HarmonEPS developments

Inger-Lise Frogner, MET Norway
on behalf of the Hirlam EPS team

EWGLAM virtual event, 2021

Three topics covered:

1. Can we use data from an operational ensemble based on HarmonEPS to generate new background error statistics "for free", and more often?

2. Single precision in a pre-operational EPS

3. Improving the Stochastically Perturbed Parameterizations (SPP) scheme by utilizing different distributions and correlating perturbations
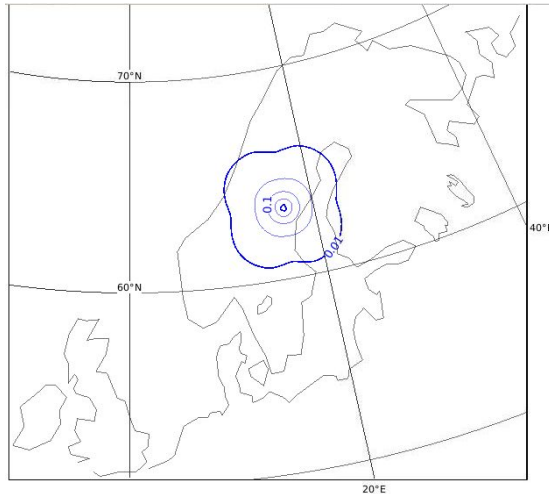
Three topics covered:

1. Can we use data from an operational ensemble based on HarmonEPS to generate new background error statistics "for free", and more often?
   - Tedious process to derive these statistics

   - The setup is similar to the operational ensemble, although with some important differences

2. Single precision in a pre-operational EPS

3. Can we improve on the Stochastically Perturbed Parameterizations (SPP) scheme by utilizing different distributions and correlating perturbations?

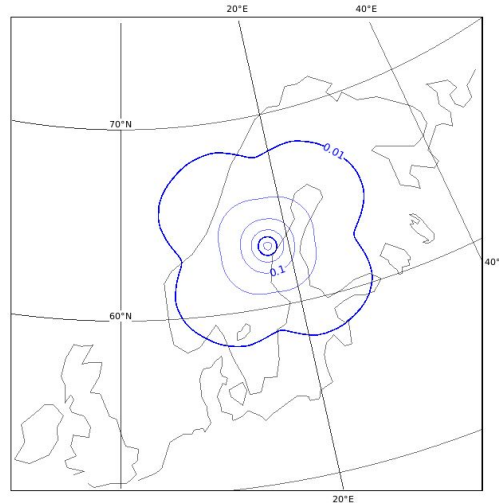# First trial with MEPS pre-operational data from May - Nov 2019

Single observations : magnitude and spread of analysis increments (analysis minus background)

- one single temperature observation 1K warmer than the corresponding background value and with an observation error standard deviation of 1K placed in the center of the domain at 500 hPa (lev=24)

Operationally used statistics

New statistics

The new statistics give increments with larger scales which means a smoother analysis losing e.g. sub synoptic scale features

