

## David A. Lilien

Assistant Professor

Department of Earth and Atmospheric Sciences, Indiana University

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### Academic Appointments

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Assistant professor Department of Earth and Atmospheric Science, Indiana University	2024 –
Research associate Centre for Earth Observation Science, University of Manitoba	2021 – 2023
Postdoctoral researcher Physics of Ice, Climate, and Earth, Niels Bohr Institute, University of Copenhagen	2019 – 2021

### Education

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PhD in Earth and Space Sciences University of Washington, Seattle, WA	2019
BS in Physics and Mathematics Yale University, New Haven, CT	2013

### Research Interests

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I study the dynamics of ice streams in Antarctica and Greenland. I am most interested in new ways to use radar to improve numerical models of ice streams and outlet glaciers, particularly through better understanding of ice-crystal fabric and rheology. I have technical expertise in ice-flow modeling and ice-penetrating radar methodology.

### Fellowships

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NASA Earth and Space Sciences Fellow 3 years stipend, portion of tuition	2015 – 2018
University of Washington Program on Climate Change Fellow 9 months stipend	2013

### Publications († denotes student author, \* denotes “equal contribution”)

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22. Voss, KM<sup>†</sup>, KE Alley, **DA Lilien**, D Dahl-Jensen. The role of near-terminus conditions in the ice-flow speed of Upernavik Isstrøm in northwest Greenland (2023). *Annals of Glaciology*, 1-15. (doi:10.1017/aog.2023.76)
21. **Lilien, DA**, NM Rathmann, CS Hvidberg, A Grinsted, MR Ershadi, R Drews, and D Dahl-Jensen. Simulating complex fabrics in a large-scale, anisotropic ice-flow model: application to Dome C, East Antarctica (2023). *Journal of Glaciology*, 1–20. (doi: 10.1017/jog.2023.78)

20. Stevens, CM, **DA Lilien**, TJ Fudge, M Koutnik, H Conway, B Horlings, and ED Waddington. Deriving a firm compaction model for South Pole based on strain measurements (2023). *Journal of Glaciology*, 1-20. (doi:10.1017/jog.2023.87)
19. Chung, A, F Parrenin, D Steinhage, R Mulvaney, C Martín, MGP Cavitte, **DA Lilien**, V Helm, D Taylor, P Gogineni, C Ritz, M Frezzotti, C O'Neill, H Miller, D Dahl-Jensen, and O Eisen (2023). Stagnant ice and age modelling in the Dome C region, Antarctica, *The Cryosphere*, **17**, 3461–3483. (doi:10.5194/tc-17-3461-2023)
18. Dmitrenko, IA, SA Kirillov, B Rudels, NX Geilfus, J Ehn, DG Babb, **DA Lilien**, and D Dahl-Jensen (2023). Modification of Pacific water in the northern Canadian Arctic, *Frontiers in Marine Science*, **10**. (doi:10.3389/fmars.2023.1181800)
17. Gerber, TA<sup>†</sup>, **DA Lilien**, NM Rathmann, S Franke, TJ Young, F Valero-Delgado, MR Ershadi, R Drews, O Zeising, A Humbert, N Stoll, I Weikusat, A Grinsted, CS Hvidberg, D Jansen, H Miller, V Helm, D Steinhage, C O'Neill, J Paden, SP Gogineni, D Dahl-Jensen, and O Eisen (2023). Crystal orientation fabric anisotropy causes directional hardening of the Northeast Greenland Ice Stream, *Nature Communications*, **14**, 2653. (doi:10.1038/s41467-023-38139-8)
16. Rathmann, NM, A Grinsted, K Mosegaard, **DA Lilien**, J Westhoff, CS Hvidberg, DJ Prior, F Lutz, RE Thomas, and D Dahl-Jensen (2022). Elastic wave propagation in anisotropic polycrystals: Inferring physical properties of glacier ice. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, **478**(2268), 20220574 (doi:10.1098/rspa.2022.0574).
15. Grinsted, A, CS Hvidberg, **DA Lilien**, NM Rathmann, NB Karlsson, TA Gerber, HA Kjær, P Vallelonga, and D Dahl-Jensen (2022). Accelerating ice flow at the onset of the Northeast Greenland Ice Stream. *Nature Communications*. **13**, 5589 (doi:10.1038/s41467-022-32999-2).
14. Rathmann, NM, and **DA Lilien** (2022). On the nonlinear viscosity of the orthotropic bulk rheology. *Journal of Glaciology*, **68**(272), 1243-1248 (doi:10.1017/jog.2022.33).
13. Rathmann, NM, **DA Lilien**, A Grinsted, TA Gerber, TJ Young, and D Dahl-Jensen (2022). On the Limitations of Using Polarimetric Radar Sounding to Infer the Crystal Orientation Fabric of Ice Masses. *Geophysical Research Letters*. **49**, e2021GL096244 (doi:10.1029/2021GL096244).
12. **Lilien, DA**, NM Rathmann, CS Hvidberg, and D Dahl-Jensen (2021). Modeling ice-crystal fabric as a proxy for ice-stream stability. *Journal of Geophysical Research: Earth Surface*. **126**, e2021JF006306 (doi:10.1029/2021JF006306).
11. Rathmann, NM, and **DA Lilien** (2021). Inferred basal friction and mass flux affected by crystal-orientation fabric. *Journal of Glaciology*. **68**(268), 236-252 (doi:10.1017/jog.2021.88).
10. **\*Lilien, DA**, \*D Steinhage, D Taylor, F Parrenin, C Ritz, R Mulvaney, C Martín, JB Yan, C O'Neill, M Frezzotti, H Miller, P Gogineni, D Dahl-Jensen, and O Eisen (2021).

