Fire in the vegetation and peatlands of Borneo, 1997-2007: Patterns, Drivers and Emissions

A. Spessa (1), U Weber (2), A Langner (3), F Siegert (4), and A Heil (5)

(1) Walker Institute for Climate System Research, Dept Meteorology, Reading University, Reading, United Kingdom (a.spessa@reading.ac.uk), (2) Max Planck Institute for Biogeochemistry, Jena, Germany, (3) Dept Environmental Studies, Tokyo University, Tokyo, Japan, (4) Remote Sensing Solutions GmbH, Munich, Germany, (5) Research Centre Juelich GmbH, Juelich, Germany

Fire activity and emissions from biomass burning in the so-called 'Arc of Deforestation' along the southern Amazonian forest has been shown to be negatively and non-linearly correlated with rainfall variability, and that this correlation is mediated by human land use and land cover change (LULCC) which drives ignitions and promotes fire spread (Cochrane et al. 1999; Cochrane 2003; Aragao et al. 2008). Other studies have established a similar correlation between fires and associated emissions versus rainfall in Borneo, in particular Kalimantan, with ENSO-driven droughts being identified as the main cause of below average rainfall events over the past decade or so (Field & Shen 2008; van der Werf et al 2008). However, while these particular Borneo studies have indicated that the non-linear relationship between fires and rainfall may be caused by LULCC, they have demonstrated this link only at a broad regional scale. Siegert et al (2001) reported a clear link between fires and logging in Borneo, but this study was restricted to east Kalimantan and the period 1997-98, during which devastating El-Nino driven fires occurred there. Further El Nino events have occurred in Borneo in 2002, 2004 and 2006. The link between fires and emissions, rainfall and LULCC across the island of Borneo therefore remains to be examined using available fine resolution data over a multi-year period.

Using rainfall and soil data in combination with state-of-the art satellite sensor data (LANDSAT ETM, MODIS, ATSR and AVHRR) to determine burnt area and deforestation patterns over the decade 1997-2007, we show at a pixel working resolution of 0.25 degrees the following: Burning across Borneo (1997-2007) predominated in southern Kalimantan. Fire activity is negatively and non-linearly correlated to rainfall mainly in pixels that have undergone a significant reduction in forest cover between 1997 and 2007, and that the bigger the reduction, the stronger the correlation. Such pixels occur overwhelmingly with the highest frequency in southern Kalimantan. These correlations are noticeably much weaker or absent in other parts of the island (principally Malaysia and central Borneo), where little or no deforestation was observed during 1997 to 2007.

Cochrane et al (1999) provided evidence from southern Amazon forests that recurrent fires promote a change from tree-dominated to grass-dominated ecosystems which, in turn, promotes even more fires. We show that recurrent fire and deforestation are also linked as part of a similar positive feedback process in southern Kalimantan. Our results not only support the detailed field work of Siegert et al (2001) but also reinforce the applicability of their findings across time and space.

Finally, our data show that emissions from biomass burning reflect fire activity, and that fires in the carbon-rich peats of southern Kalimantan dominate the emissions profile from 1997-2007.