Experiences and challenges with MetCOoP EPS

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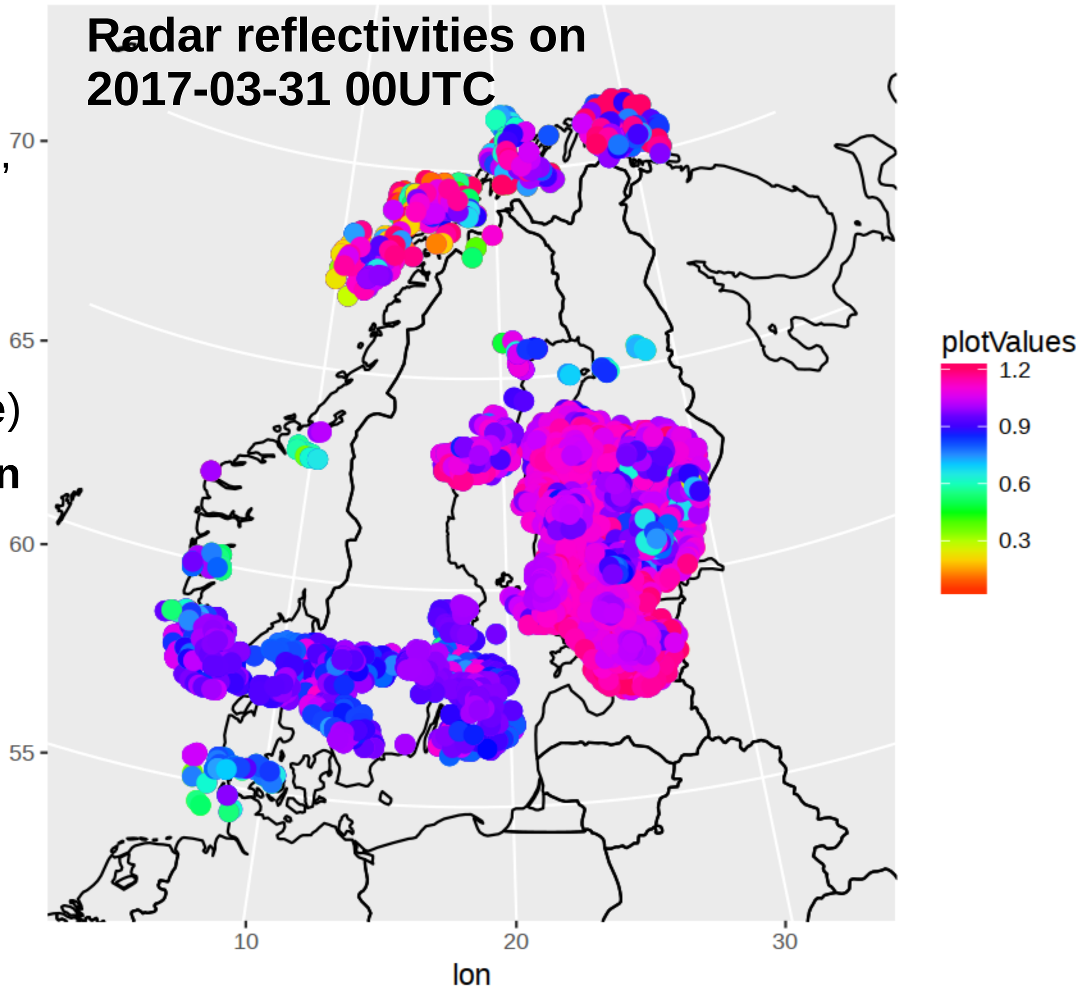
The MetCoOp ensemble: MEPS
Operational since November 2016

Model setup	New model version: harmonie-40h1.1++ 2.5km grid spacing, 65 levels **same domain for all members** HARMONIE-AROME physics
Assimilation	3h 3DVAR for the control member(s) 3h surface assimilation for the control member(s) 6h surface assimilation for all members
Forecast lengths	66h at 00,06,12,18, 3h at 03,09,15,21 for control 48h at 00,06,12,18 for members (will be 54h)
Perturbations	Initial and boundary perturbations from ECMWF forecasts (SLAF)
Members	**10 members** (without lagging) Frost:1 control, 5 members Vilje:***1 pseudo control***, 3 members

Observations used in MetCoOp

- Conventional: SYNOP, AIRCRAFT, TEMP, SHIP, DRIBU
  - GTS + **local SMHI/MET/*FMI***
- Satellite radiances: AMSU-A, AMSU-B, MHS, IASI
- ASCAT satellite winds
- Radar reflectivities
  - Sweden and Norway (**DK,FI,ES in e-suite**)
- GNSS total zenit delay from ROBH **(NGAA in e-suite)**
- T2M, RH2M, SNOW for surface assimilation
- SST/SIC from ECMWF and SMHI oceanographic model NEMO
- **New JB in e-suite**



MetCoOp deviations from 40h1.1
(remember that we are RCR)

Surface physics and assimilation

Use SST and ice concentration information from ocean models at SMHI in the Baltic Sea.

Treat the lakes Vänern and Vättern as sea.

Response to T2M/RH2M increment and associated snow melt change

SURFEX_SEA_ICE=sice

Assimilate snow 06/18 and reduce influence radius REF_A_SN=30000

Atmospheric physics

Freezing rain improvements, fix for stratospheric humidity, fix for cloud liquid to rain

Numerics

Switch on COMAD to avoid spurious water bombs in cases of low winds.

Upper air assimilation

Reduced observation errors

Observation type related changes

MetCoOp deviations from 40h1.1
(remember that we are RCR)

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Atmospheric physics

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Numerics

Switch on COMAD to avoid s… …s water bombs in cases of low winds.

