How does the MJO affect higher frequency organization of tropical convection?

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CIRES

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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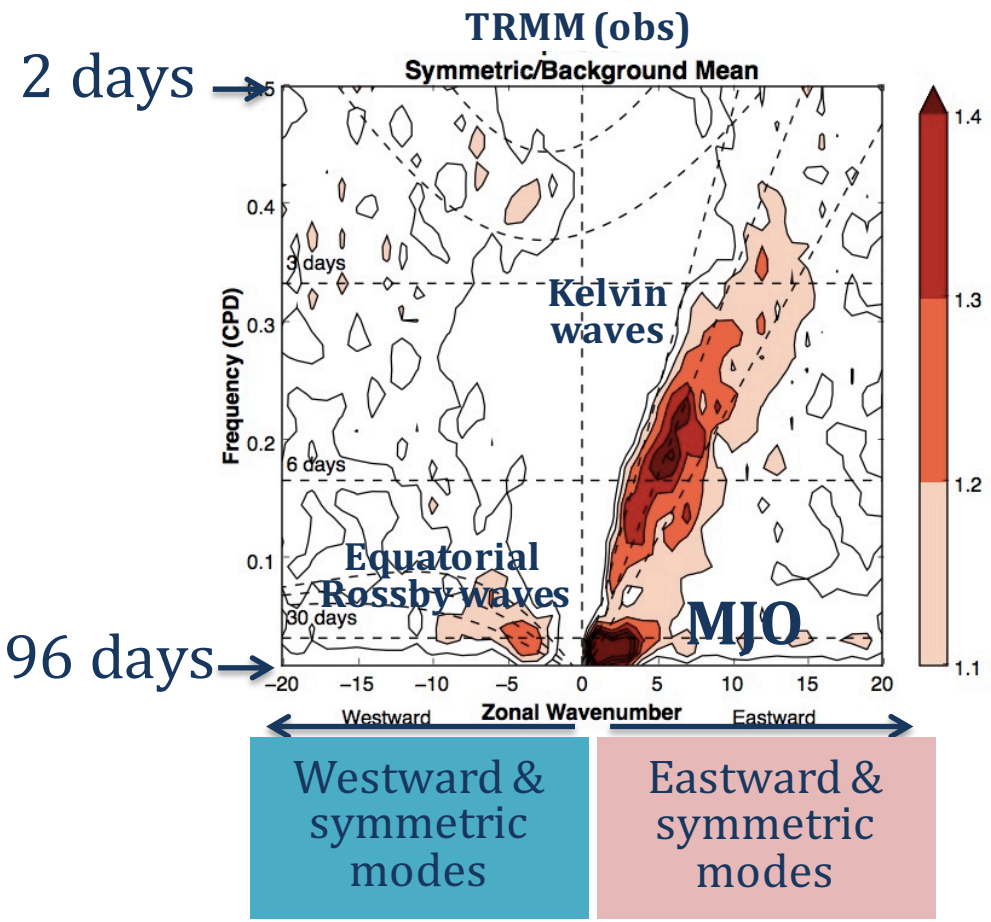
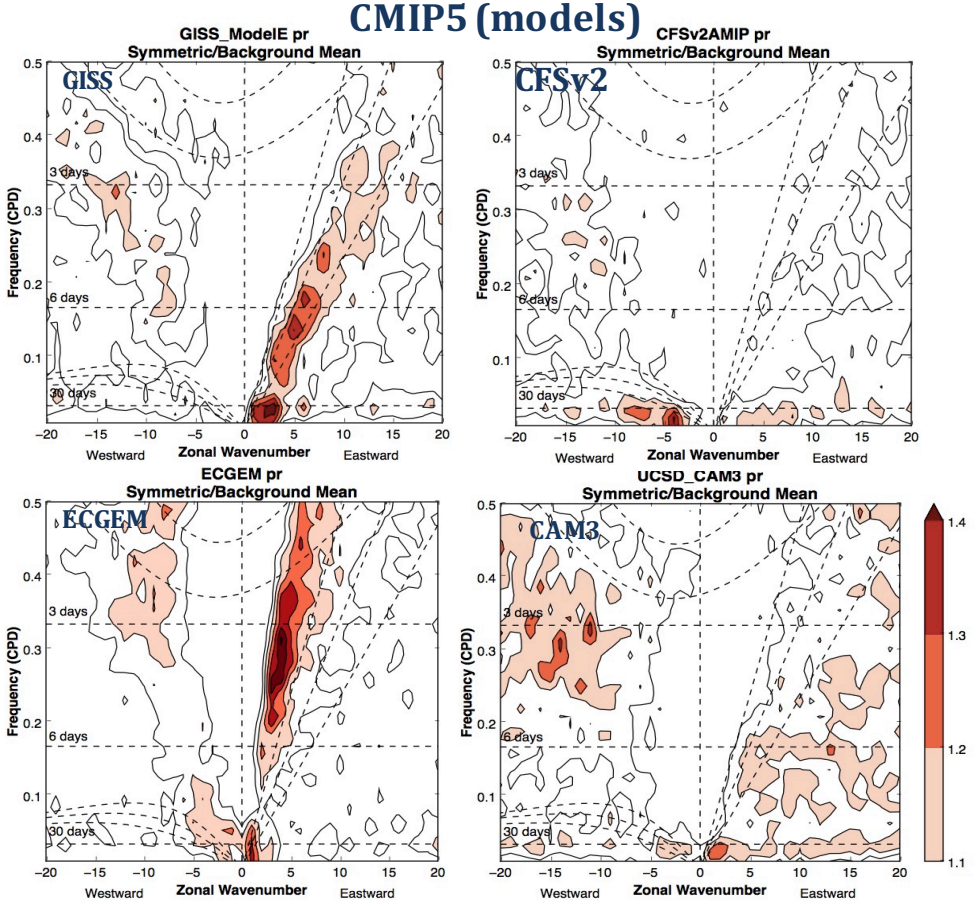
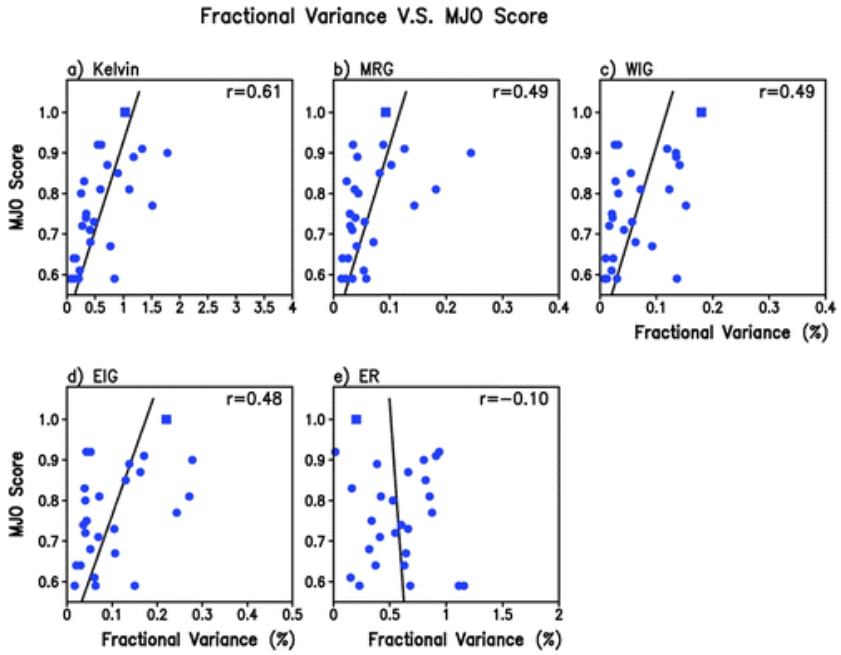
Motivation: CCEWs and the MJO in observations versus models





