

SRNWP at FMI in 2022

Reima Eresmaa, Carl Fortelius, Erik Gregow, Karoliina Hämäläinen, Markku Kangas, Ekaterina Kurzeneva, Panu Maalampi, Laura Rontu, Olli Saranko, David Schönach, Juuso Suomi*) & Niko Sokka

*) University of Turku

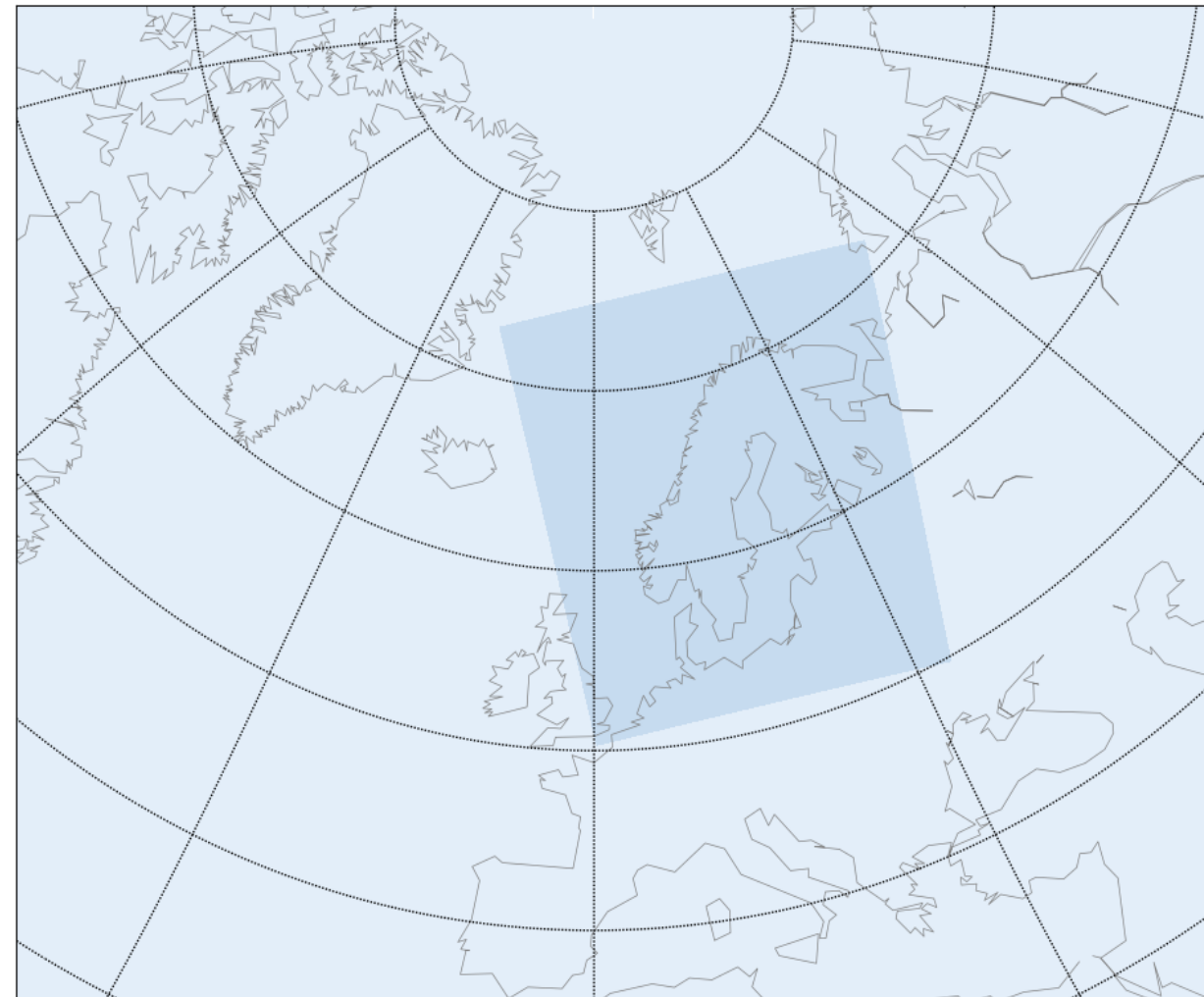
Operations

As a member of a Nordic **MetCoOp** cooperation with Norway, Sweden, and Estonia, 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 forecasts are produced every 3 hours and extend to 66 hours. Additionally, an hourly run HARMONIE-AROME-based nowcasting system **MNWC** producing 9 hour forecasts will soon be taken into operational use.

