Nutrient fluxes (across the Arctic and into the Atlantic)

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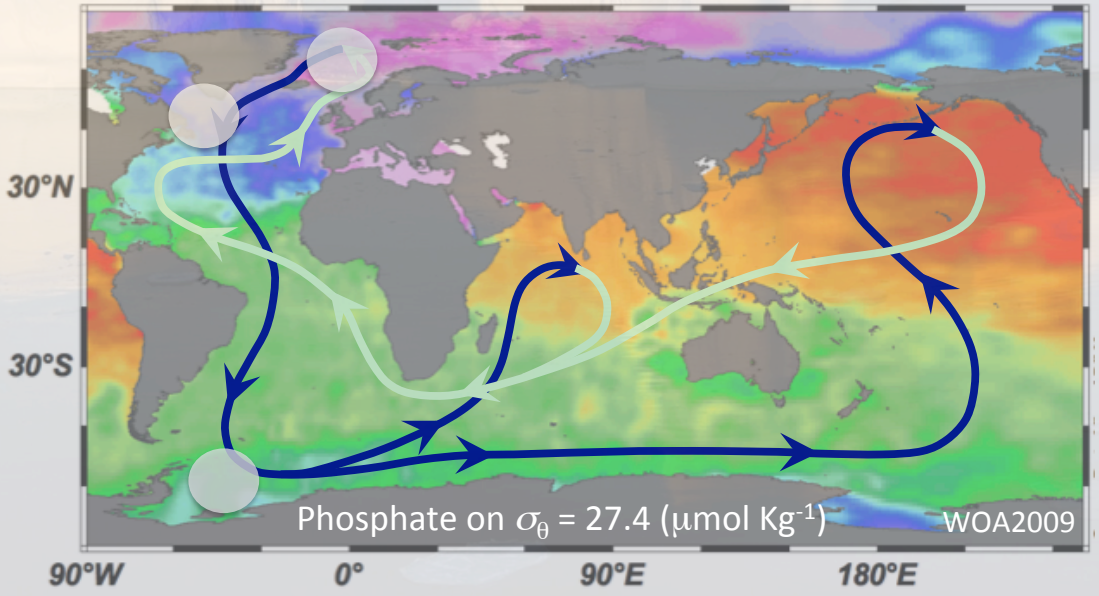
The importance of nutrients

- Nutrient supply constrains net biological productivity and primes the biological CO_2 pump
- The relative availability (or ratios) of different nutrients (N, P, Si, Fe) can affect bloom composition and thus food webs and export
- Nutrient ratios reflect biogeochemical history (tracer)
- Nutrient cycling modulates sea-air fluxes of N_2O, CO_2…

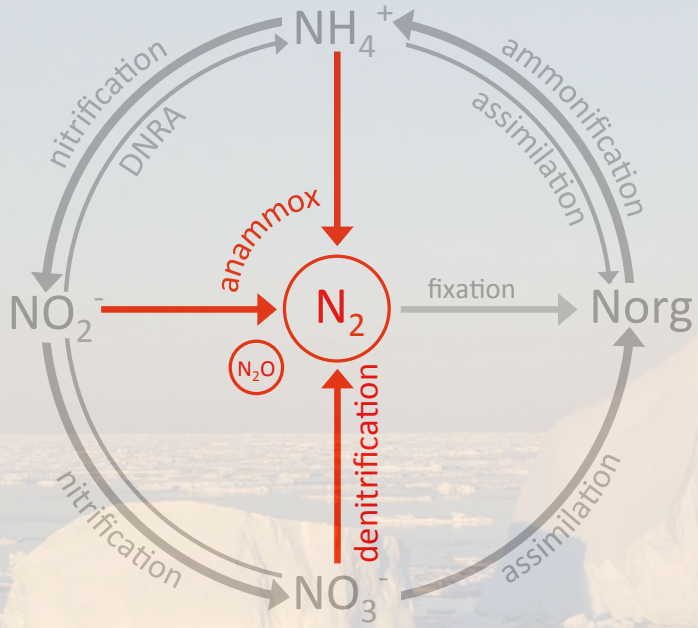
➢ Unbalanced nitrogen cycling in the North Pacific & adjacent Arctic
➢ Arctic delivers excess phosphate and silicate to the North Atlantic