Upper air assimilation

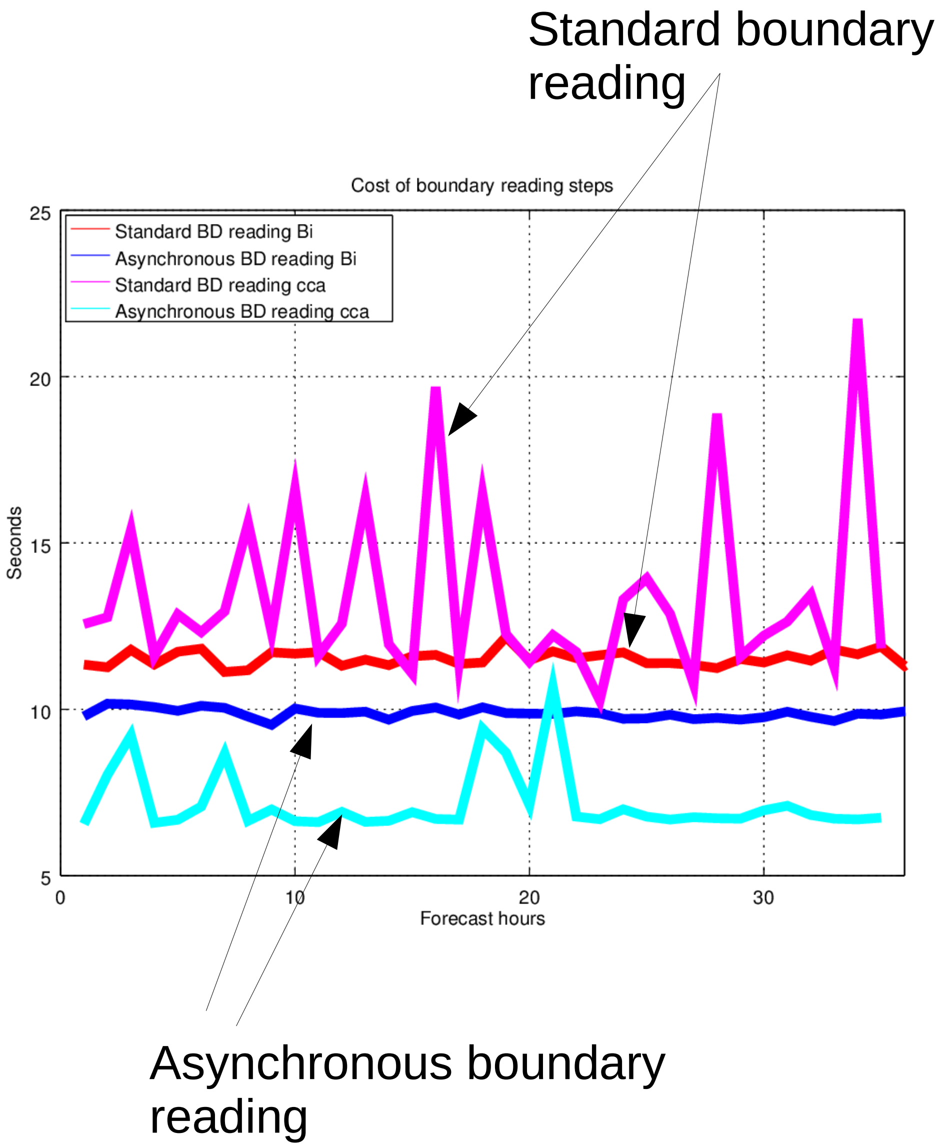
Reduced observation errors

Observation type related changes

Part of harmonie-40h1.2

MetCoOp deviations from 40h1.1
(remember that we are RCR)

- Asynchronous reading of boundaries, cuts 10-15% on each input time step **(backported from cy41)**
- Create grib files directly from the distributed IO-server files.
  - Reduces number of files on disc
- Improved parallel execution of single core tasks
  - Speedup of e.g. Bator and obsmon extraction
- Verification extraction from fullpos pressure level files.
- OpenMP parallelisation in costly gl routines (CAPE)
- Robustness of the EPS



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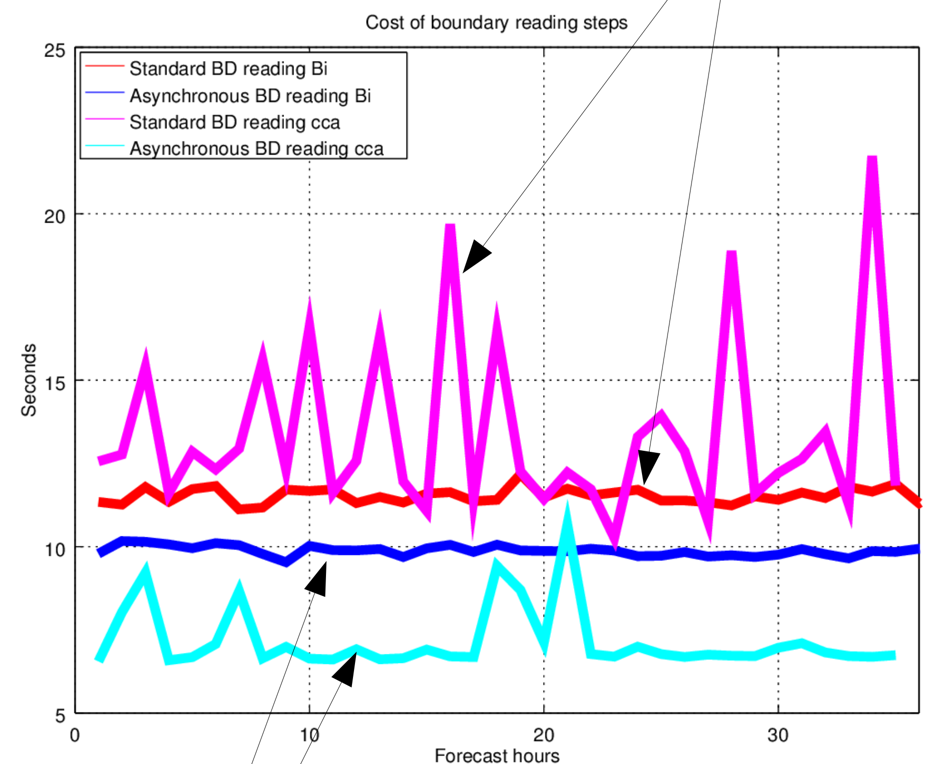
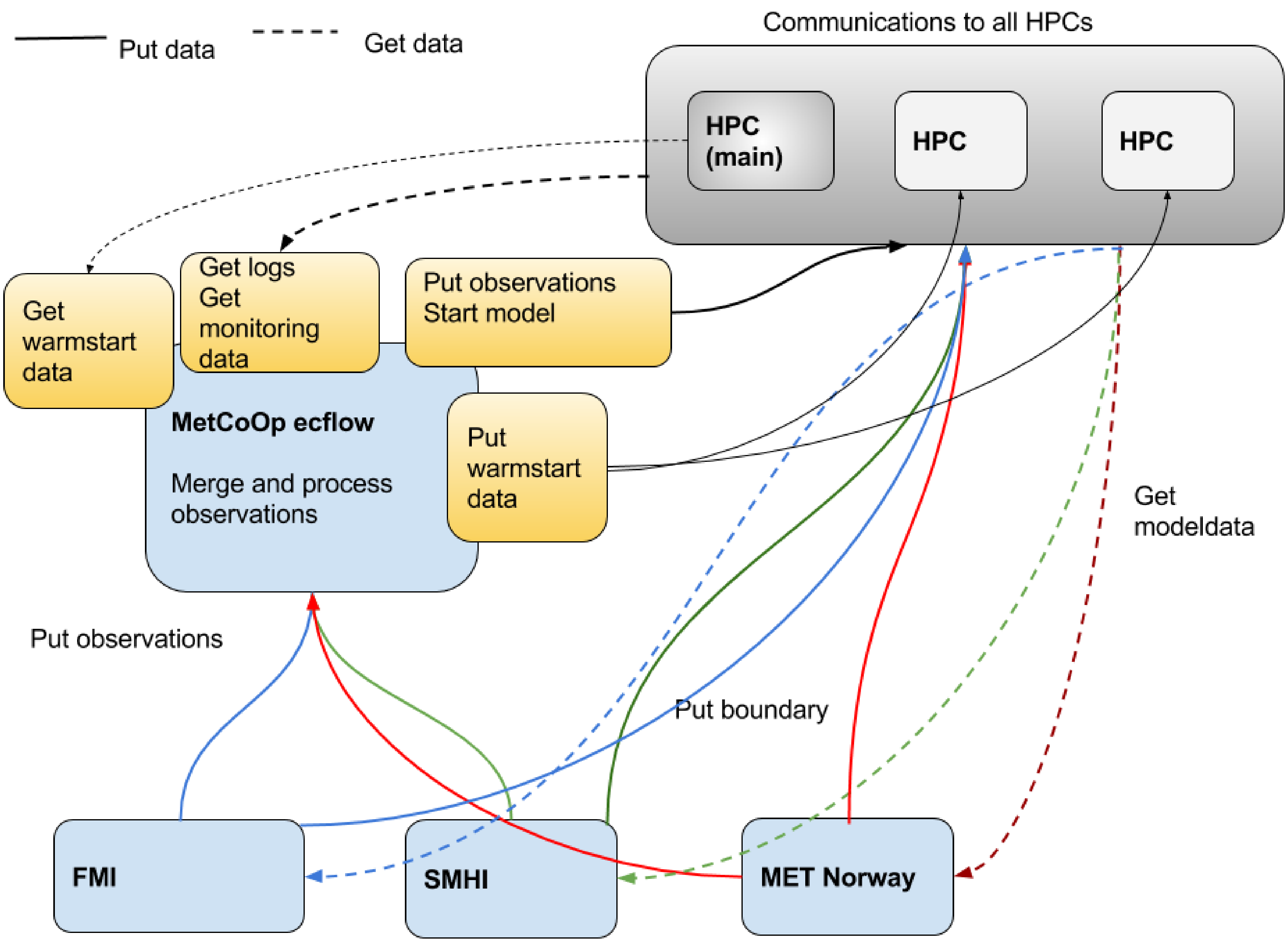
All in harmonie-40h1.2

