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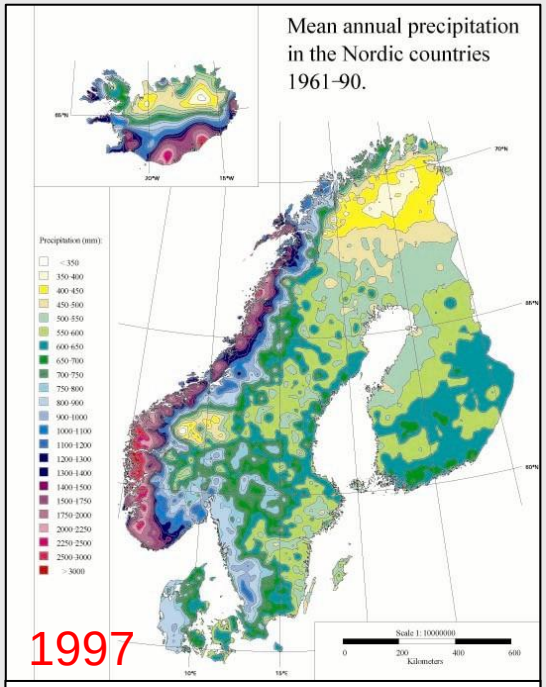
Nordic Gridded climate dataset (NGCD), status and plans

Cristian Lussana and Ole Einar Tveito

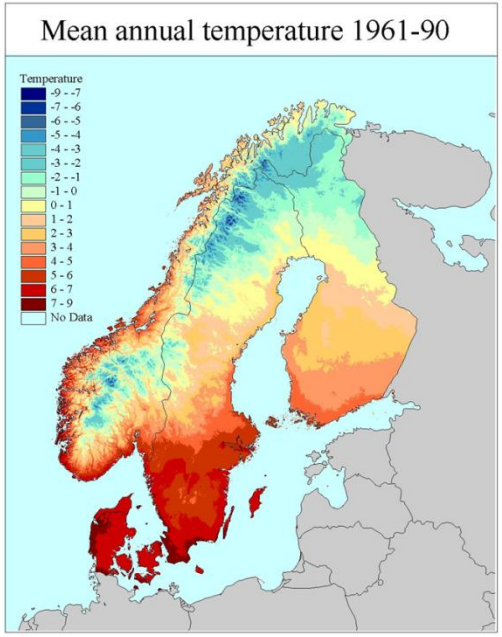
Background

- There is a long tradition of collaboration between the Nordic countries.
- Climate maps based on gridded data celebrate 20 year anniversary this year.
- 1990'ies: Normals, climate indicators.
- Since ~2005: Daily maps

- MET Norway have since 2004 provided daily gridded observation products (temperature and precipitation) covering the period 1957 to present. (SeNorge-datasets)
- Within the FP7 UERRA project have the SeNorge datasets been extended to cover Fennoscandia ➔ **NGCD**



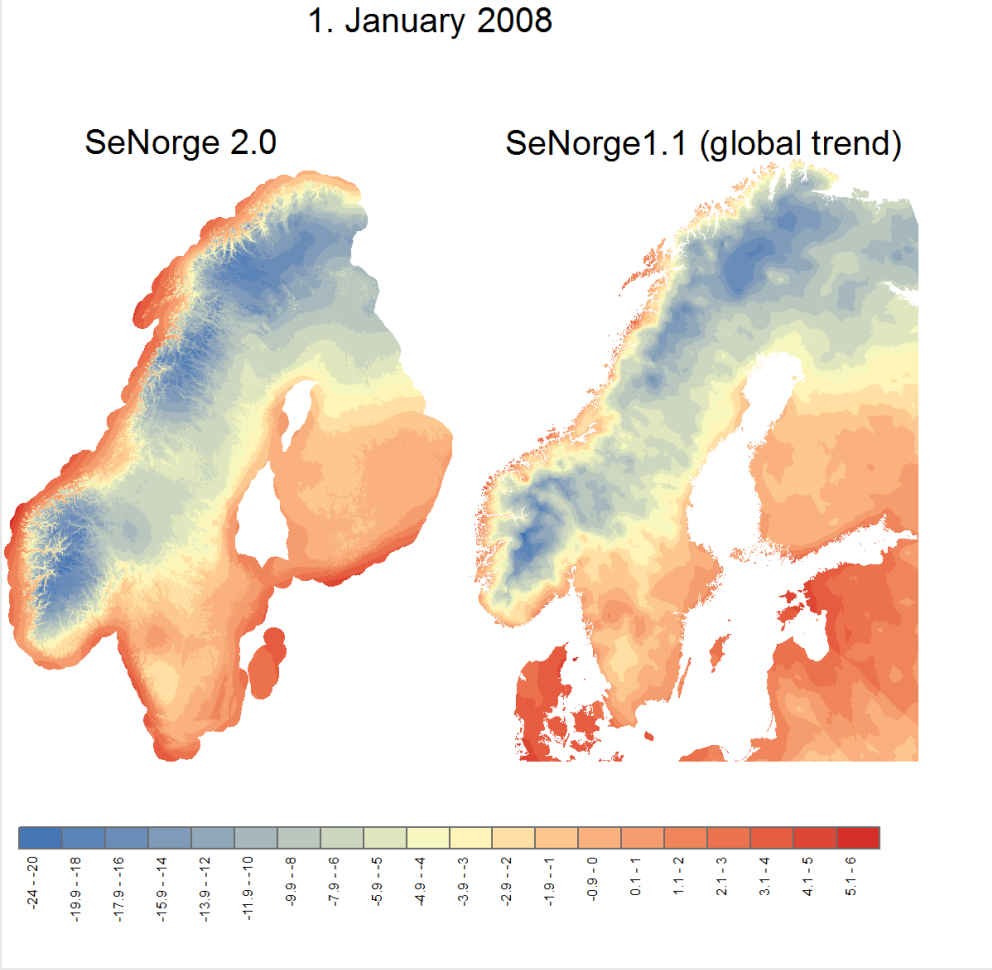
1997



2000

NGCD – Nordic gridded dataset

- Extension of the Norwegian gridded climate datasets
- Observation reference grids for UERRA evaluations and uncertainty assessments for Fennoscandia
- Two-member «ensemble»
  - SeNorge 1.1 Residual kriging, fixed monthly global trend from climatology. Five predictors.
  - SeNorge 2.0 Bayesian OI, background field from analysis of the observation field. Regionalized conditioned vertical lapse rate is used to establish the background.
- Spatial resolution: 1 km
- Period: 1981-2010
- Coverage: Fennoscandia
- Data: ECA&D + MET Norway climate data base



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NGCD – Nordic gridded dataset

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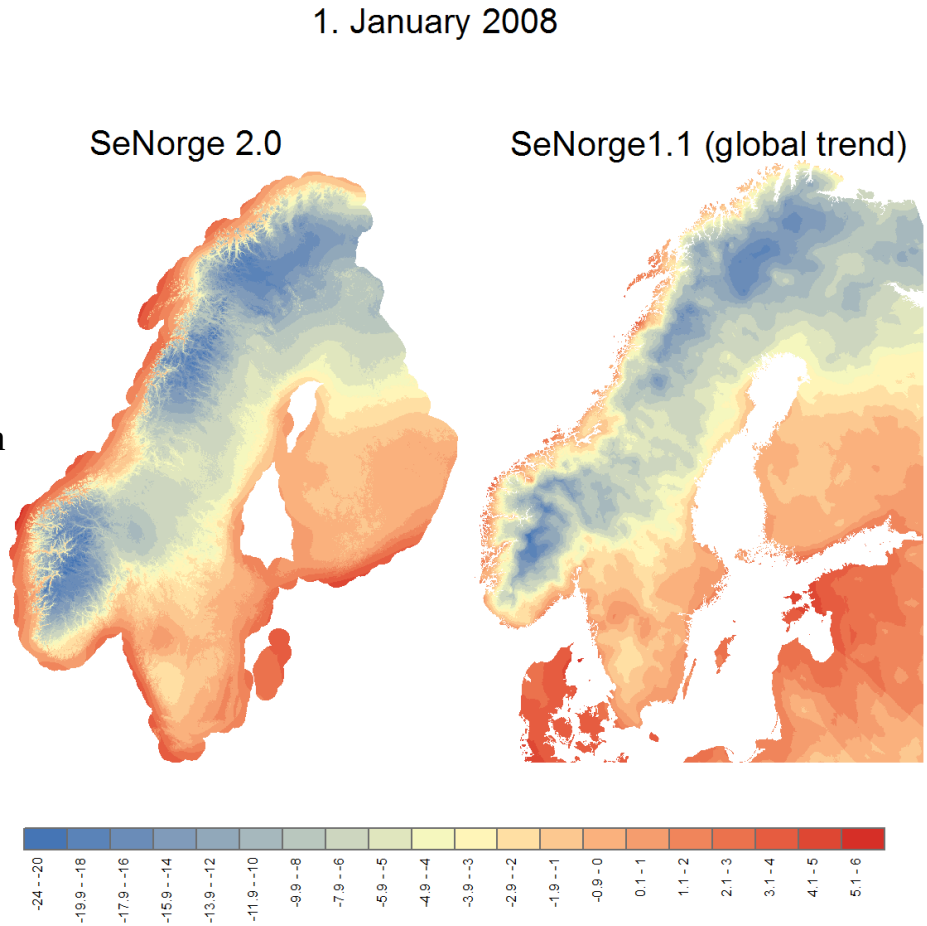

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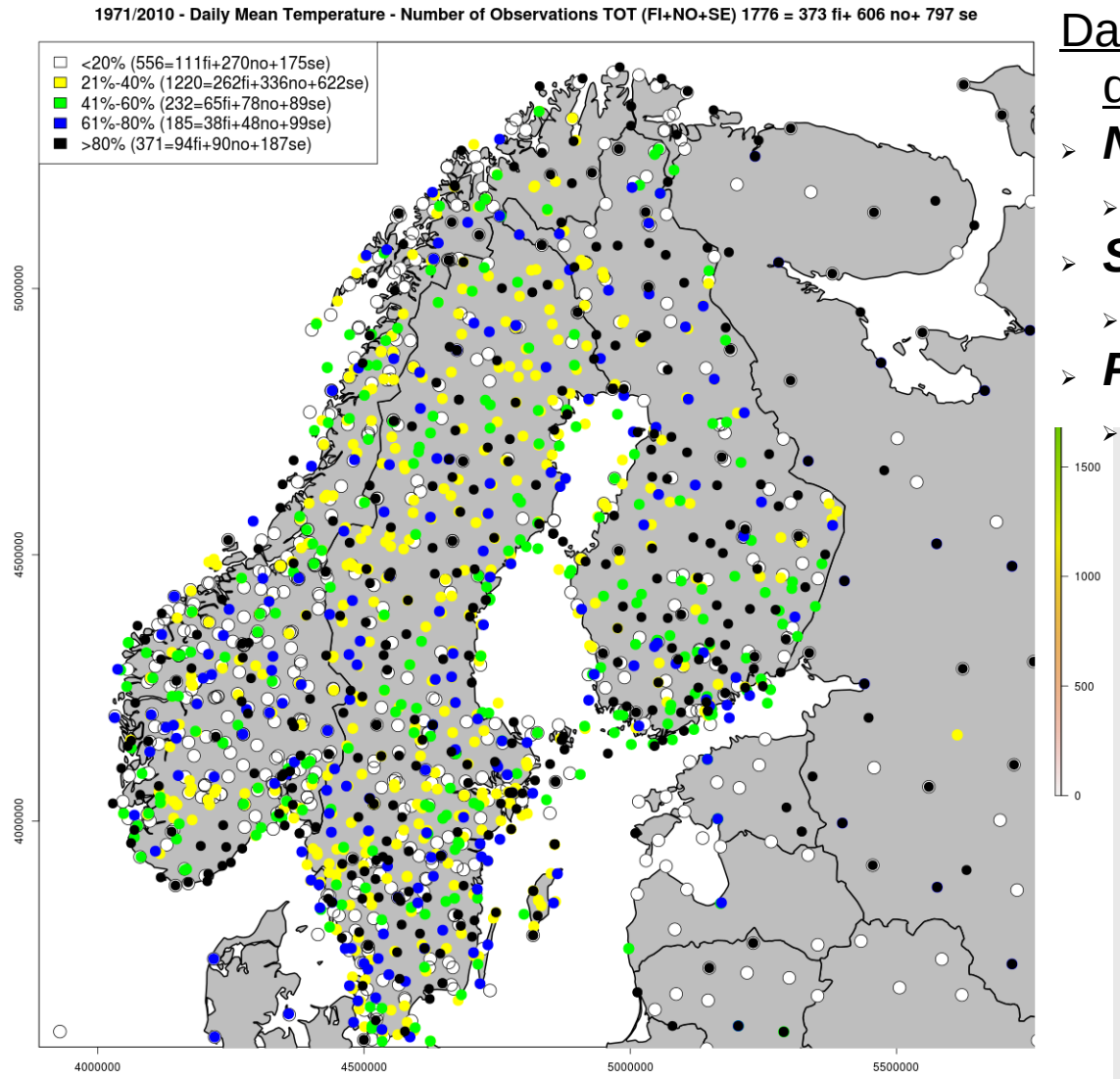
TG – daily mean temperature

Meteorologisk institutt + ECA&D European Climate Assessment & Dataset



Daily mean temperature, Element descriptions in ECA&D:

- ***Norway***: id=TG9
  - (D-1) 6UTC->D 6UTC;
- ***Sweden***: id=TG6
  - average using TN,TX,06,12,18;
- ***Finland***: id=TG6
  - average using 8 observations;

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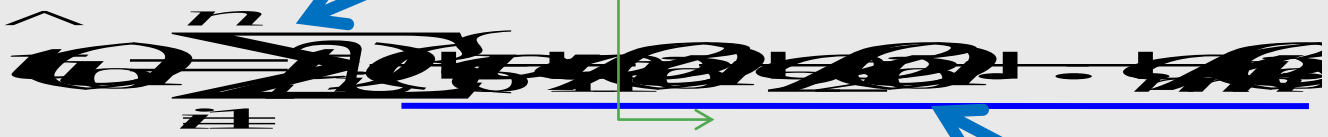
TEMP1d: Residual Kriging

Residual kriging:



Kriging (or any spatial interpolation method)

External trend/drift (linear regression)

- T = TS + TD

- Trend predictors:
  - Altitude (station)
  - Mean altitude within a 20 km circle around the station
  - Minimum altitude within a 20 km circle around the station
  - Longitude
  - Latitude
- Linear stepwise regression is used to define the trend from long term climatology.

