



AGU Town Hall TH35D



# Scientific Drilling in the Polar Regions



AGU Fall Meeting 2025



# Scientific Drilling in the Polar Regions

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## Agenda

IDP – Mary Albert

COLDEX – Ed Brook

ICECReW – Julia Andreason

Hercules Dome – Murat Aydin

Audience Participation



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# Update from the NSF Ice Drilling Program (IDP)

Mary Albert  
IDP Executive Director



[www.icedrill.org](http://www.icedrill.org)





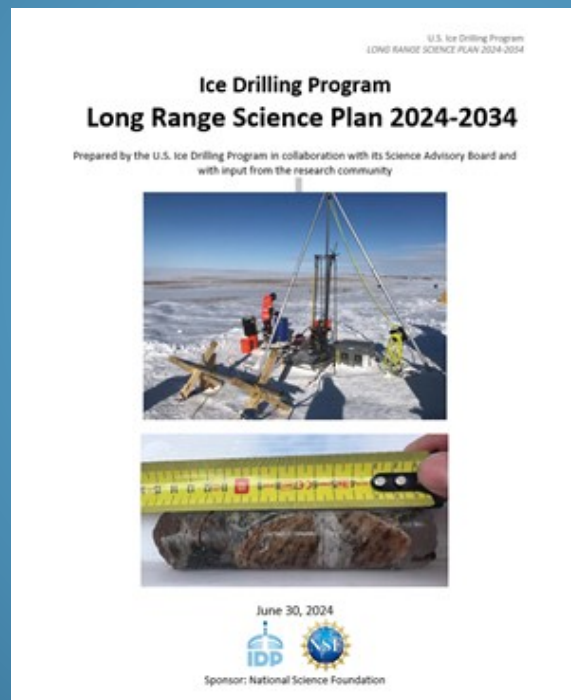
# NSF Ice Drilling Program



## Long Range Planning & Drilling For Multiple Fields of Science

### IDP Working Groups

- ❖ Ice core working group (ICWG)
- ❖ Englacial and subglacial science working group (ESAWG)



### LRSP Science Topics

- Past Climate Change
- Ice Dynamics & Glacial History
- Subglacial Geology, Sediments & Ecosystems
- Ice as a Scientific Observatory

***Science planning drives IDP drill development & use***  
**[www.lcedrill.org](http://www.lcedrill.org)**

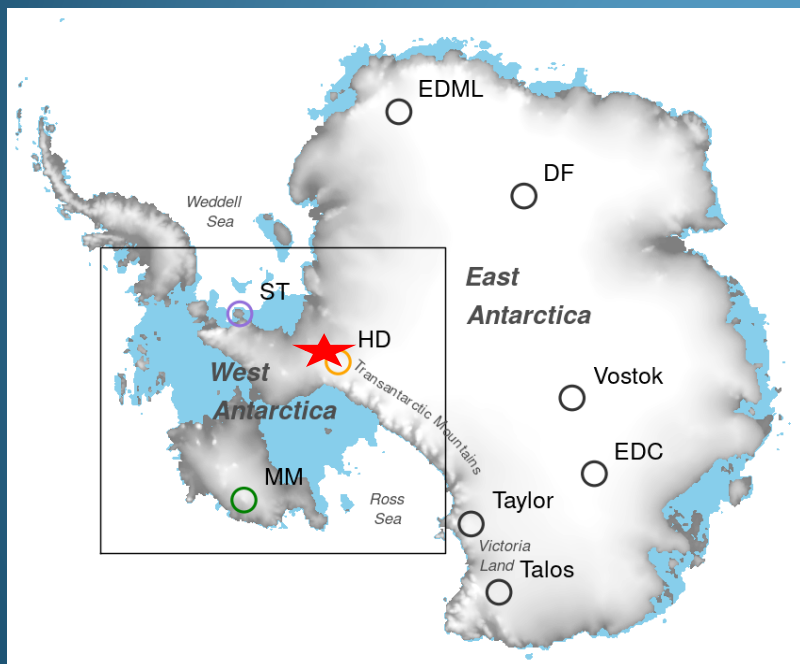


# NSF Ice Drilling Program Working Group Activities



## Ice Core Working Group

Community priority since 2016:  
Hercules Dome ice core



\* Murat Aydin's Herc Dome talk coming up

## Englacial & Subglacial Access Working Group

Community priority:  
grounding zone & bed conditions



Drilling technology priority need:

- Deep clean hot water drill



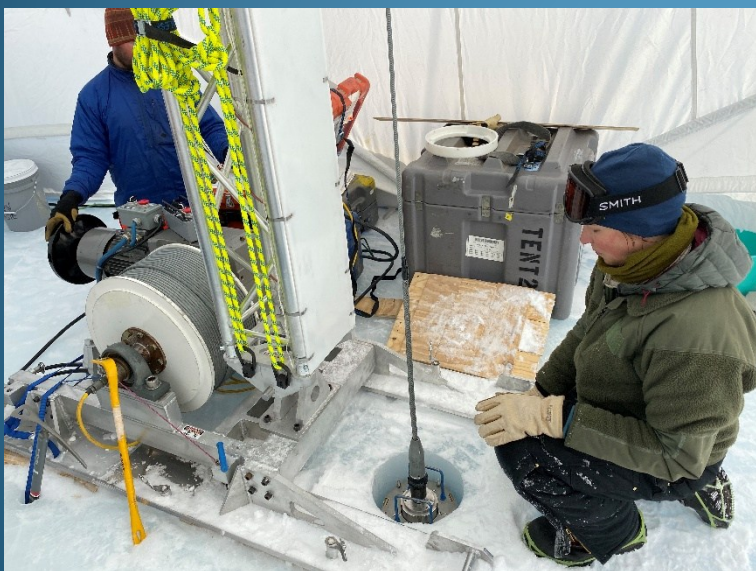


# IDP Drilling Highlights



## Blue Ice Drill

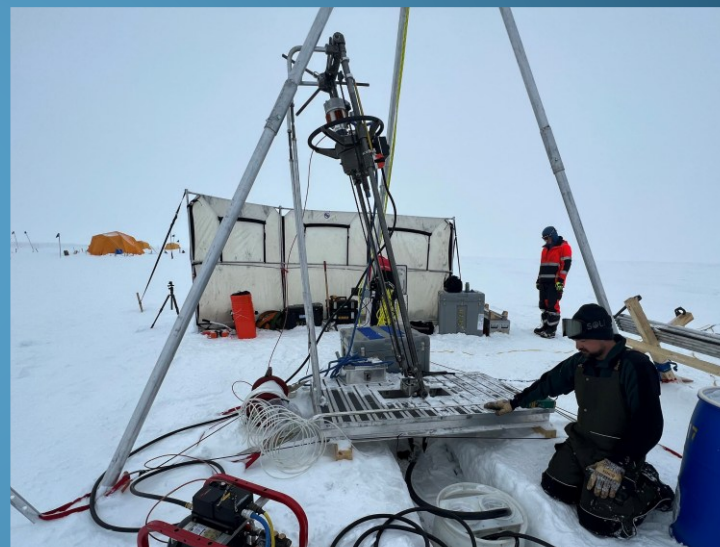
6 M year old ice < 200 m depth



IDP drilling for COLDEX 2025

## Ice-enabled Winkie Drill

5.8 m rock core under 50 m of ice



IDP drilling for Greendrill 2024

[www.lcedrill.org](http://www.lcedrill.org)





# NSF Ice Drilling Program Education & Outreach featuring *your* science!



- IDP School of Ice for educators
- IDP Virtual Field Labs for educators
- Educational resources online

Louise Huffman  
IDP Education & Outreach



Contact Louise!!  
Louise.T.Huffman@Dartmouth.edu

[www.icedrill.org](http://www.icedrill.org) and <http://icedrill-education.org/>

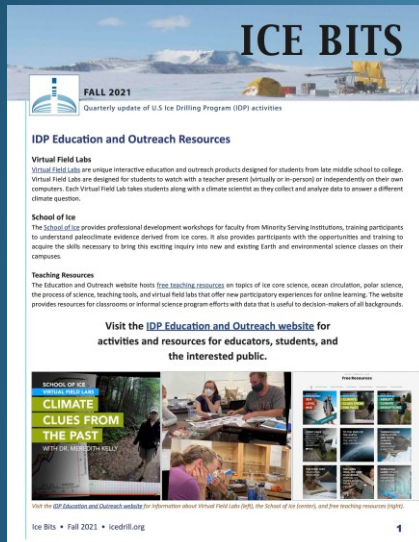




# NSF Ice Drilling Program Get involved !



- Sign up for our newsletter!
- Participate in IDP Working Group (online) meetings!
- Make sure your science is in the IDP Long Range Science Plan!
- Get help with outreach for your science!
- Request drilling & EO support for your NSF proposal!



