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Seamless Nowcasting System Development at the Finnish Meteorological Institute

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21.5.2019 **Jaakko Nuottokari**

Outline

1. Background for FMI Nowcasting System development
2. Design of the project and components
3. Work Packages
4. Results
5. Conclusions

1. Motivation

- Over the years, FMI has developed individual nowcasting solutions serving specific needs, but we have been lacking a comprehensive nowcasting system
- The 0-6h nowcasts are largely produced manually
- The current way of working does not meet all of our customers’ needs and is not updated quickly enough for automatic production processes
- Data is in siloes and not in a uniform database

2. Project Design

Vision *FMI nowcasting system represents international state-of-the-art and generates added value to our customers. Societal impact is achieved by applying open data policies.*

Goal **Seamless and automatic forecast production process in the 0-6h timeframe by the end of 2019 in the extended Scandinavian domain**

2. Objectives

1. Combine various observation and analysis data sources into an accurate current state of the atmosphere
2. Implement a rapidly updating limited area nowcasting NWP model over the extended Scandinavian domain
3. Implement radar and satellite based nowcasting products into operational production
4. Blend observations, nowcasting products and NWP data into a seamless forecast
5. Implement continuous quality control and assurance of the nowcasting information
6. Develop and implement necessary changes to the production system

3. Work Packages

WP1 Implement weather radar based observation and nowcasting for precipitation fields

1. Precipitation motion field analysis
2. Implementation of the FMI Probabilistic Precipitation Nowcasting (PPN) method
3. Blending of the precipitation field with the nowcast NWP fields
4. Development of the operational production environment
5. Verification

WP2 Hazardous weather object nowcast

1. Convective weather objects identification implementation
2. Implement trajectory and probability calculation for objects
3. Validate compliance with radar-based methods
4. Extrapolation of information from additional data sources (lightning, satellite, emergency calls, crowdsourcing, IoT, etc.)
5. Verification and operational production
6. Visualisation of objects in customer products

WP3 Enhanced mesoscale analysis system

1. Extending analysis area to match nowcast NWP domain
2. Using HARMONIE control run as baseline for LAPS analysis
3. LAPS version update
4. LAPS resolution increase to 2.5km and new projection
5. Implement 3D LAPS analysis
6. Intercomparison between MET.no and LAPS analysis methods

WP4 Implement satellite-based nowcast methods

1. Reliability analysis for parameters generated from satellite sources
2. Development of file conversions
3. Operational satellite nowcast production
4. Verification

WP5 Development and implementation of the MetCoOp HARMONIE-Nowcast (MNWC) NWP model

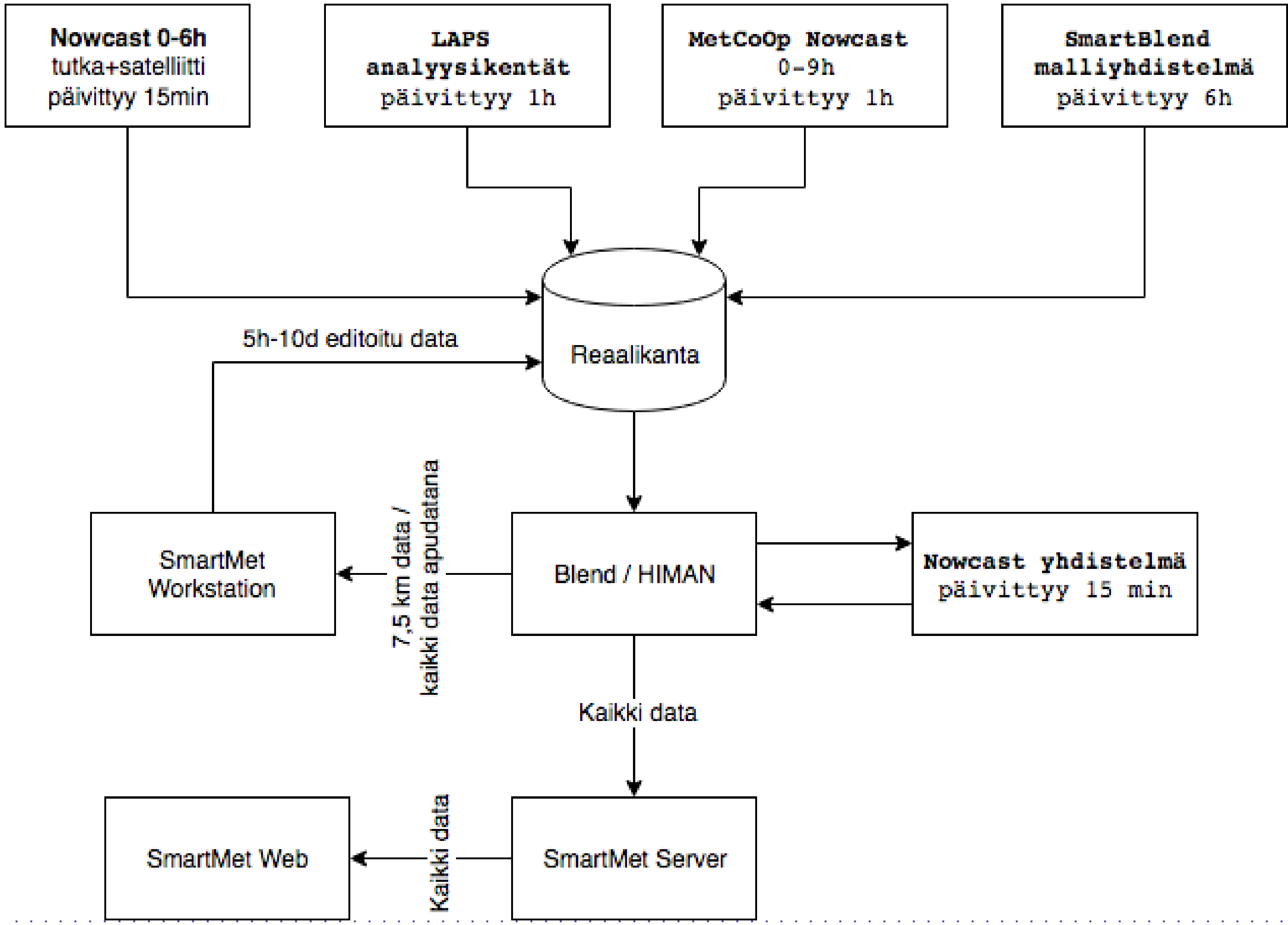
1. MetCoOp HARMONIE-Nowcast model development
2. Implement MNWC cloud correction and analysis method
3. Improvements in the MNWC data assimilation methods
4. Verification of model output

