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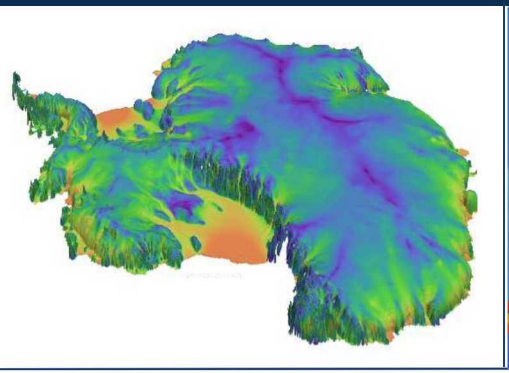
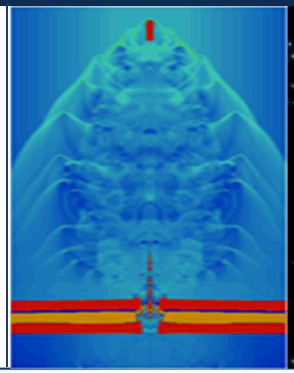
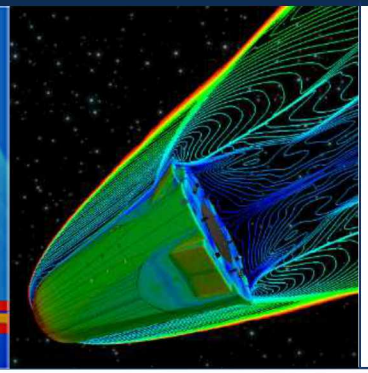

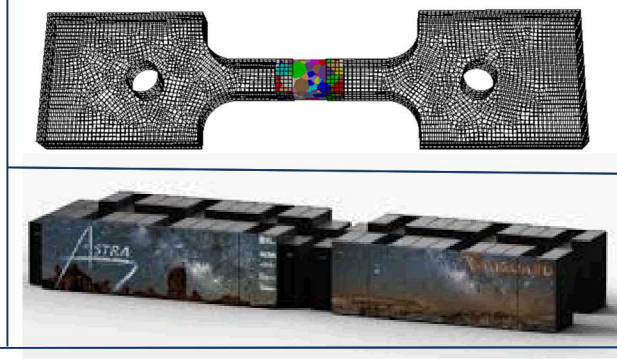

Modeling & Simulation R&D at Sandia National Laboratories

Irina Tezaur

Quantitative Modeling & Analysis Dept., Sandia National Laboratories, Livermore, CA.

Monday, November 4, 2019

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Computational Modeling & Simulation

