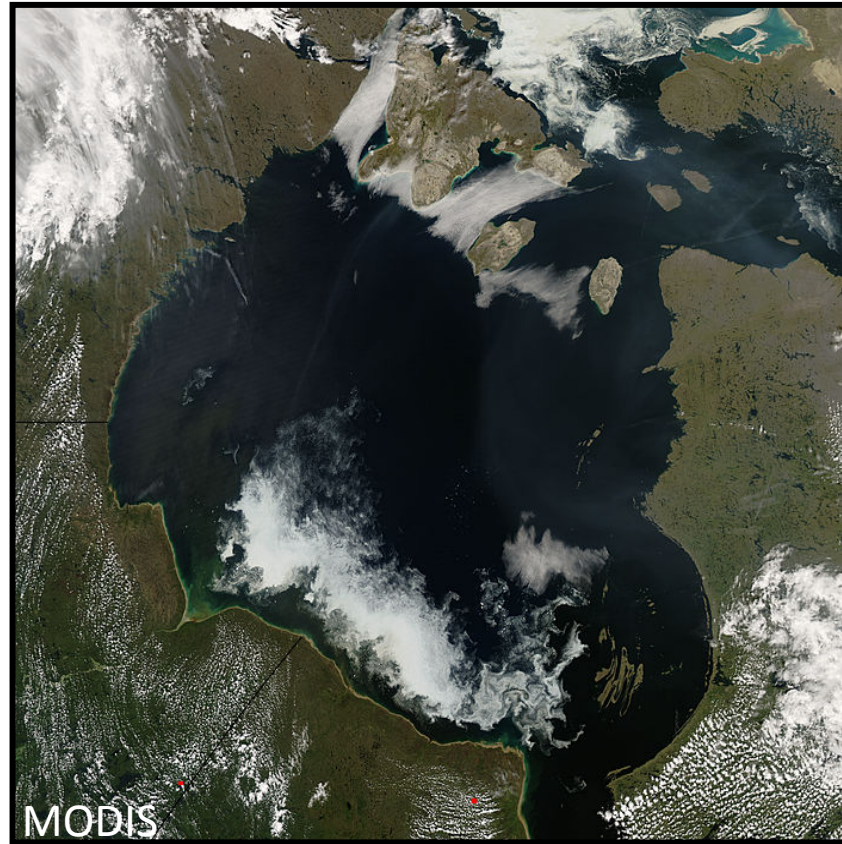


Freshwater Sources and Distribution in the Hudson and James Bay System



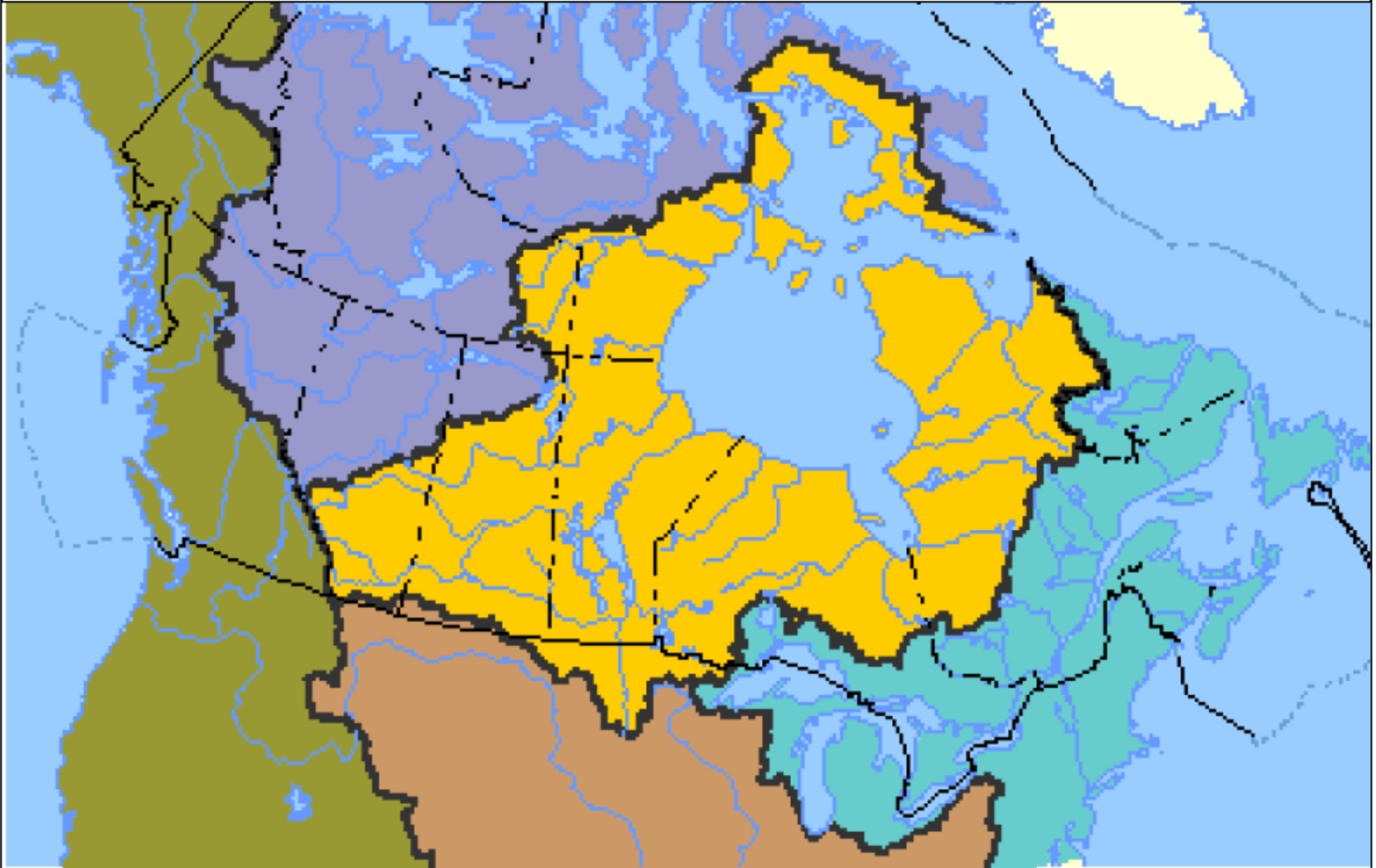
Zou Zou Kuzyk, Assistant Professor,
CEOS, University of Manitoba

Collaborators

- CEOS and ArcticNet colleagues and students
- Robie Macdonald, Institute of Ocean Sciences, Fisheries and Oceans Canada, Sidney BC
- Mats Granskog, Norwegian Polar Institute, Tromso, Norway
- Community of Churchill, Manitoba Hydro
- Joel Heath, Arctic Eider Society and Sanikiluaq community members

