ISICLES: Ice Sheet Initiative for CLimate ExtremeS

Using OASCR SciDAC tools and research capabilities to accelerate breakthroughs in ice sheet simulation

http://www.csm.ornl.gov/isicles

Program Manager for ISICLES: Bill Spotz (acting)
Katherine J. Evans, Oak Ridge National Laboratory

Bottlenecks to progress in climate modeling investments by ASCR and BER

ASCR- facilities/infrastructure investments	Well balanced?	BER- Basic science/observational/modeling investments
Computational solutions	⟷	Computational requirements
Software solutions	⟷	Software needs
Algorithm/applied math sol'ns	⟷	Algorithm needs (e.g.,efficiency)
Data management solutions	⟷	Data management needs
Networking solutions	⟷	Networking needs
Collaboration technology	⟷	Collaboration technology needs
		Investments in basic knowledge
		Investments in observations
		Investments in modeling techniques

Adequate investments here to ensure progress?? ⇒

courtesy Jim Hack, ORNL

Scientific Discovery through Advanced Computing (SciDAC)

- Advancing Science through large-scale data, modeling and simulation
  - Science Application and Science Applications Partnerships: *Astrophysics, Accelerator Science, Climate, Biology, Fusion, Petabyte data, Materials & Chemistry, Nuclear physics, High Energy physics, QCD, Turbulence, Groundwater*
  - Centers for Enabling Technology: Address mathematical and computing systems software issues
  - Institutes: Assist Scientific Applications teams and foster next generation computational scientists

http://www.scidac.gov

courtesy Walt Polanski, DOE

6 projects funded under ISICLES: separate but complementary efforts

- SEA-CISM: A Scalable, Accurate, and Efficient Community Ice Sheet Model, ORNL
- B-ISICLES: High-Performance Adaptive Algorithms for Ice Sheet Modeling, LBNL
- Uncertainty Quantification for Large Scale Ice Sheet Modeling and Simulation, U Texas
- Lagrangian Model for Ice Sheet Dynamics, PNNL
- SISIPHUS: Scalable Ice Sheet Solvers and Infrastructure for Petascale, High-resolution, Unstructured Simulations, ANL
- Modeling the Fracture of Ice Sheets on Parallel Computers, Columbia U

UT/LANL Project: Uncertainty Quantification for Large-Scale Ice Sheet Modeling and Simulation

The University of Texas at Austin Co-PIs:

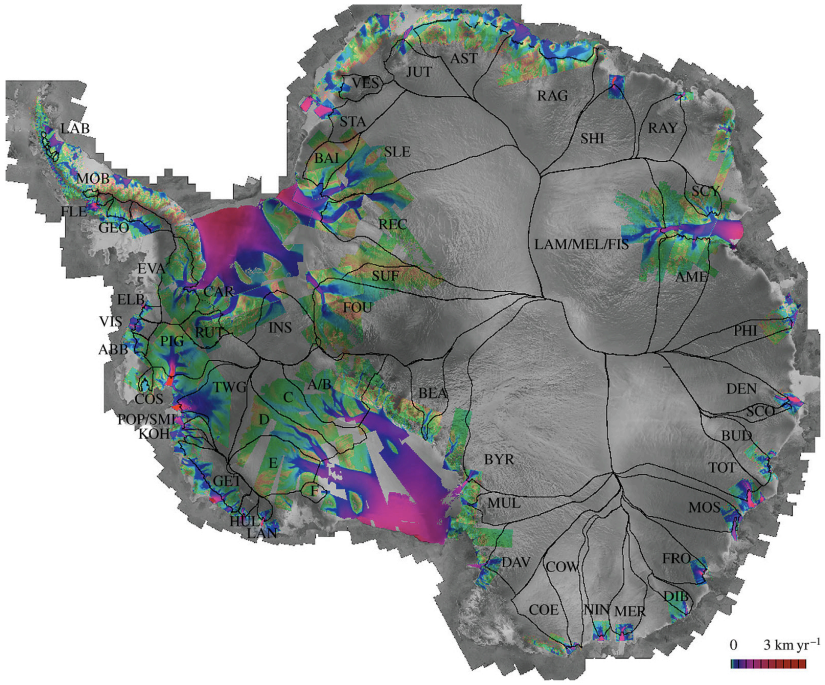
Don Blankenship (glaciology), *Carsten Burstedde* (computational math), *Omar Ghattas* (PI, computational science), *Charles Jackson* (climate science), *Georg Stadler* (applied math), *Lucas Wilcox* (scientific computing)

