Glacier-Climate Observing & Water Resource Assessment in Canada

ABCC Workshop,
Ottawa, Canada

Mike Demuth
2010 Sept. 24

Natural Resources Canada | Ressources naturelles Canada

Canada

Outline

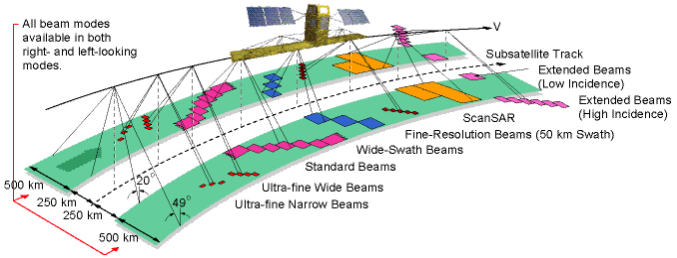
- The Team
- Where are Canada's glacier resources
- The importance of glaciers to Canada's Environmental and Natural Resource Sectors

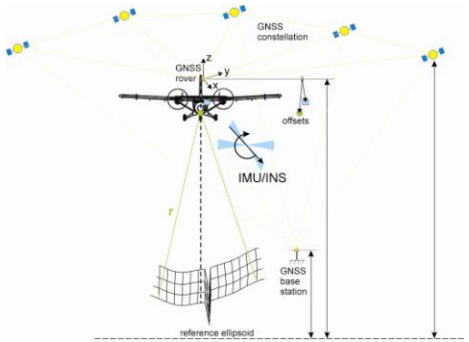
- Domestic surveillance strategy
- Highlights of monitoring and research

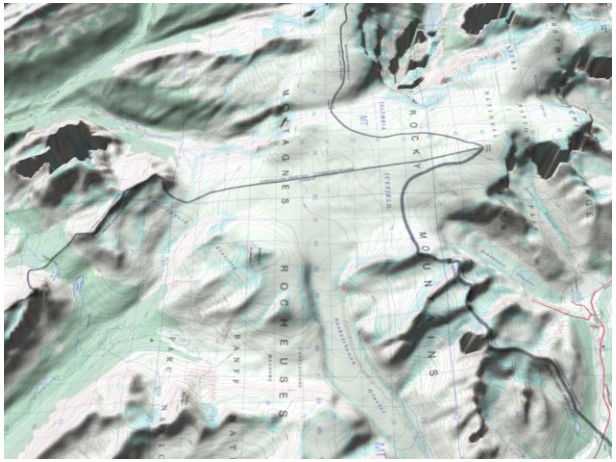
- International contribution
- Partnerships

The Team: Earth Science Sector

- **Science knowledge and tools**
  - GSC – Glaciology: thematic expertise; interpretation
  - GC – CCRS: technique R&D, Space Geodesy
  - GC – MSB: remapping topographic elements



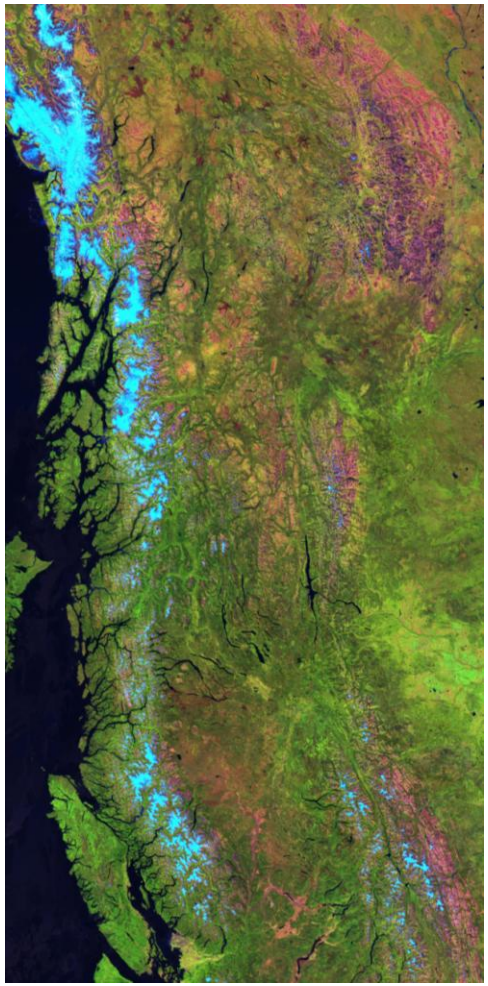




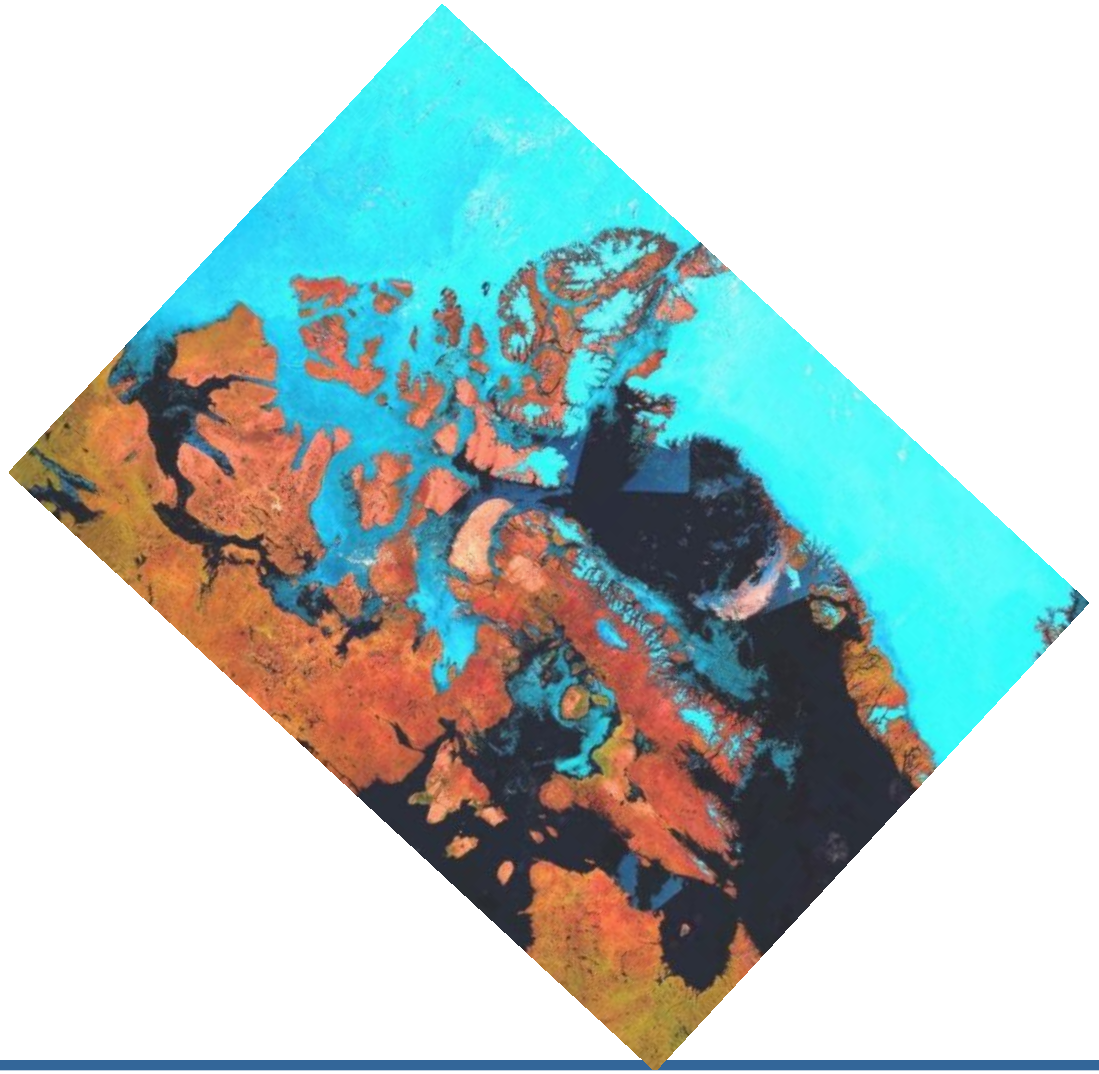
The Team: Personnel

- **Michael N. Demuth** – Cordillera
- **David O. Burgess** – High Arctic (QEI)
- **Christian M. Zdanowicz** – Low Arctic (Baffin)
- **Sasha Chichagov** – Glacier form and flow (optical)
- **Laurence Gray** – Glacier form and flow (radar)
- **Florin Zavopol** – Photogrammetry, data fusion
- **John Sekerka** – Data, web, stratigraphy
- **Geodetic Survey** – CSRS
- **GLIMS RDC Arctic** (U. Alberta – M. Sharp)
- **GLIMS RDC Cordillera** (UNBC – R. Wheate)
- **GSC** Ice Coring/Low Temp. Geochemistry Group

