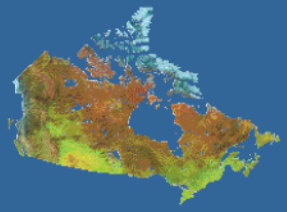
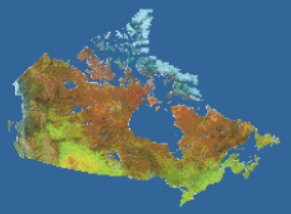


Climate Change, Carbon and Forest Management

Stephen Kull and Werner Kurz
Natural Resources Canada
Canadian Forest Service

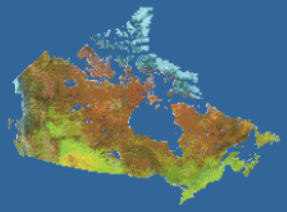
Alberta Forest Growth Organization, Forest Offsets Workshop #1
Edmonton, Alberta, January 20, 2010

Outline



- Overview of Climate Change
- Forest Carbon Cycle
- The Role of Forest Management
- Questions

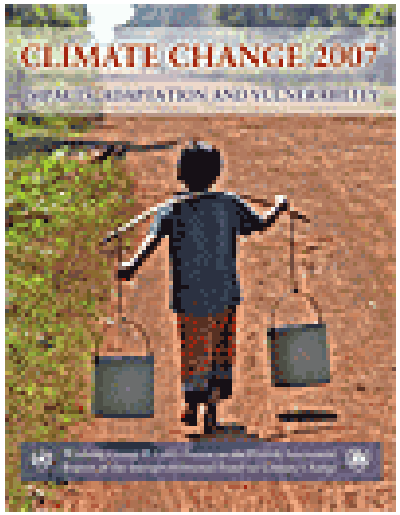
Intergovernmental Panel on Climate Change

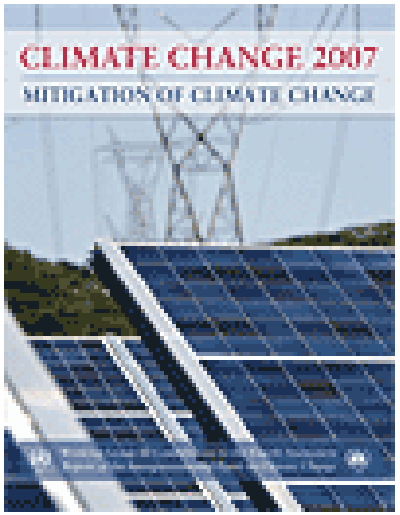


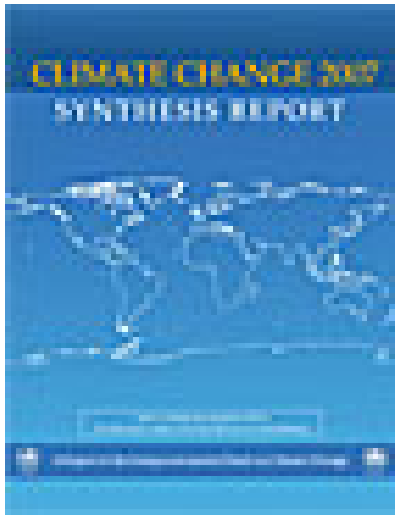
Fourth Assessment Report (2007)

Available at:

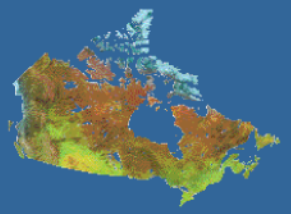
http://www.ipcc.ch/ipccreports/ar4-syr.htm







Arrhenius 1896



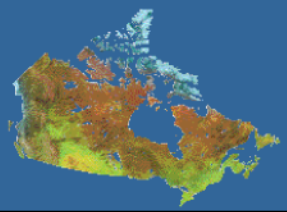
"On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground"

- Increased CO_2 in the air will increase ground temperatures.
- Stronger influence near the poles than near the equator.
- Stronger impact in the northern hemisphere.
- Diminished difference in temperature between day and night.

Svante Arrhenius (1859-1927), Stockholm University

Philosophical Magazine **41,** 237 (1896)

The Greenhouse Effect



Short-wave Radiation

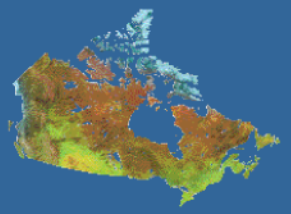
Light

Long-wave Radiation

Heat

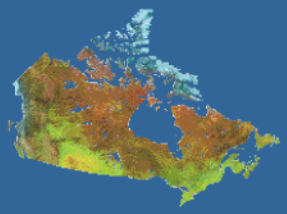
CO_2 increases insulation

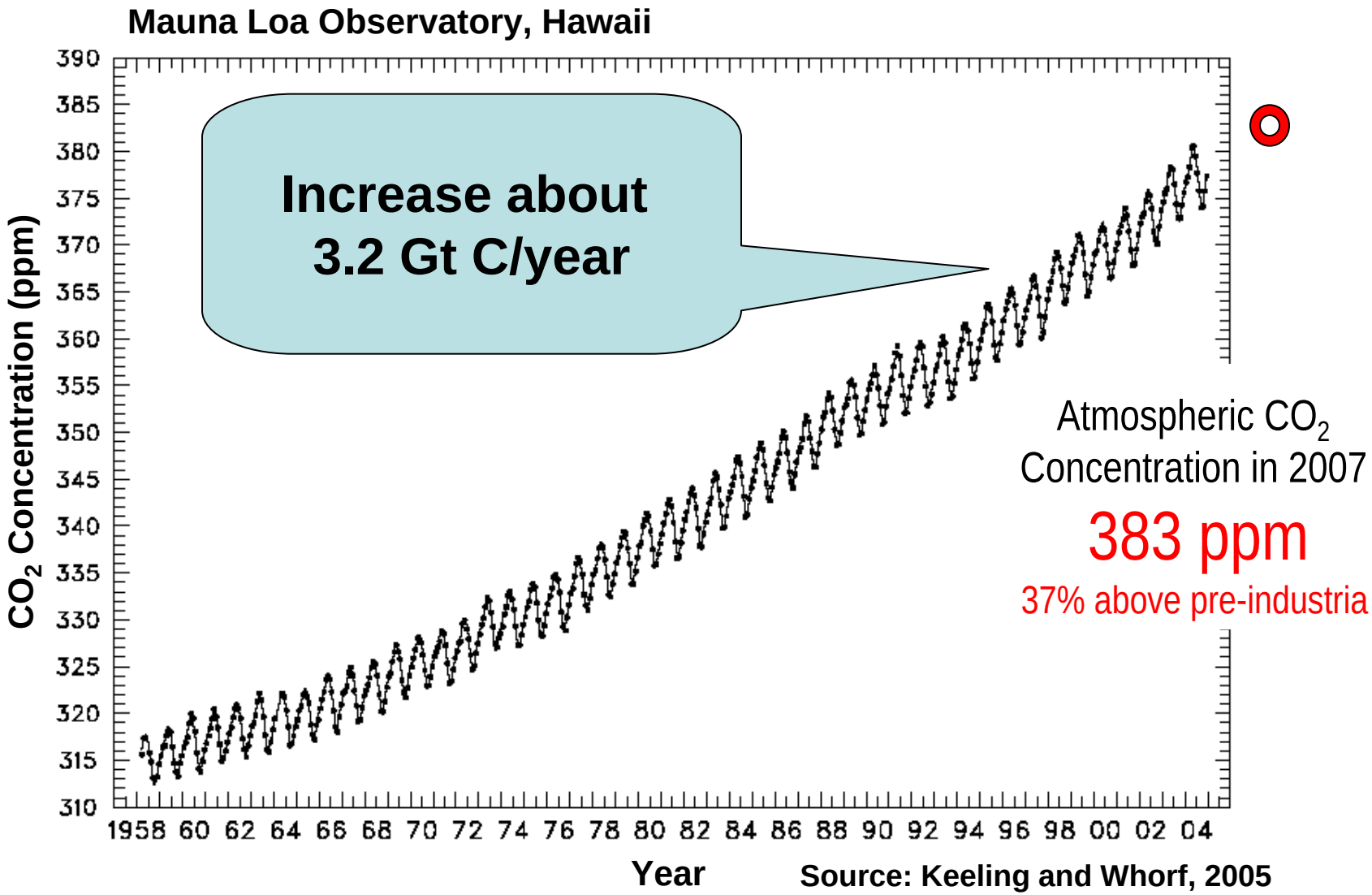
Important Greenhouse Gases



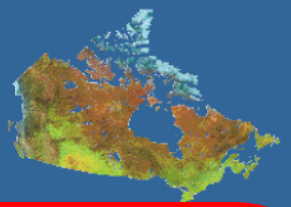
- Carbon dioxide (CO2)
- Methane (CH4)
- Nitrous oxide (N2O)
- Others (such as CFCs)

