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An Analysis Between the Rothermel and Balbi Fire Spread Model

Accurately predicting the rate of spread (ROS) of a propagating fire in various fuels, weather, and topography poses a challenge for fire modelers as there are many factors to consider when trying to calculate the ROS. There are also small-scale processes occurring that must be taken into consideration to produce an accurate calculation for the ROS. To predict the ROS, multiple models have been created in varying environments and atmospheric conditions. These models prove invaluable to those who model wildfires as they allow modelers to run simulations and generate forecasts for wildfires. A comparison of different ROS models will allow the most accurate model to be determined and implemented to improve future forecasts and simulations. The two fire ROS models in this study are the Rothermel model and the Balbi model. These two models aim to accurately predict fire spread in various conditions, however, the way they calculate the ROS differs from one another. The Rothermel model is a semi-empirical model that was created in 1972, and the Balbi model is a physics-based model that is still being worked on to this day (with the most recent model being released in 2022). Within these models, varying assumptions are made about how each mechanism within a fire contributes to the overall ROS. Conceptually, the models also differ since the Rothermel model is a semi-empirical model and the Balbi model is a fully physical model. To see how each model performs, the models are converted into a MATLAB code and various tests will be run on the codes. These tests include changing parameters within the fuels, topography, fuel moisture, and weather conditions to see how each factor influences the models. Smaller scale processes within the code that lead up to the overall ROS can be analyzed to see how the individual calculations in the models weigh into the final calculations. With the smaller scale calculation at hand, that will allow the models to be compared at a much finer scale, which will allow certain processes to be studied which will contribute to the overall ROS rather than comparing just the ROS.

To see which model performs best in an operational setting, utilization of an experimental dataset will allow the comparison of the model data to observations. The data is from the Kolgerberg dataset from the Van Wilgen experiment. These tests were performed in South African fynbos and the dataset includes the observed ROS. With this dataset, the modeled ROS can be compared to the observed ROS to see which model is more accurate in an operational setting.