

# Evaluation of a COSMO-based reanalysis system for the European CORDEX domain

**Christian Ohlwein**<sup>1,2</sup>, Jan Keller<sup>1,4</sup>, Christoph Bollmeyer<sup>1,2</sup>, Sabrina Bentzien<sup>1,2</sup>, Petra Friederichs<sup>2</sup>, Andreas Hense<sup>2</sup>, Susanne Crewell<sup>3</sup>, Ieda Pscheidt<sup>1,2</sup>, Stephanie Redl<sup>1,3</sup>, Sandra Steinke<sup>1,3</sup>

<sup>1</sup> Hans-Ertel-Centre for Weather Research – Climate Monitoring Branch

<sup>2</sup> Meteorological Institute, University of Bonn

<sup>3</sup> Institute for Geophysics and Meteorology, University Cologne

<sup>4</sup> Deutscher Wetterdienst DWD

<http://www.herz-tb4.uni-bonn.de>

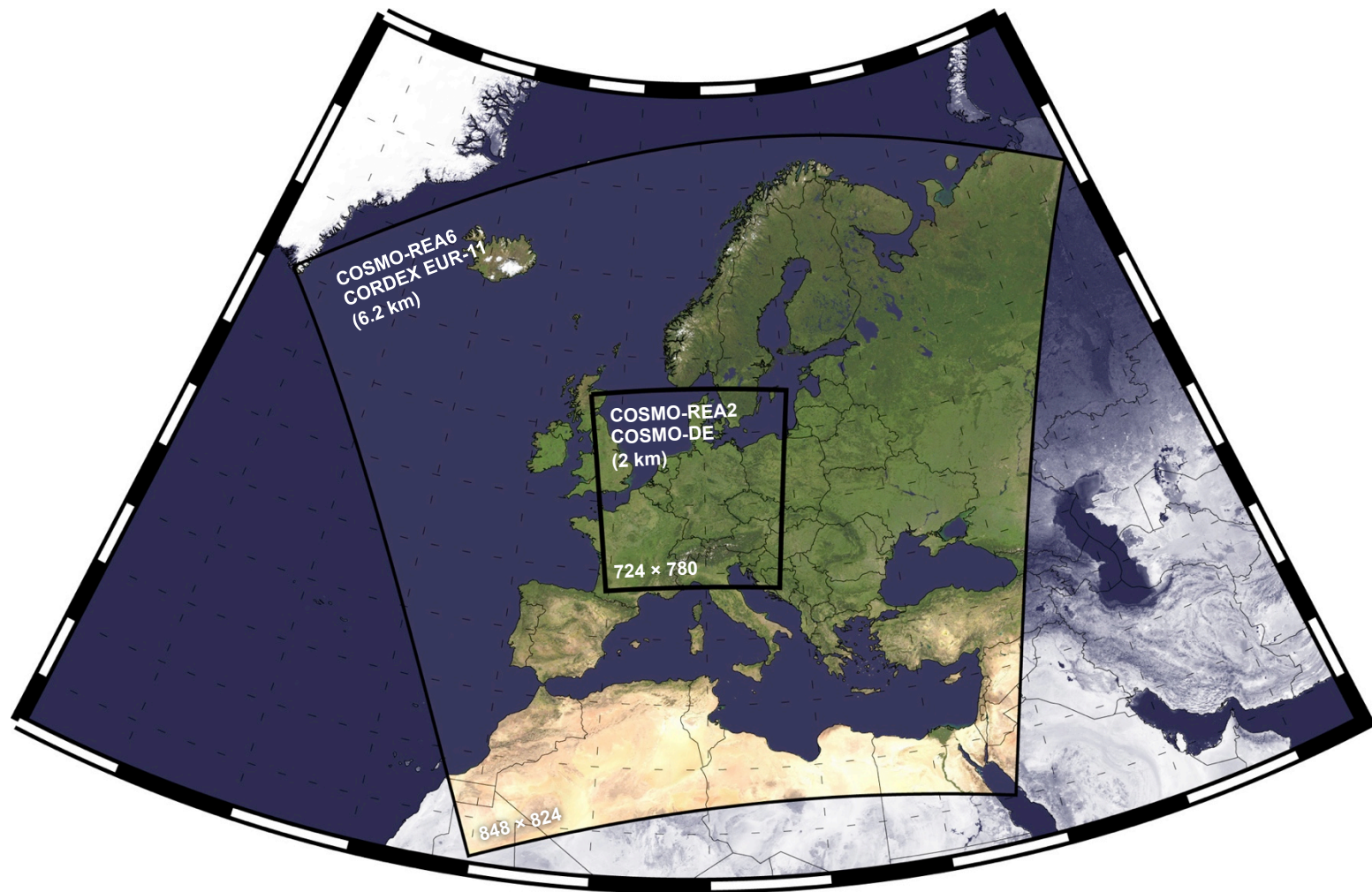
## Objective

- Develop methods for **monitoring regional climate** for operational use at DWD

