MOSAiC - A cross-disciplinary Arctic research expedition

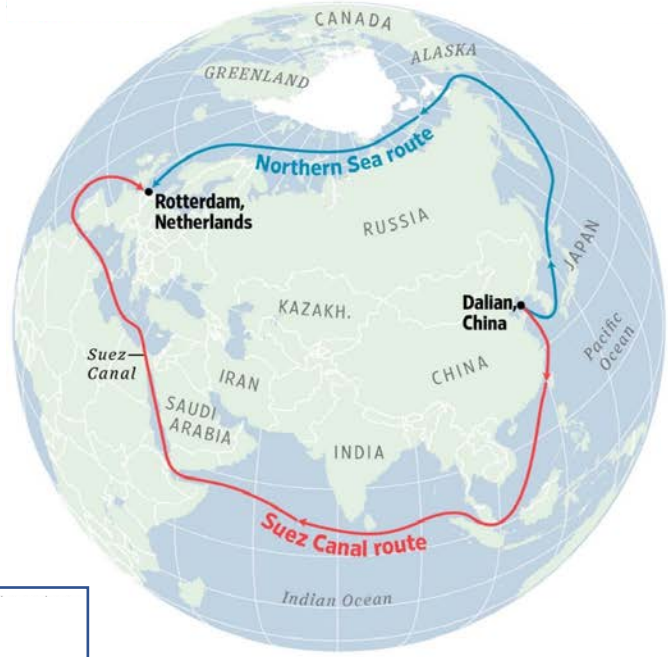
MOSAiC
Multidisciplinary drifting **O**bservatory
for the **S**tudy of **A**rct**i**c **C**limate

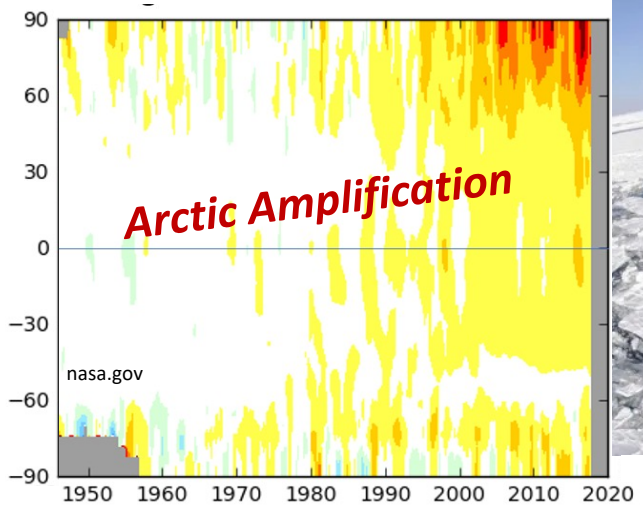
Photo: Markus Rex

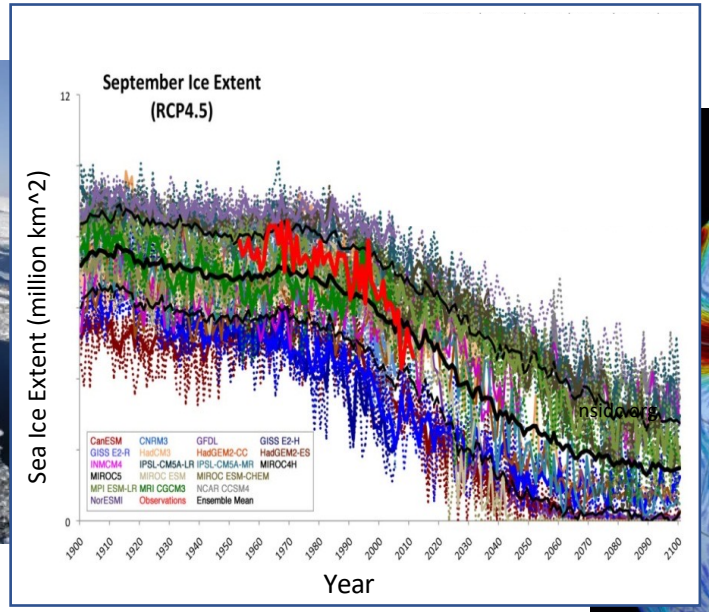
Matthew Shupe
CIRES - University of Colorado
NOAA - Physical Sciences Laboratory
CLIVAR Summit, 1 August 2023

