ACCORD
A Consortium for COnvection-scale modelling Research and Development

HIRLAM
High Resolution Limited Area Model

Overview of Land Surface DA activities in HIRLAM

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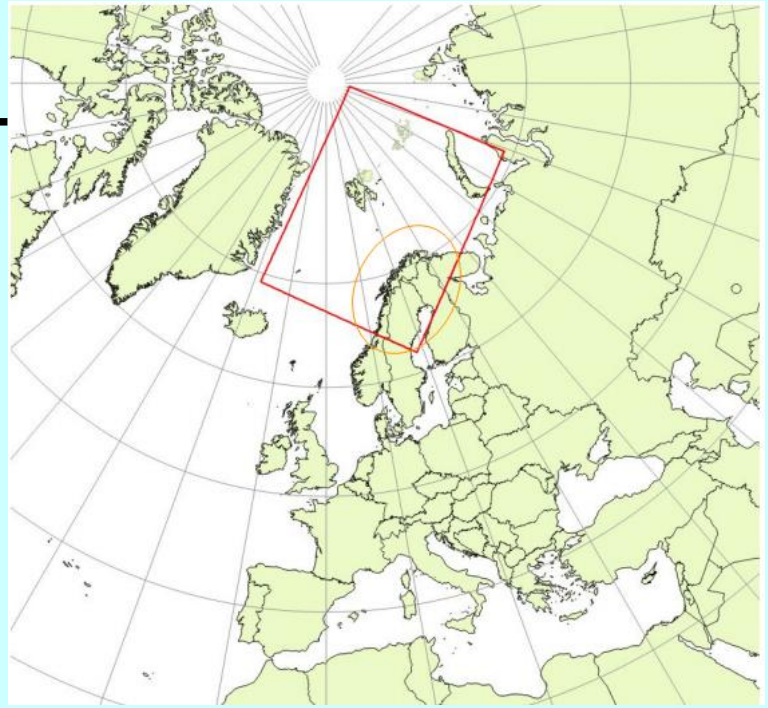
Joint LACE DAWD & DAsKIT

SEKF with ISBA-DIF/ISBA-ES/MEB

SEKF + gridPP+Titan+pysurfex +
ISBA-DIF: 14 layers, down to 12 m +
ISBA-ES: 12 layers +
MEB

