Online coupling of the mesoscale hydrologic model mHM into ICON using YAC
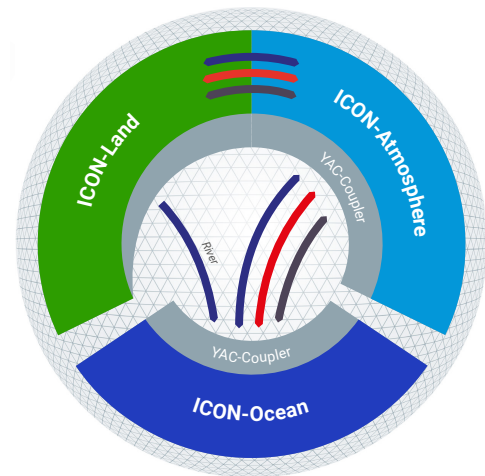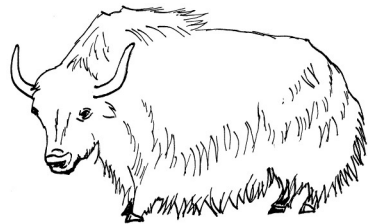
Stephan Thober[1], Daniel Klocke[2], Moritz Hanke[3], René Redler[2], Sebastian Müller[1]

6 month support to set up coupling between mHM and ICON using YAC

1 Helmholtz Centre for Environmental Research – UFZ
2 Max Planck Institute for Meteorology (MPI-M)
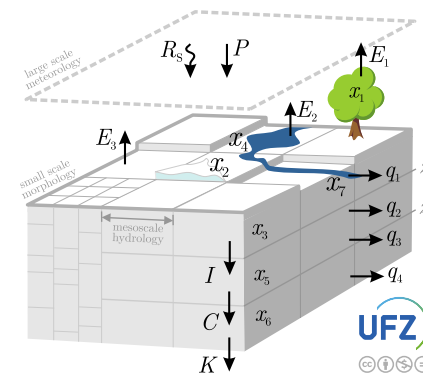3 Deutsches Klimarechenzentrum (DKRZ)

The mesoscale
Hydrologic Model

mHM

Legend:
- Energy, Momentum
- Water
- Carbon

natESM workshop 21. February 2022, virtual meeting

Paradigm shift in climate impact workflow
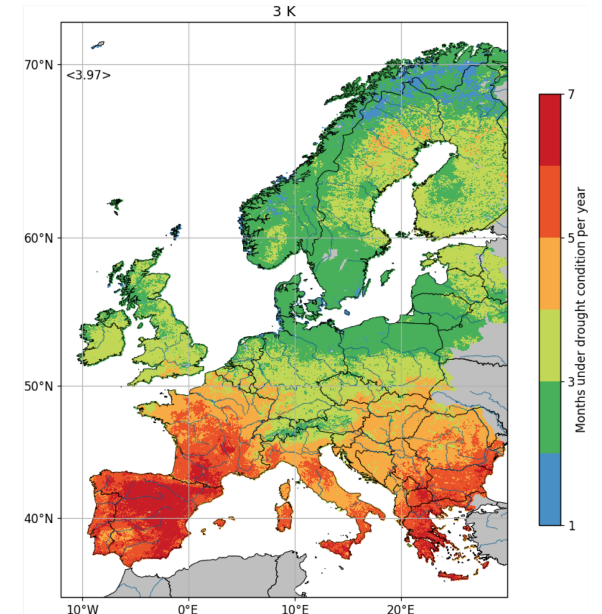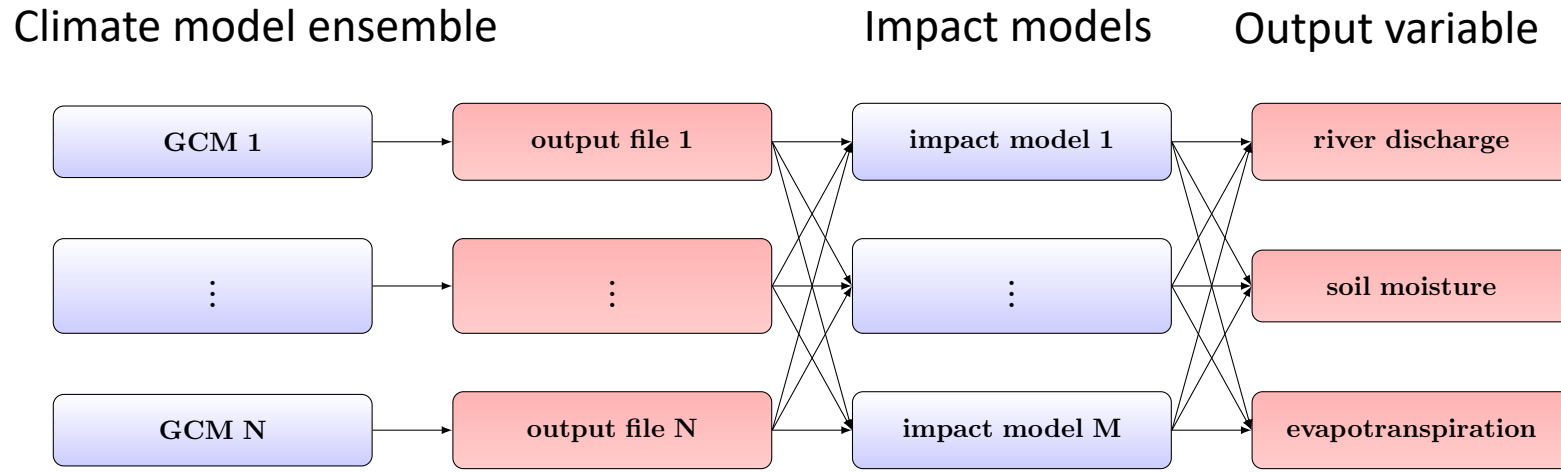
Samaniego and Thober et al., 2018 (NCC)

