

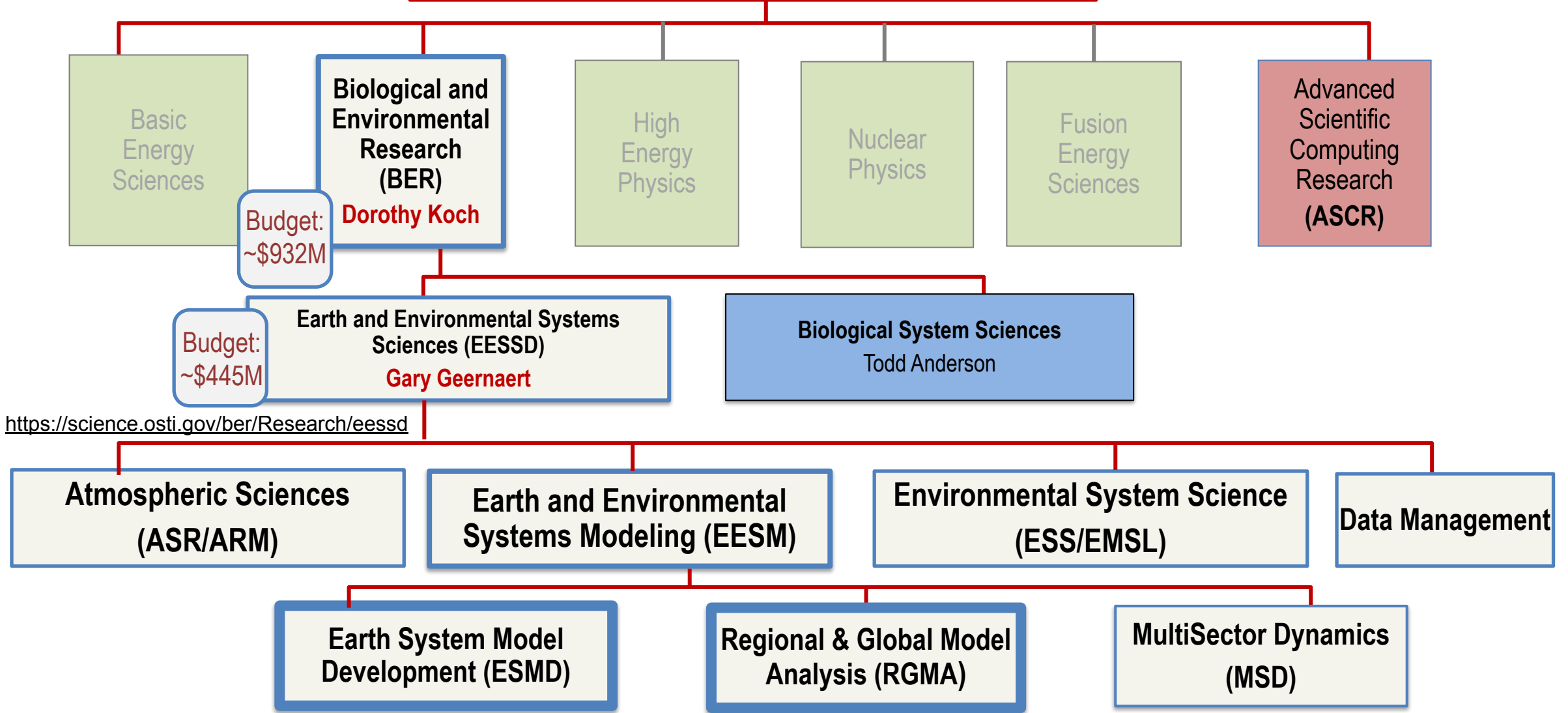
# Earth and Environmental Systems Modeling Program Overview

Renu Joseph, Xujing Davis, and Bob Vallario  
Earth and Environmental Systems Modeling (EESM)  
Earth and Environmental Systems Sciences Division  
(EESSD)



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science



# Earth and Environmental Systems Modeling (EESM)

FY 24 Budget: ~\$113M

<https://climatemodeling.science.energy.gov/>

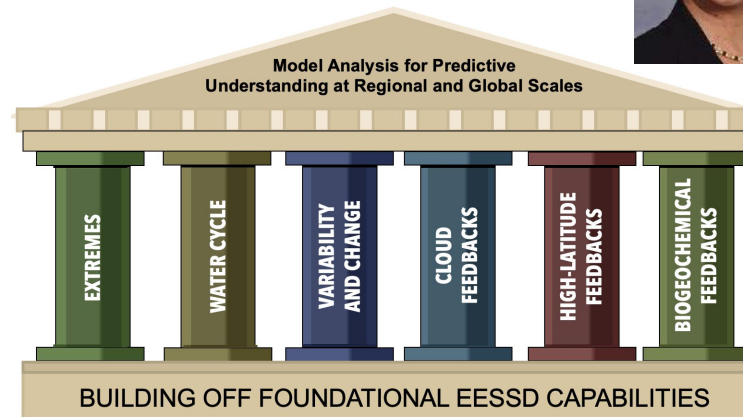
**Goal:** To develop and utilize advanced modeling and simulation capabilities to enhance the predictability of the Earth system in support of DOE's science, security, and energy mission.

**Capabilities:** Model development and discovery at the interface of natural and human systems and multisector dynamics, in ultra-high resolution Earth system modeling (E3SM), and hierarchical and multi-model analyses for deep scientific insights.

