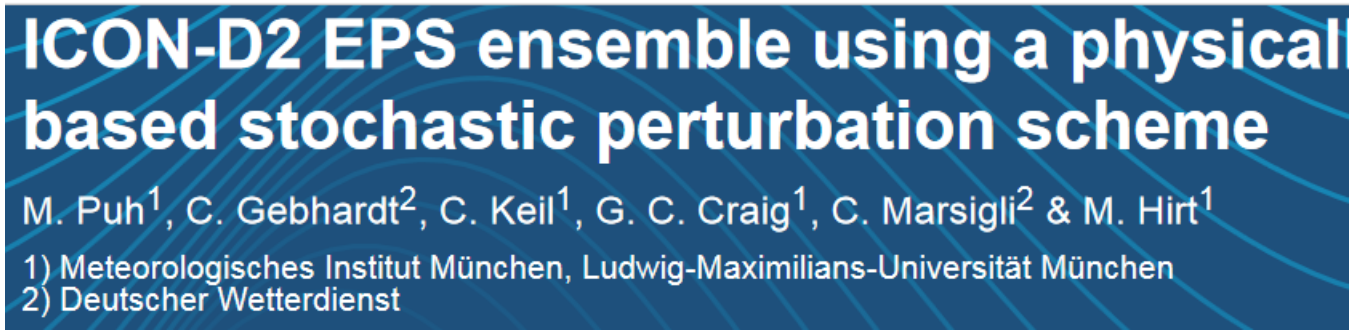
Test of PSP2 in ICON-D2-EPS

C. Gebhardt, C. Marsigli (DWD)

M. Puh, C. Keil, M. Hirt, G. Craig (LMU)

See Poster P06



Physically based stochastic perturbations for boundary layer turbulence : PSP (Kober and Craig, 2016)

WAVES TO WEATHER

$$\left(\frac{\partial \phi}{\partial t}\right)_{all} = \frac{\partial \phi}{\partial t} + \alpha \cdot \eta \cdot \sqrt{\overline{\phi'^2}}$$

Stochastic perturbations

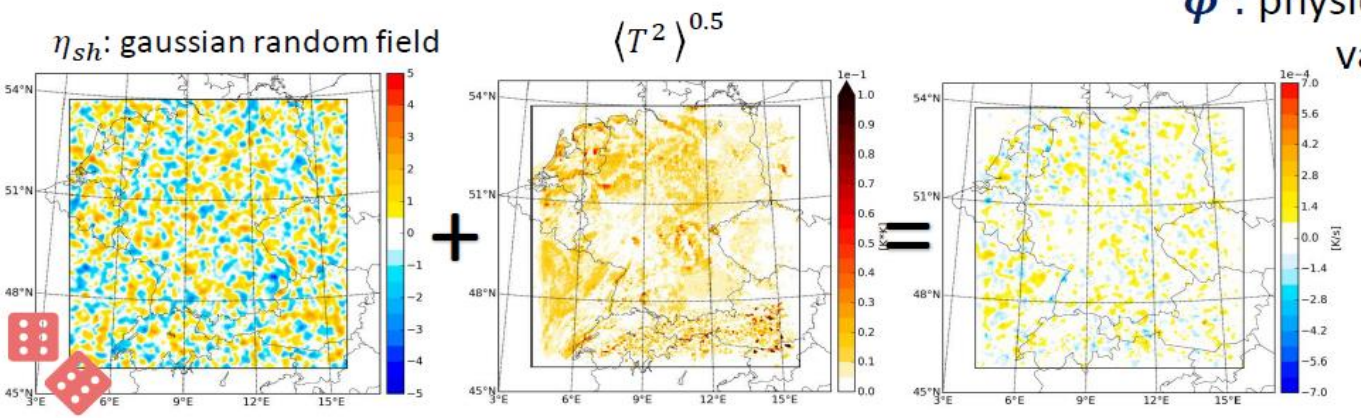
ϕ ={T, q, w}

$\eta(t, \sigma)$: Random field , regenerated every 10 min with spatial correlation σ

α: perturbation ampl., scaling factors

ϕ': physical scaling/subgrid-scale variance of variable ϕ

η_{sh}: gaussian random field



(Kober and Craig, 2016)

