Australian Government

Geoscience Australia

Digital Earth Australia Hotspots Product Description

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Table of Contents

Document History

Revision Number	Date	Nature of Change and Reason	Author	Approval
0.0	14/10/2013	Hotspots First Draft	U61169	
0.1	25/10/2013	Get the right balance of plain English and technical detail	U21472	
0.2	18/11/2013	Edits and comments on the Attributes section	U21472	
0.3	17/12/2013	Edits and comments on the Attributes section	U21472	
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0.5	26/02/2014	Conformity with v2 of Product Description Template.	Jeff Kingwell	For approval
1.0	13/03/14	Final version incorporating PDMG edits and removal of extraneous Platform and Sensor fields.	C Penning	For approval
1.1	11/04/2014	Edits to incorporate new Sentinel links	U61169	For approval
1.2	18/07/2014	Removal of platform and sensor characteristics per email D2014-145819	U61169	Adam Lewis 22 July 2014
1.3	28/08/2015	Minor revisions to licensing	Arek Drozda	Adam Lewis D2015-147919
1.4	29/7/2016	Edits to incorporate new data source	U32789	
1.5	15/08/2019	Minor revisions to algorithms, URLs, name changes	U32789	
1.6	15/05/2020	Added disclaimer, minor revisions to algorithm details and versions and technical characteristics	U32789	Simon Oliver D2020-64302
1.7	06/10/2020	Updated algorithm details, data access	U32789	Simon Oliver D2020-134121
1.8	24/09/2021	Added algorithm details, data access	U32789	Simon Oliver
1.9	3/11/2022	Updated algorithm details, updated limitations and data access	U50854	Simon Oliver
2.0	20/12/2022	Updated licensing details, removal of GA AVHRR algorithm		Norman Mueller

A Hotspots – Summary Description

Sheet A.1 Definition and Usage

Name	Digital Earth Australia Hotspots
Abbreviation	DEA Hotspots

Introduction	• Each Hotspot is represented by a spot on the map, derived from (a growing number of) satellite-born instruments that detect light in the thermal wavelengths. The colour of the spot represents the time the Hotspot was last observed by a passing satellite (e.g. 0-2 hours). The colour does not indicate severity.
	• Typically, the satellite data are processed with a specific algorithm that highlights areas with an unusually high temperature. In principle, however, Hotspots may be sourced from non-satellite sources.
	• Hotspot sources include the:
	  ○ Moderate Resolution Imaging Spectroradiometer (MODIS) sensor on the National Aeronautics and Space Administration (NASA) Terra and Aqua satellites
	  ○ Advanced Very High Resolution Radiometer (AVHRR) night time imagery from the National Oceanic and Atmospheric Administration (NOAA) satellites
	  ○ Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite
	  ○ Advanced Himawari Imager (AHI) sensor operated by the Japan Meteorological Agency (JMA) on the Himawari-8 geostationary satellite

Key Features	• Hotspots are generated using both visible and thermal sensor information. • Hotspots are updated several times each day. New Hotspots are generated as soon as possible after a data stream is received. Typically, this is 30 mins after an overpass of the Aqua and Terra satellites and 20 mins after the Himawari-8 satellite. For any given location in Australia, Hotspots are generally updated 2-10 times each day from polar orbiting satellites (MODIS, AVHRR, VIIRS), and approximately 144 times from geostationary satellites (AHI). • Hotspots published during the day: MODIS, VIIRS, AHI. • Hotspots published during the night: MODIS, VIIRS, AVHRR, AHI.
Usage	• Hotspots can indicate possible active fires in some circumstances. Taken as an ensemble, Hotspots provide an overview of thermal activity in Australia and capture the pattern of possible fires across the Australian continent over time. • Emergency management agencies use Hotspots as one of many operational data feeds to inform their broad situational awareness of, and at times tactical response to, fires. • Hotspots should not be used for safety of life decisions. For local updates and alerts, please refer to your state emergency or fire service.