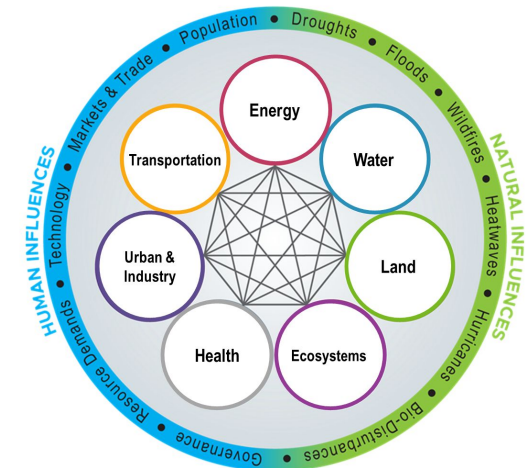
## Earth System Model Development (ESMD)



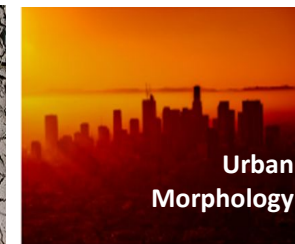
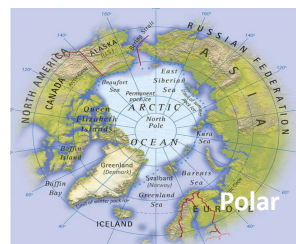
## Regional and Global Model Analysis (RGMA)



## Multisector Dynamics (MSD)



**Applications:** Capabilities help address high priority climate challenges and contribute to the U.S. NCA and the IPCC





# Overview of the EESM Portfolio

## ESMD

### Energy Exascale Earth System Model (E3SM)

#### SciDAC Projects

To accelerate E3SM via collaboration with mathematical and computational scientists

7 projects: AMOC, Antarctic icesheet, Sea ice mechanics, atmosphere coupling across scales, QBO, river dycore, Coastal and open ocean small scale processes

Enabling Aerosol-cloud interactions at Global convection-permitting scales (EAGLES)

## RGMA

Water Cycle and Climate Extremes Modeling (WACCeM)

Calibrated and Systematic Characterization, Attribution and Detection of Extremes (CASCADE)

Reducing Uncertainty in Biogeochemical Interactions Through Synthesis and Computation (RUBISCO)

High-Latitude Application and Testing (HiLAT)

Program for Climate Model Diagnosis & Intercomparison (PCMDI)

Cooperative Agreement to Analyze variability, change and predictability in the earth SysTem (CATALYST)

A Framework for Improving Analysis and Modeling of Earth System and Intersectoral Dynamics at Regional Scales (HyperFACETS)

## MSD

Integrated Multi-sector Multi-scale Modeling SFA (IM3)

Global Change Intersectoral Modeling System SFA (GCIMS)

Program on Coupled Human Earth Systems (PCHES) Cooperative Agreement

Integrated Global Systems Modeling (GSM) Cooperative Agreement

University and Early Career Projects (through joint FOAs)

Integrated Coastal Modeling (ICoM)

Interdisciplinary Research for Arctic Coastal Environments (InterFACE)

COMPASS-Great Lake Modeling (GLM)

Interagency Efforts (e.g., US CLIVAR, USGCRP-IGIM, IARPC, ICAMS, existing projects)



# Evolving Landscape over the Past 5 Years



Emphasis on **Extreme Events** and their interactions in Urban and Coastal

Emphasis on **regions of rapid transition** and associated societal challenges

## COASTAL SCIENCE

- Integrated Coastal Modeling (ICOM)
- Interdisciplinary Research for Arctic Coastal Environments (InterFACE)
- Great Lakes Modeling (GLM)
- Early Career Projects
- Puget Sound

## URBAN

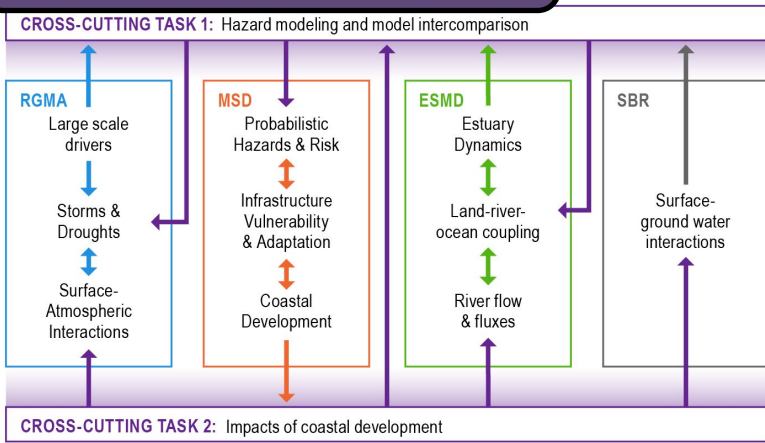
- HyperFACETS
- Integrated Multisector, Multiscale Modeling (IM3)
- Energy Exascale Earth System Model (E3SM)
- Multisector Dynamics Community of Practice (MSD-COP)
- Urban Integrated Field Laboratories (IFLs)
- Early Career Projects

