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Age-dependent effects of climate change on the growth and productivity of larch plantations using process-based model and NFI data

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Outline

1. Background and objectives
2. Data and methods
3. Model assessment and simulation
4. Discussion and conclusions

Background and objectives

- The effects of climate change on the growth, structure and function of forest ecosystem have been largely observed and modelled.

- There is great uncertainty in the direction and magnitude of the effects partly owing to modelling methodology, climate scenarios, region, forest types, development stage, scales and knowledge gap.

(Medlyn et al. 2011; Vose et al., 2014； Reyer et al., 2015; Dai et al., 2016)

Background and objectives

- Stand and tree characteristics can modify how tree responds to climatic variables at different spatial scales.
- Tree-ring based dendroclimatological studies detected age-dependent climate change-associated impacts on forest growth, not used to evaluate growth at the population level (Carrer and Urbinati, 2004, Copenheaver et al., 2011)
- Forest inventory data also showed the effects varying with stand age

(Pretzsch et al., 2014; Galván et al., 2014; Primicia et al., 2015; Gao et al., 2016; Chen et al., 2016)

Background and objectives

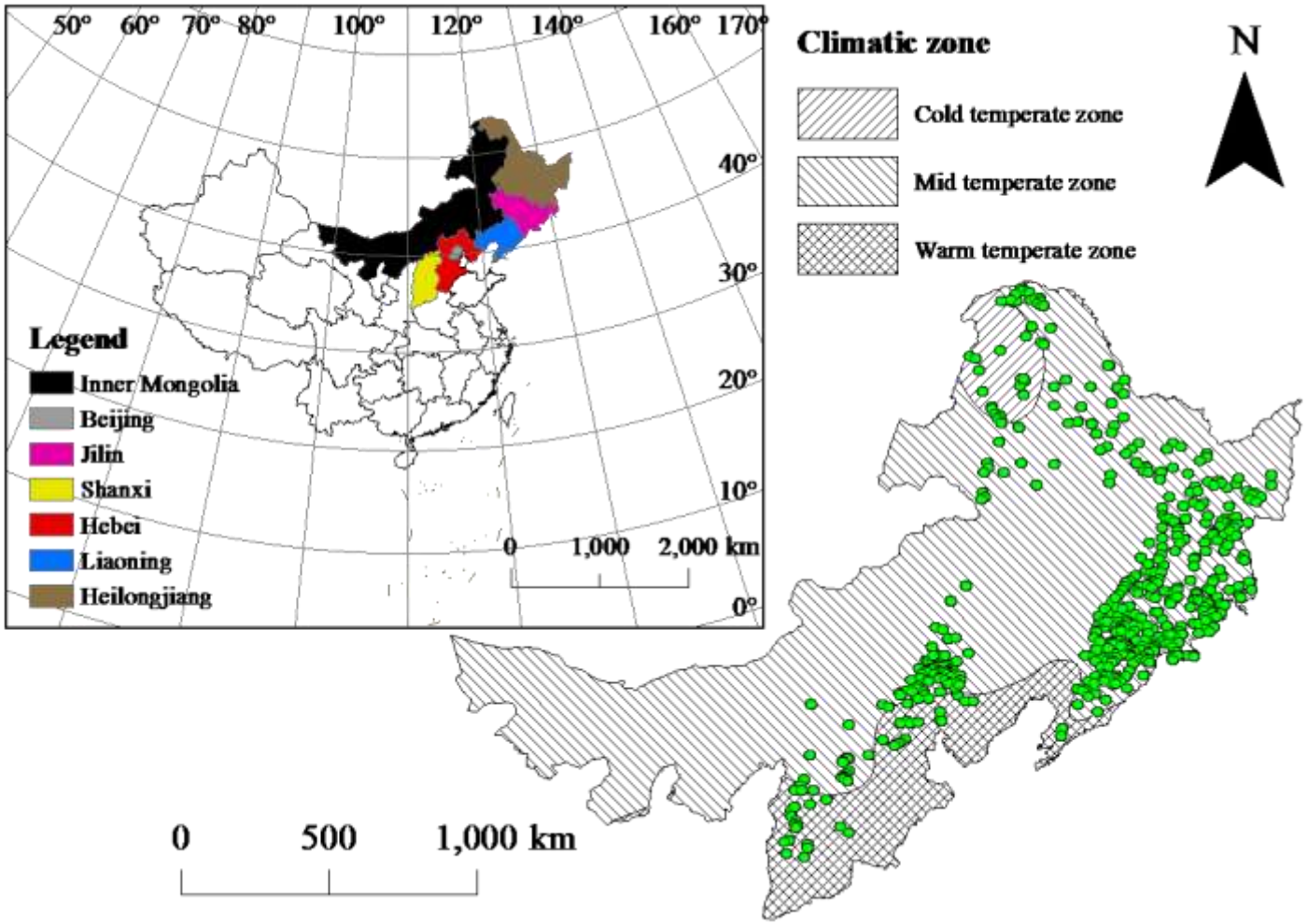
- It is seldom explored by process-based models applying physiological processes to simulate the growth and productivity given a set of environmental variables.

- To examine how forest age alters the effect of future climate change on forest biomass growth at long-term and large scale using process-based model.

Data and methods

- **National Forest inventory data**
  - **Larch plantations (4th sp.)**
  - **6th, 7th and 8th NFI (1994-2013)**
  - **552 plots→416 plots (0.06ha)**
  - **Site condition, stand age, N, average height, biomass, GPP and NPP (Zhou et al., 2002)**

