

Hot spots in the ice: importance of polynyas for Antarctic marine ecosystems

CESM workshop – June 12, 2023

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Cassandra Brooks, Stephanie Jenouvrier, Sara Labrousse, Lucie Bourreau,
Marte Vienne, Francesco Ventura, Matthew Long

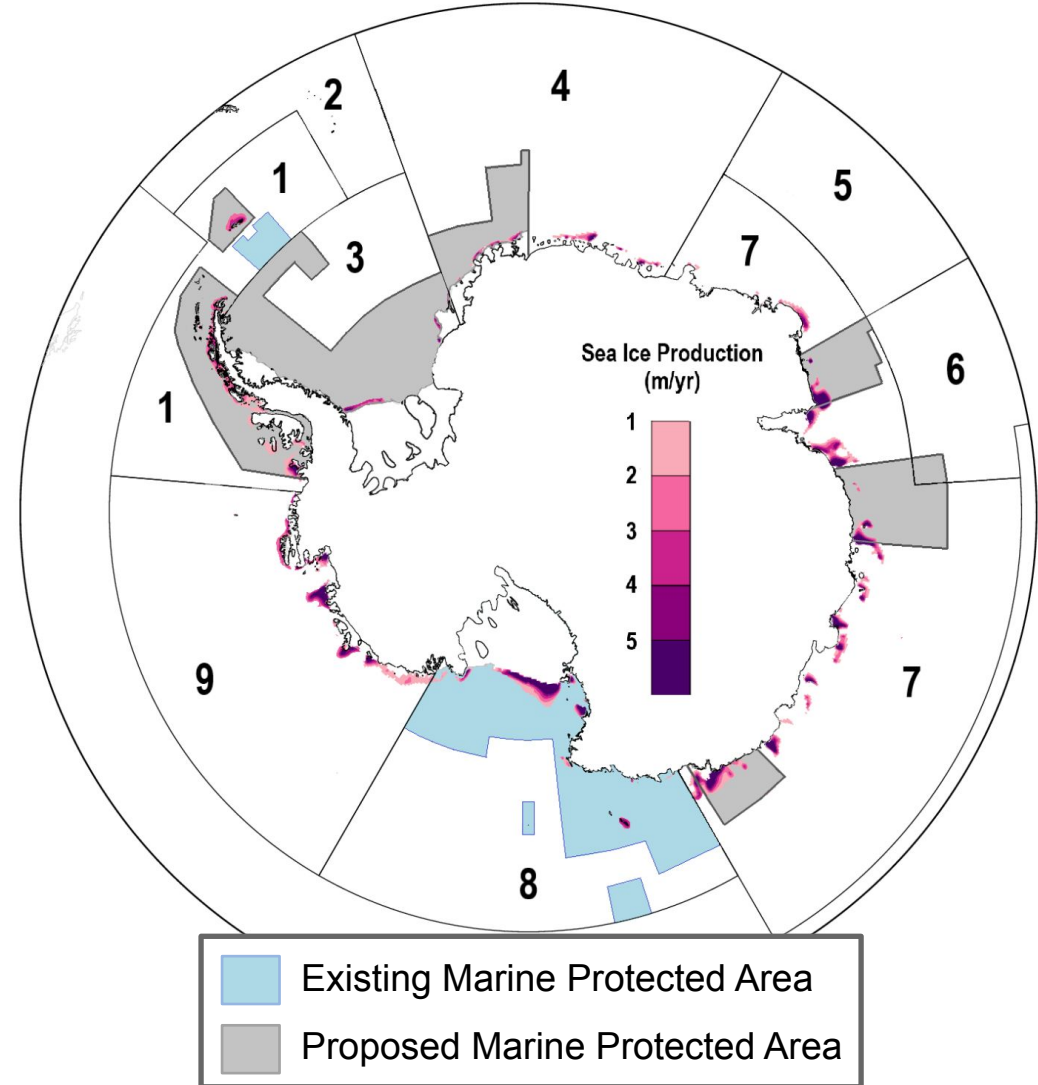


Photo: John Weller

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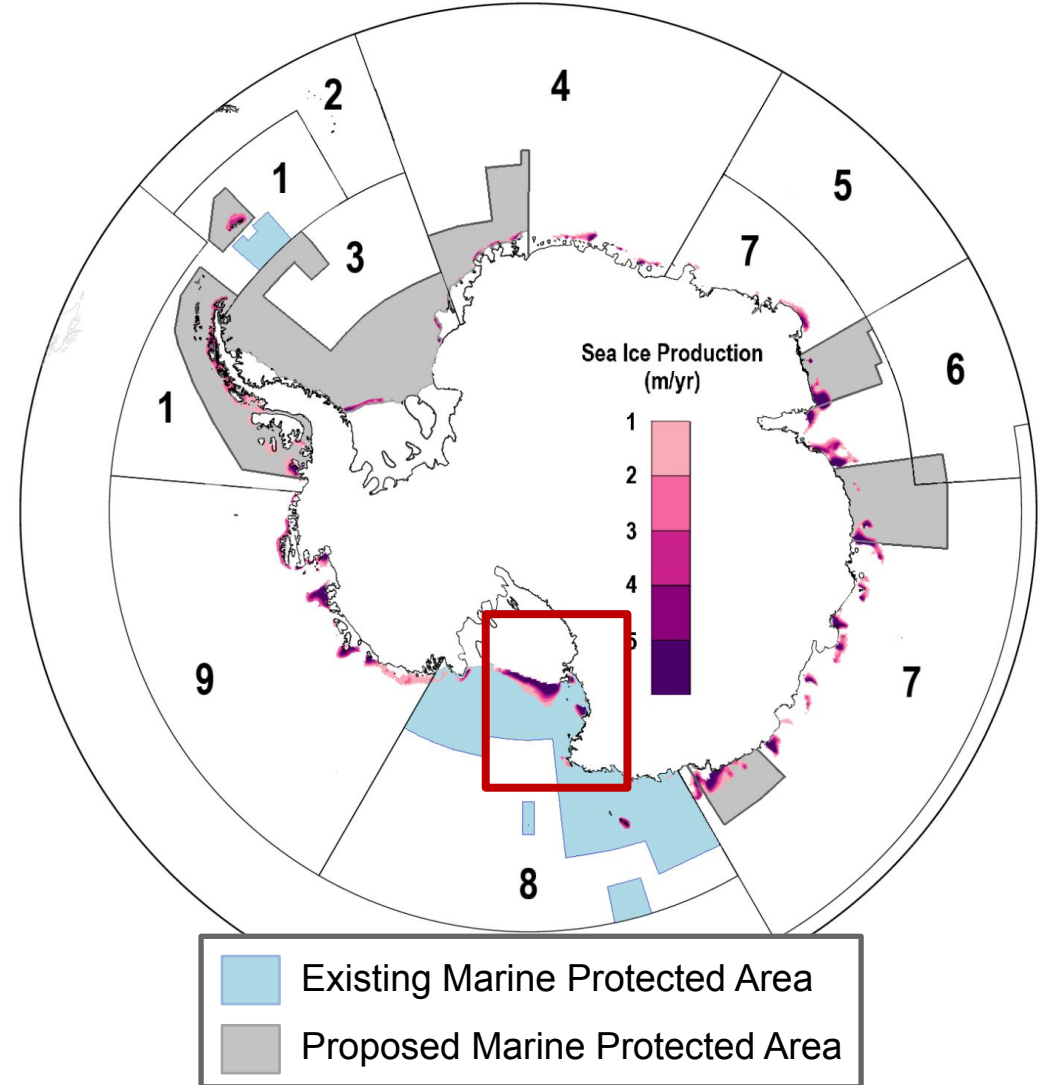
Project Goal:

Provide information about the conservation value of polynyas in different Antarctic regions over policy relevant timescales.



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How important are polynyas for the Antarctic ecosystem?

