



Norwegian  
Meteorological  
Institute

**Nye muligheter i modellering med “moderne”  
observasjoner, eksempel fra numerisk  
værvarsling.**

**[Emerging possibilities in NWP from novel  
observations]**

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# Numerisk værvarsling

- ❑ (Diagnosis) Calculate the weather now:  
*Satellite, radar, weather stations, balloons, ... ,  
model estimate (short forecast)*
- ❑ (Prognosis) Run a weather model forward in  
time:  
*Laws of physics and mechanics simulated on big  
computers (HPC)*

# Observing the atmosphere - conventional observations, structure functions, flow dependency, ...

Satellites



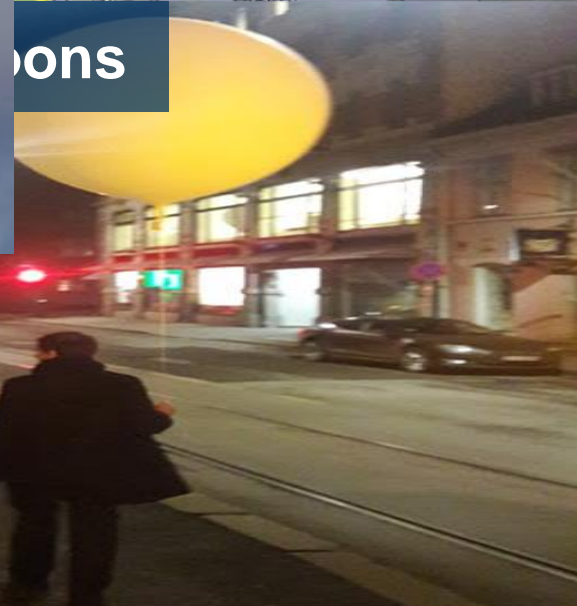
Radars



Weather stations



ons

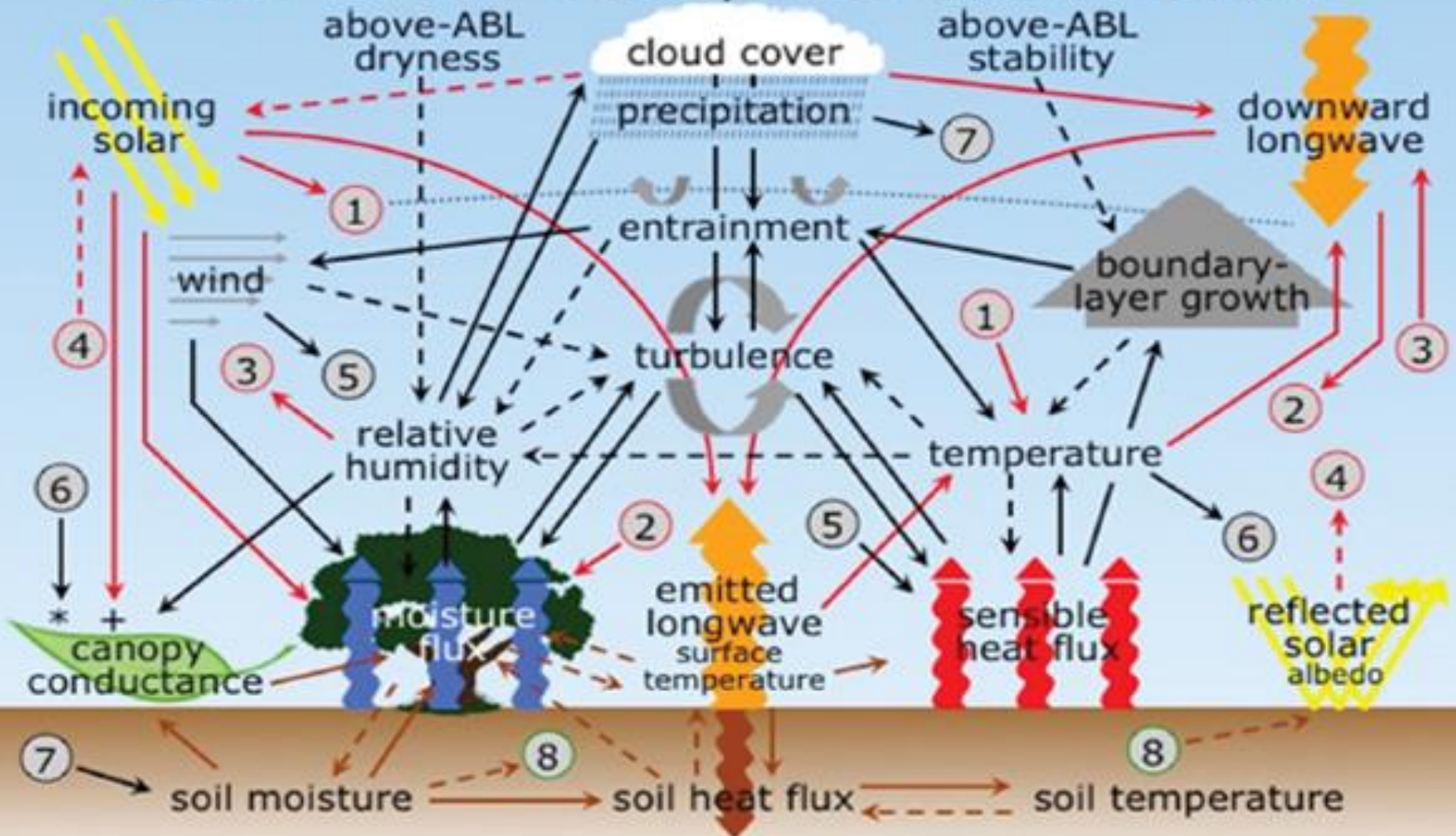




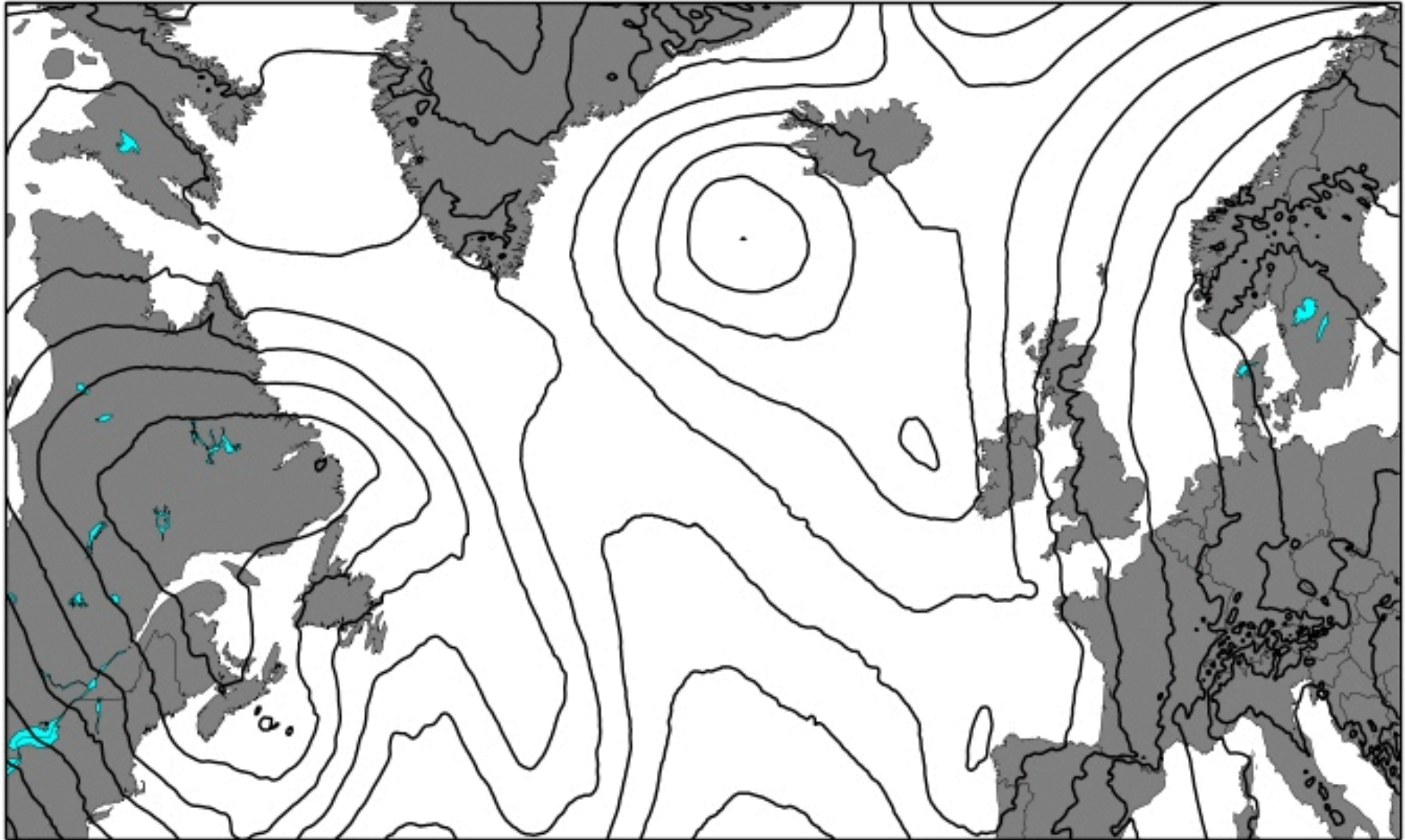
# Sunshine (and more) inside a computer - process understanding, parameterizations, earth-system, ...

