TerraMaris Modelling Framework

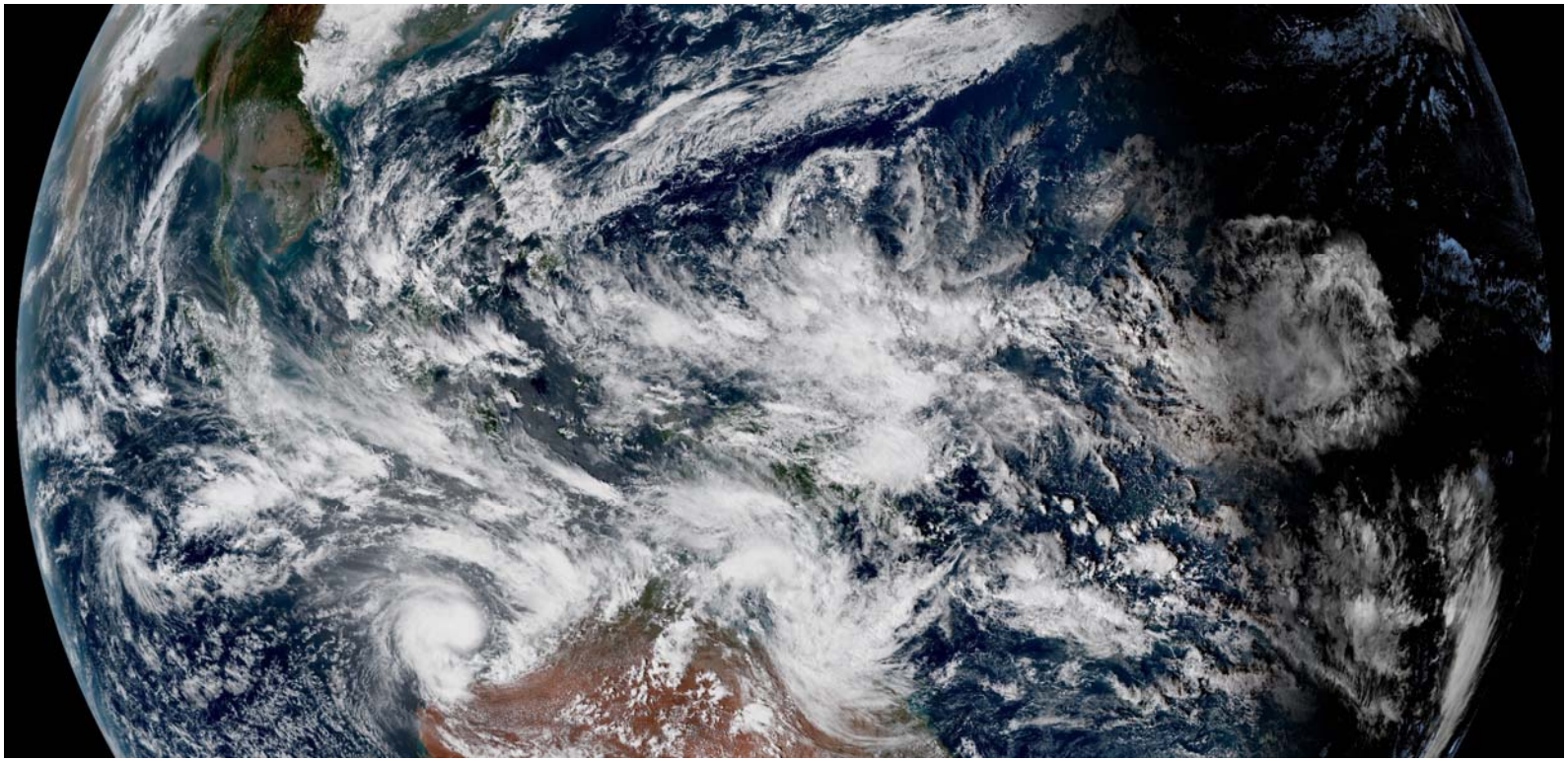
University of East Anglia

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

University of Reading

UNIVERSITY OF LEEDS

Met Office



Nick Klingaman, Steve Woolnough,
Adrian Matthews, Cathryn Birch, John Marsham

TerraMaris overview

- UK contribution to YMC
- Five-year, £3.5m research programme: October 2018 – September 2023
- Observational campaign in early 2020 (see Paul Barrett's talk later today)
- Hierarchy of modelling experiments to support campaign planning, understand MC processes and explore teleconnections.

Terra Maris, meaning "land from the sea" is *the* museum for the natural scenery of the province of Zeeland.

