

Hydrological Models and Climate Models - a plea for close collaboration-

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L. Samaniego et al.

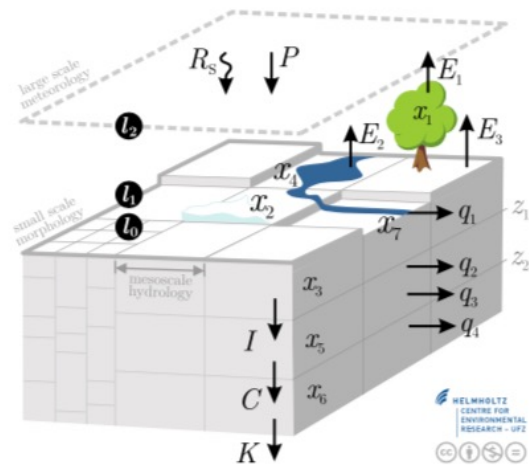
Droughts and Floods

Two of the most devastating consequences of climate change

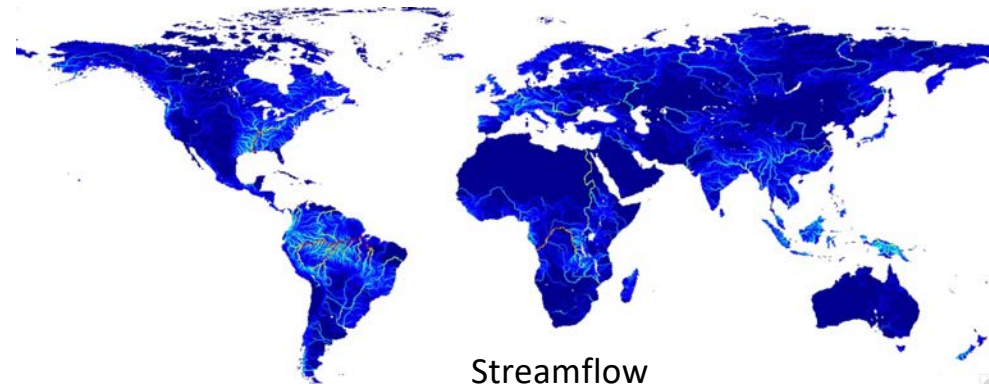


- 3 billion people affected in the last two decades
- human suffering
- huge economic losses

