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*Supplement of*

**Modelling the role of fires in the terrestrial carbon balance by incorporating SPITFIRE into the global vegetation model ORCHIDEE – Part 2: Carbon emissions and the role of fires in the global carbon balance**

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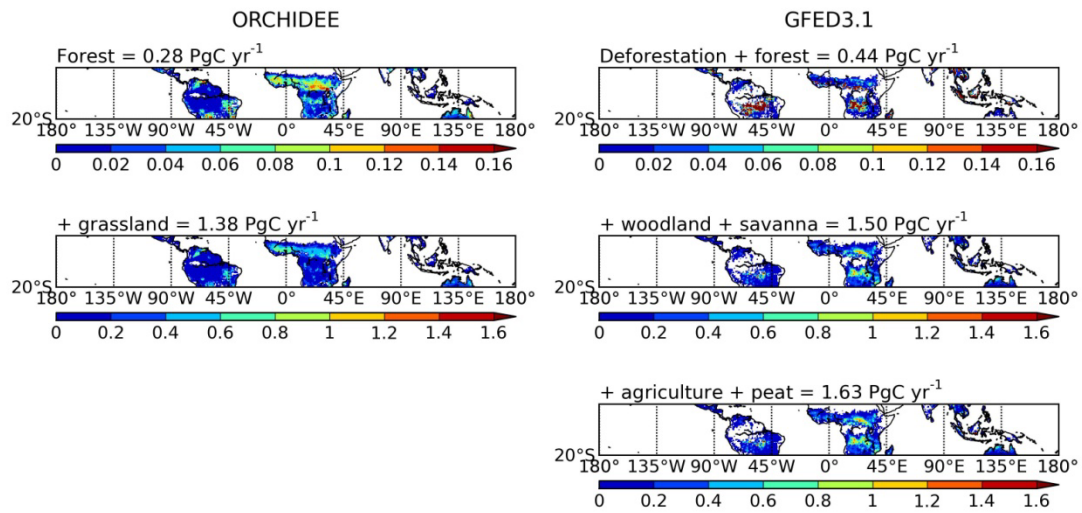


Fig. S1 Simulated and GFED3.1 fire carbon emissions for the tropical region (20°S–20°N) from different sources averaged over 1997–2009.

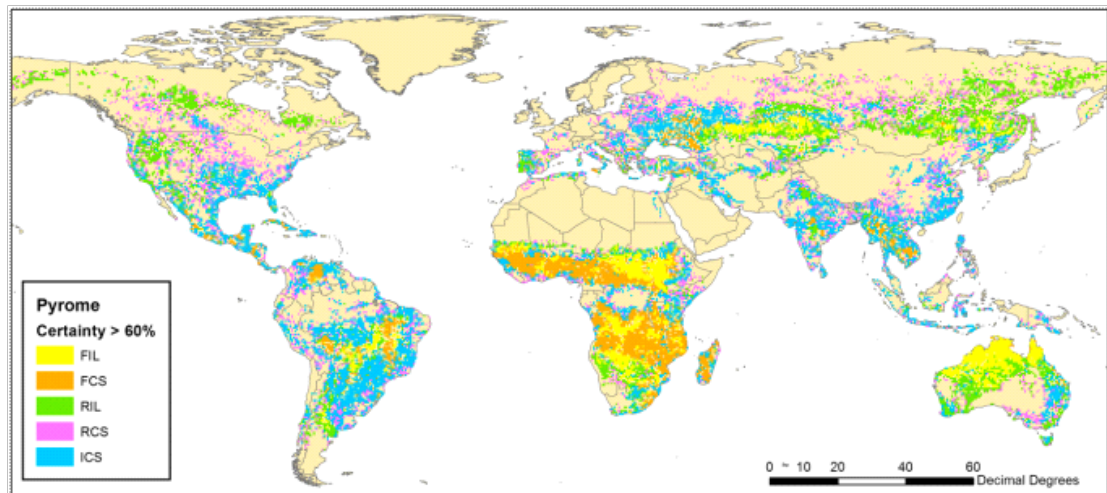


Fig. S2 The distribution of fire pyromes by Archibald et al. (2013). The five pyromes are: FIL (Frequent–Intense–Large); FCS (Frequent–Cool–Small); RIL (Rare–Intense–Large); RCS (Rare–Cool–Small) and ICS (Intermediate–Cool–Small).

