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Perturbation experiments with MetCoOp EPS (MEPS)

Andrew Singleton, Inger-Lise Frogner, Ole Vignes, Ulf Andrae

MEPS

- HarmonEPS on the MetCoOp domain
- 2.5 km grid spacing, 64 levels
- 750 x 960 grid points
- 10 members
  - 1 Arome control, 1 Alaro control
  - 8 perturbed Arome members
- Pre-operational daily runs imminent
- Aim to be operational by autumn 2016
- See Ulf Andrae et al's poster for more
  -

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Available perturbation strategies

- ICs and LBCs from IFS-ENS
  - First N_{MEPS} members
  - Selection of N_{MEPS} members from $N_{IFS\text{-}ENS}$ members
- ICs and LBCs from IFS-HIRES using SLAF
  - Scaled Lagged Average Forecast
  - $Y_{T+0} = X_{T+0} \pm k(X_{T+0} - (X\text{-}HH_i)_{T+HHi})$, $(HH_i = 6,12,18,24\ldots)$
- EDA
- Surface perturbations (currently being tested)
- Multiphysics (poster by Björn Stensen, SMHI)
- SPPT

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Common HarmonEPS setup

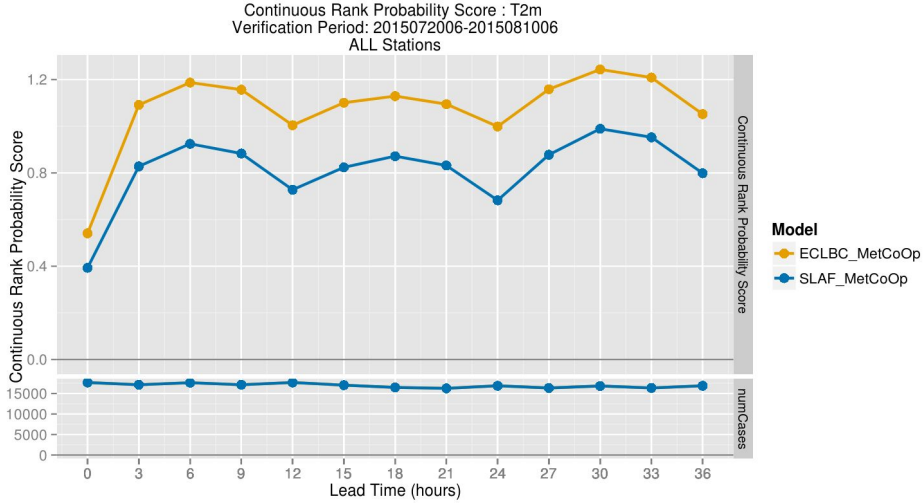
- MetCoOp domain
- Harmonie-h1.1.beta.5
- 00:00 20 July 2015 - 06:00 10 August 2015
- 1 control + 8 perturbed members (all Arome)
- 3DVAR for control - conventional observations only
- Surface assimilation for all members
- 3-hour cycling for control
- 6-hour cycling for perturbed members
- 1 long-run to 36 hours each day for 06 cycle

First Experiments

- SLAF_MetCoOp
  - ICs + LBCs from weighted time lagged IFS HiRes taken from MARS.

LAG:	0	6	12	18	24
K:	0	±1.75	±1.5	±1.25	±1.0

- ECLBC_MetCoOp
  - ICs + LBCs from control + members 1-8 of IFS-ENS.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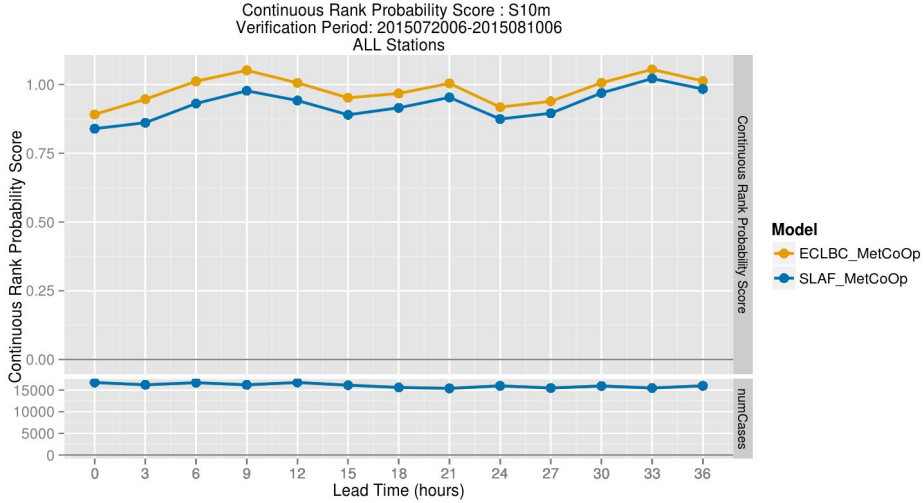
ALL Stations
Continuous Rank Probability Score
Lead Time (hours)
Model
ECLBC_MetCoOp
SLAF_MetCoOp
numCases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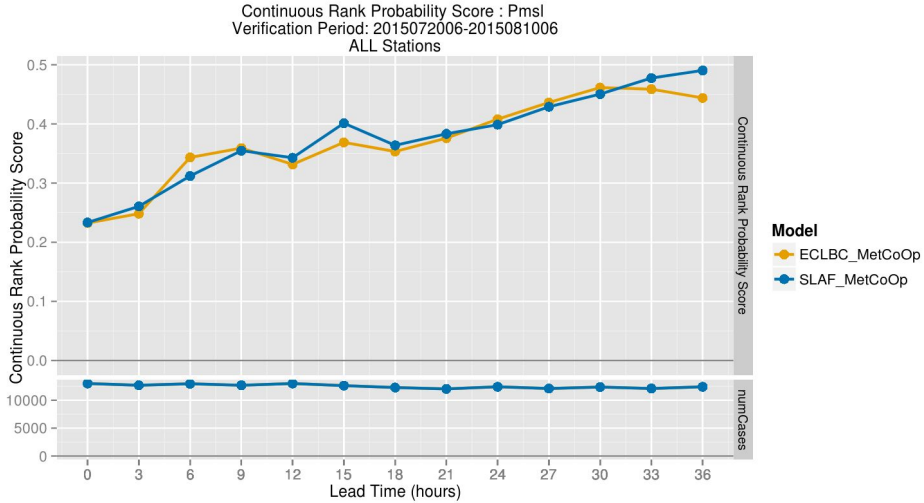
Continuous Rank Probability Score
Lead Time (hours)
Model
ECLBC_MetCoOp
SLAF_MetCoOp
numCases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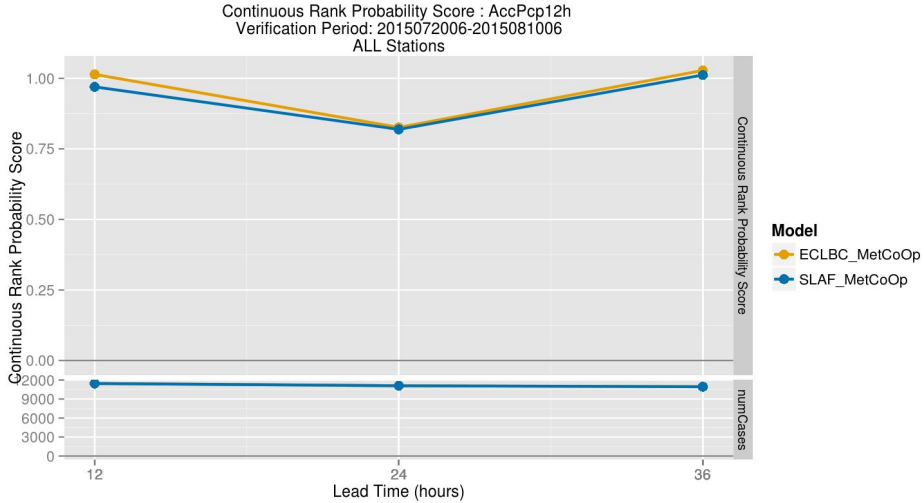
Continuous Rank Probability Score
Lead Time (hours)
Model
ECLBC_MetCoOp
SLAF_MetCoOp
numCases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ALL Stations
Continuous Rank Probability Score
Lead Time (hours)
Model
ECLBC_MetCoOp
SLAF_MetCoOp
numCases

BUT….

- SLAF perturbations do not appear to be consistent between members
- Rescale SLAFK: SLAF_rescale

LAG:	0	6	12	18	24
K:	0	±1.75	±1.35	±1.0	±0.8

- IFS-ENS perturbations smaller than those from SLAF
- Inflate ECLBC_SLAF perturbations by a factor of 1.4: ECLBC_K14_MetCoOp

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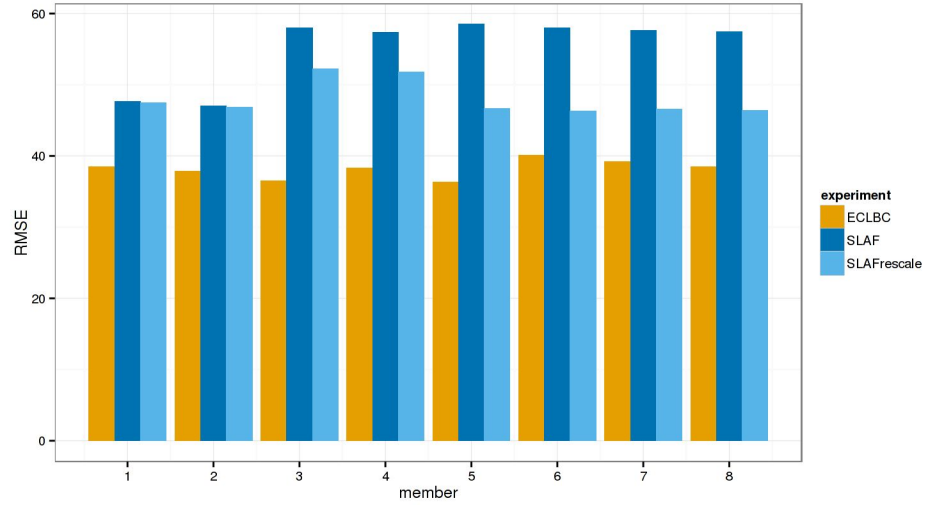

