Sediments, CDOM and nutrient flow in the Nelson–Hayes Estuary

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ArcticNet
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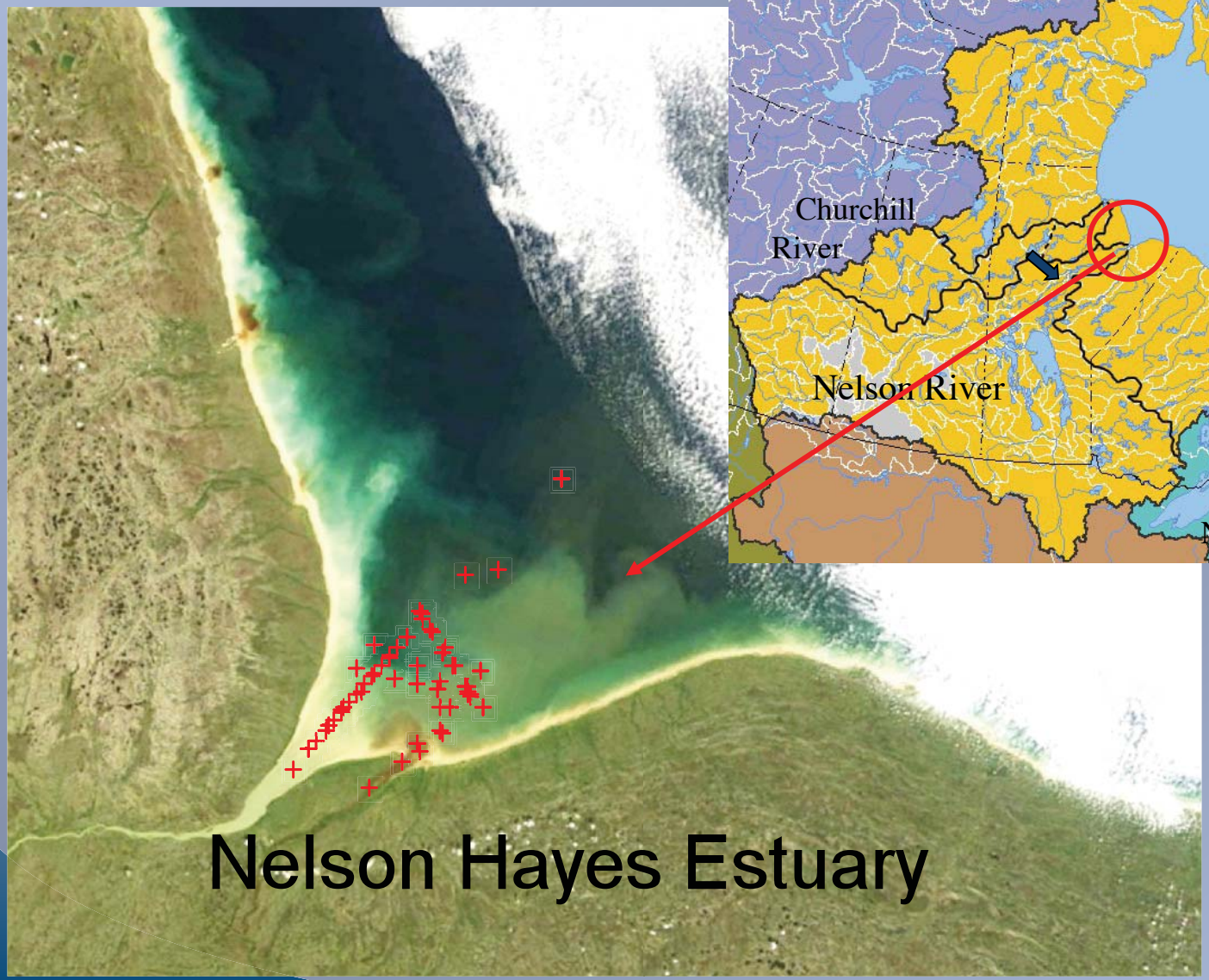
Manitoba Hydro

Funding and logistics support from ArcticNet, Manitoba Hydro & the operating funds of the Centre for Earth Observation Science.

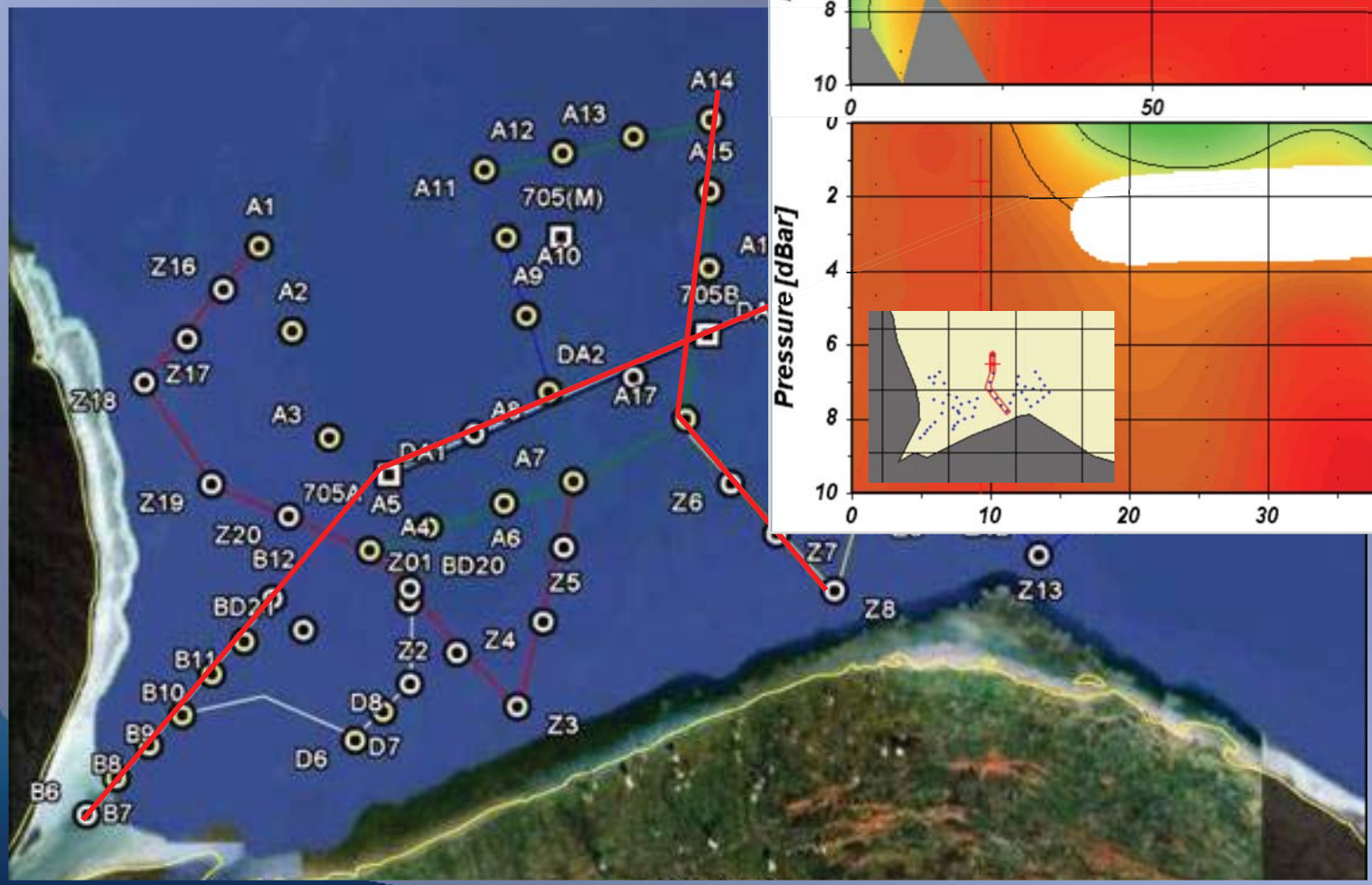
CEOS

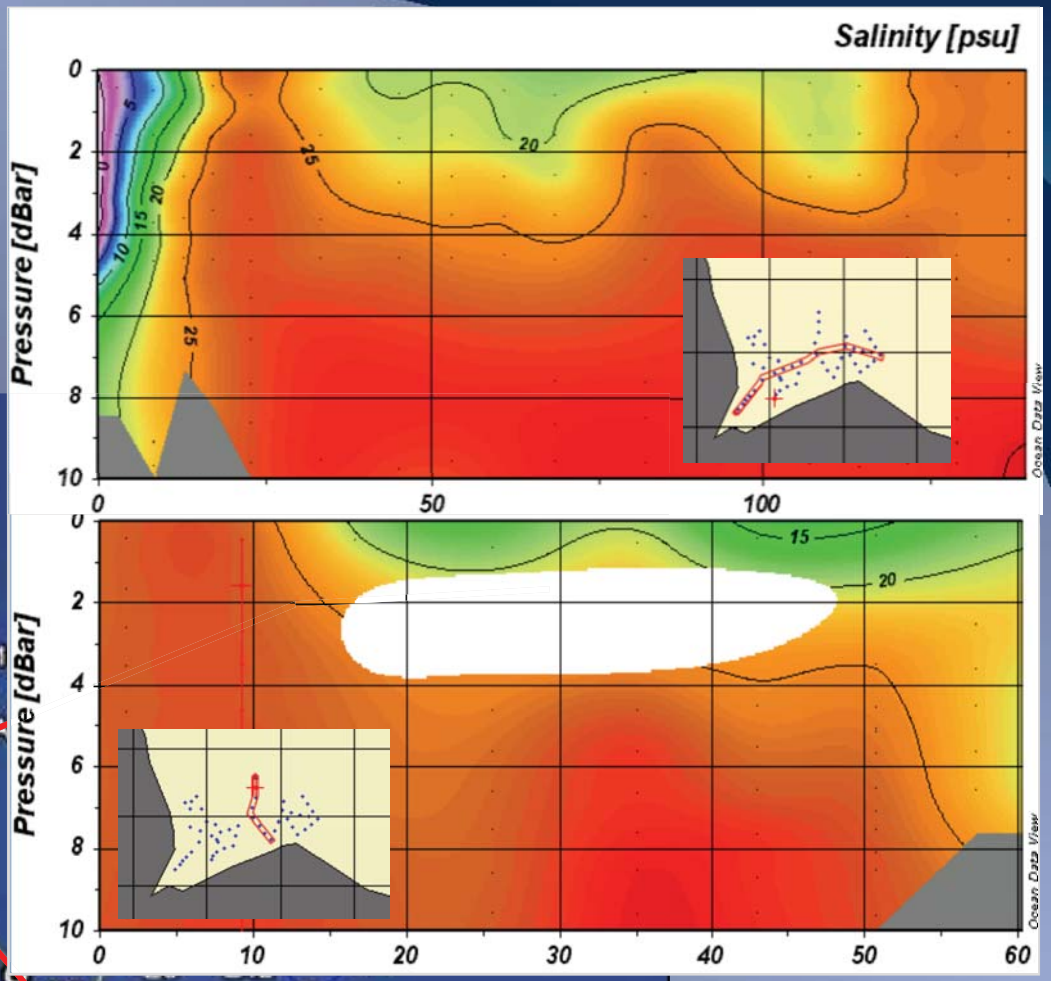


Nelson Hayes Estuary

Nelson Estuary survey (BaySys2010)

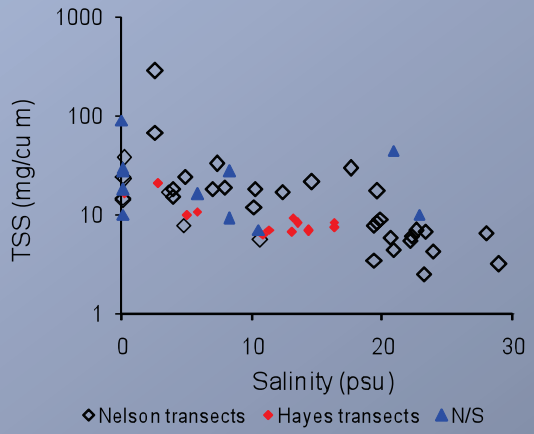
Nelson Estuary survey (BaySys2010)

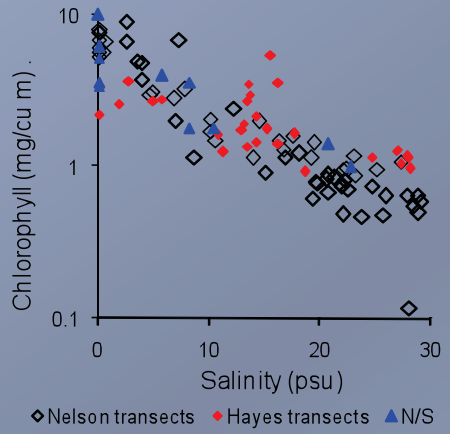


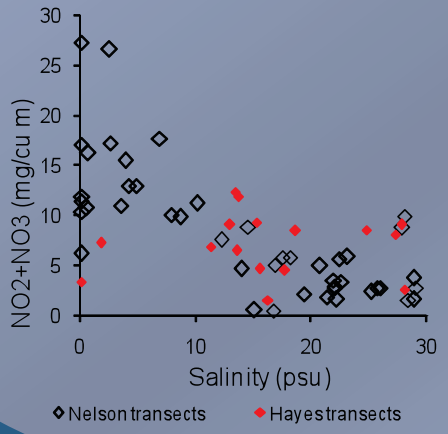


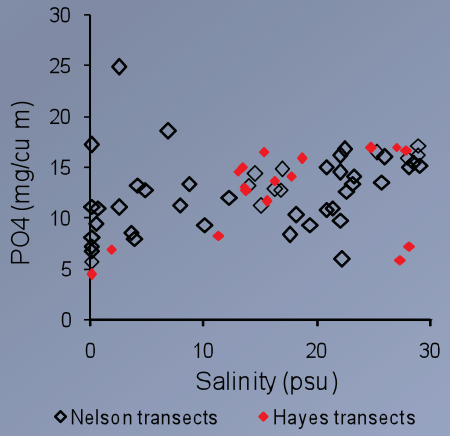
Sediments, major nutrients and chlorophyll in the Nelson/Hayes estuary

