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Chiba University

Potential application of MOLI data into terrestrial carbon cycle modeling

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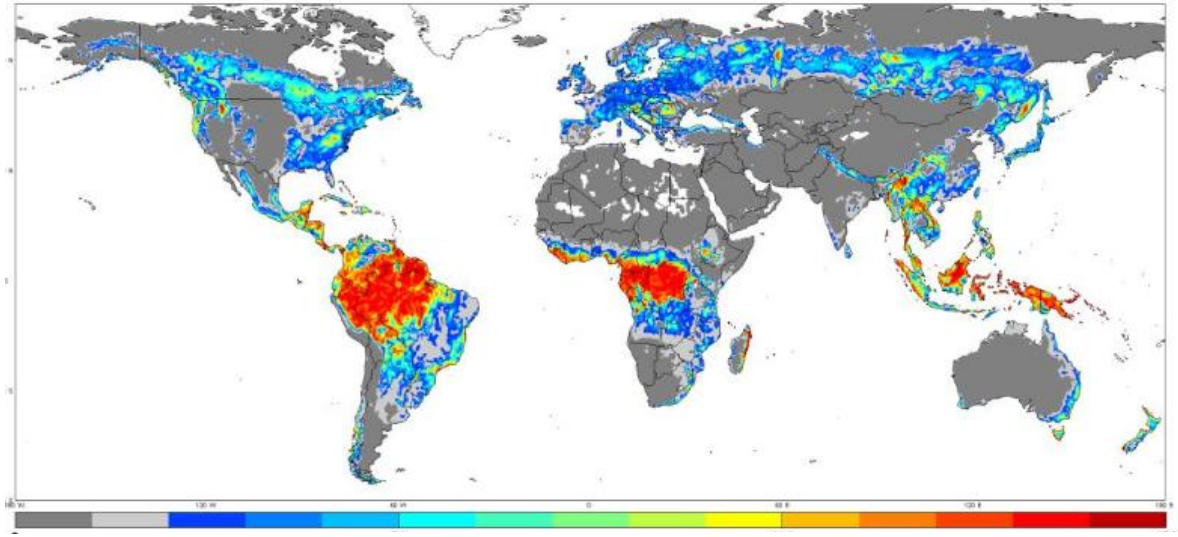
Available biomass data

Based on vegetation optical depth

1993-2012, 0.25deg, Global



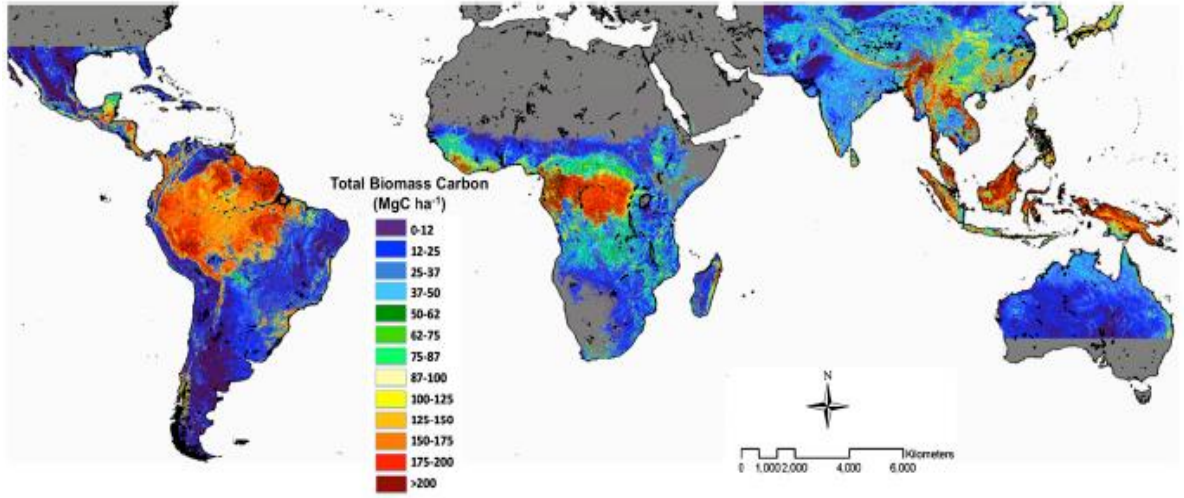
0 50 100 150

[AGB; MgC/ha]

[Liu et al. 2015; Nature Climate Change]

Based on vegetation height (ICEsat)