Polynya: Area bounded by land or sea ice that has lower sea ice concentration than surrounding region

Terra
Nova Bay
Polynya



Ross Sea
Polynya



Image: NASA Earth Observatory

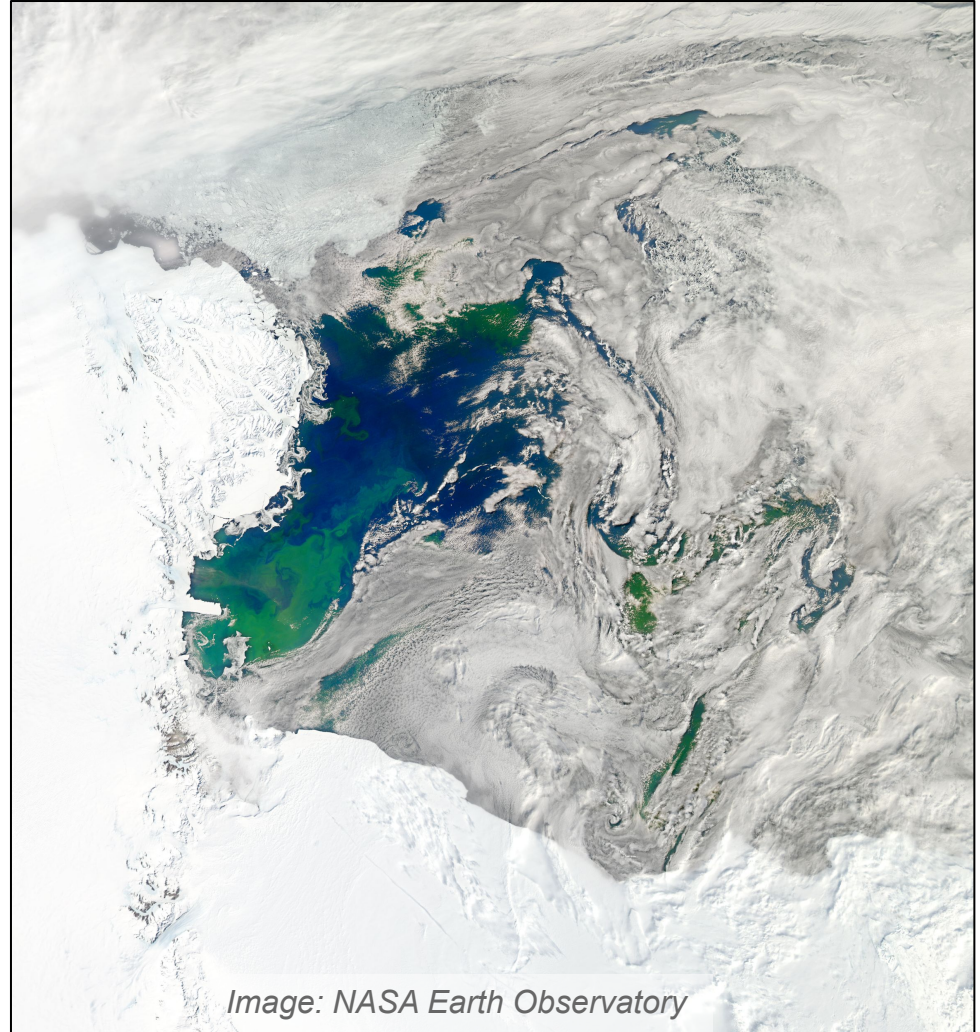


Image: NASA Earth Observatory

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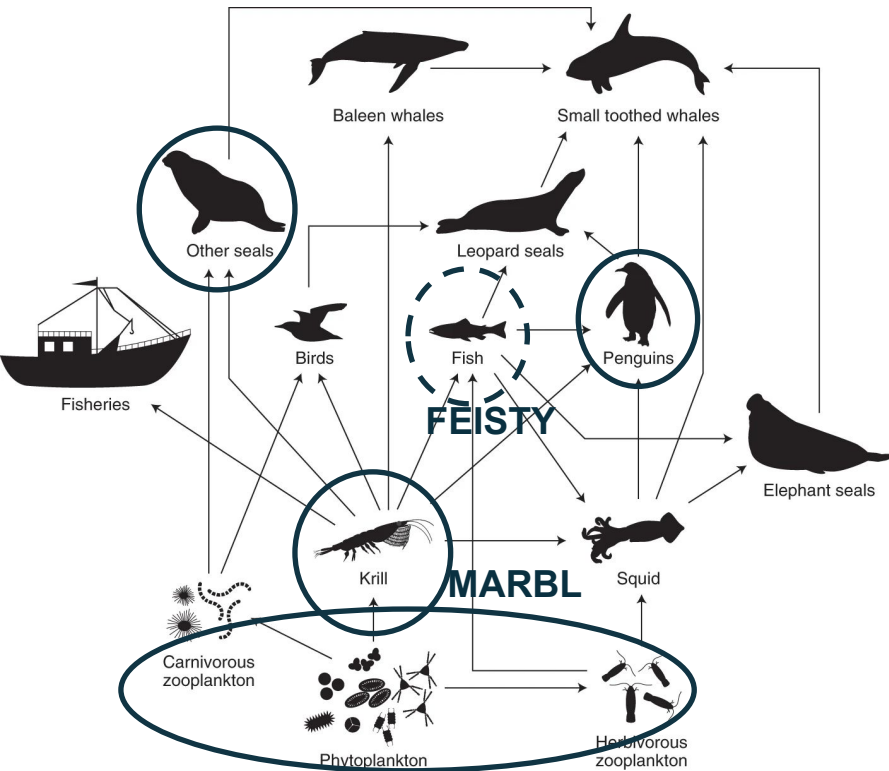


Image: McBride et al. 2019

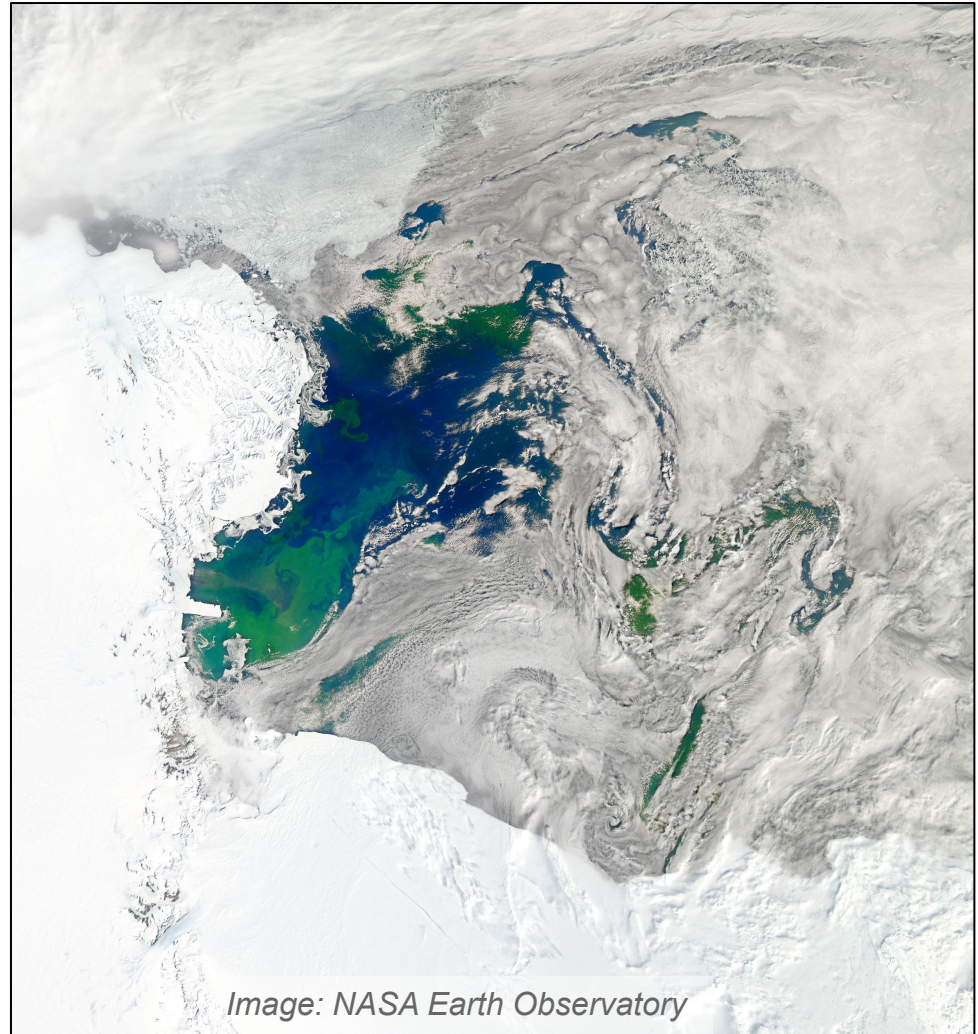
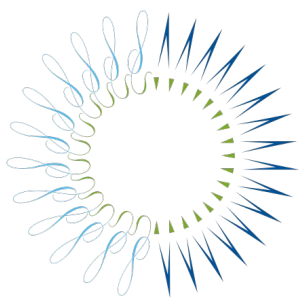


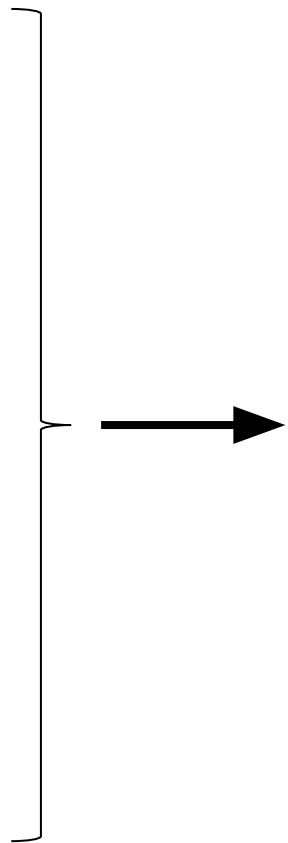
Image: NASA Earth Observatory

End users span the Science-Policy-Public Interface

End Users



THE
PEW
CHARITABLE TRUSTS



CCAMLR

(Commission for the Conservation of Antarctic Marine Living Resources)