Sheet A.1 Definition and Usage	
	• Depending on the sensor, generally, a flaming or smouldering fire would need to be at least 1,000 m^2 to be recognised as a Hotspot. Under exceptional (and rare) conditions (no cloud, smoke, wind etc.), a flaming fire at 50m^2 may be detected (Giglio et al., 2003). However, fires are often smaller than the size of the satellite pixel.
Limitations	*See also Accuracy and Limitations, in the Specifications section.* • False positives (showing a Hotspot without an underlying cause) are possible. • False negatives (failing to show a Hotspot, despite a heated land surface, fire, etc.) are possible. • Hotspots are potential bushfires, but could also indicate other phenomena, such as gas fires, heavy industry, furnaces, jet contrails and hot rocks. • Not all fires will be detected as Hotspots. • The Hotspot location on any map (no matter how detailed) is only accurate to ± 2.0 km at best. • Hotspots are not presented in real-time and not designed to be used in isolation of other data sources. It is not accurate enough to be relied upon for time-critical detection and location of fires. • Geostationary satellite derived products algorithms may be optimised for day or night conditions. For algorithms such as BRIGHT that provide hotspots every 10 minutes, 24 hours per day, temporal windows approximately +/- 1 hour of sunset and sunrise are considered unreliable periods. • No Hotspots are produced if satellite data is not received (e.g. for AHI, 0240 and 1440 UTC times are not received).
Expected Lifespan	Hotspots are produced on an ongoing basis.
Access	Hotspots are published as: • a visualisation via the Digital Earth Australia Hotspots website (https://hotspots.dea.ga.gov.au/) and NationalMap (https://nationalmap.gov.au/) • web services (see Delivery Information C.2) • a layer on DEA Maps (https://maps.dea.ga.gov.au/) • notification services (RSS, GeoRSS, KML, GeoJSON) (see Delivery Information C.2) • text files via file download for the last 30 days (https://hotspots.dea.ga.gov.au/files/L3/hotspots), with associated imagery for these sensors (VIIRS, MODIS, AVHRR) under subfolder SRSS (e.g. https://hotspots.dea.ga.gov.au/files/L3/hotspots/MODIS/SRSS) • a historical dataset since 2002 (https://hotspots.dea.ga.gov.au/files/historic) • a secure website and webservice that contains extra contextual layers and Hotspots algorithms not present on the public website. This service is restricted to emergency management agencies, state and federal government organisations and requires registration by GA before use

Sheet A.1 Definition and Usage	
	(https://hotspots.dea.ga.gov.au/login). To apply for use, please email earth.observation@ga.gov.au
Data structure	Hotspots are structured in the following way, where there may be different algorithms for the same satellite and sensors. *See also B Hotspots Specification* ○ Satellite (e.g. Terra, Aqua, SUOMI-NPP, NOAA-20, JPSS, H8) ○ Sensor (e.g. MODIS, AVHRR, VIIRS, AHI) ○ Algorithm (e.g. MOD14, Landgate, BRIGHT) e.g. MODIS • TERRA ○ MOD14 ○ Landgate • AQUA ○ MOD14 ○ Landgate
Feedback	Send feedback to earth.observation@ga.gov.au
Further information	Dyce, P., Woolner, J., and Marks, A. (2005) Technical Implementation of the Sentinel Hotspots Web-Based Pilot Wildfire Mapping System in Australia. CSIRO Land and Water unpublished report. http://www.aprsaf.org/data/malaysia_tecshop_data/Part1_Sentinel_Implement.pdf http://www.aprsaf.org/data/malaysia_tecshop_data/Part2_Sentinel_Implement.pdf Hudson, D., and Mueller, N. (2009) Fighting fire with satellite dataset: Satellite imagery aids emergency relief. AUSGEO News 94, Geoscience Australia, Canberra. Koltunov, A., and Ustin, S.L. (2007) Early fire detection using non-linear multitemporal prediction of thermal imagery. *Remote Sensing of Environment* **110**, 18-28. Reddy, S. (2005) Sentinel finds a permanent home at Geoscience Australia. AUSGEO News 80, Geoscience Australia, Canberra http://www.ga.gov.au/ausgeonews/ausgeonews200512/inbrief.jsp

