A photograph of a sunlit rainforest path. Sunlight rays (crepuscular rays) filter through the dense canopy of tall trees, creating a dramatic, hazy atmosphere. The path is covered in fallen leaves and surrounded by lush green vegetation and ferns. The overall scene is serene and emphasizes the beauty and complexity of a rainforest environment.

# Environmental controls of rainforest floristics: Climate change implications for the Gondwana rainforests

Dr Melinda Laidlaw  
Queensland Herbarium and Biodiversity Science  
Department of Environment, Science and Innovation

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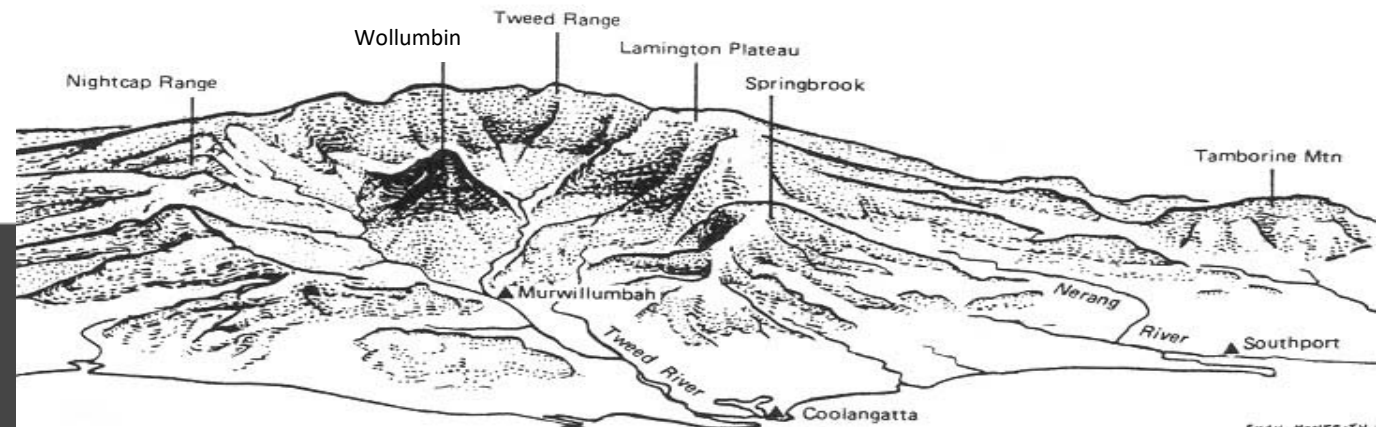
We acknowledge and pay respect to the  
land and the traditional families of the  
Yugambah language group



## Gondwana Rainforests of Australia World Heritage Area

- Gondwana Rainforests WHA, a serial property of 40 conservation reserves, approx. 600km north to south
- archipelago of upland rainforest remnants fragmented by a drying climate, fire and most recently, land clearing for farming
- remains the largest area of subtropical rainforest globally
- an important refuge for ancient lineages of flora and fauna and endemic species
- threatened by climate change

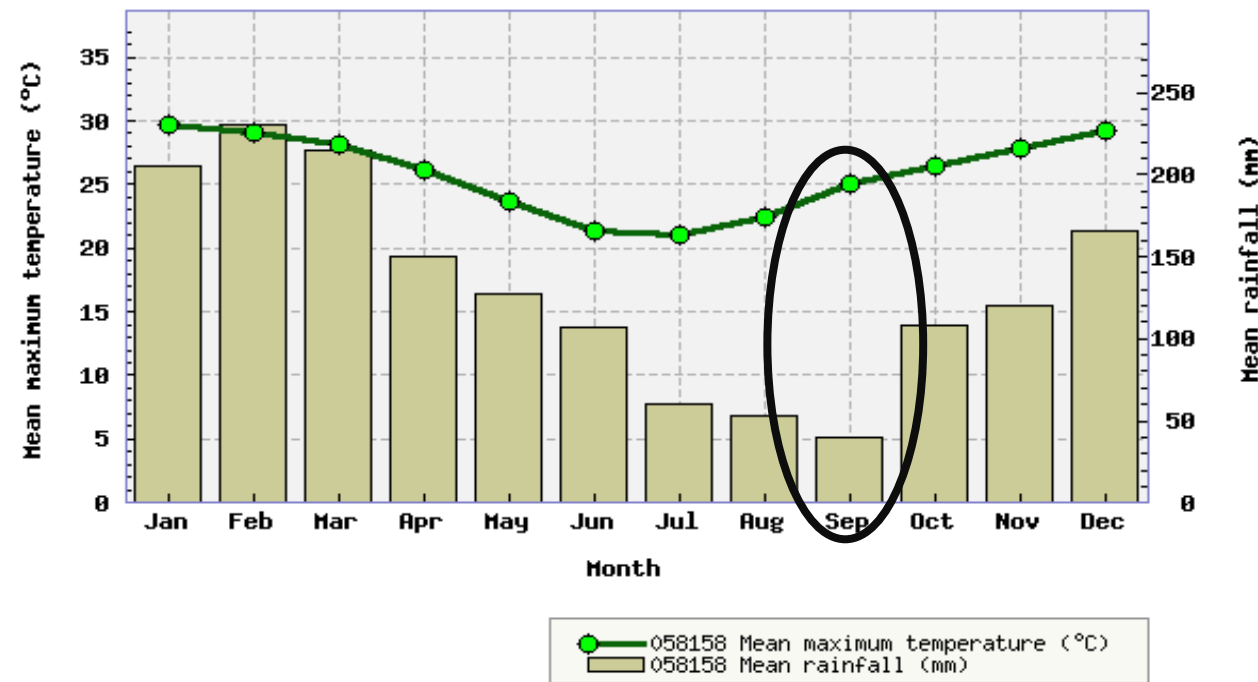
# Tweed Caldera – largest erosion caldera in the southern hemisphere



# September dry season

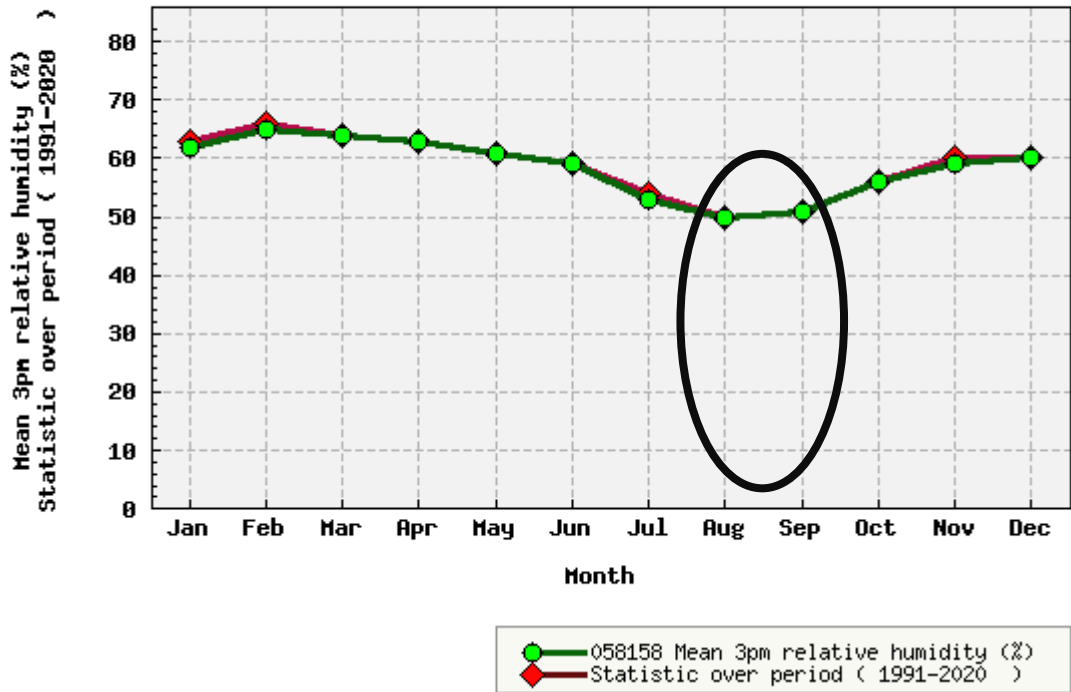
## Rainfall and temperature

Location: 058158 MURWILLUMBAH (BRAY PARK)

