Running HarmonEPS ensemble members in single precision

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Minimum requirements for single precision ensemble forecasts

- Confirm that single precision forecasts **run significantly faster** than double precision forecasts
- The difference between single and double precision forecasts must be **much smaller** than the difference between ensemble members
- Single precision forecasts must be numerically **stable**

My experiment

- “Single precision” only applies to forecasts – everything else is run in double precision
- 1 double precision, unperturbed (control) member
- 1 single precision, unperturbed member
- 3 single precision, perturbed members
- 3-hourly cycling, EDA, 18h forecasts, SLAF perturbations for LBC, cy43h2.1 + additional “HIRLAM_SP_HACKS”
- Two periods: 16-26 June 2020, 1-31 March 2021

Computational performance

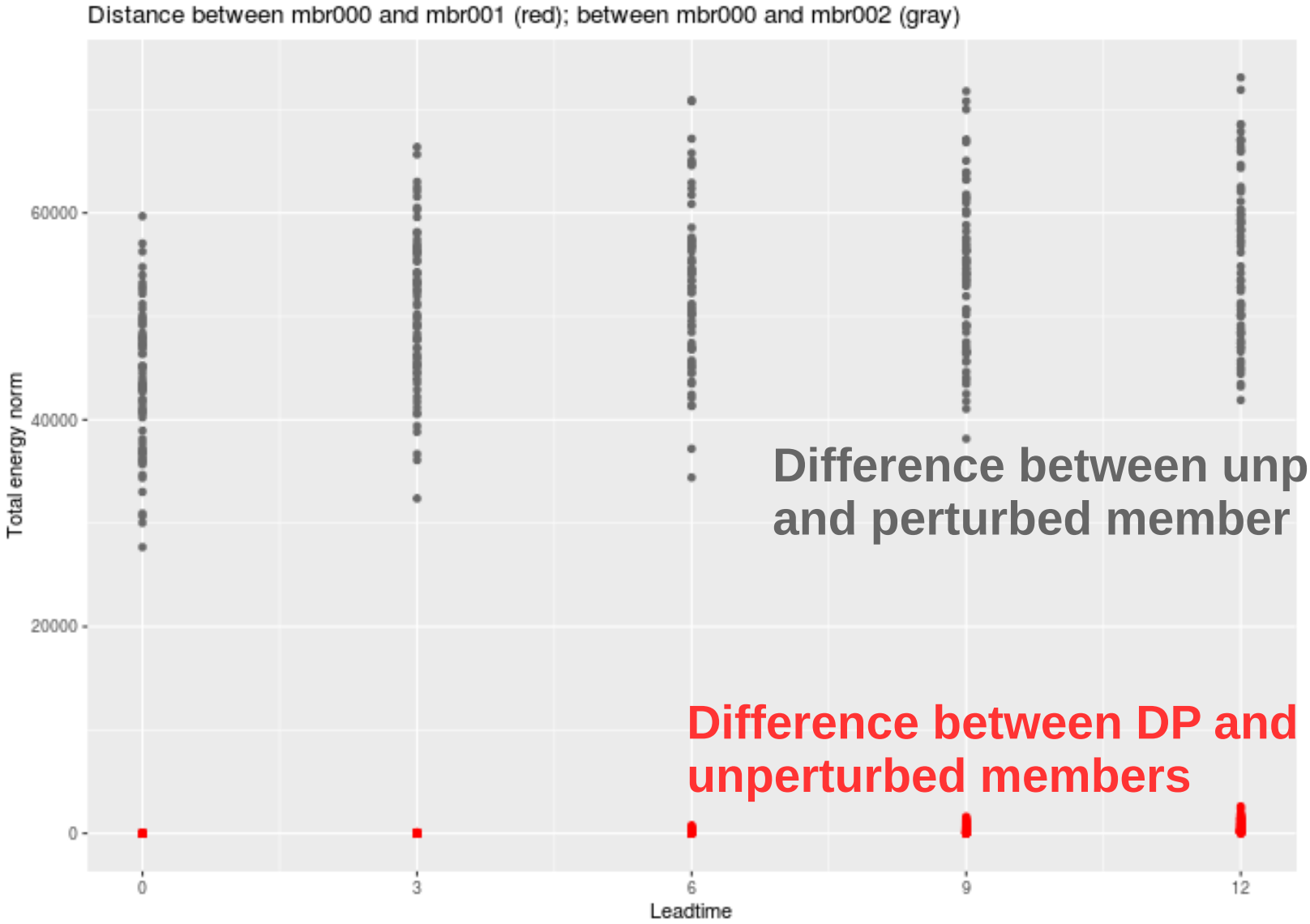
- Single precision forecasts run ~30% faster than double precision forecasts on DMI's Cray XT5
- Optimal NPROMA (single precision) ≈ 2 NPROMA (double precision);

  we use $NPROMA_{DP} = -24$; $NPROMA_{SP} = -48$

Difference between single and double precision forecasts

- Difference measured using total energy norm
- Two possible configurations for single precision unperturbed member:
  1. Copy first-guess from DP to SP, so only the forecast differs
  2. Run independent data assimilation cycling for DP and SP forecasts

