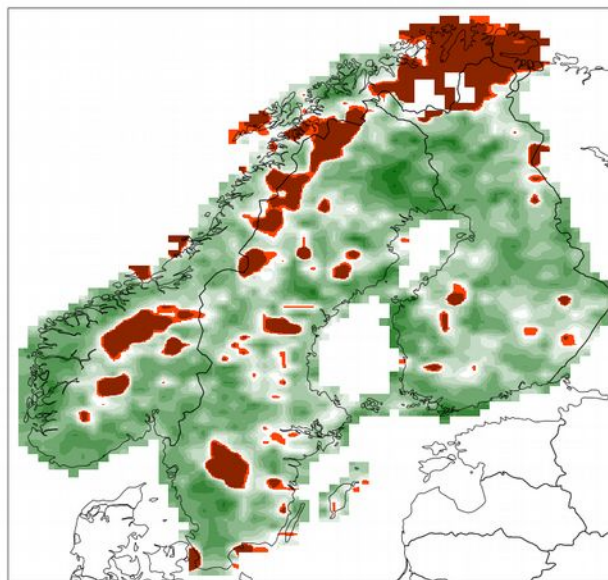
ERA20C



UKMO (median)



ERA-Interim

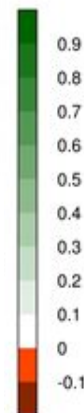


(BSS)

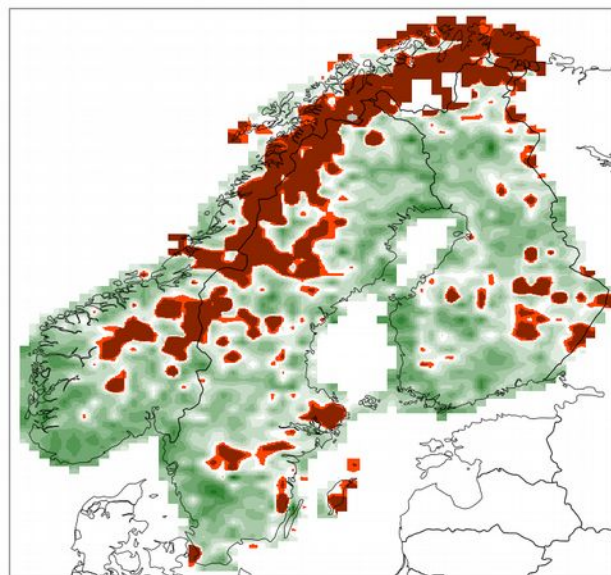
1.2008-5.2008

**UKMO 24km
grid**

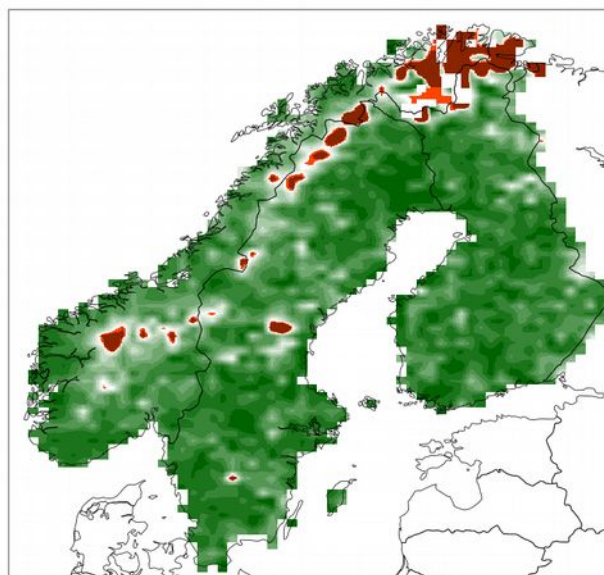
P >= 5mm



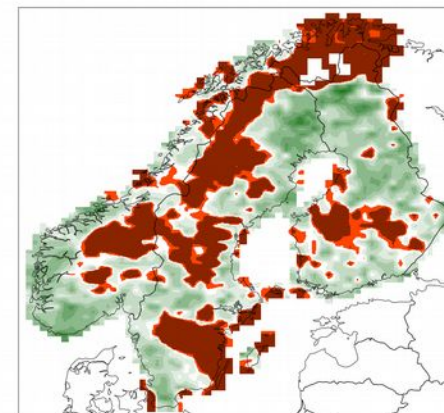
MESCAN



E-Obs



ERA20C



UKMO (median)