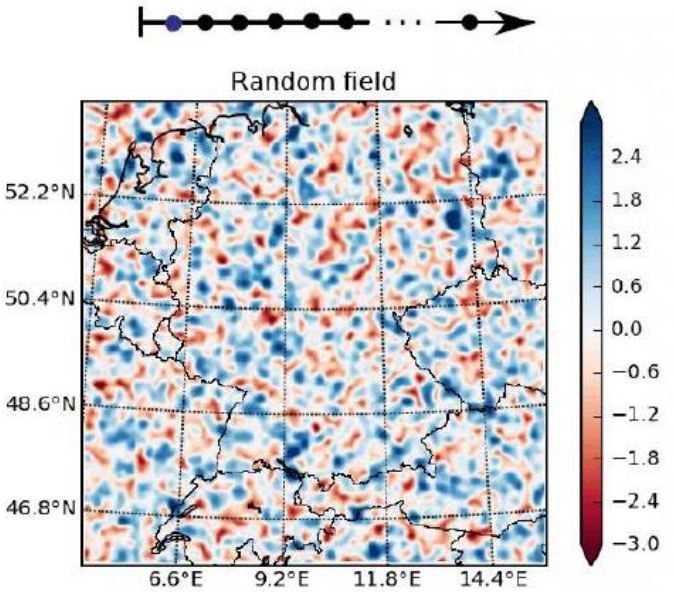
Modifications for improved physical consistency → PSP2

(Hirt et al., 2019, MWR)

- **Autoregressive Process**: Continously modifying η at every time step, but temporally correlated:

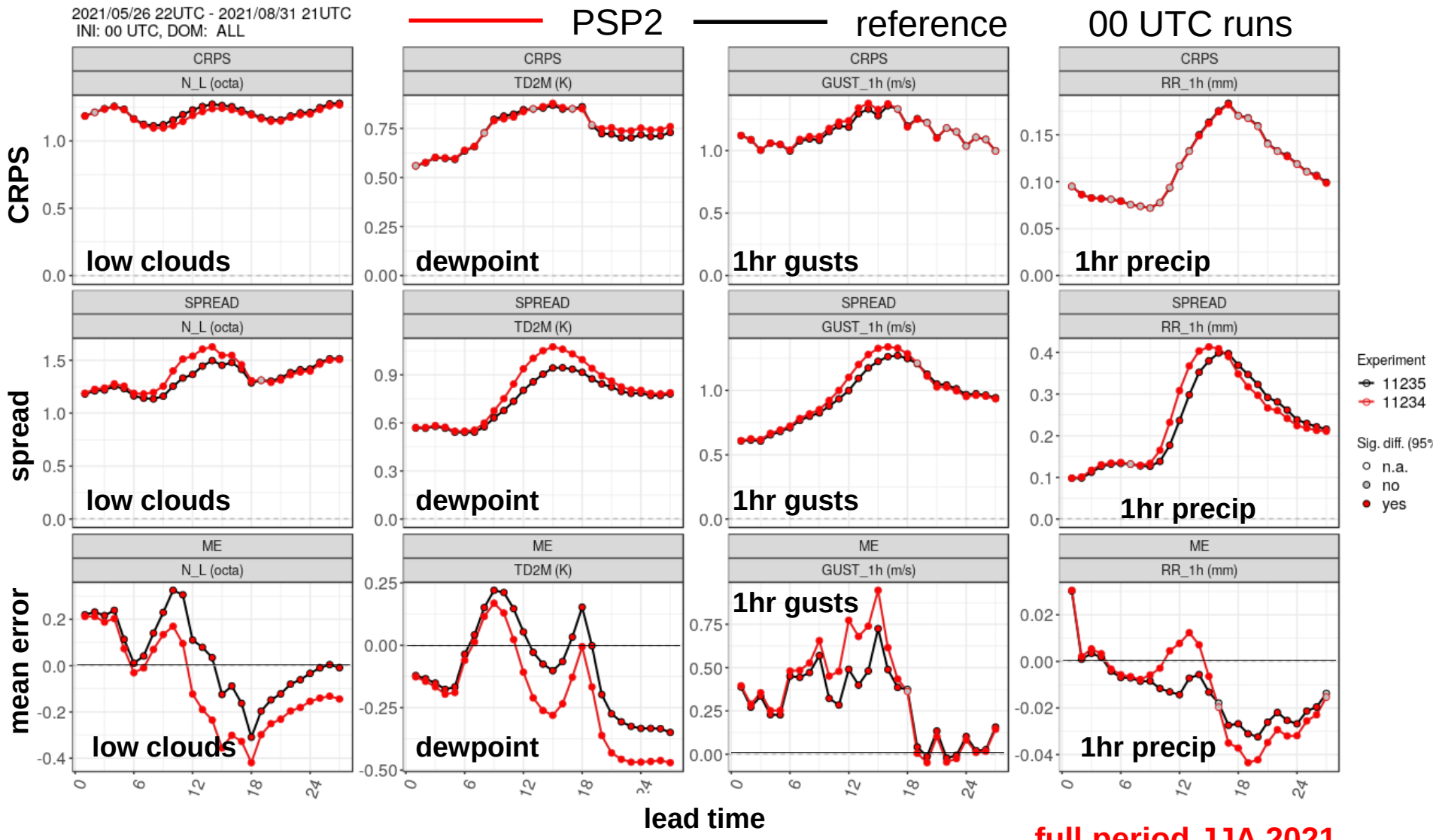
$$\eta_t = \sigma_t \cdot \eta_{t-1} + \epsilon_t$$

