First Workshop on Canadian SMAP Applications and Cal-Val
Montreal -- October 6, 2009

Canadian Flux Sites for Forests and Peatlands

Hank Margolis
Program Leader, Canadian Carbon Program

Canada's land mass is:

- 45% of North America
- Similar in size to Europe (10 M km^2 each)
- 10% of the world's forests.
- 20% of world's boreal forest
- 85% of the North American boreal forest

Canadian Carbon Program / Fluxnet-Canada

WHAT DO WE DO?

We Make High-Quality Field Measurements of the Carbon Cycle to Help Develop and Test Predictive Models of How Northern Forests and Peatlands Respond to Climate Variability and Disturbance

Canadian Carbon Program / Fluxnet-Canada

WHO ARE WE?

40-50 Canadian University and Government Scientists
Currently 50 Graduate Students and Postdocs
Funding: 2002-2010

Network Measurement Components:

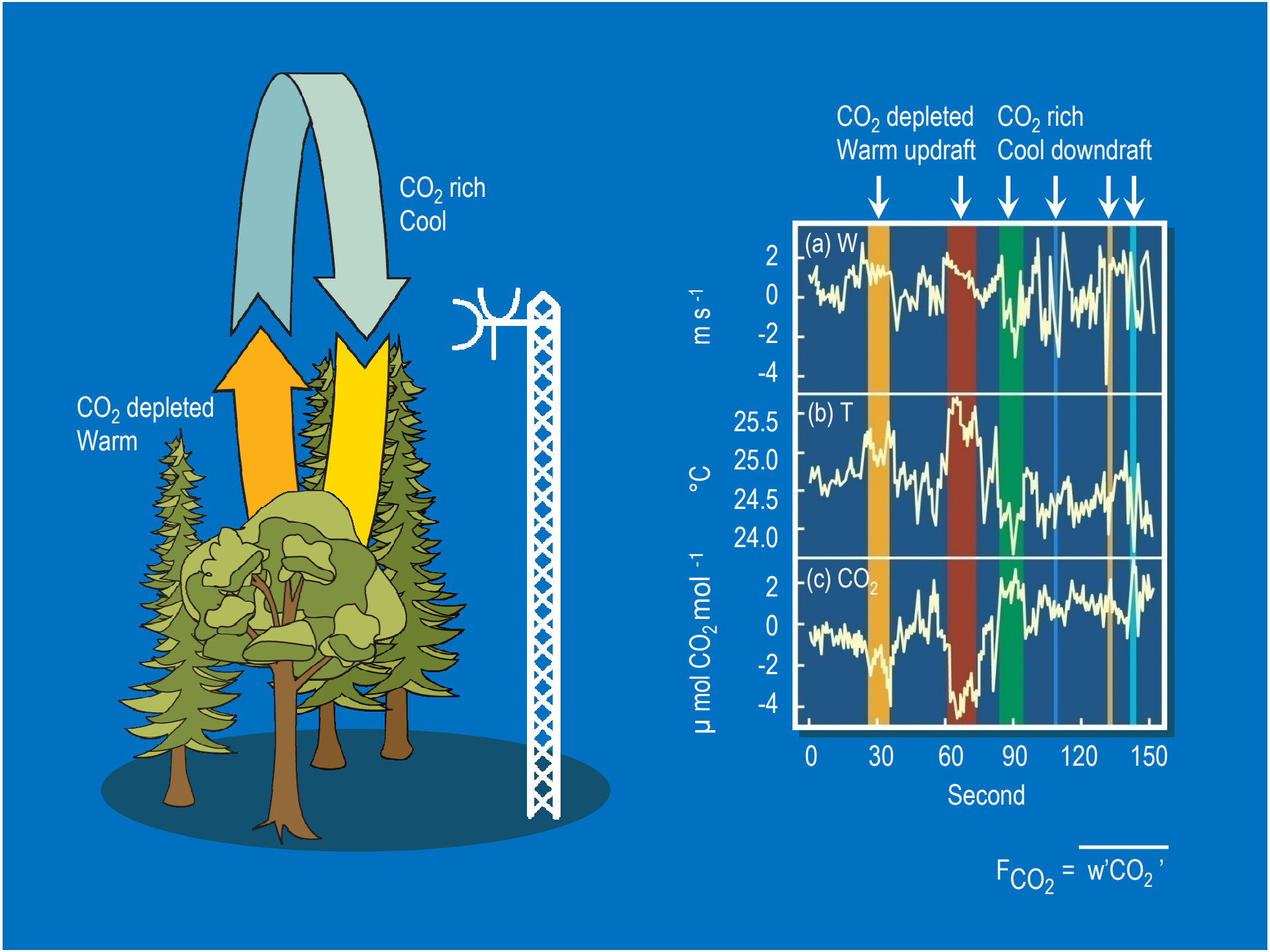
Ecosystem Fluxes: Impacts of Interannual Climate Variability and Disturbance

High-Precision Atmospheric Greenhouse Gas Concentrations & Related Isotopes

Network Modelling Components:

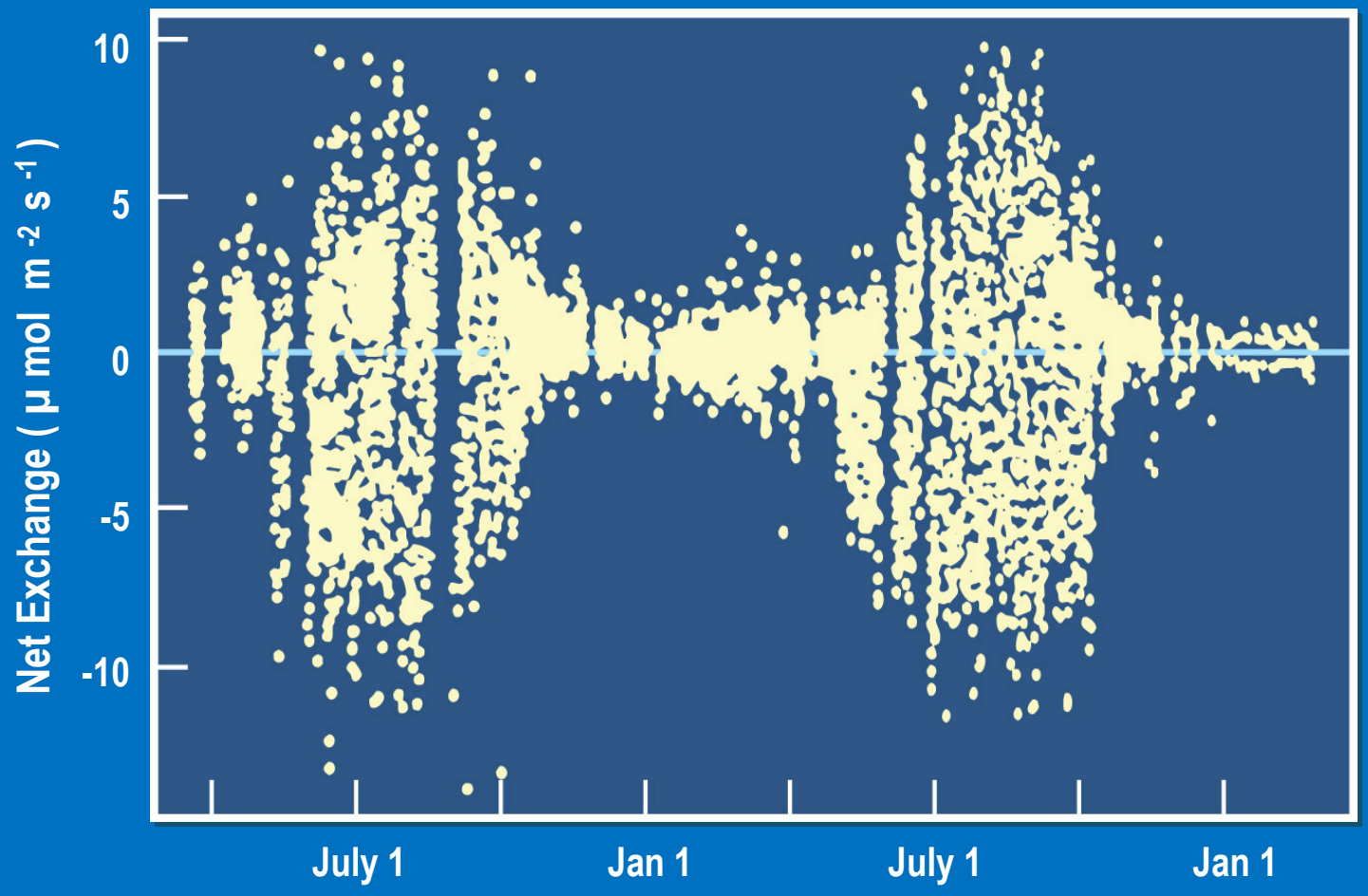
Regional, National, and Continental Scale Modelling of Carbon Sources and Sinks

Bottom-Up Process Modelling to Support Forest Carbon Accounting System


CO2 rich
Cool
CO2 depleted
Warm
CO2 depleted
Warm updraft
CO2 rich
Cool downdraft
(a) W
(b) T
(c) CO2
m s -1
°C
μ mol CO2 mol -1
2
0
-2
-4
25.5
25.0
24.5
24.0
0
30
60
90
120
150
Second
FCO2 = w'CO2'

