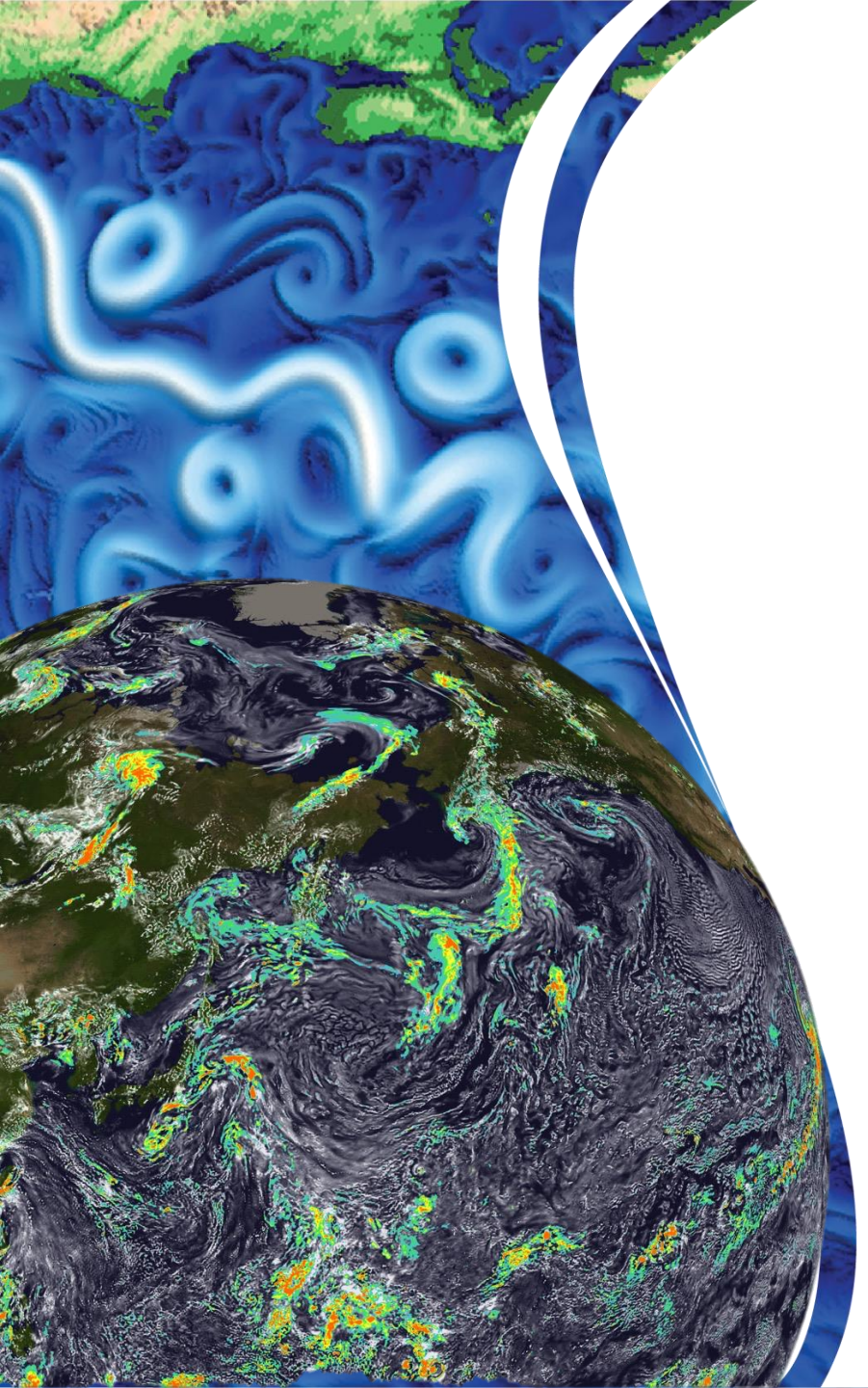

SCREAM: a Case Study in Emerging Tech

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Intro to SCREAM

- SCREAM is DOE/E3SM's exascale-ready global storm-resolving model
  - We typically run with dx=3.25 km, dt=100 sec for physics, and 8.333 sec for dynamics

- SCREAM uses
  - non-hydrostatic spectral element dycore
  - SHOC turbulence/cloud scheme
  - P3 microphysics
  - RRTMGP radiation
  - prescribed aerosols (so far)
  - no deep convection

