Workshop Facilitation

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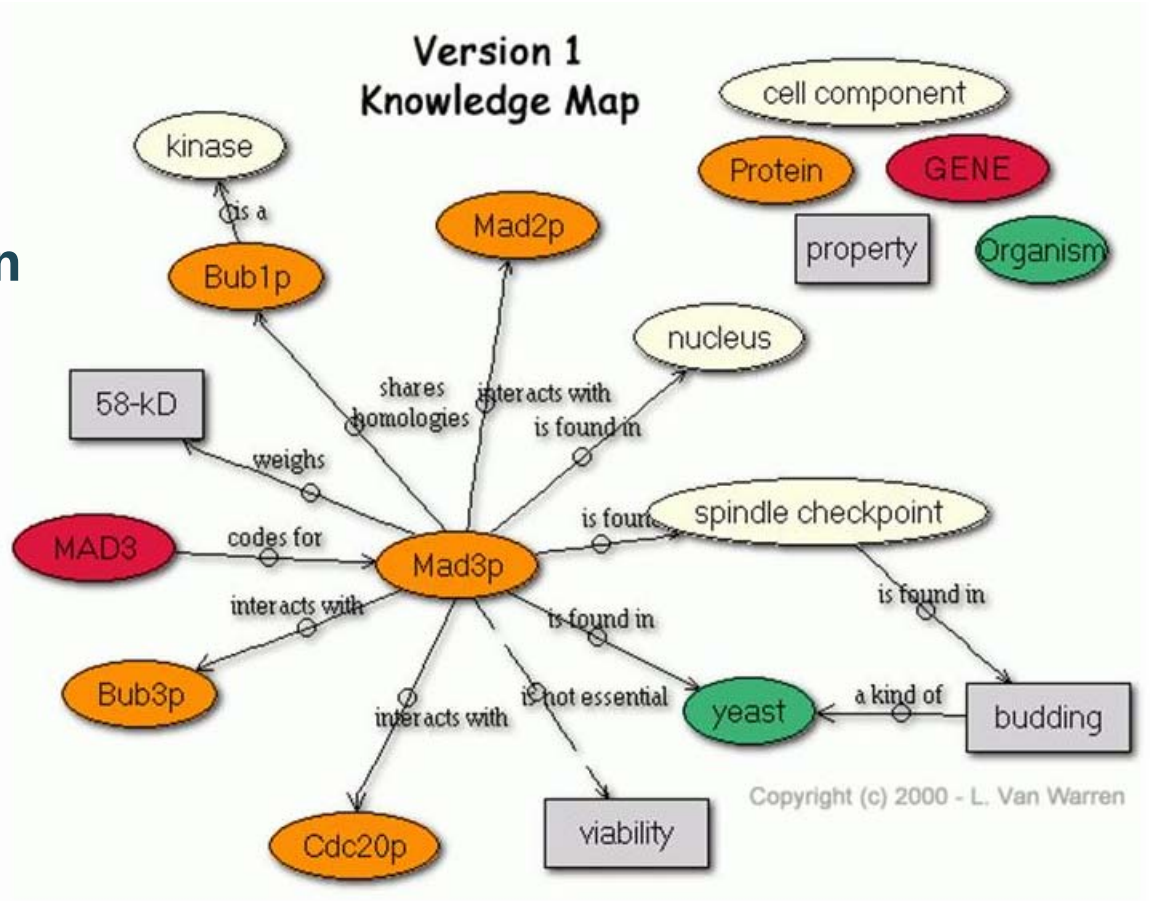
Overarching Workshop Goal

- **To develop a consensus diagram identifying critical modeling interactions and data needs that will lead to improved decision-making in response to oil spills**

Nature of the Diagram: A Knowledge/Influence Map

Incorporate toxicological endpoints, natural resource protection needs and physical modeling