Hydrological model mHM



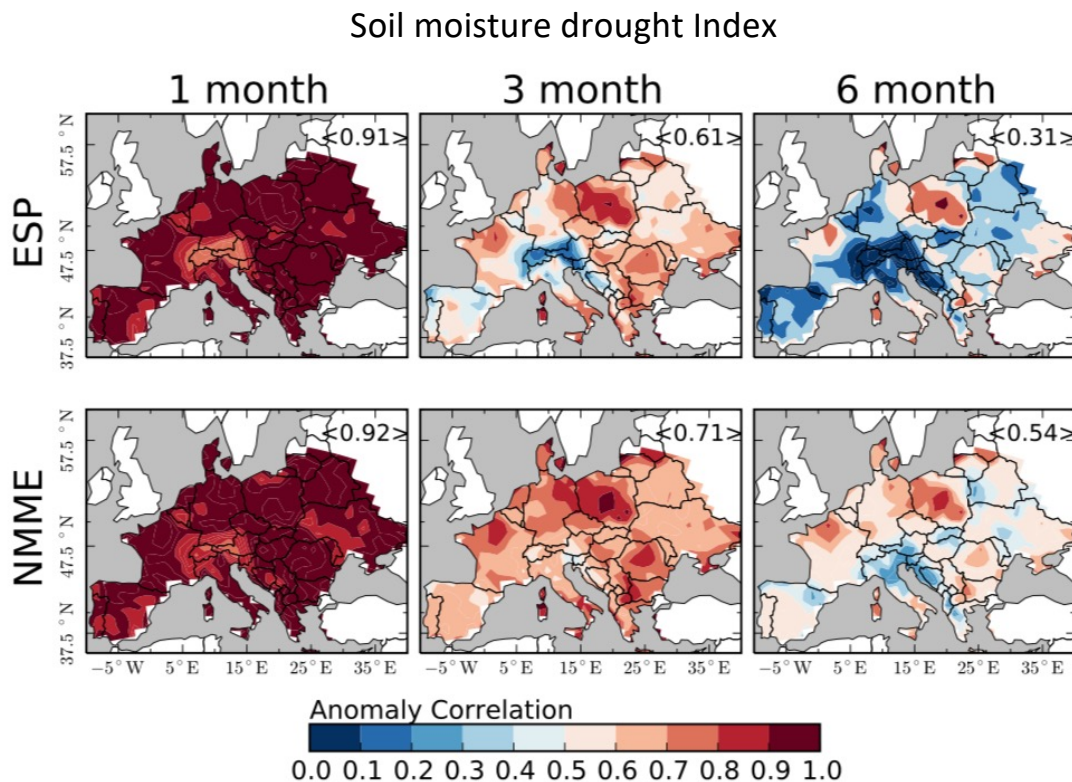
Cell i , time t



- grid-based seamless hydrological model
- state variables and fluxes like : soil moisture, streamflow, ET, groundwater recharge
- unique feature: **Multiscale Parametrization Scheme (MPR)**

mHM: Luis Samaniego et al., mesoscale Hydrologic Model. Zenodo. doi:10.5281/zenodo.1069202, <https://doi.org/10.5281/zenodo.1069202>

