SCREAM Evaluation

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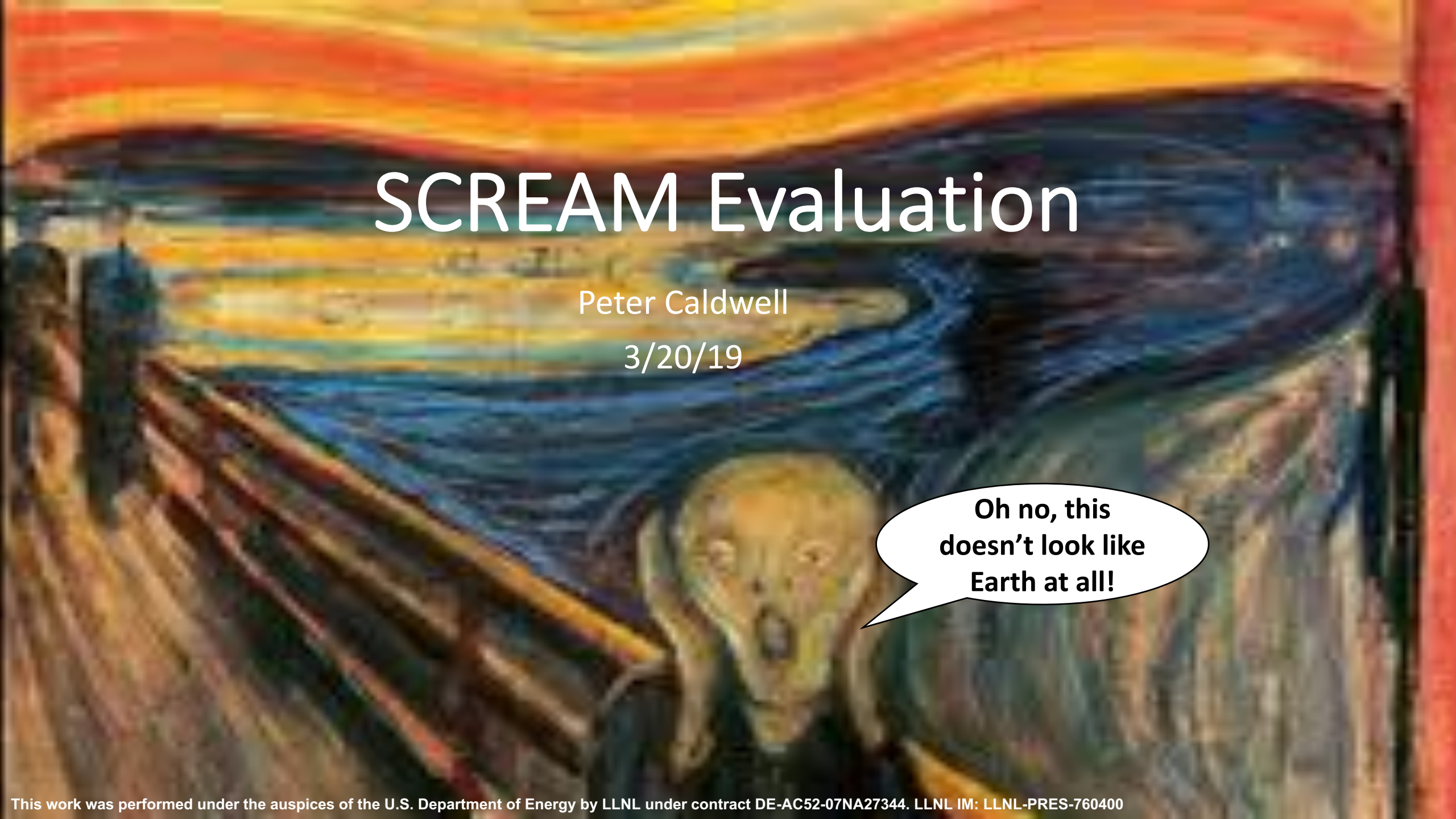

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Overview

- Goal: SCREAM should not just be *fast*, it should be *skillful*
  - A skillful model is the result of relentless evaluation

- SCREAM's evaluation effort has been ~dormant because
  - there haven't been runs to analyze ← **This is changing!**
  - staff have been busy getting the model running ← **The team is thin on evaluators… community help is welcome!**
- Evaluating such an expensive model requires tricks:
  - Single-column model runs ← **We are currently using this a lot**
  - Lower-res global runs
  - Regional refinement nudged to obs ← **Working on RRM now**
  - Short forecast runs ← **Lacking staff for these**
  - Multiple-Column Model

