

# Boreal Forests

## The Great Lung of the North

11/20/09

1

## Importance of Boreal Forests

- Second largest biome behind tropical forests and occupies 11% of land surface (Bonan and Schugart 1989)
- Contains 13% of carbon stored in biomass 43% of carbon stored in soils (Schlesinger, 1997)
- Pan Arctic Hydrologic Domain is Most Land Dominated and Pristine Ocean System (Vörösmarty 2000)
- Expected to experience the greatest amount of warming; 4-7 °C (<http://www.acia.uaf.edu/default.html>)

11/20/09

2

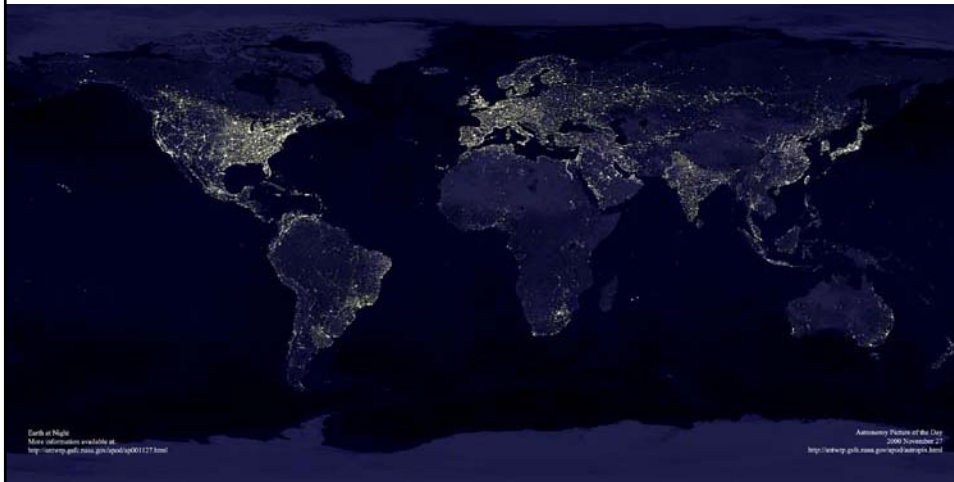
# North American Boreal Forest



11/20/09

3

# Another Method of Spotting the Boreal Forest...



Earth at Night  
More information available at:  
<http://seamless.gis.nasa.gov/epic/epic01127.html>

Anniversary Edition of the Day  
2008 November 27  
<http://seamless.gis.nasa.gov/epic/anniversary.html>

11/20/09

4

## Boreal Forest Characteristics

- ~  $12 \times 10^8$  ha, exclusively in northern hemisphere
- Short growing seasons (50 days), permafrost in areas
- Fire is most important natural disturbance; may burn 25,000-50,000 ha per year
- Soils are Histosols, Entisols and Spodosols

11/20/09

5

## Boreal Forest Characteristics Cont.

- Low species diversity, 9 dominant trees in north American and 14 in Eurasia
- Structural Characteristics include low leaf area index and spiral canopies
- Bryophytes are small amount of aboveground biomass but play important ecological roles

11/20/09

6

## Dominant Trees of the North American Boreal Forest



*Picea mariana*  
black spruce



*Pinus banksiana*  
jack pine



*Populus tremuloides*  
Trembling aspen

11/20/09

7

## Important Bryophytes of the North American Boreal Forest



*Sphagnum spp*  
Sphagnum moss



*Pleurozium schreberi*  
Feathermoss

11/20/09

8



© Robert McCaw



© CWS/SCF



11/20/09



© Tom W. Hall

9

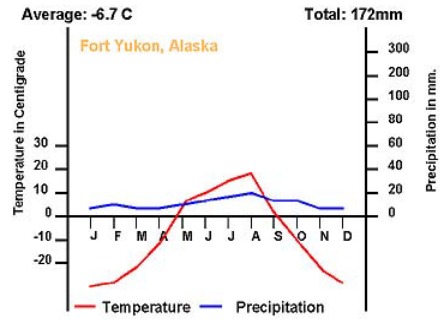
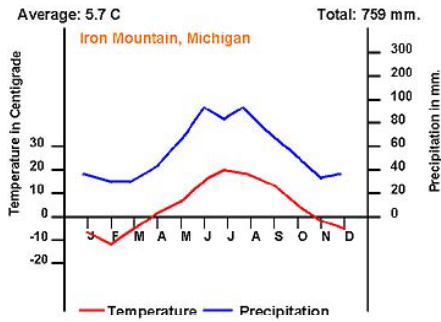
## Boreal Forest Landscapes



11/20/09

10

## Boreal Forests are Cold, Dry, and Wet?



Laramie Annual Precipitation = 277 mm  
Annual Temperature = 4.7 °C

11/20/09

11



If the continental boreal forest receives the same precipitation as a **desert**, then why does it look like a large expanse of **wetland**?

