



# Climate Connectivities: Roles of the Arctic and Subarctic Oceans in Global Change: Views from the IPY

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## Why Arctic Science? - A Narrative Framework

1. Globally, there is an emerging pattern *of increasing new nonlinear coupling in complex adaptive systems.*
2. Complex-coupled climate related shocks *can affect bottom line of relevant sectors/audiences.*
3. *The Arctic is a harbinger* - the complex-coupled climate future is developing there now, with potential *systemic impacts* on things that matter (e.g. energy, water, food)
4. *The Arctic is thus a creative frontier*, test bed for creative responses (resilient) to challenges.
5. Complex systems dynamics require the application of cross-scale thinking and research.



# The IPY & C30



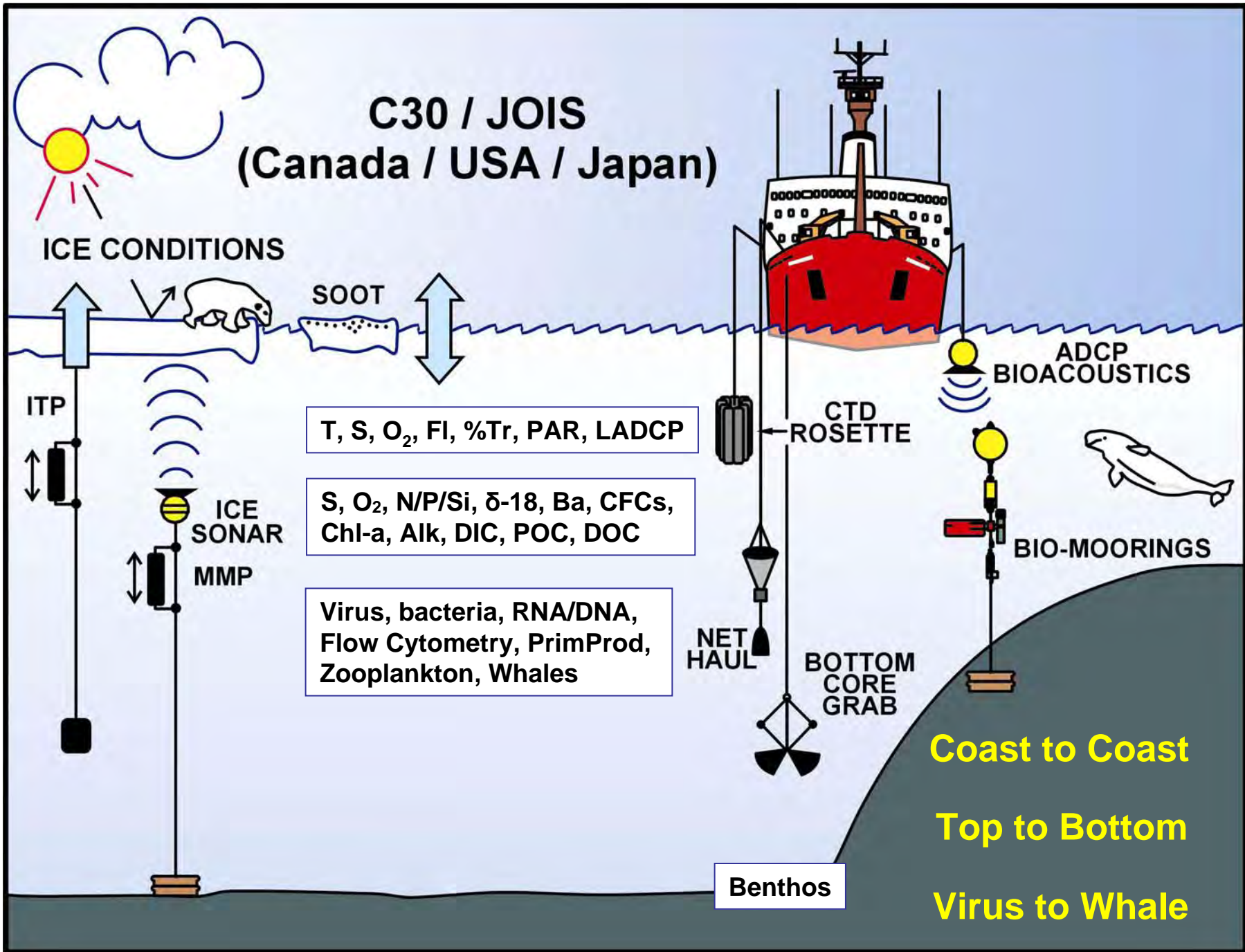


# To Study Connectivity – Connect:

The IPY – Canada's 3 Oceans **C3O** Project &  
the USA/Japan/Canada **JOIS** project



# C30 / JOIS (Canada / USA / Japan)







**Ship Work**

**Mooring Work**



# ICE Work





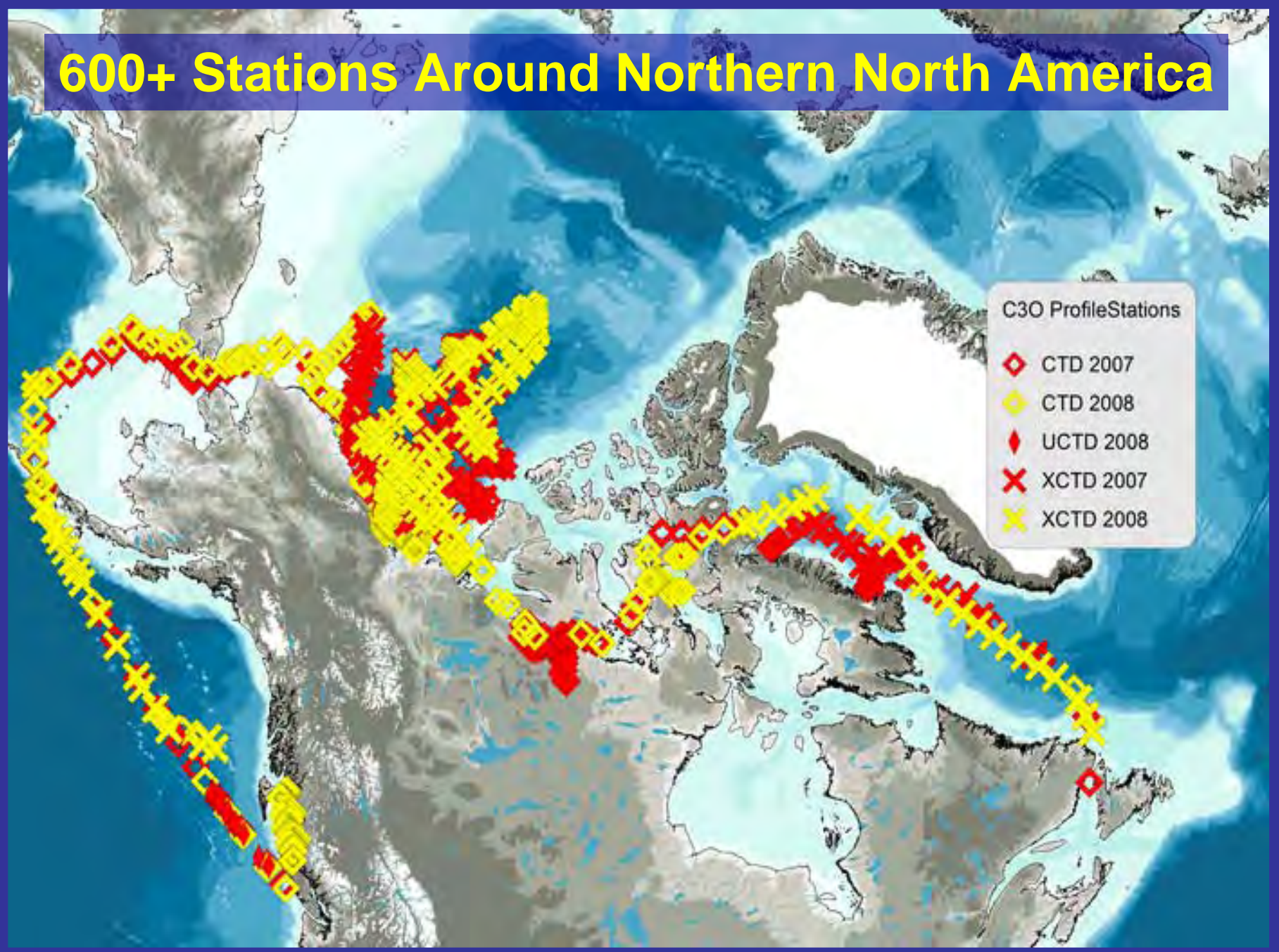
A woman wearing a bright orange jumpsuit and black boots is lying on her back on a wooden deck. She is leaning against a large, grey metal structure, possibly part of a crane or hoist. The deck is made of weathered wooden planks. In the background, there are various pieces of industrial equipment, including a stack of metal buckets and some cables. The scene is brightly lit, suggesting it is daytime.

**Hard Work**

**44 Principal Investigators  
149 Scientists & Technicians**



# 600+ Stations Around Northern North America

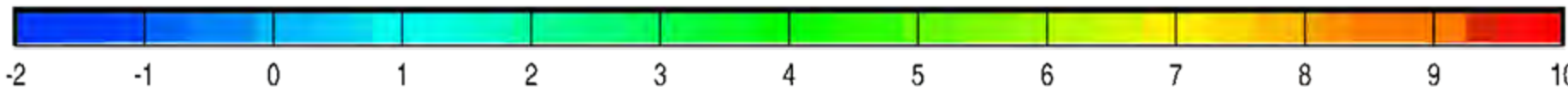
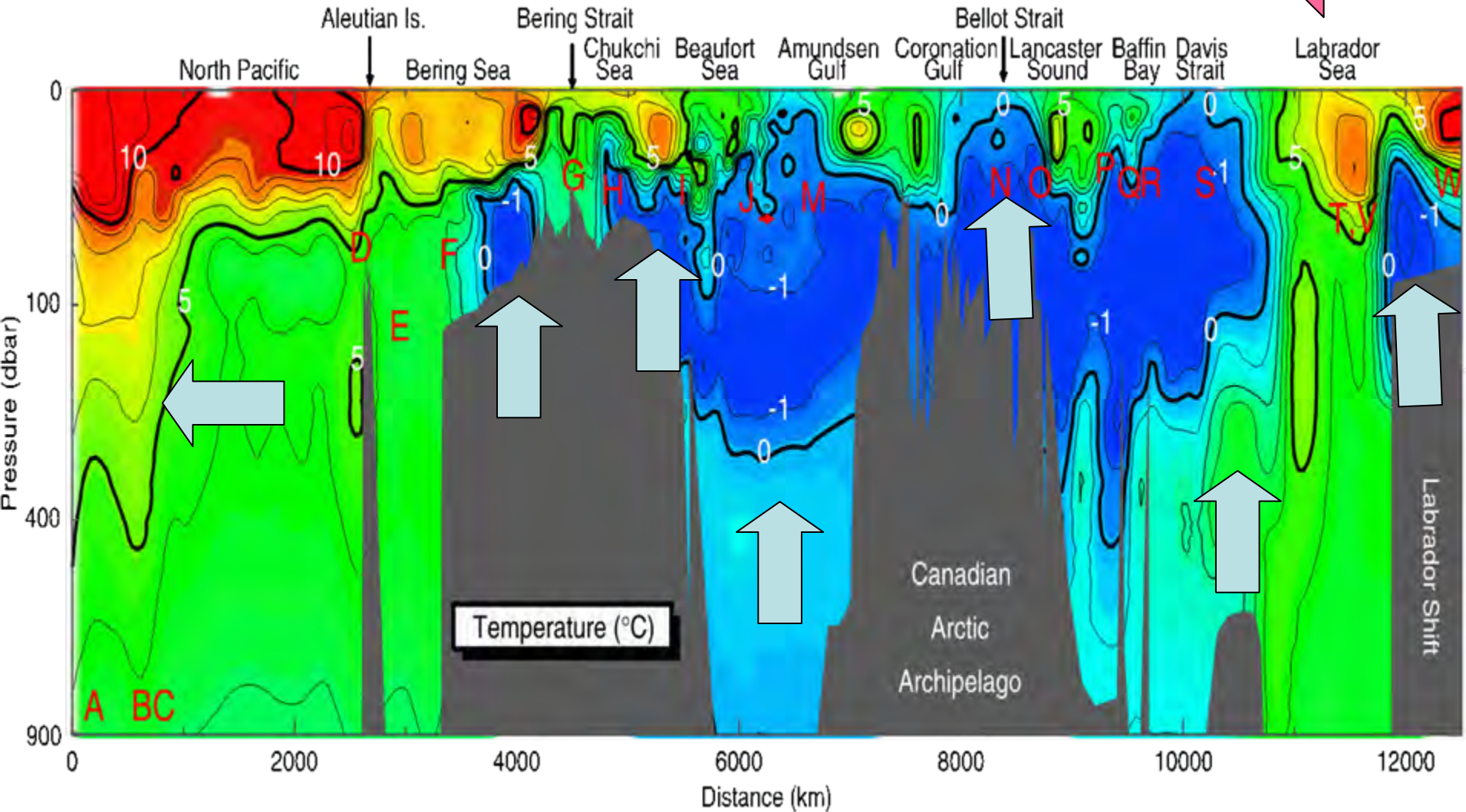
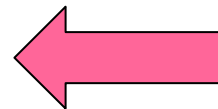




# NORTH PACIFIC

# ARCTIC

# BAFFIN/LABRADOR

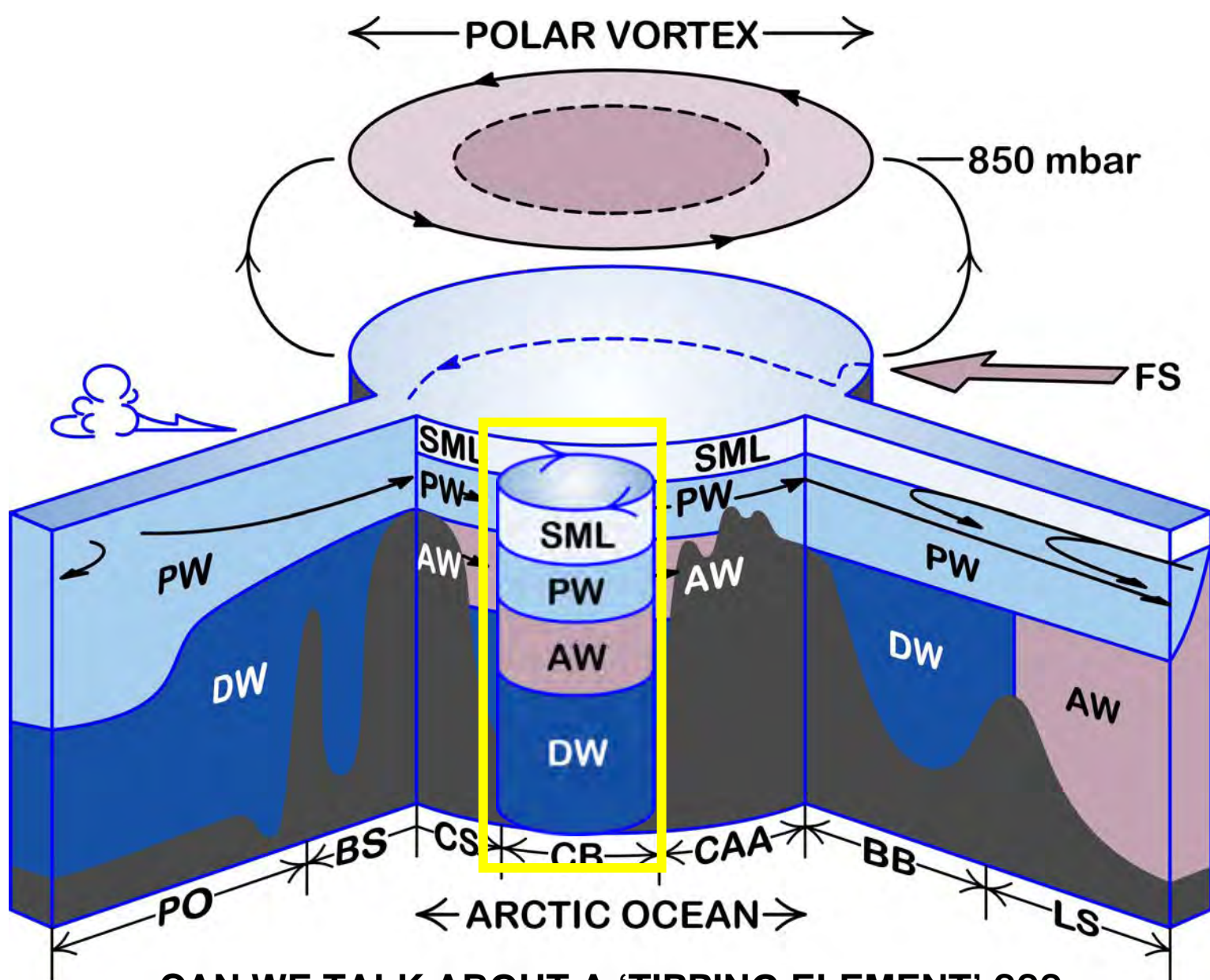




A polar bear is standing on a small, isolated ice floe in a dark, open sea. The bear is illuminated by a spotlight, making it stand out against the dark background. A speech bubble is positioned above the bear, containing the text "Yeah, But So What?".