1. Forecast only difference



Difference between unperturbed and perturbed member

Difference between DP and SP unperturbed members

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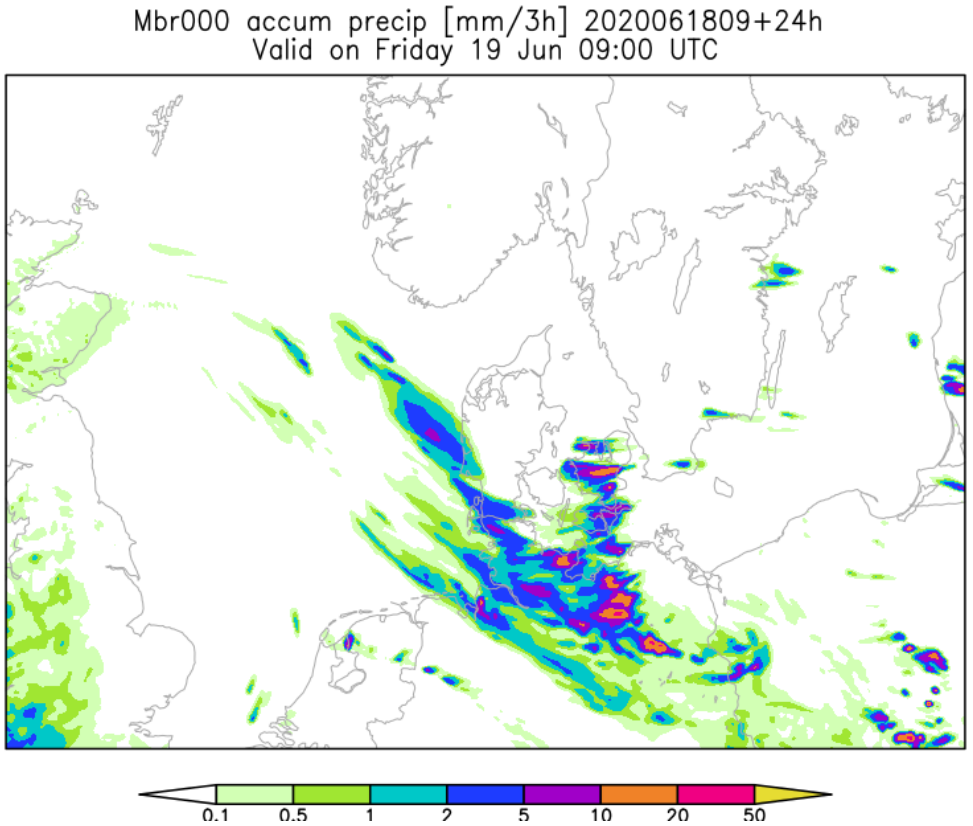
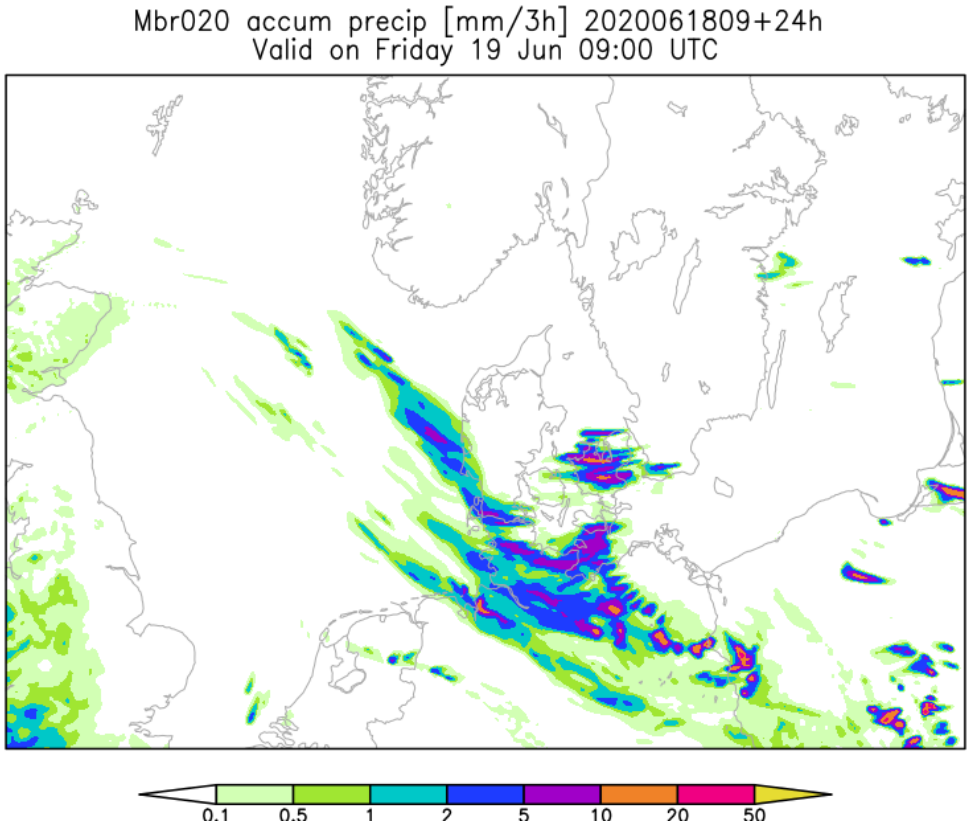
Precipitation forecast example