## ACTIONABLE SCIENCE AND R2O2R

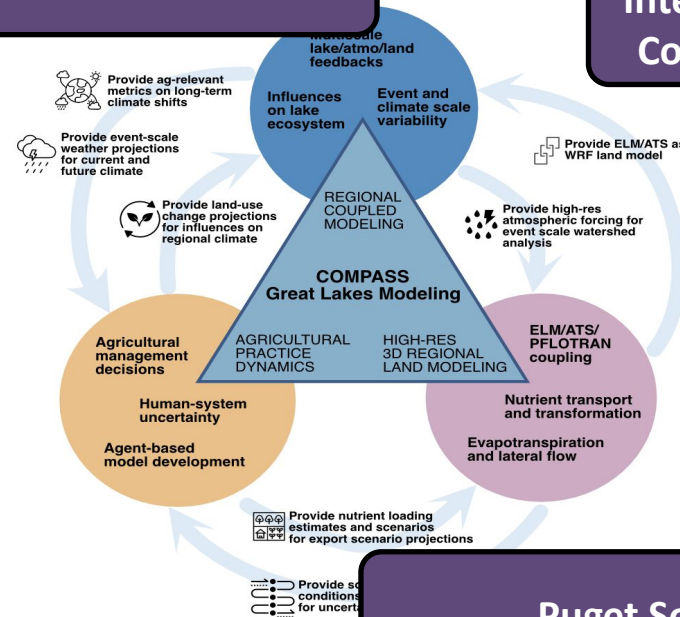
- In house – spanning natural systems to the built environment and socioeconomics (within EESM)
- Cross organizational within DOE– groups and bilateral with applied offices
- Multi-agency through working groups that include both applied and basic research agencies

# Emphasis on Co-funded Integrative Projects

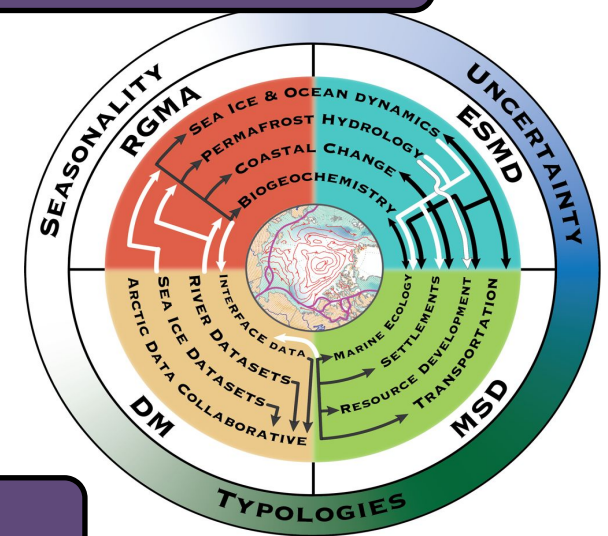
## Integrated Coastal Modeling (ICOM)



## Great Lakes Modeling (GLM)



## Interdisciplinary Research for Arctic Coastal Environments (InterFACE)



## HyperFACETS

Informing Storyline Design and Experiments



## HyperFACETS



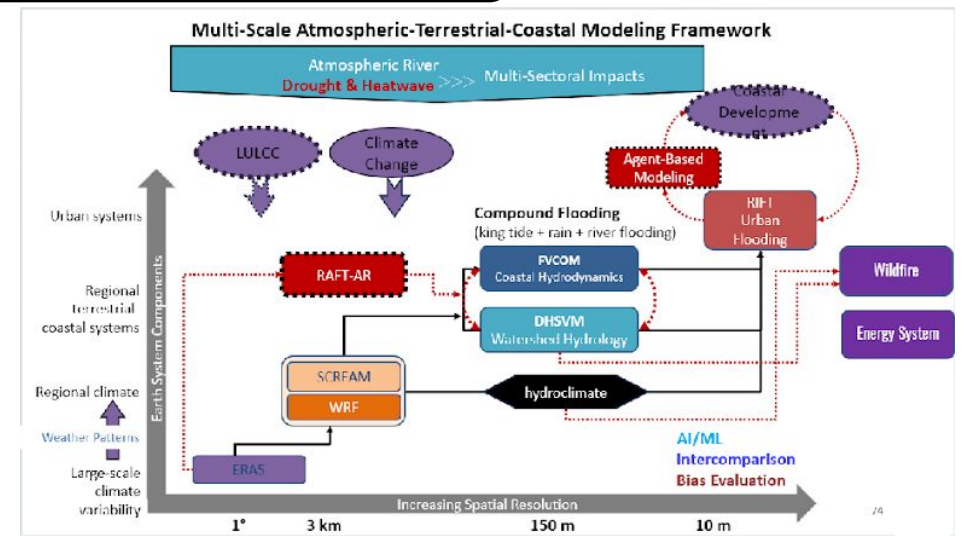
Storyline Simulations

Model Analysis  
RGMA/MSD

Identifying Impacts and Concerns

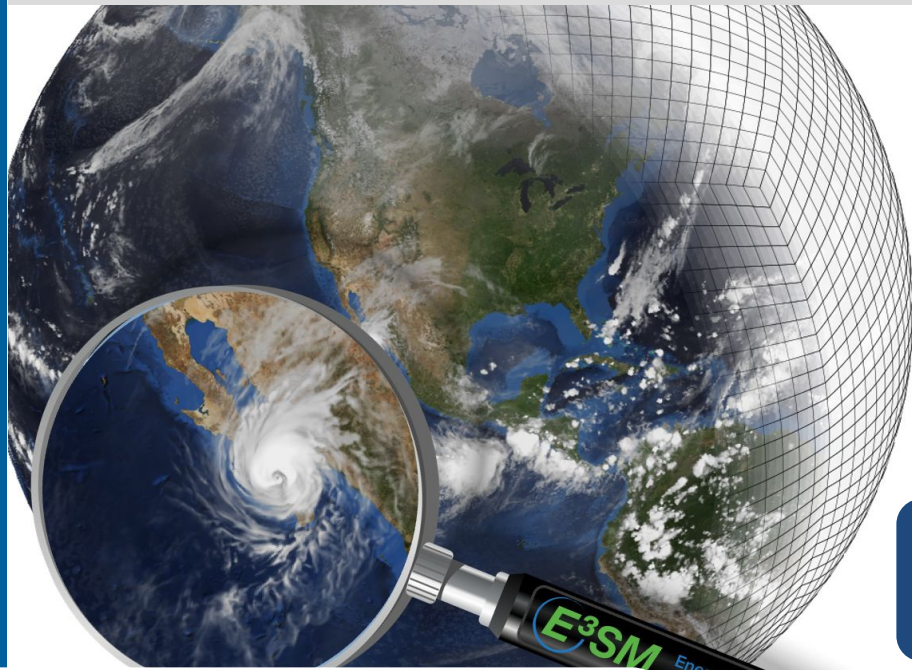
Simulation Data to Inform Decision-Making