Standard boundary reading



Asynchronous boundary reading

Controlling a multi country multi HPC setup



MEPS control performance vs ECMWF HRES Jan/Feb 2017

- Maintains a good performance vs ECMWF
- Forecasters worries
  - Convection from sea
  - Low winter temperatures
  - Too high winds (over snow)

	metcoop	norway	sweden	finland
AccPcp12h ets 30	▲	● (green)	▲▲	
AccPcp12h ets 10	● (red)	● (red)	▼▼ (red)	▲▲
AccPcp12h ets 5	● (green)	● (green)	● (green)	▲▲
AccPcp12h ets 0.2	● (green)	▲	▲	● (red)
AccPcp12h mae	● (green)	● (green)	● (green)	● (red)
AccPcp12h bias	● (green)	● (green)	● (green)	● (red)
RH2m mae	● (green)	● (red)	● (red)	● (green)
RH2m bias	● (green)	● (red)	● (green)	● (green)
Pmsl mae	● (red)	● (green)	● (red)	● (red)
Pmsl bias	● (green)	● (green)	● (red)	● (green)
s10m ets 20.8	▲▲	▲▲	▲▲	▲
s10m ets 17.2	▲▲	▲▲	▲▲	▲▲
s10m ets 13.9	▲▲	▲▲	▲▲	▲▲
s10m ets 10.8	▲	▲	▲▲	▲
s10m mae	● (green)	● (red)	● (green)	● (green)
s10m bias	● (green)	● (green)	● (green)	● (green)
t2m mae	● (green)	▲▲	● (red)	● (red)
t2m bias	▲	▲▲	● (green)	▲

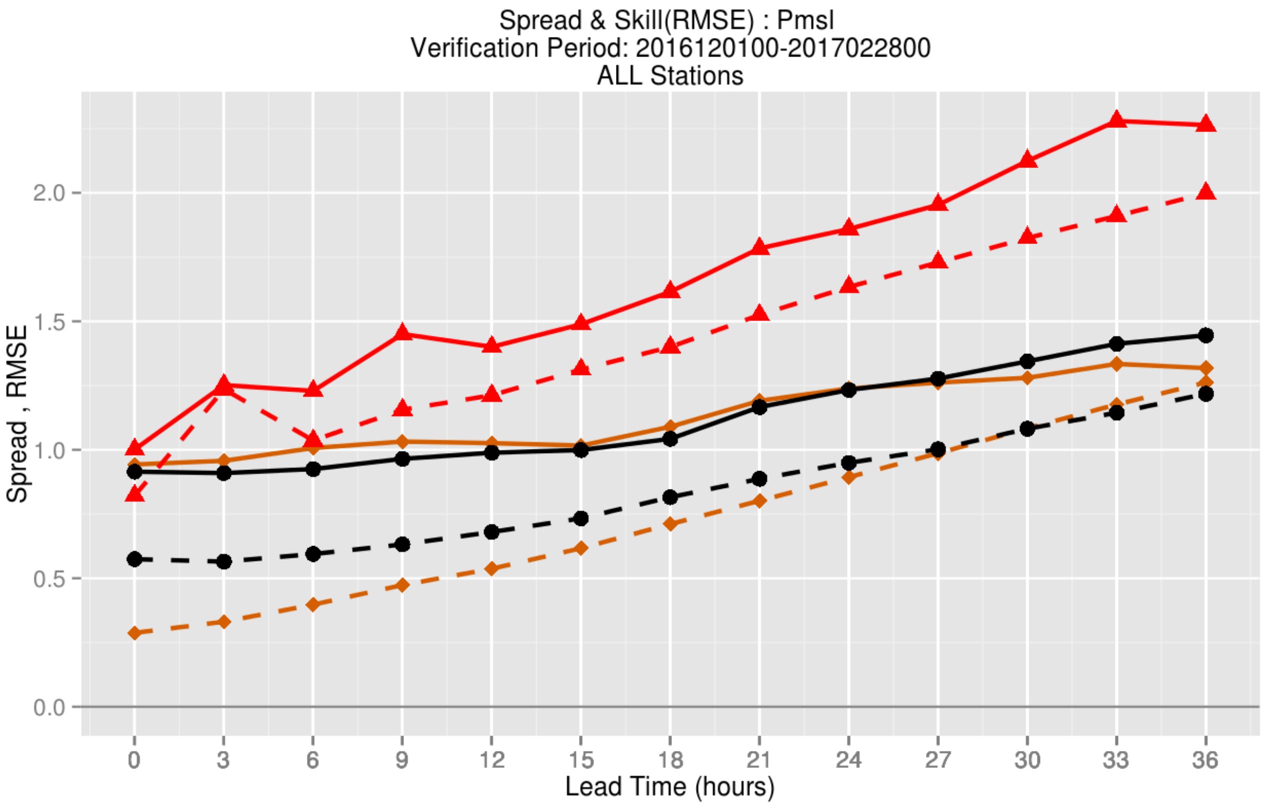
MSLP spread vs skill
Dec 2016-Feb 2017

- Competitive to ECMWF ENS and GLAMEPS

IFS ENS (51)

GLAMEPS(52)

MEPS(10)



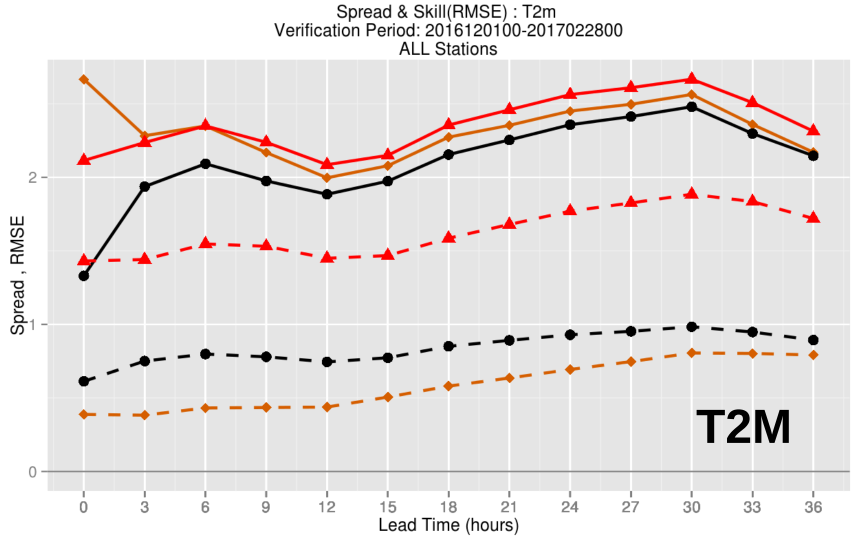
T2M/U10M spread vs skill
Dec 2016-Feb 2017

