Australian YMC plans for the period late 2018 to early 2019: RV Investigator Plan A and Plan B

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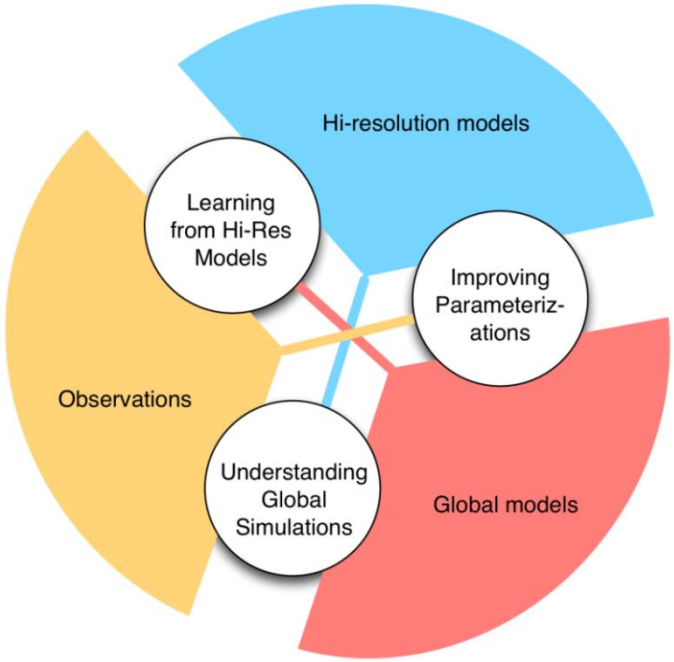
Background of Australian interest

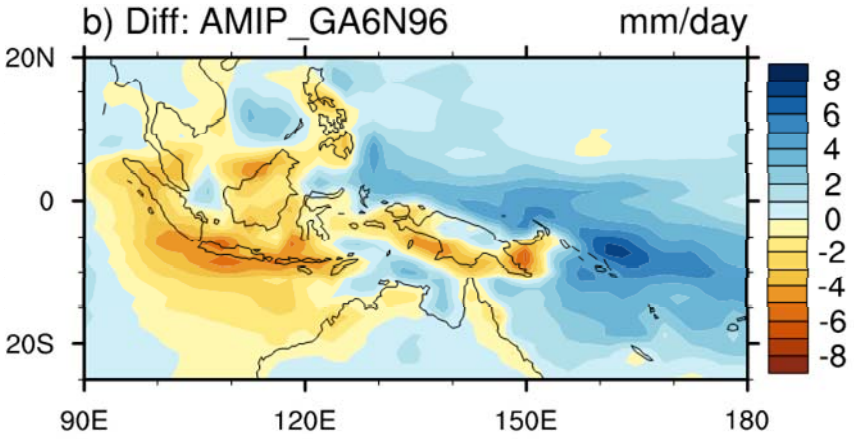
Motivated by large precipitation and other **biases** in our global numerical models in the MC region, Australian institutes (BoM, CSIRO, Universities) began a joint "Maritime Continent Initiative" in 2013. We identified a three component approach comprising global models, hi-resolution models, and observations.



Later we learned of the **YMC** concept which gained our interest, especially given the capabilities offered by our new research ship, **RV Investigator**.

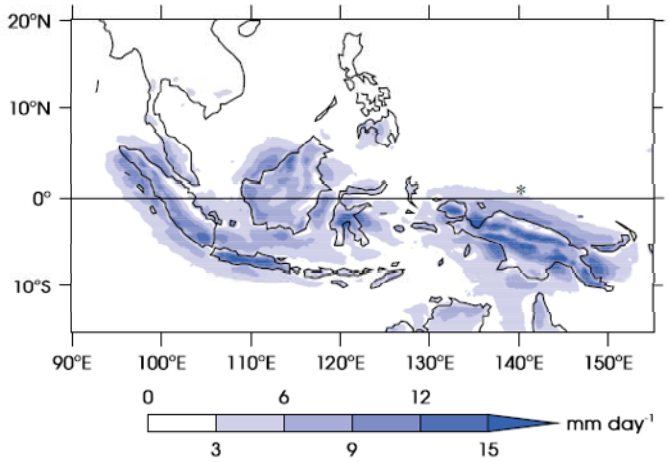
Australia's modelling collaboration with the UK Met Office has also lead to the spin-up of a **Process Evaluation Group** (PEG) on Maritime Continent biases (focussed solely on the Unified Model/ACCESS).

