

KC#29 Project Report

Imaging Radar for woodland monitoring and mapping.

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JAXA EO-RA4 “Multi-sensor data integration for monitoring woody vegetation change in eastern Australia”

Joint Remote Sensing Program (JRSP)



- Collaboration between Academia and Government
- Improve Governments use of EO for environmental monitoring
- Program partners
 - Queensland Department of Environment, Tourism, Science, and Innovation
 - New South Wales Department of Climate Change, Energy, the Environment and Water
 - The University of Queensland
 - University of New South Wales
 - University of New England

PhD Objectives

Primary objective:

To assess the utility of imaging radar to map and monitor woody vegetation change in a woodland environment.

Secondary objectives:

1. Explore the utility of imaging radar in a temperate woodland environment
2. Time series approach for clearing detection using KL divergence
3. Comparison of C, S, L, and P bands

K&C: Environmental Conservation

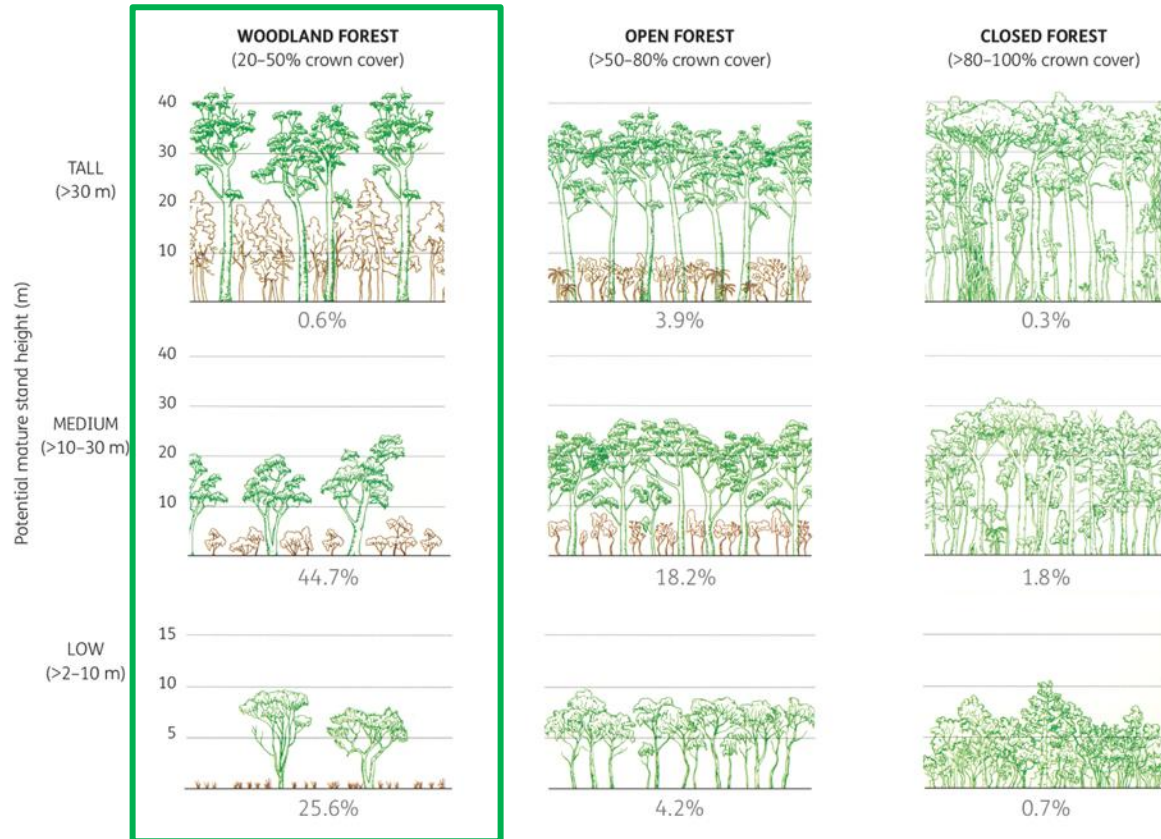
Statewide Land and Tree Study (SLATS)

- QLD gov – uses S2 for annual monitoring – Monitoring period - Aug – Aug
- Sparse vegetation listed as issue with current CNN approach
- Little recent work has been done in the with radar in Queensland
- Using SLATS as a reference to compare the utility of L and C band for clearing events in a temperate woodland environment



Woodlands defined

Figure 1.2: Native forest crown cover classes, height classes, and area proportions



Note: Percentages are area proportions of each height class/crown cover class combination in Australia's total native forest area, excluding 'Other native forest' for which height and cover class is unknown. In accordance with the definition of forest used for the National Forest Inventory, the crown cover values relate to existing or potential crown cover, and the height values relate to mature or potentially mature stand height.

Source: Adapted from Australian Land Information Group and JA Carnahan (1990). *Atlas of Australian Resources, Vegetation*. Australian Government Publishing Service, Canberra.

(Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee, 2018)



Eucalyptus brownii open woodland on Cainozoic clay plain



Melaleuca viridiflora dominates the sparse to very sparse canopy.

(Neldner et al., 2023)

Australia's Forest by the numbers

- Australia has 133 million hectares of forest, covering only 17% of Australia's total land area
- Woodland forest (93 million ha, 71% of Australia's total forest area)
- Open forest (34 million ha, 26% of Australia's total forest area)
- Closed forest (2.6 million ha, 2% of Australia's total forest area)
- 77% of native forests are Eucalypt, followed by Acacia at 8%
- 1.7 million hectares of woody vegetation cleared from 2018-2022, 83% fully cleared, the rest partially cleared



Australia's native forests, by crown cover class (2023)