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## Local Land-Atmosphere Interactions

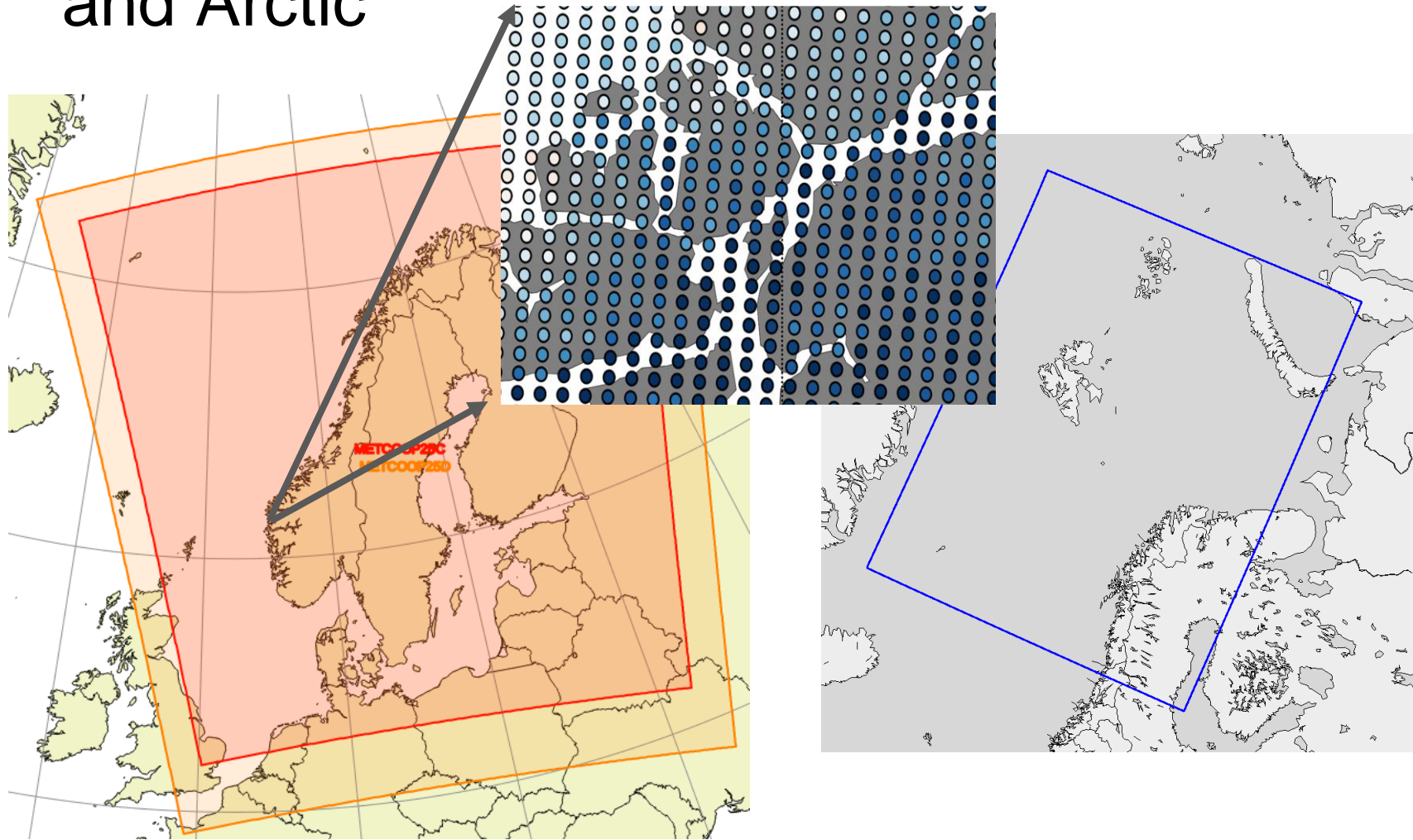


# Prognosis - global model





# Our regional model domains - AROME MEPS and Arctic



In Autumn 2018, the HPC installations will consist of three completely redundant sites, with HPCs located at FMI, SMHI and the National Supercomputer Centre (NSC) in Linköping, Sweden.

The weather forecasts have been fully automated (since 2013)

... with a human touch

The screenshot shows the YR weather website for Oslo. The page includes a search bar, navigation tabs for Front page, Norway, Oslo, and Oslo. The main content area displays the weather forecast for Oslo, updated at 23:34, with the next update around 23:00. The forecast is presented in a table format for Today (Thursday 09/02/2017) and Tomorrow (Friday 10/02/2017). A sidebar on the left provides navigation options like Overview, Hour by hour, Long term, Weather radar, Statistics, Maps, and Coastal forecast. Below the sidebar, there is a section for Relevant Places with links to Oslo, Abu Dhabi, Nice, Skullerud, Hakadal observation site, Rotnes, New Westminster, and Bjørnholt observation site. On the right side, there is a section titled 'The meteorologists on Twitter' featuring a tweet from Meteorologene (@Meteorologene) with a video player showing a map of Norway. Two orange arrows point from the text above to the search bar and the tweet section.

YR Search for a location... Advanced search My places

Front page Norway Oslo Oslo Oslo

Weather forecast for **Oslo**

Updated at 23:34. Next update around 23:00.

Add My places Forecast as PDF

Overview

- Hour by hour
- Long term
- Weather radar
- Statistics
- Maps
- Coastal forecast

RELEVANT PLACES

- Oslo
- Abu Dhabi
- Nice
- Skullerud
- Hakadal observation site
- Rotnes
- New Westminster
- Bjørnholt observation site

**Today, Thursday 09/02/2017**

Time	Forecast	Temp.	Precipitation	Wind
23:00–00:00		-4°	0.2 – 0.3 mm	Moderate breeze, 6 m/s from northeast

**Tomorrow, Friday 10/02/2017**

Time	Forecast	Temp.	Precipitation	Wind
00:00–06:00		-4°	1.0 – 1.5 mm	Moderate breeze, 6 m/s from northeast
06:00–12:00		-4°	0.6 – 1.0 mm	Gentle breeze, 5 m/s from northeast
12:00–18:00		-4°	0 – 0.5 mm	Moderate breeze, 6 m/s from northeast
18:00–00:00		-4°	0 – 0.2 mm	Gentle breeze, 5 m/s from northeast

**Saturday, 11/02/2017**

Time	Forecast	Temp.	Precipitation	Wind
00:00–06:00		-4°	0 mm	Gentle breeze, 5 m/s from northeast

**The meteorologists on Twitter**

Torsdag kl 13

**Meteorologene** @Meteorologene

Kaldlufta blir erstatta med mildare luft i #Norge til uka. Best vær i sør, fram med regnjakka og sydvest i Nord-Norge 🌧️

6:56 PM - 9 Feb 2017

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# Number of weekly unique users on Yr

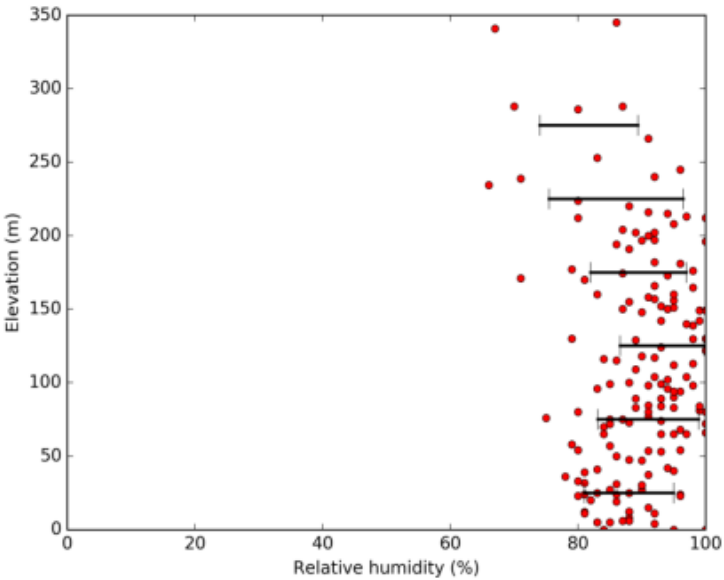




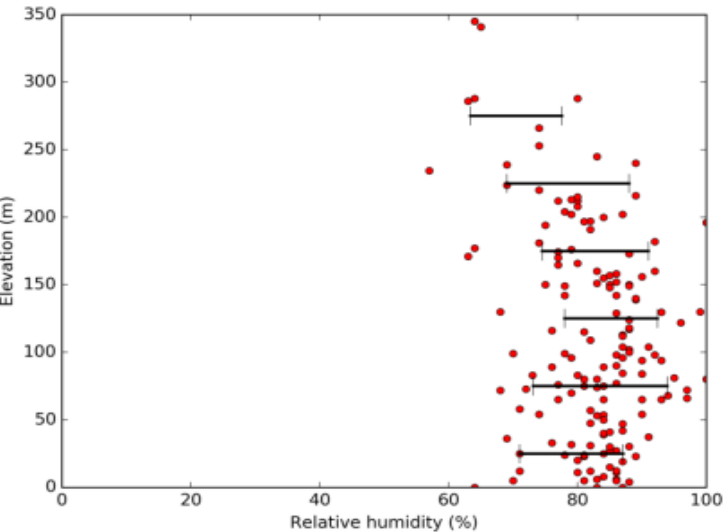
# Local weather forecasts for local weather conditions



