



Norwegian
Meteorological
Institute

Ensemble approaches to assess uncertainties in observation gridding

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*) MET Norway

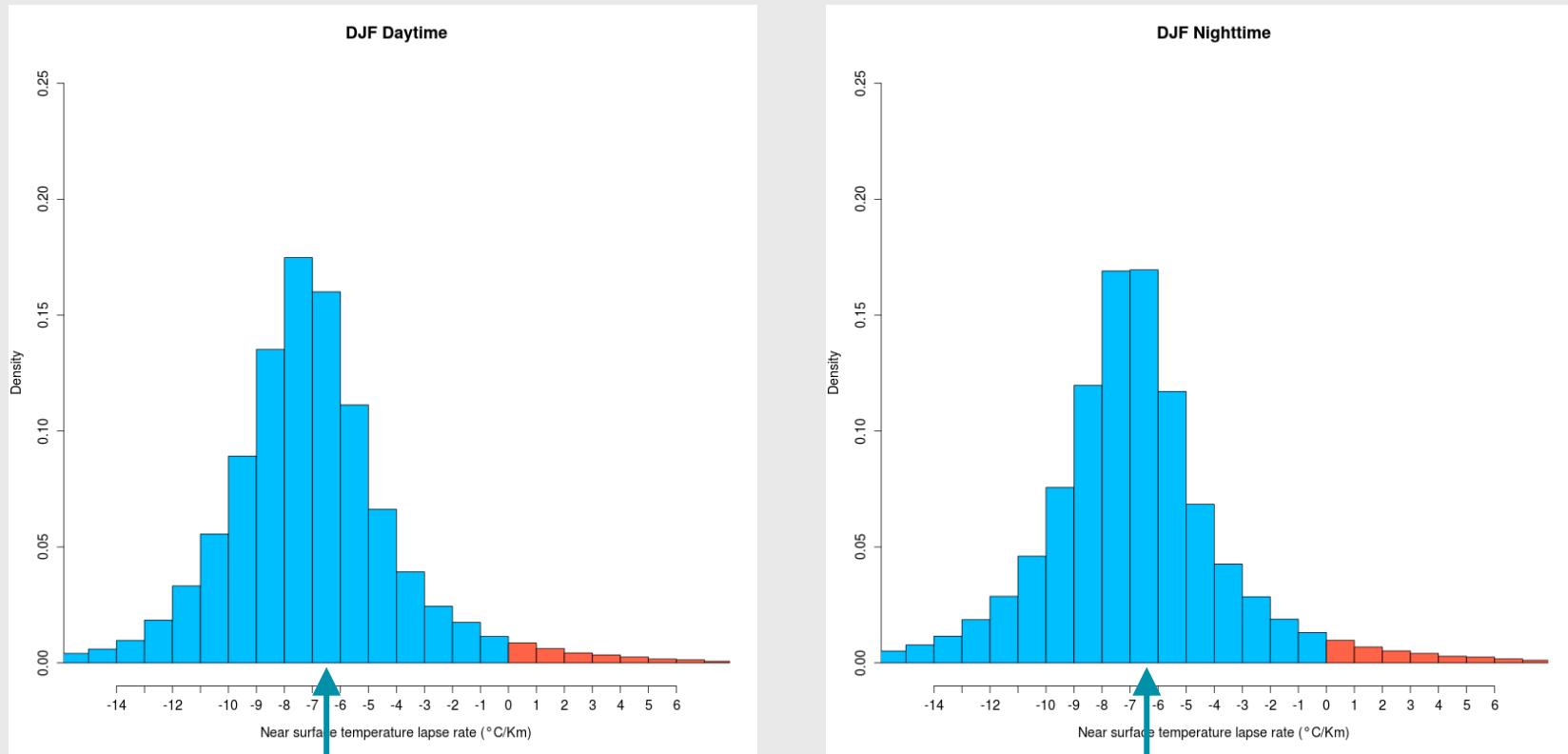
**) MET Norway & University of Bologna

Background/Motivation

- Many gridded datasets are based on a **residual interpolation** approach where a set of **external predictors** describing the background (or spatial trend field).
- The definition of the background is often held constant both in time and space, based on long term climatologies.
 - Large anomalies when applied on daily data.
- We know there is a certain randomness in observations:
 - Observation network representativity (and «biases»)
 - Measurement uncertainty
- We want to investigate spatial and temporal variations of the predictor fields in order to
 - Better understand **the sensitivity** of the choice of predictors under different atmospheric conditions
 - Better understand the spatial variations in the significance of predictors.
 - Look at the uncertainties of the methods.
 - Move towards an ensemble-approach for gridding.
- Focus here: Temperature

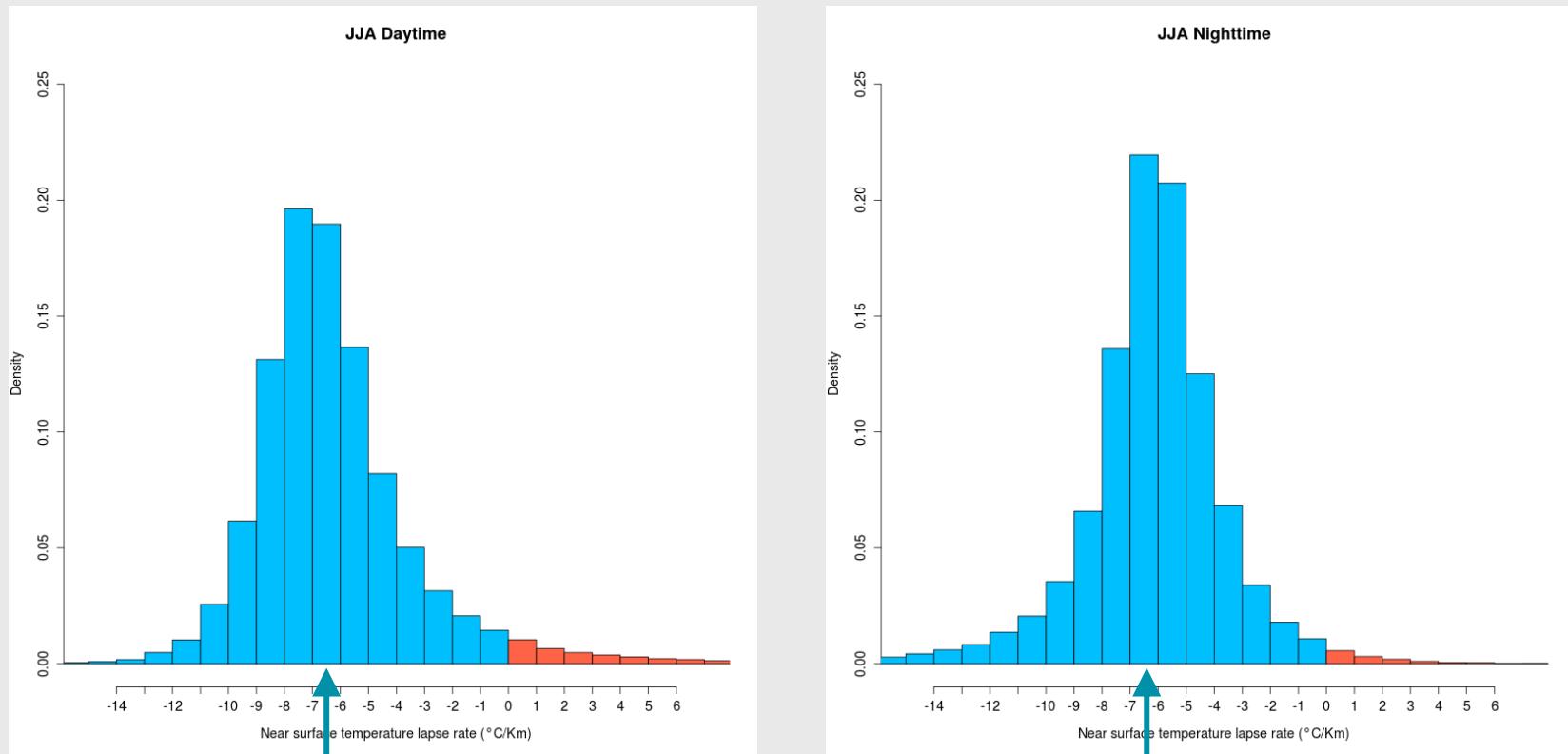
Variations in near-surface lapse rate

- Data: **hourly** observations of surface (2 meters) temperature
- Period: from 1st January 2014 to 31st August 2016



Based on hourly temperature observations

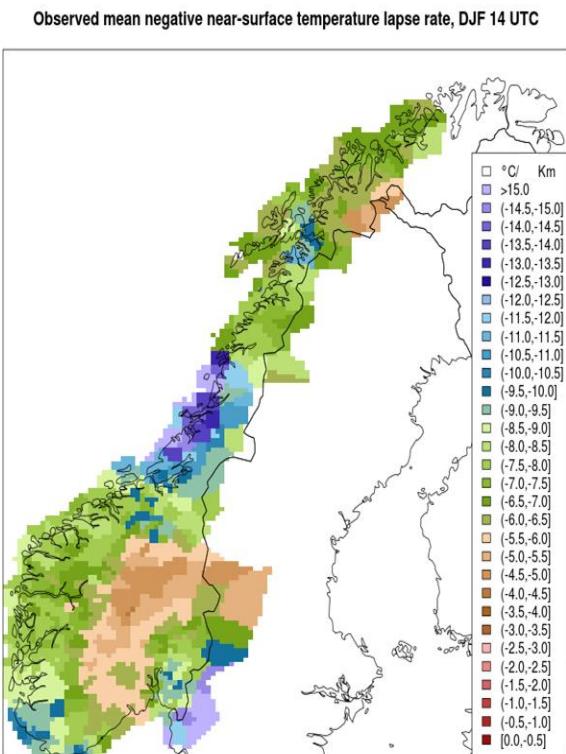
Variations in near-surface lapse rate



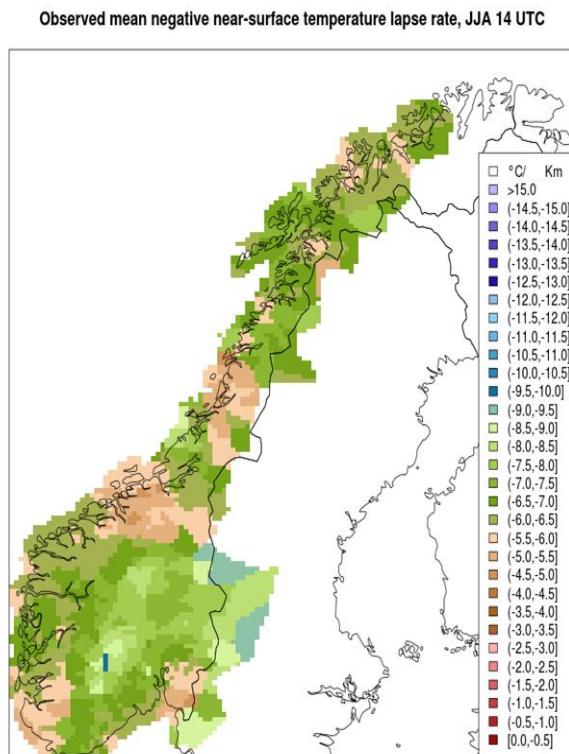
Based on hourly temperature observations

Variations in daytime near-surface lapse rate*

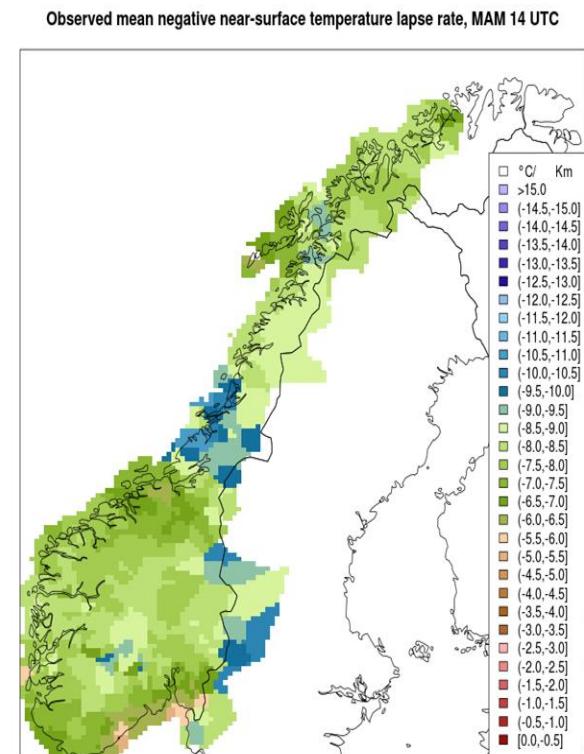
Winter



Summer



Spring

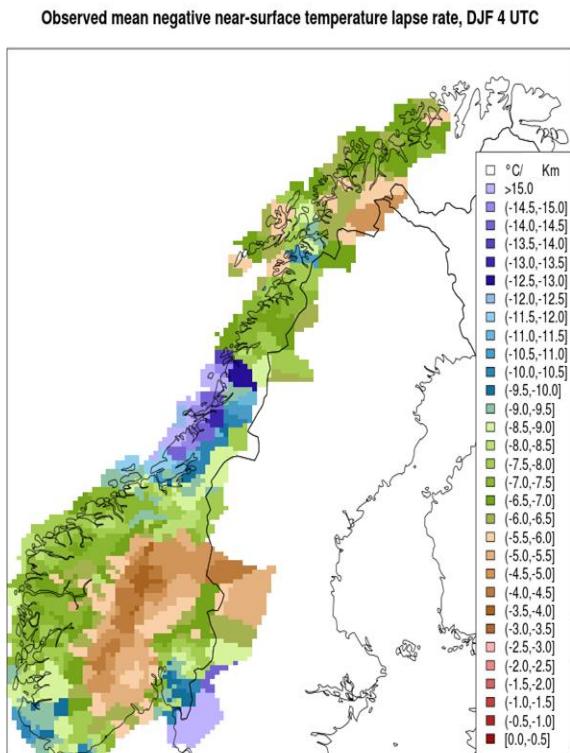


Values are in °C/Km

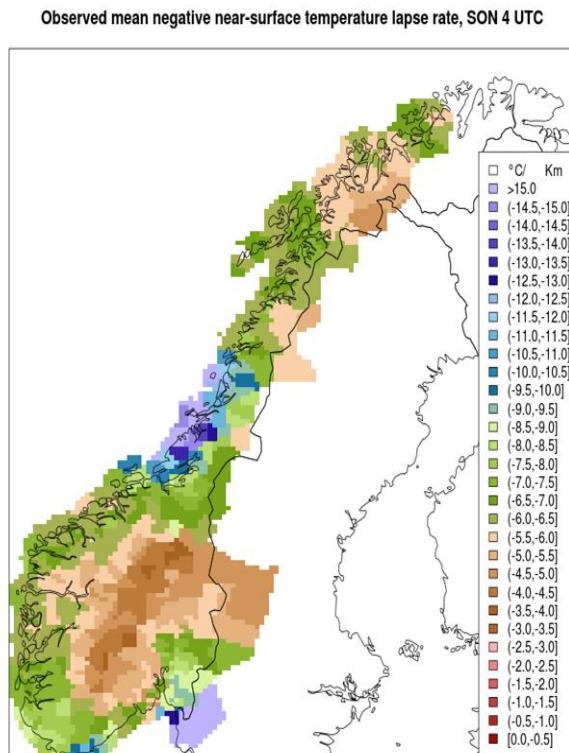
*Positive values filtered out

Variations in night-time near-surface lapse rate*

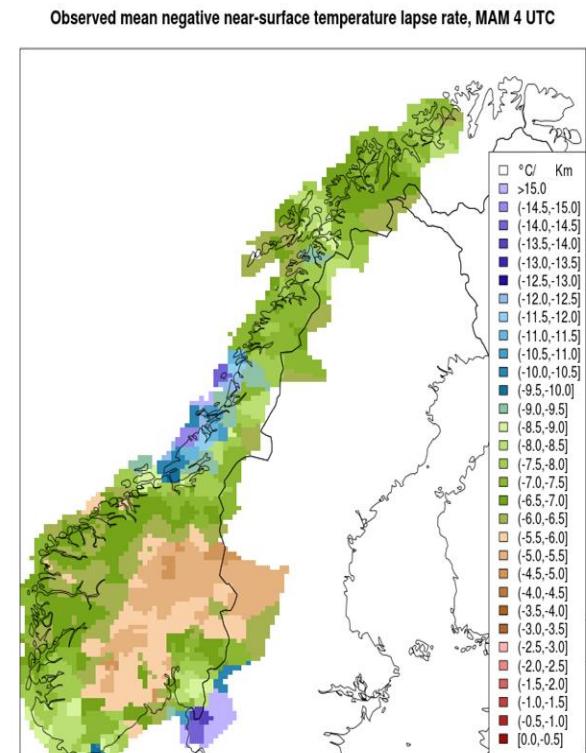
Winter



Autumn



Spring



Values are in °C/Km

*Positive values filtered out

Ensemble approaches

- Spatial co-variance structure?

Spatial covariance structures are assumed to be reasonably stable when applying residual interpolation approaches.

→ de-trending should remove local and regional anomaly patterns.

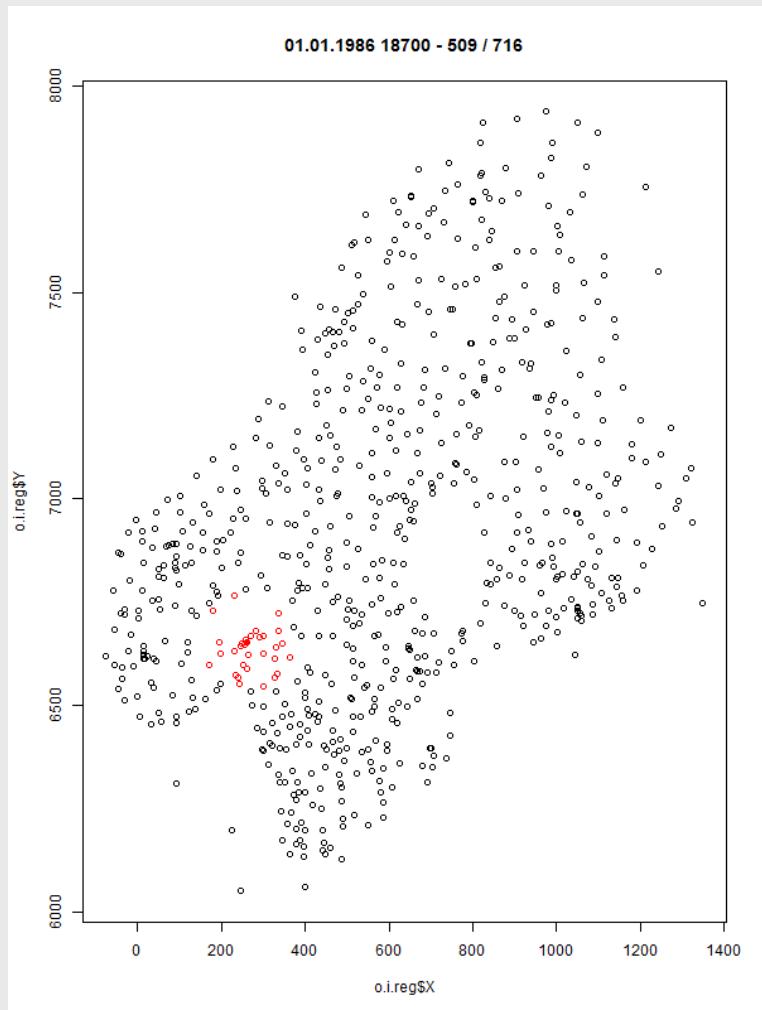
- Background /trend ?

Ensembles of parameterisations of the external predictor field.