Hudson Bay watershed

$\sim 3.7 \times 10^6 \text{ km}^2$, $> 1/3$ of Canada's land mass

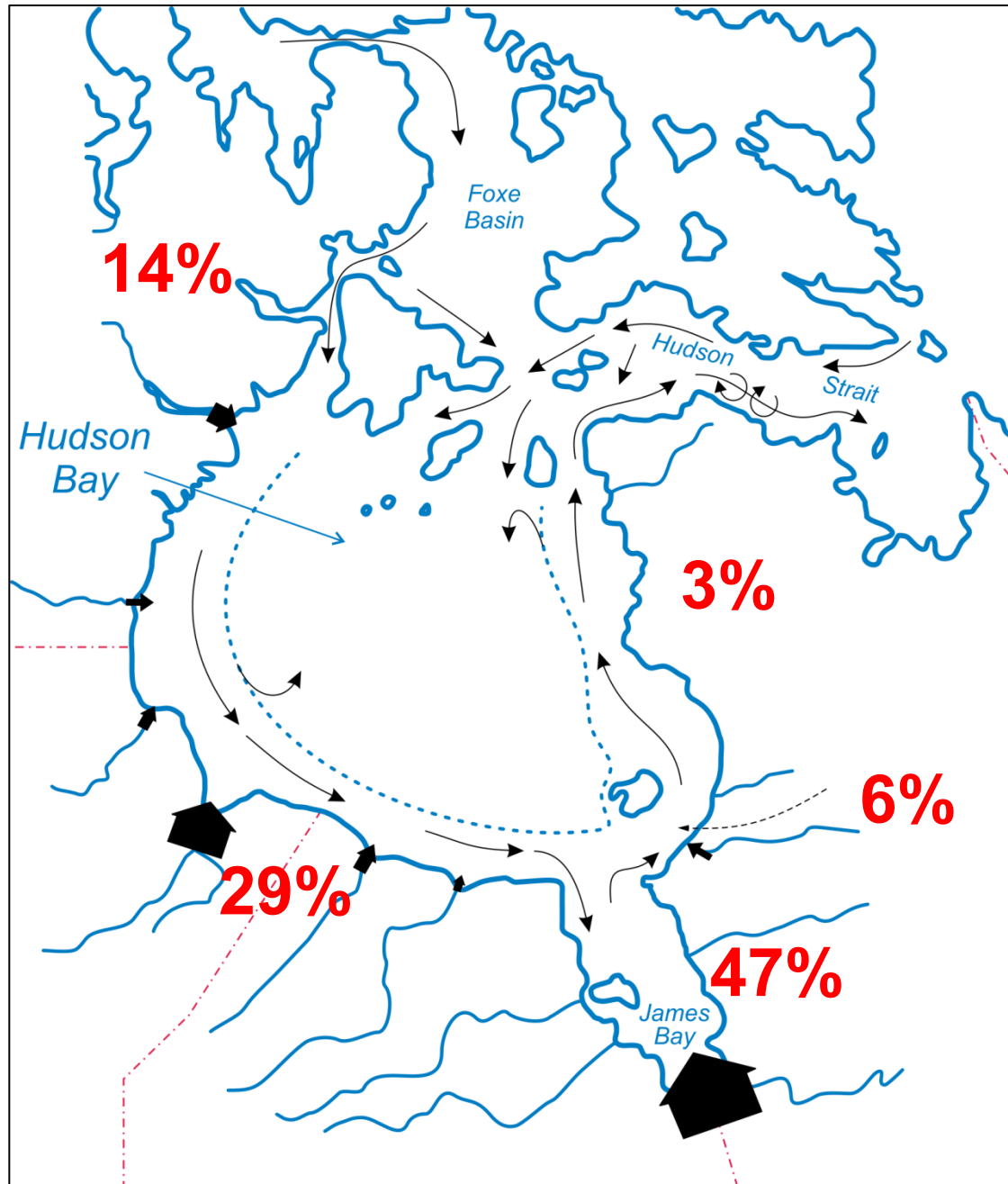




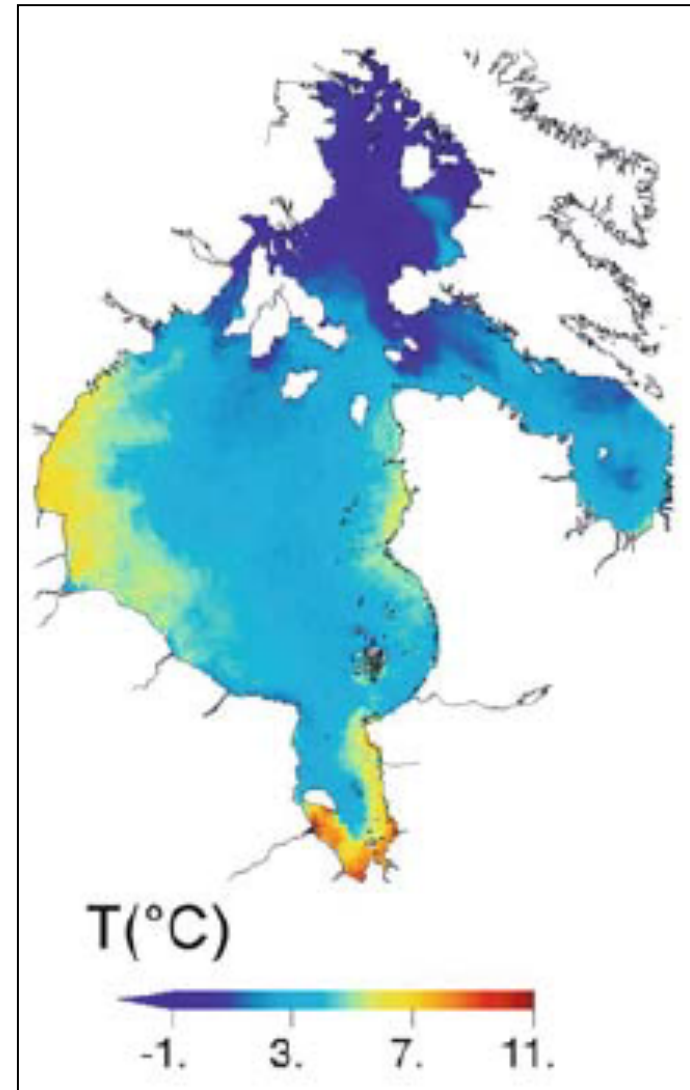
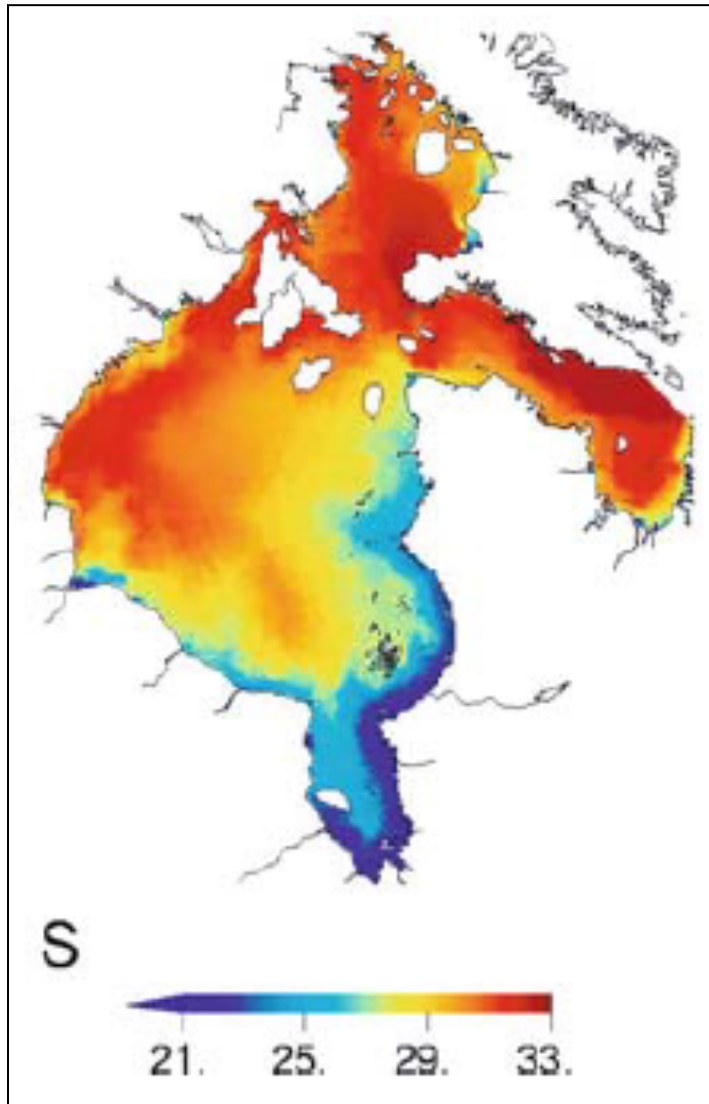
River discharge
> 750 km³/yr
> 0.8 m thick, if it were
distributed evenly over
the surface of the Bay.

Hudson Bay is essentially
an estuarine system.

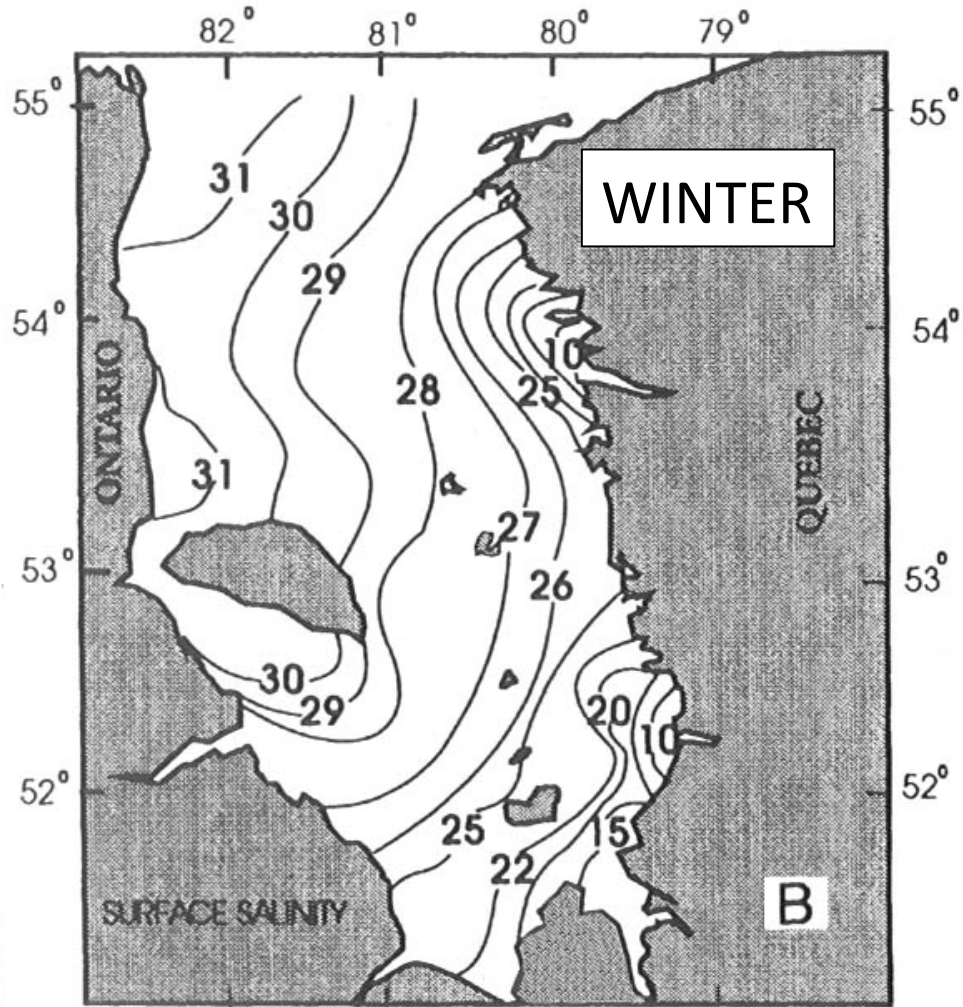
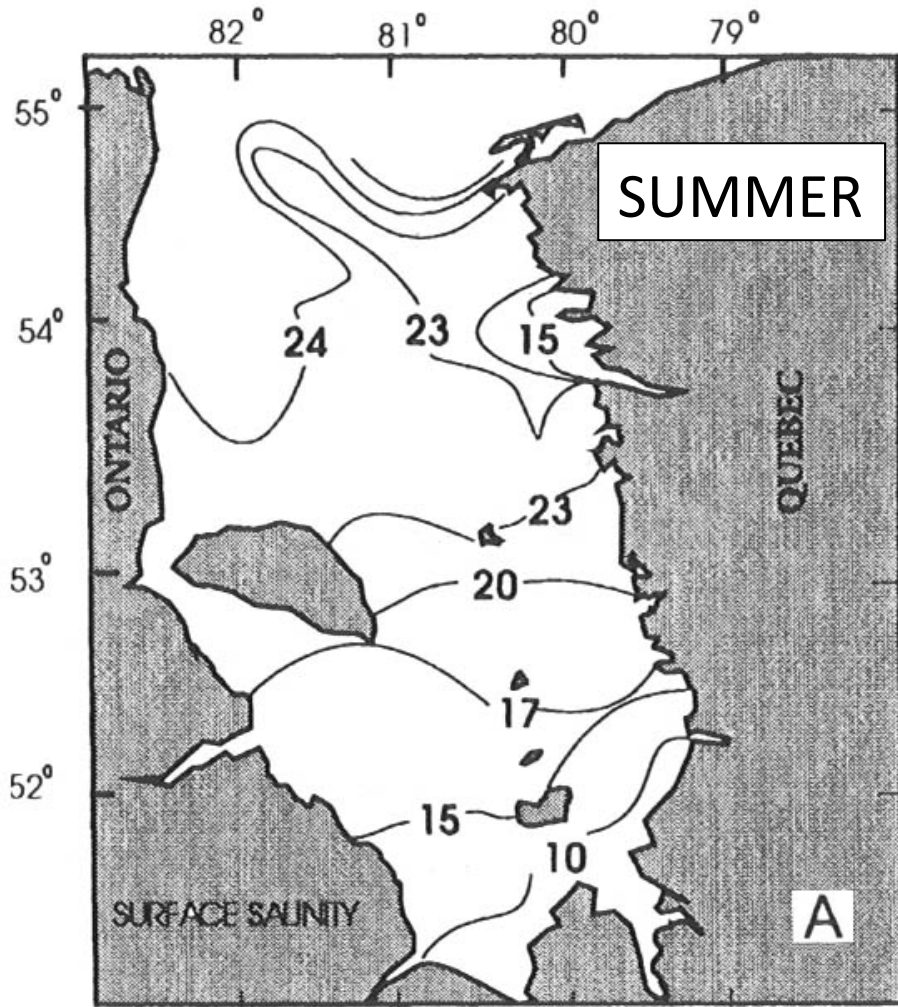
Input of
river
water by
sector



