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Local Flow Velocity Measurements During the Eruptive and Disruptive Dynamic Fire Behaviour

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Forest fires often exhibit complex and dynamic fire behaviour resulting from interactions between the various parts of a fire and the surrounding environment. These interactions can cause rapid fire progression and lead to loss of containment and critical fire safety problems. The effects of convective processes near the fireline induce a local wind flow and modified flame properties. The fire spread conditions along the fire perimeter are modified by the interaction between the fire, the flames, and the surrounding environment. It is observed that a quick-fire acceleration is followed by a deceleration of the fire front. We assimilate these phases to the eruptive process of a fire acceleration in a canyon and designate by disruptive the deceleration phase, respectively. The relevance of the convective flow induced by the fire in these processes is analysed in the present paper based on laboratory scale experiments.

To analyse the induced local wind flow, laboratory experiments were conducted at the Forest Fire Research Laboratory (LEIF) of the University of Coimbra in Lousã. It was considered Two different physical problems were considered: a point ignition fire in a slope (SP) and a point ignition fire in a canyon (DEP). The local flow velocity was measured with five S-pitot tubes 15cm above the ground. S-type pitot tubes allow the determination of the local flow velocity by measuring the differential pressure based on Bernoulli's equation. In SP tests the pitot tubes were placed along the centre line, in the middle of the fuel bed area, and in the DEP tests the pitot tubes were placed in the canyon water line.

To simplify the analysis, it was assumed that the flame is static at the position of the pitot tube. Using the average values of flow velocity every 5 seconds, the time of the passage of the flame at each pitot tube position was estimated from the curve of U'(t) when the flow velocity changed its signal from essentially positive to essentially negative values of U'. As the flow approaches the leeward side of the flame (negative values), the value of U' increases to a maximum value and then decreases due to the flame acting like a solid, leading to a stagnation point. On the lee side of the flame, the flow velocity U' becomes negative and has a clearly defined minimum value. This local flow changes the properties of the flame (flame angle and flame length) and when the local wind flow on the lee side of the flame increases, the fire ROS decreases and the flame angle increase and a flow contrary to the fire spread appears.