# Oceanography of the Hudson Bay

*by*

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# The Hudson Bay: A northern inland sea

**R. GRANT INGRAM and SIMON PRINSENBERG**
**Chapter 29. COASTAL OCEANOGRAPHY OF HUDSON BAY AND SURROUNDING EASTERN CANADIAN ARCTIC WATERS COASTAL SEGMENT**
*The Sea,* Volume 11, 1998, edited by Allan R. Robinson and Kenneth H. Brink

**THE HUDSON BAY SYSTEM**
Edited by Robie W. Macdonald and Zou Zou A. Kuzyk
Journal of Marine Systems, Volume 88, Issue 3, Pages 337-488 (1 December 2011)

# The Hudson Bay: A northern inland sea

**5. Hudson Bay**

*5.1. Sea Ice in Hudson Bay*

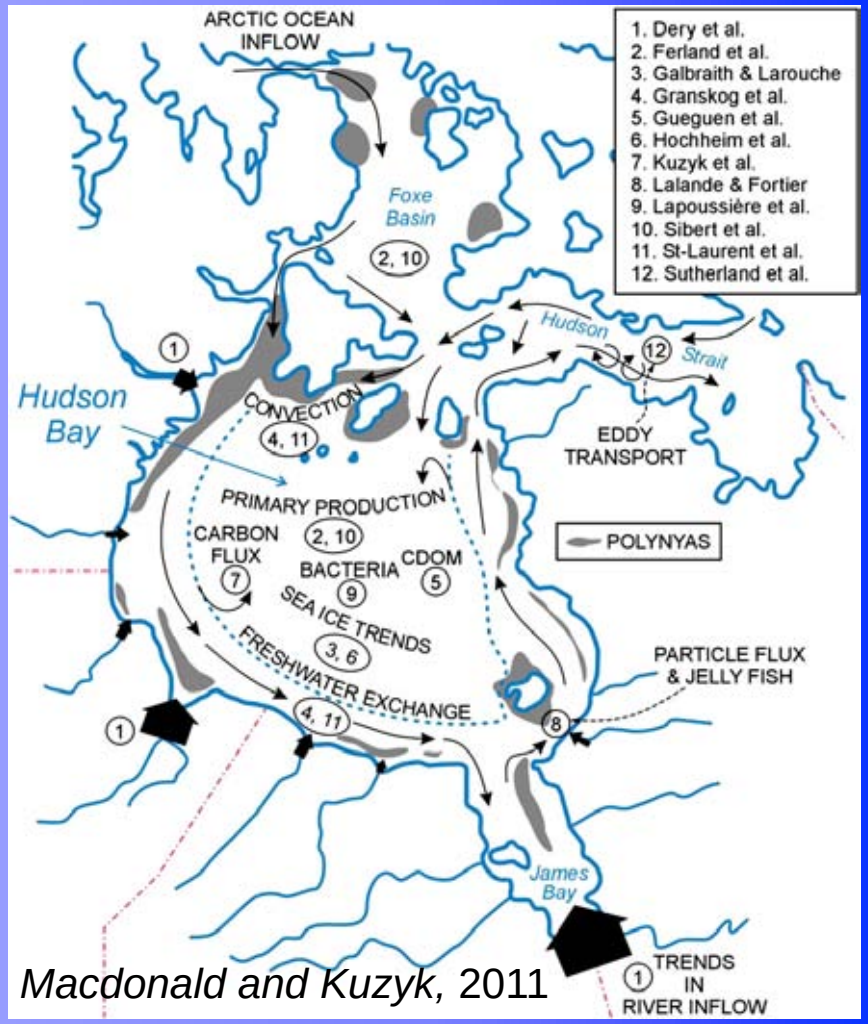
*5.2. Water Mass Characteristics in Hudson Bay*

*5.3. Hudson Bay Circulation*

*5.4. River Plumes in Hudson Bay*

*5.6. Overview of Hudson Bay*

*Ingram and Prinsenberg*, 1998




*Macdonald and Kuzyk*, 2011

# INTRODUCTION:
## Drivers of the Hudson Bay Hydrography





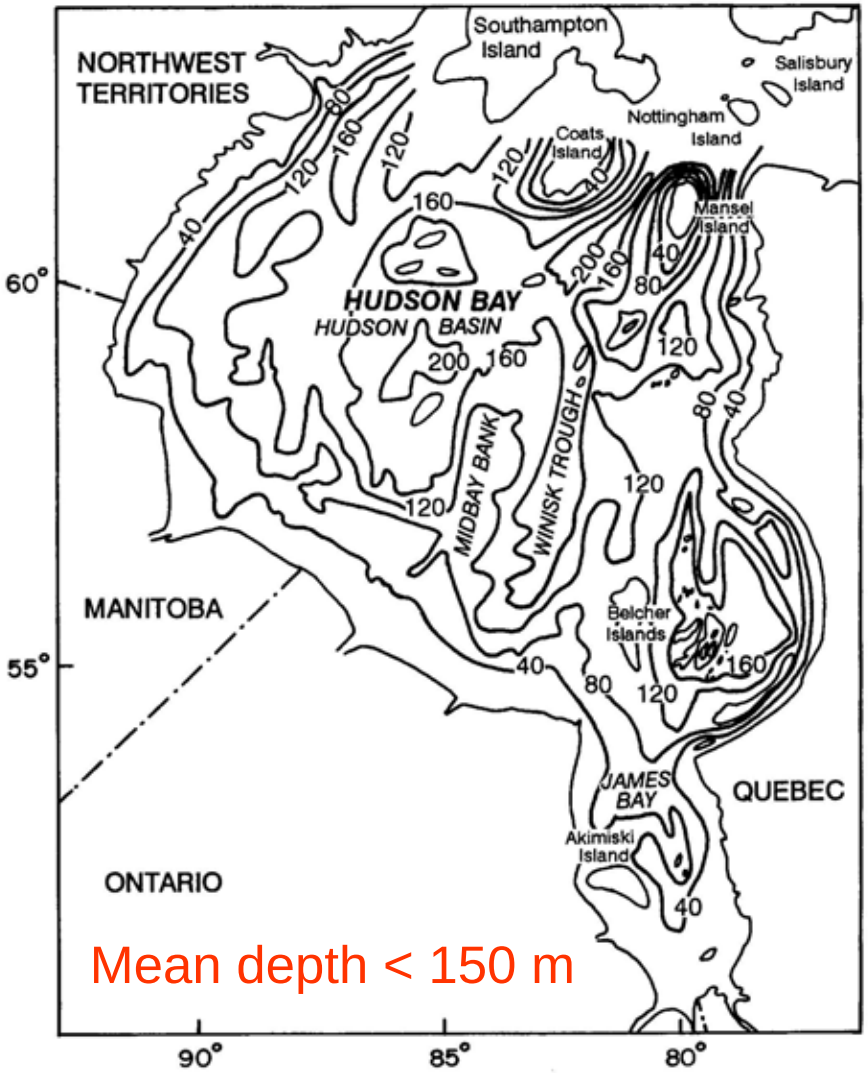
Wind-forced circulation and vertical mixing

