2021年度中巴气候变化国际合作研讨会

How vegetation phenology impacts regional water balance in tropical forests

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Beijing Normal University

Zoom meeting, China-Brazil

2021-11-23

Outlines

1. **Introduction: myself and group**
2. **Vegetation phenology vs. water balance**
3. **Potential collaborative research**

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1. **Introduction: myself and group**
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1. Short introduction

2007-2012年：**Antwerp University, Global change ecology**

Prof. Ivan Janssens (phenology response to CC)

2012-2016年：**Peking University, Postdoc, Phenology vs. Carbon cycle**

Prof. Shilong Piao (phenology affects on carbon cycle)

2016-2017年：**Antwerp University,** Marie Curie research fellow

Prof. Ivan Janssens (phenology affects on carbon and water cycle)

2017- Beijing Normal University, Full professor

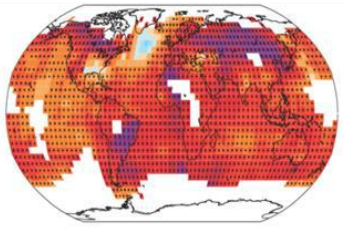
2019- Antwerp University, Guest Professor (research leader)

Interest fields: vegetation dynamics and its ecological implications

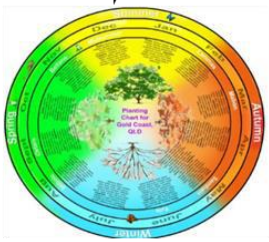
1. Short introduction

- Interests: **Focusing on vegetation phenology and its feedback on terrestrial carbon and water cycles**

Global Climate change



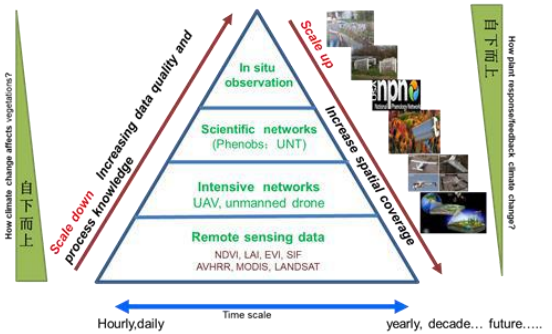
①Response ②Feedback



Vegetation dynamics phenology

③ implications

How climate change affects vegetation phenology across different spatial and temporal scales, and explore how these differences can ultimately determine community and ecosystem responses to environmental change, mainly carbon and water cycle.



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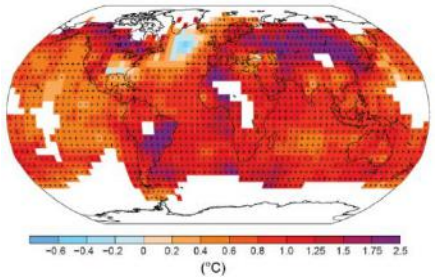
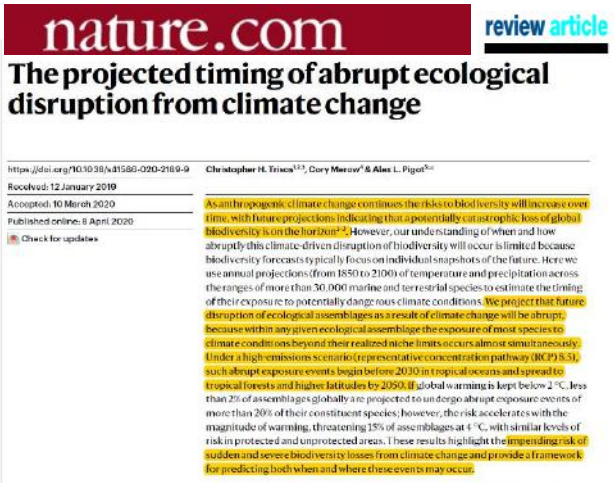
2. Phenology vs. water balance