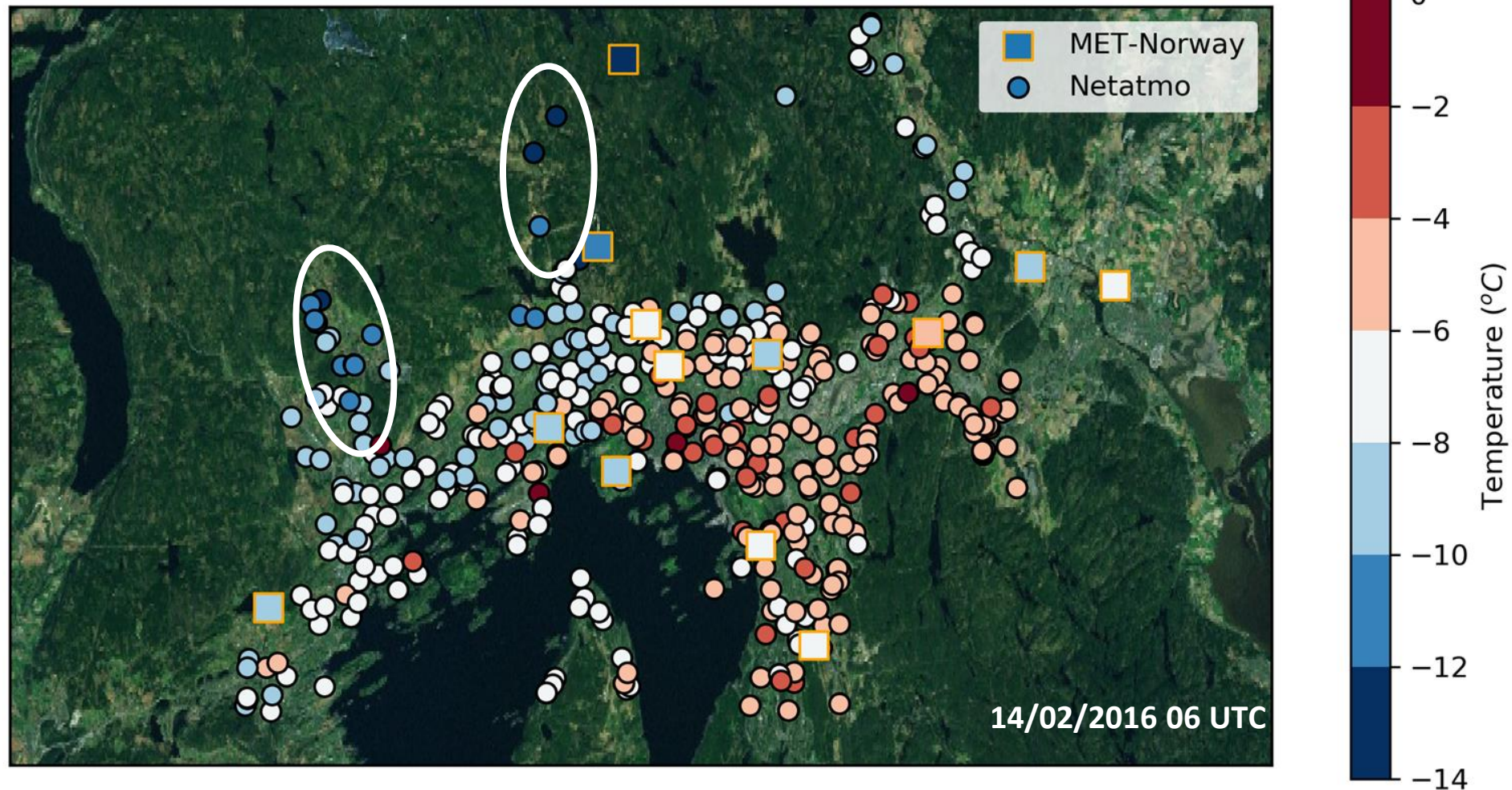
# Detecting fog using private observations 10



**Oslo (17 March 2016) noon (top); noon + 3 h (bottom)**



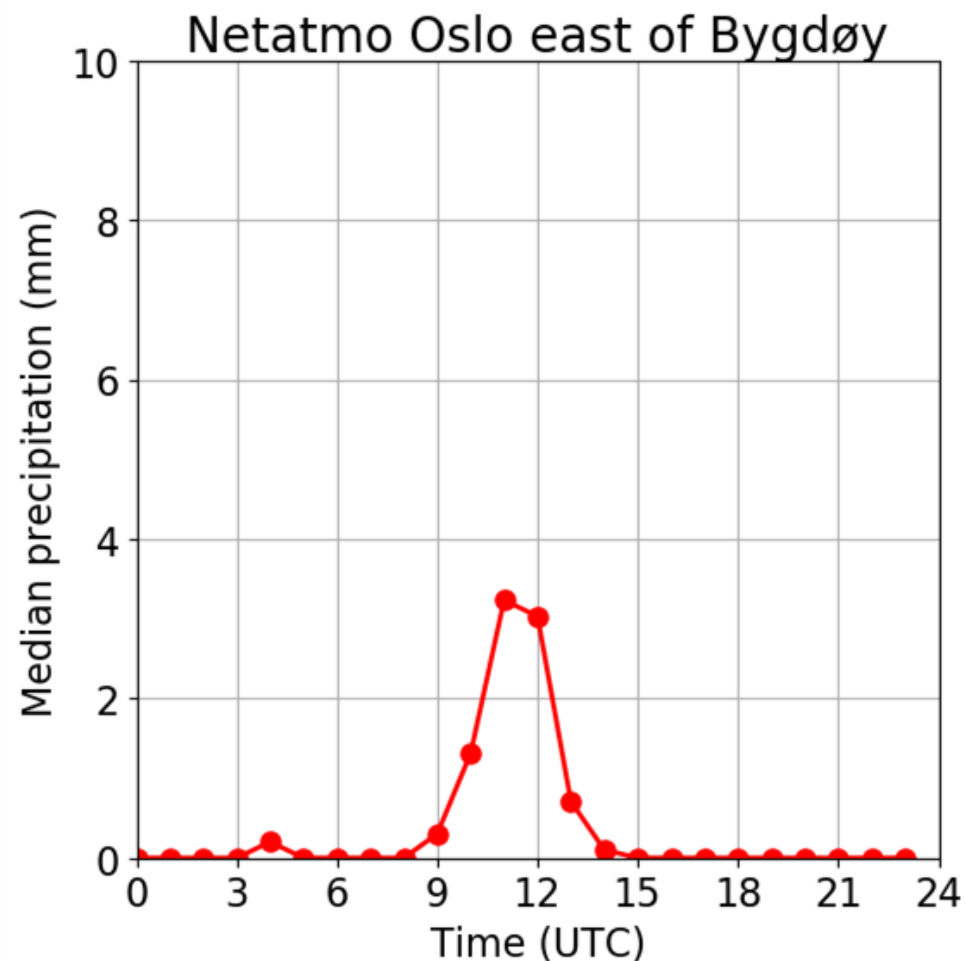
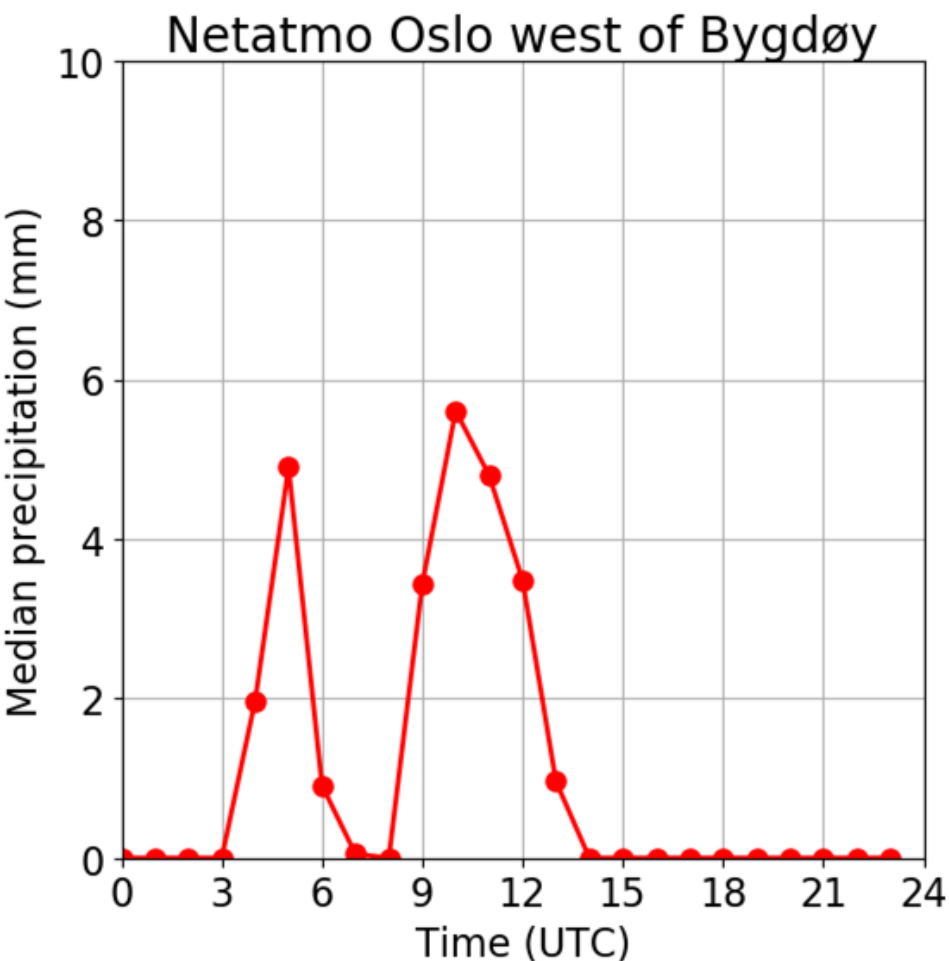
# Citizen observations: Detection of cold pools in valleys





