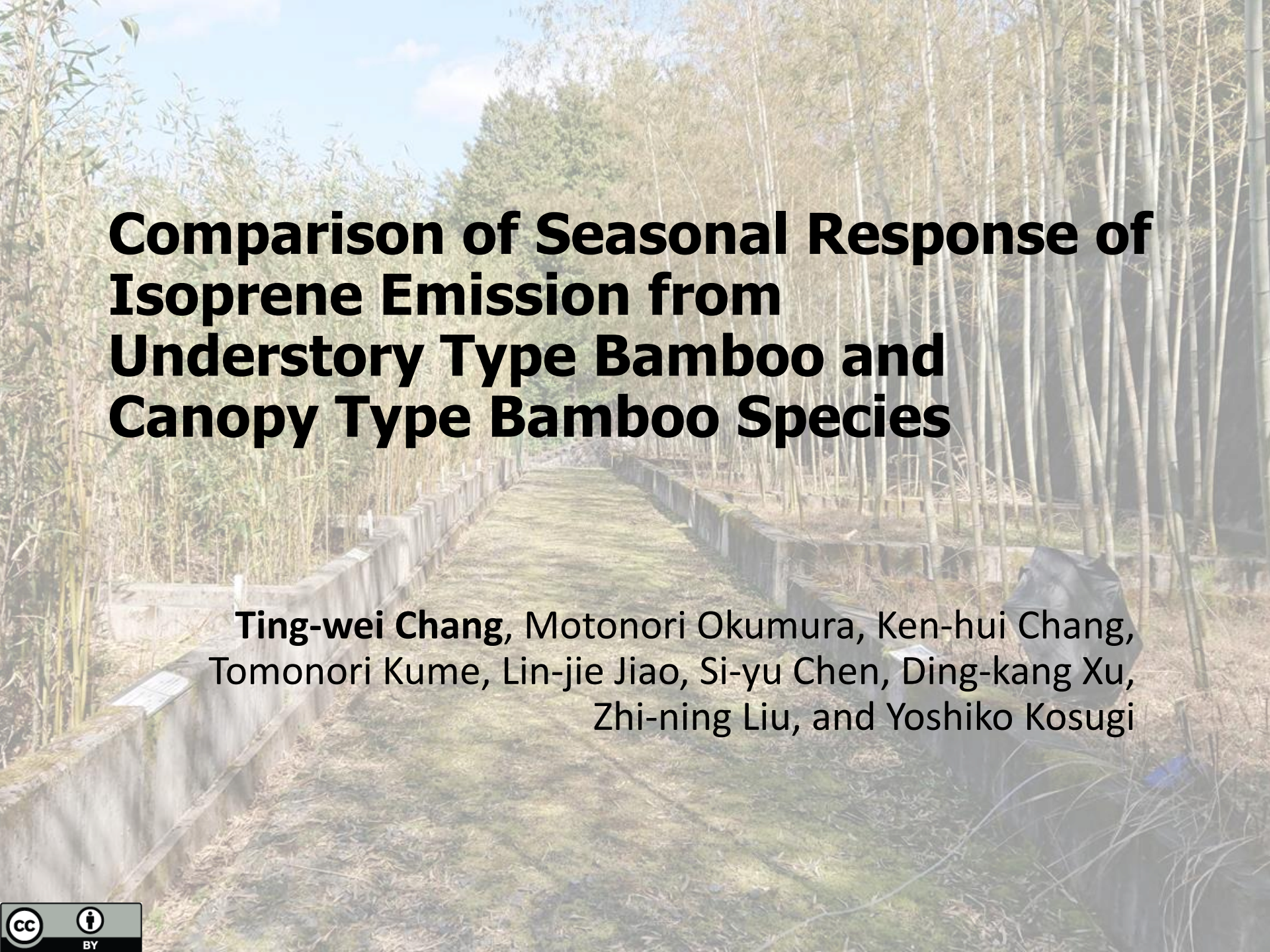


Comparison of Seasonal Response of Isoprene Emission from Understory Type Bamboo and Canopy Type Bamboo Species

Ting-wei Chang, Motonori Okumura, Ken-hui Chang, Tomonori Kume, Lin-jie Jiao, Si-yu Chen, Ding-kang Xu, Zhi-ning Liu, and Yoshiko Kosugi

Vegetation, as the largest source of isoprene

Global Biogenic VOC emission (1980-2010):