WP6 Observation and model data blend and quality assurance

1. Development of blending algorithms and operational implementation
2. Seamless blend of different temporal forecasts from 0h to 10d
3. Quality assurance of interdependencies between meteorological parameters
4. Verification

WP7 Production system development

1. Operational implementation of data fusion in the real-time database
2. GRIB support to FMI SmartMet Server
3. Modification of models to use blended data
4. Modification of production to generate products from blended data
5. Implementation of nowcast data to forecaster workstations
6. Quality control and assurance

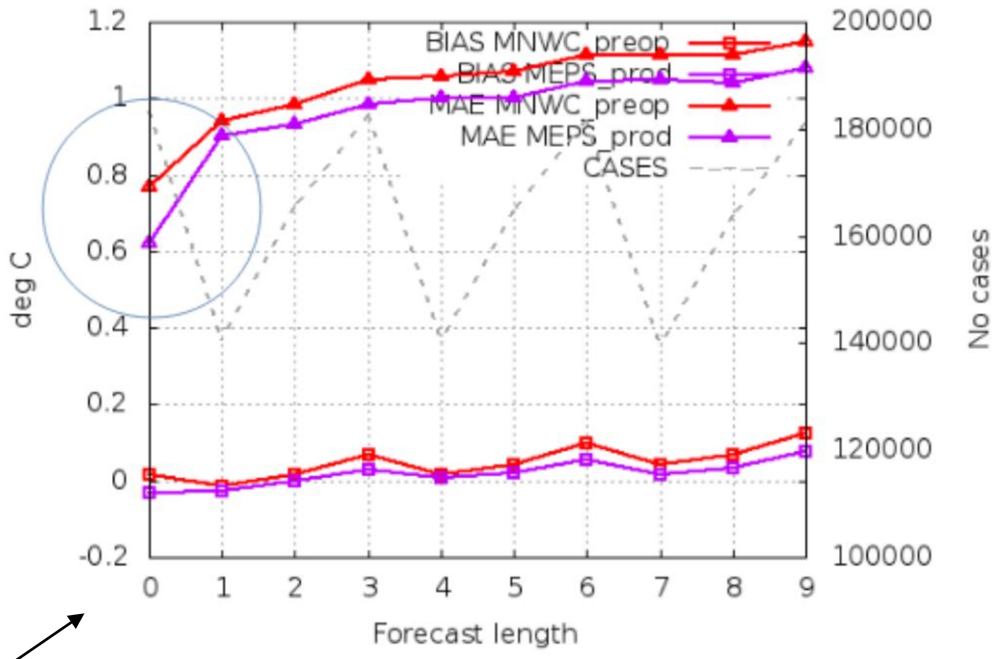


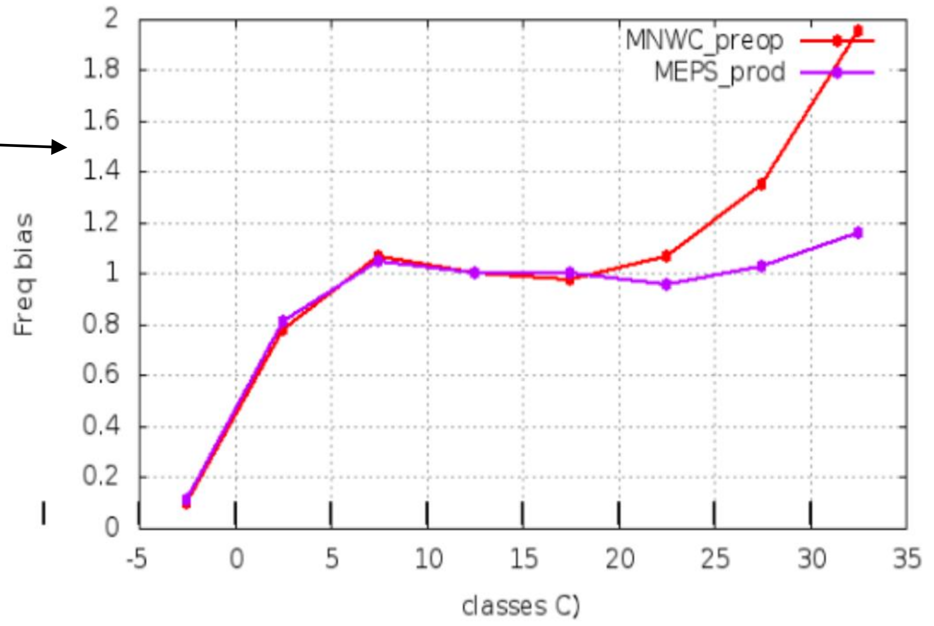
WP8 Collection and quality control of crowdsourced weather data

1. Collection of observations from NetAtmo stations
2. Implement quality control based on MET.no TITAN software
