Harnessing Data for Disaster Management : From Polar Regions to our Backyards

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Community Impacts

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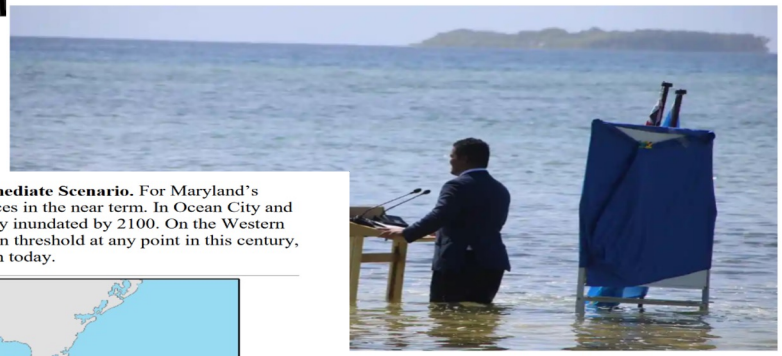
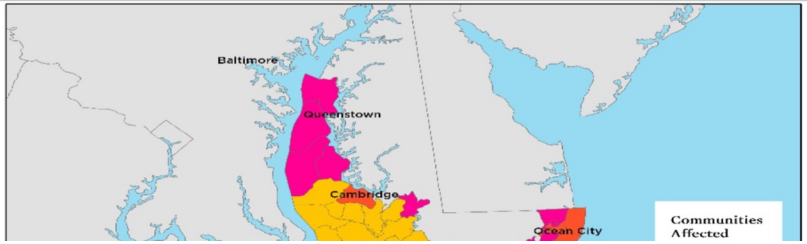


a Cop26 statement while standing in the ocean in
n Ministry/Reuters

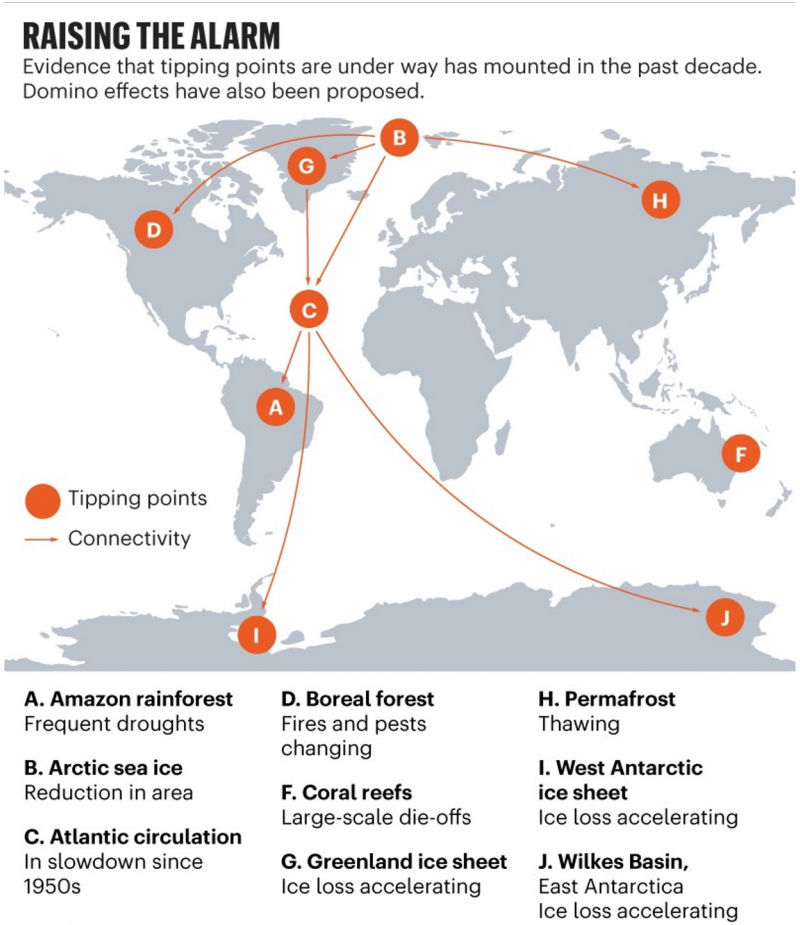
FIGURE 1. **Maryland Communities Facing Chronic Inundation in The Intermediate Scenario.** For Maryland's Eastern Shore, sinking land and rising seas will force increasingly difficult choices in the near term. In Ocean City and 19 other communities, half or more of currently usable land would be chronically inundated by 2100. On the Western Shore, cities like Annapolis and Baltimore do not reach the 10 percent inundation threshold at any point in this century, yet chronic flooding of much smaller areas is driving action and investment even today.



In the US: 167 communities in 13 states that by 2035 will face chronic inundation :
https://www.ucsusa.org/resources/when-rising-seas-hit-home#.WWldAoTytpg

Crisfield, MD 2012- Hurricane Sandy, Daily times

Old Ellicott City, MD



Melting Northern Hemisphere ice, which increased global sea levels, was linked to a retreat of the Southern Hemisphere's Antarctic ice sheet

