On the initial conditions of the ICON-D2-EPS ensemble: An analysis in terms of spread and skill

Chiara Marsigli
Deutscher Wetterdienst

with the contribution of many DWD colleagues

Outline

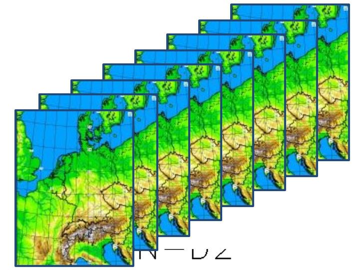
- Motivation
- ICON-D2-EPS: ensemble set-up
- Evaluation of the ensemble perturbations
  - Spread and errors
  - Perturbation spectra
- Concluding remarks and future work

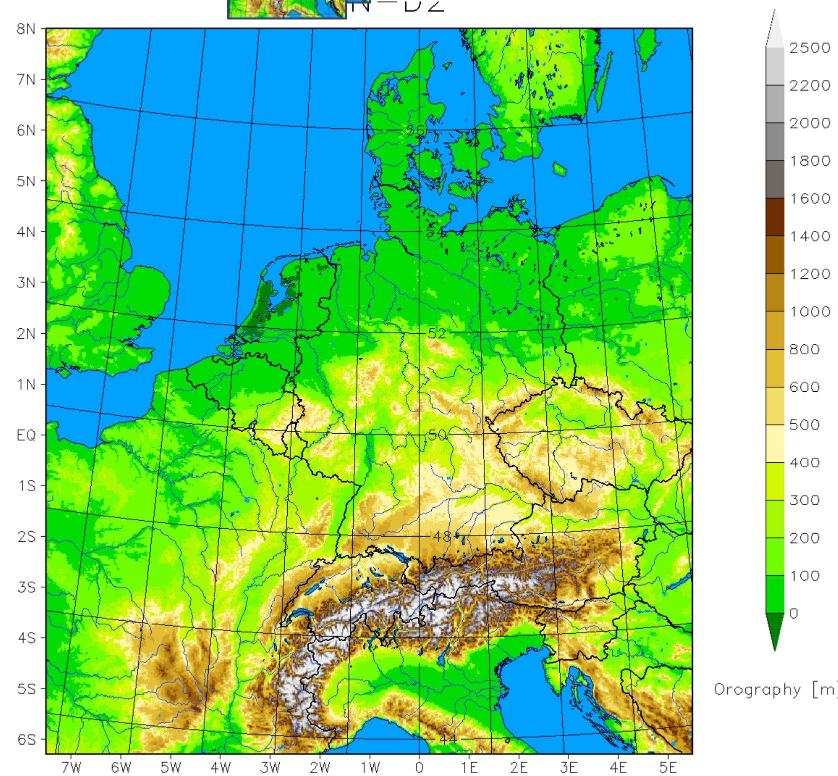
Motivation

- Why is the ensemble spread important?
- For an ensemble, statistically over a long enough period:
  - the correct forecast should be among the members
  - the range of the forecasts should resemble the range of the occurrences
- The spread of the ensemble should represent the forecast error
- The spread of the ensemble should be (almost) equal to the RMSE of the ensemble mean

ICON-D2-EPS

- ~ 2.1 km icosahedral grid, 65 vertical levels
- 20 members
- 00, 03, 06, 09, 12, 15, 18, 21 UTC
- 27 hours (45 hours for 03 UTC)
  (planned: 48 hours)
- perturbation of
  - BC: from ICON-EU-EPS
  - Physics: randomized perturbations
  - IC: from KENDA, first 20 members
  - Soil moisture and soil temperature perturbation as part of KENDA
- pre-operational: 25 November 2019
- operational in Q4 2020





Aim of this work

- The KENDA analyses used as Initial Conditions for the ensemble present the advantage of providing perturbed initial conditions, where the perturbations contain also the information on the convection-permitting scale uncertainties.
- KENDA analyses are optimised for the purpose of data assimilation. The ensemble of analyses which is the most suitable for initialising the next data assimilation cycle may not be the same which is the most suitable for initialising the weather forecast ensemble, e.g. in terms of spread.
- In this work, the analyses generated by the KENDA cycle are evaluated from the point of view of their usage for ensemble forecasting initialisation.

