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Smouldering 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 system. Indeed, smouldering mega-fires of peatlands occur with some frequency during the dry session in, for example, Indonesia, Canada, Russia, UK and USA. Smouldering fires propagate slowly through organic layers of the ground and can reach depth >5 m if large cracks, natural piping or channel systems exist. It threatens to release sequestered carbon deep into the soil. Once ignited, they are particularly difficult to extinguish despite extensive rains, weather changes or fire-fighting attempts, and can persist for long periods of time (months, years) spreading deep and over extensive areas. Recent figures at the global scale estimate that average annual greenhouse gas emissions from smouldering fires are equivalent to 15% of man-made emissions. These fires are difficult or impossible to detect with current remote sensing methods because the chemistry is significantly different, their thermal radiation signature is much smaller, and the plume is much less buoyant. These wildfires burn fossil fuels and thus are a carbon-positive fire 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. Warmer temperatures at high latitudes are resulting in more frequent Artic fires. Unprecedented permafrost thaw is leaving large soil carbon pools exposed to smouldering fires for the fist time since millennia. Although interactions between flaming fires and the Earth system have been a central focus, smouldering fires are as important but have received very little attention. DBut differences with flaming fires are important. This paper reviews the current knowledge on smouldering fires in the Earth system regarding combustion dynamics, damage to the soil, emissions, remote sensing and feedbacks in the climate system.