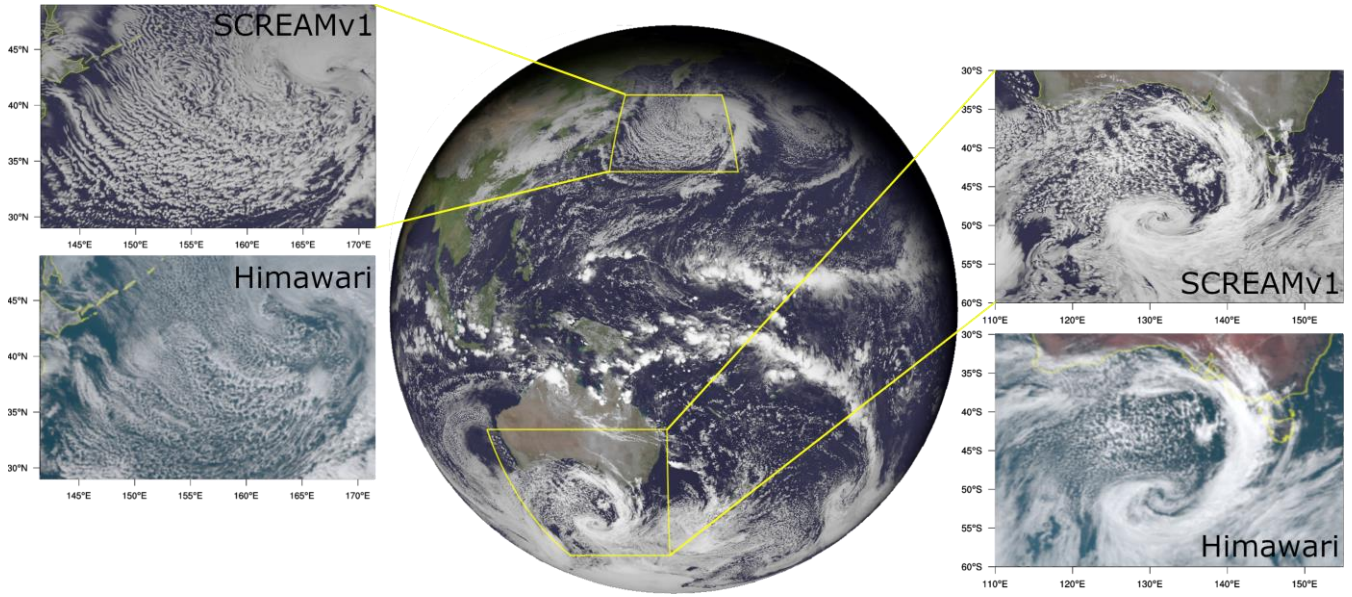


Fig: Upwelling shortwave radiation at model top taken two days into SCREAM simulation (2020-01-22 at 02:00:00 UTC).

SCREAM as Emerging Tech Exemplar

1. What can this new tech do for us?

Challenge: Exascale computers don't do any one calculation faster, they do more in parallel

Solution: parallelism enables higher resolution, increasing accuracy and localization

2. How do we overcome design challenges?

Challenge: Different exascale computers require different code syntax

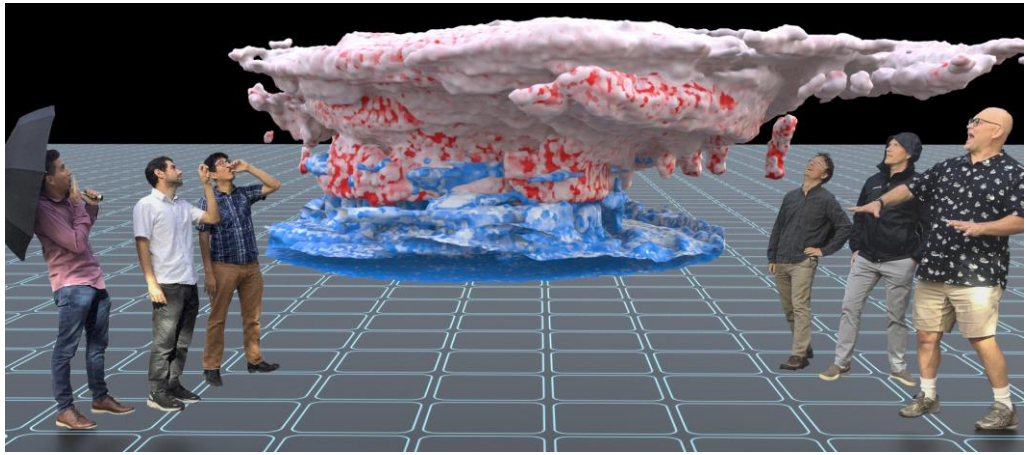
Solution: Write model in C++ using Kokkos performance-portability library

SCREAM as Emerging Tech Exemplar

3. How do we move from idea to product?

Challenge: Building a new climate model takes a big diverse team and a lot of years

Solutions:
- DOE/E3SM was made for this
- Do only what's needed
- Prototype + template using old model
- Being allowed to fail enables essential risk taking