Scientific challenges for YMC



• The MC exhibits large **mean precipitation biases** in most global models.

DJF, 1982-2009: Unified Model GA6 – GPCP observations (Harun Rashid)



• Current models also have difficulty simulating the large amplitude **diurnal cycle** of precipitation.

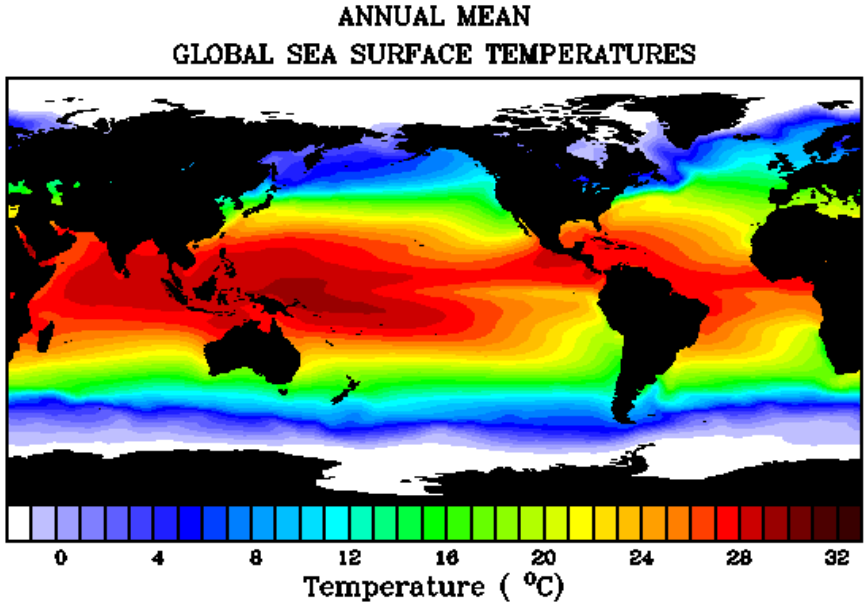
Climatological amplitude of the diurnal harmonic of precipitation rate from TRMM 3B42HQ during Nov-Apr (Peatman et al. 2014)

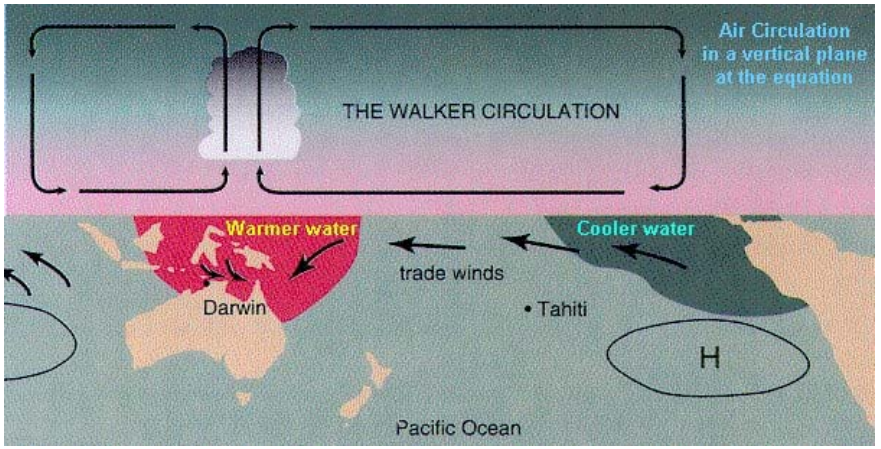
Other phenomena are also difficult in the MC region: Madden-Julian oscillation (MJO), Indian Ocean Dipole (IOD), "cold surges" from the South China Sea, El Niño-Southern Oscillation (ENSO).....

The complex topography and land/sea mix are a likely cause of the difficulties.

Why is Australia interested?