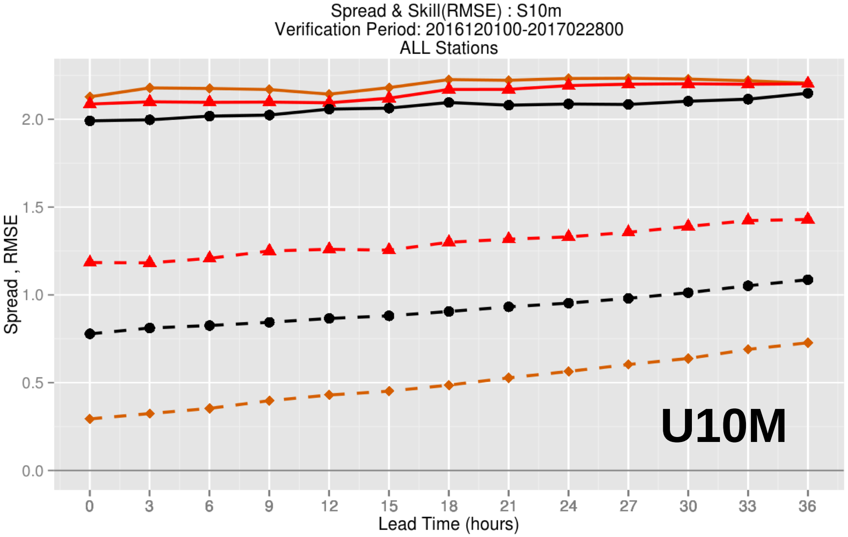
- Competitive in terms of RMSE
- Lower spread than GLAMEPS

IFS ENS (51)

GLAMEPS(52)

MEPS(10)





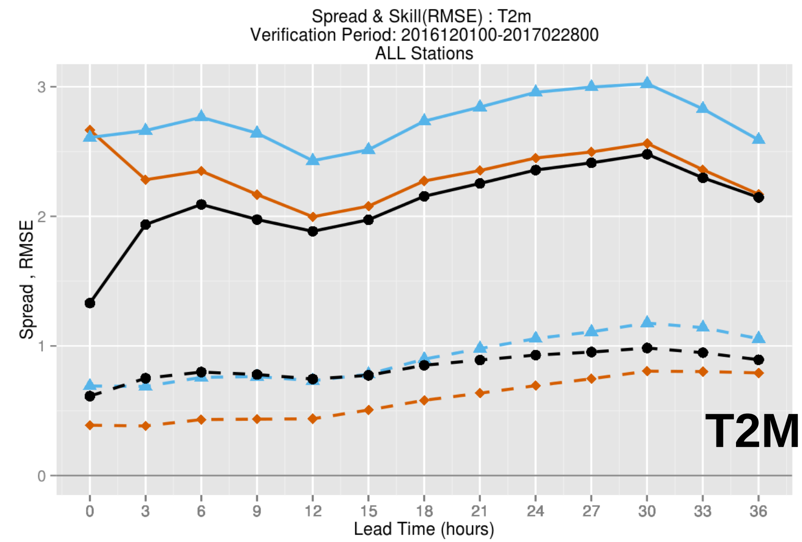
T2M/U10M spread vs skill Dec 2016-Feb 2017

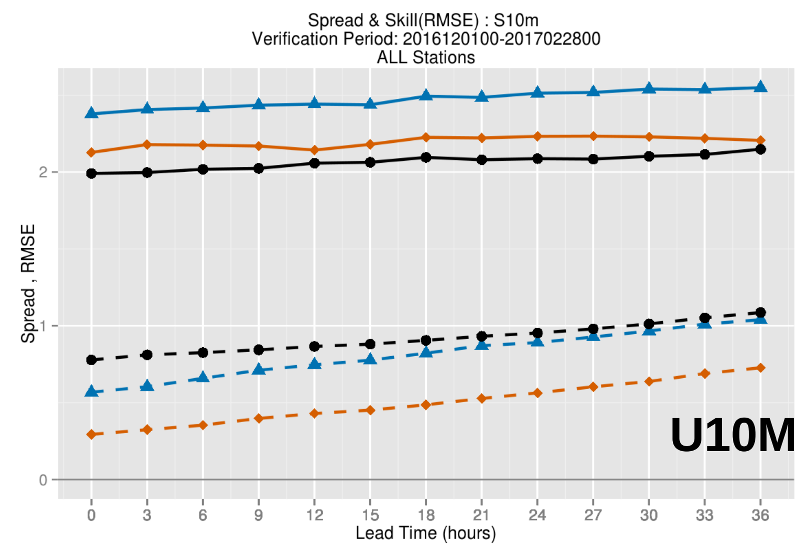
- Size and multi model a large part of GLAMEPS spread

IFS ENS (51)

GLAMEPS HIRLAM

MEPS(10)