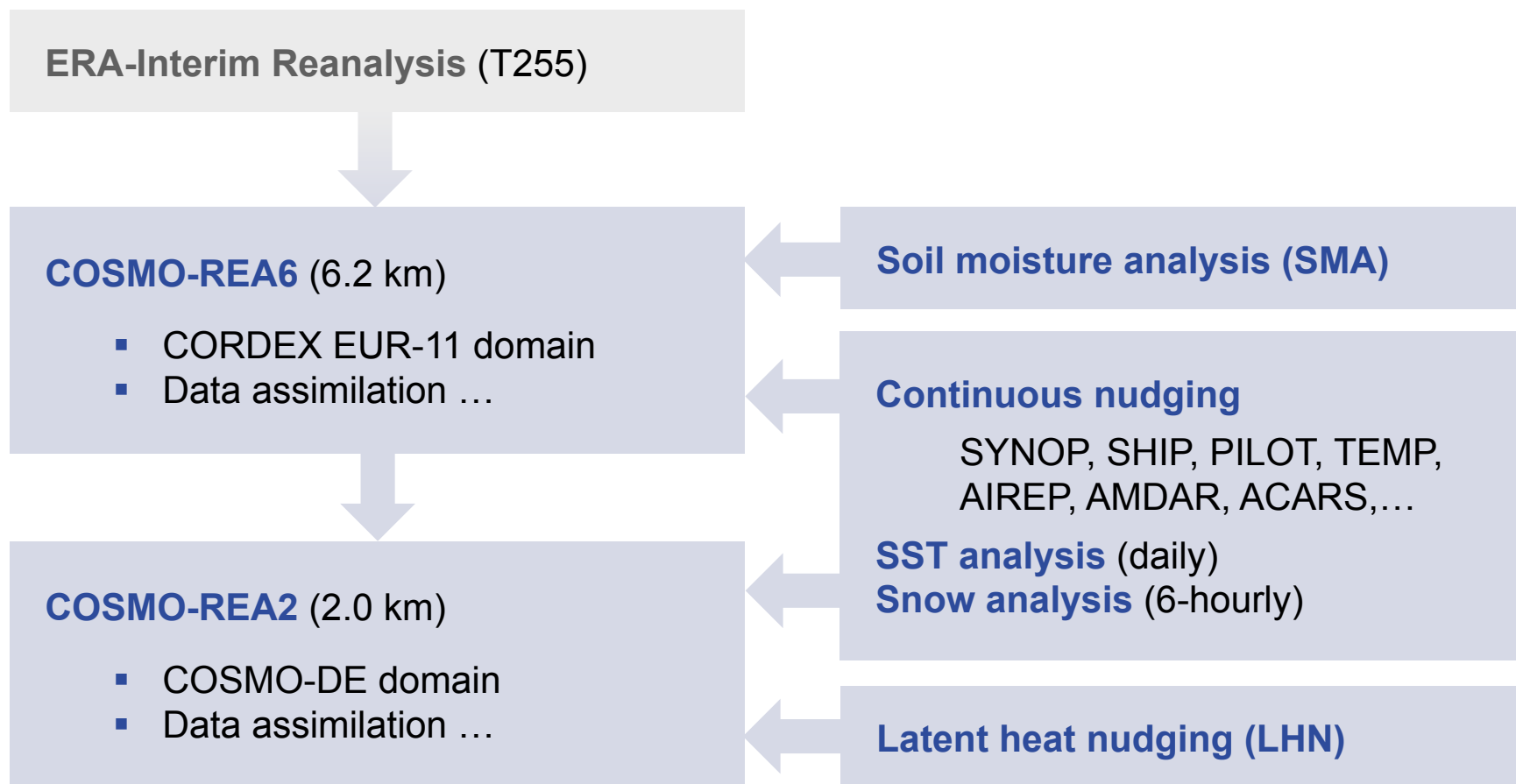
## Outline

- **Development of a regional reanalysis system**
  - Set-up and characteristics
  - Status and perspectives
- **Evaluation**
  - Various aspects of verification and validation

# Regional Reanalyses



# Regional Reanalysis System





# Regional Reanalysis System

ERA-Interim Reanalysis (T255)



**COSMO-DS6** (6.2 km)

- CORDEX EUR-11 domain
- Downscaling only



Soil moisture analysis (SMA)



Continuous nudging

SYNOP, SHIP, PILOT, TEMP,  
AIREP, AMDAR, ACARS,...

SST analysis (daily)

Snow analysis (6-hourly)

Latent heat nudging (LHN)

# Model Output

## → Direct Model Output

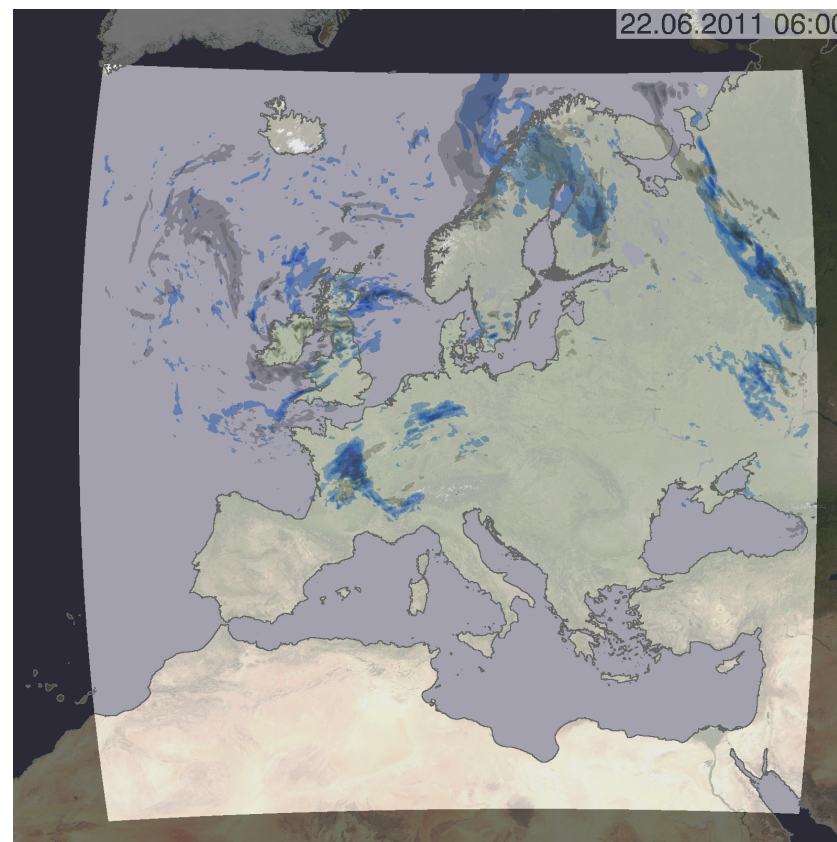
- 150 fields (2D/3D)
- **60 min** (3D) and **15 min** (2D)