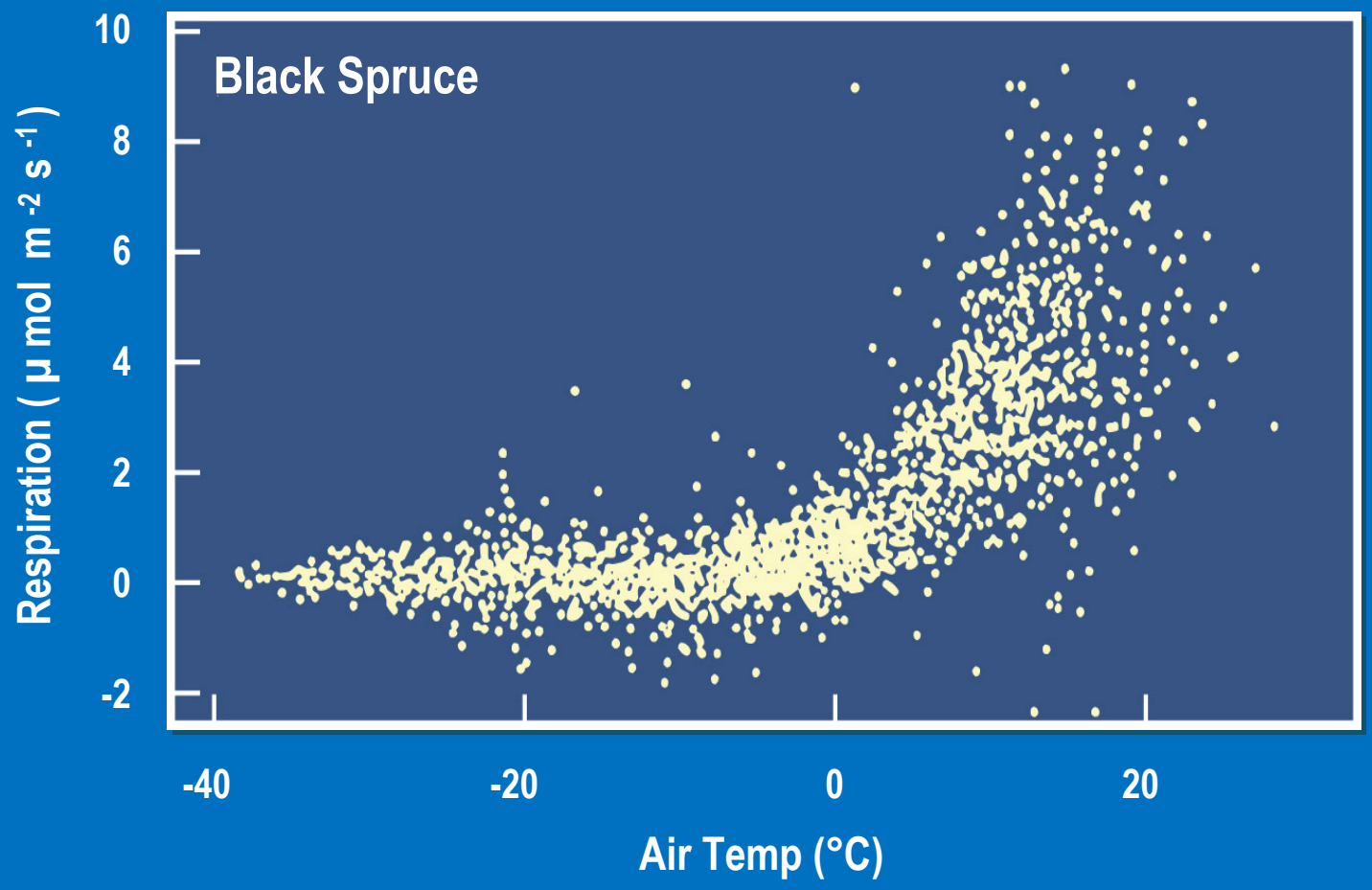
BOREAS OLD BLACK SPRUCE

Night (respiration)
Day (respiration + photosynthesis)
Difference (photosynthesis)



M. Goulden and S. Wofsy
Harvard University

WINDY NIGHTS



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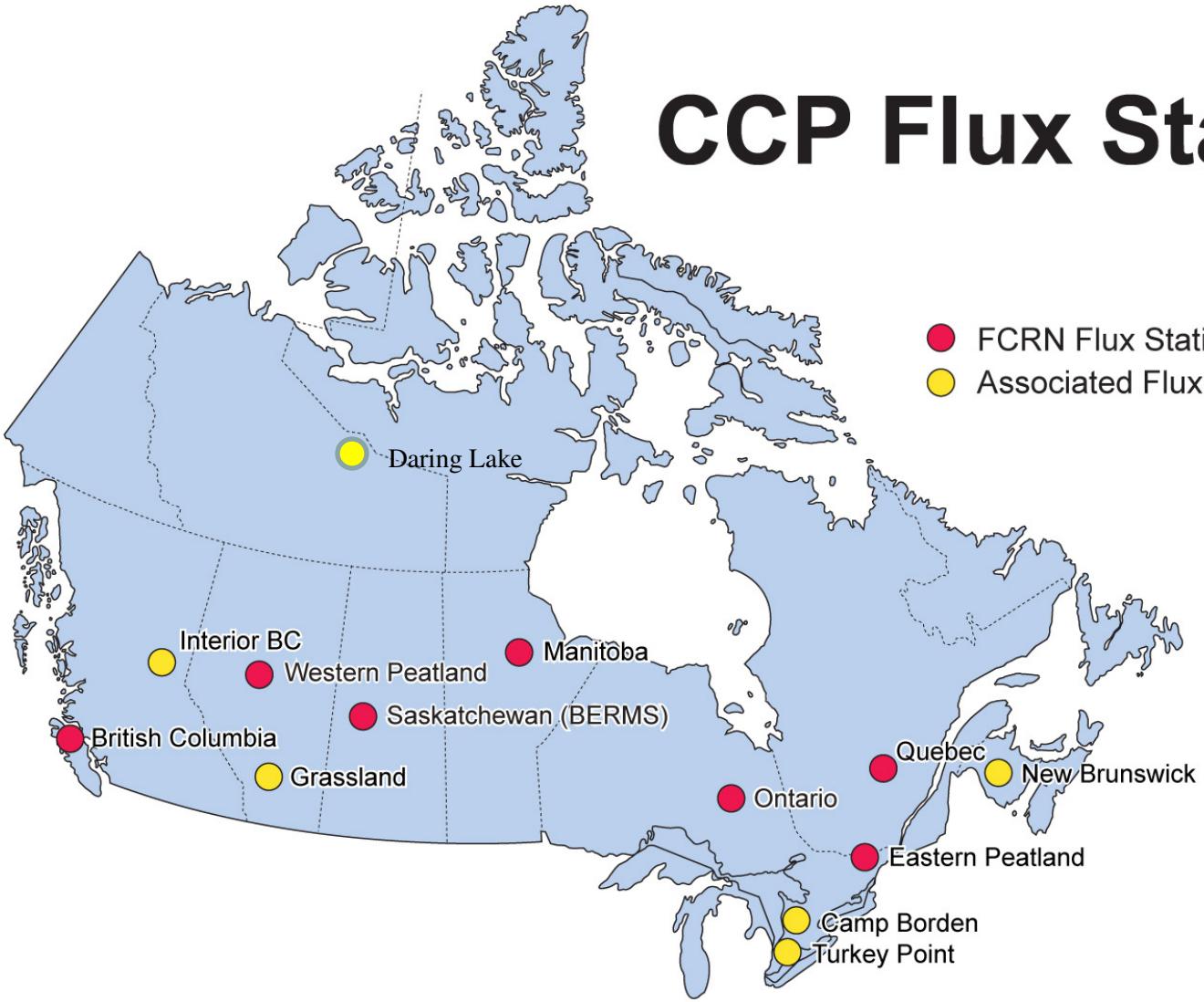
Primary Flux Variables
(half-hour, day, month, years)

Net C Flux = Net Ecosystem Productivity (NEP)

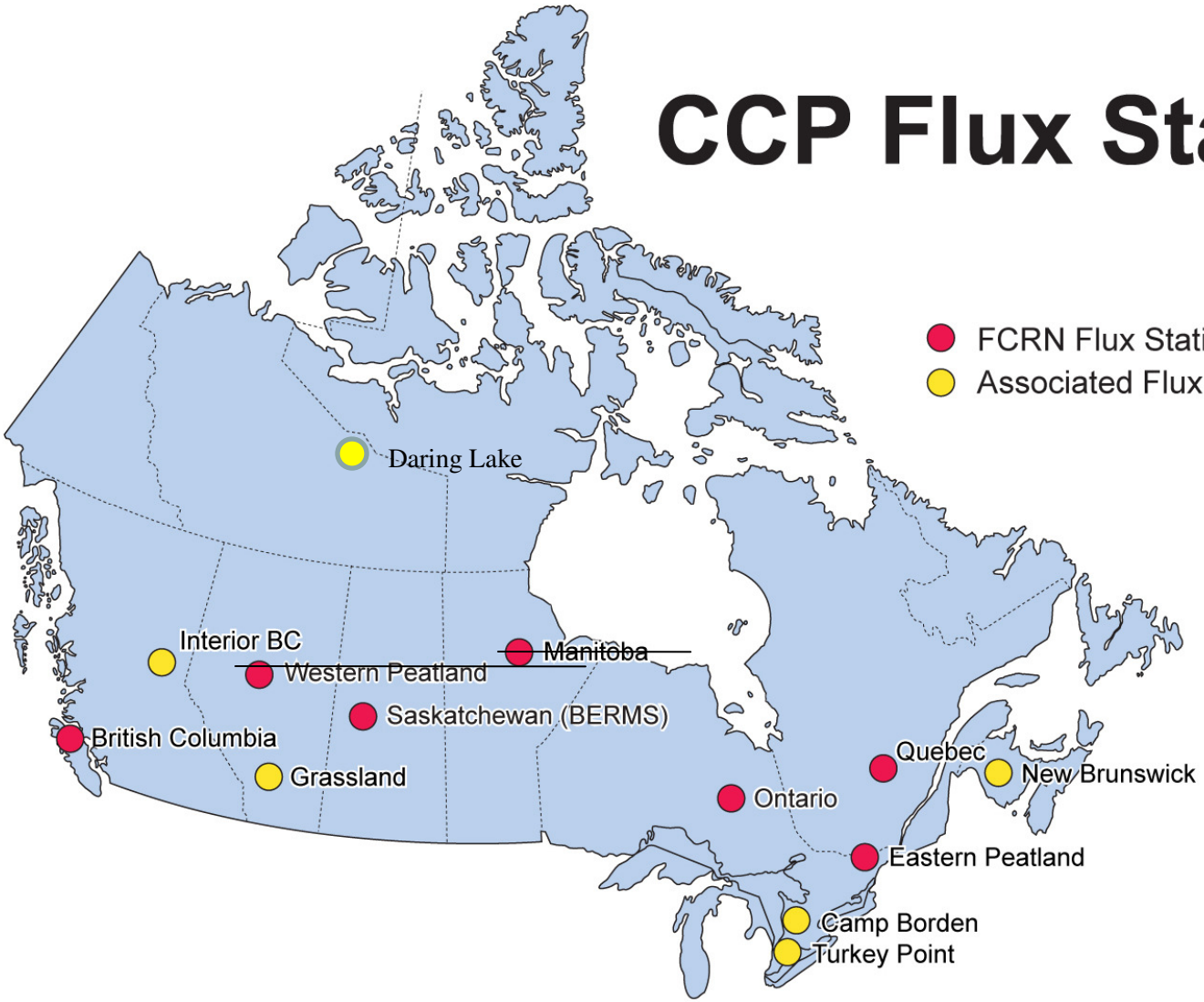
NEP = Ecosystem Photosynthesis – Ecosystem Respiration