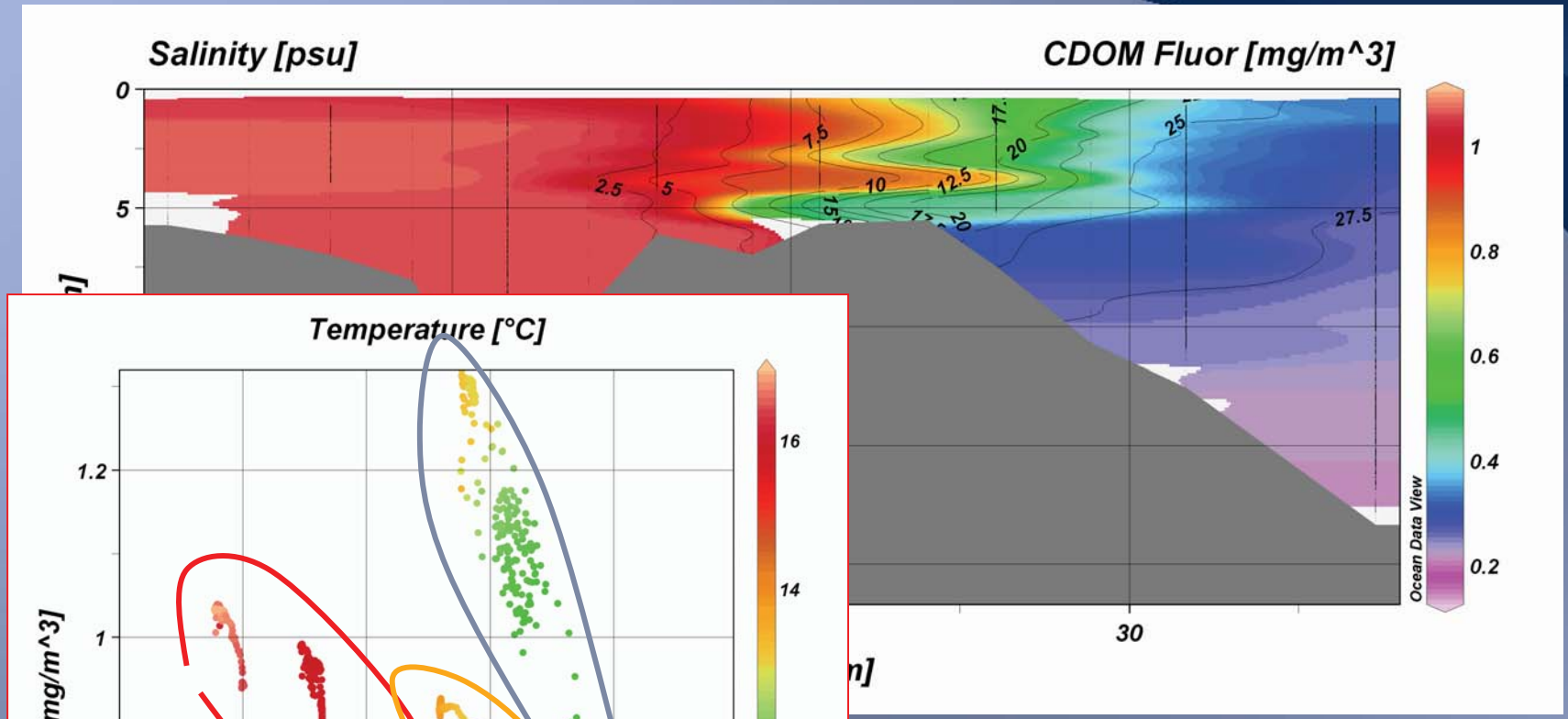
August and September 2006

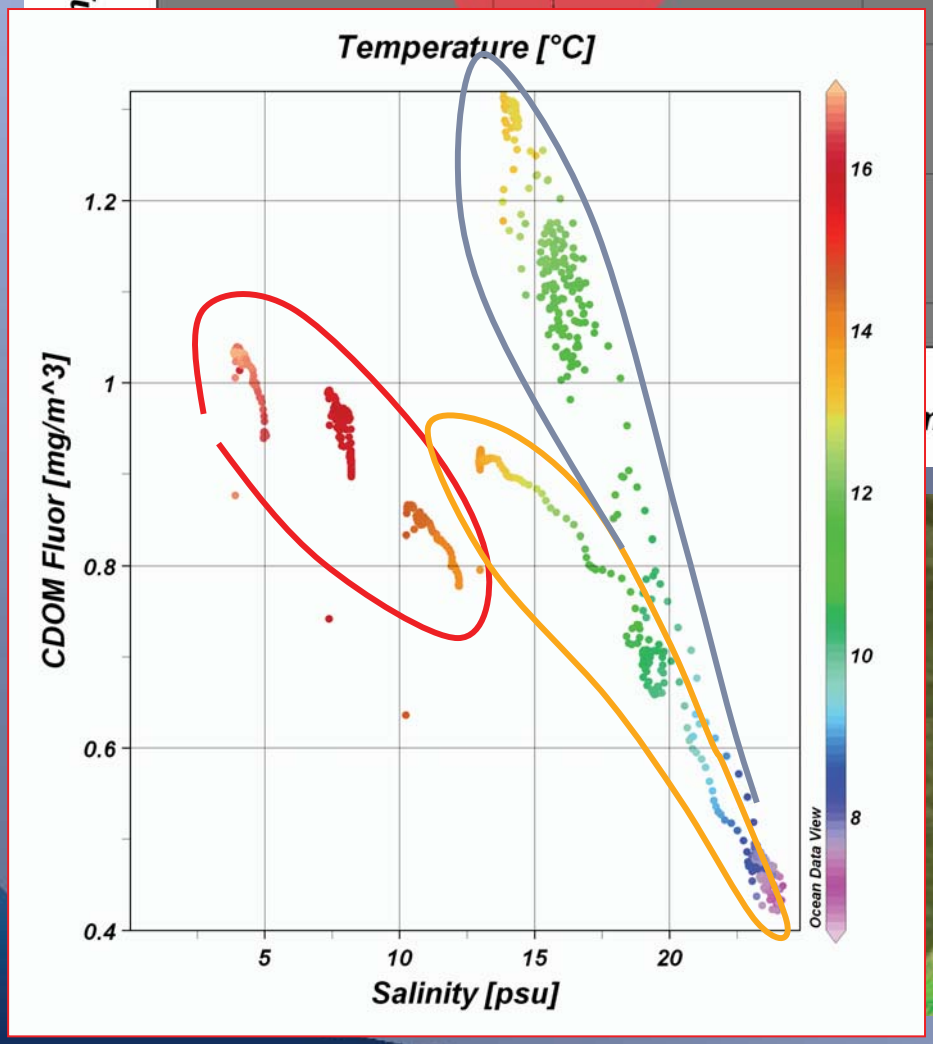


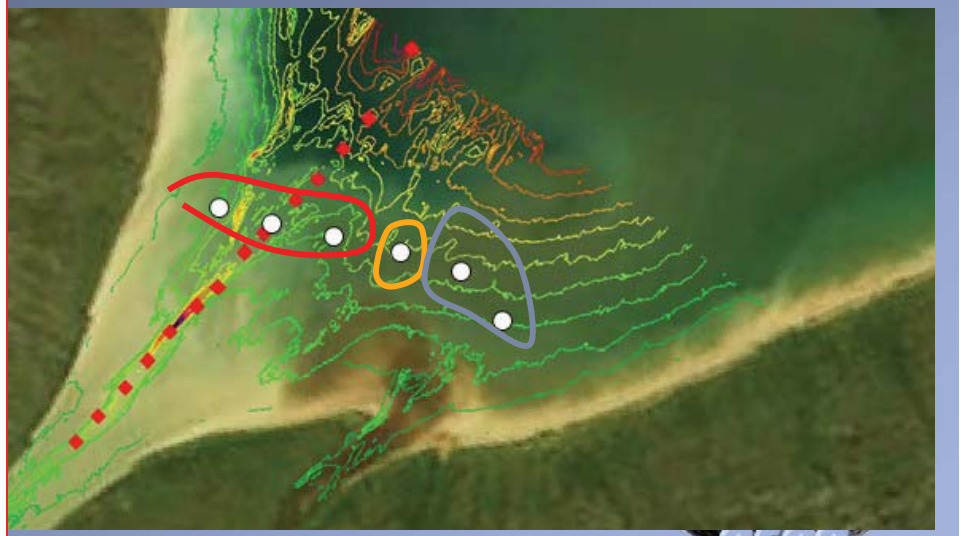







Salinity [psu]
CDOM Fluor [mg/m^3]
0
5
2.5
5
7.5
10
12.5
15
17.5
20
25
27.5
30
1
0.8
0.6
0.4
0.2
Ocean Data View

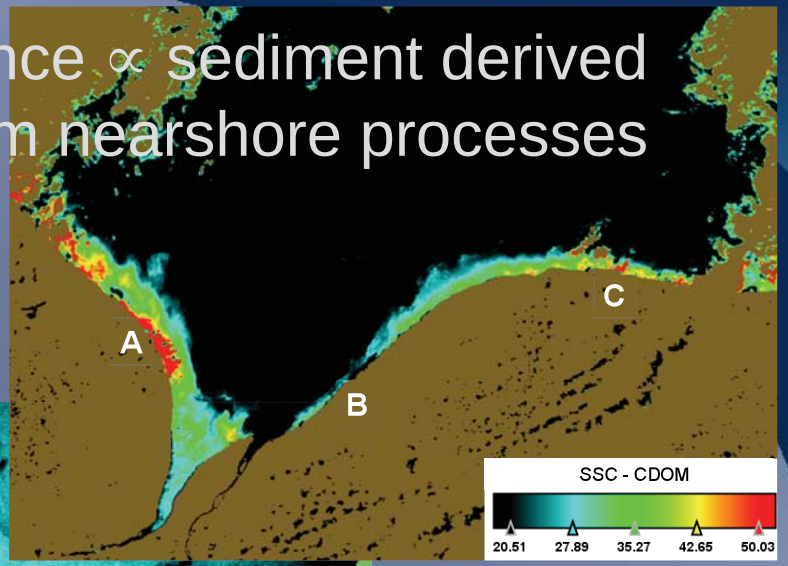

Temperature [°C]
CDOM Fluor [mg/m^3]
1.2
1
0.8
0.6
0.4
5
10
15
20
Salinity [psu]
16
14
12
10
8
Ocean Data View

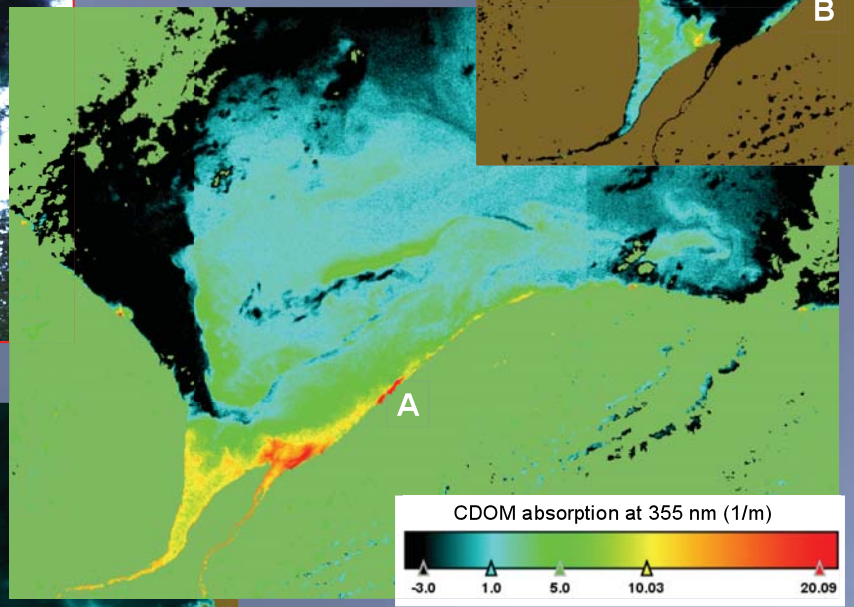


Remote sensing of the Nelson/Hayes plume

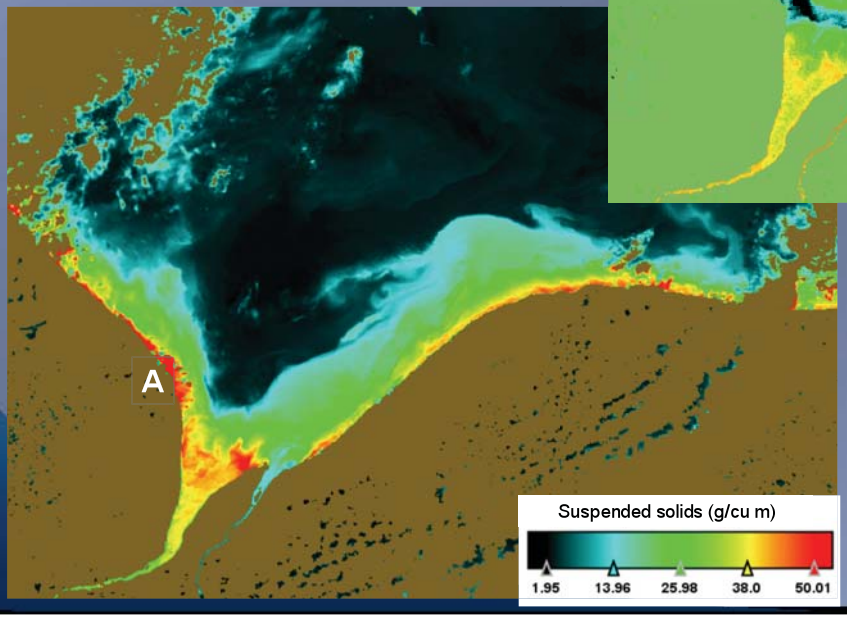
(MERIS-derived data)

