Utility of regional and mesoscale models of MJO

- Mesoscale models allow higher resolution to study local processes in detail, whilst constraining large scale, e.g.
- Coupled COAMPS® and NCOM
  - Forecast and hindcast modes
  - Multiple nests, b.c.s NOGAPS, global NCOM
  - Next speaker, Sue Chen
- Regional models such as
- IROAM- IPRC regional ocean-atmosphere model
  - Hindcast mode, NCEP/NCAR reanalysis
- SCOAR (Hyodae Seo)

Intraseasonal activity in the eastern tropical Pacific**: a regional coupled model investigation

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**Deep convection initiates in eastern Pacific in summer – some relevance to DYNAMO study of initiation, hopefully

IPRC Regional Ocean-Atmosphere Model (iROAM) on ES

Atmosphere: IPRC-RAM

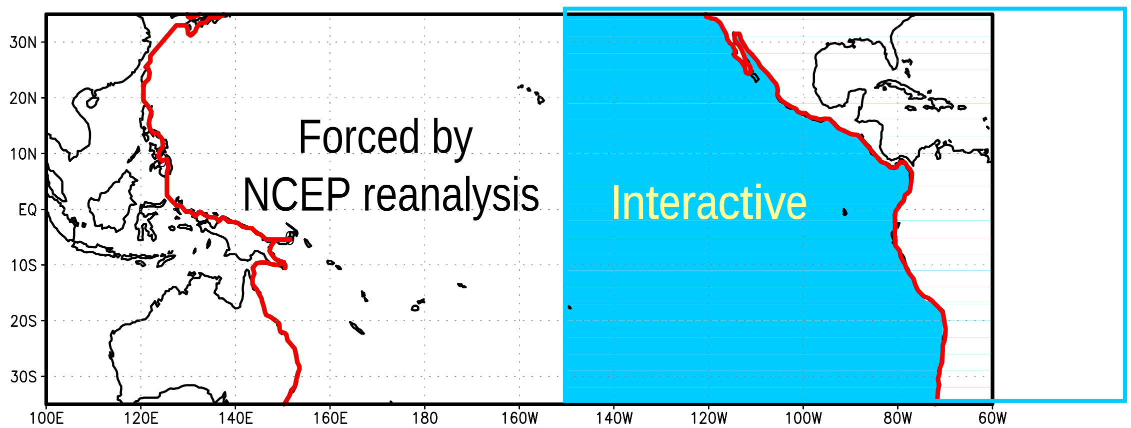
0.5°×0.5°, L 28

↕

GFDL Modular Ocean Model 2

0.5°×0.5°, L 30

Xie et al (2007), J. Climate



