

Supplementary Information: Global patterns of forest autotrophic carbon fluxes

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Table S1. Climate variable definitions, sources, and abbreviations

| Climate variable | Units | Definition | Abbreviation | Source |
|---|--------------------|---|--------------|---|
| Mean annual temperature (MAT) | °C | | MAT | Primary literature; WorldClim ¹ |
| Mean annual precipitation (MAP) | mm yr^{-1} | | MAP | Primary literature; WorldClim ¹ |
| Temperature seasonality | | Standard deviation of MAT *100 | T Seas | WorldClim ¹ |
| Precipitation seasonality | | Coefficient of variation of MAP | P Seas | WorldClim ¹ |
| Annual temperature range | °C | Maximum temperature of warmest month - minimum temperature of coldest month | ART | WorldClim ¹ |
| Solar radiation | kJ $m^{-2}yr^{-1}$ | | Solar R | WorldClim ² |
| Cloud cover | percentage | Cloud percentage cover | Cloud | CRU time-series dataset v 4.03 ³ |
| Annual frost days | days yr^{-1} | Number of freeze days annually | AFD | CRU time-series dataset v 4.03 ³ |
| Annual wet days | days yr^{-1} | Number of days with precipitation >0.1 mm annually | AWD | CRU time-series dataset v 4.03 ³ |
| Potential evapotranspiration (PET) | mm yr^{-1} | Mean annual potential evapotranspiration | PET | Global Aridity Index and Potential Evapotranspiration Climate Database ⁴ |
| Aridity | | MAP/mean annual PET | AI | Global Aridity Index and Potential Evapotranspiration Climate Database ⁴ |
| Vapour pressure deficit (VPD) | kPa | | VPD | TerraClimate ⁵ |
| Maximum vapour pressure deficit (Max VPD) | kPa | | Max VPD | Derived |
| Water stress months | months yr^{-1} | Number of months annually with MAP < PET | WSM | Derived |
| Length of growing season | months yr^{-1} | Number of months annually with mean minimum temperature > 0.5°C | LGS | Derived |

Table S2. Comparison of growing season length and mean annual temperature as predictors of FACH

| Fixed effect | AIC value | Delta AICc | Marginal R squared |
|--------------------------------|-----------|------------|--------------------|
| GPP | | | |
| MAT | 126.42617 | 0.000000 | 0.6196780 |
| Growing season length | 140.80589 | 14.379717 | 0.5411935 |
| None | 178.96179 | 52.535617 | 0.0000000 |
| NPP | | | |
| MAT | 174.88249 | 0.000000 | 0.5156614 |
| Growing season length | 191.53714 | 16.654650 | 0.4006999 |
| None | 216.16976 | 41.287265 | 0.0000000 |
| ANPP | | | |
| MAT | 249.50512 | 0.000000 | 0.2925950 |
| Growing season length | 254.20763 | 4.702509 | 0.2612187 |
| None | 268.94008 | 19.434966 | 0.0000000 |
| ANPP woody stem | | | |
| MAT | 235.95797 | 0.000000 | 0.1548800 |
| Growing season length | 237.28992 | 1.331943 | 0.1370243 |
| None | 243.13700 | 7.179027 | 0.0000000 |
| ANPP foliage | | | |
| MAT | 484.87610 | 0.000000 | 0.4462629 |
| Growing season length | 520.96482 | 36.088722 | 0.3497750 |
| None | 560.34915 | 75.473049 | 0.0000000 |
| BNPP root | | | |
| MAT | 184.54480 | 0.000000 | 0.5921282 |
| Growing season length | 204.92685 | 20.382054 | 0.4644116 |
| None | 237.46554 | 52.920743 | 0.0000000 |
| BNPP fine root | | | |
| MAT | 540.19217 | 0.000000 | 0.2429540 |
| Growing season length | 566.36955 | 26.177388 | 0.1060029 |
| None | 578.65529 | 38.463119 | 0.0000000 |
| Autotrophic respiration | | | |
| MAT | 45.25818 | 0.000000 | 0.6271133 |
| Growing season length | 50.35515 | 5.096972 | 0.5041004 |
| None | 56.16877 | 10.910597 | 0.0000000 |
| Root respiration | | | |
| MAT | 133.53500 | 0.000000 | 0.2507631 |
| Growing season length | 135.92632 | 2.391311 | 0.1990489 |
| None | 141.78719 | 8.252190 | 0.0000000 |

Table S3. Model details and R2 values for all climate variables tested

| Carbon flux | Latitude | | MAT | | MAP | | T Seas | | P Seas | | ATR | | Solar R | | AI | |
|-------------------------|----------|-----------|--------|-----------|------------|-----------|------------|-----------|--------|-----------|--------|-----------|---------|-----------|------------|-----------|
| | Model | R-squared | Model | R-squared | Model | R-squared | Model | R-squared | Model | R-squared | Model | R-squared | Model | R-squared | Model | R-squared |
| GPP | Linear | 0.6387 | Linear | 0.6094 | Polynomial | 0.324 | Polynomial | 0.7076 | - | - | Linear | 0.6269 | Linear | 0.1554 | - | - |
| NPP | Linear | 0.5108 | Linear | 0.4171 | Polynomial | 0.2138 | Polynomial | 0.4905 | - | - | Linear | 0.4442 | Linear | 0.09548 | Linear | 0.03795 |
| ANPP | Linear | 0.4351 | Linear | 0.4444 | Polynomial | 0.1625 | Polynomial | 0.4126 | - | - | Linear | 0.3331 | Linear | 0.1061 | Linear | 0.04851 |
| ANPP woody stem | Linear | 0.1773 | Linear | 0.2396 | - | - | Linear | 0.1416 | - | - | Linear | 0.1157 | Linear | 0.05048 | Linear | 0.06607 |
| ANPP foliage | Linear | 0.4999 | Linear | 0.5826 | Polynomial | 0.2509 | Linear | 0.4823 | - | - | Linear | 0.5033 | Linear | 0.172 | Linear | 0.1084 |
| BNPP root | Linear | 0.3373 | Linear | 0.2833 | Polynomial | 0.1452 | Linear | 0.3300 | - | - | Linear | 0.2904 | Linear | 0.2315 | - | - |
| BNPP fine root | Linear | 0.1704 | Linear | 0.1477 | Linear | 0.08935 | Linear | 0.1721 | - | - | Linear | 0.1790 | Linear | 0.1393 | Polynomial | 0.06915 |
| Autotrophic respiration | Linear | 0.6534 | Linear | 0.5909 | Polynomial | 0.604 | Polynomial | 0.6246 | - | - | Linear | 0.4900 | Linear | 0.26 | Polynomial | 0.4804 |
| Root respiration | Linear | 0.2612 | Linear | 0.2418 | Linear | 0.1493 | Polynomial | 0.2151 | - | - | Linear | 0.1776 | - | - | Linear | 0.1567 |