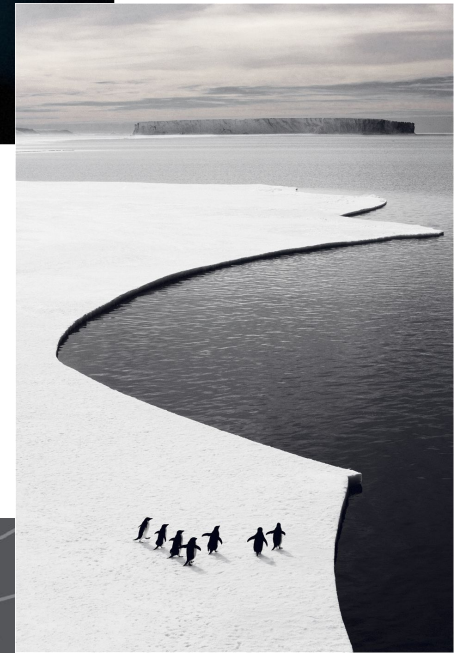
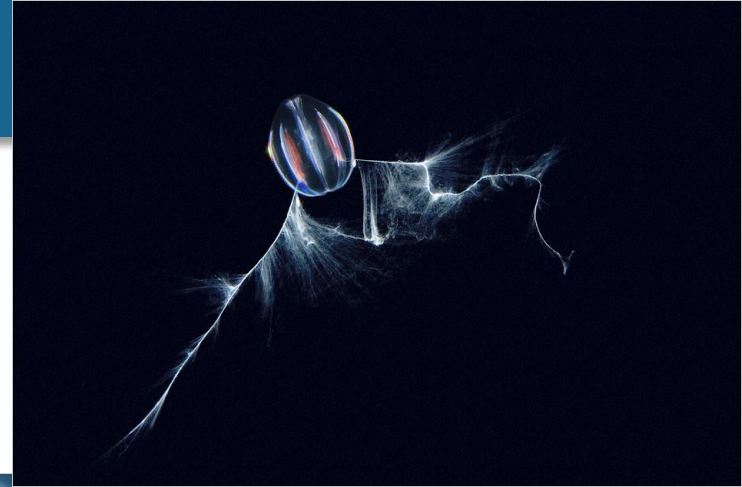


The general public



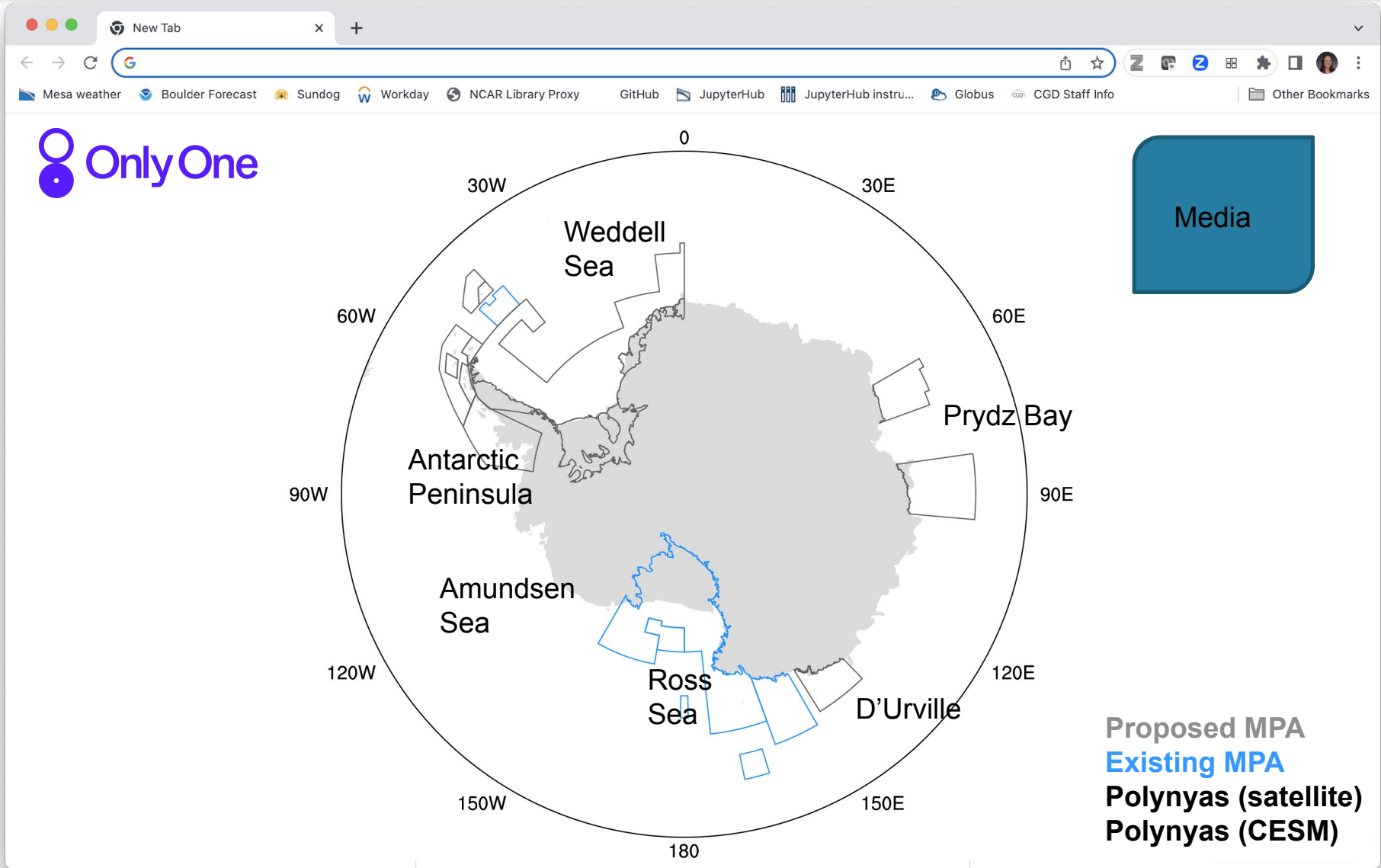
End users wants:

- Socialize the science with educational storytelling about polynyas to three audiences:
 - General Public: info on taking action
 - Policymakers: links to white papers
 - Scientists: links to data/code repositories
- Create web-based layered tool with:
 - Storytelling
 - Visually appealing
 - Clickable interfaces to dive deeper