Buoyancy-forced circulation and vertical stratification

Buoyancy- and wind-forced circulation, vertical mixing and stratification

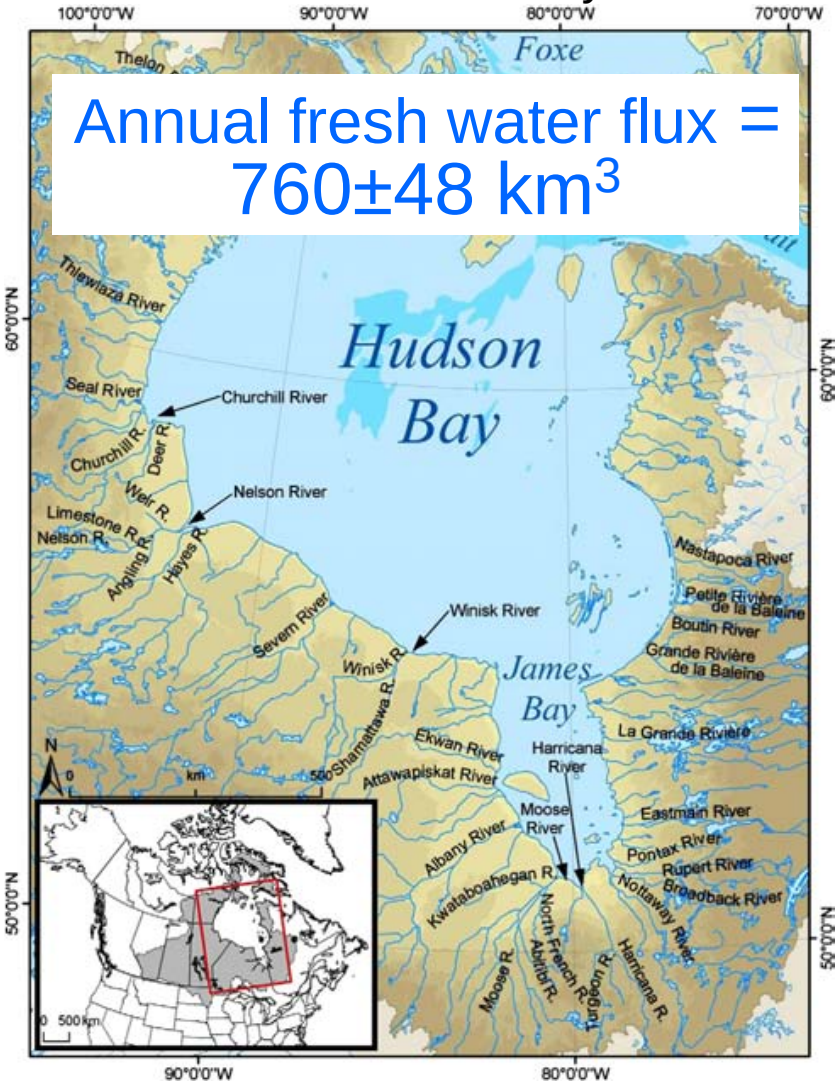
# Hudson Bay

Hudson Bay bathymetry




*Hydro-Quebec*, 1993

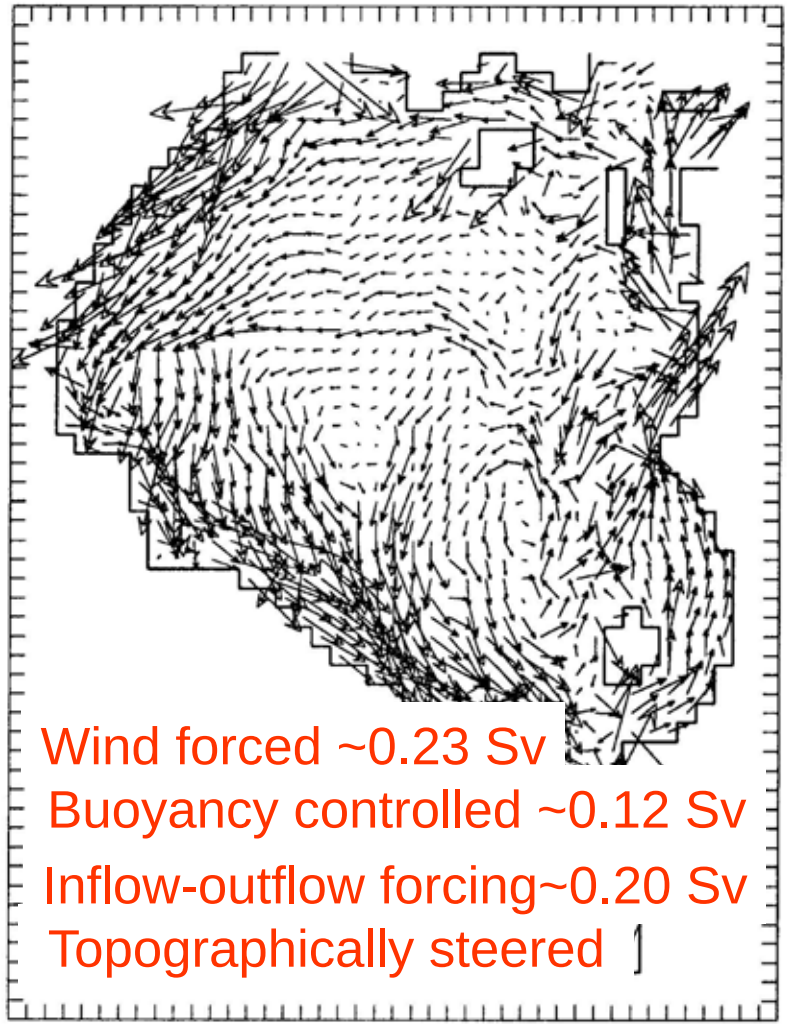
Location of rivers with outlets into Hudson Bay




