Introduction and literature study

As a part of this assignment, you will provide an introduction to the general subject of your project and provide a short literature review outlining the current state of the knowledge (what has been already done in this subject) in relation to the proposed scope of your project.

Please adhere to the following structure:

1. Introduction - general importance of the subject

2. Current state of science or technology including literature review if applicable

3. Novel aspect of the project - description of how the proposed work will improve or advance the current state of science or technology.

(30 pts)

Providing an accurate assessment of the rate of spread of a fire in varying environmental conditions and topography poses as a challenging task. However, with the formulation of an accurate rate of spread model, they can be implemented into other fire models to improve those and allow an accurate prediction of where a fire may spread to and how fast. With this knowledge, fire managers can use different tactics to control and extinguish fires much faster than before. To figure out the rate of spread, there are 3 ways to go about it. 1. Empirical models, 2. semi-empirical models, 3. Physical models. Empirical models use statistical data and observational data to figure out the rate of spread. These models lack any physical characteristics and are usually simplified models. Semi-empirical models use both observational data and physics to calculate the rate of spread. Models like these have proven to be useful with calculating the rate of spread as these models simplify fire spread processes while incorporating key principles (Chatelon et al., 2022). Physical models are models that are solely based on physical and chemical processes occurring within a fire. For physical models, they are based on a series of complex partial differential equations and include principles from fluid dynamics that can make solving the equations necessary for the rate of spread computationally challenging and time consuming. However, some models aim to simplify these principles while still producing an accurate rate of spread model so it can be computed much faster.

In fire models (such as WRF-SFIRE), they incorporate rate of spread models to help predict where the fire will spread next and how fast it will propagate. 2 models that are currently in use across an array of models are the Balbi model and the Rothermel model. The Balbi model is a physics-based model which aims to provide computationally fast and accurate simulations of fire propagation that can be used by fire managers under operational conditions (Chatelon et al., 2022). It has undergone many revisions over the past 15 years and is still being worked on to this day. The other model is the Rothermel model. This is a semi-empirical model that was created by Richard C. Rothermel in 1972 and has undergone revisions by Frank A. Albini in 1976 (Andrews, n.d.). The goal of this model was to accurately calculate fire spread in different environments with only a few inputs necessary. While these models aim to calculate the same thing, the formulas and principles used to design these models differ from each other.

During the creation of the Rothermel model, there was not much in terms of technology since it was developed in 1972. Computers were not as fast and not as much was known about fluid dynamics and other physical properties. The rothermel model is based on a heat balance model developed by Fransden (1971), and the data used was obtained from wind tunnel experiments in artificial fuel beds containing various fuels, and from Australian wildfire data in grasses (Andrews, n.d.). From these datasets, Rothermel was able to use observed data along with some physical properties to create his model. The physics being basing the model on the conservation of energy described by a heat sink (Andrews, n.d.). This model still contains a lot of assumptions and is nowhere near perfect. There are still a lot of limitations with this model, but for the purpose it was designed for it works well. However, this model still took about 20 years to formulate.

In the rothermel model,