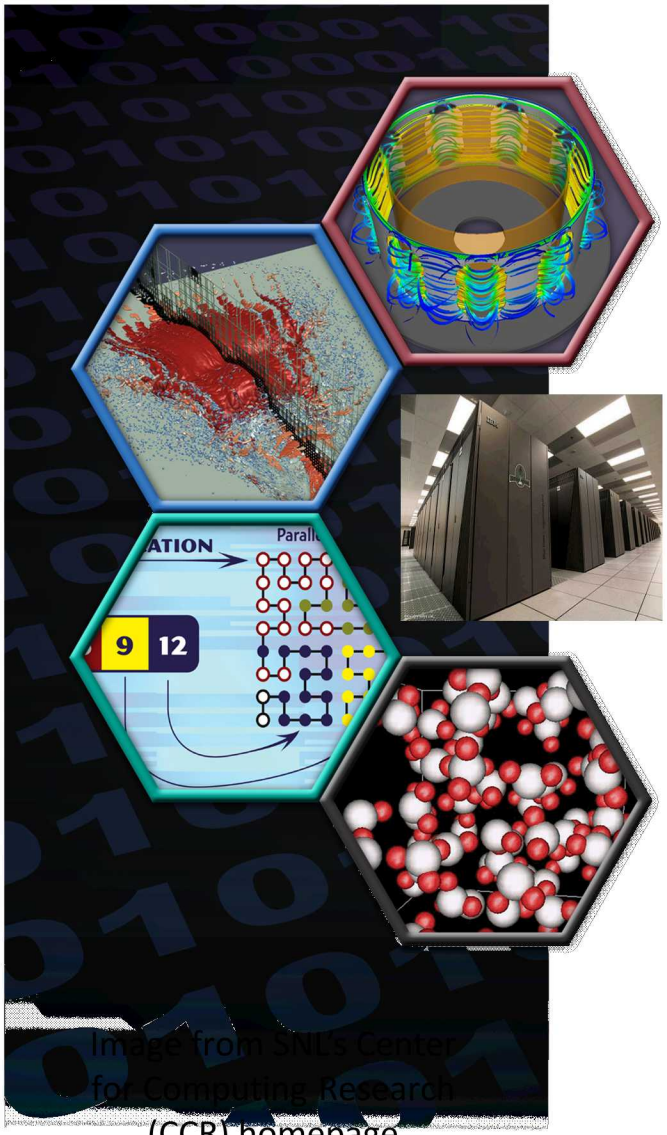


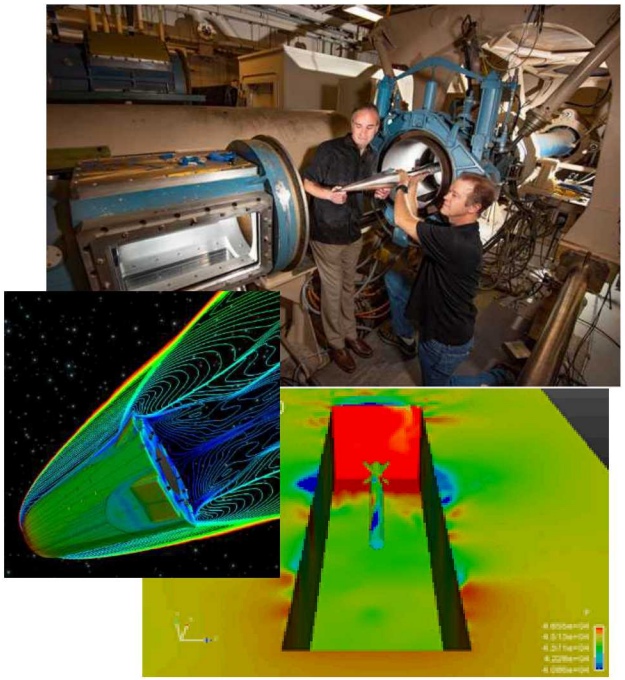
Image from SNL's Center for Computing Research (CCR) homepage

- Computational/mathematical modeling & simulation can ***replace*** and/or ***enhance*** laboratory/field experiments, which can be costly, dangerous and time-consuming.
- It allows one to explore and evaluate ***multiple configuration settings*** for engineering designs, and ***predict possible future scenarios*** of interest worldwide (e.g., disease outbreaks, climate change).

*Computer simulations can provide **actionable** information to support **public policy** and **decision making**.*

