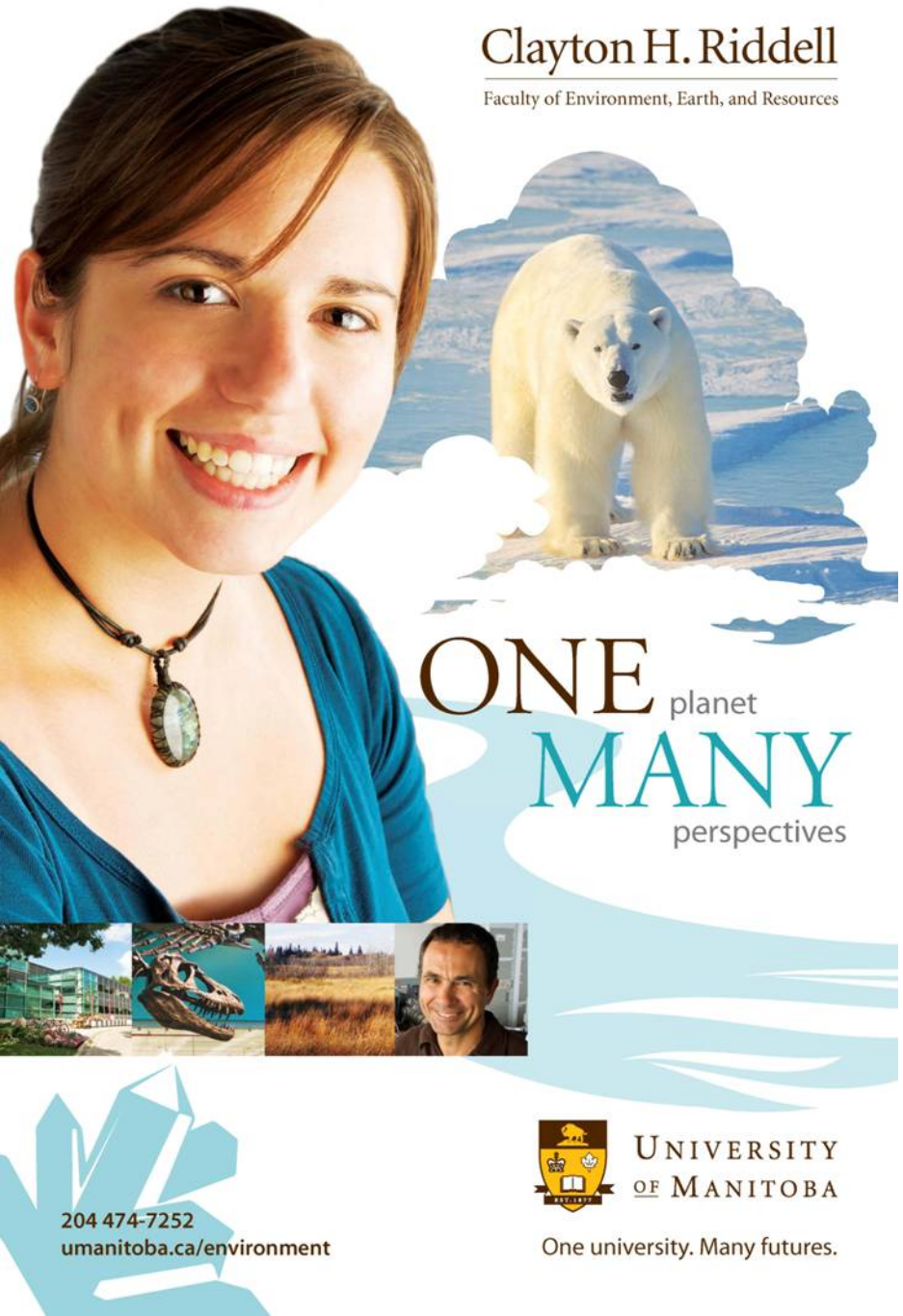


Trends, Variability and Change in Hudson Bay Climate

Prof. David Barber
Centre for Earth Observation Science
University of Manitoba

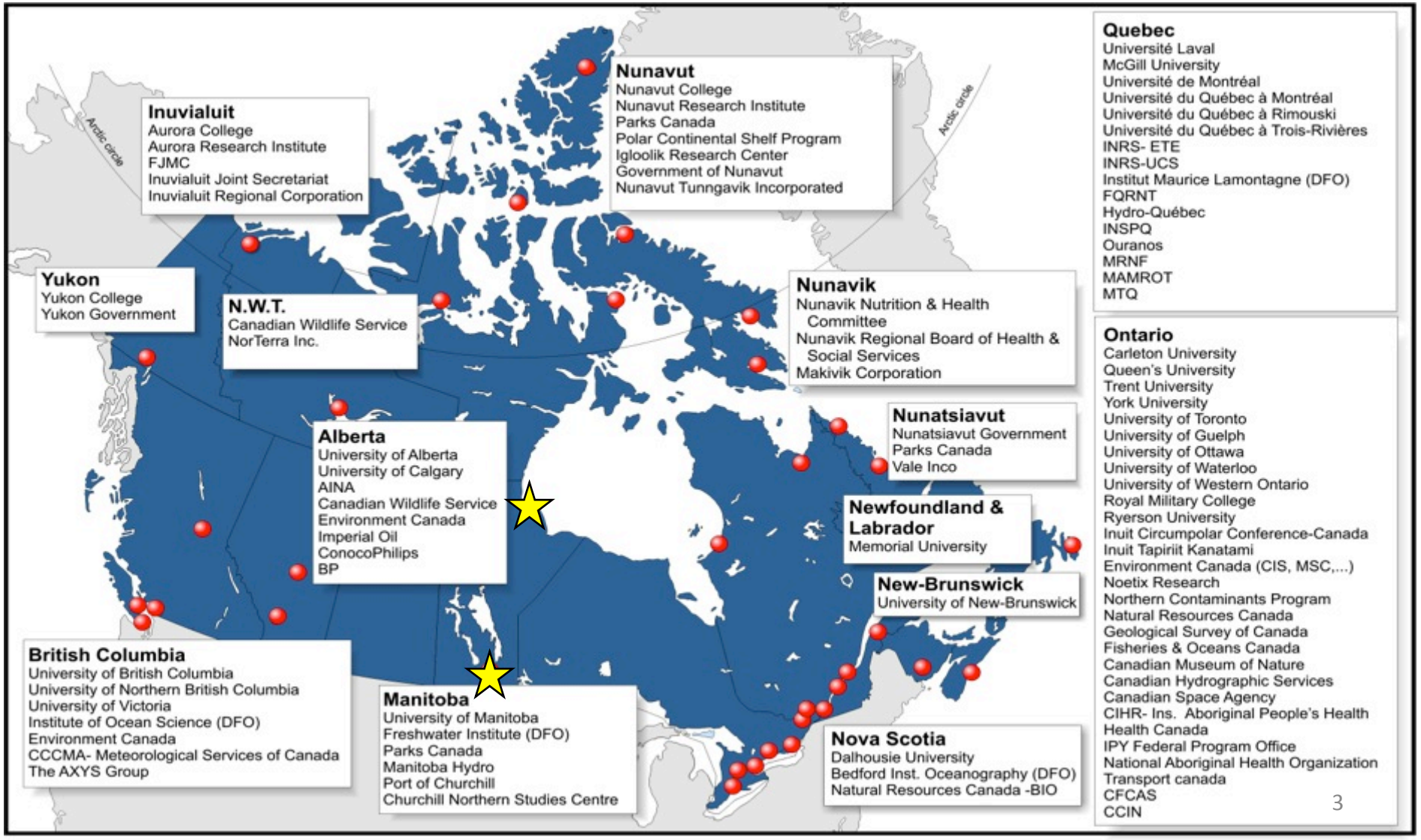
Eeyou Marine Region Symposium
March 26, 2014

Presentation Overview

- Introduction to CEOS
- The context for our work
- A summary of our Hudson and James Bay Research
- A look ahead

Why Manitoba?

Centre of a Pan-Canadian Network



Inuvialuit
Aurora College
Aurora Research Institute
FJMC
Inuvialuit Joint Secretariat
Inuvialuit Regional Corporation

Nunavut
Nunavut College
Nunavut Research Institute
Parks Canada
Polar Continental Shelf Program
Igloolik Research Center
Government of Nunavut
Nunavut Tunngavik Incorporated

Yukon
Yukon College
Yukon Government

N.W.T.
Canadian Wildlife Service
NorTerra Inc.

Nunavik
Nunavik Nutrition & Health Committee
Nunavik Regional Board of Health & Social Services
Makivik Corporation

Alberta
University of Alberta
University of Calgary
AINA
Canadian Wildlife Service
Environment Canada
Imperial Oil
ConocoPhilips
BP

Nunatsiavut
Nunatsiavut Government
Parks Canada
Vale Inco

Newfoundland & Labrador
Memorial University

New-Brunswick
University of New-Brunswick

British Columbia
University of British Columbia
University of Northern British Columbia
University of Victoria
Institute of Ocean Science (DFO)
Environment Canada
CCCMA- Meteorological Services of Canada
The AXYS Group

Manitoba
University of Manitoba
Freshwater Institute (DFO)
Parks Canada
Manitoba Hydro
Port of Churchill
Churchill Northern Studies Centre

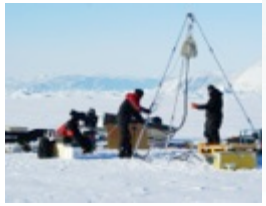
Nova Scotia
Dalhousie University
Bedford Inst. Oceanography (DFO)
Natural Resources Canada -BIO

Quebec
Université Laval
McGill University
Université de Montréal
Université du Québec à Montréal
Université du Québec à Rimouski
Université du Québec à Trois-Rivières
INRS- ETE
INRS-UCS
Institut Maurice Lamontagne (DFO)
FQRNT
Hydro-Québec
INSPQ
Ouranos
MRNF
MAMROT
MTQ

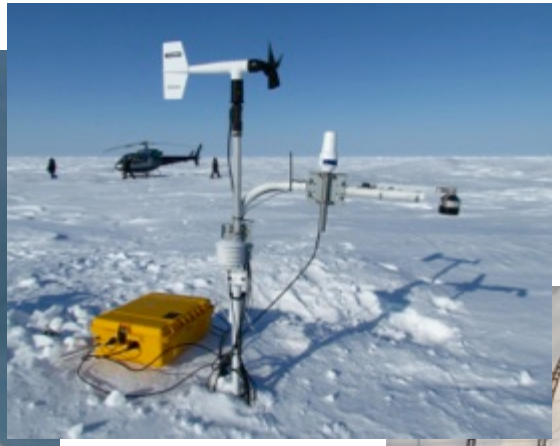
Ontario
Carleton University
Queen's University
Trent University
York University
University of Toronto
University of Guelph
University of Ottawa
University of Waterloo
University of Western Ontario
Royal Military College
Ryerson University
Inuit Circumpolar Conference-Canada
Inuit Tapiriit Kanatami
Environment Canada (CIS, MSC,...)
Noetix Research
Northern Contaminants Program
Natural Resources Canada
Geological Survey of Canada
Fisheries & Oceans Canada
Canadian Museum of Nature
Canadian Hydrographic Services
Canadian Space Agency
CIHR- Ins. Aboriginal People's Health
Health Canada
IPY Federal Program Office
National Aboriginal Health Organization
Transport canada
CFCAS
CCIN

Why Manitoba?