■ Vegetation is very sensitive to climate change, called “footprint” of CC




nature.com review article

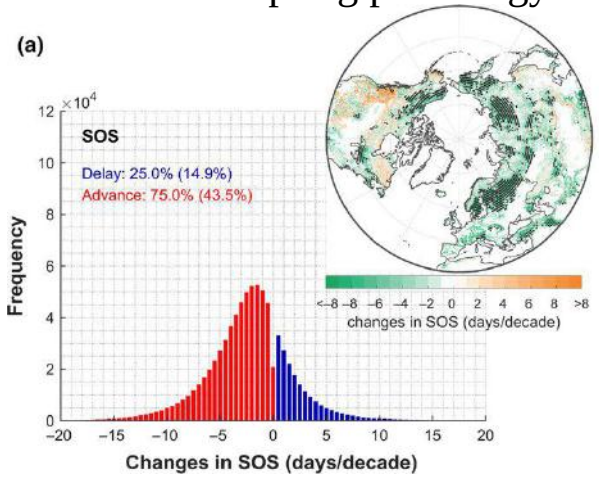
The projected timing of abrupt ecological disruption from climate change

https://doi.org/10.1038/s41586-020-2189-9
Received: 12 January 2019
Accepted: 10 March 2020
Published online: 8 April 2020
Check for updates

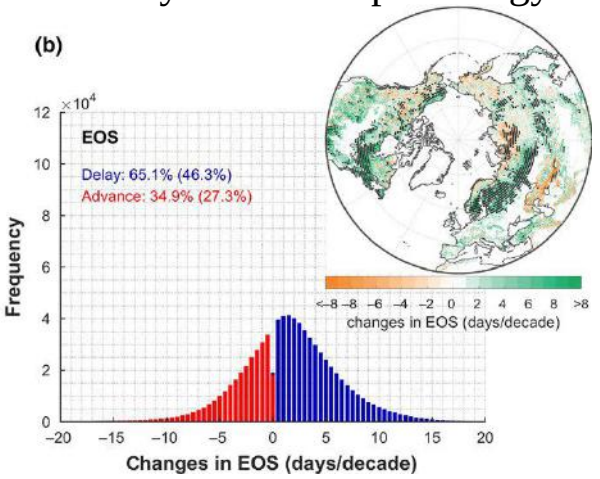
Christopher H. Trisos[1,2,3], Cory Merow[4] & Alex L. Pigot[5,6]

As anthropogenic climate change continues the risks to biodiversity will increase over time, with future projections indicating that a potentially catastrophic loss of global biodiversity is on the horizon[1–3]. However, our understanding of when and how abruptly this climate-driven disruption of biodiversity will occur is limited because biodiversity forecasts typically focus on individual snapshots of the future. Here we use annual projections (from 1850 to 2100) of temperature and precipitation across the ranges of more than 30,000 marine and terrestrial species to estimate the timing of their exposure to potentially dangerous climate conditions. We project that future disruption of ecological assemblages as a result of climate change will be abrupt, because within any given ecological assemblage the exposure of most species to climate conditions beyond their realized niche limits occurs almost simultaneously. Under a high-emissions scenario (representative concentration pathway (RCP) 8.5), such abrupt exposure events begin before 2030 in tropical oceans and spread to tropical forests and higher latitudes by 2050. If global warming is kept below 2 °C, less than 2% of assemblages globally are projected to undergo abrupt exposure events of more than 20% of their constituent species; however, the risk accelerates with the magnitude of warming, threatening 15% of assemblages at 4 °C, with similar levels of risk in protected and unprotected areas. These results highlight the impending risk of sudden and severe biodiversity losses from climate change and provide a framework for predicting both when and where these events may occur.