Data and methods



Data and methods

Summary statistics of sample plots for model calibration

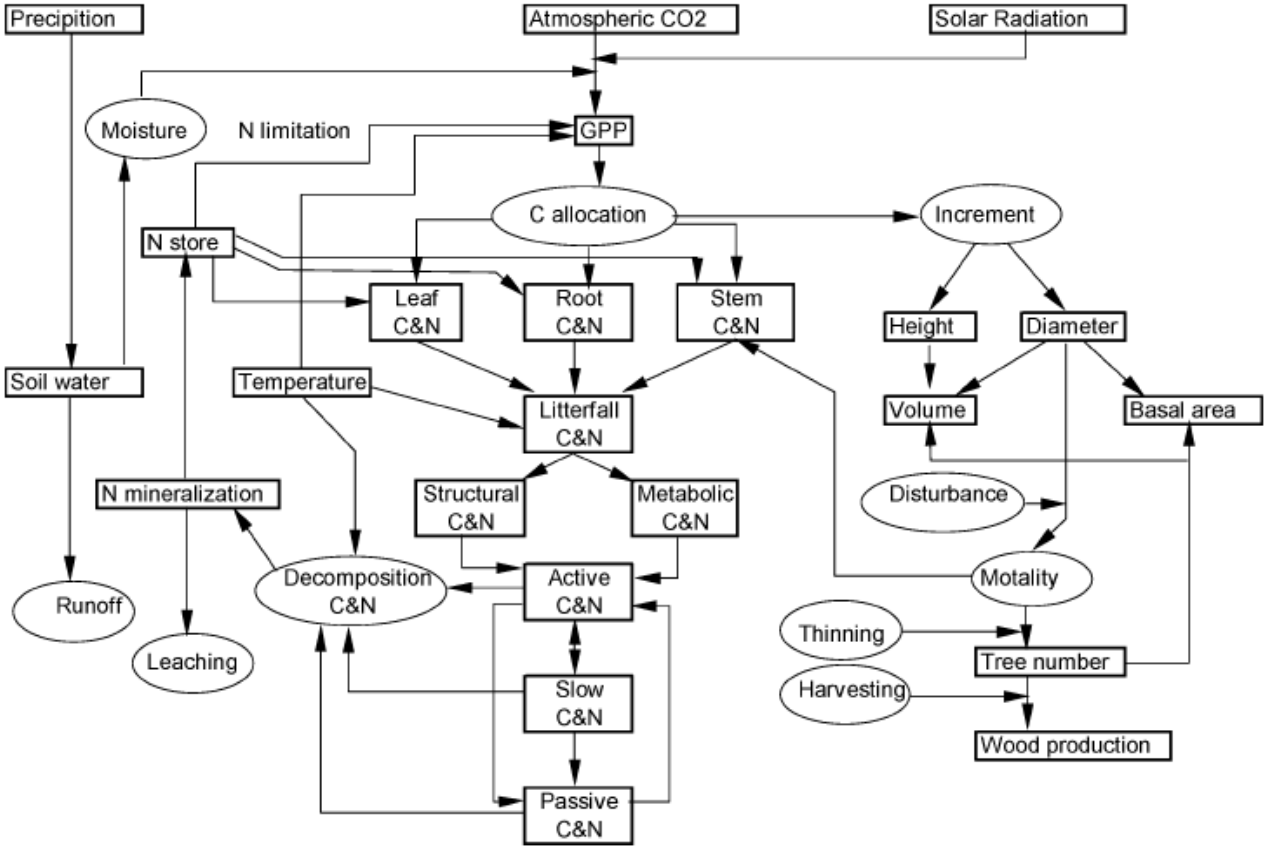
Variable	Mean	SD	Min	Max
Age(years)	21	8.0	5	50
DBH(cm)	9.3	3.5	0	21
H(m)	10.7	3.3	5.7	21.8
N(stems/ha)	1289	650.7	450	4083
V(m^3/ha)	62.92	46.48	3.72	242.45
B(T/ha)	56.85	36.57	3.93	176.15
NPP(T/ha/year)	6.99	2.10	1.43	11.22

Data and methods

- **Climate data**
  - ClimateAP (http://apfcp.sites.olt.ubc.ca/research-approaches/climate-modeling/)
  - Historical climate data (1951-2010)
  - Future climate data are based on IPCC General Circulation Models (GCM) from the CMIP5 project in the Fifth Assessment Report and include two normal periods (2011-2040, 2041-2070) under RCP (RCP2.6, RCP4.5 and RCP8.5) scenarios.

Data and methods

■ Model strategy-TRIPLEX



(Peng et al., 2002; Zhou et al., 2006)

Data and methods

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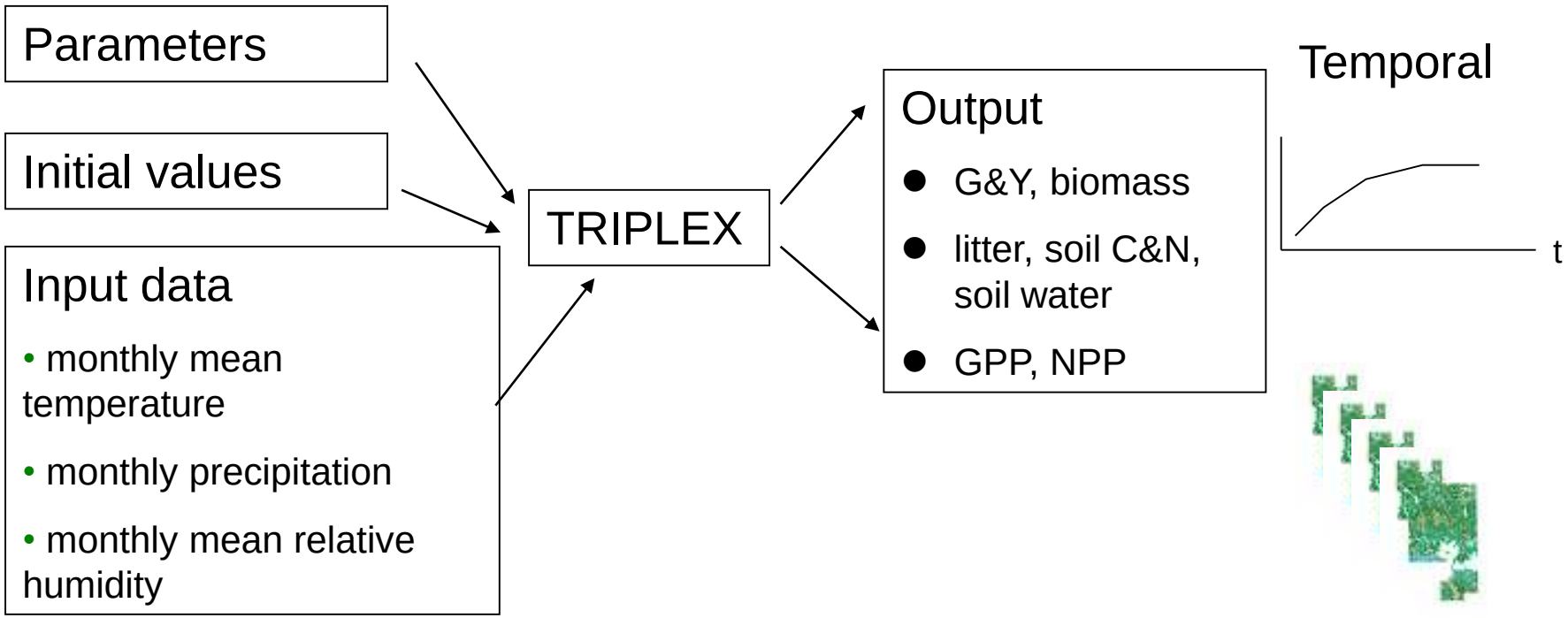


Data and methods

- **Model strategy-TRIPLEX**
  - Parameters used for TRIPLEX simulation were obtained from default, retrieval or fitted methods in the study.
  - The 6th and 7th data were for model calibration and the 8th for model validation.
  - Simulate forest growth and productivity under four climate scenarios (current, RCP2.6, RCP4.5 and RCP8.5) over the period of 60 years from 2011 to 2070 with the 2011 as the initial year (age=1 year).

