Nitrogen additions affect NPP in 3 age stands at a Larix plantation

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Paris, France

Outline

Background

Experimental design

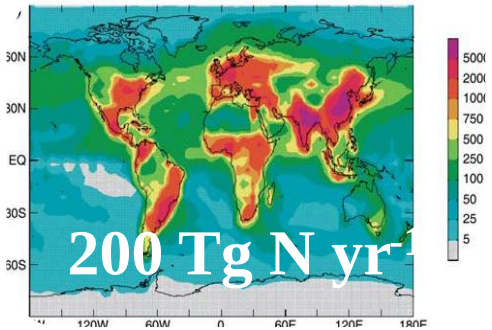
Meterials and methods

Results

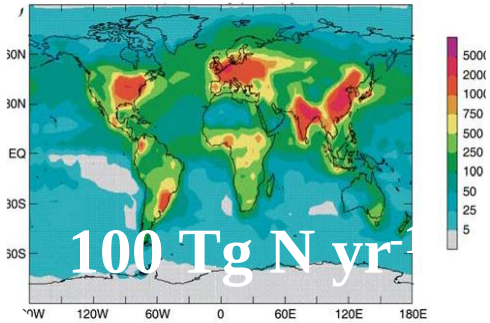
Background

Global nitrogen deposition

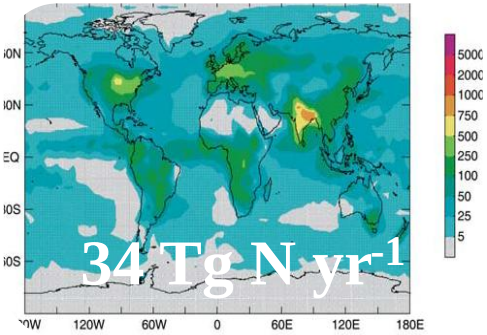
- 2050



- 1990



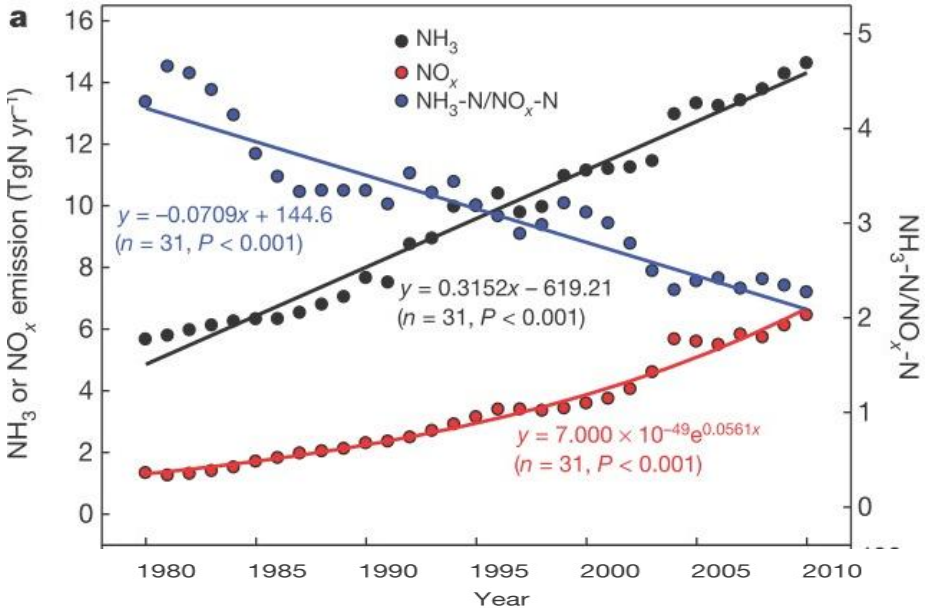
- 1860

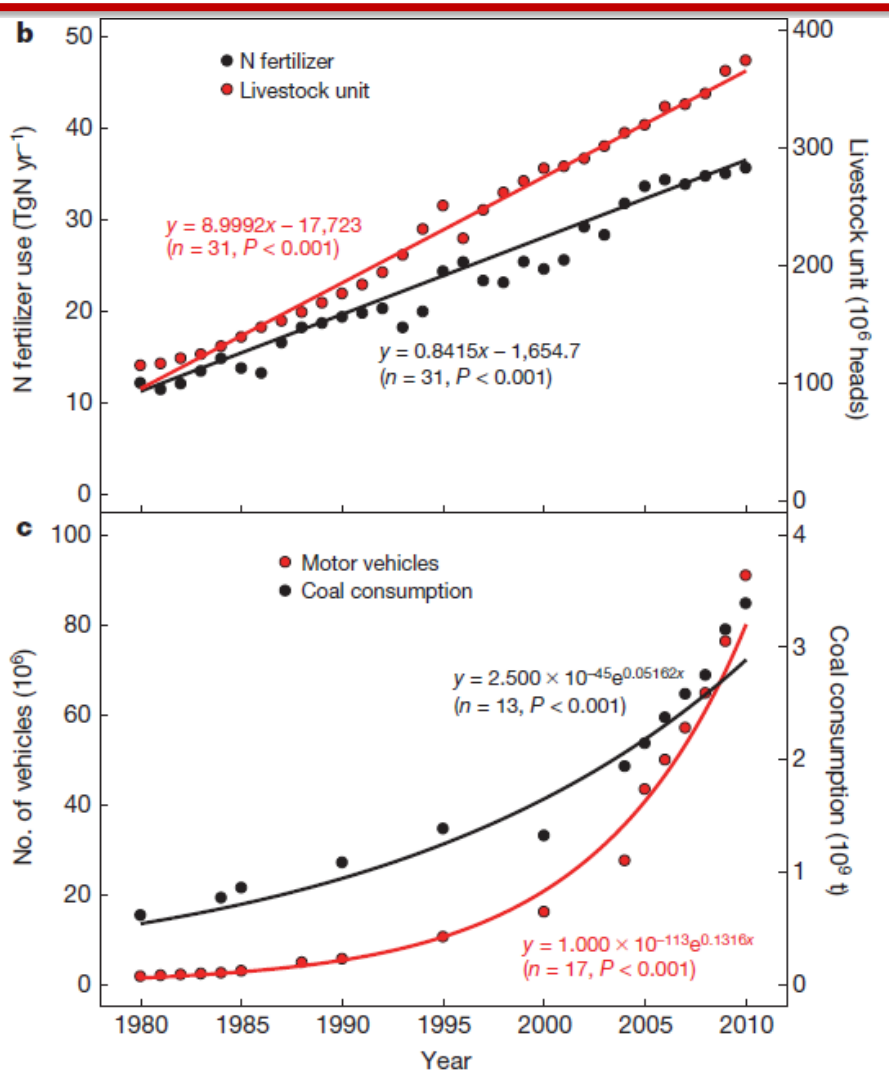


(Galloway et al., 2004 *Biogeochemistry*)

Background

Nitrogen deposition in China





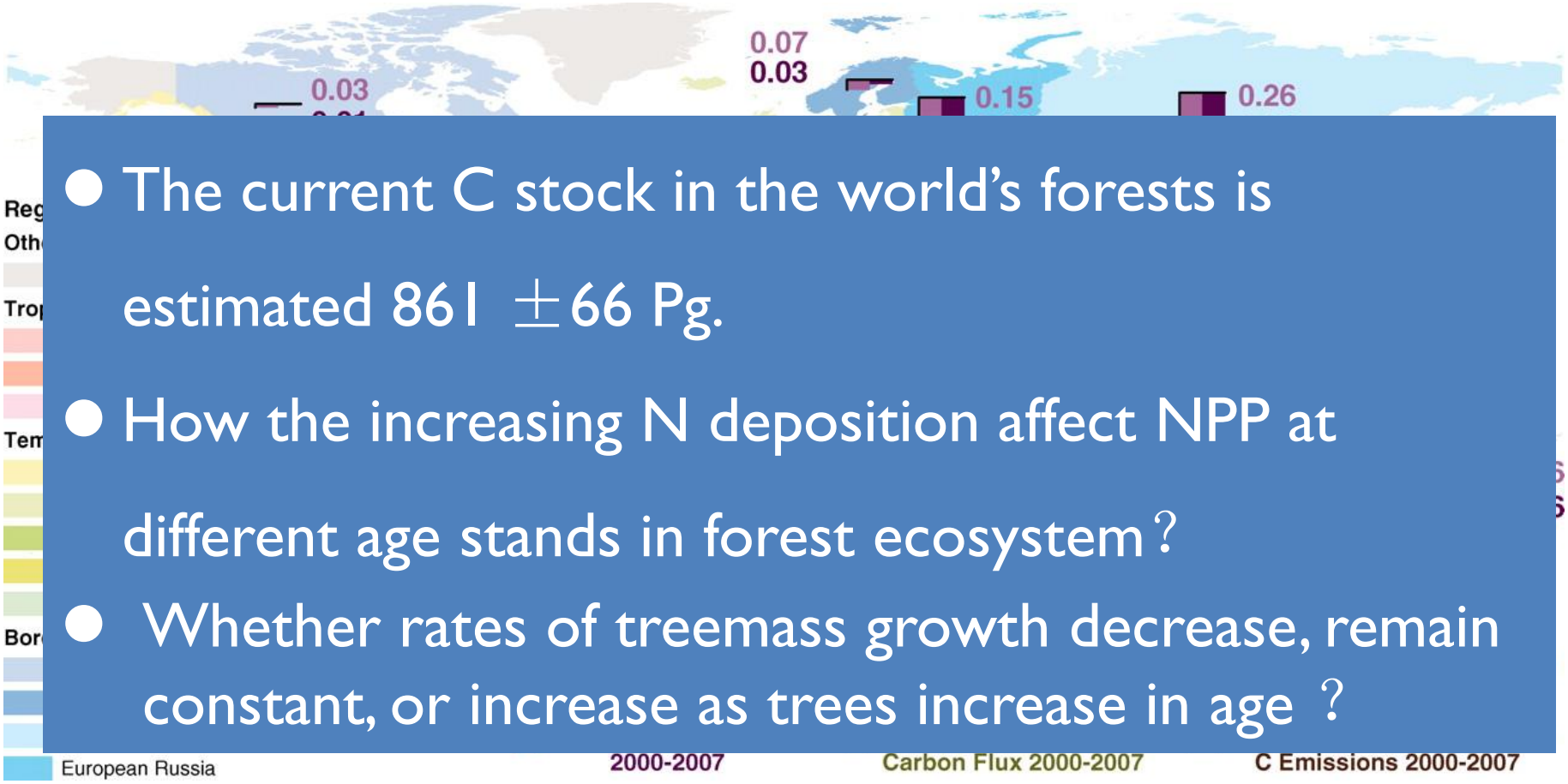
(Liu et al. 2013 Nature)

