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Accidental Carbon Emissions and Smouldering Peat Fires in the Earth System

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Smouldering fires, the slow, low-temperature, flameless burning, represent the most persistent type of combustion phenomena and the longest continuously fires on Earth. In peat, smouldering fires can be initiated spontaneously or with much weaker ignition sources than flaming fires but are much more difficult to extinguish, despite extensive rains, weather changes or fire-fighting attempts and persist for long periods of time (months, years). Under drought conditions, peat fires are a disproportionate contributor to atmospheric emissions, as seen in the 1997 extreme haze event in South-East Asia. 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 the 1997 fires released between 0.81 and 2.57 Gton of carbon gases (13–40% of man-made global emissions). Records shows that peat fires have occurred frequently in Indonesia since 1960. Smouldering is a global phenomena and burning peatlands have been reported in tropical, temperate and boreal ecosystems since records exists.

Peat smouldering is characteristically an incomplete oxidation reaction and thus emits in addition to CO2, and water vapour, a mixture of volatile organic species (e.g. CH4, C3H8, CH3OH), CO, polyaromatic hydrocarbons, and particulates at a higher yield than flaming fires. It favours CO to CO2 ratios around unity (as opposed to ratios around 0.1 in flaming combustion), so CO is as important as CO2 in smouldering peat. Laboratory measurements of gas fluxes show that peat fires release carbon 3,000 times faster than natural peat respiration.

Peat fires burn a pre-fossil fuel and thus are the only carbon-positive wildfire phenomena. This creates feedbacks in the climate system because soil moisture deficit and self-heating are enchanted under warmer climate scenarios and lead to more frequent fires.

This paper reviews the current knowledge on smouldering peat fires regarding dynamics, emissions, and feedbacks in the climate system.