Data and methods

- **Model strategy-Triplex**
  - Stands were grouped by age as:

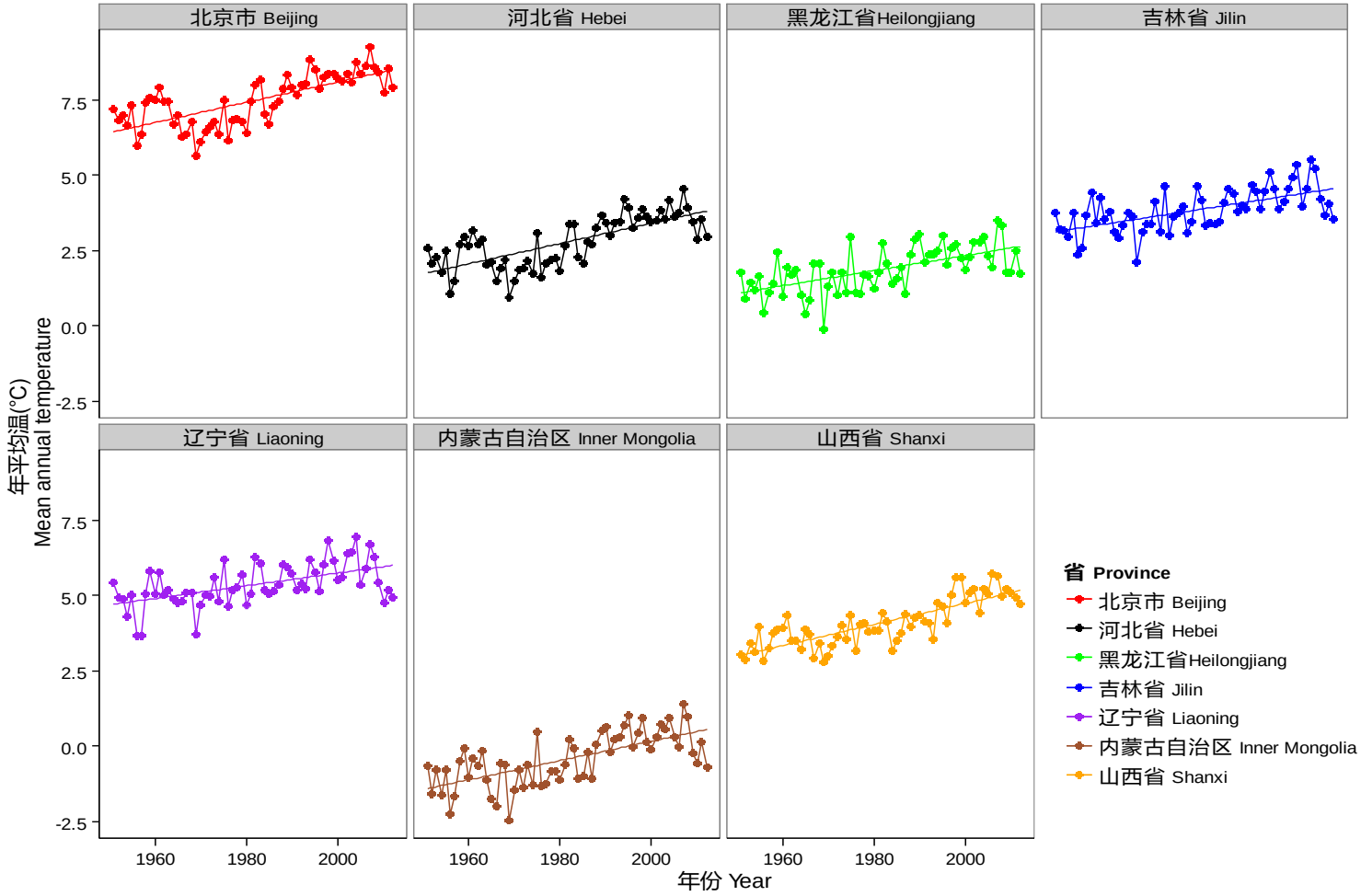
    young forest (YF): <20

    middle-aged forest (MF):21-30

    near-mutual forest (NF): 31-40

    mature and over-mature forest (MOF): >41.

Model assessment and simulation



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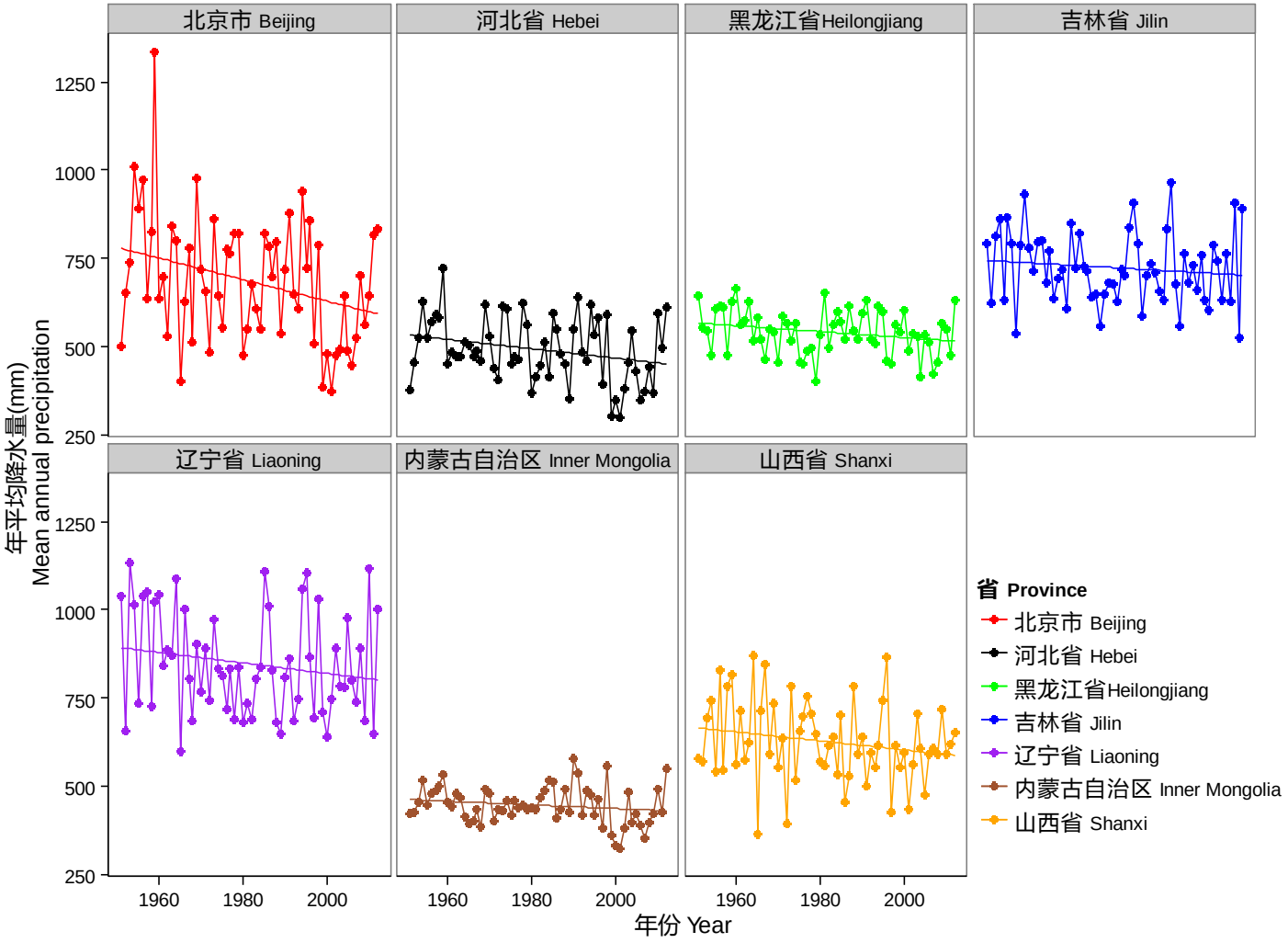