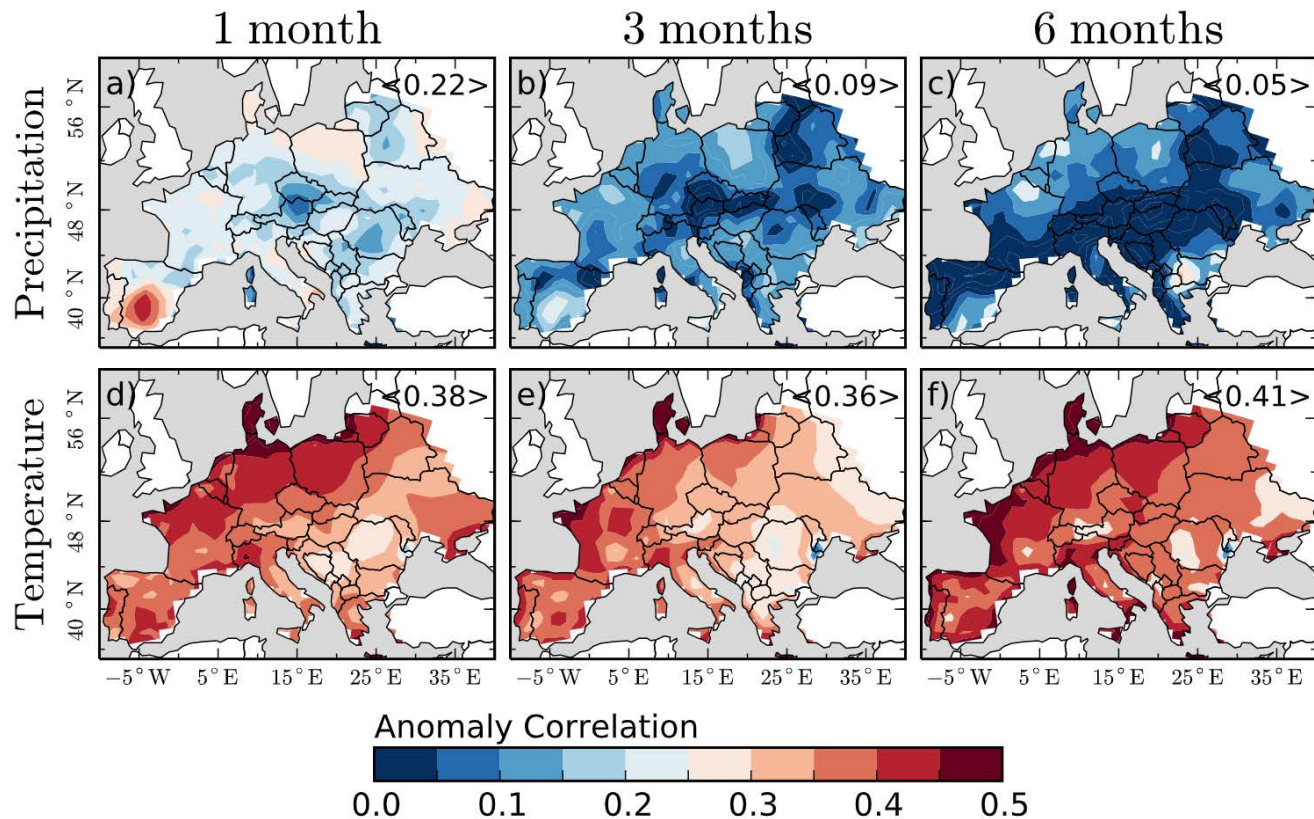
Soil moisture drought hindcast skill



- GCMs (NMME) models exhibit higher skill in drought hindcasting compared with statistical (ESP) models

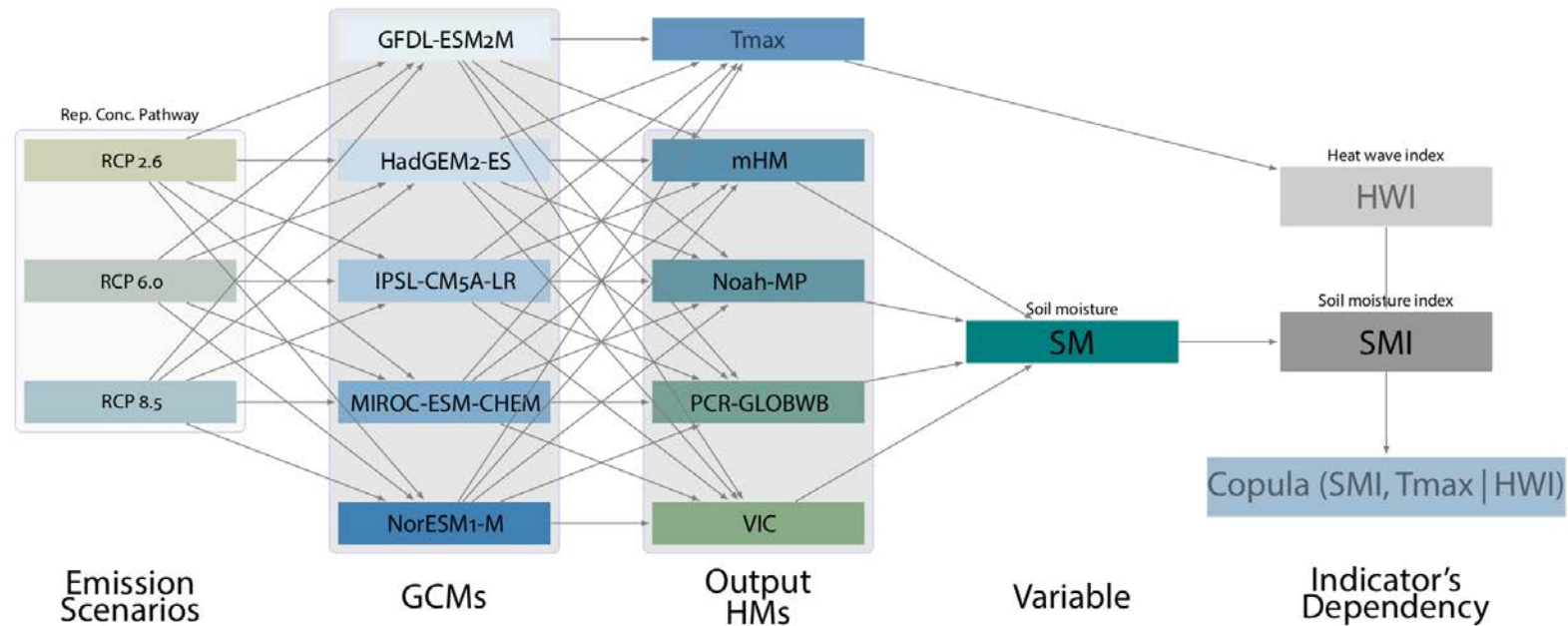
Thober, S., Kumar, R., Sheffield, J., Mai, J., Schäfer, D. & Samaniego, L. Seasonal Soil Moisture Drought Prediction over Europe Using the North American Multi-Model Ensemble (NMME). *Journal of Hydrometeorology* **16**, 2329–2344 (2015).

