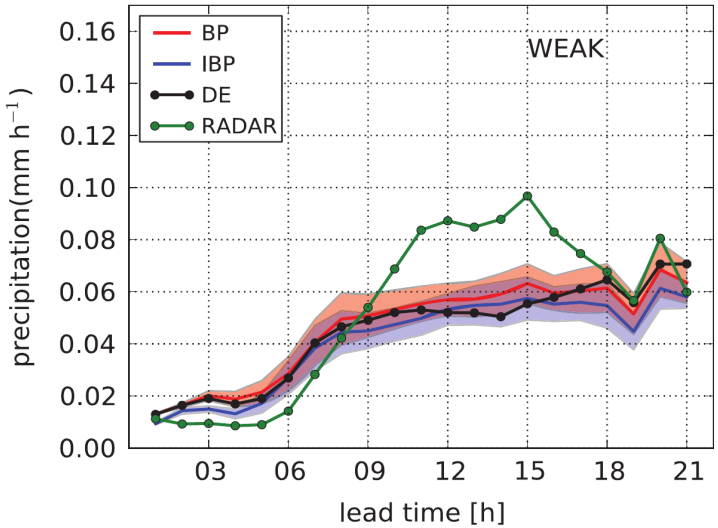
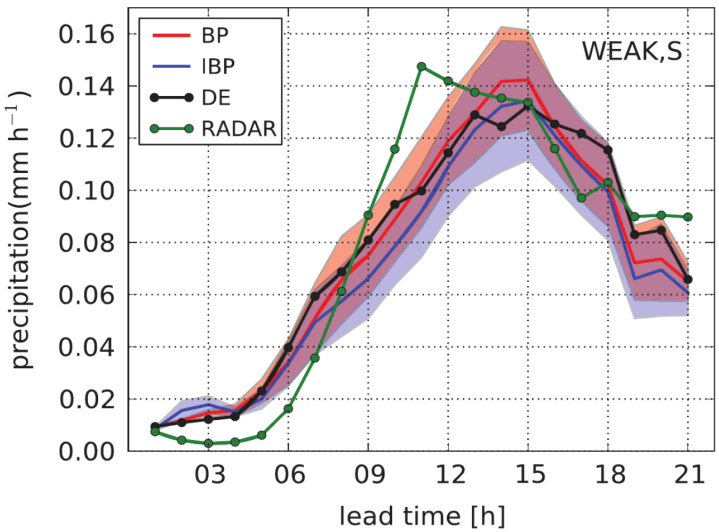
# Precipitation sensitivity on land-surface heterogeneities

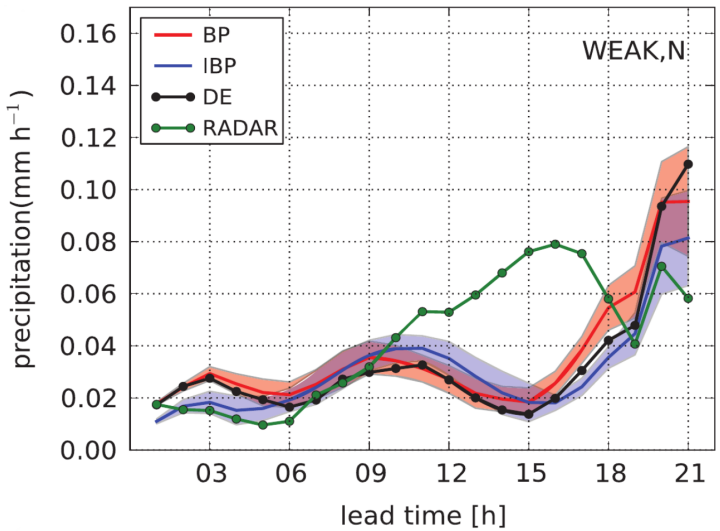
Florian Baur, Christian Keil

# Motivation

- Systematic underestimation of precipitation during weak synoptic forcing in COSMO (Kühnlein et al. 2014)
- Lack of small scale variability?



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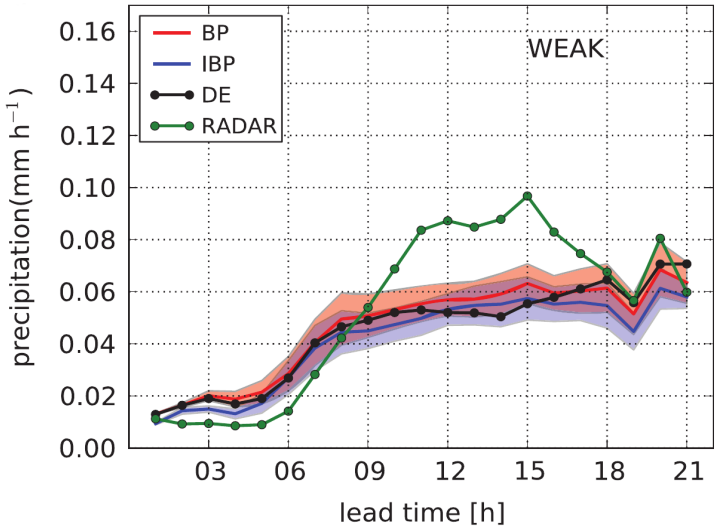


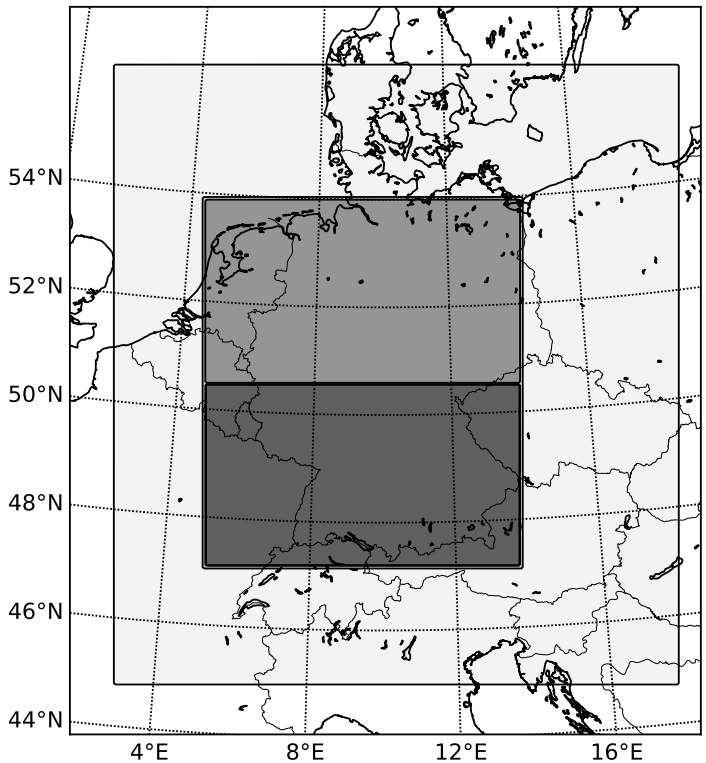

## Questions

- Can initial soil moisture perturbations cause **relevant variability** in precipitation forecast?
- Are there **regional differences** in the impact of initial soil moisture perturbations?
- Is the spatial variability caused by initial soil moisture perturbations **regime dependent**?