Australia's State of the Forests Report



Australian Government
Department of Agriculture,
Fisheries and Forestry



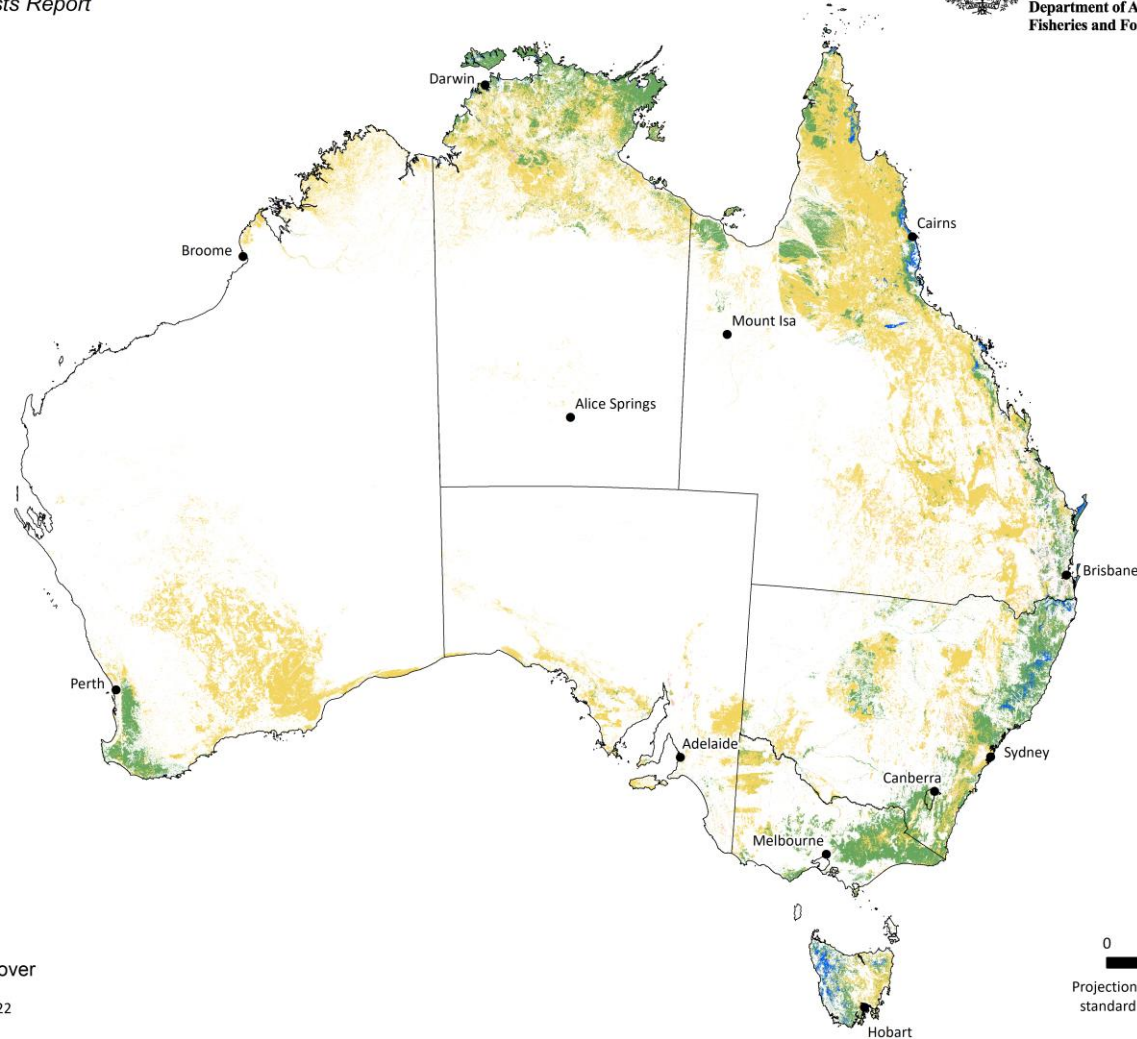
Crown cover class

- Woodland forest
- Open forest
- Closed forest
- Forest of unknown crown cover

Data sources: National Forest Inventory 2022
Map compiled by ABARES 2023

© Commonwealth of Australia

Reference: Montreal Process Implementation Group for Australia (MIG) and National Forest Inventory Steering Committee (NFISC) 2023, Indicator 1.1a.i Forest area by forest type, *Australia's State of the Forests Report*, ABARES, Canberra. CC BY 4.0.



Distribution of Australia's native forests (2023)

Australia's State of the Forests Report



Australian Government
Department of Agriculture,
Fisheries and Forestry



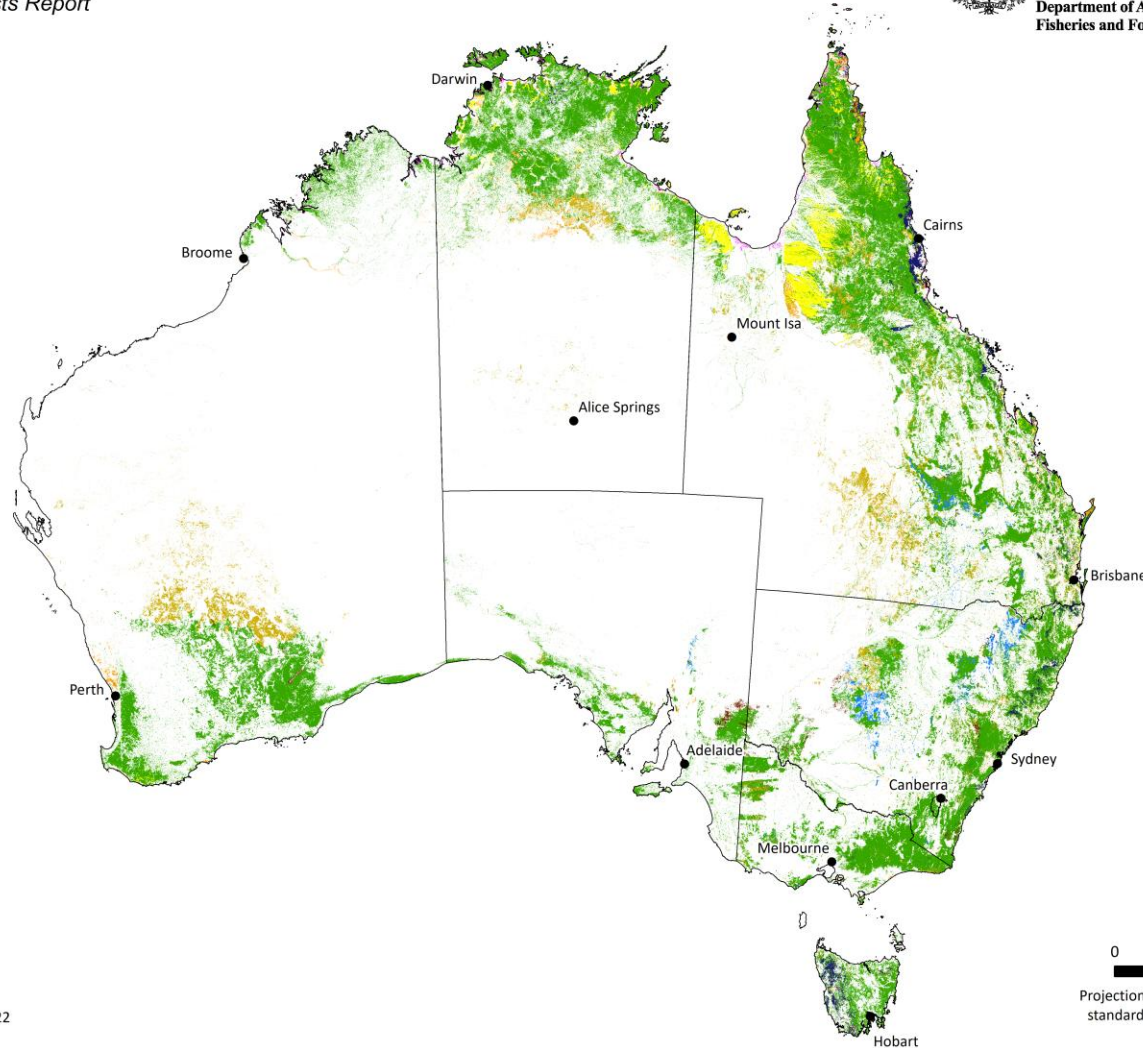
Native forest type

- Acacia
- Callitris
- Casuarina
- Eucalypt
- Mangrove
- Melaleuca
- Rainforest
- Other native forest

Data sources: National Forest Inventory 2022
Map compiled by ABARES 2023

© Commonwealth of Australia

Reference: Montreal Process Implementation Group for Australia (MIG) and National Forest Inventory Steering Committee (NFISC) 2023, Indicator 1.1a.i Forest area by forest type, *Australia's State of the Forests Report*, ABARES, Canberra. CC BY 4.0.