CCP Flux Stations



Fluxnet-Canada: 2002-2007
Canadian Carbon Program (CCP): 2007-2010

CCP Flux Stations



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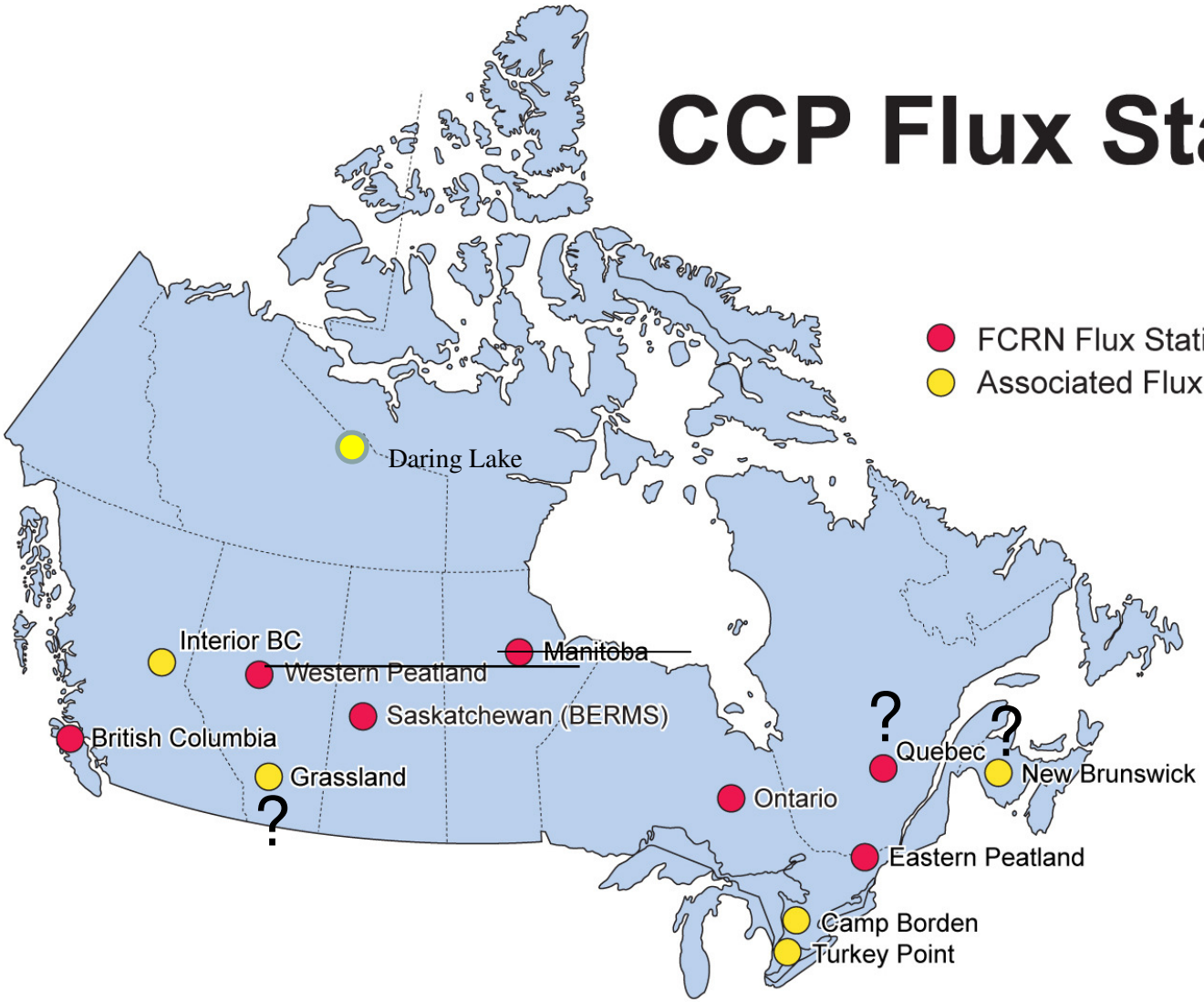

Fluxnet-Canada: 2002-2007
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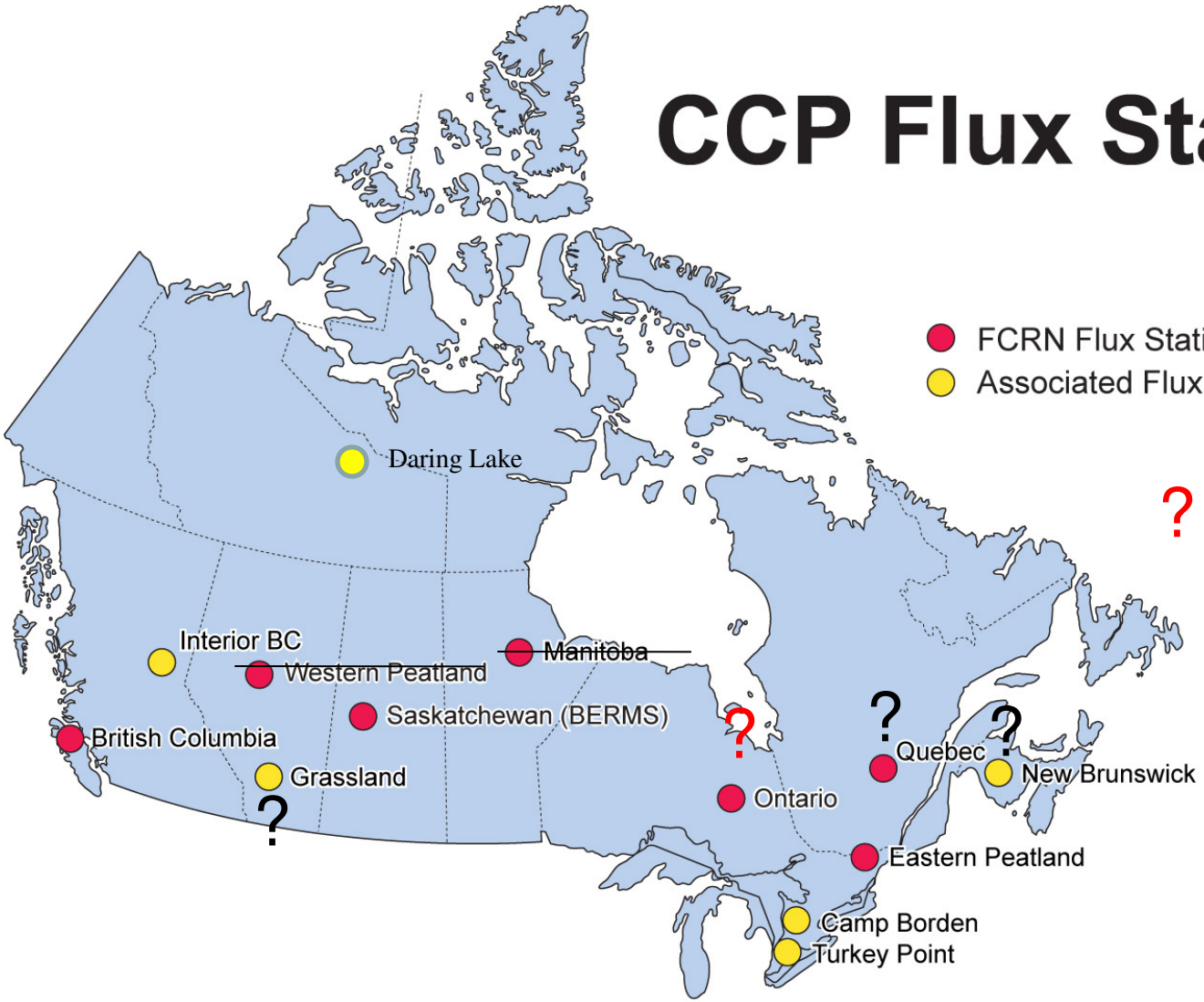
CCP Flux Stations