# Experimental Setup

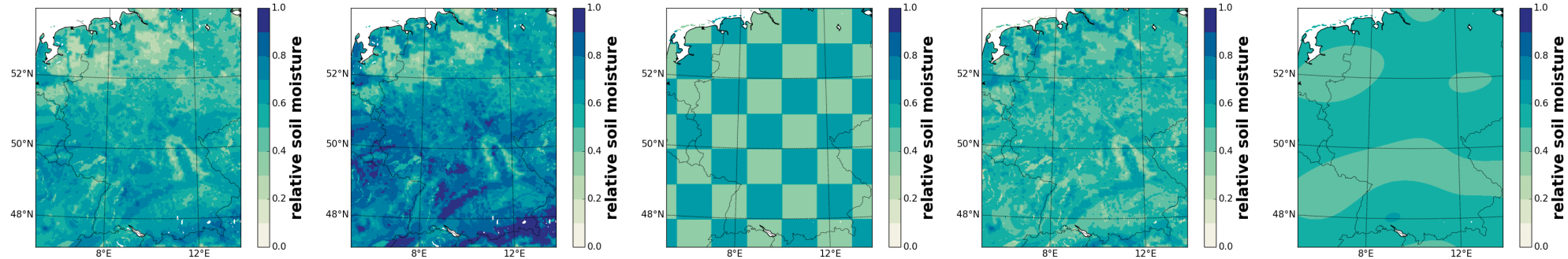
synoptic situation: weak forcing $\Leftrightarrow$ moderate forcing
kind of inhomogeneity: soil moisture
observation data: RADOLAN radar observations

- COSMO-DE Version 5.3
- 2 Moment Microphysics Scheme
- initial time: 00 UTC
- 1 hourly COSMO-EU analysis data
- explicit perturbation of initial soil moisture conditions



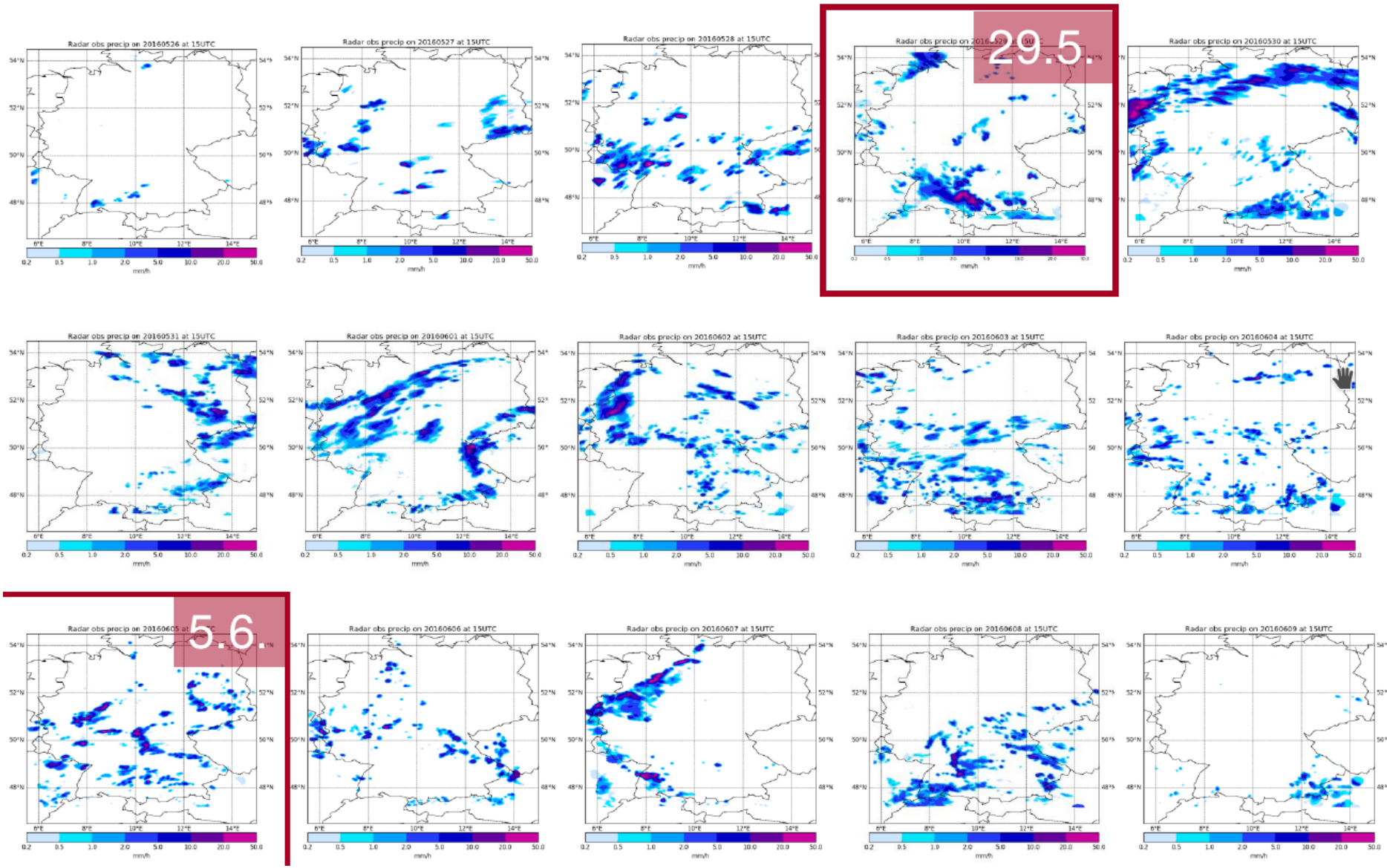
# Experimental Setup

| Experiments | patch sizes (grid cells) | relative soil moisture |
|---|---|---|
| B | entire field | $0.75\ w_{so}$ $(\overline{w_{so}} \approx 0.38)$<br>$1.25\ w_{so}$ $(\overline{w_{so}} \approx 0.64)$ |
| C25 | 10, 20, 30, 40, 50, 60, 70, 80 | $\overline{w_{so}} \pm 25\%$ |
| LP / HP | 5, 10, 20 | High-pass / Low-pass filter |
| BP | 10 km, 50 km, 100 km | Band-pass filter |