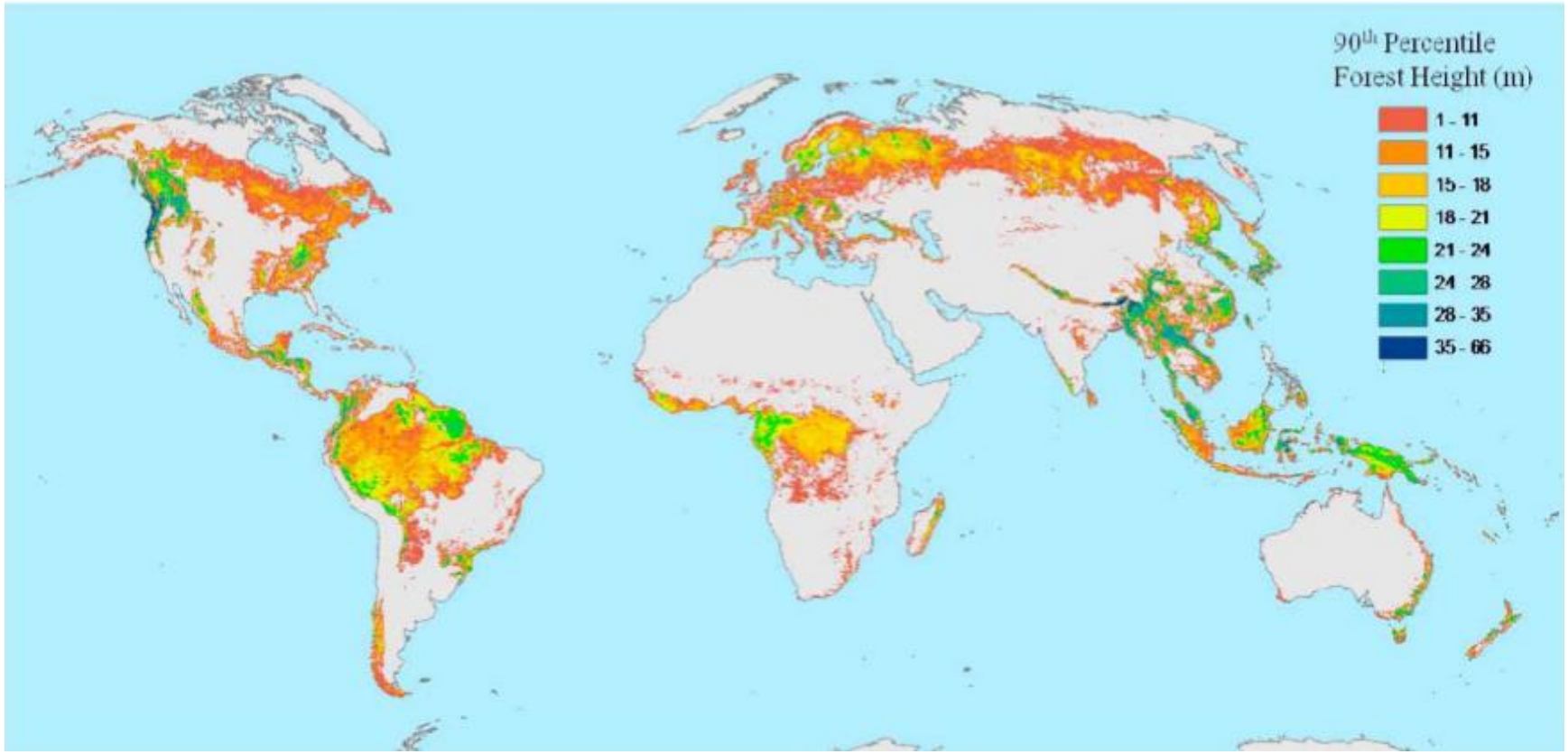
One time (around 2000), 1km, tropical



[totB; MgC/ha]

[Saatchi et al. 2011; PNAS]

Available tree height data



(ICEsat GLAS)

[Lefsky et al. 2011; GRL]

Topics

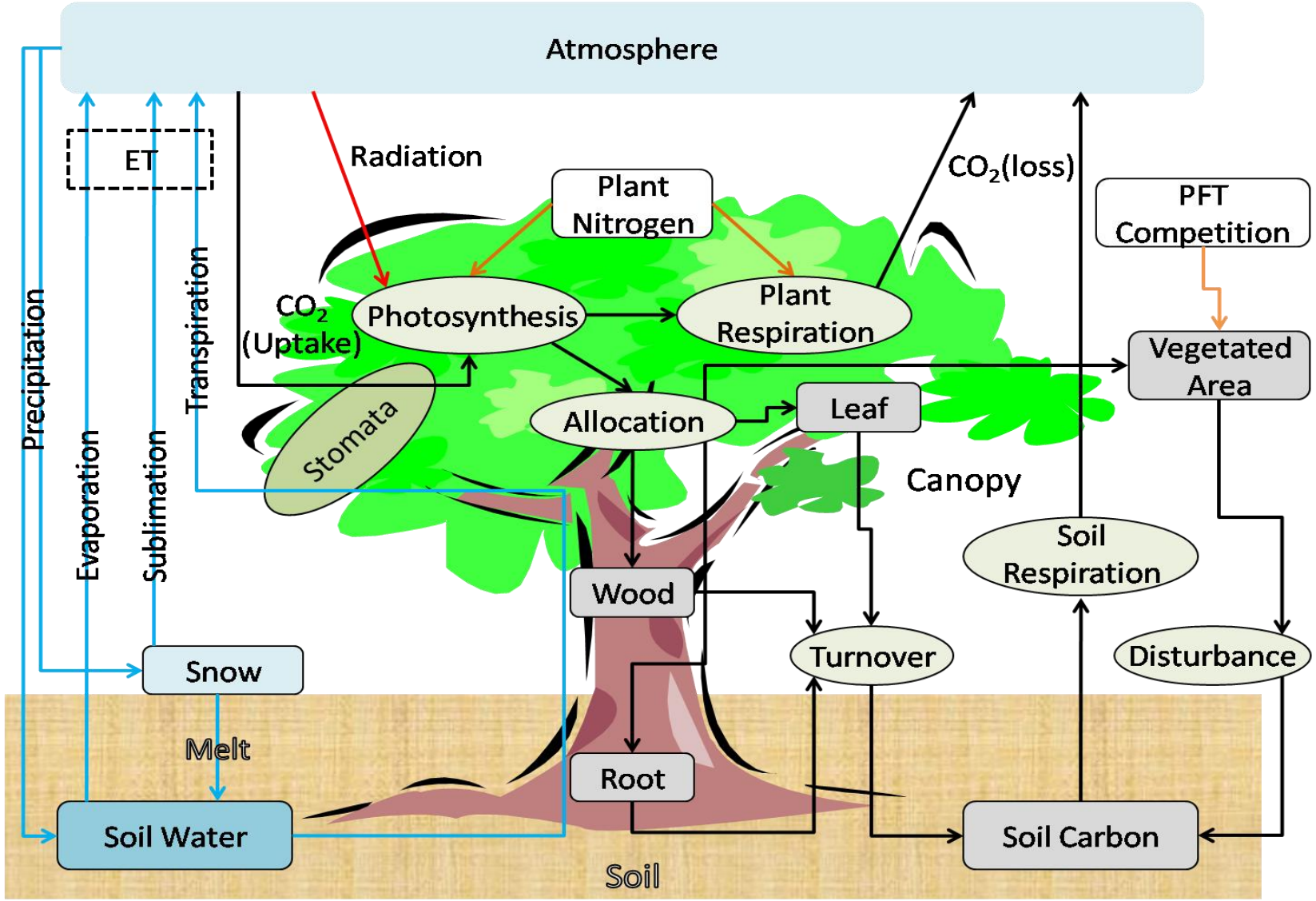
How can current terrestrial carbon cycle model simulate biomass ?