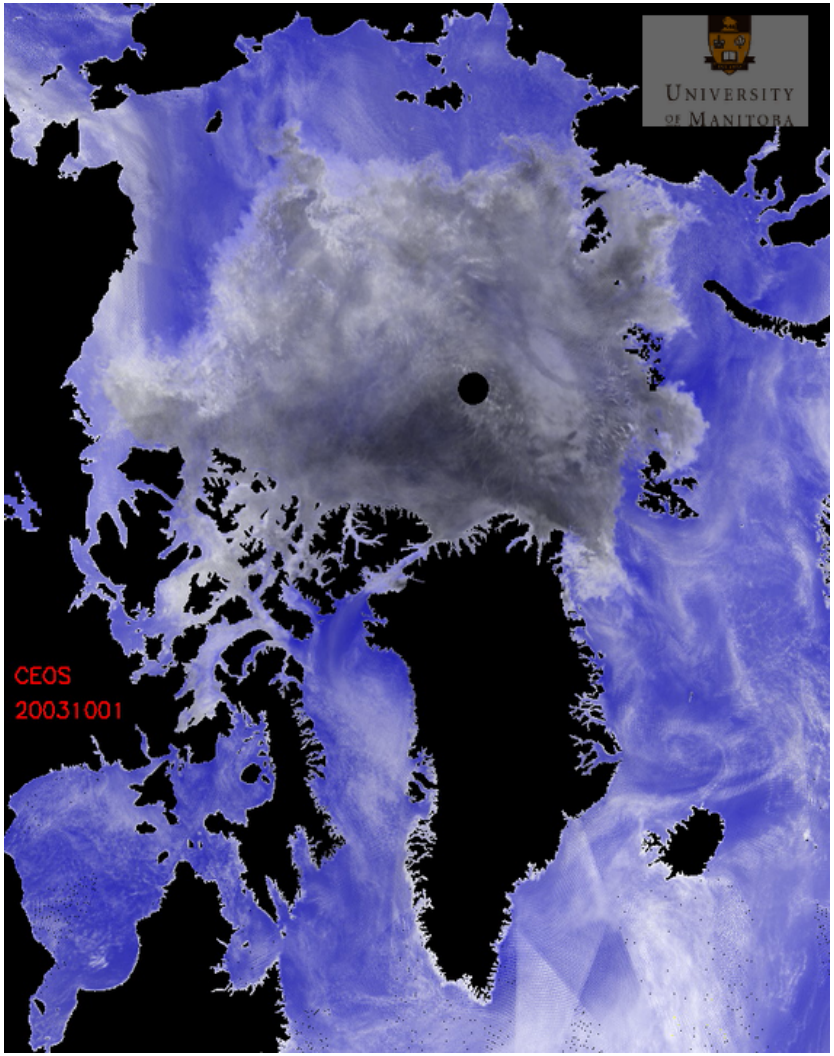
ASP – our International Network

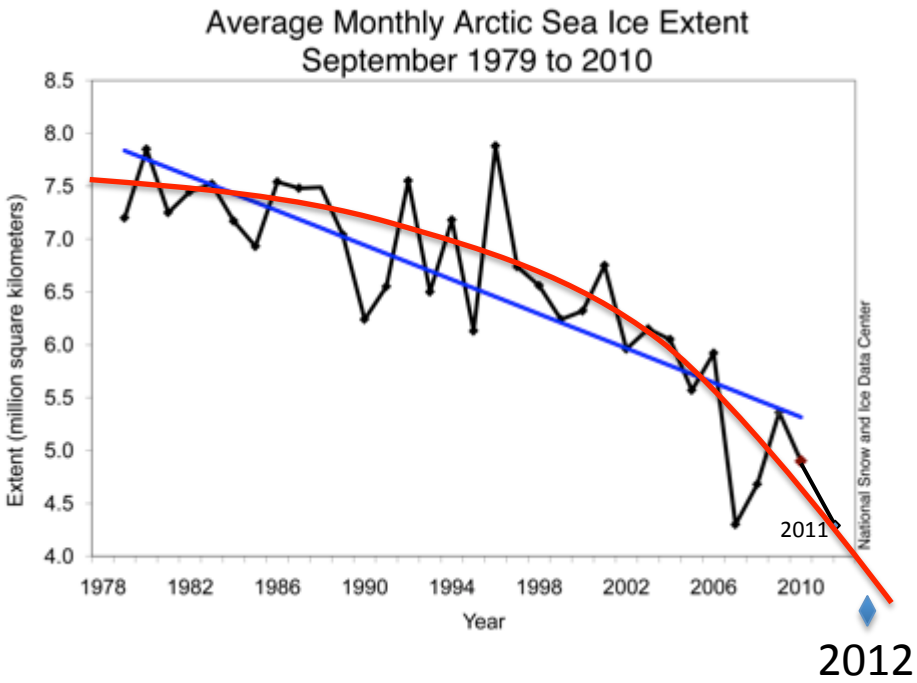


How we do our work…



CMO – Science rationale

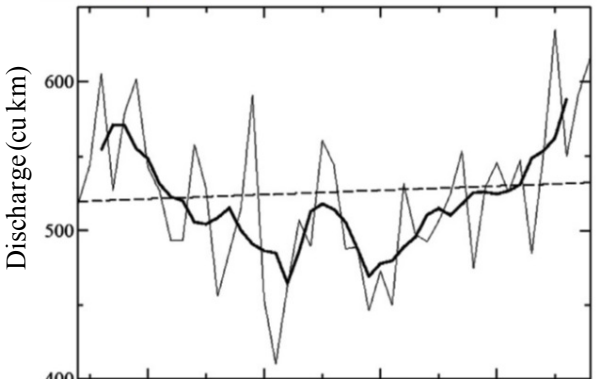




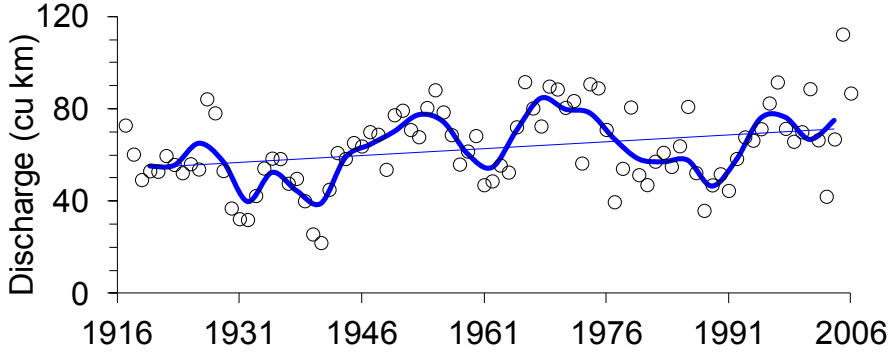
Freshwater inputs to Hudson Bay and James Bay are increasing

- River inputs to Hudson Bay have increased (e.g. Dery 2005, 2011)
- Are projected to continue to rise (Clair 1998.)

- Changes in freshwater timing and volume impact formation and thaw of sea ice, biologic productivity, contaminant cycling.



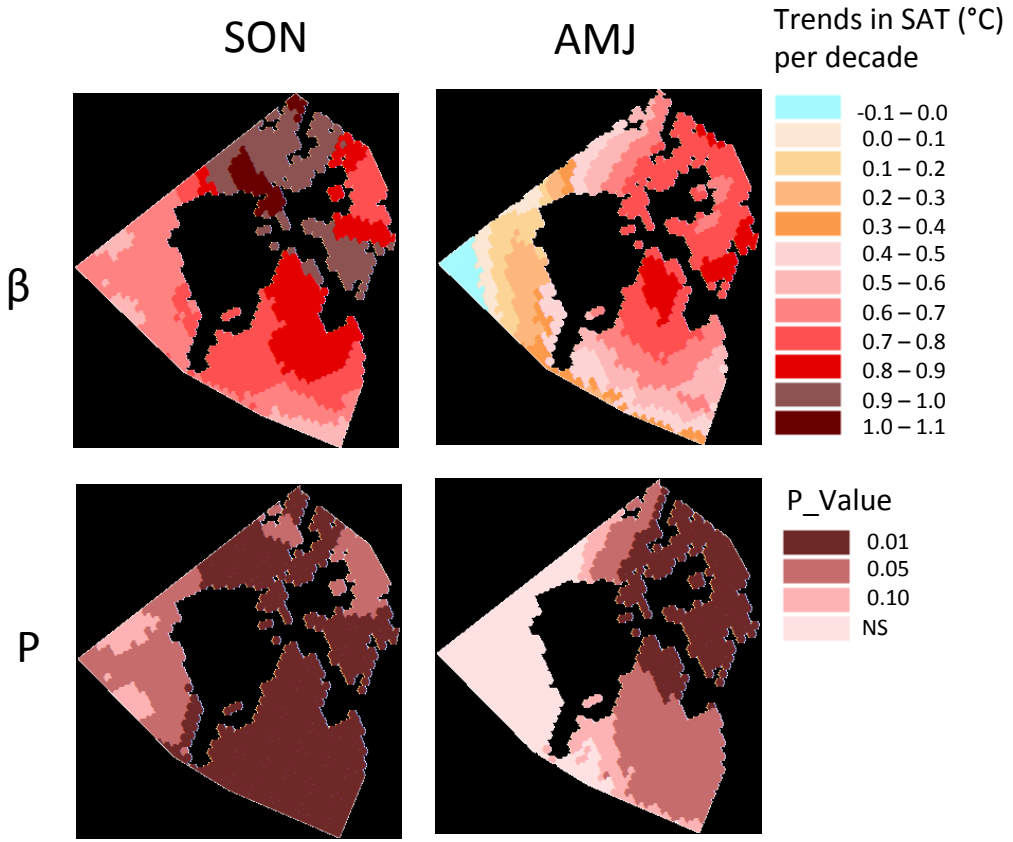
Total Discharge into Hudson Bay
(Dery *et al.* 2010)



Nelson R historic discharge
-Churchill R diversion excluded.
(McCullough *et al*. 2012)

