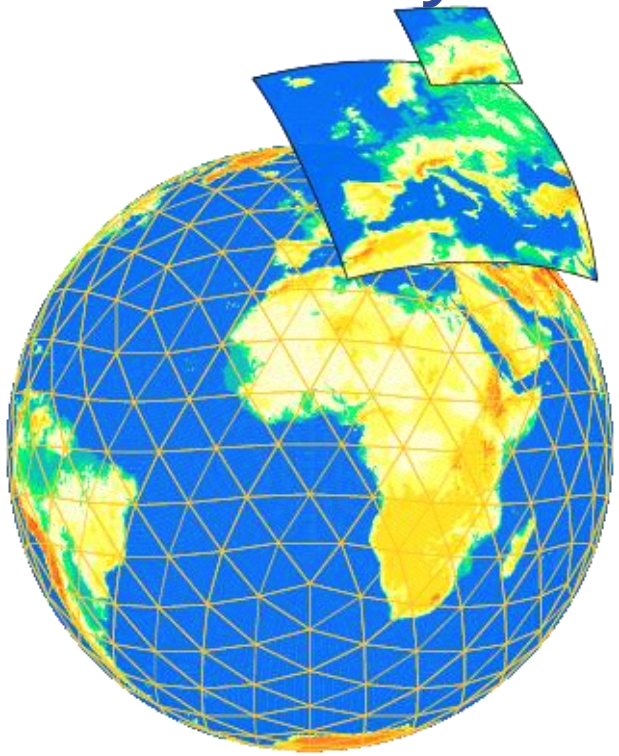
Analyses of added value for heavy rain fall and strong wind in convection-permitting climate simulations over Germany



Michael Haller, Susanne Brienen, Harald Rybka, Jennifer Brauch and Barbara Früh

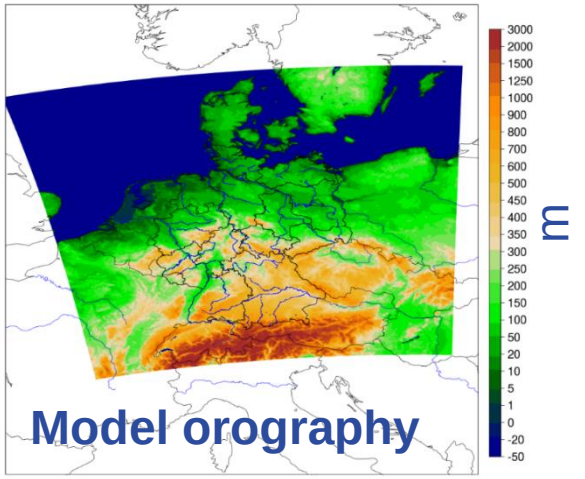
Deutscher Wetterdienst (DWD), Germany

Model data of DWD in Network of Experts

- **Convection-permitting Simulations** with COSMO-CLM5-0-16
  - 3 km grid, centred over Central Europe
  - Configuration taken from FPS-convection/CLMcom: only shallow convection parameterization, prognostic graupel
  - **Projection run** driven by MIROC-MIROC5, intermediate nest of 12 km with COSMO-CLM4-8-17
  - Time range 1971-2000 (historical), and 2031-2060, 2071-2100 (RCP8.5)
  - **Evaluation run**, driven by ERA40/ERA5 reanalysis for 1971-2019, 2020+2021 in prep.
  - Hourly output (tas, sfcWind, huss …), 5-minute-data for precipitation
- Reference data:

RADKLIM (version 2017.002, *Winterrath et al. 2018*)**:**
- Gridded radar observations for Germany, calibrated with station gauges
- www.dwd.de/radklim