[e.g. Ichii et al. 2010]

How can we use biomass data into terrestrial carbon cycle model ?

Show our experiments [e.g. Kondo et al. 2013]

Terrestrial Carbon Cycle Model



☑ Vegetation-Litter-Soil System

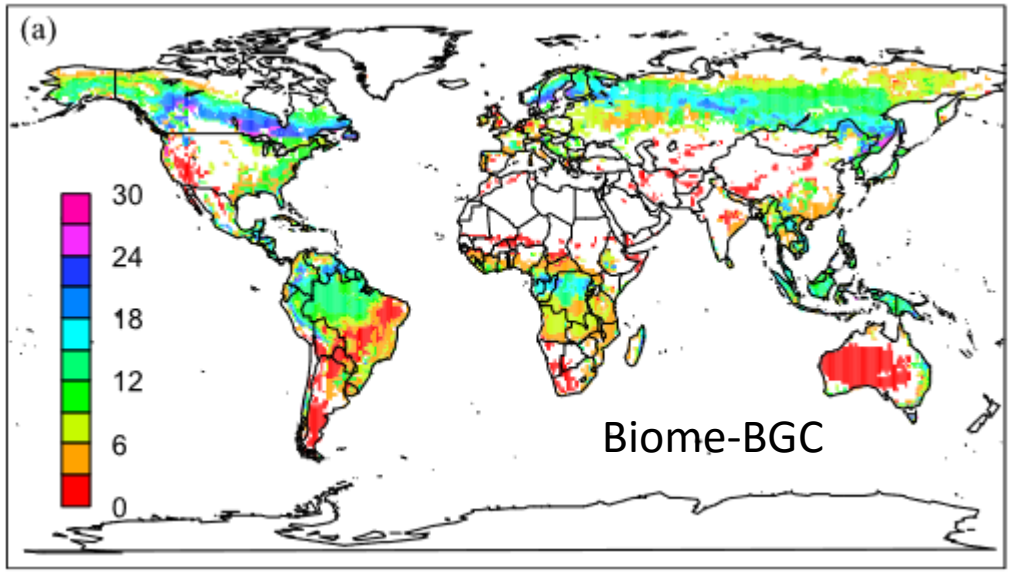
☑ Carbon-Water (Snow)-Energy

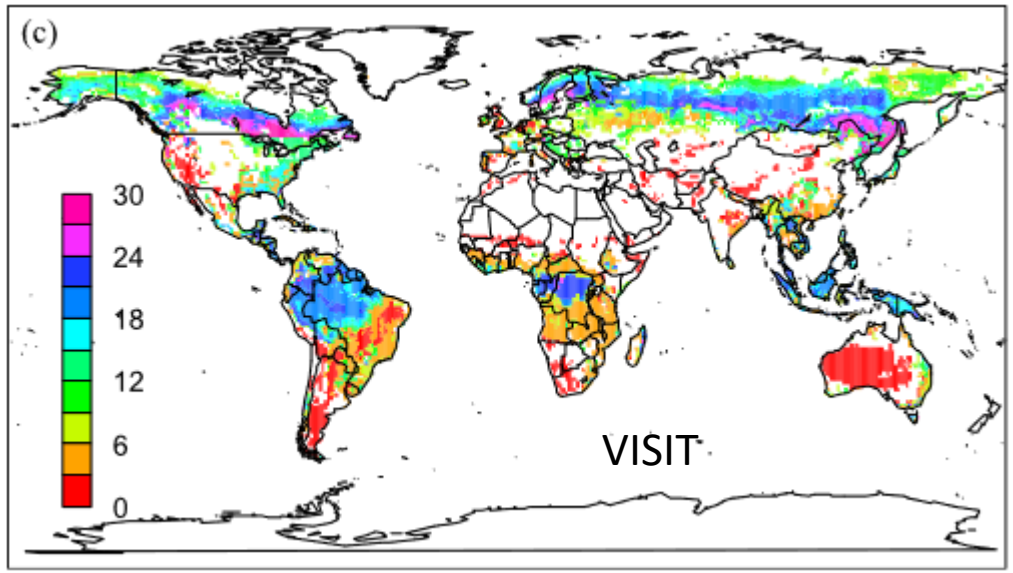
☑ Fluxes, Pools

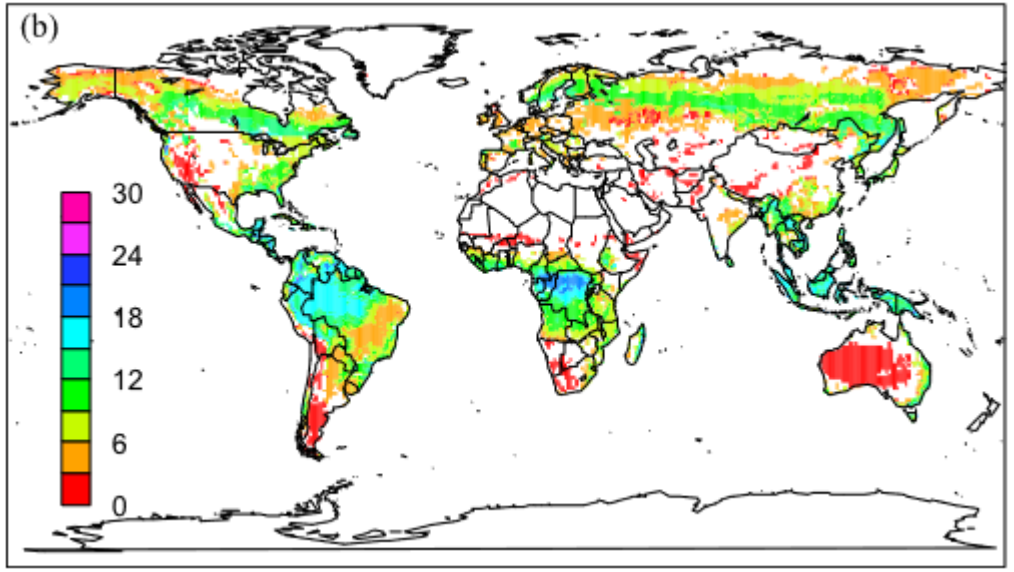
Past-Present-Future

Vegetation Status
Stock, Flux changes
Human effect (disturbance)

Model output example





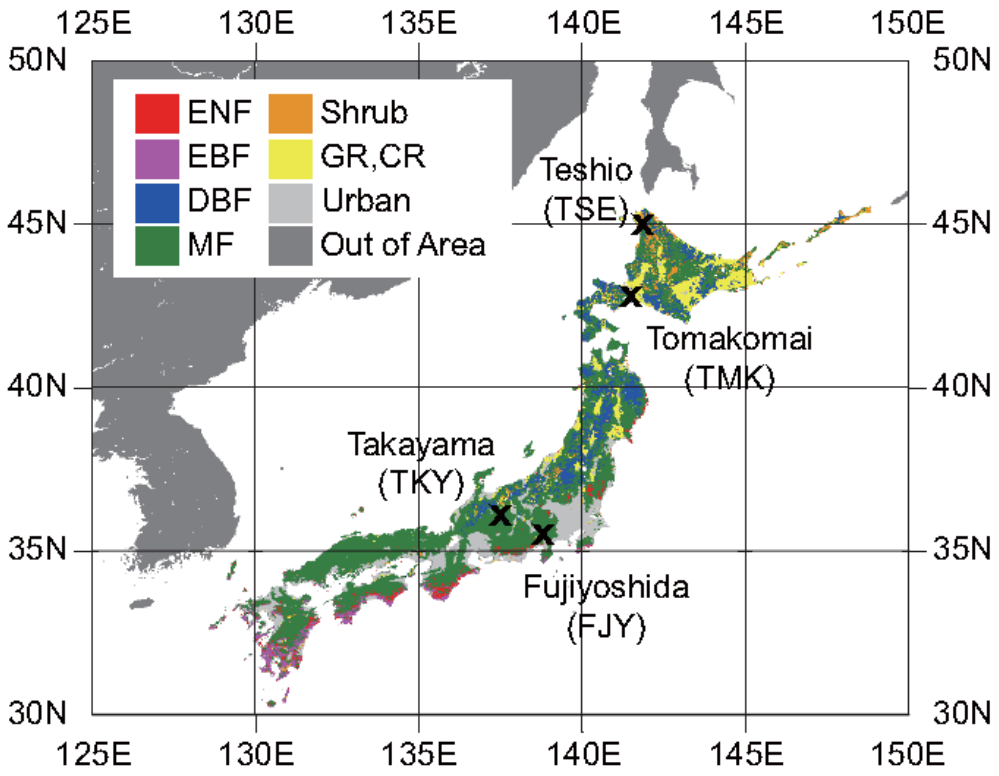


Inventory-based assumed biomass

[Ise et al. 2010; JGR-biogeosci.]

Site-level model experiment

Japan-MIP (Model Intercomparison Project)



[planted forest; age

Diagnostic model

BEAMS	[Sasai et al., 2005]
CASA	[Potter et al., 1993]
TOPS	[Nemani et al., 2003]

