

K&C Phase 3 – Brief project essentials

Australian R&D Support to Global Forest and AGB Mapping

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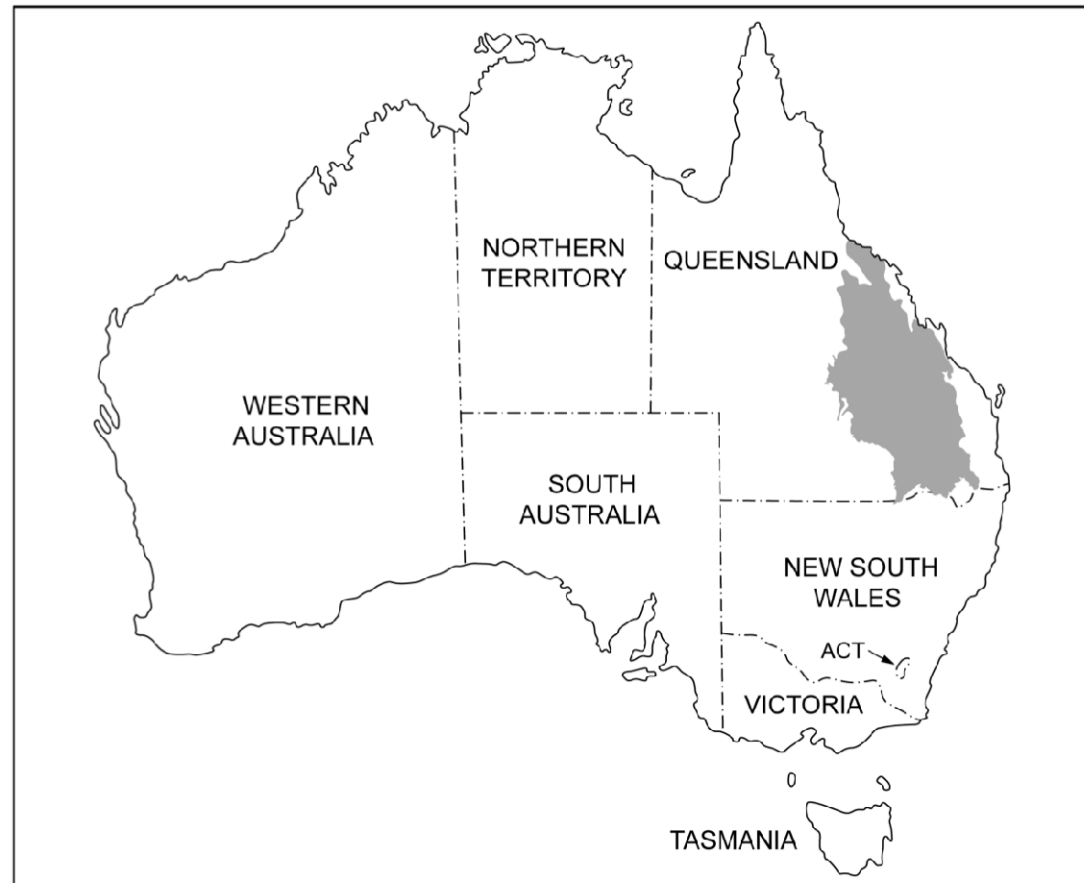
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Science Team meeting #16 – Phase 3 Kick-off
JAXA TKSC/RESTEC HQ, Tsukuba/Tokyo, October 17-21, 2011

Project area(s)

Focus initially on eastern and northern States of Australia (Queensland, NSW, the Northern Territory and Victoria) with a view to supporting extension Australia-wide



Project objectives and schedule

1. To provide Australian R&D support to the generation of JAXA's global forest/non-forest and above ground biomass (AGB) maps
2. To advance the development and validation of mapping algorithms using ALOS PALSAR data using:
 - | Annual statewide forest/non-forest maps (including woodlands) generated from Landsat-derived fractional cover time-series
 - | Field estimates of AGB generated for a range of remnant and non-remnant forests and woodlands
3. To support R&D:
 - | On quantification of **carbon stocks** held within the extensive tracts of woody vegetation within Australian and changes in these as a function of human-induced and natural events and processes including those linked with **climatic change** (e.g., cyclones, flooding, drought)
 - | On **conservation of biological diversity** by identifying regions of vegetation
 - | For **international conventions** including UNFCCC/Kyoto Protocol/REDD+

Project objectives and schedule

March 2012

- | Update minimum surface moisture mosaics using ALOS PALSAR FBD (HH+HV) mosaics at 25 m pixel spacing (2007, 2008, 2009, 2010 ++)
- | Recalibrate AGB retrieval algorithms with new field and image data
- | Produce Version 1.0 of a 25 m spatial resolution **AGB map for eastern and northern Australia** (single date) that is aligned with a JAXA global product
- | Australian field validation of the global AGB and forest/non-forest products generated by JAXA in association with TERN/Auscover activities in the states

March 2013

- | Selected case studies using ALOS PALSAR and/or JERS-1 SAR data for detecting change, either singularly or in combination with Landsat sensor data.
 - i Focus on the Injune and Charters Towers Study Sites
 - i Areas affected by cyclones, droughts, flooding and fire
- | Production of Version 1.0 of a 25 m map of forest and also woodland extent that is aligned with the JAXA global product

March 2014

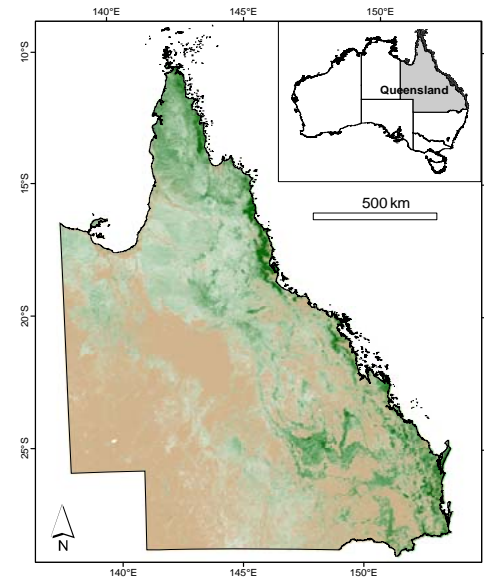
- | **Version 2.0 of a 25 m AGB map** aligned with the JAXA global product
- | **Version 2.0 of a 25 m forest and also woodland extent map** aligned with the JAXA global product
- | If the detection of change in AGB and structural change from ALOS PALSAR is deemed a significant improvement, **Version 1.0 of AGB change maps** will be generated (originally planned for 2015)

Support to JAXA's global forest mapping effort

1. Focus on Queensland, New South Wales, Victoria and the Northern Territory but ultimately Australia
 1. Maps of forest (including woodland) and non-forest generated annually as part of QDERM and by other State Agencies.
 2. Estimates of AGB for Queensland and other states through provision of data associated with the biomass library
 3. Collaboration and exchange between Aberystwyth University, Australian organisations and JAXA

Project Deliverables

- Versions 1.0 and/or 2.0 of:
 - | **AGB map (25 m spatial resolution) for eastern and northern Australia** (single date) that is aligned with a JAXA global product
 - | **Forest and woodland map** that is aligned with the JAXA global product
 - | **Forest/woodland and AGB change maps** will be generated (originally planned for 2015)



□ Why investigate ALOS PALSAR?

- | Interaction of L-band with dominant size and density of trees in Queensland ecosystems

- | Systematic acquisition strategy and data continuity

- ⇒ Consistent sensor and acquisition configuration
- ⇒ Acquisitions during Queensland dry season

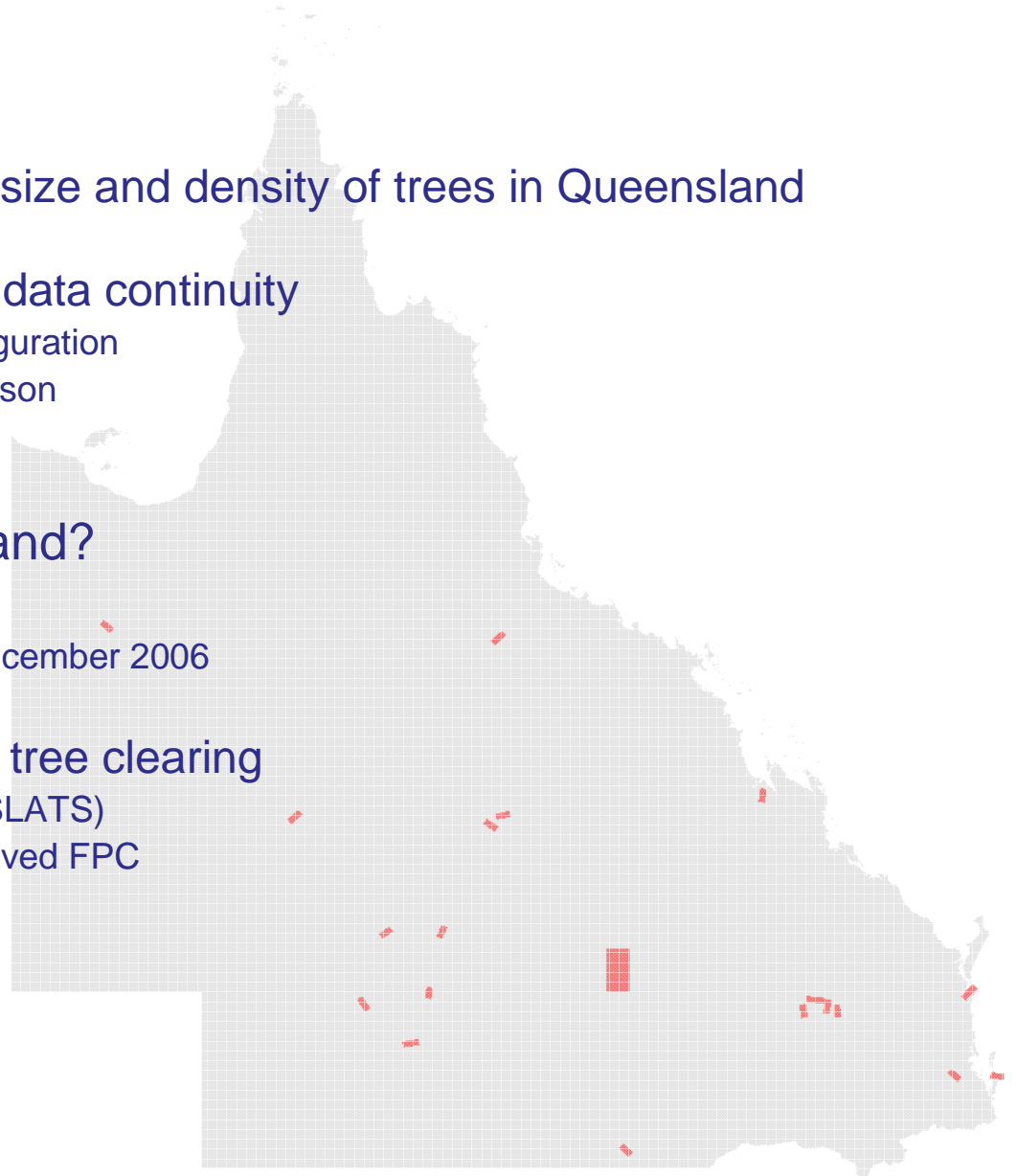
□ What's driven this work in Queensland?