Method

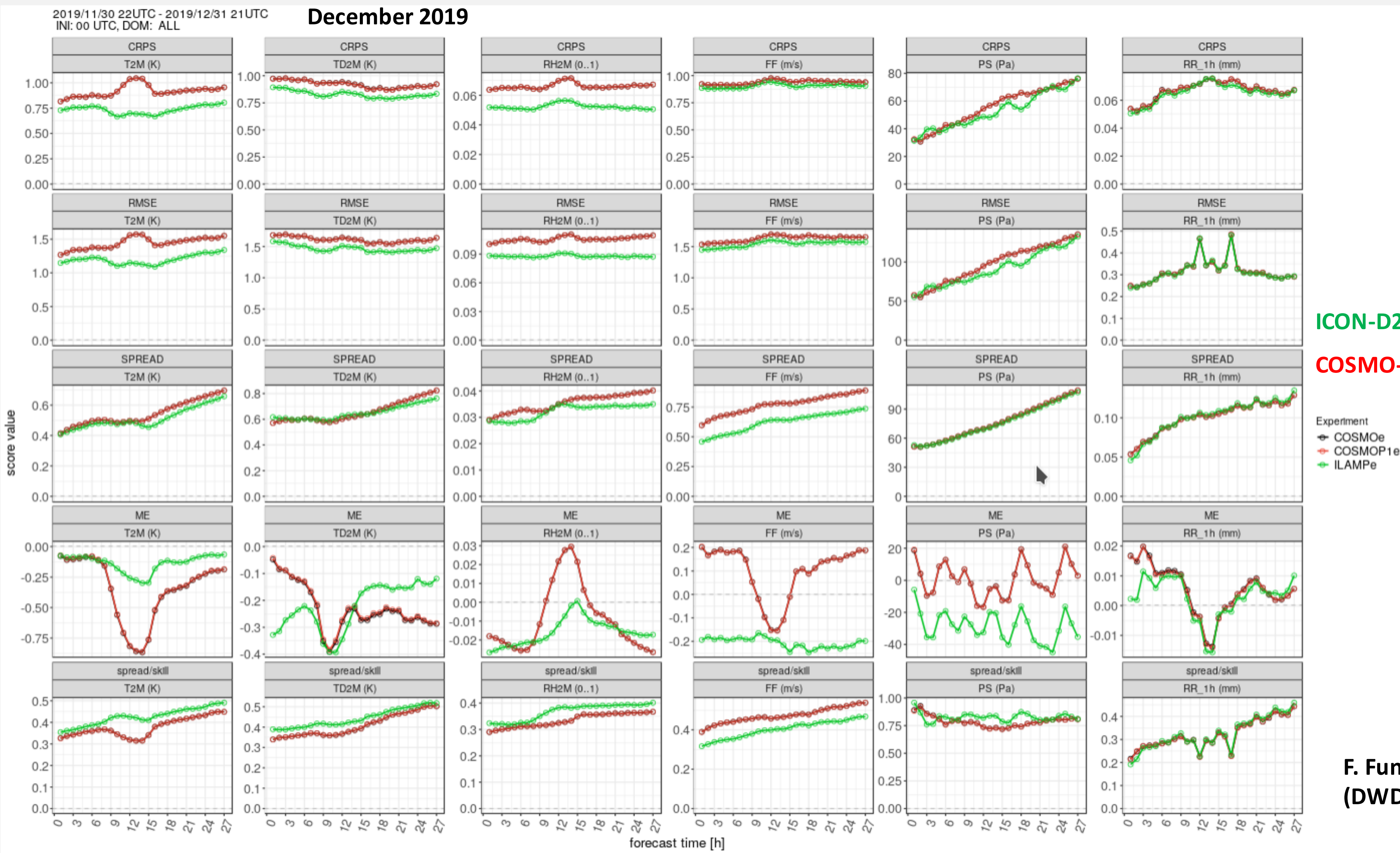
- Slide 7: verification (by F. Fundel) of ICON-D2-EPS and COSMO-D2-EPS against observations
- Slides 8-10: The spread of the ensemble is computed and compared with the ensemble forecast error, for ICON-D2-EPS. Here, the average RMSE of the members is computed against the model deterministic analysis, in order to evaluate the spread/skill relation independently from the model systematic error (at least at time 0).
- Slides 11-14: The spectra of the model perturbations are also computed, for each member (member – ensemble mean), both for ICON-D2-EPS and COSMO-D2-EPS. Two different days are shown. (Please watch only the red and the blue lines).