## → Current status

- COSMO-REA6: **2007–2012**
- COSMO-REA2: **2011**

## → Next steps

- Time-slots in the past
- COSMO-REA6: **1979–1983, ...**



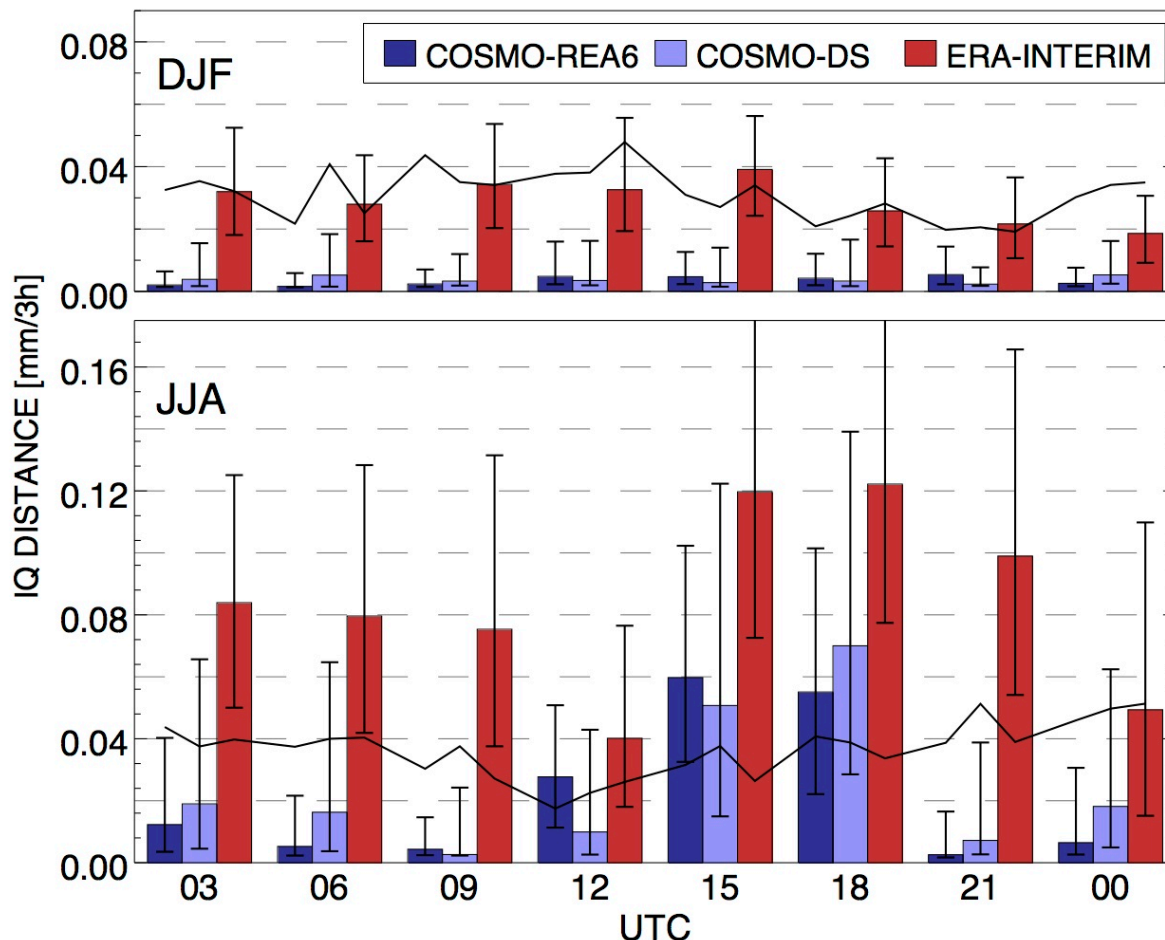
**Example:** Precipitation simulated by COSMO-REA6 (blue) and COSMO-DS6 (grey)

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# Precipitation – Distribution

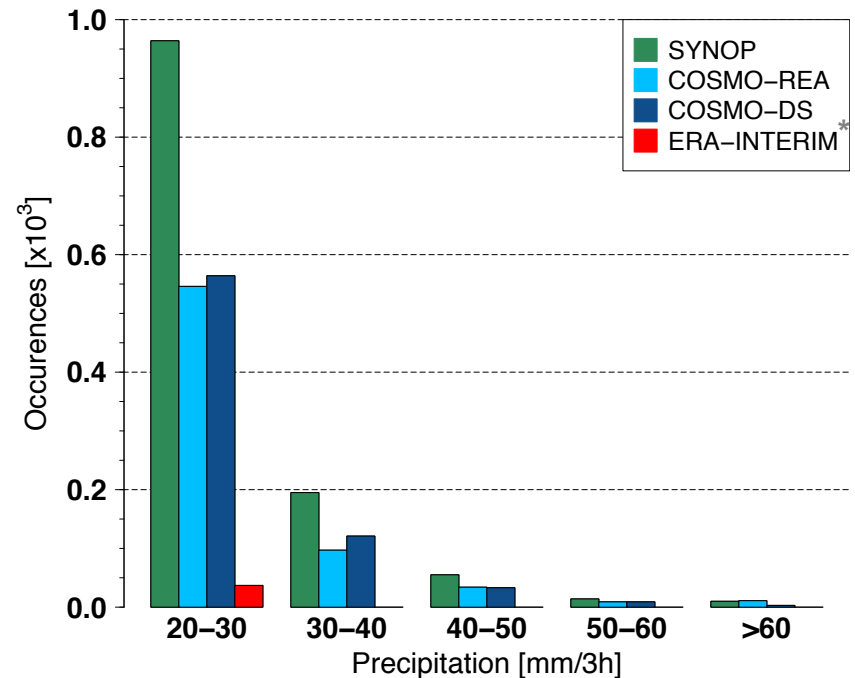
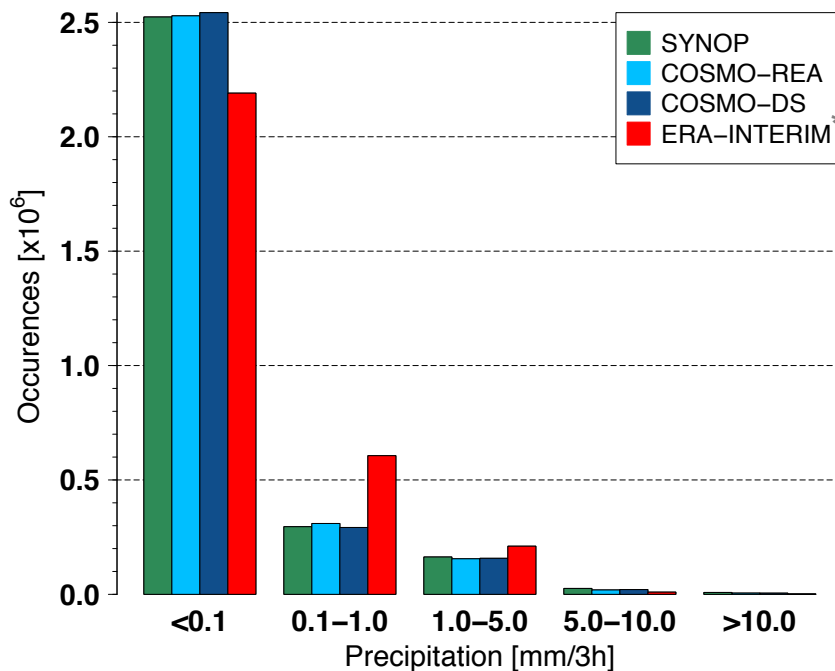
**Integrated Quadratic Distance\* (IQD)**  
COSMO-CORDEX / German SYNOP  
stations (2011)



\*) cf. Thorarinsdottir et al. (2013): Using proper divergence functions to evaluate climate models

# Precipitation – Extremes

(Sharpness)

