Contribution of terrestrial ecosystems to global carbon dynamics

GEOL 412 – Climate Change

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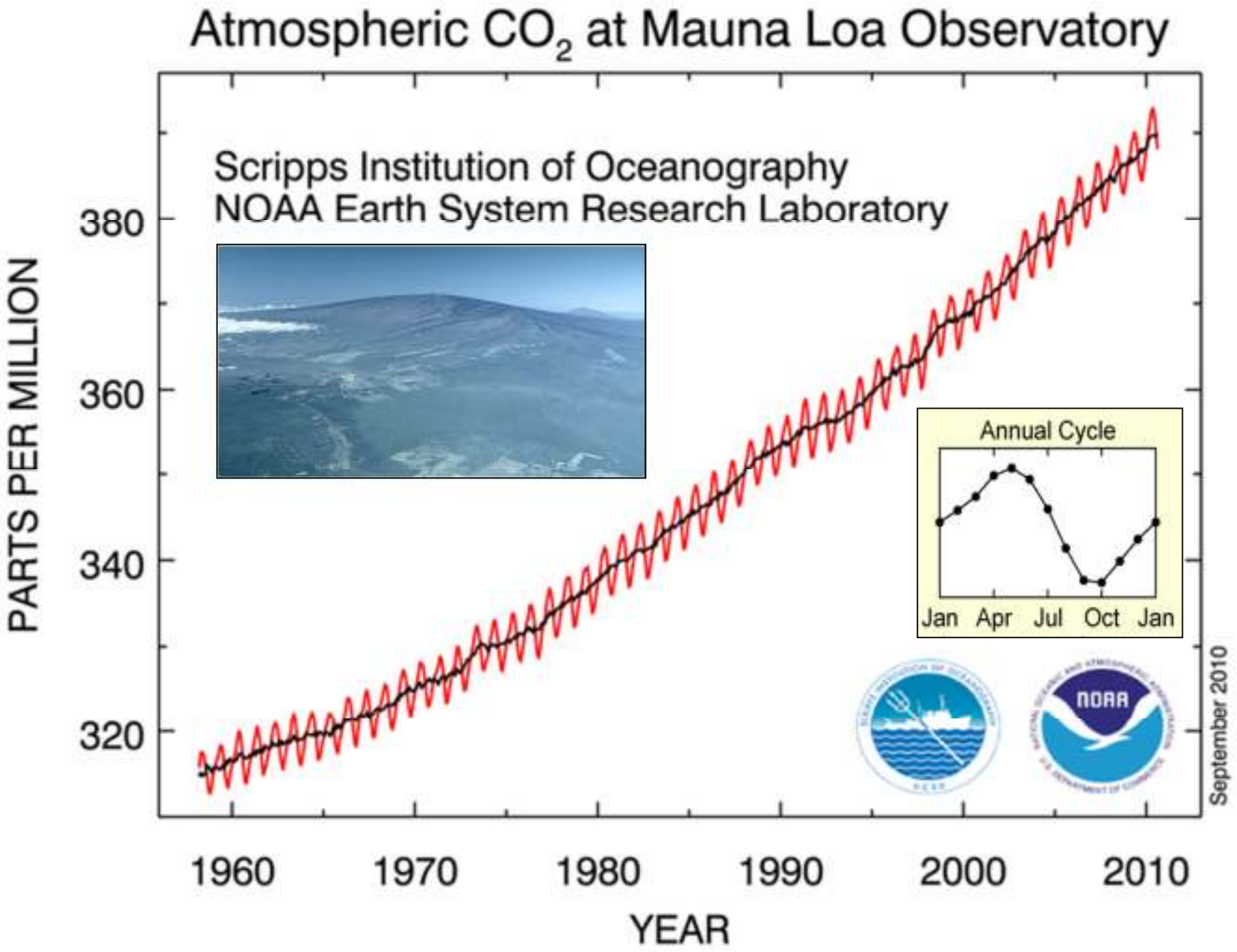
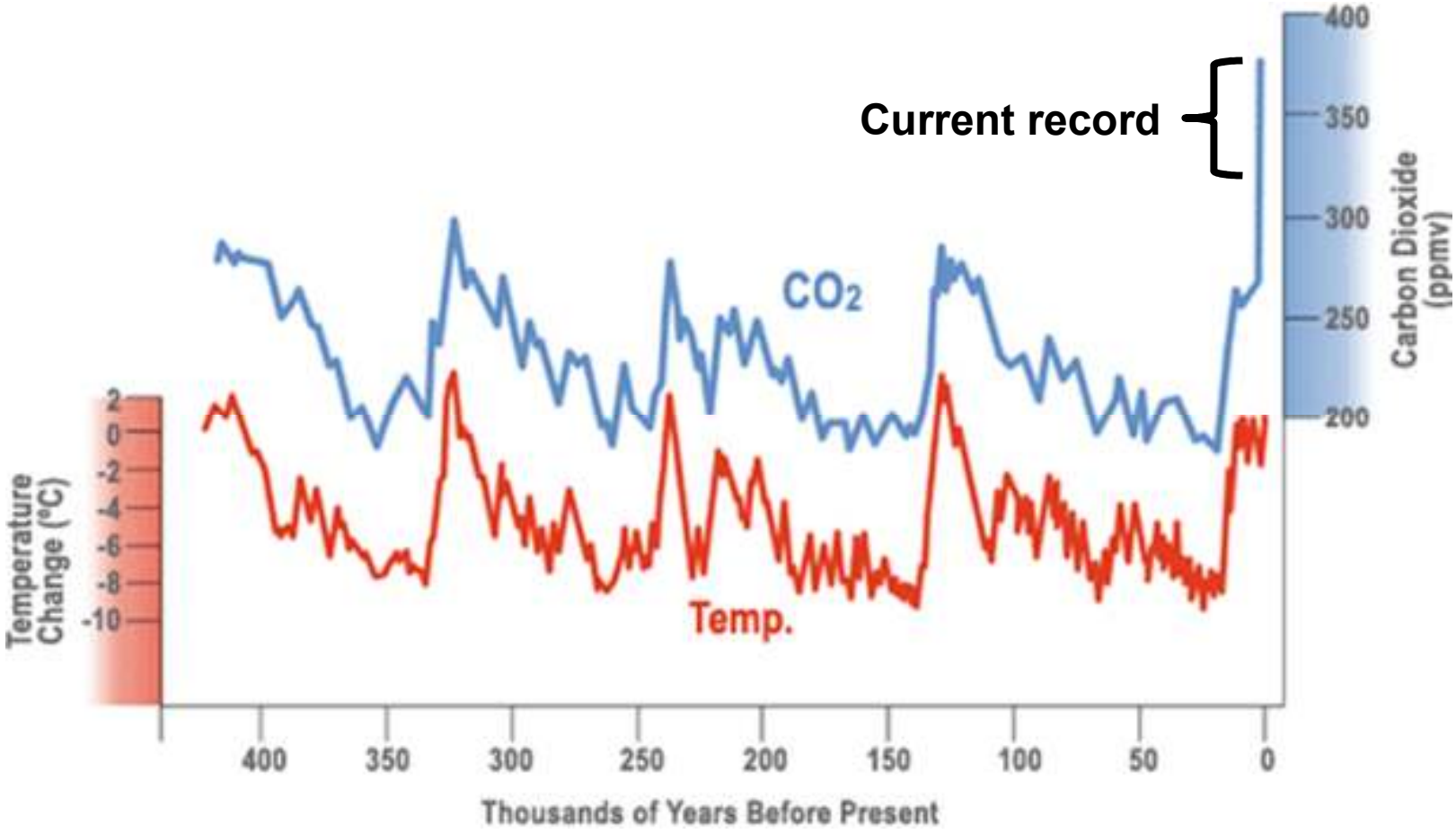
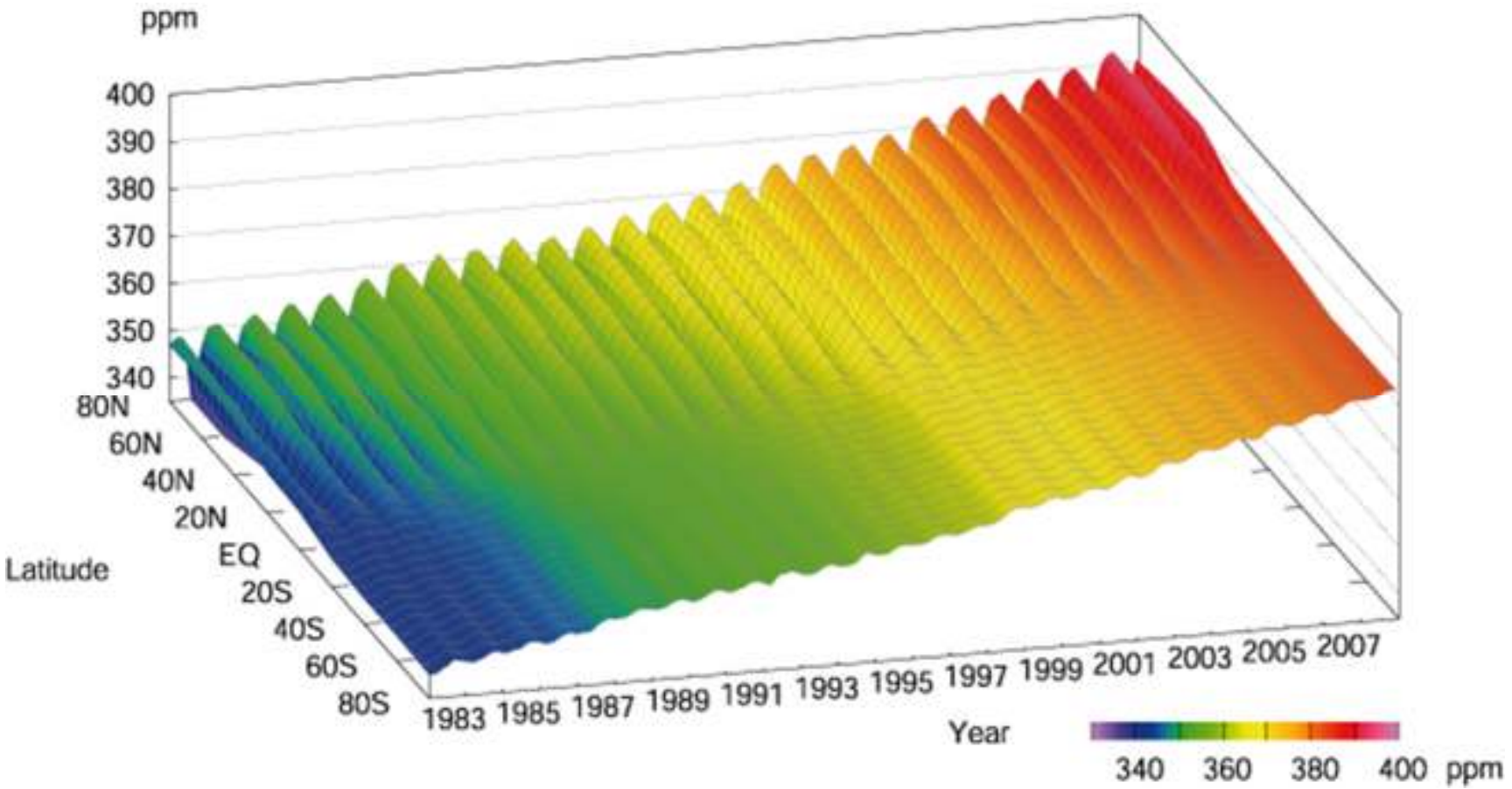
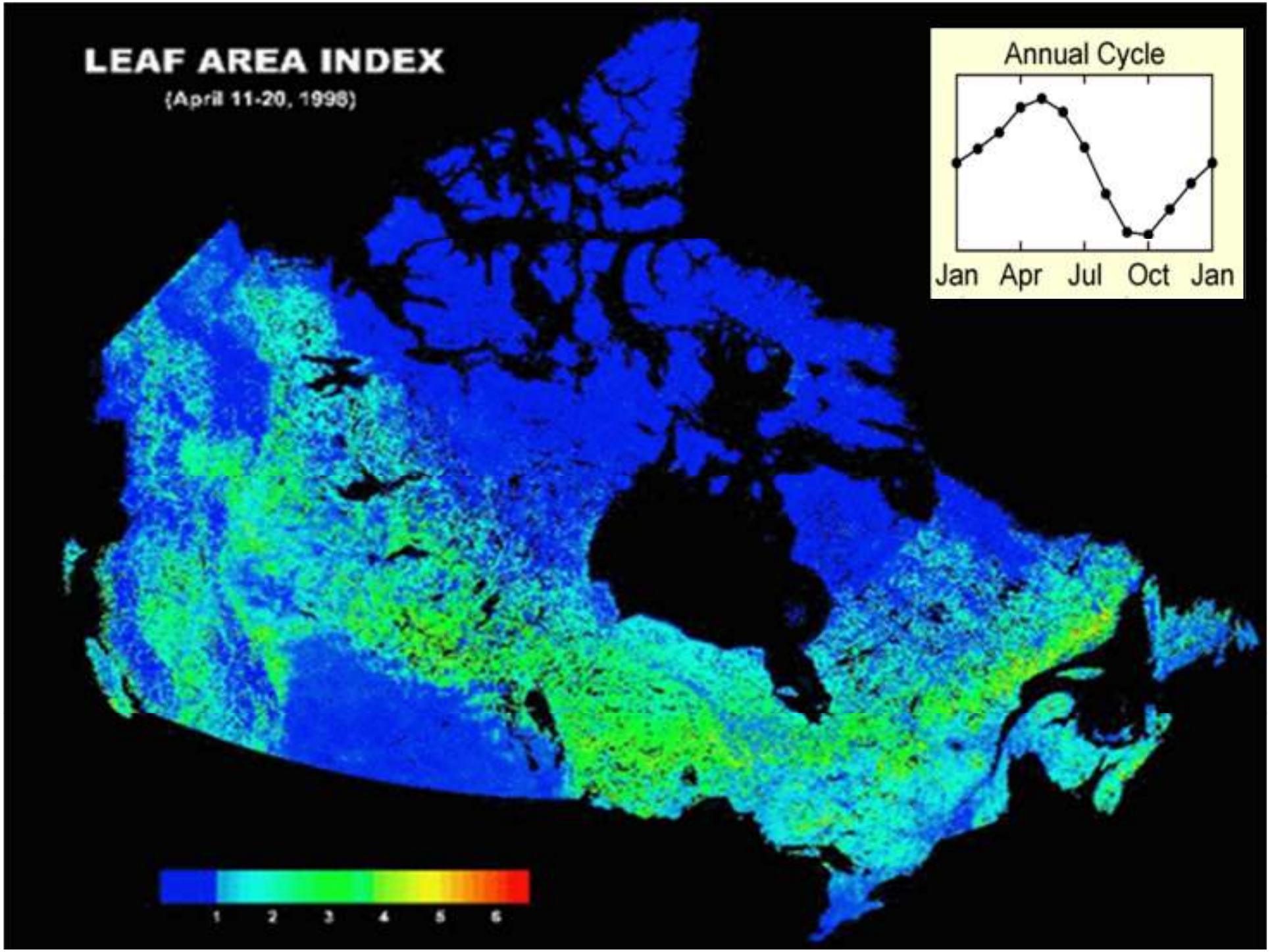
October 2011