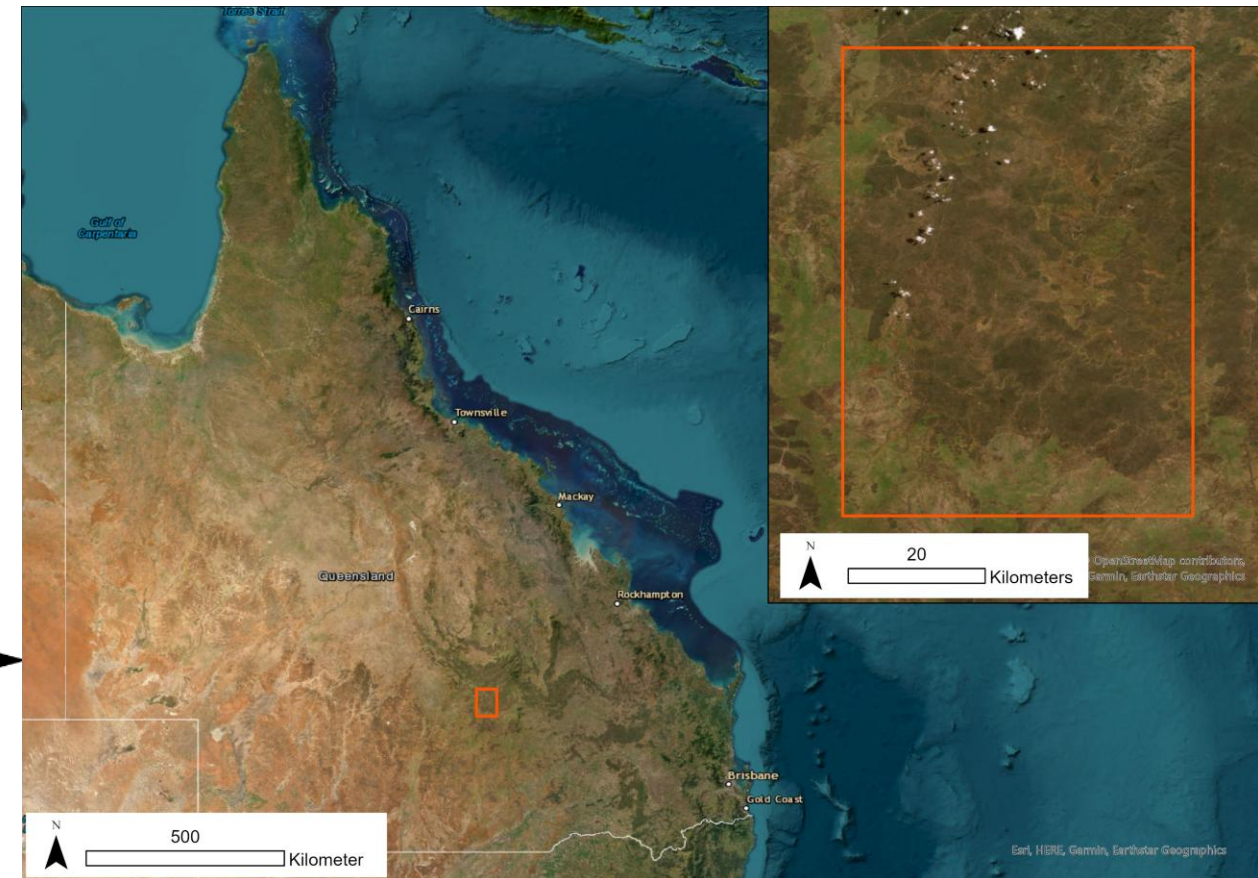
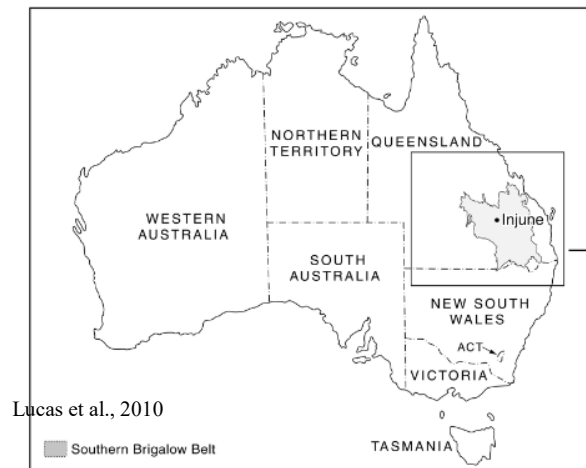
0 500
km

Projection: Albers equal-area with
standard parallels 18°S and 36°S

Project Area

Project area(s) – Injune Landscape Collaborative Project (ILCP)

- Injune, Queensland, Australia.
 - Vegetation groups representative of Queensland
- Potentially other areas in QLD/nearby Injune
- Established in 1999
- 40km x 60 km
- 20 Broad Vegetation Groups
- 5 Structural Types of Veg



ALOS

K&C Initiative
An international science collaboration led by JAXA



ALOS

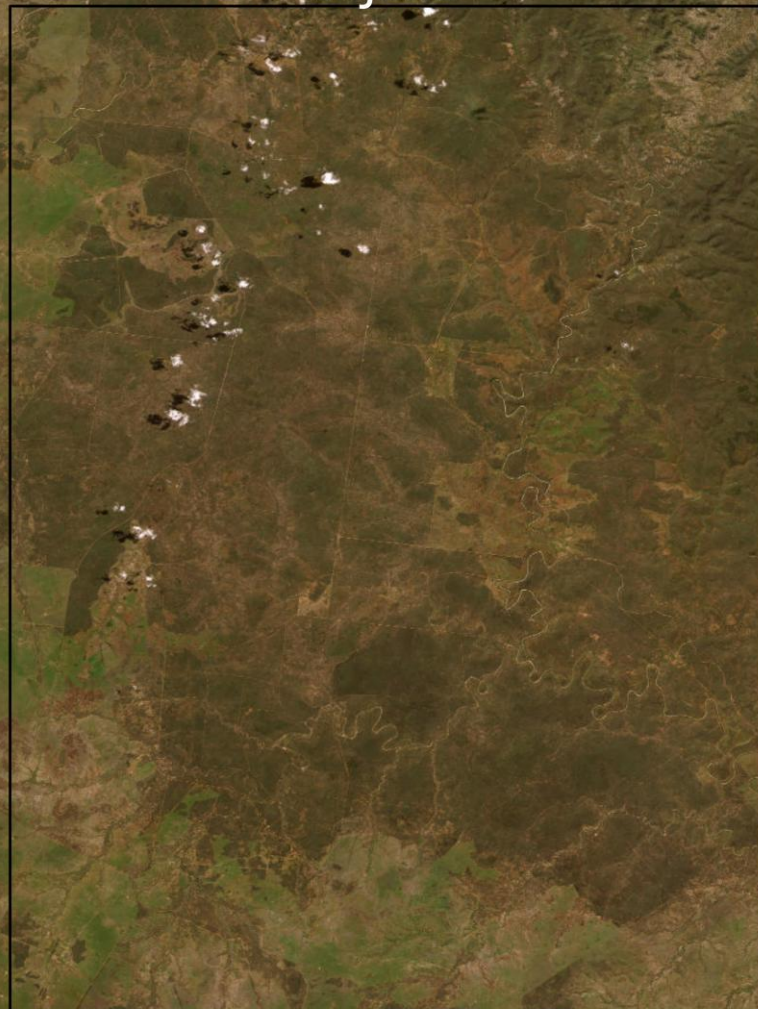
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ALOS

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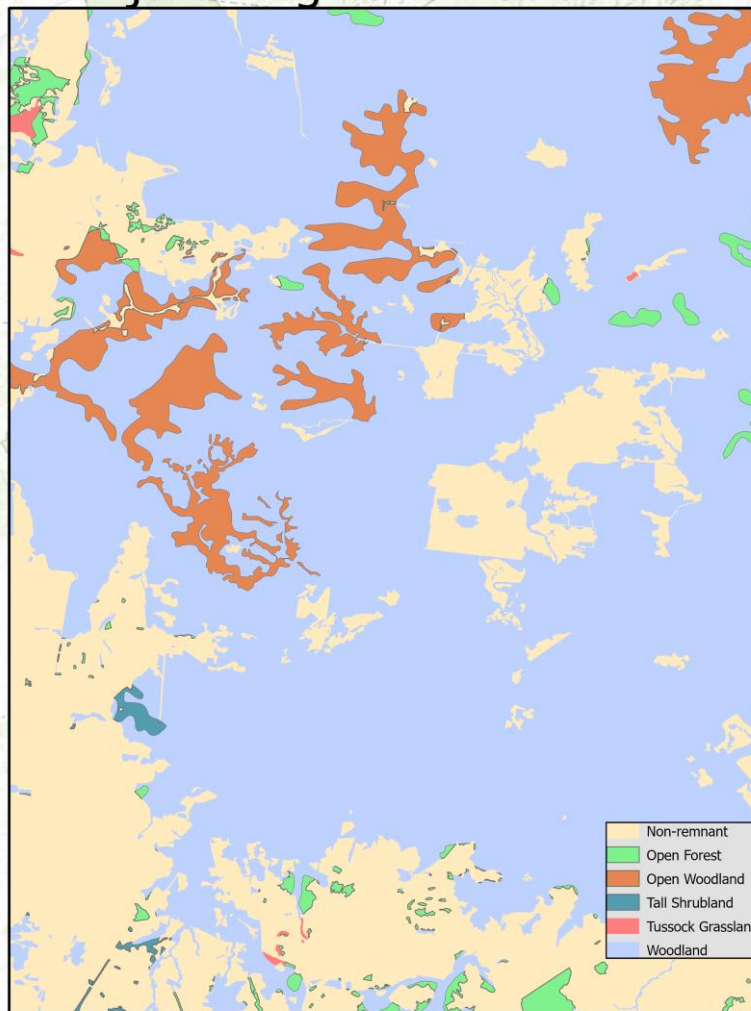
Injune