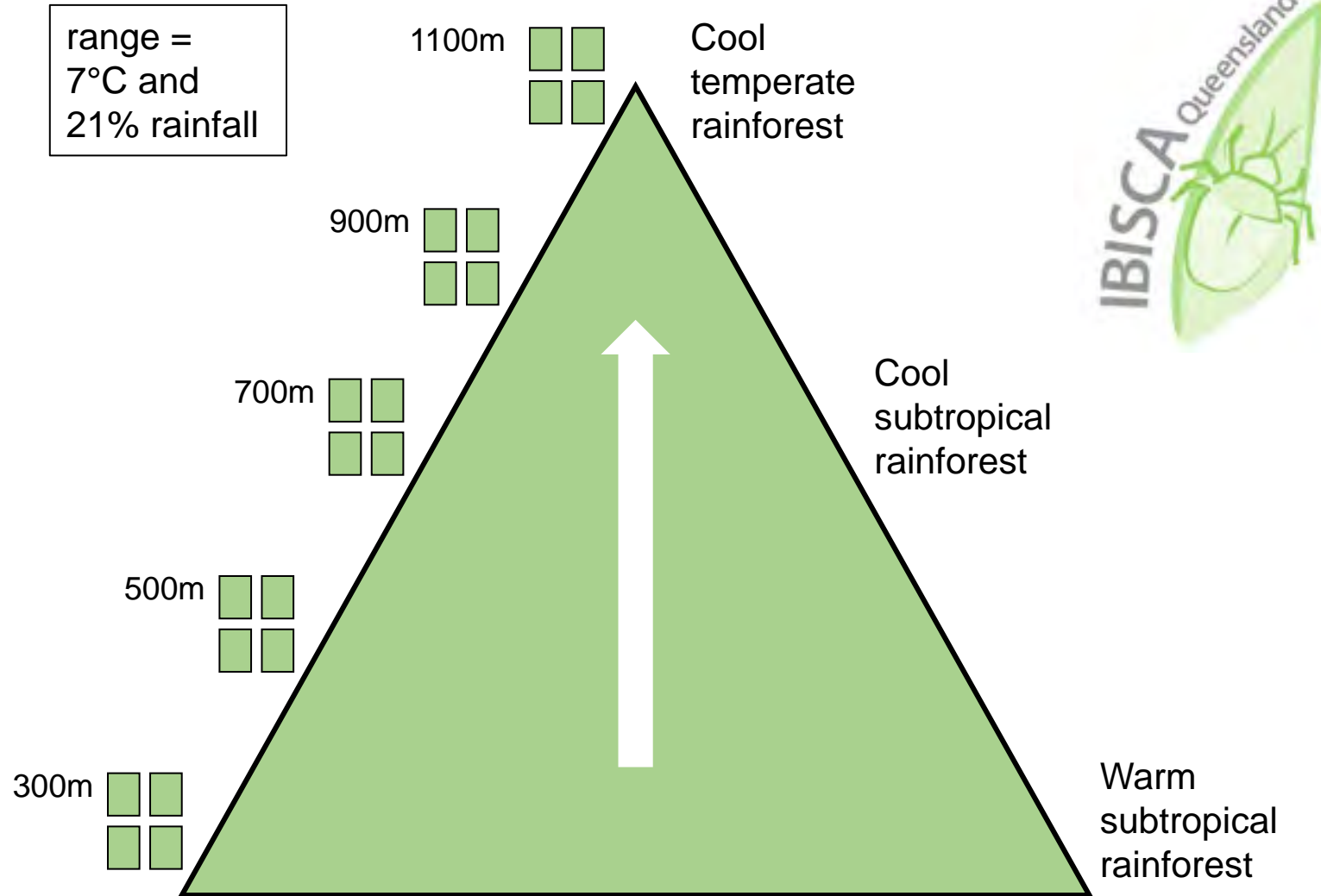


## Relative humidity

Location: 058158 MURWILLUMBAH (BRAY PARK)



# IBISCA transect - Lamington National Park



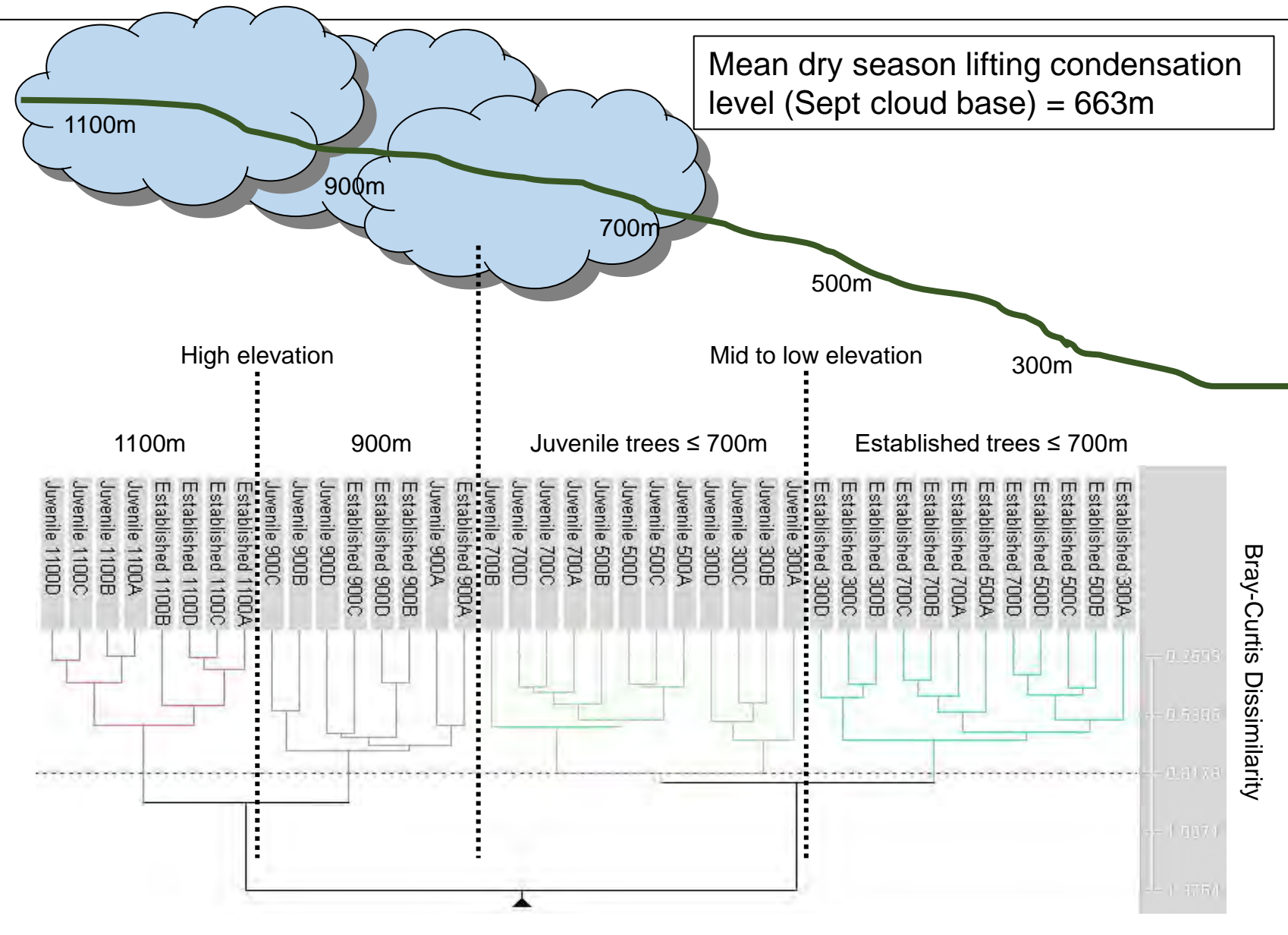
Surveys undertaken in 2006, 2011, 2016 & 2021



## Objectives

- Current environmental controls of rainforest floristics
- Climate projections for the Gondwana Rainforests
- Current evidence of floristic change and environmental controls

# Tree community floristics 2006



Earth Systems and Climate Change Hub

Understanding the impact of climate change on cloud forests in the Gondwana Rainforests of Australia World Heritage Area

Sugata Narsey, Melinda Laidlaw, Robert Colman, Karen Pearce, Mandy Hopkins and Andrew Dowdy

