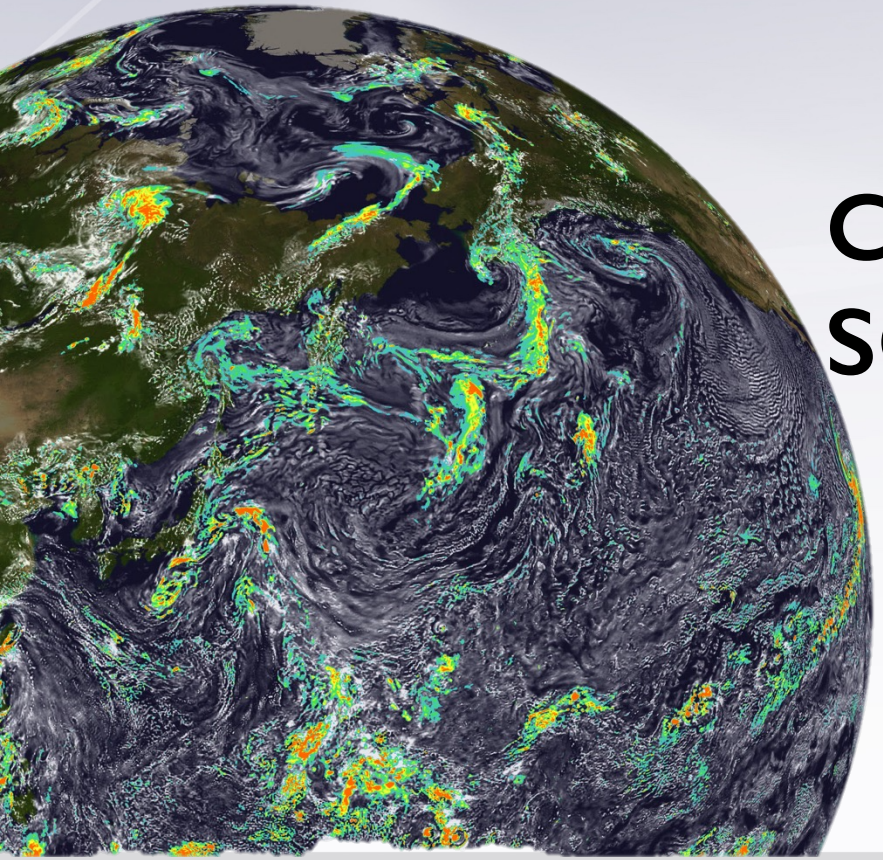
E3SM
Energy Exascale Earth System Model



# Capabilities and remaining challenges for SCREAM Evaluation

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# SCREAM is expensive to run and produces lots of data

1. Simulation throughput

   ~ 10 sim-day/day

   Need evaluation and post-processing of output of daily/hourly fields (not monthly fields)