Temperature trends are apparent over Hudson Bay and James Bay region

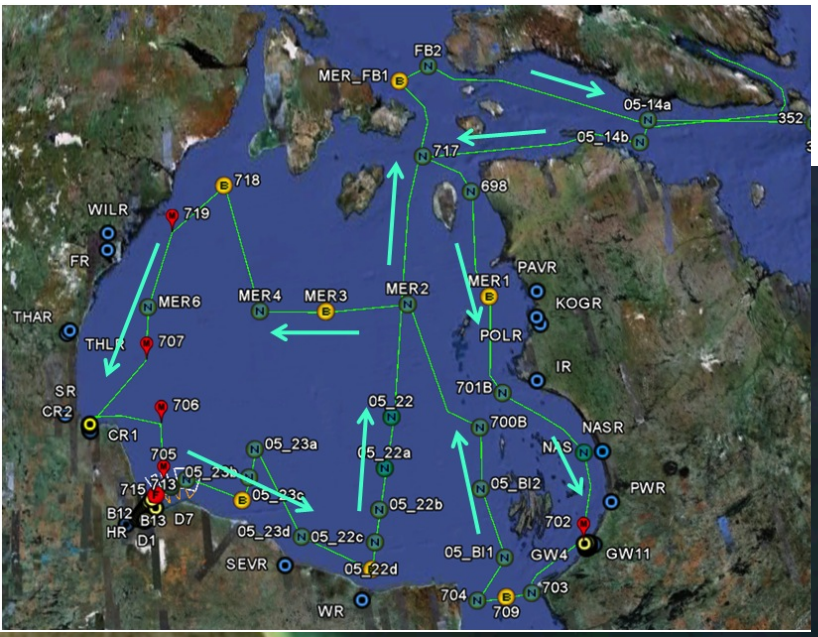
Seasonal Surface Air Temperature Trends
1980-2010



Cangrid data interpolated from Vincent et al. 2012 homogenized station data. (Hochheim, 2014)

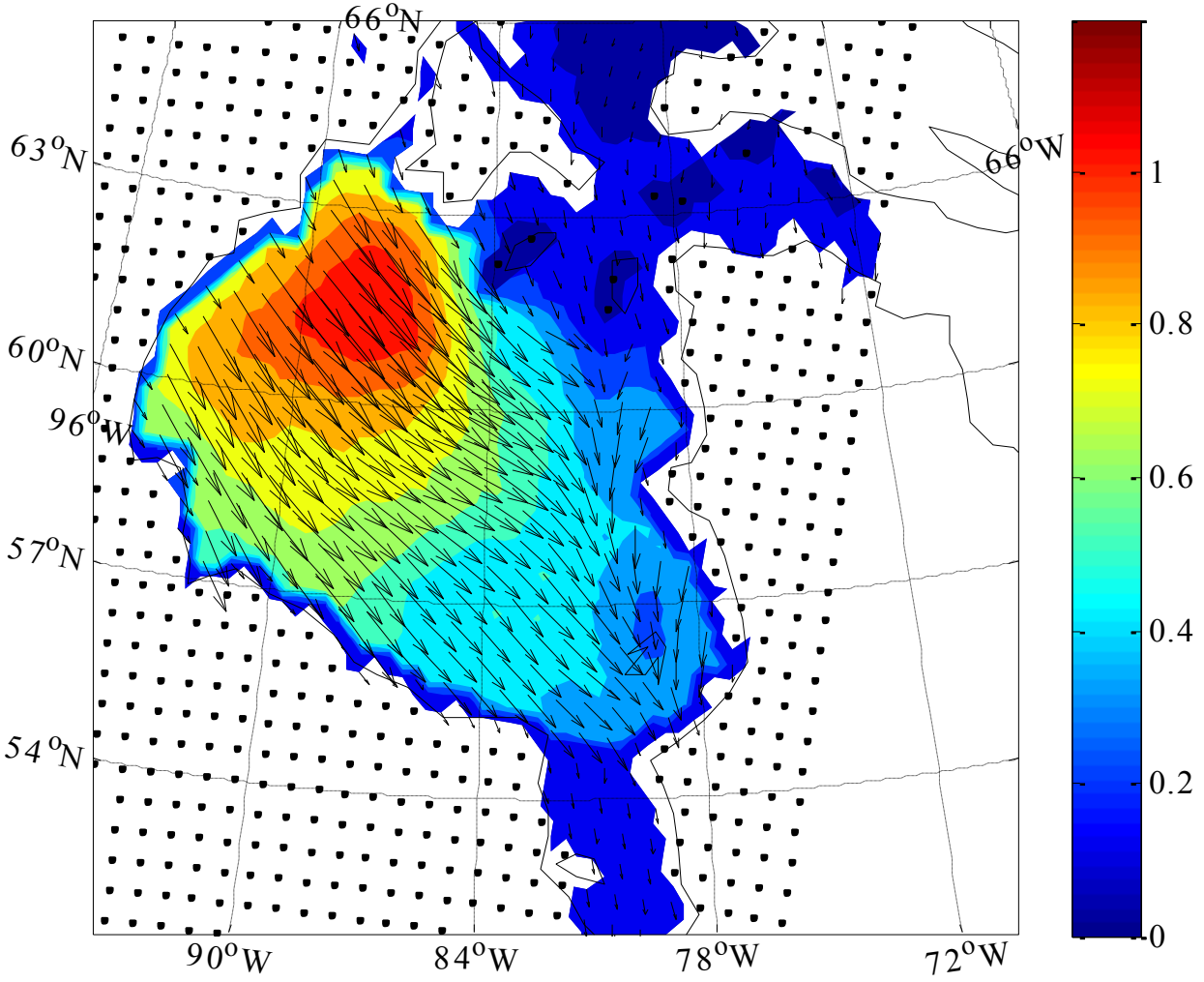
- Trends are positive in all seasons, strongest in Fall, and in NW.
- Trend was variable, slightly declining until mid 1990s, then rapidly increasing.

Our Hudson Bay, Nelson River estuary and remote sensing programs study implications of these changes



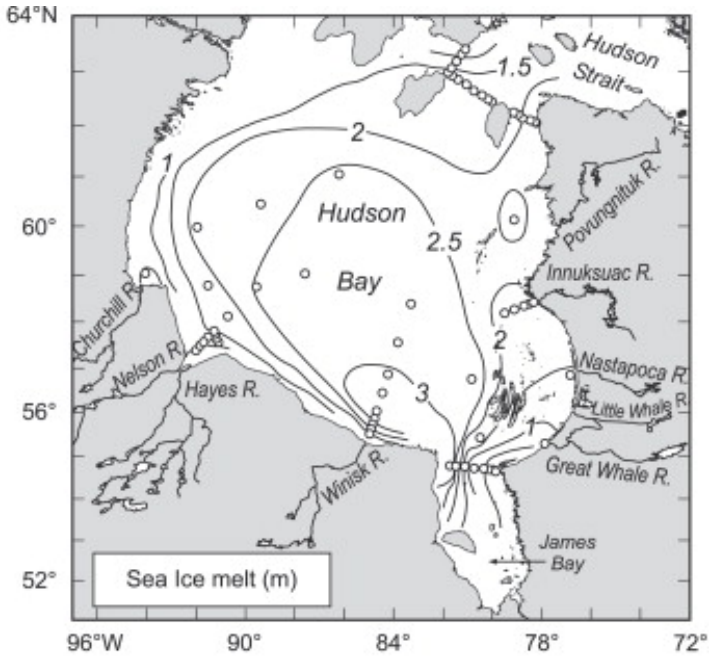
Freshwater-Marine Program

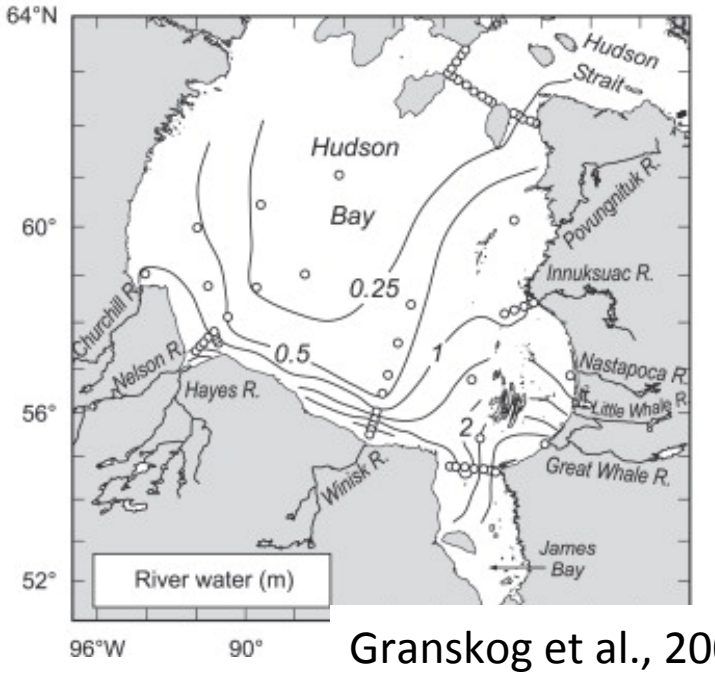
Typical Sea Ice Circulation in Hudson Bay (March, 1979-2008)



Freshwater Cycling Spatial Variability

- Isotopes and ocean color are tracers of freshwater sources
- River runoff is largely constrained to nearshore waters in Hudson Bay (top)
- Sea-ice melt is distributed more evenly in the Bay (bottom).
- Strong gradients in the bio-optical properties of the surface waters potentially control the biomass and occurrence of chlorophyll maxima