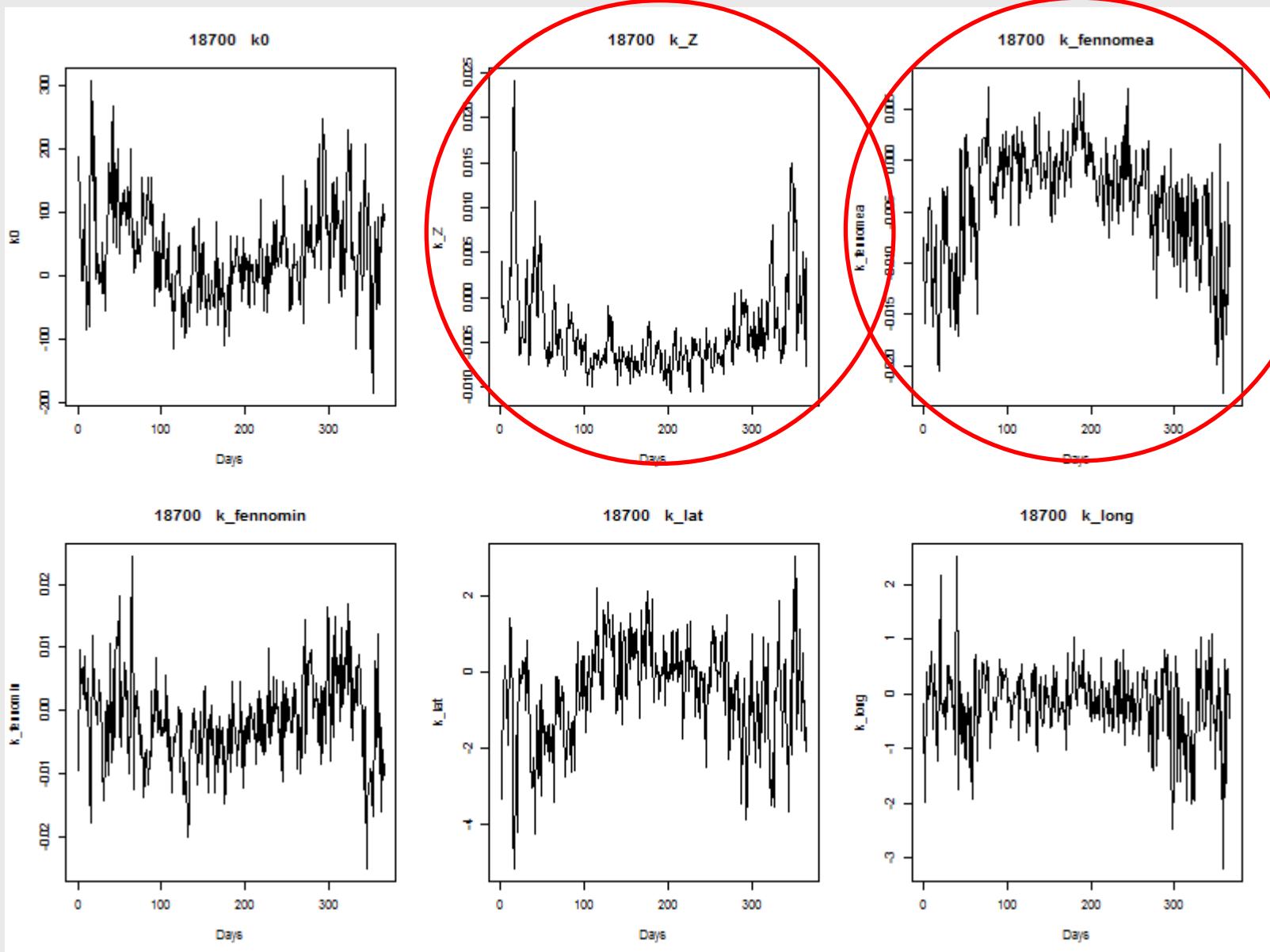
- from a set of «regional neighbourhoods»
- from a set of similar temperature days → *temperature day classification.*

Regional neighbourhood analysis

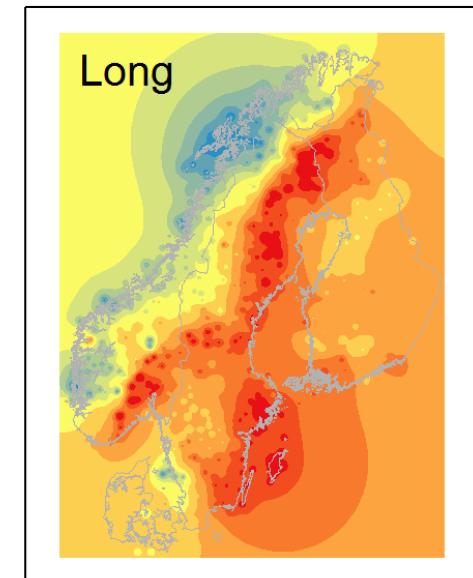
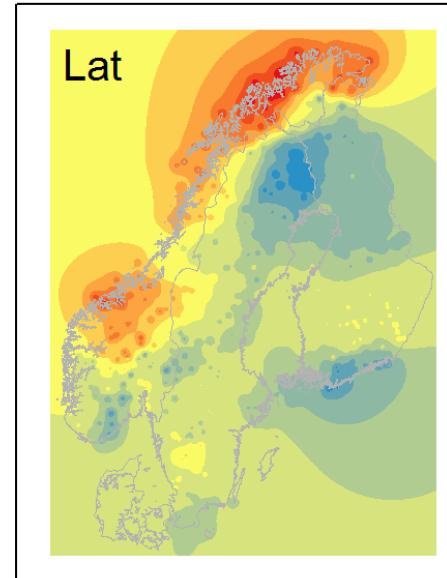
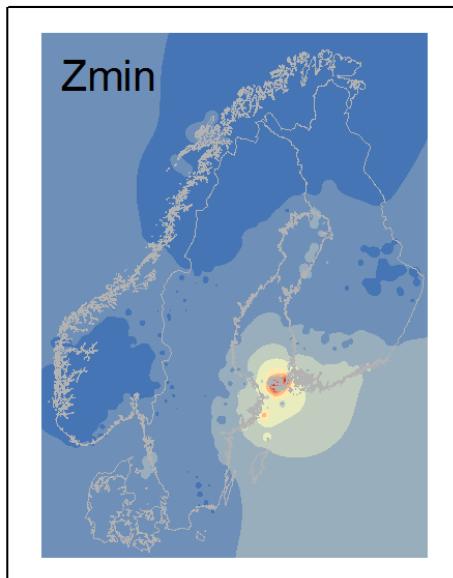
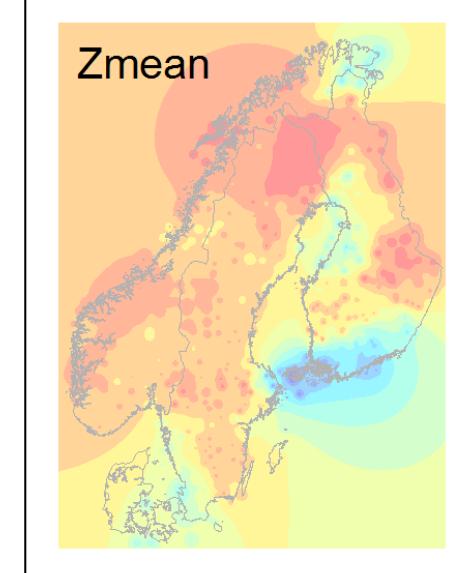
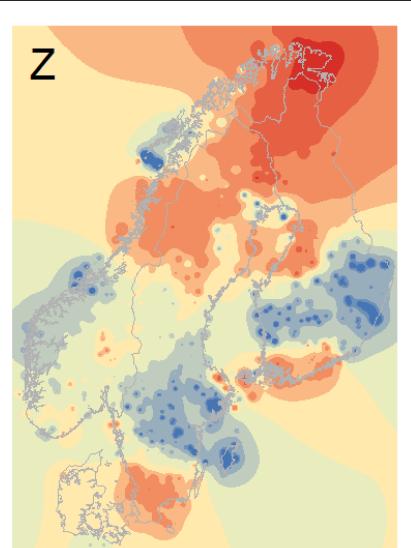
- Ongoing work (full results from only one year, **2008**, so far) applying data from all Nordic countries as a part of developing the Nordic gridded climate dataset (NGCD)
- **Daily parameters** are estimated applying the thirty nearest observations to each estimation points as input to the multiple linear regression (version 1.1 approach).
- We see large variations in coefficients from day to day related to the actual weather situation



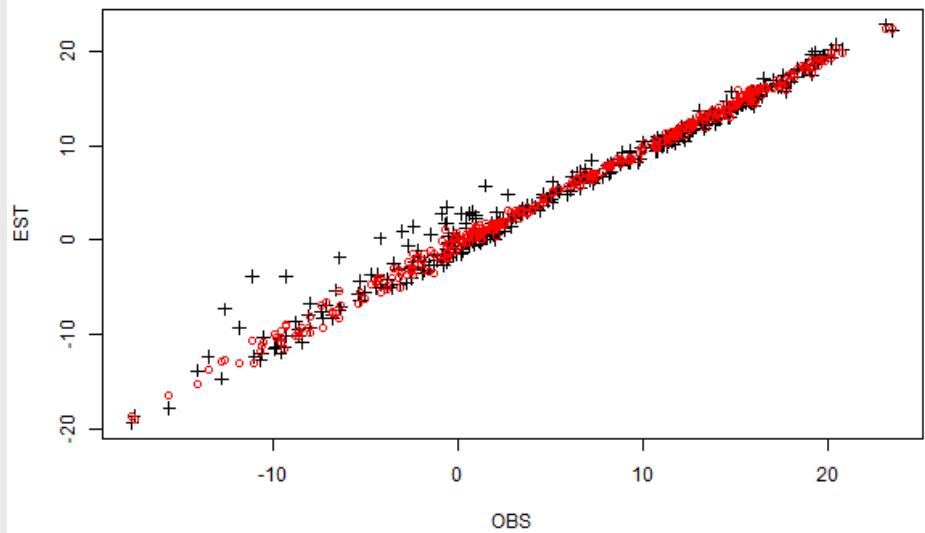
1981



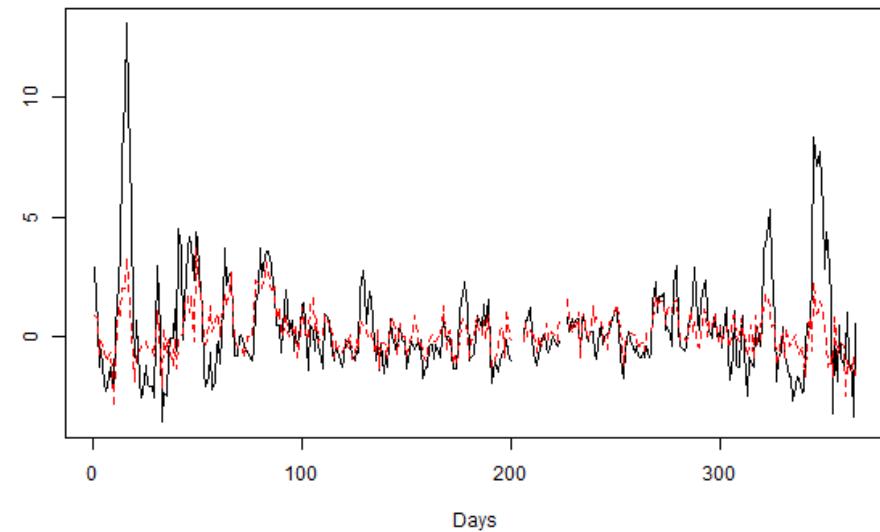
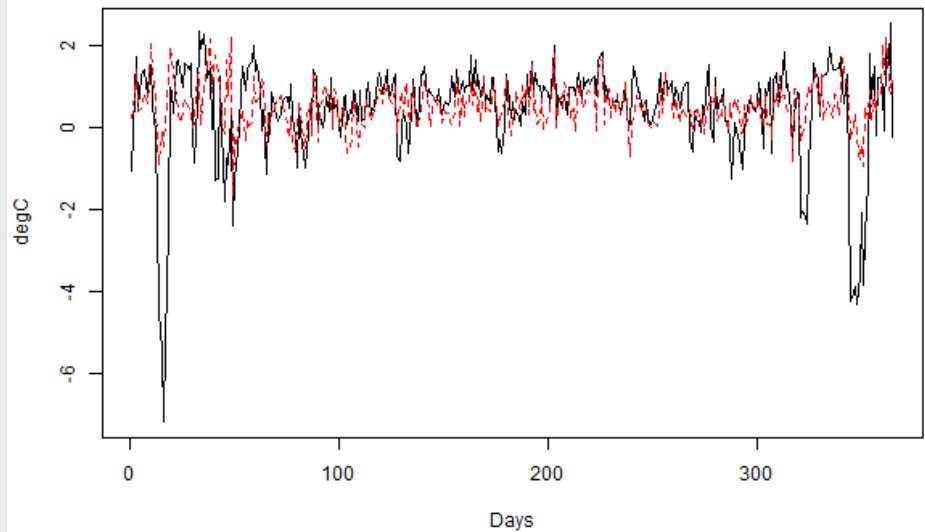
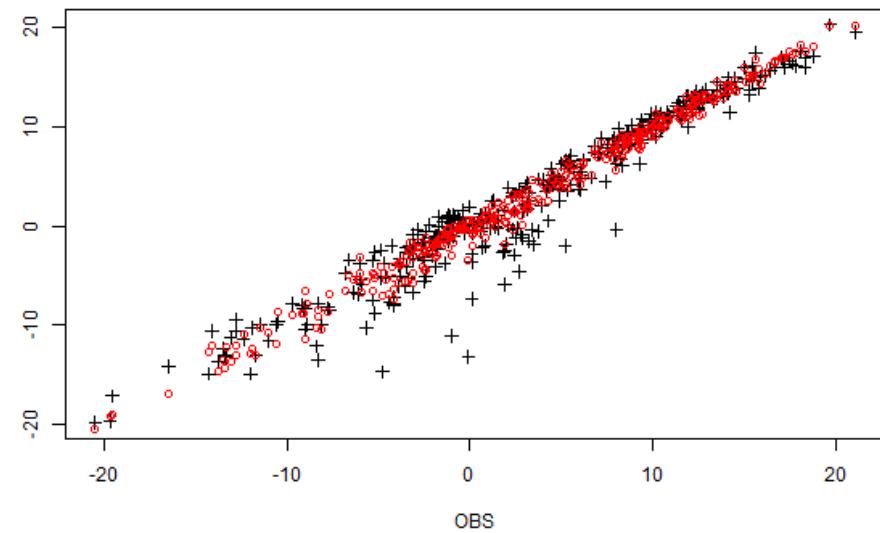
01.01.2008



18700

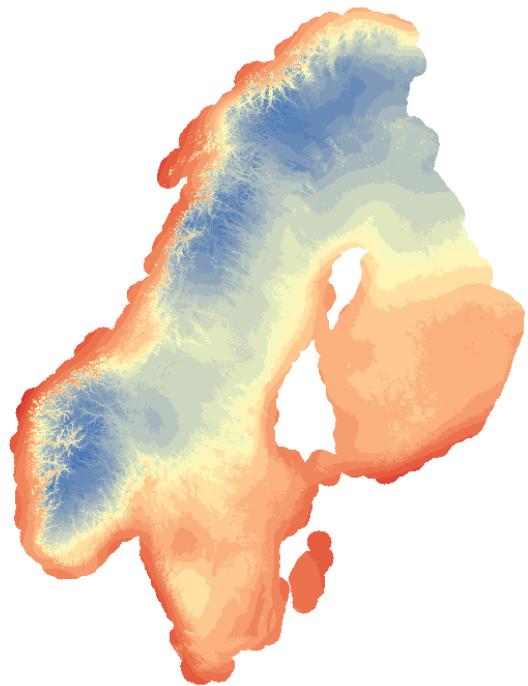


18950

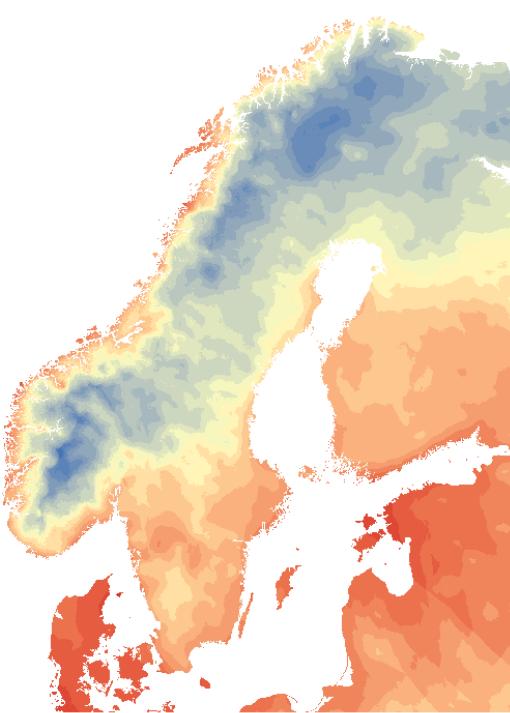


1. January 2008

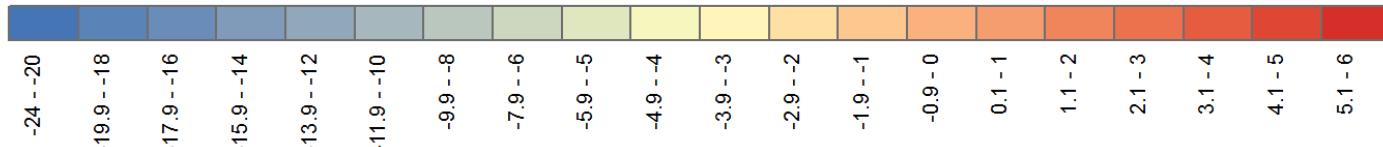
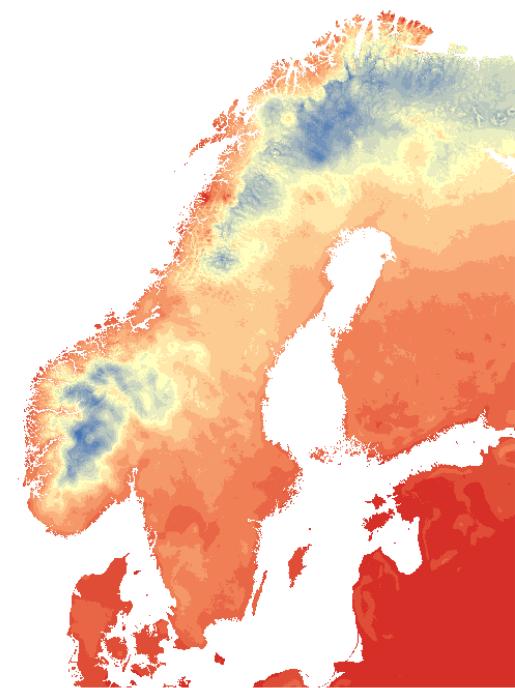
SeNorge 2.0



SeNorge1.1 (global trend)

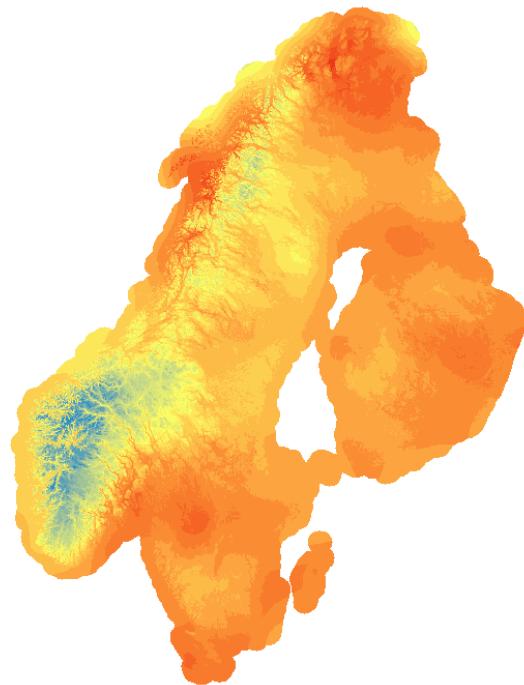


SeNorge1.1 (regional trend)

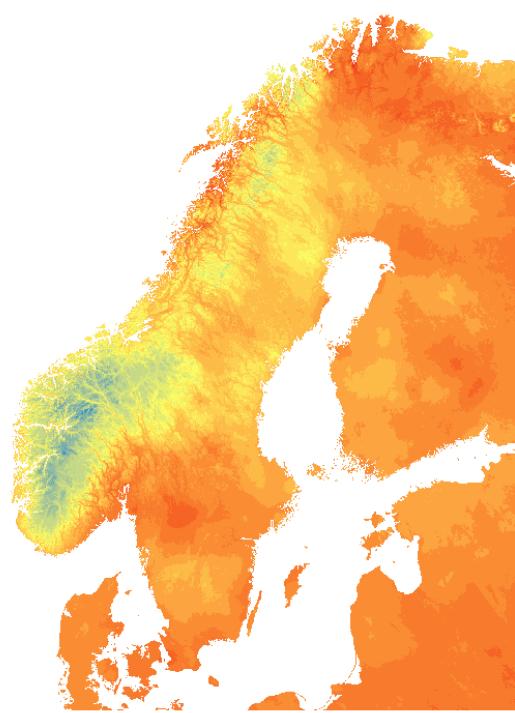


1. July 2008

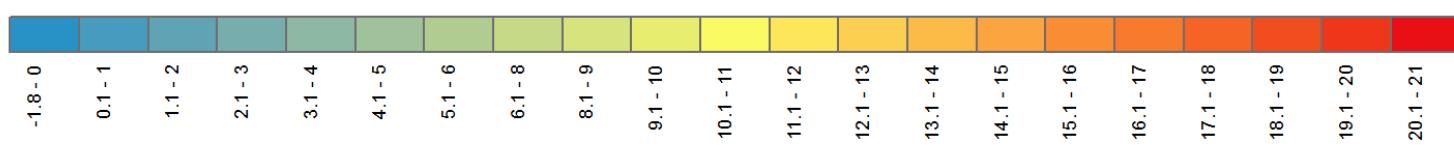
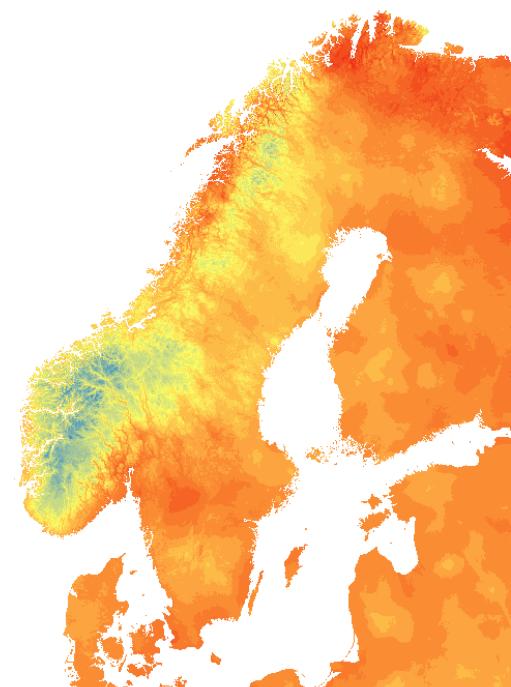
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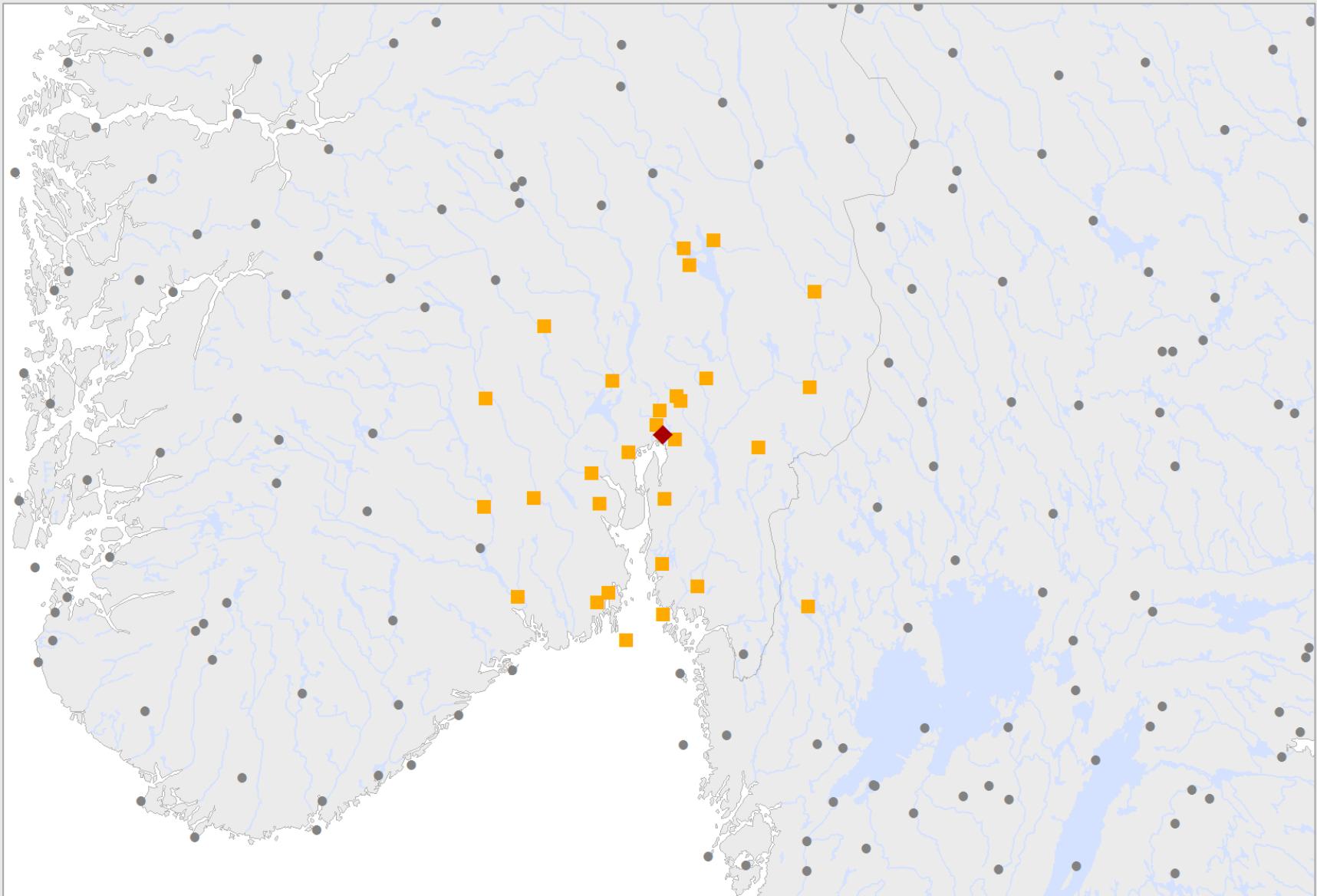


