Satellite active fire data validation using drones: Protocols and initial results from prescribed fires in Brazil

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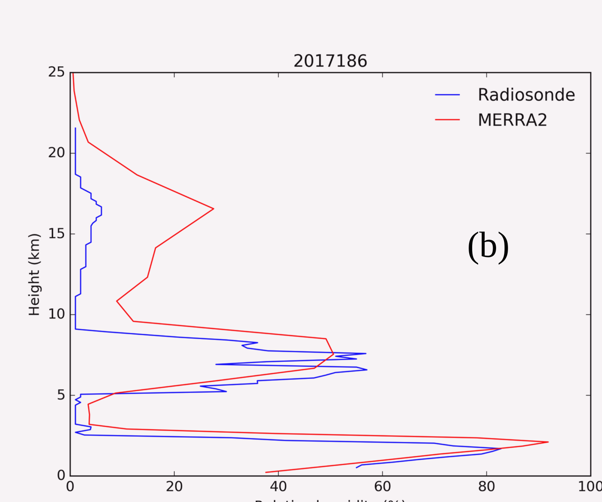
INTRODUCTION

Global biomass burning impacts millions of hectares annually resulting in high social, environmental and economic costs. Satellite-based active fire detection products provide key information in support of land management and science applications and are available routinely from a variety of sources. Data validation is an important aspect guiding product development and characterization and is addressed in this study with the use of miniaturized sensors paired to unmanned airborne vehicles, or drones.

MATERIAL AND METHODS

We deployed a custom-made broadband spectral radiometer along with a commercial off-the-shelf infrared cameras (e.g., FLIR VueProR, Zenmuze XT) mounted to small consumer drones (e.g., DJI's Phantom series) flown over small prescribed burns implemented so as to coincide with the overpass times of different Earth observing satellites (e.g., NASA Terra & Aqua, NOAA/NASA S-NPP, USGS Landsat-8, and ESA Sentinel-2). Near-simultaneous fire radiative power (FRP) retrievals were obtained using the airborne and spaceborne data acquired during prescribed fires conducted in grasslands and savannas plots in the Brazilian states of Rio de Janeiro, Tocantins and Mato Grosso do Sul between July 2017 and September 2018. A set of standard operating procedures were defined with attention to satellite active fire data validation requirements (e.g., reference data calibration) and subsequently adopted for each of the fires sampled. Airborne and spaceborne observations were co-located and temporally paired to within 2sec, and path transmittances calculated in order to account for atmospheric attenuation of fire retrievals.



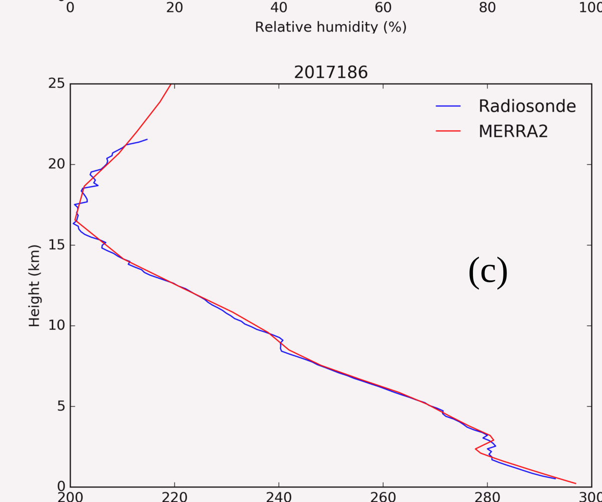
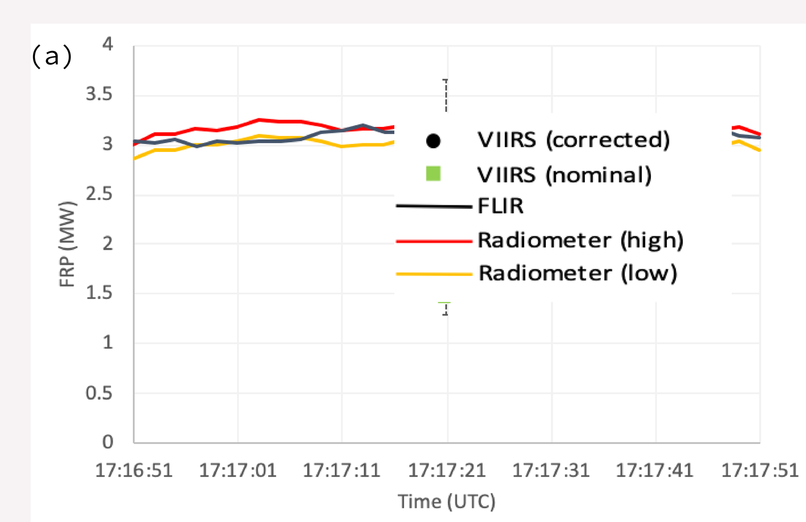
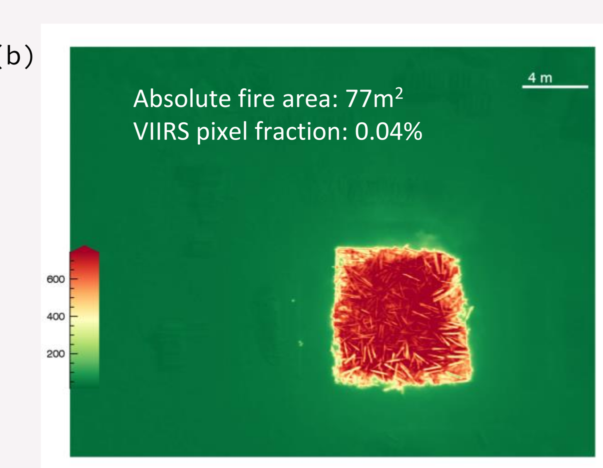


