The Canadian Carbon Program and Fluxnet-Canada: Advancing Our Understanding of the Carbon Cycle of Canada's Forests and Peatlands Using a Research Network Approach

Hank Margolis, U. Laval

(presented by Alan Barr, Environment Canada)

44th Annual CMOS Congress
Ottawa, 2 June 2010

integrated carbon observation system

A European infrastructure dedicated to high precision monitoring of greenhouse gas fluxes

Hank Margolis:
ICOS Review Panel
(Europe's Integrated Carbon Observing System)
Helsinki, May 31 to June 3

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- Introduction
- Selected Highlights
  - Inter-annual variability
  - Disturbance
  - Modelling
- Accomplishments

Background

- Airborne fraction of global CO_2 emissions ~ 40%, ~30% re-uptake by oceans, ~30% re-uptake by land
- Questions:
  - How do Canadian ecosystems contribute to the terrestrial C sink?
  - Will the terrestrial C sink be sustained in the future? What are the controlling factors and critical uncertainties?
  - Can the C cycle provide a point of convergence between environmental stewardship, economic activities and sustainable development?

Fluxnet-Canada Research Network (FCRN) 2002-2007

Understanding the influence of climate variability and disturbance on C cycling in Canadian forests and peatlands

Supported by NSERC, CFCAS, BIOCAP, Environment Canada and Natural Resources Canada

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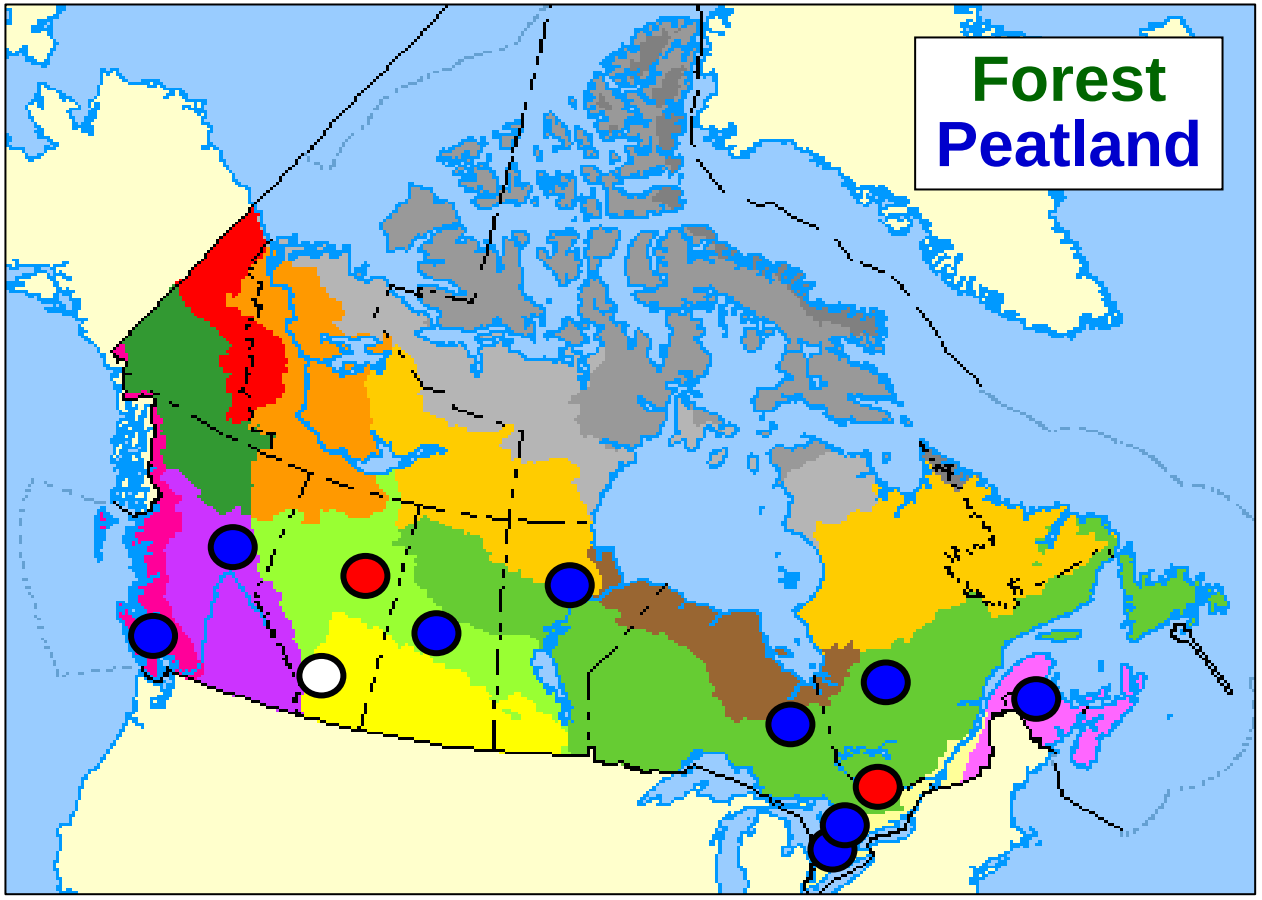
FCRN/CCP Flux Towers

Mature Forests and Peatlands



Terrestrial Ecozones

- Arctic Cordillera
- Northern Arctic
- Southern Arctic
- Taiga Plains
- Taiga Shield
- Taiga Cordillera
- Hudson Plains
- Boreal Plains
- Boreal Shield
- Boreal Cordillera
- Pacific Maritime
- Montane Cordillera
- Prairies
- Atlantic Maritime
- Mixedwood Plains