Satellite+Climate

Prognostic model

VISIT	[Ito, 2007]
Biome-BGC	[Thornton et al., 2002]
DayCENT	

Climate Only

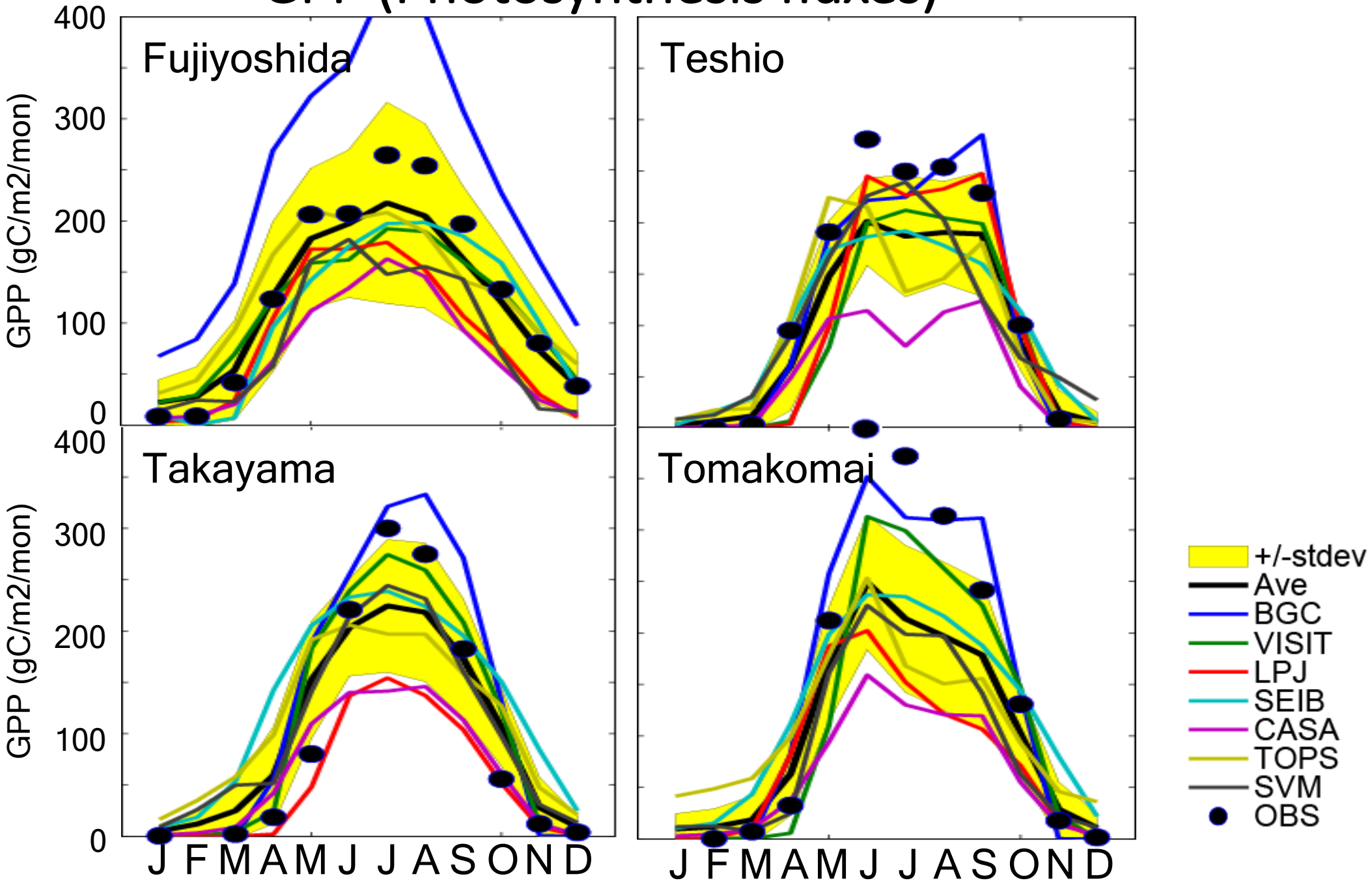
Dynamic Veg. model

SEIB-DGVM	[Sato et al., 2007]
LPJ	[Sitch et al. 2003]
TRIFFID	[Cox et al., 2001]