11/20/09

12

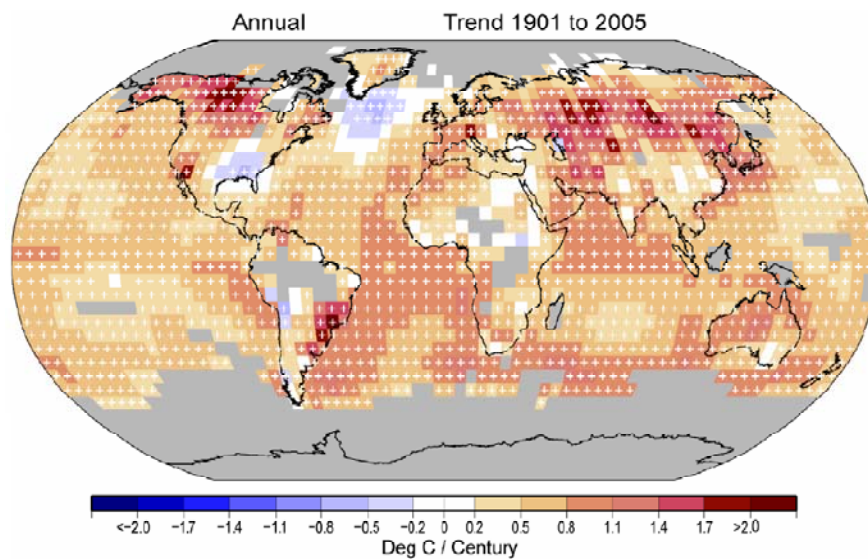
## Reasons for Apparent Wetness in Boreal Forest

- Flat topography
- Water evaporates more slowly in cold climates
- Sphagnum and feathermoss store water, prevent evaporation, and form peat which prevents drainage
- Permafrost prevents drainage and stores water