<u>Running experiment</u>
in Met.no, AROME-Arctic domain
since September 2019



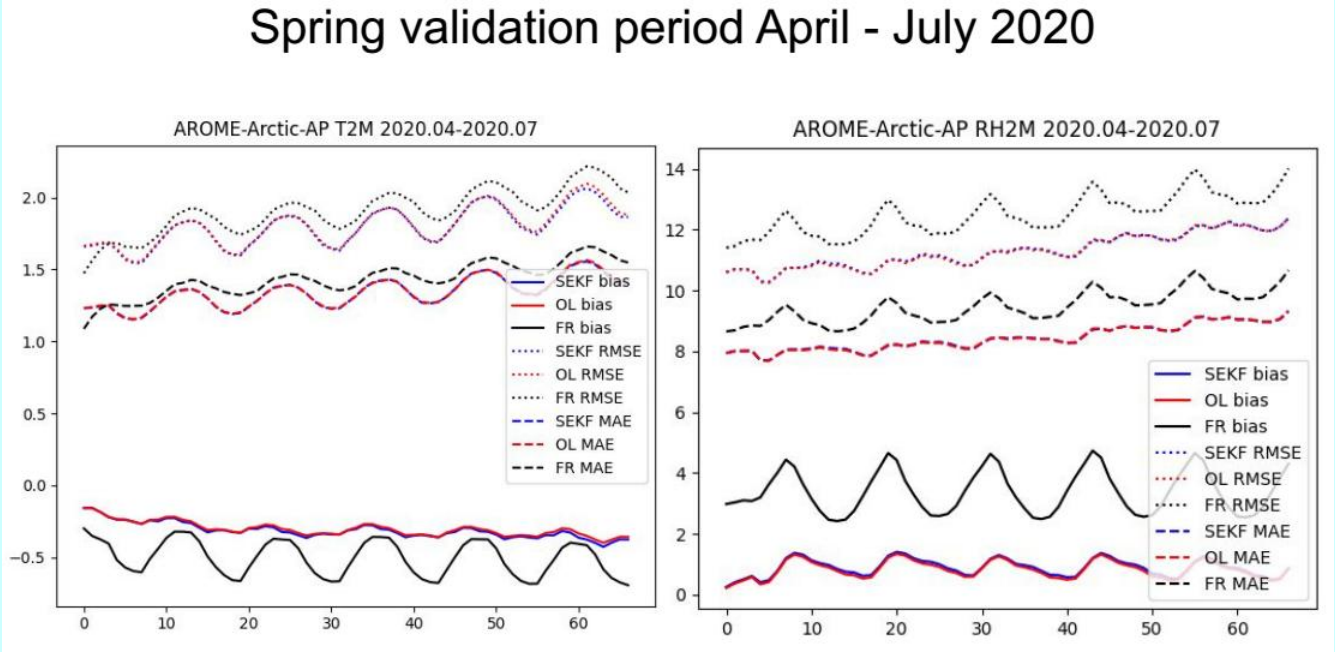
ÅsBa, TrAs, PaSa

<u>Assimilation</u>

- **T2m and RH2m from SYNOP**
- **tg1, tg2, …, wg2-wg6**
- **2 patches**
- **Symmetric perturbations and restricted Jacobians**

SEKF with ISBA-DIF/ISBA-ES/MEB

ÅsBa,
TrAs,
PaSa



- Impossible to compare SEKF and OI, because OI does not exist for ISBA-DIF
- Warming and moisturizing effect of ISBA-DIF for spring
- Currently difficult to access an impact of SEKF

EnKF with ISBA-DIF/ISBA-ES/MEB

- Research activities
- Experiments run over AROME-Arctic
- EnEKF+gridPP+Titan
- EnKF in vertical
- Ens in based on the perturbed offline forcing