B Hotspots - Specification

Sheet B.1 Provenance and Algorithms

Data Sources	**Primary**	Moderate Resolution Imaging Spectroradiometer - MODIS (Terra and Aqua)
		Advanced Very High Resolution Radiometer (AVHRR) Night Time Imagery (NOAA–19)
		Visible Infrared Imaging Radiometer (VIIRS) (Suomi NPP or S-NPP, NOAA-20)
		Advanced Himawari Imager (AHI) Himawari-8
	Ancillary	Predicted satellite ephemeris data (location and attitude of the satellite)
		Two Line Element (TLE) files
		Scan zenith angle and azimuth
		Solar zenith and azimuth
		Emissivity
	Satellite image Metadata	Acquisition day and time (in UTC) to compute sun position
		Image Size (number of pixels and lines)
		Image Cell Size
		Location of the north-west corner of the image
		Location of the centre of the image
Major Algorithms (GA)	• The MODIS Hotspots methodology is based on the MOD14 (Terra) and MYD14 (Aqua) Fire Image product (Justice *et al.*, 2002). These products compute brightness temperatures from two 4µm channels (21 and 22, which saturate at different temperatures) and channel 31 (11µm). Other channels are used to exclude 'bright', non-fire pixels (channels 1, 2 and 7) or cloud (channels 1, 2, 7 and 32) (Giglio *et al*., 2003; Justice *et al*., 2006). • The VIIRS Hotspots fire detection algorithm (VIIRS, AER Version 6) is based on the MODIS Version 4 Fire Mask (Giglio *et al.,* 2003, Baker *et al.,* 2011). The thermal bands M13 (4.05 µm), M15 (10.763 µm) and M16 (12.013 µm) are converted to brightness temperatures using the VIIRS Sensor Data Record (SDR) interface. The AFMOD product	

Sheet B.1 Provenance and Algorithms	
	is based on 750m moderate resolution “M” band radiometric measurements and contains the location of Hotspot in a sparse array format (Csiszar *et al*., 2014). The VIIRS AFIMG product is based on the 375m data described in Schroeder *et al*. (2014), and uses a multi-spectral contextual algorithm that highlights sub-pixel thermal anomalies in level 1 data. SDR processing involves applying calibration (radiometric, geometric, engineering) and geo-locating using ephemeris and altitude and Earth model information. Environmental Data Records (EDR) contains pinpoint locations of active fires from the Suomi NPP.
Algorithm Version (GA)	• MODIS: MOD14_SPA (v. 6.2.1) • VIIRS-NPP: CSPP SDR v.3.3.1 and VIIRS Active Fire v.1.1.1
Major Algorithms (Landgate)	• The MODIS fire detection methodology is based on the MOD14 (Terra) and MYD14 (Aqua) Fire Image product (Justice *et al.*, 2002). These products compute brightness temperatures from two 4μm channels (21 and 22, which saturate at different temperatures) and channel 31 (11μm). Other channels are used to exclude ‘bright’, non-fire pixels (channels 1, 2 and 7) or cloud (channels 1, 2, 7 and 32) (Giglio *et al*., 2003; Justice *et al*., 2006). • The MODIS nighttime algorithm is based on a ‘contextual fire detection algorithm’ (Lee and Tag, 1990, Flasse and Ceccato, 1996) with extra tests and thresholds modified to suit Australian conditions by Landgate. • The MODIS daytime algorithm is based on the MOD14 (Terra) and MYD14 (Aqua) Fire Image product (Justice *et al.*, 2002) with extra tests for sunglint. • The AVHRR nighttime fire detection algorithm is based on a ‘contextual fire detection algorithm’ (Lee and Tag, 1990, Flasse and Ceccato, 1996) with extra tests and thresholds modified to suit Australian conditions by Landgate. • The AVHRR daytime fire detection algorithm is based on a ‘contextual fire detection algorithm’ with extra tests for cloud and sunglint using the visible bands. • The VIIRS AFIMG product is based on the 375m data described in Schroeder *et al*. (2014), and uses a multi-spectral contextual algorithm that highlights sub-pixel thermal anomalies in level 1 data. SDR processing involves applying calibration (radiometric, geometric, engineering) and geo-locating using ephemeris and altitude and Earth model information. • The VIIRS nighttime algorithm is based on a ‘contextual fire detection algorithm’ (Lee and Tag, 1990, Flasse and Ceccato, 1996) with extra tests and thresholds modified to suit Australian conditions by Landgate. The I04 channel (3.74 μm) is used to detect hotspots at 375m resolution.