[www.Icedrill.org](http://www.Icedrill.org)



# Scientific Drilling in the Polar Regions

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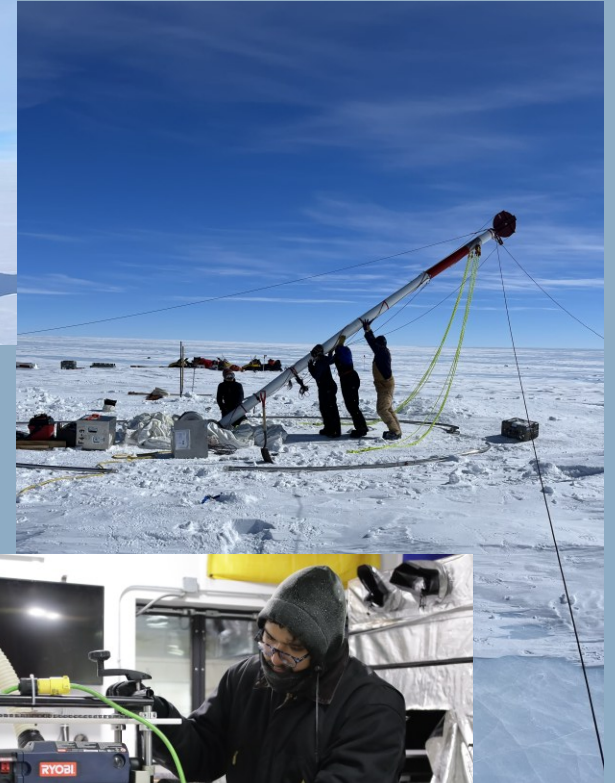
Hercules Dome – Murat Aydin

Audience Participation

# Center for Oldest Ice Exploration



- NSF Science and Technology Center
- Headquartered at Oregon State University
- Funded 2021-2026.
- Phase 2 (2026-2031) proposal in review
- 14-institution collaboration in research, education, technology, broadening participation, knowledge transfer

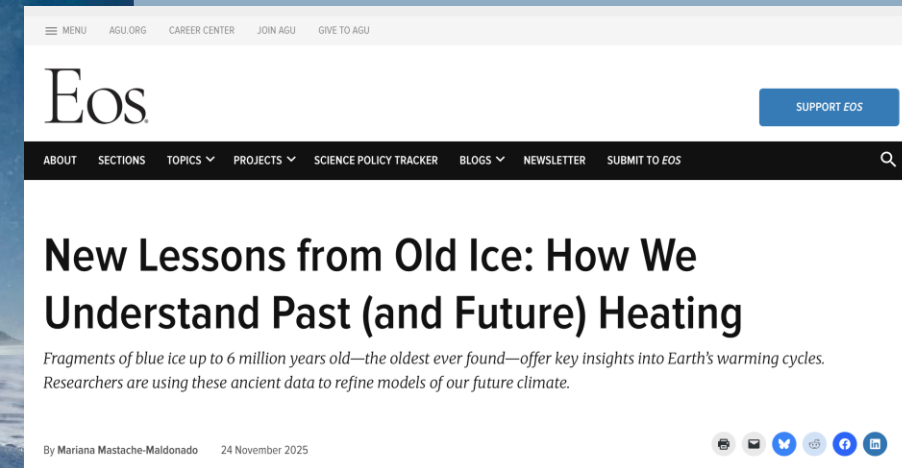
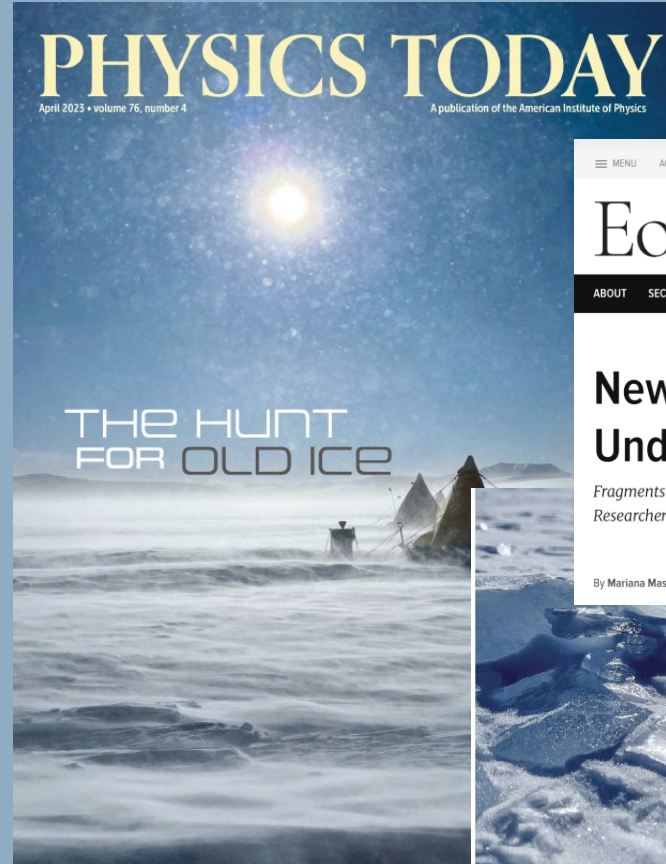




# COLDEX MISSION



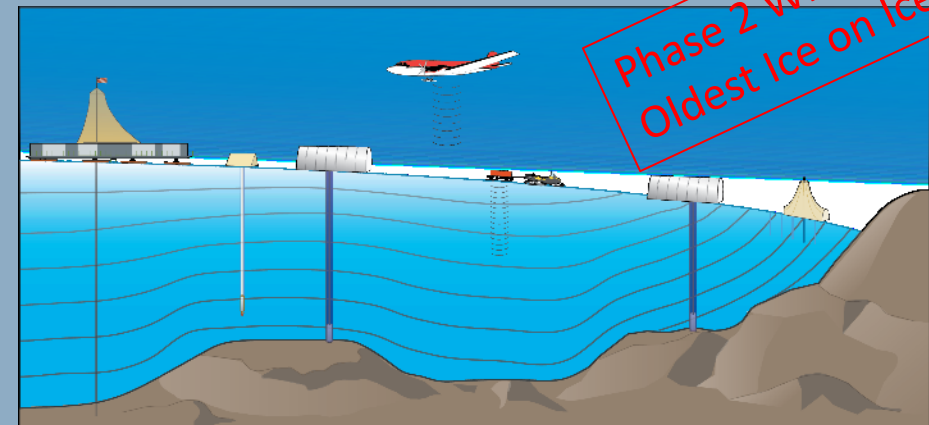
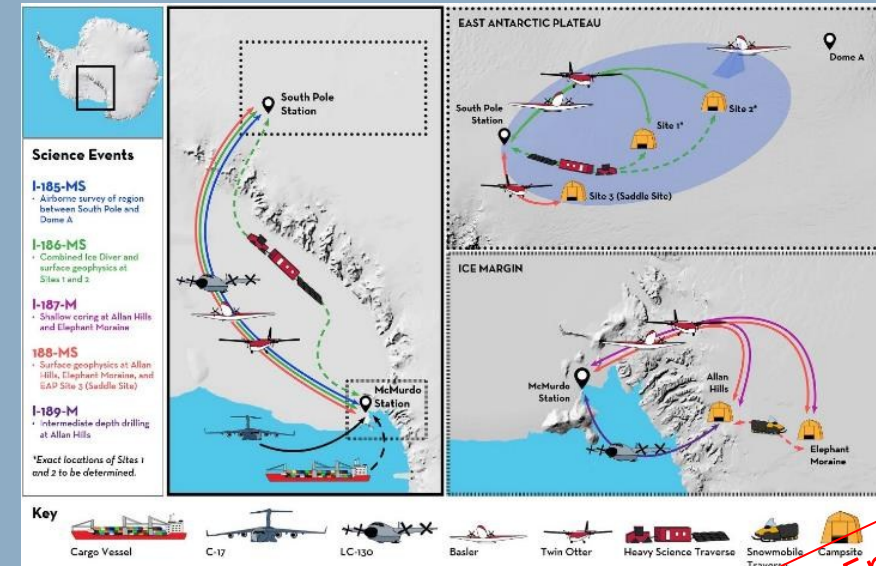
- Explain the evolution of Earth's climate over the last 5+ million years.
- To do this we want very old ice from Antarctica.
- The challenge is that the oldest ice is rarely preserved and can be difficult to interpret.