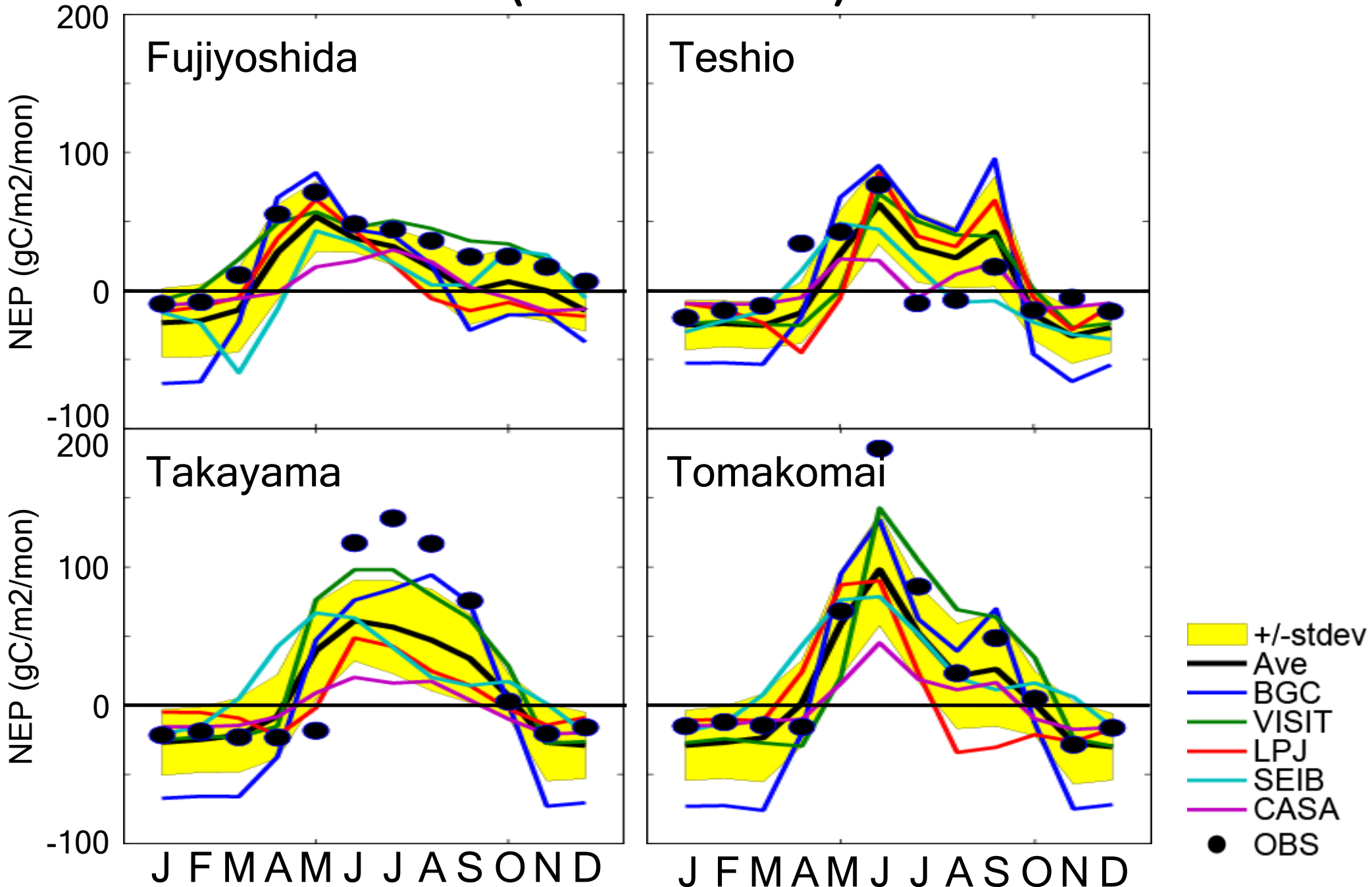
Climate Only

[Ichii et al. 2010; Biogeosciences]

GPP (Photosynthesis fluxes)



NEP (net CO2 flux)



Biomass… Large variation among models

(a) Biomass

	FJY	TKY	TMK
BGC	55.2	69.5	61.7
CASA	6.3	9.9	8.9
LPJ	12.9	6.5	13.9
DayCENT	12.0	5.5	7.9
SEIB	1.0	12.0	16.4
TRIFFID	11.3	6.6	10.1
VISIT	1.1	16.5	5.2
Total	14.3±18.7	18.1±23.0	17.7±19.7
OBS	19.2	15.7	15.2

Why is biomass poorly estimated?

1. Data Availability

CO2 fluxes (GPP, RE, NEE) :	easily available from network observation (e.g. AsiaFlux, FLUXNET)