0 2.5 5 10 Kilometers

Earthstar Geographics

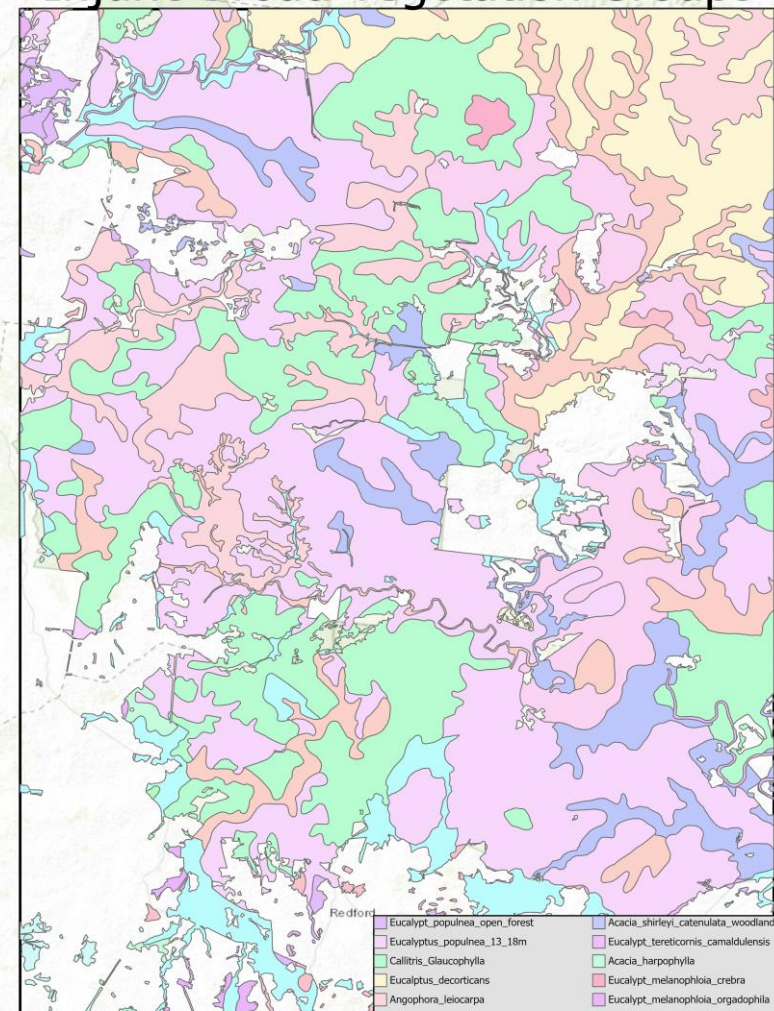
Injune Vegetation Structure



0 2.5 5 10 Kilometers

NPSR, Esri, © OpenStreetMap contributors, HERE, Garmin, USGS, NGA

Injune Broad Vegetation Groups

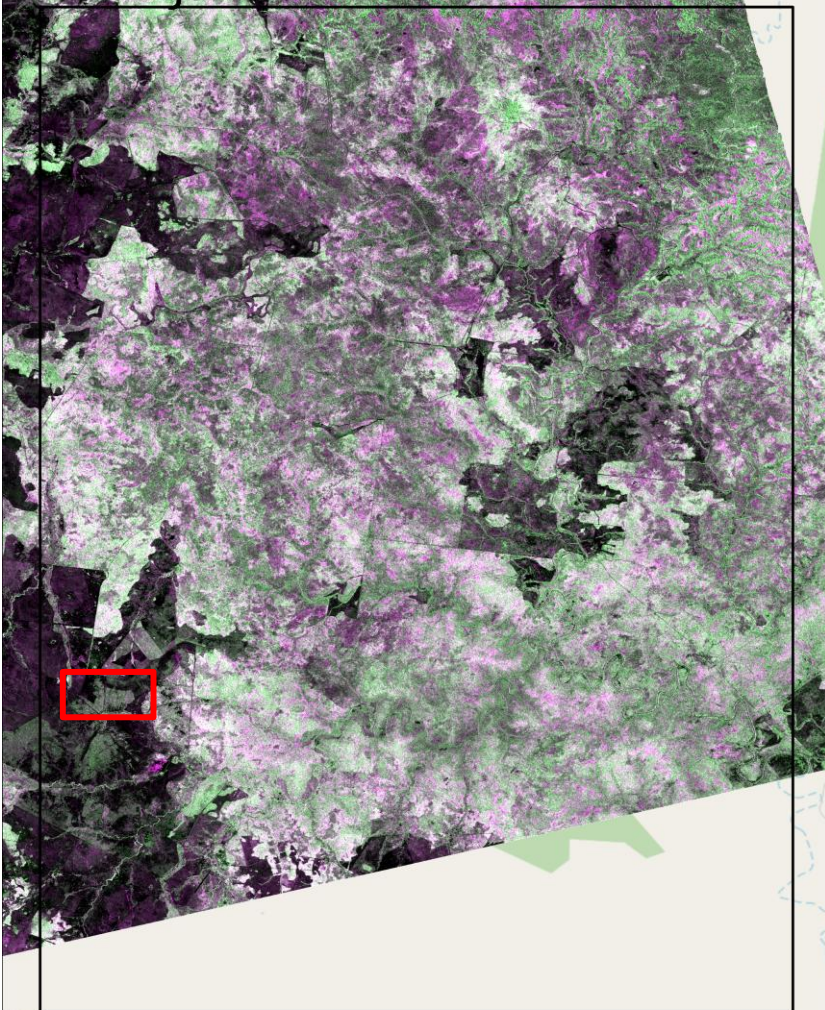


0 2.5 5 10 Kilometers

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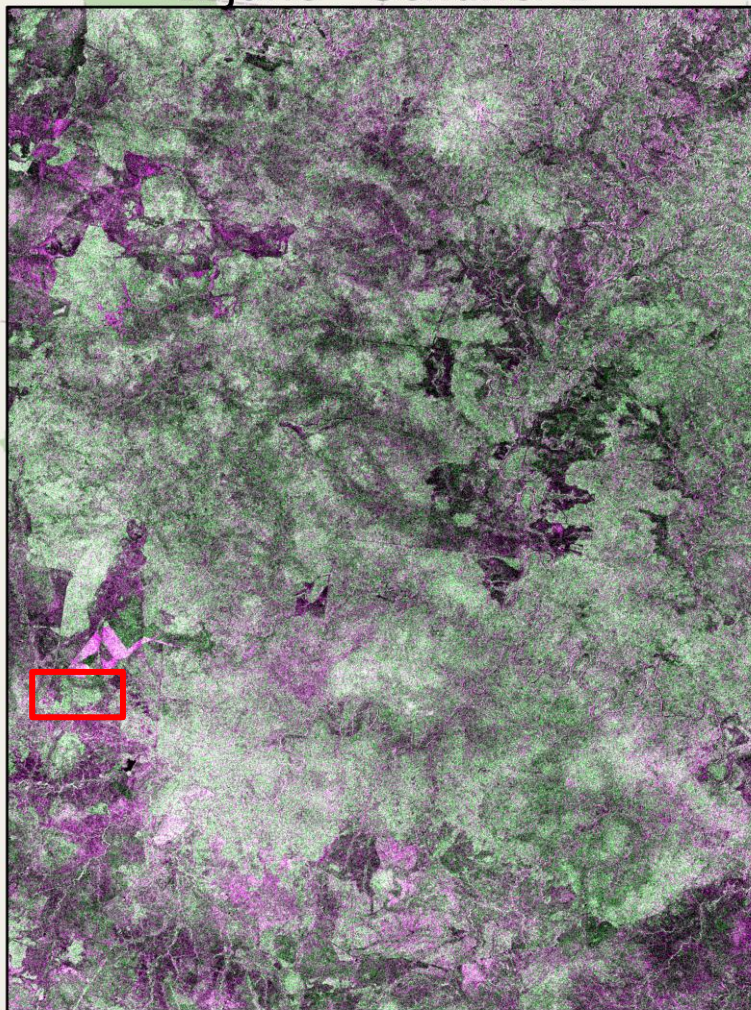
Injune - ALOS-2 PALSAR-2