3. Development of quality control algorithms for FMI data sources

4. Results
MetCoOp Nowcast Model (MNWC)

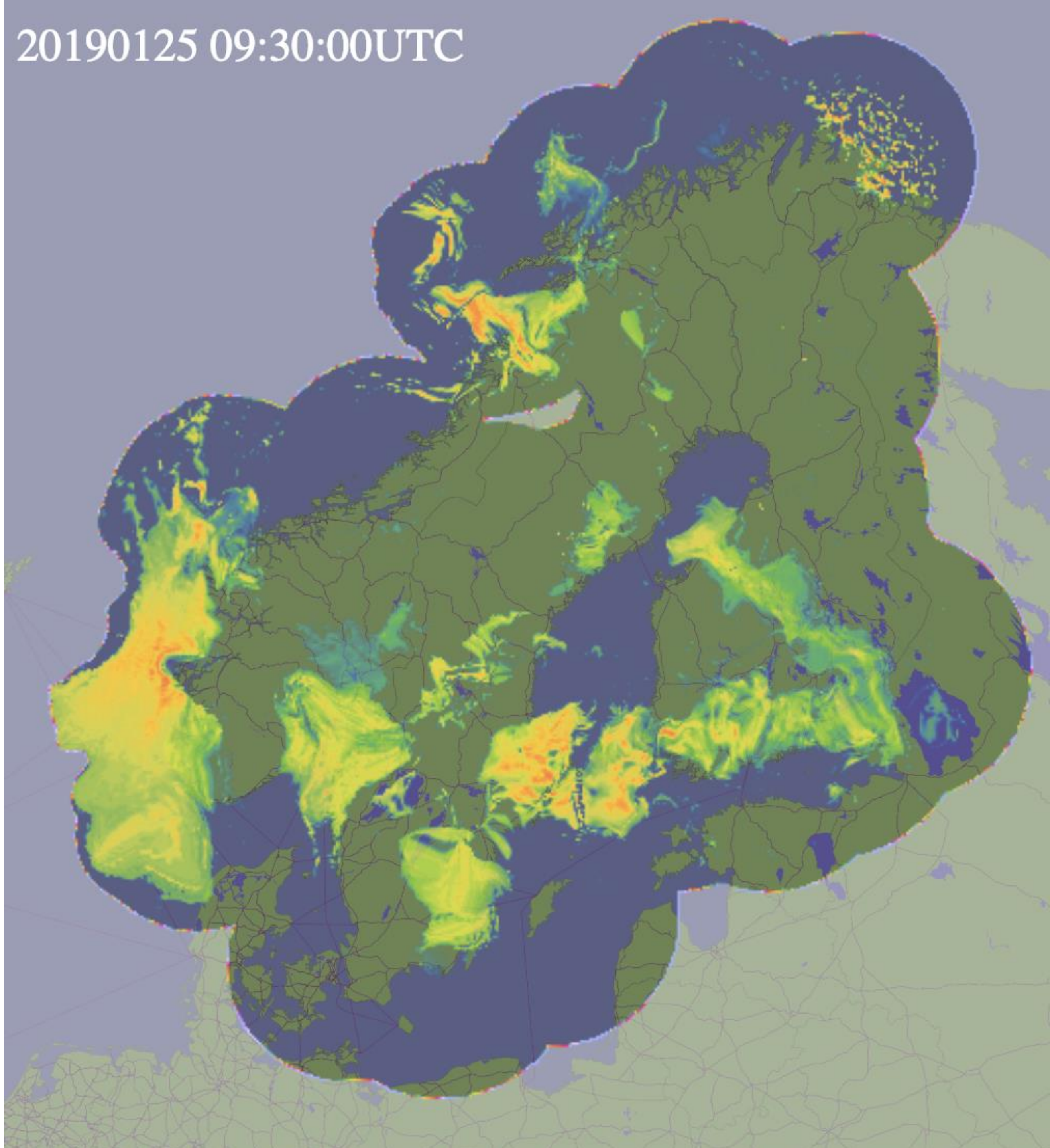
- Since April 2018 FMI is running real-time 9h forecasts with a 15-minute cutoff hourly assimilation suite using a rapid refresh approach with the upper air first guess from the MEPS control member. Forecasts are available ~20 minutes after cutoff.
- Short cutoff penalizes conventional observations but the frequent analysis gives more satellite data. Short cutoff GNSS is currently being introduced. Assimilation of AMV, MODE-S data and radar winds planned
- We see an over-prediction of max temperatures related to the shorter assimilation frequency. This was circumvented by taking the first guess from MEPS instead of the nowcasting itself.
- Work by Erik Gregow and David Schönach, FMI