models representation of tropical waves is not uniform

Motivation: CCEWs and the MJO in observations versus models



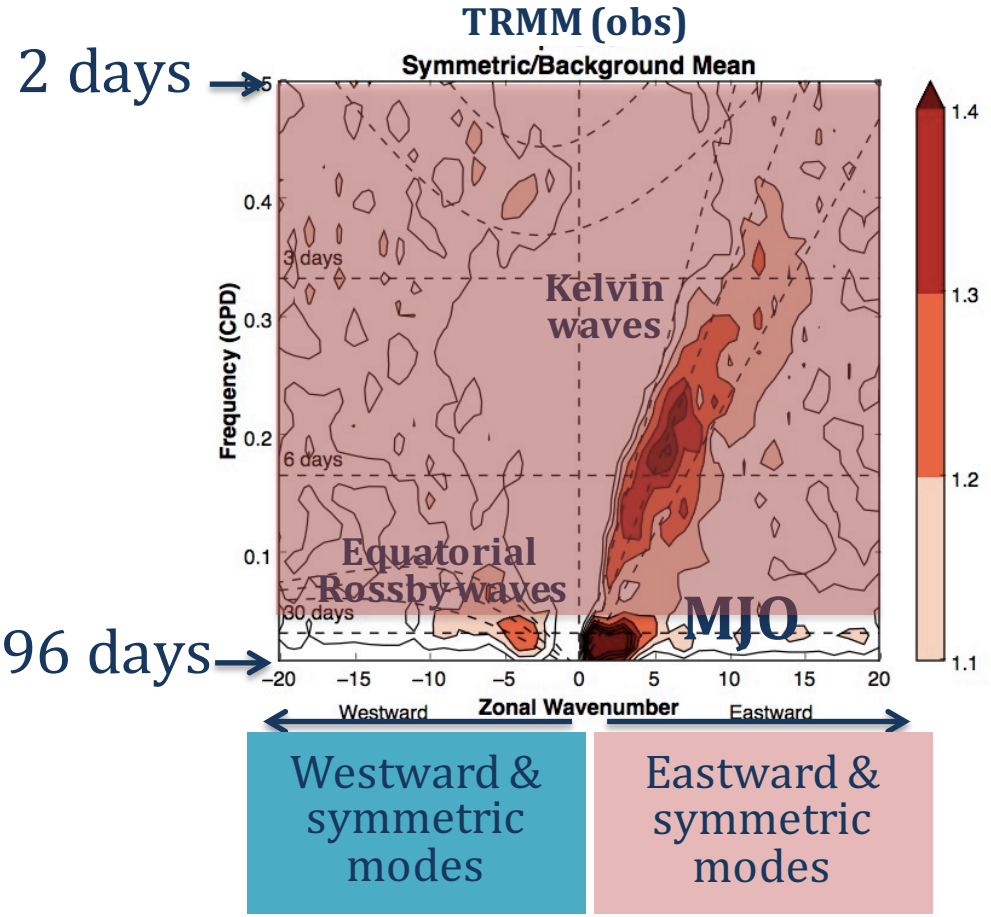
GASS MJO model intercomparison

From Guo et al. (J. Clim 2015)

FIG. 10.
Scatterplots of the MJO score and the ISV associated variances of (a) Kelvin, (b) MRG, (c) WIG, (d) EIG, and (f) ER wave modes. Here, the values of the ISV-associated CCEW variances are computed by averaging the CCEW variances in the concurrent regression maps over 5°S–5°N, 75°–85°E. For example, values of the Kelvin case come from the averages of the Kelvin variances in Fig. 6 over the averaging domain. Filled circles represent individual GCM simulations, while the filled square represents the TRMM observations. The correlation coefficient of each scatterplot is indicated by the number at the top-right corner of the panel. Correlation coefficients that are statistically significant at the 90%, 95%, and 99% confidence levels for 27 samples are 0.32, 0.37, or 0.48 respectively, based on the two-tailed Student's *t* test.

but there appear to be a relationship between better MJO and CCEWs

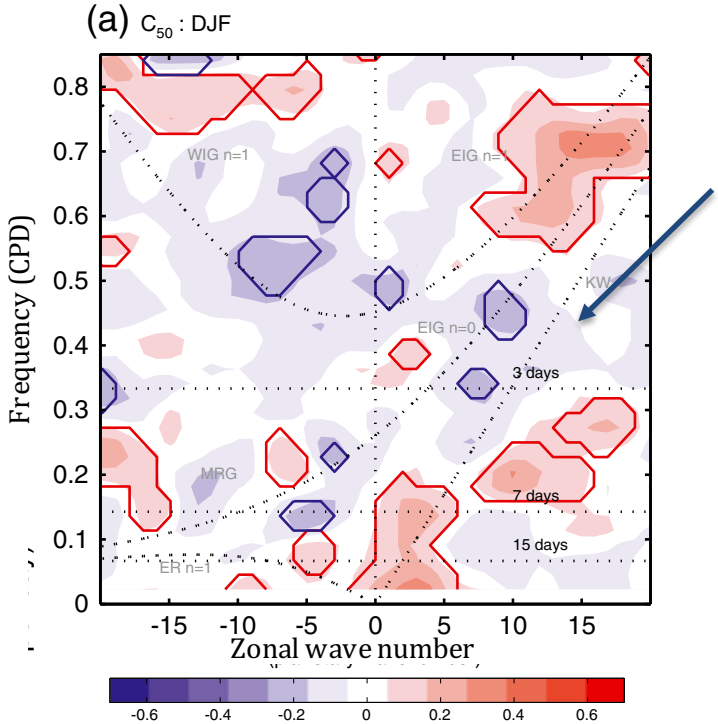
Motivation: CCEWs and the MJO in observations versus models



- **To what extent improving a model's representation of the MJO will lead to better representation of meso- and synoptic scale convective organization?**

Motivation: CCEWs and the MJO in observations versus models

In a previous study (Dias et al. 2012, *GRL*), we focused on whether there are systematic changes in the **scales** of CCEWs associated with the MJO.



Correlation between PS(k,ω) and MJO index

No systematic relationship between scales of CCEWs and the MJO

Figure 3. DJF and JJA correlation patterns: (a,c) C_{50} and (b,d) C_{rmm}. Solid contours enclose regions where the correlations exceed 50% of the mean correlation near the MJO spectral peak (details in the text). The theoretical shallow water dispersion curves are overlaid and labeled in Figure 3a (with an equivalent depth of 25 m, see details in [*Kiladis et al.*, 2009]). The time window is 44 days.

Today we will focus on two more general issues of how the MJO influence:

I) the space **x** time **distribution of tropical convection**, and

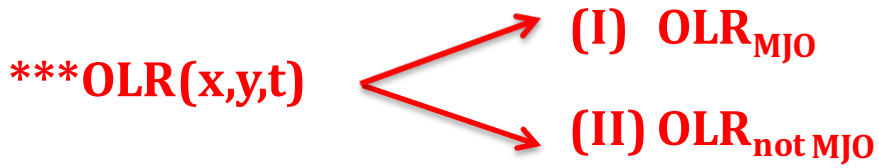
II) the properties of tropical **mesoscale** organization.

Part 1:

Does the MJO influence the space-time distribution of tropical OLR?

Approach

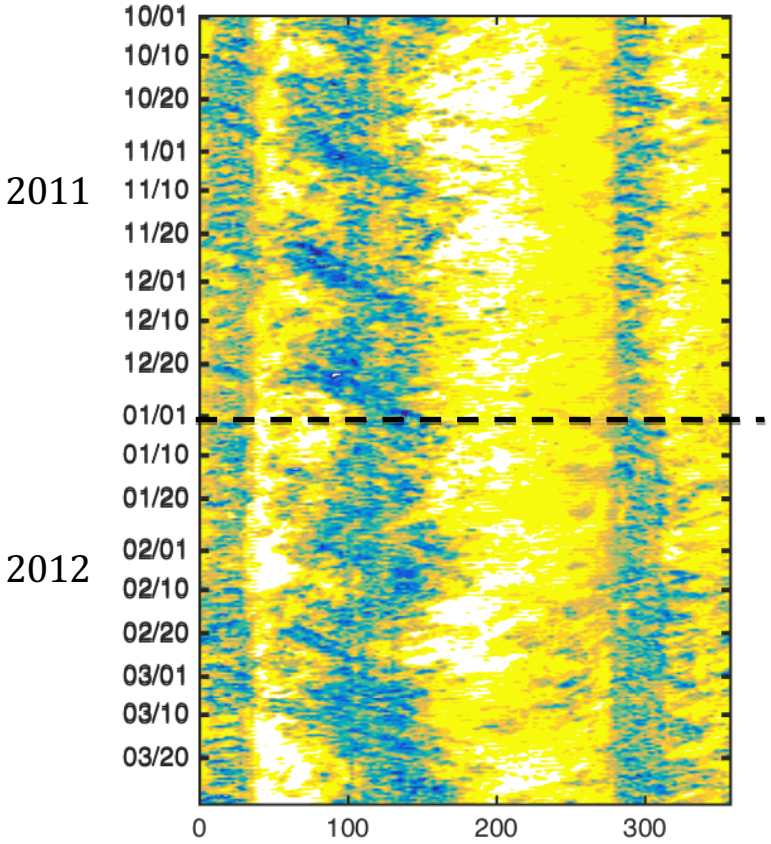
- NOAA OLR 2x daily dataset (1979-present)
- MJO filter: 30-96 days, eastward wave numbers 1-9
- we use DJF data from 15°S to 15°N and 0° – 360°.
- OLR binning depending on the MJO:



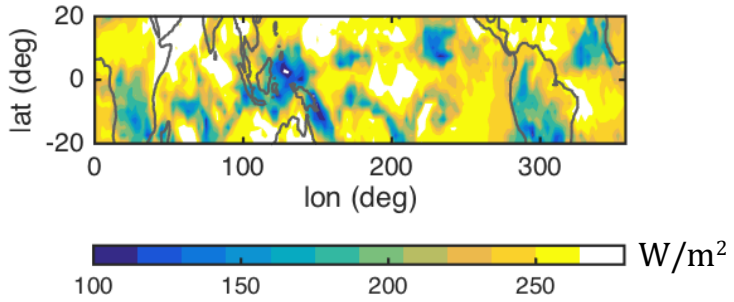
***The decomposition is done in:
- space **and** time using MJO OLR filtered data
- or only in time using an **MJO index**

(1) Space-time binning

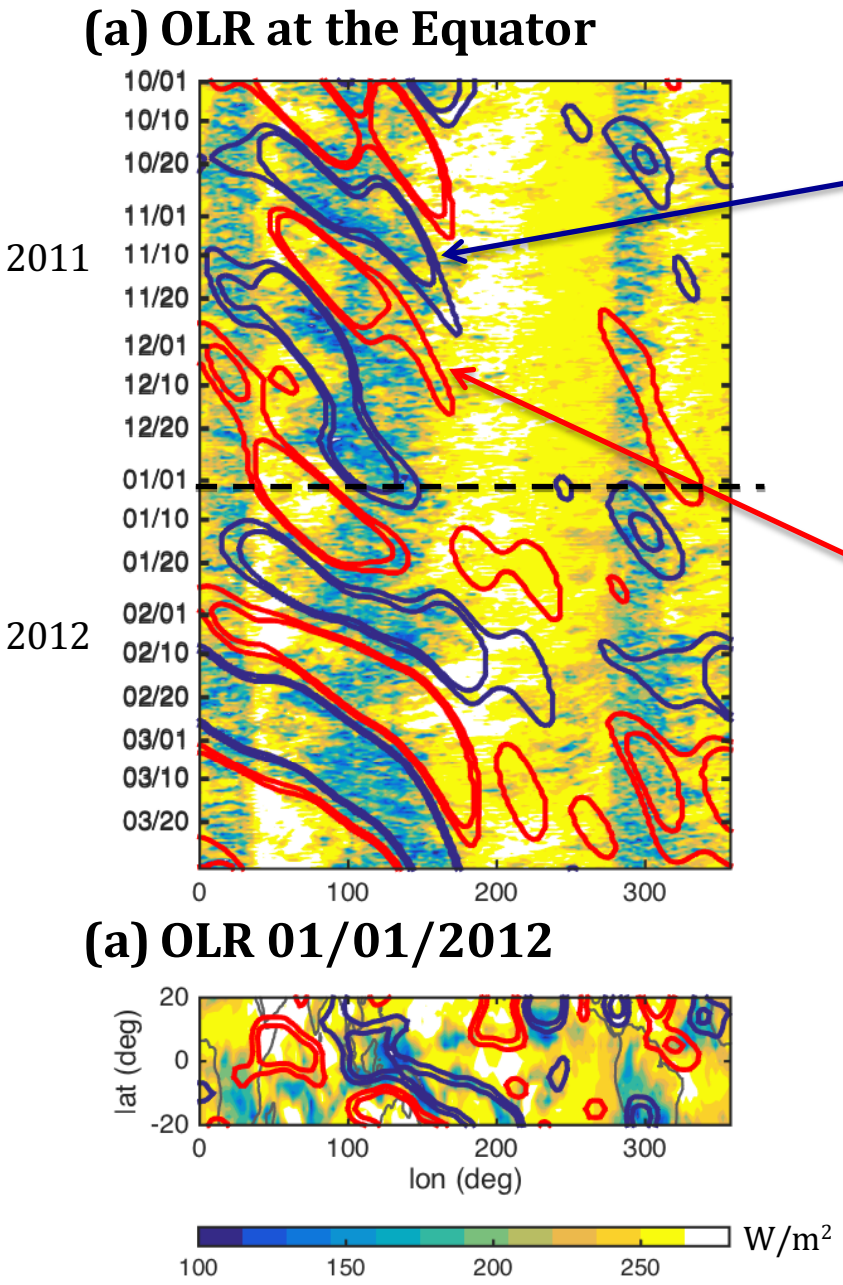
(a) OLR at the Equator



(a) OLR 01/01/2012



(1) Space-time binning



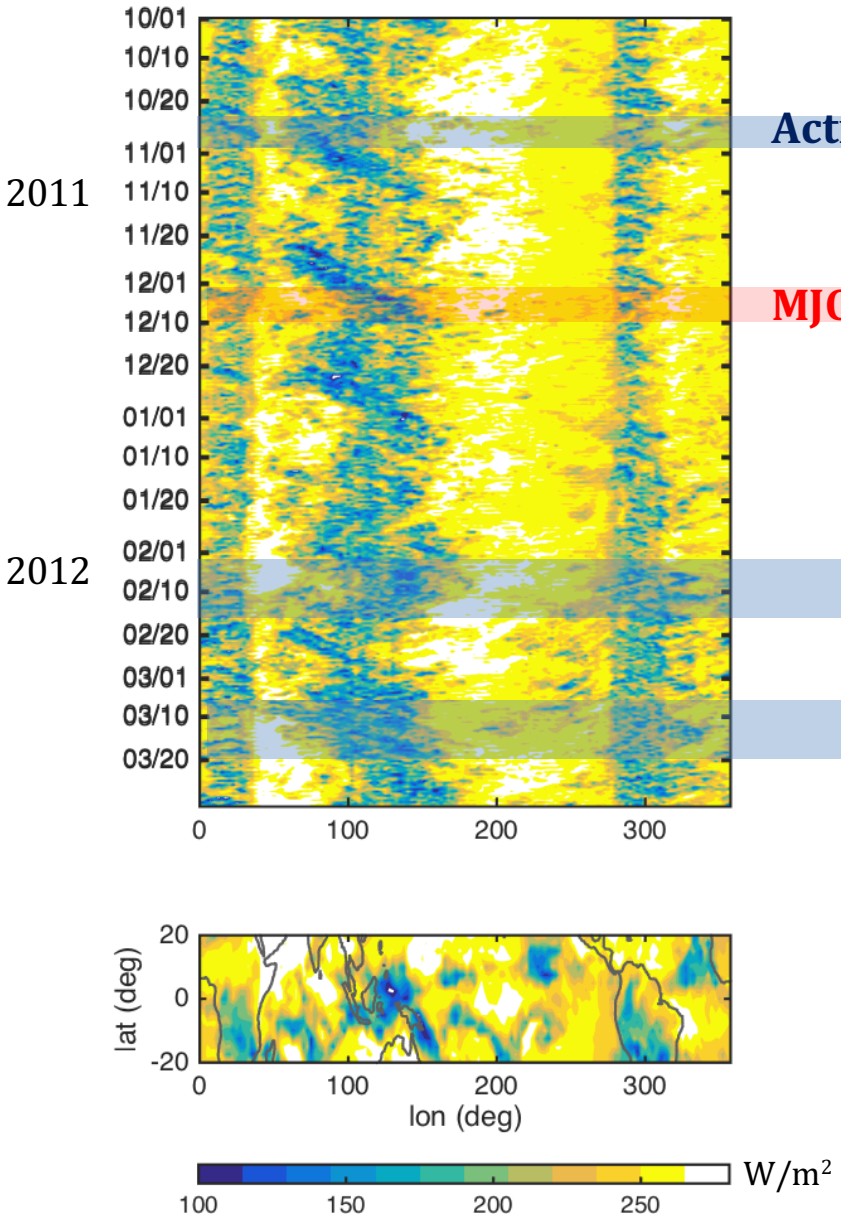
Convective MJO envelope (**CE**)