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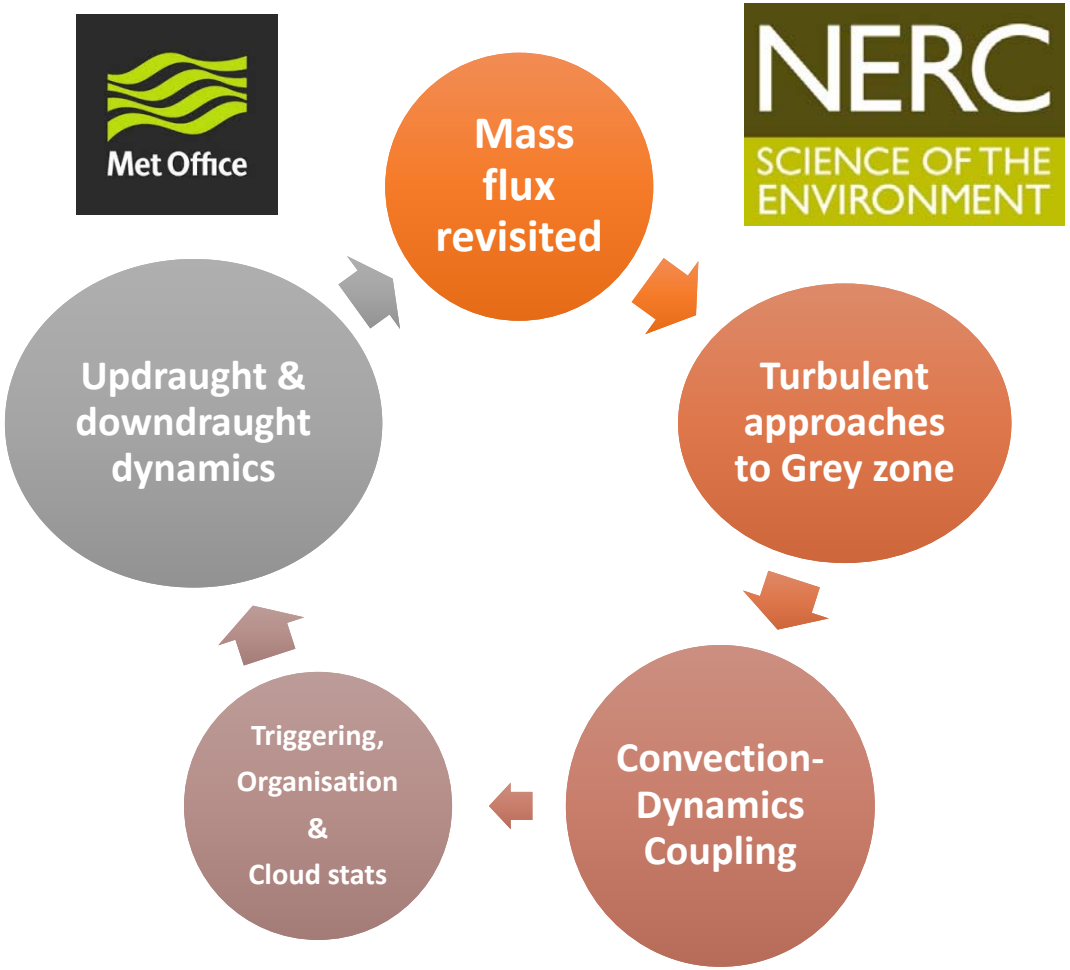
TerraMaris modelling context

- Joint Met Office – NERC ParaCon programme on the representation of convection (2016-2021).
- “To make significant improvements to the representation of convection across a range of scales (primarily 1-100km)”
- YMC observations and modelling frameworks offer a testbed for parameterisation developments.



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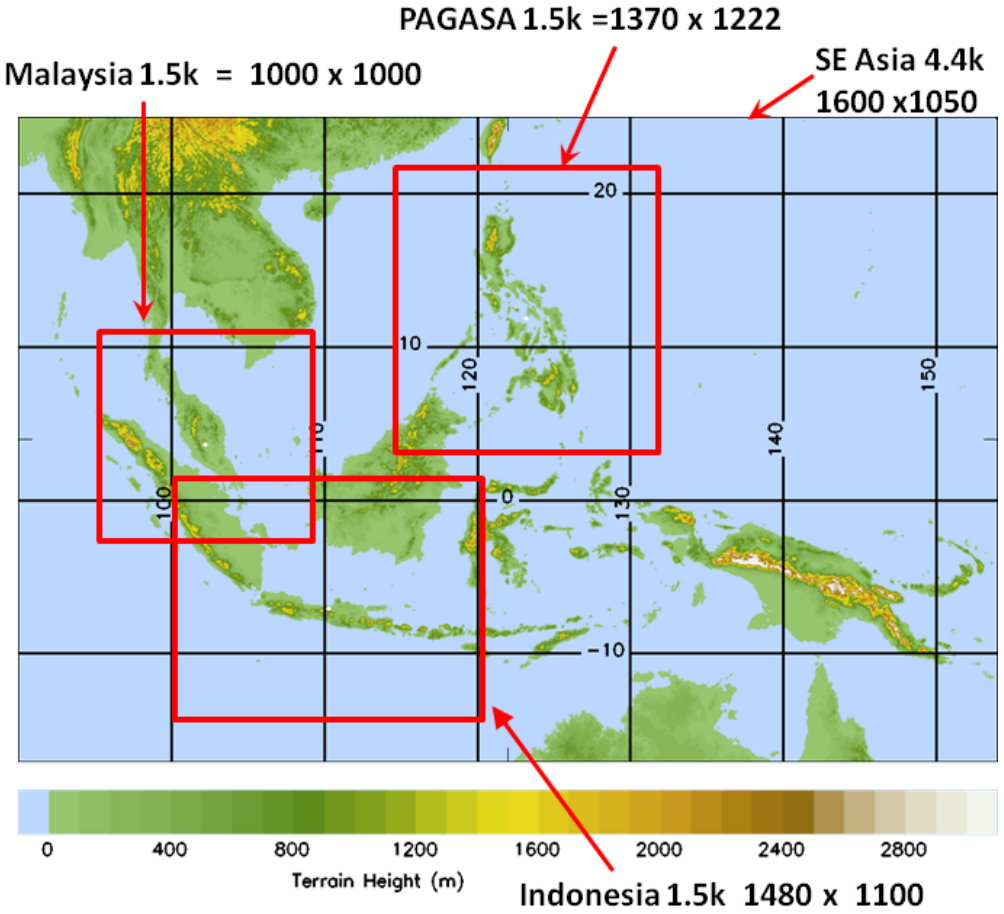
TerraMaris modelling context

- UK Government investment in Weather and Climate Services for SE Asia Programme
- Met Office working with University partners and in-country agencies to deliver improved weather and climate models for Southeast Asia, particularly convective-scale NWP.
- PAGASA to become a Met Office Unified Model partner.
- Research into tropical cyclones, MJO and equatorial waves, vertical structure.