Roohollah Azad
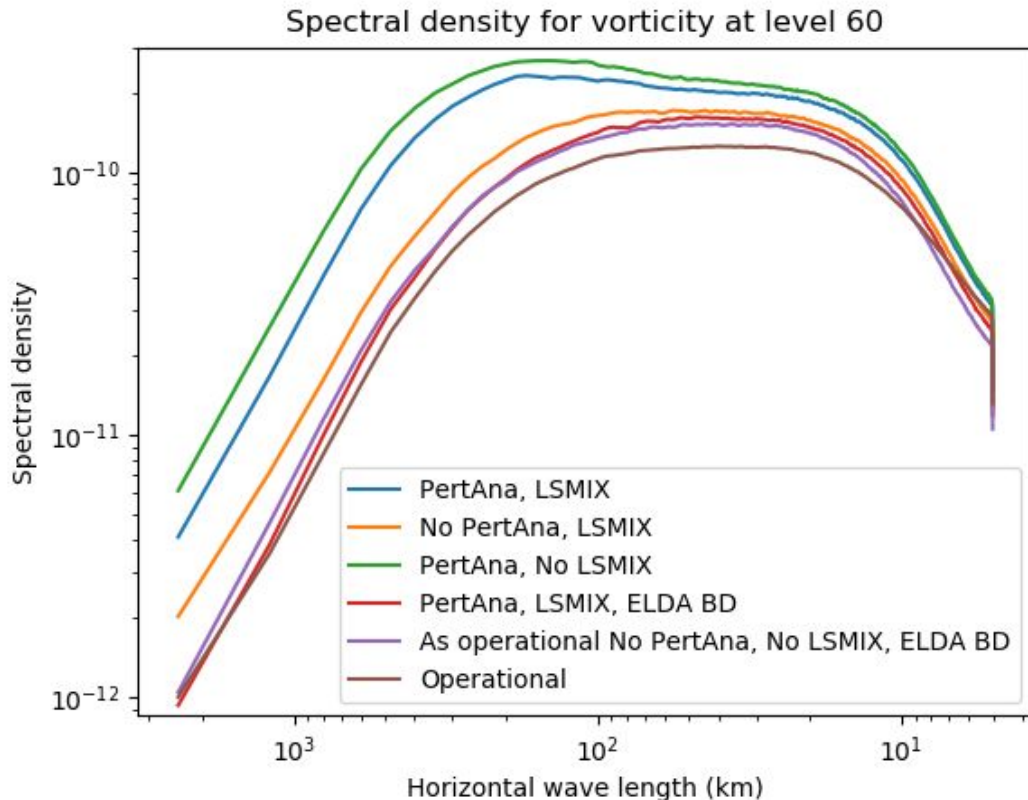
EDA setup for August 2019 using 4 members

	Boundaries	PertAna	LSmix	Surfpert scale
Operationally used	IFS ELDA	No	No	0km (off)
ELDA, no PertAna, no LSMIX	IFS ELDA	No	No	150km
ELDA boundaries	IFS ELDA	Yes	Yes	150km
MEPS like	IFSENS	Yes	Yes	150km
No PertAna	IFSENS	No	Yes	150km
No LSMIX, no PertAna	IFSENS	No	No	150km
50km surface pert	IFSENS	Yes	Yes	50km
No LSMIX	IFSENS	Yes	No	50km

Ulf Andrae, Magnus Lindskog, Inger-Lise Frogner

Effect of the spectral density from various components

IFSENS boundaries unless stated

- LSMIX constrains the setup

- PertAna with IFSENS gives more energy on larger scales

- IFSENS give more energy than ELDA

- PertAna with ELDA doesn't change much

- **Operational** still smaller but based on different periods and more cases **and does not include surface perturbations**

Ulf Andrae, Magnus Lindskog, Inger-Lise Frogner

Spectral density for vorticity at level 60

Legend:
- PertAna, LSMIX
- No PertAna, LSMIX
- PertAna, No LSMIX
- PertAna, LSMIX, ELDA BD
- As operational No PertAna, No LSMIX, ELDA BD
- Operational

Spectral density vs Horizontal wave length (km)