Atmospheric CO_2 at Mauna Loa Observatory
Scripps Institution of Oceanography
NOAA Earth System Research Laboratory
PARTS PER MILLION
380
360
340
320
1960
1970
1980
1990
2000
2010
YEAR
Annual Cycle
Jan
Apr
Jul
Oct
Jan
NOAA
September 2010


Current record
CO2
Temp.
Temperature Change (°C)
2
0
-2
-4
-6
-8
-10
400
350
300
250
200
Carbon Dioxide (ppmv)
400
350
300
250
200
150
100
50
0
Thousands of Years Before Present

Atmospheric CO_2 concentration – Latitude




LEAF AREA INDEX
(April 11-20, 1998)
Annual Cycle
Jan Apr Jul Oct Jan
1 2 3 4 5 6

The global carbon budget (Fluxes = Pg C year^{-1})

1 Gt = 1 billion tons

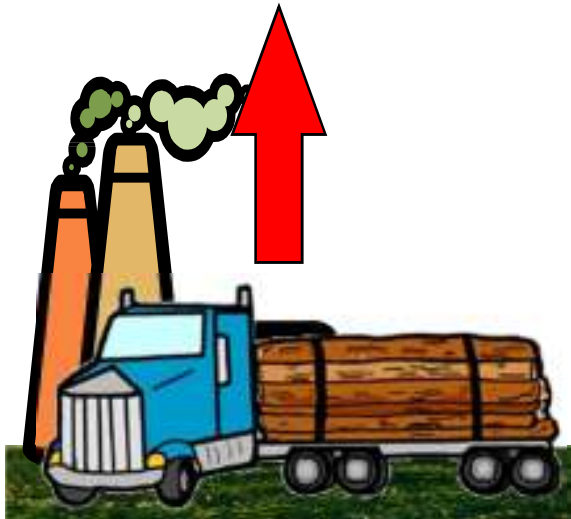
1990s

Fossil fuel emissions + Land use change 8 (6.4+1.6)

Land sink 2.6

Atmosphere 760 Pg

Atmospheric sink 3.2



Land Plants 600 Pg

Ocean sink 2.2

Soil 1700 Pg

Ocean 38,300 Pg

Adapted from IPCC 4AR (2007), Scientific basis, Figure 7.3

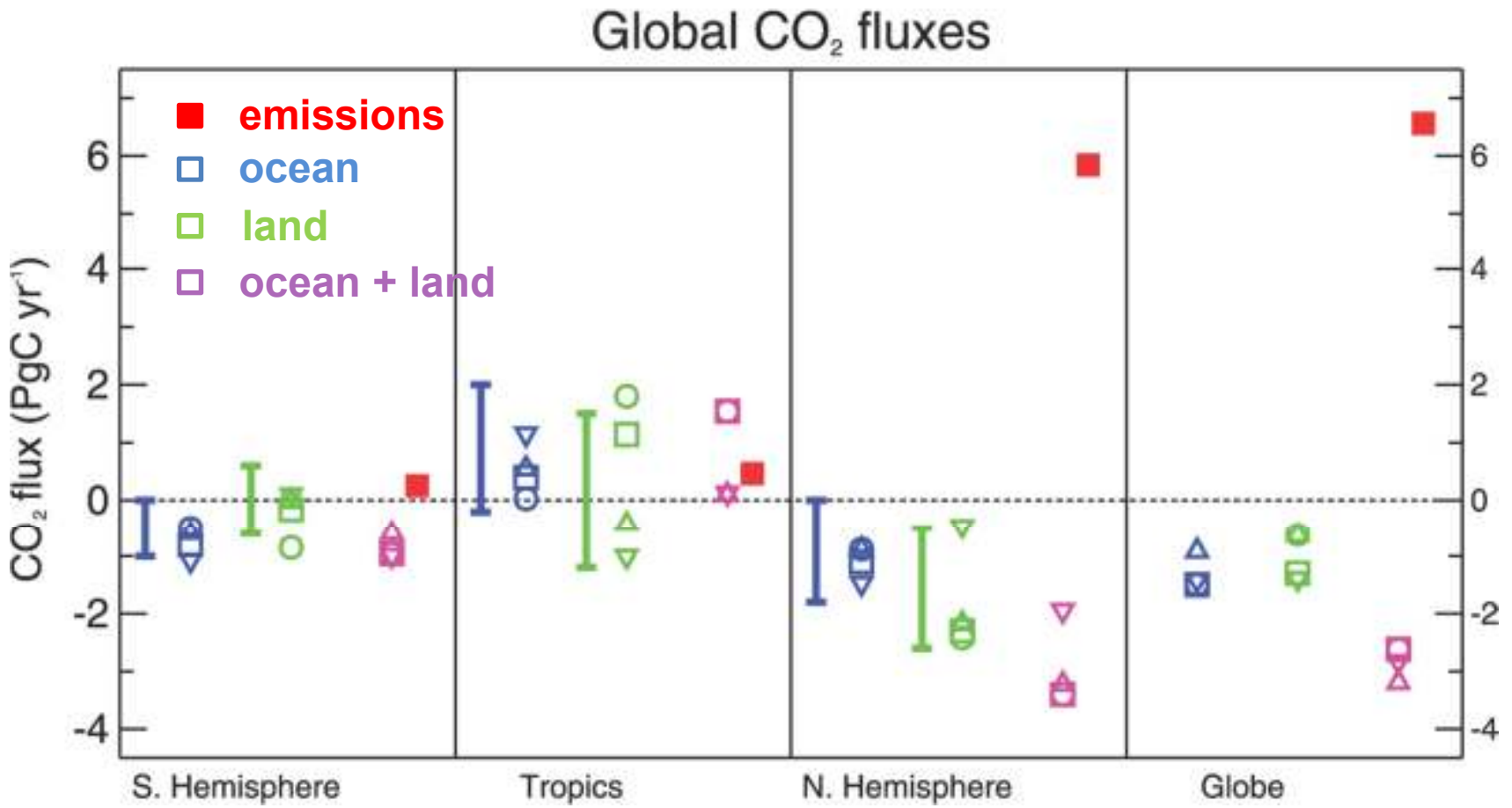
The global carbon budget (Fluxes = Pg C year^{-1})

+ = source (to atmosphere) - = sink

	1980s	1990s	2000-2005
Atmospheric increase	3.3	3.2	4.1
Emissions	5.4	6.4	7.2
Net ocean-to-atmosphere flux	-1.8	-2.2	-2.2
Net land-to-atmosphere flux	-0.3	-1.0	-0.9
Partitioned as follows			
Land use change flux	1.4	1.6	Na
Residual terrestrial sink	-1.7	-2.6	Na

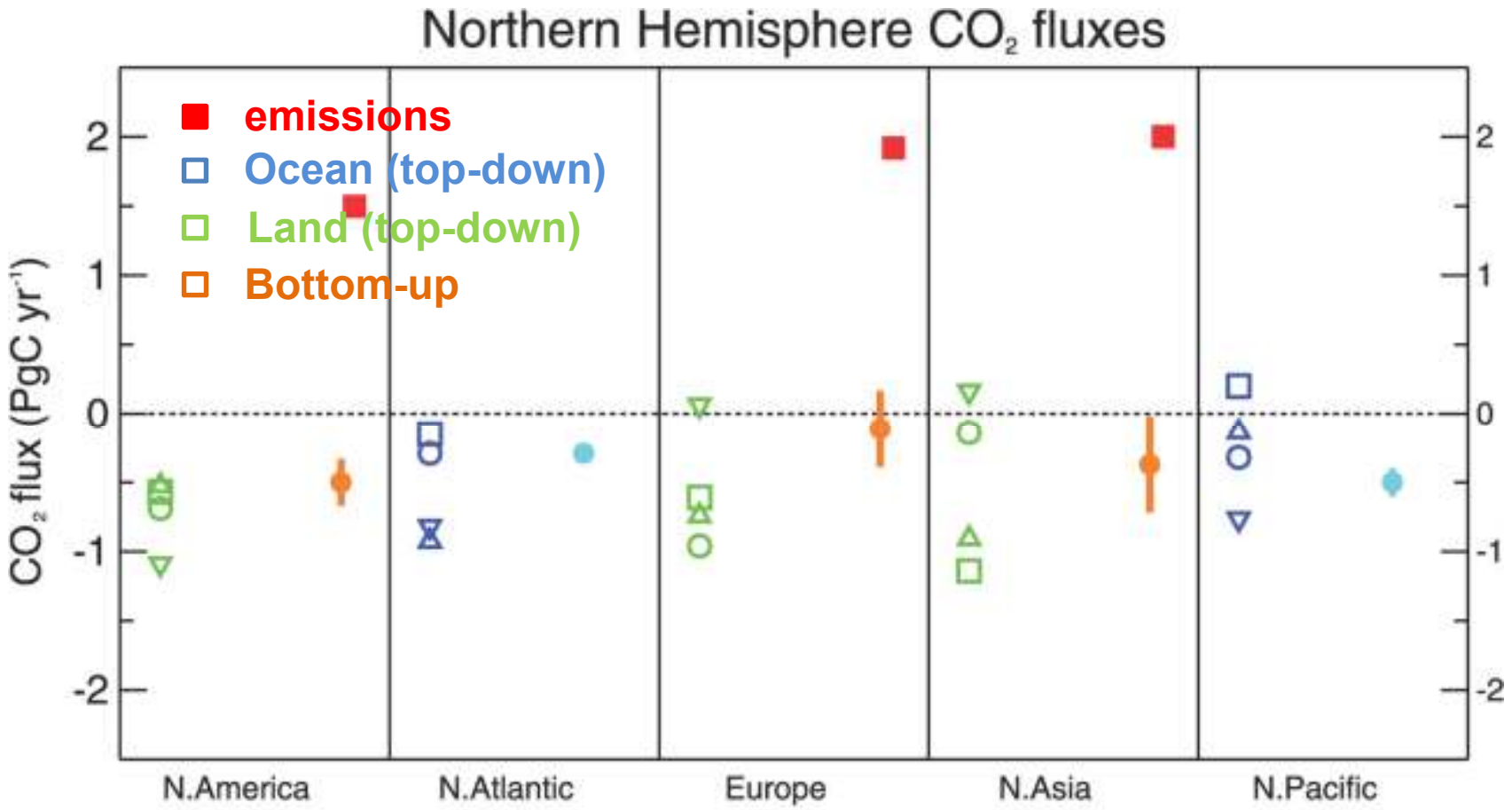
Adapted from IPCC 4AR (2007), Scientific basis, Table 7.1

The global carbon budget (Fluxes = Pg C year^{-1})



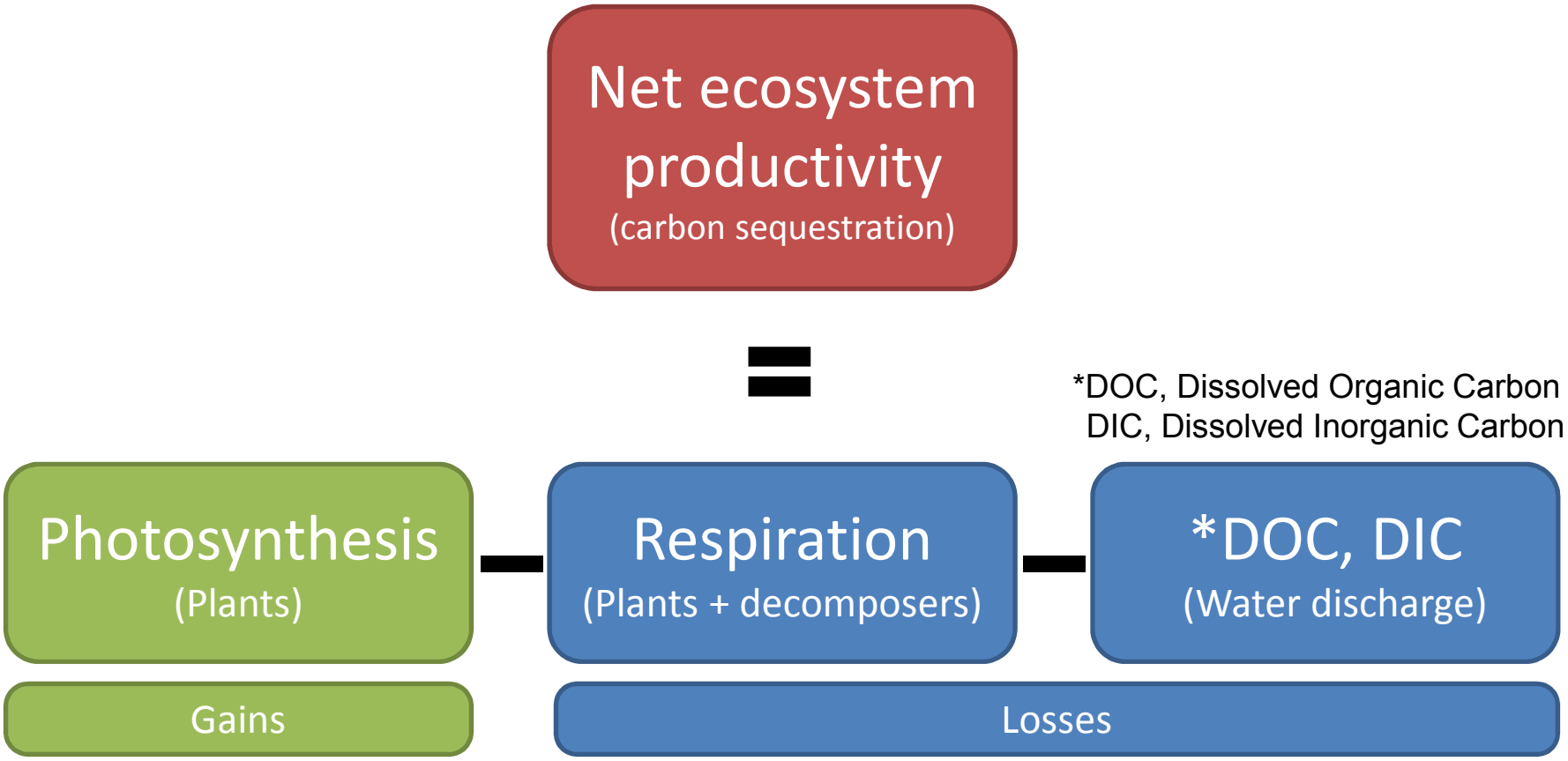
Adapted from IPCC 4AR (2007), Scientific basis, Figure 7.7

The global carbon budget (Fluxes = Pg C year^{-1})