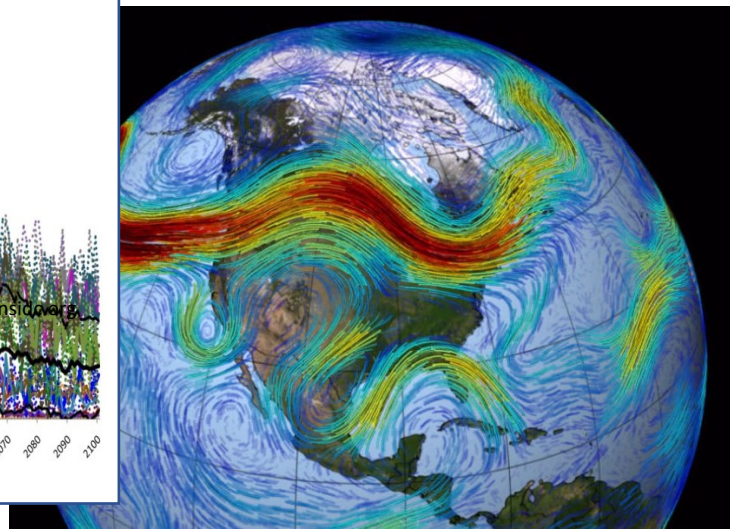
Why Cross-Disciplinary in the Arctic?

- Rapid Arctic change is a cross-disciplinary problem (sea-ice decline, amplification, ecosystems, land surface)
- Models often lack cross-disciplinary capabilities
- Emerging operational/management needs are cross-disciplinary (physical, chemical, economic, ecosystem, geopolitical, social)
- Dearth of cross-disciplinary observations

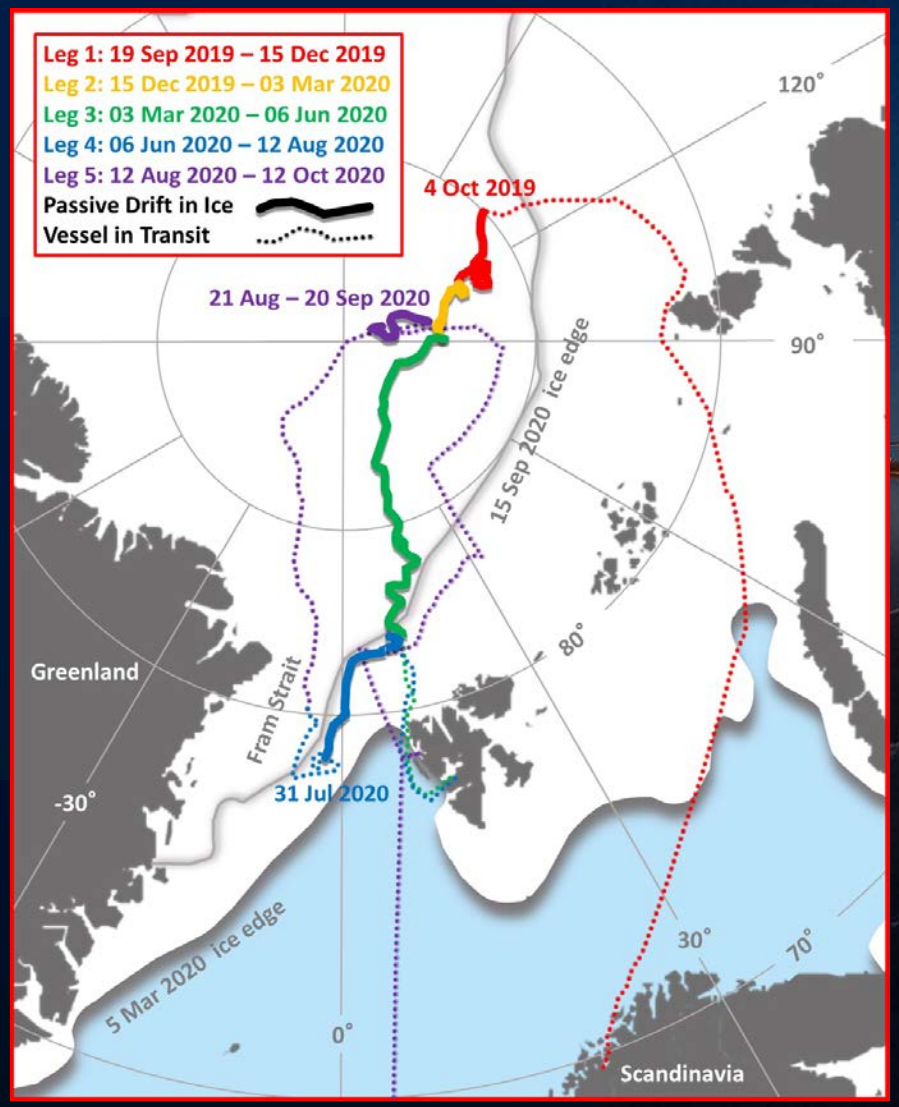








What is MOSAiC?



