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Estimating of Fire Emissions in Central Siberia

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The Russian boreal zone is globally significant in terms of climate change impacts and carbon storage. Forest wildfires are the largest cause of carbon fluxes in this region. Climate predictions from the 4th IPCC Assessment indicate the region will become warmer and drier suggesting that wildfire impacts will increase there in future, further adding to forcing of trace greenhouse gases and aerosols to the atmosphere. Accurate regional to continental estimates of carbon emissions from wildfires in Siberia require data and models that accurately quantify not only burnt area, but also emissions per unit burnt area for a range of different fire regimes.

We show that emissions from surface fires, which during normal fire years comprise roughly 80% of all fires, may increase three-fold, as a function of fuel type and the weather conditions preceding and during a fire. Emissions from crown fires may add another 7-15%, depending on the intensity of the fire and on crown structure.

An algorithm for accurate burnt area recognition based AVHRR and LANDSAT/ETM data underpins our methodology. Here we present new area burnt product and emission estimates for Siberia that span 1998 to 2008, and explicitly quantifies associated error estimates in burnt area. To determine the influence of errors occurring when detecting active fires from AVHRR, these data were compared with LANDSAT 30m2 resolution images of fire scars. As a result of hot spot geo-reference inaccuracies and the omission of small sites left intact within fire contours, we estimate the error as: 27% for burned areas up to 5000 ha; 23% those up to 30000 ha; and 12% for beyond 30 000 ha.

Using GIS, we overlaid annual burned area surfaces across 23 unique ecoregions comprising Siberia. Carbon consumption estimates based on the Seiler & Crutzen equation range from 3.4 to 75.4 t C ha-1 for three classes of severity. Emissions range from 116 Tg C in 1999 (6.9 M ha burned) to the extreme scenario estimate of 520 Tg C in 2002 (11.2 M ha burned), which are equivalent to 5 and 20%, respectively, of total global carbon emissions from forest and grassland burning. Accounting for smoldering combustion in soils and peatlands results in increases in CO, CH_4, and total non-methane hydrocarbons and decreases in CO_2 emitted from fire events.

KEYWORDS: AVHRR/NOAA, MODIS, LANDSAT/ETM+data, area burned, emissions, carbon consumption, boreal Siberia