Difference ∝ sediment derived from nearshore processes

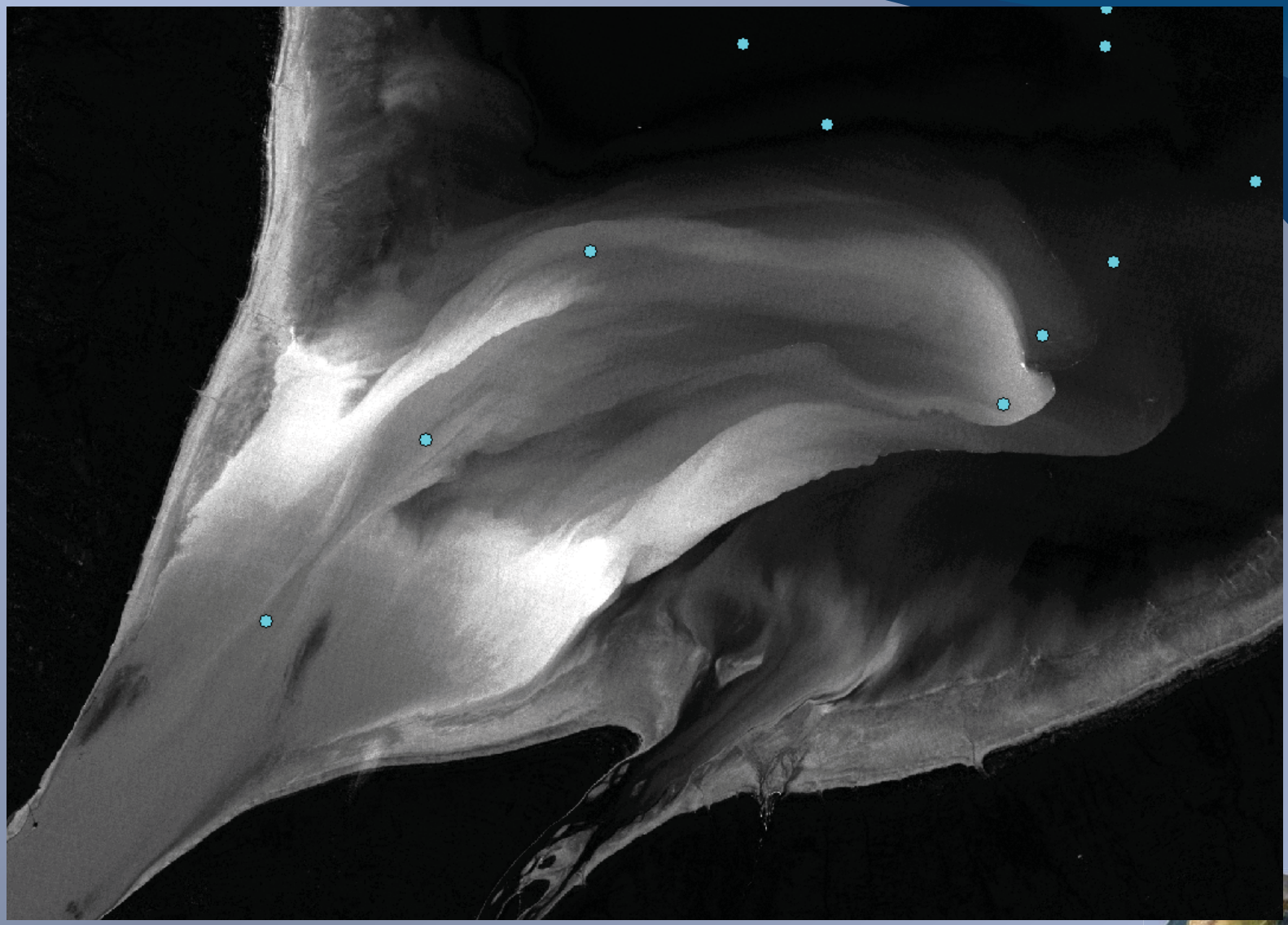




CDOM

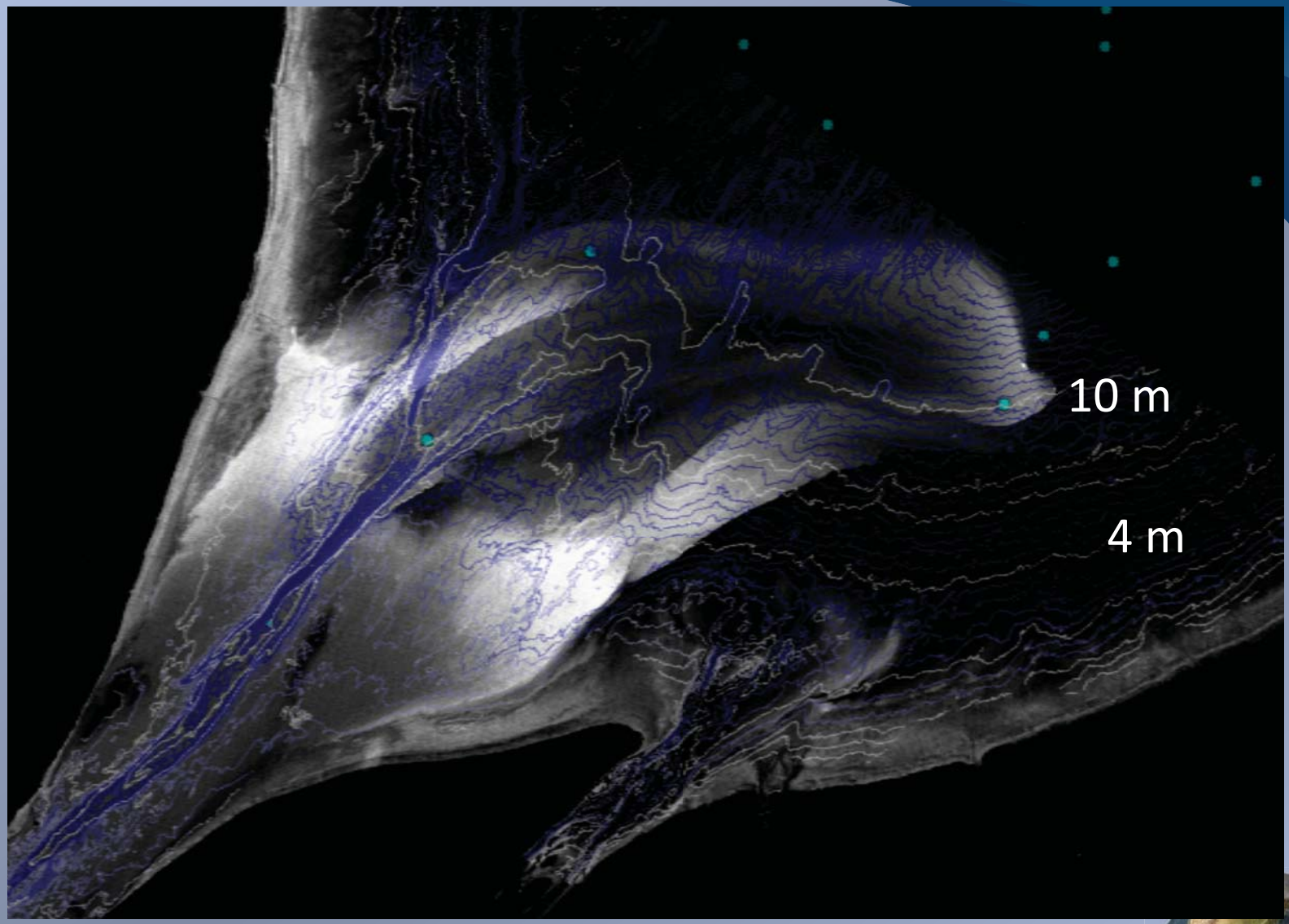


Suspended Sediment



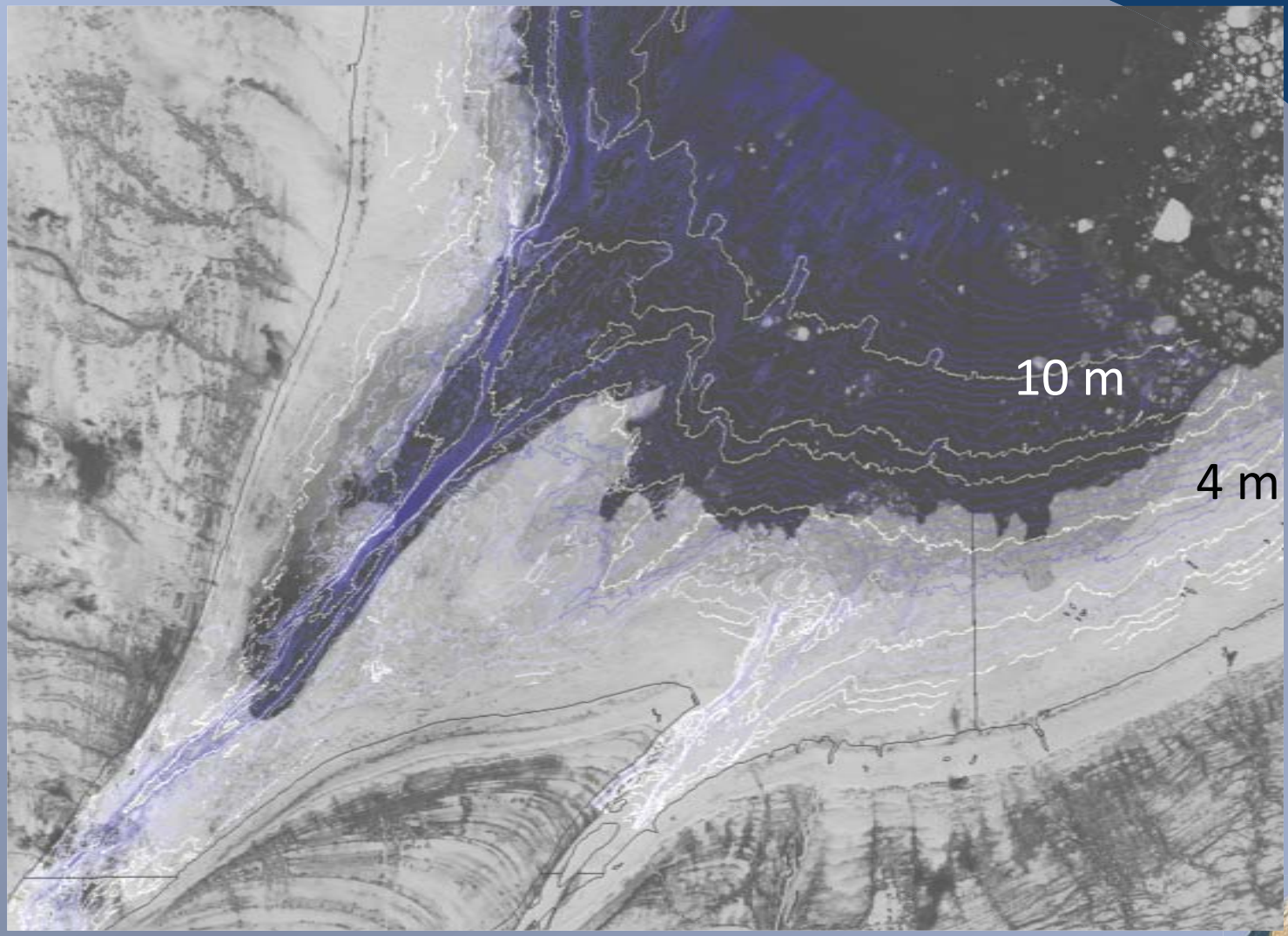
Suspended solids concentration
20 July 2010 (Landsat 5 TM)

0 10 20 30 40 50 g/cu m

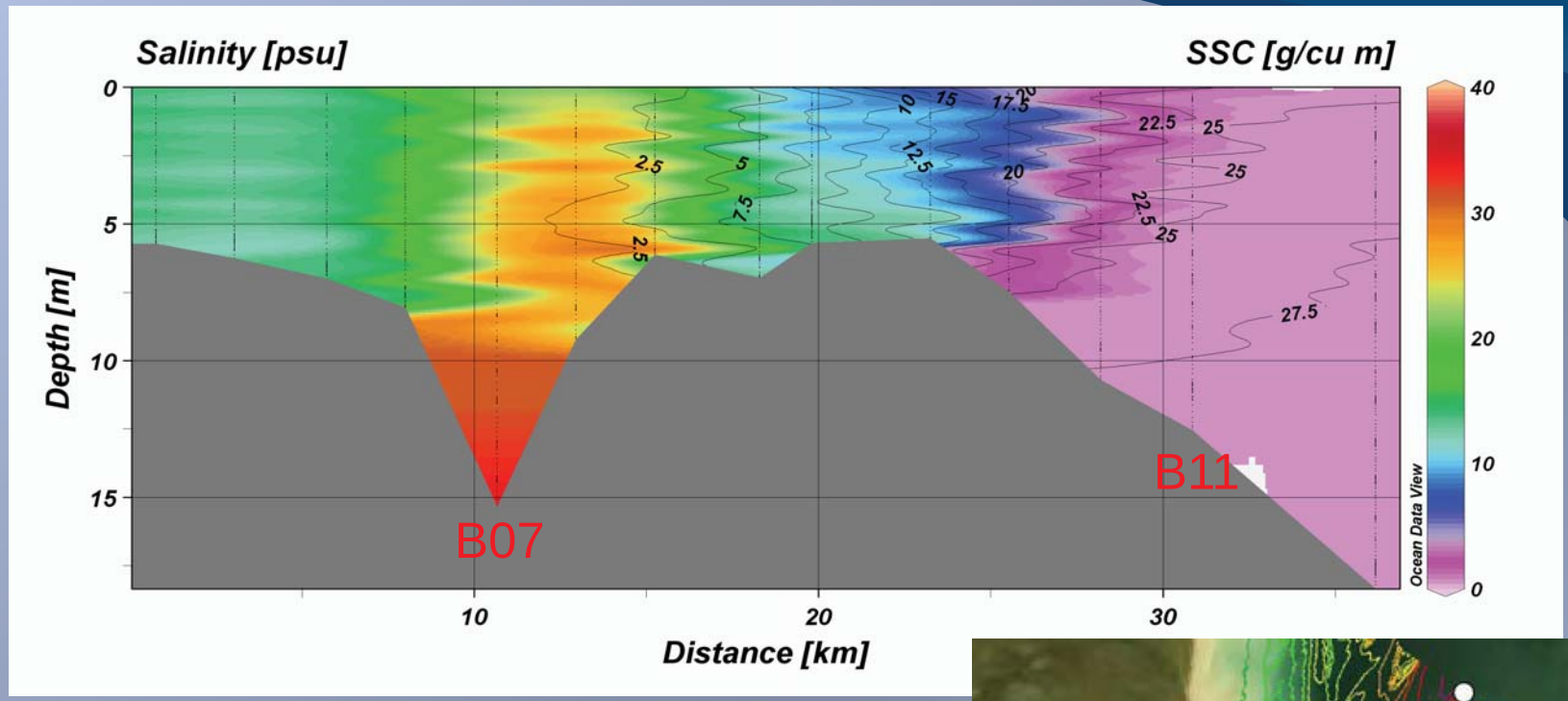


Suspended solids concentration
20 July 2010 (Landsat 5 TM)