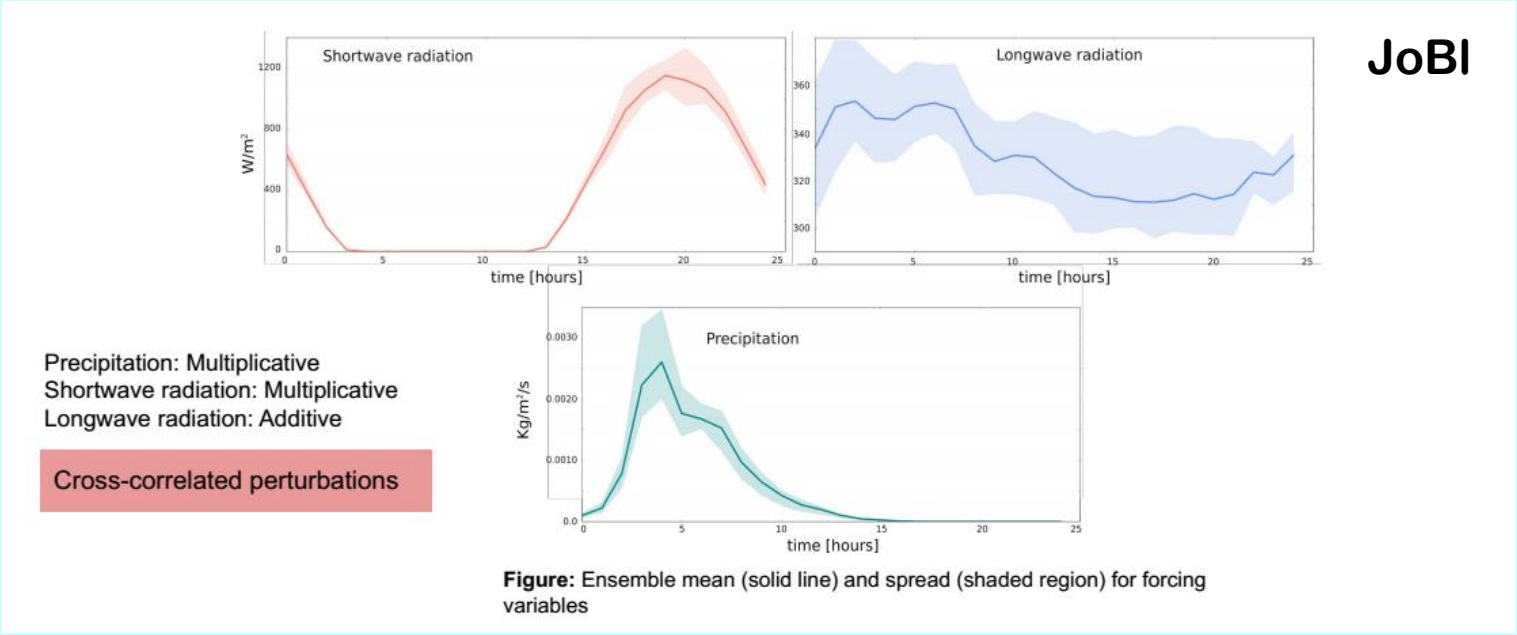


Figure: Ensemble mean (solid line) and spread (shaded region) for forcing variables

JoBI

EnKF with ISBA-DIF/ISBA-ES/MEB

Soil temperature TG analysis increments.