2. Computational cost

   9500 node-hours/sim-day

   Limits number& length of simulations to evaluate the model at ne1024

3. Output size

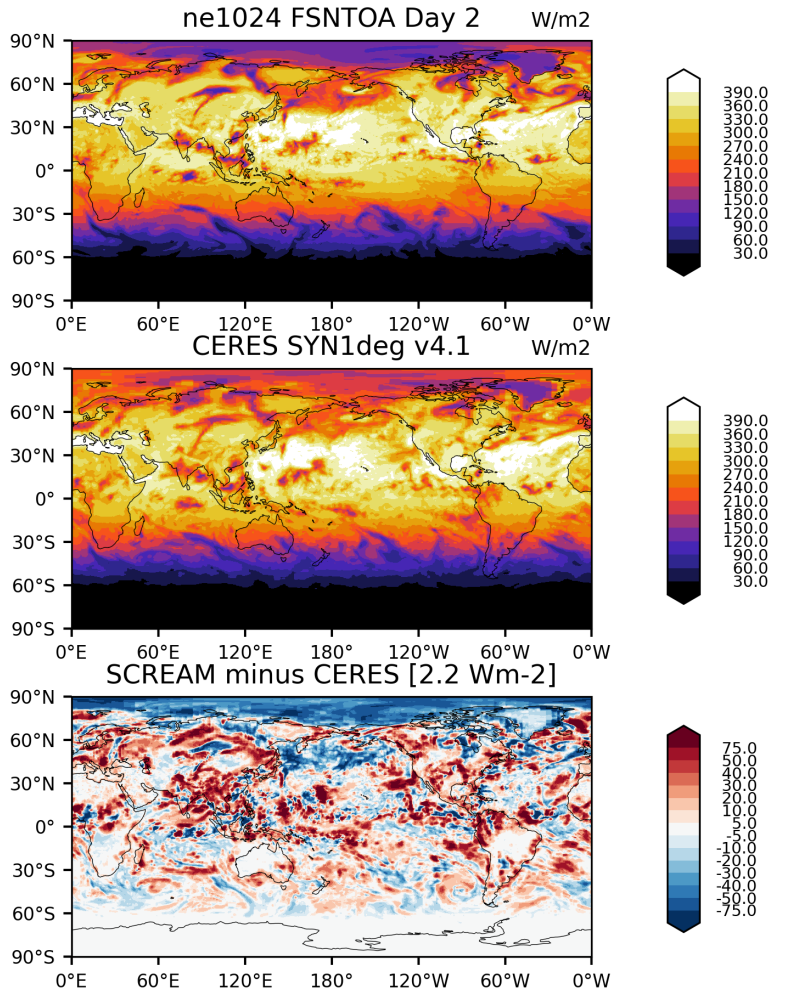
   ~100 MB per 2D data field

   ~8TB per 3 days of simulation (incl. restart) vs ~25 TB of scratch

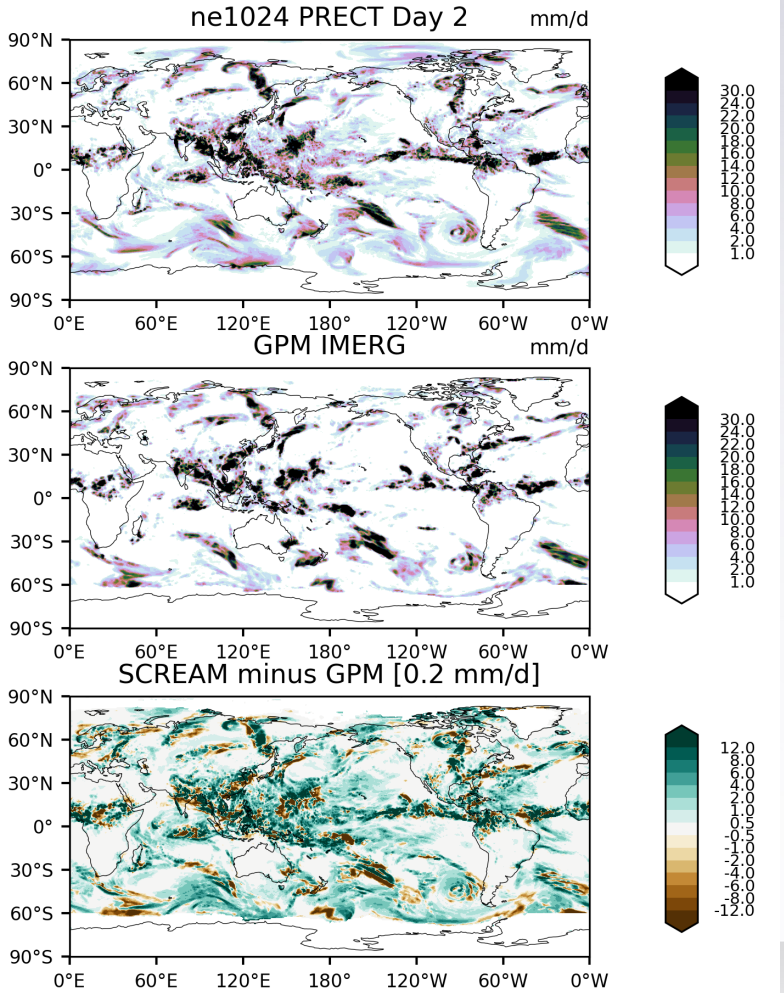
   Need a workflow for quick analysis and regridding of data to manageable size before movement of data to HPSS

