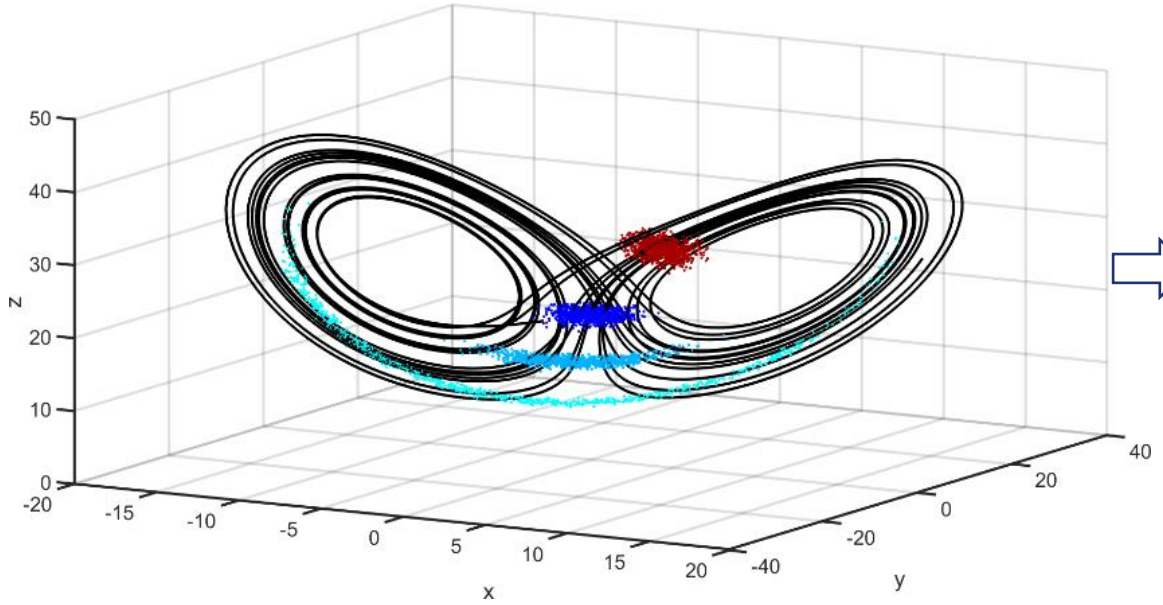
A 4D-Localized Particle Filter Method for Regional Data Assimilation at DWD

Nora Schenk, Anne Walter, Roland Potthast, …

Motivation for Particle Filters



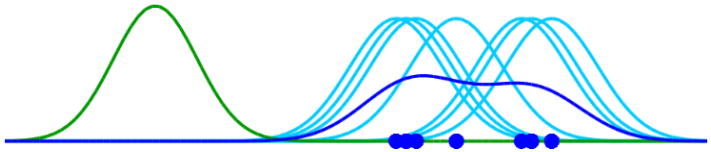
Development over time of a Gaussian distributed sample following the Lorenz 1963 model

In general background ensemble does not represent a Gaussian distribution

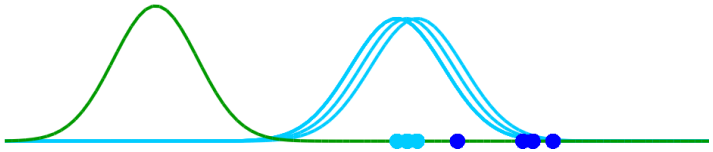
Localized Mixture Coefficients PF (LMCPF)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