**Yeah, But  
So What?**

**Photo: B. Van Hardenberg**



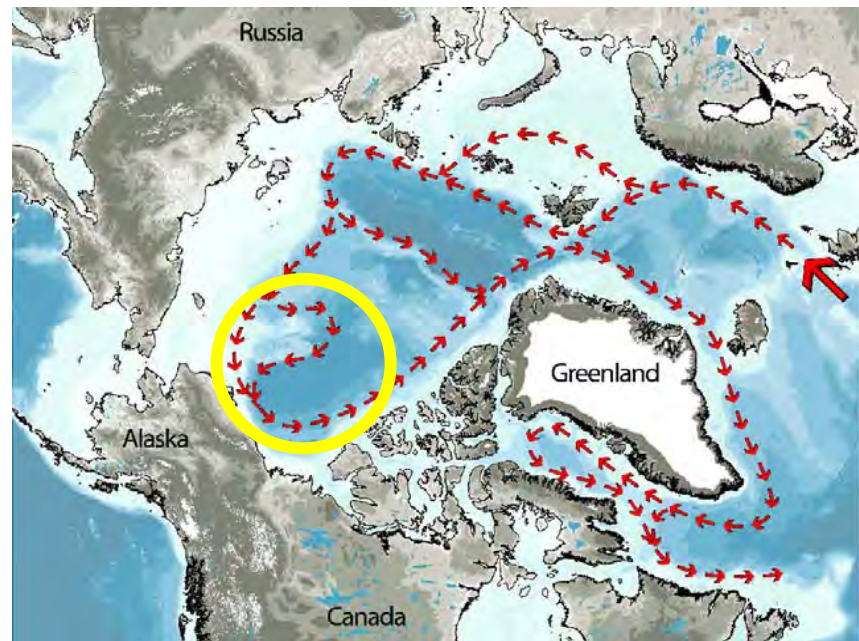
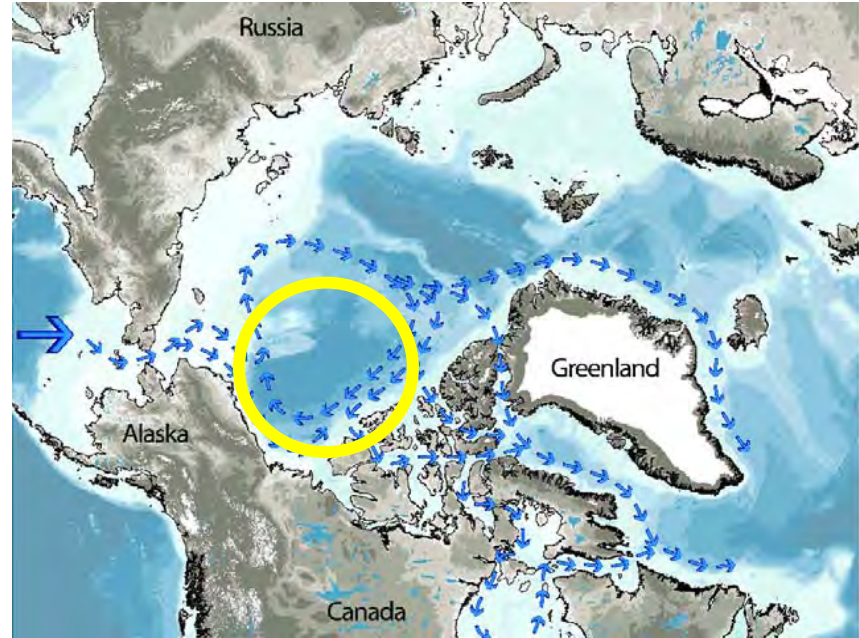
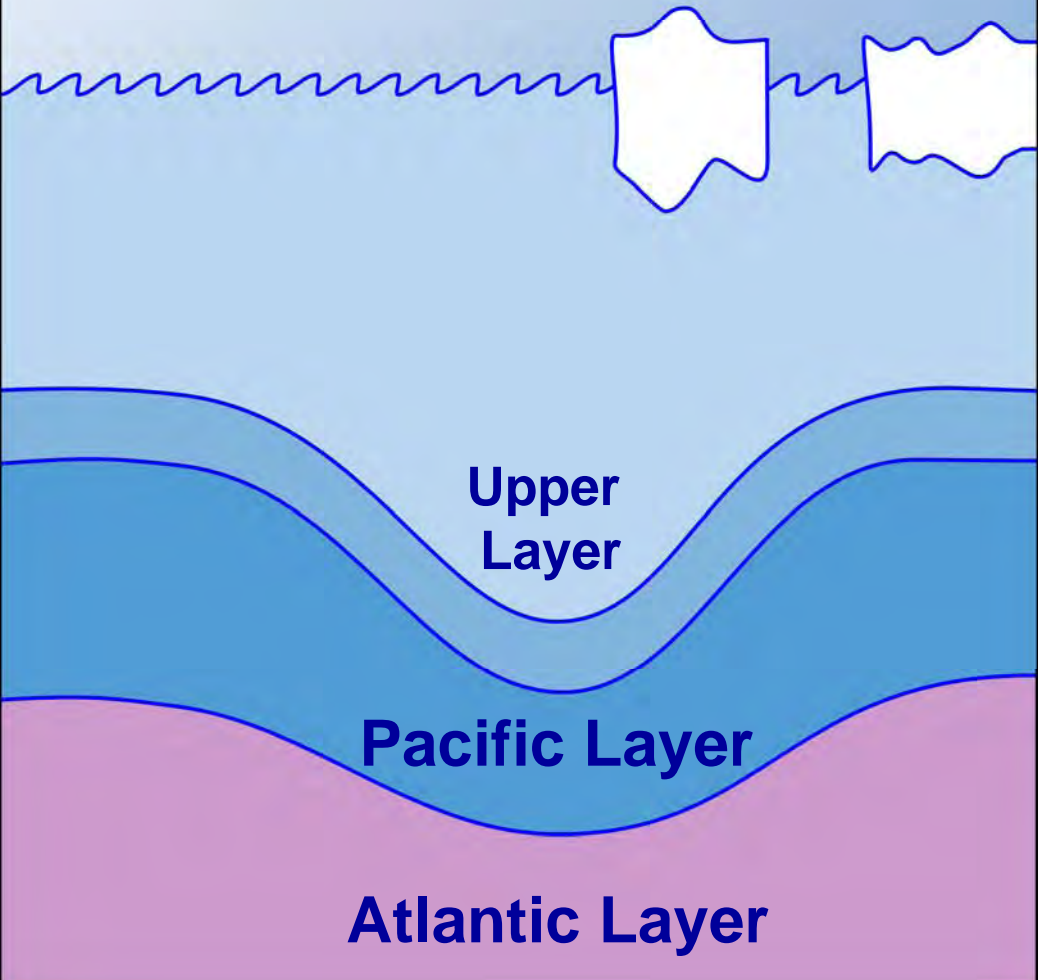
**CAN WE TALK ABOUT A 'TIPPING ELEMENT' ???**

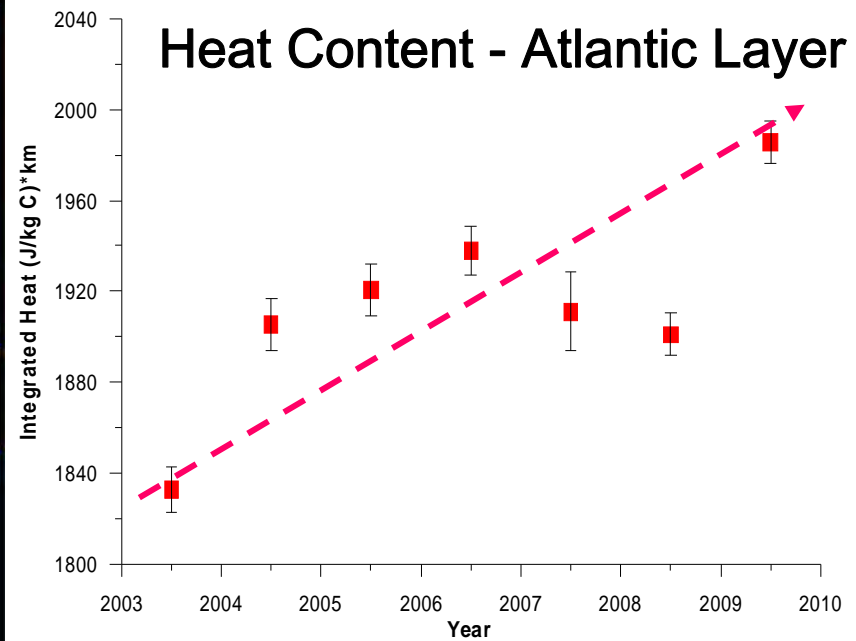
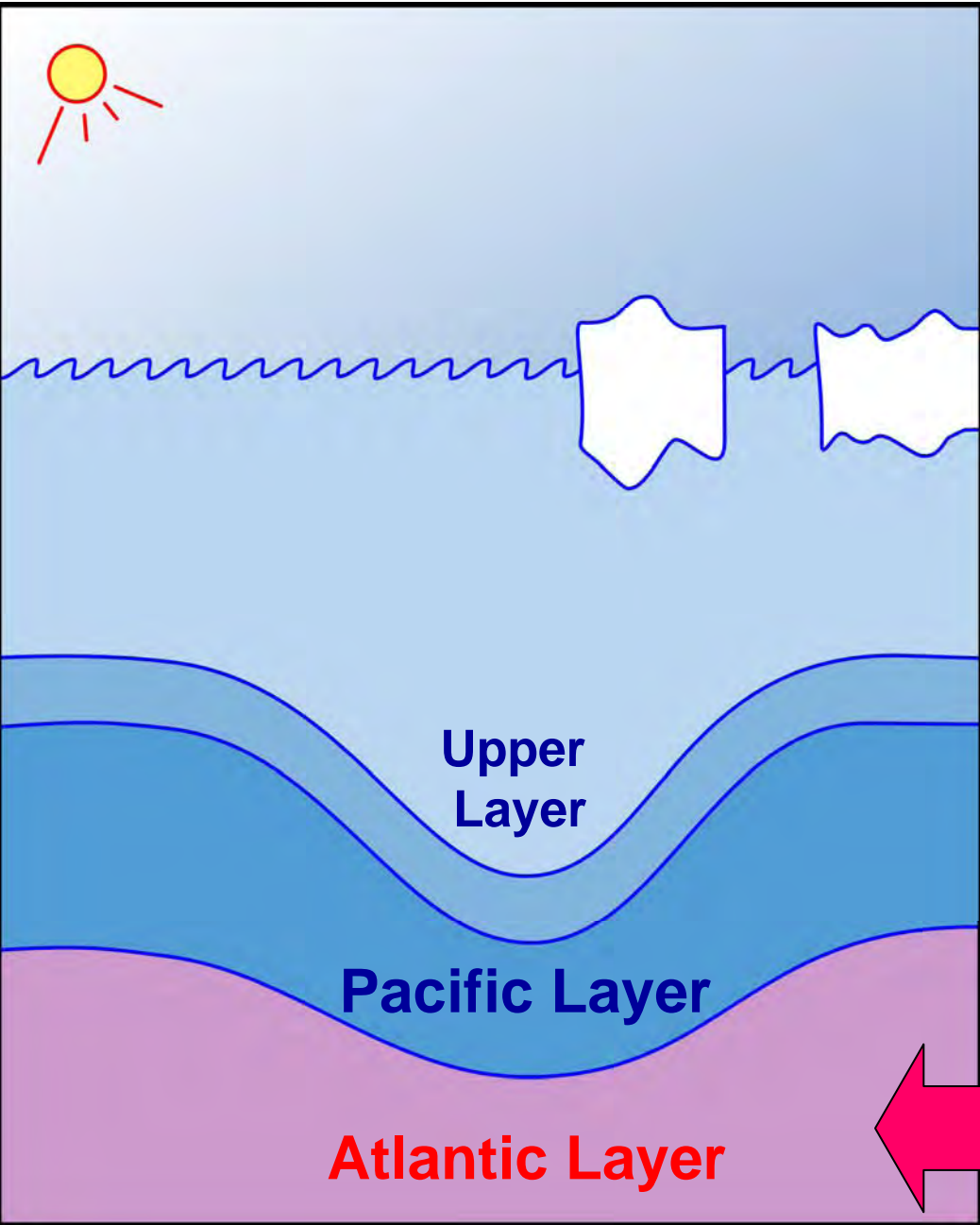
**A subsystem of the Earth System that can be switched – under certain circumstance – into a different state by a small perturbation (Linton et al., 2008)**



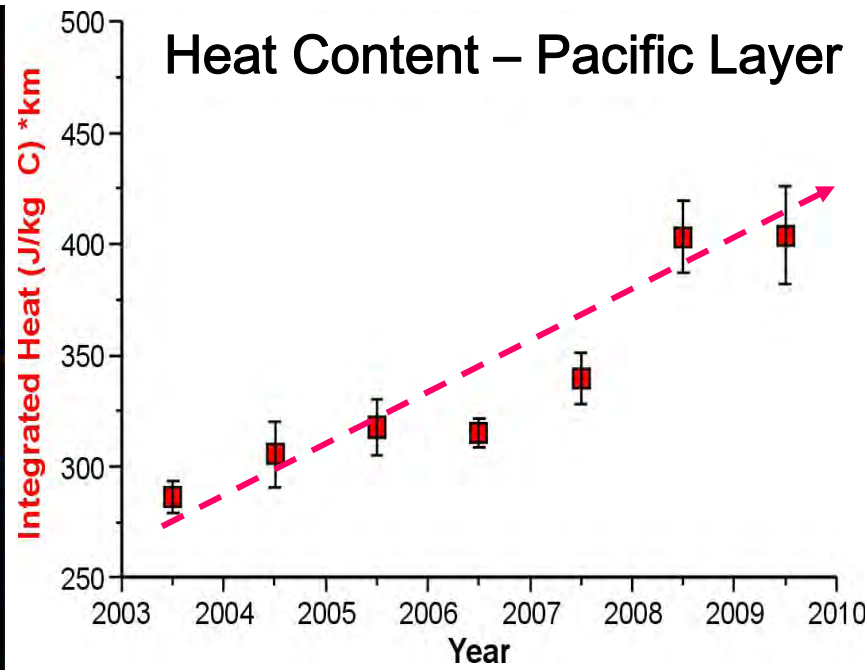
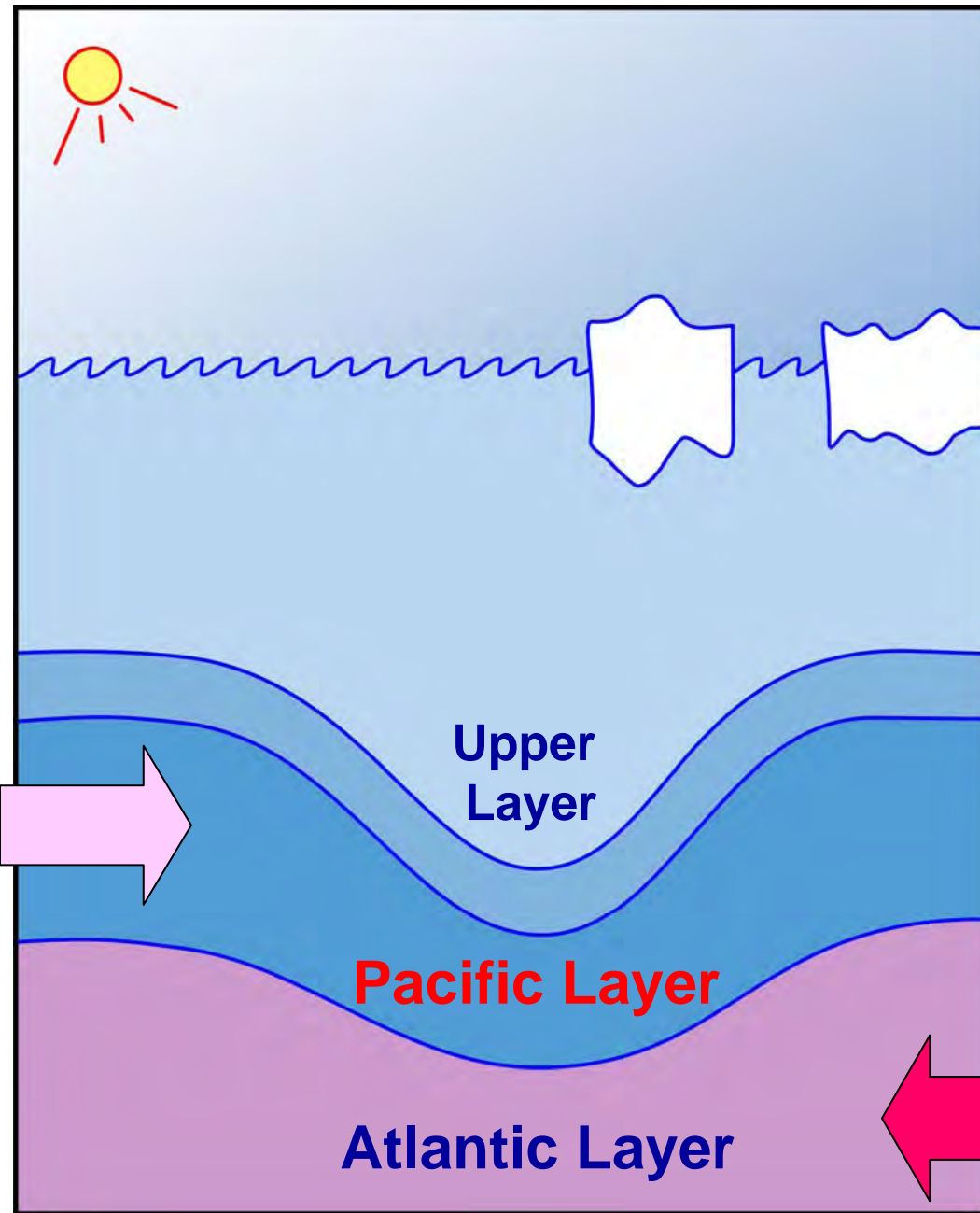


