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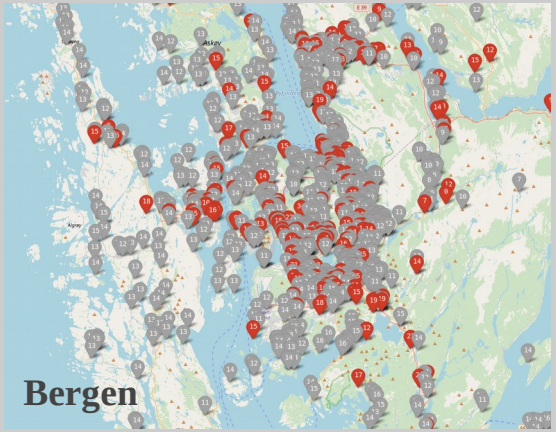
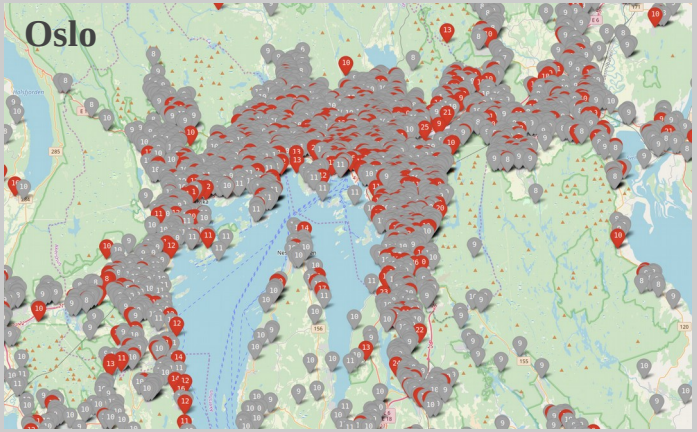




Integrating citizen observations in operational weather forecasts

Thomas Nils Nipen, Cristian Lussana, Ivar Ambjørn Seierstad, Trygve Aspelien

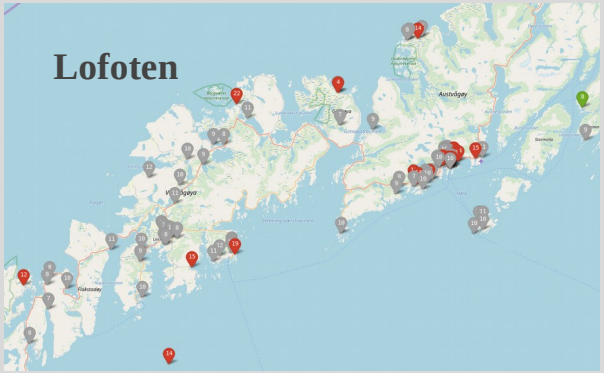
Presented by
Roger Randriamampianina

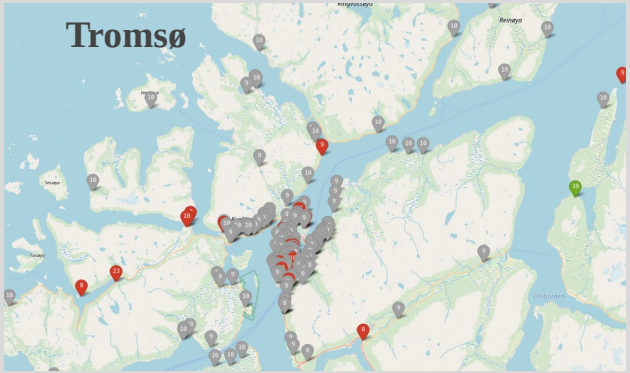
Acknowledgments: RadPrO, YR, HIRLAM, MetCoOP, iOBS

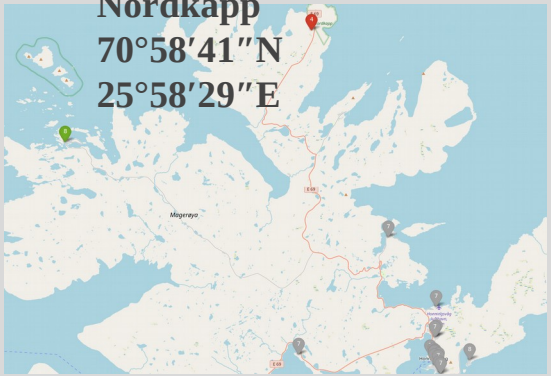
Outline

- Background/motivation
- TITAN and gridpp -- Quality control and statistical interpolation
- Impact of citizen observations on operational weather forecasts
- Application in Harmonie system
- Future plan

Data available everywhere…







Background

- World's 5th largest web-based forecast platform
- Interface allows lookup on the neighbourhood scale

- Private weather stations are becoming popular
  - Low-cost and off-the-shelf devices
  - Data in real-time
- In March 2018, MET Norway introduced Netatmo observation into the post-processing of operational temperature forecast on Yr (for Nordic countries)

We use amateur weather stations...

- To adjust automatic weather forecasts (Yr.no)
- To improve the initial condition of the NWP model
- To quality control the other data sources
- To improve knowledge of small-scale atmospheric processes (e.g. study the variability of precipitation measurements in 1x1 km2 boxes)
- ...

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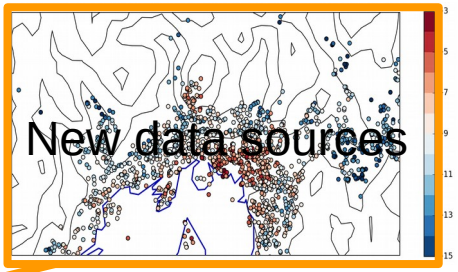
About numerical weather prediction