| Carbon flux | Cloud | | AFD | | AWD | | PET | | VPD | | Max VPD | | WSM | | LGS | |
|-------------------------|--------|-----------|--------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|--------|-----------|
| | Model | R-squared | Model | R-squared | Model | R-squared | Model | R-squared | Model | R-squared | Model | R-squared | Model | R-squared | Model | R-squared |
| GPP | - | - | Linear | 0.5498 | Linear | 0.11 | Polynomial | 0.3602 | Polynomial | 0.3076 | - | - | - | - | Linear | 0.5312 |
| NPP | Linear | 0.06339 | Linear | 0.4036 | Linear | 0.1118 | Polynomial | 0.3165 | Polynomial | 0.178 | - | - | Linear | 0.03561 | Linear | 0.3782 |
| ANPP | Linear | 0.0439 | Linear | 0.3668 | Linear | 0.1732 | Polynomial | 0.2672 | Polynomial | 0.2294 | Polynomial | 0.0632 | Polynomial | 0.06269 | Linear | 0.3425 |
| ANPP woody stem | - | - | Linear | 0.1380 | - | - | Polynomial | 0.2024 | Polynomial | 0.2146 | Linear | 0.07403 | - | - | Linear | 0.1041 |
| ANPP foliage | - | - | Linear | 0.5306 | Linear | 0.1469 | Linear | 0.3076 | Polynomial | 0.3751 | Polynomial | 0.07489 | Polynomial | 0.1724 | Linear | 0.4552 |
| BNPP root | - | - | Linear | 0.2799 | Polynomial | 0.1113 | Polynomial | 0.3601 | Polynomial | 0.2584 | - | - | - | - | Linear | 0.2550 |
| BNPP fine root | - | - | Linear | 0.1631 | Linear | 0.08161 | Linear | 0.1376 | - | - | - | - | - | - | Linear | 0.1335 |
| Autotrophic respiration | - | - | Linear | 0.5502 | Linear | 0.226 | Linear | 0.3298 | Polynomial | 0.4499 | - | - | Linear | 0.2613 | Linear | 0.4664 |
| Root respiration | Linear | 0.1578 | Linear | 0.1647 | Linear | 0.1698 | Polynomial | 0.1905 | Polynomial | 0.272 | - | - | Linear | 0.1388 | Linear | 0.1889 |

Table S4. Results of analysis of interactions effects between MAT and MAP, for all FACF

| Carbon flux | Significant interactive effect | Significant additive effect | Significant effect of MAT | p-value | R-squared value |
|-------------------------|--------------------------------|-----------------------------|---------------------------|---------|-----------------|
| GPP | FALSE | TRUE | TRUE | <0.0001 | 0.66 |
| NPP | TRUE | TRUE | TRUE | 0.018 | 0.48 |
| ANPP | FALSE | TRUE | TRUE | 0.0349 | 0.45 |
| ANPP woody stem | TRUE | TRUE | TRUE | 0.021 | 0.26 |
| ANPP foliage | FALSE | FALSE | TRUE | <0.0001 | 0.59 |
| BNPP root | FALSE | FALSE | TRUE | <0.0001 | 0.29 |
| BNPP fine root | FALSE | FALSE | TRUE | 0.002 | 0.15 |
| Autotrophic respiration | FALSE | TRUE | TRUE | 0.041 | 0.71 |
| Root respiration | FALSE | FALSE | TRUE | 0.001 | 0.25 |