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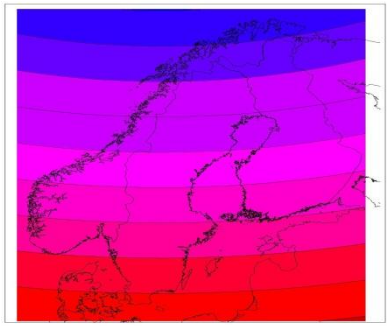
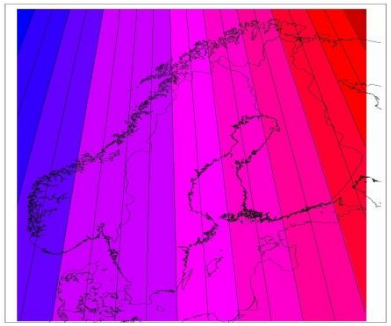
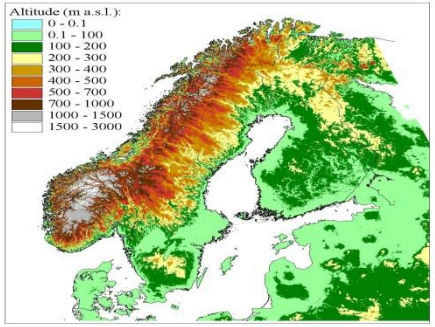
Grids of the independent variables

Latitude

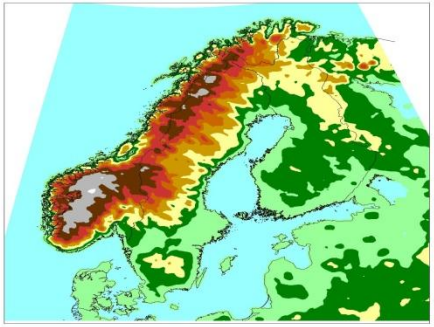


Longitude

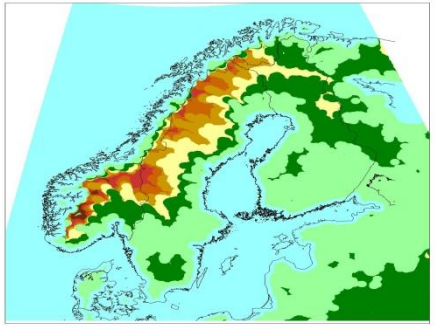




DEM



DEM_MEAN



DEM_MIN

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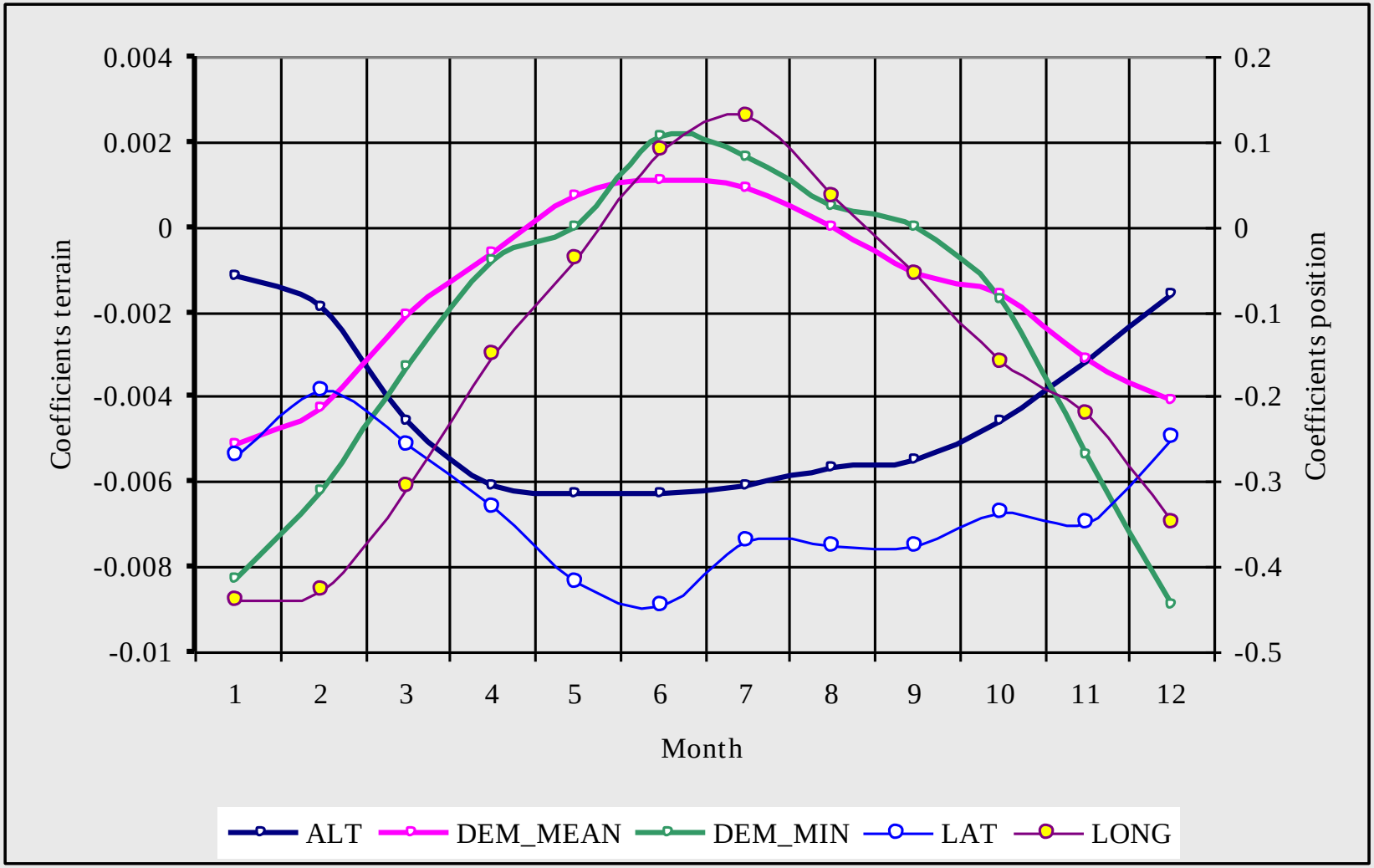
Regression coefficients



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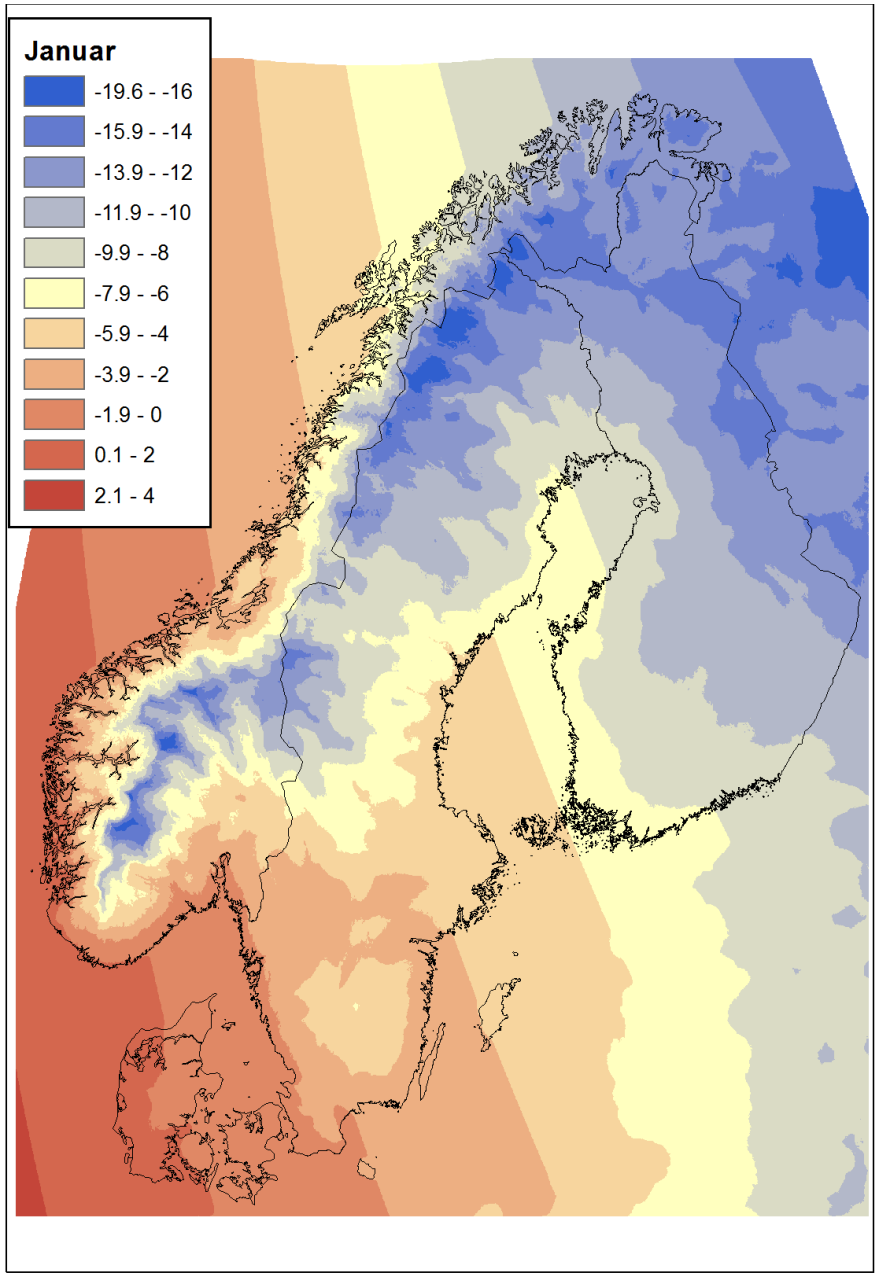
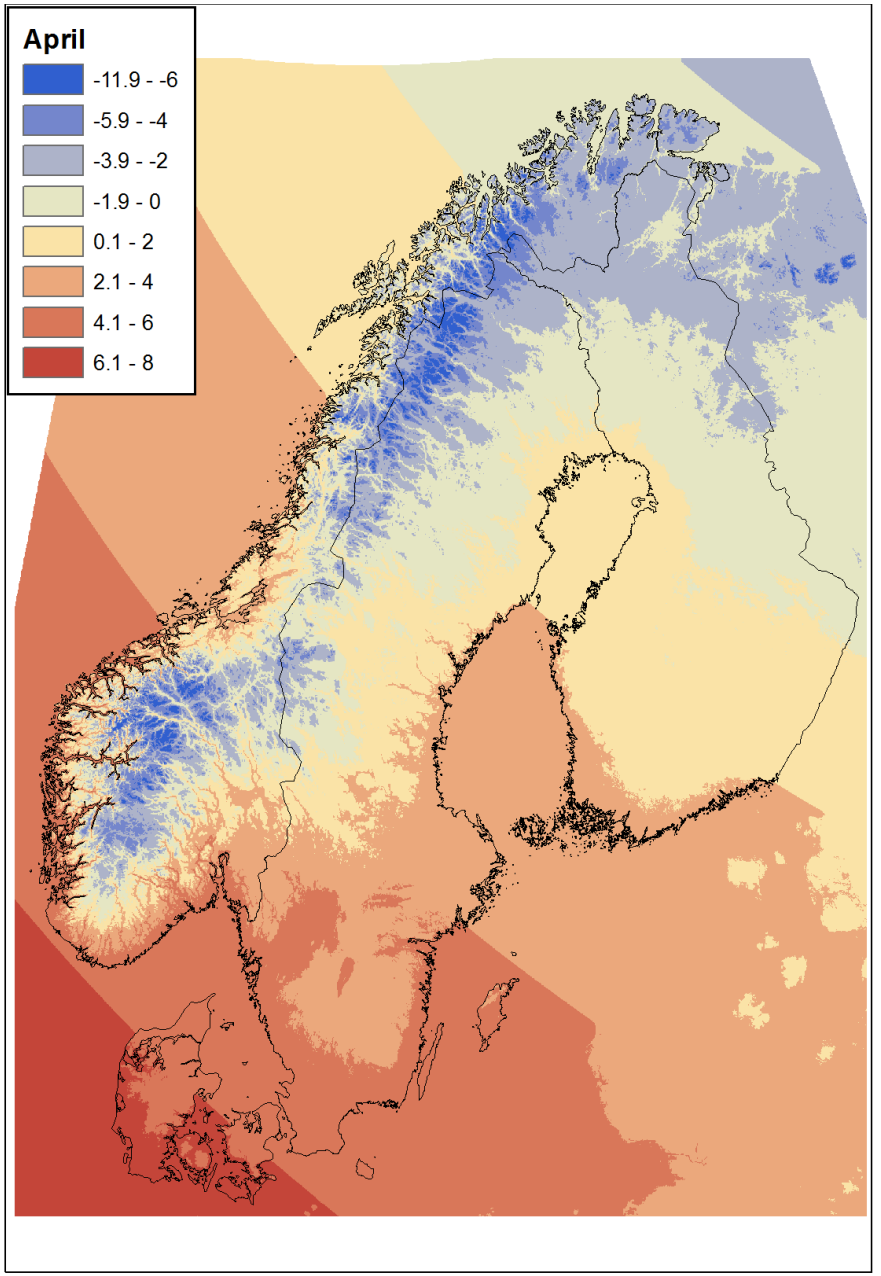
Trend ➔ climatological first guess