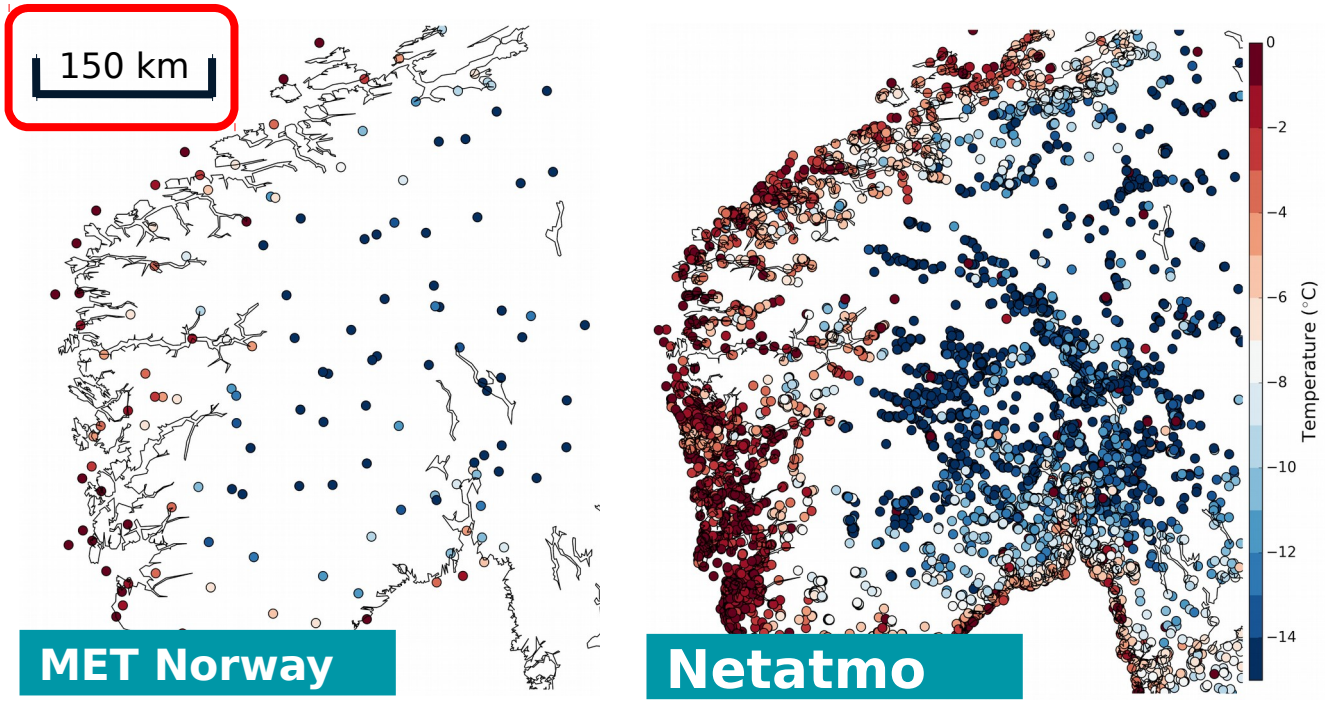


Data assimilation → NWP model (forecast) → Post-processing → End users

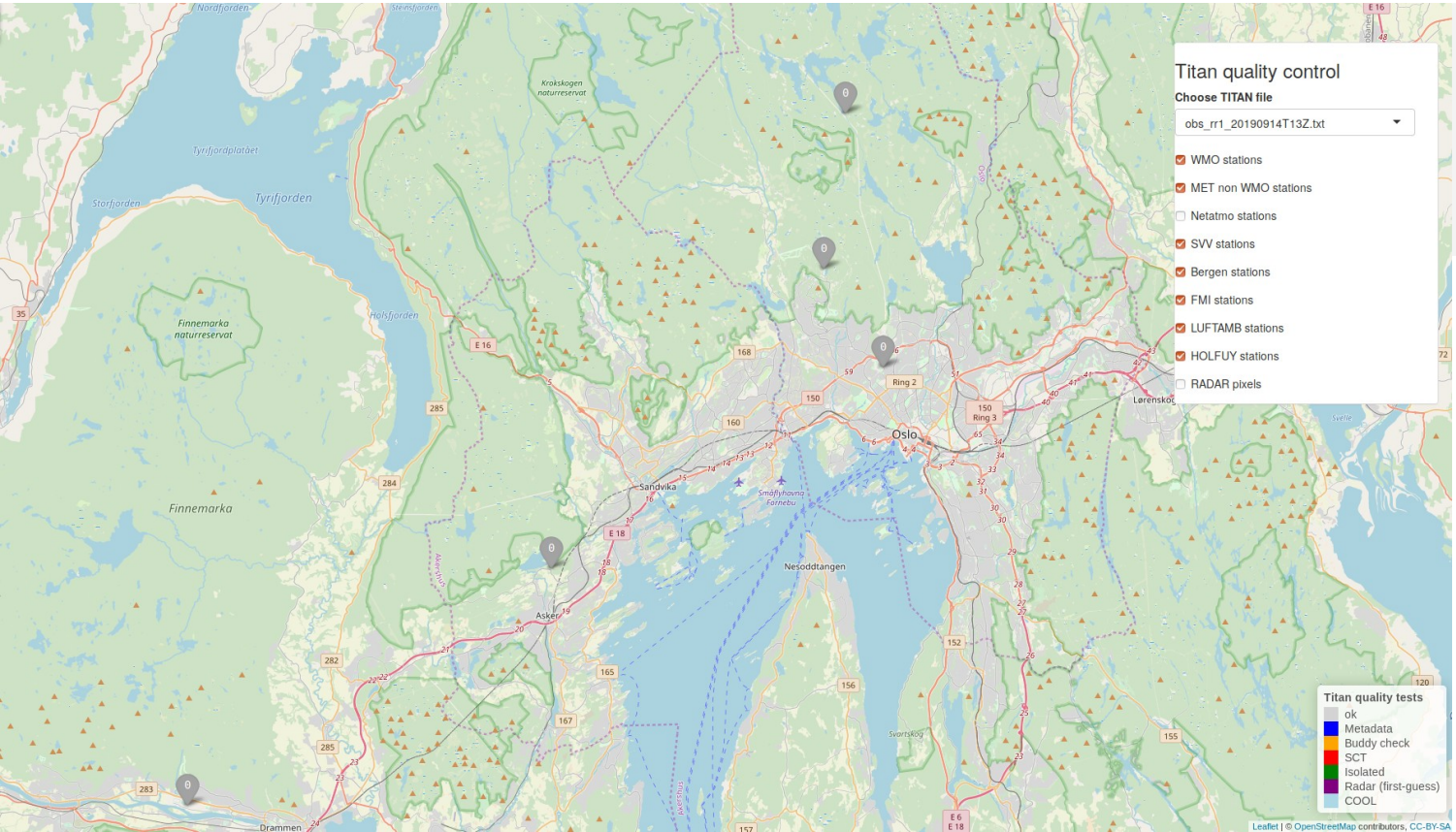
Müller, M., M. Homleid, K. Ivarsson, M.A. Køltzow, M. Lindskog, K.H. Midtbø, U. Andrae, T. Aspelien, L. Berggren, D. Bjørge, P. Dahlgren, J. Kristiansen, R. Randriamampianina, M. Ridal, and O. Vignes, 2017: AROME-MetCoOp: A Nordic Convective-Scale Operational Weather Prediction Model. *Wea. Forecasting,* **32**, 609–627, https://doi.org/10.1175/WAF-D-16-0099.1

Potential of citizen observation systems

Netatmo's station density is roughly 50 times greater than MET Norway's



Why use citizen observations?



2019-09-14 13:00 UTC

Oslo

1-hour precipitation tot

most likely, no rain over most part of the region

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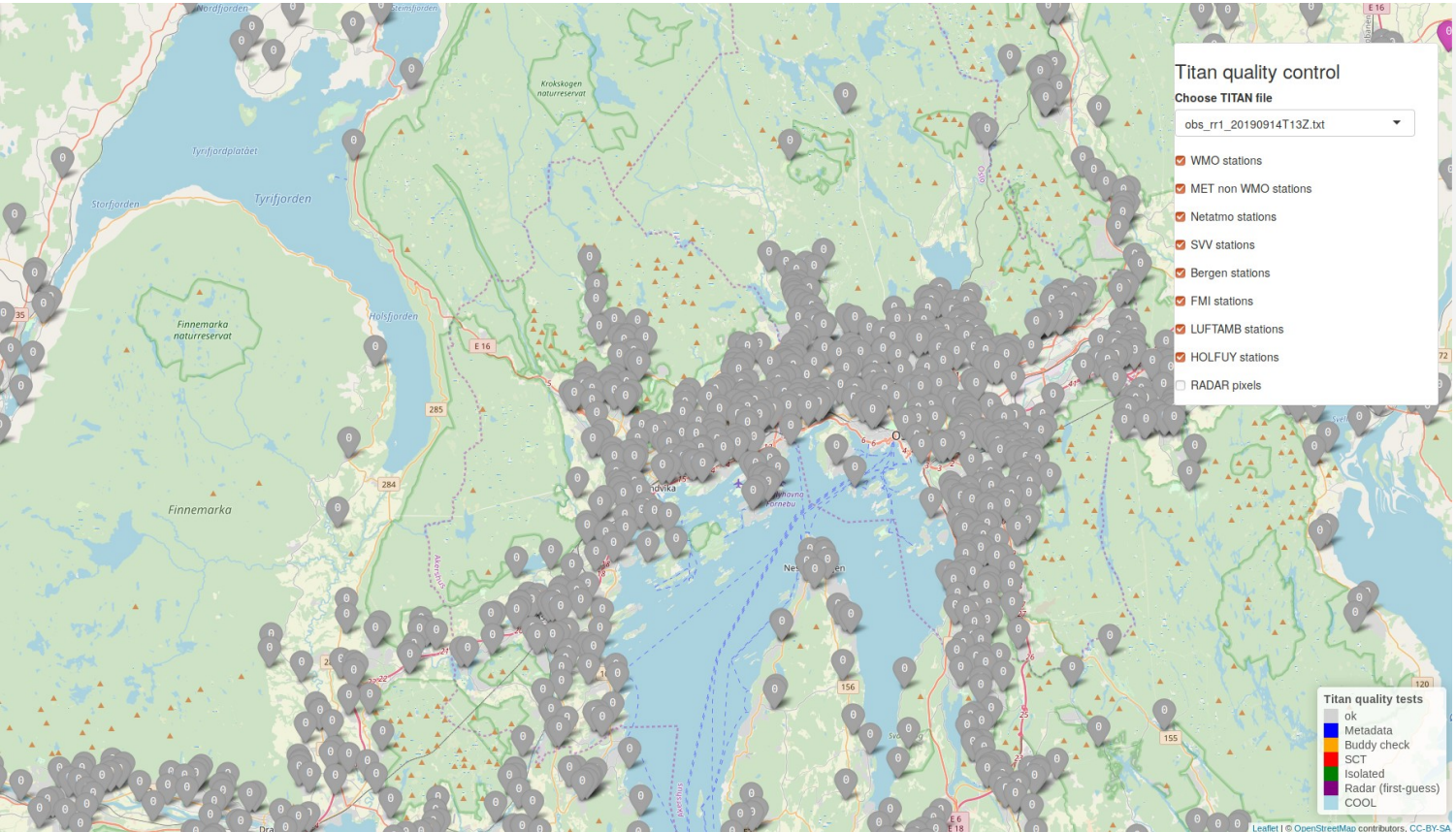
to gain confidence in our predictions