# MEETING THE OLD ICE CHALLENGE



- **Exploration and Ice Sheet Modeling**
  - Find site for 1.5-million-year ice core
    - Airborne and surface radar echo-sounding
    - Novel thermal melt probes
    - Modeling age vs. depth along ice flow lines
- **Ice coring and analysis**
  - Ice coring on ice margin and (eventually) interior
  - Centralized laboratory at OSU
  - Improving age and other analyses
  - Advanced ice imaging



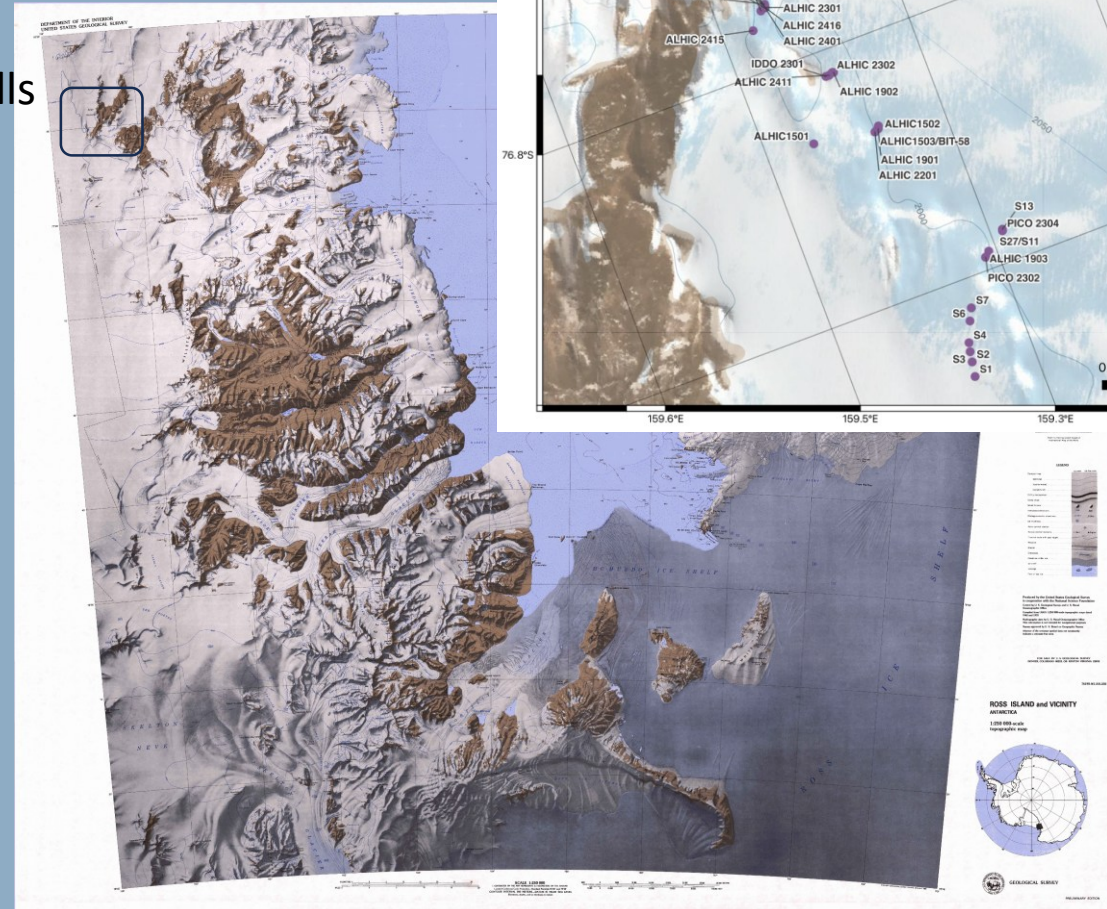


# Very Old Ice at Allan Hills



- Shallow (~100-200 m) cores
- 9-inch, 4-inch and 3-inch diameter cores
- Ages based on  $^{40}\text{Ar}_{\text{atm}}$  chronometer
- Multiple cores with ages up to 5-6+ Ma
- Stratigraphy is complex, but over 300 depth intervals have been dated
- Year 5 Drilling happening now