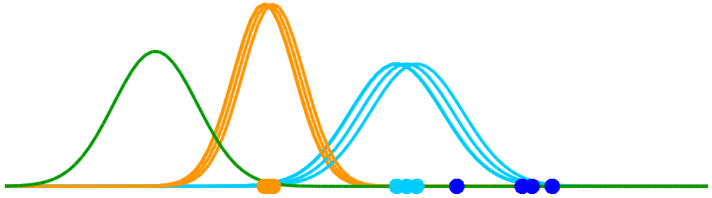
1 Background



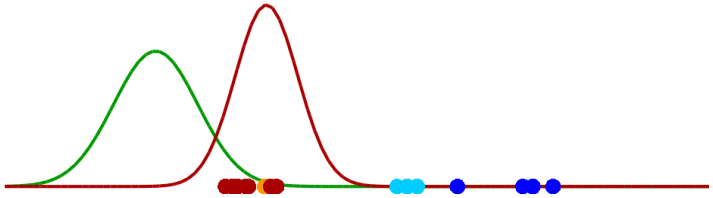
2 Resampling



3 Shift of Particles

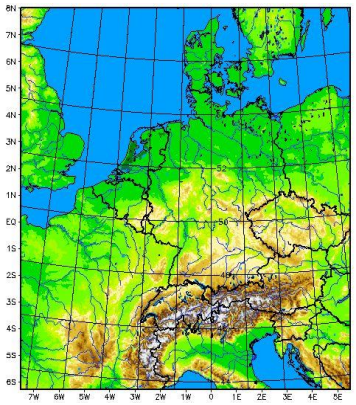


4 Gaussian Rejuvenation



KENDA – Kilometre-scale Ensemble DA

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



https://www.dwd.de/

ensemble
(size = 40)

ICON-D2

o-fg

fg

LETKF
(Hunt et al. 2007)

ana

ICON-D2

o-fg

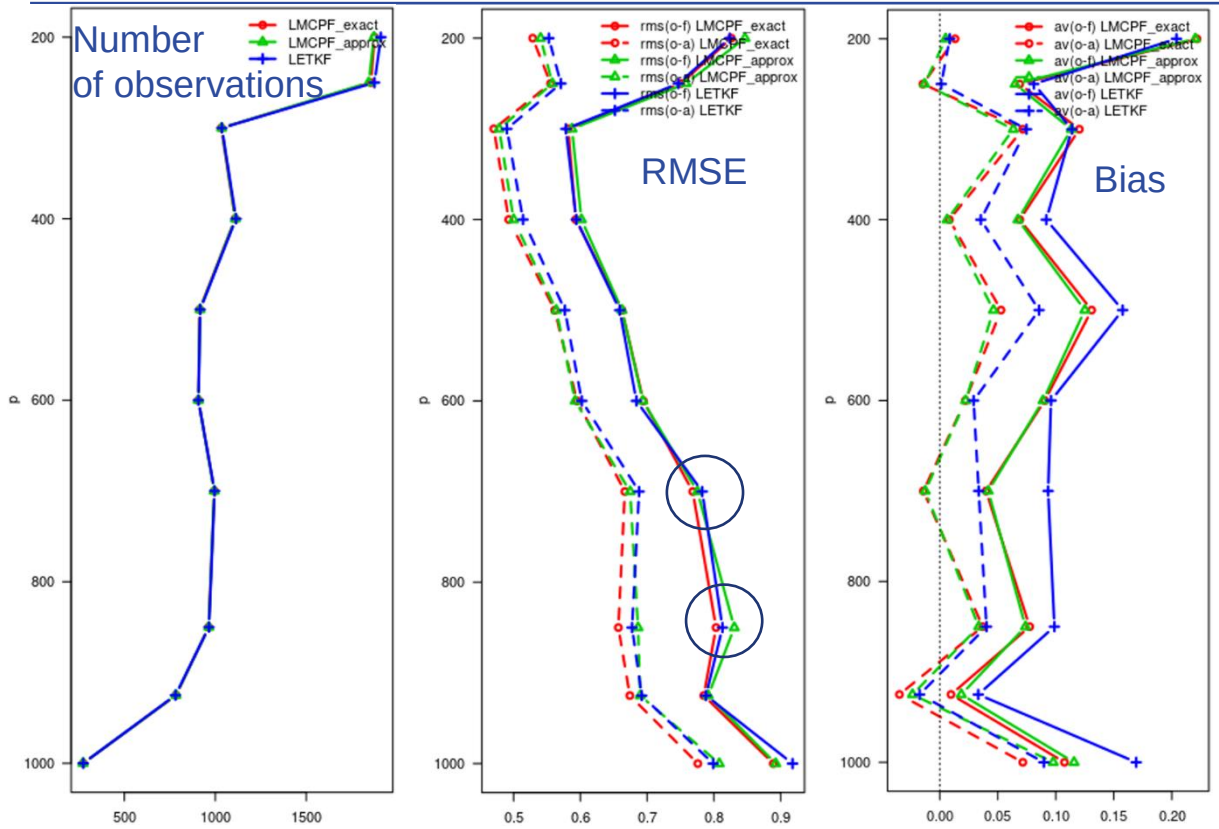
fg

Schraff et al. (2016)

LMCPF in KENDA for ICON-D2

- Period: June 01, 2021 – June 02, 2021
- Model: ICON-D2
- 40 ensemble member
- Observation systems
  - Conventional data (AIREPs, TEMPs, …)
  - Radar data
  - SYNOP data (T2M and RH2M)
- LMCPF method: shift parameter $\kappa = 2.5$
- Comparison of ensemble means