Canada's Glaciers: Cordillera



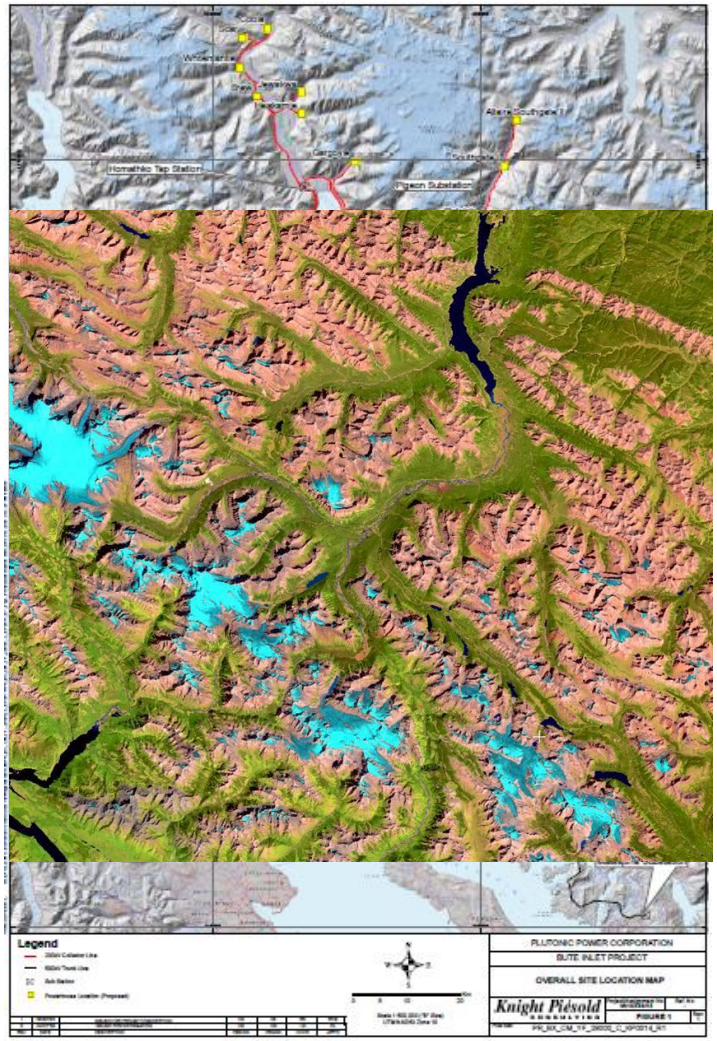
Canada's Glaciers: Arctic Islands



Glaciers and the Energy Sector

Variables

- **Inflows***
- **Demand**
- **Fuel mix**
- **Market opportunity**



Constraints

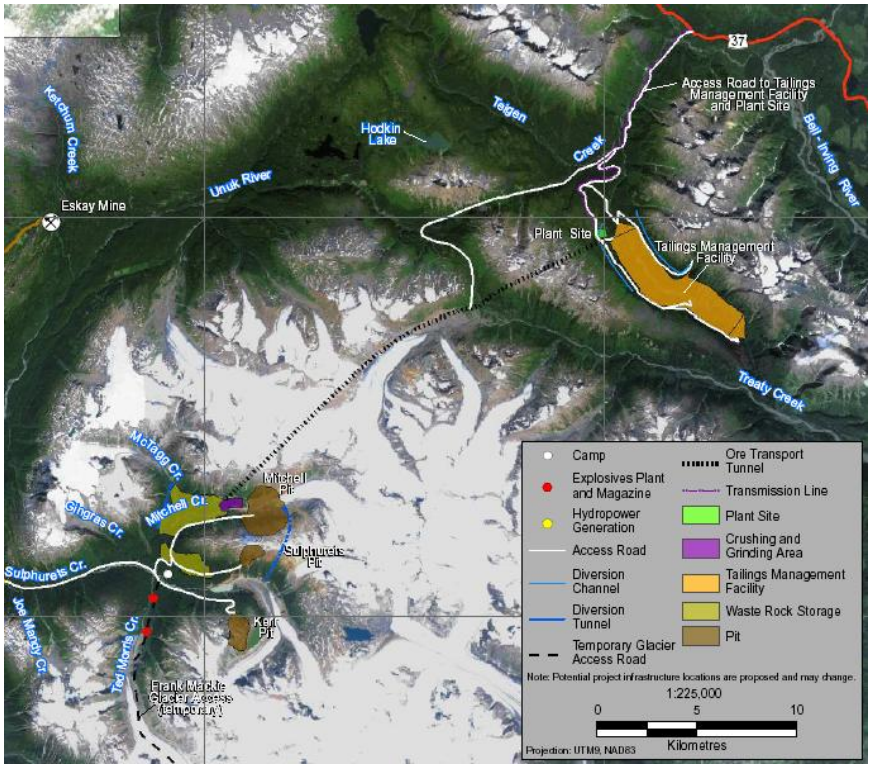
- **Dam safety**
- **Recreation**
- **International objectives**
- **Flood control**
- **Ecology**

Glaciers and Mining

- Over ice corridors / under ice tunnels
- Water supply for slurry and tailings
- Slope de-buttressing

- Major Projects Management Office / Legislated Environmental and Resource Assessment

e.g., Seabridge Gold



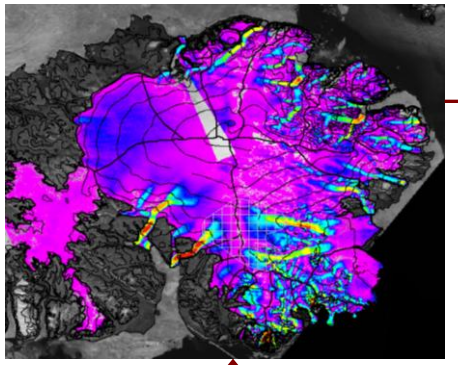
Glaciers and Forestry

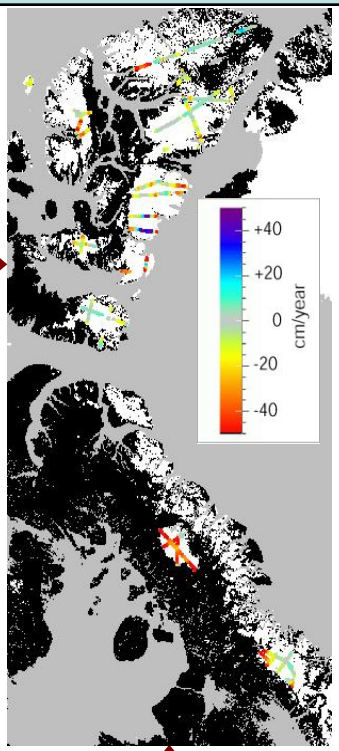
- Climate Change
  - Hydrology
  - Forest loss/sprawl
- Growing population
  - Increasing water and energy use
  - Development leading to forest loss
  - Threats to public water supplies

Multi-scale, multi-mode Surveillance Strategy

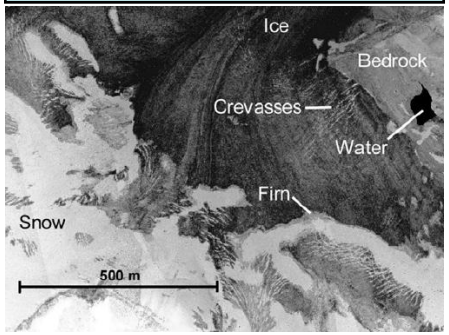
Altimetry
– Radar (CryoSat)
– Lidar (ICESat, ALTM)

