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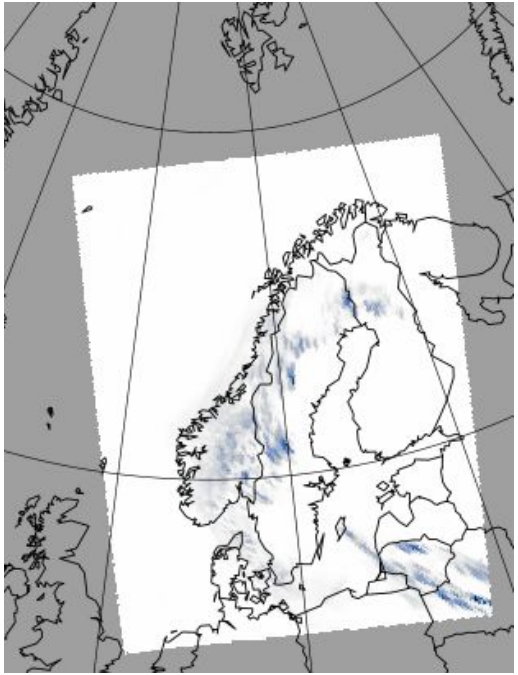
EMS – UP1.4 – 12.09.2025
High-resolution precipitation monitoring and statistical analysis for hydrological and climate-related applications

MET Nordic Analysis of hourly precipitation over Scandinavia

Amélie Neuville • Line Båserud • Thomas Nipen • Ivar Seierstad • Cristian Lussana

What is MET Nordic analysis dataset ?



met_analysis_1_0km_nordic_20240823T1...	met_analysis_1_0km_nordic_20240823T15Z.nc
air_pressure_at_sea_level	air pressure at sea level
air_temperature_2m	air temperature
altitude	surface altitude
cloud_area_fraction	cloud area fraction
forecast_reference_time	forecast reference time
integral_of_surface_downwelling_lo...	integral of surface downwelling longwave flux in air ...
integral_of_surface_downwelling_sh...	integral of surface downwelling shortwave flux in ai...
land_area_fraction	land area fraction
latitude	latitude
longitude	longitude
precipitation_amount	precipitation amount
projection_lcc	projection lcc
relative_humidity_2m	relative humidity
time	time
wind_direction_10m	wind from direction
wind_speed_10m	wind speed

Covers Scandinavia, 1 km grid
Data since September 2012

https://github.com/metno/NWPdocs/wiki/MET-Nordic-dataset

Workflow for precipitation / temperature

Observations measured by traditional weather stations

Observations measured by citizen weather stations (Netatmo, Cordulus,...)

Corrections

Quality control

MEPS
NWP model
2.5 km
downscaled to 1 km

Statistical interpolation

MET Nordic Analysis (1 km)

Versions of the datasets

Real Time (RT) :

- every hour (ca 15 minute delay)
- from 2018
- methods can change along the time
- not all observations available at the time of the run

Archive datasets :

- consistent rerun over a long time
- from 2012
- more observations

RT Dataset applications

- Used in “current conditions” on Yr
- Used to post-process forecasts
- Used during weather-related emergencies

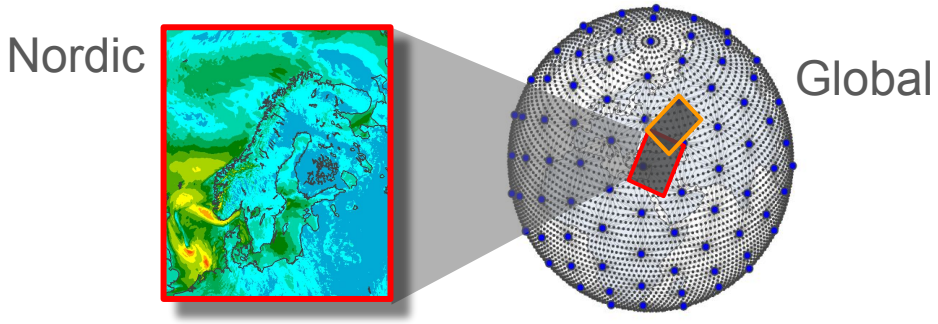
  Ex: MET Nordic Dataset can be coupled to hydrological models so we get flood warnings

Real Time Dataset :

- every hour (ca 15 minute delay)
- from 2018
- methods can change along the time
- not all observations available at the time of the run

Archive Dataset applications

- Used for case studies (hydrology, building new infrastructure…)
- Used to train the Bris machine learning weather forecasting model



Archive datasets :

- consistent rerun over a long time
- Previous version **V3** from 1. september 2012 to January 2023
- *New version* ***V4*** *from 1. september 2012 to July 2025*

What is new in V4 ?