The Expedition: Sept 2019 – Oct 2020

- *20 Nations, 7 Ships, 400 Field people, 80 Institutions, $170M*
- *Polarstern & Central Observatory within 2 km*
- *Distributed network out to 200 km, plus satellite observations*
- *Periodic resupply, mostly by Russia*
- *Followed Transpolar Drift (“Nansen”)*
- *Most data is publicly available: PANGAEA, DOE ARM, Arctic Data Center & others*

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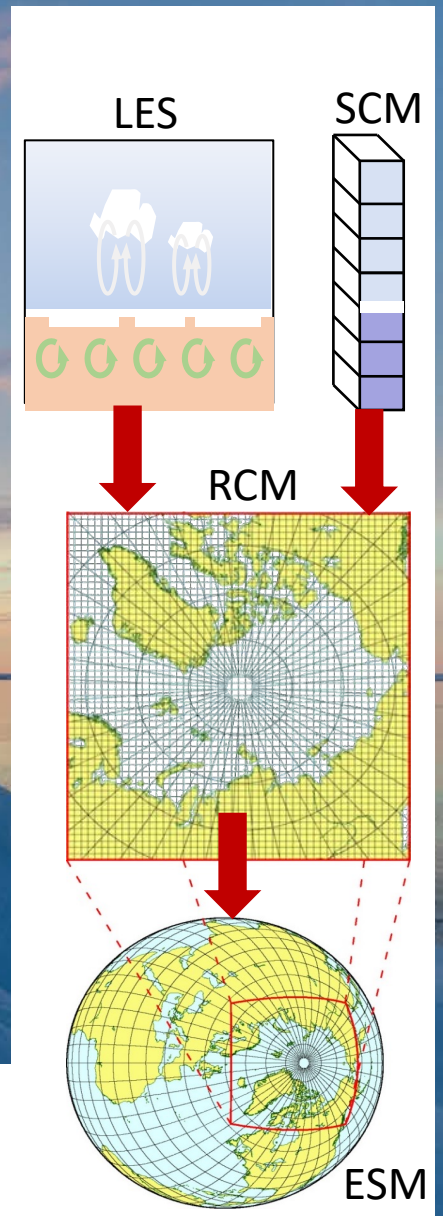
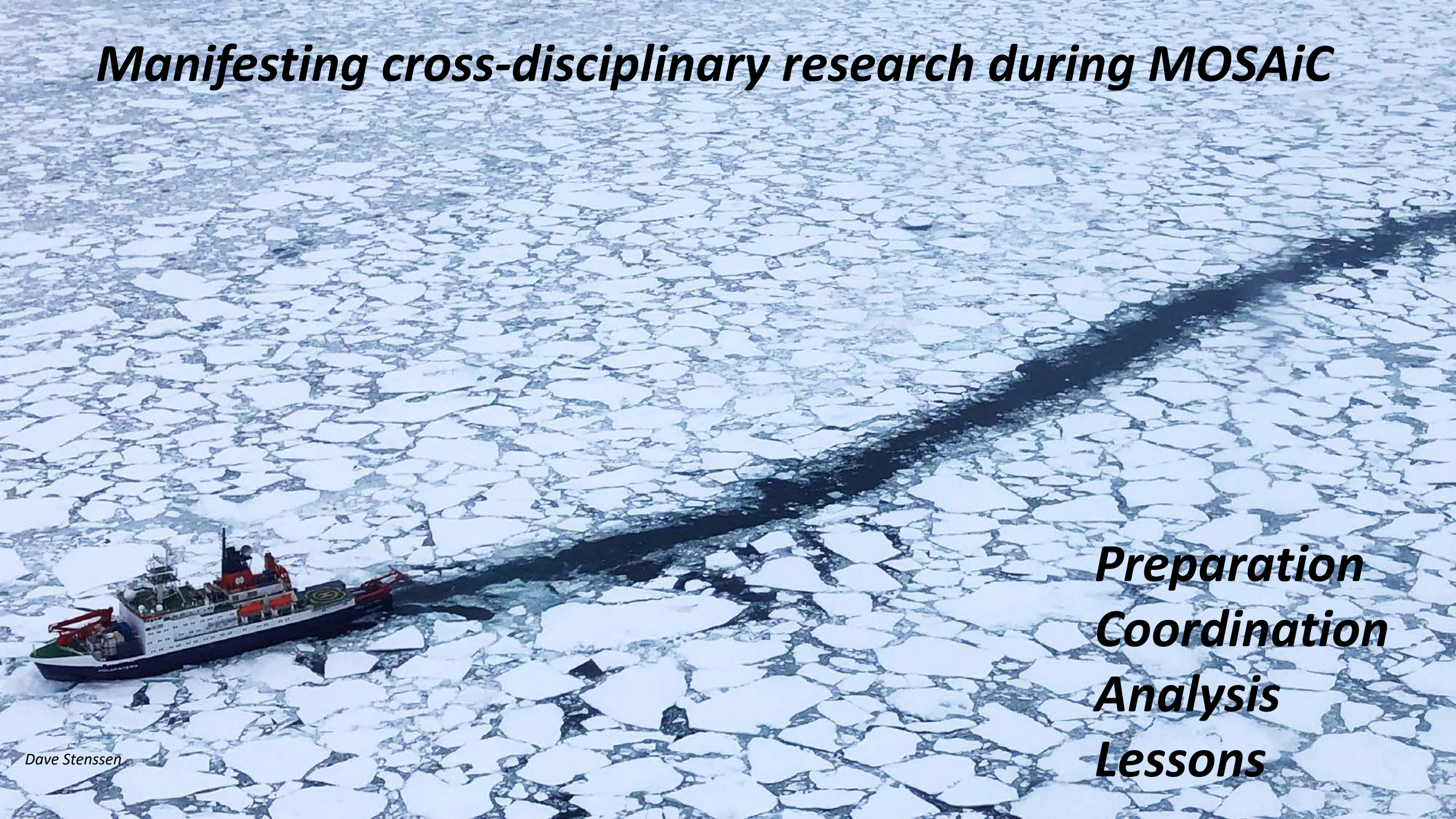
Broad Science Question