Sheet B.1 Provenance and Algorithms	
	• The VIIRS daytime algorithm is based on Schroeder *et al*. 2014 with extra tests and thresholds modified to suit Australian conditions by Landgate. • The AHI nighttime algorithm is based on a 'contextual fire detection algorithm' (Lee and Tag, 1990, Flasse and Ceccato, 1996) with extra tests and thresholds modified to suit Australian conditions by Landgate. • The AHI daytime fire detection algorithm is based on a 'contextual fire detection algorithm' with extra tests for cloud and sunglint using the visible bands.
Algorithm Version (Landgate)	• MODIS: MOD14 (v.5.0.1) IMAPP • MODIS: Landgate Nighttime algorithm v1.6 • MODIS: Landgate Daytime algorithm v1.4 • AVHRR: Landgate Nighttime algorithm v1.52 • AVHRR: Landgate Daytime algorithm v1.41 • VIIRS: Landgate Nighttime algorithm v0.56 • VIIRS Landgate Daytime algorithm v0.7 • VIIRS: CSPP SDR v3.1.2 and AFIMG v1.1.0 • AHI: Landgate Nighttime algorithm v0.95 • AHI: Landgate Daytime algorithm v0.1
Major Algorithm (RMIT & BNHCRC)[1]	• The AHI day and night-time algorithm is based on the enhanced Biogeographical Region and Individual Geostationary HHMMSS Threshold (BRIGHT) algorithm for day and night time (Engel et al., 2021a and Engel et al., 2021b. All hotspots will be available on the Secure version of DEA Hotspots but only hotspots with at least 50% confidence will be available on the public version of DEA Hotspots
Algorithm Version (RMIT & BNHCRC)	• AHI: BRIGHT AHI v2(Day and Night)
Validation of Underlying Algorithms	Validation of MODIS Fire Products has used simulated (Giglio *et al*., 2003; Justice *et al*., 2006) and acquired (Morisette *et al*., 2005; Schroeder *et al*., 2008a, 2008b) ASTER imagery. BRIGHT Hotspots from 01/04/2019 to 31/03/2021 are validated against VIIRS and MODIS hotspots from the same time period (Engel et al., 2021a and Engel et al., 2021b). Hotspots sourced from other sources are un-validated.
Processing Sequence	Hotspots data acquisition and processing are described below: • ***Data acquisition:*** Satellite telemetry data is received at the Geoscience Australia data acquisition facility ground station at Alice Springs and processed to produce a level 0 (MODIS), NOAA HDF file (AVHRR) and Raw Data Record (VIIRS) datasets. These datasets are then transferred via a network link to Canberra, and then AWS for further processing. For AHI data, satellite telemetry data is

[1] *When using the BRIGHT hotspots for publication purposes, please cite Engel CB, Jones SD, Reinke KJ. Real-Time Detection of Daytime and Night-Time Fire Hotspots from Geostationary Satellites. Remote Sensing. 2021 Jan;13(9):1627.*

Sheet B.1 Provenance and Algorithms	
	received and managed by BOM. GA subscribe to BOMs FTP service and transfer the data to AWS. There is no direct reception of AHI data at GA. • ***Data processing:*** Currently MODIS and AVHRR night time data are processed using MOD14/MYD14 and CATS respectively to produce Hotspots. VIIRS data are processed using the CSPP SDR software package. Himawari-8 AHI input files (arriving every 10 minutes) are processed using the Landgate Daytime and Night-time hotspots (public site) and the BRIGHT algorithm (>50% confidence hotspots are on public site, and all are on secure site) to produce Hotspots. Hotspot pixels are identifiedand extracted from the image into an ASCII file, and are saved in the Geoscience Australia Reference Hotspot database (the Reference database). The Reference database provides a complete and on-going record of Geoscience Australia's Hotspots product (the Reference database attribution details are described in the Attribution for Point-Based Products sub-section).
Accuracy and Limitations	*See also section A1 above.* Hotspot data can show false positives; i.e., locations mapped as fire which are identified as 'hot' for some other reason, such as black soil, gas fires, heavy industry, jet contrails, furnaces, and hot rocks. Smoke and cloud also confound active Hotspot detection. Small and brief fires can also be omitted from Hotspot images due to topography (de Klerk, 2008), the spatial resolution of the imagery being too coarse, or the timing of the satellite overpass not coinciding with peak fire intensity (Bradley and Millington, 2006; Smith *et al.,* 2007c; Hawbaker *et al.,* 2008). Limitations of the Digital Earth Australia Hotspots mapping system include, but are not limited to, the following: • The Hotspot location on any map (no matter how detailed) is only accurate at best to ± 1.5 km. o AVHRR: ± 1 km o MODIS: ± 1 km o VIIRS: ± 0.375 km (AFIMG), ± 0.750 km (AFMOD) o AHI: ± 2 km • The symbol used for the Hotspot on the maps does not indicate the size of the fire. • Not all Hotspots are detected by the satellites. Some heat sources may be too small, not hot enough, or obscured by thick smoke or cloud. • The Hotspot algorithms show different pixel locations on source satellite imagery: o All Landgate Hotspots are located within the centre of the pixel (VIIRS, AVHRR, MODIS, AHI). ▪ Hotspots are calculated from mapped space where the imagery is first reprojected to determine line and pixel of the Hotspot,