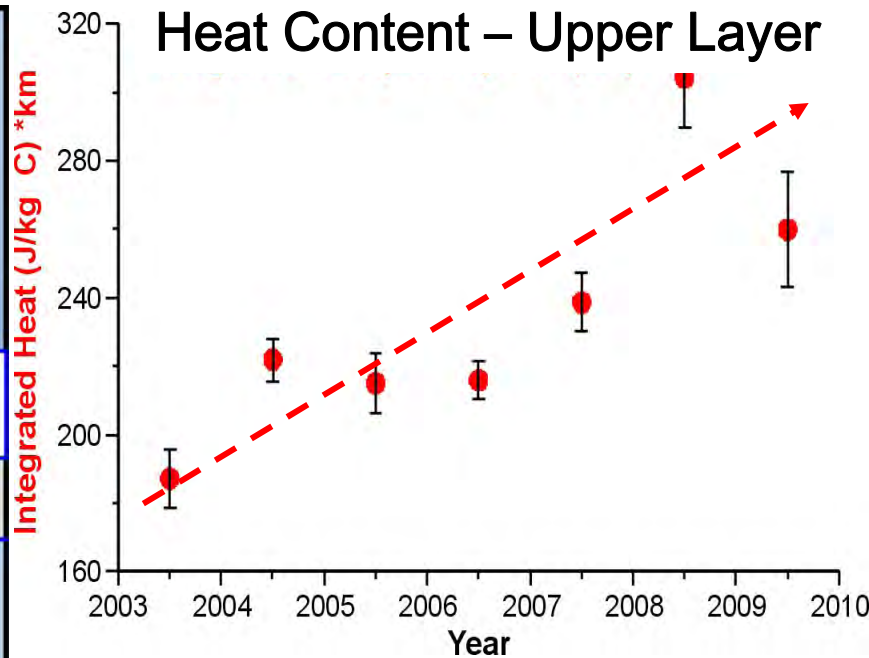
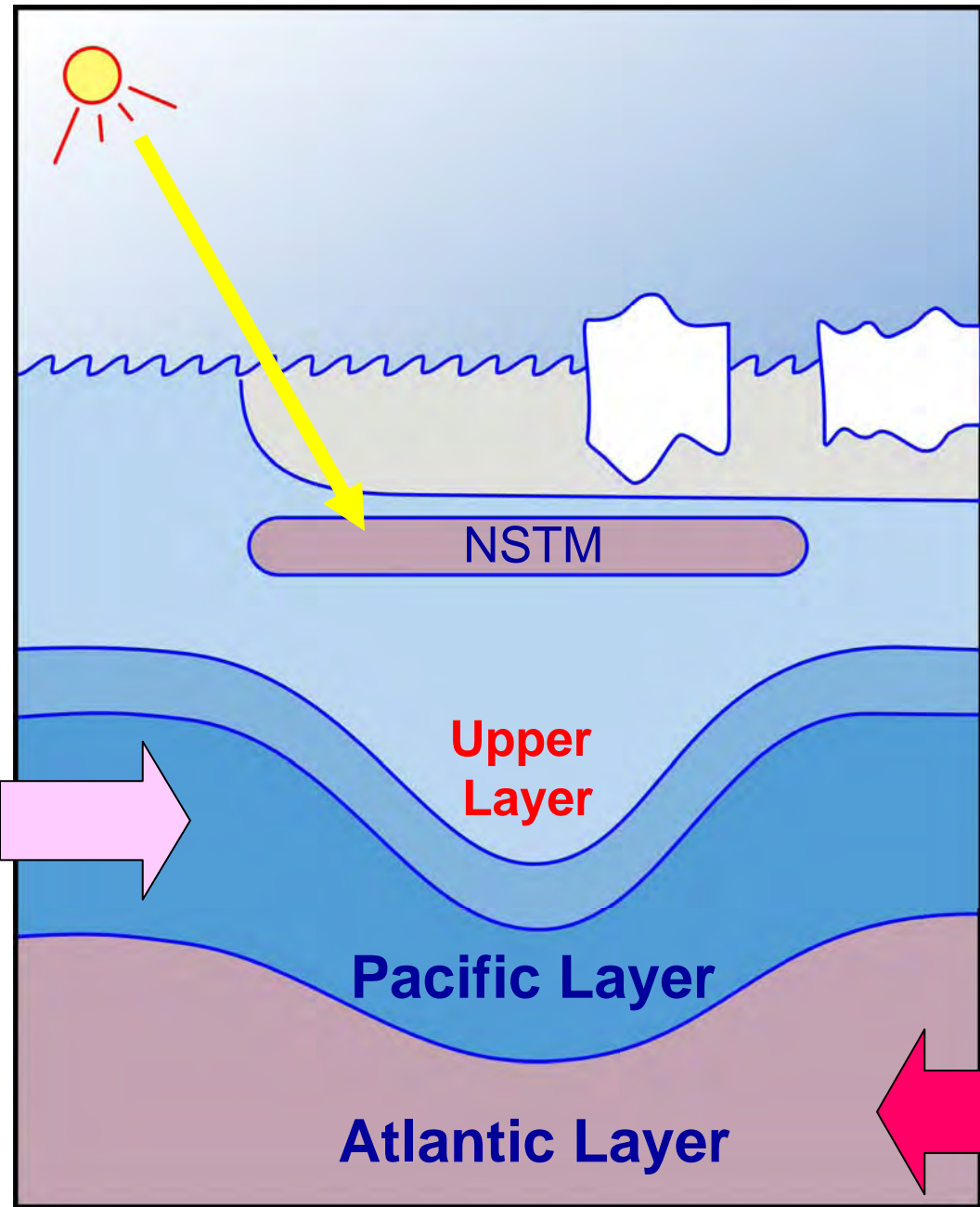
# Canada Basin Beaufort Gyre



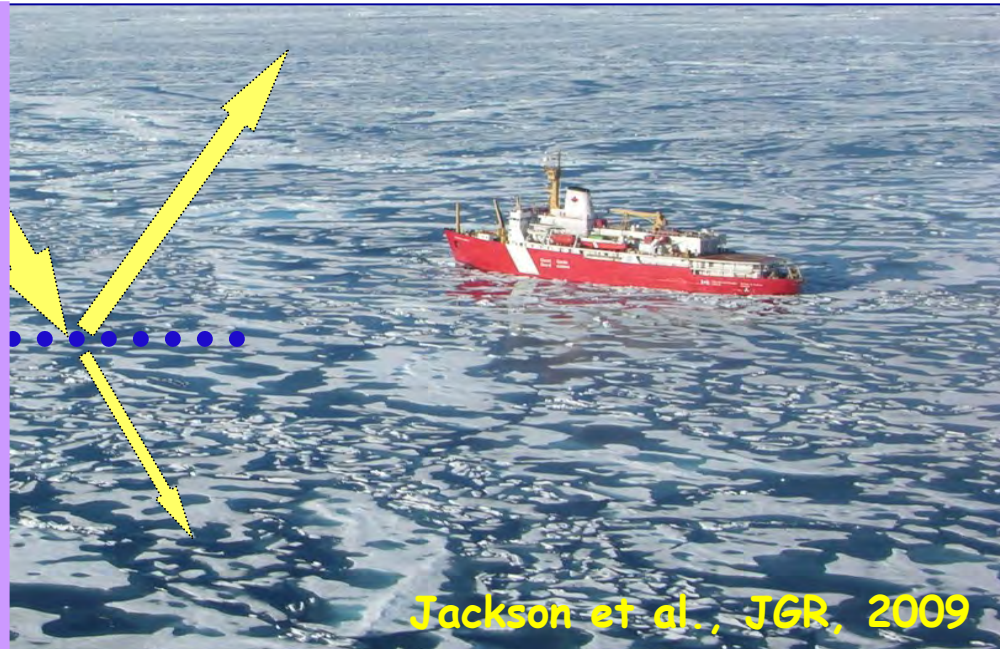
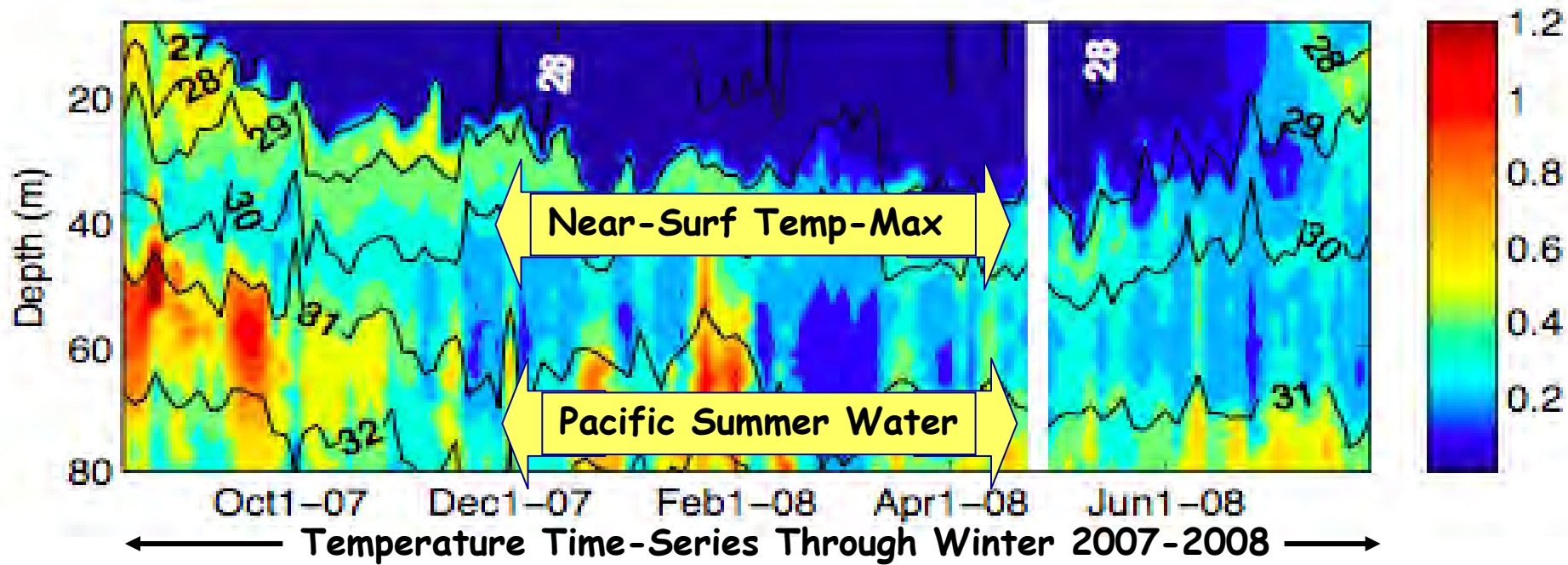


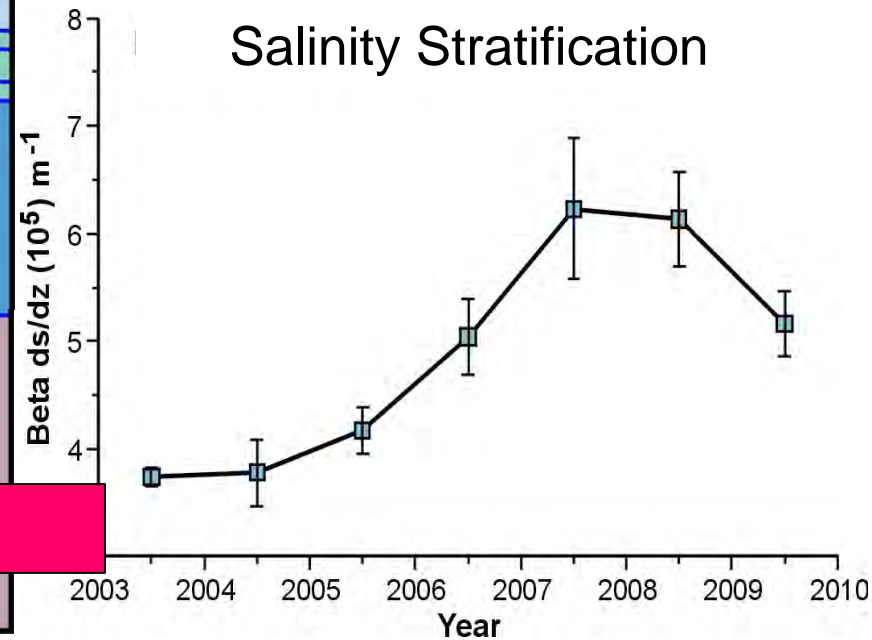
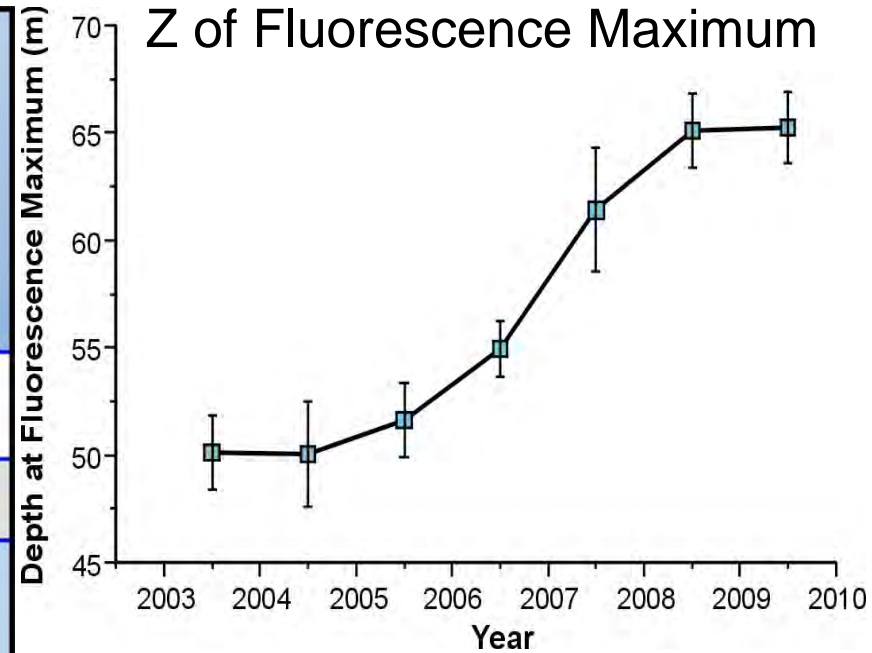
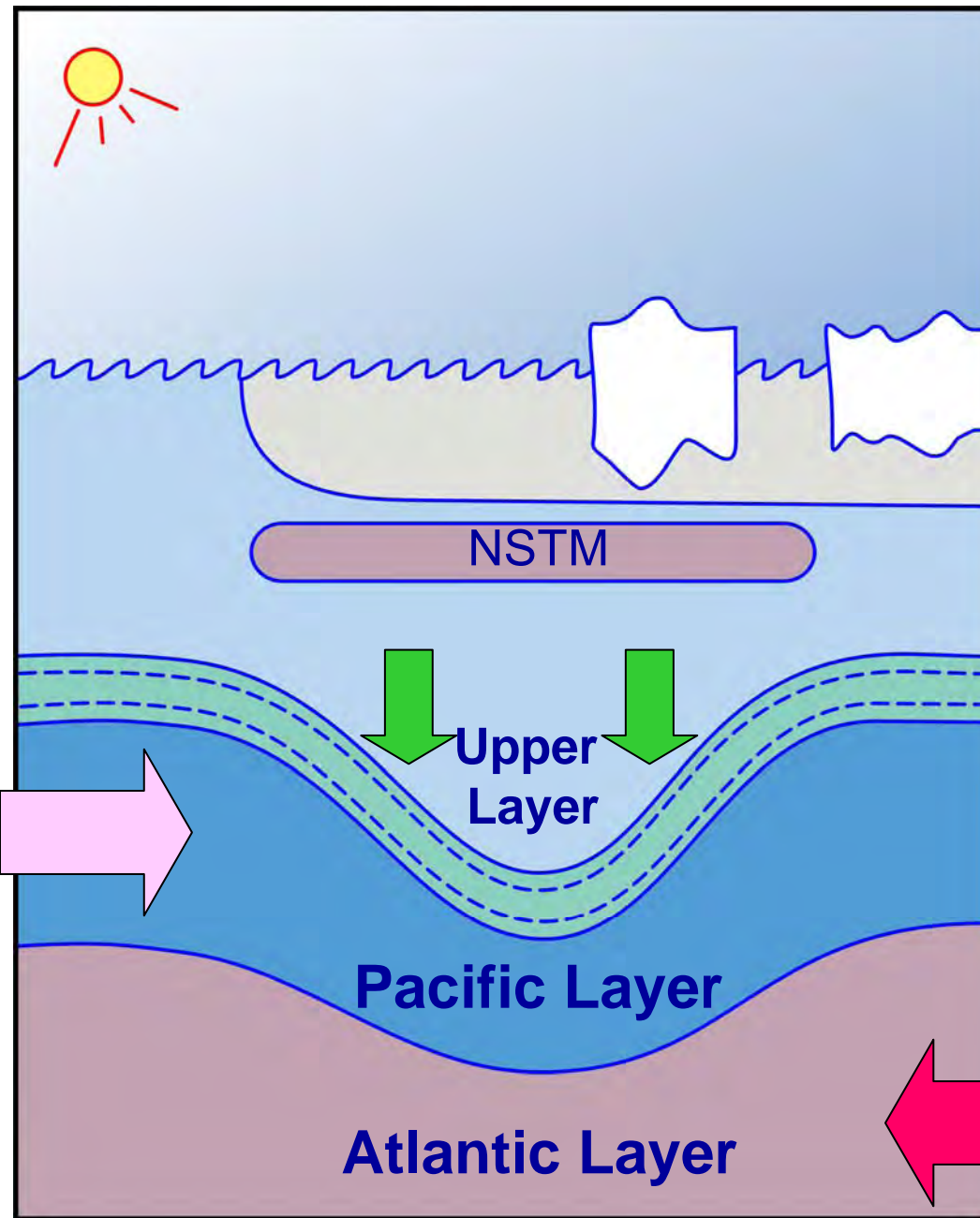