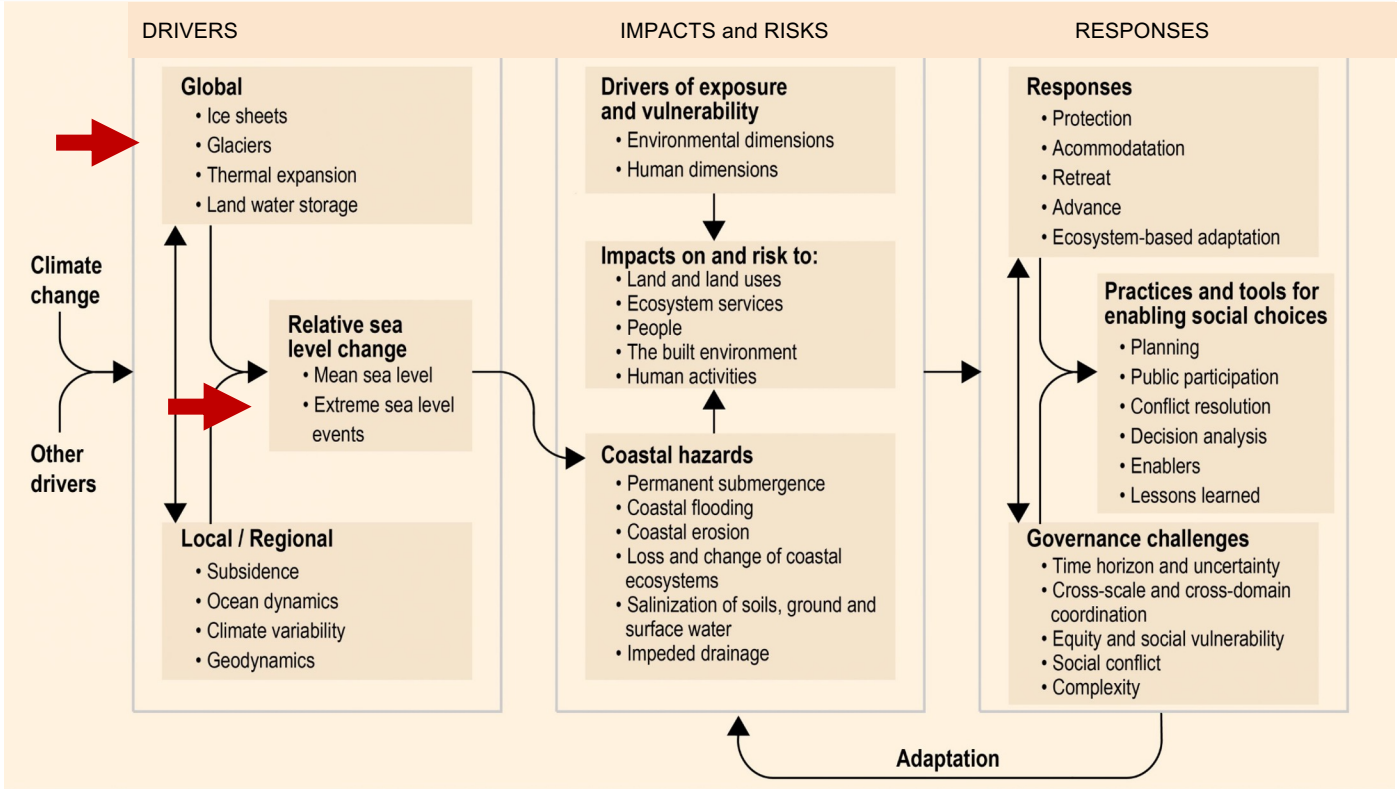
Gomez, N., Weber, M.E., Clark, P.U. *et al.* Antarctic ice dynamics amplified by Northern Hemisphere sea-level forcing. *Nature* **587,** 600–604 (2020). https://doi.org/10.1038/s41586-020-2916-2

Climate tipping points — too risky to bet against

Nature **575**, 592-595 (2019)

doi: https://doi.org/10.1038/d41586-019-03595-0

Drivers, Impacts/Risks, Reponses



Intergovernmental Panel on Climate Change (IPCC), Feb 2022

Oppenheimer, M., B.C. Glavovic , J. Hinkel, R. van de Wal, A.K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R.M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, and Z. Sebesvari, 2019: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: *IPCC Special* ***Report on the Ocean and Cryosphere in a Changing Climate*** [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 321-445. https://doi.org/10.1017/9781009157964.006.

Polar Ice Melting => Sea Level Rise

- At present: Two thirds of freshwater on earth
  - Melting, glaciers and shelf-collapse => sea-level rise
- Future Projections for sea level rise
  - 2100: Best estimate = 0.6 m (range 20cm - 2m)
  - Many centuries later : 65-70 m if polar ice melts completely
- Impact on coastal communities, blue economies, and
  - cascading effects on inland communities

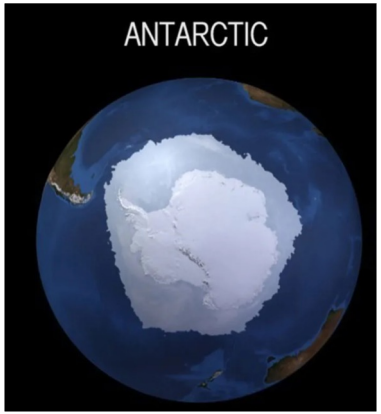


Image Credit: NASA's Goddard Space Flight Center

Alley, R., Clark, P., Huybrechts, P., & Joughin, I. (2005). **Ice-sheet and sea-level changes**. Science, 310(5747), 456–460. https://doi.org/10.1126/science.1114613
Lenaerts, Jan TM, et al. "**Observing and modeling ice sheet surface mass balance**." *Reviews of Geophysics* 57.2 (2019): 376-420.

What is iHARP…

Vision | iHARP advances our understanding of the response of polar regions to climate change and its global impacts by deeply integrating data science and polar science to spur physics-informed, data-driven discoveries.