Sheet B.1 Provenance and Algorithms	
	with latitude and longitude calculated based on the top-left of the image. ○ VIIRS (AFIMG, AFMOD, EDR): Hotspot points are located within the centre of the pixel. ○ MODIS (MOD14): Hotspots arelocated in the north-west corner of the pixel ○ AHI (RMIT & BNHCRC) Hotspots are located within the centre of the pixel, noting the native Himawari-8 coordinate system which uses an irregular grid is used for processing hotspots. • The geolocation of the imagery is linked to the nominal position of the satellite. Satellites like MODIS (Terra) have inbuilt GPS and are more accurately geolocated than NOAA AVHRR. • There are known spurious Hotspots associated with poorly calibrated SDR input data (VIIRS-AFIMG) (Schroeder and Giglio, 2018). This may be seen as Hotspots occurring as a line across the map. • Hotspots information is not published in real-time due to delays in processing and publishing the information.

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<table>
<tr><th colspan="6">Sheet B.2 Technical Characteristics</th></tr>
<tr><th colspan="6">Sheet B.2.1 Product Spatial Details</th></tr>
<tr><td>Frequency</td><td colspan="5">Based on available satellite data</td></tr>
<tr><td>Temporal Extent</td><td colspan="5">MODIS: from 27 August 2002
AVHRR: from 19 October 2006
VIIRS: from 21 February 2014
AHI: from September 2016</td></tr>
<tr><td rowspan="4">Spatial Extent</td><td rowspan="4">Geographic Coverage</td><td colspan="2">Min latitude</td><td colspan="2">-43.005096</td></tr>
<tr><td colspan="2">Min longitude</td><td colspan="2">107.751236</td></tr>
<tr><td colspan="2">Max latitude</td><td colspan="2">-1.042098</td></tr>
<tr><td colspan="2">Max longitude</td><td colspan="2">166.17131</td></tr>
<tr><td rowspan="6">Geographic Coordinate System Properties</td><td rowspan="3">Datum

Ellipsoid</td><td colspan="5">GDA94</td></tr>
<tr><td rowspan="3">GRS 1980</td><td>Semimajor axis</td><td colspan="2">6378137</td></tr>
<tr><td>Semiminor Axis</td><td colspan="2">6356752.3</td></tr>
<tr><td>Inverse Flattening</td><td colspan="2">298.25722210</td></tr>
<tr><td rowspan="2">Angular Unit</td><td colspan="2">Unit</td><td colspan="2">Degrees</td></tr>
<tr><td colspan="2">Radians per Unit</td><td colspan="2">π/180</td></tr>
<tr><td>Prime Meridian</td><td colspan="5">Greenwich</td></tr>
<tr><td>Projection</td><td colspan="5">EPSG:4283 (https://epsg.io/4283)</td></tr>
</table>

Sheet B.2 Technical Characteristics		
Sheet B.2.2 Attributes		
Hotspot Attributes	**Observation Time**	Time of acquisition for the data in which the Hotspot was detected (UTC). This is determined based on the start and end time of the acquisition. For the current satellites the level of accuracy should be of the order of 5 mins. Format: *YYYY-MM-DDThh:mm:ssZ (YYYY-MM-DDT Local time)* where YYYY-MM-DD is the date, and Thh:mm:ssZ is the time in UTC There are different rules for observation times for different satellites: • Aqua and Terra (MODIS): the observation time is an estimated value based on the location of the Hotspot within the satellite acquisition and time range of the acquisition. • NPP and NOAA (VIIRS and AVHRR): the observation time is an estimated value based on the mid-point of the time range of the satellite acquisition. • Himawari-8 (AHI): the observation time is an estimated value based on the location of the Hotspot within the satellite acquisition and time range of the acquisition.
	Latitude	Hotspot latitude is based on WGS84 (º) at the centre of the pixel. • Units: signed decimal degrees • Format: *-dd.d* • Valid range: -90.000 to +90.000 • Uncertainty: the latitude is no more accurate than the pixel size (e.g. MODIS 1km x 1km)
	Longitude	Hotspot longitude is based on WGS84 (º) at the centre of the pixel. • Units: signed decimal degrees • Format: ddd.d • Valid range: -180.000 to +180.000 • Uncertainty: the longitude is no more accurate than the pixel size (e.g. MODIS 1km x 1km)