(BSS)

1.2008-5.2008,

UKMO 24km grid,

P \geq 5mm

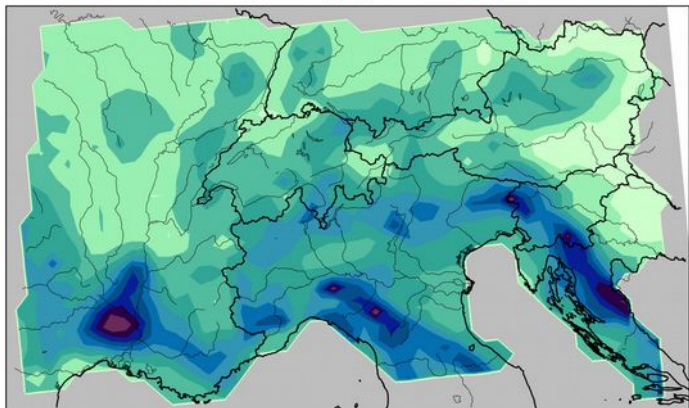
uncertainty

reliability

resolution

MESCAN

UKMO (median)

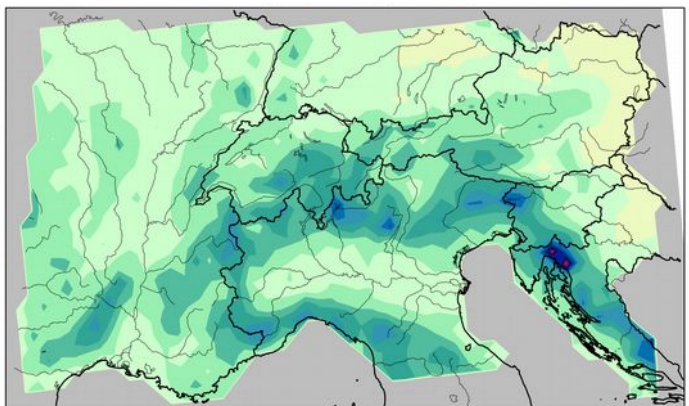


MAE

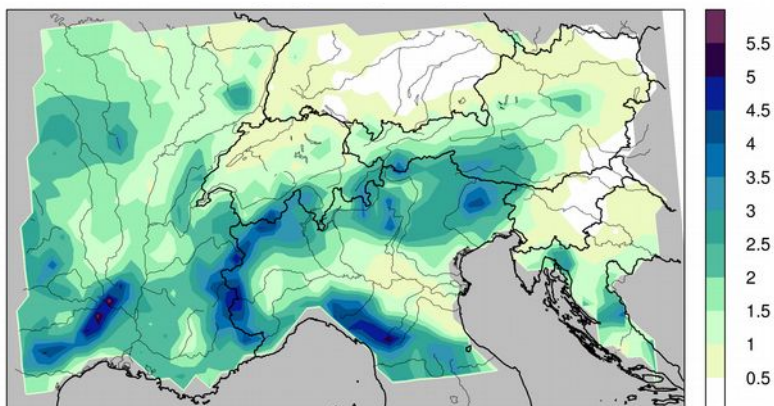
1.2008-5.2008

