Energy Exascale Earth System Model

ANL, BNL, LANL, LBNL, LLNL, ORNL, PNNL, SNL, NCAR

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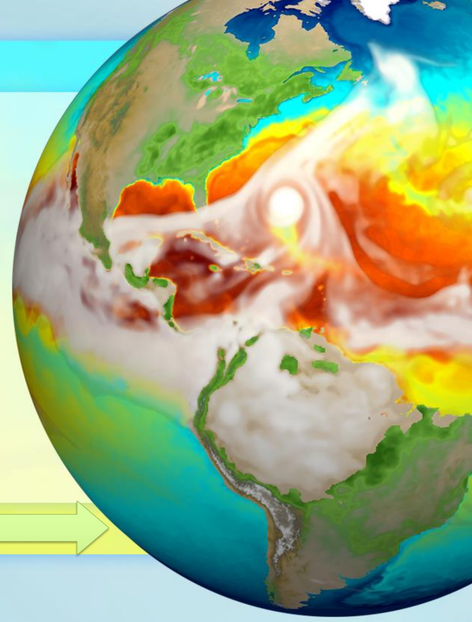


Introduction

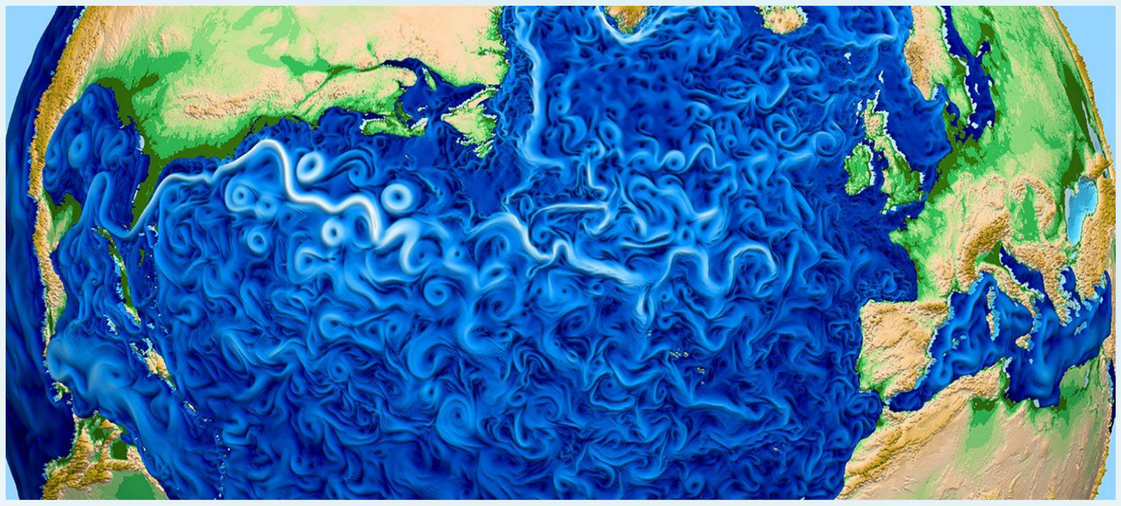
The Energy Exascale Earth System Model (E3SM) Project is an ongoing, state-of-the-science Earth system modeling, simulation, and prediction project that is intended to address the Department of Energy (DOE) mission needs while efficiently using DOE Leadership Computing Facilities.

The model will have weather-scale resolution and use advanced supercomputers to reliably simulate aspects of earth system variability and project decadal changes that will critically impact the U.S. energy sector in the near future.

Project Goal:

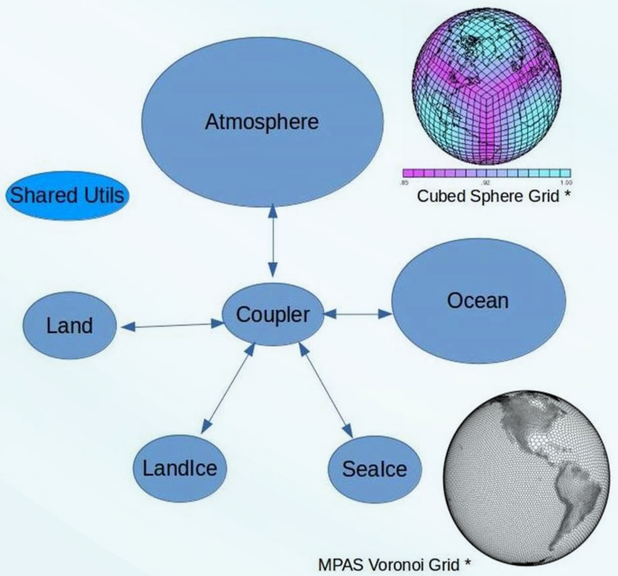
Assert and maintain an international scientific leadership position in the development of Earth system models that address the grand challenge of actionable projections of Earth system variability and change, with an emphasis on the most critical scientific questions facing the nation and DOE.

The high-resolution E3SM earth system model simulates the strongest storms with surface winds exceeding 150 mph —hurricanes that leave cold wakes that are 2 to 4 degrees Celsius cooler than their surroundings. This simulation represents how sea surface temperature changes evolve as a hurricane (seen here approaching the U.S. East Coast) moves across the Atlantic and how the resultant cold wake affects subsequent intensification of the next hurricane.



Three new model components are included in the E3SM v1 configuration: Model for Prediction Across Scales (MPAS) Ocean, MPAS Sea Ice, and MPAS Land Ice. Pictured above is global E3SM simulation showing eddy activity. Credit: M.Petersen, P.Wolfram and T.Ringler.

Application Overview



* Fig from "Terascale Spectral Element Dynamical Core for Atmospheric General Circulation Models", Loft R D, Thomas S J, Dennis J M, SC2001, Nov 2001
* Fig from "Global Nonhydrostatic Modeling Using Voronoi Meshes", Skamarock W, Klemp J, Duda M, Fowler L, Park S H, ECMWF Workshop on Non-hydrostatic Modelling, 8-10 November 2010

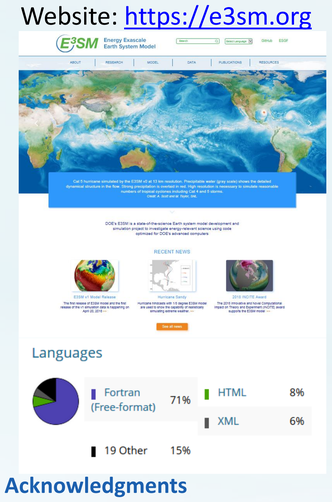
- DOE Climate Model
- Collaboration among 7 National Labs, NCAR, 4 Academic Institutions and a private sector company
- Fortran, MPI, OpenMP, OpenACC
- Uses Unstructured Grids
- Independent component models and shared infrastructure
- Simulations on O(100,000) cores

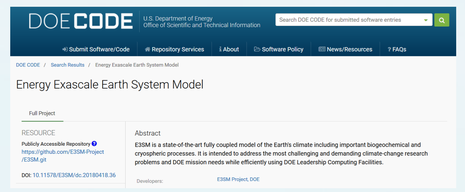
Software

E3SM v1.0.0 : Public Release – April 23, 2018

Website: https://e3sm.org

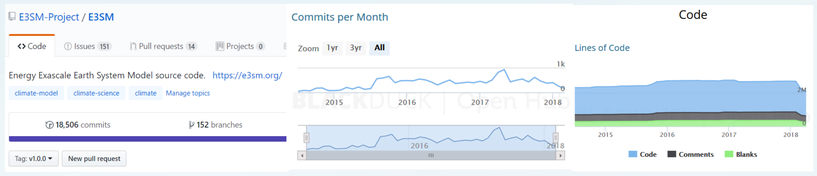
DOI: 10.11578/E3SM/dc.20180418.36





Github: https://github.com/E3SM-Project/E3SM

OpenHub: https://www.openhub.net/p/e3sm



In a Nutshell, E3SM...
... has had 18,506 commits made by 193 contributors representing 1,462,618 lines of code
... is mostly written in Fortran (Free-format) with a very well-commented source code
... maintained by a very large development team
... took an estimated 410 years of effort (COCOMO model)

Acknowledgments

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E3SM Energy Exascale Earth System Model

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