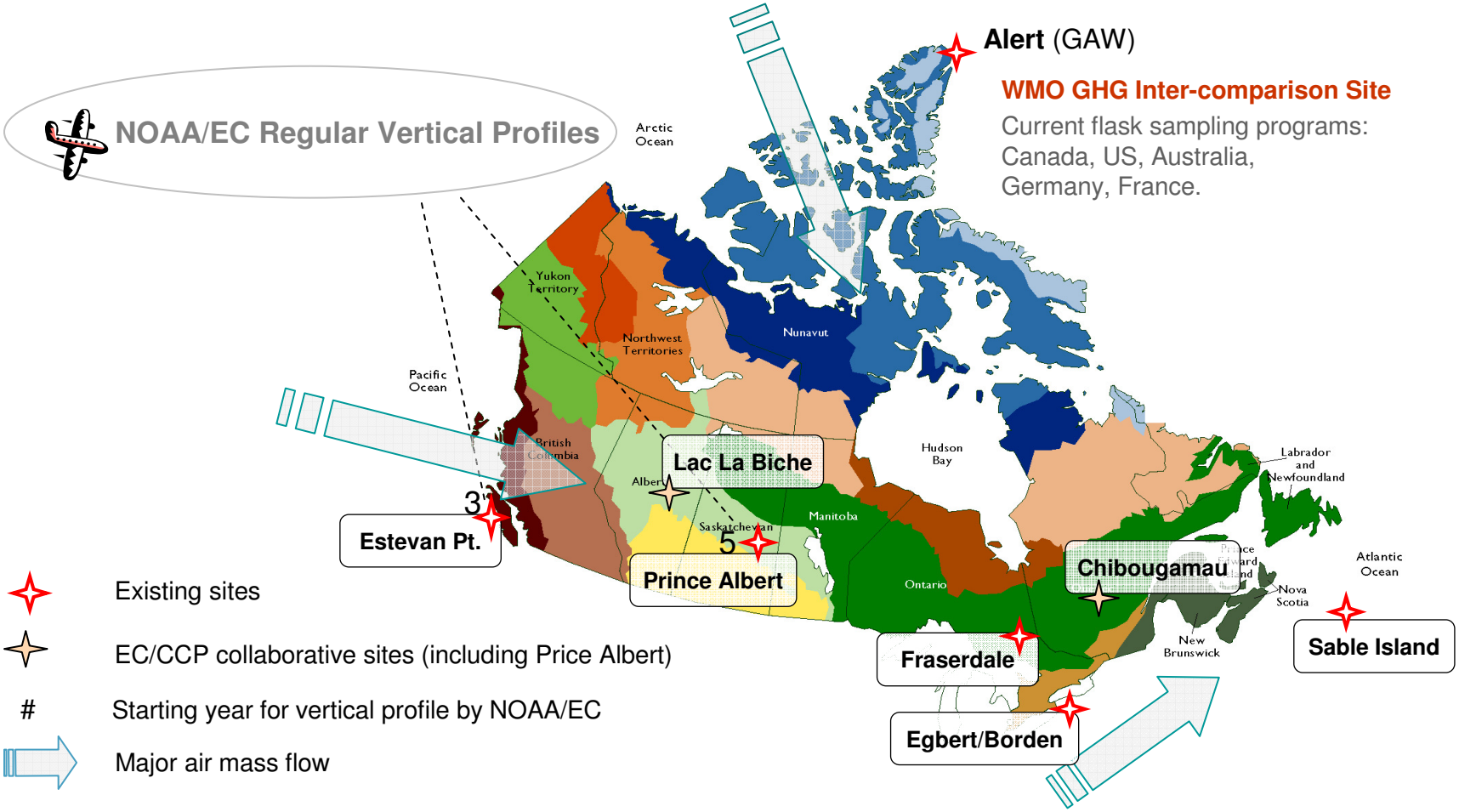


? Hudson Bay Lowlands

Moosonee
Attawapiskat
Polar Bear Prov. Park

Fluxnet-Canada: 2002-2007
Canadian Carbon Program (CCP): 2007-2010

Environment Canada/CCP Collaborative Network of Atmospheric GHGs & Related Isotopes Measurements (High-Precision)



Concentration Measurements
Contact: D. Worthy (EC)

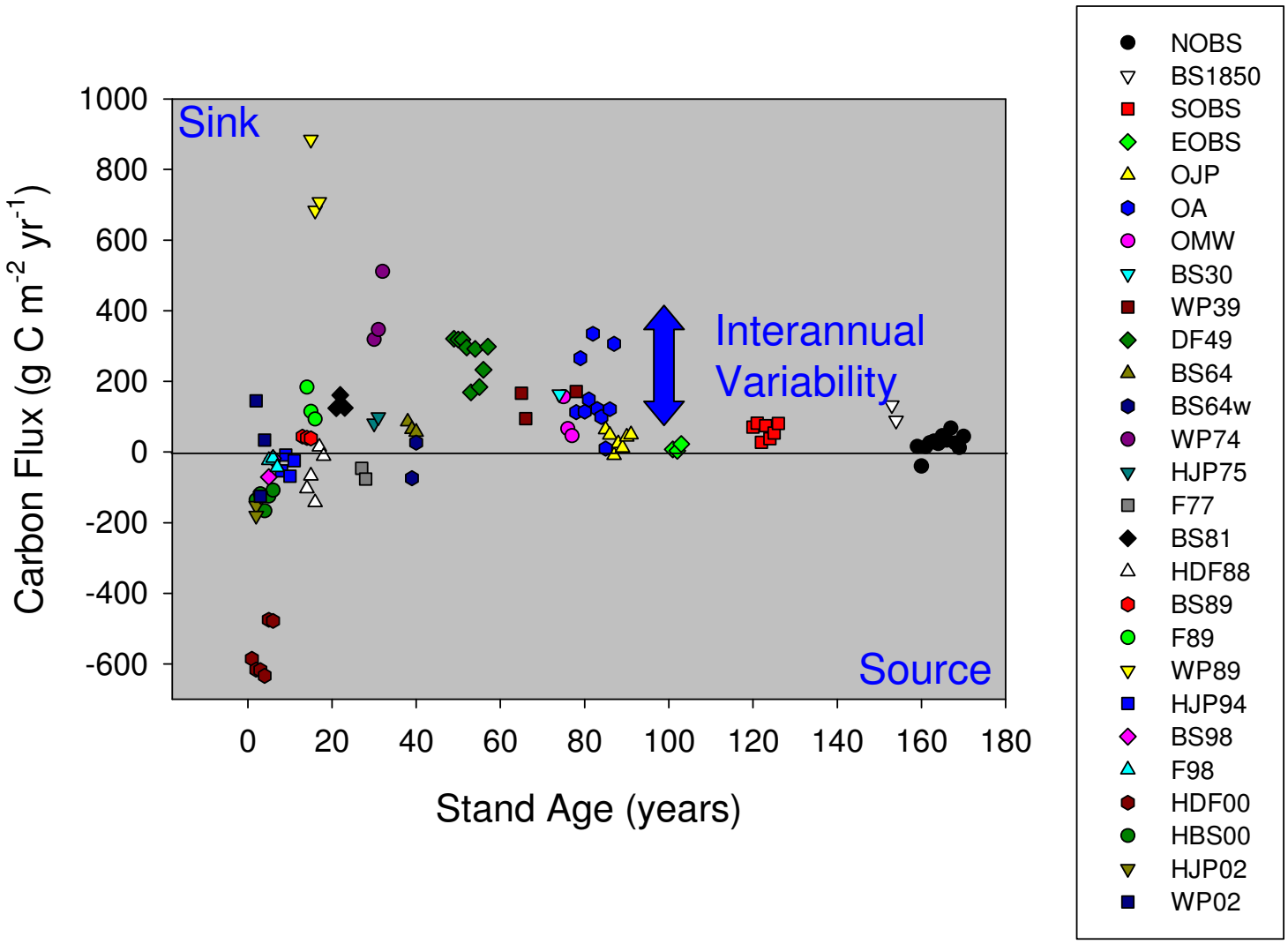
Isotope Measurements
Contact: L. Huang (EC)

Canada Carbon Program (CCP)
Contact: H. Margolis

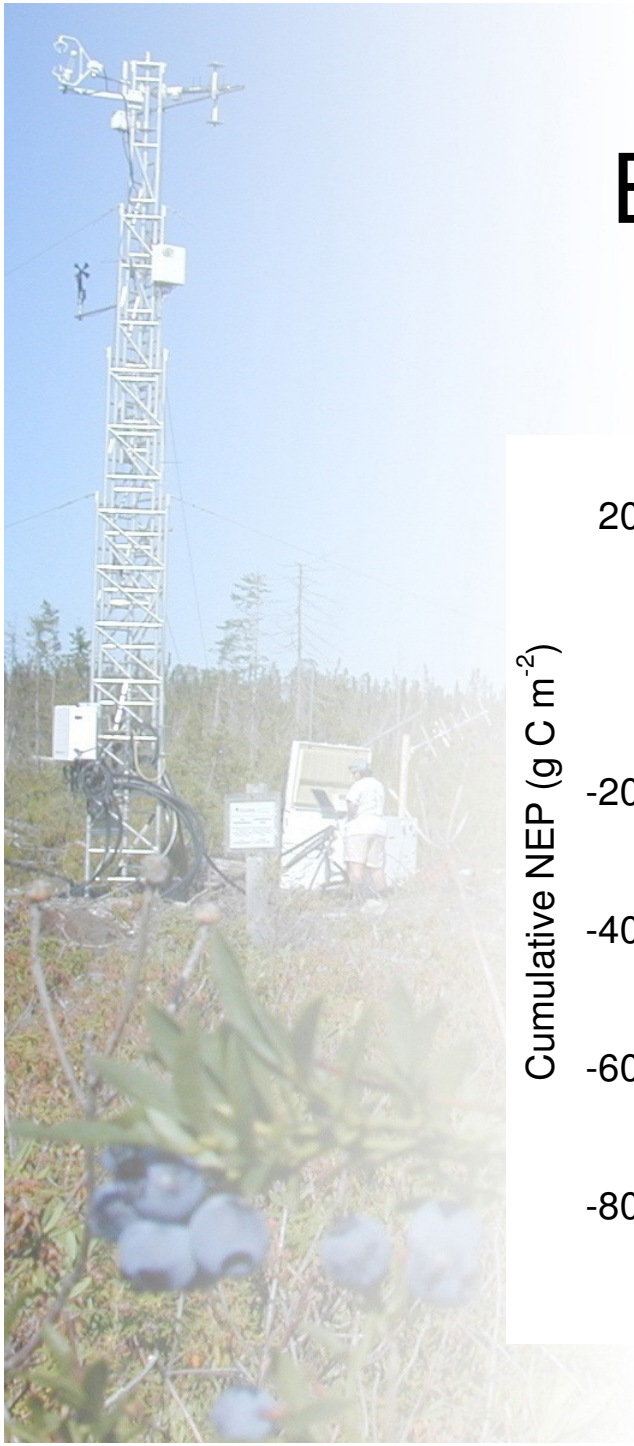
CCP Remote Sensing Collaborations

- Assessing Forest C Stocks from Space
- Remote Sensing of Light Use Efficiency
  - Photochemical Reflectance Index (PRI) and Other Biospectral Indicators
  - $FPAR_{chlorophyll}$
- Canopy Biochemistry and AVIRIS
- Landsat Time-Series for Disturbance Analyses