SCREAM as Emerging Tech Exemplar

4. What do you do once you have the tool?

Challenges:
- New models have rough edges
- Building vs doing science requires different expertise
- Everything about the model is a research question

Solution: Expand team, build collaborations (a work in progress)

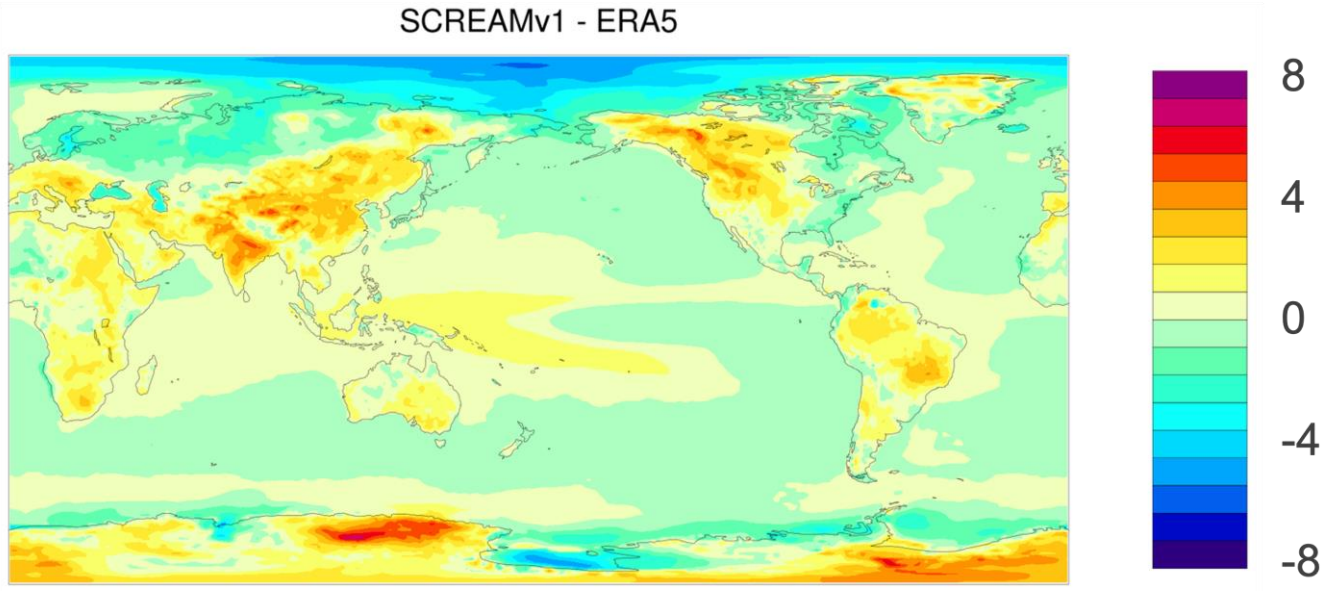


Fig: 2m T bias from 1 year of SCREAM data

Next Steps: Grand Challenges

1. Make SCREAM trustworthy enough for planning decisions (w/ ARM/ASR/RGMA)
2. Enable centennial-scale SCREAM simulations (w/ ASCR)
3. Store/analyze decades of high-frequency km-scale output (w/ Hnilo program)
4. Expand SCREAM for applied climatology (w/ RGMA/MSD)
5. Merge SCREAM into a coupled km-scale E3SM (E3SM-internal)

