Opportunities in SPACE for South Australian Professionals

Spatial Information Day - 2019

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AUSTRALIA RE-ENTERS THE “SPACE RACE”

1967 - WRE SAT - 45kg payload launched from Woomera and completes 642 near polar, Low Earth orbits in 42 days

2002 - FED SAT – 58kg payload launched from Tanegashima and completes approx. 20,000 near polar, Low Earth orbits in 4 years

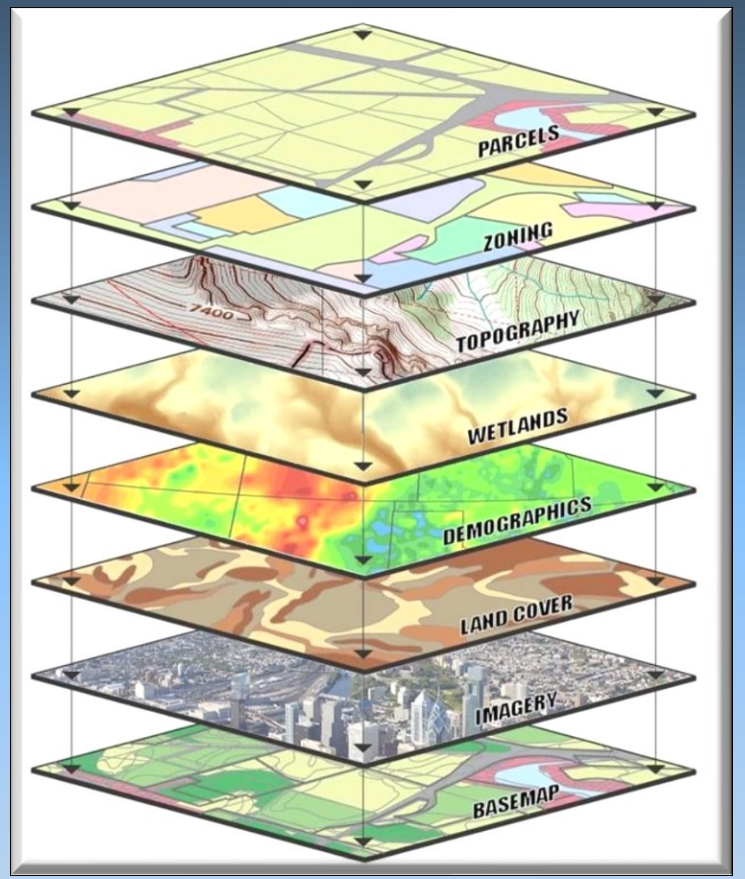
Sept **2017** – IAC Adelaide

2018 – Australian Space Agency formed; based in Adelaide; several M$100’s of investment

Opportunities ?