Mission | iHARP conducts data intensive research, education, outreach, and cyberinfrastructure development that will transform understanding of the effects of climate change in polar regions. This institute brings together stakeholders and leading scholars in data science and polar science to reduce uncertainties in projecting Greenland and Antarctica's future mass balance, associated sea-level rise, and impacts on global communities.

https://iharp.umbc.edu/ (Currently in year 3 of project)

Photo of iHARP Members, Collaborators and Partners taken at the January 2023 All Hands Meeting. *Photo by Marlayna Demond '11 for UMBC*

9 Collaborating Universities
20+ Partners in Government, Academia and Industry

25 Senior Researchers
25+ Student Researchers and growing (High School, Undergraduate, Graduate, PhD)
32+ Individual Collaborators

11+ Projects
4 Focus Areas
1 Overarching theme of Education & Outreach

Projects Overview

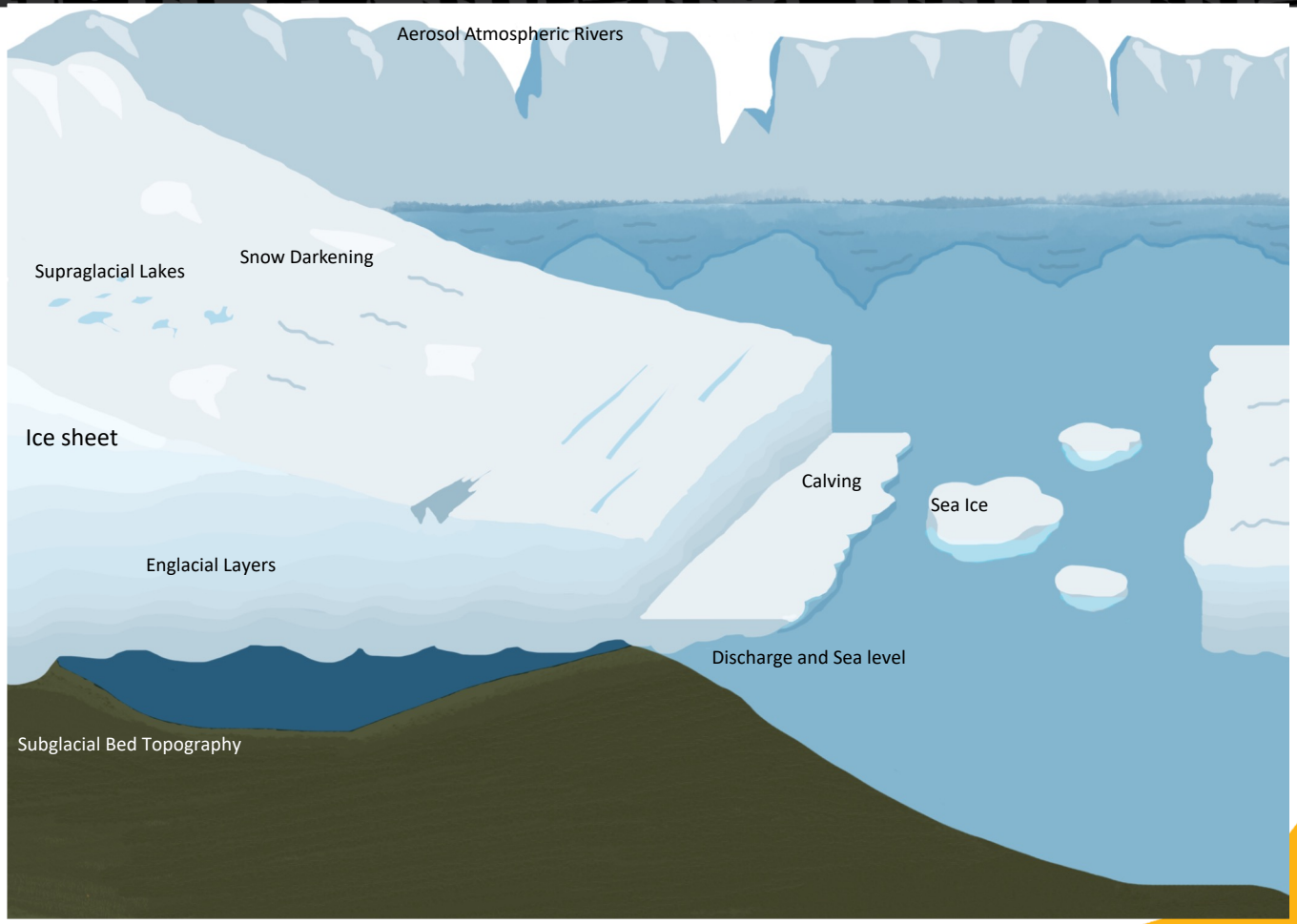
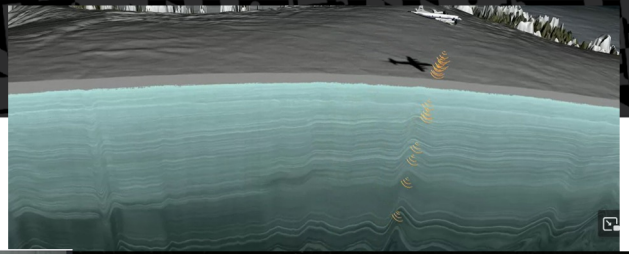
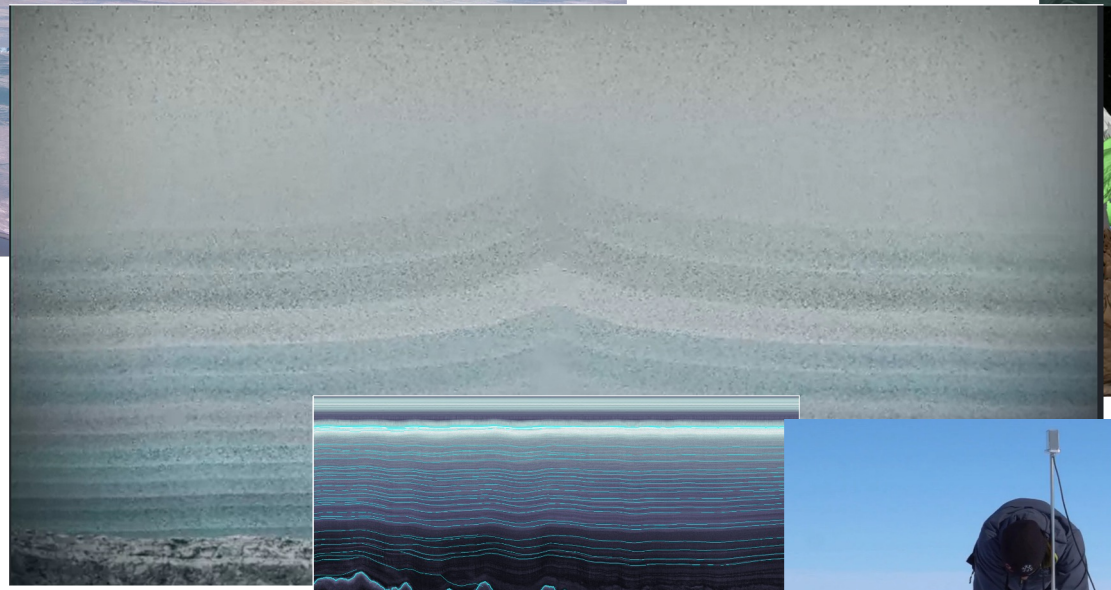


