SUPPLEMENTARY MATERIALS

Spectral Analysis of Solid Peat Samples

Air dried peat samples were spread on petri-dishes, placed 5 cm below the fiber optic probe tip of a laboratory-based FieldSpec FR 350 – 2500 nm (VIS-SWIR) spectrometer (3.8 cm diameter field of view), and lit by a DC lamp adjusted to 24º beam angle (Rodionov *et al.*, 2014). Three absorbance spectra were obtained from three different samples collected at each location detailed in Table 1. Absorbance spectra had their baselines removed using asymmetric least squares fitting (Eilers & Boelens, 2005), were averaged to maximise signal to noise ratio, and were subject to Savitsky-Golay filtering to enable the best identification of wavelength-specific features associated with functional groups.

Clear absorption features around 600 nm were seen in all samples and at all depths, potentially indicative of humic acids resulting from organic matter decomposition (Klingenfuß et al, 2014; Zeitz & Velty, 2002; Succow & Joosten, 2001) – see Fig. S1. The strongest absorption features related to sugars and starches were seen in the O-horizon samples from Location 2 (Table 1), as seen in Fig. S1 (top). These are very likely related to living roots rich in easily degraded organic compounds and supporting the biotic interpretation of the lower C:N ratio found in the surface layer (Kuzyakov 2010; Succow & Joosten, 2001). Lignin was detected via 1670 - 1680 nm absorptions, and is related to the presence of aromatics. These occurred most strongly in the deepest (and thus oldest) samples (10 - 30 cm depth, Fig. S2 bottom), indicating the relative enrichment of aromatics via decomposition of easily degraded compounds in this layer (e.g. sugar, starch; Succow & Joosten, 2001).

Peak spectral absorption heights were calculated for wavelengths associated with phenolic compounds, which inhibit peat decomposition during drought in temperate and boreal peats (Wang *et al.*, 2015), and which may decrease in surface peat layers with increasing peatland degradation (Yule *et al.*, 2016). The lack of a mineral admixture meant that light absorption by minerals (which can bias interpretations of peat absorption spectra) could be excluded. Strong NIR absorptions (1000-2500 nm) caused by stretching and bending of CH and CO groups were seen, and are related to the presence of non-humic substances such as carbohydrates, i.e., sugar/starch/lipids, cellulose, and lignin, further confirming the rich organic matter content.