# Observations that we currently use

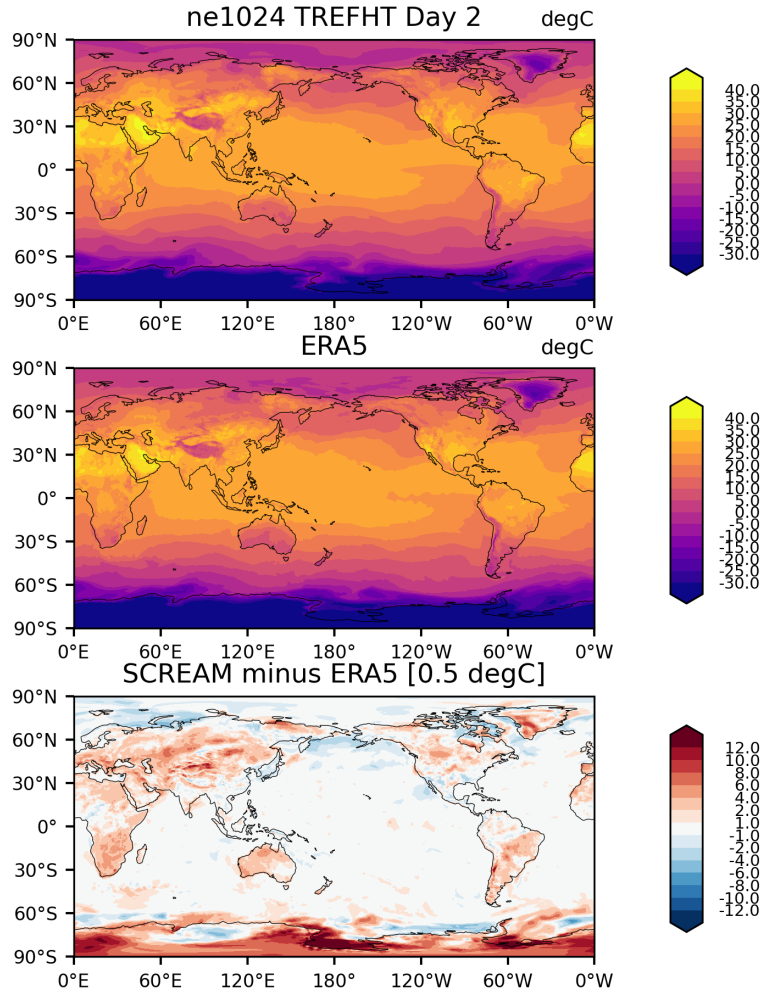
## CERES-SYN1deg



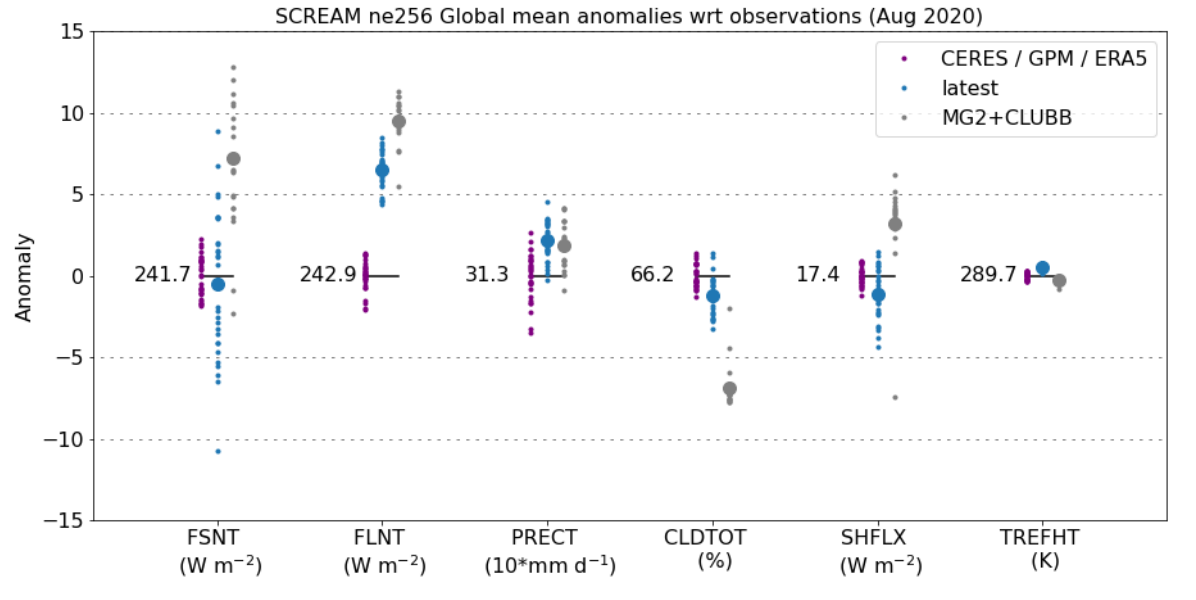

## GPM




## ERA5

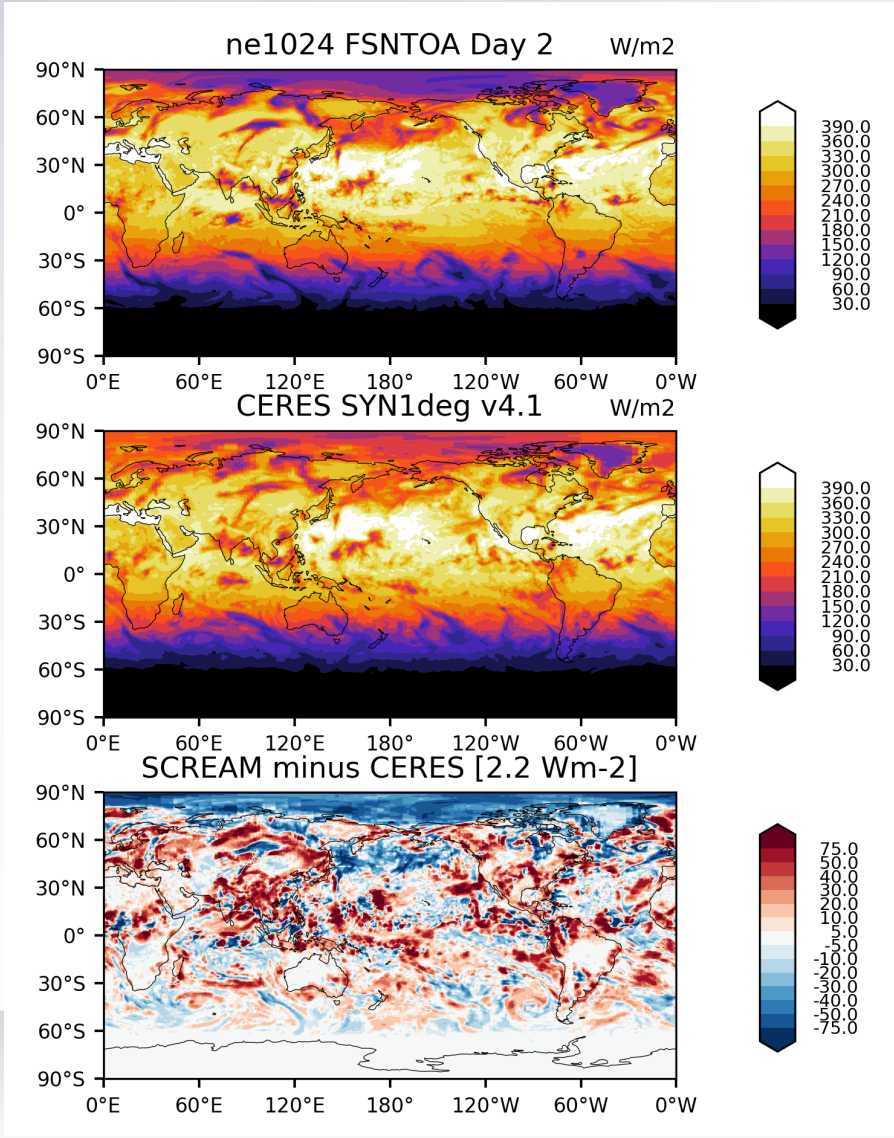


# Evaluation diagnostics using regridded data and lower resolution testbed

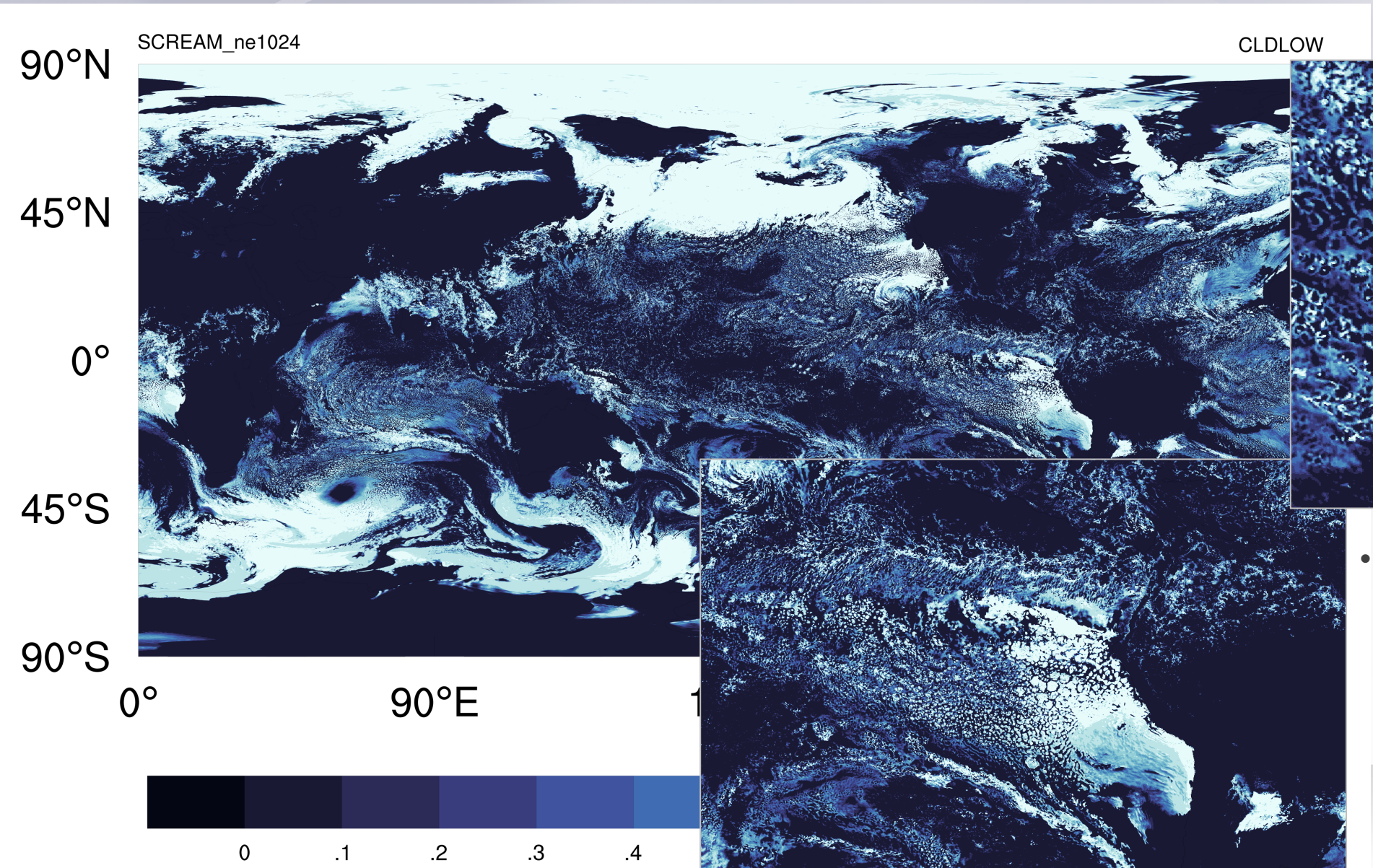



*(**above**) Running simulations at ne256 (12km) shows how different physics set ups (blue and gray) impact model performance with respect to observations (purple) without running at ne1024 (3km).*

*(**right**) DYAMOND1 simulation tests at ne1024 show too much absorbed shortwave, which differs from ne256 simulations (above). Other examined fields, however, are surprisingly similar between ne256 and ne1024.*



# Native grid plotting reveals complexity




- PyNGL python package allows for native grid plotting, which highlights the intricate patterns in cloud fields typically lost from regridding model output.