JoBI

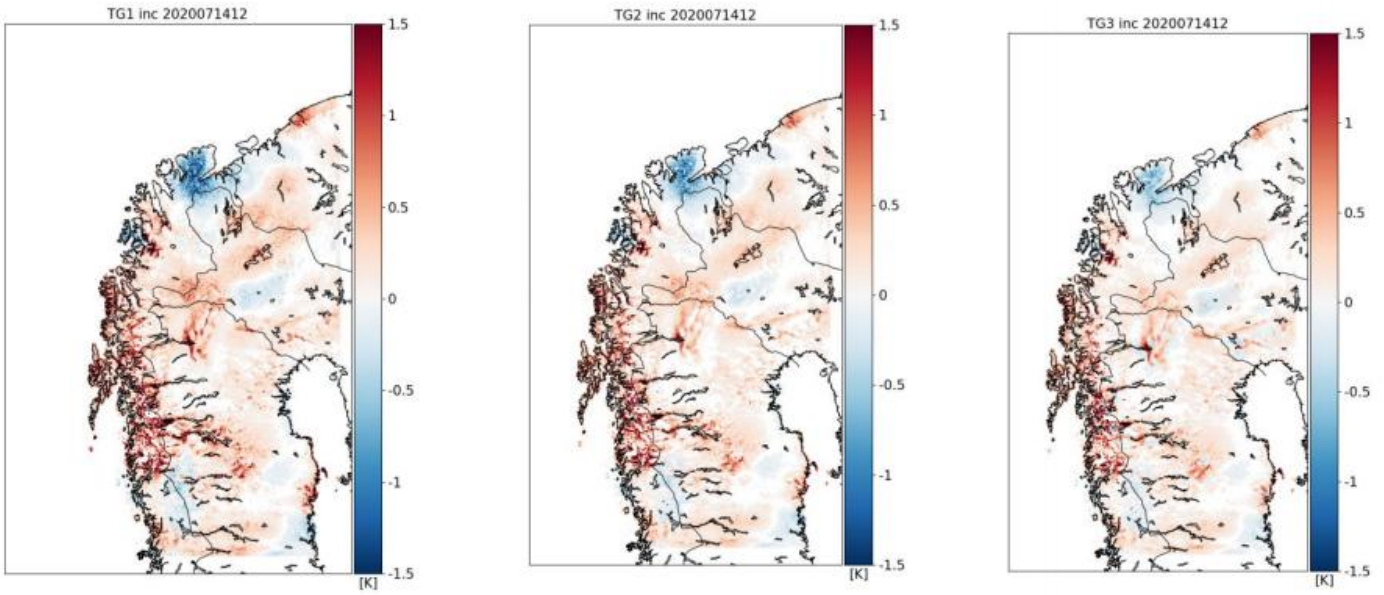


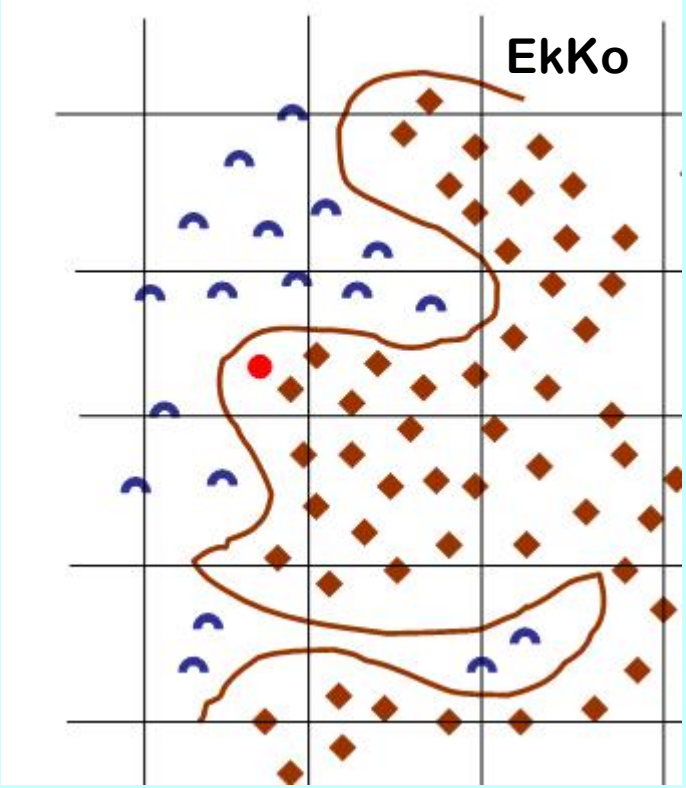
Figure: TG1 to TG3 increments for 14th July 2020 at 12 local time. Blue/red indicates decrease/increase in soil temperature for that layer.

Meteorologisk institutt

- **Plans: to assimilate satellite-derived vars, such as soil moisture etc., with obs operators, relating them to passive microvawe brightness temperature.**

Physiography in DA

- **CANARI:**
  E923, 150 sec., water and land, 50% masking
- **SURFEX:**
  ECOCLIMAP(SG), 30(10) sec., 4 tiles and up to 20 patches, fractional cover 0-100%.
- **The concept of fractions in SURFEX is not adjusted to DA.**
- **0 or 100% threshold is not save, because of machine accuracy. We need smth. more robust for DA.**



Physiography in DA

- In CANARI, technical issues with the observation operator
- For ECMWF cold start data, fields are inconsistent with the LSM, due to interpolations
- Inconsistency affects different parts of the system, with different effects depending on CSC. The weakest point is snow analysis.

Work done and on track

- CANARI may use SURFEX fields in HARMONIE-AROME
- PGD and PREP: to limit fractions of patches and tiles by the NAMELIST options. E.g. for 5%, 1%, etc.
- Cleaning of the ECMWF cold start data.
- Corrections in CANARI obs operator.