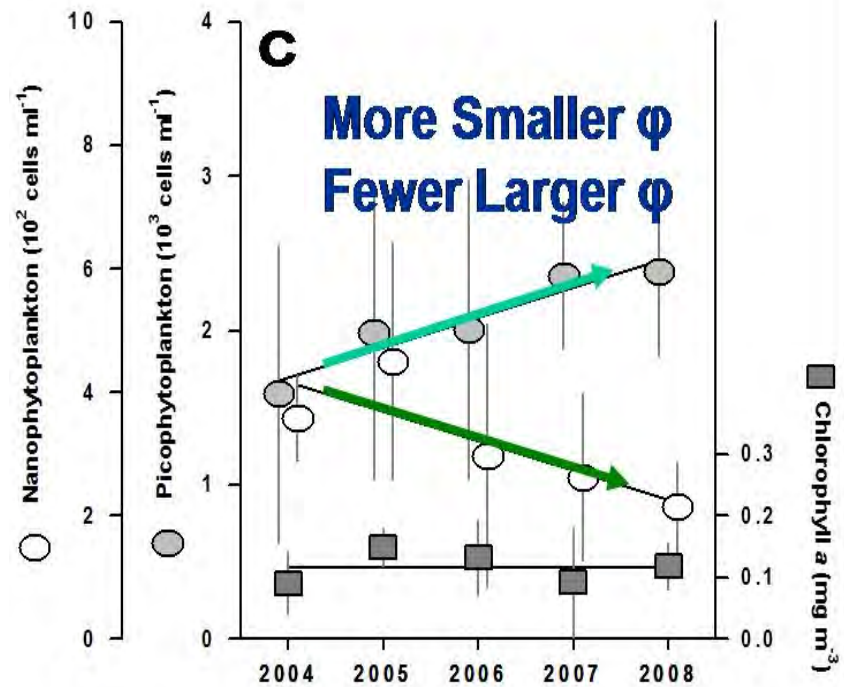
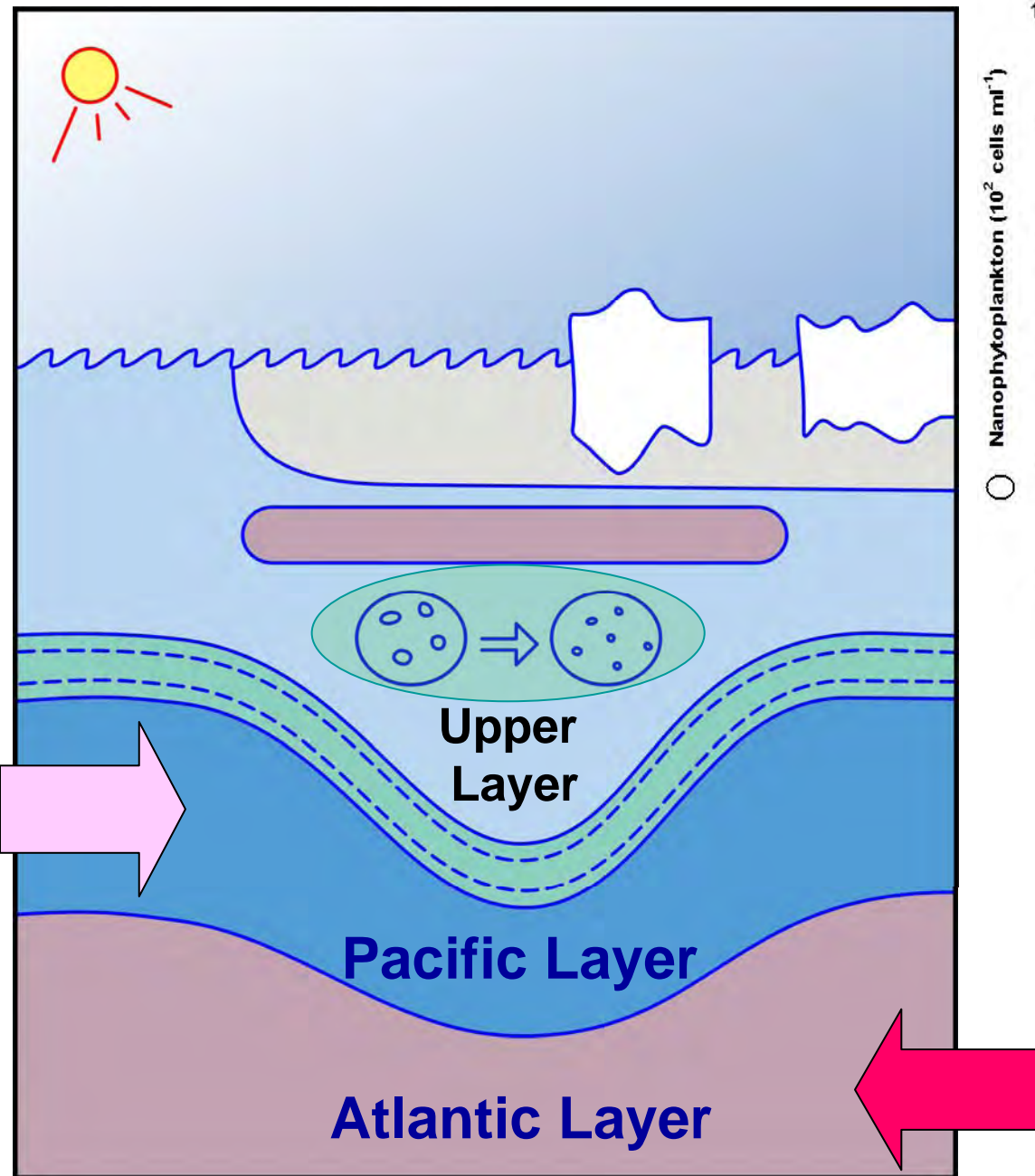


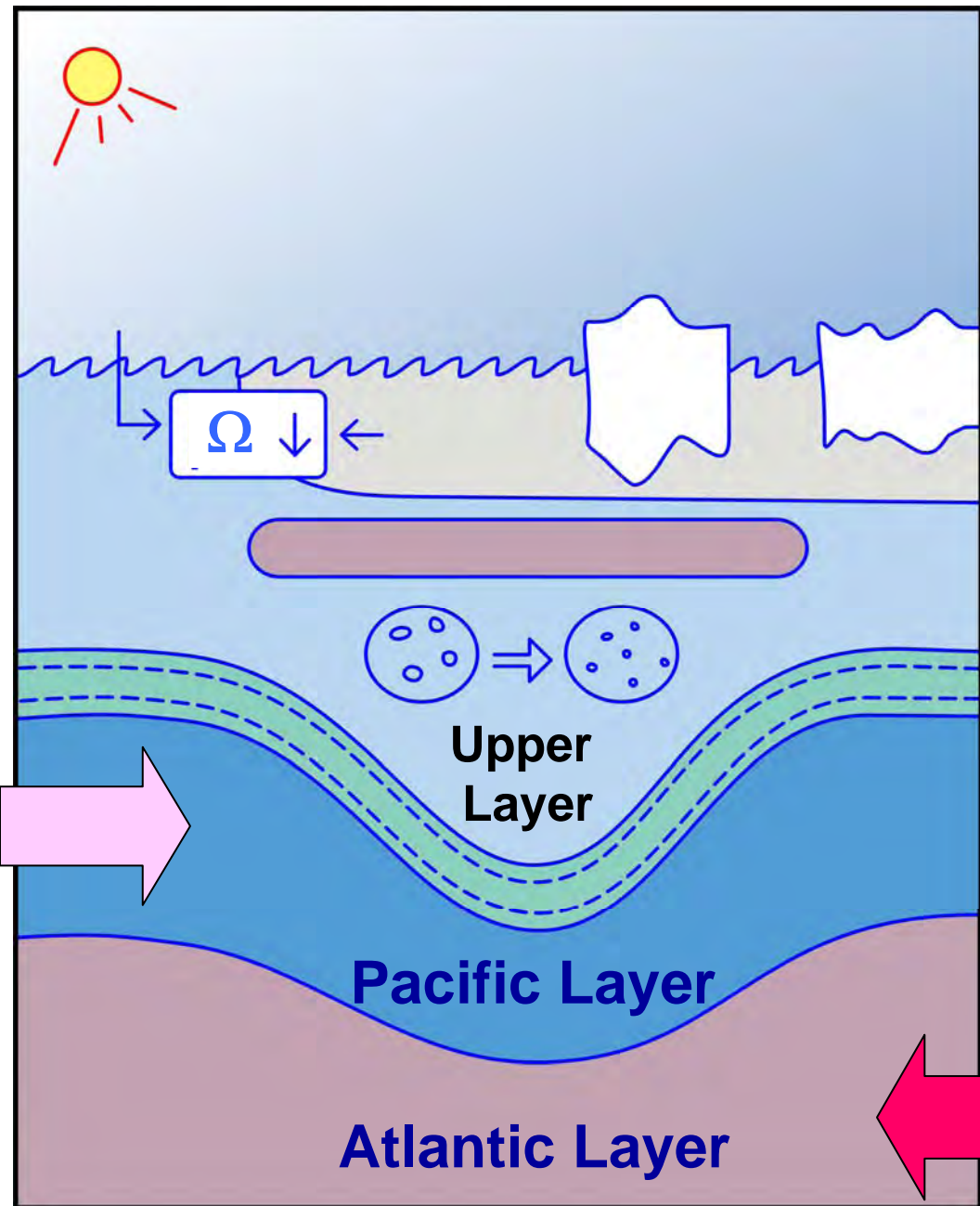




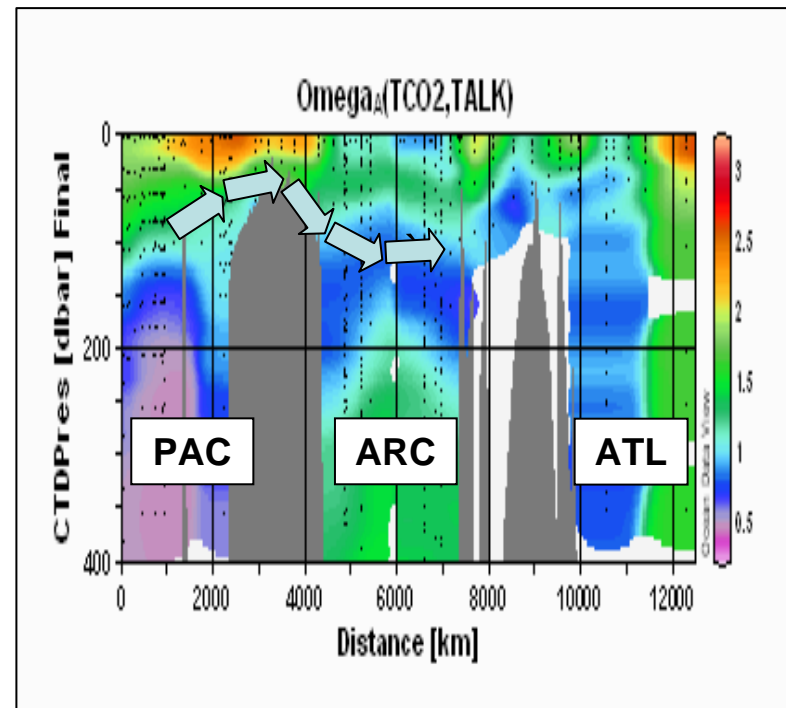
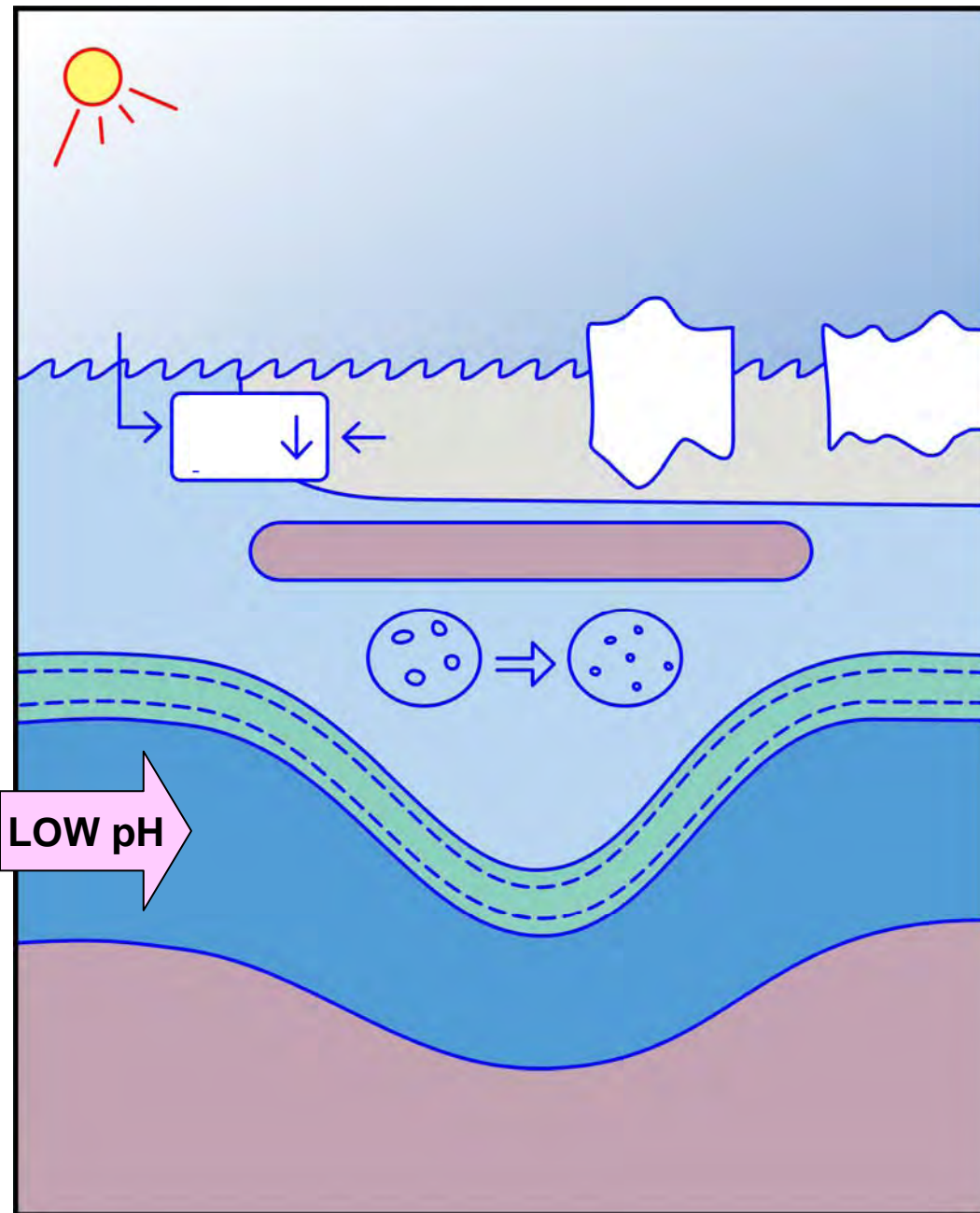