2019-09-14 13:00 UTC

Oslo

1-hour precipitation tot

citizen observations

no rain over Oslo, Drammen and the coast of the Oslo fjord. Most likely, no rain in the forests

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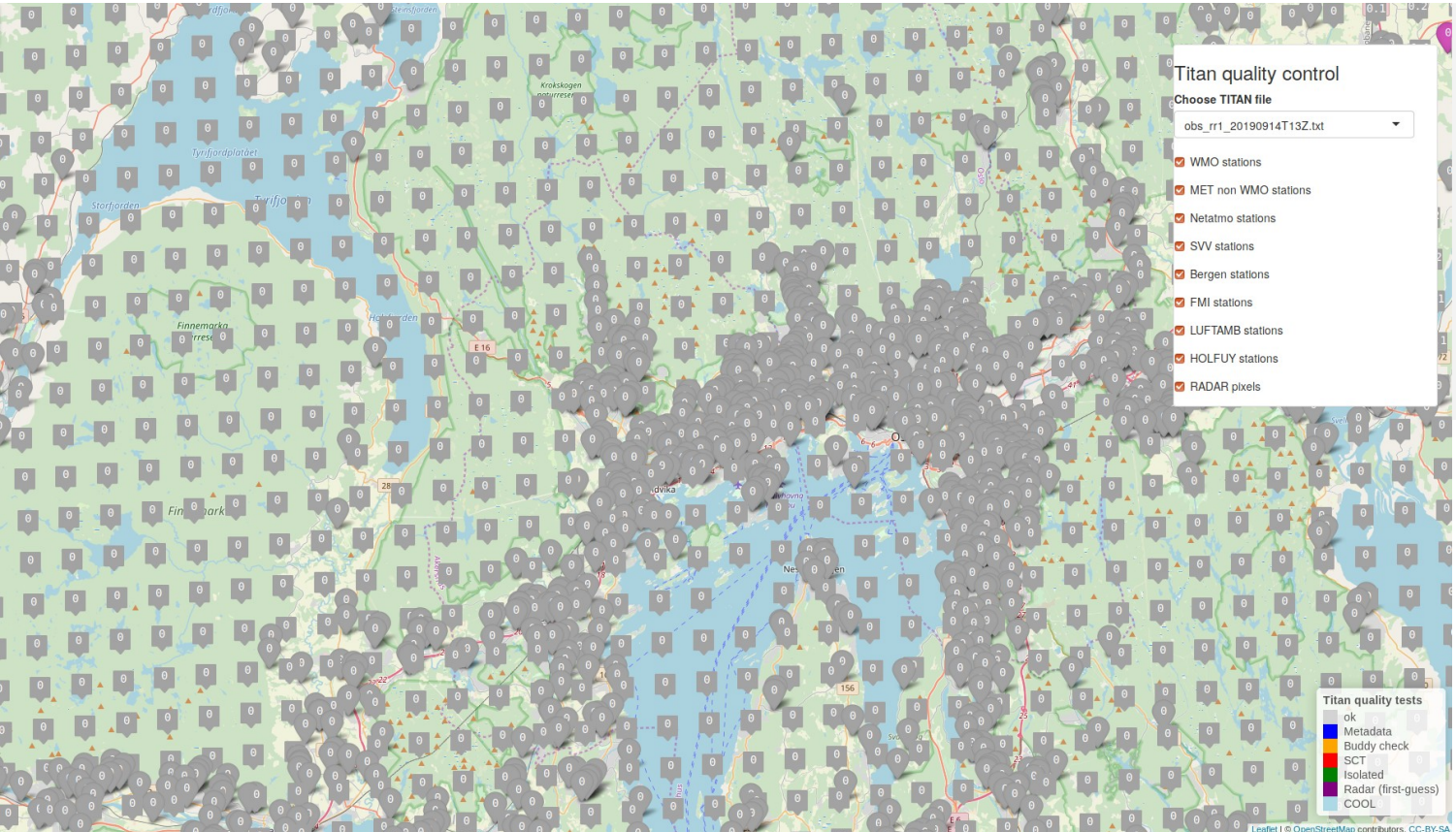
...even better if we have multiple sources



2019-09-14 13:00 UTC

Oslo

1-hour precipitation tot

citizen observations

radar estimates

no rain.

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...citizen observations turn out to be useful even when it is raining...

Extreme local precipitation in Oslo (Aug 4, 2019)

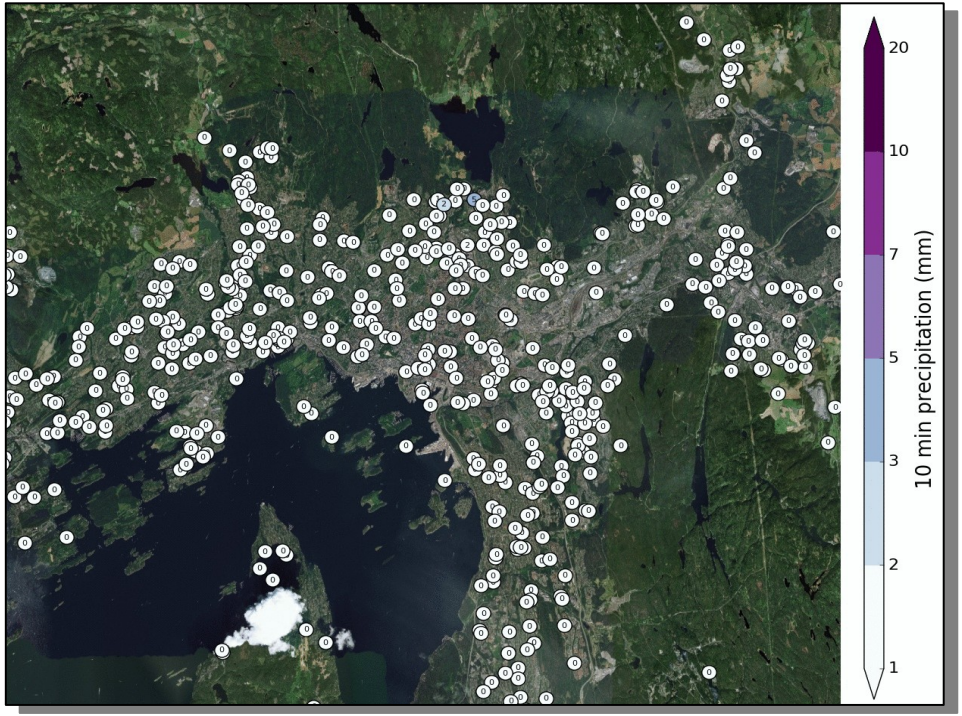
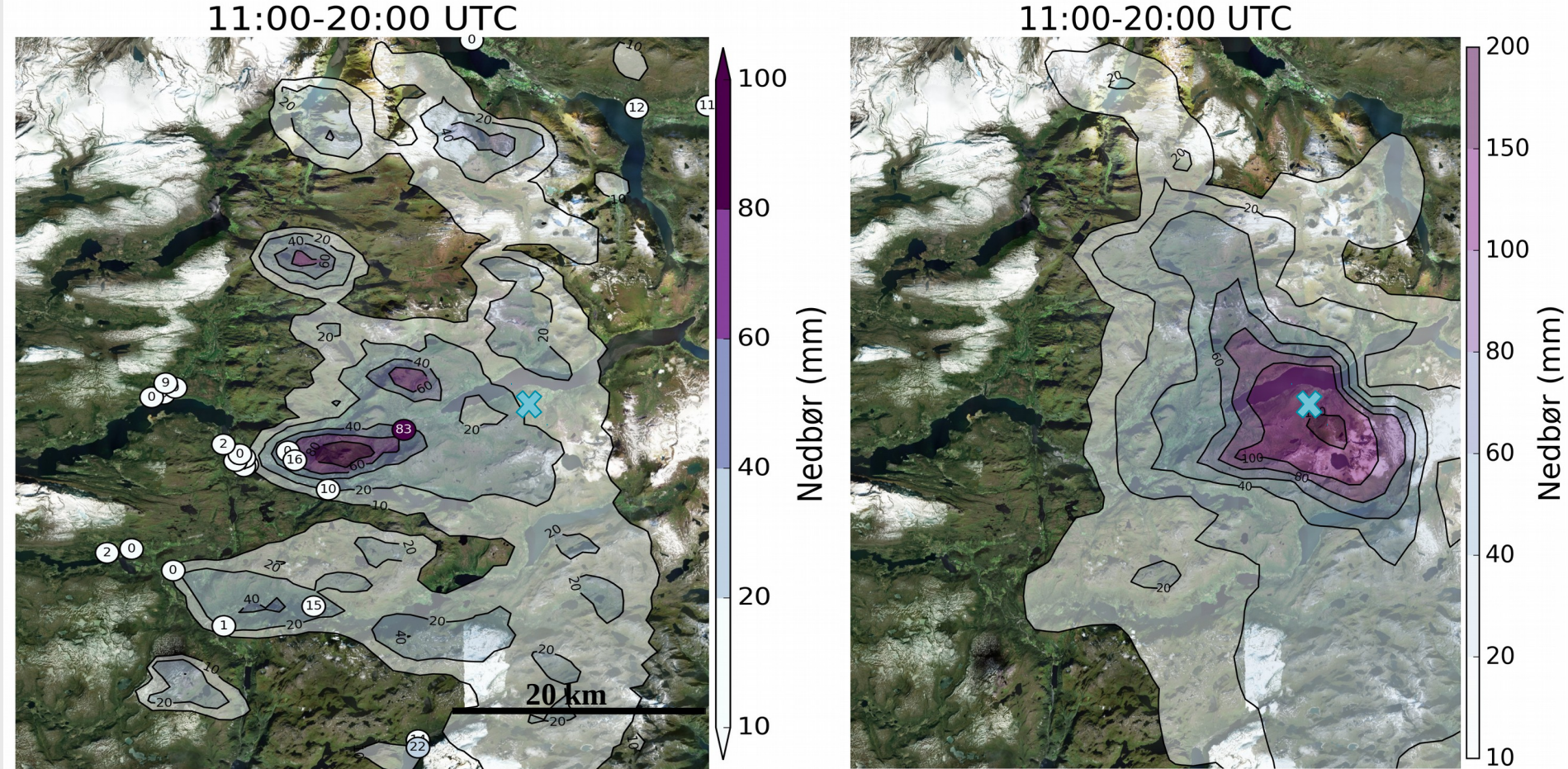