Background

Tree growth rate and age

- The mass growth rate of individual trees declines with increasing tree size
- Mass growth rate should increase continuously with tree size

Background



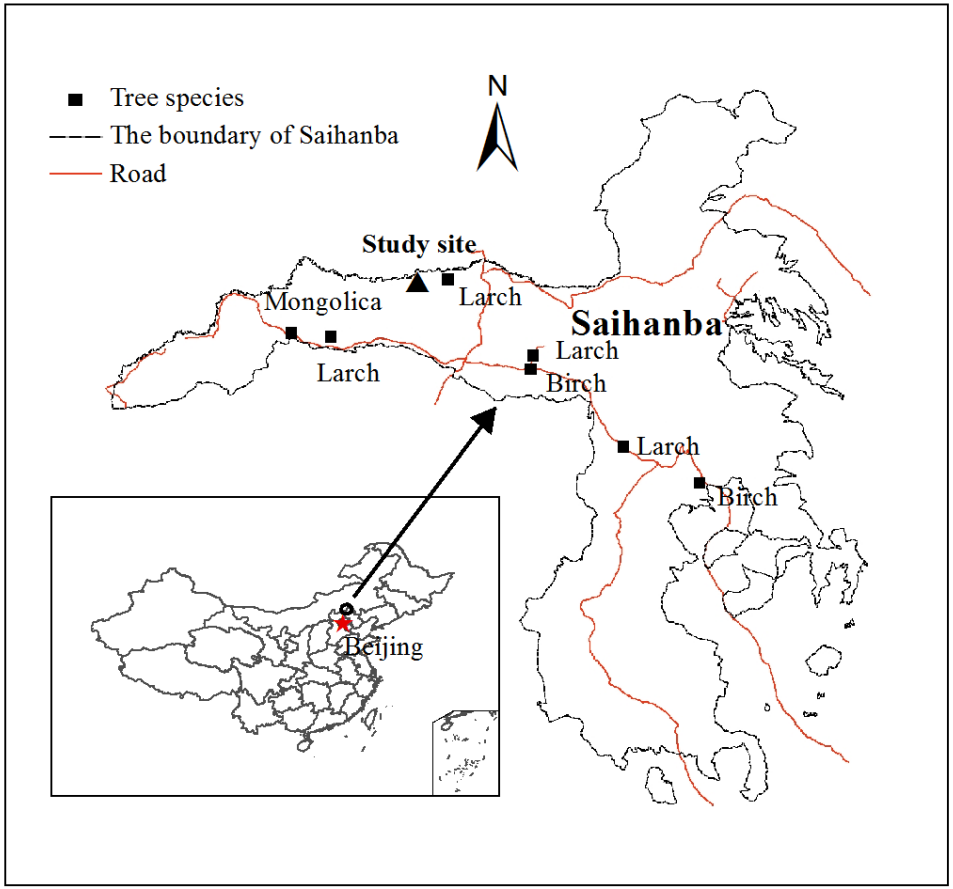
- The current C stock in the world's forests is estimated 861 ±66 Pg.
- How the increasing N deposition affect NPP at different age stands in forest ecosystem?
- Whether rates of treemass growth decrease, remain constant, or increase as trees increase in age ?

Carbon sinks and sources (Pg C year^{-1}) in the world's forests.