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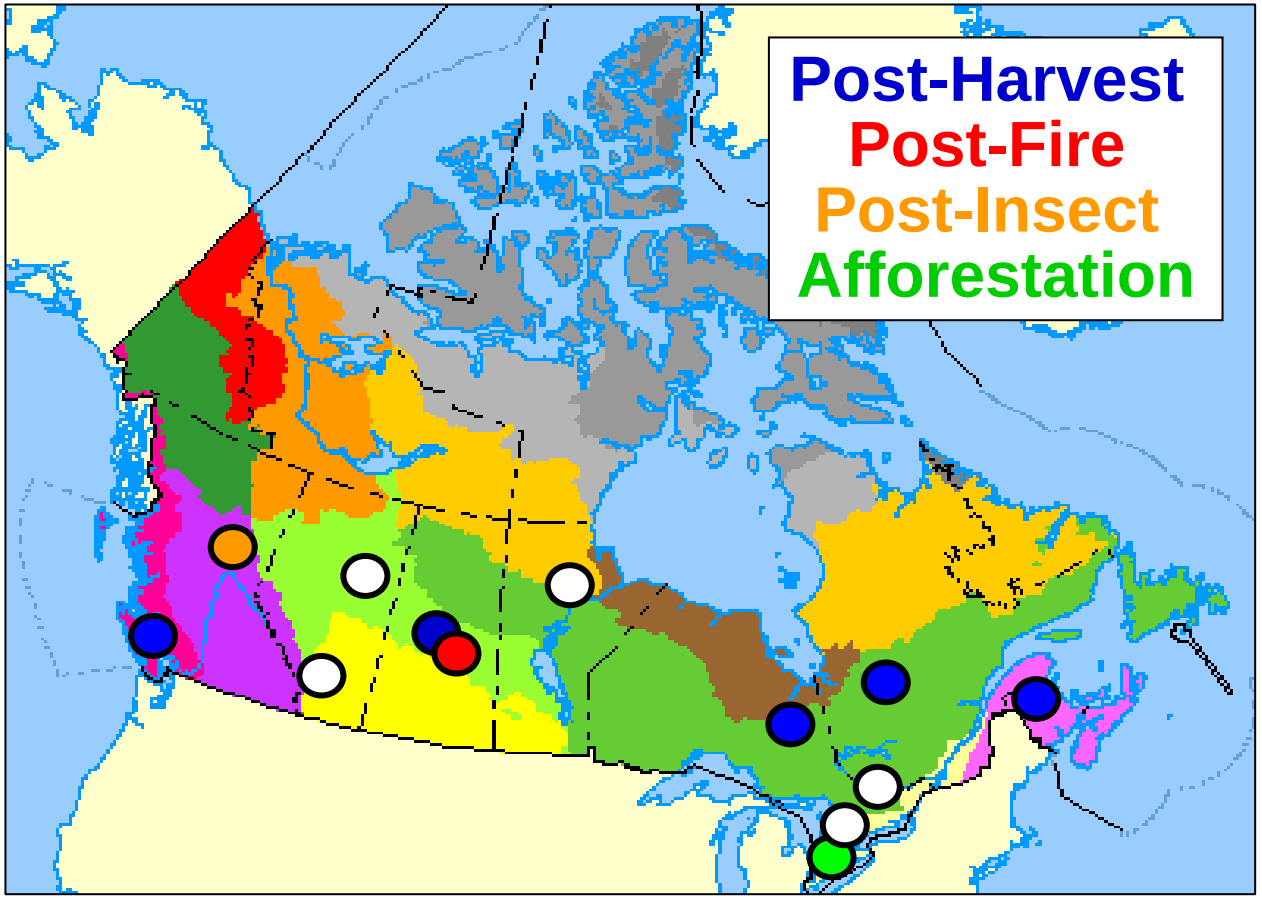
Juvenile Forests Following Disturbance



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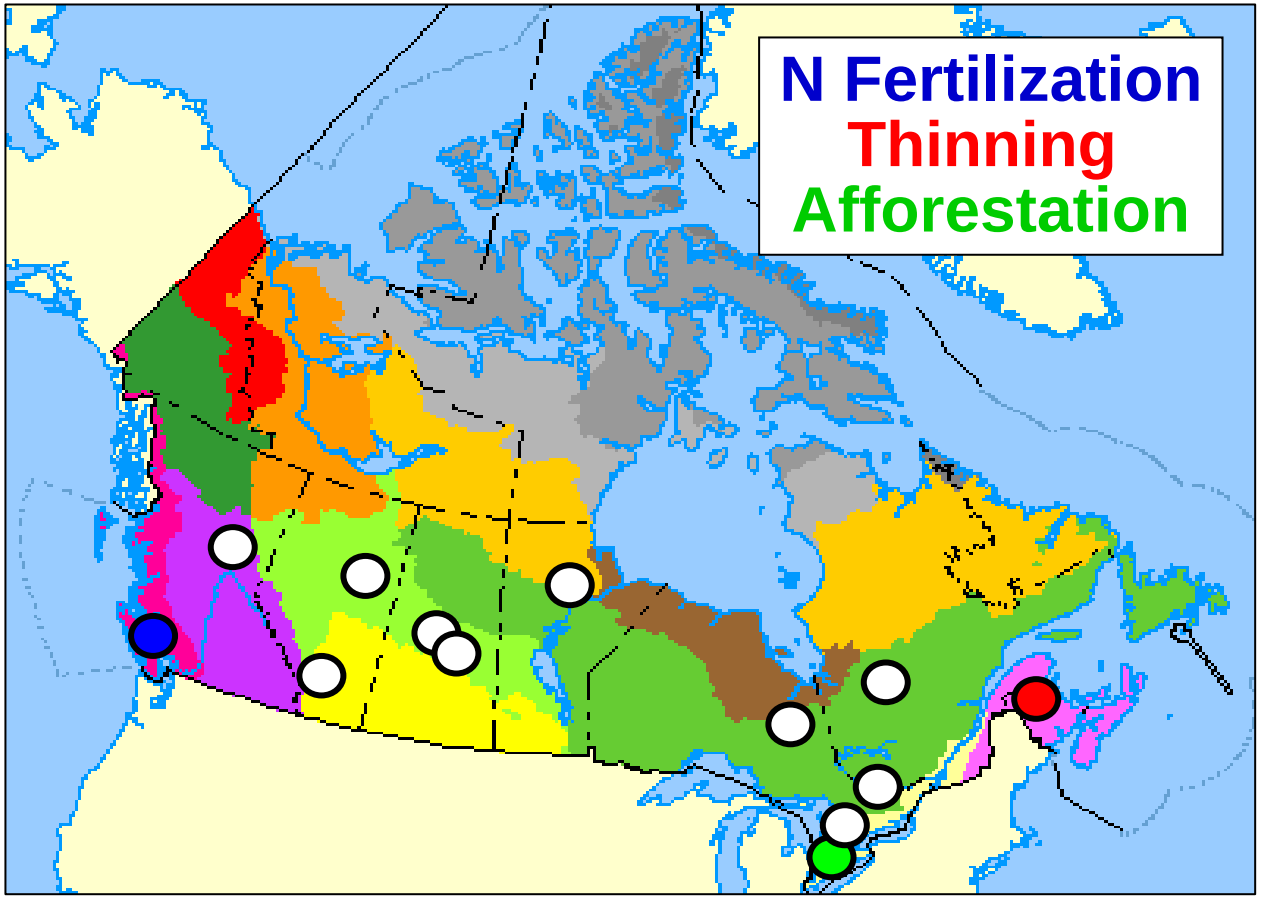
FCRN/CCP Flux Towers