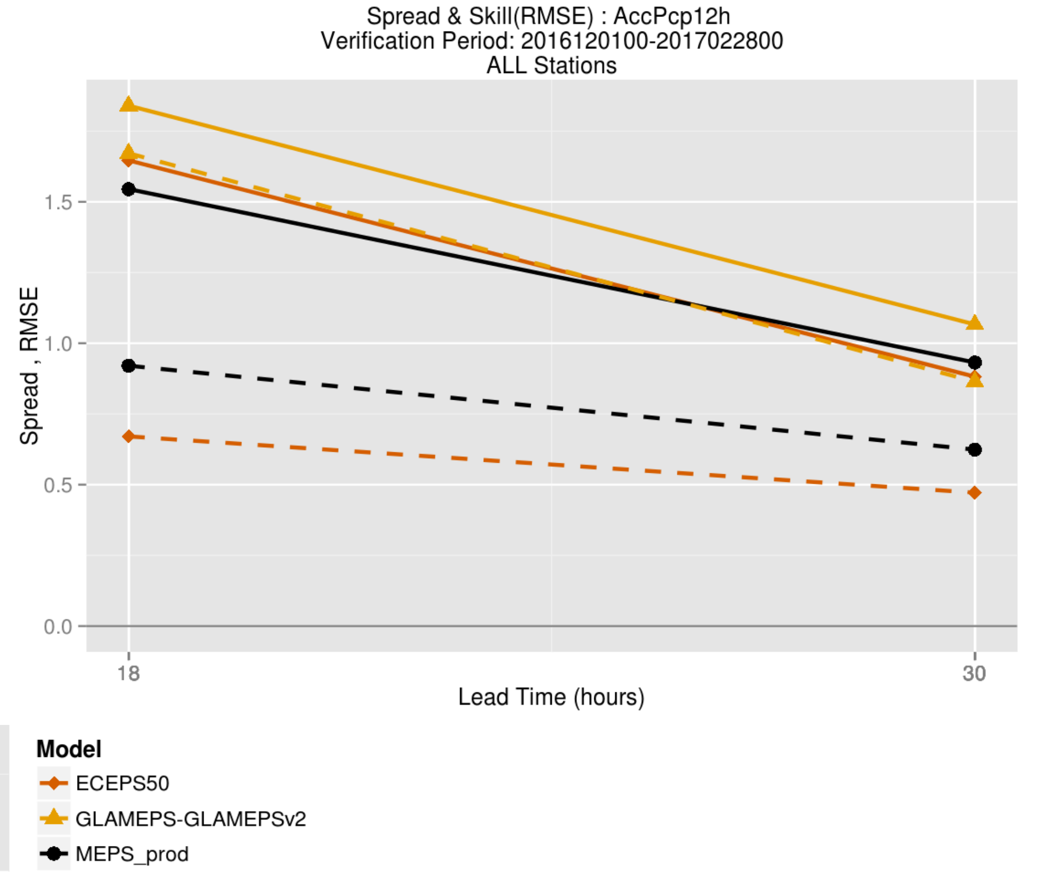


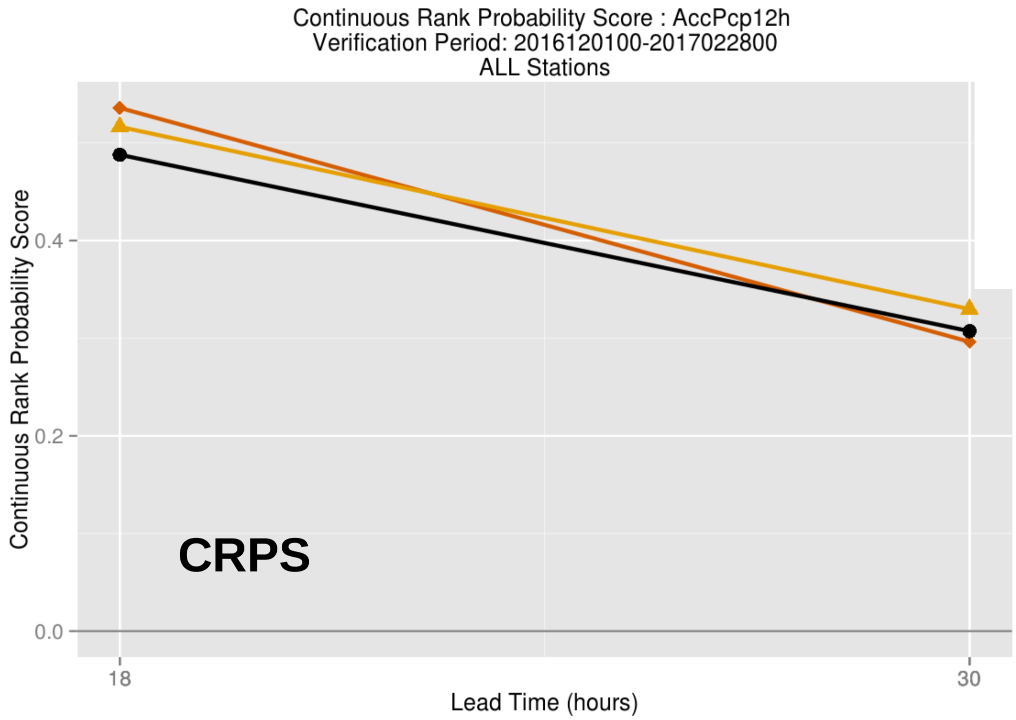
12h precipitation skill/spread & CRPS
Dec 2016 – Feb 2017

GLAMEPS (52)

IFS ENS(51)

MEPS(10)