- Constraining the perturbations to the boundary layer (HPBLcut)
  → Reduce impact of perturbations at night
  →Scheme developed for buoyant turbulence, not shear (vertically correlated perturbations)



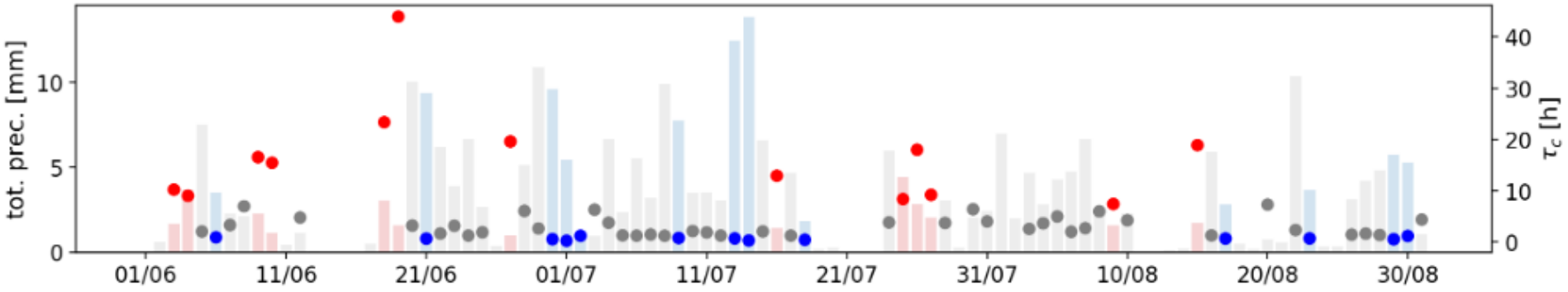
Physically based stochastic perturbations for boundary layer turbulence (PSP2)

- cooperation with Ludwig-Maximilians-Universität in Munich (LMU)
- @COSMO GM 2021:
  - BACY tests for a short period in August 2020 with ICON-D2-EPS
  - Test run from May 26th to August 1st 2021 at DWD
- New @ICCARUS 2022
  - Increased period to August 31st 2021
  - Evaluation conditional on weak and strong forcing
  - Very first steps towards dealing with degradation for some variables
  - Next steps



full period JJA 2021

- Synoptic forcing classification using the **convective adjustment timescale** τ_c, an indicator of predictability of convective precipitation (Keil et al., 2014):
  - Upper 20% (13) of daily averaged τ_c: **weak forcing**.
  - Lower 20% (13) of daily averaged τ_c: **strong forcing**.