Monthly Average CO_2 Concentrations

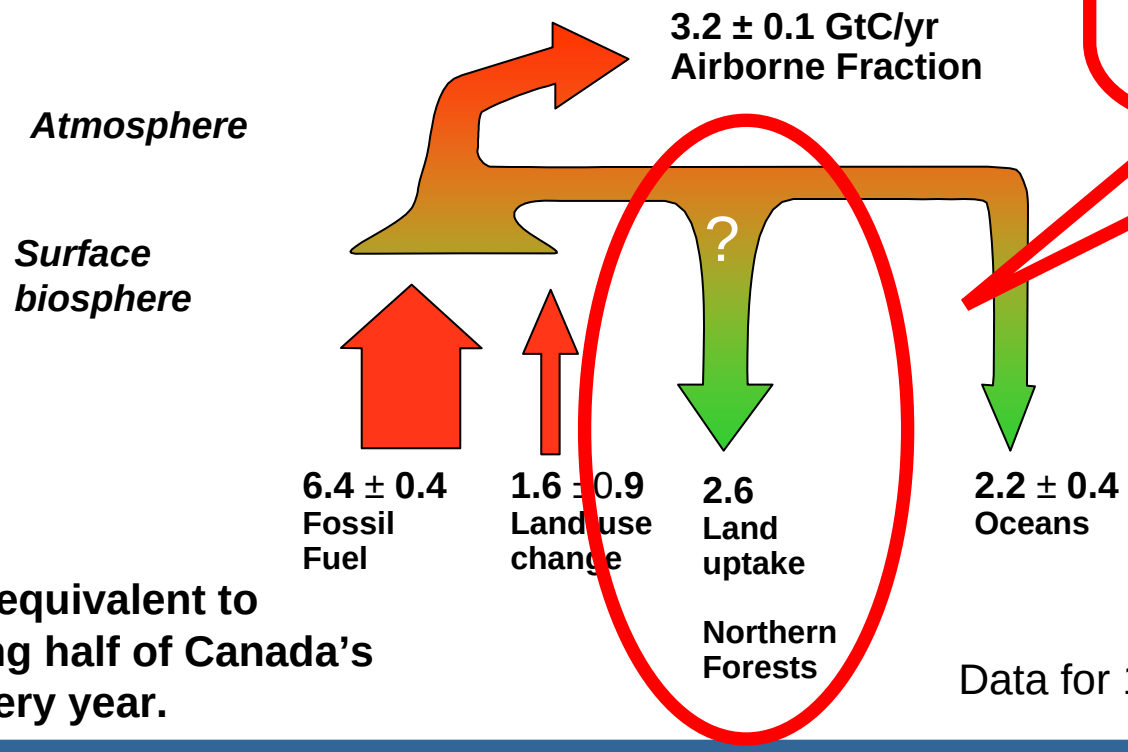




Human Perturbations to the Global C Cycle



Only half of *human* emissions stay in the atmosphere:
8.0 up but only 3.2 remains

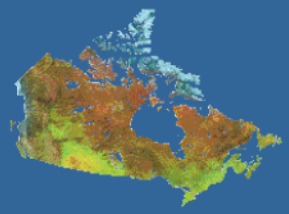


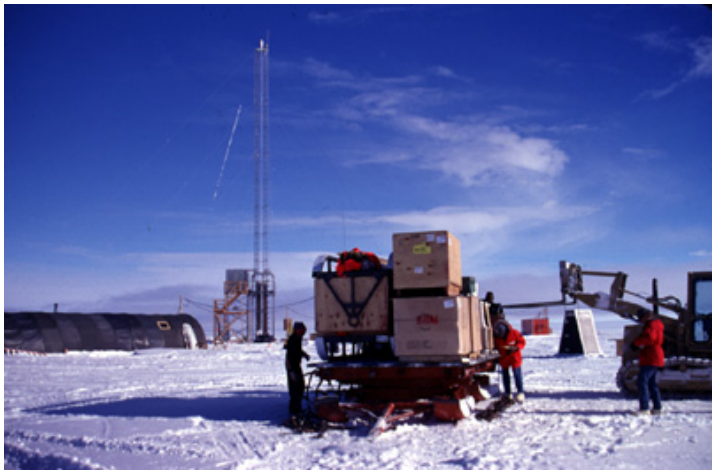
The C balance of northern forests will affect the future CO_2 concentration.