Forecast production within MetCoOp is distributed among the participating institutes.

FMI has also continued to run hydrostatic NWP model **HIRLAM** with horizontal resolution of 7.5 km. Hirlam runs, started in January 1990 will, however, be discontinued in September 2022.

Model Integration areas
Inner MEPS, outer Hirlam



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

Operational MetCoOp nowcasting (MNWC)

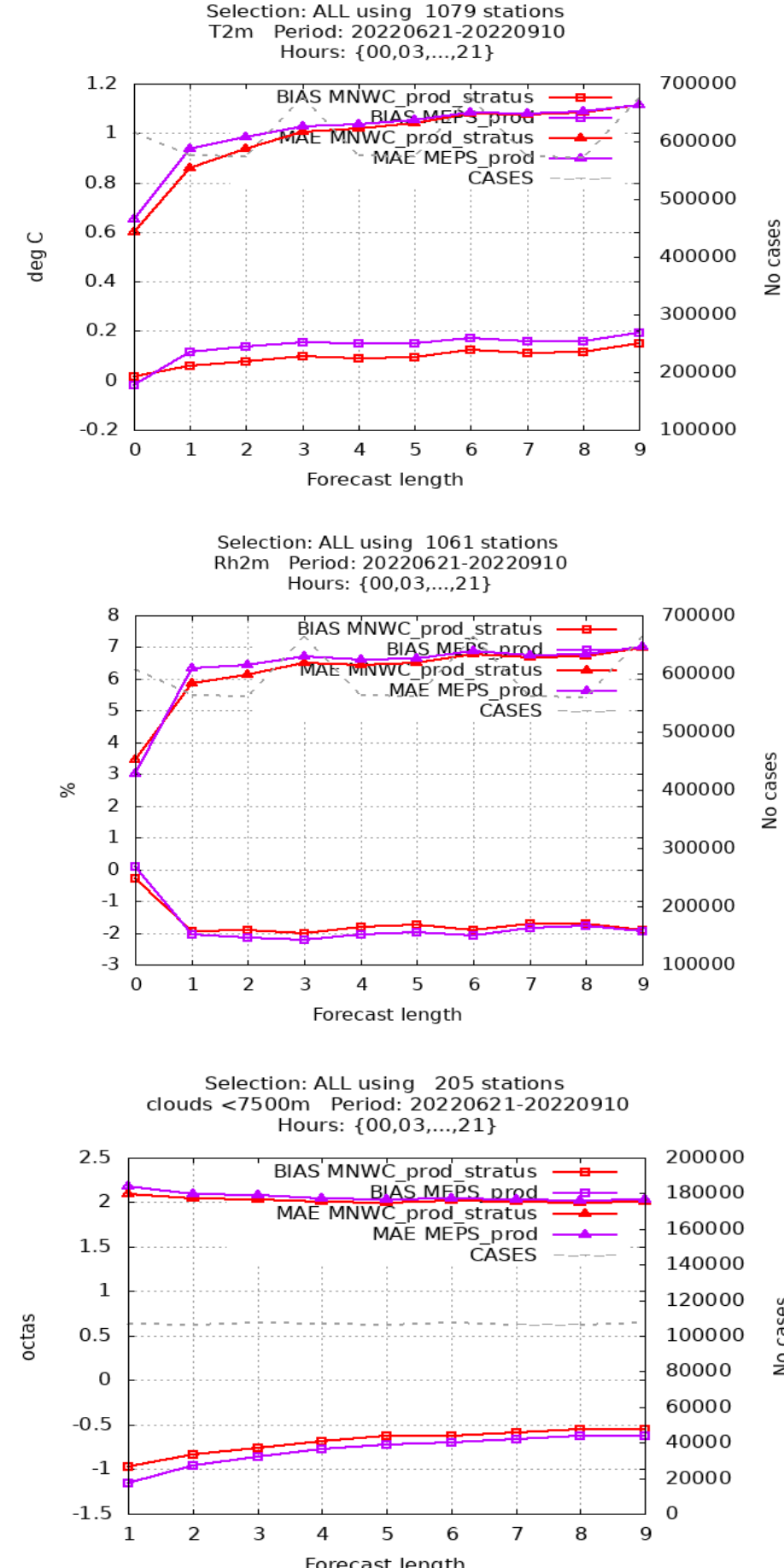
MetCoOp-NoWCasting (MNWC) becoming operational