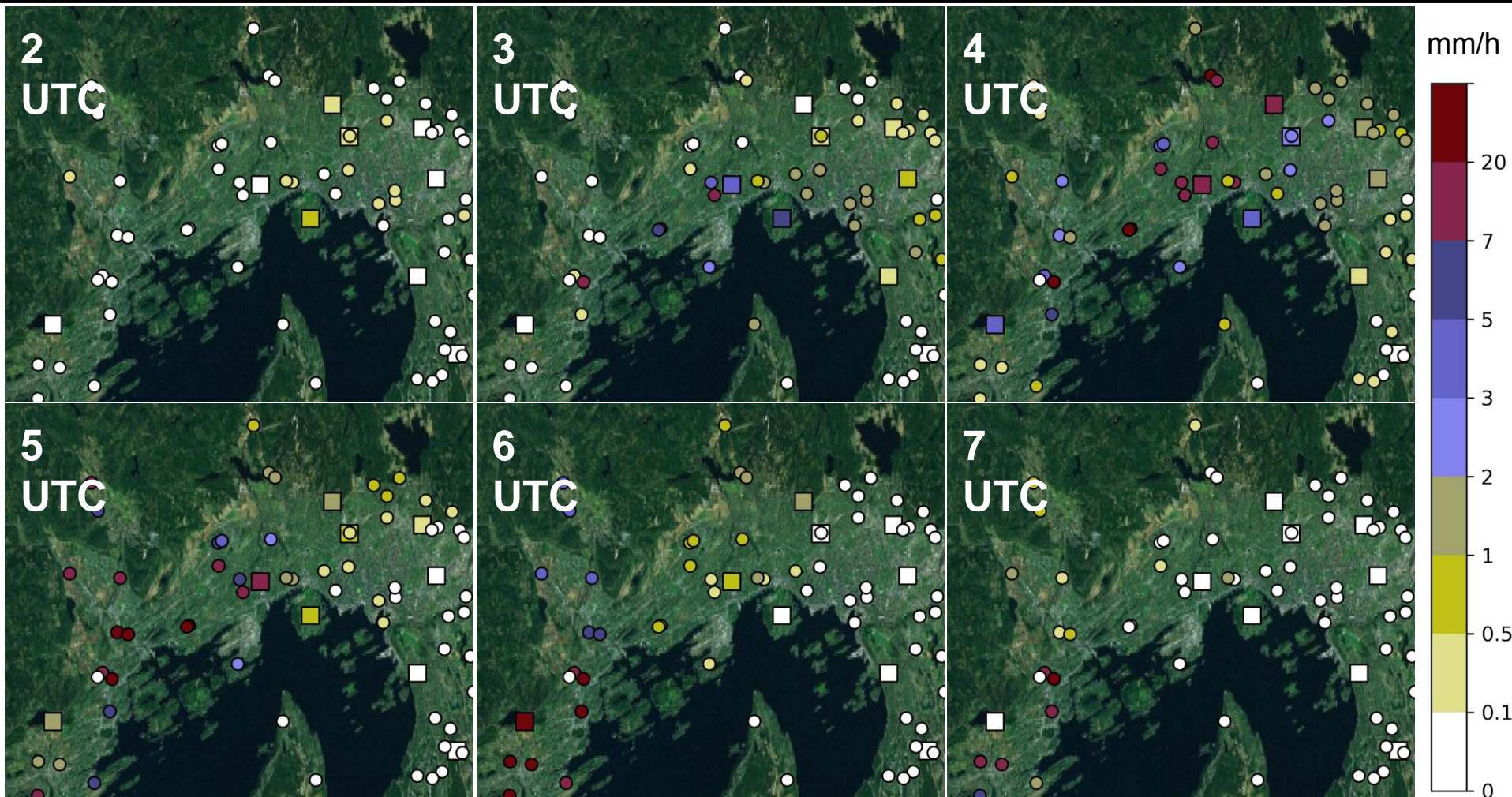
# Tidsutvikling - intens byge 6. august 2016

*Ulik utvikling vest og øst for Bygdøy: To bygesystemer vest for Bygdøy og én øst for Bygdøy. Grafene viser medianen av alle Netatmo-stasjoner.*



# Tidsutvikling første byge

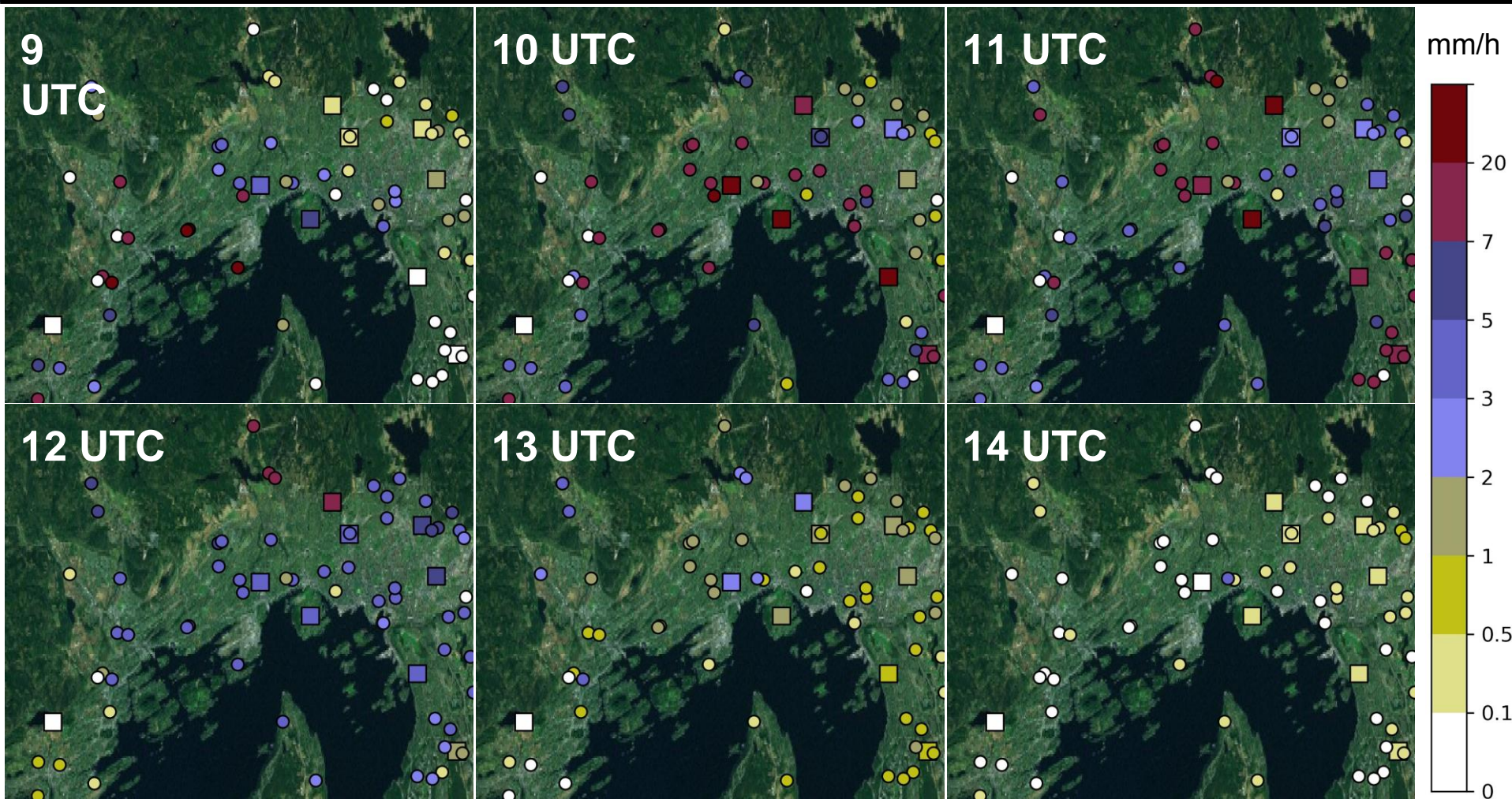
*Starter ca. rundt Bygdøy og beveger seg mot sørvest*





# Tidsutvikling andre byge

*Kommer fra vest og beveger seg mot øst*





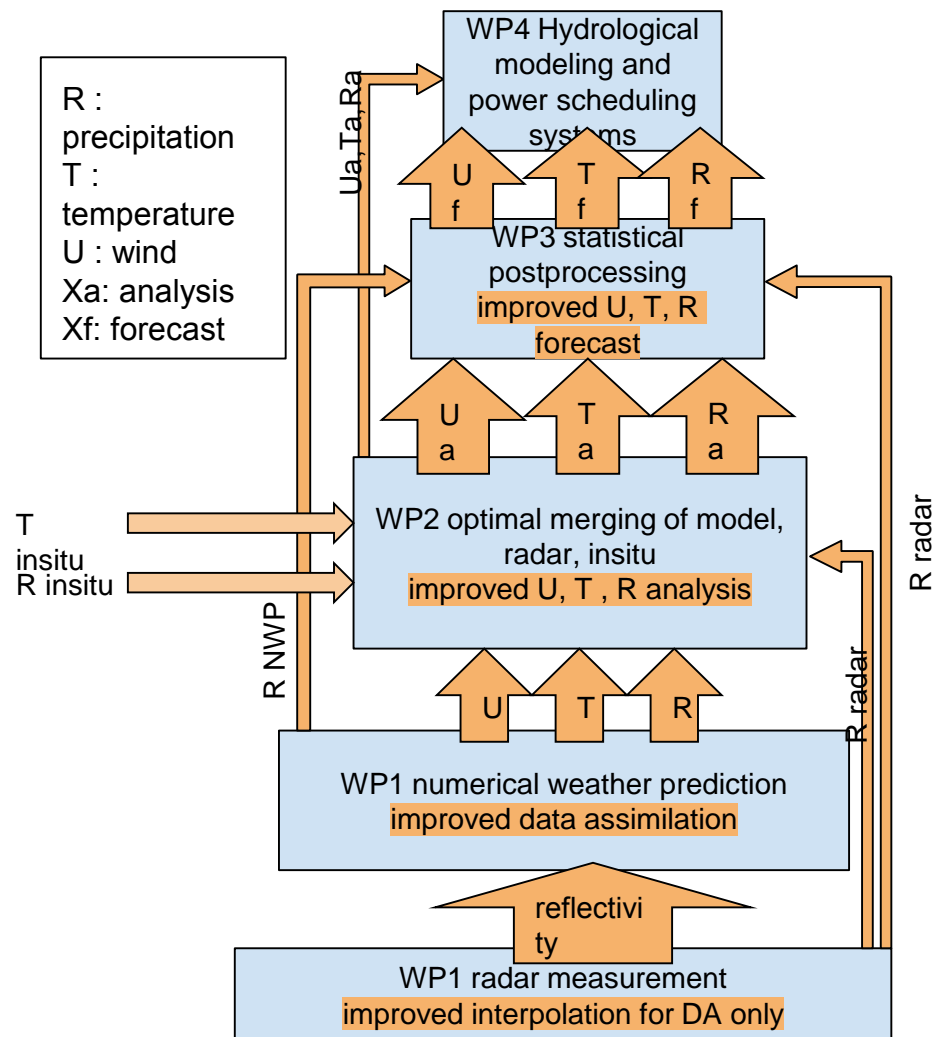
- Improve **analysis and forecasts of precipitation** by combining information from **radar reflectivity, output from NWP model, and in-situ precipitation observations.**
- **Deliver estimate of precipitation, temperature, and wind in time (1 hour) and space (1km) for hydrological models to forecast inflow at catchment scale.**

