NCAS Centre for Global Atmospheric Modelling

The MJO in Global Climate Models

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Modelling the MJO

"It is a truth, universally acknowledged, that a GCM in possession of a good MJO simulation will lose it as soon as ANYTHING at all is changed in the model formulation."

Jane Austen (mostly), *Pride and Prejudice*, (1818)

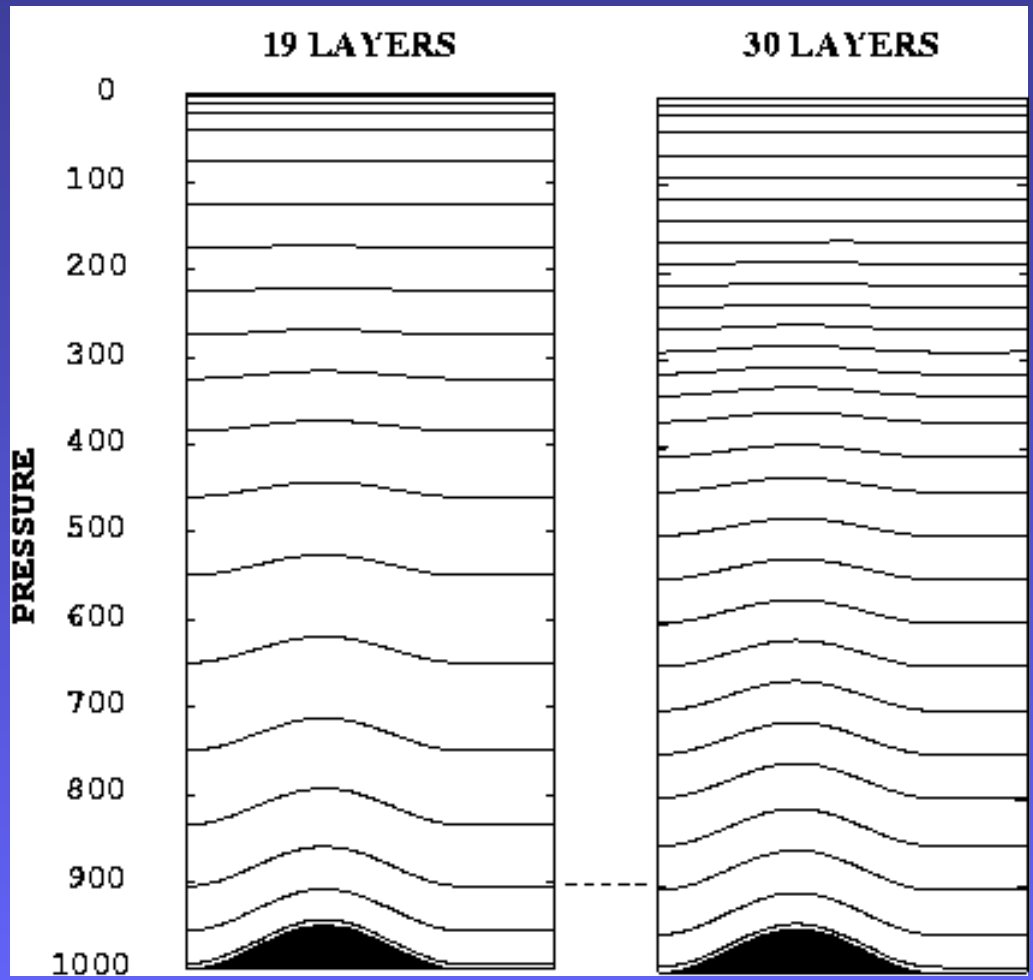
Outline

How have various changes to a GCM affected the MJO simulation, in the light of MJO theories and observations?