6 GtC/yr - equivalent to incinerating half of Canada's forests every year.

Data for 1990s from IPCC 2007

Ice Cores to Reconstruct Past CO_2 Levels

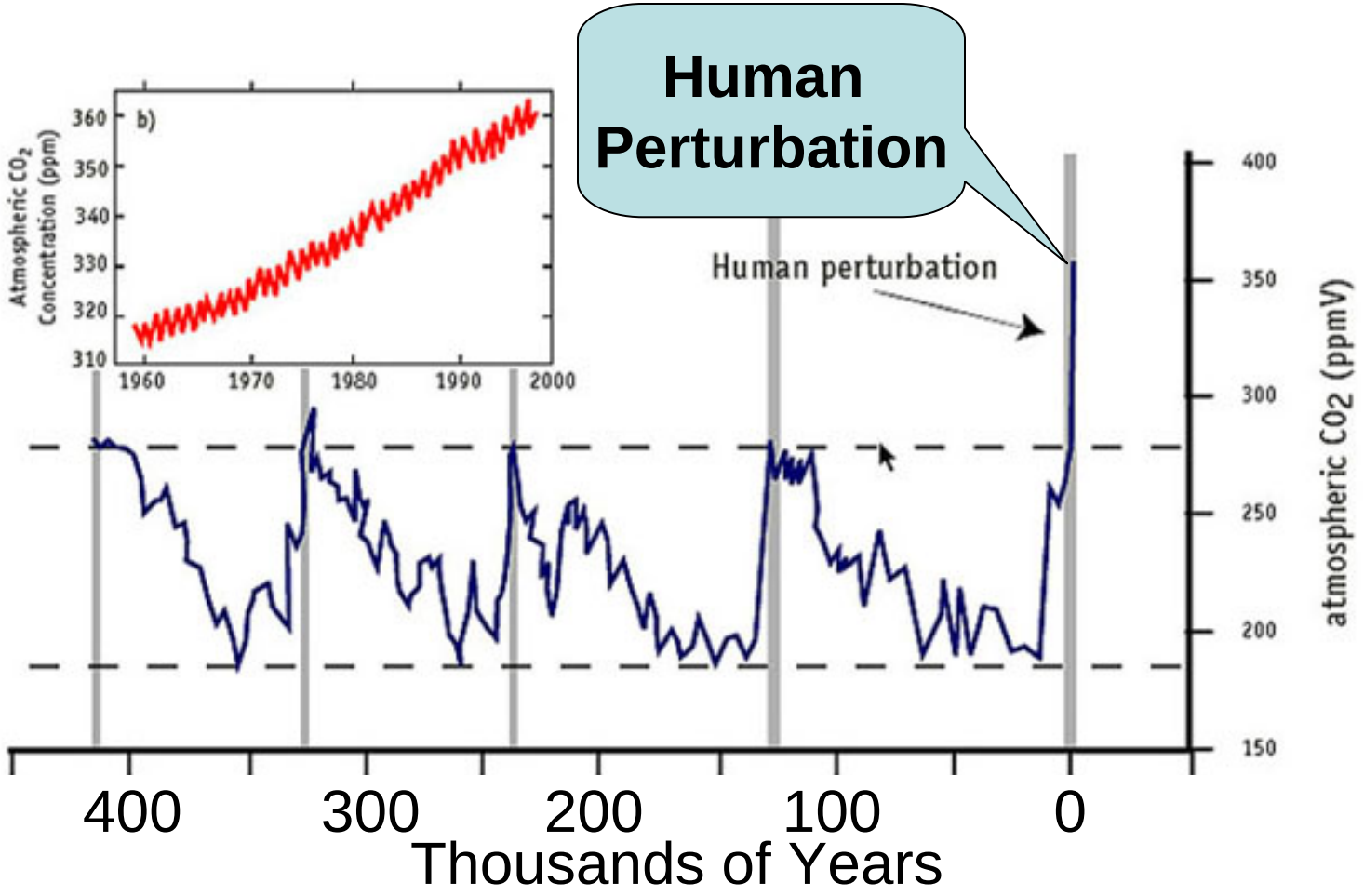




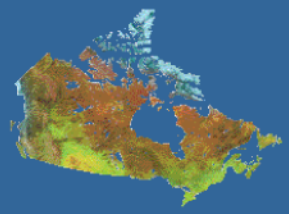
Ice cores from many continents have been used to reconstruct CO_2 levels in the atmosphere.

Historic Levels of CO_2

- Current CO_2 levels are the highest in the last 420 thousand years, possibly the last 20 million years.

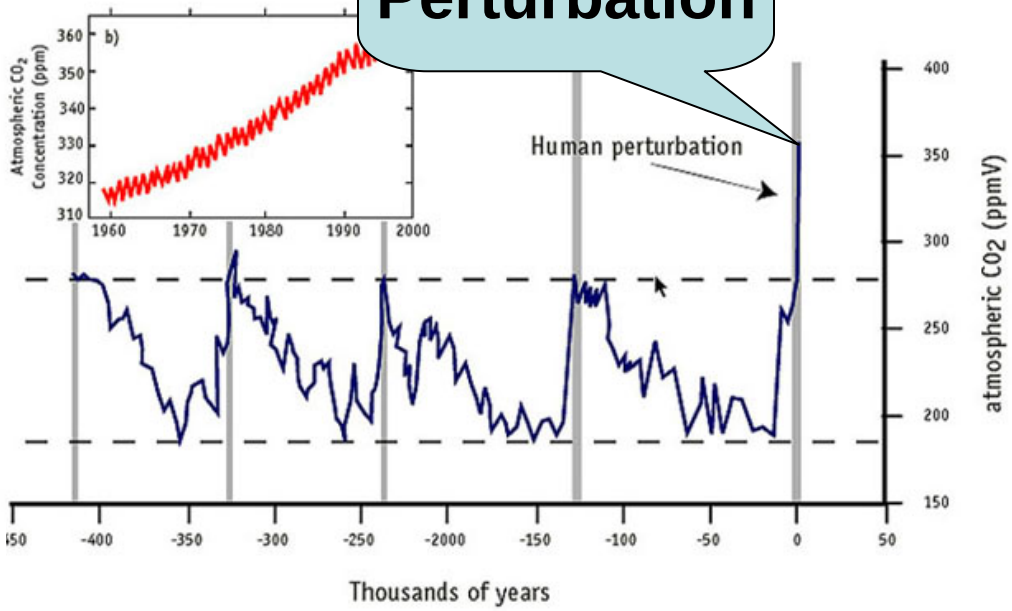


Projected Levels of CO_2 by the Year 2100

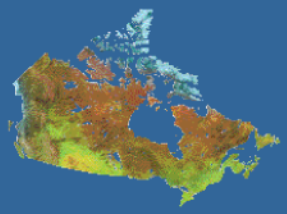


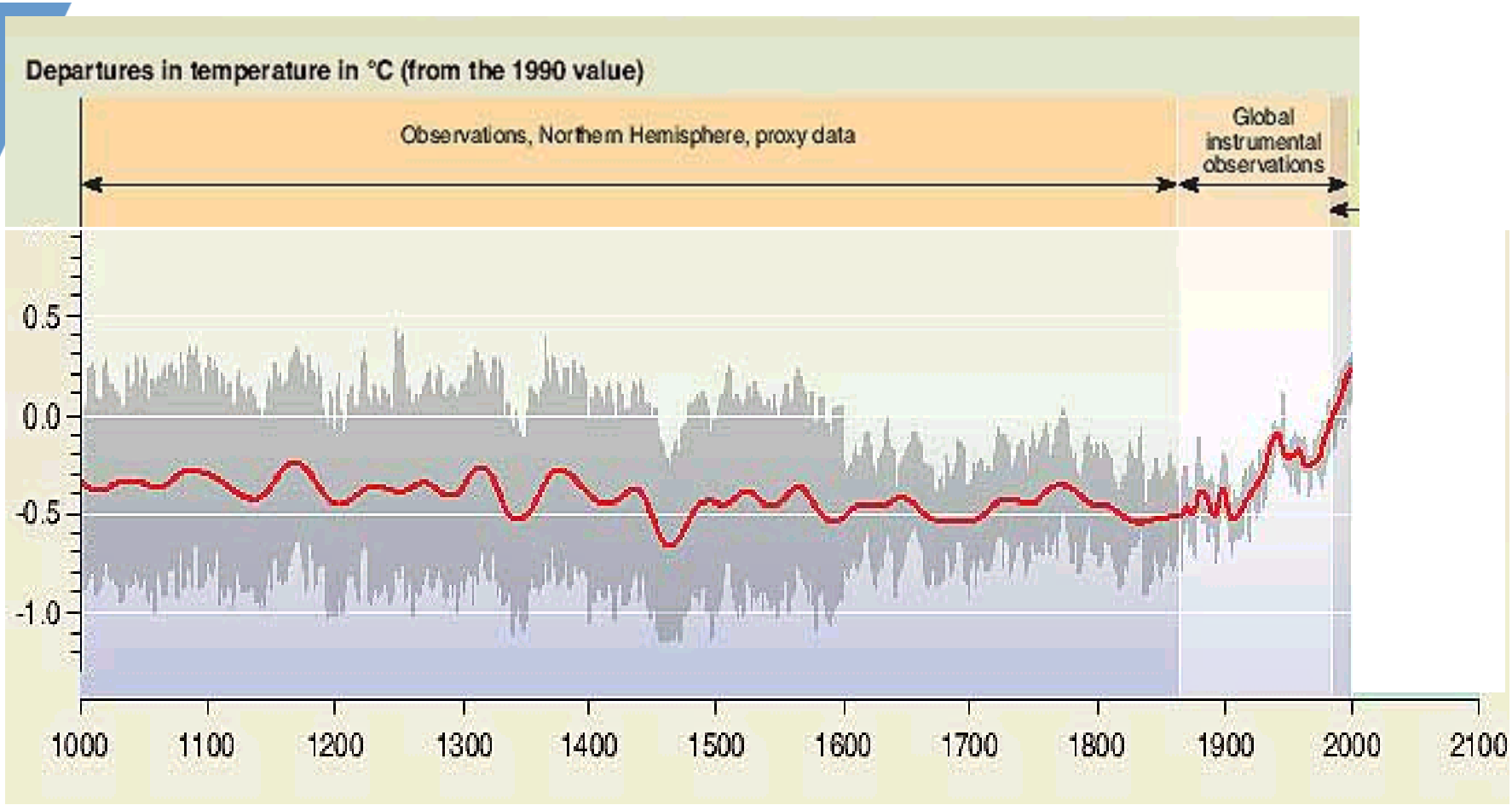
Projected Levels 550 - 950 ppm

Human Perturbation



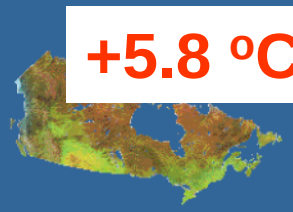
Temperature Variations over the Past 1000 Years