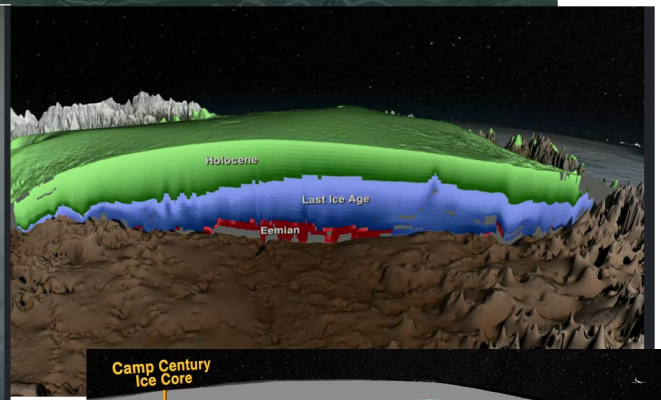
Image designed by : Marissa Chapman (iHARP)

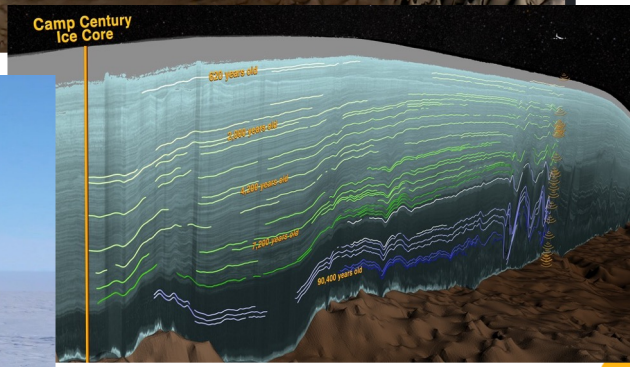
Project Spotlight with Transdisciplinary focus
Englacial Image Annotation

Team Members and Collaborators: Vandana Janeja, Bayu Tama, Atefeh Jebeli, Sanjay Purushotham,
Joe MacGregor (NASA-Org Code: 615); Nicholas Holschuh (Amherst), Claire Jensen (Amherst), Don Engel (UMBC), Naomi Tack (UMBC), Sharad Sharma (UNT), Rebecca Williams (UMBC)