Form and Flow
– Radar
– Optical (ASTER)

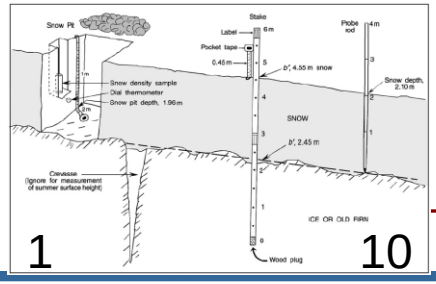




Surface Facies
– Radar (RS 1, 2)
– Lidar (ALTM)
– Optical (ModIS)



In-situ
– Mass balance
– Thickness
– Surface velocity
– Strain



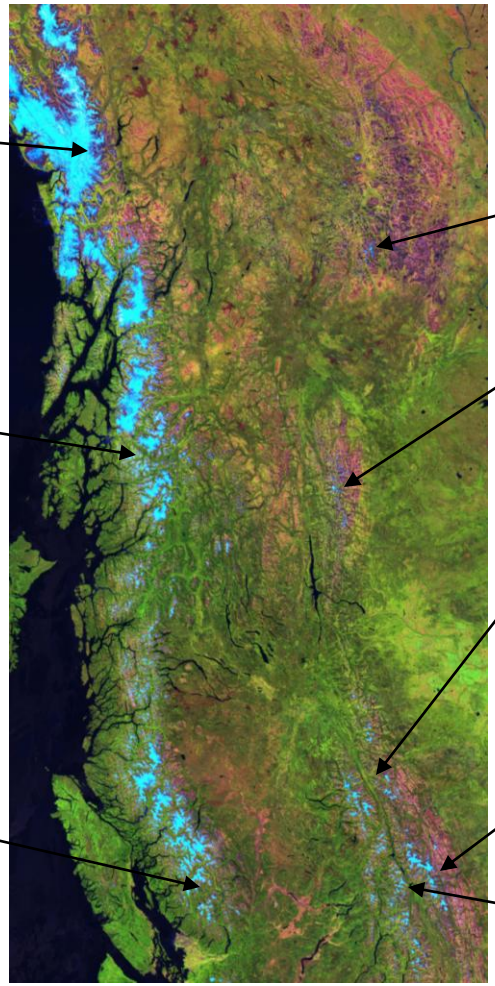
1 10 100 1000 km

Multi-scale, multi-mode Surveillance Strategy

- Multi-scale and multi-mode measurements of land ice changes are incorporated into local, regional and national scale assessments and related strategic planning and decision making concerning the state and evolution of Canada's glaciers and related water fluxes.
- Reduced uncertainty in the detection of the regional imprint of climate change and its impacts on vast frontier regions that had previously been based on a valuable but too sparse network of point investigations

- An enhanced federal northern/climate-cryosphere surveillance strategy

Reference Mass Balance Network Sites – Cordillera



Kaskawulsh (0)

Andrei (5 + g)

Bridge River (8 + 2)

Place (45)

Helm (34)

Decho (3)

Kwadacha (2)

Castle Creek (2)

Athabasca (1)

Saskatchewan (1)

Yoho (1)

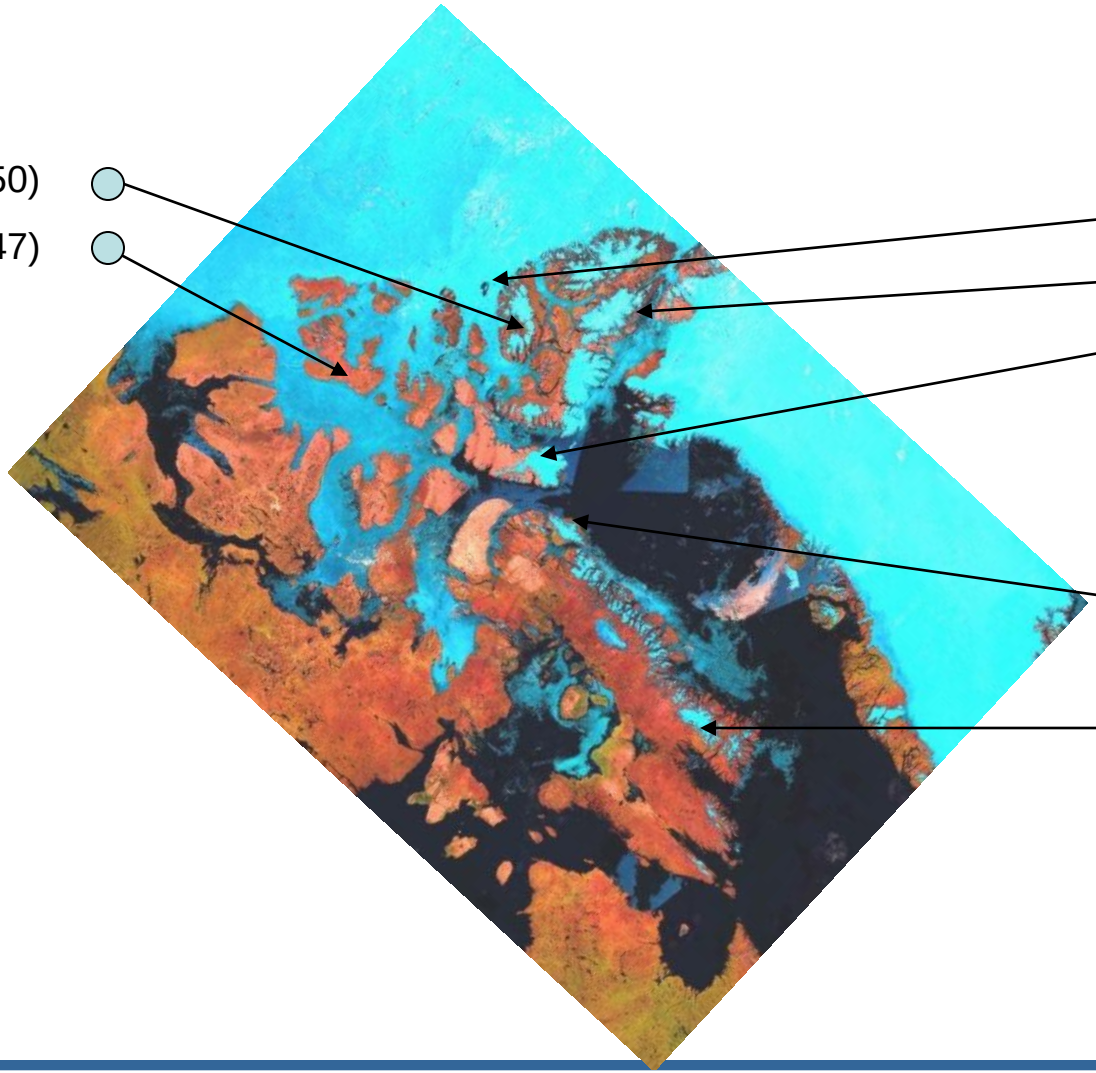
Peyto (44)

Ram River (10 + 6)

