Influence of meteorological variations on albedo in tropical peat swamp forests in Borneo

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Tropical peatland which pools 105 Gt carbon equal to 21% of global peatland carbon, had been played as an important carbon reservoir (Page et al., 2011; Dargie et al., 2017). Currently, large part of tropical peat is found in Southeast Asia which contain about 43% of all tropical peat area. Nevertheless, many tropical peatlands in this region have experienced major change in environmental conditions due to land conversion mainly for agricultural and acacia plantations, field.

Many studies on tropical peatland, had evaluated the influence of such changes on CO_2 dynamics in relation to global warming. Drainage which creates aerobic conditions, stimulates microbial degradation. This means CO_2 efflux would increase from soil surface to the atmosphere. Aridification increases the risk of fire occurrence and accelerates fire propagation. Fire is a significant disturbance which contributes to global warming. In recent decades, tropical peatland in Southeast Asia especially Indonesia repeatedly experienced large-scale fire in 1997, 2002, 2009, 2014 and 2015, which were El Niño years. Huijnen et al. (2016) reported that widespread forest and peatland fires burned over large parts of maritime Southeast Asia in September and October 2015. The CO_2 emission rate (11.3 Tg CO_2 per day) during Sept-Oct 2015 exceeded the fossil fuel CO_2 release rate of the European Union (EU28) (8.9 Tg CO_2 per day).

Evaluating the impact of disturbance on global warming, the variation of energy fluxes between land and the atmosphere has to be considered, in addition to Greenhouse gas fluxes. Sensible heat, which directly warms the atmosphere, is distributed from net radiant energy. Net radiant energy strongly depends on albedo and incoming solar radiation. Many studies evaluated albedo over broad area using satellite products. But, there is still room for improvement on precision and resolution. Meanwhile, long-term field observation could reveal the characteristics of albedo responding to environmental variations. However, there are few such studies in tropical peatland.

For analyzing the influence of meteorological variations on albedo in tropical peat swamp forest in Borneo, we conducted continuous field observation for equal to or longer than four years simultaneously at five experimental sites. Three of them are undrained forest, drained forest and drained burned forest in Central Kalimantan, Indonesia. The other two are intact forest and secondary forest in Sarawak, Malaysia.

The extreme lowering of GWL induced aridification that can trigger both forest and peat fire, especially during El Niño years. Smokes from the fire temporarily increased the observed albedo regardless of vegetation change. In burnt forest with the absence of canopy, the albedo decreased when soil surface was saturated and patched with puddles. This would be because the albedo of surface water is generally lower than that of soil. As the vegetation of the burnt forest progressively recovered, the albedo had been increasing. This would reflect the brighter color of vegetation compared with soil.

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