NMME hindcast skill

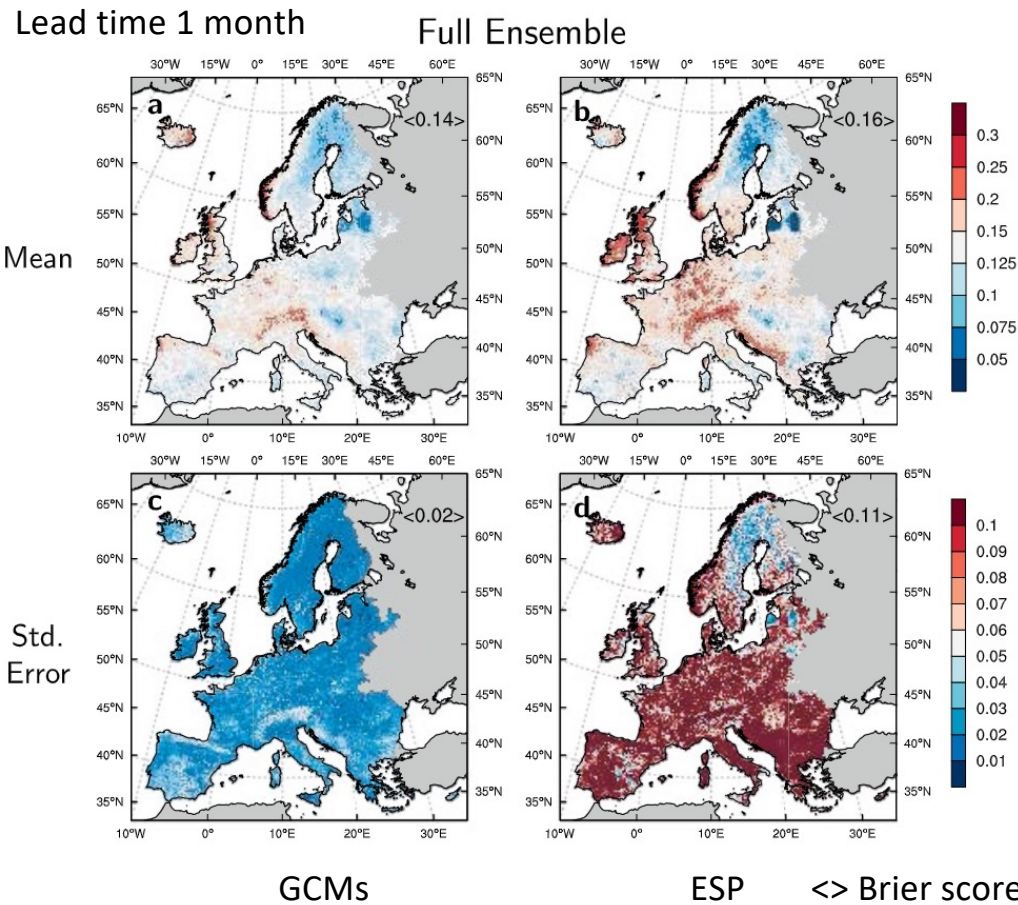


- Precipitation forecast of NMME was poor.
- Skill of drought forecast originates from the capability of the models to forecast temperature.

Prediction Modeling Chain (European Project EDgE)



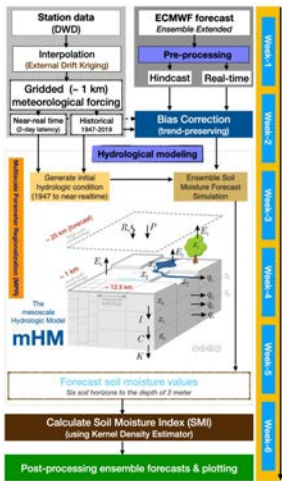
SM drought Index (EDgE-project)