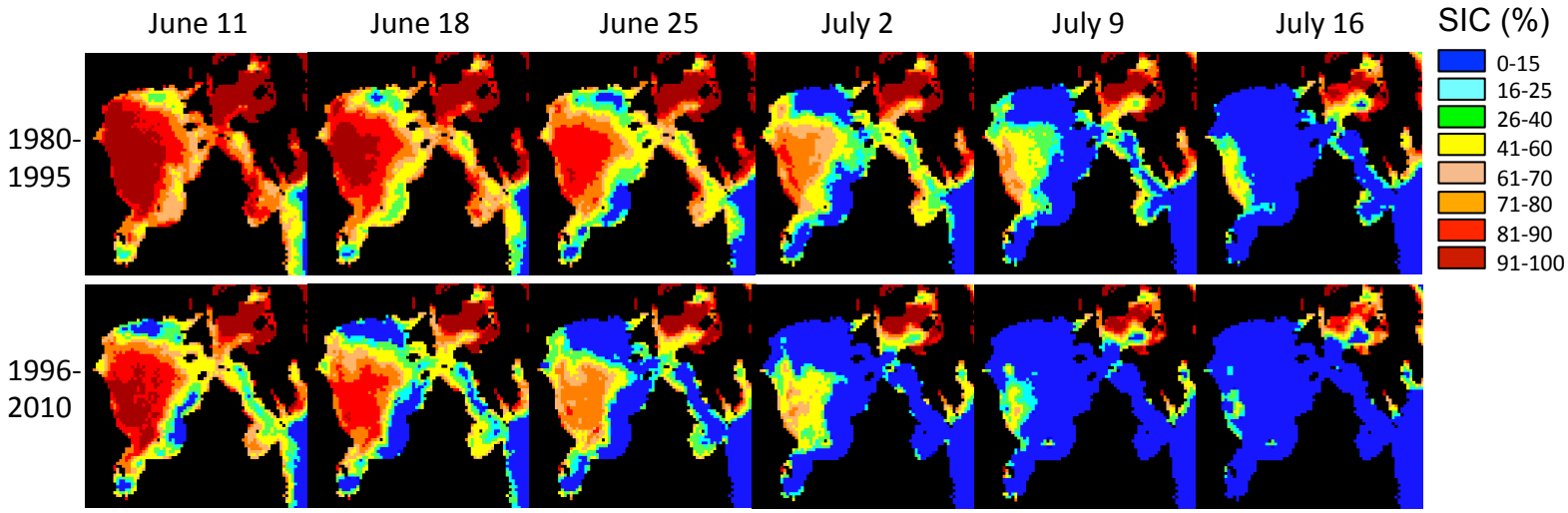




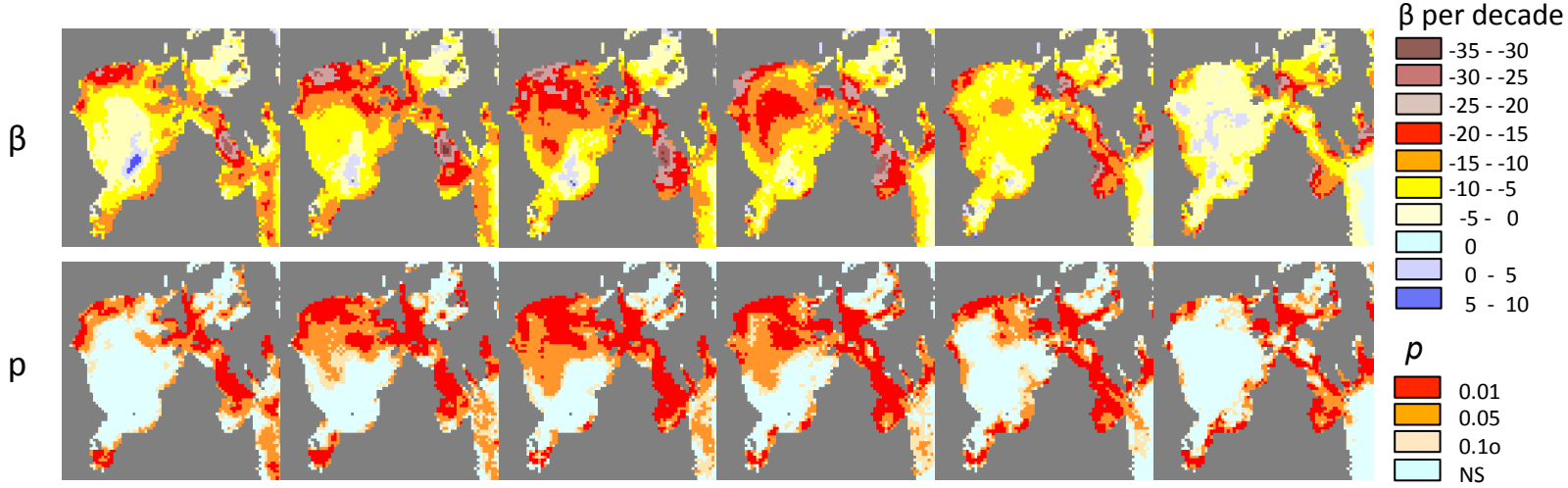
Granskog et al., 2007

Passive microwave remote sensing of spatial, temporal sea ice trends - Spring

Sea Ice Concentration (SIC) per week, 1980-1995 vs. 1996-2010

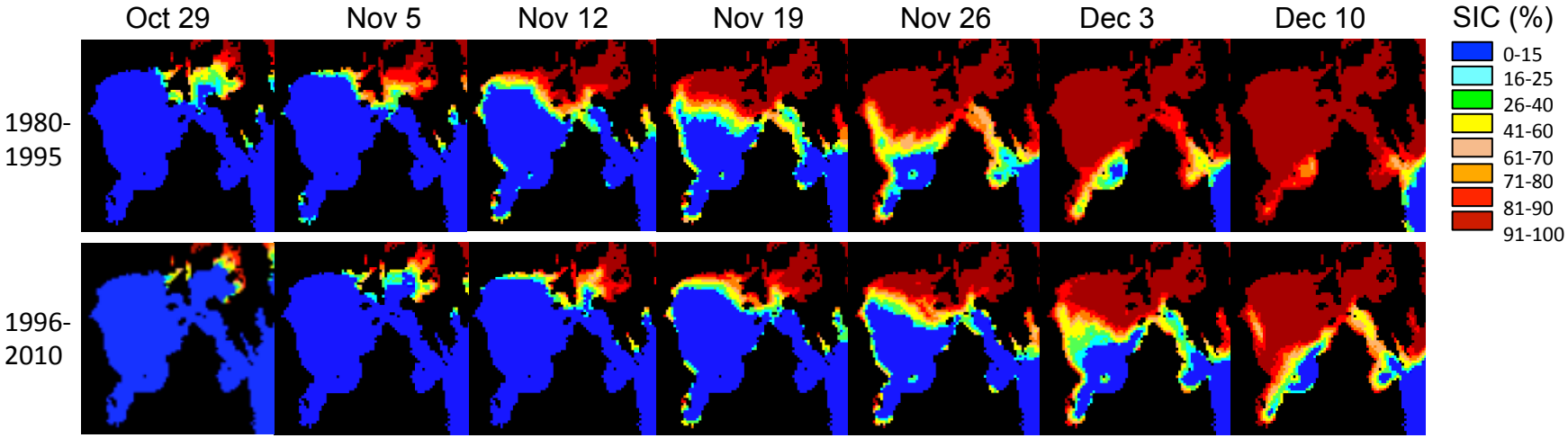


Sea Ice Concentration (SIC) Trends (β) and significance (p), 1980 to 2010

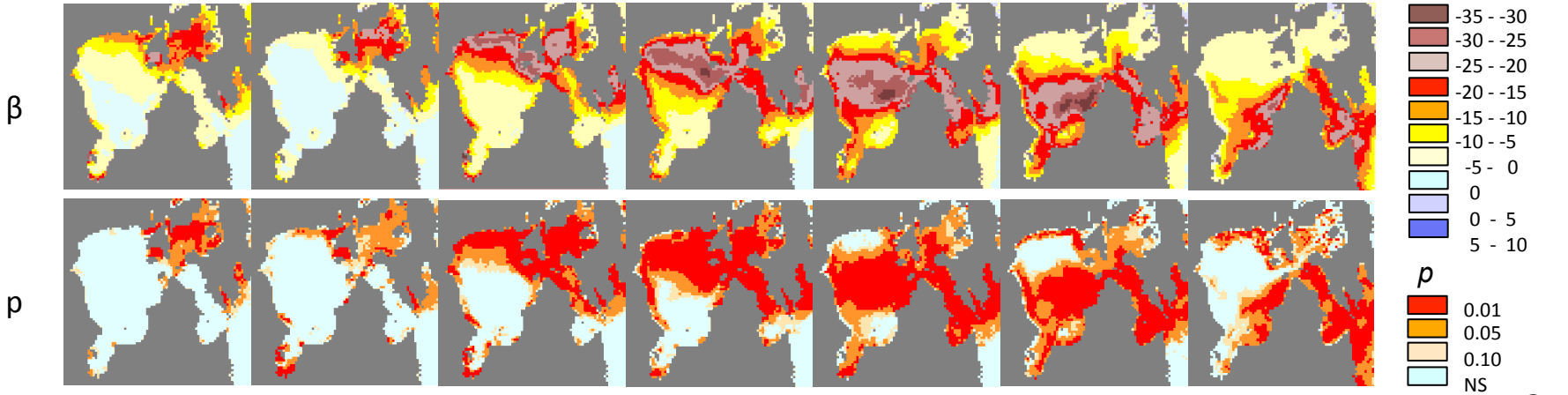


Passive microwave remote sensing of spatial, temporal sea ice trends - Fall

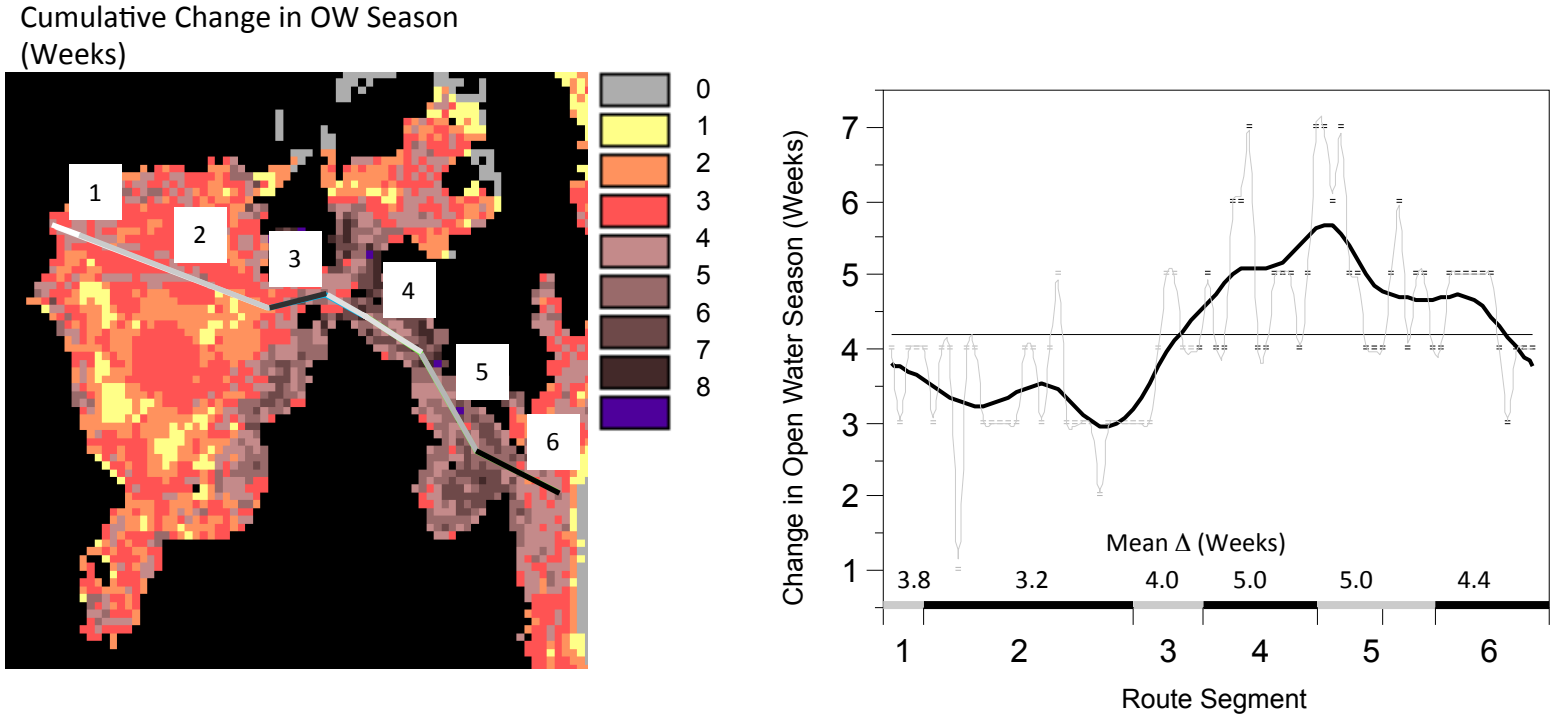
Sea Ice Concentration (SIC) per week, 1980-1995 vs. 1996-2010