Allan Hills

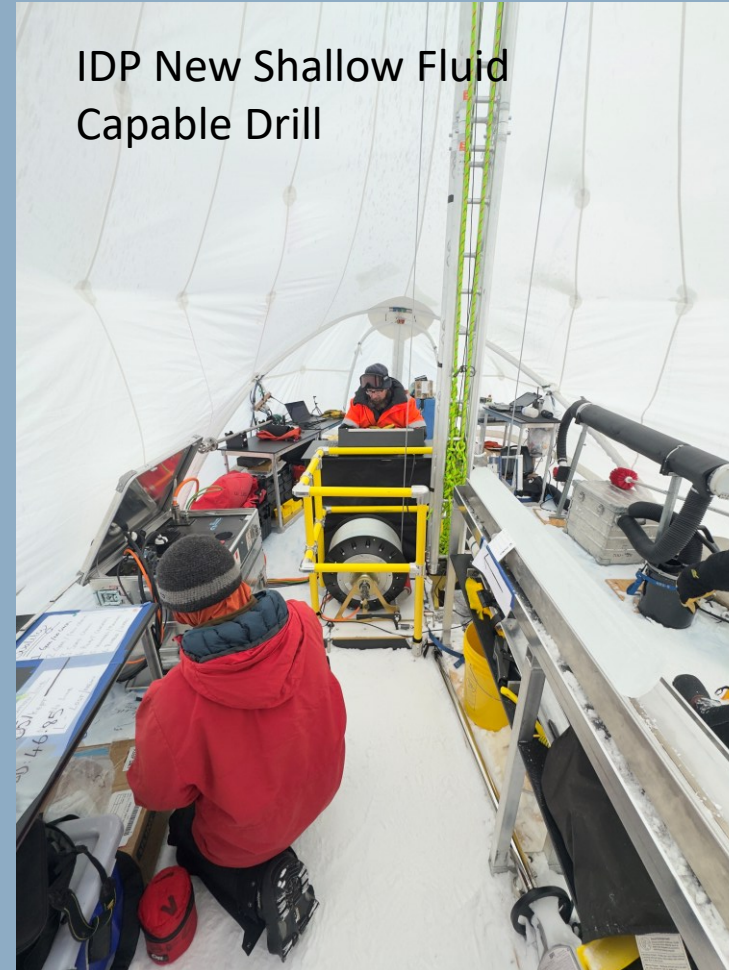




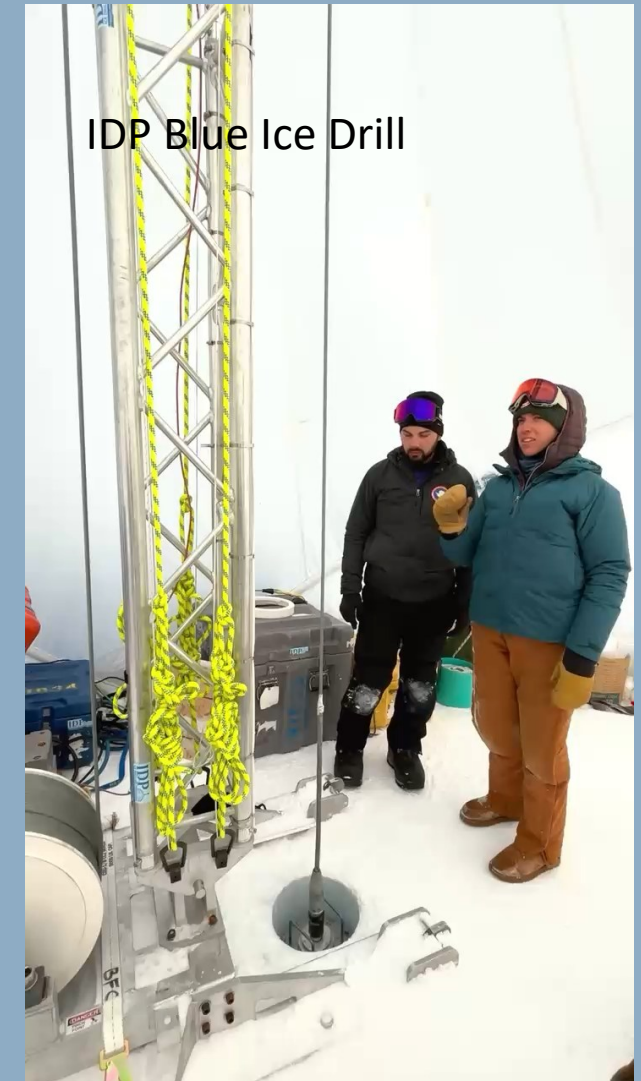
# Allan Hills Cores Shallow Drilling



IDDO Hand Auger



IDP New Shallow Fluid  
Capable Drill



IDP Blue Ice Drill

# Extending The Ice Core Record



- Antarctic climate back to 6 Ma (Shackleton et al., 2025, *PNAS*).
- Greenhouse gas and mean ocean temperature back to 3 Ma (Marks Peterson et al. and Shackleton et al., forthcoming in *Nature*).
- More papers coming out now
- Numerous (~30) presentations this week
- [coldex.org/news](https://coldex.org/news)

Articles / Volume 21, issue 11 / CP, 21, 2389–2406, 2025

<https://doi.org/10.5194/cp-21-2389-2025>  
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Research article | ©

24 Nov 2025

Ice core site considerations from modeling CO<sub>2</sub> and O<sub>2</sub>/N<sub>2</sub> ratio diffusion in interior East Antarctica

Marc J. Sailer<sup>✉</sup>, Tyler J. Fudge<sup>✉</sup>, John D. Patterson, Shuai Yan, [Duncan A. Young](#), Shivani Don Blankenship, and Megan Kerr

*Journal of Glaciology*



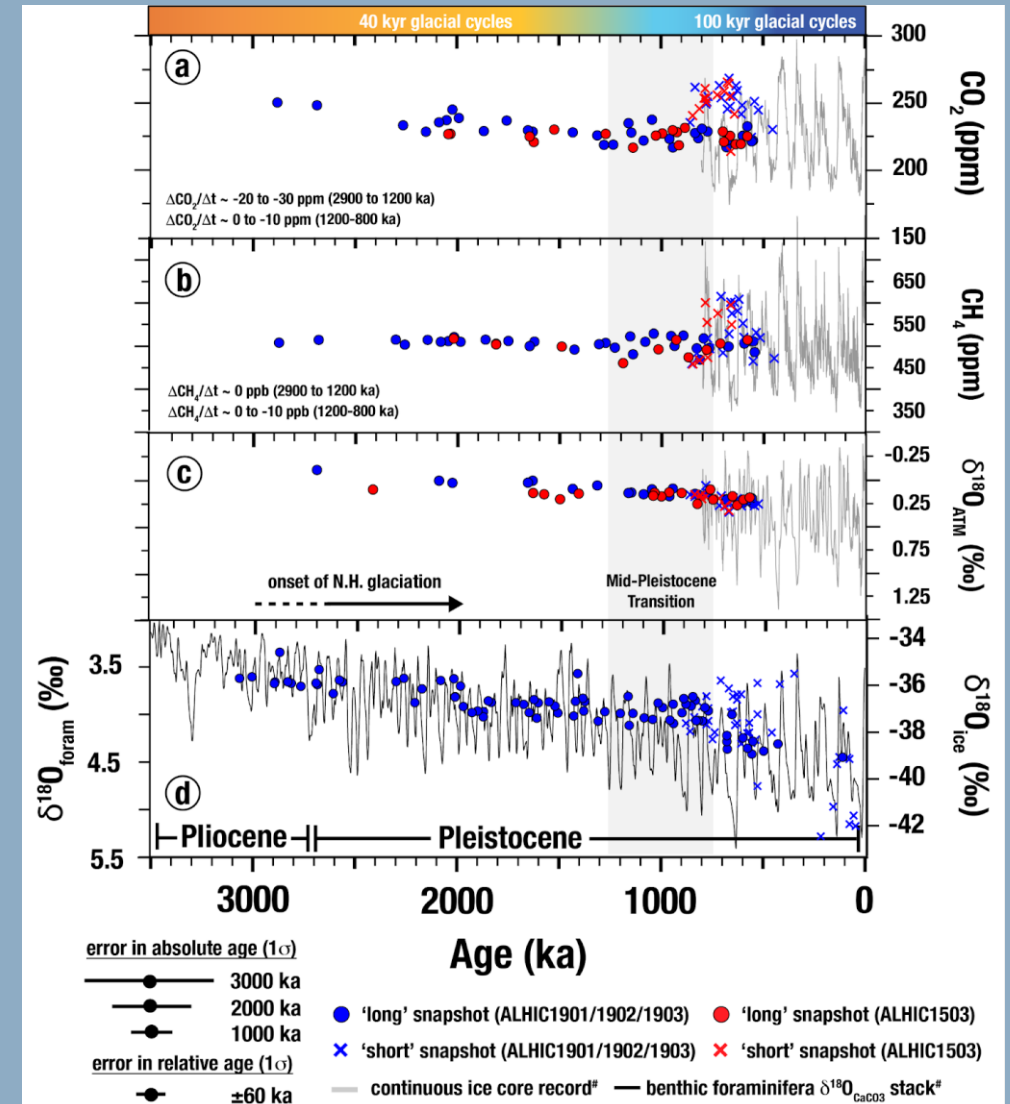
Article

**Cite this article:** Kirkpatrick LR, Carter AJ, Marks-Peterson J, Shackleton S, Fudge TJ (2025) Three-dimensional multitrack electrical conductivity method for interpretation of complex ice core stratigraphy. *Journal of Glaciology* **71**, e105, 1–13. <https://doi.org/10.1017/jog.2025.10081>

Three-dimensional multitrack electrical conductivity method for interpretation of complex ice core stratigraphy

Liam Reed Kirkpatrick<sup>1</sup>, Austin Joseph Carter<sup>2</sup>, Julia Marks-Peterson<sup>3</sup>, Sarah Shackleton<sup>4</sup> and T.J. Fudge<sup>1</sup>

<sup>1</sup>Department of Earth and Space Sciences, University of Washington, Seattle, WA, USA; <sup>2</sup>Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, USA; <sup>3</sup>College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, OR, USA and <sup>4</sup>Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA, USA