Questions

- How does connectivity with the Arctic and Pacific oceans affect nutrient fluxes into the North Atlantic (surface & deep)?
- What's the impact of biological processes on nutrient inventories and ratios along different circulation pathways?
- How are nutrient fluxes into the North Atlantic affected by rapid change at higher latitudes (e.g. sea ice, freshening, river discharge, warming)?



Loss of fixed nitrogen

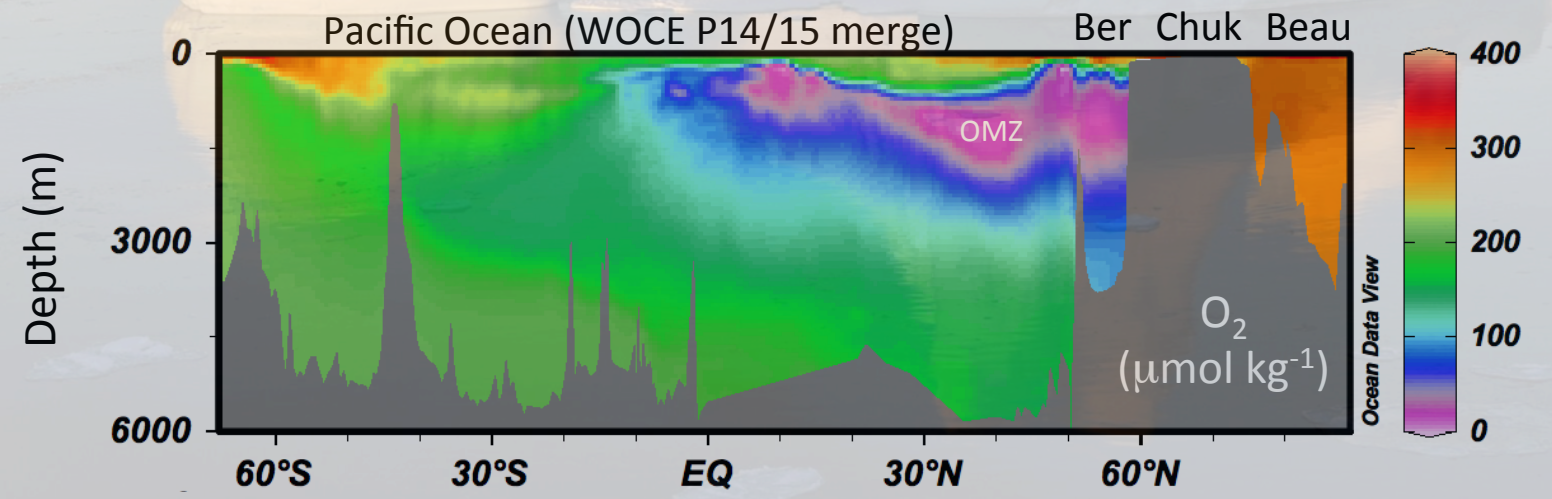


Nitrogen deficit relative to Redfield

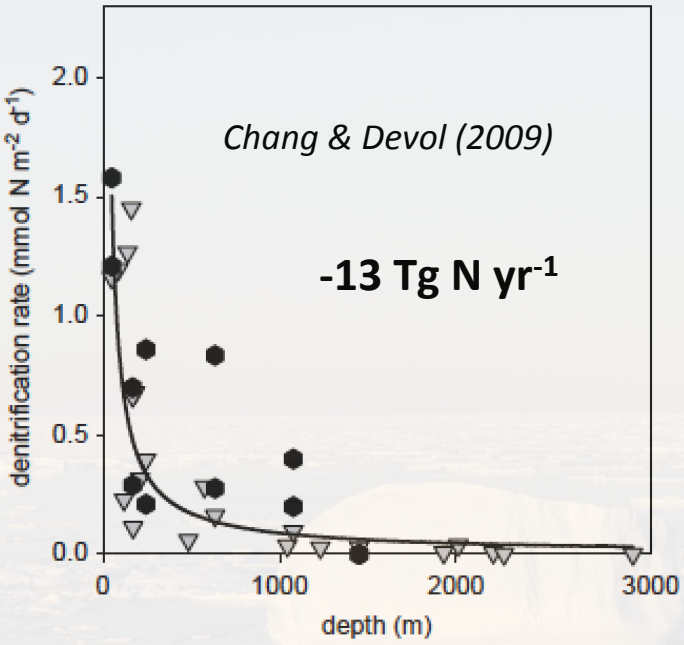
$N^* = DIN - 16\ DIP$

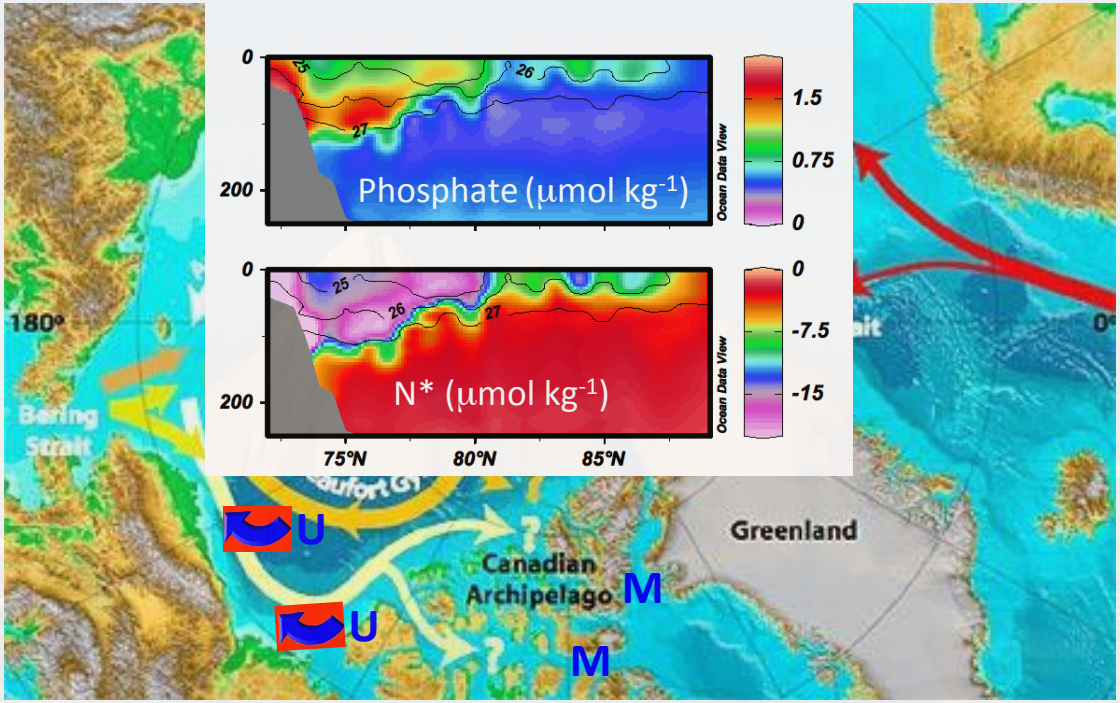
Phosphorus excess relative to Redfield