advanced spring phenology



delayed autumn phenology

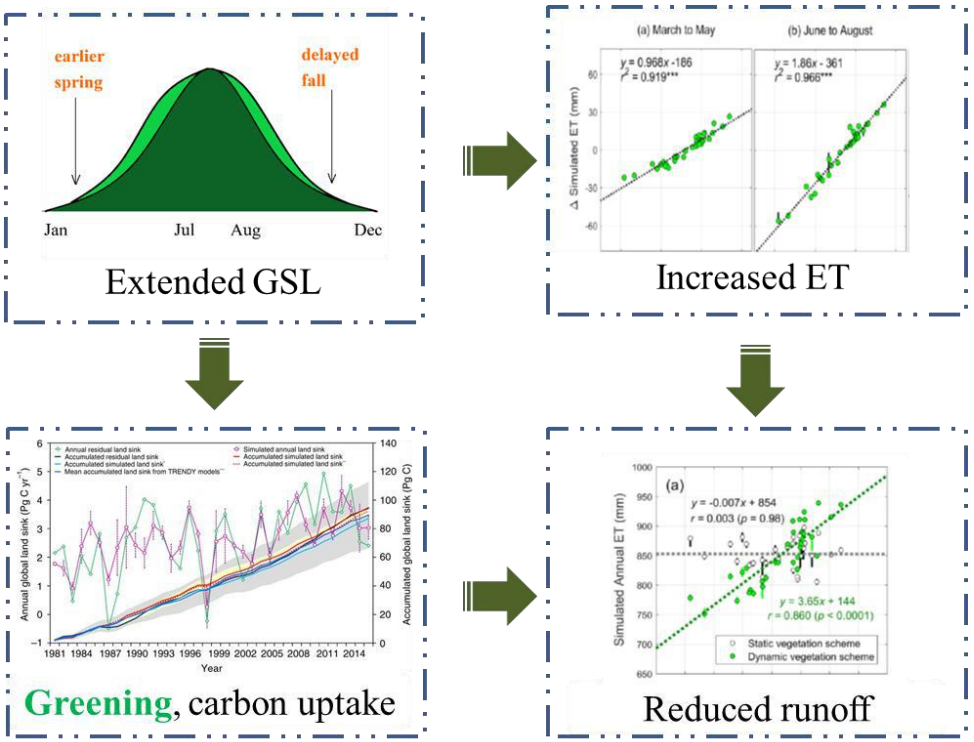


Extended vegetation growing season length by **5d/decade** since 1980s.

Fu et al., 2014 GEB
Piao & Fu et al. 2019 GCB

2. Phenology vs. water balance

- Shifted vegetation phenology affects local water flux



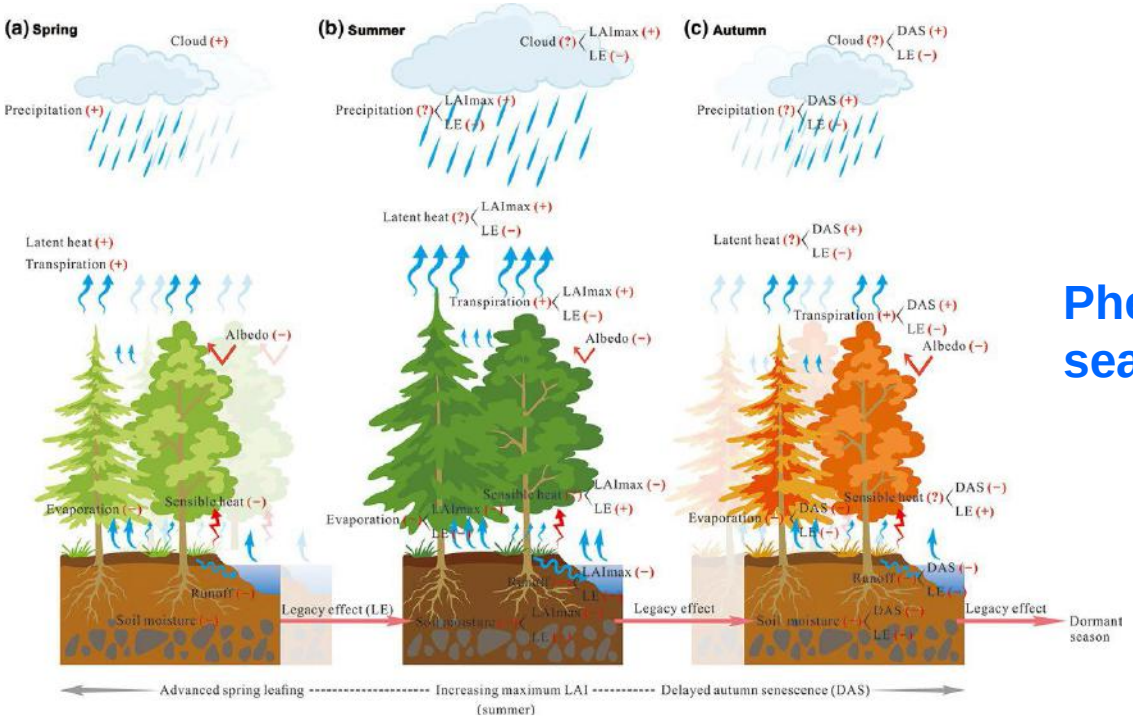
1. Richardson et al, 2013, GCB
2. Piao, S. et al, 2007, GBC
3. Hwang et al., 2018 WRR
4. Geng, Fu*., 2020 JH

