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LLNL-PROC-813710

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August 18, 2020

Using Satellite Observations to Advance Climate Models
Pasadena, CA, United States
August 17, 2020 through August 28, 2020

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The Implementation of Framework for Improvement by Vertical Enhancement (FIVE) into Energy Exascale Earth System Model (E3SM)

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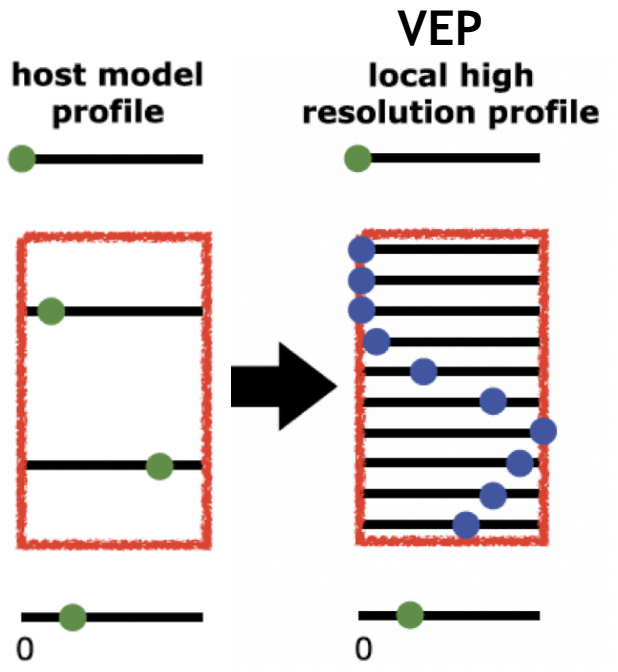
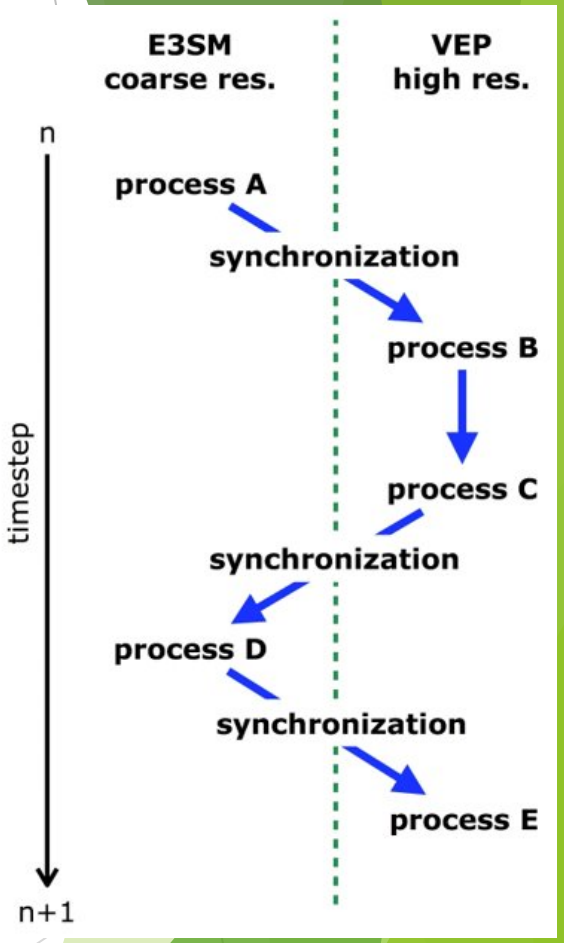
Work at LLNL was performed under the auspices of the U.S. DOE by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. IM release: LLNL-PROC-813710.

Methodology – the Framework for Improvement by Vertical Enhancement (FIVE)

- Vertically Enhanced Physics (VEP)
  - Create a separate computational domain, in which prognostic variables are allocated on a locally high resolution grid.
  - High resolution information is always kept.
  - Selected processes (microphysics, radiation, turbulence, vertical advection) are computed on the locally high resolution grid (VEP grid).
- Synchronization between host model and VEP is done by passing tendencies back and forth.





Comparison of Computational Cost

Benchmarks	CNTL (72 L)	DOUB (92 L)	QUAD (132 L)	OCT (212 L)	SEXDEC (373 L)
E3SM-Benchmarks (SYPD / 1024 cores)	4.3	2.2	1.2	0.23	0.03
E3SM-FIVE (SYPD / 1024 cores)	N/A	1.8	1.6	1.21	0.67

Can E3SM-FIVE replicate benchmarks?