UKMO 24km grid

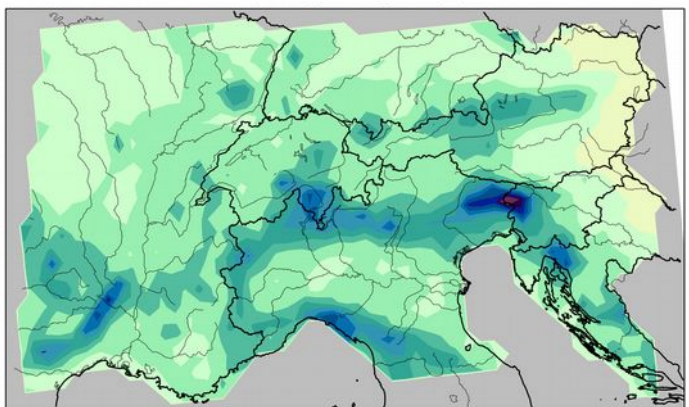
MESCAN



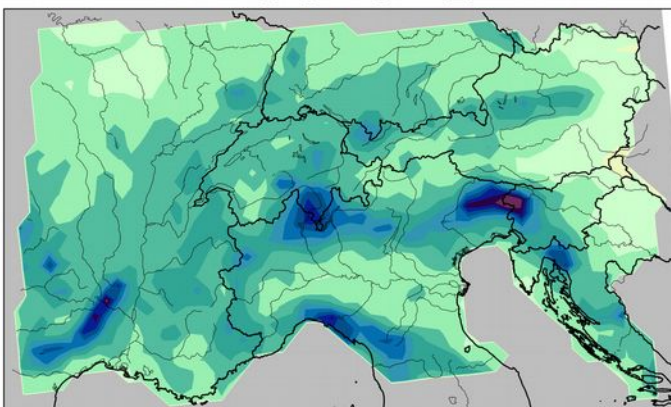
E-Obs



ERA-Interim

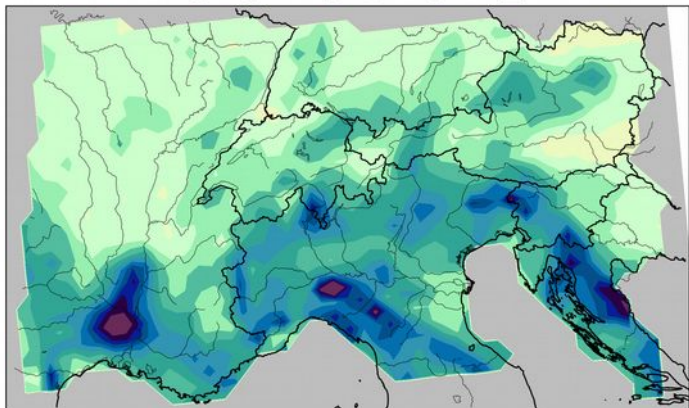


ERA20C



5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5

UKMO (median)