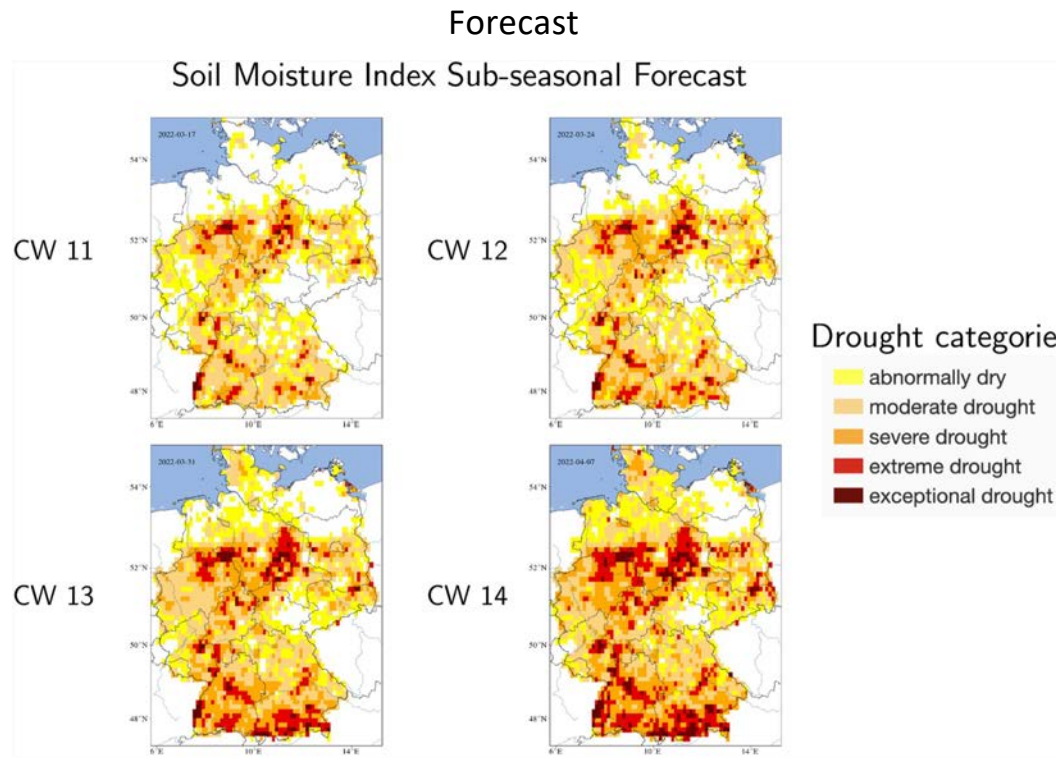
- GCMs performed much better than statistical models
- Hydrological models 5km, GCMs 0.25 deg
- No bias correction

Samaniego, L., Thober, S., Wanders, N., Pan, M., Rakovec, O., Sheffield, J., Wood, E. F., Prudhomme, C., Rees, G., Houghton-Carr, H., Fry, M., Smith, K., Watts, G., Hisdal, H., Estrela, T., Buontempo, C., Marx, A. & Kumar, R. Hydrological Forecasts and Projections for Improved Decision-Making in the Water Sector in Europe. *B Am Meteorol Soc* **100**, 2451–2472 (2019).