- | Vegetation Management Act

- ⇒ End of broad-scale remnant clearing December 2006
- ⇒ Regrowth clearing moratorium 2009

- | Reporting on carbon losses through tree clearing

- ⇒ Statewide Landcover and Tree Study (SLATS)
- ⇒ Current approach relies on Landsat-derived FPC



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Biomass library - 1139 sites (2781 plots)

Brigalow Forest Regrowth



Open Callitris Forest



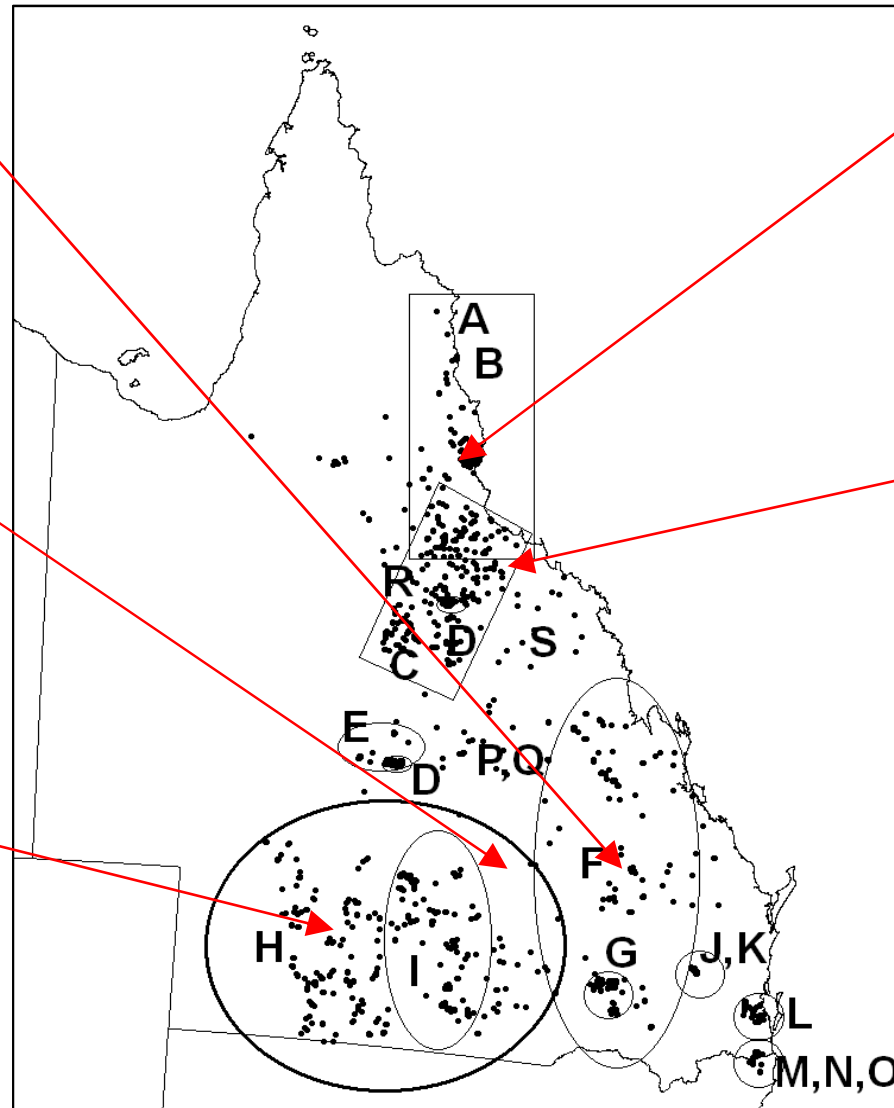
Low Acacia Woodland



Tall Closed Rainforest



Eucalypt Woodland

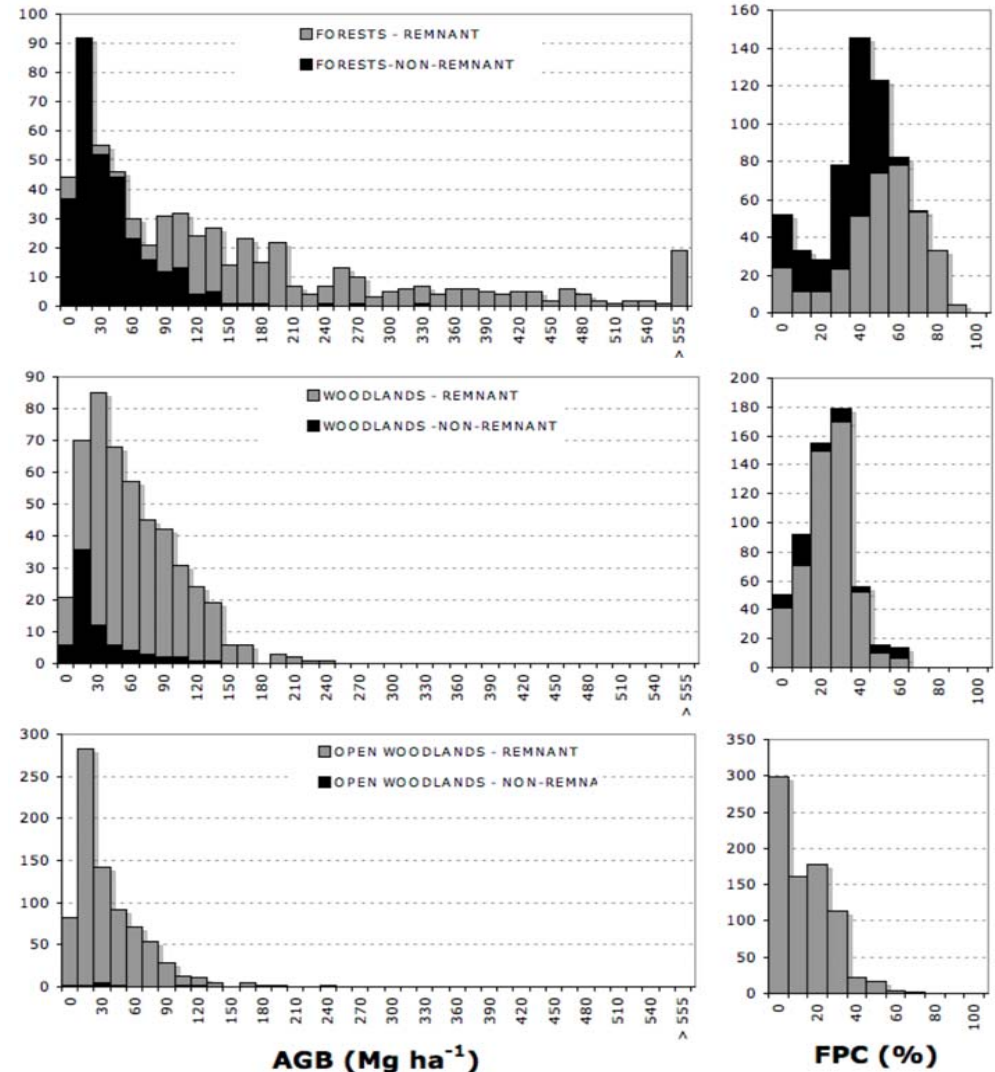


□ *Post hoc* data analysis

- | Allometric equations evaluated for Australian tree species
- | Corrections for conditions of dead trees and minor differences in size class
- | Variable plot sizes (400 m² to 1 ha)

□ Distribution of AGB

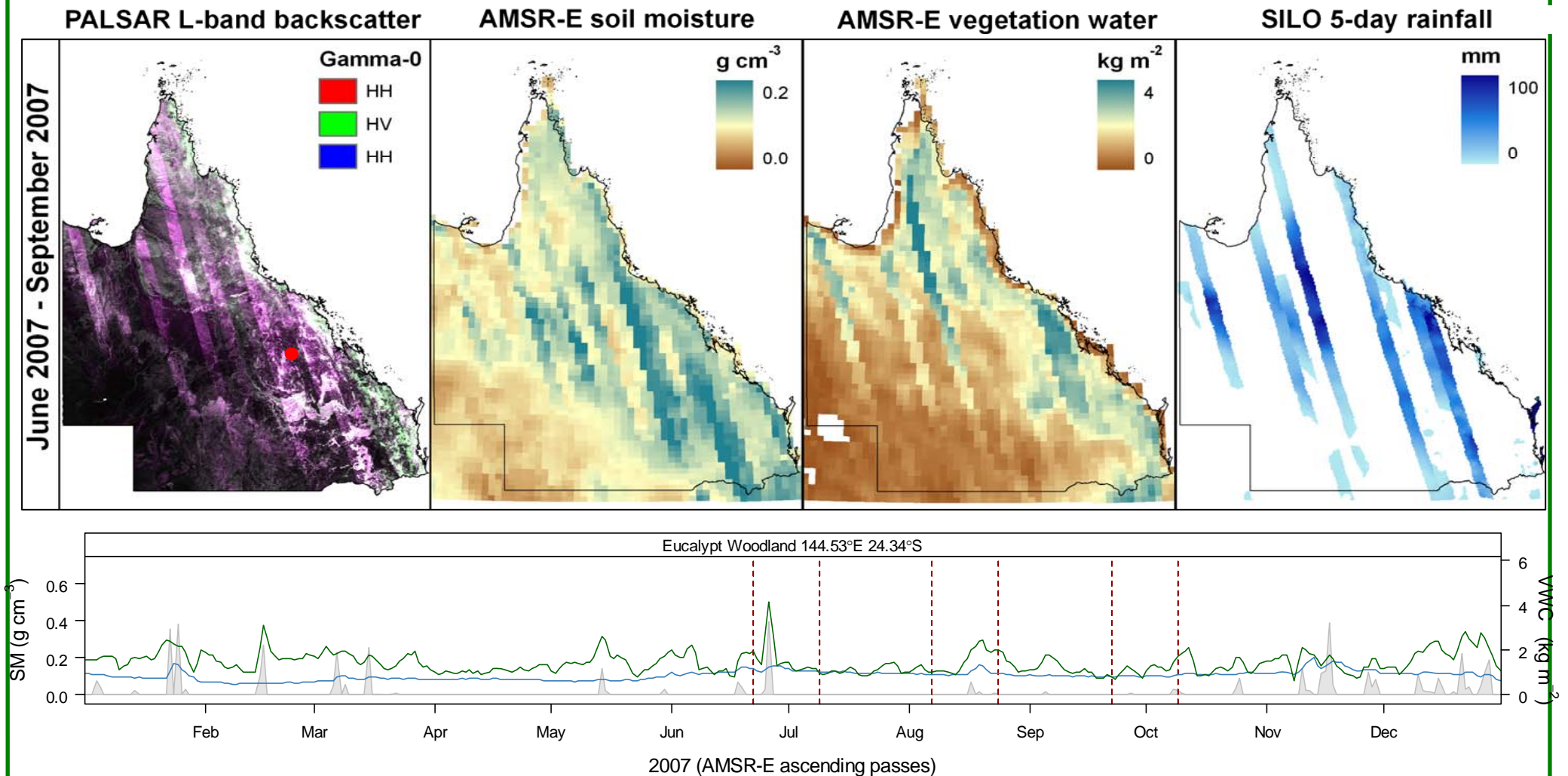
- | AGB > 250 Mg ha⁻¹ in forests
- | Non-remnant stands typically < 200 Mg ha⁻¹
- | Open woodlands have naturally low biomass (< 100 Mg ha⁻¹)
- | Low representation of non-remnant open woodland stands