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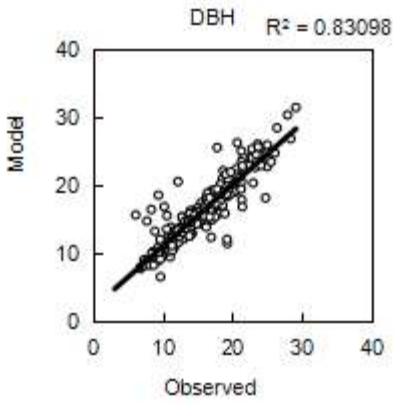
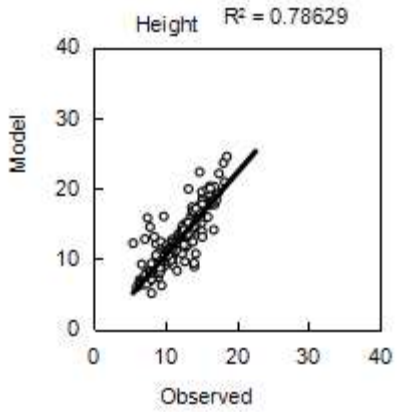
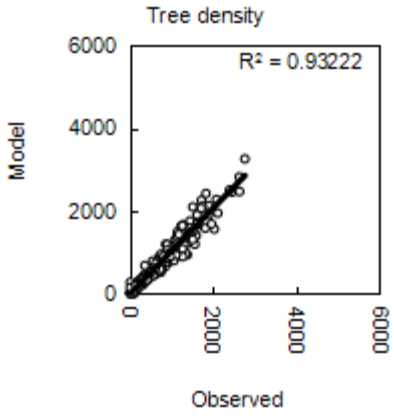
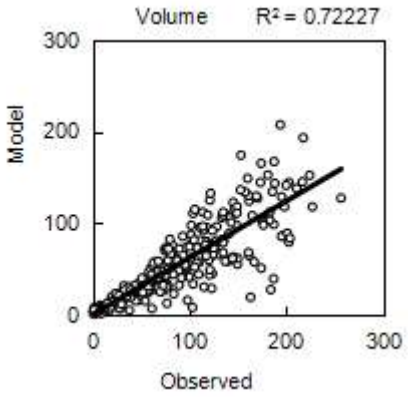
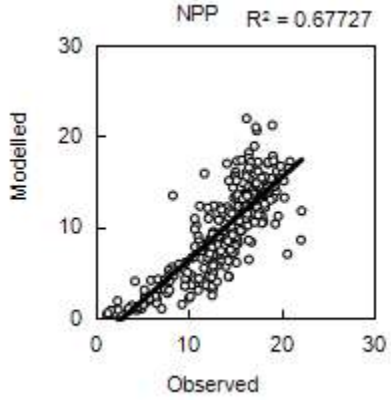