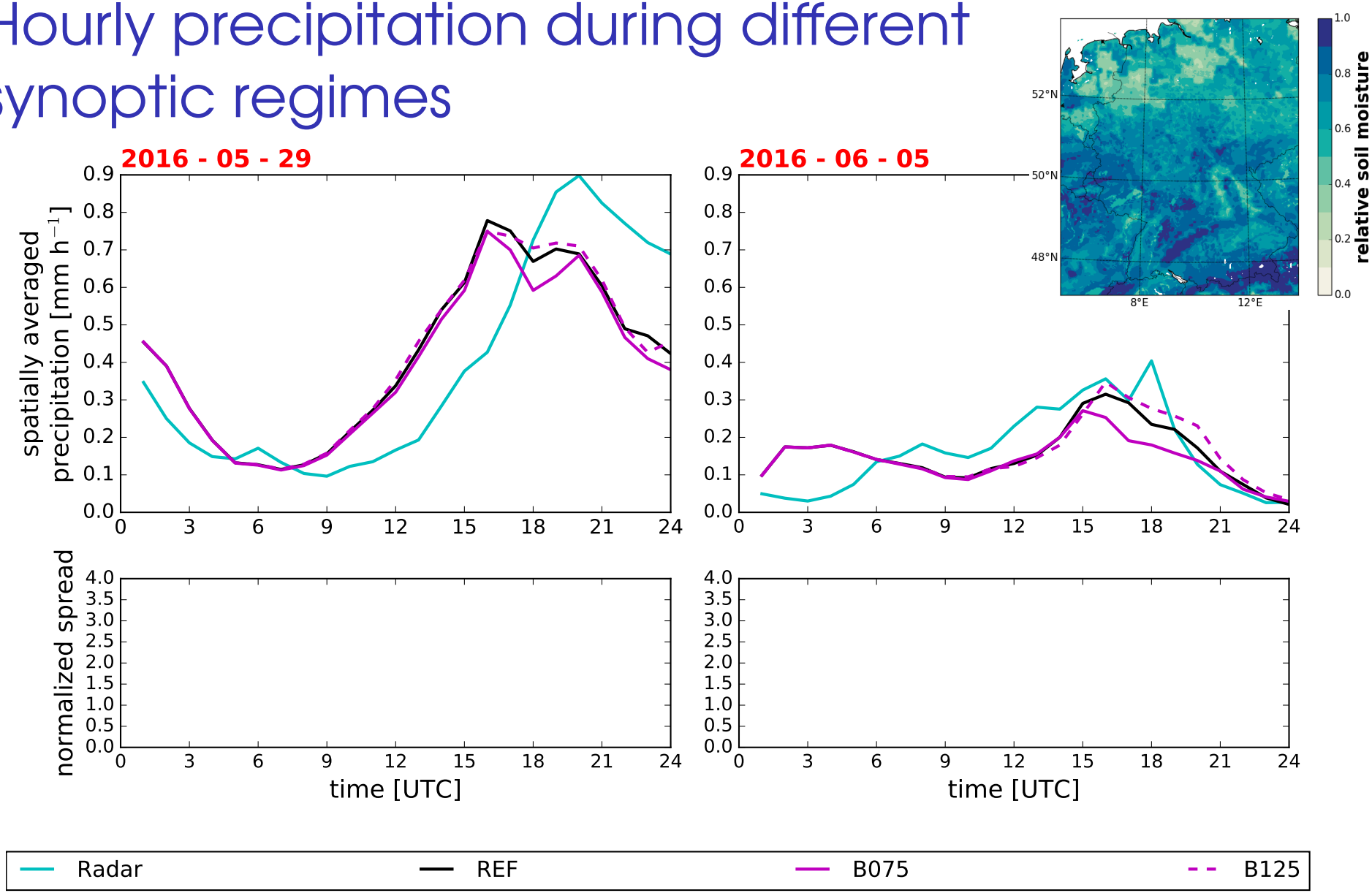



Reference $\overline{w_{so}} \approx 0.51$ | B125 $\overline{w_{so}} \approx 0.64$ | C25_40 $\overline{w_{so}} \approx 0.51$ | HP10 $\overline{w_{so}} \approx 0.51$ | BP50 $\overline{w_{so}} \approx 0.51$

# HIW period: 26.May – 09.June 2016: Obs. 15 UTC



# Hourly precipitation during different synoptic regimes



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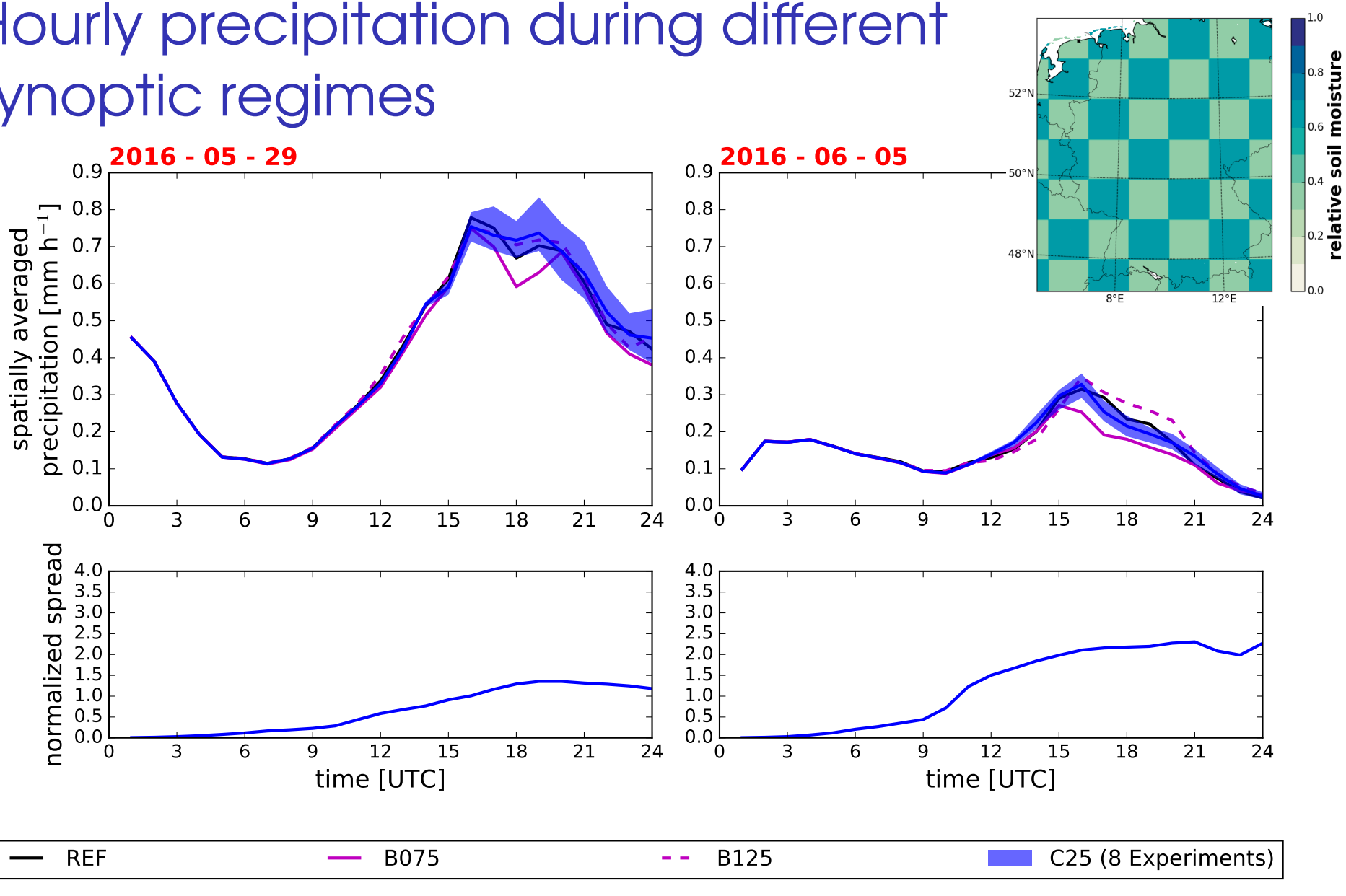

