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seNorge_2018 observational gridded datasets over Norway

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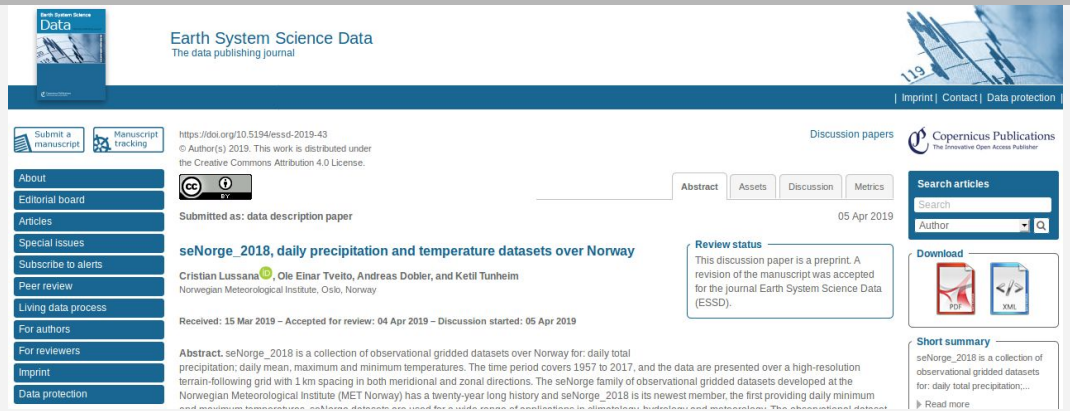
Norwegian Meteorological Institute, Oslo, Norway

17 September 2019 - 5th Conference on Modelling Hydrology, Climate and Land Surface Processes, Lillehammer, Norway



Lussana, C., Tveito, O. E., Dobler, A., and Tunheim, K.: seNorge_2018, daily precipitation and temperature datasets over Norway, Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2019-43, in review, 2019.
03.09.2019, Accepted for publication in Earth Syst. Sci. Data

Also related:
Lussana, C., Saloranta, T., Skaugen, T., Magnusson, J., Tveito, O. E., and Andersen, J.: seNorge2 daily precipitation, an observational gridded dataset over Norway from 1957 to the present day, Earth Syst. Sci. Data, 10, 235–249, https://doi.org/10.5194/essd-10-235-2018, 2018.

Lussana, C. , Tveito, O. E. and Uboldi, F. (2018), Three‐dimensional spatial interpolation of 2 m temperature over Norway. Q.J.R. Meteorol. Soc., 144: 344-364. doi:10.1002/qj.3208

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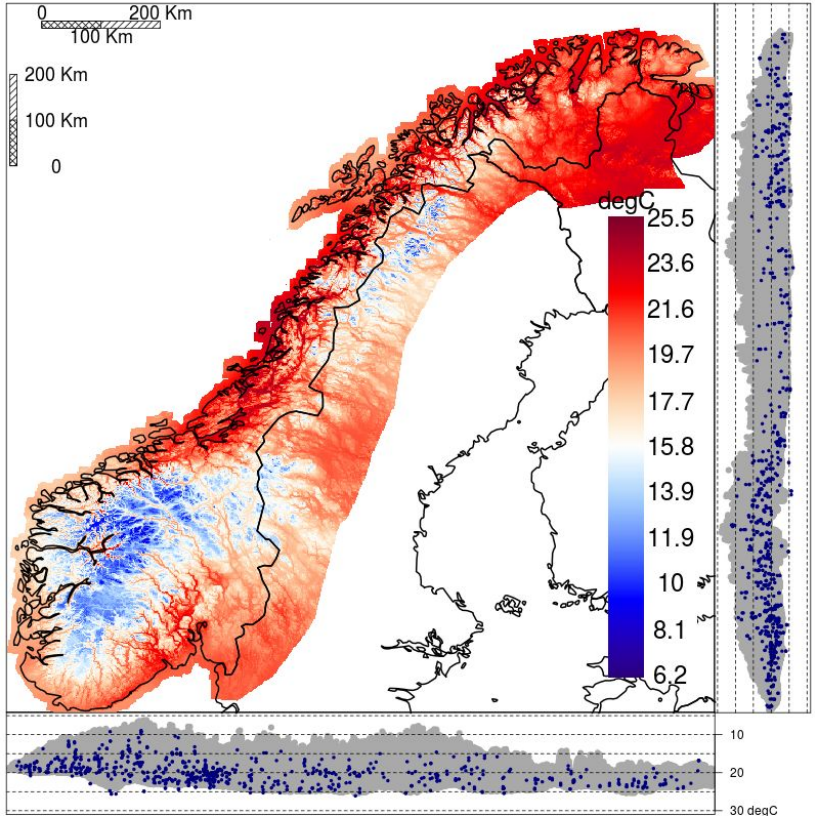
seNorge_2018 dataset

2019-08-29,
max temperature



Data sheet

daily total precipitation
daily mean/min/max temperatures
High-resolution (1 km)
Time range 1957-today

Production Strategies

<u>Provisional Archive</u>
daily updated

<u>Historical Archive</u>
updated once a year

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Flowchart

Data collection

OpenData from SMHI, FMI, METNorway

OpenData from ECA&D

Pre-processing, accurate and precise observations

DQC

Correction for wind-induced undercatch

Spatial Analysis

Statistical Interpolation (OI)

Spatial scale-separation

small-scale details depend on local station density

locally stationary random fields

Model parameters change over our big domain

Dissemination

Provisional archive

thredds.met.no

one file per day

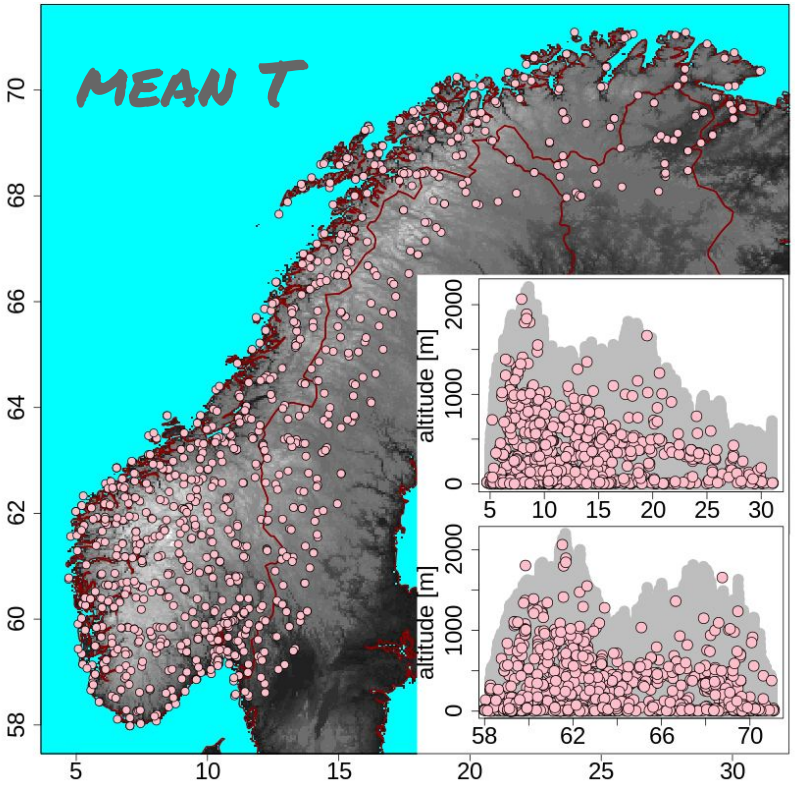
Historical archive

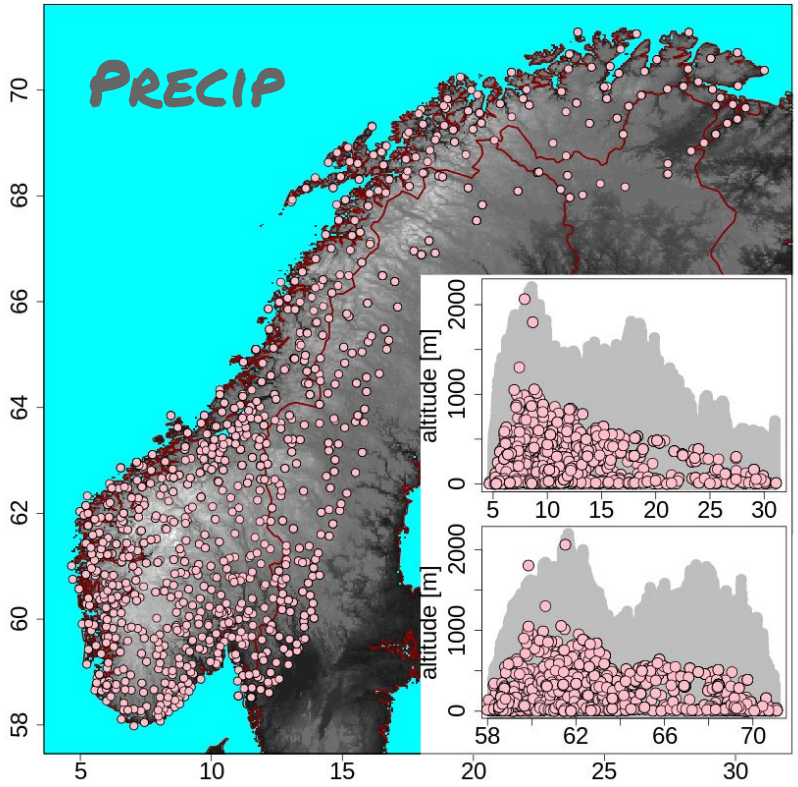
thredds.met.no

zenodo.eu (DOI)

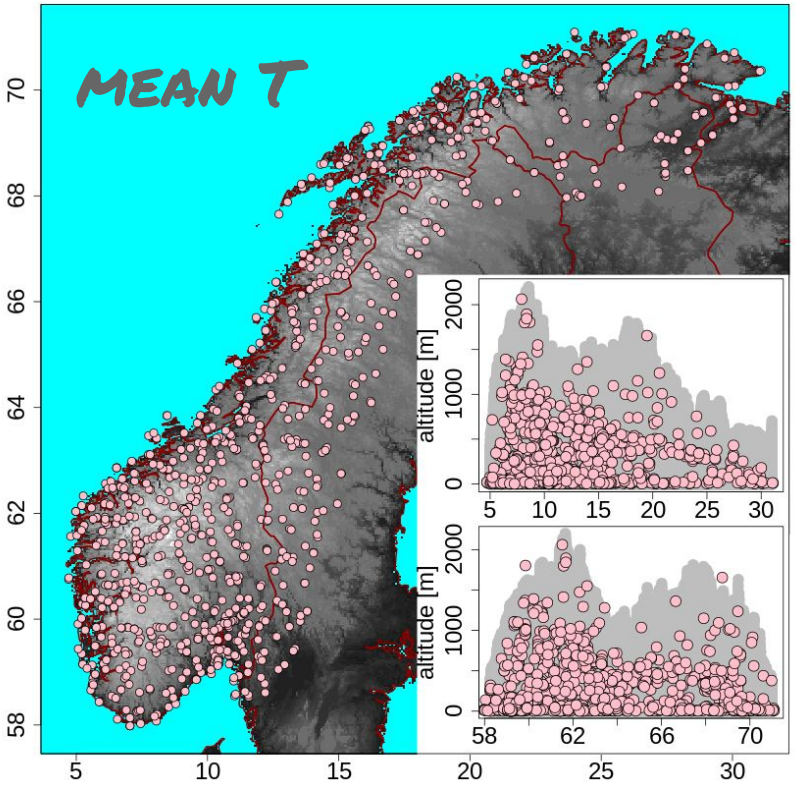
one file per year

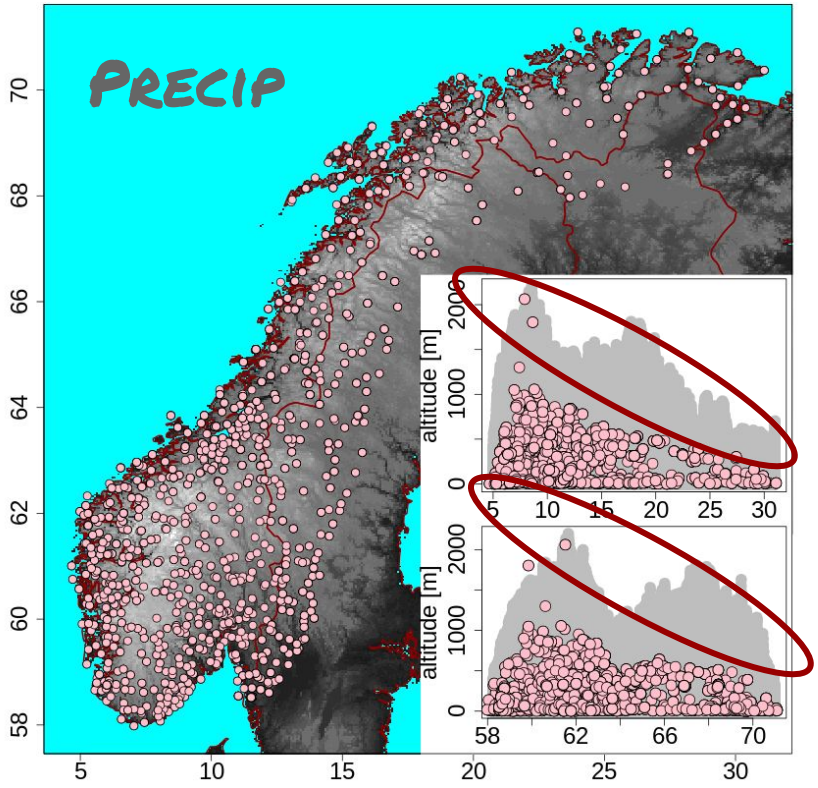
precip, 500-700 observations
temperature, 200-450 observations