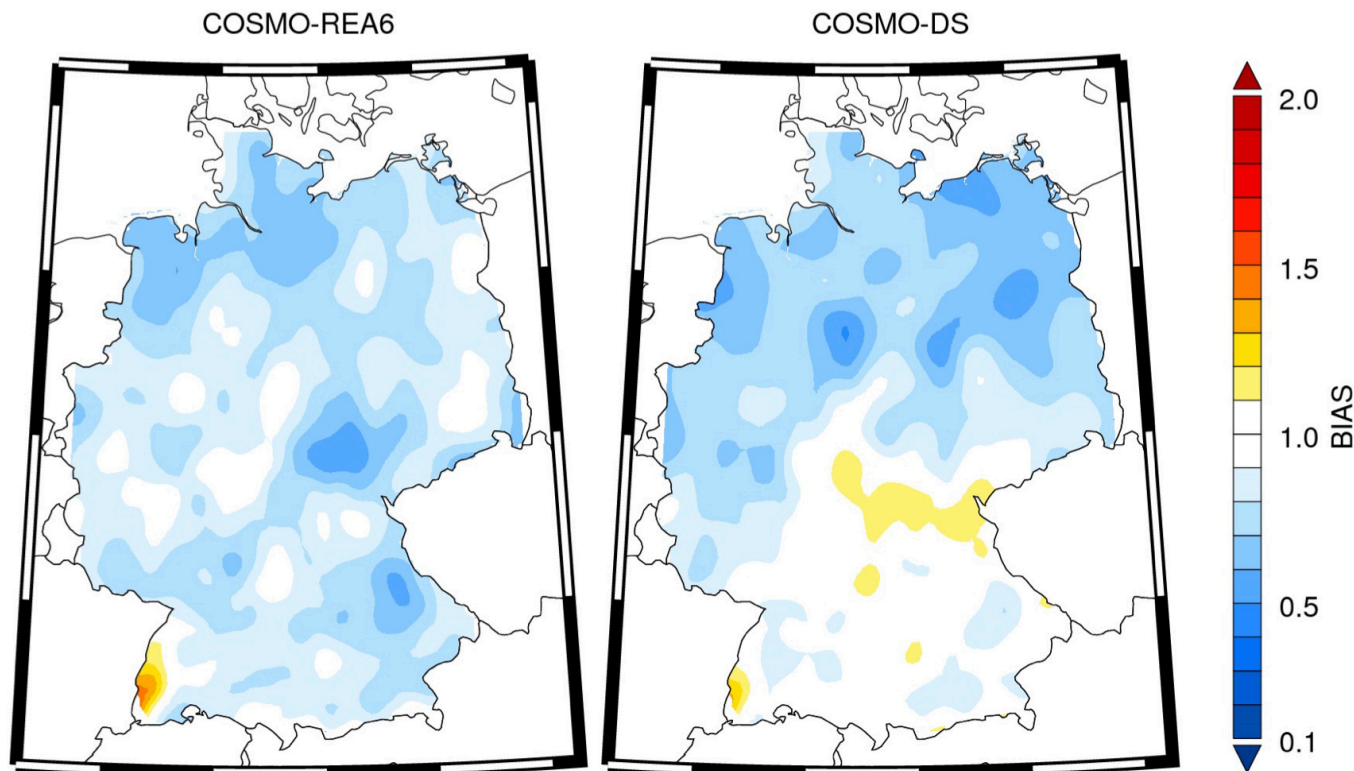


**Histogram of 3-hourly precipitation events at German SYNOP stations**  
(COSMO-REA6/DS6 simulations, 2011)

*\*) note the change of support*

# Precipitation – Frequency Bias

(Bias)

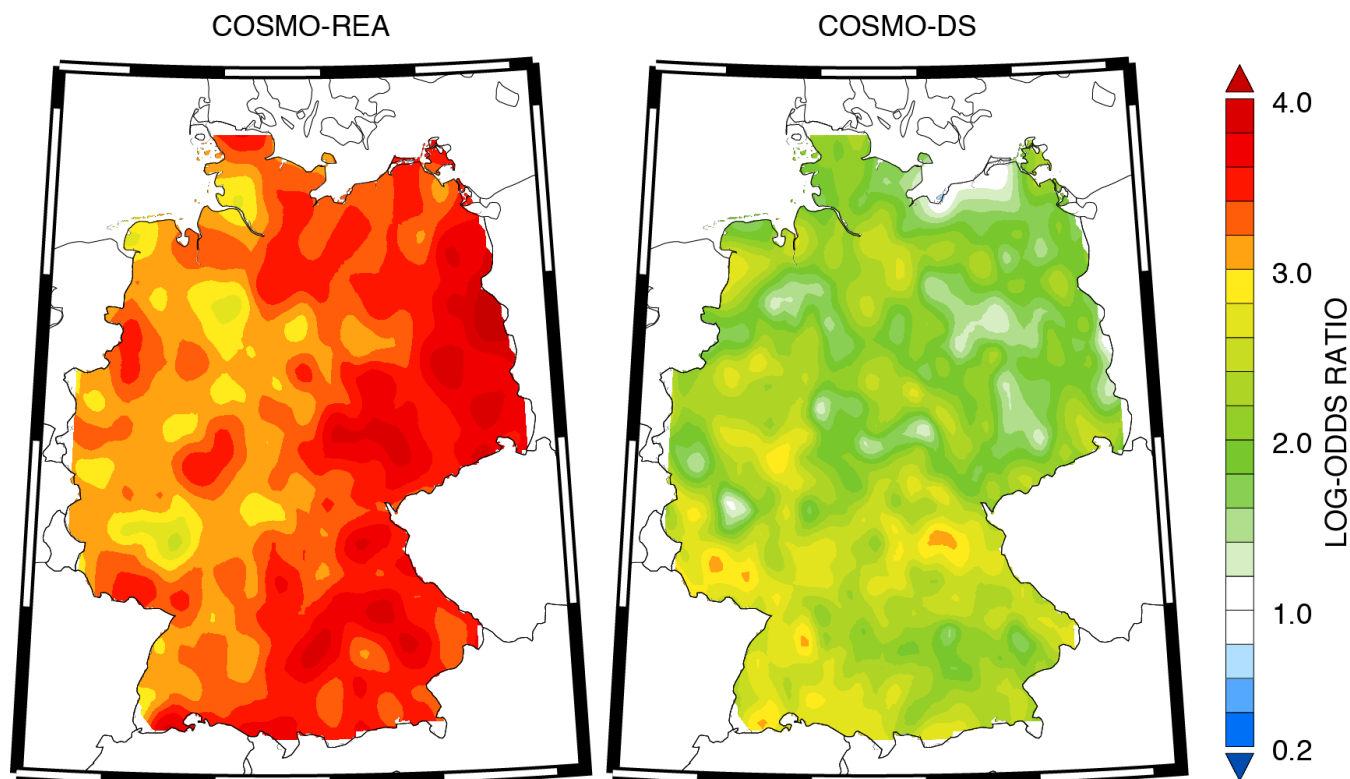


Threshold 2.5 mm/3h

**Frequency bias for 3-hourly precipitation events compared to German SYNOP stations**  
(COSMO-REA6 simulations, 2011)

# Precipitation – Log-Odds Ratio

(Accuracy)



