ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

SRNWP at FMI in 2025

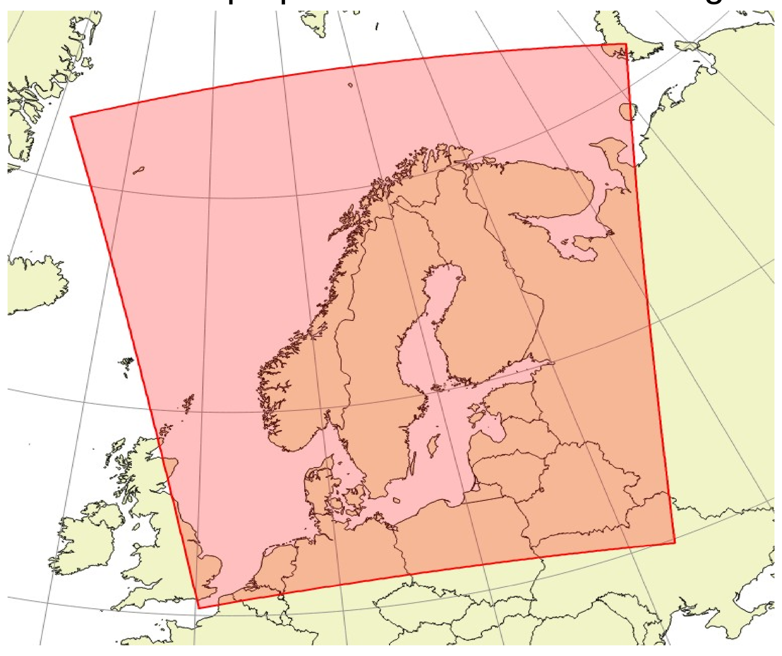
Reima Eresmaa, Carl Fortelius, Erik Gregow, Mikael Hasu, Svante Henriksson, Karoliina Hämäläinen, Ekaterina Kurzeneva, Panu Maalampi, Rudolf Mård, Pirkka Ollinaho, Laura Rontu, Eerik Saarikalle, Olli Saranko, David Schönach & Niko Sokka

Operations

As a member of a Nordic **MetCoOp** cooperation with Norway, Sweden, Estonia and Latvia, FMI participates in developing and running a common high resolution (2,5 km) ensemble prediction system called **MEPS,** based on non-hydrostatic convection-permitting **Harmonie-Arome,** developed in a code cooperation with Météo-France and ALADIN. Operational ensemble forecast is updated every hour and it runs out to 66 hours. In addition, a HARMONIE-AROME-based nowcasting system **MNWC** is run hourly and produces 12 hour forecasts.

Forecast production within MetCoOp is distributed among the participating institutes.

Model Integration area
The MetCoOp operational domain coverage



Research

The main research topics, mostly related to numerical weather modelling (NWP) within the context of ACCORD, are as follows:

- Limited area weather forecast models (LAM)
- Short range rapid update weather forecasting (nowcasting)
- Ensemble prediction systems in numerical weather prediction (EPS)
- Weather forecast model data assimilation
  - satellites
  - snow
  - lake surface temperature
- Radiation and the effect of aerosols in NWP
- Forecast quality assurance
- Renewable energy power production estimation
- Icing phenomena in wind power production
- Urban meteorology
- High performance computing (HPC) in meteorology

Extending SEVIRI Satellite Coverage in the MetCoOp forecasting system

The use of satellite radiances from geostationary satellites, such as SEVIRI onboard METEOSAT satellites, has traditionally been limited in the Nordic region of MetCoOp. This is due to the large viewing angles, or satellite zenith angles (SZA), which were thought to degrade signal quality too much. A study by Schönach et al. (2025) challenges that assumption by assimilating data from SEVIRI's water vapour channels (WV062 and WV073) into the HARMONIE-AROME numerical weather prediction model at SZAs up to 84°.

