THE DIURNAL CYCLE AND ITS ROLE IN FIRE DETECTION USING HIMAWARI-8

bushfire&natural HAZARDSCRC

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ACCURATELY ESTIMATING BACKGROUND TEMPERATURE IS VITAL FOR IDENTIFYING FIRE USING REMOTE SENSING. NEW TEMPORAL-BASED METHODS FOR TEMPERATURE ESTIMATION ARE HARNESSING THE INCREASED STREAM OF IMAGERY FROM NEW SATELLITE SENSORS TO IMPROVE OUR UNDERSTANDING OF THE DIURNAL CYCLE OF THE LANDSCAPE.

INTRODUCTION

Determination of the background temperature of active fire pixels assists both in the initial detection of fire and the ongoing monitoring of fire activity. Efforts to measure this temperature effectively are often hampered by the existence of obscuring influences such as fire, cloud and smoke, which add to or obscure the output radiation from the background land surface. This research seeks to harness the increased frequency of satellite information from new sensors to improve understanding of the diurnal cycle, and subsequently improve fire detection capability.

DIURNAL ESTIMATION OF TEMPERATURE

The diurnal cycle of temperature at the land surface consists of three main components:

- Rapid temperature rises in the morning period, with highs just after noon
- Steady afternoon fall in temperature, albeit more slowly than morning
- Slow decline during the night as surface temperatures cool

An example of this cycle is shown in Fig. 1a. This characteristic shape is consistent over areas of the same latitude at similar points of the annual cycle. Knowing this shape and consistency, we can use this information to guide a temperature fitting process that can help identify fires in the time series of a pixel.

Figure 1 shows examples of the fitting process in action. Fig. 1a demonstrates a time series with no cloud or fire, whilst Figs 1b and 1c show the fitting response to fire and cloud respectively. Threshold values can be applied to fittings of this type to identify disturbances of the diurnal cycle.

CASE STUDY: NW AUST., AUGUST 2016

Method

- Locations and times randomly selected over study area for August 2016 (Fig 2)
- Fittings applied to Band 7 brightness temperature using the broad area training method (after Hally et al. 2017)
- Temperatures above 4K threshold flagged as detections
- Visual examination of detections to determine cause of anomalies
- Classified by MODIS burned area product (after Maier, 2010) detection

Results

Fire detection was reported in about 0.4% of all examined pixels across the area – this corresponds well with 4.3% total burned area for the month for the area, considering that some fire events may last multiple days. The algorithm successfully identified fire with AHI imagery in 79% of cases where there was a corresponding detection in the burned area product, with the majority of remaining detections (15%) caused by misclassification of cloud. Cloud was also the major cause of detections where no burned area detection was registered, comprising 67% of these instances.