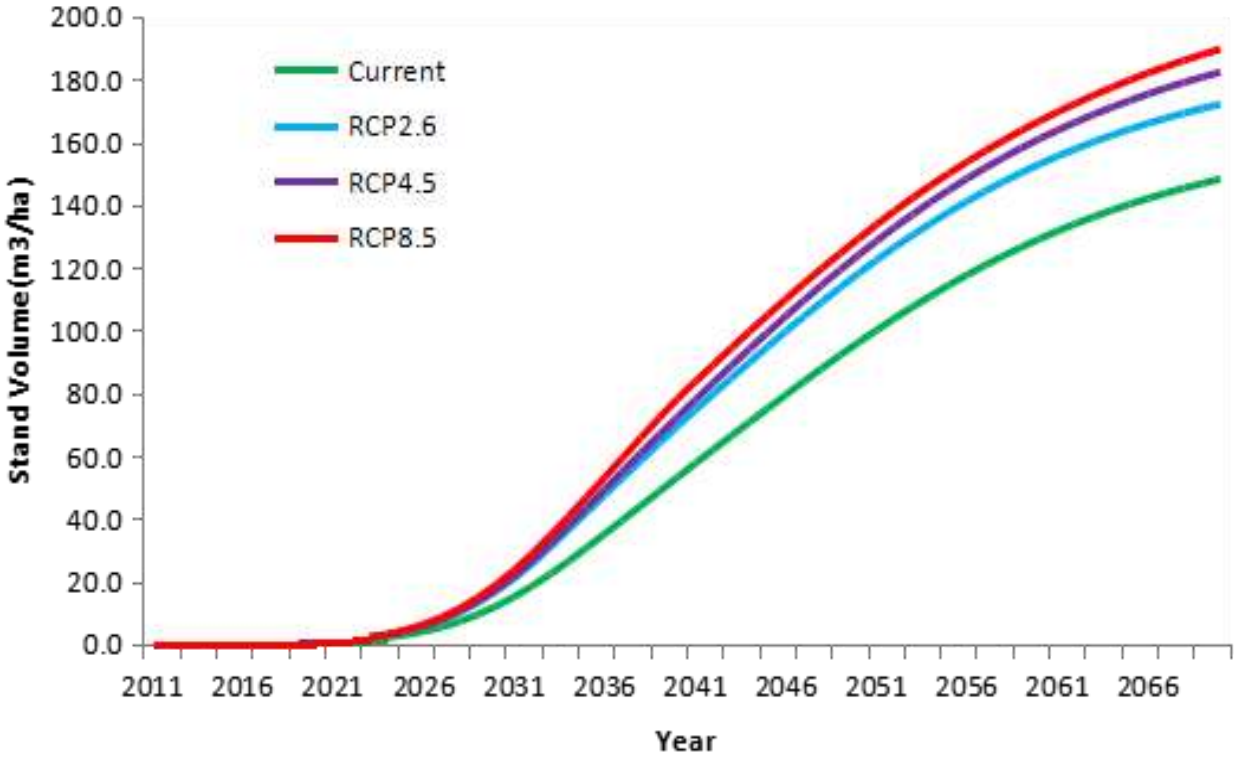






Model assessment and simulation

- **Projections of forest growth and productivity under future climate change**



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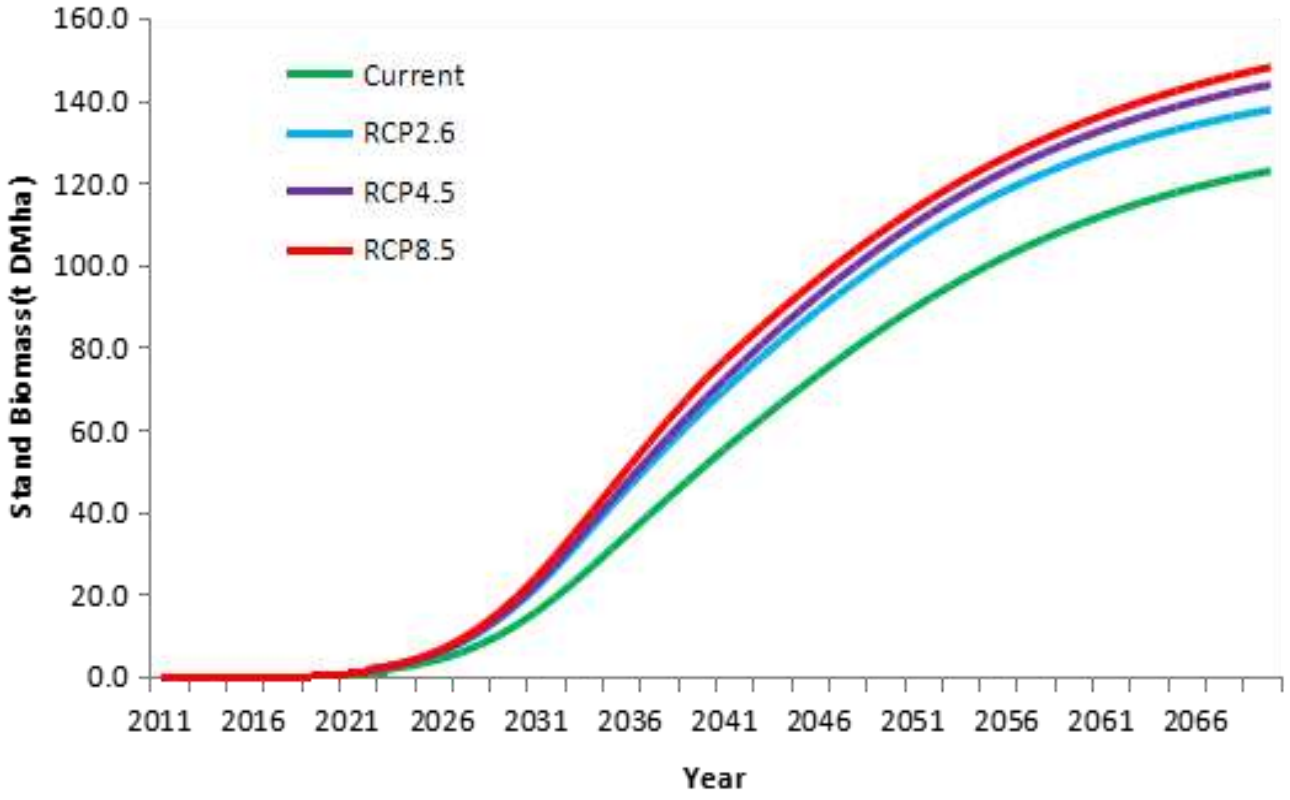

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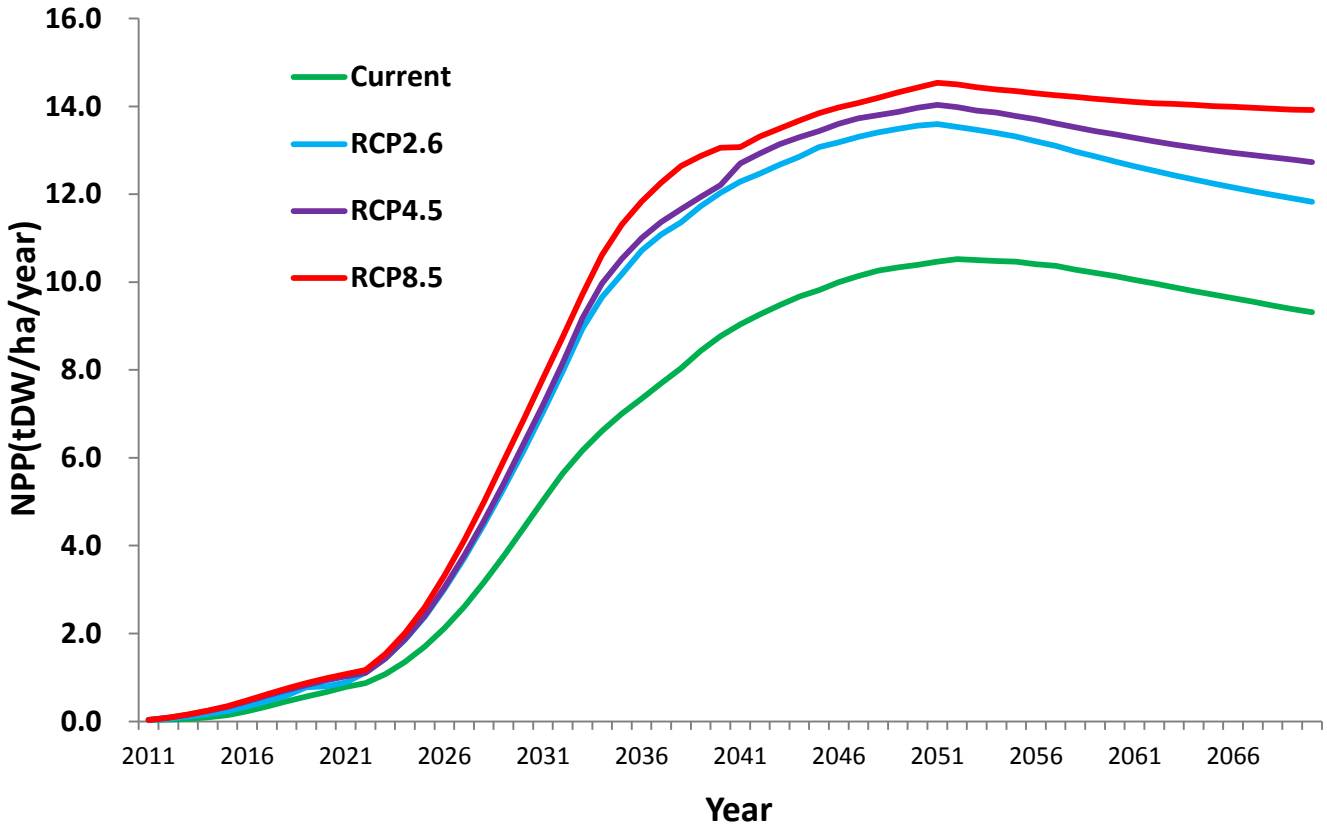