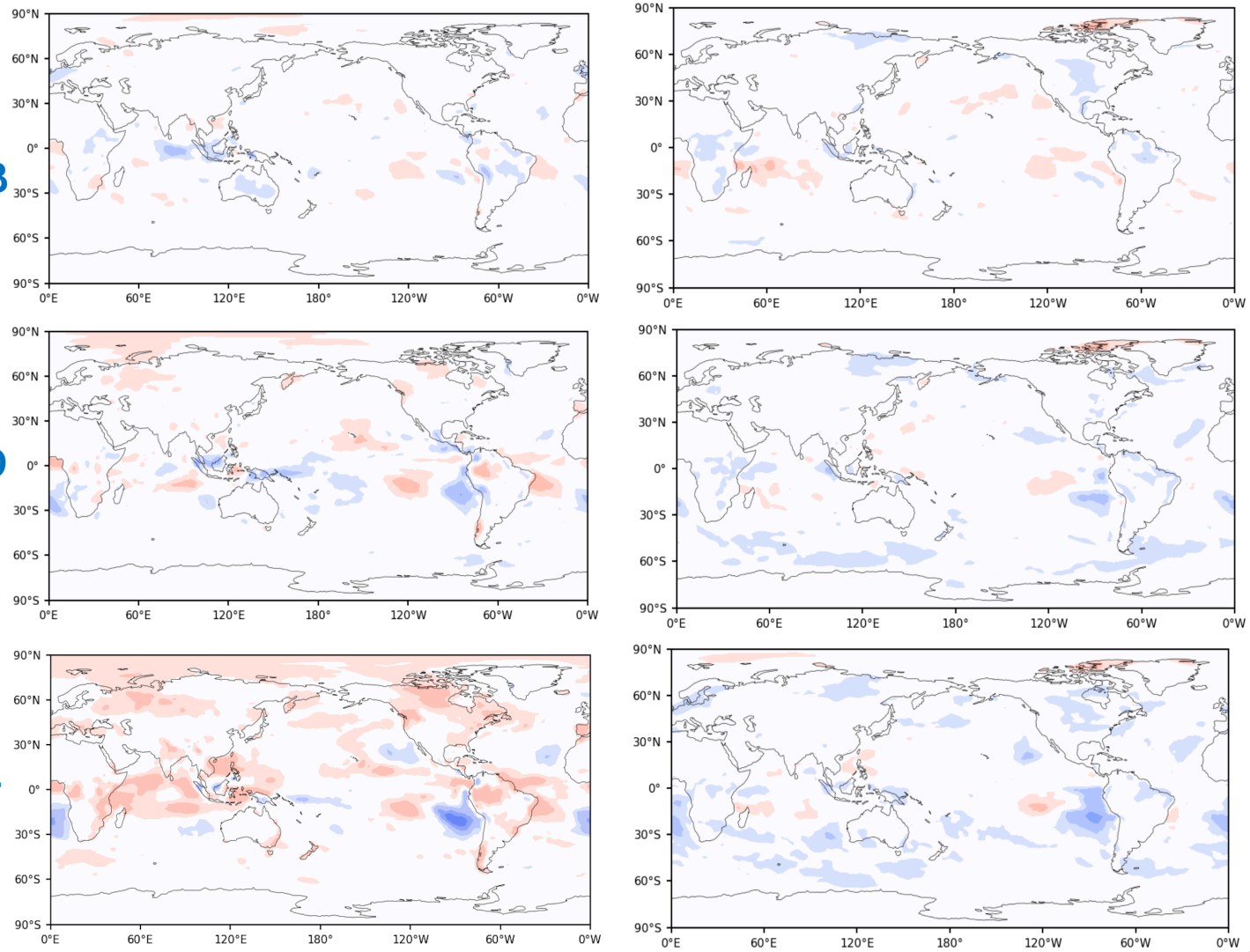
E3SM BENCHMARKS

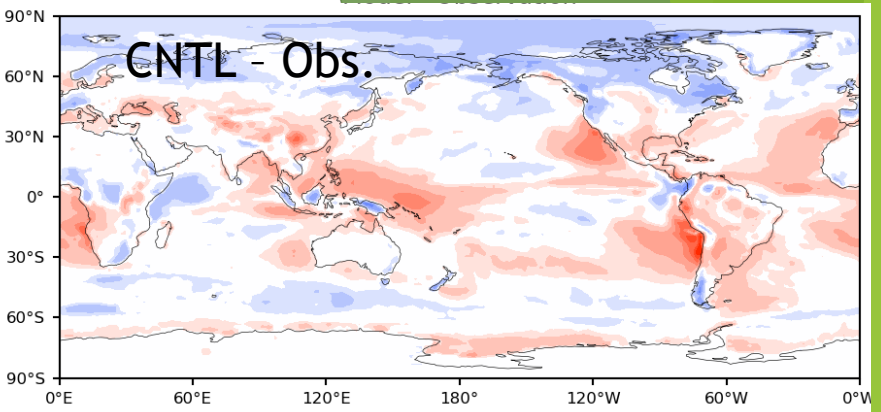
E3SM-FIVE

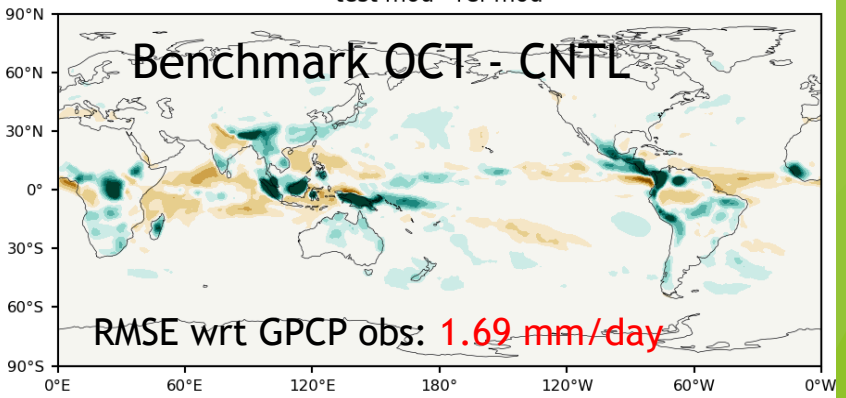
DOUB

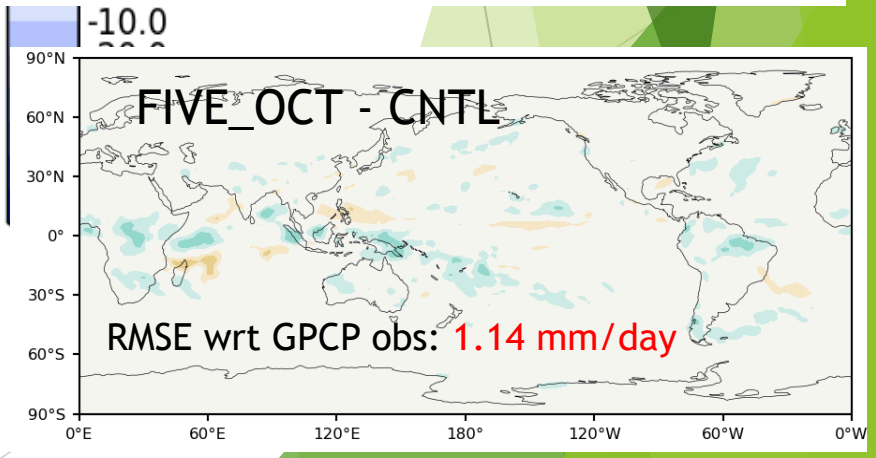
QUAD

OCT

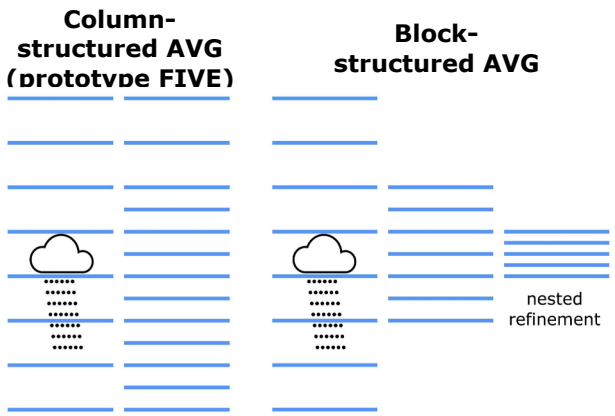






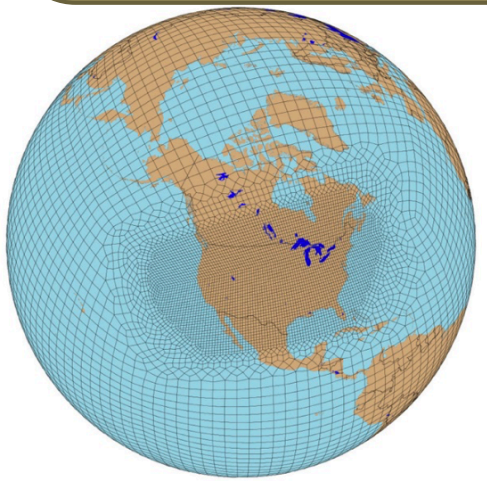
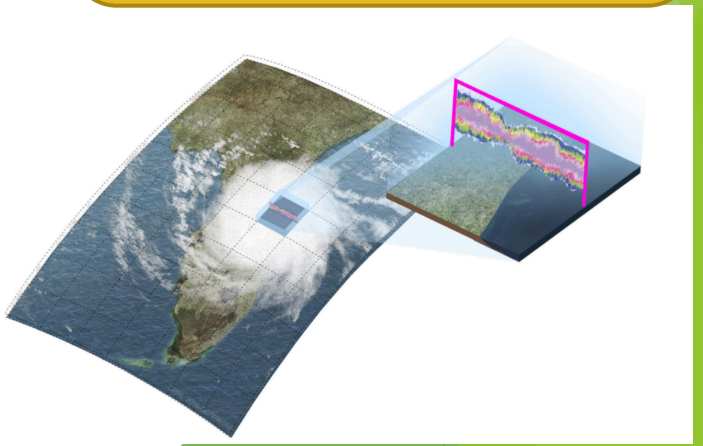


Future applications



LBNL collaborators are currently working on applying adaptive mesh refinement (AMR) for E3SM-FIVE, so we only increase vertical resolution where/when we need it.

FIVE can be to use regional refinement in the horizontal over stratocumulus regions



FIVE can be applied to the embedded CRMs in super-parameterization