1019 Tg yr^{-1}

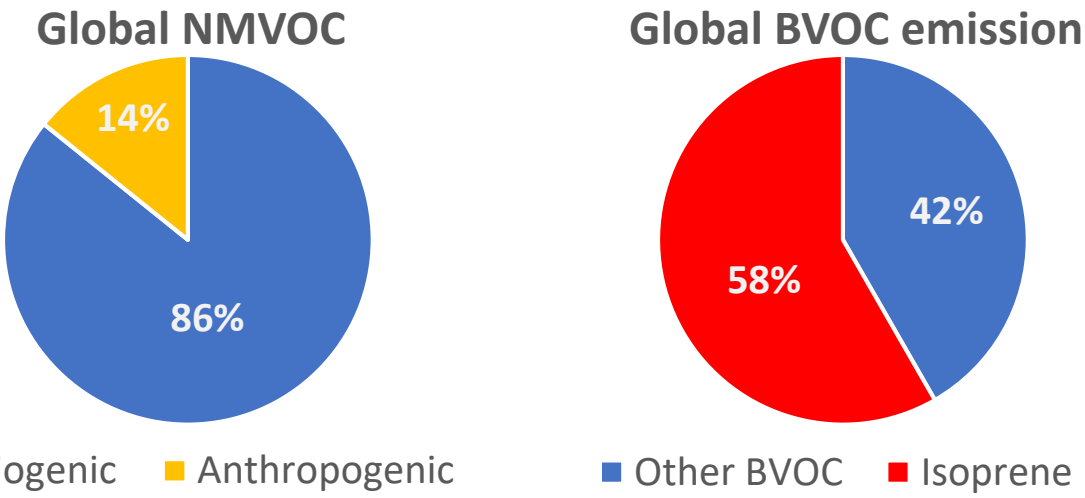
Isoprene: 594 Tg yr^{-1} (Sindelarova et al., 2014)

Global anthropogenic NMVOC emission (2012):

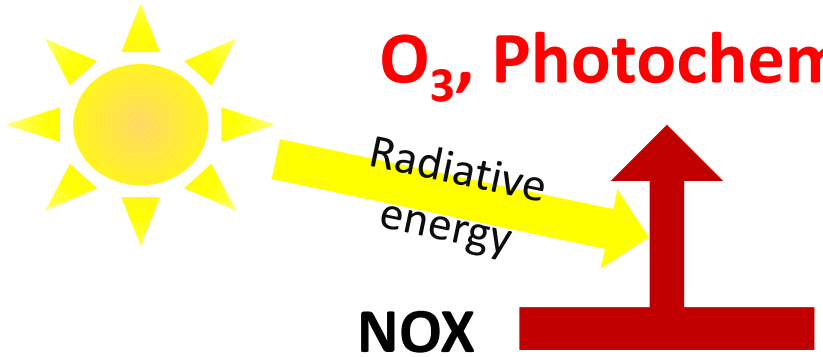
169 Tg yr^{-1} (Huang et al., 2017)

Global methane emission:

593~880 Tg yr^{-1} (Saunois et al., 2019)



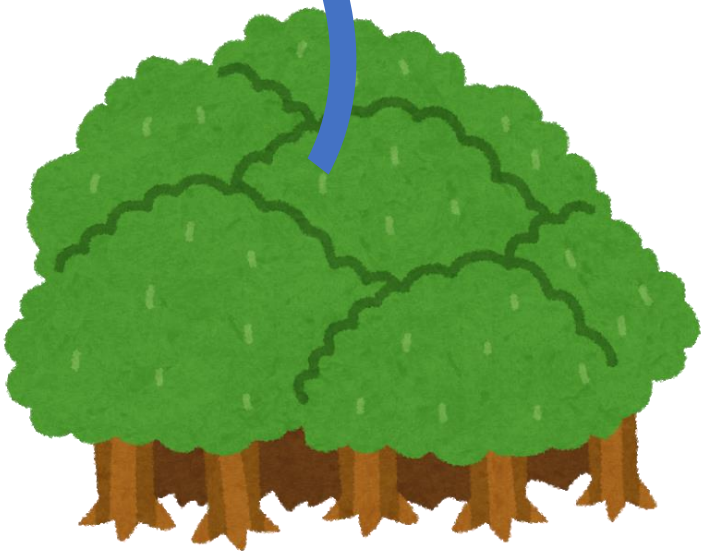
Introduction



O_3, Photochemical smoke

NOX

VOC
(e.g. isoprene, monoterpene)



Several canopy-type bamboo species show significant Isoprene emission

Bamboo (assuming leaf mass area = 80 g m^{-2}):

Phyllostachys spp. (in Japan): 174 μg g^{-1} hr^{-1}(57 nmol m^{-2} s^{-1}) (Okumura et al., 2018)

Bambusa spp. (in Japan): 196 μg g^{-1} hr^{-1} (64 nmol m^{-2} s^{-1}) (Okumura et al., 2018)

Semiarundinaria spp. (in Japan): 144 μg g^{-1} hr^{-1} (47 nmol m^{-2} s^{-1}) (Okumura et al., 2018)

Phyllostachys pubescens (in Central Taiwan): 122 μg g^{-1} hr^{-1} (40 nmol m^{-2} s^{-1}) (Chang et al., 2019)

Top 3 emitter species among 377 species (Benjamine et al., 1996):

Elaeis guineensis: 172.9 μg g^{-1} hr^{-1}

Salix babylonica: 115.0 μg g^{-1} hr^{-1}

Quercus robur: 76.6 μg g^{-1} hr^{-1}

※Comparing in basal emission flux (PPFD = 1000 μmol m^{-2} s^{-1}, Leaf temperature = 30 ˚C, from leaf)

However, the emission from understory-type bamboos are not well understood.

As the important components of the understory vegetations in forest ecosystem, this can be an uncertainty in evaluation of isoprene emission

This study conducted measurement on isoprene emission flux from leaves of 18 species of bamboo

Understory-type bamboo (*Sasa veitchii*)

Canopy-type bamboo (*Phyllostahys pubescens*)


Kamigamo experimental station
Location: 35˚ 04’N, 135˚ 46’E;
Elevation: 109～225m;
Mean annual temperature: 14.6℃;
Mean annual precipitation: 1,582mm.