Phenology affects local water balance

One days extension in GSL increase forest carbon uptake (GPP) by **0.5-1.0%**; and increased ET by **0.2-1.0 %** in temperate forest (watersheds at the upper Yadkin basin (inset) in North Carolina, USA)

2. Phenology vs. water balance

- Vegetation phenology affects seasonal local water balance



Legacy effect

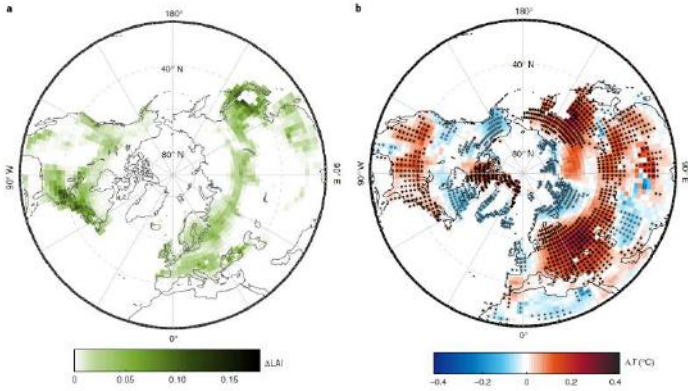
Phenology affects seasonal water balance

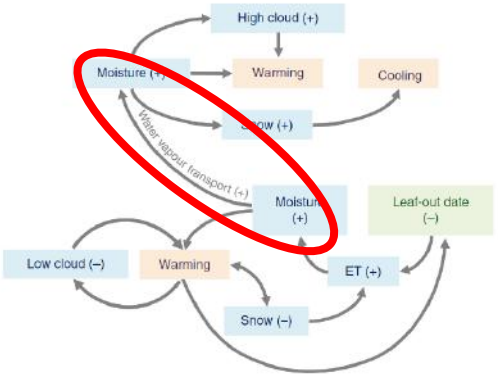
- The timing of leaf phenology affects seasonal water flux, early growing season onset (SOS) may increase ET and reduce runoffs in spring, and reduce soil moisture and increase the water stress in summer.

Piao & Fu et al. GCB 2019
Li et al., Science Advance 2020
Zhou, Fu* et al., AFM 2020