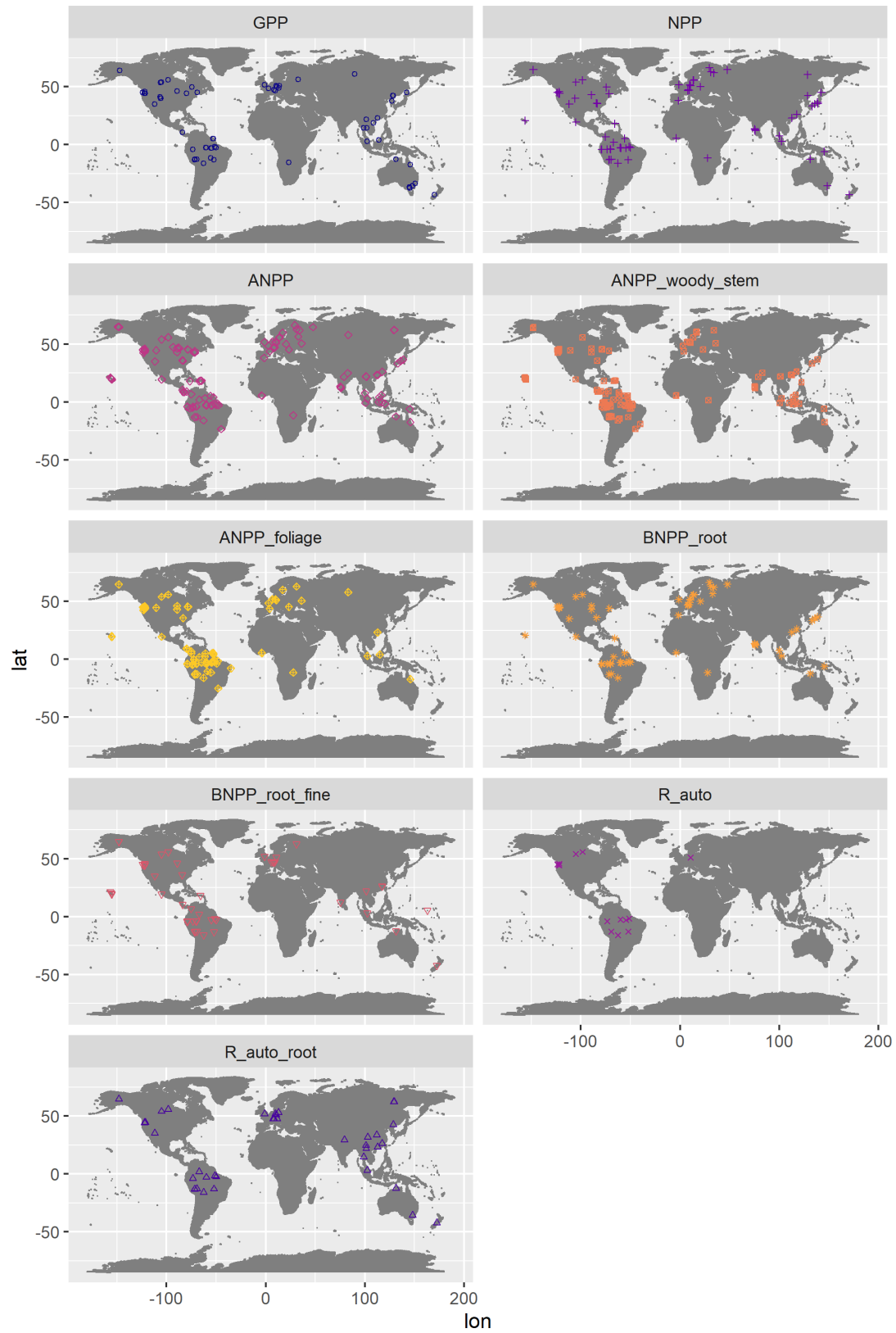


Figure S1: Maps showing distribution of samples for the nine FACF analyzed here.