SPACE

SPATIAL



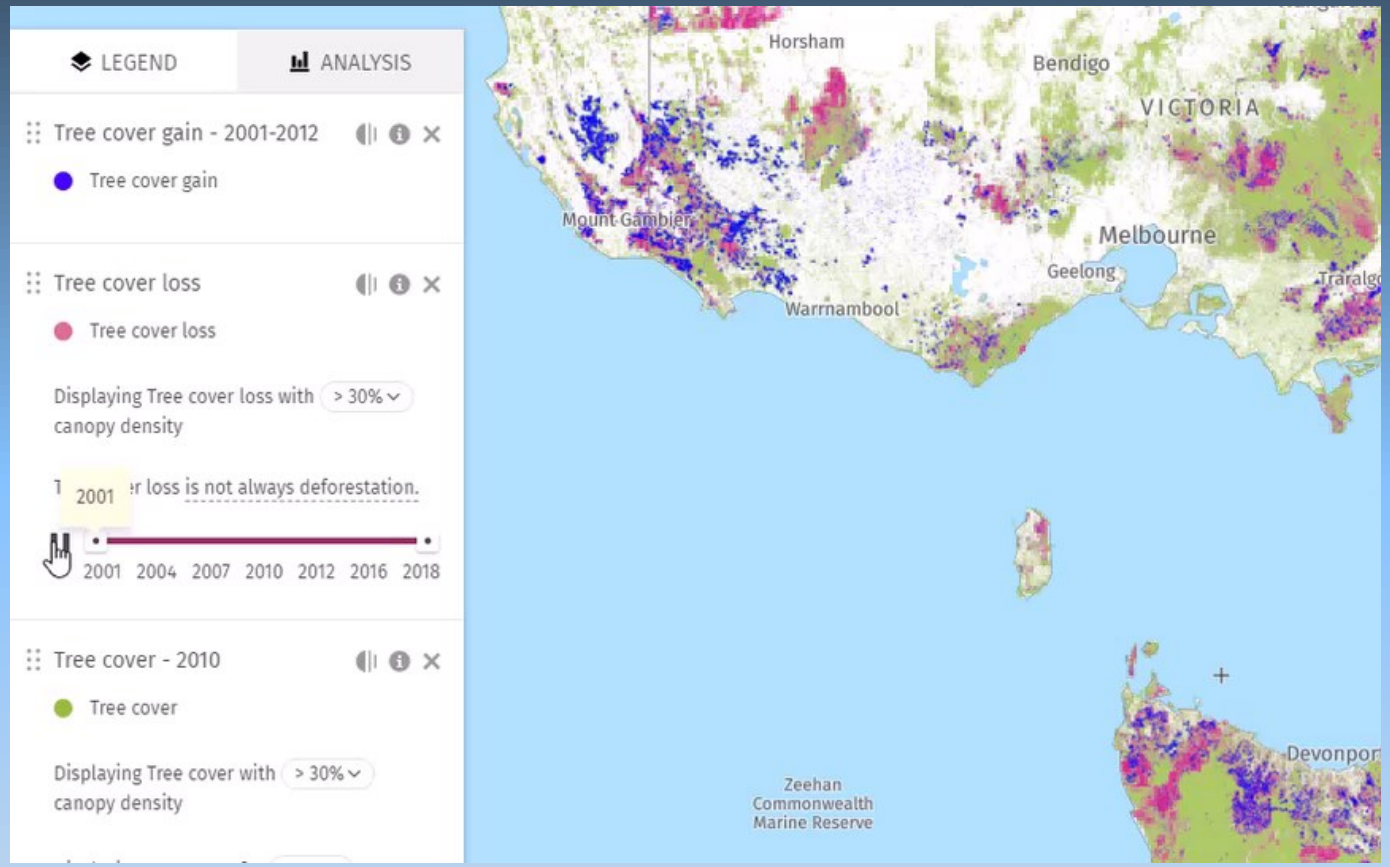
TWO EXAMPLES

Opportunities ?