0 10 20 30 40 50 g/cu m

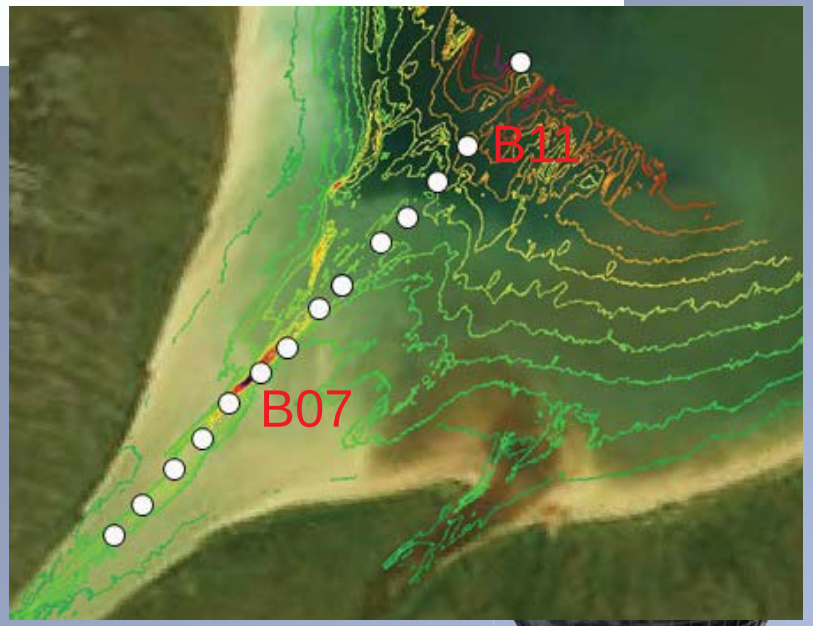


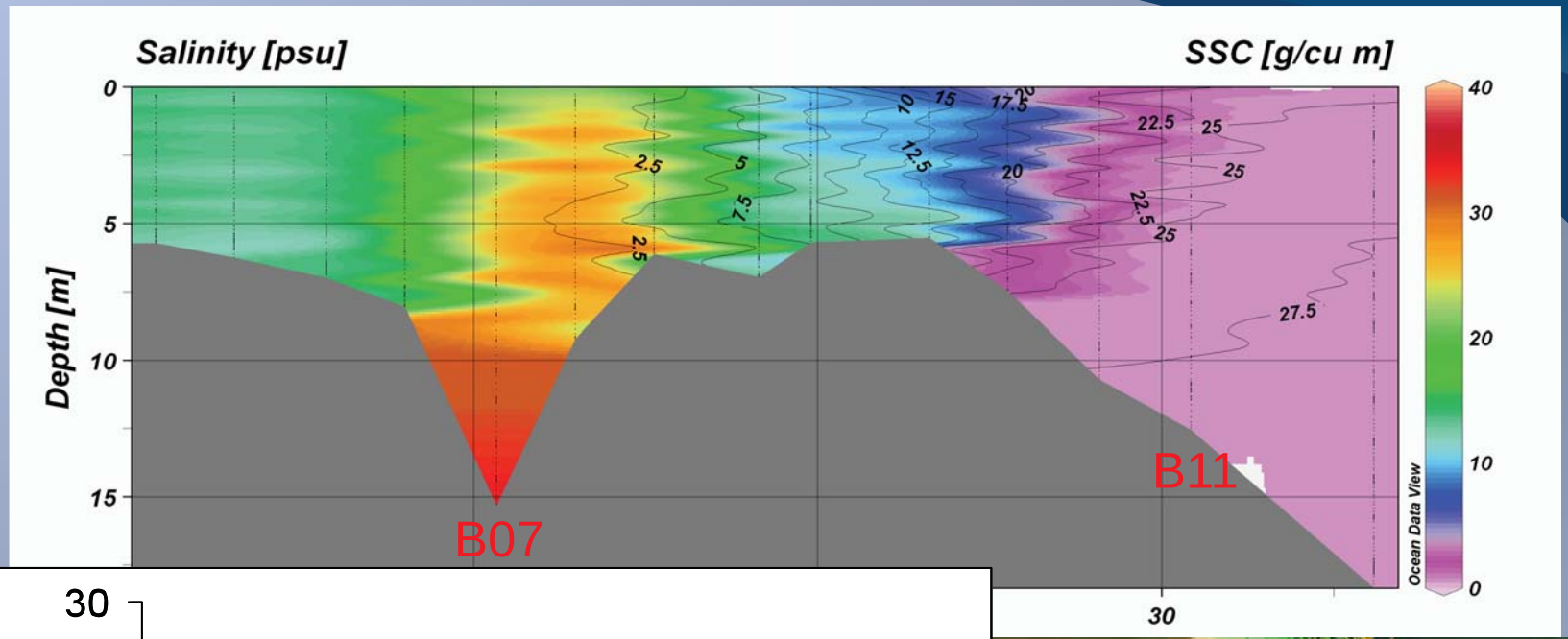
Landfast ice, MODIS, 14 April 2007

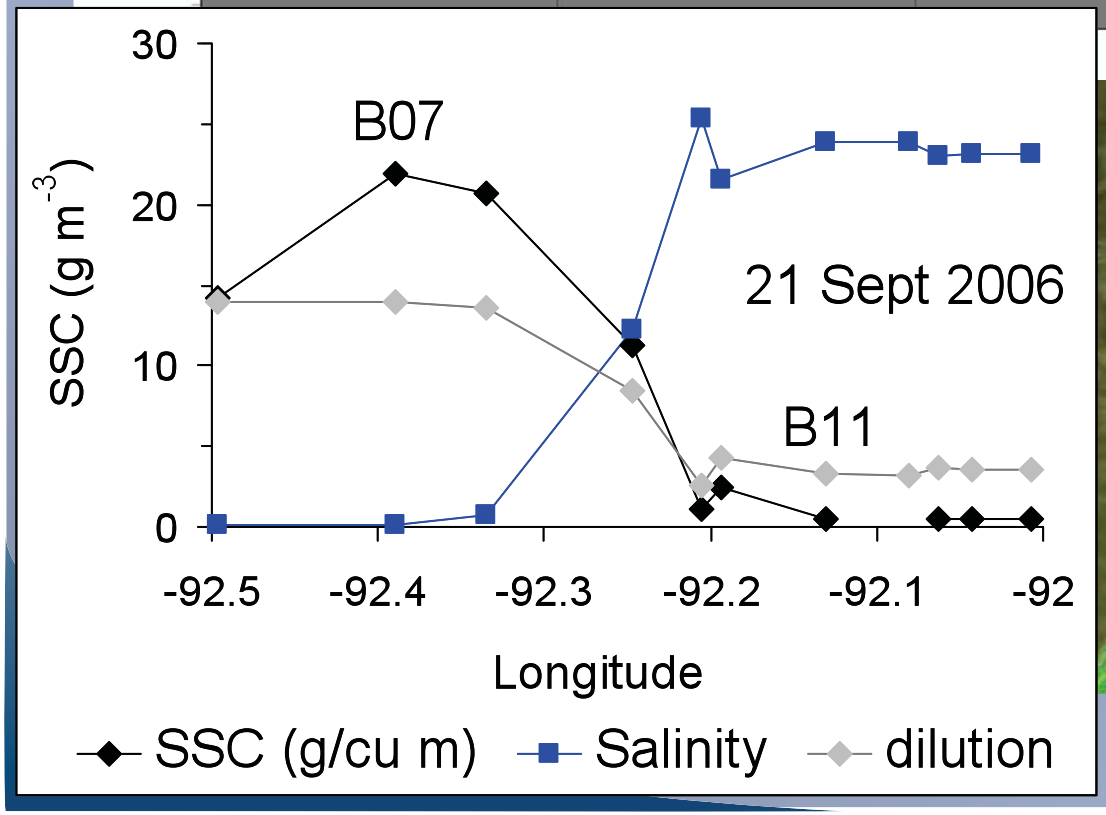


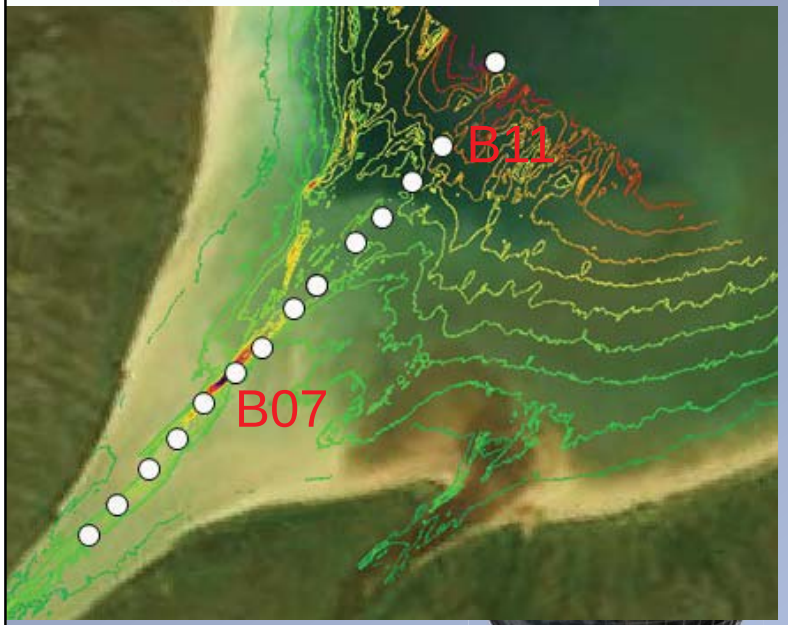
Nelson Estuary nearing low tide
16:20–18:44 CDT 21 Sept 2006.

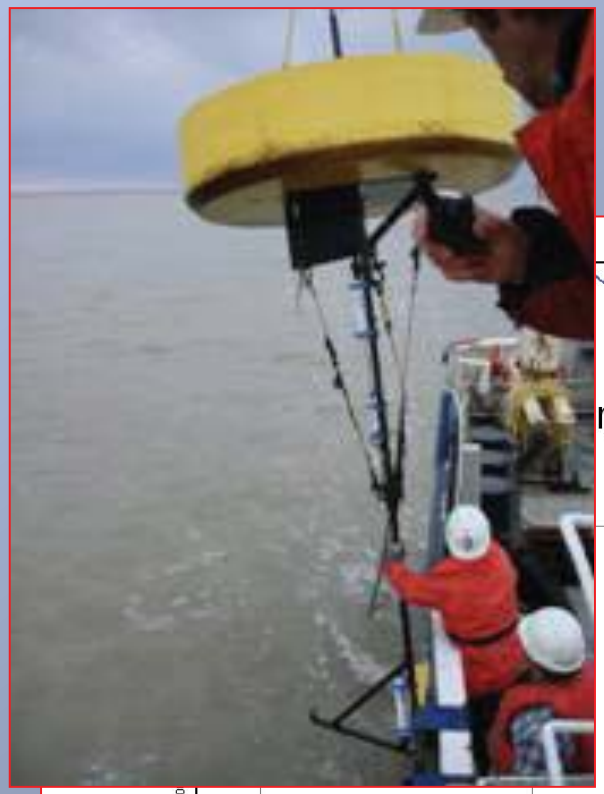
Satellite image is MODIS
14:00 CDT 21 Sept 2006.



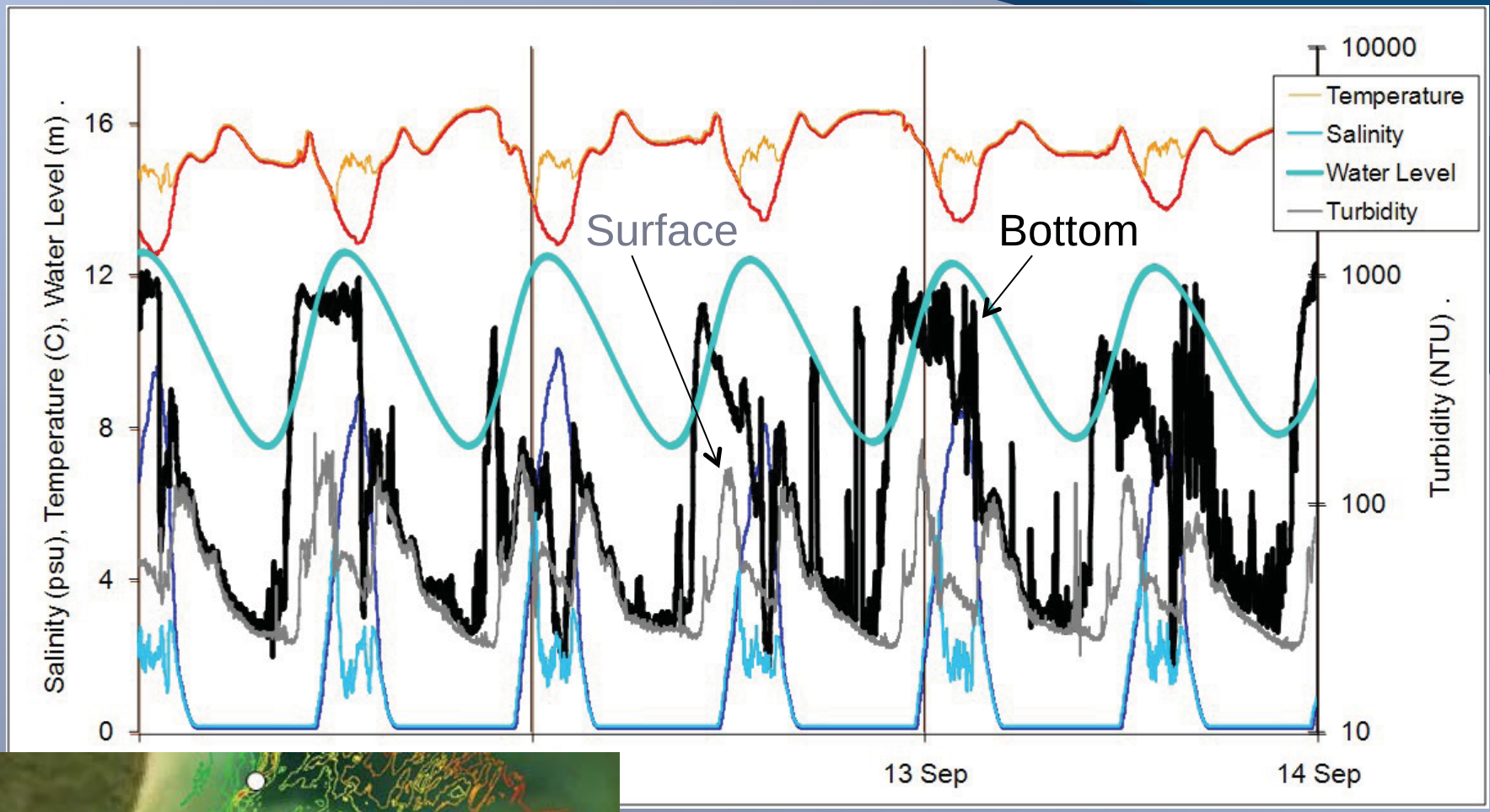

Salinity [psu]
SSC [g/cu m]
Depth [m]
0
5
10
15
30
B07
B11
Ocean Data View
40
30
20
10
0


