

Title	PI	Institution	Location	Synopsis
Parameterizing the Impact of Mesoscale Eddies on Earth System Process in the Energy Exascale Earth System Model	Gnanadesikan, Anand	The Johns Hopkins University, Baltimore	Baltimore, MD	The goal of the project is to improve the representation of the diffusive component of mesoscale ocean eddies in the Energy Exascale Earth System Model (E3SM). The ocean component of E3SM, the Model Prediction Across Scales, currently ignores this diffusive component. The new representation is expected to improve the representation of nutrient cycles, chlorophyll, global overturning, sea-surface temperatures and modes of variability such as the El Nino Southern Oscillation. The project is in collaboration with Los Alamos National Laboratory.
The Multi-Plume Eddy-Diffusivity/Mass-Flux (EDMF) Unified Parameterization: Stratocumulus and the Transition to Cumulus Boundary Layers	Teixeira, Joao	Regents of the University of California, Los Angeles	Los Angeles, CA	The project goal is to implement a new cloud physics scheme, called the Eddy Diffusivity Mass Flux (EDMF) scheme into the Energy Exascale Earth System Model (E3SM). EDMF is able to simulate both stratocumulus and convective clouds and is therefore known as a “unified approach”. This will enable a better representation of the transition from stratocumulus to cumulus clouds, a feature that plays a key role in capturing realistic cloud-climate feedbacks. The initial implementation will be into the E3SM Single Column Model, and followed by implementation into the full atmospheric model.
Improving Momentum Transport Processes in E3SM	Richter, Jadwiga	University Corporation for Atmospheric Research	Boulder, CO	The goal of the project is to develop and implement treatments of subgrid momentum transport in the atmosphere of the Energy Exascale Earth System Model (E3SM), with focus on effects from convective motion and from orographically or convectively generated gravity waves. The improvements are expected to improve biases such as the double intertropical convergence zone, excessive wind stress over Southern Ocean, precipitation biases, including over tropical west Pacific, weak convectively-coupled waves (Kelvin and Madden-Julian Oscillation) and the representation of El Nino Southern Oscillation. The project is in collaboration with Pacific Northwest and Lawrence Livermore National Laboratories.
Incorporate more realistic surface-atmosphere radiative coupling in E3SM	Huang, Xianglei	Regents of the University of Michigan	Ann Arbor, MI	This project will improve the longwave (LW) radiative treatments in the Energy Exascale Earth System Model (E3SM). The focus will be on the LW land emissivity and on the scattering effects of ice-phase clouds. The improvements are expected to improve the surface air temperatures in the Arctic, as well as the interactions between ice-phase clouds and the surface. The project is in collaboration with Brookhaven National Laboratory.

<p>Enhancing Convection Parameterization for Next Generation E3SM</p>	<p>Zhang, Guang</p>	<p>The Regents of the University of California-SIO</p>	<p>La Jolla, CA</p>	<p>The goal of the project is to improve the representation of deep convection in the Energy Exascale Earth System Model (E3SM), by adding stochasticity and by improving its microphysics. The model improvements will be tested by driving the model with Cloud-Associated Parameterization Testbed (CAPT)-generated hindcasts and comparing the regionally-refined E3SM atmosphere model with the ARM Southern Great Plains and Tropical West Pacific field site datasets. The model improvements have the potential to reduce the double Intertropical Convergence Zone bias and to improve the precipitation intensity and dry bias in the Amazon region. The project is in collaboration with Lawrence Livermore National Laboratory.</p>
<p>Earth System Model Development and Analysis</p>	<p>Liu, Zhengyu</p>	<p>The Ohio State University</p>	<p>Columbus, OH</p>	<p>The project will develop and implement a coupled data assimilation (DA) capability for the Exascale Energy Earth System Model (E3SM). This will enable E3SM to initialize its coupled system relatively quickly so that the model can achieve some skill in seasonal to decadal predictability and avoid the requirement of a lengthy control simulation. DA is most likely essential to do this, but many DA methods are not appropriate due to computational cost. This project is in collaboration with Los Alamos and Pacific Northwest National Laboratories.</p>
<p>Mechanisms of Pacific decadal variability in ESMs: the roles of stochastic forcing, feedbacks & external forcing</p>	<p>DiLorenzo, Emanuele</p>	<p>Georgia Tech Research Corporation</p>	<p>Atlanta, GA</p>	<p>This project aims to develop a fundamental understanding and synthesis of the processes that drive Pacific decadal variability (PDV) in Earth System Models (ESMs) under both 20th century and future conditions, using simulations from the Coupled Model Intercomparison Project and the Energy Exascale Earth System Model (E3SM). This research will diagnose, and compare across ESMs, the role of coupled ocean-atmosphere processes and feedbacks, determine how they contribute to predictable PDV dynamics and how they are affected by unpredictable stochastic forcing, and evaluate current and future mean state dependencies. The innovation proposed here is the development of a thorough assessment of mechanisms contributing to the total decadal variability in the pacific across both tropical and extra-tropical regions, and this will provide a mechanistic framework for predicting droughts, heatwaves, and ecosystem changes.</p>