BMDV Network of Experts
Knowledge Ability Action



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- Re

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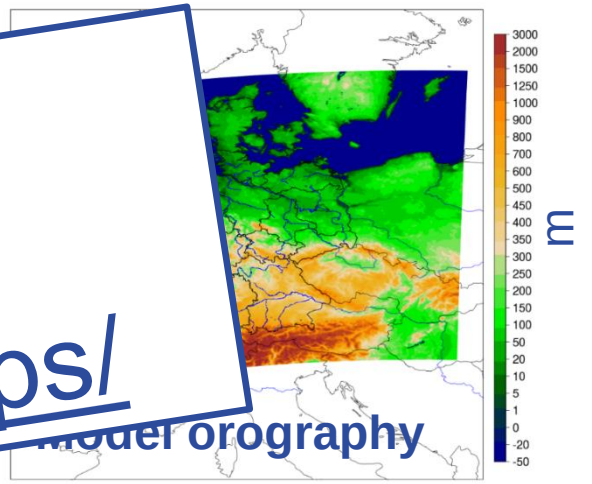
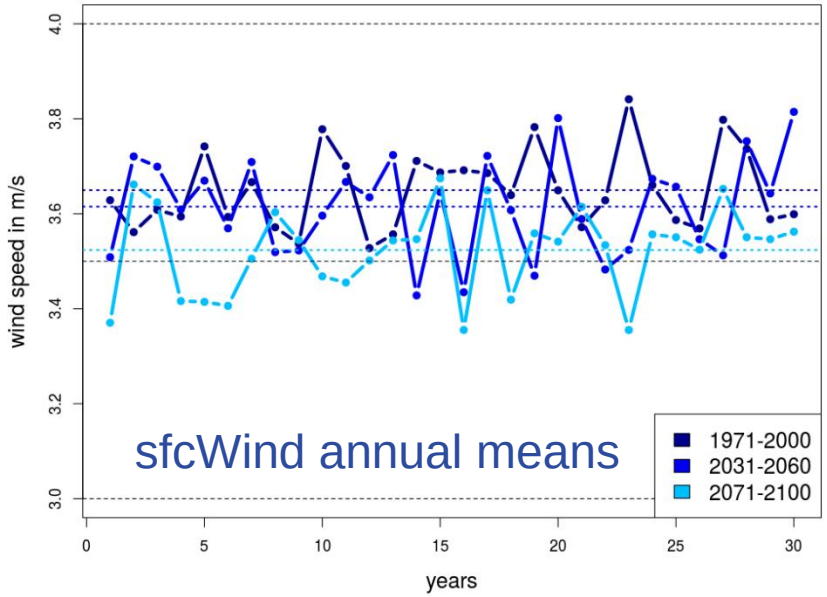
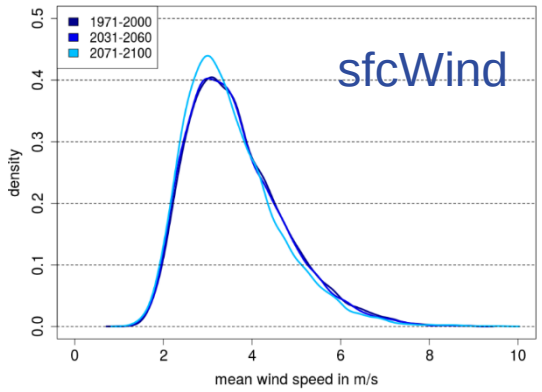
Projections and Evaluation run available on ESGF:
https://esgf.dwd.de/projects/dwd-cps/