SeNorge1.1 (global trend)

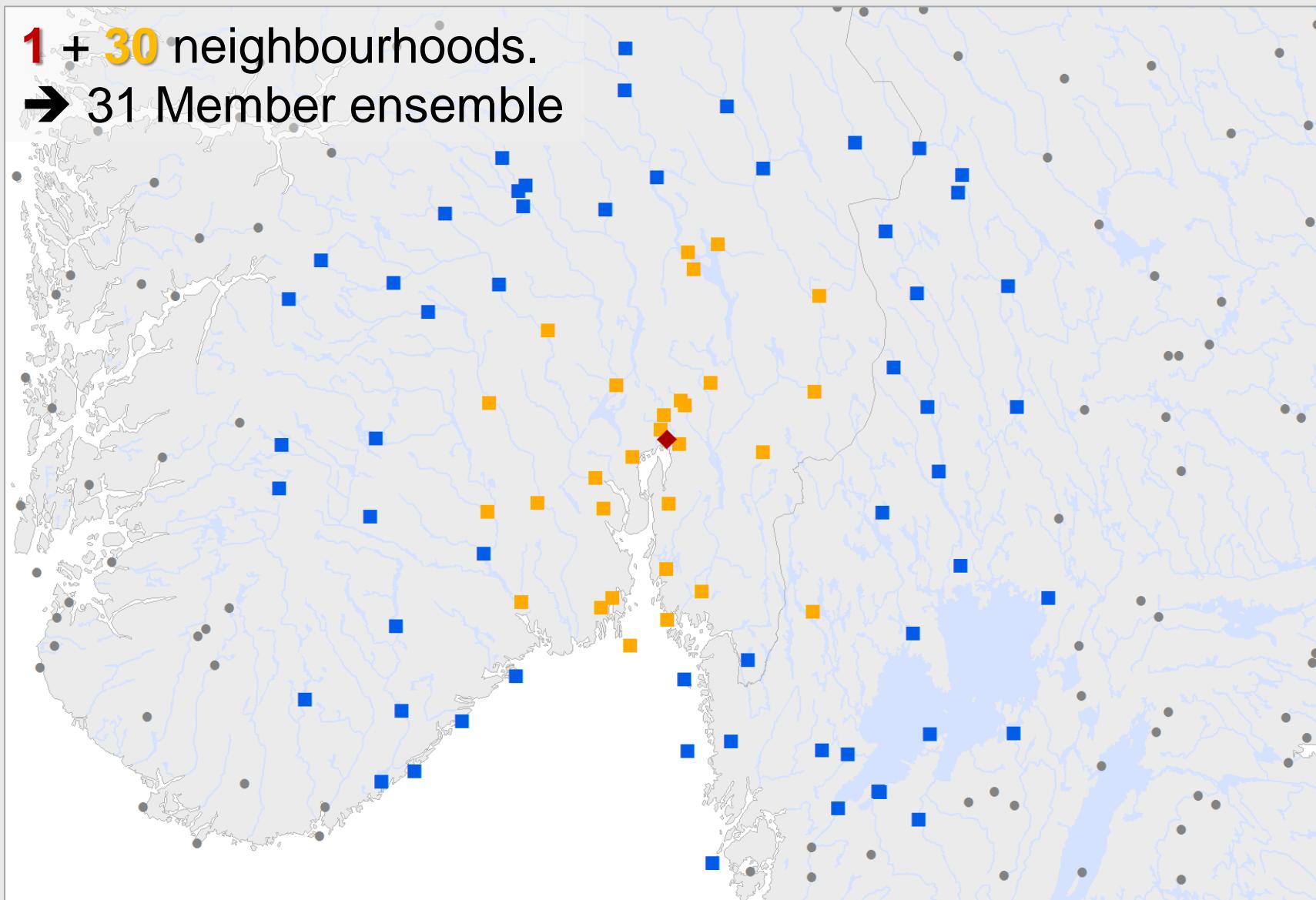


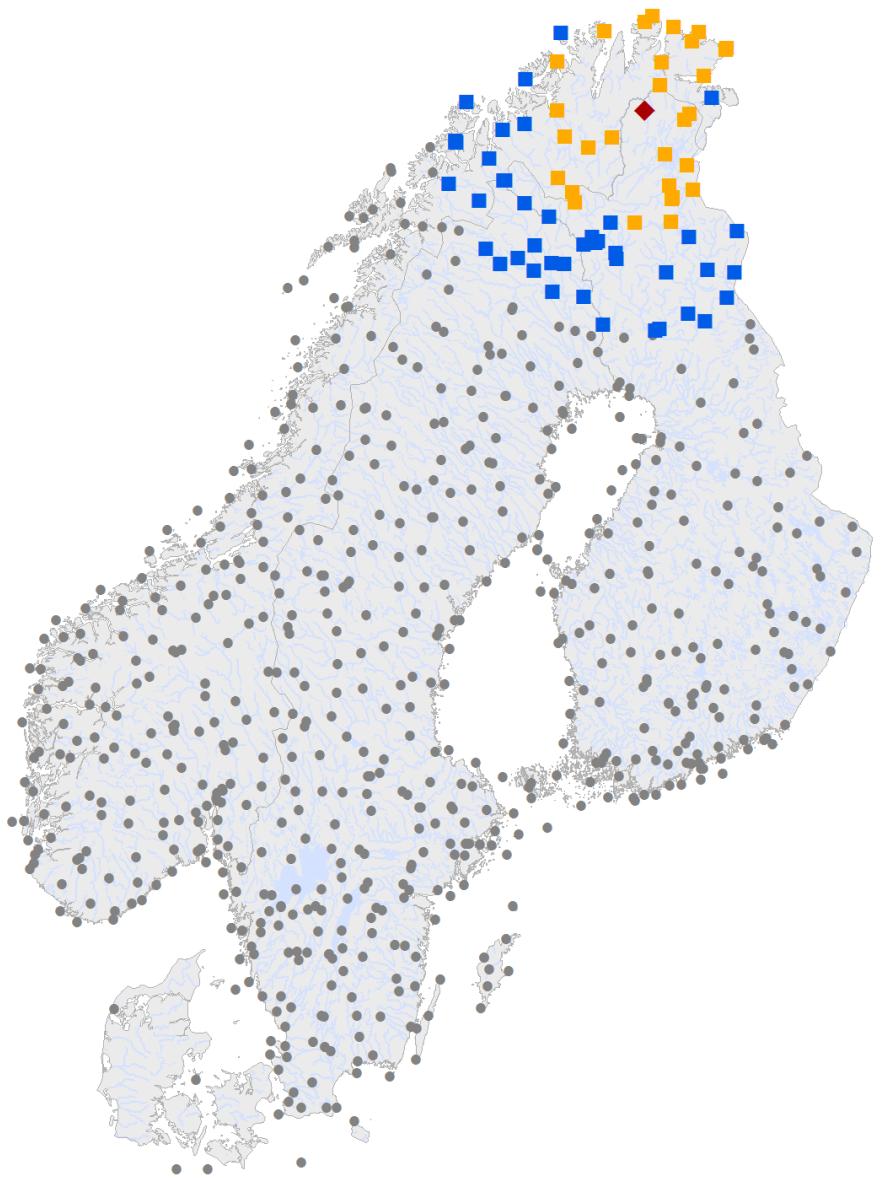
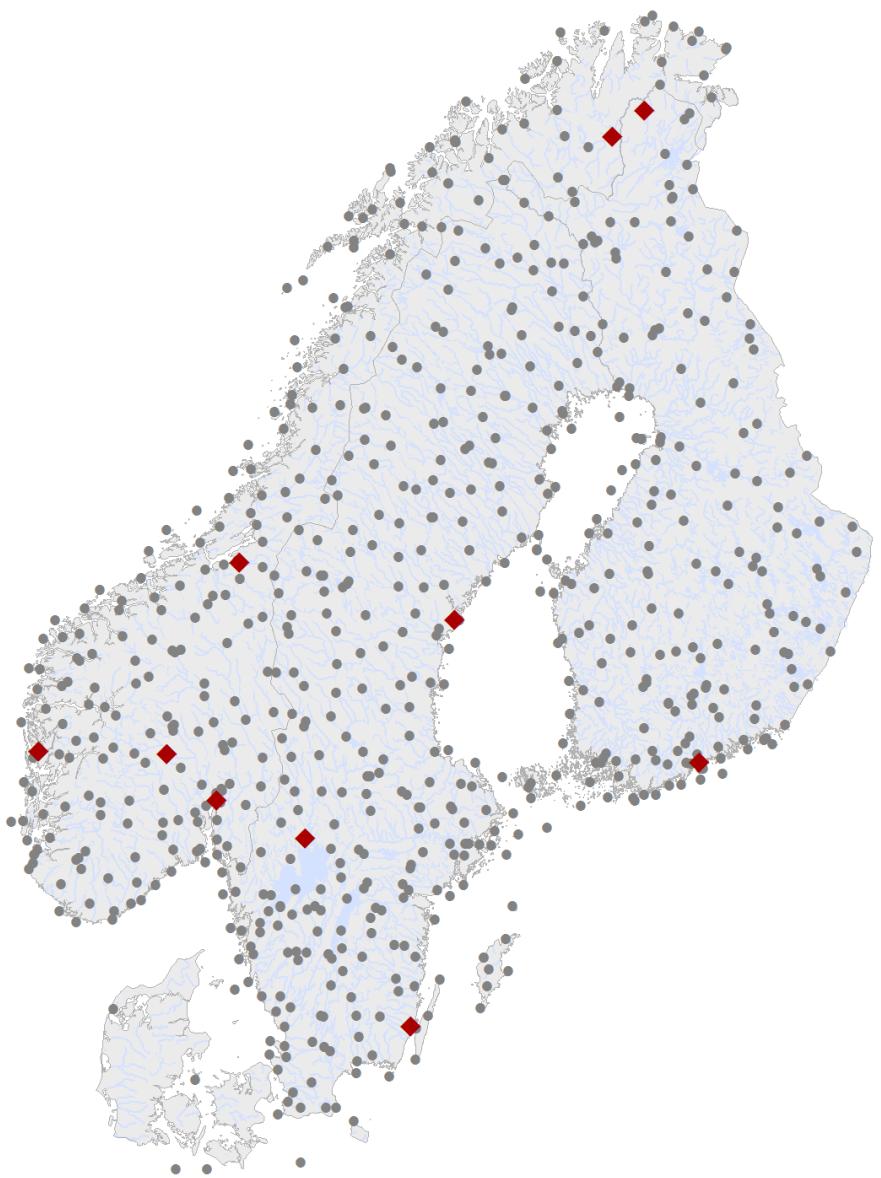
SeNorge1.1 (regional trend)