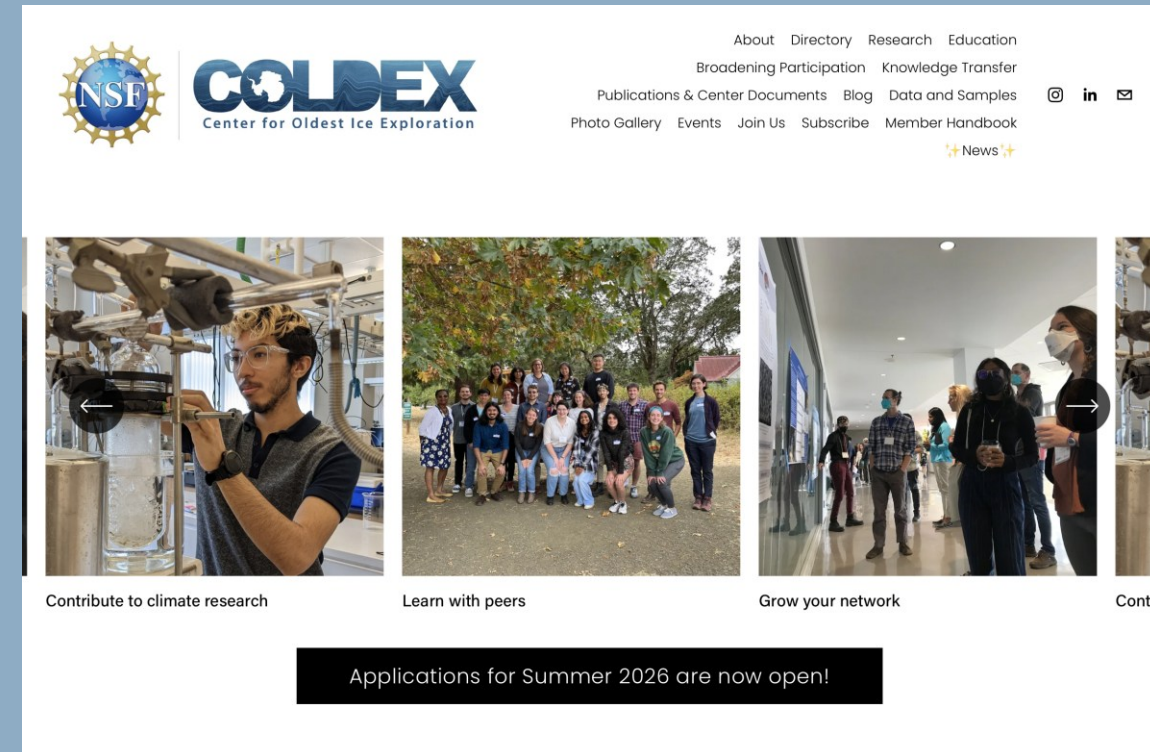




# Get Involved!



- Allan Hills ice core samples are available now.
  - Sample information and request form at [www.coldex.org](http://www.coldex.org)
  - For more information contact Ed Brook ([brooke@geo.oregonstate.edu](mailto:brooke@geo.oregonstate.edu)) or Jenna Epifanio ([jenna.epifanio@gmail.com](mailto:jenna.epifanio@gmail.com)).
- Annual COLDEX Open Science Meetings
  - Watch web site for 2026 date
- COLDEX REU Program
  - Applications open now
  - <https://coldex.org/reu>
- Apply for a COLDEX Early Career Researcher Scholarship
- ECR Workshops
- Data at USAP Data Center and Open Polar Server







Important Dates   Venue   Travel   Accommodations   Plan Your Stay   Program   About IPICS   Committees  
Early Career Researchers   ICYS Workshop   Contact   RSVP for IPICS 2026

International Partnerships in Ice Core Sciences (IPICS)  
October 11-16, 2026  
The Banff Centre



# IPICS 2026 in North America: Banff Center for Arts and Creativity, Banff, Canada October 11-16 2026

RSVP: [ipics2026.org](https://ipics2026.org)

## IPICS 2026 Local Organizing Committee

Fowzia Ahmed, University of Manitoba  
Ed Brook, Oregon State University  
Christo Buizert, Oregon State University  
Alison Criscitiello, University of Alberta  
Dorthe Dahl-Jensen, University of Manitoba  
Rafael dos Reis, Ohio State University  
Romilly Harris Stuart, Oregon State University  
Karl Kreutz, University of Maine  
Rhys-Jasper Leon, University of Colorado Boulder  
Bradley Markle, University of Colorado Boulder  
Anne Myers, University of Alberta  
Anais Orsi, University of British Columbia  
Joerg Schaefer, LDEO, Columbia University  
Armina Soleymani, University of Manitoba  
Danielle Whittaker, Oregon State University



# Ice Core Early Career Researchers Workshop

**2025 Organizers:** Bess Koffman (Colby), T. J. Fudge (U. Washington), **Julia Andreassen** (U. Alaska Fairbanks), Jacob Chalif (Dartmouth), Laurel Bayless (CU Boulder), Kara Lamantia (U. Bristol), Ursula Jongebloed (MIT)



*Supported by NSF*



# ICECReW's Mission

To provide **early career researchers** (ECRs) who study **ice cores and related topics** with opportunities to meet each other and form **relationships**, learn **skills** relevant to academic work and beyond, and feel **included** in the ice core community.

We strive for:

- Broad participation
- Broad research representation
- ECR leadership
- Tangible takeaways





# What does ICECReW look like?

- **~ 1.5 days** before or after the Ice Core Community Meeting (IceCOMM)
- **30 - 40 participants** (+/- 3 years of PhD)
- **4 - 6 panelists** from various career stages and career types
- **Early Career focus**; all scientists welcome



# What does ICECReW do?

- **2022: History and future of ice core science**
  - Review major scientific discoveries made possible by ice cores
  - *Takeaway: Write PAGES articles on ice core-related research*
- **2023: Science collaboration and proposal writing**
  - Learn about the process of applying for funding
  - *Takeaway: Write up mock-proposals and discuss with NSF Directors*
- **2024: Career opportunities for ECRs studying ice cores**
  - Discuss opportunities and job-search strategies for careers in academia, industry, and government
  - *Takeaway: Share application materials and receive feedback from mid-late career leaders*
- **2025: Scientific paper writing (with COLDEX!)**
  - Share best practices for communicating scientific research in academic papers
  - *Takeaway: Peer feedback on writing samples and writing check-ins every 2 weeks*

EDITORIAL: EARLY-CAREER PERSPECTIVES ON ICE-CORE SCIENCE

doi.org/10.2449/pages.30.2.97

## Early-career perspectives on ice-core science

Jessica Badgley<sup>1</sup>, T.J. Fudge<sup>2</sup>, B. Koffman<sup>3</sup> and S. Rupper<sup>3</sup>

Ice cores have changed the way we understand the Earth. Ice cores drilled in the 1990s in Greenland showed definitively for the first time the abrupt nature of climate change events in the past (e.g. Dansgaard et al. 1993; Grootes et al. 1993). Ice cores from Antarctica have yielded a continuous climate history of the past 800,000 years, as well as snapshots of climate older than two million years (Louzel et al. 2007; Yin et al. 2019; Bergelin et al. 2022), providing important context for climate changes underway today. The global network of ice cores drilled in remote mountainous and polar regions provides insight into topics beyond climate, including the history of wildfires and anthropogenic activities (e.g. Dahe et al. 2002; Grenman et al. 2018). Today, we continue to drill ice cores in Greenland, Antarctica, and mountain glaciers worldwide to better understand the Earth.

It takes a global community of scientists from a variety of disciplines to locate sites, drill cores, conduct analyses, and interpret the data in the broader context of the Earth system (Fig. 1). Like many countries around

must occur at every level – for instance, the International Partnerships in Ice Core Sciences (IPICS; [partnershipsipics.org/ipics/](https://partnershipsipics.org/ipics/)) open science meetings foster international inclusion. Through both individual and institutional actions, we can create a community where all feel welcome.

In addition, ice-core science is a global endeavor. It requires international partnerships, but will also require cooperation. Analytical ice-core data with mode field as dry analysis or spherical coordinate measurement

**PROJECT MOTIVATION AND SUMMARY** (P. Joughin (lead), P. McCrann (DR) and C. Aylward (SUCS))  
Atmospheric aerosols affect human health, climate, and atmospheric chemistry. Particulate ammonium (NH<sub>4</sub><sup>+</sup>), which is in equilibrium in the atmosphere with gas-phase ammonia (NH<sub>3</sub>), is an important component of aerosols that controls aerosol acidity and abundance (Timpf et al., 2007; Holt et al., 2015; Park et al., 2004; Pye et al., 2009). Model-observation comparisons indicate that climate and chemistry models overestimate aerosol acidity due to an underestimate in ammonium concentrations in aerosols, leading to uncertainty in aerosol abundance and thus aerosol radiative effects (Nault et al., 2022).

Sources of atmospheric ammonium include wildfires and soil emissions. Soil ammonia emissions originate from microbes breaking down nitrogen in soil. Large, short-lived spikes of ammonium in ice core records above the background in summer ice layers have been linked to forest fire events (Legrand et al. 1992; Fischer et al. 2015). Ammonium (NH<sub>4</sub><sup>+</sup>) has been used as a proxy for fire activity in ice core reconstructions from many polar and alpine locations (Brugger et al. 2022; Rubino et al. 2016; Legrand et al. 2016; Fischer et al. 2015; Kjerfve et al. 2022). High resolution ammonium records exist for many ice core locations across the Greenland ice sheet (ex. Figure 1), and several exist in Antarctica, but few exist elsewhere such as the North Pacific or equatorial regions. Additionally, no model-ice core comparisons have been made to assess ammonium concentrations over the preindustrial through industrial era, which is a time period of large changes in wildfires and agriculture.

Fire peaks are measured as excess ammonium above the background baseline ammonium levels, which originate from soil emissions and agricultural activity. There is an observed increase in the baseline in the 1900s in several, but not all, Greenland ice cores (ex. Fig. 1).