Similar to **MetCoOp-Ensemble Prediction System (MEPS)** with the following deviations:

- Use of pySURFEX for SFC analysis
- GridPP for OI and Titan for QC
- Improved T2m and RH2m forecasts

- Cloud-ingest process
- Correction to cloud-base and -top
- Modifications to 3D moisture fields
- Improved cloud (and precipitation) properties

- Forecast at every hour (rapid-refresh using MEPS as first-guess)
- Forecast out to +9h lead-time with 15 minute output frequency
- Cut-off of observations +25 minutes (i.e. less observations used in MNWC)
- GNSS uses new whitelist but only for Sweden area (due to cutoff)
- MNWC_prod running on both NSC:Stratus and on FMI:Voima for redundancy



Verification between MNWC (NSC:Stratus; red) and MEPS (control mbr; blue), for 2m temperature (upper figure), 2m relative humidity (middle figure) and cloud cover (cloud ceiling < 7500m; lower figure). For period 11 June – 10 September 2022.

High-resolution heat wave simulations

Conditions in Finnish cities during a heat wave were modelled in the context of the research project HERCULES (funded by Academy of Finland, decision numbers 329235 and 329241) focusing on the impact of climatic conditions on human health. The temperatures simulated by HARMONIE-AROME were compared to measurements from an extensive network of data loggers in the city of Turku in Southwest Finland.

Methods

- HARMONIE-AROME experiment with a spatial resolution of 750 m was conducted for the 2018 July heat wave
- Modelled results were compared to observed temperatures from TURCLIM loggers in the period of 25.-31.7.2018.
- Physiography correspondence was evaluated by comparing the ECOCLIMAP-SG physiography description of the 750 m x 750 m grid cell containing the logger site, to (Corine land-use data from 2018, and also by examining) aerial satellite images and photographs from the sites.