- New radar constraints support presence of ice older than 1.5 Myr at Little Dome C. *The Cryosphere*. **15**(4), 1881–1888 (doi:10.5194/tc-15-1881-2021).
9. Rathmann, NM, CS Hvidberg, A Grindsted, **DA Lilien**, and D Dahl-Jensen (2021). Effect of a nonlinear grain rheology on polycrystalline directional enhancement factors. *Journal of Glaciology*. **67**(263), 569-575 (doi:10.1017/jog.2020.117).
  8. **Lilien, DA**, B Hills, J Driscoll<sup>†</sup>, R Jacobel, and K Christianson (2020). ImpDAR: An open-source impulse radar processor. *Annals of Glaciology*. **81**(61), 114-123 (doi:10.1017/aog.2020.44).
  7. Fudge, TJ, **DA Lilien**, M Koutnik, H Conway, CM Stevens, ED Waddington, EJ Steig, AJ Schauer, and N Holschuh (2020). Advection and non-climate impacts on the South Pole Ice Core. *Climate of the Past*. **8**, 819-832 (doi:10.5194/cp-16-819-2020).
  6. **Lilien, DA**, I Joughin, B Smith, and N Gourmelen (2019). Melt at grounding line controls observed and future retreat of Smith, Pope, and Kohler Glaciers, *The Cryosphere*. **13**, 2817–2834 (doi:10.5194/tc-13-2817-2019).
  5. Holschuh, N, **DA Lilien**, and K Christianson (2019). Thermal Weakening, Convergent Flow, and Vertical Heat Transport in the Northeast Greenland Ice Stream Shear Margins. *Geophysical Research Letters*. **46**(14), (doi:10.1029/2019GL083436).
  4. **Lilien, DA**, TJ Fudge, MR Koutnik, H Conway, EC Osterberg, DG Ferris, ED Waddington, and CM Stevens (2018). Holocene Ice-Flow Speedup in the Vicinity of the South Pole. *Geophysical Research Letters*. **45**(13), 6557–6565 (doi:10.1029/2018GL078253).
  3. **Lilien, DA**, I Joughin, B Smith, and DE Shean (2018). Changes in flow of Crosson and Dotson ice shelves, West Antarctica, in response to elevated melt. *The Cryosphere*. **12**, 1415–1431 (doi:10.5194/tc-12-1415-2018).
  2. Poinar, K, I Joughin, **D Lilien**, L Brucker, L Kehrl, and S Nowicki, (2017). Drainage of Southeast Greenland firn aquifer water through crevasses to the bed. *Frontiers in Earth Science*, **5**(5), (doi:10.3389/feart.2017.00005).
  1. \*Wasik, BR, \*SF Liew, \***DA Lilien**, A Dinwiddie, H Noh, H Cao, & A Monteiro (2014). Artificial selection for structural color on butterfly wings and comparison with natural evolution. *PNAS*, 1402770111 (doi:10.1073/pnas.1402770111).