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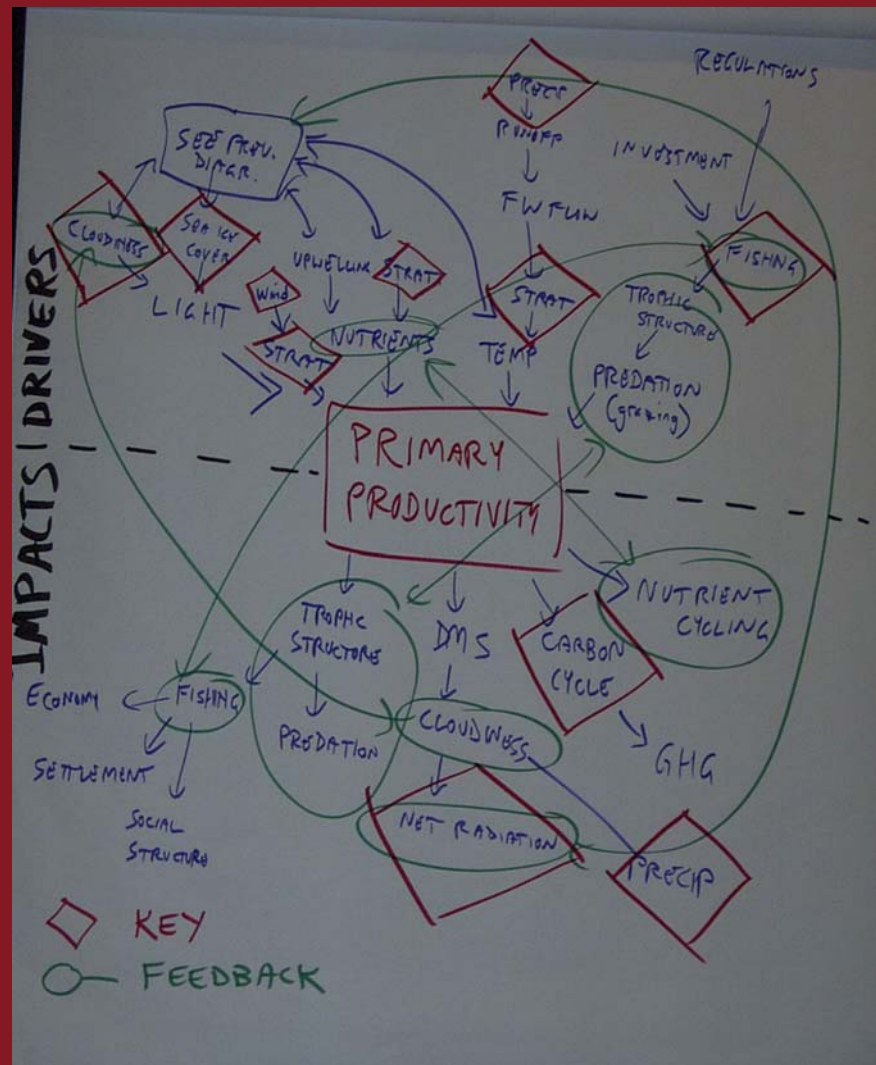
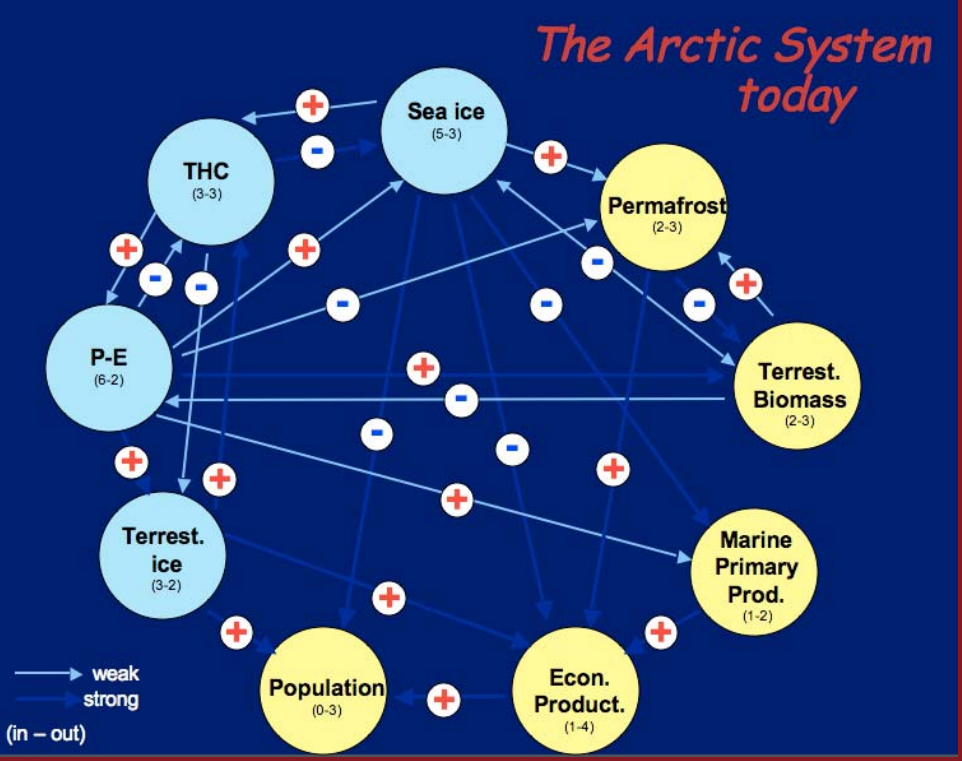
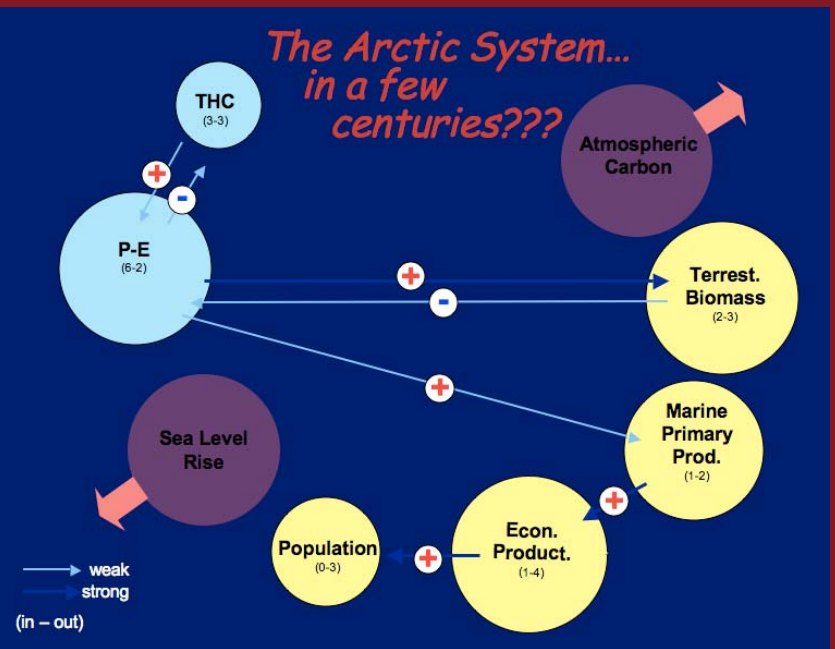
The 2003-04 ARCSS Arctic System Synthesis

