Increasing carbon dioxide & its effect on forest productivity!

OUTLINE
- Forest productivity
- Climate and forest production
- Global temperature and precipitation trends
- Global trends in CO₂
- Trends by forest types
- Productivity response
- FACE
- Future directions

INTRODUCTION
- Forest ecosystems cover only 27% of the total land surface area, i.e. 3.5 billion ha (FAO, 1995), but they contain over 60% of all carbon stored in the terrestrial biosphere.

- Moreover, more than 85% of the total plant carbon (C) on the earth and between 60±70% of the total soil C is contained in forests (Dixon et al., 1994).
FOREST PRODUCTIVITY

A forest ecosystem's natural capacity to capture energy, sustain life and produce forest resources.

Categorized as gross, net, primary or secondary,

Specific components (leaves, wood, above-ground or below-ground constituents).

CLIMATE AND FOREST PRODUCTION

Finer controls of forest productivity
Beyond the basic requirements,

- Amount of foliage,
- Light-use efficiency of this foliage
- Water availability
- Ambient temperature
- Availability of soil nutrients
- Adaptations of species to extreme temperatures and
- Efficient use of water and nutrients.
Potential limits to vegetation net primary production based on fundamental physiological limits by vapor pressure deficit, water balance, and temperature (from Churkina & Running, 1998; Nemani et al., 2003; Running et al., 2004).

**TEMPERATURE**

- Temperature (heat) controls the rate of plant metabolism. Most biological metabolic activity takes place within the range of 0–50°C.

- The optimal temperatures for productivity coincide with 15–25°C.

- The optimal range of photosynthesis and lethal levels are between 44°C and 52°C.

**GLOBAL TEMPERATURE AND PRECIPITATION TRENDS**

- Global average temperature has increased by 0.8–0.4°C in the past 100 years, and global average precipitation has increased slightly (Barnett, 2004; Houghton et al., 2004; Levitus, 2004).
GLOBAL TRENDS IN CO₂

- An increase of more than 16% during the last 50 years (Keeling & Whorf, 2005).
- Of the approximately 760 Gt C in the atmosphere, photosynthesis by terrestrial vegetation removes approximately 120 Gt, almost 16% of the atmospheric content annually.
- Can return an equivalent amount through autotrophic and heterotrophic respiration (Prentice et al., 2001; Schimel et al., 2001).

Trends by forest types

An increase in temperatures and in growing degree days, between 0°C to 11.7°C and 16%, respectively.

For the northeast of British Columbia (BC), Canada, Alaska, northwestern Canada, northern Eurasia and northwestern Europe Borical forest

TEMPERATE

- Pacific NW of North America, changes in temperature (10.8°C) and precipitation (14%)
- Exceeded the global average during the last century.
- 0.6°C and 1.1°C in the interior of the province, and precipitation has been increasing by 3-4% per decade.
TROPICAL
- Temperature increases averaging 0.26 + 0.05°C since the mid-1970s.
- Decline in precipitation at a rate of 1.0 - 0.8% per decade since 1960.

PRODUCTIVITY RESPONSE
Global and Continental trends
- According to Nemani et al. (2006), globally, NPP seems to have increased by 6% (3.4 Pg C) over last decade but with declines during the major ENSO events.
- The Amazon rain forest accounted for 42% of the 6% global increase in NPP (Lewis et al., 2007b).

PRODUCTIVITY RESPONSE
- Long growing seasons in aspen boreal forests increased the GPP, and evapotranspiration, as it increases the carbon storage (White et al., 1999).
FACE

- A median increase of 23% in NPP has been recorded across sites exposed to elevated CO2 (550 ppm) in comparison with control sites (370 ppm) (Norby et al., 2005).

- The leaf CO2 assimilation and the ecosystem primary production increased across all species.

FUTURE DIRECTIONS

- The contribution of CO2 fertilization to the future global C cycle is uncertain.

- Models that include a feedback between terrestrial biosphere metabolism and atmospheric [CO2] are poorly constrained by experimental evidence.

FUTURE DIRECTIONS

Unresolved questions about

- Carbon partitioning and retention.

- Spatial variation in NPP response caused by availability of other growth limiting resources.