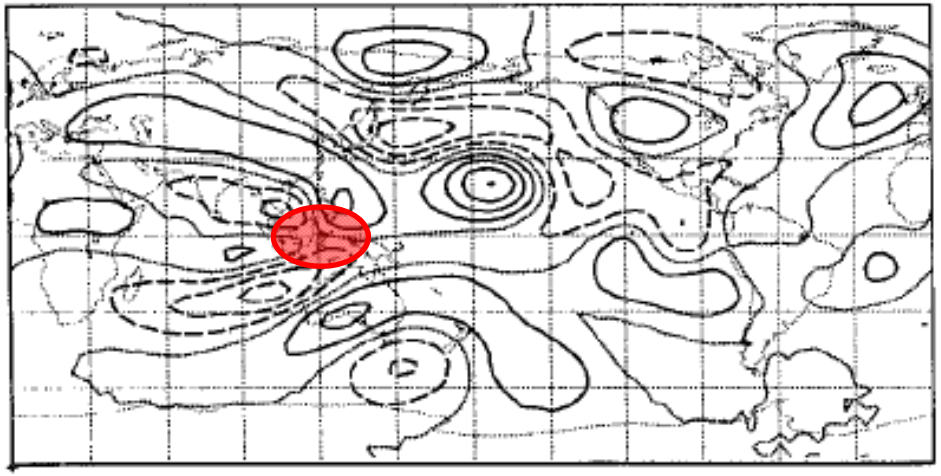
The MC is located within the climatological 'boiler box' of the globe, and largest centre of atmospheric rising motion.





The global weather and climate is therefore particularly sensitive to the intensity of precipitation, and its associated latent heating, over the MC region.

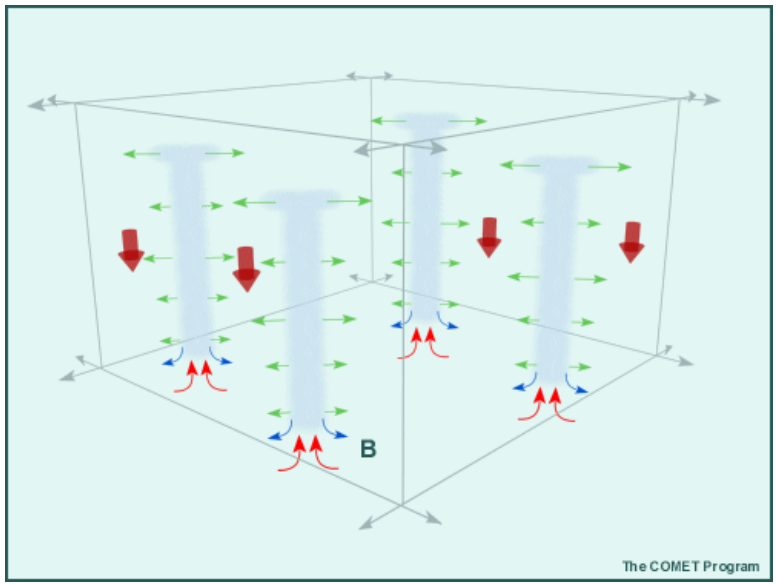
Rossby wave trains (as measured by streamfunction anomalies) emanating from a heat source in the Maritime Continent region using a DJF basic state (Jin and Hoskins 1995).



Why are new measurements needed?

The main issue with our numerical models is the **parameterization of physical processes** related to the formation of clouds, moist convection, and precipitation.

parameterization



These parameterizations often critically depend on quantities that are difficult to measure, e.g. the **vertical mass flux** within **sub-grid scale plumes.**

We also need integrated measurements of the entire physical system (ocean and land surface states, fluxes into and out of the ocean and land, radiation, atmospheric waves) to understand the sensitivities and improve the model parameterizations.

The uniqueness of the MC's mix of ocean, land, topography and surface types, reduces the relevancy of the detailed observations that have been taken elsewhere (e.g. over the Pacific and Indian oceans). Satellite measurements also have problems.

What can Australia offer? *RV Investigator*

New research vessel: **Operated by CSIRO as the "Marine Research Facility"**

Statistics:
93.9 m long, up to 300 days at sea per year (60 days max per voyage)
It can accommodate 40 scientists on board

Constructed in Singapore – 1 year commissioning period for instrumentation and functionalities during 2014-2015.

Available instrumentation:
- Dual-pol C-band Doppler radar (MNF/BOM)
- Cloud radar and lidar (BOM)
- Radiative and air-sea fluxes (BOM/Uni Melb)
- Atmospheric composition (CSIRO/Uni Melb)
- Ozone and COBALD* backscatter sondes

Has space for:
- A microwave radiometer
- Radiosonde launch facility
- Wind profiler

We are very open to hosting other scientists and their instruments on board.
(e.g. Seagliders from Adrian Matthews, University of East Anglia; radiosondes from Taiwan?)