List of Measured Bamboo Species

"Bamboo" group (9 species, 2 genera)

Genus	Botanical Name
Phyllostachys	*P. nigra* var. *henonis*
	P. bambusoides
	P. makinoi
	P. aurea
	P. pubescens
Semiarundinaria	*S. fatsuosa*
	S. kagamiana
	S. fortis
	S. yashadake

Canopy type

List of Measured Bamboo Species

"Sasa" group (9 species, 3 genera)

Genus	Botanical Name
Pleioblastus	*P. hindsii*
	P. linearis
	P. simonii
	P. chino
Sasa	*S. veitchii*
	S. chartacea
	S. tsuboiana
Sasaella	*S. hortensis*
	S. ramosa

Canopy type

Understory type

Material and methods

Period:

- Aug 2nd-5th, 2019
- Sep 12th-16th, 2019
- Oct 15th-17th, 2019

Leaf selection:

- Three leaves per species
- Sunlit leaf

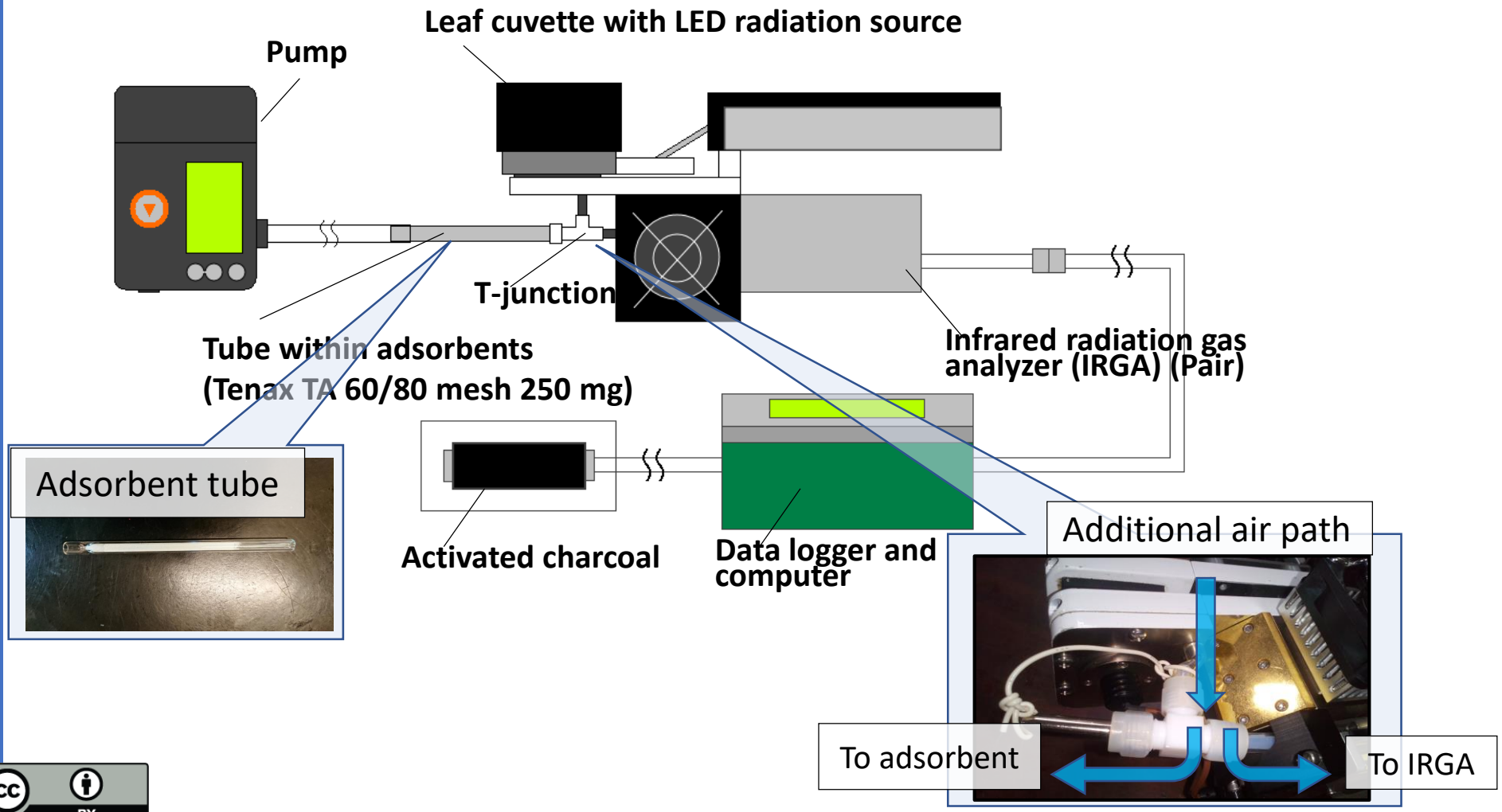
Measurements:

- Photosynthesis rate
- Isoprene emission flux
- Leaf temperature

※ In this plot, understory type species are grown at sun-lit positions, where differ to their natural niches

