Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

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

Evaluation and uncertainty assessment of precipitation in UERRA regional re-analyses: First results for the Alpine Region and Fennoscandia.

Francesco Isotta[1], Cristian Lussana[2], Barbara Casati[3], Christoph Frei[1], and Ole Einar Tveito[2]

14th September 2016

(1) Federal Office of Meteorology and Climatology MeteoSwiss, Zurich, Switzerland
(2) Norwegian Meteorological Institute, Oslo, Norway
(3) Meteorological Research Division, Environment and Climate Change Canada, Dorval (QC), Canada

SEVENTH FRAMEWORK PROGRAMME

UERRA
Uncertainties in Ensembles of Regional ReAnalyses

Evaluation over Europe - UERRA

Successor project of EURO4M
Start: 1 March 2014, 4 Years period

- **Development of an ensemble system of regional re-analyses (for climatological time scales). Assessment of the information content and uncertainties.**
- **Provide long-term datasets of some essential variables to support adaptation, policy development and for climate monitoring and research.**

- Focus here: Contributions of MeteoSwiss and Met Norway
  → Evaluate and quantify uncertainties of regional re-analyses using probabilistic forecast verification.
  → Precipitation and temperature
  → Alpine Region and Scandinavia
  → Reference: gridded observations APGD and NGCD
  → Scale dependency

Method (precipitation)

→ **06h-06h daily precipitation**
→ **Deterministic/probabilistic**

Analysis:

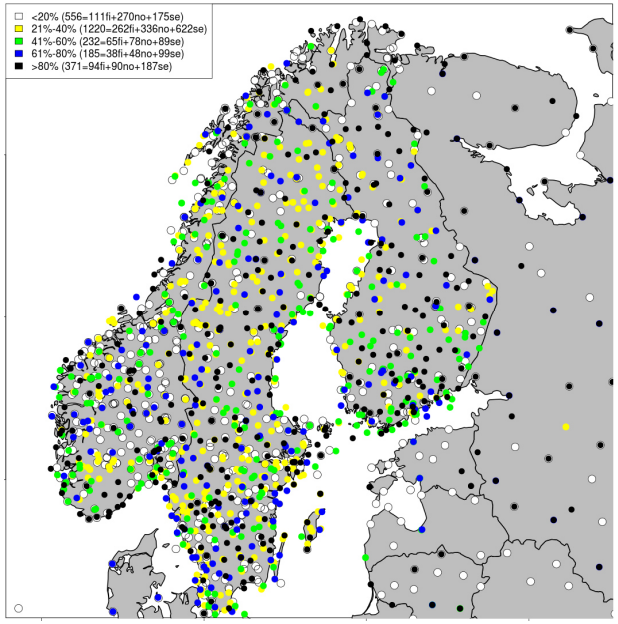
- **Case studies: intense precipitation events**
- **Precipitation indices (mean annual precipitation, freq. wet days, q95)**
- **Frequency distribution function**
- **Yearly cycle**
- **Scores, for example:**
  - **RMSE=** $\sqrt{\frac{1}{n}\sum_i^n (y_i - o_i)^2}$
  - **SEEPS (Rodwell et al., 2010)**

    Robust 3-category error score for daily precipitation
  - **BRIER** $\frac{1}{n}\sum_i^n (Y_i - O_i)^2$ (forecasted/observed event probability)
  - **Wavelet-based score**

UERRA Reanalysis datasets (in prep.)

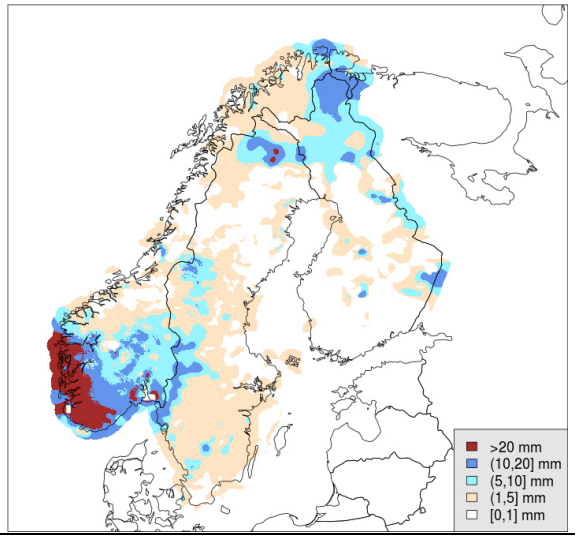
Dataset	Grid spacing	Period	Information
UK MetOffice Reanalysis	24 km	1978-	20 members (→ mean and spread) Static 4DVAR
UK MetOffice Reanalysis	12 km	1978-	deterministic uses ensemble reanalysis uncertainty in the assimilation
HARMONIE reanalysis SHMI, Météo-France	11 km	1961-2014	deterministic
COSMO-REA6 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