Double precision



Single precision



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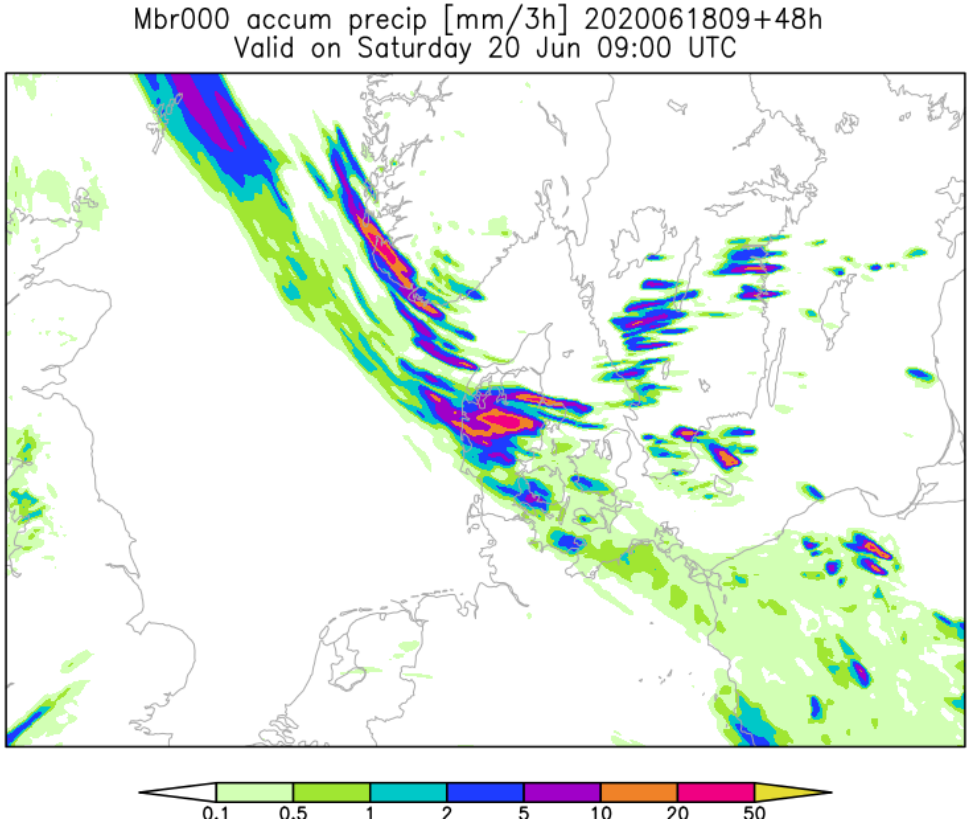
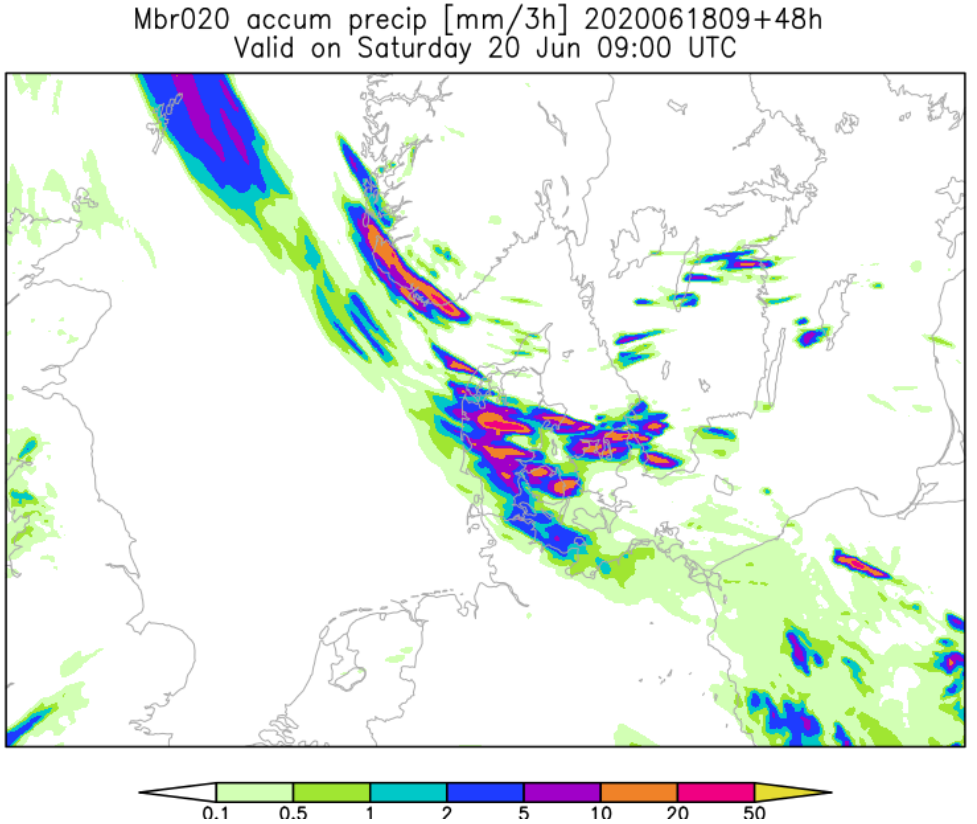
Precipitation forecast example