R - HH G- HV - HH

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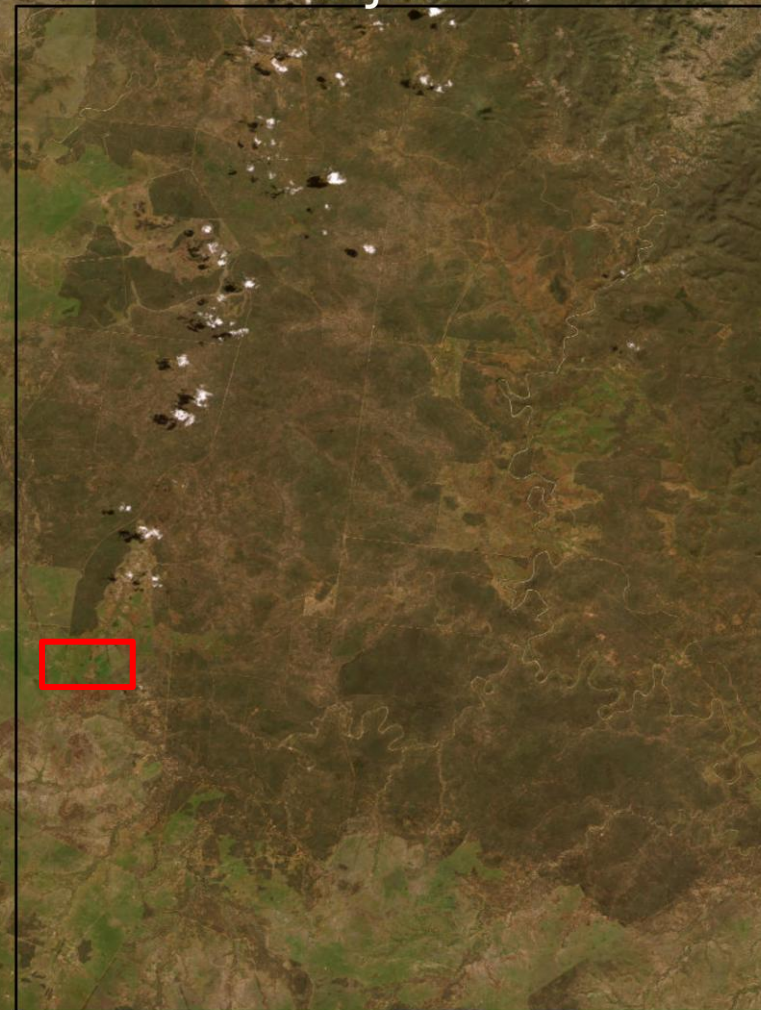
Injune - Sentinel-1



R- VV G- VH B- VV

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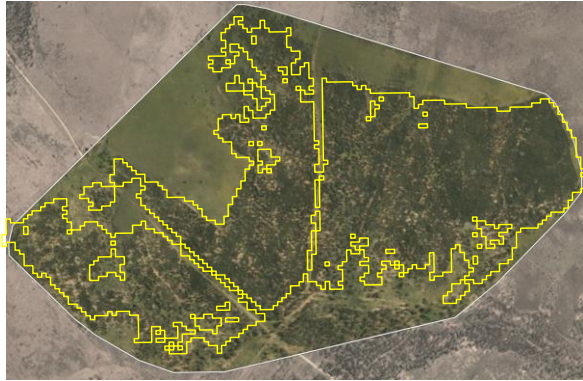
Injune



Earthstar Geographics

SLATS Clearing occurring between Aug 2016 – Aug 2017

2016 Sept 25



2016 Dec 30



2017 Jan 11



2017 Jan 21



2017 Jan 26



2017 Jan 31



2017 Feb 1



2017 Feb 4



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2016 Sept 25 (ALOS2 26)

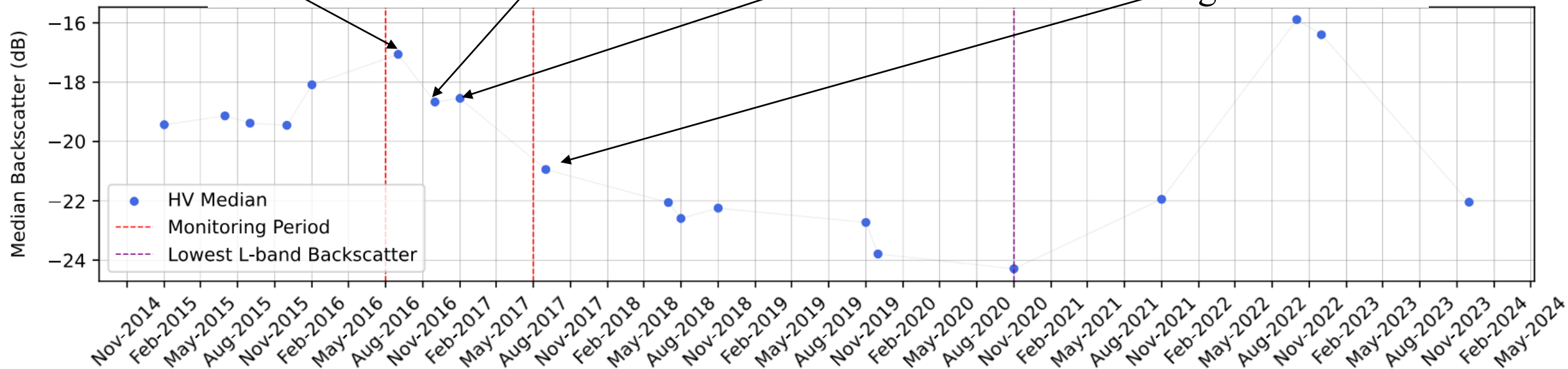
2016 Dec 12 (05)