1 + 30 neighbourhoods.
→ 31 Member ensemble

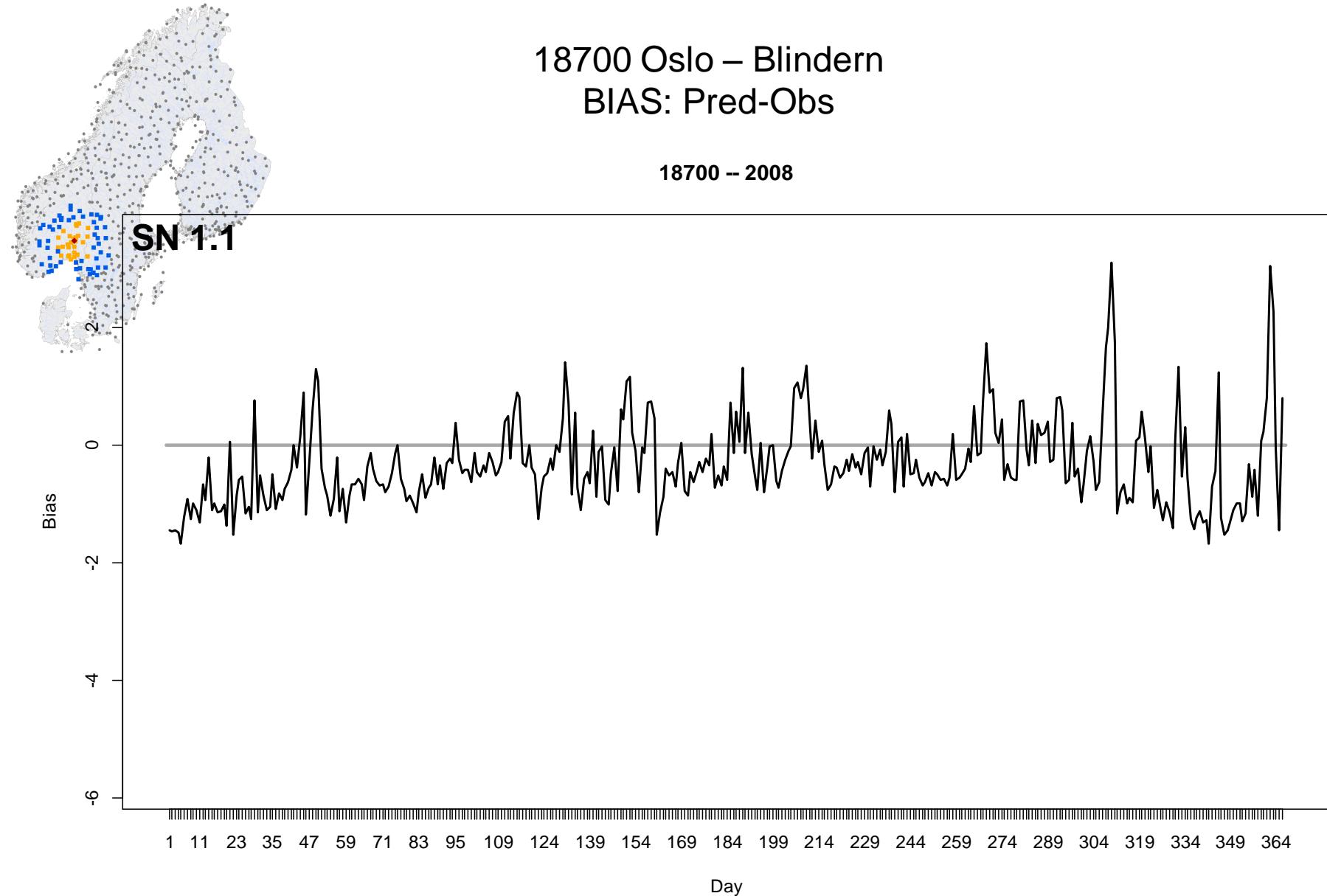




18700 Oslo – Blindern

BIAS: Pred-Obs

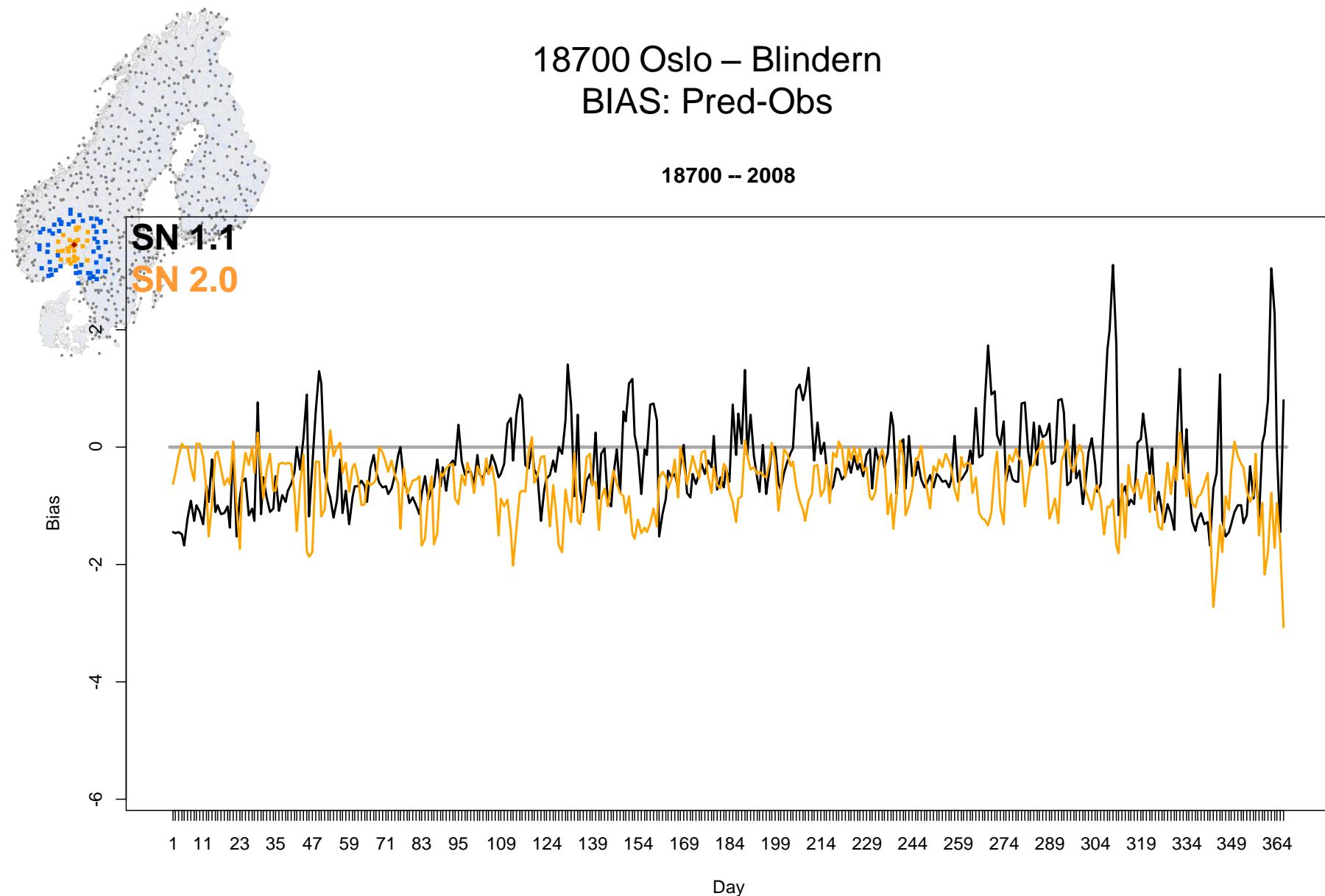
18700 -- 2008



18700 Oslo – Blindern

BIAS: Pred-Obs

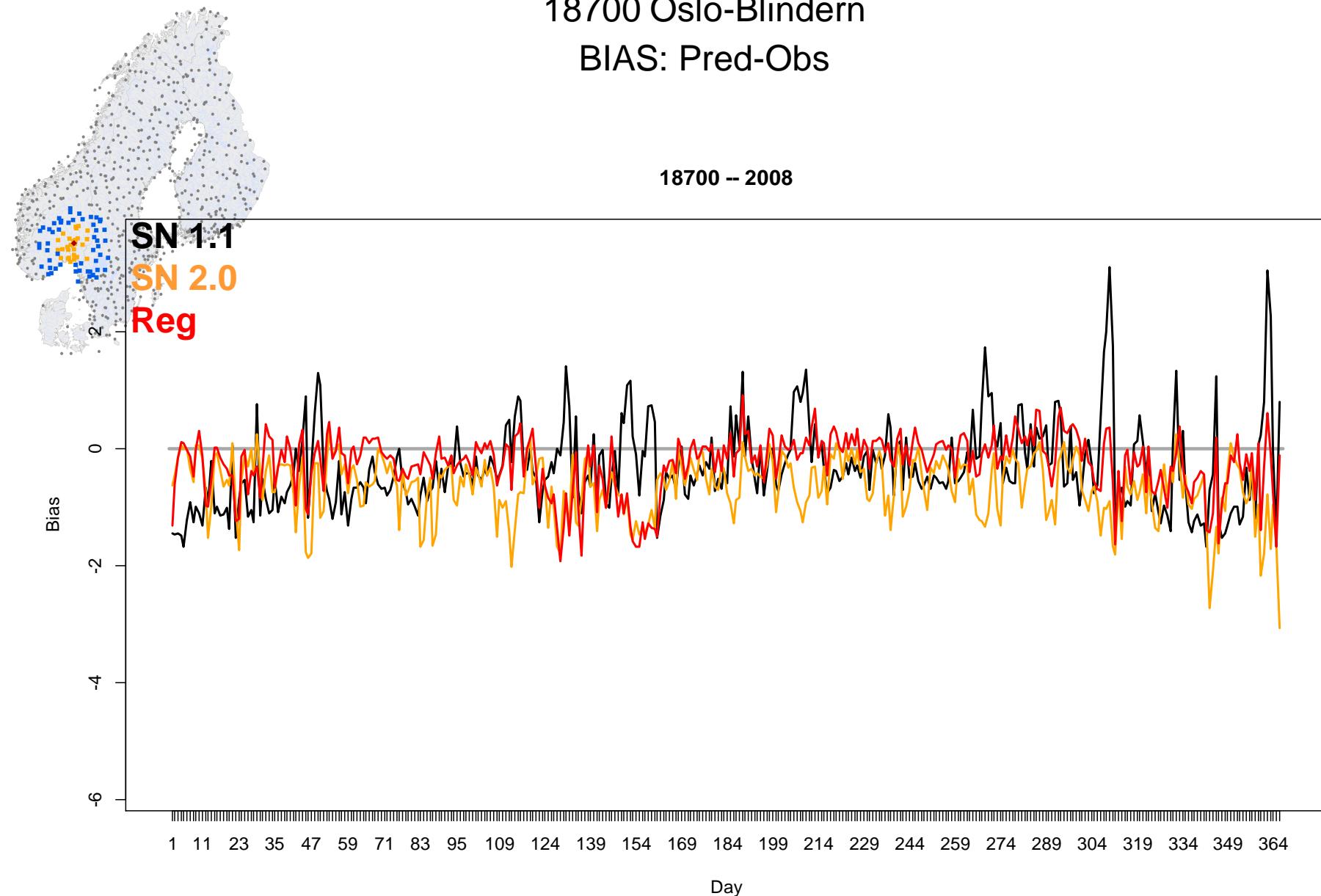
18700 -- 2008



18700 Oslo-Blindern

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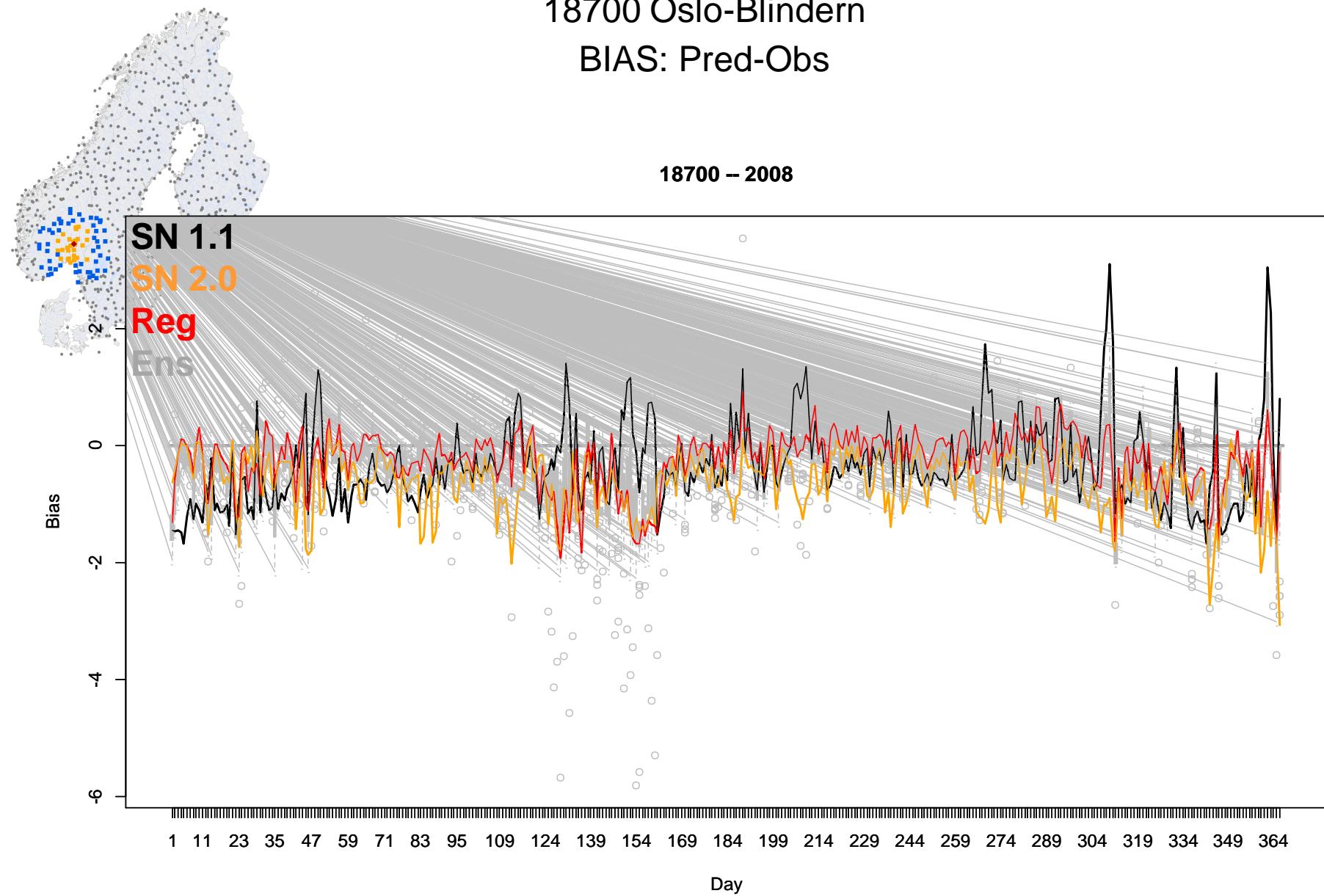
18700 -- 2008



18700 Oslo-Blindern

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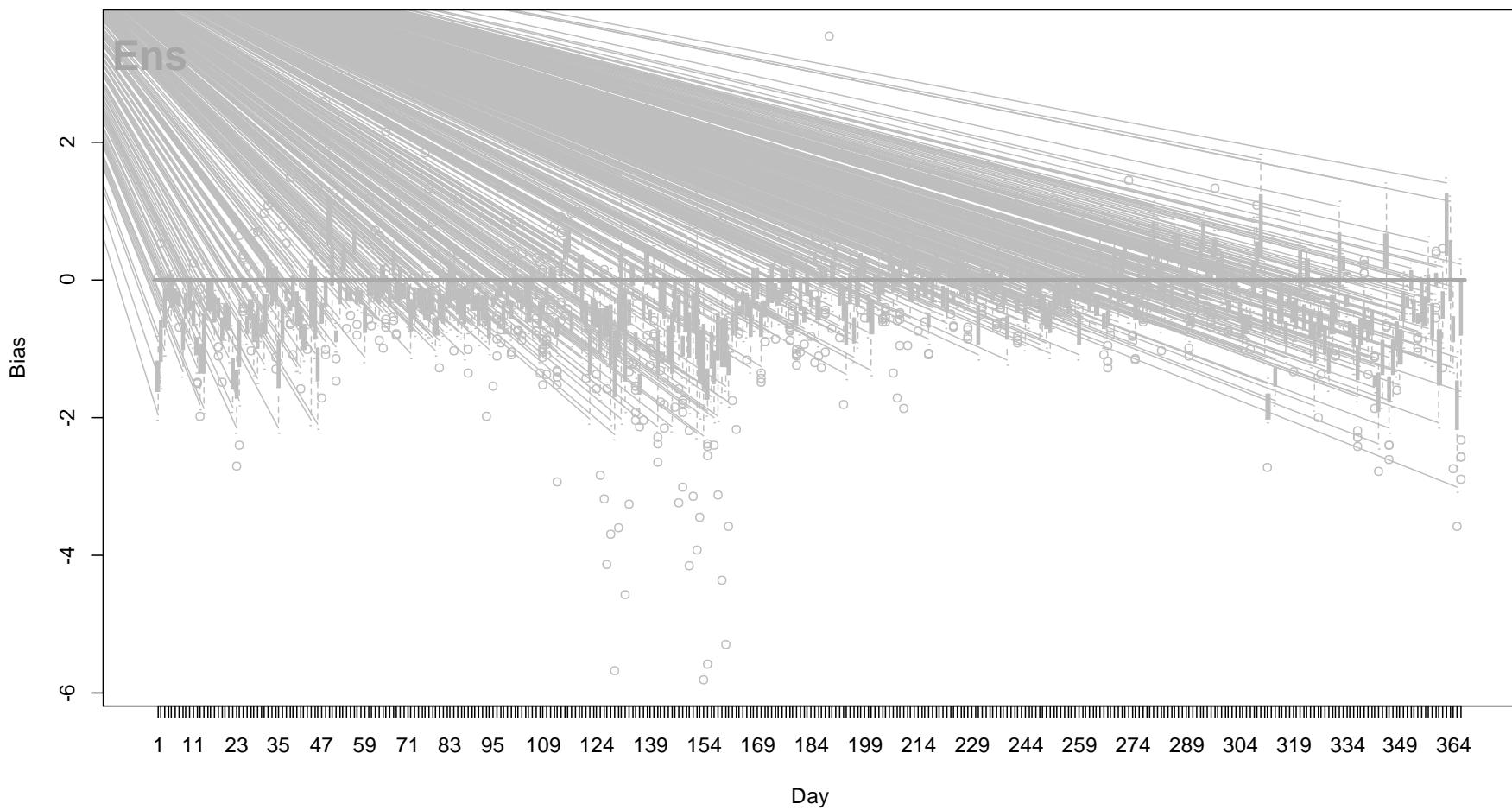
18700 -- 2008



18700 Oslo-Blindern

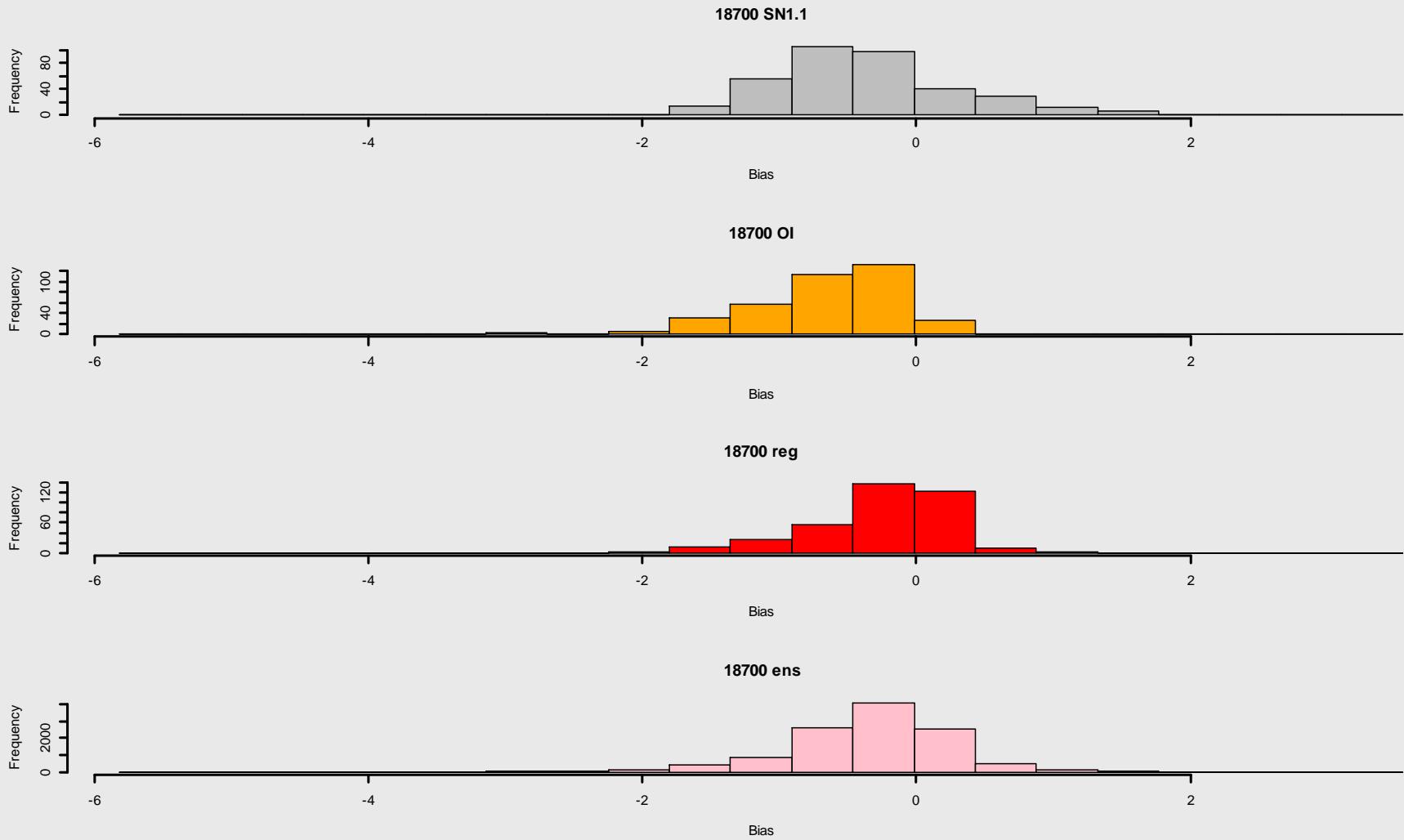
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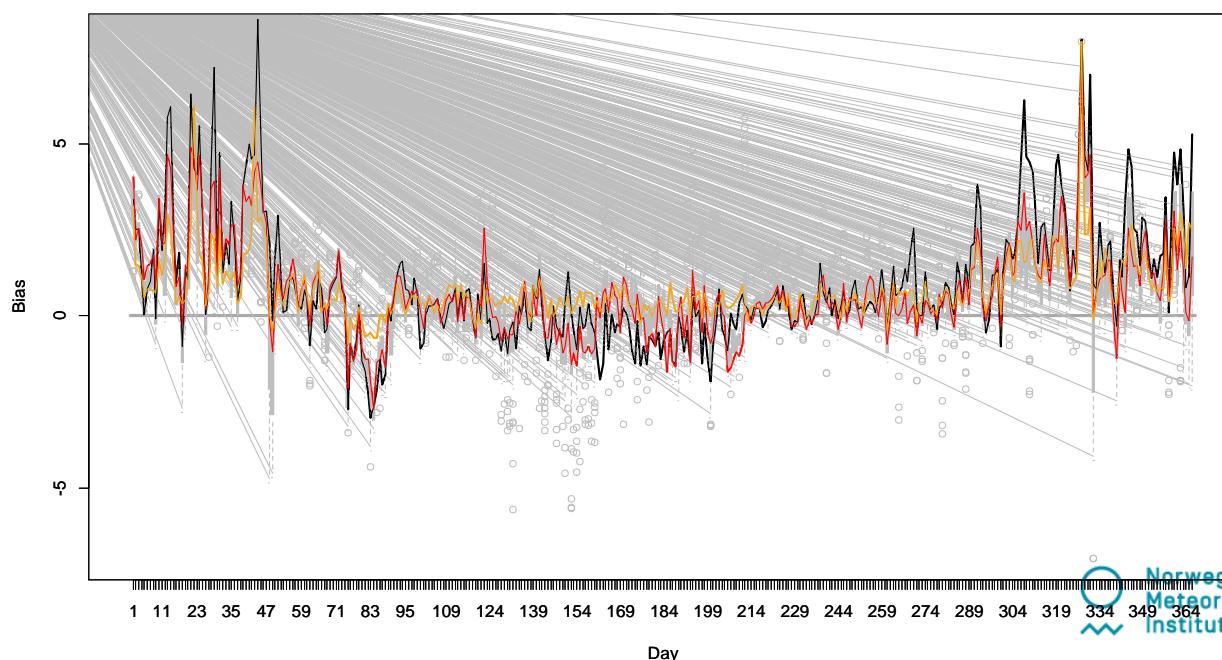
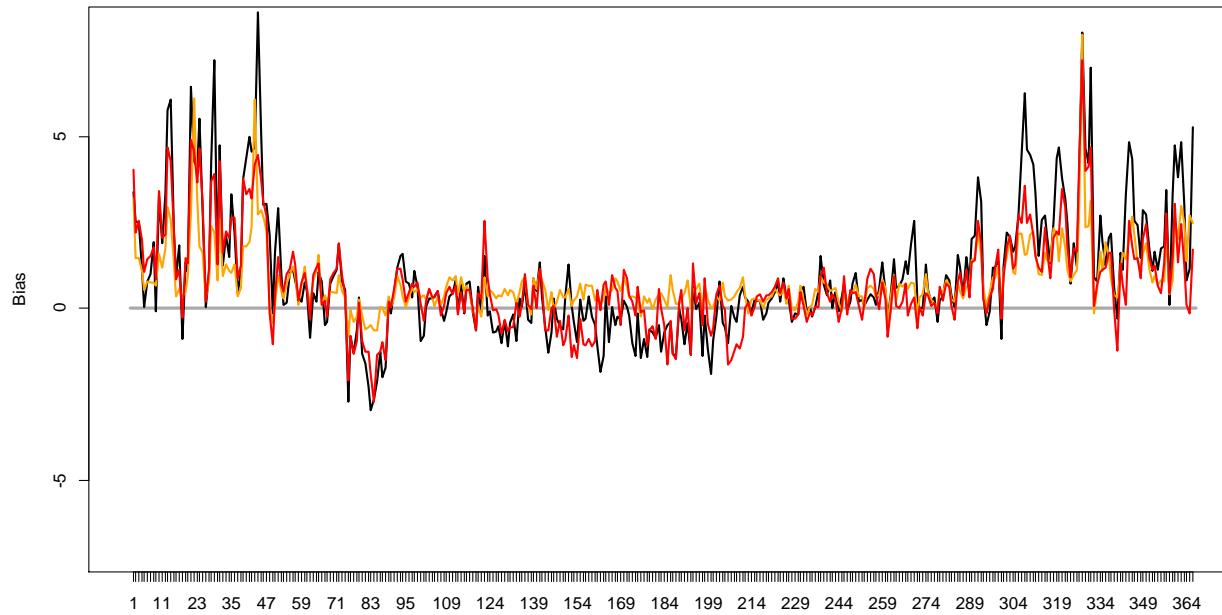
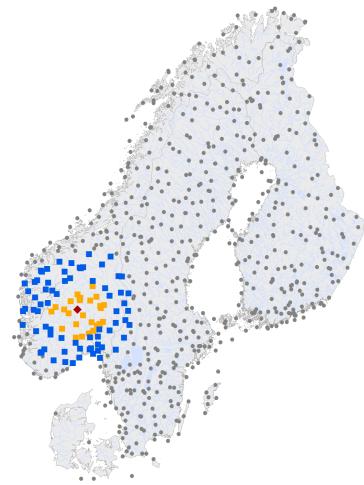


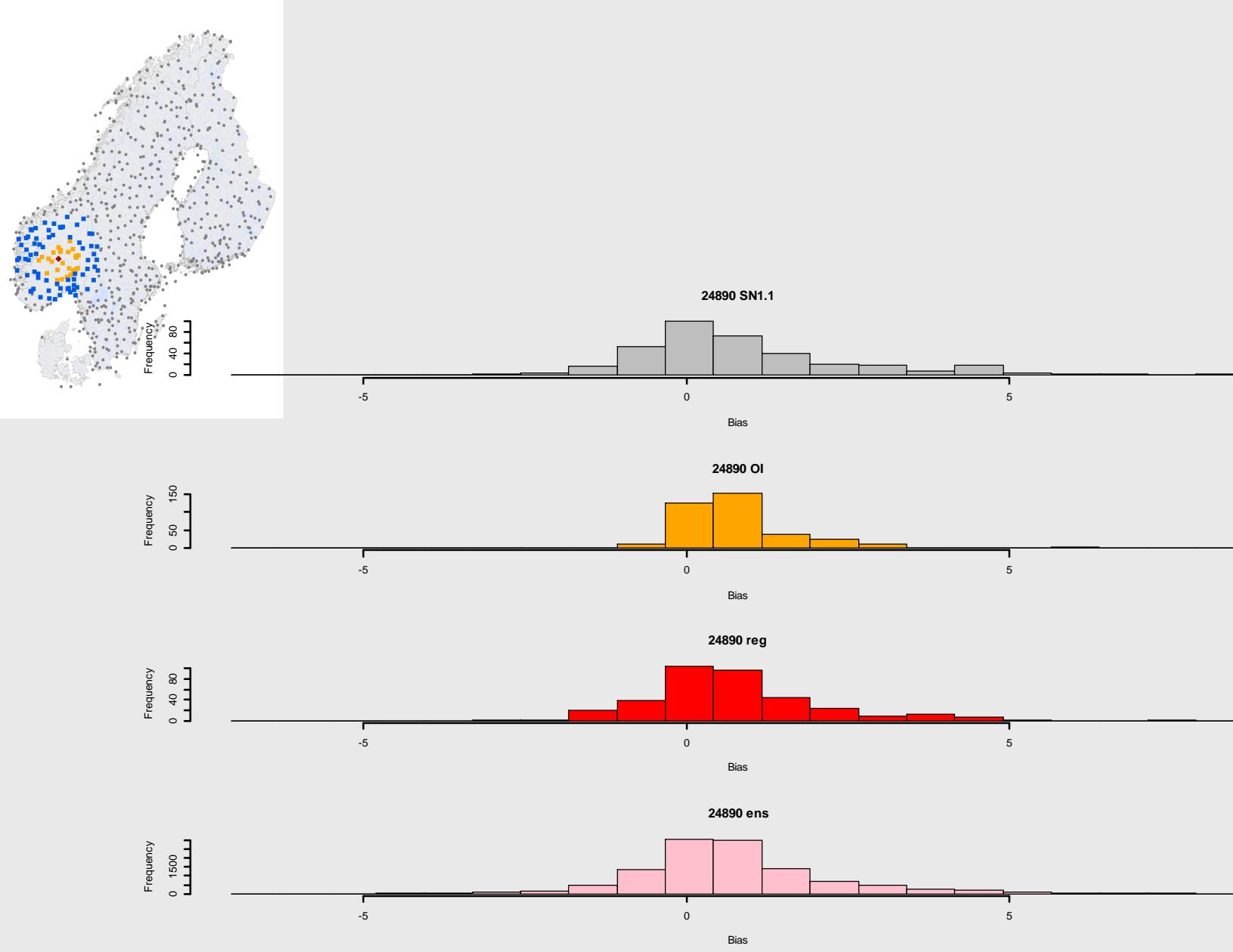
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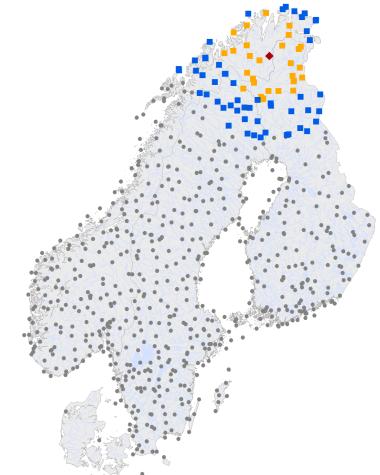
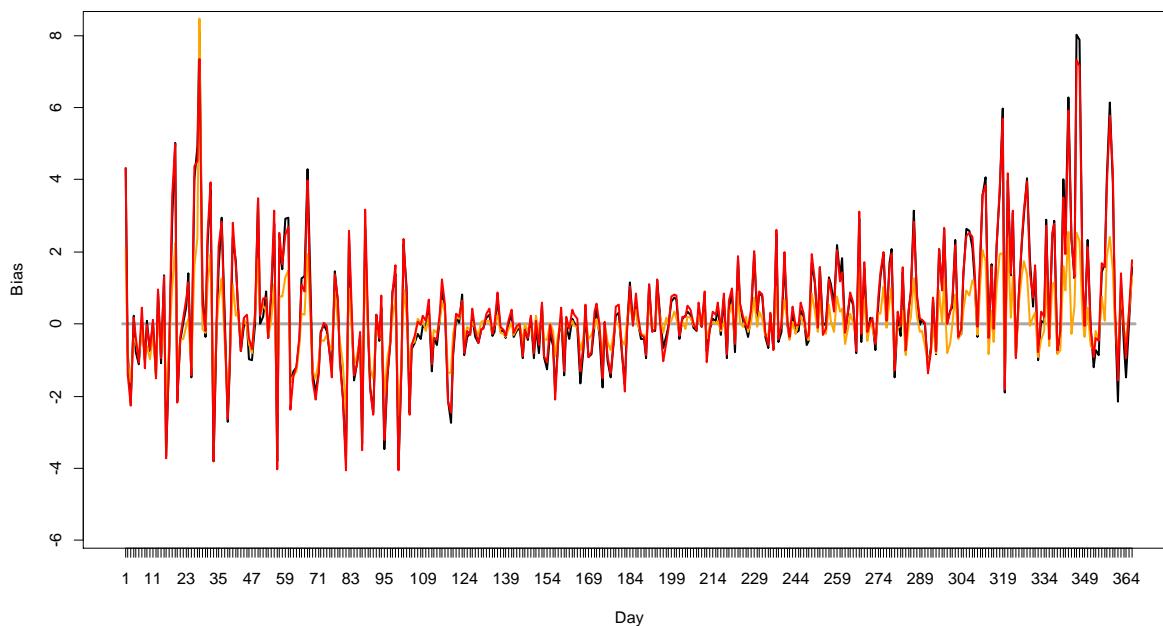