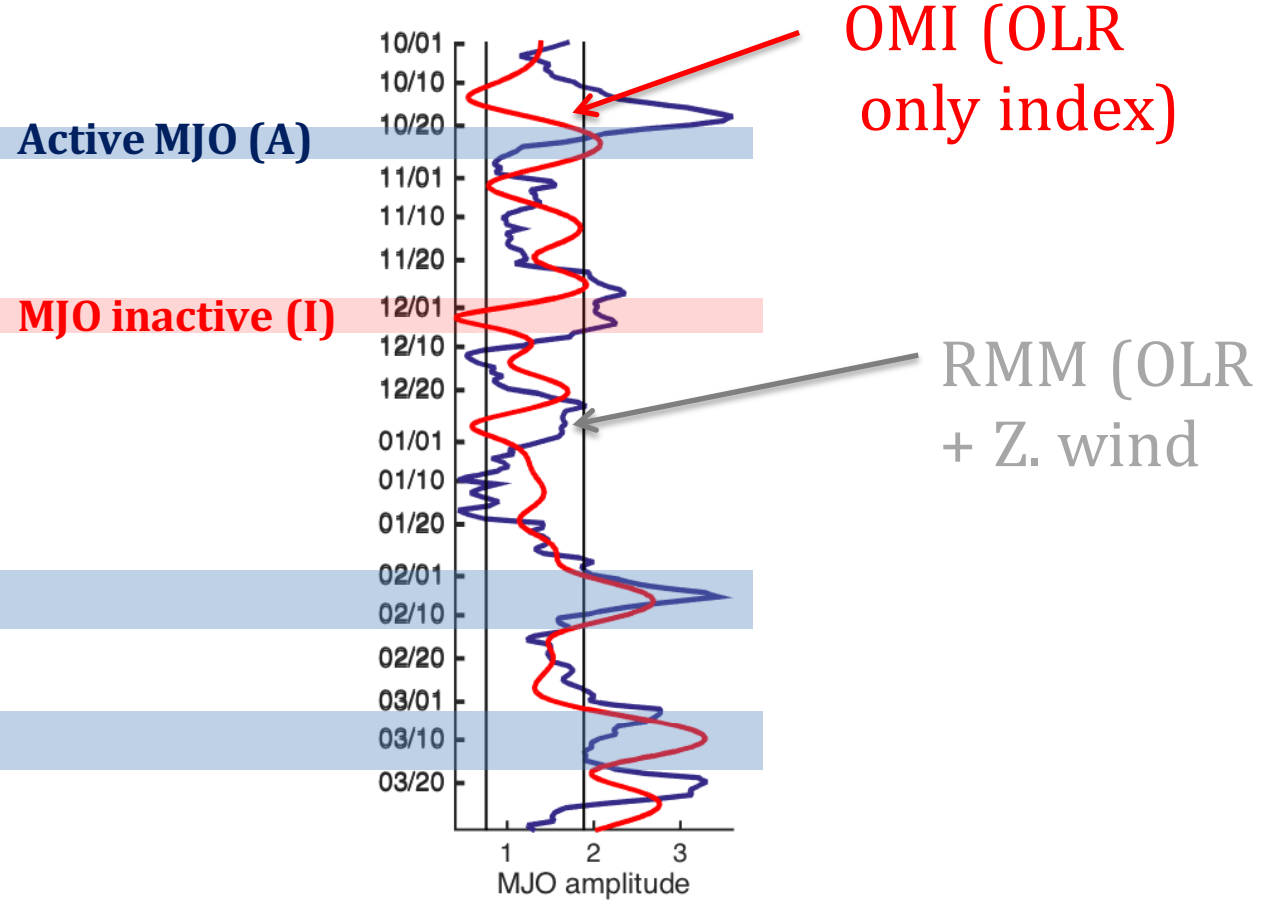
Supressed MJO envelope (**SE**)

Calculate the total OLR variance within **CE** and **SE**

VAR(OLR|**CE**)
VAR(OLR|**SE**)

(2) Time-only binning



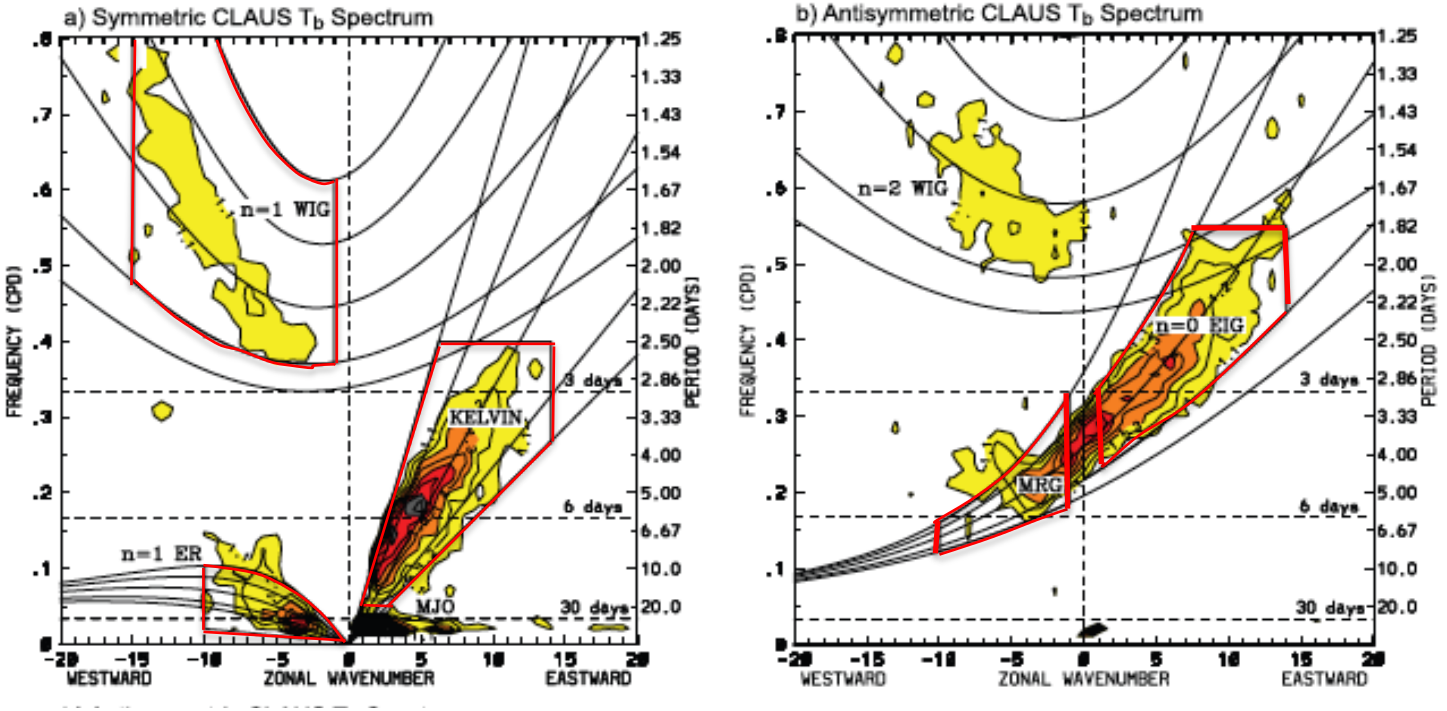


Calculate the total OLR variance within **A** and **I**

VAR(OLR|**A**)