Sheet B.2 Technical Characteristics		
Sheet B.2.2 Attributes		
	Temperature	In order to detect the presence of a Hotspot, a set of detection criteria has been developed. These criteria (which differ for day and night observations) are based on: • the absolute detection of a fire (when the fire strength is sufficient to be detected) • detection relative to the difference between the fire pixel and its background temperature (to account for the variability of surface temperature and reflection by sunlight) (Justice *et al.,* 2006). • For BRIGHT Hotspots, the 3.9µm brightness temperature as defined by the Himawari-8 satellite. Units: degrees Kelvin Format: *nnn.n*
	Power[2]	Estimate of Fire Radiated Power (FRP) of MODIS Hotspot pixel (based on Justice *et al*., 2006) detected after April 2008. No power estimate is available for AVHRR Hotspots, VIIRS, AHI, or any MODIS Hotspots detected before April 2008. In these cases, null values, or (-1) are displayed. Estimate of Fire Radiation Power of BRIGHT hotspot pixel (in Megawatts) based on Wooster, Zhukov and Oertel (2003), documented in Engel et al. (2022). No FRP value is indicated with -999. Units: MW Format: *nnn.n* Valid range: ≥ 0.0 (maximum observed value 1900.0)

[2] The 'Power' attribute should not be confused with 'Fireline Intensity' which is a ground-based measurement typically taken at the hottest part of the firefront as MW/m.

Sheet B.2 Technical Characteristics		
Sheet B.2.2 Attributes		
	Confidence	MOD14 Fire Detection Algorithm indication of the confidence that a Hotspot *is* a fire (Giglio *et al*., 2003): • 0-30% “low” • 30–80% “nominal” • 80–100% “high” No Confidence is given for Hotspots detected from AVHRR and AHI data as the algorithm does not calculate this attribute. Confidence for BRIGHT AHI Hotspots are given as percentage for each detected Hotspot (0- 100%). Confidence for VIIRS imagery is given as a percentage for each detected Hotspot (0-100%). The Confidence attribute is intended to help users to gauge the quality of individual fire pixels within the fire mask. Geoscience Australia displays and provides all Hotspots, regardless of Confidence. Units: none (scalar value) Format: *nnn* Valid range: 0 – 100
	Instrument	The name of the instrument used to detect the Hotspot (e.g. MODIS, VIIRS, AVHRR, AHI).
	Orbit Number	The orbit number is determined using the information provided in the NORAD TLE file(s). The TLE file provides reference information for an “epoch” orbit that allows the current orbit to be calculated using the acquisition information.
	Algorithm	The name of the algorithm used to produce Hotspots (e.g. MOD14, CATS, AFIMG, AFMOD, VCM, Landgate VIIRS nighttime, Landgate VIIRS daytime, Landgate MODIS daytime, Landgate MODIS nighttime, BRIGHT).
	Algorithm Version	Algorithm version number
	Satellite	Name of the satellite platform using the “National Space Science Data Centre” unique satellite number (*http://nssdc.gsfc.nasa.gov/nmc/*)
	Agency Source	Name of the agency providing the data

Sheet B.2 Technical Characteristics		
Sheet B.2.2 Attributes		
	Fire Category Name (AHI Hotspots only)	The fire category name field on Web Services and the website contain Processed and Saturated categories only. Hotspot files on the file transfer site contain all fire category names (Processed, Saturated, Low Possibility, Medium Possibility and High Possibility).