Sea Ice Concentration (SIC) Trends (β) and significance (p), 1980 to 2010

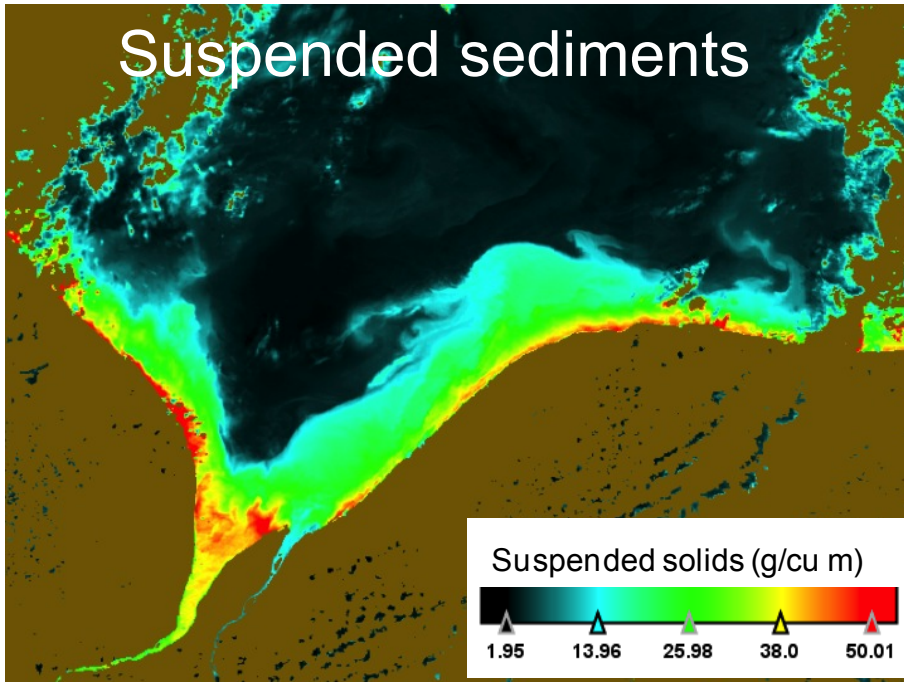


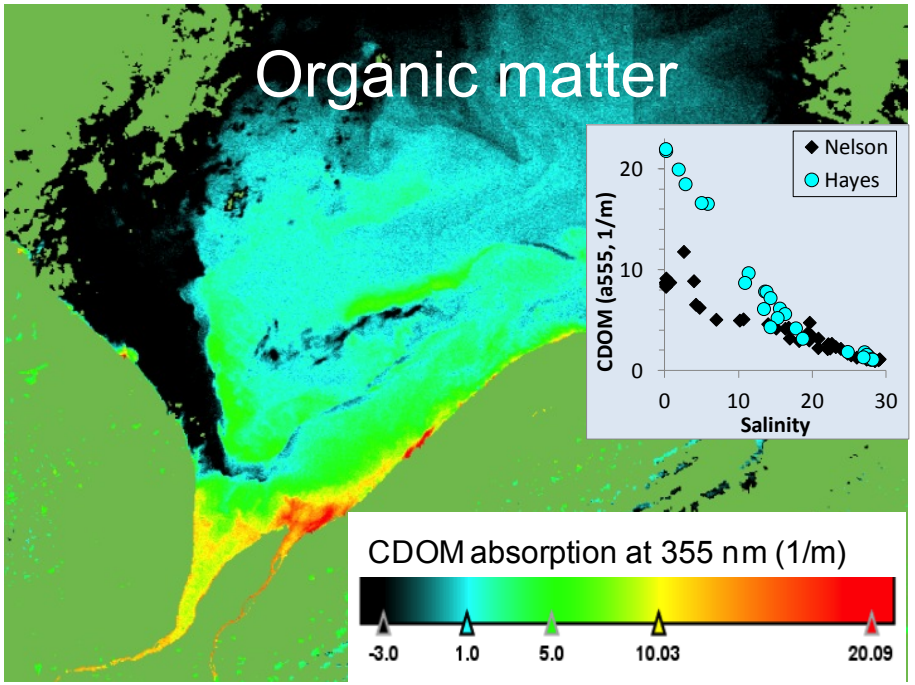
Implications of changes to marine transportation



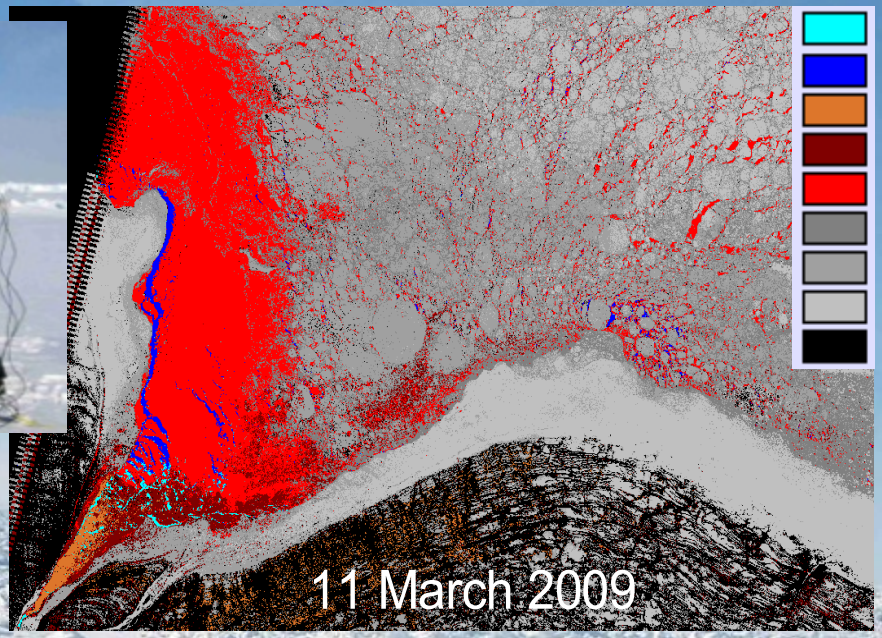
- Significant inter-annual variability remains in near-shore zones.
- Synoptic controls over temperature and circulation (EP/NP Index) raise the potential for seasonal forecasting of Fall ice extent.

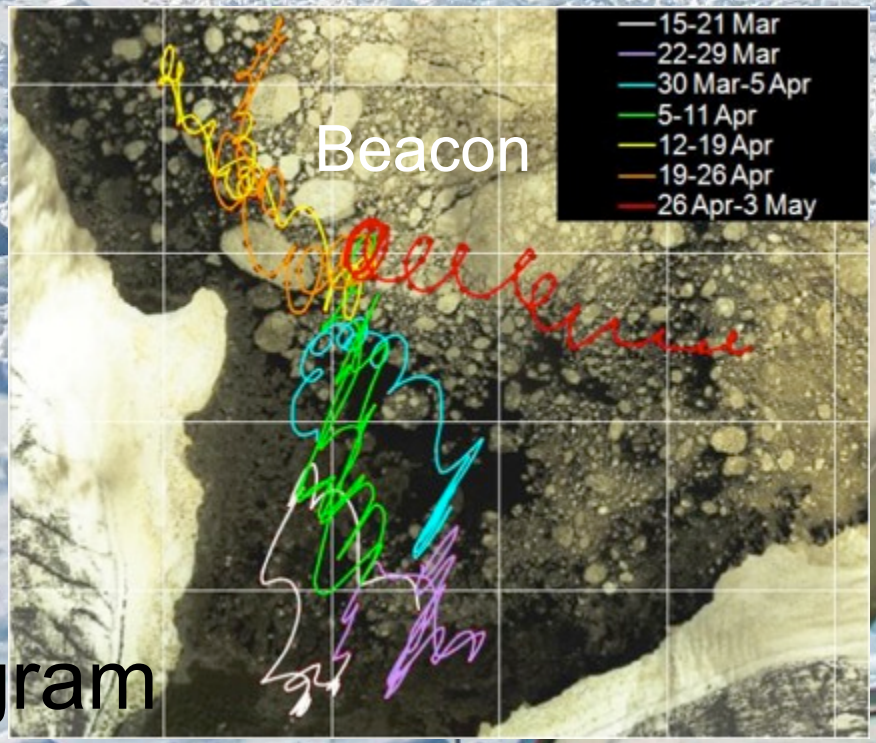
Satellite (MERIS) remote sensing of freshwater/marine coupling.





- Suspended solid signal includes both river plume and tidal resuspension along the coast.
- Organic matter isolates the signal of river water – showing river plume extending into the bay.