Material and methods

Conducting with a modified LI-6400 (Li-Cor Inc., USA)



Material and methods

The observation process

LI-6400 settings

- Fixed photosynthetic photon flux density: 1000 µmol m^{-2} s^{-1}
- Flow rate: 500 µmol s^{-1}

Clipping on the leaf

↓

Waiting for steady state in leaf and cuvette for 5 minutes

↓

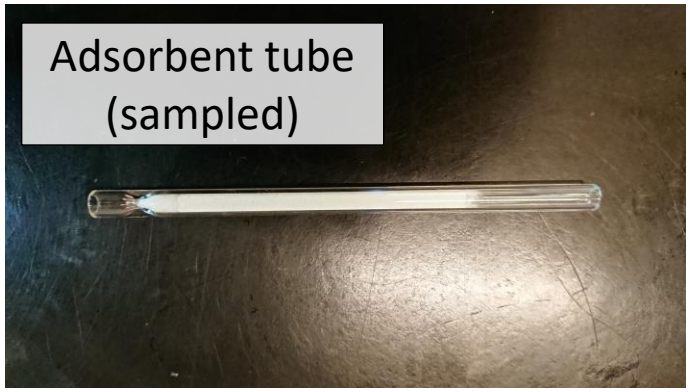
Pumping 0.15 L min^{-1} for 6'40" (1 L) air through adsorbent

↓

Store the sampled adsorbent at 5 ℃ until analysis

Material and methods

Sampled adsorbent analysis



Heat desorption & Cold re-trap

Preconcentrator (Entech 7100A, Entech Instruments Inc.)

Gas chromatography analysis

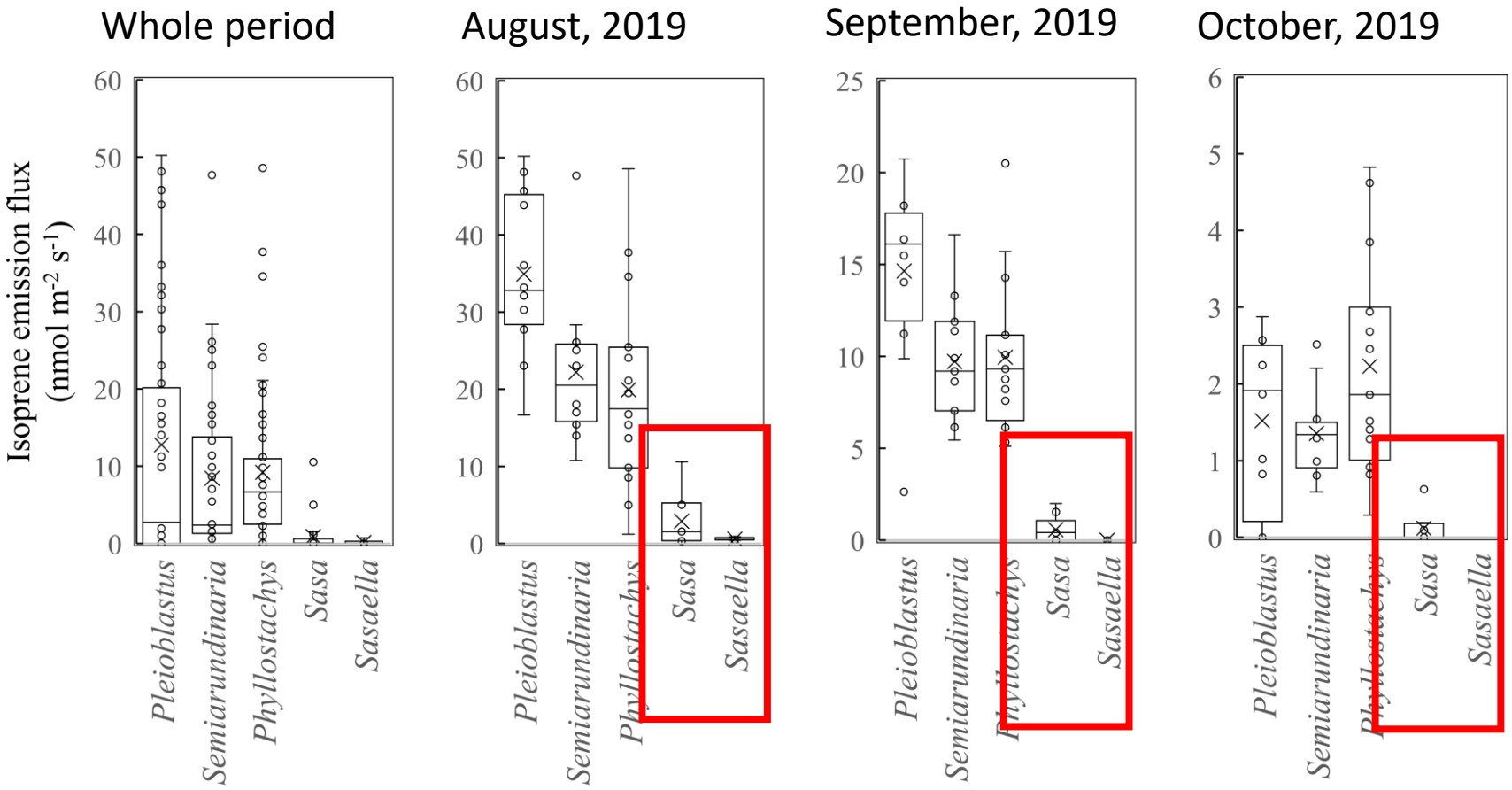
Monthly established calibration line

GC-MS (HP6890, AgilentTechnologies Inc.)