Example of forecasters usage

- MET forecasters communicates polar low track options

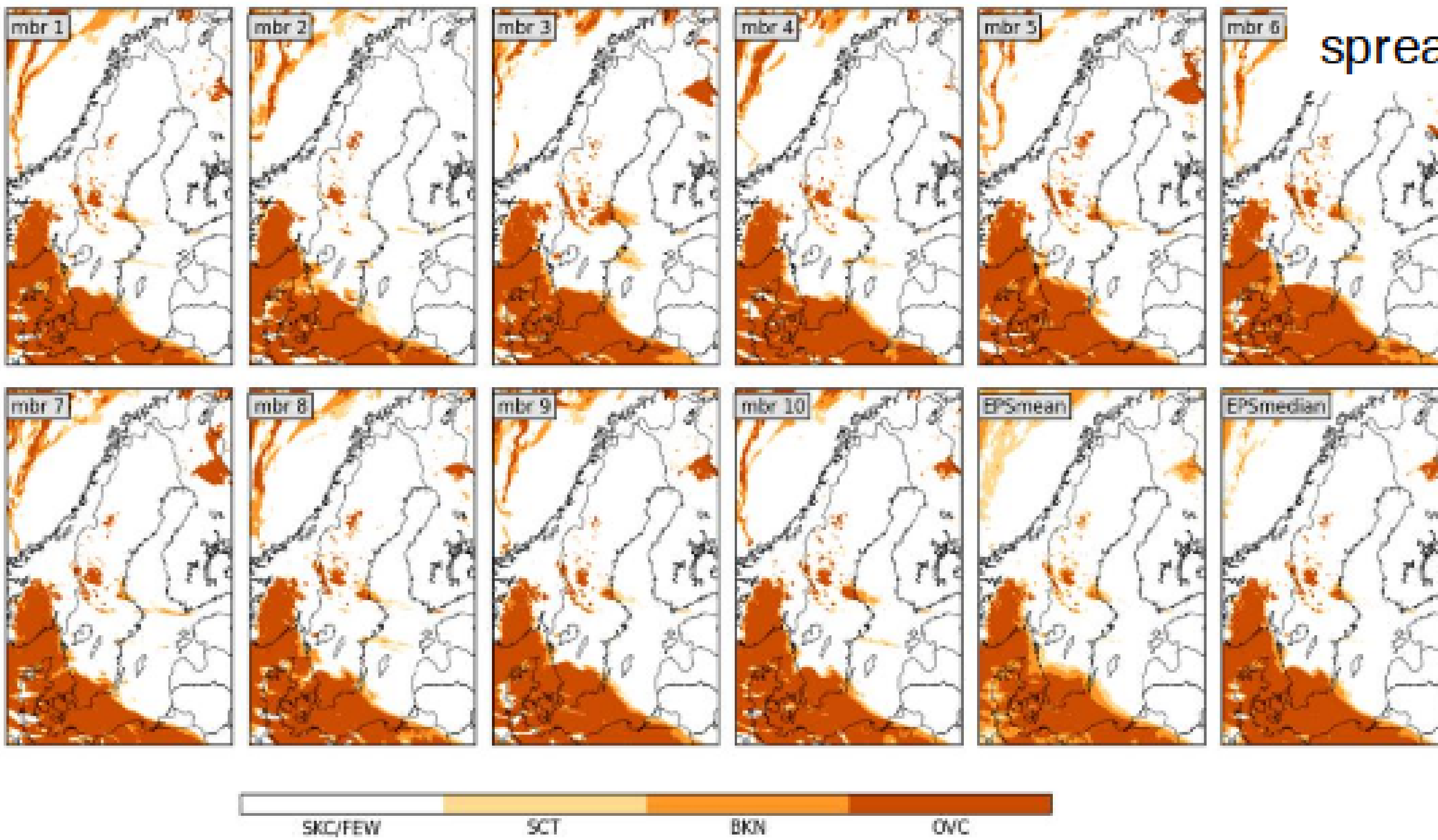
Option 1

Option 2

Possible target area

And some SMHI forecasters frustration of lacking spread in clouds

…still no more spread



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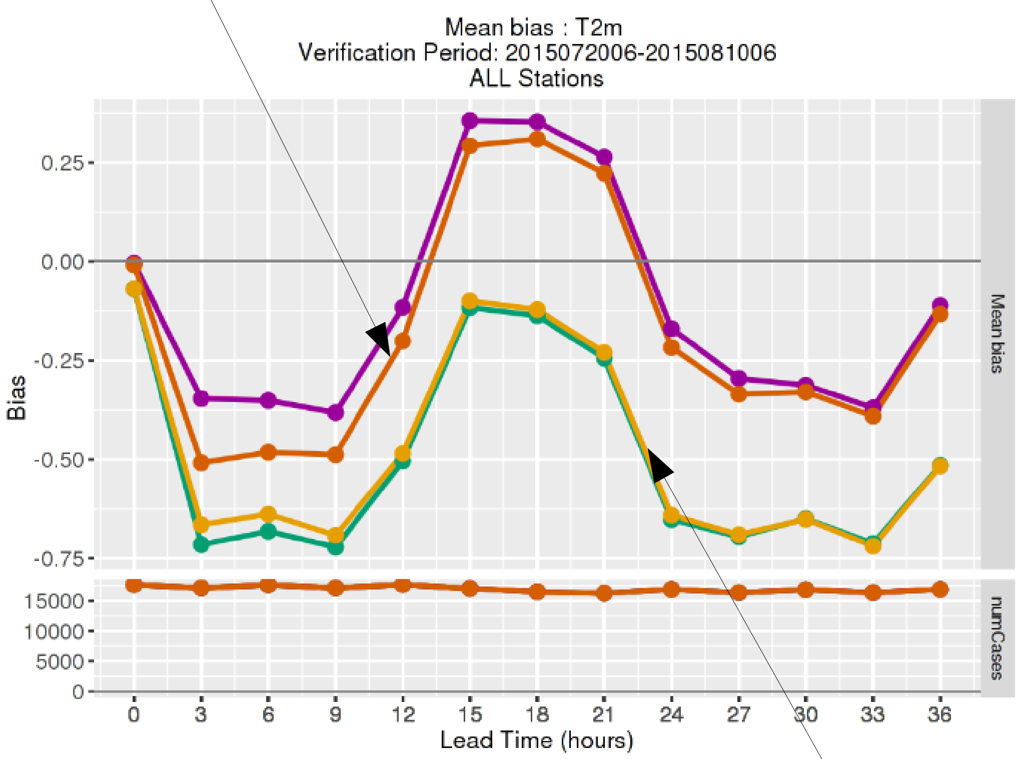
EPS challenges

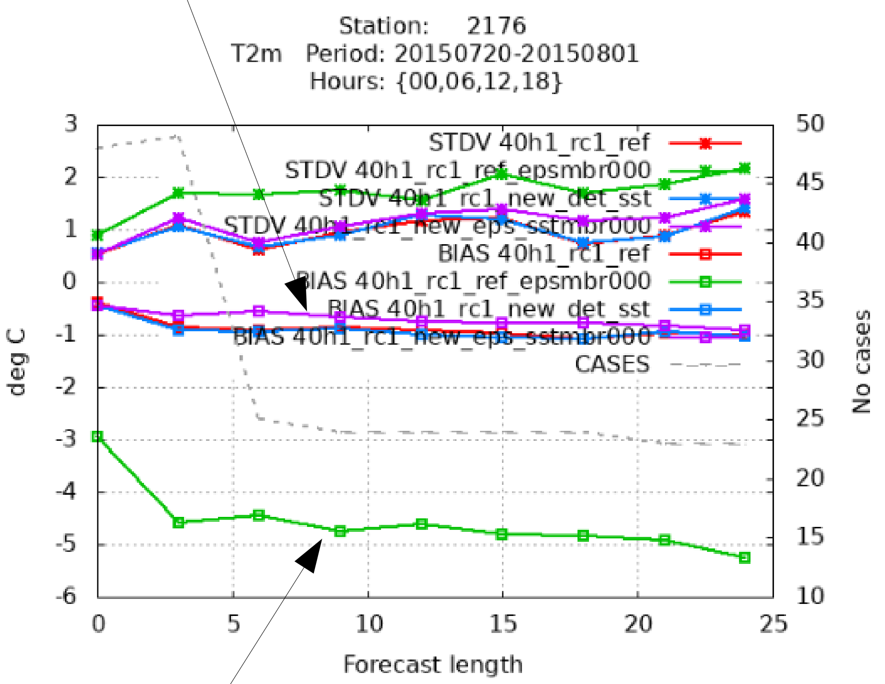
- How to increase the spread?
  - Surface perturbations (talk by Andrew Singleton)
  - Physics perturbations (talk by Inger-Lise Frogner)
- Using IFS ENS instead of SLAF
  - What can we expect from hourly ENS boundaries? Ongoing investigations
  - Remove current limitations on ensemble size and forecast length
- Surface assimilation aspects
  - Same frequency for control&members or no assimilation for members