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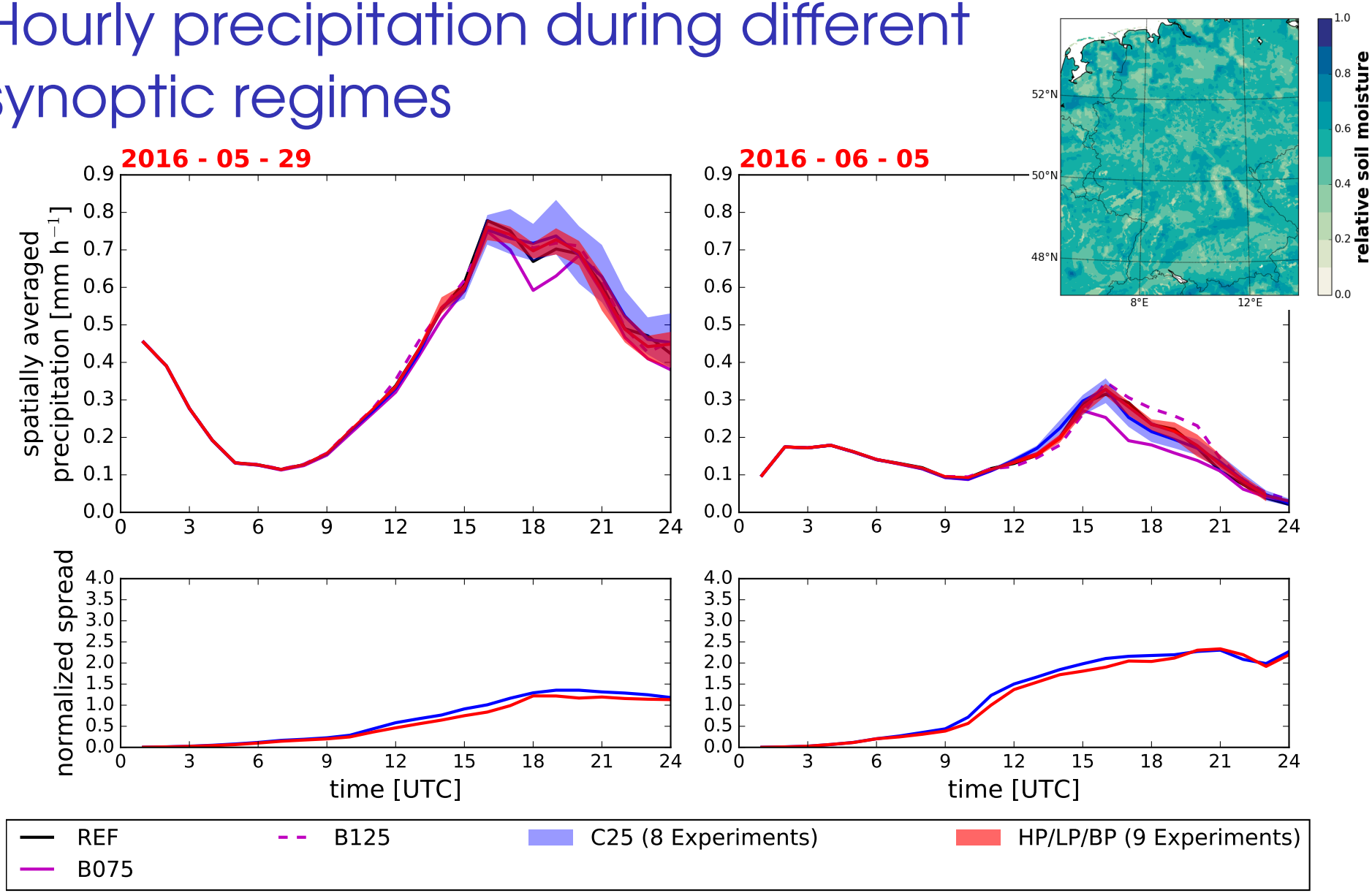