Forest Management



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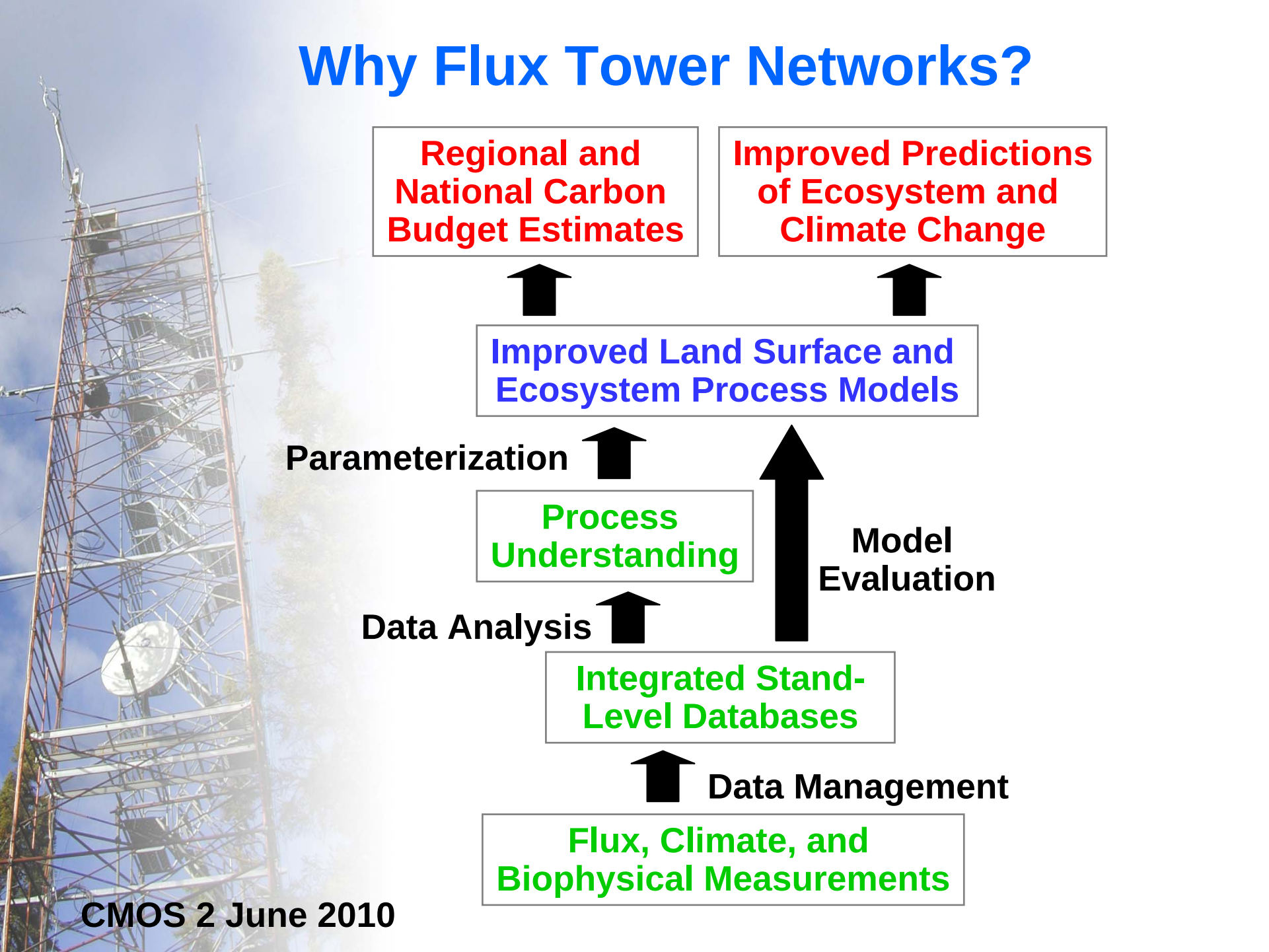
Why Flux Tower Networks?



Canadian Carbon Program (CCP) 2007-2010+

Developing a scientific framework for reducing uncertainty in Canada's C budget

Linked to North American Carbon Program's strategy of top-down, bottom-up dual constraint

