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Seasonal Forecasting of Fires across Southern Borneo, 1997-2010

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Wildfire is a fundamental Earth System process, affecting almost all biogeochemical cycles, and all vegetated biomes. Fires are naturally rare in humid tropical forests, and tropical trees are generally killed by even low-intensity fires. However, fire activity in the tropics has increased markedly over the past 15-20 years, especially in Indonesia, Amazonia, and more recently, central Africa also. Since fire is the prime tool for clearing land in the tropics, it not surprising that the increase in fire activity is strongly associated with increased levels of deforestation, which is driven mainly by world-wide demand for timber and agricultural commodities. The consequences of deforestation fires for biodiversity conservation and emissions of greenhouse gases and aerosols are enormous. For example, carbon emissions from tropical biomass burning are around 20% of annual average global fossil fuel emissions.

The destructive fires in Indonesia during the exceptionally strong El Niño-induced drought in late 1997 and early 1998 rank as some of the largest peak emissions events in recorded history. Past studies estimate about 1Gt of carbon was released to the atmosphere from the Indonesian fires in 1997 (which were mostly concentrated in carbon-rich forested peatlands). This amount is equivalent to about 14% of the average global annual fossil fuel emissions released during the 1990s. While not as large as the 1997-98 events, significant emissions from biomass burning have also been recorded in other (less severe) El Niño years across Indonesia, in particular, 2002, 2004, 2006 and 2009-2010.

Recent climate modelling studies indicate that the frequency of El Niño events may increase under future climate change, affecting many tropical countries, including Indonesia. An increased drought frequency plus a projected increase in population and land use pressures in Indonesia, imply there will be even more fires and emissions in future across the region. However, while several studies using historical data have established negative relationships between fires and antecedent rainfall, and/or positive relationships between fires and deforestation in regions affected by El Nino, comparatively little work has attempted to predict fires and emissions in such regions.

Ensemble seasonal climate forecasts issued with several months lead-time have been applied to support risk assessment systems in many fields, notably agricultural production and natural disaster management of flooding, heat waves, drought and fire. The USA, for example, has a long-standing seasonal fire danger prediction system. Fire danger monitoring systems have been operating in Indonesia for over a decade, but, as of yet, no fire danger prediction systems exist. Given the effort required to mobilise suppression and prevention measures in Indonesia, one could argue that high fire danger periods must be anticipated months in advance for mitigation and response measures to be effective.

To address this need, the goal of our work was to examine the utility of seasonal rainfall forecasts in predicting severe fires in Indonesia more than one month in advance, using southern Borneo (comprising the bulk of Kalimantan) as a case study.

Here we present the results of comparing seasonal forecasts of monthly rainfall from ECMWF's System 4 against i) observed rainfall (GPCP), and ii) burnt area and deforestation (MODIS, AVHRR and Landsat) across southern Borneo for the period 1997-2010. Our results demonstrate the utility of using ECMWF's seasonal climate

forecasts for predicting fire activity in the region. Potential applications include improved fire mitigation and responsiveness, and improved risk assessments of biodiversity and carbon losses through fire. These are important considerations for forest protection programmes (e.g. REDD+), forest carbon markets and forest (re)insurance enterprises.