Model: HARMONIE-AROME

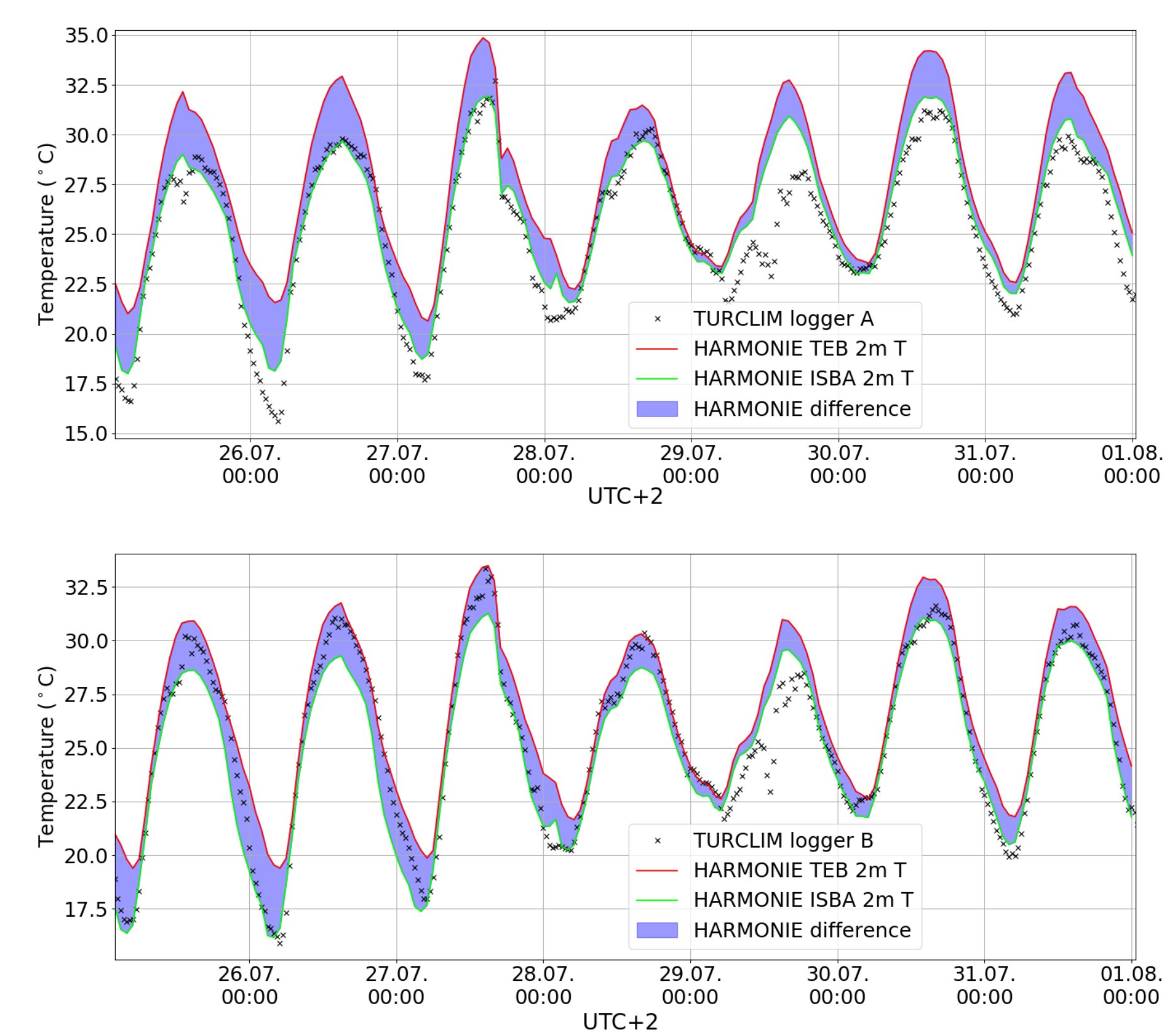
- cy43h2.1, SURFEX v8.1, ECOCLIMAP-SG
- 750 m horizontal spacing (grid type: cubic)
- 65 vertical levels
- domain: Southern Finland (centre at 23.68W, 60.83N)
- nesting: analysis only (ECMWF data)
- surface analysis: CANARI + SURFEX OI, no atmospheric assimilation
- 6-hourly cycling
- spin-up run 15 days (15-30.6.2018)

Results

- Generally, HARMONIE-AROME predicted the daily temperature cycle well. At nighttime, there was generally a positive bias of a few degrees.
- The effect of accurate physiography description within the model is best seen in the comparison of two logger sites: site A located at a busy commercial area, and site B located at a suburban area.
- Logger A is located within a small vegetated green area with a diameter of less than 100 m, surrounded by heavy traffic and commercial areas. ECOCLIMAP-SG has no information on this small patch of land, and only sees the area as large low-rise urban area.
- Logger B is located on a suburban area with some buildings, some forest, and crop fields a little farther away. ECOCLIMAP-SG sees the area as mostly sparsely built area, with a small percentage (6.7%) of crop fields. The description therefore is quite good.

TURCLIM measurement network

- Location: Turku region, Finland
- planning started 1998, measurements since 2001
- measurements with 75 loggers
- measurement device HOBO U23 Pro V2 (air temperature and relative humidity)
- located to cover varying environments by e.g. land use, topography, and water bodies
- extensively used both in research and education