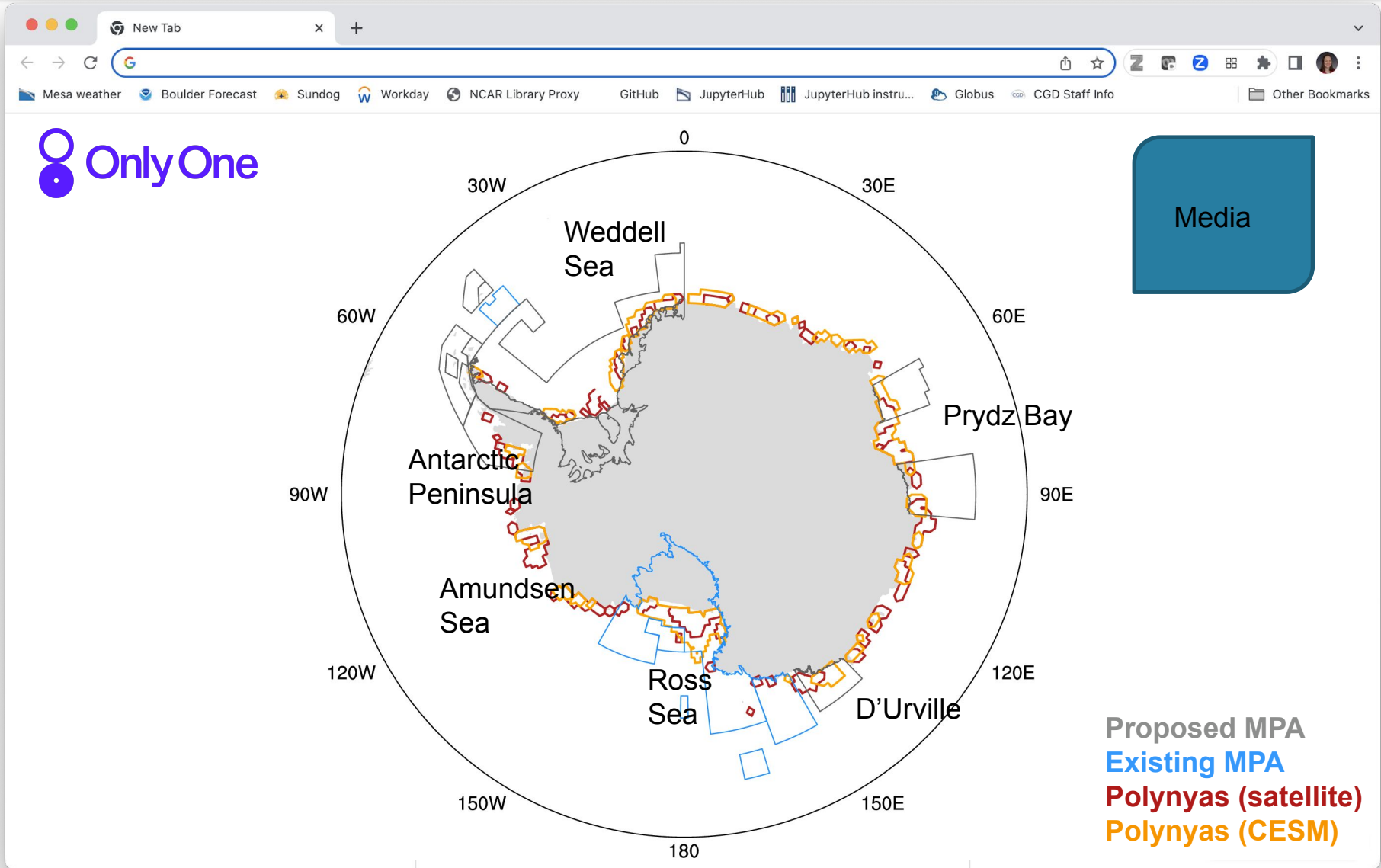


Photos: John Weller

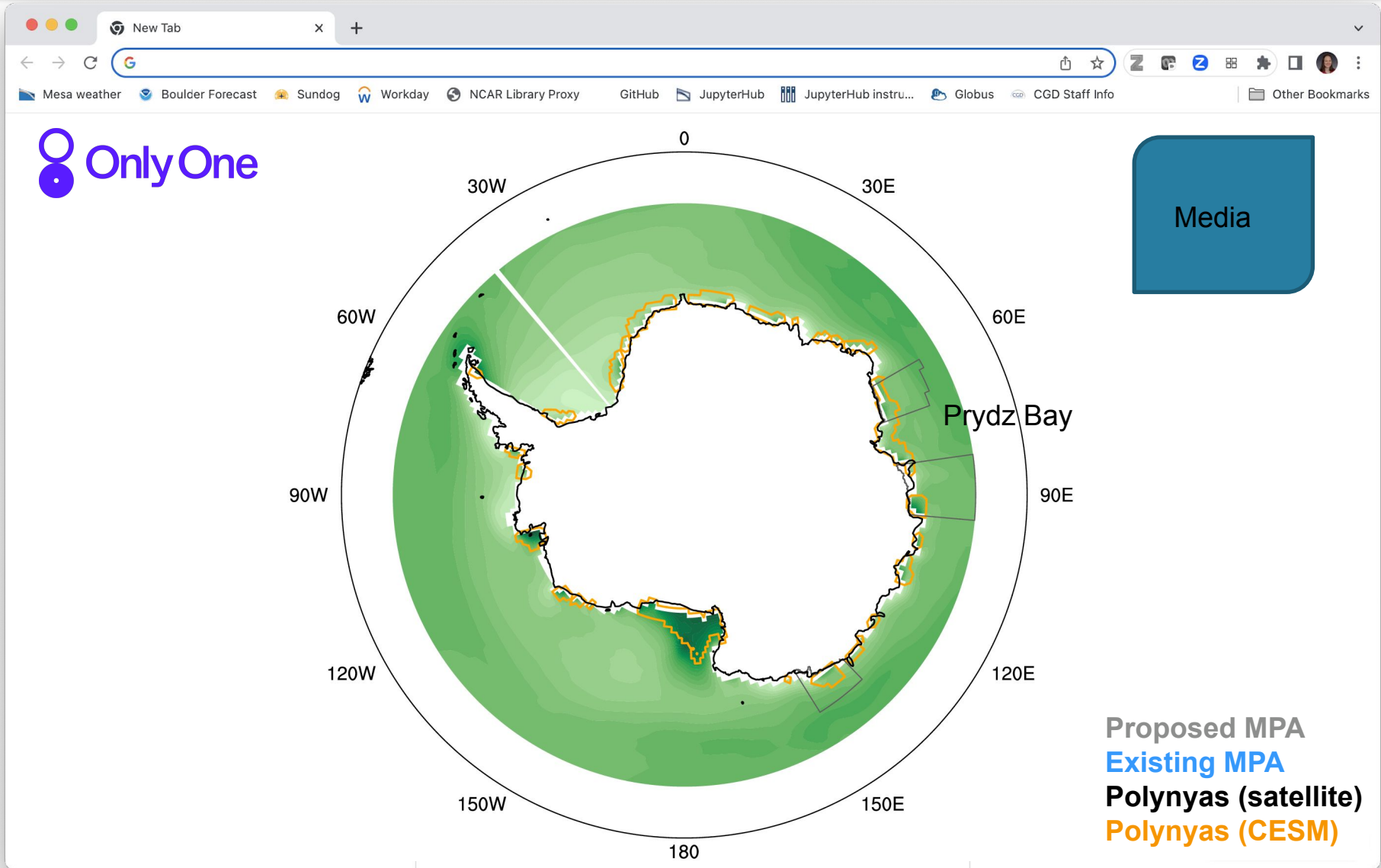
Tool Conception



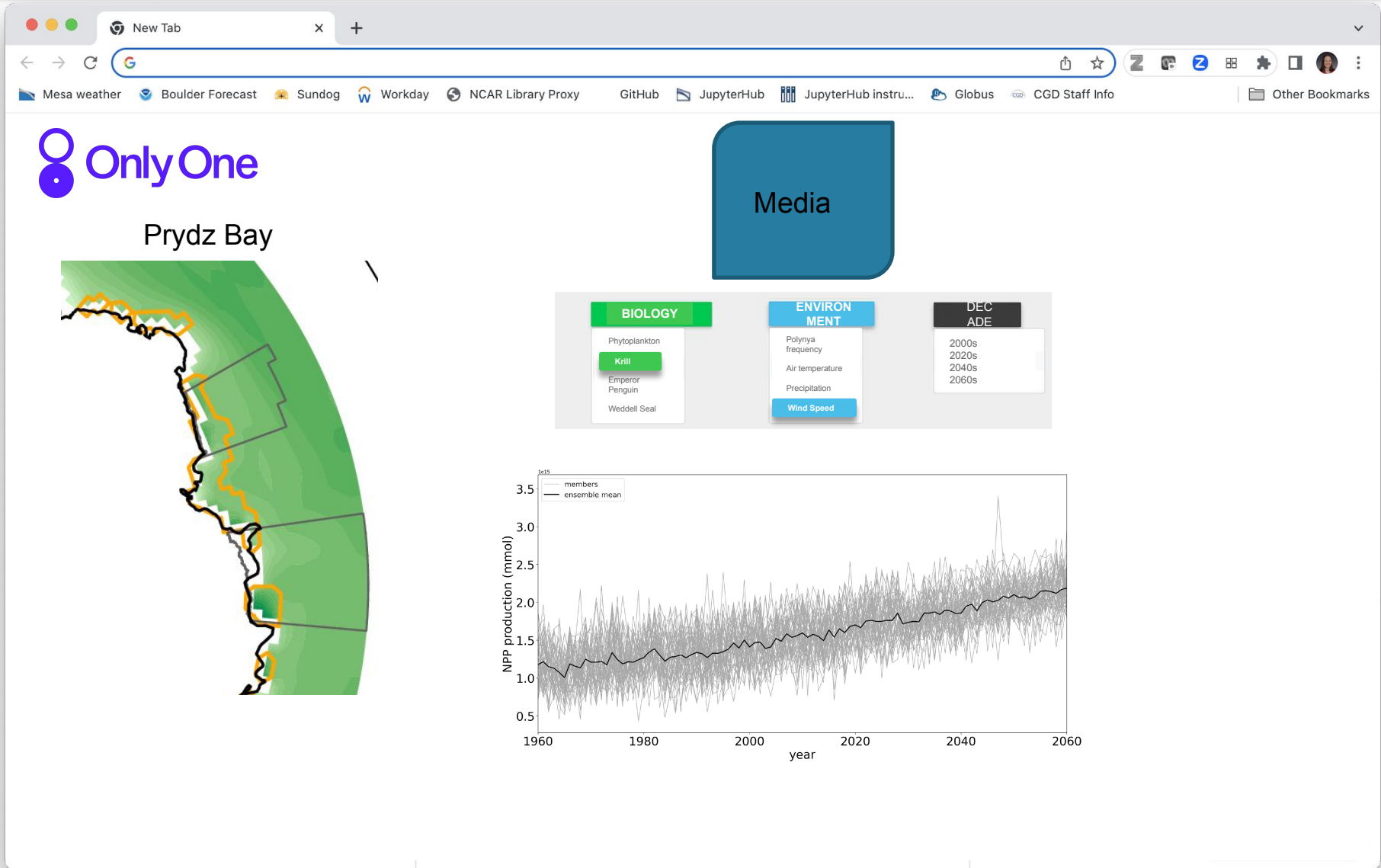
Tool Conception



Tool Conception



Tool Conception



Tool Conception

Only One

Prydz Bay

Media

BIOLOGY

- Phytoplankton
- Krill**
- Emperor Penguin
- Weddell Seal

ENVIRONMENT

- Polynya frequency
- Air temperature
- Precipitation
- Wind Speed**

DECADE

- 2000s
- 2020s
- 2040s
- 2060s

Global climate policy has the capacity to halt the future projected declines of emperor penguins

