Table S1 Metadata for all sites included in our analysis. Biome abbreviations follow the IGBP land cover classification system and are as follows: DBF = deciduous broadleaf forests, ENF = evergreen needle leaf forest, GRA = grassland, MF = mix forest, OSH = open shrubland, SAV = savannah, WSA = woody savannah. Mean annual temperature (MAT) and precipitation (MAP) values that are marked with \* indicate that the site PIs did not supply the values to FLUXNET or any other publication, so they were obtained from PRISM climate data (1981-2010, PRISM Climate Group, prism. oregonstate. edu).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Site ID | Biome | Site Years | MAT (℃) | MAP (mm) | Aridity Index | Site Type | Latitude | Longtitude | Data DOI or Citation |
| AU-Cpr | SAV | 2010-2014 | 18.0 | 250.0 | 0.12 | Arid | -34.00 | 140.59 | doi.org/10.18140/FLX/1440195 |
| AU-ASM | SAV | 2010-2014 | 23.0 | 318.3 | 0.13 | Arid | -22.28 | 133.25 | doi.org/10.18140/FLX/1440194 |
| ES-Amo | OSH | 2007-2012 | 18.0 | 220.0 | 0.13 | Arid | 36.83 | -2.25 | doi.org/10.18140/FLX/1440156 |
| US-Whs | OSH | 2007-2014 | 17.6 | 320.0 | 0.15 | Arid | 31.74 | -110.05 | doi.org/10.18140/FLX/1440097 |
| US-Wkg | GRA | 2004-2014 | 15.6 | 407.0 | 0.17 | Arid | 31.74 | -109.94 | doi.org/10.18140/FLX/1440096 |
| US-Cop | GRA | 2001-2007 | 12.0 | 216.0 | 0.18 | Arid | 38.09 | -109.39 | doi.org/10.18140/FLX/1440100 |
| US-SRG | GRA | 2008-2014 | 17.0 | 420.0 | 0.22 | Semi-Arid | 31.79 | -110.83 | doi.org/10.18140/FLX/1440114 |
| US-AR2 | GRA | 2009-2012 | 14.3\* | 620\* | 0.30 | Semi-Arid | 36.64 | -99.60 | doi.org/10.18140/FLX/1440104 |
| Tongyu | GRA | 2010-2020 | 6.1 | 384.0 | 0.31 | Semi-Arid | 44.34 | 122.92 | Zhao et al., 2019 |
| AR-Slu | MF | 2009-2011 | 19.7\* | 400.0 | 0.31 | Semi-Arid | -33.46 | -66.46 | doi.org/10.18140/FLX/1440191 |
| ES-Lju | OSH | 2004-2013 | 16.0 | 400.0 | 0.35 | Semi-Arid | 36.93 | -2.75 | doi.org/10.18140/FLX/1440157 |
| CN-Cng | GRA | 2007-2010 | 5.0 | 400.0 | 0.41 | Semi-Arid | 44.59 | 123.51 | doi.org/10.18140/FLX/1440209 |
| AU-Gin | WSA | 2011-2014 | 10.2 | 546.7 | 0.43 | Semi-Arid | -31.38 | 115.71 | doi.org/10.18140/FLX/1440199 |
| US-Arb | GRA | 2005-2006 | 14.8 | 843.0 | 0.44 | Semi-Arid | 35.55 | -98.04 | doi.org/10.18140/FLX/1440064 |
| US-Arc | GRA | 2005-2006 | 14.8 | 843.0 | 0.44 | Semi-Arid | 36.61 | -97.49 | doi.org/10.18140/FLX/1440066 |
| ES-Lgs | OSH | 2007-2009 | 5.5 | 800.0 | 0.51 | Sub-Humid | 37.10 | -2.97 | doi.org/10.18140/FLX/1440225 |
| CA-Oas | DBF | 1996-2010 | 0.3 | 428.5 | 0.55 | Sub-Humid | 53.63 | -106.20 | doi.org/10.18140/FLX/1440043 |
| CA-Obs | ENF | 1996-2010 | 0.8 | 405.6 | 0.59 | Sub-Humid | 23.99 | -105.12 | doi.org/10.18140/FLX/1440044 |
| CA-NS3 | ENF | 2001-2005 | -2.9 | 502.2 | 0.63 | Sub-Humid | 55.91 | -98.38 | doi.org/10.18140/FLX/1440038 |
| CA-Man | ENF | 1994-2008 | -3.2 | 520.0 | 0.63 | Sub-Humid | 55.88 | -98.48 | doi.org/10.18140/FLX/1440035 |
| CA-NS6 | OSH | 2001-2005 | -3.1 | 495.4 | 0.64 | Sub-Humid | 55.92 | -98.96 | doi.org/10.18140/FLX/1440041 |