### Manuscripts accepted, submitted, and in preparation

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- Lilien, DA**, and 12 others. Potential to recover a record of Holocene climate and sea ice from Müller Ice Cap, Canada. In review.
- Nyman, NF<sup>†</sup>, **DA Lilien**, TA Gerber, CS Hvidberg, D Steinhage, SP Gogineni, D Taylor, and D Dahl-Jensen. Double reflections in birefringent ice reveal orientation and strength of ice fabric. In review (doi:10.22541/au.171987057.70357157/v1).
- Chung, A<sup>†</sup>, and 8 others. Refined age estimates of the Beyond EPICA ice core site from a 2.5D ice flow model. In review (doi:10.5194/egusphere-2024-1650).

**Lilien, DA**, KE Alley, and RB Alley. Can deformation concentrated by melt channels determine ice-shelf stability? In prep.

Gerber, TA, **DA Lilien**, and 4 others. Anisotropic Scattering in Radio-Echo Sounding: Insights from Northeast Greenland. In Prep.

Rathmann, NM, and 4 others. A spectral directors method for modelling the coupled evolution of flow and CPO in polycrystalline olivine. In prep.

\*Hills, B, \*TJ Young, \***DA Lilien**, and 23 others. Radar polarimetry in glaciology: Theory and measurement techniques for electromagnetic wave propagation through birefringent ice masses. Invited manuscript in prep.

## Conference Papers

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Knerr, N, D Taylor, S Gogineni, **D Lilien**, D Steinhage, D Dahl-Jensen, H Miller, and O Eisen (2022). Processing and Analysis of Radar Data to Map Layers Near the Bed to Determine Optimum Ice Core Site. *IGARSS 2022 IEEE International Geoscience and Remote Sensing Symposium*, 4182–4184. (doi:10.1109/IGARSS46834.2022.9884035)

SF Liew, **D Lilien**, H Noh, H Cao, BR Wasik, AJ Dinwiddie, and A Monteiro (2014). Artificial selection for structural color on butterfly wings and comparison to natural evolution. *Conference on Lasers and Electro-Optics (CLEO) - Laser Science to Photonic Applications*. 1-2.

## Field Experience

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Müller Ice Cap, Nunavut, Canada 2023

Led planning and logistics for two week, five person team based on an ice cap in the Canadian Arctic, supported by the Polar Continental Shelf Program. Led radar survey in support of ice-core selection.

EastGRIP, Greenland 2022

Worked on extensive radar survey using two new, state-of-the-art radars. Led radar operation and data processing, co-led survey design. Work included supervision of two PhD students while in the field.

Little Dome C, Antarctica 2019

Part of a 3-person radar team surveying to select the location of the Beyond EPICA Oldest Ice core. Led data processing, assisted in data collection and survey design.

South Pole, Antarctica 2016 – 2019

Three seasons on an NSF-sponsored project at South Pole Station and in the deep field. Led extensive high frequency radar survey. Co-led shallow-core and GPS survey. Assisted in drilling operations and firn-densification instrument installation.

Mt. Baker and Mt. Rainier, WA 2015 – 2018

Assisted with various 1-2 day surveys using Lidar, ground-based interferometric radar, and GPS on Easton, Coleman, and Nisqually glaciers.