By leveraging new radiative transfer coefficients (v9 instead of v7) and applying careful quality control, this work demonstrates that valuable atmospheric information can be extracted even at these extreme angles. This significantly expands the geographical data coverage within the MetCoOp operational area, as illustrated in Figure 1.

The results show a clear positive impact on forecast accuracy. Assimilating this previously unused data leads to statistically significant improvements in short-range forecasts, particularly for near-surface temperature, humidity, mean sea level pressure, and cloud cover. The benefits are most pronounced within the first 24 hours of the forecast, which is typical for data assimilation within a limited-area modelling system.

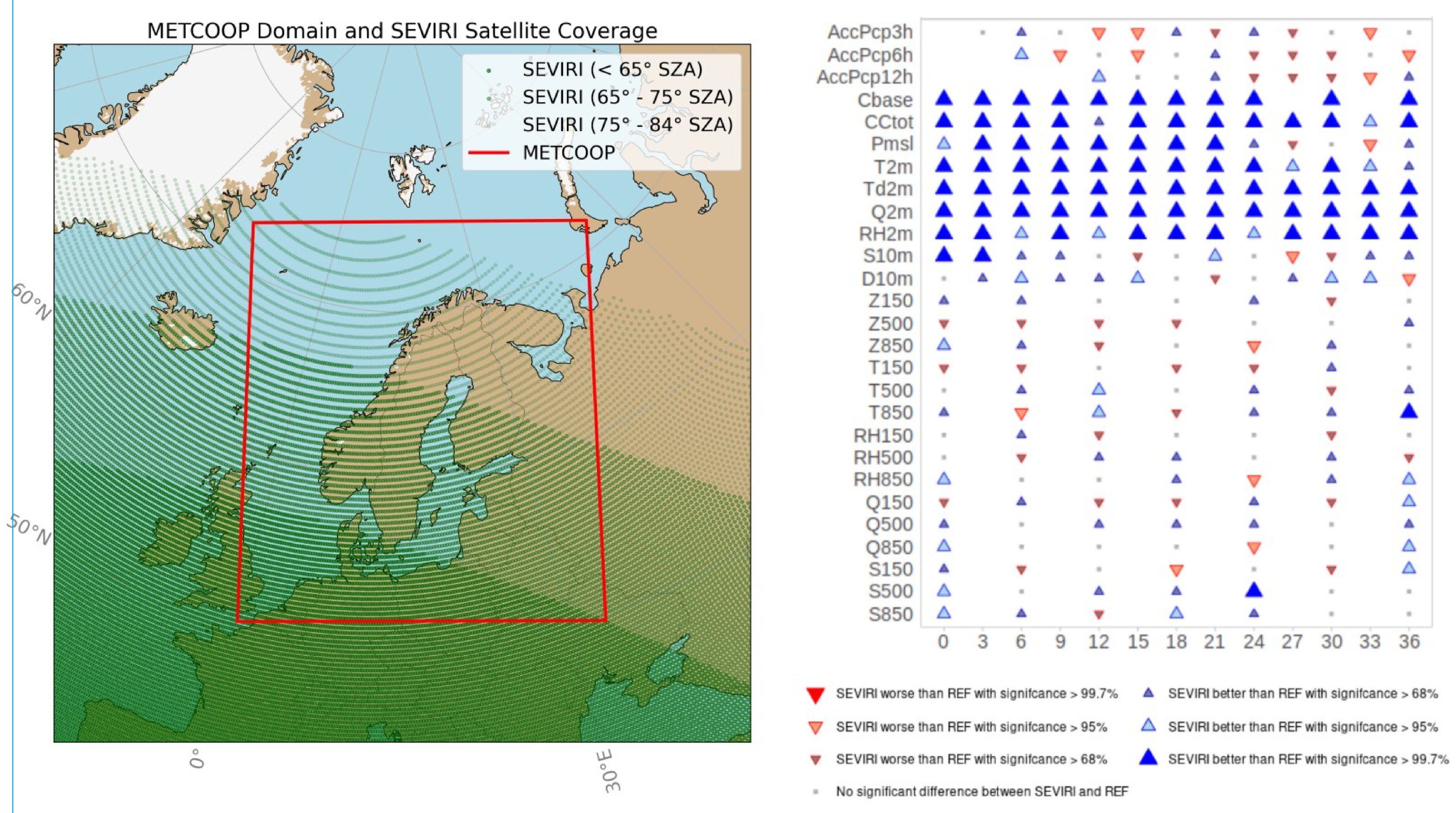


Figure 1. SEVIRI data coverage and forecast impact. (left) Geographical coverage within the METCOOP domain (red box) for SZA limits of 65°, 75°, and 84°. (right) Forecast impact scorecard comparing the assimilation of SEVIRI data up to 84°SZA against a reference (REF).

Fine resolution ML-based physiography for NWP

Background
Moving of NWP models to hectometric resolution needs physiography data with decametric resolution. Maps with decametric resolution exist, but they distinguish only several basic land cover types, while NWP models use more detailed classification of land covers. In G. Bessardon et al., 2024 and T. Rieutord et al., 2024, the new ML-based approach was applied to combine many existing maps with different resolution, and the new 60m resolution cover map for Europe ECO-SG-ML distinguishing 33 cover types was created.

Objectives

- to evaluate the new ECO-SG-ML
- to combine the ECO-SG-ML with other parameter fields such as LAI and albedo and use it in SURFEX
- to train the ML model with more data and produce an improved version of ECO-SG-ML

Preliminary results

- In ECO-SG-ML comparing with ECO-SG (which is a current basic map in SURFEX, with resolution of 300m), temperate grassland seems to be more common, at the expense of flooded grasslands and winter C3 crops, and temperate needleleaf evergreen forest slightly more common at the expense of temperate grasslands (Fig. 2)
- ECO-SG-ML is collocated with LAI and albedo fields (example on Fig. 3); SURFEX runs technically with ECO-SG-ML; evaluation of results is in progress.
- ML model to create ECO-SG-ML is parallelized; an updated version of it using data on coordinates is produced.