Ocean spin-up → ‘91 – ‘95

Coupled → 96 – 03

Lag correlations: from NOAA OLR and IROAM OLR

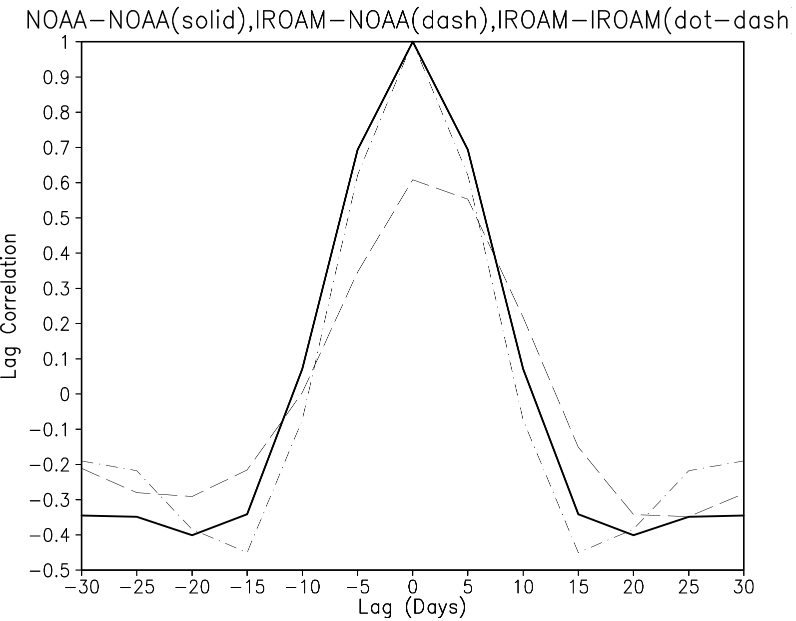


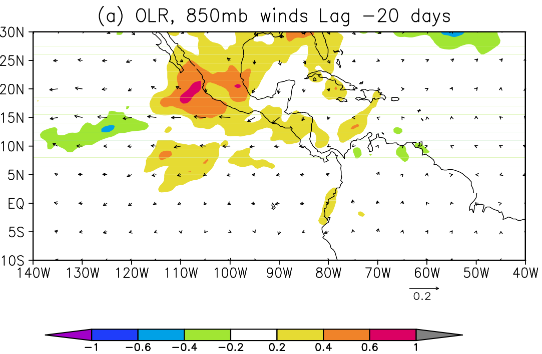
Fig. 6. Top: NOAA filtered OLR autocorrelation (solid line, symmetric), IROAM filtered OLR autocorrelation (dash-dot line, symmetric) and the lag correlation of IROAM filtered OLR onto NOAA filtered OLR (dashed line). Data is averaged in the box 10°N to 20°N, 110°W to 100°W before analysis. Data is taken from 1998-2003, all seasons.

IROAM OLR has an instantaneous correlation of 0.6 with NOAA OLR. Timescales appear to be similar (Half periods of 15-20 days).

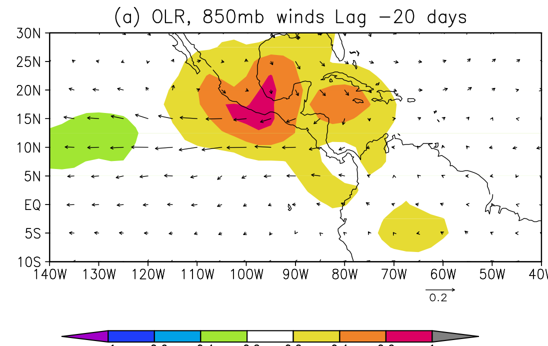
Comparison: MJO time evolution.

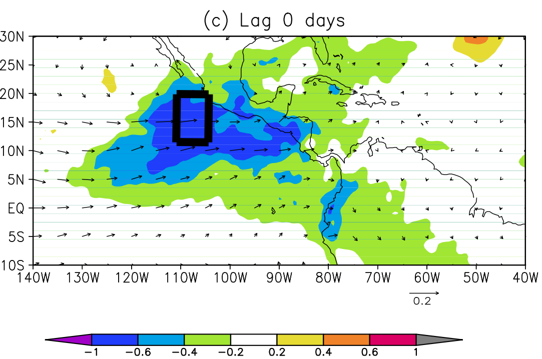
MODEL

OBSERVATIONS



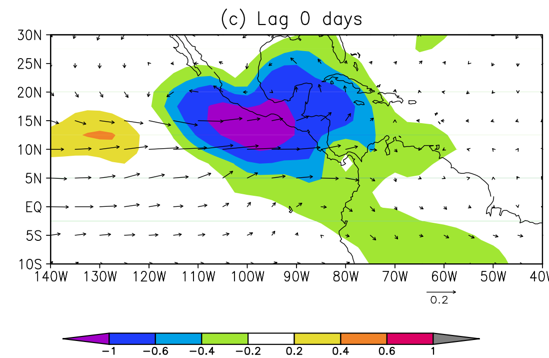
Lag regression onto NOAA OLR averaged over box shown in middle left panel. Shown at -20 days, 0 day and 20 day lag.