Some tiny but important details about ELDA availability
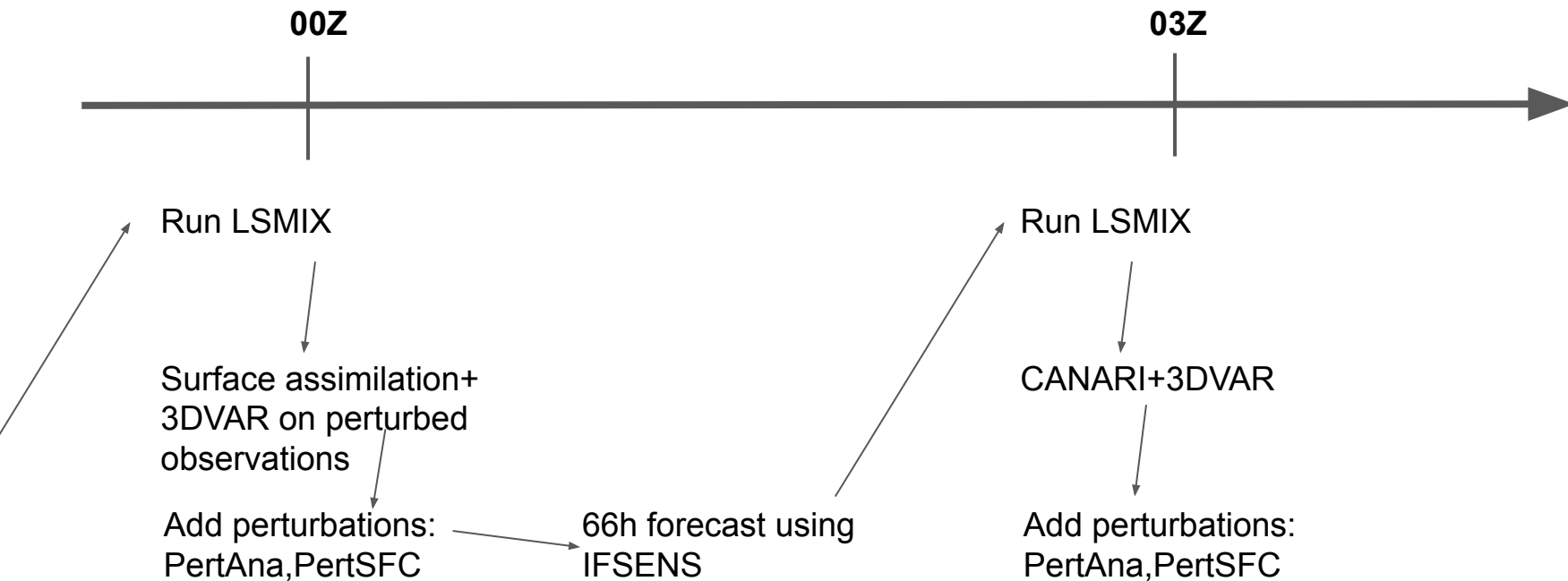
- Model level output is only archived at +3,6,12

- It only runs at 06/18Z IFSENS runs 00/06/12/18Z

- It's currently not available in the dissemination catalogue

On request ECMWF has decided to make available 1h output data up to 18h (not in dissemination). Will be available in 47r3 to become operational on the 12th of October 2021

Note that we still only have fresh forecasts two times a day => Impossible construct a consistent ensemble.
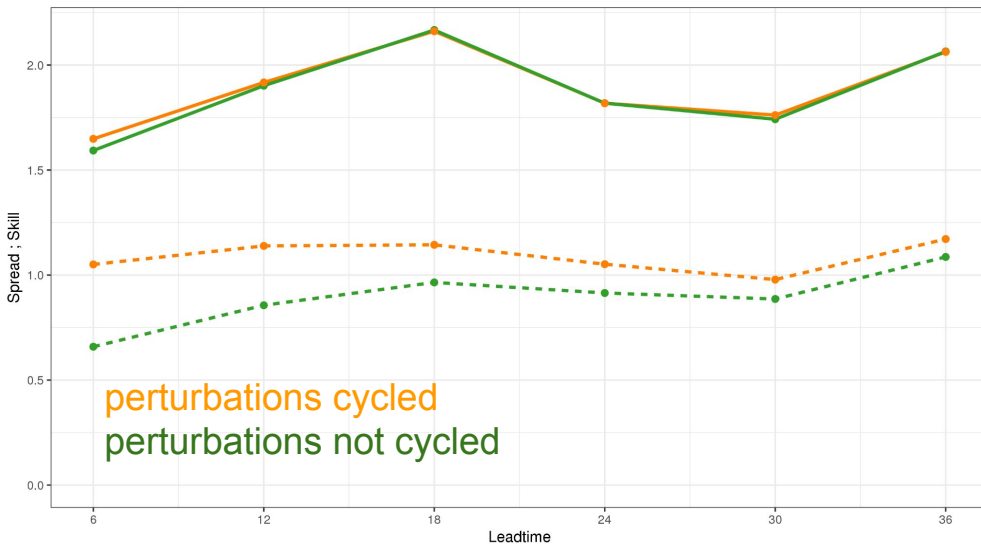
Ulf Andrae