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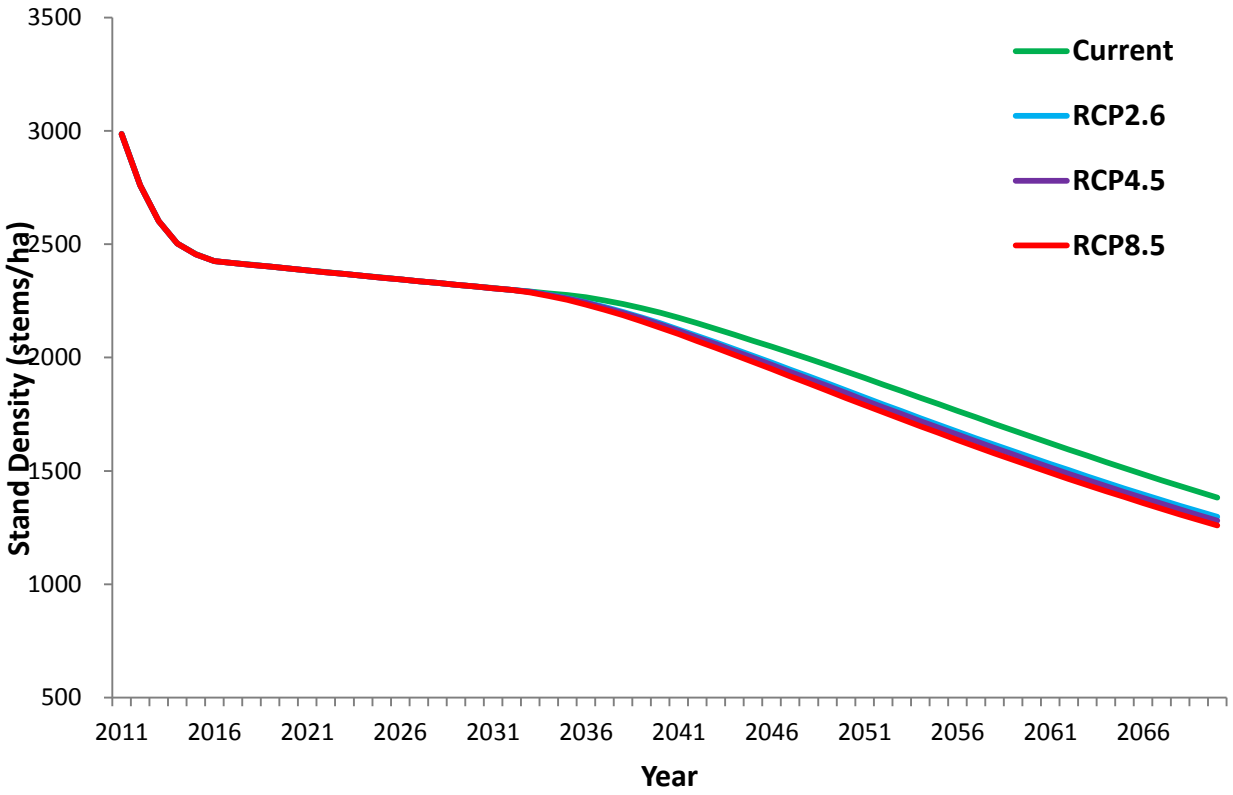
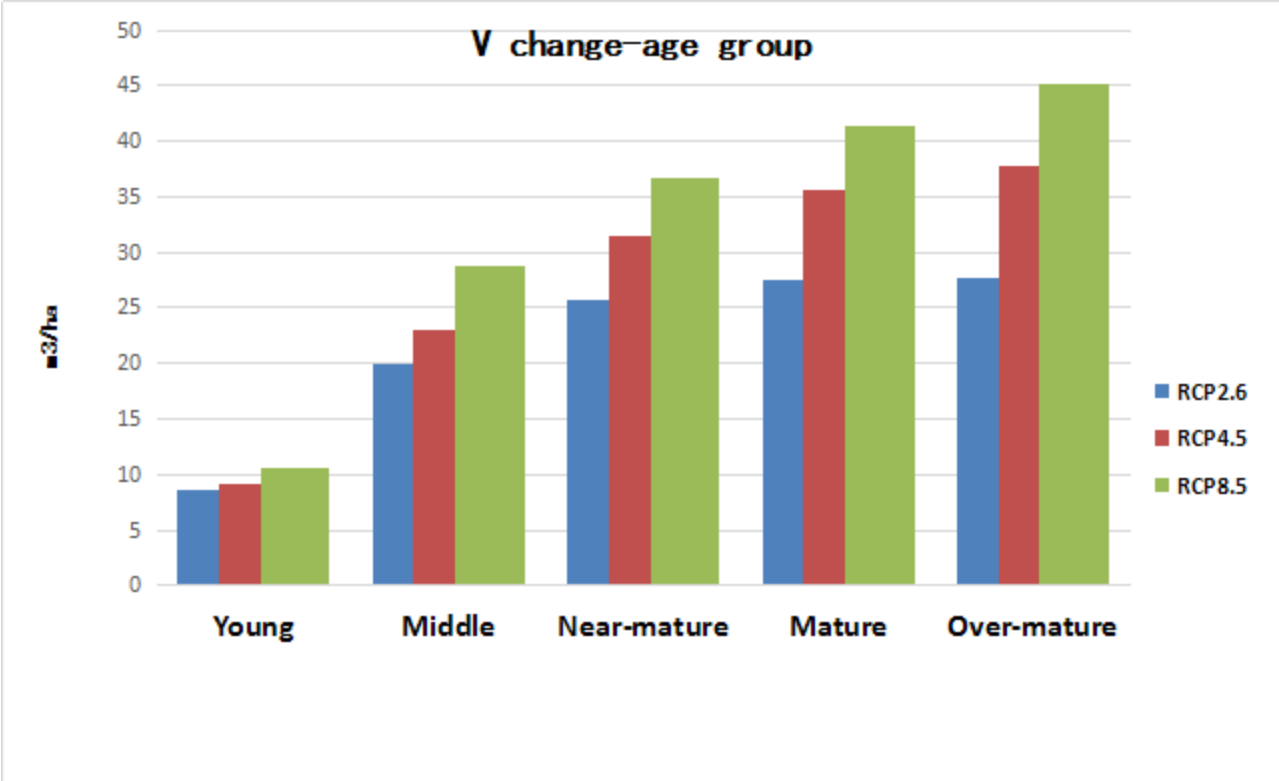