Photo:
Audun Braastad / NTB Scanpix

Estimated observed precipitation (Jul 30,2019)

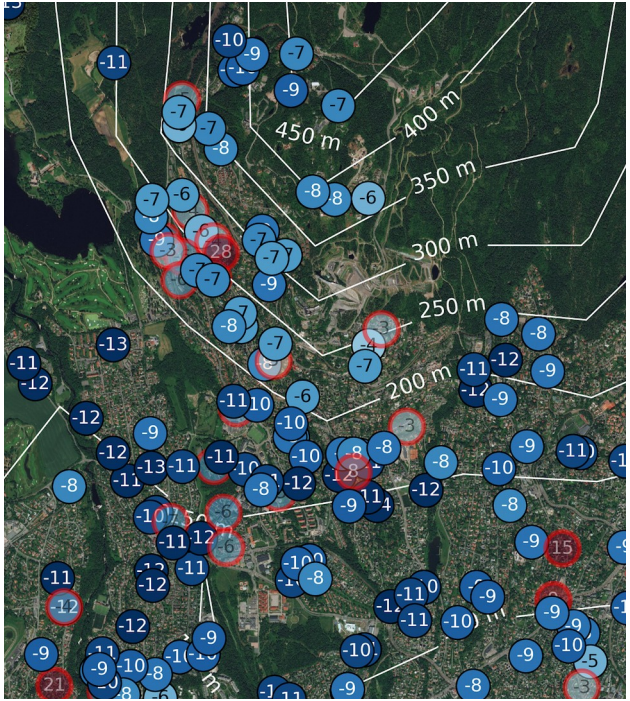
citizen observations, (blocked) radar and NWP

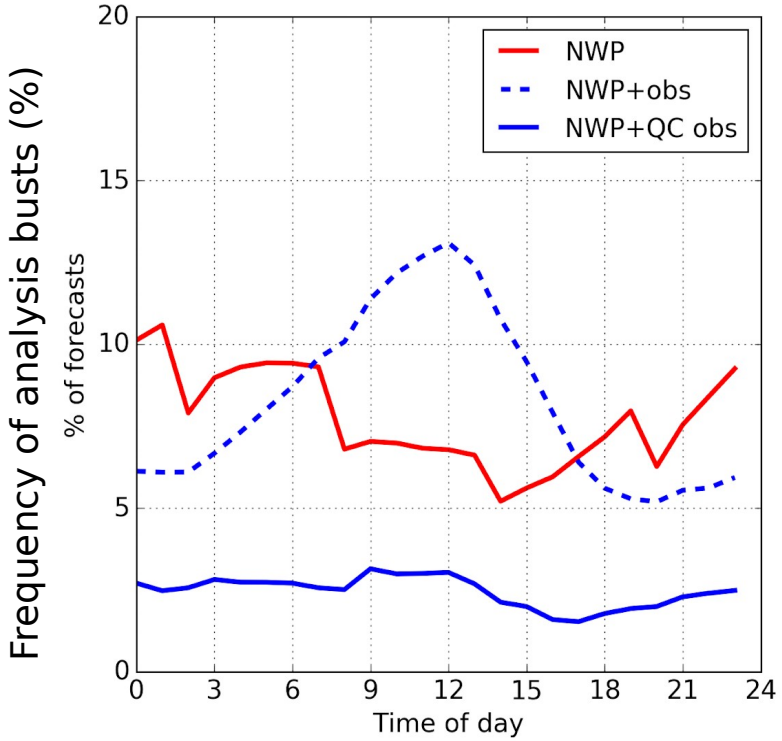


Quality control is essential to get value!

Network should be treated as a whole, not as individual stations

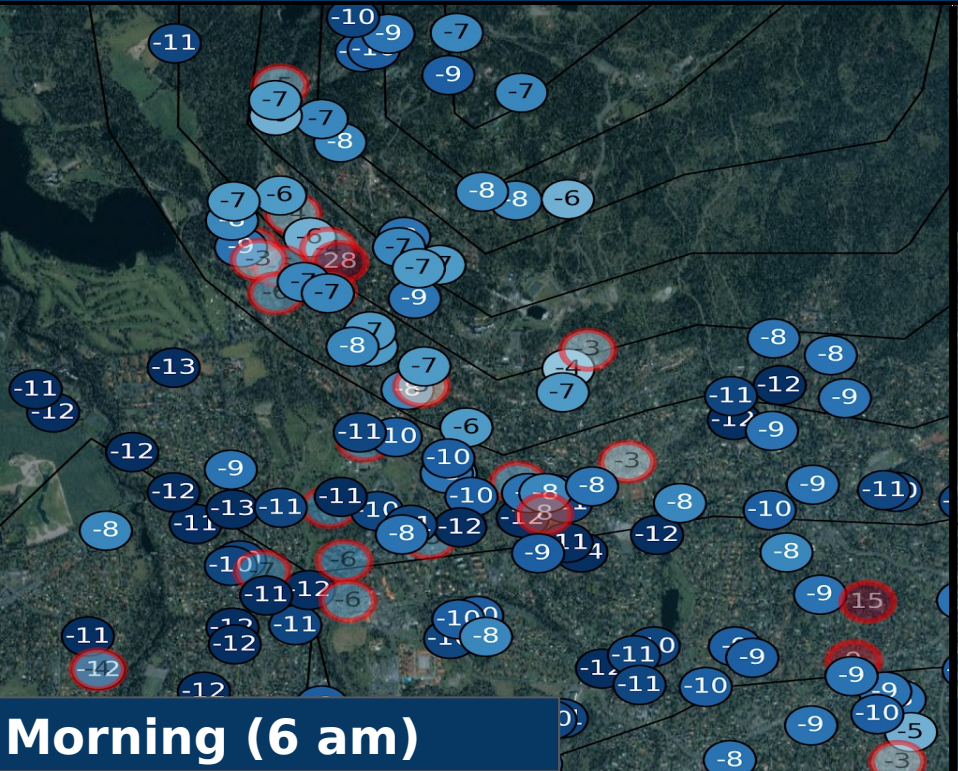
Only 20% are removed in our conservative QC