2. Phenology vs. water balance

- Earlier spring vegetation phenology affects regional water flux



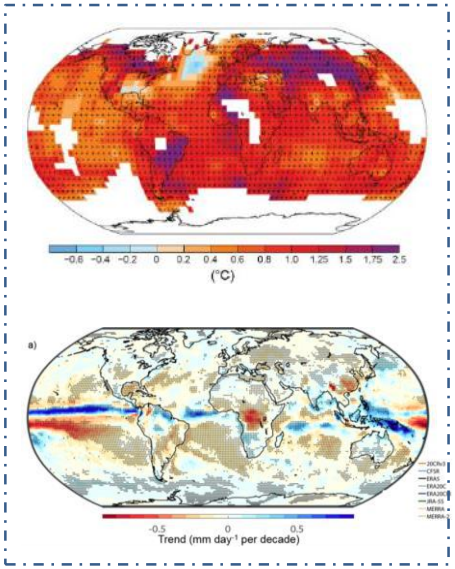


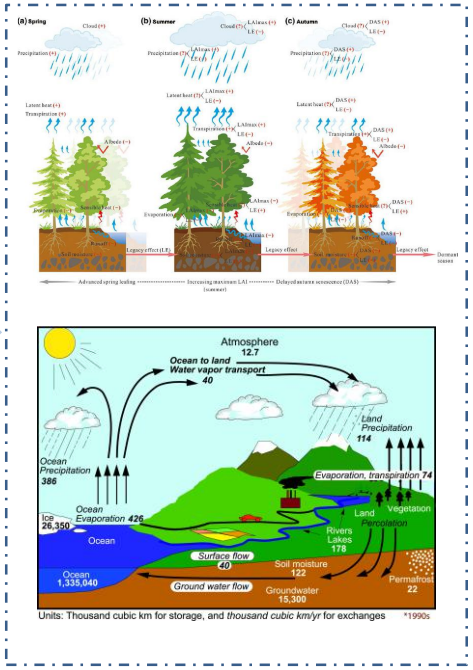
Phenology affects regional water balance

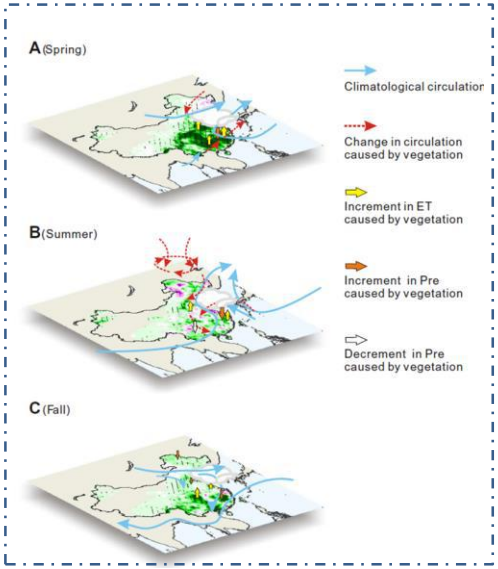
Early spring phenology at middle latitudes enhanced warming at high latitudes, which was related to indirect water vapor, cloud and snow-albedo radiative feedbacks through intensified poleward water vapor transport.

Xu et al, 2020 NCC

2. Phenology vs. water balance







- The vegetation spring phenology affected the water balance of temperate forests in northern China, how about the **tropical forests**?

- How vegetation phenology (different phenological events) affects large-scale water balance by altering **seasonal vapor transport**?

Outlines

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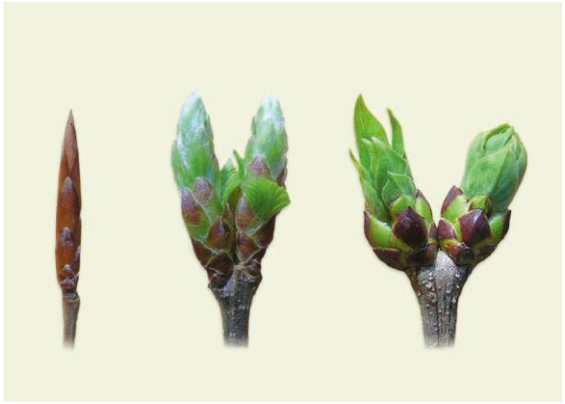
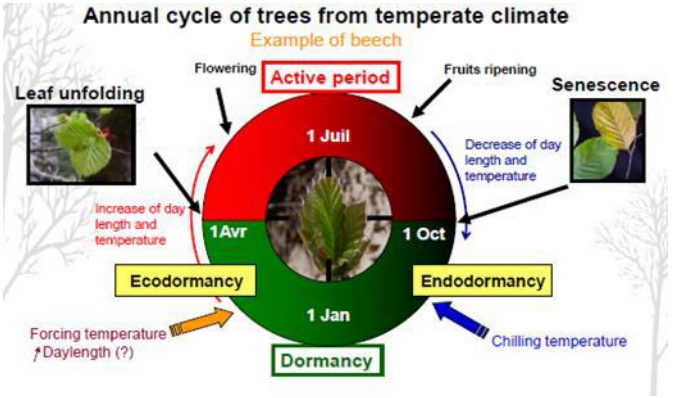
3. **Potential collaborative research**