Reference Datasets Fennoscandia I



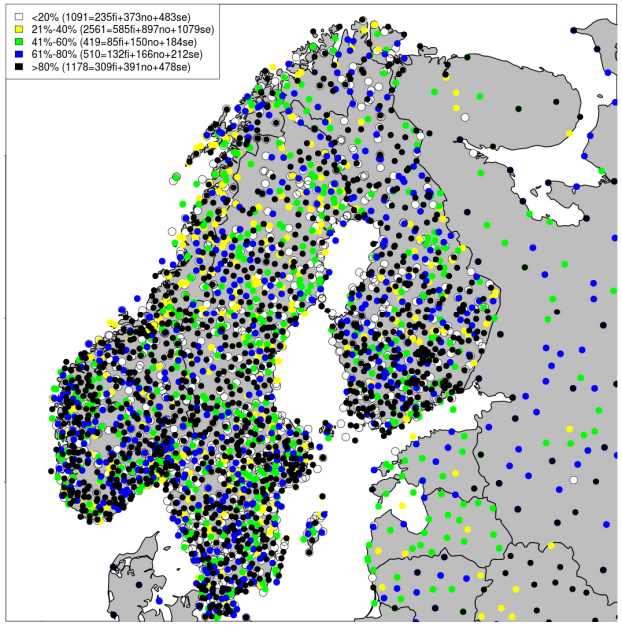
Nordic Gridded Climate dataset (NGCD)	
Variable	Precipitation
Δx	1km
t	1981-2010, daily
x	Finland, Norway, Sweden (mainland)
Stations	~1800
Source	ECA&D, eklima.met.no, SMHI + FMI

EU-FP7 UERRA project



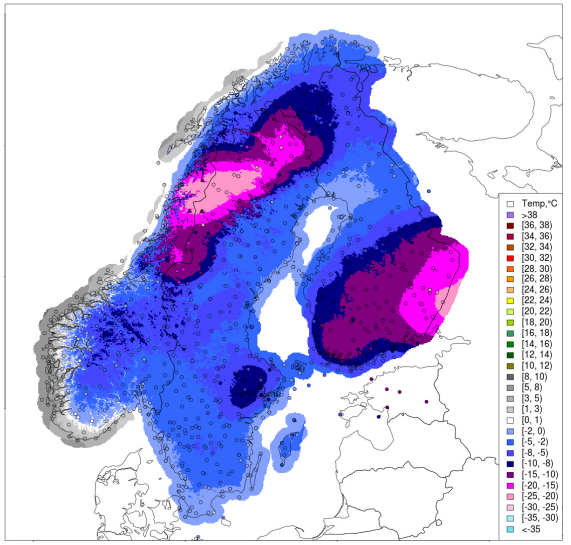
Experimental release available (free):
MET Norway Thredds Service

Reference Datasets Fennoscandia II



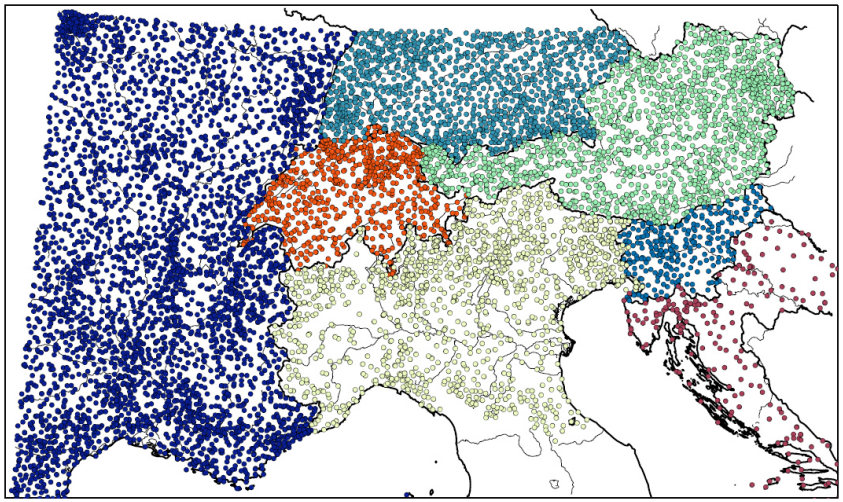
Nordic Gridded Climate dataset (NGCD)	
Variable	Temperature
Δx	1km
t	1981-2010, daily
x	Finland, Norway, Sweden (mainland)
Stations	~3850
Source	ECA&D, eklima.met.no, SMHI + FMI

EU-FP7 UERRA project



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

Reference Datasets Alpine Region

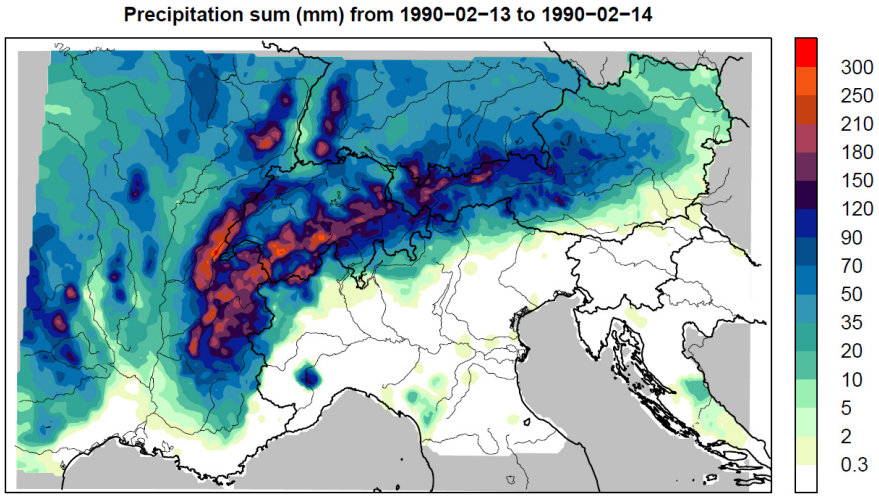


Alpine Precipitation Grid Dataset (APGD)	
Variable	Precipitation
Δx	5km
t	1971-2008, daily
x	Alpine Region (2-17.5E, 43-49N)
Stations	>8500 (~6000 per day)
Quality	Quality checked