* Compact Optical Backscatter AerosoL Detector

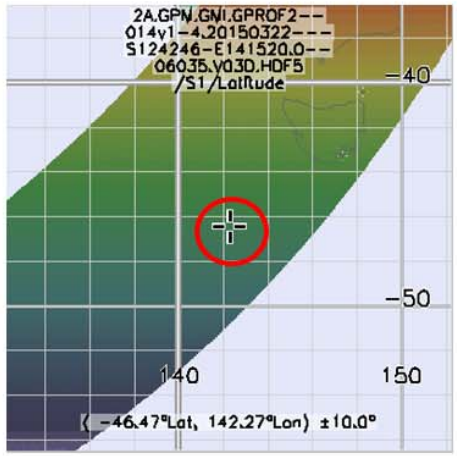
Example of the new ship radar observations

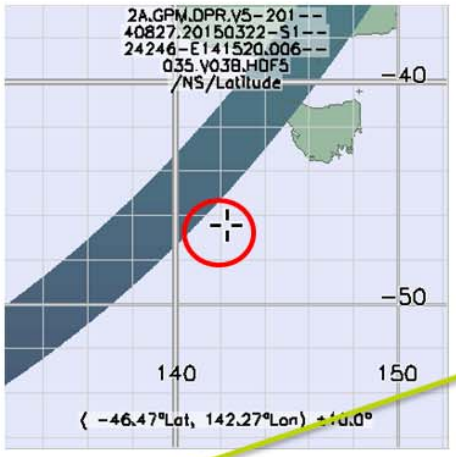
Alain Protat

First-ever GPM overpass of dual-pol C-band radar over the Southern Ocean

Dual-polarization C-band Doppler radar on R/V Investigator:

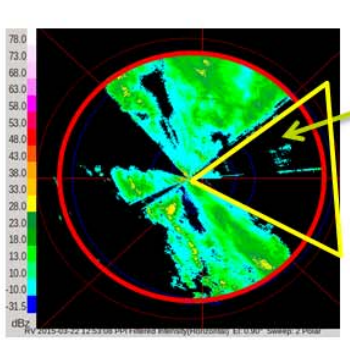
Data quality is great, polarimetric variables over ocean are unique !
Antenna control does not work well at all. EEC working on it.
Should be ready for new validation cruise on 1-22 October 2015.



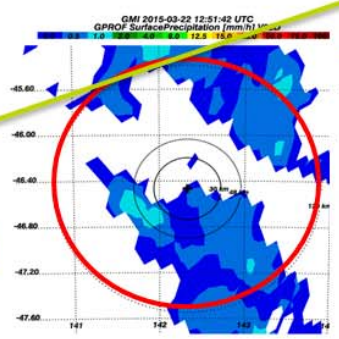


Three GPM overpasses collected during the 10-day research voyage

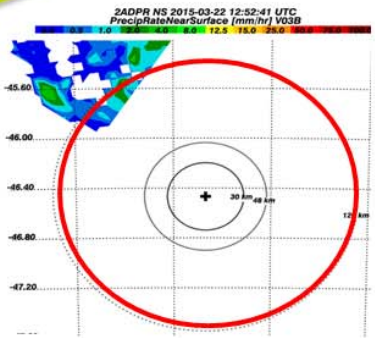
Wedge of missing data : ship motion compensation not working