Soil moisture sub-seasonal forecast DE

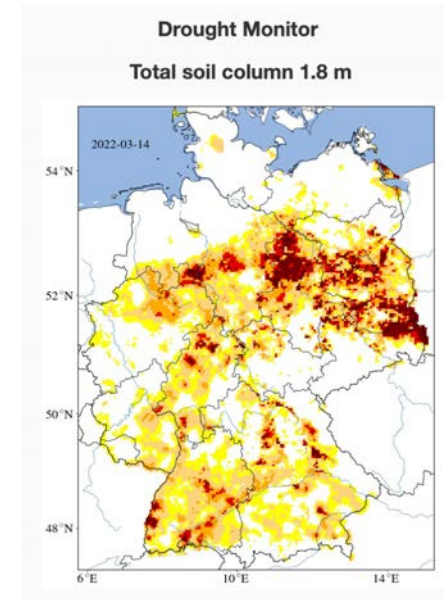


Realistic compared with GCM



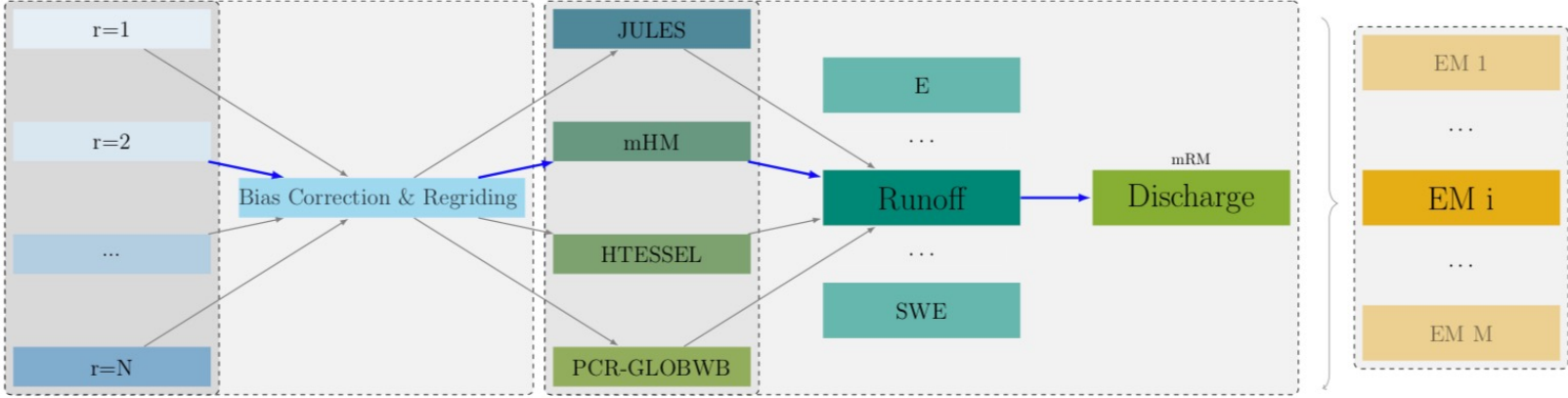
<https://www.ufz.de/moses/index.php?en=47304>