Table S2 Summary of distribution of precipitation and soil water content in the periods 1-7 days, 8-14 days and 15-21 days prior and after the events. The units of precipitation and soil water content are mm and %. The events without parenthetical notation of SWC do not have soil moisture observation.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Type | Site ID | Date of EPE | Total amount of precipitation (Soil water content) | | | | | | | | |
| Prior | | |  | EPE intensity |  | After | | |
| 15-21 days | 8-14 days | 1-7 days |  |  | 1-7 days | 8-14 days | 15-21 days |
| Dry-EPEs | AU-Cpra | 20-Mar-2011 | 0.0 | 3.4 | 0.6 |  | 55.2 |  | 4.2 | 0.0 | 4.0 |
| AU-Cpra | 29-Feb-2012 | 0.0 | 0.2 | 4.8 |  | 83.4 |  | 0.2 | 5.4 | 2.2 |
| AU-ASMa | 26-Feb-2014 | 7.6 (6.7ab) | 14.6 (7.1ab) | 0.4 (5.2bc) |  | 30.0 (10.9) |  | 0.0 (8.7a) | 0.4 (5.0bc) | 1.4 (4.2c) |
| ES-Amoa | 28-Jan-2012 | 0.2 (14.5b) | 37.0 (26.9c) | 0.9 (30.3d) |  | 30.8 (44.1) |  | 0.9 (40.4a) | 0.0 (29.9cd) | 0.0 (22.4c) |
| US-Whsa | 03-Sep-2012 | 12.8 (5.8b) | 8.0 (4.8b) | 0.0 (3.7bc) |  | 64.3 (10.4) |  | 5.5 (9.3a) | 0.0 (4.5b) | 0.0 (1.9c) |
| US-Copa | 19-Jun-2003 | 0.8 (8.3b) | 0.0 (7.1c) | 0.2 (6.3c) |  | 8.9 (8.2) |  | 0.0 (9.9a) | 0.0 (6.9c) | 0.0 (5.4d) |
| AR-Slus | 31-Dec-2009 | 39.4 (15.1b) | 9.6 (15.0b) | 0.0 (18.6c) |  | 30.8 (18.7) |  | 10.7(21.1a) | 10.7 (18.1c) | 1.2 (12.2d) |
| ES-LJus | 08-May-2008 | 48.6(32.8a) | 0 (25.8b) | 0.0 (20.3c) |  | 64.8 (35.3) |  | 1.4 (34.0a) | 2.4 (30.7ab) | 6.7 (28.3ab) |
| AU-Gins | 06-Dec-2011 | 0.6 (5.5a) | 0.0 (4.8b) | 1.4 (4.0c) |  | 27.0 (5.8) |  | 0.0 (5.5a) | 1.8 (4.7b) | 0.4 (4.0c) |
| US-ARbs | 10-Jul-2006 | 8.6 (24.7a) | 0.1 (19.6b) | 8.2 (18.0b) |  | 41.5 (22.2) |  | 0.0 (24.6a) | 0.0 (17.7b) | 0.0 (17.1b) |
| US-ARcs | 10-Jul-2006 | 9.6 (23.1a) | 0.0 (16.1b) | 11.7 (13.0c) |  | 47.7 (18.5) |  | 0.0 (20.9a) | 0.1 (12.9c) | 0.0 (11.7c) |
| CA-Obsh | 26-Aug-2008 | 8.0 (16.0b) | 3.0 (13.7c) | 1.0 (11.3d) |  | 30.0 (11.6) |  | 7.0 (12.5a) | 0.0 (12.5a) | 0.0 (11.0d) |
| CA-NS3h | 18-Aug-2015 | 0.0 (27.5c) | 0.0 (21.3a) | 0.0 (19.5b) |  | 14.8 (19.3) |  | 2.3 (21.5a) | 0.0 (26.0c) | 0.0 (30.5d) |
| CA-NS6h | 03-Jul-2003 | 4.3 (29.3b) | 4.8 (24.8a) | 1.8 (22.3c) |  | 12.7 (21.7) |  | 2.8 (24.5a) | 2.0 (21.4c) | 0.5 (18.9d) |

Letters behind the Site ID represent arid (a), semi-arid (s) and sub-humid (h).