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TerraMaris modelling context

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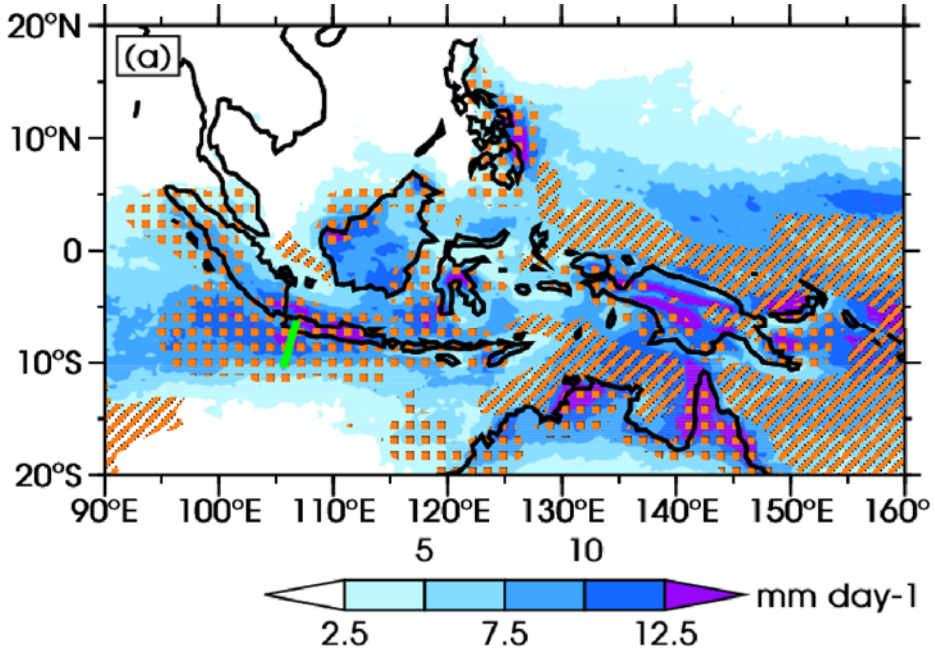
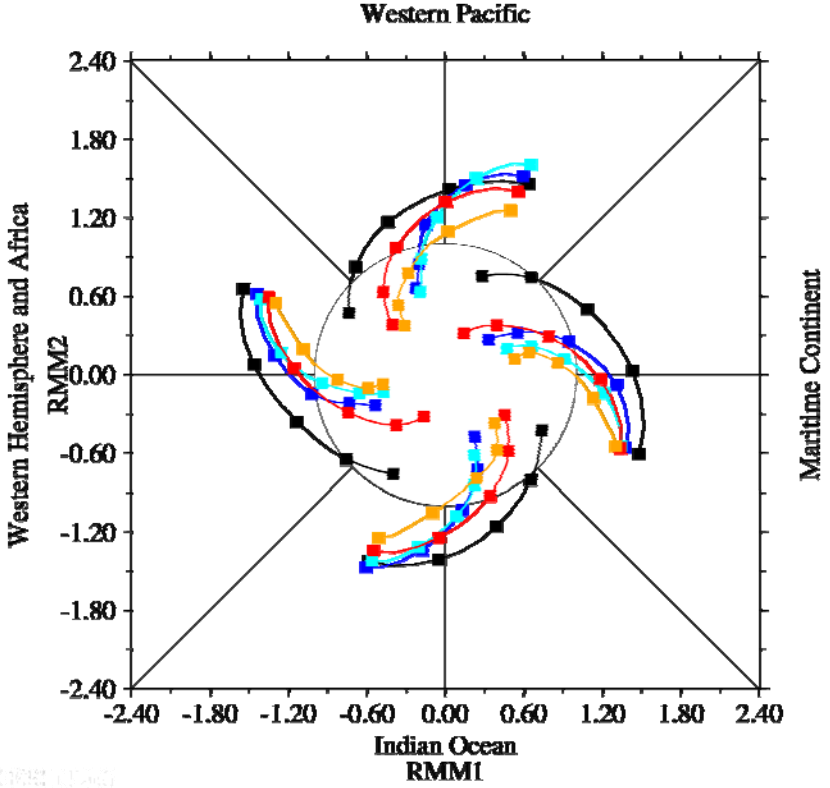
Like many other climate models, the MetUM struggles to represent convection over the Maritime Continent.