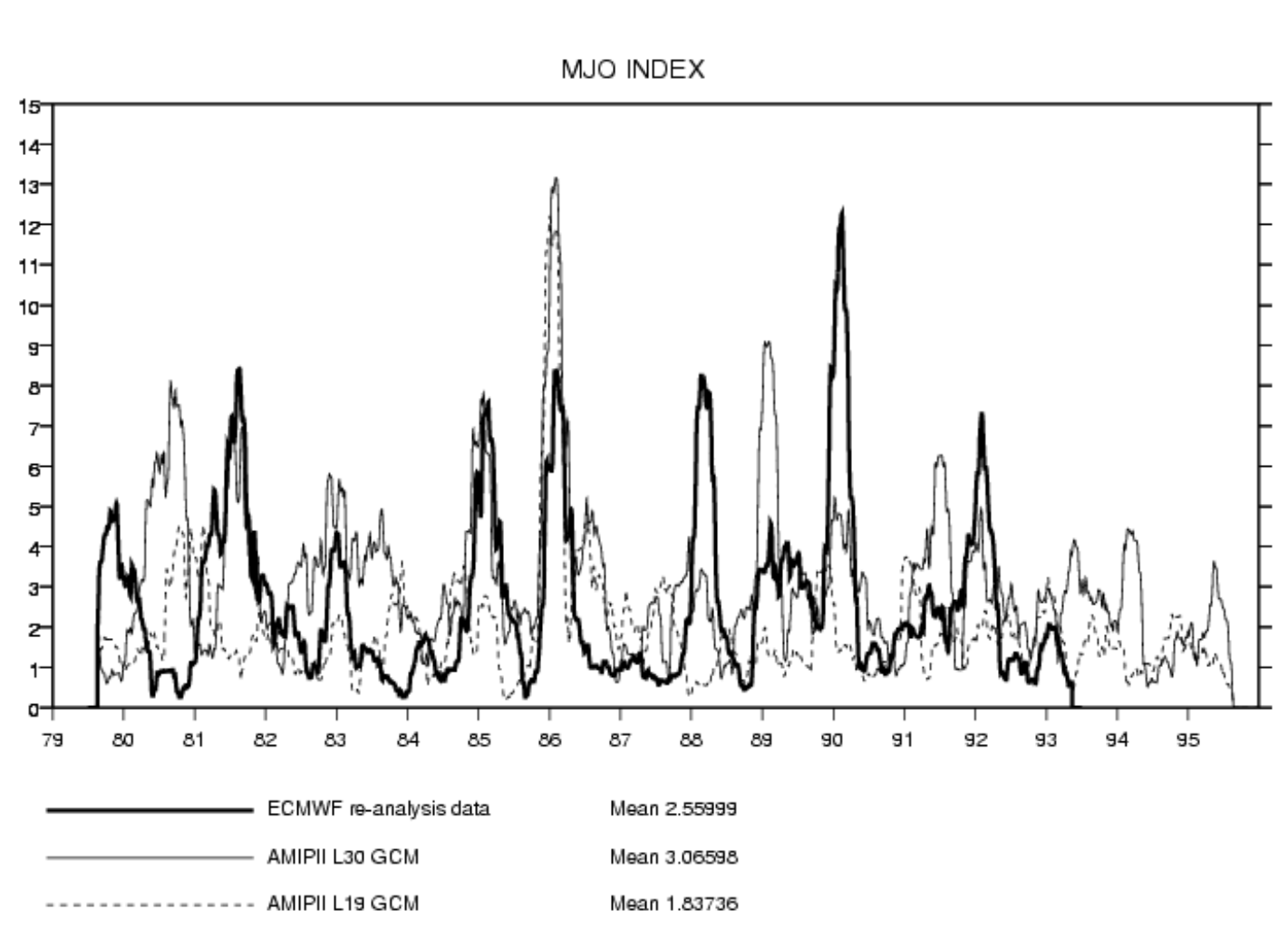
- Atmosphere-only. L19 vs L30
- Atmosphere only vs coupled
- poor(ish) basic state vs good(ish) basic state

