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Smouldering Subsurface Fires in the Earth System

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Smouldering fires, the slow, low-temperature, flameless form of combustion, are an important phenomena in the Earth system. These fires propagate slowly through organic layers of the forest ground and are responsible for 50% or more of the total biomass consumed during wildfires.

Only after the 2002 study of the 1997 extreme haze event in South-East Asia, the scientific community recognised the environmental and economic threats posed by subsurface fires. This was caused by the spread of vast biomass fires in Indonesia, burning below the surface for months during the El Niño climate event. It has been calculated that these fires released between 0.81 and 2.57 Gton of carbon gases (13–40% of global emissions).

Large smouldering fires are rare events at the local scale but occur regularly at a global scale. Once ignited, they are particularly difficult to extinguish despite extensive rains or fire-fighting attempts and can persist for long periods of time (months, years) spreading over very extensive areas of forest and deep into the soil. Indeed, these are the oldest continuously burning fires on Earth.

Earth scientists are interested in smouldering fires because they destroy large amounts of biomass and cause greater damage to the soil ecosystem than flaming fires do. Moreover, these fires cannot be detected with current satellite remote sensing technologies causing inconsistencies between emission inventories and model predictions.

Organic soils sustain smouldering fire (hummus, duff, peat and coal) which total carbon pool exceeds that of the world's forests or the atmosphere. This have important implications for climate change. Warmer temperatures at high latitudes are resulting in unprecedented permafrost thaw that is leaving large soil carbon pools exposed to fires. Because the CO2 flux from peat fires has been measured to be about 3000 times larger that the natural degradation flux, permafrost thaw is a risk for greater carbon release by fire and subsequently influence carbon-climate feedbacks.

This presentation will revise the current knowledge on smouldering fires in the Earth system regarding ignition, spread patterns and emissions. It will explain the key differences between shallow and deep fires, and flaming fires.