Nov-Apr rainfall – dry biases in dots, wet biases shaded



Composite MJO propagation in RMM phase space



TerraMaris modelling context

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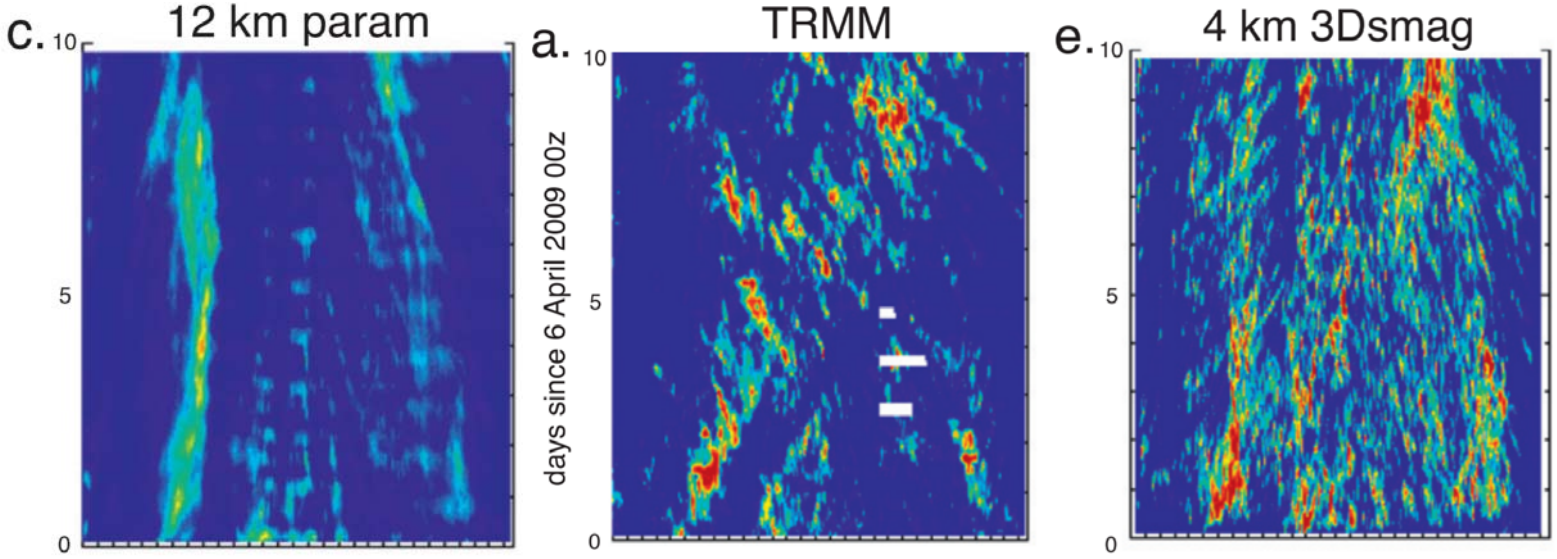
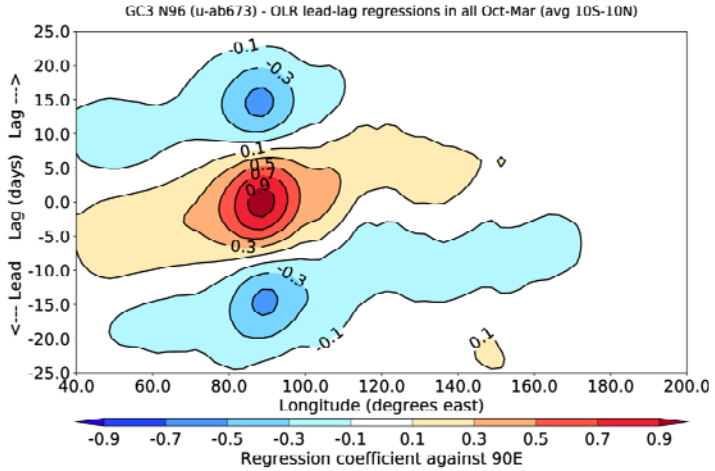
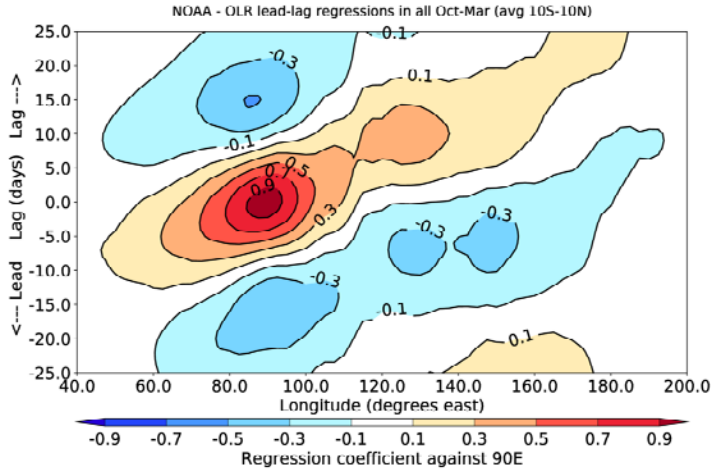
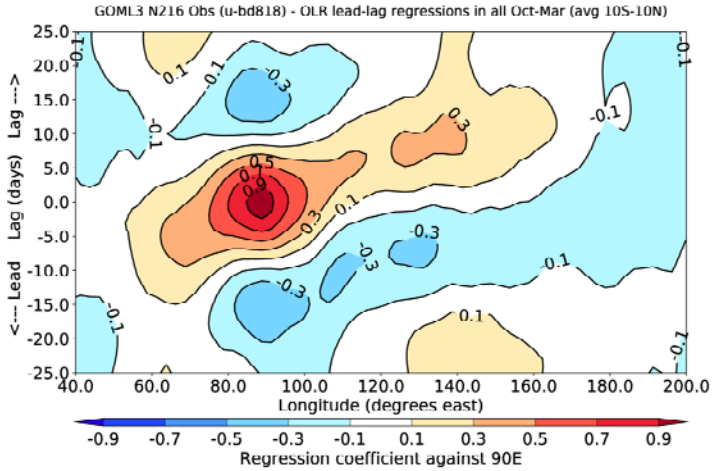


Explicit convection and air-sea coupling have separately been shown to improve MJO amplitude and propagation.