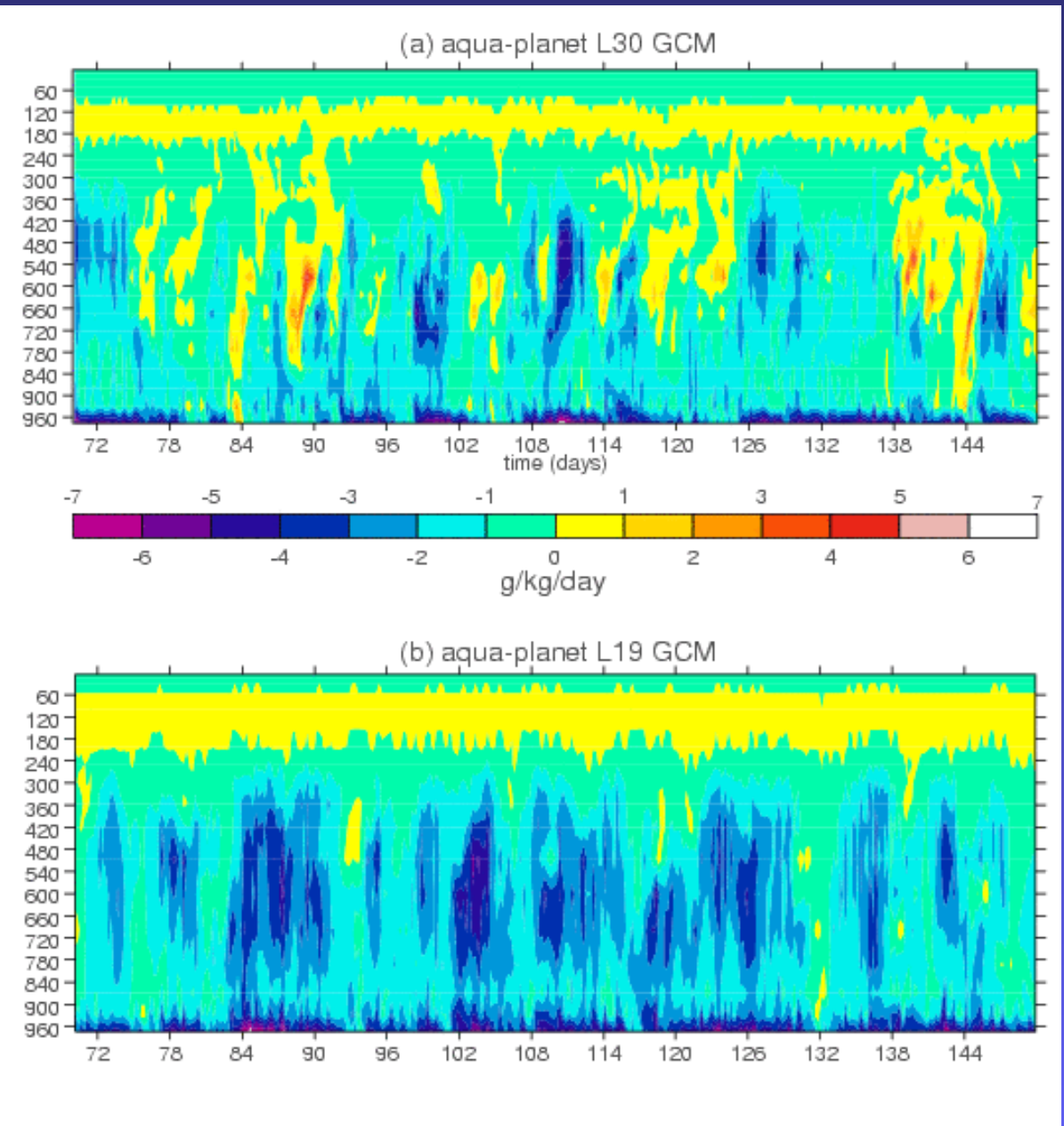
Impact of vertical resolution

- Atmosphere-only version of Hadley Centre GCM (HadAM3)
- Vertical resolution doubled in free troposphere



MJO Index


MJO INDEX
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
ECMWF re-analysis data
Mean 2.55999
AMIPII L30 GCM
Mean 3.06598
AMIPII L19 GCM
Mean 1.83736