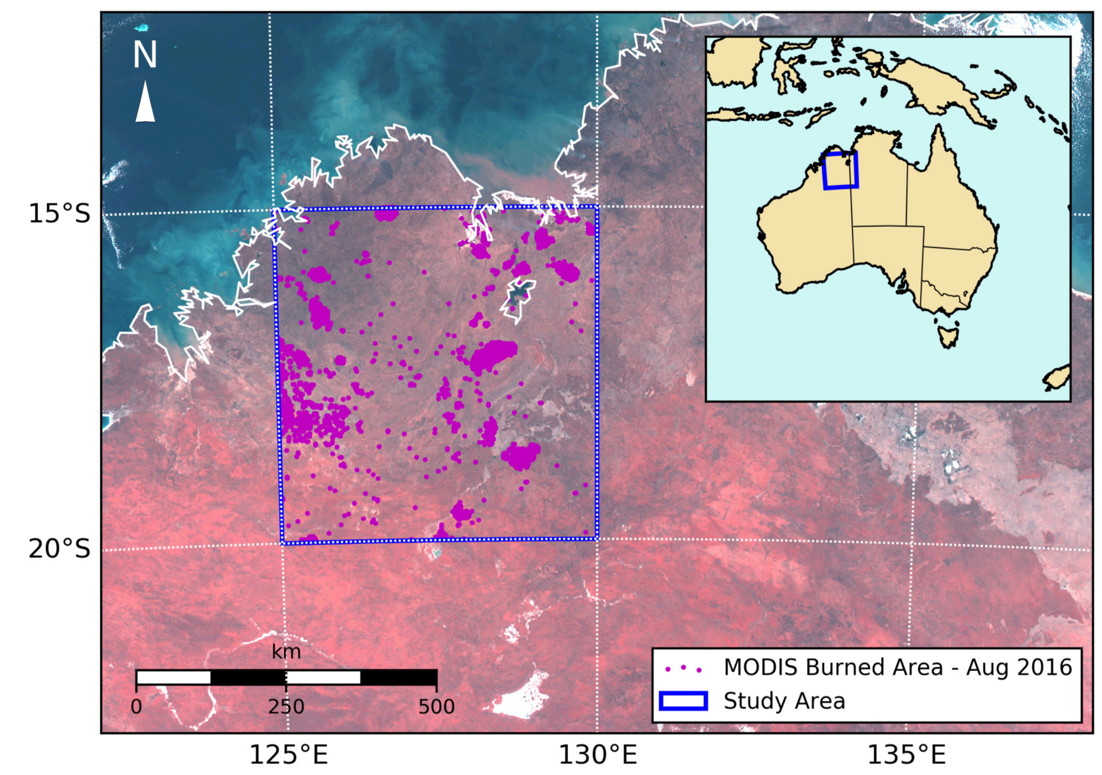

Figure 2. Study area and locations of MODIS burned area detections (Maier, 2010) for the month of August 2016.

Conclusions

The results demonstrate that the BAT method for deriving background temperature from AHI imagery provides sufficient accuracy for use in a fire detection framework, noting the comparison to a product with much higher spatial resolution than the Band 7 AHI images used. Whilst results from this study show satisfactory rates of error, results would be significantly improved by the availability of an operational cloud masking product for AHI.

"Timely and accurate detection of bush fires is vital for successful fire management. While the Himawari-8 satellite sensors are already proving useful for fire detection, existing algorithms are limited in their ability to resolve the effect of ground temperature, particularly when it matters most: on hot days. This research will lead to better fire management outcomes by improving the accuracy of satellite derived fire intelligence."

Dr Simon Heemstra, Manager Community Planning, NSW Rural Fire Service

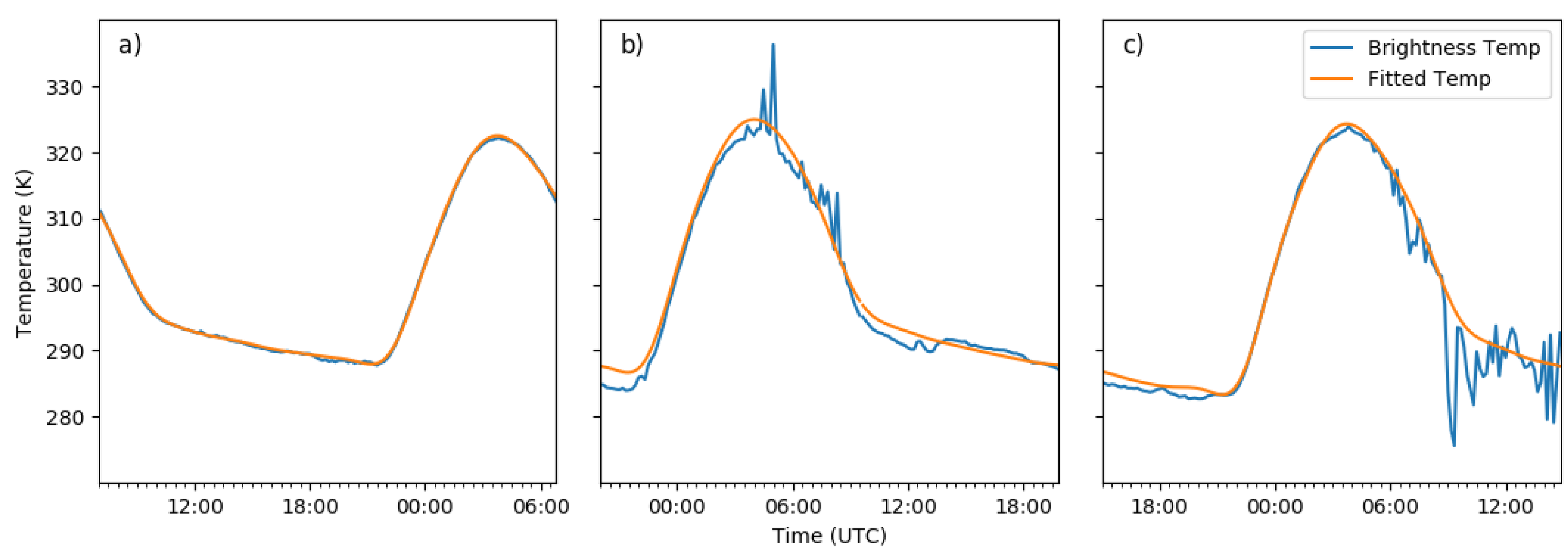

Figure 1. Examples of temperature fitting using a temporal estimation method. a) shows a normal fitting of a cloud-free pixel, b) shows fire as a positive anomaly, and c) shows false detection caused by cloud. Times shown are in UTC, add 8 hours for local solar time.