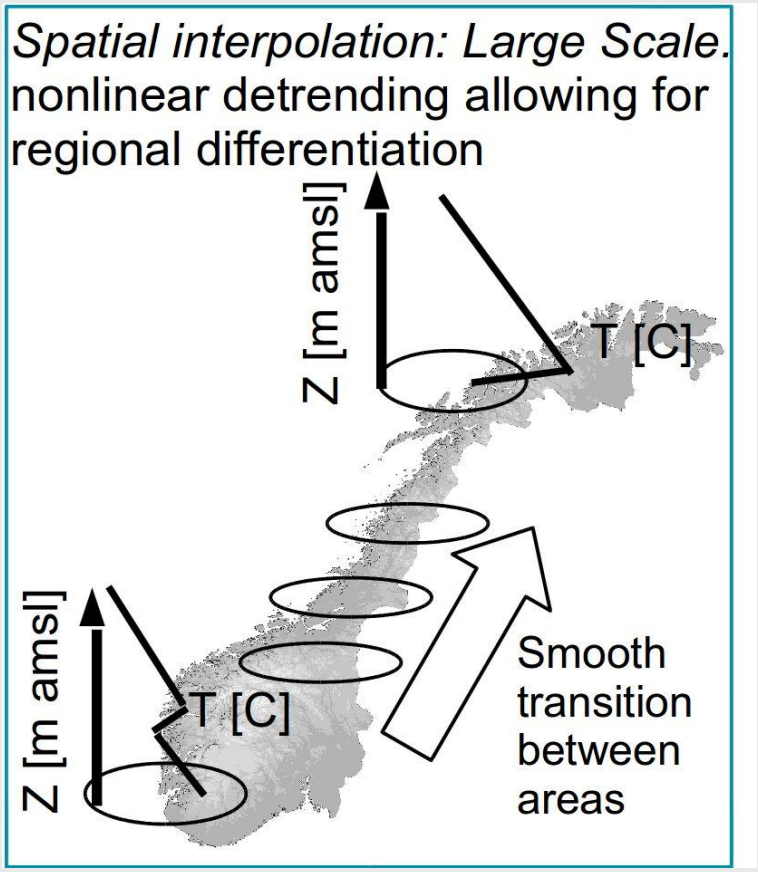




TEMP1d: Optimum Iinterpolation

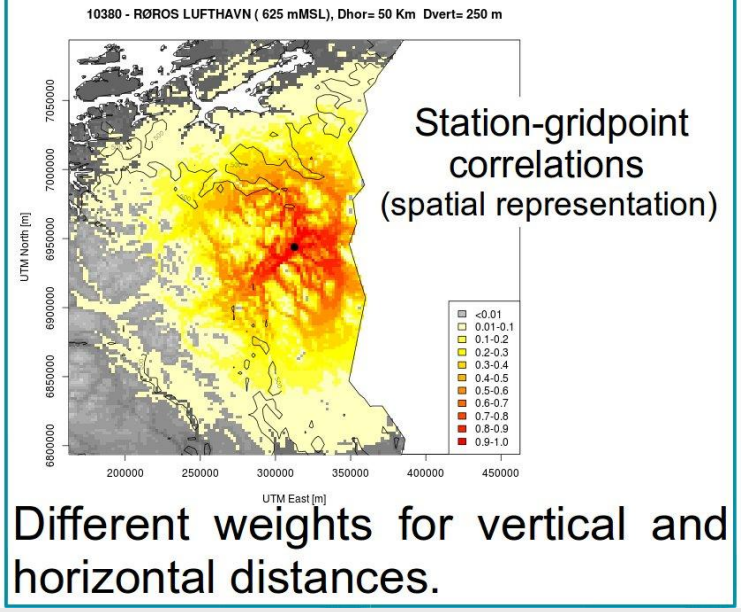
Large(coarser) scale trend estimation

Spatial interpolation: Large Scale.
nonlinear detrending allowing for regional differentiation



+

Spatial Interpolation: Small Scale.
Correlation functions are defined a priori in the Optimal Interpolation scheme.



Different weights for vertical and horizontal distances.

OI introduces the Local(finer) scale

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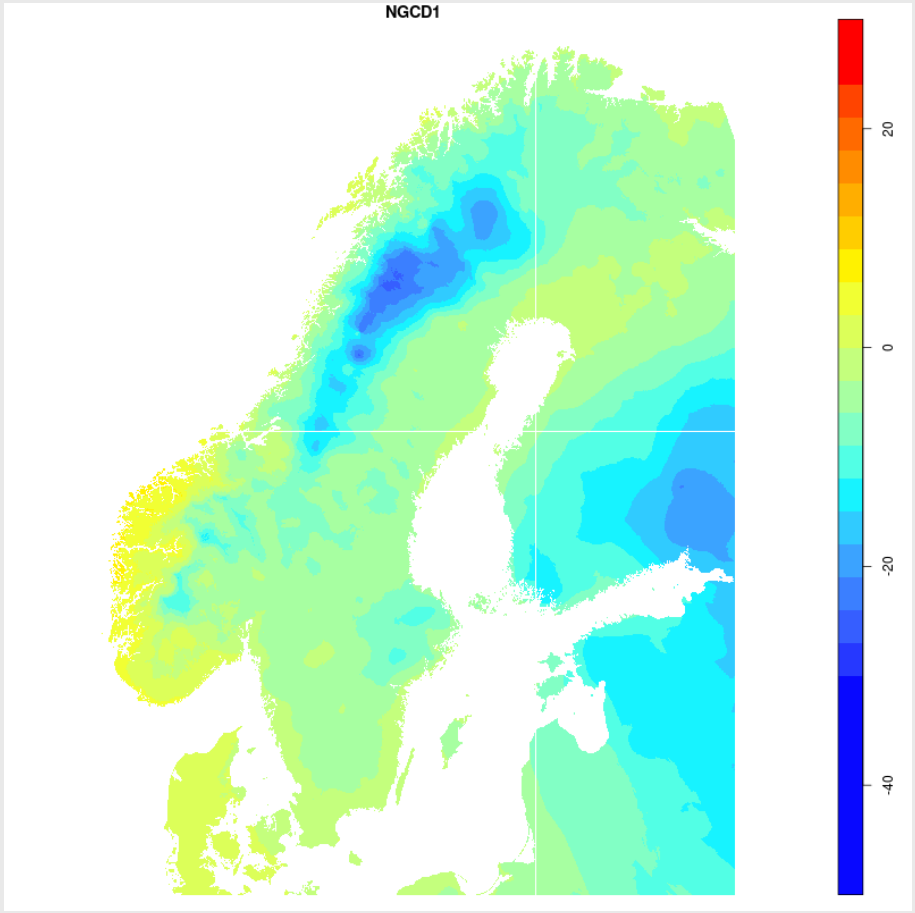
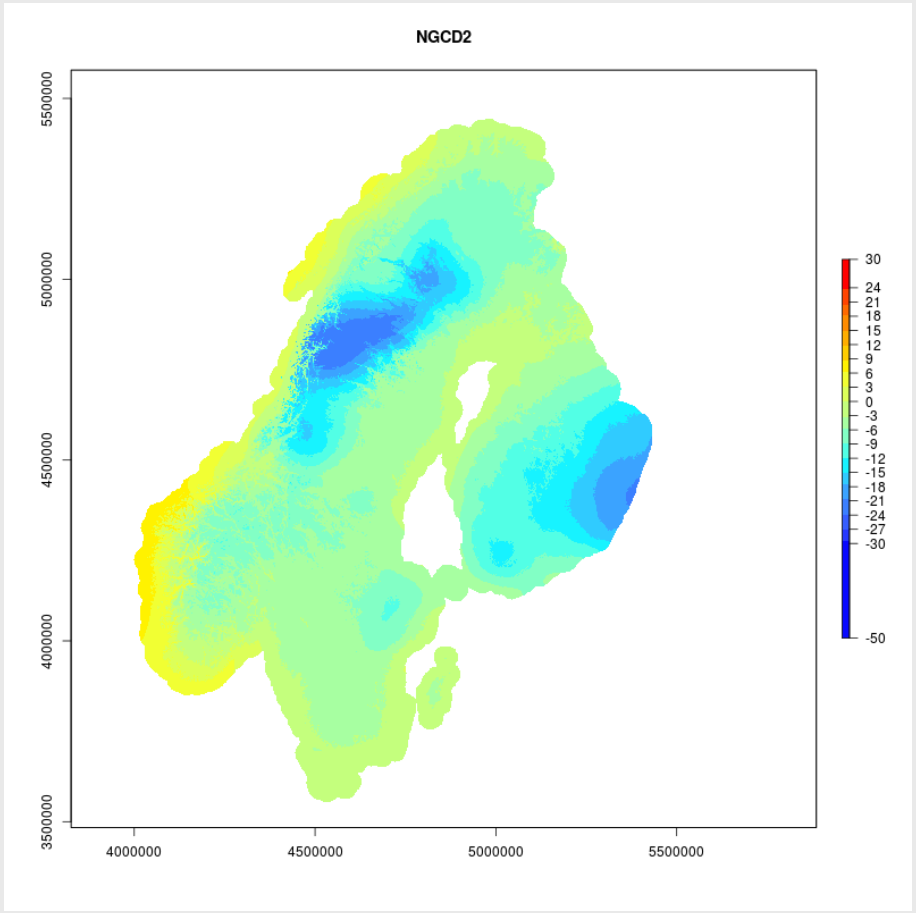
NGCD TAM 11.01.2004