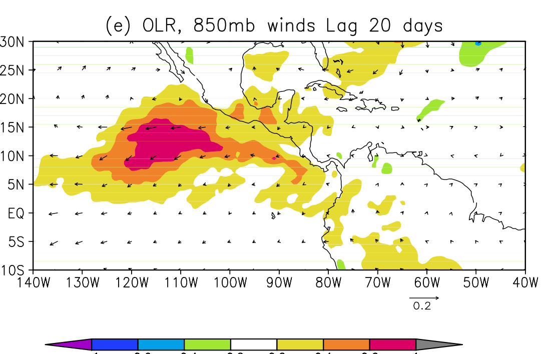




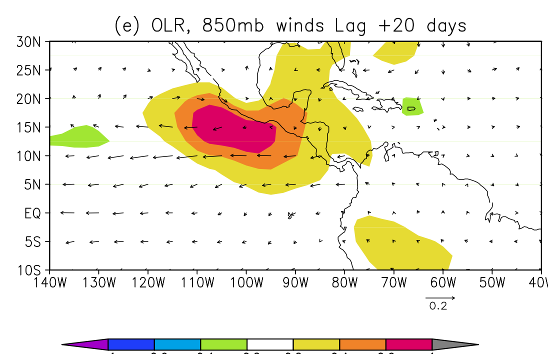
Left: IROAM OLR (col) and 850hPa winds regressed onto observed (NOAA) OLR.

Right: NOAA interpolated OLR data from satellite and NCEP 850hPa winds.