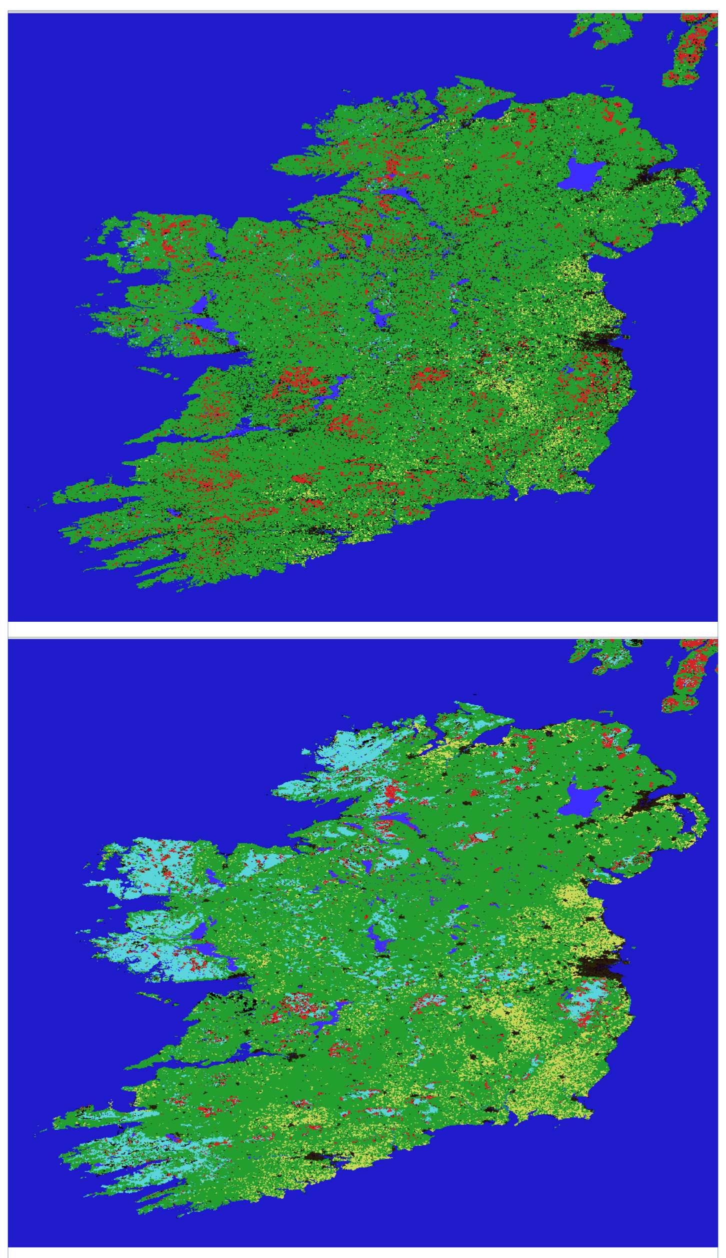


Figure 2. Physiography maps over Ireland. Top: ECO-SG-ML map, bottom: ECO-SG map. Blue: sea and inland water; red: temperate needleleaf evegreen; green: temperate grassland; yellow: winter C3 crops; turquoise: flooded grassland; black: other covers (mostly urban and temperate broad-leaf decidious)

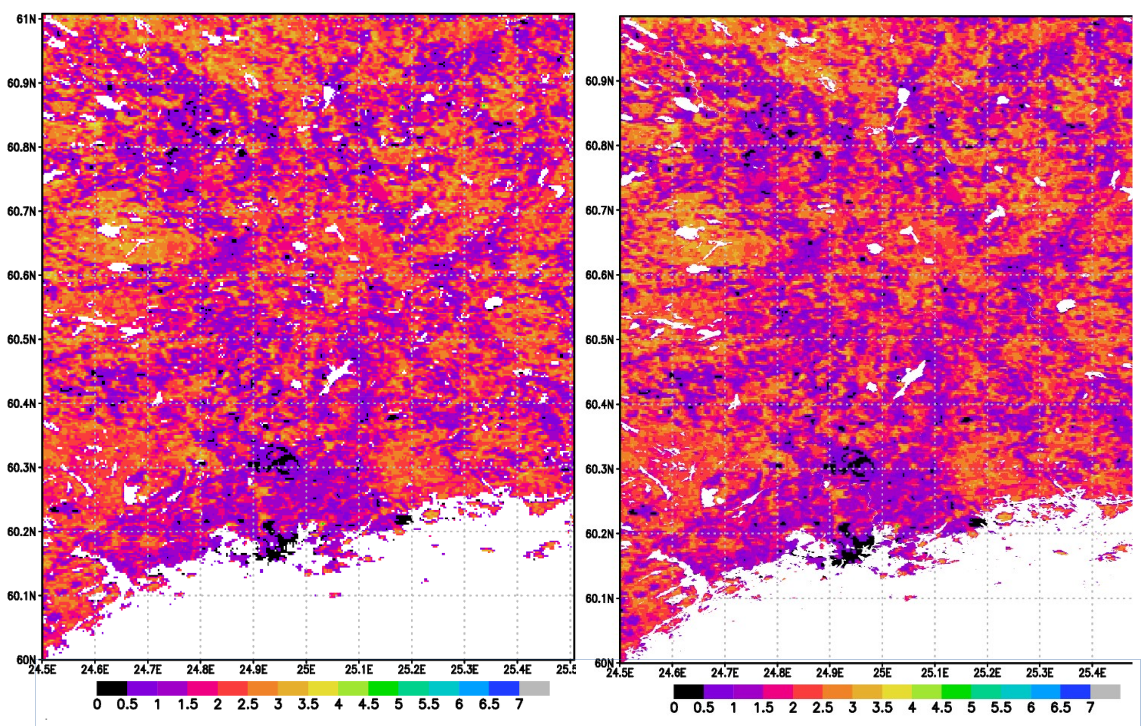


Figure 3. LAI for the last decade of August for Helsinki area, left: collocated with ECO-SG, right: collocated with ECO-SG-ML