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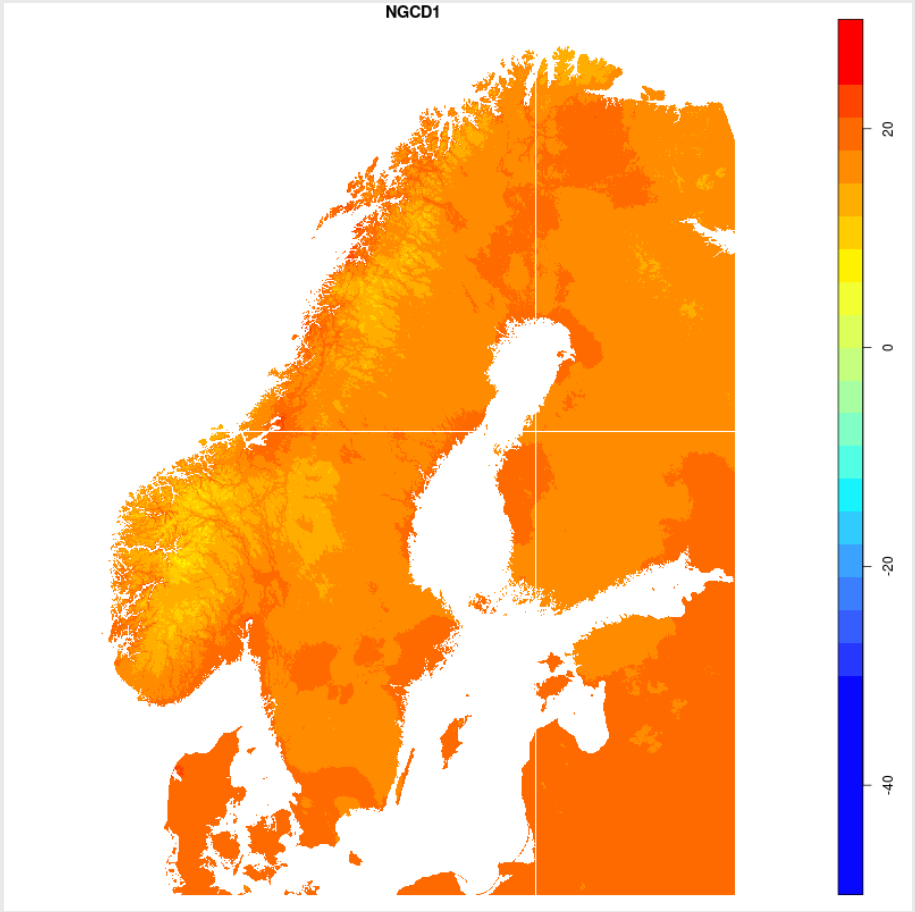
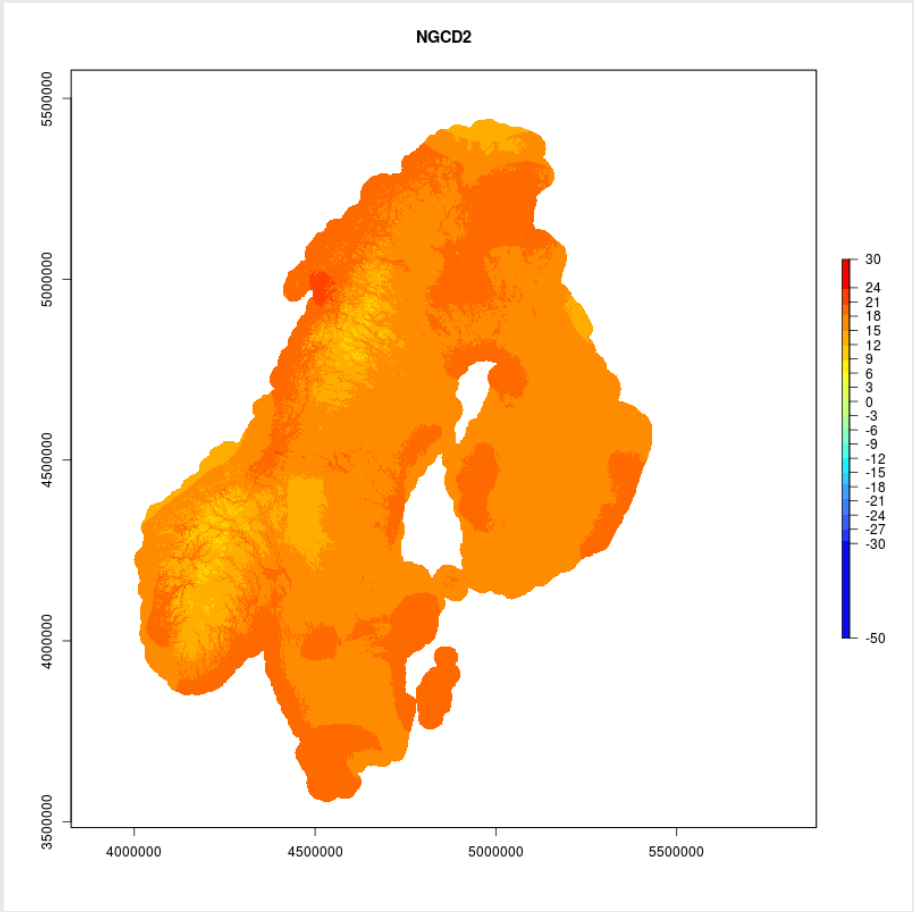
NGCD TAM 01.08.2004





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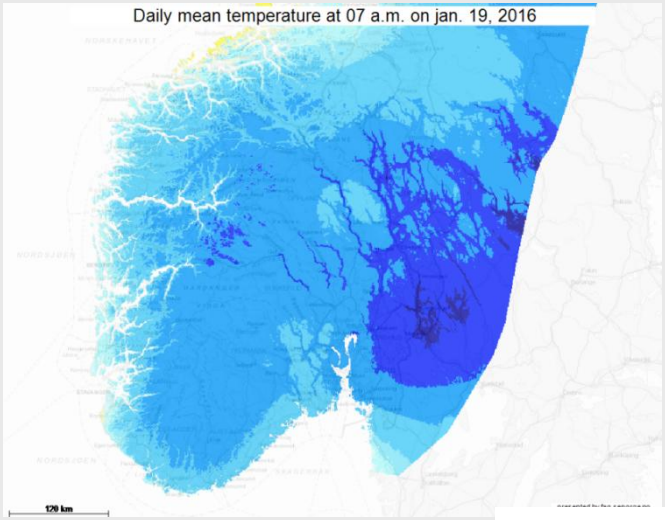
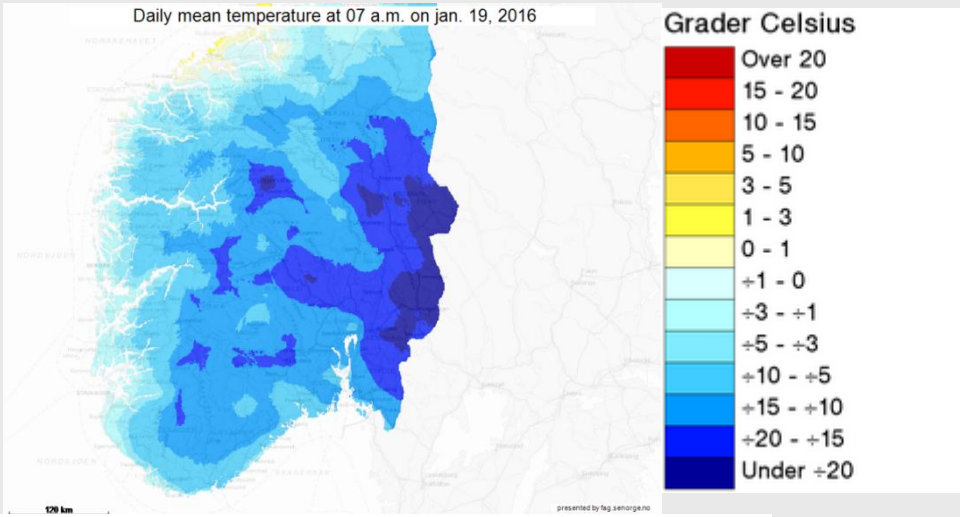
SeNorge 2.0