(Pan et al., 2011 *Science*)

Experimental design

Study site



Geographic position

Entrance of the park

Experimental design

Three age stands

- **Forest age**
  - Mature (45yr)
  - Young forest (20yr)
  - Sapling(10yr)

Experimental design

Indices of forest structure of three age stands

	Tree density (stem ha)	DBH (cm)	Height (m)	Basal area (m ha)
Mature	870±48	19.9±2.8	15.8±1.6	48.54±3.10
Young	3160±129	7.6±0.1	7.8±0.3	58.35±7.30
Sapling	2640±157	2.4±0.3	2.5±0.2	7.46±1.66

Experimental design

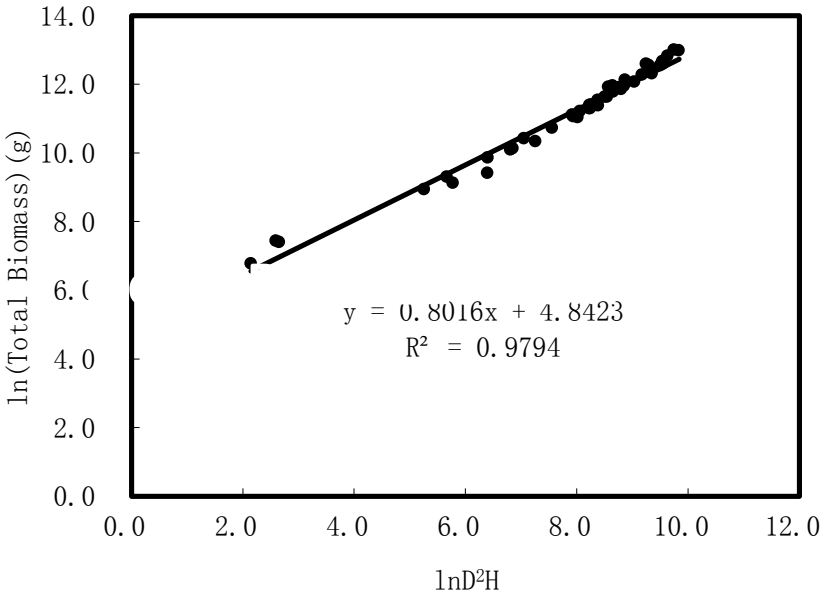
Three nitrogen additions

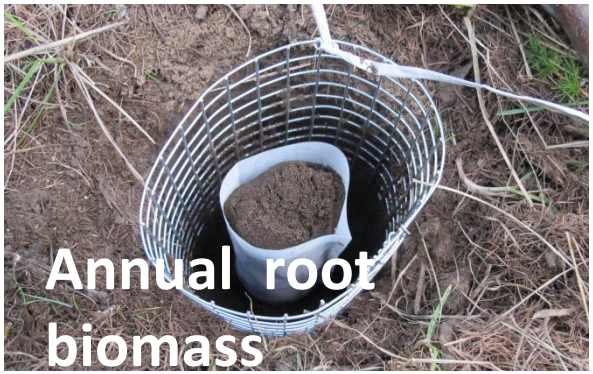
- **Nitrogen addition gradients**
  - CK (0 kg $ha^{-1}yr^{-1}$)
  - N20 (20kg $ha^{-1}yr^{-1}$)
  - N50 (50kg $ha^{-1}yr^{-1}$)

Meterials and methods

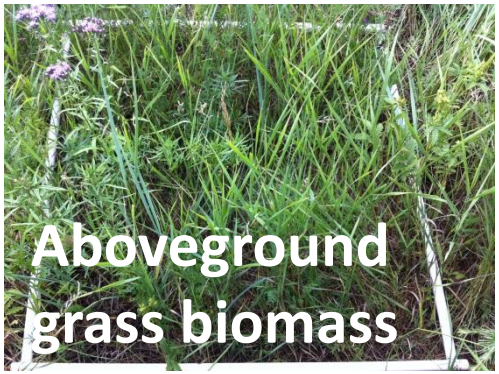
Measurement of forest NPP

Measurement of DBH





Annual root biomass



Aboveground grass biomass

Meterials and methods

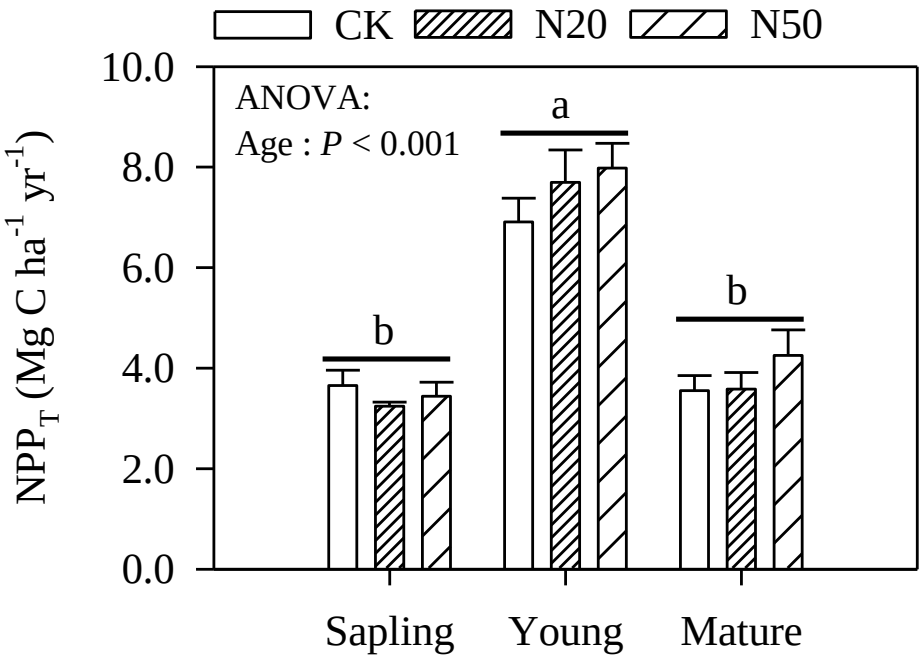
Measurement of litterfall and forest NPP