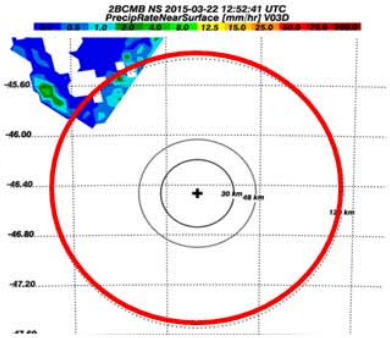
SEAPOL 0.9° El. dBZ



GPM radiometer rainfall

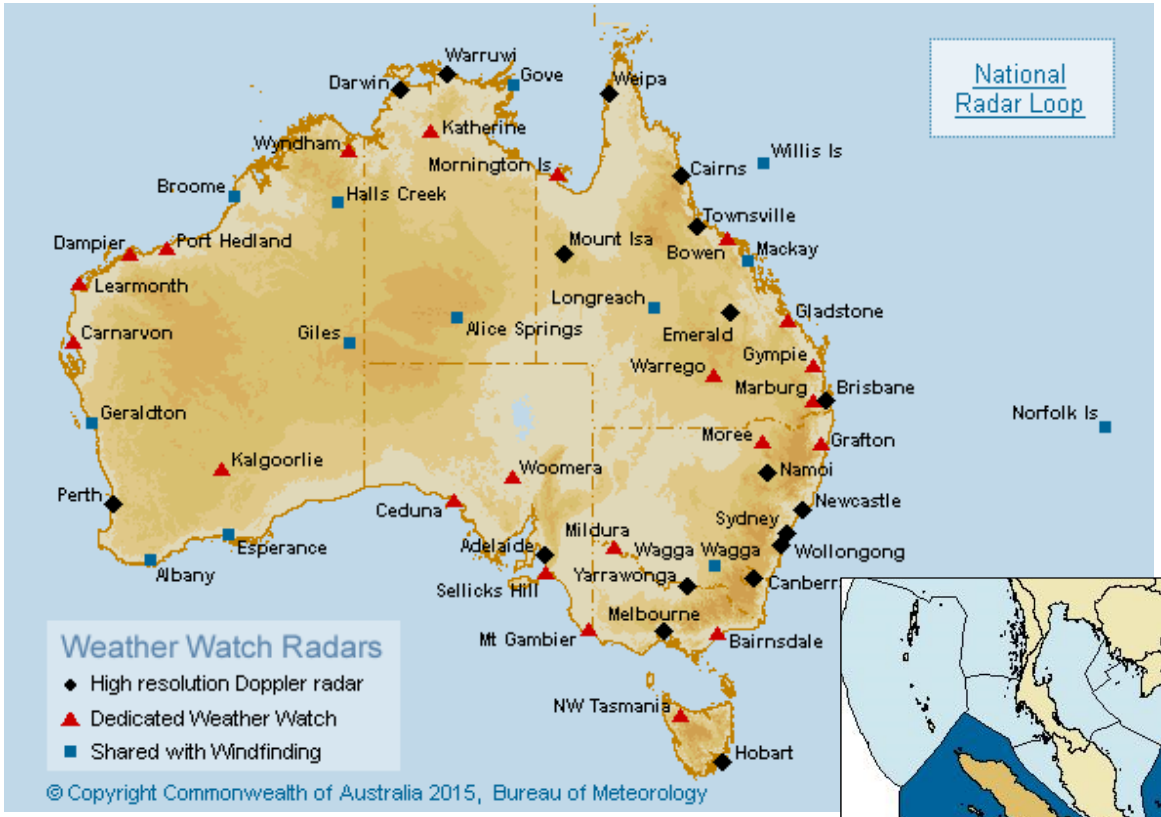


GPM radar rainfall 1

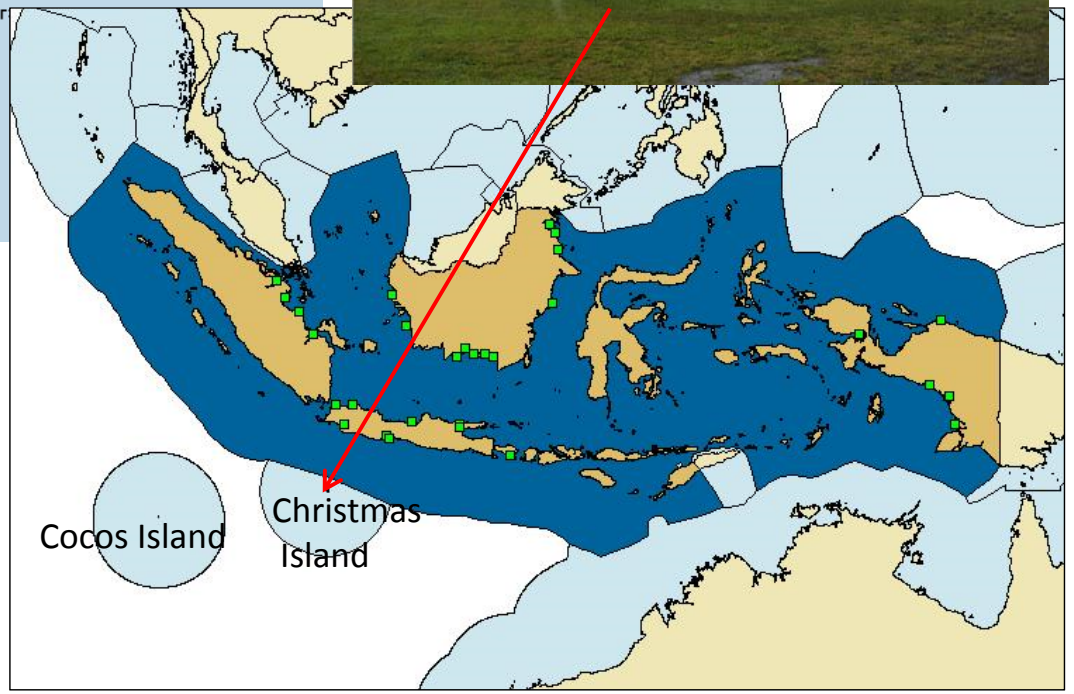


GPM radar rainfall 2

What else can Australia offer YMC?



Several high-resolution Dopper radars on our far northern coastline (Darwin, Warrawi, Weipa).



Radiosondes at **Cocos Island** (as well as at many locations on Australian mainland)

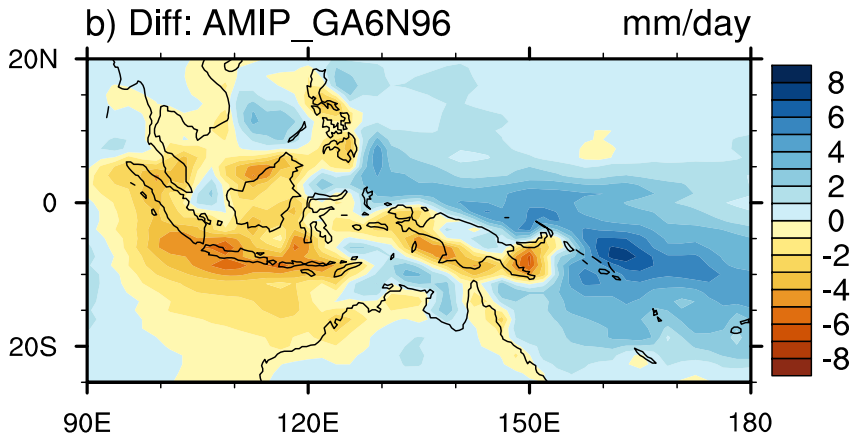
Surface meteorology at **Christmas Island**, and willingness to host more.

Note also the ship proposal led by Robyn Schofield for 2017/18.

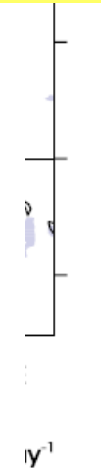