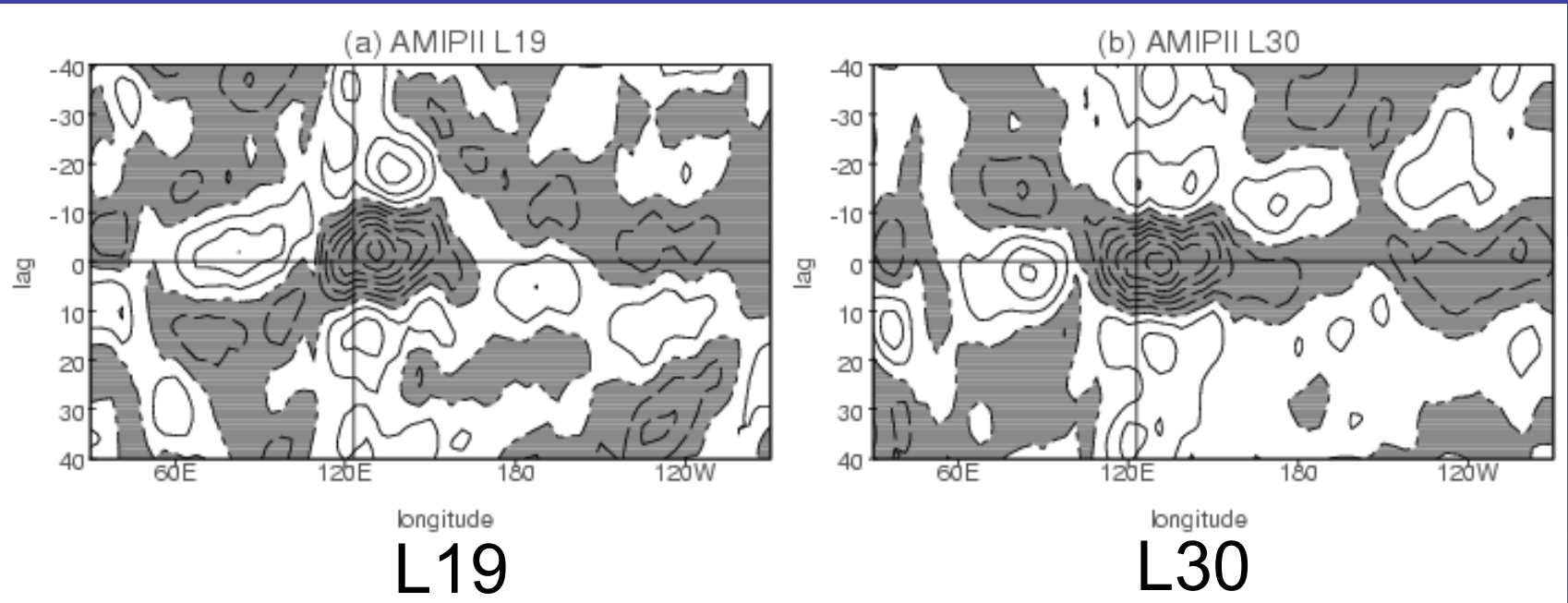


Convective increment to specific humidity

Test the impact of increased vertical resolution in an aqua-planet version

Change in behaviour of convection – L30 captures cumulus congestus

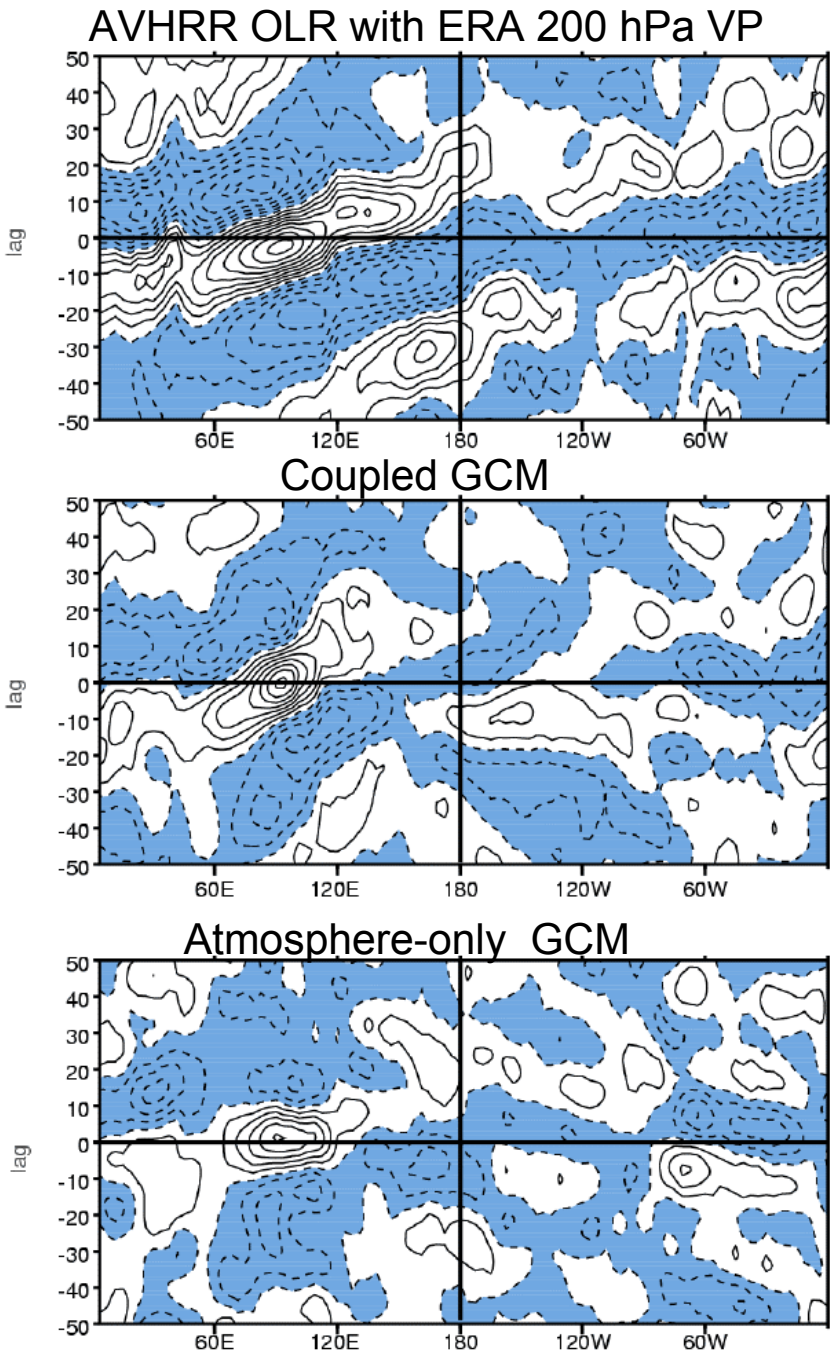
Propagating convection?