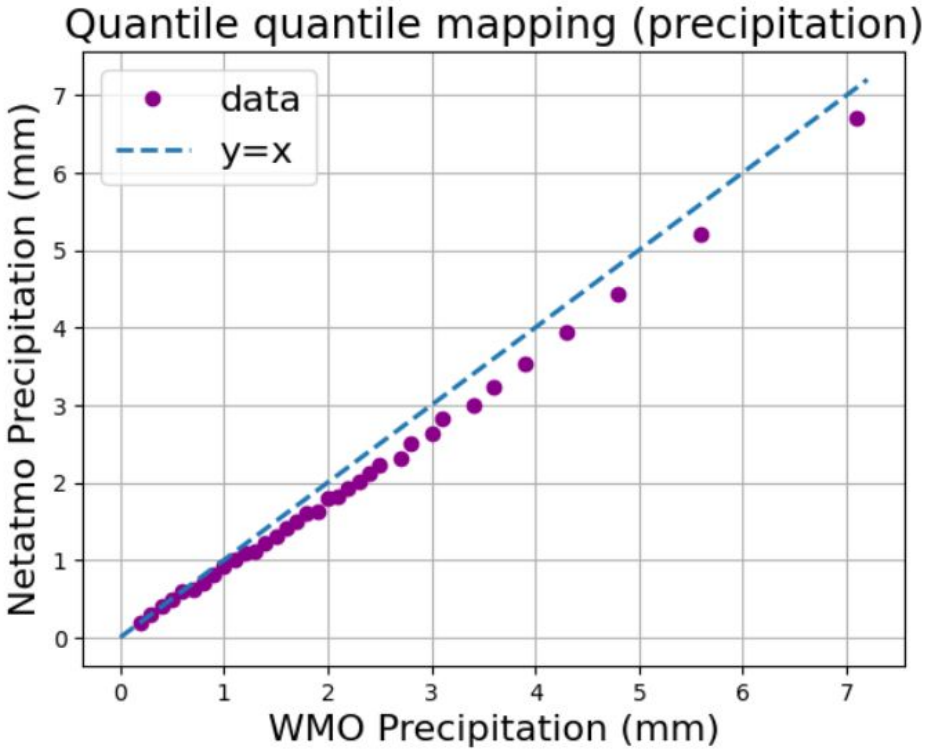
V4: updated with **focus on improving precipitation** compared to **V3**

- Precipitation observation corrections :
  - bias adjustment
  - wind undercatch
- Upgraded statistical interpolation method
  to be closer to the precipitation observations
- More observations (especially over Finland and Sweden)
- Better quality control
- longer time coverage : from 1. september 2012 to July 2025

Bias corrections for crowdsourced precipitations

Instrument bias :

Netatmo precipitations are underestimated compared to WMO stations



C. Lussana et al: Exploratory analysis of citizen observations of hourly precipitation over Scandinavia, ASR, 20, 35–48, 2023 https://doi.org/10.5194/asr-20-35-2023

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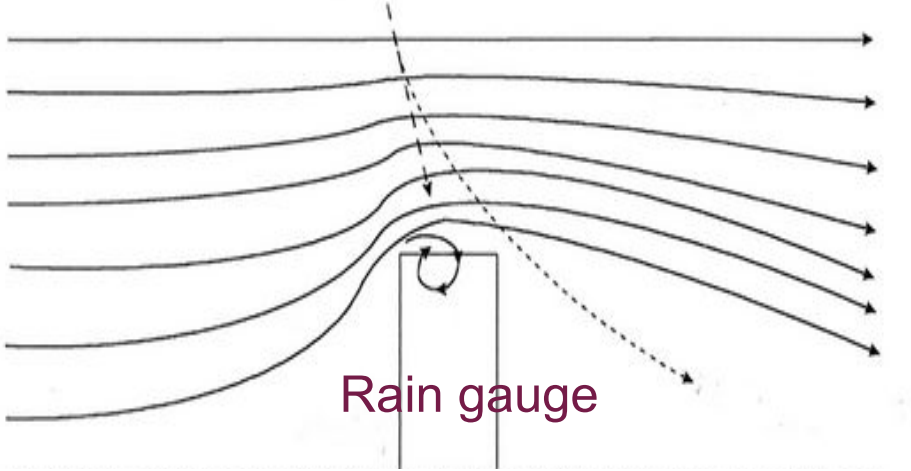
Wind induced undercatch (all stations)



Strangeways, Weather 75(10) https://doi.org/10.1002/wea.3686

"Airflow over a rain gauge showing the deflected path of raindrops. The problem is much greater with snowflakes."