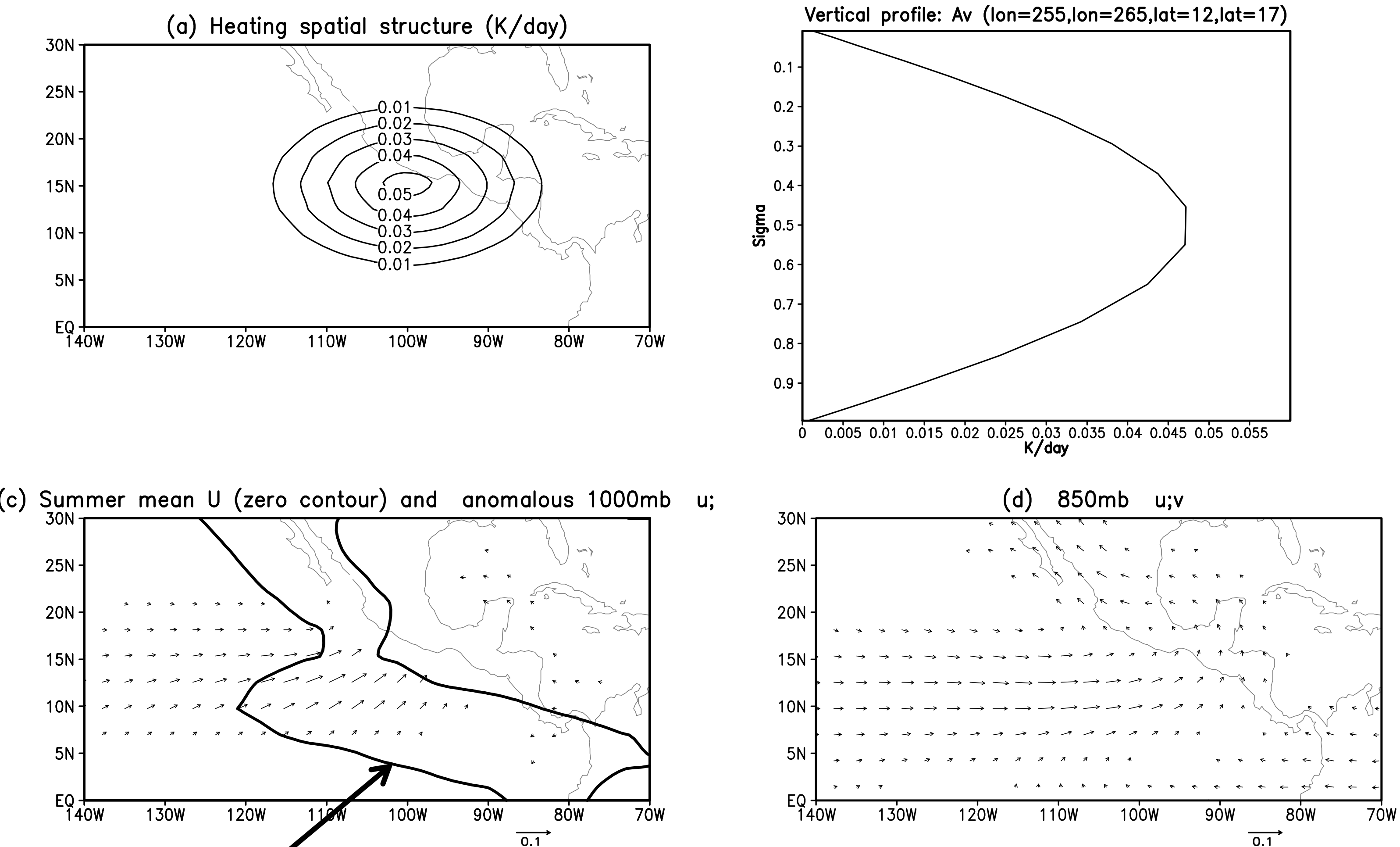




Progression of MJO is good in model.



Response to heating: Linear Baroclinic Model



Zero contour of mean zonal winds

Figure 18. Linear baroclinic model simulations of the response to a heat source over the Eastern Pacific in summer. (a) horizontal structure (heating rate in K/day at sigma =0.55). b) Vertical structure plotted against sigma (K/day, area-average as labeled). C) Model-simulated 1000hPa wind response (ms^{-1}) and the zero contour of the background summer-mean zonal wind from NCEP/NCAR reanalysis (westerlies are enclosed within the contour). D) Model-simulated 850hPa wind response (ms^{-1}) Model of Watanabe and Kimoto 2000

Response is similar to that observed. However stationary source cannot explain eastward propagation.

Surface latent heat flux and OLR

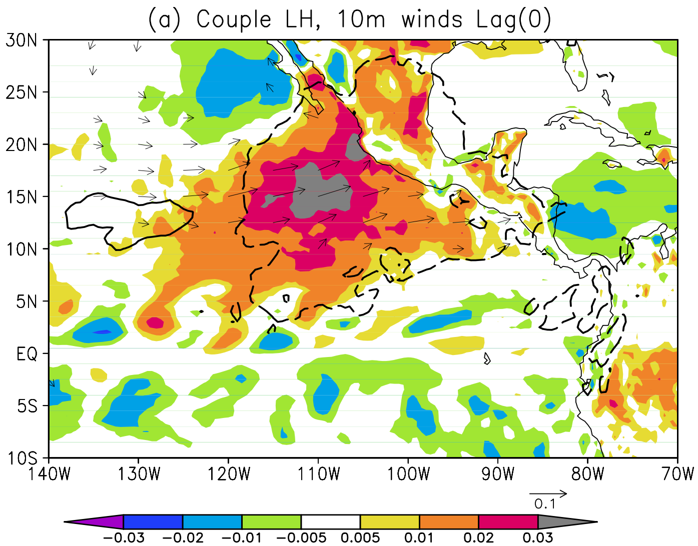
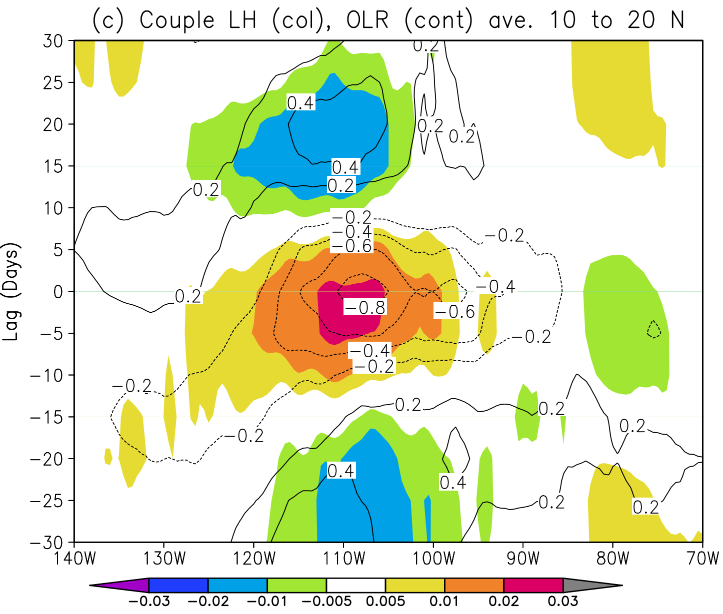