Current MEPS DA and EPS setup

Perturbations are cycled

00Z   **03Z**

Run LSMIX   Run LSMIX

Surface assimilation+
3DVAR on perturbed
observations

CANARI+3DVAR

Add perturbations:
PertAna,PertSFC

66h forecast using
IFSENS

Add perturbations:
PertAna,PertSFC

Ulf Andrae

Example on the effect on ensemble scores: Td2m

Spread Skill : 00:00 01 Jun 2019 - 00:00 15 Jun 2019
824 stations

perturbations cycled
perturbations not cycled
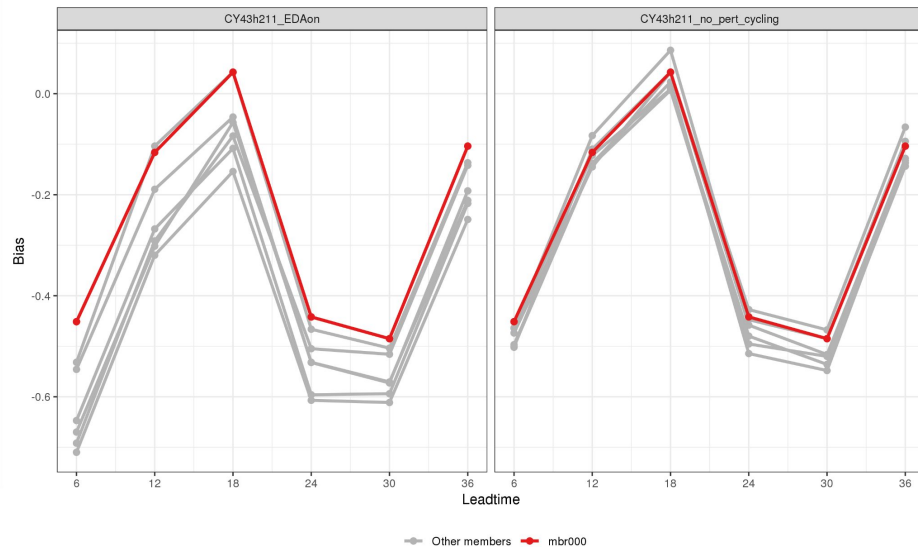
CY43h211_EDAon   CY43h211_no_pert_cycling   — rmse   --- spread

Verification for Td2m

Bias : 00:00 01 Jun 2019 - 00:00 15 Jun 2019
824 stations

Other members   mbr000

Verification for Td2m

Spread is clearly reduced, little change on RMSE. The members bias is more in agreement with the control.

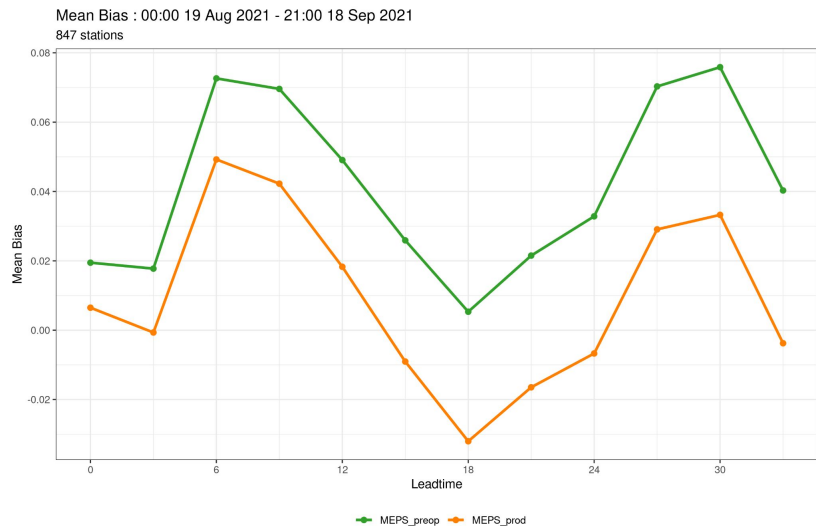# Conclusions and further investigations

- Separate DA and EPS perturbations like in the example shown, bias of the members more in agreement with the bias of the control, but less spread

- Rerun BG generation experiments with ELDA or IFSENS boundaries and compare forecast scores
  - It is very complicated to use ELDA operationally so it would be interesting to know the performance when IFSENS is used