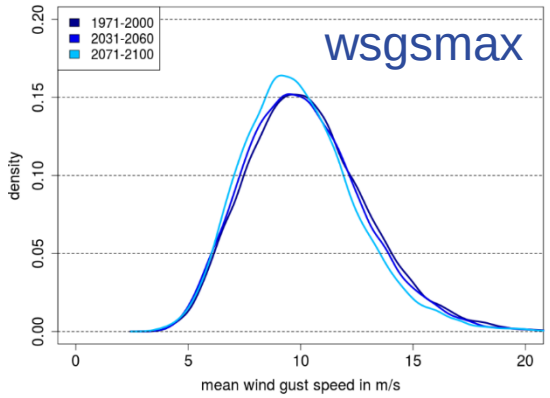


Model orography

Wind time series



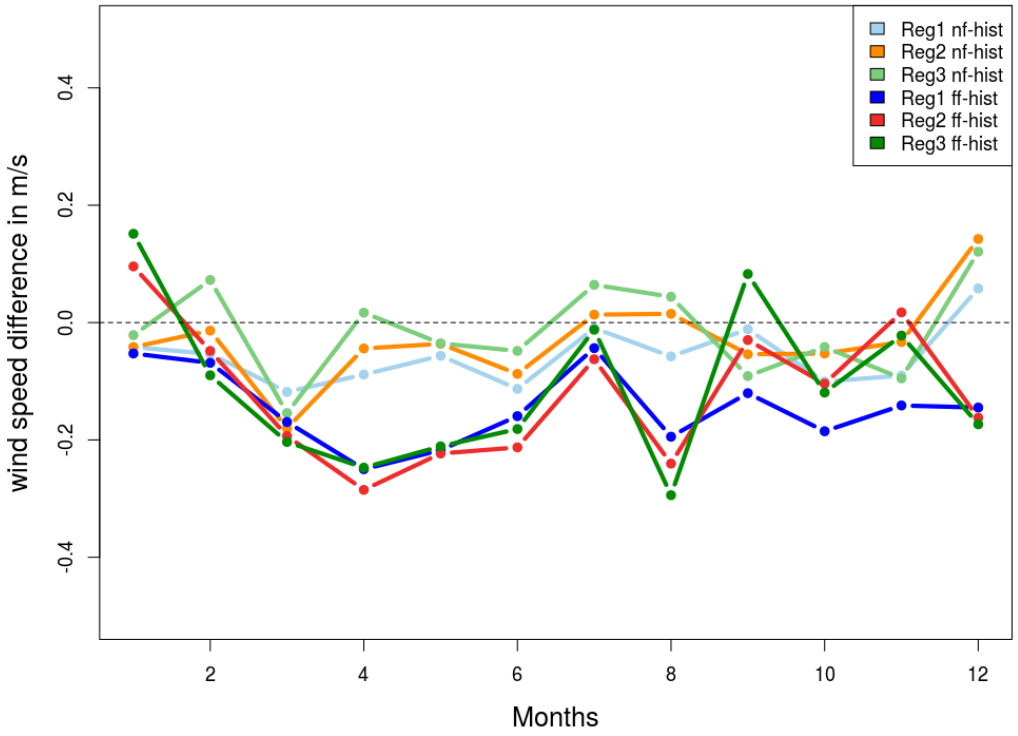




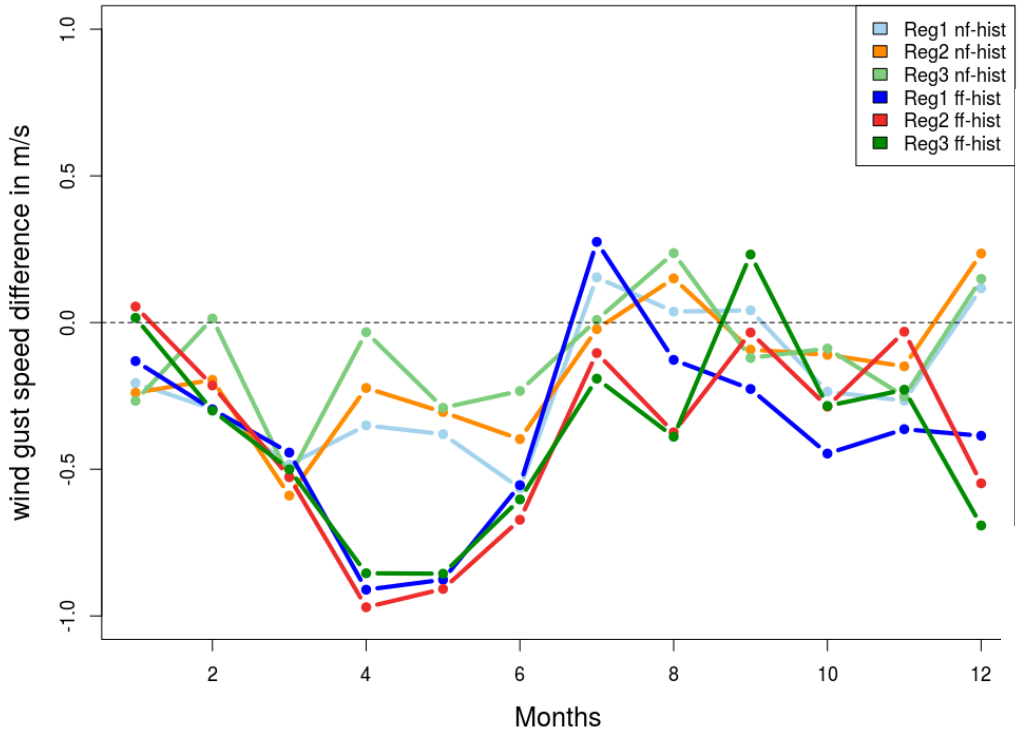
- ➔ Do the time series differ and is the difference significant?
- ➔ Mann-Whitney-u-Test:
  - ➔ Significance at p-Value < 0.05
  - ➔ historical / near future: p=0.68
  - ➔ historical / far future: p=4.867e-06
- ➔ Similar results also for wind gusts: significant changes in the far future for wind and wind gusts