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- Independent comparison with surface moisture and rainfall datasets
→ Environmental conditions are important



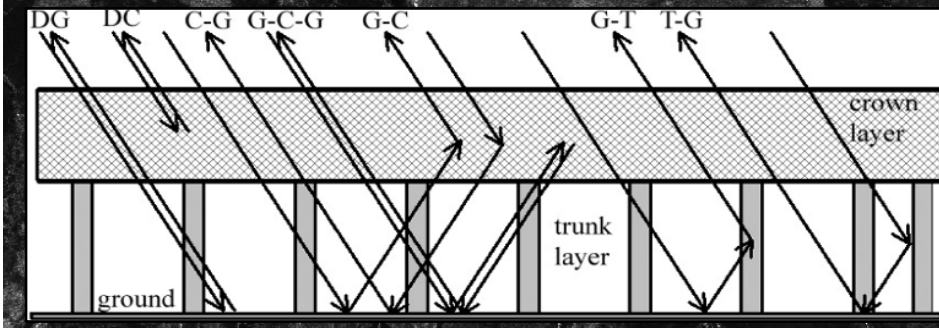
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AMSR-E

RSP 374
2007/07/21
L-HH

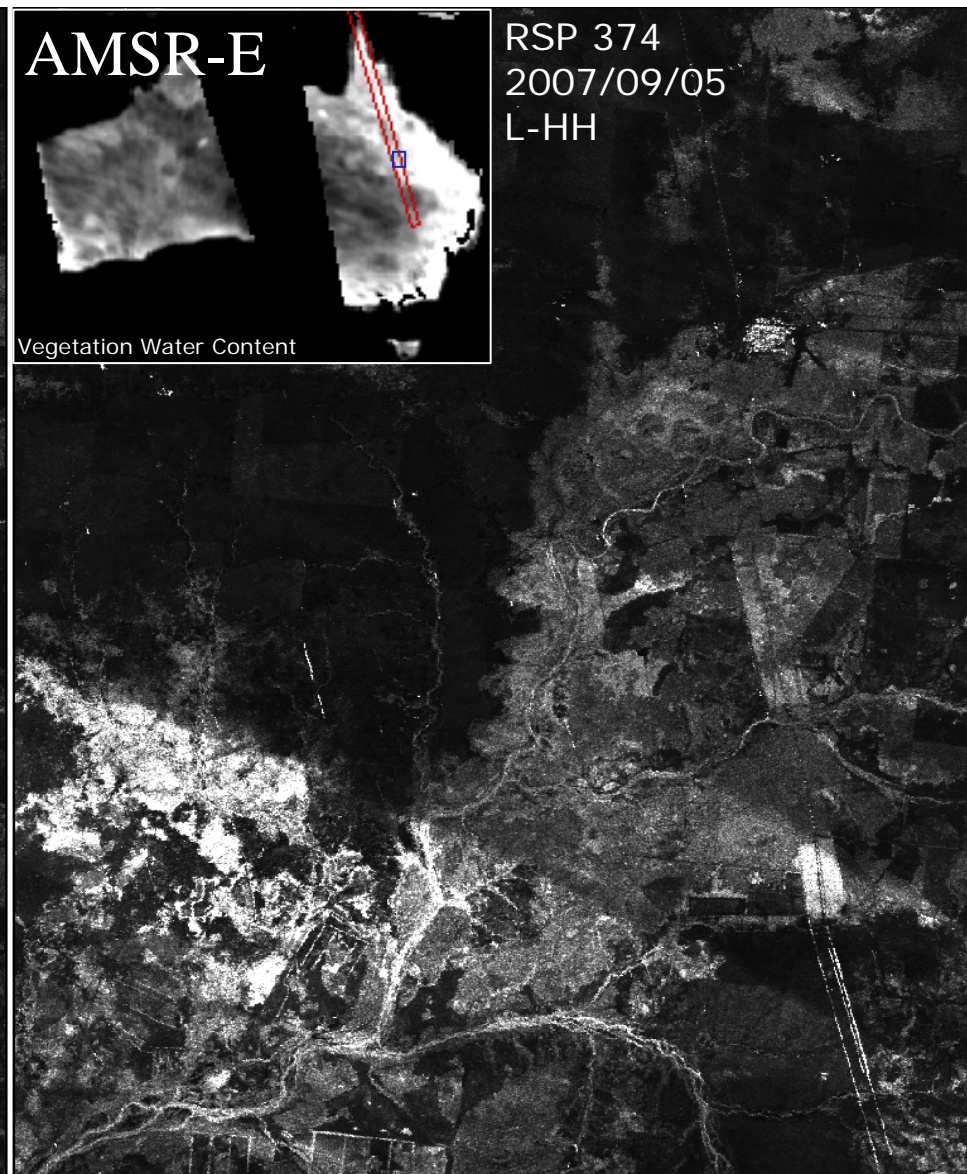
Vegetation Water Content



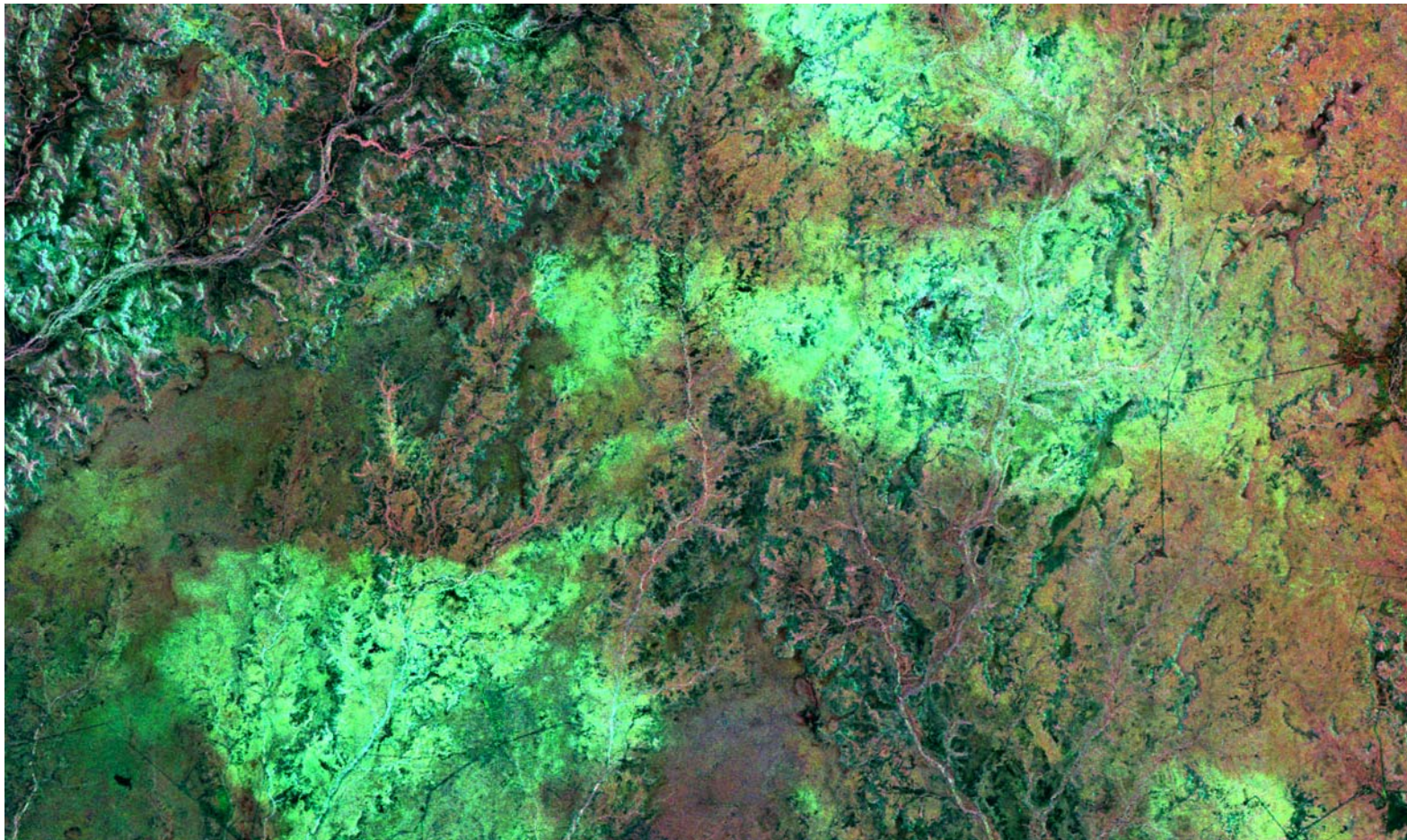
AMSR-E

RSP 374
2007/09/05
L-HH