## Puget Sound





# E3SM: Connections and applications through EESM

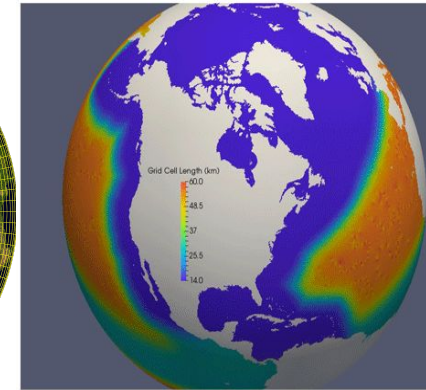
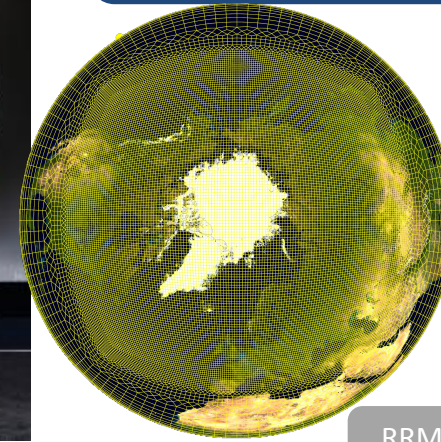


Success of the Simple Cloud Resolving E3SM Atmosphere Model at 3km global grid spacing!



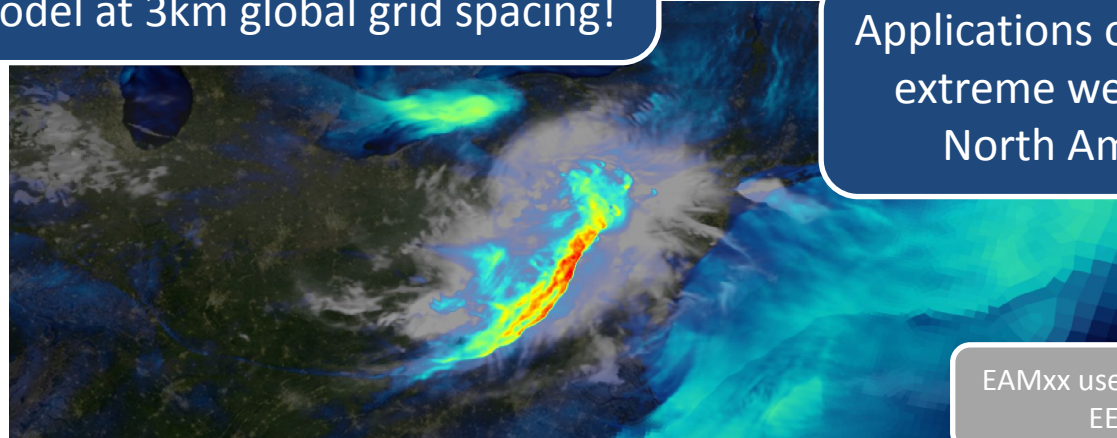
Winner of the inaugural Gordon Bell Prize for Climate Modeling

The world's first coupled Regionally Refined Modeling (RRM) capability

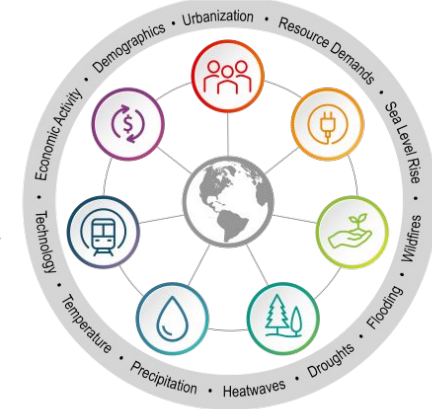


RRMs used extensively across EESM projects

Applications of E3SM to simulating extreme weather events (2012 North American Derecho)