24890 -- 2008

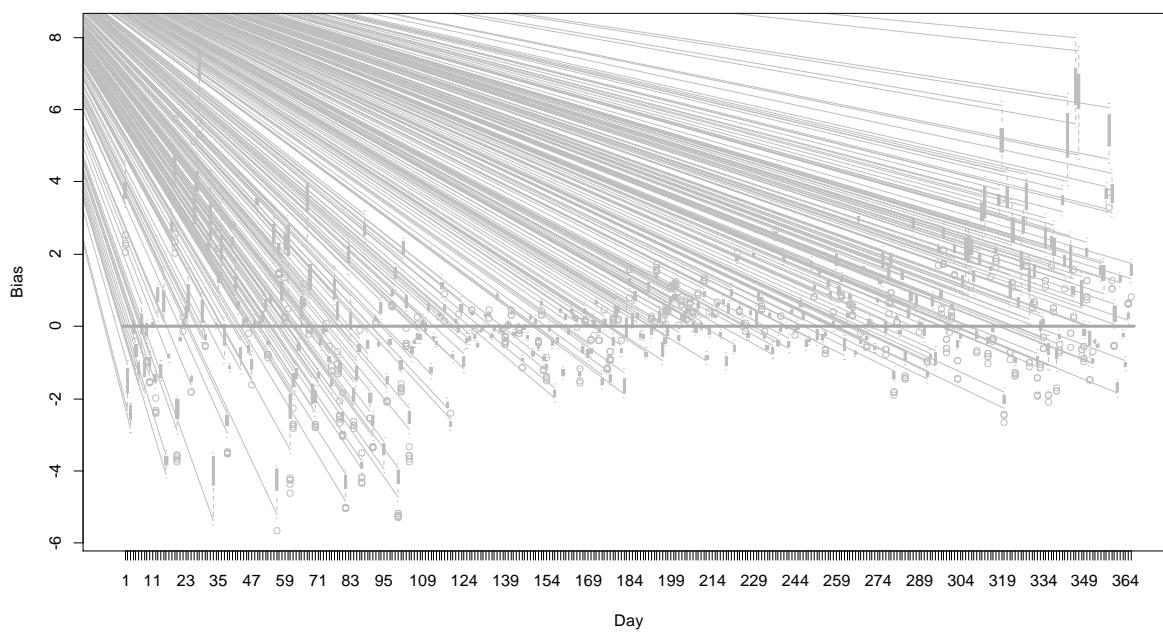


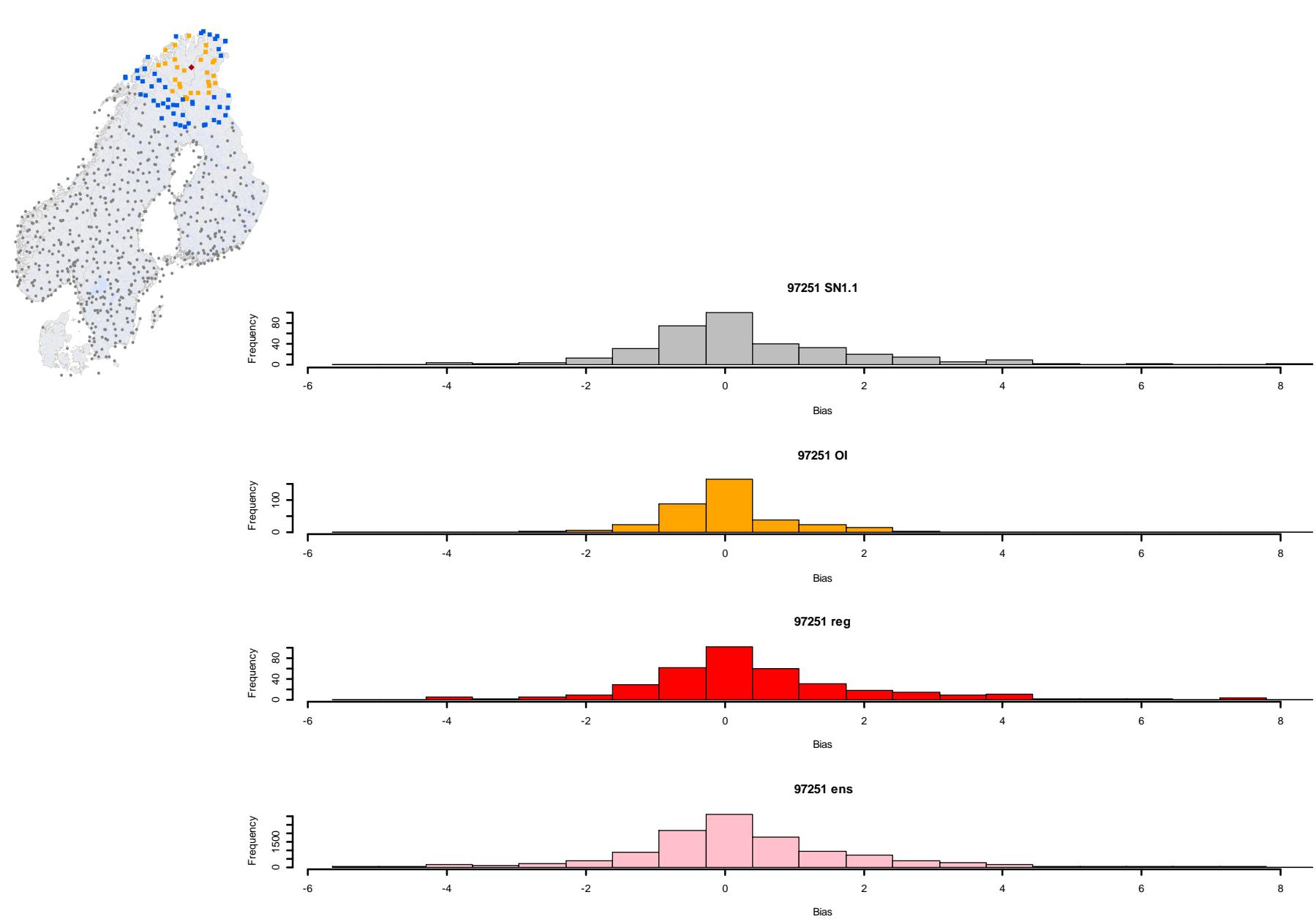


97251 – 2008

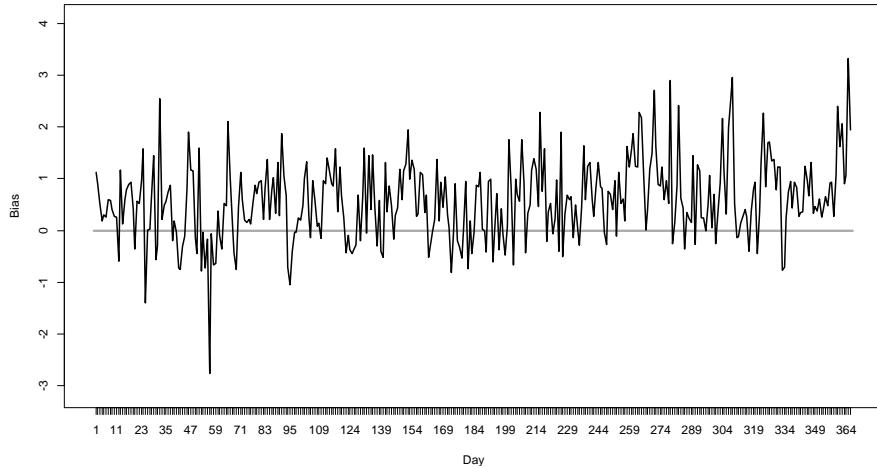


97251 – 2008

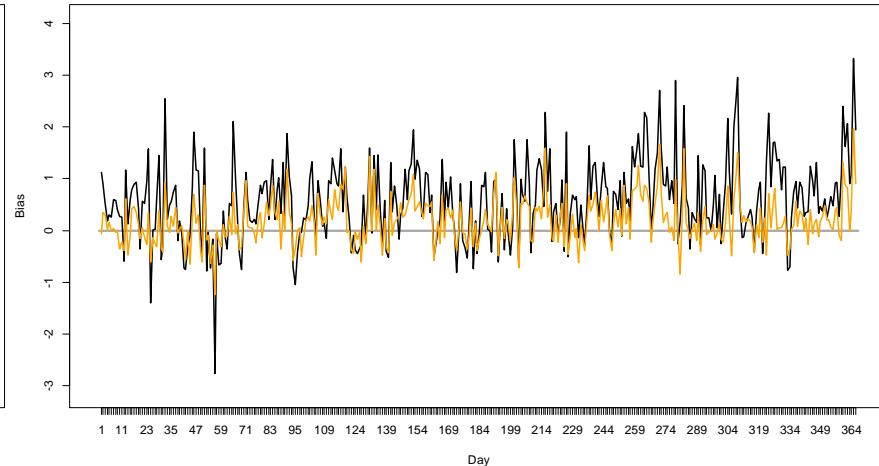




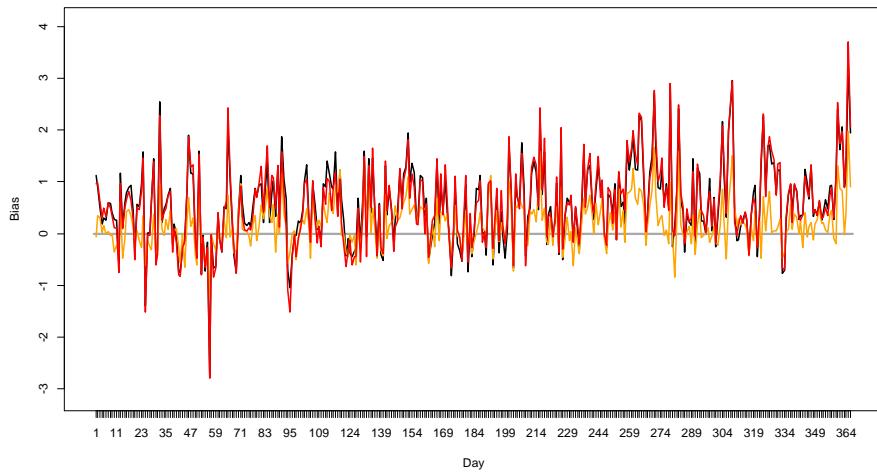
135351 – 2008



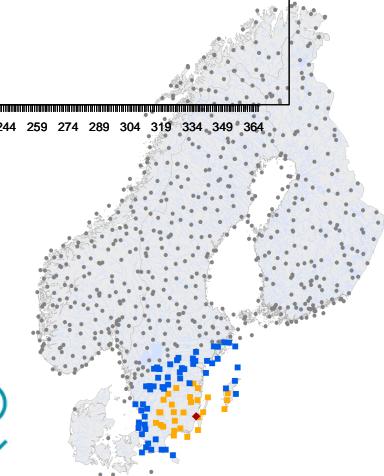
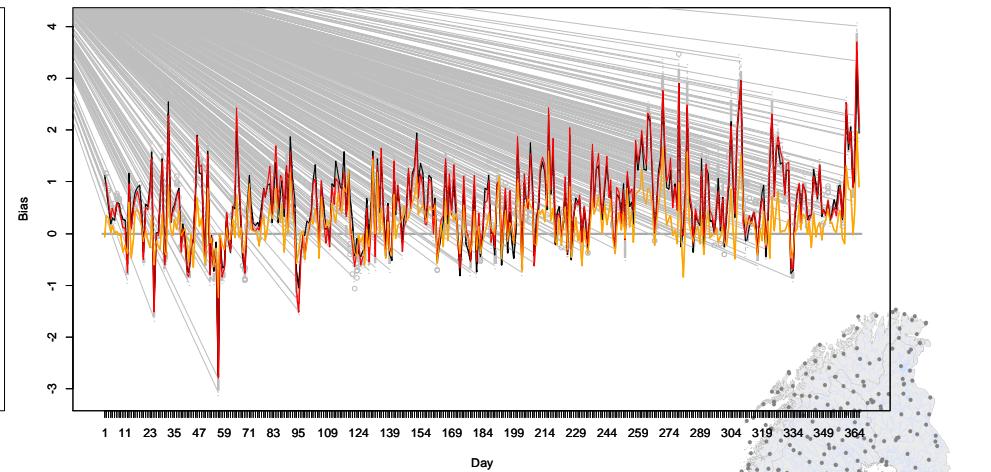
135351 – 2008

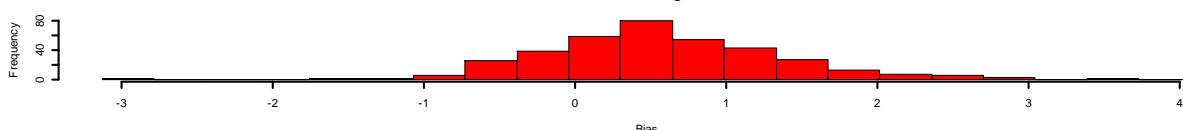
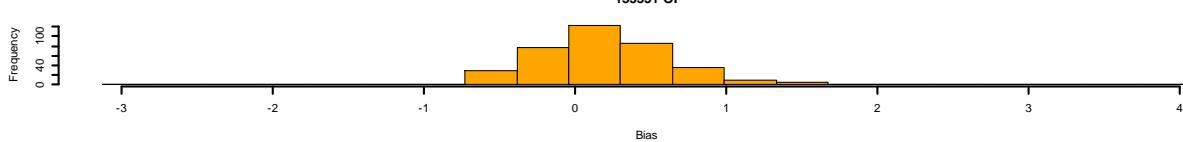
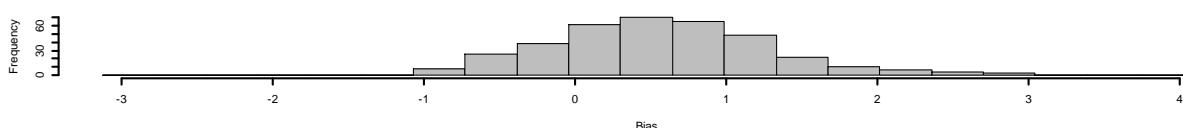
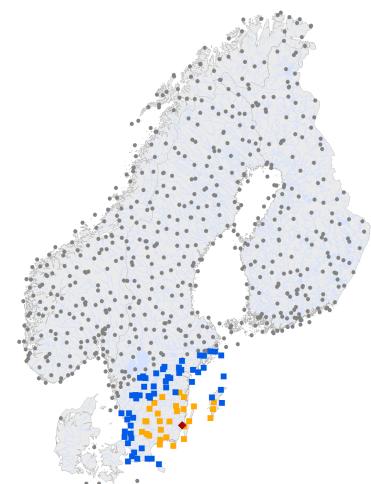
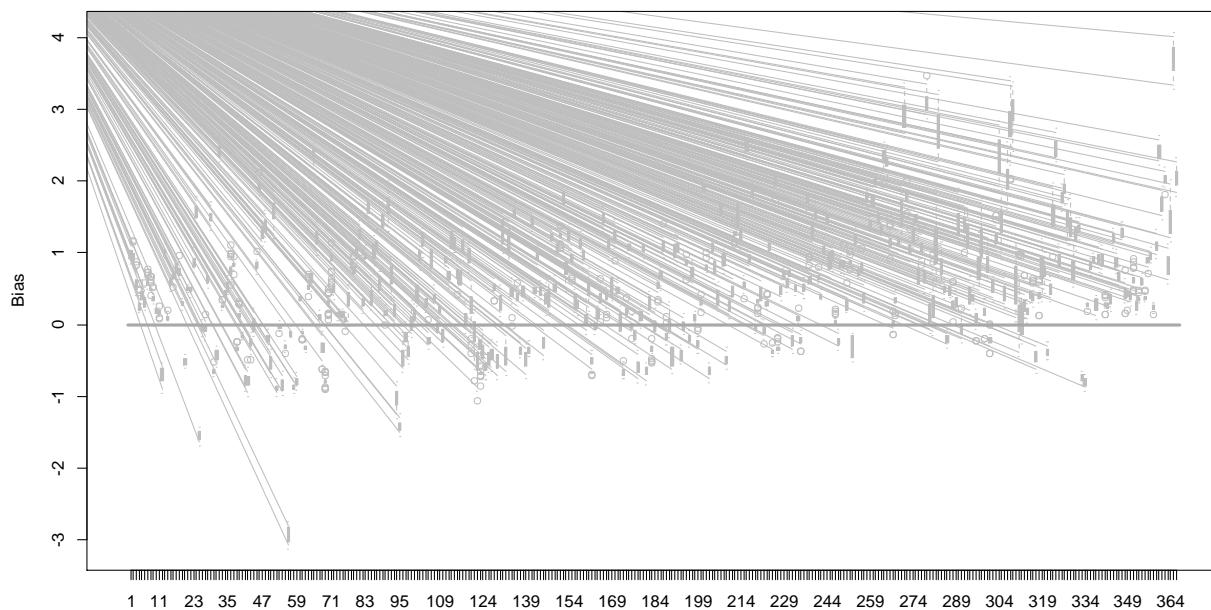


135351 – 2008



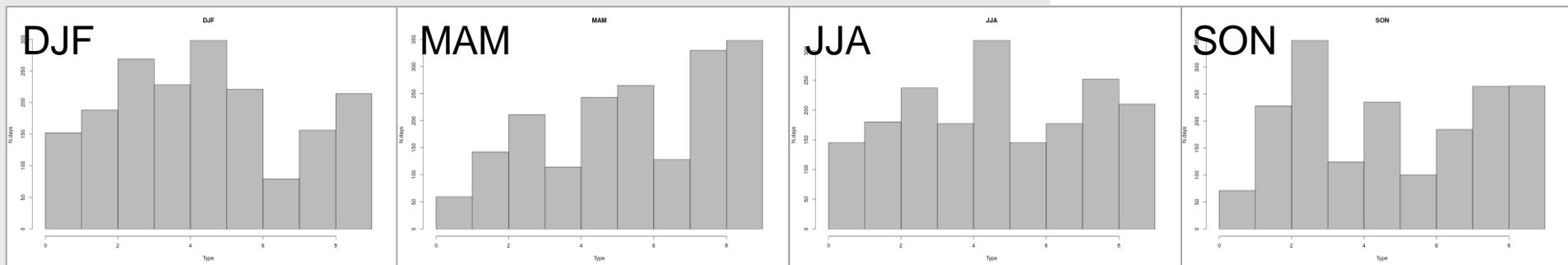
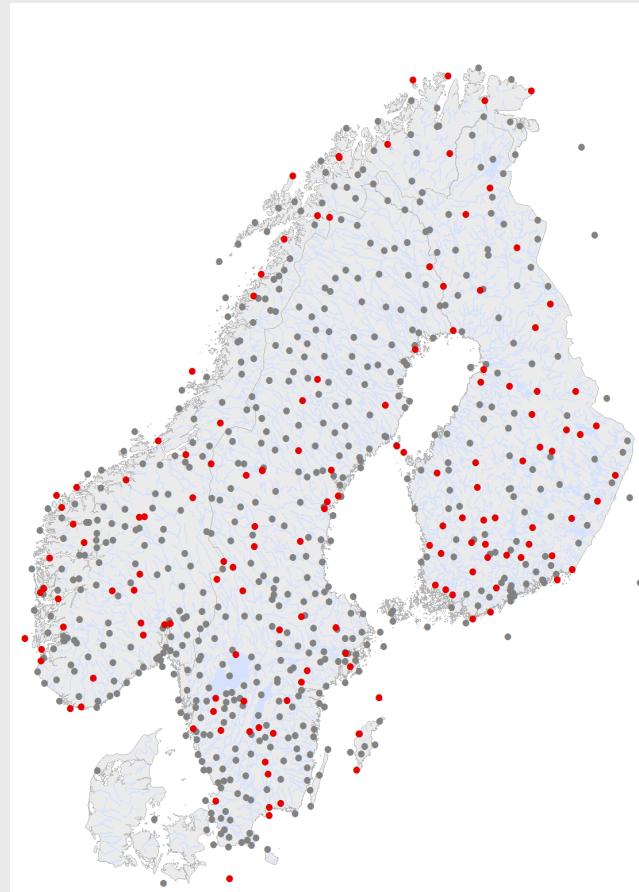
135351 – 2008