precip, 500-700 observations
temperature, 200-450 observations





use long-term averages from numerical models to fill-in the missing information

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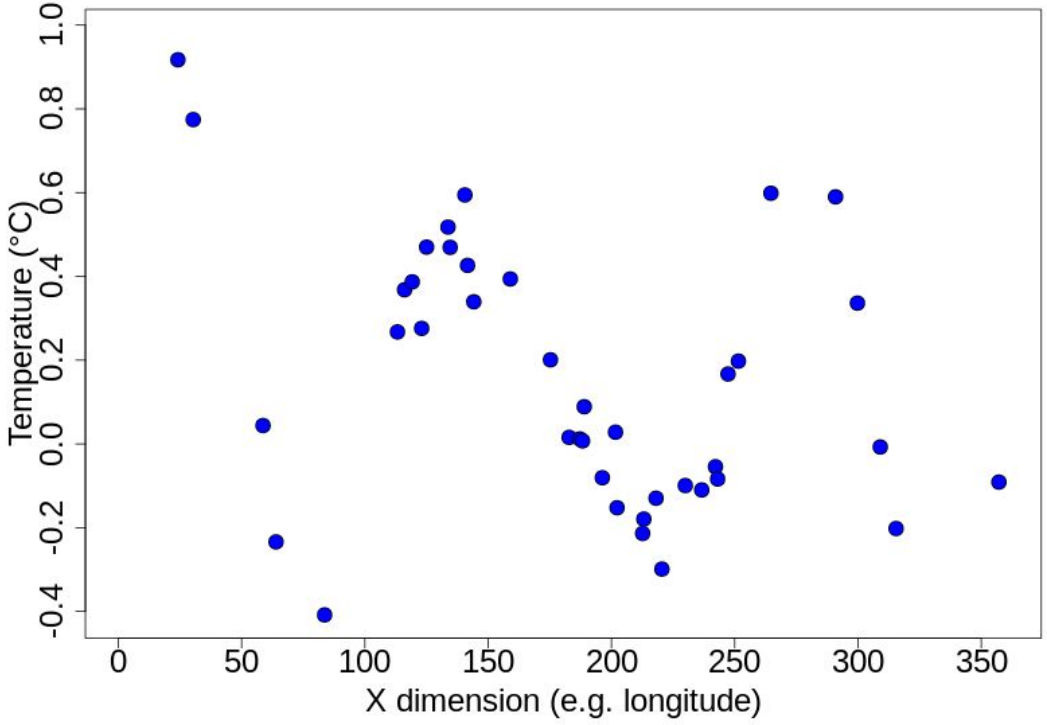
TEMPERATURE

Spatial analysis - Scale separation



1D example

Observations

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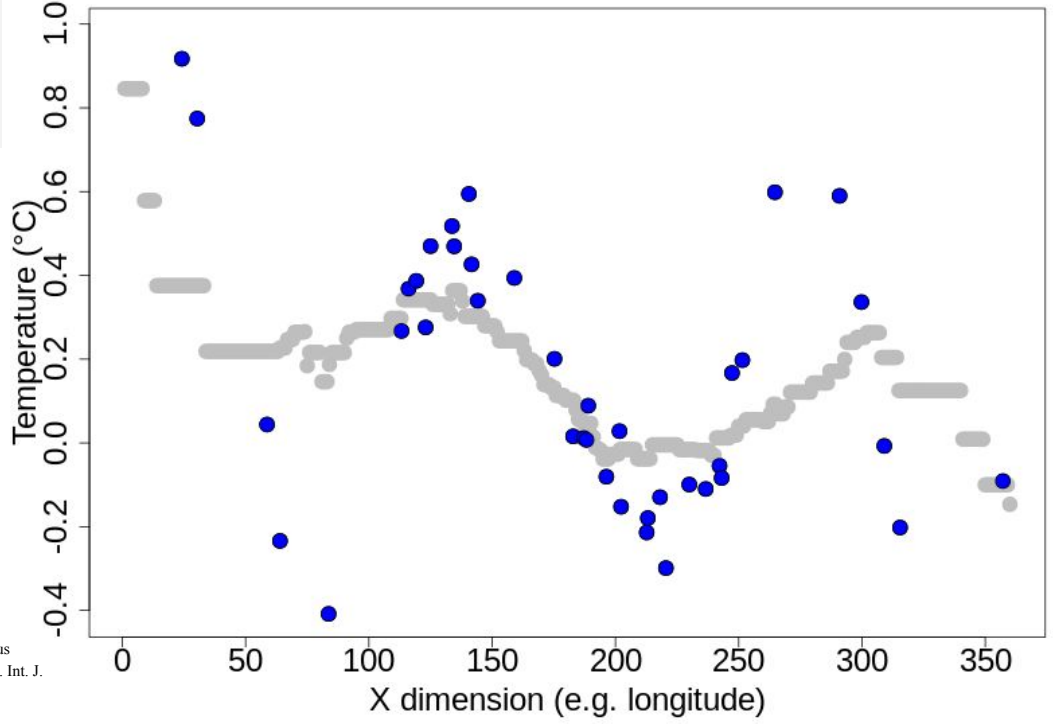
Spatial analysis - Scale separation

seNorge_2018 Large scale:

fitting vertical temperature profile (Frei, 2014) to observed data



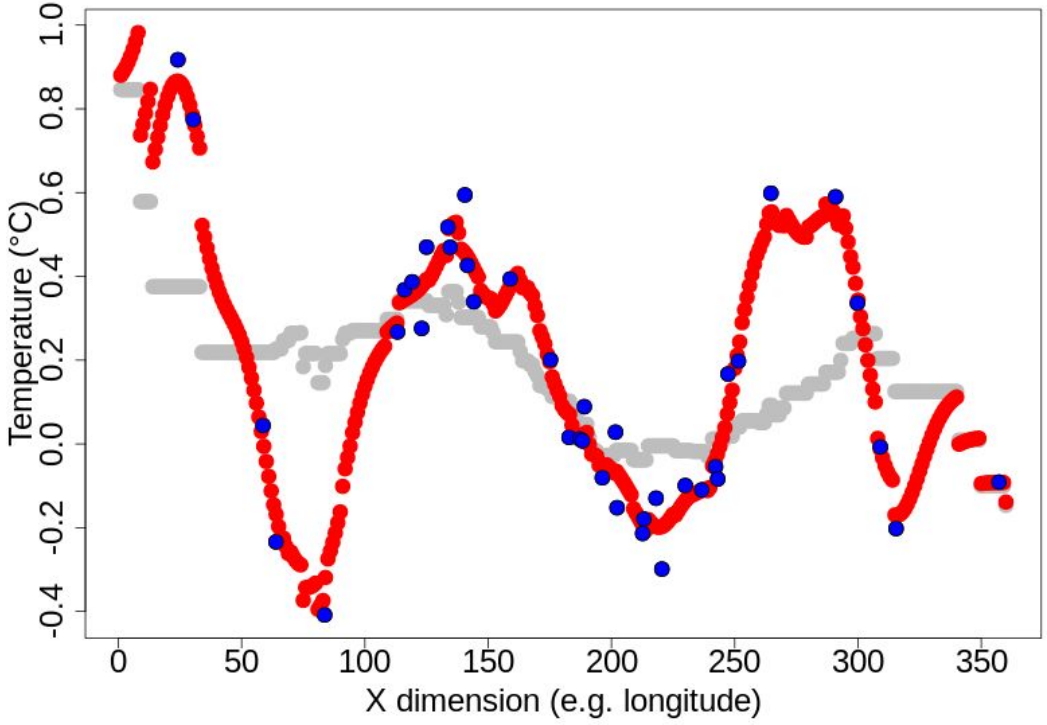
1D example

Observations

Large-scale background
(spatial support 50 Xunits)

Frei, C. (2014), Interpolation of temperature in a mountainous region using nonlinear profiles and non-Euclidean distances. Int. J. Climatol., 34: 1585-1605. doi:10.1002/joc.3786

Spatial analysis - Scale separation



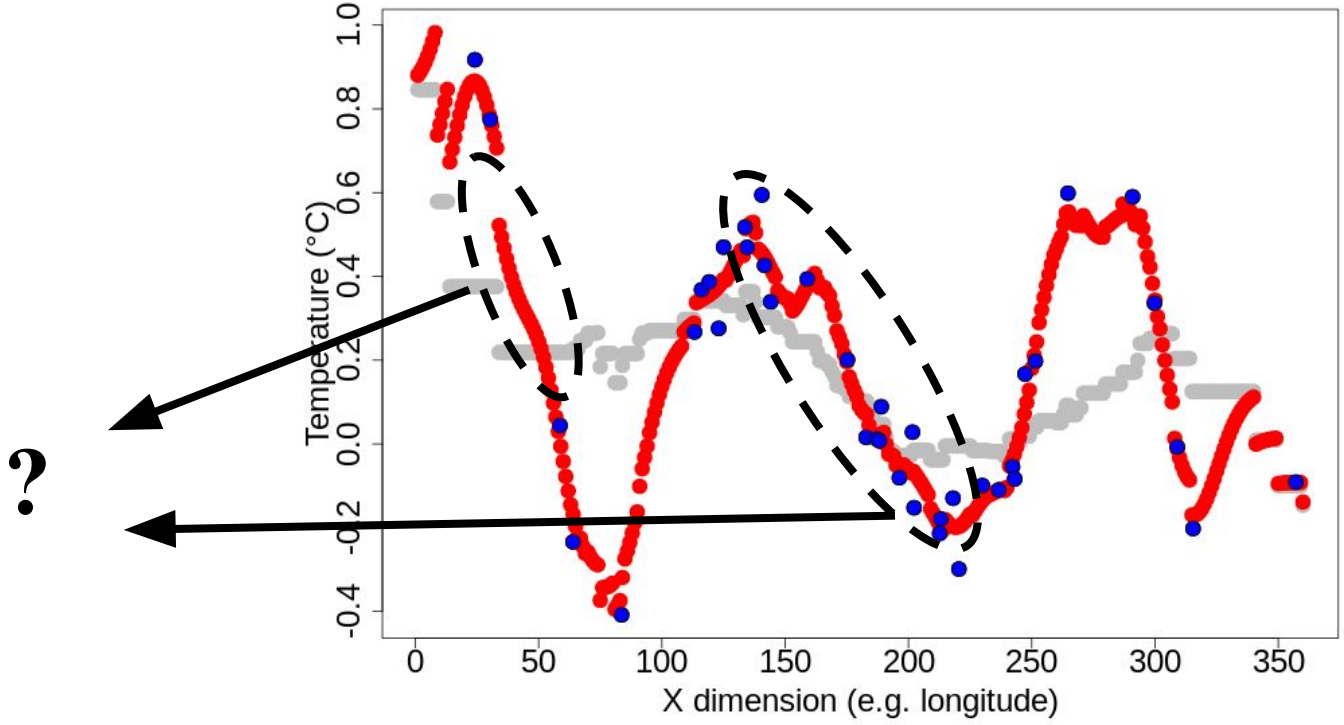
1D example

Observations

Large-scale background
(spatial support 50 Xunits)