Figure 13. a). IROAM filtered evaporation lag regressed onto the IROAM OLR index: lag (0days) (color). 1998-2003 data, summer. The +/-0.3 OLR contour is overlaid for reference. c) Hovmoller plot of the evaporation regression (color) averaged between 10N and 20N, with OLR contours overlaid. Units for evaporation are mmday^{-1} per Wm^{-2}.



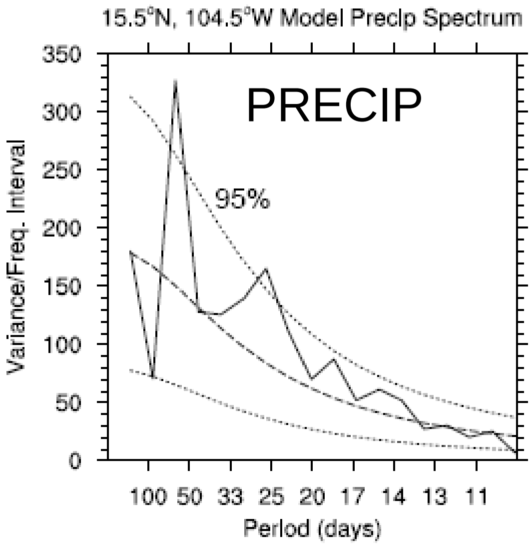
Evaporation essentially out of phase with OLR i.e. more evaporation in low OLR (strong convection) conditions. Agrees with observational analysis of Maloney et al (2008).

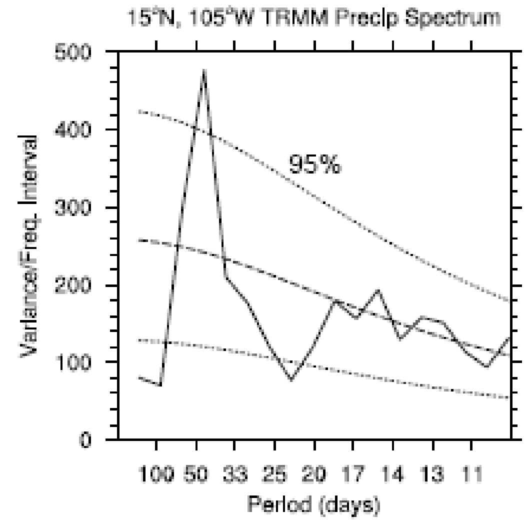
Note that high evaporation coincides with westerly wind anomalies in a region of climatological mean westerly wind, i.e. stronger wind speeds (explicitly confirmed by analysis of the scalar wind speed anomalies, not shown).