## Service

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Reviewer for <i>The Cryosphere</i> , <i>Nature Geoscience</i> , <i>JGR: Earth Surface</i> , <i>Journal of Glaciology</i> , <i>Annals of Glaciology</i> , <i>DLR</i> (German research foundation), German polar airtime applications	
Panelist for NSF glaciology	
Participant, NASA DEBRIS mission design workshop	2022
Graduate student representative on first-year PhD exam committees	2017 – 2018
Graduate student representative on student awards committee	2018

## Teaching Experience

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### Courses taught

EAS-A476: Climate change science (IU)	Spring 2024
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### Mentor for graduate students

Kelsey Voss, UoM – MSc student, advised on glacier modeling	2021 – 2023
Niels Nymand, UCPH – PhD student, advising on radio echo sounding	2022 – present
Debanshu Banarjee, UoM – PhD student, advising on glacier modeling	2022 – present

### Mentor for undergraduates

Ian Lee – remote sensing of Nivlisen Ice Shelf	2015
Joshua Driscoll – automatic layer picking for radar	2018 – 2019

### Teaching assistant

UW ESS 451: <i>Principles of glaciology</i>	2015
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### Guest Lectures

Ice-crystal fabric and glacier dynamics: modeling a property that controls and records ice flow. For U. Manitoba GEOG 3390 Introduction to Climate Change.	2023
Ice flow modeling. For U. Manitoba ENVR 3000 T05: Introduction to Numerical Modelling.	2023
Open source software in the geosciences: lessons from ImpDAR. for University of Washington summer interns in glaciology	2022
ImpDAR: an open-source radar processor for University of Maine graduate students	2022
Substitute lecturer for University of Washington ESS 431, 1 class	2018

## Presentations

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- “Ice-crystal fabric: modeling and observing a property that controls ice-sheet flow.” *Georgia Tech Glaciology Group*. February, 2024. Invited.
- “Ice-crystal fabric: modeling and observing a property that controls ice-sheet flow.” *Indiana University Earth and Atmospheric Sciences*. March, 2023. Invited.
- “Using ice-flow models and radar to understand ice-stream retreat.” *Washington State University School of the Environment*. February, 2023. Invited.
- “Simulating complex fabrics in a coupled, anisotropic ice-flow model: application to Dome C.” Poster. *AGU Fall Meeting*. December, 2022.
- “Ice-crystal fabric: inference from radar and why it matters.” *DEBRIS Workshop, NASA JPL*. September, 2022. Invited.
- “Modeling ice-crystal fabric as a proxy for ice-stream stability.” Poster. *AGU Fall meeting*. December, 2020.
- “Modeling ice-crystal fabric as a proxy for ice-stream stability.” *University of Tubingen/Alfred Wegner Institute structural geology seminar*. November, 2020. Invited.
- “Melt at grounding line controls observed and future retreat of Smith, Pope, and Kohler Glaciers.” *EGU General Assembly*. May 2020. Highlight talk.
- “Using ice-flow models to understand and contextualize modern ice-stream retreat.” *University of Wisconsin Weeks lecture*. February 2020. Invited.
- “Modeled temperature and basal shear stress of NEGIS and implications for surge mechanics of Storstrømmen.” *EastGRIP Steering Meeting*. November 2018.
- “Elevated melt causes varied response of Crosson and Dotson Ice Shelves.” *West Antarctic Ice Sheet Workshop*. October 2017.
- “Modeling the influence of melt and buttressing on the recent speedup of Smith Glacier.” *International Symposium on the Interaction of Glaciers and Ice Sheets with the Ocean*. July 2016.
- “Quantifying Uncertainty in Inferred Viscosity and Basal Shear Stress Over Ice Streams.” Poster. *AGU Fall Meeting*. December 2015.
- “Modeling ocean-forced changes in Smith Glacier, West Antarctica.” Poster. *AGU Fall Meeting*. December 2014.

## Outreach

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Volunteer, Science Fest, Indiana University	2024
Organizer, glaciology display, Polar Science Weekend, Pacific Science Center	2015–2018
Volunteer, University of Washington Rockin’ Out	2013–2019

## **Computer Skills**

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Proficient: Python, Git, Bash, Elmer/Ice, Fortran, QGIS

Familiar: Matlab, C, Slurm, Torque

## **Professional Affiliations**

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International Glaciological Society

American Geophysical Union

European Geosciences Union