

Efficient Configurations: Single Column and Standalone Cloud Resolving Models

Peter Bogenschutz¹, Peter Caldwell¹, and Chris Eldred²

¹Lawrence Livermore National Laboratory, Livermore, CA

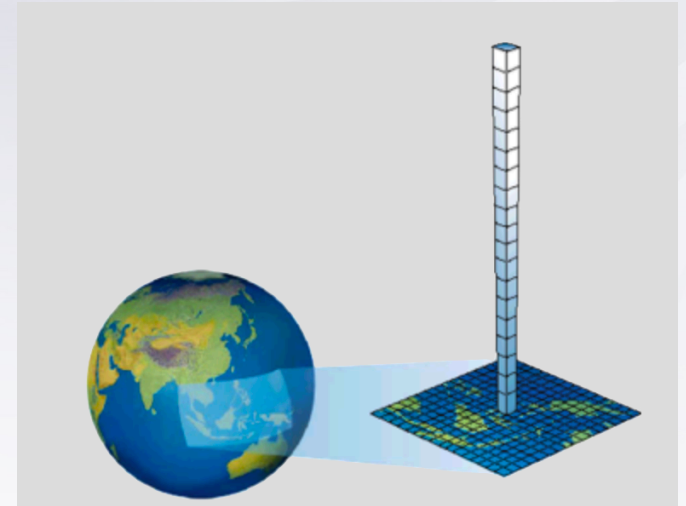
²Center for Computing Research, Sandia National Laboratory, Albuquerque, NM

Brief Overview of E3SM SCM

- Most conventionally parameterized GCMs contain a “single column model” (SCM) functionality.
- Energy Exascale Earth System Model (E3SM) SCM (Bogenschutz et al. 2020):
 - Github wiki: <https://github.com/E3SM-Project/scmlib/wiki/E3SM-Single-Column-Model-Home>
- E3SM SCM primarily used to:
 - Study cloud processes and evaluation of parameterizations
 - Support parameterization implementation/development efforts
 - Perform perturbed parameter sensitivity studies
 - Efficiently debug the model

Brief Overview of E3SM SCM

- E3SM SCM was originally inherited from CAM.
- E3SM SCM updated to use the same dynamical core as EAM (to compute large-scale vertical transport in a consistent manner).
 - E3SMv2 SCM will update to use the “theta-l” implementation of the SE dynamical core.
- Ability to seamlessly “replay” a column from a GCM run.
- E3SM SCM diagnostics package available on Github wiki
 - Currently only supports model vs. model run.
 - Ability to add LES/CRM and observations can be extended.



E3SM SCM – How to Run

E3SM Single Column Model Case Library

bogensch edited this page on Feb 4 · 66 revisions

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Verified Cases:

- [AEROSOLINDIRECT - Study of Aerosol Indirect Effects in China](#)
- [ARM95 - Deep Cumulus Convection](#)
- [ARM97 - Deep Cumulus Convection](#)
- [ARM GCSS Shallow Convection - Diurnal Cycle of Continental Shallow Convection](#)
- [ARM - SGP Continuous Forcing \(2004 - 2015\)](#)
- [BOMEX - Trade Wind Cumulus](#)
- [DYCOMS RF01 - Nonprecipitating Marine Stratocumulus](#)
- [DYCOMS RF02 - Drizzling Subtropical Stratocumulus](#)
- [DYNAMO AMIE - Dynamics of the Madden Julian Oscillation](#)

DYNAMO Revelle - Dynamics of the Madden Julian Oscillation

Overview This is a 90 day case from the [Dynamics of the Madden Julian Oscillation](#) (DYNAMO) field campaign which was an IOP over the Indian Ocean to collect data to study the onset of the MJO. This particular case includes forcing data collected aboard the R/V Roger Revelle operated by the Scripps Institution of Oceanography.

[DYNAMO Revelle Run Script](#)

GATE - Tropical Atlantic Deep Convection

Overview: This case is based on the Global Atmospheric Research Program's Atlantic Tropical Experiment (GATE, [Houze and Betts 1981](#)), who's goal was to improve basic understanding of topical convection and its role in the global atmospheric circulation. This is a 20 day case that begins on 30 August 1974.

Verification Notes: This case is simulated with the expected behavior.

[GATE Run Script](#)

GOAMAZON - Green Ocean Amazon

Overview This is a 23 month case from the Observations and Modeling of the [Green Ocean Amazon](#) (GOAMAZON) field campaign ([Martin et al. 2017](#)). Observations and forcing are derived from the ARM Mobile Facility, which was located downwind of the city of Manaus, Brazil near

E3SM SCM webpage on Github (publicly viewable) is the primary official resource.

Currently we provide support for 27 cases that will run out of the box with E3SMv1 and master.

Each case has short description and supported run script.

All needed input is preinstalled on widely used E3SM machines.

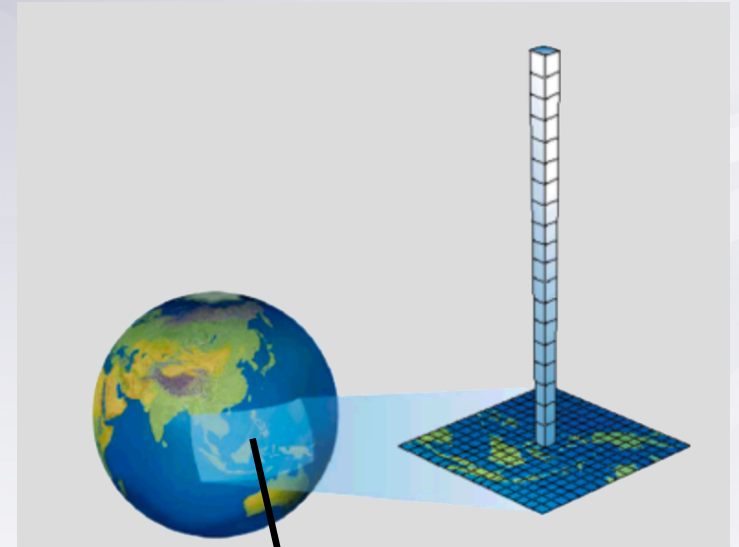
Updates/support for E3SMv2 will be provided.