## People involved from MET Norway:

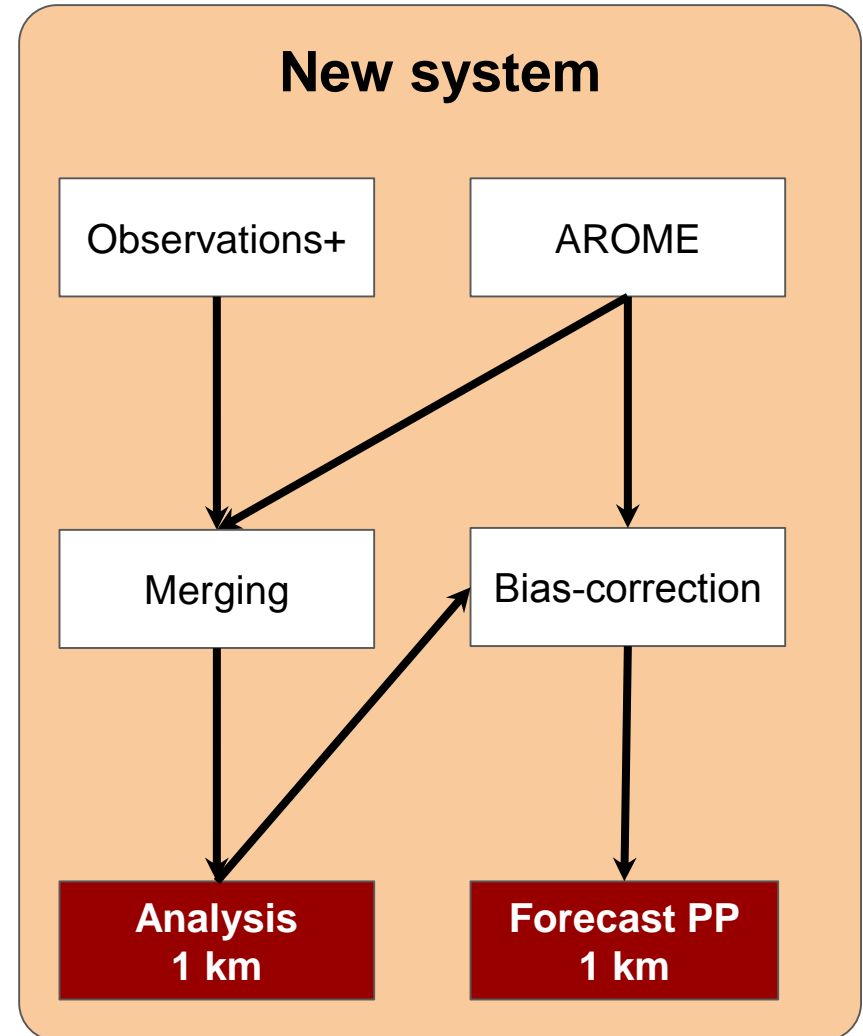
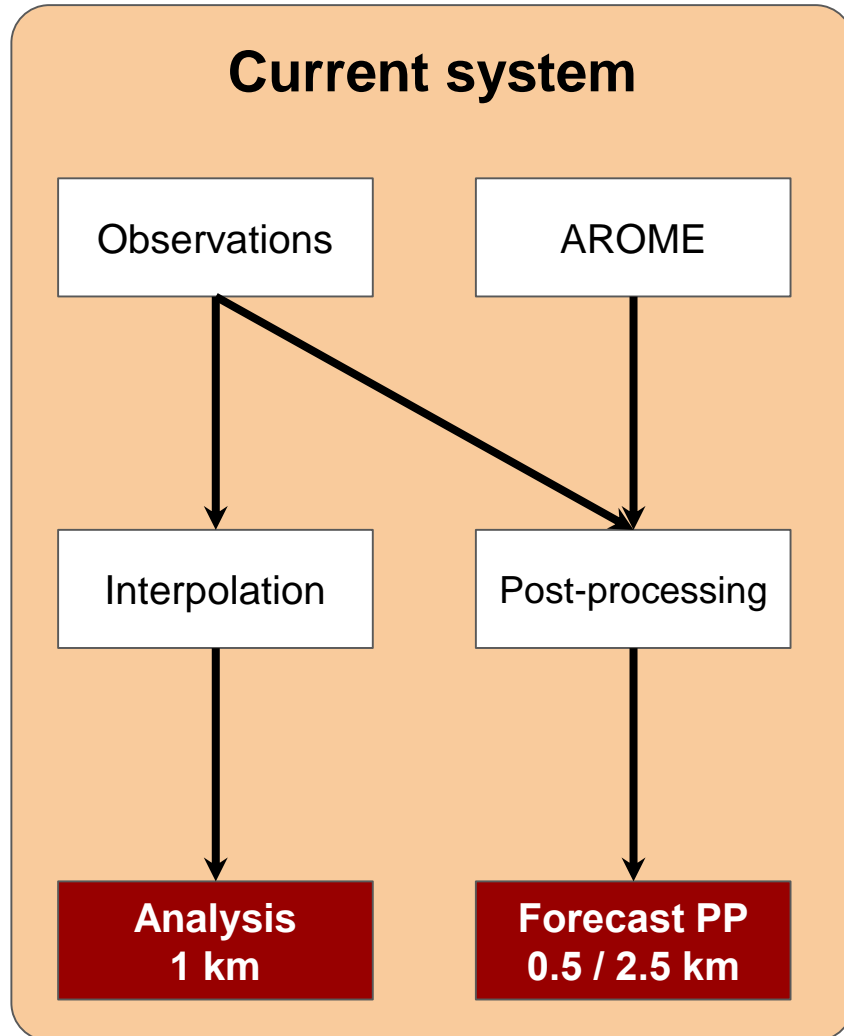
Roger Randriamampianina (project leader), Roohollah Azad, Thomas Nipen, Cristian Lussana, Christoffer Elo, Jørn Kristiansen

## Partners:

Statkraft, Agder Energi, Lyse, Energi Norge, Glitre Energi, Hydro Energi, GLB, E-CO, NVE



# Analysis/forecast co-production (RadPro)



# Varslene fra Yr oppdateres nå mye oftere, og blir mer treffsikre

Yr får fra i dag av tilgang til data fra et stort antall private værstasjoner over hele landet.

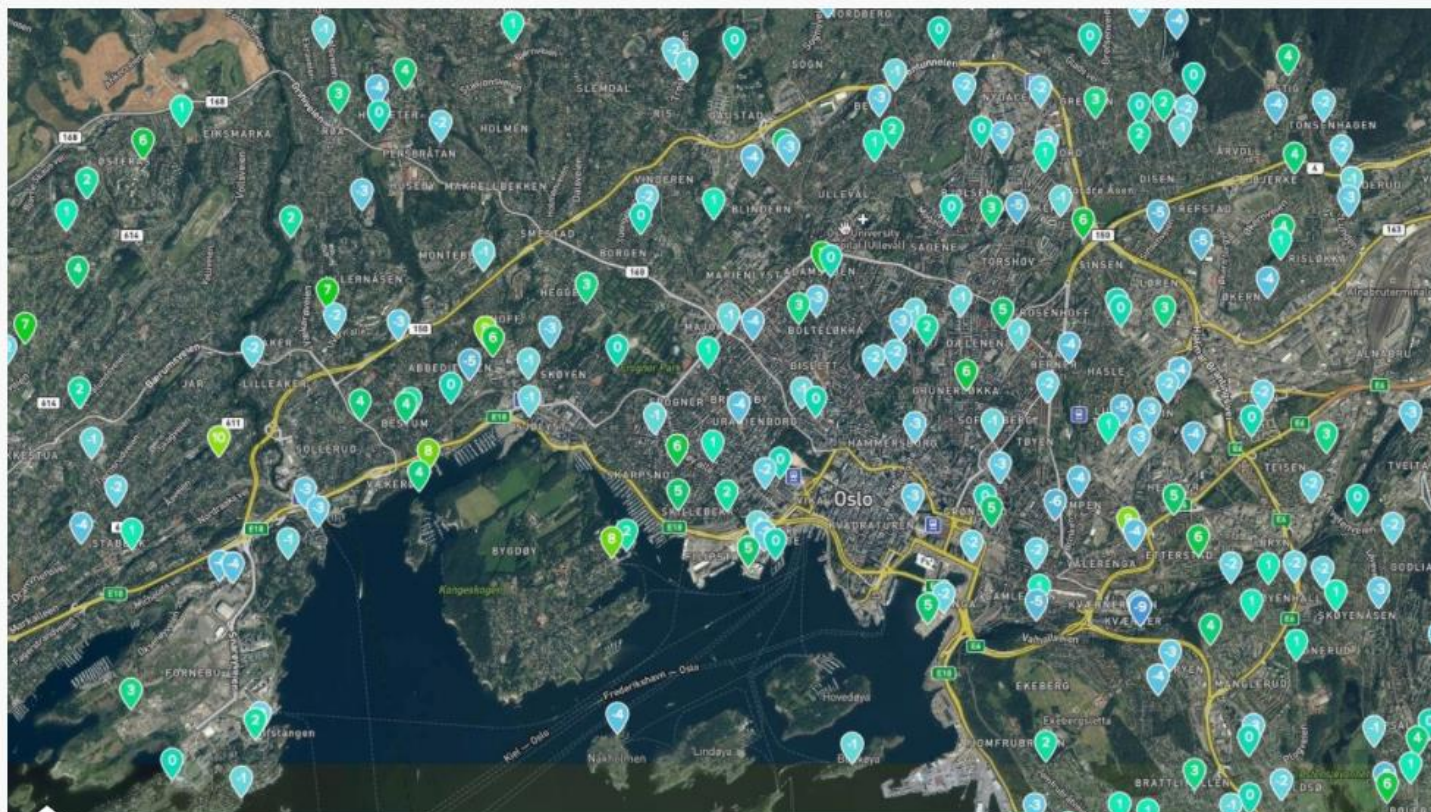
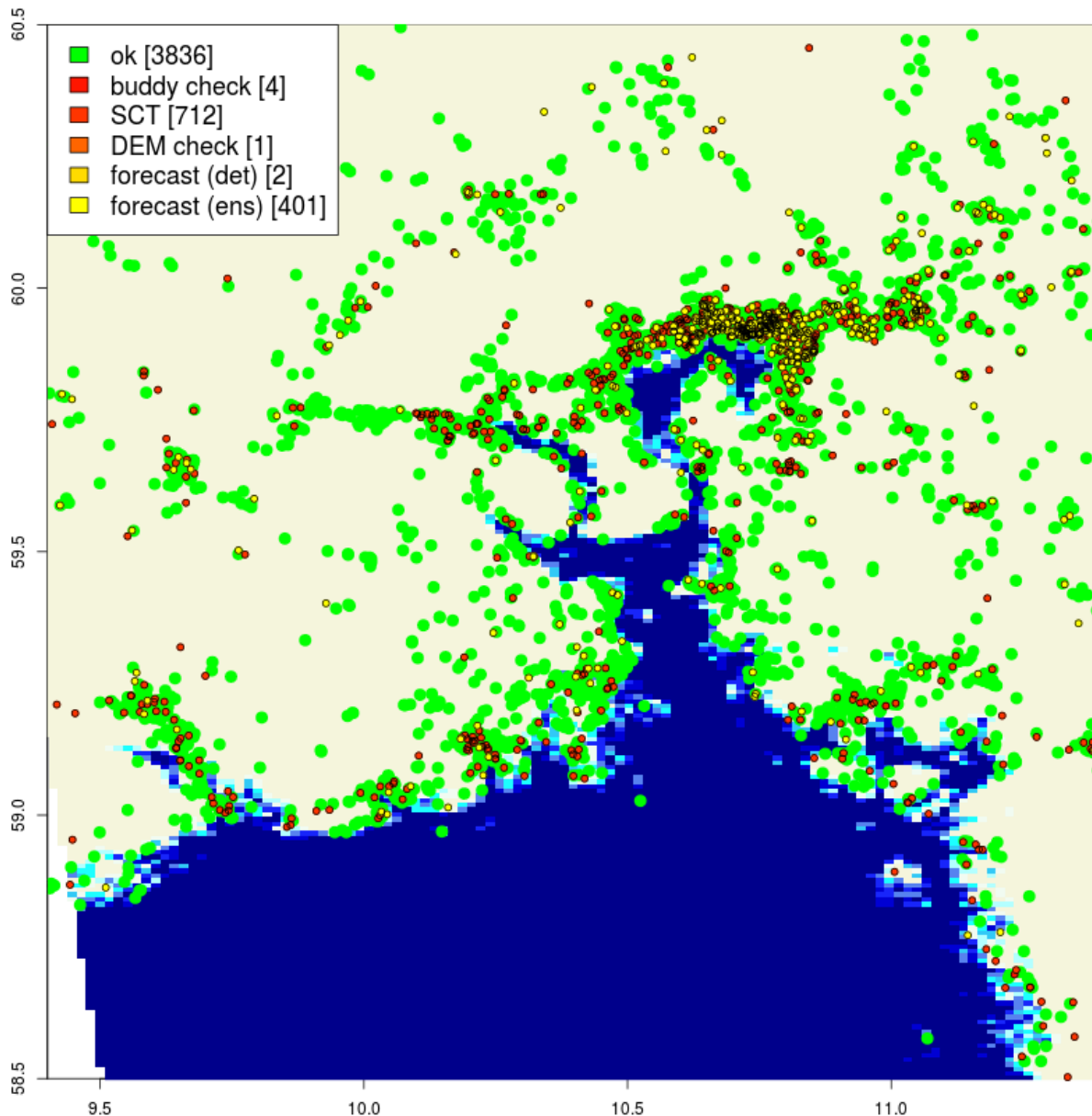