$$NPP_T = (W_T - W_T') \times c_1 + W_G \times c_2 + W_R \times c_3 + W_L \times c_4$$

Where W_T and W_T' (kg ha^{-1}) are the woody biomass in a plot at the end and the beginning of the local growing season, respectively. W_G, W_R and W_L (kg ha^{-1}) are the understory plants biomass, root biomass from tree and grass, and litterfall mass, respectively, in a plot. ci is the average carbon content in biomass (c_1 = 0.49, c_2 = 0.44, c_3 = 0.425, c_4 = 0.50).

Results

——NPP at 3 age stands



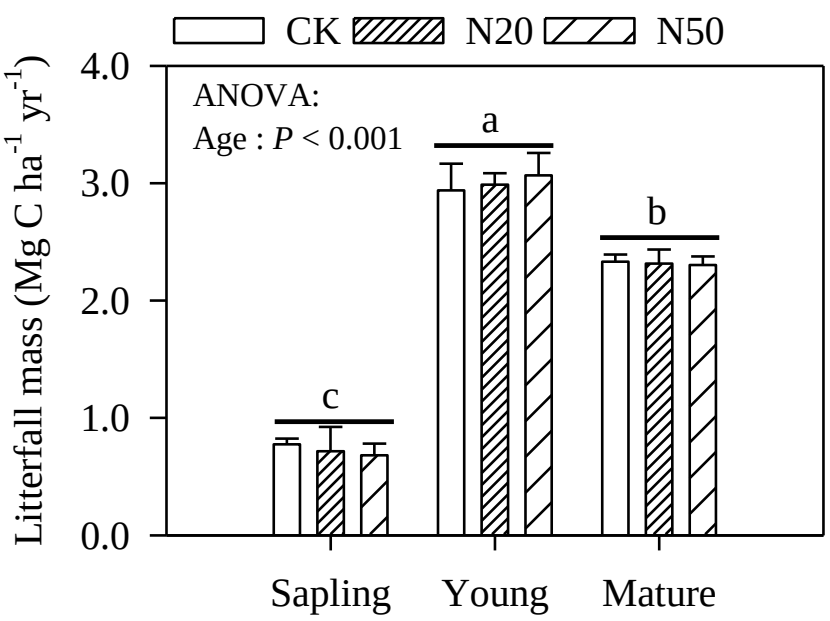
Mean annual NPP_T in 3 age stand forests across 4 years from 2010 to 2013.

- Average NPP_T in young forest was significant higher than those in sapling stand ($P < 0.001$) and mature stand ($P < 0.001$).

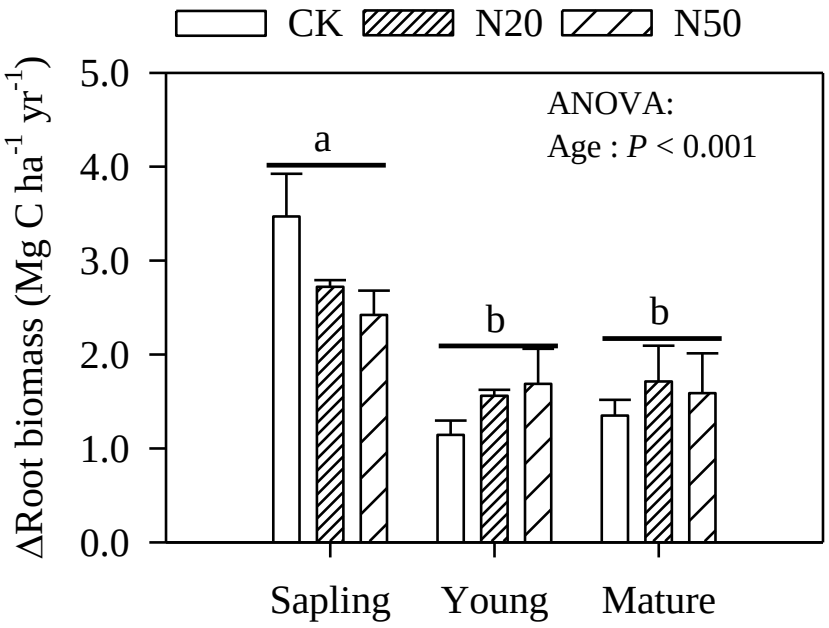
Results

——NPP at 3 age stands

annual littlefall and root biomass



Mean annual litterfall masses in 3 age stand forests across 4 years from 2010 to 2013.