Los Alamos National Laboratory Co-PIs:

Jim Gattiker (statistics), *Dave Higdon* (statistics), *Steve Price* (glaciology)

Overall goal:

Develop *scalable uncertainty quantification techniques* for inferring uncertain parameters in ice sheet dynamics models by assimilating noisy observations into advanced petascale forward models via solution of *large-scale statistical inverse problems*



Observed surface velocities from InSAR

Scalable Ice-sheet Solvers and Infrastructure for Petascale, High-resolution, Unstructured Simulations (SISIPHUS)

Timothy J. Tautges (PI), Barry Smith, Dmitry Karpeev, Jean Utke (ANL)
Jed Brown (ETH-Zurich)
Patrick Heimbach (MIT)
Bill Lipscomb (LANL)

"For this project, we propose to develop techniques for solving the fully 3D Stokes problem, for continent-scale ice sheets, integrated over hundreds or thousands of years, on petascale computers ..."

[by developing]

"... more accurate, high-performing ice sheet modeling methods, and a framework for constructing the models, connecting them to solvers, and coupling them to regional and global climate models."

Modeling the Fracture of Ice Sheets on Parallel Computers

PI: Haim Waisman, David Keyes and Robin Bell (consultant)
Columbia University

Ray Tuminaro and Erik Boman
Sandia National Labs

Project website: http://www.civil.columbia.edu/waisman/ice/index.html

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Objective: Employ parallel computers to study the fracture of land ice to better understand how it affects global climate change. In particular the collapse mechanism of ice shelves, the calving of large icebergs and the role of fracture in the delivery of water to the bed of ice sheets.

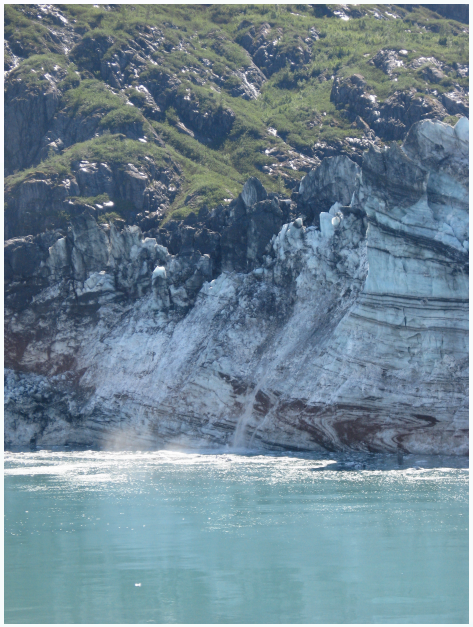
Columbia University

Sandia National Laboratories

SEA-CISM: A Scalable, Efficient and Accurate Community Ice Sheet Model

Key goals:

✧Improvements for ice sheet prediction for next IPCC report
✧1km resolution efficient ice sheet model this year
✧Longer term work on unstructured grids, solver development, coupling to CCSM



Team Members:

Erin Barker, Dana Knoll, LANL

J.-F. Lemieux, NYU (postdoc)

Ryan Nong, Andy Salinger, SNL

Kate Evans (PI), Trey White, Pat Worley, ORNL

Consultation/Assistance from:
David Holland, NYU
Bill Lipscomb, Los Alamos
Steve Price, Los Alamos
GLIMMER Steering committee

OAK RIDGE NATIONAL LABORATORY
Managed by UT-Battelle for the Department of Energy

