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Smoldering combustion of biomass in wildfires - modeling and experimental results

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We present a numerical modeling and experimental approach to study smoldering combustion of biomass in wildfires. A numerical model is used to solve the set of conservation equations using a finite volume approach. Drying, pyrolysis, and heterogeneous reactions were calculated for sound logs with a cylindrical geometry. The model approaches the smoldering combustion process in two dimensions. The model was developed to investigate the front propagation of the smoldering combustion in sound logs as well as smoldering of deep organic soils. The model is tested using data from experimental fires in deforestations of the Amazon forest. In those fires, we have observed that many logs burn to completion through smoldering. The laboratory data used to calibrate the numerical model was obtained in a combustion chamber facility; the model was then applied to predict the smoldering propagation rate in different types of biomass substratum. The numerical model also keeps track of emissions of condensable species. This capability will improve assessment of smoke emissions, which are hazardous for firefighters and general public, impair air quality, and contribute to greenhouse gases. The model also tracks the energy released during the entire combustion process, which can be used to assess site effects. A parametric study was conducted to identify which physical and chemical properties play important roles in sustaining the burning front.