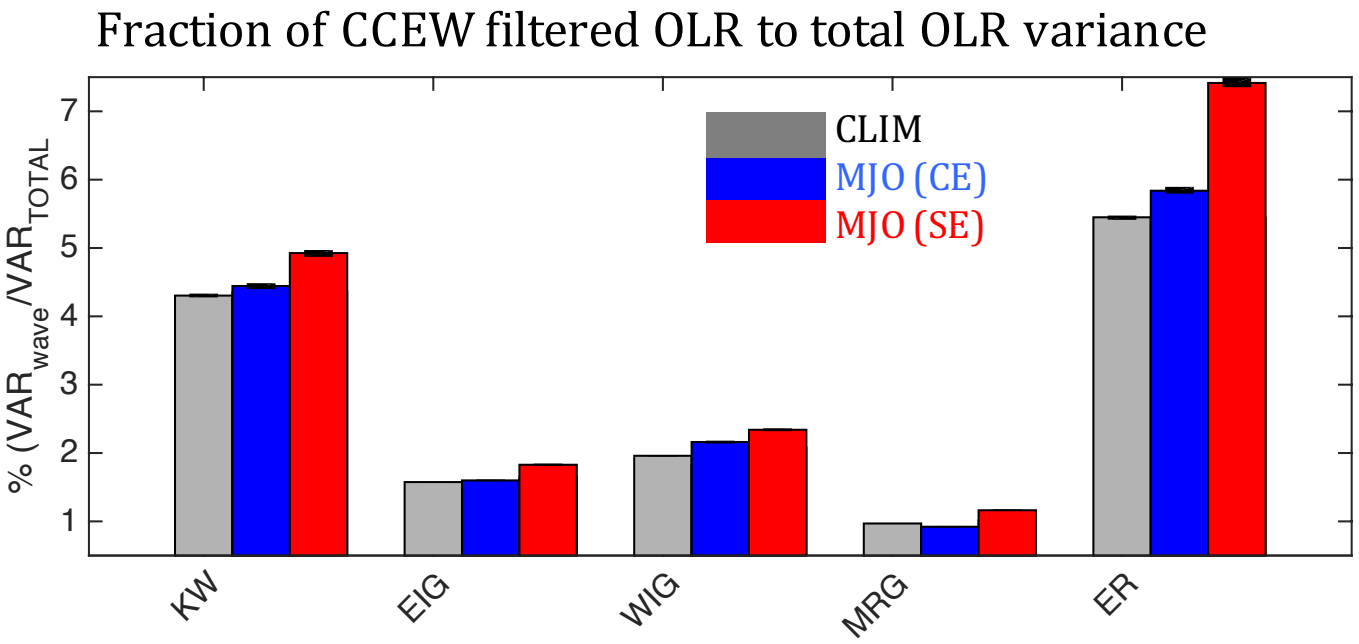
VAR(OLR|**I**)

Are CCEWs variance sensitive to the MJO?



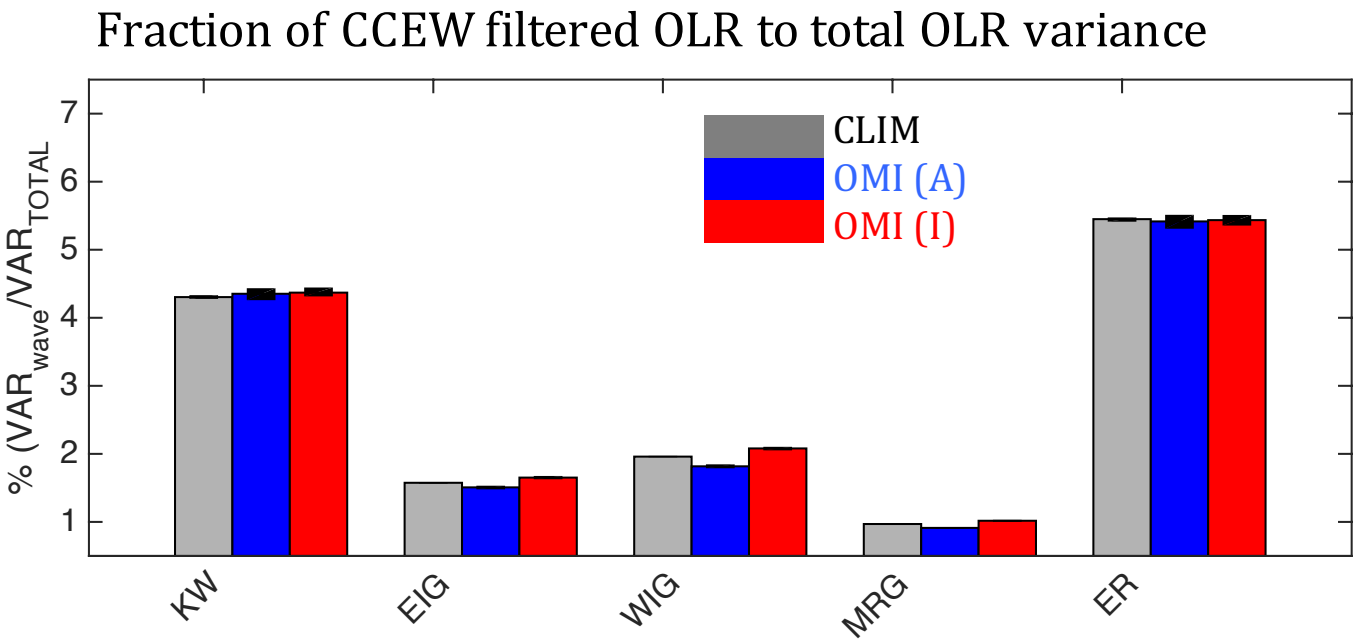
- OLR is first filtered for KW, ER, MRG, WIG and EIG spectral bands
- Then filtered OLR values are binned depending on the MJO

Are CCEWs variance sensitive to the MJO?



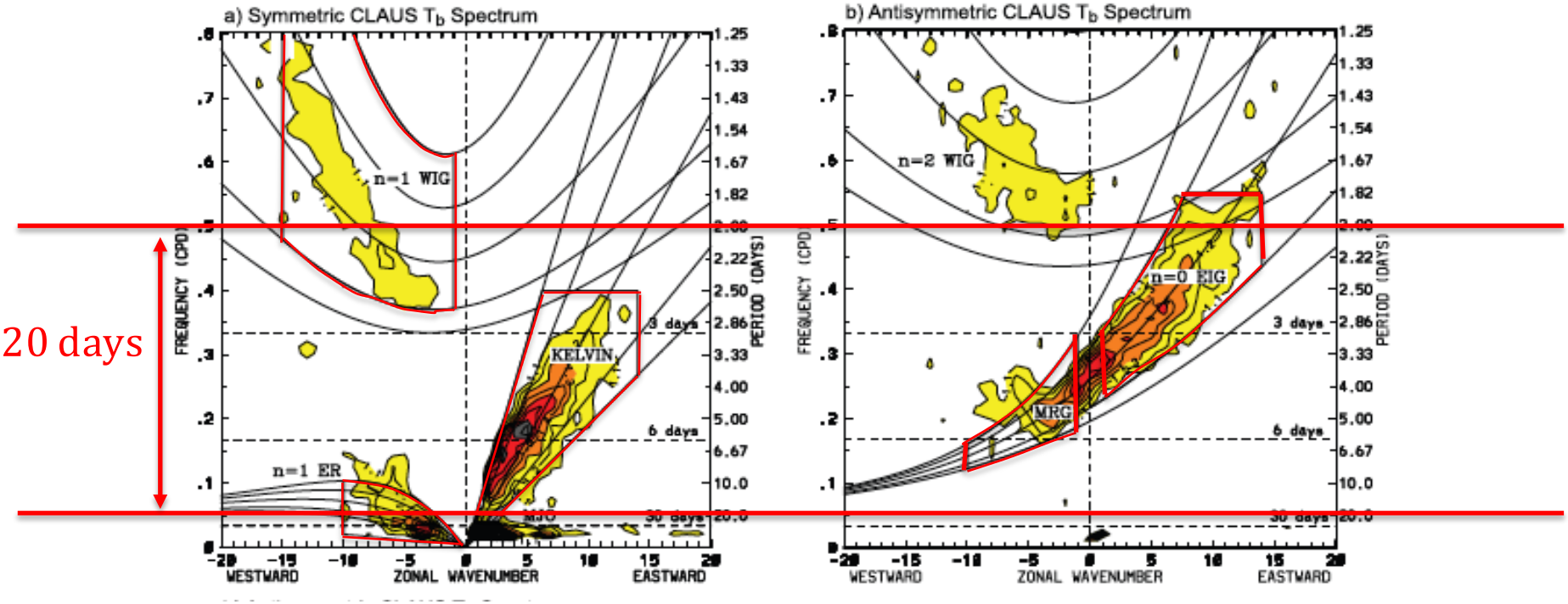
Locally, CCEWs variance increases within the MJO CE and SE

Are CCEWs variance sensitive to the MJO?



globally, not very much changes

Is there something particular about CCEWs variance?



