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LEMONTREE
Land Ecosystem Models based On New Theory, obseRvations and ExperimEnts

Implementing P-model in JULES

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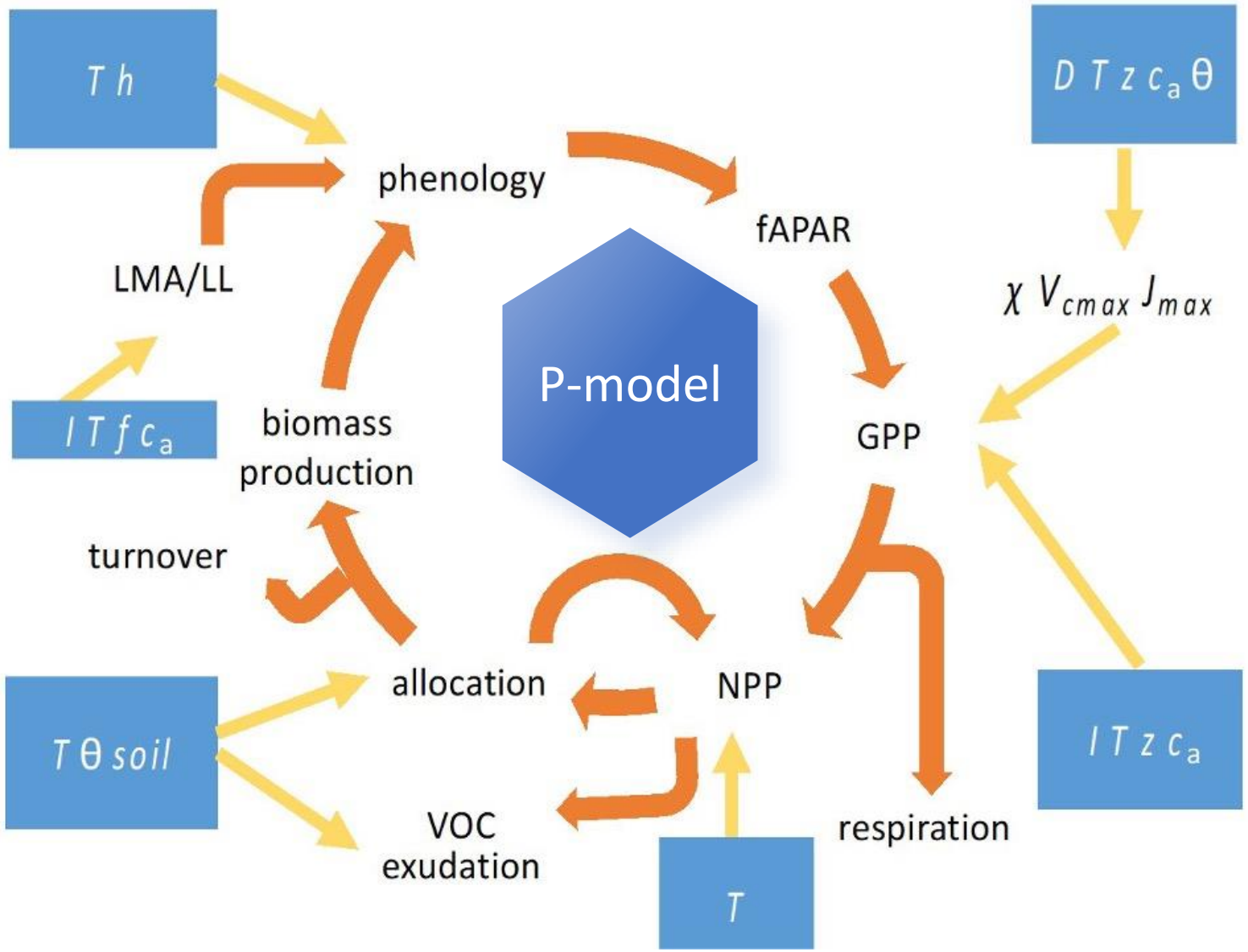
Background


T h
D T z c_a θ
phenology
fAPAR
LMA/LL
χ V_cmax J_max
P-model
I T f c_a
biomass production
GPP
turnover
allocation
NPP
T θ soil
I T z c_a
VOC exudation
respiration
T

Background


pft
bigleaf
light use
least cost
efficiency model
evolutional optimality theory
acclimation

Method

Model description

GPP longer term response + instant response

$$V_{\mathrm{cmax}}[\mathrm{opt}] = \varphi_0 I_{\mathrm{abs}} \frac{(c_i + K)}{(c_i + 2\Gamma^*)} \sqrt{1 - \left[c^* \frac{(c_i + 2\Gamma^*)}{(c_i - \Gamma^*)}\right]^{\frac{2}{3}}}$$

$$J_{\mathrm{max}}[\mathrm{opt}] = \frac{4\ \varphi_0 I_{\mathrm{abs}}}{\sqrt{\frac{1}{1 - \left[\frac{c^*(c_i\ +\ 2\Gamma^*)}{(c_i\ -\ \Gamma^*)}\right]^{\frac{2}{3}}} - 1}}$$