	uniform observation methods (e.g. eddy-covariance)
Biomass	difficult (time-consuming) for observation
	observation-method varies among sites

2. Difficulty in tuning

CO2 fluxes (GPP, RE, NEE) :	Directly related to process (e.g. photosynthesis)
	Easy to tune..
Biomass	calculated by the balance of fluxes..
	Hard to tune..

Model parameter optimization experiment

Experiment:
Biome-BGC model (C, H2O, N cycle)

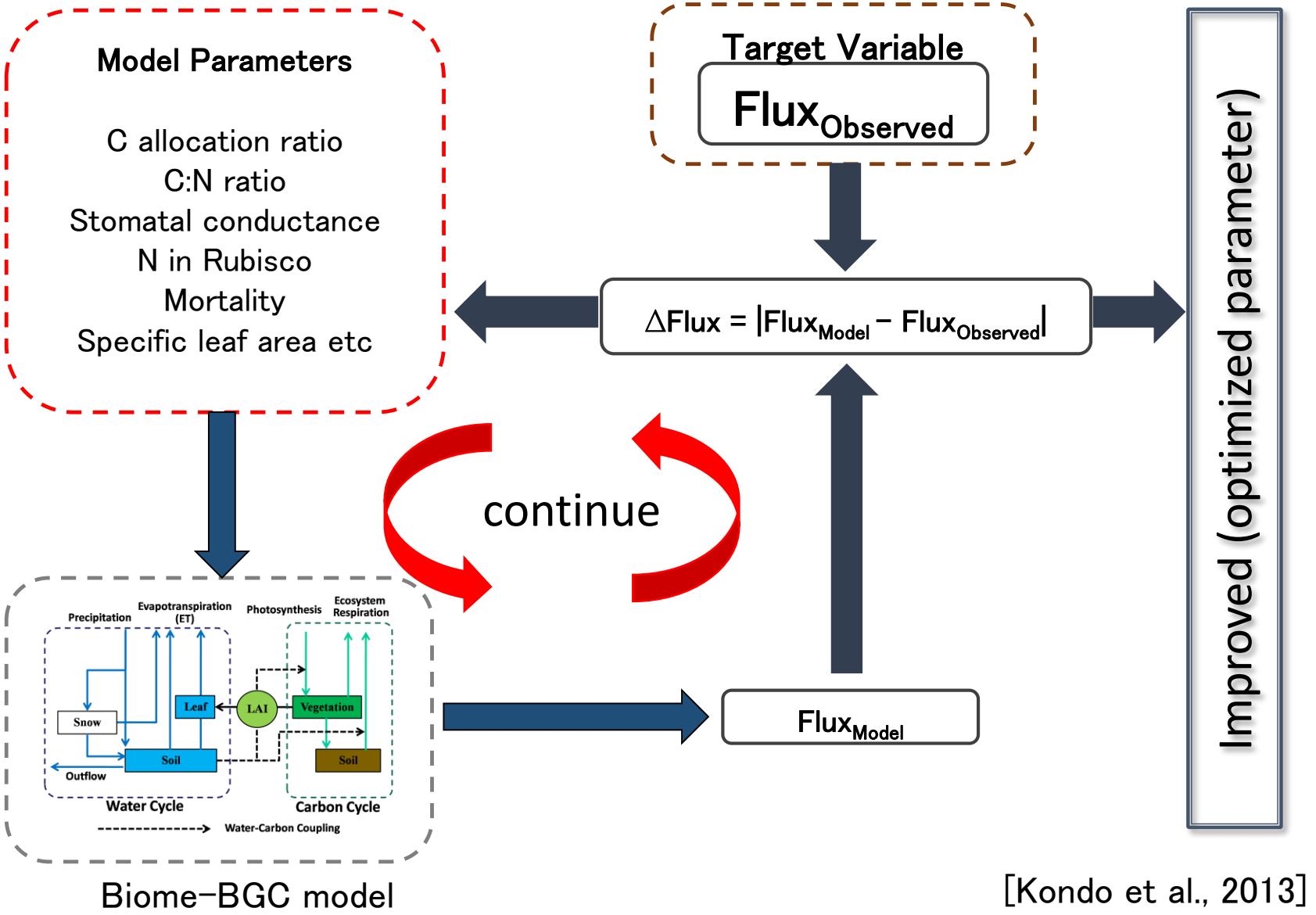
Importance of Carbon Flux, Pool data
to reproduce terrestrial carbon state.
(CO2 flux and biomass)