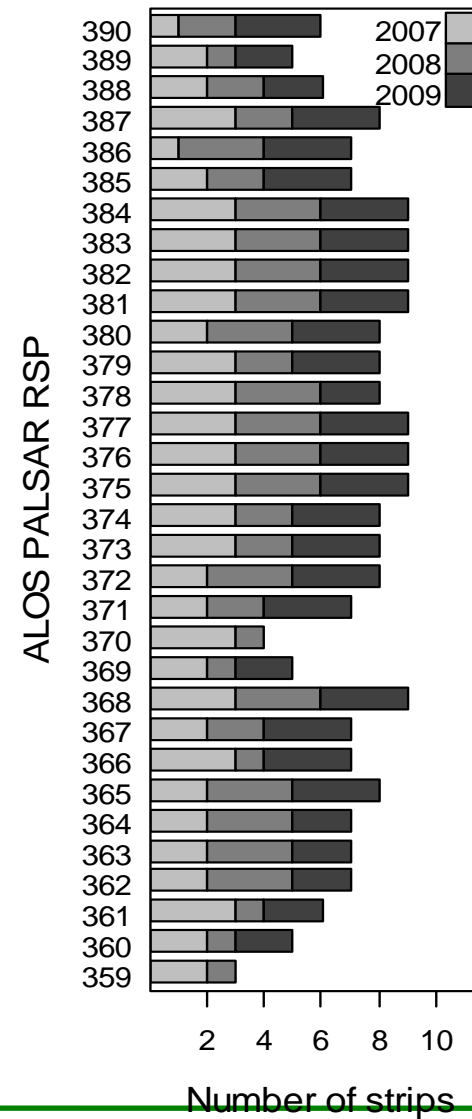
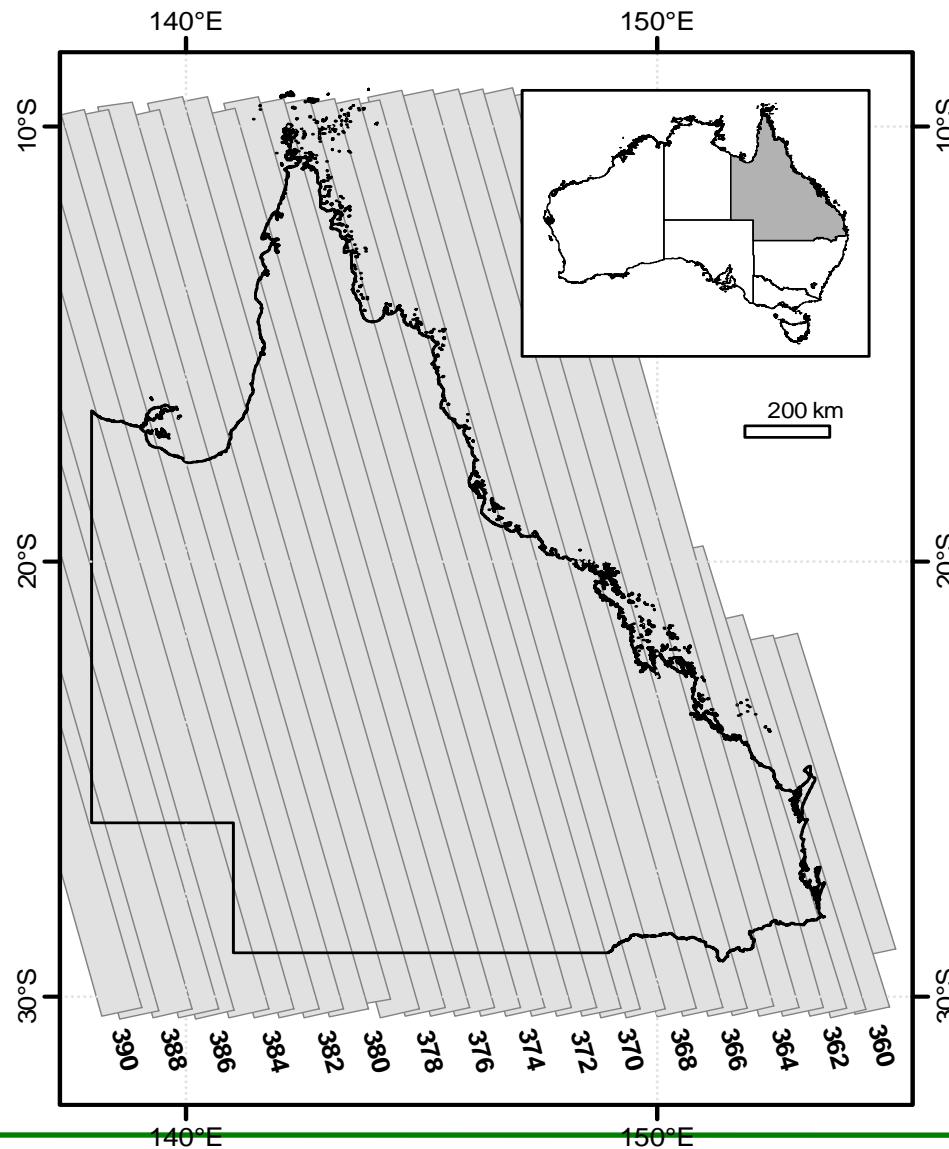
Vegetation Water Content



Rainfall impacts: FPC, L-band HH and HV

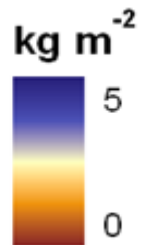
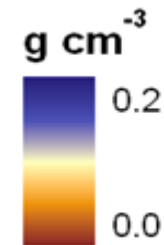


- Extra dates provided by JAXA for investigation of moisture effects

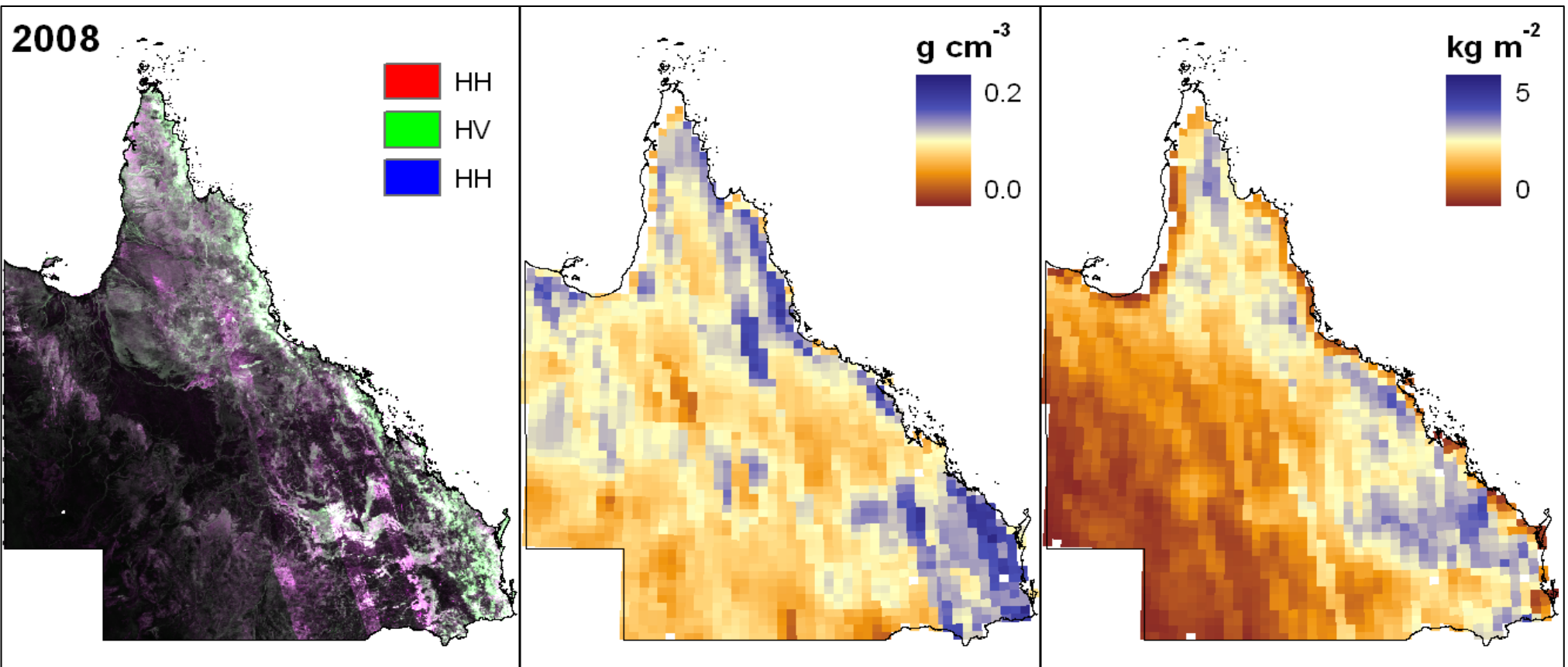


- Annual mosaics from 2007 to 2009
 - Used strip dates captured under driest conditions
 - Mosaic for 2010 possible