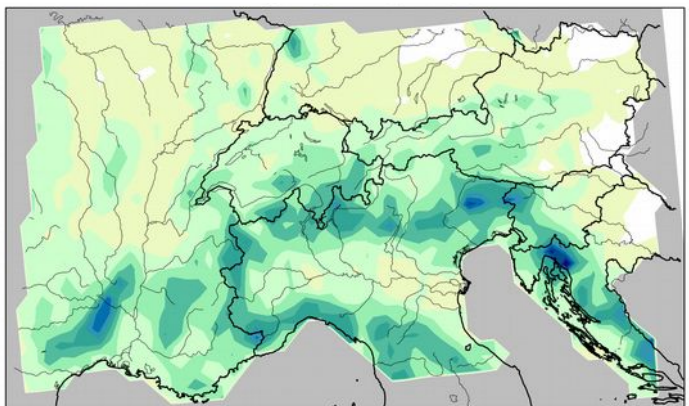


RMSE

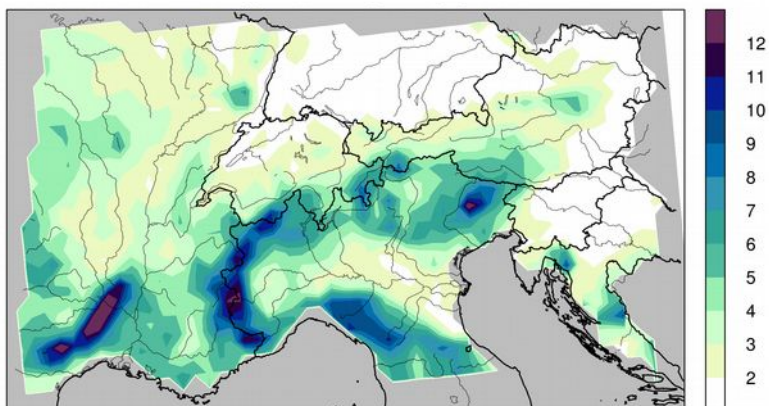
1.2008-5.2008

UKMO 24km grid

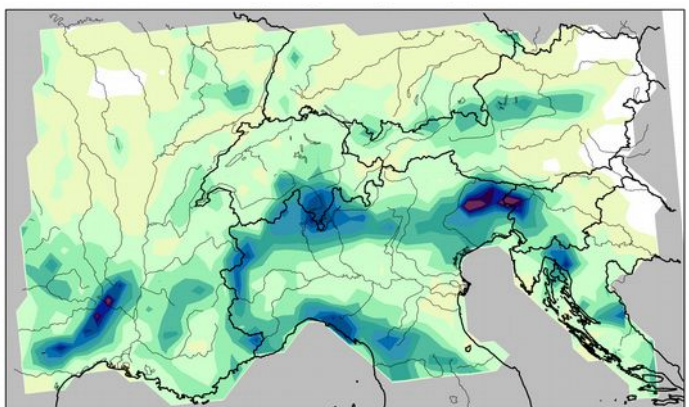
MESCAN



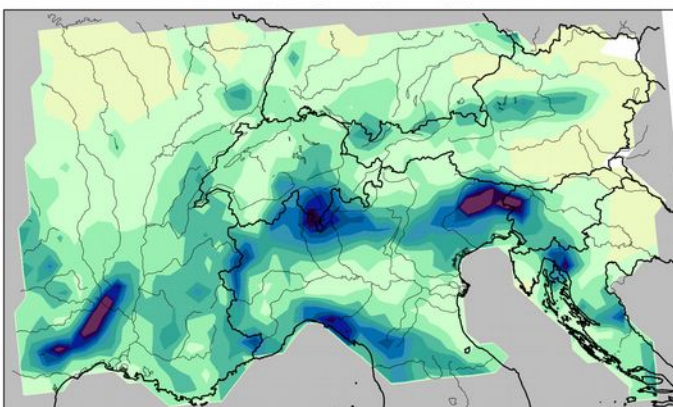
E-Obs



ERA-Interim

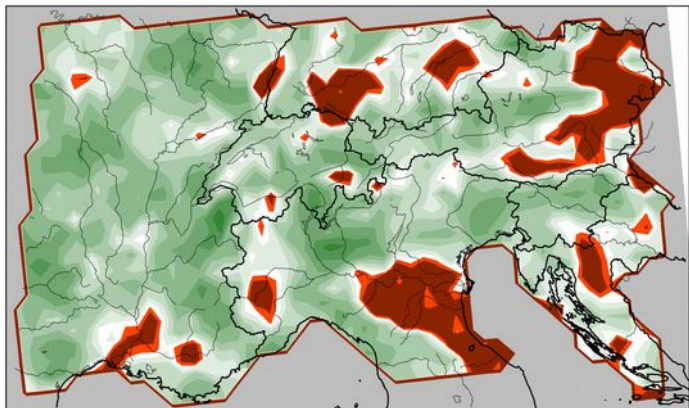


ERA20C

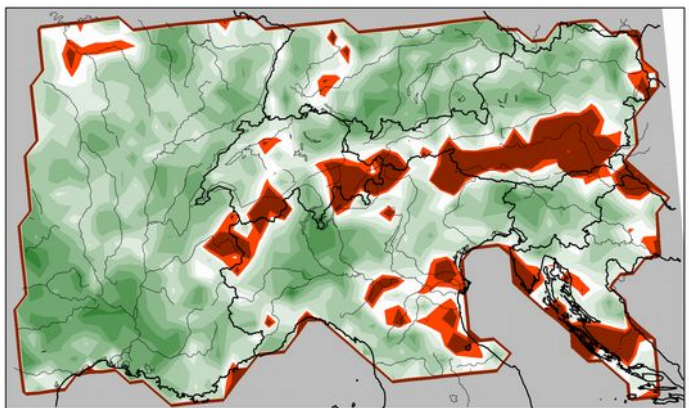