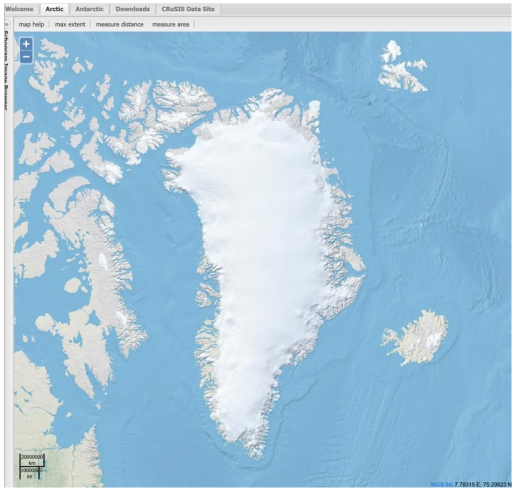


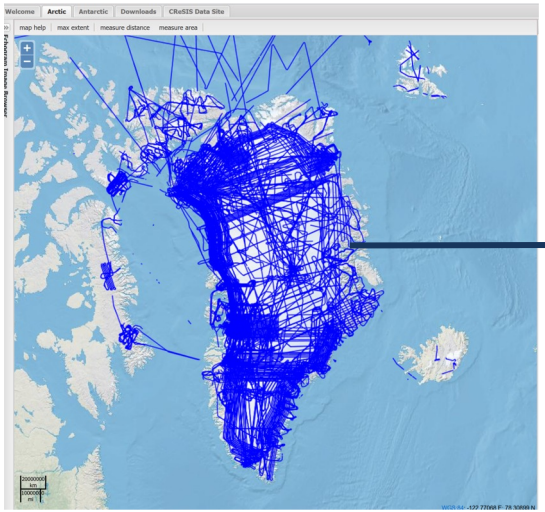


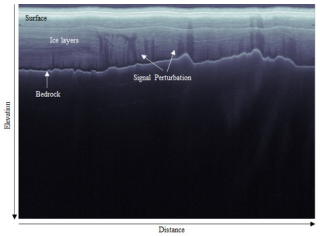


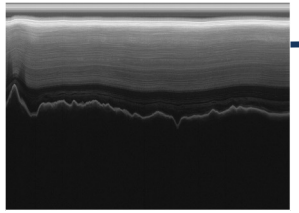
https://svs.gsfc.nasa.gov/4249
Joe MacGregor (NASA/GSFC)
Mark Fahnestock (Geophysical Institute, University of Alaska Fairbanks

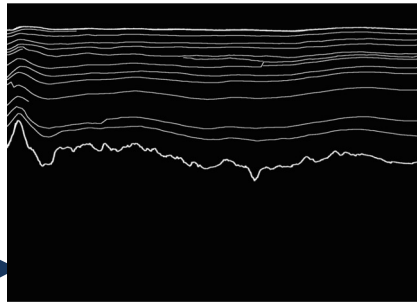
Image Annotations for Englacial Images

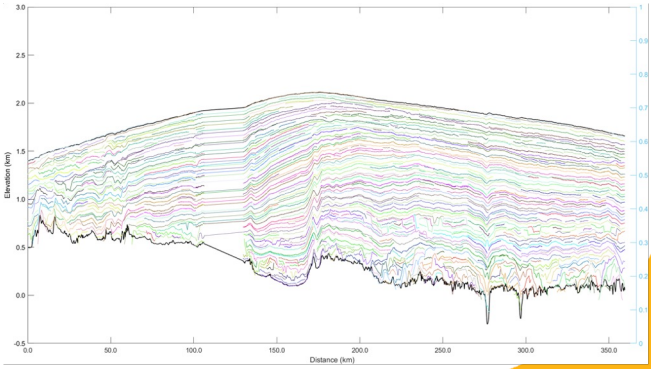








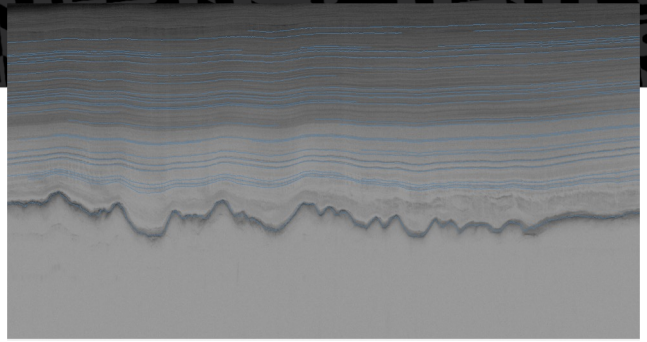




A. Jebeli, B. A. Tama~, S. Purushotham, V. Janeja,*Tracing Englacial Layers in Radargram via Semi-supervised Method: A Preliminary Result, AAAI Fall Symposium Oct. 2023*

A. Jebeli, B. A. Tama~, V. Janeja, N. Holschuh, *C. Jensen*, M. Morlighem, J. A MacGregor, M. Fahnestock, TSSA: two-step semi-supervised annotation for englacial radargrams on the Greenland ice sheet. IEEE International Geoscience and Remote Sensing Symposium, July 2023

N. Tack, B. A. Tama~, *A. Jebeli,* V. Janeja, D. Engel, R. Williams, Metrics for the quality and consistency of ice layer annotations, IEEE International Geoscience and Remote Sensing Symposium, July 2023