Prentice et al., 2014

$$\mathrm{param}\ (T_1) = \mathrm{param}\ (T_0)\ \exp\left[\left(\frac{\Delta H_a}{R}\right)\left(\frac{1}{T_0} - \frac{1}{T_1}\right)\right]$$

$$V_{\mathrm{cmax}}\mathrm{adjusted} = V_{\mathrm{cmax}}[\mathrm{opt}]\ \exp\left[\left(\frac{\Delta H_a}{R}\right)\left(\frac{1}{T_0} - \frac{1}{T_1}\right)\right]$$

$$J_{\mathrm{max}}\mathrm{adjusted} = J_{\mathrm{max}}[\mathrm{opt}]\ \exp\left[\left(\frac{\Delta H_{aj}}{R}\right)\left(\frac{1}{T_0} - \frac{1}{T_1}\right)\right]$$

Mengoli et al., 2022

Dark respiration

$$R_{d,accl} = R_{d,25} \times f_r\left(T_{accl}\right) \qquad R_{d,25} = b_{25} V_{c\max,25} \qquad f_r\left(T_{accl}\right) = \exp\left[0.1012\left(T_{accl} - 25\right) - 0.0005\left(T_{accl}{}^2 - 25^2\right)\right]$$

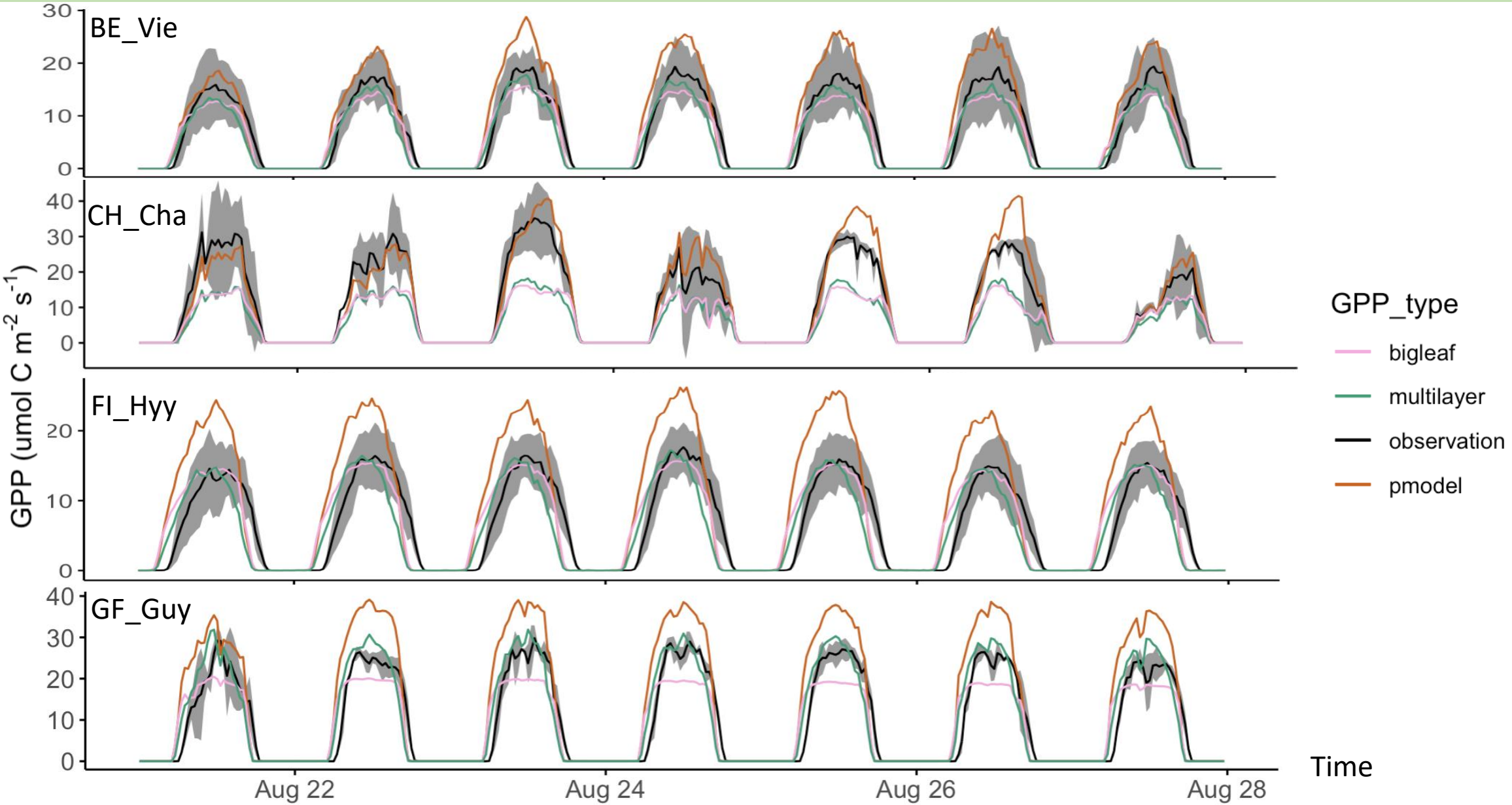
Wang et al., 2020; Ren, in prep

Method

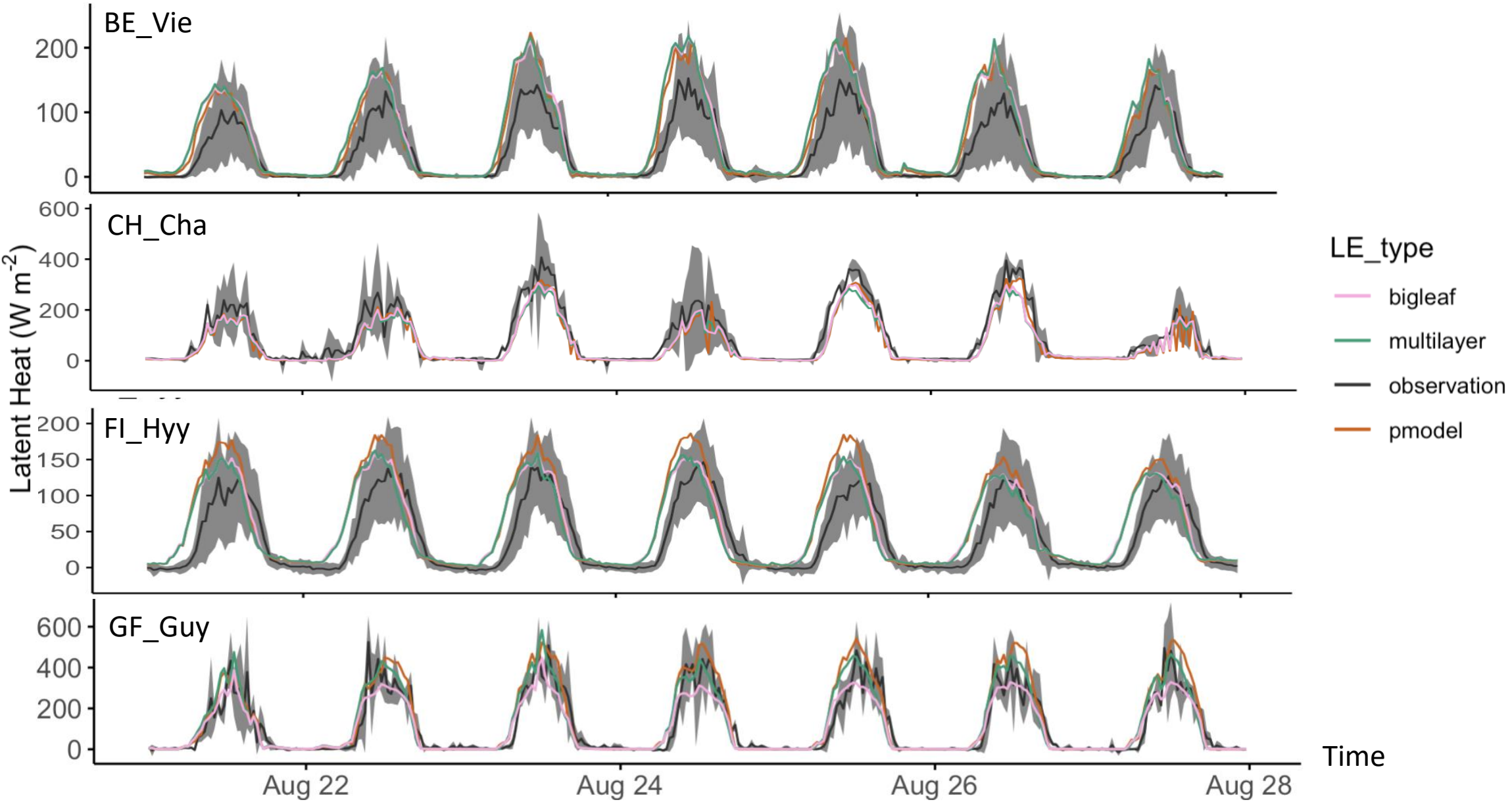
Site name	Site ID	Latitude (°)	Longitude (°)	MAT (°C)	MAP (mm)	IGBP vegetation type	Climate Koeppen
Hyytiälä	FI-Hyy	61.85	24.29	3.8	709	Evergreen needleleaf forest	Dfc (Subarctic)
Vielsalm	BE-Vie	50.30	5.99	7.8	1062	Mixed forest	Cfb
Chamau	CH-Cha	47.21	8.41	9.5	1136	Grasslands	Cfb (no dry season)
Guyaflux(French Guiana)	GF-Guy	−52.92	5.28	25.7	3041	Evergreen Broadleaf forest	
Demokeya	SD-Dem	13.2829	30.4783	26	320	Savana	
Santa Rita Mesquite	US_SRM	31.8214	-110.8661	17.92	380	Woody Savana	Bsk
Walnut Gulch Lucky Hills Shrub	US_Whs	31.7438	-110.0522	17.6	320	Open Shrubland	Bsk
Haibei Alpine Tibet site	CN-HaM	37.3700	101.1800	−2	550	Grasslands	