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Correction for the wind-undercatch

Multiplicative correction factor : $k(T, Wind)$

Wolff formula for snow

Wolff et al: Derivation of a new continuous adjustment function for correcting wind-induced loss of solid precipitation: results of a Norwegian field study, Hydrol. Earth Syst. Sci., 19, 951–967, 2015, doi:10.5194/hess-19-951-2015

Førland formula for rain

Førland et al: Manual for operational correction of nordic precipitation data, DNMI report, 24, 96/96, 1996

Smooth transition for 1C < T < 3C

MEPS Model inputs:

- Wind at gauge level, derived from the 10m wind
- Temperature at 2m

C. Lussana: MET report

No. 05/2024 ISSN 2387-4201

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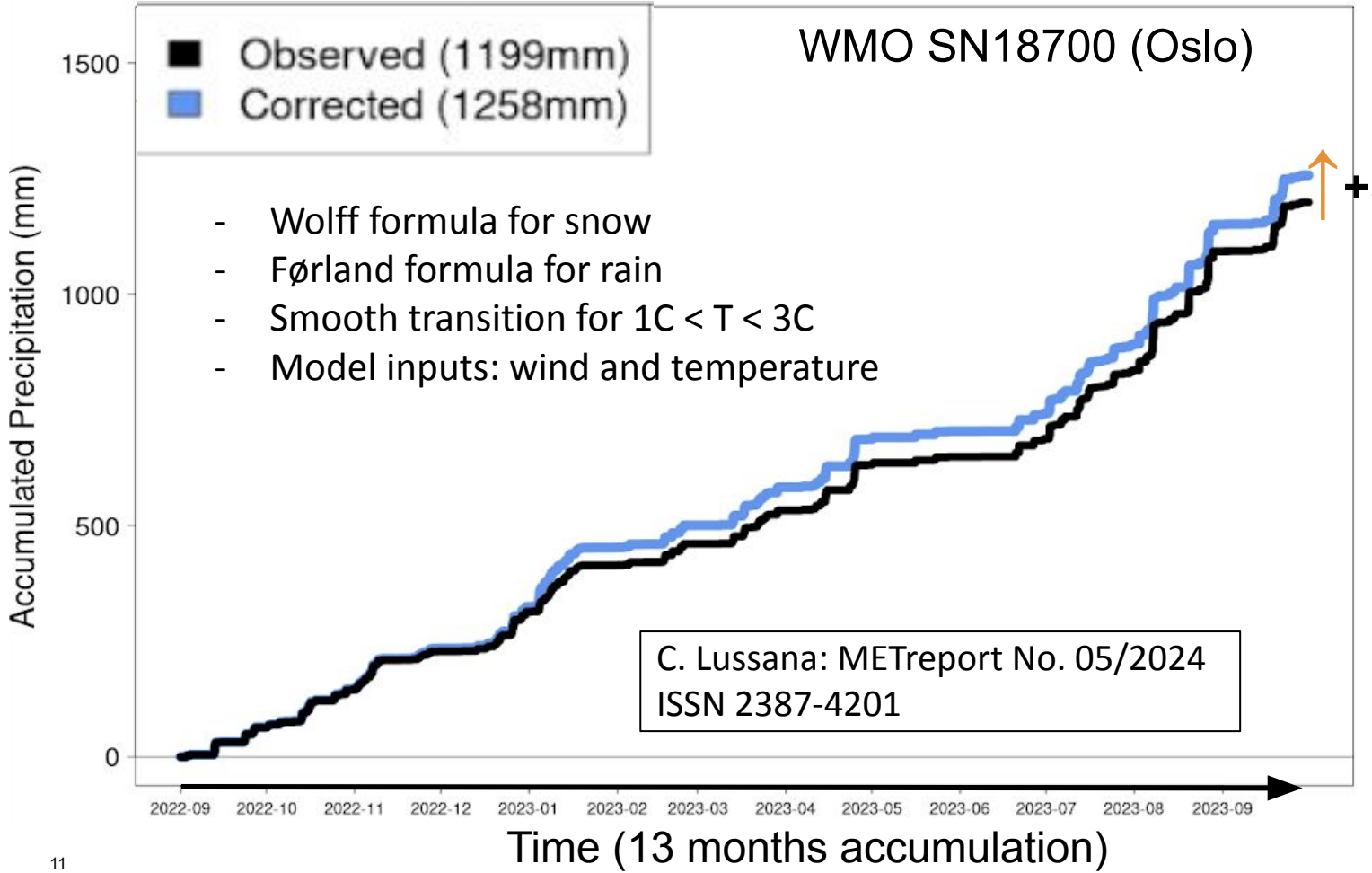
Correction for the wind-undercatch