$P^* = DIP - DIN/16$



Sediment denitrification on shallow Arctic shelves





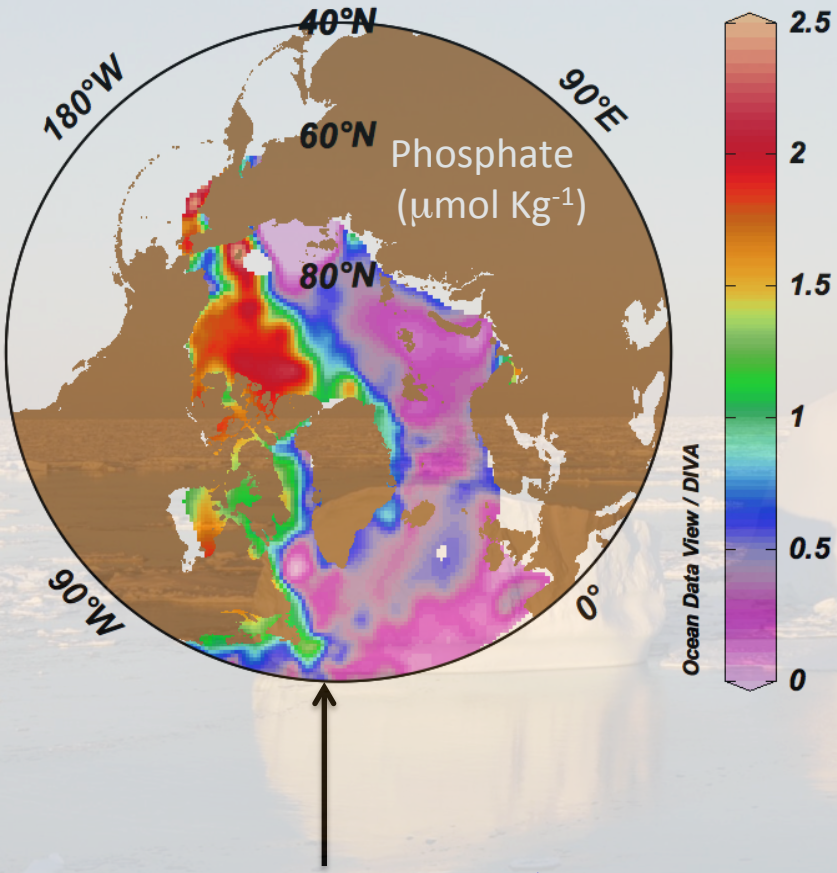
Nutrients accumulate in the halocline due to:

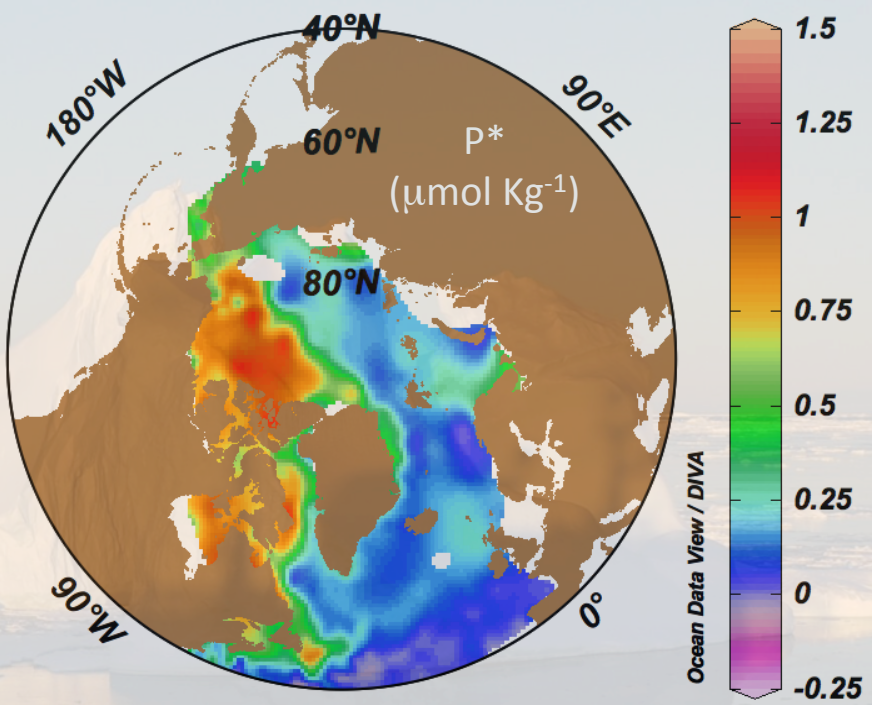
- winter convection (pre-formed)
- decomposition (re-mineralized)
- strong vertical stratification