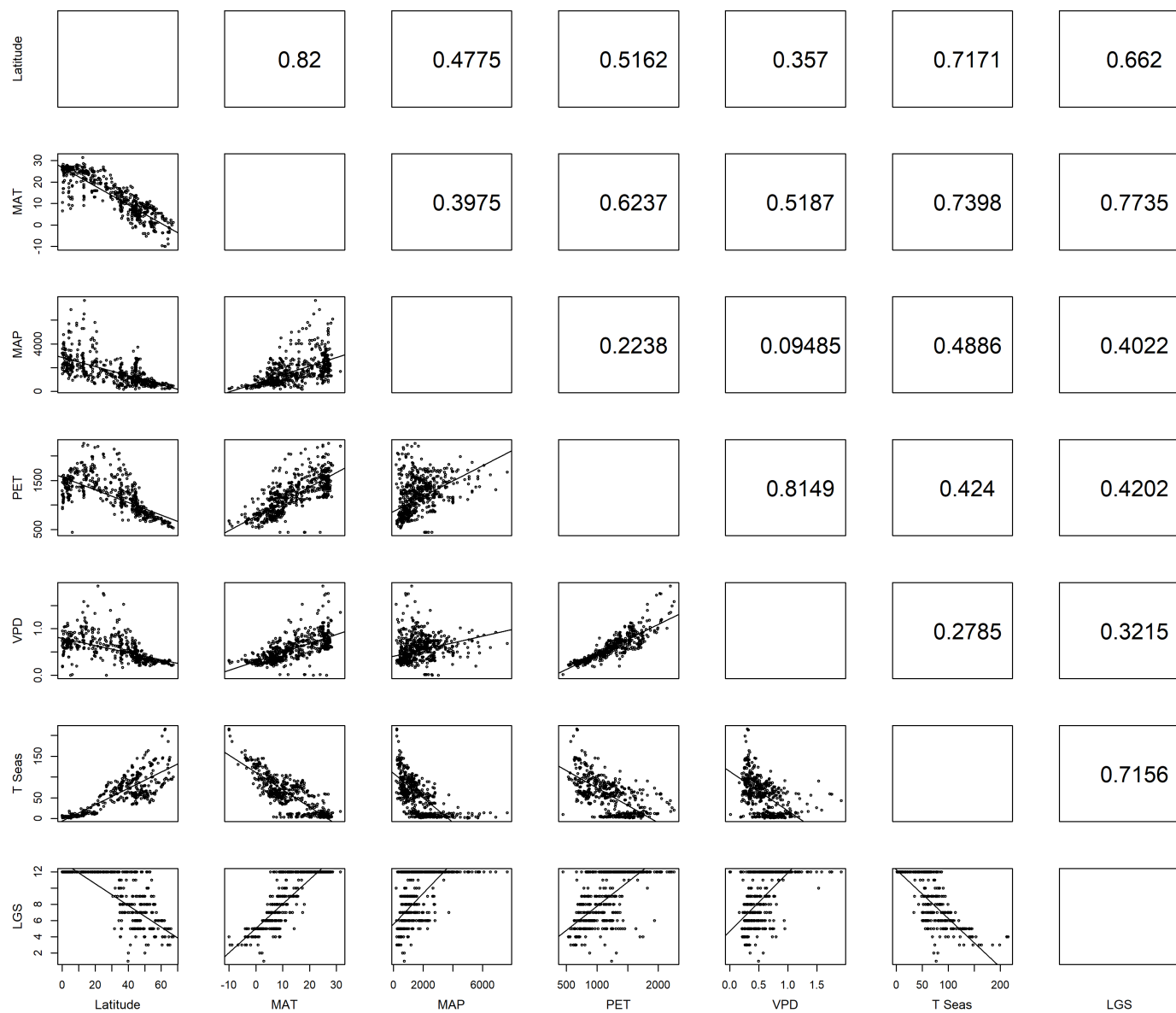


Figure S2: Correlations among latitude and climate variables. Variable names and units given in Table S1

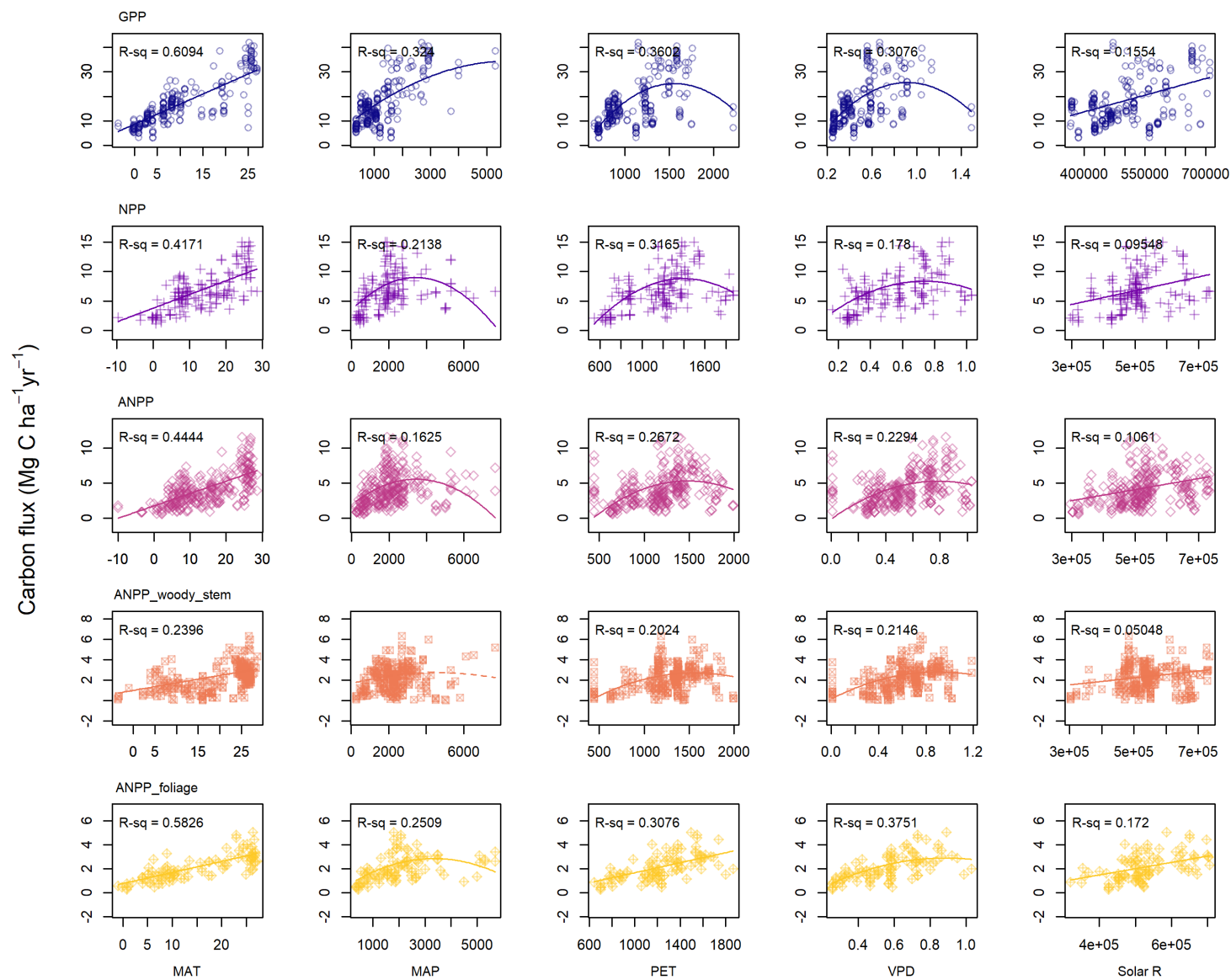


Figure S3: Individual plots of FACP in relation to mean annual climate, part 1.