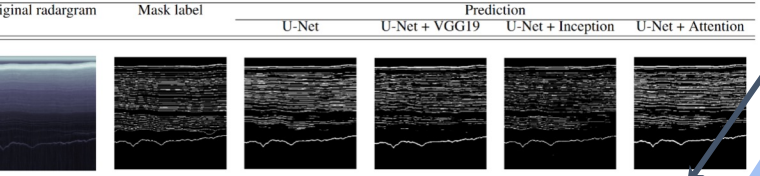


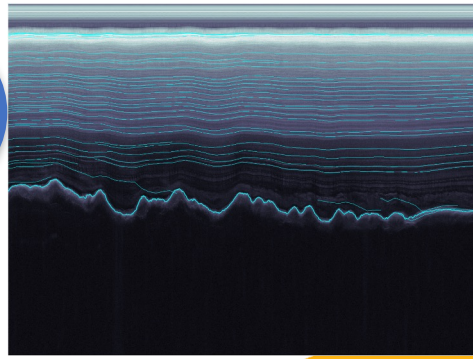
Expert Annotations

Ice Layer Annotations

AI auto Annotations

Semi supervised





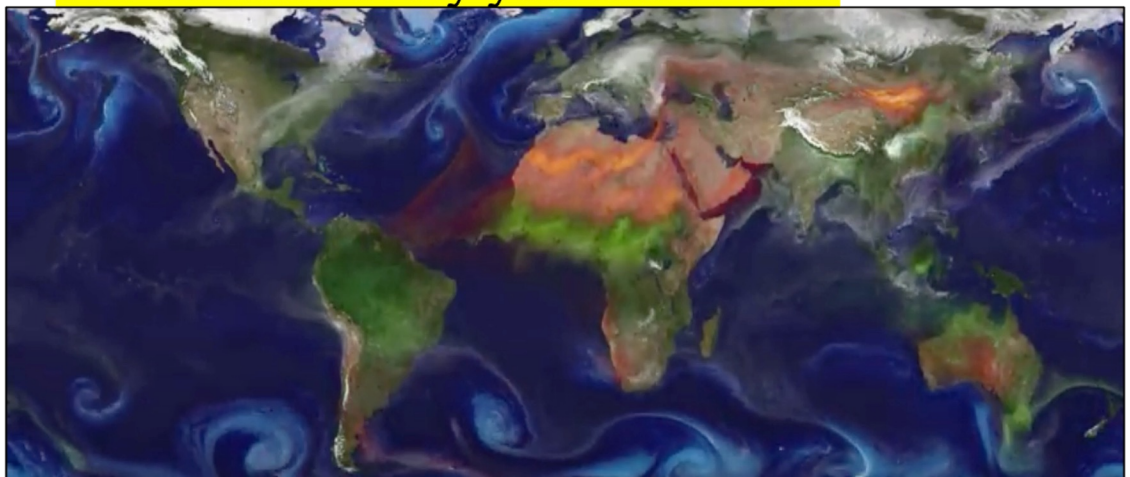
Spotlight : Understanding the Role of 2019 Amazon Wildfires on Antarctic Sea Ice Extent

Team Members and Collaborators: Chakraborty, Sudip, Kulkarni, Chhaya, Jebeli, Atefeh, Sampath, Akila, Boteju, Gehan, Wang, Jianwu, and Janeja, Vandana

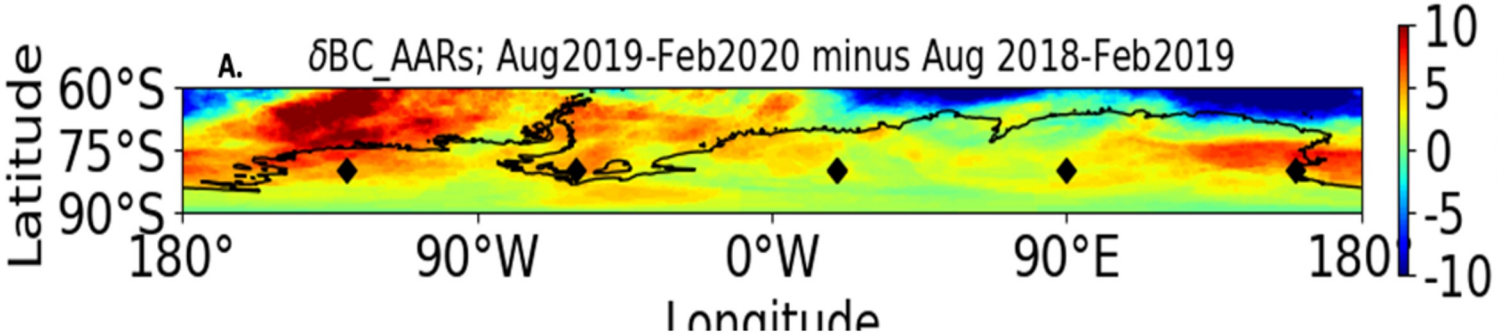
Chakraborty, Sudip, Kulkarni, Chhaya, Jebeli, Atefeh, Sampath, Akila, Boteju, Gehan, Wang, Jianwu, and Janeja, Vandana “Understanding the Role of 2019 Amazon Wildfires on Antarctic Sea Ice Extent Using Data Science Approaches” *Fragile Earth Workshop 2023, collocated with ACM SIG KDD 2023*, August 2023

Understanding the Role of 2019 Amazon Wildfires on Antarctic Sea Ice Extent Using Data Science Approaches

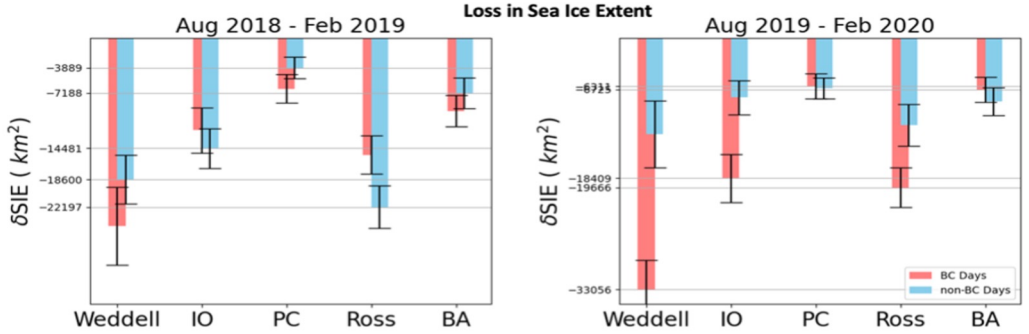
- The most recent study shows that the Antarctic Sea ice extent reached a new record-smashing low of 1.965 million km^2 on 23rd February 2023, which is ~ 32% below climatological values.
- The ice sheet melt has accelerated in recent times as the Antarctic has lost ~300-500 Gt of ice every year since 2018.



- Every year, narrow and elongated channels of smoke reach the Antarctic from the Amazon region.
- The number of wildfires have dramatically increased since 2018.
  - Smoke contains black carbon (BC) particles.
  - BC particles darken the snow surface and reduce albedo.
  - Darker the snow - lower the reflection of the sunlight.
  - Higher the absorption of the sunlight.
  - Snow/ice temperature increases.
  - Higher the melt.