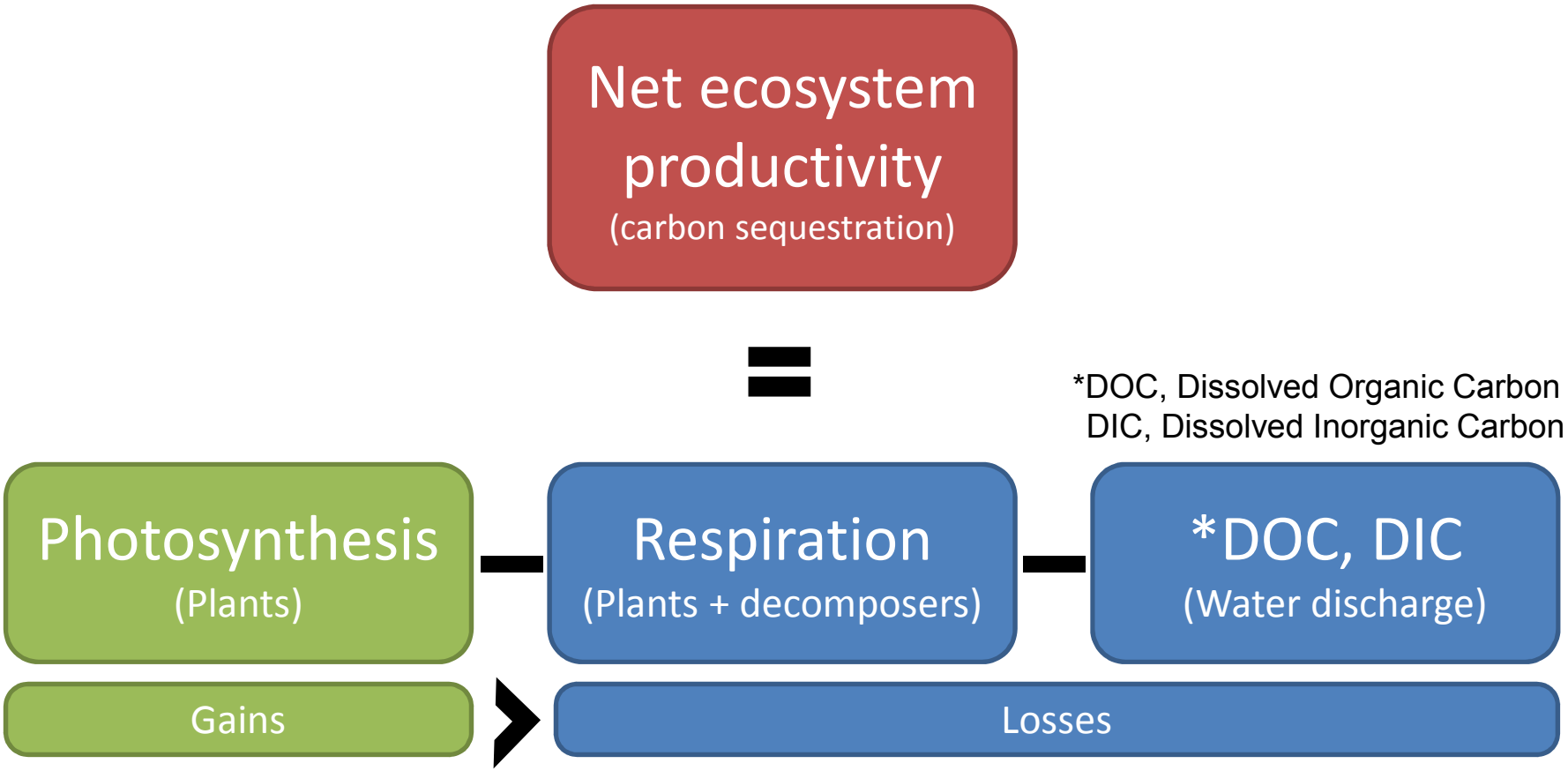


Adapted from IPCC 4AR (2007), Scientific basis, Figure 7.7

Sink or source? – The theory (for land only)

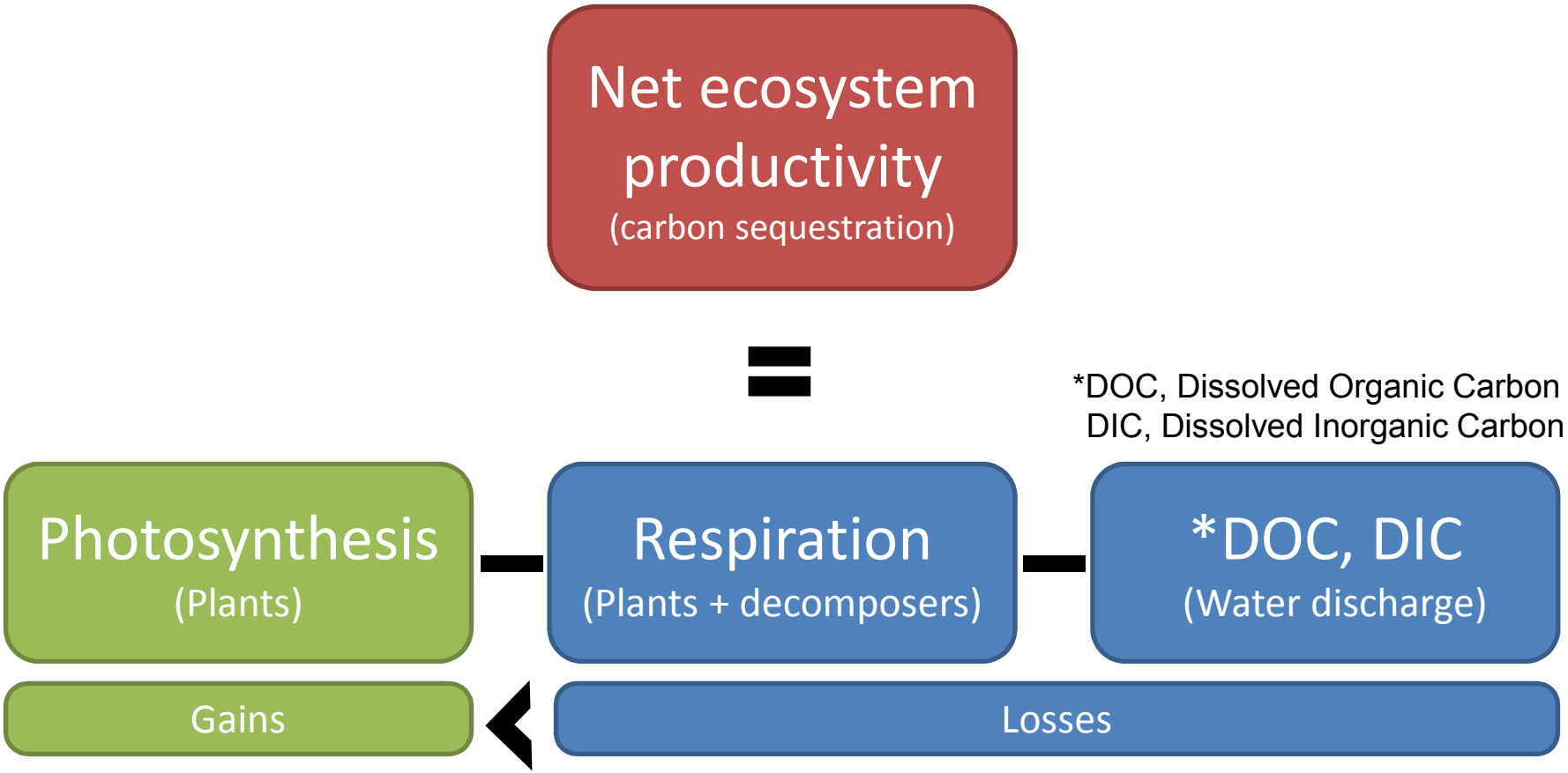


Sink or source? – The theory (for land only)



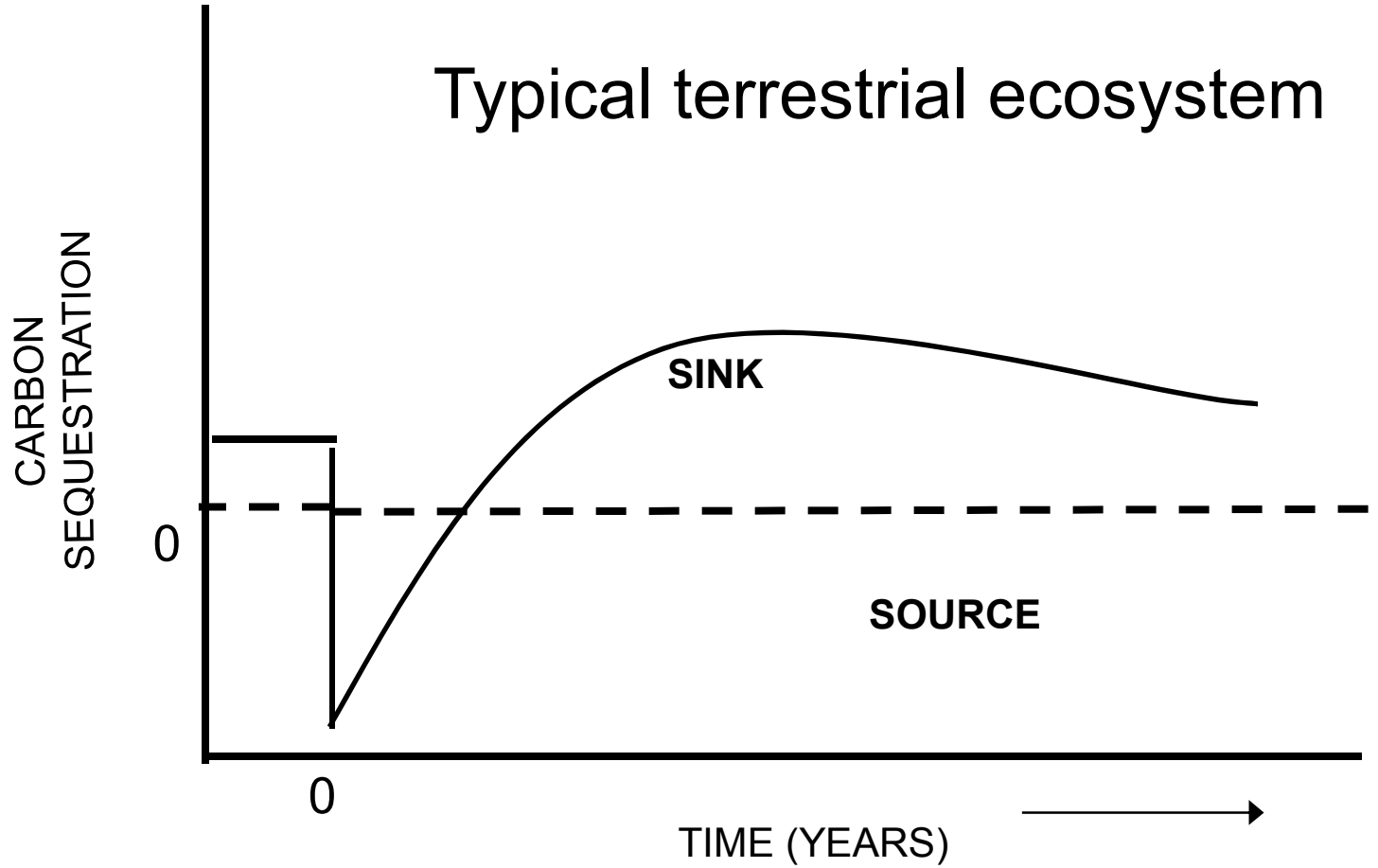
Carbon SINK (sequestration)

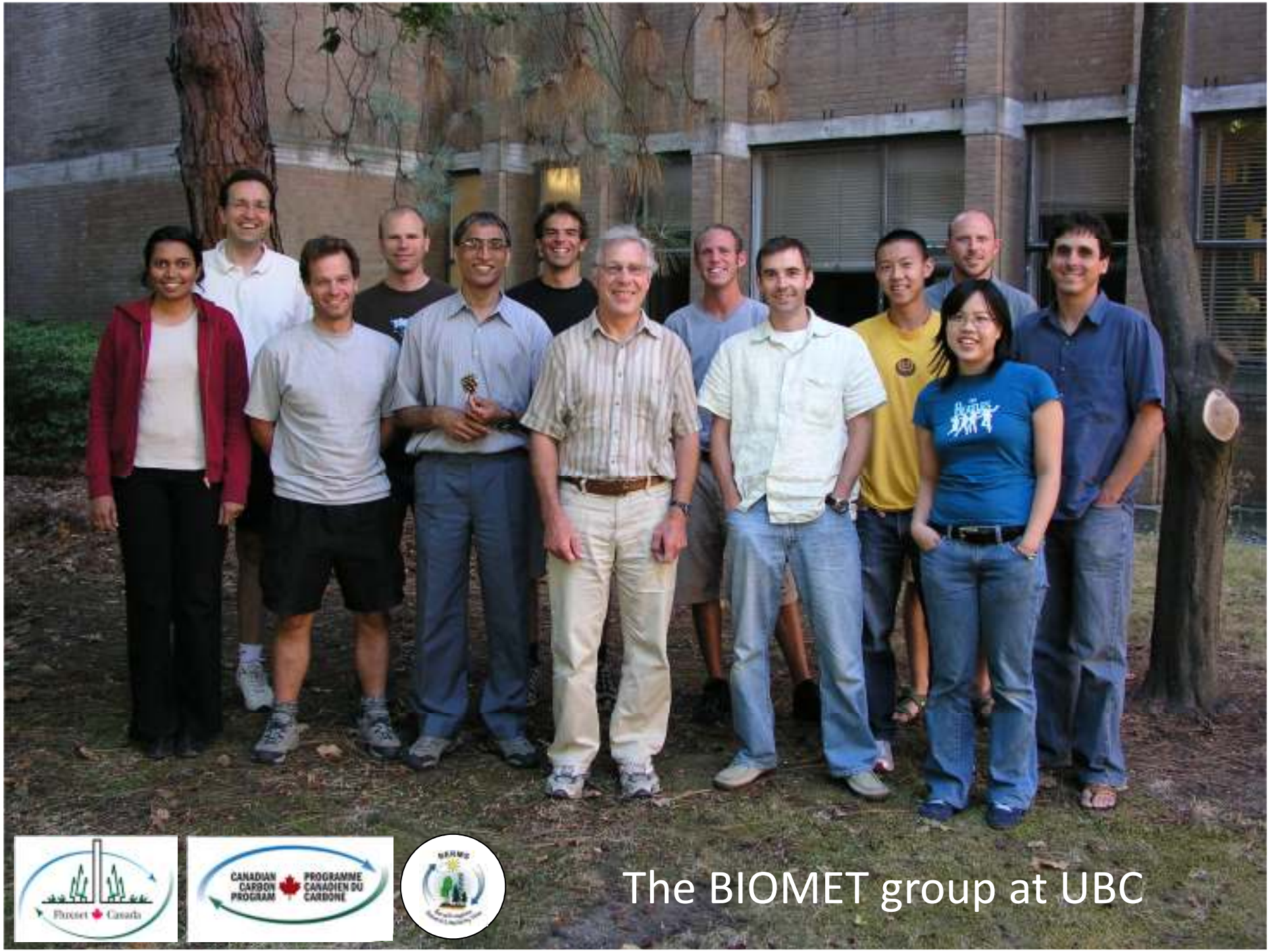
Sink or source? – The theory (for land only)