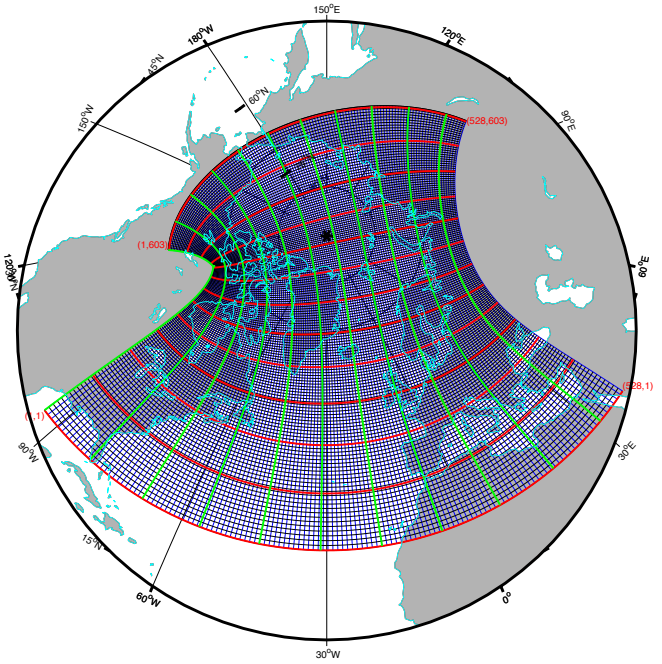


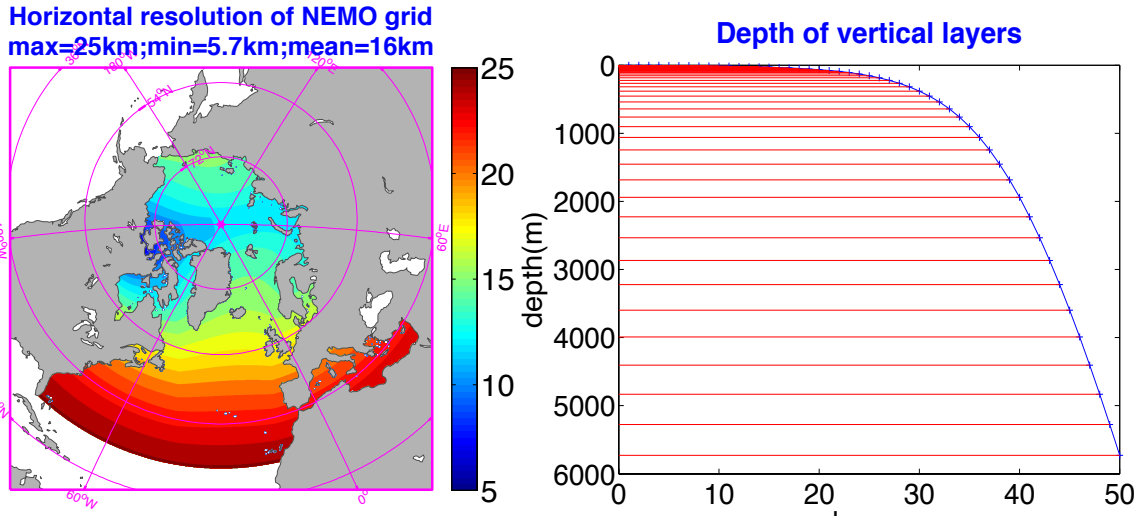


BaySYS Winter 2009 Program

NEMO at CEOS

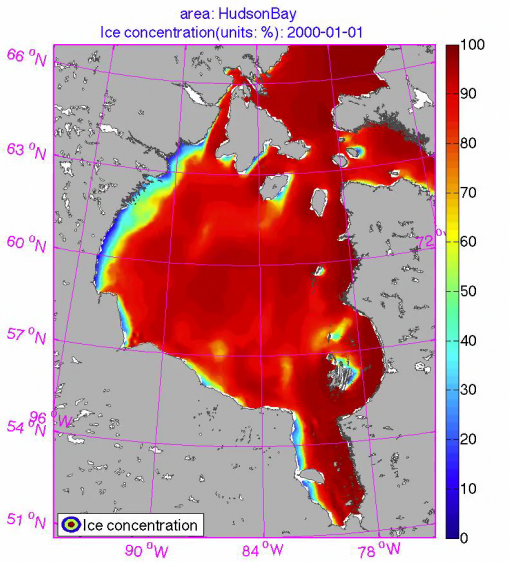
- An ocean model(OPA) coupled with a sea-ice model(LIM2)
- Covers entire Arctic Ocean and part of North Atlantic Ocean
- Horizontal resolution varies 6-18km(within Arctic Ocean)

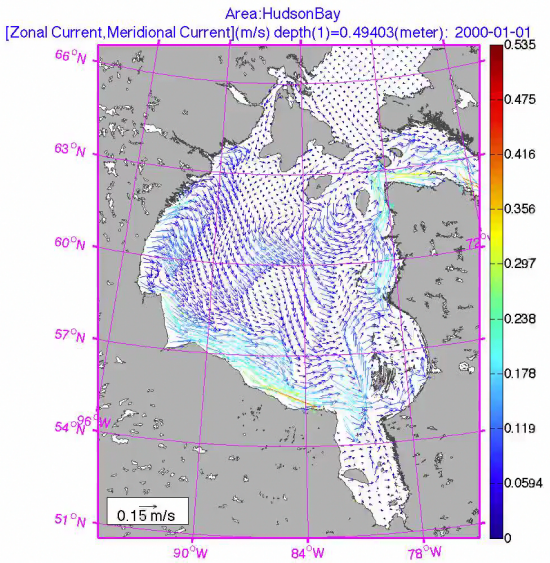


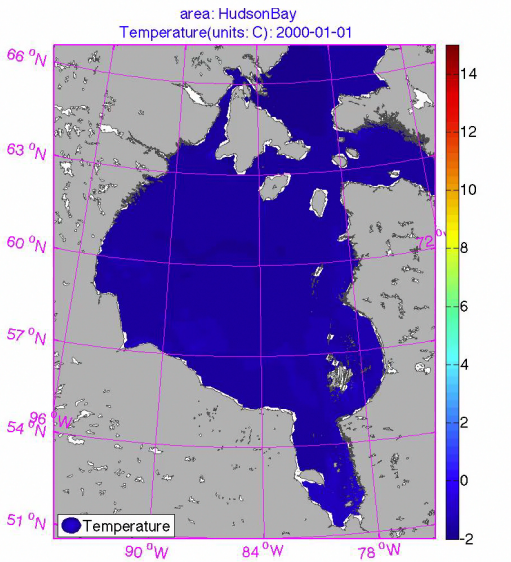


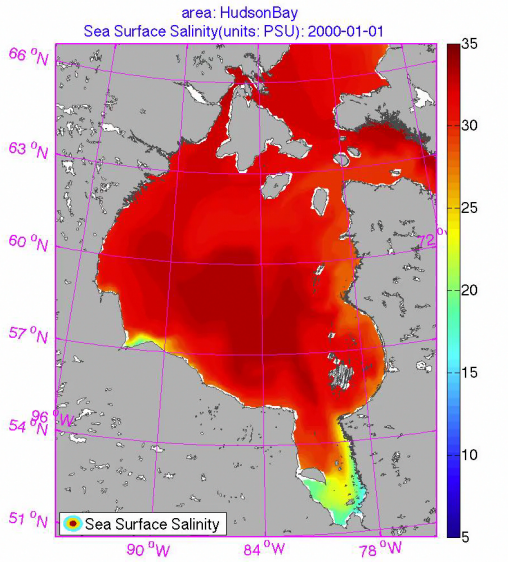
- Vertical levels: 50; The maximum depth is 5.7km
- 9 layers are within 11m from surface
- Time step: 15minutes