Supported by CFCAS, Environment Canada and Natural Resources Canada

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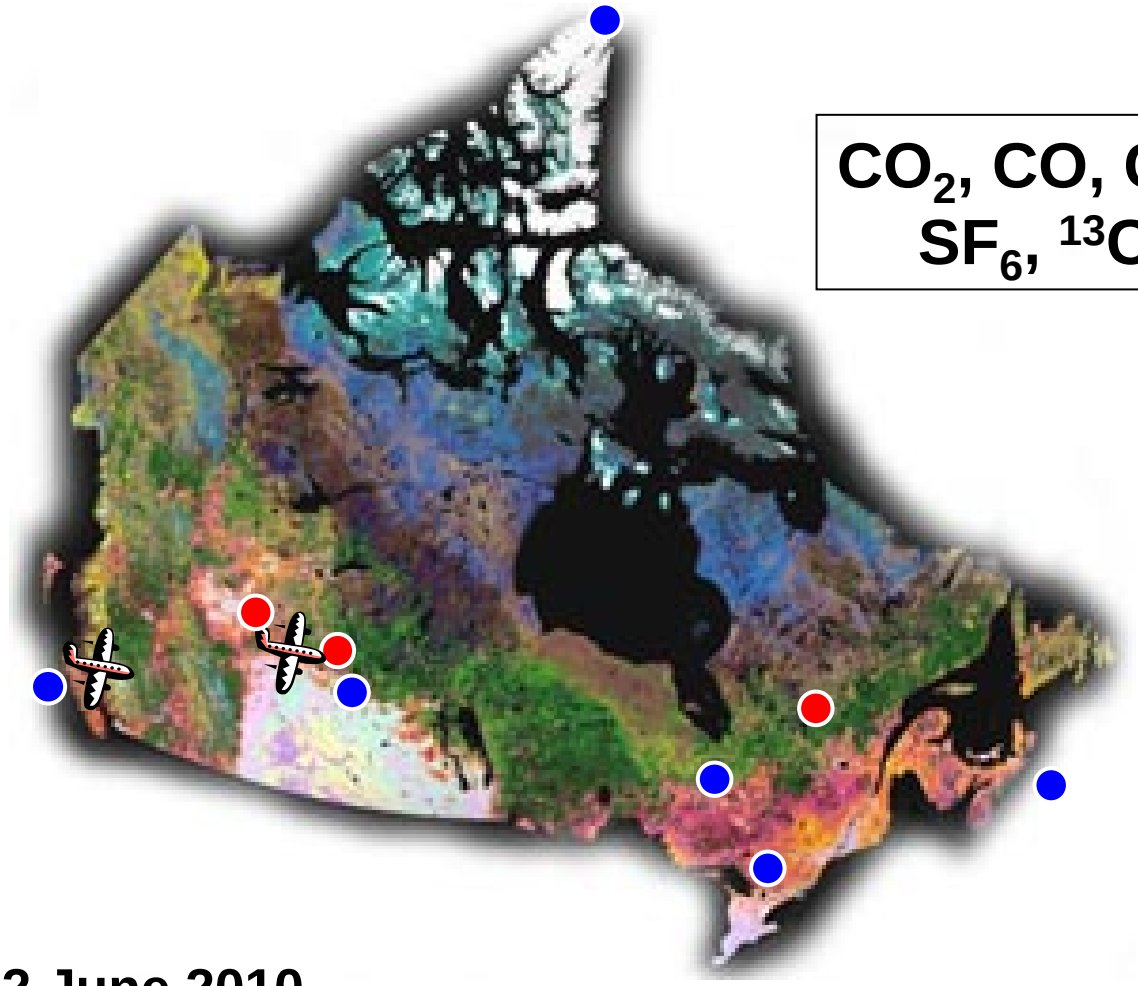
Environment Canada's Greenhouse Gas Air Sampling Network (Doug Worthy)

(FCRN/CCP collaborative sites in red)



CO_2, CO, CH_4, N_2O, SF_6, ^{13}C & ^{18}O

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Bottom-Up Top-Down Dual Constraint

Atmospheric GHG Measurements

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Atmospheric Inversion Models

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Regional and National Carbon Budget Estimates

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Improved Land Surface and Ecosystem Process Models

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Flux, Climate, and Biophysical Measurements

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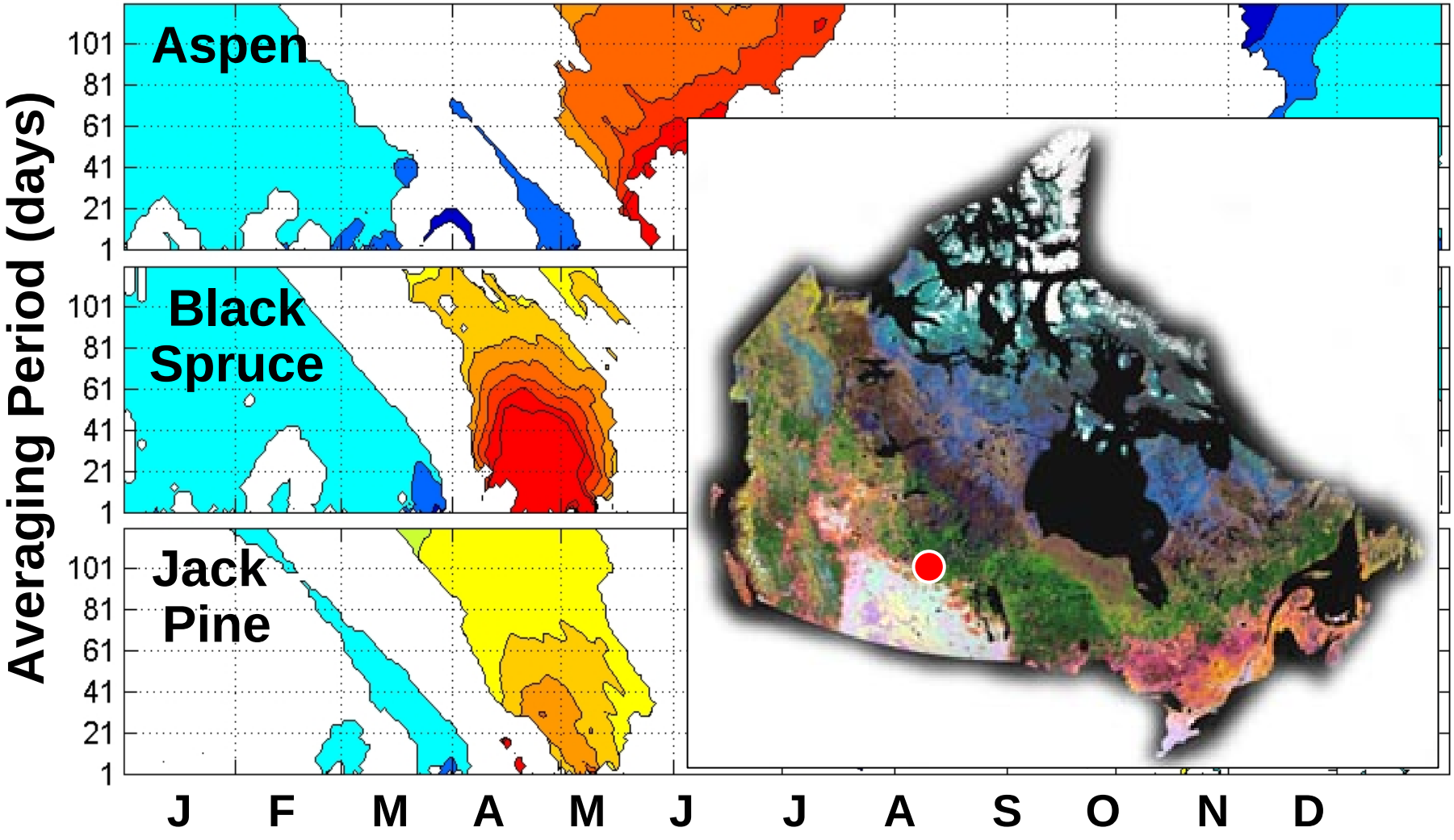
Seasonal Sensitivity of Boreal Forest CO_2 Uptake to Interannual Variations in Soil Temperature