Summer surface salinity and temperature

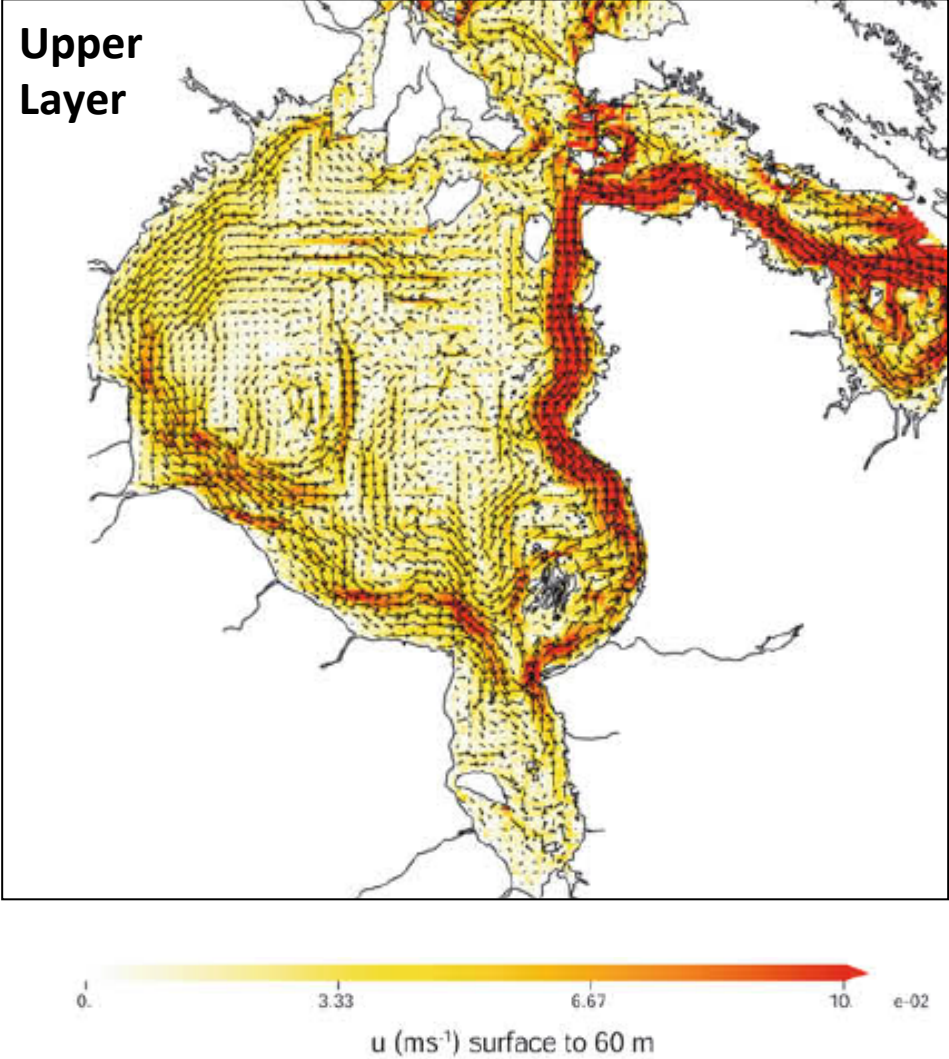
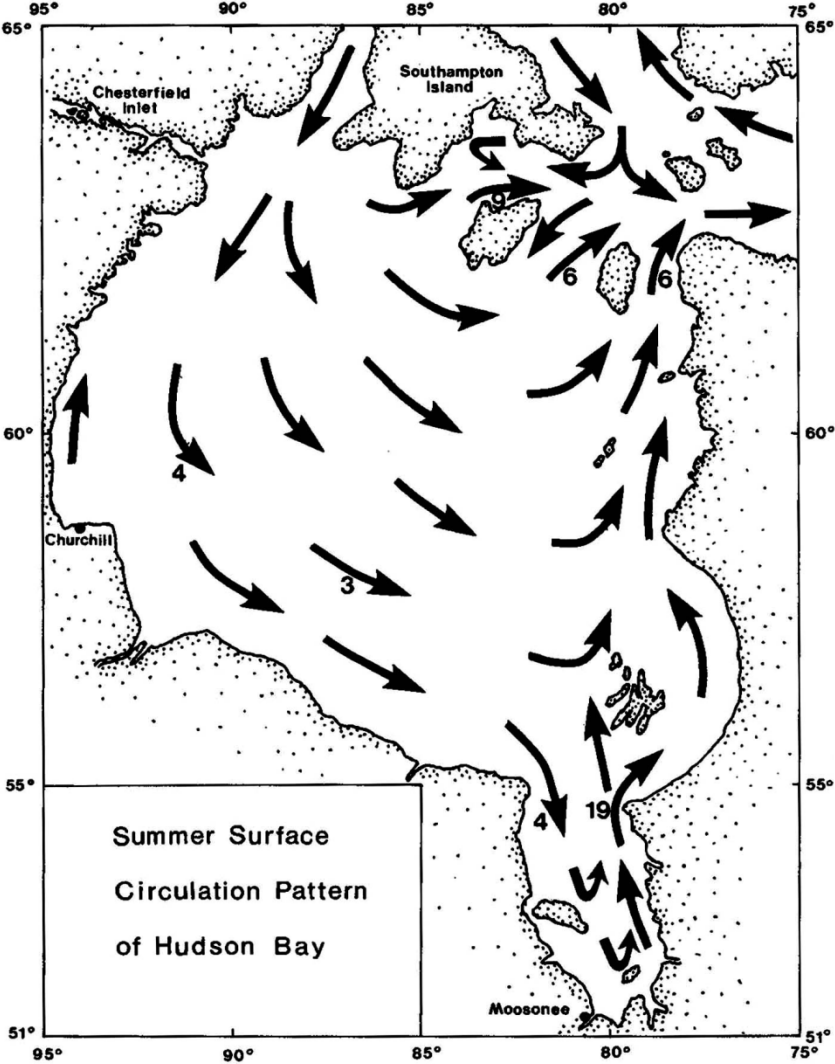


Surface salinity in James Bay

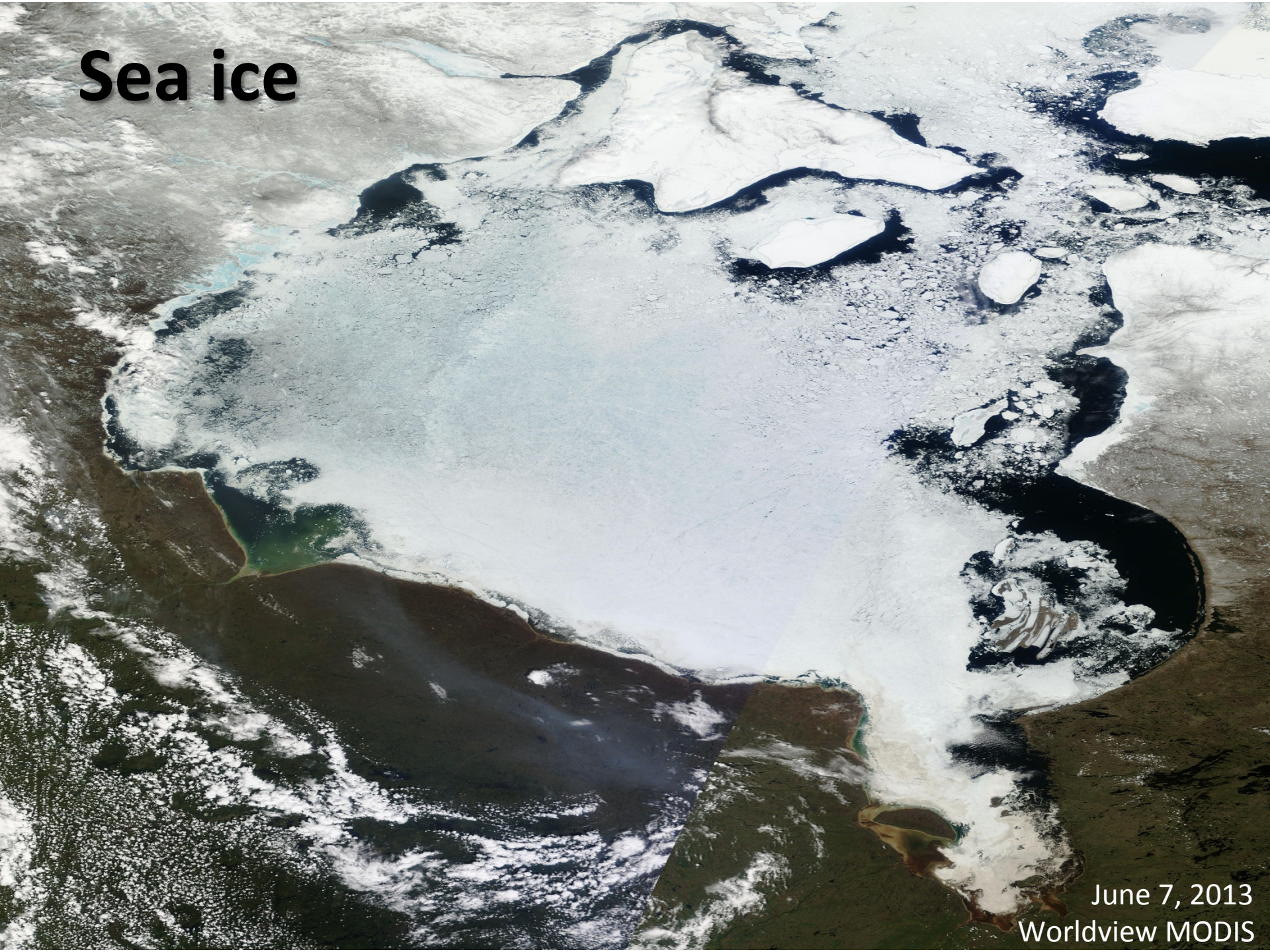


*early data (1970s)