What are the causes and consequences of an evolving and diminished Arctic sea ice cover?



Goal: Improve Models for weather, climate, sea-ice, ecosystems
Focus on “processes” and “coupling”

Manifesting cross-disciplinary research during MOSAiC



Dave Stenssen

Preparation
Coordination
Analysis
Lessons

Preparation: Define cross-disciplinary science questions

- **What are the seasonally-varying energy sources, mixing processes, and interfacial fluxes that affect the heat and momentum budgets of the Arctic atmosphere, ocean and sea ice?**
- **How does sea ice formation, drift, deformation and melting couple to atmospheric, oceanic & ecosystem processes?**
- **What are the processes that regulate the formation, properties, precipitation & lifetime of Arctic clouds & their interactions with aerosols, boundary layer structure & atmospheric fluxes?**
- **How do interfacial exchange rates of biogeochemical process- related trace gases trigger the Arctic climate system?**
- **How do sea ice and pelagic ecosystems respond to changes in Arctic sea ice?**
- **How do ongoing changes in the Arctic climate system impact large-scale heat, momentum & mass fluxes & how do these changes feed back into the Arctic climate and ecosystem?**

These are then a metric for participation

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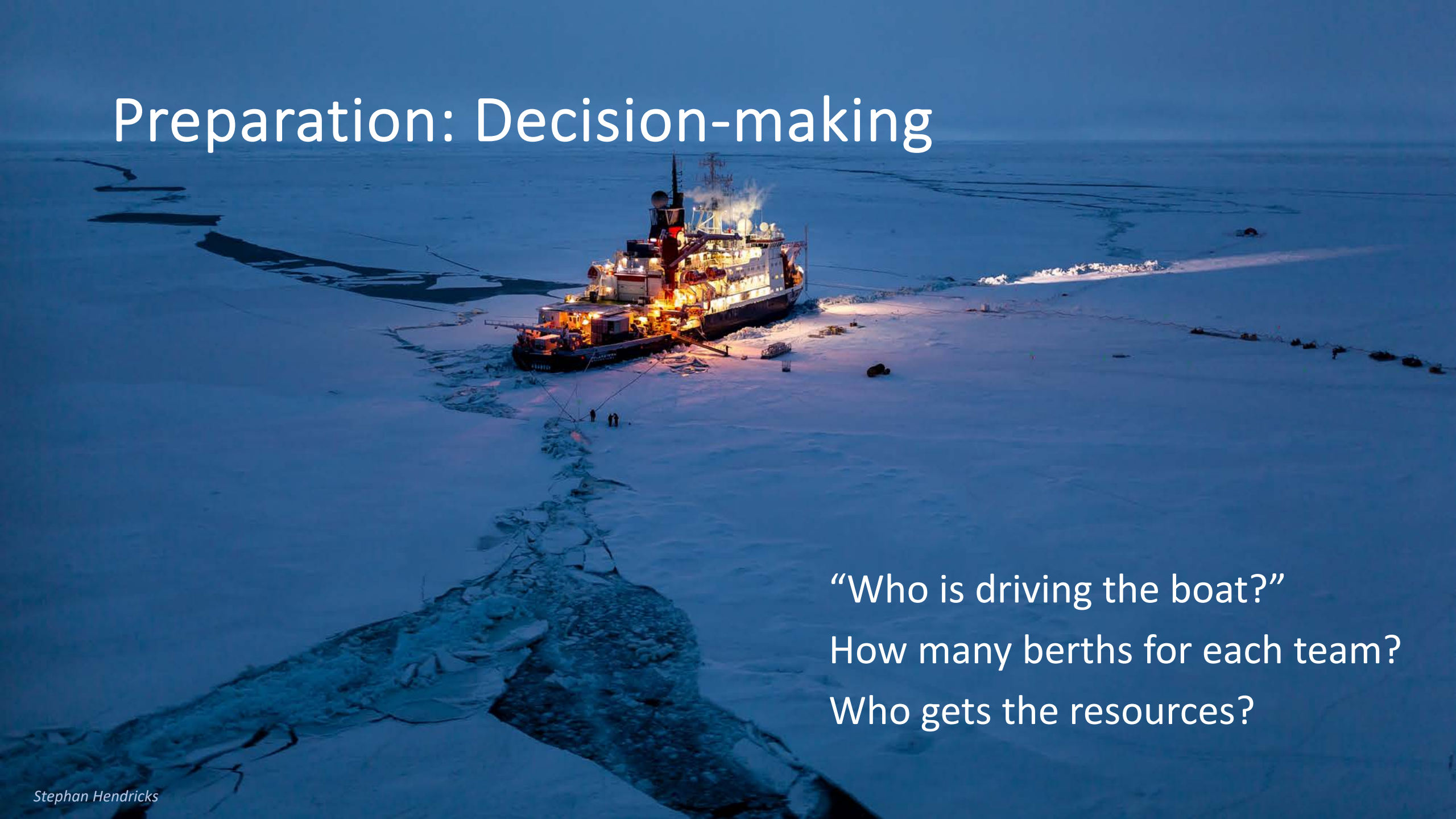
Preparation: How to define teams?