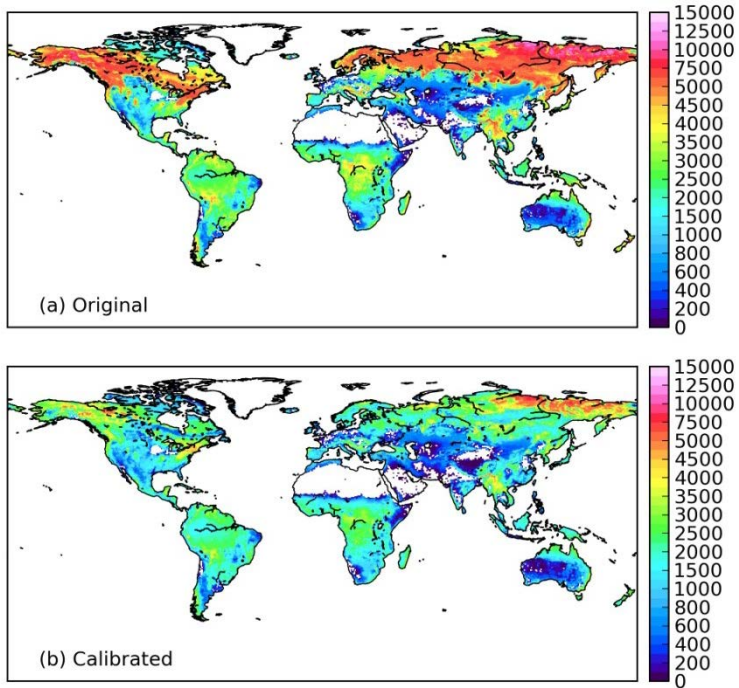


Fig. S3 Simulated surface dead fuel ( $\text{g C m}^{-2}$ ) (a) before and (b) after productivity calibration.

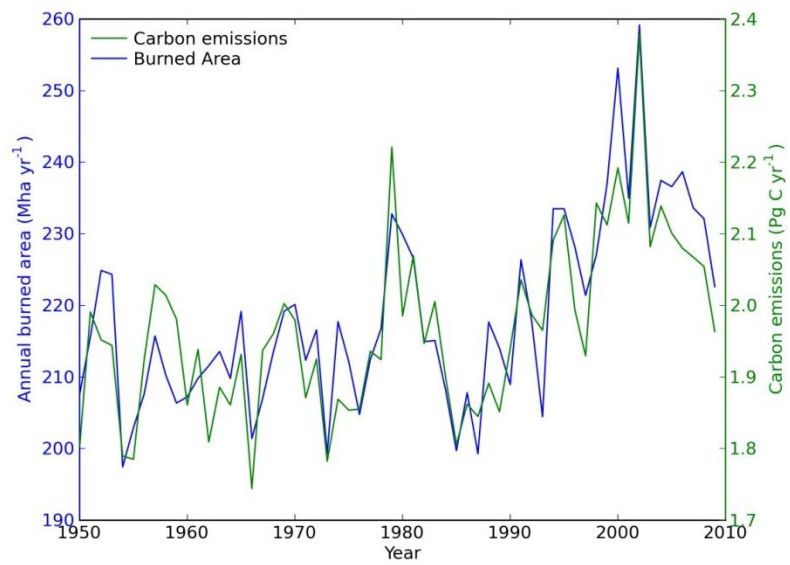


Fig. S4 Simulated annual global burned area (blue, left vertical axis) and carbon emissions (green, right vertical axis) for 1950–2009.