L19 L30

The impact of coupling

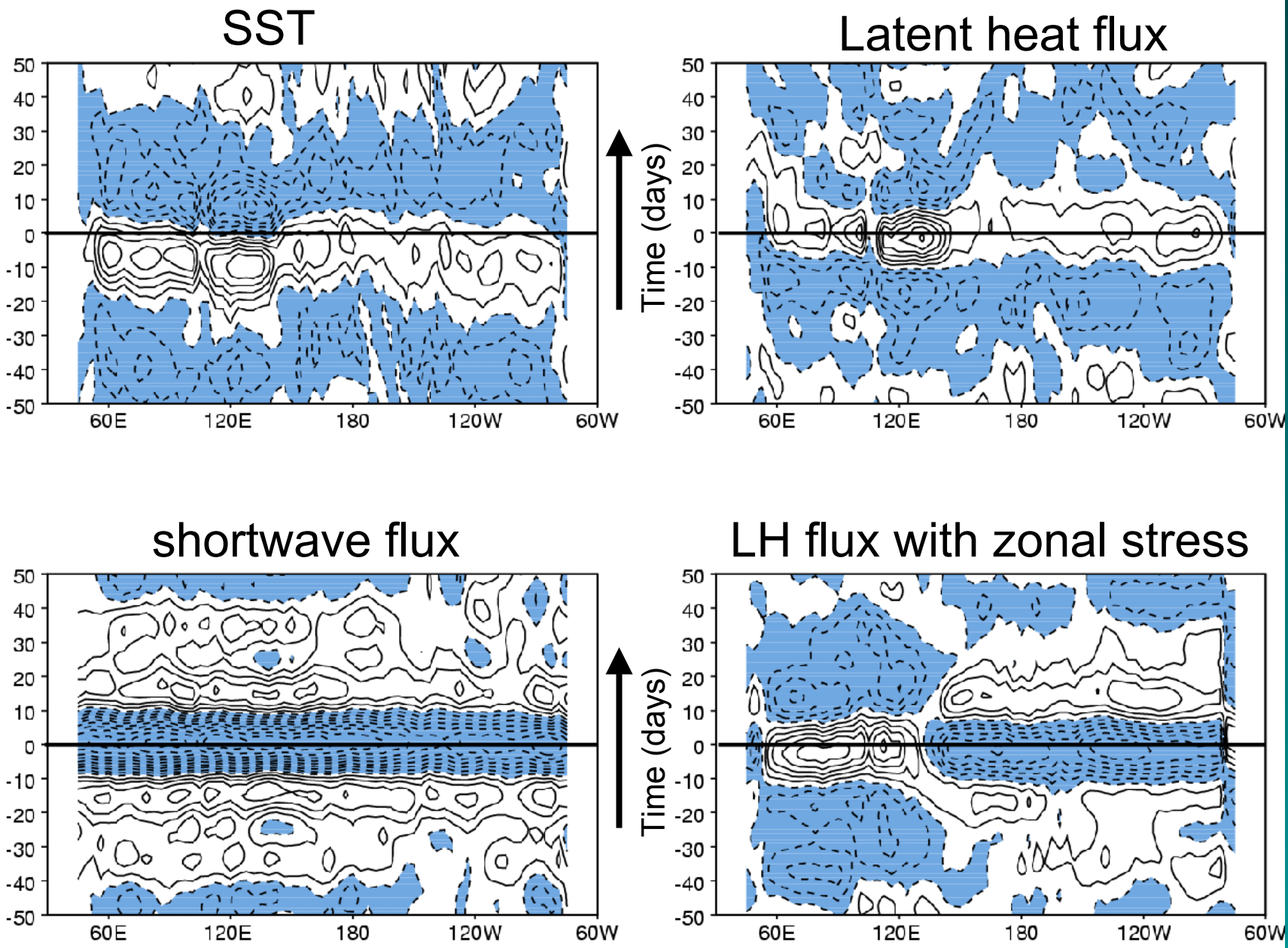
- Observational and theoretical studies suggest a role for air-sea interaction in maintaining the MJO
- What is the impact on the MJO of using a coupled GCM?
- Hard to study in isolation as coupling affects basic state