<https://github.com/E3SM-Project/scmlib/wiki/E3SM-Single-Column-Model-Home>

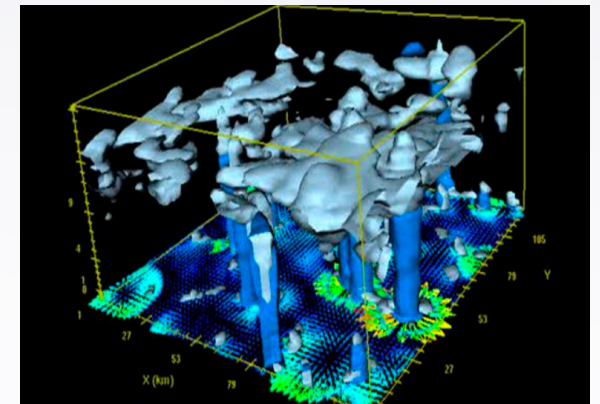
Development of **DP-SCREAM**

- Doubly Periodic (DP) – SCREAM represents **a limited-area doubly-periodic cloud resolving model** (CRM), forced with Intensive Observational Period (IOP) cases.
- The next-generation SCREAM (global cloud resolving) model is NOT a conventionally parameterized GCM.
- A SCM does not make sense for a non-hydrostatic model.
- However, SCREAM will be an expensive model so a SCM-like proxy to run and evaluate IOP cases is desirable.

E3SM SCM View



DP-SCREAM



DP-SCREAM Development

- A two-step parallel effort:
 - **Infrastructure** (Bogenschutz):
 - Read in "large-scale" forcing data using pre-existing structure for SCM
 - Use the lat/lon of the desired case to cover the entire domain with a homogenous surface, etc.
 - Prototype tests validated infrastructure by using a "small planet" configuration (reduced earth radius and rotation turned off).
 - **Planar HOMME** (Eldred):
 - Ability to run standalone HOMME dynamical core on doubly-periodic planar grids.
 - Uses shallow water (sweqx) and hydrostatic/non-hydrostatic primitive equations (preqx and theta-l) models.

DP-SCREAM status

- First test cases involved running several IOP cases with the DP-SCREAM framework *without dynamics*.
 - Essentially a planet of identical SCMs with no interaction between columns to validate infrastructure.
- Current status: Validated tests *with dynamics* of “prototype” DP-SCREAM with select cases from the E3SM SCM case library ([GATE](#), [TWP06](#), [ARM97](#), [DYCOMS-RF01](#), [BOMEX](#), [MPACE](#)).
- *Planar version of the SE non-hydrostatic dy-core has been developed and will soon be married with the DP-SCREAM infrastructure.*

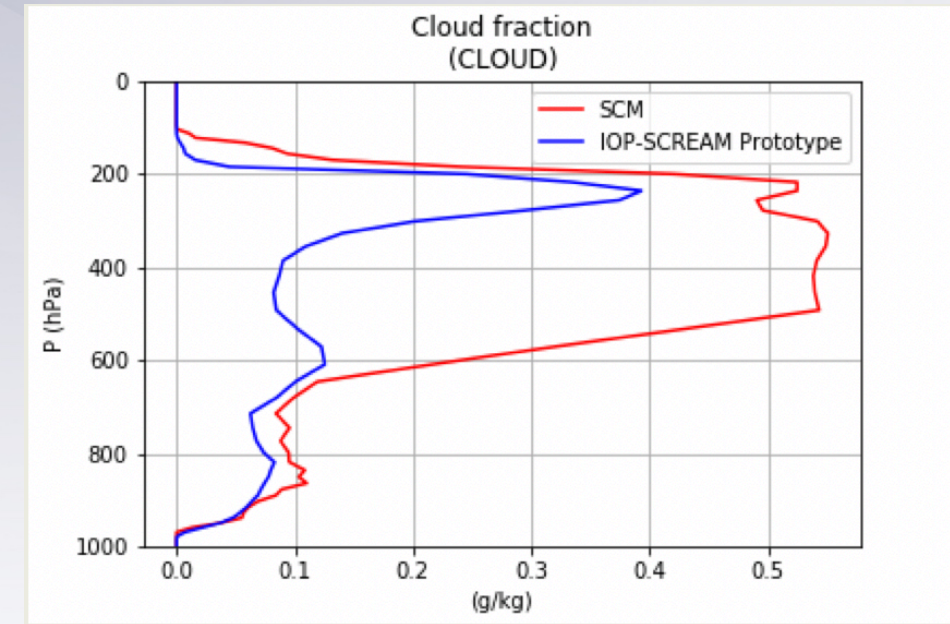


Fig: 20 day GATE simulation comparison between SCM and prototype DP-SCREAM.

Prototype DP-SCREAM run with ne16 grid and planet shrunk down to achieve 3 km resolution. Meridional winds set to zero and gently nudged to obs to prevent mass convergence at poles.

Summary

- E3SM/SCREAM provide configurations for rapid feedback of model performance.
- E3SM has a fully supported traditional single column model configuration, which is an ideal tool evaluate and debug parameterized physics.
- SCREAM will support **a limited-area doubly-periodic cloud resolving model** driven by established IOP forcing files.
 - Will provide an efficient tool to study resolution sensitivity of the model's dynamics and physics.