Figure 1: (a) View of experimental plot located at the INPE facility in Cachoeira Paulista-SP/Brazil (44.999ºW 22.686ºS); (b-c) atmospheric profiles derived from radiosonde and MERRA-2 reanalysis data on 05 July 2017 to correct near-coincident S-NPP/VIIRS fire pixel radiances.

RESULTS AND DISCUSSION

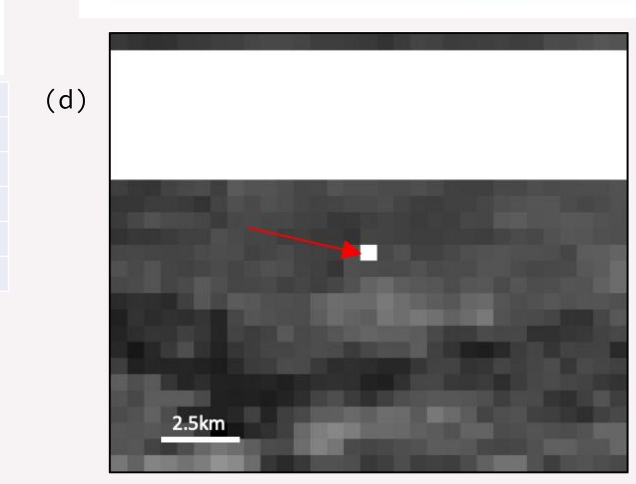
Our results (Figure 2) showed good agreement (differences as low as 5%) between drone and satellite-based fire retrievals while also serving to demonstrate the potential for fully reproducible satellite data validation protocols using small sensor and drone technologies.





(c) S-NPP/VIIRS mid-infrared I4 channel brightness temperature (K)

		Image Sample		
		1138	1139	1140
Image Line	5799	**295.2**	**297.6**	**297.5**
	5800	**299.8**	**326.5**	**298.2**
	5801	**299.4**	**299.0**	**298.7**



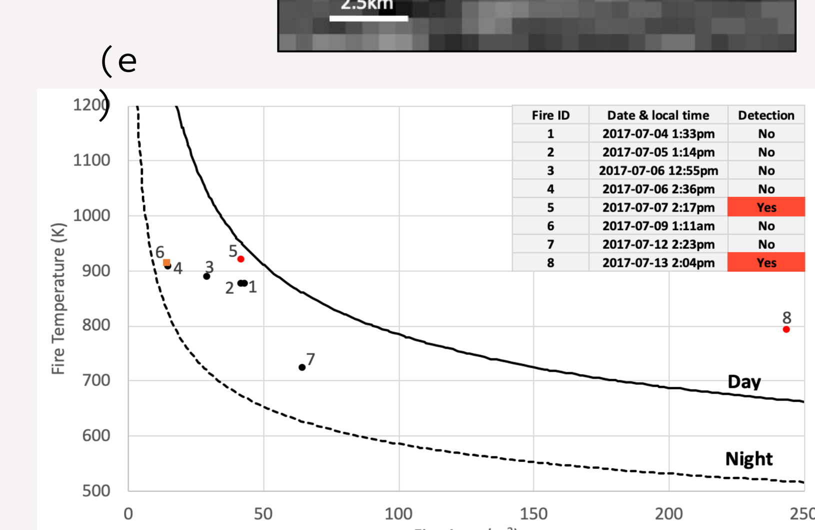


Figure 2: (a) Fire radiative power (FRP) retrievals derived for 07 July 2017 experimental fire (b) using single S-NPP/VIIRS afternoon observation and near-coincident reference data from FLIR VueProR camera and spectral radiometer mounted to DJI Phantom series drones; (c, d) corresponding VIIRS brightness temperature values and Level1B image subset coinciding with fire plot; (e) effective fire area and temperature data derived from eight separate experimental burns overlaid to VIIRS active fire algorithm daytime and nighttime detection envelope curves.

CONCLUSIONS

Satellite active fire data validation have been traditionally approached with the use of near-coincident Landsat-class and/or airborne reference data. Sensor miniaturization and the emergence of lower cost consumer drones have since expanded the opportunities for active fire data sampling in support of algorithm validation. Here we demonstrated such potential over small experimental fires and prescribed burns in Brazil. Using those field data, VIIRS fire detection envelopes have been successfully verified as a function of effective fire temperature and area.

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