Small-scale analysis
(spatial support 10 Xunits)

Spatial analysis - Scale separation



1D example

Observations

Large-scale background
(spatial support 50 Xunits)

Small-scale analysis
(spatial support 10 Xunits)

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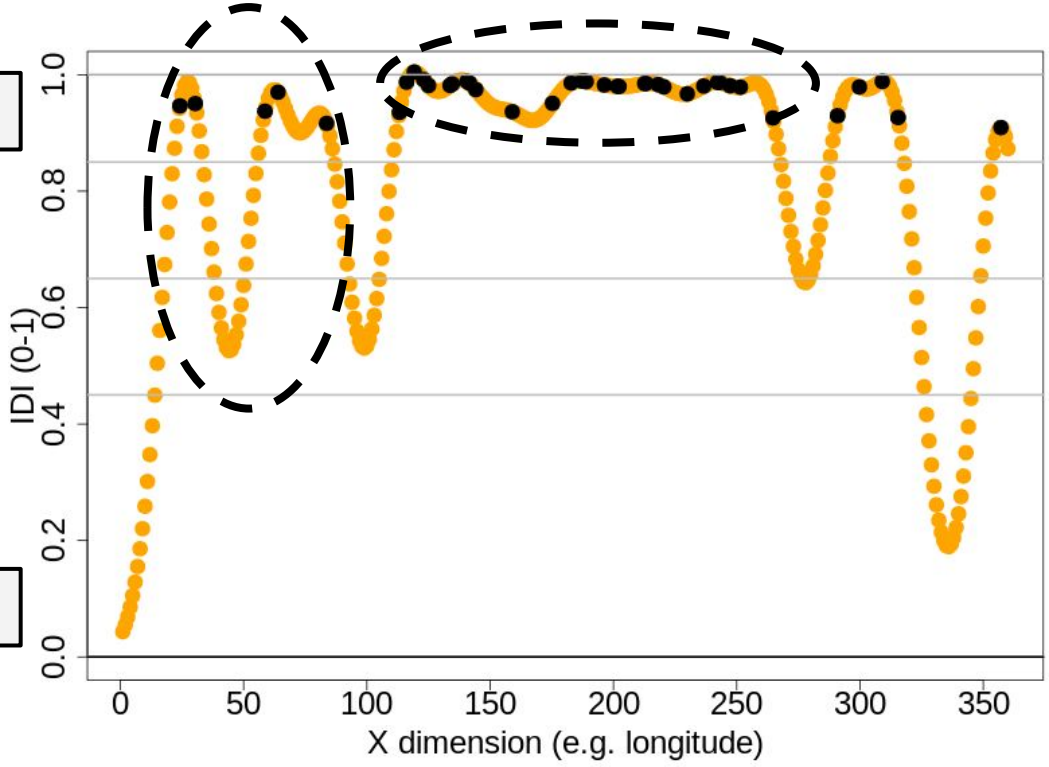
Spatial analysis - Integral Data Influence

Data Dense regions

Data void regions



1D example

at station locations
(spatial support 10 Xunits)

at grid points
(spatial support 10 Xunits)

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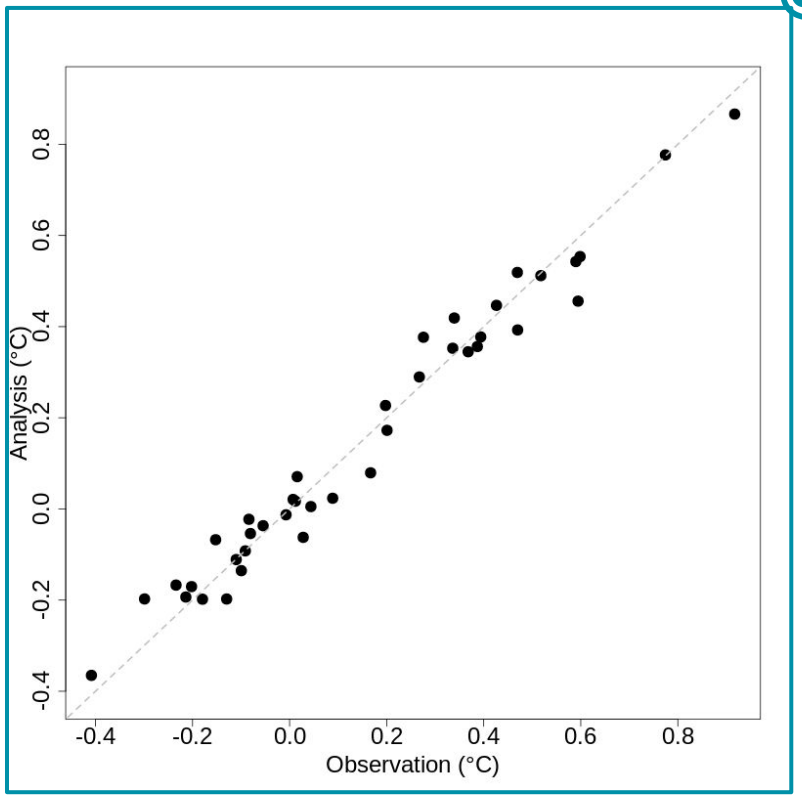
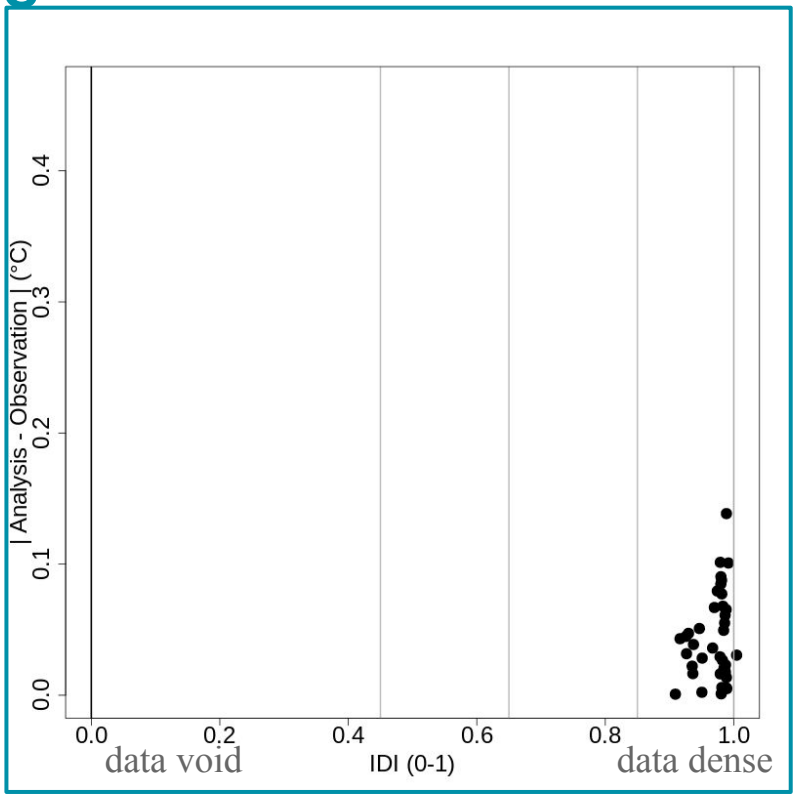
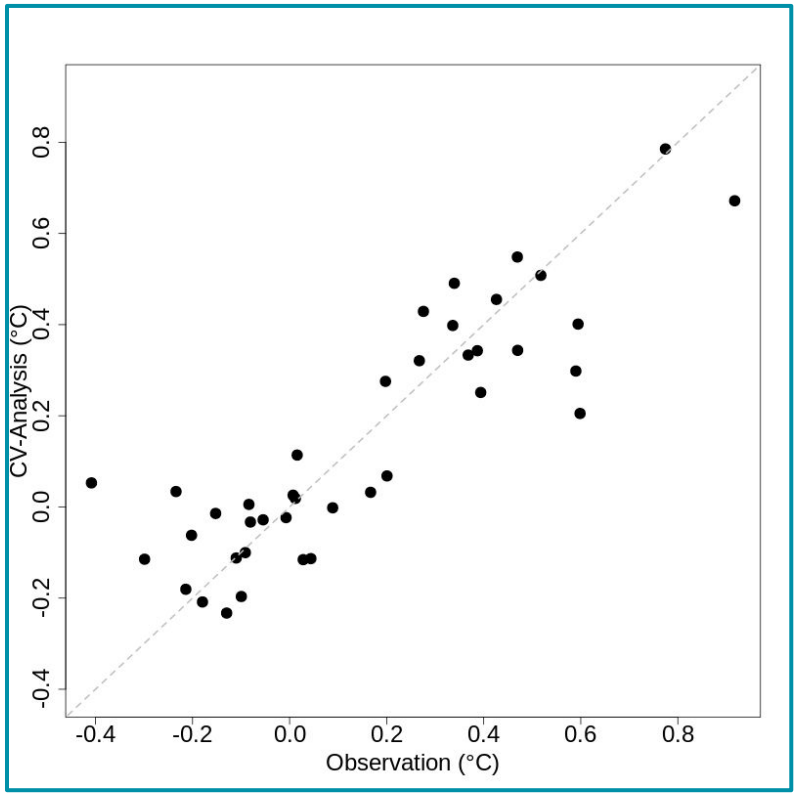
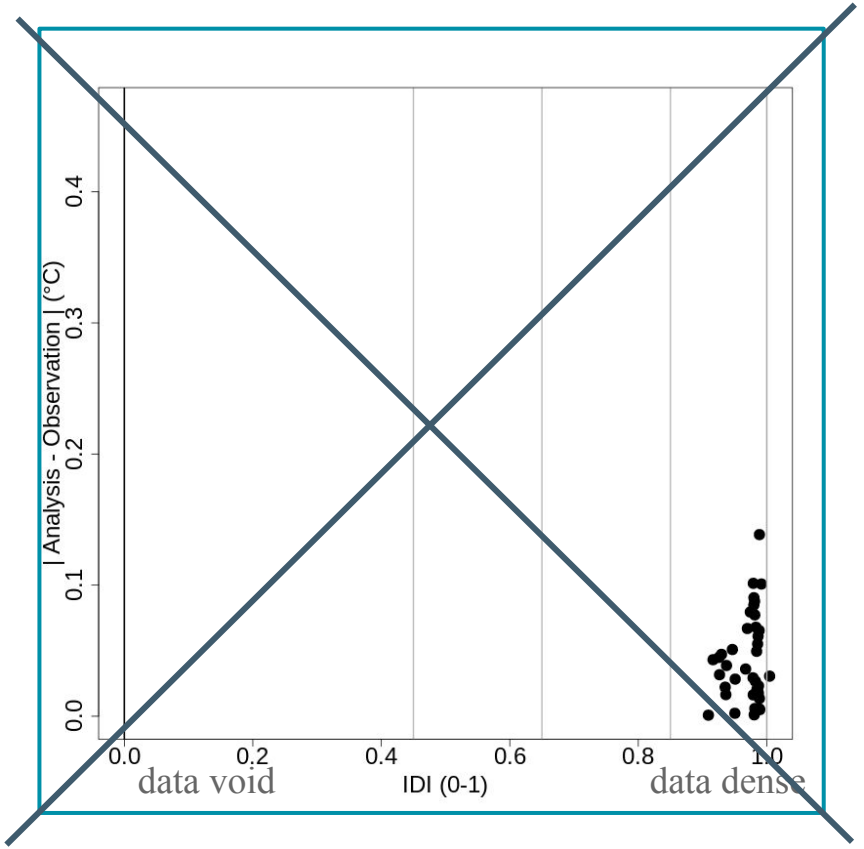
use Integral Data Influence to explain Analysis performances @stations





What about leave-one-out CrossValidation (CV)?