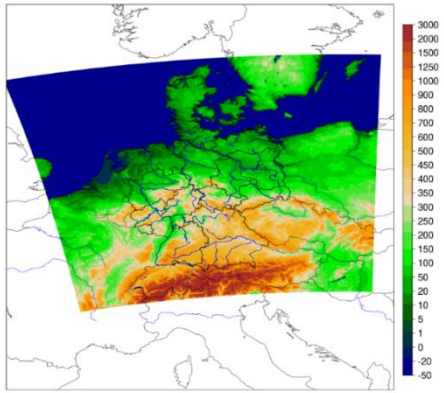
Wind analyses: annual cycle differences

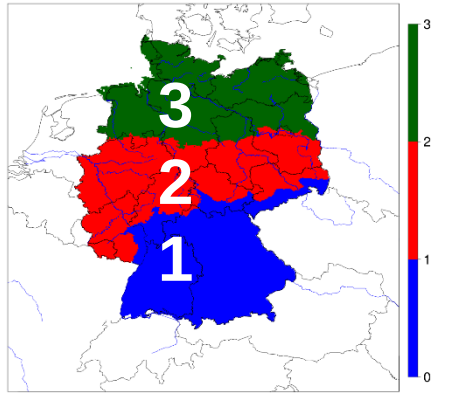
sfcWind annual cycle of 30 years



wsgsmax annual cycle of 30 years



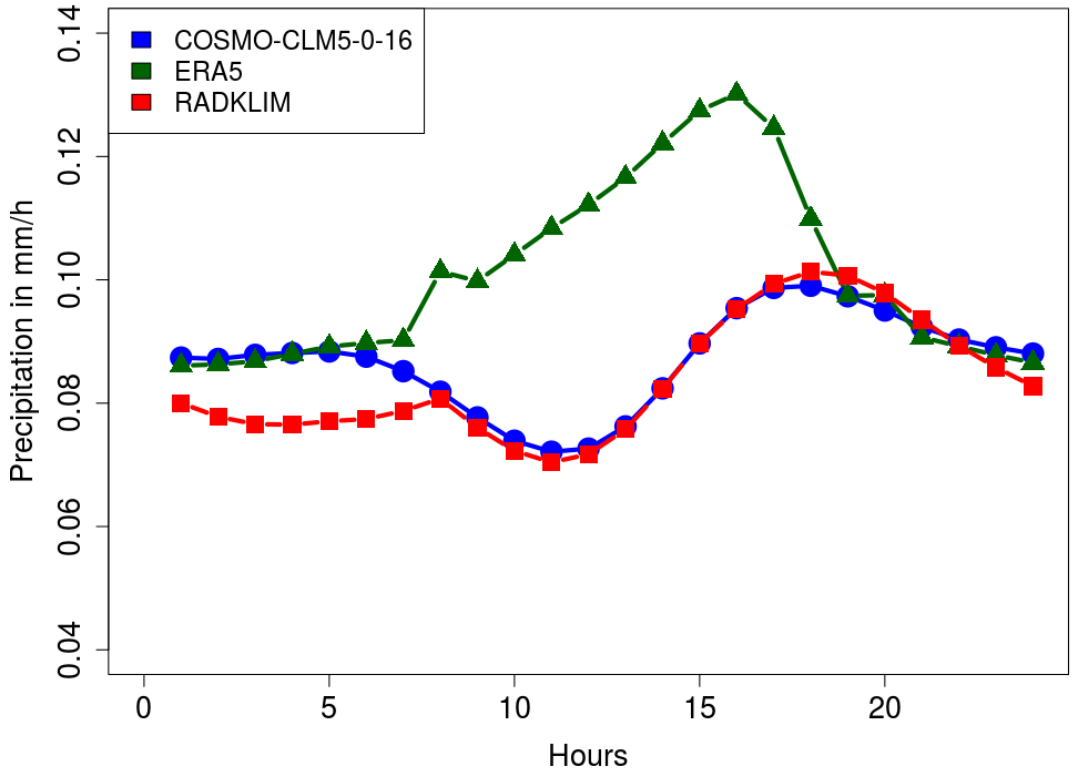




- Aggregating the analyses from 12 to 3 regions:
  - Decreasing wind and wind gusts in nearly all months, especially in spring
    - Visible in all three regions
    - Reasons?

Diurnal cycle of precipitation

Diurnal cycle for **year** (Jan-Dec)