(contours show periods when linear regression is significant at 5% level)



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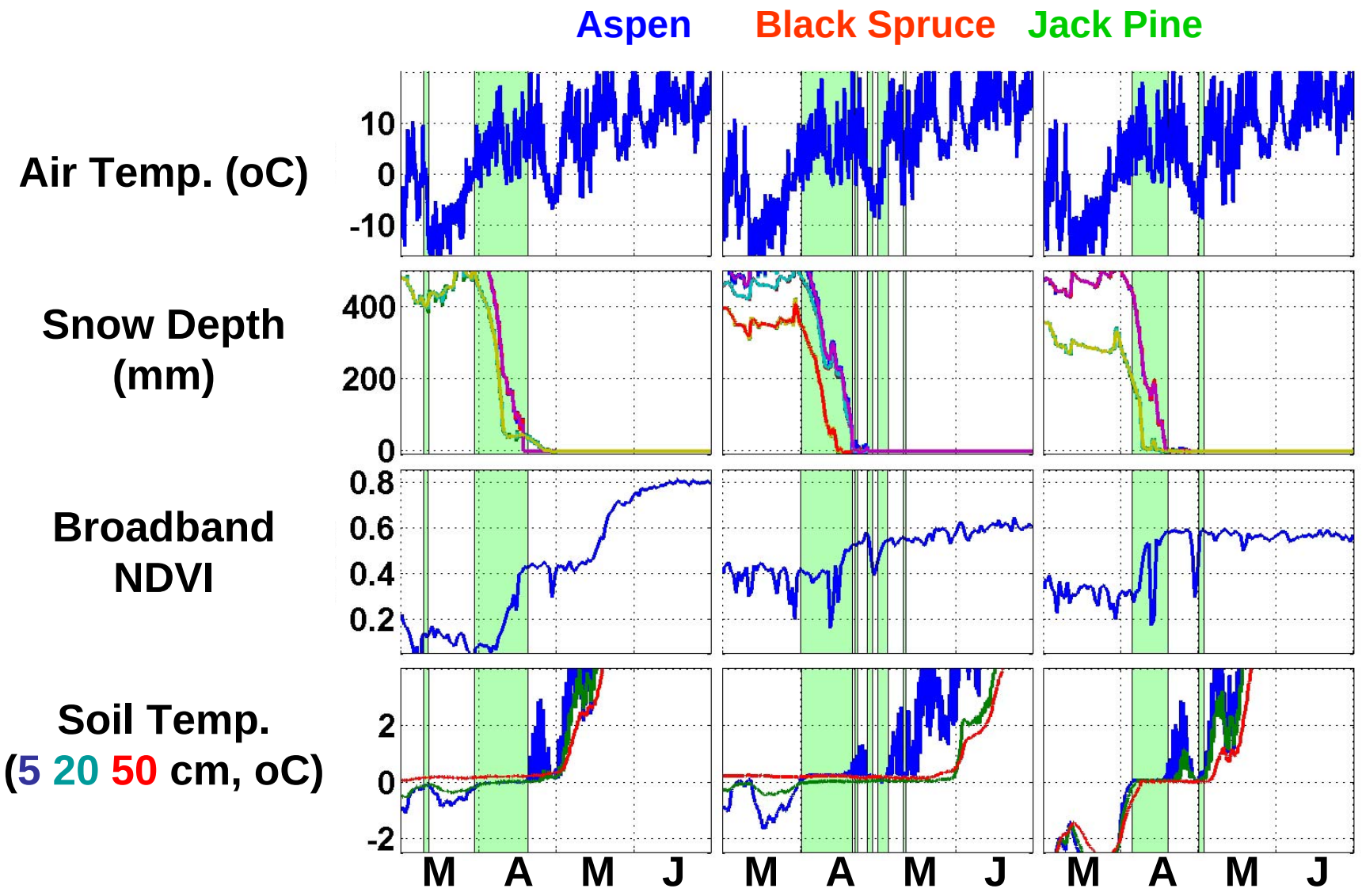
(courtesy: Andy Black, Harry McCaughey & Alan Barr)

Snowmelt and Spring Thaw (2005)

(thaw period is shaded green)



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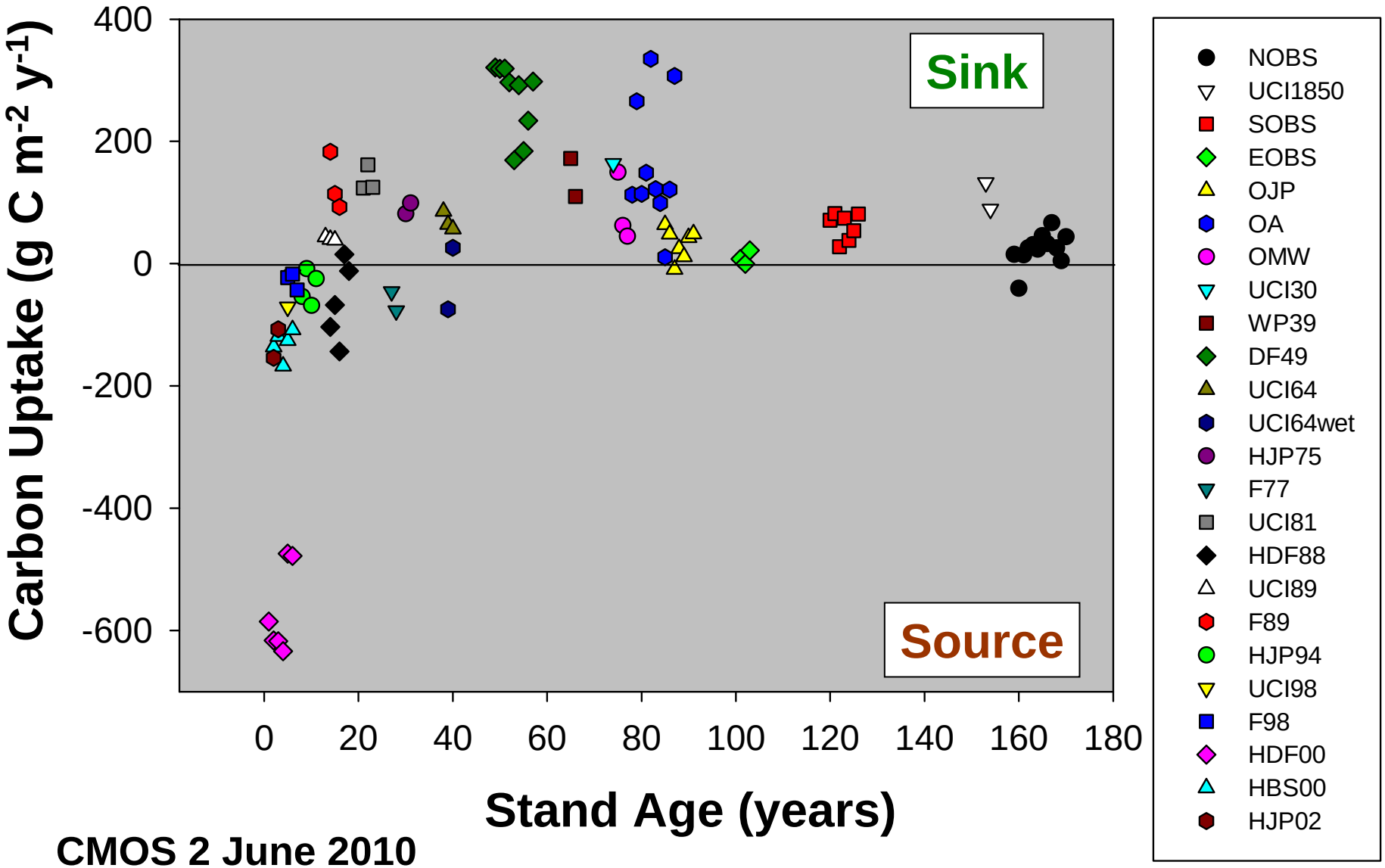
CCP Synthesis: Forest Age and Carbon Uptake