Holloway et al. (2013)







TerraMaris modelling plans

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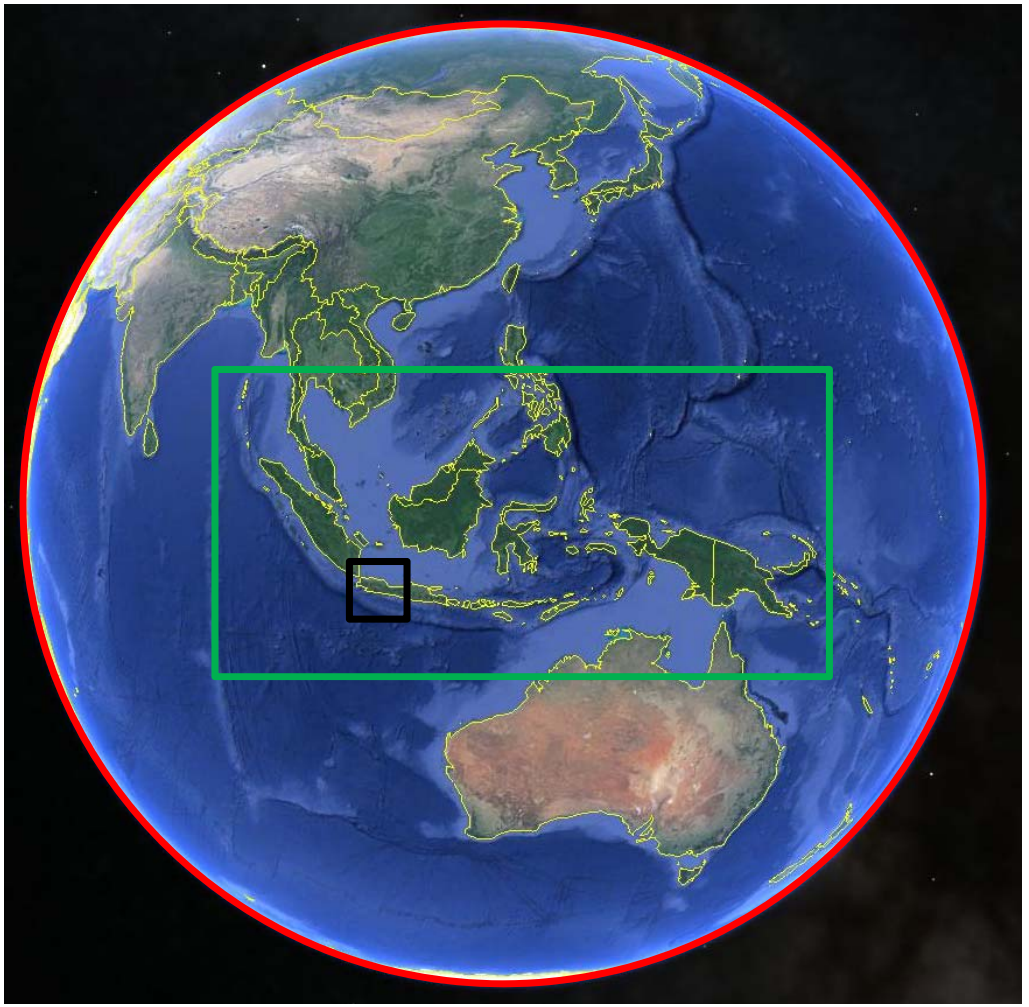
Hierarchy of MetUM model simulations:

- 200m cloud-resolving simulations with domain approximating aircraft transect
- 2km large-domain convection-permitting simulations over MC
- 17km large-domain parameterised convection simulations over MC
- 90km global simulations to study how teleconnections are sensitive to variations in MC heating



TerraMaris modelling plans

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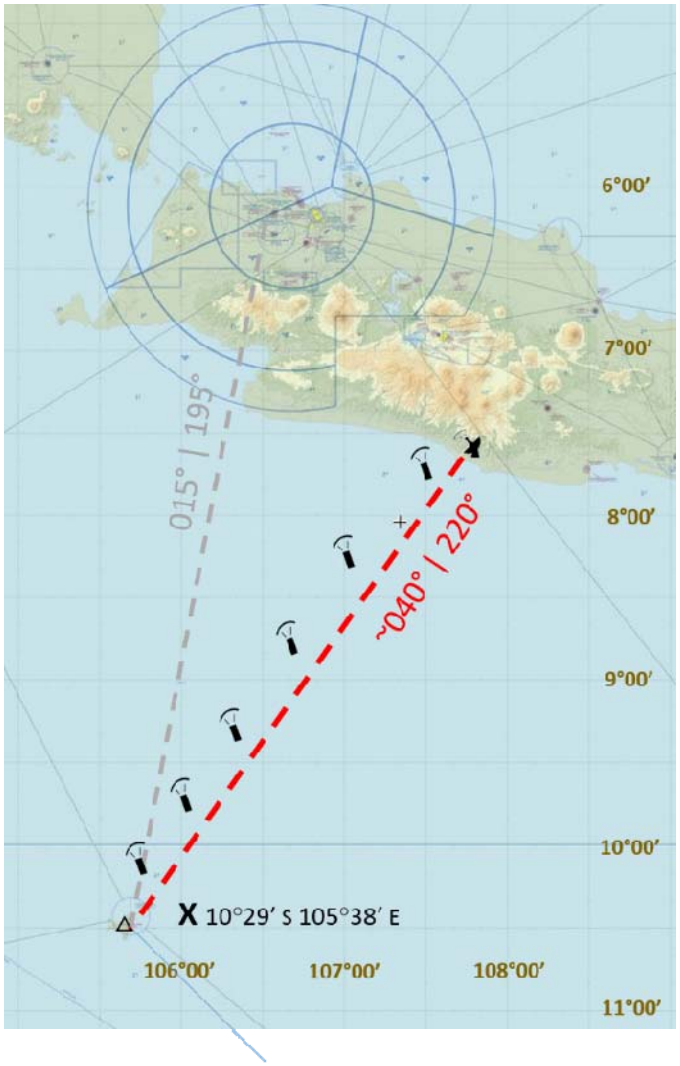
- 200m CRM simulations over a domain of approximately 1000x200km
- Designed to encompass main aircraft transect from Java to Christmas Island
- Experiments to focus on processes controlling diurnal evolution of convection over land and offshore propagation.
- Sea-breeze convergence, upslope flows, gravity waves and currents, sensitivity to island geometry and surface characteristics.