September 2020

Earth Systems and Climate Change Hub Report No. 20

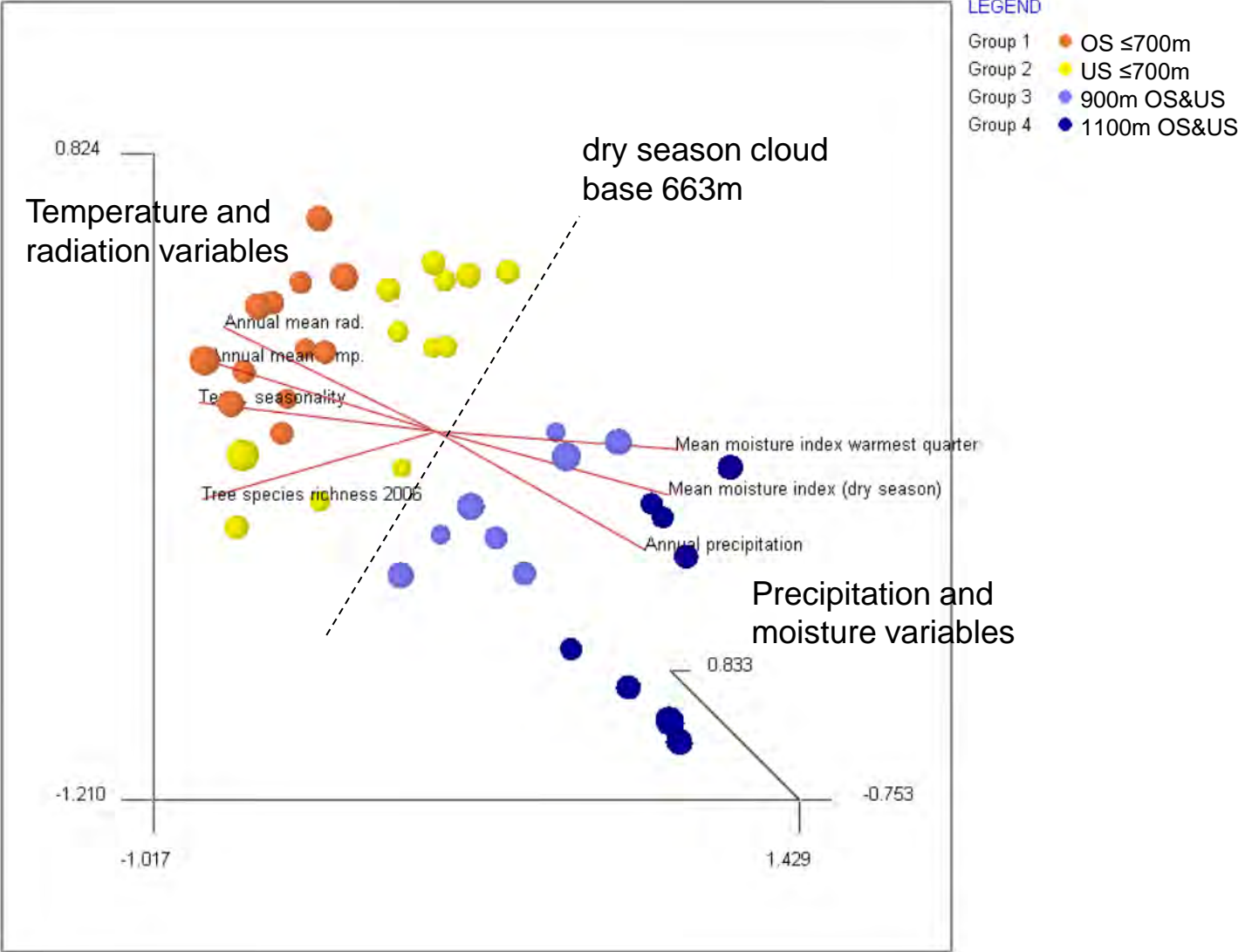
Australian Government

National Environmental Science Programme

# Environmental controls 2006 – moisture stress

3D SSH MDS, PCC,  
MCAO significance testing

Stress: 0.1664



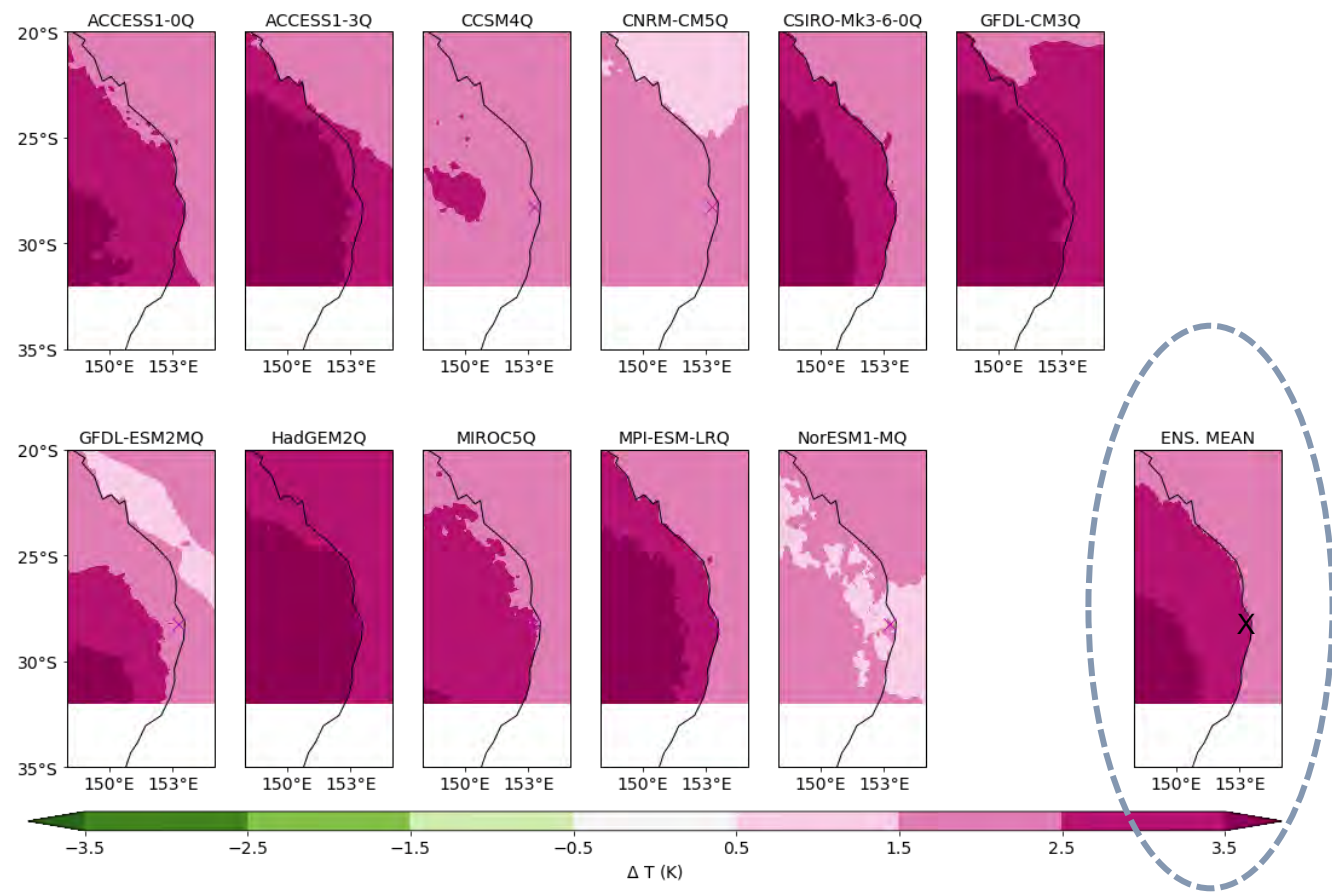


## Objectives

- Current environmental controls of rainforest floristics
- Climate projections for the Gondwana Rainforests
- Current evidence of floristic change and environmental controls