What location for the RV Investigator in 2018/19?

From a **scientific perspective**, we would like to concentrate on a region that has both a strong diurnal cycle of precipitation, and with a large mean bias in models:

Model precipitation bias during DJF: GA6 – GPCP observations

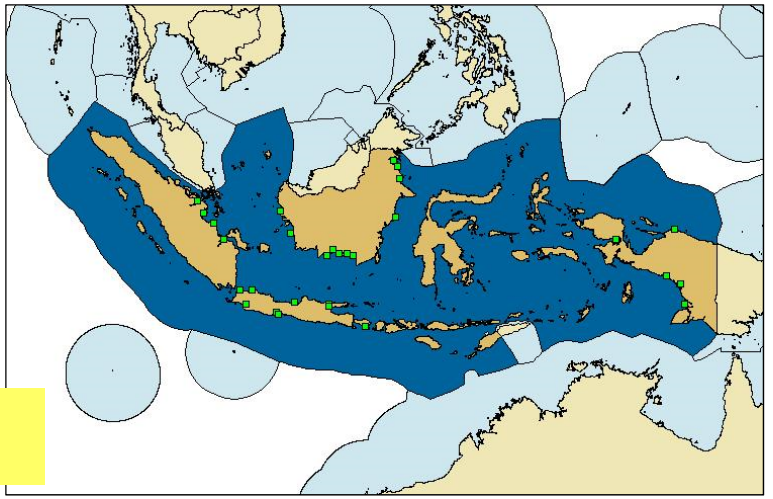


Amplitude of the diurnal harmonic of precipitation from TRMM



Ideally, the ship radar should be located about 100-150km offshore from a land-based radar and instrumentation.

However, we are also constrained by the logistics of taking observations in the Exclusive Economic Zone (EEZ) of other countries.