GDM today



<https://www.ufz.de/index.php?en=379>
37

Flood Forecast Modeling Chain ULYSSES



ECMWF SEAS5
Ensemble

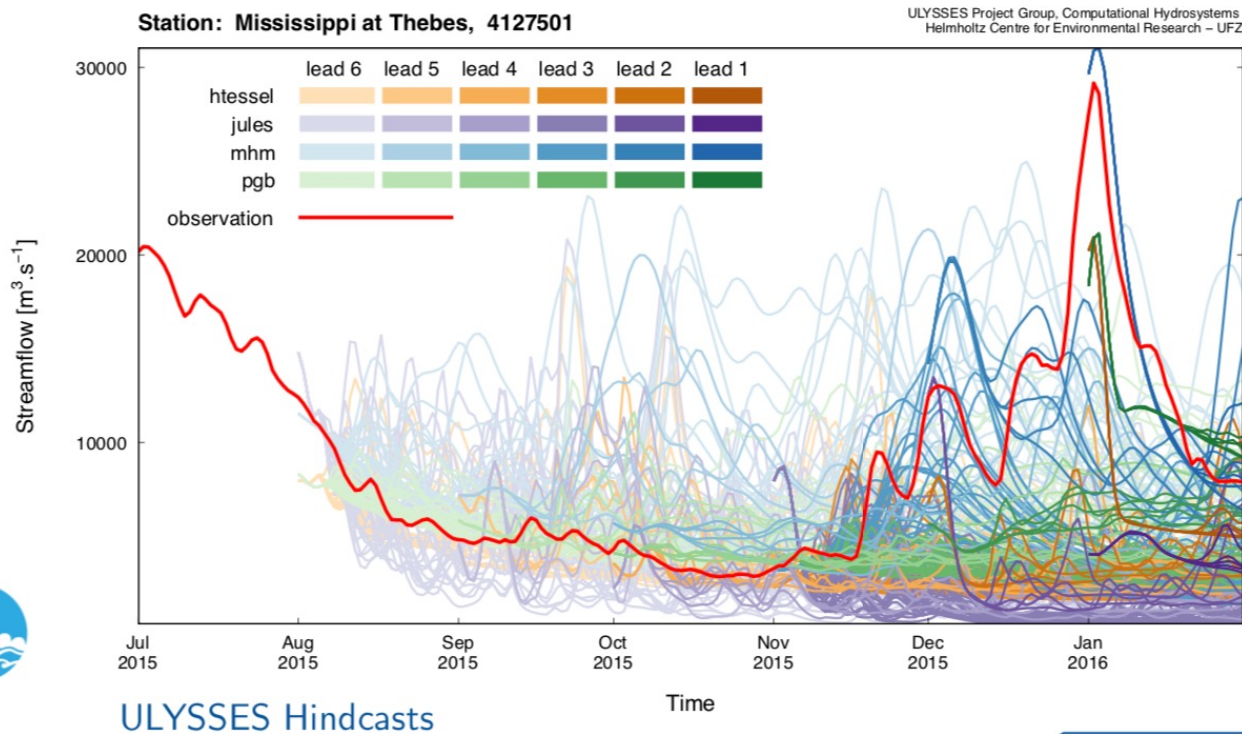
N=25, Lead = 6 m

Hydrological
Models

tECVs

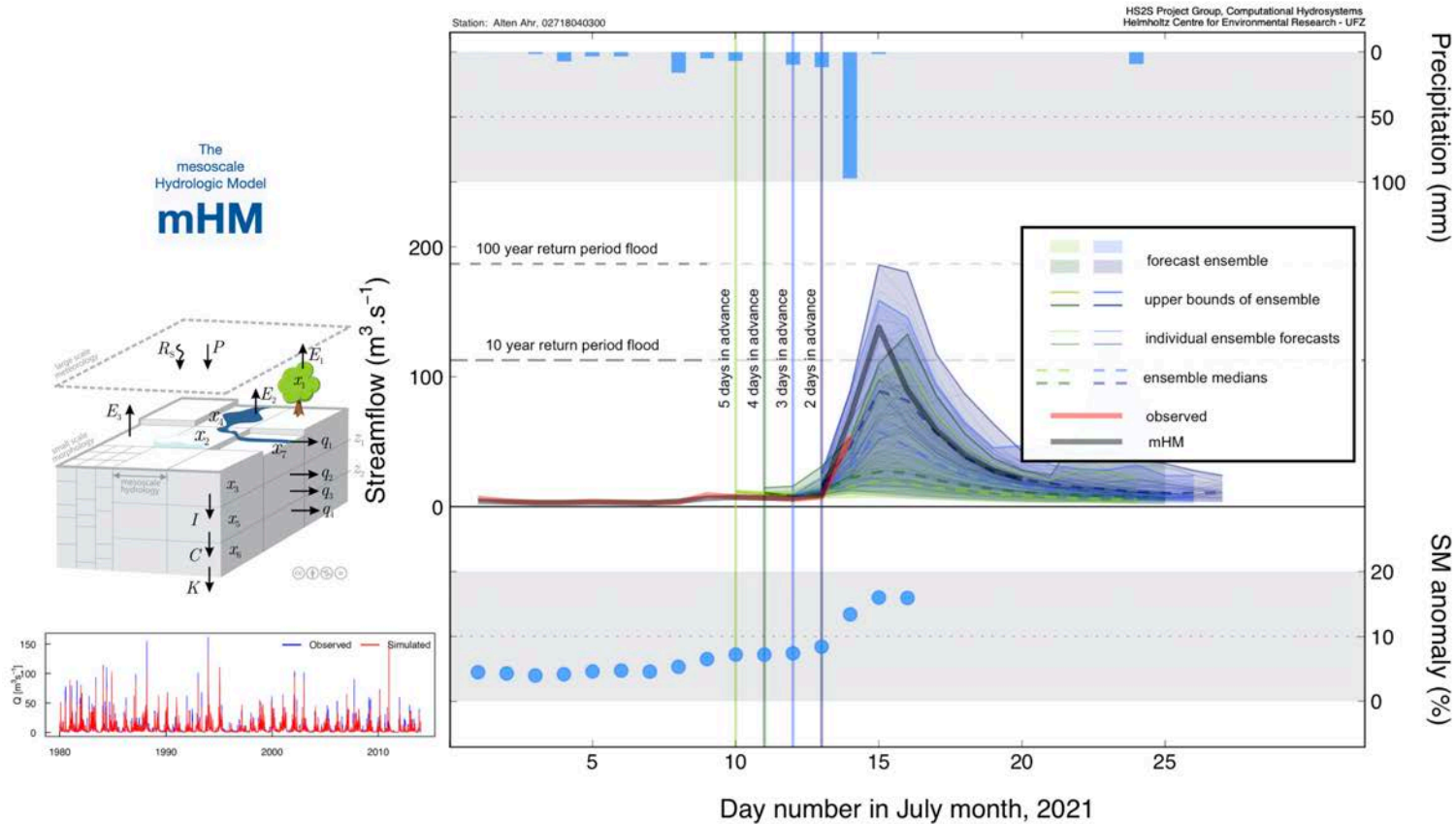
Efficiency
Metrics

New ULYSSES flood forecast



- Bias correction, downscale full ensemble IFS (0.2deg). Initial conditions ERA5-land
- The **IFS-mHM** forecast is skillfull. Lead time 1 month!
- **Other LSM/HM are not skillfull.**

Flash flood forecast DE (1 km)



Bias correction of the IFS PRECIP is NEEDED to catch the observed Q records

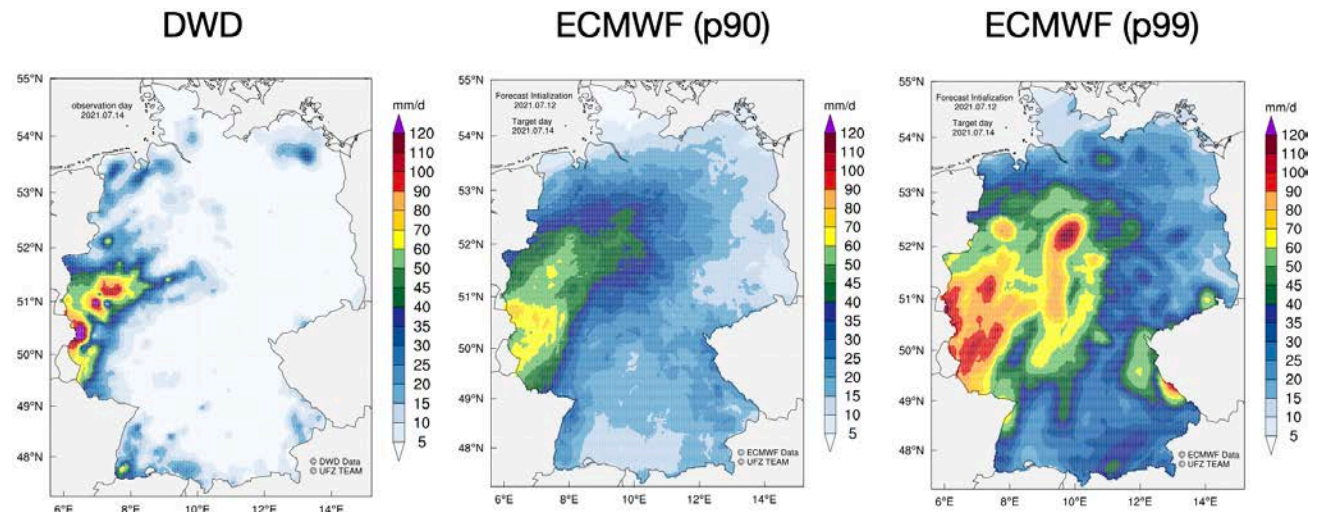
Needed: realtime meteo data (DWD) HYRAS 1 h to generate initial conditions

The ECMWF IFS model got the event, but...

Magnitude of the precip is underestimated!

Timing is fundamental for flash forecast

Resolution should be 1-2 km at most. Convection permitting mech. needed.



Samaniego et al. 2021, AGU.

NWP Resolution .2 deg
Disagg. 1 km

Summary

- Existing prediction modelling chains of GCMs combined with HMs show high skills in predicting soil moisture droughts (temperature + initial hydrological conditions)
- Skillful flood forecasting systems are the next step: need hourly precipitation, convection resolving GCMs and a fast online coupling with GCMs --> Destination Earth Project (DestinE)