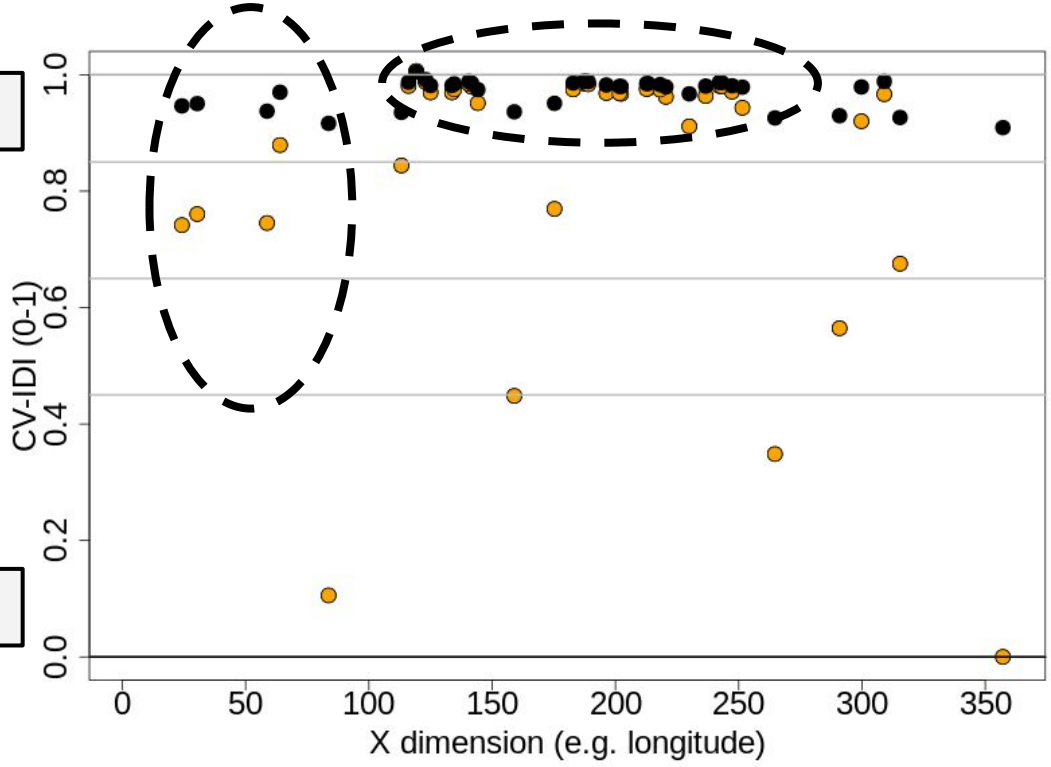




Spatial analysis - Integral Data Influence

Data Dense regions

Data void regions



1D example

at station locations
(spatial support 10 Xunits)

at station locations
CrossValidation IDI
(spatial support 10 Xunits)

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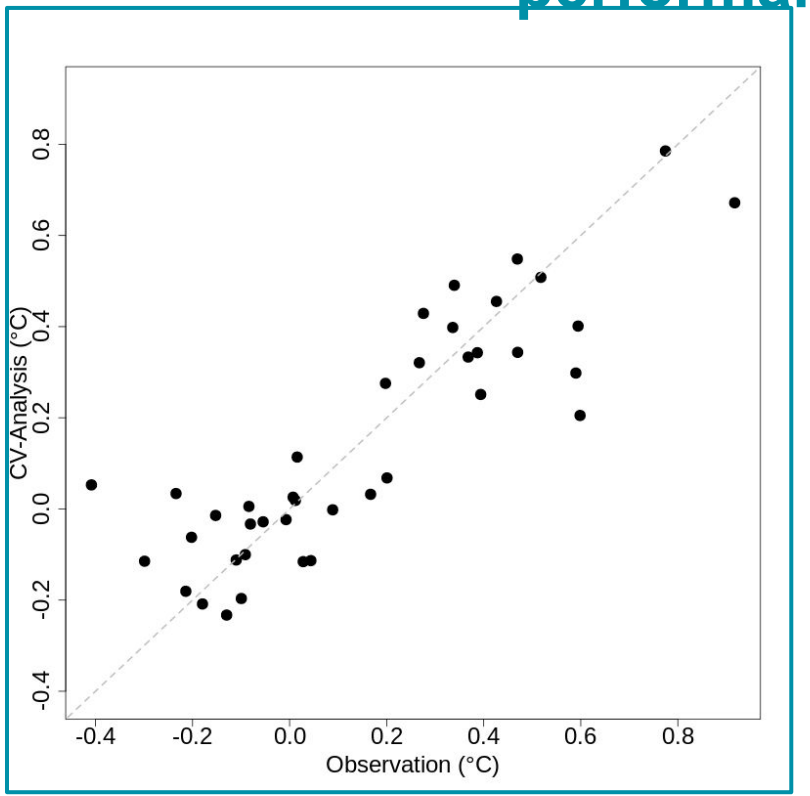
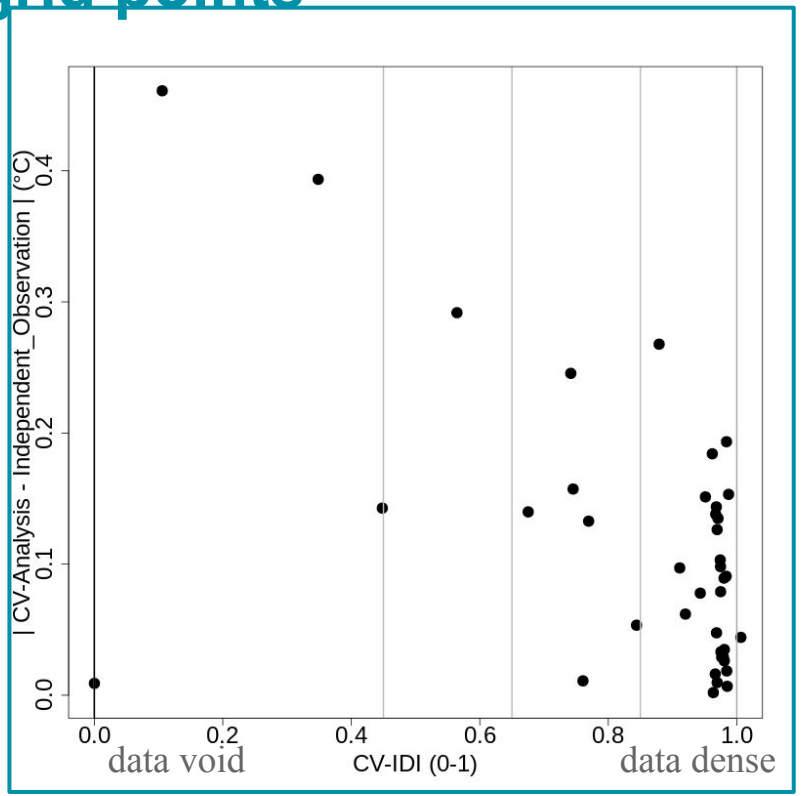
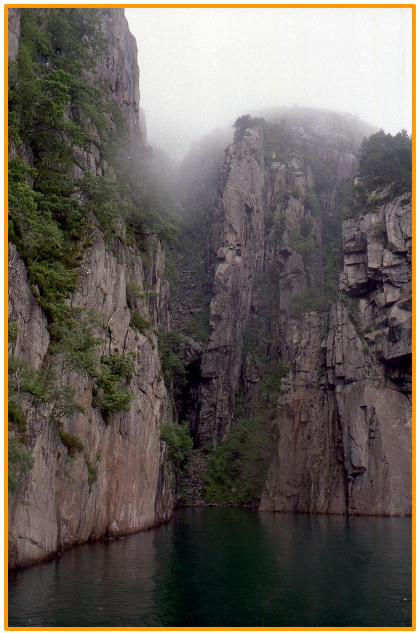
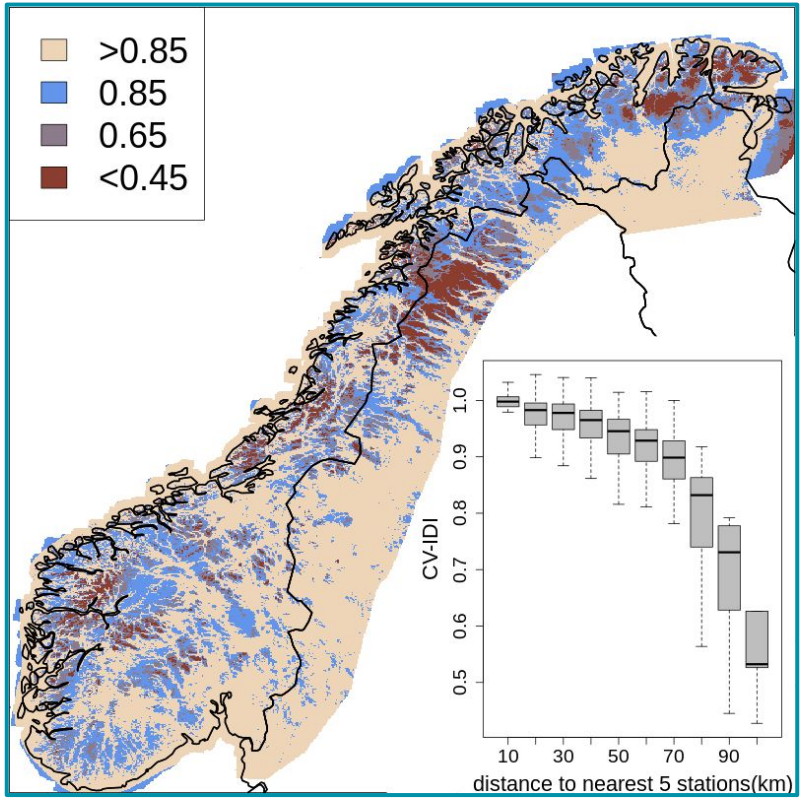
use CV-Integral Data Influence to explain Analysis performances @grid points





Integral Data Influence (IDI)





correlation function

Gaussian

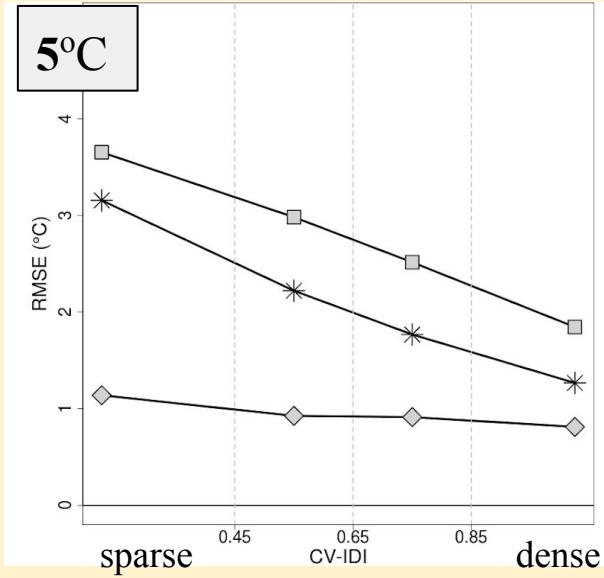
Characteristic length scales

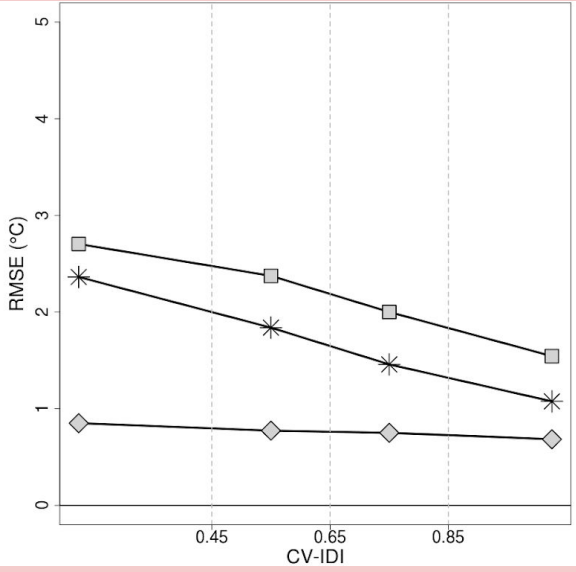
horizontal (radial) = 60 km

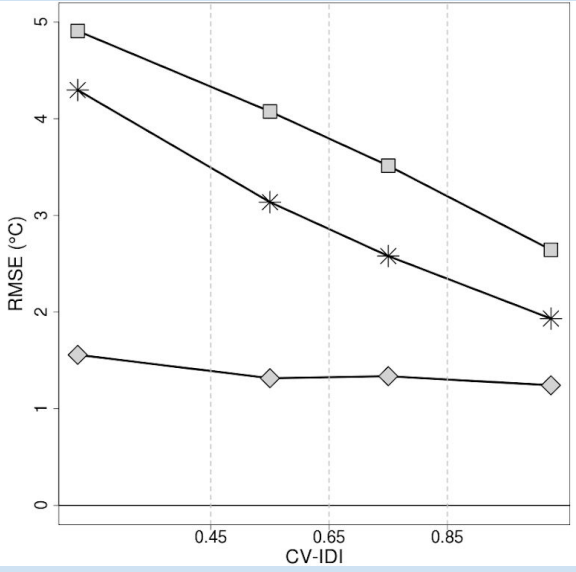
vertical = 250 m

RMSE - Temperatures - Winter 1961 2017

Large-scale background Small-scale analysis (no CV) * Small-scale analysis (CV)