- How does the Arctic work?
- >30 individuals from numerous sub-disciplines







Many "AHA!" moments….capped by a high impact publication

Eos, Vol. 86, No. 34, 23 August 2005

EOS

EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

VOLUME 86 NUMBER 34
23 AUGUST 2005
PAGES 309–316

Arctic System on Trajectory to New, Seasonally Ice-Free State

PAGES 309, 312–313

The Arctic system is moving toward a new state that falls outside the envelope of glacial-interglacial fluctuations that prevailed during recent Earth history. This future Arctic is likely to have dramatically less permanent ice than exists at present. At the present rate of change, a summer ice-free Arctic Ocean within a century is a real possibility, a state not witnessed for at least a million years. The change appears to be driven largely by feedback-enhanced global climate warming, and there seem to be few if any processes or feedbacks within the Arctic system that are capable of altering the trajectory toward this "super interglacial" state.

The Changing Arctic

For nearly 30 years, Arctic sea ice extent [e.g., *Stroeve et al.*, 2005] and thickness [*Rothrock et al.*, 2003] have been falling dramatically (Figure 1). Permafrost temperatures are rising and coverage is decreasing [*Osterkamp and Romanovsky*, 1999]. Mountain glaciers and the Greenland ice sheet are shrinking [*Meier et al.*, 2003; *Box et al.*, 2004]. Evidence suggests we are witnessing the early stage of an anthropogenically induced global warming superimposed on natural cycles [*Intergovernmental Panel on Climate Change*, 2001], reinforced by reductions in Arctic ice.

Despite 30 years of warming and ice loss, the Arctic cryosphere is still within the envelope of glacial-interglacial cycles that have characterized the past 800,000 years. However, although the Arctic is still not as warm as it was during the Eemian interglacial 125,000 years ago [e.g., *Andersen et al.*, 2004], the present rate of sea ice loss will likely push the system out of this natural envelope within a century. Climate models corroborate this projection with depictions of sea-ice-free summers within the same time frame [*Arctic Climate Impact Assessment*, 2005]. There is no paleoclimatic evidence for a seasonally ice free Arctic during the last 800 millennia.