*Déry et al.*, 2011

# Hudson Bay: Circulation

Simulated surface circulation



Wind forced ~0.23 Sv

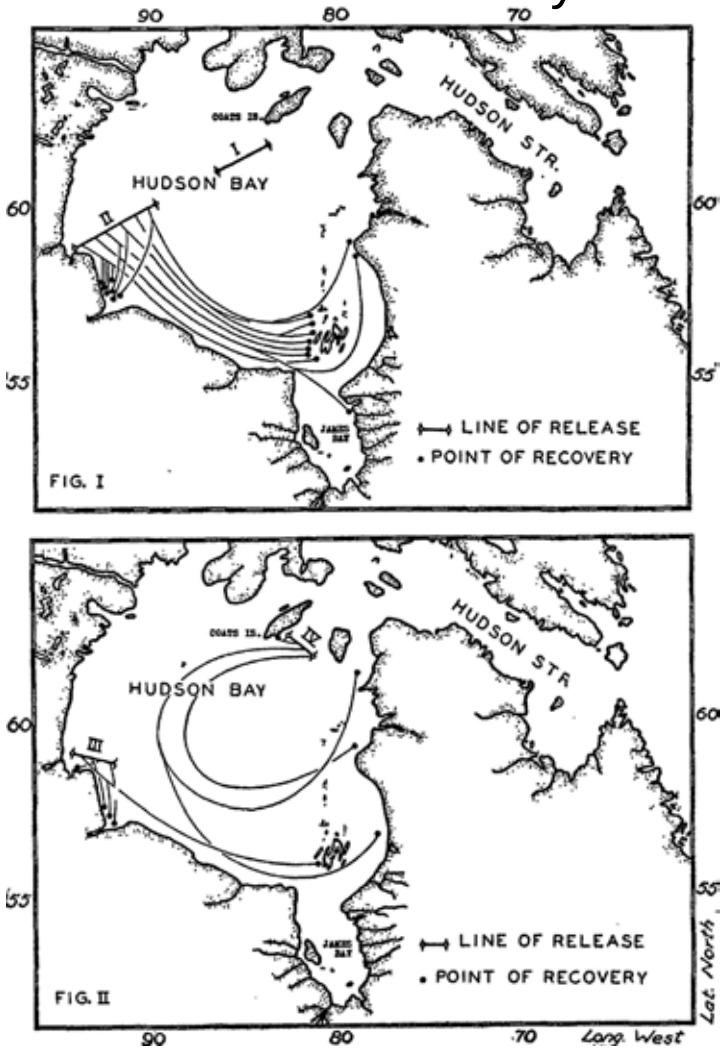
Buoyancy controlled ~0.12 Sv

Inflow-outflow forcing~0.20 Sv

Topographically steered

***Wang*, 1993**

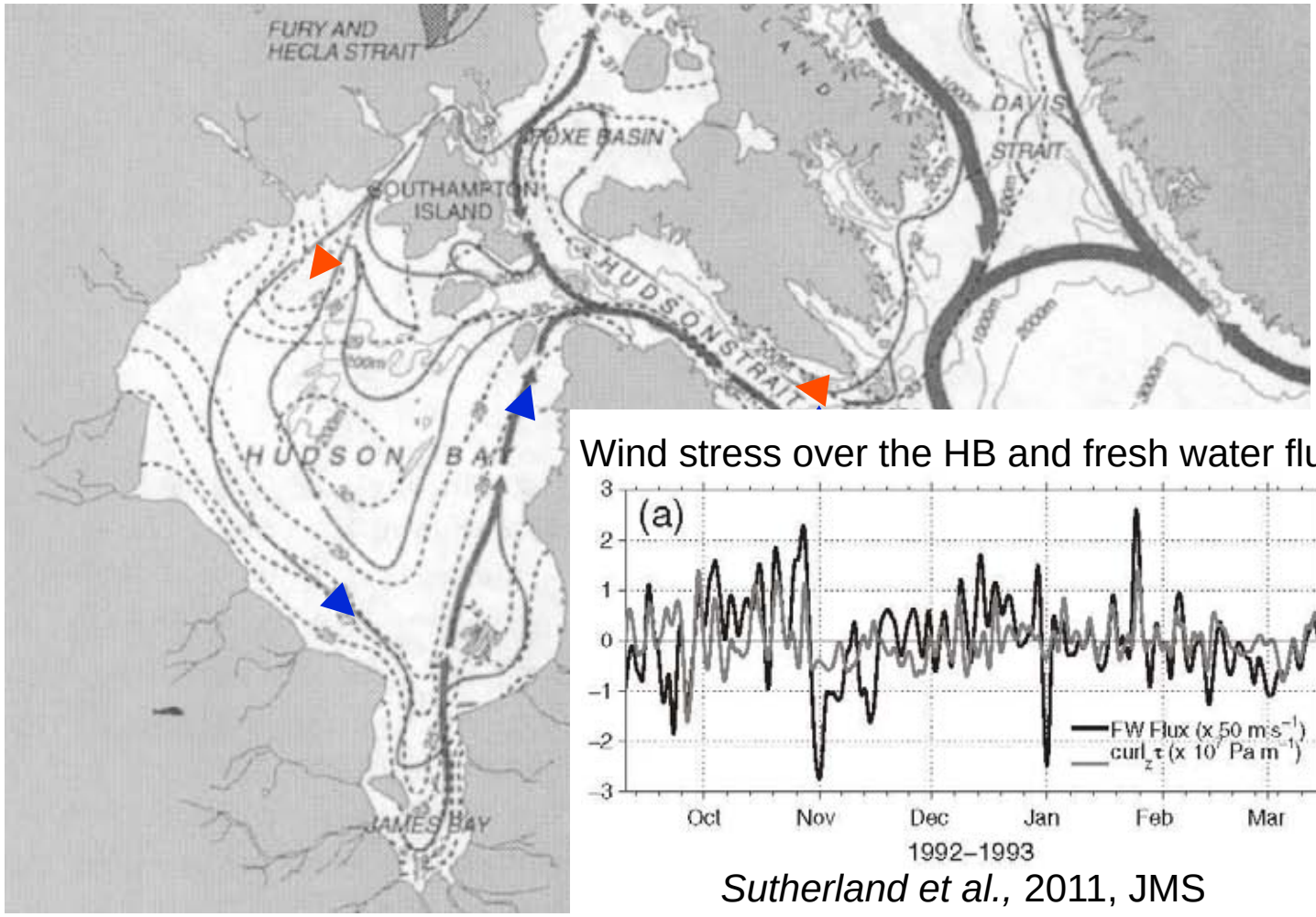
Circulation as indicated by drifters




*Hachey*, 1935, Science

# Hudson Bay: Circulation

Surface salinity (dashed lines) and general circulation scheme




Wind stress over the HB and fresh water flux



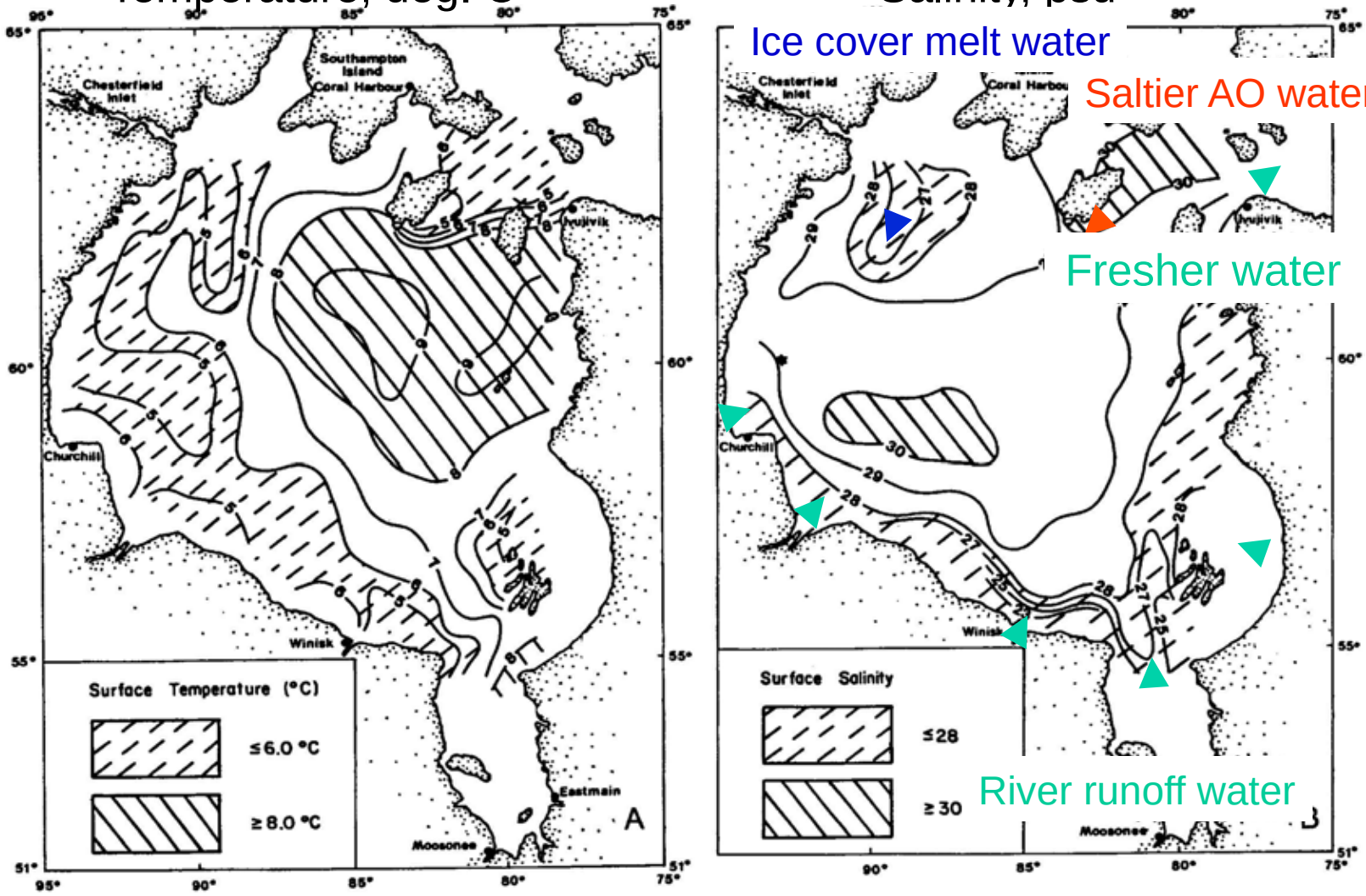

*Sutherland et al.,* 2011, JMS

*Ingram and Prinsenberg, 1998*

# Summer surface conditions

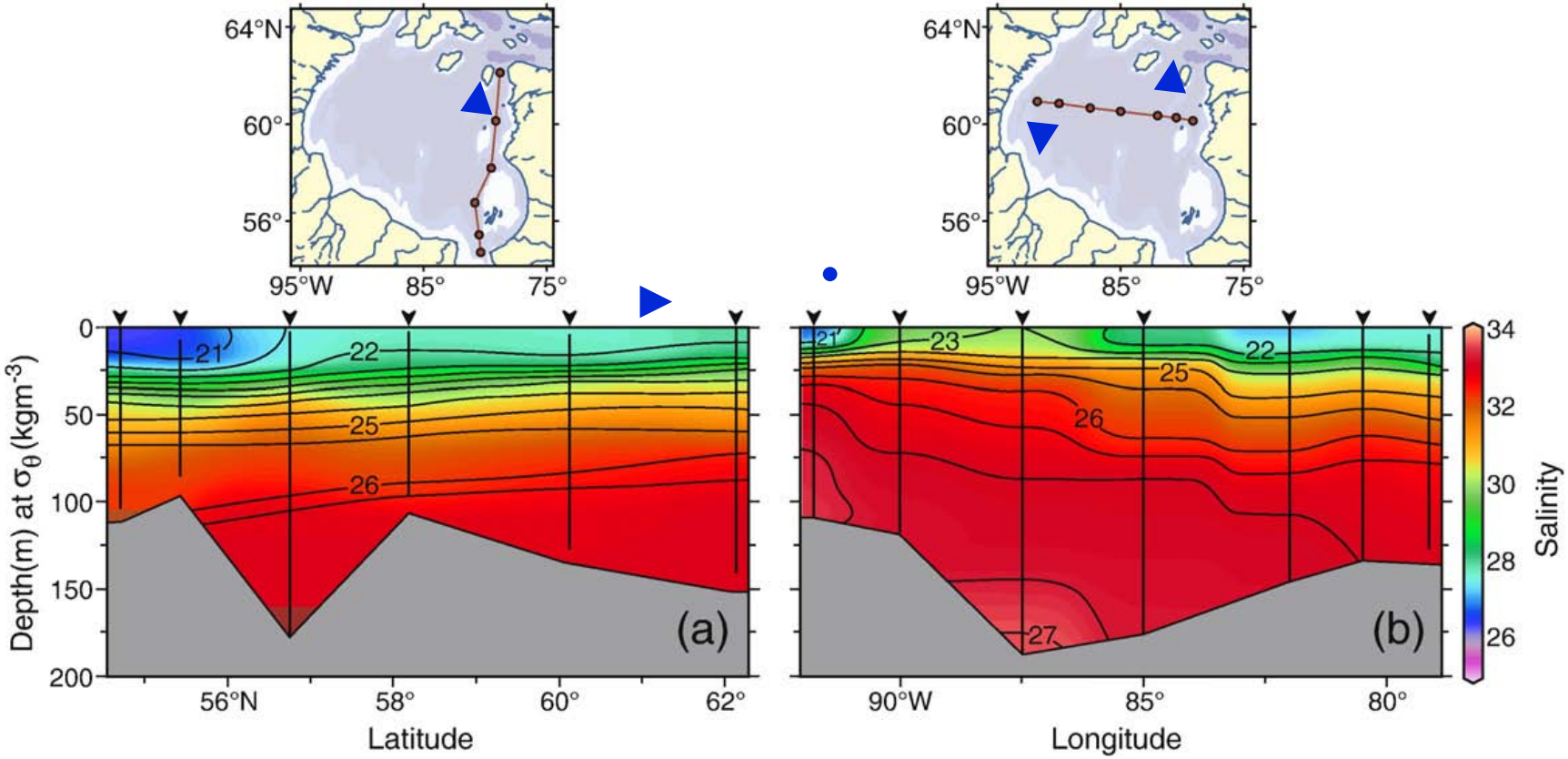
Temperature, deg. C

Salinity, psu