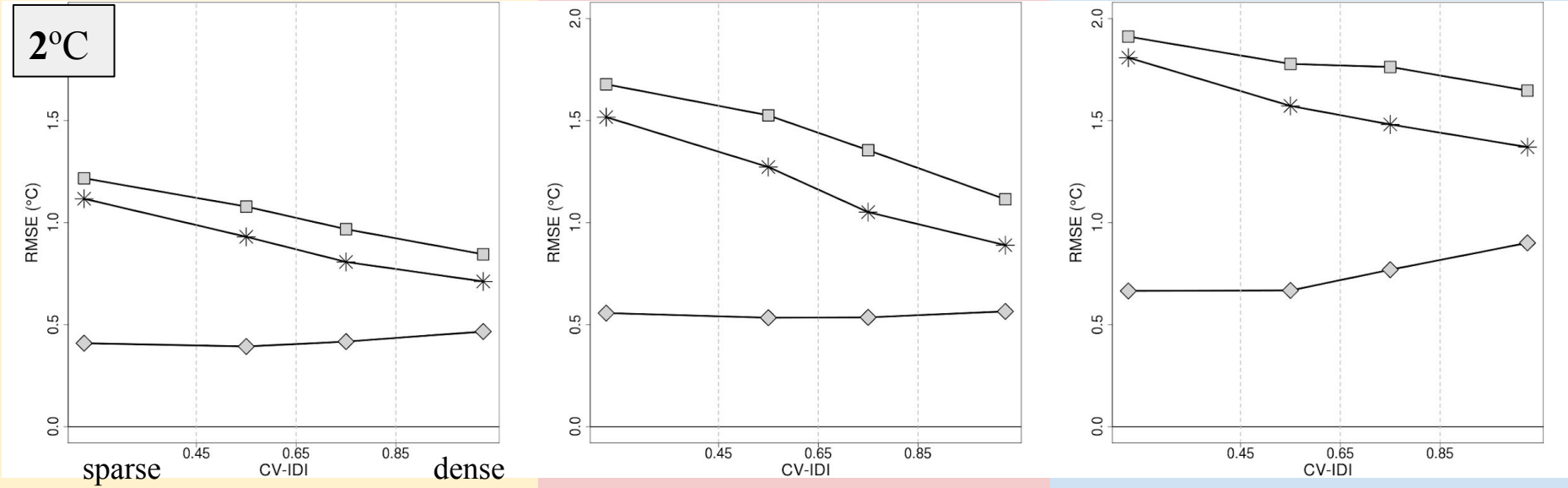




daily mean daily max daily min

RMSE - Temperatures - Summer 1961 2017

Large-scale background Small-scale analysis (no CV) * Small-scale analysis (CV)



daily mean daily max daily min

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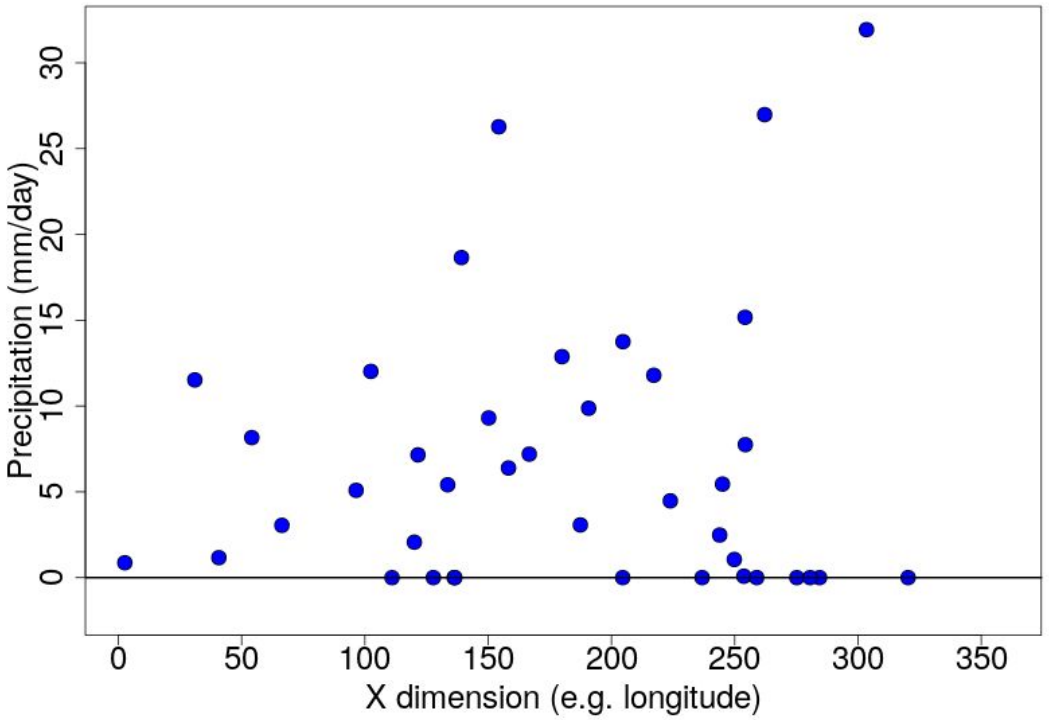
PRECIPITATION

Spatial analysis - MultiScale approach (successive corrections)

random numbers from the gamma distribution with a prescribed frequency of no-prec



1D example

Observations

Reference

Transformation

Larger-scale background
(spatial support Y+Δ Xunits)

Smaller-scale analysis
(spatial support Y Xunits)

Inverse Transformation

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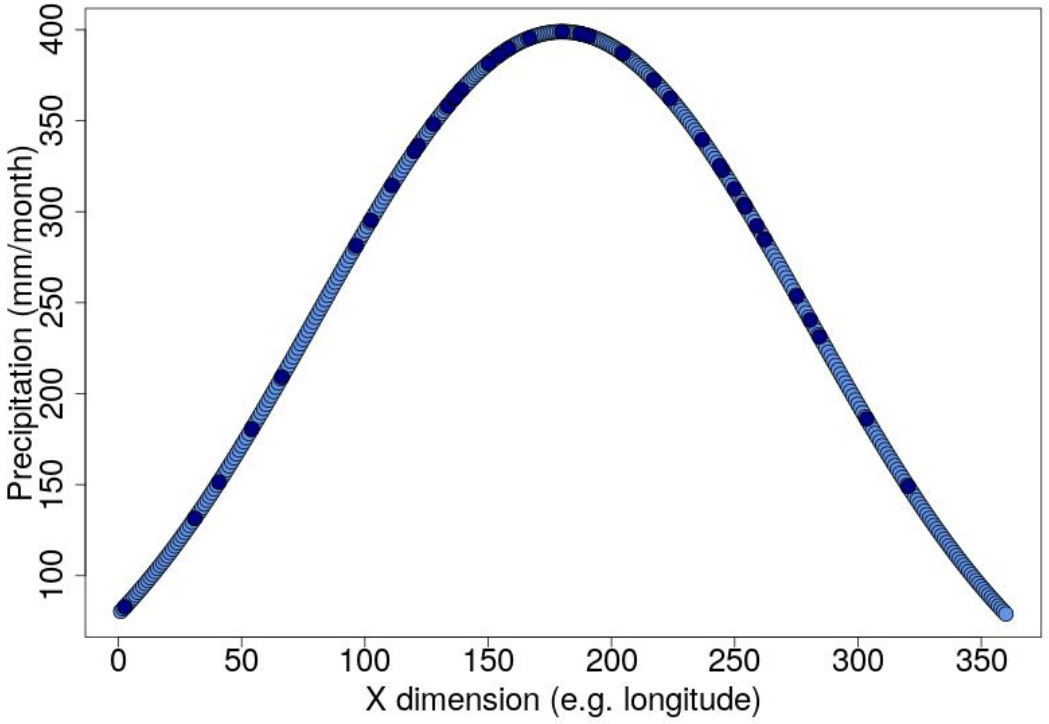
Spatial analysis - MultiScale approach (successive corrections)

seNorge_2018 Reference:

long-term monthly averages climate model version of HARMONIE

model has been set-up with AROME physics and the SURFEX surface scheme

The climate runs covers the period July 2003 to December 2016 on a 2.5 km grid over the Norwegian mainland



1D example

Observations

Reference

Transformation

Larger-scale background
(spatial support Y+Δ Xunits)

Smaller-scale analysis
(spatial support Y Xunits)

Inverse Transformation

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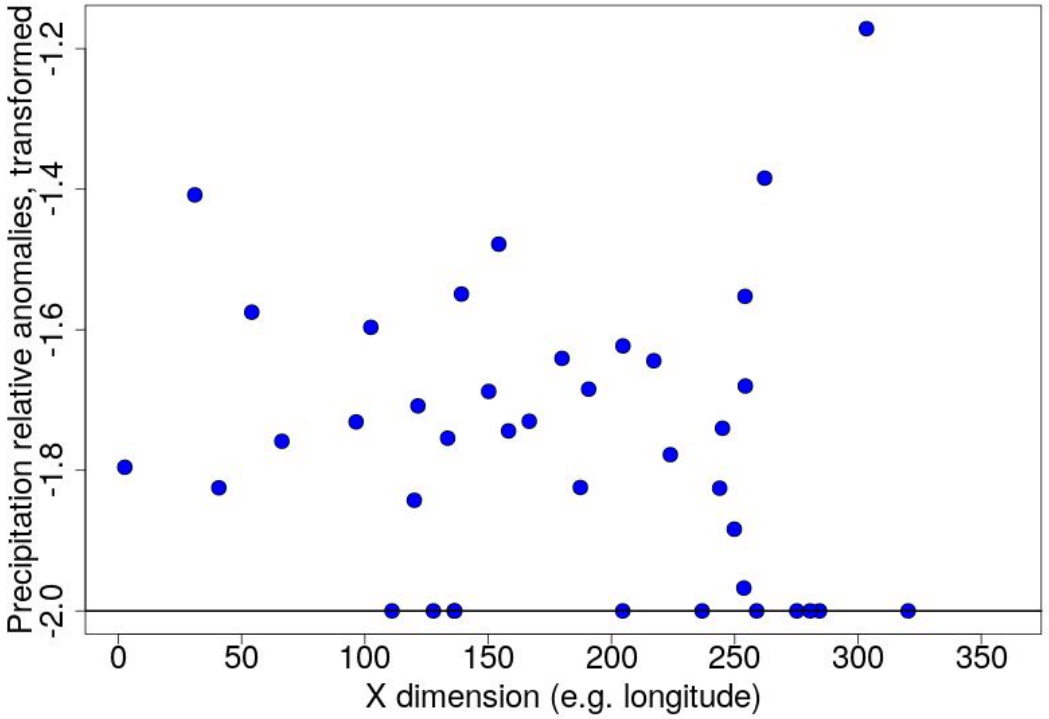
Spatial analysis - MultiScale approach (successive corrections)

Box-Cox (lambda=0.5) transformation

applied to relative anomalies observation/reference

1D example



Observations

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Transformation

Larger-scale background (spatial support Y+Δ Xunits)