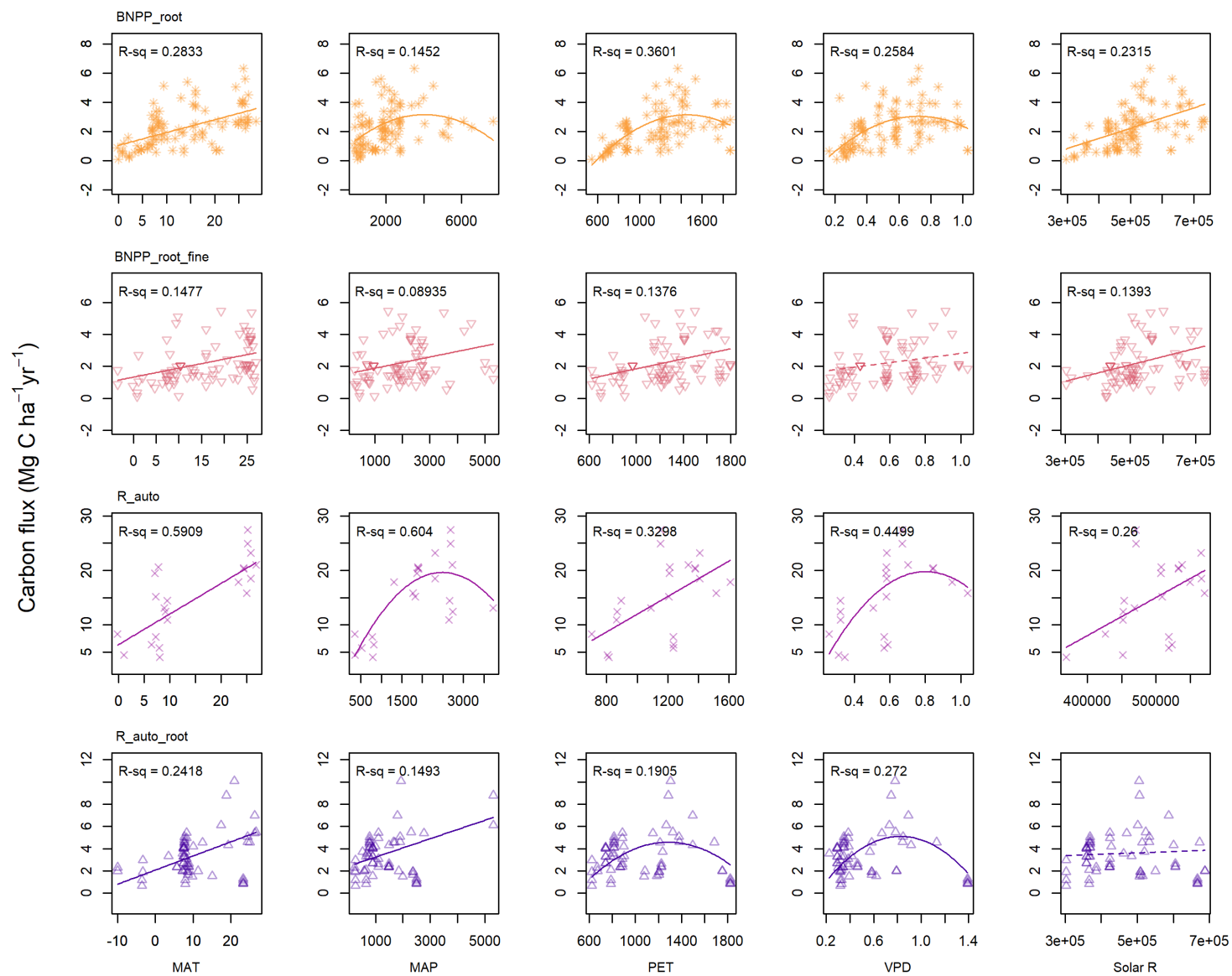


Figure S4: Individual plots of FACP in relation to mean annual climate, part 2.

