Cascade

Organised convection and scale interactions in the tropical atmosphere

- Cloud-system resolving simulations over large tropical domains
- Real case studies and idealised equatorial waves
- UK NERC funded consortium, 2008-2012

Aims

- Advance understanding of convective organisation and scale interactions
- Inform the development of new approaches to convective parameterization
- Create a new framework for process modelling

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL
Walker INSTITUTE
UEA University of East Anglia
UNIVERSITY OF LEEDS
Met Office

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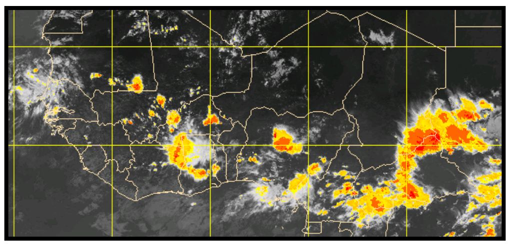
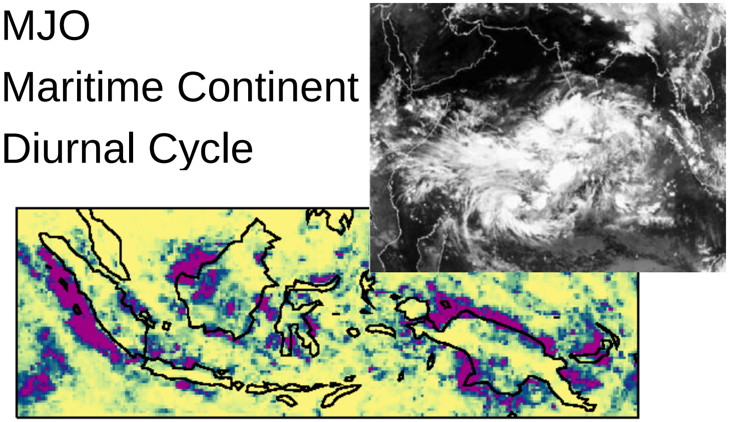
Case Studies

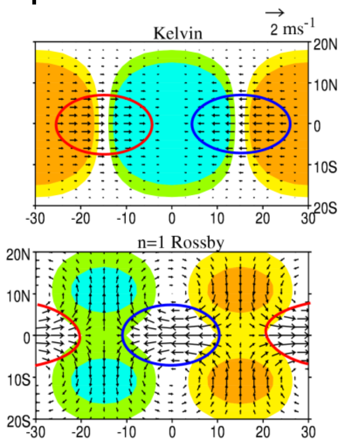
West Africa
- African Easterly Waves
- Diurnal Cycle



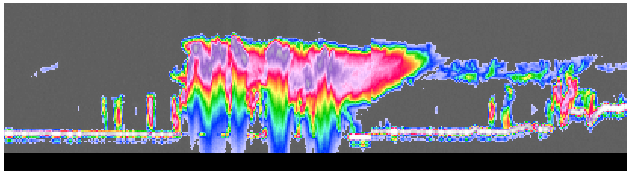
Warm Pool
- MJO
- Maritime Continent
- Diurnal Cycle

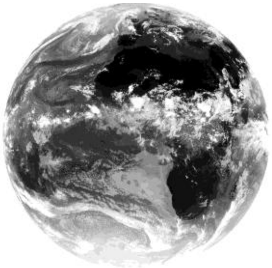


Idealised
- Warm Pool Convection
- Equatorial Waves



Model Evaluation against Observations
- CloudSat/CALIPSO: vertical cloud properties
- GERB/SEVIRI/MTSAT: horizontal and time





Synthesis
- Analysis of scale interactions
- Insight into physical processes
- Compare with climate / NWP resolution
- Conclusions for parameterization

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- Cascade PIs

  Steve Woolnough (Project Manager), Julia Slingo, Doug Parker, Adrian Matthews, Mike Blackburn Robin Hogan, Brian Hoskins, Lois-Steenman Clark

- Cascade Post-docs

  Grenville Lister, Chris Holloway, Barney Love, Nick Dixon, Thorwald Stein, Kevin Pearson, Guiying Yang

- Met Office Involvement

  Numerous people in Atmospheric Process and Parametrization and the Joint Centre for Mesoscale Modelling, led by Paul Field

http://ncas-climate.nerc.ac.uk/Cascade

Model

- Met Office UM at 40, 12, 4, 1.5km resolution
    - All used operationally at MO
    - Operational configuration starting point for testing
- 40, 12km
    - 38 levels
    - Convection scheme
    - Diagnostic cloud scheme

Model

- 4km
  - 70 levels
  - Convection scheme on with closure timescale function of CAPE
    - High CAPE $\Rightarrow$ long timescale $\Rightarrow$ resolved dynamics does strong convection, convection scheme does weak convection
  - 3 component cloud microphysics (prognostic liquid, ice, rain)
  - Horizontal mixing by 2D Smagorinsky type scheme

Model

- 1.5km
    - 70 levels
    - Testing with and without convection scheme (configured similar to 4km)
    - Testing 3 (liquid, ice, rain) and 5 (liquid, 2 ice, rain, graupel) component microphysics
    - Horizontal mixing by 2D Smagorinsky type scheme
    - Stability dependent vertical mixing throughout depth

West Africa Case Studies

- Chosen from AMMA so not strictly YoTC but hopefully results still useful
  - Domain 20W-20E, 5S-28N
  - Forced by ECMWF analysis at boundaries

Case 1: 26-28 July 2006 – Significant but “unusual” AEW with a range of significant scales

Case 2: 31 July – 5 Aug 2006 – Weak AEW activity but several strong storms, good examples of diurnal cycle, secondary initiation etc

Case 3: around 10 September 2006 – A “textbook” AEW subsequently initiating a hurricane

- 40,12 km simulations of Case 1 & 2 completed
- 4km simulation of Case 1 & 2 running

Indian Ocean West Pacific Warm Pool

- Coincide with YoTC
- Domain 40E-183E, 22S-22N
- Forced with ECMWF analysis
- 7 months of integration starting 11 Oct, reinitialized every 30 days at 40km, 12km to look at diurnal cycle and MJOs
- 2 MJO events at 4km resolution (for about 20 days)
    - 11 October 2008
    - 5 April 2009
- 1 of above MJO events at 1.5km resolution (TBD based on analysis of 4km runs)
- 3 months of 40km and 1 month of 12km runs complete
- 4km run for October being setup

Idealized Experiments

- ~8000x4000km domain
- 4km resolution
- ~50 day integrations

- f=0 plane
  - Examine the organization of convection in the absence of equatorial wave dynamics.
  - Assess the sensitivity of the results of Bretherton et al. (2005) and Stephens et al. (2008) to dimensionality and domain size.
- Full rotational effects
  - Organization of convection by equatorial waves
  - Impact of convection on equatorial waves

Analysis

- Comparison with observations
  - CloudSat/Calipso to look at vertical structure and assess model representation of microphysics
  - Geostationary satellites to assess horizontal structures and temporal evolution
- Convective Organization and scale interactions
  - Analysis of spatial scales – spectral, clusters etc
  - Energy and PV budgets
  - Processes based studies, e.g. role of cold pools, gravity waves, tropospheric humidity…
  - Dependence of heating, moisture transports etc on mesoscale organization
  - Role of diurnal cycle