FOTO: Skjermdump/Netatmo

Wærstasjonskartet til Netatmo viser at et stort antall privatpersoner deler værd data i Norge. Her fra Oslo.







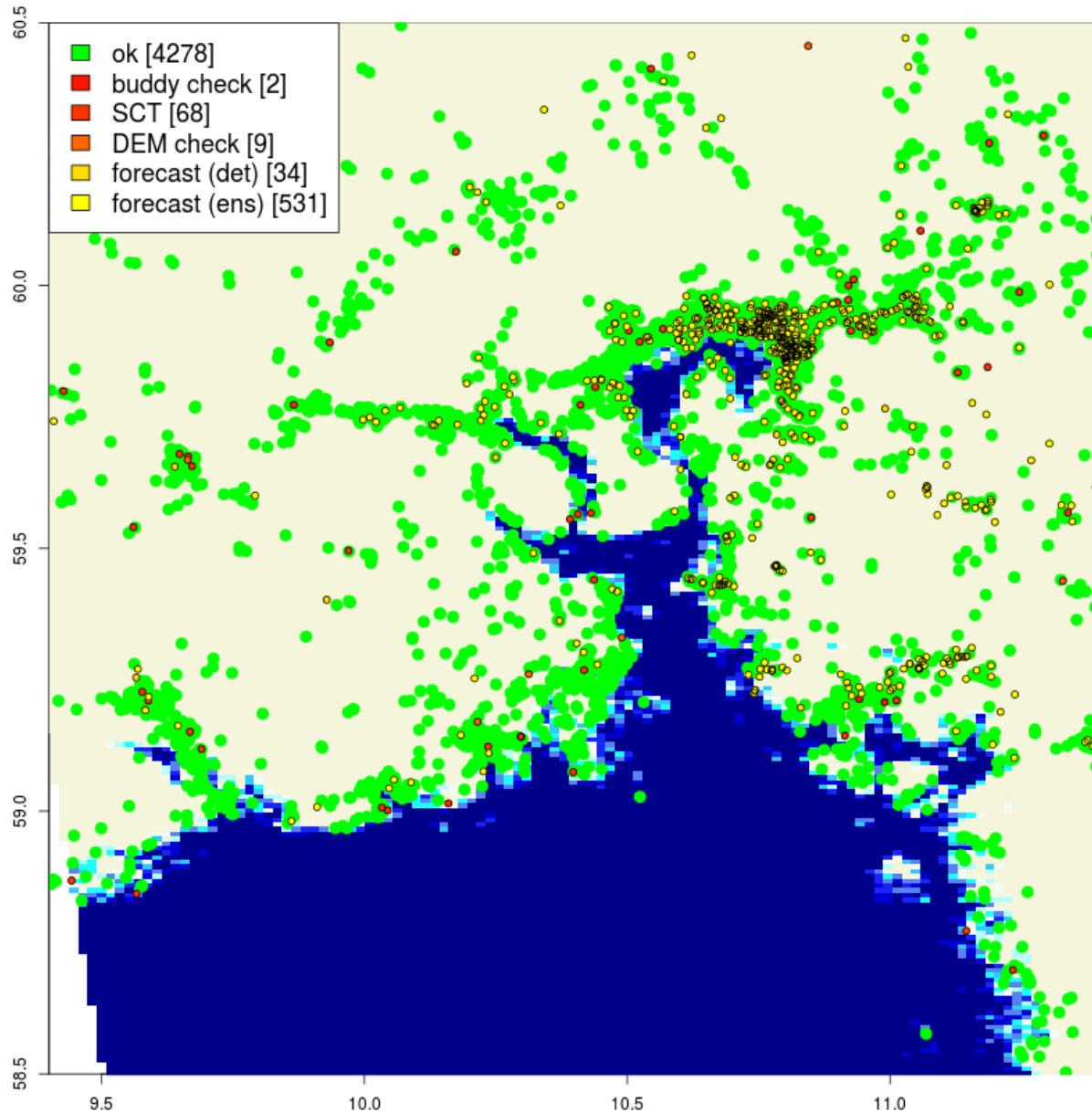
## Temperature

Thousands of observations used over relatively small but densely populated area

SCT, spatial consistency test

DEM, digital elevation model

forecast test. The observations are compared against the NWP model fields. It is possible to consider deterministic and ensemble NWP outcomes.

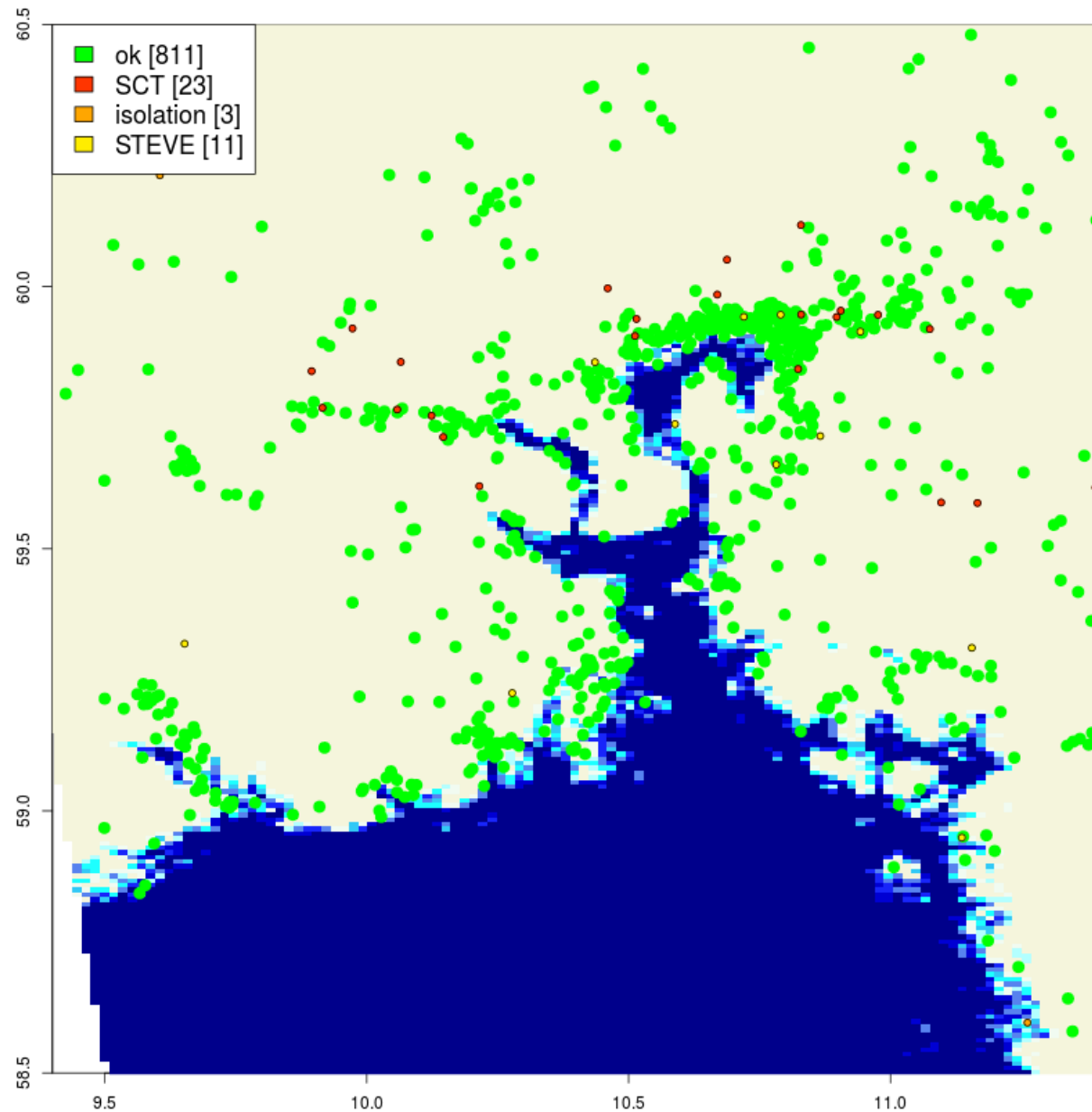


## Relative humidity

Dense network, comparable to temperature.