2017 Feb 12 (12)

2017 Sep 27 (25)



ALOS-2 PALSAR-2 Gamma0 Backscatter for 2016-2017 Clearing Event



ALOS

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Planet 3m

2016 Sept 25



2016 Dec 12



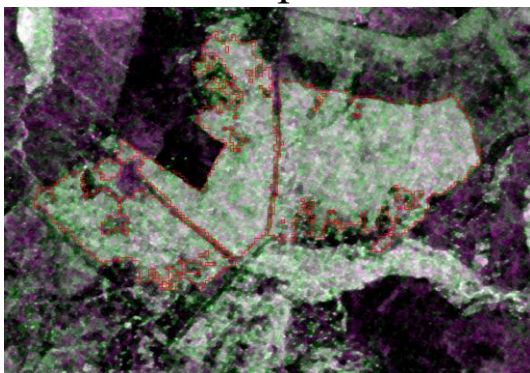
2017 Feb 12



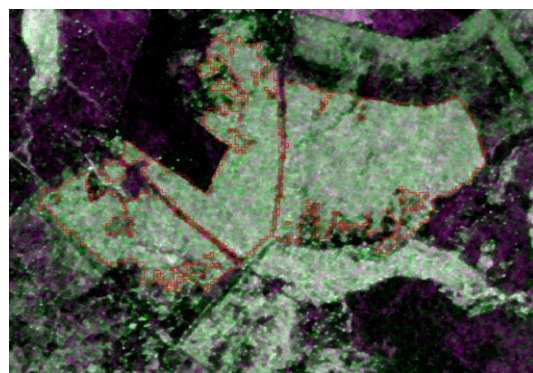
2017 Sep 27



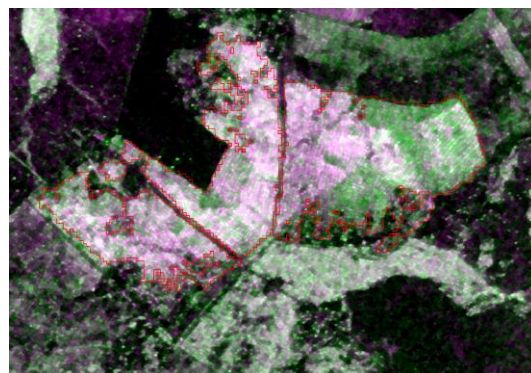
2016 Sept 26



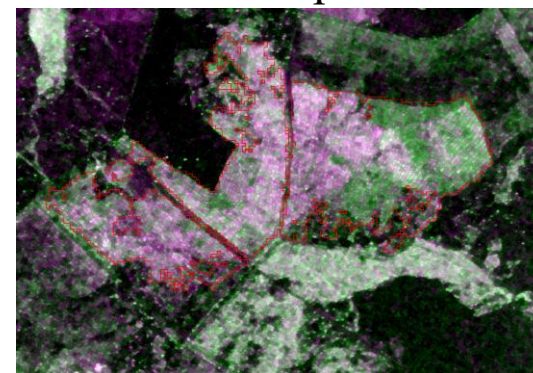
2016 Dec 05



2017 Feb 13

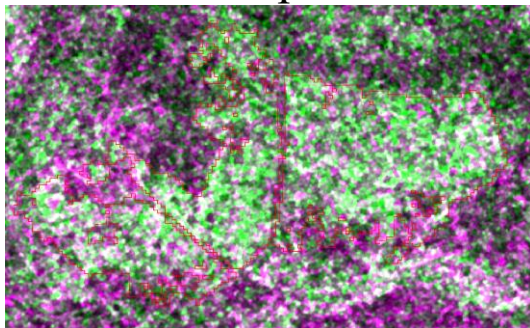


2017 Sep 25

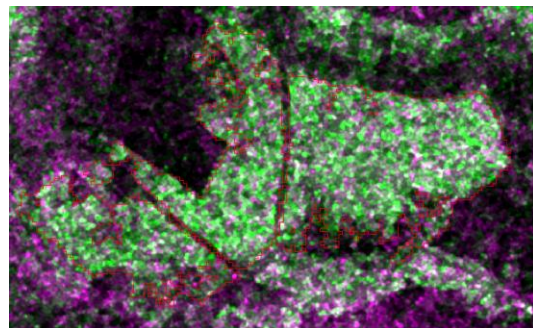


ALOS2 - HH:HV:HH

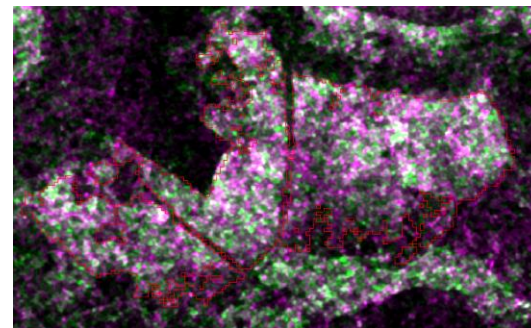
2016 Sept 13



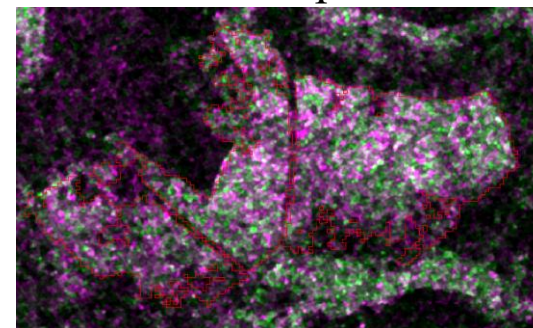
2016 Dec 06