Concentration of Isoprene (ppb)

Results and discussion

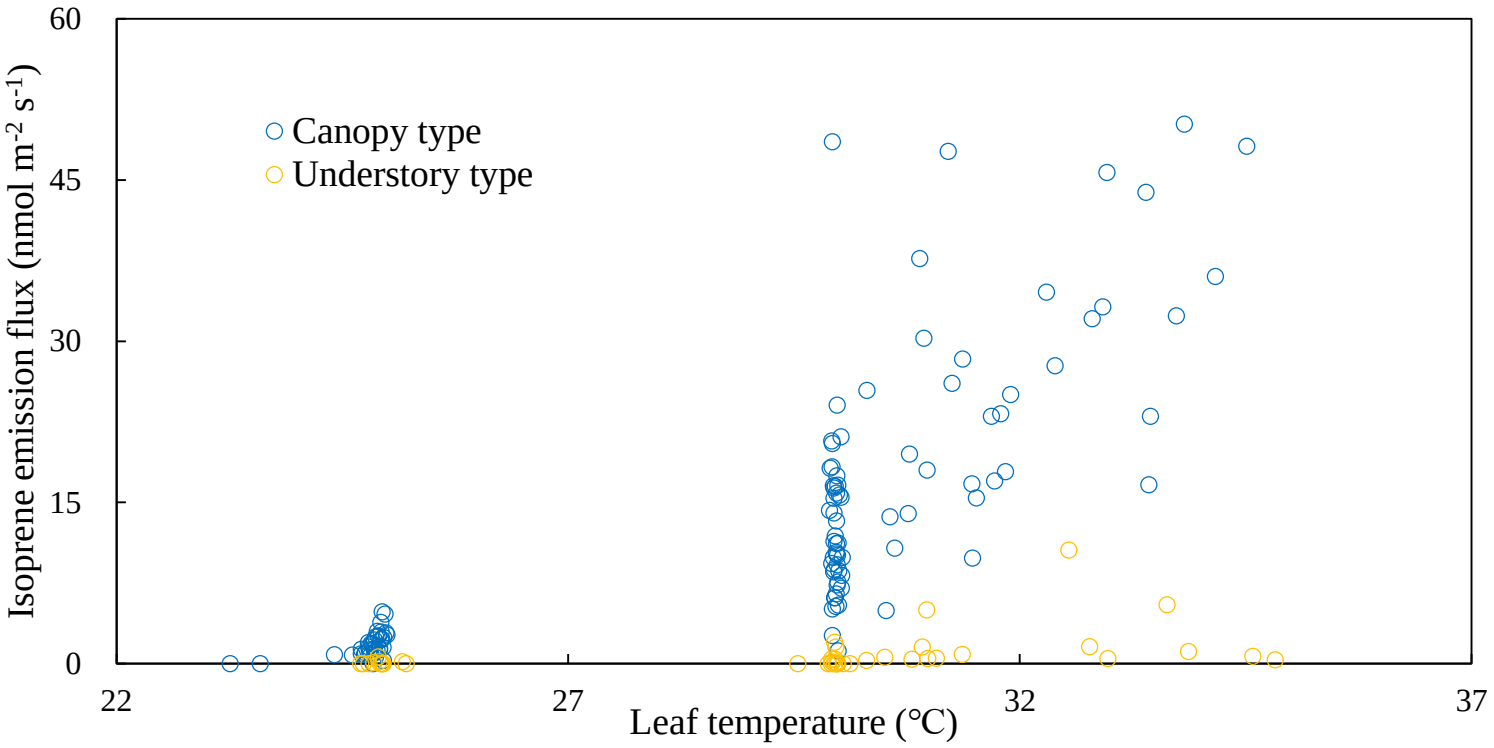
Isoprene emission flux in each months by genus



- Pleioblastus spp showed the highest average isoprene emission flux in Aug and Sep.
- Understory-type species showed significantly lower isoprene emission flux.