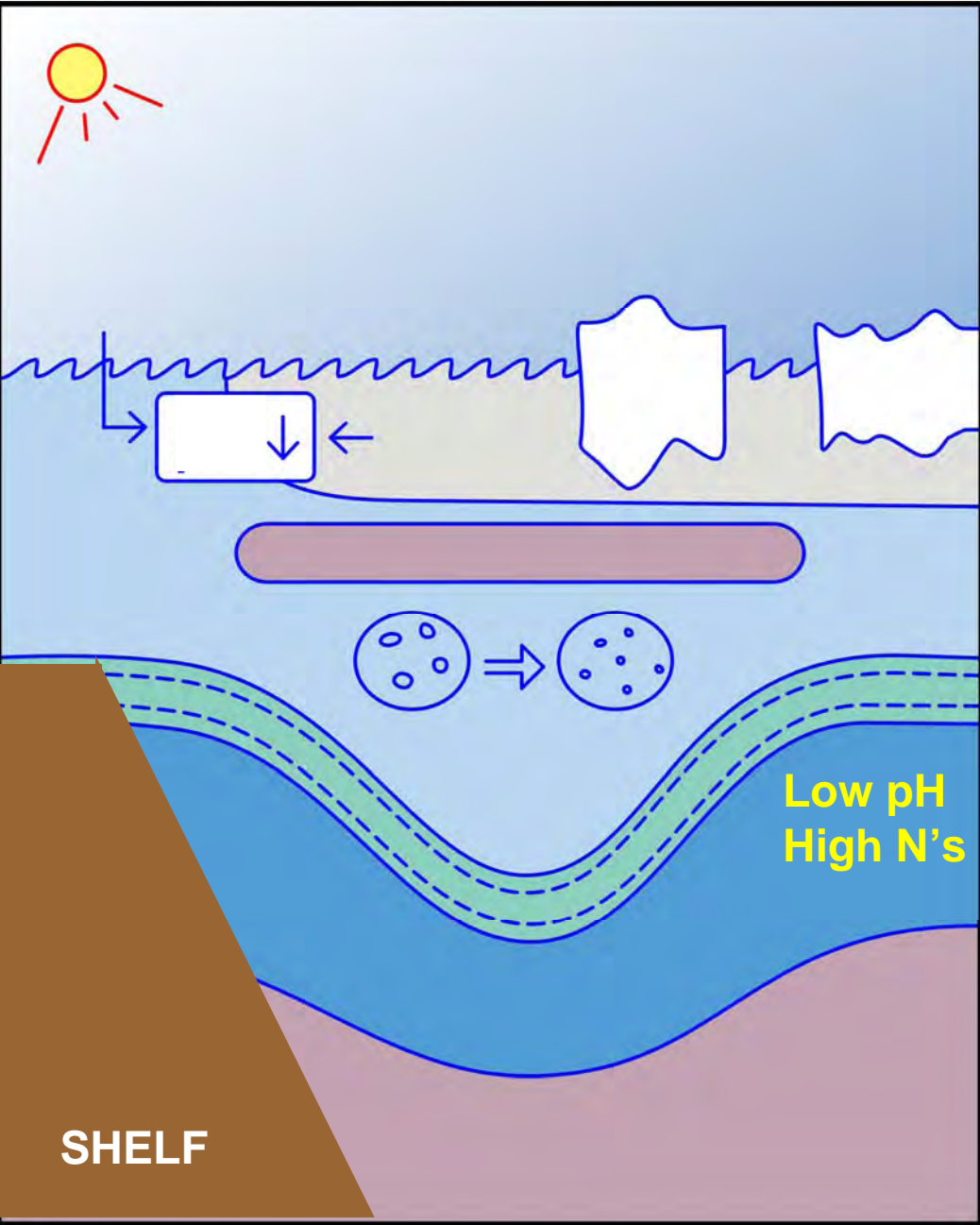




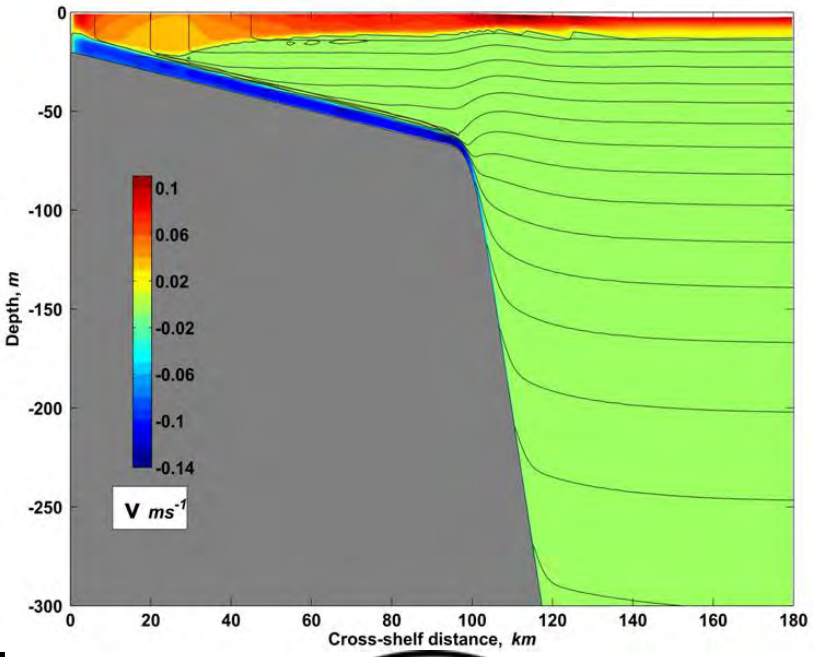
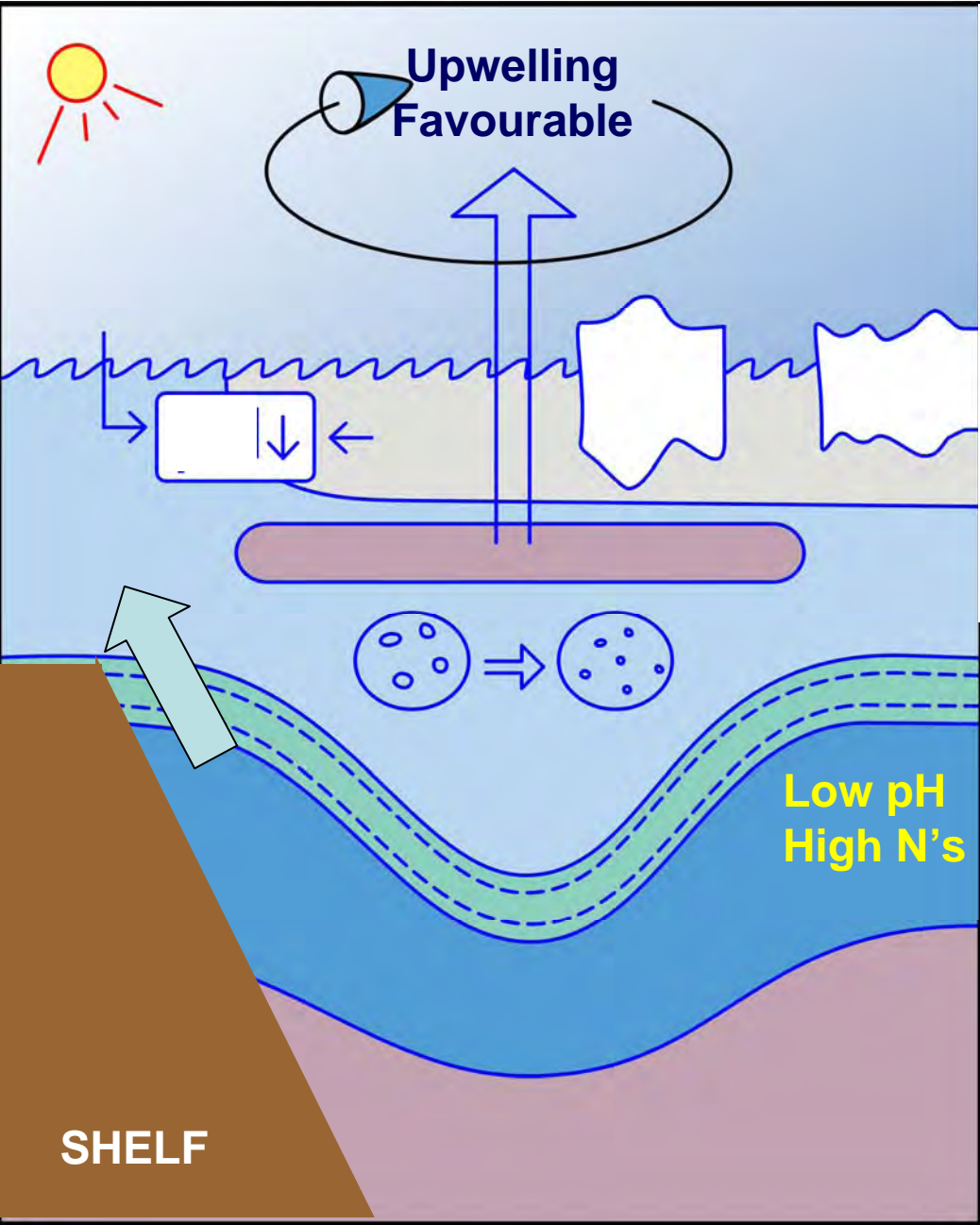


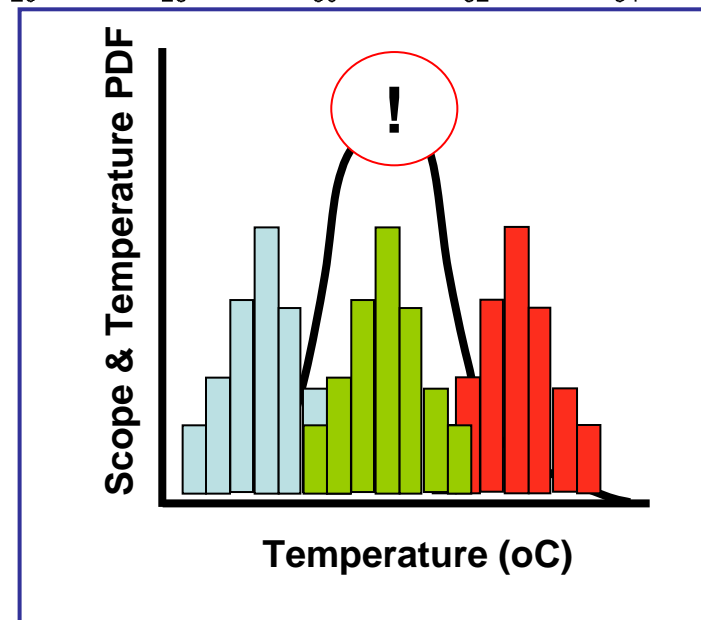
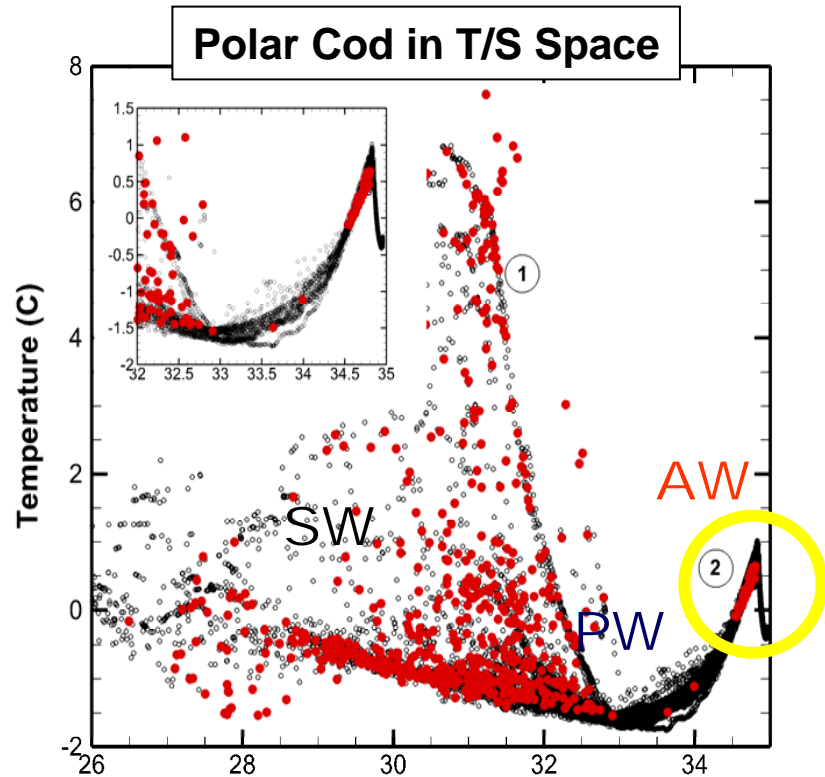
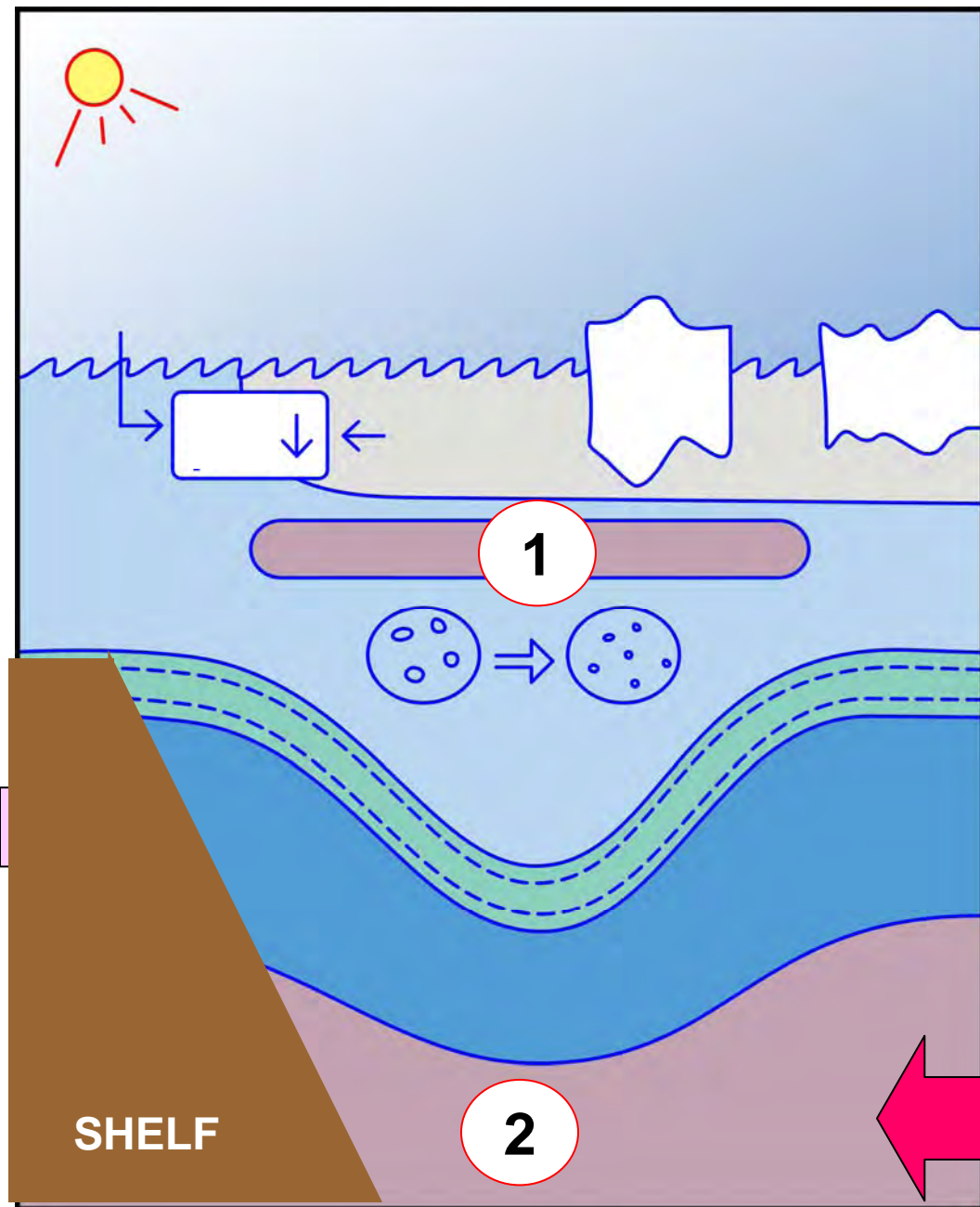




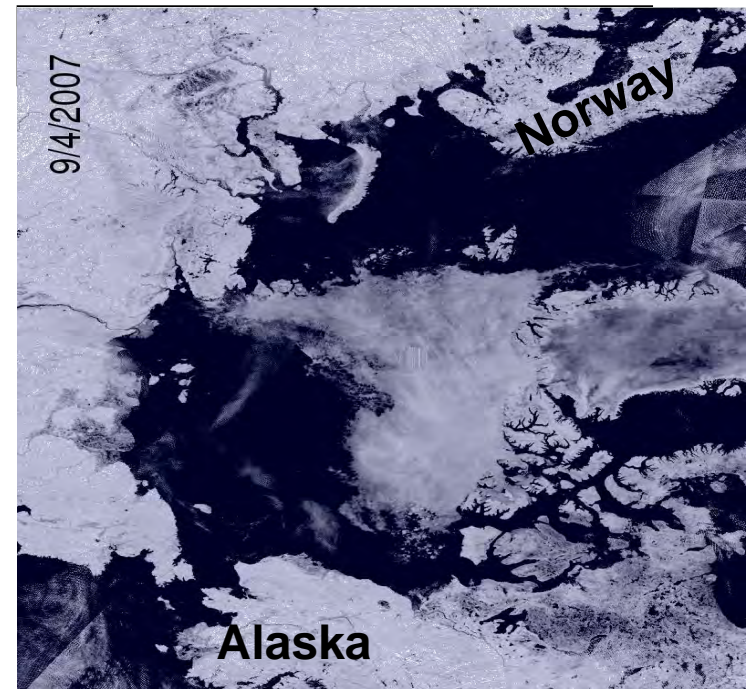
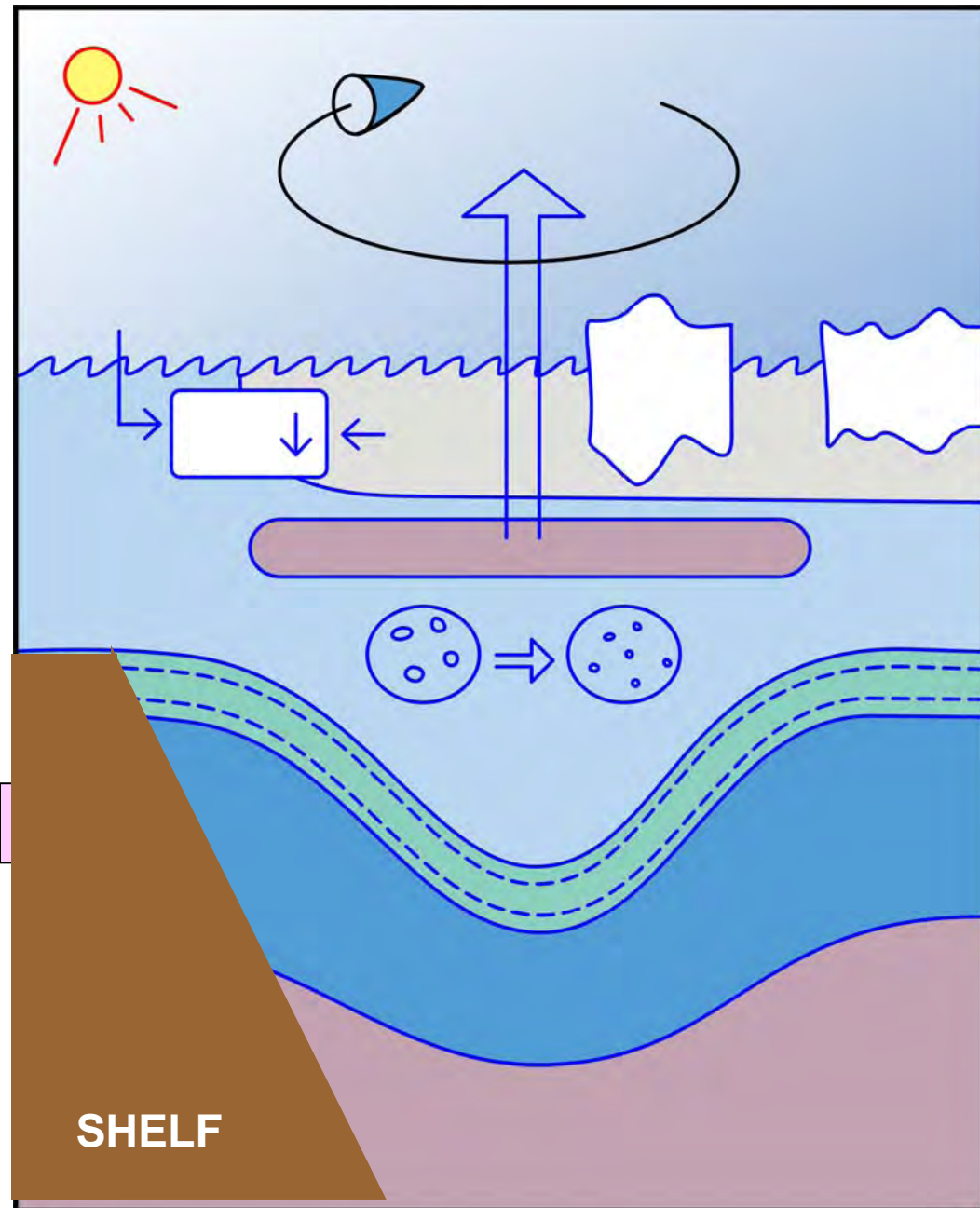