2. Potential collaborative research

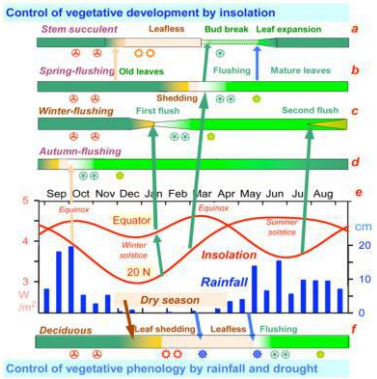




Science
AAAS

Phenology Under Global Warming
Christian Körner, *et al.*
Science **327**, 1461 (2010);
DOI: 10.1126/science.1186473

Temperate and boreal forest



UNCLEAR

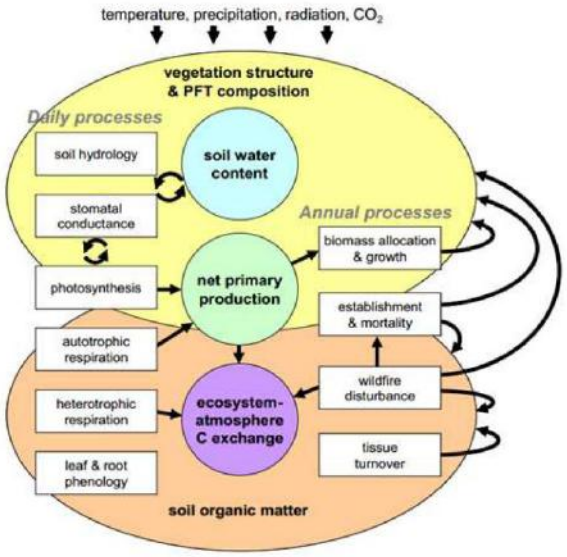
Tropical monsoon forest?

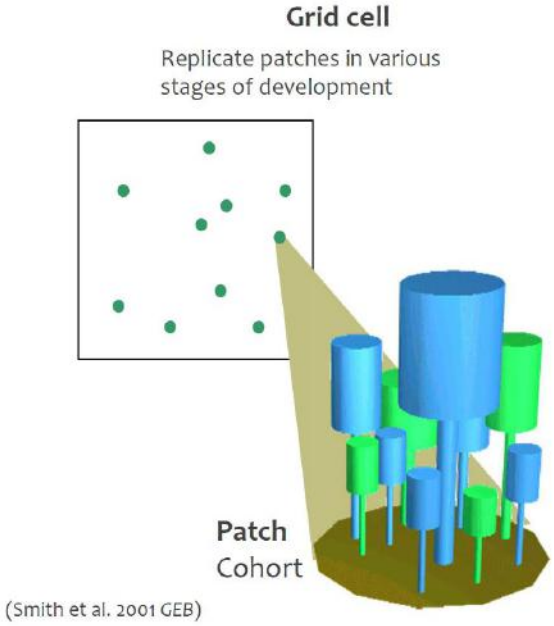
- The phenological processes has been well investigated in temperate trees, but the processes of tropical phenology is still largely unclear!