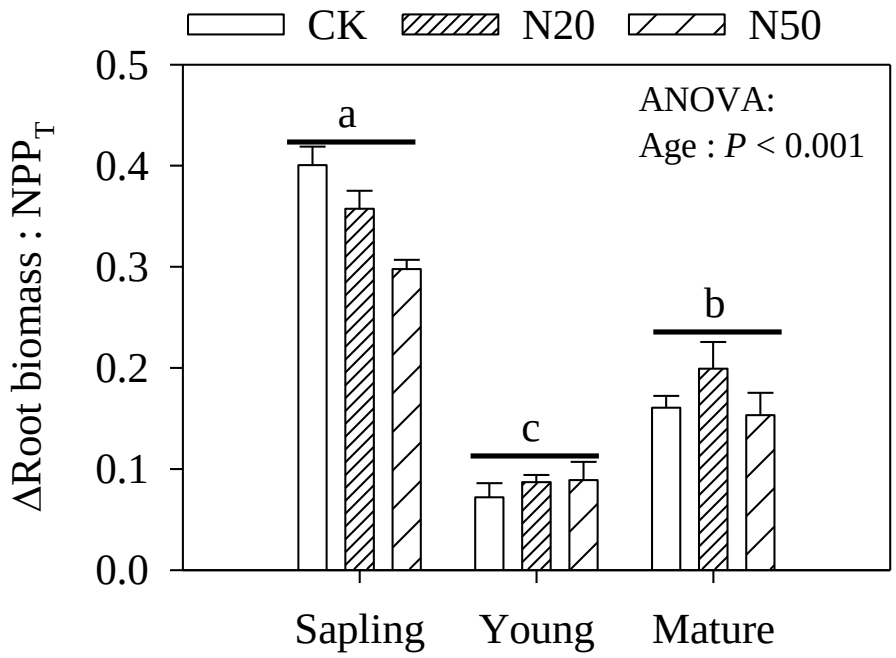


Mean annual root biomass in soil above 40 cm in 3 age stand forests across 3 years from 2011 to 2013.

Results

——NPP at 3 age stands

The ratio of annual root biomass and NPP_T



- Sapling > Mature > Young ($P < 0.001$)

The ratio of annual root biomass and NPP_T in three age stands across four years from 2010 to 2013.