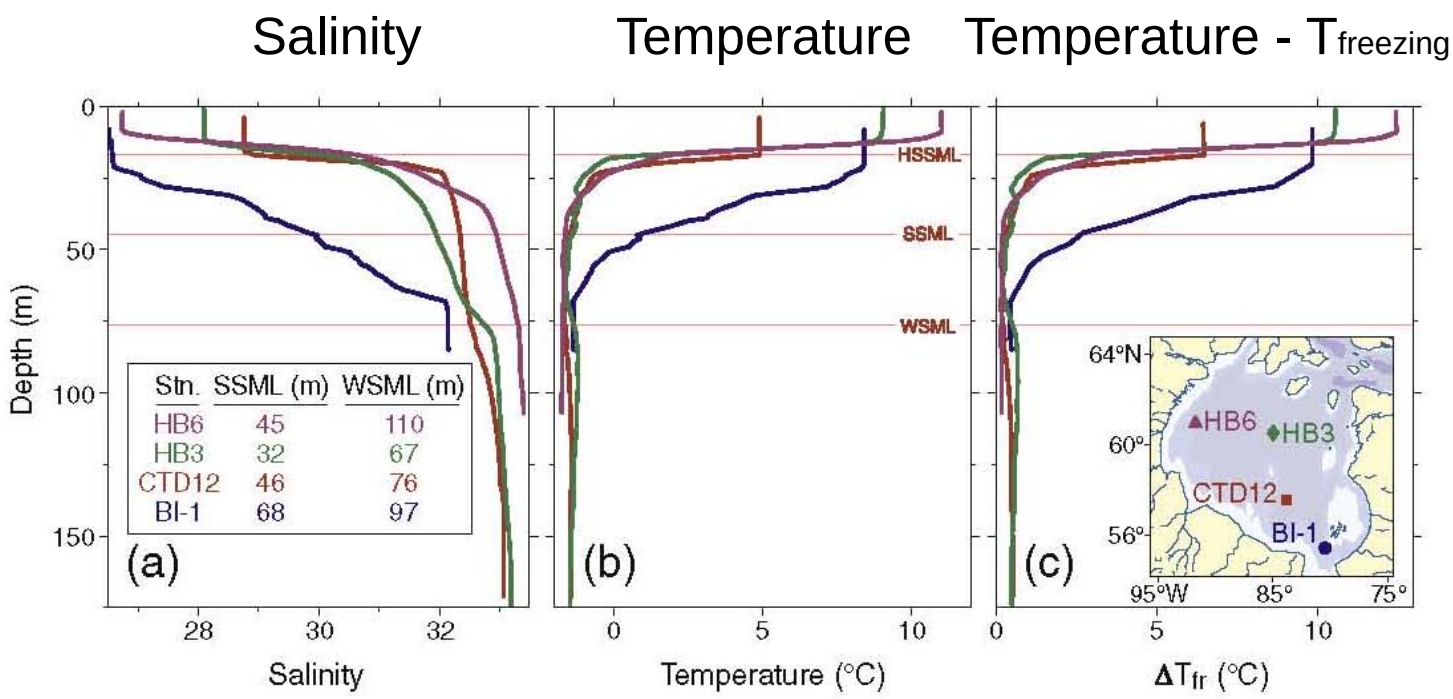

*Freeman,* 1982

# Summer salinity transects




*Granskog et al.*, 2011, JMS

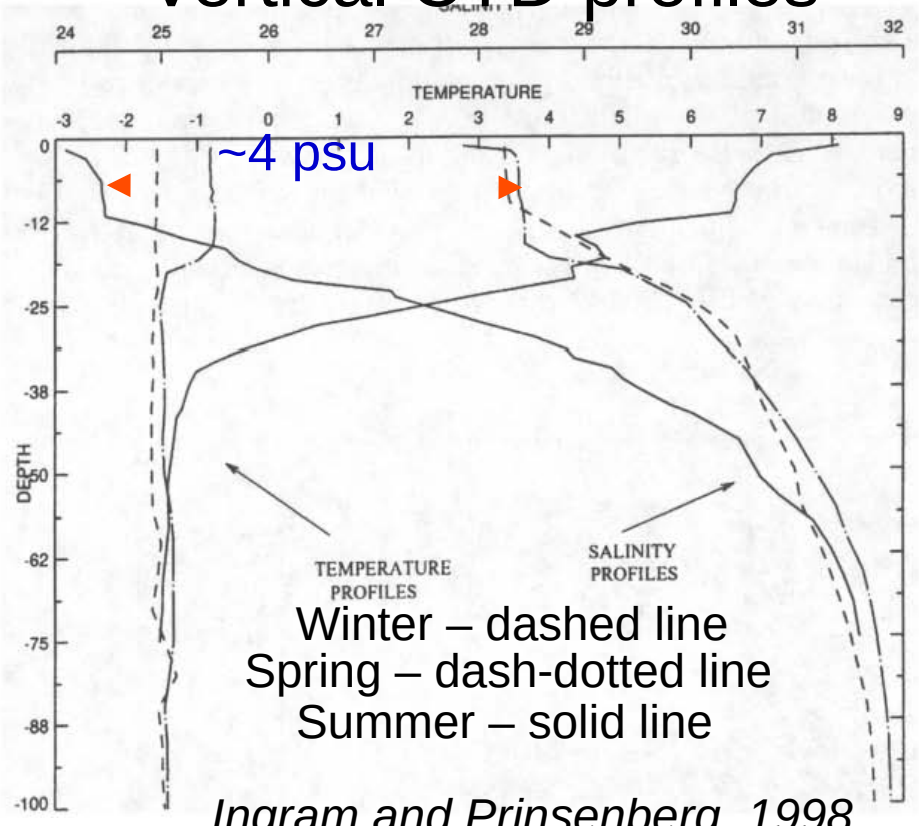
# Summer vertical profiles




*Granskog et al.*, 2011, JMS

# Seasonal Variability

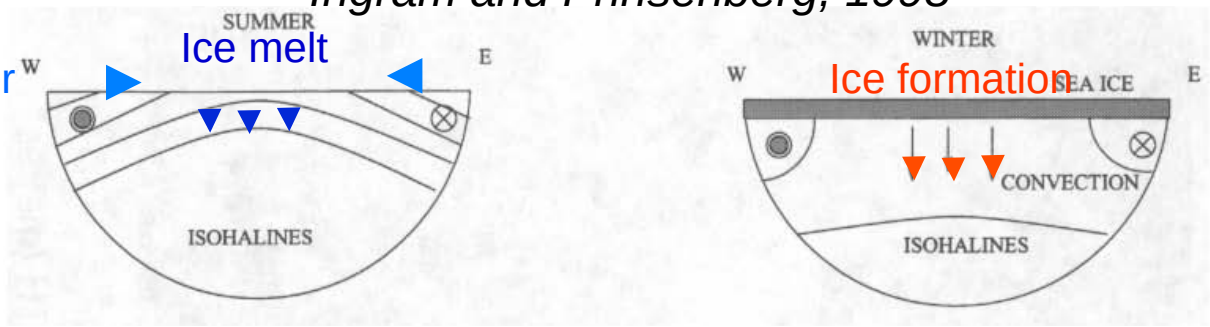
## Vertical CTD profiles



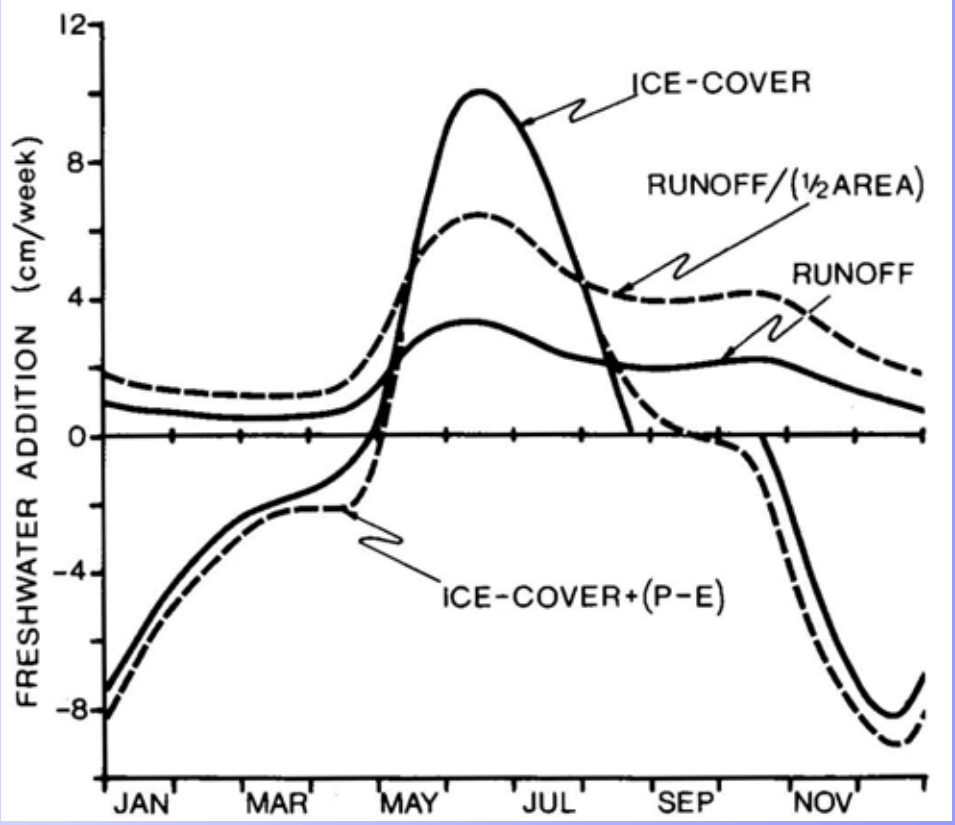

Winter – dashed line
Spring – dash-dotted line
Summer – solid line

*Ingram and Prinsenberg, 1998*

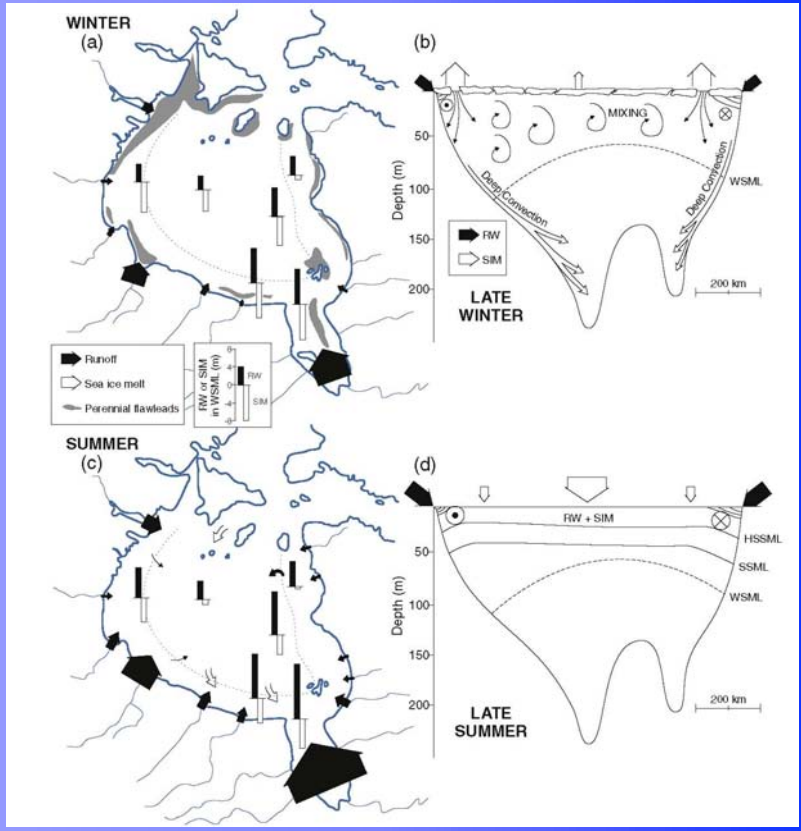
River water



# Fresh water balance

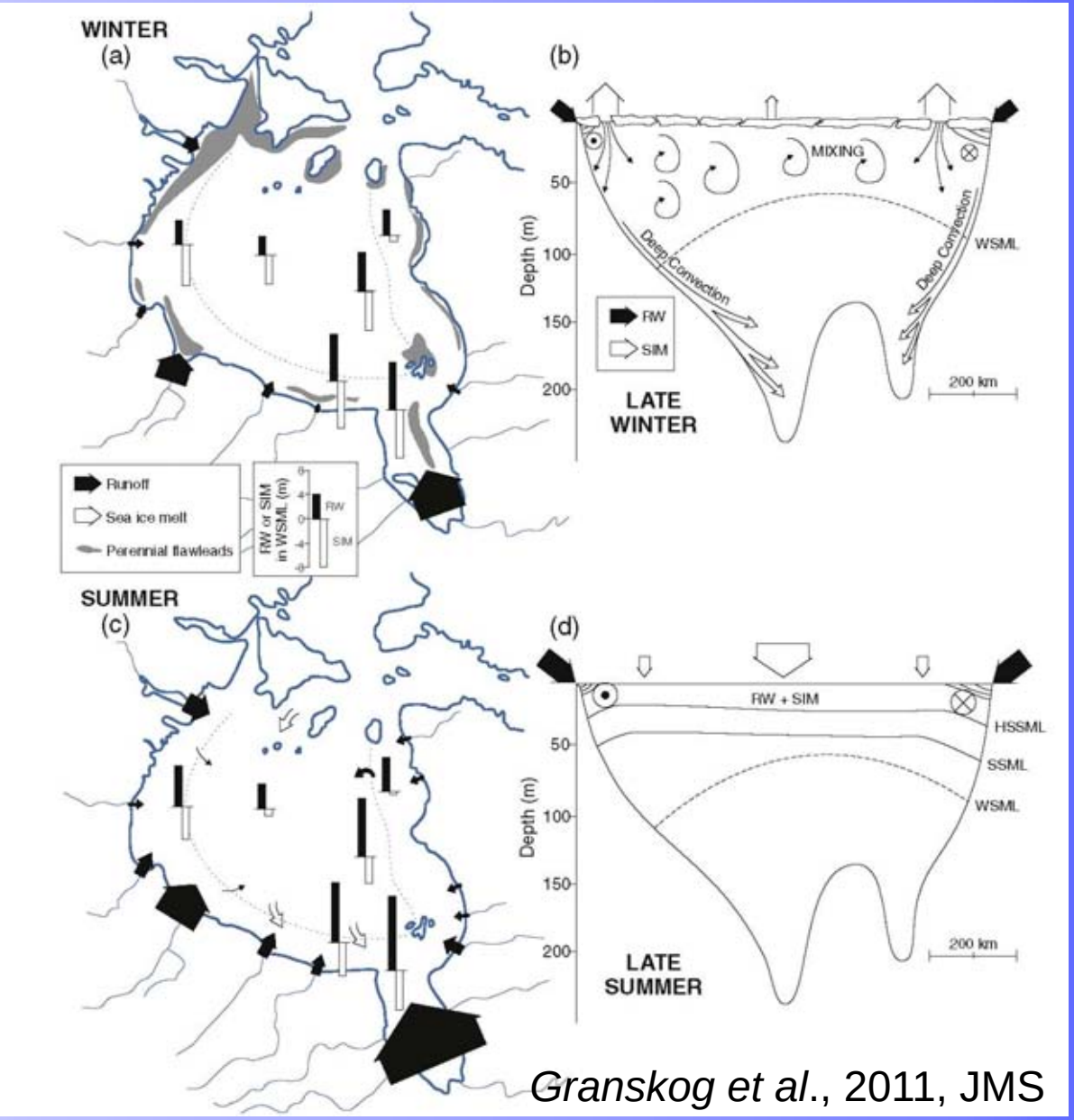



*Prinsenberg*, 1988, Arctic




*Granskog et al.*, 2011, JMS

# Fresh water balance




*Granskog et al.*, 2011, JMS