Korner and Basler, Science 2010
Fu* et al., Nature 2015

2. Potential collaborative research

- **Regional water balance study:** dynamics global vegetation model



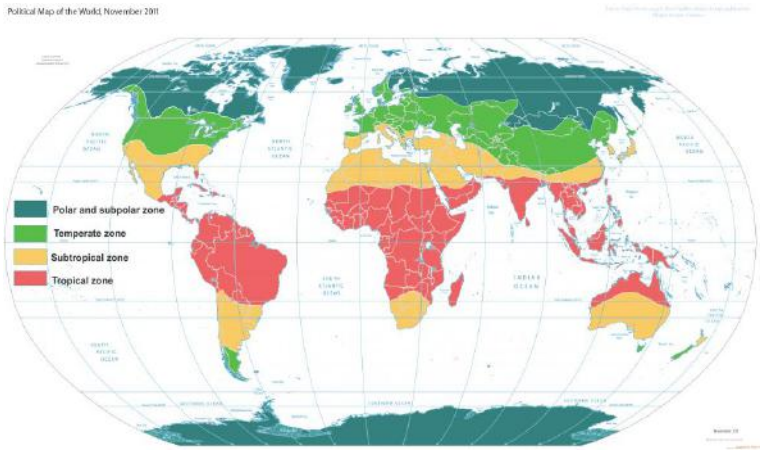


LPJ-GUESS is a process-based dynamic vegetation-terrestrial ecosystem model designed for regional or global studies.

- **Phenology module:** simple temperature dependent model, i.e. degree-days-chilling approach

Smith et al. 2001 GEB & Sitch et al., 2003, GCB

2. Potential collaborative research



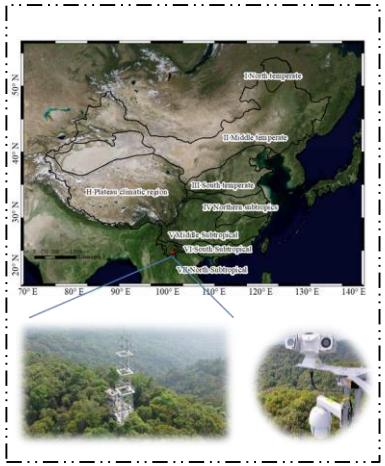
Climate Zone	LPJ	LPJ_BNU
Polar and subpolar	Phe = × (*no corresponding vegetation type*)	$Phe = \mathcal{F}(Temperature)$
Temperate	$Phe = \mathcal{F}(Temperature)$	$Phe = \mathcal{F}(Temperature, Photoperiod)$
Subtropical and Tropical	$Phe = \mathcal{F}(Temperature,$ soil moisture)	Phe $= \mathcal{F}$(Radiation, Precipiation) $= \mathcal{F}$(Photoperiod, Light intensity, VPD, soil moisture)

- **LPJ-guess model will be updated by coupling the process-based phenology modules**

