Dr. Joseph H. Kennedy

Contact Information

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Research Interests

- ◇ Verification, validation and uncertainty quantification of Earth system models and their constituents
- ◇ Developing cross-disciplinary tools to facilitate collaboration, sharing, and reproducibility
- ◇ Applying computational physics methods to novel and unique problems
- ◇ Investigating the link between climate history and ice crystalline fabric
- ◇ Glacier dynamics and the effects of anisotropic ice on bulk properties

Professional Experience

Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA
Computational Scientist in Glaciology
Climate Change Science Institute **December 2016 – present**

Perform research tasks using Earth System Models (ESMs; e.g., DOE's E3SM, CESM) and ice sheet models (e.g., MPAS-LI, BISICLES, PISM, CISM); coordinate the verification and validation of E3SM, MPAS-LI, and BISICLES simulations; development of the Land Ice Verification and Validation toolkit (LIVVkit), a python-based toolkit for robust evaluation of ice-sheet models; and develop an extended V&V evaluation tool (EVE) for climate reproducibility testing of ESMs.

Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA
Postdoctoral Research Associate
Climate Change Science Institute **January 2015 – November 2016**

Perform research tasks using the Community Ice Sheet Model (CISM) and coordinate the development of the Land Ice Verification and Validation toolkit (LIVVkit) — a python-based toolkit for robust evaluation of ice-sheet models.
Advisor: Dr. Katherine J. Evans

Education

University of Alaska Fairbanks, Fairbanks, Alaska, USA
Department of Physics

Ph.D., 2015, Dissertation Topic:
"Linking climate history and ice crystalline fabric evolution in polar ice sheets."
Advisor: Dr. Erin C. Pettit

Western Washington University, Bellingham, Washington, USA
Department of Physics

B.S., Physics, June, 2008
Minors: Astronomy, The Study of Religion

Selected Publications

Lipscomb, W.H., S.F. Price, M.J. Hoffman, G.R. Leguy, A.R. Bennett, S.L. Bradley, K.J. Evans, J.G. Fyke, *J.H. Kennedy*, M. Perego, D.M. Ranken, W.J. Sacks, A.G. Salinger, L.J. Vargo, and Patrick H. Worley. (In Review). Description and evaluation of the community ice sheet model (CISM) v2.1. Geoscientific Model Development.
Discussion article: gmd-2018-151. (Online soon)

Evans, K.J., *J.H. Kennedy*, D. Lu, M.M. Forrester, S. Price, J. Fyke, A.R. Bennett, M. Hoffman, I. Tezaur, C. Zender, and M. Vizcaino. (In Review). LIVVkit 2.1: Automated and extensible ice sheet model validation. Geoscientific Model Development.
Discussion article: gmd-2018-70.

Goelzer, Heiko, S. Nowicki, T. Edwards, M. Beckley, A. Abe-Ouchi, A. Aschwanden, R. Calov, O. Gagliardini, F. Gillet-Chaulet, N. Golledge, J. Gregory, R. Greve, A. Humbert, P. Huybrechts, *J.H. Kennedy*, E. Larour, W. Lipscomb, S. Le clec'h, V. Lee, M. Morlighem, F. Pattyn, T. Payne, C. Rodehacke, M. Ruckamp, F. Saito, N. Schlegel, H. Seroussi, A. Shepherd, S. Sun, R. van de Wal, F. Ziemen. (2018). Design and results of the ice sheet model initialization experiments initMIP-Greenland: An ISMIP6 intercomparison. The Cryosphere, 12, 1433–1460.
doi:10.5194/tc-12-1433-2018

Kennedy, J.H., A.R. Bennett, Evans, K.J., S. Price, M. Hoffman, W.H. Lipscomb, J. Fyke, L. Vargo, A. Boghozian, M. Norman, P.H. Worley. (2017). LIVVkit: An extensible, python-based, land ice verification and validation toolkit for ice sheet models. Journal of Advances in Modeling Earth Systems, 9(2), 854–869.
doi:10.1002/2017MS000916

Price, S., M. Hoffman, J. Bonin, T. Neumann, I. Howat, J. Saba, J. Guerber, D. Chambers, K.J. Evans, *J.H. Kennedy*, J. Lenaerts, W.H. Lipscomb, M. Perego, A. Salinger, R. Tuminaro, M. van den Broeke, and S.M.J. Nowicki. (2017). An ice sheet model validation framework for the Greenland ice sheet. Geoscientific Model Development, 10, 255–270.
doi:10.5194/gmd-10-255-2017

Kennedy, J.H., and E.C. Pettit (2015). The response of climate induced fabric variations to simple shear and migration recrystallization. Journal of Glaciology, 61(227), 537–550.
doi:10.3189/2015JoG14J156.

