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Description of the funded research project

2nd Call for H.F.R.I. Research Projects to Support Post-Doctoral Researchers

Title of the research project:

Flammable Greece – Increasing awareness and preparedness for extreme fire weather and behavior

Principal Investigator:

Theodore M. Giannaros

Reader-friendly title:

FLAME

Scientific Area:

Physical Sciences

Institution and Country:

National Observatory of Athens, Greece

Host Institution:

National Observatory of Athens, Greece

Collaborating Institution(s):

Project webpage (if applicable):

Budget:

163,701€

Duration:

36 months (01.12.2020 – 30.11.2023)

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Research Project Synopsis

On July 23 2018, Greece experienced the second deadliest natural disaster of its modern history. A wildfire that broke up early in the afternoon, in the region of Ntaou Pentelis in East Attica, spread erratically and within a couple of hours almost literally wiped out the residential area of Mati, resulting in a record-high 100 civilian fatalities and innumerable destroyed properties. Prior to the Mati wildfire, a total of 208 fatalities in 78 wildfires were recorded in the country between 1977 and 2013. Most of them did occur under extreme fire weather conditions, promoting extreme fire behavior. These figures urgently call for increasing awareness and preparedness for extreme fire weather and behavior. FLAME envisages advancing the scientific knowledge of extreme fire weather and behavior by aiming to (i) compile the climatology of critical fire weather patterns, determining their strength, frequency and duration during a typical fire season, and verifying their relationships with atmospheric teleconnection indices and sea-surface temperature anomalies, (ii) to study the conditions and processes under which major transitions in fire behavior take place, seeking to answer whether threshold conditions exist, which could allow for predicting extreme fire behavior, and (iii) to advance fire spread modeling by considering the concept of atmospheric stability through the development of a wind gust parameterization scheme for a coupled fire-atmosphere modeling system. Our approach is founded on the consideration of the dynamics of the three-dimensional atmosphere for describing and characterizing key atmospheric processes related to the transport (horizontal and vertical) of dry, warm and high-momentum air in the vicinity of wildfires. FLAME will provide new scientific understanding, able to open new horizons for fire weather and behavior research, and wildfire management.

Project originality

Our scientific understanding of extreme fire weather and behavior has advanced significantly over the past 100 years. The simple notion that dry, hot and windy weather intensifies wildfires has been replaced by more mechanistic and physical descriptions of the various fire-atmosphere interactions. However, there still exist areas of research with great potential for further advances. Employing fire-prone Greece as a testbed, FLAME envisages advancing the scientific knowledge of extreme fire weather and behavior by adopting a holistic approach. For this, it is necessary to consider the dynamics of the three-dimensional atmosphere. Recent advances provide a unique opportunity for quantifying the role of synoptic dynamics in fire behavior, by specifying threshold conditions related to the dryness, momentum and rate of air descent in synoptic and sub-synoptic systems. Further, accurate specification of critical fire weather patterns could be used in conjunction with routine weather forecasting for predicting periods when extreme fire weather and behavior are most likely to occur. Another major contribution of FLAME is the upgrade of a coupled fire-atmosphere modeling system by considering the concept of atmospheric stability through the development of a wind gust parameterization scheme, in order to improve the accuracy of fire spread predictions. Ultimately, the scientific knowledge to be gained for extreme fire weather and behavior in Greece will allow for increasing awareness, while the advances on the modeling side will set the stage for improving preparedness.

Expected results & Research Project Impact

FLAME will assess the influence of weather on fire behavior by taking into consideration the dynamics of the three-dimensional atmosphere. Improved understanding of the role of synoptic and sub-synoptic dynamics can form the basis for a better definition of critical fire weather patterns, which could be then used as proxy in operational weather forecasting applications. Our findings will also shed light on the processes that govern the downward transport of high-momentum and low-moisture air, relating them with our broader understanding of atmospheric Rossby wave structures. This may allow for combining standard measures used in atmospheric dynamics with other measures that account for moisture and momentum transport, resulting in new measures that could be of particular value for fire weather. Further, the consideration of atmospheric dynamics will allow for exploring the definition of “fire fronts”, regions of the atmosphere that mark sharp transitions in potential fire behavior.

FLAME will develop a wind gust parameterization scheme for a coupled fire-atmosphere modeling system to explicitly consider the concept of atmospheric stability in fire spread simulations, which is typically either neglected or implicitly considered in the majority of fire spread simulators. The upgraded model code will be made publicly available to the scientific and model user communities, and will thus contribute to the direction of improved fire spread modeling. Further, the degree of control provided by a coupled fire-atmosphere model will enable us to examine in detail the role of atmospheric stability, gaining new insights on fire-atmosphere interactions.

FLAME will set the stage for enhanced wildfire management. Our research will provide the opportunity for developing new tools to assist fire managers in better identifying those situations where extreme fire behavior may occur, delivering also an upgraded model that will be operationally deployed for fire spread prediction at the National Observatory of Athens.

The importance of this funding

Overall, FLAME is expected to establish a research team devoted to the study of fire weather and behavior in Greece. This is particularly important, considering that fire meteorology is under-represented in academic and research communities of Greece.

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