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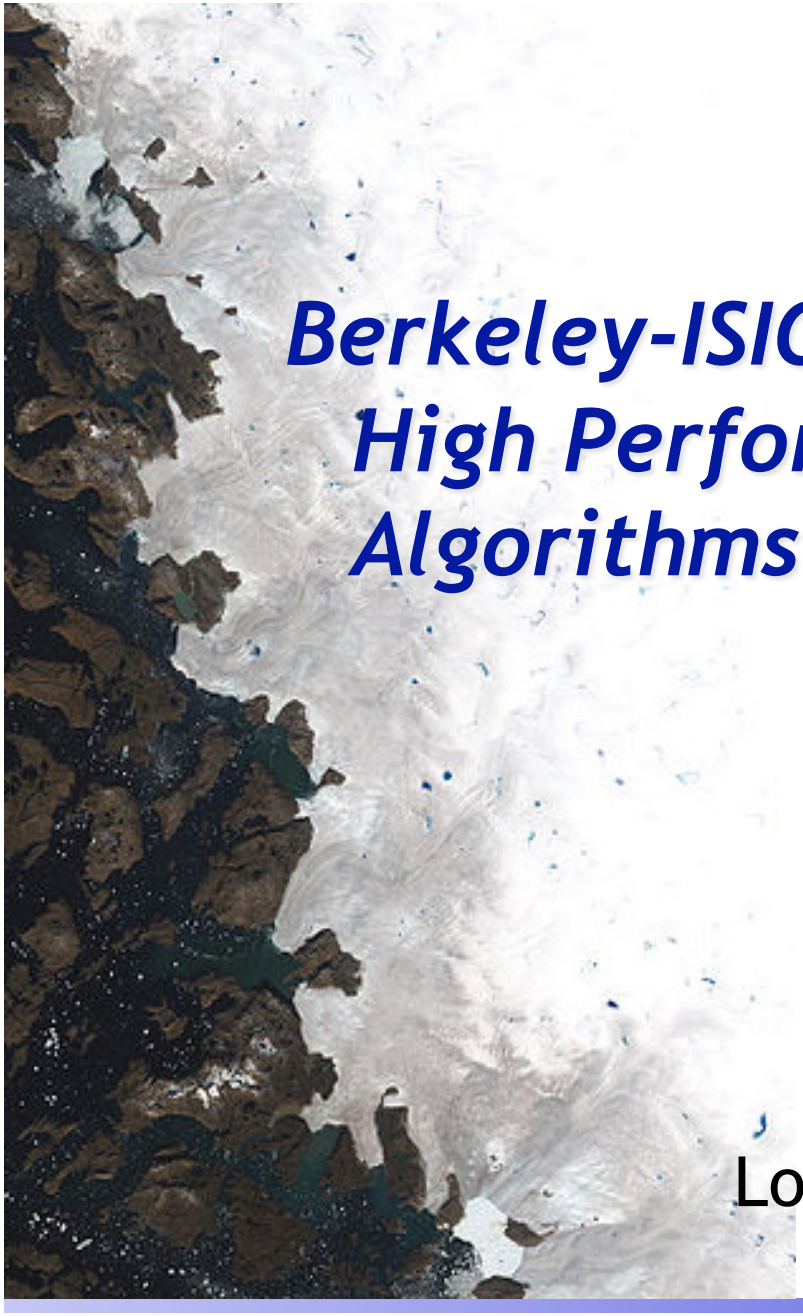
Sandia National Laboratories

New York University



Berkeley-ISICLES: High Performance Adaptive Algorithms For Ice Sheet Modeling

Joint project between

Lawrence Berkeley National Laboratory
(PI: Esmond Ng)

Los Alamos National Laboratory
(co-PI: William Lipscomb)

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BISICLES

BERKELEY LAB

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Lagrangian Model for Ice Sheet Dynamics

PI: Alexandre Tartakovsky

Pacific Northwest National Laboratory

Investigators: Bruce Palmer, Xin Sun, Barry Lee, Guang Lin

Phillip Rasch, BER project "Improving the Characterization of Clouds, Aerosols and the Cryosphere in Climate Models".

Paul Meakin, Idaho National Laboratory

Advanced Scientific Computing Research,
SciDAC,
Computational Science Research for Ice Sheet Modeling

Pacific Northwest
NATIONAL LABORATORY

Intra-ISICLES interactions

- Some projects have overlap of tasks
- Projects range from short term deliverables to longer term impact
- Approaches vary; mesh, tools, dynamics
- All are using iterative numerical methods where appropriate
- Interactions with climate scientists provide a link

ISICLES Projects Goals

- Address the importance and complexity of ice sheet predictability
- Leverage computational science tools developed through related ASCR efforts
- Provide petascale ready simulation capabilities for the ice sheet modeling community in short order
- Stay tuned at http://www.csm.ornl.gov/isicles

Glacier National Park, Alaska