Kennedy, J.H., E.C. Pettit, and C.L. Di Prinzio (2013). The evolution of crystal fabric in ice sheets and its link to climate history. Journal of Glaciology, 59(214), 357–373.
doi:10.3189/2013JoG12J159.

Gusmeroli, A., E.C. Pettit, *J.H. Kennedy*, and C. Ritz (2012). The crystal fabric of ice from full-waveform borehole sonic logging. J. Geophys. Res., 117, F03021.
doi:10.1029/2012JF002343.

Grant Proposals

DOE BER/ASCR sea-level projections (2017)
Co-I and V&V task lead, funded: *Probabilistic sea-level projections from ice sheet and Earth system models*, $1.33M over 5 years to ORNL

DOE BER ACME-SM project (2016)
Co-I, funded: *A Global climate model software modernization surge*, $1.35M over 3 years to ORNL

ORNL/NOAA performance project (2016)
CO-I, funded: *Performance analysis of climate workflows*, $336K over 1 year to ORNL

DOE BER RGCM-IAR Integration Framework for Climate Evaluation (2016)
Co-I, declined, *Biofeuls, land-use change, and implications for the water-energy-food nexus: a multi-model systems approach*, $1.8M over 3 years to ORNL

Significant Reports and White Papers

Kennedy, J.H., B.W. Mayer, K.J. Evans, J. Durachta (2017). Performance analysis of large scale HPC worflows for Earth system models. ORNL Technical Memo, ORNL/TM-2017/540.
doi:10.2172/1439154

Allen, M.R., H.M.A. Aziz, M.A. Coletti, *J.H. Kennedy*, S.S. Nair, and O.A. Omitaomu (2017). Workshop on human activity at scale in Earth system models. ORNL Technical Memo, ORNL/TM-2017/24. doi:10.2172/1343540

Kennedy, J.H., B. Debusschere, K. Sargsyan, F.M. Hoffman, K.J. Evans (2016). Full-system evaluation of Earth system models. Ideas paper 51 in E. Ng, K.J. Evans, et al. (Authors), Advancing Cross-Cutting Ideas for Computational Climate Science, Workshop Report, Rockville, MD, September 12-13, 2016. ORNL/TM-2016/717. doi:10.2172/1341564.

Law, K., R. Archibald, *J.H. Kennedy* (2016). Data assimilation for ice-sheet models. Ideas paper 22 in E. Ng, K.J. Evans, et al. (Authors), Advancing Cross-Cutting Ideas for Computational Climate Science, Workshop Report, Rockville, MD, September 12-13, 2016. ORNL/TM-2016/717. doi:10.2172/1341564.

Software

E3SM (Energy Exascale Earth System Model) core developer (infrastructure group) for phase 2; DOE's E3SM is a state-of-the-science Earth system model development and simulation project to investigate energy-relevant science using code optimized for DOE's advanced computers. Latest open-source release of E3SM, version 1.0.0, was on April 23, 2018.
https://github.com/E3SM-Project/E3SM

Lead developer of the Land Ice Verification and Validation toolkit (LIVVkit); a python-based, extensible verification and validation suite for land-ice models. Latest open-source release of LIVVkit, version 2.1.3, was on July 28, 2018. https://github.com/LIVVkit/LIVVkit

Developer of the ISMIP6 Atlas submission validation tool; an extension to LIVVkit which checks submissions to ISMIP6 experiments for correct file names, paths, metadata, etc. and produces a large variety of diagnostic plots. https://github.com/LIVVkit/Atlas

Developer on DOE's E3SM ecosystem projects

- MPAS-Analysis: Analysis for simulations produced with Model for Prediction Across Scales (MPAS) components and DOE's E3SM.
  https://github.com/MPAS-Dev/MPAS-Analysis
- A-Prime: Python based scripts to generate coupled priority metrics for DOE's E3SM.
  https://github.com/ACME-Climate/a-prime
- EVE: Extended verification and validation for Earth system models, public release forthcoming.