EARLY FIRE DETECTION

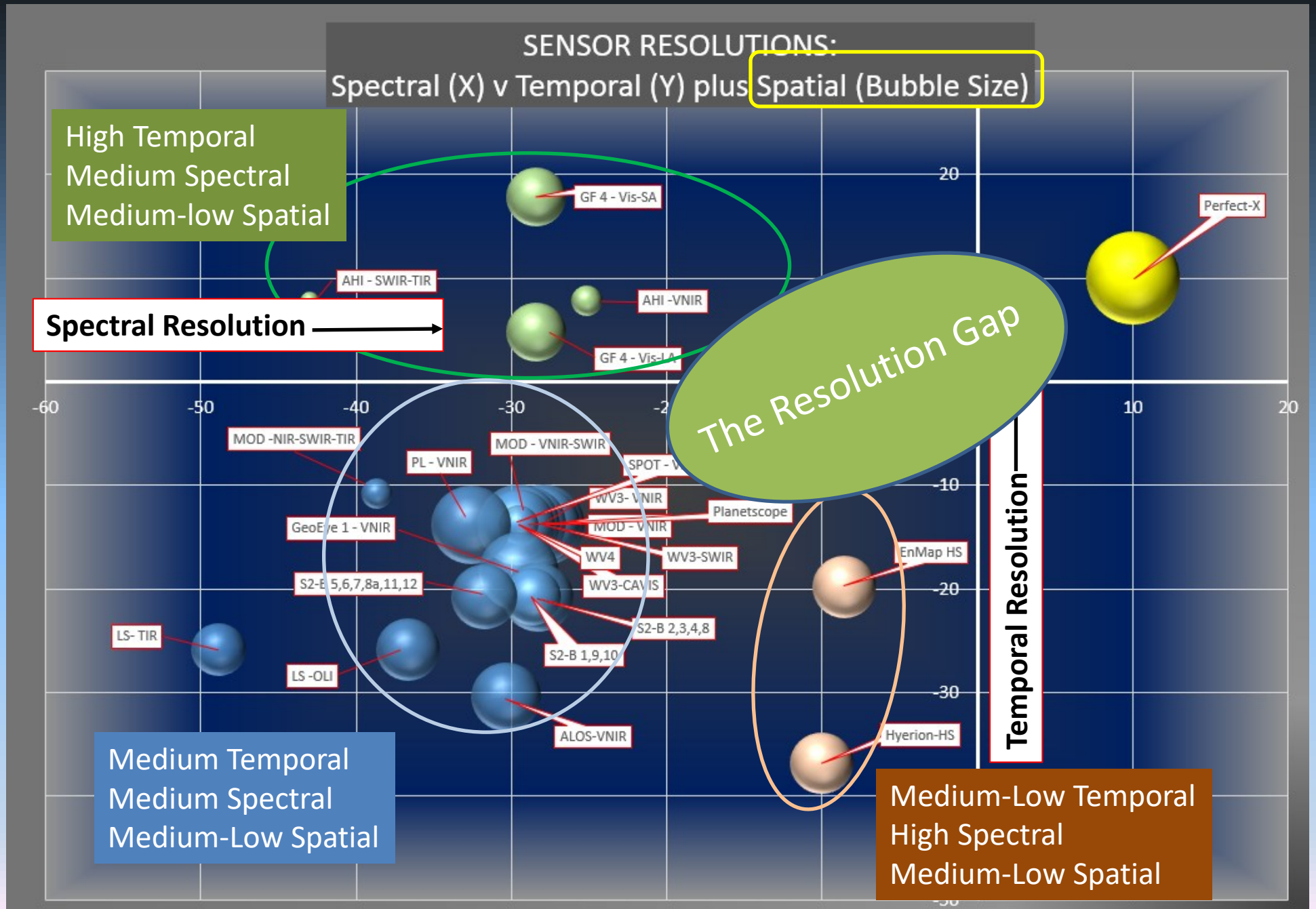
Global application - a sensor resolution issue

FOREST STATE MAPPING



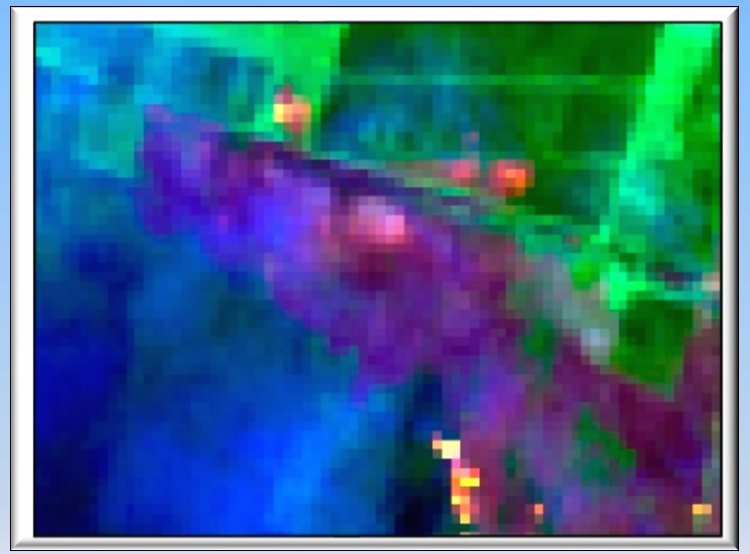
Continental application - a computing issue