Model assessment and simulation

- **Response to climate change among age groups**



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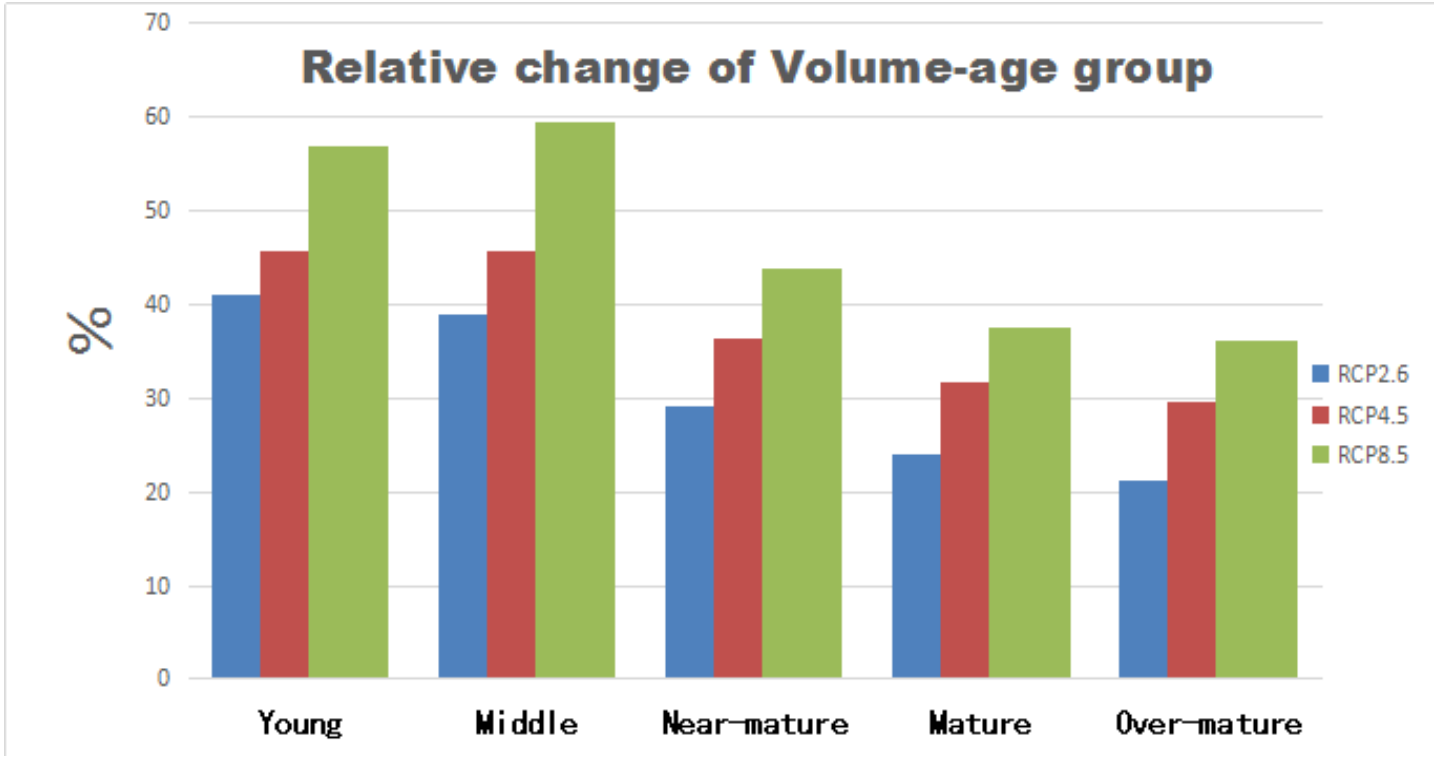