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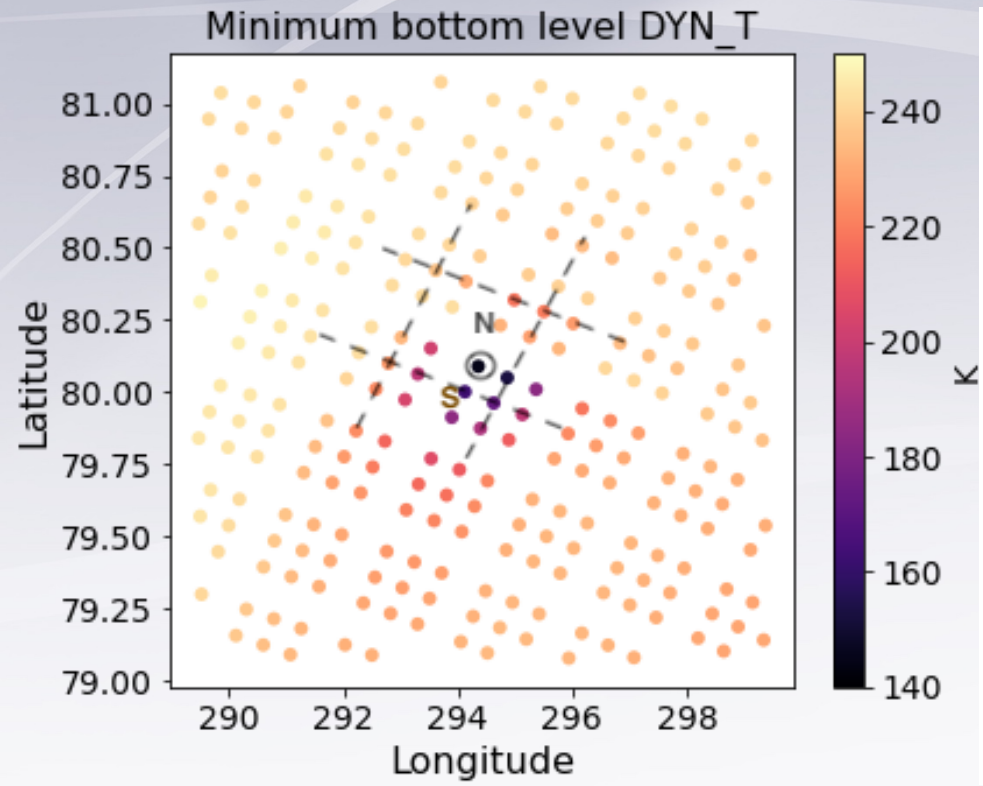