FLUXNET 2015 Subset Tier2
GPP: GPP_NT_VUT_REF Latent Heat: LE_F_MDS

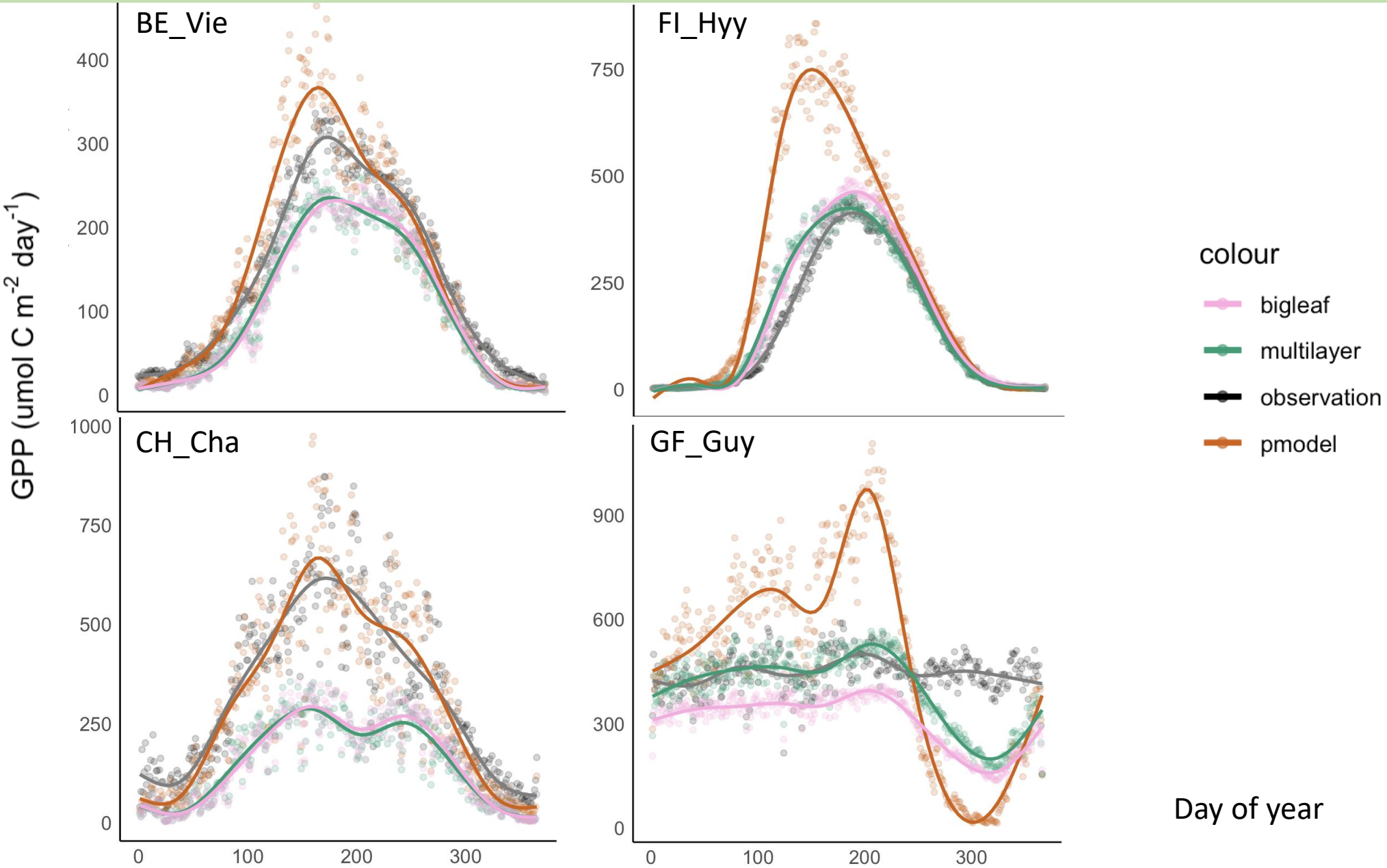
Result -- well watered sites



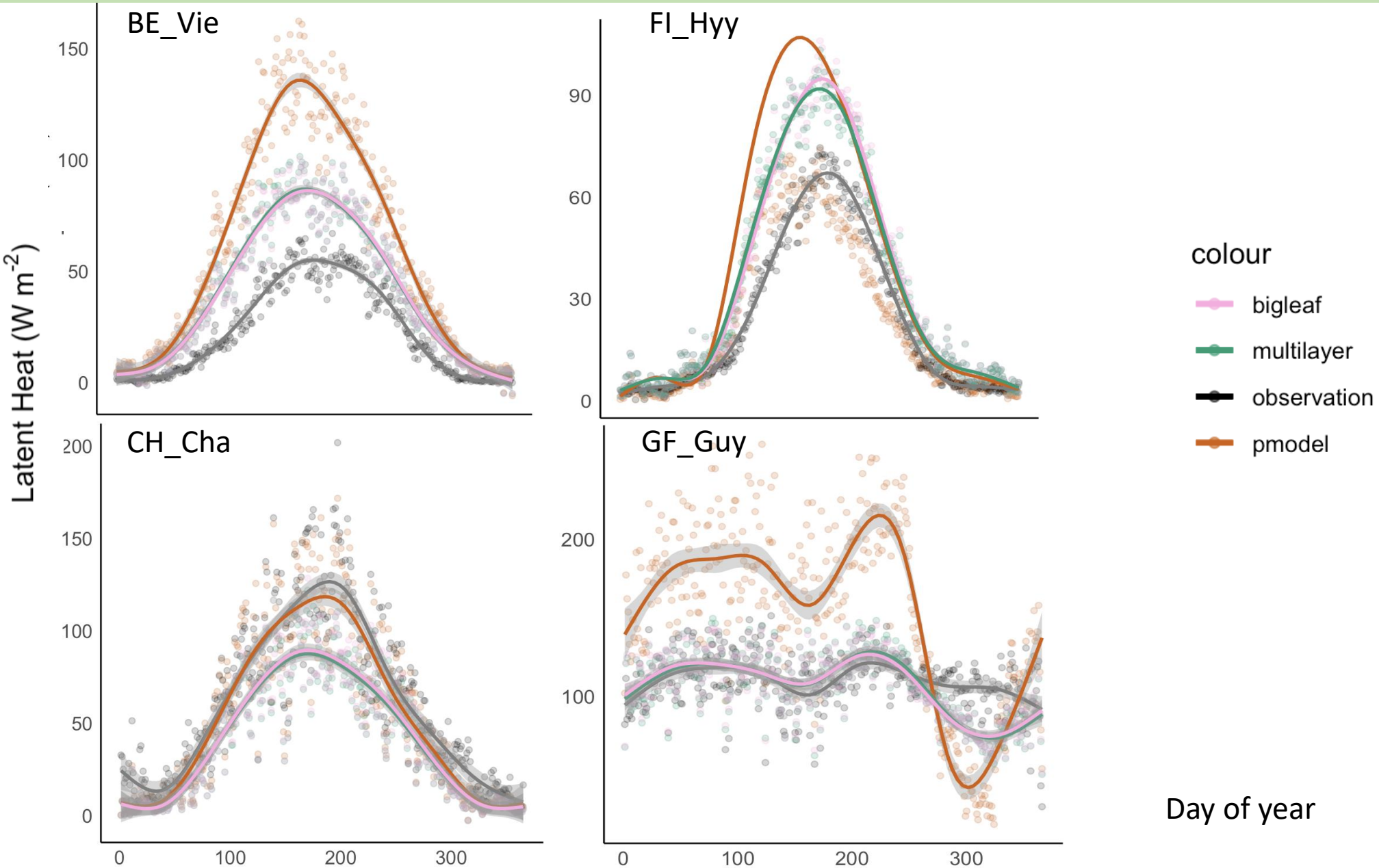