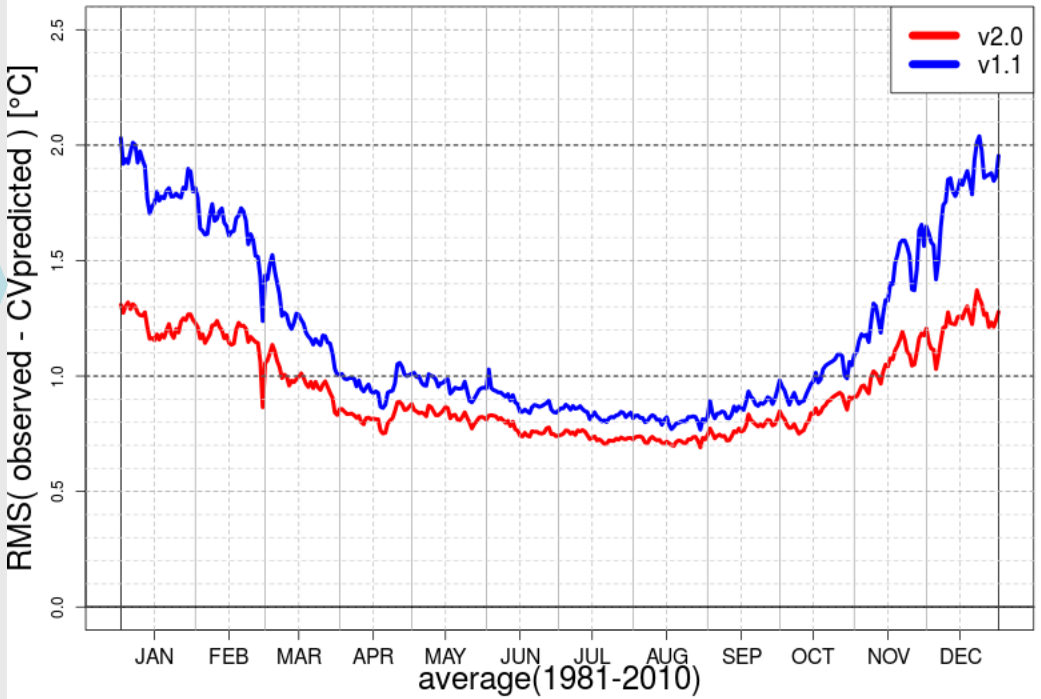


SeNorge 1.1

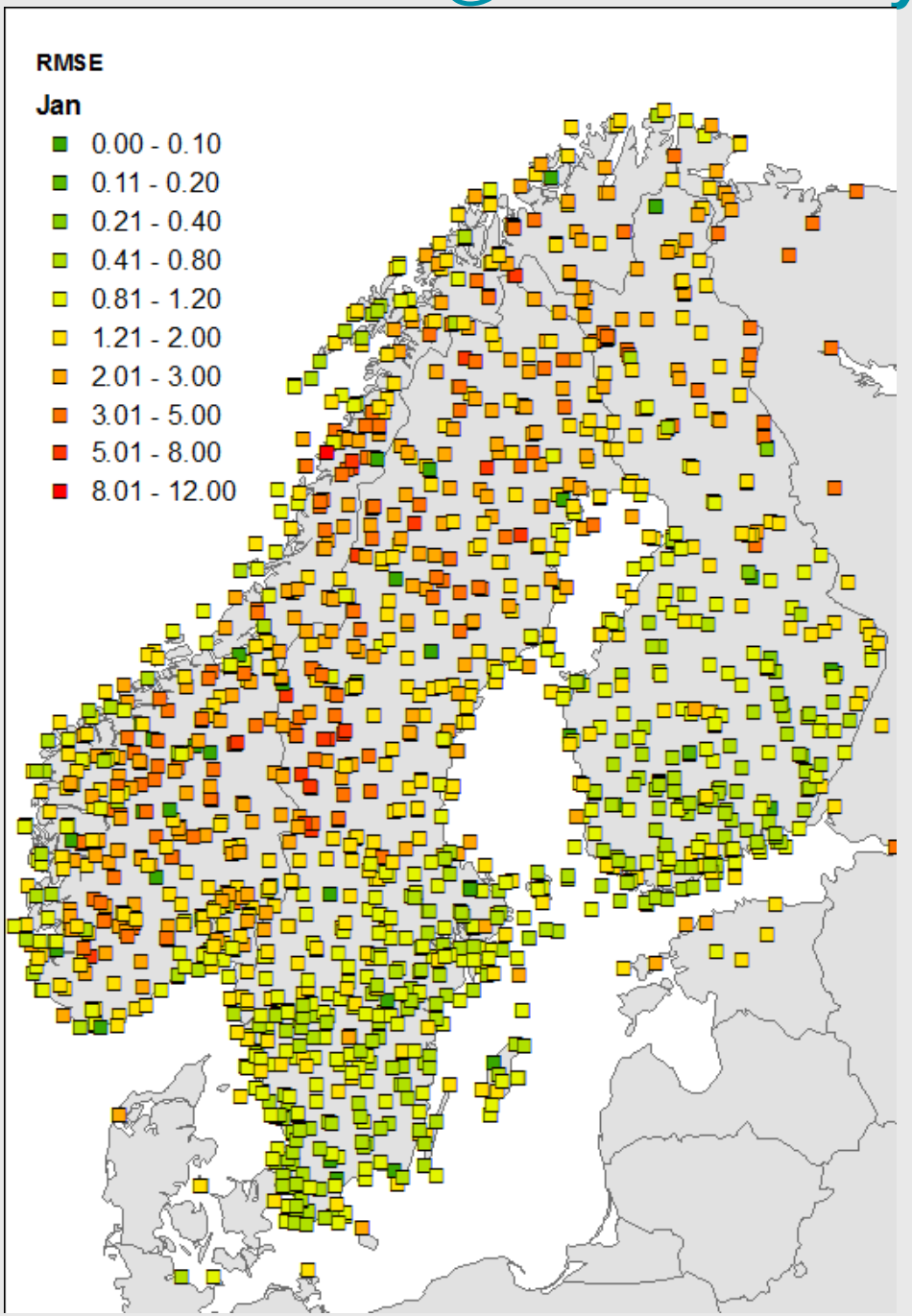


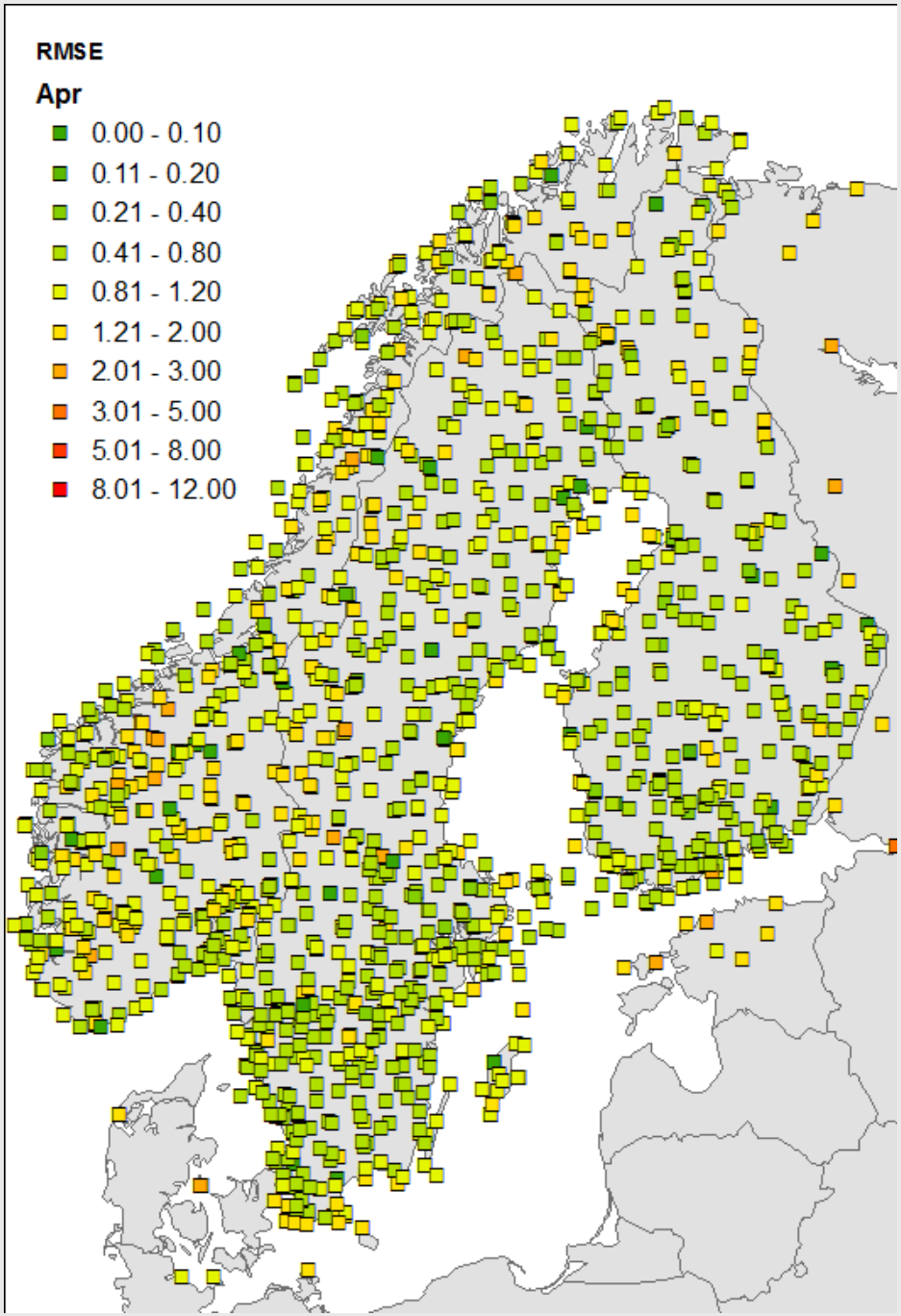
New method reduce estimation error.

(RMSE, independent cross-validation)



NGCD.RK @ MET Norway – TEMP1d - Evaluation

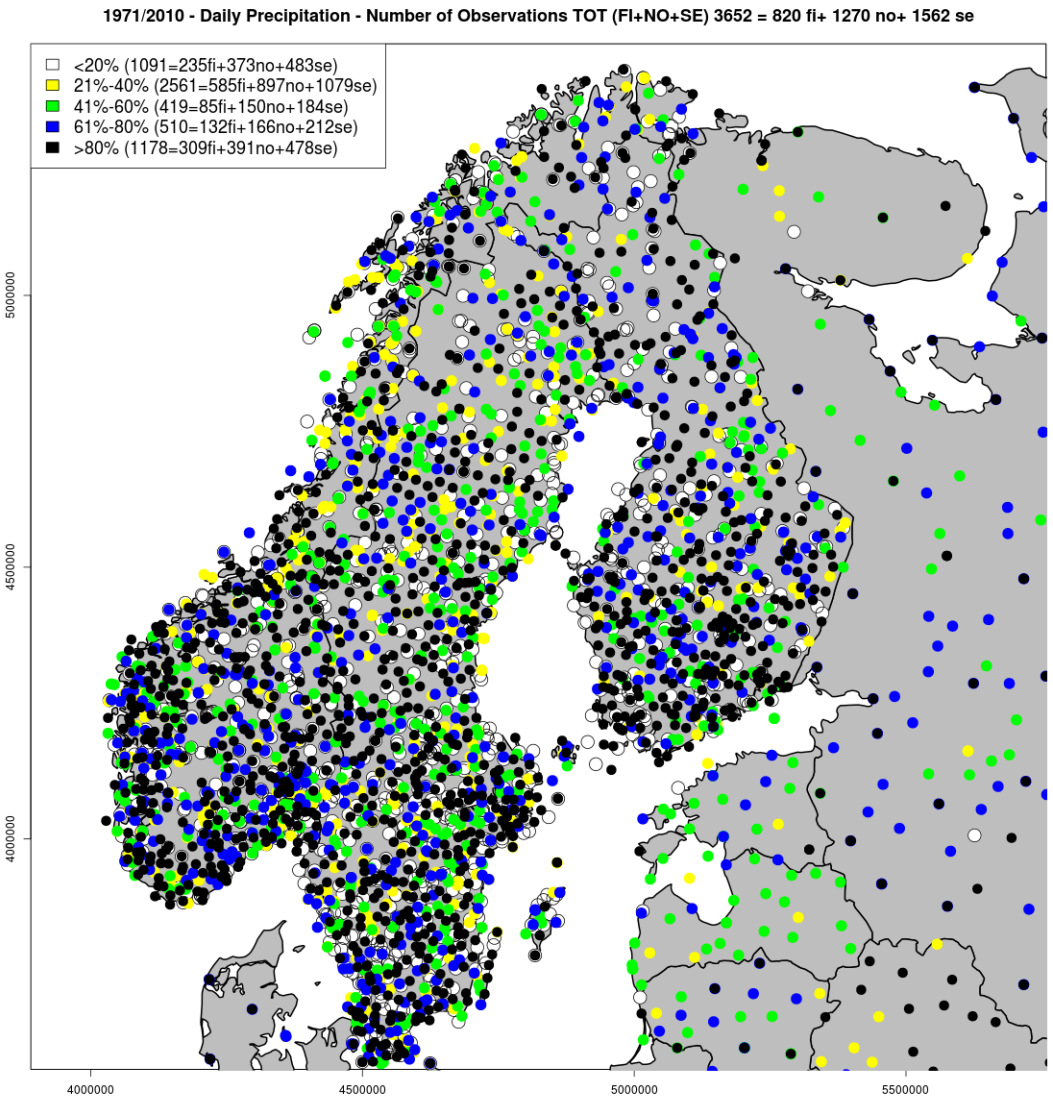




RR – daily precipitation

Meteorologisk institutt + ECA&D

European Climate Assessment & Dataset



24h PREC, Element descriptions in ECA&D:

- ***Norway***: id=RR2
  - (D-1) 06UTC -> D 06UTC;
- ***Sweden***: id=RR9
  - D 06UTC -> (D+1) 06UTC;
- ***Finland***: id=RR5
  - D 07.30 -> (D+1) 07.30UTC;

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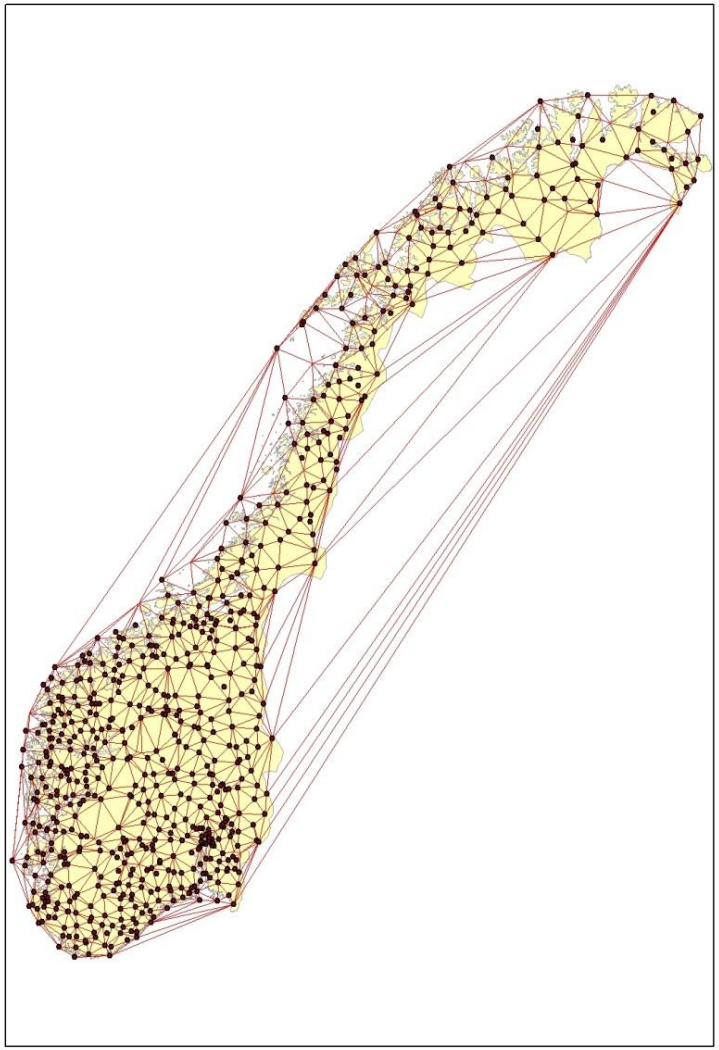
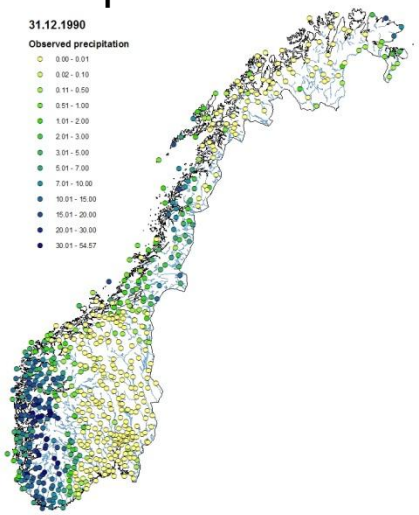
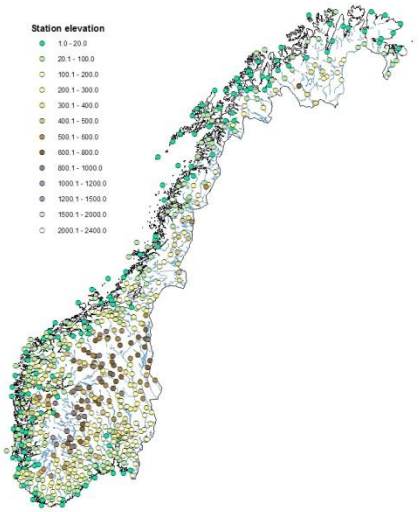
NGCD 1: Precipitation estimation