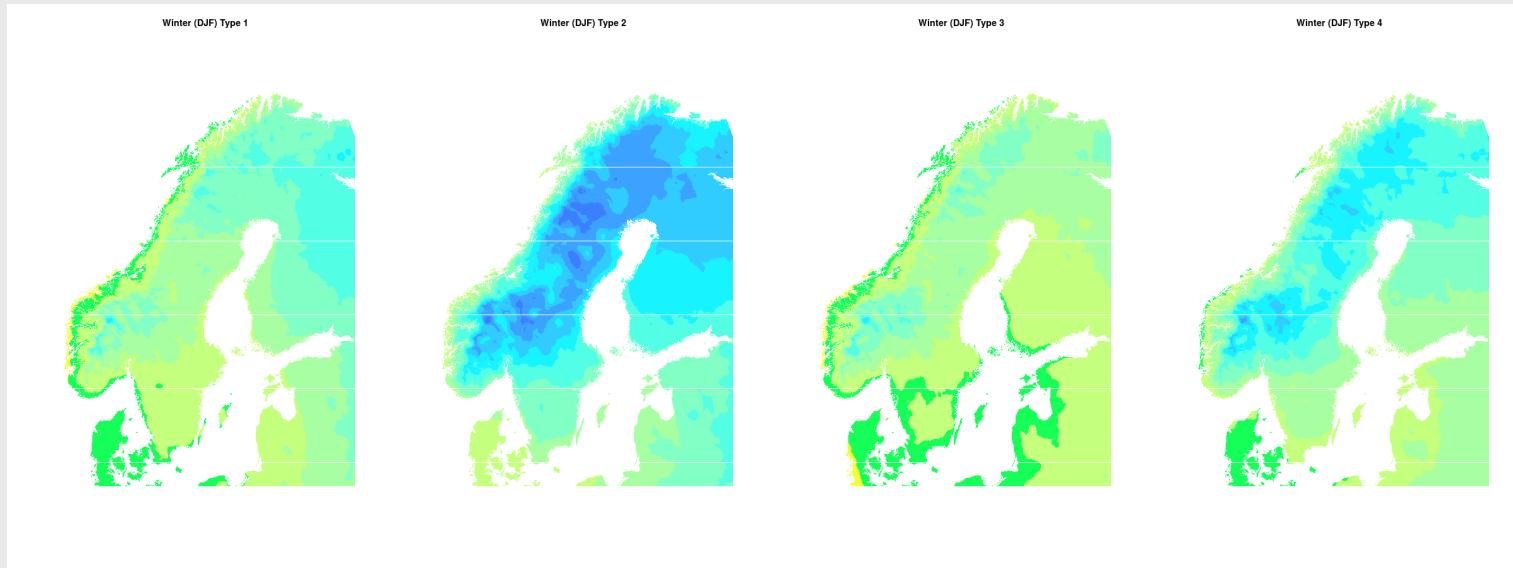


Weather type approach

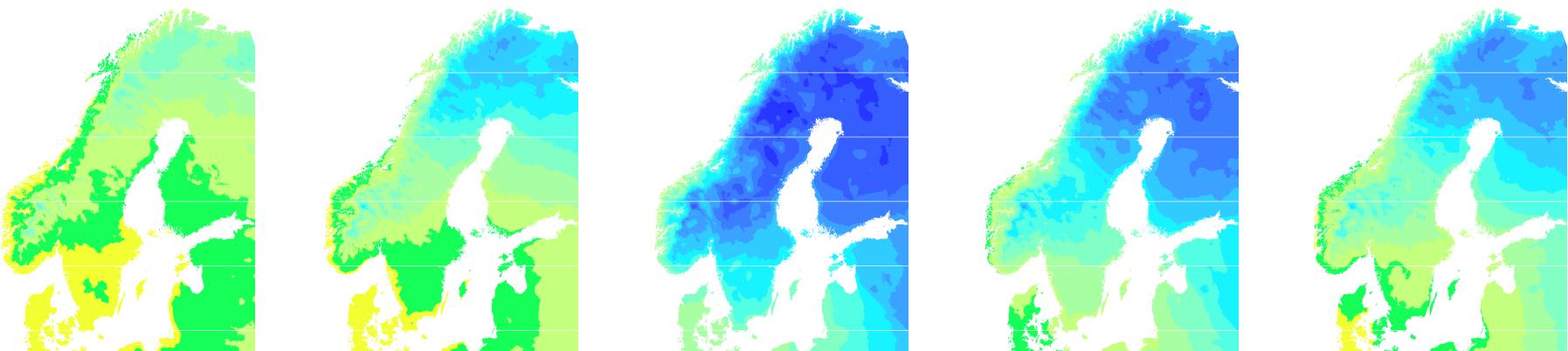
- Assume that it is possible to group together days with similar temperature characteristics;
- Kmean cluster analysis of **145** temperature series with complete timeseries 1981-2000 (20 years).
- Seasonal analysis (DJF, MAM, JJA, SON)
 - 9 types within each season.



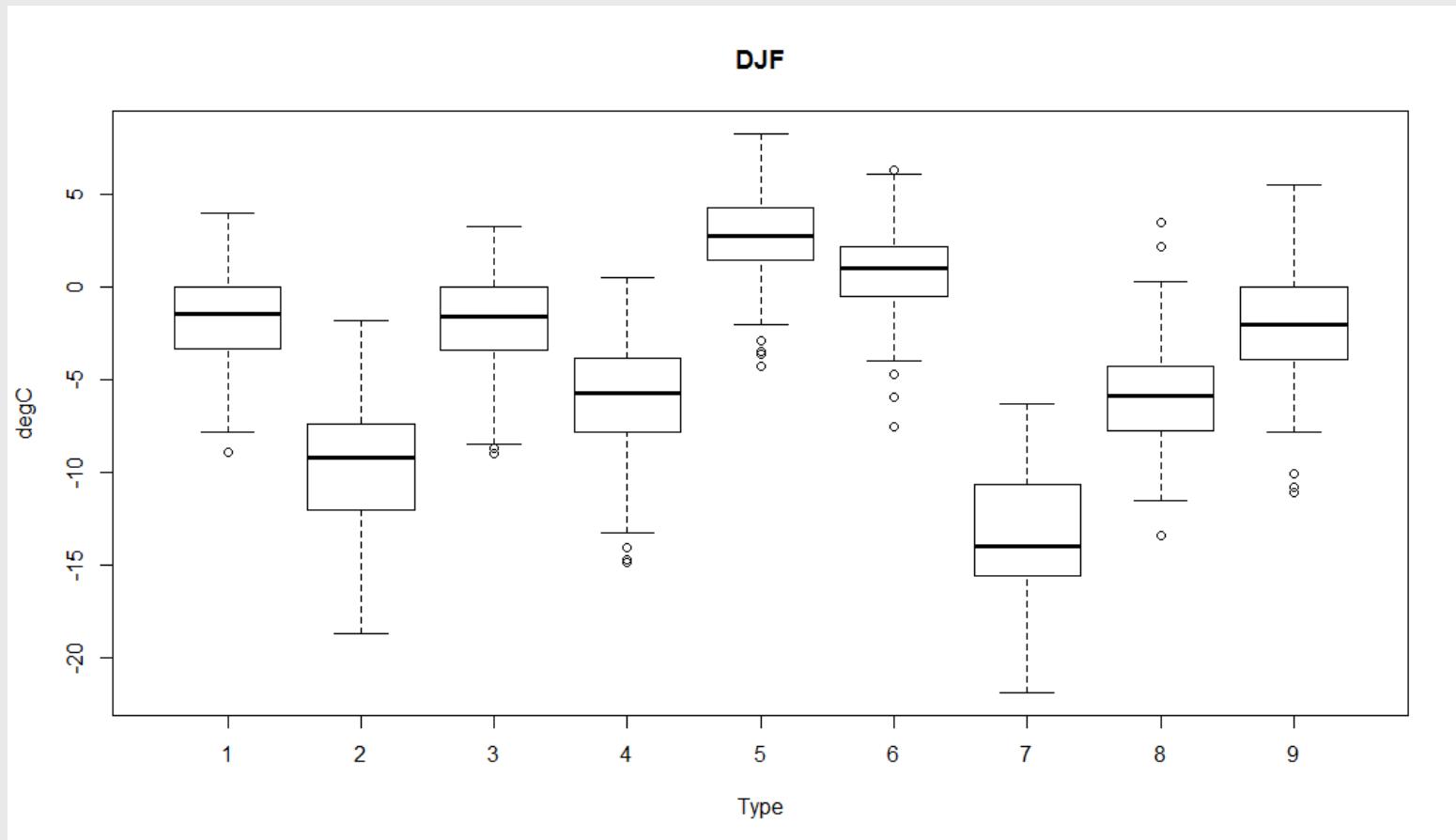
Winter (DJF)



Winter (DJF) Type 5 Winter (DJF) Type 6 Winter (DJF) Type 7 Winter (DJF) Type 8 Winter (DJF) Type 9

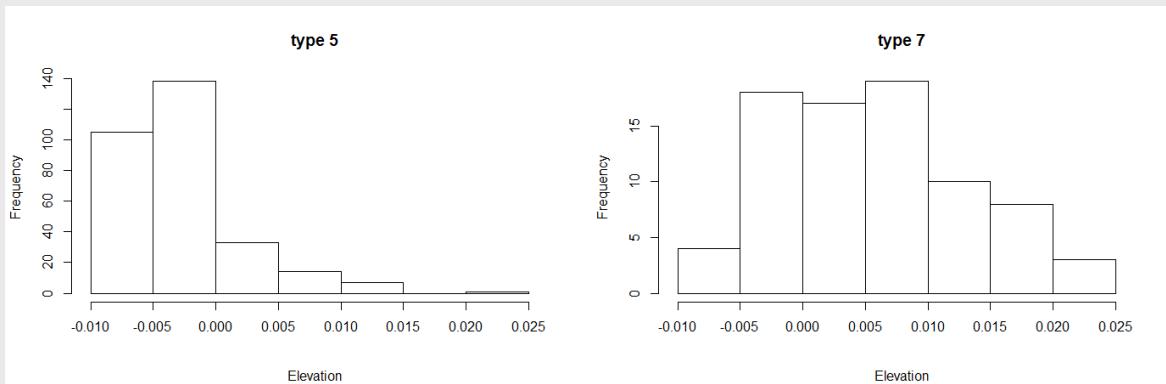


TAM@18700_Oslo vs Types

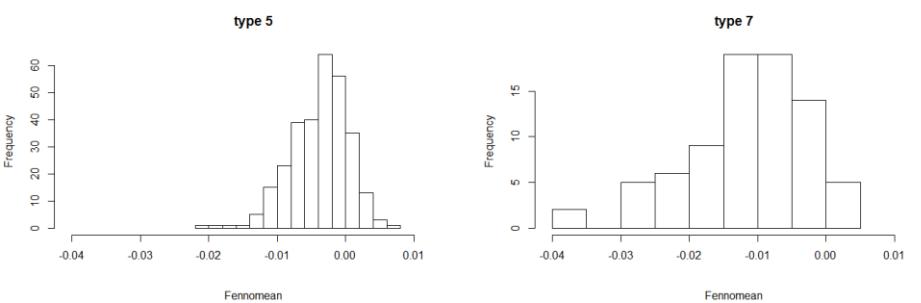


Elevation

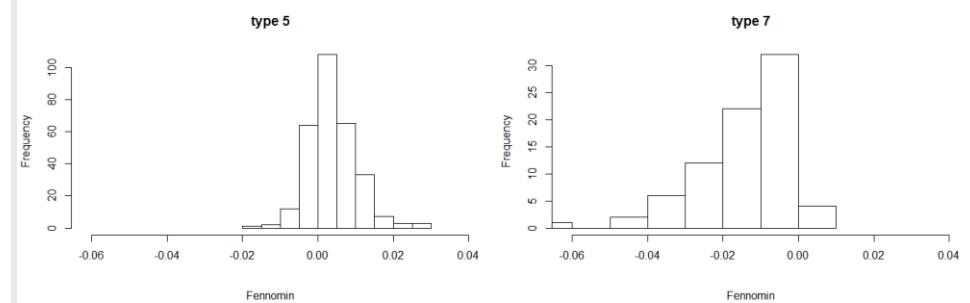
n₅: 298
n₇: 79



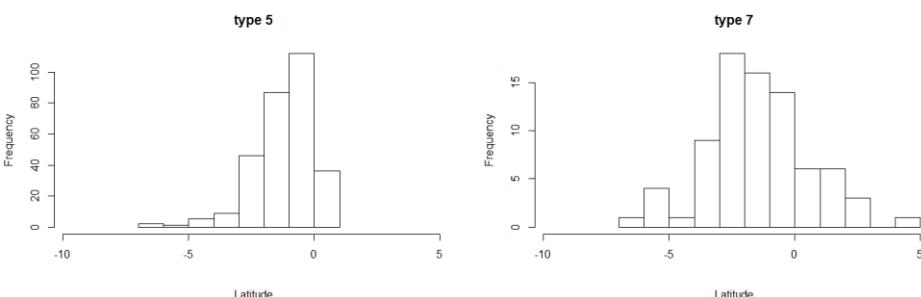
Fennomean



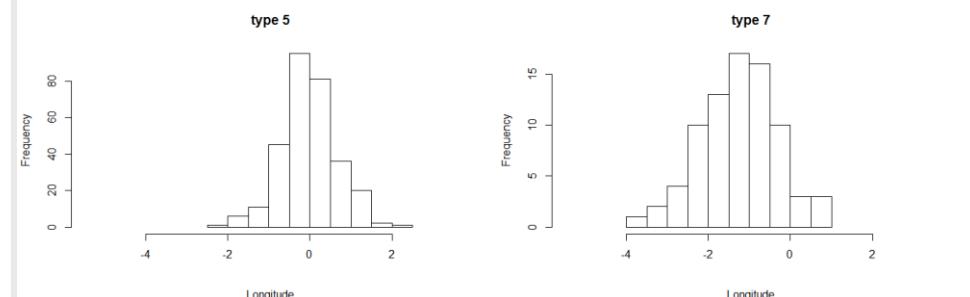
Fennomin



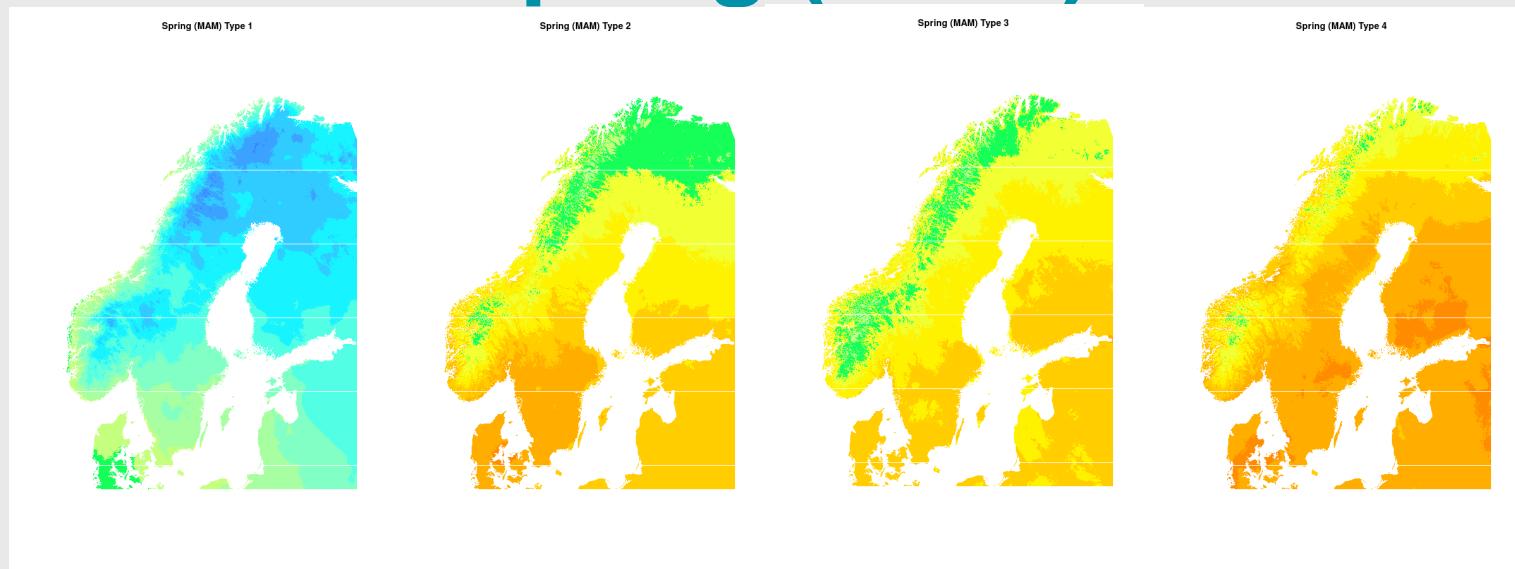
Latitude



Longitude



Spring (MAM)



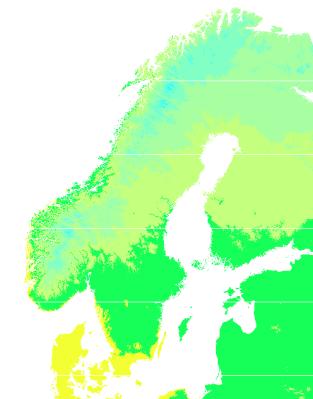
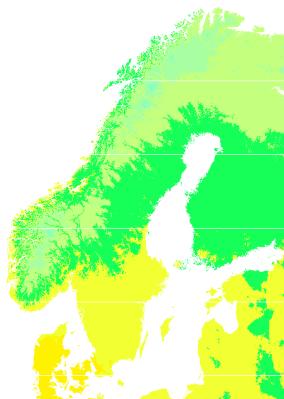
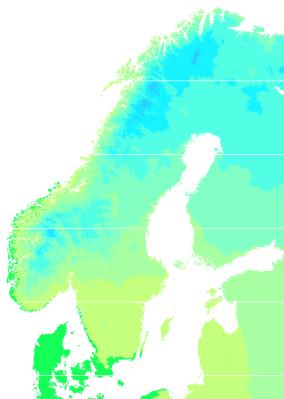
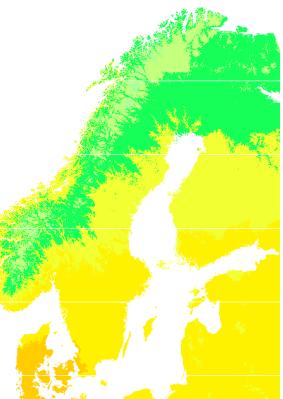
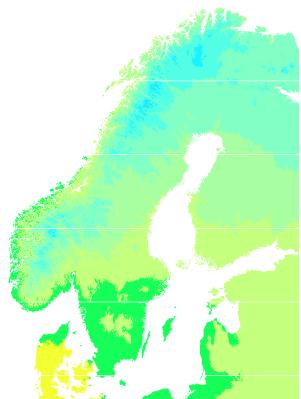
Spring (MAM) Type 5