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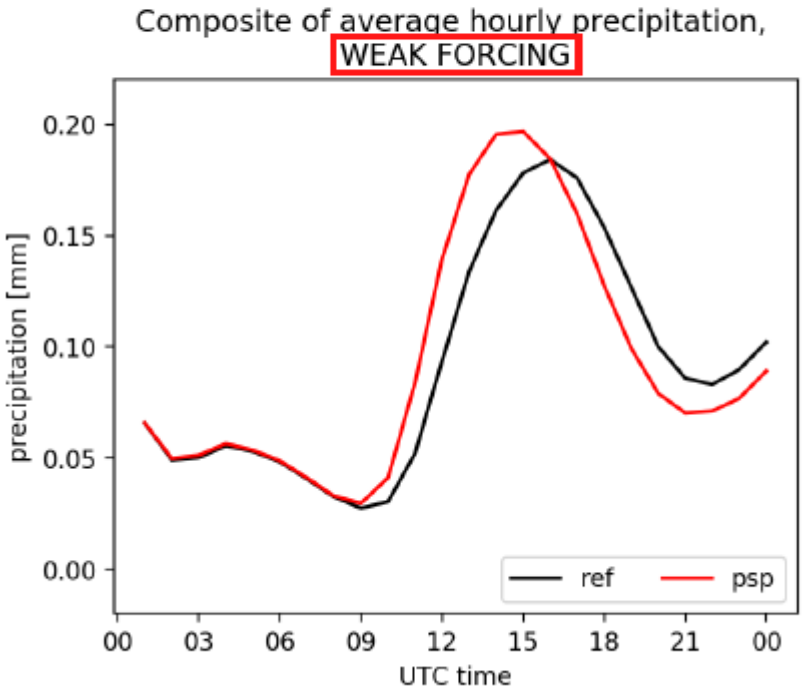
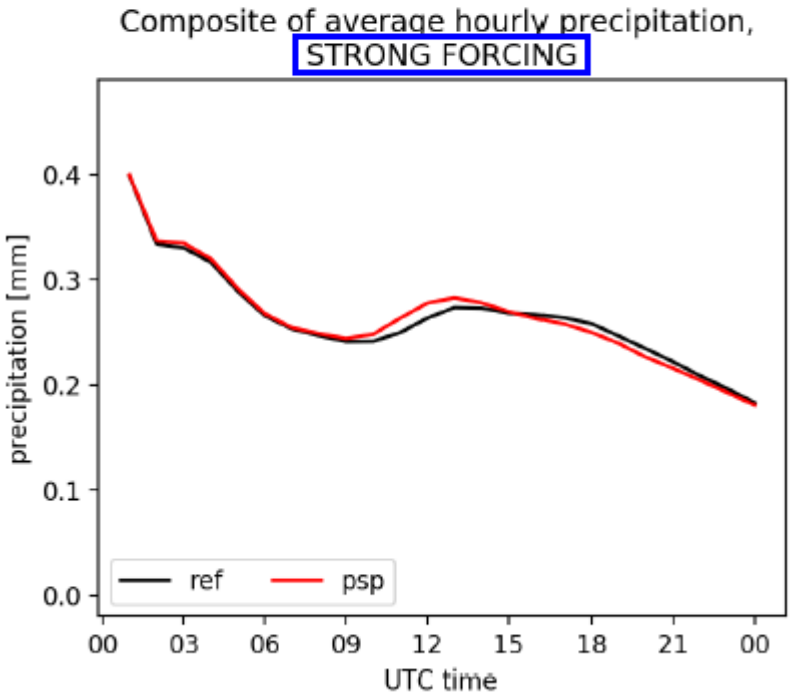
upper 20%
(13 days)



lower 20%
(13 days)



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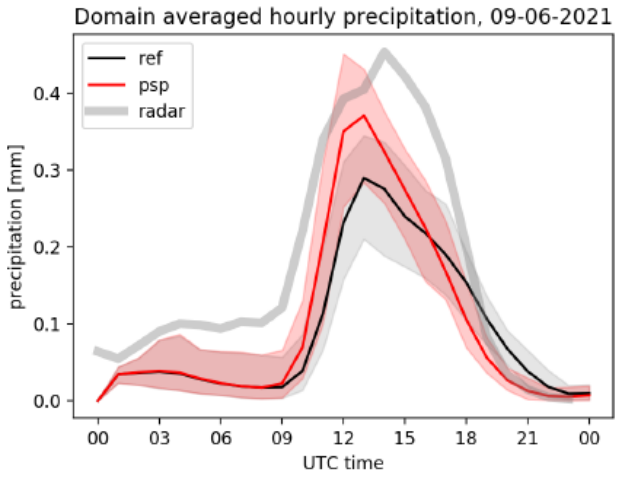
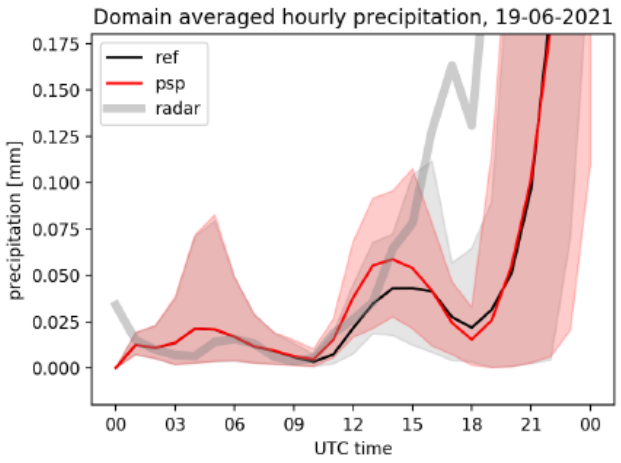
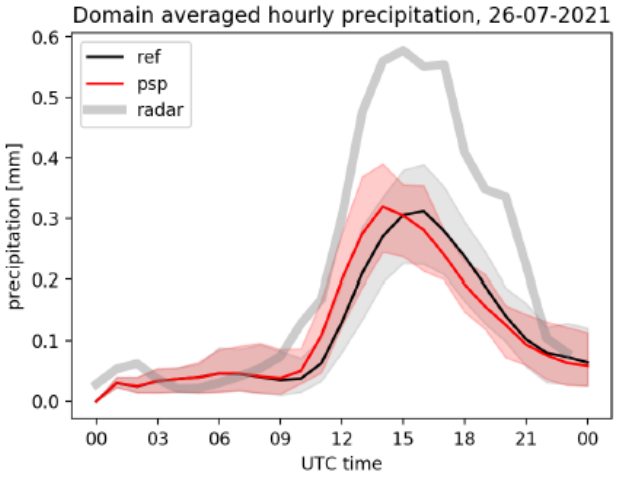
Selected cases weak forcing