# Temperature projections – dry season (September)

QldFut RCP8.5 September tas change 2070



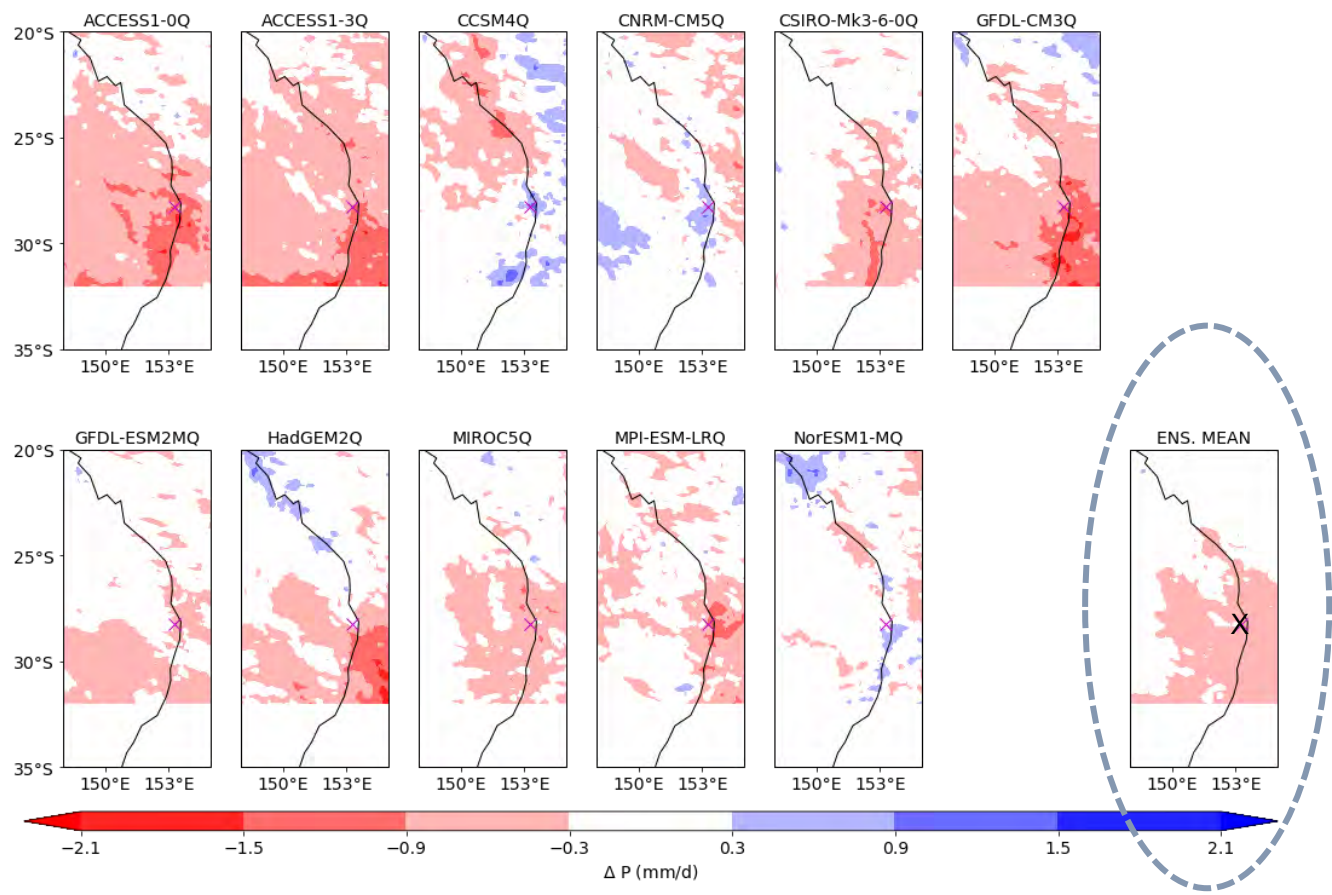
## Gondwana Rainforests

2030 increase  
2050 increase  
2070 increase



# Rainfall projections – dry season (September)

QldFut RCP8.5 September Pr change 2070



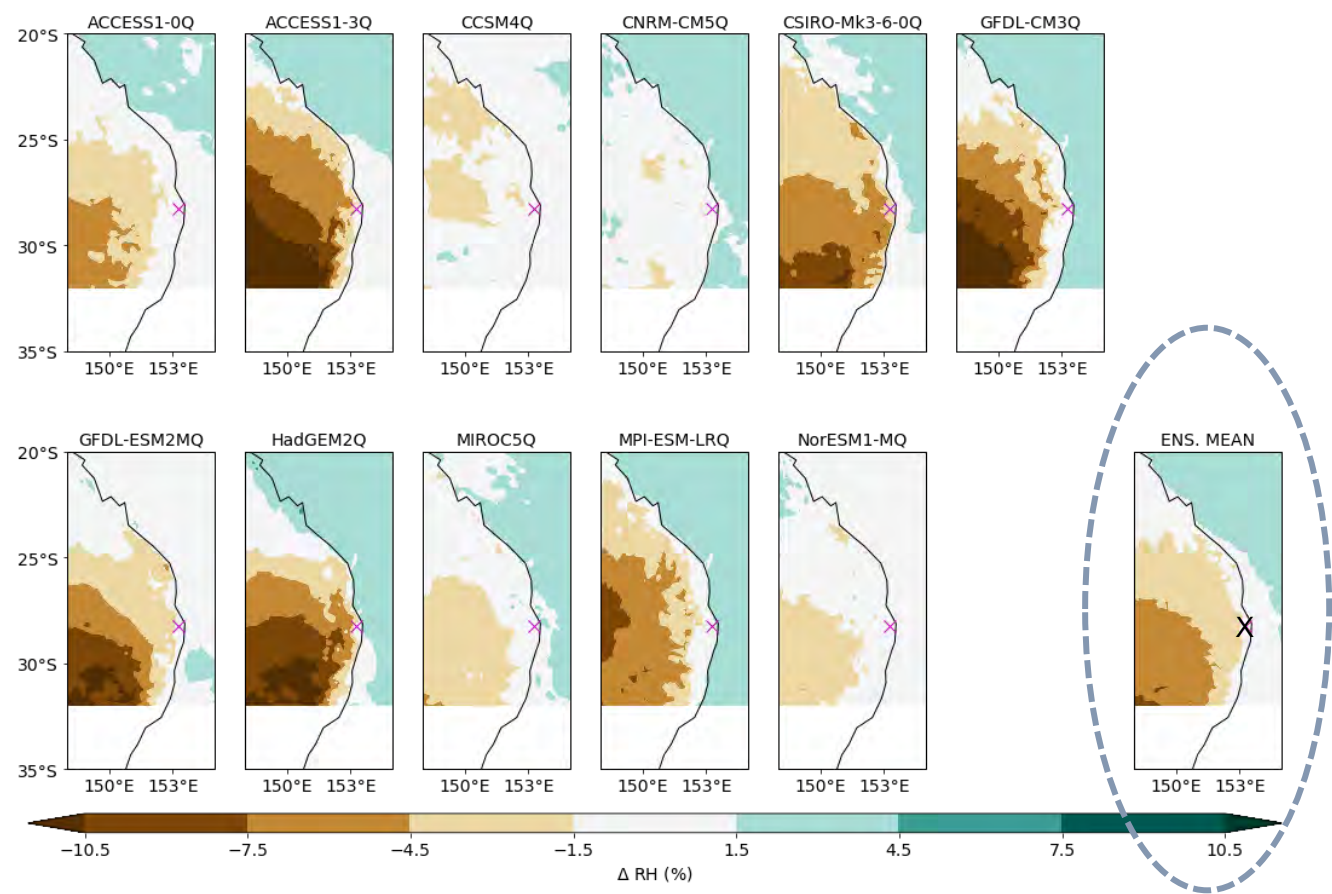
## Gondwana Rainforests

2030    unclear  
2050    unclear  
2070    unclear

Expected and consistent  
with GCM values

# Relative humidity projections – dry season (September)

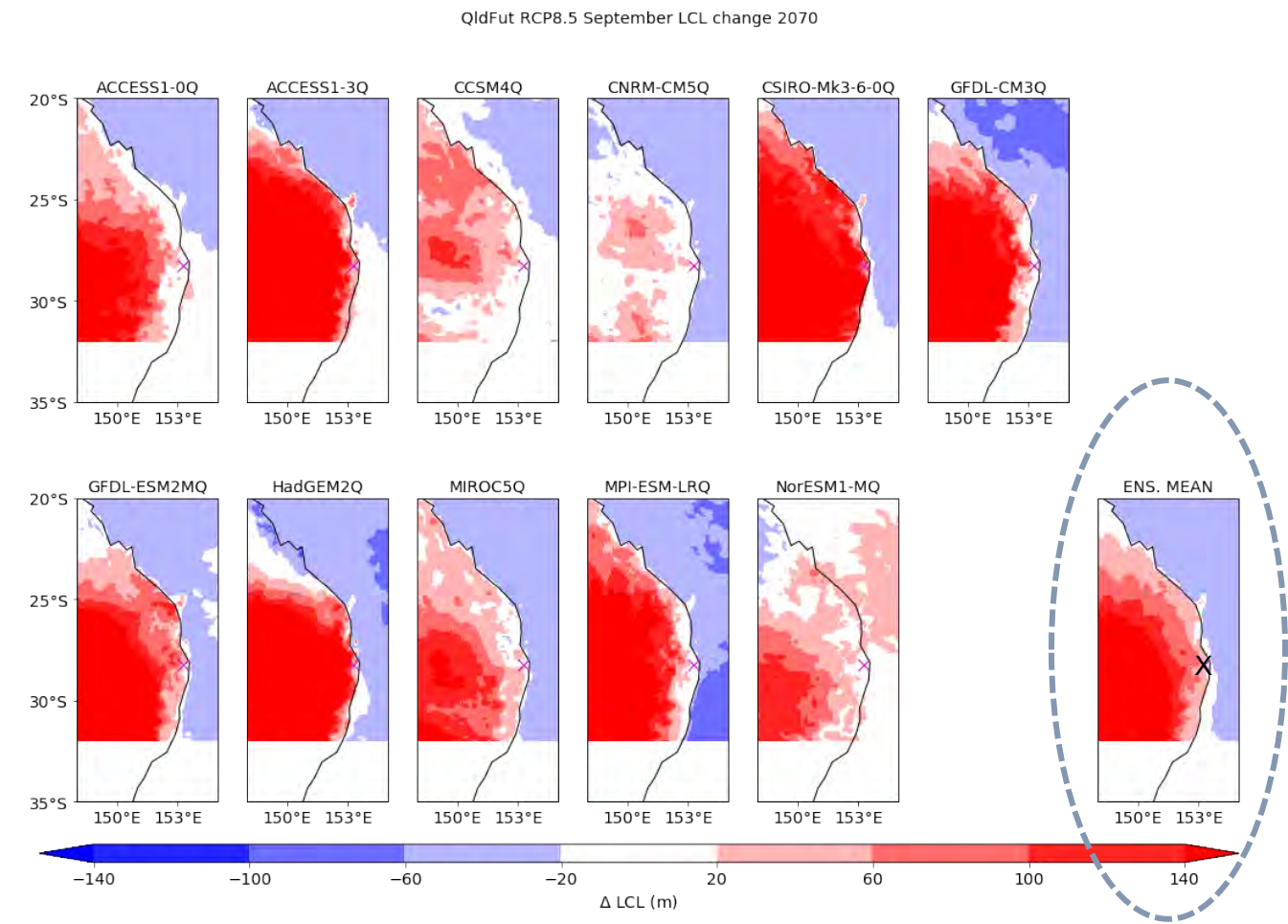
QldFut RCP8.5 September RH change 2070



## Gondwana Rainforests

- 2030 slight decrease or little change
- 2050 slight decrease or little change
- 2070 decrease