11/20/09

13

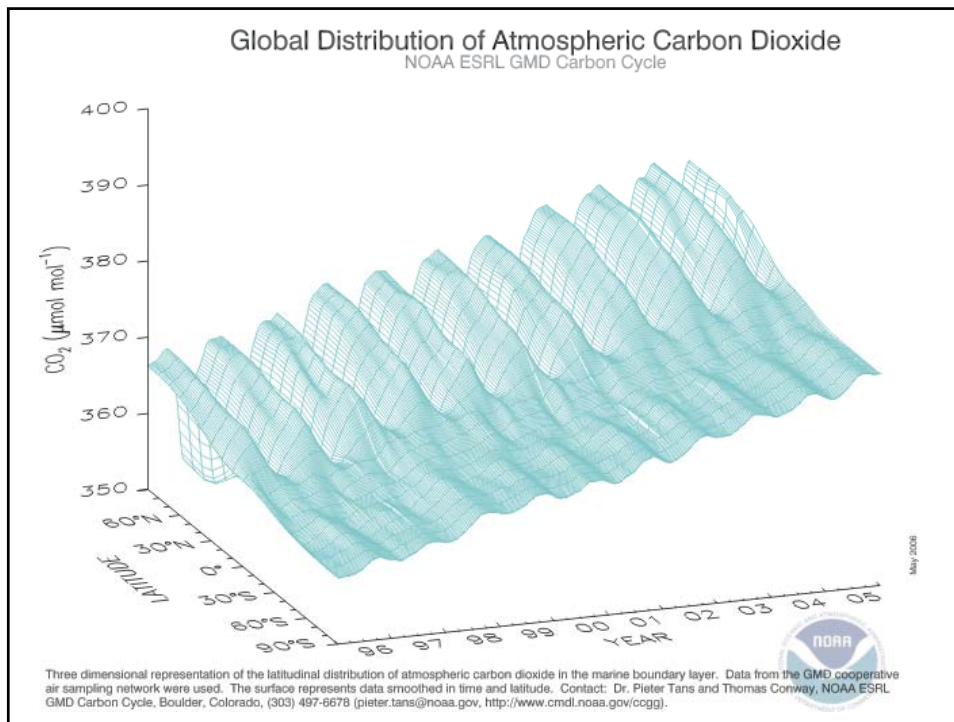
## Climate change and carbon cycling



11/20/09

IPCC 2007

14



Northern high latitudes are warming and greening

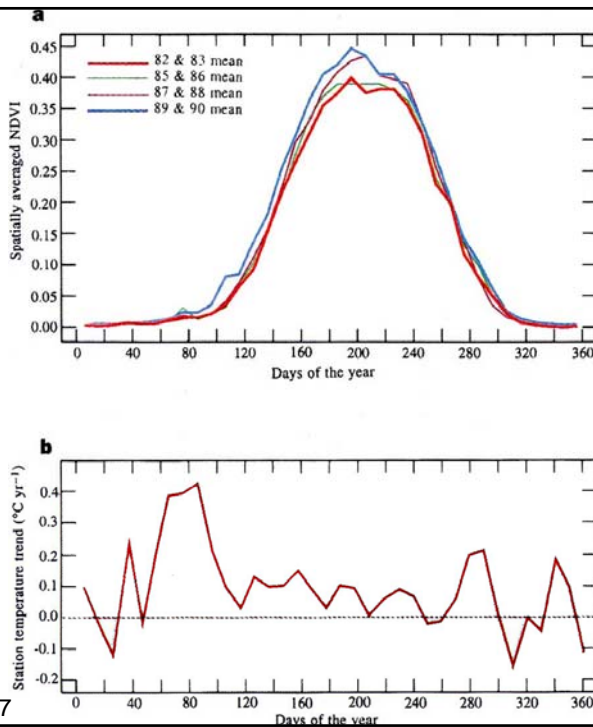
**NDVI** = Normalized Difference Vegetation Index,

- Ratio of red to near infrared wavelength reflectance,
- Indicates “greenness”
- Measured from satellites since early 1980’s