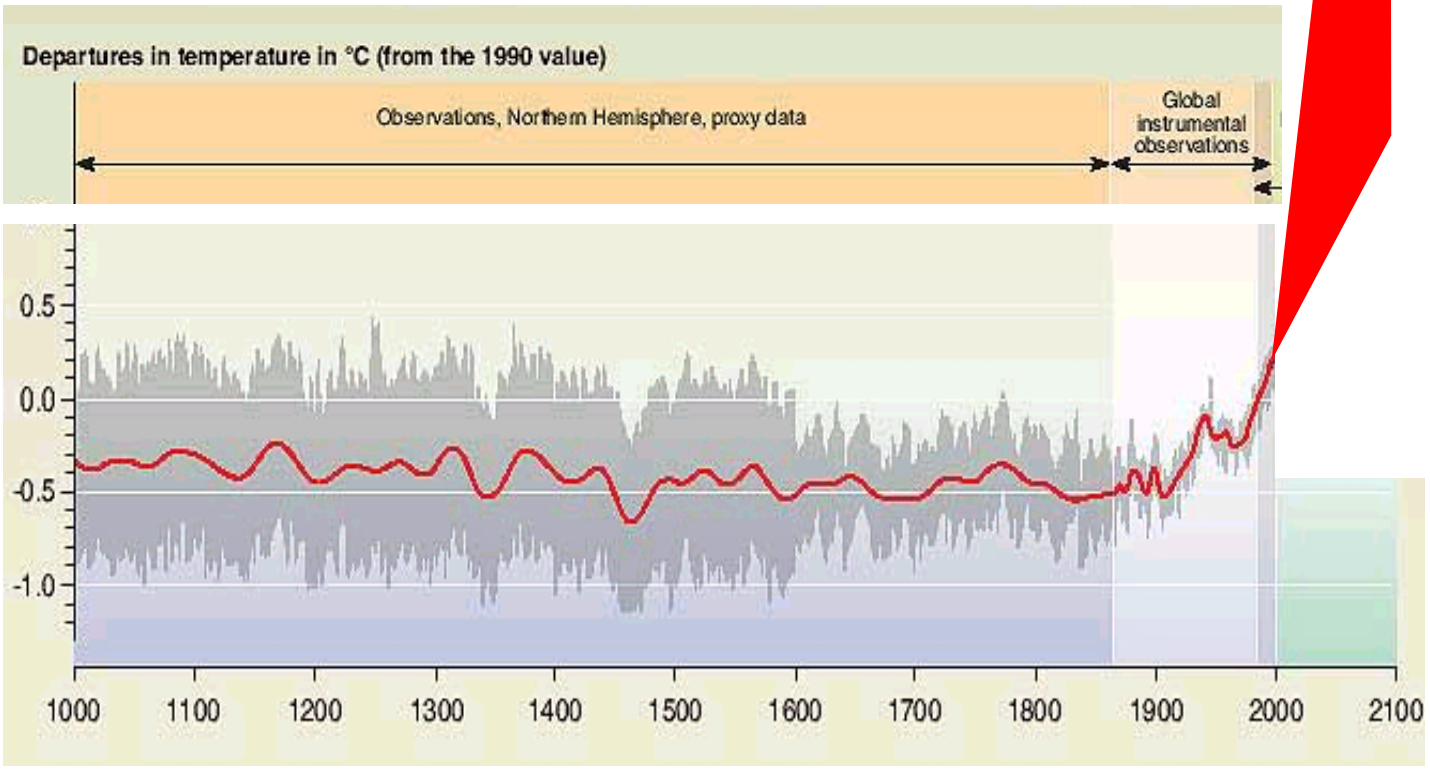


IPCC 2001

Temperature Projections for the Next 100 Years



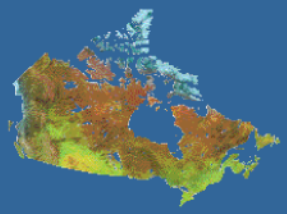
Higher than average increases in continental regions and in the north.



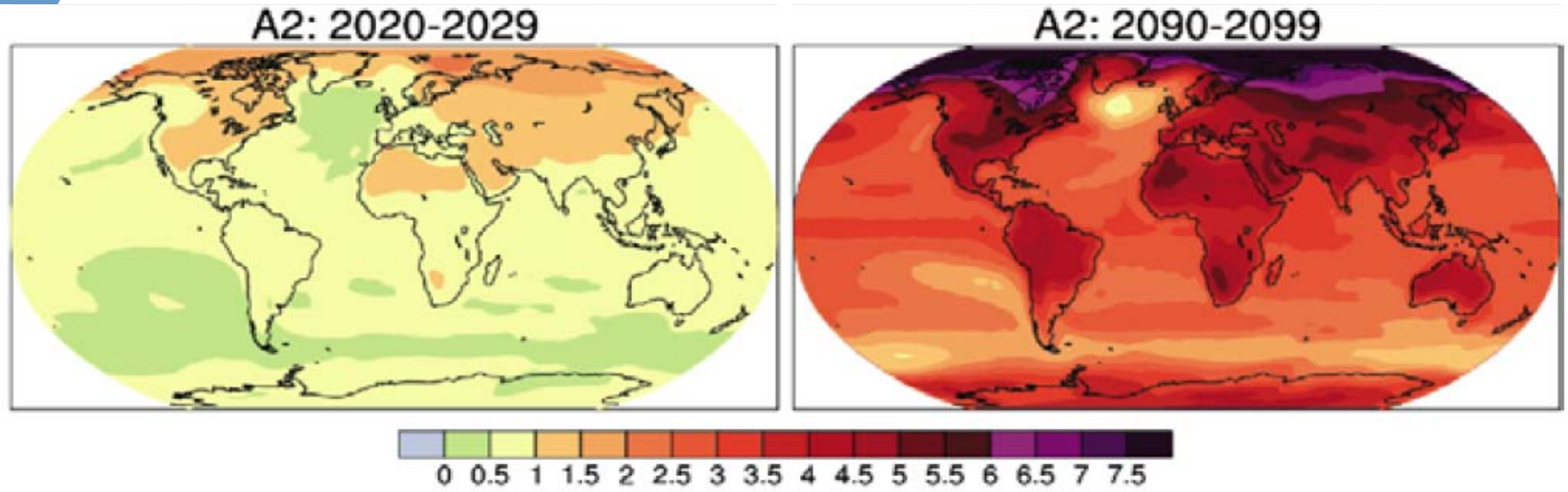
+ 1.5 ºC

IPCC 2001

IPCC Projected Temperatures (Examples)

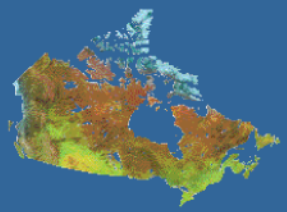


Greater warming over northern land areas.



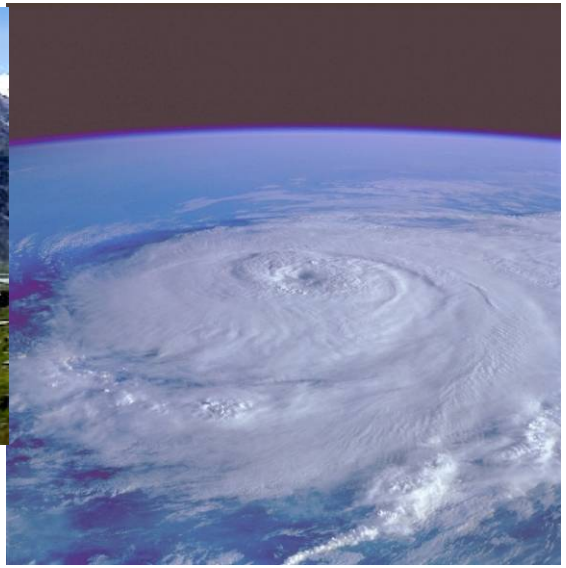
IPCC AR4 WG1 2007

Climate Changes

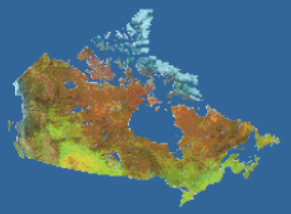


1900

2001



Climate Changes



Positive Feedback:

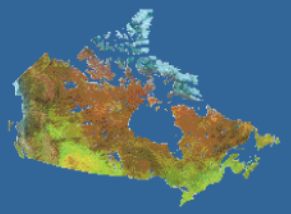
- **Less sunlight reflected (albedo)**
- **Greater warming of surface water**