30
20
10
0
SSC (g m-3)
B07
B11
21 Sept 2006
-92.5
-92.4
-92.3
-92.2
-92.1
-92
Longitude
SSC (g/cu m)
Salinity
dilution

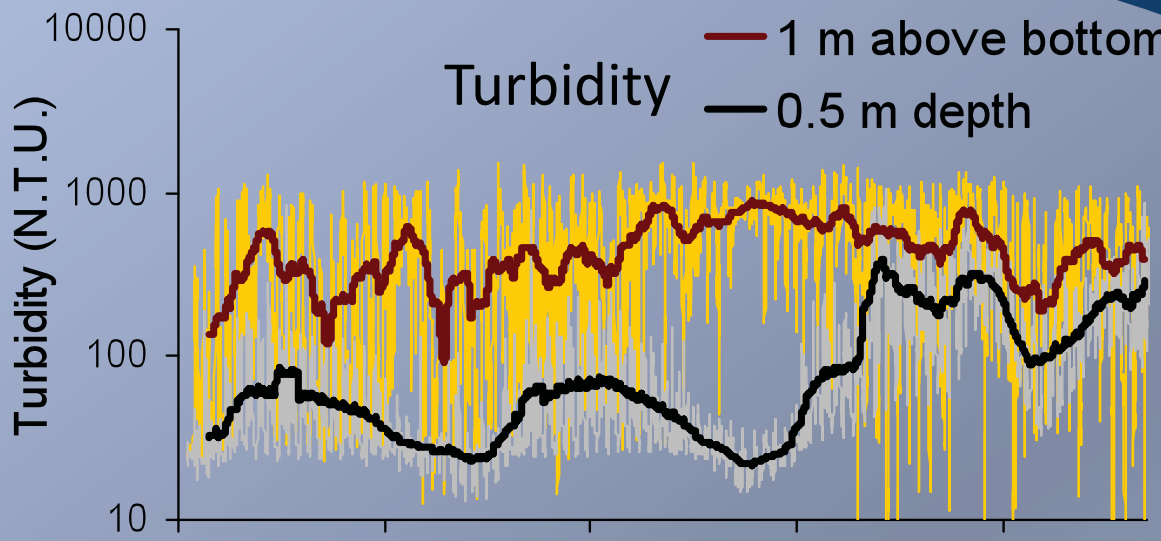

B11
B07

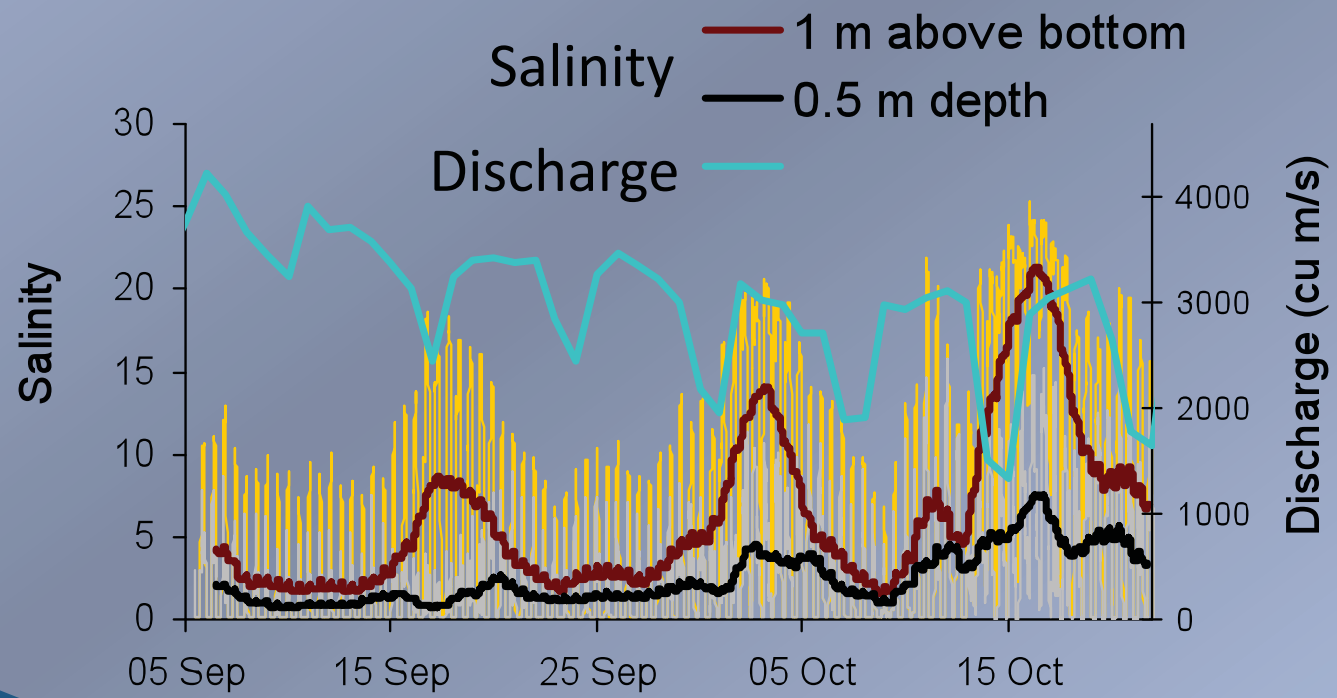


Manitoba Hydro Mooring Locations

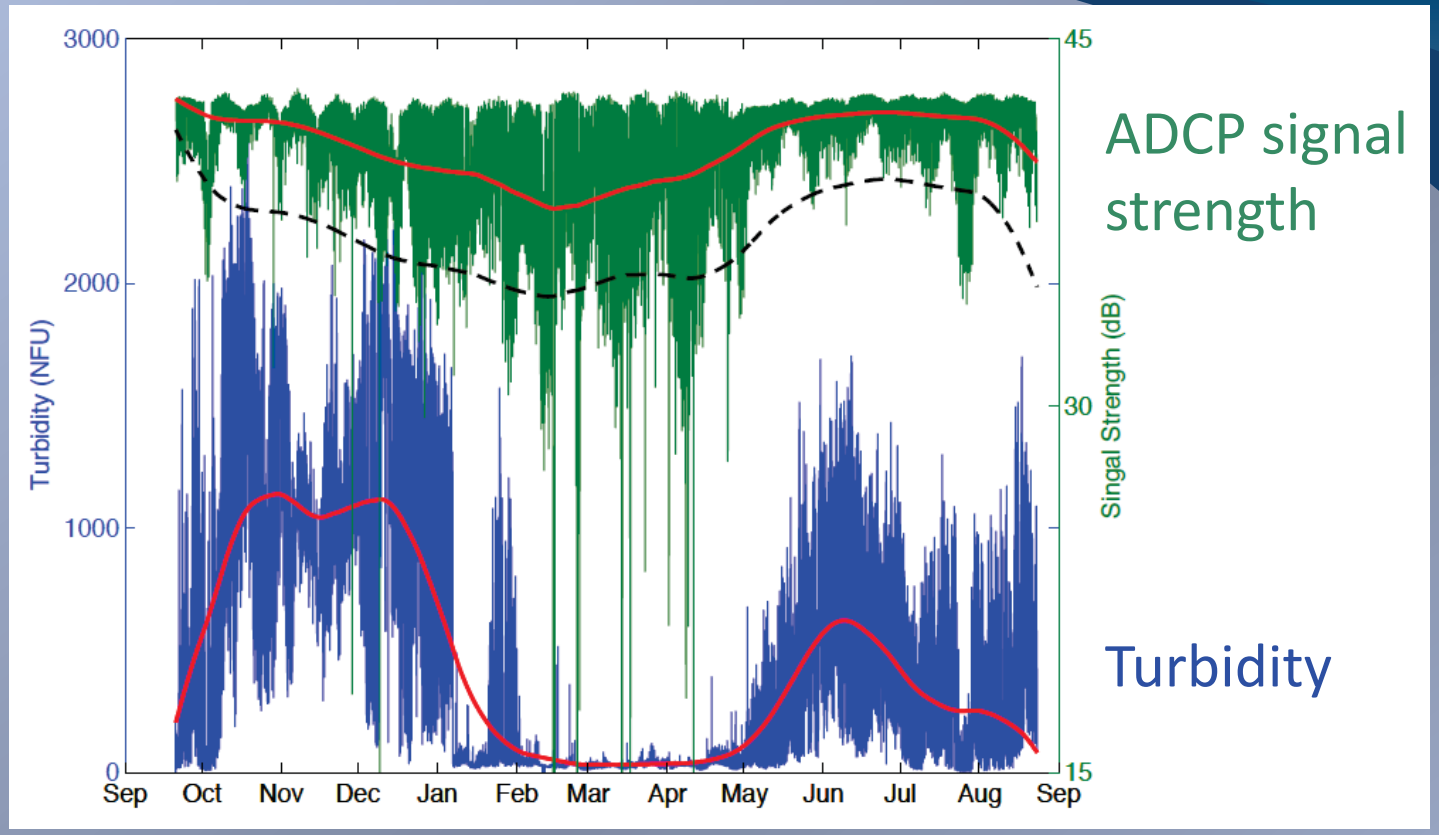


Manitoba Hydro Mooring 4. Turbidity at 0.5 m below surface & 1 m above bottom (z~8 m).

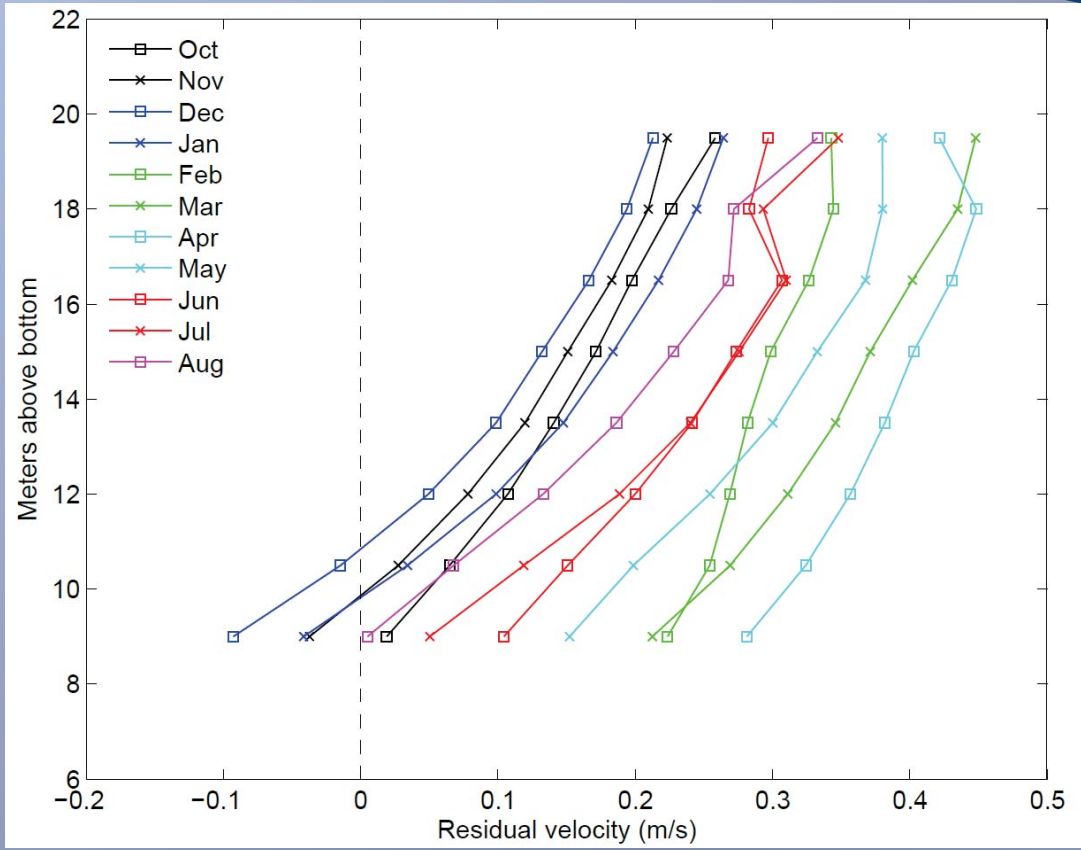

Turbidity
1 m above bottom
0.5 m depth
Turbidity (N.T.U.)
10000
1000
100
10

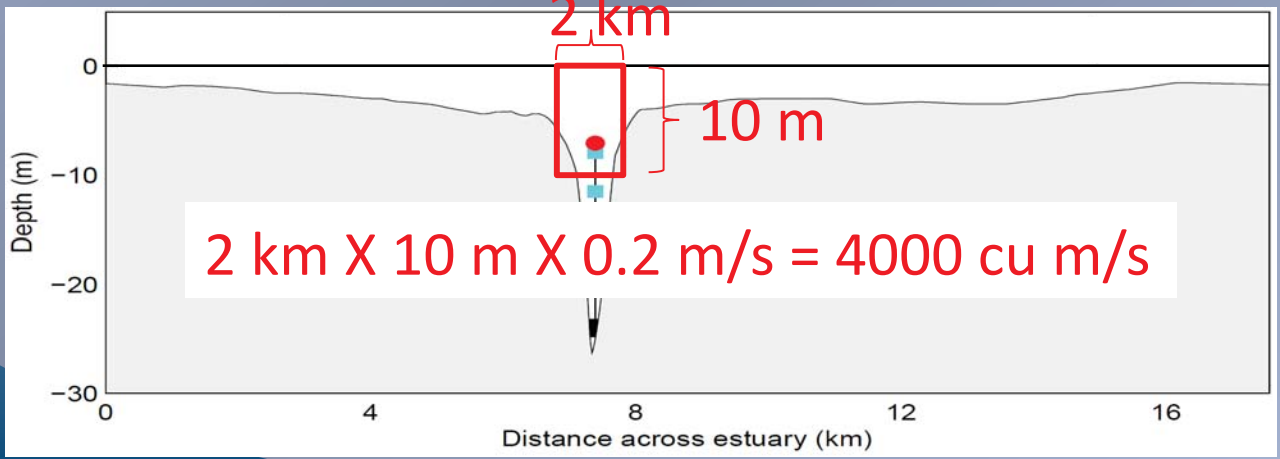

Salinity
1 m above bottom
0.5 m depth
Discharge
Salinity
Discharge (cu m/s)
30
25
20
15
10
5
0
4000
3000
2000
1000
0
05 Sep
15 Sep
25 Sep
05 Oct
15 Oct