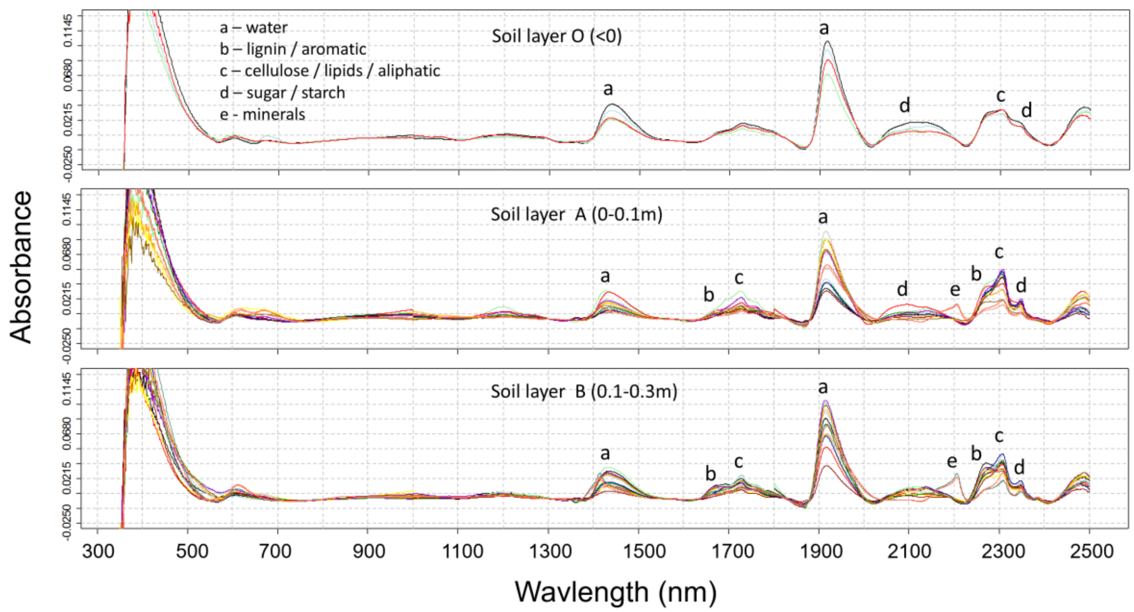

Figure S1. Absorbance spectra (350-2500 nm) recorded from dried peat samples collected in three soil layers (surface, 0 – 10 cm and 10 – 30 cm depth). Spectra were baseline corrected (asymmetric least squares). Lower-case letters indicate important absorbance peaks as shown in the legend and given by Stenberg et al. (2010) and Workman and Weyer (2008).

The VIS-NIR-SWIR spectra of the peat substrate were similar between locations and depths (see spectra overlain in Fig S1). However, the moisture content measures indicated that peat moisture was substantially lower for the surface O-horizon layer compared to the underlying substrate (see Table 2), and on average the 0 - 10 cm depth samples were also substantially less moist than the 10 - 30 cm samples, in accordance with expectation and previous studies (e.g. Okazaki and Yonabashi, 1992).