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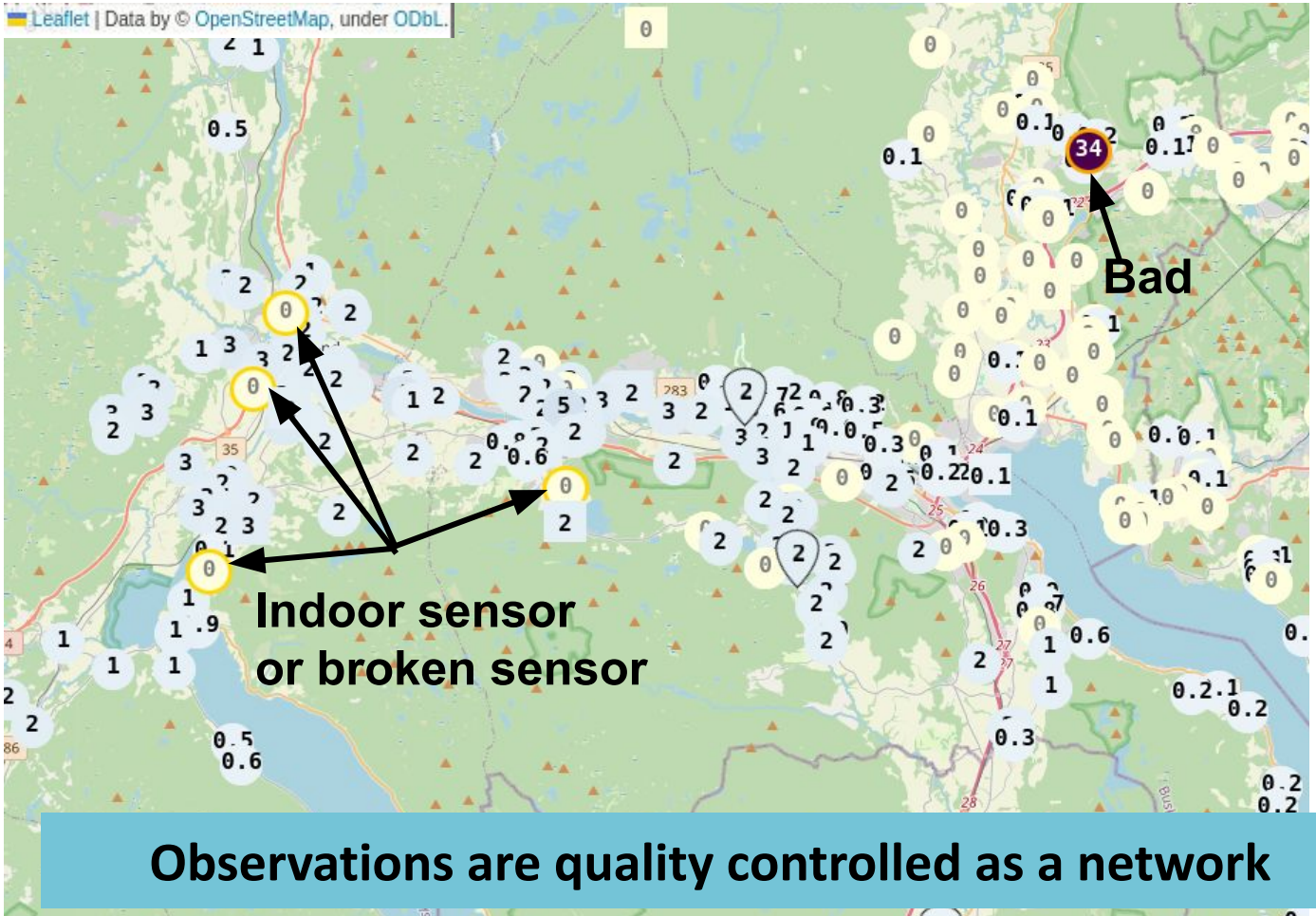
Automatic spatial QC for hourly precipitations



Flagged stations

QC methods available on https://github.com/metno/titanlib/

Observations are quality controlled as a network

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Statistical interpolation

Quarterly Journal of the Royal Meteorological Society

RESEARCH ARTICLE | Open Access

Ensemble-based statistical interpolation of atmospheric variables near the surface

Cristian Lussana, Thomas N. Nipen, Benjamin Menetrier, Ivar A. Seierstad

First published: 30 July 2025 | https://doi.org/10.1002/qj.5046

Abstract

This study presents a sequential implementation of ensemble optimal interpolation (EnOI) applied to the spatial analysis of near-surface atmospheric variables. The proposed scheme, ensemble-based statistical interpolation (EnSI), combines numerical model output with observations, as commonly done using optimal interpolation (OI) in some national meteorological services. However, EnSI extends OI by incorporating a multi-scale loop, consecutive observation times, and cross-correlations between