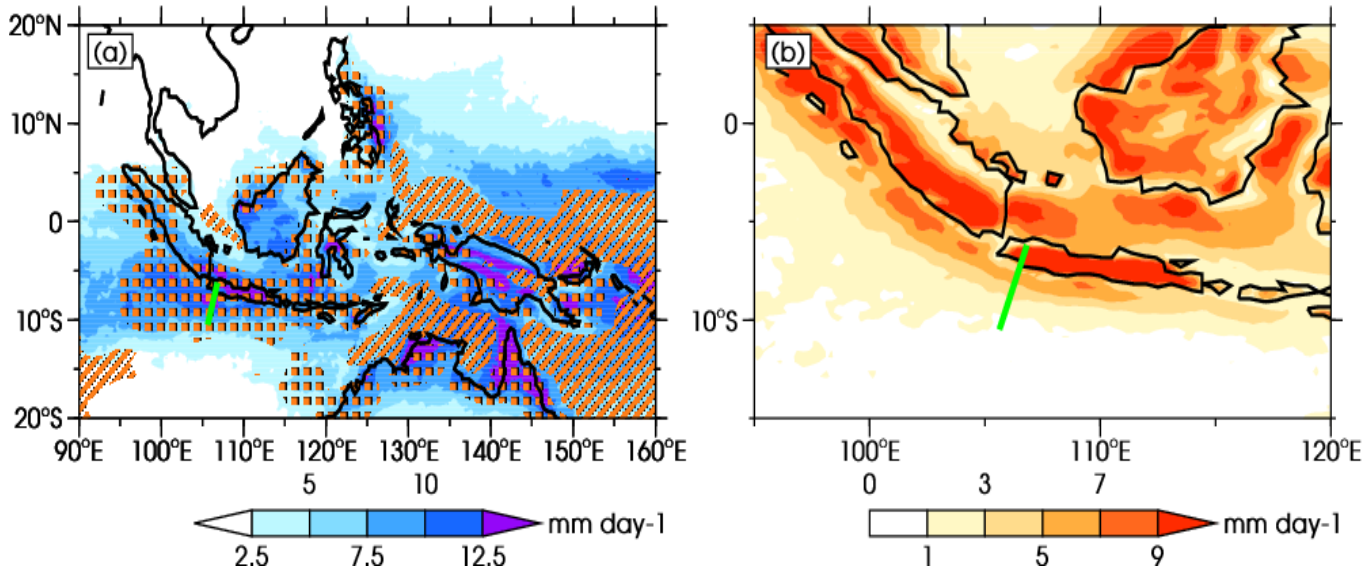


The EEZ of Indonesia (dark blue) and surrounding countries (light blue)

Plan A: The Christmas Island to Java line

Collaborate with Indonesian scientists and the UK group (NERC proposal) to focus on the Christmas Island to Java line in late 2018 to early 2019.

Advantage: Best science and international collaboration.
Disadvantage: Requires additional cost and effort for permission to enter Indonesian EEZ.



(a) Observed mean precipitation for February (shading), and Met Office climate model error (squares below –2 mm day-1, diagonal shading above +2 mm day-1) over the MC. (b) Amplitude of diurnal harmonic of observed precipitation over Java region. Green lines shows the proposed 400 km flight transect from Jakarta to Christmas Island.