EkKo

gridPP, Titan and pysurfex

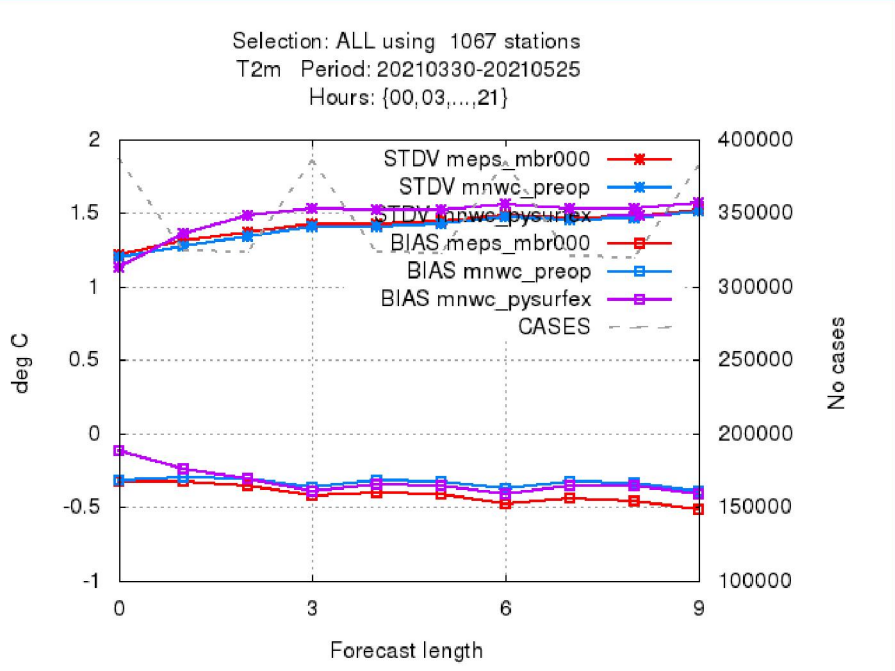
- gridPP (gridded Post-Processor)
  - OI.
  - Supports various file formats. Reads SURFEX phys.
- TITAN (automatic data quality control)
  - Contains various methods of QC, including OI QC.
  - Highly modular, allows easy tuning.
- pysurfex
  - New scripting system written on pyton, which combines everything with SURFEX within and HARMONIE-AROME.
- Developed and supported by Met.no.
- Equations are derived alternatively: maximize probabilities vs minimizing errors. Different terminology and different parameters.
- C++, not parallel.