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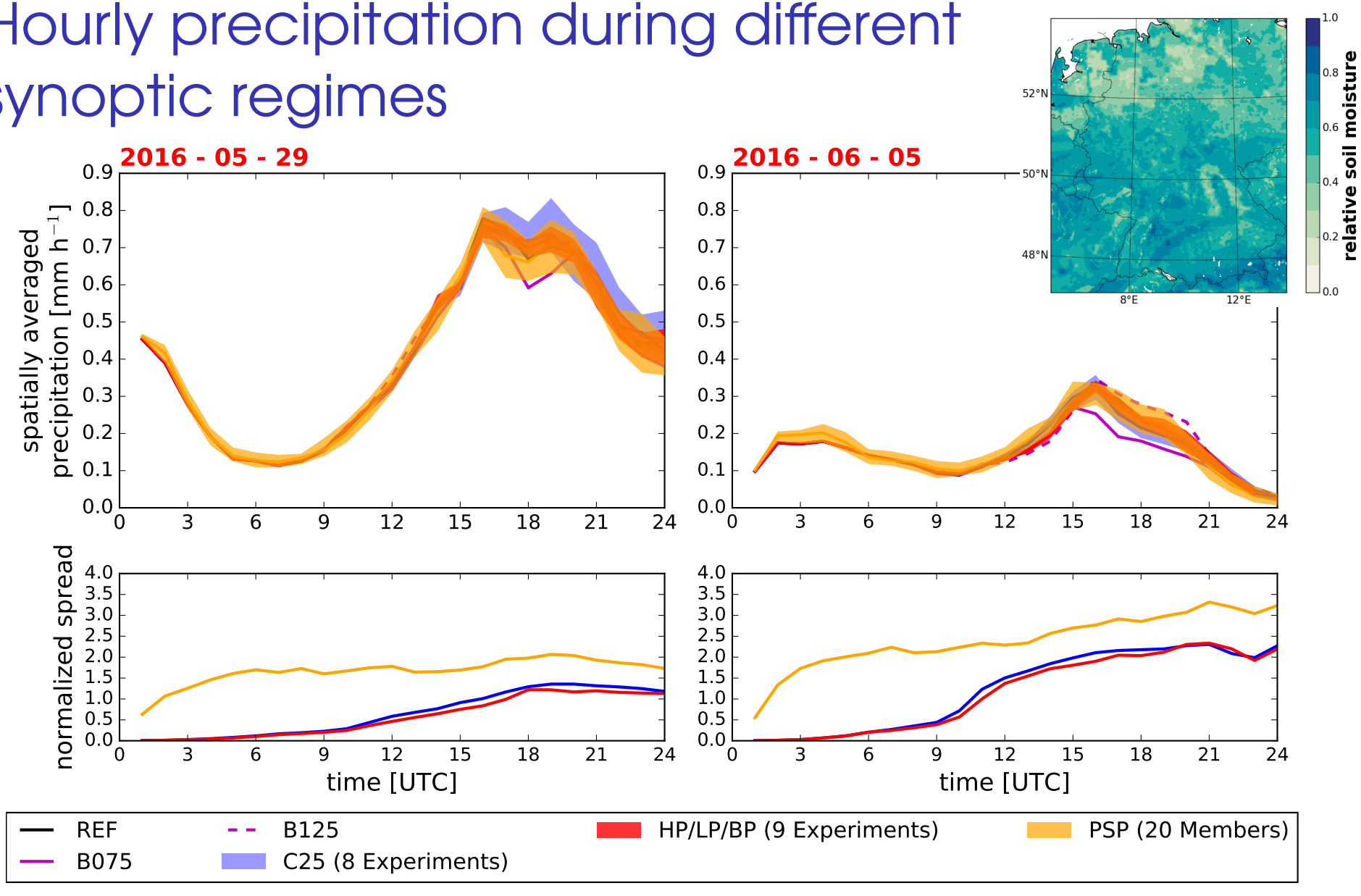


PSP simulations performed by Stephan Rasp, LMU

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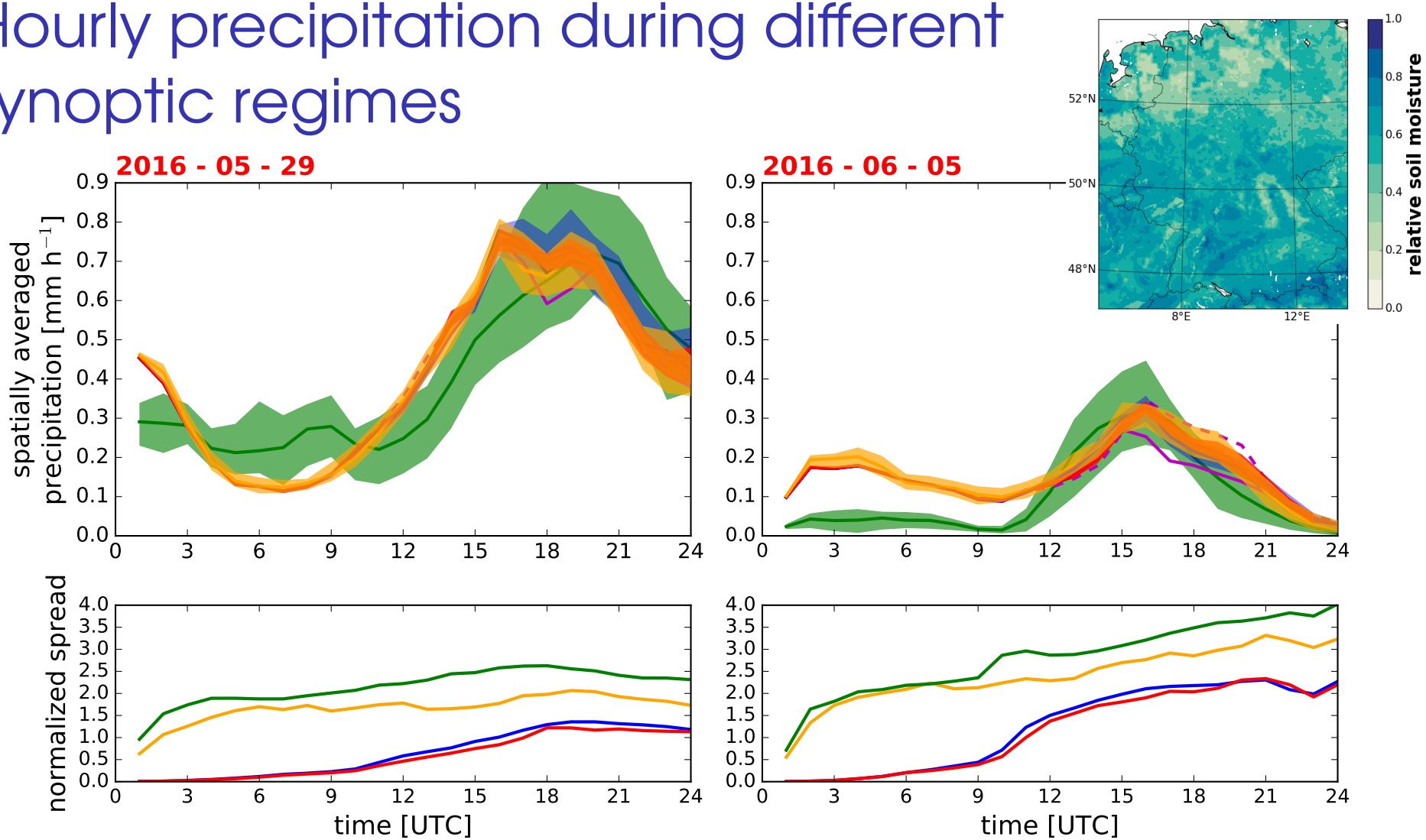