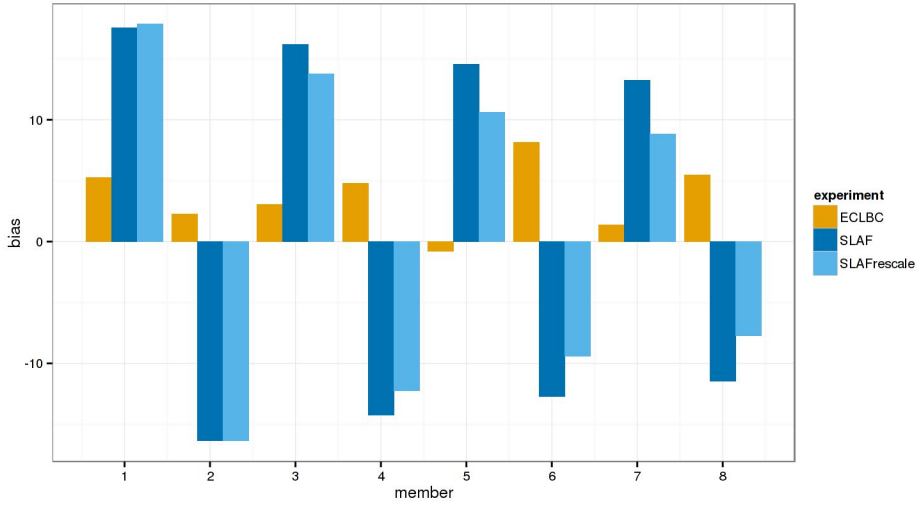

LAG:	0	6	12	18	24
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K:	0	±1.75	±1.35	±1.0	±0.8

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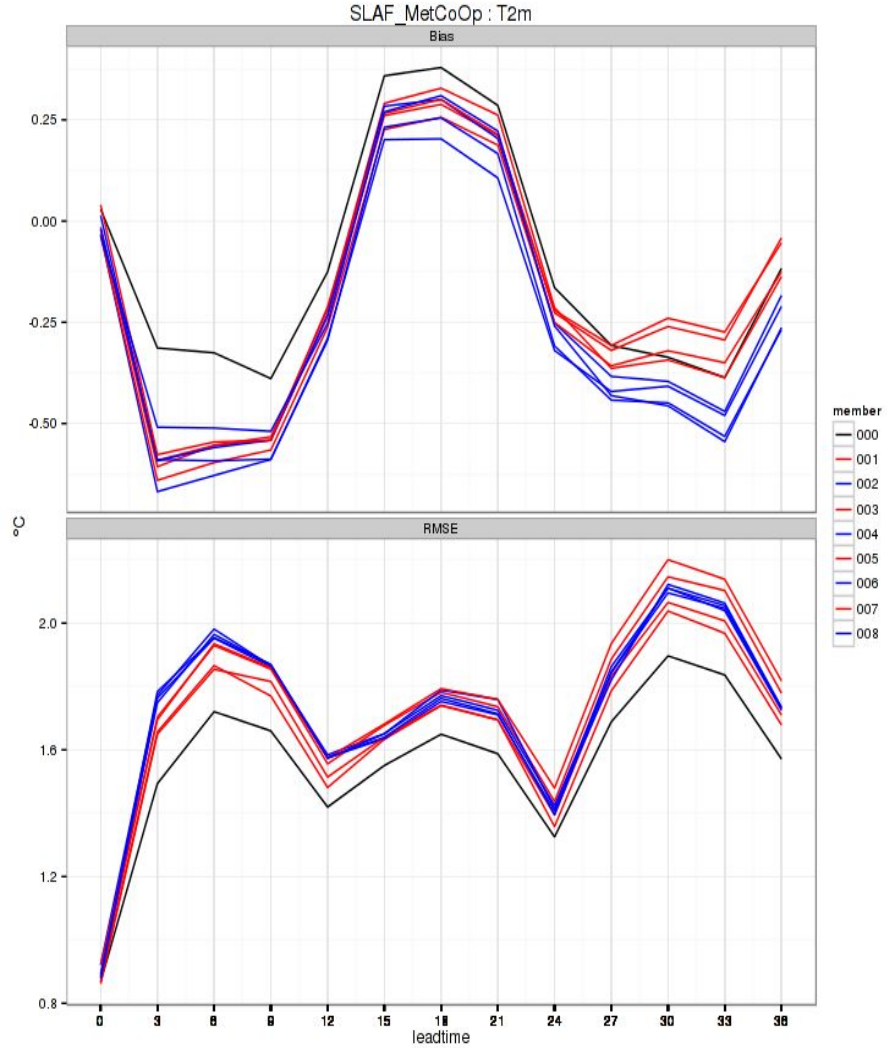
AND....

- Individual members cluster together depending on the sign of the perturbation…
- This is undesireable…
  - leads to “gaps” in the ensemble forecast between clusters of members,
  - in a stochastic system, individual members should have similar statiscal properties.
  -