1979 – 2000
median minimum

2005 minimum

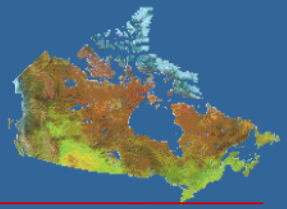
Source: NASA 2007

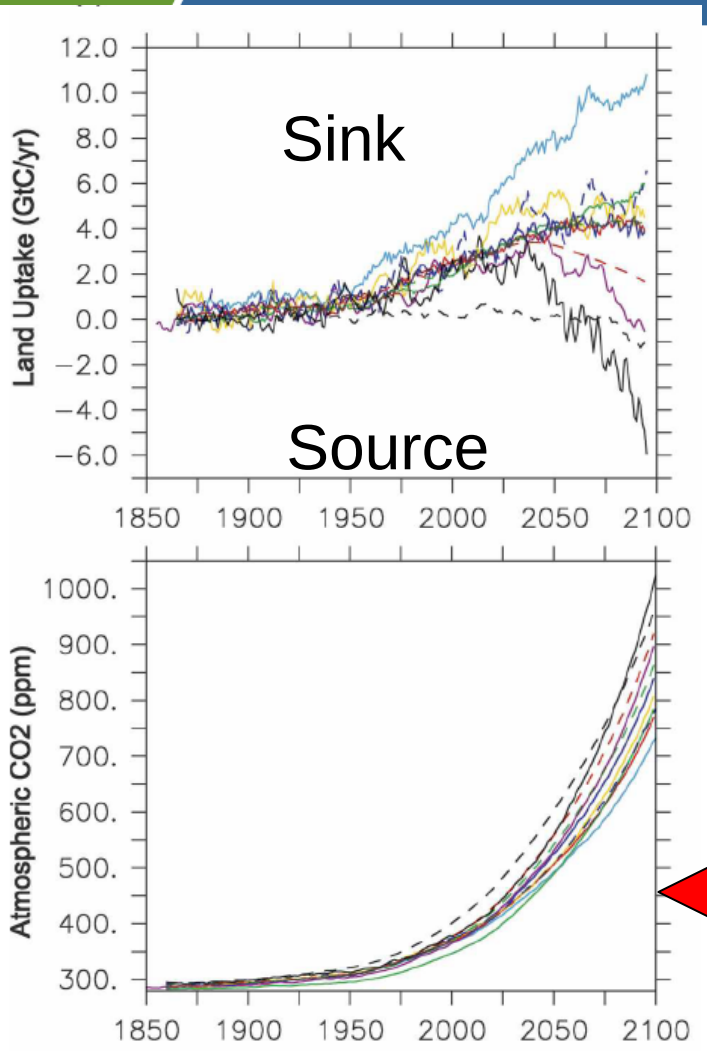
Climate Change Summary



- The impacts of climate change will be wide-spread with large regional variation.
- The ability to adapt to and mitigate the impacts also differs regionally.
- Although there will be costs associated with actions aimed at reducing climate change, the costs of inaction are also very significant.
- Reducing emissions lowers the risk to future generations from the actions of this generation.

Climate Change impacts on forest C will affect required level of mitigation efforts





Uncertainty among 11 global models on future C balance of terrestrial ecosystems in 2100: ~16 Gt C yr^{-1}

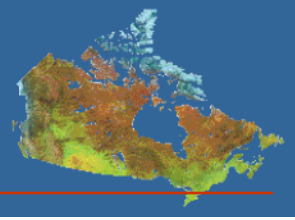
Contributes to uncertainties about future CO_2 concentration….

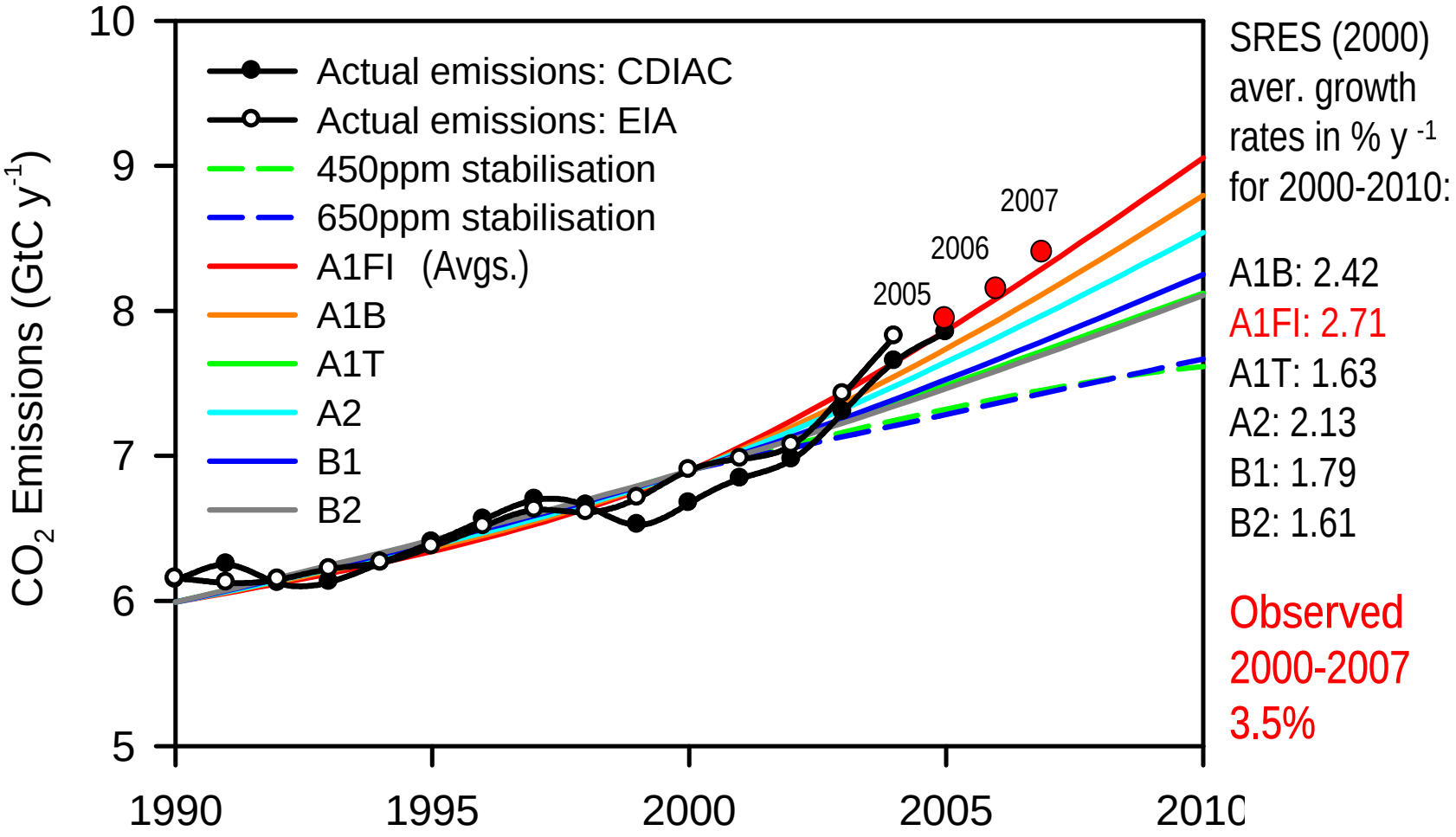
Stabilization Target ~ 450 ppm

… and uncertainties about required level of mitigation efforts.