In 2019, 10 more AARs reach the Antarctic region compared to the previous year.



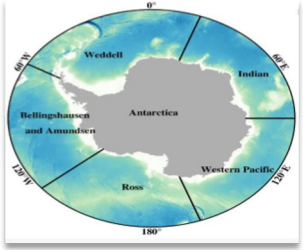
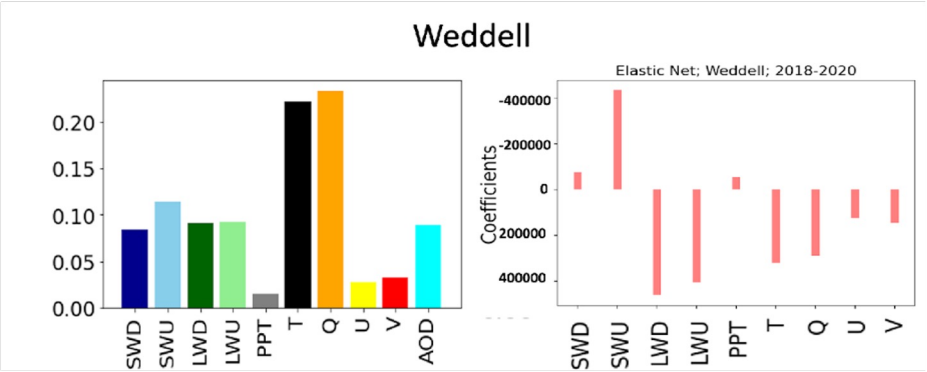


Figure. Mean and standard errors of Sea ice extent (km^2) loss over different regions in season18 and season19 during BC and non-BC days.



- SWD or the incoming sunlight, SWU or the reflected sunlight (or a representation of the albedo or snow darkness), LWU (emitted radiative energy), LWD (longwave downward energy back to earth), Temperature (T), and relative humidity (Q) are the major factors impacting the SIE loss over there.

Regions	Time lag = 1	Time lag = 2	Time Lag = 3
Weddell	SWD↓, LWU↓	LWU↓, SWU↑	LWU↓, SWU↑

Causal discovery:

1. SWD and LWU negatively influence sea ice extent (↓).
2. SWU positively impact sea ice extent (↑).
3. Thus, incoming sunlight, albedo (or SWU) and temperature (or LWU and T) are two primary factors governing the SIE loss.

Supraglacial Lakes
And K-12 Partnership

The tracking of lakes through a melt season, when they fill, how much they fill, and (most importantly) when they drain, throughout a year, and tracking those trends across years, will help us solidify our understanding of the way water on the ice sheet is behaving in a rapidly changing climate over Greenland.

Supraglacial Lakes

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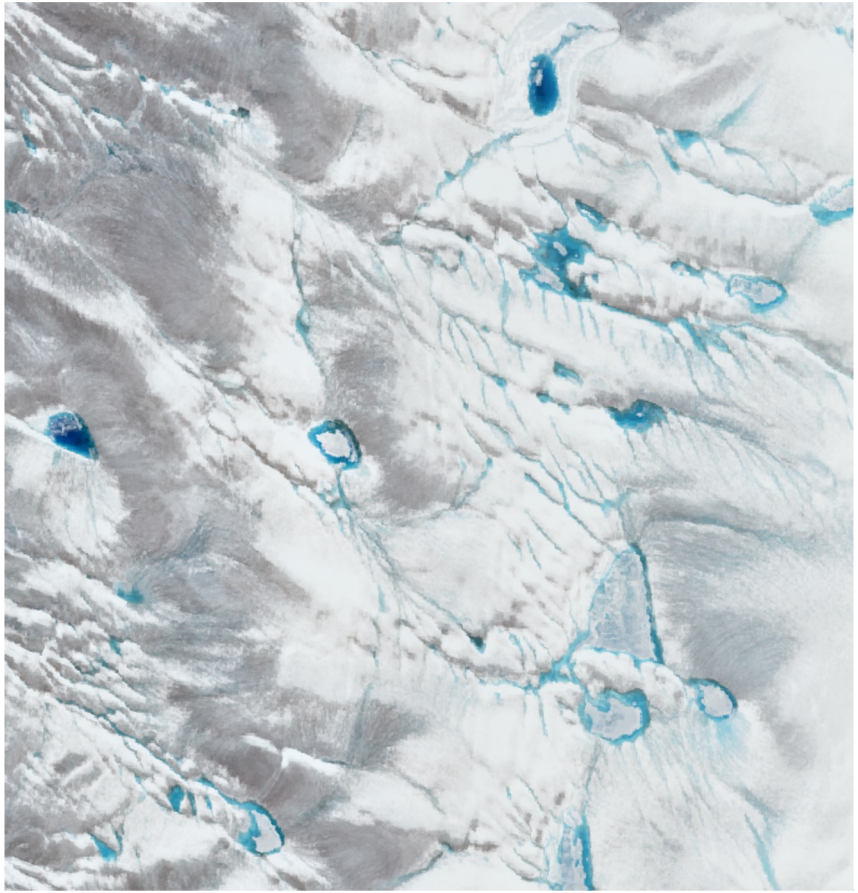
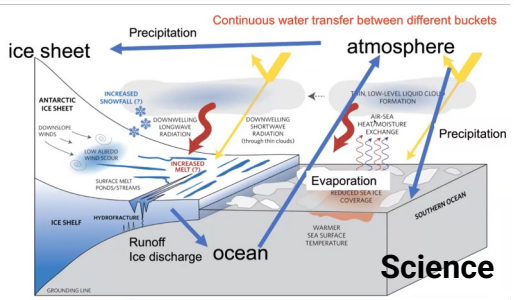