Can be mobilized by:

- Upwelling (shelf-break or ice-edge) = **U**
- Mixing in narrow channels = **M**

A static view of phosphate and P* on σ_θ = 26.7



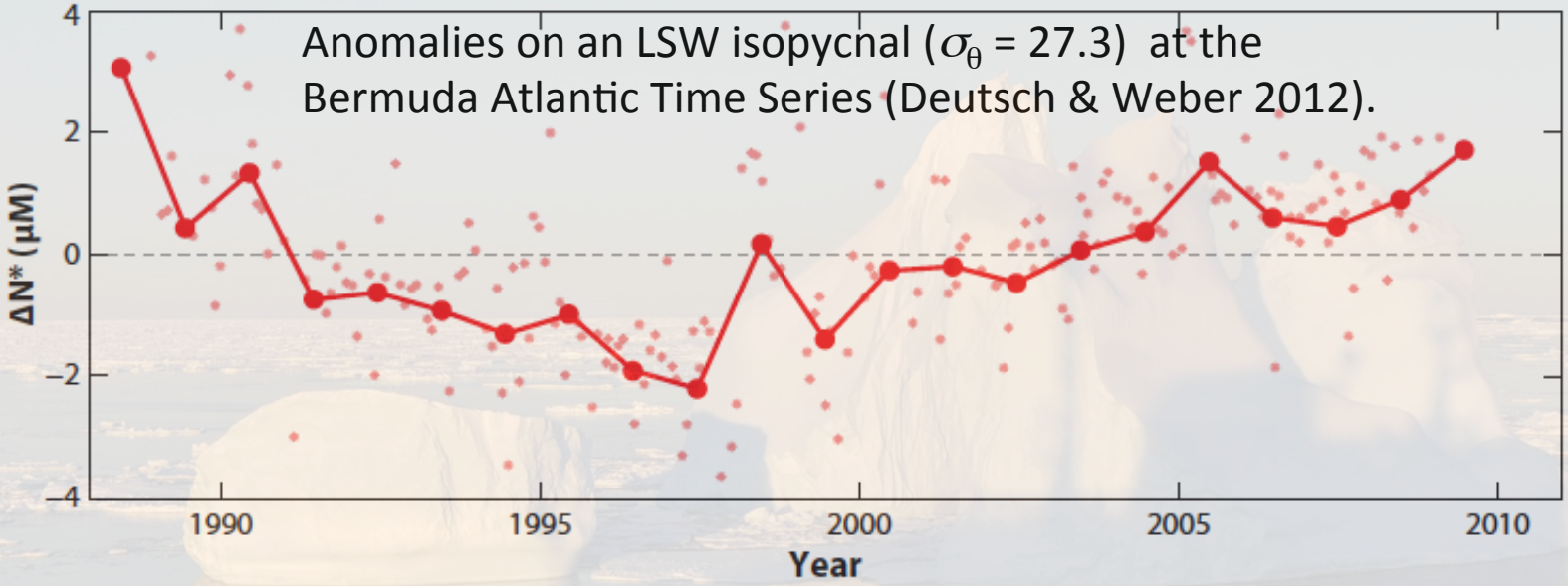


Same pattern for silicate

- Excess P supports nitrogen fixation?
- Nitrogen fixation and excess Si support diatom growth?