Comparison between ICON-D2-EPS and COSMO-D2-EPS

Scores against observations

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

December 2019



ICON-D2-EPS

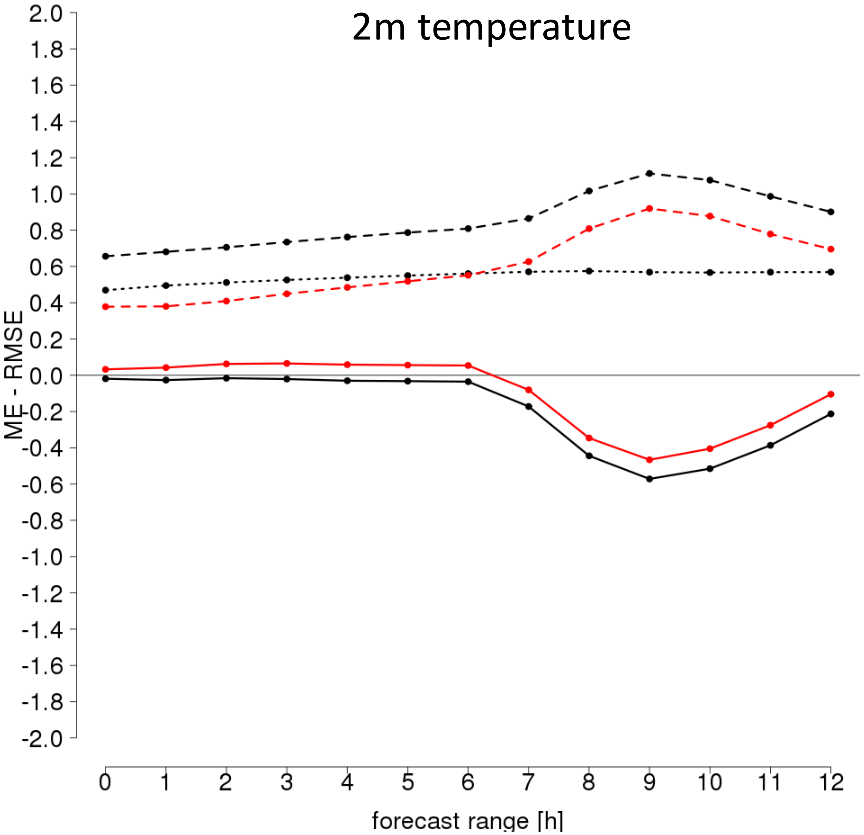
COSMO-D2-EPS

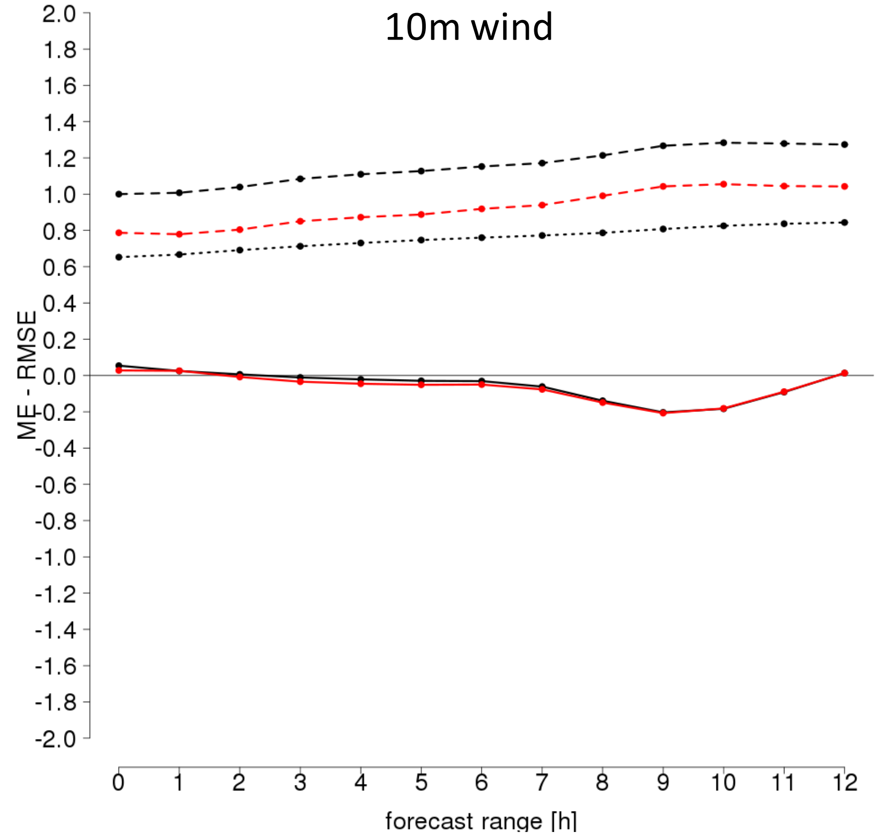
F. Fundel (DWD)

ICON-D2-EPS: scores against model deterministic analysis (in fact, +1h forecast, first guess of the KENDA cycle)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