Statistical interpolation methods available on https://github.com/metno/gridpp

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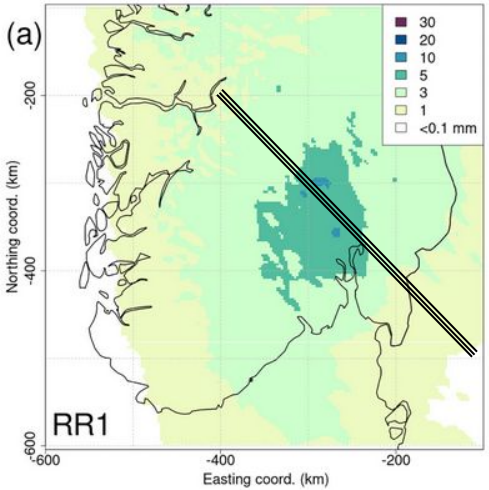
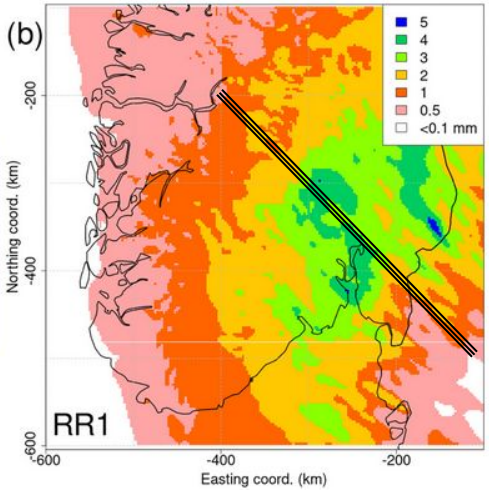
Statistical interpolation

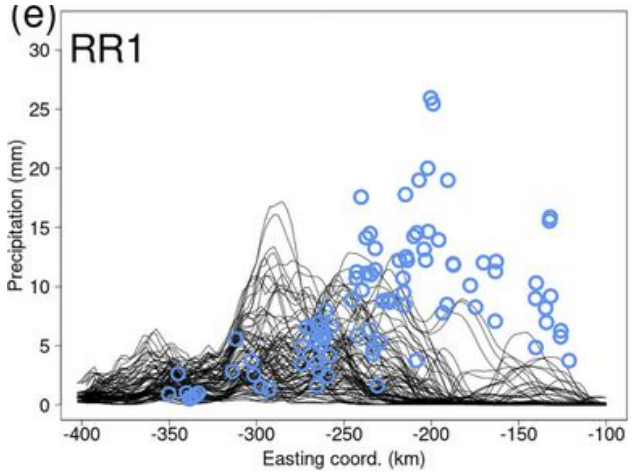
Hans event, 7th August 2023 T10Z

Mean



Spread





Before post processing (model)

Misalignment between observations and model outputs

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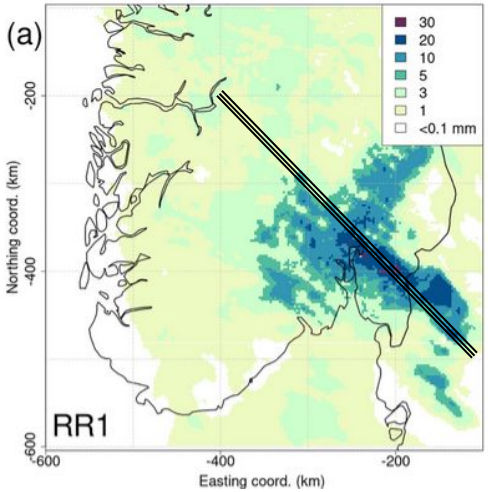
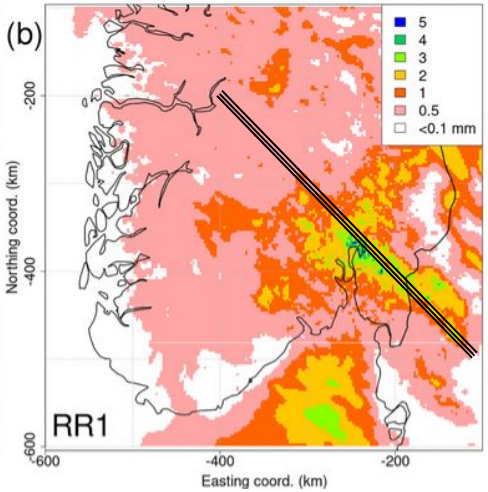
Statistical interpolation