Sebastian Grote

Preparation: Decision-making



"Who is driving the boat?"

How many berths for each team?

Who gets the resources?

Stephan Hendricks

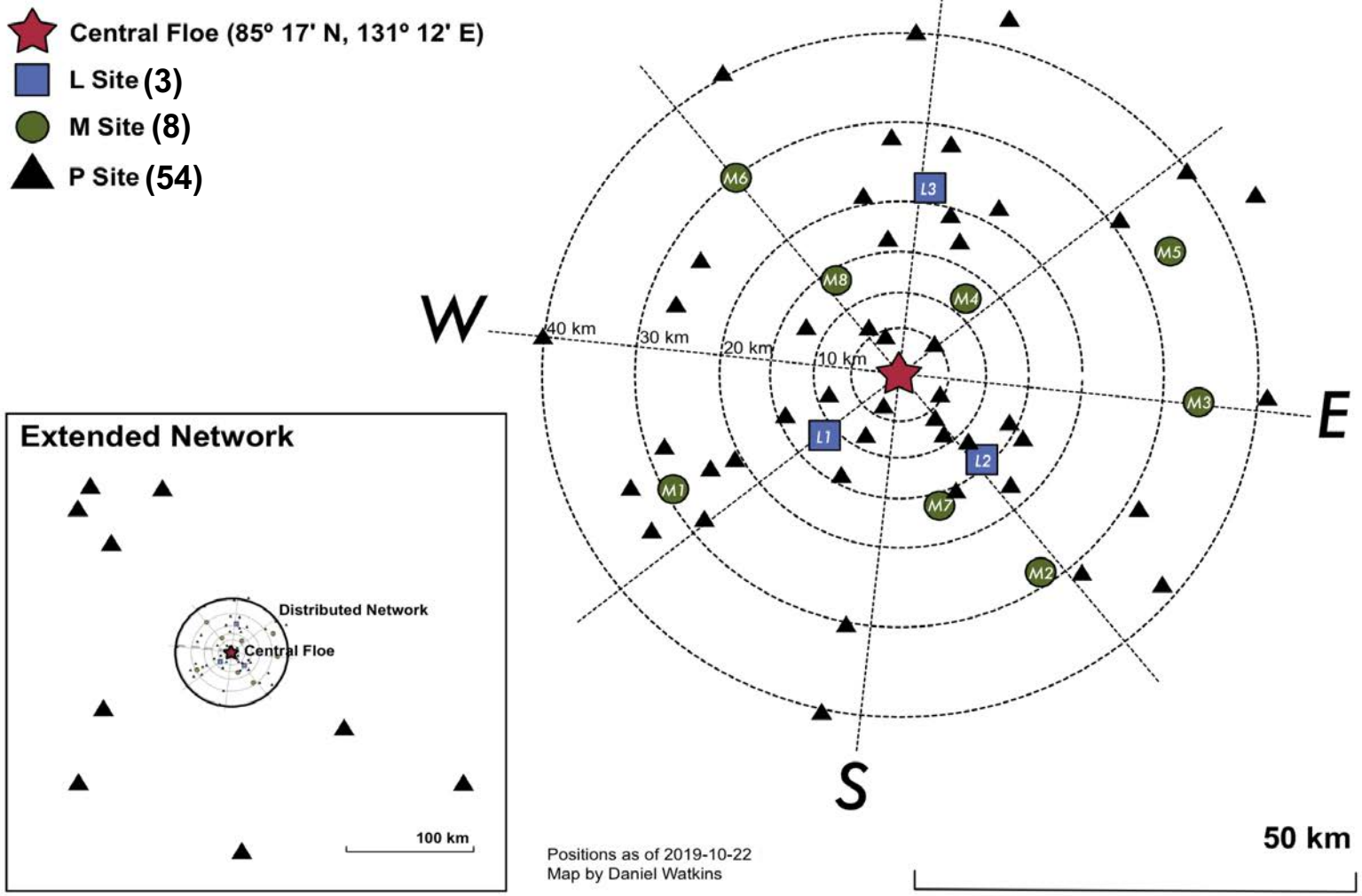
Coordination: Decision-making

LEG 4 Leadership Team