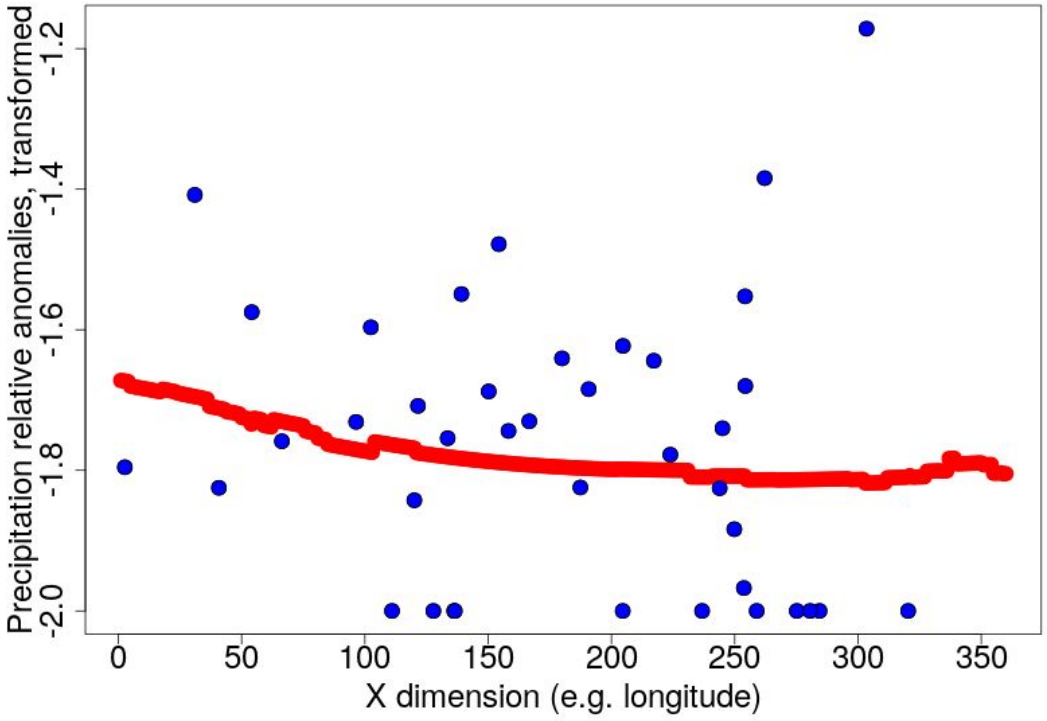
Smaller-scale analysis (spatial support Y Xunits)

Inverse Transformation

Norwegian Meteorological Institute

Spatial analysis - MultiScale approach (successive corrections)

1D example



Observations

Reference

Transformation

Larger-scale background
(spatial support Y+Δ Xunits)

Smaller-scale analysis
(spatial support Y Xunits)

Inverse Transformation

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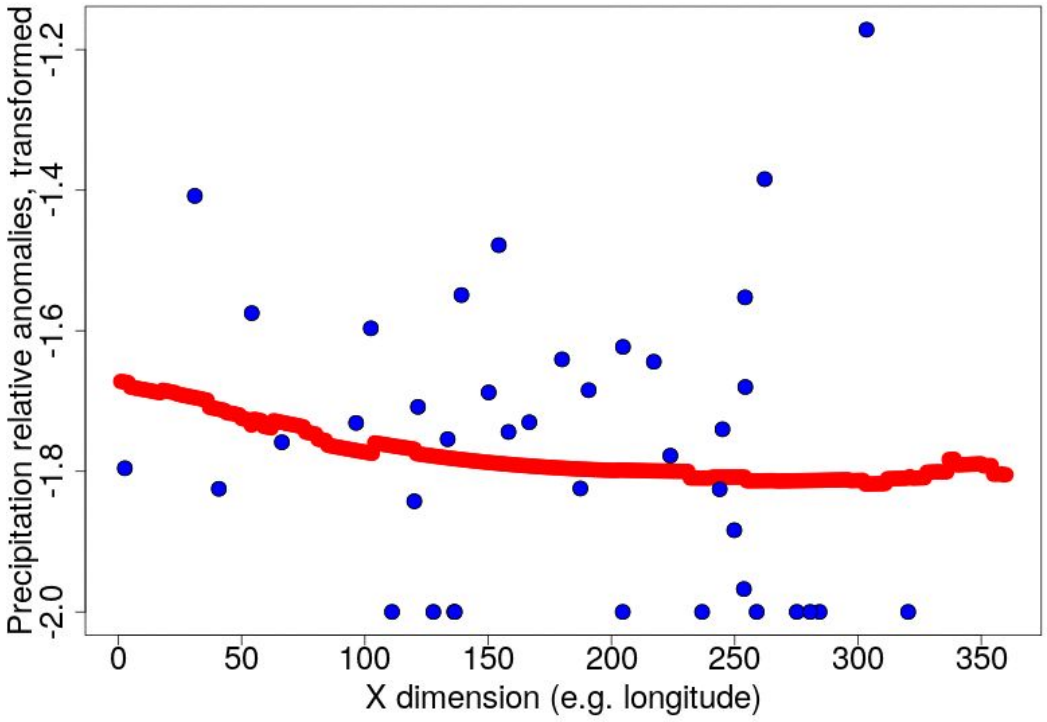
Spatial analysis - MultiScale approach (successive corrections)

1D example



Observations

Reference

Transformation

Larger-scale background
(spatial support Y+Δ Xunits)

Smaller-scale analysis
(spatial support Y Xunits)

Inverse Transformation

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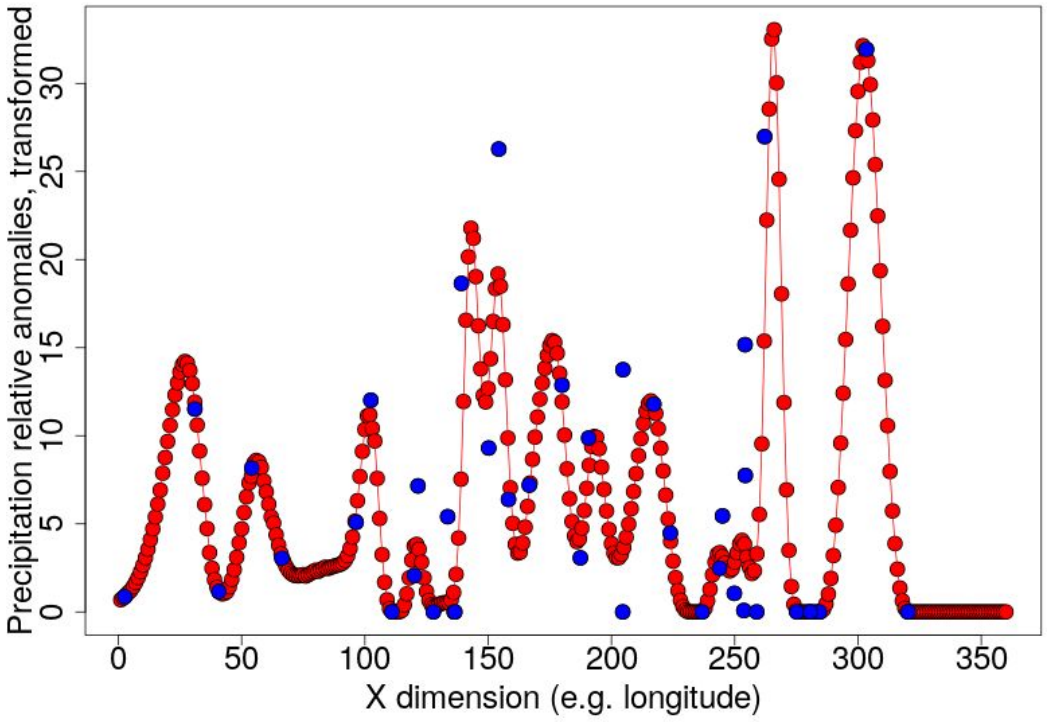
Spatial analysis - MultiScale approach (successive corrections)

1D example



Observations

Reference

Transformation

Larger-scale background
(spatial support Y+Δ Xunits)

Smaller-scale analysis
(spatial support Y Xunits)

Inverse Transformation

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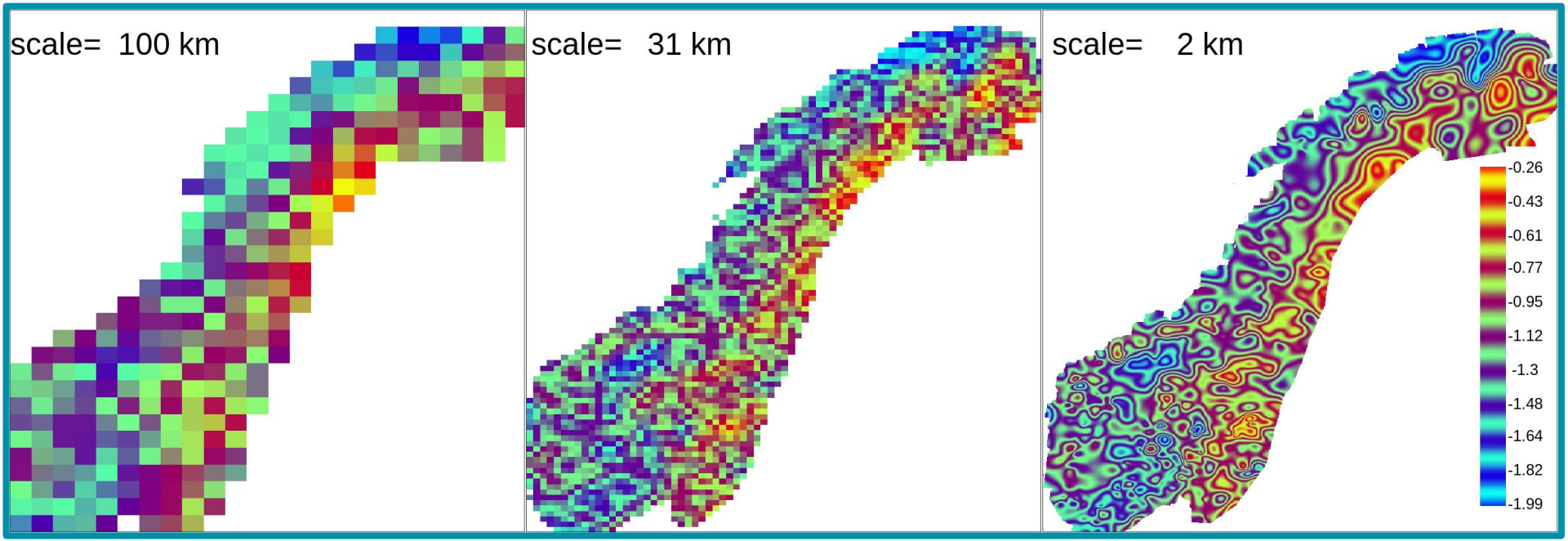
Multi-scale Optimal Interpolation relative anomalies