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# Impact of different scales on precipitation in C25

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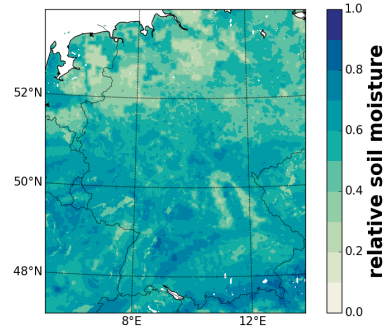


Reference
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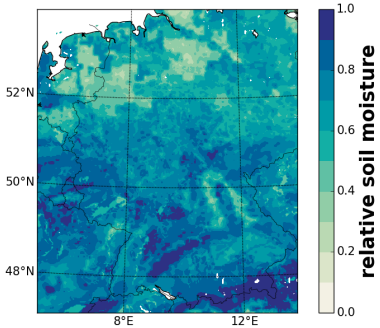
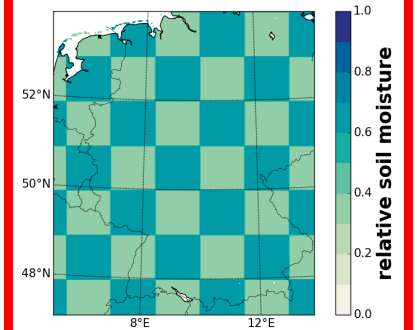
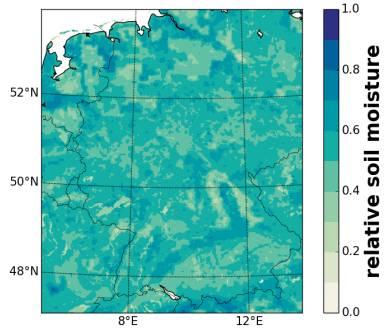


