Sea ice melting – impacts on physics, biogeochemistry, ecosystems

Annual cycle of productivity – over what scale

Going from climate to humans – Physical to BGC to Ecosystems to Human AND feedback – end to end integration – with observations, models, -- leading to case study on specific systems, as well as climate and impacts on transport.

Connectivity – national approaches are addressing individual processes. Connectivity requires the larger collaboration. Gateways in the physical system, and/or connectivity in the ecosystems .. Biogeography – makes the questions more tractable.

Strategy. Sustainable delivery of ecosystem and climatic regulation services in the changing coupled NA/Arctic system. Covers productivity -> food webs -> distribution patterns. Humans at the start may sell better in the EU. US would like to see this ? How to get buy-in from agencies as the starting point. Do we include the biological carbon pump as an ecosystem? Yes. Solubility pump is also an “oceanic” service in this region. Interaction of food to carbon pumps.

To date, general conclusion is that fishing is not altering nutrient cycles in a manner that is biogeochemically significant globally. But locally, might be of importance. Changing of this harvest could raise to the level. More addressing of nutrients so far, not so much on carbon. Restructuring of the ecosystem may have downstream impacts – no question that food web alterations have impacted ecosystems

Bottom up vs Top-Down. Global BGC models not addressing both. Could these be jointly addressed in a coupled, mechanistic manner?

Size-spectrum models as a tool

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Sustainable delivery of ecosystem and climatic regulation services in the changing coupled NA/Arctic system.

Paragraph on these topics: Brings in physics, connectivity, gateways, boundaries; hot and cold spots (high and low change); local and remote; shelves, ice zone; ecologically and biogeochemically relevant; need to understand mean state vs. change.

Southern Ocean has shown – importance of comparative studies in different regions. International coordination required to allow for cross-basin synthesis. And to identify regions where we do not have adequate information. What are the criteria to make these choices? Have to set it up from beginning.

Theme areas

* Total productivity – primary production all the way down
	+ Primary productivity
	+ Metabolic rates
	+ Fishery pressure
	+ Deoxygenation (e.g. compare Siberian shelf to N. Africa)
	+ OA
* Carbon sequestration
	+ Biological pump
	+ Solubility pump
* Large scale circulation
	+ Surface to deep ocean connectivity
	+ N. Atlantic / Arctic
	+ Ocean-shelf coupling
* Sea ice
* Freshwater

Functions / Processes

Criteria to choose regions

* Where is sea ice changing the most? How are food webs responding?
* Are the physical criteria? Cross-shelf transport driven by upwelling, riverine influence,
* Where SST has the largest positive trend?
* Latitudinal range / impact on seasonality
* “OA Highways” Amap website. Arctic change and Acidification. Response of ecosystems and socio-economic based on ESMs. Approach also being applied in S. Ocean.

Requirements

* Essential ocean variables (EOVs) need to be identified (OA group ongoing, different levels; Biology and Biogeochemistry and Physics groups also)
* Add unique ones and will need to add EOV lists with regional-specific additions. e.g. 18dO
* JGOFS approach, but add much more ecological information – e.g. FlowCAM, genetics…
* Sampling scales will vary
* Nested structure to include Array of autonomous platforms – reduced number of variables can be measured in comparison to process studies. A capacity that did not exist with JGOFS. Integrate efforts on both sides of the Atlantic. “Capacity Building”

What is core observational system? Via augmentation vs. new?

Existing

* OSNAP, RAPID – physical right now. Could augment instrumentation. But designed to capture physical features optimally. Are they the appropriate backbone for biogeochemistry and ecosystems? What questions could be addressed by this – carbon sequestration, perhaps; spring bloom, perhaps not?
* FixO3 – open ocean observatories. Funds available for international access.
* Jericho
* Davis strait and Fram strait and Baffin Bay arrays – hydrography that happens already and could be augmented
* OOI
* VITALS

What observations are needed?

* Remineralization length scales – tractable but need to be carried out in a wide variety of regions across contrasting environments. Direct connection to carbon sequestration / BCP. Need to also know the mechanisms that control this so can drive process models.
	+ Marginal ice zone
	+ Open water of subpolar gyre / spring bloom
	+ Latitudinal variation – stratify by Arctic and sub-Arctic
	+ Shelf
* Build selectively upon the existing arrays to develop the distribution needed.
* High temporal resolution (millennial timescales) data for paleo
* Fisheries and biodiversity data – what is observed, what data is available? Link to this field more closely. There is monitoring that occurs, esp in sub-Arctic. CPR data. Maps of benthic biodiversity.
* CONNECT TO OTHER GROUPS
	+ with fisheries expertise especially - Need to link to ICES organization. IMBER program – ESSAS (on sub-Arctic seas). IOC meeting in Nov (Barcelona).
	+ US Arctic interagency group.

Which Observations are needed for models?

* To constrain parameterizations of processes
* Distributed observations to get more space
* Additional constraints on rate variables and state variables
* Data assimilation
	+ Typically for physics with ARGO, SSH, etc.
	+ Parameter estimation approaches

What are models needed?

* ESMs
* Regional models
* Different complexity - trophic levels, socio-economic
* Needed – end to end ecosystem modeling system – all trophic level and socio-economic – coupled vs. one to the other. What are the key variables that need to be passed? Physically nested vs. passing down. Need ensemble approach with different approaches. Intercomparison. Different groups focus in nationally important regions.
* Organized regional modeling comparisons for Arctic (ongoing FAMOUS). This is needed for North Atlantic.
* Comparative approach that can be integrated into a larger whole.
* Paleo proxies are needed in the models. Oxygen and carbon isotopes – something that is being worked on. Need to add Pa, Th. Geotraces information may help constrain the needed processes, fractionation factors.