EAMxx used extensively across EESM projects



E3SM and GCAM Coupling and Co-Benefits



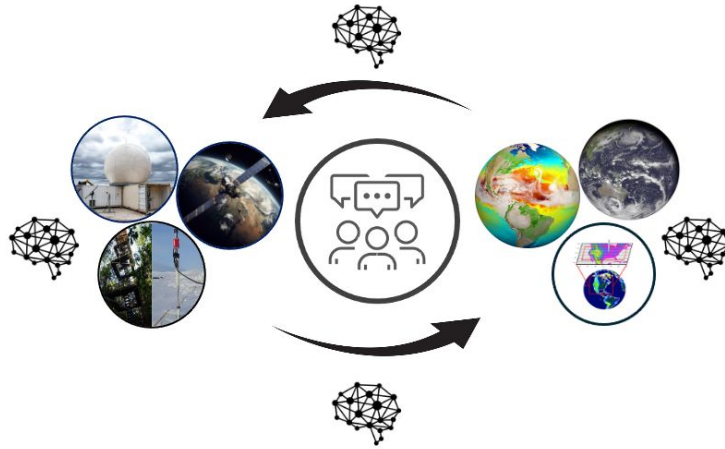
**Hierarchical Modeling**

**Energy Exascale Earth System Model**

**Global Change Analysis Model**

**Sectoral Models**

**Integrated Modeling Frameworks for Digital Earth**



**Emerging Technologies**

**Artificial Intelligence & Machine Learning**

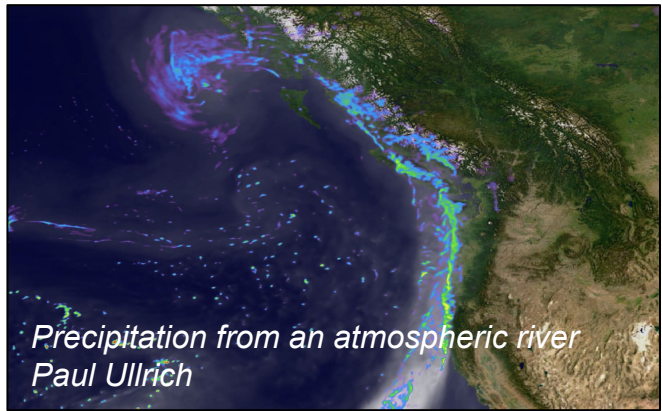
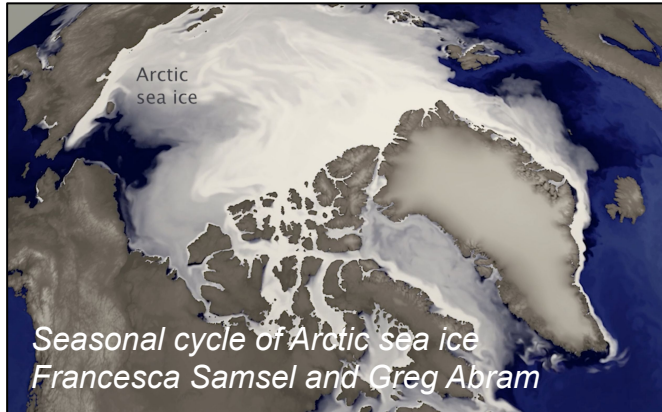
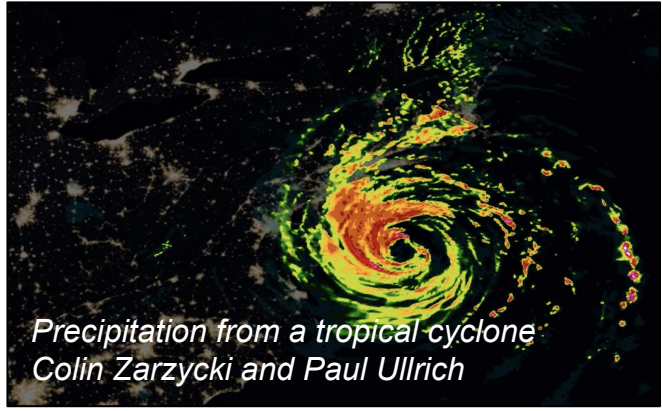
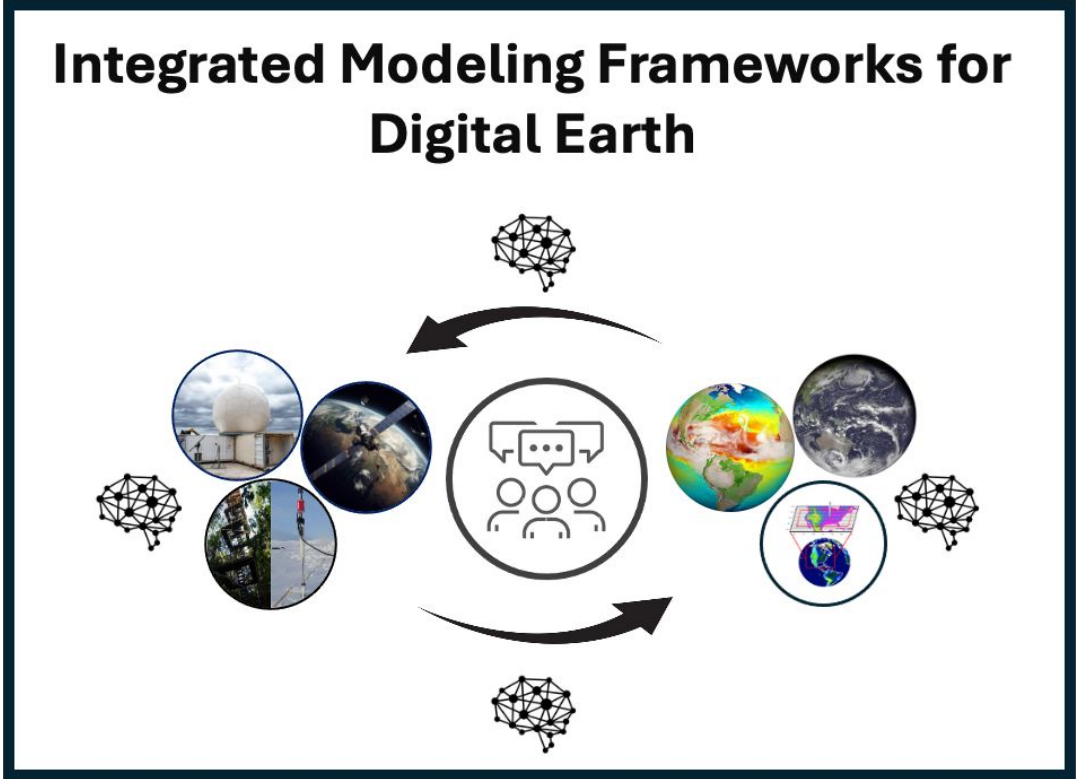
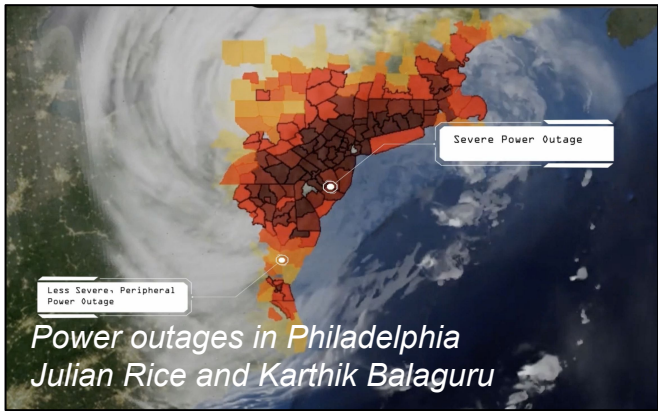
**Metrics and Diagnostics**