Spring (MAM) Type 6

Spring (MAM) Type 7

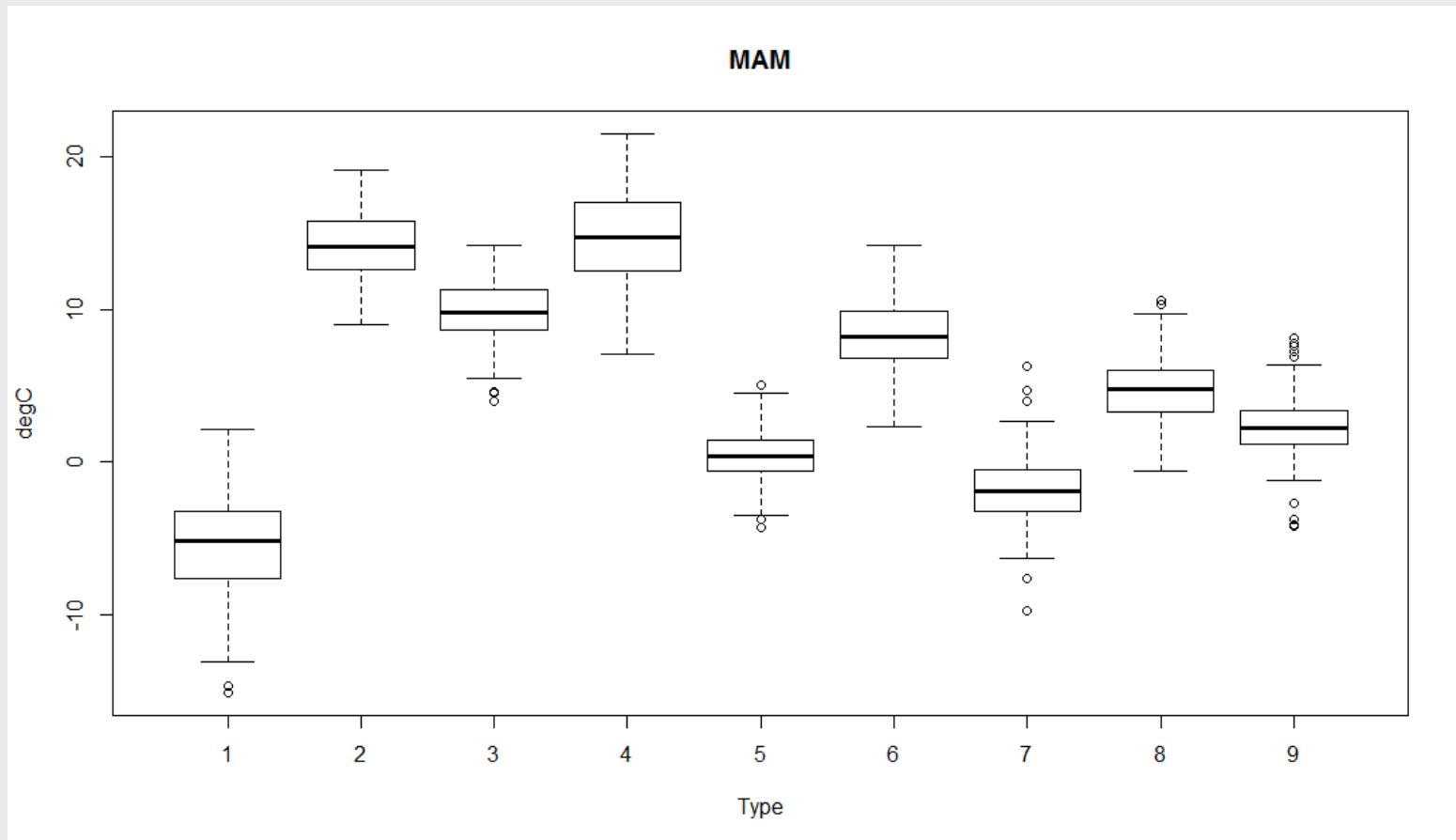
Spring (MAM) Type 8

Spring (MAM) Type 9

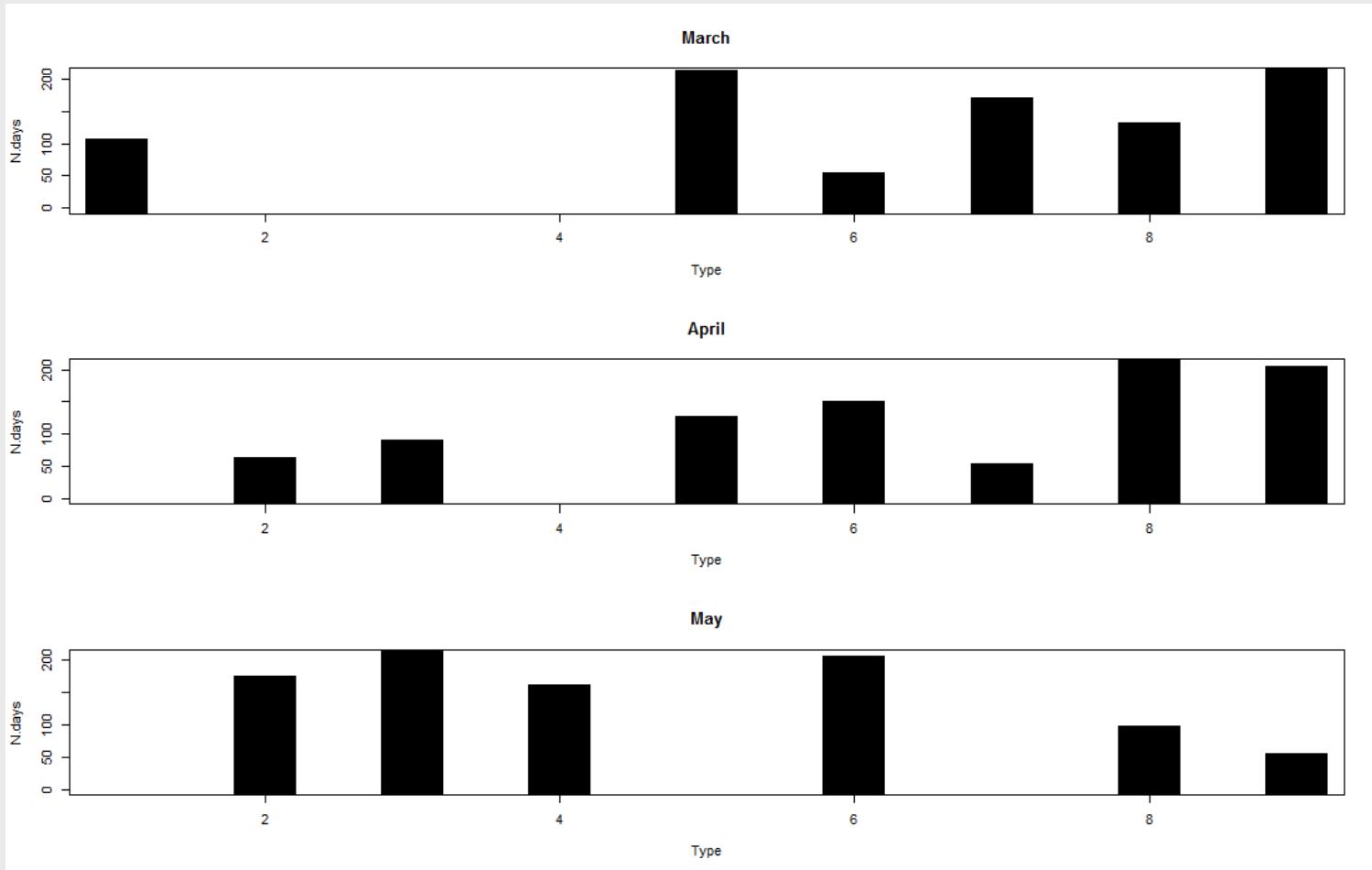


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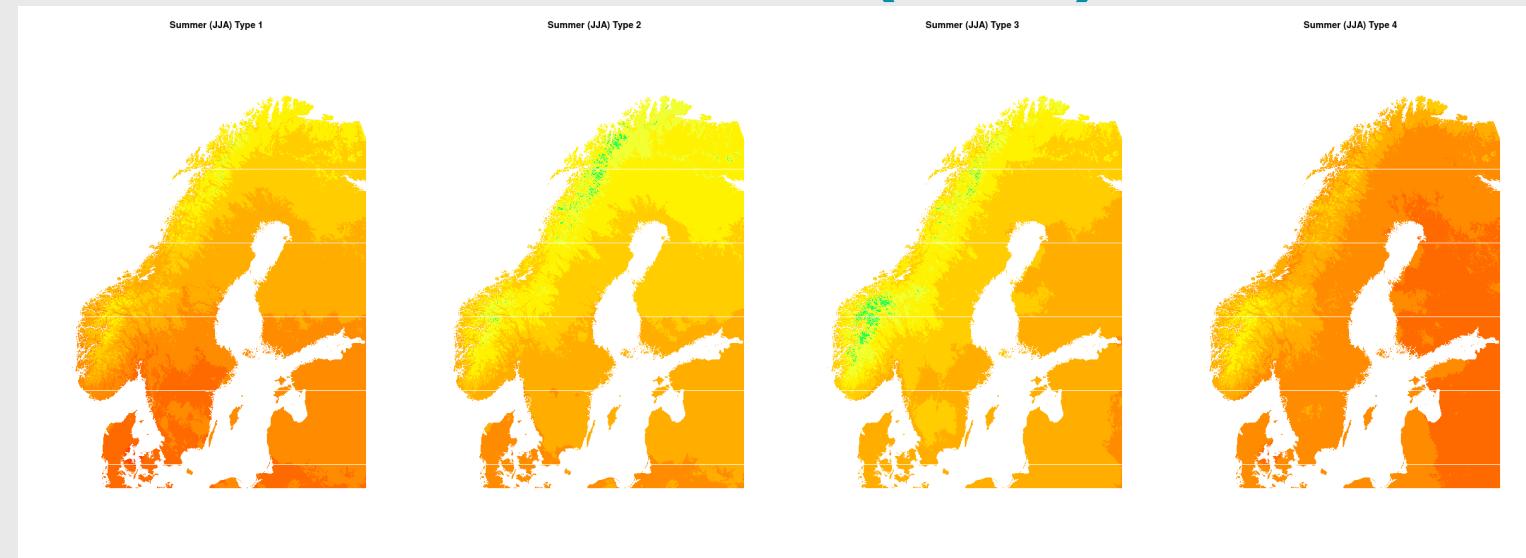
TAM@18700_Oslo vs Types



Monthly distribution of types



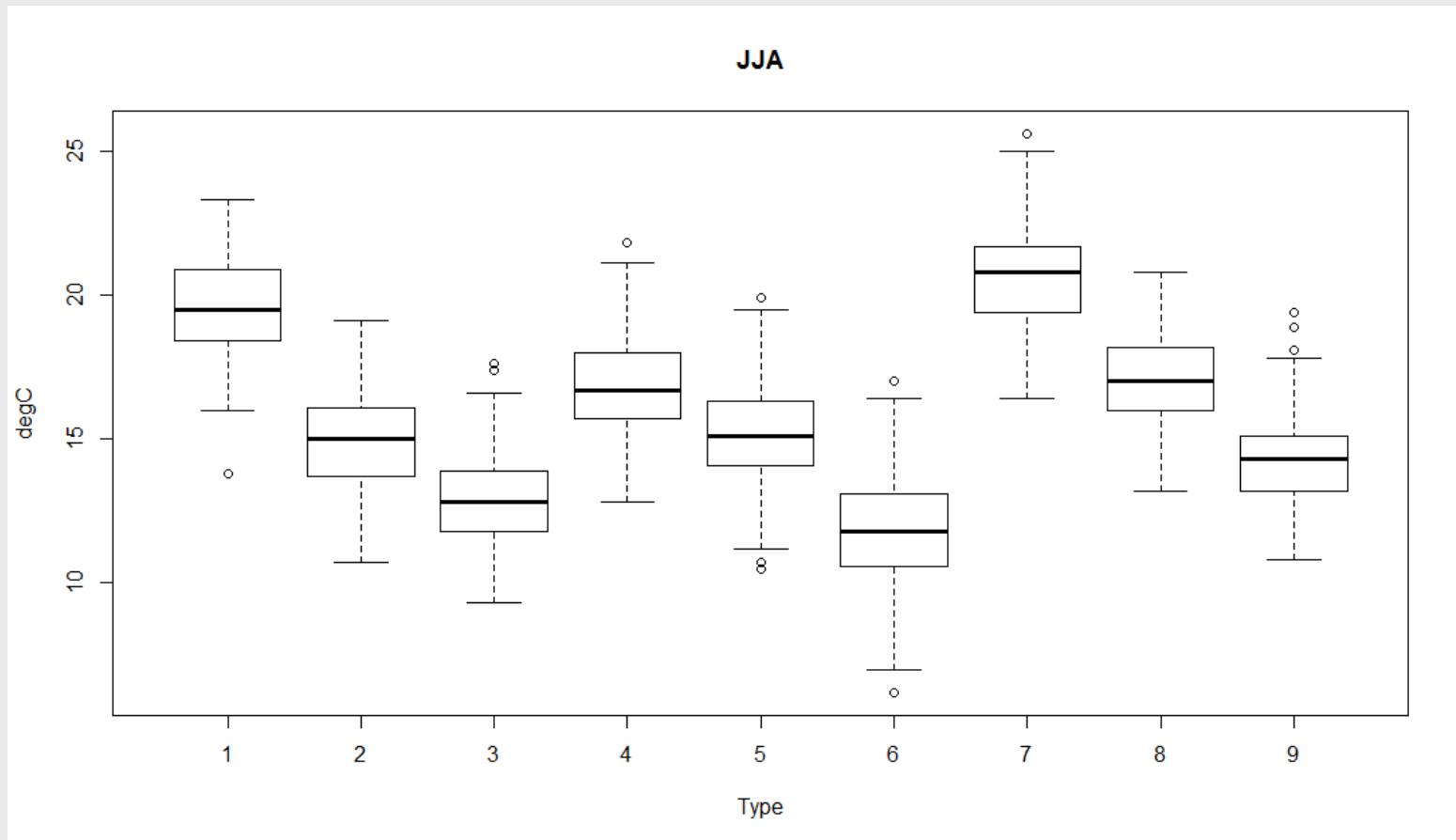
Summer (JJA)



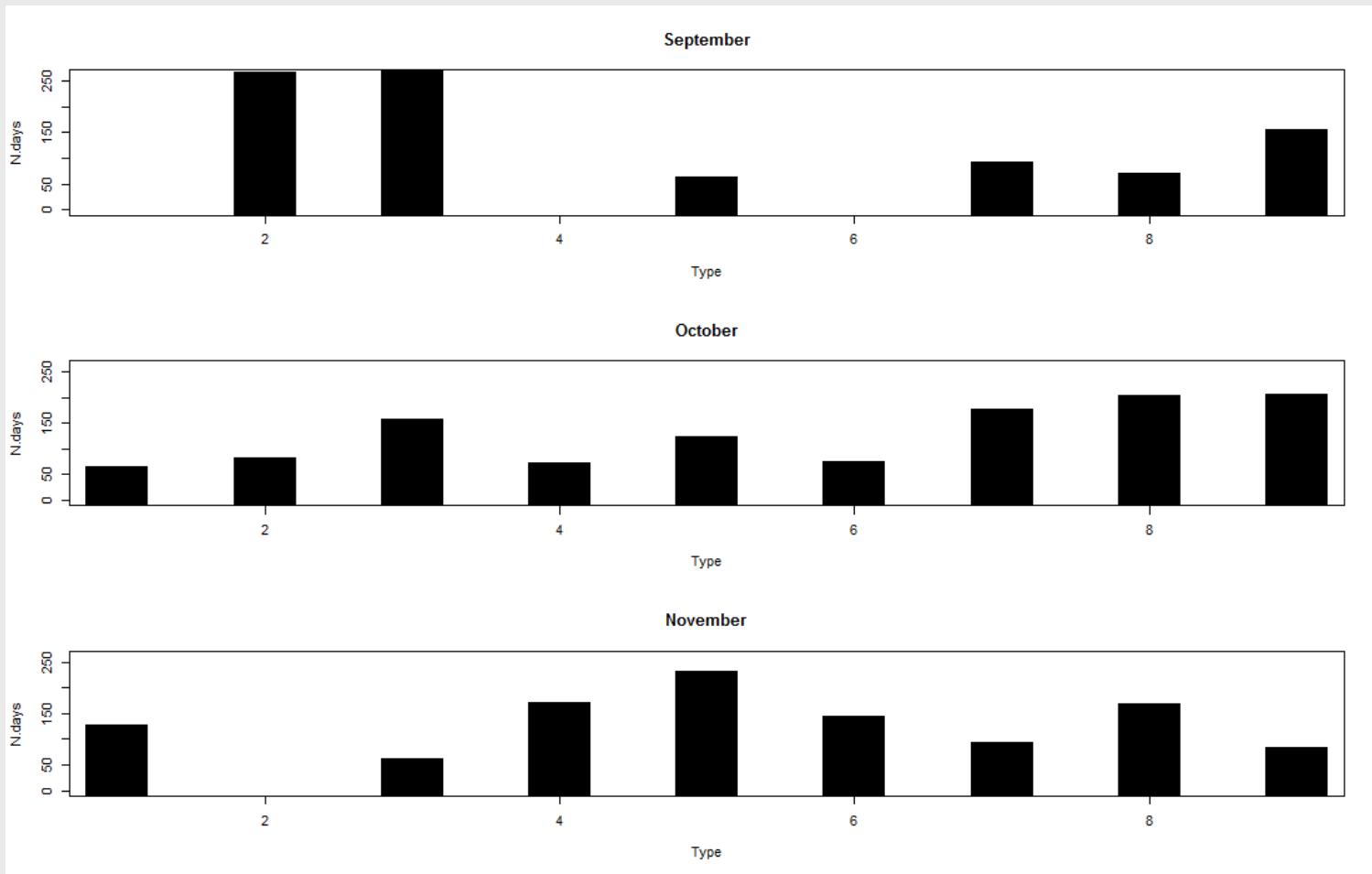
Summer (JJA) Type 5 Summer (JJA) Type 6 Summer (JJA) Type 7 Summer (JJA) Type 8 Summer (JJA) Type 9



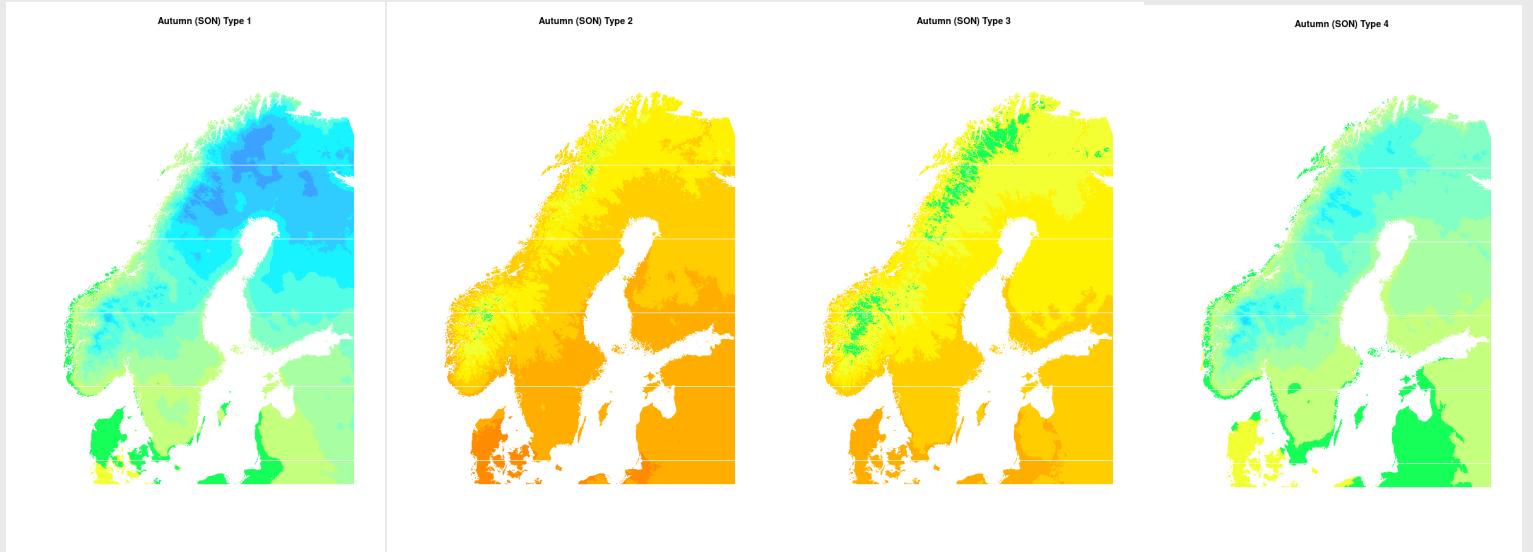
TAM@18700_Oslo vs Types



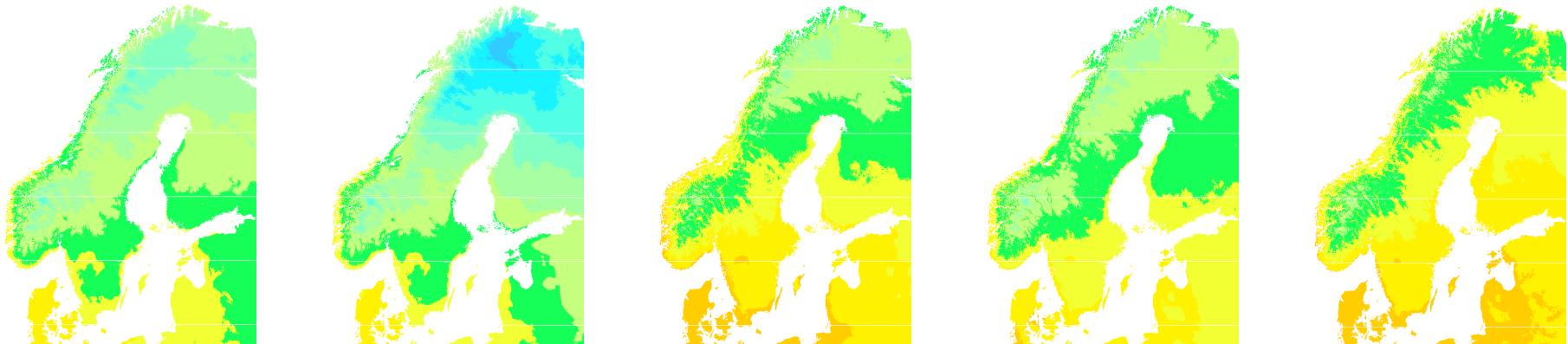
Monthly distribution of types



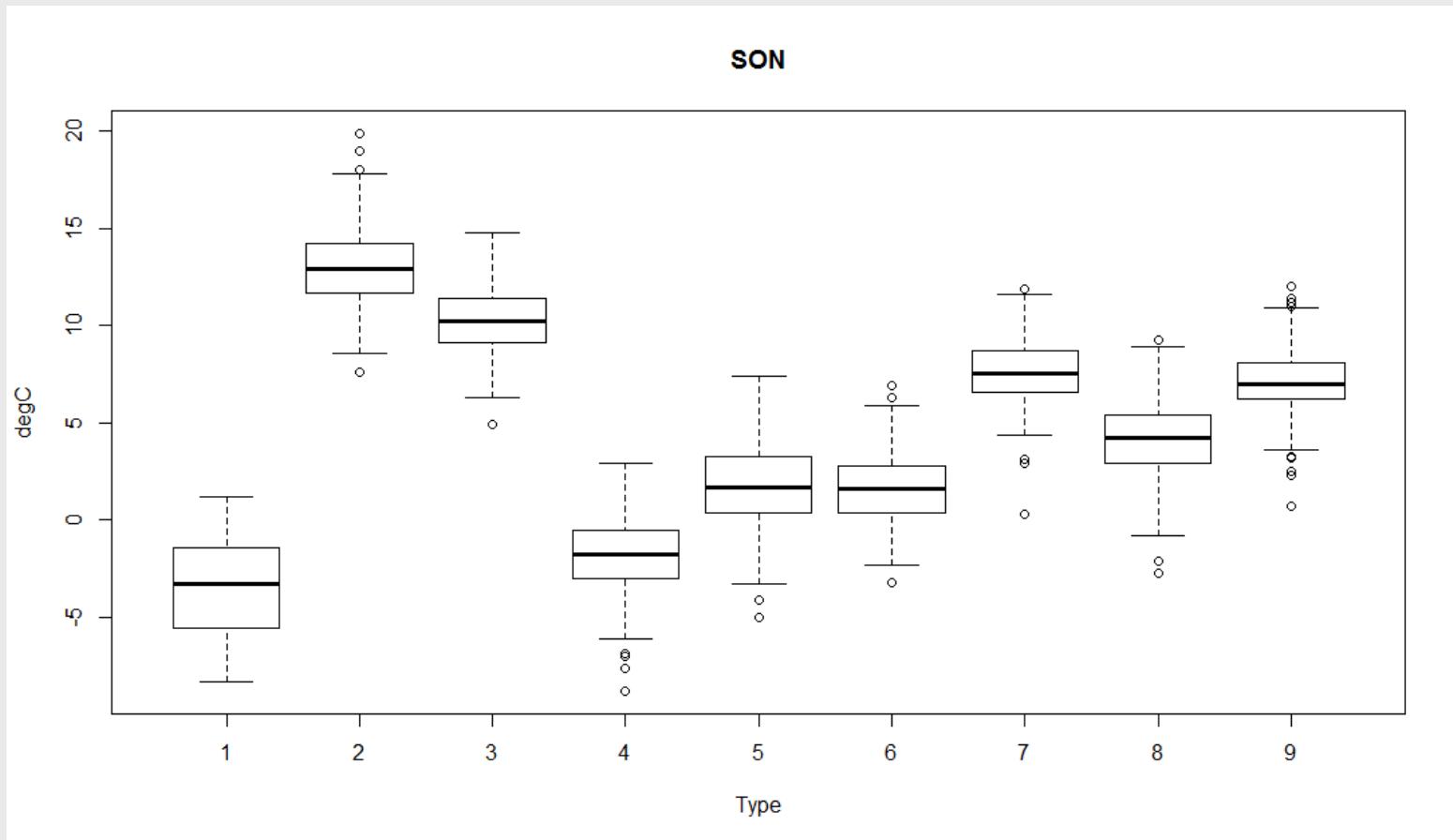
Autumn (SON)