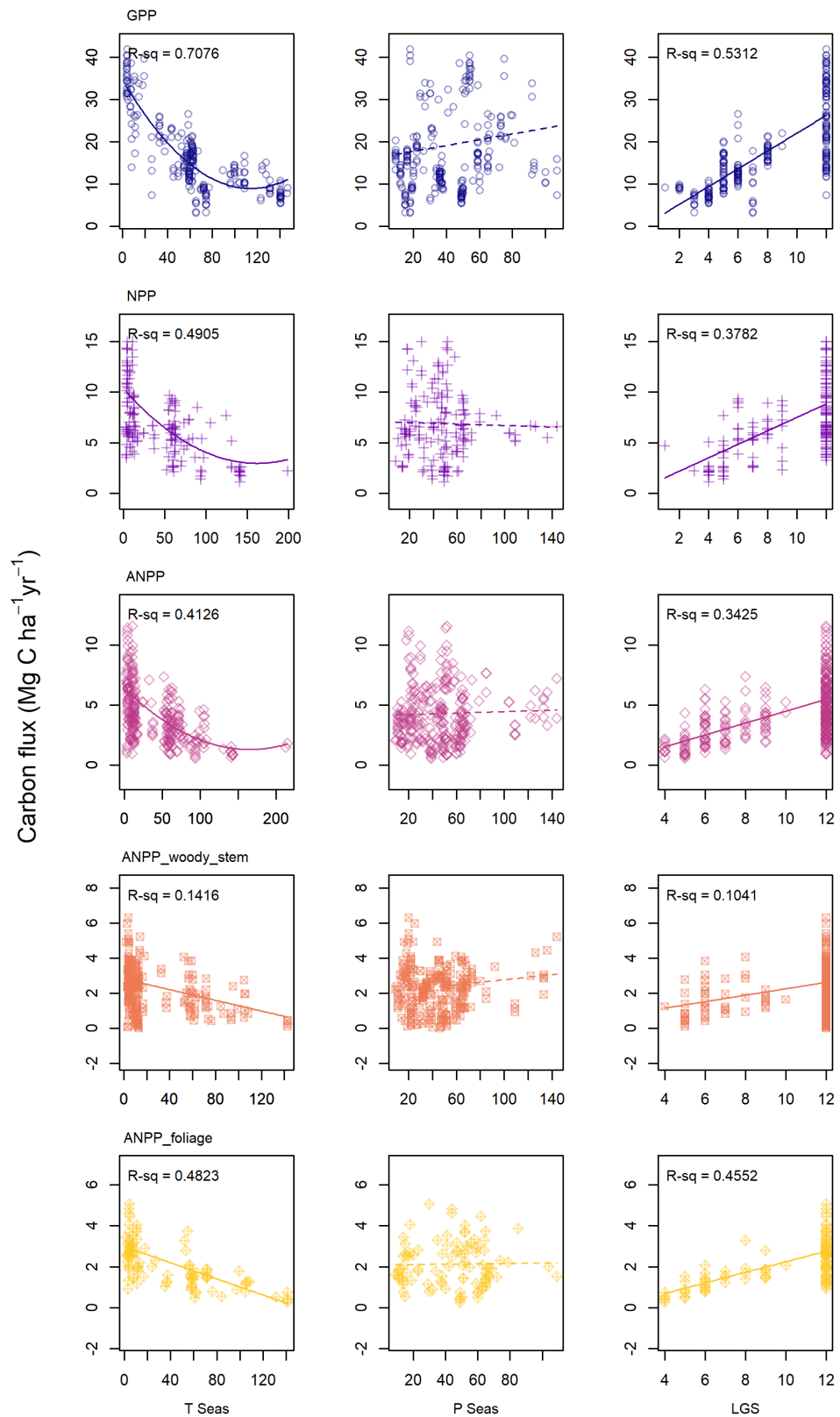


Figure S5: Individual plots of FACP in relation to mean climate seasonality, part 1.

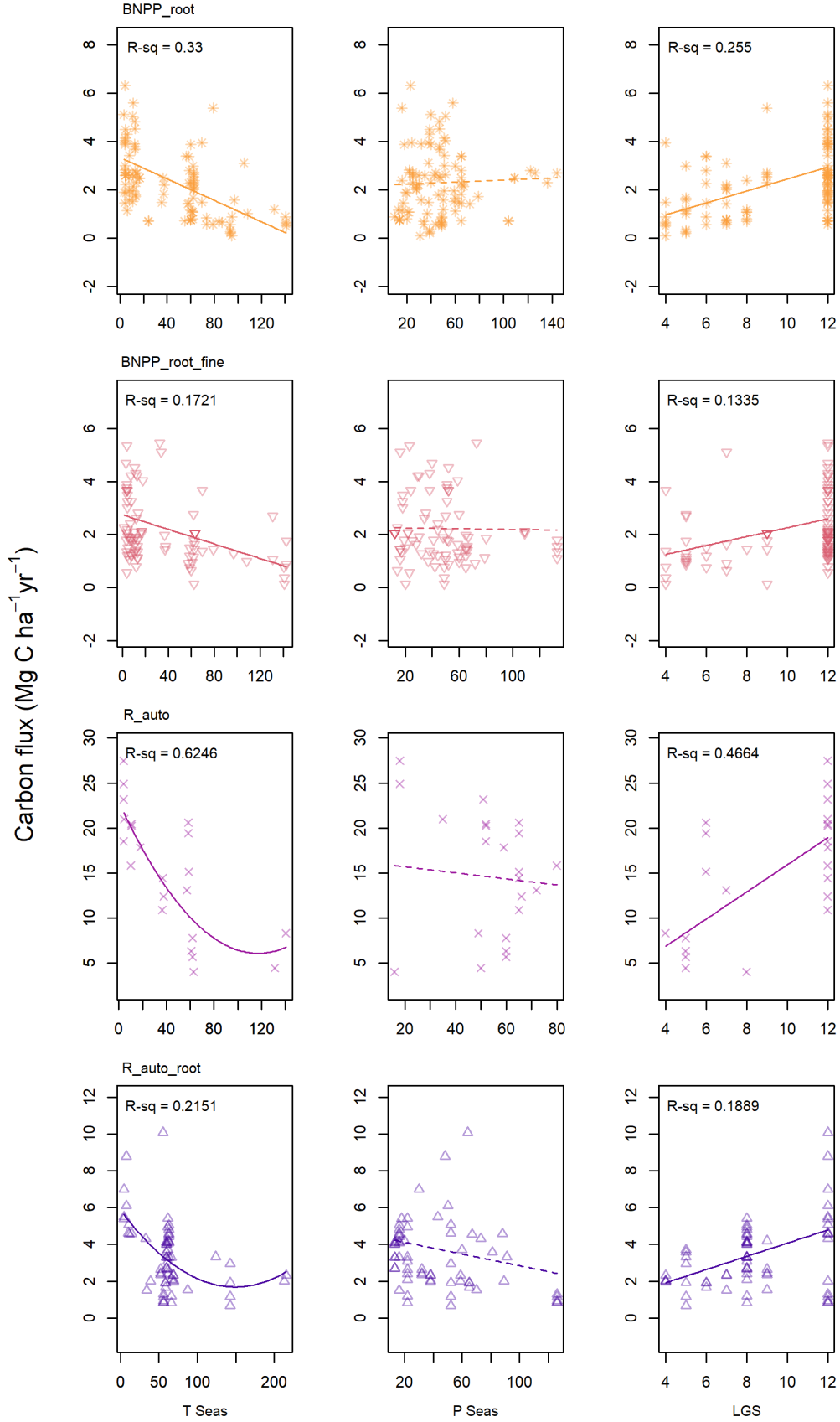


Figure S6: Individual plots of FACP in relation to mean climate seasonality, part 2.

