別紙 4

報告番号	※ 第

主　論　文　の　要　旨

論文題目　Evaluation of Carbon Emissions from Forest Fires in Southeast Asia during the Period 2001-2010

（2001 年から 2010 年の東南アジアにおける森林火災による炭素放出量の評価）

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論　文　内　容　の　要　旨

Fire and biomass burning are unique disturbances on ecosystem processes and dynamics. They can lead to the direct release of ecosystem carbon that is stored in large terrestrial pools (live vegetation, dead vegetation, litter, organic soil), which have deep implication to the ecosystem productivity and stability. At the same time, they can result in elevated concentrations of trace gases (e.g., carbon monoxide, methane) and aerosol particles in the atmosphere, which have significant effects on global atmospheric chemistry and climate change in various regions of the world, and are causing serious air pollutions as well.

Carbon emissions induced by biomass burning are commonly calculated as a product of burned area, fuel loads, and combustion completeness, integrated over the time and space scales of interest. With the help of the recently released satellite products, and terrestrial biosphere model, this study developed a new high-resolution and multi-year inventory of carbon emissions by open biomass burning in Southeast Asia (SEA) during the period of 2001-2010, and evaluated their global warming potentials. The high resolution emission grid showed its advantage in quantifying small sized fire emissions, which were frequently misinterpreted by the coarse grid data due to their smoothed large pixels.

Using the recently developed MODerate resolution Imaging Spectroradiometer (MODIS) burned area products and the improved biosphere model integrating fire carbon processes at a spatial resolution of 5 km, our results showed that burned areas were predominantly concentrated in Myanmar, north Thailand, eastern Cambodia, and northern Laos, with marked differences in Sumatra and Kalimantan of Indonesia, where peatland is extensively distributed. Through comparison among different burned area products, we found that the burned area datasets from MCD64A1, MCD45A1 and GFED3 (Global Fire Emission Database) showed consistent temporal variation from 2001 to 2010 with average annual burned areas of 68104, 50933 and 61263 km^2 $year^{-1}$, respectively. Fire carbon emissions estimated in the three simulations (BEAMS/MCD64A1, BEAMS/MCD45A1-Peat and BEAMS/GFED) by using the three burned area products exhibited similar spatial patterns with respect to the burned areas, with average annual fire carbon emissions of 232.6, 214.1 and 228.8 TgC, respectively. The best result among the three estimations was BEAMS/MCD45A1-Peat, which was close to that obtained by GFED3 with 210.7 TgC. Aerosol Optical Depth (AOD) values showed good consistency with both fire CE and Multivariate ENSO (El Niño Southern Oscillation) Index values from 2001 to 2010, likely because of the deep peat soil burning under the influence of the El Niño phenomenon and Indian Ocean Dipole pattern in combination with anthropogenic disturbance through deforestation for palm oil plantation.

Besides, by using the biomass density and spatio-temporal variable combustion factors derived from the satellite observation data, our study also developed a new high-resolution and multi-year emissions inventory for open biomass burning on SO_2, NO_x, CO, Non-Methane Volatile Organic Compounds (NMVOC), NH_3, Black Carbon (BC), Organic Carbon (OC), CH_4, CO_2, and N_2O in SEA during the period of 2001-2010, and evaluated their global warming potentials. The average annual biomass burning emissions were 261.8 Gg $year^{-1}$ SO_2, 1013.2 Gg $year^{-1}$ NO_x, 51838.2 Gg $year^{-1}$ CO, 3529.0 Gg $year^{-1}$ NMVOV, 437.3 Gg $year^{-1}$ NH_3, 302.0 Gg $year^{-1}$ BC, 2278.0 Gg $year^{-1}$ OC, 3525.6 Gg $year^{-1}$ CH_4, 761948.6 Gg $year^{-1}$ CO_2, 96.0 Gg $year^{-1}$ N_2O, respectively. The result showed that high emissions by biomass burning were mainly concentrated in Myanmar,

Cambodia, and Indonesia, and were accounted for approximately 60% of the total biomass burning emissions. And forest burning emissions were found to be the dominant contributor to the total emissions among all land types. In addition, we found that the biomass burning emissions exhibited similar trends from 2001 to 2010 with strong interannual and intraannual variability. Three high emission years were 2004, 2007, and 2010, which were attributed to the three peaks of corresponding burned areas in 2003, 2007, and 2010, respectively. The intraannual trend showed that biomass burning emissions in January-March were the highest all year around, with another small peak in Oct. The total net global warming potential estimated from the SEA biomass burning emissions during 2001-2010 was around 792 (20 year horizon) and 775 (100 year horizon) Tg CO_2 equivalent, which contributed to 8.6% and 10.5% for both time horizons to the globe, respectively.