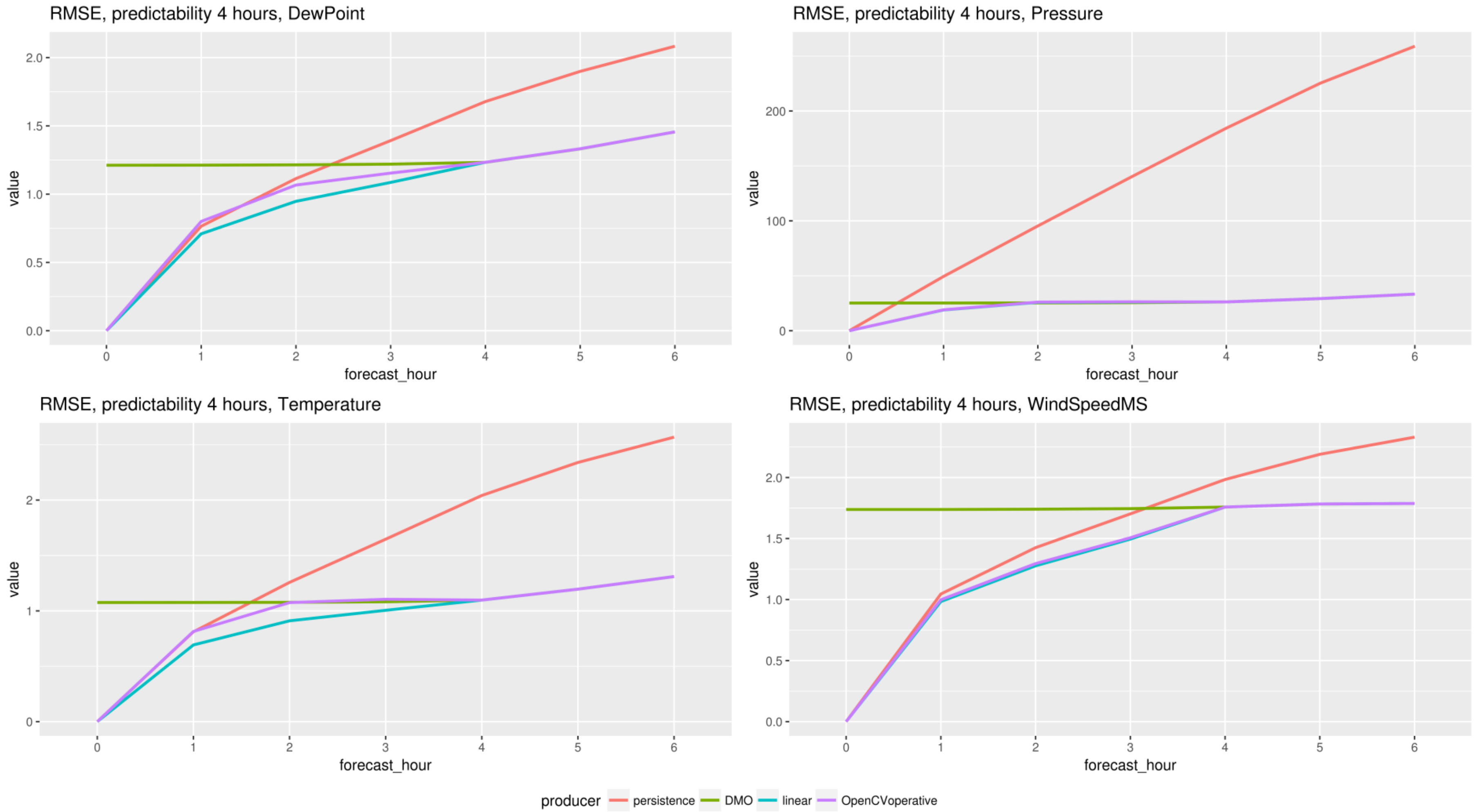
4. Results
Radar nowcast

- Operational implementation of the FMI Probabilistic Precipitation Nowcast – method (FMI PPN) currently ongoing
- Based on STEPS (Short-Term Ensemble Prediction System) is a stochastic ensemble method for precipitation nowcasting
    - Originally developed at the Australian Bureau of Meteorology (Alan Seed) in collaboration with the UK Met Office
- Work by Seppo Pulkkinen, Petteri Karsisto and Harri Hohti from FMI