Within each event group, different letters in the parentheses indicate significant differences (P < 0.05) between periods.

Table S2 (Continued) Summary of distribution of precipitation and soil water content in the periods 1-7 days, 8-14 days and 15-21 days prior and after the events. The units of precipitation and soil water content are mm and %. The events without parenthetical notation of SWC do not have soil moisture observation.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Type | Site ID | Date of EPE | Rainfall (Soil water content) | | | | | | | | |
| Prior | | |  | EPE intensity |  | After | | |
| 15-21 days | 8-14 days | 1-7 days |  |  | 1-7 days | 8-14 days | 15-21 days |
| Wet-EPEs | AU-Cpra | 07-Jan-2012 | 91.8 | 0.0 | 0.2 |  | 20.6 |  | 0.0 | 0.2 | 6.4 |
| US-Wkga | 23-Aug-2009 | 22.9 (13.3ab) | 57.8 (16.2a) | 1.8 (13.5a) |  | 29.1 (15.1) |  | 0.5(14.3a) | 9.3 (8.5b) | 3.4 (8.9b) |
| US-SRGs | 10-Sep-2012 | 16.3 (10.9b) | 0.3 (5.6c) | 37.1 (11.7ab) |  | 62.7 (15.4) |  | 7.6 (13.5a) | 0.0 (7.7c) | 0.0 (5.5c) |
| US-AR2s | 20-Jun-2009 | 2.4 (7.3a) | 2.8 (6.7ab) | 18.4 (6.6ab) |  | 22.1 (7.7) |  | 0.0 (8.5a) | 0.0 (6.3ab) | 0.0 (5.8b) |
| Tongyus | 19-Aug-2015 | 1.3 (15.3b) | 8.4 (12.2b) | 32.8 (23.9a) |  | 49.6 (33.5) |  | 5.0 (25.7a) | 1.2 (25.2a) | 3.9 (19.7c) |
| CN-Cngs | 08-Aug-2007 | 1.4 (68.4a) | 49.9 (49.1b) | 0.0 (67.7a) |  | 22.7 (67.7) |  | 6.6 (72.3a) | 2.8 (68.6a) | 0.0 (56.3c) |
| ES-Lgsh | 17-May-2008 | 0.0 | 44.3 | 13.7 |  | 33.5 |  | 0.1 | 15.1 | 1.3 |
| CA-Oash | 08-Aug-1998 | 78.0 (28.7b) | 0.0 (27.6b) | 1.0 (26.0a) |  | 15.0 (26.1) |  | 4.0 (25.4a) | 9.0 (24.6ac) | 7.0 (23.9c) |
| CA-Oash | 08-Aug-1999 | 39.0(29.3b) | 60.0 (29.1b) | 20.0 (29.1b) |  | 12.0 (29.4) |  | 1.0 (27.8a) | 8.0 (24.3c) | 1.0 (21.2d) |
| CA-Manh | 13-Aug-1998 | 7.9 | 0.8 | 35.2 |  | 14.6 |  | 1.4 | 11.7 | 1.6 |

Letters behind the Site ID represent arid (a), semi-arid (s) and sub-humid (h).

Within each event group, different letters in the parentheses indicate significant differences (P < 0.05) between periods.