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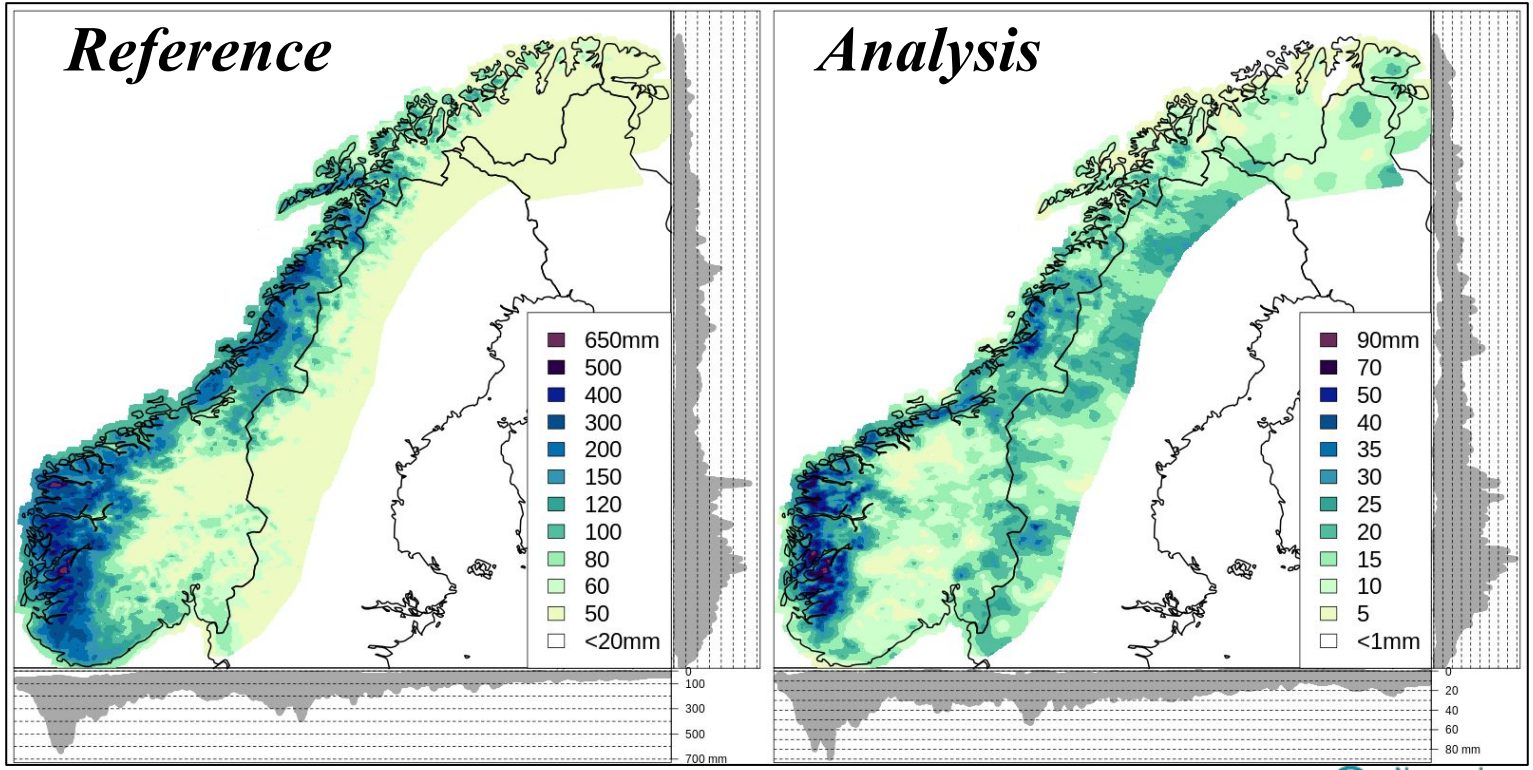
How does the field look like?



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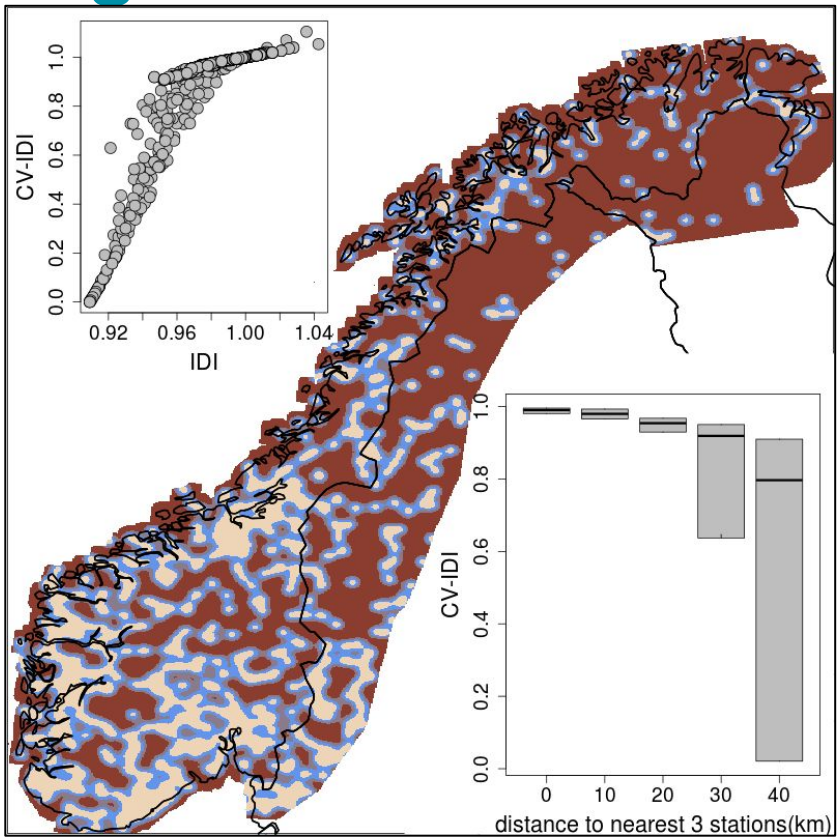
Integral Data Influence (IDI)

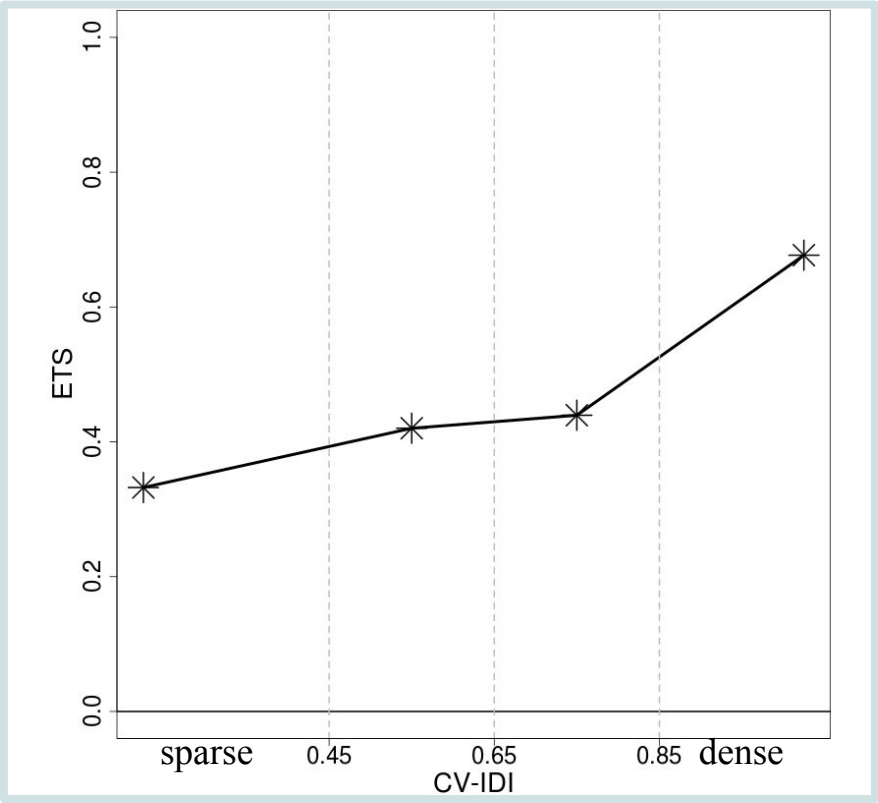


correlation function
Gaussian

Characteristic length scales
horizontal (radial) = 10 km
~~*vertical*~~

Equitable Threat Score - All data

* analysis (CV)



ETS Equitable Threat Score

event definition:
precipitation gt/eq 1 mm/day

How well did the CV-analysis "yes" events correspond to the observed "yes" events (accounting for hits due to chance)?

How can spatial analysis help improving observational networks?

mean temperature

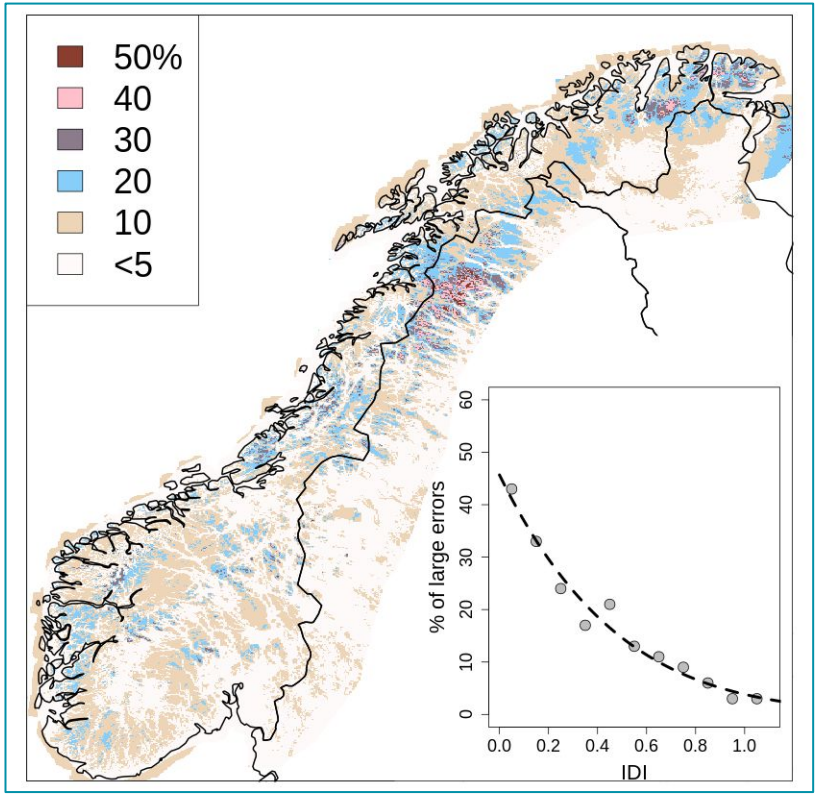


Fig. Probability of occurrence of large errors in daily mean temperature during winter.

large error: deviation of estimate from actual value larger than 3°C.

seNorge_2018, a step in the right direction

1. Spatial analysis. Scale separations. Locally stationary random fields.
   a. *Optimal Interpolation / successive corrections / Data Influence.*

2. Precipitation not exclusively based on observations
   a. *monthly fields from a numerical model.*

3. Temperature, quality depends on:
   a. *the season of the year,*
   b. *the station density and the terrain complexity,*
   c. *minimum daily temperature is the most challenging variable.*

4. Precipitation, quality:
   a. *the station density and the terrain complexity.*

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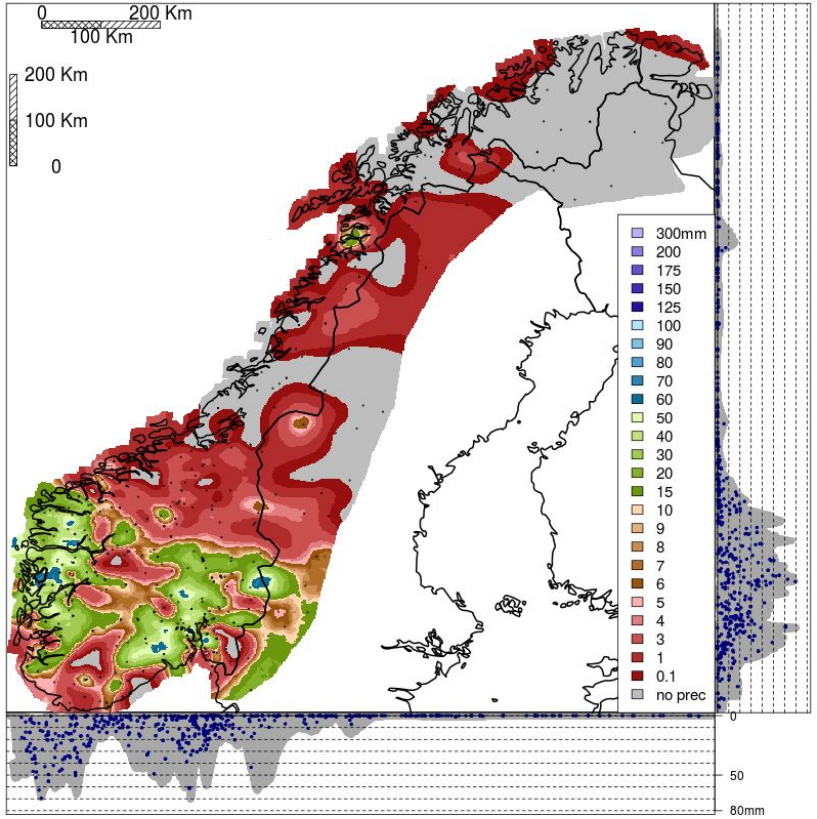
Supplementary Material

seNorge_2018 dataset

2019-08-29, precipitation



Data sheet

daily total precipitation
daily mean/min/max temperatures
High-resolution (1 km)
Time range 1957-today

Production Strategies

Provisional Archive
daily updated

Historical Archive
updated once a year

Lussana, Tveito, Tunheim and Dobler: seNorge_2018 observational gridded datasets over Norway