SLAF_MetCoOp : T2m
Bias
RMSE
°C
leadtime
member
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002
003
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006
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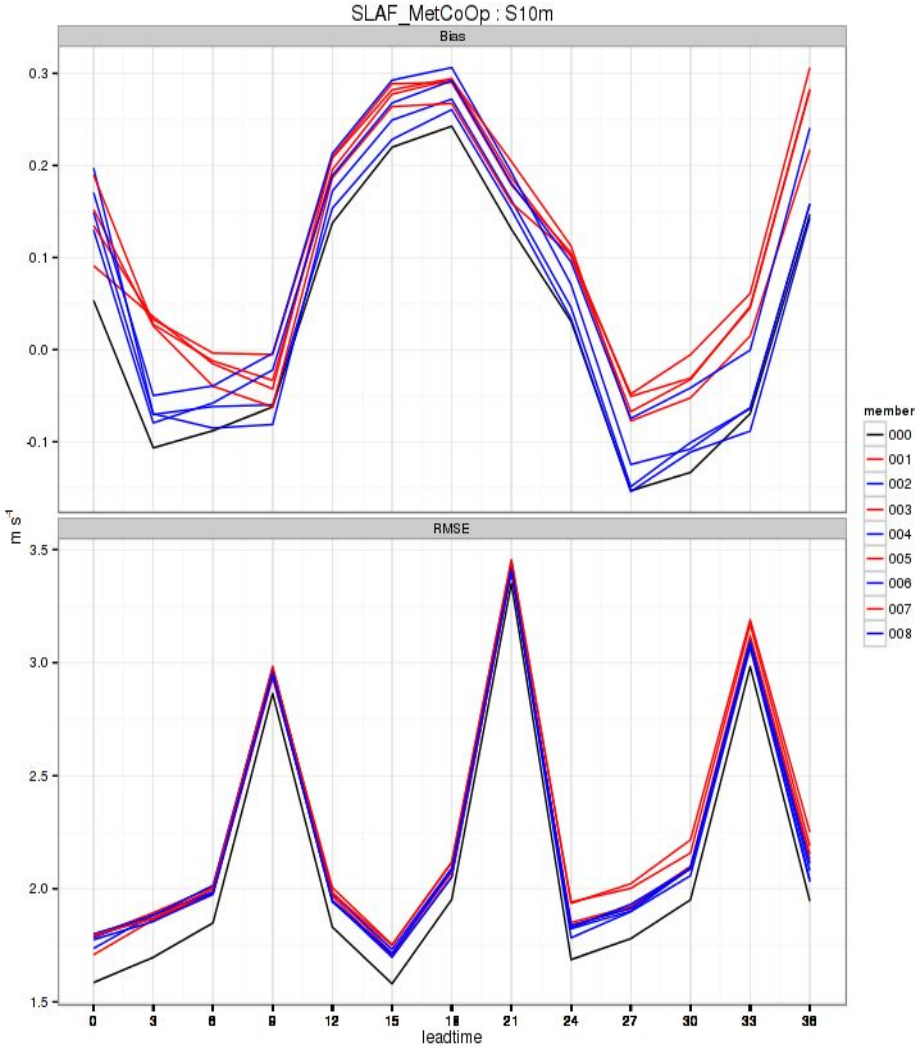
008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Bias
RMSE
m s-1
leadtime
member
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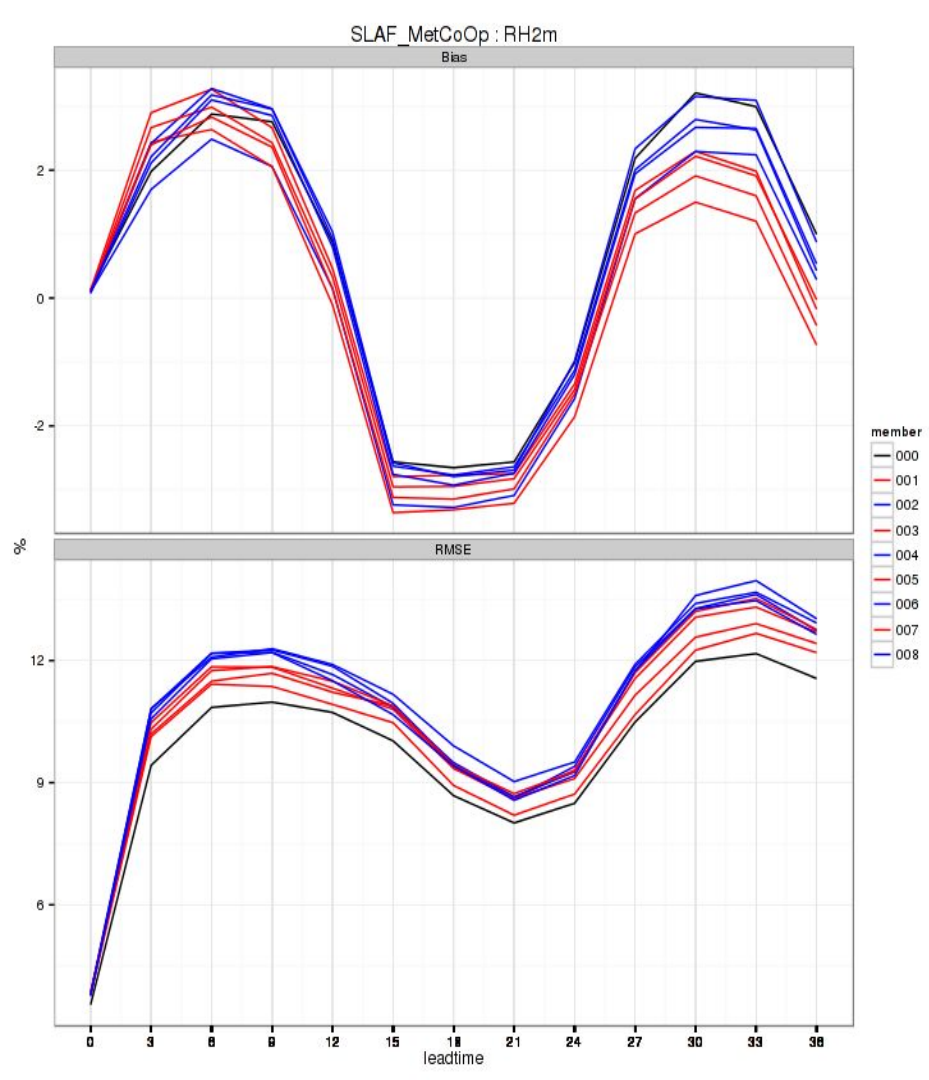
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Bias
RMSE
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leadtime
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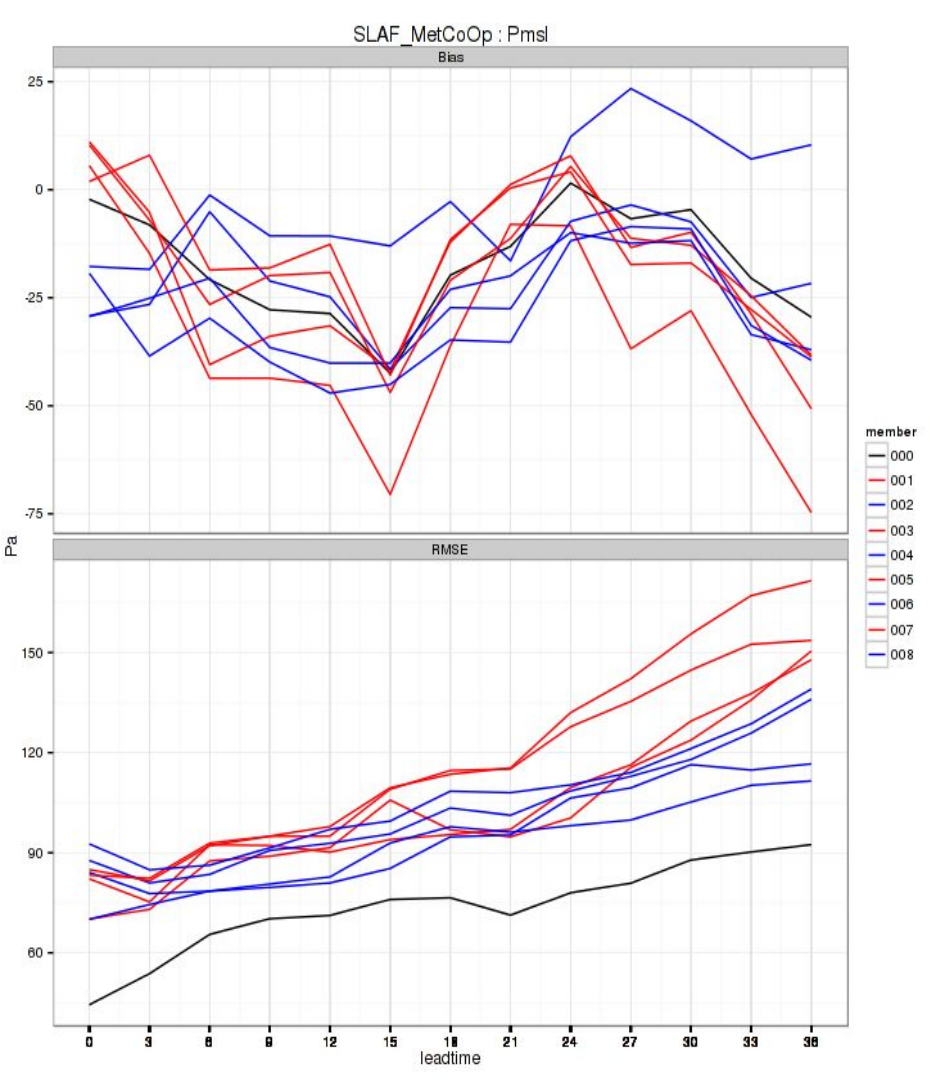
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Bias
RMSE
Pa
leadtime
member
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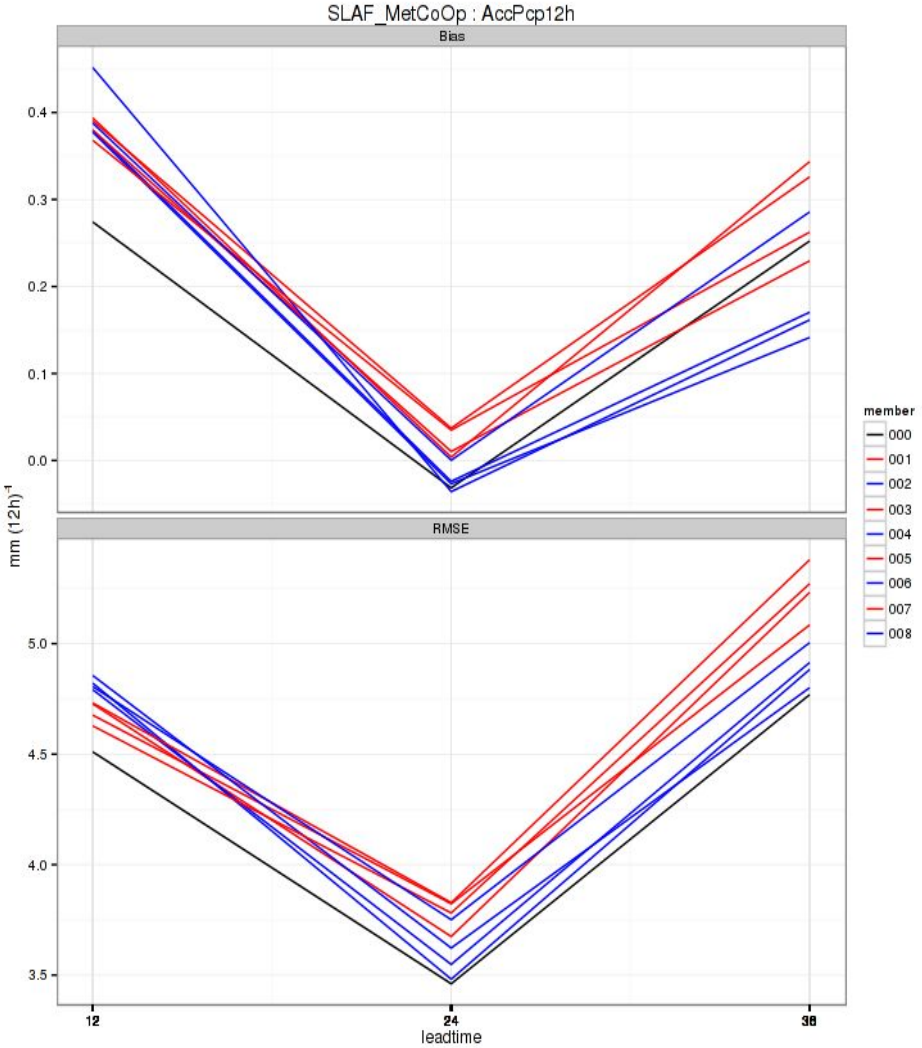