EU-FP7 EURO4M project

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

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

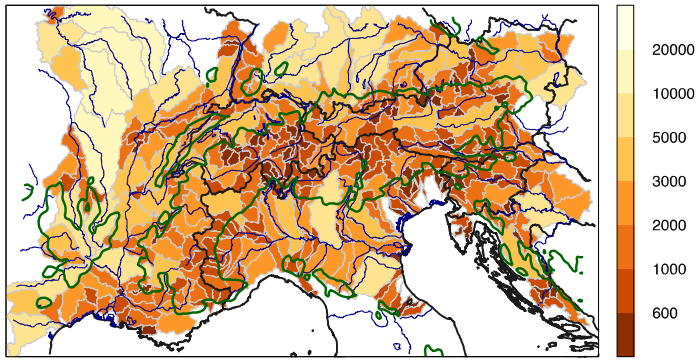


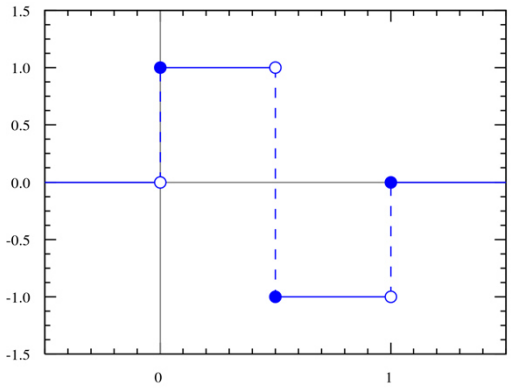
Scale dependency

→ Skill of models, uncertainty depend on scale

→ Scale dependent evaluation

Two methods





«Polygoning»

Scale separation on catchment areas of different size classes

«Wavelet»

Mathematical-theoretical scale separation

Pan-Alpine Probabilistic Dataset

Area-mean precipitation over hydrological units in the Alps

Same data as for APGD

100 ensemble members

534 hydrological units,

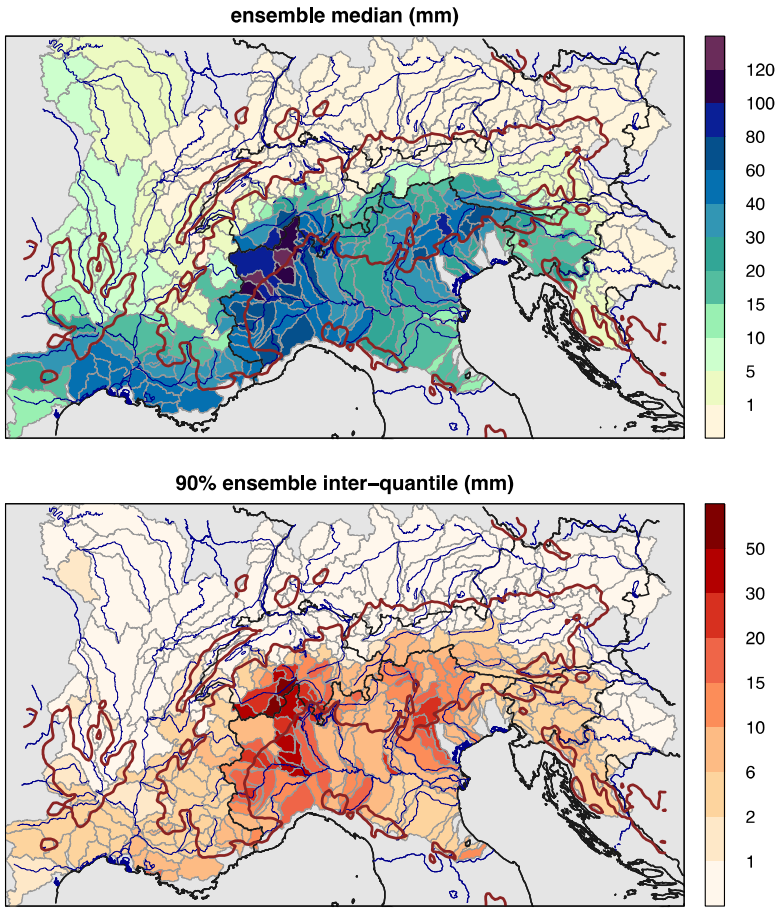
- at four hierarchical scales
- 325 elementary units (EEA)

consistent within 68 super-units

daily, 1971-2008

2005-2008 processed so far

2008.11.04



Probabilistic “Polygoning”

Estimate pdf of daily area-average precipitation over polygons, conditional on point observations in the neighbourhood

Capture dependencies of interpolation uncertainty on

- spatial variance of precipitation (day-to-day)
- station density
- area of hydrological unit (scale)