Model Parameter Optimization

Exp1) Constrained by CO2 fluxes & Biomass

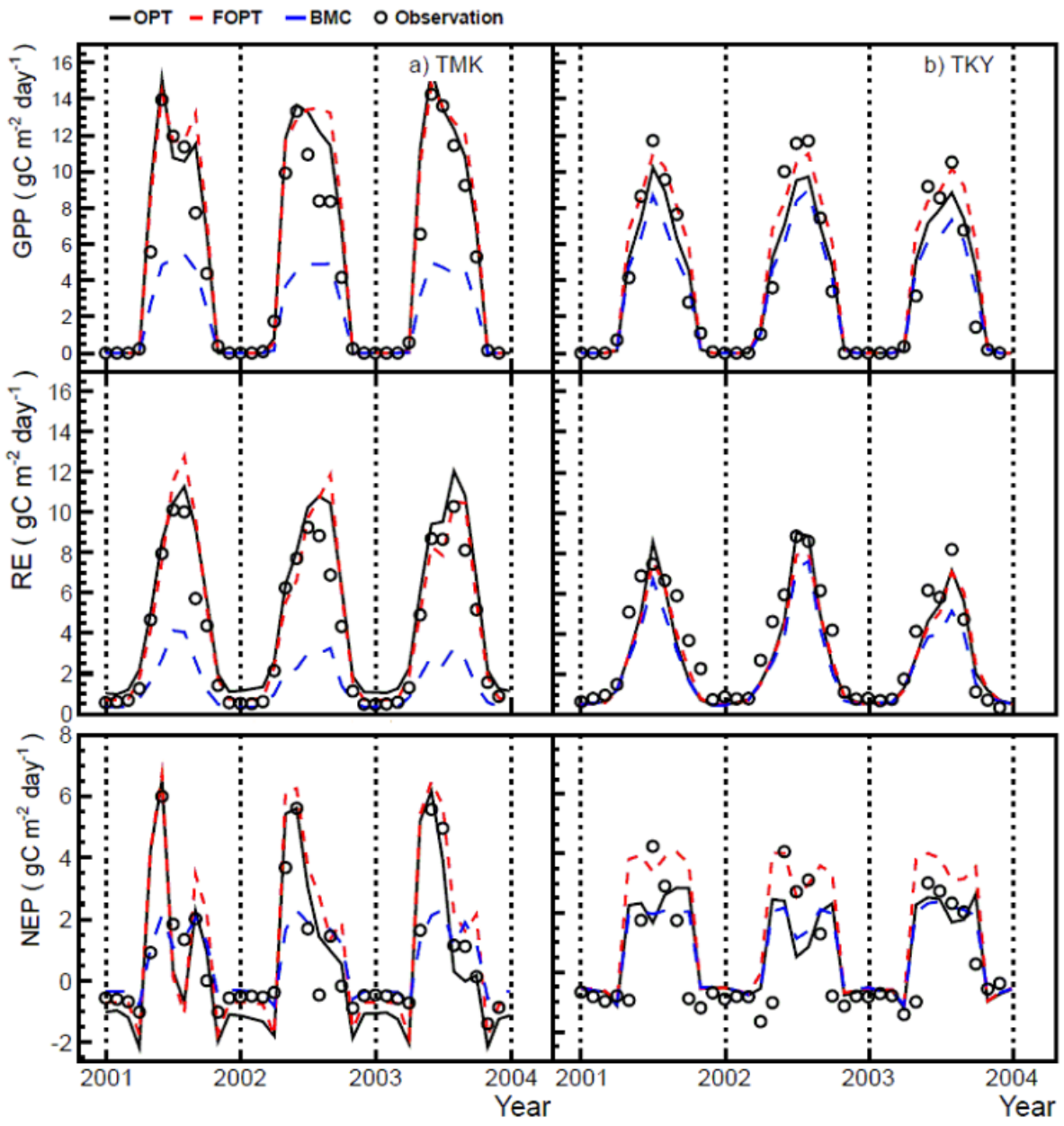
Exp2) Constrained by CO2 fluxes only

Exp3) Constrained by Biomass only



[Kondo et al., 2013]