C Hotspots - Availability

Sheet C.1 Licencing and Access	
Support	Supports: Open Geospatial Consortium (OGC) Web Feature Service (WFS), versions 1.0.0, 1.1.0, and 2.0.0. Supports: Open Geospatial Consortium (OGC) Web Map Service (WMS) versions 1.1.1 and 1.3.0.
Licensing	Creative Commons 4.0 Attribution International license (CC BY 4.0 International). Landgate hotspot data attribution: • © Western Australia Land Information Authority (Landgate) BRIGHT hotspot data explicit attribution: Attribution for use of hotspots location and date/time data. • Engel, C.B., Jones, S.D. and Reinke, K.J., 2021. Real-time detection of daytime and night-time fire hotspots from geostationary satellites. *Remote Sensing*, *13*(9), p.1627. • Engel, C.B., Jones, S.D. and Reinke, K., 2020. A seasonal-window ensemble-based thresholding technique used to detect active fires in geostationary remotely sensed data. *IEEE Transactions on Geoscience and Remote Sensing*, *59*(6), pp.4947-4956. Attribution for use of hotspots location, date/time and FRP data. • Engel, C.B., Jones, S.D. and Reinke, K.J., 2022. Fire Radiative Power (FRP) Values for Biogeographical Region and Individual Geostationary HHMMSS Threshold (BRIGHT) Hotspots Derived from the Advanced Himawari Imager (AHI). *Remote Sensing*, *14*(11), p.2540. • Engel, C.B., Jones, S.D. and Reinke, K.J., 2021. Real-time detection of daytime and night-time fire hotspots from geostationary satellites. *Remote Sensing*, *13*(9), p.1627.
Search and preview Tool	DEA Hotspots Web Page: https://hotspots.dea.ga.gov.au/
Ordering and Distribution	DEA Hotspots Web Page: https://hotspots.dea.ga.gov.au/ Via File Download: https://hotspots.dea.ga.gov.au/files DEA Hotspots Information page: https://www.dea.ga.gov.au/products/dea-hotspots DEA Hotspots s3 bucket: s3://ga-sentinel/L3/hotspots
Disclaimer	The information displayed on DEA Hotspots (the “Service”) is for general informational purposes only, and is not intended to provide any commercial, financial, or legal advice.

Sheet C.2 Delivery Information		
Hotspots Standard Product		Standard Hotspot dataset available through WMS, WFS, KML, GeoRSS, and RSS and provide additional time attributes: • Hotspots detected in last 2 hours • Hotspots detected in last 6 hours • Hotspots detected in last 24 hours • Hotspots detected in last 48 hours • Hotspots detected in last 72 hours Data on the OGC WFS and WMS have additional attributes that represent 'Hours since detection' and are relevant at the time of web service access
Hotspots Query Product		Ability to query the historical Hotspot database based on satellite, sensor, orbit, date, algorithm, algorithm version, latitude, longitude, temperature, power, confidence level and time.
Hotspots Metadata		XML
Services		The Hotspots product can be obtained via the following data access services (Web services follow Open Geospatial Consortium standards): • OGC compliant Web Map Services allowing users to view the Hotspots as a georeferenced composite image (e.g. PNG, GIF, JPEG) https://hotspots.dea.ga.gov.au/geoserver/wms?service=wms&version=1.1.1&request=getcapabilities • OGC compliant Web Feature Services (WFS) allowing users to obtain the Hotspots as geographical features (e.g. KML, CSV, GML, shapefiles) https://hotspots.dea.ga.gov.au/geoserver/wfs?service=wfs&version=1.1.1&request=getcapabilities • Rich Site Summary (RSS) feed enabling users to access the last 72 hours of Hotspots data and metadata • Geographically Encoded Objects for Rich Site Summary feeds (GeoRSS) enabling users to access the last 72 hours of Hotspots data and metadata • Keyhole Markup Language (KML) files enabling users to access the last 72 hours https://hotspots.dea.ga.gov.au/geoserver/wms/kml?layers=public:hotspots_three_days • GeoJSON file enabling users to access the last 72 hours of Hotspots data https://hotspots.dea.ga.gov.au/data/recent-hotspots.json • File Download enabling users to obtain a 30-day rolling archive of the Hotspots generated from DEA Hotspots and the MODIS mosaic (e.g. TEXT and TIF) https://hotspots.dea.ga.gov.au/files
Data Volume	**Historical**	34.7 million records (as at September 2021)
	Per year	5 million records per year, on average