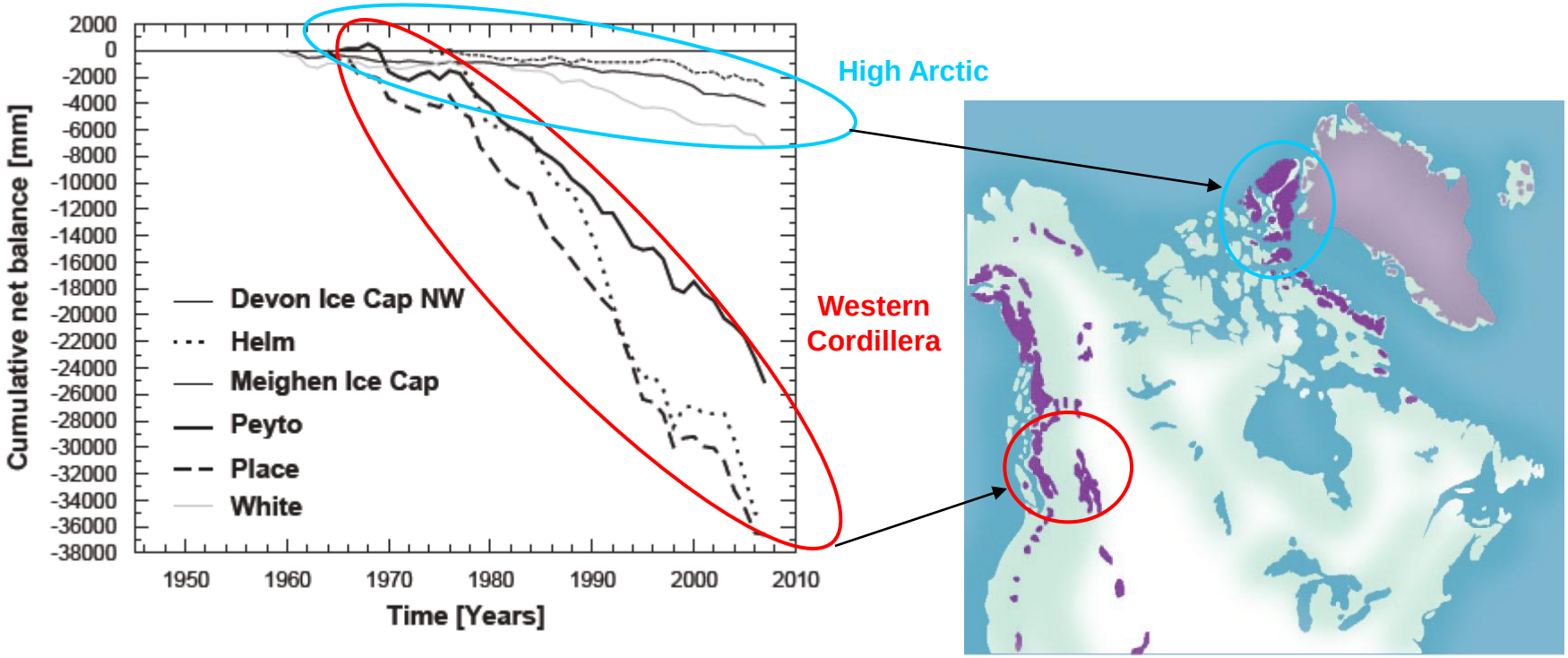
Haig (6 --)

Illecillewaet (2)

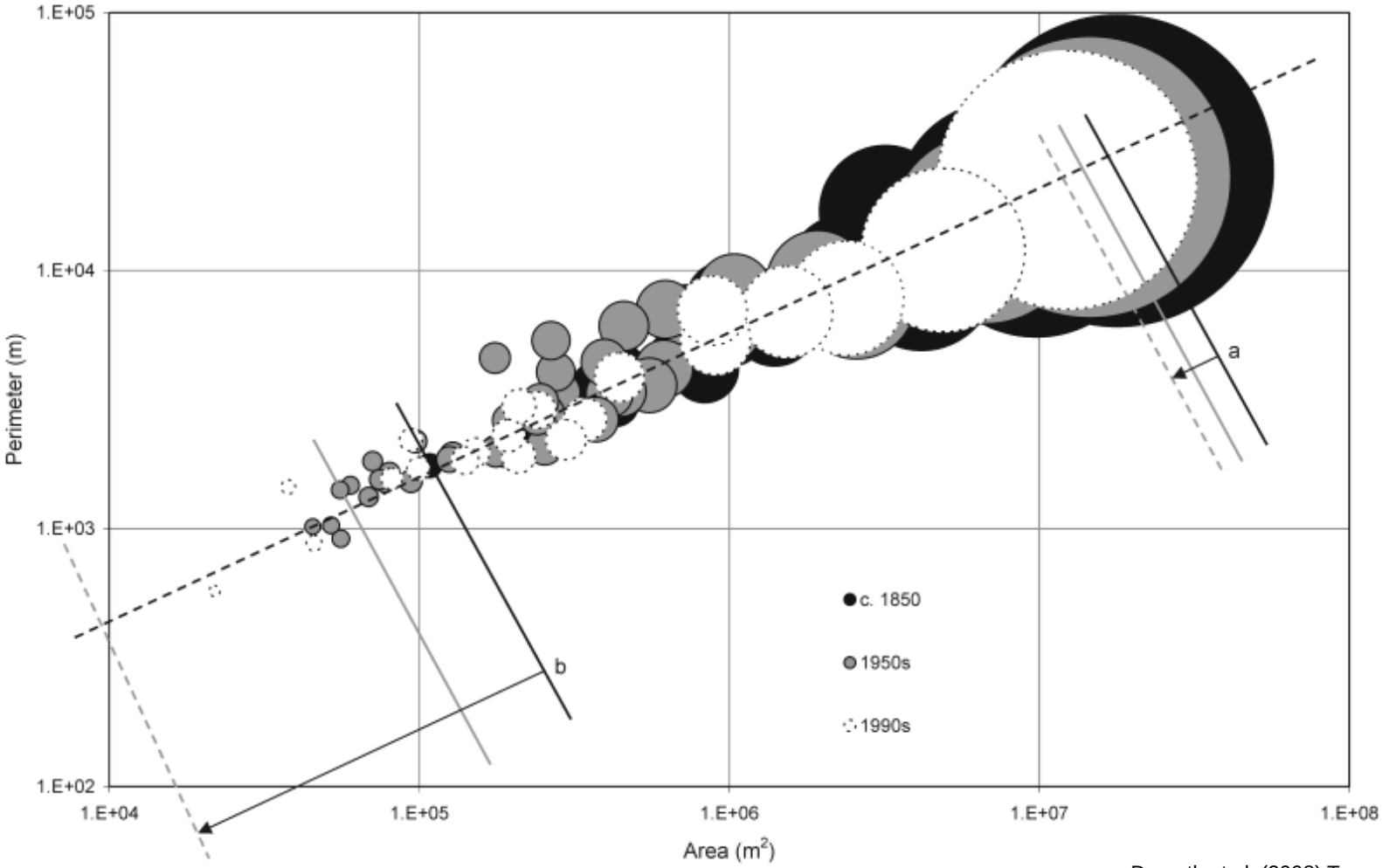
Reference Mass Balance Network Sites – Arctic Islands



Net Mass Balance series'

