The HyperHydro (H^2) experiment for comparing different large-scale hydrological models

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Overview:

HyperHydro (http://www.hyperhydro.org/) is an open network of scientists with the aim of simulating large-scale hydrological models at hyper-resolution (Bierkens et al., 2014, DOI: 10.1002/hyp.10391). We initiated the **H^2 experiment** for comparing different large-scale hydrological models, at various spatial resolutions, from 50 km to 1 km. Model results are evaluated to available observation data and compared across models and resolutions.

Methodology:

The modeling protocol is summarized below:

- As the starting point, we use the Rhine and San Joaquin river basins as the test bed areas. In the near future, we have an ambition to extend our study areas to the CONUS (Contiguous-US) and EURO-CORDEX (Europe) domains.
- Models can be run at 4 spatial resolutions for inter-comparison:
  - 1/2-degree (30-min, ~50km)
  - 1/8-degree (12.5km) or 5-min (~10km)
  - 4 km
  - 1 km
- Modeled soil moisture, evaporation , latent heat flux, discharge, runoff, groundwater table level, snow water equivalent are compared among the models and with ground truth and/or remote sensing data.

Workshop:

To start the experiment, a modeling workshop was organized in Utrecht on 9-12 June 2015. The setup of the modeling workshop was related to the three month appointment of Prof. Reed Maxwell as a Belle van Zuylen chair at Utrecht University.

Fig. 1 – Modeling workshop in Utrecht, 9-12 June 2015.

Forcing:

We use the same forcing:

- 4km (NLDAS-based) forcing from Princeton University is used over the CONUS (including San Joaquin).
- 5km EFAS forcing from EU JRC is used for the EURO-CORDEX (Rhine).

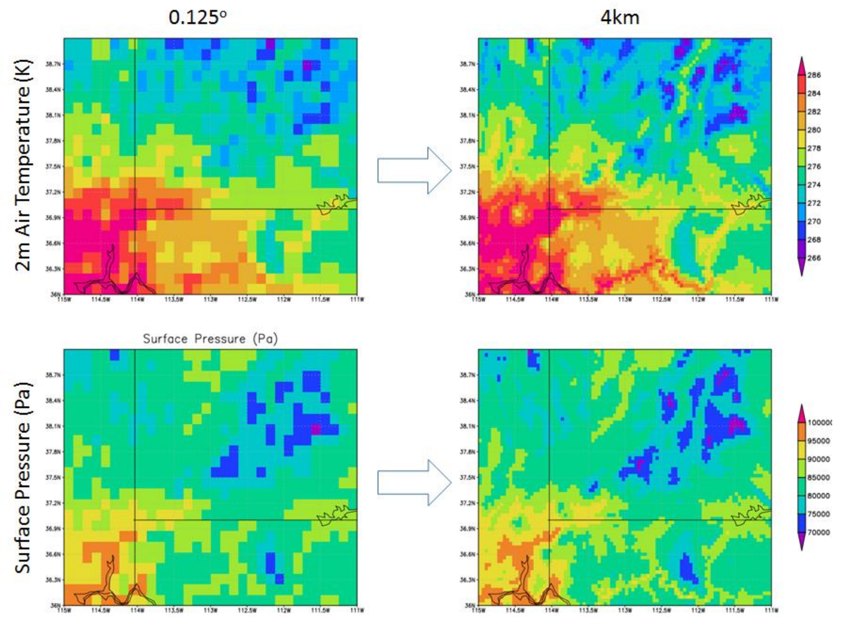

Fig. 2 – Forcing data (NLDAS-based) from Princeton University at the spatial resolution of 1/8-degree (left) and 4 km (right).