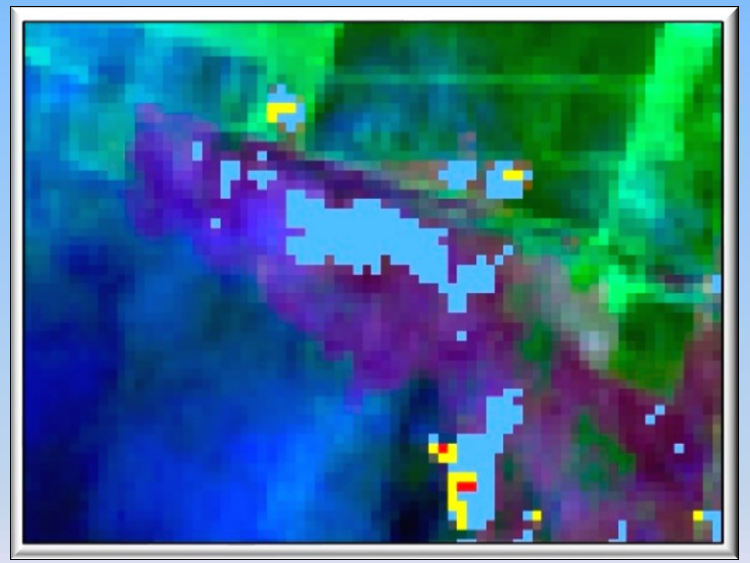
LOCATE 2018 - ADELAIDE

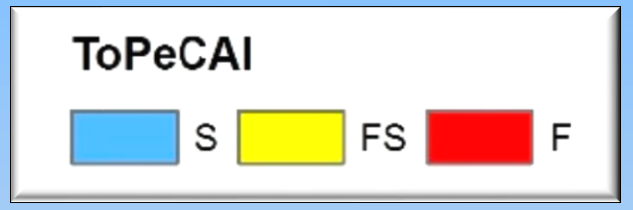


Example 1: Early Forest Fire Detection

- **15 mins warning** of commencement of fire – **high temporal resolution**.
- Need a sensor and platform which will detect fire at medium (~10m) spatial resolution.
- Current solutions use Middle IR (Hot fires) or Thermal IR (Cool fires) - **MODIS (1000m** pixels); **VIIRS (375m** pixels) **low spatial resolution**
- **ToPeCAI** (Tropical Peatland Combustion Algorithm) - Parwati Sofan and David Bruce (UniSA) detects cool fires using Landsat 8 imagery (30m pixels), but **low temporal resolution**.







S = Smouldering;
FS = Flaming & Smouldering; F = Flaming
Sofan, Bruce, Jones and Marsden (2019)

Sensor / Platform solutions

LEO
Sensors

GEO Sensor

CO_2 CH_4 CO H_2O K

Example 2: Forest State Mapping

Australian and New Zealand forestry managers require **monthly updates of forest state** (new plantings, growth state and harvesting)

- Australia's total commercial plantation area - 1,955,100 ha 2016–17 (ABARES, 2018)
- Total area of softwood plantations - 1,036,900 Ha (2016-2017)
- **Approx. area to be mapped (red polygons) 65,000,000 ha**

Forest State Mapping

- **Monthly satellite imagery** - all forest areas in ANZ. **Cloud cover** is a confounding issue for optical imagery.
- E.G. Sentinel 2 (optical) satellite availability for 4 sites in Australia over 1 year (May 2017 to April 2018)

Location	2017								2018				% cover (mth/ yr.)
	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
Mt Lofty (SA) - GT	✓	✓	✓	✓	☁	✓	✓	✓	✓	✓	✓	✓	92
Mt Gambier (SA)	✓	✓	✓	✓	☁	✓	✓	✓	✓	✓	✓	✓	92
Jindabyne (NSW)	☁	☁	✓	☁	✓	✓	✓	✓	✓	✓	✓	✓	75
NW Tasmania	☁	☁	☁	✓	☁	☁	✓	☁	✓	✓	☁	✓	42

Satellite **Radar imagery** to augment Optical imagery.

