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Satellite Data Fusion for Active Fire Detection

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Introduction

The increasing number and profound impact of bushfires emphasize the urgent need for better ways to spot and manage them. Earth observation satellites remains one of the most dependable ways to monitor fires due to its capacity to monitor large areas continuously. Table 1 shows various infrared-based instruments capable of detecting bushfires in Australia. Nonetheless, most existing active fire products algorithms only utilize data from a single sensor. **This presents an opportunity to explore the potential of utilizing data from multiple sensors for fire detection algorithms**. Integrating information from multiple infrared sensors makes it possible to significantly enhance the accuracy and reliability of fire detection systems, as evidenced by studies conducted by Rashkovetsky et. Al (2021).

Table 1. Instruments with middle infrared wavelength that covers Australia

Instruments	MIR Channel	Spatial Res.	Temporal Res.	Satellite Orbit	Coverage	Satellite/Agency
Advanced Himawari Imager (AHI)	3.9 µm	2km	10 mins	GEOS	140.7° E	Himawari/JAXA and JMA
Advanced Meteorological Imager (AMI)	3.83 µm	2km	10 mins	GEOS	128.2° E	GeoKompsat/KMA
Advanced Geosynchronous Radiation Imager (AGRI)	3.5-4.0 µm	2km	15 mins	GEOS	104.7° E	Fengyun-4A/NSMC-CMA
Sea and Land Surface Temperature Radiometer (SLSTR)	3.74 µm	1km	0.5 - 1.9 days	LEO	Global	Sentinel-3 /Eumetsat and ESA
Medium Resolution Spectral Imager -2 (MERSI-2)	3.8 µm	1km	0.5 days	LEO	Global	Fengyun-3D/NSMC-CMA, NRSCC
Moderate-Resolution Imaging Spectroradiometer (MODIS)	3.66 - 4.08 µm	1km	0.5 -1 days	LEO	Global	Terra, Aqua/NASA
Advanced Very High Resolution Radiometer (AVHRR-3)	3.74 µm	1 km	0.5 -1 days	LEO	Global	POES/NOAA; METOP/Eumetsat
Visible/Infrared Imager and Radiometer Suite (VIIRS)	3.74 µm	750 m	1 day	LEO	Global	S-NPP, JPSS1/NOAA and NASA

Aim

To create an active fire detection product for Australia by fusing data from multiple satellite observation sensors.

Methods

We used data from three middle-infrared (MIR) sensors: AHI, AMI, and SLSTR, with plans to incorporate additional data sources. These MIR data are then fused to establish a background temperature reference line. Kalman Filter is preferred as the data fusion method over Machine Learning (ML) based approaches due to its transparency and interpretability of computed results, which ML algorithms often lack due to their "black-box" nature (Felix 2019). Additionally, we employ the Diurnal Temperature Cycle Model (Robert and Wooster 2014) derived from high temporal resolution MIR data as temperature model. The established background temperatures are then compared to the MIR measurements. Any measurement exceeding a predefined statistical threshold is classified as a fire event.