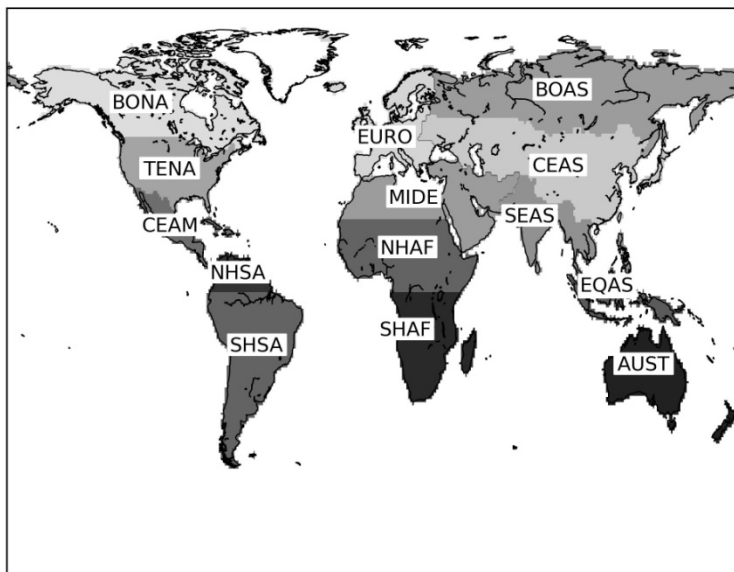


Fig. S5 The 14 GFED regions are, BONA: Boreal North America; TENA: Temperate North America; CEAM: Central America; NHSA: Northern Hemisphere South America; SHSA: Southern Hemisphere South America; EURO: Europe; MIDE: Middle East; NHAF: Northern Hemisphere Africa; SHAF: Southern Hemisphere Africa; BOAS: Boreal Asia; CEAS: Central Asia; SEAS: Southeast Asia; EQAS: Equatorial Asia; AUST: Australia and New Zealand.

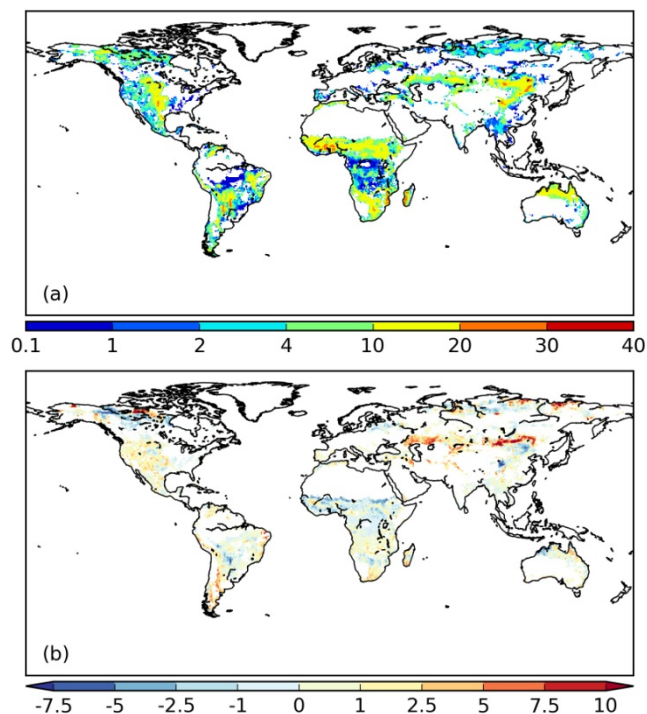


Fig. S6 (a) Fire carbon emissions as percentage of NPP for the average of 1901-2012. (b) The difference in the emissions as percentage of NPP between 2003-2012 average and 1901-2012 average, with positive values indicating that emission ratio as against NPP is higher in 2003-2012.