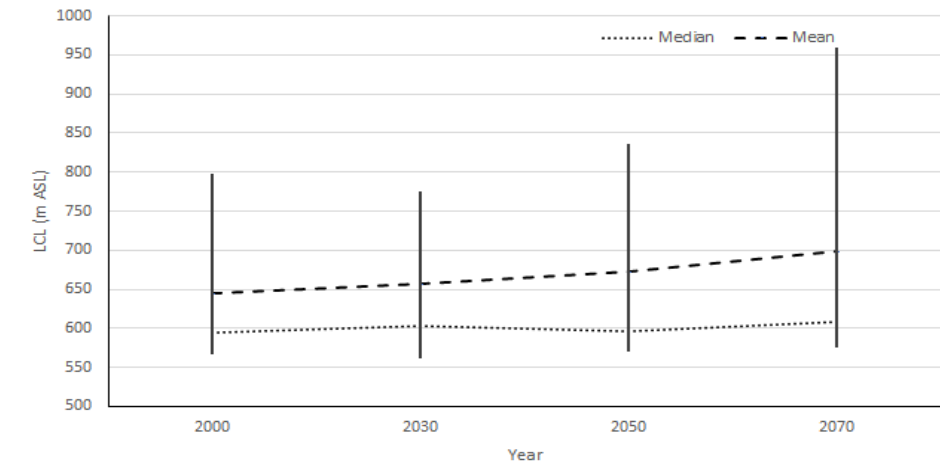
# Cloud height (LCL) projections – dry season (September)



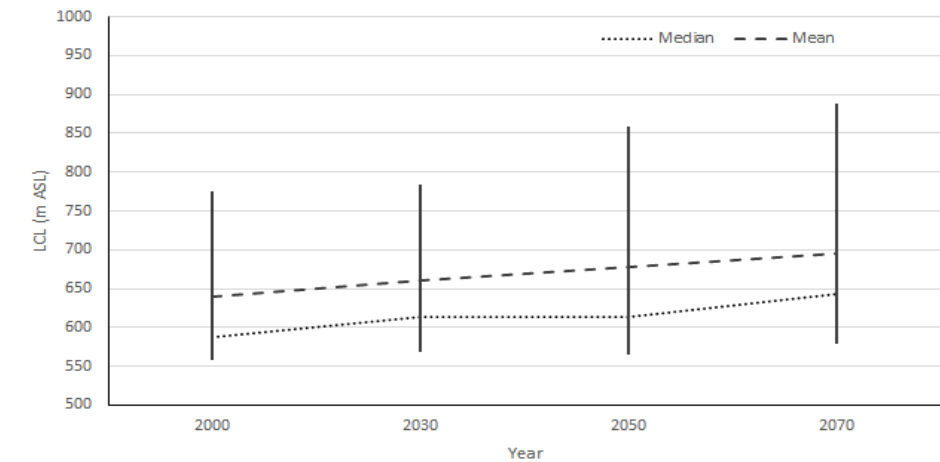
## Gondwana Rainforests

2030	increase or little change
2050	increase or little change
2070	increase

# Projected rise in dry season cloud base across the IBISCA transect



QFC RCP4.5 – Sept (Narsey et al. 2020)



QFC RCP8.5 – Sept (Narsey et al. 2020)

Water from clouds has been found to provide the equivalent of an additional 40% of rainfall at 1000m elevation (Hutley *et al.* 1997)



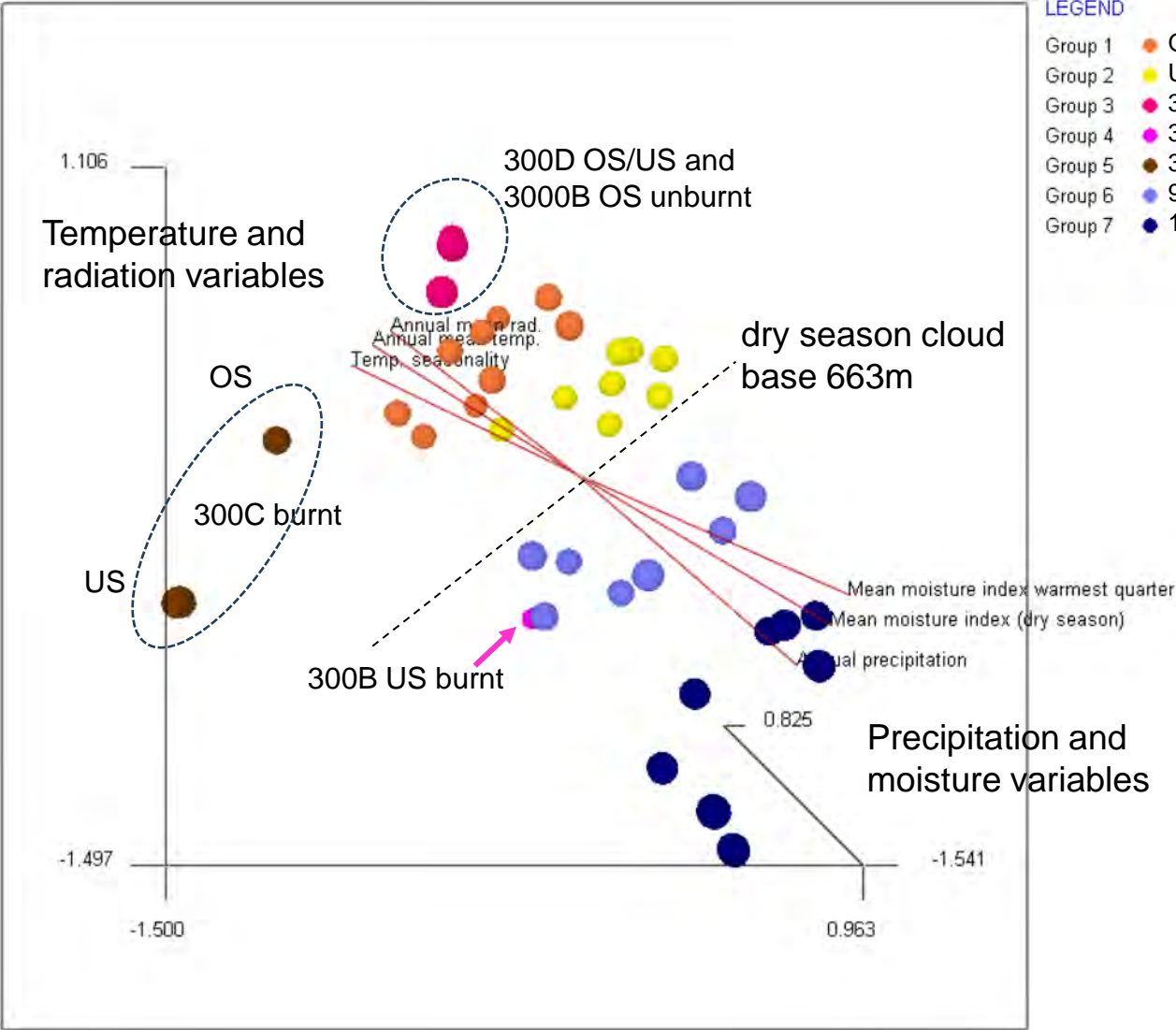
## Objectives

- Current environmental controls of rainforest floristics
- Climate projections for the Gondwana Rainforests
- Current evidence of floristic change and environmental controls