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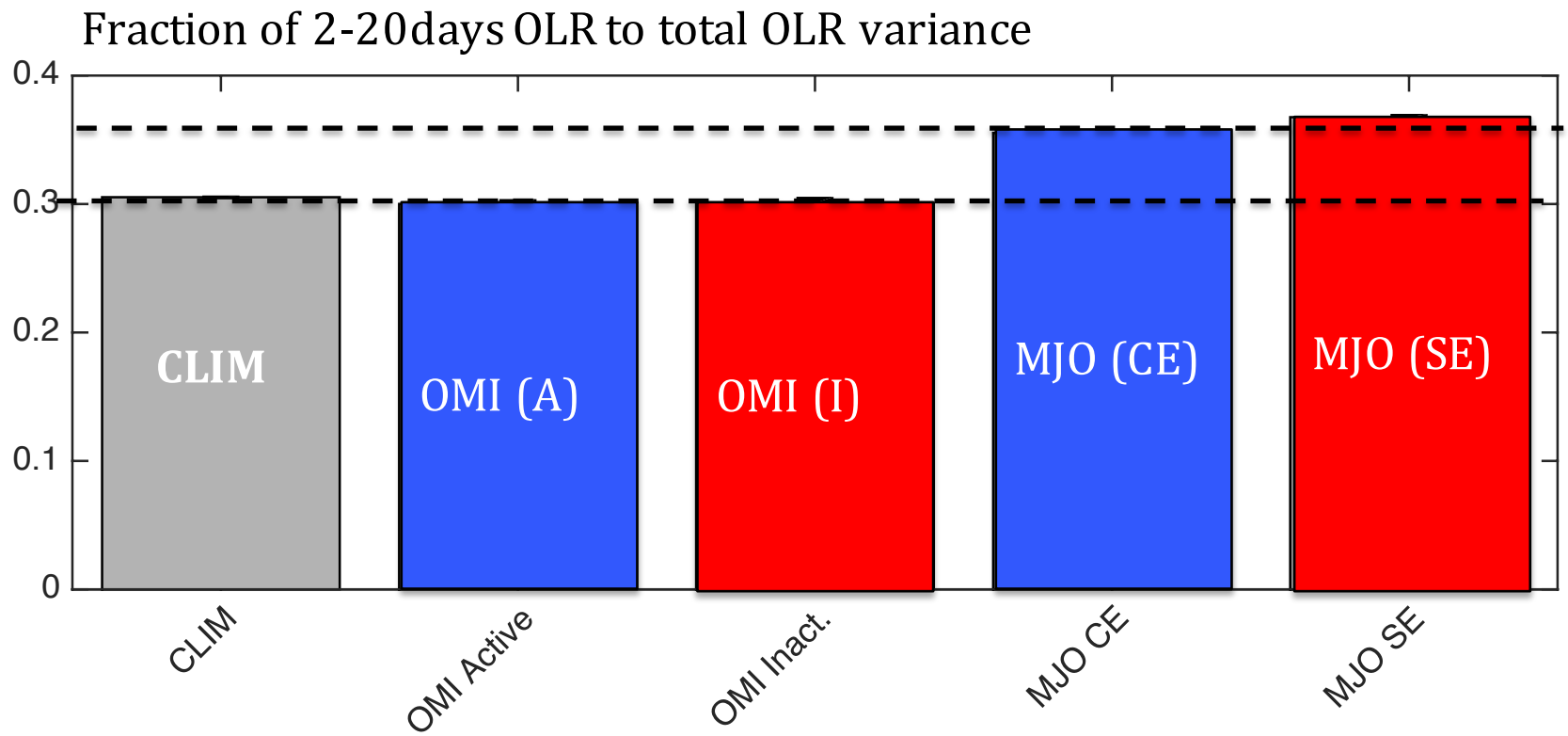


Similarly to CCEWs variance, the fraction of synoptic variance to total increases both within MJO CE and MJO SE

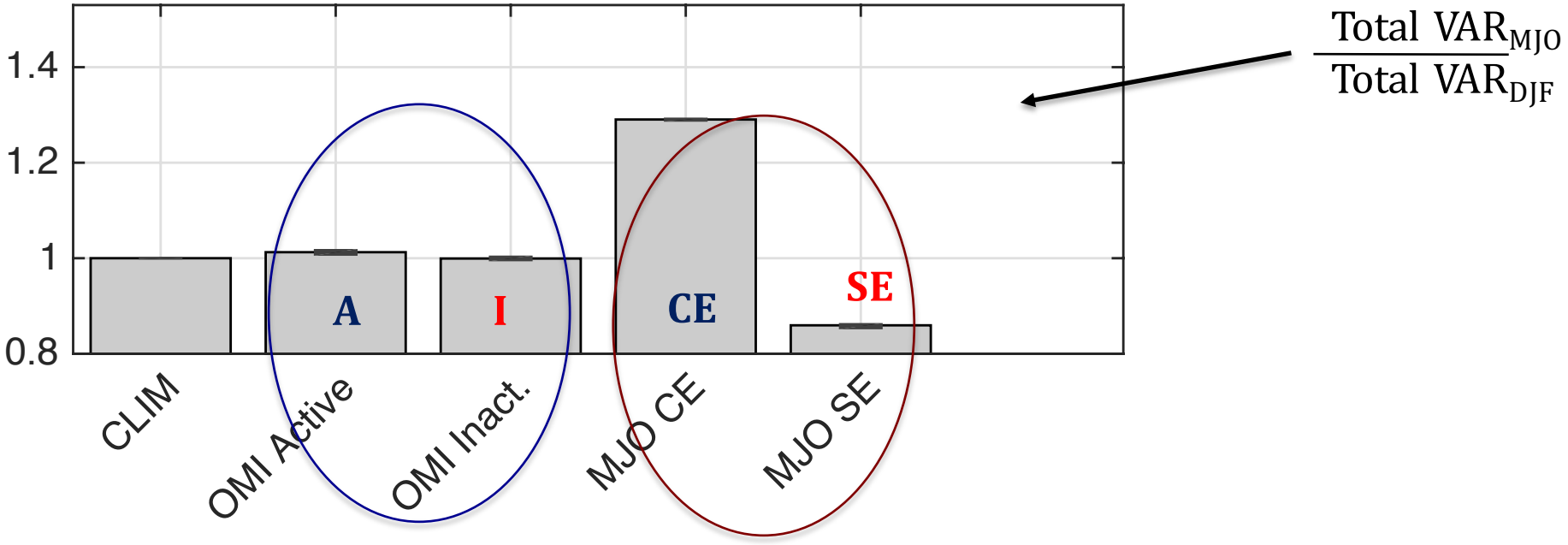
Is there something particular about CCEWs variance?

- changes in CCEW fractional variance are similar to changes in 2-20 fractional variance; thus, they do not imply more CCEWs organization;

- changes in higher frequency fractional variance are only local to the MJO envelope; that is, globally CCEWs variance are not affected by the MJO

How about unfiltered tropical OLR variance?