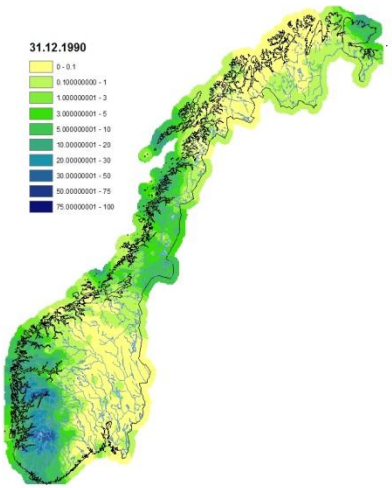


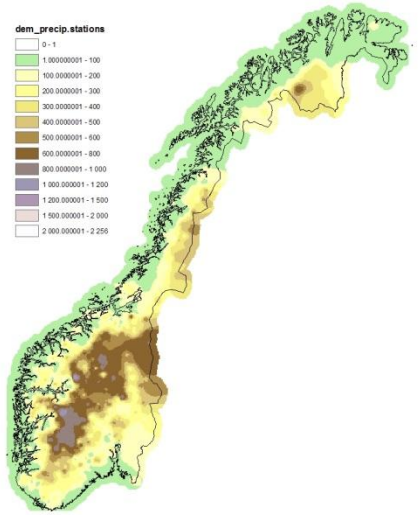
Precipitation



Elevation





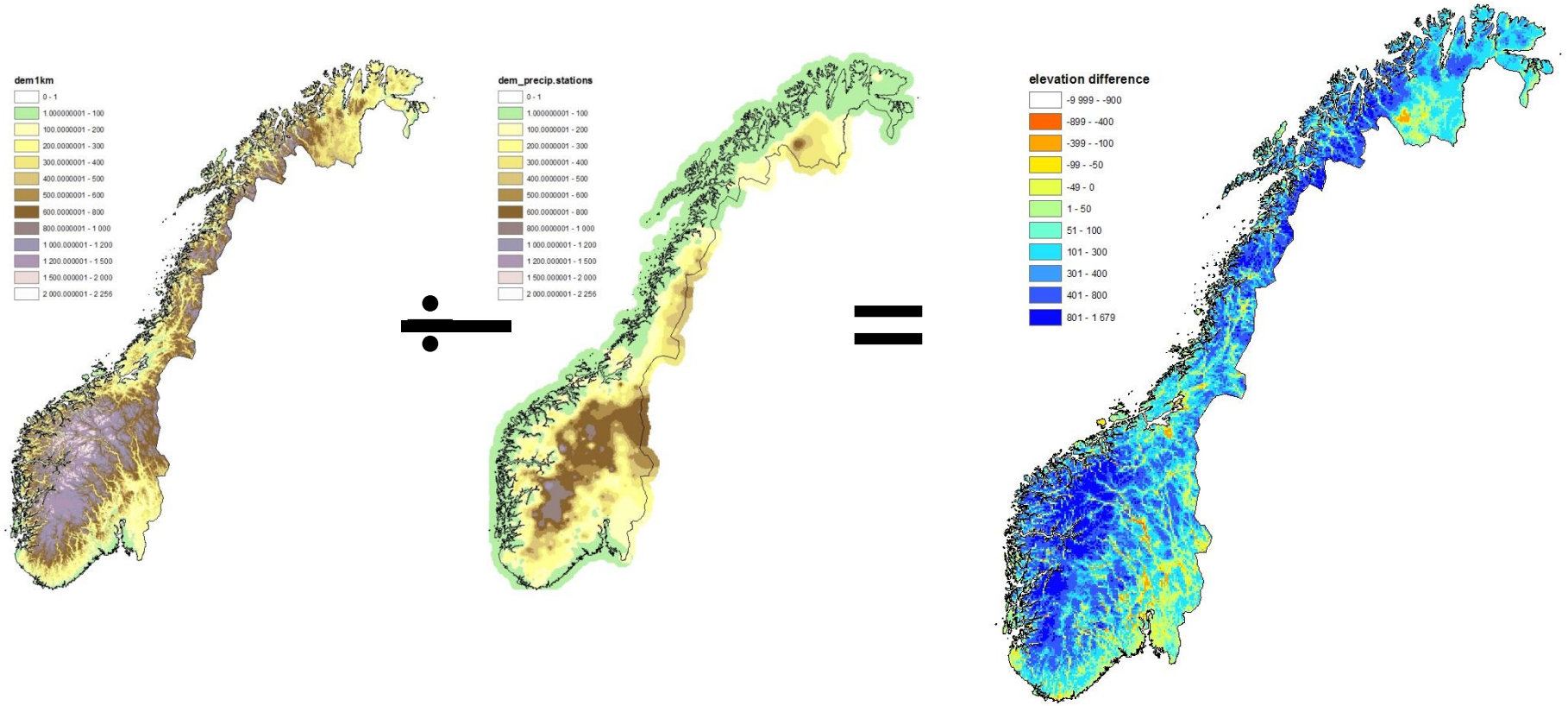


NGCD 1: Precipitation estimation

Elevation model (1km x 1km)

Elevation model from precipitation stations

Elevation "*anomaly*" model



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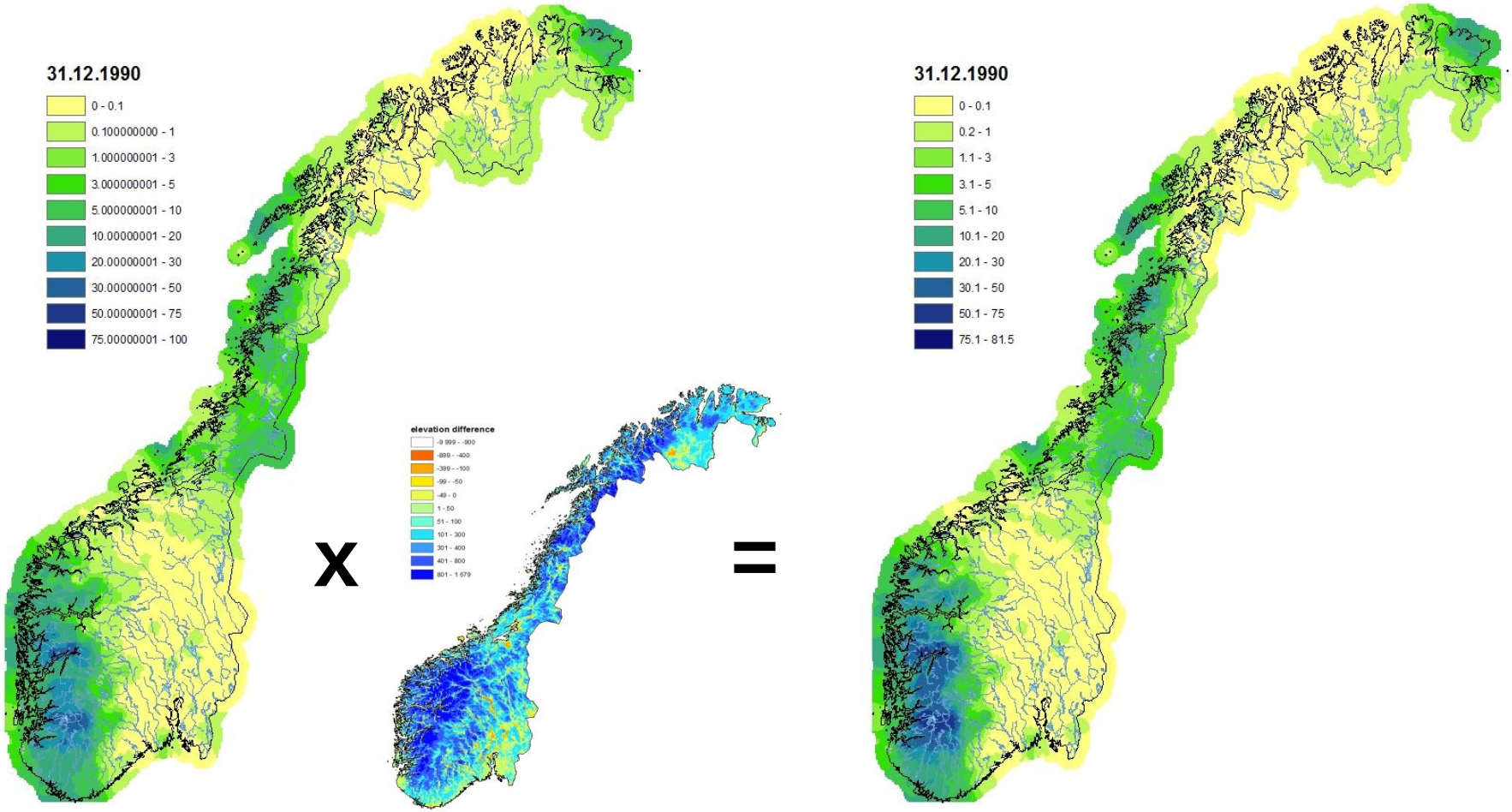
NGCD 1: Precipitation estimation

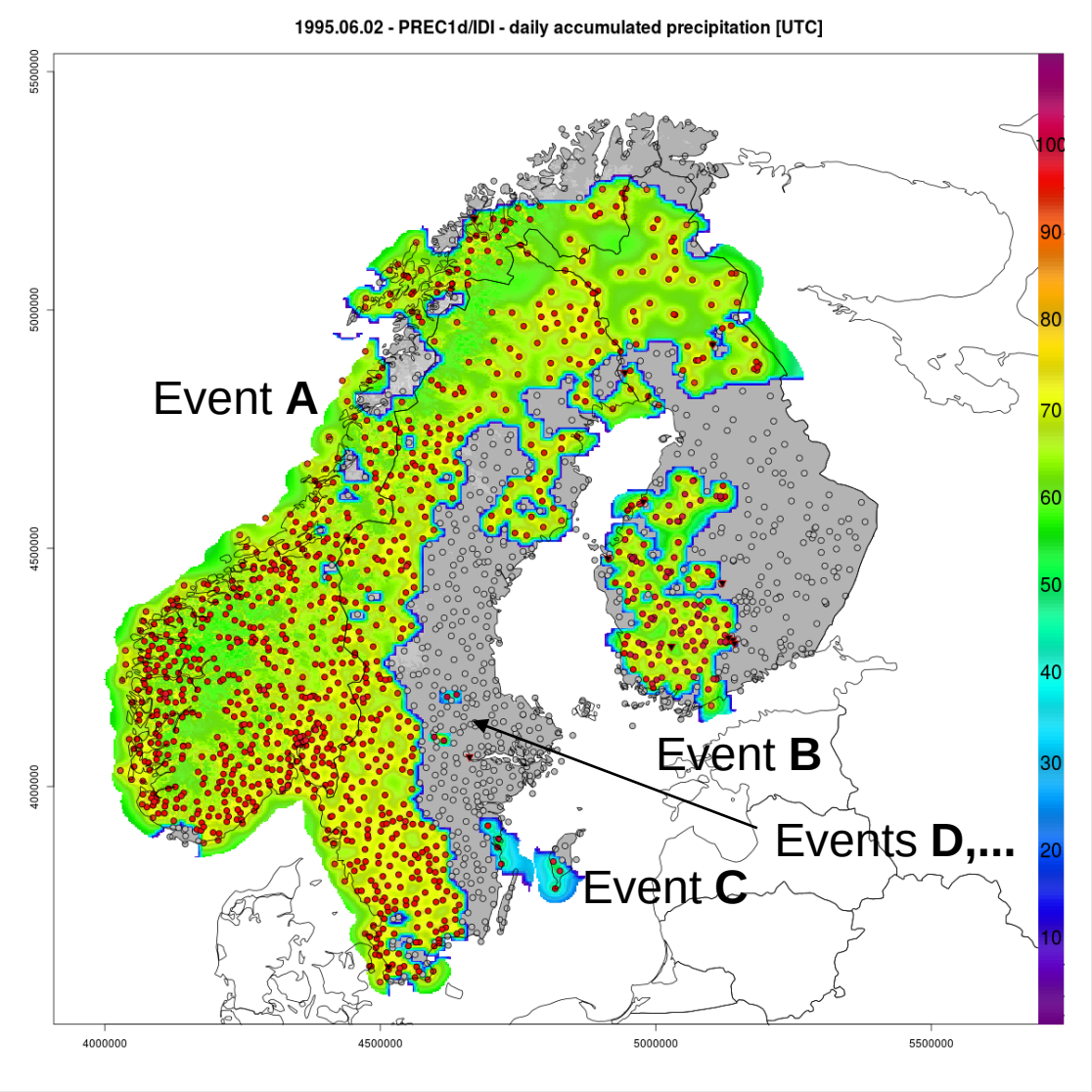
Interpolated from “observations”

Terrain adjusted



NGCD2: Multi-scale Optimal Interpolation

Step 0: Identification of Precipitation Events (Observed Areas of Precipitation)
(given the Station distribution)