Results and discussion

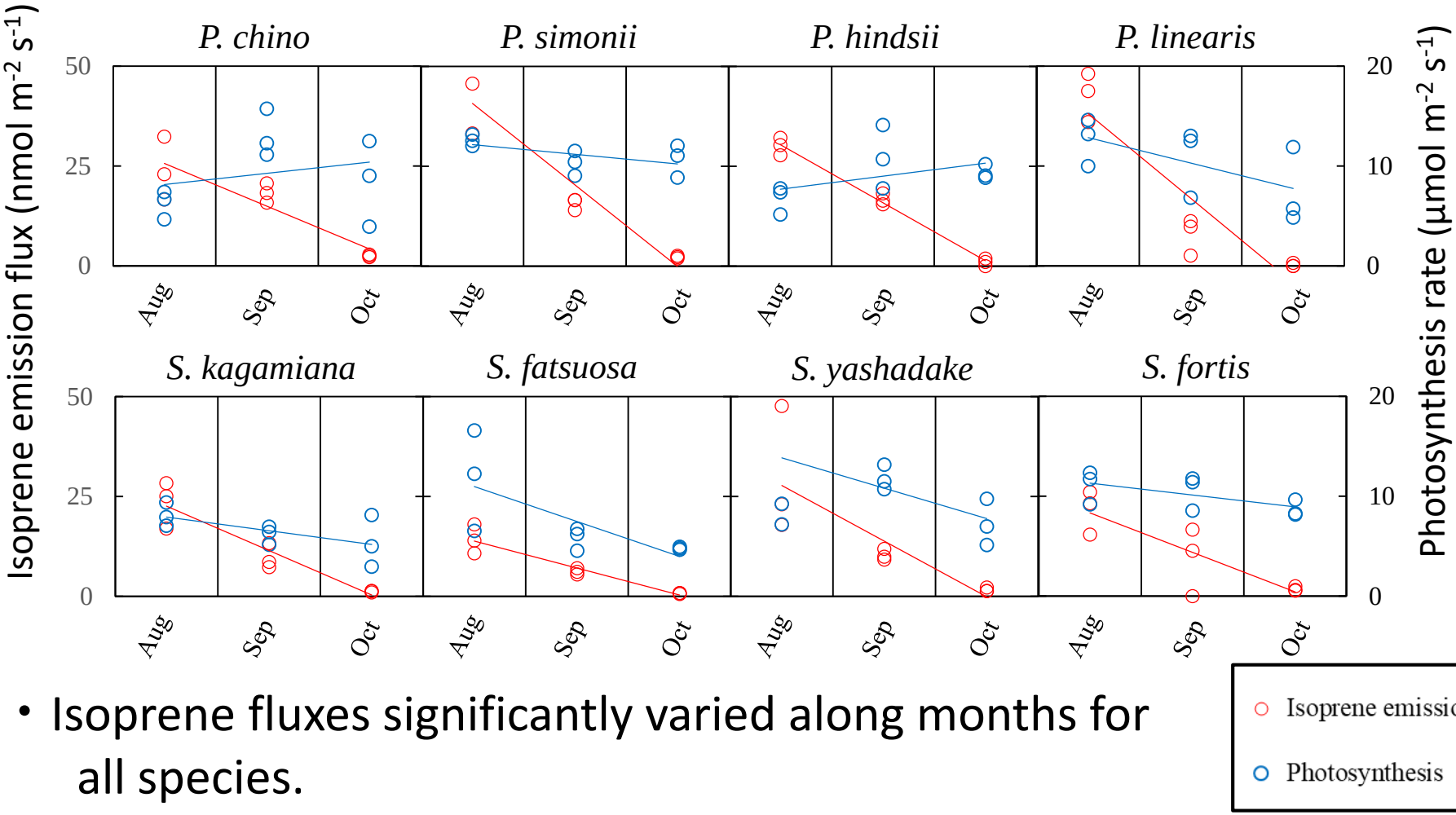
Isoprene emission flux in response to leaf temperature



- Isoprene emission fluxes generally increase with leaf temperature.
- The increase slope in isoprene flux of understory type species significantly smaller than that of canopy species.

Results and discussion

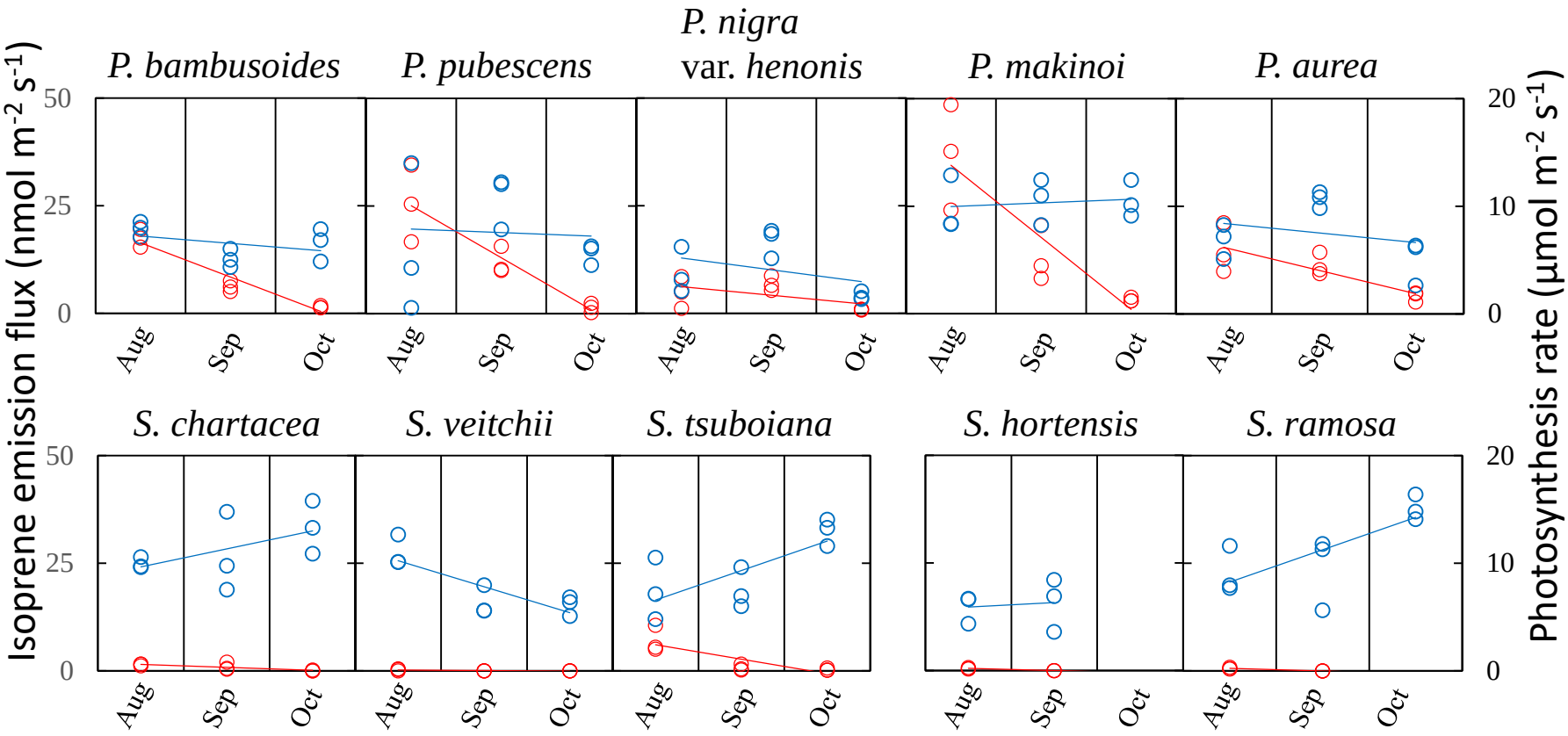
Month variation of isoprene emission flux and photosynthesis rate