Horizontal circulation and coastal current



Sea ice



June 7, 2013
Worldview MODIS

Seasonal sea-ice growth and melt cycle

Winter

- ice growth

- withdrawal

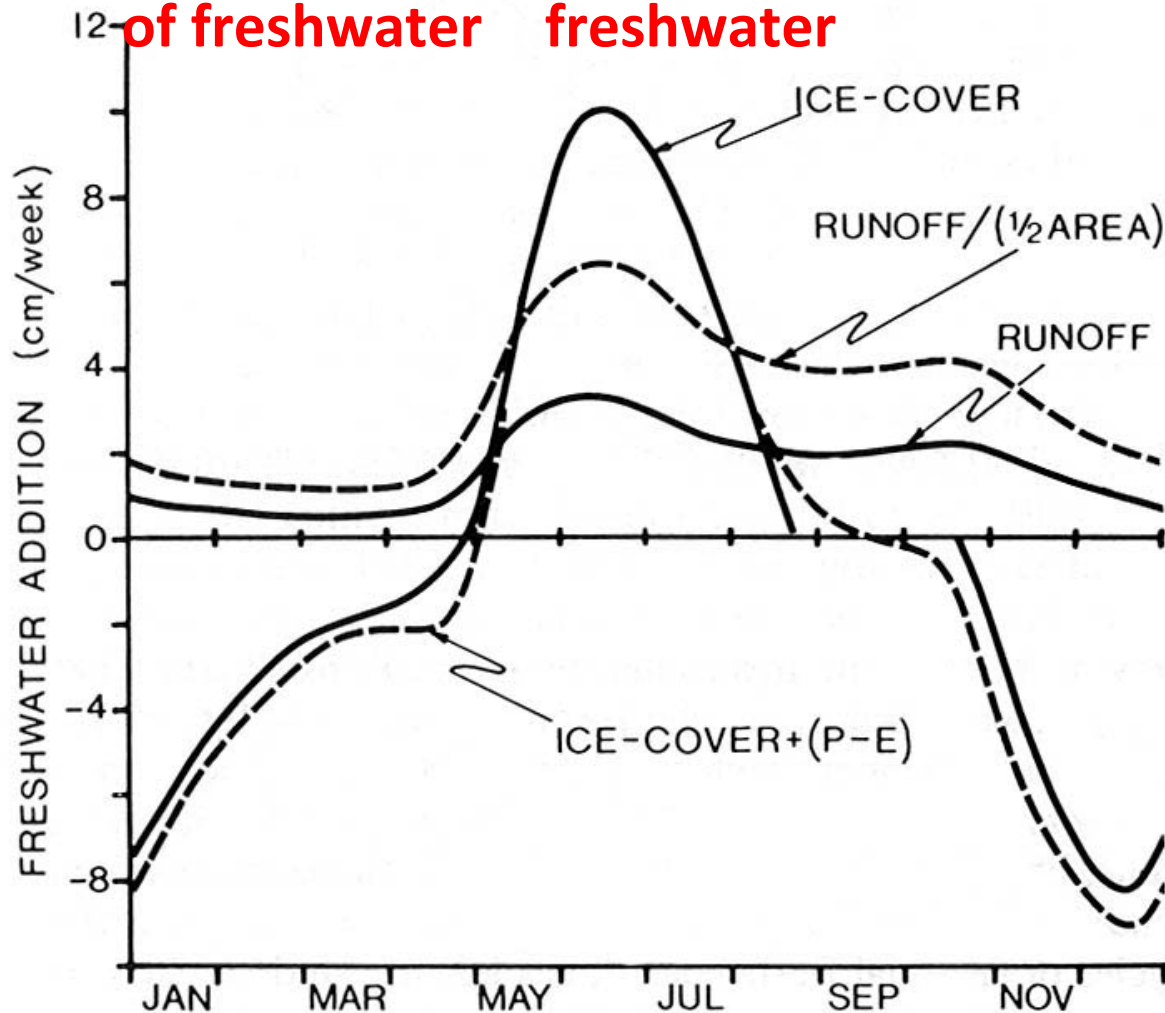
of freshwater

Summer

- ice melt

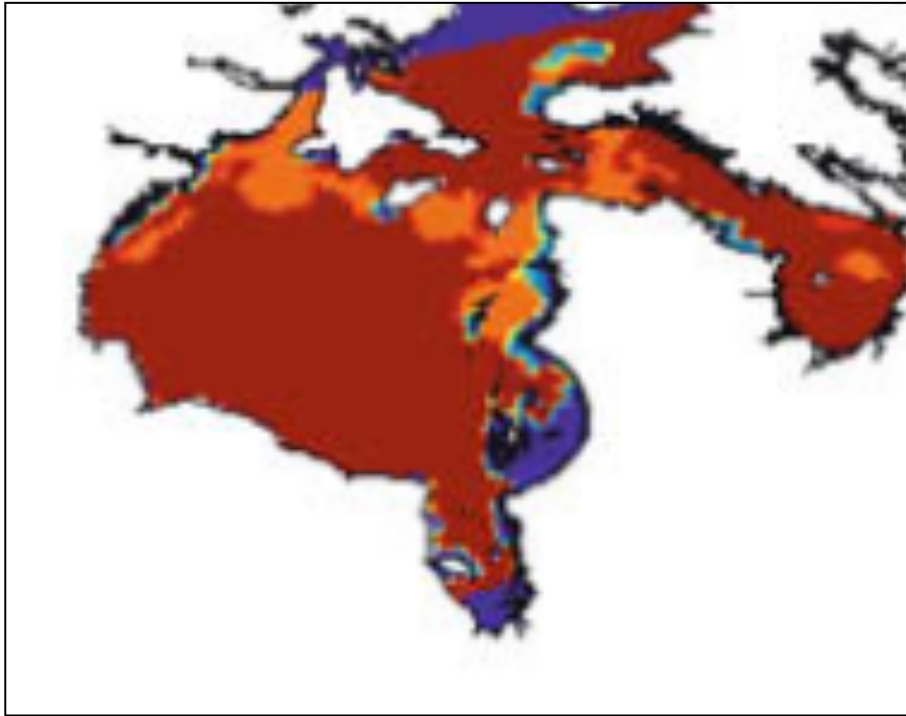
- addition of

freshwater

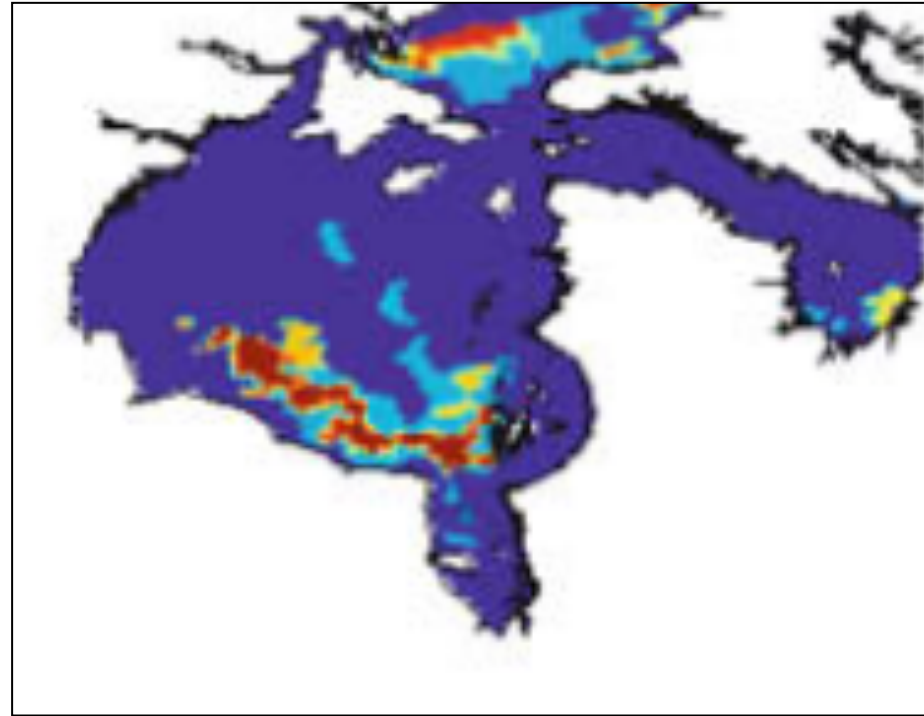


Sea-ice distribution during melt season

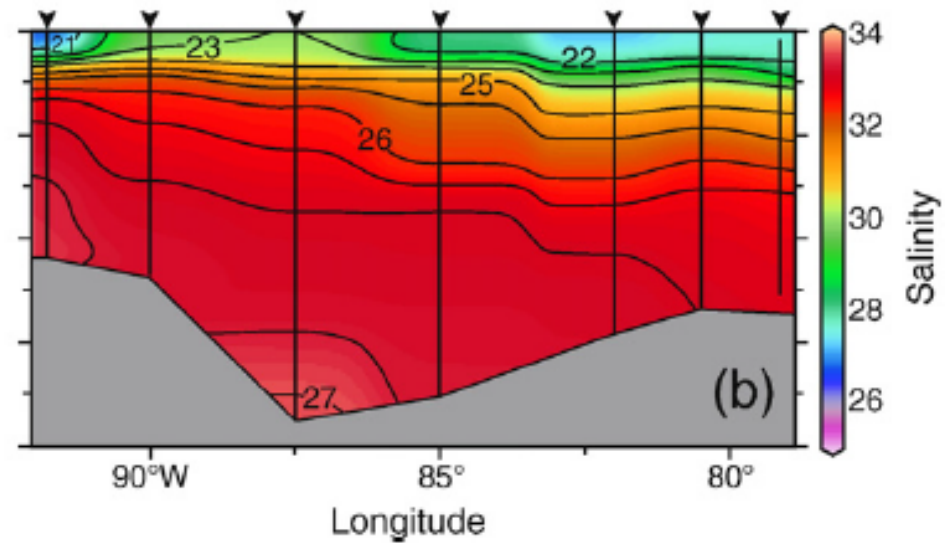
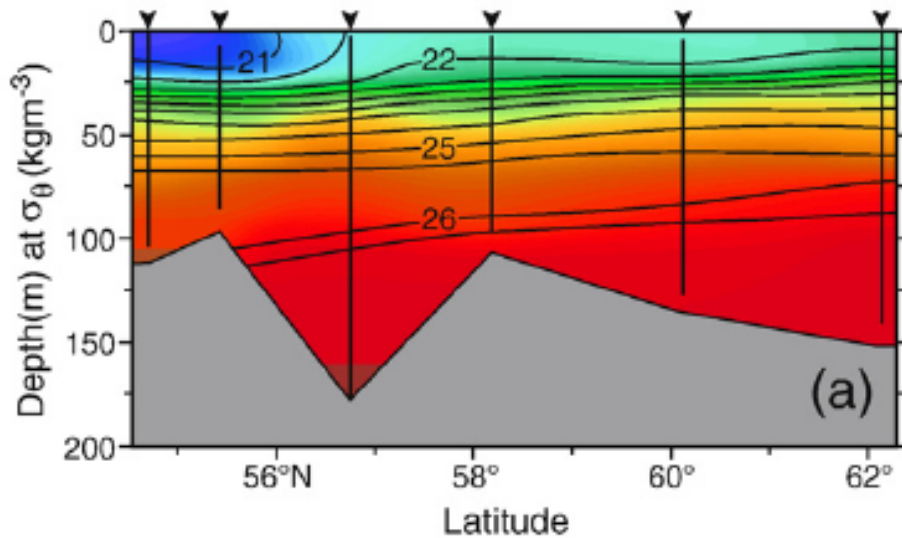
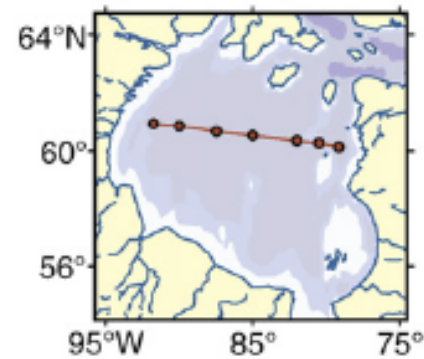
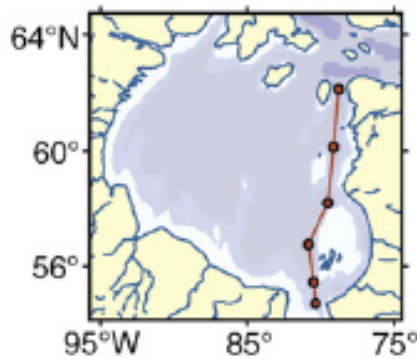
Spring