GFAS and GFED PM2.5 Emissions Maps

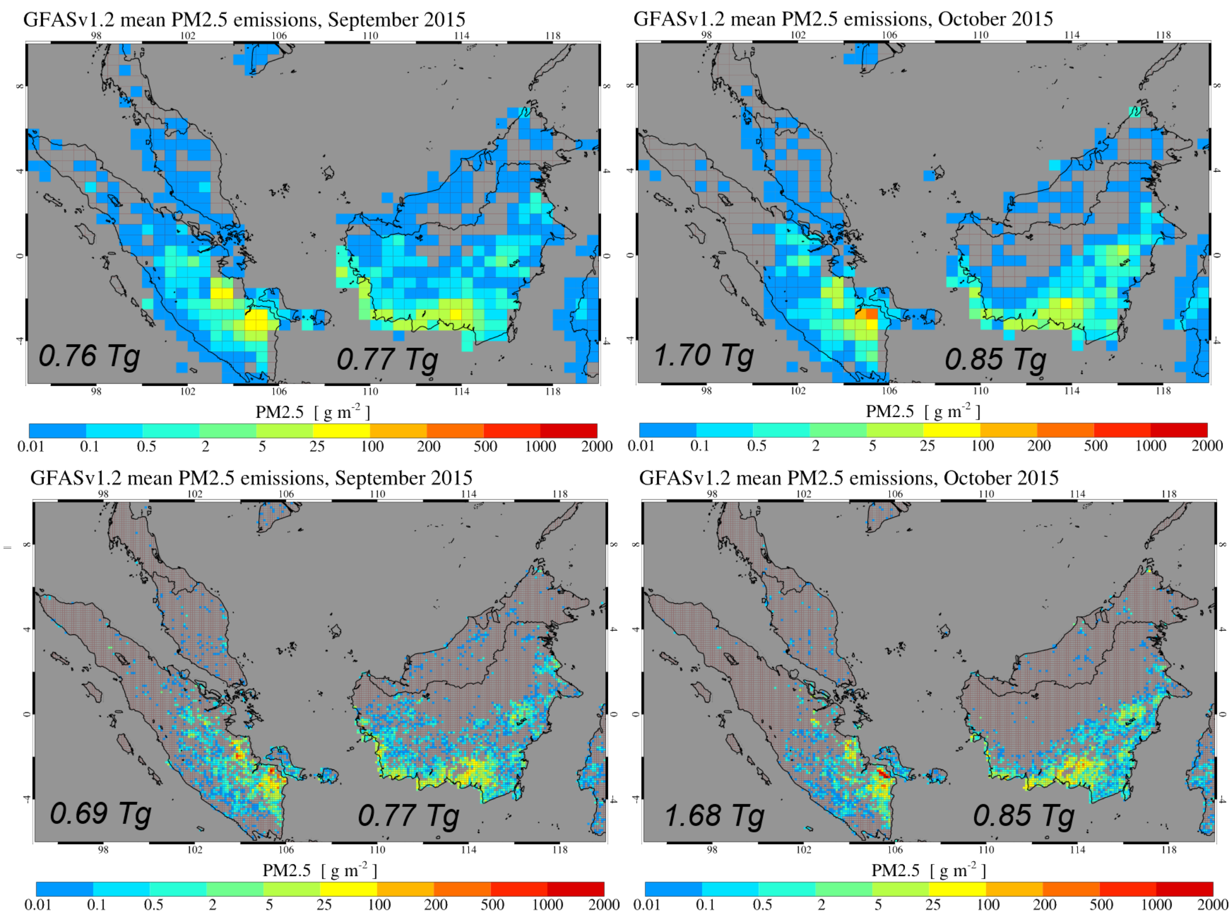

Fig. S2: Monthly mean $PM_{2.5}$ emissions per grid cell unit area (kg·m^{-2}) as reported by GFASv1.2 for the main region of southeast Asian fires that occurred in September and October 2015. GFASv1.2 is based on MODIS FRP data, and results are shown at both the original 0.5° resolution of Kaiser *et al.* (2012) (top row) and the more recent 0.1° resolution of GFAS (bottom row). Total monthly $PM_{2.5}$ emissions for Sumatra and Kalimantan are indicated, and are very similar for both resolution datasets.

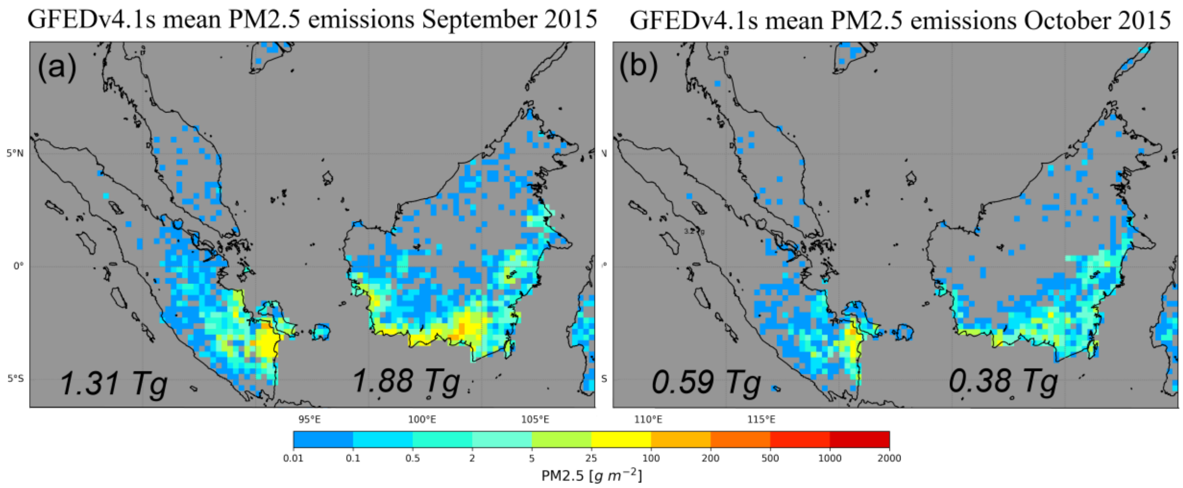

Fig. S3: Monthly mean $PM_{2.5}$ emissions per 0.25° grid cell unit area ($kg{\cdot}m^{-2}$) as reported by GFEDv4.1s for the main region of southeast Asian fires that occurred in September and October 2015. GFEDv4.1s is based MODIS MCD64A1 burned area data and fuel consumption modelling, as detailed in Van der Werf *et al.* (2017). Monthly $PM_{2.5}$ emissions for Sumatra and Kalimantan are indicated, which reduce from a total of 4.2 Tg to 3.7 Tg if the effect of the "small fire" boosting employed in GFED4.1s is removed.

References:

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