Result – well watered sites



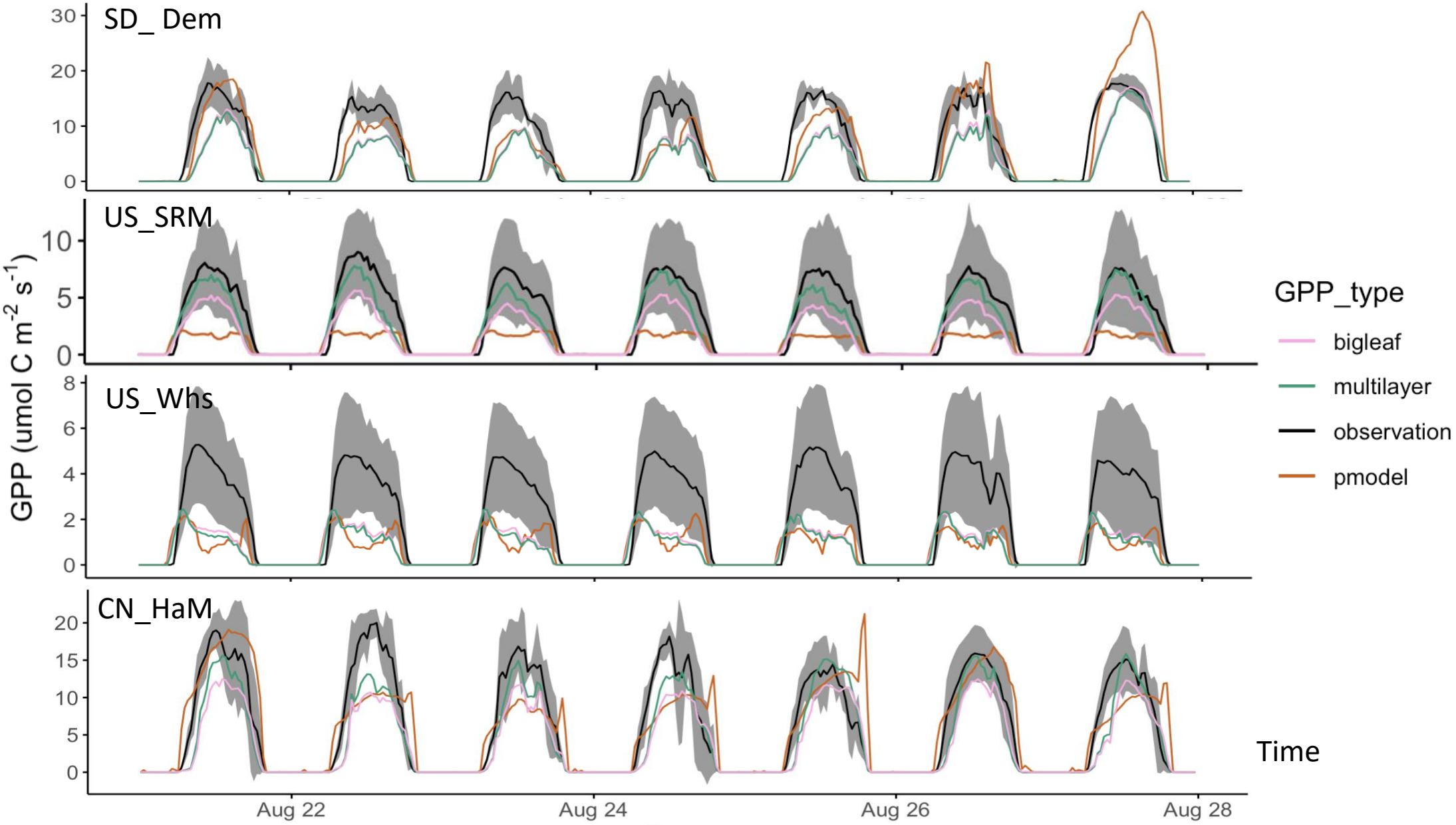
Result -- well watered sites



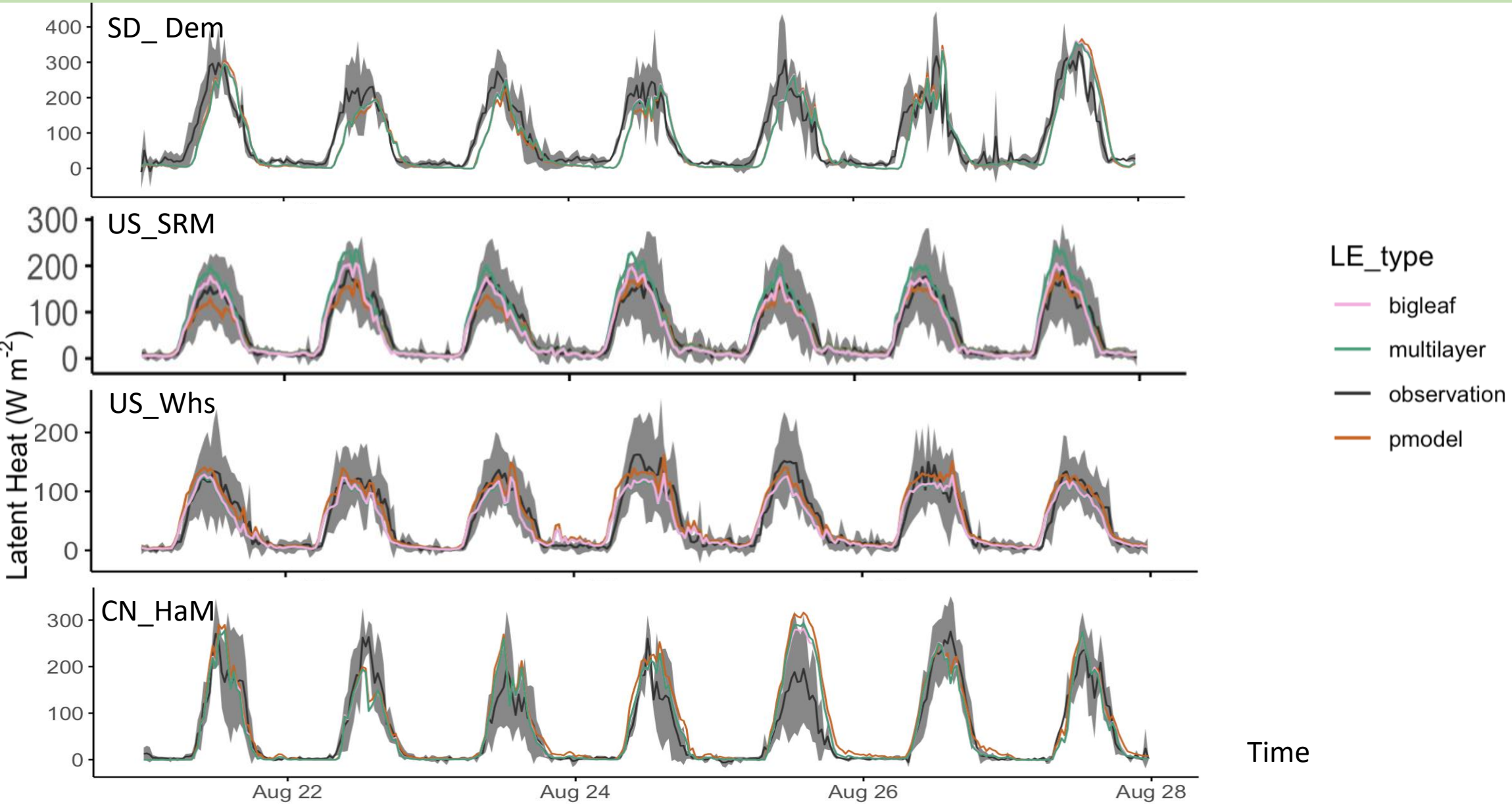
Result -- well watered sites



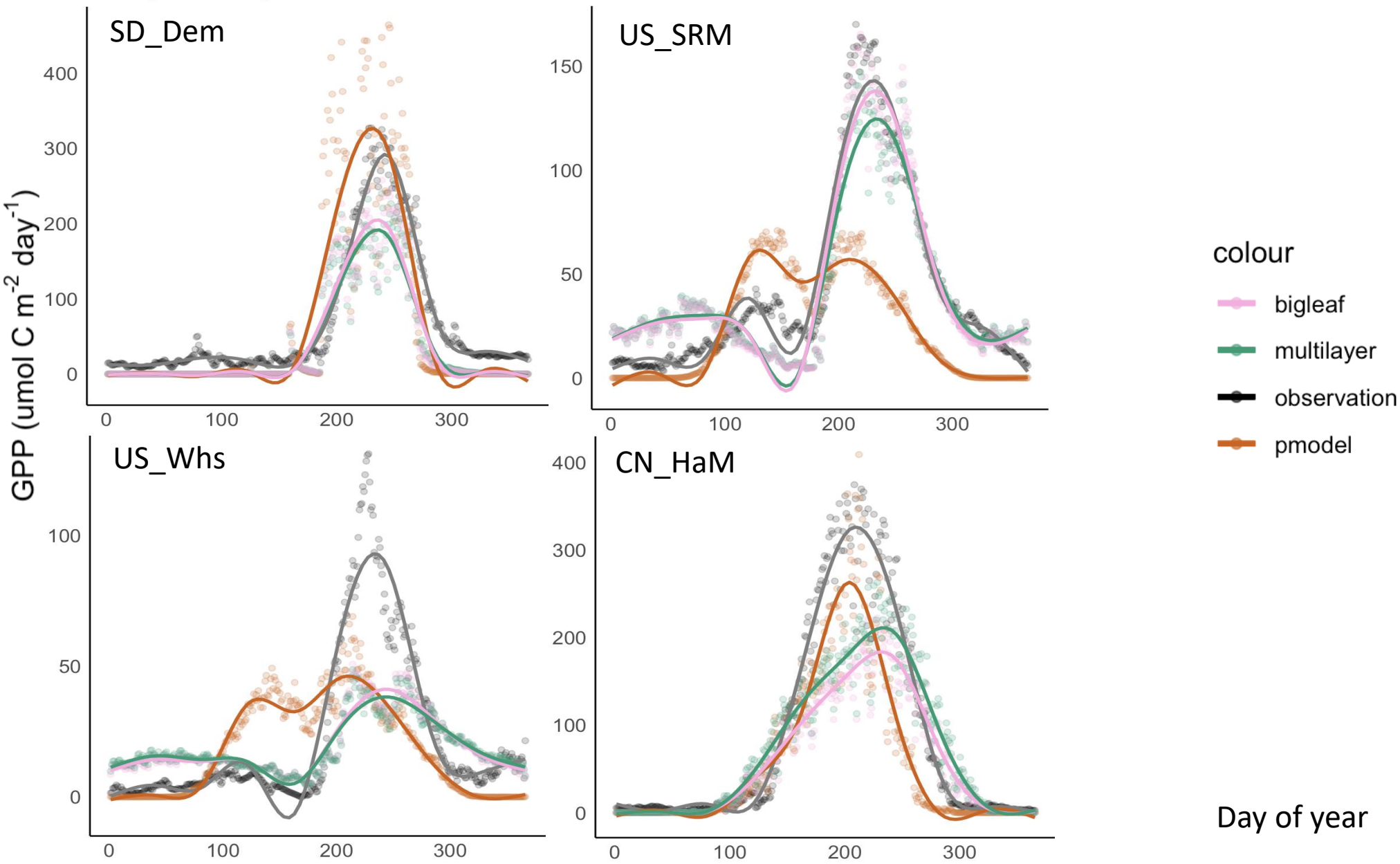