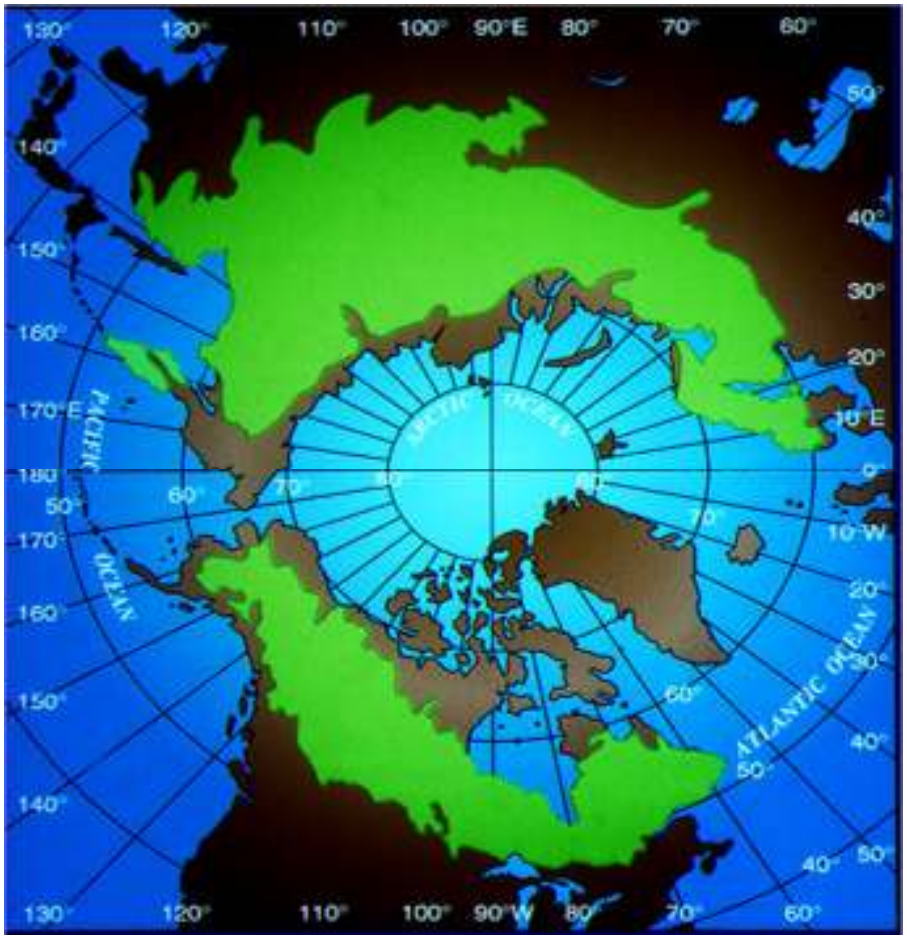
Carbon SOURCE (no sequestration, loss to atmosphere)

Sink or source? – The theory (for land only)




The BIOMET group at UBC

Then – Boreal forest



~29% of world's forested area

~50% of total C (soil and biomass)

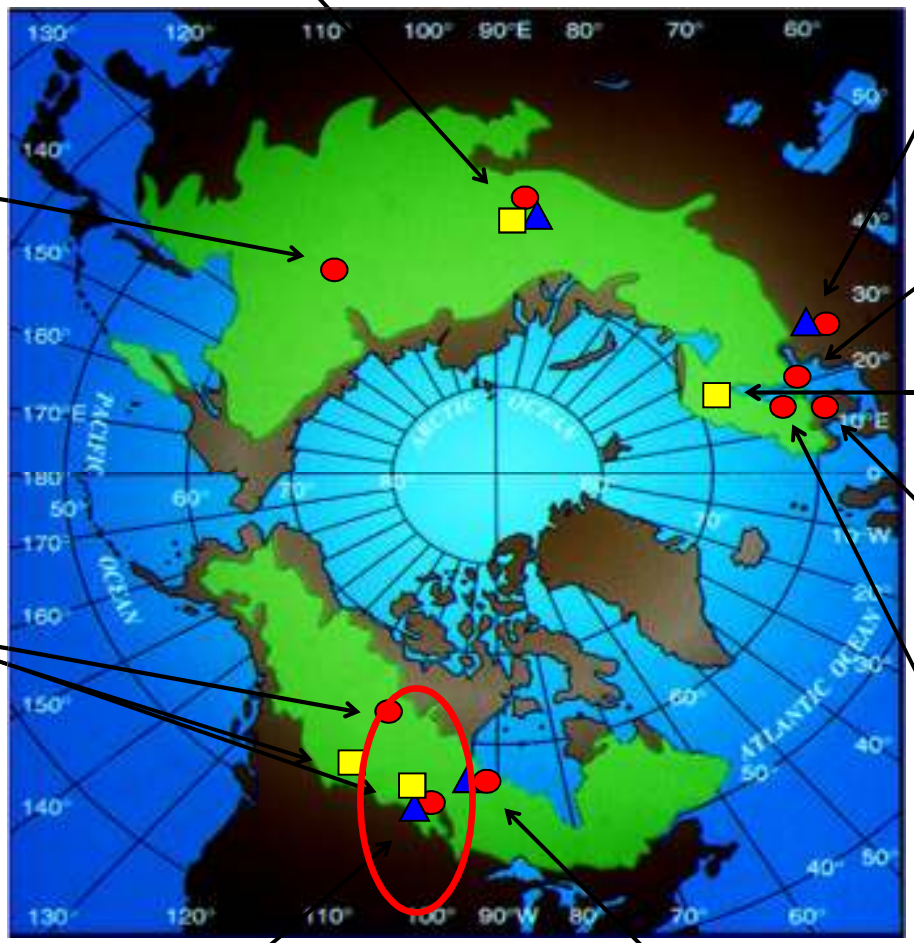
Zotino - Chronosequence - Central Siberia

Pinus sylvestris (5), *Betula* spp. (1), Bog (2)

Fyedorovskoye - European Russia

Picea abies (2), Bog (1)

Deciduous **Coniferous** **Bog and Fen**



Yakutsk - Eastern Siberia

Larix gmelinii (1)

Hyytiälä - Finland

Pinus sylvestris (2)

Petsikko - Finland

Betula spp. (1)

Chronosequence - Canada

Populus tremuloides (2)

Pinus - Picea (5)

Norunda - Sweden

Pinus sylvestris - Picea abies (1)

38 sites

Flakaliden - Sweden

Picea abies (1)

SSA BOREAS, BERMS - Canada

Populus tremuloides (1), *Picea mariana* (1), *Pinus banksiana* (3), Fen (1)

NSA BOREAS,Chronosequence - Canada

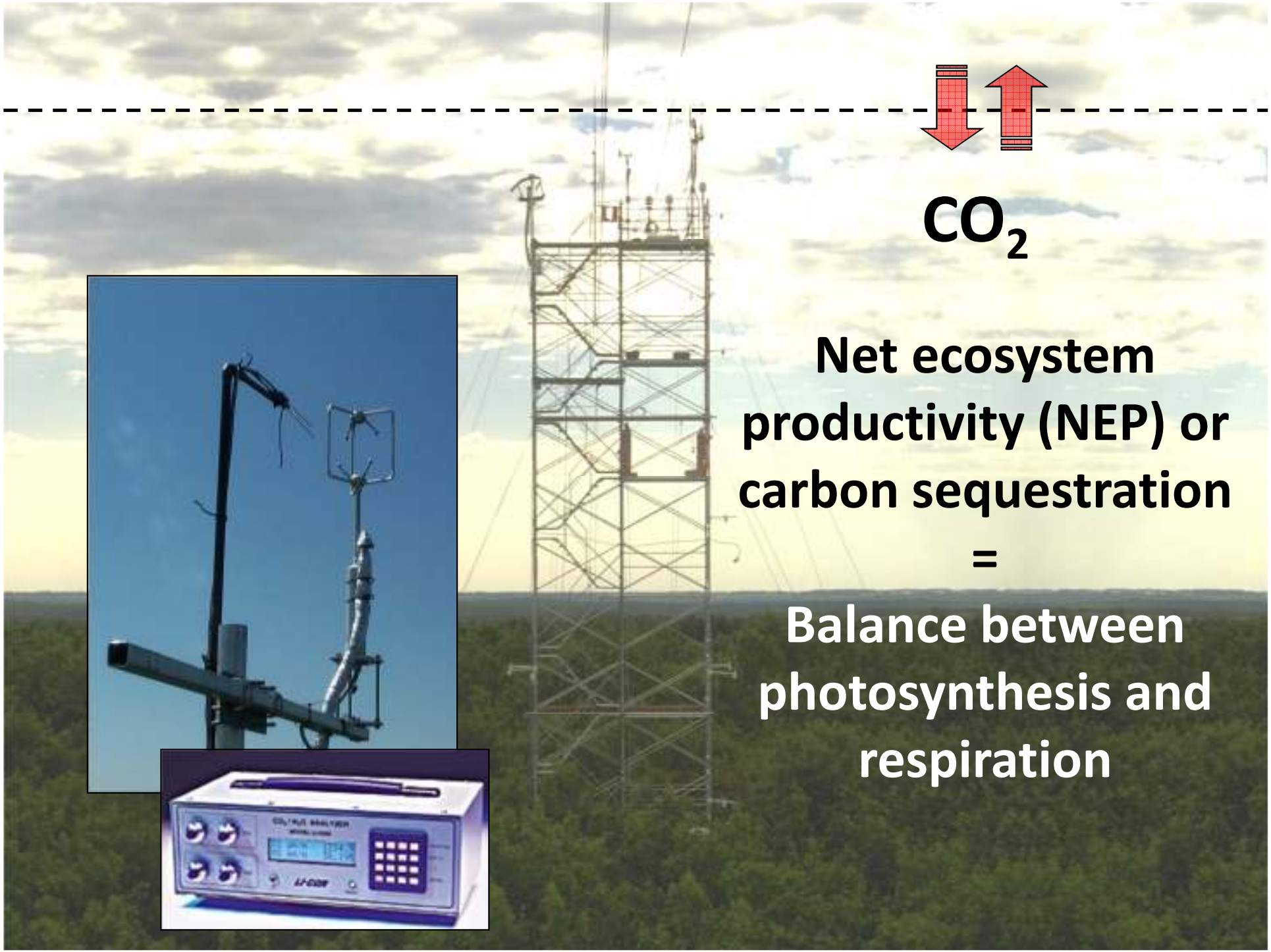
Picea mariana (5), *Pinus banksiana* (2), Fen (1)