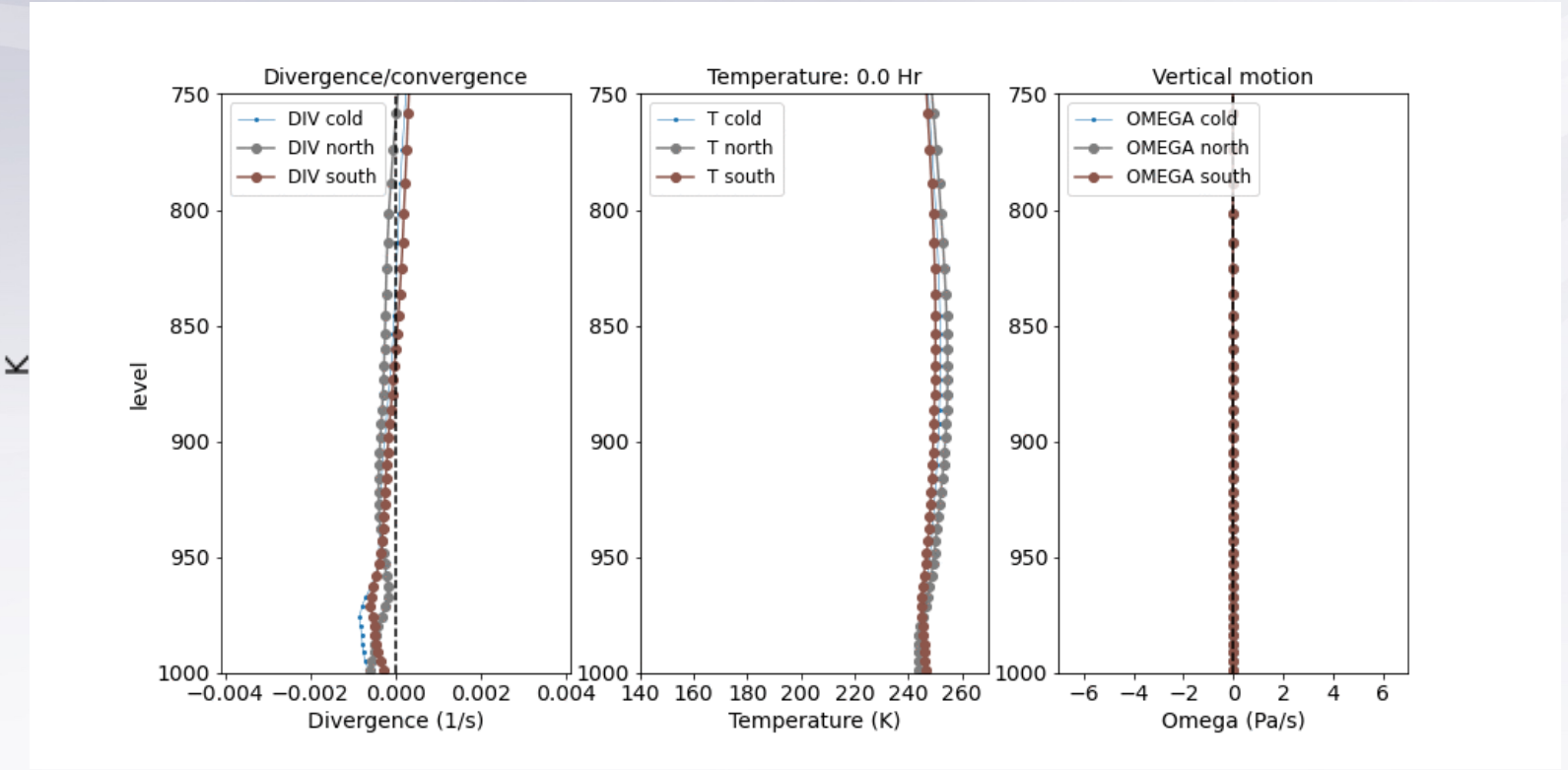
# Evaluation diagnostics with limited area output