Sheet C.2 Delivery Information

Service metadata	Please refer to Sheet B.2 regarding technical information for more detail on each attribute. These attributes are found on the web service for each Hotspot. Type: Point Coordinates: (longitude, latitude) Geometry_name: location Properties: (metadata properties of the Hotspot - ID: numeric ID assigned to hotspot - Satellite: Name of the satellite platform acquiring the data (e.g. Aqua, Terra etc.). - Satellite_nssdc_id: Name of the satellite platform using the National Space Science Data Centre unique satellite number - Satellite_operating_agency: Name of the agency providing the satellite data (e.g. NASA) - Sensor: Primary data source of the Hotspot (e.g. MODIS, AVHRR, VIIRS, AHI) - Orbit: Orbit number of the satellite (-1 indicates orbit not reported) - Start_dt[3]: Start date and time (in UTC) of the satellite pass acquisition - Stop_dt: Stop date and time (in UTC) of the satellite pass acquisition - Filename: File name that the Hotspot is contained in and uses the following format: satellite_dateUTC_Hotspot.txt - Process_dt: Date and time (in UTC) that the Hotspot was processed (file creation time) - Process_algorithm: Algorithm that the Hotspot was processed with - Process_algorithm_version: Algorithm version used to process the Hotspot - Product: Name of the product within the database (e.g. LANDGATE_AHI, MOD14) - Load_dt: Date and time (in UTC) that the Hotspot was loaded into the database - Latitude: Hotspot latitude in WGS84 (º) - Longitude: Hotspot longitude in WGS84 (º) - Temp_kelvin: Temperature of the Hotspot in Kelvins

[3] In addition, the following table describes the start_dt, stop_dt field inclusions and process algorithms present for Hotspots

Satellite	Sensor	start_dt	stop_dt	Process_algorithm
Aqua	MODIS	YES	YES	MOD14 / Landgate MODIS daytime & Landgate MODIS Nighttime
Terra	MODIS	YES	YES	MOD14 / Landgate MODIS daytime & Landgate MODIS Nighttime
Himawari-8	AHI	YES	NO	Landgate AHI, BNHCRC_BRIGHT
NOAA 19	AVHRR	YES	YES	Landgate AVHRR
NOAA 20	VIIRS	YES	YES	AFIMG/AFMOD
NOAA 20	VIIRS	YES	NO	Landgate Daytime VIIRS algorithm
SUOMI NPP	VIIRS	YES	NO	Landgate Nighttime VIIRS algorithm

Sheet C.2 Delivery Information	
	- Power: Estimate of Fire Radiated Power. Null values, or -1, are displayed when no estimate is available. - Confidence: Confidence (%) that a Hotspot is a fire. Null values, or -1 are displayed. - Datetime: Date and time (in UTC) that the Hotspot was captured and is the midpoint in time between the attributes start_dt and stop_dt. - Australian_state: State that the Hotspot was captured in (e.g. NSW, ACT, WA, NT, VIC, TAS, QLD, SA)

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Glossary

AFIMG	NASA Land-SIPS VIIRS 375m Active Fire product (experimental)
AFMOD	NASA Land-SIPS VIIRS 750m Active Fire product
Aqua	NASA satellite collecting data on Earth's water cycle (USA)
AER	Atmospheric and Environmental Research
ABI	Advanced Baseline Imager
AHI	Advanced Himawari Imager (JMA)
ASTER	Advanced Space-borne Thermal Emission and Reflectance Radiometer
BNHCRC	Bushfires and Natural Hazards Cooperative Research Centre
BRIGHT	Biogeographical Region and Individual Geostationary HHMMSSThreshold algorithm
CATS	Cloud-Aerosol Transport System
CSPP	Community Satellite Processing
EDR	PackageEnvironmental Data Record
EOS	Earth Observing System (NASA)
GDA	Geocentric Datum of Australia
GOES-R	Geostationary Operational Environmental Satellite
GPX	GPS eXchange Format
JMA	Japan Meteorological Agency
JP1	Joint Polar Satellite System
KML	Keyhole Markup Language
MODIS	MODerate resolution Imaging Spectroradiometer (NASA)
MOD14	MODIS Terra Thermal Anomalies product
MYD14	MYD14 Aqua Thermal Anomalies
MW	Megawatts
NASA	National Aeronautics and Space Administration (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NPP	National Polar-orbiting Partnership (USA)
OGC	Open Geospatial Consortium
POES	Polar-orbiting Operational Environmental Satellites
RMIT	Royal Melbourne Institute of Technology
SDR	Sensor Data Record
SRSS	Satellite Remote Sensing Services (former name for Landgate Imagery team)
SUOMI NPP	Satellite mission replacing EOS satellites (NASA)
Terra	NASA satellite collecting data on Earth's land processes (USA)
VIIRS	Visible Infrared Imaging Radiometer Suite
WFS	Web Feature Service
WGS	World Geodetic System

WMS	Web Map Service
XML	Extensible Mark-up Language