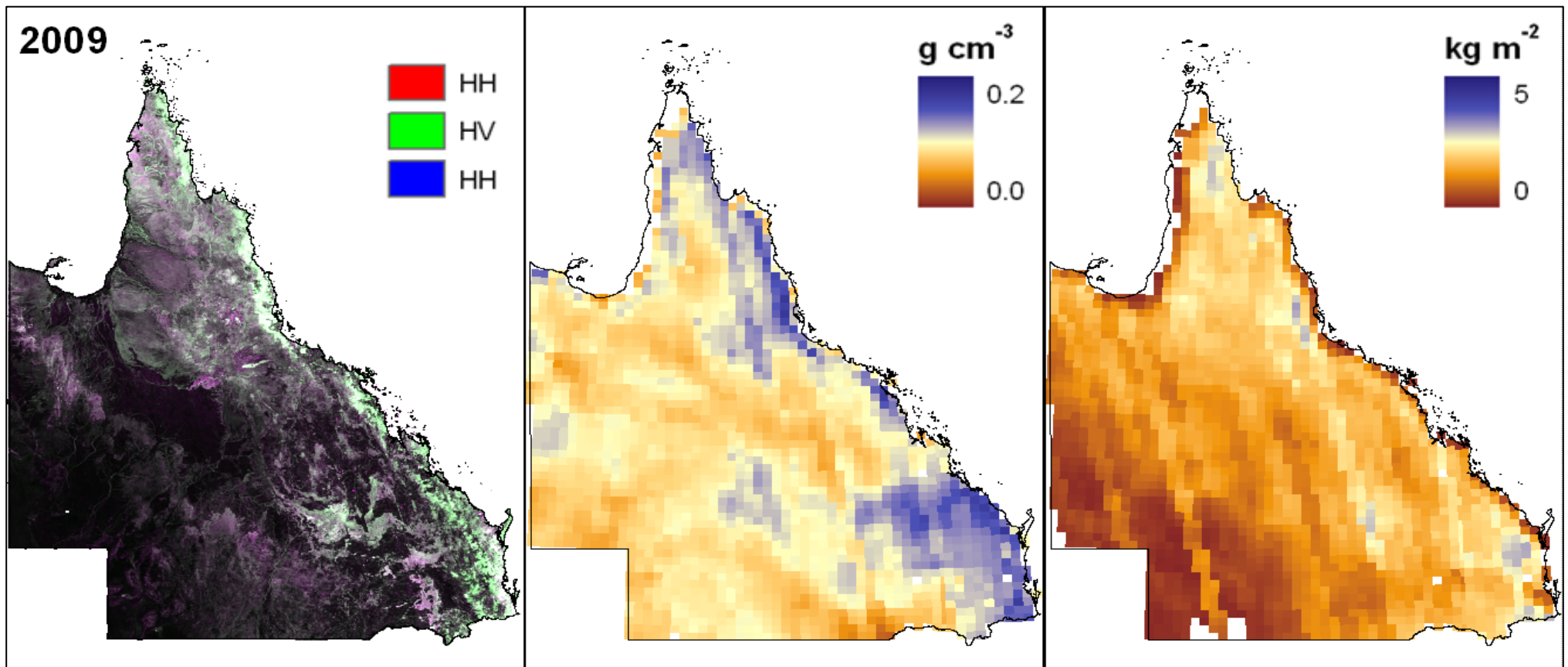
2007

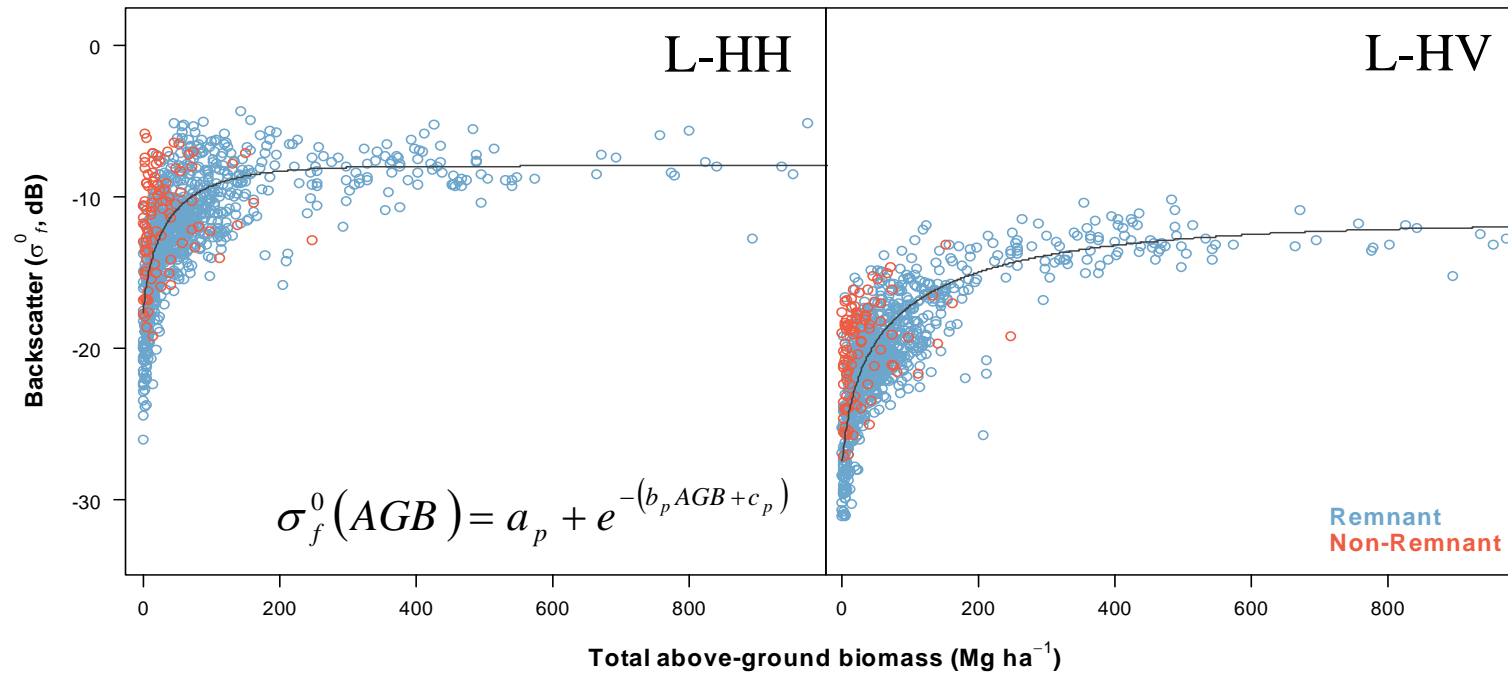


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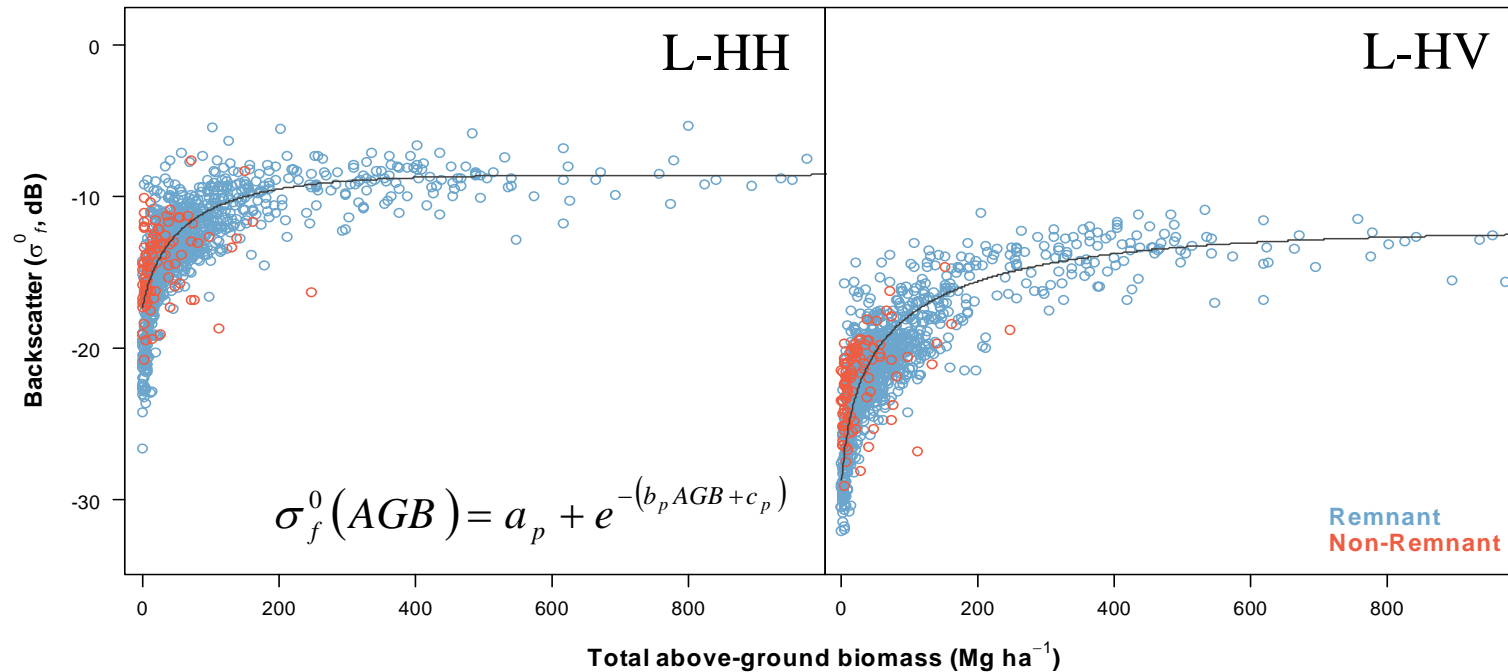


- Annual mosaics from 2007 to 2009
 - Used strip dates captured under driest conditions
 - Mosaic for 2010 possible



Maximum vegetation water content

Remnant	Saturation AGB (Mg ha^{-1})	Saturation (dB)	RMSE (dB)	Dynamic range (dB)
L-HV (dry)	247	-14.8	2.29	11.3
L-HV (wet)	232	-14.4	2.34	11.2
L-HH (dry)	136	-10.1	2.05	8.87
L-HH (wet)	111	-9.35	2.36	9.18

Minimum vegetation water content

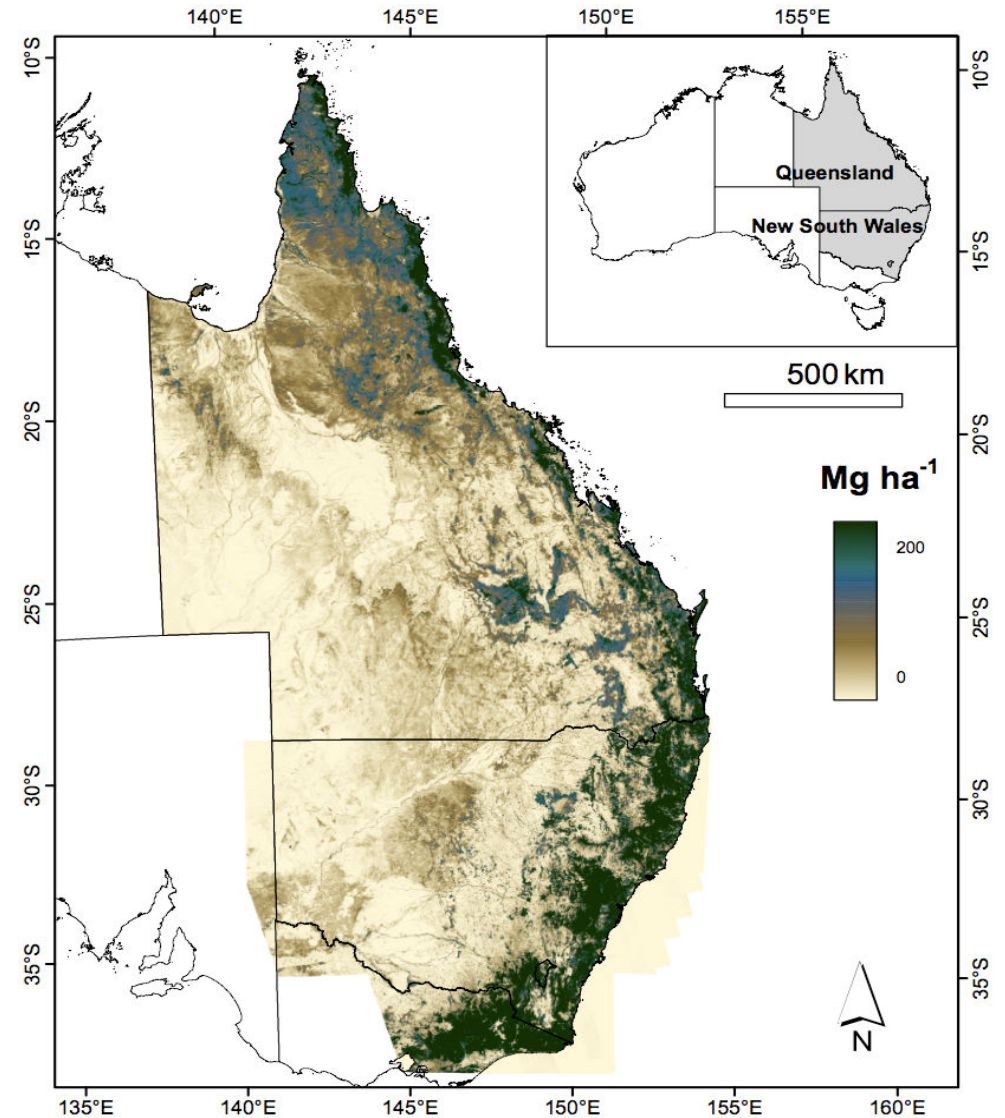
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□ Qld + NSW (2009)

- Estimation using L-band HV
- 50 m spatial resolution
- Minimum moisture conditions
- Saturation at 263 Mg ha^{-1}
@ 20% estimation error
- Validation critical

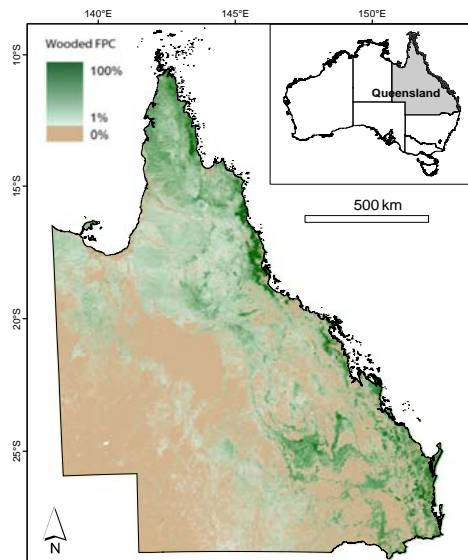
□ Factors of uncertainty

- Saturation level
- Structure and moisture variations
- Preprocessing limitations
- Local anomalies