# Seasonal Variability

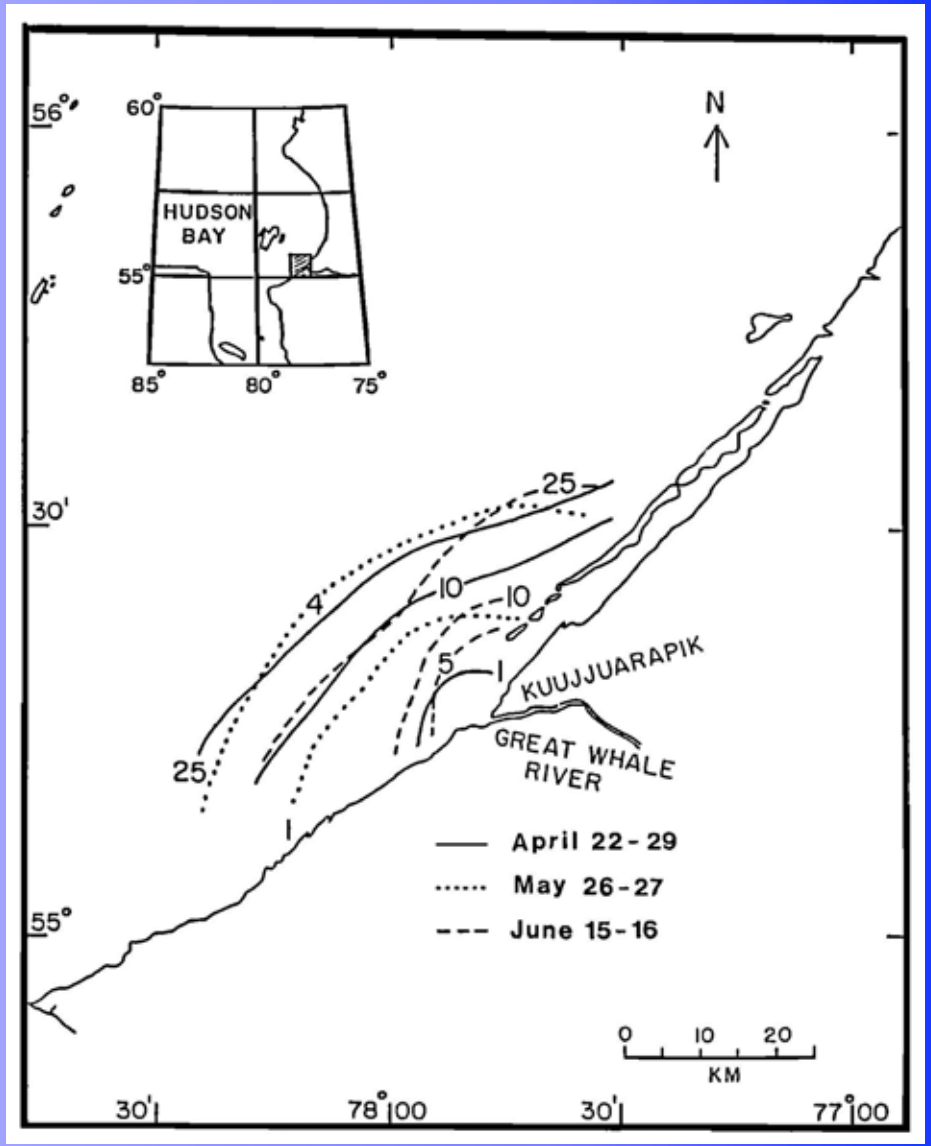
## In winter:

Offshore plume areas are 10-40 times larger under ice than in open water for similar discharge levels

Plume thickness is two to three times deeper under ice than without

The absence of direct wind energy input to the surface waters, coupled with damped tidal currents, leads to reduced levels of mixing than in open water

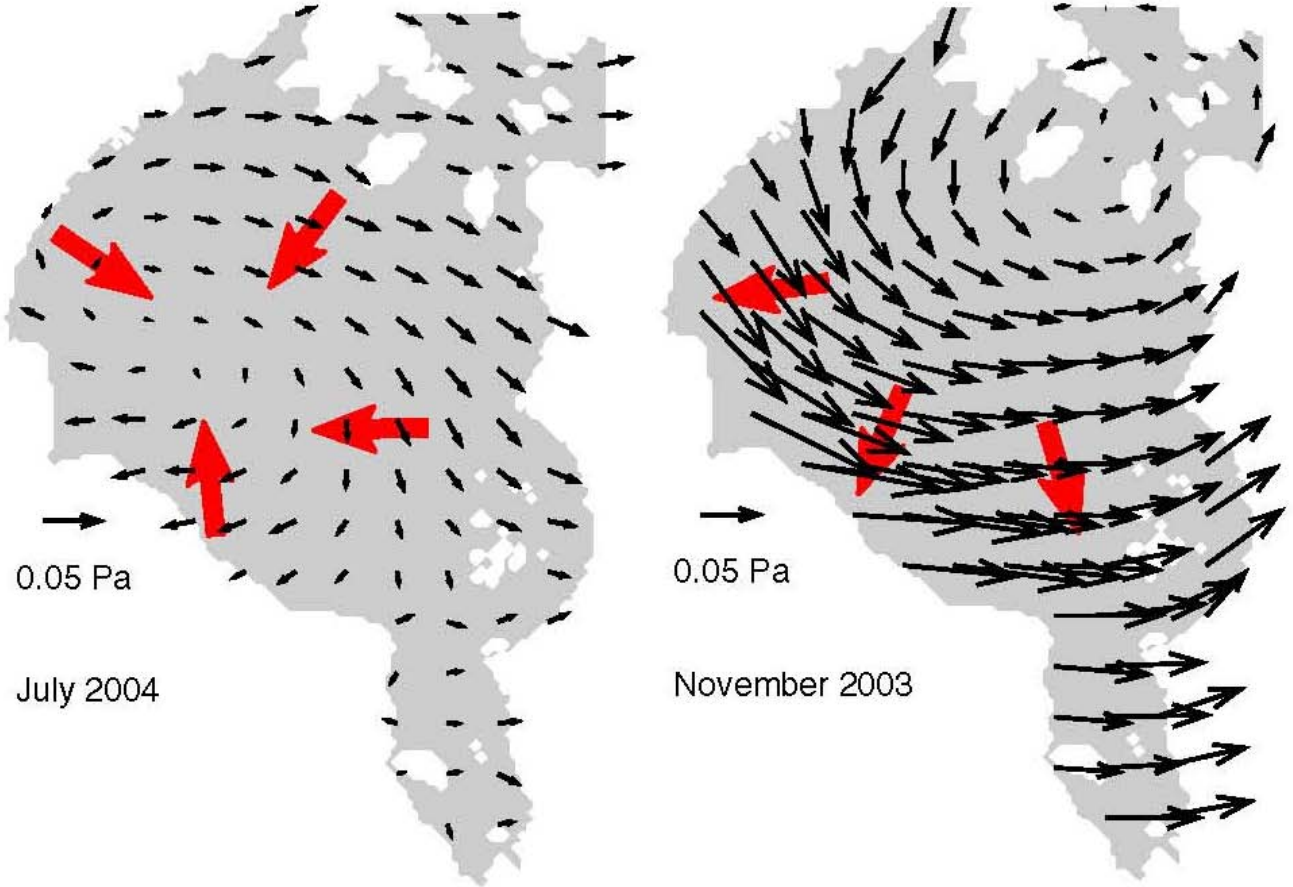
Surface salinity distribution, 1986




*Lepage and Ingram*, 1991, JGR

# Seasonal Variability

## Wind-forcing seasonality

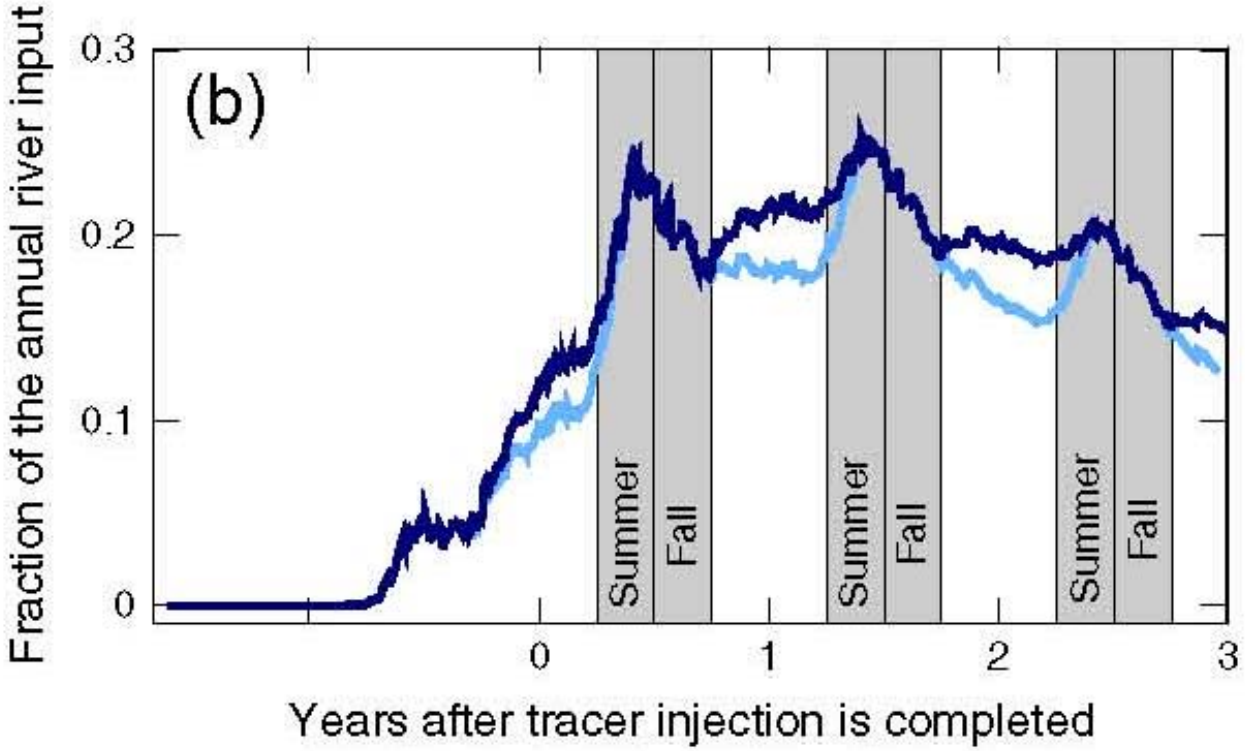



Mean stress (black arrows) at the ocean surface. Ekman transport (red arrows) is directed toward the right of the stress