Results

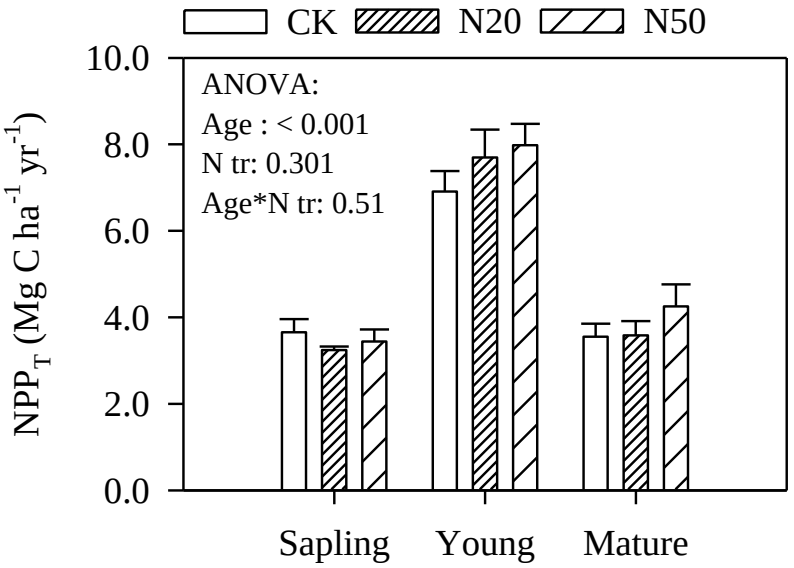
——NPP at 3 age stands

Short summary

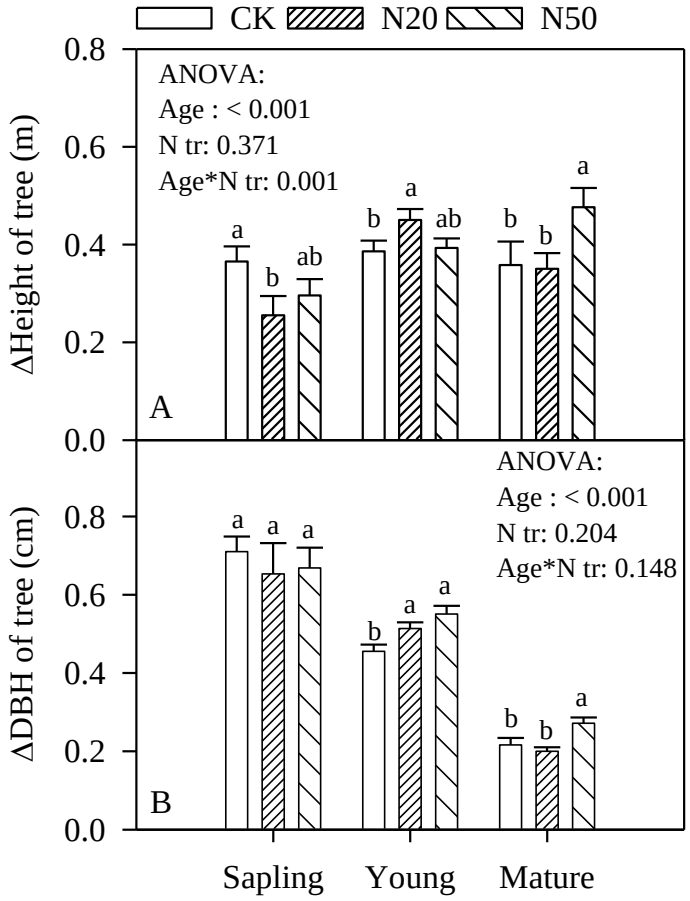
- Forest NPP increase from 10-year-old to 20-year-old, and then decrease at 45-year-old.
- The trends of annual litterfall masses were: Young > Mature > sapling. Annual root biomass in sapling stand was higher than those in young and mature stands.
- Sapling stand has highest ratio of annual root biomass and NPP, followed by mature and yound stand. The differences in the shifts of the carbon allocation to forest above and belowground among 3 age stands maybe the explaination of the aging related change in NPP.

Results

——The effects of N addition on NPP in 3 age stands



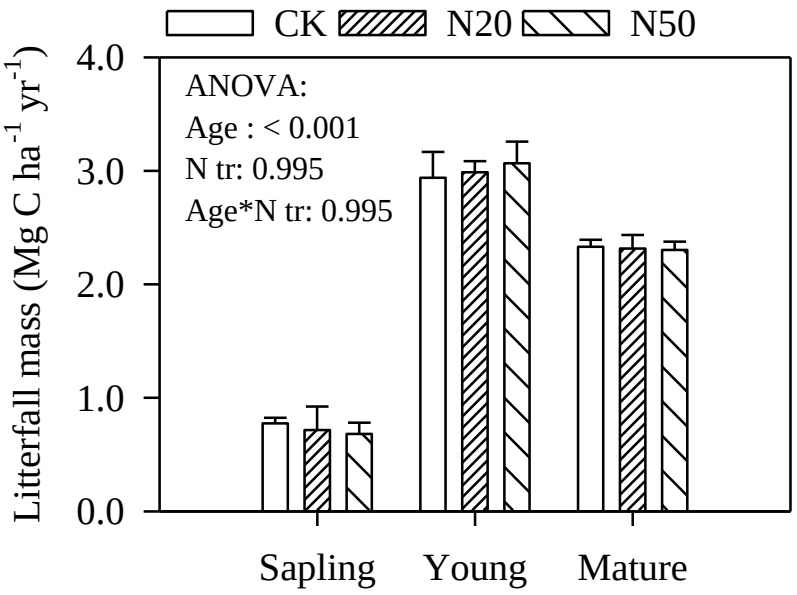
Mean annual NPP_T , tree hight and DBH under 3 N addition treatments in 3 age stand forests across 4 years from 2010 to 2013.