Single Column Model (SCM)

- The SCM is our main tool for testing SCREAM-F90 parameterizations
  - Instead of SCM, SCREAM-C++ will have a doubly-periodic-like CRM mode (see slide 7)
  - The SCM is great for finding bugs during development (see graphic)
  - We have 25 SCM cases to choose from (https://github.com/E3SM-Project/scmlib/wiki/E3SM-Single-Column-Model-Case-Library)

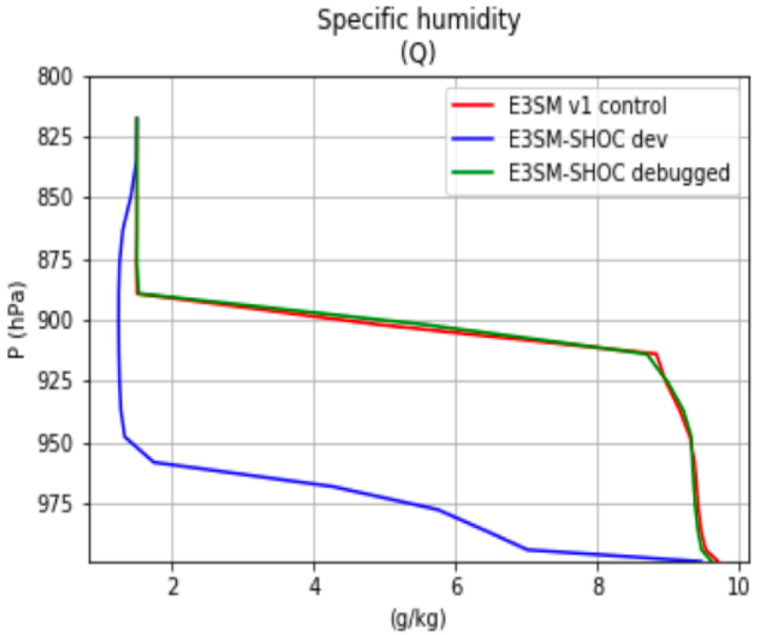


Fig: Q profiles from DYCOMS RF01 case during SHOC development revealing a big bug. Plot generated automatically using SCM diagnostic package.

Low-Res Global Simulations

- Low-res simulations are a cheap way to check whether code is stable and produces earth-like runs
  - Skill at coarse resolution is NOT a goal of SCREAM, so low-res evaluation will be limited
- Results so far:
  - The model runs stably with SHOC and (separately) P3
  - Swapping MG2 for P3 has minor effect on precip and major impact on SWCF (which can be tuned away)