Sources of Uncertainty

- Measurement Errors (to be considered later)
- Interpolation Errors

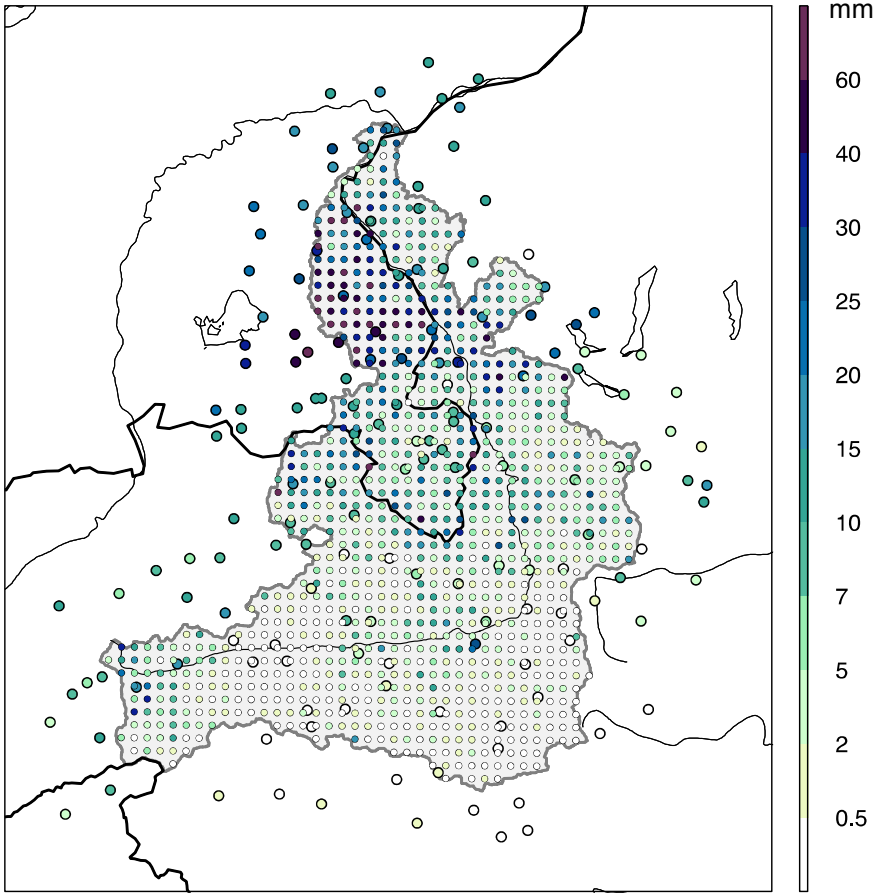
- Probabilistic estimation → Stochastic Model: Trans-Gaussian Random Fields
- Inference: Bayesian (full a posteriori distribution of all model parameters)
- Ensemble of Polygon Means: Conditional Simulation (on a regular sub-grid)

→ EMS2016-174, C. Frei et al.
Presentation Thursday 11:45 (MC2)
Room: Vulcania 1

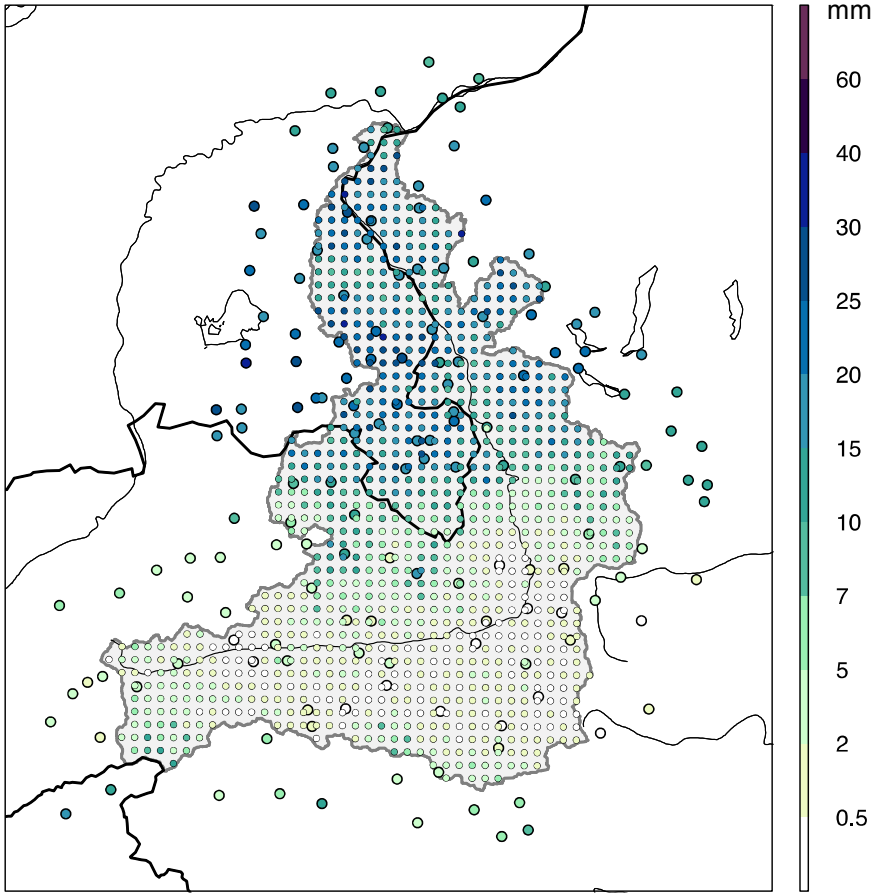
Extending ideas from: Ahrens & Jaun 2007, Moulin et al. 2009, Pappenberger et al. 2009, Erdin et al. 2012, Wilson et al. 2014