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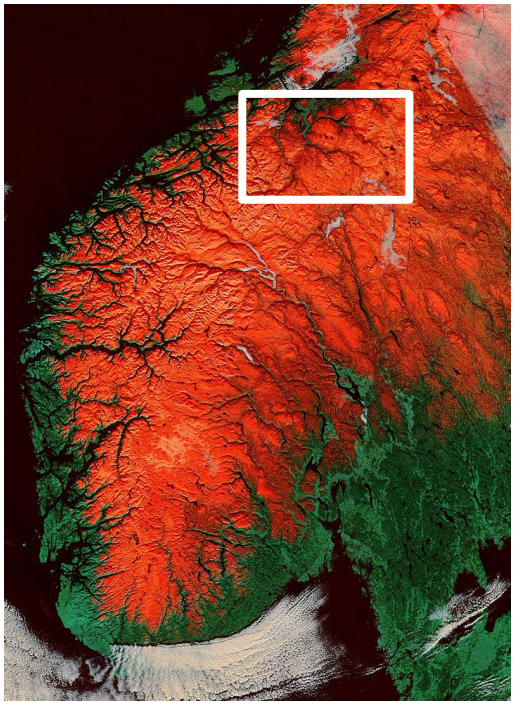
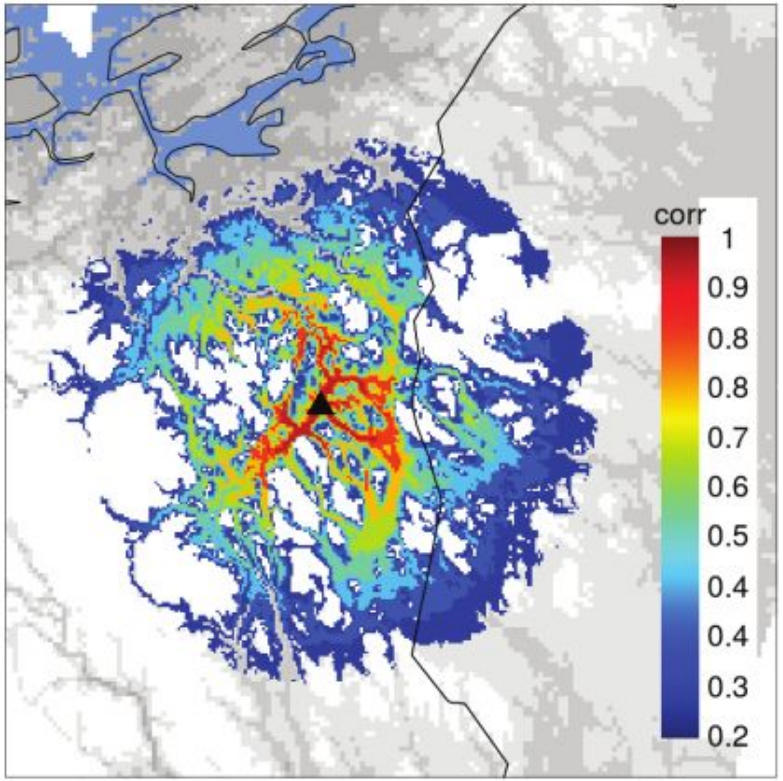
Integral Data Influence (IDI)



Satellite image of southern Norway, higher areas shown in red.
https://en.wikipedia.org/wiki/Geography_of_Norway#/media/File:Terrain_of_Norway_with_red_snow.jpg



correlation function
Gaussian

Characteristic length scales
horizontal (radial) = 60 km
vertical = 250 m

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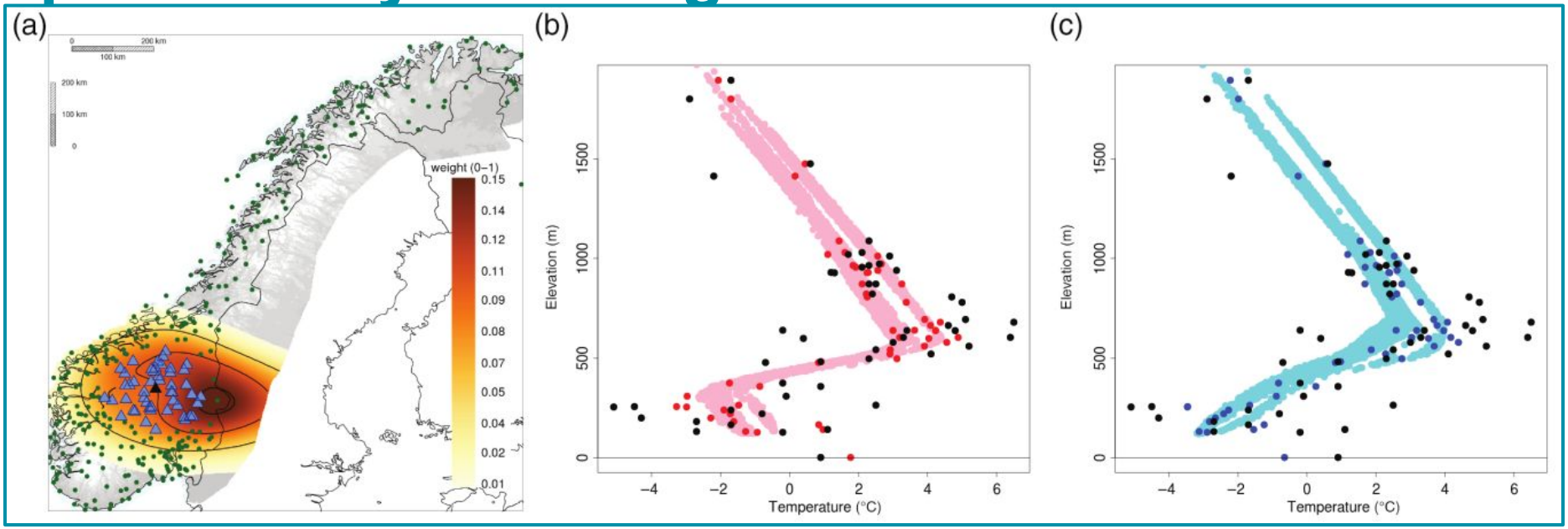
Spatial analysis - Large Scale



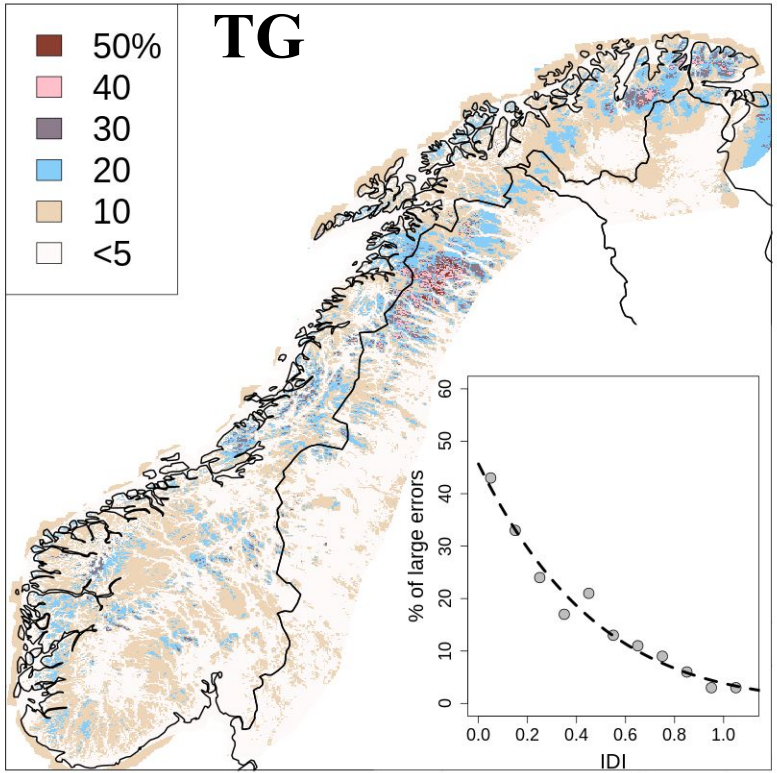
(a) consider a subregion

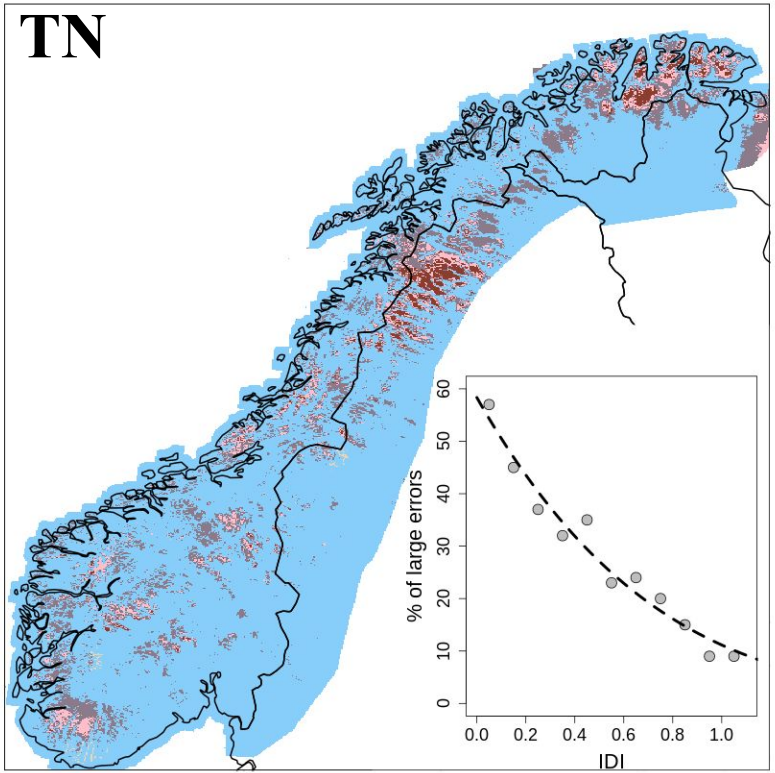
(b) fitting vertical temperature profile (Frei, 2014) to observed data

(c) blending subregions together

Frei, C. (2014), Interpolation of temperature in a mountainous region using nonlinear profiles and non‐Euclidean distances. Int. J. Climatol., 34: 1585-1605. doi:10.1002/joc.3786

Verification - Large Errors





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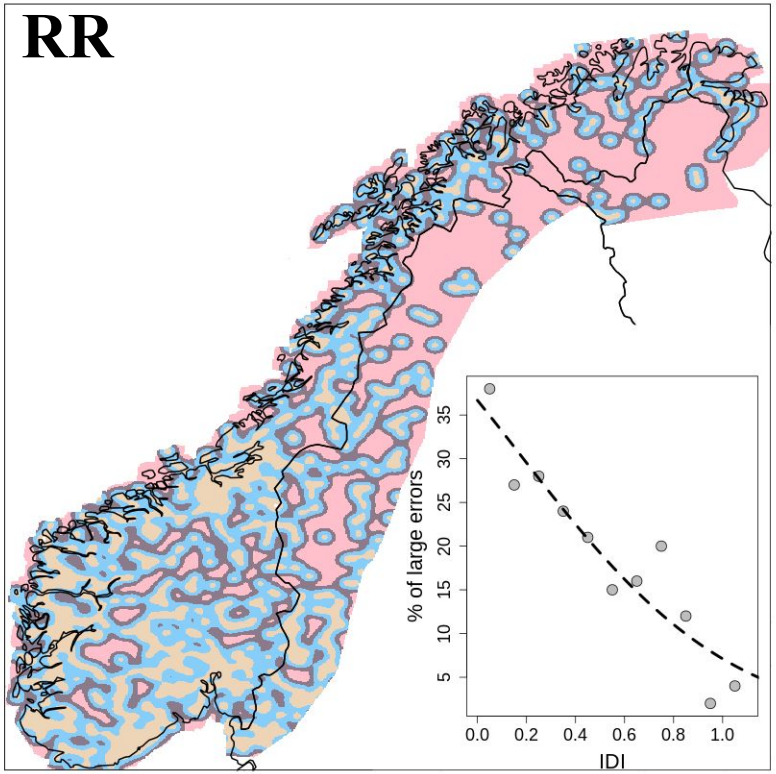

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