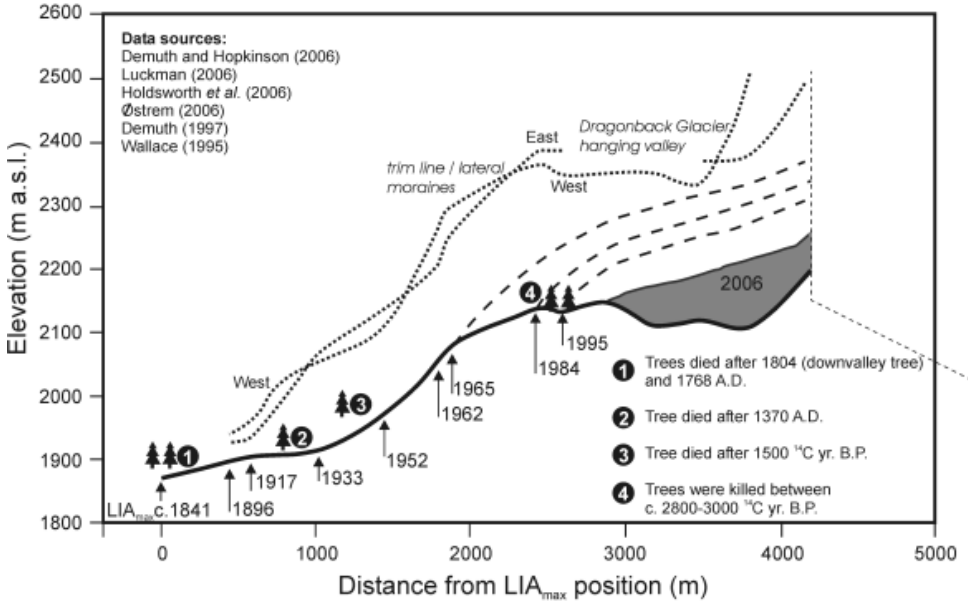


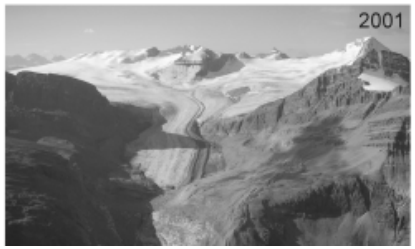
Past Changes: Rocky Mountains



Demuth et al. (2008) Terra Glacialis

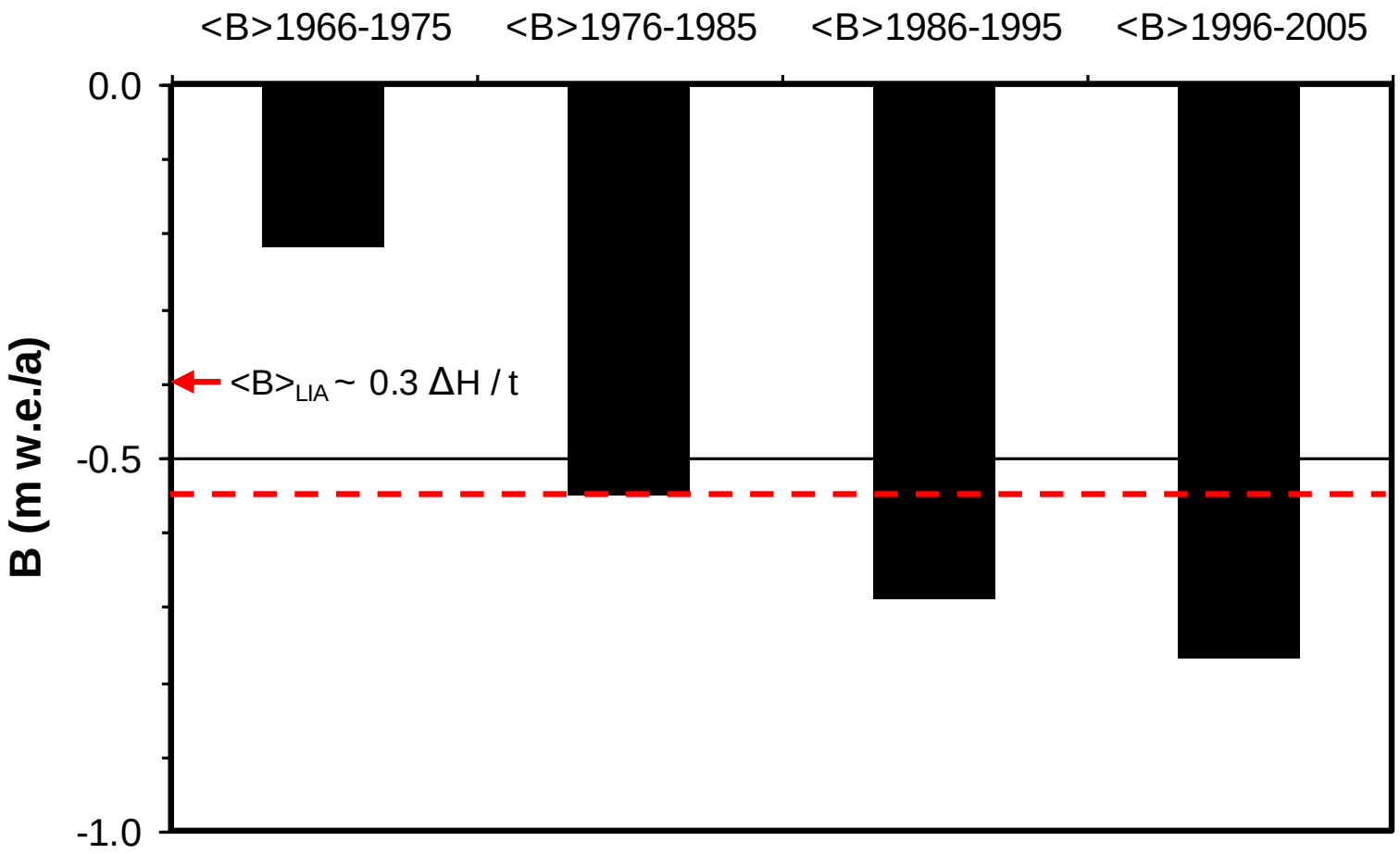
Past Changes: Peyto Glacier





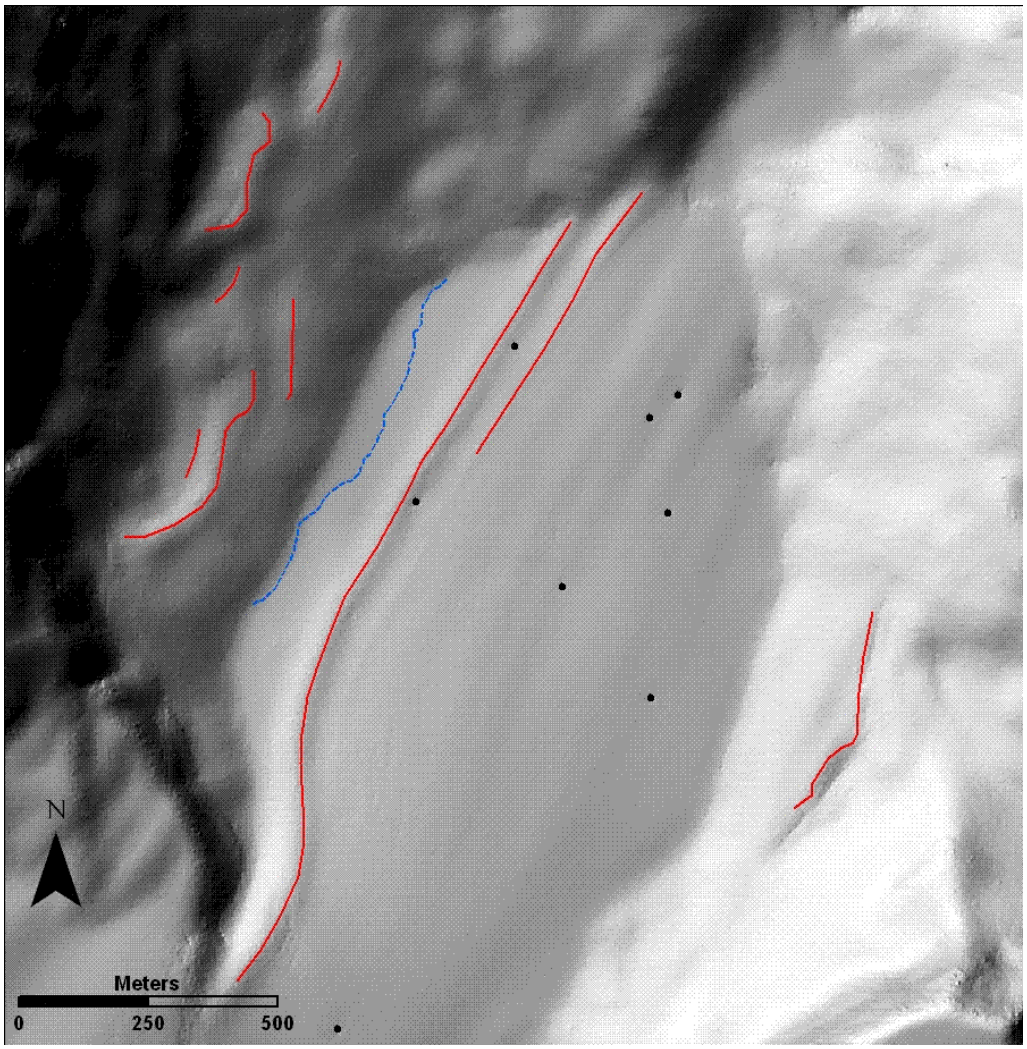
Demuth et al. (2008) Terra Glacialis

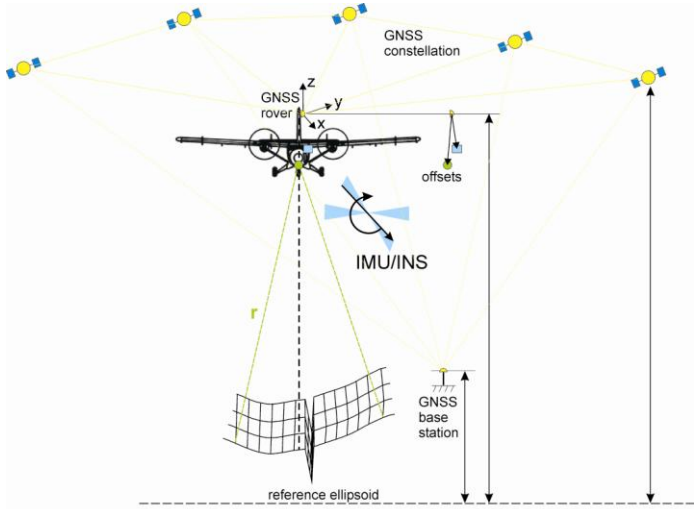
Peyto Glacier: Net Mass Balance