# Environmental controls 2021 – moisture stress

3D SSH MDS, PCC,  
MCAO significance testing

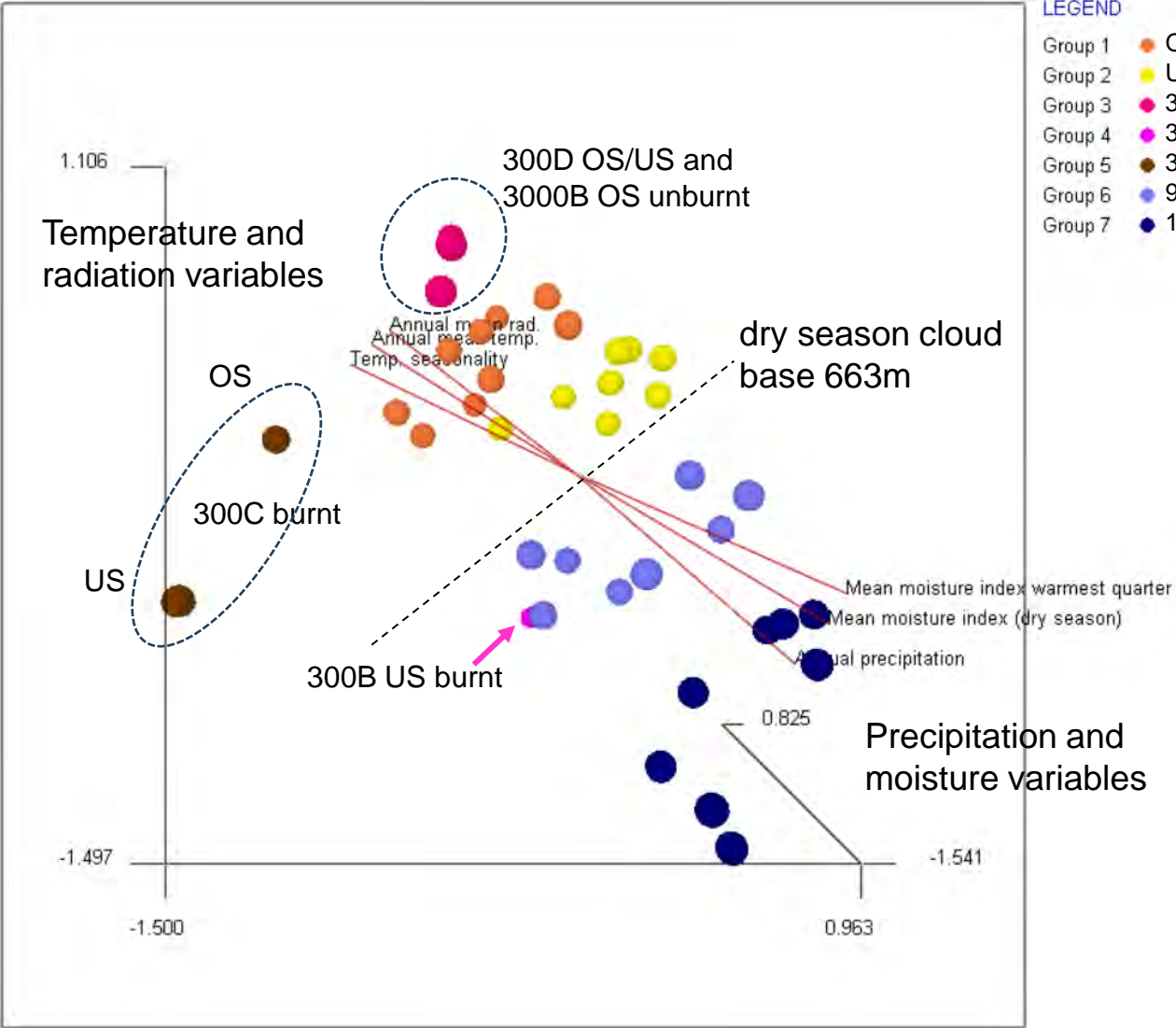
Stress: 0.1654



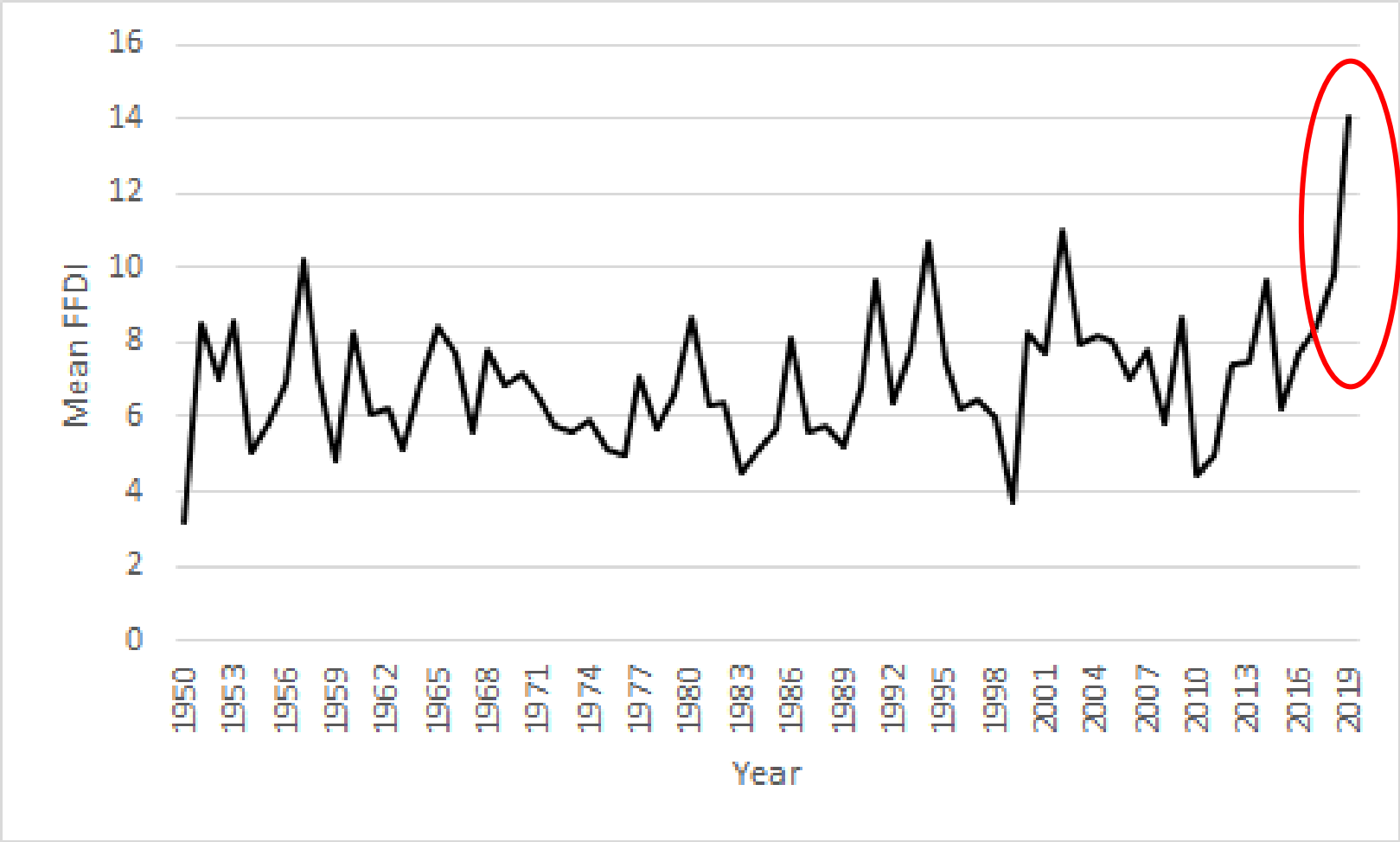
# Environmental controls 2021 – moisture stress

3D SSH MDS, PCC,  
MCAO significance testing

Stress: 0.1654



# Forest fire danger index – black summer 2019/20



Time series of annual averaged Forest Fire Danger Index for south-east Queensland (28–29° S, 152–153.5° E). Data provided by A. Dowdy, Bureau of Meteorology, February 2020.