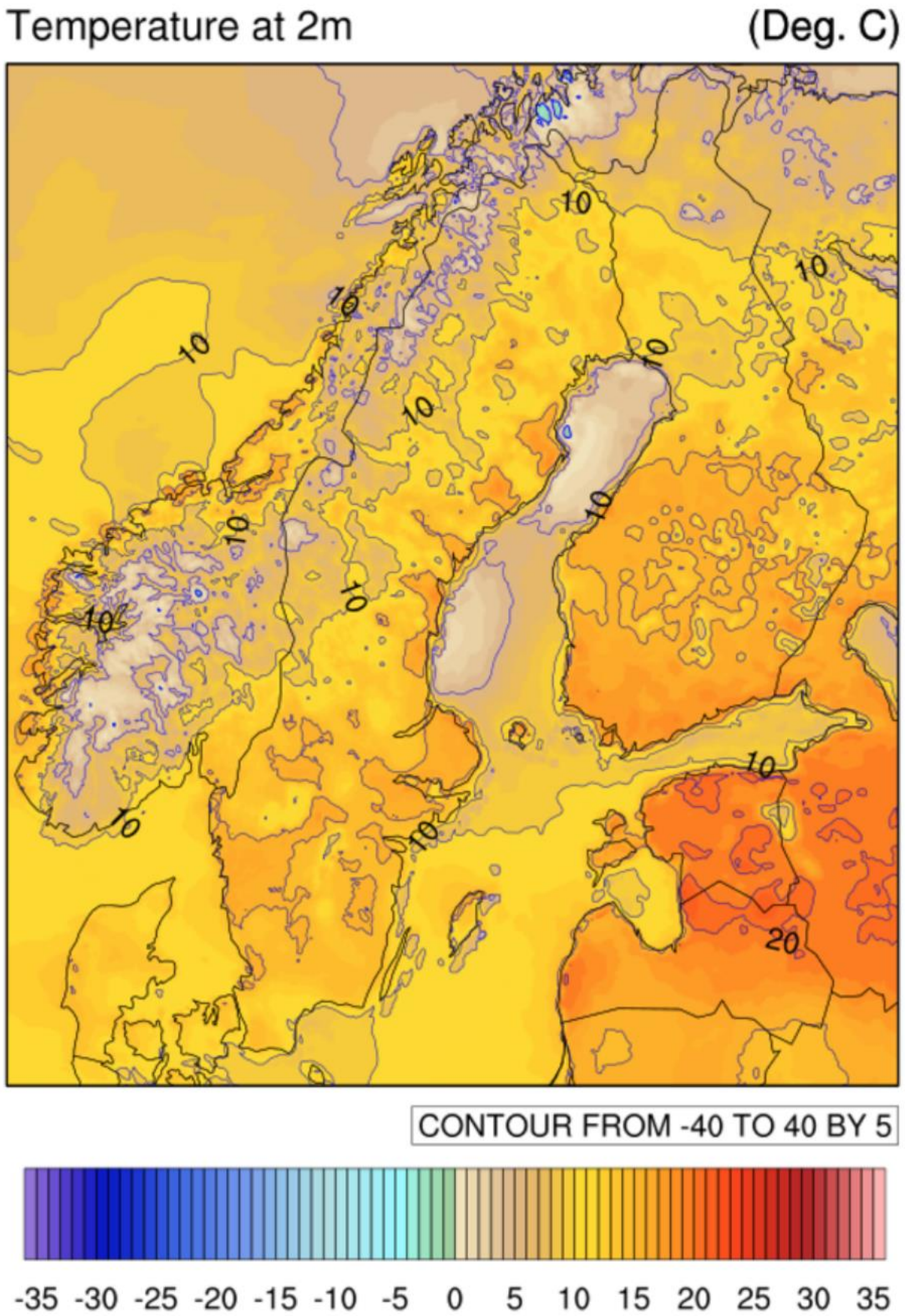
4. Results
Blending

- Smooth blending from LAPS & FMI PPN to NWP
- Similar calculation basics as in NWS “National Blend of Model”
- Blends deterministic model data:
  - GFS, ECMWF, Hirlam, Harmonie (MEPS control), ECMWF MOS
- Currently calculated twice a day (00&12utc) and available for T2m
- Shows better increase in skill over current MNWC NWP model setup, reducing errors in the very initial phase
- Work by Jussi Ylhäisi, Leila Hieta, Marko Laine at FMI



4. Results
LAPS

- Main improvement by radar and gauges
- Lightning important in specific cases
- Verification scores shows improved results
- Work by Erik Gregow