Demuth et al. in preparation

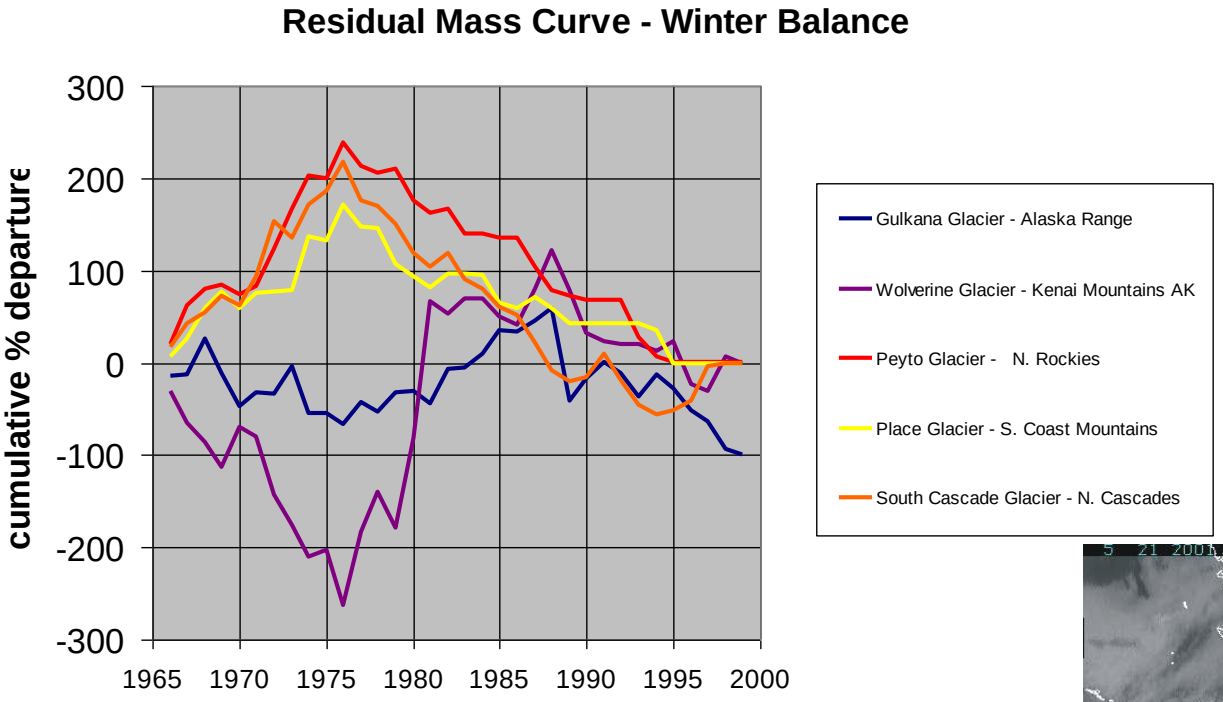
Outlet glacier disintegration





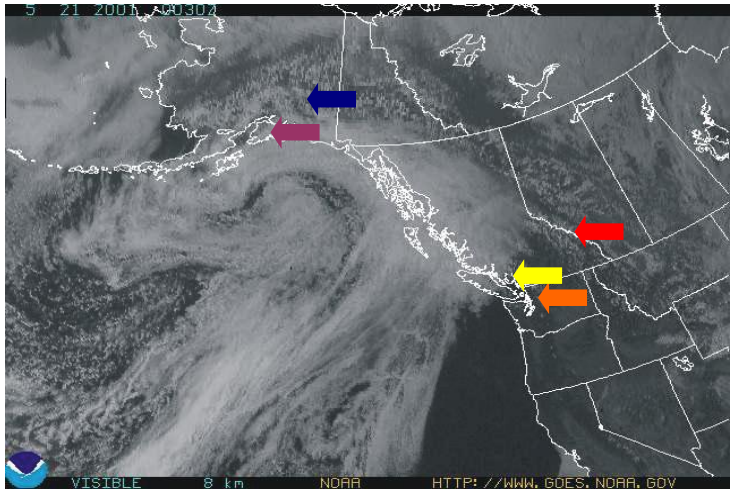
Hopkinson and Demuth in preparation

North – South PDO Bifurcation



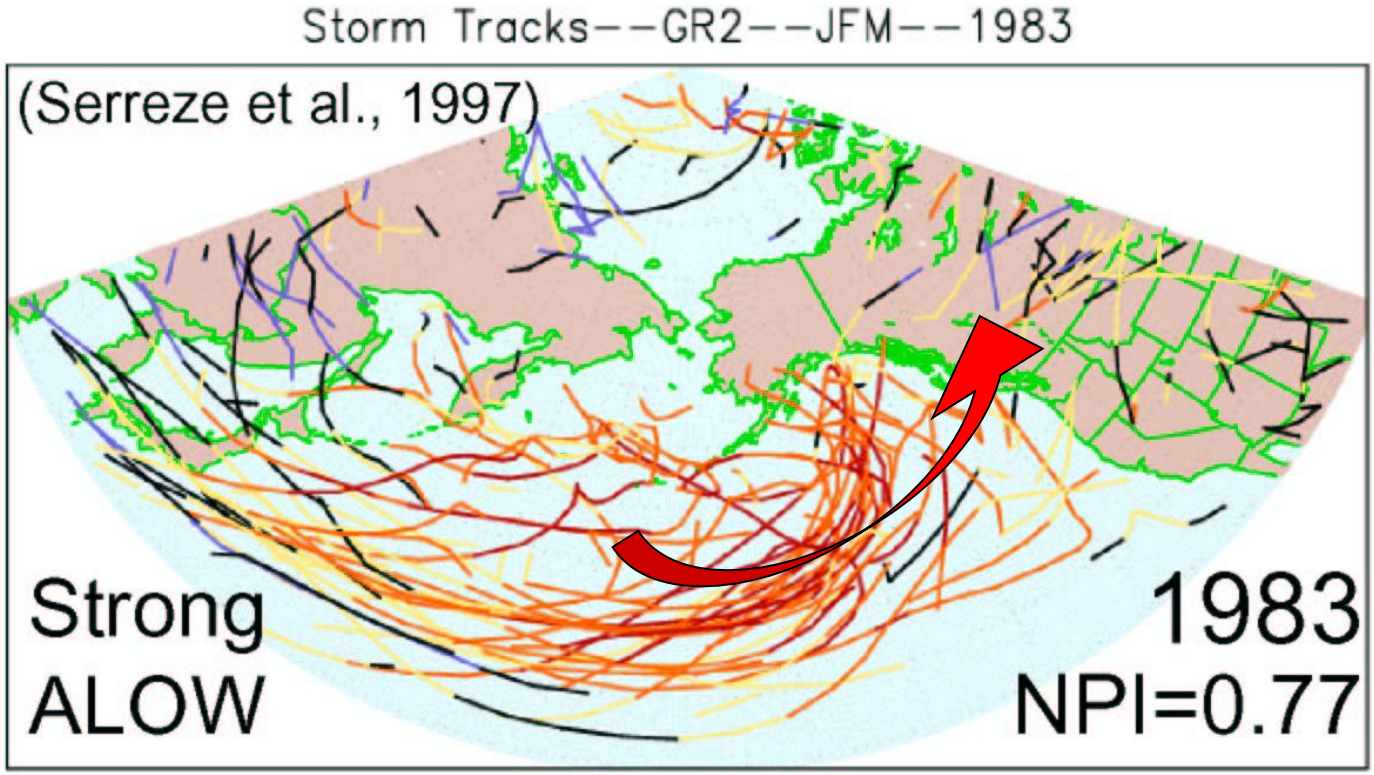
$$B_i \uparrow\downarrow = 100 \sum_{i=1}^{Ny} \left[\frac{B_i}{\langle B \rangle} - 1 \right]$$

