Global Boreal Forest Responses to Climate Change

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Long-term normal circulation in the North Pacific

warm air mass

cold air mass

source:
Salmon (1992), On Interannual Variability and Climate Change in the North Pacific
(adapted by G. Juday)
Simultaneous warm and cold anomalies in the Arctic from strengthened meridional flow

*Source:* Salmon (1992), On Interannual Variability and Climate Change in the North Pacific (adapted by G. Juday)
Opposite temperature trends at large-scale northern North American treeline and Interior Alaska

- **reconstructed northern N. America annual**
- **reconstructed Interior Alaska warm season**
- **recorded Interior Alaska warm season**
Negative temperature relationships at climate stations in the boreal region

Summer (Jun - Aug) (annual values)

- Fairbanks, Alaska USA
- Yakutsk, Russia

Mean Annual Temperature (MAT) (smoothed)

- Goose Bay, Labrador, Canada
- Haparanda, Sweden
Correlation of relative tree growth with mean monthly temperatures and monthly total precipitation along central Siberian IGBP Y Transect

**climate effect on growth**
- Good: warm mid summer same yr.
- Bad: wet July same yr.

**Northern treeline**
- Good: warm early summer same yr
- Bad: wet early summer same yr

**Northern taiga**
- Good: warm early summer same yr
- Bad: wet prev. winter, June same yr

**Middle taiga**
- Good: warm spring & summer same yr
- Bad: wet prev. fall, June same yr

**Southern taiga**
- Good: warm spring & early summer same yr
- Bad: warm spring & early summer same yr & prev. fall

**Forest-steppe**
- Good: wet spring & early summer same yr
- Bad: warm spring & early summer same yr & prev. fall
Historic relationship between Siberian larch growth and warm season temperature with climate scenarios in the central Taymyr Peninsula, northern Russia

- **Regional tree ring-width**
- **Recorded temperature**
- **ECHAM scenario**
- **CSM scenario**
Historic and reconstructed relationship between white spruce growth and summer temperature and climate scenarios in central Alaska

- **temperature**
- **regional tree ring-width**

**Fairbanks 2-yr. mean May-Aug temperature (°C)**

- colder
- warmer

**Probable zone of species elimination**

- reconstructed temperature (isotope & density)
- period of instrument record
- period of climate model scenarios

**White spruce radial growth (mm)**

- CCC scenario
- CSM scenario

- Time slice #1
- Time slice #2
- Time slice #3

Year range: 1800 to 2100
Relationship of summer temperatures and relative growth of black spruce on permafrost, Togatelee, central Alaska

- **recorded temperature** (mean of May, Jun, -1Jun, -1Jul)
- **regional tree ring-width**

- NCAR scenario
- CCC scenario

**mean growth**

- warmer
- colder

**probable zone of species elimination**

**year**

**relative radial growth (stdev units)**


11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0

0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6
Historic and scenario July mean temperature at Umiat, Brooks Range foothills, north slope of Alaska

- CCC
- GFDL
- NCAR
- recorded

mean monthly temperature (°C)

year

forest climate

treeline transition zone

tundra climate

Relationship of timing of climate stress to landscape-level tree mortality from outbreaks of spruce bark beetle on the southern Kenai Peninsula

1. Consecutive series of warm summers
3. Large-scale tree death from spruce bark beetle
Energy transfer and temperature variability among major global life regions

- **Cold**
  - Arctic
  - Boreal
  - Temperate
  - Subtropical
  - Tropical

- **Heat**
  - No transfer
  - Maximum transfer
  - Minimal transfer

- Temperature variability
  1. Minimal transfer
  2. Maximum transfer
  3. Minimal transfer
  4. No transfer
  5. No transfer