**Julia R. Andreasen** (she/her)  
IARC Postdoctoral Researcher  
University of Alaska, Fairbanks, AK 99709  
Email: [jrandreasen@alaska.edu](mailto:jrandreasen@alaska.edu)  
Website: [juliaandreasen.weebly.com](https://juliaandreasen.weebly.com)

**EDUCATION**

<b>Ph.D. in Land and Atmospheric Science</b> , University of Minnesota, Twin Cities Advisor: Dr. Peter D. Neff, Minor: Geographic Information Science	<b>2025</b>
<b>Master of Research in Climate and Atmospheric Science</b> , University of Leeds, UK Advisor: Anna E. Hogg, Dissertation: <i>The Analysis of Circum-Antarctic Calving Fronts- How have Antarctica's Major Ice Shelves Changed in the Past 10 Years?</i>	<b>2019</b>
<b>Bachelor of Science in Atmospheric Sciences</b> , The Ohio State University, Columbus Green Engineering Scholar, Minor: Women's Gender and Sexuality Studies	<b>2018</b>

**RESEARCH APPOINTMENTS**

<b>International Arctic Research Center</b> , UAF, Fairbanks, AK Postdoctoral Researcher	<b>2025-Present</b>
<b>NASA Earth Science Division</b> , Twin Cities, MN NASA FINESS Future Investigator and Research Fellow	<b>2021 - 2025</b>
<b>University of Minnesota SWAC Department</b> , Twin Cities, MN Graduate Research Assistant	<b>2020 - 2021</b>

**NASA Goddard Space Flight Center**  
**Instructions:**  
(1) Have you added your name to the Daily writing tracker? No? STOP! Go add your name to that tab, and you will get a column here.  
(2) In rows 2-26, add dates when you've reached a milestone. Either double click the cell to open a calendar, or write in the date.  
(3) Only the lightest blue cells are for direct editing; the rest are read-only.  
(4) If you submitted your SECOND manuscript/parameter, use the drop-downs on the left to add another one, you're ready!  
(5) Some milestones are on the bottom, and check out the Footer below!

	Jacob Chalif	Liam Kirkpatrick	Bridget Hall	Maddy Lewis	Margot Shaya	Austin Weber
<b>The Ohio State University</b>	6/2/2025	6/2/2025	6/3/2025	6/4/2025	6/16/2025	6/4/2025
<b>Climate Analysis</b>	Submitted a manuscript!	Submitted a manuscript!	Submitted a manuscript!	Submitted a manuscript!	Submitted a manuscript!	Submitted a manuscript!
<b>Undergraduate</b>	Got reviews back	Got reviews back	Got reviews back	Got reviews back	Got reviews back	Got reviews back
<b>Got published!</b>	Got published!	Got published!	Got published!	Got published!	Got published!	Got published!
<b>Stats</b>						
Total writing time since you joined (hours)	8.1	3	0.5	6.7	52.8	8.8
Longest streak	2	2	1	5	9	2
Consecutive days achieving goal (weekends don't count against you)						
<b>Monthly progress!</b>						
Month	Days you met your goal (Total writing hours)	Days you met your goal (Total writing hours)	Days you met your goal (Total writing hours)	Days you met your goal (Total writing hours)	Days you met your goal (Total writing hours)	Days you met your goal (Total writing hours)
June 2025	5 days (8 total hours)	3 days (3 total hours)	1 days (1 total hours)	8 days (7 total hours)	10 days (15 total hours)	6 days (9 total hours)



# When is the next ICECReW?

**2027!** For 2026, we encourage you to attend the Ice Core Young Scientists (ICYS) Workshop on **October 11, 2026** as part of the IPICS Conference in Banff



ICYS is an informal, international network of early career scientists dedicated to the study of polar and alpine ice cores and ice core-related sciences.

All ECRs are encouraged to join the ICYS Workshop in Banff, with costs for the workshop covered by the conference registration fees.

This is a great opportunity to meet other ECRs, initiate new collaborations, and kickstart the week. Registration opens March 2026, more information coming soon!



# How do I get involved?

- If you are an ECR, keep an eye out for **ICECReW 2027** applications!
- If you are a researcher (e.g., professor) or late-stage ECR, reach out to be an organizer!
- If you are a researcher in another field and want to bring this to your community, email us!
- **Information from ICECReW 2025 can be found here:**

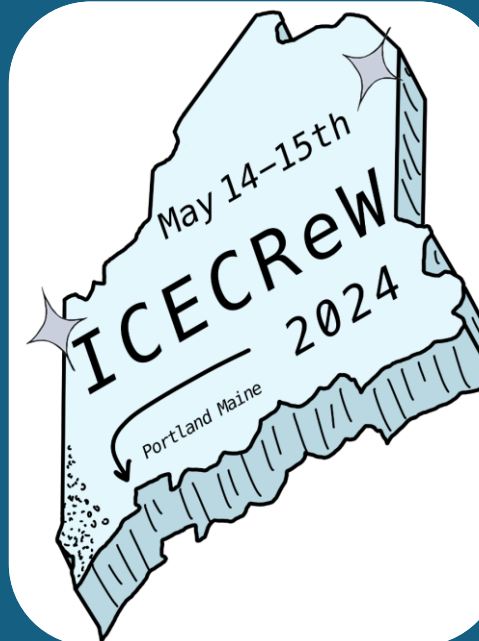
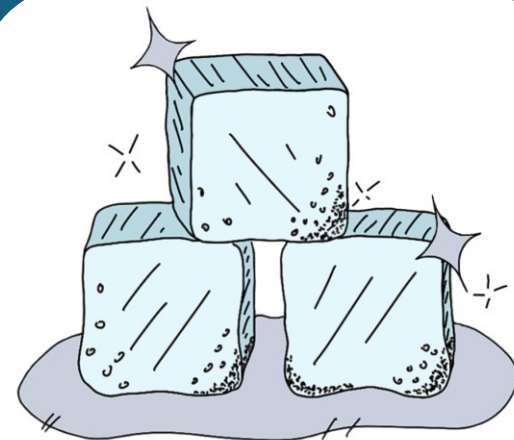
<https://herculesdome.org/icecrew-2025>

**My email: [jrandreasen@alaska.edu](mailto:jrandreasen@alaska.edu)**

"This was one of the most **well-organized and open/welcoming** workshops I have ever been a part of."

"For the first time since starting my program, **I feel like part of the ice core community.**"

"It provided a great way for me to interact with many people in my field that I haven't met before. I felt **really excited and hopeful about the future of ice core science!** I'm specifically looking forward to contributing to the synthesis publication."