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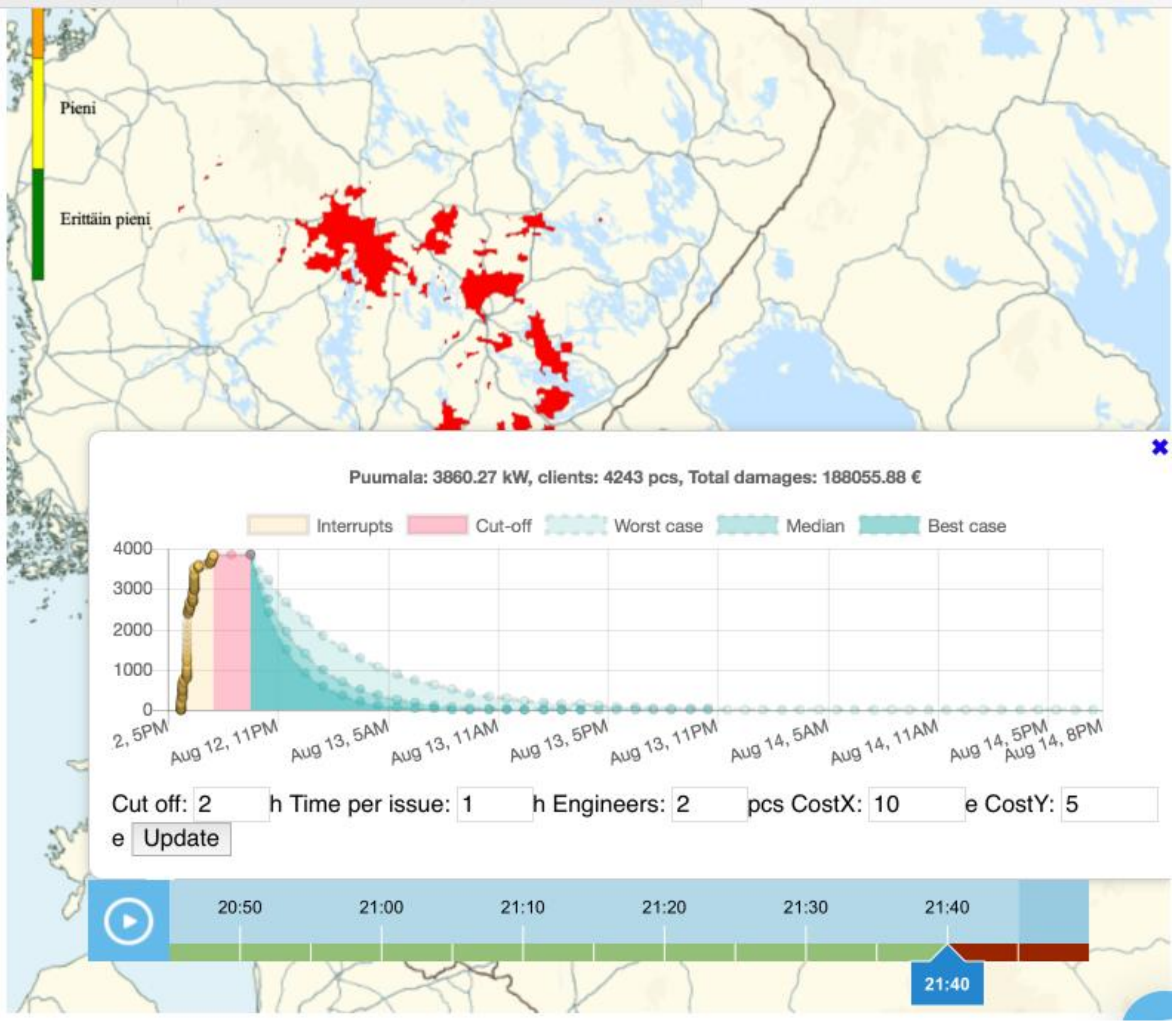
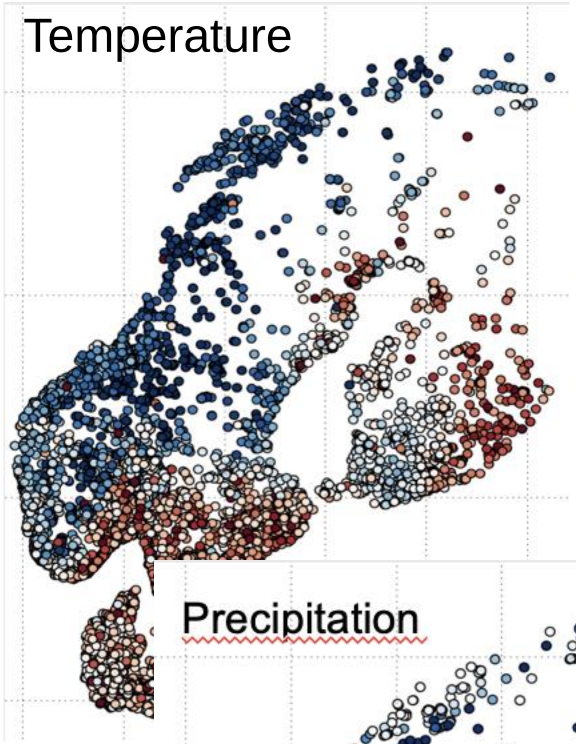
4. Results
Hazardous weather objects

