Increasing carbon dioxide & its effect on forest productivity!

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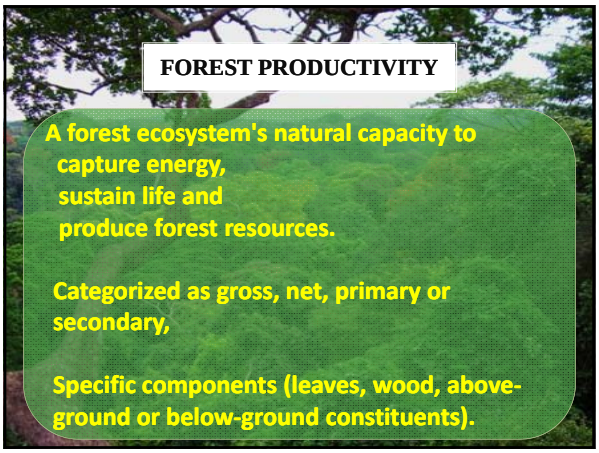
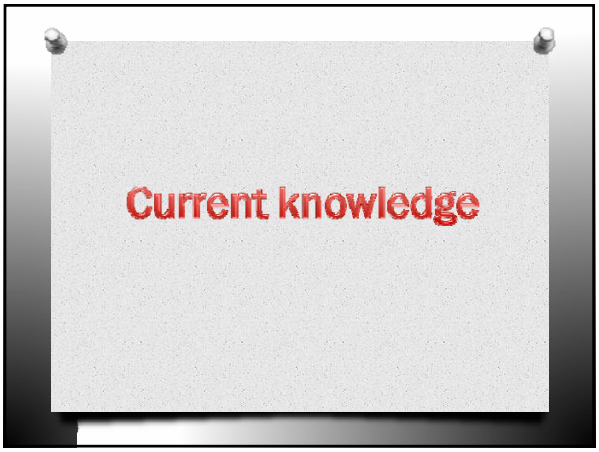
OUTLINE

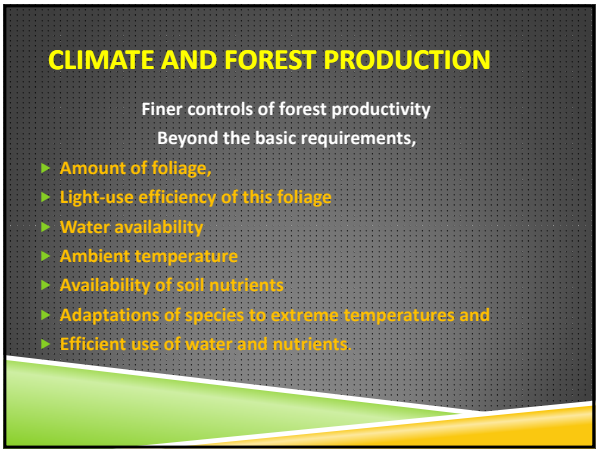
- Forest productivity
- Climate and forest production
- Global temperature and precipitation trends
- Global trends in CO_2
- Trends by forest types
- Productivity response
- FACE
- Future directions

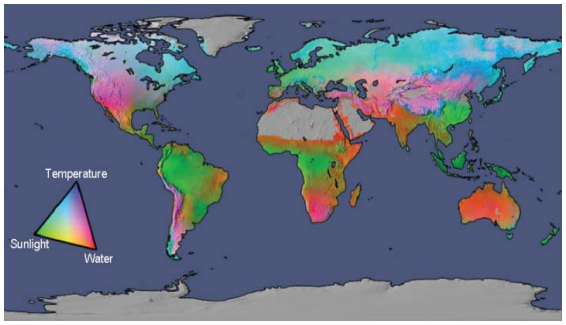
INTRODUCTION

- 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).


Current knowledge


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.

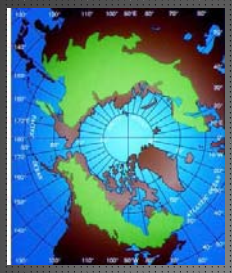
GLOBAL TEMPERATURE AND PRECIPITATION TRENDS

- **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 CO_2

- An increase of more than 16% during the last 50years (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 Boreal 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 2–4% 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.**