Double precision



Single precision



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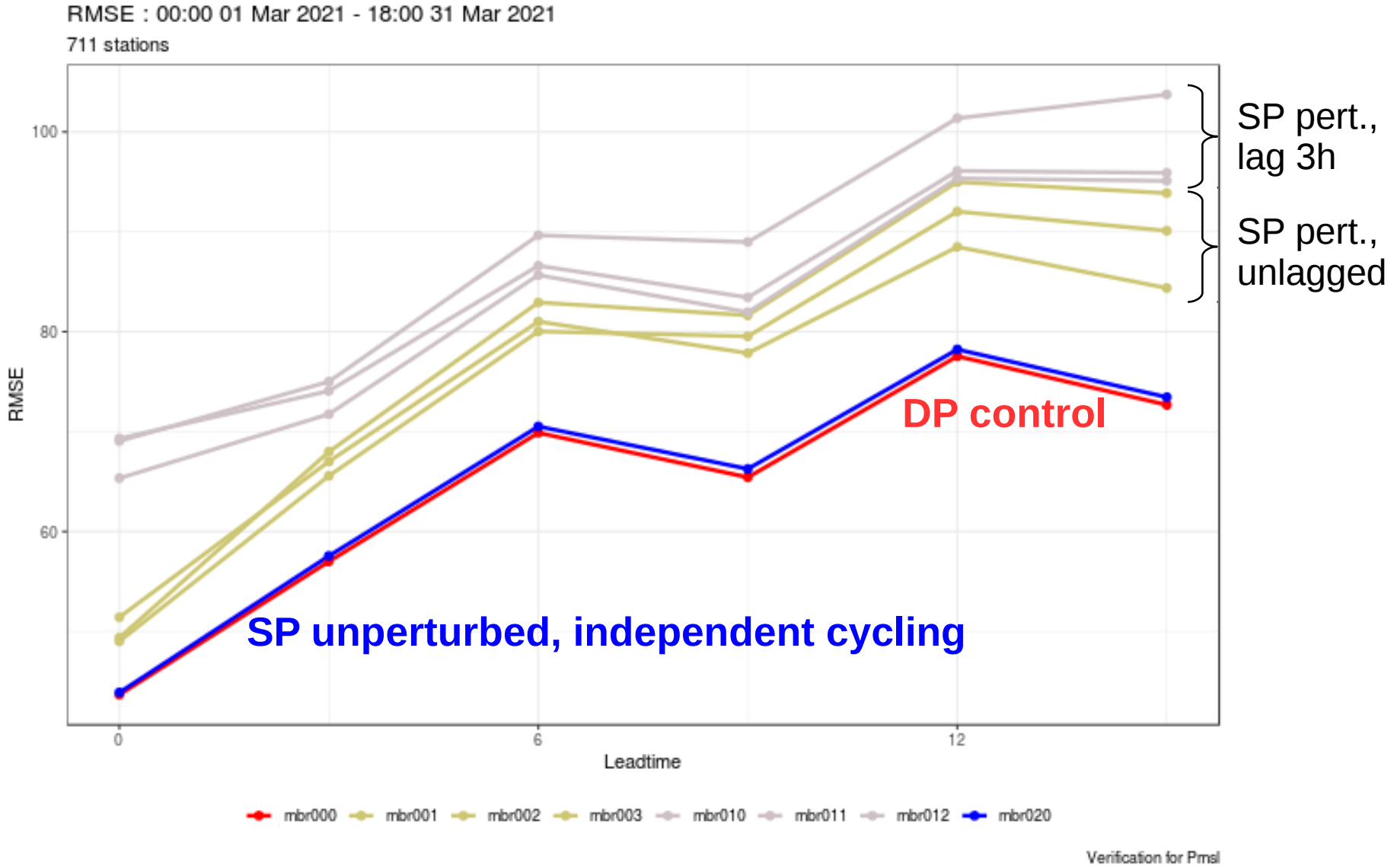
Single precision forecast stability

- 2 SP perturbed members crashed out of the last 1500+ SP members
- No crashes observed during summer runs – is SP more unstable in winter than in summer?