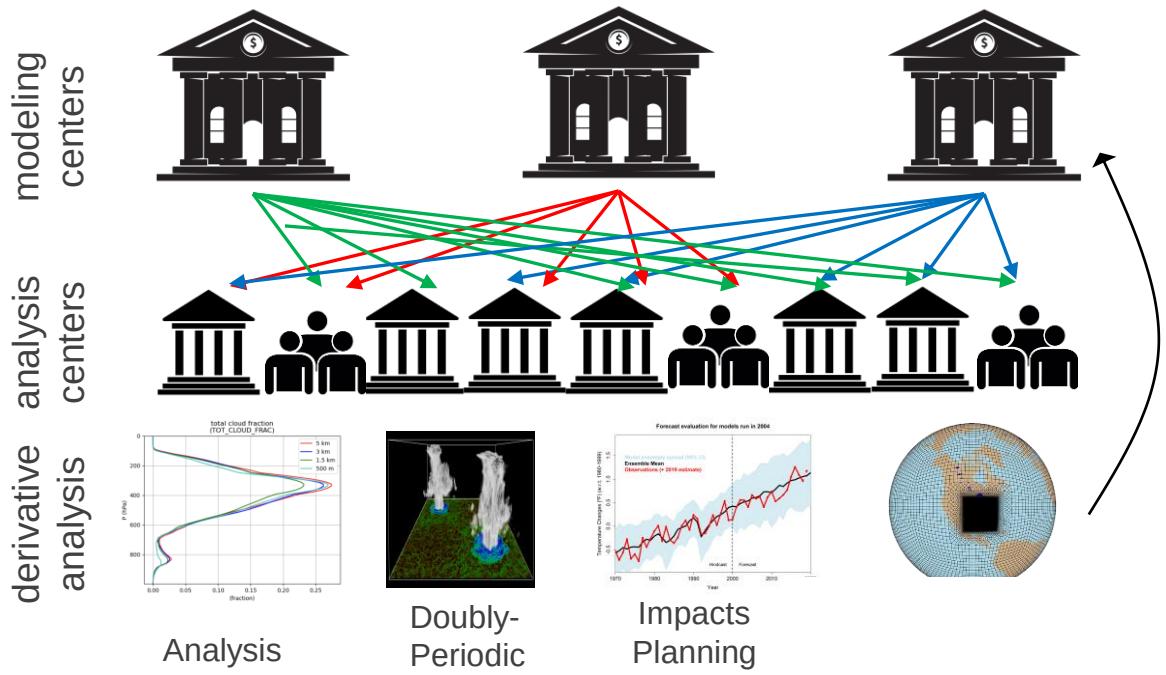
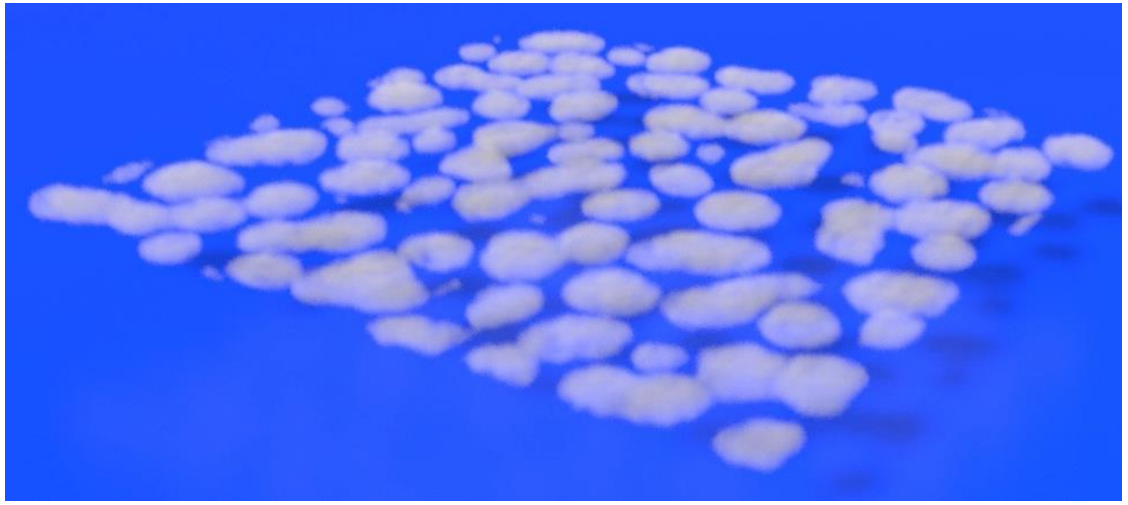


Fig: Few centers have access to exascale computers, changing the climate-modeling paradigm

SCREAM Opportunities

- All SCREAM simulations are/will be publicly available (on NERSC)
- Doubly-periodic and regionally-refined configurations are cheap and relevant
- SCREAM runs at 100 simulated years per day at dx=100 km
- Bundled low-res runs are a perfect use for exascale computers



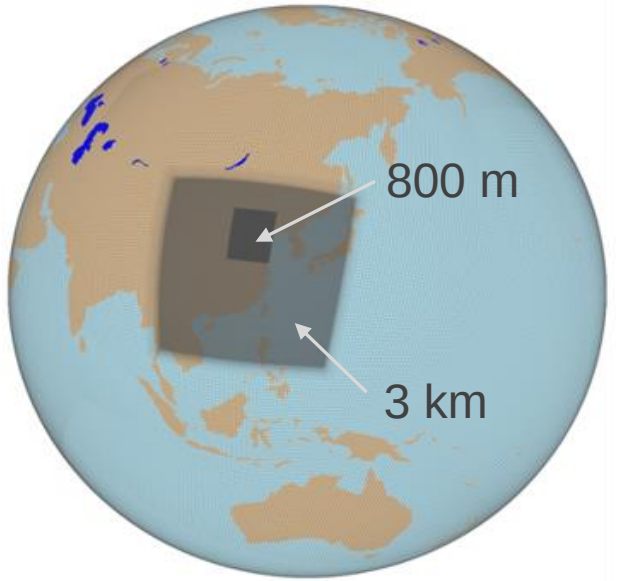


Fig: Doubly-periodic mode (left) and regional refinement (right)

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