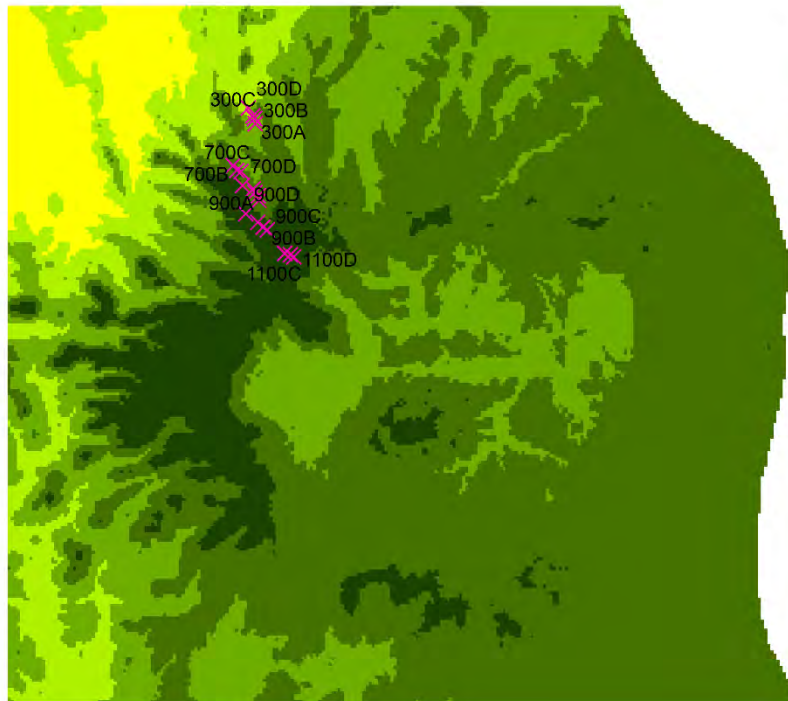


Plot 300C - 87% of stems killed; 98% loss of basal area in November 2019 bushfires

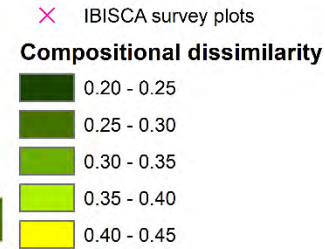
# Modelled compositional dissimilarity - GDM

green = likely to remain suitable for existing species  
orange/red = likely to become less suitable for existing species

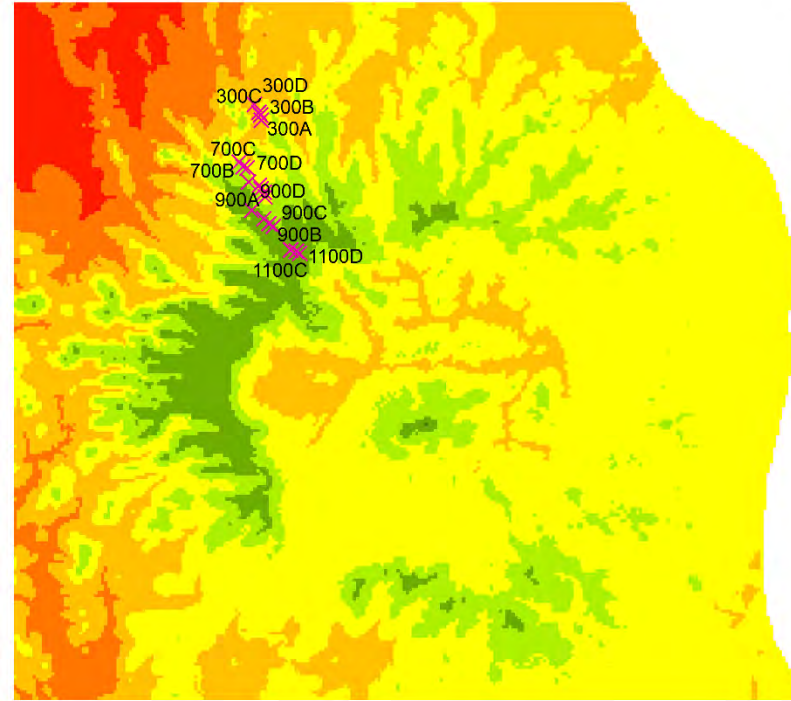
2030



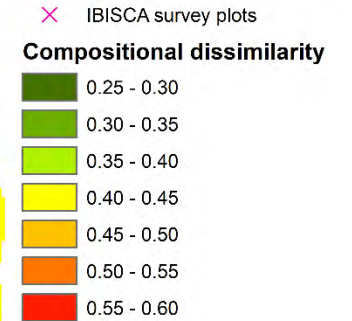
Compositional dissimilarity 2000-2030



2070



Compositional dissimilarity 2000-2070

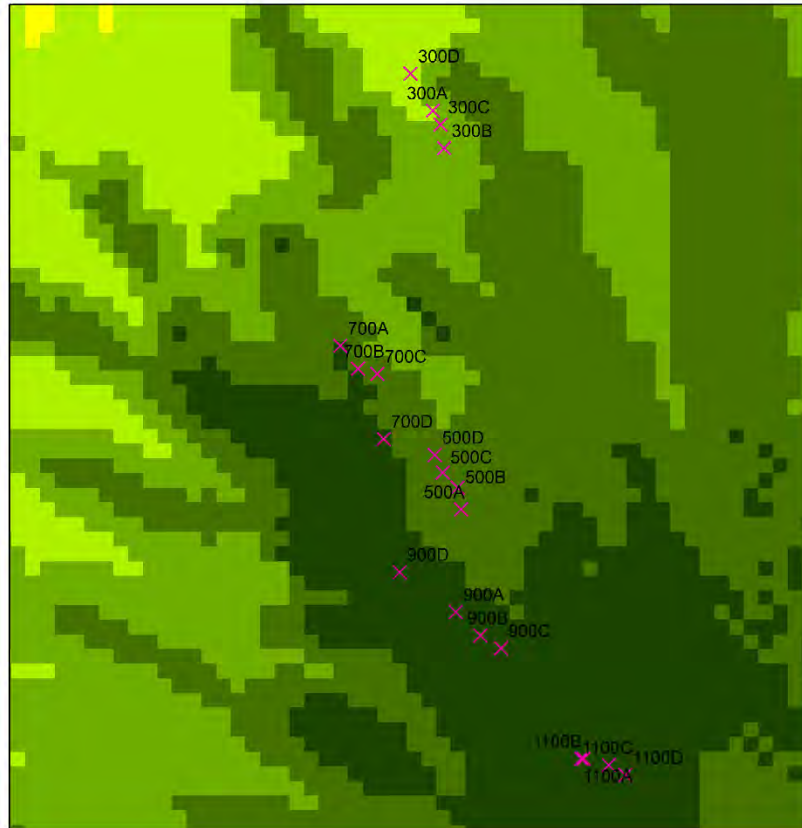


Generalised dissimilarity models (GDMS) developed for the year 2000 (baseline) and 12 climate futures centred on both 2030 and 2070 (State Government of NSW & Department of Planning and Environment 2016)

# Modelled compositional dissimilarity - GDM

green = likely to remain suitable for existing species  
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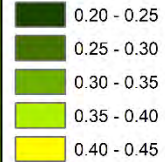
2030