December 2019





average ME of the members

average RMSE of the members

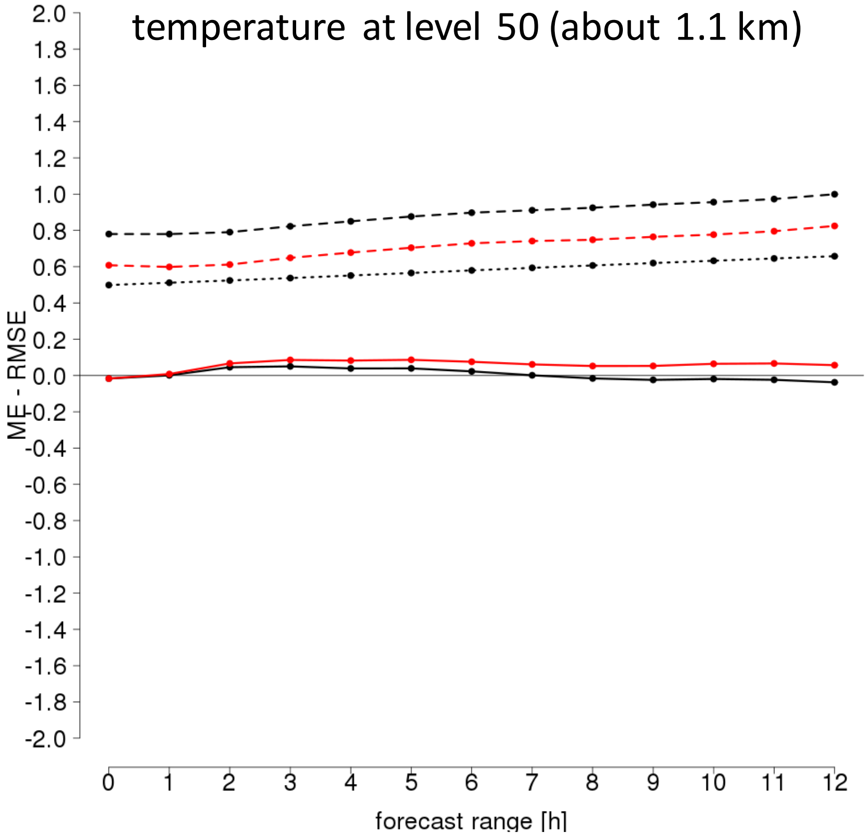
ME of the deterministic ICON-D2

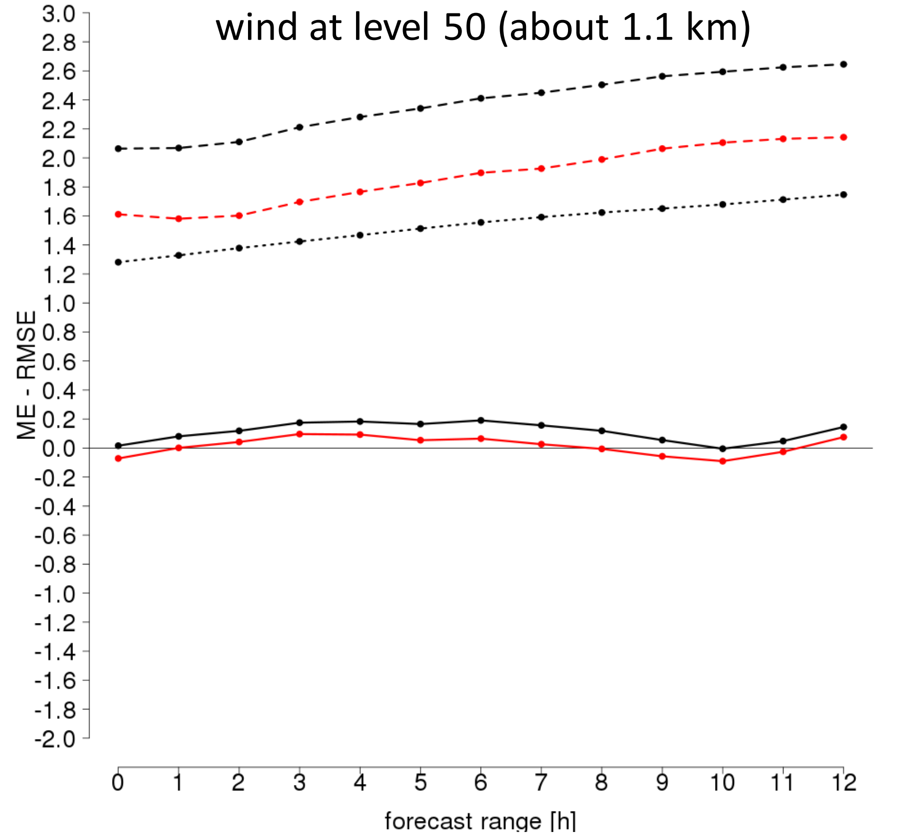
RMSE of the deterministic ICON-D2

ensemble spread

ICON-D2-EPS: scores against model deterministic analysis (in fact, +1h forecast, first guess of the KENDA cycle)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand





average ME of the members

average RMSE of the members

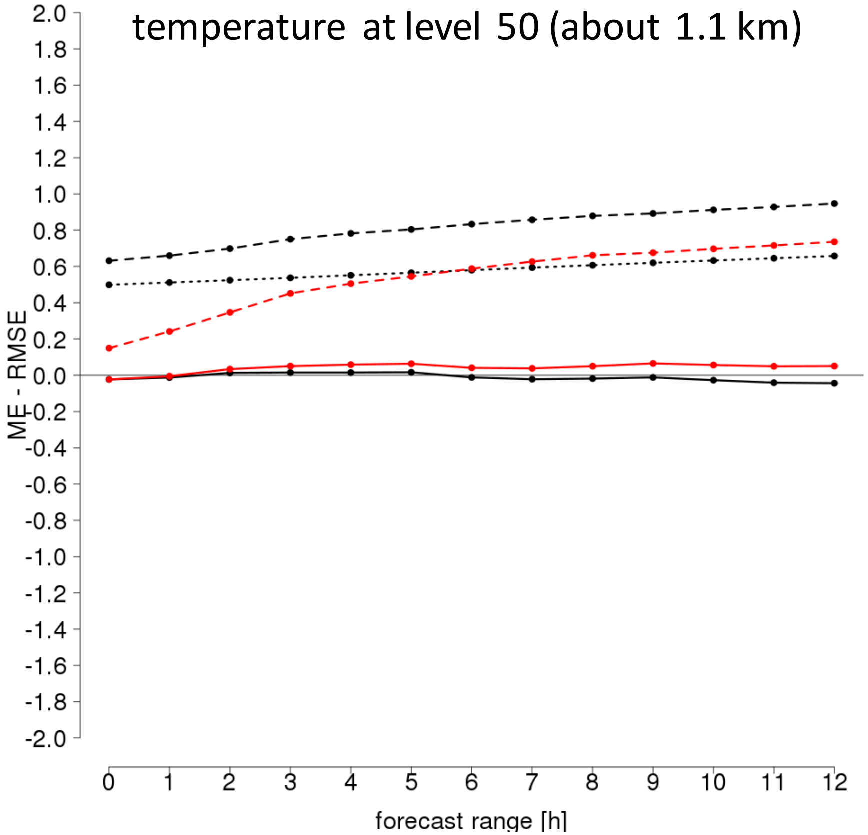
ME of the deterministic ICON-D2

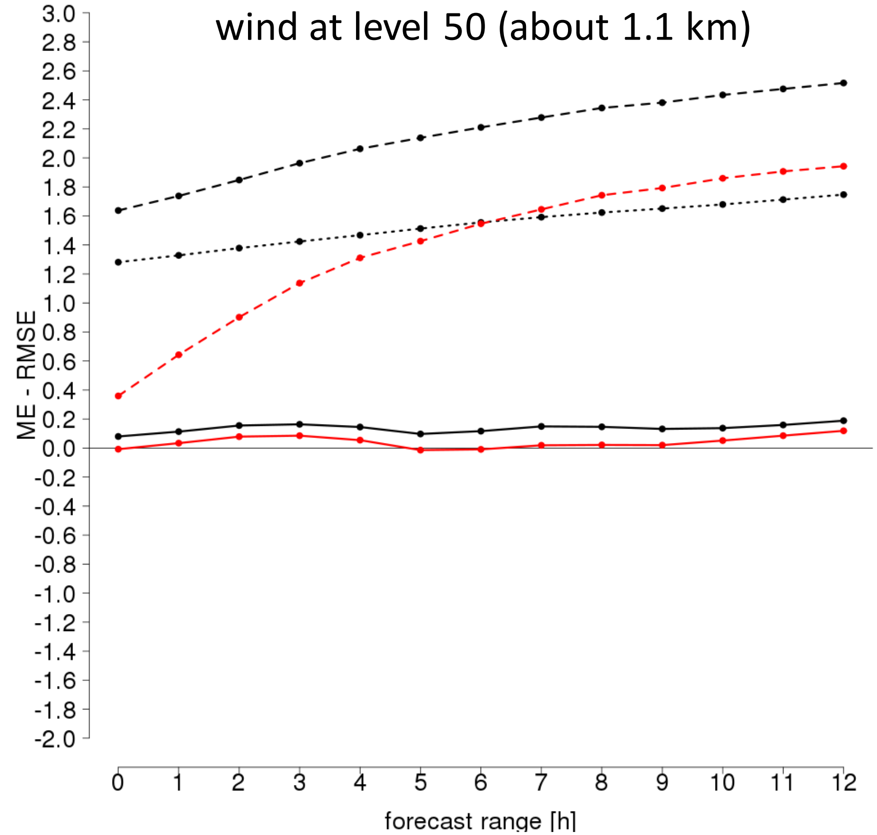
RMSE of the deterministic ICON-D2

ensemble spread

ICON-D2-EPS: scores against model deterministic analysis (really the analysis)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand





average ME of the members

average RMSE of the members

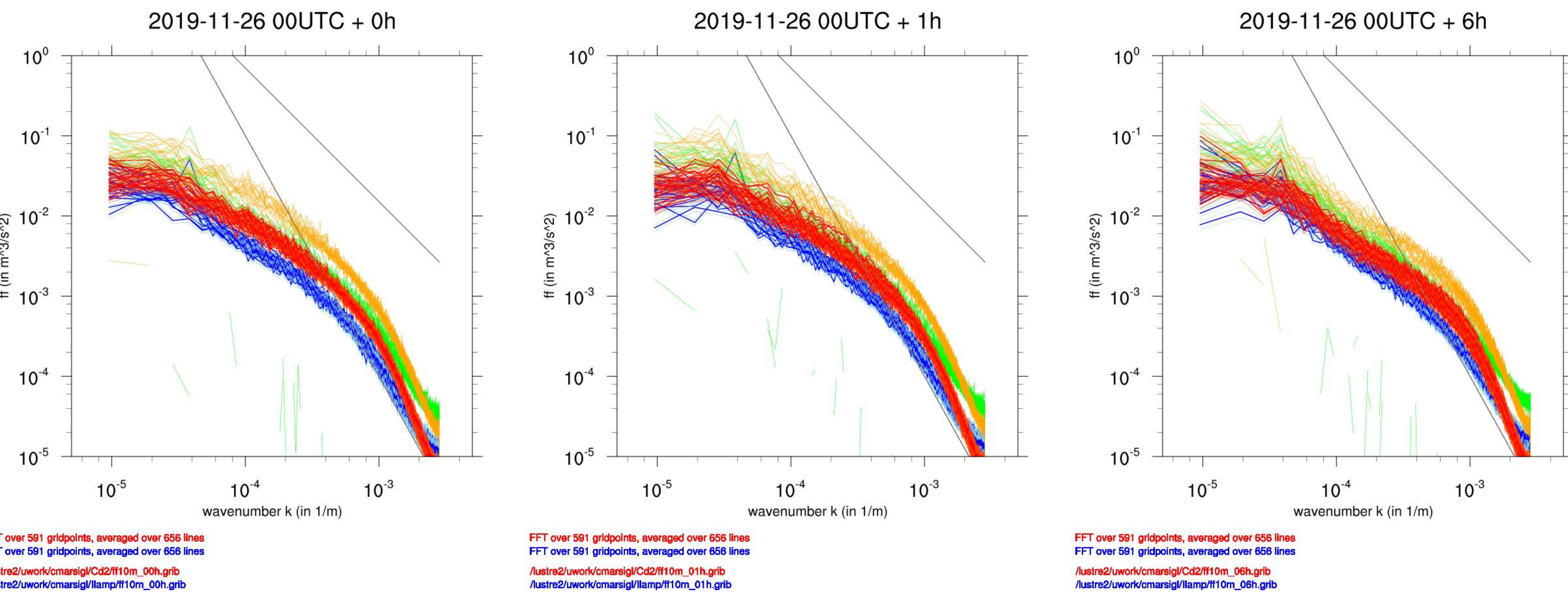
ME of the deterministic ICON-D2

RMSE of the deterministic ICON-D2

ensemble spread

Spectra of the perturbations, for each member

10m wind – 26/11/2019

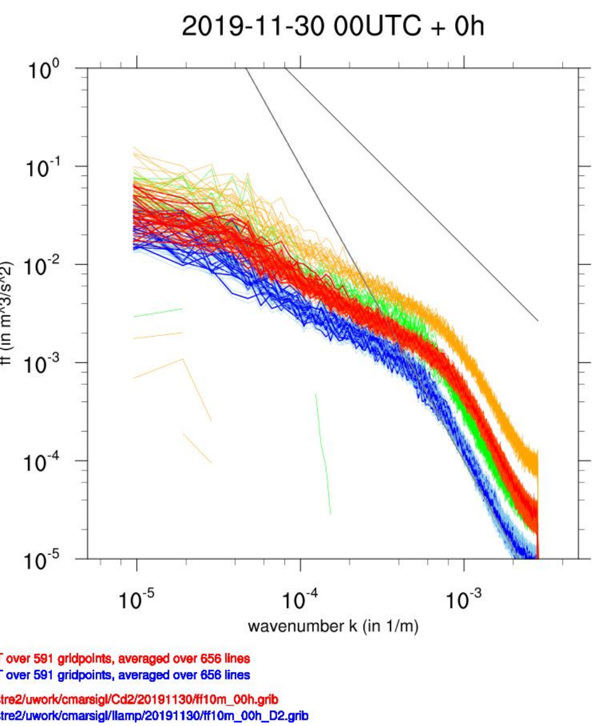


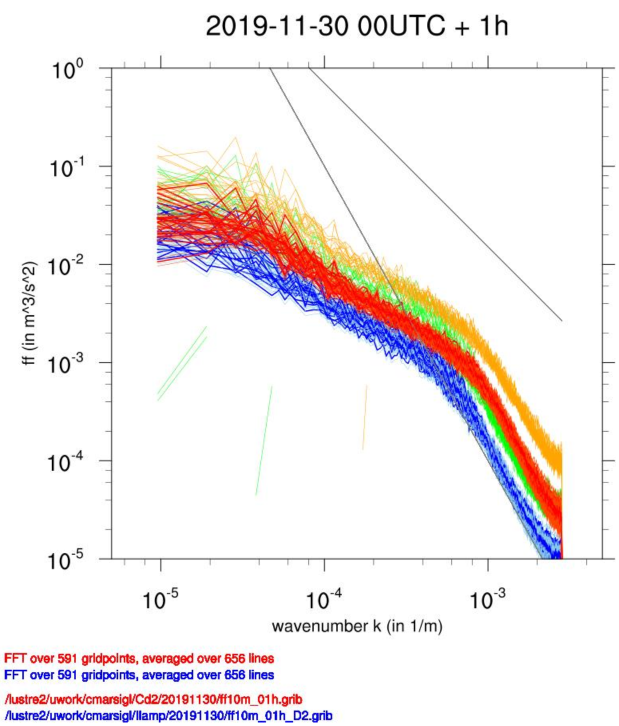
ICON-D2-EPS

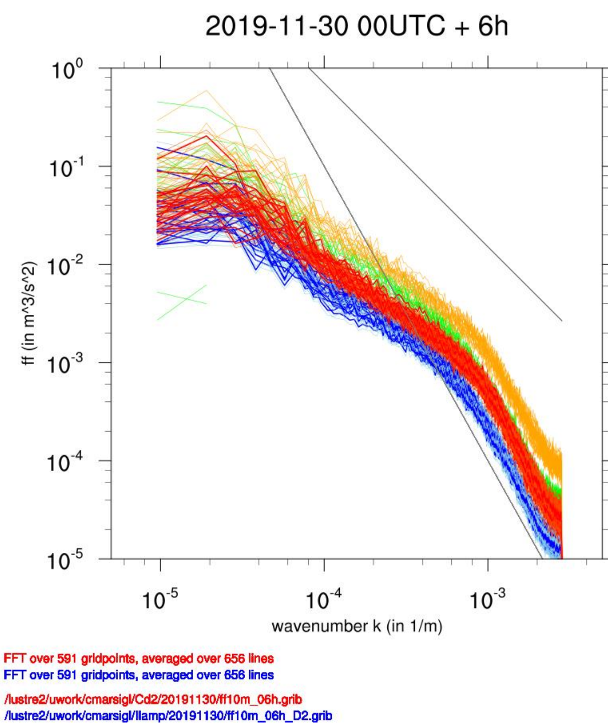
COSMO-D2-EPS

Spectra of the perturbations, for each member

10m wind – 30/11/2019





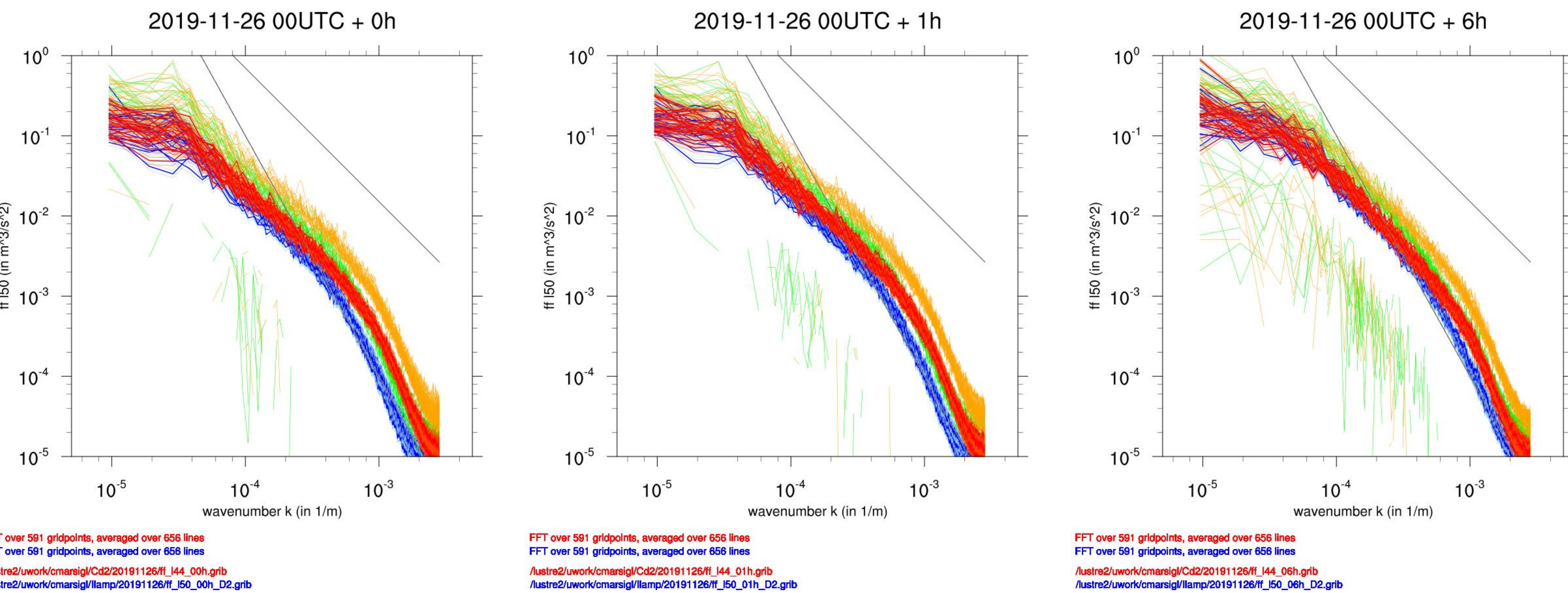


ICON-D2-EPS

COSMO-D2-EPS

Spectra of the perturbations, for each member