**Uncertainty Quantification**

**Local and Regional Testbeds**

**Stakeholder Engagement**





# EESM Program Manager Intra- and Interagency Engagements



United States  
Global Change  
Research Program

Interagency Group on Integrative Modeling (IGIM)  
Integrated Water Cycle Group (IWCG)  
Coasts Interagency Group (CoastsIG)  
Coastal Integrated Hydro-Terrestrial Modeling (C-IHTM)

## Other Federal Agency Working Groups

Interagency Arctic Research Policy Committee (IARPC)  
Interagency Council for Advancing Meteorological Services (ICAMS)  
ICAMS Earth System Modeling and Prediction (ESMP)  
ICAMS Artificial Intelligence / Machine Learning (AI/ML)  
ICAMS Research to Applications and Decision Making (R2ADM)  
Climate and Ocean - Variability, Predictability, and Change (CLIVAR)  
National Science and Technology Council (NSTC)  
National Oceanographic Partnership Program (NOPP)  
CICE Sponsor Group

## International Working Groups

Model Intercomparison Projects (MIPs)  
DYnamics of the Atmospheric general circulation Modeled  
On Non-hydrostatic Domains (DYAMOND)

## Joint PM Briefing Products

US CLIVAR Summit  
CESM Advisory Board Meeting  
The Urban Briefing IWG kickoff  
AD Briefing  
Division & BER Strategic Plans

## Joint Town Halls

Annual or near-annual American Geophysical Union (AGU)  
Frequent American Meteorological Society (AMS)

## Bilateral & Multi-Lateral Agency Coordination

SC Energy Earthshots, Energy-Water SETT, WPTO, WETO, Grid  
Reliability, USGS, NSF

## Interagency Workshops

US Climate Modeling Summit  
Workshops via US CLIVAR  
IHTM 1 & 2 workshops  
Coastal workshop with GLERL



# BER FY25 FOA-0003420

## Earth and Environmental Systems Science Research in the Southeast U.S.

FOA-0003420 was released July 25, 2024

Pre-applications are due [Sept. 19, 2024](#)

Full applications are due [Nov. 21, 2024](#)

Measurements, Experiments, Field data, **Modeling, Analysis, and Synthesis to provide improved understanding and representation of Southeast U.S. ecosystems, watersheds, atmospheric processes, and regional modeling** to address one or more of the following research topics:

1. Vegetation and Land-Atmosphere Interactions
2. Spatial Heterogeneity and Scaling
3. Convection, Clouds, Precipitation, and Biogenic Aerosols
4. Extreme Events and Disturbance.

Total of \$12 million in FY25 funds anticipated

3-year awards ranging from \$300,000 to \$1 million

Program Managers:

Renu Joseph (EESM), Shaima Nasiri (ASR), Daniel Stover (ESS)



<https://science.osti.gov/ber/Funding-Opportunities>

# PI Meeting Acknowledgements

Thanks to the all who submitted abstracts (300+) and are attending the meeting, those who helped organize the 30+ Plenary talks, 145+ breakout talks, 216+ posters into the thematic science and methodological topics.

In addition to cross-program interactions at this PI meeting building on the strengths of the individual projects, we look forward to the 15 white papers that will inform us about research gaps.