Power spectra

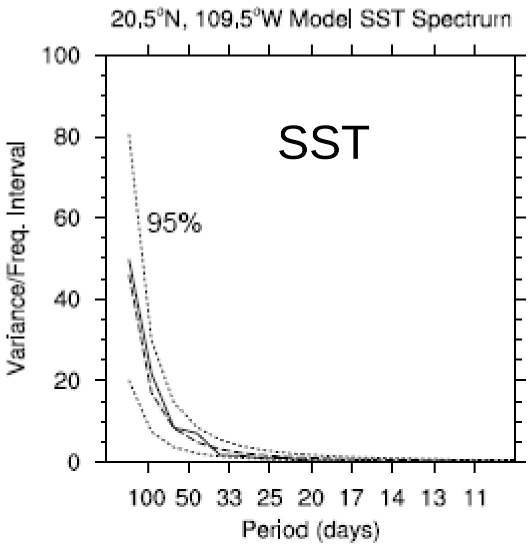
MODEL

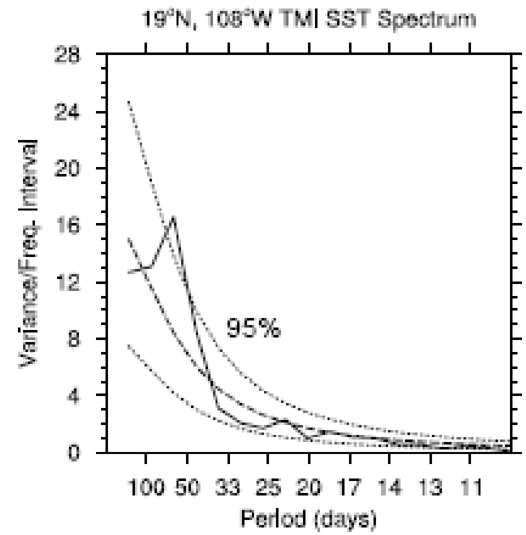
OBSERVATIONS



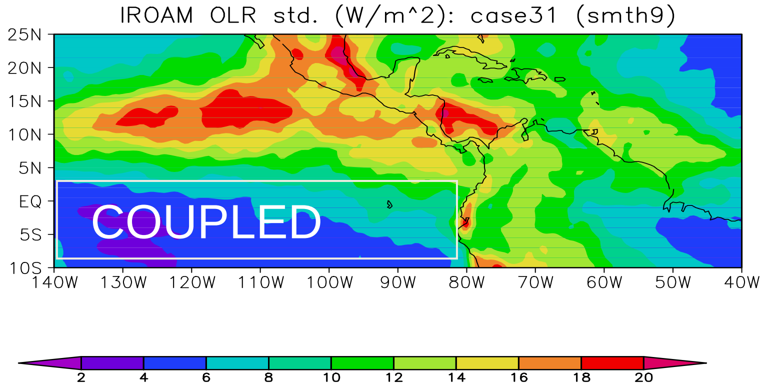


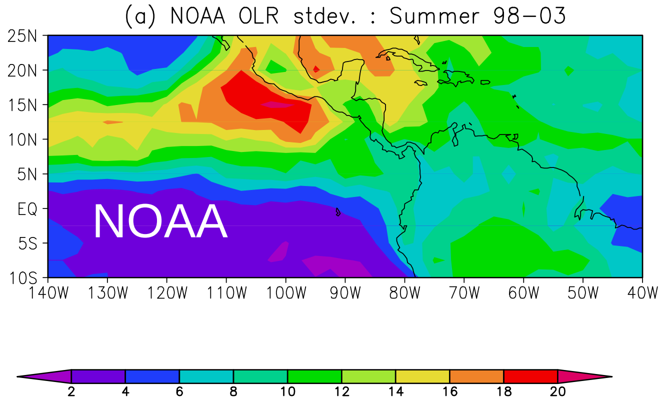
Precipitation spectrum is good compared to observations (Maloney et al 2008) but SST spectrum does not show the observed peak in the intraseasonal band.