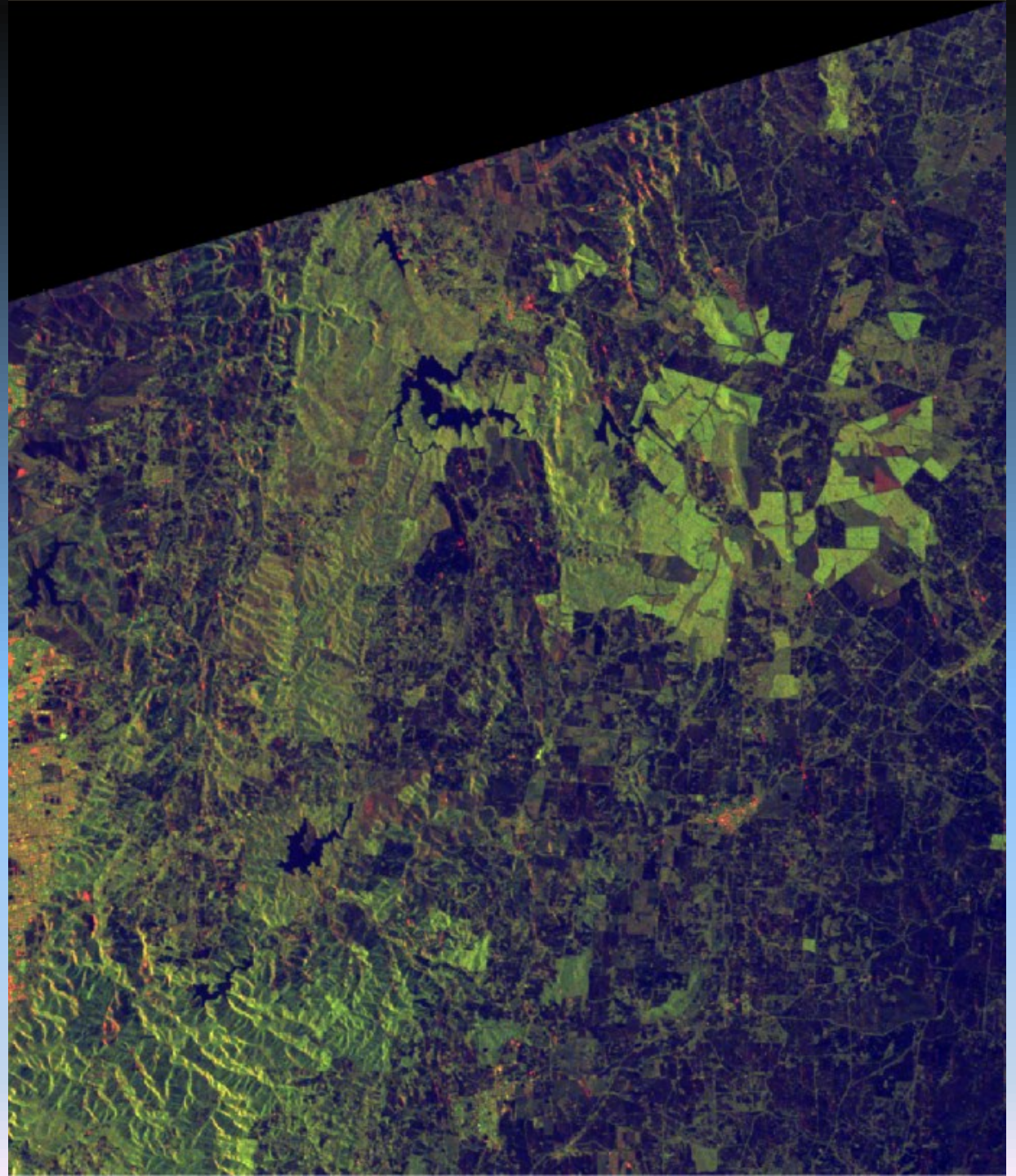
- Radar imagery **penetrates cloud**.
- Available night and day

