Fire activity and smoke pollution in Indonesia under the influence of drought induced by 2015 El-Niño episode

(2015 年のエルニーニョに伴う干ばつのもとで発生したインドネシアの火災と煙汚染)

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ABSTRACT

During the 2015 dry season, there were massive forest fire events in Indonesia associated with the extremely dry condition due to the El-Niño event. Previous El-Niño episodes have caused forest fire events in Sumatra and Kalimantan islands, that potentially alters the function of tropical forest from carbon sink to carbon source. In addition, the fire can influence on hydrological cycle because low soil moisture could reduce evapotranspiration and atmospheric moisture, resulting in inactive convection process and less precipitation. Therefore, the synthetic study of fire events have collected global attention in recent years, especially after 1997/1998 El-Niño event brought considerable environmental and economic damages. This study aims to evaluate the impact of the latest strong El-Niño episode in 2015 in comparison to past events to understand the drought and fire conditions under which they occurred. For this purpose, a long term reanalysis dataset, MERRA2, provided by NASA was utilized to examine the relationship between aerosol optical depth (AOD) and meteorological parameters during 1980-2015. This study also used the Global Fire Emission Dataset version 4 (GFED4) to examine the biomass burning carbon emissions during 1997-2015.

The fire and smoke pollution in 2015 had occurred repeatedly in southern Sumatra and south-central Kalimantan. The fires often occur during abnormally dry years. Precipitation anomaly and sea surface temperature anomaly over Indonesia show strong positive correlation over Indonesia region during July to October. This indicates less precipitation and resulting drought condition was due to the lower than normal sea surface temperature around Indonesia which weakened the convective activity.

The most severe drought and forest fires during 2015 occurred in September and October. In September, precipitation decreased considerably and precipitation anomaly reached -3.1 mm/day relative to climatology in Kalimantan. This probably contributes to 78.6 TgC of carbon emission and 0.71 of AOD. Meanwhile, in Sumatra it was noted that precipitation anomaly decreases by -2.73 mm/day relative to climatology and contribute to 35.2 TgC emissions and 0.6 of AOD. In October, precipitation anomaly reached -2.71 mm/day relative to climatology in Kalimantan, and contribute to 15.6 TgC of emission and 0.76 of AOD. In Sumatra the precipitation decreased by -3.78 mm/day and caused 16.1 TgC of emission and 0.90 of AOD.

The mean precipitation during July-October 2015 was the second lowest since 1997 both in Sumatra (4.85 mm/day) and Kalimantan (2.94 mm/day). It was a favorable condition for fire and haze occurrence. Since 1997 the aerosol emission in 2015 (29.2 TgC) was the third highest after 1997 (95.6 TgC) and 2006 (29.8 TgC) events, and the 2015 AOD (0.46) was fourth highest after 1997 (1.01), 2002 (0.6) and 2006 (0.51) in Kalimantan. Despite the emission in 2006 (16.2 TgC) was higher than in 2015 (16.1 TgC), the 2015 AOD (0.5) was higher than 2006 (0.46) in Sumatra. This indicates that high emissions do not always accompany high AOD because of the dynamical transport of aerosols in the atmosphere.

The difference in fire environments between Sumatra and Kalimantan may be partly attributed to different patterns of human activity and government policy. This study analyzed the drought as the preconditioning of the fire occurrence. Further studies will be needed to clarify the contribution of local human activity as a trigger of fires.

Key words: El-Niño 2015, forest fire, biomass burning emission, aerosol optical depth (AOD), precipitation