www.berms.ccrp.ec.gc.ca

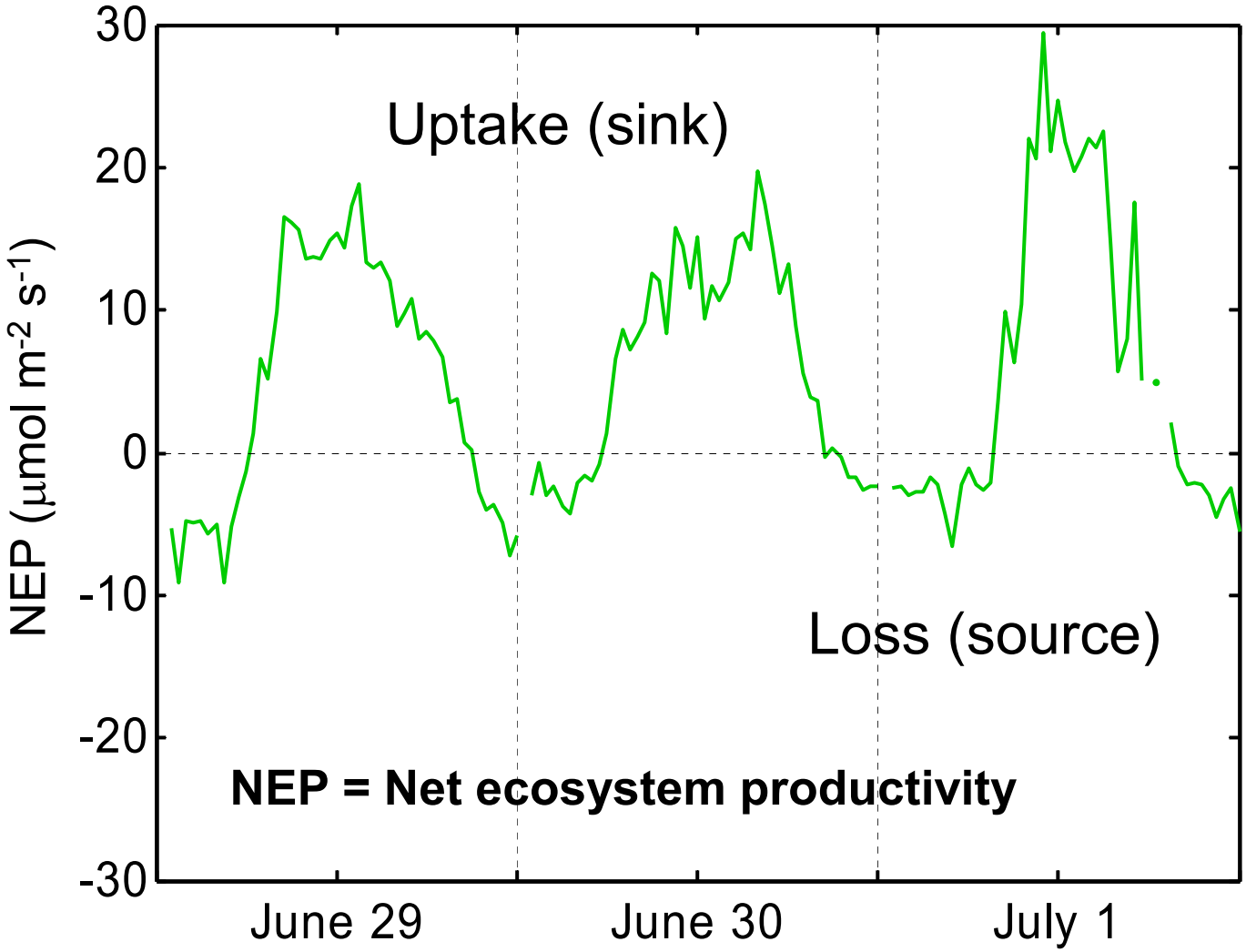
Trembling aspen
Deciduous
85 y-old

Black spruce
Coniferous wet
128 y-old

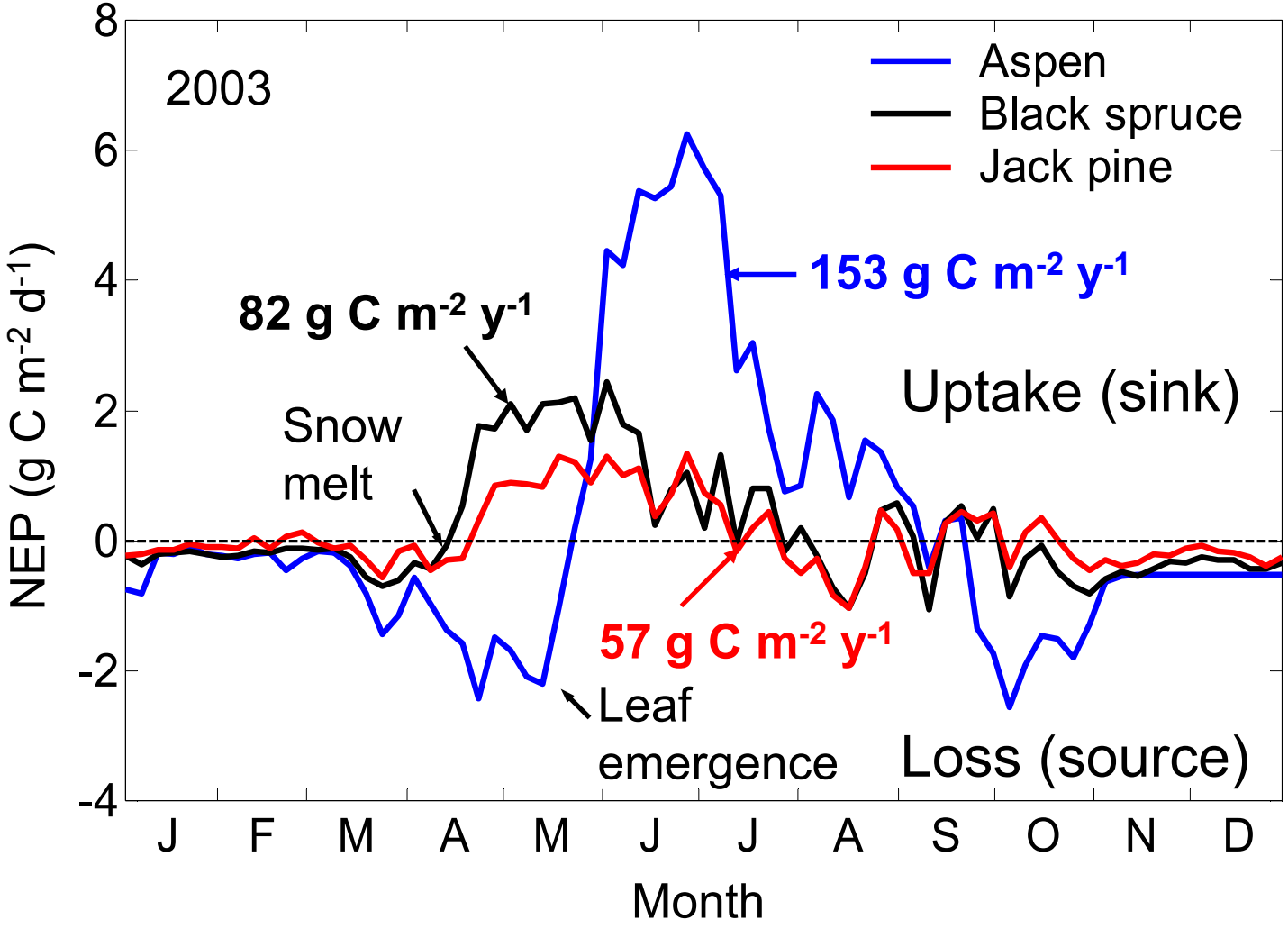
Jack pine
Coniferous dry
80 y-old


CO_2
Net ecosystem productivity (NEP) or carbon sequestration
=
Balance between photosynthesis and respiration

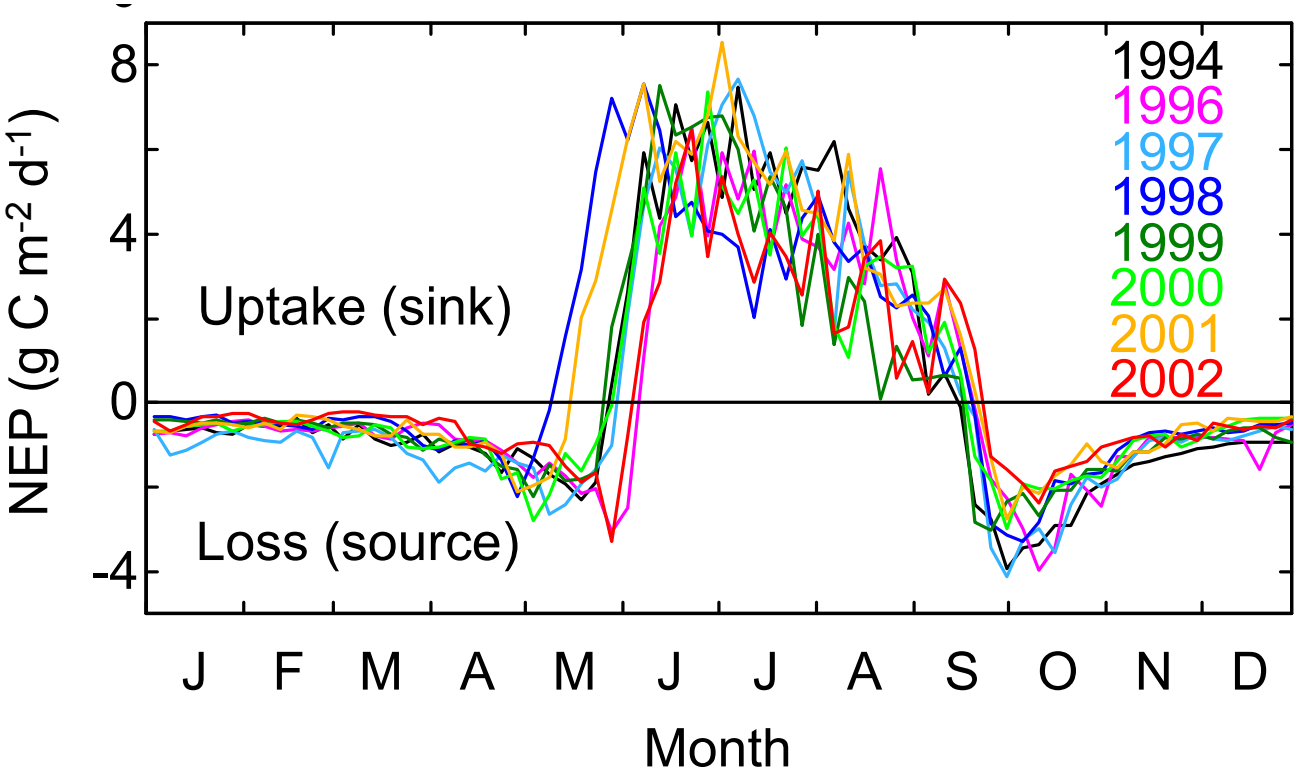
Eddy covariance approach – Instantaneous



Eddy covariance approach – Seasonal and annual



Eddy covariance approach – Interannual



Aspen in spring

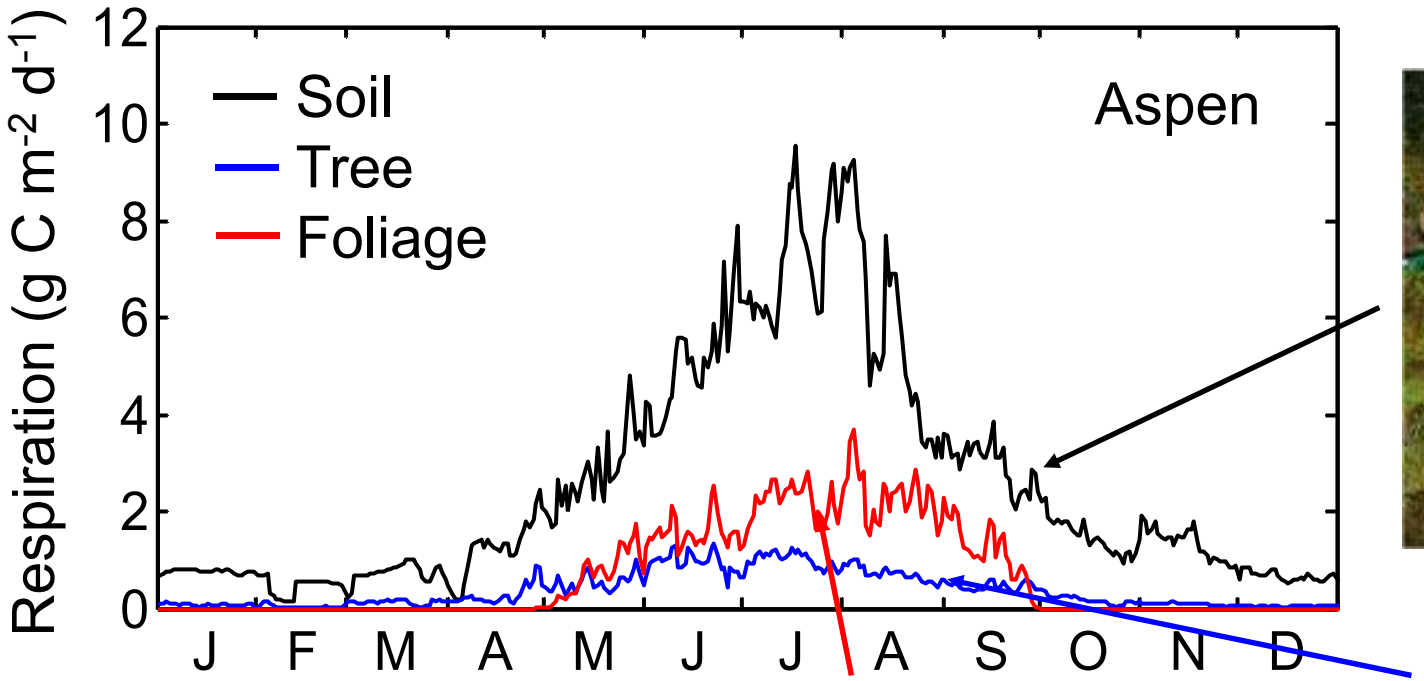
Component approach

Component approach

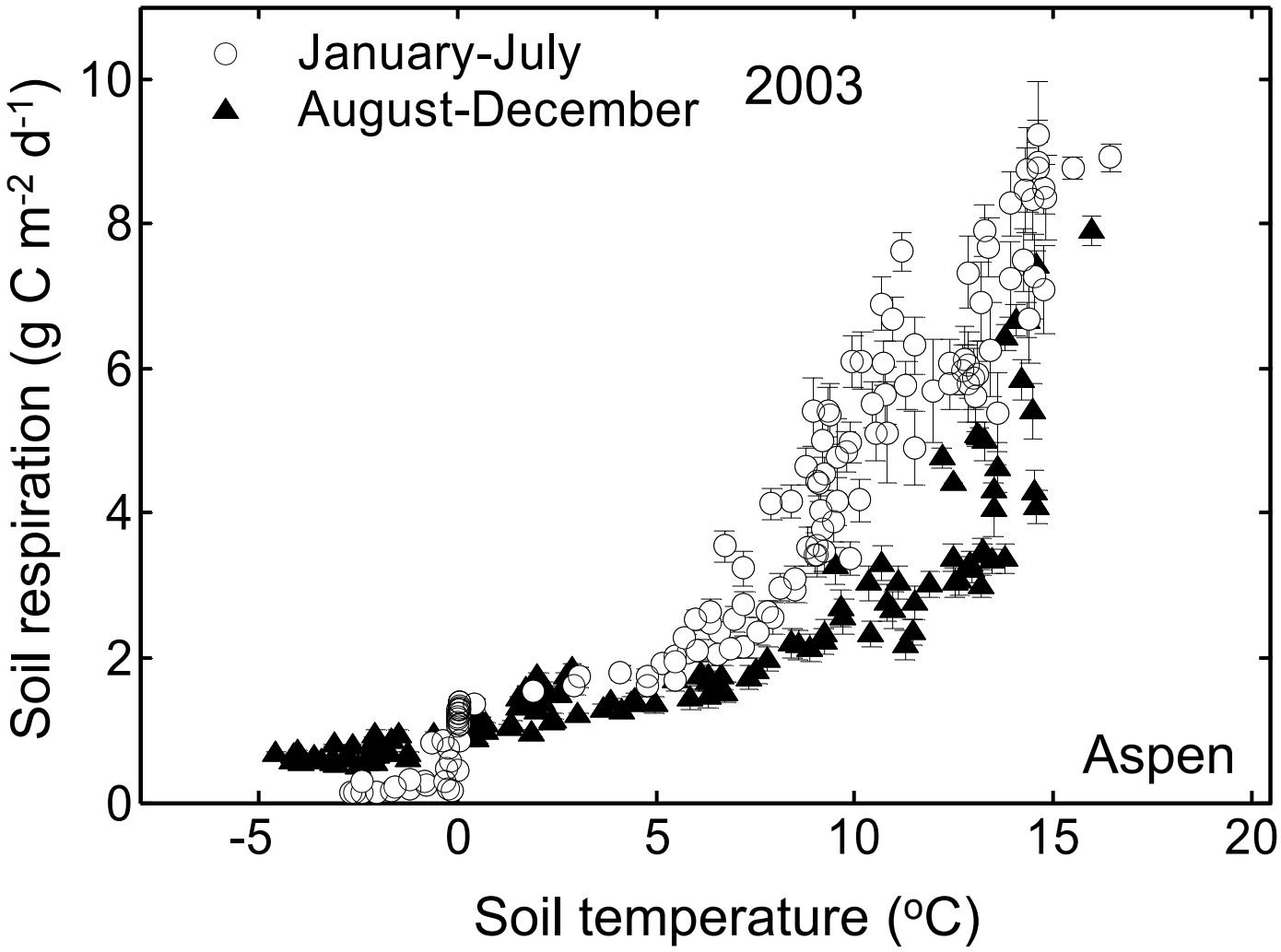
Component approach

Component approach

Components of ecosystem respiration



Importance of soil respiration



Now – Temperate forest

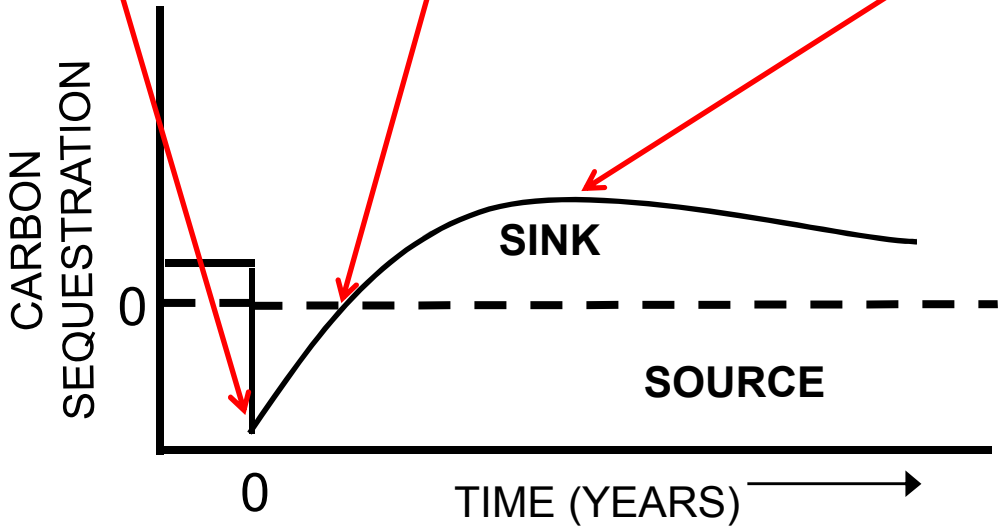
Douglas-fir forest on Vancouver Island, near Campbell River