CEOS

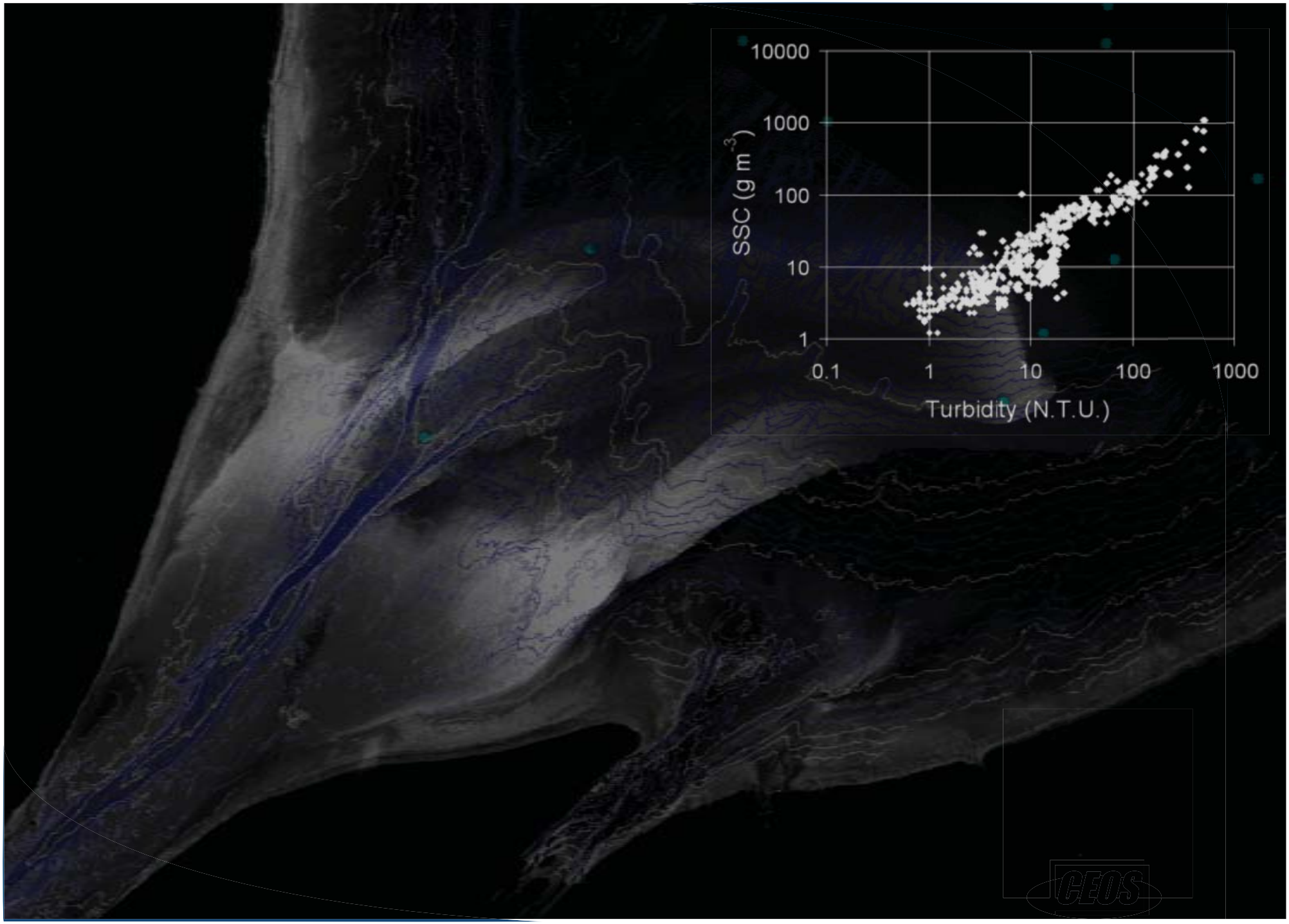


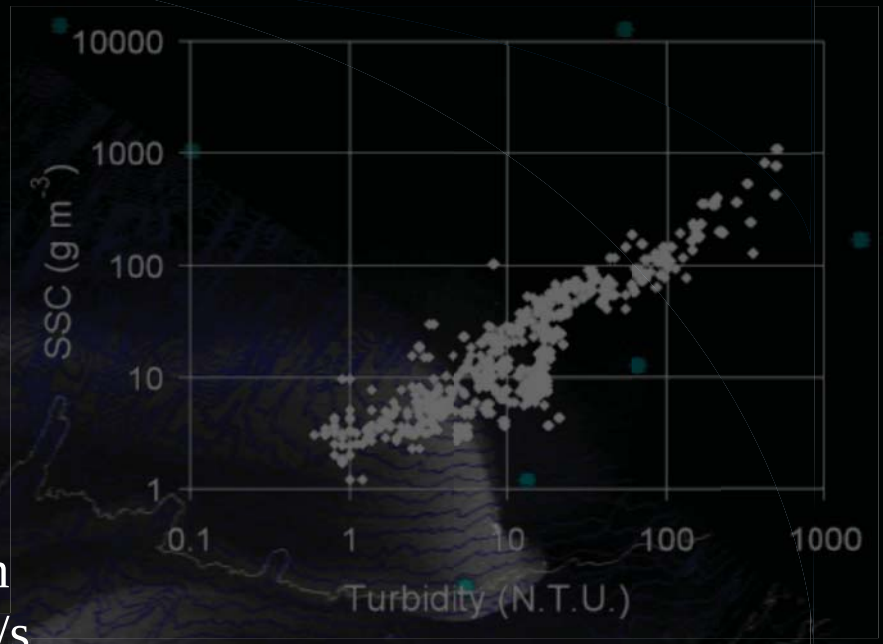
Red lines indicate mean acoustic (Nortek RDCP) return signal strength at 12 m above bottom and mean optical turbidity (Seapoint turbidity meter) at 10 m above bottom.


Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Meters above bottom
Residual velocity (m/s)
22
20
18
16
14
12
10
8
6
−0.2
−0.1
0
0.1
0.2
0.3
0.4
0.5


2 km
10 m
2 km X 10 m X 0.2 m/s = 4000 cu m/s
Depth (m)
Distance across estuary (km)
0
−10
−20
−30
0
4
8
12
16


CEOS


10000
1000
100
10
1
SSC (g m-3)
0.1
1
10
100
1000
Turbidity (N.T.U.)
CEOS



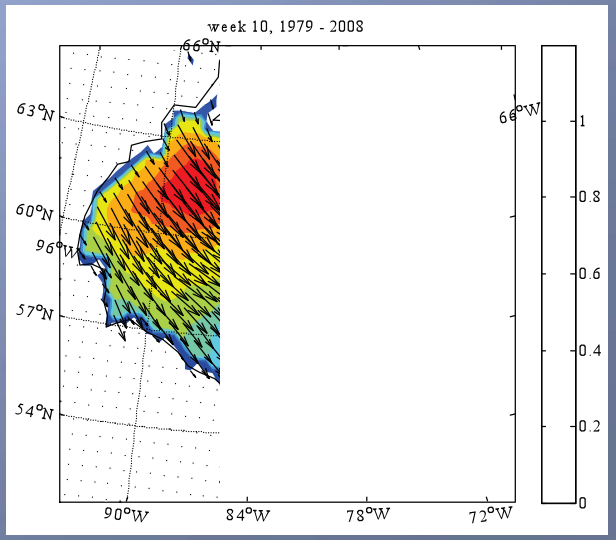
Annual suspended solids load
of the Nelson River at the mouth (minimum):

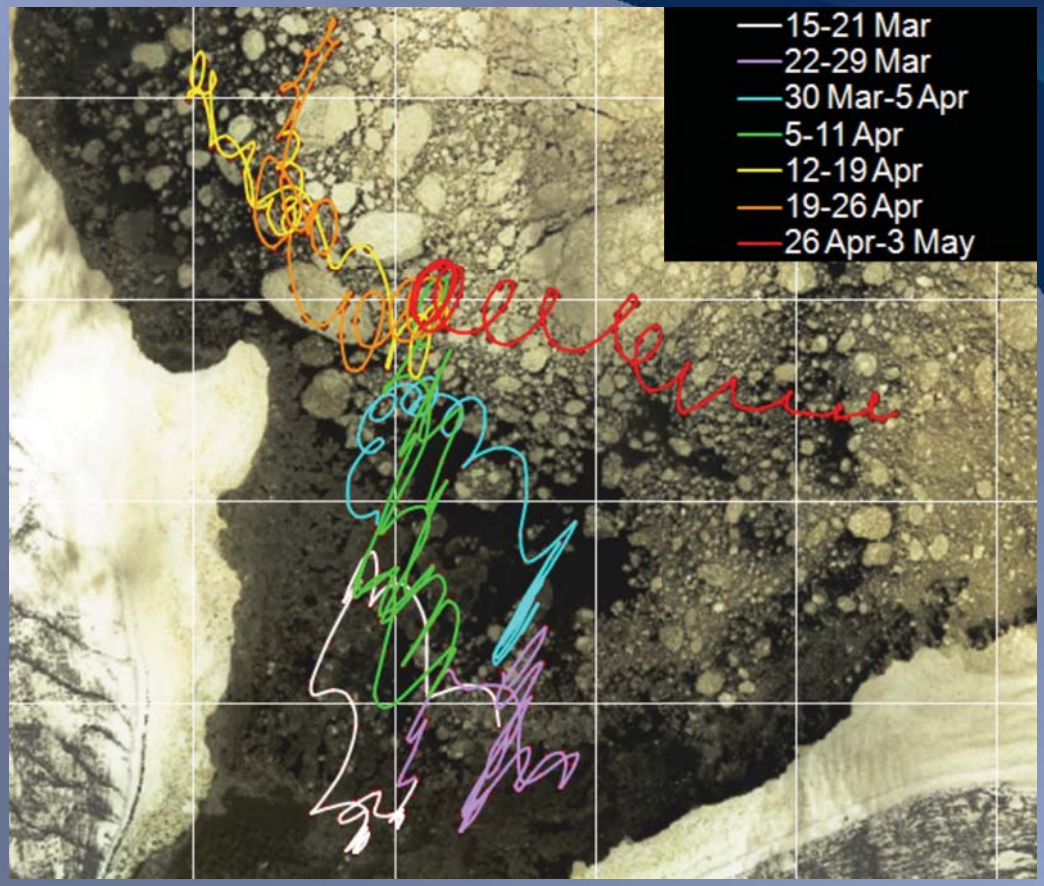
Average concentration	100 g/cu m
Average discharge	4000 cu m/s
Duration of high sediment loading	8 months
Total load	8,400,000 tonnes/year

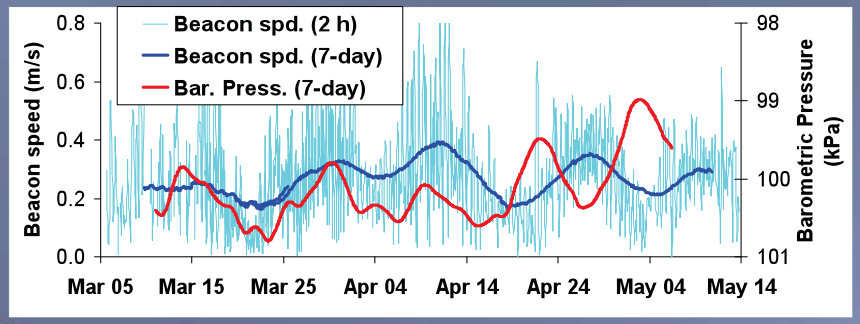
Annual suspended solids load
of the Nelson River upstream of the mouth:

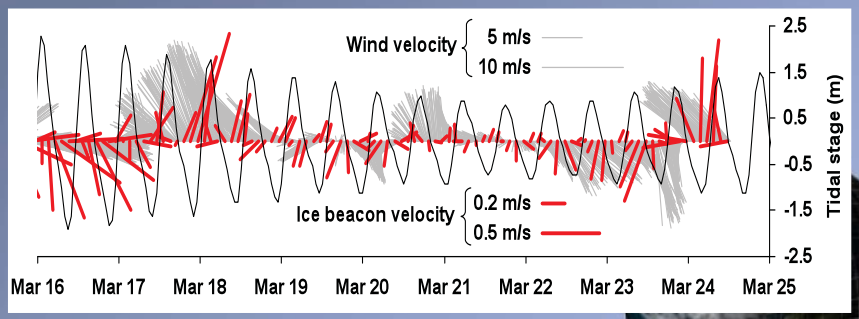
1,900,000 tonnes/year	KGS Acres for Manitoba Hydro
1,500,000 tonnes/year	Environment Illimité for Manitoba Hydro