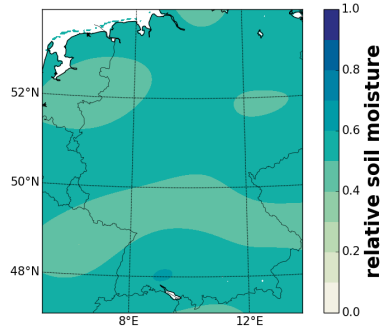

B125
$\overline{w_{so}} \approx 0.64$




C25_40
$\overline{w_{so}} \approx 0.51$

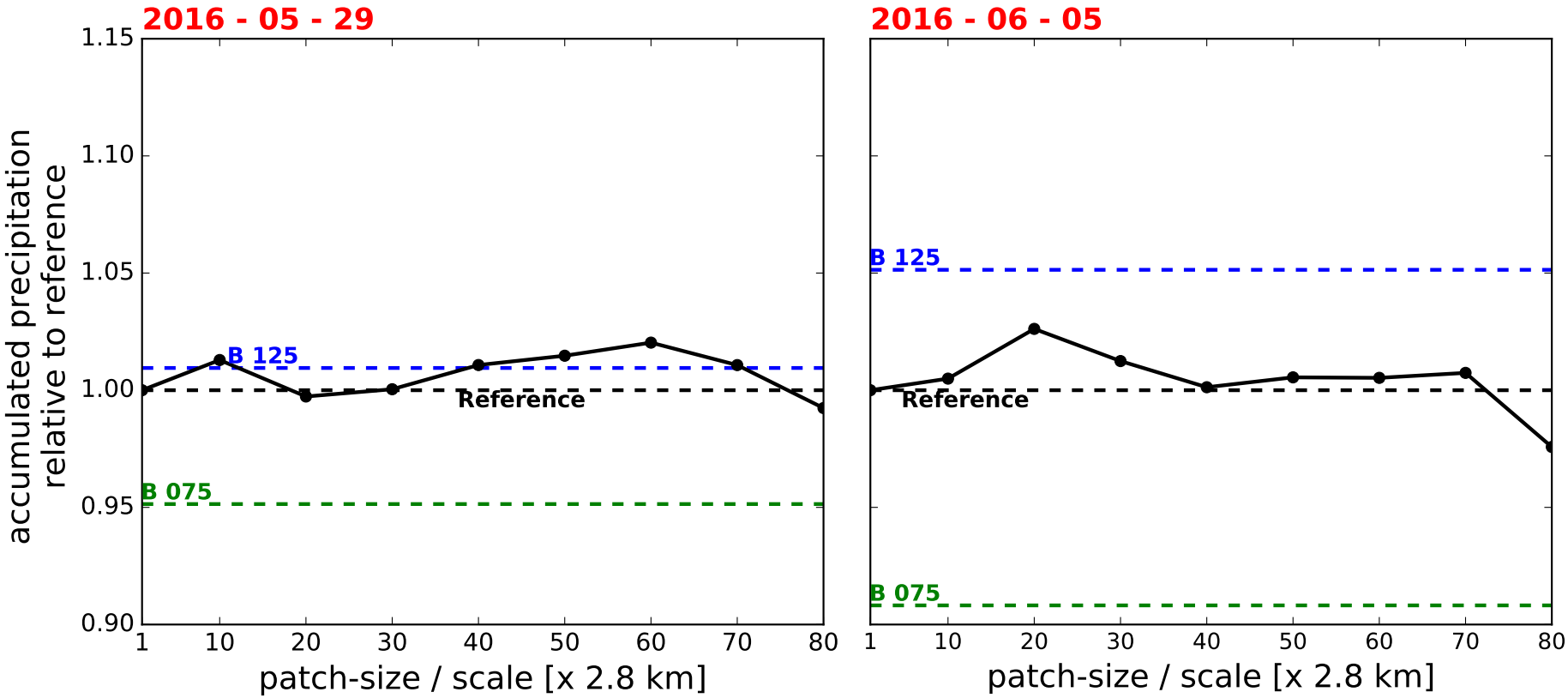



HP10
$\overline{w_{so}} \approx 0.51$



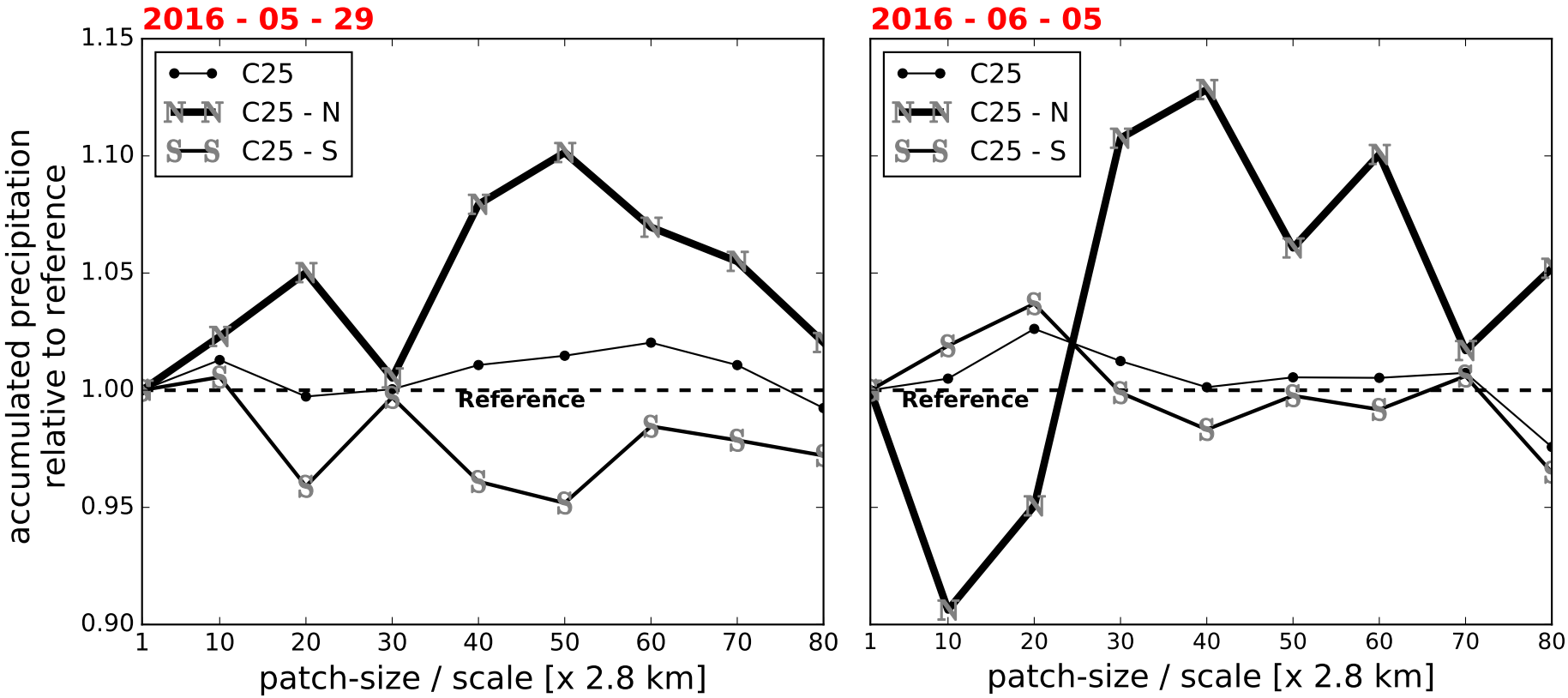

BP50
$\overline{w_{so}} \approx 0.51$

# Impact of different scales on precipitation in C25




- higher impact of bias experiments for weak synoptic forcing

# Impact of different scales on precipitation in C25

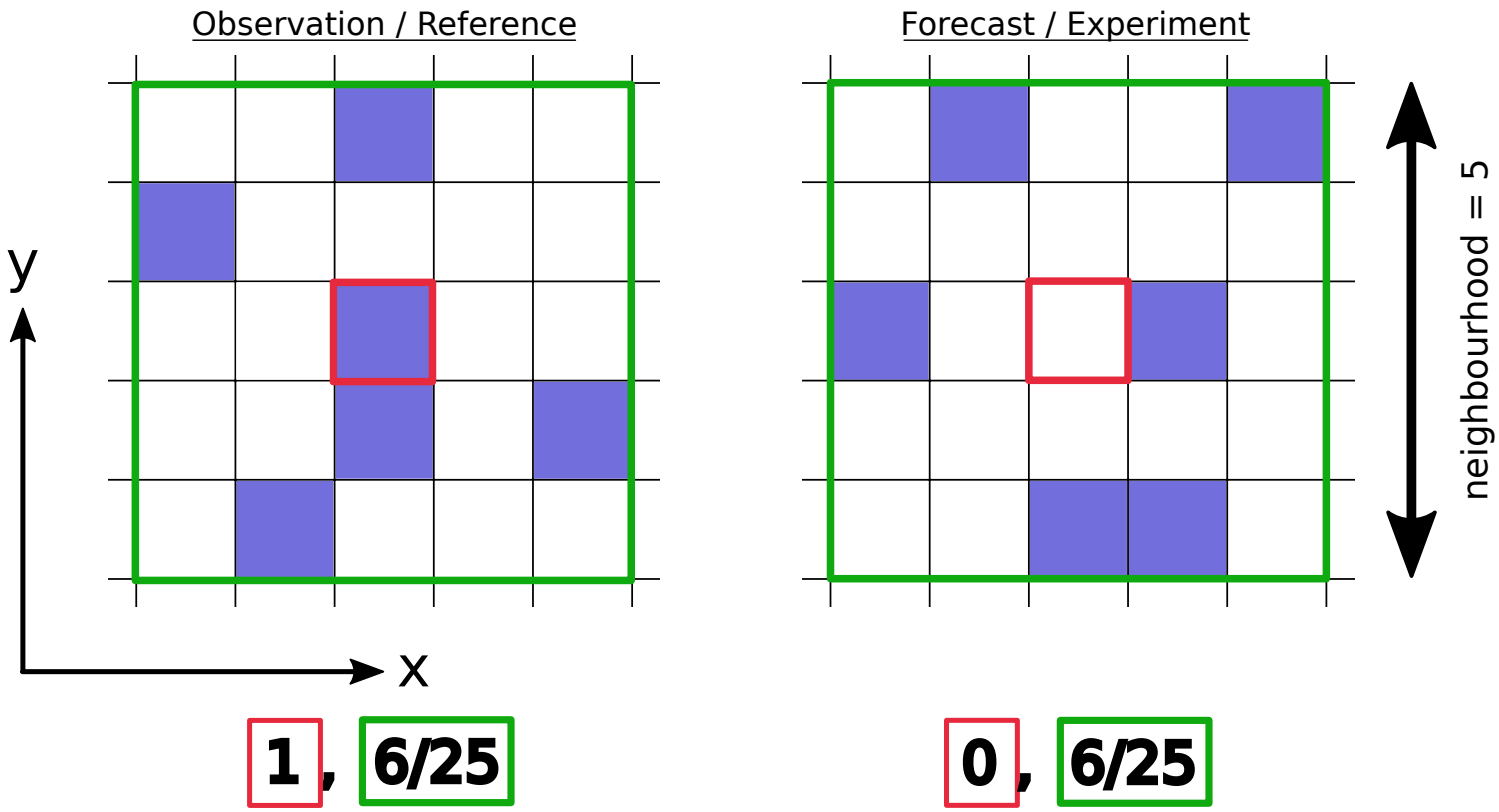



- higher impact of bias experiments for weak synoptic forcing
- higher impact over northern Germany
- scale dependence not significant