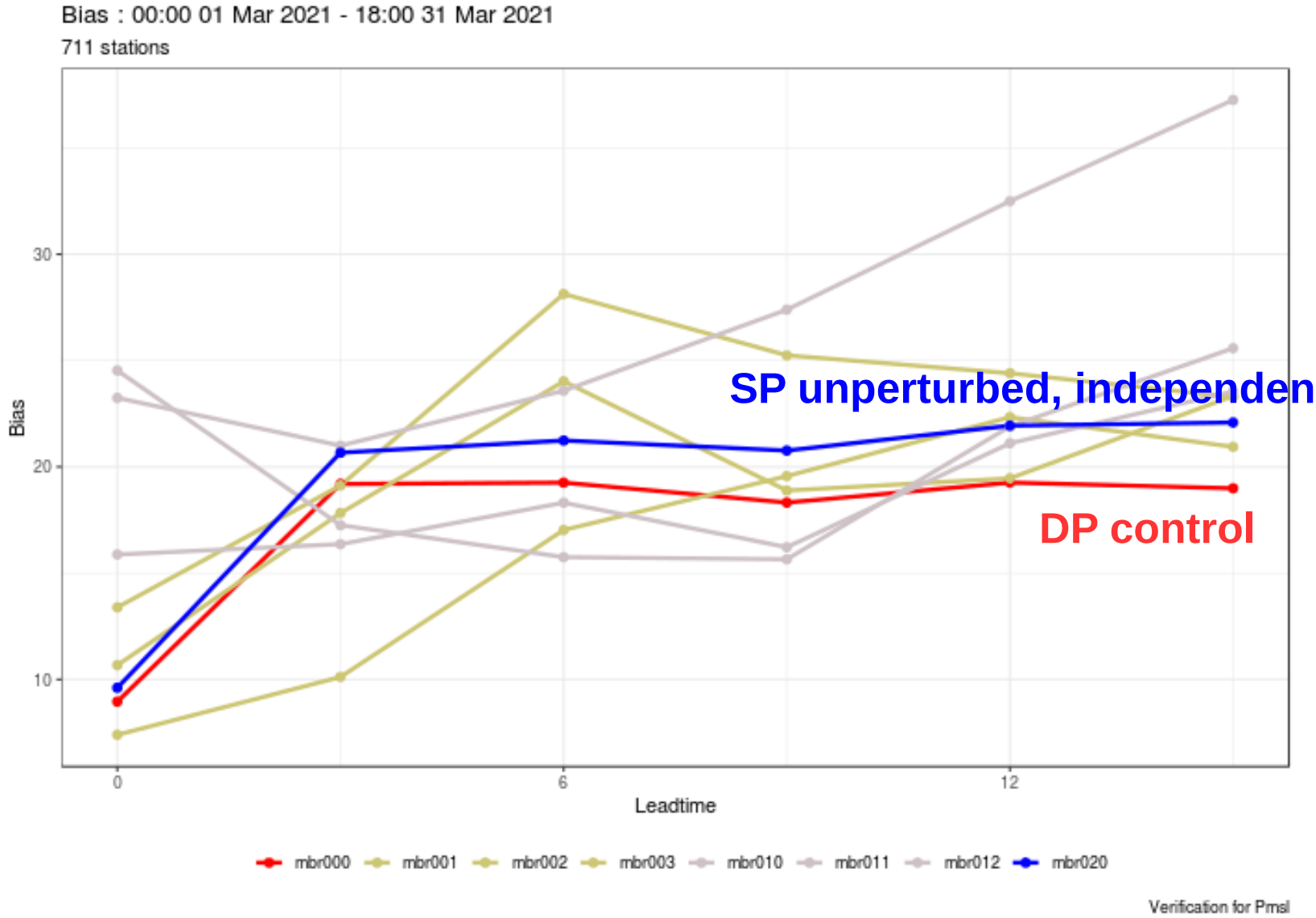
Forecast verification

Pmsl, RMSE



Forecast verification

Pmsl, bias

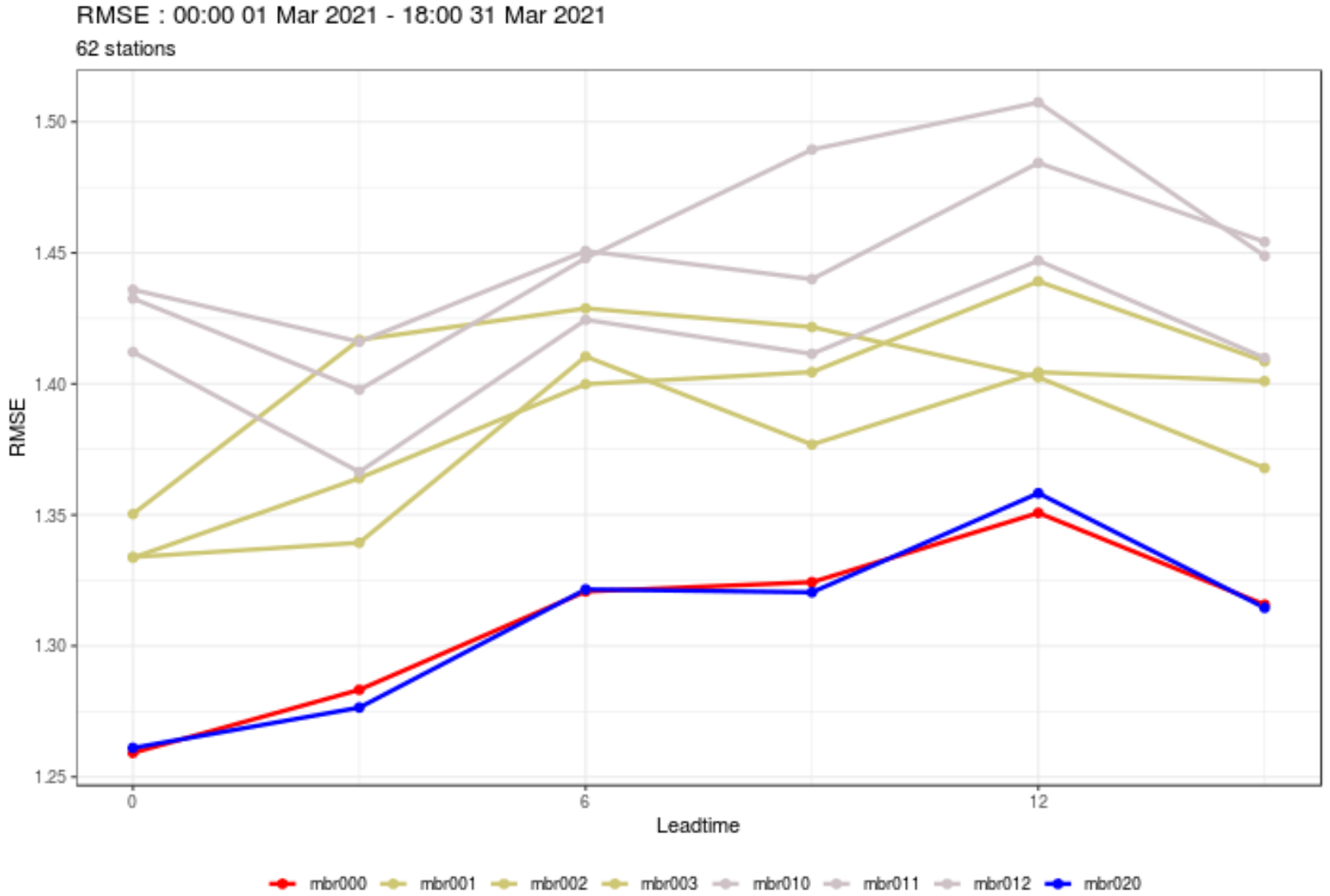


SP unperturbed, independent cycling

DP control

Forecast verification