(a)Normalized DJF OLR variance



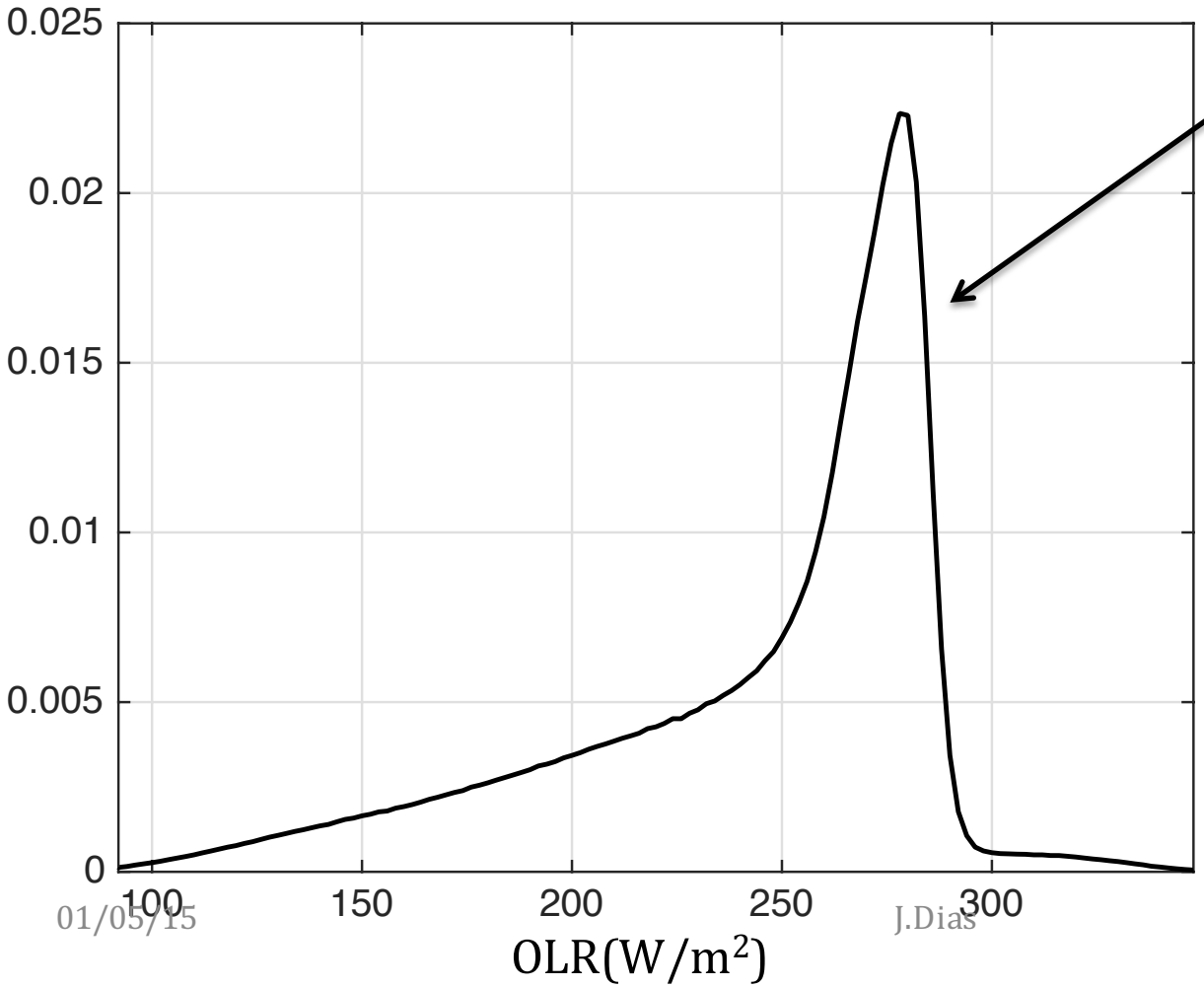
Globally, not really. But, it does locally.

sum over grid points in: 0-360 and 15S-15N

How else can the MJO affect tropical convection?

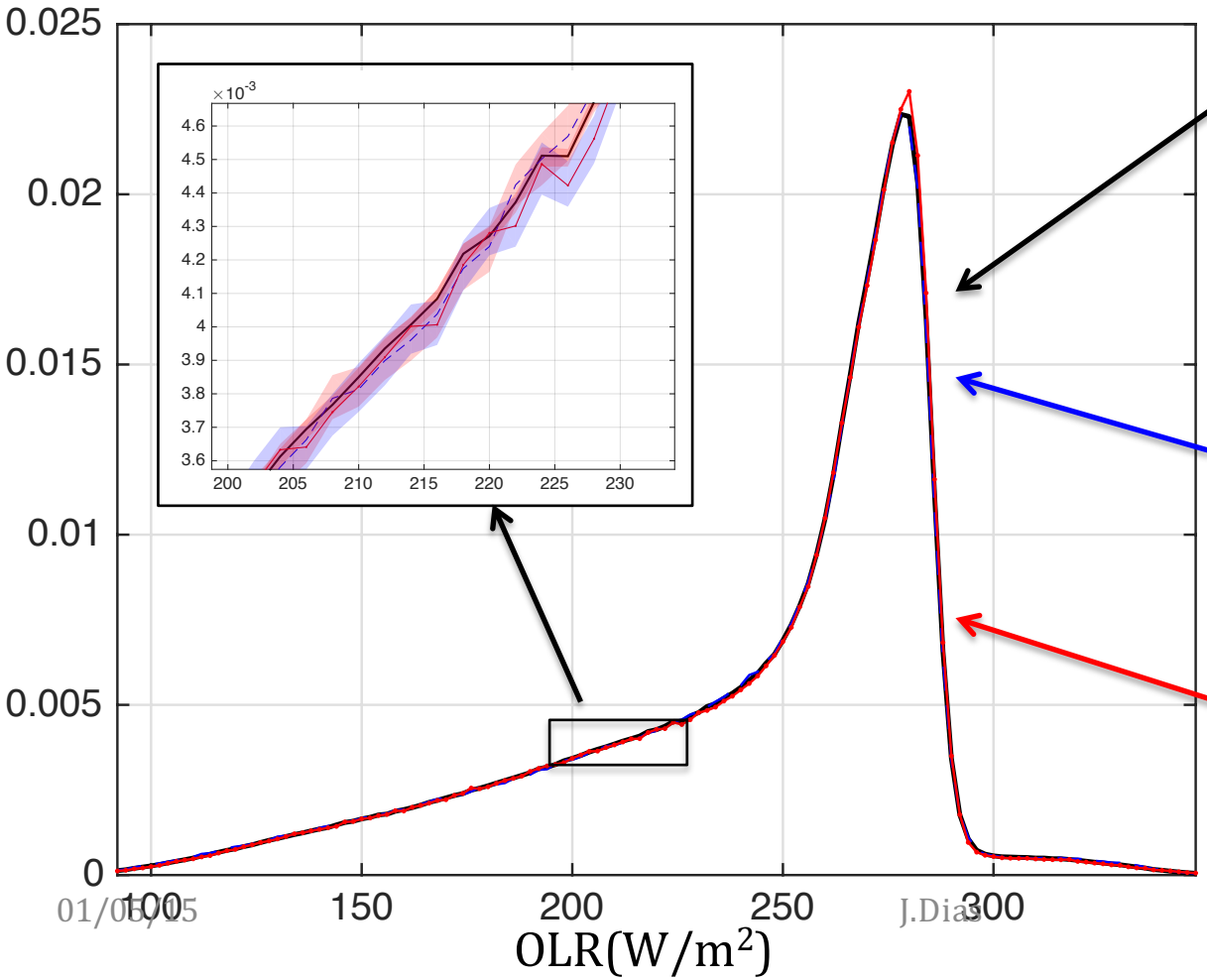
- We use the same binning approach to estimate OLR PDFs;
- PDFs are estimated based on the histograms for each subset of OLR values;
- As with the variance, we use DJF data from 15^{o}S to 15^{o}N and 0^{o} – 360^{o}.

Does the MJO affect the PDF of tropical convection?



Climatological tropical OLR_{DJF} PDF

Does the MJO affect the PDF of tropical convection?