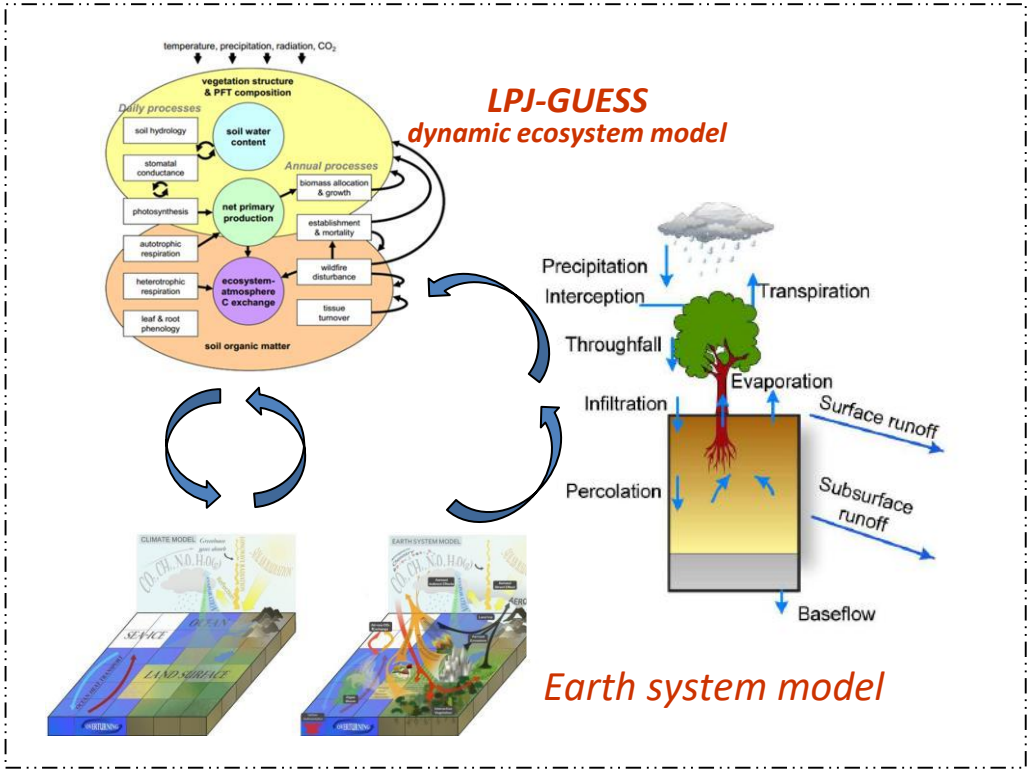
Chen, Fu*, Sitch et al., in pre

2. Potential collaborative research

collaborative research



Coupling



- **Phenology processes study in tropical forests**

Pu'er flux tower in tropical forest China

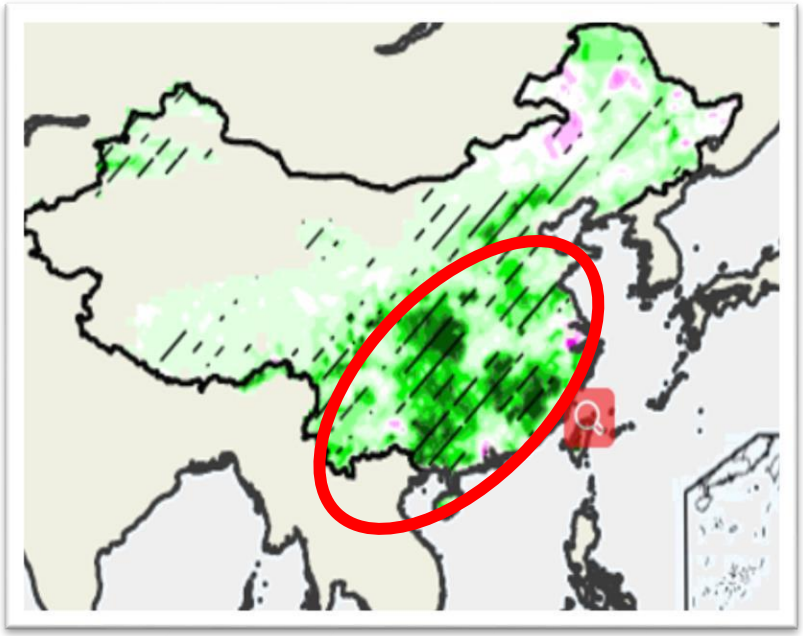
- **Coupling phenological processes into the LPJ-guess model to explore the vegetation effect on local water transport**?
- **How vegetation phenology affects seasonal water balance by coupling water transport in ESM and LPJ-guess**?

Chen, Fu*, Sitch et al., in pre

2. Potential collaborative research

collaborative research

Amazon rainforest, deforestation



Subtropical rainforest, afforestation

- How the **human activity impacts the phenology-water balance relationship** in tropical forests?

- What's the fundamental role of vegetation in water resource? (SDG06)

6 CLEAN WATER AND SANITATION

Thanks for your attention!

BNU Welcome you！

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