Summer



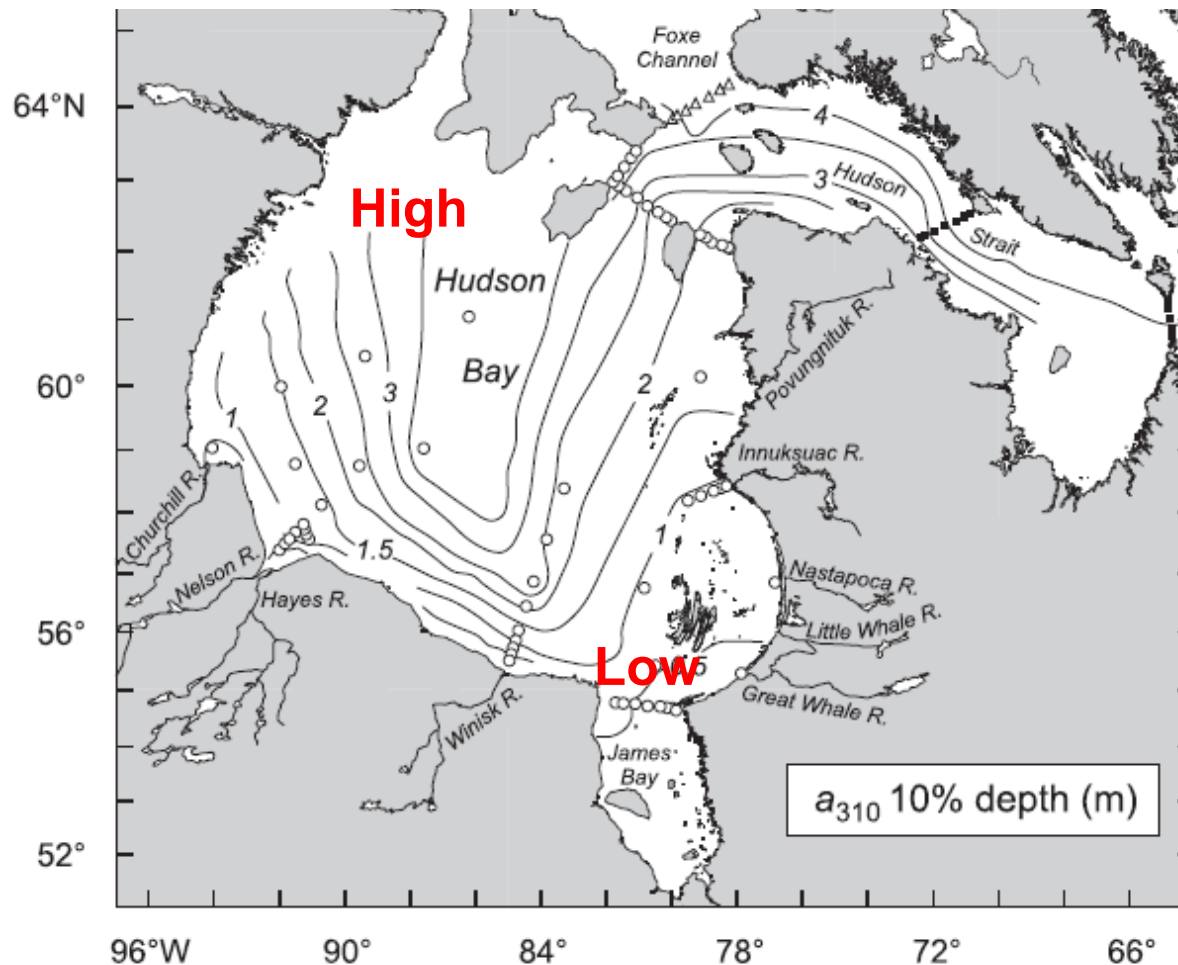
Vertical stability of water column



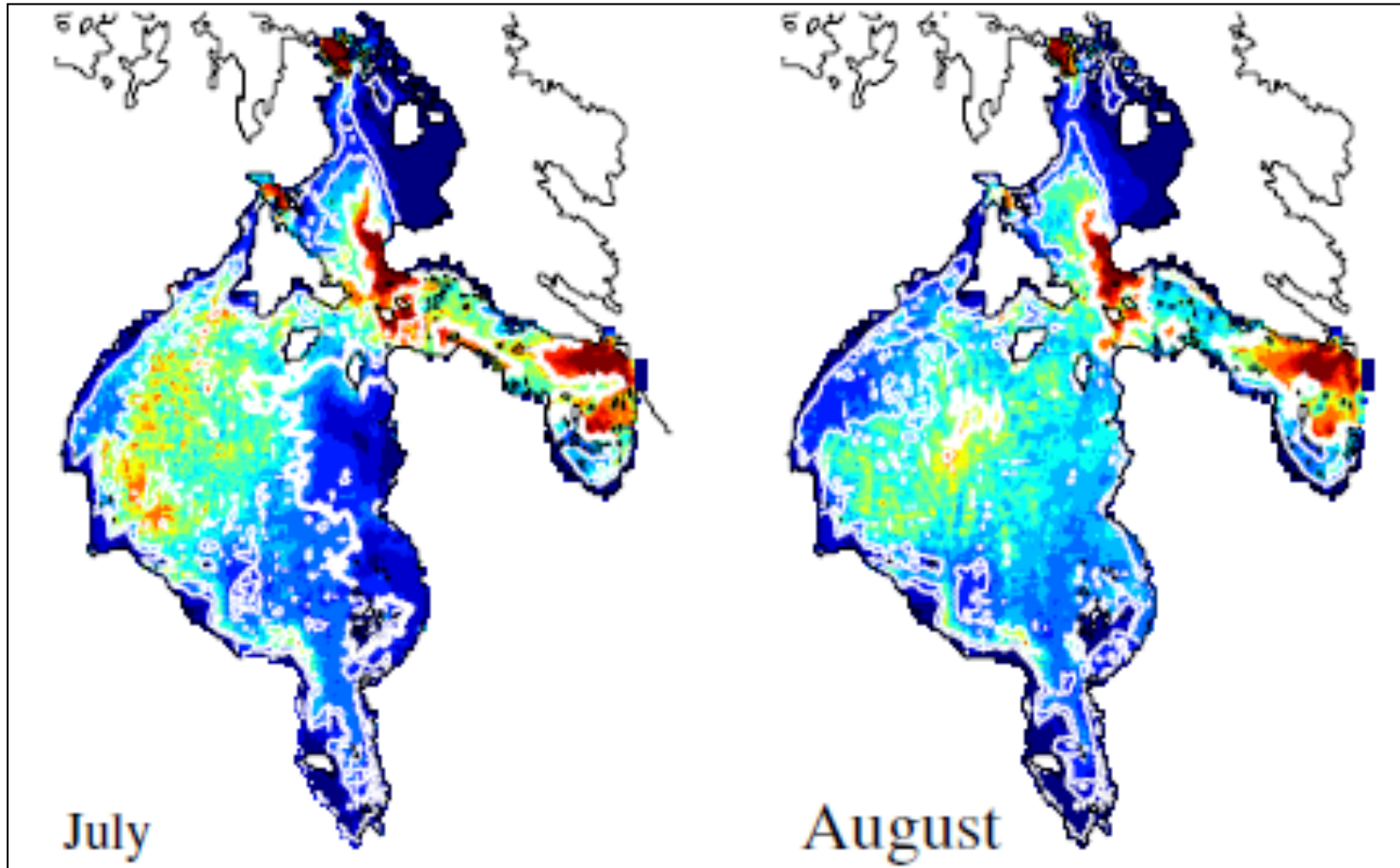
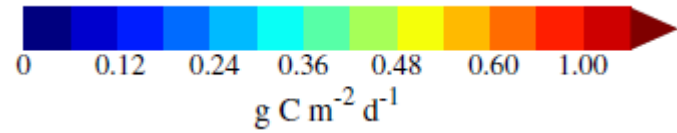
Impacts of river water and sea-ice melt