In the coupled GCM, convection does propagate across the Indian Ocean

However, the signal is weaker than observed and does not extend into West Pacific

Has coupling to an ocean helped?



Lag correlations of surface fields with convective rain

Impact of coupling

- There are several reasons why coupling may not improve the MJO

1. The ocean may not produce large enough intraseasonal SST variability
2. The basic state may prevent correct air-sea interaction
3. The convection scheme is insensitive to intraseasonal SST variations
4. More fundamental model deficiencies

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(see Hendon (2000), *JAS*, for an example, related to 1 and 2)

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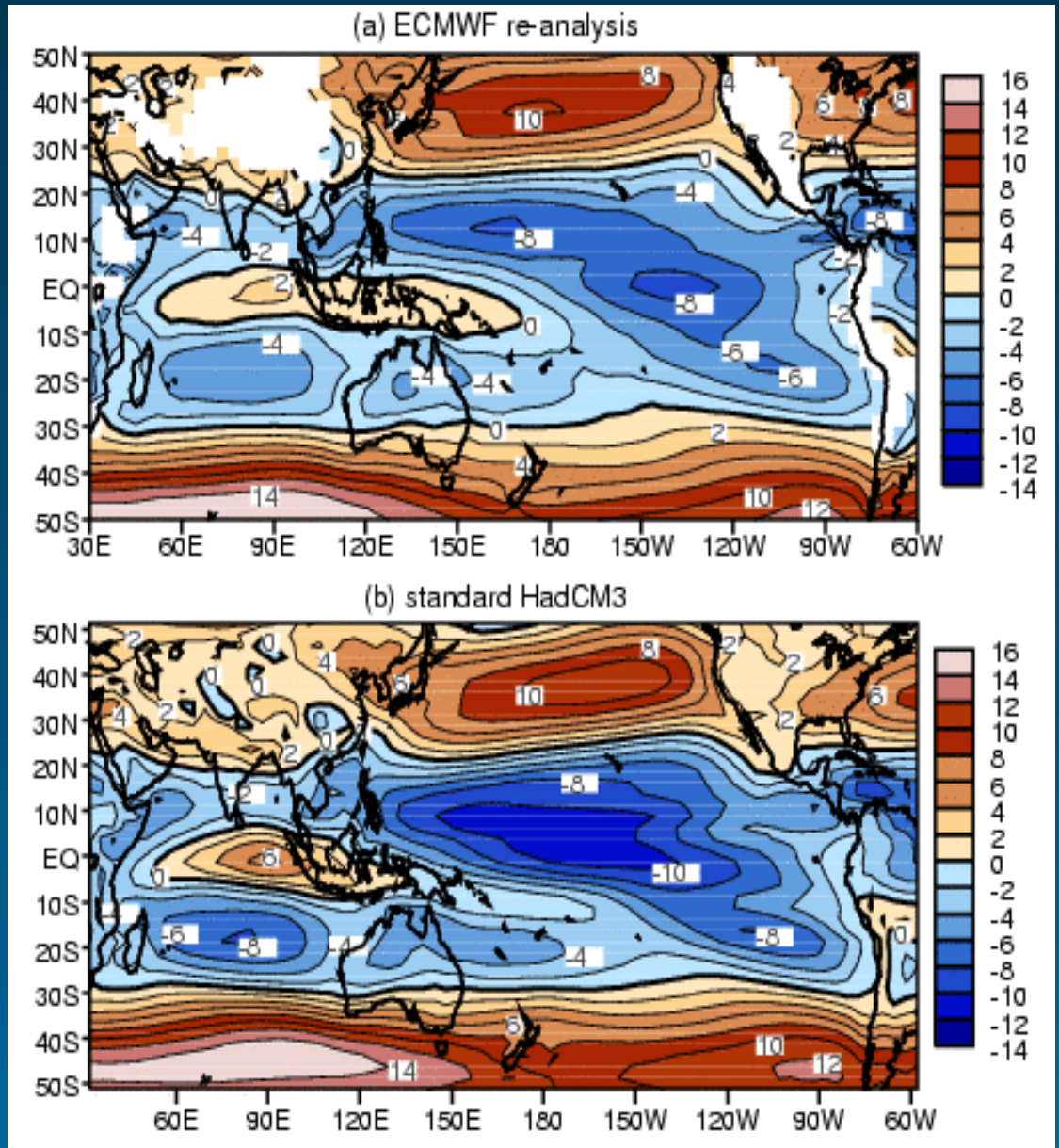
Impact of the basic state