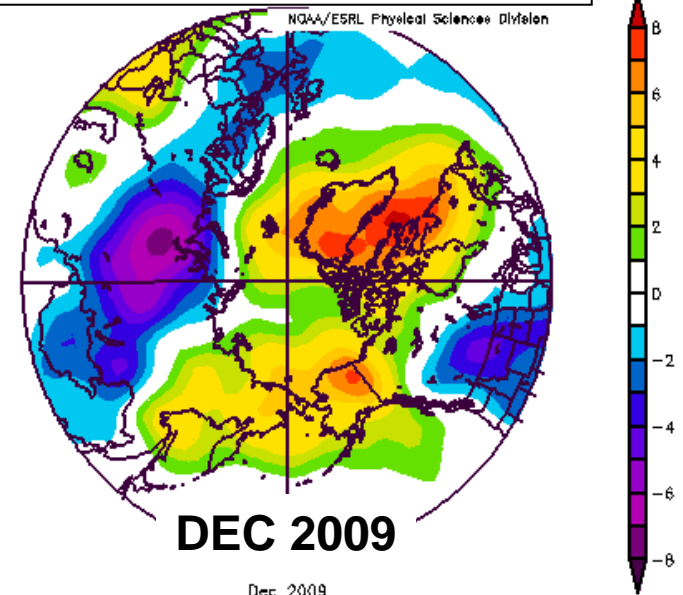






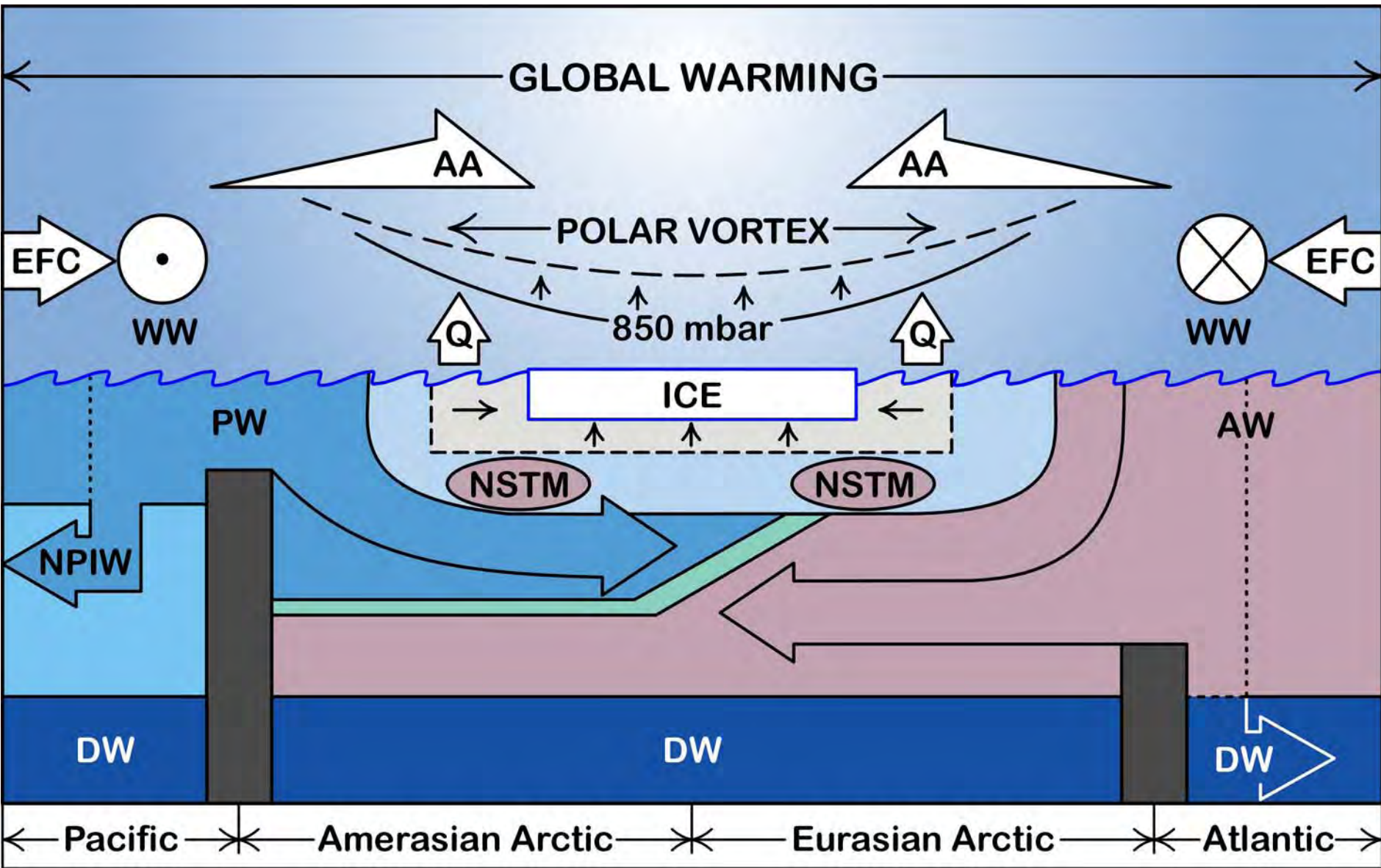


850mb oC Anomaly

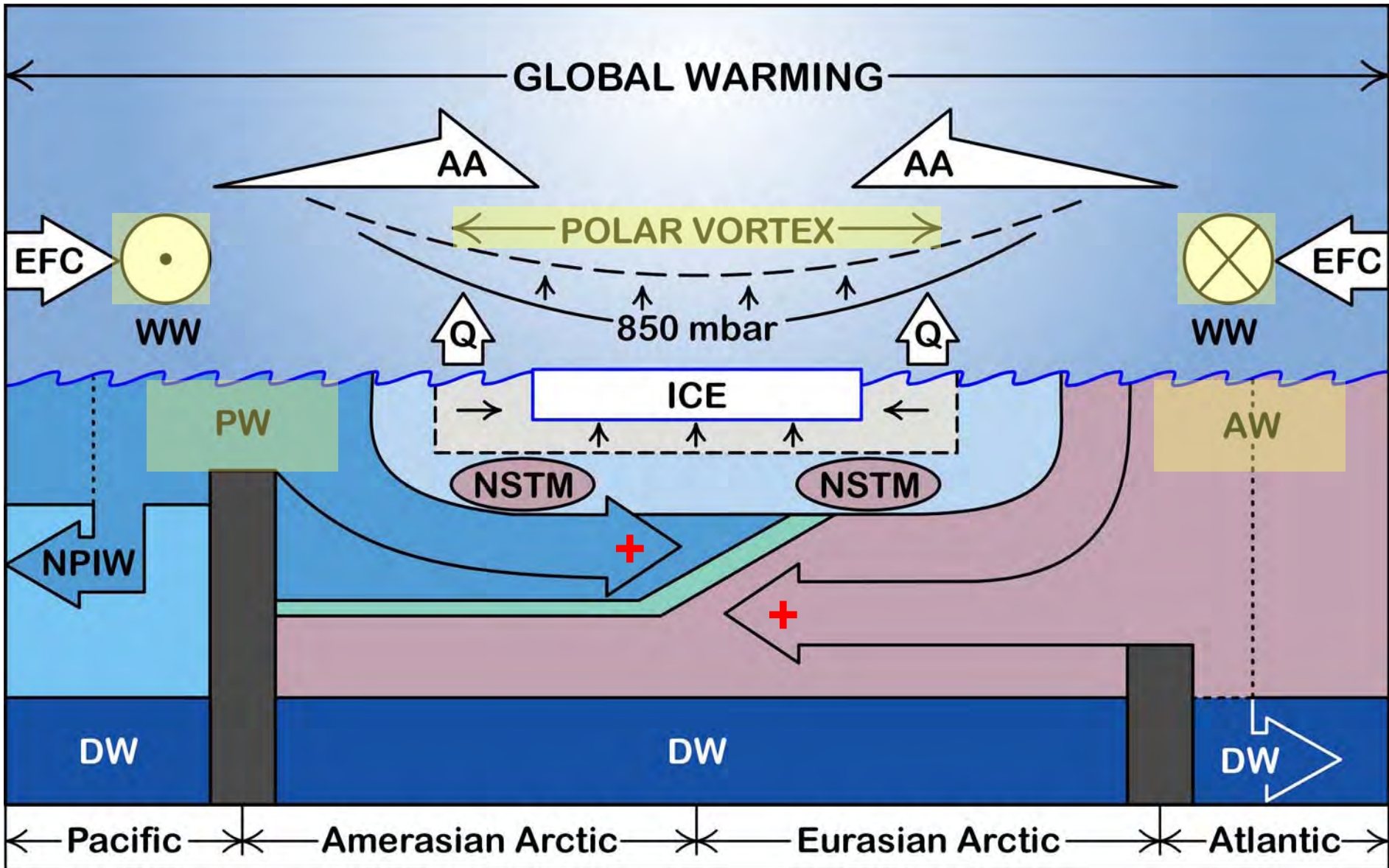


**Now, back the other way...**



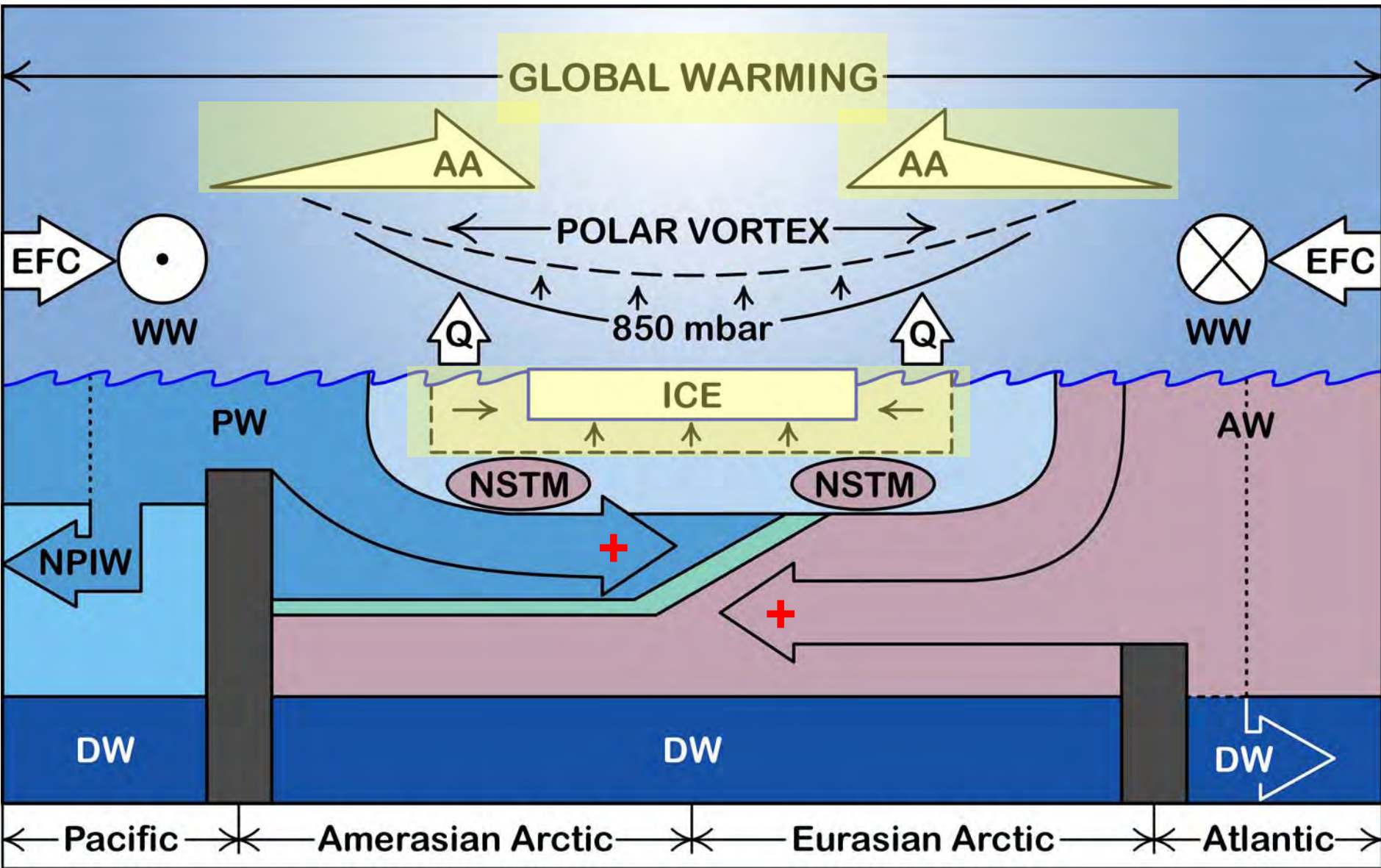


**The Basic Atmosphere-Ocean System Centered over the Arctic Ocean**

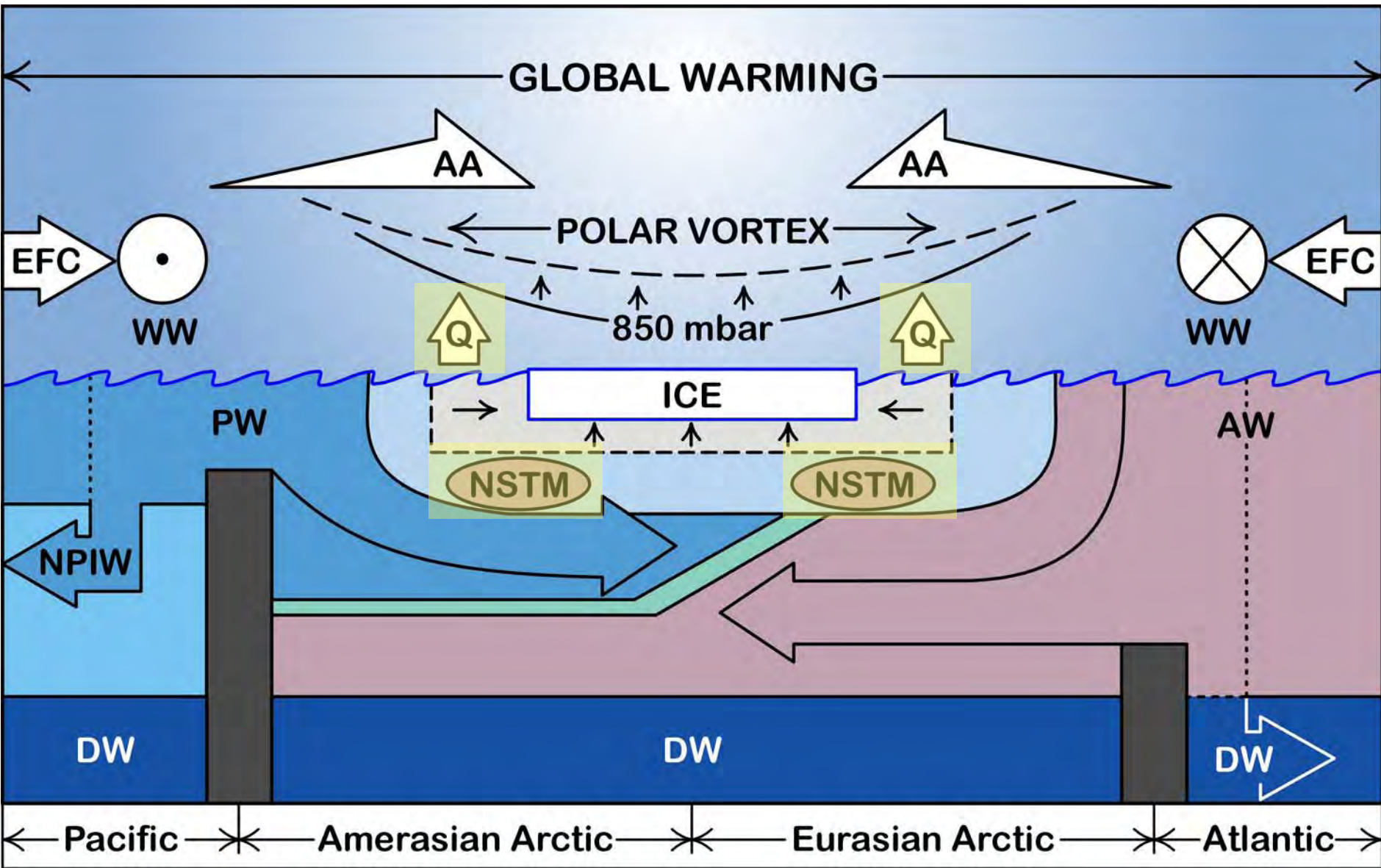


The Polar Vortex (above 850 mbar) and Westerly Winds (WW)  
Oceanic inflows enter from the Pacific (PW) and Atlantic (AW)