Heat-related climate risk analysis for Helsinki

Experiment

- Surface-atmosphere interaction module SURFEX was used to simulate surface conditions in Helsinki during hot summer months. The experiment was reiterated for May 2018, June and July 2021, and August 2022, and then again for equivalent hot months in the climates of the periods 2025–2054 and 2055–2084.
- For the past months, the atmospheric forcing data sets required by SURFEX were created with HARMONIE-AROME runs for each month separately.
- For the months in the future climates, the forcing was created by utilizing a delta change method: projected changes (according to SSP2-4.5 scenario) between 2005–2035 and target periods were averaged from the results of 20+ climate models (Ruosteenoja & Jylhä 2021). The changes were calculated for temperature, wind speed, relative humidity, precipitation and solar radiation. The changes were then applied to the forcing of the past months, creating example months for the future climates with similar annual probability of occurrence as those modeled for the current climate.
- In order to achieve modeling resolution of 100 m, a ML-enchanced ECOCLIMAP-SG-ML cover map was used (Rieutord et al 2024, see also the ML-section of this poster). The urban land use at 100 m resolution can be seen in Figure 4.

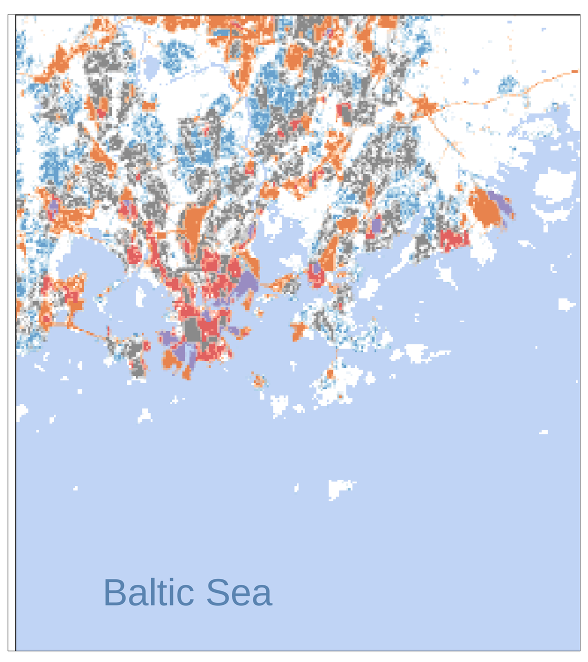


Figure 4. Urban land use in Helsinki as seen by the model. Blue: lowrise; grey: midrise; red: highrise; purple: heavy industry; orange: LCZ8: large lowrise.