Composite of data from: ArcticNet (2005-2013), Codispoti et al. 2010, WOA2009, JOIS, C3O

N* of Labrador Sea Water varies substantially on interannual & decadal time scales

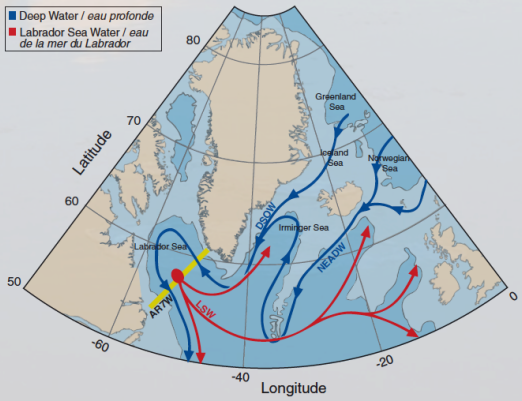


What causes this variability and where?

Subarctic Atlantic, Arctic or North Pacific?

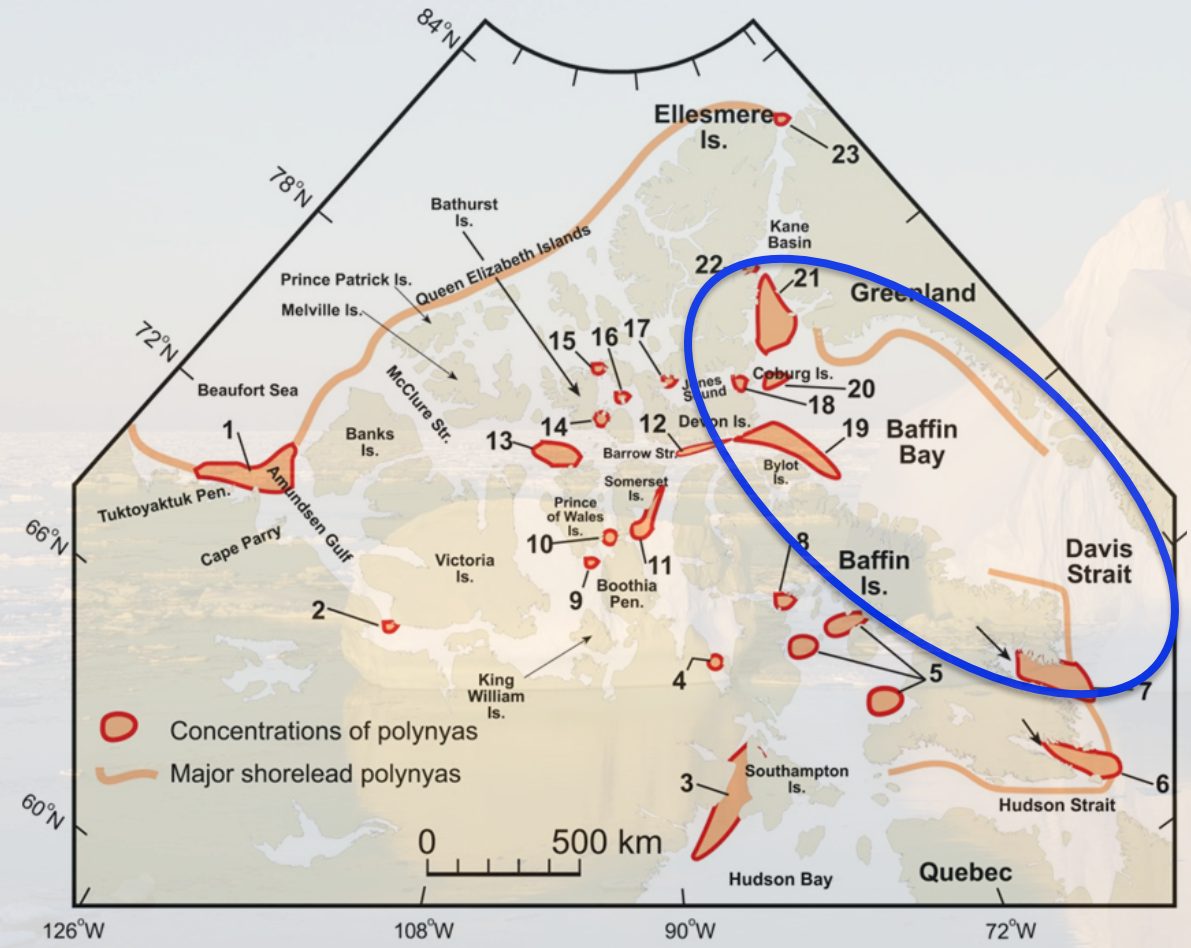
LSW formation?