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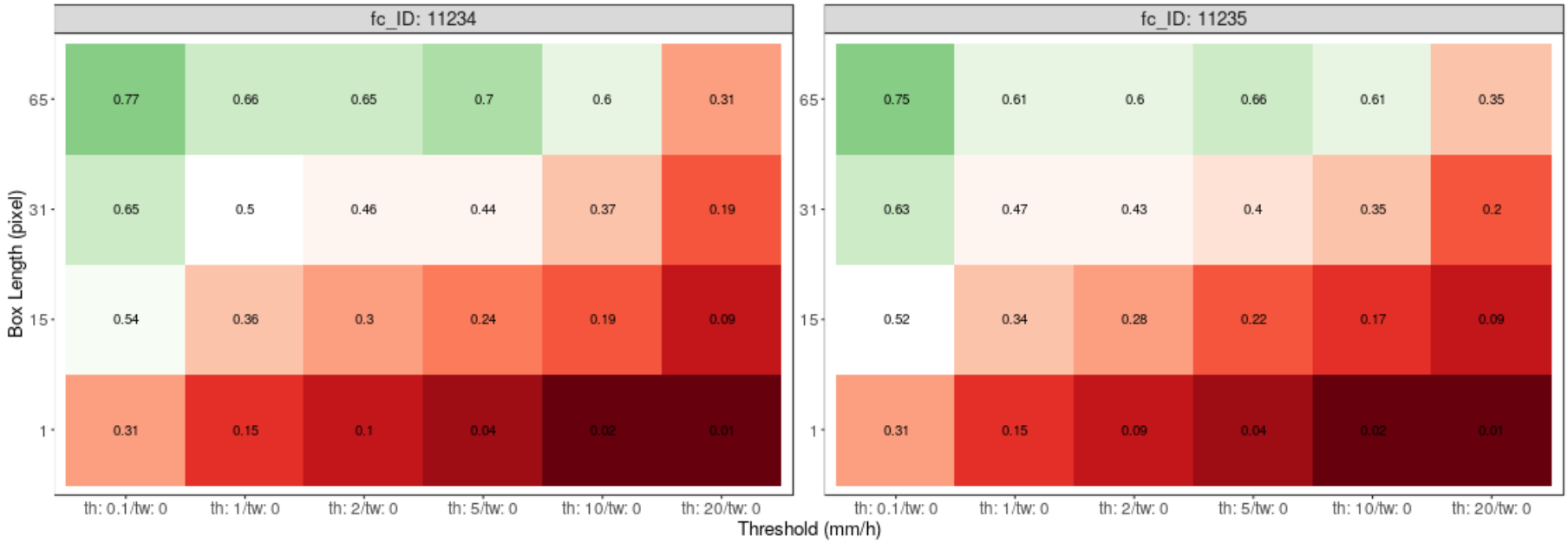
FSS of precipitation using radar estimates