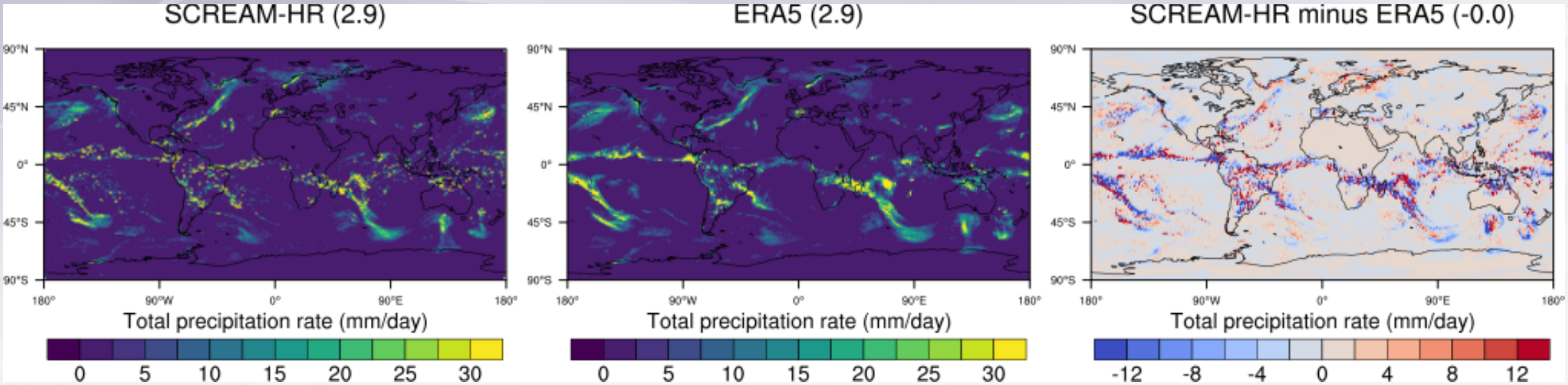




**Limited area output capabilities in E3SM help debugging at ne1024 scale**

*In the case above, surface temperatures (top left) dropped to ~100K, eventually triggering model crashes. Limited area outputs allowed us to output and analyze 3D variables at high temporal frequency without stressing I/O or storage. In this case, mixing in physics was not strong enough to counteract dynamically driven cooling (top right).*

# e3smplot: Evaluation diagnostics on native grid

**Credit: Ben Hillman**




- **Native grid:** Plots model and observational data at their native resolution
- **Smart:** Package will figure out the time period over which model output is available and locate observations for the corresponding time period for comparison
- **Flexible:** The package is flexible to take in different observations and model output (more observations are currently being added).

**Model's climate (mid Oct 2020)**

Too much absorbed SW

Too much outgoing LW

Precipitation generally good except, not as organized over Tropics

Land temperatures slightly too warm

# Summary and Challenges

1. The 3km resolution SCREAM poses 2 big challenges: large output and computational cost.

2. Ongoing development to post-process and analyze data in a hierarchy of detail to allow quick analysis and movement of data to long-term storage

3. Forecast diagnostics under development will help assess model using a different lens than typical climate-type diagnostics (see Weiran Liu's poster)

4. Challenges – working with and deriving the most out of 3D fields