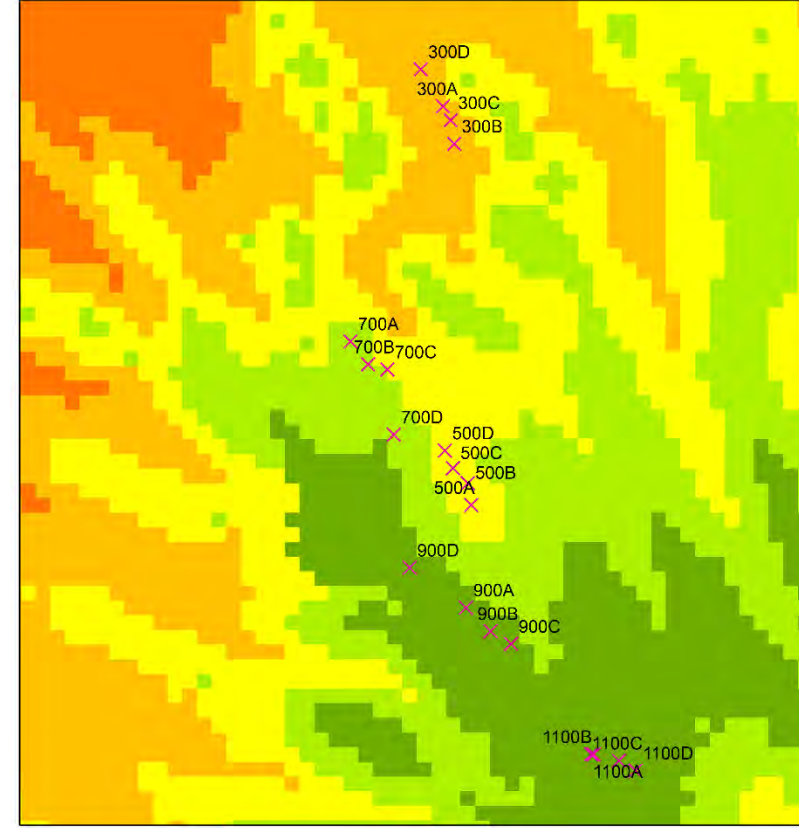
Compositional dissimilarity 2000-2030

× IBISCA survey plots

**Compositional dissimilarity**



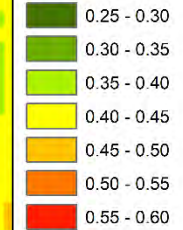
2070



Compositional dissimilarity 2000-2070

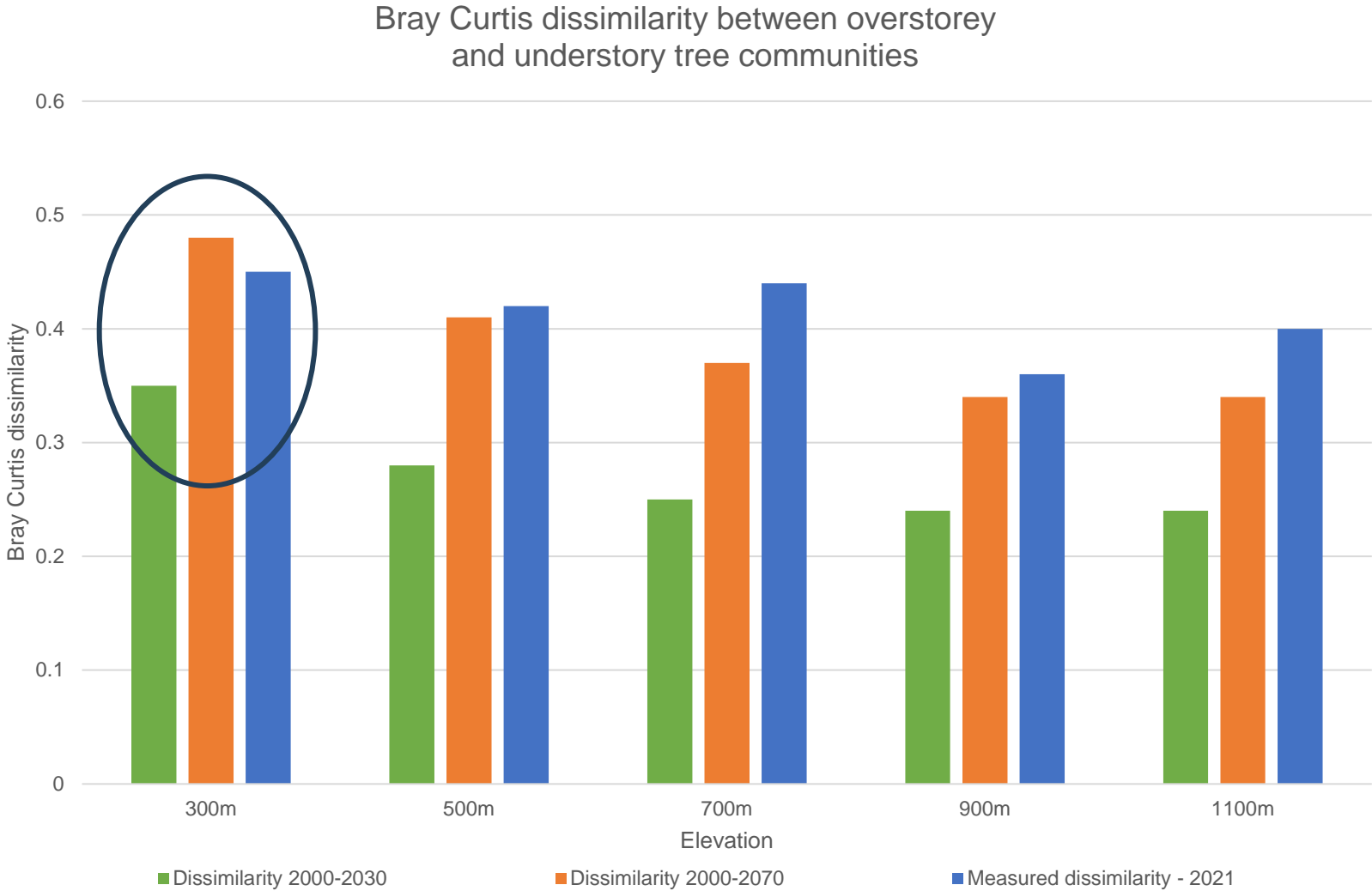
× IBISCA survey plots

**Compositional dissimilarity**



Generalised dissimilarity models (GDMS) developed for the year 2000 (baseline) and 12 climate futures centred on both 2030 and 2070 (State Government of NSW & Department of Planning and Environment 2016)

# Compositional dissimilarity – field survey vs GDM



# Summary

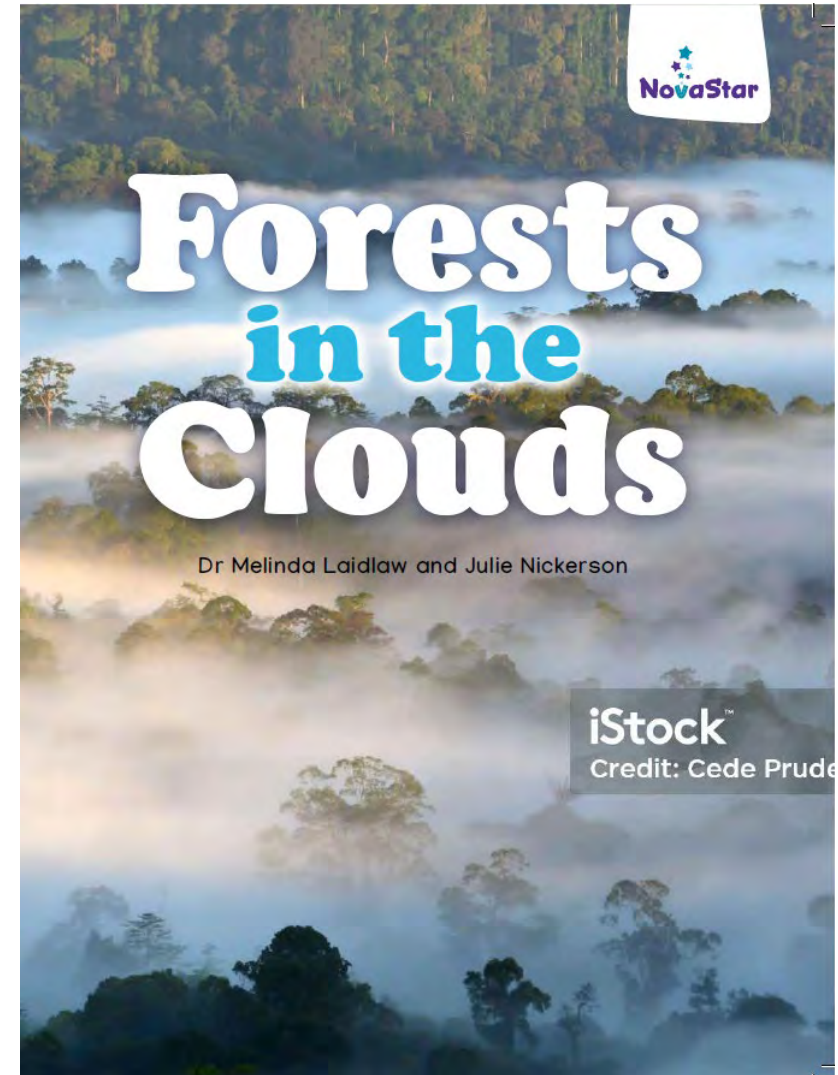
- The current environmental controls of rainforest floristics depend on elevation. High elevation floristics ( $\geq 900\text{m}$ ) are associated with low moisture stress driven by precipitation and significant cloud water inputs. Mid to low elevation sites are associated with higher moisture stress driven by higher temperatures, evaporation, and lower humidity.
- There is evidence of floristic change occurring within the Gondwana Rainforests, particularly at mid to low elevations ( $\leq 700\text{m}$ ). Floristic change may be mitigated by cloud water at high elevations.
- Climate projections for the Gondwana Rainforests include higher temperatures, lower humidity and a rising cloud base contributing to increased moisture stress and fire risk. Rainfall projections are unclear.





Rainforests high up on the tops of mountains are called cloud forests, because clouds often cover them and even reach down to the forest floor. Cloud forests are special places – many kinds of plants and animals live there that can't live anywhere else.

Climate change is threatening cloud forests, but many scientists are working to study and protect these magical-looking forests.



# Acknowledgements

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- Supported by DCCEEW Australian Heritage Grant and the Australian Government's Bushfire recovery program
  - Ranger in Charge Lamington NP Wil Buch, QPWS staff and many field volunteers
  - Queensland Herbarium staff and honorary researchers, including Rosemary Niehus, Bill McDonald
  - Tricia Waters, Nick Reid and the Gondwana Rainforests WHA Committees
  - Sugata Narsey, Rob Colman, Andrew Dowdy, Jo Brown (Bureau of Meteorology)
  - John Clarke, Mandy Hopkins, Karen Pearce (CSIRO)
  - Jamie Love, Polly Mitchell (NSW DPE)
  - Prof. Roger Kitching, David Putland (Griffith University)
- 