(courtesy: Carole Coursolle & Hank Margolis)



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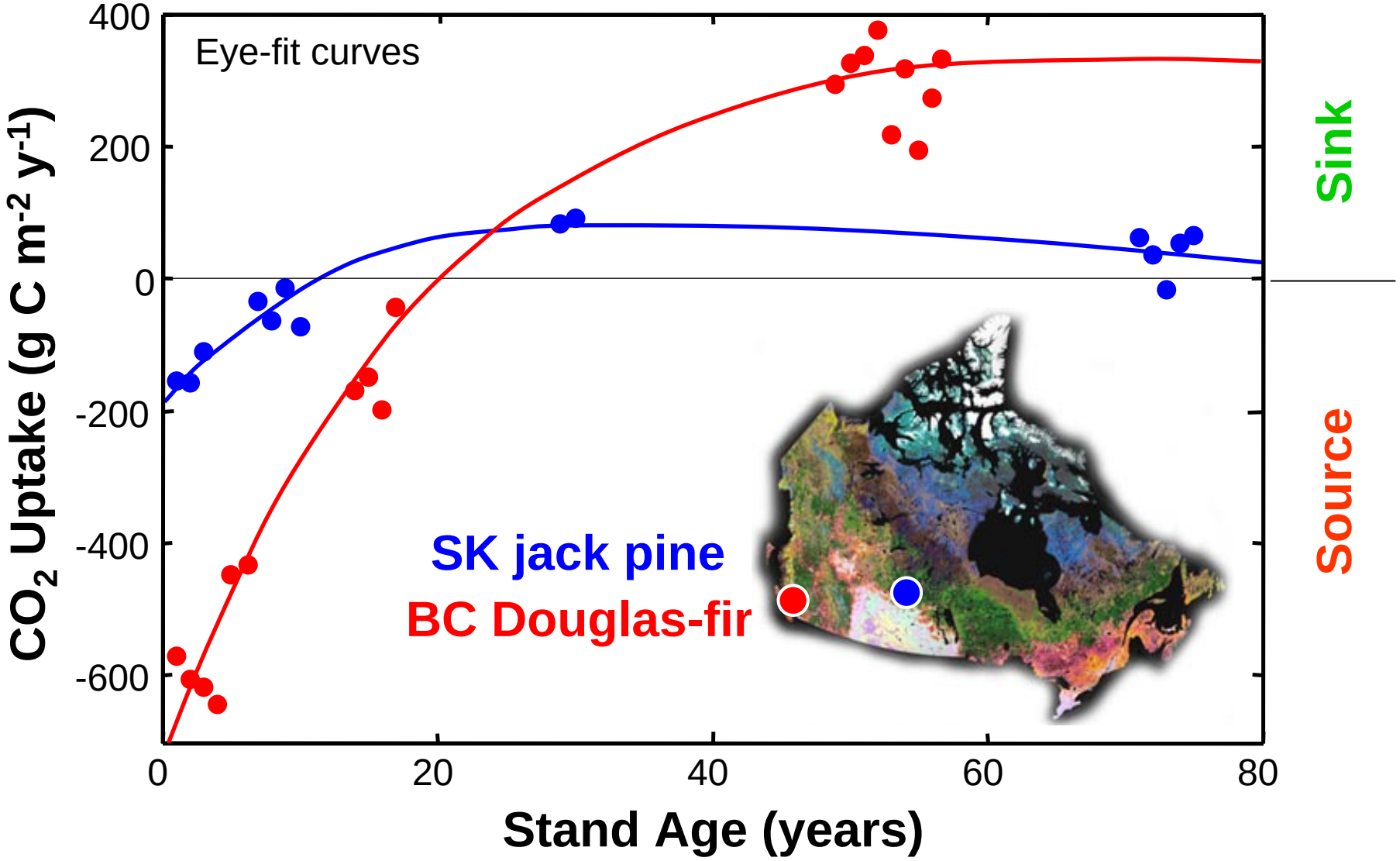
Trajectory of CO_2 Uptake Following Harvest

(courtesy: Andy Black, Harry McCaughey & Alan Barr)