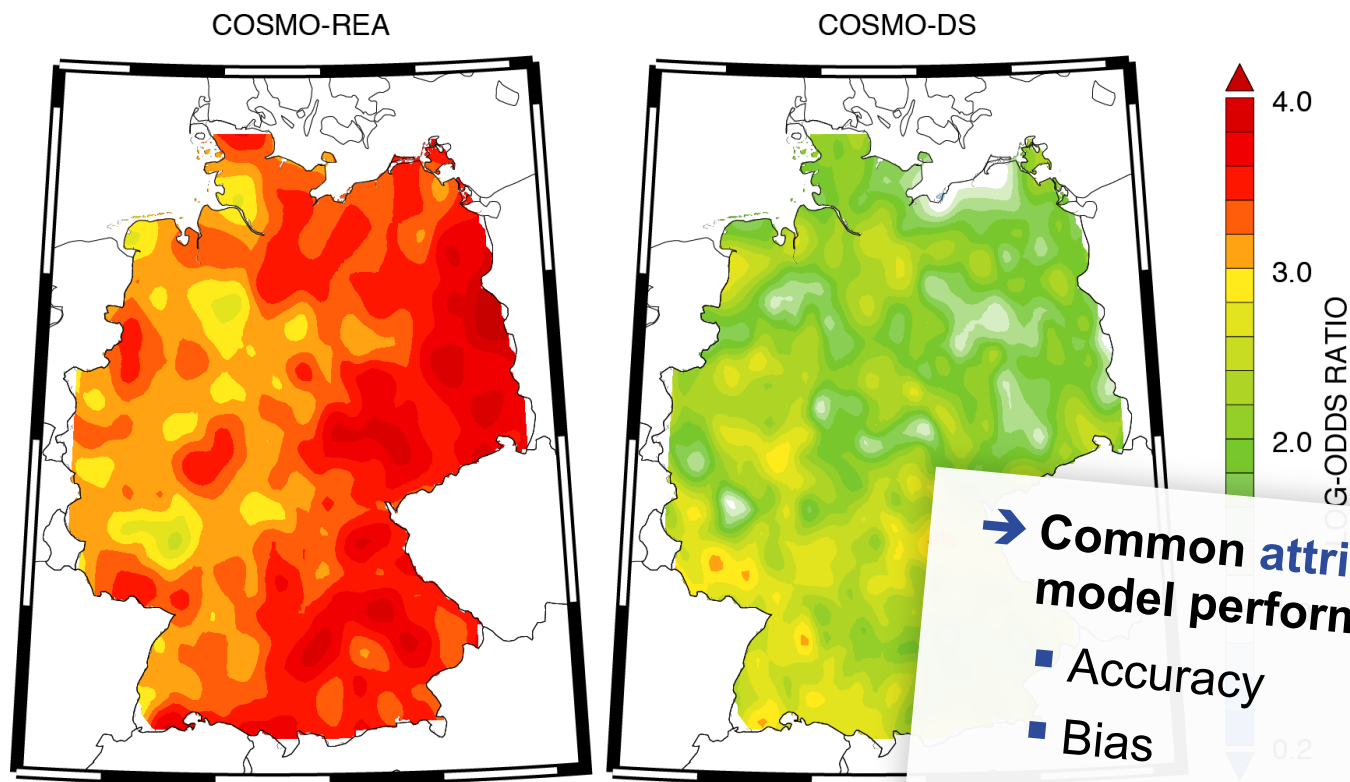
Threshold 2.5 mm/3h

**Log-odds ratio for 3-hourly precipitation events compared to German SYNOP stations  
(COSMO-REA6 simulations, 2011)**



# Precipitation – Log-Odds Ratio

(Accuracy)



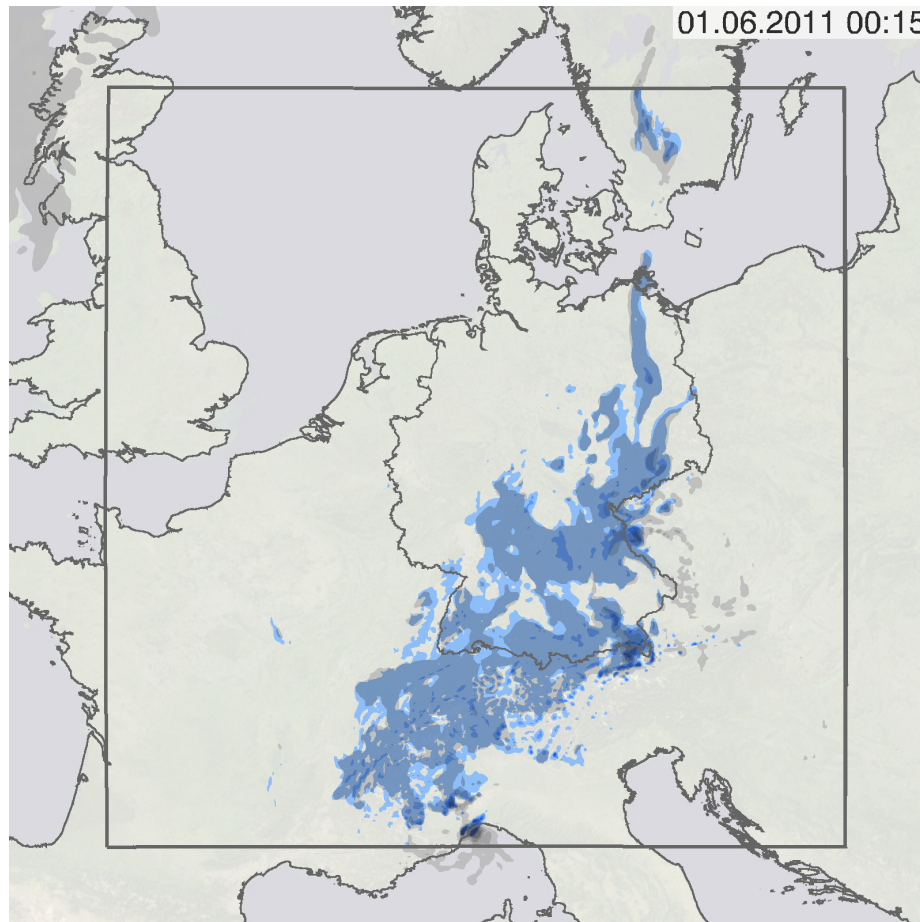
Threshold 2.5 mm/3h

Log-odds ratio for 3-hourly precipitation events compared to German Synoptic Stations  
(COSMO-REA6 simulations, 2011)