NEMO Spatial and Temporal Patterns

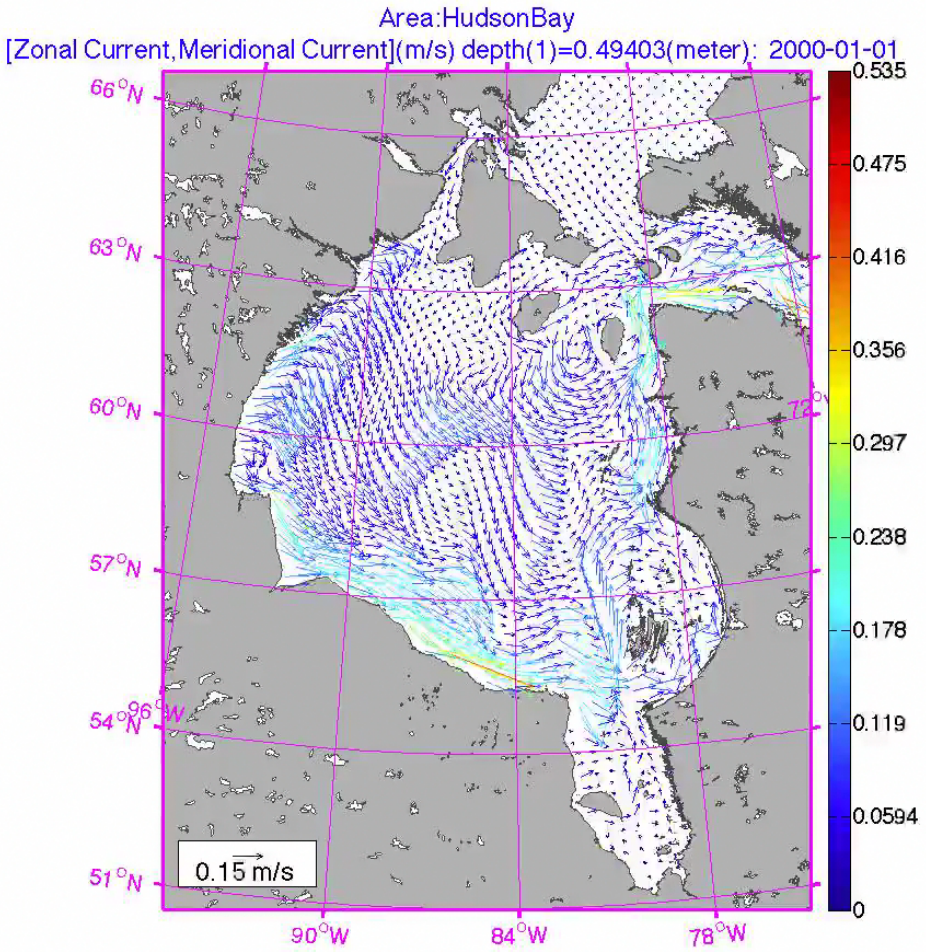


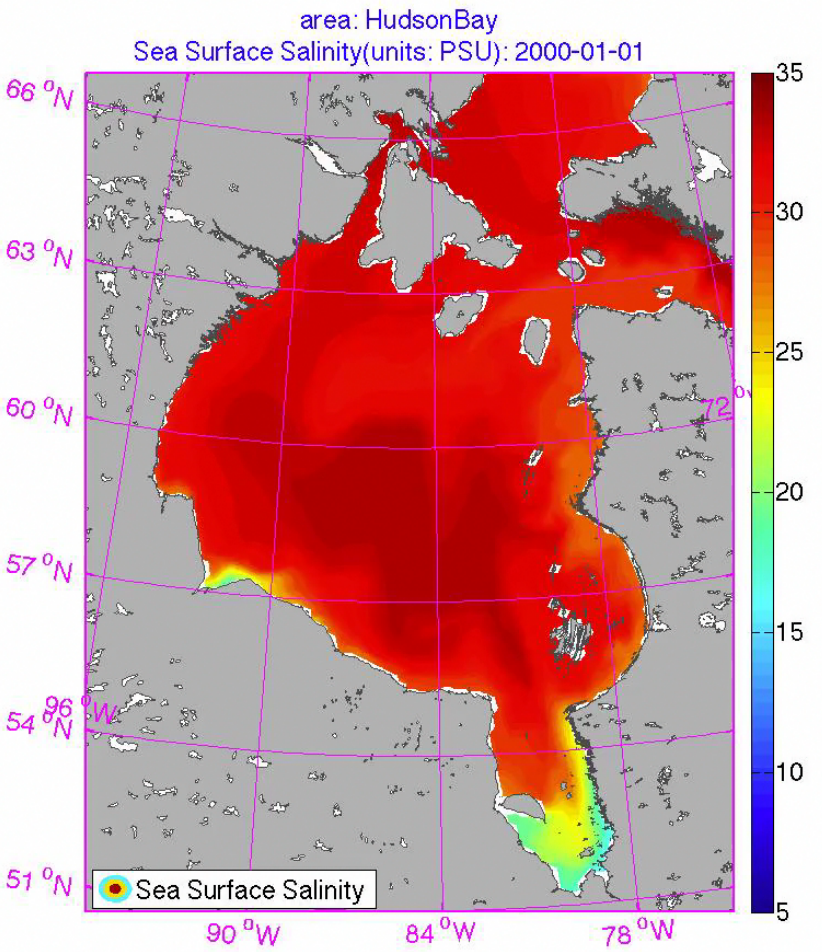






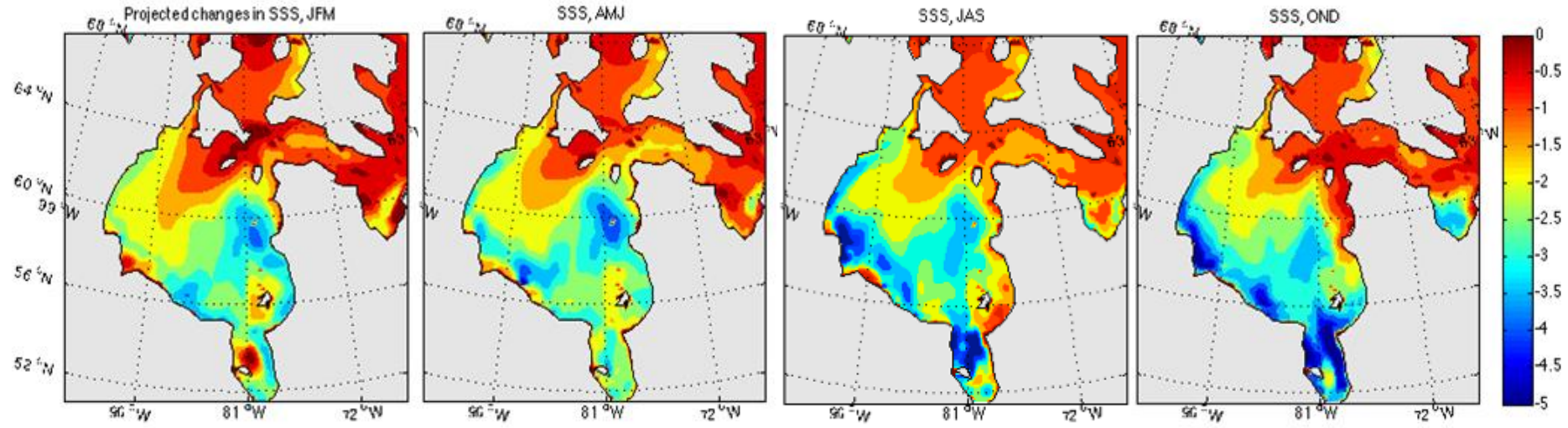
NEMO Spatial and Temporal Patterns





NEMO Projections - Salinity

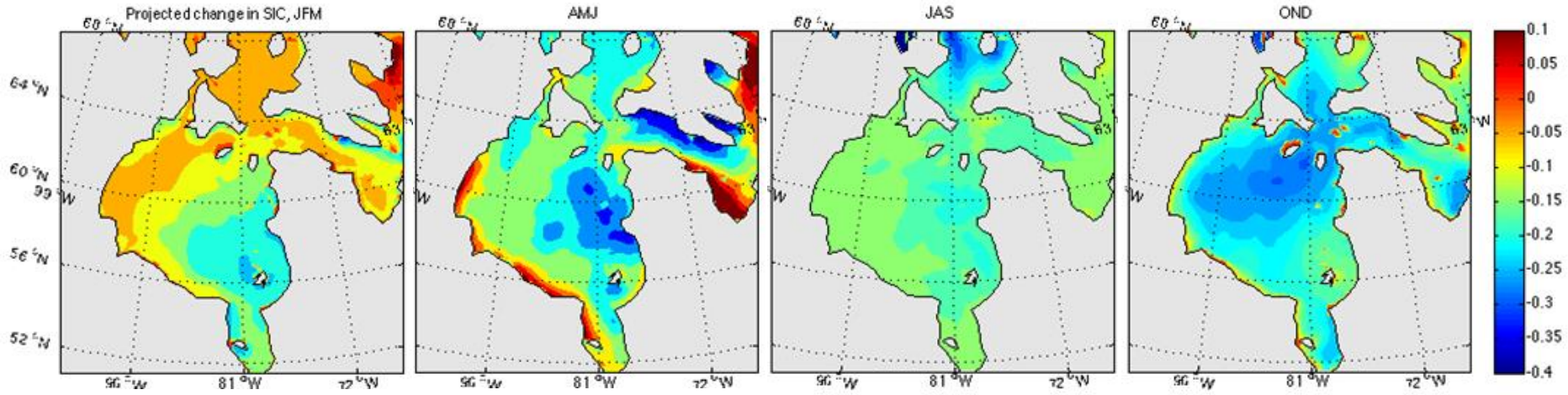
- Seasonal projected change in salinity 2006 – 2050 from relative to 1981 – 2000 climatology



Winter Spring Summer Fall

NEMO Projections – Sea Ice Concentration

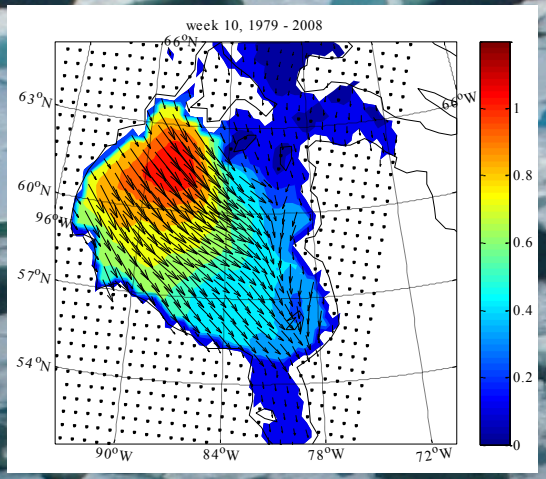
- Seasonal projected change in SIC 2006 – 2050 from relative to 1981 – 2000 climatology



Winter Spring Summer Fall

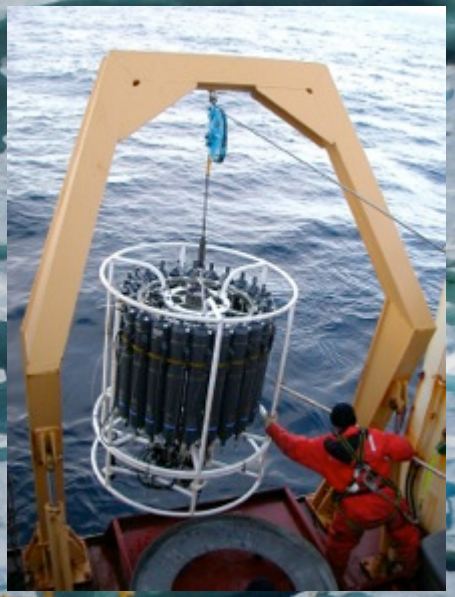
Key Unknowns – Future areas of study

- Freshwater marine coupling is only partially understood.
  - Timing of hydrograph impacts biologic productivity, ice formation and decay, contaminant and carbon cycling.
  - Lack of winter & spring observations, and difficulty accessing Quebec hydrologic data pose challenges to model validation
- Ensemble of climate models required to estimate anticipated changes in ocean ice conditions.
- Monitoring at community and regional scales will enhance understanding of ocean-sea-ice-atmosphere interactions.