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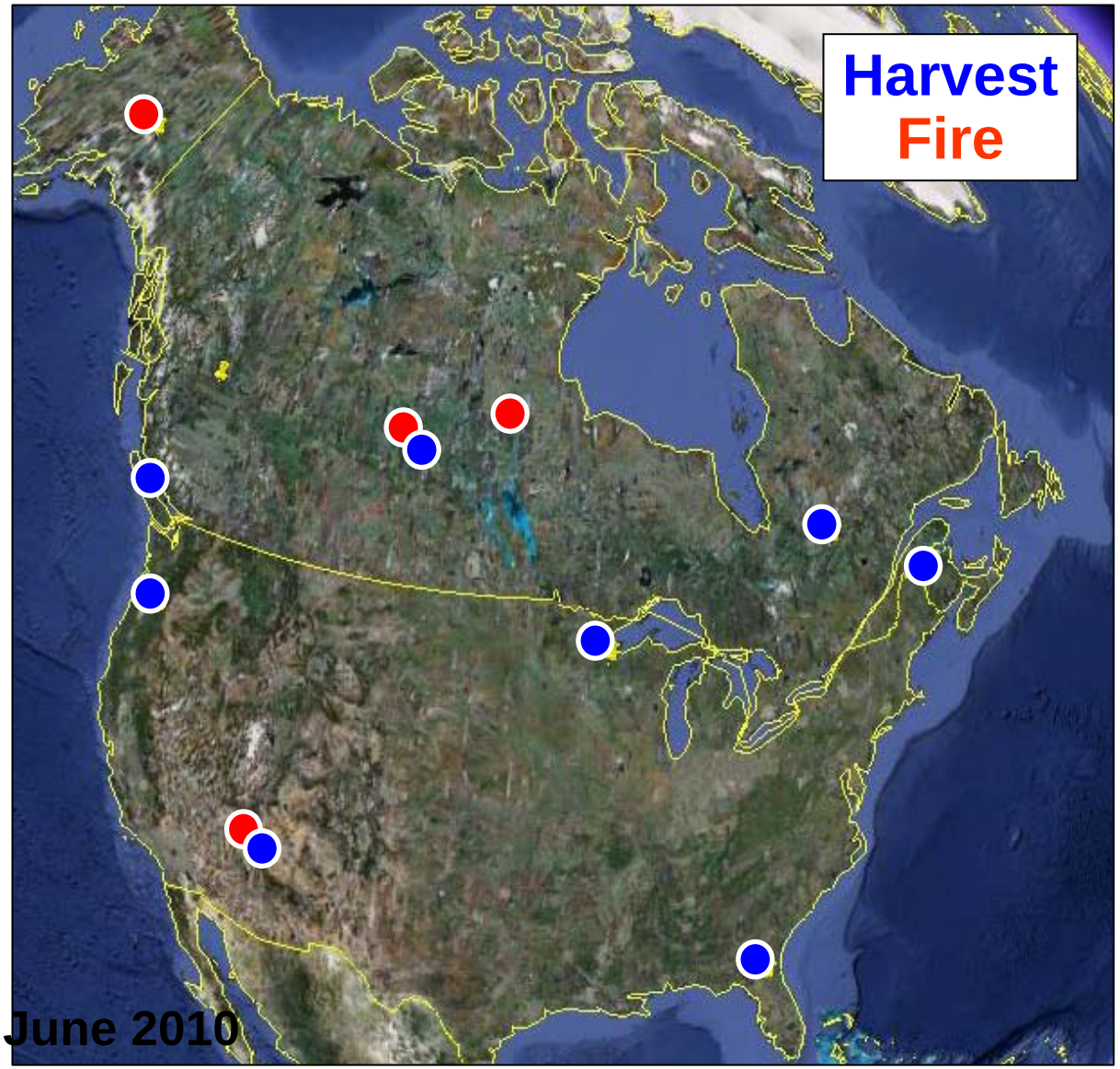
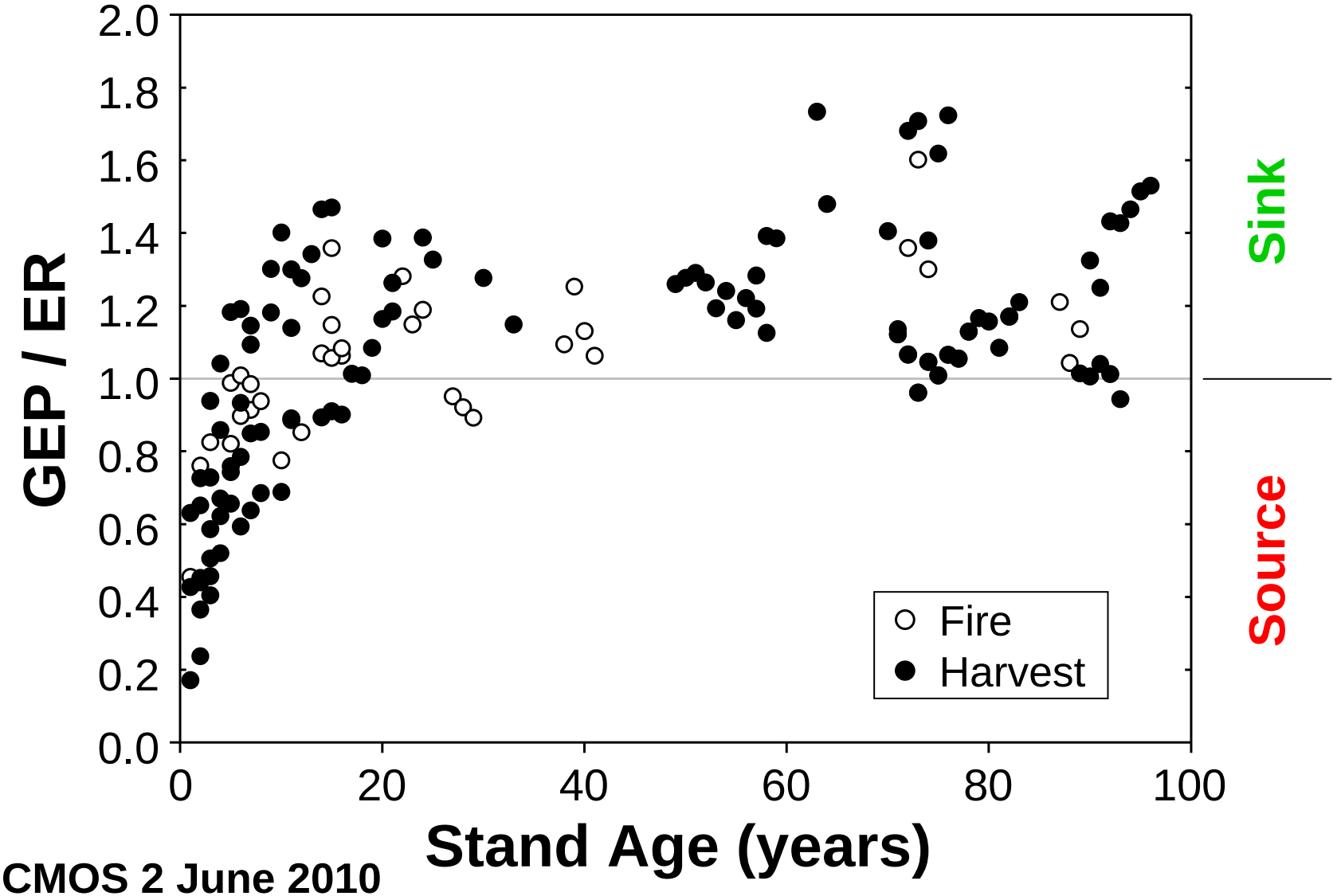
Forest Flux Towers: A Synthesis of Fire and Harvest Sites (courtesy: Brian Amiro)