*St-Laurent et al.*, 2011, JMS

# Seasonal Variability

River tracer in the Hudson Bay interior

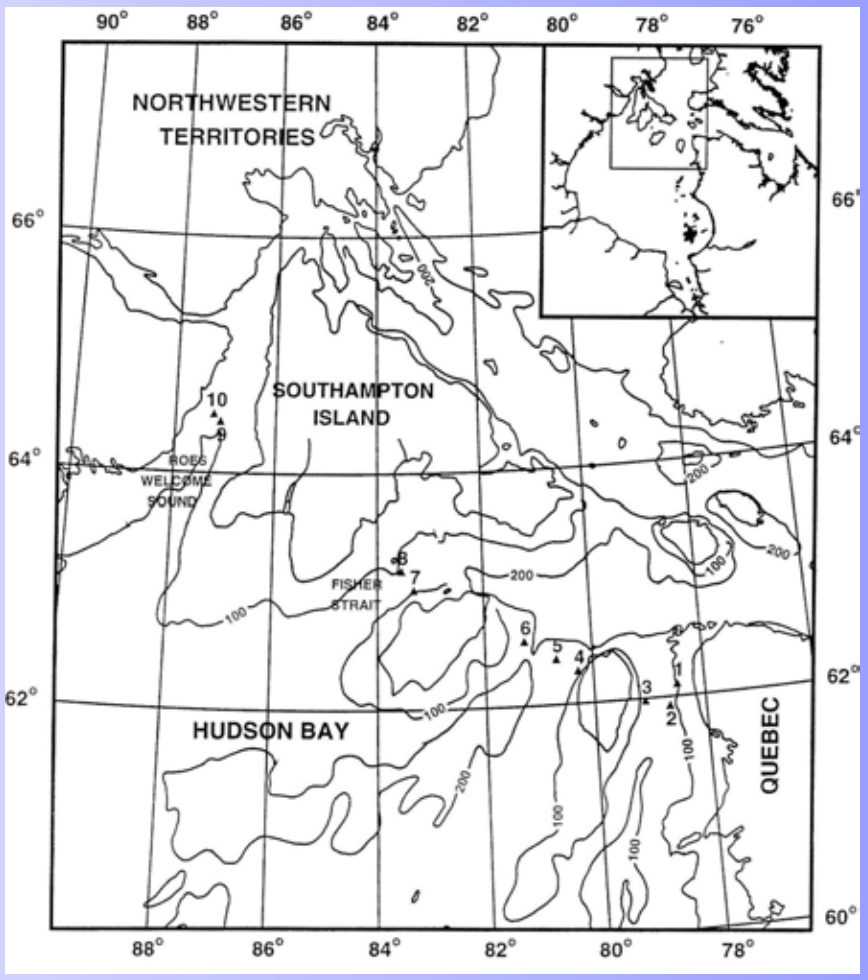



The volume increases (decreases) during the summer (fall)

*St-Laurent et al.*, 2011, JMS

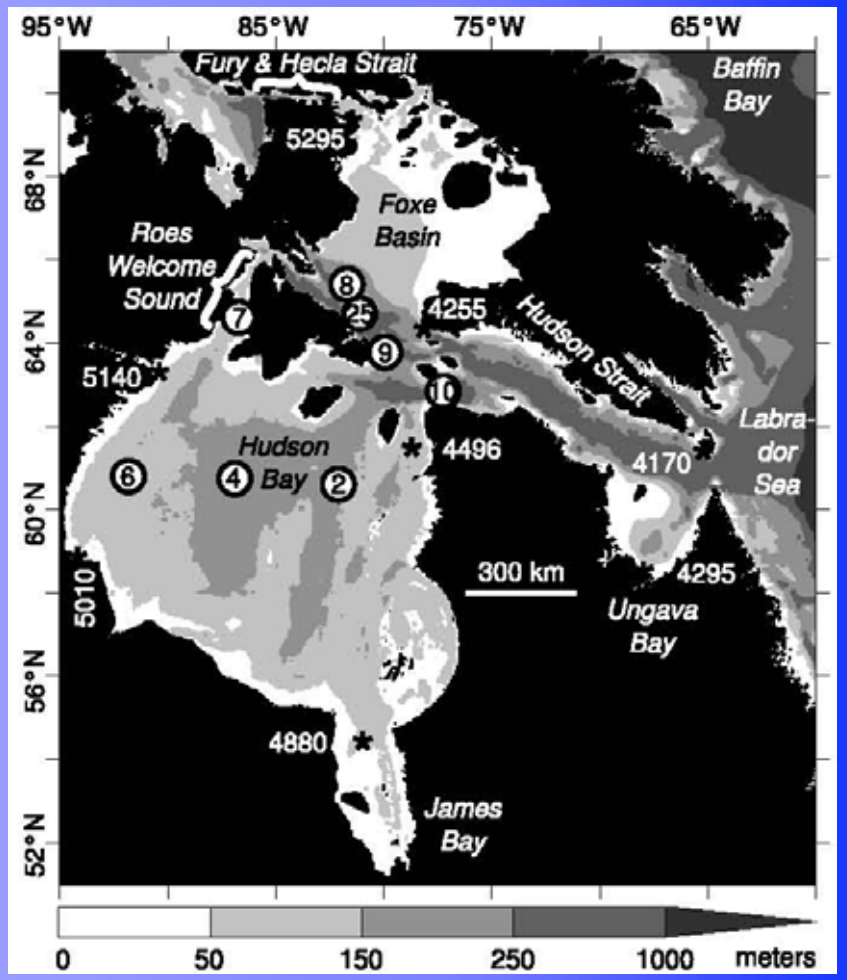
# Mooring Data

1992-1993 moorings




*Saucier et al.*, 1994, Data Rep.