- Isoprene fluxes significantly varied along months for all species.
- All species showed similar tendency that isoprene flux gradually decrease or ceased in Sep. and Oct.

Results and discussion

Month variation of isoprene emission flux and photosynthesis rate



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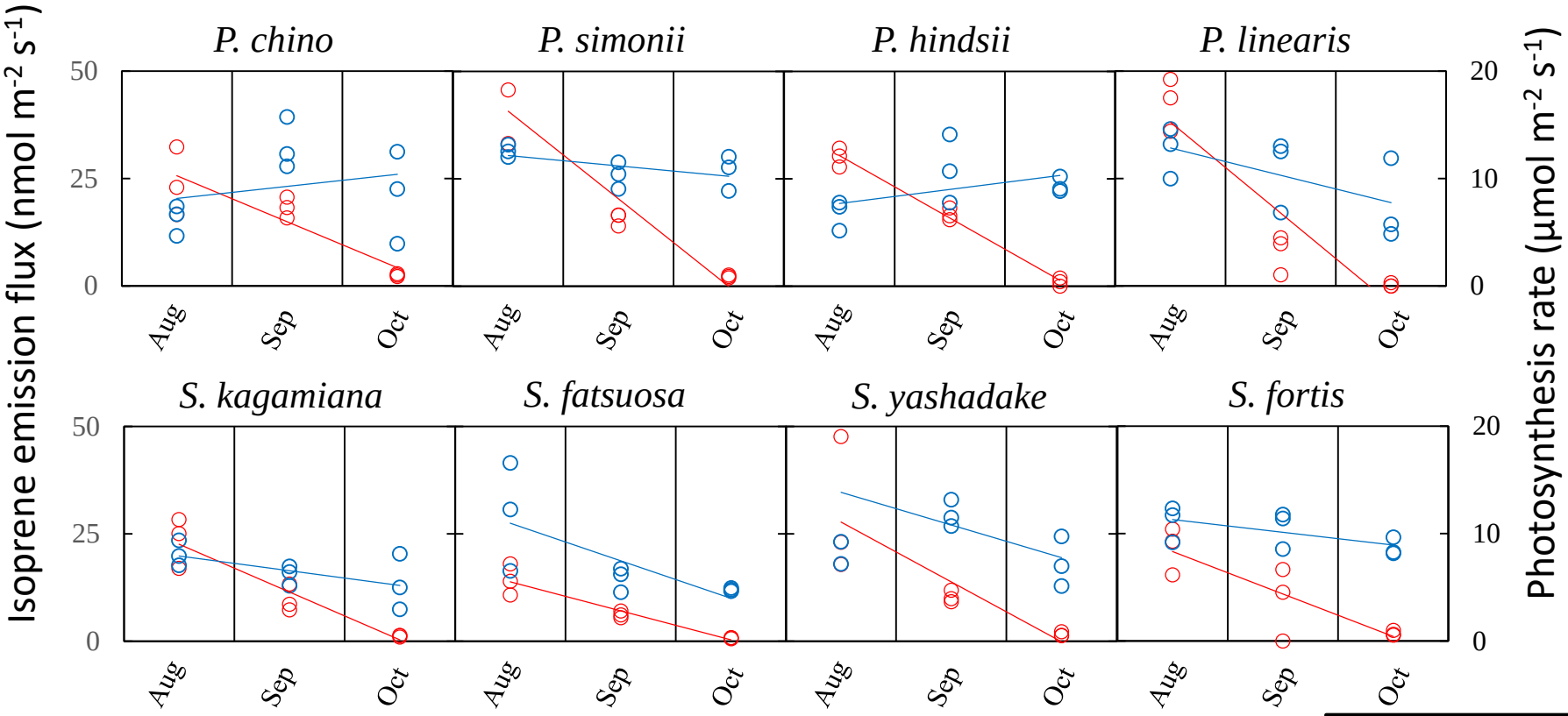
Results and discussion

