Post Doctoral Position: Stochastic modeling of firebrand ignition

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Description of the Post Doc

This research project will be funded by the "Institute for Mechanical Engineering" of Aix-Marseille University. Once selected by the reaserch team, the project and the candidate will be evaluated in a sigle round in November, 2025 for a final decision in december, 2025. The Post Doc will last up to 24 months (12 months renewable once). He/she will benefit from an additional support budget of 5 keuros/year (for symposium participation, international collaboration missions, small equipment, etc.).

This research project investigates firebrand spotting, a critical mechanism for fire spread in both wildland and wildland-urban interface (WUI) fires. Firebrands, which are flaming or glowing embers, are generated by burning vegetation or structures. These embers are then lifted by fire plumes and carried downwind, where they can ignite new fires or structures far from the main flame front [1]. Spotting significantly influences fire spread patterns because it acts over much longer distances than heat transfer mechanisms from flames to unburnt vegetation. In addition, it is estimated that more than half of the homes destroyed in WUI fires are due to firebrands [2].

The complex problem of spot wildfires can be broken down into three individual processes:

1. Firebrand generation and thermochemical state: How firebrands are produced and their initial chemical and thermal properties [3].

2. Transport and thermochemical evolution during flight [4].

3. Ignition upon landing: the initiation of smoldering or flaming combustion in a receptive fuel bed after the firebrand lands [1].

Stochastic models have been developed to model firebrand spotting [5, 6, 7]. These models are particularly well-suited for integration into operational fire spread models, providing real-time capabilities that are highly valuable for operational use and decision-making in fire management [7]. The stochastic spotting models rely on model parameters that are difficult to estimate and strongly depend on the weather (wind speed, ambient temperature, relative humidity) and the vegetation (type, moisture content).

This project research aims to combine CFD modeling of the spotting process with statistical learning methods to explore how the stochastic model parameters evolve with the most sensitive input data. The CFD simulations of the spotting process will be performed with FireStar3D, a fully physical, three-dimensional wildfire simulation model, co-developed at M2P2, the Lebanese American University and Toulon University. [8]. A particular fundamental focus of this project will be on developing ignition models for fuel beds by firebrands. This aspect is crucial as it represents the least understood of the three processes previously described in firebrand spotting.

Candidate profile
The desired candidate must hold a PhD related to combustion, fire research, and numerical simulation. The candidate will work in a research laboratory environment and will have to demonstrate autonomy, pragmatism, and a proactive approach.

- **Contact and candidature:** Jean-Louis Consalvi (jean-louis.consalvi@univ-amu.fr)).

References

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