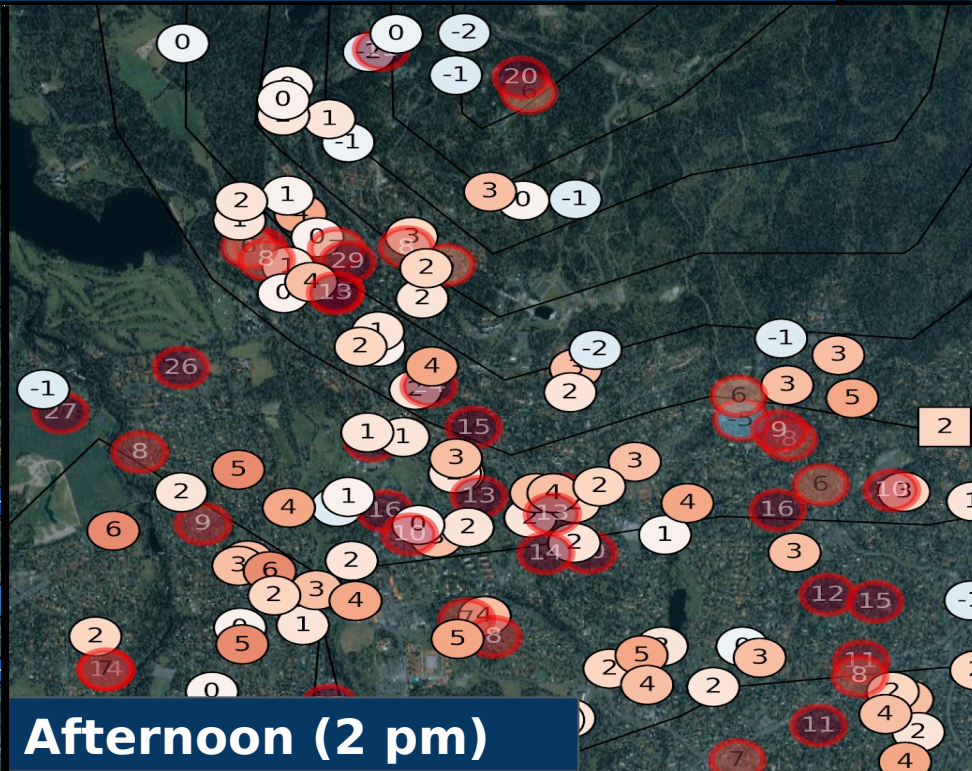




1. Observation quality control

- ☐ Use neighbouring stations to remove suspicious values (21%)
  Each hour is checked independently

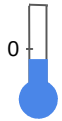




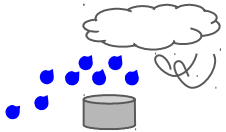
Sequential tests for climate datasets

Precipitation

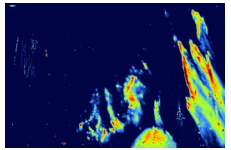
Cross-check temperature and precipitation



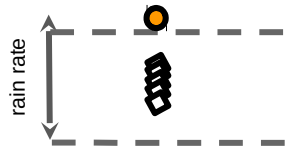
Adjust for wind-induced undercatch



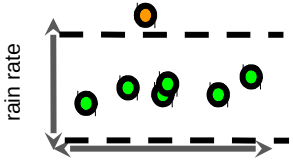
Check against radar data



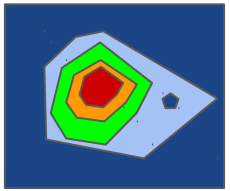
Check against NWP ensemble



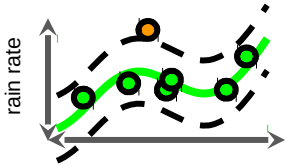
Buddy check
(r = 10 km, minimum 4 stations)



Check for holes in the field



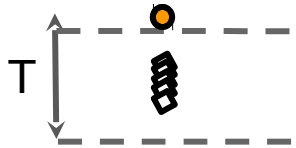
Spatial consistency test
(first guess, 20 closest stations)



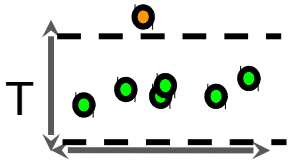
Sequential tests for climate datasets

Temperature

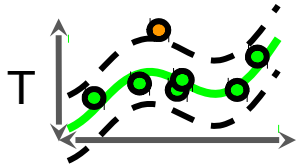
Check against NWP ensemble



Buddy check
(r = 10 km, minimum 4 stations)



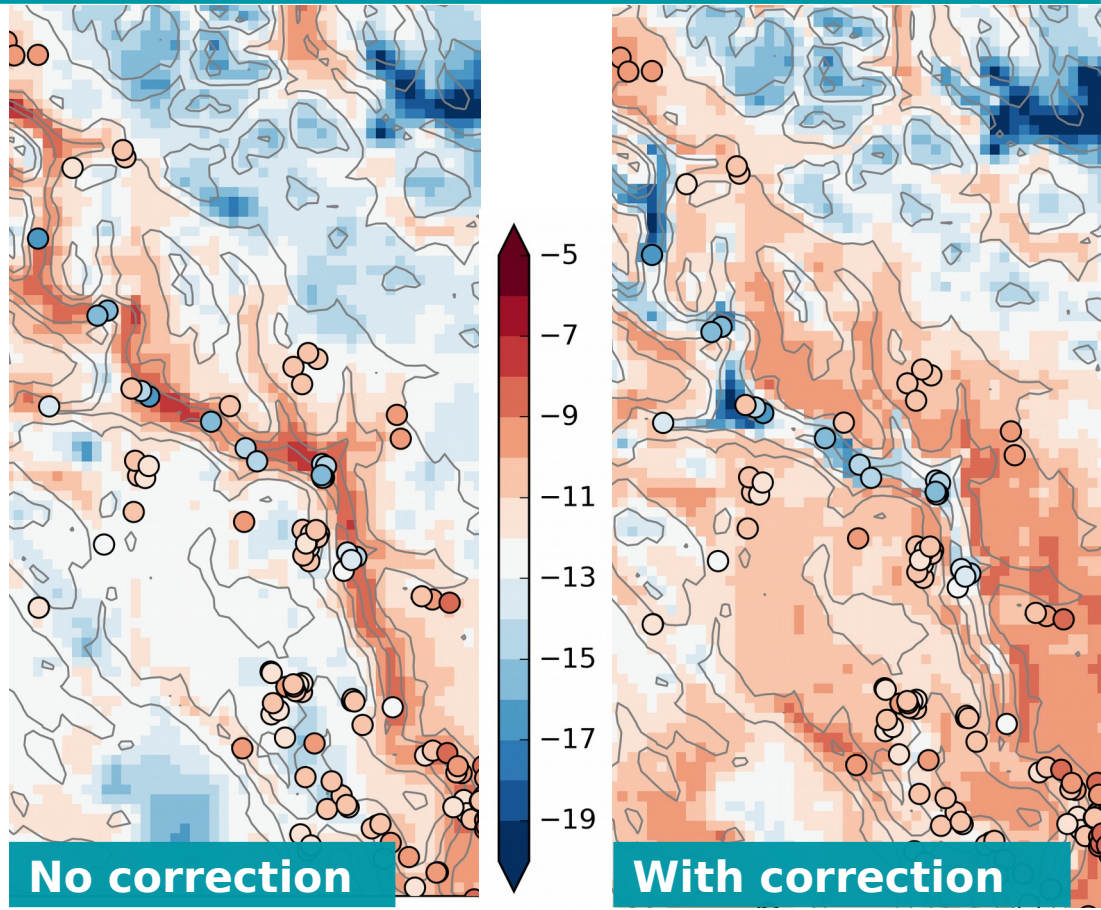
Spatial consistency test
(first guess, 50 closest stations)