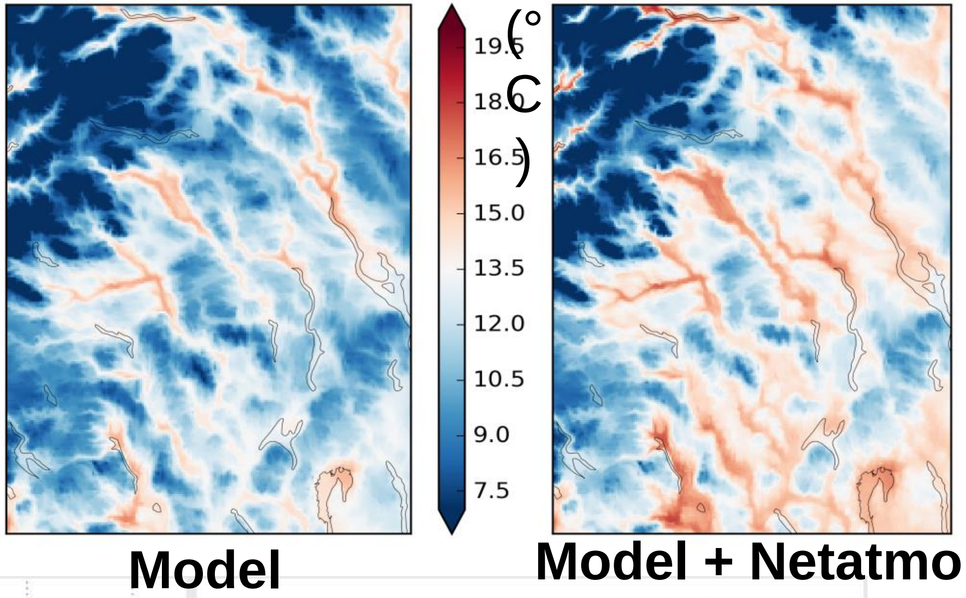
- Hazardous weather objects calibrated to real-time power outages is an existing customer product
- Project will re-calibrate the method to other input sources to create wind gust objects
- Based on PhD thesis of Pekka Rossi and additional work by Roope Tervo and Joonas Karjalainen, FMI

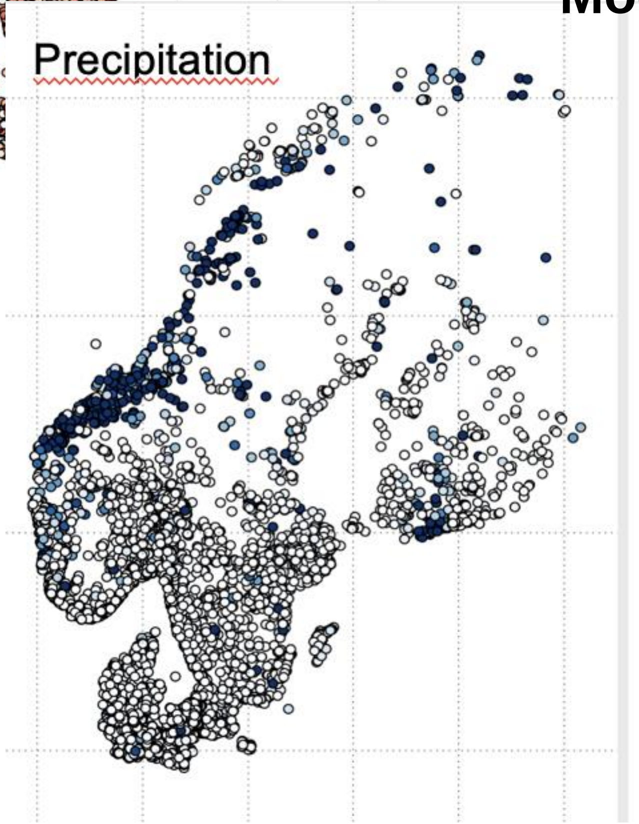


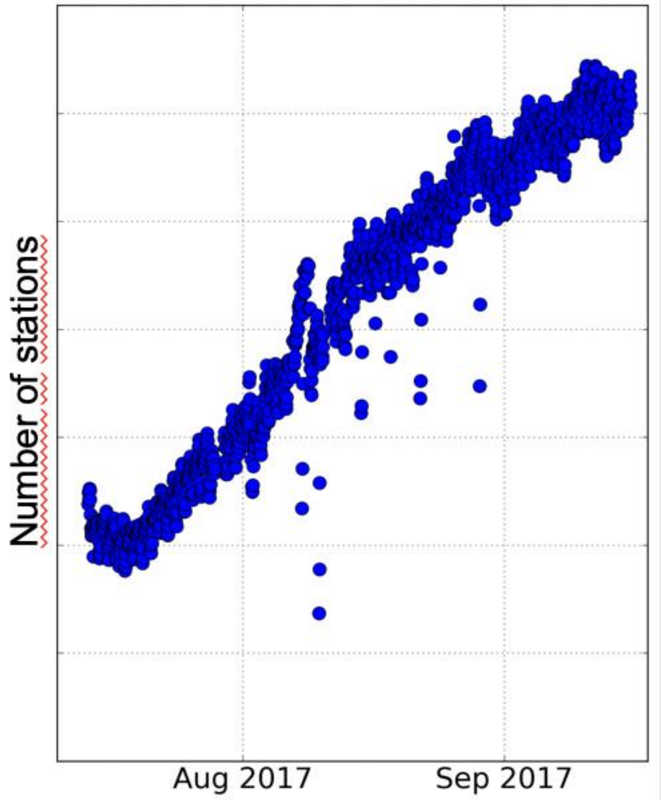
4. Results NetAtmo

- FMI ingests NetAtmo observations from the Scandinavian domain and feeds these into the LAPS analysis
- QC by the TITAN algorithm in the format used at MET.no
- Example images from Norway, work by Ismo Karjalainen, FMI