Ulf Andrae, Magnus Lindskog, Inger-Lise Frogner

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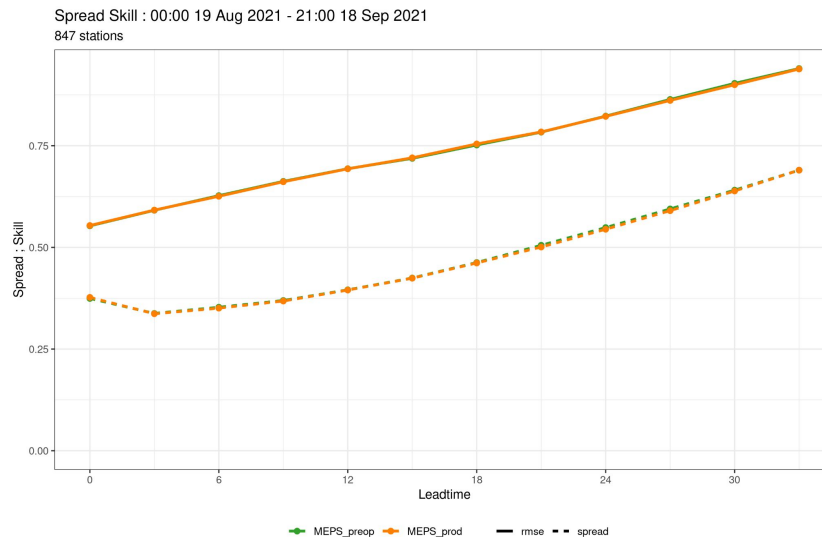
Single precision in MEPS preop

SP was introduced 16 June 2021

Mean bias MSLP
changes slightly

MSLP Spread and skill
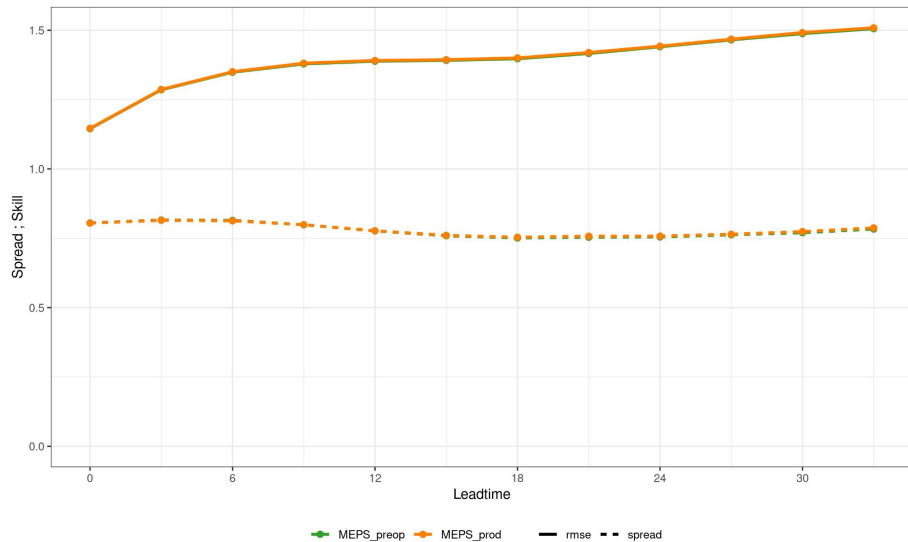The change is marginal