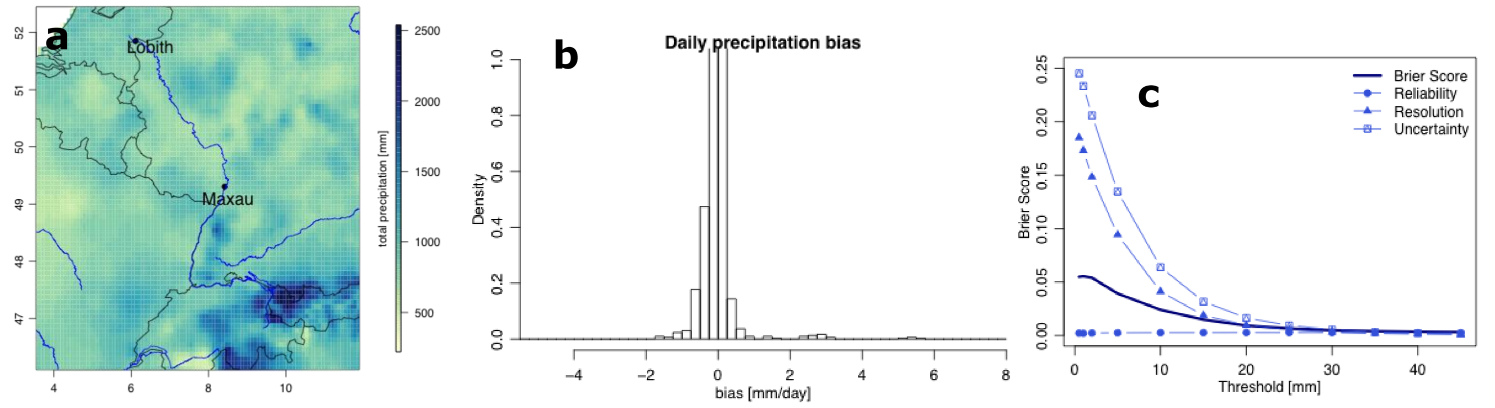

Fig. 3 – (a) Total annual precipitation [mm] from EFAS gridded observations over the Rhine. The EFAS forcing is verified with 3429 station observations from the German Weather Service (DWD), located in Germany. It shows a mean bias of 0.3 mm/day over the entire domain and all available stations; as indicated in the histogram of (b). The Brier Scores in (c) for daily precipitation events and for different thresholds indicate a good accuracy of the EFAS precipitation used to force the hydrological models. The decomposition of the Brier score shows that the modelled precipitation is reliable.

Current results/progress for Rhine:

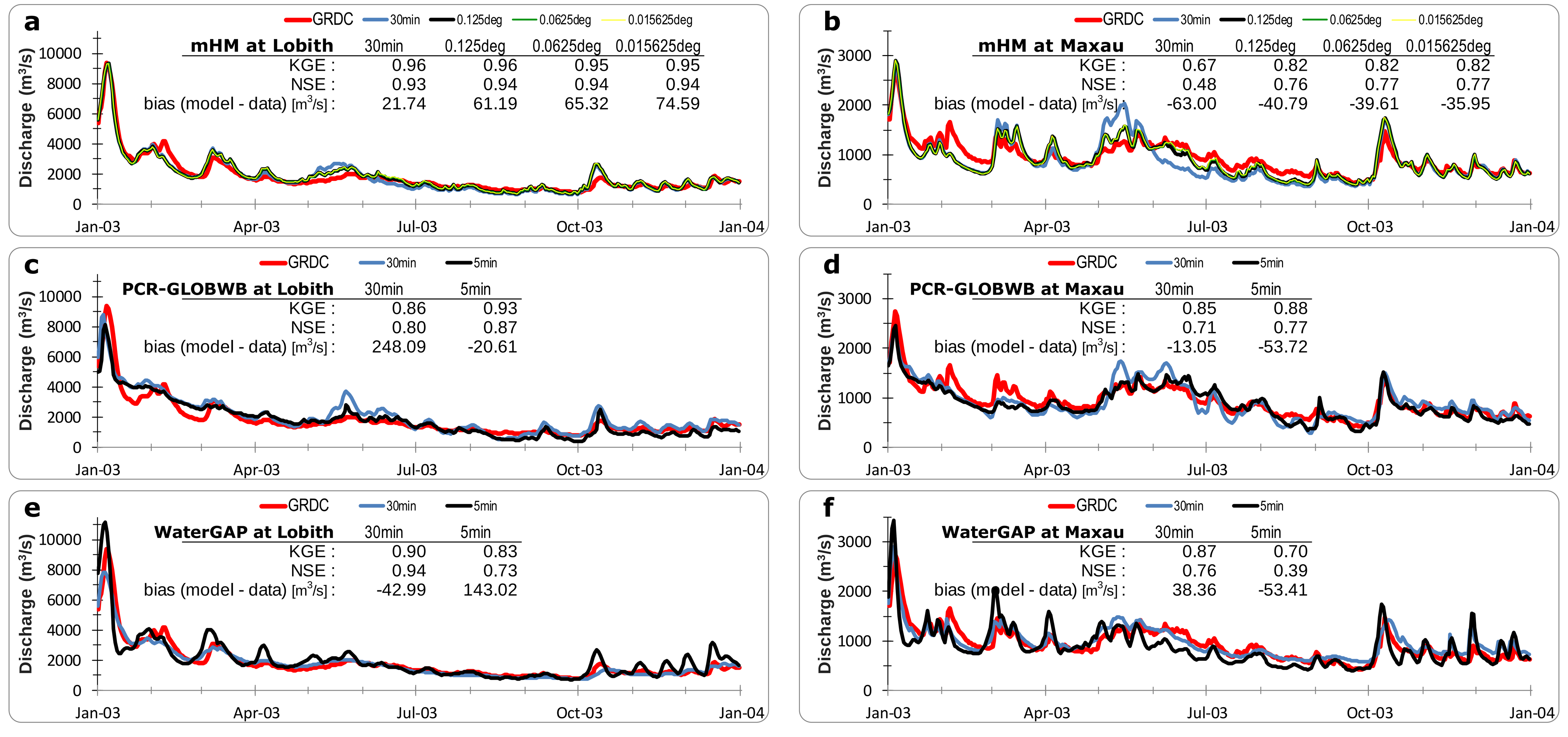

Fig. 4 – Discharge simulation results for the Rhine basin from various models and different spatial resolutions for two locations: Lobith (a, b, and c) and Maxau (c, d, and e). Figs. (a) and (d) are from the mHM model (30-min, 0.125-deg, 0.0625 deg and 0.015625 deg), Figs. (b) and (e) are from the PCR-GLOBWB model (30-min and 5-min), while Figs. (c) and (d) are from the WaterGAP model (30-min and 5-min). Some indicators of model performance evaluated to GRDC data are also given.

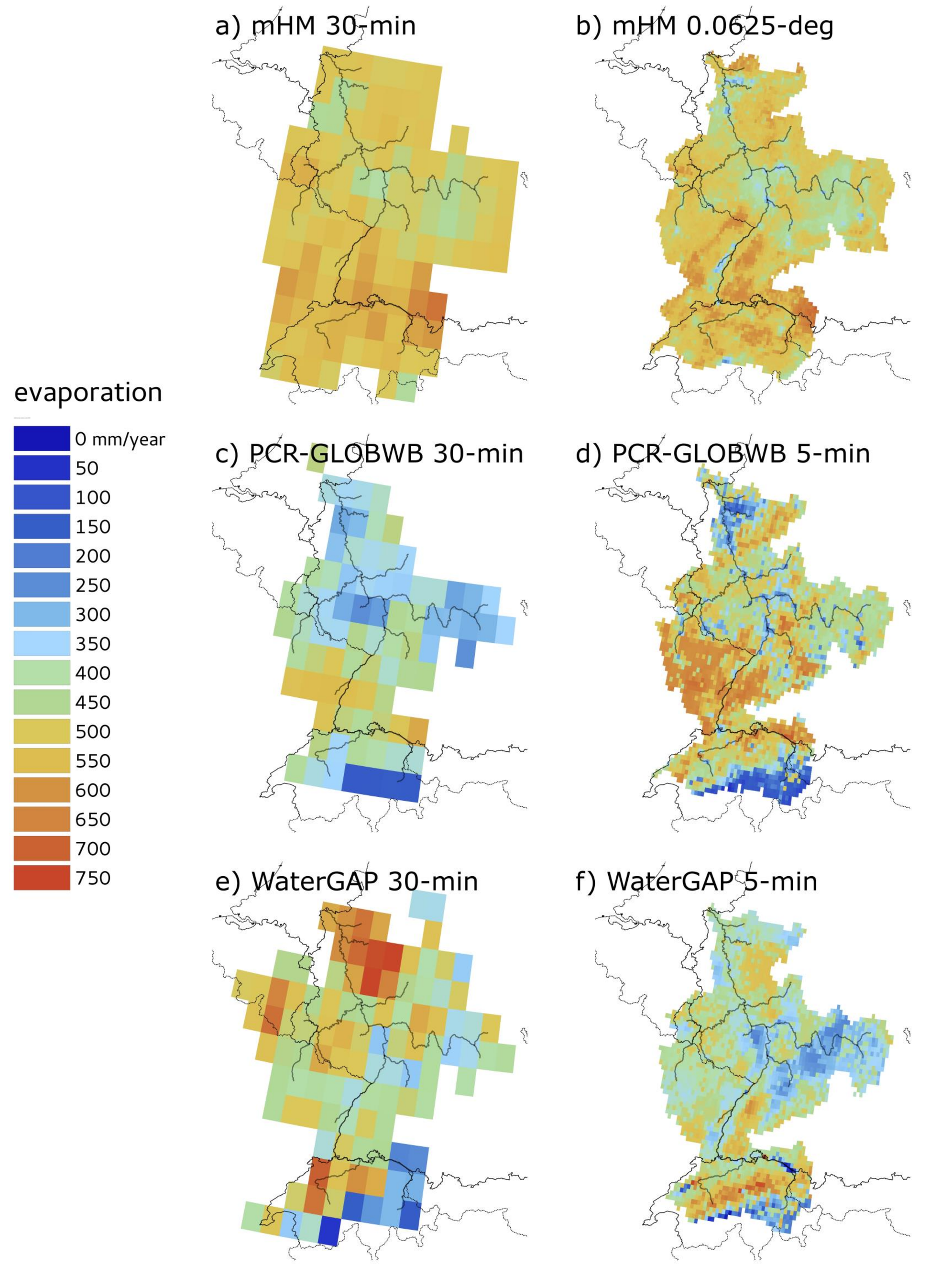

Fig. 5 – Annual evaporation [mm] for the year 2003 from the mHM model at 30-min (a) and 0.0625-deg (b), from the PCR-GLOBWB model at 30-min (c) and 5-min (d), and from the WaterGAP model at 30-min (e) and 5-min (f).