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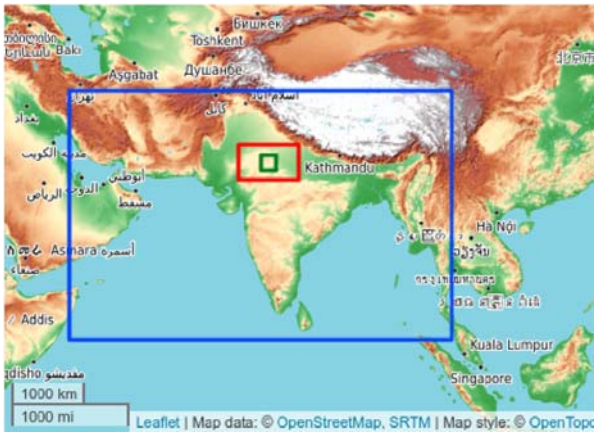
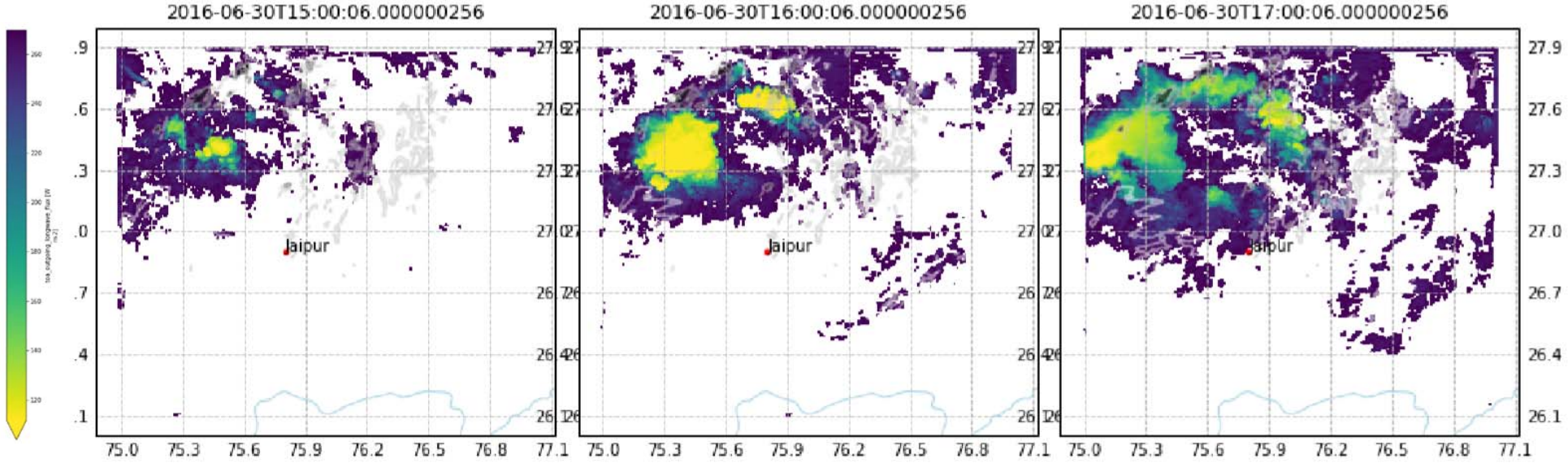
- 200m model configuration follows similar work at University of Leeds for convection over India.
- TerraMaris will explore coupled simulations with mixed-layer ocean.



Development of diurnal convection in northern India.

Figures from Leif Denby, U. Leeds.



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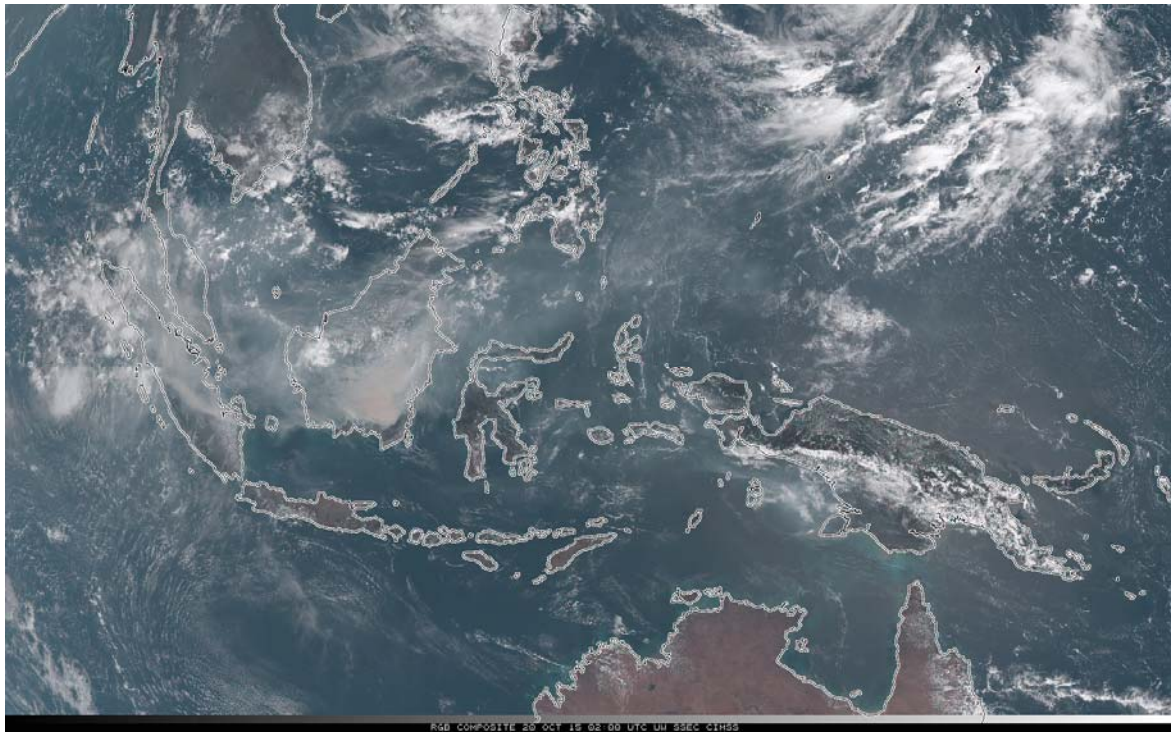
- Regional MetUM runs over a large MC domain
  - 2.2km convection-permitting
  - 17km parameterised convection
- MetUM driven at boundaries by reanalysis (ERA5?) or operational analyses
- Coupled to mixed-layer ocean
- 10x DJF season-long simulations to robustly sample MJO, CCEWs, cold surges and their response to inter-annual variability (e.g., ENSO, IOD).