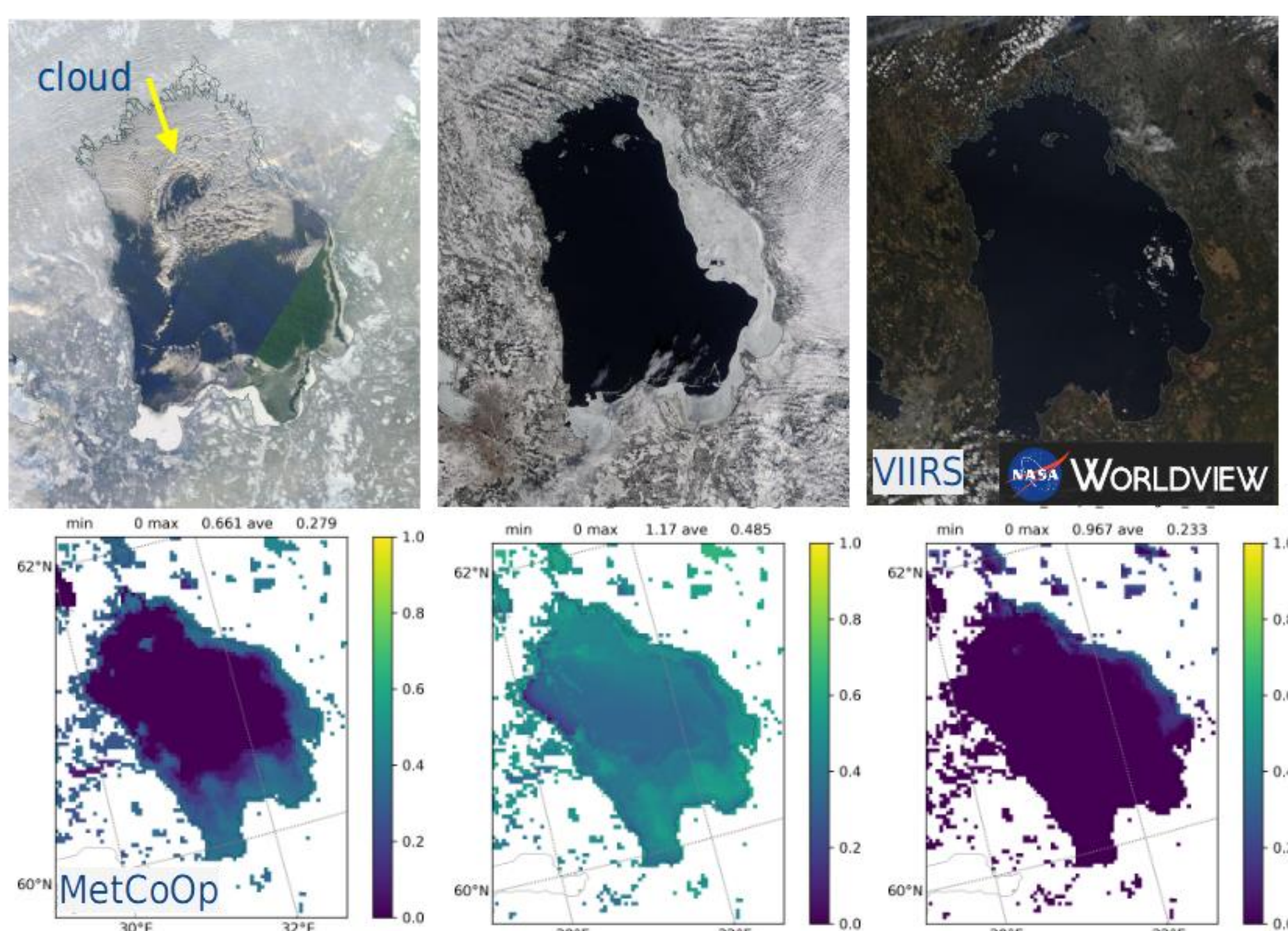
In the upper figure, logger A observations and the corresponding HARMONIE-AROME modelled temperatures are presented; the lower figure shows the same for logger B. In the logger B case, where the physiography of the model corresponds better to reality, there is a better fit between the observations and the town temperatures predicted by TEB as well as nature temperatures predicted by ISBA. With 750 m resolution, model physiography in the logger A grid cell is 90% for town and 10% for nature; with logger B the same values are 28% and 72%, respectively.

Reference: Suomi et al. (under review): Evaluation of surface air temperature in the HARMONIE-AROME weather model during a heatwave in the coastal city of Turku, Finland

Freshwater lake model FLake in MEPS

Lakes influence the energy exchange between the surface and the atmosphere, the dynamics of the atmospheric boundary layer and the near-surface weather. This is important for weather forecasting over Fennoscandia where lakes with a large yearly variation of the water temperature, freezing in autumn and melting in spring, cover a significant area of the surface.

The operational MetCoOp HARMONIE-AROME NWP system (MEPS) includes a prognostic lake scheme, Freshwater Lake (FLake). FLake allows to predict the lake surface state in interaction with the atmospheric processes treated by the NWP model.



Lake Ladoga ice cover : comparison of satellite images with MEPS.