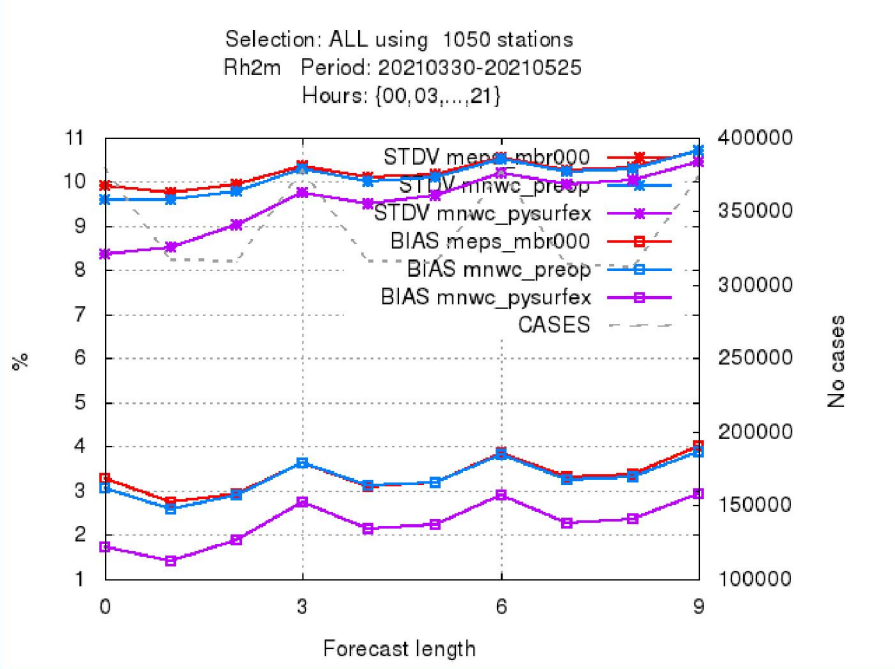
TrAs, ErGr

gridPP, Titan and pysurfex

Runs in MetCoOp for nowcasting mode **TrAs, ErGr**

- **using crowd-source NetAtmo observations**
- **without cycling**





Assimilation of satellite Snow Extent

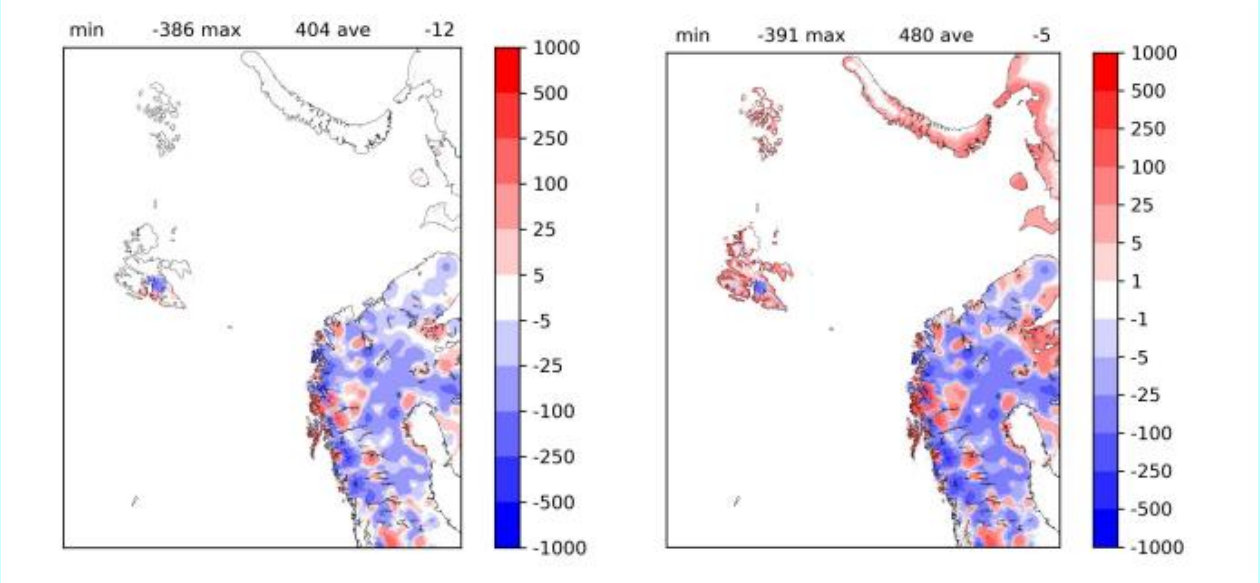
- MetCoOp domain, cy43 MaHo, LaRo, EkKo
- Simple algorithm of removing/adding snow:
  - "no snow" in obs and "snow" in bgr => removing snow
  - "snow" in obs, "no snow" in bgr => adding some snow
- 2 products:
  - CryoLike (Met.no). Composite.
  - EUMETSAT H SAF (FMI). Metop.
- Processing of satellite data is different, however both NWP-oriented:
  - CryoLike: swaths => 2.5 km model grid => thinning to 10 km
  - H SAF: swaths => snow barrels, irregular locations representing 10x10 pixel boxes
- Removing of data over water and glaciers in preprocessing

Assimilation of satellite Snow Extent

- Not easy to demonstrate an effect on standard scores
- Most effects are in SYNOP-obs sparse areas
- However sensitivity is well seen

SWE, kg/m**2, 12.04.2017

- Snow barrels, CARRA domain



OL – (SYNOP) OL – (SYNOP+barrels)

MaHo, LaRo, EkKo

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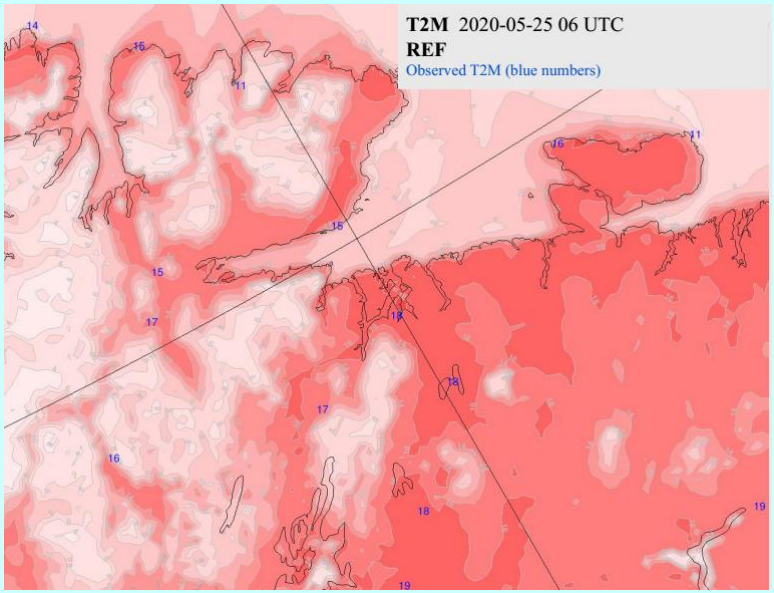
Assimilation of satellite Snow Extent