Single precision in MEPS preop

T2m and AccPcp12 h
Spread and skill
Hardly any change

Single precision in MEPS preop

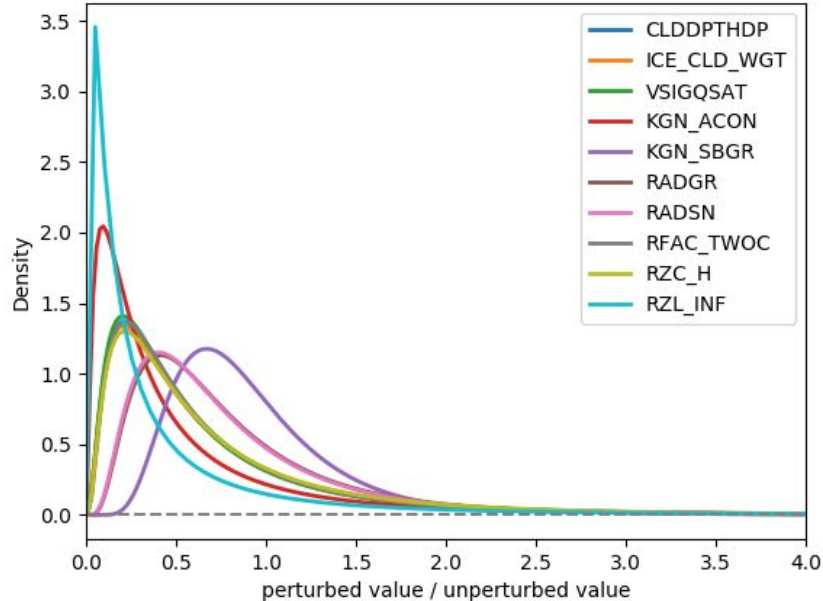SP looks good for EPS, but experiences show that it sometimes crashes in winter
We also need to make SPP ready for single precision
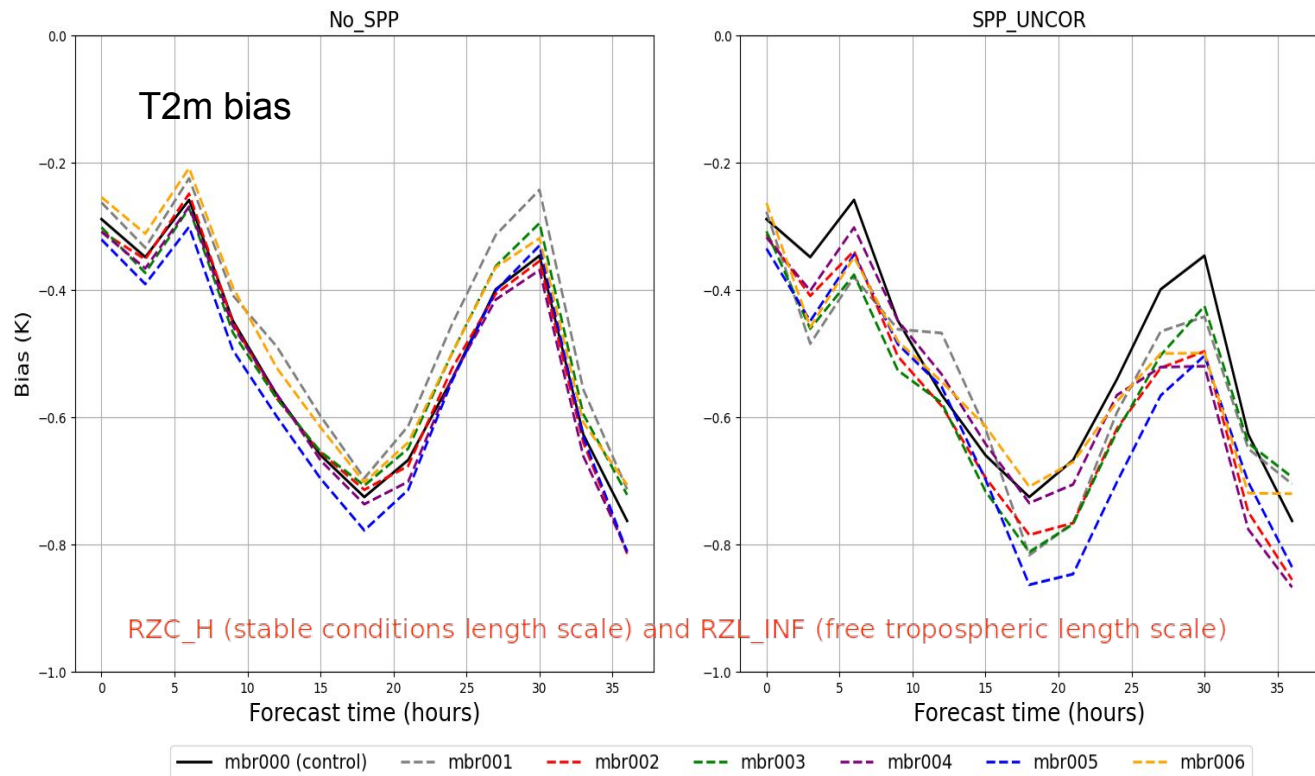
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   ○ SPP show good potential, and introduce variability in the ensemble that the other perturbations do not, but it can also change the bias of the model