Coupling via files.

Climate model ensemble

Impact models

Output variable

GCM 1 → output file 1

⋮ → ⋮

GCM N → output file N

impact model 1

⋮

impact model M

river discharge

soil moisture

evapotranspiration

Coupling via memory

ICON

YAC

mHM

Precipitation, 2-m air Temperature, humidity, Downward radiation

ICON image from:
Jungclaus, J. H., Lorenz, S. J., Schmidt, H., Brovkin, V., Brüggemann, N., Chegini, F., et al. (2022). The ICON Earth System Model version 1.0. Journal of Advances in Modeling Earth Systems, 14, e2021MS002813. https://doi.org/10.1029/2021MS002813
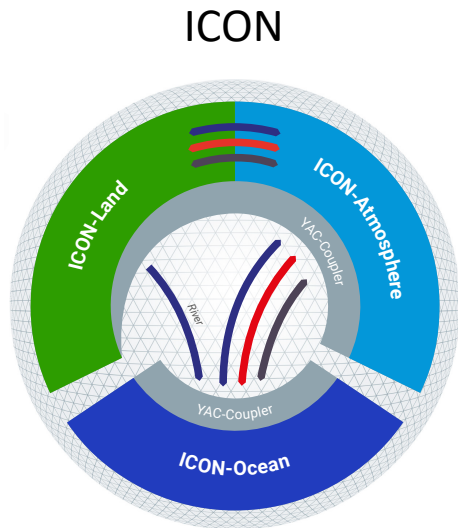
Model/Software Application Field

- Scientific highlights:

ICON is a state-of-the-art Earth System Model that is used for numerical weather prediction and climate studies. mHM is a state-of-the-art hydrologic model that is used for hydrologic impact assessment in various studies, e.g., in studies contributing to IPCC reports.

- Social relevance:

ICON is used operationally for weather prediction at the German Weather Service. mHM is a center piece of the German Drought Monitor that provides daily updated information on agricultural droughts in Germany (www.ufz.de/duerremonitor).

- Plans for further use and dissemination:

The ICON modifications will also allow other external models to run in parallel. For mHM, scientific studies for climate change impact and flood modelling will be done.

Brief Overview of Model/Software

- ESM field: land and impact modelling

- User group: mHM: > 30 active users; ICON: **> 100 users**

- Targeted simulations: coupled simulations of ICON and mHM

- HPC usage: DKRZ, JUWELS, ECMWF HPC, for mHM CPU-based

- Maintenance:

  mHM: > 7 active developers, GNU lesser public license, YAC interfaces will be maintained beyond the lifetime of the support, **institutional commitment**

  YAC: 2 active developers, institutional commitment, BSD 3-Clause license

  ICON: > 30 active developers, proprietary license

Description of Planned Work

- Scope of Request:

   6 months, test-driven development, CPU HPC

- Criteria for fulfilment:

   1.) mHM stand-alone simulation controlled by YAC

   2.) coupled ICON mHM simulation for a small test domain and short period

- Expected scientific and/or performance improvements:

   Using high resolution data from climate models for impact studies that provide a greater wealth of information than currently possible.

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Thank you for your attention.
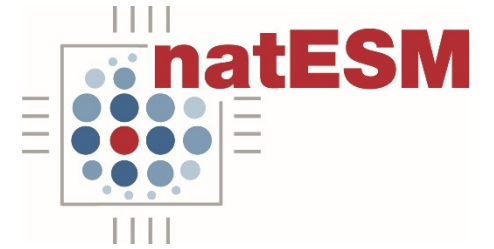
Thank you for your attention.

Any questions?
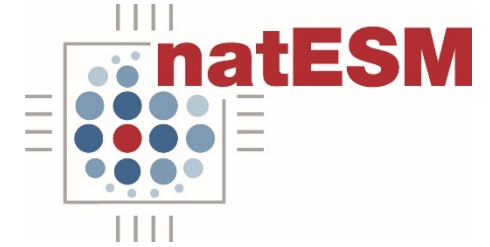
References

L. Samaniego, *S. Thober*, R. Kumar, N. Wanders, O. Rakovec, M. Pan, M. Zink, J. Sheffield, E. F. Wood & A. Marx: Anthropogenic warming exacerbates European soil moisture droughts, Nature Climate Change, Volume 8, Pages 421–426 (2018), https://doi.org/10.1038/s41558-018-0138-5

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