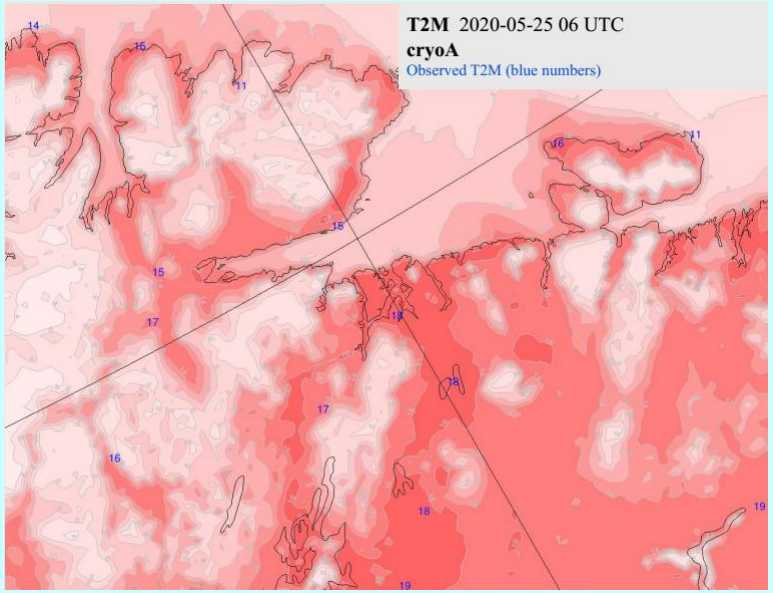
CryoLike, MetCoOp domain

T2m, °C, 25.05.2020, 15 UTC

MaHo, LaRo, EkKo



Only SYNOP



SYNOP+CryoLike

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EKF for SICE

YuBa

- **Model: SICE** – 1D Simple Sea ice scheme: predicts the temperature profile in the ice and ice depth. Snow on ice is described by ISBA-ES. The default sea ice parameterization since cy43 of HARMONIE-AROME. Governed by Sea Ice Concentration observations.
- **Obs: L2 NRT VIIRS Sea Ice Surface Temperature (SIST)** product from OSI SAF. Obs are from visual band, of fine (750m) resolution, contain gaps due to cloudiness and exist only over satellite overpass.
- **DA method: Bias-aware 1D EKF.**
- For horizontal part: OI of CANARI, with some adjustments to fine resolution and large data gaps.

EKF for SICE

- Ice surface temperature is a fast variable; difficult to cope with a model bias due to that.
- Bias correction is applied incrementally during the model forecast
- Much attention is paid to tune Q matrix and to get M-matrix for fast variables.
- EKF is re-initialized when snow appears and disappears.