Total population size

Years

Paris 1.5

Paris 2

Unmitigated scenario

Year	Paris 1.5 (Population)	Paris 2 (Population)	Unmitigated scenario (Population)
2020	250,000	250,000	250,000
2040	220,000	180,000	180,000
2060	190,000	140,000	110,000
2080	170,000	120,000	70,000
2100	160,000	110,000	50,000

Tool Conception

Only One

Prydz Bay

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A

Map showing observed fluorescence (mg.m^{-3}) in Prydz Bay. The color scale ranges from 0 (yellow) to 25 (dark blue). Key locations marked include Cape-Darnley, Barrier Bay, and Shackleton. The map covers latitudes from 60°E to 100°E and longitudes from 64°S to 68°S.

How to make this work?

- Communicate!



Photo: John Weller



How to make this work?

- Communicate!
- Trust and relationships



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How to make this work?

- Communicate!
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- Be realistic!



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How to make this work?

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- Audience



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How to make this work?

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- Goals can differ



Photo: John Weller

How to make this work?

- Communicate!
- Trust and relationships
- Be realistic!
- Audience
- Goals can differ
- Scales and uncertainty



Photo: John Weller



Thanks for your attention!

Questions?



Alice DuVivier - NCAR



Cassandra Brooks - CU Boulder



Zephyr Sylvester - CU Boulder



Laura Landrum - NCAR



Matt Long - NCAR



Marika Holland - NCAR



Kristen Krumhardt - NCAR

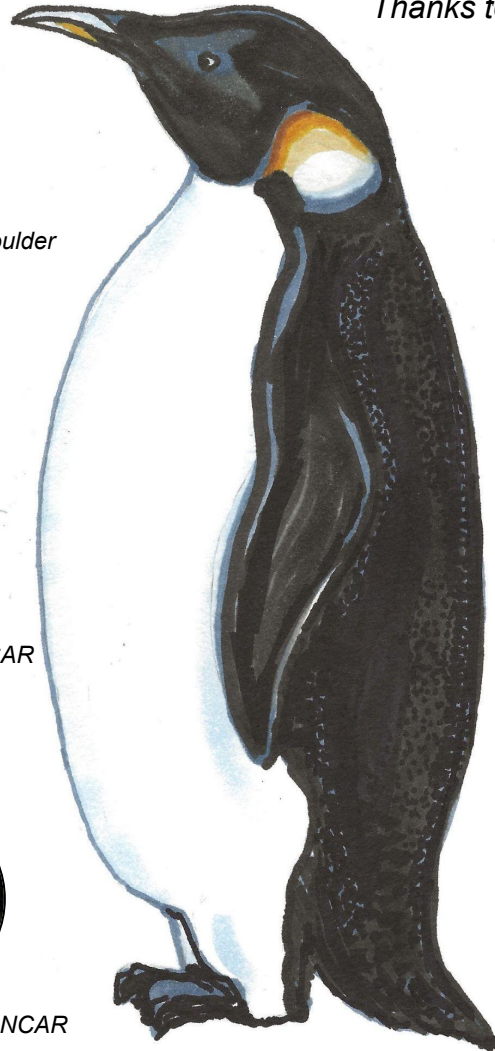


Image: Kristen Krumhardt

Thanks to the entire science team!



Stephanie Jenouvrier - WHOI



Sara Labrousse - L'OCEAN



Francesco Ventura - WHOI



Marte Vienne - L'OCEAN



Lucie Bourreau - L'OCEAN

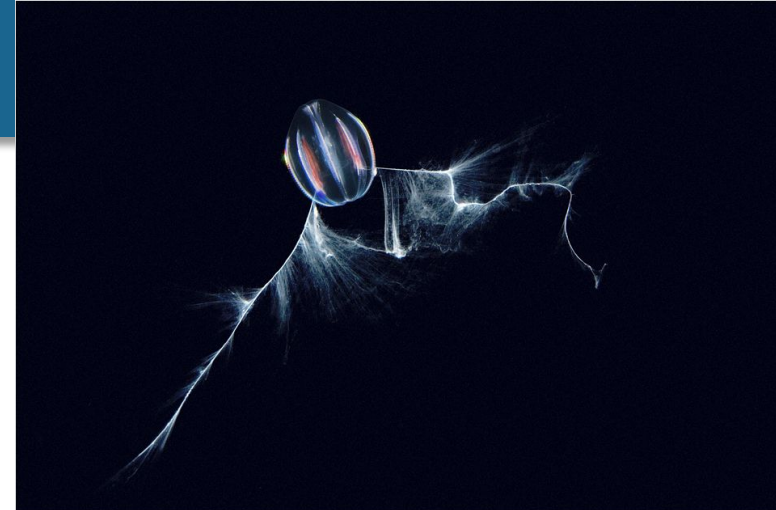
8-10 minute talk

As such, we ask that you think about deviating from a traditional science research presentation and think about focusing on elements of your research related to a) the collaborative process, b) stakeholder (community partner) engagement, c) differences between traditional methods in science and actionable science, d) concepts of actionable model information, e) markers of successful actionability of information, and/or f) recommendations for evolving actionable research in the context of CESM. Emphasis should be placed on the process of generating actionable knowledge working in a collaborative research environment with community partners as opposed to presenting on technical aspects of research or presenting research products.



How to make this work?

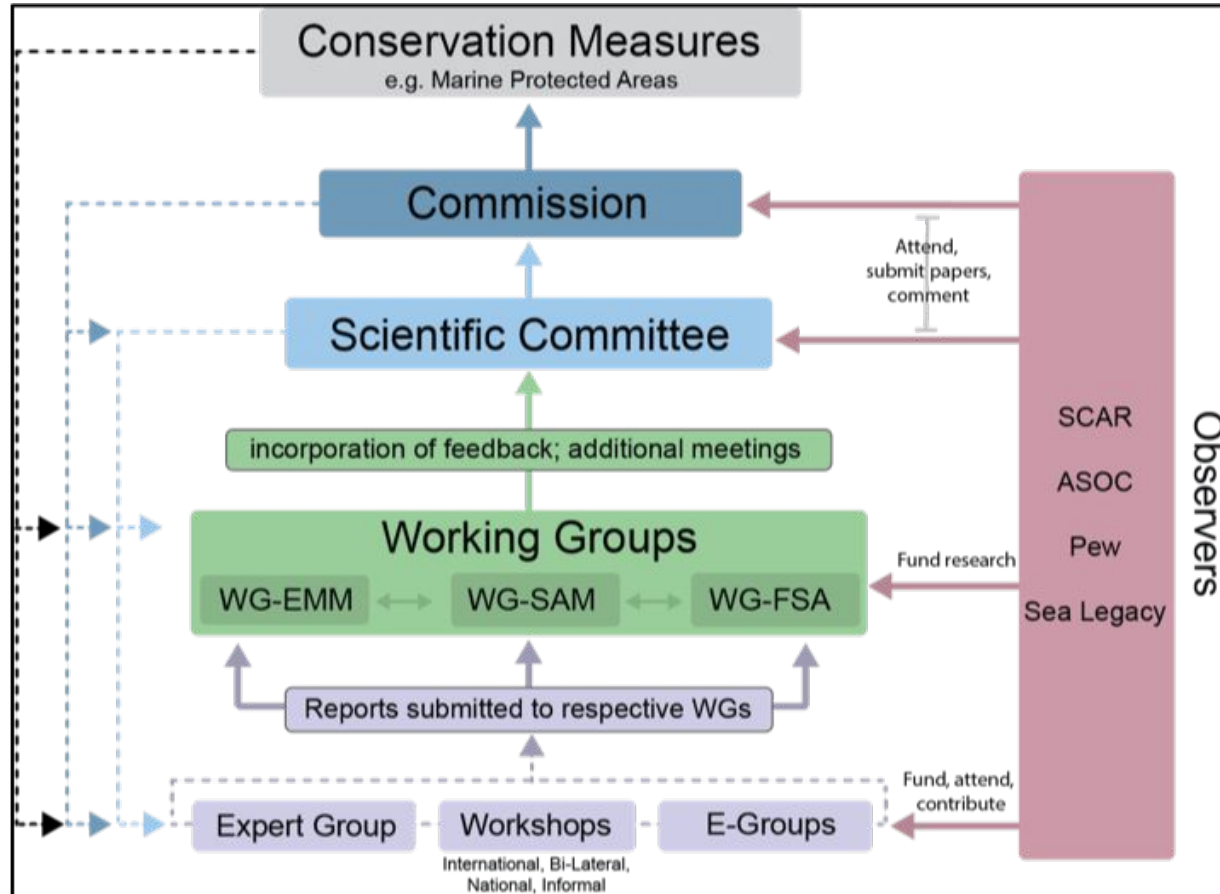
- Communicate!
 - Regular science team meetings
 - One team member meets monthly with end users to discuss progress. Biannual larger meetings.
 - Trust is key □ build a relationships
 - In person end user meeting was really beneficial
- Be realistic!
 - Policy goals are not often achievable within the lifetime of a grant. Do good science so you're ready for when an opportunity comes.