Source: Friedlingstein et al., 2006

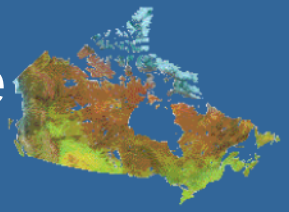
2000-2006 CO2 emissions growth rate exceeds all IPCC scenarios



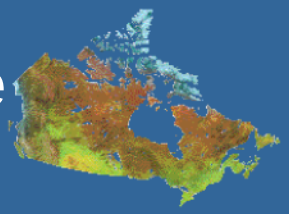


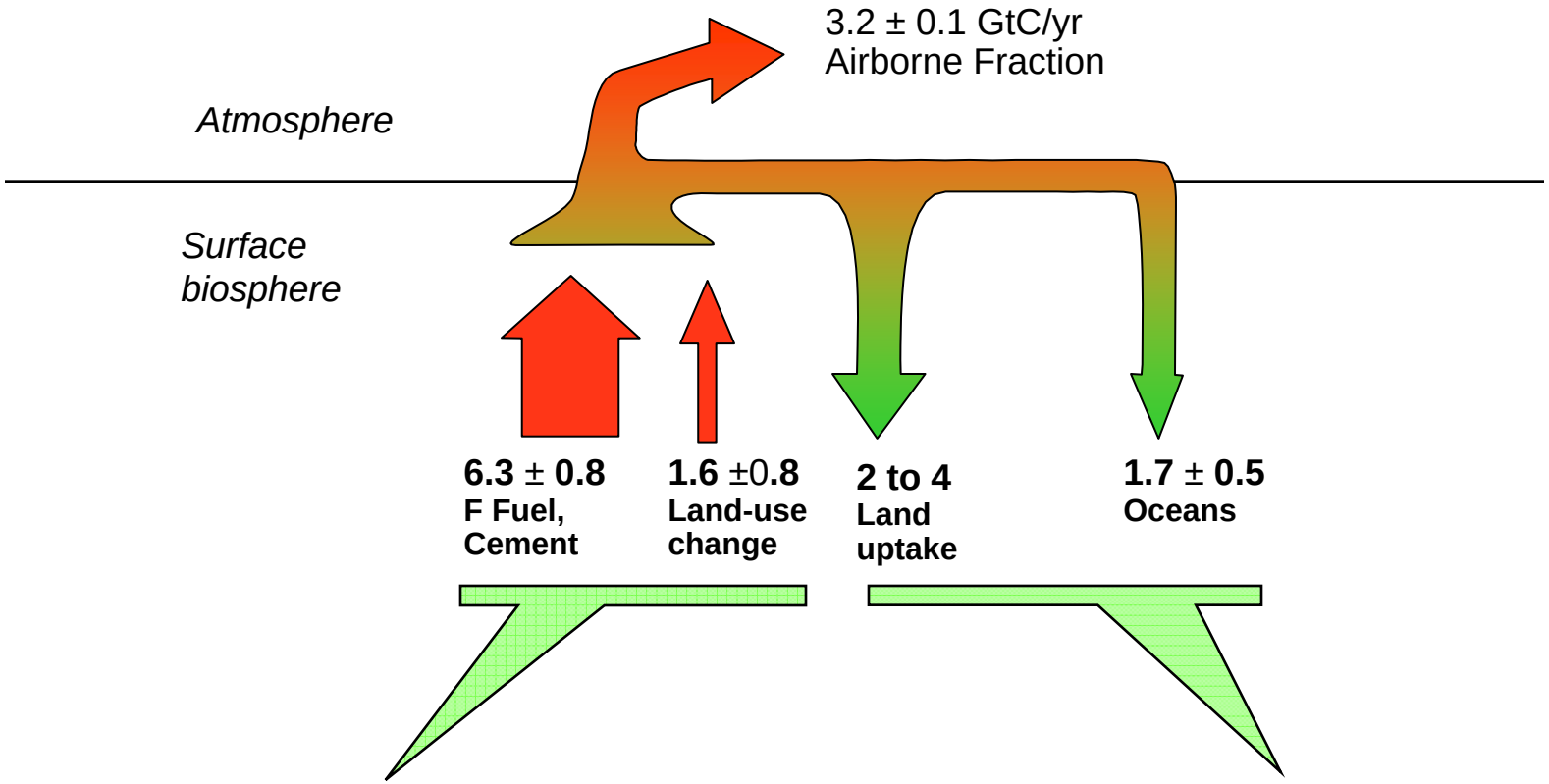
Raupach et al 2007, PNAS (updated), Global Carbon Project, 2008

Mitigation Opportunities: How can we influence the atmospheric GHG balance?



Mitigation Opportunities: How can we influence the atmospheric GHG balance?





Forest Carbon 101

1 ton of carbon

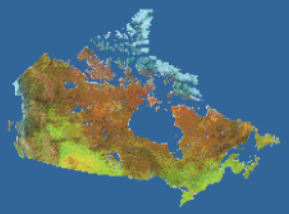
~ 4 m^3 of wood

if burned releases

~ 3.7 tons of CO_2


~ 1 million cubic meters of wood
~ 0.25 Mt C
Credit: Ola Nilsson

Global Fossil C Emissions



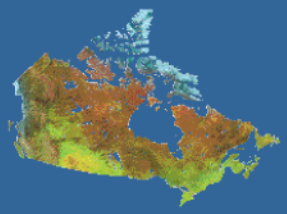
- Global Fossil Carbon Emissions ~ 7 Gt C / yr
- Equivalent to C stored in about half of Canada's forest biomass
- Solid wood cube of 28 billion m3 or 28 km3

X 28,000

- Enough wood to produce a 2 x 4 that wraps around the earth at equator …

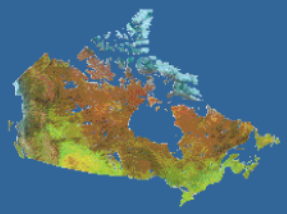
…. over 200,000 times.

Forest Mitigation Options



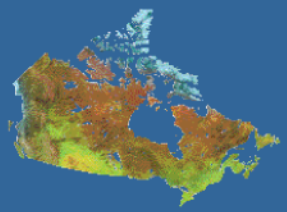
- Forests and forestry cannot solve the problem of fossil C emissions, but they can contribute to the solution.

Forest Mitigation Options



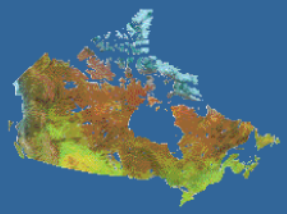
- Increase (or maintain) forest area
  - Reduce deforestation, increase afforestation
- Increase stand-level carbon density
  - Silviculture, harvest systems with partial cover, avoid slashburning, reduced regeneration delays, species selection, fertilization, tree improvement programs
- Increase landscape-level carbon density
  - Longer rotations, conservation areas, protection against fire and insects
- Forest management technologies for mitigation portfolios exist and are implemented operationally.