Important variable for the closure of the water balance.





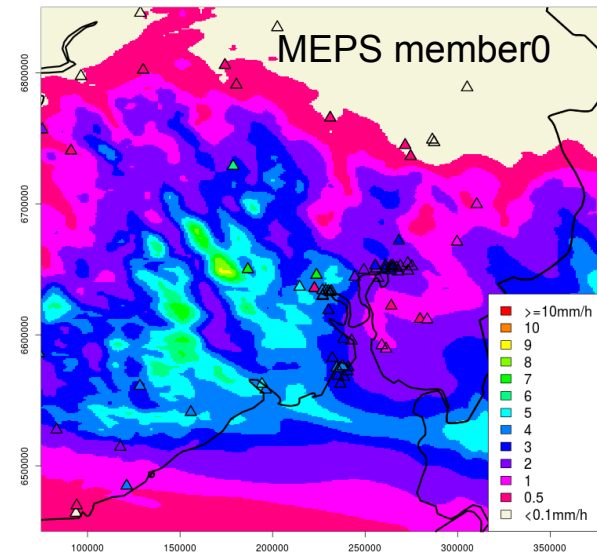
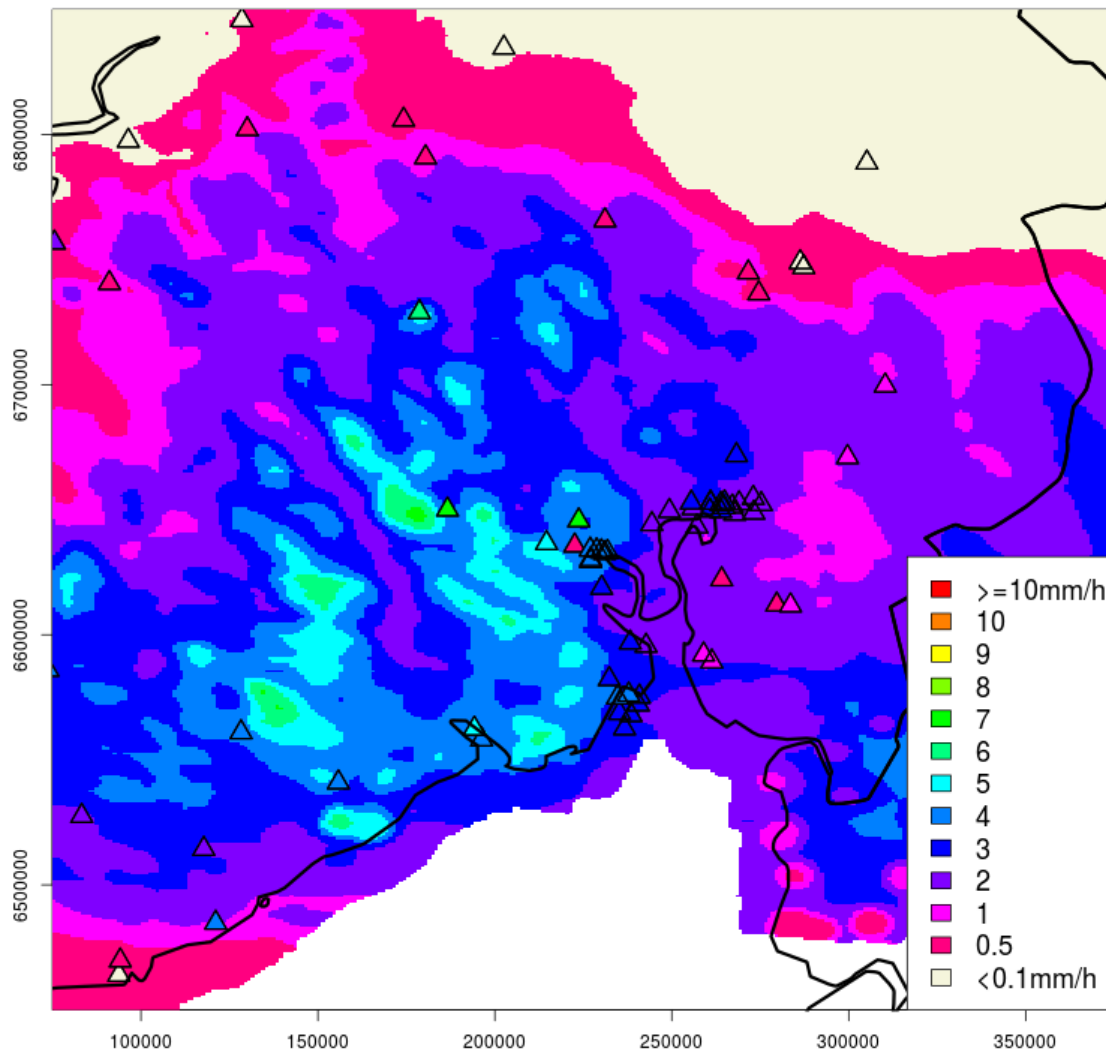
## Precipitation

If compared to temperature, less observations are available.

STEVE, isolated event test, such as an observation not measuring precipitation surrounded only by observations that measure precipitation (or vice versa).

# Combination MEPS-Radar-Gauge

Ex. Jun 07, 2017 12:00 UTC



Independent observations are shown (triangles), they have not been used in the analysis procedure

Combined product based on Ensemble Optimal Interpolation (EnsOI).

Features:

- preserves the MEPS fine-scale precipitation pattern
- improves prediction accuracy (better ETS over 100 cases of intense precipitation)

# Nowcasting of rain - further improvements



Tromsø  
Troms (Norway), elevation 5m



Overview

Details

Precip. Map

Precipitation expected next 90 minutes



0mm  
No precipitation next hour

0°  
Feels like -3°

2 m/s ↗  
Light breeze from south west

	Night	Morning	Afternoon	Evening	Max/min temp.	Precip.	Max wind
Today, Mar. 28					2° / -1°	2.5mm	6m/s
Thursday, Mar. 29					0° / -6°	0.9mm	5m/s
Friday, Mar. 30					0° / -6°	3.8mm	7m/s