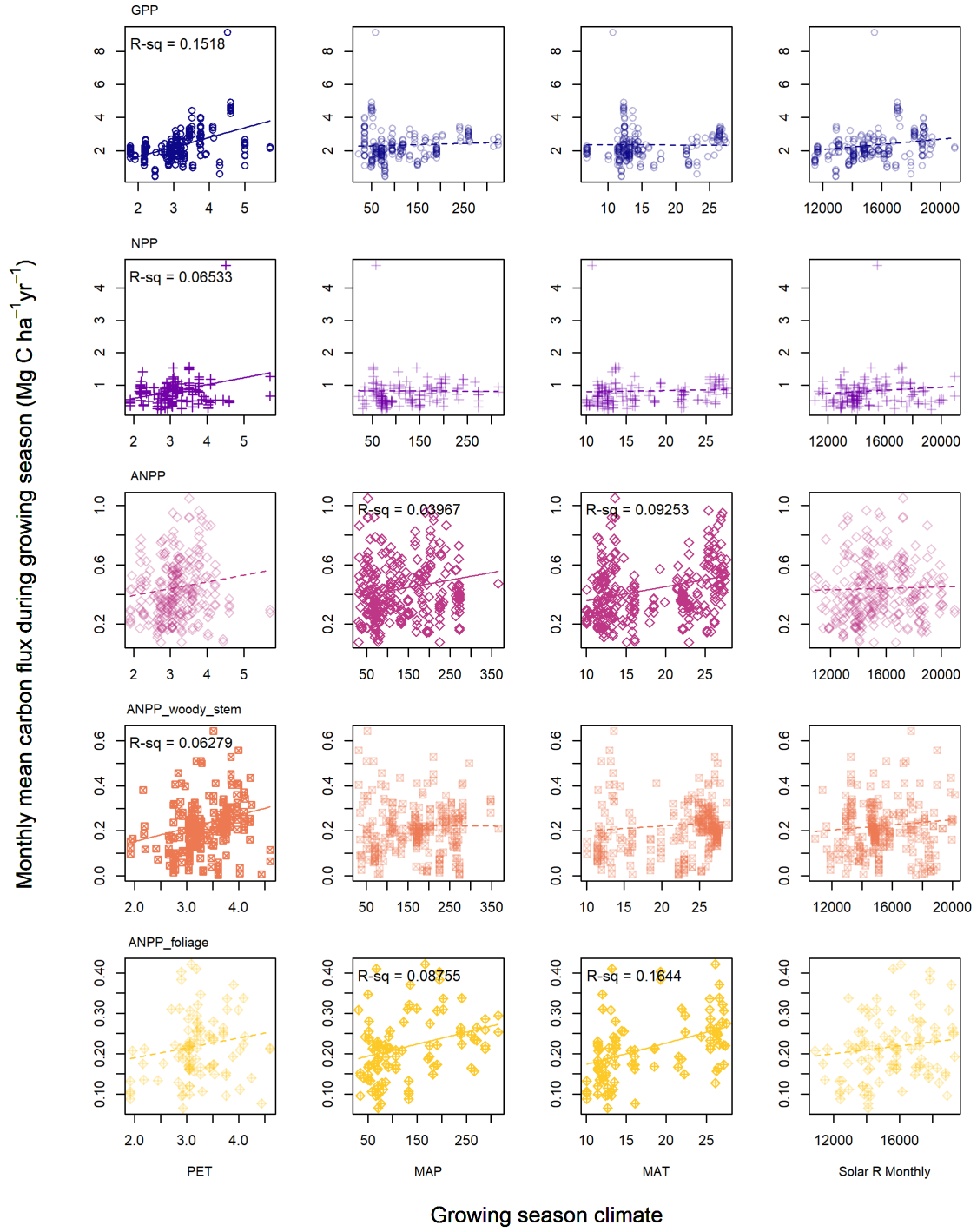


Figure S7: Growing season length-standardized FACP in relation to mean growing season climate, part 1.