River water brings in nutrients, organic matter, sediments

Depth of light penetration into the water column

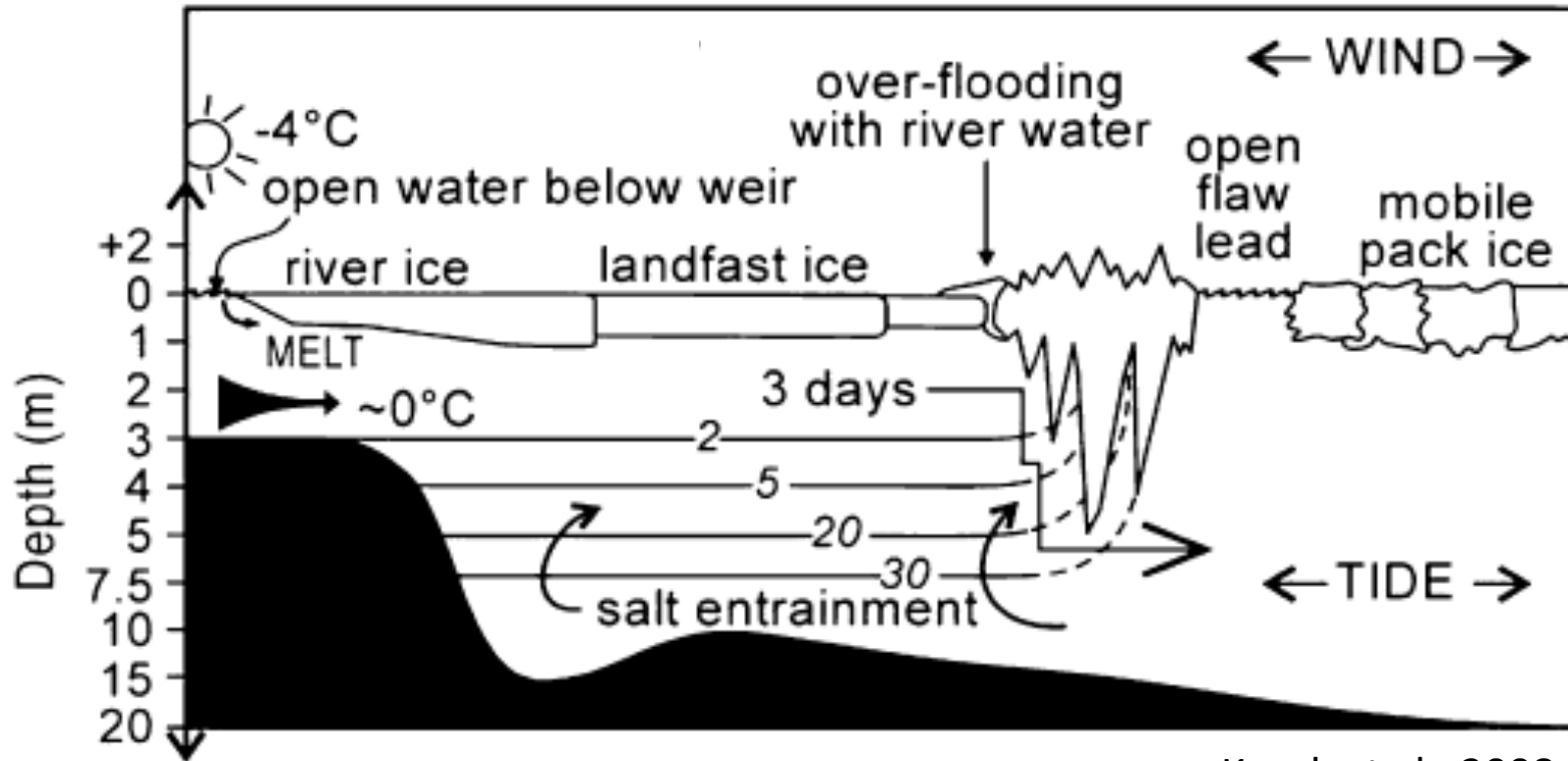


Spatial pattern in algae growth rates



Sea-ice and river runoff interact

In estuaries:



Kuzyk et al., 2008

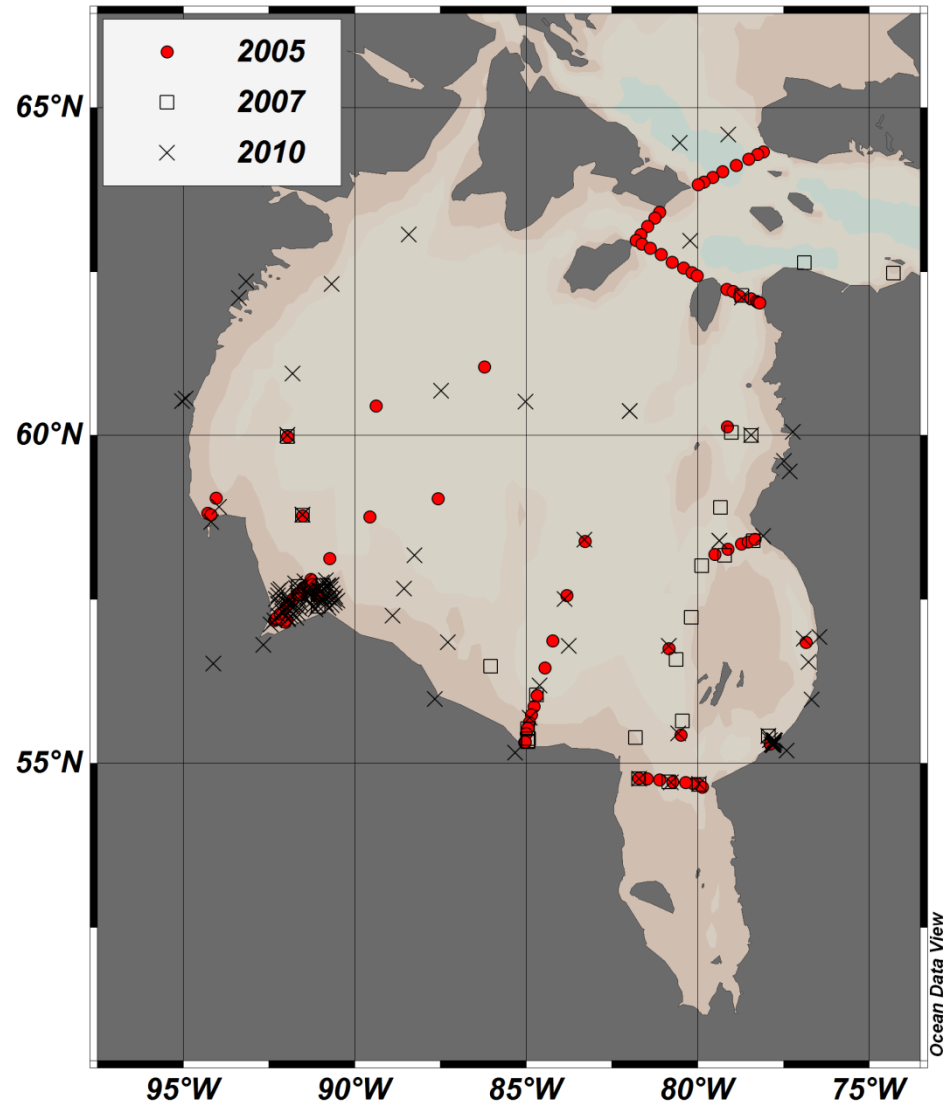
At the large scale, positive association between river runoff and sea-ice extent or thickness has been observed.

Both river runoff and sea ice are undergoing change

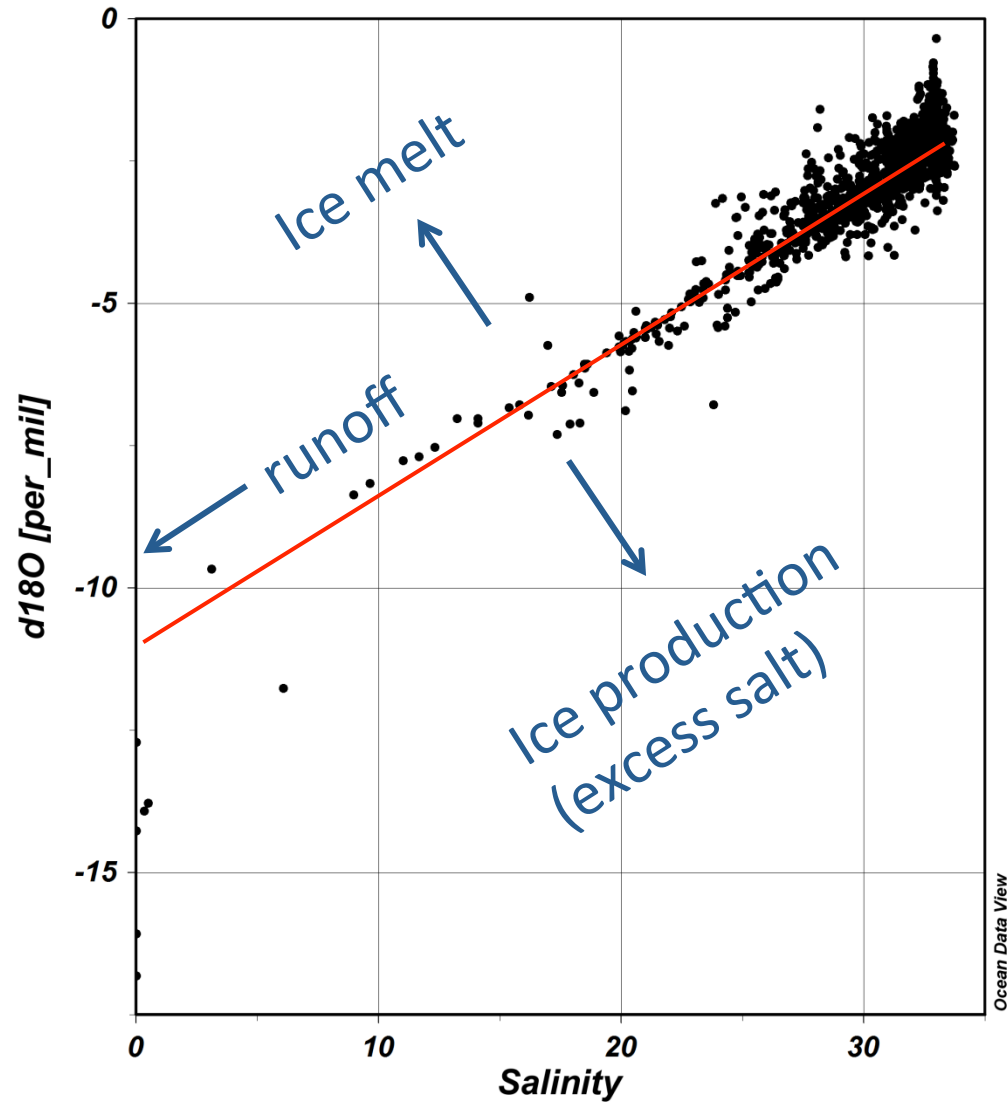
- Climate
 - Surface air temperatures have risen at nearly one degree per decade
 - The season of sea-ice cover has been shortened by a couple weeks or more
 - The timing and volume of river runoff has changed over the period of record
 - Future predictions of increase in river runoff
- Hydroelectric development

Three ArcticNet cruises have allowed study of freshwater distribution in Hudson Bay:

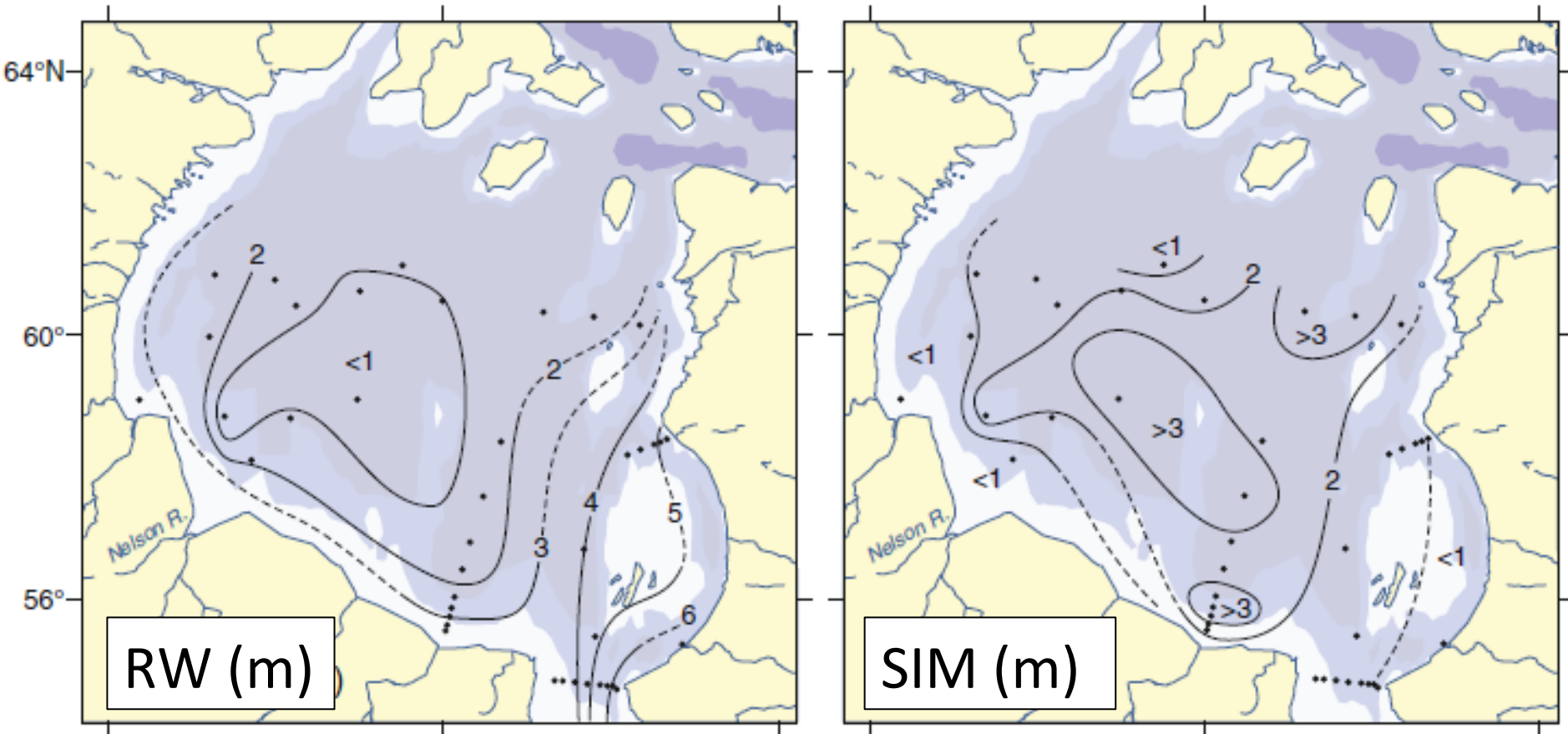
- Sept 22-Oct 16, 2005
 - Aug 3-16, 2007
 - July 7-30, 2010
-
- Goal was to obtain baseline data and gain insight into possible impacts of change
 - Systems approach, linking oceanography, chemistry, biology



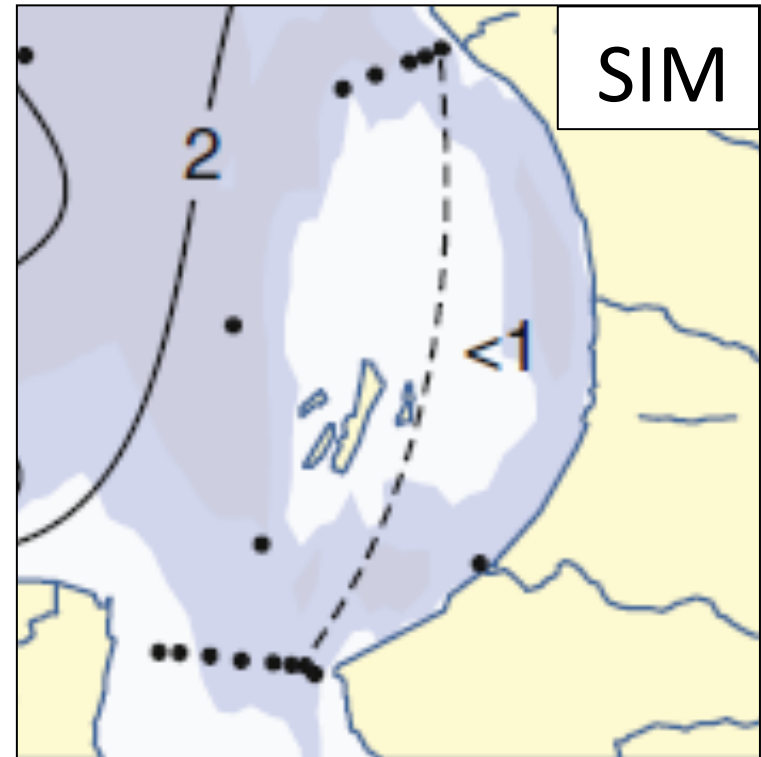
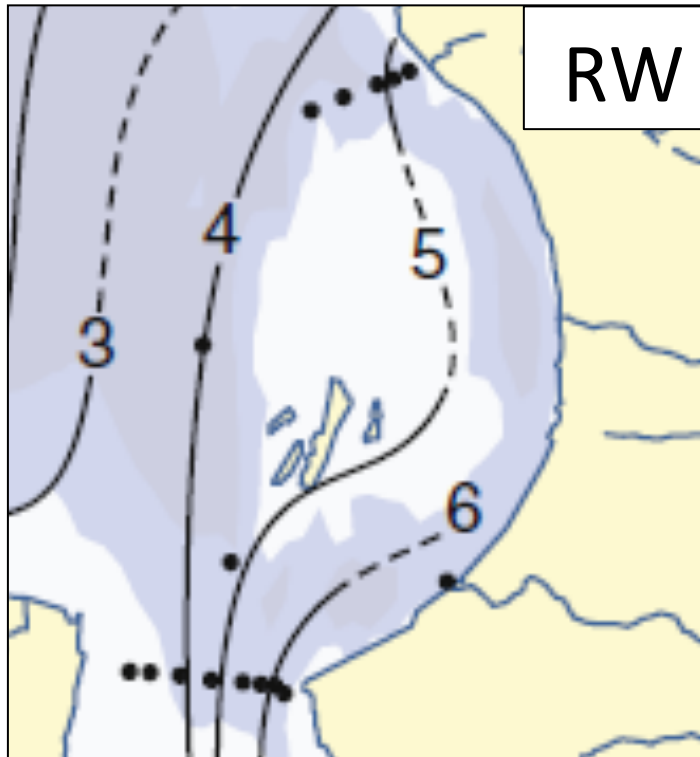
Various tracers were applied to discriminate sources of freshwater

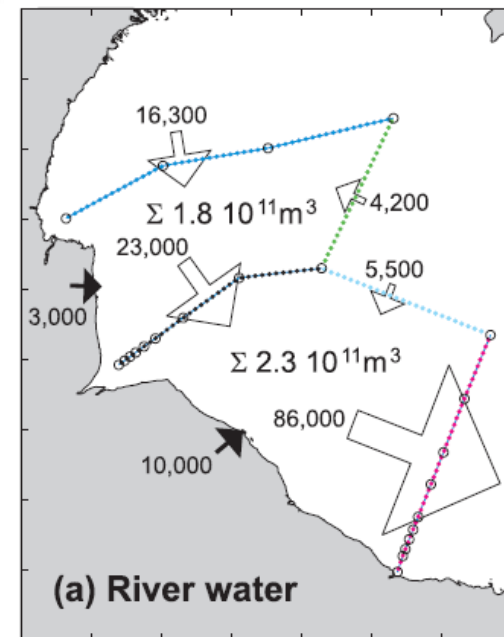
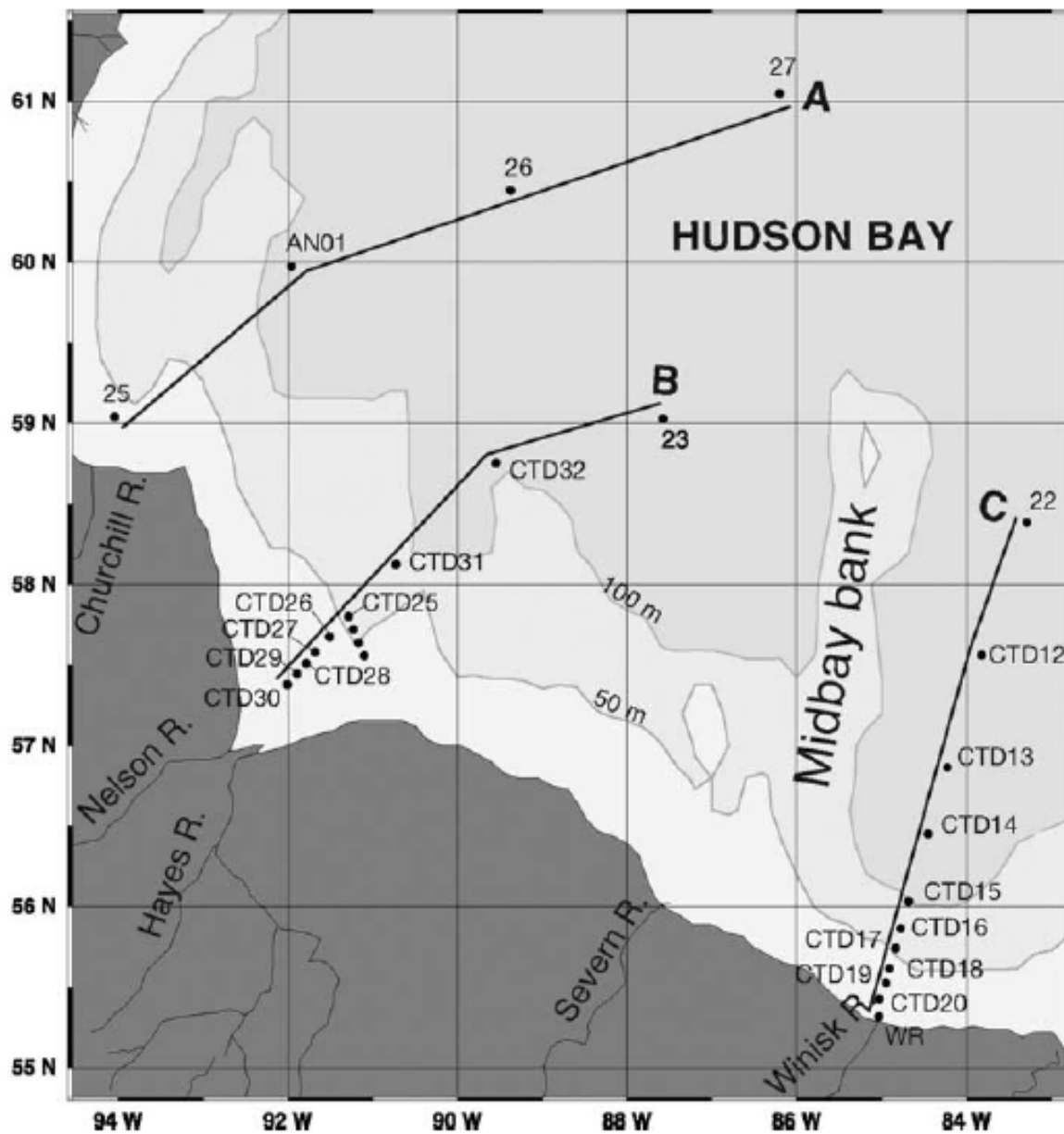