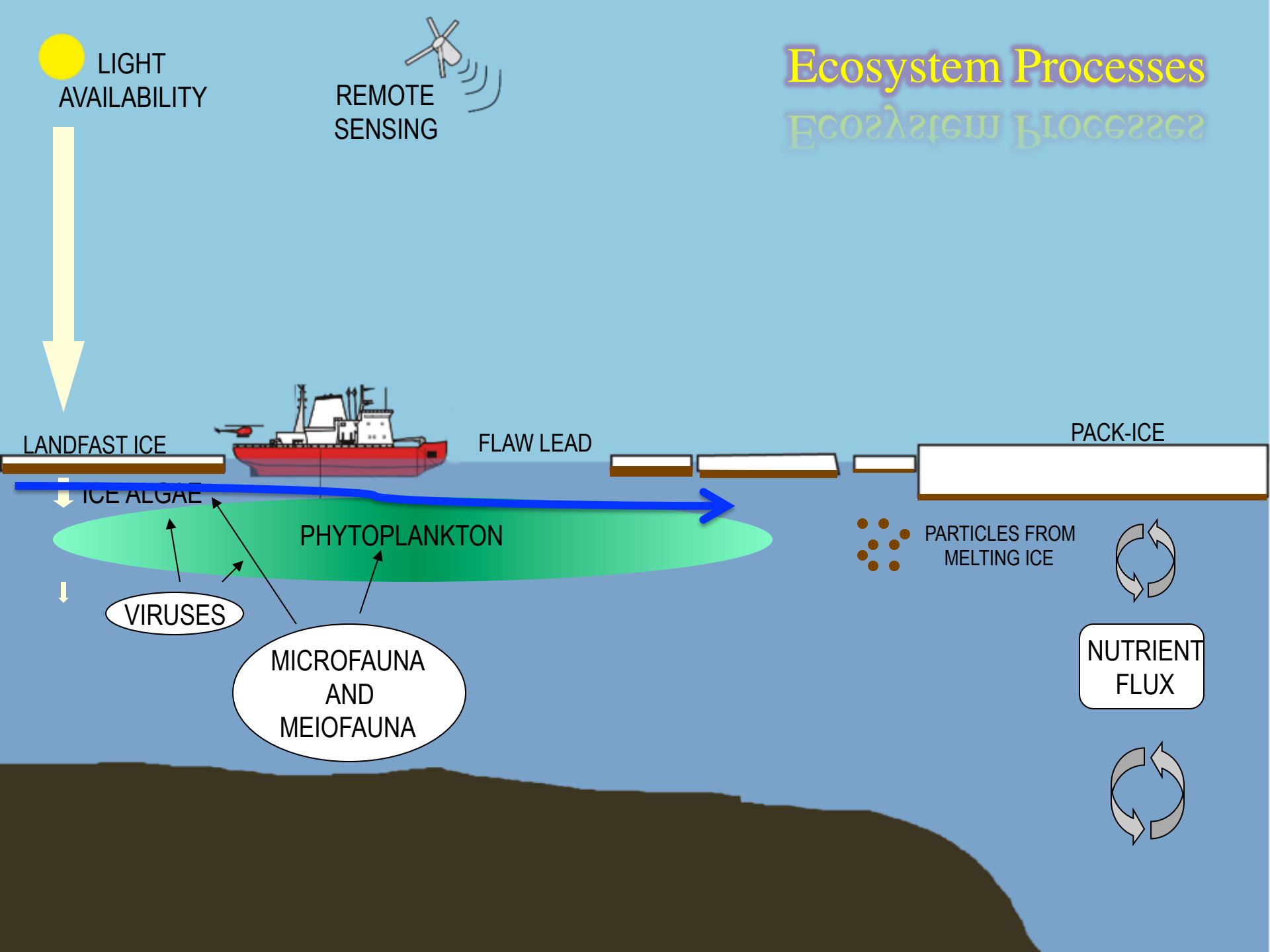


BaySys 2014-2018

NSERC CRD proposal ($13.12M)



1) Winter program
2) Summer program
3) Modelling program
4) ArcticNet IRIS


LIGHT AVAILABILITY
REMOTE SENSING
Ecosystem Processes
LANDFAST ICE
FLAW LEAD
PACK-ICE
ICE ALGAE
PHYTOPLANKTON
PARTICLES FROM MELTING ICE
VIRUSES
MICROFAUNA AND MEIOFAUNA
NUTRIENT FLUX

Proposed collaborative research with Manitoba Hydro

Overarching objective to provide a scientific basis to separate climate change effects from those of hydroelectric regulation for the following:

- Marine/Climate System – D. Barber
- Freshwater/Littoral System – T. Stadynk
- Marine Ecosystem – J.E. Tremblay
- Carbon Cycling – T. Papakyriakou
- Contaminants – F. Wang

University of Manitoba

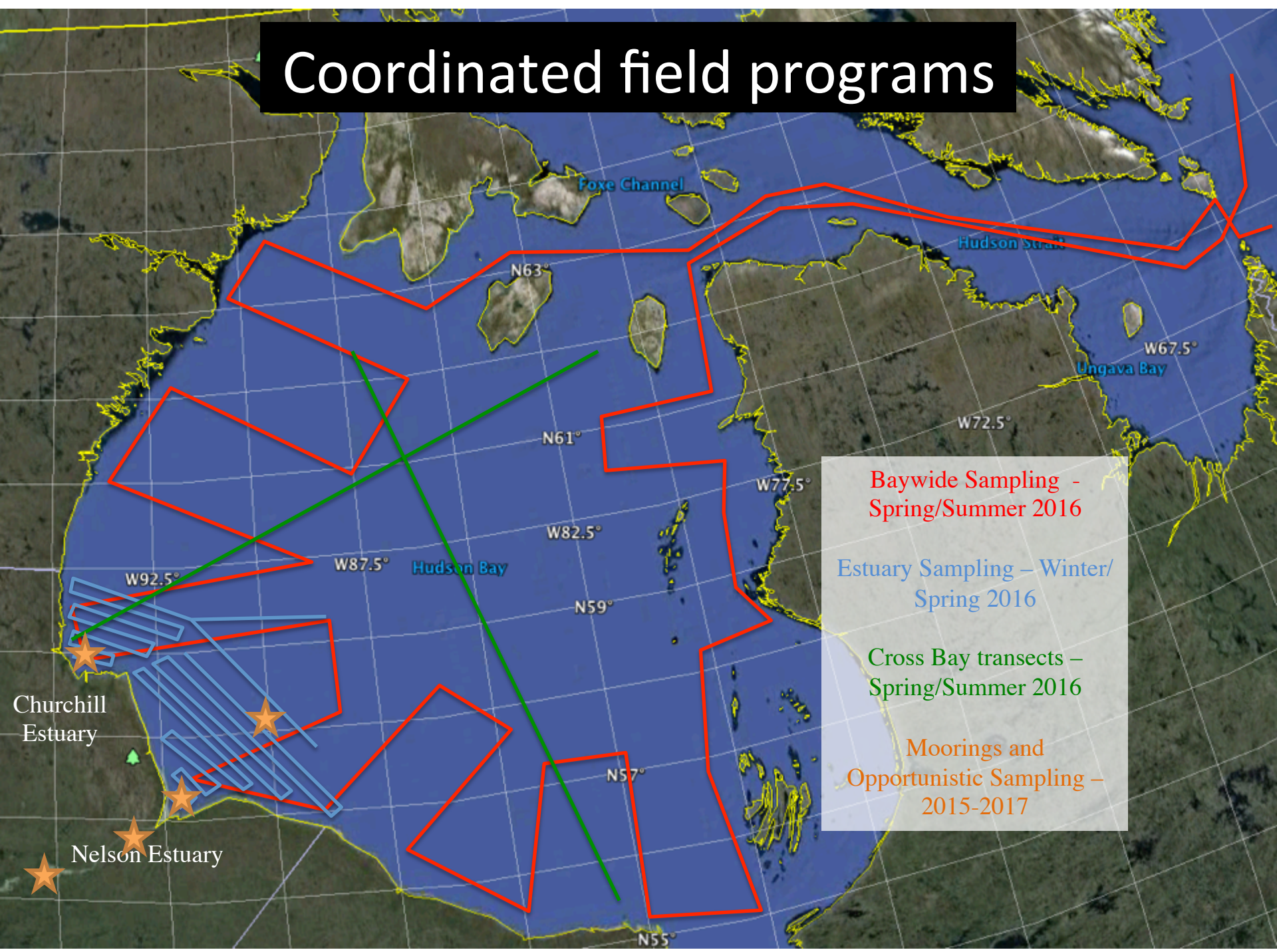
Université Laval

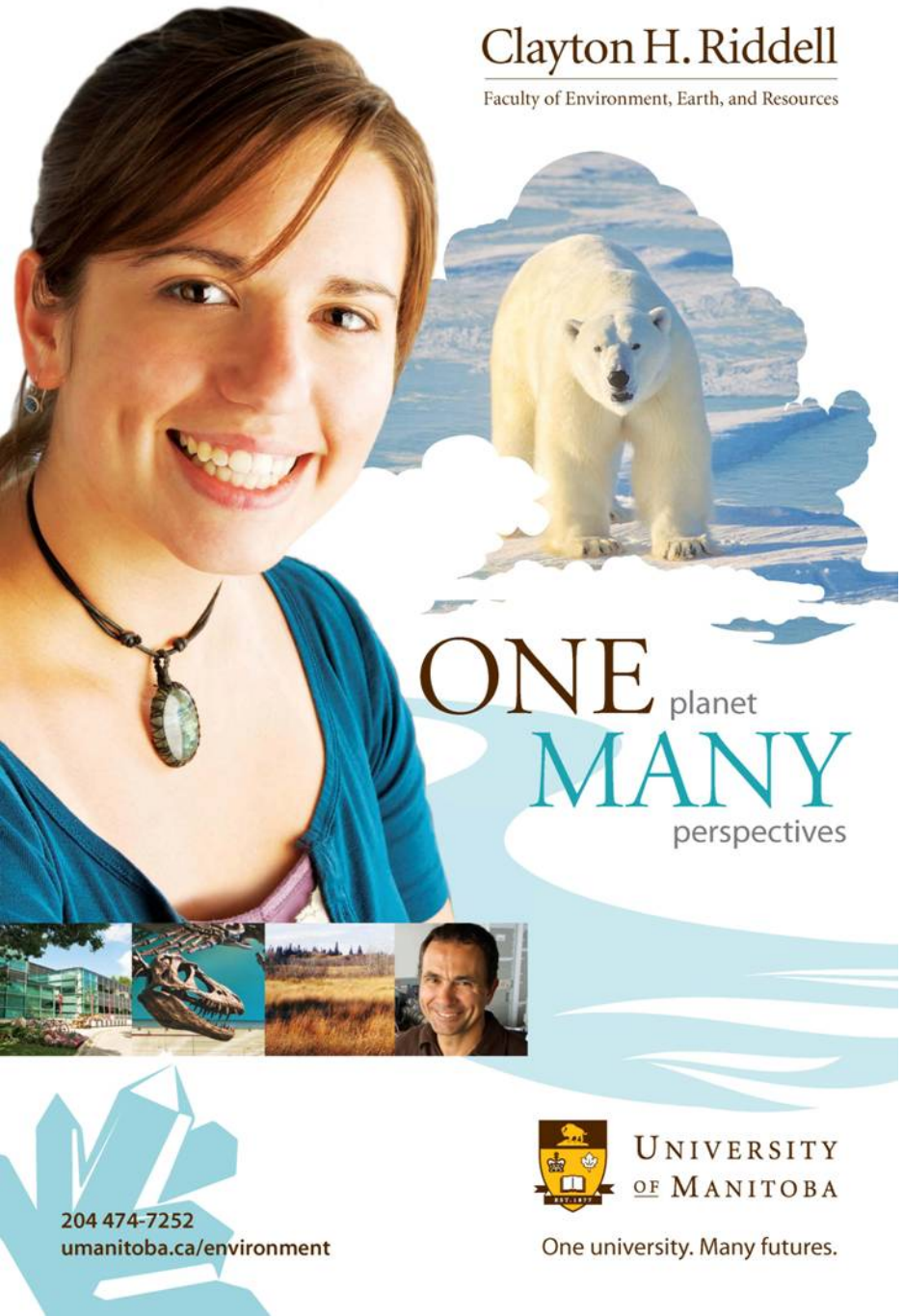
UQAR Université du Québec à Rimouski

UNBC

Manitoba Hydro

Coordinated field programs





Thank you!

David.Barber@umanitoba.ca