Ice circulation in the Nelson estuary

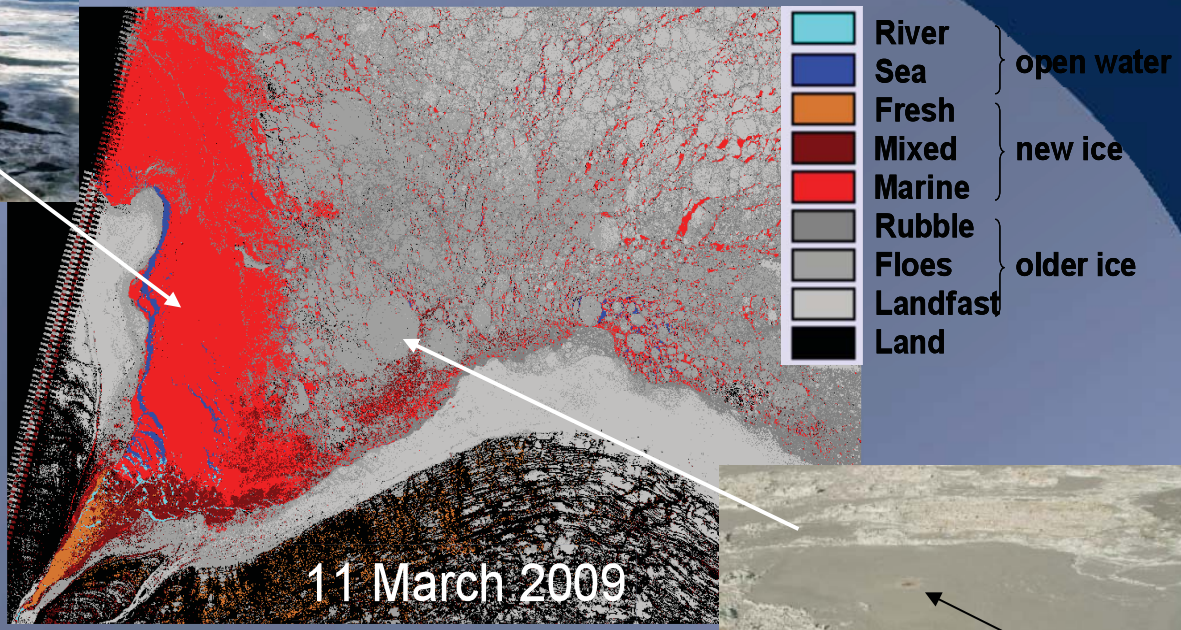


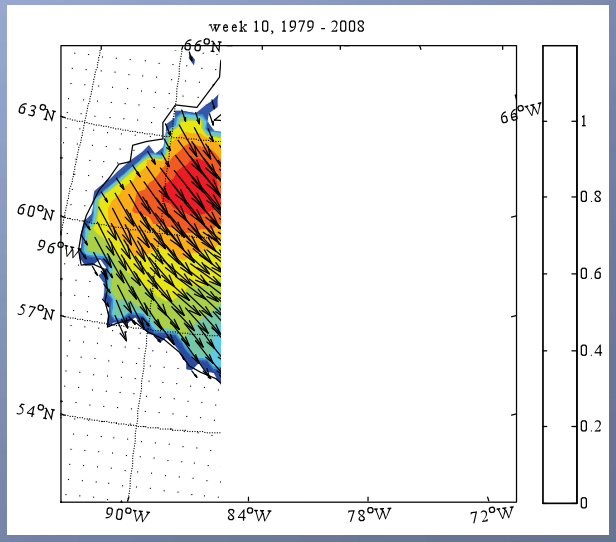


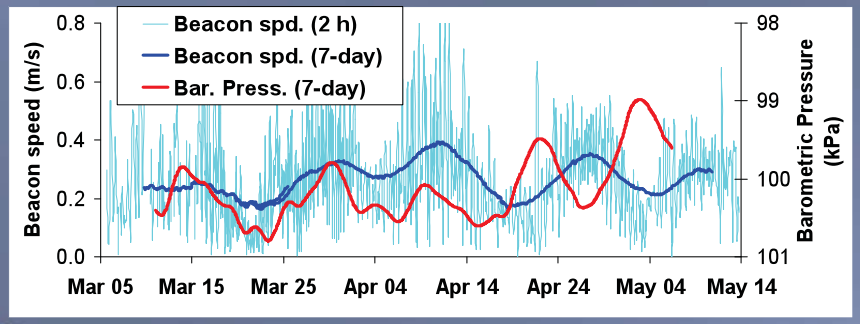


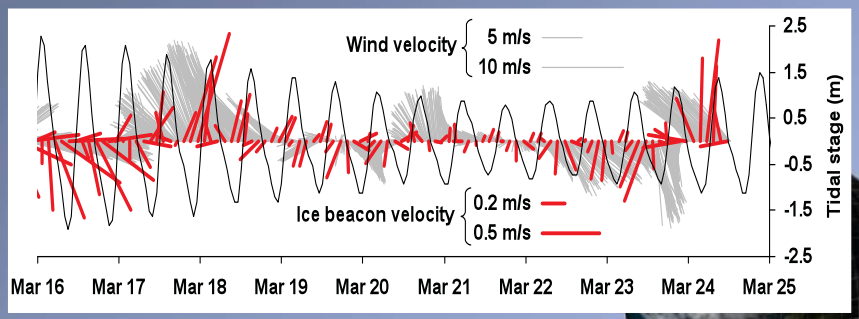


Ice circulation in the Nelson estuary region

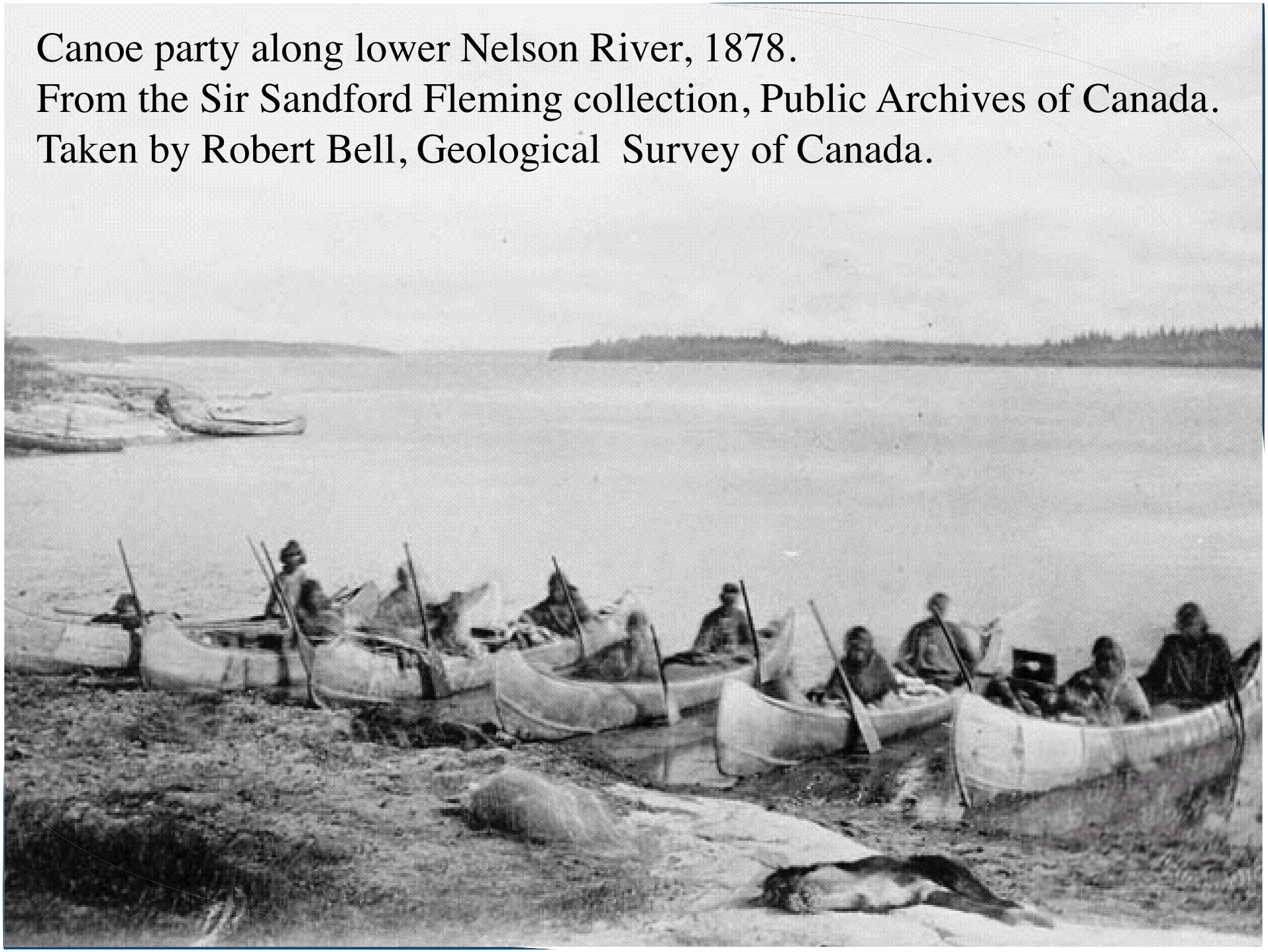






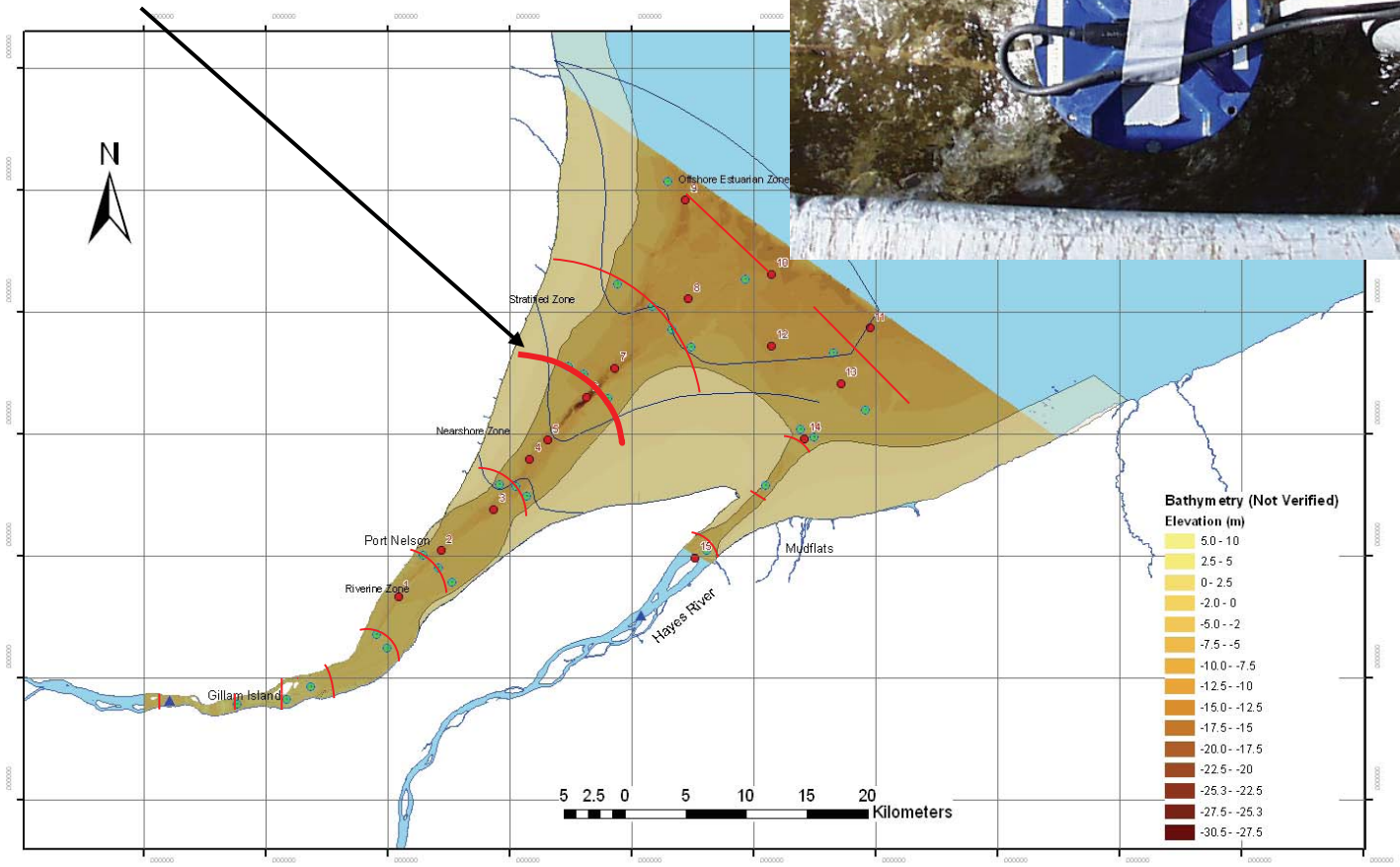


Canoe party along lower Nelson River, 1878.
From the Sir Sandford Fleming collection, Public Archives of Canada.
Taken by Robert Bell, Geological Survey of Canada.