Domain: **Germany**
Time range: **2001-2015**
Reference: **RADKLIM**

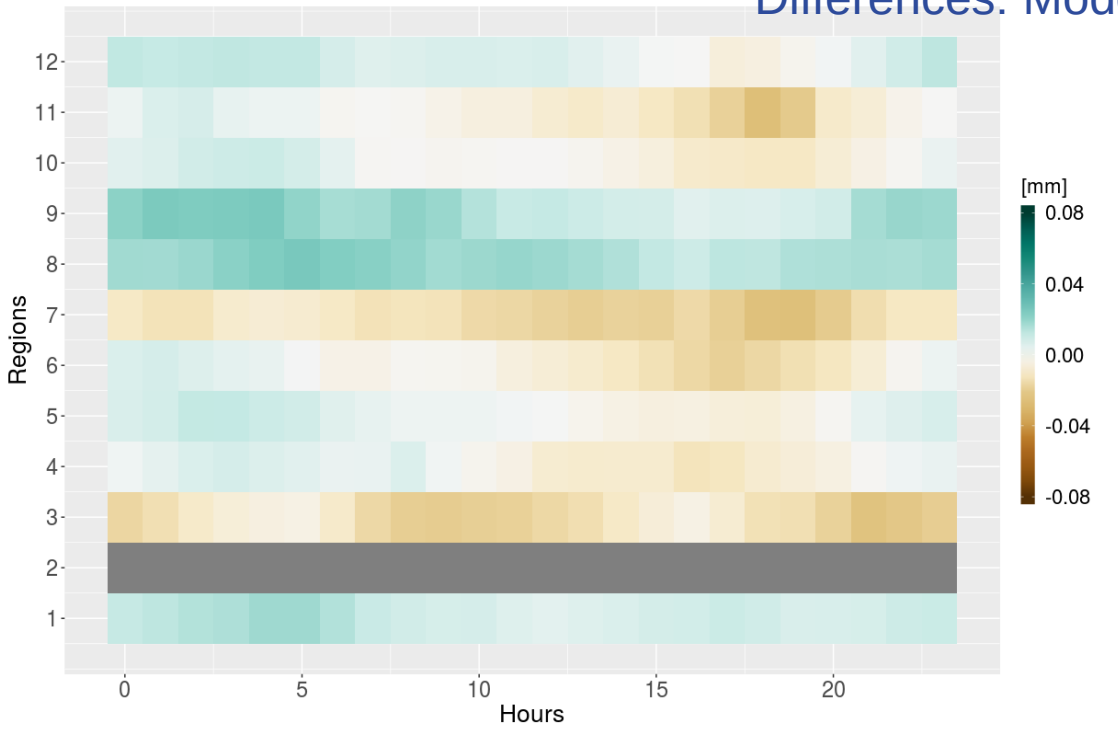
- Good correspondence between COSMO-CLM and RADKLIM, except night-time precipitation
- Strong overestimation of ERA5 precipitation over the day

