



2025-2026 EOAS Colloquium Series

Computing the Full Earth System at 1 km Resolution

We present the first global simulation of the full Earth system at 1.25 km grid spacing, achieving the highest time compression with an unseen number of degrees of freedom. Our model ICON captures the flow of energy, water, and carbon through key components of the Earth system: atmosphere, ocean, and land.

To achieve this landmark simulation, we harness the power of 8192 GPUs on Alps and 4096 GPUs on JUPITER, two of the world's largest GH200 superchip installations. We use both the Grace CPUs and Hopper GPUs by carefully balancing Earth's components in a heterogeneous setup and optimizing acceleration techniques available in ICON's codebase.

We show how separation of concerns between scientists and software engineers can reduce the code complexity by half while increasing performance and portability. Our achieved time compression of 92 simulated days per day enables long studies including full interactions in the Earth system and outperforms earlier atmosphere-only simulations at a similar resolution. Until now it has not been possible to represent the interaction between the fine and fast scales that mediate the interactions between water and energy – for instance the daytime heating over land that causes afternoon thunderstorms – with the large and slow scales of the carbon reservoirs they influence. These reservoirs collectively define the land biosphere, which then go on to influence how the fast and fine scales develop in the future. The performance demonstrated allows to simulate two scenarios of future warming, each with three ensemble members on the currently largest machines. This has enormous and enduring potential to provide full global Earth system information on local scales about the implications of future warming for both people and eco-systems, information that otherwise would not exist.



Dr. Daniel Klocke
Max Planck Institute for Meteorology

Time: 3:00 PM, Friday, November 07, 2025

Location: EOA 1044

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