→ Common attributes of model performance

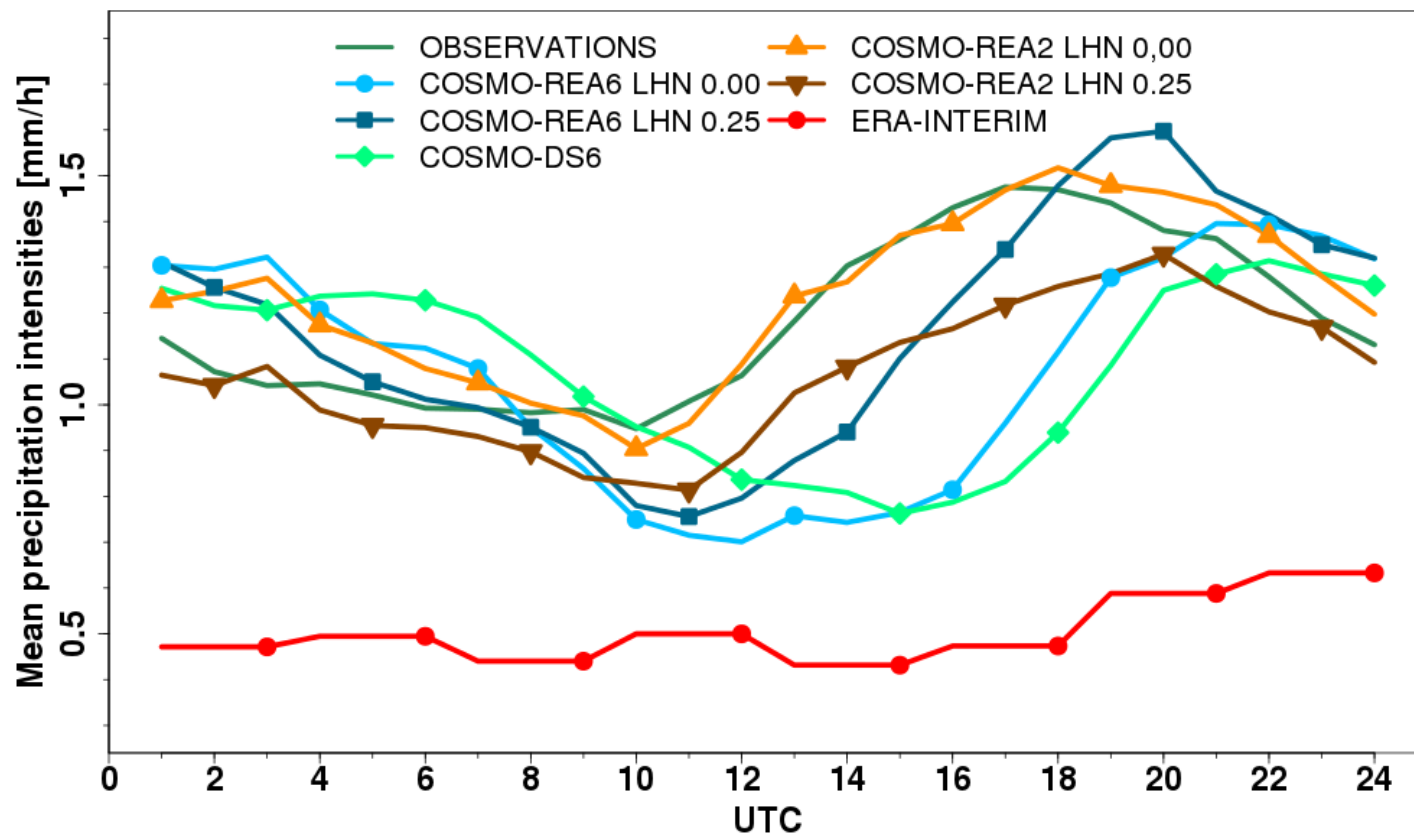
- Accuracy
- Bias
- Sharpness
- Reliability
- ...

## Model Output (REA6/REA2)



**Example:** Precipitation simulated by COSMO-REA2 (blue) and COSMO-REA6 (grey)

# Precipitation – Diurnal Cycle



Mean precipitation intensities (>0.1 mm/h) at German SYNOP stations  
(June–August 2011)

## Further Evaluation

### → Standard evaluation

- Analysis increments
- Water and energy cycle
- ...

### → Spatial verification

- Object-based
- ...

### → Remote sensing data

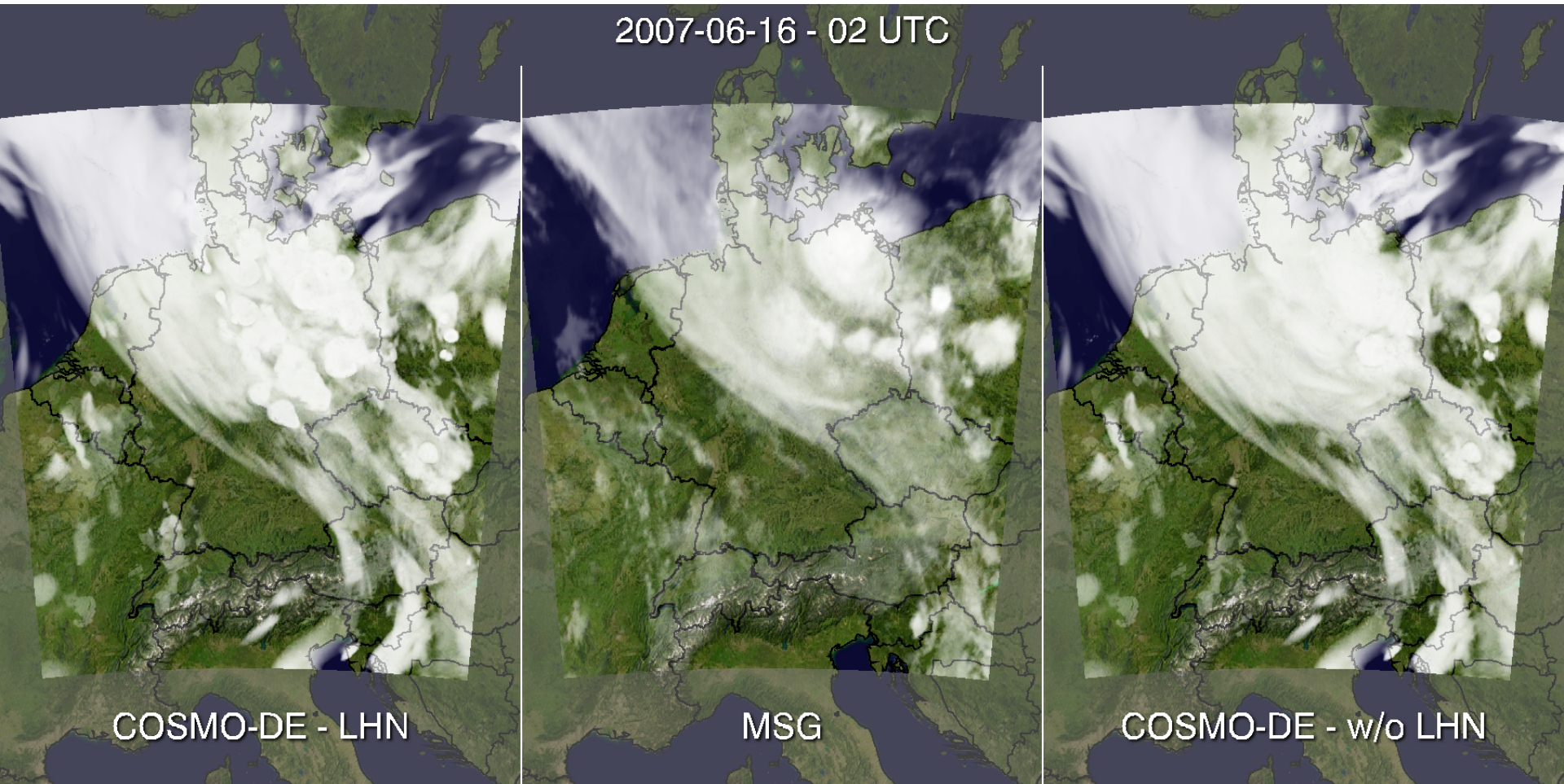
- AMSU-B Microwave Humidity Sensor
- MSG brightness temperature
- IWV from GNSS measurements
- Ceilometer measurements
- ...