SST problem with our usage of ECMWF ENS data solved

Using deterministic ECMWF SST

New (40h1.2) method for ECMWF ENS SST interpolation

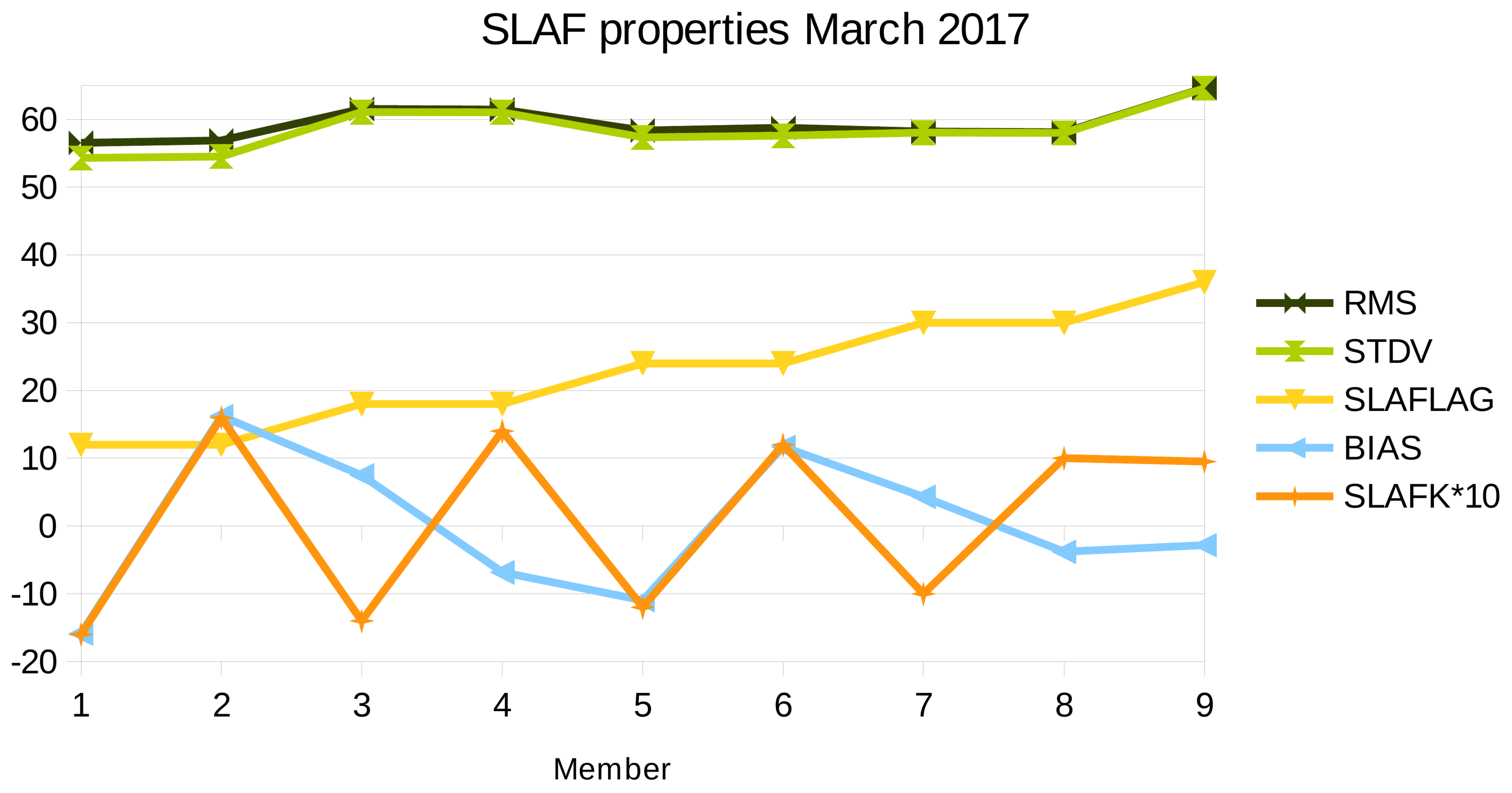




Old (40h1.1) method for ECMWF ENS SST interpolation

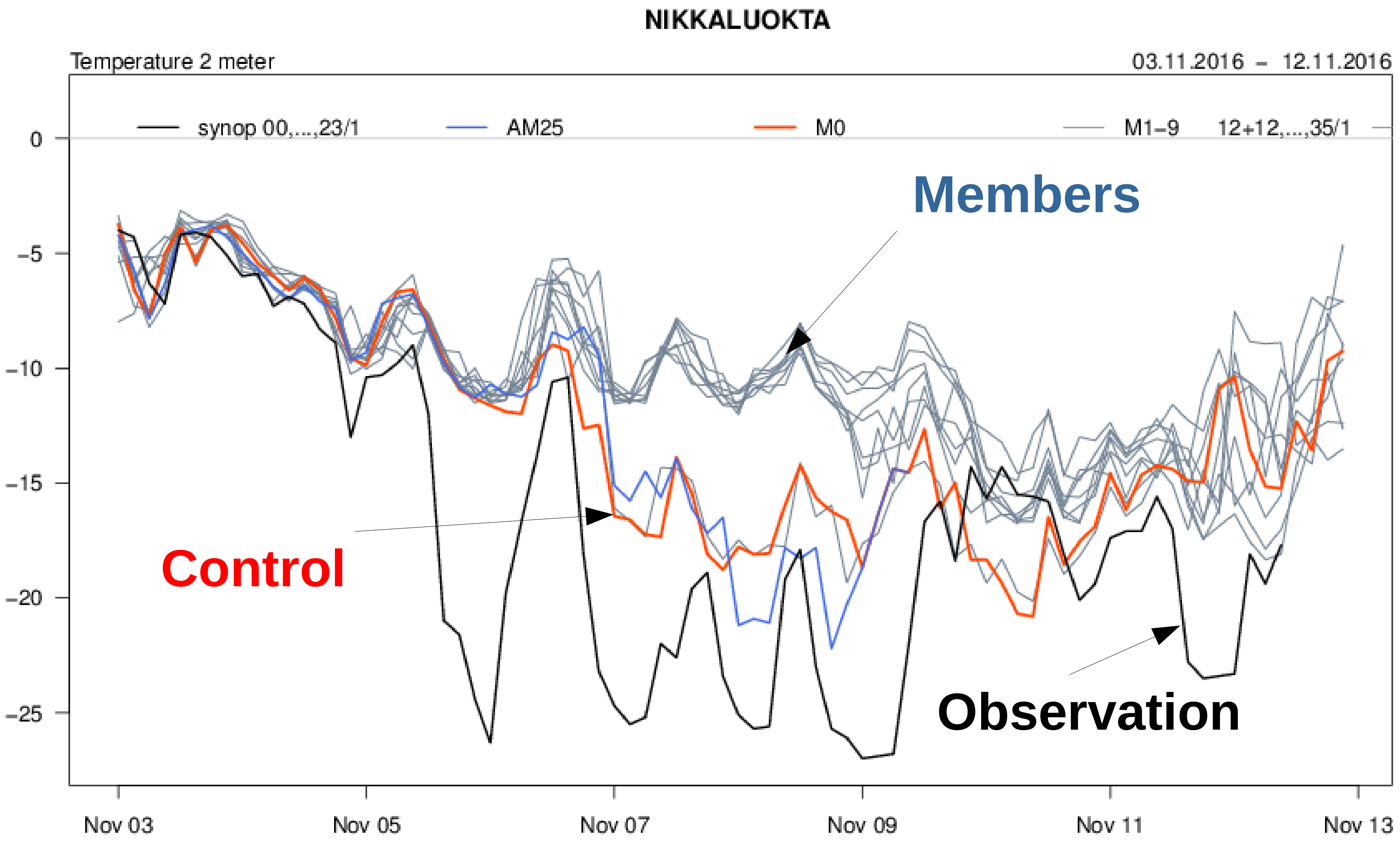
Tuning of the SLAF perturbations

Surface pressure diagnostic for initial perturbations



Members not always distributed around the control...

Could it be the difference in cycling?