CO_2 fluxes are effective to constrain CO_2 fluxes



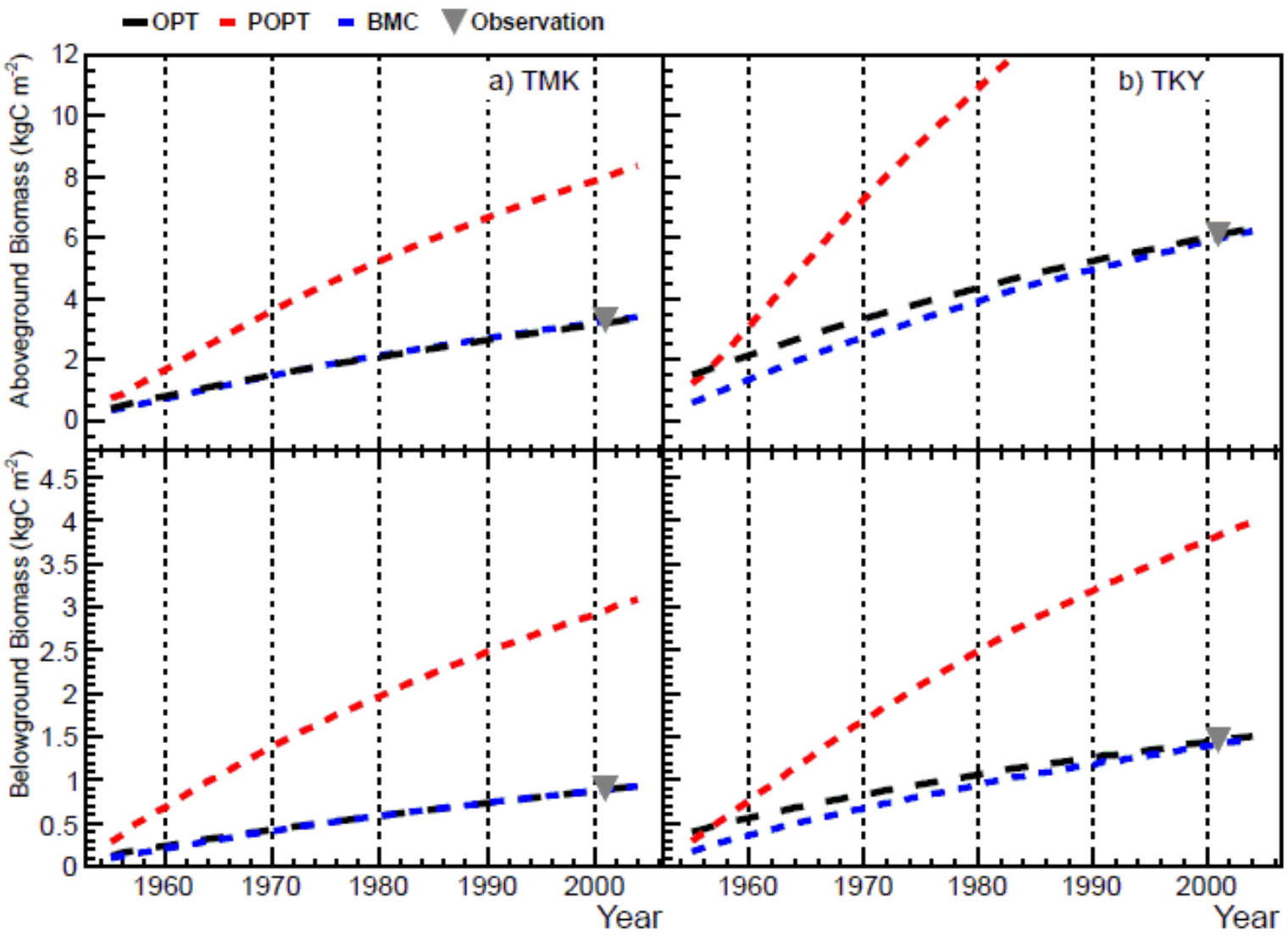
Optimizing using CO_2 flux (and both CO_2 flux and pool) can reproduce observed fluxes.

Biomass data cannot constrain CO_2 fluxes.

Optimize by Flux and Biomass
Optimize by Flux only
Optimize by Biomass only
Observation

[Kondo et al. 2013]

Biomass data are required to reproduce “observed” Biomass



Experiment:
Biome-BGC model (C, H2O, N cycle)

Optimizing using biomass (and both CO_{7u} flux can reproduce observed fluxes.

Biomass data cannot constrain CO2 fluxes..

Optimize by Flux and Biomass
Optimize by Flux only
Optimize by Biomass only
Observation

[Kondo et al. 2013]

Summary and some comments

- Biomass is one of the key parameters of terrestrial ecosystems. However, many ecosystem models cannot reproduce it.

- In general, so far, terrestrial ecosystem model (carbon cycle model) are well calibrated to CO_2 fluxes, such as GPP, RE, NEE.

- MOLI products (e.g. biomass) will help to improve terrestrial carbon cycle models. It leads to improve terrestrial CO_2 simulation, including future projection.

- In addition, I would like to look ‘changes of forest status’ through multi-year observation using a single sensor.