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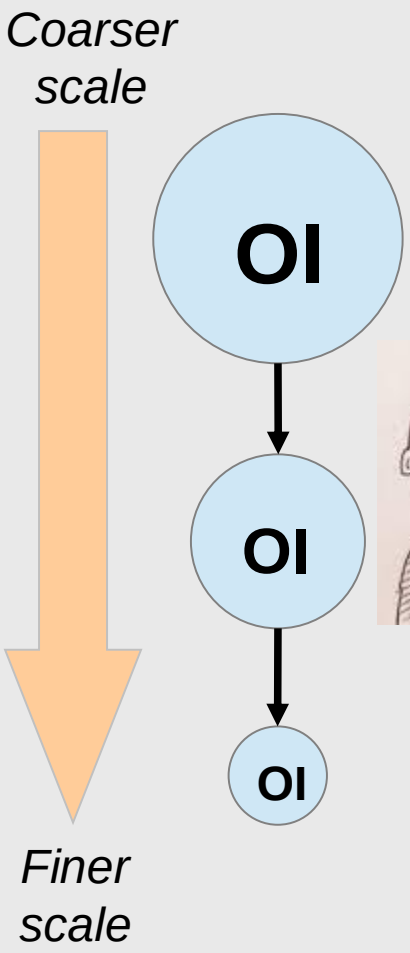
NGCD2: Multi-scale Optimal Interpolation

Given a **single event**, the spatial interpolation is based on an *iterative* process:



Given a predefined (horizontal) spatial *scale.*

OI assumptions:

- Additive error model:
  - $obs_{scale} = truth_{scale} + err_{scale}$
  - $back_{scale} = truth_{scale} + err_{scale}$
- Gaussian errors:
  - $err_{scale} = N(0, CovMat)$
- CovMat = f(*scale*, Vertical coord)
- OI (through leave-one-out cross validation) is used to optimize the influence of the vertical coordinate in the error covariance matrix

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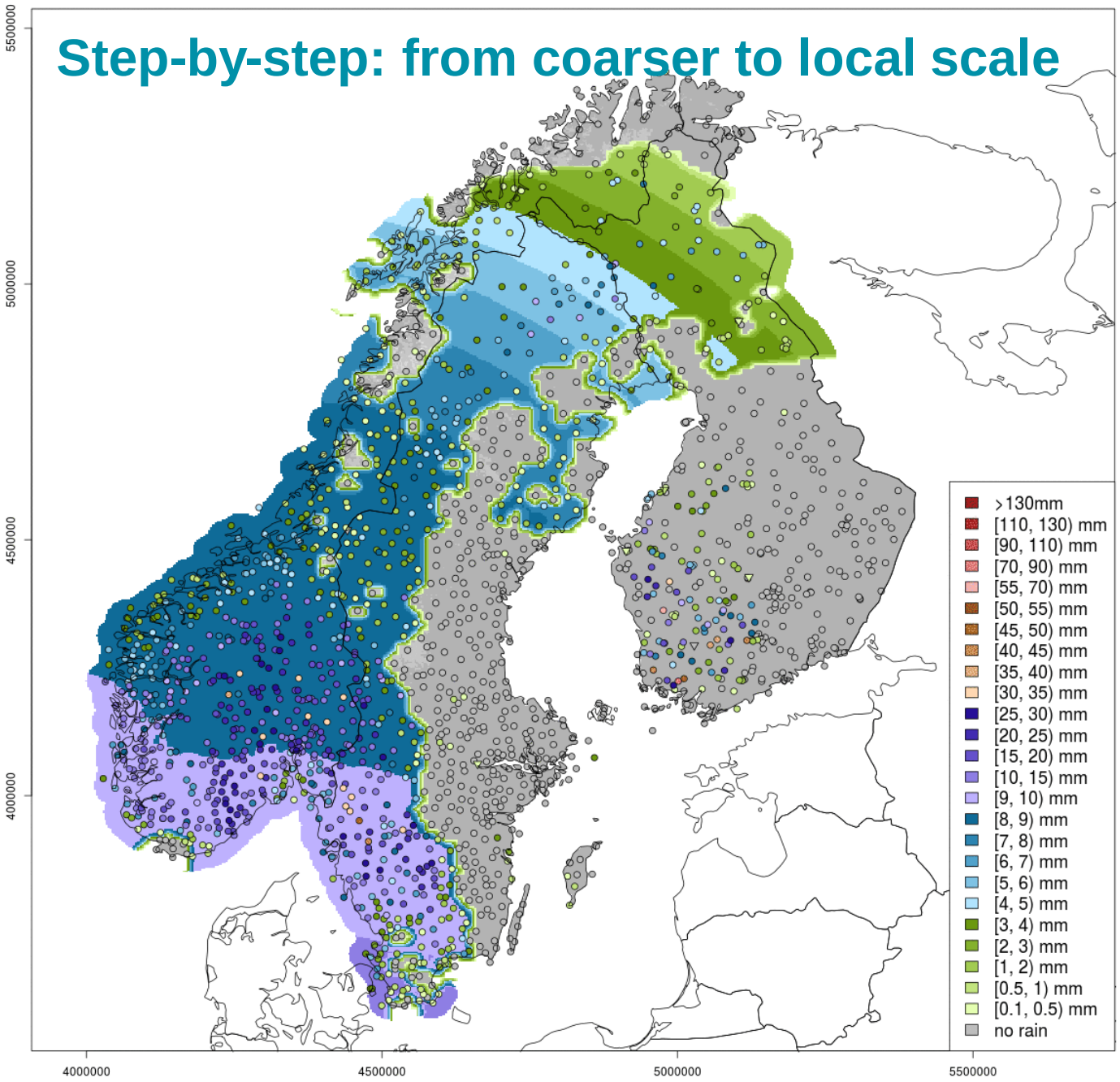
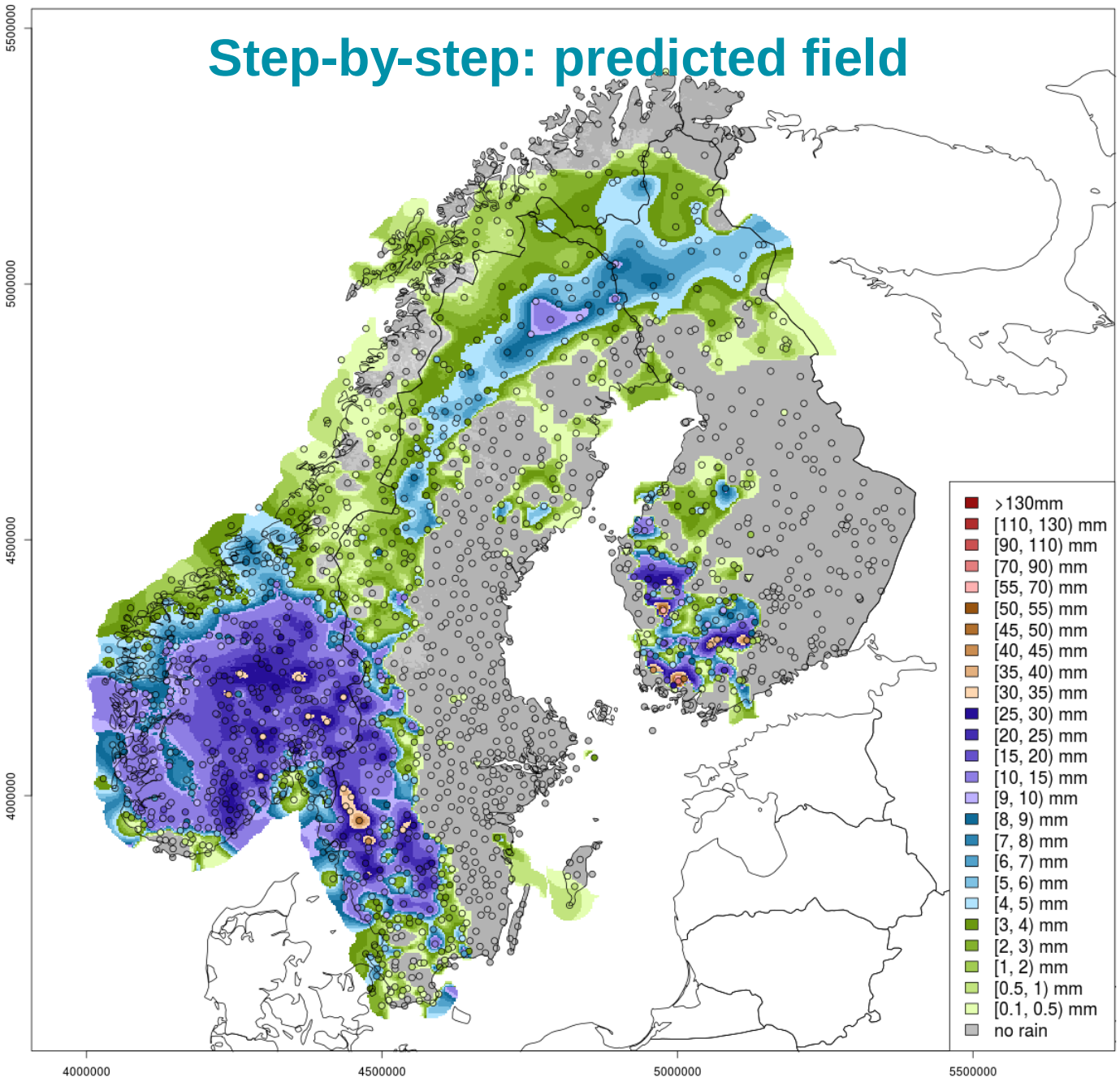
Multi-Scale Optimal Interpolation