**Warming** is pronounced in spring and fall, lengthening the growing season

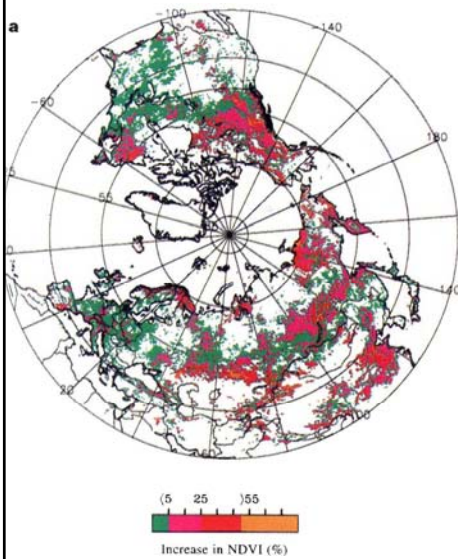
11/20/09

Myneni et al., 1997



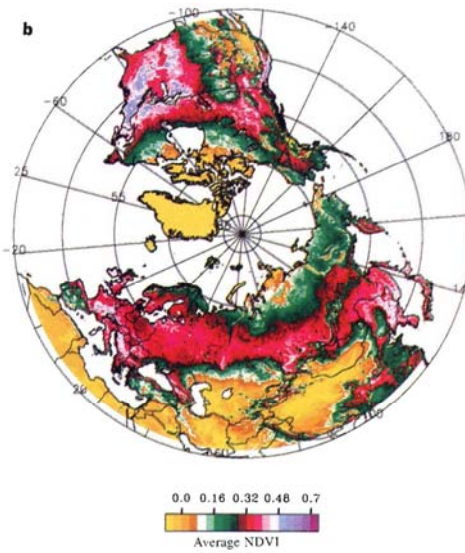


### NDVI is increasing at high latitudes



11/20/09

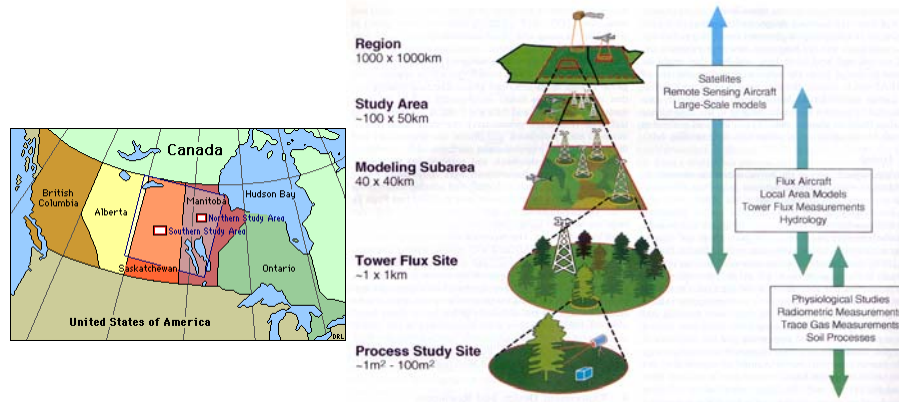
### Average NDVI for 1990's



17

Myneni et al., 1997

## Boreal Ecosystem Atmosphere Study (BOREAS)

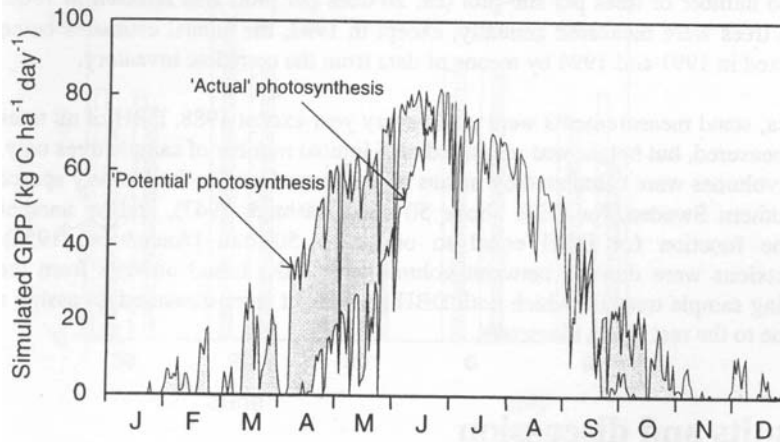


What are some advantages and disadvantages of the BOREAS experimental design to address questions about global change?

11/20/09

18

## Photosynthesis in Boreal Forest Requires Winter Recovery Period

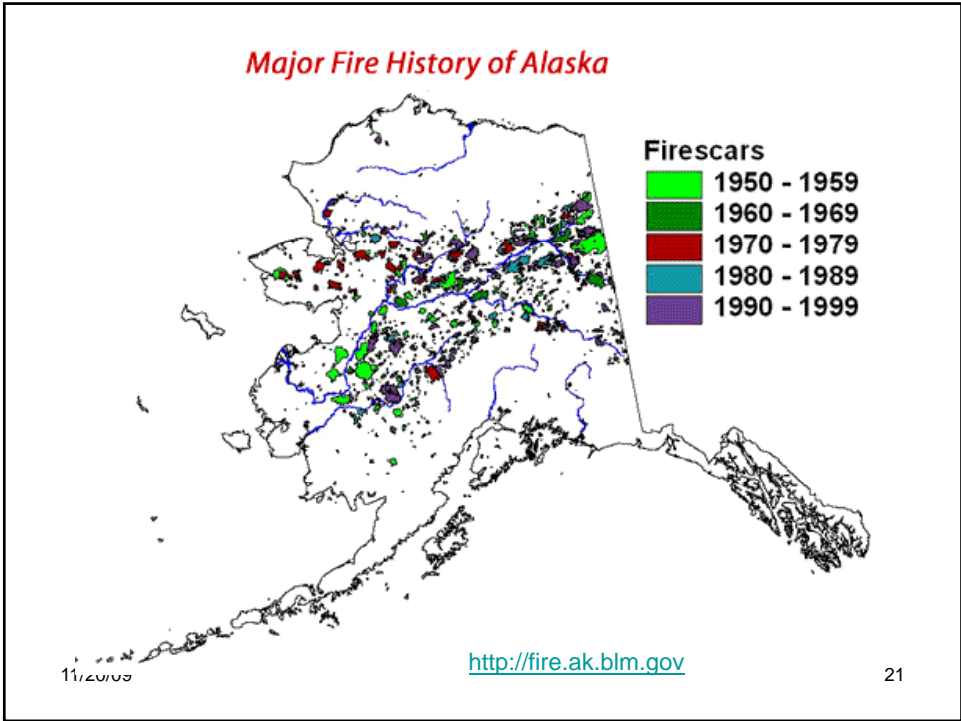


11/20/09

Bergh et al. 1999



### Major Fire History of Alaska









## Effects of Boreal Forest Succession on Annual Water and Carbon Fluxes

Burn Year	Age of Stand	Leaf Area Index	Transpiration (mm yr <sup>-1</sup> )	NPP (g m <sup>-2</sup> yr <sup>-1</sup> )
1989	11	0.4	24	189
1981	20	1.4	97	521
1964	36	2.0	224	373
1930	80	7.5	332	295
1850	150	6.1	183	229

Annual Precipitation  
= 400 mm

Medicine Bow Mountains  
Annual Transpiration ~ 200 mm  
with LAI = 7.3 and Annual Precipitation  
= 580 mm

11/20/09

28

*B. Ewers, unpublished data*