Annotation of Supraglacial -- Surface Lakes



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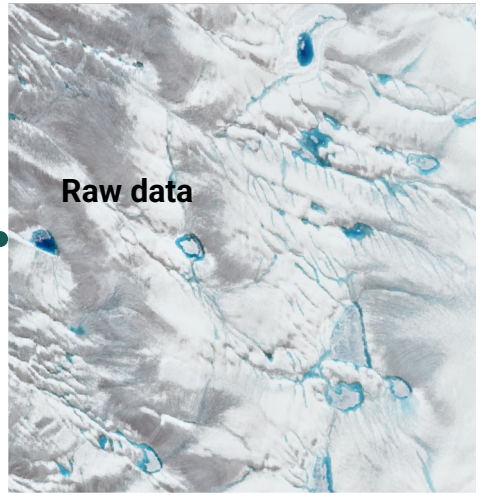
02

Raw data



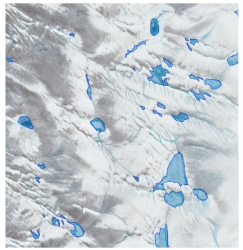
AI algorithms - Competition

ACM SIGSPATIAL Cup 2023

SIGSpatial Cup Chairs: Mike MacFerrin, Aneesh Subramanian, Mohamed Mokbel

iHARP Talk Tuesday: Ed Boyda and Kim Young:
https://www.youtube.com/watch?v=ePhgNOcx8pU

K-12 Curriculum development
Annotation
Validation

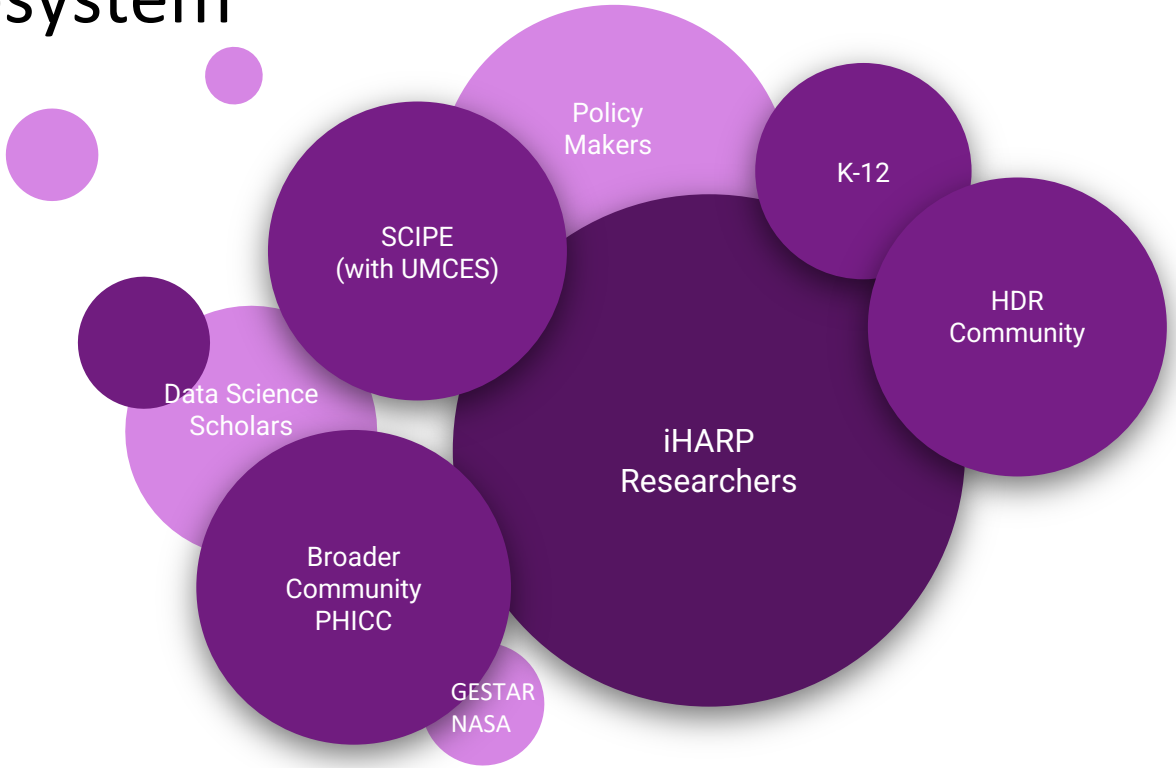


Accomplishments

- 20 publications and counting…
- Multiple proposal defenses, internships and fellowships
  - High School mentee competed in International Regeneron ISEF 2023
  - Multiple Data Science Scholars
- Growth through new supplemental grants and NSF SCIPE award
  - Developing of new community connections & council
  - Building upon Hack-a-ton success
- Data Competition with K-12 and scientific community (ACM SIGSpatial)
- Continued development of partnerships - AWS, NASA/JPL/ GESTAR, Earth Genome, UMCES, and GHub
  - New cloud computing resources and capabilities
  - Building Open Science and Data repositories
- Expansion into local impact in Maryland

iHARP was featured as a part of a Artificial Intelligence series on a CBS WJZ Baltimore news segment that aired on February 15, 2023.

iHARP Ecosystem



iHARP: https://iharp.umbc.edu/

Pan-HDR Ice-Melt Community Council (PHICC) https://iharp.umbc.edu/phicc/