Photos: John Weller

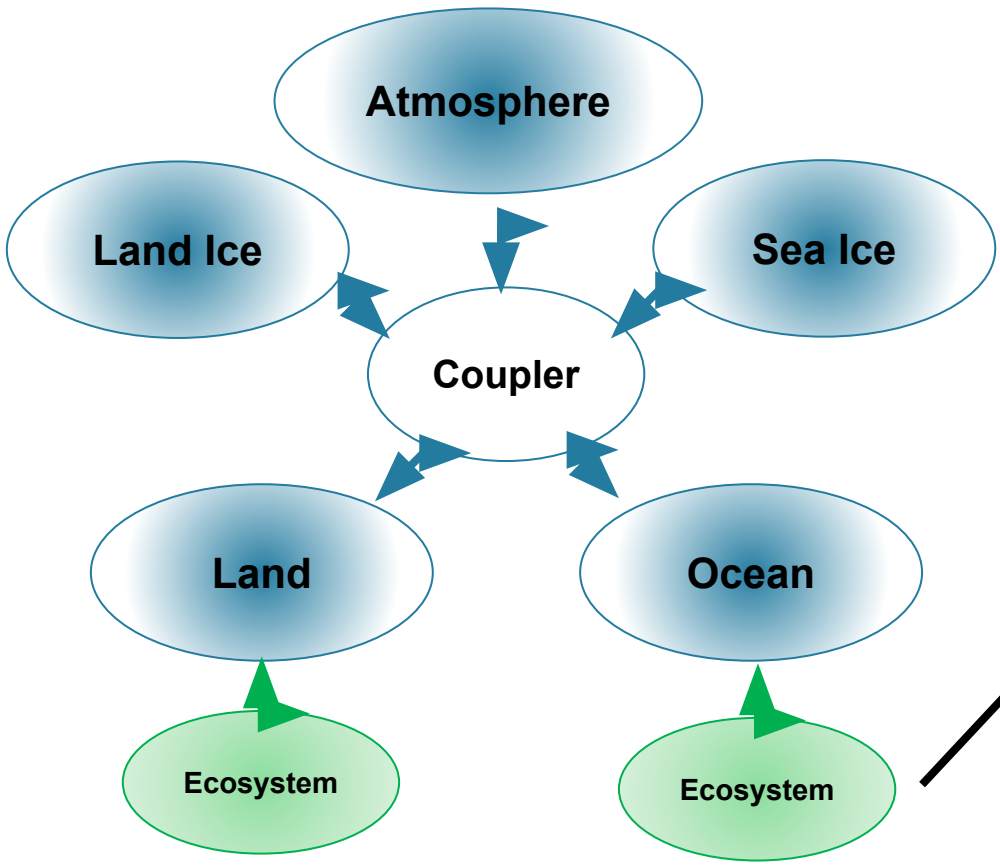
- Challenges:
 - It takes time to build relationships.
 - Identifying audience and story is key. Work as a team to figure out the story you want to convey.
 - End users don't always know what they want regarding science.
 - Need to provide options and don't get stuck in the weeds.
 - Less about new science, more about making existing tools (i.e. CESM2-LE runs) useable.
 - Deliverables and goals can differ for end users and scientists (i.e. publications aren't the focus).
 - Scales of climate models with place-based focus and modeling uncertainties.

Project Goal:



Earth System Models are a tool to understand future physical and ecosystem changes

Community Earth System Model (CESM)



FOSI and Fully coupled options

CESM2-MARBL: 4phyto/2zoo ecosystem

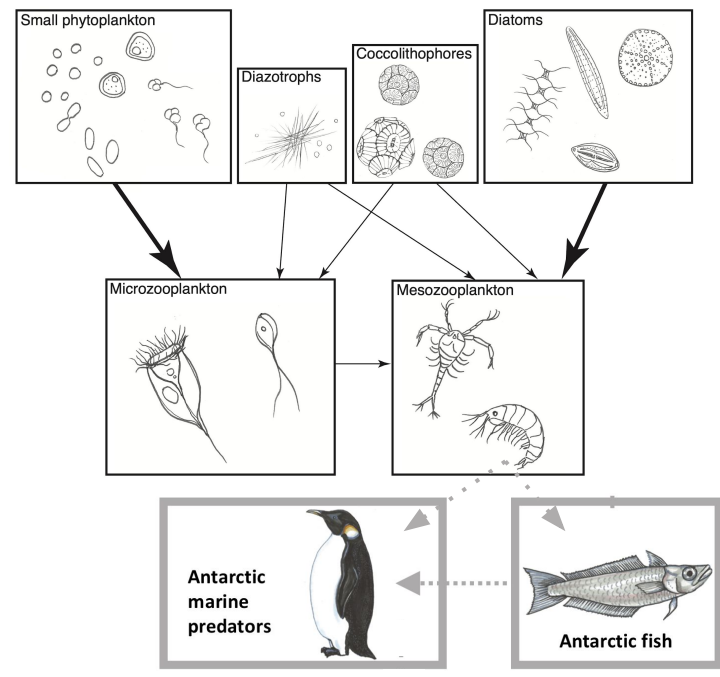
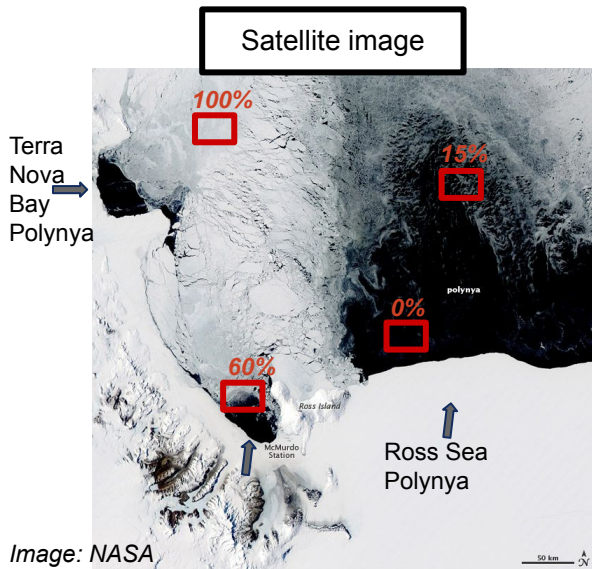


Image: Kristen Krumhardt

Linkages to Antarctic marine predators



Developed a tool that is reproducible, verifiable, and applicable to gridded data - satellite and Earth System Model.