Table S1 Original and modified values for the carboxylation rates ( $V_{\text{cmax}}$ ,  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ) used in the model and the ratio used for GPP calibration.

| Biome/Plant functional type (PFT)  | Original | Modified | Ratio |
|------------------------------------|----------|----------|-------|
| Bare soil                          | -        | -        | -     |
| Tropical forest                    |          |          |       |
| Tropical broad-leaved evergreen    | 65       | 51       | 1.3   |
| Tropical broad-leaved raingreen    | 65       | 51       | 1.3   |
| Temperate forest                   |          |          |       |
| Temperate needleleaf evergreen     | 35       | 24       | 1.4   |
| Temperate broad-leaved evergreen   | 45       | 31       | 1.4   |
| Temperate broad-leaved summergreen | 55       | 38       | 1.4   |
| Boreal forest                      |          |          |       |
| Boreal needleleaf evergreen        | 35       | 20       | 1.7   |
| Boreal broad-leaved summergreen    | 45       | 26       | 1.7   |
| Boreal needleleaf summergreen      | 35       | 20       | 1.7   |
| Grassland                          |          |          |       |
| C3 grass                           | 70       | 45       | 1.5   |
| C4 grass                           | 70       | 45       | 1.5   |
| Agriculture                        |          |          |       |
| C3 agriculture                     | 70       | 27       | 2.6   |
| C4 agriculture                     | 70       | 27       | 2.6   |

Table S2 1997–2009 area-averaged NPP, combustion completeness for litter, and combustion completeness for the litter and aboveground live biomass combined by ORCHIDEE simulation and reported by van der Werf et al. (2010) for different regions. The combustion completeness for litter for GFED3.1 was taken from the last column of Table 4 in van der Werf et al. (2010), and the combustion for the litter and aboveground live biomass combined for GFED3.1 data was taken from the second to last right column of Table 4 in van der Werf et al. (2010). See caption to Fig.

S5 for location of GFED regions and expansion of abbreviations.

| Region | NPP (g C m <sup>-2</sup> yr <sup>-1</sup> ) |          | Combustion completeness for<br>litter and aboveground<br>biomass combined |          | Combustion completeness<br>for litter |          |
|--------|---|----------|---|----------|---------------------------------------|----------|
|        | GFED3.1                                     | ORCHIDEE | GFED3.1   | ORCHIDEE | GFED3.1                               | ORCHIDEE |
|        | BONA  | 235      | 290   | 0.23     | 0.58                                  | 0.69     |
| TENA   | 388   | 377      | 0.17  | 0.34     | 0.75                                  | 0.75     |
| CEAM   | 674   | 583      | 0.22  | 0.29     | 0.79                                  | 0.8      |
| NHSA   | 1001  | 1138     | 0.2   | 0.19     | 0.81                                  | 0.75     |
| SHSA   | 796   | 806      | 0.29  | 0.24     | 0.82                                  | 0.77     |
| EURO   | 400   | 304      | 0.21  | 0.22     | 0.8                                   | 0.73     |
| MIDE   | 35  | 46       | 0.16  | 0.4      | 0.93                                  | 0.7      |
| NHAF   | 366   | 511      | 0.09  | 0.33     | 0.86                                  | 0.8      |
| SHAF   | 627   | 696      | 0.07  | 0.28     | 0.83                                  | 0.8      |
| BOAS   | 257   | 345      | 0.21  | 0.52     | 0.7                                   | 0.78     |
| SEAS   | 205   | 616      | 0.3   | 0.22     | 0.84                                  | 0.75     |
| CEAS   | 545   | 243      | 0.29  | 0.45     | 0.8                                   | 0.75     |
| EQAS   | 1213  | 1159     | 0.47  | 0.2      | 0.77                                  | 0.76     |
| AUST   | 238   | 320      | 0.09  | 0.42     | 0.88                                  | 0.83     |