Annual Carbon Budgets

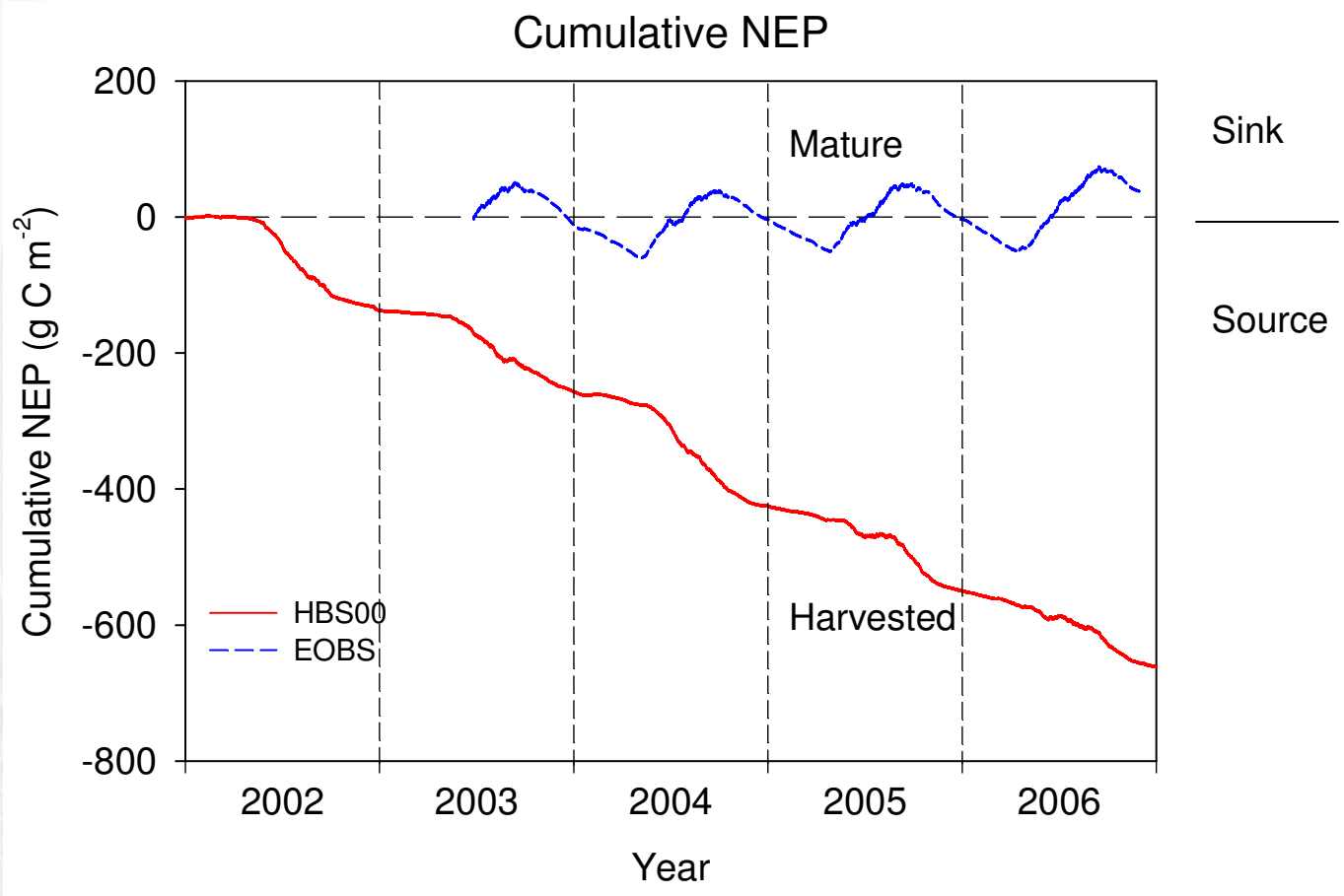


Quebec Cutover Site
Photo : H. Margolis



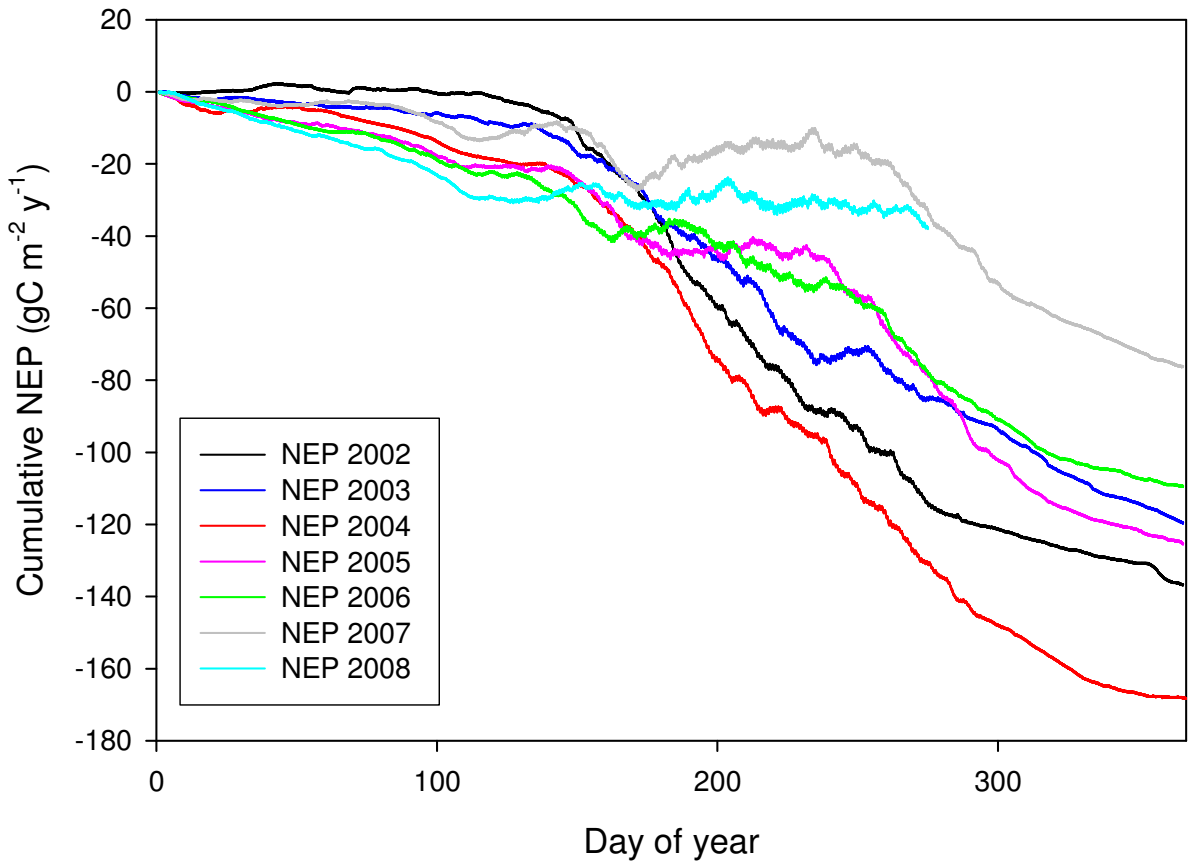
Harvested vs Mature Black Spruce in Quebec