Likely size of regional model domain

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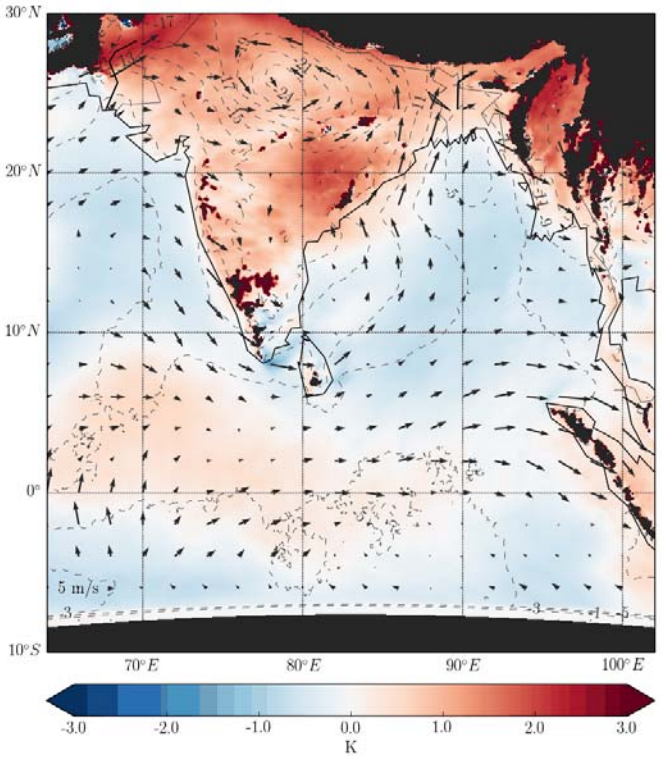
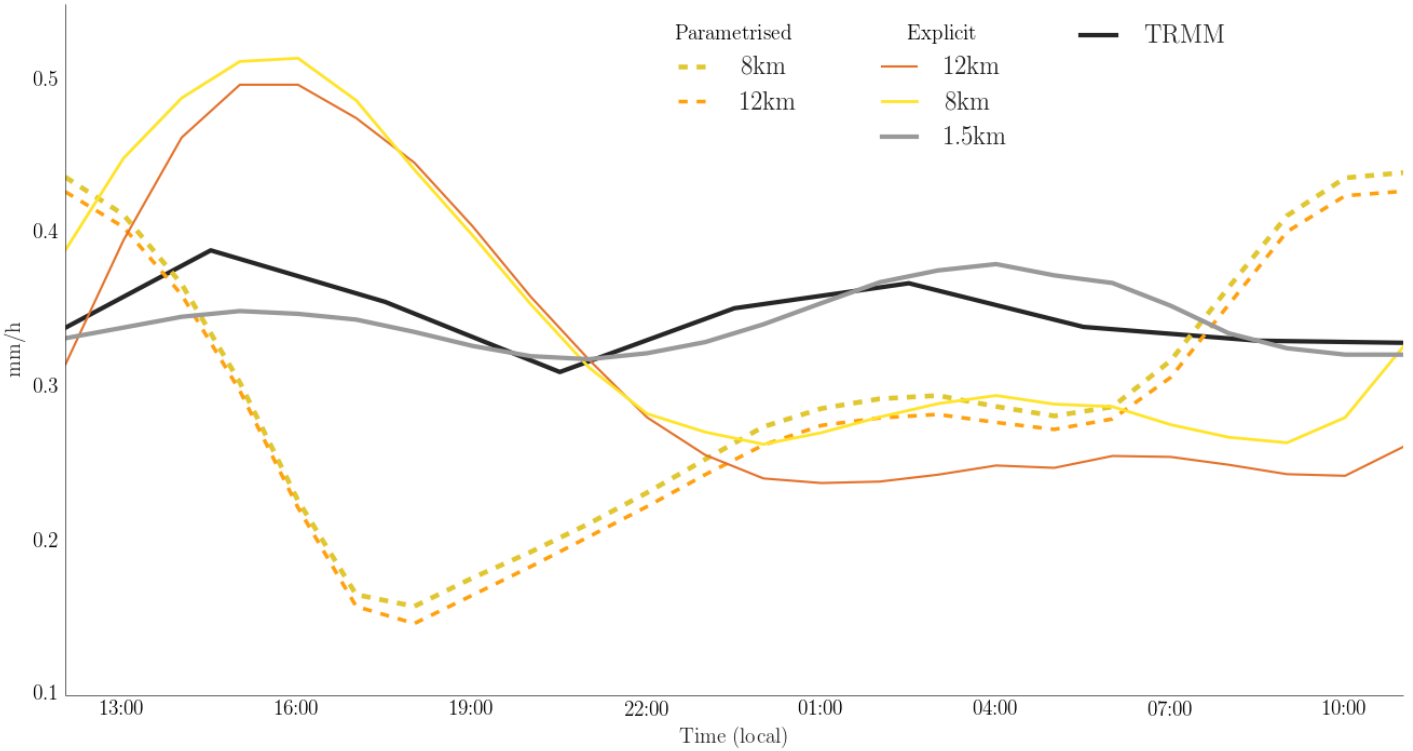


Explicit convection gives a stronger land-sea contrast and stronger monsoon trough.