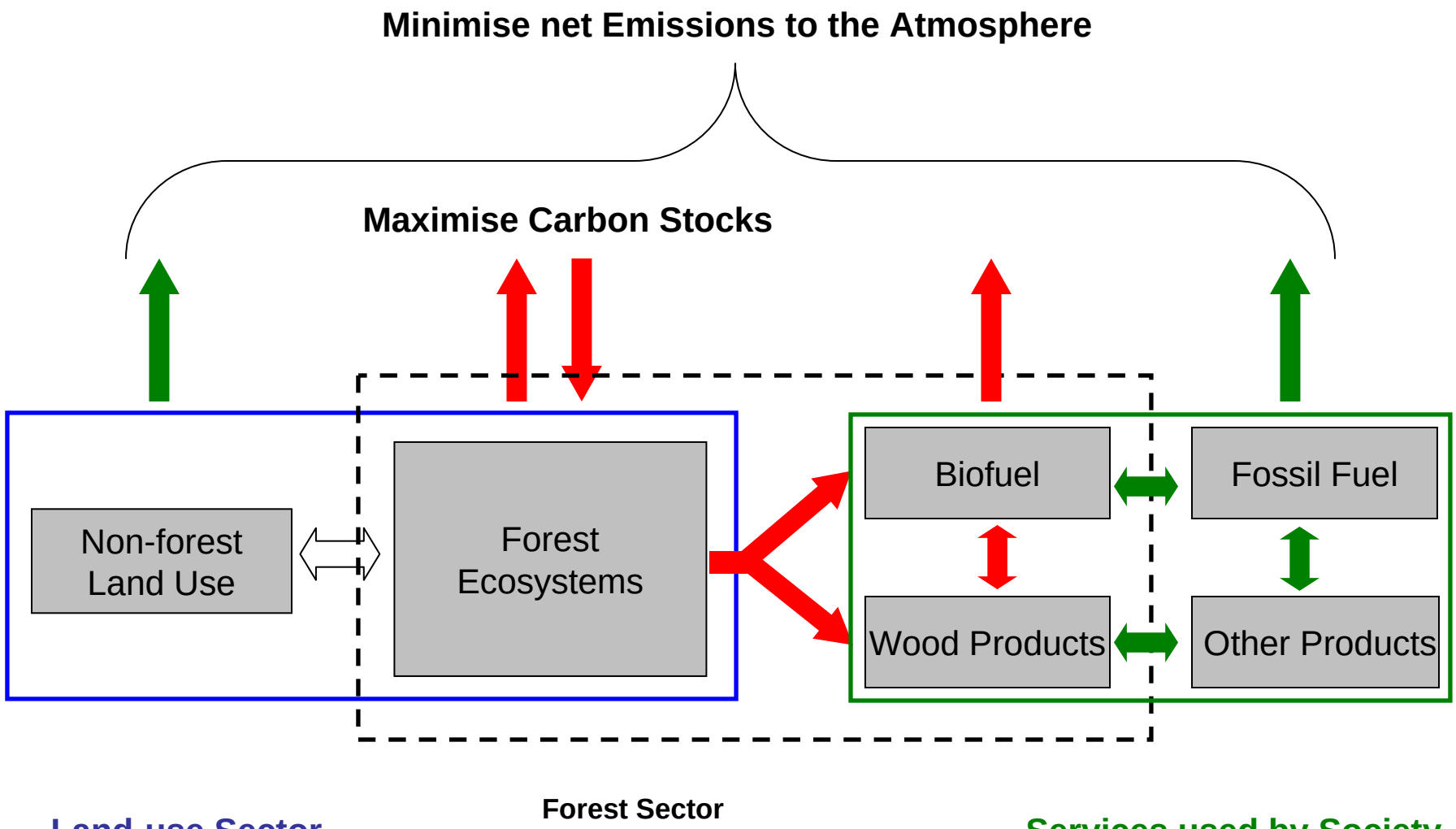
Forest Mitigation Options



- Global wood harvest transfers ~750 Mt C/yr to meet society's needs.
- Canada harvests 46 Mt C /yr (average over 2000 – 2005)
- Mitigation options include
  - longer retention of C in harvested wood products,
  - increased use of wood products instead of more fossil-energy intensive materials (e.g. steel)
  - reduce wood disposal in landfills (reduce CH_4 emissions)
  - increased use of woody biofuels to substitute fossil fuels

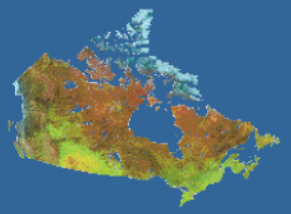
Forest Mitigation Strategies: What to Optimise?





Source: IPCC 2007, AR4 WG III, Forestry

Requirements for Forest Carbon Accounting Tools



Contribution of Canada's forests to the global C cycle

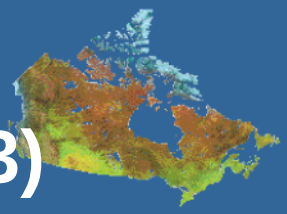
Looking backward:

- Monitoring and reporting of forest C stock changes (annually to UNFCCC, FAO, C&I etc).

Looking forward:

- Support policy analyses (projections):
- Decision on forest management in Kyoto reporting,
- Negotiations for post-2012 climate regime,
- Develop climate mitigation and adaptation strategies,
- Assess implications of forest management options.

Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)



- An operational-scale model of forest C dynamics.
- Allows forest managers to assess carbon implications of forest management: increase sinks, reduce sources

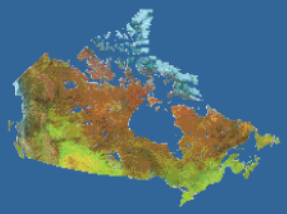
- Builds on ~20 years of CFS Science

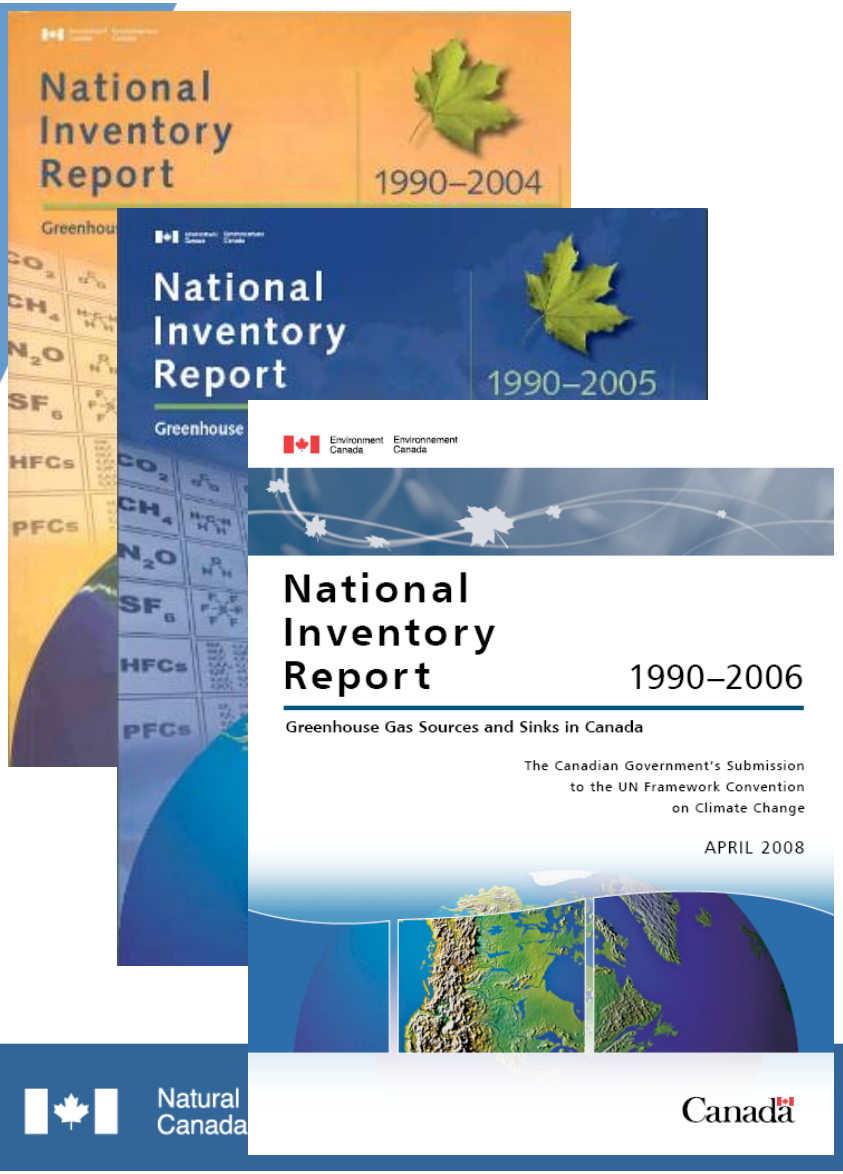
- Available at: carbon.cfs.nrcan.gc.ca

CBM·CFS3
Operational Scale Carbon Budget Model of the Canadian Forest Sector Release 1.0