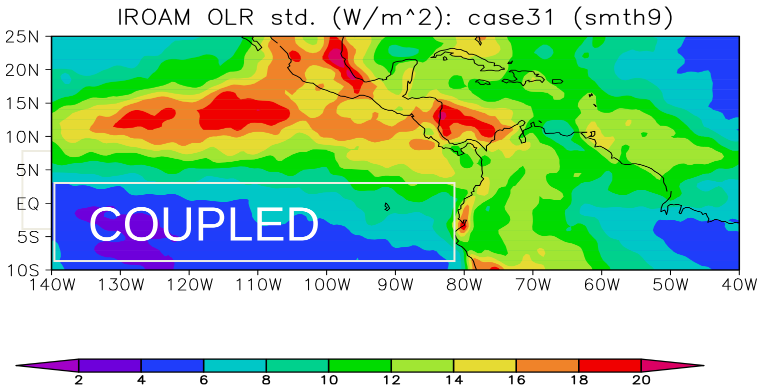
OLR variance in coupled & uncoupled models

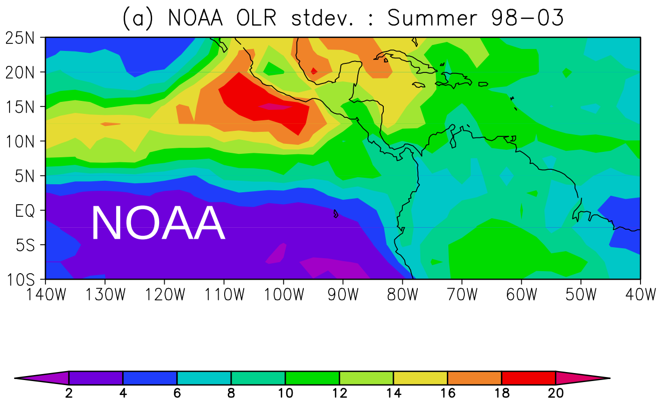


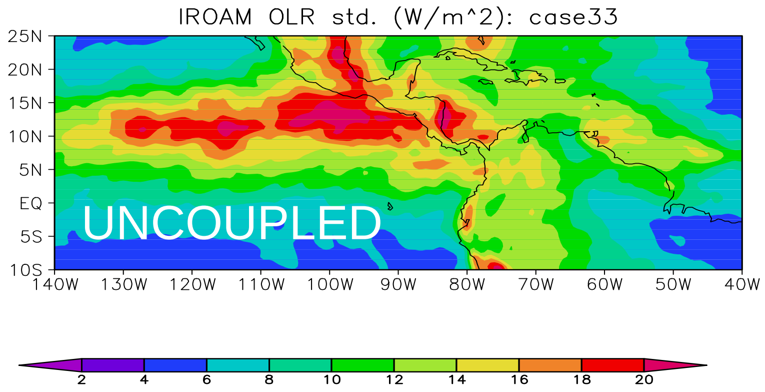


Coupled model variance peaks too far to west. Uncoupled model (Reynolds SST at boundary) is further east, closer to observations. Smoothing SST in an atmosphere-only run does not reduce MJO activity.