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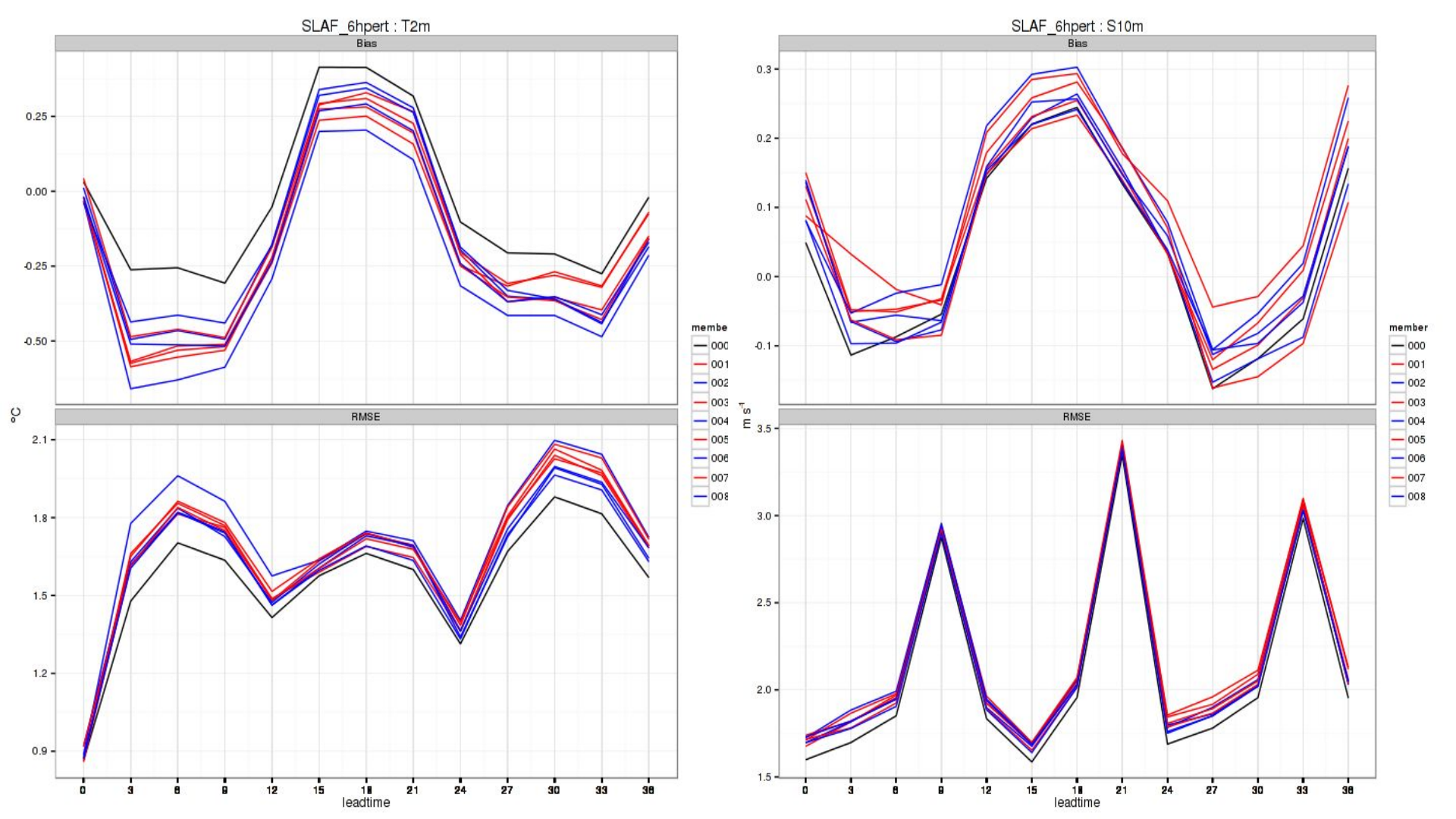
6h SLAF perturbations

- Instead of computing perturbations relative to current analysis time, compute from differences relative to consecutive forecasts:

$$Y_{T+0} = X_{T+0} \pm k((X\text{-}HH_i)_{T+HHi} - (X\text{-}HH_{(i+1)})_{T+HH(i+1)})$$

SLAF_6hpert


SLAF_6hpert : T2m
Bias
RMSE
°C
leadtime
SLAF_6hpert : S10m
Bias
RMSE
m s-1
leadtime
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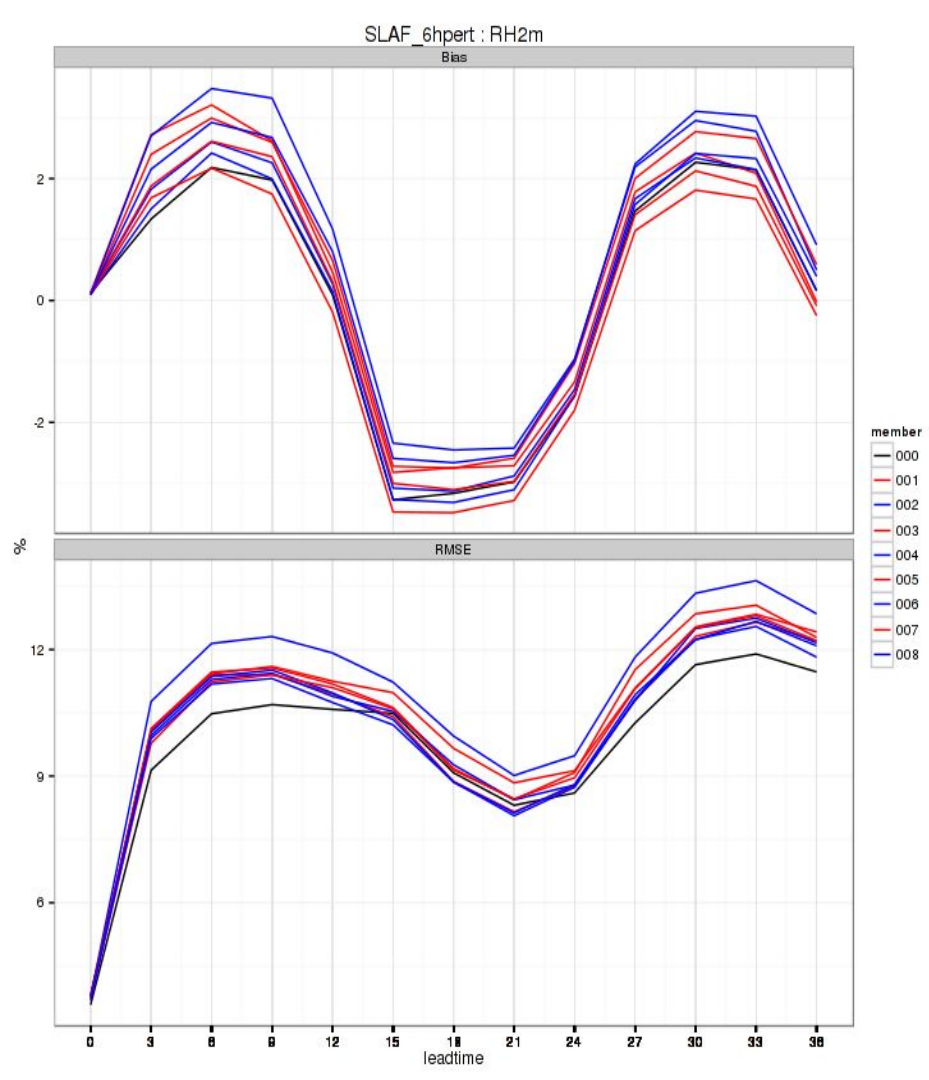
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Bias
RMSE
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leadtime
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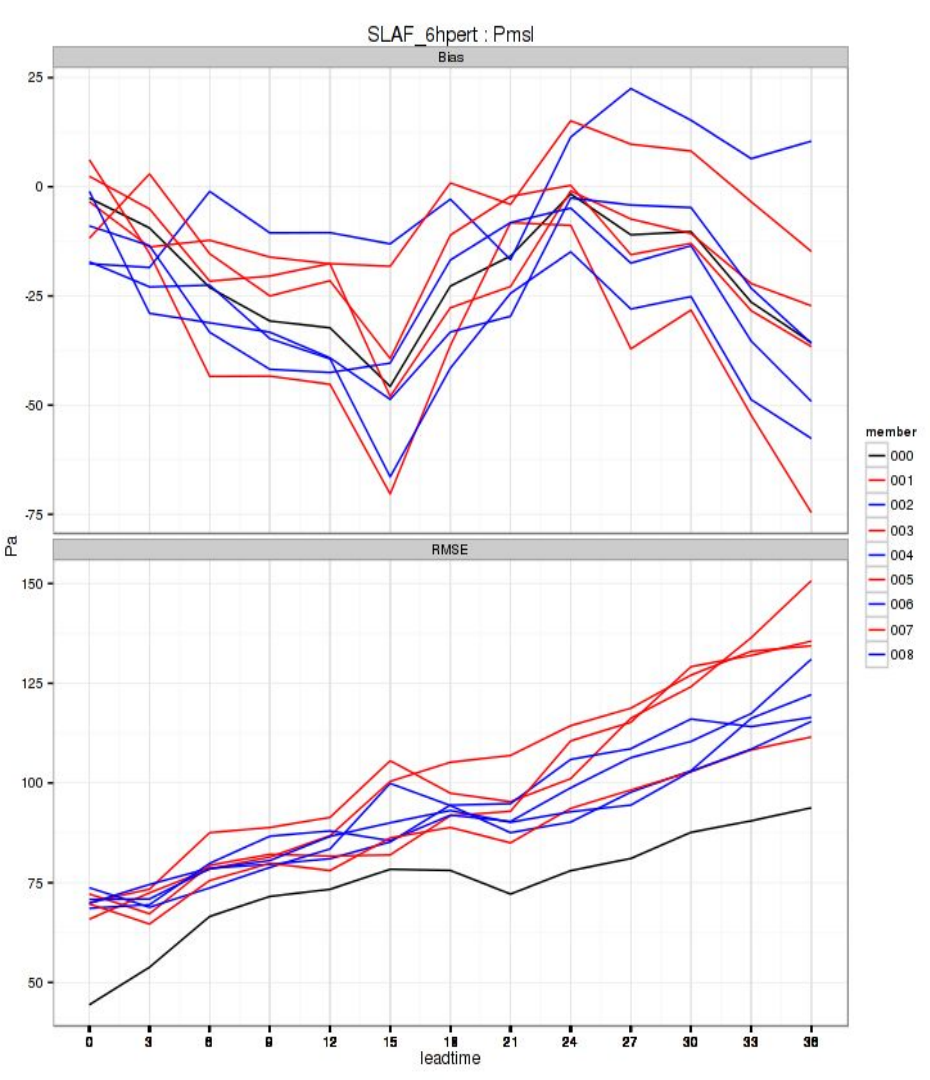
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Bias
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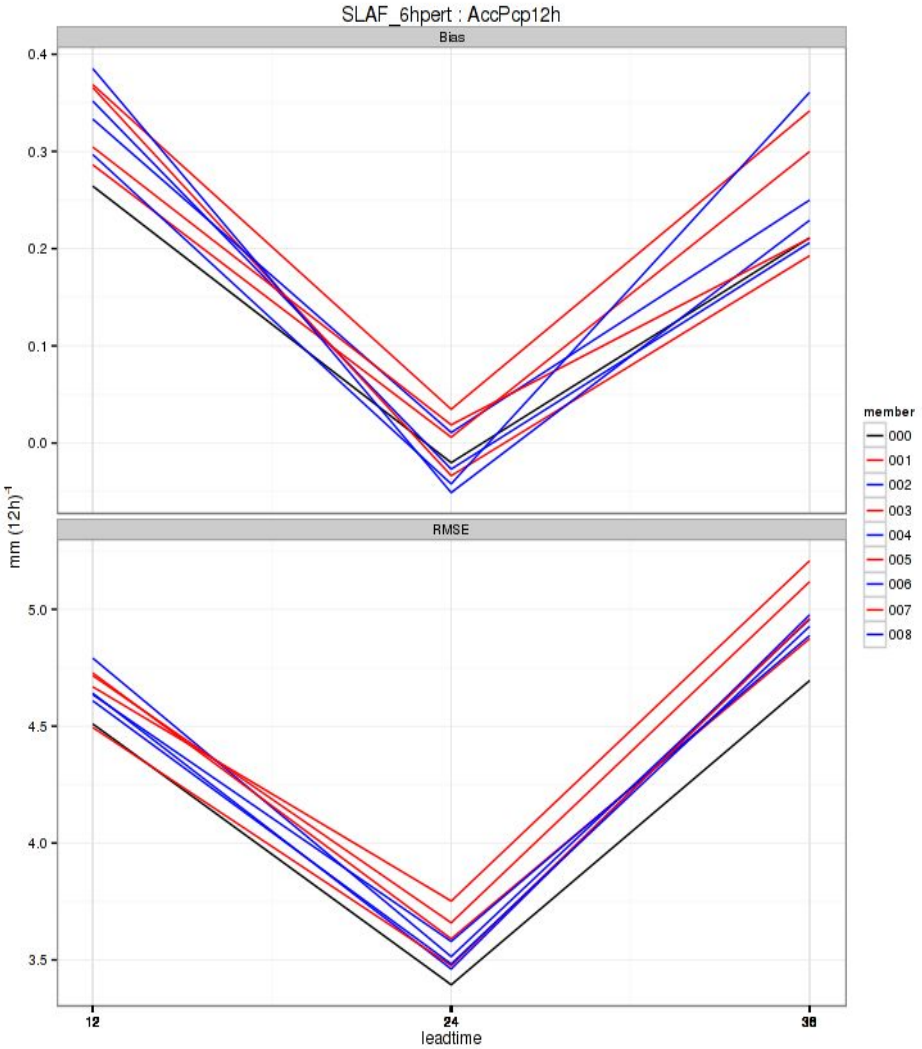