No	No				
No	No		OWP		
		OWP	OWP		CP
					CP

No = not polynya

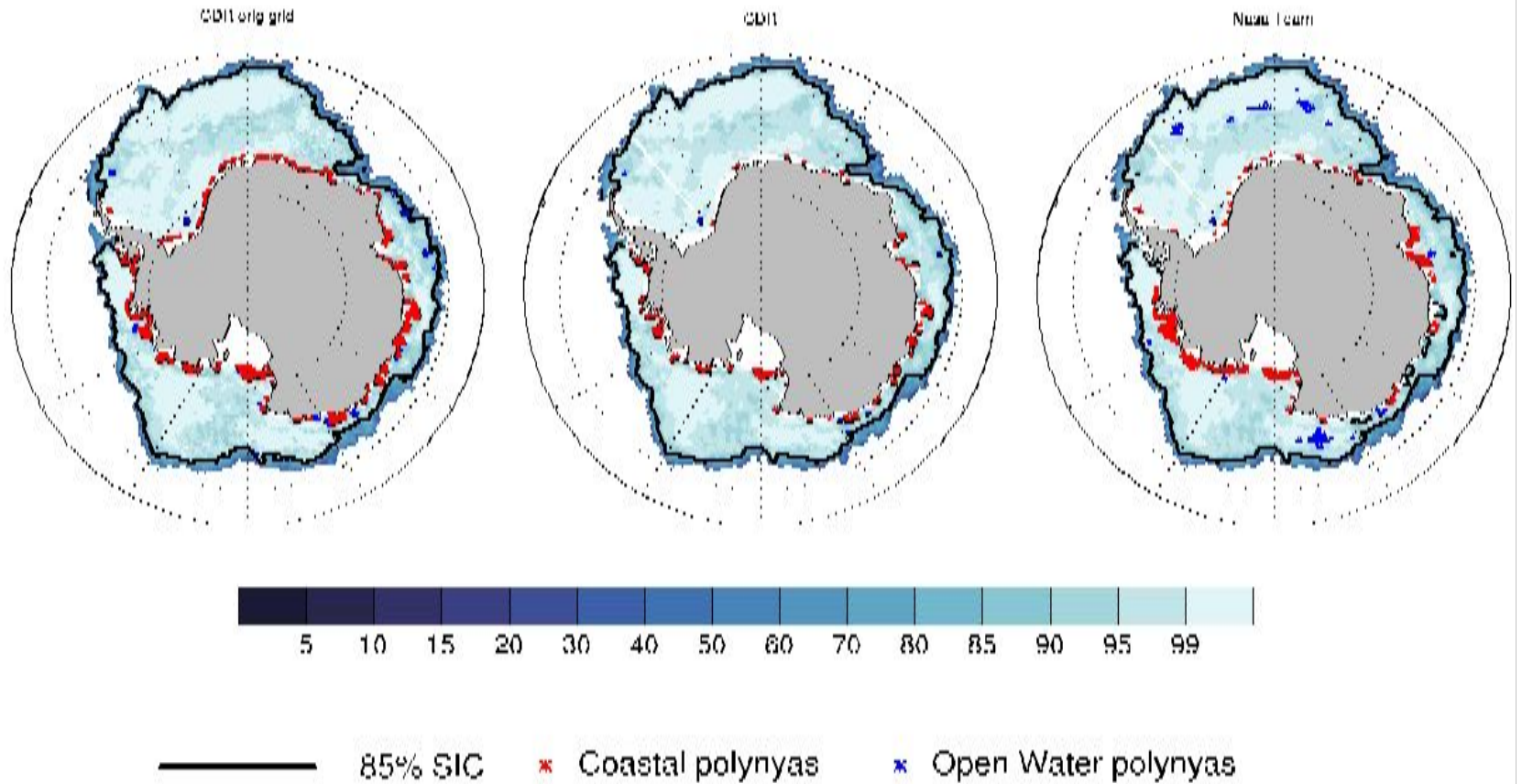
OWP = open water polynya

CP = coastal polynya

	0% SIC
	< threshold (e.g. 50% SIC)
	> threshold (e.g. 90% SIC)
	Land

Image: Laura Landrum

SSM/I polynyas JUL 15 2003 (85% SIC threshold)



Identifying polynyas

- Developed a polynya identification tool that is reproducible, verifiable, and applicable to gridded data (satellite or model) using sea ice concentration or thickness.