classic extended Kalman filter

$$B = MAM^T + Q$$

$$K = BH^T\left[HBH^T + R\right]^{-1}$$

$$X_a = X_b + K\left[Y - \mathcal{H}(X_b)\right]$$

$$A = [I - KH]B$$

bias-aware extended Kalman filter

$$B = MAM^T + Q$$

$$K = BH^T\left[HBH^T + R\right]^{-1}$$

$$K^b = B^bH^T\left[HB^bH^T + HBH^T + R\right]^{-1}$$

$$b_a = b_b - K^b\left[Y - \mathcal{H}(X_b - b_b)\right]$$

$$X_a = (X_b - b_a) + K\left[Y - \mathcal{H}(X_b - b_a)\right]$$

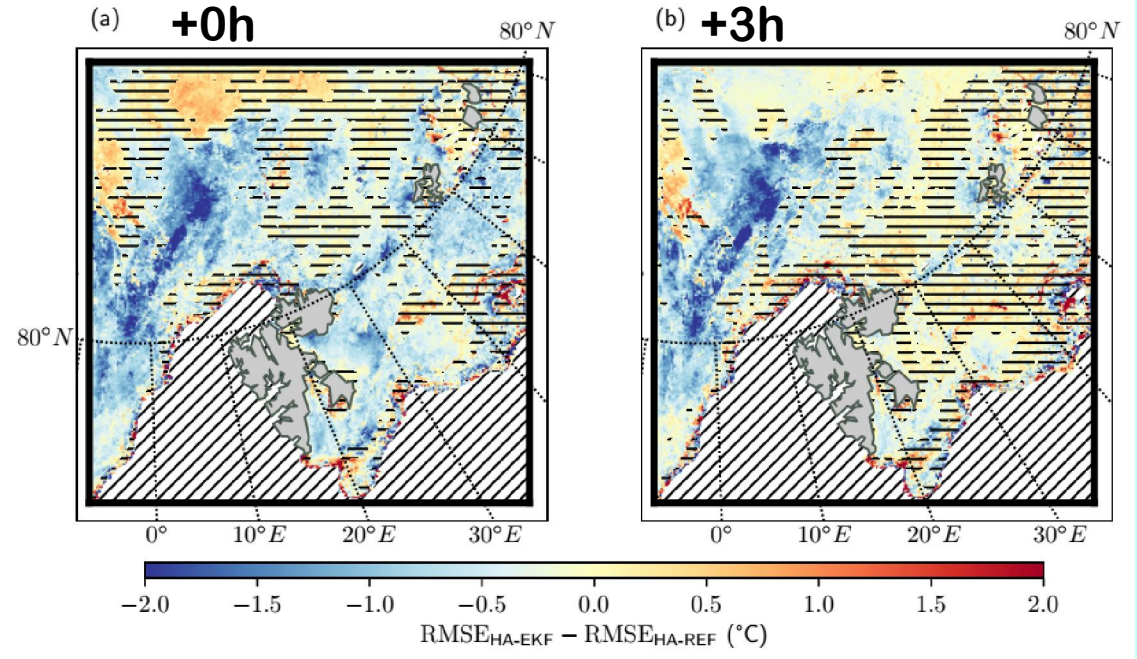
$$A = [I - KH]B\,[I - KH]^T + KRK^T$$

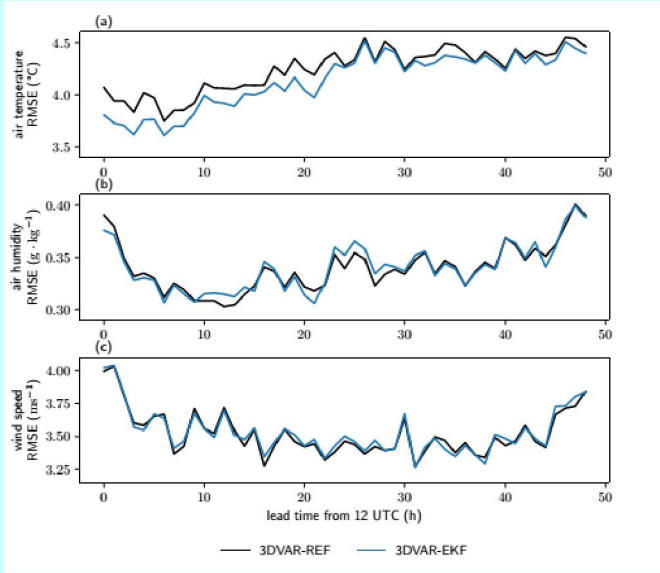
YuBa

EKF for SICE

- Verification against SIST of MODIS, and T2m of coastal stations at Swalbard
- Experiments over small domain, covering overall period of 1.09.2019-01.02.2020
- 3h cycling with 3h and 48h forecasts

YuBa





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Towards coupled DA

- Internally funded project H2O at Met.no
  R. Stappers
- Application of project CAISA at SMHI
  J. Bojarova
- Ts from the surface analysis is used in UA analysis

Thank you for attention!