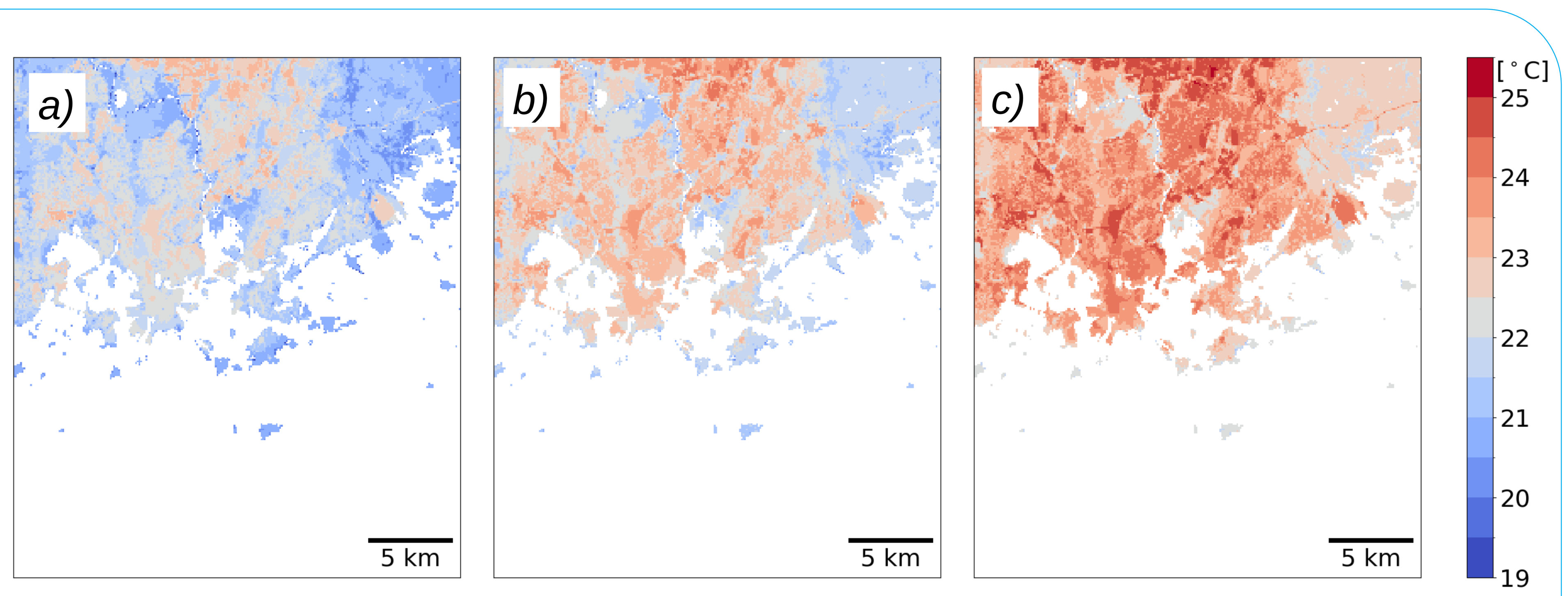


Figure 5. Average modeled temperatures for July in different climates: a) July 2021, b) 2025–2054 and c) 2055–2084. According to the climate models, the average change in July temperature for 2025–2054 and 2055–2084 climates is 0.78 °C and 1.68 °C, respectively (when comparing to the reference climate of 2005–2035).

Results
Modeled results show that the sea affects significantly the spatial temperature variation during all the summer months (July shown in Figure 5). Of all the different urban cover types, areas with large and low buildings (Local Climate Zone 8) experienced the highest temperatures, especially when located inland. In addition to temperature, UTCI (Universal Thermal Climate Index) results were also studied. Modeled heat stress values were typically higher in inland than near the coast.

References:

- *Bessardon, G., Rieutord, T., Gleeson, E., Pálmason, B., Oswald, S. (2024) 'High-Resolution Land Use Land Cover Dataset for Meteorological Modelling—Part 1: ECOCLIMAP-SG+ an Agreement-Based Dataset', Land. 13(11):1811.*
- *Rieutord, T., Bessardon, G., Gleeson, E. (2024) High-Resolution Land Use Land Cover Dataset for Meteorological Modelling—Part 2: ECOCLIMAP-SG-ML an Ensemble Land Cover Map. Land. 13(11):1875.*
- *Ruosteenoja, K., & Jylhä, K. (2021): Projected climate change in Finland during the 21st century calculated from CMIP6 model simulations. Geophysica, 56(1), 39–69.*
- *Schönach, D., Eresmaa, R. and Järvinen, H. (2025) 'Assimilation of SEVIRI Water Vapour Radiances in HARMONIE-AROME at Large Satellite Zenith Angles', Tellus A: Dynamic Meteorology and Oceanography, 77(1), p. 118–135.*