Illustration – Simulation

1990.06.30, convective



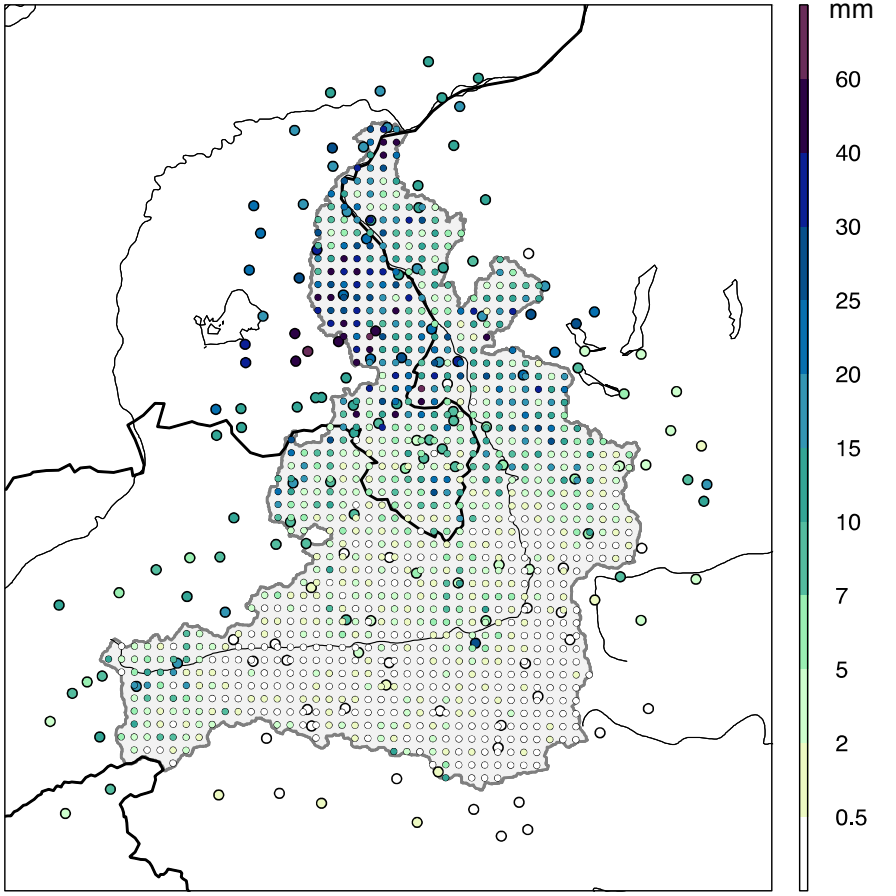
1990.10.29, stratiform



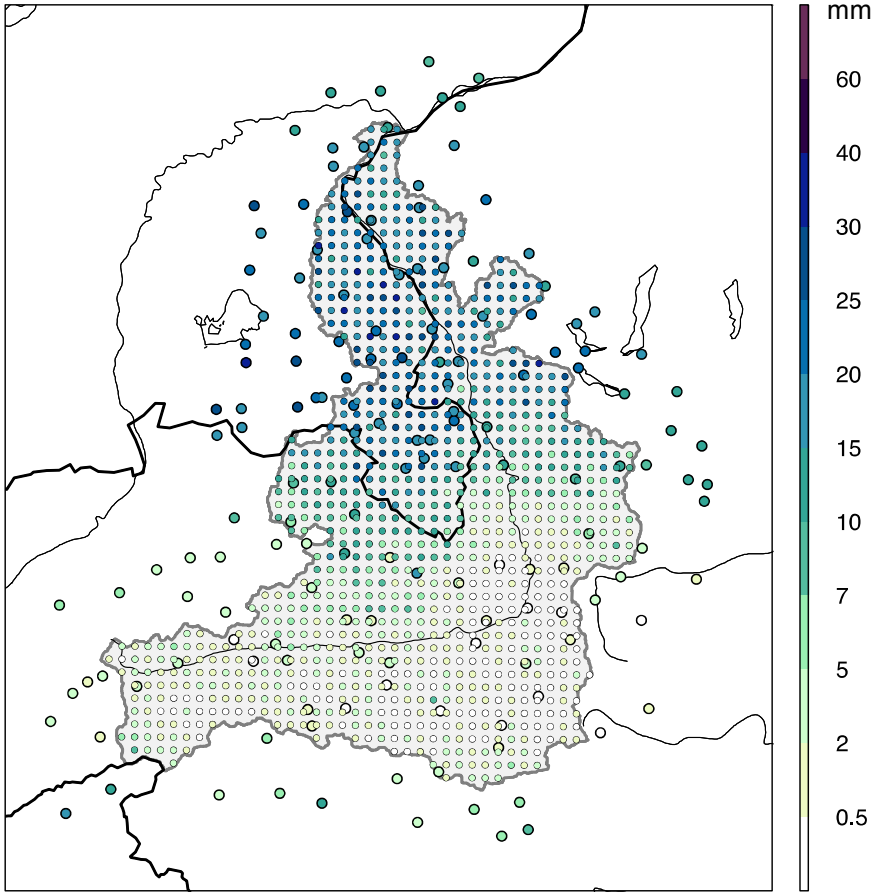
Ensemble Member

Illustration – Simulation

1990.06.30, convective

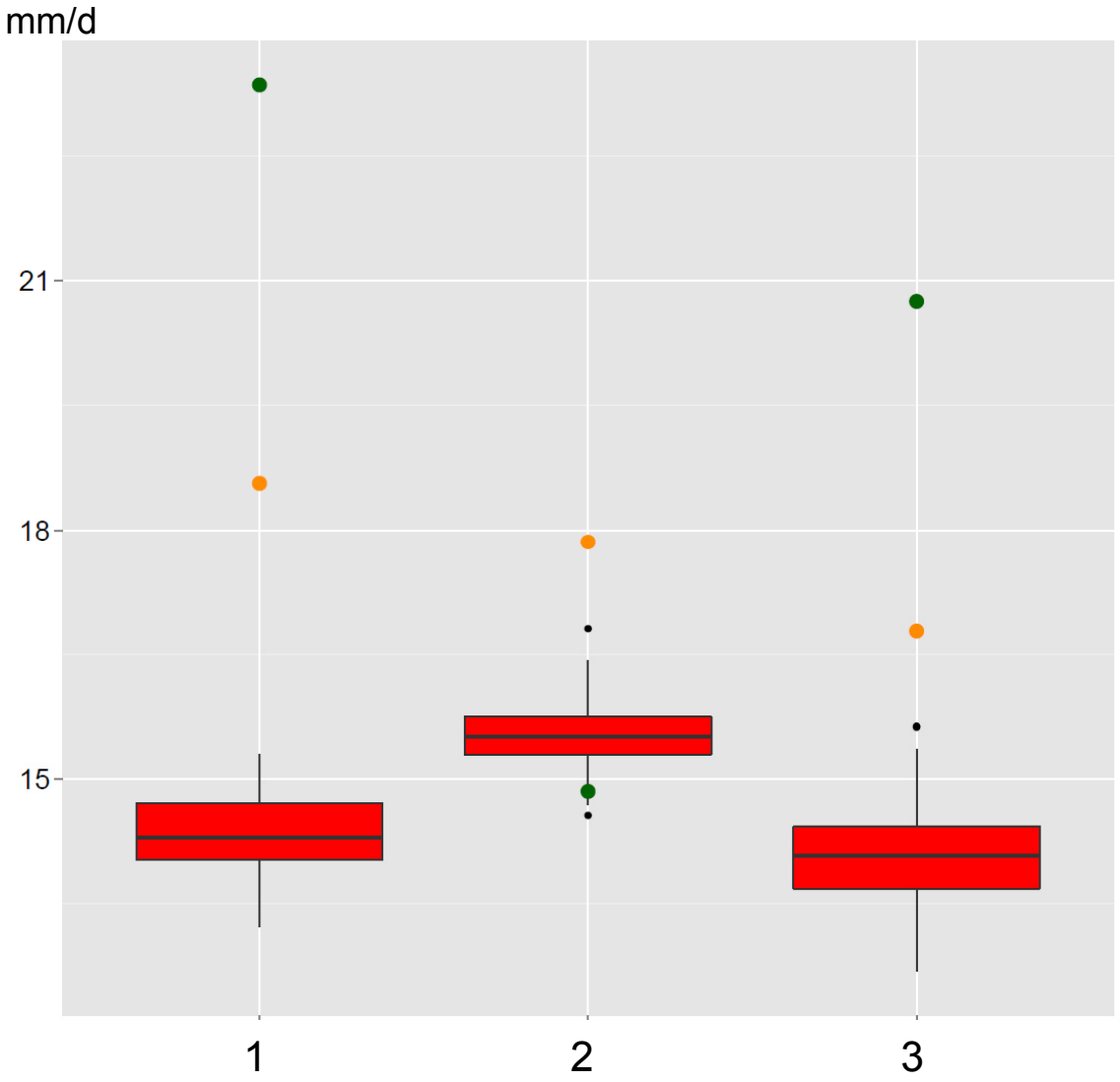


1990.10.29, stratiform

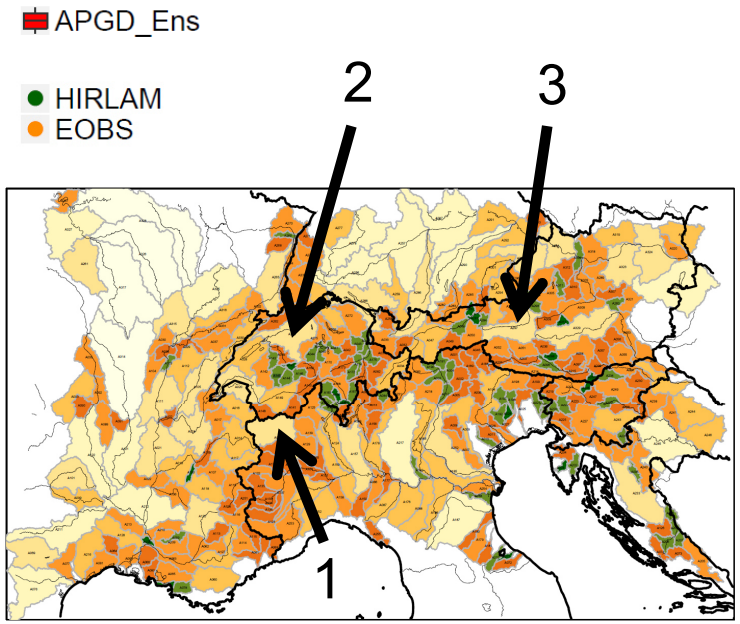


Ensemble Member

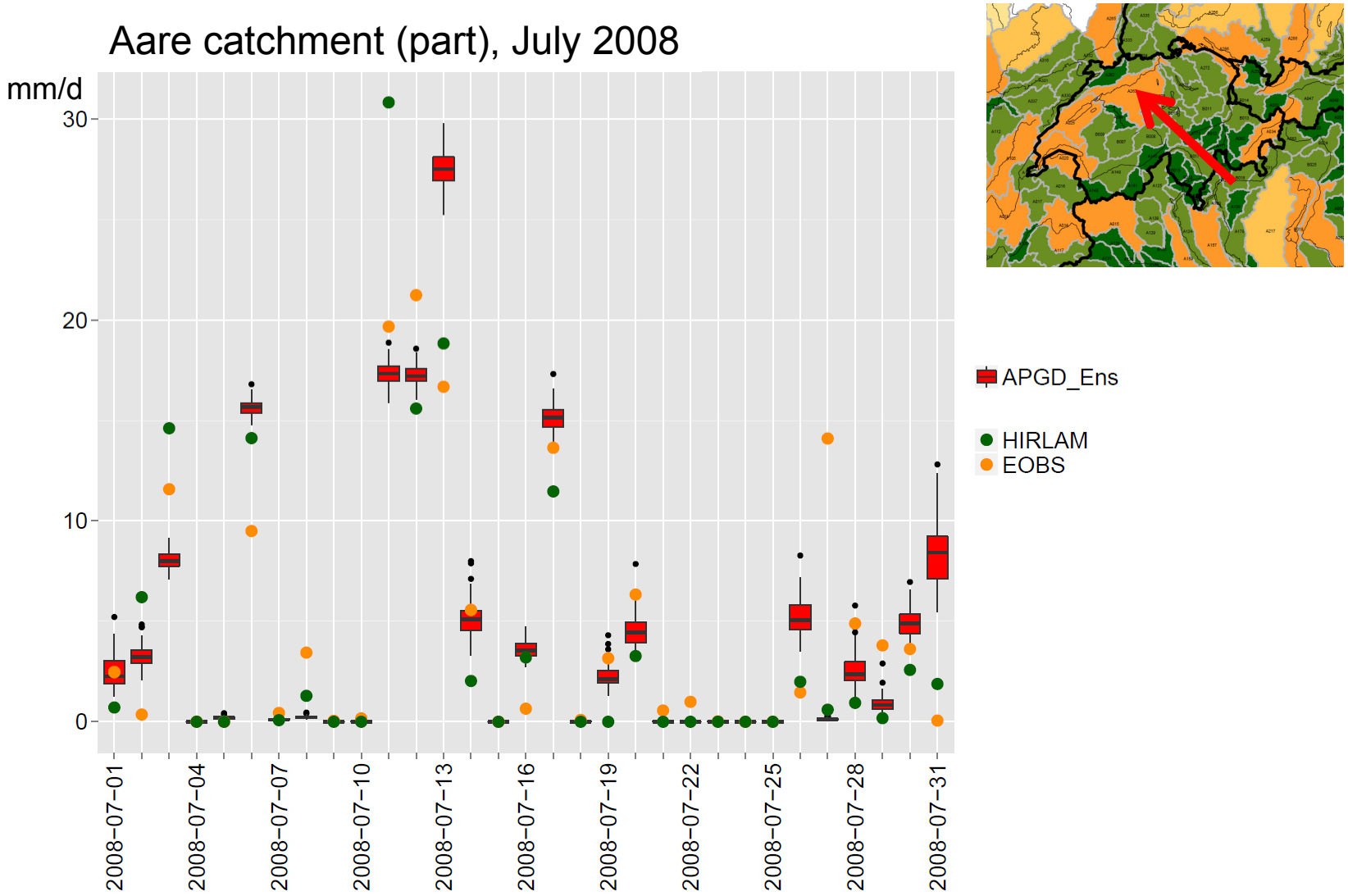
Q95



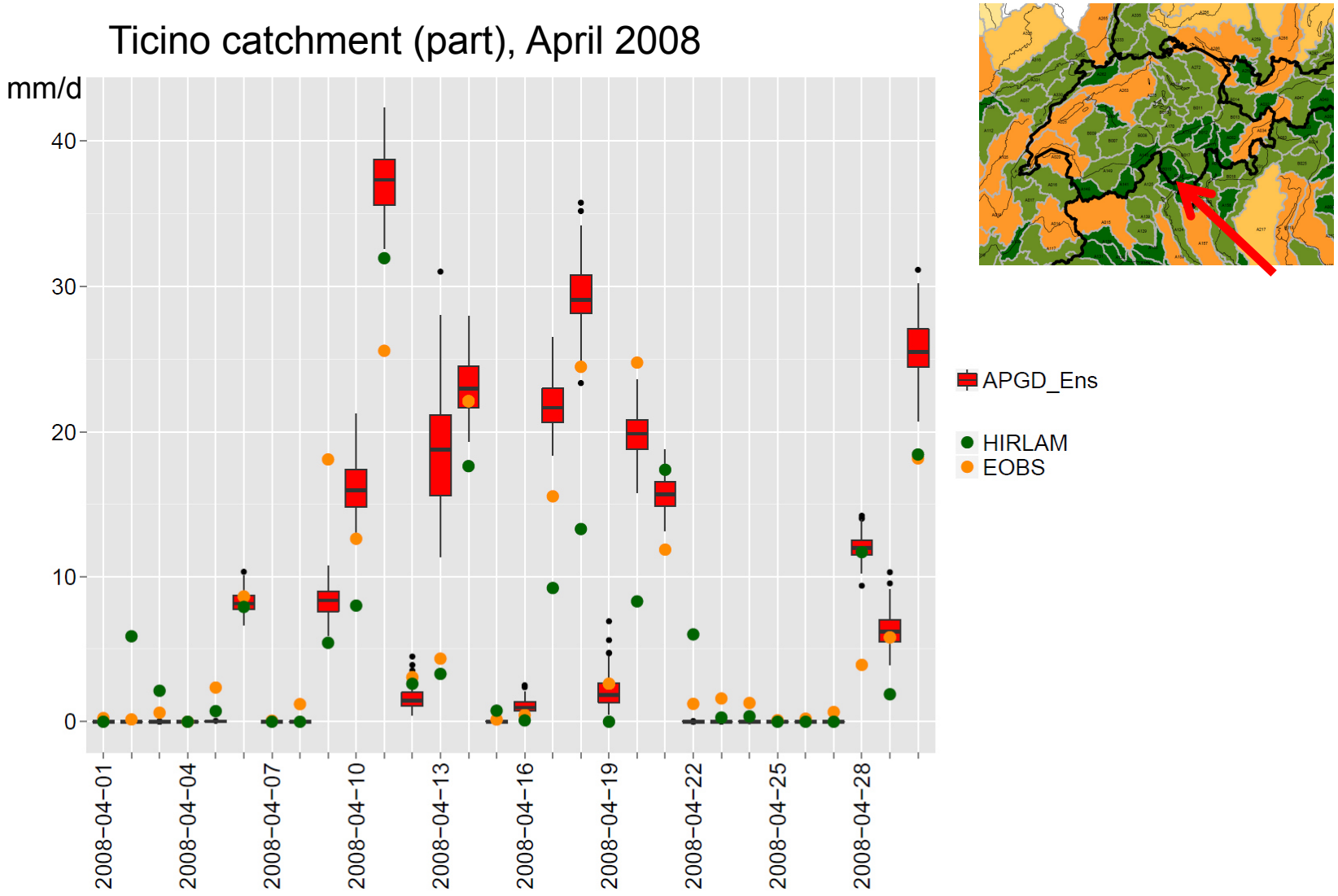