T2m, Danish stations, RMSE



- and similarly for RMSE and bias for other surface parameters

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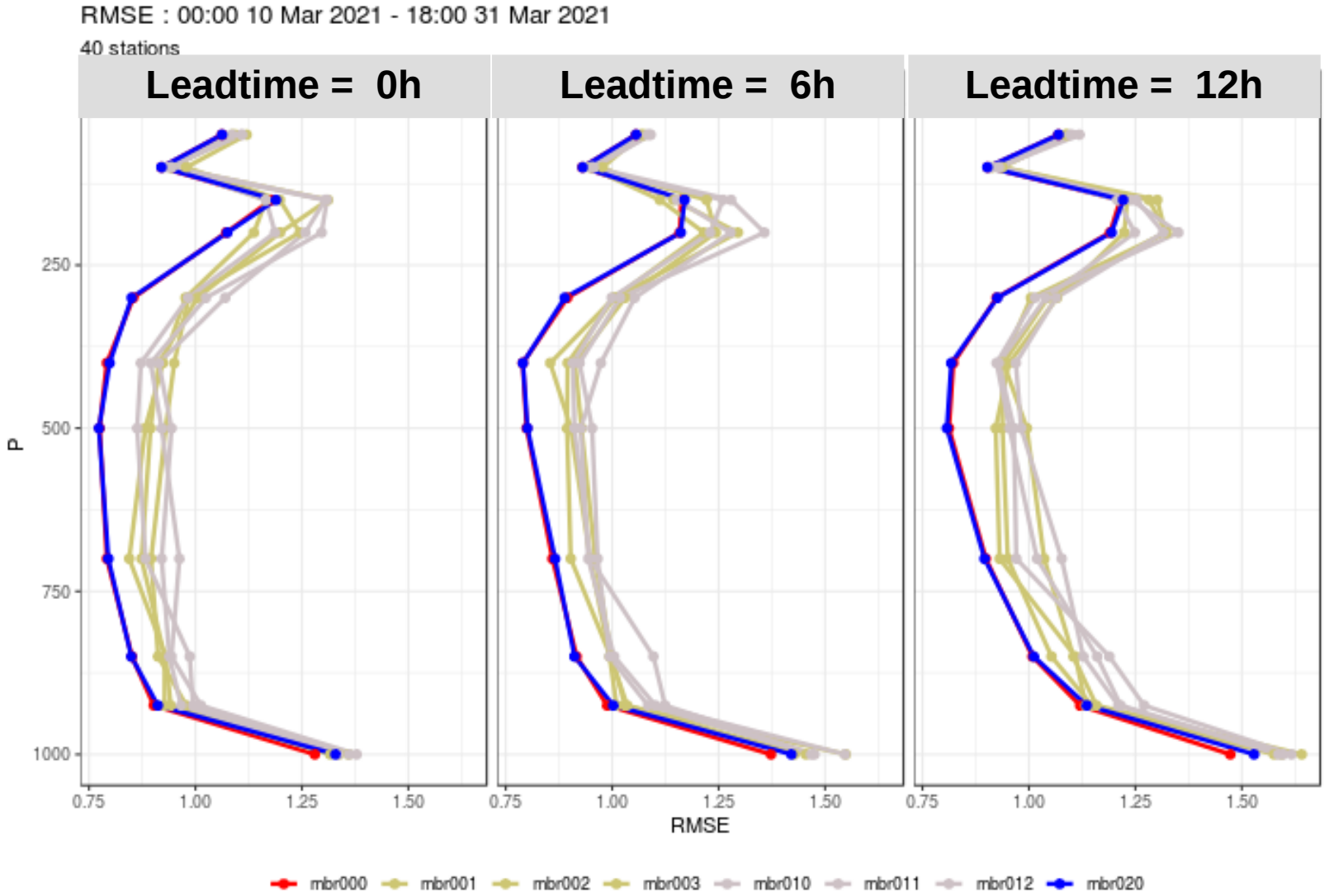
Forecast verification

