Radio Watching: Modelling of Radio Wave Fire Detection

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Developing early and reliable forest fires detection systems is of most importance in the current climate change scenario. For that purpose, using radio waves attenuation patterns reveals several advantages towards other methods. This study relies on CFD simulations that are built to generate specific fire scenarios. Three simulations were made, two of them optimized for small bushfires and another recreating 1987 Australian CSIRO's experiment. The propagation model is assembled by assigning a refractive index to each simulation cell from the flame's collision and plasma frequencies. Time dependent values are plotted for 150, 300 and 450 MHz. As attenuation only occurs if the fire is in the propagation path between two antennas, optimal antenna distributions were calculated by another software, specially programmed for that goal. The results show the emergence of characteristic patterns associated with flame behavior. The results also show that one meter wide fires are the cause of significant attenuation, making them detectable. Optimal antenna positioning generates solutions with a low number of antennas. Its application for a 100x100m square of forest shows that not more than 20 antennas are needed to detect every possible fire. Using a spectrum of 200-250 MHz is ideal to guarantee predictable loss in forest environments maintaining fire detectability and enabling waves to travel close to the ground. In this way, building a detection system based on radio wave attenuation proves having meaningful advantages, namely on application cost, low environmental concerns and, above all, enabling very early detection.

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