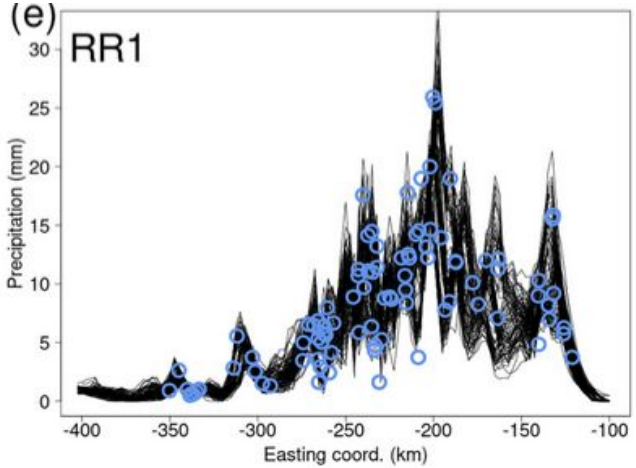
Hans event, 7th August 2023 T10Z

Mean



Spread





After post processing (model + obs)
Better agreement between observations and model outputs

Multiscale method based on optimal interpolation
with successive spatial scales: Dh = [10 km, 8 km, 6 km, 4 km, 2 km]

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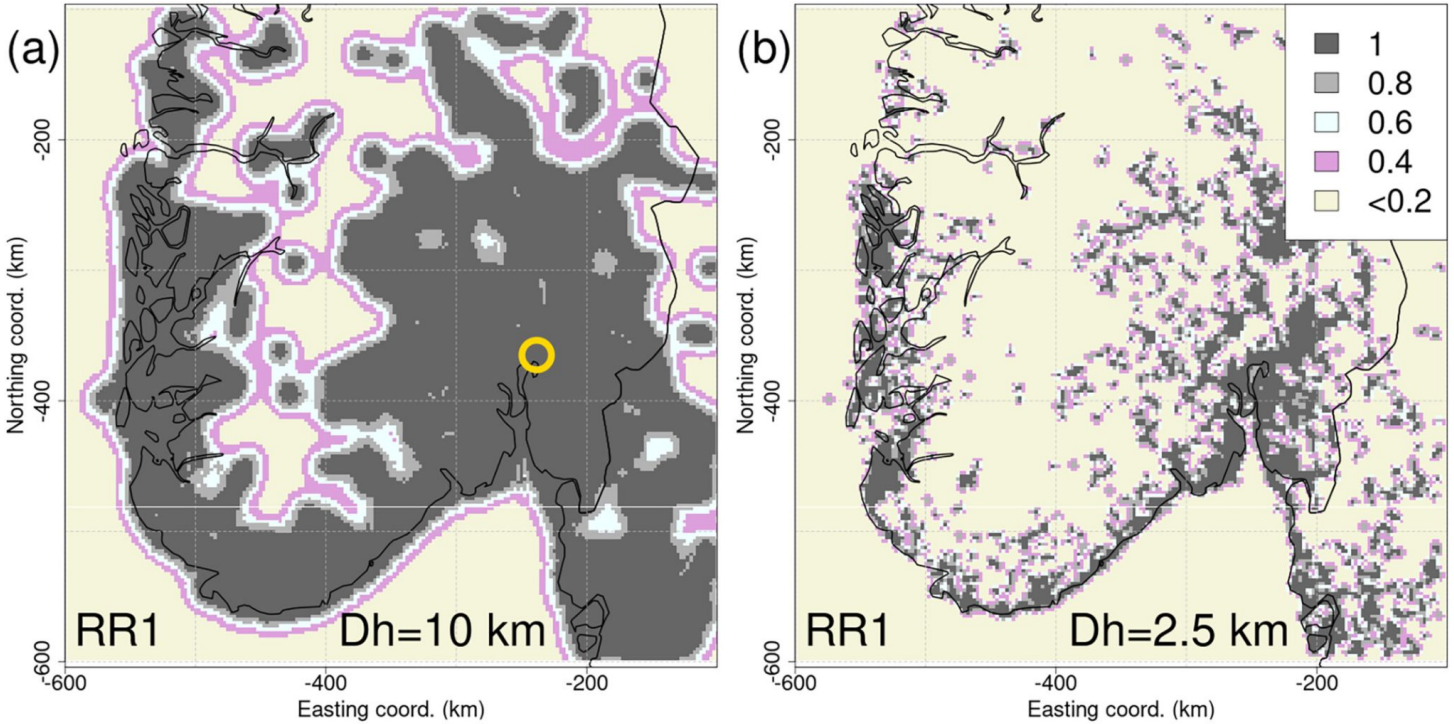
Where do we modify the model ?