Optimal Interpolation

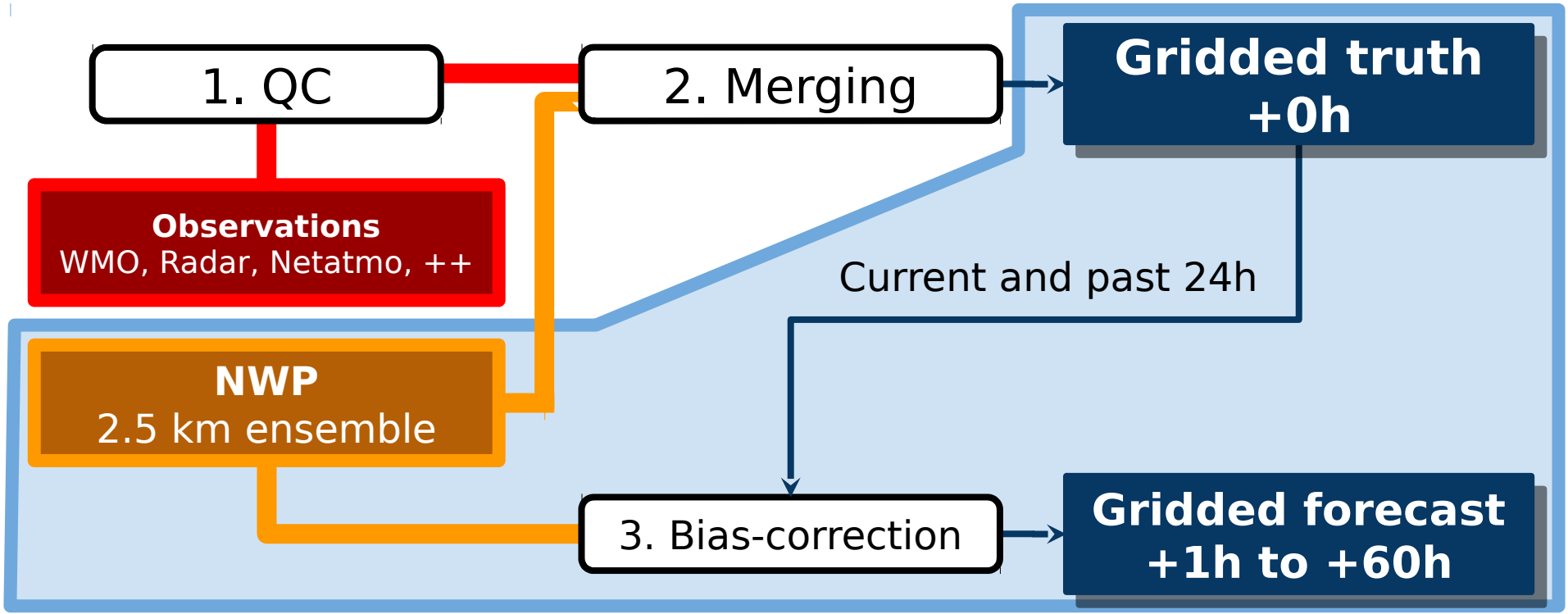
Correction are spread in space, but limited by:

- Distance (~30km)
- Elevation (~200m)
- Land/ocean
- MEPS covariance structure
  - E.g. will not spread across a front



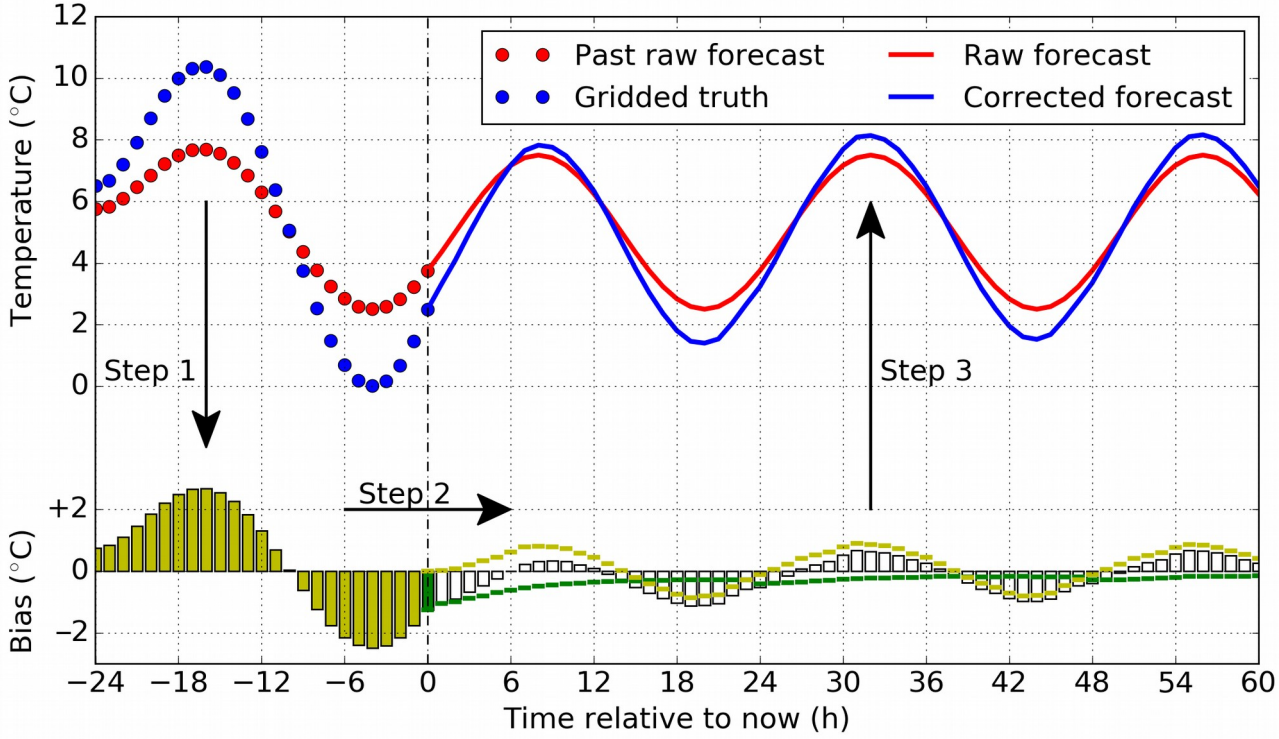
MET Nordic Forecast

- Used in post-processing of temperature & precip from NWP
  System is run every hour
  Seamless transition from +0h to +1h

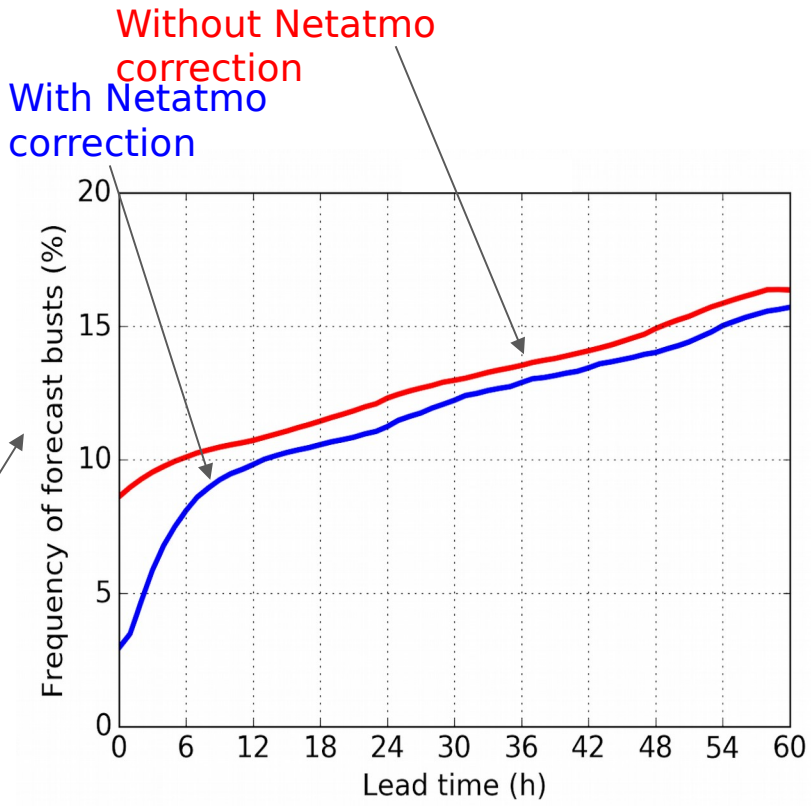


3. Bias-correction

- Gridpoint by gridpoint correction
  Seamless transition from gridded truth to gridded forecast
  Diurnally varying bias based on last 24 hours



