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Computing High Resolution Fire Behavior Metrics from Prescribed Burn using Handheld Airborne Thermal Camera Observations

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Over the past 20 years, the development of earth observation satellite product enables the observation of wildfire at the global scale and show an increase of fire activity in fire-prone regions such as western USA or eastern Australia. To mitigate wildfire effects, operational forecast systems have been developed with either focus at fire scale for application in fire operational attack, or at plume scale for application in air quality. More recently, coupled fire-atmospheres systems have been developed to resolve simultaneously the plume updraft/smoke dispersion, the propagation of the fire front, and their mutual interactions. While still mostly used as research tools, they are intended to become operational. They are design to simulate landscape-scale (>100m) propagating fire and rely on parameterized fire model. Fires are set as front lines with associated Rate Of Spread (ROS) and sensible heat flux both predicted according to empirical model based on local orography and atmospheric variables (ie wind speed, humidity).

As started during the RxCadre campaign, to pursue the development and validation of coupled fire-atmosphere system, the fire modelling community need validation datasets of fire scenarios where fire induced winds influence fire front behavior (eg monitoring of front acceleration induced by merging). Because of the high variability of fire behavior, potential complex front geometry structures and fast spread, high temporal and spatial resolution observation are required to build such dataset.

According to the original measure of McRae et al in 2005, Infra Red (IR) thermal cameras operated from helicopter can be used to monitor landscape scale propagating fire at high resolution in the context of Prescribed Burn (PB). To extract valuable information from those observations (eg front position, ROS), image processing task need to be applied on the raw radiance field collected by the camera and can be divided into 3 steps: (a) orthorectification which consists in warping the raw images on a fix coordinate system grid to correct for camera lens distortion and perspective effects induced by camera tilt and terrain, (b) segmentation which reside in delineating the fire front location out of the orthorectified radiance field, and finally (c) the computation of fire behavior metrics (e.g. computation of the ROS from the consecutive location of the front location).

In this presentation we will discuss the last development of a set of algorithms to automatically orthorectify helicopter-borne IR handheld imager observation of PB and compute ROS. We keep the obligation of having a set scene (no wildfire), but the constraint on the necessity of having bone fires presence on every image is released, hence making easier high frequency observation. The presentation will focus on the data postprocessing of 4 Savannah PB with approximative burnt surface of 7 ha that were conducted in Kruger National Park (South Africa) in 2014. The use of a deep learning to help the image segmentation task will be highlighted. At the end, from IR images collected at 1m spatial resolution with a frame rate of 1Hz, maps of ROS at 1m resolution will be presented.