# Thank you! Questions?

Get involved: <https://herculesdome.org/icecrew-2025>



*Supported by NSF*

# Hercules Dome Ice Core



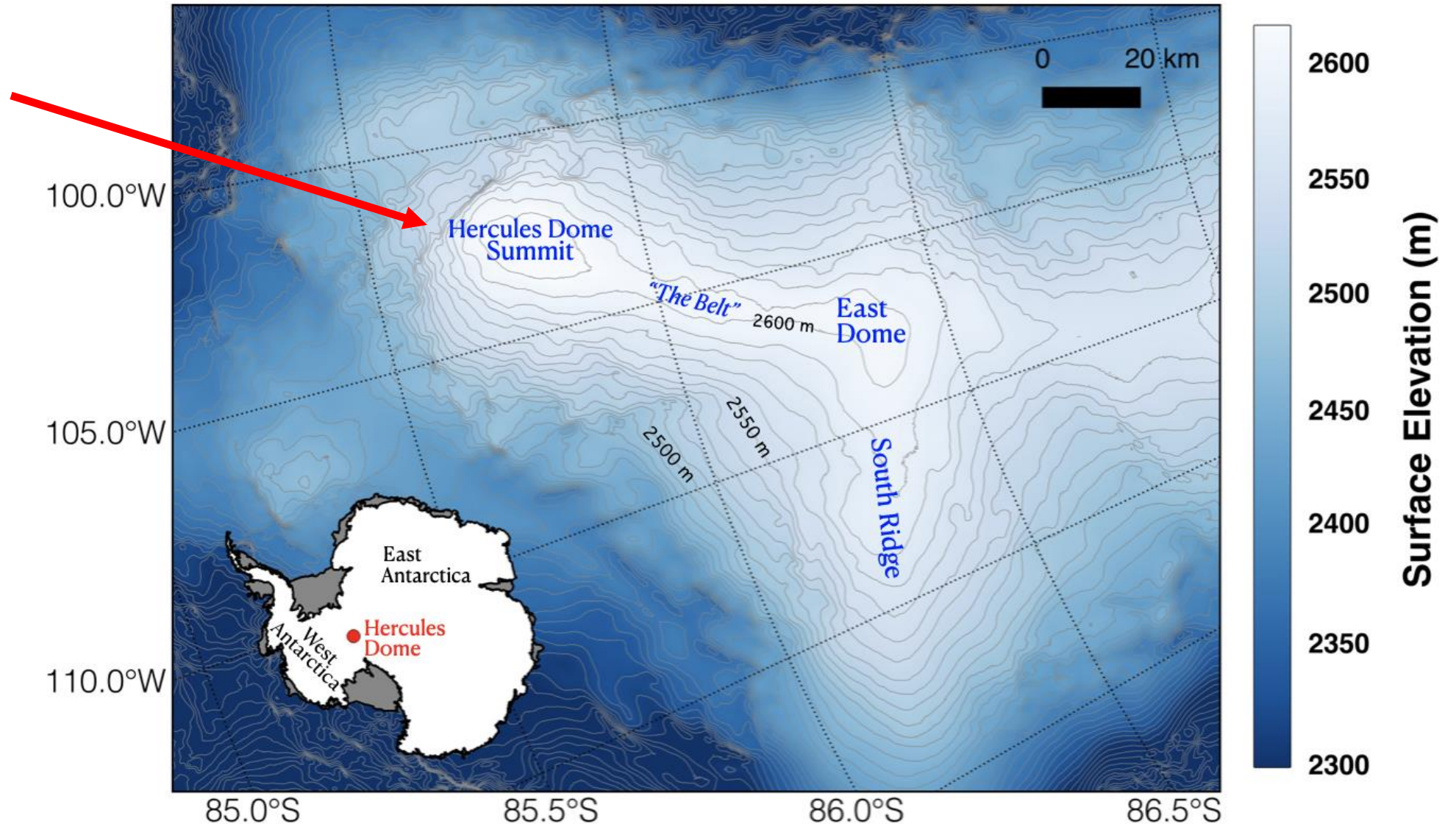
**Murat Aydin, Eric Steig, Joe Souney, Mark Twickler, T.J. Fudge**

With: Knut Christianson, Ben Hills, Nick Holschuh, Annika Horlings, Andrew Hoffman, Gemma O'Connor, John Christian, Liam Kirkpatrick, Emma Erwin, Heidi Roop



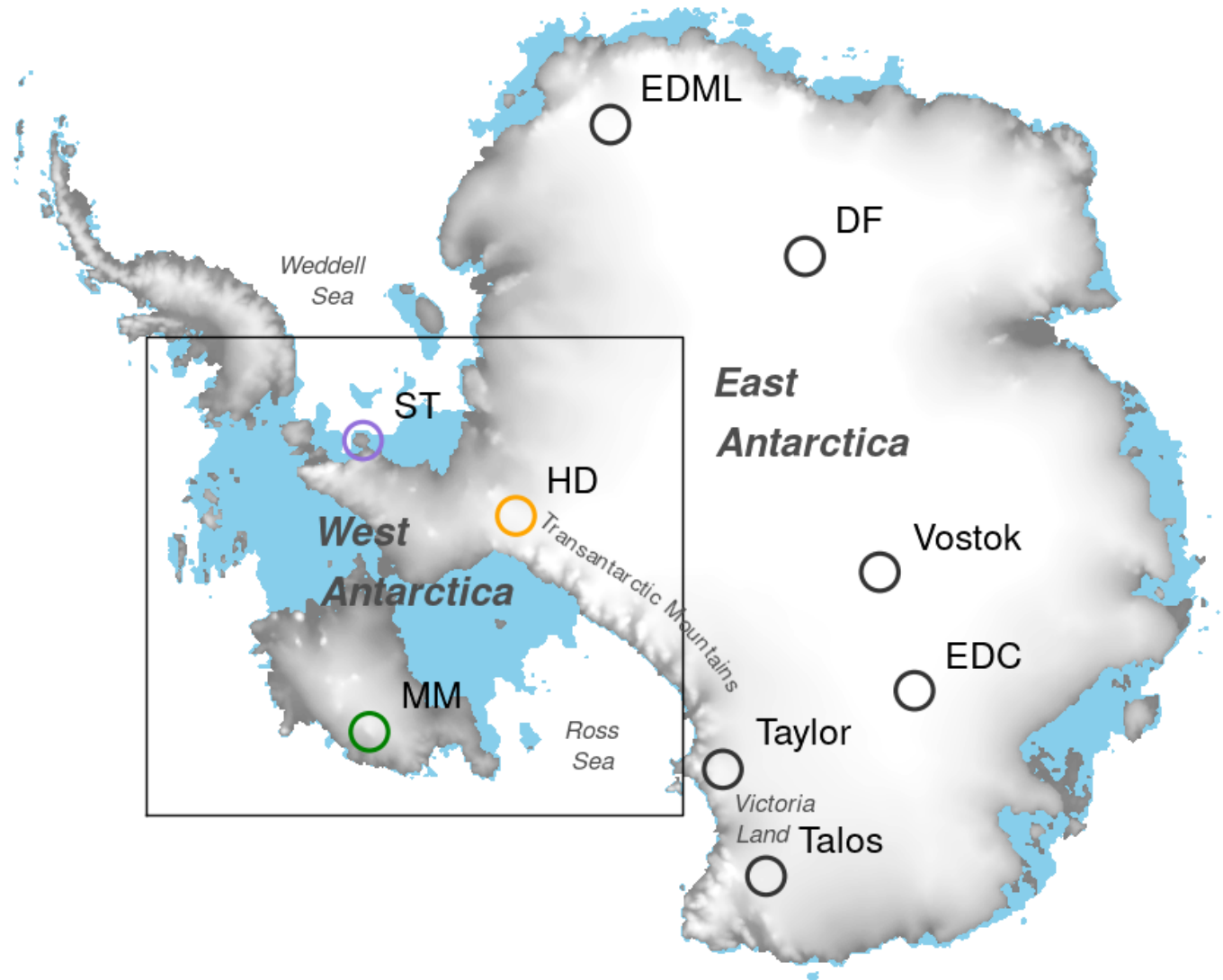
# Location map

Core will be drilled at the Summit



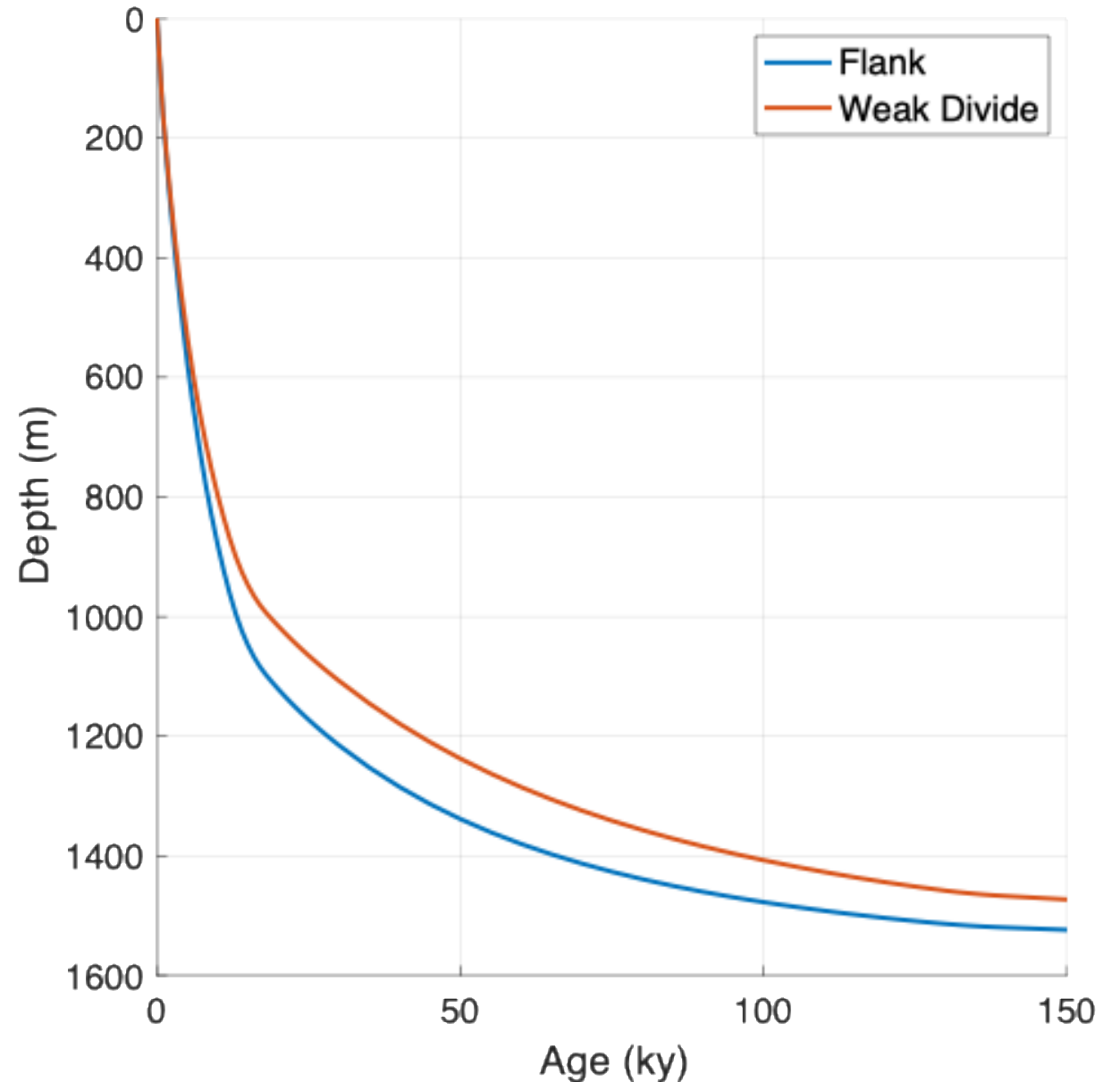
# Why Hercules Dome?