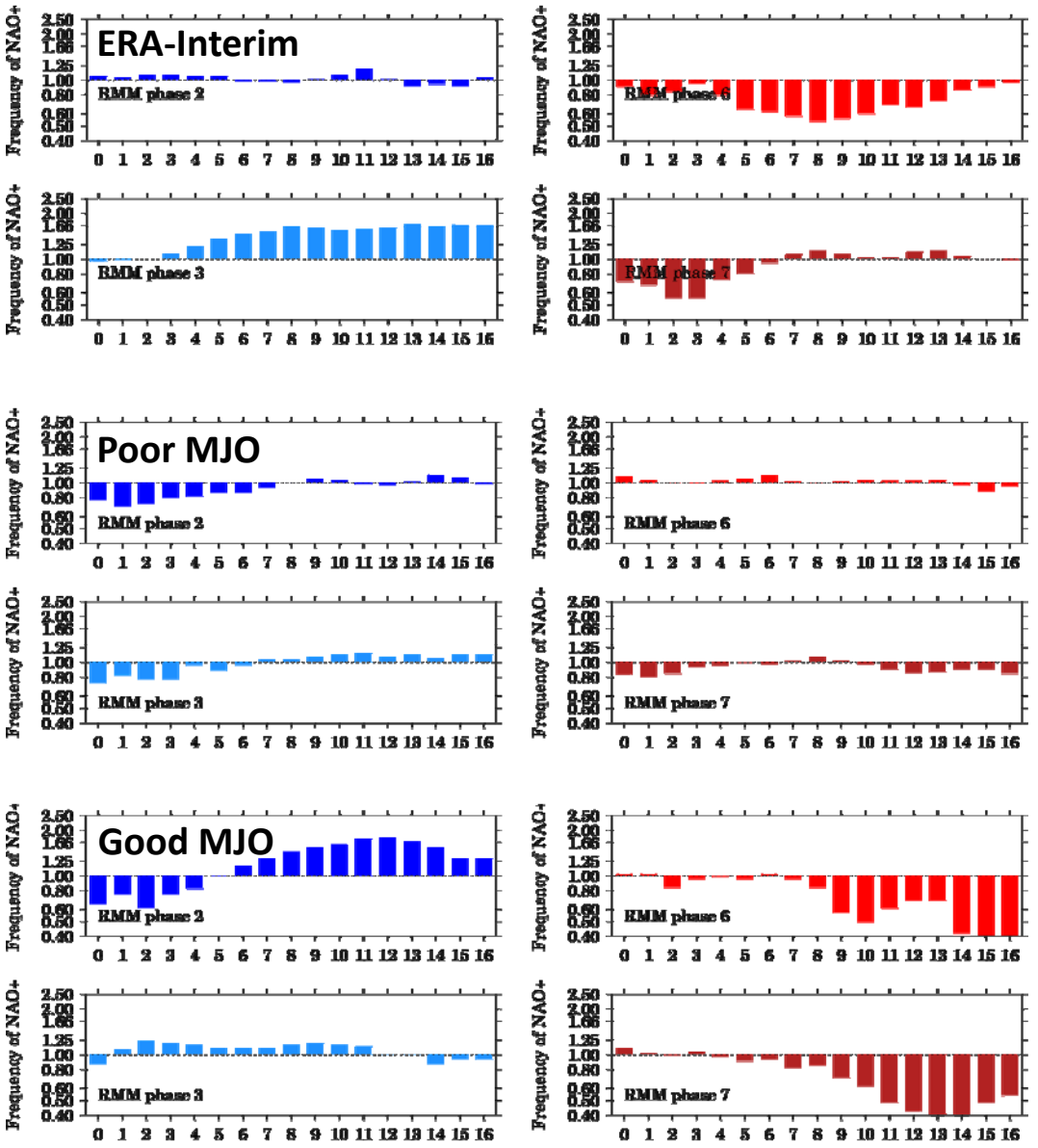


Explicit convection improves the timing of the diurnal cycle of rainfall over India.

Figures from Peter Willetts, U. Leeds

TerraMaris modelling plans

- Climate-length MetUM simulations at approximately 90km to study the response of global teleconnections to variations in MC heating.
- Sensitivity tests to the vertical structure and intensity of MC heating.
- Prescribe MC heating profiles from regional convection-permitting runs.
- Examine response of known MC teleconnections to monsoons and extra-tropical circulations (e.g., NAO)



Summary

- TerraMaris modelling builds upon and extends the UK capability for simulations targeting convective processes and their interaction with the large-scale environment.

- We plan a linked hierarchy of experiments, from 200m CRMs to global climate simulations, to understand Maritime Continent convection and improve our ability to predict its evolution and global teleconnections
  - 200m CRM simulations to study land-sea breezes
  - 2km large-domain, multi-season simulations to study the development of convection and its interactions with large-scale variability (MJO, CCEWs, ENSO)
  - 90km global climate simulations to study the global teleconnections from Maritime Continent heating – does improved MC heating lead to improved teleconnections?

- First simulations (2km large-domain) to start later in 2019.