Cumulative NEP



Harvested Black Spruce in Quebec

Cumulative NEP



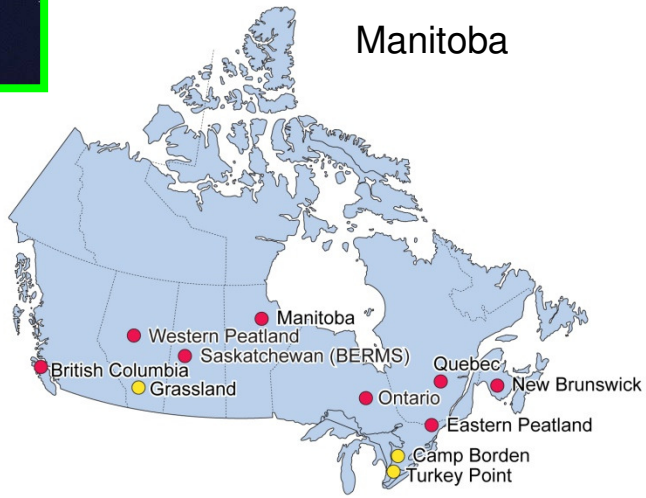
Winter

Inter-Regional Comparison of the Same Forest Type – Boreal Black Spruce

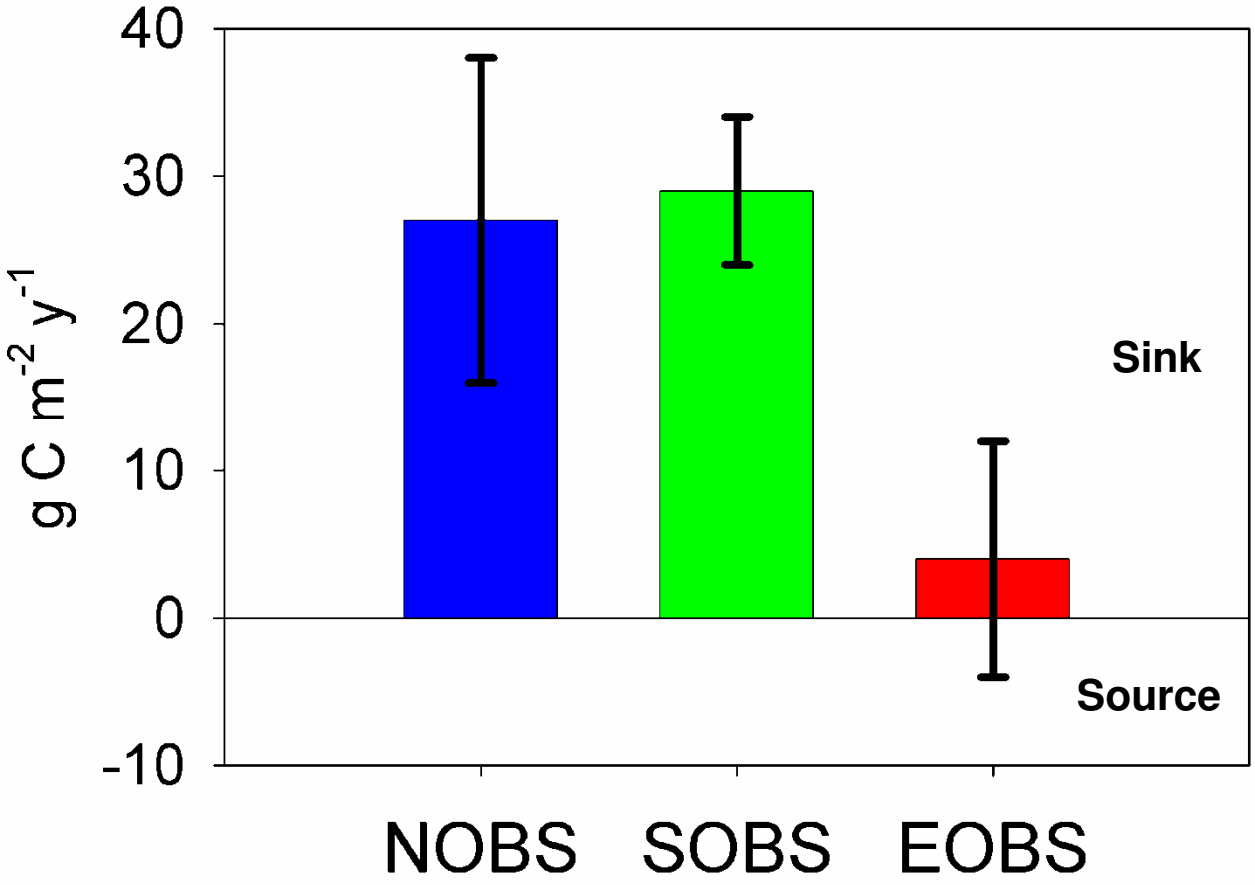
Saskatchewan

Manitoba

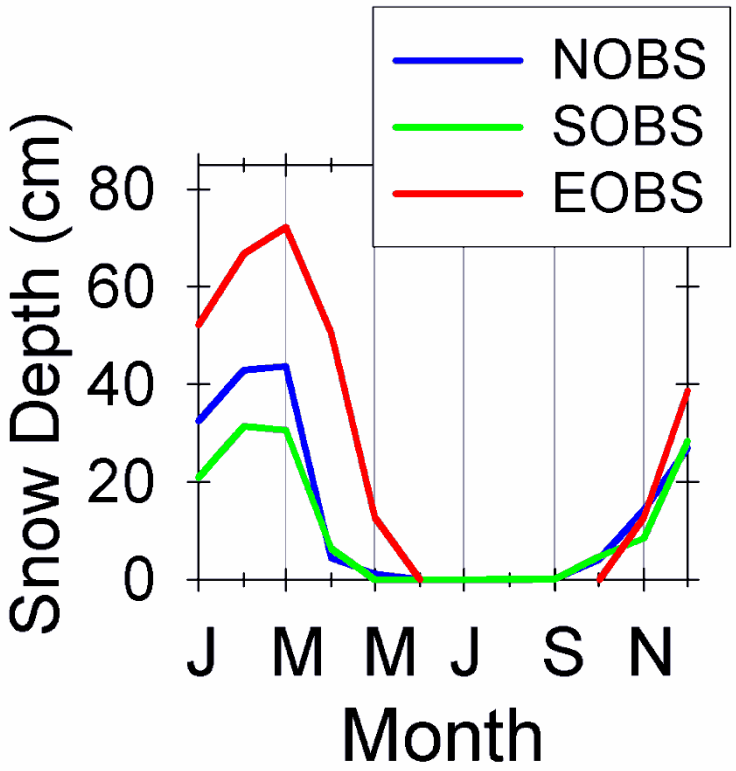
Quebec

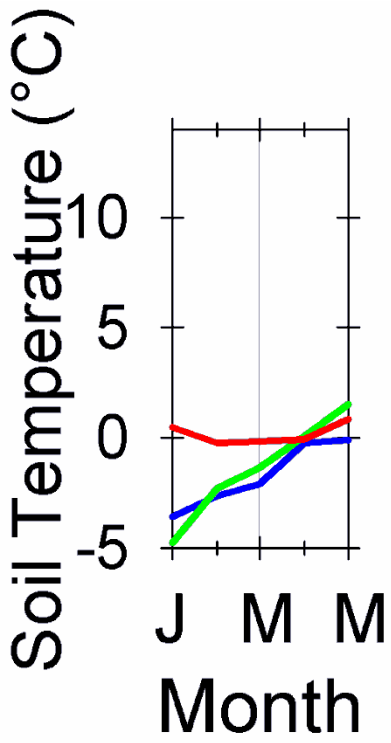


2004 Annual NEP



Cross-Spruce Comparison

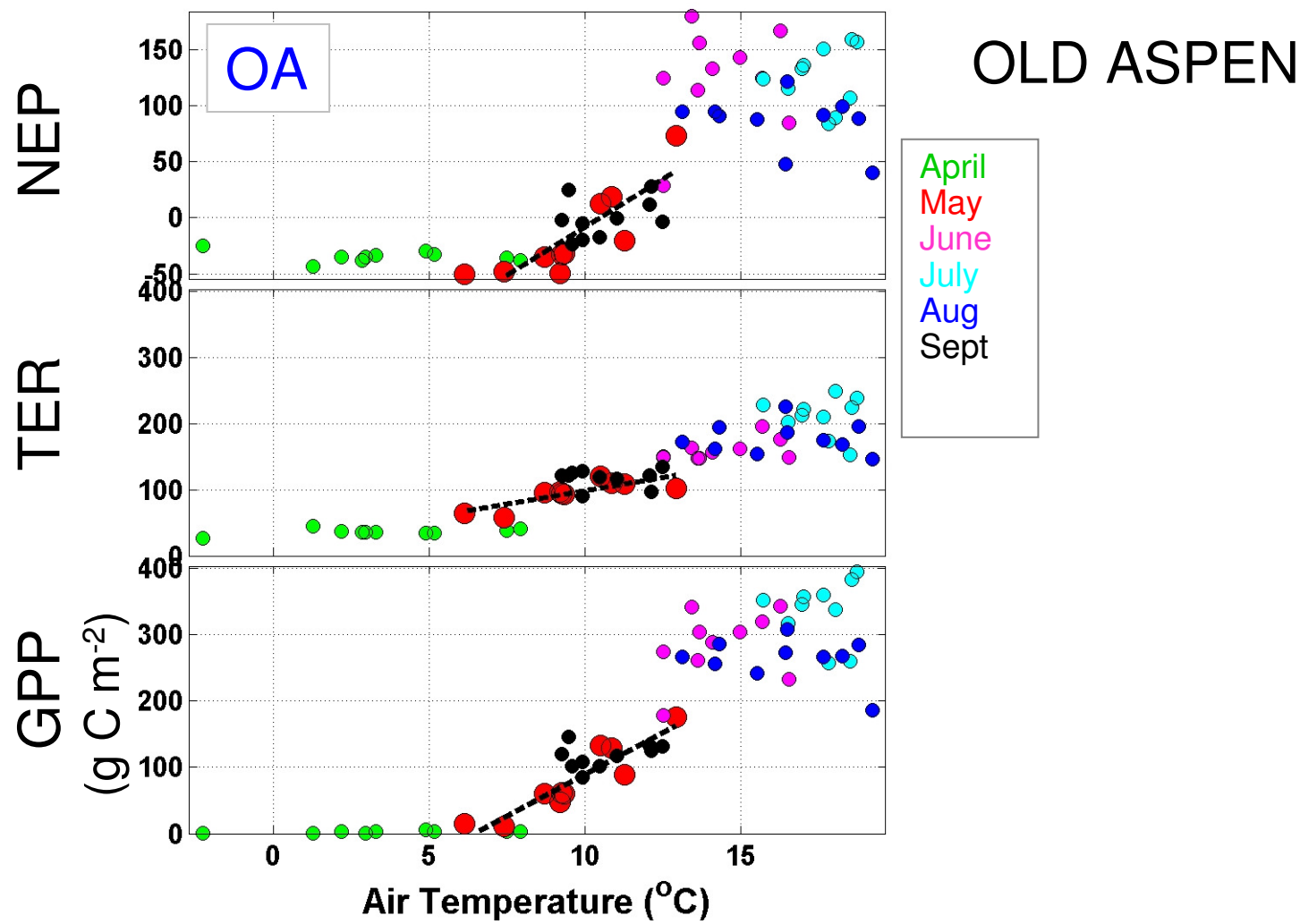




Spring

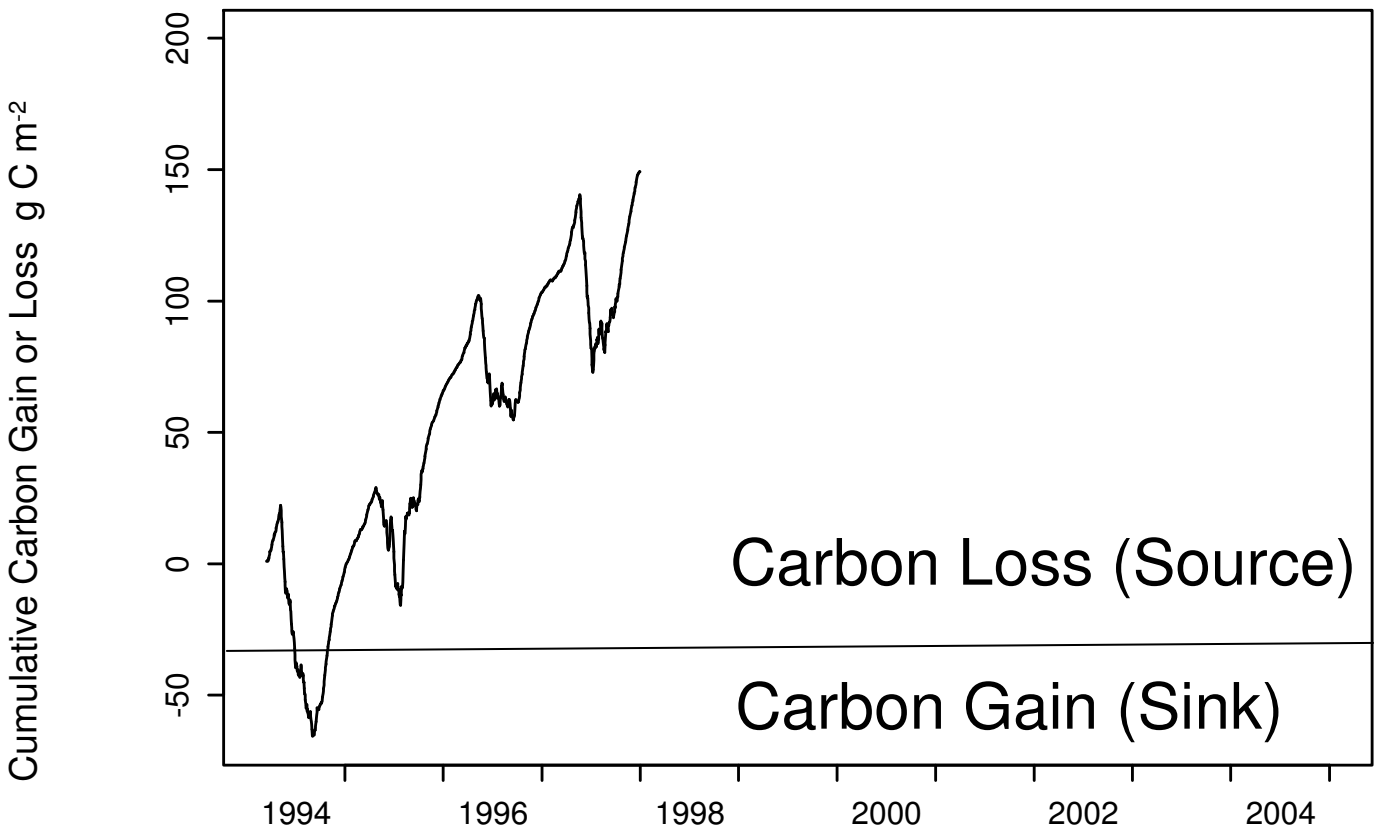
Relationship Between Monthly NEP, TER and GPP and Monthly Mean Air Temperature at OA 1997-2006

(Dashed lines are plotted when linear regression $p \leq 5\%$)