Result – arid/semi arid



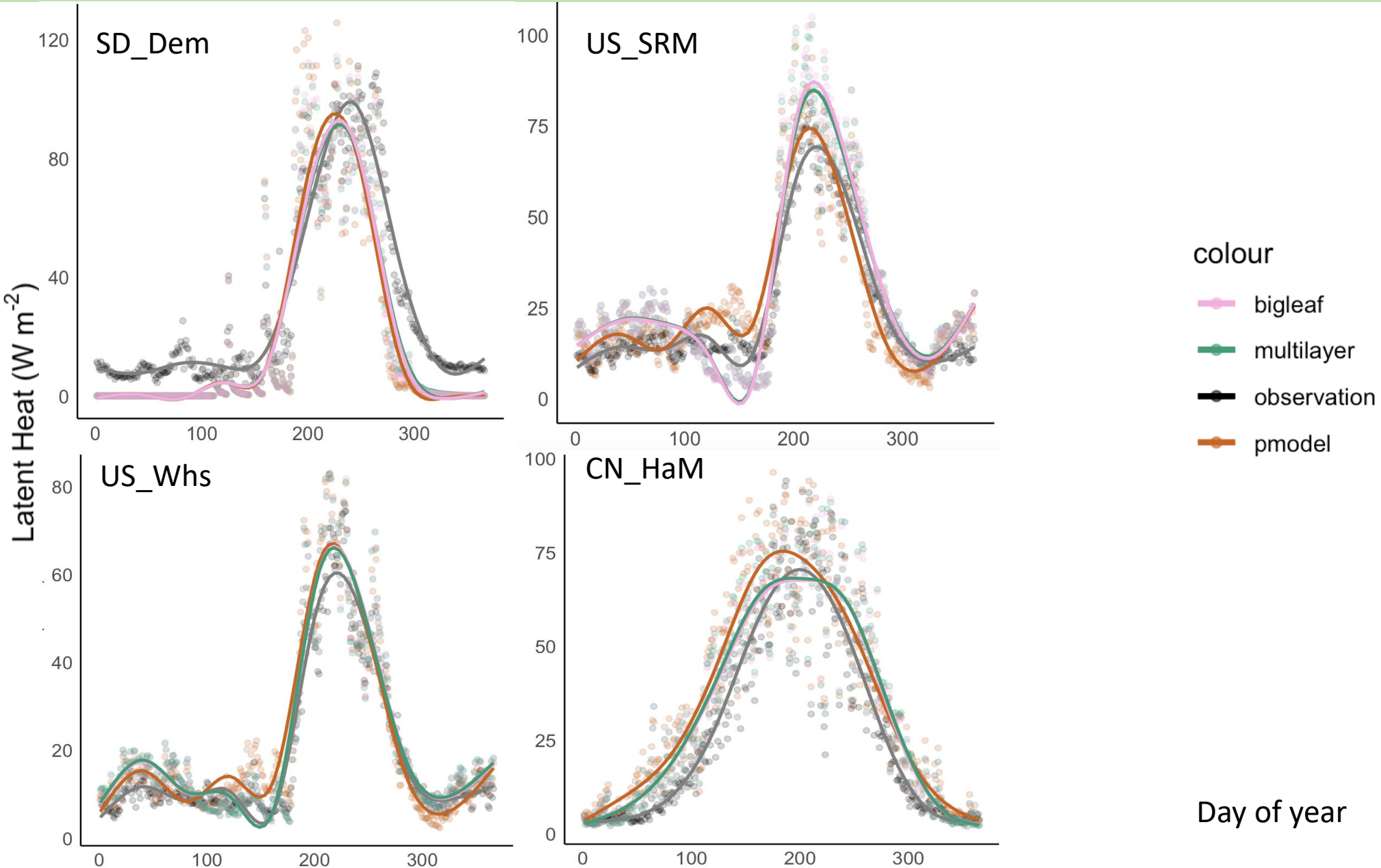
Result – arid/semi arid



Result – arid/semi arid



Result – arid/semi arid



Wrap up and outlook

Wrap up

1. P-model with acclimated response has been implemented in JULES.
2. JULES P-model reproduces the daily cycle of carbon dioxide uptake by plants.
3. P-model is better at capturing the extremes of GPP.
4. Model performance at well watered sites is better than arid/semi arid sites.
5. Latent heat is better simulated than GPP

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