RMSE for AIREPs (Temperature)

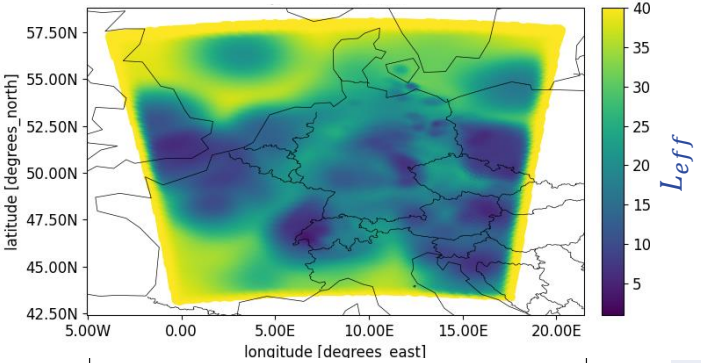


Period:
June 01, 2021 12 UTC –
June 02, 2021 00 UTC

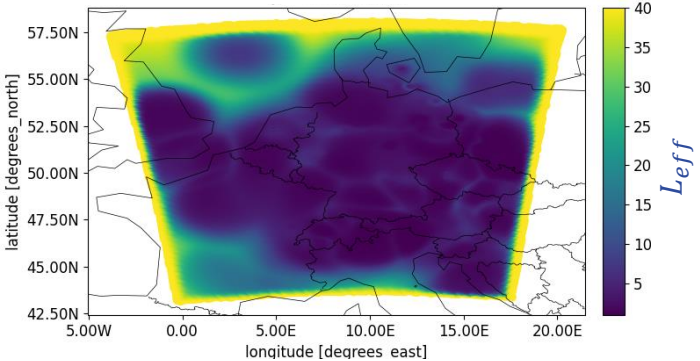
LMCPF (exact weights)
LMCPF (approx. weights)
LETKF

obs-first guess ——
obs-analysis - - - -

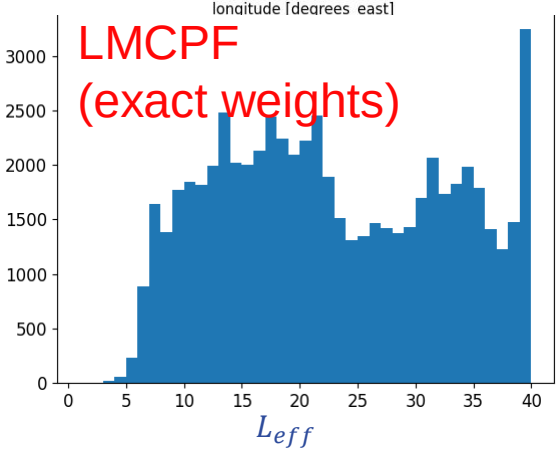
Effective Ensemble Size L_{eff} – 850hPa



2021/06/02
00 UTC



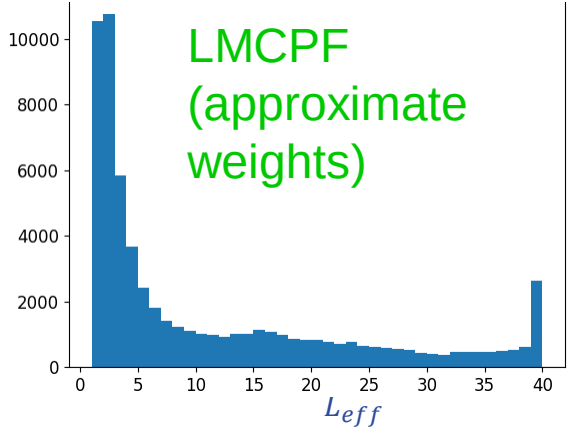
LMCPF
(exact weights)



$L_{eff} \to 1$
filter degeneracy

$L_{eff} \to L$
uniform weights

LMCPF
(approximate
weights)



Summary

- Particle filters as the LMCPF aim to improve the numerical weather prediction in a non-Gaussian setting
- In the KENDA framework for regional NWP, the LMCPF is a 4D-Particle Filter method with 4D background error covariance matrices
- With the application of exact particle weights, the LMCPF is much improved and the effective ensemble size is increased

Outlook:

- Further experiments for ICON-D2 with the LMCPF with exact weights and different values for κ
- Further analysis of background distributions in ICON-D2

Many thanks for your attention!
Questions?

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Literature

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