<p>Simulating extreme precipitation in the United States in the Energy Exascale Earth System Model: Investigating the importance of representing convective intensity versus dynamic structure</p>	<p>Kooperman, Gabriel</p>	<p>The University of Georgia Research Foundation, Inc.</p>	<p>Athens, GA</p>	<p>The main goal of the project is to investigate how realistically extreme precipitation, in particular mesoscale convective systems(MCS), tropical cyclones (TCs), extratropical cyclones (ETCs), and atmospheric rivers (ARs), are captured in two versions of Exascale Energy Earth System Model (E3SM). An innovative component of the proposed activity is that it proposes to constrain both E3SM models, the High-resolution E3SM and the Superparameterized E3SM, to similar computational demands. This will indicate whether extreme weather events are better simulated by resolving the convective intensity or focusing on the dynamic structure. The results of this work have the potential to highlight areas of model development that need more attention, especially in the context of the different types of extreme events (MCS, TCs, ETCs, ARs) being investigated. This project is in collaboration with Lawrence Livermore National Laboratory.</p>
<p>Decadal Prediction and Predictability of Extremes in Ocean Eddy Resolving Coupled Models</p>	<p>Kirtman, Benjamin</p>	<p>University of Miami (School of Marine and Atmospheric Science)</p>	<p>Miami, FL</p>	<p>The goal of the project is to develop and enhance decadal prediction capabilities for Energy Exascale Earth System Model (E3SM v1) and the Community Earth System Model (CESM). The focus is on exploring decadal predictability in ocean eddy-resolving versions of the models. The research has two objectives: (i) investigation of how the mesoscale features in the ocean feedback onto representation of known modes of decadal variability; and (ii) diagnosis how these known modes teleconnect to regional US extremes. Retrospective predictions with ocean eddy resolving version CESM2 (i.e., 0.1 degree for ocean and ice and 0.25 degree for atmosphere and land) and the high-resolution version of E3SMv1 will be performed.</p>
<p>Reducing uncertainty of polar to midlatitude linkages using DOE's E3SM in a coordinated model-experiment setting</p>	<p>Magnusdottir, Gudrun</p>	<p>Regents of the University of California, Irvine</p>	<p>Irvine, CA</p>	<p>The focus of the application is on: (1) Causes of polar amplification; (2) Consequences of polar amplification, both in terms of mean climate and characteristics of extreme weather events; (3) Oceanic response to Arctic/Antarctic sea ice loss, and its feedback on the atmospheric response. To address these overarching topics, the applicants will use the Energy Exascale Earth System Model (E3SM) model in conjunction with a suite of other earth system models that participate in the Polar Amplification Model Intercomparison Project that will be part of the Coupled Model Intercomparison Project phase 6. The strength and the scientific innovation of this effort is that it aims at understanding the complex chain of mechanisms and feedbacks involving ocean, sea ice, and atmosphere, and polar-tropical connections, as well as tropospheric-stratospheric connections.</p>

<p>Monsoon Extremes: Impacts, Metrics, and Synoptic-Scale Drivers</p>	<p>Boos, William</p>	<p>The Regents of University of California</p>	<p>Berkeley, CA</p>	<p>The applicants propose to enhance a mechanistic understanding of precipitation extremes in monsoon systems by examining synoptic scale systems embedded in monsoons. The work will focus on synoptic (2-12 day) time scales, which include important events such as Gulf of California moisture surges, East Pacific easterly waves, and waves in the upper-level eastward jets that lie on the poleward edge of monsoon regions. The North American monsoon system which shares important characteristics to those of the South Asian monsoon will be investigated. An innovative component of the project is that it combines the work traditionally conducted by two separate groups into one unified approach, i.e., by focusing weather-climate continuum. The high-resolution models that will be used in this work include the high-resolution Exascale Energy Earth System Model (E3SM) in addition to a suite of models in High Resolution Model Intercomparison Project. This project is in collaboration with Lawrence Berkeley National Laboratory.</p>
<p>Madden-Julian oscillation, tropical cyclones, and precipitation extremes in E3SM</p>	<p>Kim, Daehyun</p>	<p>University of Washington</p>	<p>Seattle, WA</p>	<p>The applicants propose to provide a deeper process-level understanding of the Madden-Julian Oscillation (MJO) and Tropical Cyclones (TCs) in Earth System Models (ESMs) and to simultaneously indicate paths toward model improvement. Cutting-edge process-oriented diagnostics will be used to evaluate the Energy Exascale Earth System Model (E3SM) and other models that participate in the latest Climate Model Intercomparison Project. Innovative model sensitivity tests using E3SM, and model validation using a large suite of independent observations, and process-oriented diagnostics proposed in this effort will provide valuable results regarding the intrinsic dynamics of the MJO, TCs, and their linkages to extreme precipitation events. This project is in collaboration with Pacific Northwest National Laboratory.</p>

The Atlantic Multidecadal Oscillation: Key Drivers and Climate Impacts	Kwon, Young-Oh	Woods Hole Oceanographic Institution	Woods Hole, MA	The applicants propose to use a hierarchical modeling framework to advance process-level understanding on the respective roles of, and the feedback between, the key drivers of the Atlantic Multidecadal Variability (AMV). The two drivers that will be investigated are: 1) the ocean circulation associated with the Atlantic meridional overturning circulation; and 2) random atmospheric noise, primarily associated with the variability of the North Atlantic Oscillation. Based on the improved dynamical understanding of the key drivers and impacts of AMV, a set of metrics for the AMV will be developed to assess the Energy Exascale Earth System (E3SM) and the latest generation of earth system models. This project is in collaboration with Pacific Northwest National Laboratory.

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