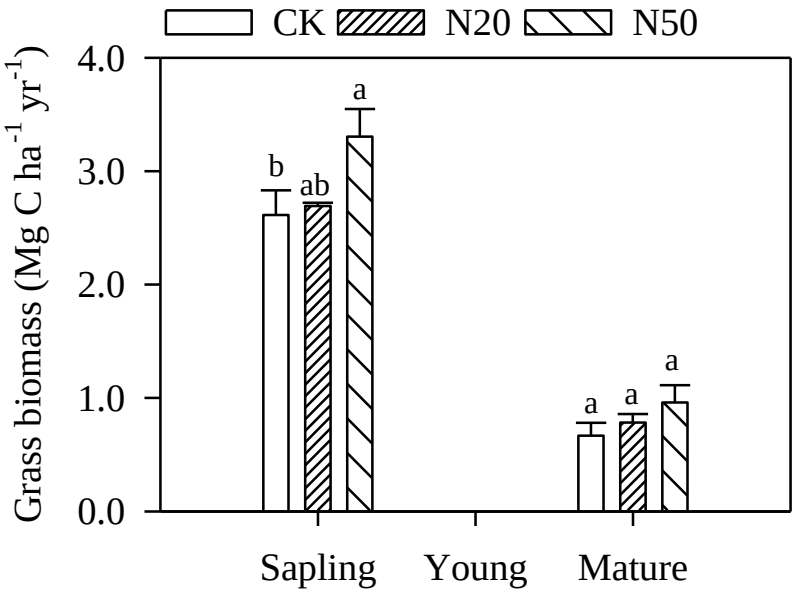


Results

——The effects of N addition on NPP in 3 age stands

Grass biomass and littlefall



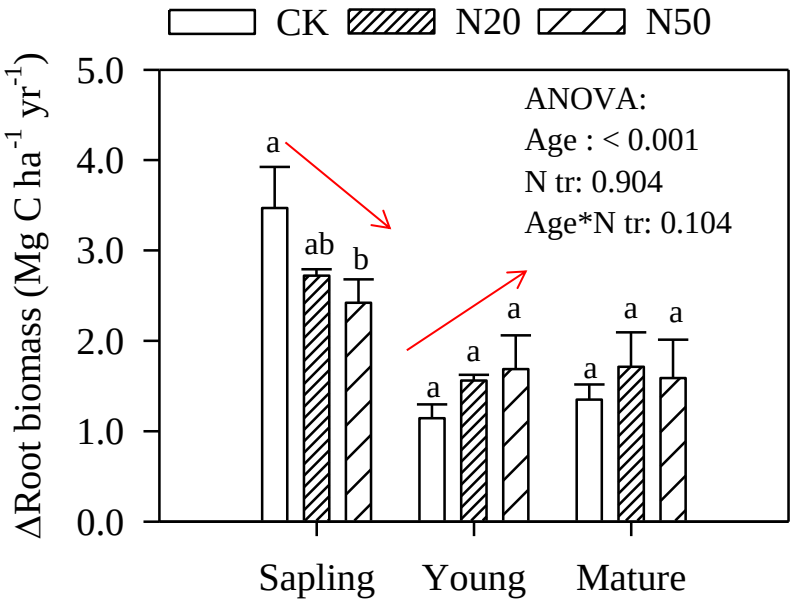


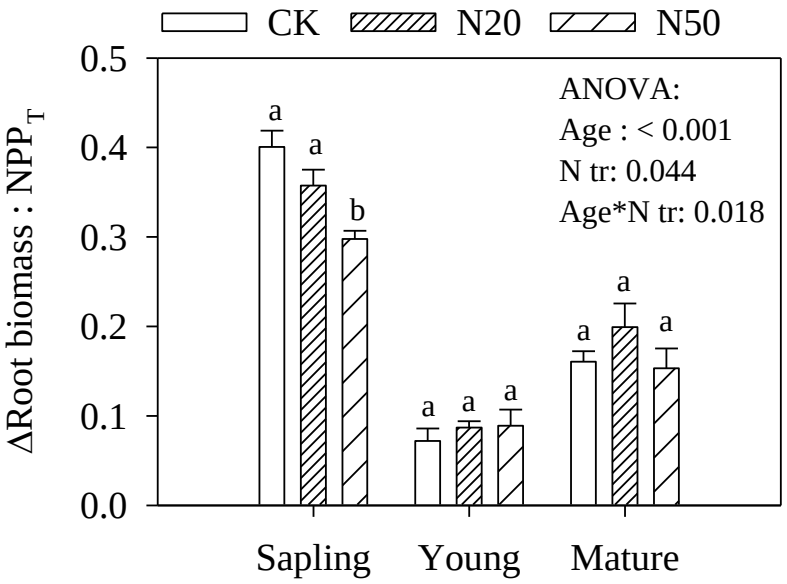
Mean annual grass biomass and litterfall masses under 3 different N addition treatments in 3 age stand forests across 4 years from 2010 to 2013.

Results

——The effects of N addition on NPP in 3 age stands

Annual root biomass and the ratio of annual root biomass and NPP_T





Mean annual root biomass in soil above 40 cm and the ratio of annual root biomass and NPP_T under 3 N addition treatments in 3 age stand forests across 3 years from 2011 to 2013.

Results

——The effects of N addition on NPP in 3 age stands

Short summary

- Forest NPP were not incluenced by N addition in 3 age stands. However, N addition increased annual increment of tree height and DBH in young and mature stands, decreased annual tree height in sapling stand, while no significant N effects on annual tree DBH increment in sapling stand.
- In sapling stand, high-N treatment significantly increased annual aboveground grass biomass.
- Nitrogen addition decreased annual increment of root biomass and the ratio of annual root biomass and NPP_T in sapling stand.

Sampling photos


Thanks for your attention !
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