Kurz et al. 2009, Ecological Modelling

CBM-CFS3 is core model of Canada's NFCMARS

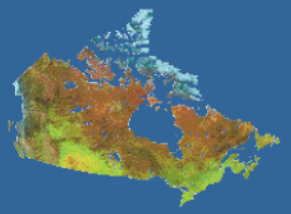


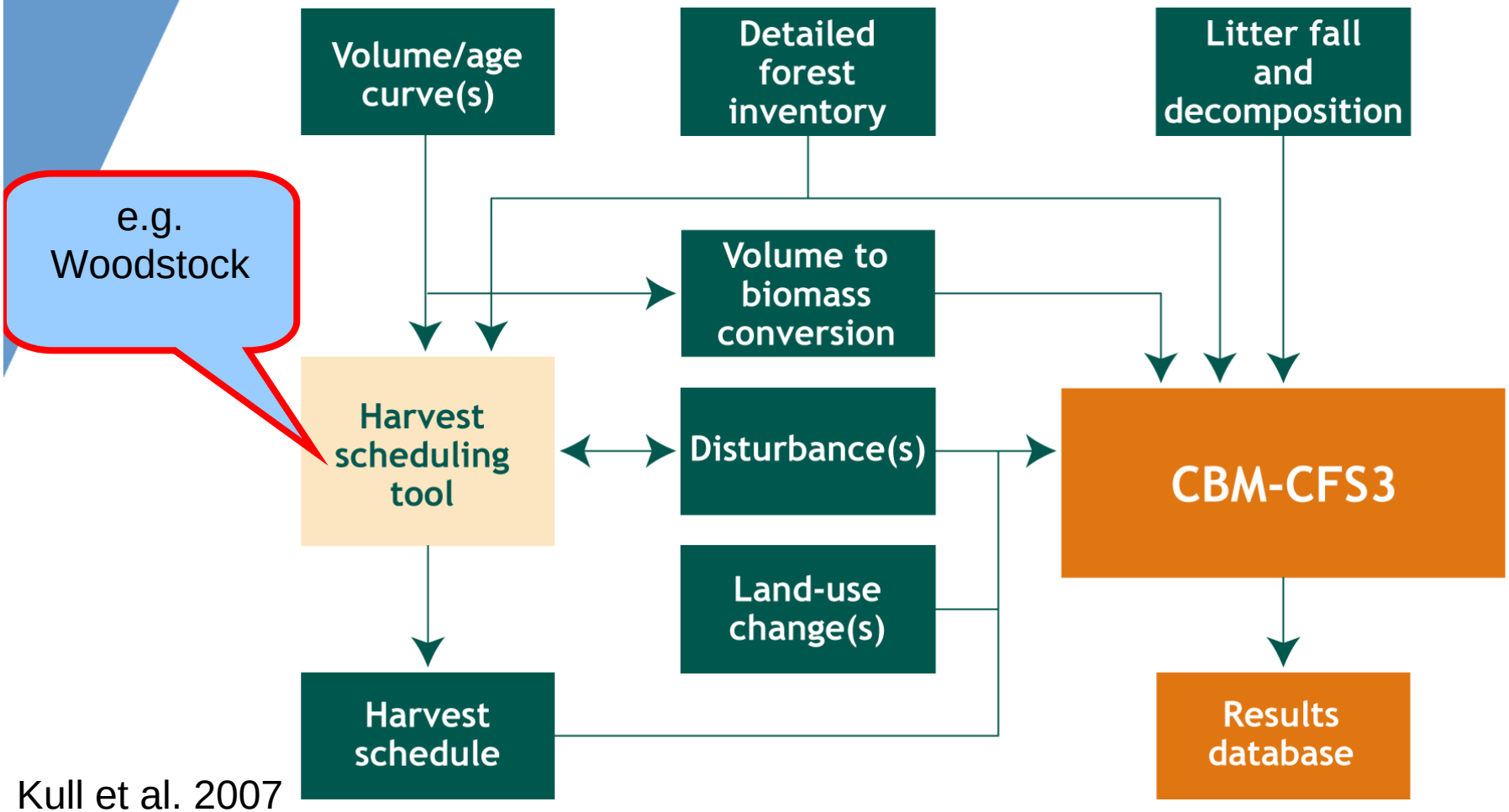


National
Forest
Carbon
Monitoring,
Accounting and
Reporting
System
(NFCMARS)

Estimation of greenhouse gas emissions and removals and reporting to Environment Canada for National GHG Inventory Reporting.

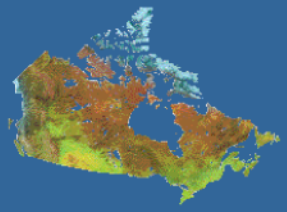
CBM-CFS3 Builds on Existing Forest Planning Information





Kull et al. 2007

National Forest Carbon Monitoring, Accounting and Reporting System (NFCMARS)



Forest inventory and growth & yield data

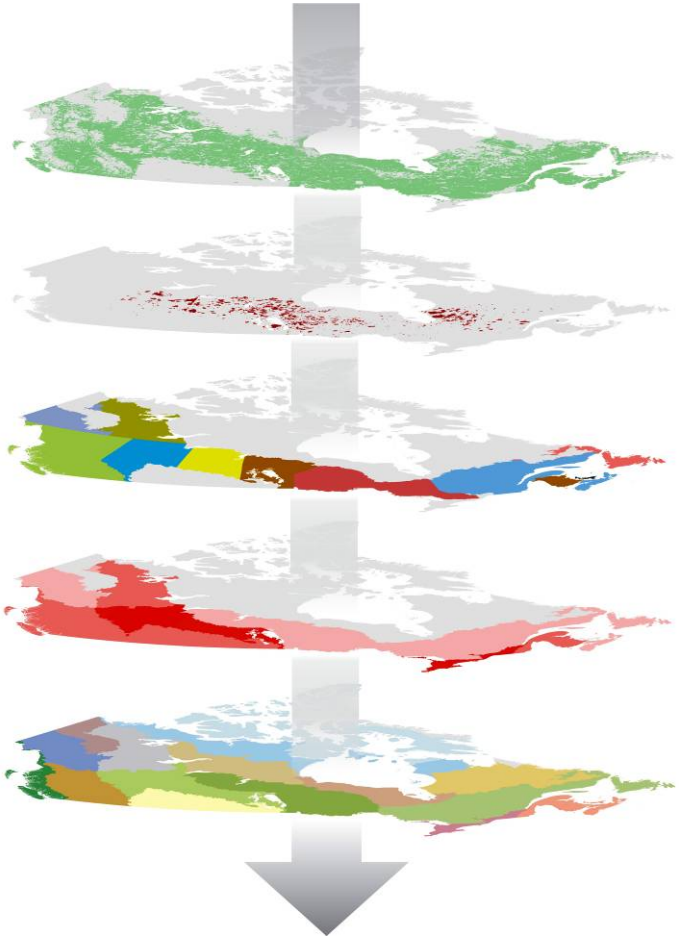
Natural disturbance monitoring data

Forest management activity data

Land-use change data

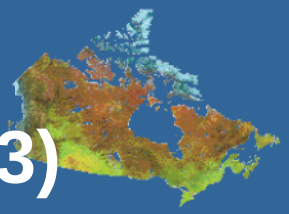
Ecological modelling parameters

Kurz and Apps, 2006



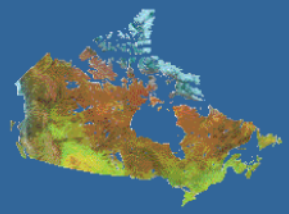
CBM-CFS3

Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)



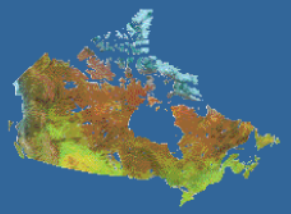
- Will forests and forest management be part of the problem or part of the solution?
- Tools such as the CBM-CFS3 enable us to answer this question for each forest management unit, and help to develop strategies to reduce sources and increase sinks.
- The CBM-CFS3 reports on carbon-related indicators required for forest certification, criteria and indicators reporting, and other international GHG reporting requirements such as the United Nations Framework Convention on Climate Change (UNFCCC).

Conclusions

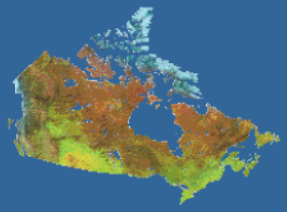


- Land use, land-use change and forestry affect forest carbon pools and non-CO_2 greenhouse gas emissions. Their impacts need to be quantified to meet international reporting requirements (UNFCCC, Kyoto Protocol, Criteria & Indicators, Certification, etc.)
- The CBM-CFS3 supports forest carbon budget analyses for both monitoring and future projections.
- Canada uses the CBM-CFS3 as the core model in the National Forest Carbon Monitoring, Accounting and Reporting system.

Conclusions



- A sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit (IPCC AR4).



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Forest Carbon Accounting
Comptabilisation du Carbone Forestier

Canadian Forest Service
Service canadien des forêts

Website: http://carbon.cfs.nrcan.gc.ca