# Nowcasting of cloud cover by weather cameras - under development



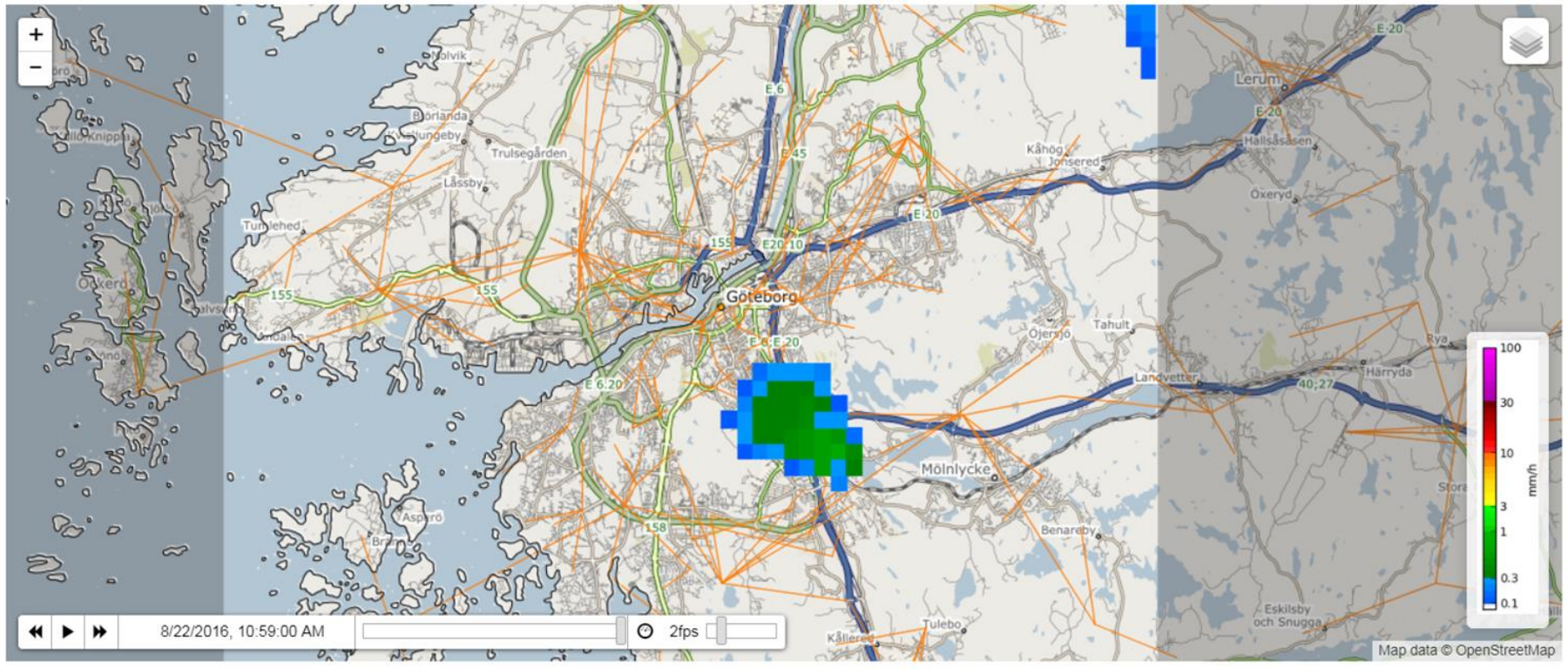
Stiftelsen  
Norsk Luftambulans



# Postdoc UiB

UiB og MET med støtte fra SMHI og KNMI

## MicroWeather - Exempeldata

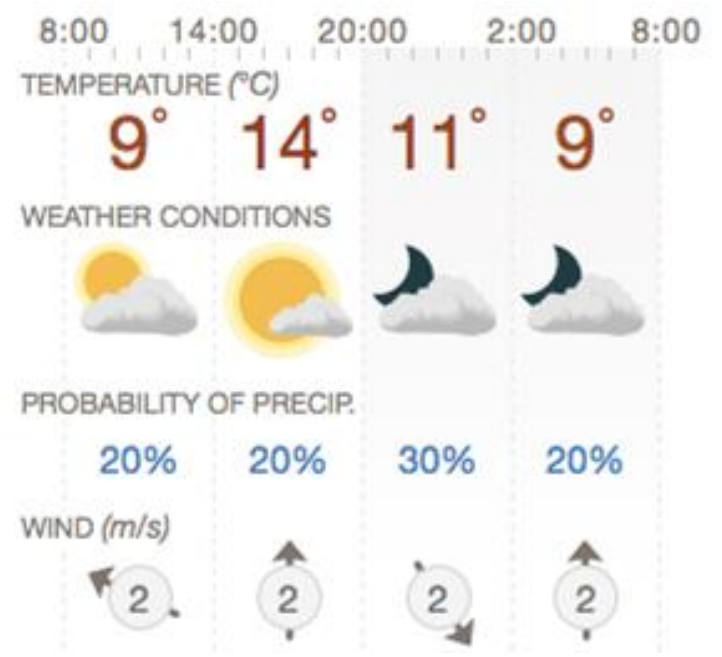
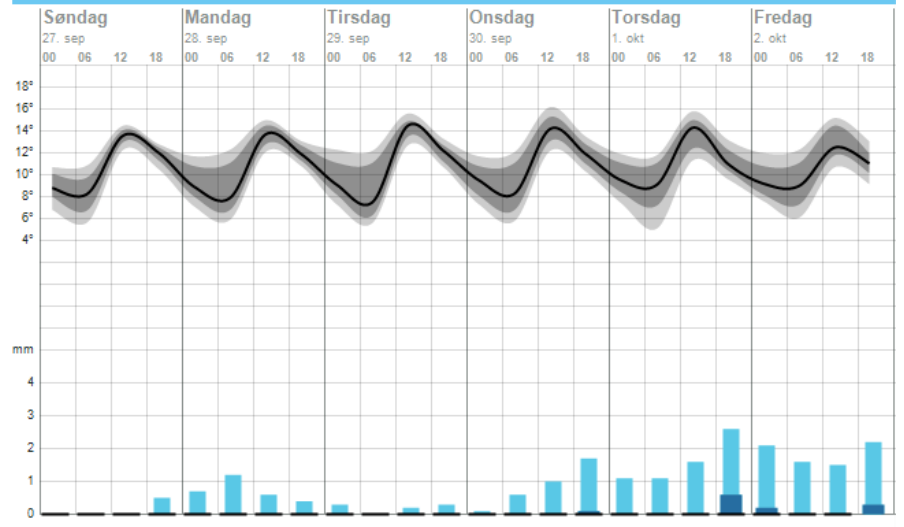


# Last but not least: Seamless long-term forecasts (2018)



## Precipitation probabilities on Yr.no

Sannsynlighetsvarsel for Bergen





**Thank you for your attention!**

**[jornk@met.no](mailto:jornk@met.no)**

**Visit [api.met.no](https://api.met.no) and [thredds.met.no](https://thredds.met.no) for  
open data free of charge.**

The decision on an open data policy is not user-oriented -> How you make data available is user-oriented

TdsStaticCatalog hi x  
thredds.met.no/thredds/cata

Norwegian Meteorological Institute

Dataset

met.no/ →

MET MetCoOp EPS (MEPS)

MEPS 2.5 files/

MEPS 2.5 VC files/

MEPS 0.5 files/

MET Arome Arctic Svalbard (Sep 2013)

Arome Arctic Svalbard (Sep 2013)

MET Arome Arctic

RAW MODEL DATA/

FULL MODEL DATA/

POST PROCESSED MODEL DATA/

SURFACE DATA SURFEX/

VERTICAL PROFILES AND CROSS SECTIONS

Latest version of each file with

MET MetCoOp EPS (MEPS)

MEPS 2.5 files EPS archive/

MEPS 2.5 files Det (member0) archive/

MET Arome MetCoOp Forecast Archive (2013 Aug-Dec) files/

Arome MetCoOp Forecast Archive (2013 Aug-Dec) files/

MET Arome Norway Forecast Archive (2013 Aug-Dec) files/

Arome Norway Forecast Archive (2013 Aug-Dec) files/

Norwegian Meteorological Institute

MET Norway Thredds Service

THREDDS Data Server

Catalog <http://thredds.met.no/thredds/catalog/meps25files/catalog.html>

Dataset: MEPS 2.5 files/meps\_allmembers\_full\_2\_5km\_latest.nc

- Data size: 188.7 Gbytes
- ID: meps25files/meps\_allmembers\_full\_2\_5km\_latest.nc

Access:

1. OPENDAP: [/thredds/dodsC/meps25files/meps\\_allmembers\\_full\\_2\\_5km\\_latest.nc](/thredds/dodsC/meps25files/meps_allmembers_full_2_5km_latest.nc)
2. HTTPServer: [/thredds/fileServer/meps25files/meps\\_allmembers\\_full\\_2\\_5km\\_latest.nc](/thredds/fileServer/meps25files/meps_allmembers_full_2_5km_latest.nc)
3. WMS: [/thredds/wms/meps25files/meps\\_allmembers\\_full\\_2\\_5km\\_latest.nc](/thredds/wms/meps25files/meps_allmembers_full_2_5km_latest.nc)
4. WCS: [/thredds/wcs/meps25files/meps\\_allmembers\\_full\\_2\\_5km\\_latest.nc](/thredds/wcs/meps25files/meps_allmembers_full_2_5km_latest.nc)
5. NetcdfSubset: [/thredds/ncss/meps25files/meps\\_allmembers\\_full\\_2\\_5km\\_latest.nc](/thredds/ncss/meps25files/meps_allmembers_full_2_5km_latest.nc)

Dates:

- 2017-05-26T05:38:18Z (modified)











Viewers:

- Godiva2 (browser-based)
- NetCDF-Java ToolsUI (webstart)

- **F** Findable
- **A** Accessible
- **I** Interoperable
- **R** Re-useable

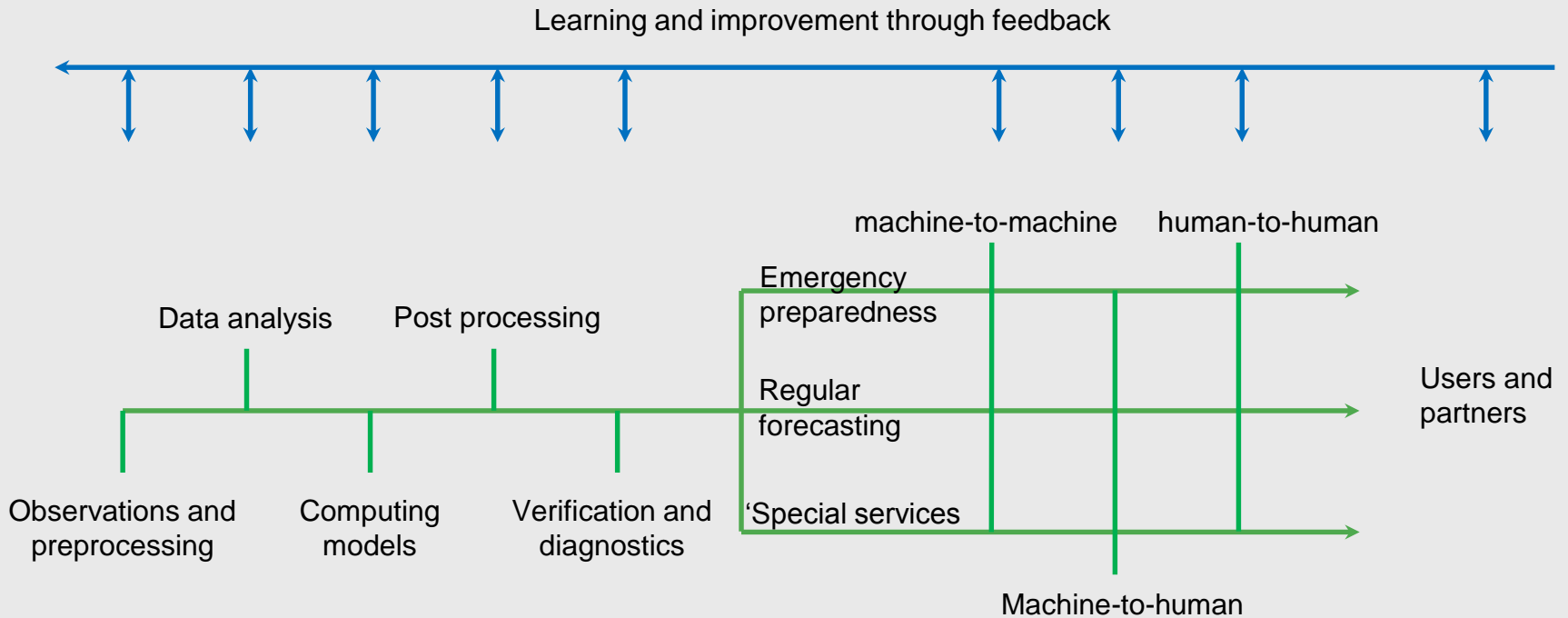
# Future opportunities

OECD: 10 disruptive technologies for the (near) future

-  Internet of Things
-  Big data analytics
-  Artificial intelligence
-  Neurotechnologies
-  Nano/microsatellites
-  Nanomaterials
-  Additive manufacturing
-  Advanced energy storage technologies
-  Synthetic biology
-  Blockchain



# Evolution: MET Value chain



R & D & I with a short path to operational use

Collaboration internally - nationally - internationally

Infrastructure and policies