2017 Feb 4

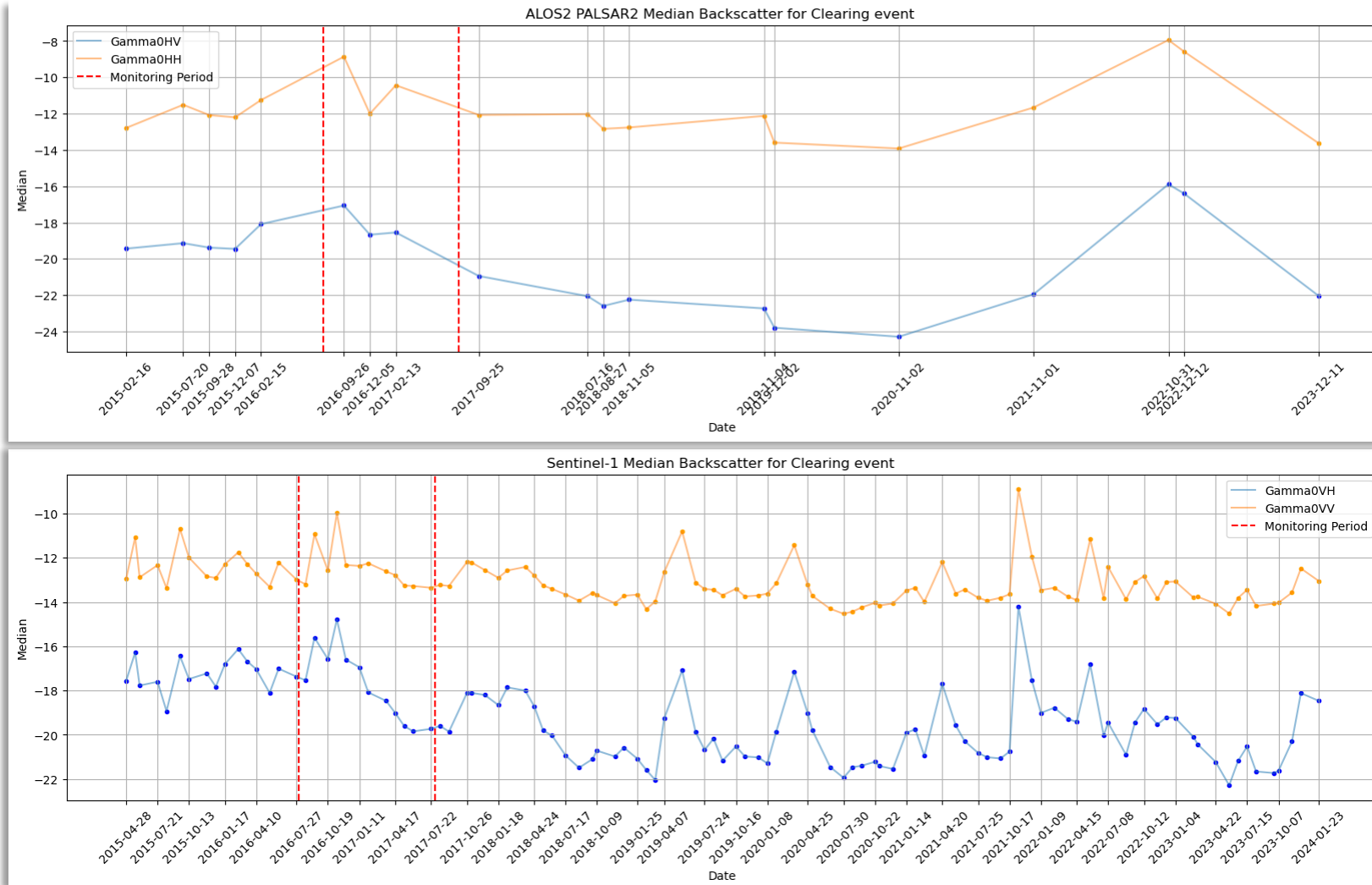


2017 Sep 08



S1 - VV:VH:VV

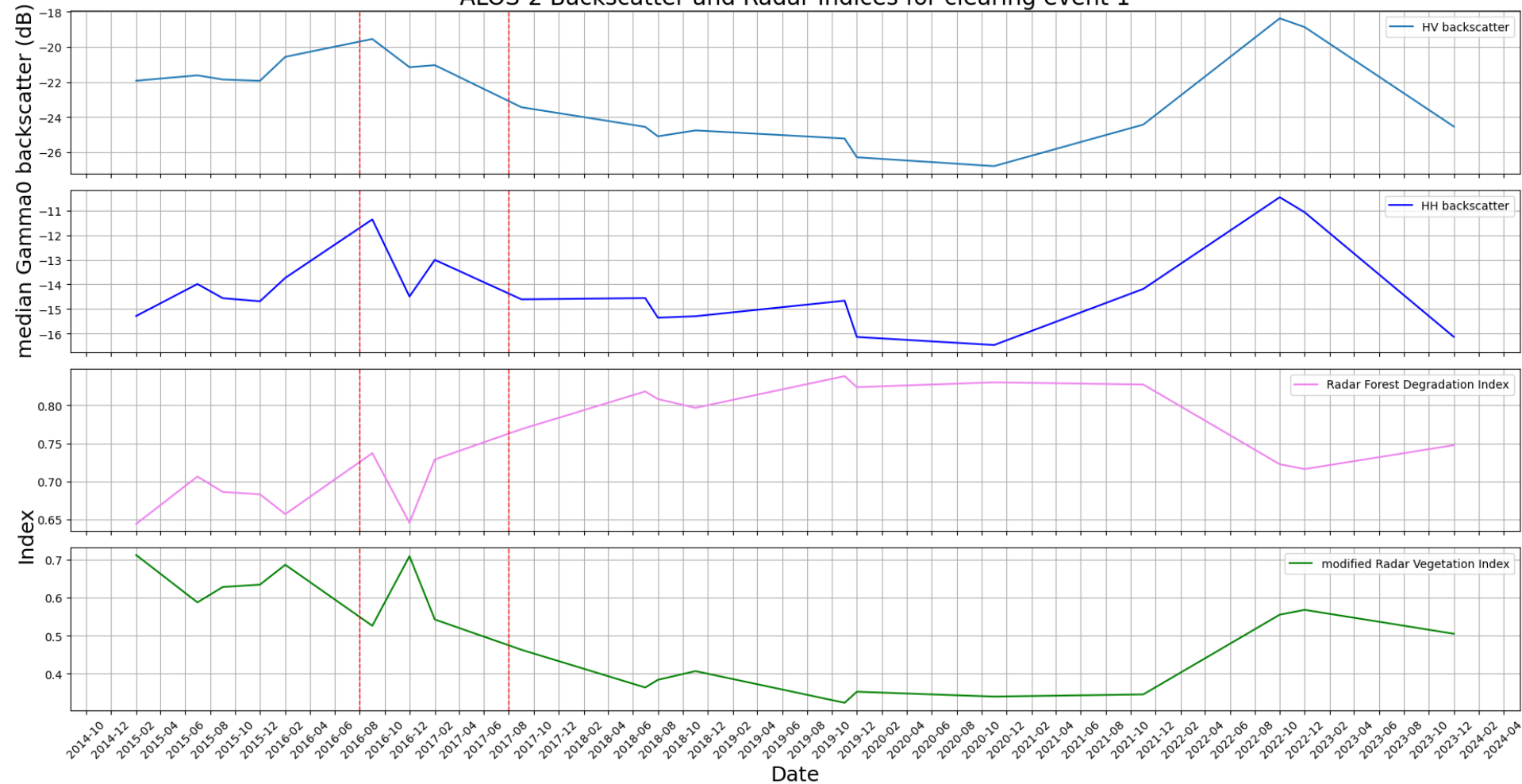
Findings



Change in both C and L band can reflect changes in structure on the ground

Indices

ALOS-2 Backscatter and Radar Indices for clearing event 1

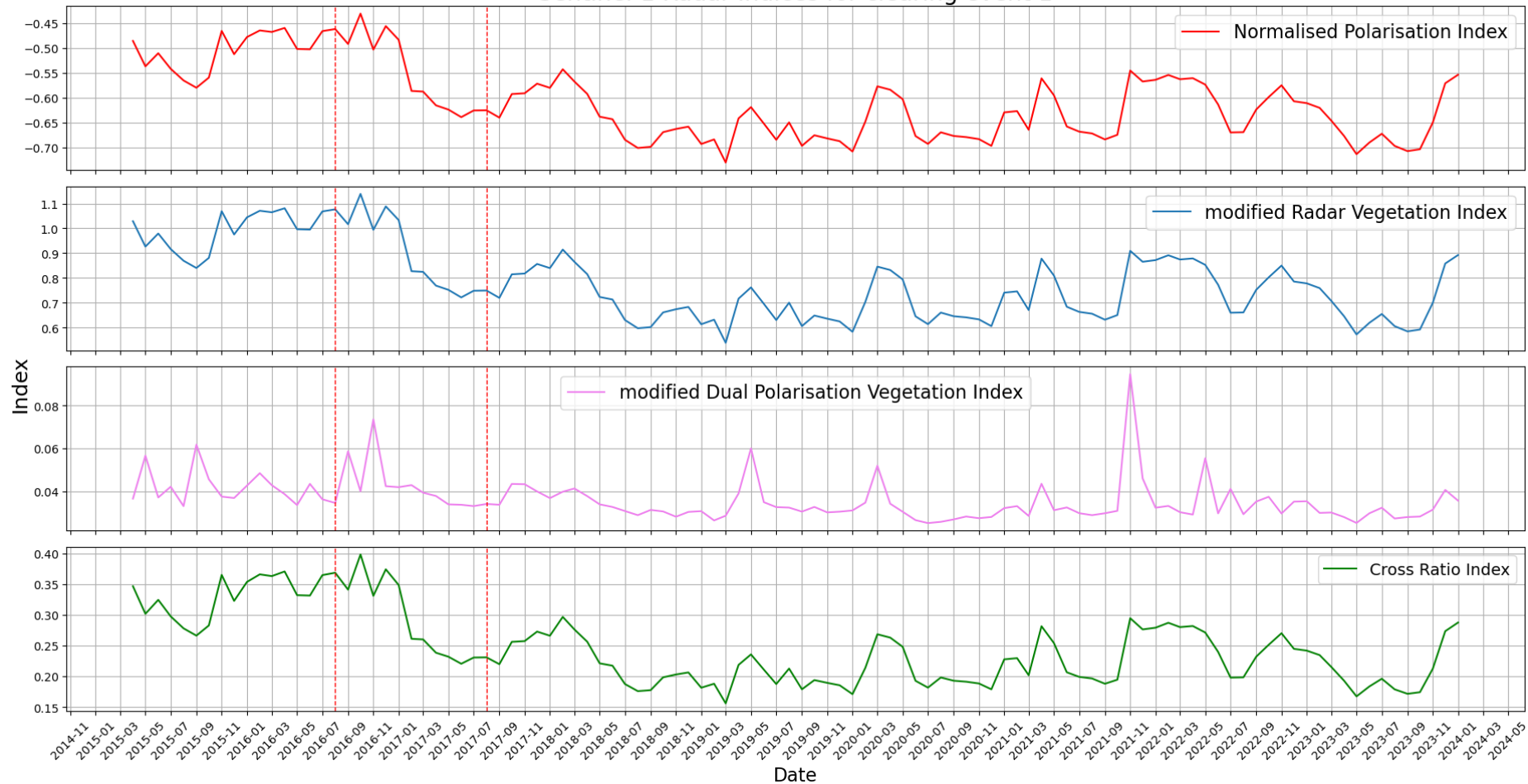


$$\frac{HH - HV}{HH + HV}$$

$$\frac{4 * HV}{HH + HV}$$

Indices

Sentinel-1 Radar Indices for clearing event 1



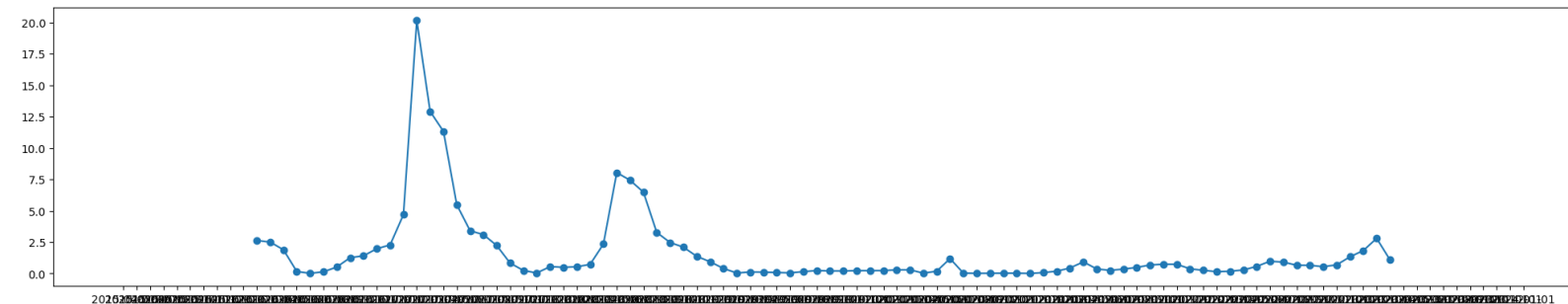
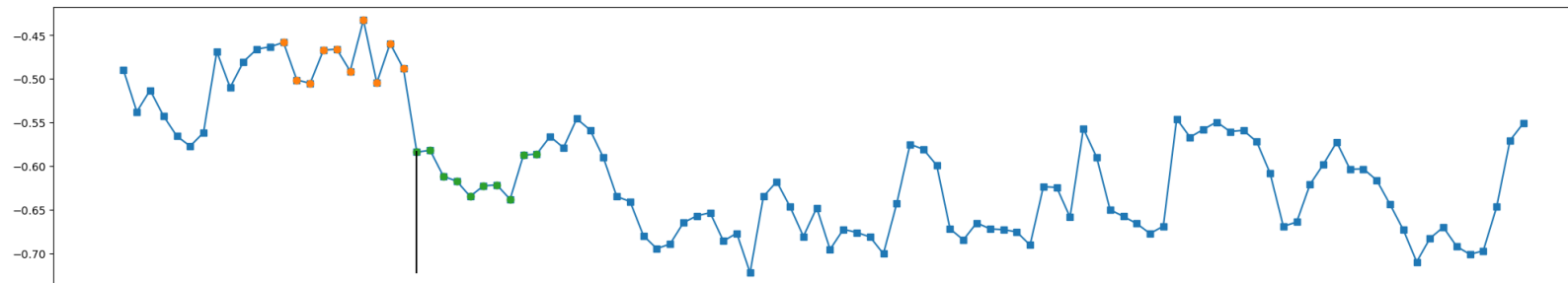
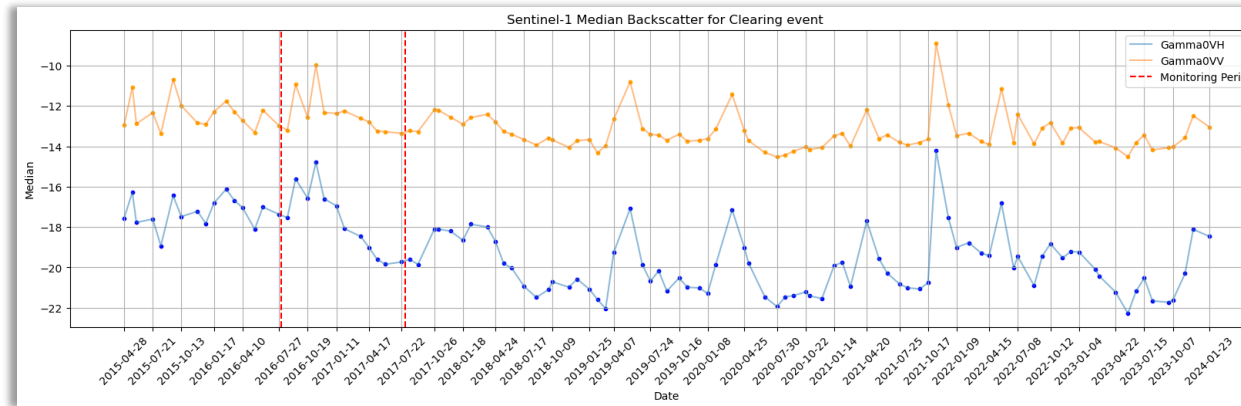
$$\frac{VH - VV}{VH + VV}$$

$$\frac{4 * VH}{VH + VV}$$

$$\frac{VV + VV * VH}{\sqrt{2}}$$

$$\frac{VH}{VV}$$