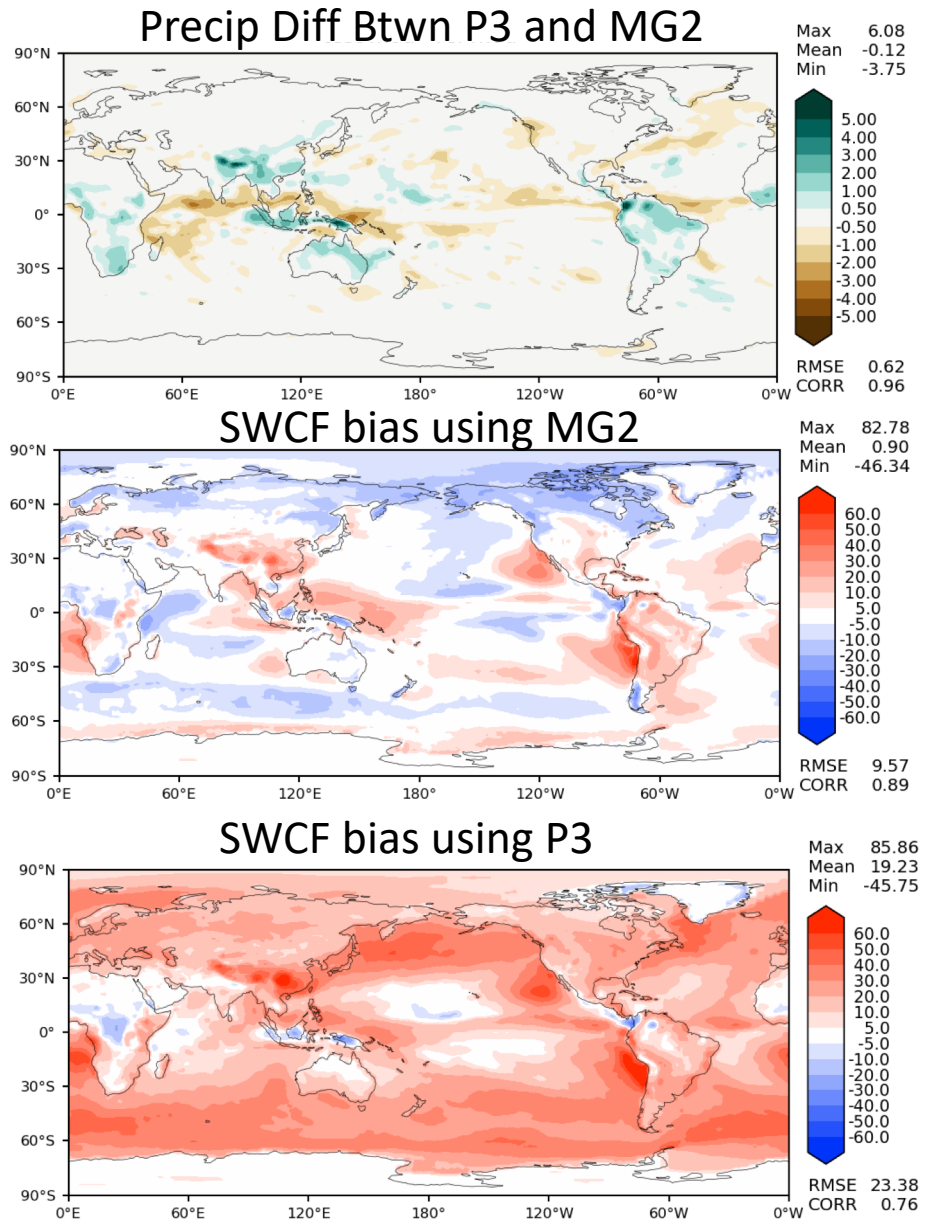


Fig: Top: precip differences between P3 and MG2. Middle and bottom: SWCF bias (relative to CERES-EBAF4.0) for MG2 and P3 runs (respectively). All plots show annual averages from 2 yr ne30 runs.

Weather Forecasts

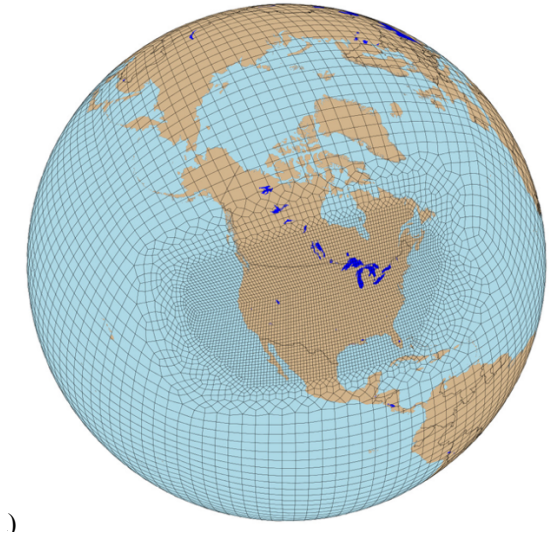
To compare against obs on the O(1 day) timescales we can afford to run often, we need to do weather forecasts. This requires accurate initial conditions. Two methods for obtaining these:

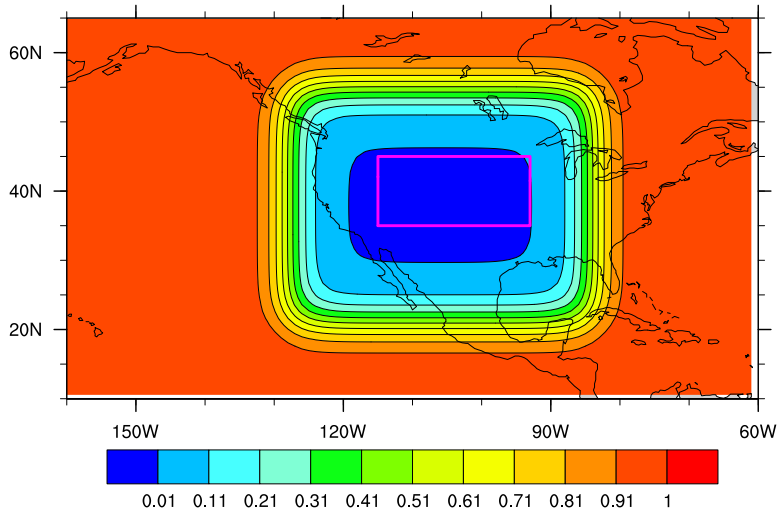
- Zarzycki Method (Zarzycki and Jablonowski, MWR 2015):
  - Take atm IC from analysis, then run for 6 hrs and apply a filter to remove small-scale disturbances
  - Get aerosol information from AMIP climatology(?)
  - Compute land IC by doing 24 hr forecasts for the same day 15-30x using the final land state as the IC for the next forecast
- CAPT Method (Philips et al, BAMS 2004 and Ma et al, JAMES 2015)
  - Take atm IC from analysis, then run nudged to obs for O(1 mo)
  - Starting from previous forecast or AMIP, run for O(3 mo) with nudged atm

Needed: 1). Research saying which method is better

2). Get infrastructure in place for routinely doing these runs

Regional Refinement with Coarse-Region Nudging





- Ability to create/run regionally-refined grids is built into the SE dycore (and is available now)
- Geographically-varying nudging is also available now
- By using fine resolution in a region of interest and nudging to obs elsewhere, the functionality of a regional weather model (like WRF) is obtained
  - We will need to pay for solution on the coarse grid, but this is generally negligible compared to that of the fine grid

Needed: 1). Confirmation that RRM/nudging works
2). Generation of desired RRM grids

Fig: top: an SE RRM grid. Bottom: nudging strength zoomed in over high-res region. Courtesy Qi Tang

Multiple-Column Model (MCM)

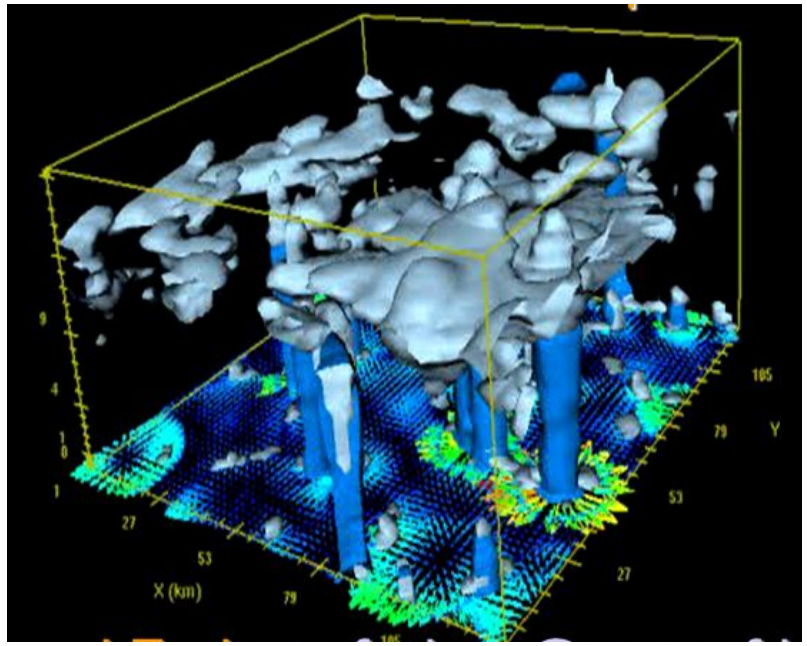


Fig: example of classical limited-area CRM from Richard Forbes (ECMWF)

- A classic doubly-periodic limited-area CRM with ~400 columns will be approximated by:
  - using the ne2 grid
  - turning off rotation
  - forcing columns homogeneously with spatial IC noise
- This mode is better than SCM because:
  - it requires much less computational infrastructure
  - multiple columns are needed to handle convection if there's no parameterization allowing for simultaneous upward and downward motion in a column

Needed: 1). A better name than MCM?

2). Someone to implement this

Conclusions

- Initial evaluation using SCM and low-res runs is occurring
  - Looks like a poorly-tuned Earth
  - What more can we/should we say?
- High-res grids are coming soon
  - will existing post-processing tools handle them? See Thurs afternoon infrastructure session!
- Weather forecasts, regional refinement, and the Multiple Column Model will be important for high-res evaluation