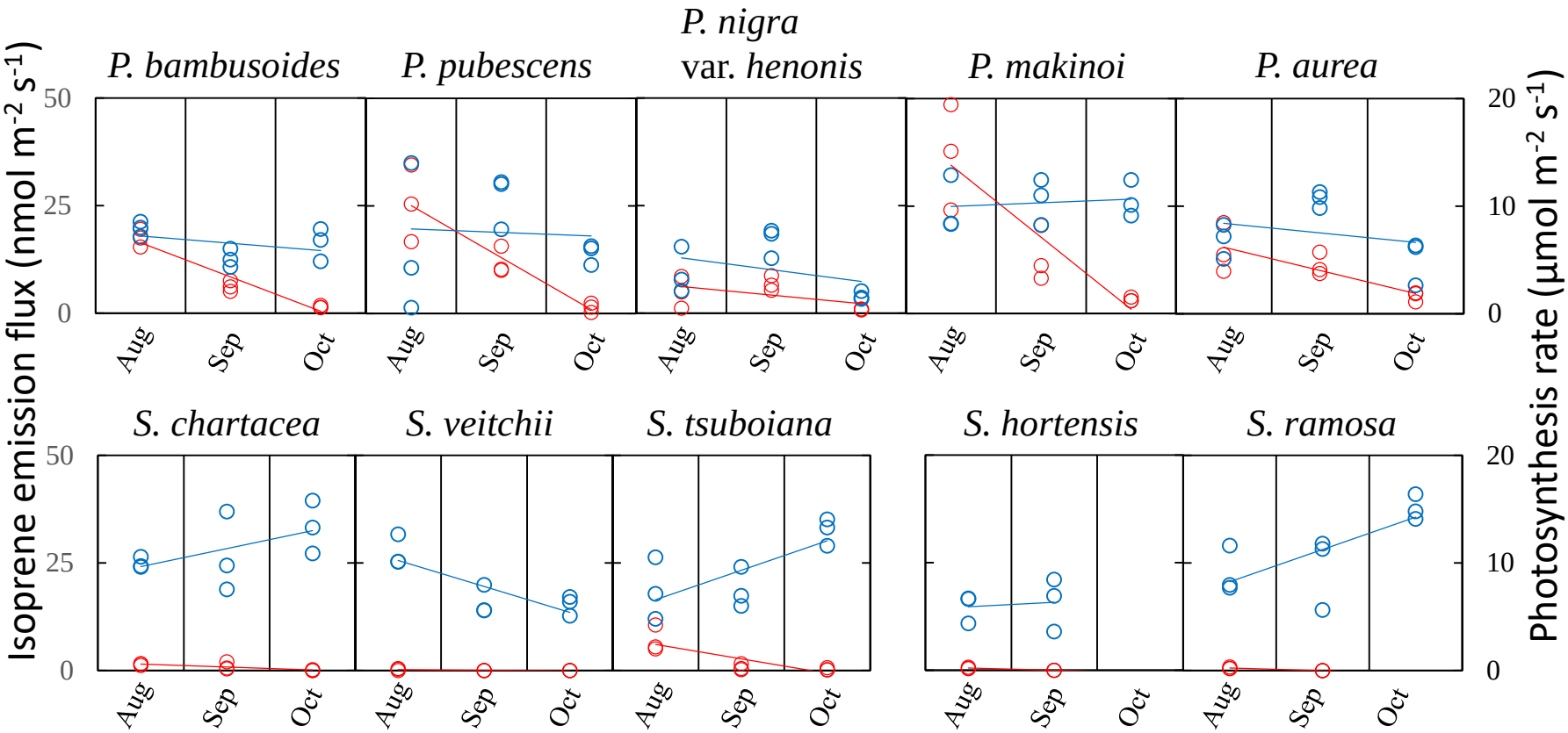
Month variation of isoprene emission flux and photosynthesis rate



- Photosynthesis rate did not show consistent seasonal tendency among the species.
- Semiarundinaria spp showed decrease tendency

Results and discussion

Month variation of isoprene emission flux and photosynthesis rate



- Sasa and Sasaella spp showed increase tendency
- The low carbon investment in isoprene for understory-type bamboos is reasonable for lower heat stress at understory.

In short…

- Consistent to taxonomical group:

Species in a same genus showed similar isoprene emission ability.

- Comparison of Understory species and Canopy species:

Isoprene flux significantly lower in understory-type bamboos than the canopy-type bamboos, even under the same light and temperature conditions.

- Seasonality pattern:

Isoprene emission flux gradually decreased from August (Summer) to October (Autumn); photosynthesis rate did not show consistent seasonal tendency.