Distribution of river water (RW) and sea-ice melt (SIM)



Distribution of river water (RW) and sea-ice melt (SIM) in the EMR

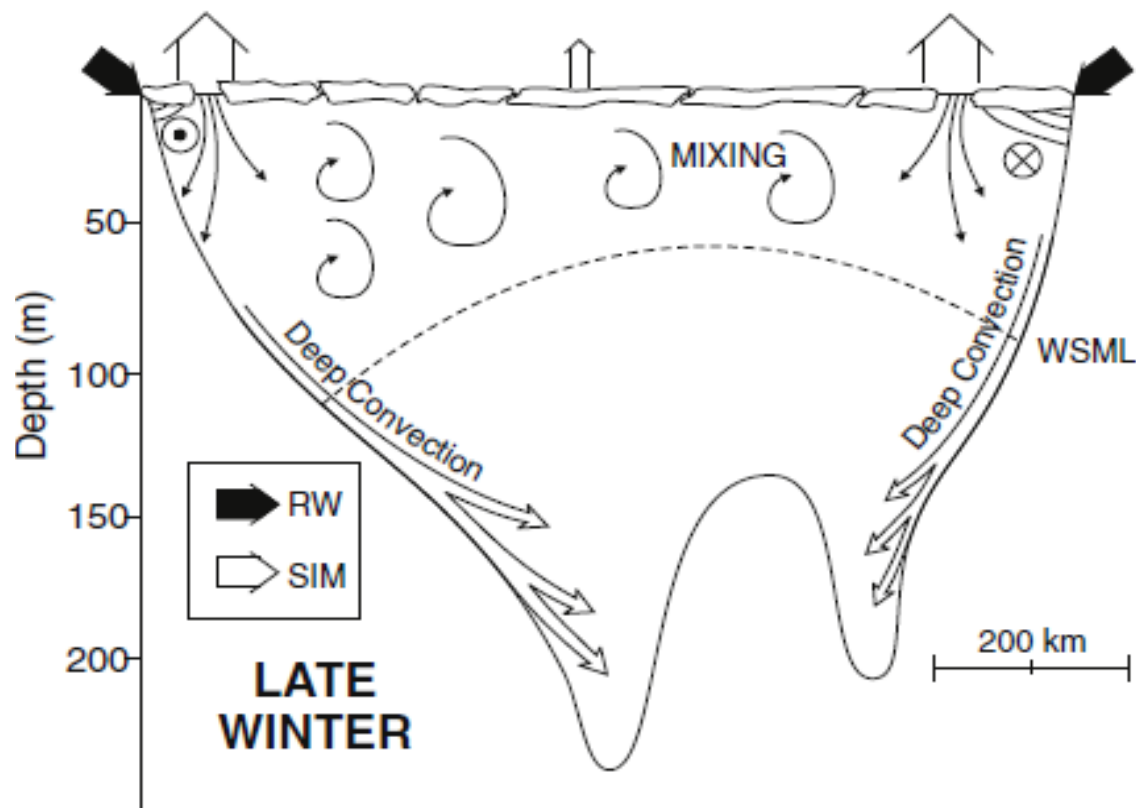


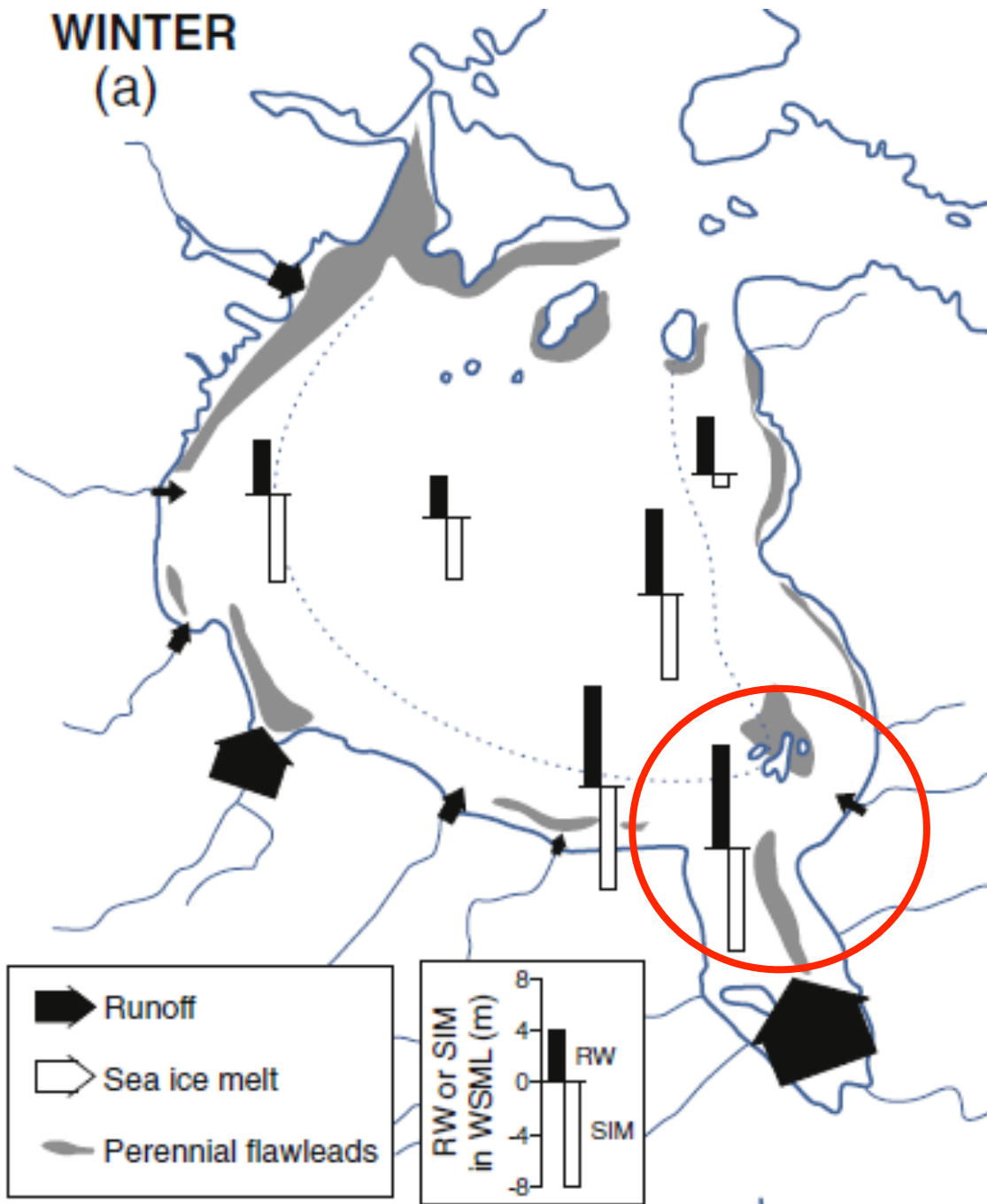


Residence times for RW 1-3 months

Sea-ice and river runoff inter-relationships

Some river water ends up in deep offshore waters because of sea ice production in polynyas and flaw leads. These areas may be sensitive to changes in river water amount/timing.





**Estimate of
river water in
outflow from
James Bay in
winter**

Winter observations in Hudson Bay are very scarce, with the exception of localized estuaries. Polynyas are not well studied.



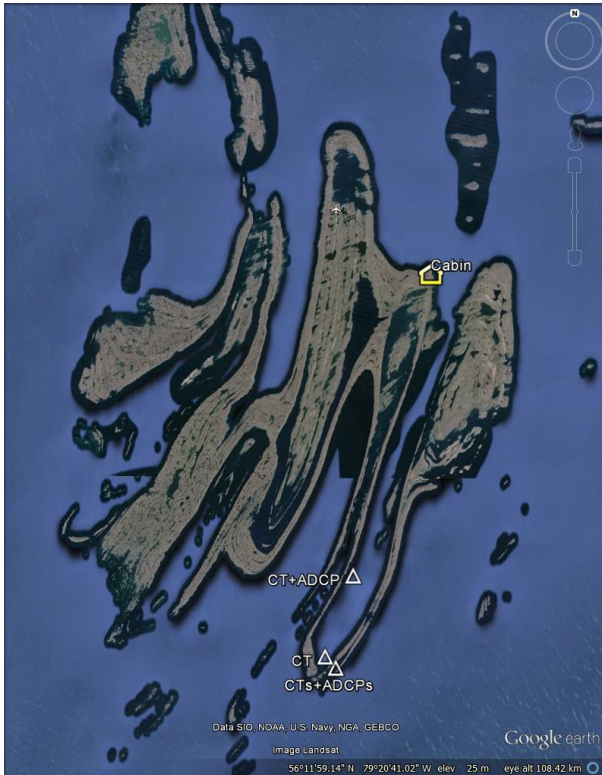
Summary

- There are two important sources of freshwater
 - Different properties
 - Different impacts on system (physical, chemical, biological)
 - Interact with one another, influencing sea-ice production and river water distribution
 - Undergoing different changes
- Baseline data set for summer is good on large scale but is weak regionally

Closing Remarks

- Enlargement of the under-ice plume area from La Grande complex was predicted due to increased outflow and altered seasonality.
 - Other factors besides river discharge will affect river water distribution, including nature of the sea-ice cover (ridges, bottom roughness), winds, tides.
 - Amount of river water may affect sea-ice production, although other factors such as heat left over from previous summer are also important.
- Winter conditions, especially in James Bay and southeast Hudson Bay, need to be assessed.

- New collaborations and partnerships, pooling of resources, systems-approach, is promising.
 - E.g., recent partnership between Arctic Eider Society, Sanikiluaq, University of Manitoba to study freshwater and impacts on ice and wildlife



Regional-scale,
coherent rather than
fragmented,
assessment of impacts
(present conditions)
would provide
foundation for future
planning and decision
making.

Thank you!