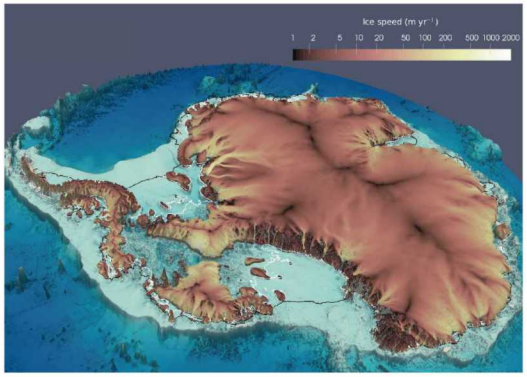
Modeling & Simulation R&D Projects

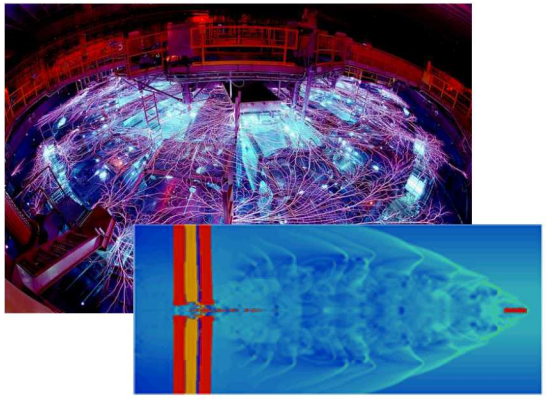
My R&D focuses on improving computational modeling & simulation of complex ***multiscale/multiphysics*** problems of interest to the SNL, DOE and US nuclear weapons, national security and climate missions.