95% quantile, 2008
1: Aosta Valley (Dora Bàltea)
2: Aare river (part)
3: Salzach (part)



Daily precipitation



Daily precipitation



Verification method: Wavelet

Scale decomposition approach based on the Haar wavelet filter

Key points:

1. Decompose reanalysis and observation fields into the sum of spatial components on different scales (wavelets)
2. Perform verification on different scale components, separately

Account for the field coherent spatial structure:

➔ Assess scale structure

➔ Bias, error and skill on different scales

Refrerences: Casati et al. (2004), Casati (2010)

Verification method: Wavelet

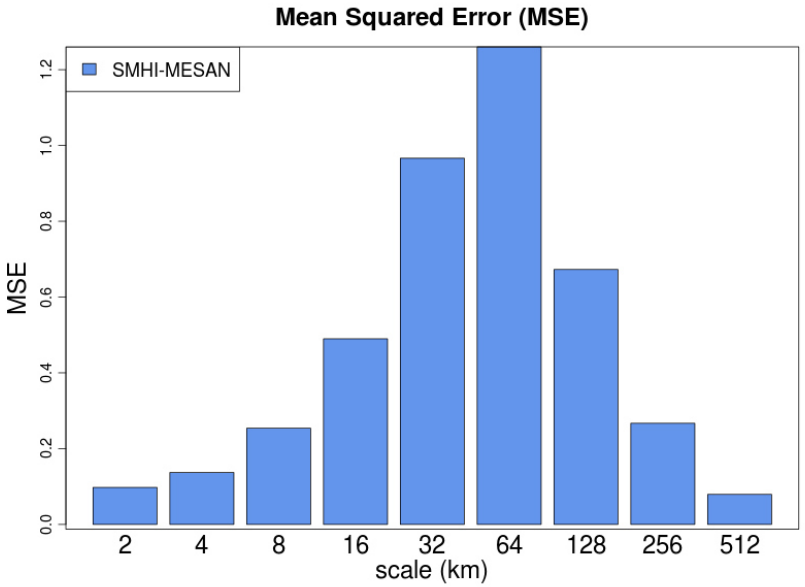
Case study: Precipitation 20.6.2008

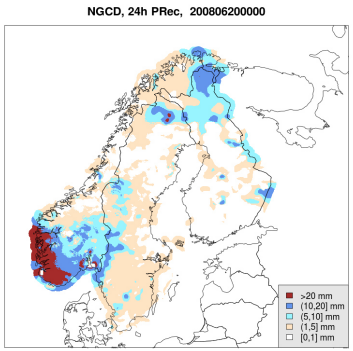
Mean Squared Error(MSE)
for each scale component

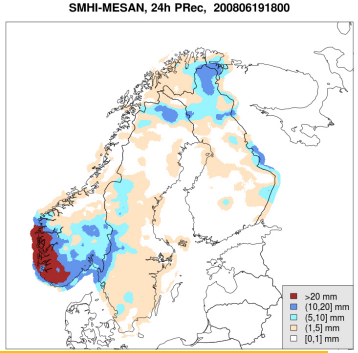
Observation: NGCD
Reanalysis: EURO4M MESAN data

Wavelet scale separation

- informative on bias, error and skill on different scales
- suitable for comparing models with different resolutions
- informative on performances for specific intensity events (thresholded binary fields)







→ **EMS2016-175, C. Lussana et al.**
Presentation Friday 14:45 (AM5/UC3)
Room: Vulcania 1

Conclusion

- → **Ready for the evaluation in UERRA**
  - → **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.**