Step-by-step: from coarser to local scale



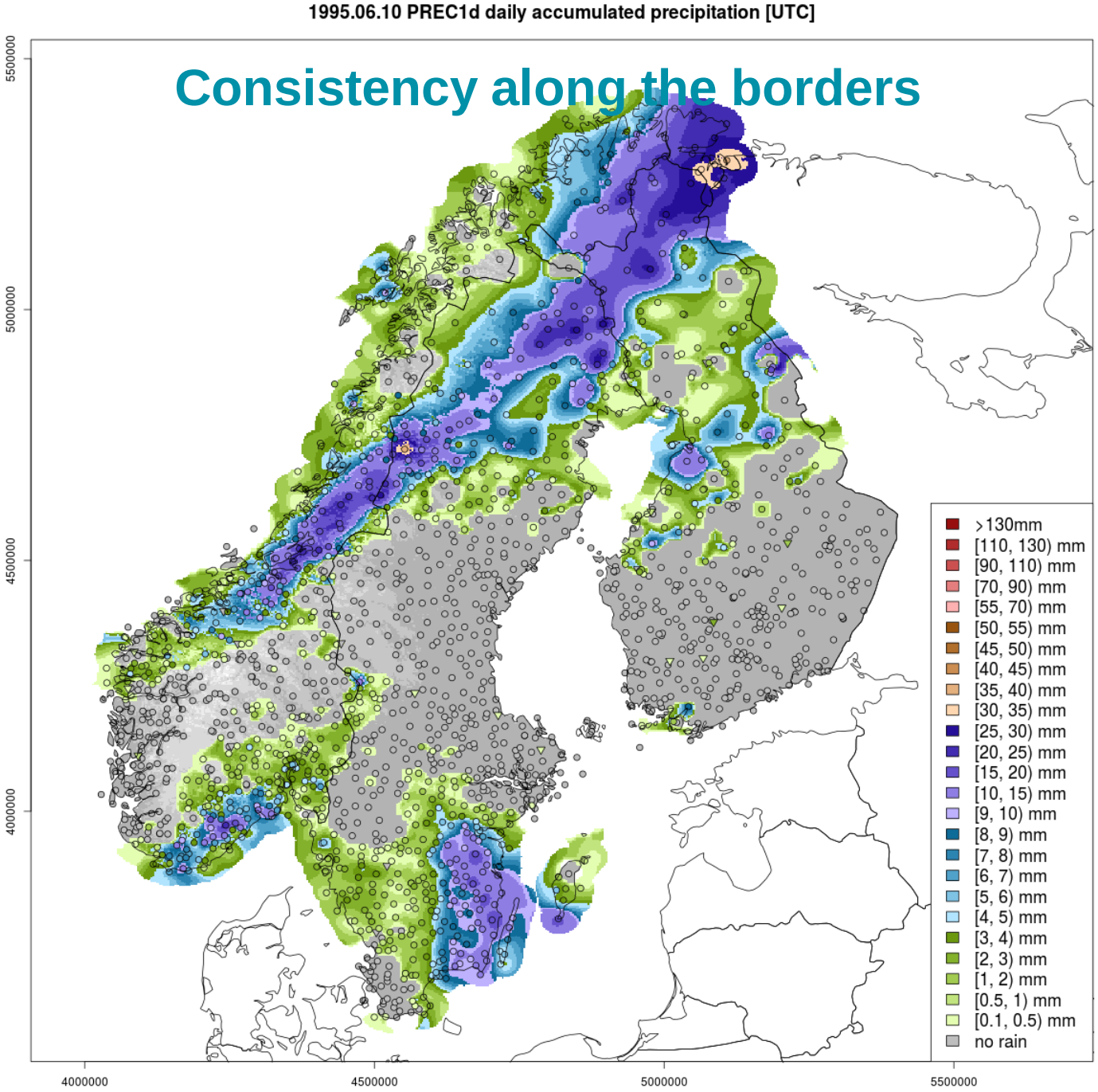
Multi-Scale Optimal Interpolation

Step-by-step: predicted field

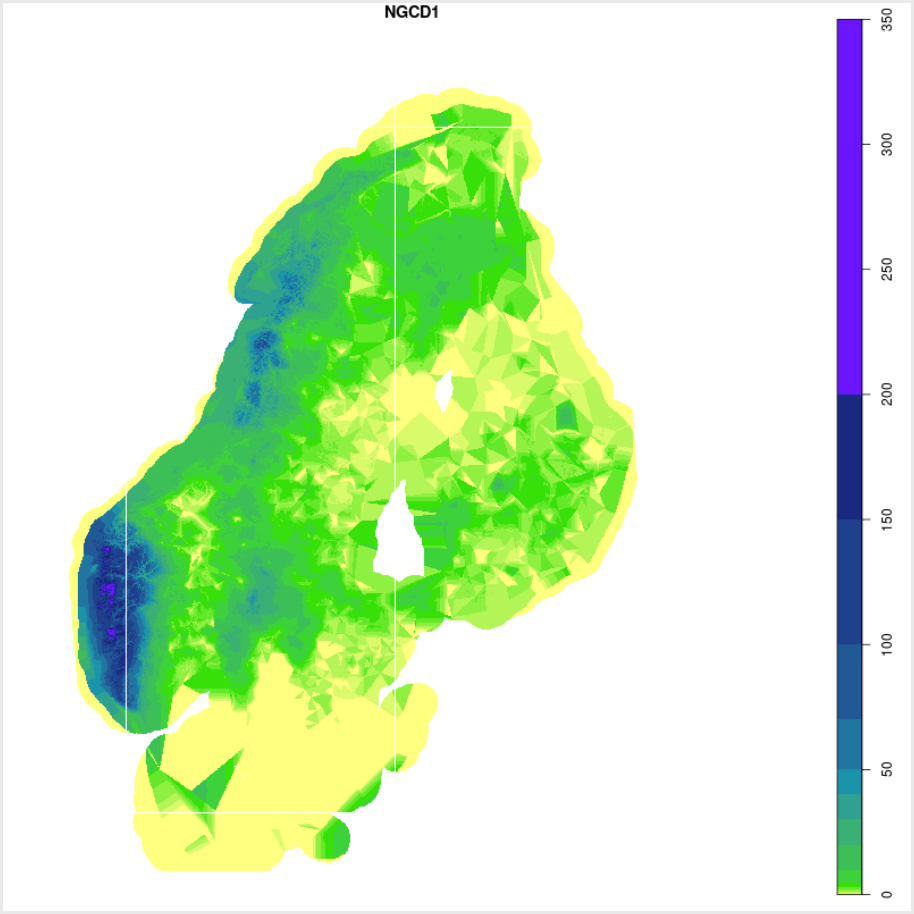


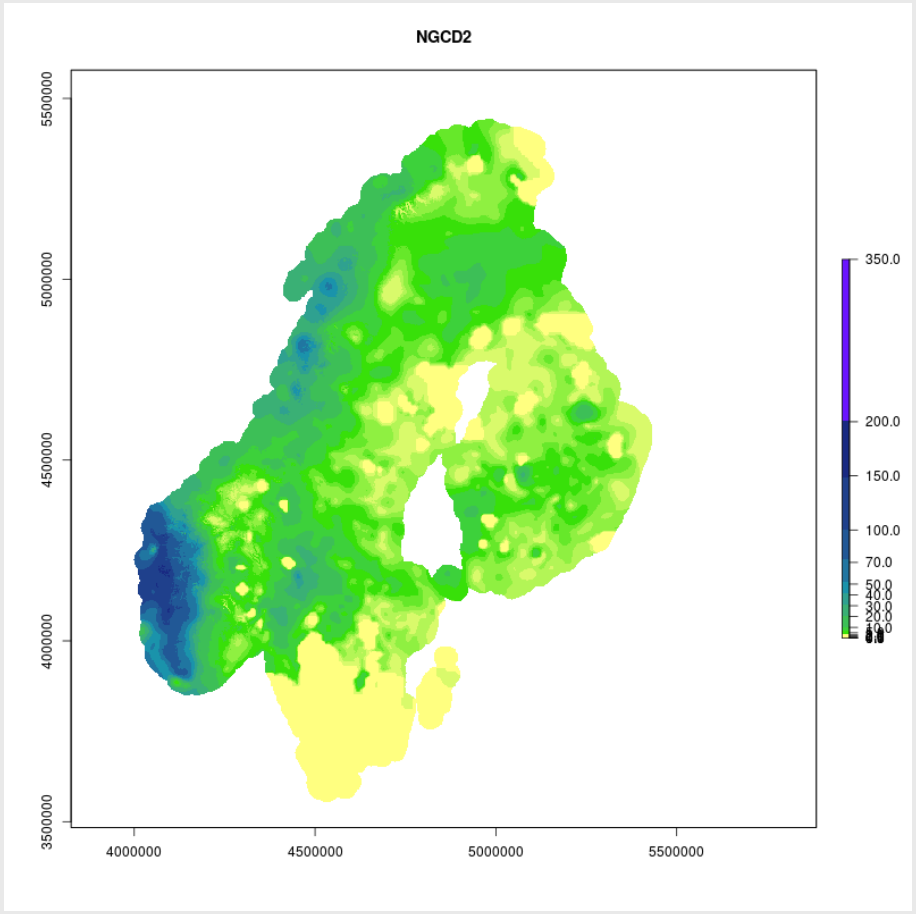
Multi-Scale Optimal Interpolation

Consistency along the borders



Case example: 14.09.2005





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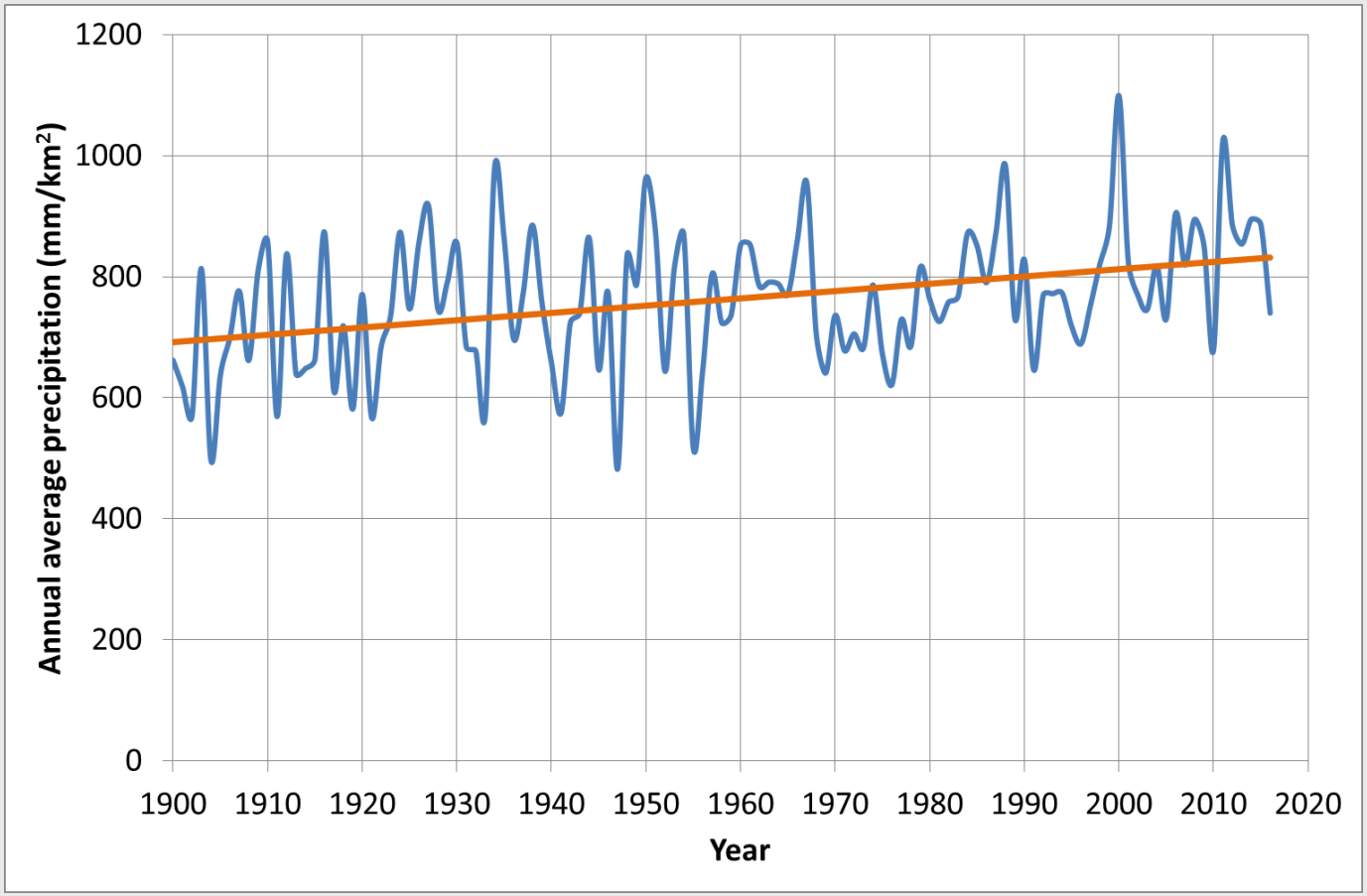
NGCD_Rec: Long term monthly dataset

Annual average precipitation 1900-2016
in Norway from monthly gridded datasets.



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NGCD_Rec: Long term monthly dataset

- Produce monthly gridded precipitation grids for Fennoscandia back to early 20th century, depending on data availability.
- Similar approach as HISTALP_Rec
- Spatial resolution < 5 km.
- Method, RSOI
  - Utilizes information from periods with «dense» observation networks in periods with sparser data coverage.

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Present status & Further plans

- NGCD v.0 (beta) is produced and applied within UERRA
  - Daily mean temperature
  - Daily precipitation
  - Based on two methods: SeNorge 1.1, SeNorge2.0
  - Period 1981-2010
  - Spatial resolution 1 km
  - LAEA ETRS89
- NGCD v.1 (operational)
  - Will be provided as a part of C3S 311a_Lot4 (C3S Surf)
  - Cover the period 1971-present
  - Include: Tmin and Tmax
  - Improved QC-routines
- NGCD will be the primary «sandbox» for further observation gridding development at MET Norway.
  - Provide open access to data
  - Provide open access source codes developed at MET

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Thank you!

ole.einar.tveito@met.no

Call for papers EMS 2017

Abstract submission deadline: 21. april 2017

OSA3.2 Spatial Climatology

Conveners: Ole Einar Tveito, Mojca Dolinar , Christoph Frei

Abstract submission Spatially comprehensive representations of past weather and climate, for example in the form of gridded datasets, are an important basis for analyzing climate variations and for modelling weather-related impacts on the environment and natural resources. They are also indispensable for validation and downscaling of climate models. Increasing demands for, and widespread application of grid data, call for efficient methods of spatial analysis from observations, and profound knowledge of the potential and limitations of these datasets in applications. At the same time, the growing pool of observational data (radar data, satellite based data…) offers the opportunity to improve the accuracy and reduce uncertainty of gridded climate data. Modern spatial climatology therefore deals with a wide range of space and time scales. As a result, actual developments in the field are concerned with a range of challenging issues. These include for example the spatial characteristics and representation of extremes, the representation of small-scale processes (auxiliary variables), the integration of several observational data sources (e.g. station, radar, satellite, re-analysis data), the quantification of uncertainties, the analysis at sub-daily time scales, and the long-term consistency as well as cross-variable consistency in grid datasets.

This session addresses topics related to the development, production, quality assessment and application of gridded climate data with an emphasis on statistical methods for spatial analysis and interpolation applied on observational data. Contributions dealing with modern methodological challenges and applications giving pertinent insights are particularly encouraged. Spatial analysis by applying e.g. GIS is a very strong tool for visualizing and disseminating climate information. Examples showing developments, application and dissemination of products from such analyses for climate services are also very welcome.

The session intends to bring together experts, scientists and other interested people analyzing spatio-temporal characteristics of climatological elements, including spatial interpolation and GIS modeling within meteorology, climatology and other related environmental sciences.

EMS 2017, Dublin, 4-8.September 2017