12
11
10
9
8
7
6
5
4
3
2

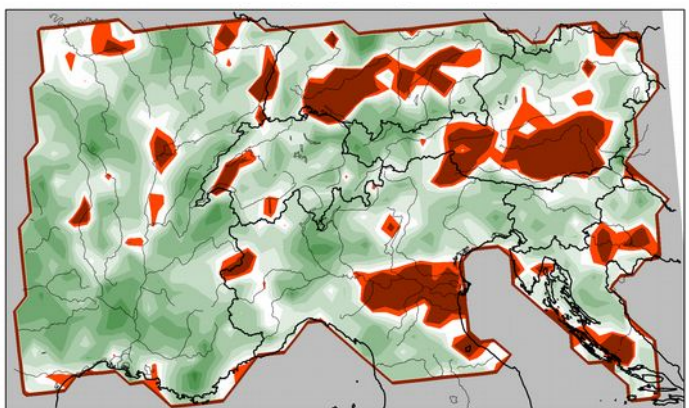
UKMO (median)



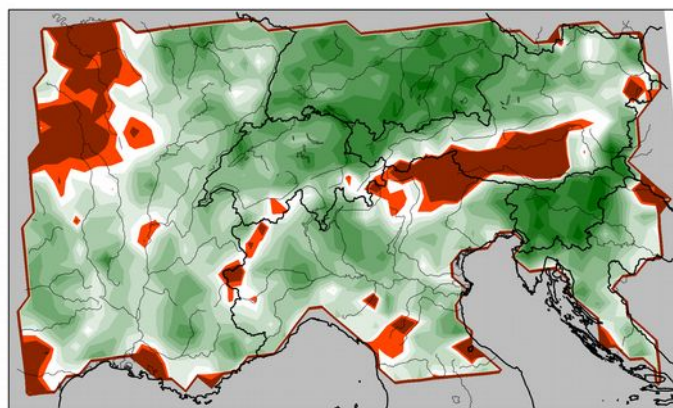
MESCAN



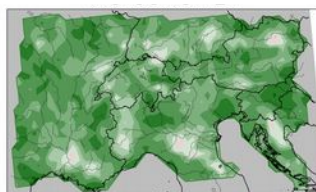
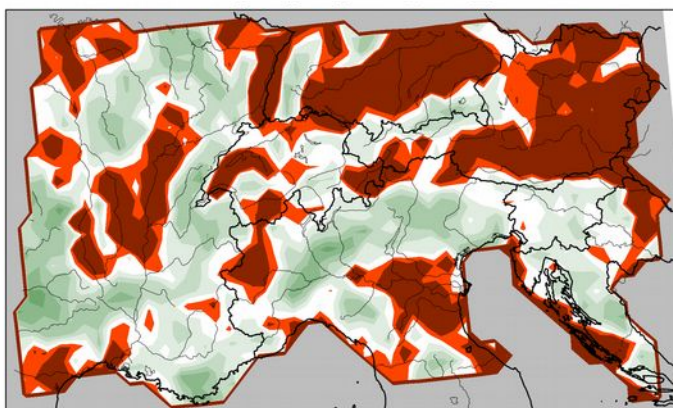
ERA-Interim



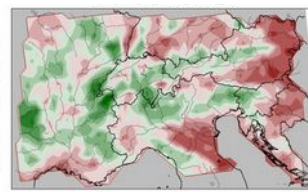
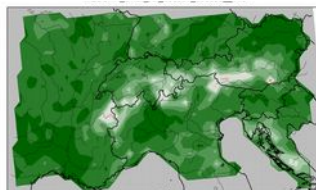
E-Obs