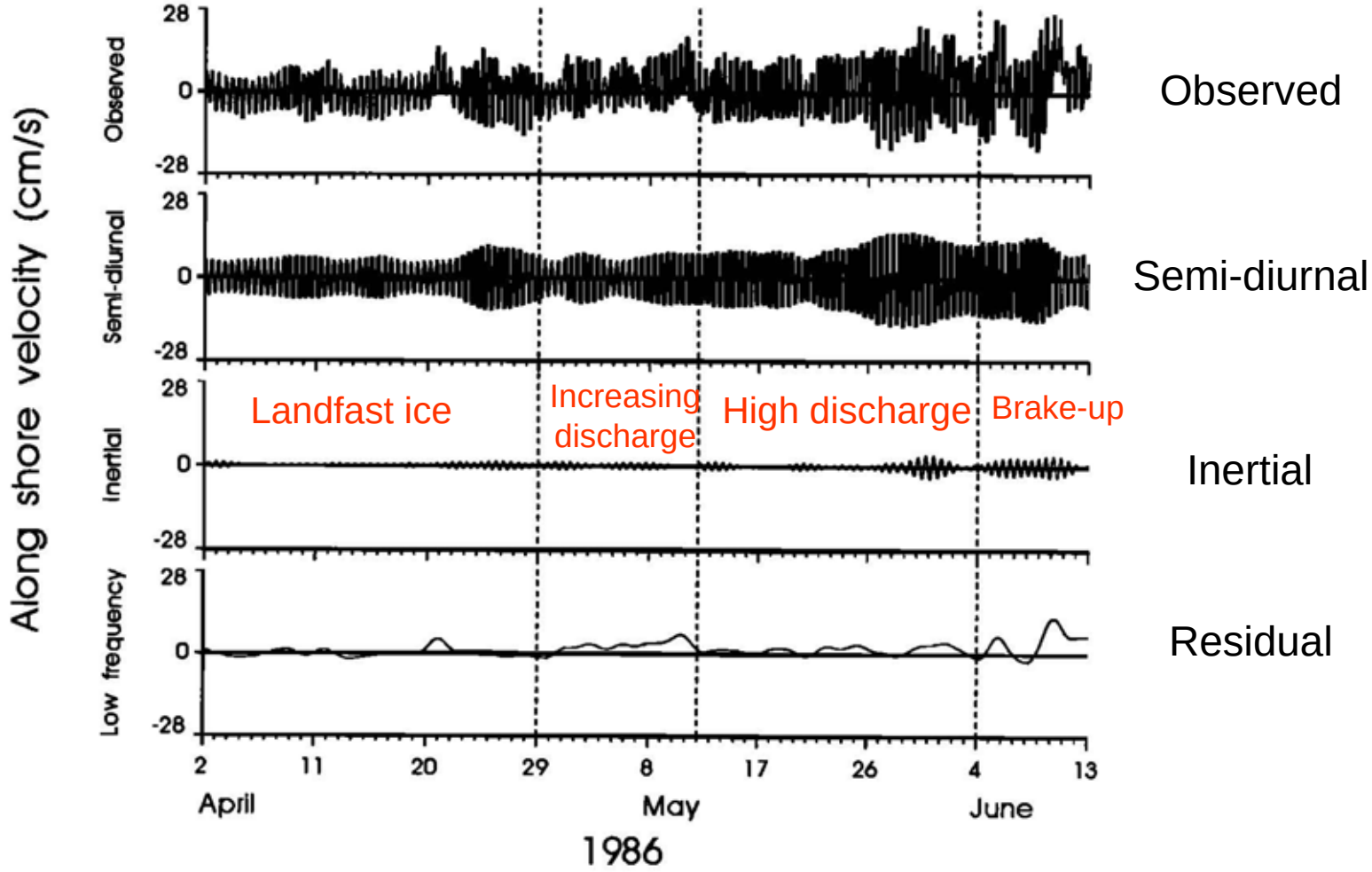
2003-2005 moorings




*St-Laurent et al.*, 2008, JGR

# Seasonal Dynamics

Velocity record at 10 m, 20 km off the Great Whale estuary

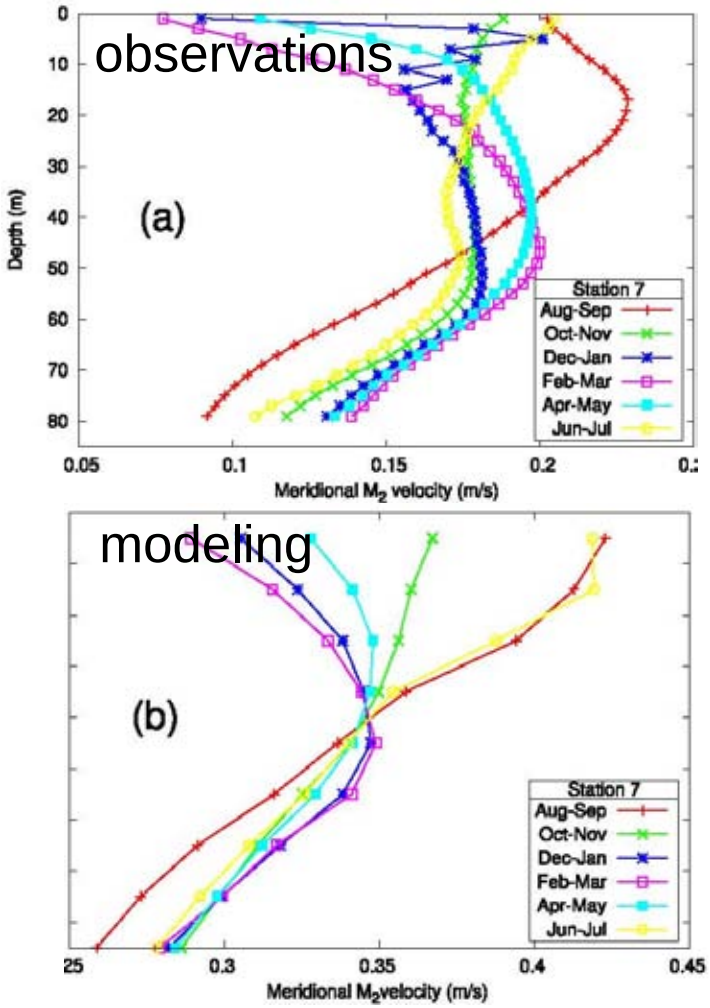



*Lepage and Ingram*, 1991, JGR

# Tidal currents

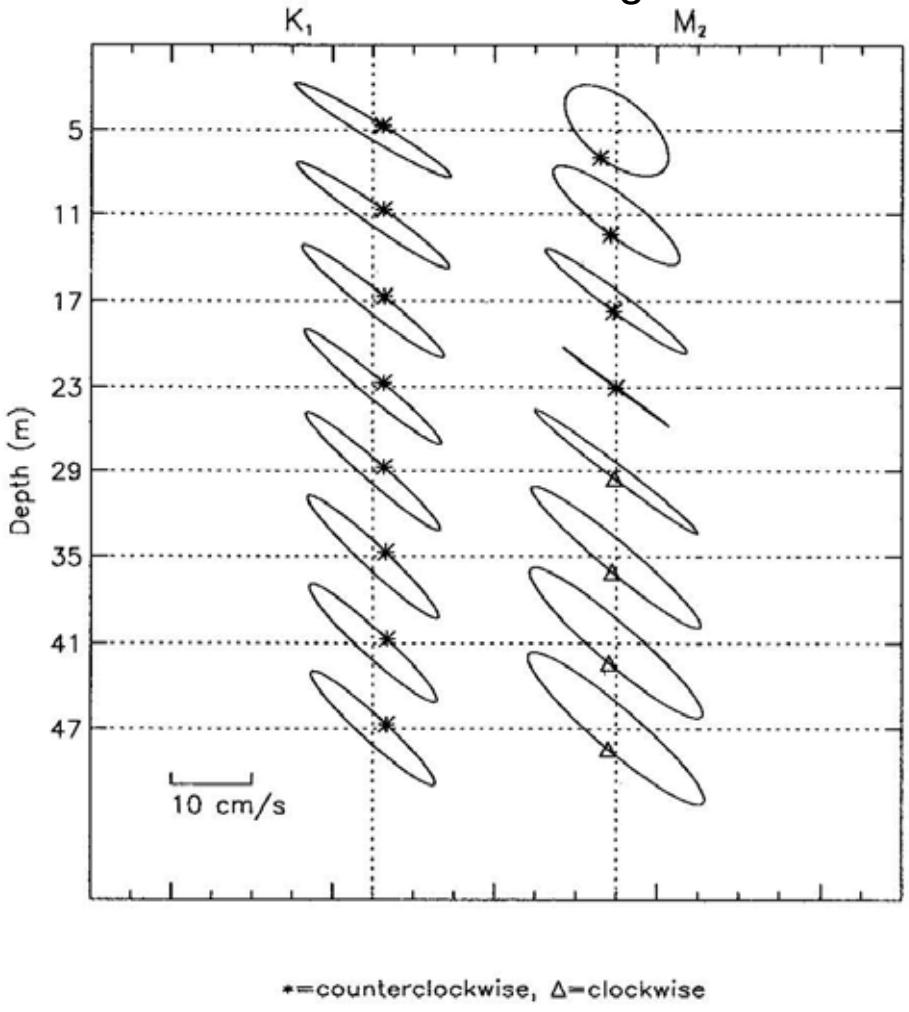
Depth-dependant behavior of the tidal (M2) currents below the ice