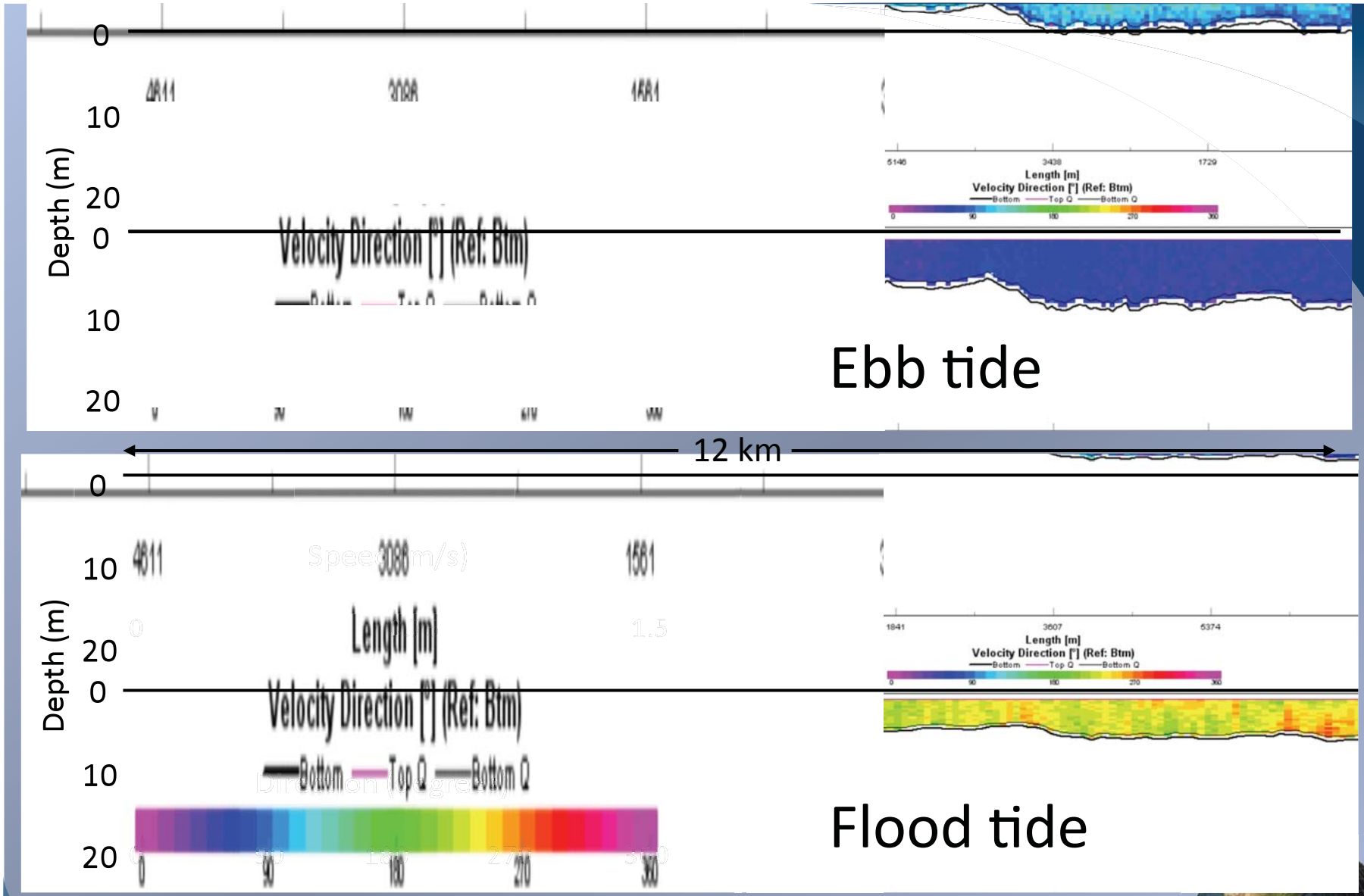


Cross-channel current velocity distribution

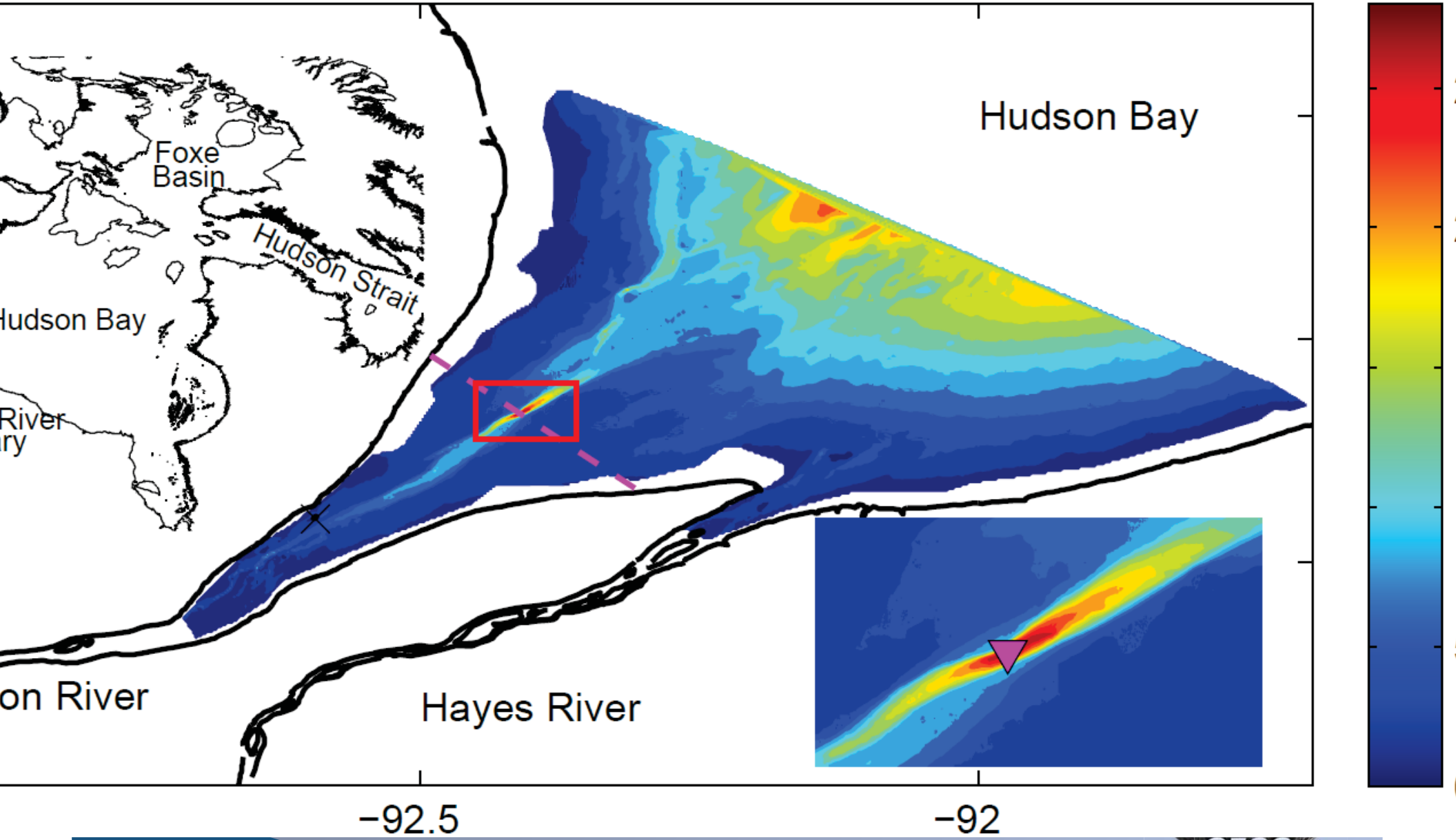
ADCP line H



Hydraulic Engineering and Operations
March 21, 2005



Currents at ebb and flood tide
ADCP line H (Manitoba Hydro, 22 August 2005)

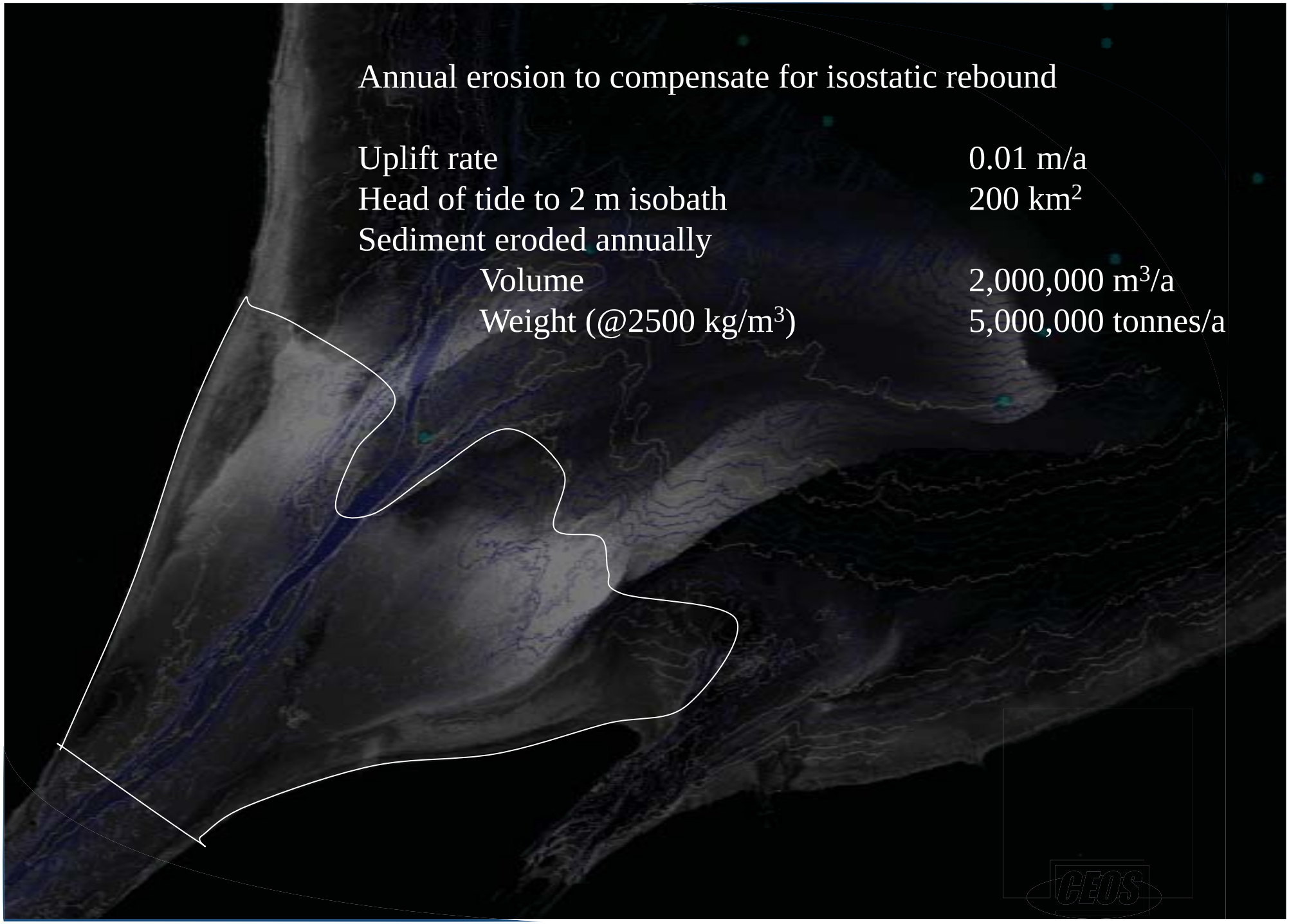

Hudson Bay
Foxe
Basin
Hudson Strait
Hudson Bay
River
ry
on River
Hayes River
−92.5
−92

ArcticNet Freshwater/Marine Publications

- Granskog, M.., R. Macdonald, C.–J. Mundy, D. Barber. 2007. Distribution, Characteristics and Potential Impacts Of Chromophoric Dissolved Organic Matter (CDOM) in Hudson Strait And Hudson Bay. Canada Continental Shelf Res. 27(15):2032-2050.
- St. Laurent, P., M. Defossez, F. Saucier, F. Straneo, S. Senneville, J. Dumais. 2007. New Observations and Numerical Simulations of the sea Ice-Ocean Seasonal Cycle in Hudson Bay, Foxe Basin and Hudson Strait, Canada. Eos Trans. AGU 87(36)
- Kuzyk, Z.Z.A., R. Macdonald, M. Granskog, R. Scharien, R. Galley, C. Michel, D. Barber, G. Stern. 2007. Sea ice, hydrological, and biological processes in the Churchill River estuary region. Hudson Bay Estuarine, Coastal and Shelf Sci.
- Granskog, M. R. Macdonald, Z. Kuzyk, S. Senneville, C.J. Mundy, D. Barber, G. Stern and F. Saucier. 2008. On the use of oxygen isotopes to resolve freshwater budget and colored dissolved organic matter dynamics in southwestern Hudson Bay. J. of Geophys. Res..
- Stainton, E., R. Hesslein, T. Papkyriakou, and D. Barber. 2009. Summer air-water CO2 exchange of the Churchill River as it enters Hudson Bay. Limn. & Oceanog.
- Granskog, M. R. Macdonald, Z.Z.A. Kuzyk, S. Senneville, C.-J. Mundy, D. Barber, G. Stern, and F. Saucier. 2009. Coastal conduit in southwestern Hudson Bay (Canada) in summer: Rapid transit of freshwater and significant loss of colored dissolved organic matter. J. Geophys. Res.

ArcticNet Freshwater/Marine Publications

- Hochheim, K. and D. Barber. 2009. Atmospheric Forcing of Sea Ice in Hudson Bay during the Fall Period, 1980-2005. J. Geophys. Res.
- Stainton, E. 2010. Air-water CO2 exchange in relation to chemical and phyusical characteristics of the Churchill R. and estuary, SW Hudson Bay. MSc. Thesis.
- St-Laurent, P., F. Straneo, J.-F. Dumais, and D.G. Barber. 2008. What controls the dispersion of riverine fresh water in Hudson Bay during the summer?
- St. Laurent, P., M. Defossez, F. Saucier, F. Straneo, S. Senneville, J. Dumais. 2007. New Observations and Numerical Simulations of the sea Ice-Ocean Seasonal Cycle in Hudson Bay, Foxe Basin and Hudson Strait, Canada. Eos Trans. AGU 87(36)



Annual erosion to compensate for isostatic rebound

Uplift rate	0.01 m/a
Head of tide to 2 m isobath	200 km^2
Sediment eroded annually	
Volume	2,000,000 m^3/a
Weight (@2500 kg/m^3)	5,000,000 tonnes/a