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Integrating field surveys and MODIS data to evaluate the effects of the 2005 drought in Amazonia

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In 2005, large areas of the Amazon Basin experienced one of the most intense droughts of the past 100 years, driven by the elevation in temperature of the tropical North Atlantic sea surface. Contrasting results have emerged in the literature between studies based solely on remote-sensing data and studies based on field surveys. The evaluation of the enhanced vegetation index (EVI) from the Terra satellite's Moderate Resolution Imaging Spectroradiometer (MODIS) showed a large-scale photosynthetic green-up in intact evergreen forests during the drought period. On the other hand, multiple long-term monitoring plots showed that forests experiencing the most elevated moisture stress exhibited an increase in tree mortality. In this study, we integrated MODIS data with field ecological data in order to generate the first large scale evaluation of the impacts of the 2005 drought on Amazonian primary forests from a remote sensing perspective based on multiple field data sites. To achieve this objective, two datasets were used. The first one encompasses interval-corrected data on the 2005 tree mortality derived from the pan-Amazonian RAINFOR database. The second database encompasses the MODIS MOD13A3 c5 monthly images product, with 1 km spatial resolution, for the 2005 drought period (June to September). In addition to the EVI, shade (S), vegetation (V) and non-photosynthetic vegetation (NPV) fraction images (F) derived from a linear spectral mixture model were generated. Samples were acquired from the MODIS-derived dataset for 17 sites, aggregated based on the clusters of 42 field plots, to reduce the influence of spatial-autocorrelation. The preliminary analysis showed a positive relationship between the EVI and VF from June 2005 with the number of dead trees (R^2= 0.67 and R^2= 0.68, respectively, $p<0.001$). The NPVF derived from June also exhibited a positive relationship with stem mortality (R^2= 0.52, $p<0.001$). Interestingly, the SF analysis revealed a negative relationship with the number of dead trees (R^2= 0.73, $p<0.001$). The interpretation of these results indicates that areas with higher tree mortality exhibited higher NPV fraction and lower shade fraction, suggesting that the MODIS data are sensitive to changes in the forest canopy. The decrease in shade fraction and hence the increase in the EVI and VI in areas with higher tree mortality can be attributed to changes in the forest structure and not to increases in forest productivity. Next steps will focus on a detailed evaluation of the NPV fraction for mapping the areas with high tree mortality rates, and ultimately for assessing the large-scale carbon loss during the 2005 drought event.