By J. T. Overpeck, M. Sturm, J. A. Francis, D. K. Perovich, M. C. Serreze, R. Benner, E. C. Carmack, F. S. Chapin III, S. C. Gerlach, L. C. Hamilton, L. D. Hinzman, M. Holland, H. P. Huntington, J. R. Key, A. H. Lloyd, G. M. MacDonald, J. McFadden, D. Noone, T. D. Prowse, P. Schlosser, and C. Vörösmarty

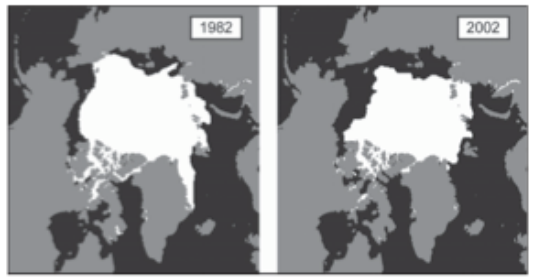


Fig. 1. Sea ice extent (white) at the end of summer in 1982 and 2002 observed with passive microwave satellite sensors. The record minimum extent was observed in 2002, but that record was nearly equaled in 2003 and 2004.

A major deglaciation of Greenland would take many centuries at present rates [*Intergovernmental Panel on Climate Change*, 2001], but destabilizing mechanisms such as basal sliding could accelerate the pace [*Zwally et al.*, 2002]. The third perennial ice type—permafrost—is difficult to observe, and thus little is known about its past state. Recent surveys indicate, however, that it too is warming and thawing in some areas [*Arctic Climate Impact Assessment*, 2005].

A System View of the Arctic

In a recent synthesis by the authors, it was found that the fundamental Arctic system could be understood by links among nine key components, or hubs. Three are related to the permanent ice types, and two others involve net precipitation (precipitation minus evaporation, or P-E) and the thermohaline circulation (THC). Putative changes in the interactions among these five hubs reveal how radically the future Arctic might be altered. The remaining four hubs capture the living parts of the system: terrestrial biomass, marine primary productivity, economic productivity, and human population.

Interactions among all hubs are shown schematically in Figure 2a. P-E is the fundamental driver of Arctic hydrology, but also affects the surface energy budget. Snow depth largely governs river runoff and also influences surface reflectivity, sea ice melt, and atmosphere/ocean coupling. The THC, long recognized as a primary driver of Arctic and North Atlantic temperatures, has strong ties with atmospheric circulation, P-E, and the cryosphere as a whole. The THC is also driven by changes in P-E either directly (weakened by freshening the North Atlantic) or indirectly (through the export of freshwater to the North Atlantic as sea ice and low-salinity water [*Curry and Mauritzen*, 2005]).

Interactions between hubs can be unidirectional or bidirectional (single or double arrowheads), strong or weak (arrow thickness), and positive or negative. In a positive interaction, a change in one component produces a change in another of the same sign. On the basis of whether a hub primarily affects or is affected by other hubs, the components can be classified as either drivers (blue) or recipients (yellow). This classification is important because feedbacks start at driver hubs and must loop back to amplify or dampen the initial change. Feedbacks also operate within each hub; but from an Arctic system perspec-

WORKSHOP OBJECTIVES

NOAA Office of Response & Restoration :

(1) Provide opportunity for NOAA OR&R scientists to interact with scientists from diverse disiplines in government and academic to identify new approaches to integrating oil spill modeling across a wide range of scales and uncertainties

(2) Develop strategies for better integration of transport models w/ ecological endpoints for use in oil spill emergency response

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WORKSHOP OBJECTIVES

Coastal Response Research Center (CRRC):

(1) Provide a learning experience for NOAA staff that increases interactions with scientists from diverse disciplines

(2) Identify technical and research gaps for incorporating data quickly into a new version of a modeling framework

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COASTAL RESPONSE RESEARCH CENTER OUTCOMES

(1) Specific topics for CRRC annual Requests for Proposals (RFPs)

(2) Documentation

-- Minimum: A Workshop Report

(3) Identify targets for followup

-- Facilitate interactions of working groups "post Durham"

-- Support potential peer-reviewed articles that might be identified during the Workshop or any other products (e.g. data bases) or roles (e.g. clearinghouse for info)

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Workshop Organization

- **Organized Around Five Major Themes:**
  - **Predicting Environmental Risk**
  - **Predicting Environmental Effects**
  - **Integrating Physical, Biological and Toxicological Models**
  - **Defining Appropriate Time/Space Scales for Integrated Modeling**
  - **Communicating with Decision-Makers**
- **Mix of Plenary Talks, Break-out Discussion and "Mapping Exercise", Informal Dialogue, Reports Back to the Group at Large, Plenary Discussion**

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Workshop Organization

- **At the End of the Workshop We Will:**
  - **Attempt to Reach Consensus on Key Findings**
  - **Revisit Our Stated Goals & Outcomes**
  - **Define a Set of Follow-on Activities and Action Items, Including a Plan for Producing the Required *Workshop Report***
  - **Ask You to Evaluate the Workshop…post-WS and 1 year hence**

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