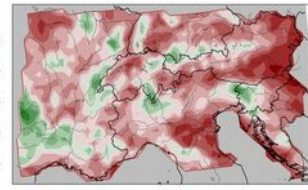
ERA20C



Reliability

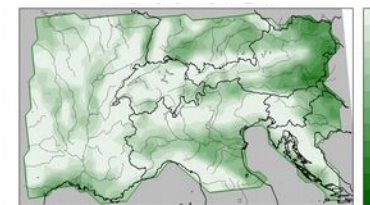


Resolution



UKMO

Uncertainty



MESCAN

**Brier
Skill
Score
(BSS)**

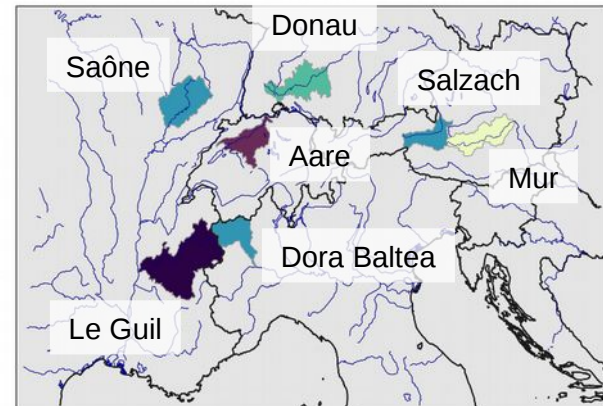
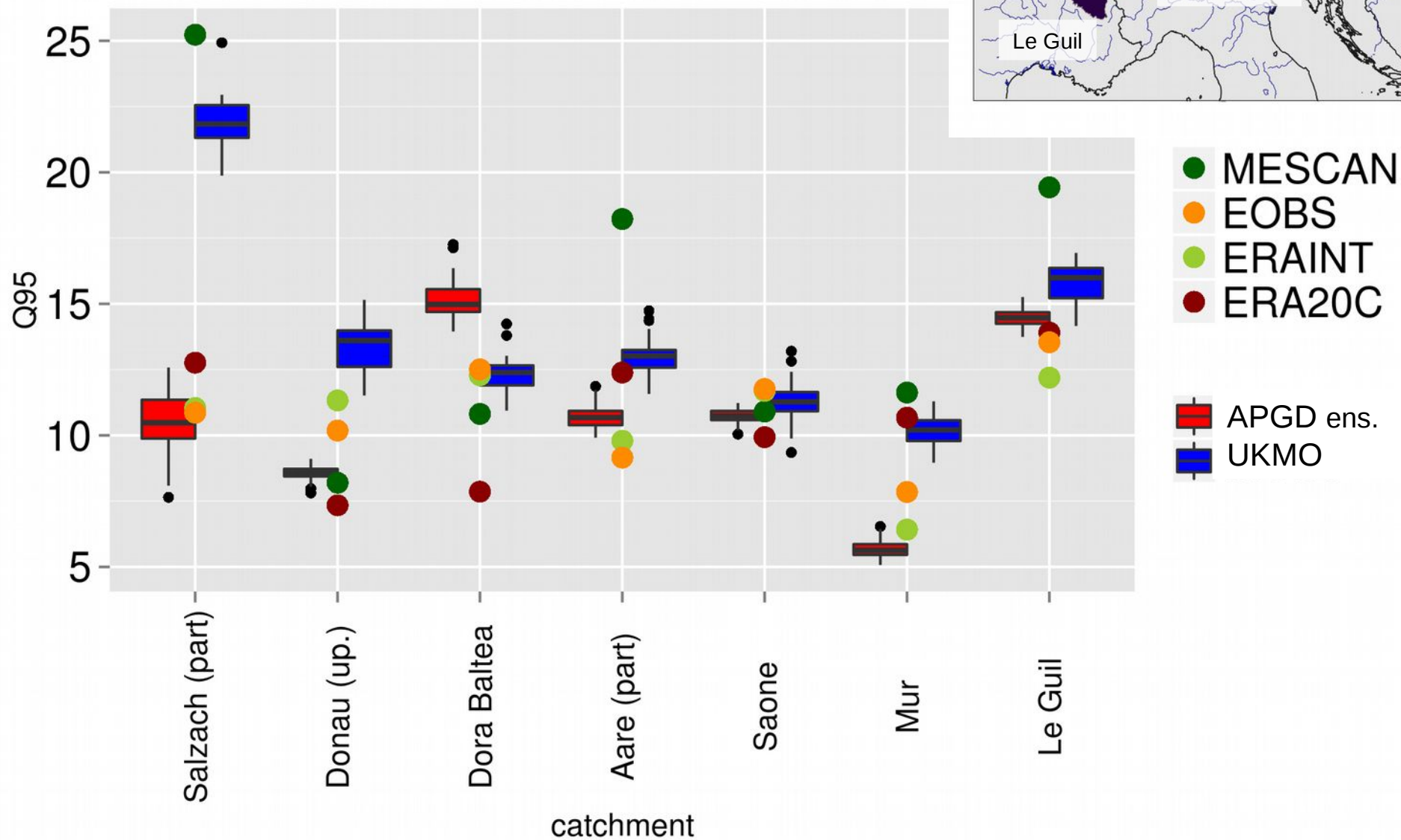
$P \geq 5\text{mm}$