Contributor to open-source software projects

- Conda-forge recipe maintainer for JSON tricks
- PR19 and PR27 to sphinx-js leading to release of (bugfix) v2.0.1 and contributing to v2.2.

Past: Developer and integrator for the joint DOE/NSF Community Ice Sheet Model (CISM); a next-generation ice sheet model used for predicting ice sheet evolution and sea level rise in a changing climate. Last public, open-source release of CISM was version 2.0.5 on was August 28, 2015.

Allocation Proposals

Energy Research Computing Allocations Process (ERCAP) for NERSC (2016)
Co-I, accepted, *Predicting ice sheet and climate evolution at extreme scales*, 10M hours on Edison

OLCF Directors Discretion Allocation (2015)
Co-I, accepted, *Earth system modeling collaborative*, 10M hours on Titan

Awards

2016 CCSI Professional Development Award, $100,000
Co-I: *Understanding the links between neighbourhood level human activity and global climate change by developing an integrative methodology using data analytics, agent-based modelling and Earth system modelling.* Project PI: Dr. Melissa R. Allen.
Climate Change Science Institute, Oak Ridge National Laboratory

2013–2014 Thesis Completion Fellowship, $15,000 + tuition
University of Alaska Fairbanks Graduate School

2011–2012 CASE GK-12 Fellow, $45,000
NSF Graduate STEM Fellow in K-12 Education, Changing Alaska Science Education

Synergistic Activities

2016–present	Referee for the Australian Antarctic Division, the Geophysical Journal International, and the Journal of Mountain Science
2015–present	Currently participating in the Ice Sheet Model Intercomparison Project 6 (ISMIP6)
2015–present	Conducting multiple experiments for the Initialization of Models Intercomparison Project (initMIP)
2015–present	Outreach talks, entitled "Using computational science to understand Earth's climate"

- ◇ UT Governor's School, June 18, 2018
- ◇ APSU Governor's School, June 15, 2018; June 16, 2017; June 17, 2016; and June 12, 2015
- ◇ McCalie School (8th grade), May 9, 2018; May 10, 2017
- ◇ UAH Joint Space Weather Summer Camp, June 30, 2017
- ◇ University of Louisville's Society of Physics Students, March 15, 2017
- ◇ White House High, April 7, 2016
- ◇ Lipscomb Academy, Oct. 1, 2015

Teaching Experience

Oak Ridge Institute for Continued Learning at Roane State Community College, Oak Ridge, Tennessee, USA

Co-lecturer with Dr. Melissa R. Allen (ORNL)
Climate Change Science **June 2016**
We presented four lectures, one and a quarter hours in length, on the topics: 1) global warming and the carbon cycle, 2) indicators of climate change, 3) impacts of climate change on human life and 4) global and regional climate modeling and uncertainty.

University of Alaska Fairbanks, Fairbanks, Alaska, USA

Graduate Teaching Assistant
Geology & Geophysics Department **August 2014 – December 2014**
I taught the computational portion of the graduate level geophysics course Foundations of Geophysics and was responsible for lectures, homework assignments, and grades. Further duties included holding weekly office hours.

- ◇ GEOS 631/431 – Foundations of Geophysics, Fall 2014

Guest Lecturer
GEOS 631/431 — Foundations of Geophysics (Oct. 25 and Oct. 30, 2012): I gave two lectures, one and a half hours in length, on general conservation laws, conservation of energy, and heat transfer. The first lecture started with the general form of the conservation laws, derived the conservation of momentum equation the students were familiar with, and then discussed the definition and forms of energy. The lecture concluded with a discussion on the first law of thermodynamics as well as a derivation of the conservation of energy equation. The second lecture discussed Fourier's law and solved practical heat flow problems; some of which were taken from Chapter 4 of Turcotte and Schubert's Geodynamics textbook.