Cross-disciplinary leadership always. Establish shared vision. Resolve conflicts positively.

Coordination: Cross-disciplinary design

Distributed Network



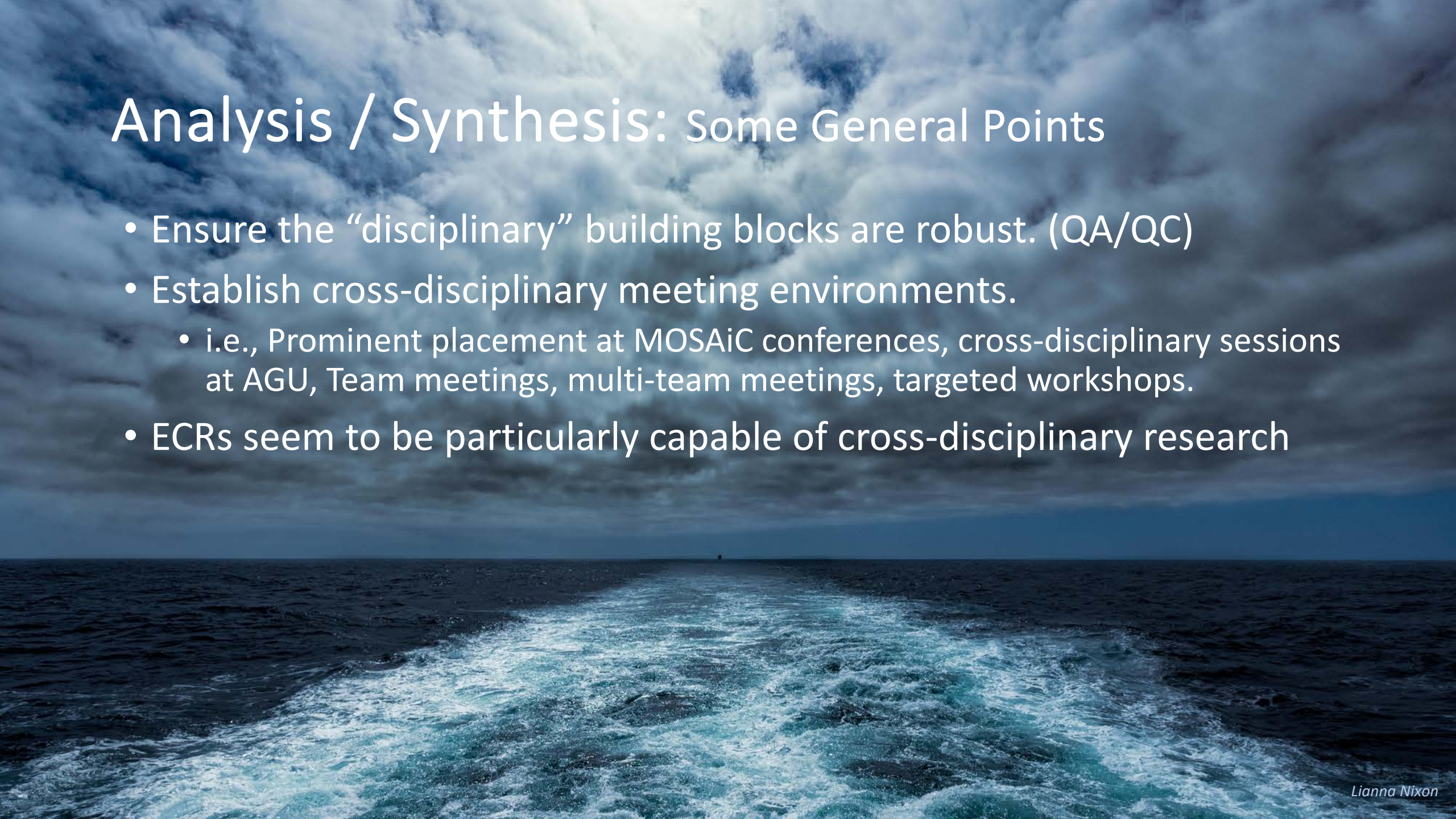
Balancing the Scales of Variability Across Media (ice, ocean, atmosphere)