LSW export pathways?



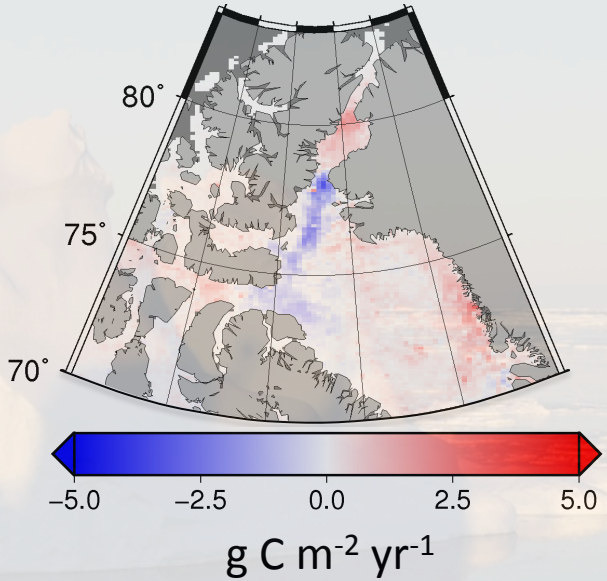
Slide from Jaime Palter (McGill U)

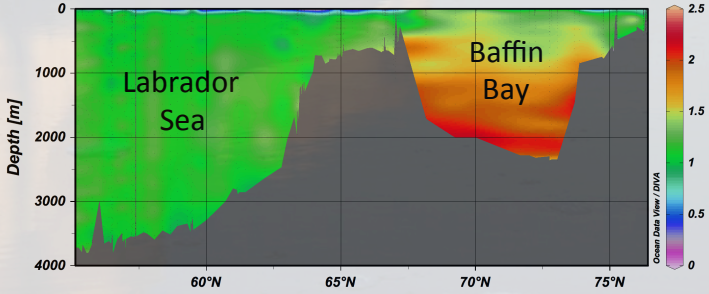
Polynyas: nutrient traps at the edges of Baffin Bay