Mt Crawford forest area

Sentinel 2 – 27 Jan 2017
Bands 8,4,2 – R,G,B

Sentinel 1 – 27 Jan 2017
Polarisations:
VV, HV, VV – R,G,B

ALOS PALSAR 2– 24 Jan 2017
Polarisations:
HH, HV, HH PHASE – R,G,B

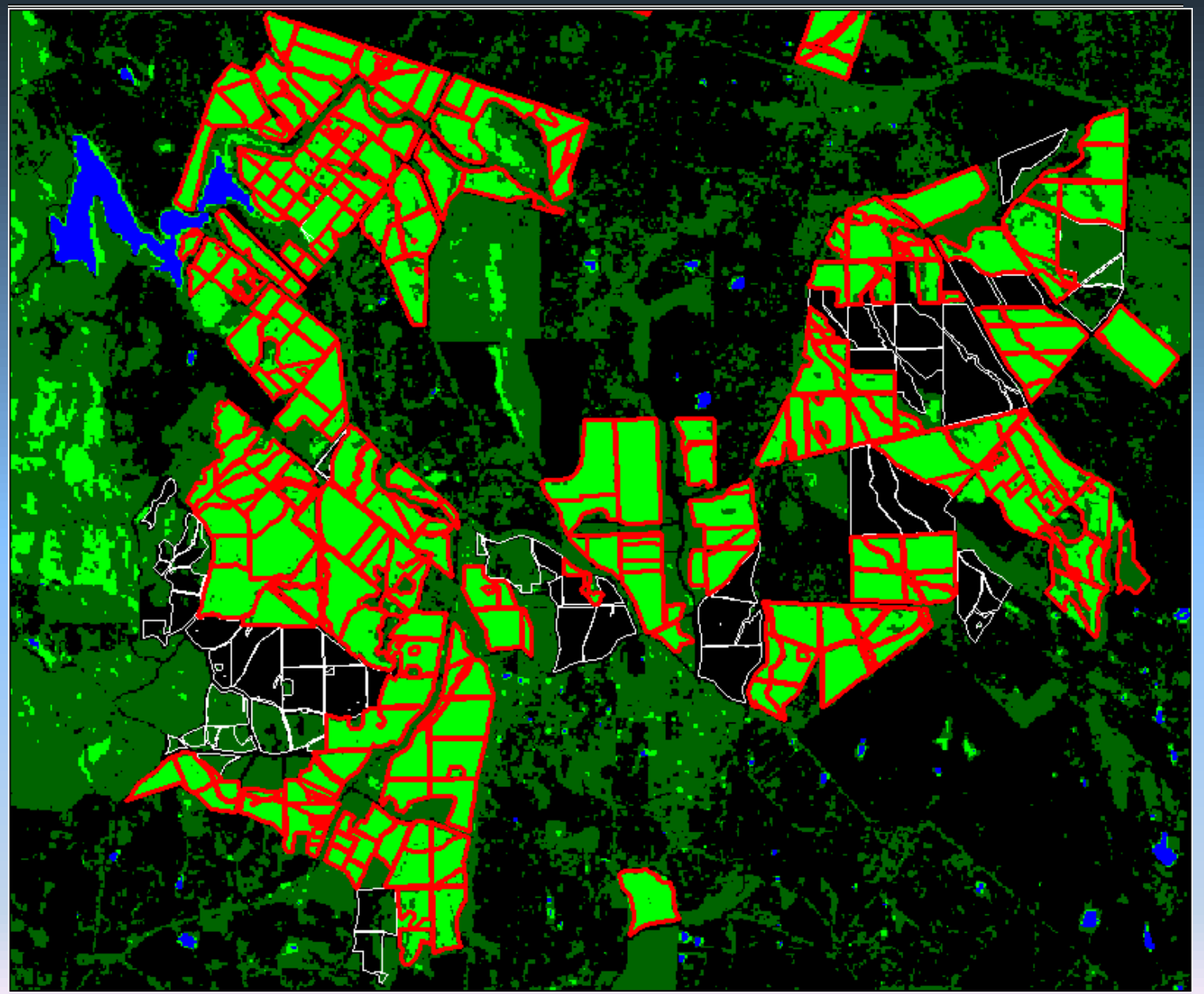


Forest State Mapping

Mt Crawford – enlargement Classification of S2

Class_Names	Color
Not classified	
Water	
PR Forets	
Other forest - trees	

PR Stand. Vol. > zero (end 2016)



Forest State Mapping

- Use satellite L Band Radar imagery to augment Optical imagery.
- Radar imagery penetrates cloud and available day or night.
- Tests site results (Std RS classification) for Adelaide Hills (Mt Crawford), using Forestry SA forest GIS data as control.