SPP - present status

- Currently perturbing 11 parameters
- Perturbations are drawn from log-normal distributions

Pirkka Ollinaho, Ulf Andrae, Karoliina Hämäläinen, Inger-Lise Frogner

Effect of SPP on the bias

No_SPP   SPP_UNCOR

T2m bias

RZC_H (stable conditions length scale) and RZL_INF (free tropospheric length scale)

Can result in systematic bias for ensemble members

Unrealistically low (high) parameter values at the lower (higher) ends of the distribution

Negative and positive perturbations not even distributed around the default value

Increase in ensemble RMSE for T2m and RH2m during winter

Aristofanis Tsiringakis, Wim de Rooy, Sibbo van der Veen and Jan Barkmeijer

Correlated perturbations and "pseudo uniform" distributions
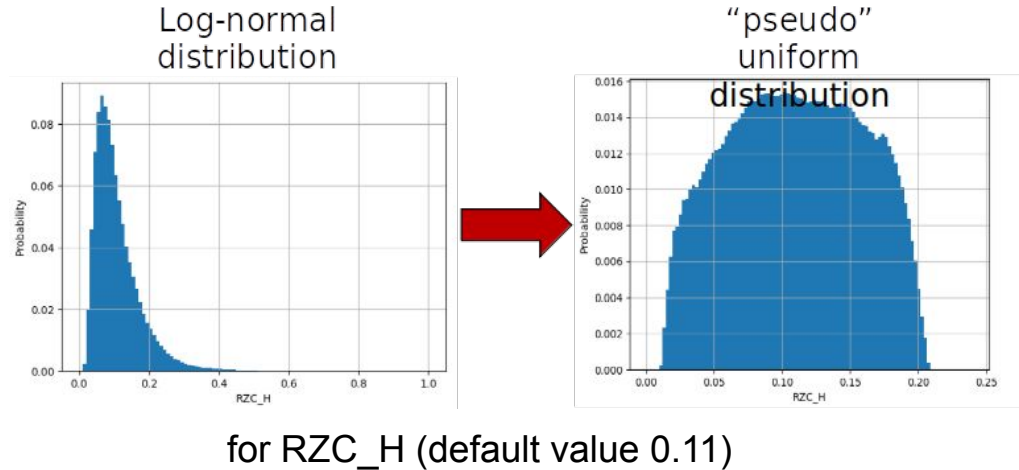
Correlated perturbations :

Turbulence parameters' perturbations acting in an similar direction in the boundary layer and free troposphere

"Pseudo" uniform distributions:
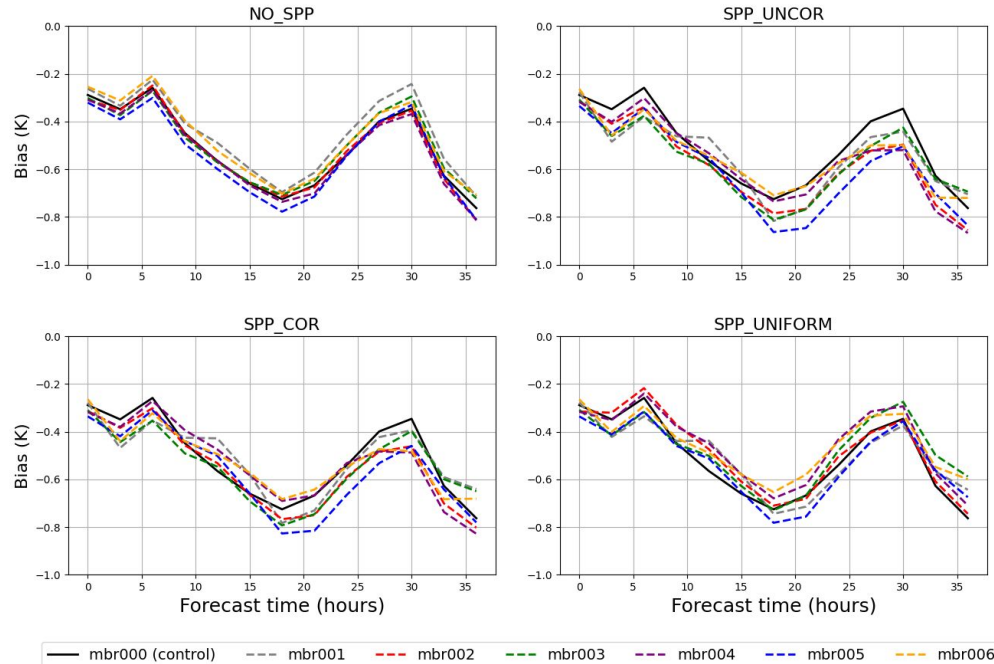
More realistic parameter range for some parameters