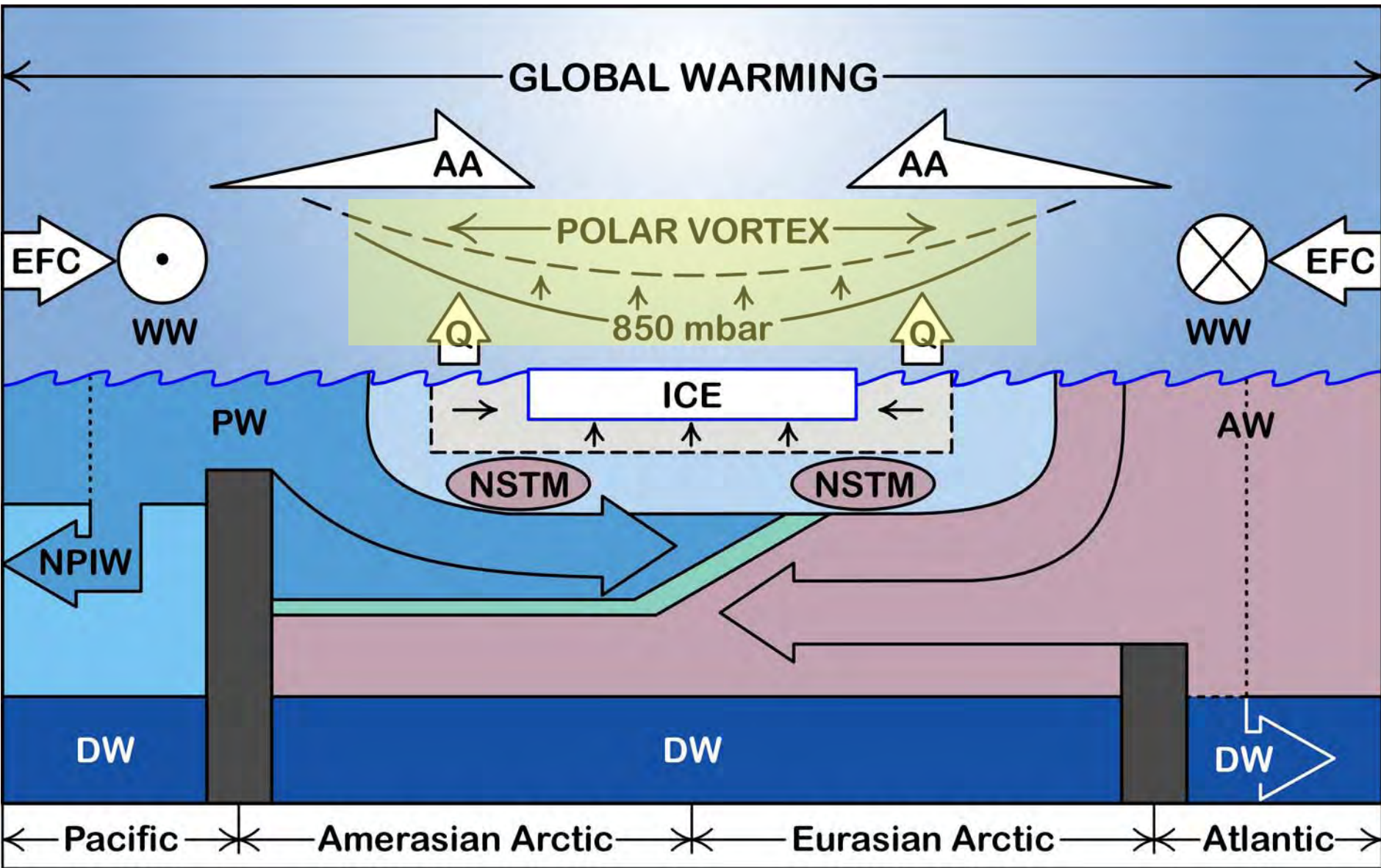


**Global warming, Arctic Amplification (AA) and warmer oceanic inflows combine to decrease the extent and thickness of sea ice**



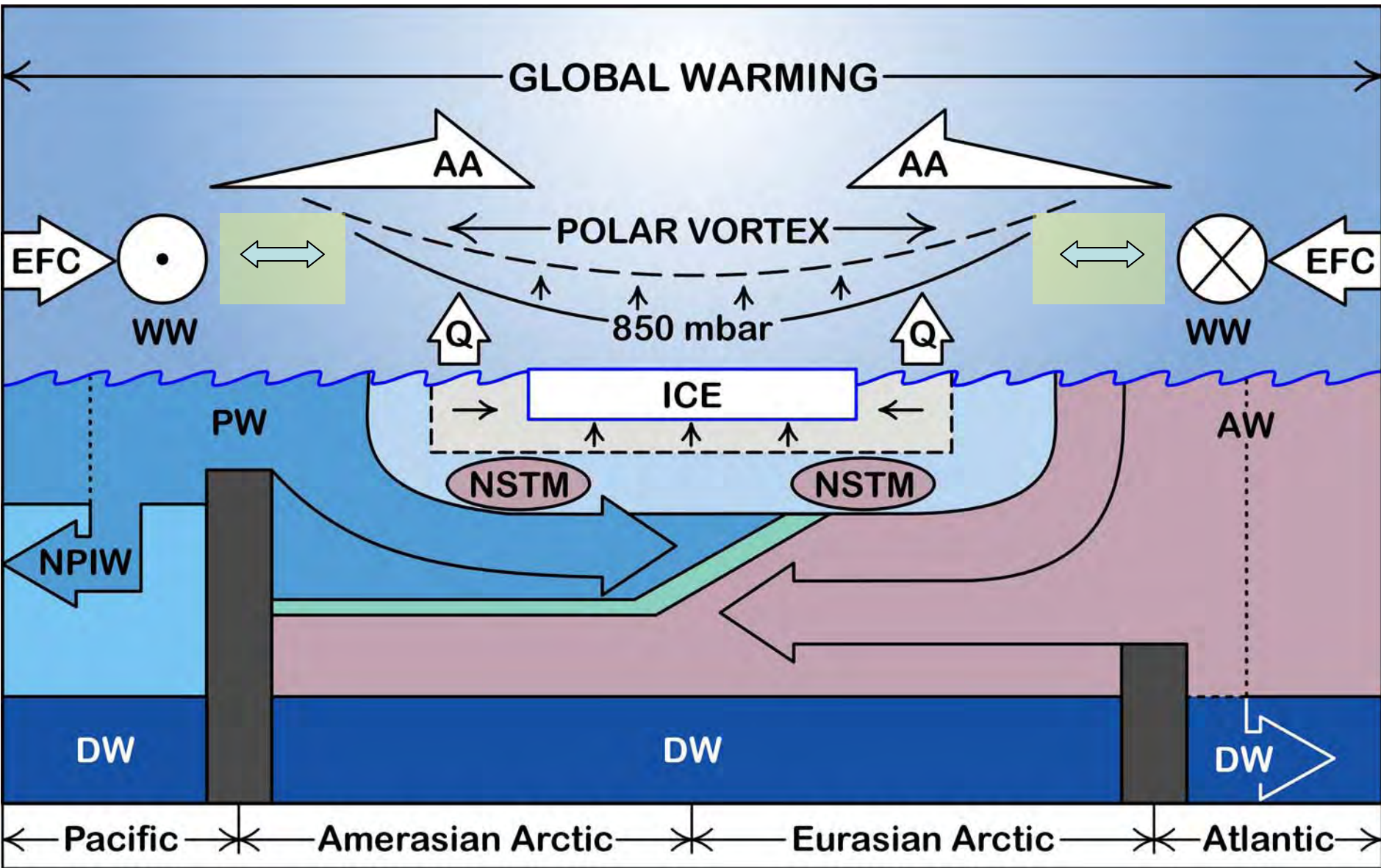
**With more open water in summer, more incoming solar radiation is stored as heat below the summer mixed-layer in the Near Surface Temperature Maximum (NSTM) and subsequently released to the atmosphere (Q) during autumn and early winter**



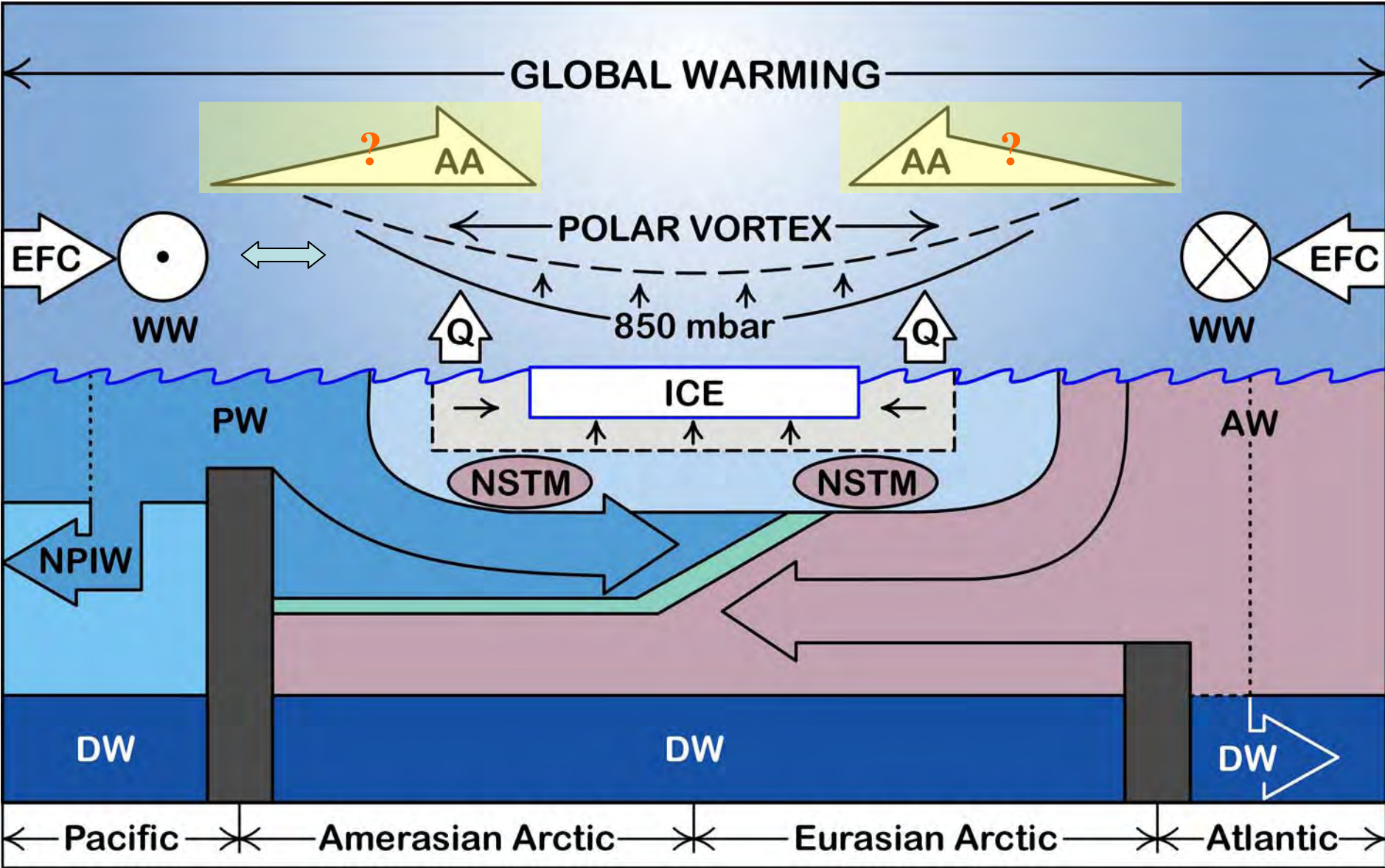


Thus raising the height of geopotential height fields within the Polar Vortex





Reducing the stability of the Polar Vortex and leading to increased meridional winds (MW)

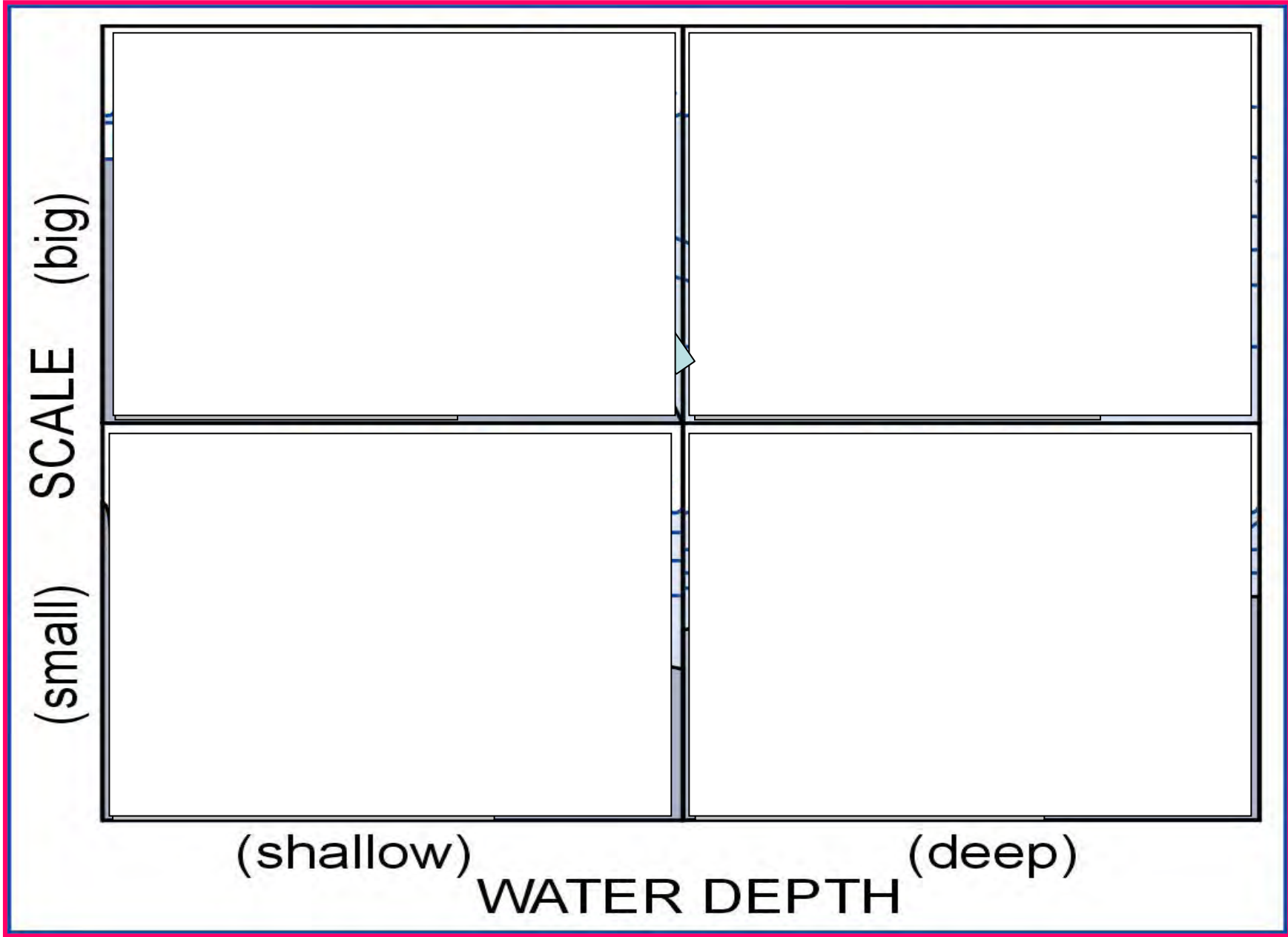


With potential feedbacks to Arctic Amplification through teleconnections

A Question ... Will the continued  
Trends of warming and freshening  
Lead to increased primary production  
or to decreased primary production?

The likely answer is ... Yes ...

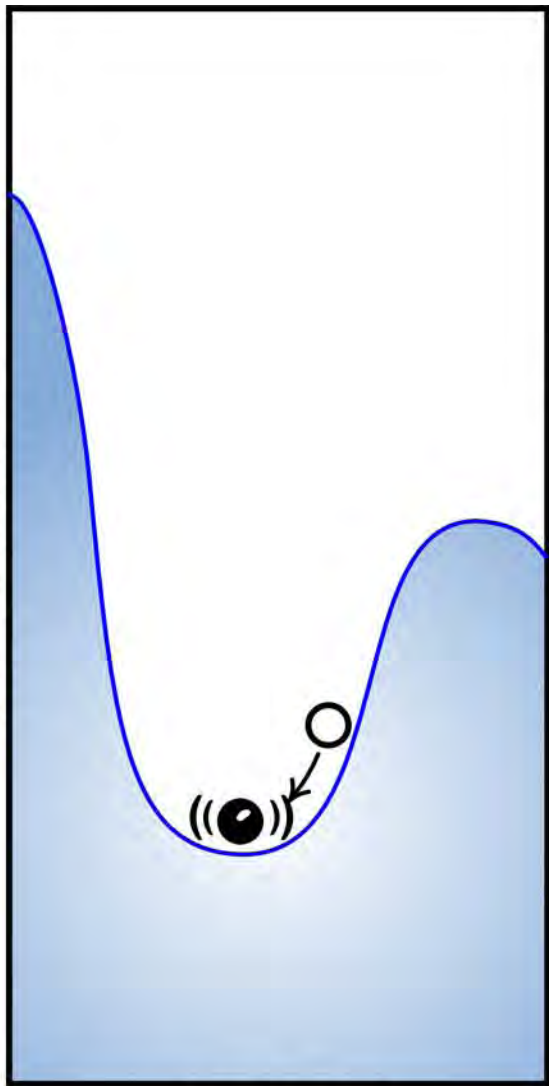




# Regime Shift: A bigger Question

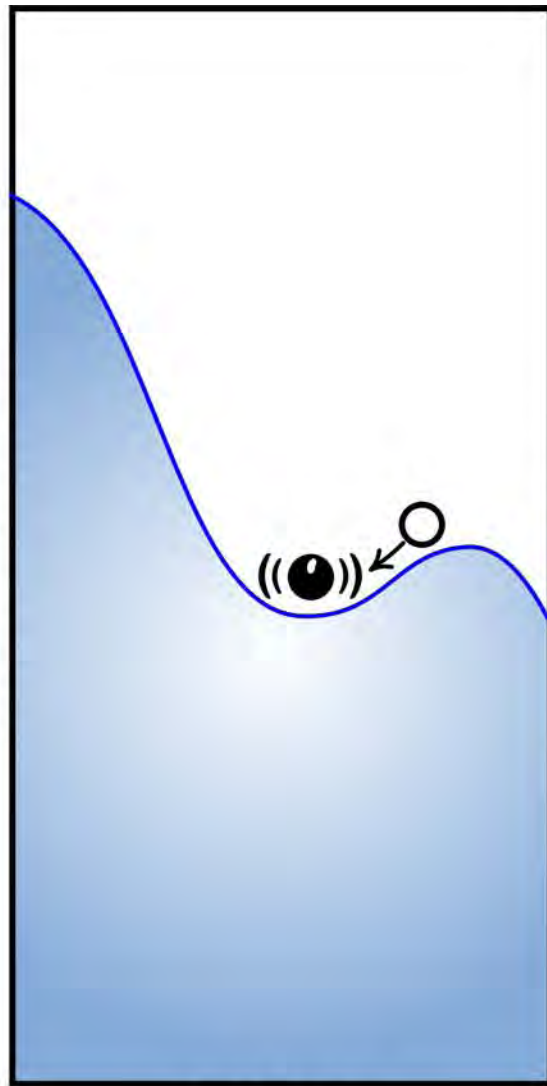
- **A regime shift occurs when internal dynamics are perturbed beyond a critical threshold either because:**
- **a stability domain has contracted;**
- **an external variable has forced a movement of internal variables beyond the stability boundary.**