RESULTS FOR SENTINEL 2 (OPTICAL)			
Comparison	Number Polygons	%	Comment
Pinus Radiata Forest same	905	93.6	Correct
Sat = no forest; GIS = forest	37	3.8	Omission
Sat = forest; GIS = no forest	25	2.6	Commission
Total	967	100	

RESULTS FOR ALOS PALSAR (SYNTHEIC APETURE RADAR)			
Comparison	Number Polygons	%	Comment
Pinus Radiata Forest same	771	79.7	Correct
Sat = no forest; GIS = forest	180	18.6	Omission
Sat = forest; GIS = no forest	16	1.7	Commission
Total	967	100	

Use of AI – machine learning shows increase in accuracy of ~5%

Forest State Mapping

For Australia:

- Sentinel 2 (S2) image size is 290 x 290km delivered in 100 x 100 km tiles. Imagery is free for non-commercial purposes and lost cost otherwise.

- Approx. **65 tiles** required to map softwood plantations **per month**.

- Data for S2 is **325 Gb per month** (4 Tb per year)

- Processing space required **1 Tb per month**.
- **ALOS PALSAR** (JAXA) is **expensive** (~A$3200 per image) So mapping forests is not viable with this satellite sensor. However, a free source of L and S Band radar will become available in late 2021 with the launch of **NISAR**
  https://directory.eoportal.org/web/eoportal/satellite-missions/n/nisar

- Processing of Radar requires more time and space than for optical.

Professional Expertise Requirements

EARLY FIRE DETECTION	FOREST MAPPING
Spatial (RS) scientists	Spatial (RS) scientists
Spatial (GIS) scientists	Spatial (GIS) scientists
Sensor developers	
Optics specialists	
AI experts	AI experts
Satellite systems engineers	
Telecommunication engineers	
Database managers	Database managers
	Web portal managers

CONCLUSIONS

- Opportunities exist for professionals to **collaborate, innovate** and be part of Australia in Space 2.0.

- It is not the launch of the satellite – it is the **application** of space technology to solve problems hither to either not solved or solved by less efficient means.

- **Spatial Science has a role to play**.

- Space collaboration and grants - through:
  - The SMARTSAT CRC - https://smartsatcrc.com/
  - SA Space Innovation fund https://www.sasic.sa.gov.au/industry-and-grants/grants
  - Australian Government: International Space Investment Expand Capability Grants https://www.business.gov.au/assistance/international-space-investment-expand-capability-grants

Resources, references and acknowledgements:

Slide 2: Launch of WRESat https://www.dst.defence.gov.au/innovation/wresat-%E2%80%94-weapons-research-establishment-satellite

Launch of FedSat https://www.unisa.edu.au/research/Institute-for-Telecommunications-Research/Projects/FedSat---historical-highlights/

Slide 3: NASA satellites https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-a-satellite-58.html

GIS Layers https://www.usgs.gov/media/images/gis-data-layers-visualization

Slide 4: Greece Fires: Contains modified Copernicus Sentinel data (2017), processed by ESA, CC BY-SA 3.0 IGO http://www.esa.int/spaceinimages/Images/2017/08/Kalamos_fires ;

Global Forest Watch https://www.globalforestwatch.org/

Slide 5:

Bruce, D. (2018) *Sensor resolutions from space: the tension between temporal, spectral, spatial and swath*, presented at Locate 18, 11 April, 2018, Adelaide, Australia.

Slide 6:

Sofan, P., Bruce, D., Jones, E. and Marsden, J. (2019) *Detection and Validation of Tropical Peatland Flaming and Smouldering using Landsat-8 SWIR and TIRS Bands*, Remote Sensing, 11 (4), Special Issue: New Trends in Forest Fire Research Incorporating Big Data and Climate Change Modeling, Doi: 10.3390/rs11091013

Slide 7: HAPS – Zephyr – Airbus: https://www.airbus.com/newsroom/press-releases/en/2017/12/airbus-and-williams.html-61.jpg

Fire Truck – Robe CFS: https://www.coastalleader.com.au/story/4452033/robe-cfs-benefiting-from-new-truck/

Slide 17: Himawari image of Earth – NOAA / JMA:

Acknowledgements:

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THANK YOU FOR LISTENING