Haller et al. in prep

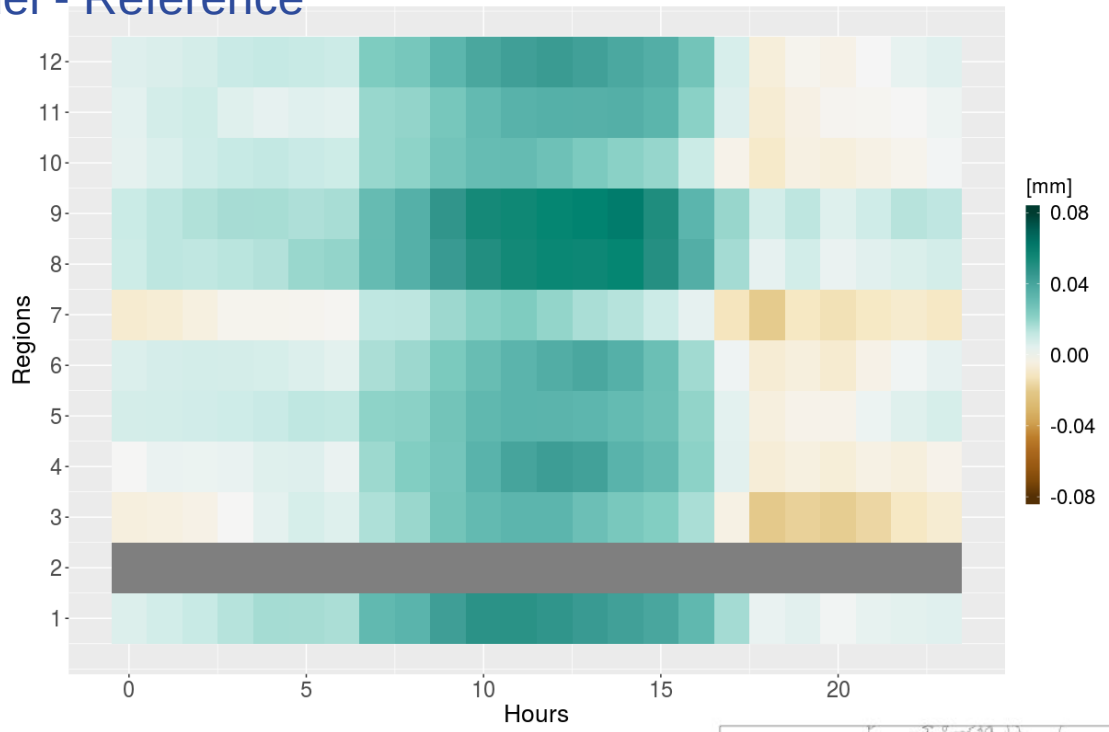
Diurnal cycle of precipitation

70 Jahre Deutscher Wetterdienst
Wetter und Klima aus einer Hand

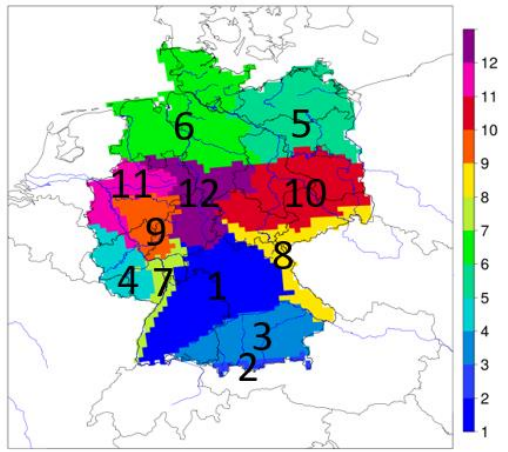
Differences: Model - Reference



COSMO-CLM



ERA5



- Differences show better performance of COSMO-CLM for all regions
- Strong overestimation of precipitation at noon by ERA5
- Differences of COSMO-CLM vary for different regions

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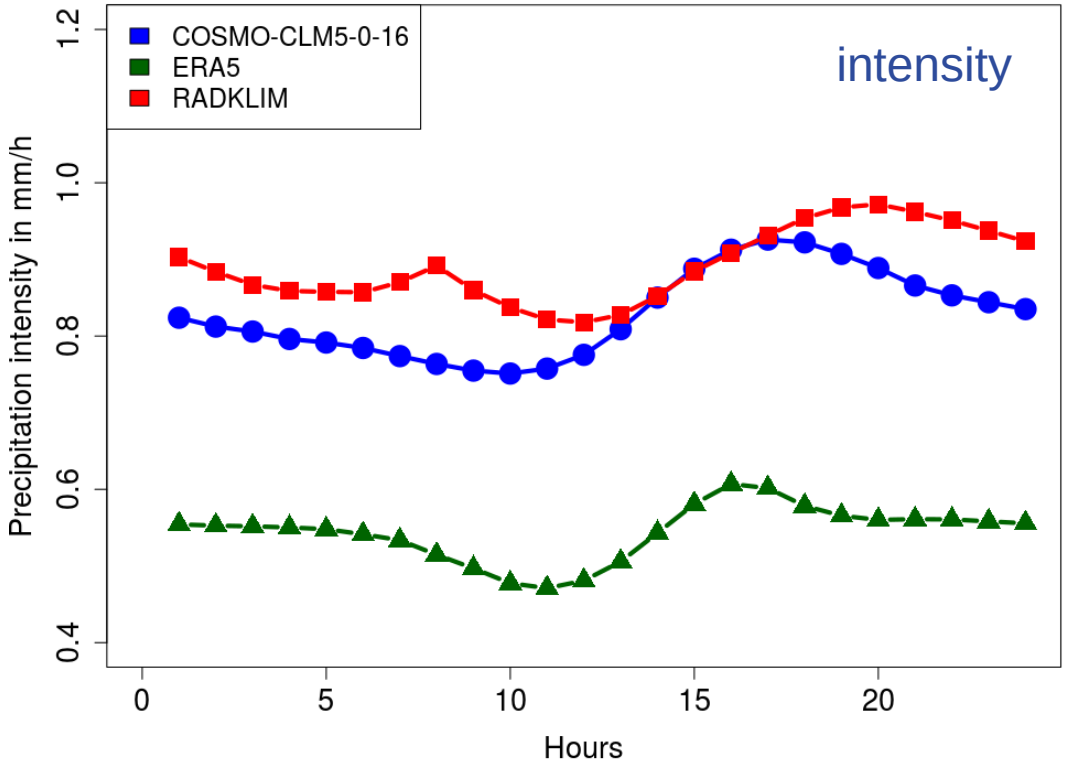
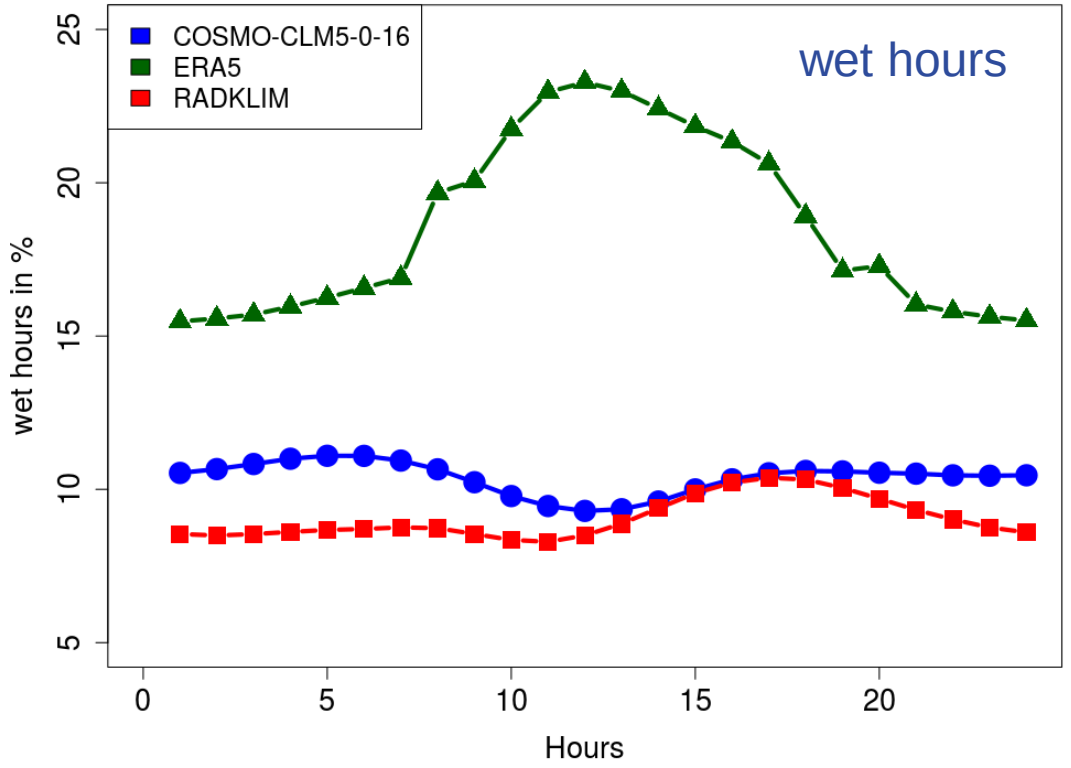
Precipitation intensity and wet hours