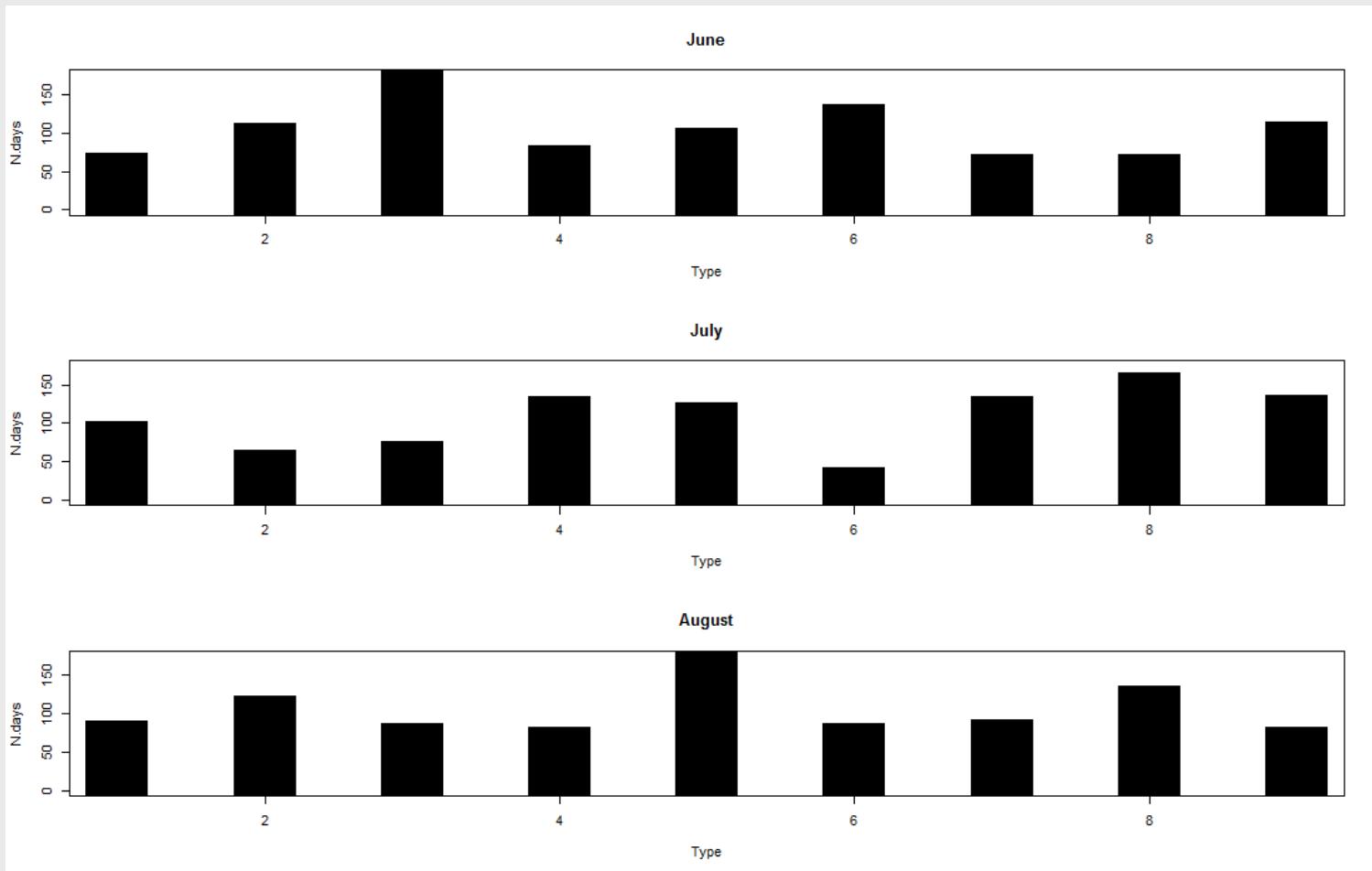
Autumn (SON) Type 5 Autumn (SON) Type 6 Autumn (SON) Type 7 Autumn (SON) Type 8 Autumn (SON) Type 9



TAM@18700_Oslo vs Types



Monthly distribution of types

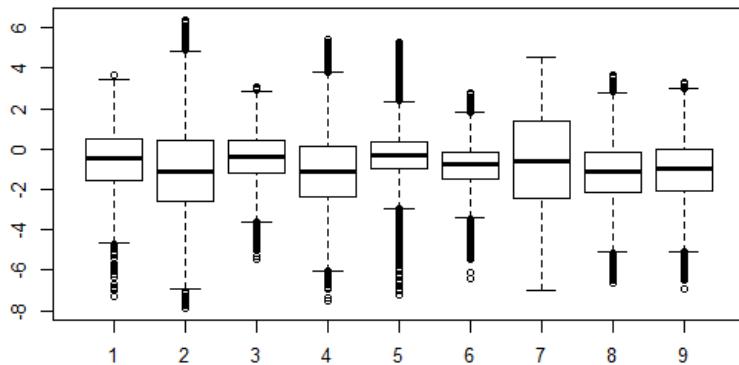


Ensemble analysis

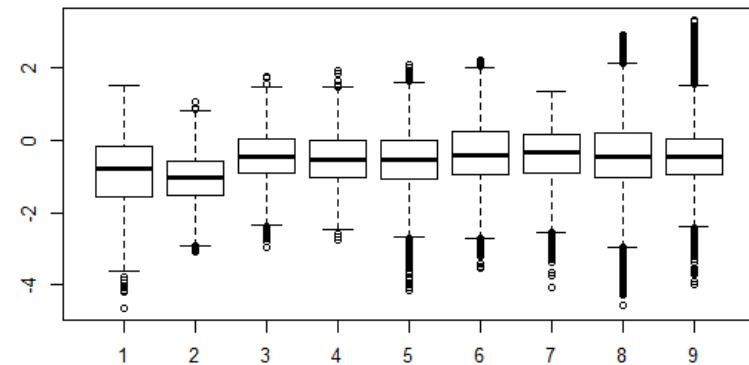
- Each day is estimated applying the regional trend from all the days belonging to the same «temperature day class»
- Number of ensemble members vary from 59 to 349
- Very time consuming procedure. Only one station is checked by cross-validation interpolation so far → 18700 Oslo-Blindern

Estimation error (18700 Oslo-Blindern)

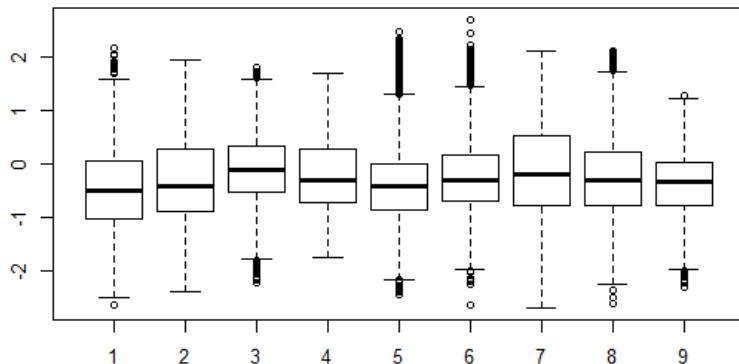
DJF



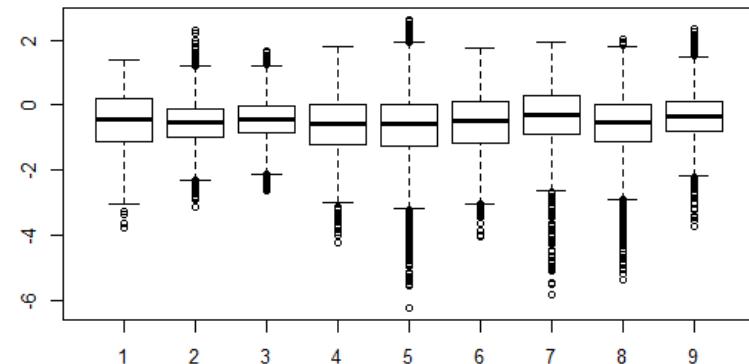
MAM



JJA

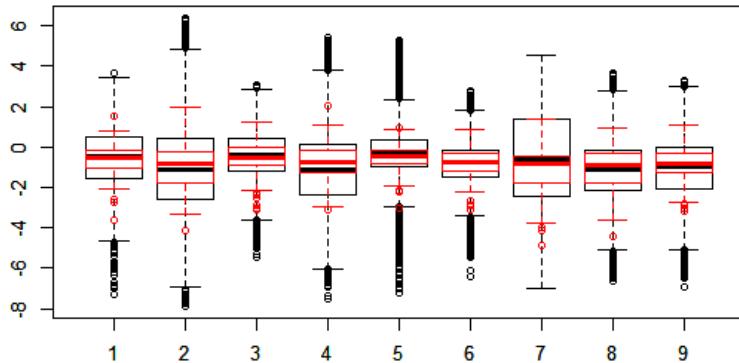


SON

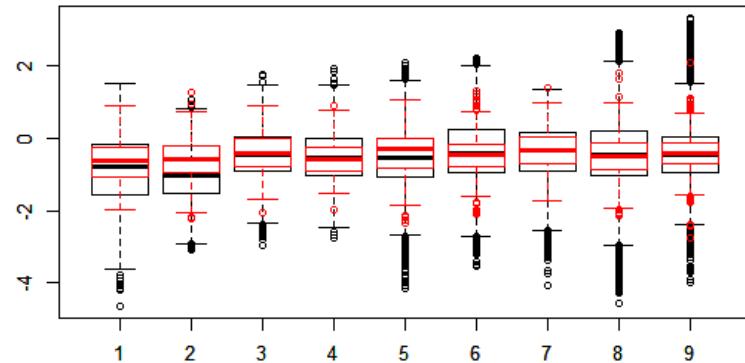


Estimation error (18700 Oslo-Blindern)

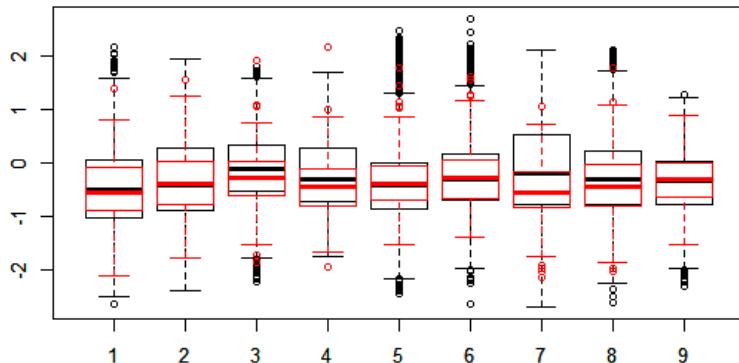
DJF



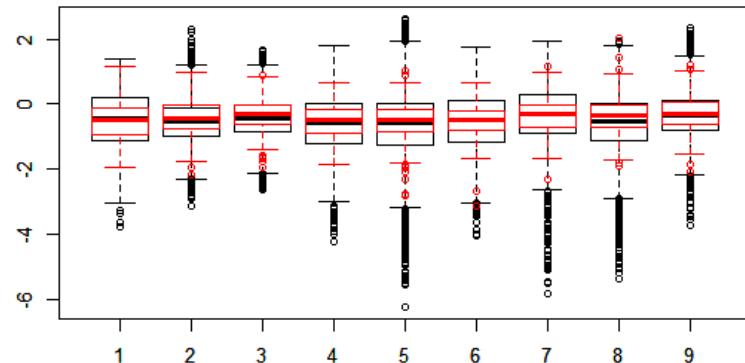
MAM



JJA

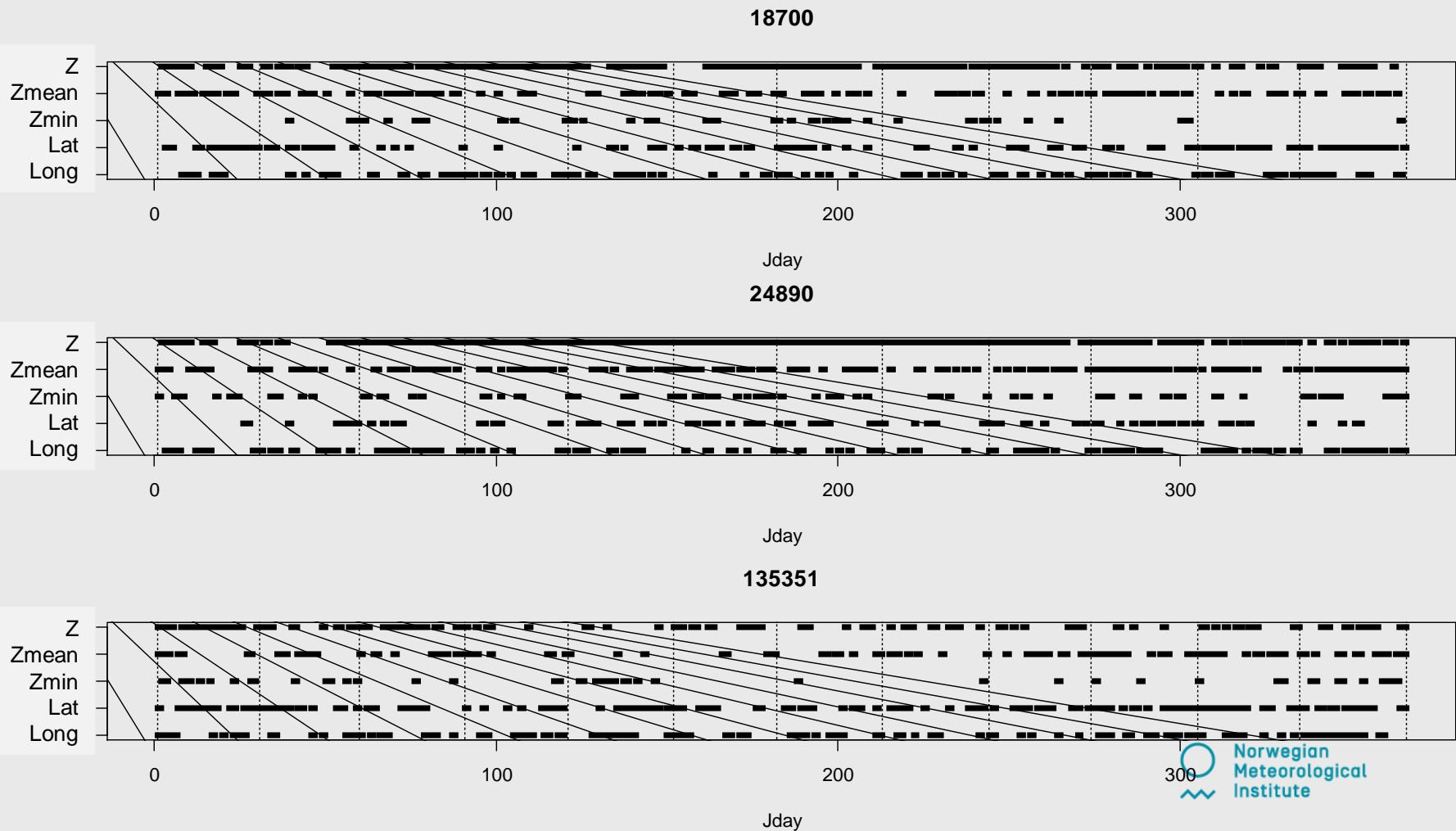


SON

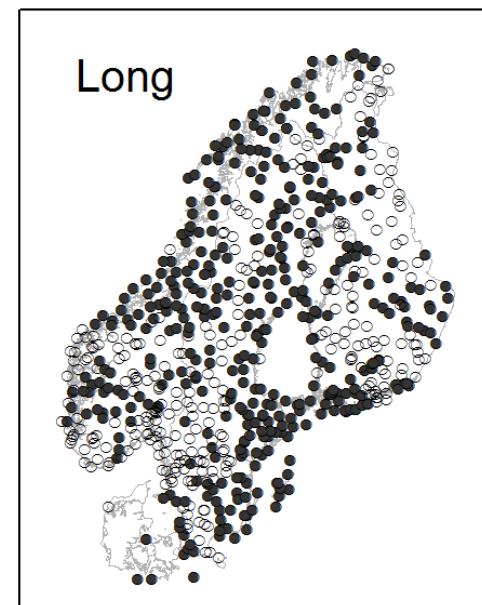
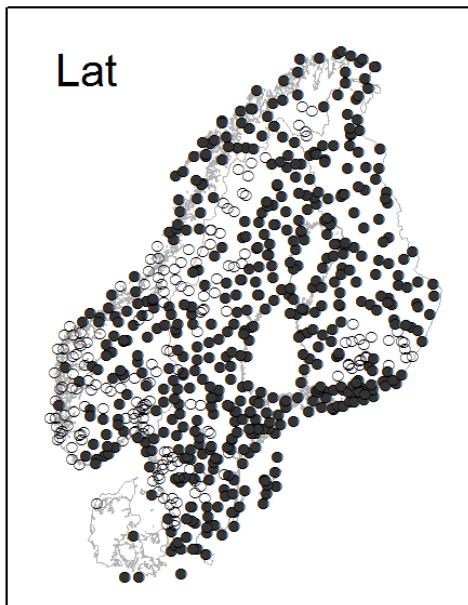
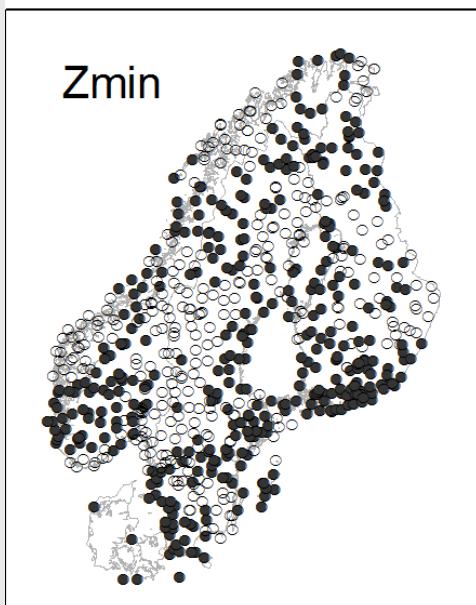
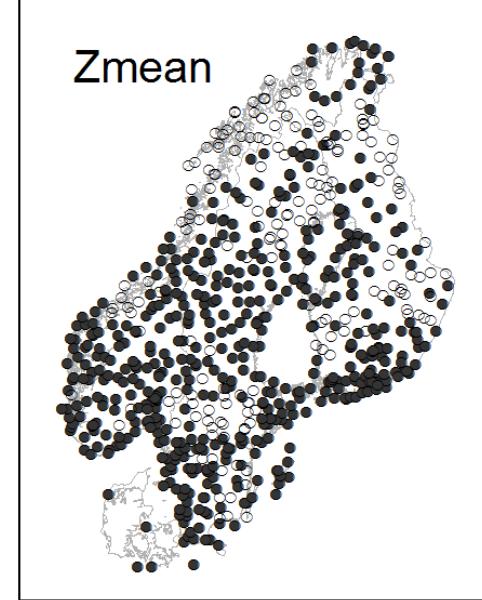
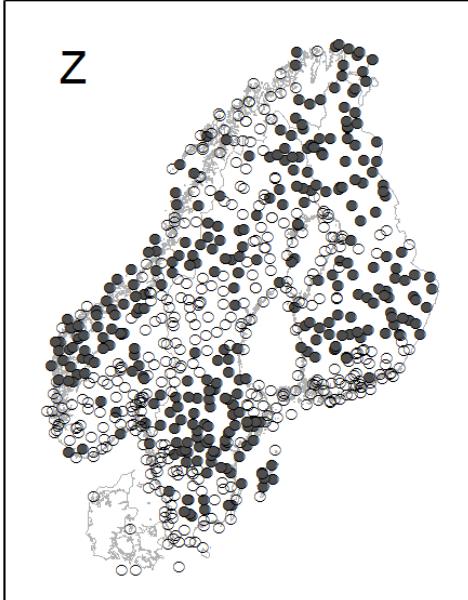


Sensitivity of external predictors

Stepwise regression can be applied in the daily regional analysis in order to retain only significant predictors for the estimation of the background field.

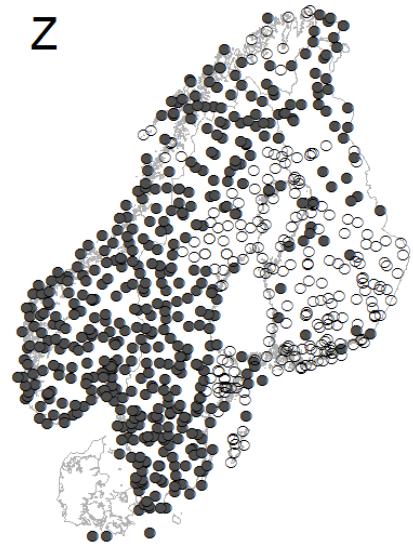


1.January 2008



**1.July
2008**

Z



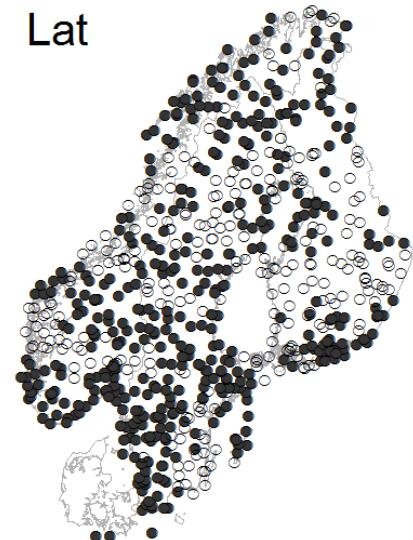
Zmean



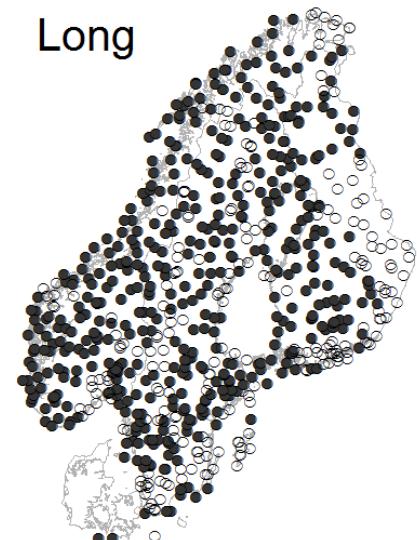
Zmin



Lat



Long



Conclusions

(which actually is more like an endless list of further work....)

- Large temporal and spatial variations in
 - Weights
 - Significanceof external predictors
- Selection of predictors must **reflect regional conditions.**
 - More work is needed to identify the best representation of these
- Smart algorithms for regional averaging is needed
 - The OI-approach shows that this is promising
- Find the optimum number of temperature classes.
- Make more efficient use of the temperature day classes information, find appropriate ensemble sizes.
- Are there significant differences in the spatial covariance structures for the different temperature classes?
- A smart combination of horizontal and vertical distances is needed. How to condition a robust ensemble approach?
 - Are «background ensembles» the only way?
 - Ensembles based variations of spatial covariance structures using n-dimensional anisotropic distance functions? (inspired by Frei, 2013)



thank you

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