Temperature, vert. profile, RMSE



- and similarly for RMSE and bias for other upper air parameters, except...

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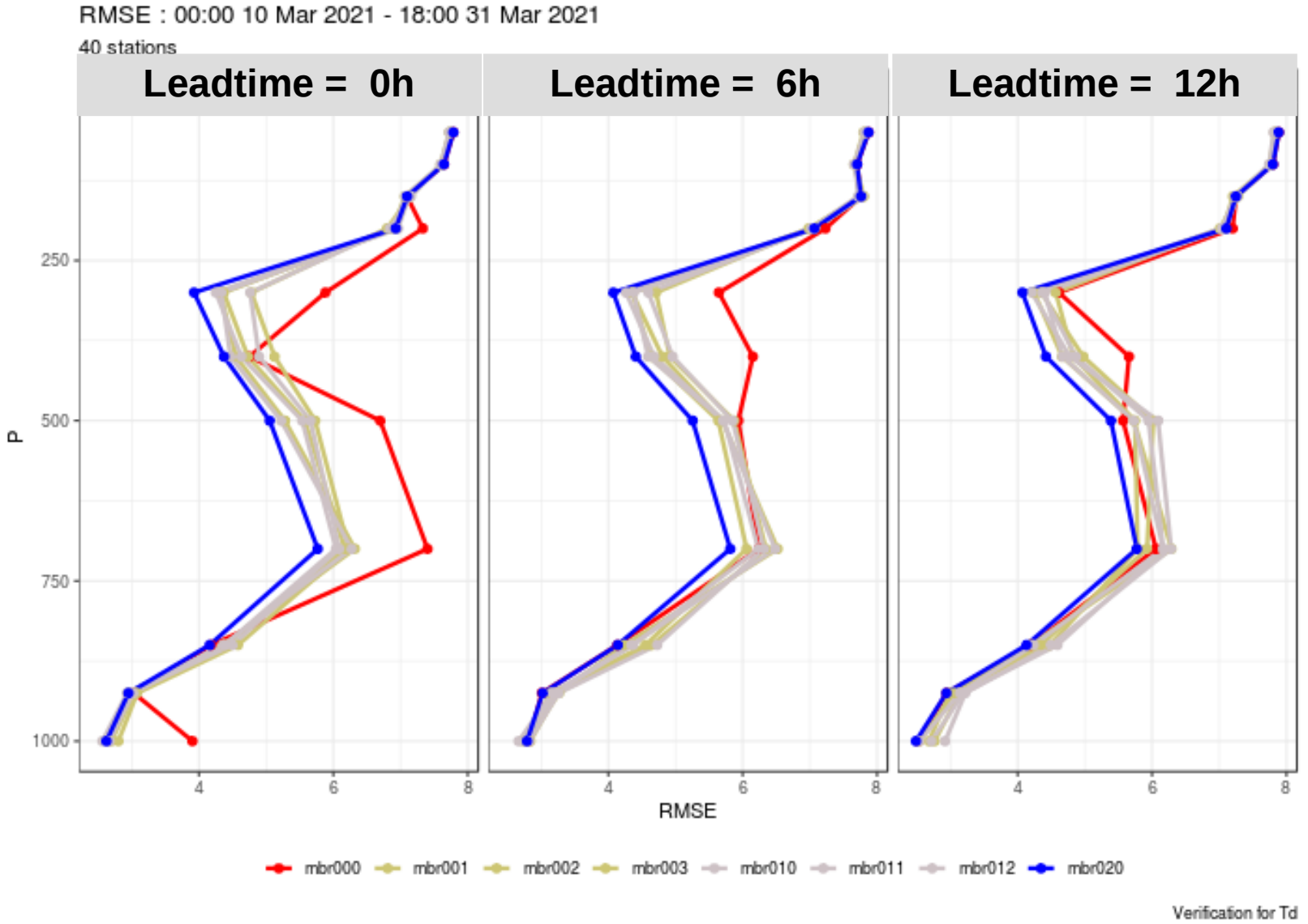
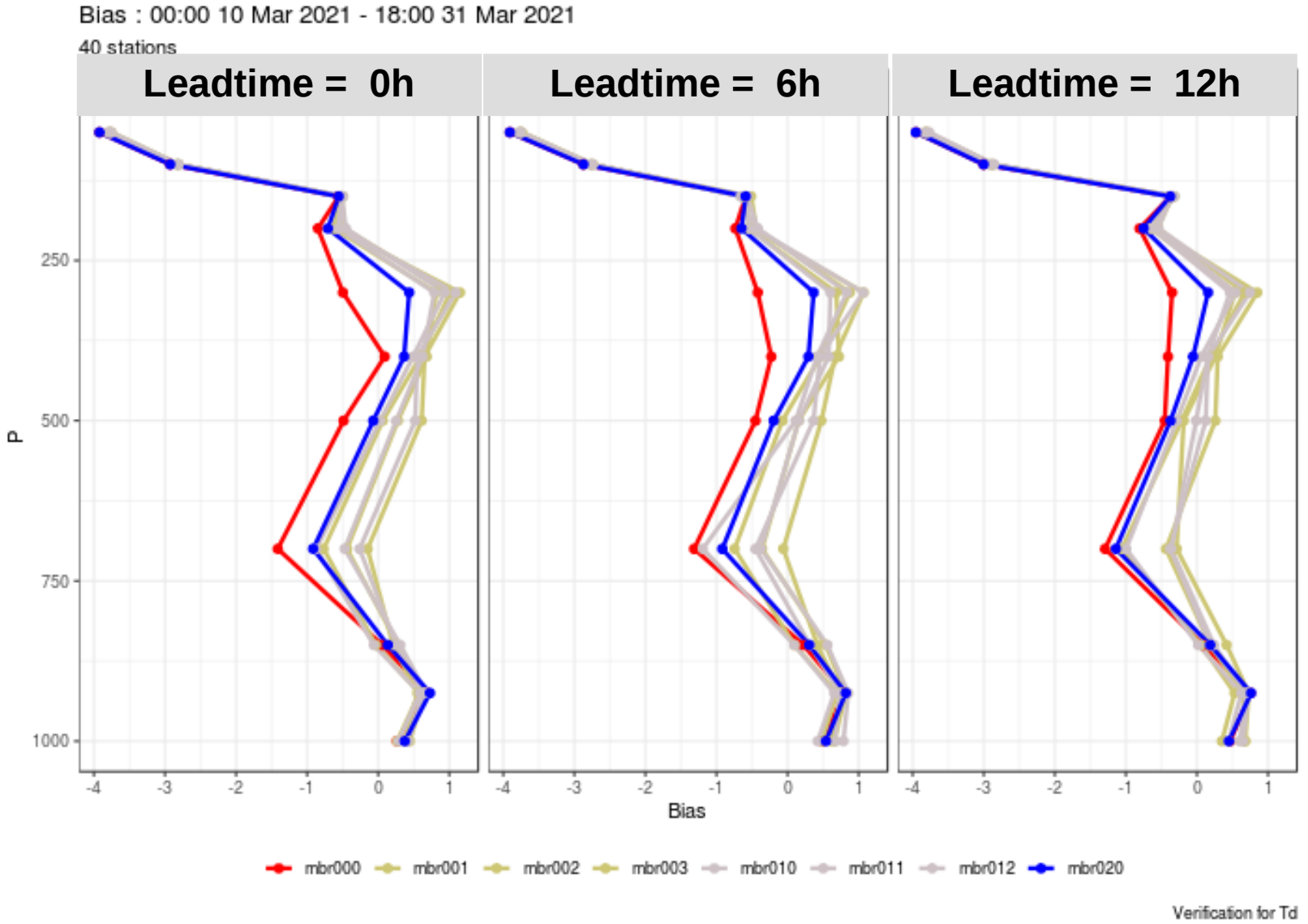
Forecast verification

Dewpoint temperature, vert. profile, RMSE



Forecast verification

Dewpoint temperature, vert. profile, bias



Summary

- Single precision forecasts are suitable for EPS as they
  - **run ~30% faster** than DP forecasts
  - **differ much less** from DP forecasts than from perturbed ensemble members (issue with dewpoint vertical profile needs to be resolved)
  - **perform as well** as DP forecasts
  - **are stable enough** to be used for perturbed ensemble members (but possible winter-time issue)