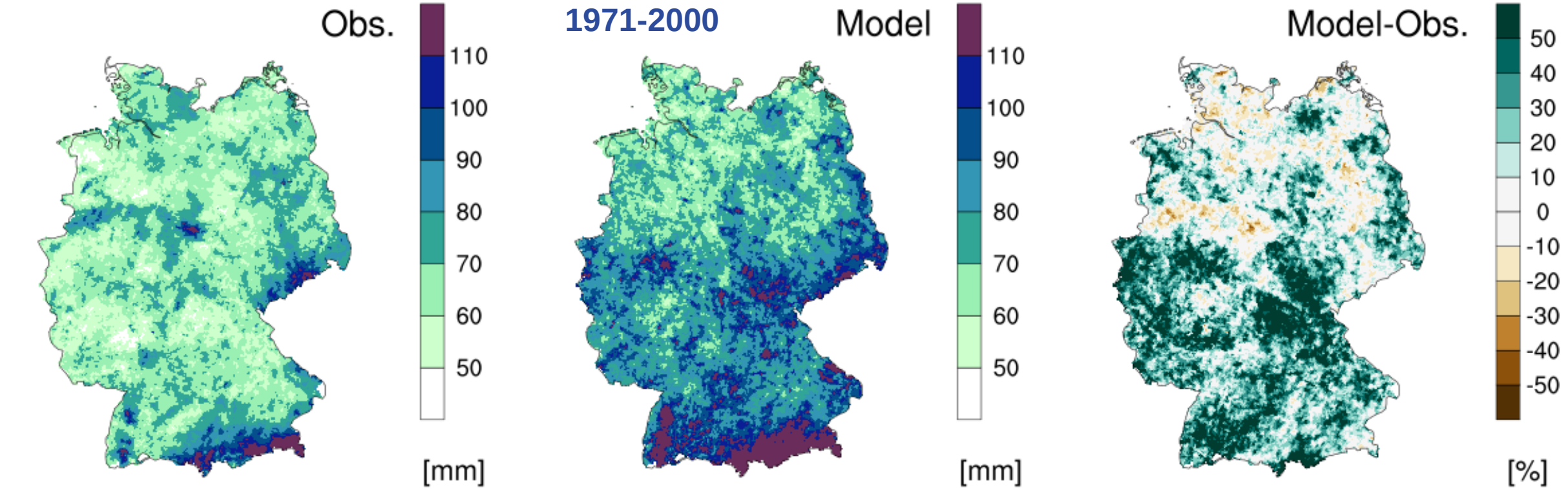
- Good performance of COSMO-CLM, small shift in diurnal cycle
- Strong underestimation of ERA5, but diurnal cycle of intensity is present in both model data. Wet hours are too high in ERA5, especially around noon