Guest Lecturer
GEOS 636/436 — Beyond the Mouse: Computer Programming and Automation for Geosciences (Sept. 11 and Nov. 15, 2012): The September lecture was 1 hour in length and focused on an introduction to variables and data types. We discussed what a computer is, how a computer thinks, what a program is, and what a programming language is. The students were then taught how to create variables and store different types of data. The November lecture was a demonstration of live programming and was 2 hours in length. I demonstrated how to use common command line tools, a scripting language, and good file structure to create a manuscript preparation work-flow. I developed scripts to help create a LaTeX document and introduced tools such as a distributed version control system to keep track of changes and share work with collaborators.

Graduate Teaching Assistant
Geology & Geophysics Department **August 2012 – December 2012**
I taught the computational portion of graduate level geophysics courses and was responsible for lectures, homework assignments, and grades. Further duties included holding weekly office hours.

- ◇ GEOS 631/431 — Foundations of Geophysics, Fall 2012
- ◇ GEOS 636/436 — Beyond the Mouse: Computer Programming and Automation for Geosciences, Fall 2012

NSF GK-12 Fellow
Denali Elementary School **May 2011 – May 2012**
I taught 4 science lessons a week in two first grade classrooms of 30 students (10 contact hours per week). We covered a variety of subjects, including: the scientific method, the five senses, plants, birds of prey, migratory birds, caribou, weather, glaciers, heat transfer, food science, rockets, pressure-volume-temperature, volcanoes and how to design a testable question. I primarily designed the lesson plans, homework, and experiments for the students. At the end of the year, the classes worked on a joint science fair project in which the students designed and conducted the entire experiment. The classes won a first place ribbon and a $50.00 prize for *Exceptional Women in Science* at the Fairbanks Northstar Borough School District Science Fair.

Graduate Teaching Assistant
Physics Department **August 2008 – May 2009**
I taught the laboratory portion of introductory physics courses and was responsible for lectures, homework assignments, and grades. Further duties included holding weekly office hours and staffing the homework help office.

- ◇ PHYS 103 – College Physics I, Fall 2008, 2 sections
- ◇ PHYS 104 – College Physics II, Spring 2009
- ◇ PHYS 115 – Physical Science I, Spring 2009

Western Washington University, Bellingham, Washington, USA

Undergraduate Teaching Assistant **September 2006 – June 2008**
I taught the laboratory portion of the introductory physics courses and was responsible for lectures, homework assignments and grades.

- ◇ PHYS 131 — Physics with Calculus I Lab, Fall 2006, 2007
- ◇ PHYS 132 — Physics with Calculus II Lab, Winter 2007, 2008
- ◇ PHYS 133 — Electricity and Magnetism Lab, Spring 2007, 2008

Invited Talks

Kennedy, J.H., K.J. Evans, A.R. Bennett, P. Worley, S. Price, M. Hoffman
Evaluating the performance of ice sheet models using LIVVkit
Minisymposium on numerical methods towards next generation ice sheet models
SIAM Conference on Mathematical and Computational Issues in the Geosciences
Erlangen, Germany, Sept. 11, 2017

Kennedy, J.H.
Climate change today: An overview of the science, the observations, and a look toward the future
TENS: The Executive Network of Seattle, Seattle, Washington, January 16, 2017

Kennedy, J.H., M.R. Allen
Climate change overview
League of Women Voters of Oak Ridge, Oak Ridge, Tennessee, February 16, 2016

Kennedy, J.H.
Glacier modeling in < 10 minutes
CCSI Earth System Modeling Workshop, Oak Ridge National Laboratory, June 9, 2015

Kennedy, J.H.
A closer look at the link between climate history and fabric evolution in ice sheets
MicroDice Ice Flow Workshop, Nuuk, Greenland, August 22, 2011

Pettit, E.C., A. Gusmeroli, *J.H. Kennedy*
Exploring the link between climate history and fabric evolution in ice sheets
Laboratoire de Glaciologie et Gophysique de l'Environnement, Grenoble, France, April 12, 2011