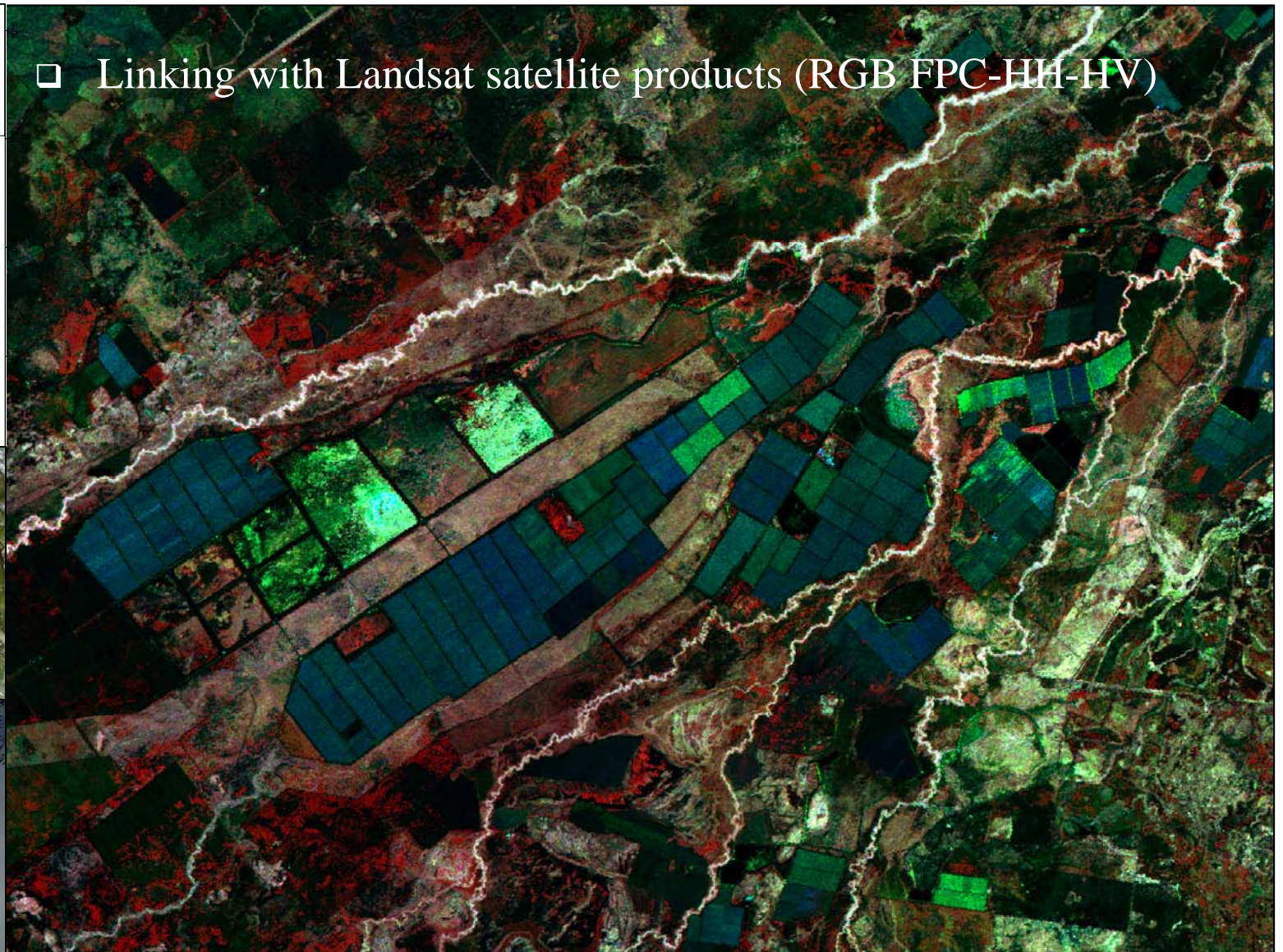


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□ Linking with Landsat satellite products (RGB FPC-HH-HV)



70% foliage cover



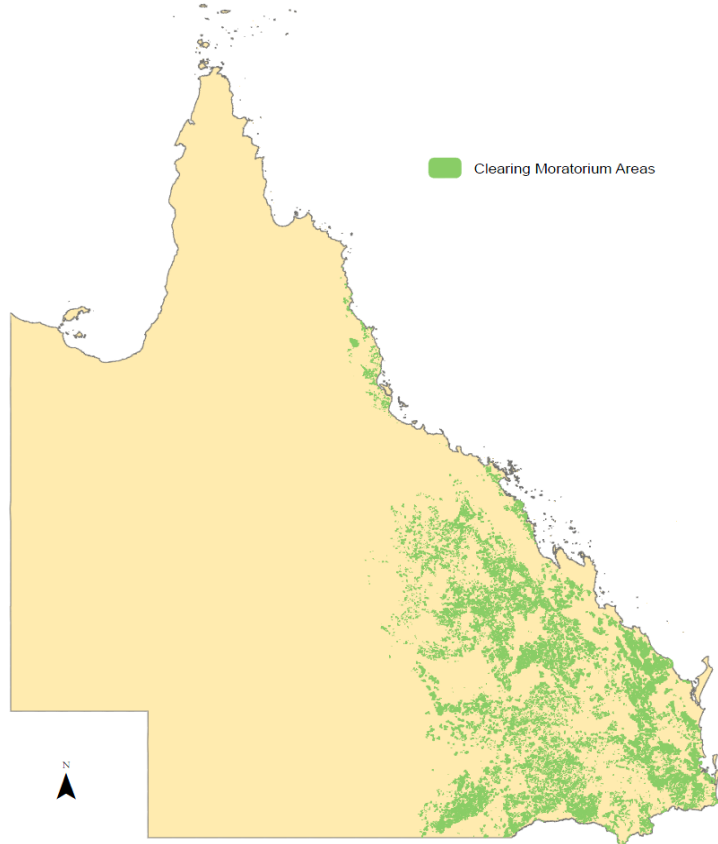
6% foliage cover



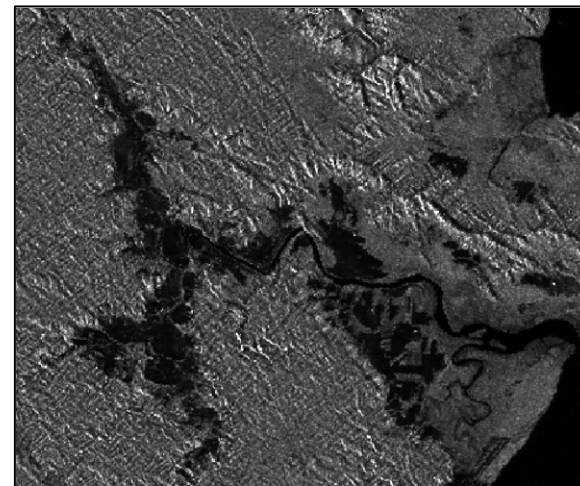
Woody extent mapping

Areas Subject to 2009 Queensland Government Moratorium
on Clearing Non-Remnant Woody Vegetation Occurring
on Endangered Regional Ecosystems

Clearing Moratorium Areas



Landsat
FPC

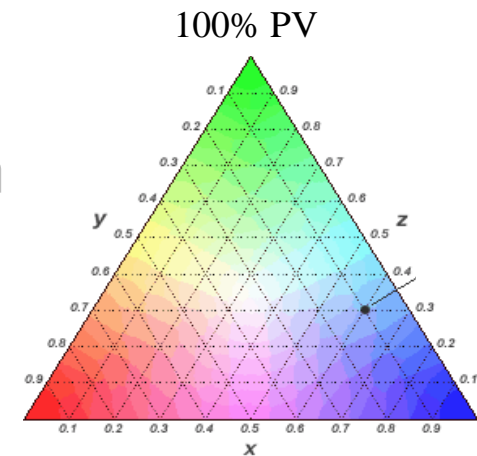


PALSAR
L-HV

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Integrating
fractional
information



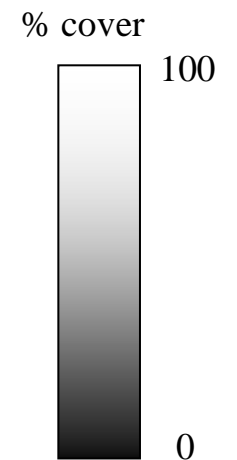
100% Bare

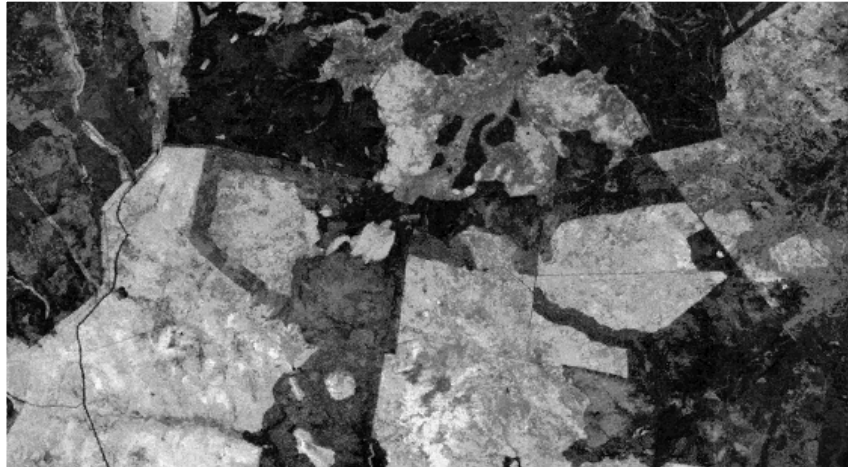
100% NPV

PV

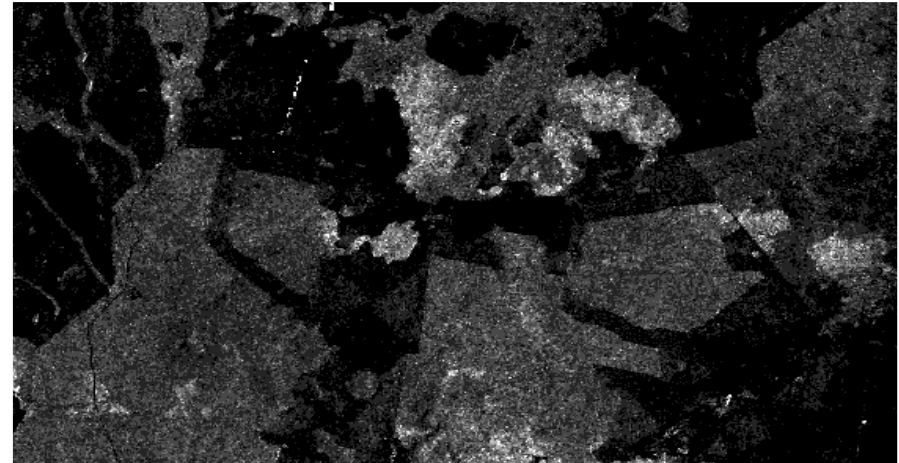
NPV

Bare

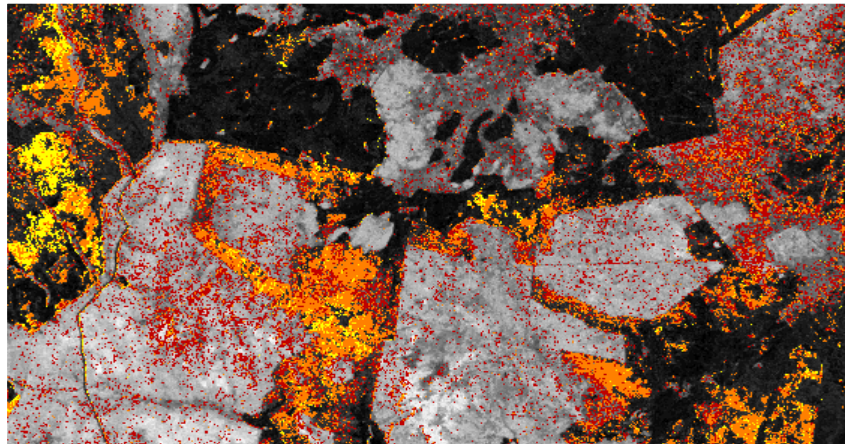




Landsat Foliage Projected Cover
(Woody vegetation defined as $> 12\%$ FPC)