Haller et al. in prep

PoT-method application to extreme precipitation

D=24h T=30a

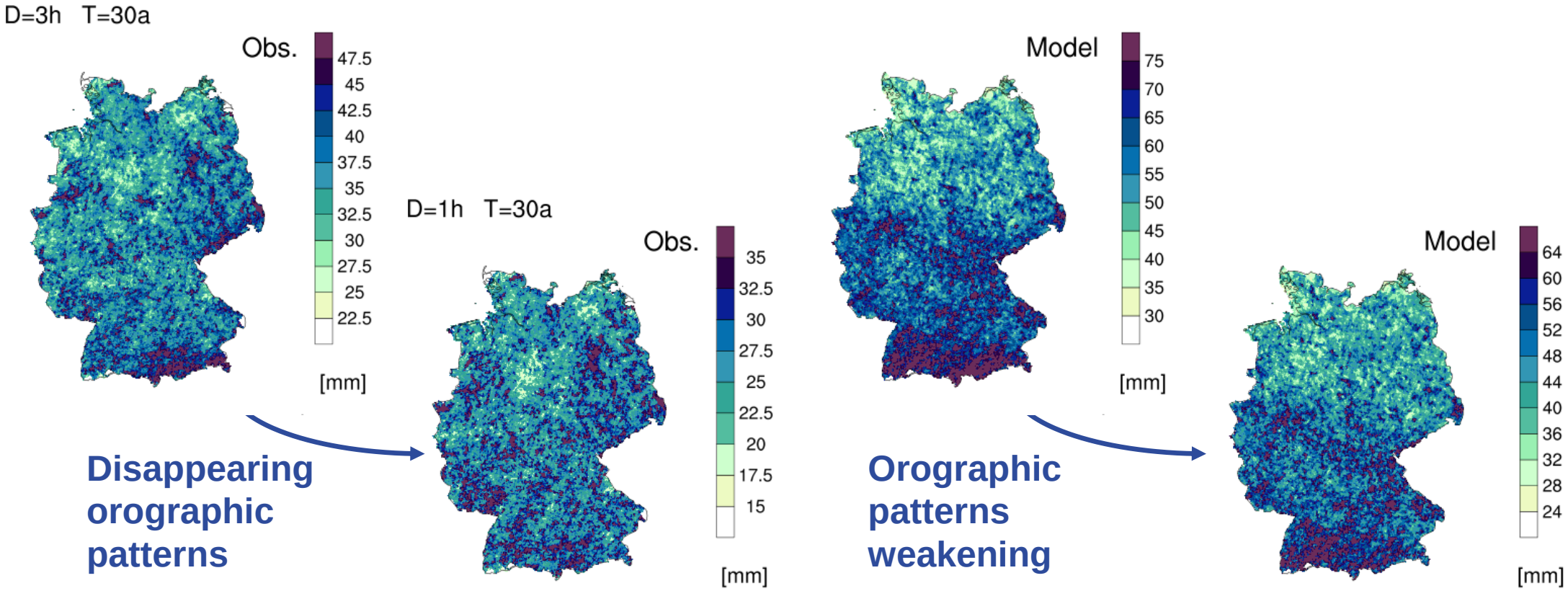
Historical: 1971-2000



- Good correspondence in Northern Germany
- Strong overestimation (30-50%) in mountainous areas / Southern Germany

Rybka et al. 2022, submitted

Short durations (D=3h / 1h; T=30a)



Rybka et al. 2022, submitted

- Model overestimation of short durations (mind the scale!)
- Overestimation of orographic dependance of extreme precipitation

Development of ICON-CLM

- **CLM Community**
  - Contribution to **CORDEX-FPS-convection** with COSMO-CLM runs
    - Part of conv.-perm. climate model ensemble (Coppola et al. 2020)
  - Transition from **COSMO-CLM to ICON-CLM**
    - Development of the regional climate mode of ICON by CLM-Community (Pham et al. 2021) → **ICON-CLM**
    - Model is now applied (first by project NUKLEUS) on 0.11° grid (12 km), for EURO-CORDEX simulations
    - Planned for CMIP6 downscaling activities
    - Need for tuning experiments to find recommended settings (COPAT2)
      - Quasi-parallel to tuning of last official COSMO-CLM6 version
    - Following step would be the tuning for the convection-permitting scale

Conclusion & Outlook

- COSMO-CLM Simulations with 3km grid spacing for 30-year periods
  - CMORized and published on ESGF: **https://esgf.dwd.de/projects/dwd-cps/**
  - Data quality check and evaluation on 3-step scheme in preparation
- Precipitation:
  - Positive added value in comparison to coarse reanalysis data

  …but
  - Overestimation of very extreme precipitation and its orographic patterns on short time intervals (1-3h)
- Wind/ wind gusts:
  - Comparisons to station data are planned
  - Slight but significant decrease of mean winds for far future (2071-2100), more work needed!
- Transition from COSMO-CLM to ICON-CLM ongoing for 12 km grid spacing