1.2008-5.2008

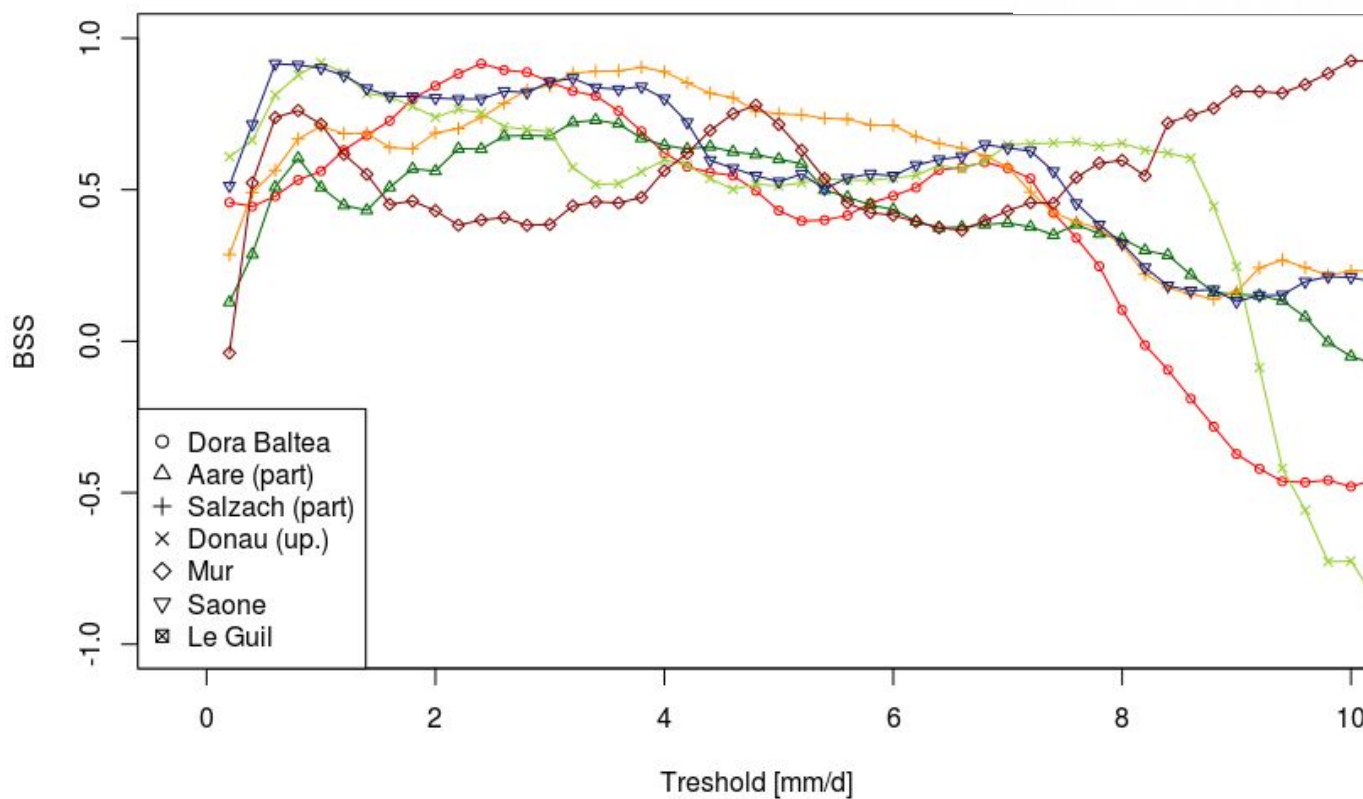
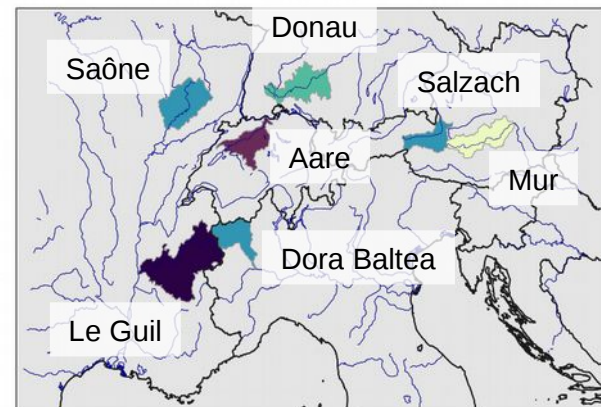
UKMO 24km grid

