PA - Atmospheric characterization of wildfire environment

Context and Objectives

Wildfires are a major natural hazard, impacting ecosystems, human health, and infrastructure. Understanding the atmospheric conditions within and around a wildfire—including smoke plumes, heat release, and turbulence—is crucial for predicting fire behavior, assessing atmospheric impact, and optimizing aerial firefighting operations. This project aims to characterize the atmospheric environment of wildfires through the analysis of measurement data and the exploration of operational applications.

Key Objectives:

During the 6 month internship period, the candidate will address the following objectives:

1. **Literature Review and State-of-the-Art:** Compile a comprehensive bibliography on atmospheric characterization techniques for wildfires, focusing on both in-situ and remote sensing measurements (e.g., satellite, LIDAR, aircraft-based sensors).
2. **Analysis of Measurement Means:** Evaluate the capabilities, limitations, and complementarity of various measurement technologies (e.g., accelerometers, LIDAR, satellite imagery, thermal cameras, UAV-borne sensors) for capturing critical atmospheric parameters (e.g., local and environmental wind profiles).
3. **Modeling and Data Integration:** Develop a method for integrating analyzed atmospheric data (wind, temperature, humidity) with existing regulatory aerospace/atmospheric turbulence models (e.g., standard atmospheric models adapted for convective plumes) to create a representation of the wildfire environment for simulation.
4. **Application to Firefighting Operations:** Explore how atmospheric characterization data can be integrated into operational tools, specifically focusing on its impact on:
   - **Trajectory Optimization:** How can real-time wind and turbulence data be used to optimize the flight paths of firefighting aircraft (e.g., water bombers) to maximize payload delivery effectiveness and ensure safety, particularly during the scooping phase over water bodies?
   - **Risk Assessment:** Using atmospheric data for improved modeling of smoke dispersion and heat flux to enhance safety protocols for ground and aerial crews.

Required Skills

- Major in Aerospace Engineering, Flight testing or Remote Sensing.
- Proficiency in data processing and analysis (e.g., Python, MATLAB, or C++).
- Familiarity with atmospheric modeling concepts is a plus.

Expected Outcome

The successful completion of this internship will result in:

1. A comprehensive literature review document detailing the state-of-the-art in wildfire atmospheric characterization.
2. A mathematical model predicting atmospheric wind components in a wildfire environment, along with an implementation for real-time simulation.
3. An evaluation of existing measurement systems and their suitability for operational use.
4. A conceptual framework demonstrating how atmospheric data can inform and optimize aerial firefighting strategies, particularly concerning aircraft trajectory and scooping maneuvers.

Contact

Interested candidates are encouraged to submit their CV and a brief cover letter to jonathan.beck@positive-aviation.com for consideration.