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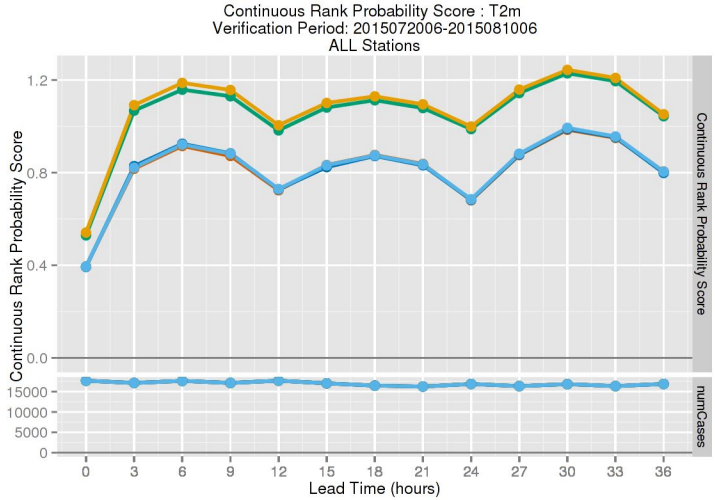
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Continuous Rank Probability Score
Continuous Rank Probability Score
numCases
Lead Time (hours)
Model
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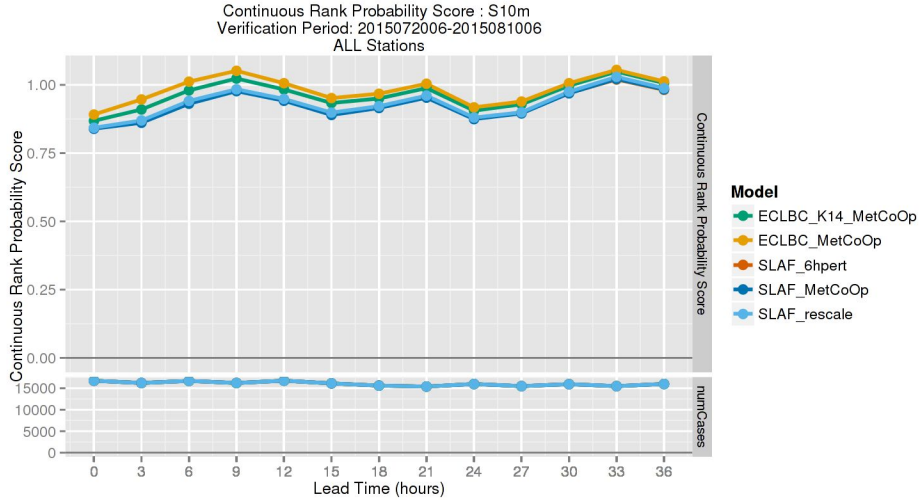
ECLBC_MetCoOp
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale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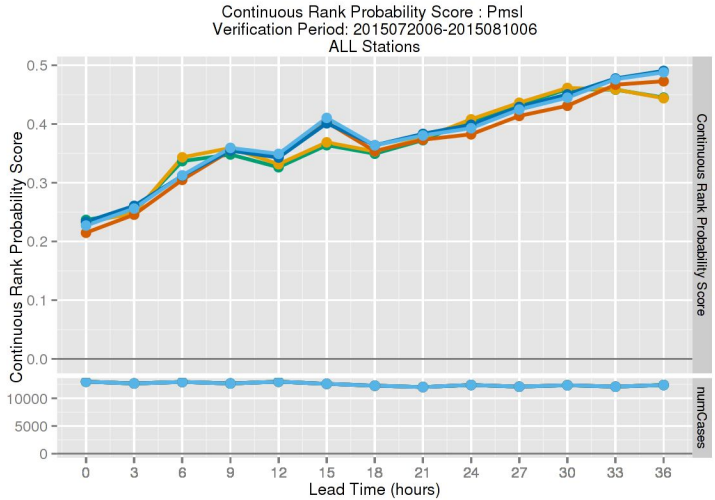
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale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Lead Time (hours)
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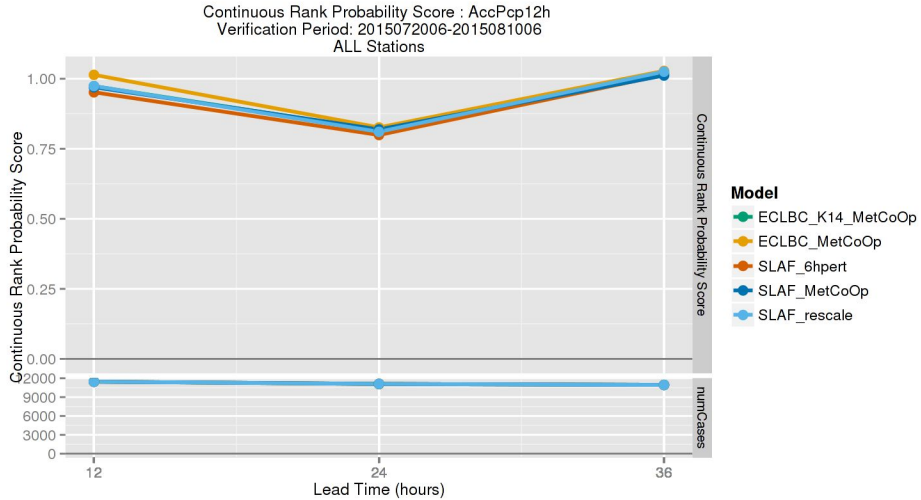
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SLAF_MetCoOp
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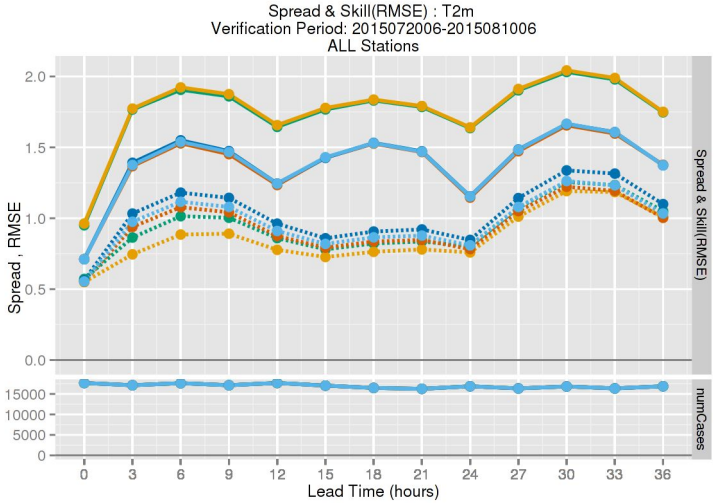
Spread & Skill(RMSE) : T2m
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Spread , RMSE
Spread & Skill(RMSE)
numCases
Lead Time (hours)
Score
RMSE
Spread
Model