Even distribution around the default values

Easier adjustment of systematic biases

for RZC_H (default value 0.11)

Aristofanis Tsiringakis, Wim de Rooy, Sibbo van der Veen and Jan Barkmeijer

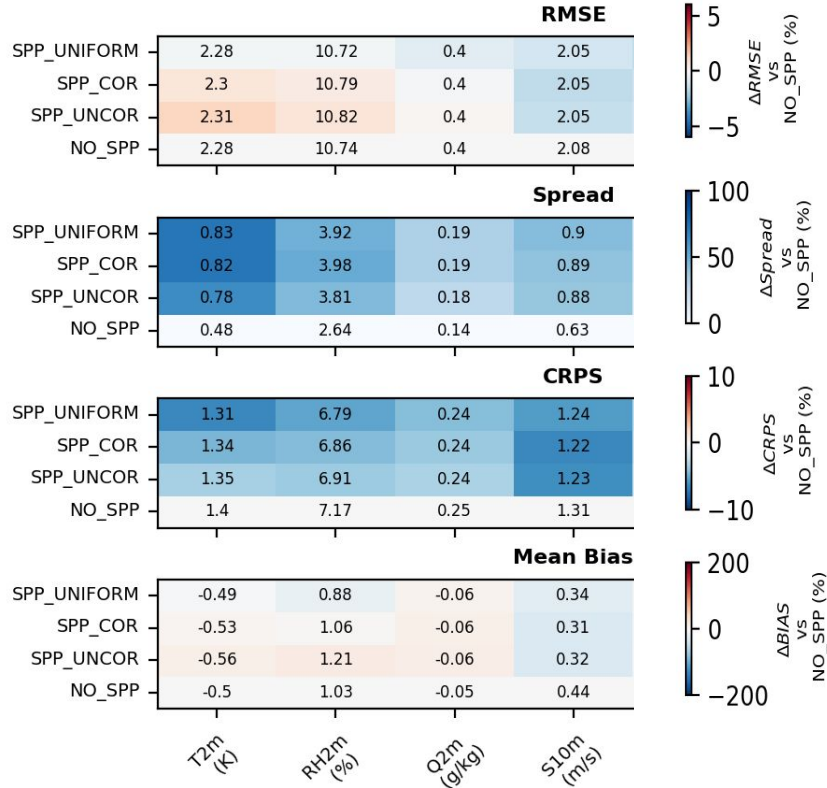# Correlated perturbations and "pseudo" uniform distributions

RZC_H (stable conditions length scale) and RZL_INF (free tropospheric length scale)

Ensemble members from SPP_COR show slightly less systematic bias compared to the SPP_UNCOR experiment

Almost zero systematic member bias for SPP_UNIFORM with members evenly spread around the control member

Aristofanis Tsiringakis, Wim de Rooy, Sibbo van der Veen and Jan Barkmeijer

Correlated perturbations and "pseudo" uniform distributions

Summary for 20-26 Feb 2019:

SPP_COR and SPP_UNIFORM show:

- Higher spread

- Lower (better) CRPS

Correlated has lower systematic bias compared to the uncorrelated

Aristofanis Tsiringakis, Wim de Rooy, Sibbo van der Veen and Jan Barkmeijer

Further SPP work

- Test correlating more parameters
  - RZC_H/RFAC_TWOC, RFAC_TWOC/RZL_INF, ...
- Test correlated *and* "uniform" distributions together
- Testing more distributions
- Add more parameters to the scheme
- Optimize cost of running the scheme

Model uncertainty representation in a convection-permitting ensemble - SPP and SPPT in HarmonEPS

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Paper submitted to MWR

Thank you for your attention