Low level zonal winds (ONDJFMA)

Re-analysis

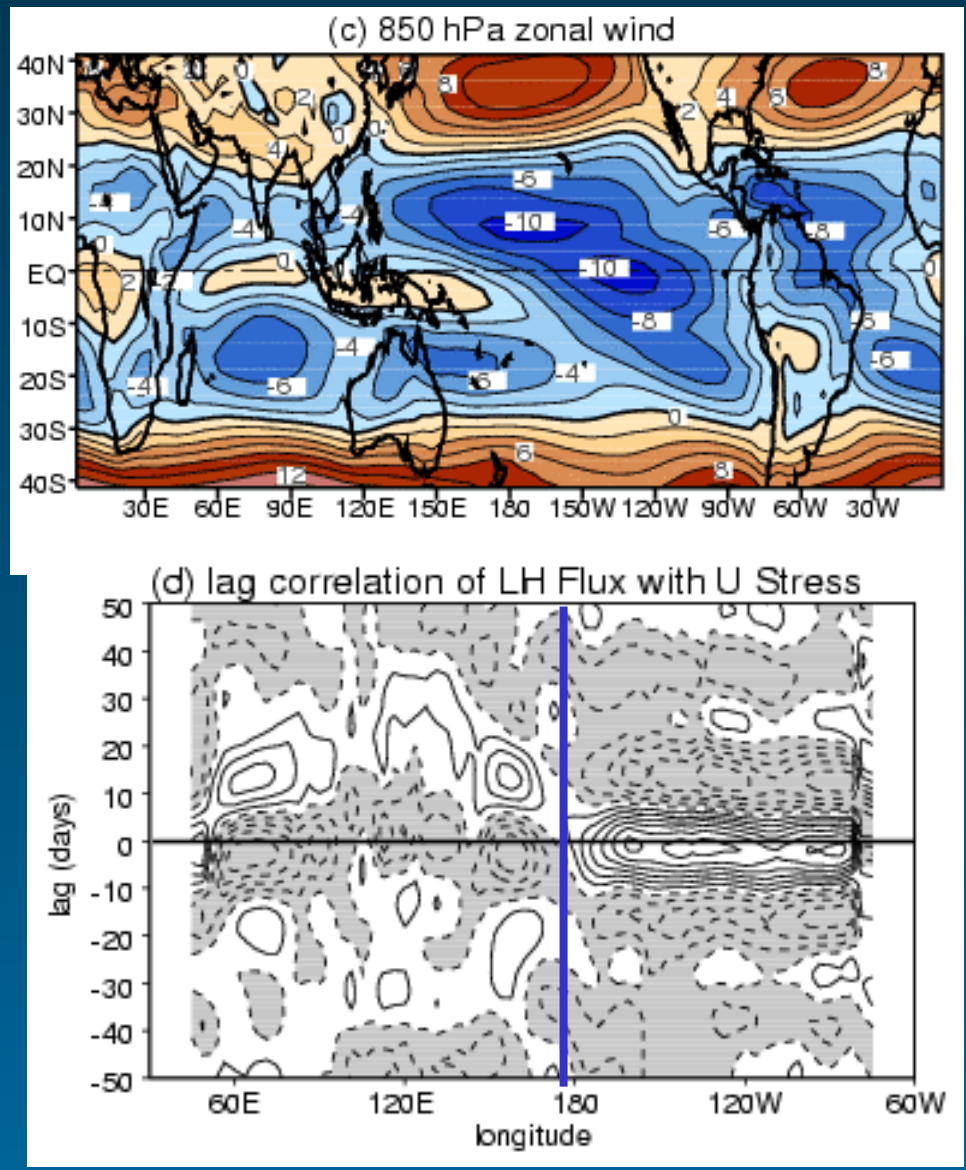
HadCM3



Impact of the basic state

Applying limited flux adjustments in the equatorial cold tongue of the coupled model induces westerly winds in W. Pacific.