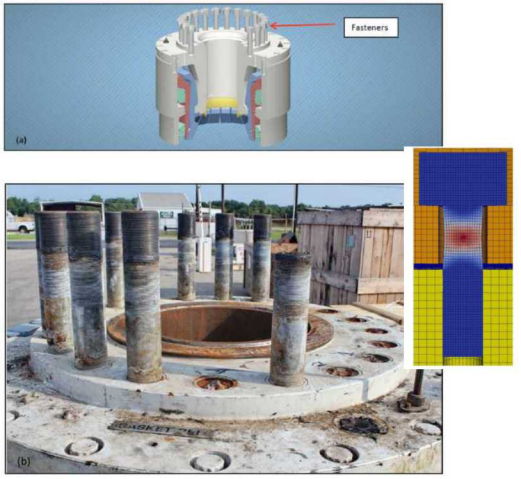


Model Order Reduction of Captive-Carry and Re-Entry Environments

Ice Sheet and Climate Modeling





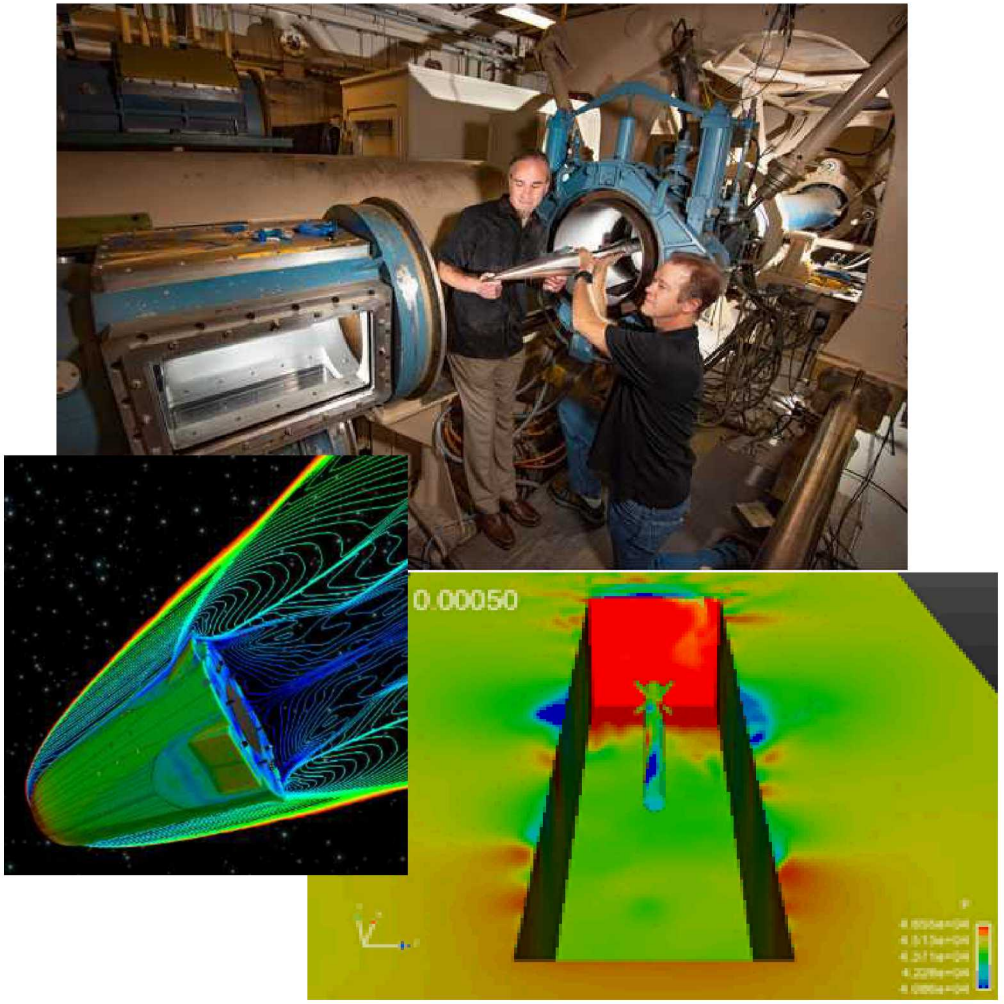


Multi-Scale Methods for System/ Component Failure Analyses

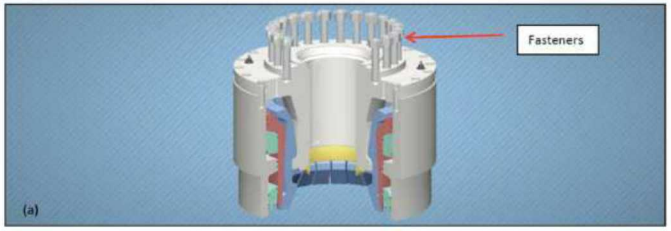
Shock Multi-Physics for Z-Machine Implosion and Advanced Armor Simulations

Model Order Reduction of the Captive-Carry and Re-Entry Environments

- ***Data-driven approach*** that speeds up simulations, which can take weeks even when run on massively parallel supercomputers
- Enables ***real-time*** design quantification and ***uncertainty quantification***
- Complements ***experimental work*** performed in Sandia's wind tunnels.



Multi-Scale Methods for System/Component Failure Analyses



Components held together by fasteners

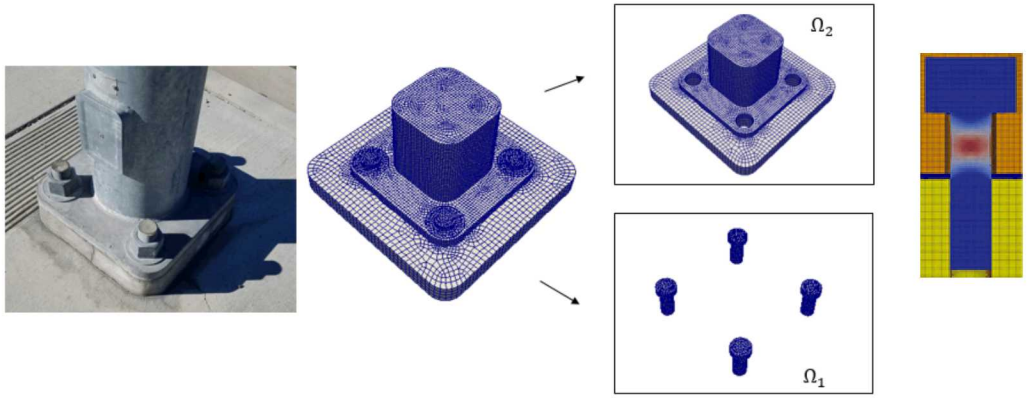
- ***Small-scale*** defects can lead to ***large-scale*** structural failure (left).
- Simulating multiple scales is ***very challenging!***

Sandia *LabNews*

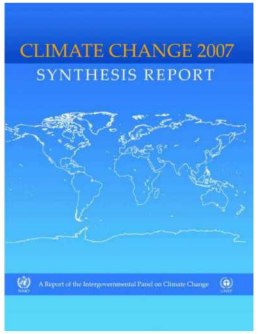
Getting to the nuts and bolts of nuts and bolts

BY MICHAEL ELLIS LANGLEY | PHOTOGRAPHY BY MICHAEL ELLIS LANGLEY
THURSDAY, AUGUST 29, 2019

"Plug-and-play" multi-scale simulation framework ***reduces*** simulation time from ***months to weeks*** and enables exploration of ***many*** failure scenarios.