Impact on operational forecasts

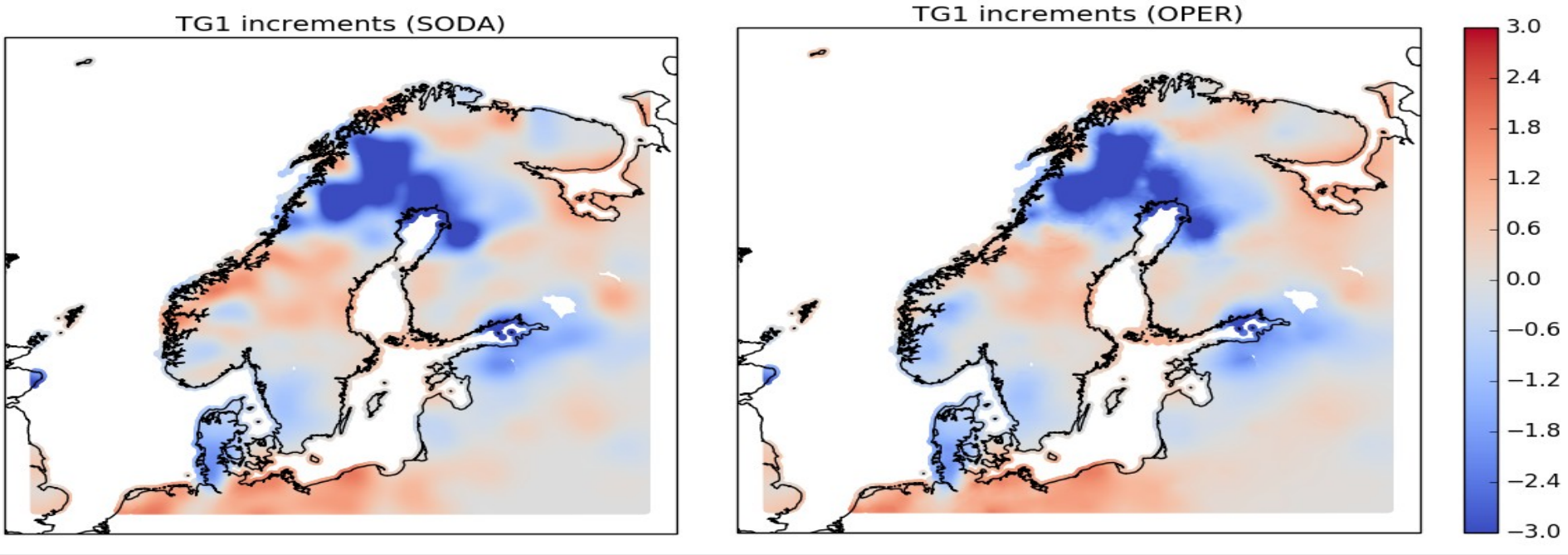


% Errors > 3 degrees

Soil assimilation (TG1)

Offline SODA

Operational:
Inline CANARI



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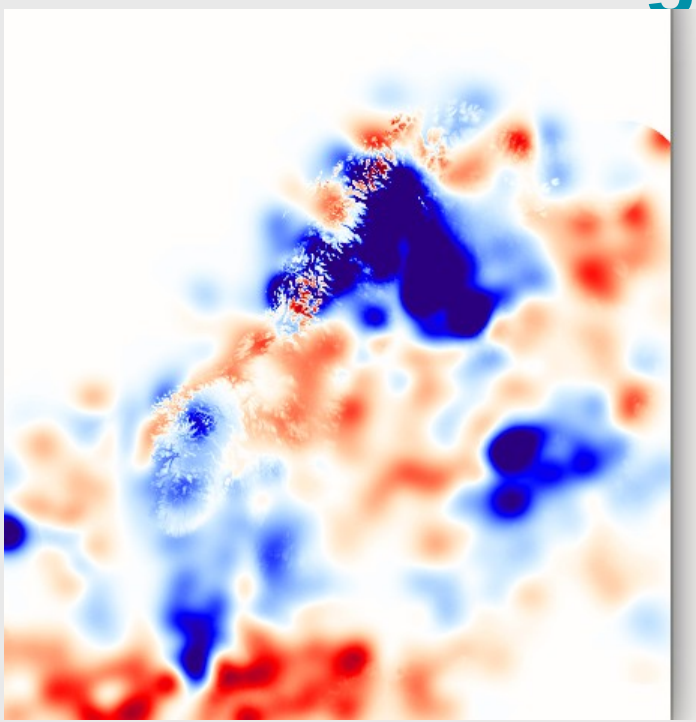
T2M

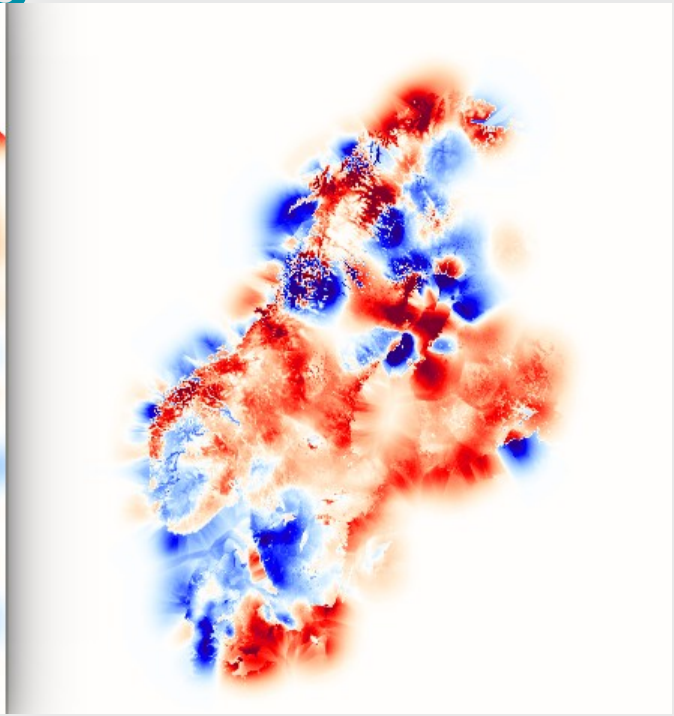
OPER + height



d=60km
gradient=0.065

h=300m
sigma=0.6

Amateur T2M



d=60km
gradient=0.065

h=300m
sigma=0.6

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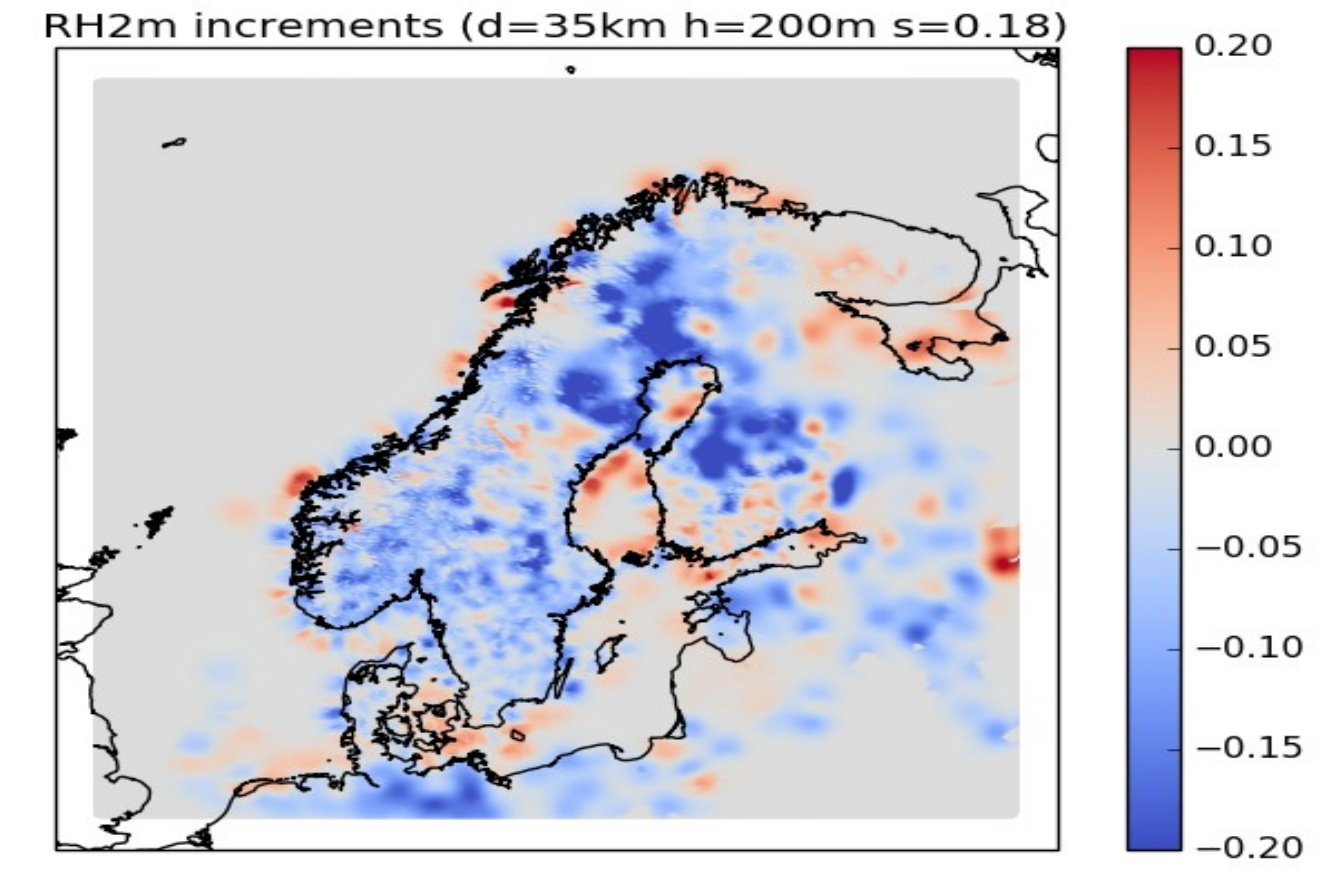
Amateur relative humidity observations



