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Biogeosciences Discussions

Interactive comment on "Fire, drought and El Niño relationships on Borneo during the pre-MODIS era (1980–2000)" *by* M. J. Wooster et al.

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We welcome the fact that the reviewer recommends publication of our manuscript, and are grateful for the incisive comments that greatly help us improve the clarity and content of our manuscript.

We have now included more information on the human influence on fire in Borneo, as discussed in the comments we make in response to the reviews of A. Langner and G. van der Werf. In the Results (Section 5.1 and 5.2) we have now also included more detail on how fire is regionally distributed across the island (e.g. East and Central Kalimantan).

Abstract We change the abstract to describe more closely the exact relationships we

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investigate and the correlations we find: “We use these metrics to investigate relationships between the strength and timing of the El Niño-Southern Oscillation (ENSO) event, the associated drought, and the fire activity. During each El Niño, we find areas of major fire activity confined within two or three fire sub-seasons (separated by monsoons) and focused in parts of South and Central Kalimantan, and sometimes also in East and/or West Kalimantan. We also find significant correlations between monthly ENSO index and measures of rainfall deficit, and between rainfall deficit and fire.”

Introduction We replace the term “ENSO” with “El Niño” throughout the manuscript as suggested, and only use ENSO when discussing the ENSO-indices. We explicitly define El Niño as a warm ENSO event, as suggested by the reviewer.

Study Area We include reference and brief detain on the suggested Schulz et al (2008) study in Section 2.3, as suggested by the referee.

In the analysis, we now include separation of rainfall metrics into ‘all Borneo’ and ‘southern Borneo’ as suggested by the reviewer, since the fires are mainly located in southern Borneo. We also now use the NOAA merged analysis of precipitation (CMAP) rainfall dataset, and the TRMM rainfall dataset, in addition to data from the 12 rainfall stations used previously. We intercompare all these individual rainfall measures.

Datasets As suggested, in the reference list we have added reference to the download site and download date of all datasets used (NOAA CMAP rainfall data, NOAA ENSO indices and NASA rainfall data).

The reviewer makes a good suggestion with regard to the timing of El Nino events, and that since different measures are used for the definition of El Niño conditions there is no widely agreed definition of the duration of an El Niño event. The NOAA Operational Nino Index (ONI) is probably the metric now most widely used to define whether a month is showing El Niño conditions or not. The ONI represents the three-month moving average of the NINO-3.4 SST anomaly measure (Smith, and Reynolds, 2003) and is used by NOAA to classify months as showing El Niño conditions (Kousky and

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Higgins, 2007). We will now add use of this index and this definition in Section 3.2, and perform the relevant cross-correlation analyses using both all 24 months of ENSO Year 1 and Year 2 (as done previously), and also just the months defined as El Niño via the ONI index threshold used by NOAA. We also analyse each El Niño separately, and all months of all five El Niños pooled together.

The reviewer asks if we are using running mean data. We now clarify this by using only NINO index data downloaded from the official NOAA CPC web site (download site and download date listed in the reference list), which for NINO-3, NINO-4 and NINO-3.4 are not running means. The ONI data are downloaded from the same site, and this is a 3-month running mean of the NINO-3.4 index measure.

Methodology

As suggested, we now define the term AF (Active Fire) prior to each use of the acronym. The number of AVHRR scenes used per year was a mean of 120±15, with typically a couple of scenes per week. We do not feel that the fact that there are some days between observations will influence our result in a major way, since we work only on monthly averages and we find that our active fire count metrics derived from AVHRR GAC data agree very well with those derived via alternative methodologies and datasets (see our Figure 6 for comparison to AVHRR LAC-derived fire counts, and the ATSR-derived fire counts).

We normalised for changing observations times using the diurnal cycle information derived from TRMM – i.e. the data shown in Figure 5. We now make clear what years these diurnal cycle data are from in the figure caption. The same diurnal cycle information was used for all El Niños, as it is not known what diurnal cycle differences exist (if any) between different El Niños. We make this clear in the text.

Page 911, Line 11: The erroneously mentioned “2003” is changed to “1983”. Page 911, Line 14. As suggested, we include the fact that the the 1991/92 El Niño period was followed by warm ENSO conditions in 1993 and 1994, and was not immediately

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followed by a La Niña episode. We do indeed mean Figure 9b (not 8b) and have removed this typo.

We now include a spatial component to the rainfall analysis, as suggested by the reviewer (separating the island into 'all Borneo' and 'southern Borneo' for the comparison of rainfall and fire).

We have significantly expanded the cross-correlation analysis, including analysis of individual ENSO years and of 'pooled data' from all years, of all months and just those showing ONI > 0.5 oC, and of all Borneo and Southern Borneo. These results are discussed in detail in Section 5.3, and even when using the same variables as in our previous draft the correlations are changed somewhat, due to our now using the most up to date ENSO index values.

We explain that the data of Figure 10 show the relationship between cumulative AF count and cumulative NINO-3 index, since this is the index showing the strongest such relationship. We include the strength of comparable relationships in a new Table (Table 5).

Figures and Tables The table caption now explicitly states that for correlations we are showing the value of r.

Figure 1: The caption describing the provincial geography of Borneo has been amended as suggested. "Landcover" has been changed to "land cover"

Figure 2: As suggested, we emphasise in the caption that the selected images show typical examples for each climatological condition, and indicate that it is due to the relative scarcity of LAC data that we have to show different dates for each year.

Figure 7: We have removed the unused NINO-1 and NINO-2 indices as suggested. All ENSO indices have been downloaded from the official NOAA CPC web site (download site and download date listed in the reference list), and the differences between each are discussed in Section 3.2 and the caption of Figure 1.

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Figure 9: We have corrected the labelling error pointed out by the reviewer. We now also show the ONI data rather than NINO-3, as suggested. This also visually allows the figure to demonstrate the El Niño months having ONI > 0.5o C (which are also listed in Table 1).

Figure 10: We have now downloaded the most recent NINO index data from the NOAA CPC web site (download site and download date listed in the reference list).

References Kousky, V. E., R. W. Higgins (2007) An Alert Classification System for monitoring and assessing the ENSO Cycle. Weather Forecasting, 22, 353–371. doi: 10.1175/WAF987.1 Smith, T. M., and Reynolds, R. W. (2003) Extended reconstruction of global sea surface temperatures based on COADS data (1854–1997). Journal of Climate, 16, 1495–1510.

Interactive comment on Biogeosciences Discuss., 8, 975, 2011.