Q95

mm/d



UKMO



Conclusion

- Huge effort to convert the data to the needed format (netcdf, 06-06h)
- First analysis over five months (January to May 2008)
 - Reference:
 - NGCD (Fennoscandia, precipitation and temperature).
Complex terrain, sea-land.
 - APGD (Alpine region, precipitation)
Complex terrain.
 - NEW: polygoning, wavelet (scale dependence)
- Evaluation: case studies, indices, scores, frequency distributions.

Thank you for your attention!

The Brier Score / Brier Skill Score

- **Brier Score**

$$BS = \frac{1}{N} \sum_{i=1}^N (Y_i - O_i)^2$$

Y_i : forecasted event probability

O_i : event (1), no-event (0)

\bar{o} : climatological event frequency

- Similar to MSE but with probabilities
- $0 \leq BS \leq 1$, perfect forecast: $BS=0$
- Climatology forecast: $Y_i = \bar{o} \Rightarrow BS_{clim} = \bar{o} \cdot (1 - \bar{o})$

- **Brier Skill Score**

$$BSS = \frac{BS - BS_{ref}}{BS_{perf} - BS_{ref}} = 1 - \frac{BS}{BS_{ref}}$$

- Generic form of skill scores. Perfect: $BSS=1$, no-skill: $BSS \leq 0$
- E.g. $BS_{ref} = BS_{clim}$
- BSS cannot be hedged.

Method (precipitation)

- 06h 06h daily precipitation
- Deterministic/probabilistic

Analysis:

- Case studies: intense precipitation events
- Precipitation indices (mean annual precipitation, freq. wet days, q95)
- Frequency distribution function
- Yearly cycle
- Scores, for example:
 - RMSE = $\sqrt{\frac{1}{n} \sum_{i=1}^n (Y_i - O_i)^2}$ (Rodwell et al., 2010)
 - Robust 3-category error score for daily precipitation
 - SEEPS (Rodwell et al., 2010)
 - BRIER (forecasted/observed event probability)
 - Robust 3-category error score for daily precipitation
 - Wavelet-based score
 - BRIER $\frac{1}{n} \sum_{i=1}^n (Y_i - O_i)^2$ (forecasted/observed event probability)
 - Wavelet-based score