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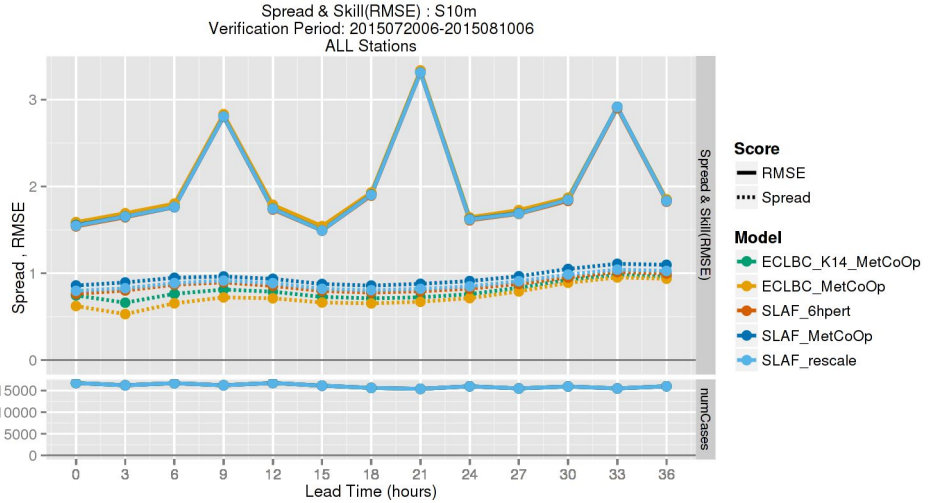
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale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Spread , RMSE
Spread & Skill(RMSE)
numCases
Lead Time (hours)
Score
RMSE
Spread
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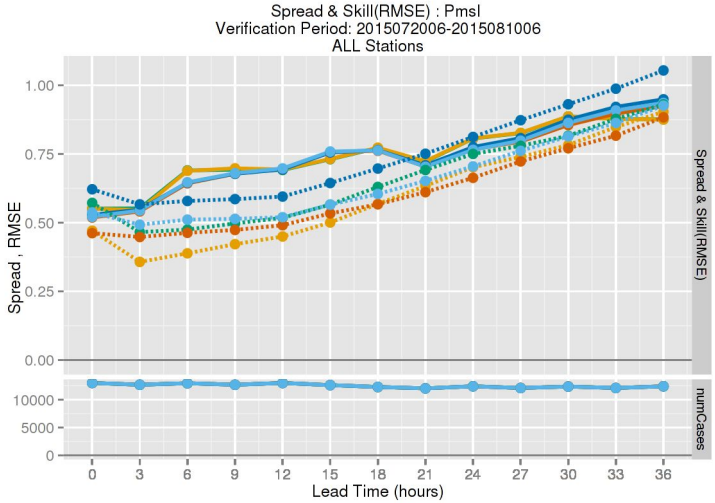
ECLBC_MetCoOp
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale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Spread , RMSE
Spread & Skill(RMSE)
numCases
Lead Time (hours)
Score
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Spread
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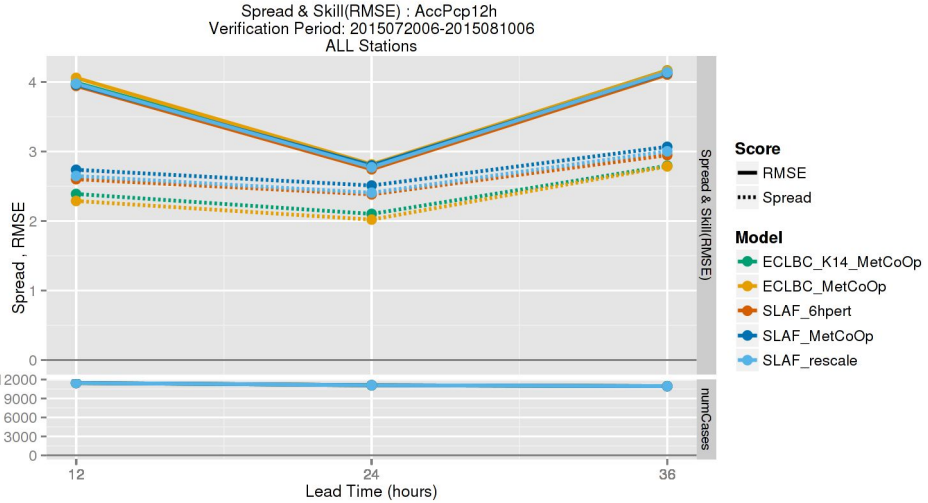
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Spread , RMSE
Spread & Skill(RMSE)
numCases
Lead Time (hours)
Score
RMSE
Spread
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SLAF_6hpert
SLAF_MetCoOp
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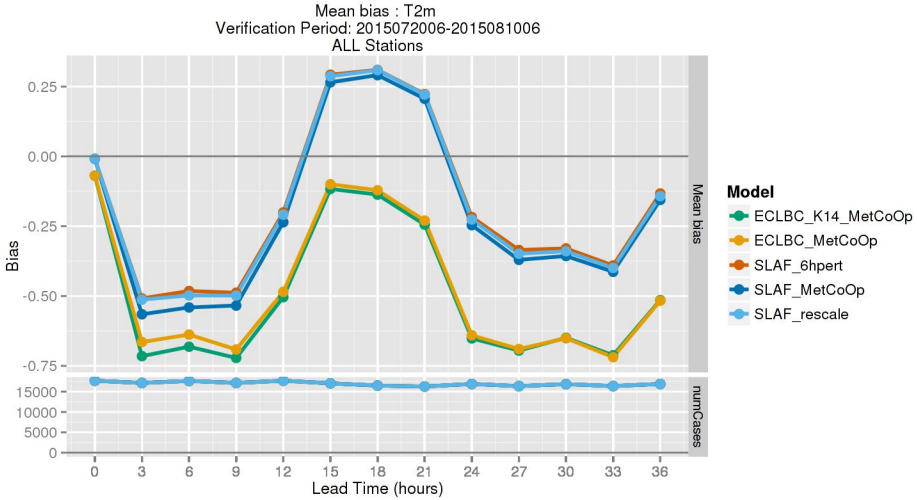
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ALL Stations
Bias
Lead Time (hours)
Mean bias