Checking the sensitivity for 3/6h cycling with different initial conditions

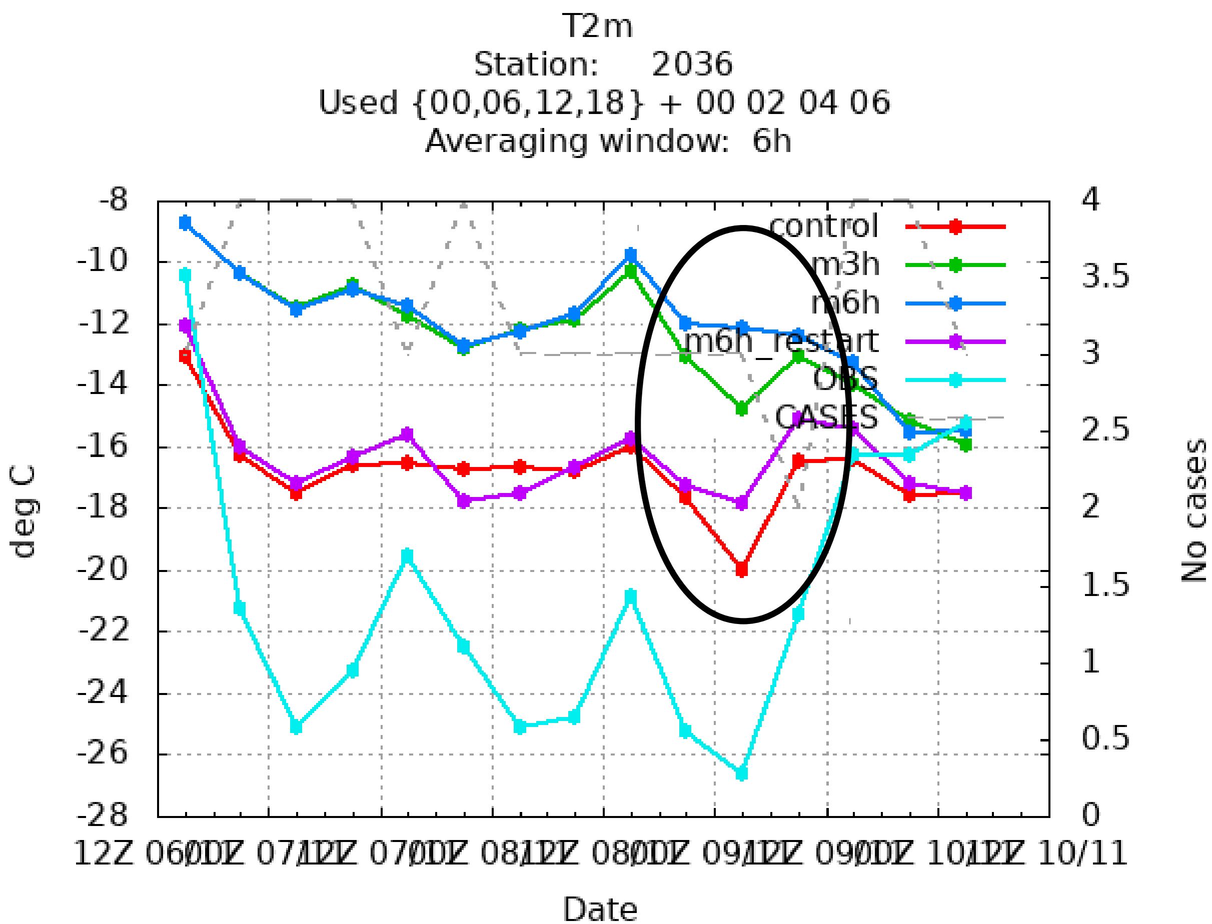
Member climate

- 3h cycling
- 6h cycling

Control climate

- 3h cycling
- 6h cycling

observations

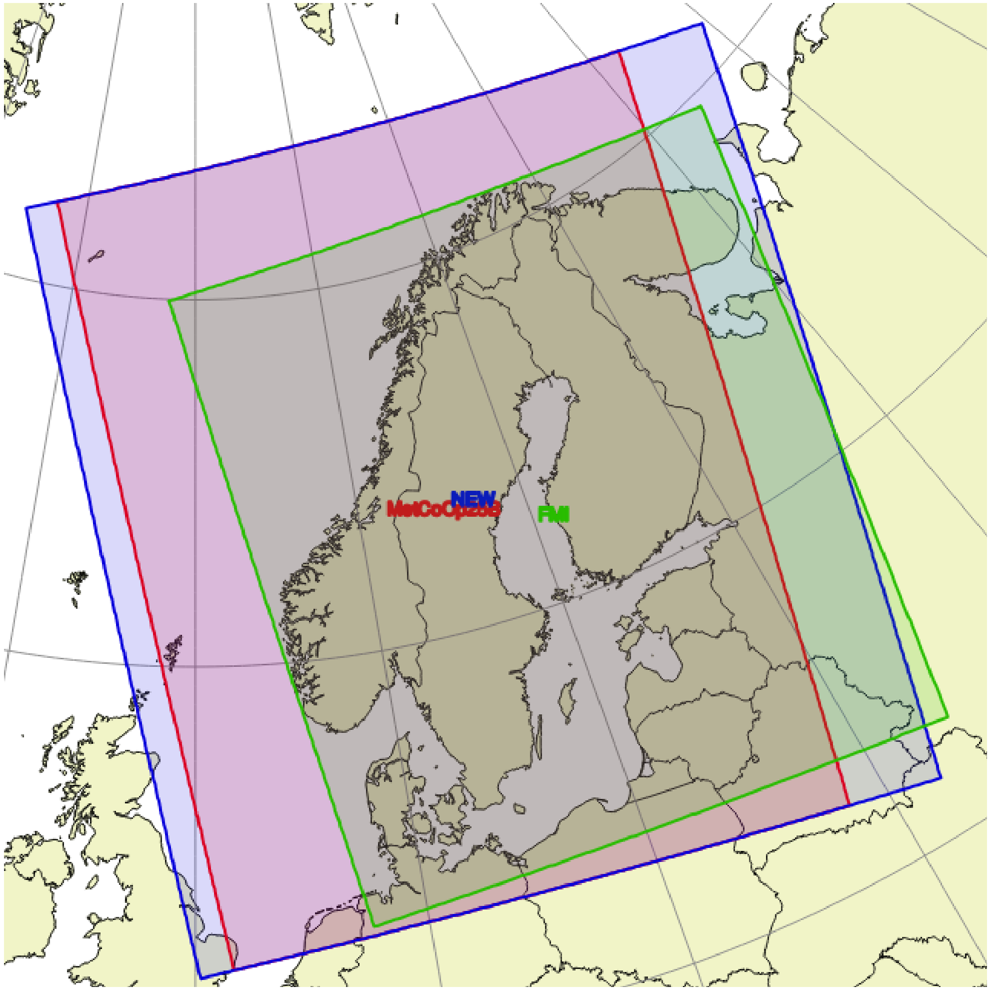


Important in single sites but small overall differences

Including FMI in MetCoOp

- 20% increase of current MetCoOp will cover the common needs.
- The distributed EPS approach is “easy” to extend to yet another HPC. **Allows more ensemble members!**
- From 2018/2019 various HPC solutions are on the table.

We aim to run harmonie-40h1.2 on the new domain after summer



Conclusions

- MEPS is operational and used by forecasters
- Deterministic and probabilistic scores are promising but there are issues to solve
- Stronger MetCoOp with FMI included!

SMHI public MEPS forecast for Helsinki valid today

kl. 10	Troligt: 55% 4 °C 0 mm	40% 0 °C 0 mm	5% 1 °C 0.1-0.2 mm
kl. 11	Troligt: 65% 6 °C 0 mm	30% 1 °C 0 mm	5% 1 °C 0.1-0.2 mm
kl. 12	Troligt: 45% 8 °C 0 mm	40% 2 °C 0 mm	15% 1 °C 0 mm
kl. 13	Troligt: 40% 8 °C 0 mm	40% 2 °C 0 mm	20% 1 °C 0 mm
kl. 14	Troligt: 40% 8 °C 0 mm	35% 2 °C 0 mm	25% 1 °C 0 mm

We are looking forward to the first summer with MEPS!