After Demuth and Keller 2006, with additional data from USGS-Water Resources Division (R.M. Krimmel, D. Trabant, R. March)



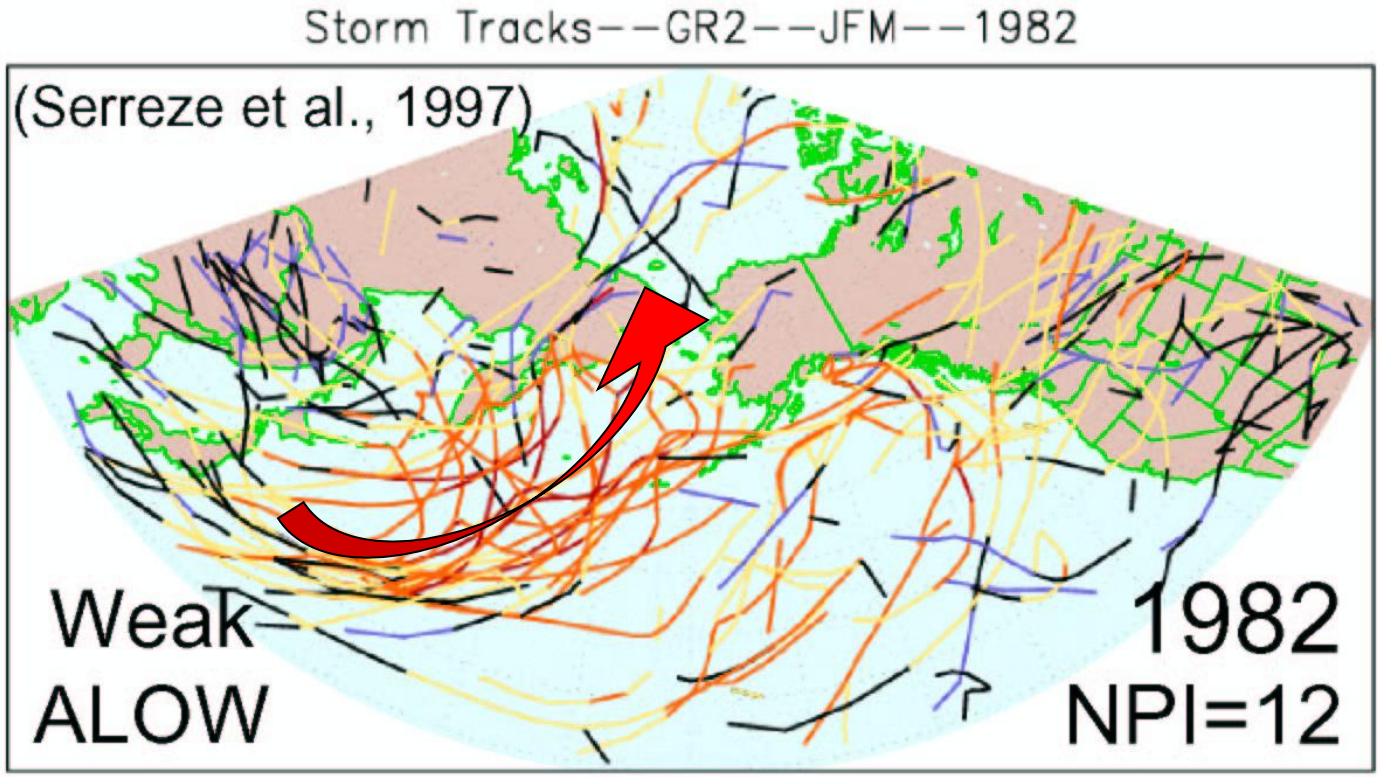
Pre 1976 – Deeper Aleutian Low

More frequent cyclone tracks steered towards Gulf of Alaska
Increased meridional moisture advection towards Cordillera



Post 1976 – Weaker Aleutian Low

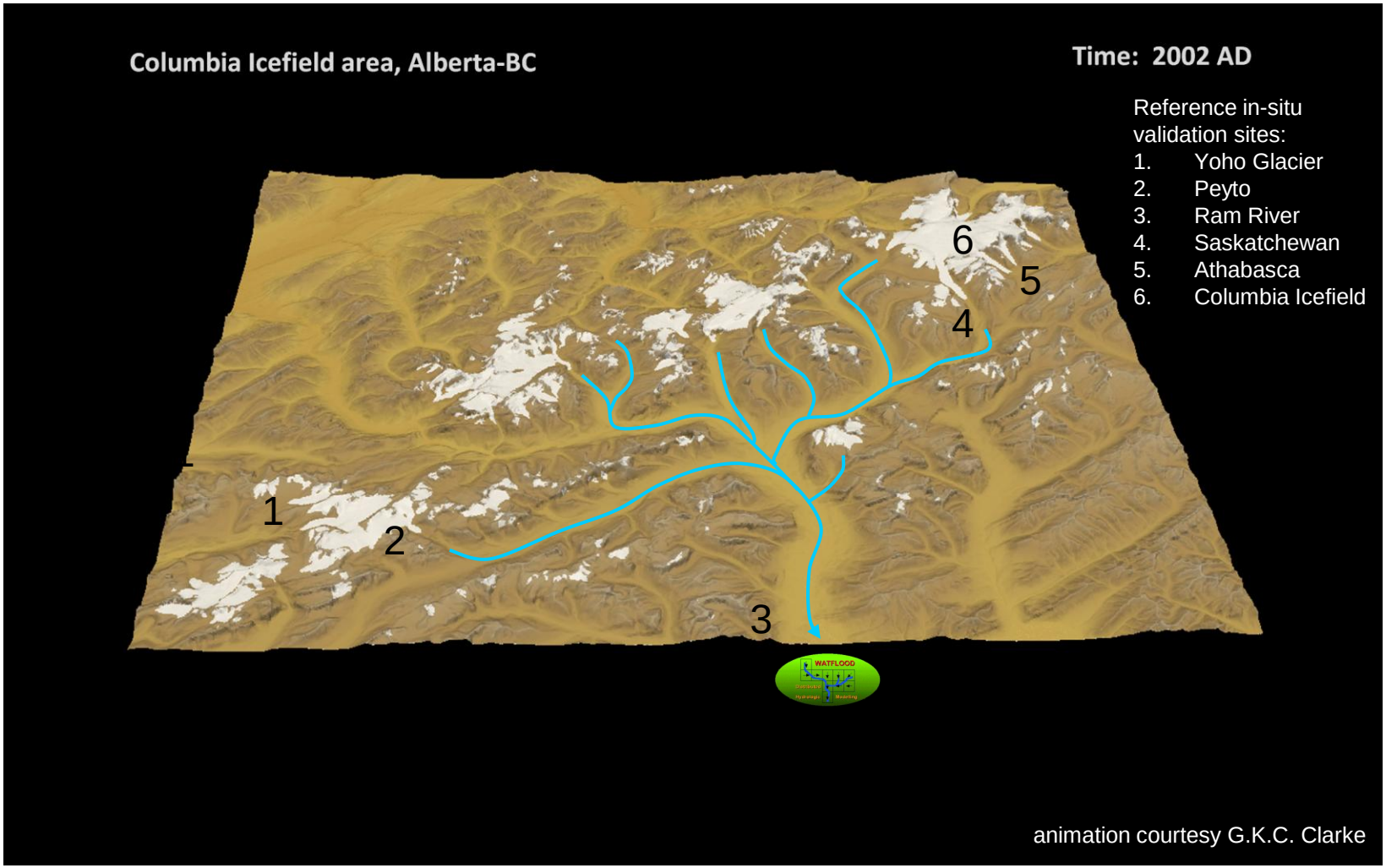
Fewer cyclone tracks steered towards Gulf of Alaska
More zonal moisture transport in North Pacific