### → Overall quality?

- More complicated than for interpolation approaches
- Beyond standard scores
- Physical processes
- ...

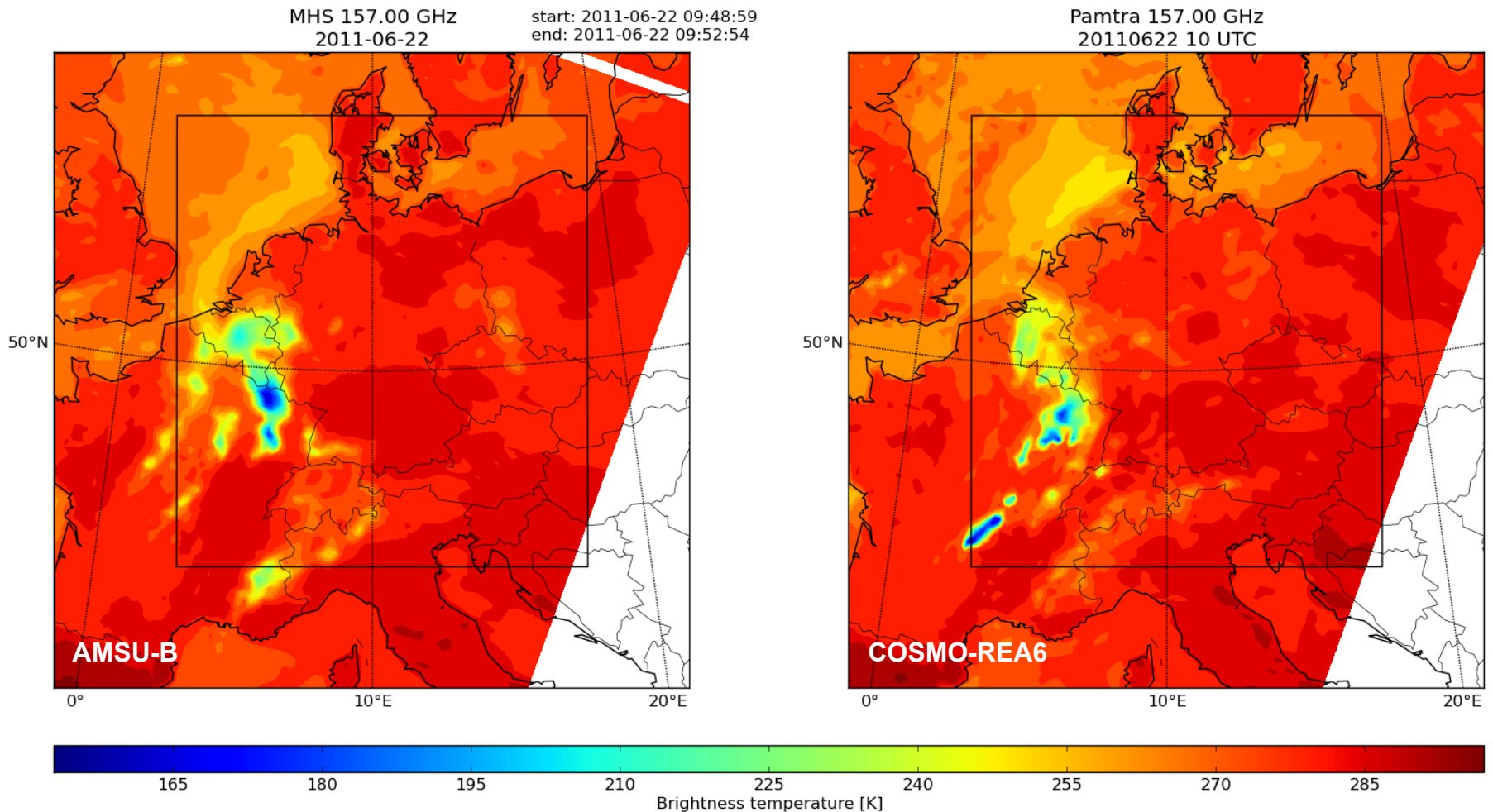


## Further Evaluation – Clouds



Brightness temperature ( $10.8 \mu\text{m}$ ) – COSMO-REA (LHN test runs at 2.8 km)

# Further Evaluation – Frozen Hydrometeors



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# Summary

## → High-resolution **regional reanalysis** system

- **COSMO-REA6**: CORDEX EUR-11 domain (6.2 km)
- **COSMO-REA2**: COSMO-DE domain (2.0 km)

## → Evaluation of the system

- Common **attributes** of model performance
  - **Sharpness**: representation of **spatio-temporal variability**
  - **Accuracy**: coherence between **model** and **independent observations**
  - ...
- Beyond standard scores: **physical processes**

## → Perspectives

- UERRA: Uncertainties in **ensembles of regional reanalysis** (FP7-SPACE)