The correlation between zonal wind anomaly and LH flux anomaly changes sign near the date-line



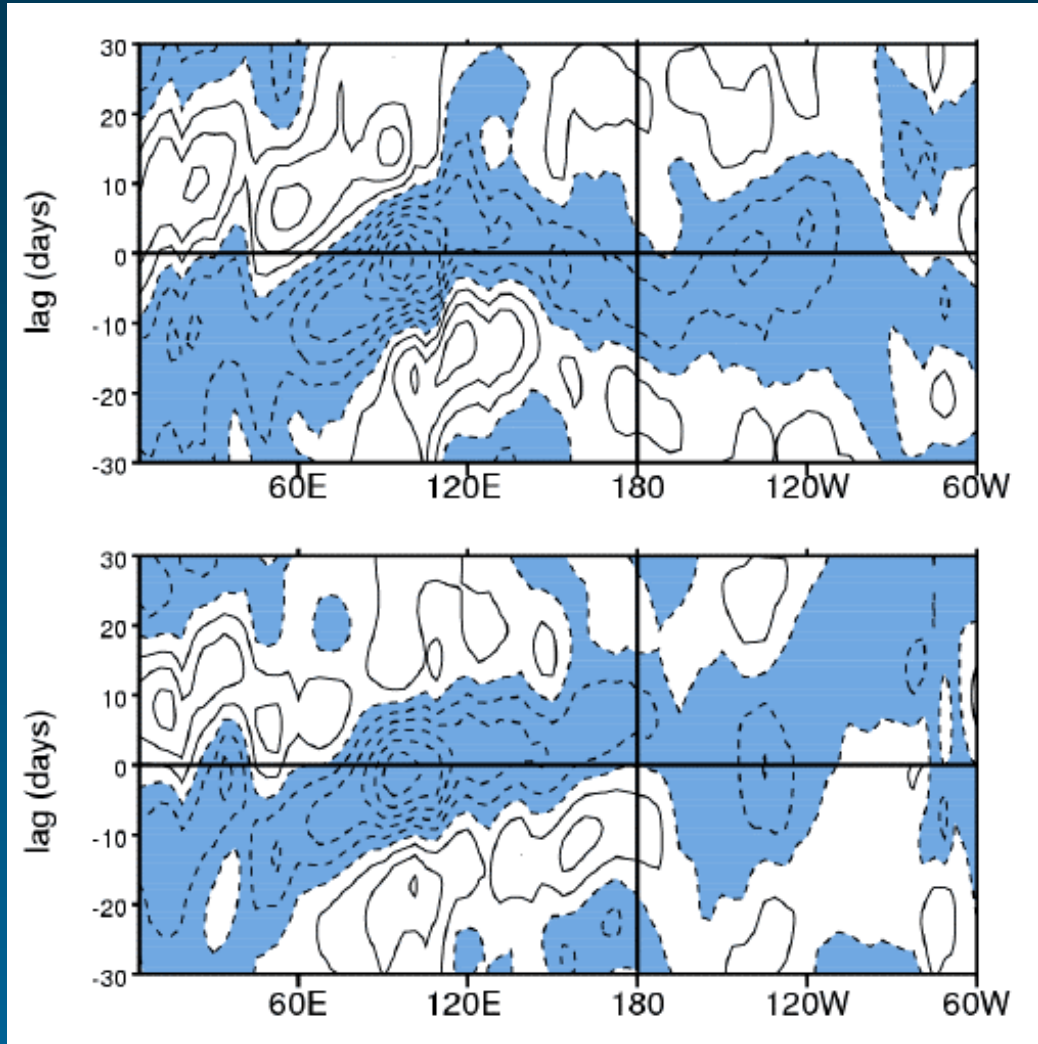
Impact of the basic state

Standard coupled model

Eastward propagation of MJO only through low level westerlies

Flux-adjusted version

Eastward propagation extends into West Pacific



Some outstanding issues…

- The overall convective variance around the equator in HadCM3 is very low, and not well coupled to the equatorial wave modes
- The cumulus congestus phase is only just captured at L30
- The intraseasonal SST variability is rather weak