Kennedy, J.H.
Climate signal evolution in crystal orientation fabric
Physics Department Colloquium, Western Washington University, Bellingham, WA, October 21, 2010

Conference Presentations (last 5 yrs)

Kennedy, J.H., et al.
A Look at the challenges of, and some solutions to, evaluating next-generation Earth system models
6th European Seminar on Computing (ESCO), June 6, 2018

Kennedy, J.H., et al.
A tour of ORNL's Earth system model assessment tools
ORNL Software Expo, May 16, 2018

Kennedy, J.H., et al.
Using the LIVVkit 2.0+ validation infrastructure
22nd Annual CESM Workshop, June 19, 2017

Kennedy, J.H., et al.
Climate reproducibility testing with EVE
ACME all-hands meeting, June 5, 2017

Kennedy, J.H., et al.
PISM-FEvoR: a multi-scale ice flow model incorporating fabric evolution with recrystallization
SIAM Conference on Computational Science and Engineering, MS243, March 2, 2017

Kennedy, J.H., et al.
LIVVkit 2: A robust and extensible python package for ice-sheet model verification and validation
AMS Annual Meeting, Seventh Symposium on Advances in Modeling and Analysis Using Python, January 24, 2017

Kennedy, J.H., et al.
LIVVkit 2: An extensible land ice verification and validation toolkit for comparing observations and models
AGU Fall Meeting, Abstract GC21A-1051, December 13, 2016

Kennedy, J.H., et al.
Full-system evaluation of Earth system models
Advancing X-cutting Ideas for Computational Climate Science, September 12, 2016

Kennedy, J.H., et al.
Building LIVVkit
CCSI Earth System Modeling Workshop, August 16, 2016

Kennedy, J.H., et al.
Developing LIVVkit
Oak Ridge Postdoc Association Research Symposium, August 8, 2016

Kennedy, J.H., et al.
An introduction to LIVVkit 2.0
21st Annual CESM Workshop, June 22, 2016

Kennedy, J.H., et al.
LIVVkit now and into the future: A discussion
Land Ice Working Group Meeting, February 10, 2016

Kennedy, J.H., et al.
Building confidence in the community ice sheet model (CISM) with LIVVkit, the land-ice validation and verification toolkit
AGU Fall Meeting, Abstract C51C-0741, December 18, 2015

Kennedy, J.H., et al.
LIVV awakens: A toolkit for land ice verification and validation
20th Annual CESM Workshop, June 17, 2015

Kennedy, J.H., et al.
The record may be in the fabric: Preservation of climate history in polar ice sheets
AGU Fall Meeting, Abstract C52B-08, December 13, 2013

Field Work

Dome C, East Antarctica. Deploying a sonic probe down the Dome C ice core borehole and prepping ice core samples. 3 weeks.

Valdez, AK, USA. Deploying sea temperature moorings. 3 days.

Yakutat Glacier, AK, USA. Taking GPS measurements, ablation stake measurements, and deploying time laps cameras. 5 days.

Icy Bay, AK, USA. Deploying hydro-acoustic mooring, taking CDT casts, and hydro-acoustic recordings. 5 days.

Affiliations

APS	American Physical Society
IGS	International Glaciological Society
AGU	American Geophysical Union

Computer Skills

Operating Systems:	Unix/Linux, Windows, OSX
Languages:	Python, C/C++, FORTRAN, Bash, LaTeX
Mathematics Packages:	MATLAB, Mathematica, Octave
Data science:	netCDF4, HDF5, NCO, NCL, Anaconda, R, Gnuplot
Web:	Apache, PHP, HTML, CSS, Drupal
Applications:	Mendeley, Adobe Creative Suite, Microsoft Office

Other Skills and Activities

- ◇ Wilderness experience including a continuous 700 mile, 33 day, canoe trip down the Yukon River
- ◇ Skilled with soldering, hand and power tools, and simple electrical systems
- ◇ Extensive boat experience: sailing, canoeing, power-boating, etc.
- ◇ Enjoy outdoor recreation: biking, hiking, backpacking, camping, etc.
- ◇ Trained in bear safety