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# Outline

➔ **Appendix**

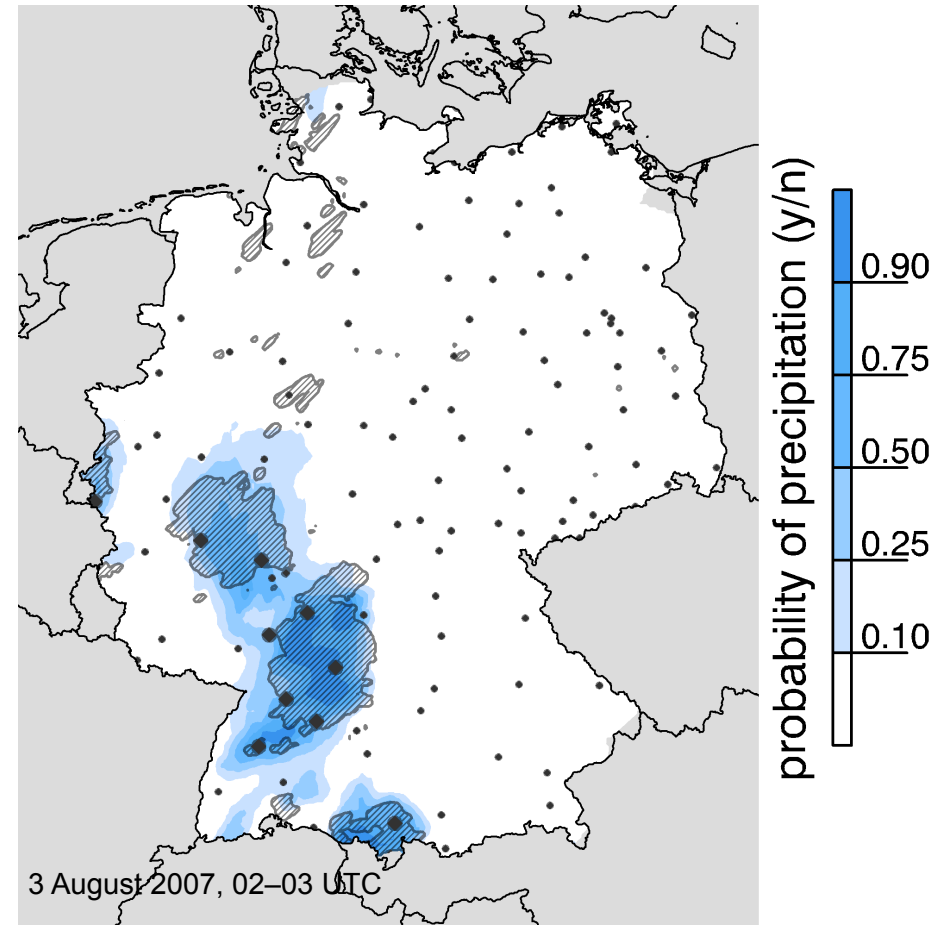
# Assimilation of rain gauge measurements

## → Spatio-temporal disaggregation

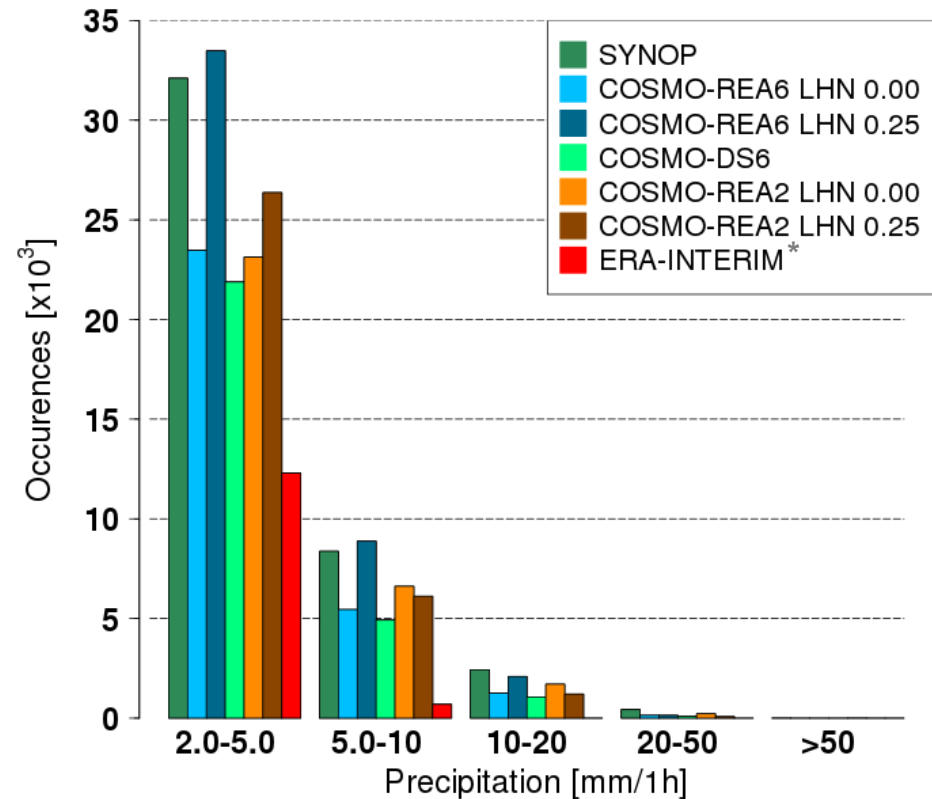
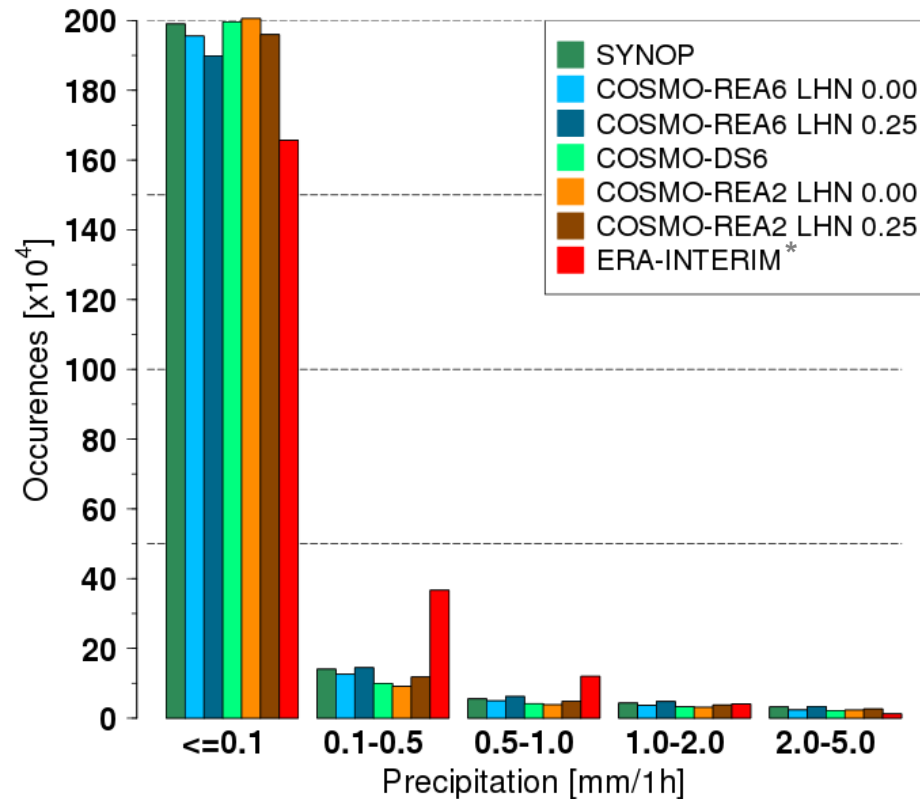
- Rain gauge measurements
- Covariates such as MSG  $T_B$

## → Assimilation via LHN

- Prerequisite for long-term runs of COSMO-REA2



# Precipitation – Extremes



**Histogram of 3-hourly precipitation events at German SYNOP stations  
(June–August 2011)**

*\*) note the change of support*