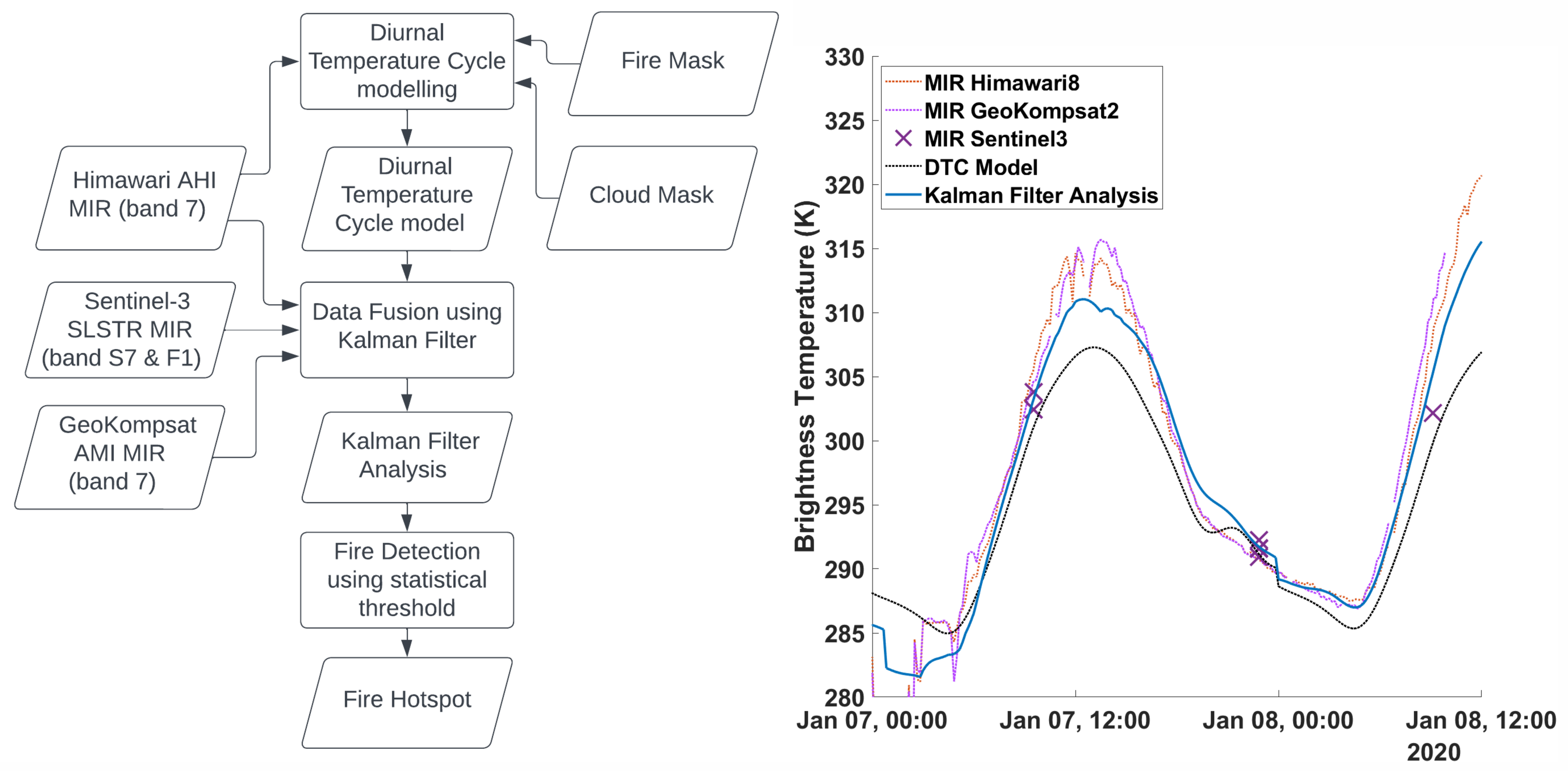

Figure 1. Data fusion of MIR data from Himawari AHI, Sentinel-3 SLSTR, GeoKompsat AMI, and the diurnal temperature cycle model

Results

Preliminary result shown in Figure 2 demonstrates the promising performance of the data-fusion-based fire detection algorithm. In this study case, comparative evaluation against existing products from various sensors and algorithms, including VIIRS, Landgate AHI, BRIGHT, and MODIS, indicate detection rates of around 98%. Future works involve adding more sensors to the mixture and fine-tuning the parameters of the fusion.

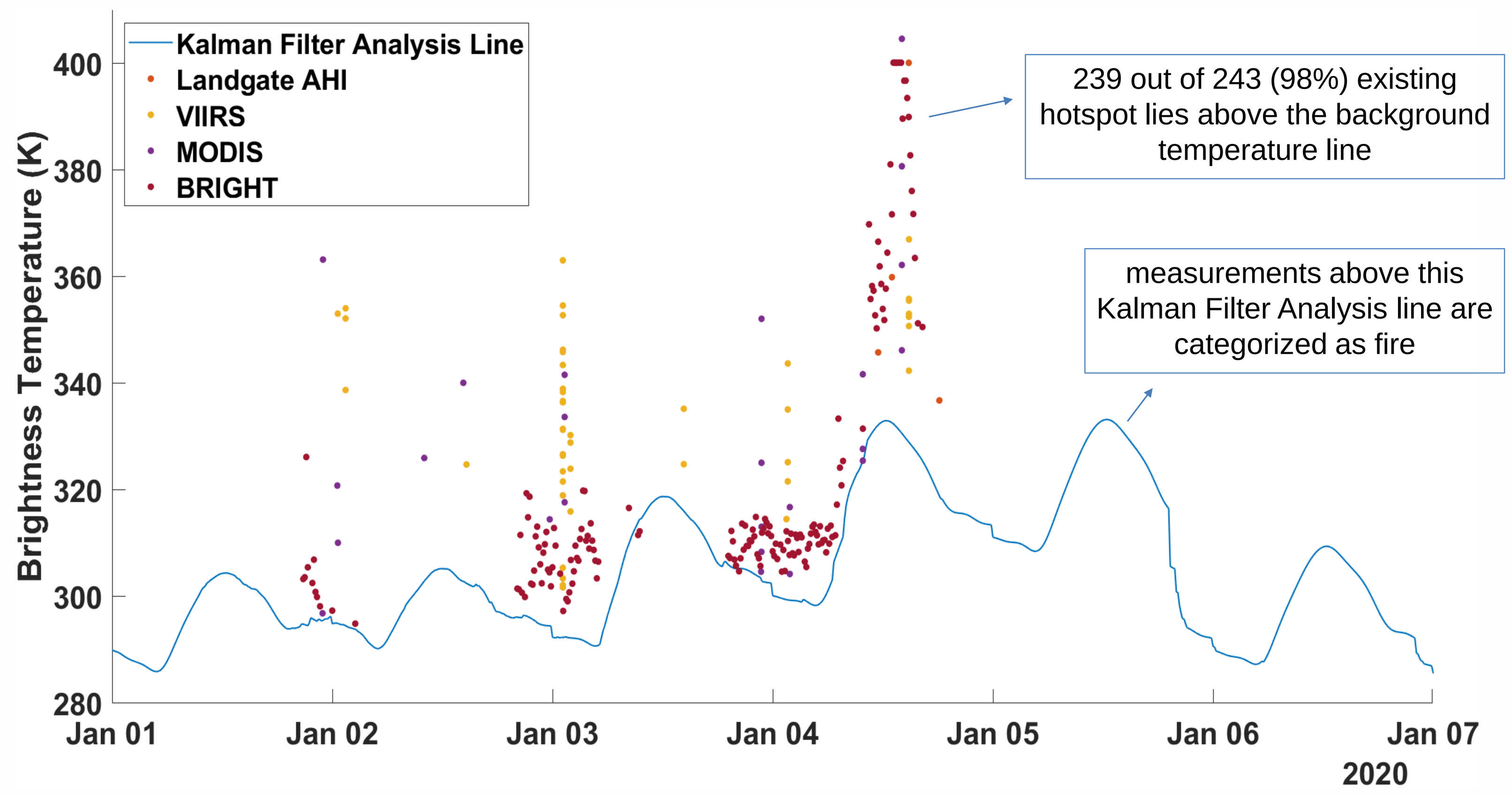

Figure 2. Kalman-Filter based fire detection was able to capture 98% of existing active fire detection product

References

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