Effect of Forest Stand Age on the Ratio of Gross Ecosystem Photosynthesis GEP to Respiration ER

(NACP synthesis, Brian Amiro)



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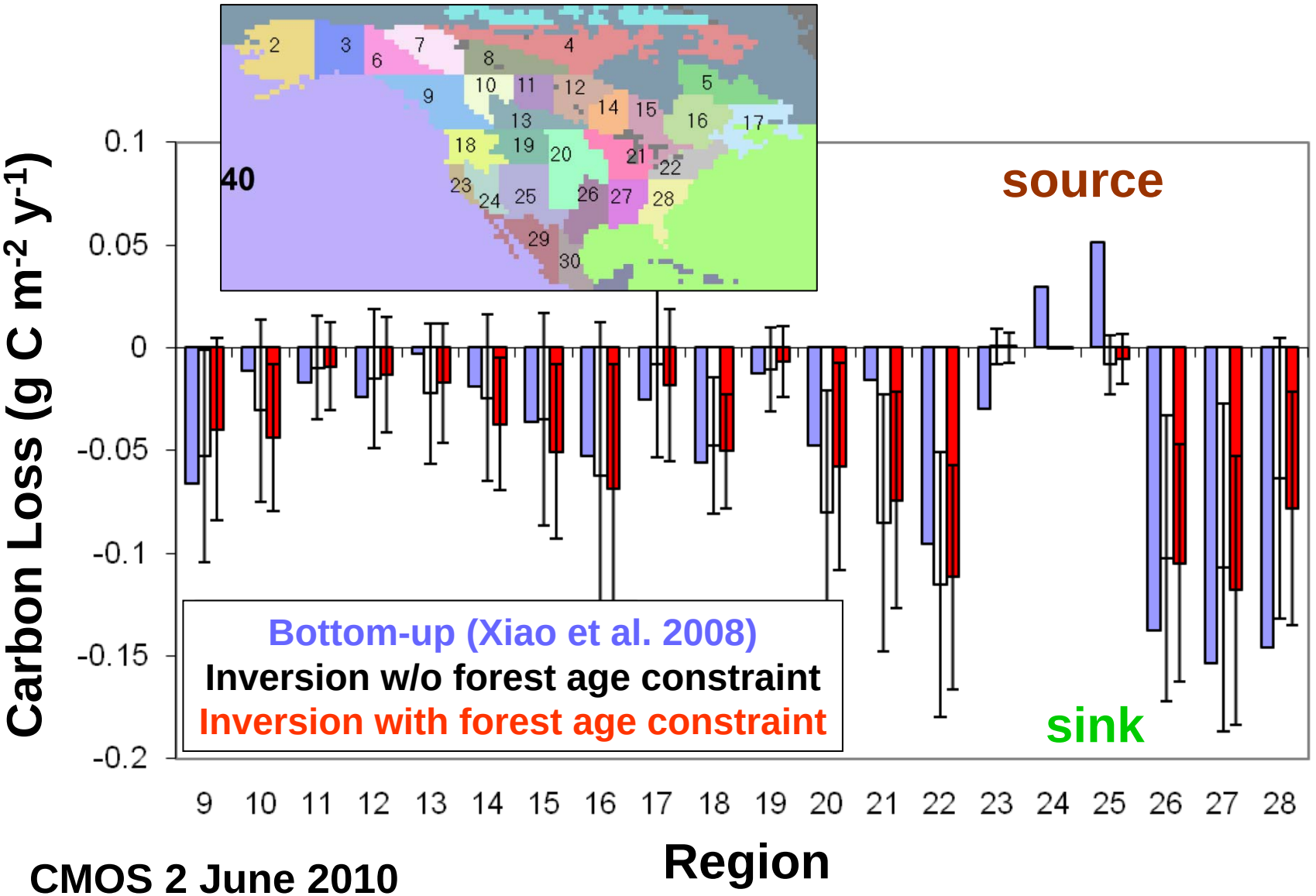
Regional Bottom-Up Top-Down Comparison

(courtesy: Jing Chen)



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CCP's Initial Estimate of the Mean Annual Canadian and USA Land Sink 1994-2003

(courtesy: Jing Chen)

Region	C Sink ($Pg\ C\ y^{-1}$)	% of Sink
Canada	0.14 ± 0.15	20%
USA	0.58 ± 0.15	80%

FCRN/CCP Accomplishments

- Established a national standardized ecosystem flux network for Canada
- Advanced understanding and quantified the effects of inter-annual climate variability on the fluxes of carbon, water and energy of Canadian forests and peatlands
- Advanced understanding and quantified the effects of disturbance (harvest, fire, insects)

FCRN/CCP Accomplishments

- **Rigorously evaluated Canadian ecosystem process models**
- **Developed a capability for integrating bottom-up and top-down C cycle models to provide regional and continental scale estimates of C fluxes**

FCRN/CCP Accomplishments

- **Worked with those responsible for Canada's forest carbon accounting to integrate the effects of inter-annual climate variability into the accounting system**
- **Trained more than 120 graduate students and postdocs**
- **Contributed a large amount of data to the global flux database and participated in global scale analyses**

Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)

Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)

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CANADIAN CARBON PROGRAM / PROGRAMME CANADIEN DU CARBONE

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