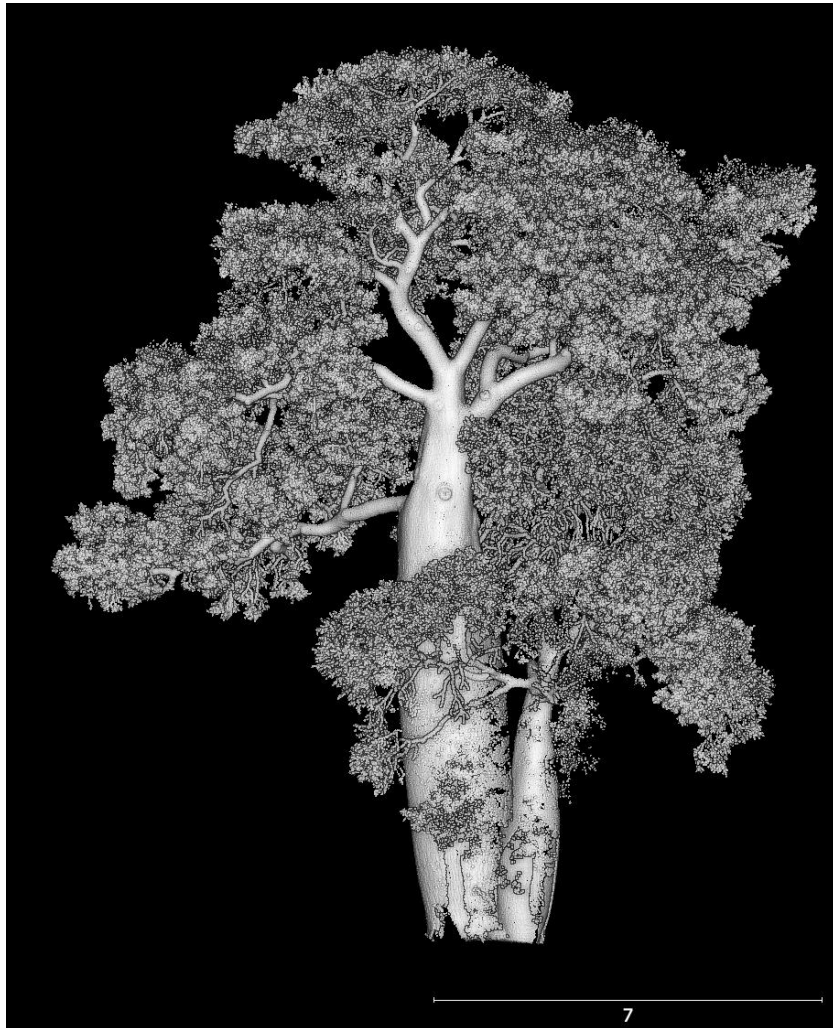
Change detection with Kullback-Leibler Divergence



Discussion and Future Plans

- C and L band are both suitable for detecting clearing events in a temperate woodland environment where vegetation can be sparsely distributed.
- Rainfall events and areas where the effects of soil moisture are newly exposed to the sensor are an issue
 - Try denser time series with KL divergence/Jensen-Shannon/
 - Happy to hear feedback and any suggestions/critiques
 - Thanks to JAXA for allowing me access to the data
 - Thanks to Anthea for including me in the her project

Thanks for listening



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