Eddy covariance approach – Forest harvesting

Clear-cut

Intermediate

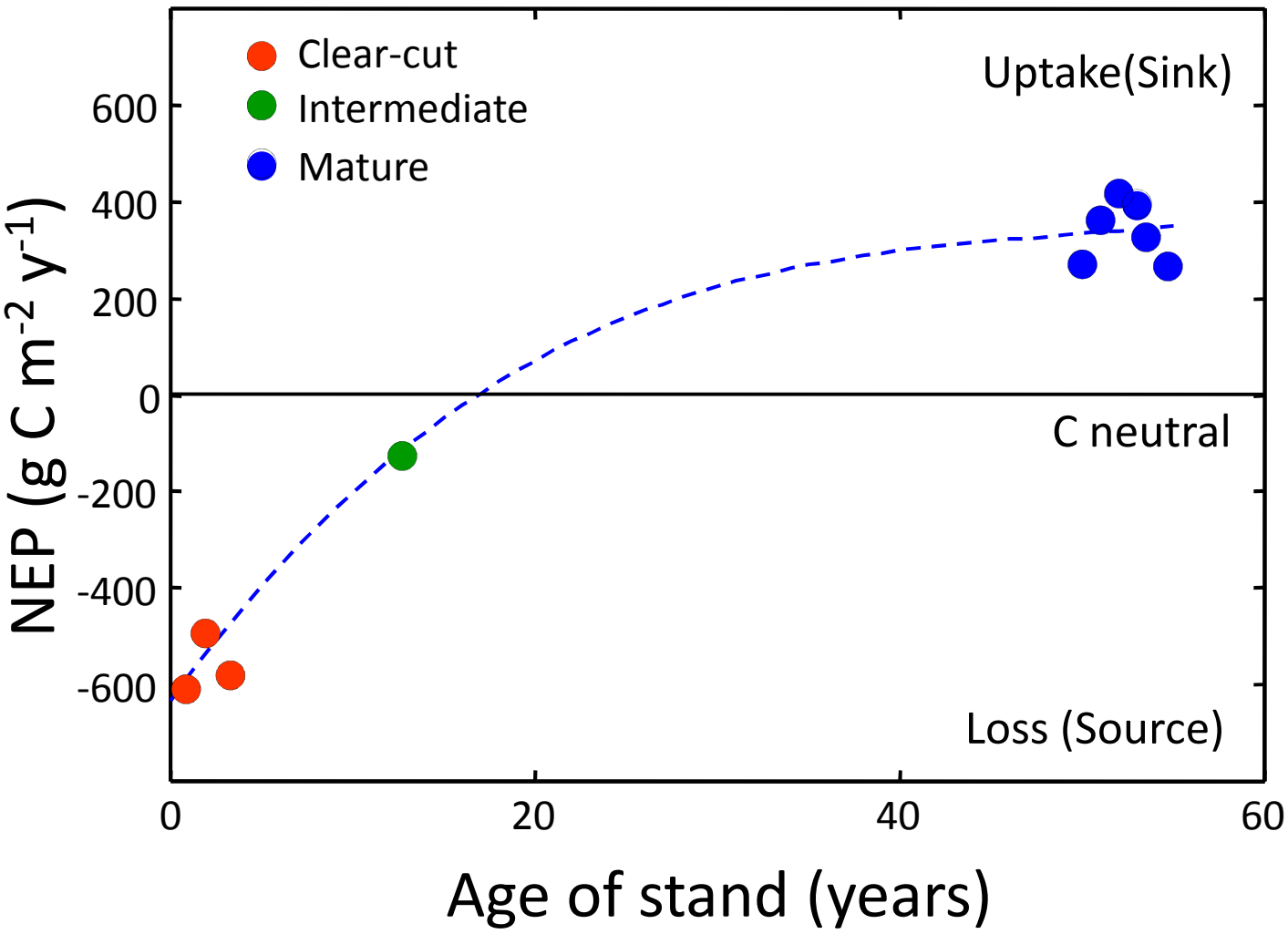
Mature



Mature Douglas-fir forest

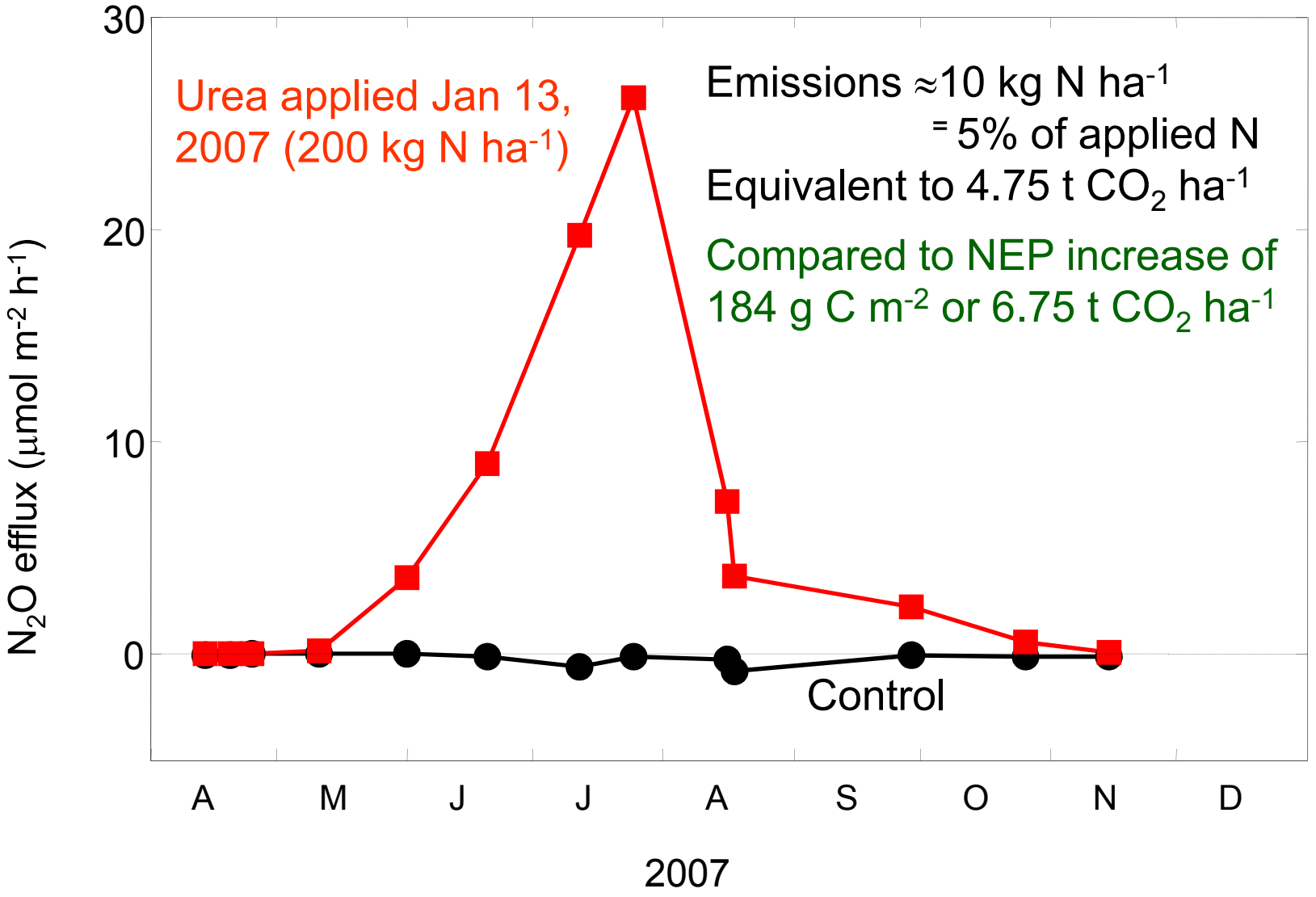
Young Douglas-fir forest

Eddy covariance approach – Forest harvesting



Eddy covariance approach – Forest fertilization

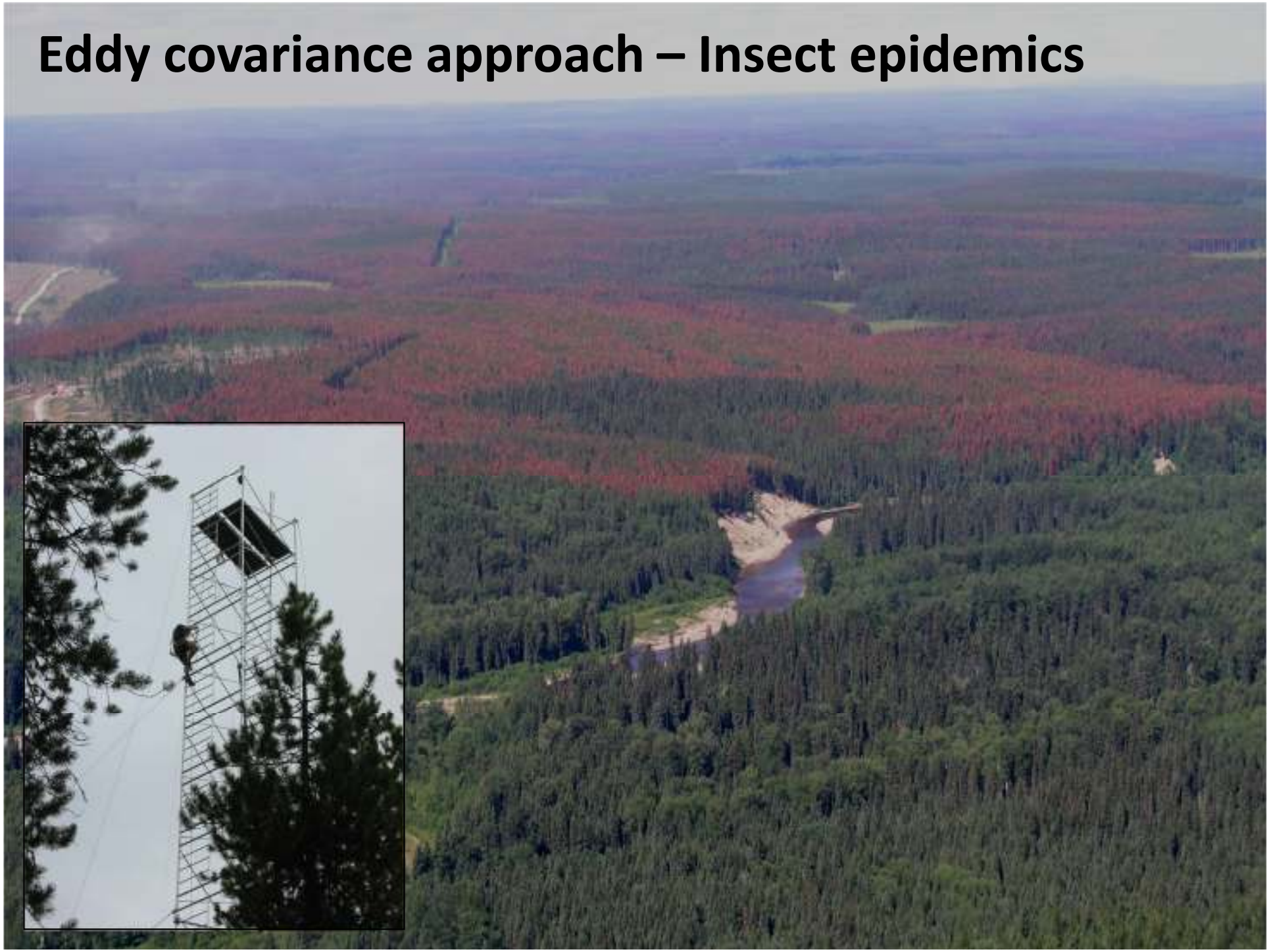
Eddy covariance approach – Forest fertilization



Eddy covariance approach – Insects epidemics

Lodgepole pine forest in northern BC, near Prince George

Eddy covariance approach – Insect epidemics



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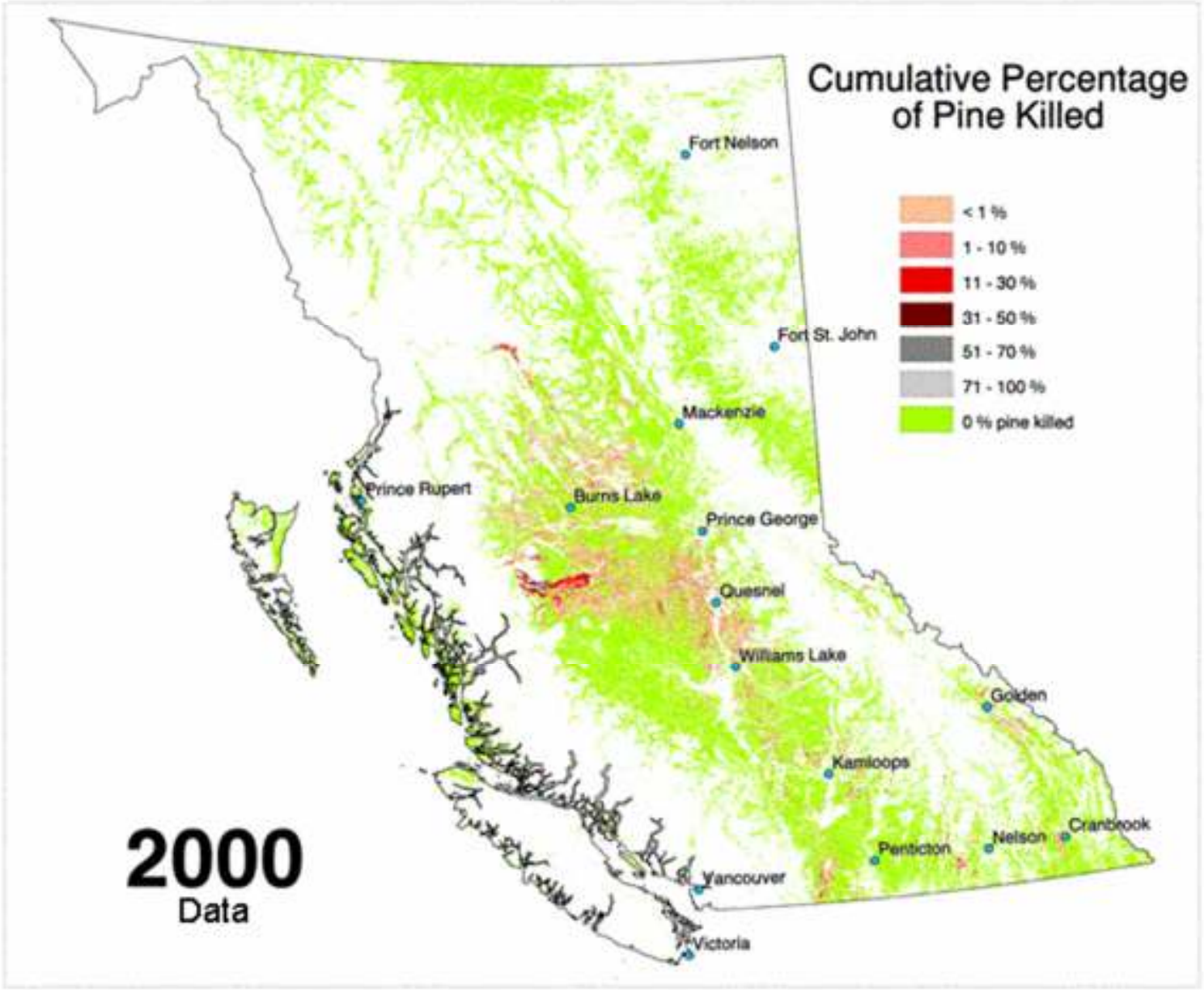