Current results for the San Joaquin and CONUS:

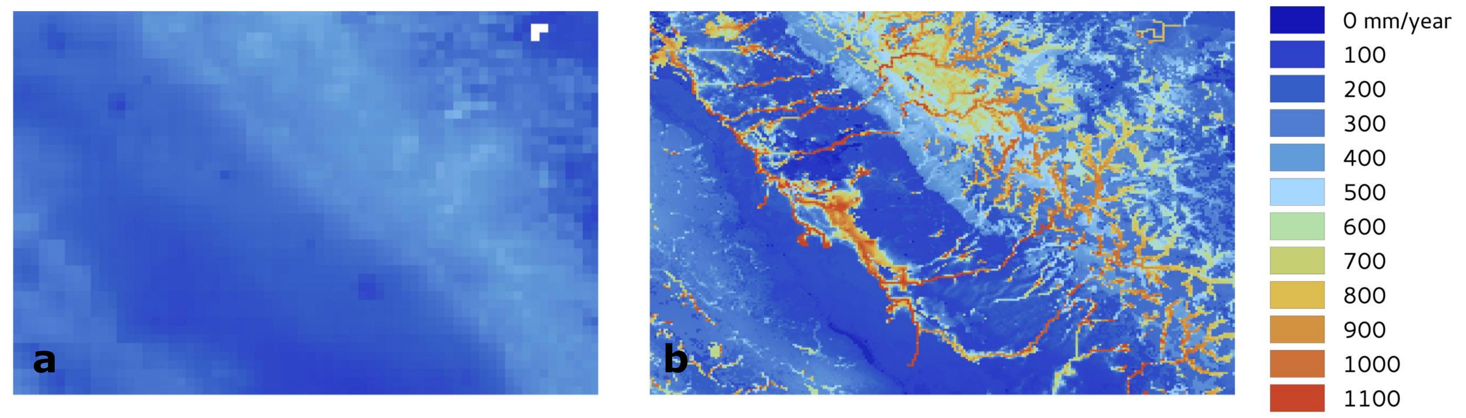

Fig. 6 - Total annual evaporation [mm] for the year 2008 over the San-Joaquin region (California) from the model simulation results of (a) VIC at the spatial resolution of 4 km and (b) Parflow-CLM at the spatial resolution of 1 km.

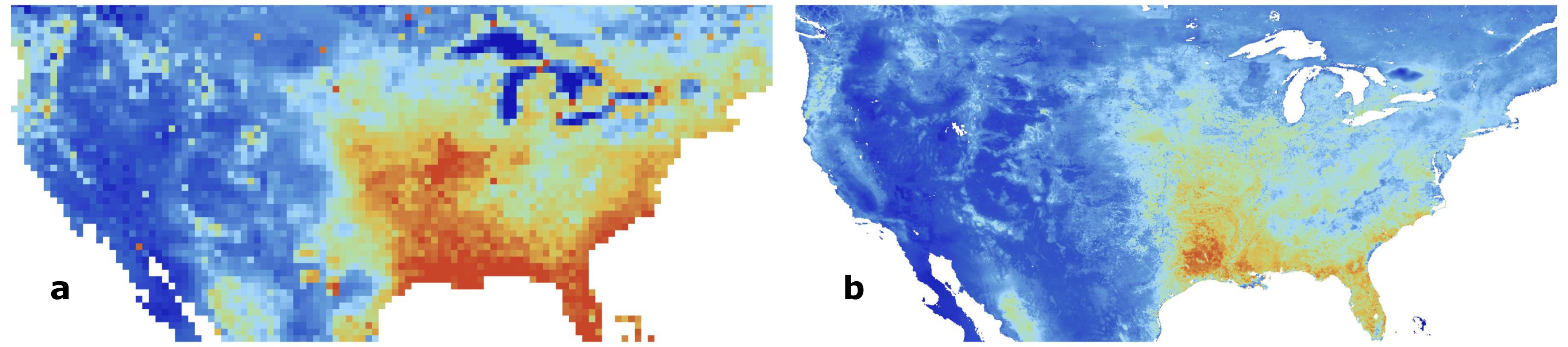

Fig. 7 - Total annual evaporation [mm] for the year 2008 over the CONUS region from the model simulation results of (a) WaterGAP at the spatial resolution of 30 arc-minute (~ 50 km) and (b) VIC at the spatial resolution of 4 km.