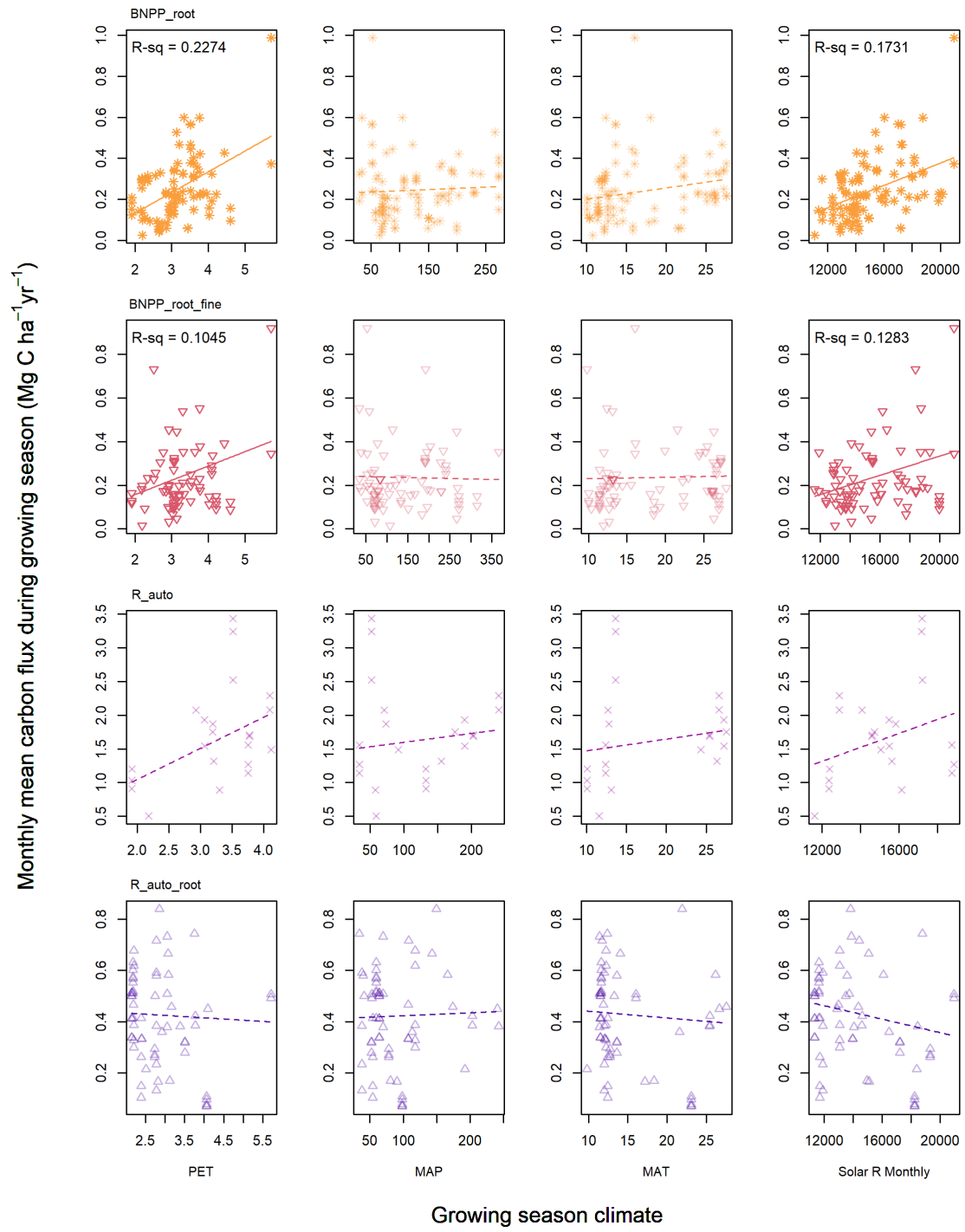


Figure S8: Growing season length-standardized FACF in relation to mean growing season climate, part 2.

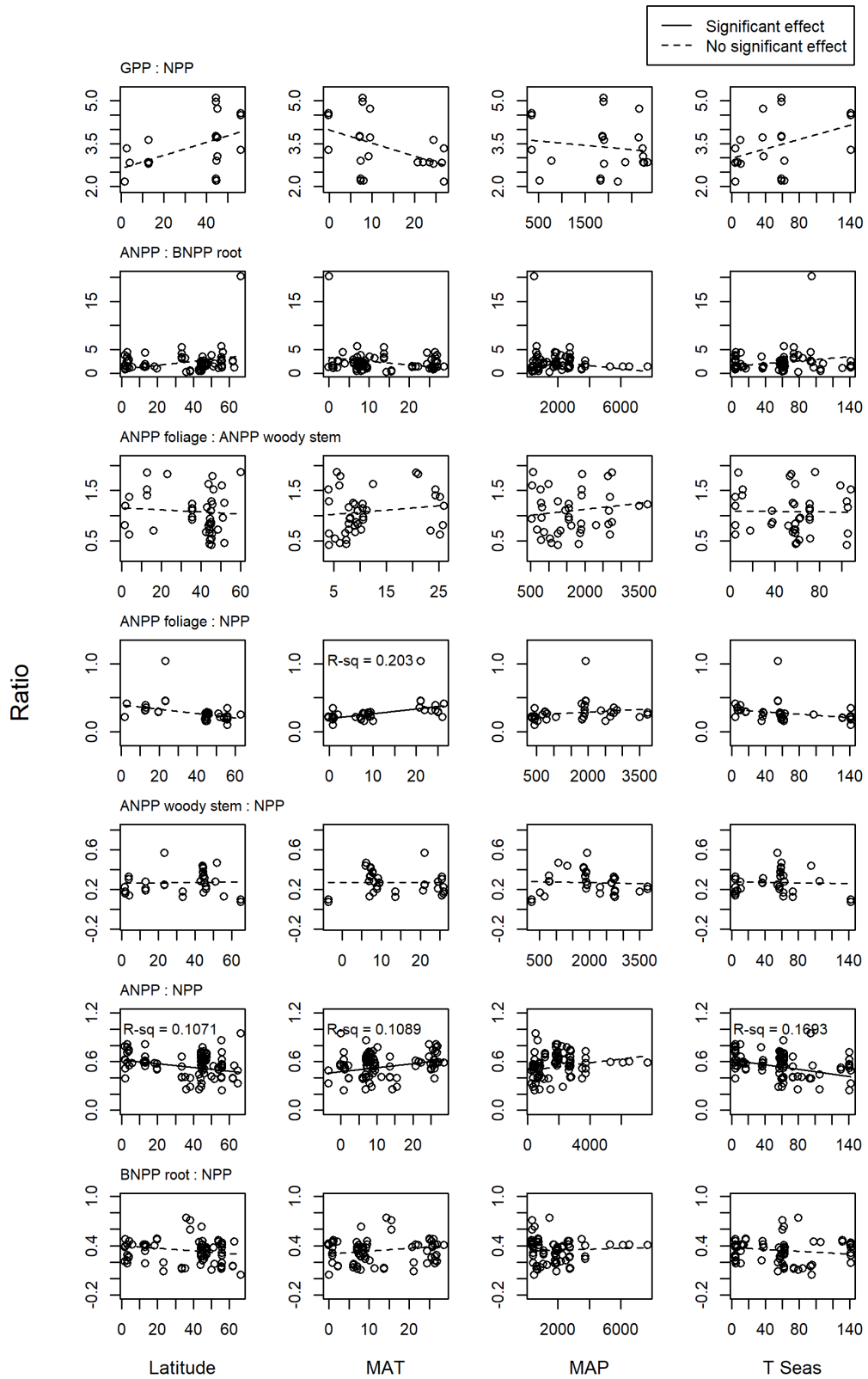


Figure S9: Ratios among FACF as a function of latitude and climate variables