numCases
Model
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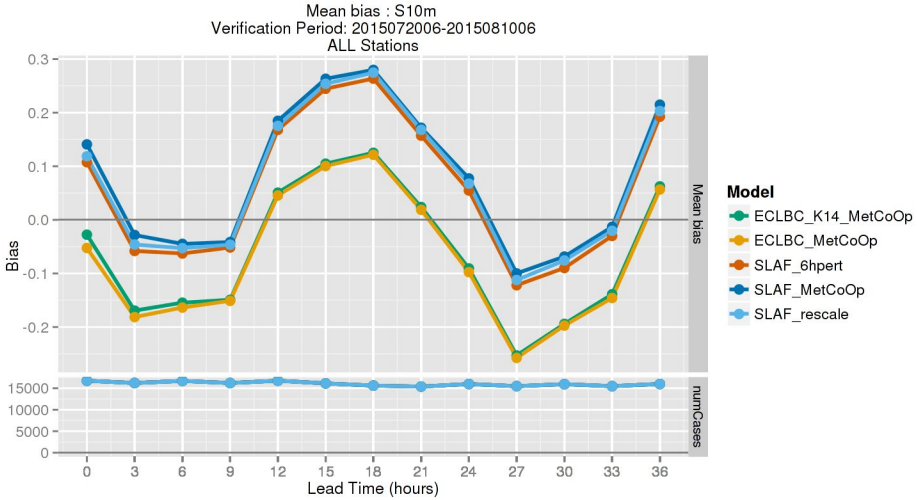
ECLBC_MetCoOp
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale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Bias
Lead Time (hours)
Mean bias
numCases
Model
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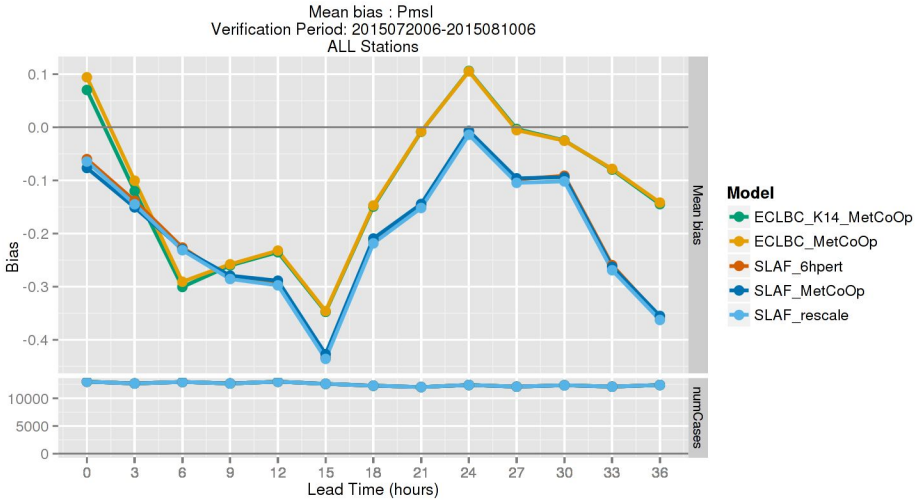
ECLBC_MetCoOp
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale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ALL Stations
Bias
Lead Time (hours)
Mean bias
numCases
Model
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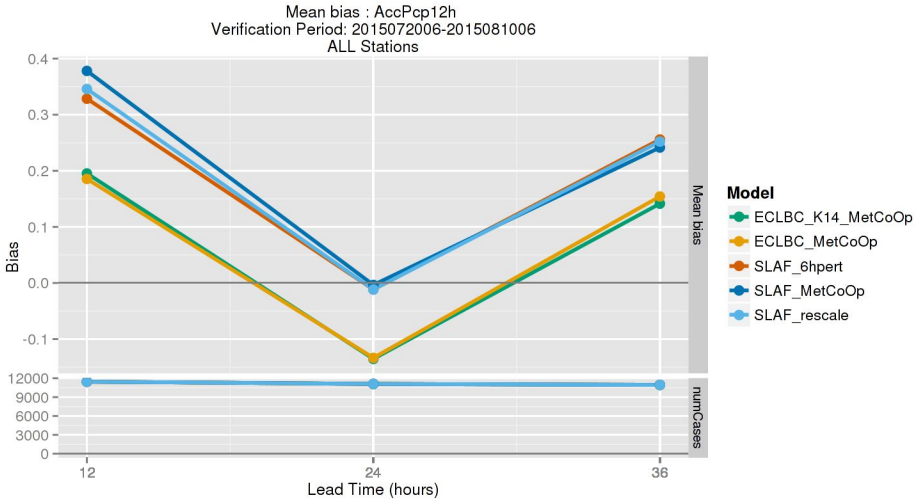
ECLBC_MetCoOp
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale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ALL Stations
Bias
Lead Time (hours)
Mean bias
numCases
Model
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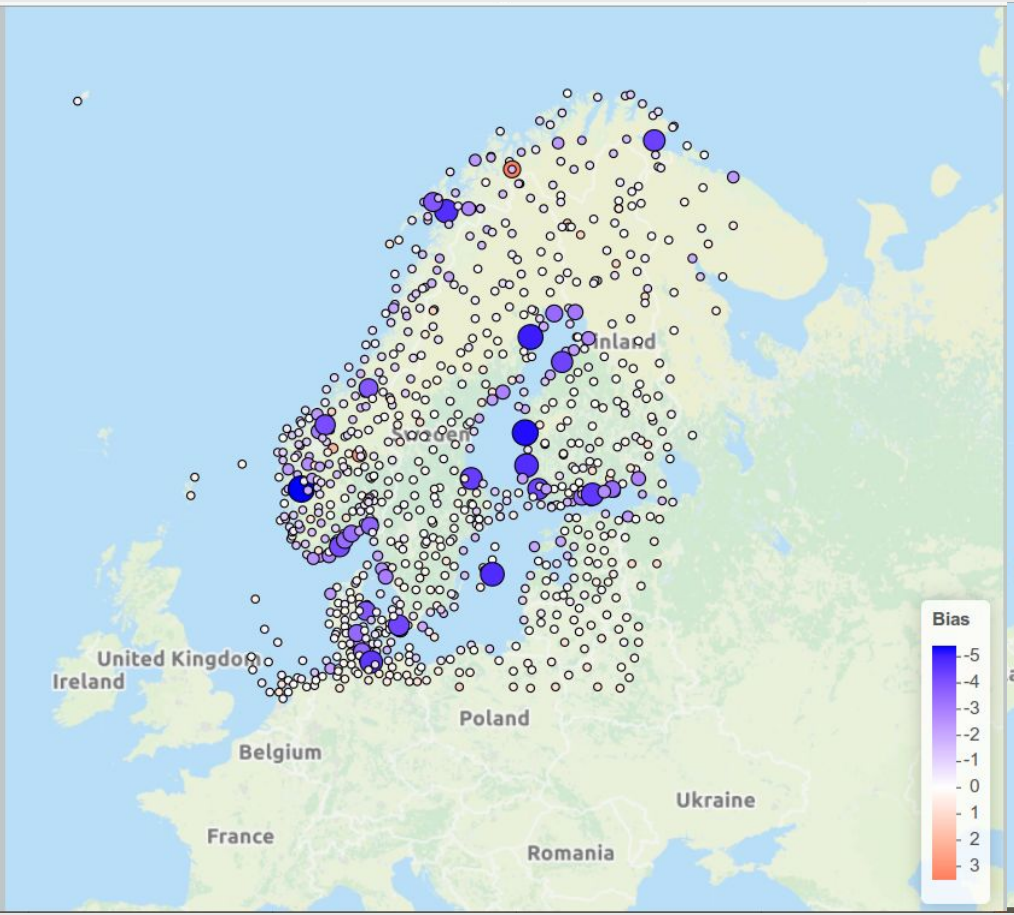
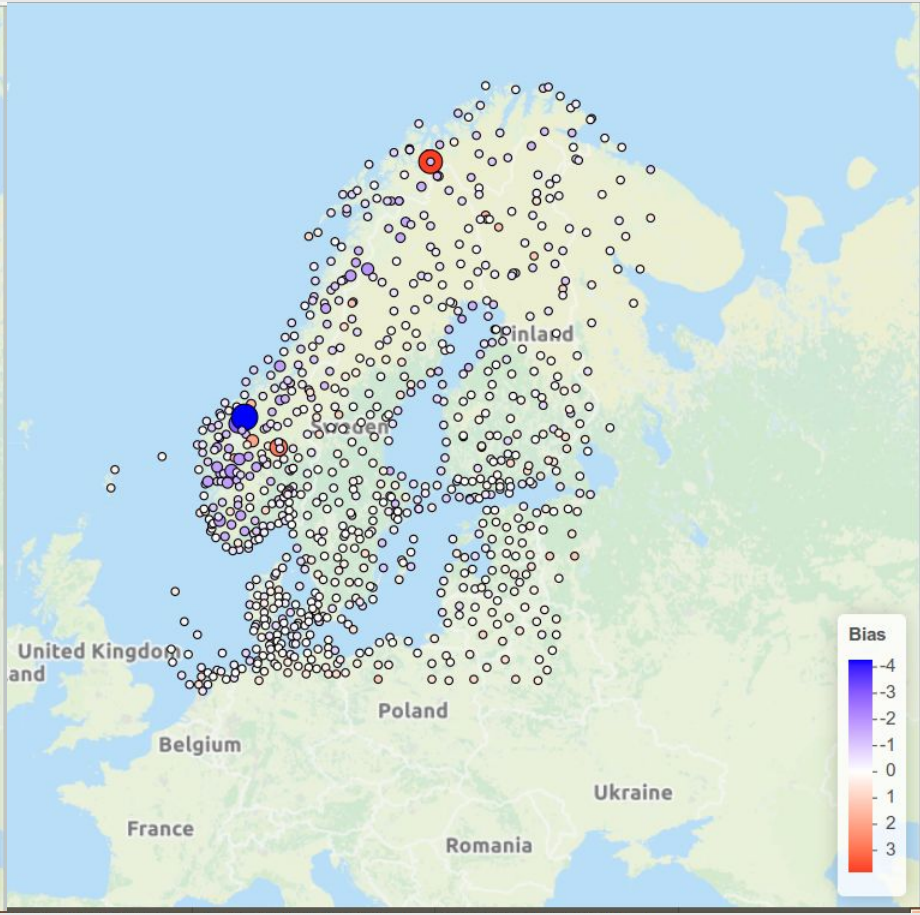
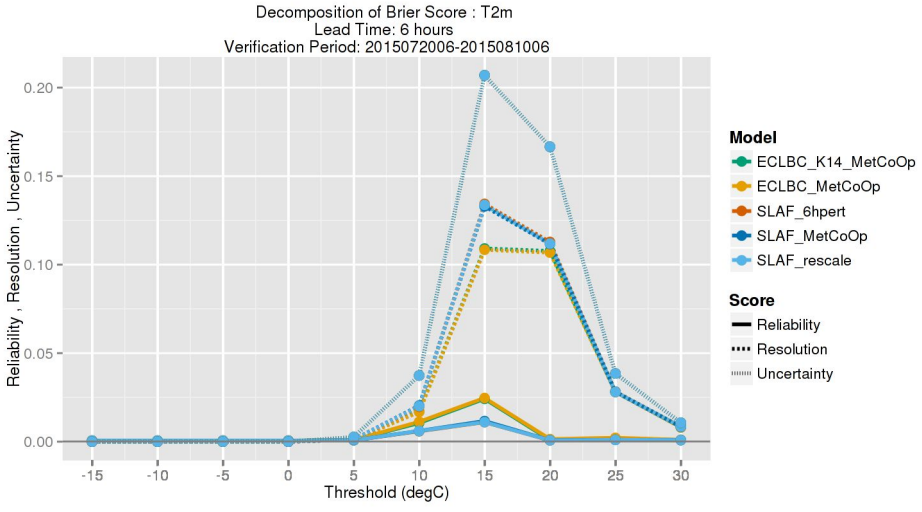
ECLBC_MetCoOp
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale