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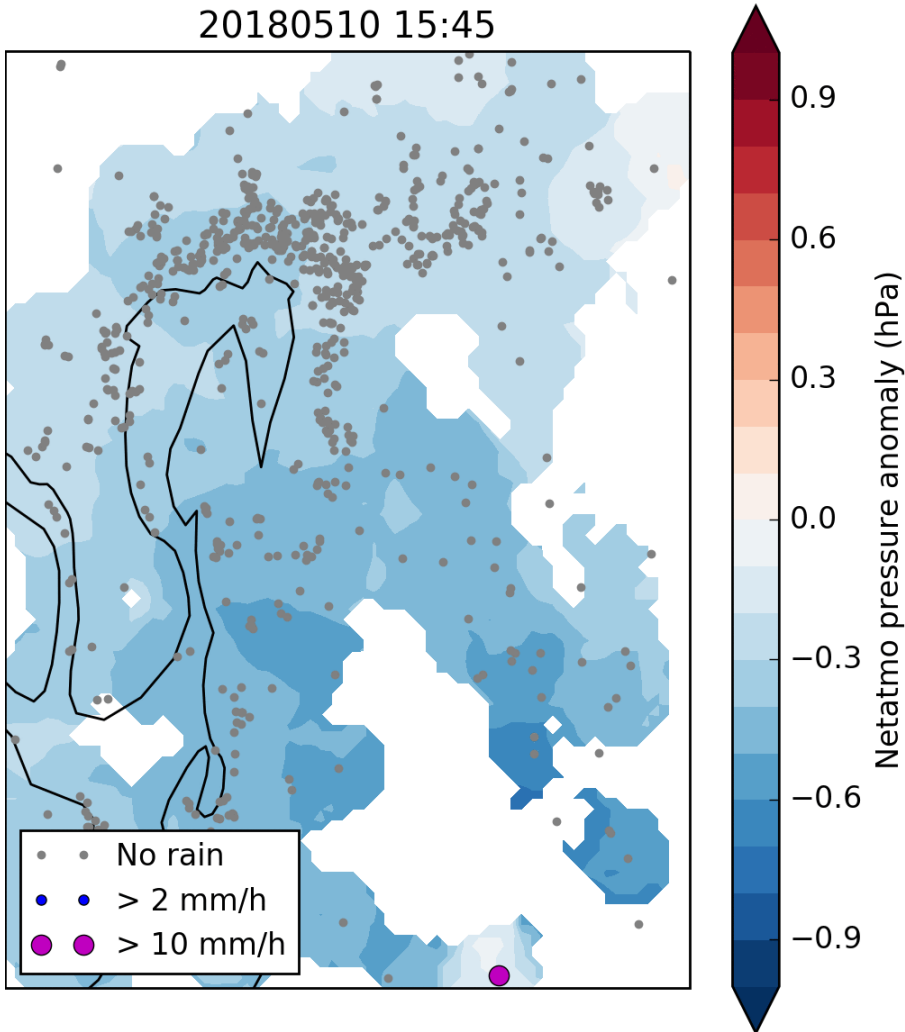
Pressure and rain - correlation on high spatiotemporal resolutions



Nipen, T. N., Seierstad, I. A., Lussana, C., Kristiansen, J. and Hov Ø. (2019), Adopting citizen observations in operational weather prediction. Bull. Amer. Meteor. Soc., accepted for publication

Temperature, Ensemble Statistical Interpolation
Lussana, C. , Seierstad, I. A., Nipen, T. N. and Cantarello, L. (2019), Spatial interpolation of two meter temperature over Norway based on the combination of numerical weather prediction ensembles and in situ observations. Q J R Meteorol Soc. Accepted Author Manuscript. doi:10.1002/qj.3646

Softwares:
Gridpp, Statistical post-processing
https://github.com/metno/gridpp

TITAN, data quality control
https://github.com/metno/TITAN

Data Repository *MET post-processed products*
http://thredds.met.no/thredds/metno.html

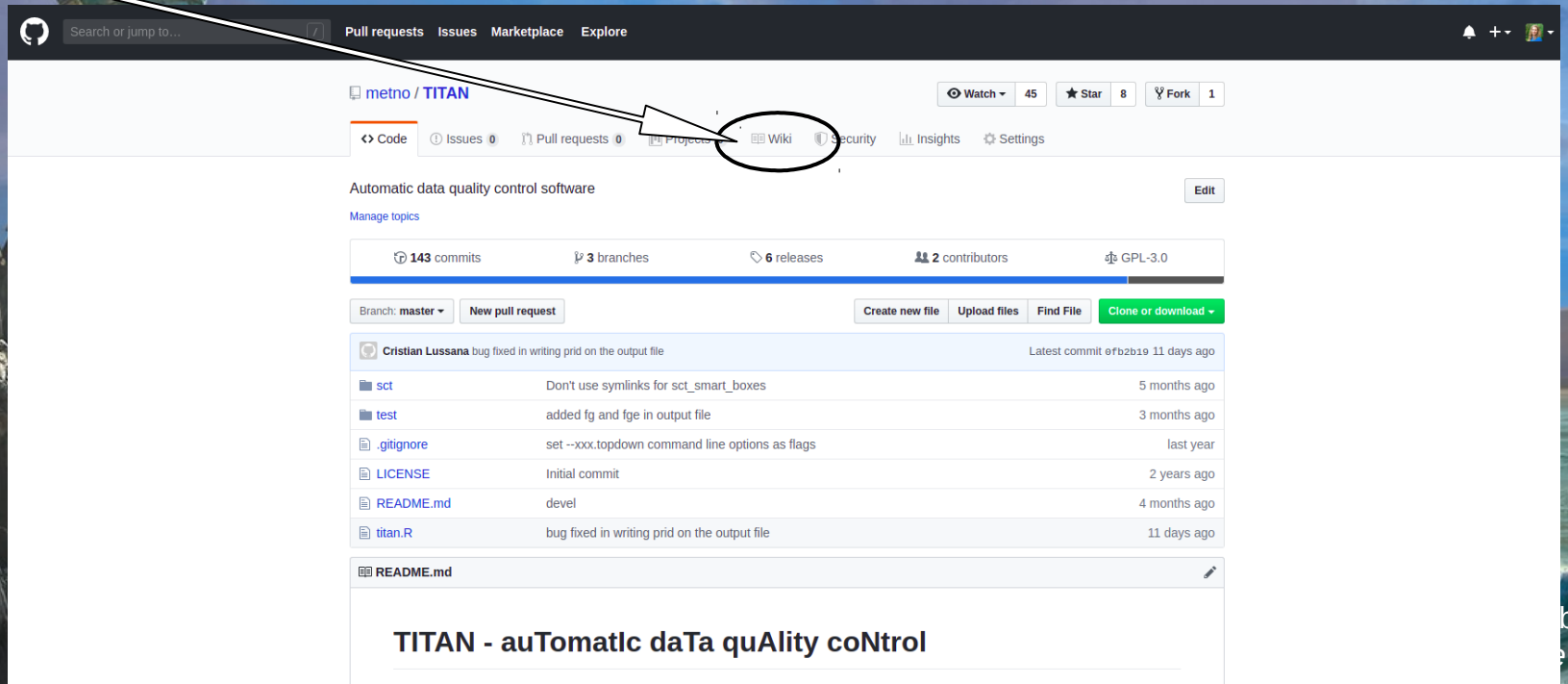
Documentation
https://github.com/metno/NWPdocs

TITAN

automatic data quality control software

https://github.com/metno/TITAN

check out the wiki !



Summary and more information

1) Quality control is essential to get value from the citizen observation system
2) Methods using the citizen network must take into account observation and NWP model uncertainties
3) Easy access to data in near real time through APIs
4) Citizen observations are used operationally in post-processing and under testing for surface data assimilation in Harmonie

Open data:
api.met.no, thredds.met.no, dev.netatmo.com

Quality control software:
www.github.com/metno/TITAN

Post-processing software:
www.github.com/metno/gridpp

Thank you for your attention