OLR variance in coupled & uncoupled models







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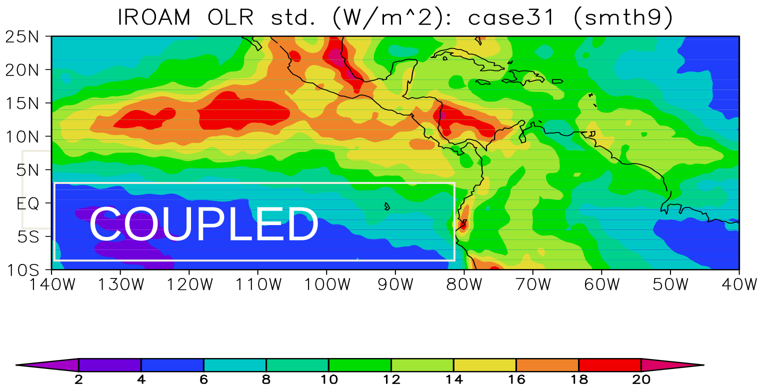
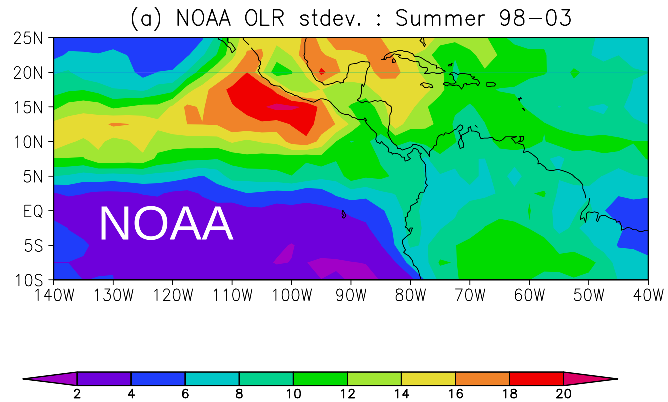
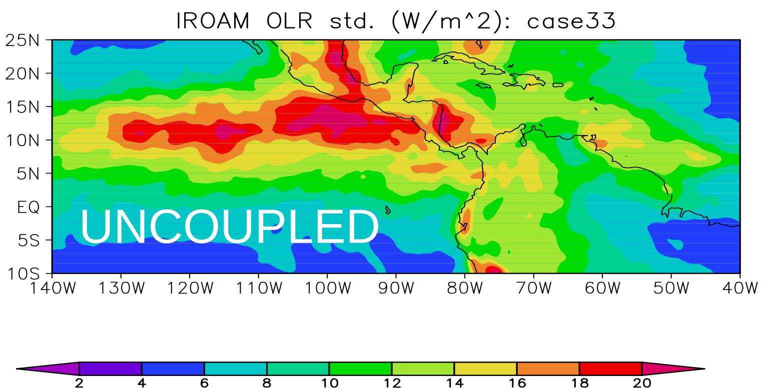
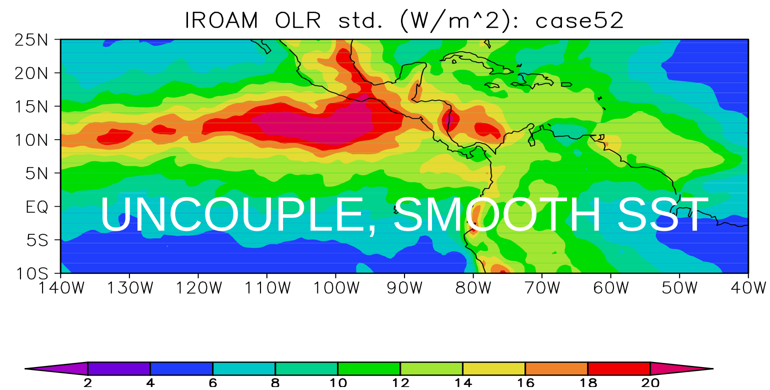
OLR variance in coupled & uncoupled models









Coupled model variance peaks too far to west. Uncoupled model (Reynolds SST at boundary) is further east, closer to observations. Smoothing SST in an atmosphere-only run does not reduce MJO activity.

Summary

- Regional coupled model reasonably represents overall amplitude and propagation of MJO in east Pacific.
- However, uncoupled run has slightly better detailed structure of OLR variance (shifted east relative to coupled, closer to observed.)
- In an uncoupled sensitivity study, intraseasonal variations in SST are not important to the overall MJO magnitude. With following caveats:
  - SST phasing with convection is better in coupled model than in uncoupled (not shown).
  - SST anomalies in coupled run are weaker than in Reynolds and TMI SST (not shown).

Future Work

- Application to DYNAMO region –
  - Dynamic signal propagates in from west- where/when will deep convection start ?