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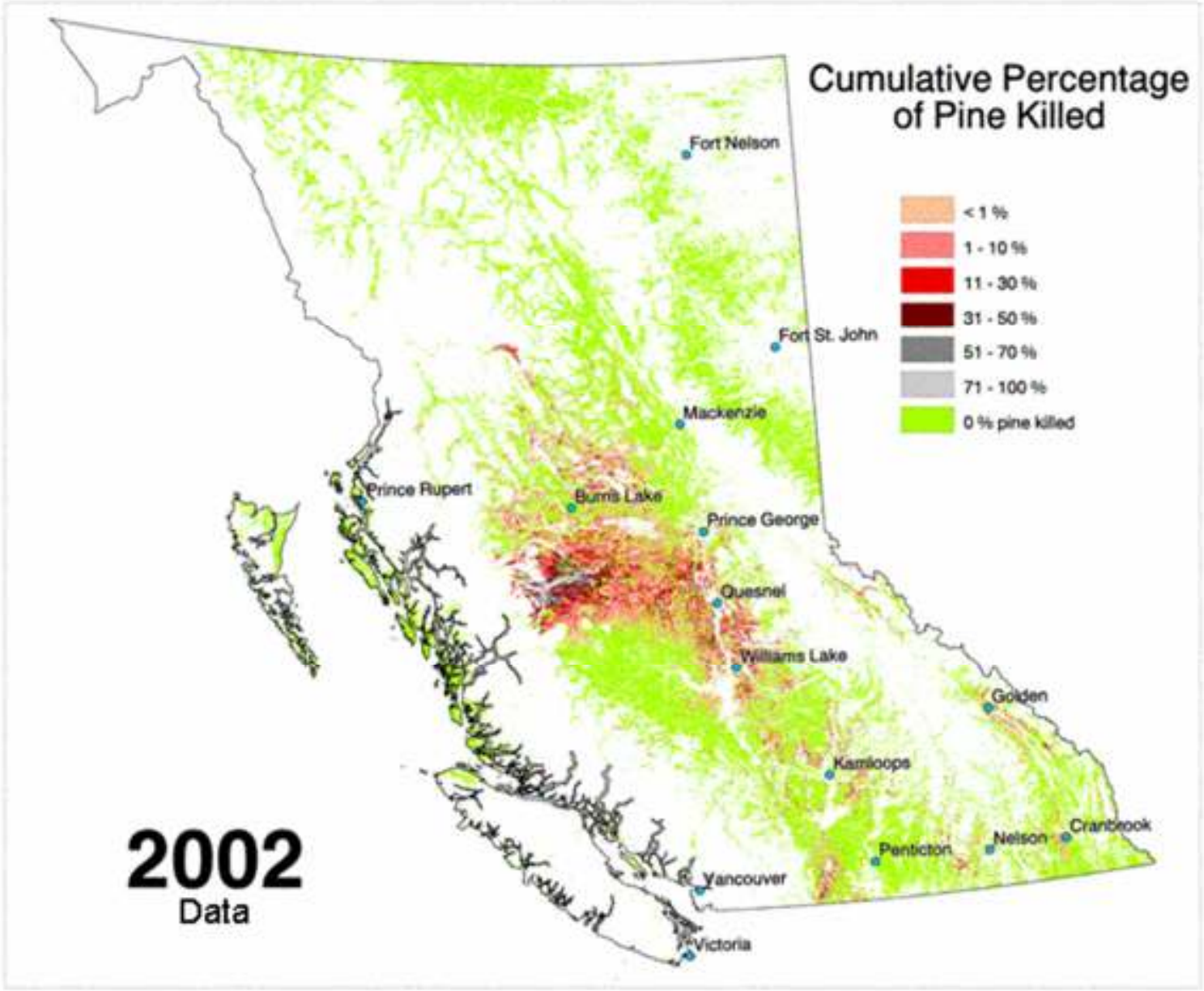

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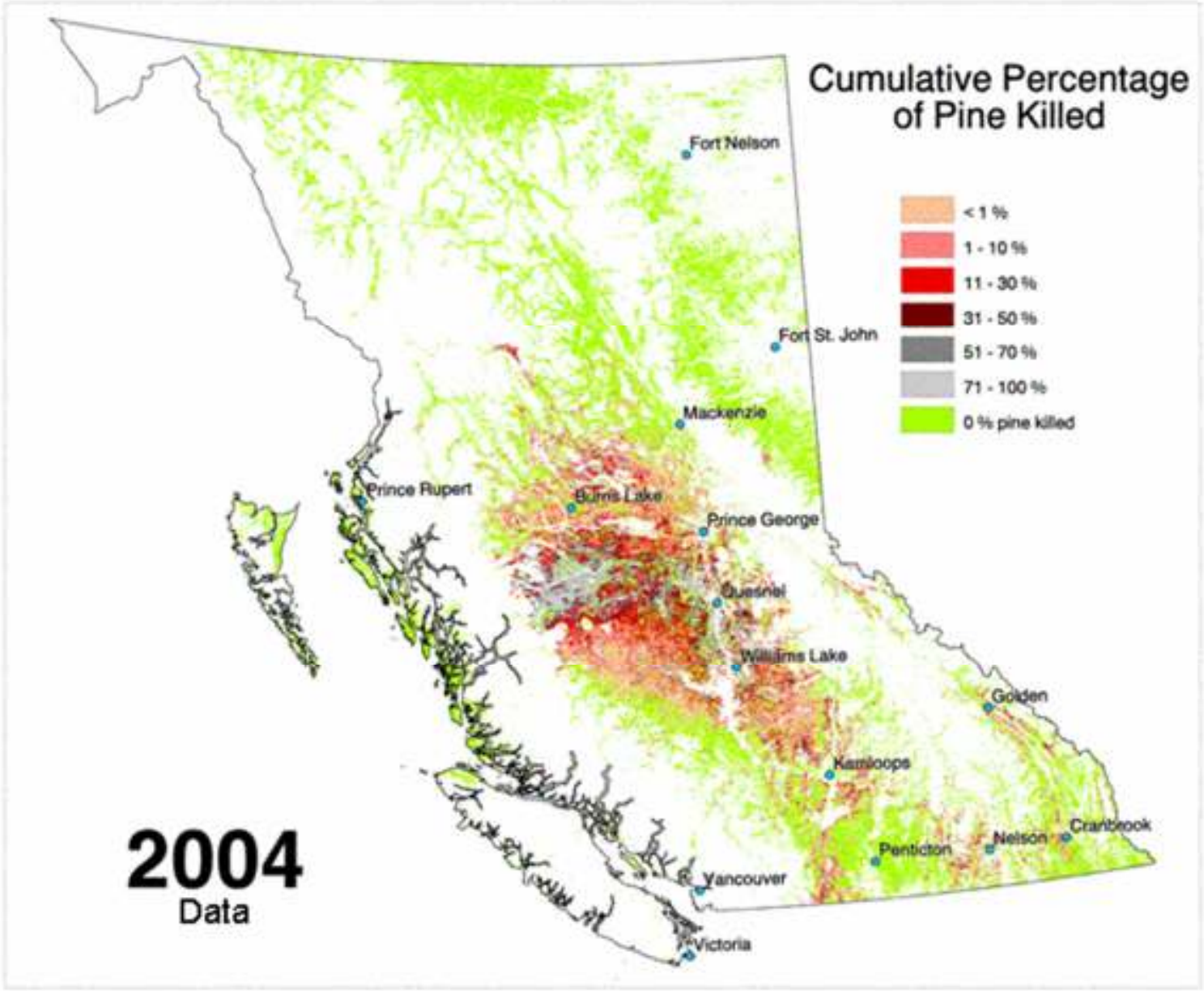

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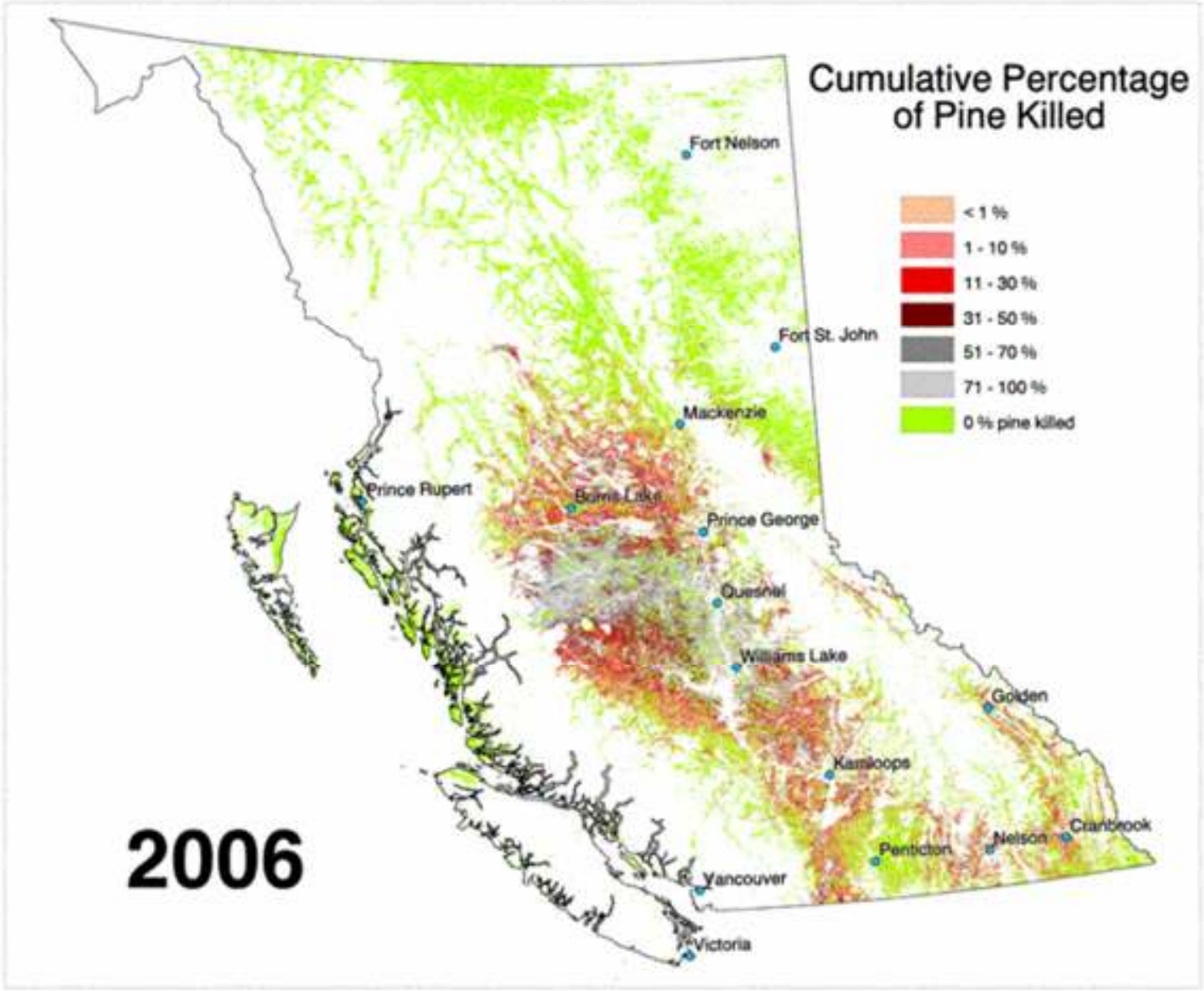

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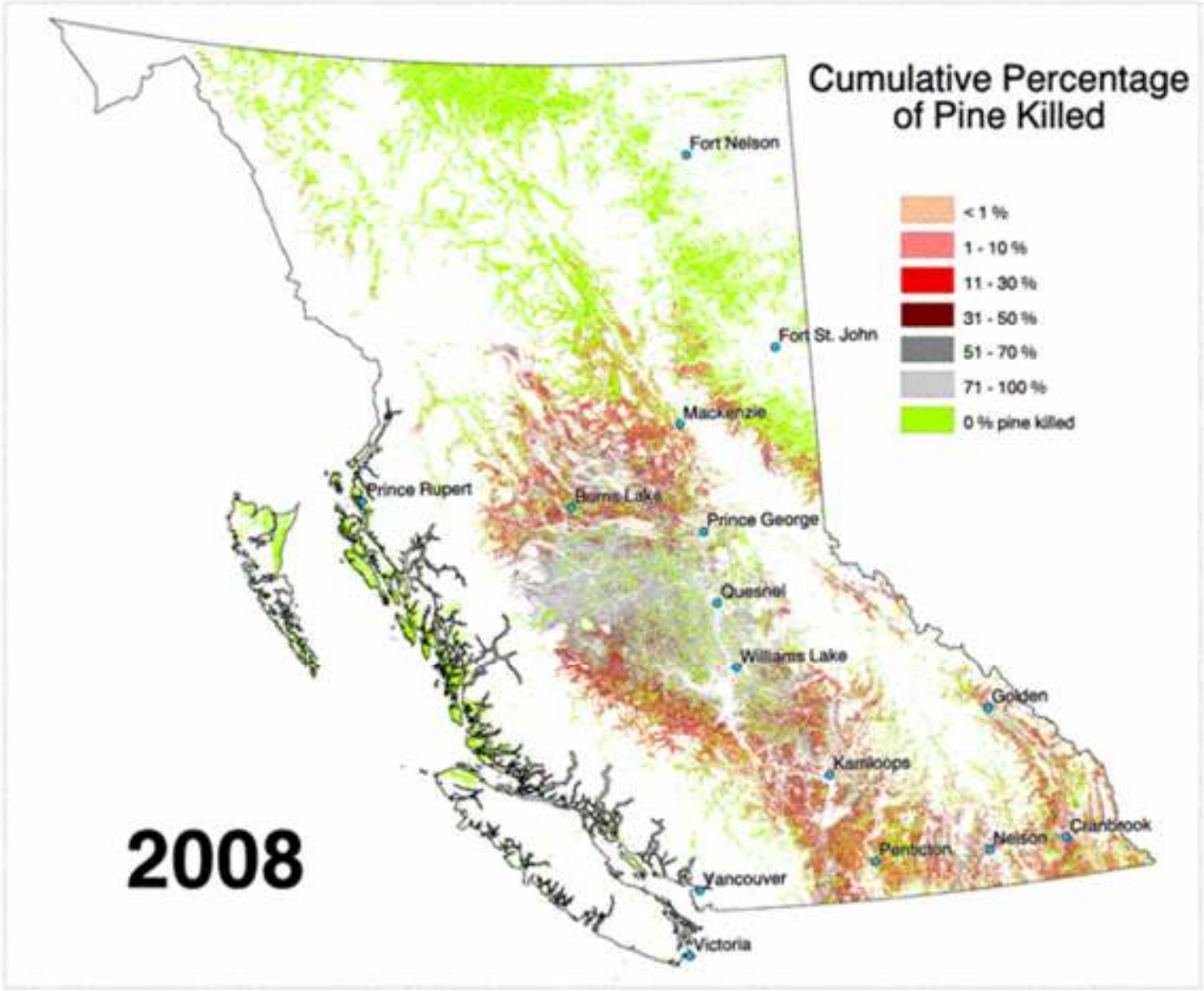