Wind on a model level, height ~ 1100 m – 30/11/2019



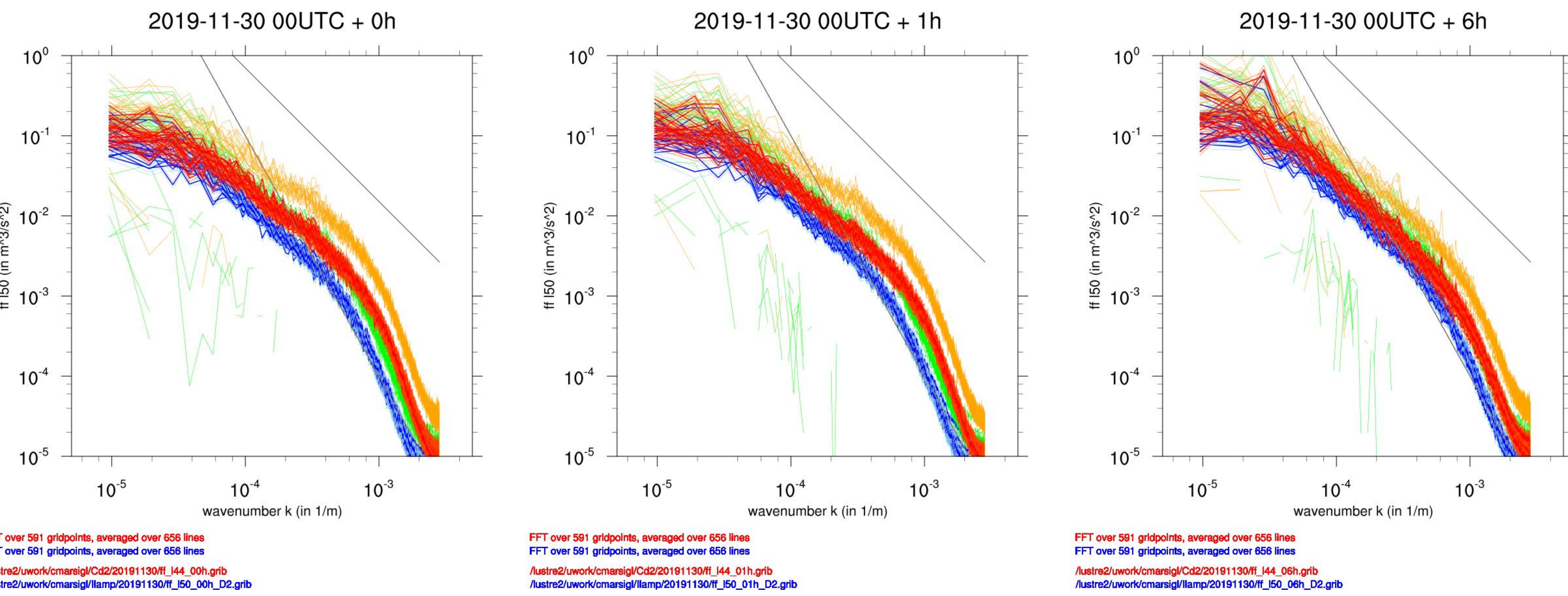
ICON-D2-EPS

COSMO-D2-EPS

Spectra of the perturbations, for each member

Wind on a model level, height ~ 1100 m – 30/11/2019

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



ICON-D2-EPS

COSMO-D2-EPS

Comments and future plans

- The ensemble has too little spread, when compared to the forecast error, computed against its own analysis. This happens from the beginning of the forecast, so Initial Conditions seem to have too little spread, both for near-surface wind and temperature and upper-air.
- This is seen in the wind also in comparison with COSMO-D2-EPS (spectra).
- Next step: it will be tested the impact of generating a different set of KENDA analyses, by performing an extra LETKF step where the inflation is increased. (These analysis will not be used in the successive KENDA cycle, only for ensemble initialisation). With this method, analyses better suitable for ensemble initialisation can be generated, without influencing the data assimilation. This can be extended to other aspects than the inflation.

Thank you for your attention!