- Climate of the West Antarctic region during the LIG is unknown.
- Climate at Hercules Dome is affected by the topography and climate of West Antarctica.



# Why Hercules Dome?

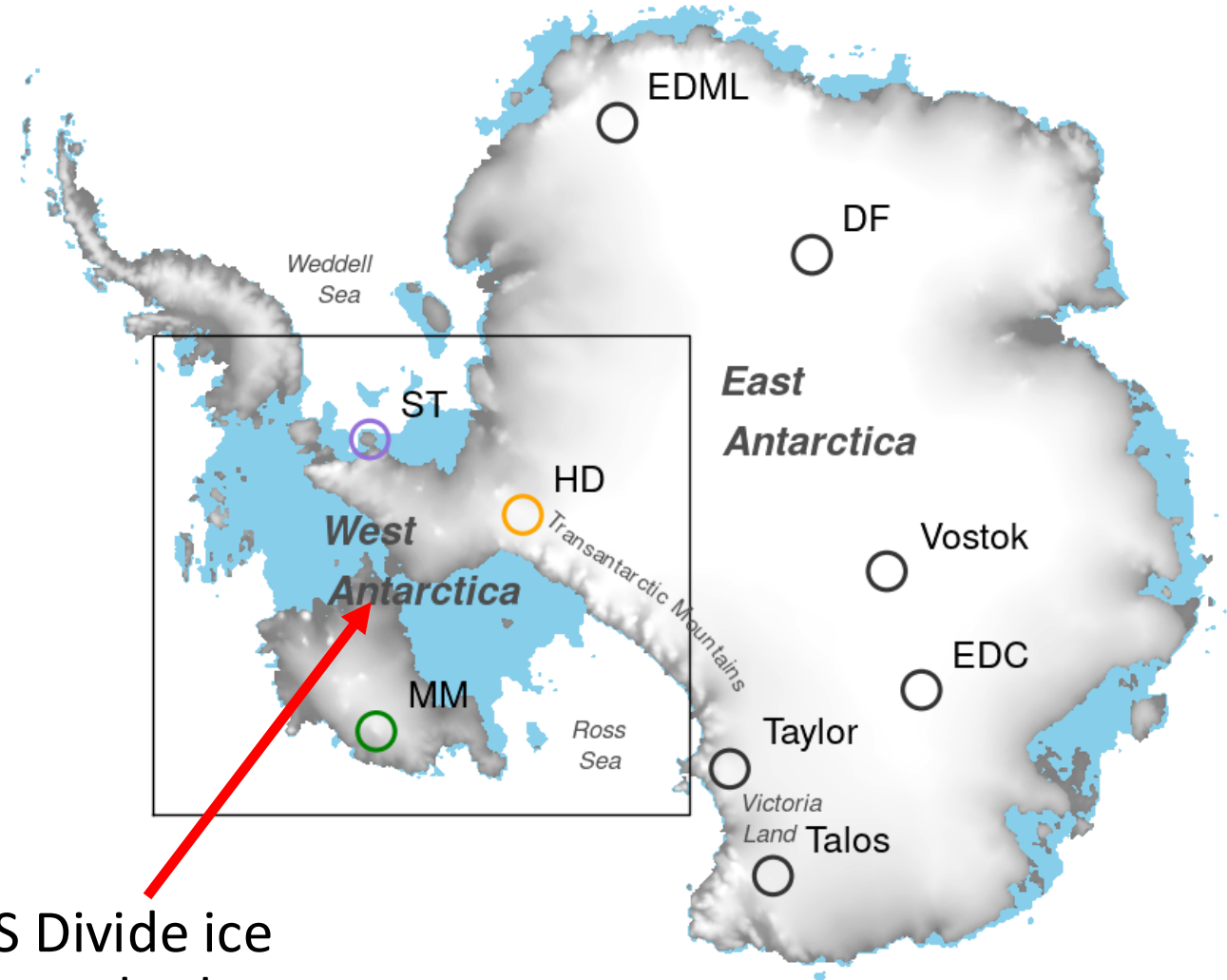
- Accumulation rate is in 11 - 14 cm/year: high for East Antarctica.
- Mean annual temperature is about  $-40^{\circ}\text{C}$ .
- Bedrock at about 1600 m.
- Expected to reach 130-150 ky.





# Why Hercules Dome?

- Will provide ice for numerous other science goals.
- Ice and gas records through MIS 5: Beyond what is available from the WAIS Divide and South Pole ice cores.



WAIS Divide ice  
core reached  
68,000 years

# Brief history and update

- Herc Dome has been a priority deep ice core site in Antarctica for the U.S. ice core community since 2016.
- Funded in 2019 for drilling intended to start in 2022.
- A Science Logistics Plan (SLP) has been submitted to the NSF.
- Logistical plan includes use of Heavy and Intermediate Science Traverse platforms via the well established South Pole Traverse (SPOT) route (via a deviation on the plateau) to reduce reliance on aircrafts (LC-130s).
- This plan benefits Antarctic logistics for other projects that might need traverse capability.

# Timeline

- **24/25:** Intermediate Science Traverse vehicles were tested successfully.
- **25/26 26/27:** Improve traverse capabilities and develop CAMP 20 (on the South Pole Traverse route) as a logistics hub (by NSF/ASC).
- **27/28:** First cargo traverse to Hercules Dome.
- **28/29:** Second traverse, camp and drill set-up, drill and case the firn, possible summer core processing at the NSF ICF
- **29/30:** First main drilling season through the Holocene, followed by summer core processing.
- **30/31:** Second main drilling season to bedrock, followed by summer core processing
- **31/32:** Final drilling season if needed. Perhaps replicate coring (not yet proposed).

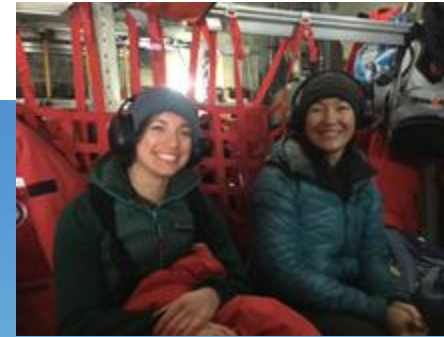




# Herc Dome is a community project

Get involved:

- Get on the Herc Dome mailing list at [herculesdome.org](https://herculesdome.org).
- Plan to be at the proposal-planning workshop expected in 2027 or 2028.
- Proposals will require discussion with the lead team, which will consider contribution to overall project and ice allocation needs in collaboration with the NSF.



AGU Town Hall TH35D

# **Scientific Drilling in the Polar Regions**

Thanks for attending!