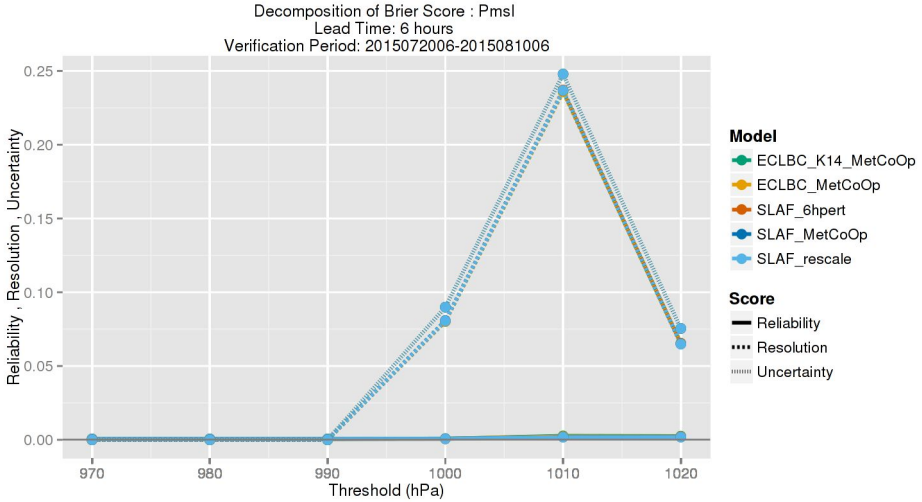
ECLBC_MetCoOp

SLAF_6hpert









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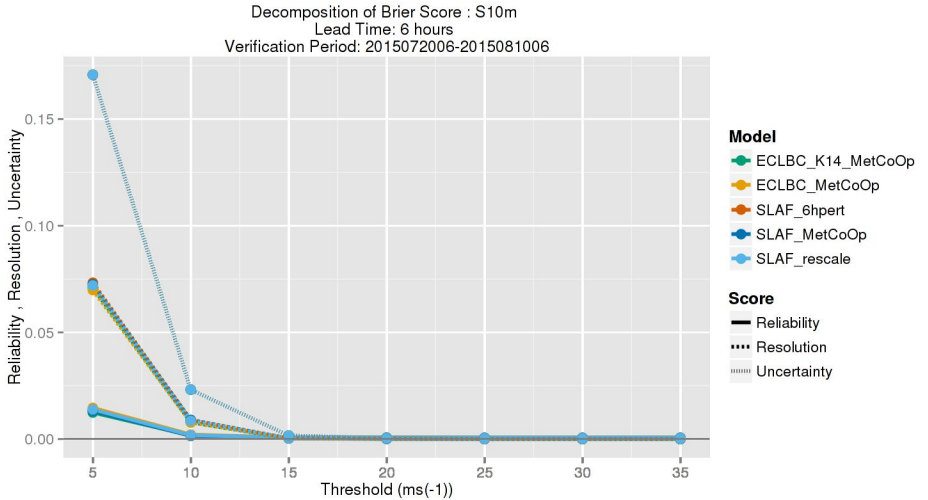
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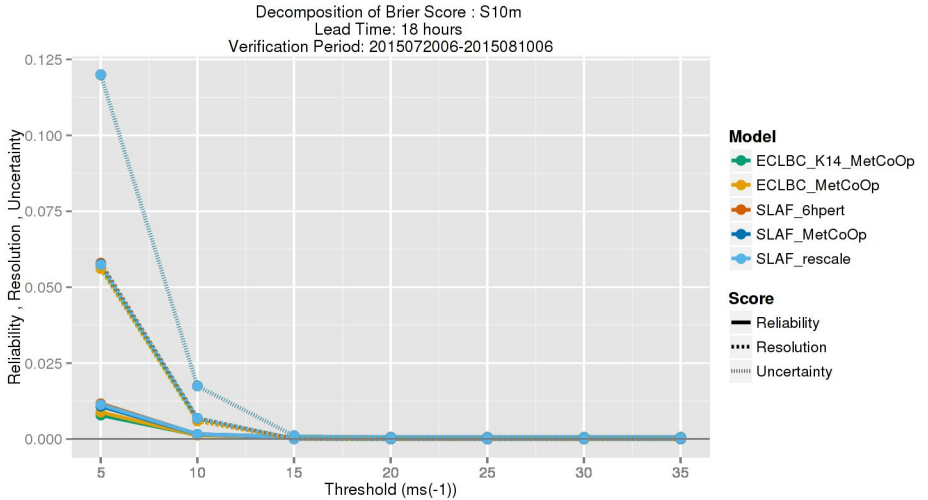
Lead Time: 6 hours
Verification Period: 2015072006-2015081006
Reliability , Resolution , Uncertainty
0.15
0.10
0.05
0.00
5
10
15
20
25
30
35
Threshold (ms(-1))
Model
ECLBC_K14_MetCoOp
ECLBC_MetCoOp
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale
Score
Reliability
Resolution
Uncertainty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Verification Period: 2015072006-2015081006
Reliability , Resolution , Uncertainty
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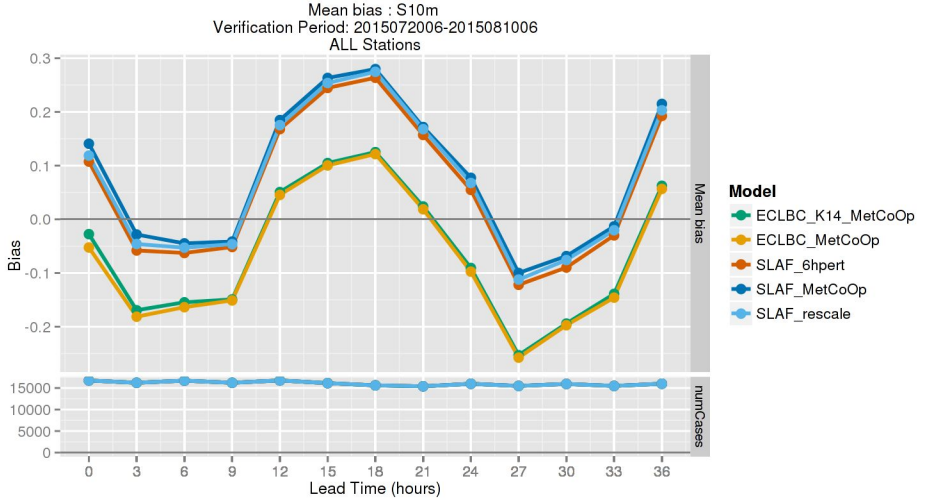
0.100
0.075
0.050
0.025
0.000
5
10
15
20
25
30
35
Threshold (ms(-1))
Model
ECLBC_K14_MetCoOp
ECLBC_MetCoOp
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale
Score
Reliability
Resolution
Uncertainty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ALL Stations
Bias
0.3
0.2
0.1
0.0
-0.1
-0.2
Mean bias
15000
10000
5000
0
numCases
0
3
6
9
12
15
18
21
24
27
30
33
36
Lead Time (hours)
Model
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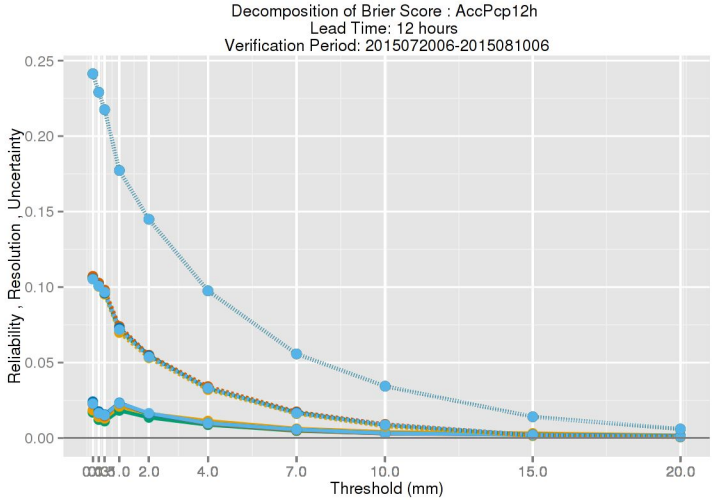
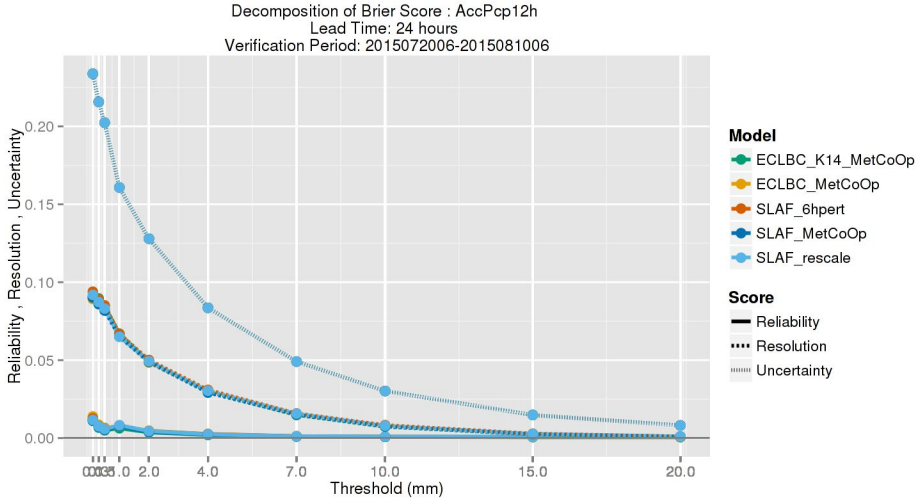
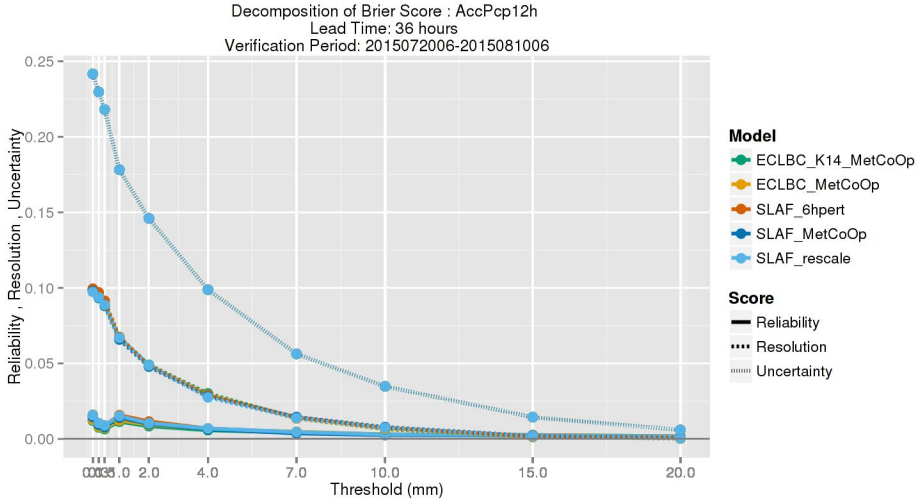
ECLBC_MetCoOp
SLAF_6hpert
SLAF_MetCoOp
SLAF_rescale







Norwegian Meteorological Institute

Summary

- SLAF gives superior verification scores
  - Requires both rescaling and using consecutive forecasts to compute perturbations
- Inflation of IFS-ENS LBCs improves spread with no adverse effects on skill.

- Open questions
  - Will member selection improve IFS-ENS IC + LBC perturbation scores?
  - How do SLAF and EPS boundary perturbation methods compare for individual forecasts, especially for extreme events?
  - Is better performance of SLAF simply due to resolution of boundary data?