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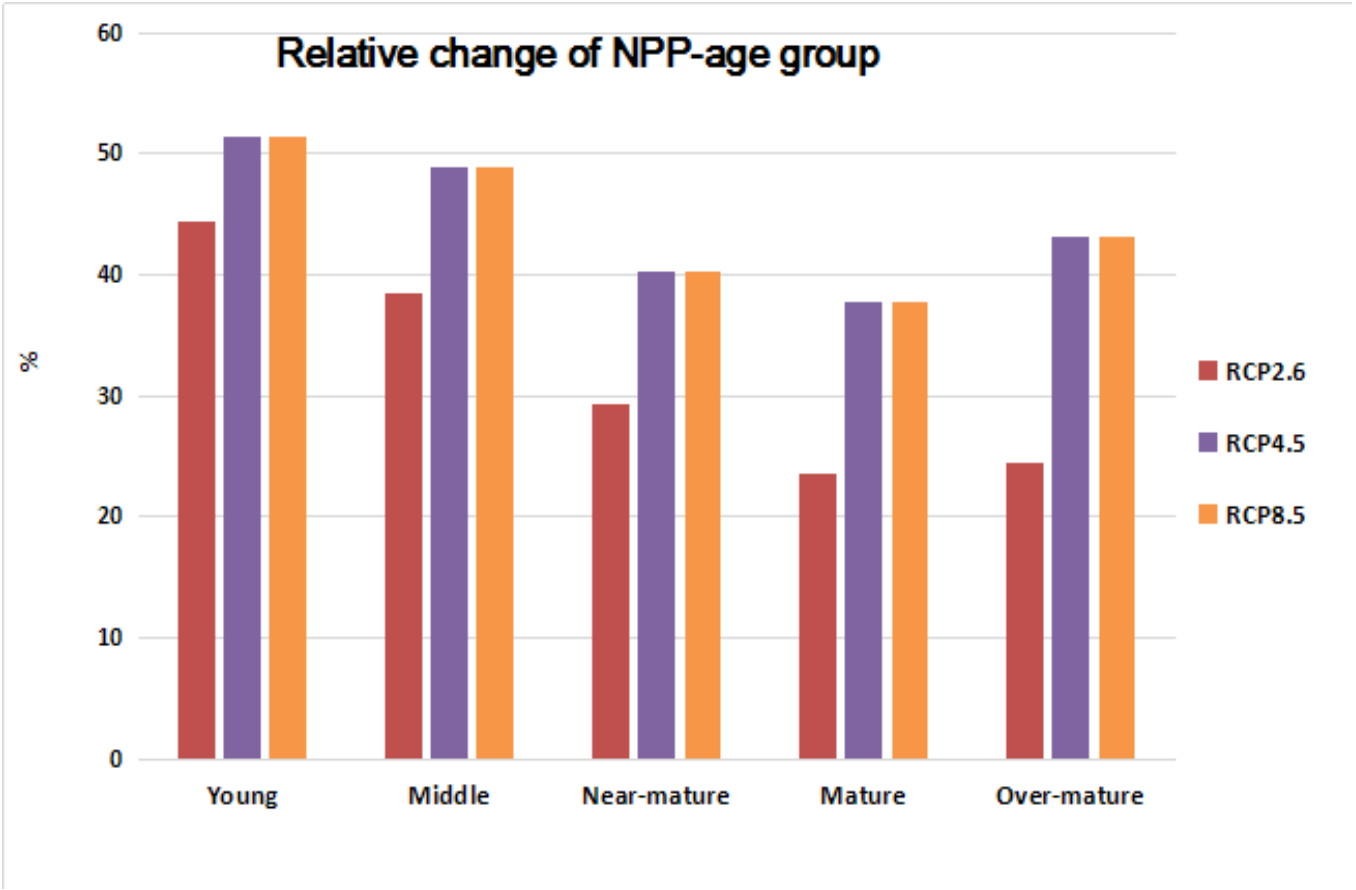

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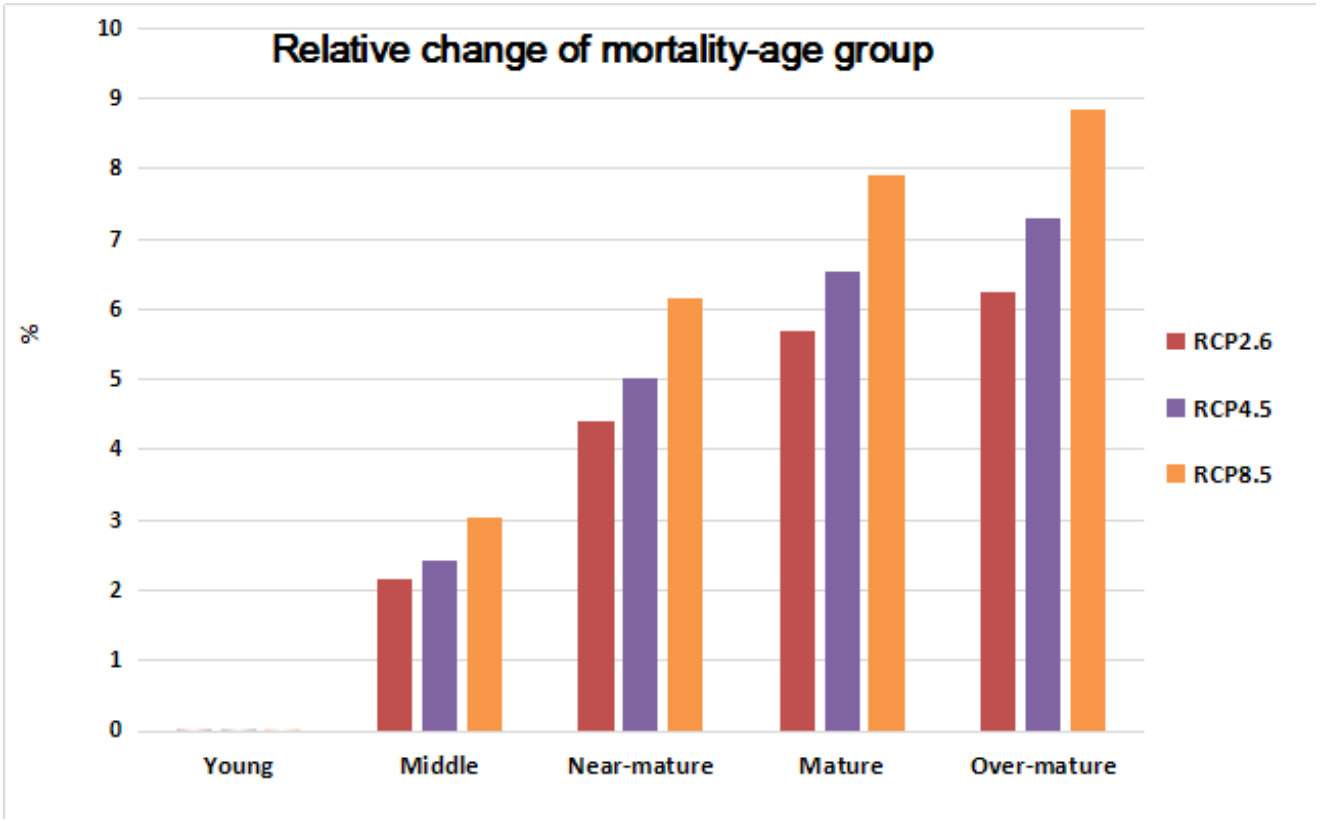

Conclusions and discussion

- Main findings
  - TRIPLEX could accurately and reasonably simulate the growth of larch plantations in northern and northeast China.
  - More increase of forest volume, biomass and NPP for young and middle-aged forests than old ones owing to climate change.
  - Old forests have more mortality associated with climate change.
  - Different response to climate change with stand age

(Pretzsch et al., 2014; Chen and Luo, 2015; Lei et al., 2016; Chen et al., 2016)

Conclusions and discussion

- Management implication
  - Age-specific adaptive forest management-more attention should be given to young- and old-aged forests
  - Inclusion of stand age into the projection of forest growth and productivity under future climate change is necessary.

Conclusions and discussion

- Limitation and future work
  - *Larix* spp.
  - Uncertainties in climate scenarios
  - Spatial change of the impacts
  - Multi-modelling

Climate-sensitive forest growth and yield modelling (No.31270679)

SFA (Data use permission)


Thanks for your attention!