Figure from UK group proposal to NERC

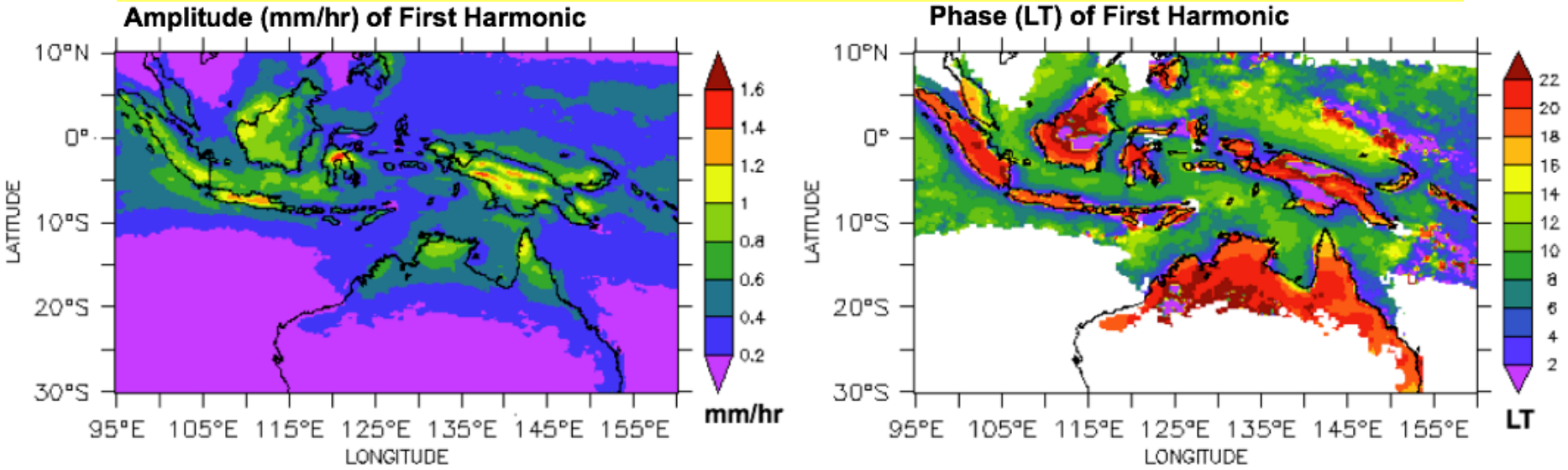
Plan B: North coast of Australia

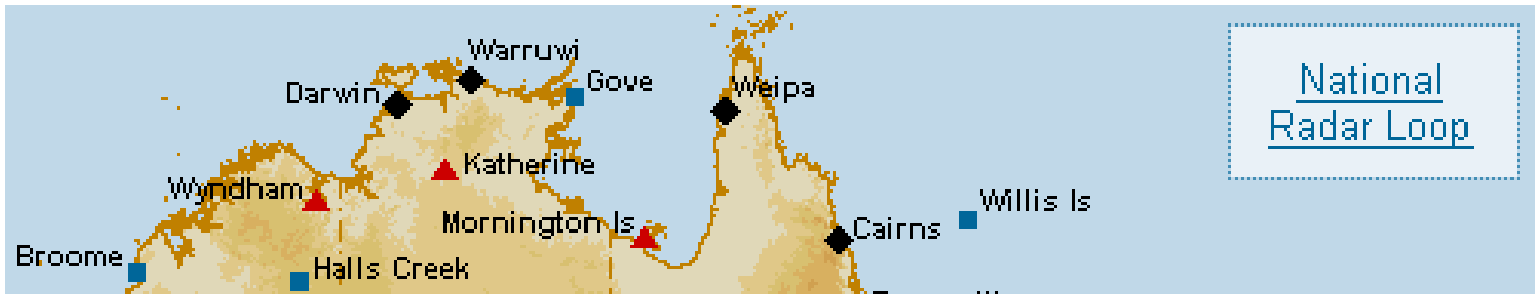
If we cannot secure the funding and help to operate in the Indonesian EEZ we plan to instead propose to go to a location off-shore from one of the existing radars in northern Australia (e.g. Warruwi or Weipa).

The offshore amplitude of the diurnal cycle is still large in these locations.

We would still be welcoming of scientists from other countries on board.

Diurnal cycle analysis of 10 DJF seasons (1989-2010) of TRMM3B42 by Surendra Rauniyar





Time-line of Australian YMC activities

- Sep 2014 – Jakarta kick-off meeting (M. Wheeler)
- Jan 2015 – Singapore science planning meeting (C. Jakob, M. Wheeler)
- Oct 2015 – Robyn Schofield's full proposal submitted for Investigator cruise in 2017/18
- Nov 2015 – Jakarta implementation planning meeting (R. Schofield, T. Lane, M. Wheeler)
- Nov 2015 – UK NERC full proposal due (Australia listed as Project Partner)
- Apr 2016 – MJO/Maritime Continent science workshop in Singapore organised by S2S and MJO Task Force (H. Hendon and M. Wheeler)
- July 2016 – Pre-proposal for Investigator time in 2018/19 due
- Oct 2016 – Full proposal for Investigator time in 2018/19 due

- Late 2017 to early 2018 – Robyn Schofield's cruise from Cairns to Darwin.

- Late 2018 to early 2019 – Our main YMC cruise, either Plan A or Plan B.

- Ongoing interest in modelling, understanding, and model improvement (many people)

Thanks

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Australian Government
Bureau of Meteorology