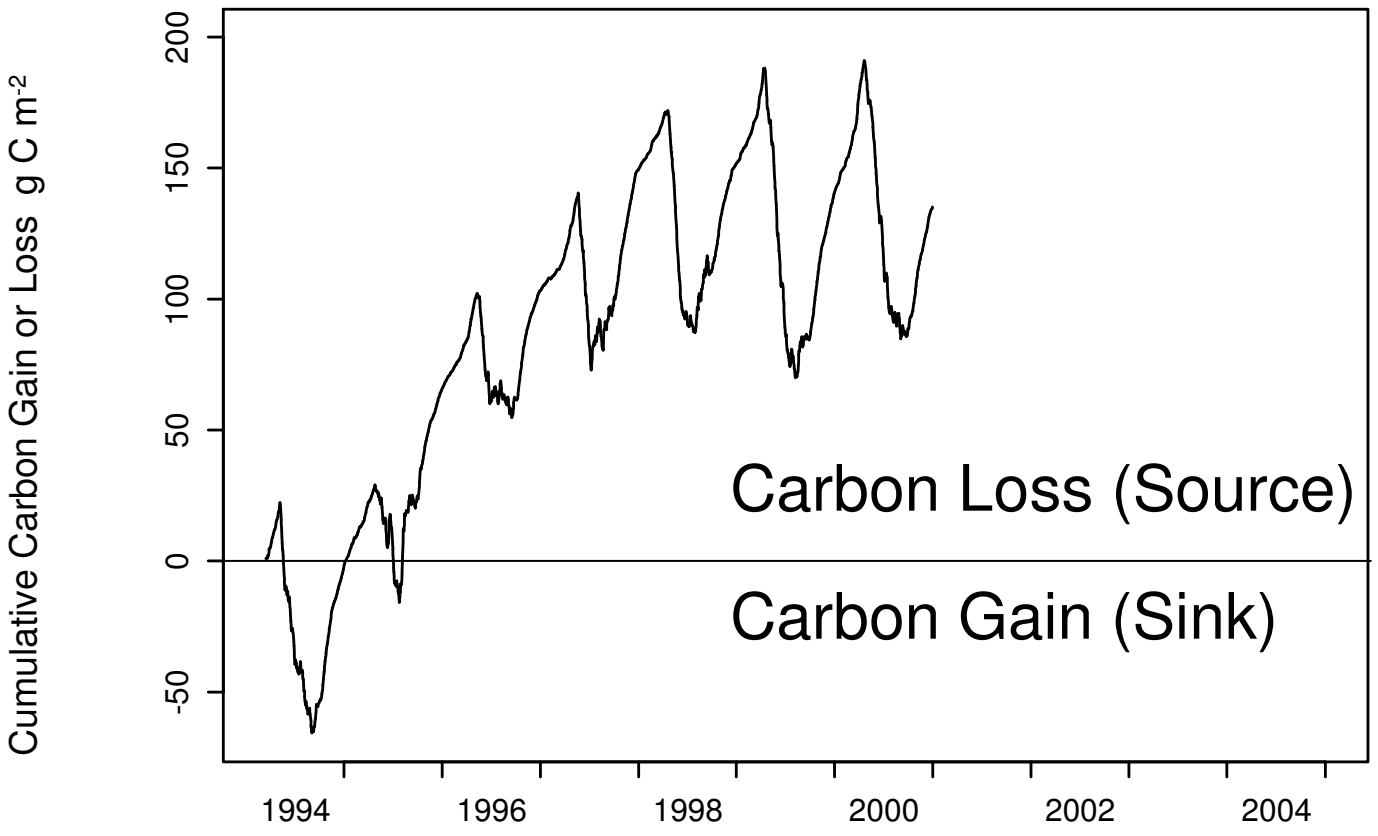
Summer

Northern Old Black Spruce, Manitoba

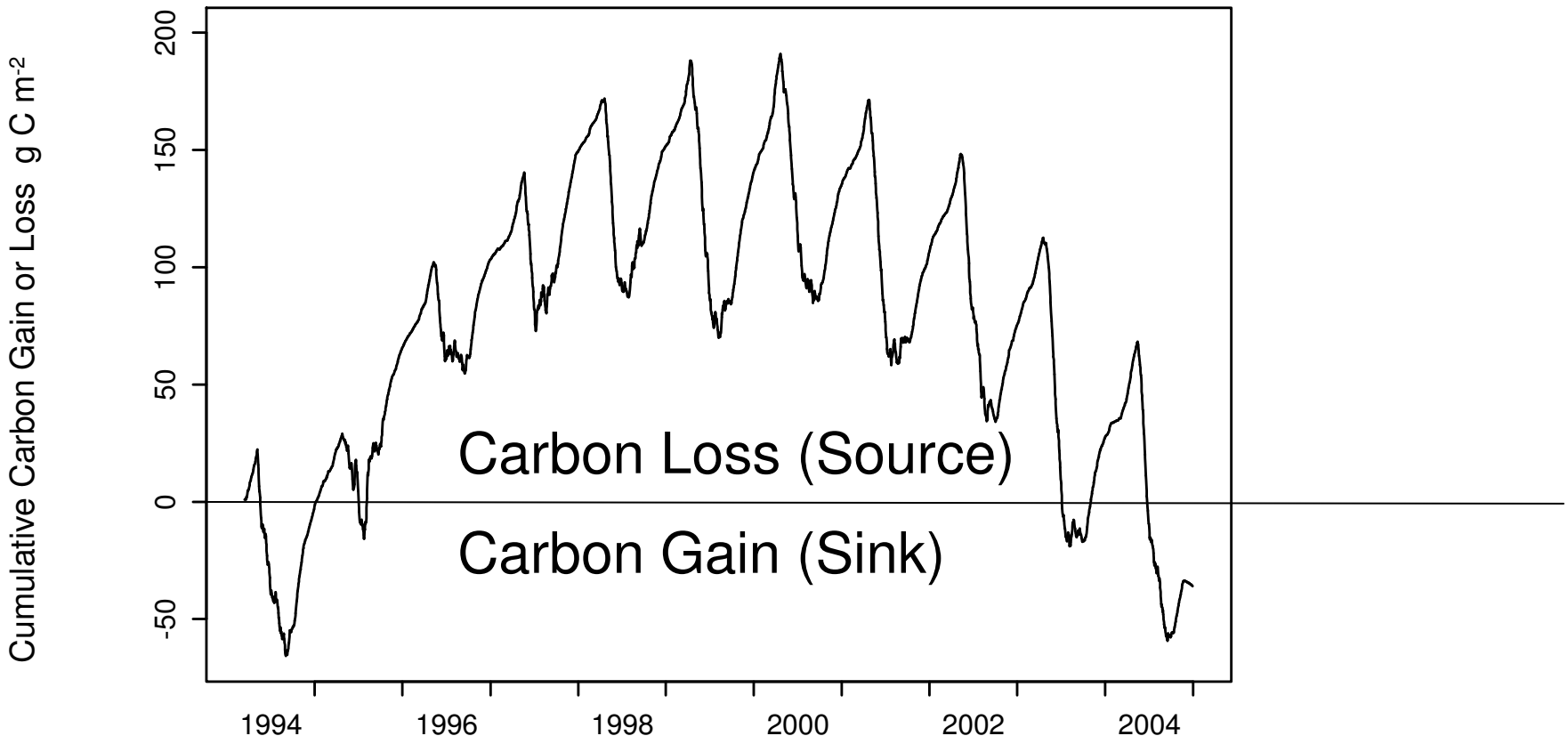


(Wofsy et al., Harvard Univ.)

Northern Old Black Spruce, Manitoba

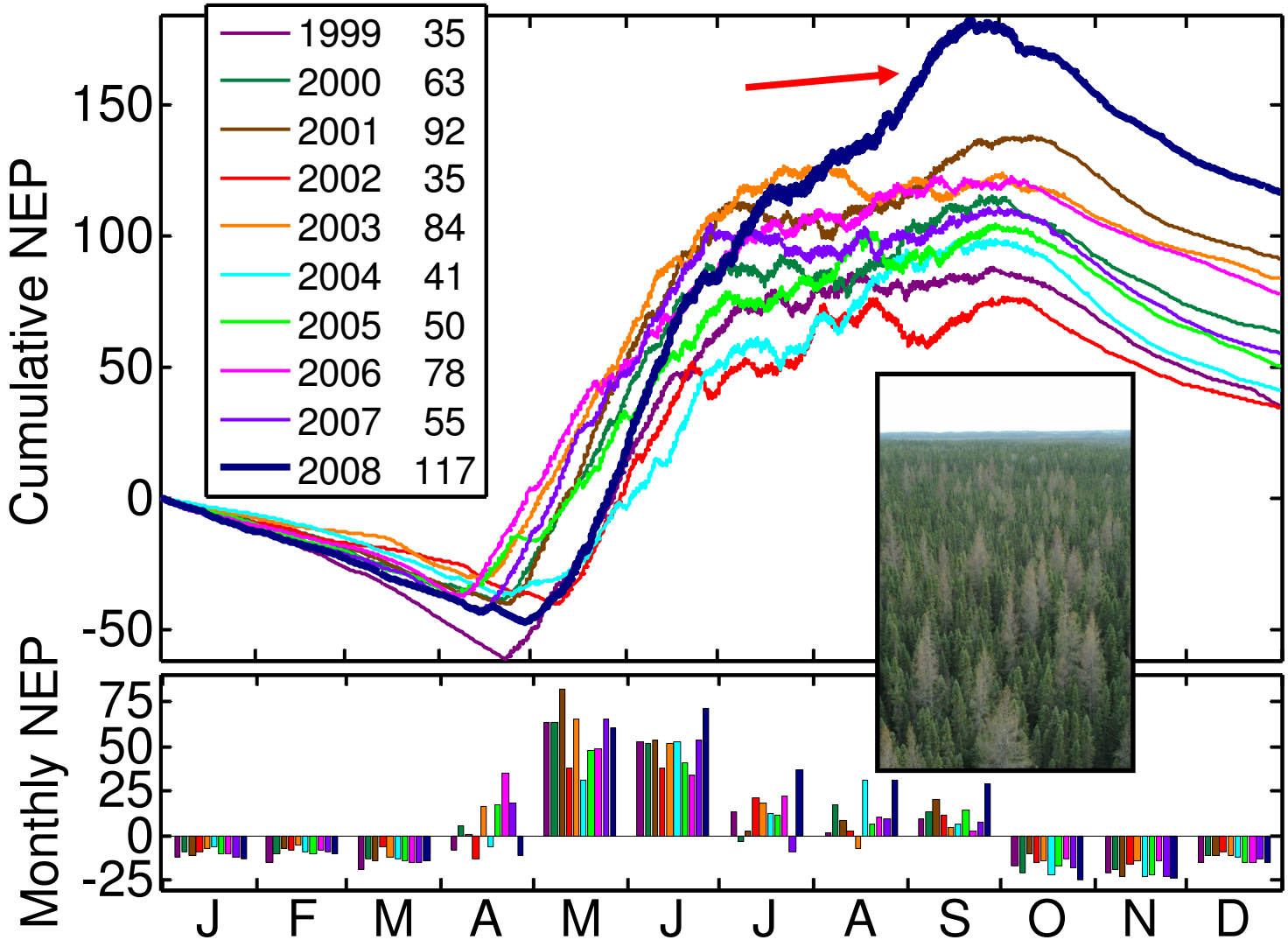


Northern Old Black Spruce, Manitoba



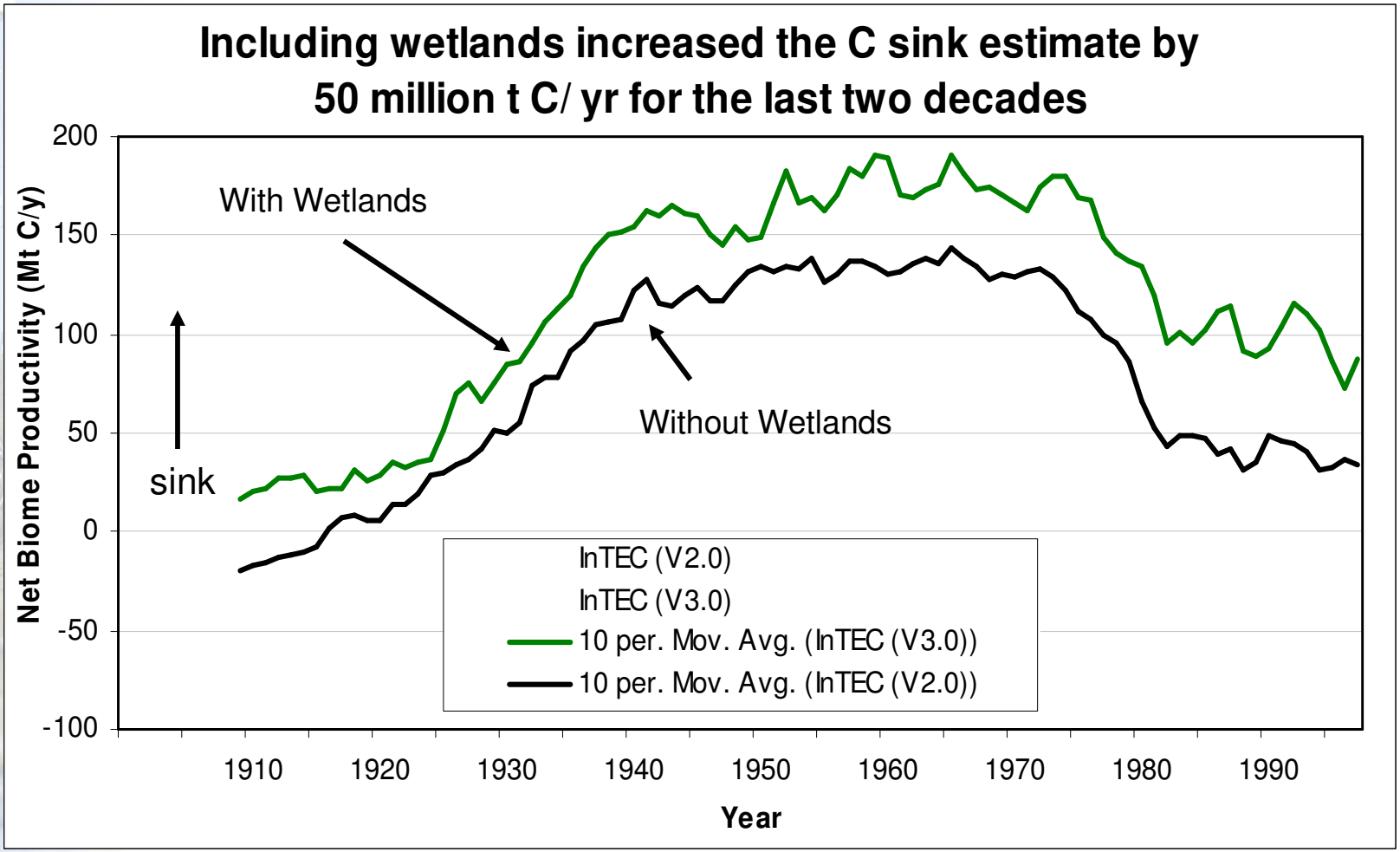
Autumn

OBS 2008: Enhanced late growing season C sequestration (g C m^{-2})



Periods of below normal soil temperatures, and of enhanced PAR and diffuse PAR fraction, produced an exceptional year for C sequestration through their timing and influence on R and GEP, respectively.

Effect of Adding Simple Hydrology and an Explicit Wetland Parameterization for Canada



Ju, Chen, Black, Barr, McCaughey and Roulet (2004)