Hudson Bay




*St-Laurent*, 2008, JGR

Resolute Passage

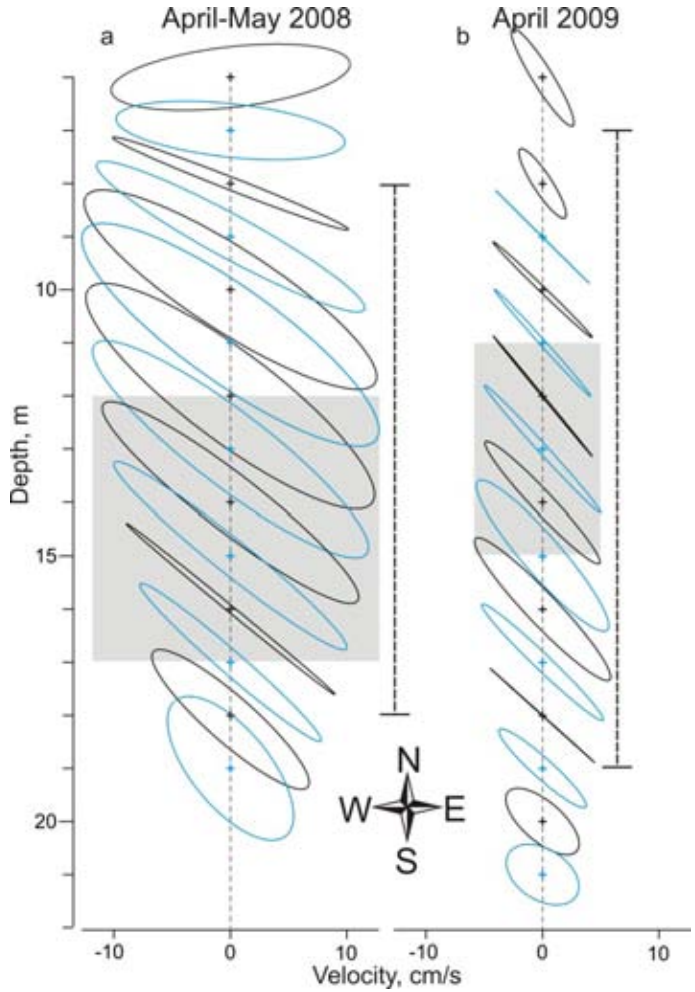



*Marsden et al.*, 1994, JMR

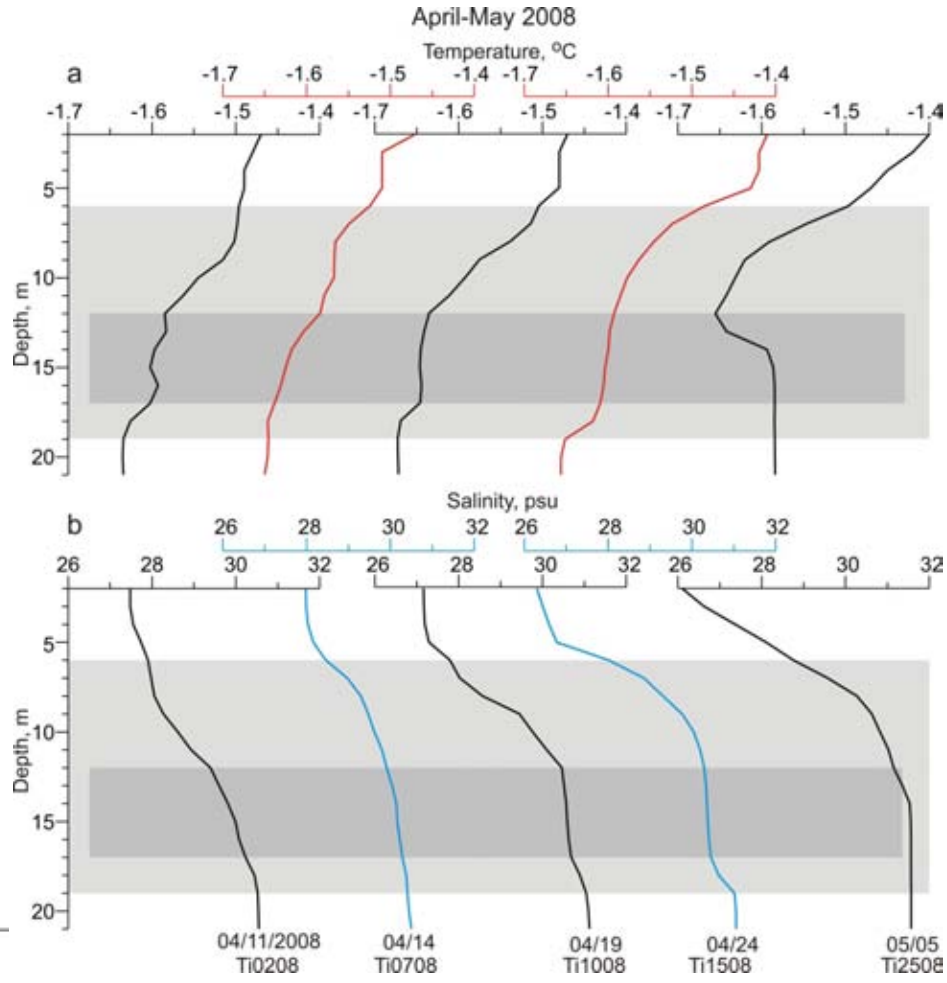
# Tidal currents: Laptev Sea

Depth-dependant behavior of the tidal (M2) currents below the ice

M2 tidal ellipses



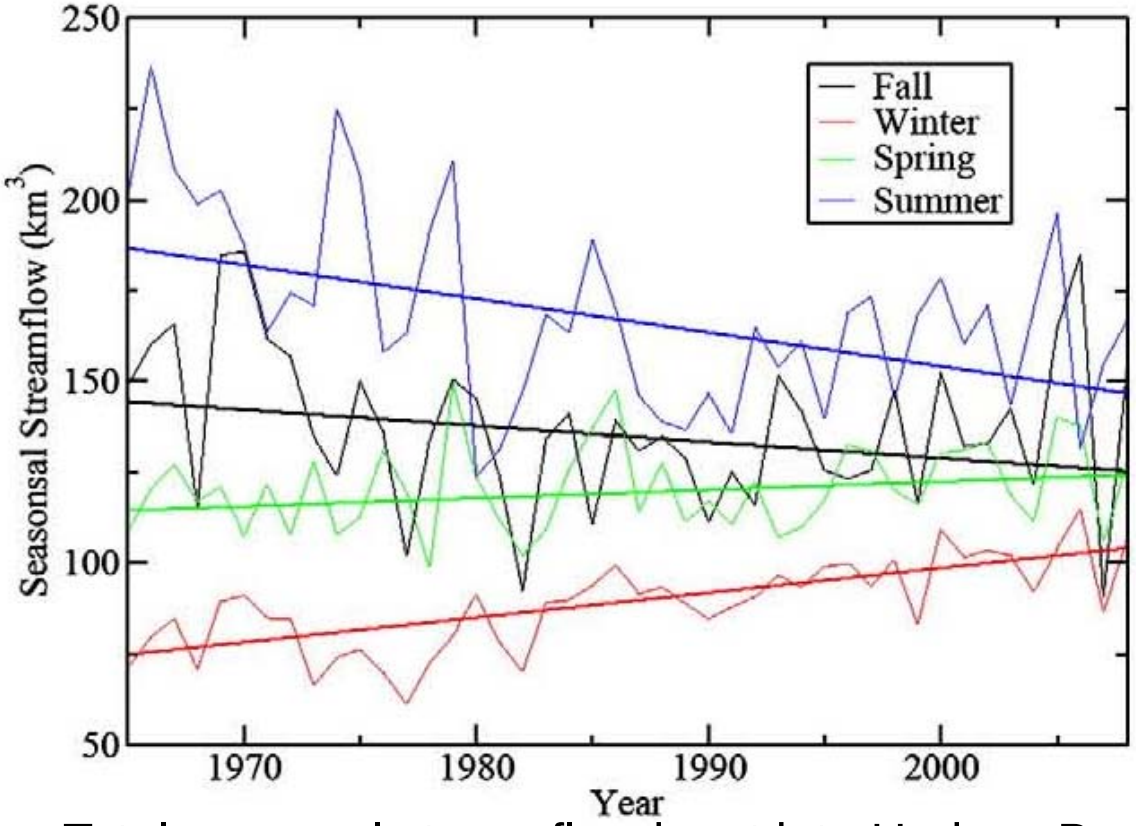

CTD profiles




*Dmitrenko et al.,* 2012, JGR

# Outlook: The Hudson Bay in transition

## River Discharge



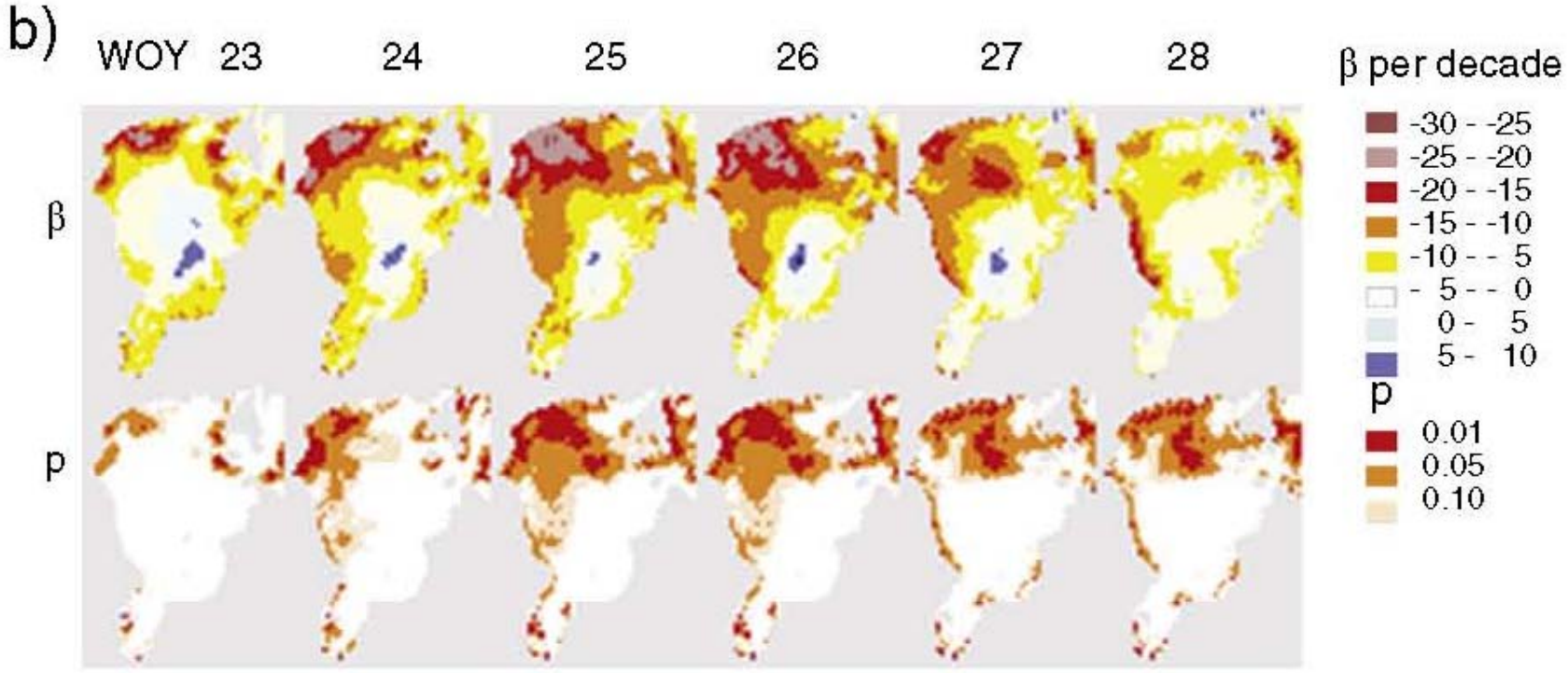


Total seasonal streamflow input into Hudson Bay

*Déry et al.*, 2011

# Outlook: The Hudson Bay in transition

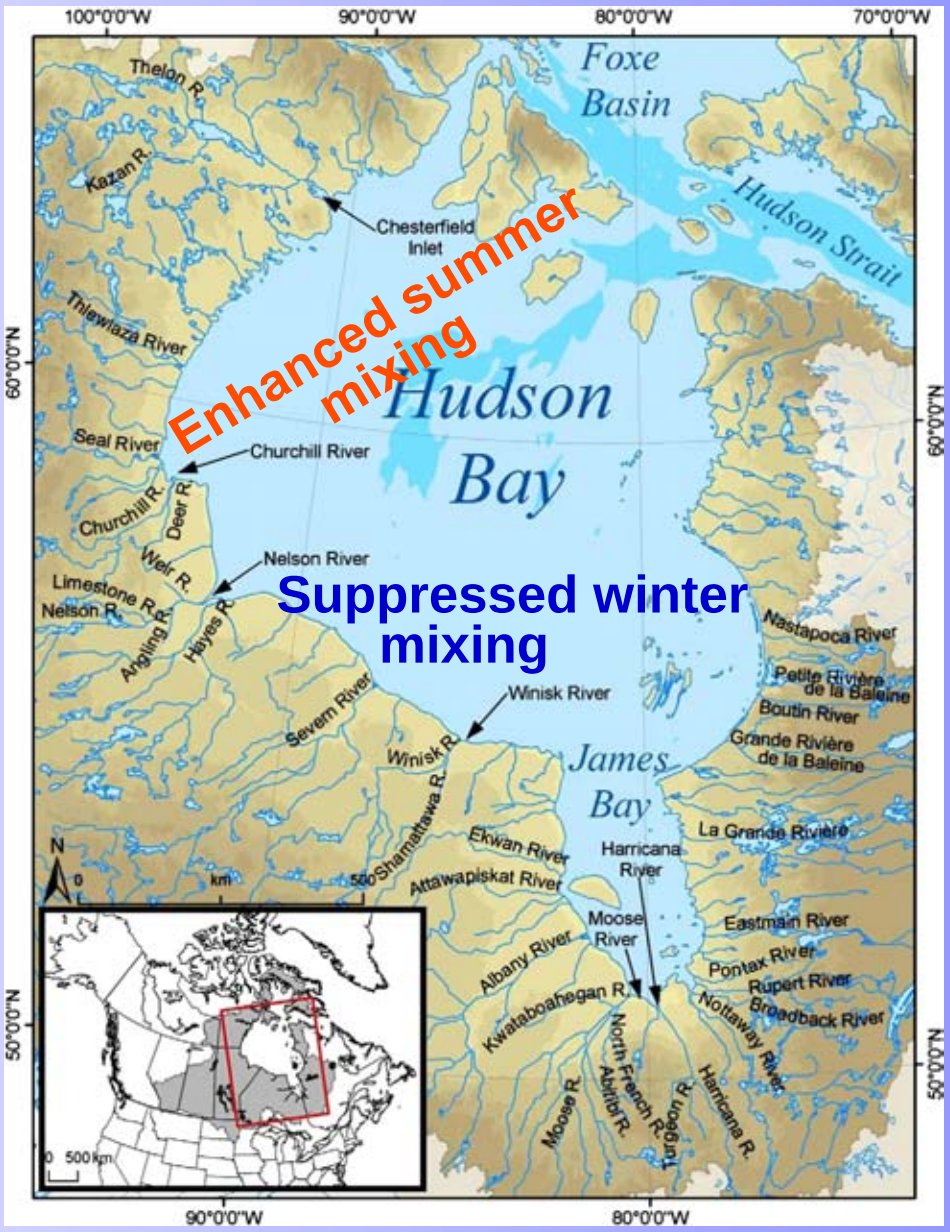
## Sea Ice




Linear trends (β)/decade in sea ice concentration anomalies and (p) their statistical significance in May-July

*Hochheim et al*., 2011, JMS

# Outlook




## Open questions

### Winter vertical mixing:

Enhances winter stratification can result in enhanced vertical mixing through the enhanced velocity shear generated by baroclonic tides, especially during the spring tide

### Summer vertical mixing:

Reduced summer stratification can result in enhanced downward transport of the river water

### Year-around:

Seasonal dynamics and vertical fluxes should be better resolved using year-around mooring-based observations


Thank you!!!