## Co-Chairs

Forrest Hoffman, ORNL  
Nicole Jeffery, LANL  
Patrick Reed, Cornell  
Paul Ullrich, LLNL  
Ruby Leung, PNNL

## Logistical Support

Tracey Viser, ORISE  
Rolanda Jundt, PNNL  
Michelle Prichard, PNNL  
Mike Wasem, LLNL

## Steering Committee Members

Adam Schlosser, MIT  
Andrew Roberts, LANL  
Ben Bond Lamberty, PNNL  
Casey Burleyson, PNNL  
Dave Bader, LLNL  
Forrest Hoffman, ORNL  
Ian Kraucunas, PNNL  
Jennie Rice, PNNL  
Jerry Meehl, UCAR  
Jiwen Fan, ANL  
Luke Van Roekal, LANL  
Manu Di Lorenzo, Brown  
Nicole Jeffery, LANL  
Patrick Reed, Cornell  
Paul Ullrich, LLNL  
Peter Caldwell, LLNL  
Peter Thornton, ORNL  
Ruby Leung, PNNL  
Shaocheng Xie, LLNL  
Stephanie Waldhoff, PNNL  
Travis O' Brien, Indiana University  
Wilbert Weijer, LANL

# Acknowledgements (continued)



## Topic Leads

Abigail Snyder, PNNL  
Abigail Swann, U. of Washington  
Aixue Hu, UCAR  
Alan Di Vittorio, LBNL  
Alan Rhoades, LBNL  
Alexey Fedorov, Yale  
Andrew Gettelman, PNNL  
Andrew Roberts, LANL  
Andy Jones, LBNL  
Andy Salinger, Sandia  
Antonia Hadjimichael,  
Ben Sulman, ORNL  
William Collins, LBNL  
Brian Medeiro, UCAR  
Brian O'Neill, PNNL  
Bryce Harroop, PNNL  
Charlie Koven, LBNL  
Chia-Ying Lee, Columbia U.  
Chris Golaz, LLNL  
Chris Vernon, PNNL  
Christine Shields, UCAR  
Claudia Tebaldi, PNNL  
Colin Zarzycki, Penn State U.  
Dan Lu, ORNL  
Dan Ricciuto, ORNL  
Darin Comeau, LANL

Dave Lawrence, UCAR  
Debra Sulsky,  
Elias Massoud, ORNL  
Elizabeth Hunke, LANL  
Erin Thomas, LANL  
Erwan Mornier, UC Davis  
Ethan Coon, ORNL  
Eva Sinha, PNNL  
Gautam Bisht, PNNL  
Hailong Wang, PNNL  
Hsi-Yen Ma, LLNL  
Hui Wan, PNNL  
Ian Kraucunas, PNNL  
Ian Sue Wing,  
Jen Morris, MIT  
Jennie Rice, PNNL  
Jennifer Holm, LBNL  
Jiafu Mao, ORNL  
Jiali Wang, Argonne  
Jian Lu, PNNL  
Jill Zhang, LLNL  
Jim Benedict, LANL  
Jim Randerson,  
John Fasullo, UCAR  
Jon Lamontagne, Tufts U.  
Jon Schwenk, LANL

Karen Fisher-Vanden,  
Karthik Balaguru, PNNL  
Kat Smith, LANL  
Kevin Reed, Stonybrook U.  
Klaus Keller, Dartmouth U.  
Libby Barnes, Colorado State U.  
Maria Molina, UCAR  
Mark Peterson, LANL  
Mark Taylor, Sandia  
Marshall Wise, PNNL  
Matt Hoffman, LANL  
Melissa Allen-Dumas, ORNL  
Mike Wehner, LBNL  
Milena Veneziani, LANL  
Mort Webster,  
Naresh Devineni, CUNY  
Nate Collier, ORNL  
Nicole Jeffery, LANL  
Ning Sun, PNNL  
Paul Ullrich, LLNL  
Peter Bogenschutz, LLNL  
Qi Tang, LLNL  
Qing Zhu, LBNL  
Rob Hetland, PNNL  
Rob Jacob, Argonne  
Rob Nicholas,

Ryan McManamay, Baylor U.  
Samson Hagos, PNNL  
Sarat Sreepathi, ORNL  
Scott Painter, ORNL  
Scott Rupp,  
Shaocheng Xie, LLNL  
Shineng Hu, Duke U.  
Stephanie Waldhoff, PNNL  
Steve Brus, Argonne  
Steve Price, LANL  
Susannah Burrows, PNNL  
Tom Wild, PNNL  
Trithankar Chakraborty, PNNL  
Umakant Misra, Sandia  
Weiqing Han  
Wieslaw Maslowski,  
Wilbert Weijer, LANL  
Wuyin Lin, Brookhaven  
Xianan Jiang, UCLA  
Xiangdong Zhang,  
Xubin Zeng  
Yaga Richter, UCAR  
Youtong Zheng,  
Yun Qian, PNNL



Thank You

# Critical and growing connections in such areas as coastal, urban, and extremes

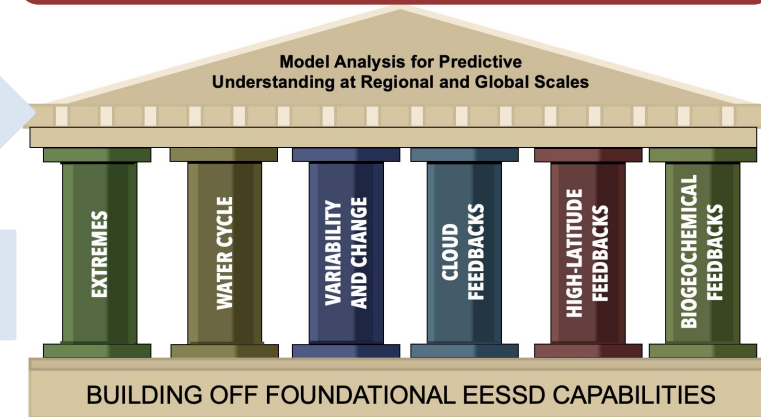
## Earth System Model Development (ESMD)