POTENTIAL



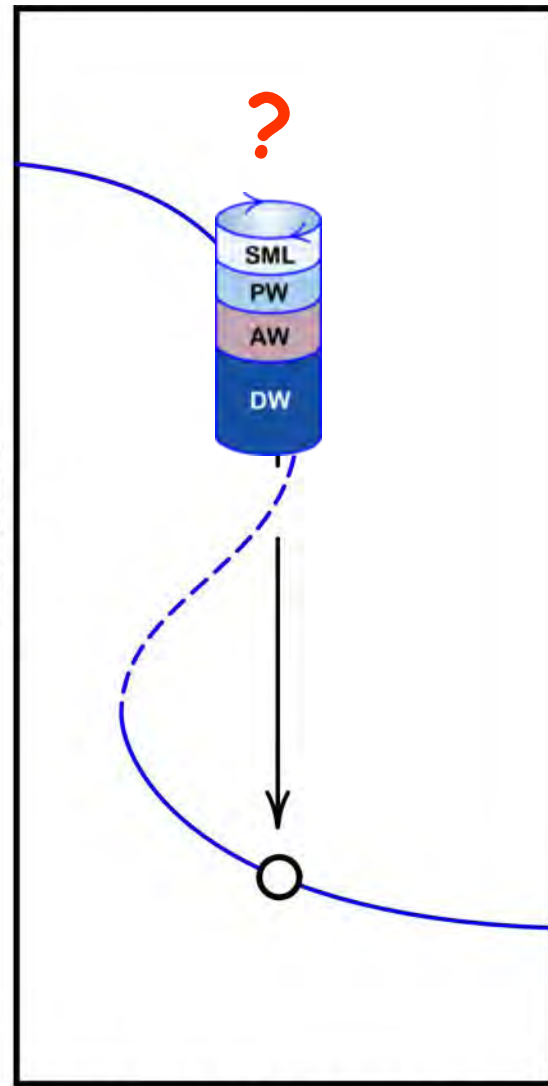
STATE

POTENTIAL



STATE

STATE

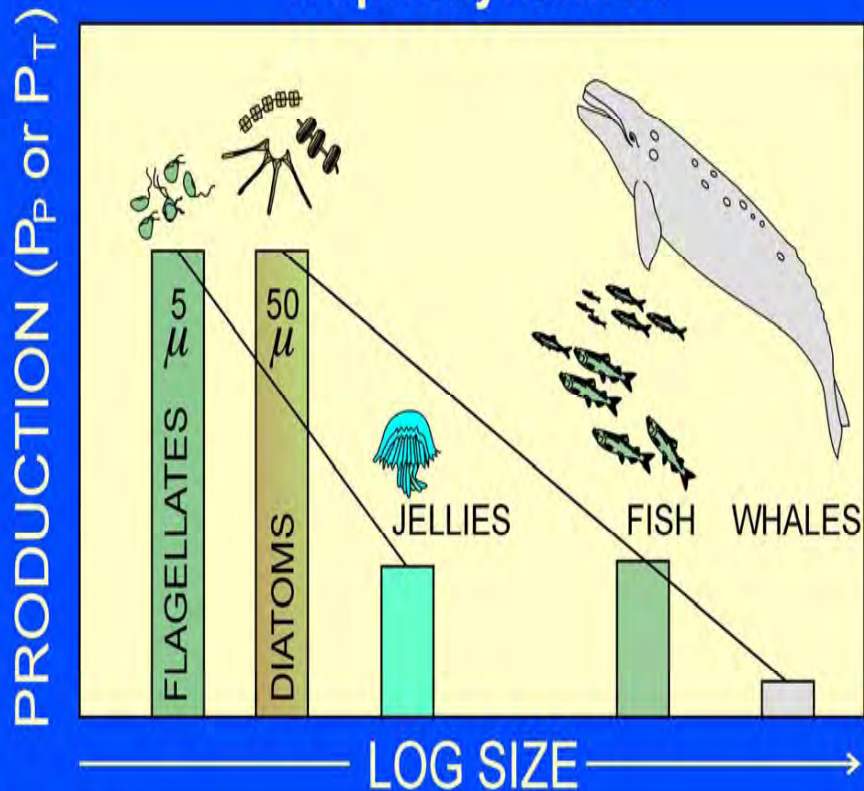


CONDITIONS



# A Potential Flip: The Ascendancy of Pelagic Food Chains

## Size Scale of Evolutionary Trophodynamics



**Tim Parsons**  
UBC & DFO/IOS Emeritus

# The Fundamental Quest

To find - if they exist - the so-called  
'Leading Indicators'  
Of Regime Shift (collapse, or flips)  
By studying the behaviour of the system  
Before such flips occur.

## Some Candidates

Increased Variance prior to the flip

Increased Skewness in the pdf

Slowing down of the time series



**Leading Indicators are great; but**

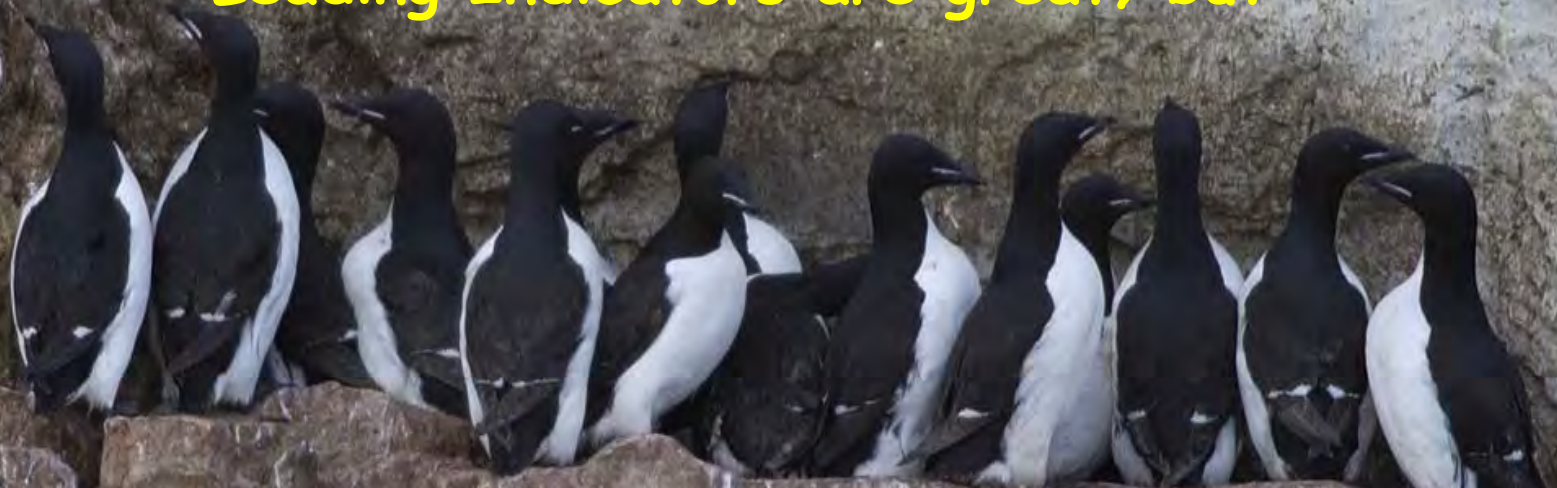


Photo: Jean Lemire

**... our Arctic Time-series are poor ... so ...**

**Substitute space for time ???**

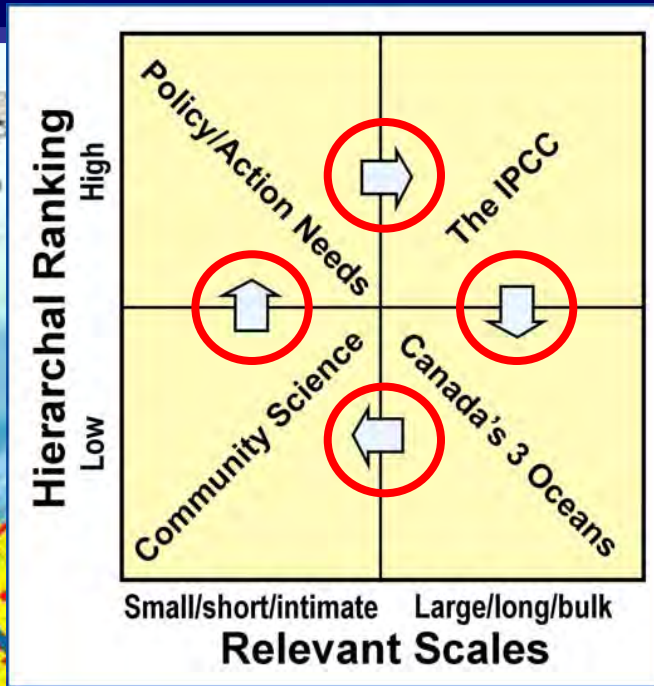
**Establish an Early Warning System  
to maintain vigilance and recognize  
the onset of non-linear change ???**

**The Northern Communities?**

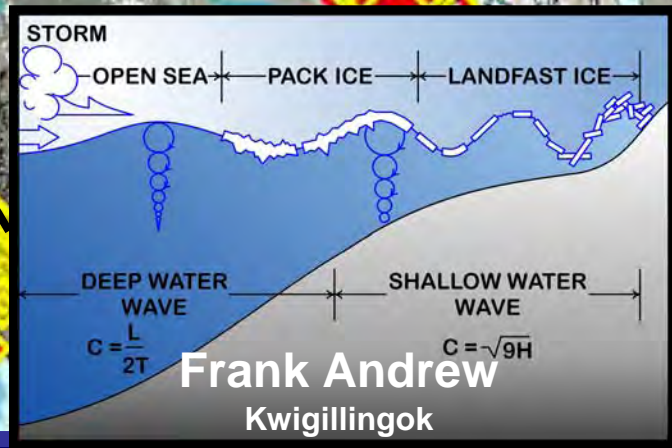
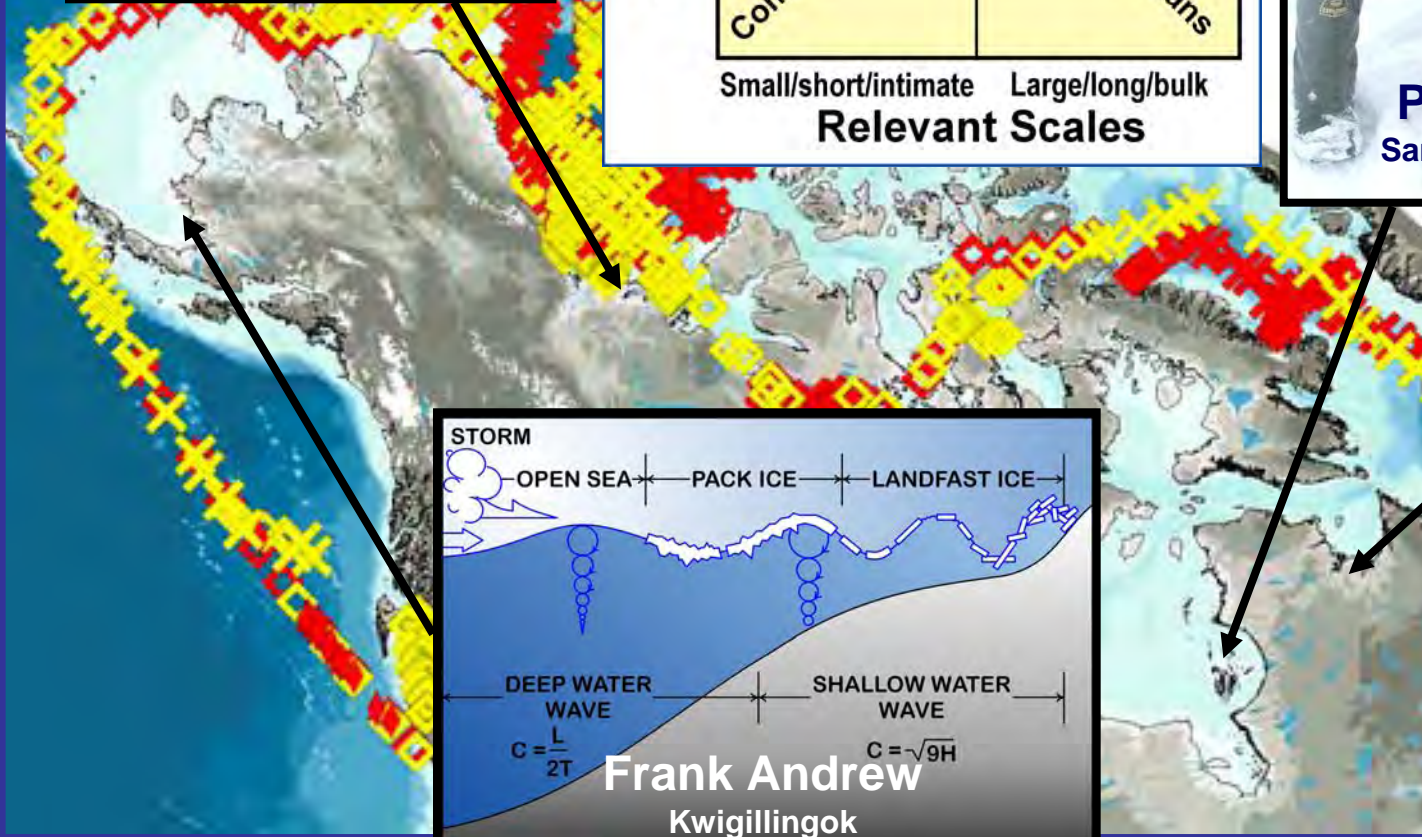




**Jimmy Jacobson**  
Tuktoyaktuk



**Peter Kattaq**  
Sanakiluqaq, Nunavut



**Frank Andrew**  
Kwigillingok



**Adamie Thomassie**  
Kangirsuk, Nunuvik

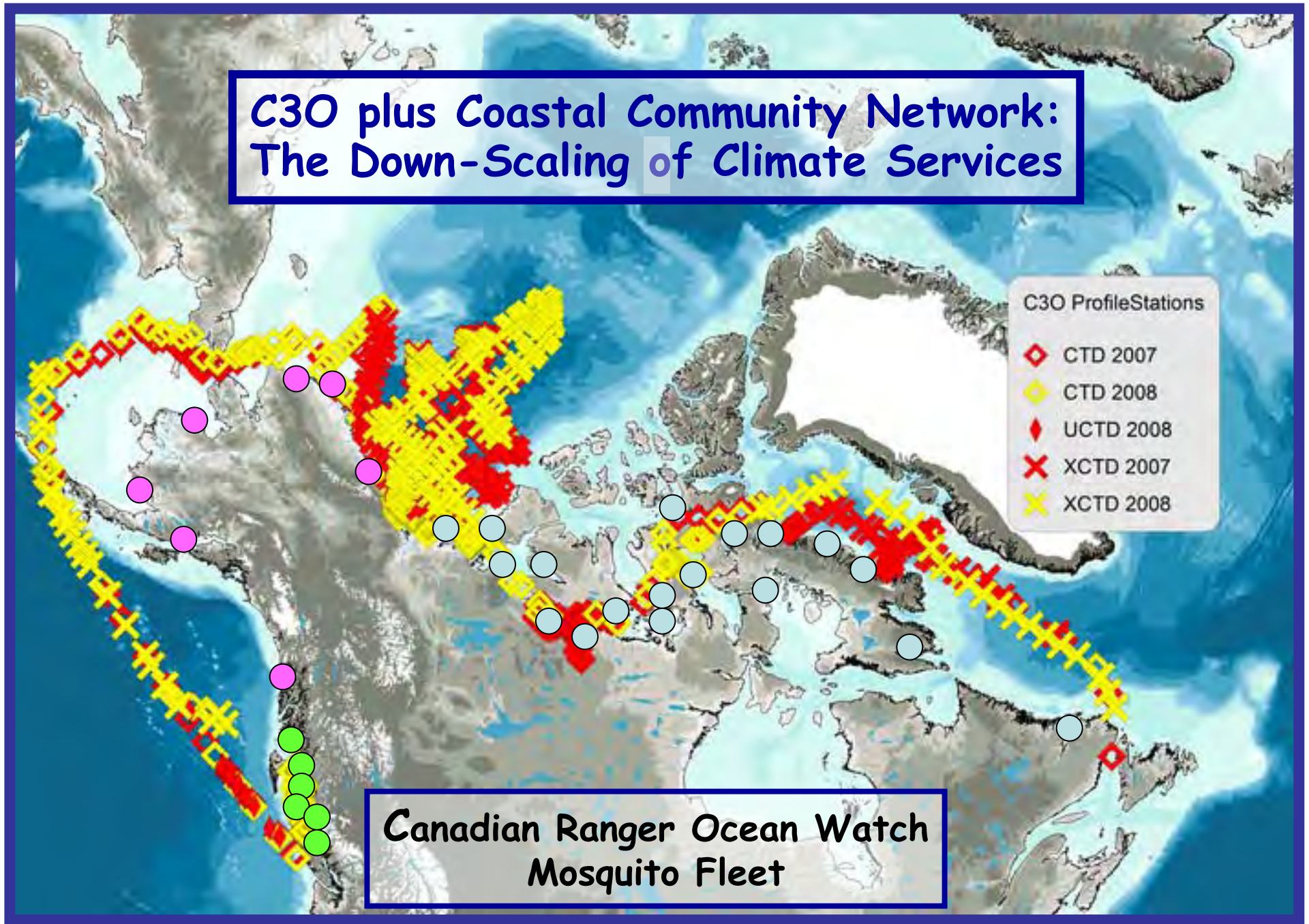


# C30 plus Coastal Community Network: The Down-Scaling of Climate Services

## C30 ProfileStations

- ◇ CTD 2007
- ◇ CTD 2008
- ◇ UCTD 2008
- × XCTD 2007
- × XCTD 2008

Canadian Ranger Ocean Watch  
Mosquito Fleet







Dieter Moeller  
26.08.2001 Cape Lawrence

IPY 2012 CONFERENCE  
MONTREAL, APRIL 22-27  
INTERNATIONAL POLAR YEAR



Panarchy?



**The Arctic Ocean is fully connected to the Global Ocean System; and must be observed accordingly**



**Science is very much about people:**

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**The People who do the Science ...  
and  
The People for whom the science is done**



STEVE  
ROMAINEE



**The Complexity & Resilience of  
Biogeography Deserves Our Most  
Serious Attention**



STEVE  
ROMAINEE



**Thank You Very Much**

**QUESTIONS?**