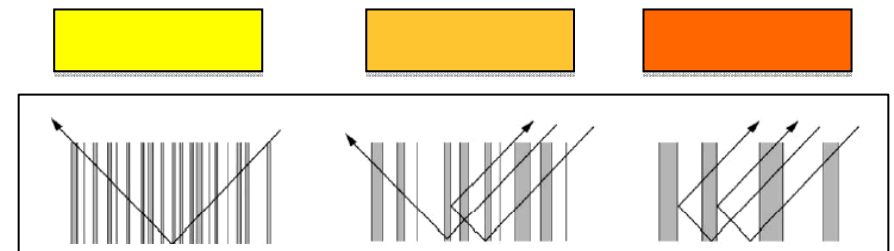


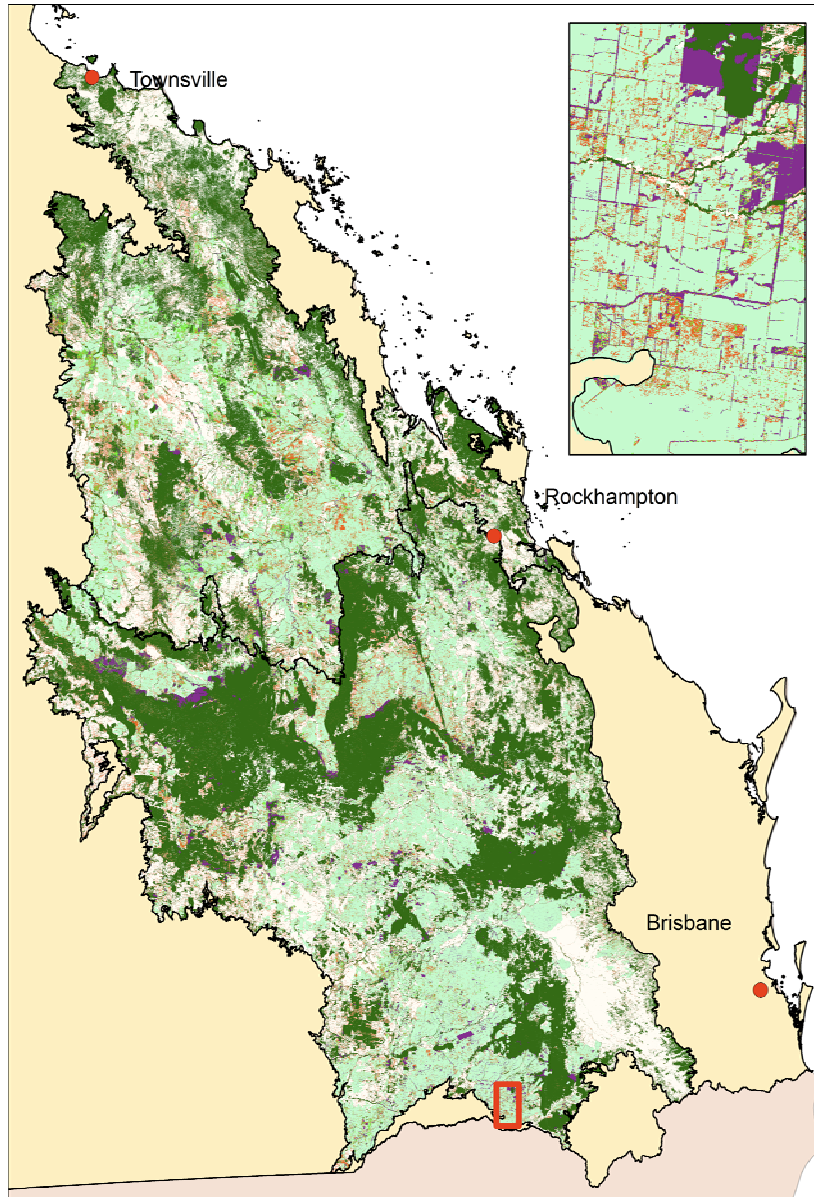
ALOS PALSAR L-band HH



Regrowth mapping

Stages of structural development



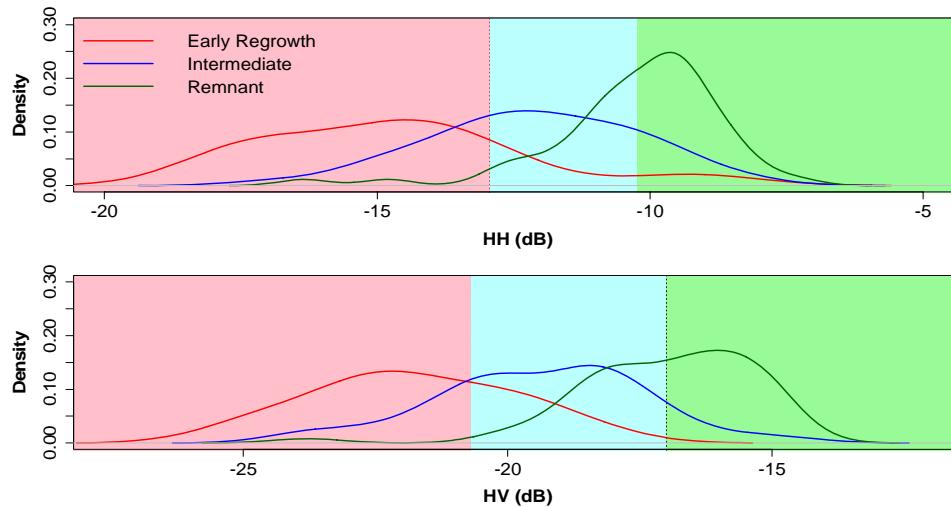


Regrowth stage mapping

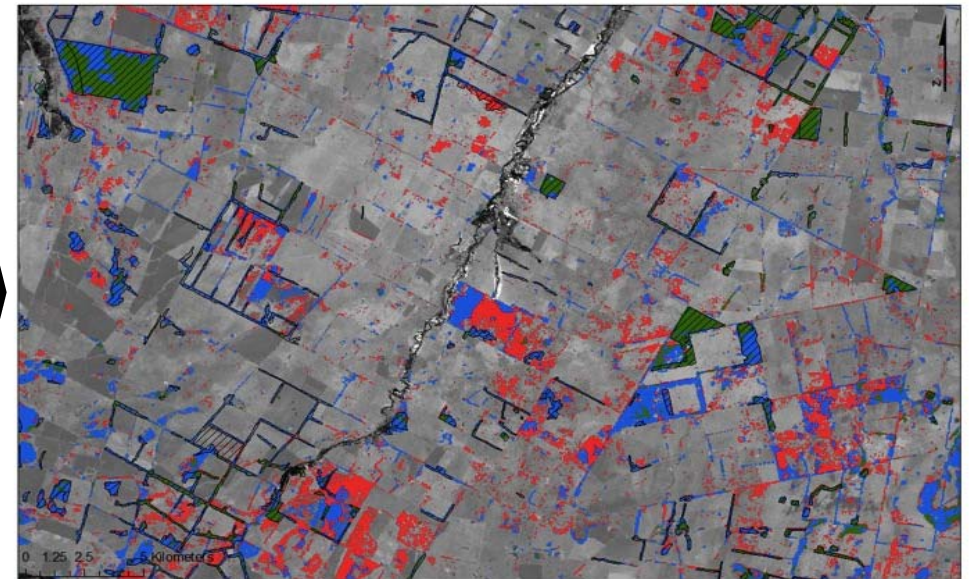
Uses combination of ALOS PALSAR L-band HH, HV and FPC

Initially based on thresholds for discriminating early and intermediate regrowth from remnant (mature) forest

Revised based on relative distribution of data values



- Distribution of backscatter values from field plots compared to those from objects
- Used to create fuzzy classification for each regrowth stage
- Thresholds applied to create regrowth stage map



Remnant (Dominant)
Remnant (Sub-dominant)

HH Lower than Remnant

HH Higher than Remnant

Pre Clearing Brigalow Extent
Remnant (Dominant)
Remnant (Sub-dominant)
Early Regrowth
Intermediate
Remnant

RETRIEVAL OF FOREST STRUCTURE AND BIOMASS FROM RADAR DATA USING BACKSCATTER MODELLING AND INVERSION

DANIEL CLEWLEY

A thesis submitted in fulfilment of the requirements for the degree of Doctor of
Philosophy

Friday 23rd September, 2011

Aberystwyth University

Supervisors: Professor Richard Lucas, Dr Pete Bunting and Professor Mahta
Moghaddam

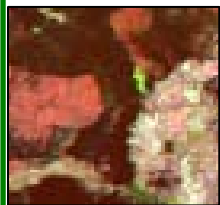


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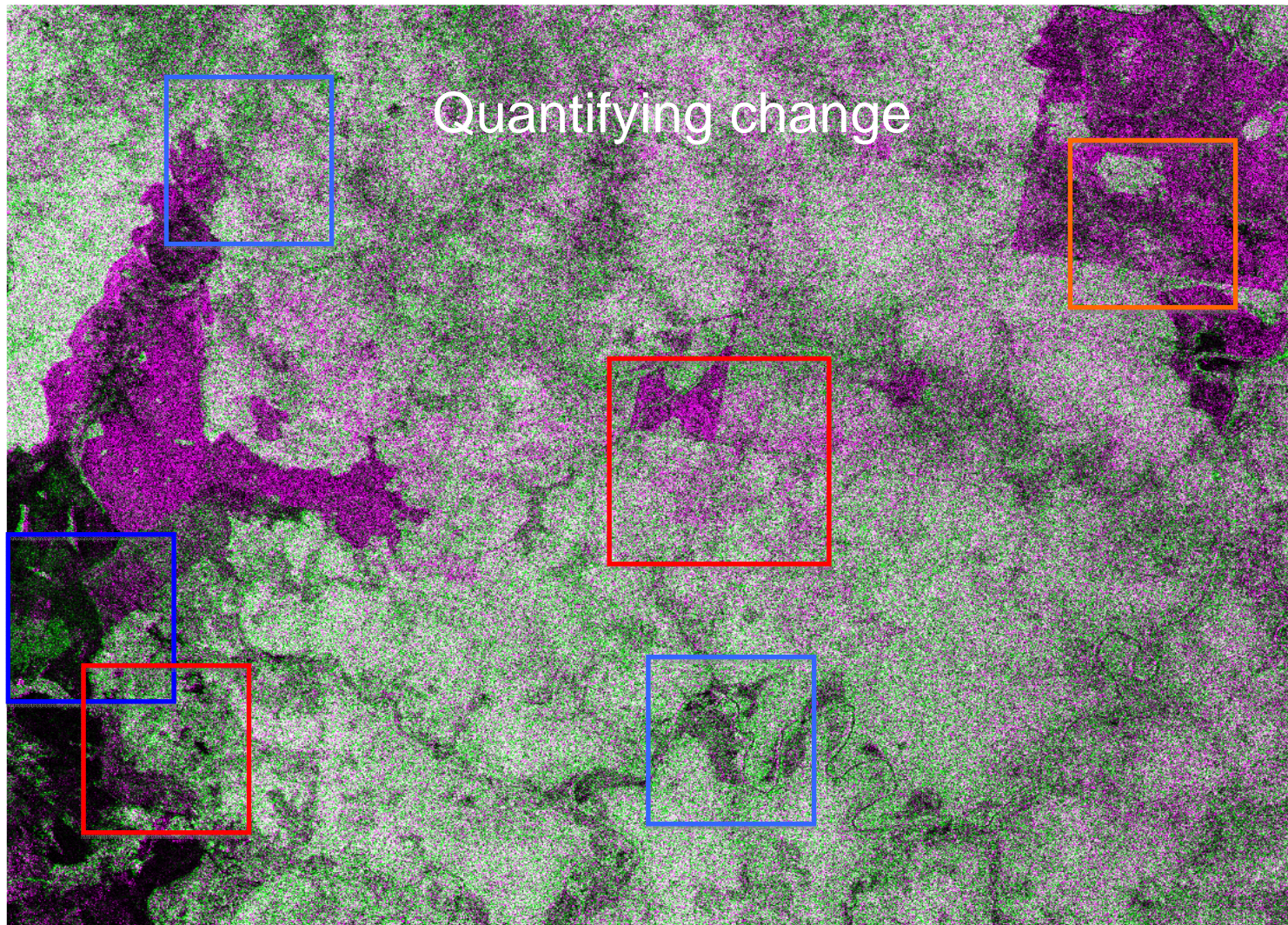
Regrowth
after fire