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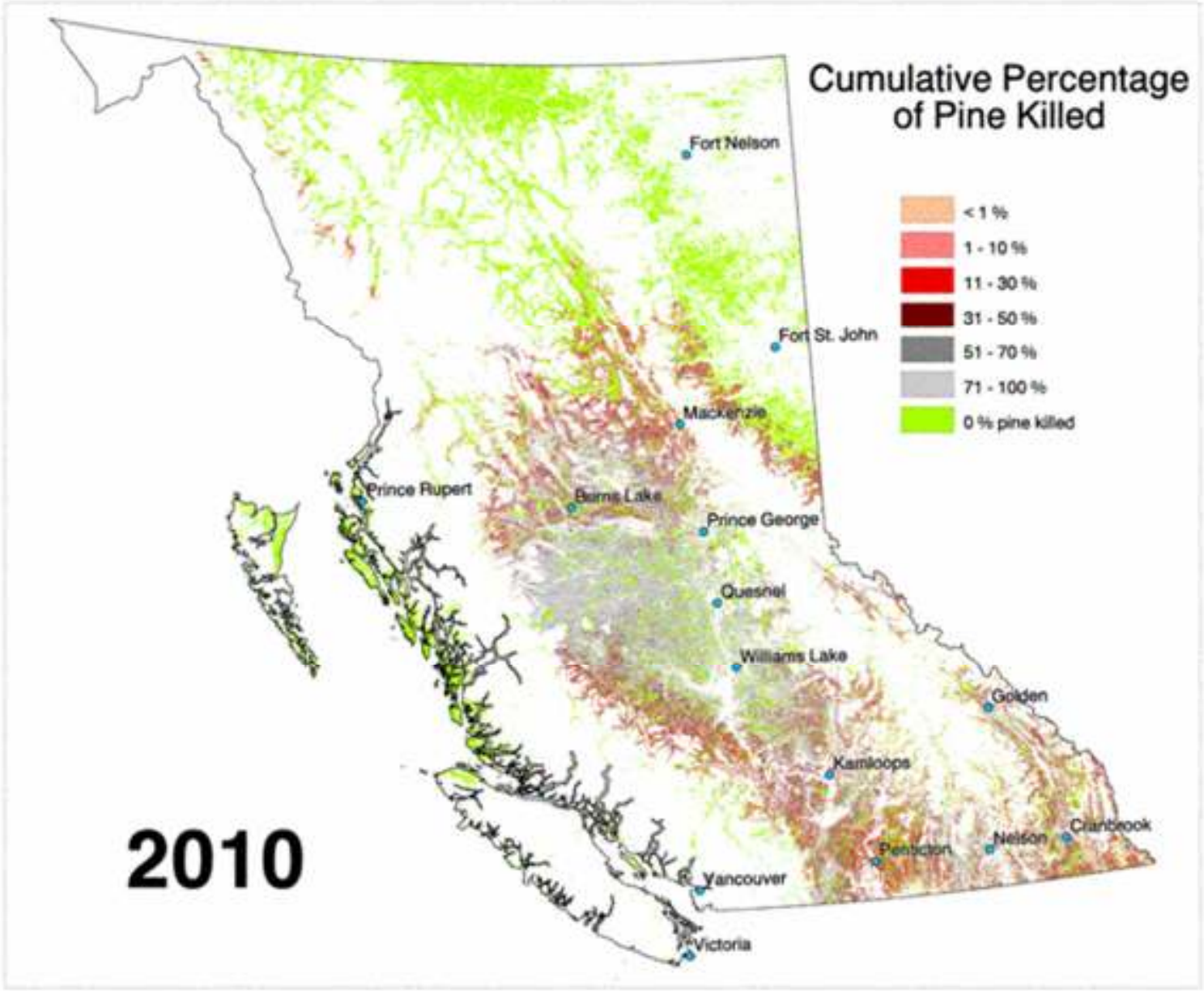
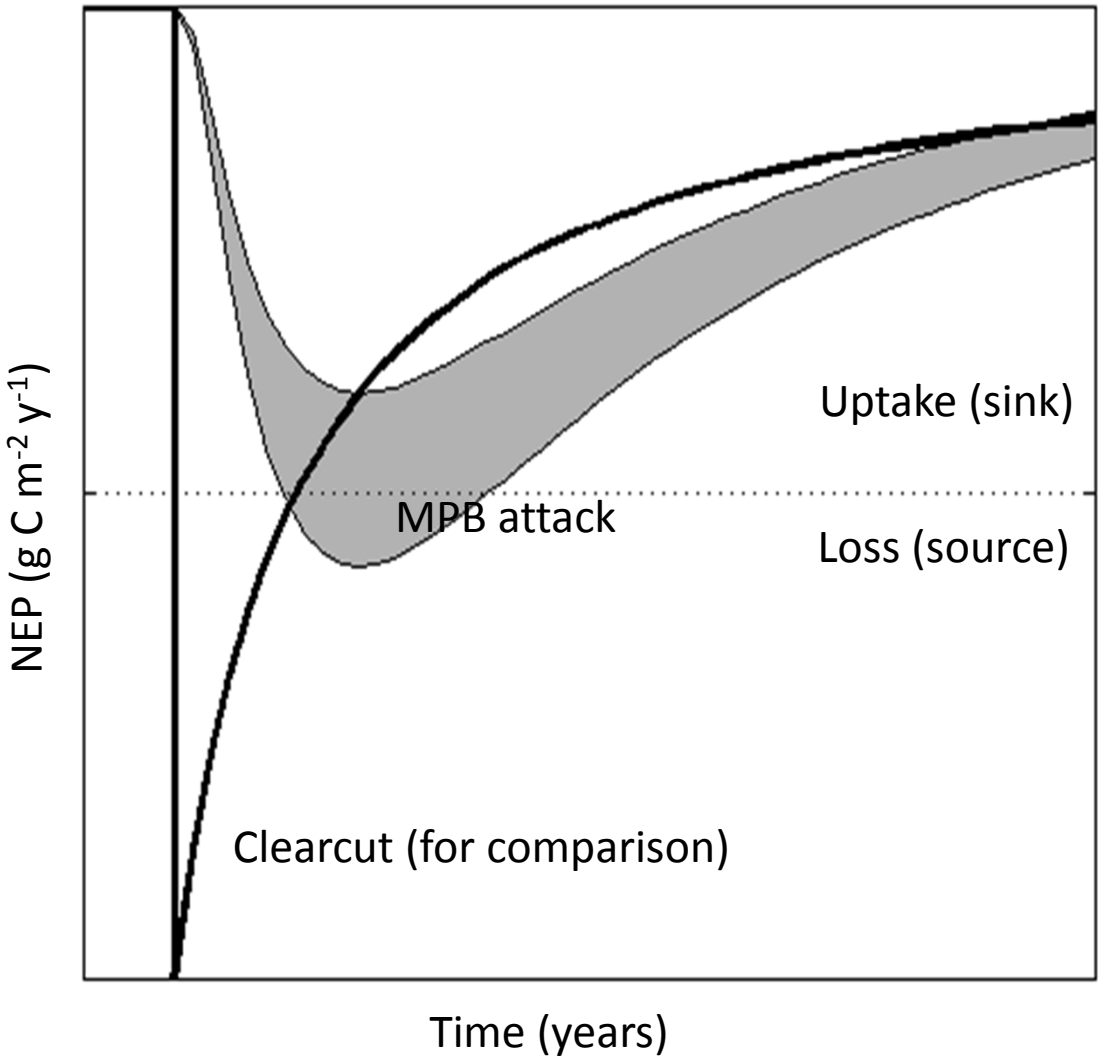


Eddy covariance approach – Insect epidemics



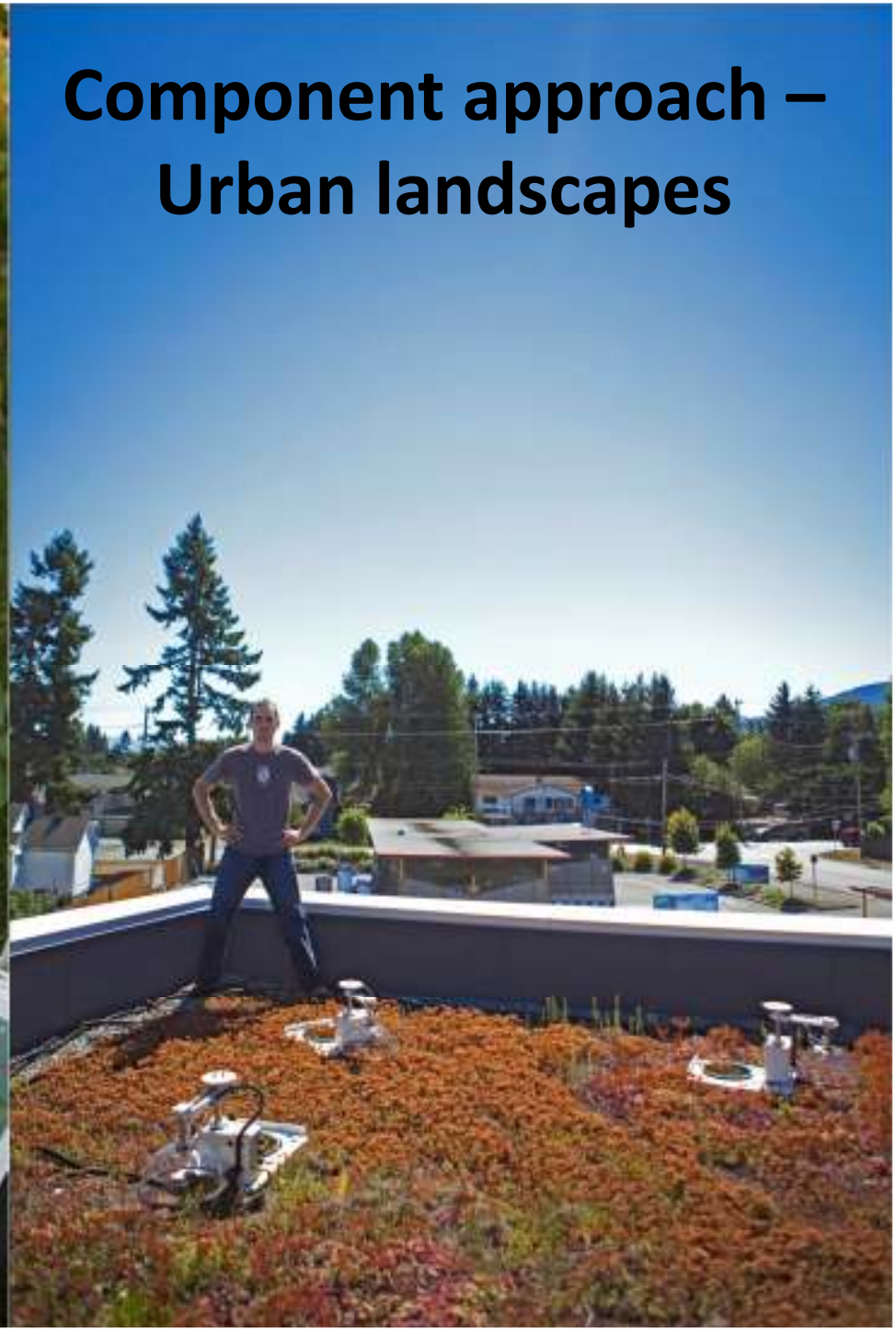
Component approach – Urban landscapes

Component approach – Urban landscapes


Cowichan campus VIU


RDN transit building

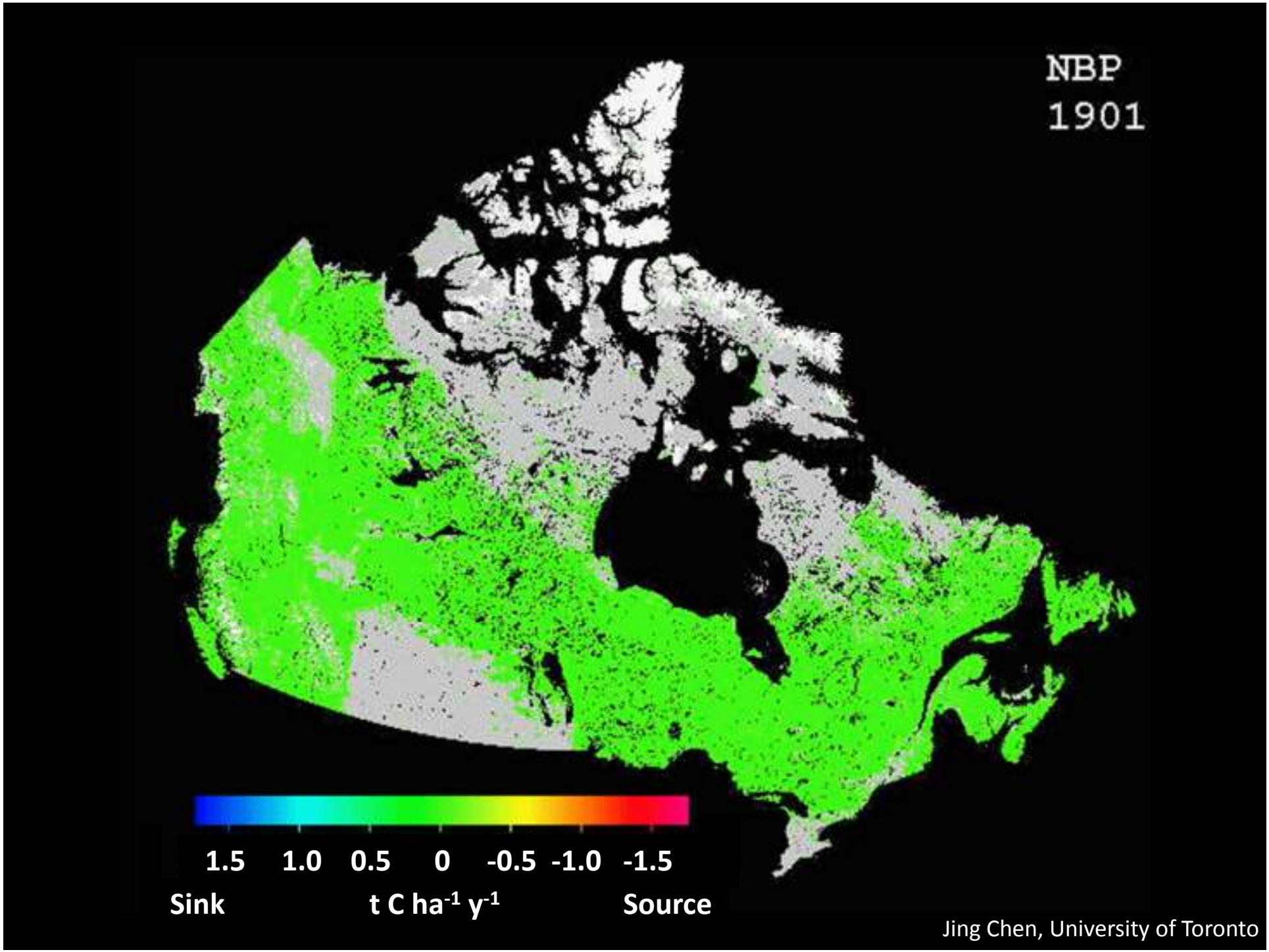
Component approach – Urban landscapes



Net Biome Productivity (NBP)

Integration of carbon sequestration (NEP) across the landscape taking into account:

- **Vegetation diversity**
- **Soil characteristics**
- **Climate**
- **Disturbances**
- **Management practices**
- **Urban landscapes (?)**


NBP
1901
1.5 1.0 0.5 0 -0.5 -1.0 -1.5
Sink
t C ha-1 y-1
Source
Jing Chen, University of Toronto