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Observations on wildfire spotting occurrence and characteristics in Greece

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Abstract

This paper presents a study on the phenomenon of spotting in some of the most common forest vegetation types in Greece, during wildfires in the 2007-2017 period. Monitoring and documenting selected wildfires during this period, noting the appearance or absence of spot fires and the prevailing conditions at the time, a database of 166 field observations was developed. The database includes information on the number of observed spot fires (Nκ), the in situ measured relative humidity (RH, %) values, the wind speed, the forest fuel type where the firebrands had landed, namely maquis, phrygana and grasses, the maximum spotting distance (Dκ, m) from the fire perimeter, the fire perimeter segment (head or flank) where the firebrands came from, and the fire type, namely surface, passive crown, active crown and plume dominated fire.

The database was analyzed first by examining the correlation of RH values with Nκ for the three fuel types. An ordinal variable named Kκ was created in order to represent the following four empirical classes: a) no spotting (Nκ=0, Kκ=0), b) rare spotting (Nκ<3, Kκ=1), c) limited spotting (3 ≤ Nκ ≤ 9, Kκ=2) and d) profuse/massive spotting (Nκ ≥ 10, Kκ=3). At RH values higher than 46%, no spotting ignition was recorded. Massive spotting that triggered extreme fire behavior, was documented for RH values lower than 17%. The RH thresholds for spotting occurrence that were identified for the three forest fuel types on which the firebrands landed, are presented and discussed. The Dκ and the Nκ were correlated with both the fire type and the fire segment on which they were observed. Their descriptive statistics are also presented and discussed. The study confirmed the great spotting potential of the plume dominated wildfires, both in regard to spotting distance and the number of spot fires.

Keywords: Spotting, Spot fire, Forest fire, Wildfire behaviour, Firefighting, Greece

1. Introduction

Spotting ignition is one of the three significant mechanisms of wildfire spread. It can be considered as a discontinuous fire spread mechanism (Koo et al. 2010) that is synonymous with solid mass transport (Albini1979, Alexander 2009). The transport of burning fire embers outside the fire perimeter, is a cause of serious concern to firefighters because it affects fire behaviour and difficulty of control and poses a serious threat for them and for civilians.

Spotting involves the source of firebrands, how far they travel, and the probability of ignition on landing (Rothermel 1983). It is mainly caused by lofted firebrands, including burning tips of branches, cones, and pieces of bark, that fly and land beyond the main fire perimeter, but may also be caused by burning cones or pieces of wood rolling down steep slopes (Van Wagner 1988). The type of forest vegetation that is burning is important for the creation of firebrands.

The probability of ignition at the point where a firebrand lands, is a function of both firebrand size and temperature. It has been found that as firebrand size is reduced, increased temperature is required for ignition (Hadden and Scott 2011). Additionally, the probability of ignition depends on the characteristics of the dead fuels where the firebrand lands, such as fuel quantity, dimension (fineness), arrangement (compactness and continuity) and fuel moisture content (FMC, %). Atmospheric relative