Regrowth
Following
clearance



Tree death
(stem injection)



Clearing



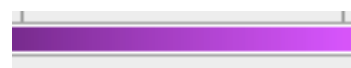
Fire
damage



Thickening?

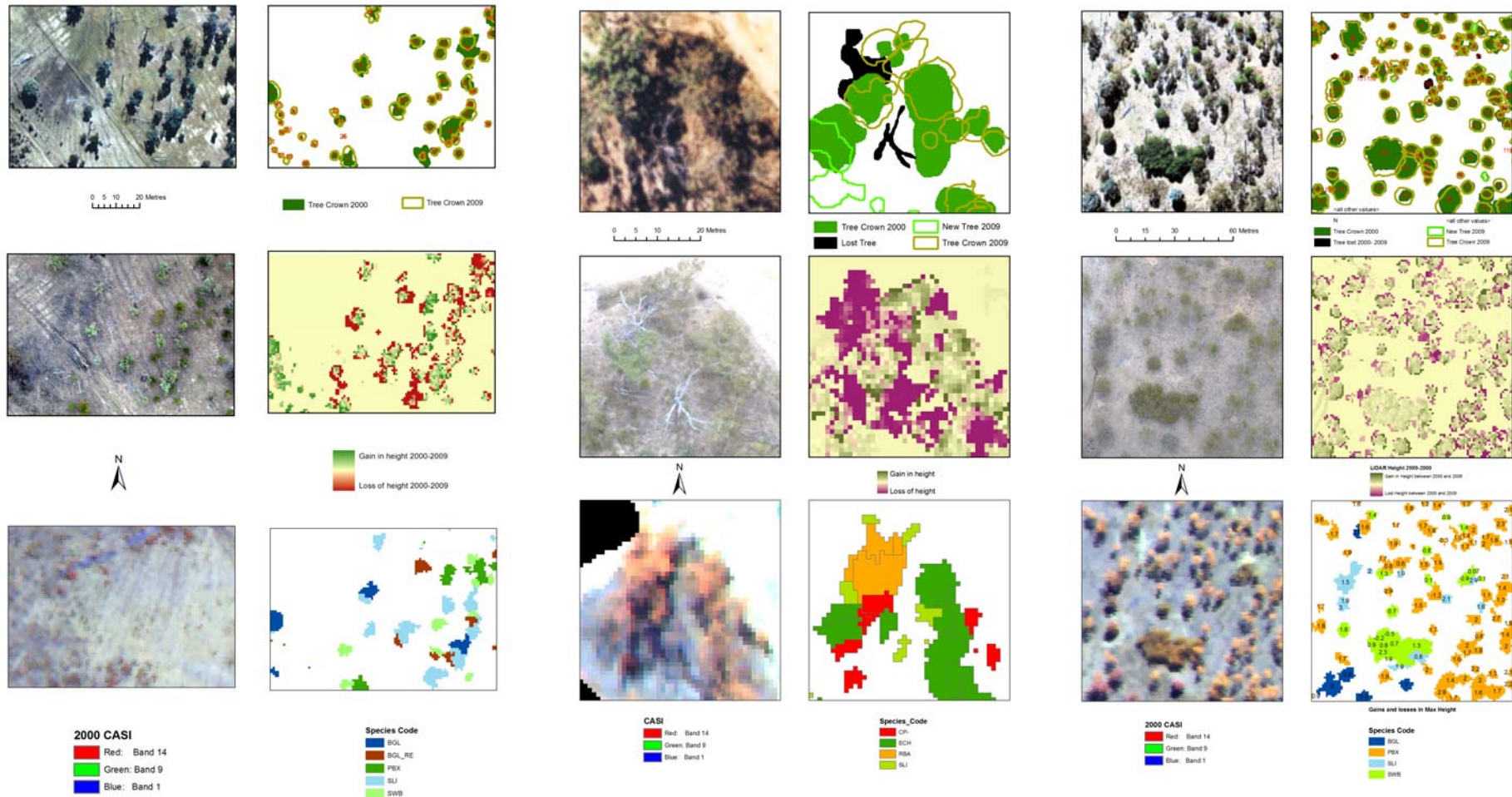


Relative Increases from
1995



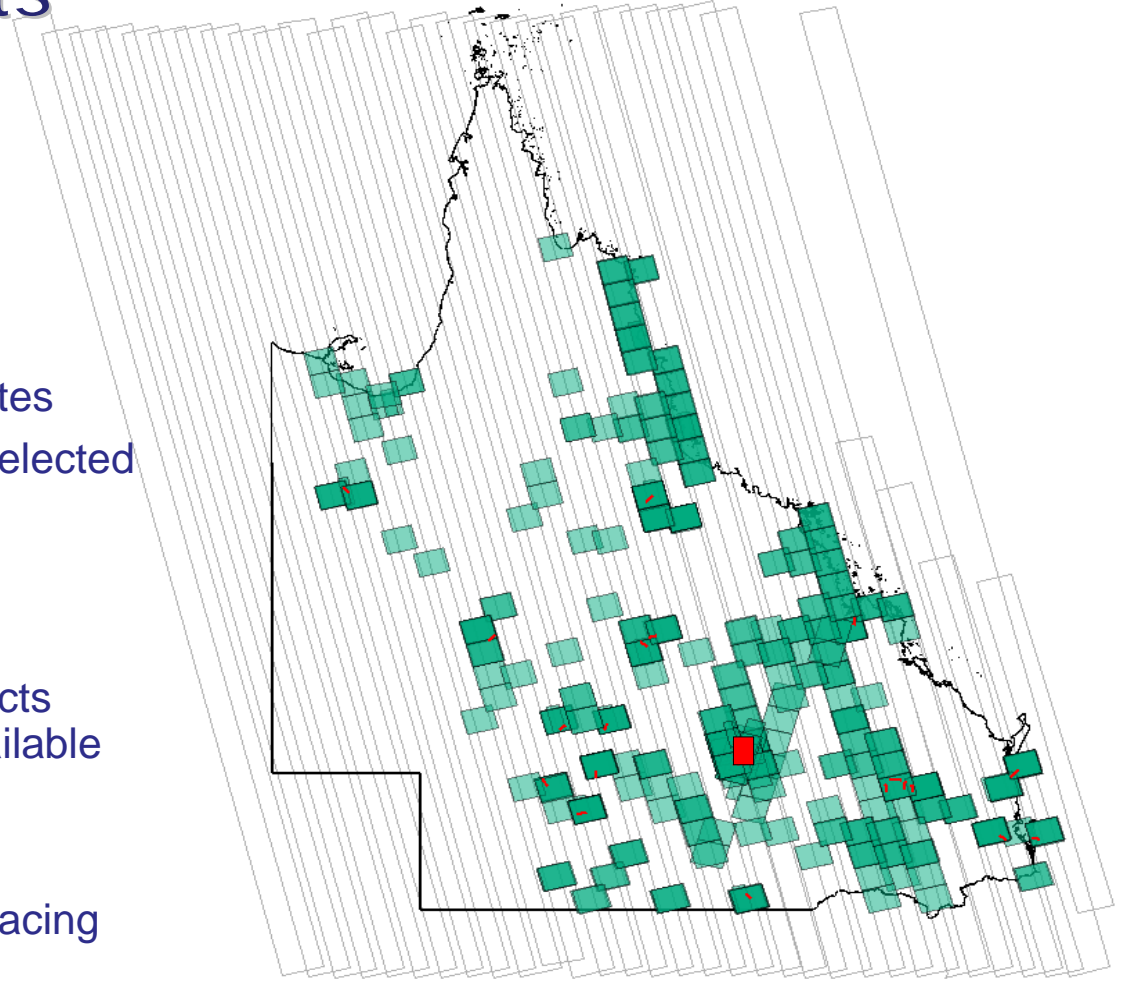
Relative decreases
from 1995

Change Detection based on time series of HR data, Injune



Ideal data requirements

- PALSAR K&C Level 1.1 25 m strip data
 - | FBD 2007-2010 (extending to Victoria)
- PALSAR Level 1.0 scene data (FBD)
 - | minimum moisture dates at CAL/VAL sites
 - | to maintain complete time-series over selected monitoring sites
- ALOS PALSAR FBD (HH+HV) products
 - | forest/non-forest and AGB global products (2007, 2008, 2009, 2010, ++ or just available dates) over validation sites
- JERS-1 SAR (HH) mosaics at 25 m pixel spacing (mid 1990s)



❑ Collaborators

- AusCover/Terrestrial Ecosystem Research Network (TERN)
- Aberystwyth University, Aberystwyth, UK
- The Joint Remote Sensing Research Program
 - ⇒ Department of Geography, Planning and Environmental Management, The University of Queensland
 - ⇒ Queensland Department of Environment and Resource Management (QDERM)
 - ⇒ New South Wales Department of the Environment, Climate Change and Water (DECCW)
 - ⇒ Victorian Department of Sustainability and Environment (DSE)
- The Northern Territory Department of Natural Resources, The Arts and Sport and Bushfires NT

❑ Acknowledgments

- João Carreiras (IICT)
- Jack Kelley, John Dwyer, Teresa Eyre, Melinda Laidlaw (Qld Herbarium)
- Michiala Bowen (University of Queensland)
- Steven Bray (DEEDI)
- Dan Metcalfe (CSIRO)
- Masanobu Shimada (JAXA)