Integral data influence (IDI) for precipitation for different scales used in the interpolation



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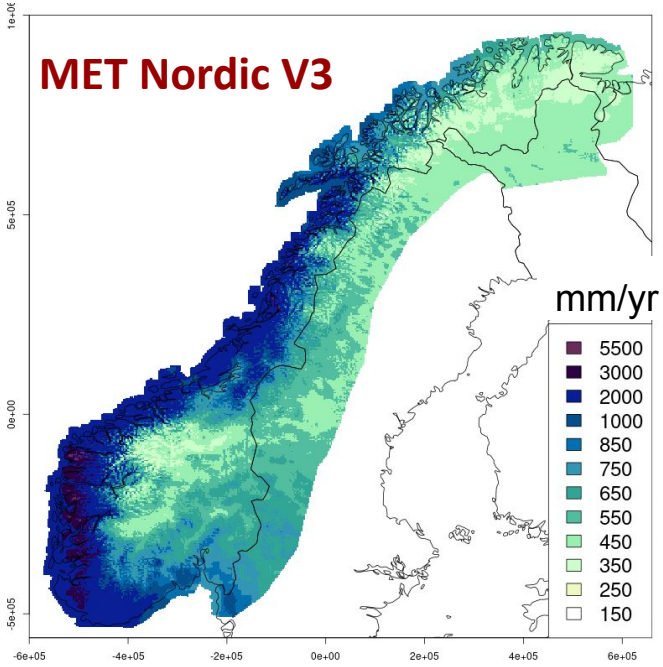
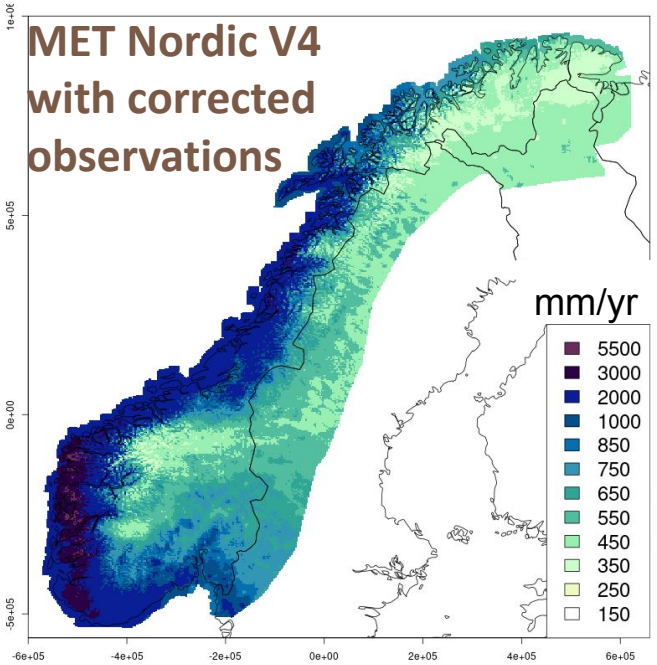
Mean annual rain from 2013 to 2022

Rain = Total precipitation amount accumulated in the period considered when daily mean temperature is greater or equal to 0.5 °C