# Spatial variability with respect to Reference

## $\overline{FSS}$ threshold: 1.0 mm/h

Create binary field by applying precipitation threshold




adapted from Roberts and Lean (2008)

# Spatial variability with respect to Reference

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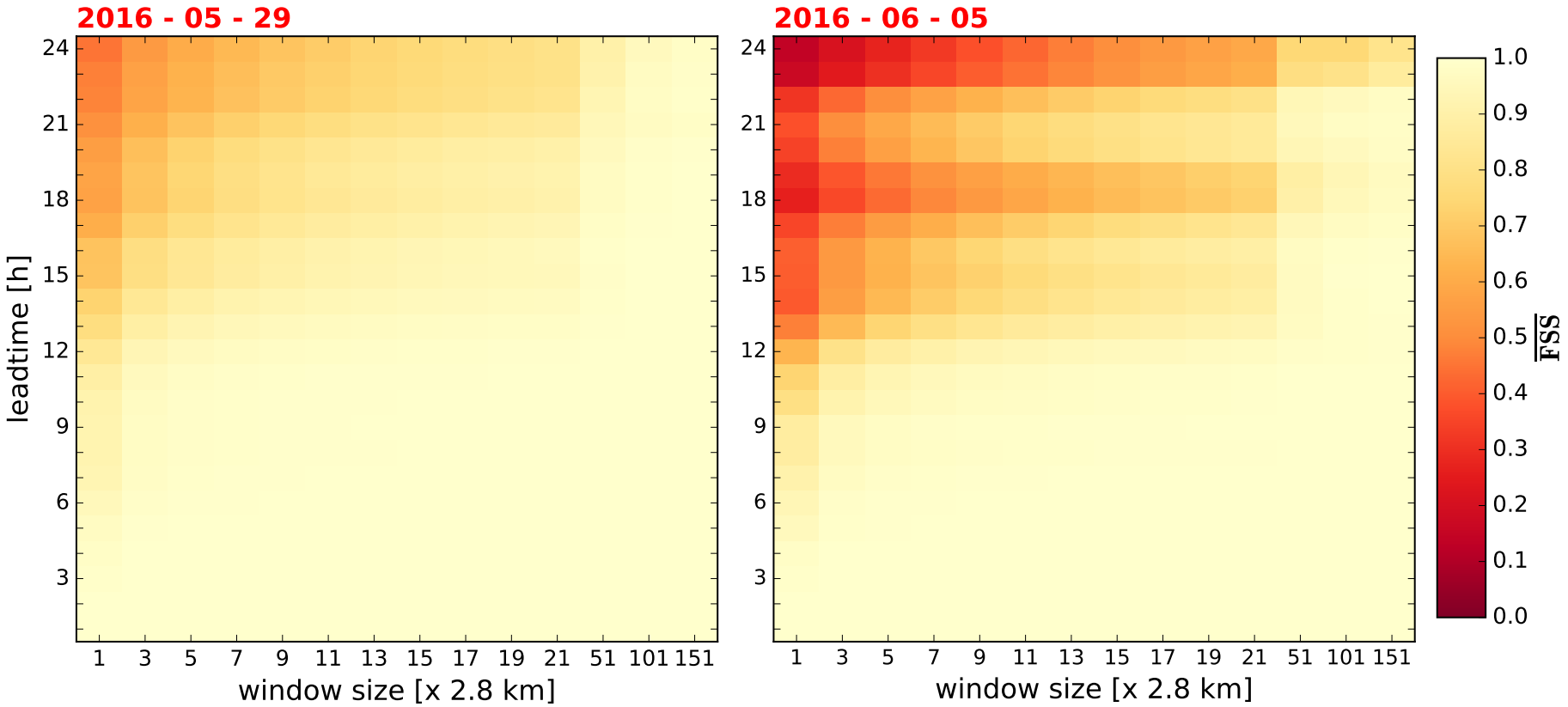
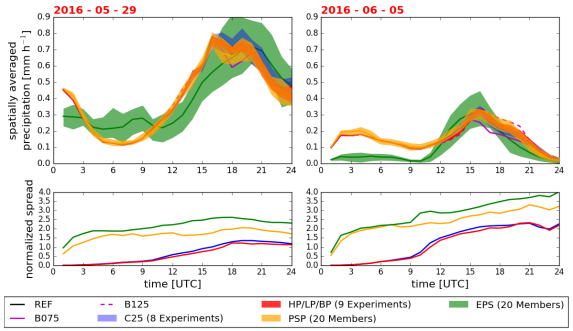
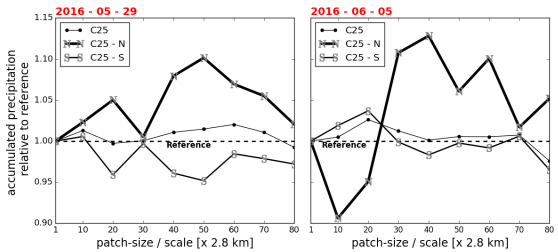
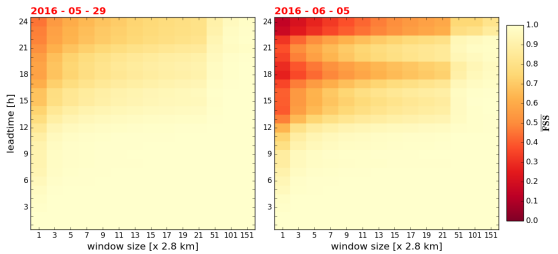



- spatial variability higher for weak synoptic forcing (right)

# Summary




- soil moisture perturbations can cause relevant variability in precipitation forecast
- stochastic boundary layer perturbation (PSP) reproduces almost 80 % of the spread caused by the COSMO-DE-EPS
- soil moisture perturbation largest impact over N-Germany across all scales
- impact of soil moisture perturbation larger for weak synoptic forcing

**Thank you for your attention!**