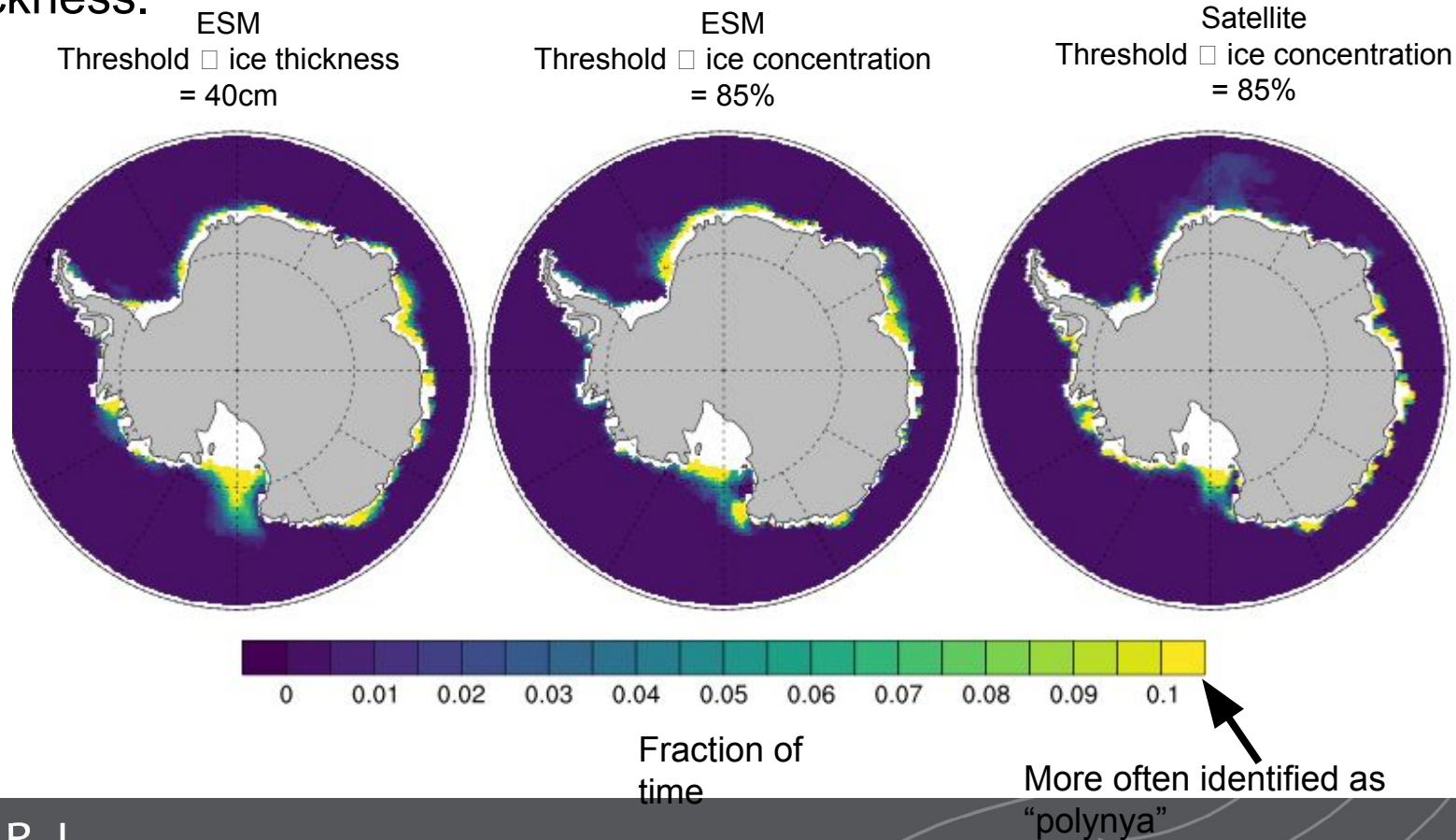
Laura Landrum
NCAR



Alice DuVivier,
NCAR



Marika Holland,
NCAR



Modeled productivity in polynyas



Zephyr Sylvester,
CU Boulder

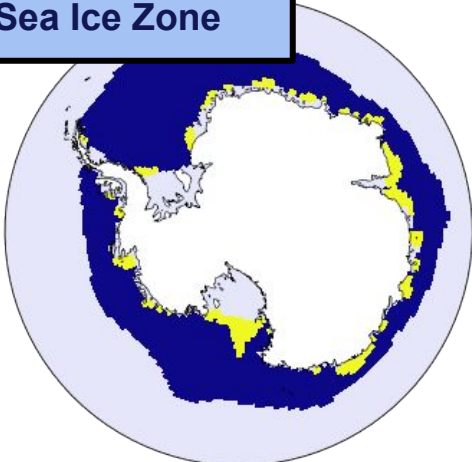


Kristen Krumhardt,
NCAR

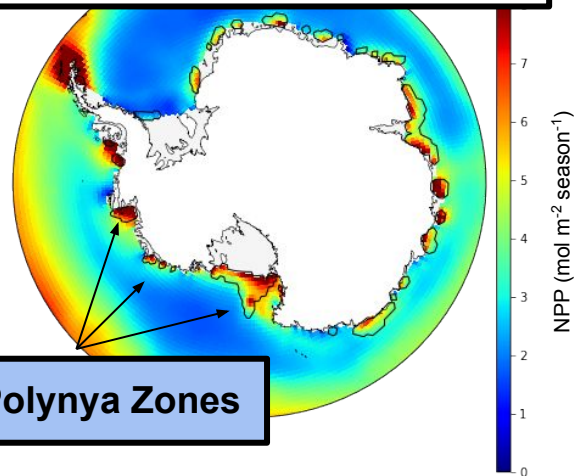


Alice DuVivier,
NCAR

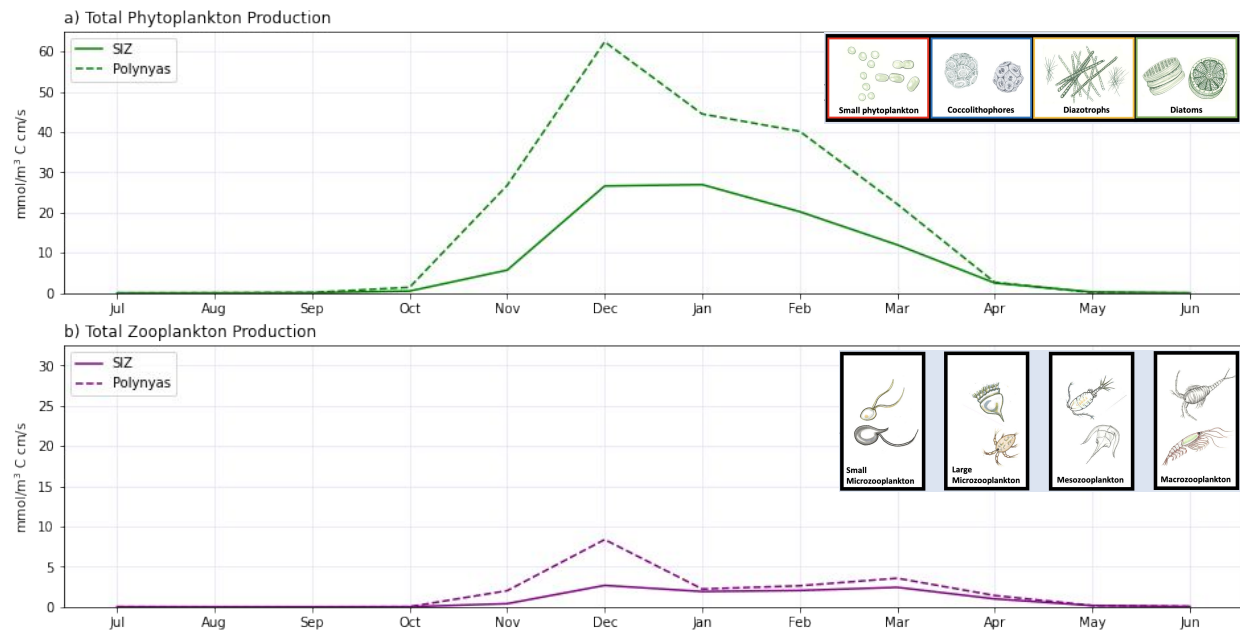
Polynya Zone
Sea Ice Zone



CESM simulated Annual Net Primary Production (NPP)



Polynya Zones



Emperor penguin population dynamics

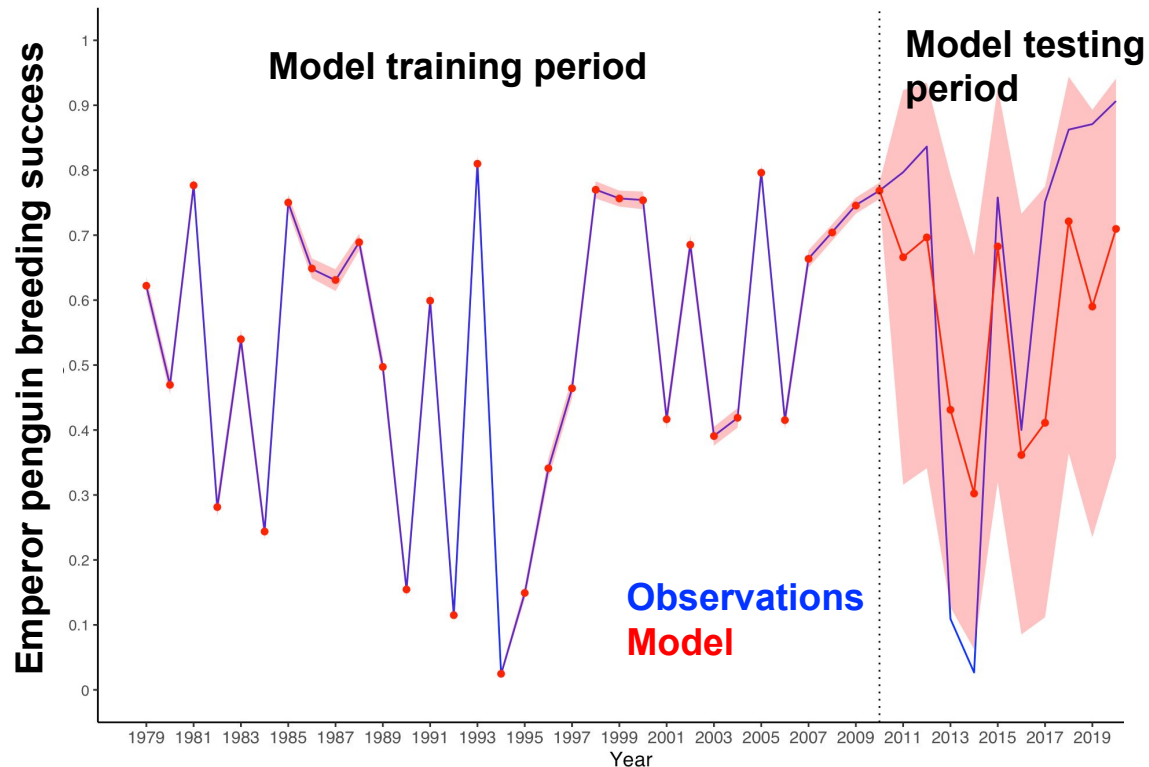
Done: Using satellite data, found that incorporating distance from penguin colony to open water improves model of breeding success.



NASA WORLDVIEW
4 Layers



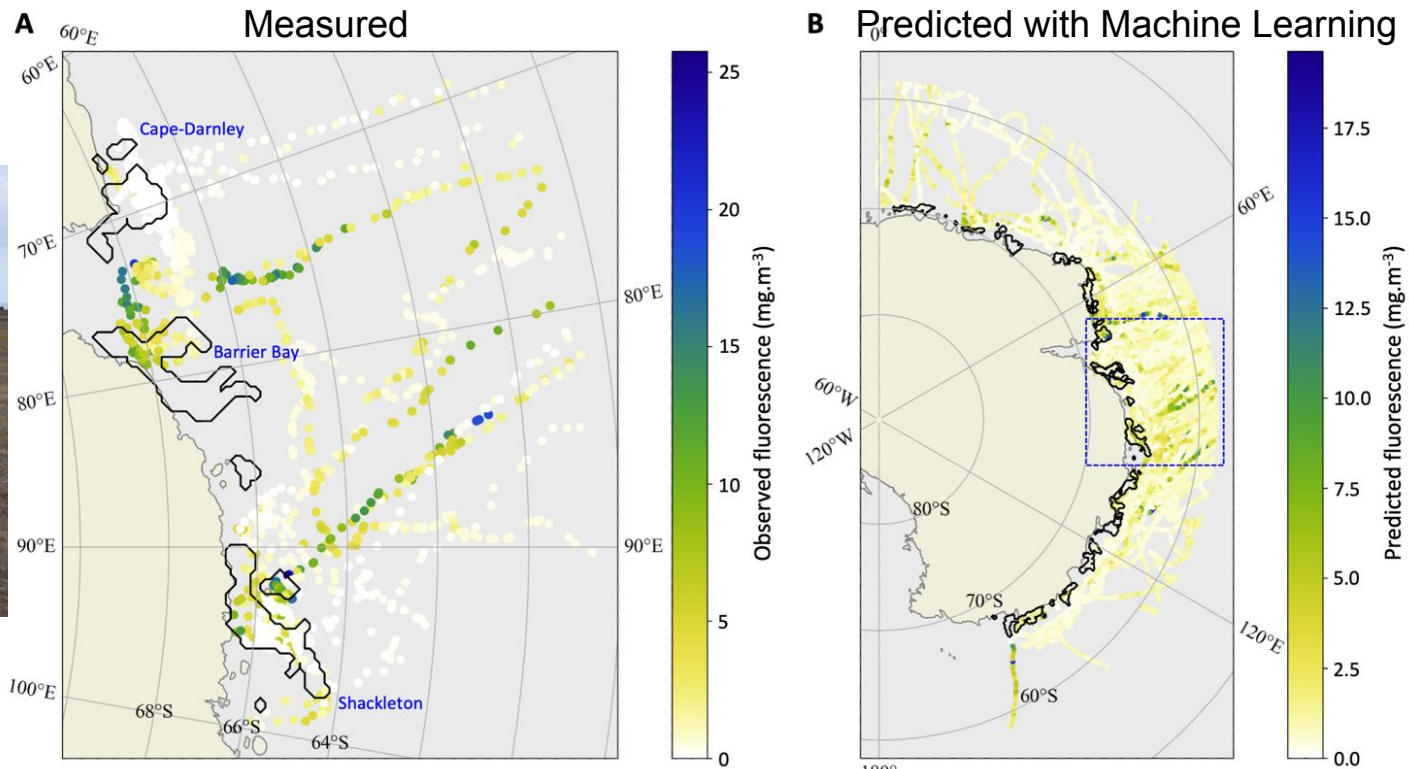
Figures: Francesco Ventura



Now: using Earth system model data, including distance to open water, to make projections of penguin populations

Predator habitat use and projections

Done: Used Southern Elephant Seal Tags to measure and predict chlorophyll, including in polynyas



Sara Labrousse

Now: using tag data to understand habitat usage and assess polynya residence times.