weakly forced period June 1-17

Summary overlead times

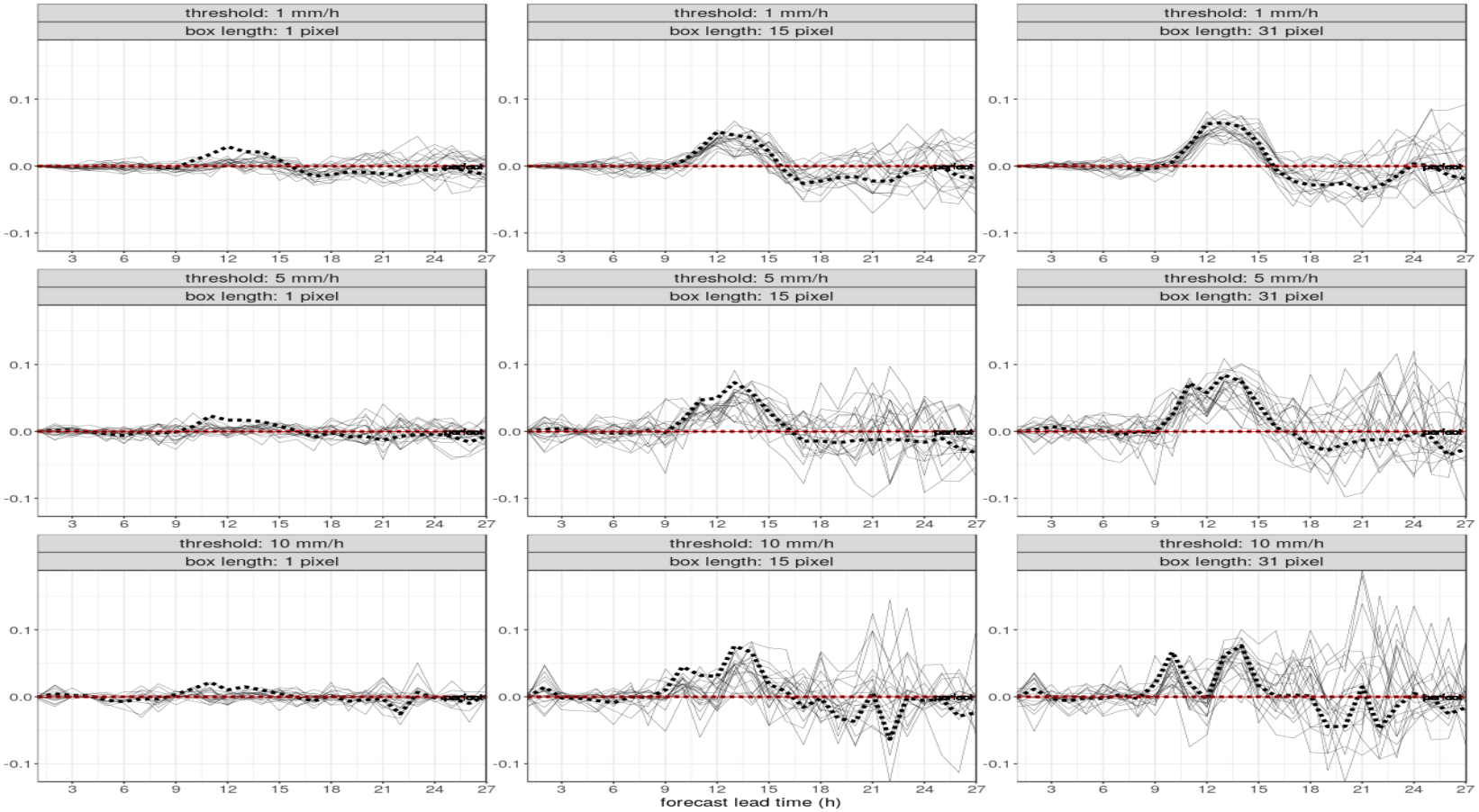


PSP2 **reference**

FSS of precipitation using radar estimates

weakly forced period June 1-17

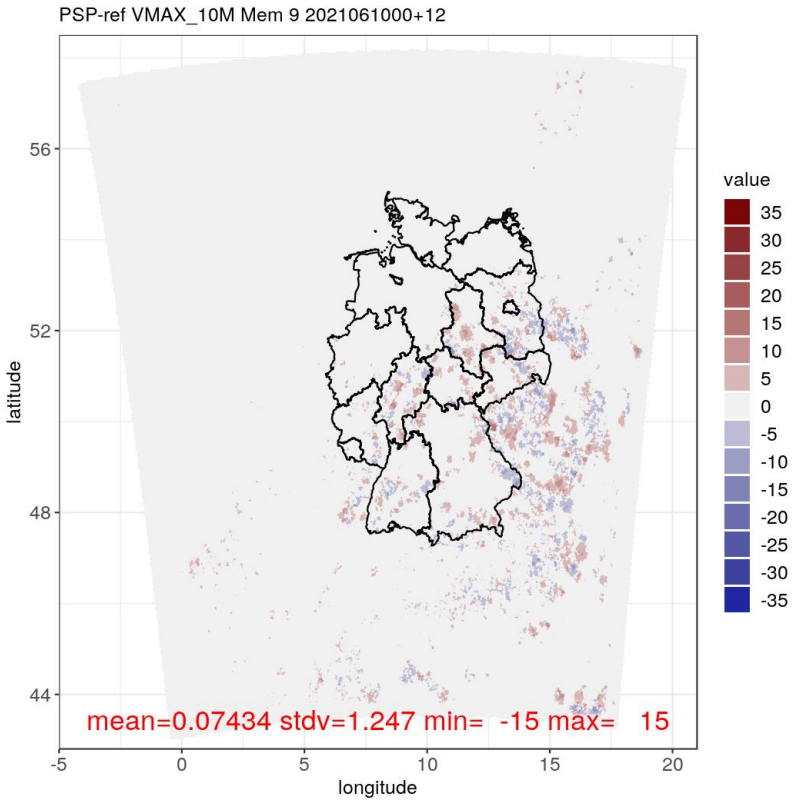
Diff. PSP2 - reference

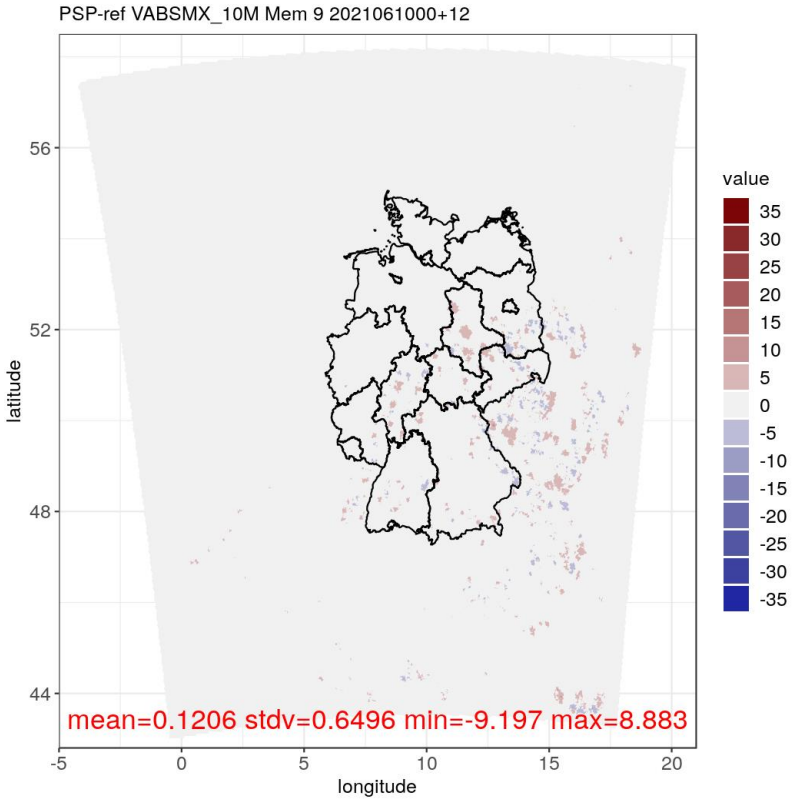


Effects of PSP2 to work on

➔ Positive Bias in 10m wind gusts