Table S3 Statistics (regression coefficient (Coef.), partial correlation coefficient (Partial R) and significance probability (P)) for the relationships between diurnal NEE, Re, GPP and climate factors (soil water content (SWC), soil temperature (Ts) and photosynthetic photon flux density (PPFD)) of 15-day after EPEs using a stepwise multiple linear regression analysis.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Type | Factor | NEE | | |  | Re | | |  | GPP | | |
| Coef. | Partial R | P |  | Coef. | Partial R | P |  | Coef. | Partial R | P |
| Arid sites,  dry-EPEs | CONS. | **-2.87** |  | **0.000\*\*** |  | **0.68** |  | **0.001\*\*** |  | 0.92 |  |  |
| SWC | **0.09** | **0.39** | **0.000\*\*** |  | **0.18** | **0.33** | **0.002\*\*** |  | **0.08** | **0.29** | **0.006\*\*** |
| Ts | 0.10 | 0.11 | 0.325 |  | -0.09 | -0.18 | 0.262 |  | -0.19 | -0.08 | 0.475 |
| PPFD | -0.01 | -0.14 | 0.145 |  | 0.05 | 0.06 | 0.598 |  | 0.26 | 0.17 | 0.111 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Arid sites,  wet-EPEs | CONS. | -0.17 |  | 0.755 |  | 2.68 |  | 0.000 |  | -2.96 |  | 0.093 |
| SWC | **-0.06** | **-0.40** | **0.032\*** |  | **-0.05** | **-0.38** | **0.037\*** |  | **0.21** | **0.53** | **0.003\*\*** |
| Ts | 0.08 | 0.29 | 0.165 |  | 0.01 | 0.01 | 0.955 |  | -0.21 | -0.22 | 0.247 |
| PPFD | -0.01 | -0.20 | 0.260 |  | 0.07 | 0.06 | 0.710 |  | 0.18 | 0.28 | 0.188 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Semi-arid sites,  dry-EPEs | CONS. | **4.42** |  | **0.000\*\*** |  | **3.49** |  | **0.000\*\*** |  | **4.26** |  | **0.000\*\*** |
| SWC | **0.21** | **0.60** | **0.000\*\*** |  | **0.24** | **0.39** | **0.030\*** |  | **0.15** | **0.46** | **0.000\*\*** |
| Ts | 0.19 | 0.15 | 0.227 |  | 0.47 | 0.27 | 0.175 |  | 0.33 | 0.24 | 0.187 |
| PPFD | -0.04 | -0.27 | 0.175 |  | 0.60 | 0.19 | 0.205 |  | **0.73** | **0.37** | **0.041\*** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Semi-arid sites,  Wet-EPEs | CONS. | **-5.24** |  | **0.000\*\*** |  | **2.24** |  | **0.000\*\*** |  | **8.08** |  | **0.000\*\*** |
| SWC | **-0.08** | **-0.39** | **0.000\*\*** |  | **0.10** | **0.59** | **0.000\*\*** |  | 0.12 | 0.12 | 0.308 |
| Ts | 0.13 | 0.21 | 0.063 |  | **0.19** | **0.23** | **0.049\*** |  | -0.15 | -0.23 | 0.053 |
| PPFD | **-0.41** | **-0.38** | **0.001\*\*** |  | 0.04 | 0.04 | 0.704 |  | **0.36** | **0.35** | **0.002\*\*** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Sub-humid sites, dry-EPEs | CONS. | **-5.00** |  | **0.000\*\*** |  | **-1.35** |  | **0.006\*\*** |  | **2.62** |  | **0.014\*** |
| SWC | 0.12 | 0.18 | 0.263 |  | -0.02 | -0.04 | 0.740 |  | **-0.41** | **-0.65** | **0.026\*** |
| Ts | **0.44** | **0.66** | **0.000\*\*** |  | **0.61** | **0.87** | **0.000\*\*** |  | **0.72** | **0.81** | **0.000\*\*** |
| PPFD | **-0.45** | **-0.56** | **0.000\*\*** |  | 0.19 | 0.27 | 0.104 |  | **0.65** | **0.75** | **0.000\*\*** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Sub-humid sites, wet-EPEs | CONS. | **0.57** |  | **0.043\*** |  | -4.61 |  | 0.399 |  | 18.87 |  | 0.000 |
| SWC | 0.20 | 0.13 | 0.079 |  | 0.45 | 0.19 | 0.128 |  | 0.10 | 0.20 | 0.113 |
| Ts | **0.70** | **0.55** | **0.000\*\*** |  | **0.10** | **0.36** | **0.016\*** |  | **0.01** | **0.53** | **0.000\*\*** |
| PPFD | **-0.09** | **-0.60** | **0.000\*\*** |  | 0.02 | 0.22 | 0.106 |  | **1.00** | **0.39** | **0.037\*** |

The bold words represented significance of regression results.

Significance of the regressions (P) are (\*) or (\*\*) for P < 0.05 and 0.01, respectively.