mm/yr

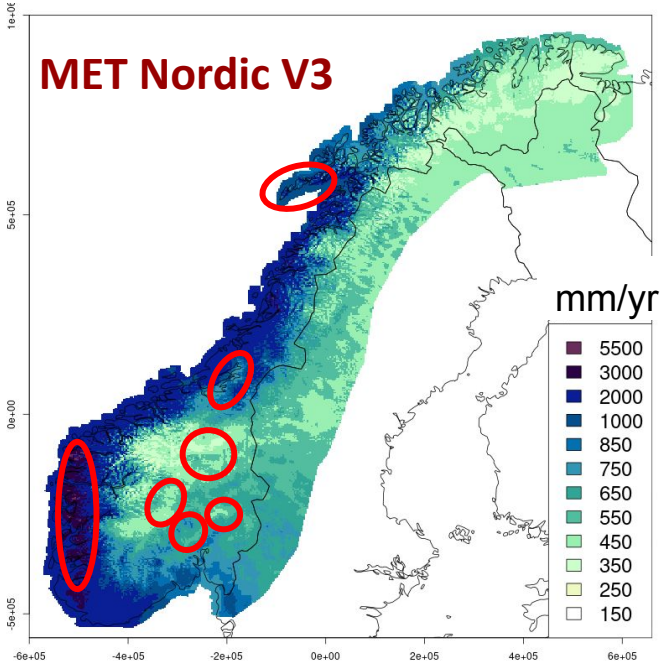
q10	q50	q90	Max
369	557	1308	4369

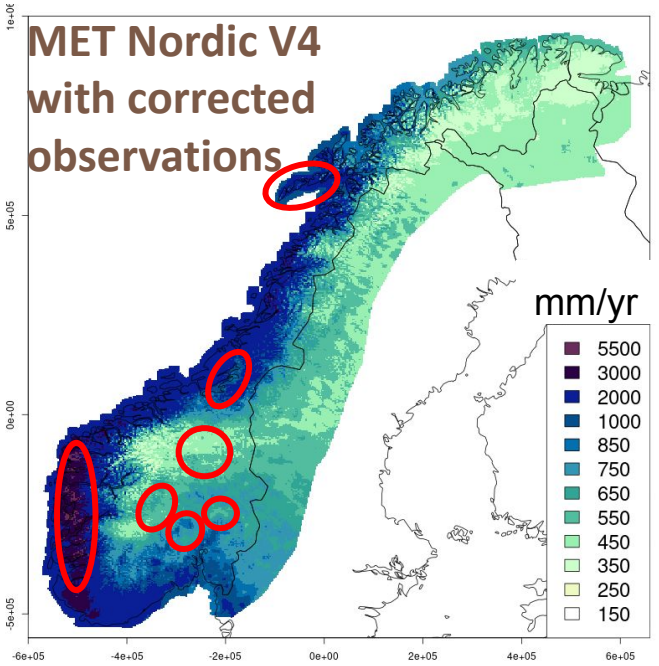
q10	q50	q90	Max
371	587	1483	4486

Preliminary results

Mean annual rain from 2013 to 2022

Rain = Total precipitation amount accumulated in the period considered when daily mean temperature is greater or equal to 0.5 °C





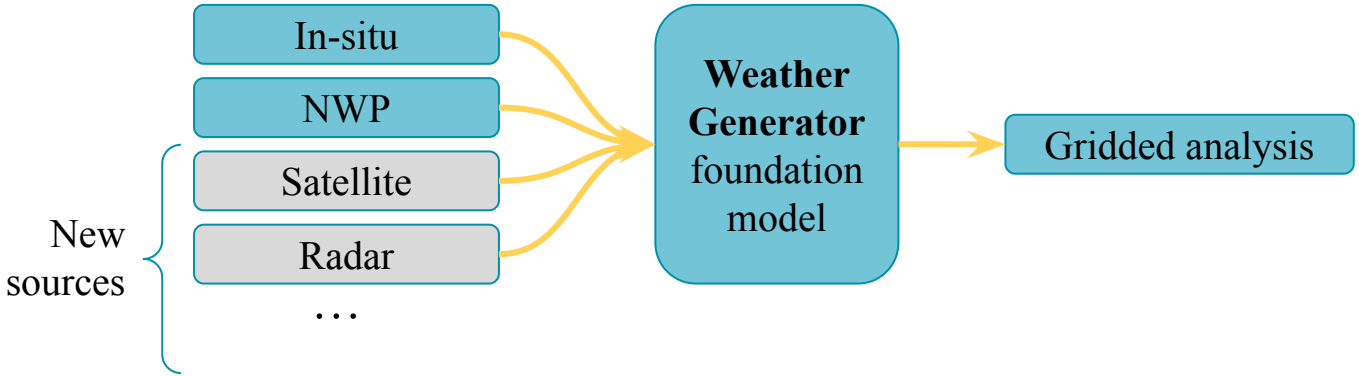
mm/yr	q10	q50	q90	Max
	369	557	1308	4369

q10	q50	q90	Max
371	587	1483	4486

Preliminary results

Future versions of MET Nordic ?

- Using the WeatherGenerator foundation model to develop analyses
  - Ability to integrate further data sources
  - Better handling of data sources that are intermittent or changing over time



- Using the WeatherGenerator for quality control of the observations

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Conclusion

MET Nordic analysis v4 2012-2025
https://github.com/metno/NWPdocs/wiki/MET-Nordic-dataset

Bias correction for crowdsourced observations
Wind induced undercatch
Spatial QC with Titanlib
https://github.com/metno/titanlib/
Statistical interpolation: multiscale method
https://github.com/metno/gridpp
https://rmets.onlinelibrary.wiley.com/doi/epdf/10.1002/qj.5046

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Thomas Nipen
Ivar Seierstad
Cristian Lussana

Future plans:

Funded by the European Union
Coordinated by ECMWF
Weather Generator
www. weathergenerator.eu

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