Coordination: Establish cross-disc. observation teams

Coordination: Establish cross-disc. observation activities

Analysis / Synthesis: Some General Points

- Ensure the “disciplinary” building blocks are robust. (QA/QC)
- Establish cross-disciplinary meeting environments.
  - i.e., Prominent placement at MOSAiC conferences, cross-disciplinary sessions at AGU, Team meetings, multi-team meetings, targeted workshops.
- ECRs seem to be particularly capable of cross-disciplinary research



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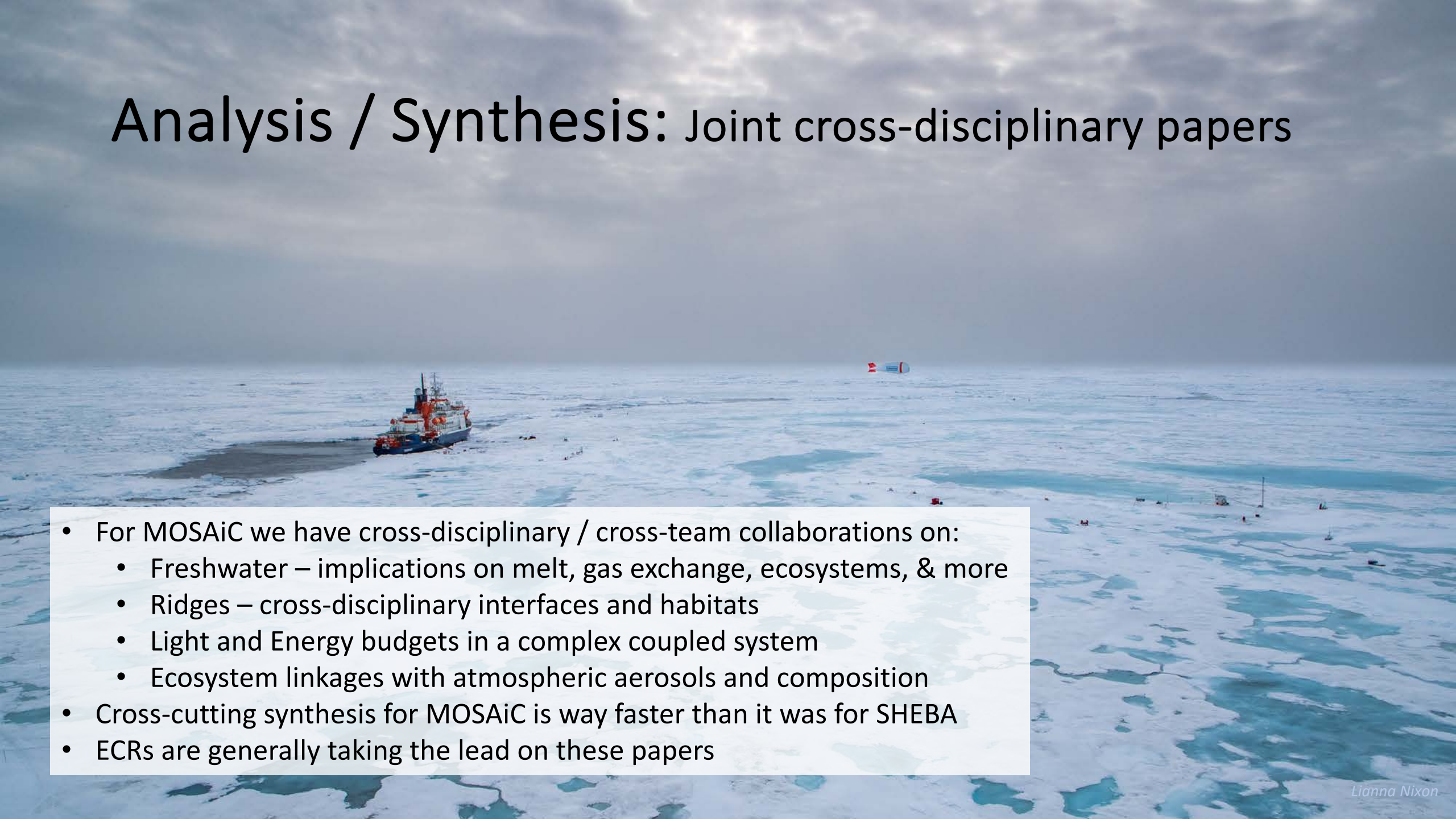
Analysis / Synthesis: Joint cross-disciplinary papers