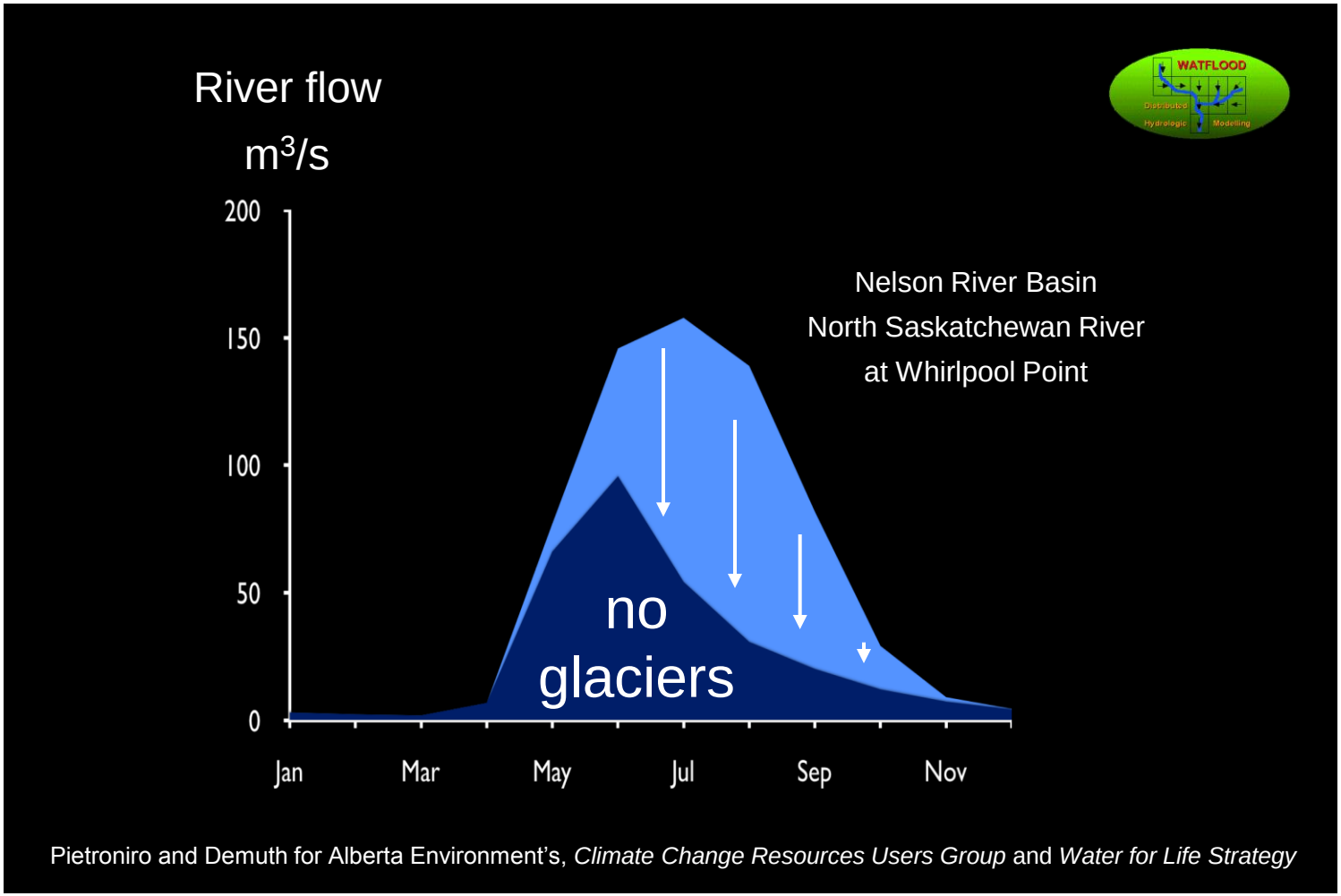
Columbia Icefield

2005 SPOT5 drape over SRTM DEM
by A. Chichagov

Prediction


Columbia Icefield area, Alberta-BC
Time: 2002 AD
Reference in-situ validation sites:
1. Yoho Glacier
2. Peyto
3. Ram River
4. Saskatchewan
5. Athabasca
6. Columbia Icefield
1
2
3
4
5
6
WATFLOOD
animation courtesy G.K.C. Clarke

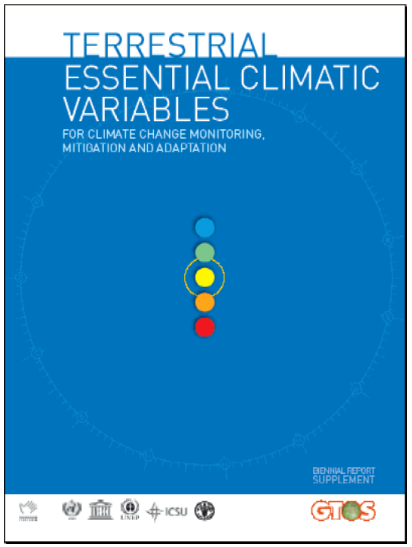
Impacts on Hydrology



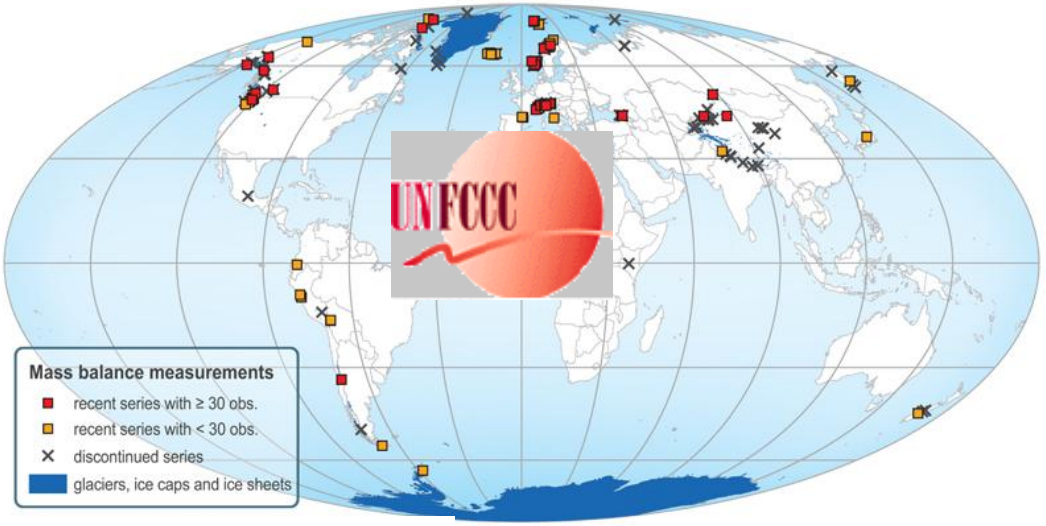
Pietroniro and Demuth for Alberta Environment's, *Climate Change Resources Users Group* and *Water for Life Strategy*

International contribution

- Global Climate Change Surveillance



GTOS
GLOBAL TERRESTRIAL OBSERVING SYSTEM



- International fora
- Partnerships / technology transfer

INTERNATIONAL JOINT COMMISSION
ENGLISH | FRANÇAIS
COMMISSION MIXTE INTERNATIONALE

wgms CA

Canadian Parks Service

Environment Canada

Canada

Water Survey Relevés hydrologiques

CSA ASC

Columbia Icefield Water for Life
Mackenzie
Columbia
Saskatchewan
2010 - 2015

WC²N
WESTERN CANADIAN CRYOSPHERIC NETWORK

IP3
Improved Processes & Parameterisation for Prediction in Cold Regions

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uOttawa
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Canada's university

TRENT UNIVERSITY

BC hydro

TransAlta

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CENTRO DE ESTUDIOS AVANZADOS EN ZONAS ÁRIDAS
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Thank you for your attention

Mike.Demuth@NRCan.GC.CA

NRCan Climate Change Geoscience Programme

"State and Evolution of Canada's Glaciers"

www.pathways.geosemantica.net