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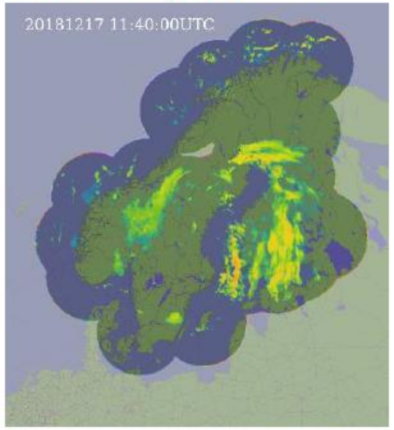
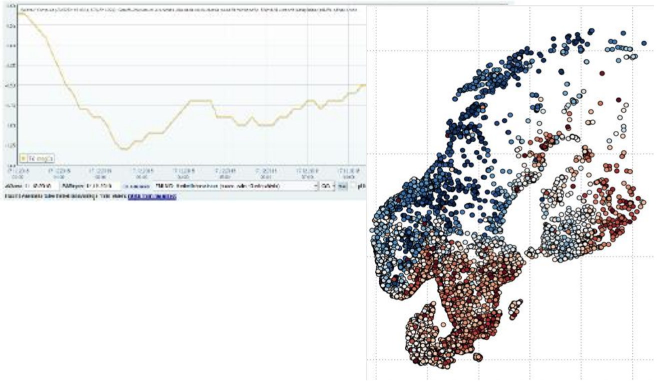
5. Conclusions

Radar composite

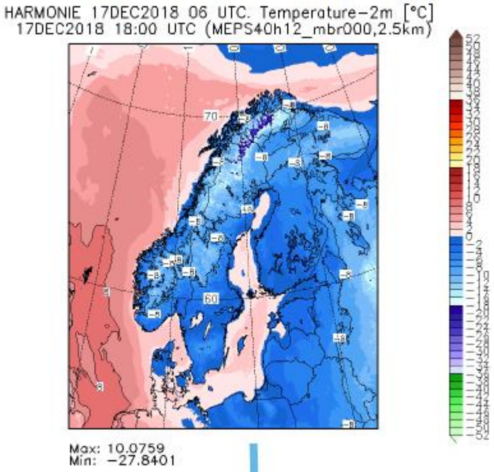


Station observations

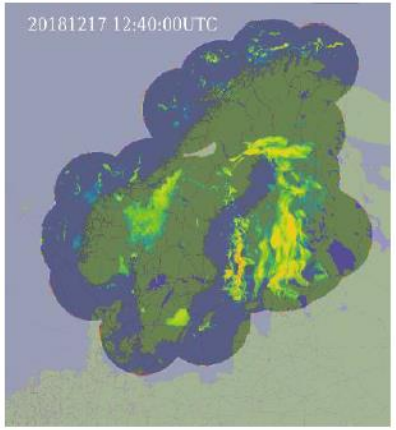
NetAtmo



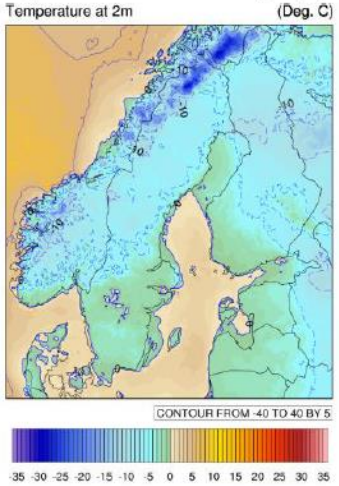
NWP forecasts
(MetCoOp Rapid-Refresh Nowcast 7h, MEPS 66h, ECMWF 240h)



Radar nowcast
(AMV + extrapolation, 3h)

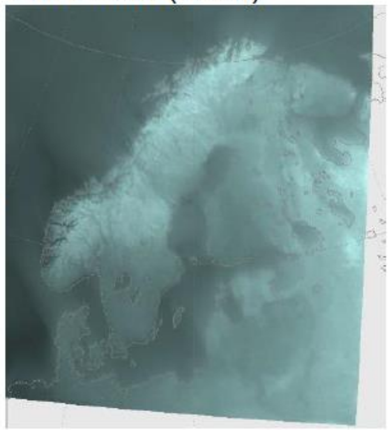


LAPS analysis
(testbed.fmi.fi/history_browser-laps-Scandinavia.php)



”spatially seamless”

FMI Blend (240h)



5. Conclusions

- FMI Nowcasting System (ULJAS) development well under way, but still early days to showcase impacts
- Strong mandate from FMI board of directors to implement nowcasting methods
- Project is special because it brings together various nowcasting components to operational data stream
- Project requires resources from all corners of FMI and commitment from a large pool of experts

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