- For MOSAiC we have cross-disciplinary / cross-team collaborations on:
  - Freshwater – implications on melt, gas exchange, ecosystems, & more
  - Ridges – cross-disciplinary interfaces and habitats
  - Light and Energy budgets in a complex coupled system
  - Ecosystem linkages with atmospheric aerosols and composition
- Cross-cutting synthesis for MOSAiC is way faster than it was for SHEBA
- ECRs are generally taking the lead on these papers

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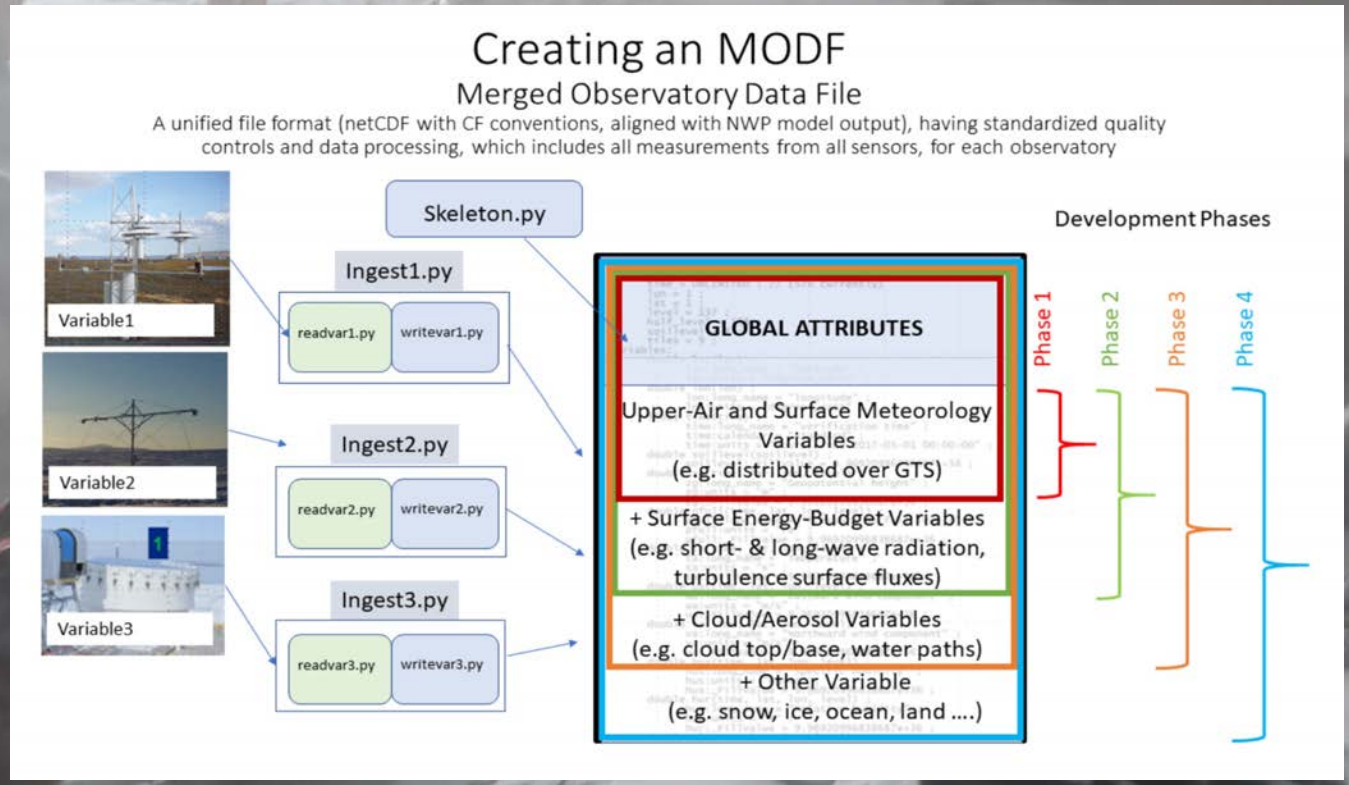
Analysis / Synthesis: Joint data products

- Merged Observatory Data Files (Obs data packaged for modelers)
- Model forcing data sets
- We are currently integrating ATMOS-ICE-OCEAN, and considering how to expand further
- Can be implemented by ECRs



Enabling Model Assessment with Observations

Lessons Learned

- Establish ground rules & expectations BEFORE people are funded
- Open / Shared data policy is essential

Lessons Learned

- Modelers can be a good cross-disciplinary link
- Think beyond science (economics, communities, fisheries, etc.)

Lessons Learned

- Need advocates for all parts AND the whole
- Establish collaborative work plans

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Lessons Learned

- Cross-disciplinary research is hard!
- Some reversion to disciplinary focus
- Must fight urge to isolate scientifically

Esther Horvath

Lessons Learned

Engage Early Career Researchers in all Aspects
Leadership, Design, Fieldwork, Analysis

Fresh new perspectives!

Lianna Nixon


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