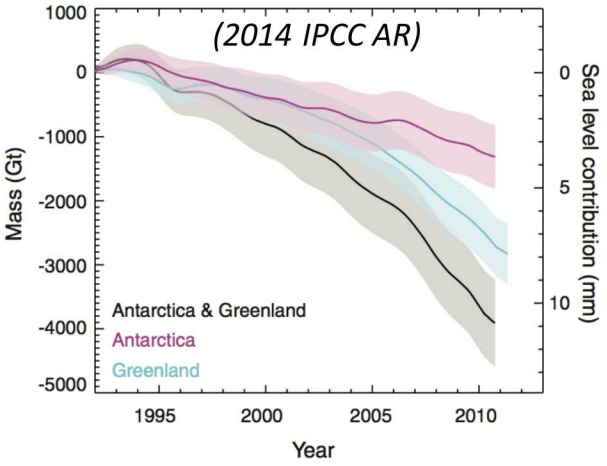


Ice Sheet & Climate Modeling



Motivation: *2007 IPCC AR declined to include estimates of future sea-level rise from ice sheet dynamics due to deficiencies in ice sheet models.*

***Most likely SLR by 2100**: 0.8-1m*



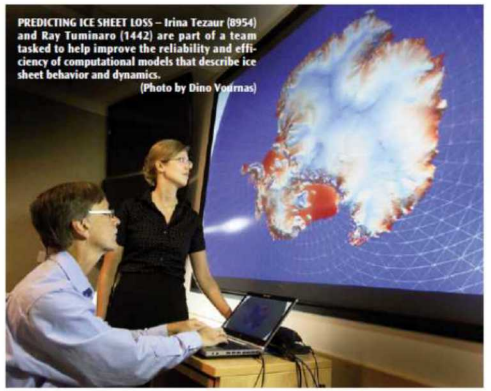
- We are developing a ***next-generation*** ice model that will provide ***actionable predictions*** of 21st century ***sea-level rise*** and supports ***national security missions*** as part of DOE Energy Exascale Earth System Model (E3SM).

- Related work involves detecting ***Arctic tipping points*** due to climate change using the E3SM and ***data-driven*** (machine-learned) models.

Ice sheet modeling of Greenland, Antarctica helps predict sea-level rise

Michael Padilla

The Greenland and Antarctic ice sheets will make a dominant contribution to 21st century sea-level rise if current climate trends continue. However, predicting the expected loss of ice sheet mass is difficult due to the complexity of modeling ice sheet behavior.



PREDICTING ICE SHEET LOSS – Irina Tezaur (8954) and Ray Tuminaro (1442) are part of a team tasked to help improve the reliability and efficiency of computational models that describe ice sheet behavior and dynamics. (Photo by Dino Vournas)

Computing (SciDAC) program. PISCEES is a multi-lab, multi-university endeavor that includes researchers from Sandia, Los Alamos, Lawrence Berkeley, and Oak Ridge national laboratories; the Massachusetts Institute of Technology; Florida State University; the University of Bristol; the University of Texas Austin; the University of South Carolina; and New York University.

Sandia's biggest contribution to PISCEES has been an analysis tool: a land-ice solver called Albany/FELIX (Finite Elements for Land Ice eXperiments). The tool is based on equations that simulate ice flow over the Greenland and Antarctic ice sheets and is being coupled to Earth models through the Accelerated Climate for Energy (ACME) project.

"One of the goals of PISCEES is to create a land-ice solver that is scalable, fast, and robust on continental scales," says computational scientist Irina Tezaur, a lead developer of Albany/FELIX. Not only did the new solver need to be reliable and efficient, but it was critical that the team develop a solver capable of running on new and emerging computers, and equipped with advanced