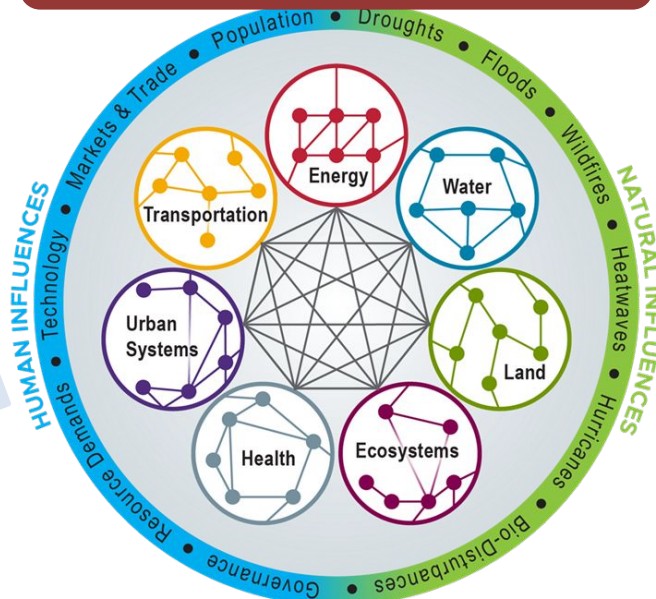
Advanced E3SM capabilities for RGMA to enhance understanding

Knowledge from RGMA simulations and analyses to benefit E3SM development

## Regional and Global Model Analysis (RGMA)



## Multisector Dynamics (MSD)



ESMD provides high resolution climate information and extremes, with feedbacks, for use in MSD models

MSD develops and supports GCAM in E3SM

RGMA Metrics and simulations developed inform different sectors

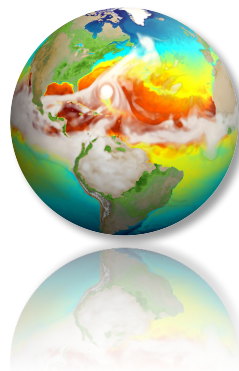
MSD Scenarios needed for projections and uncertainty quantification

# Other Asks and Announcements

## Request for Images for EESSD Strategic Plan

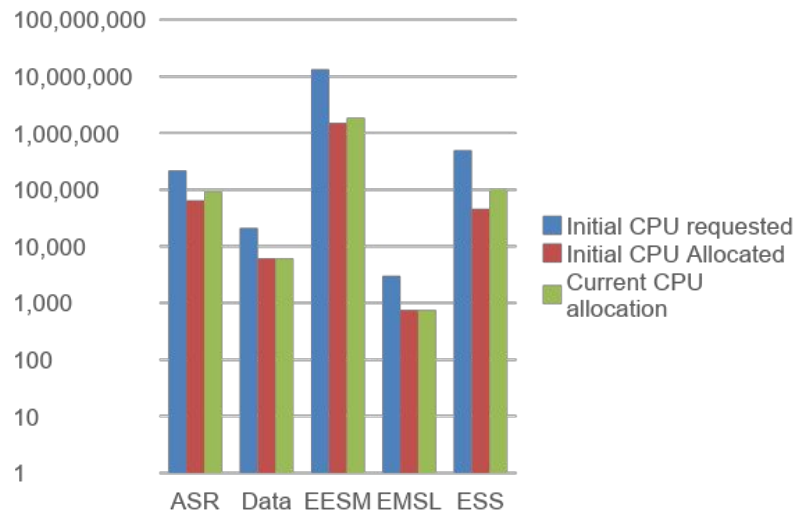
Please submit your favorite research images for activities like the **Earth and Environmental Systems Sciences Division Strategic Plan**.

[www.berscience.org/  
image-submission/](http://www.berscience.org/image-submission/)



## NERSC Request

As you are going to start your ERCAP requests be reasonable in your ask



One request per project. In FY23 use your allocation and then ask for more.

## SULI and CCI Internship Programs

Applications are currently being accepted for the spring 2025 term of two DOE Office of Science internship programs:

**Science Undergraduate Laboratory Internships (SULI) program**

**Community College Internships (CCI) program**

**Application deadline is Oct. 2, 2024**

SULI and CCI interns work directly with national laboratory researchers, assisting them on projects that support the DOE mission.

Potential mentors should reach out to SULI and CCI program contacts at their labs for info on how to request an intern.

# EESM Contributions to National and International Research Endeavors: e.g., Fifth National Climate Assessment

**Christa Brelsford**, Oak Ridge National Laboratory  
**Xujing Jia Davis**, US Department of Energy  
**Alex Hall**, University of California, Los Angeles  
**Forrest M. Hoffman**, Oak Ridge National Laboratory  
**Tianzhen Hong**, Lawrence Berkeley National Laboratory  
**Kripa Jagannathan**, Lawrence Berkeley National Laboratory  
**Renu Joseph**, US Department of Energy  
**David Judi**, Pacific Northwest National Laboratory  
**Stephen Klein**, Lawrence Livermore National Laboratory  
**L. Ruby Leung**, Pacific Northwest National Laboratory  
**Richard Moss**, Pacific Northwest National Laboratory  
**Angeline Pendergrass**, Cornell University  
**Patrick M. Reed**, Cornell University  
**Claudia Tebaldi**, Pacific Northwest National Laboratory  
**Peter E. Thornton**, Oak Ridge National Laboratory  
**Paul A. Ullrich**, Lawrence Livermore National Laboratory  
**Robert Vallario**, US Department of Energy  
**Nathalie Voisin**, Pacific Northwest National Laboratory  
**Michael F. Wehner**, Lawrence Berkeley National Laboratory



EESM funded scientists were heavily involved in writing of the Fifth National Climate Assessment!