PSP2 increases 10m wind variability / feedback with gust diagnostics

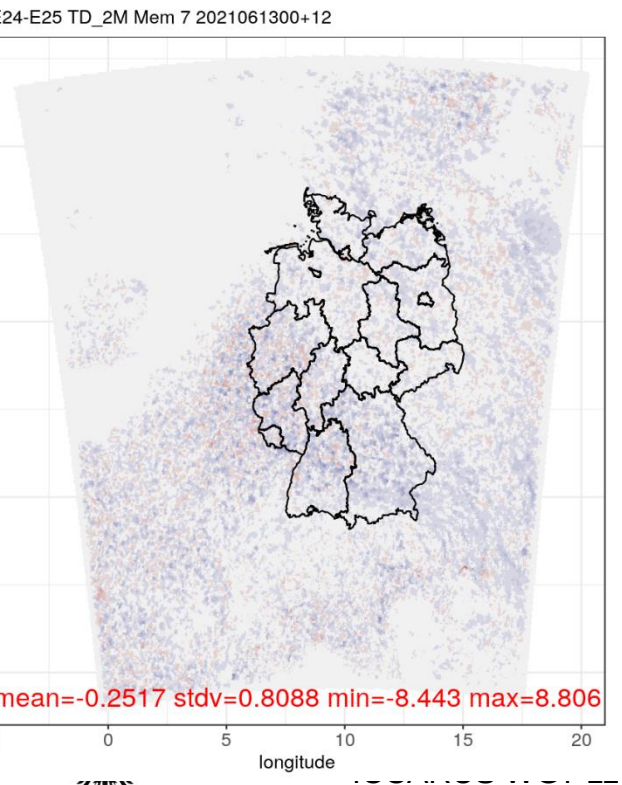




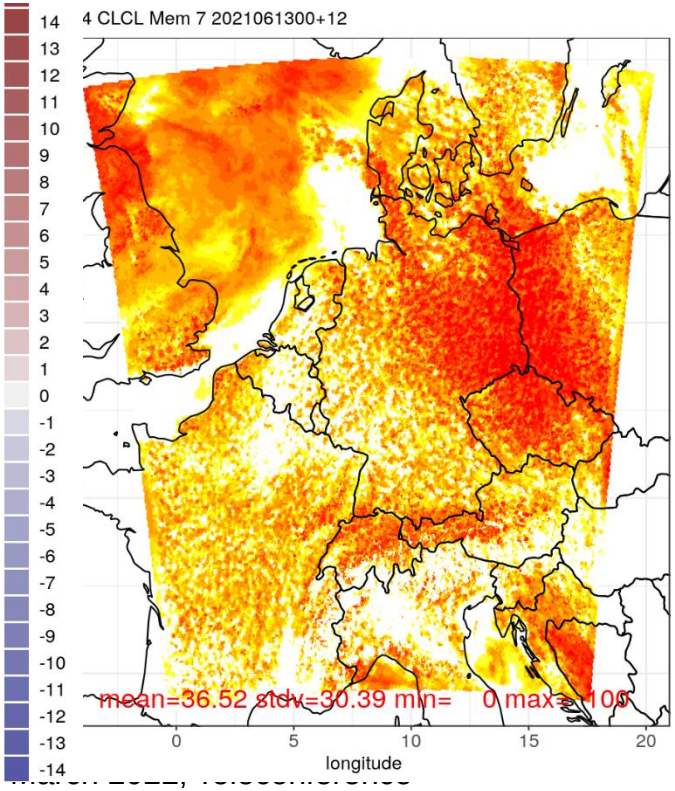
Effects of PSP2 to work on

➔ Noisy low cloud fields & TD_2M bias → reduce vertical extent of pert.
use online PBL diagnostics ?

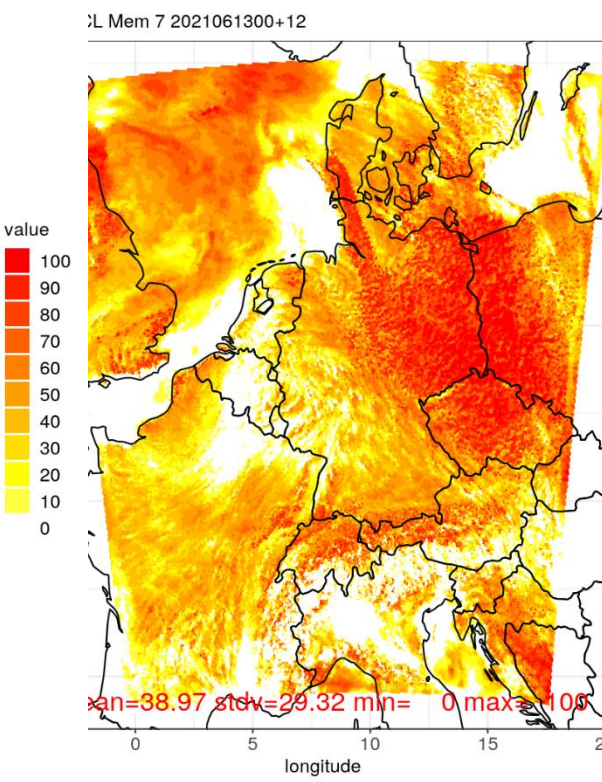
TD_2M PSP2-reference



low clouds PSP2



low clouds reference



Next steps

- make tests to further investigate deficiencies
- make tests closer to operational setting
  (i.e. initial and boundary conditions)
- further evaluations/verifications, i.e. FSS based on quantile threshold
- paper in preparation
- long-term goal: implement a version which is a candidate for operational implementation in ICON-D2-EPS