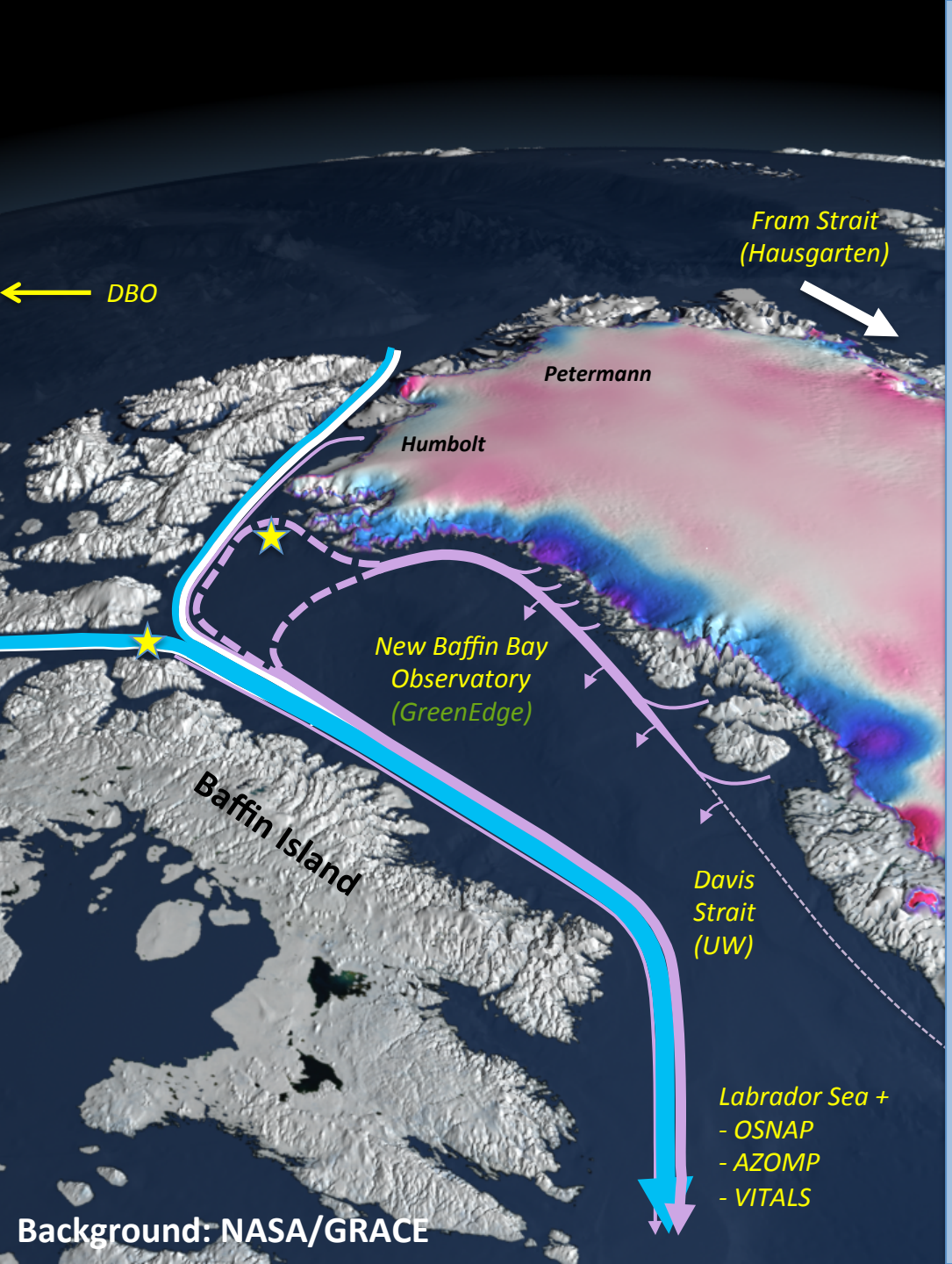
1 Cape Bathurst
2 Lambert Channel
3 Roes Welcome Sound
4 Committee Bay
5 Foxe Basin
6 Frobisher Bay
7 Cumberland Sound
8 Fury and Hecla Strait
9 Franklin Strait
10 Bellot Strait
11 Prince Regent Inlet
12 Lancaster Sound
13 Viscount Melville Sound
14 Karluk Brooman
15 Queens Channel and Penny Strait
16 Dundas Island
17 Hell Gate – Cardigan Strait
18 Lady Ann Strait
19 Bylot Island
20 Coburg Island
21 North Water (NOW)
22 Flagler Bay
23 Lincoln Sea

Trends in Primary production[1] (1998 – 2010)





[1]Bélanger et al. 2013



Key Points

- The Arctic affects nutrient load and dynamics in the North Atlantic
- Mostly a black box!
- Recent nutrient budget: P & Si not balanced, N balanced?
  (Torres-Valdés et al. 2013)
- Need coordinated observatories
  (+ Baffin Bay)