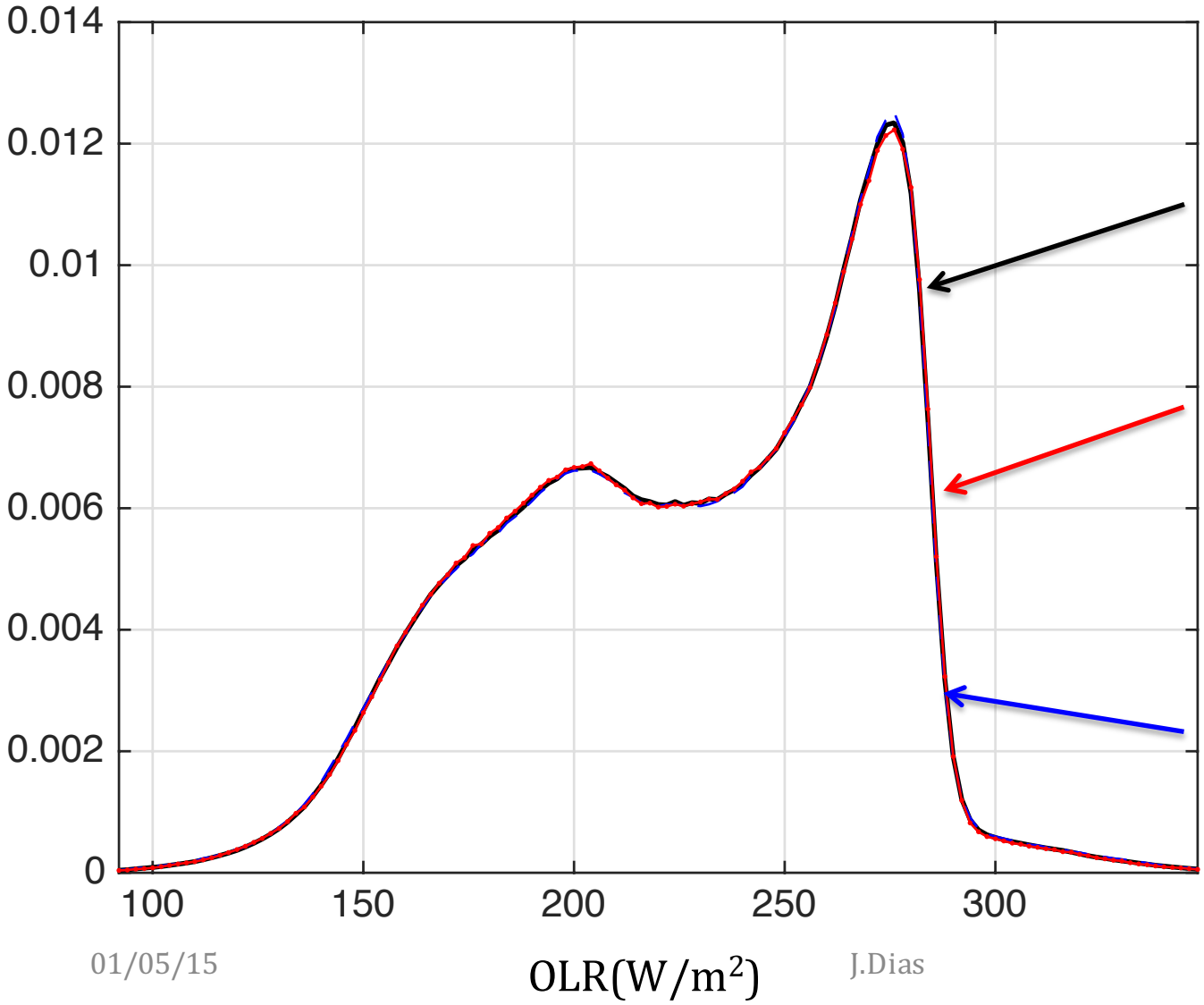


Climatological tropical OLR_{DJF} PDF

Tropical OLR_{DJF} PDF conditional on OMI (A)

Tropical OLR_{DJF} PDF conditional on OMI (I)

Is the **global** OLR PDF affected by the MJO?

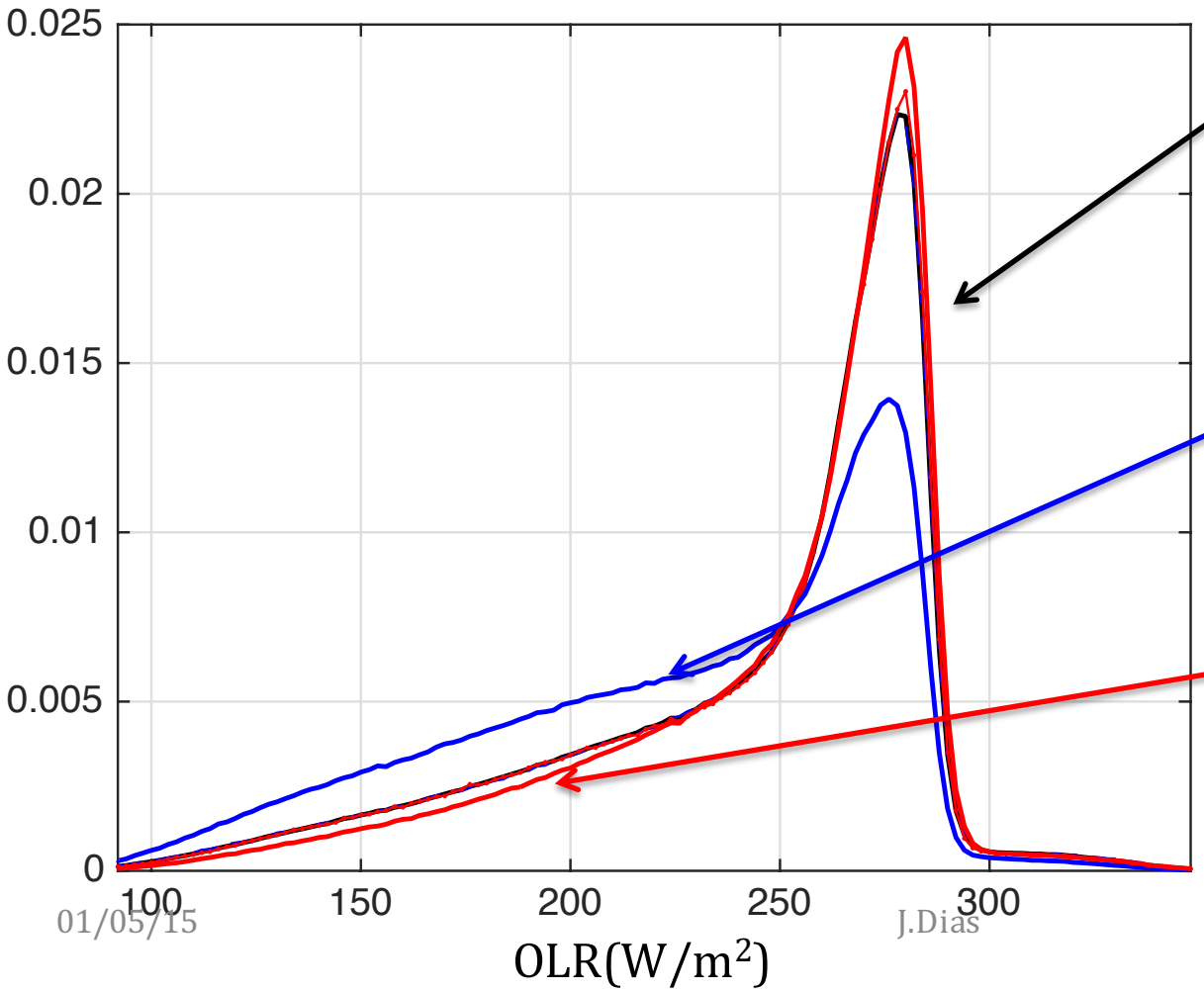


OLR_{DJF} PDF

OLR_{DJF} PDF conditional on OMI (S)

OLR_{DJF} PDF conditional on OMI (A)

Does the MJO affect the **local** PDF of tropical convection?



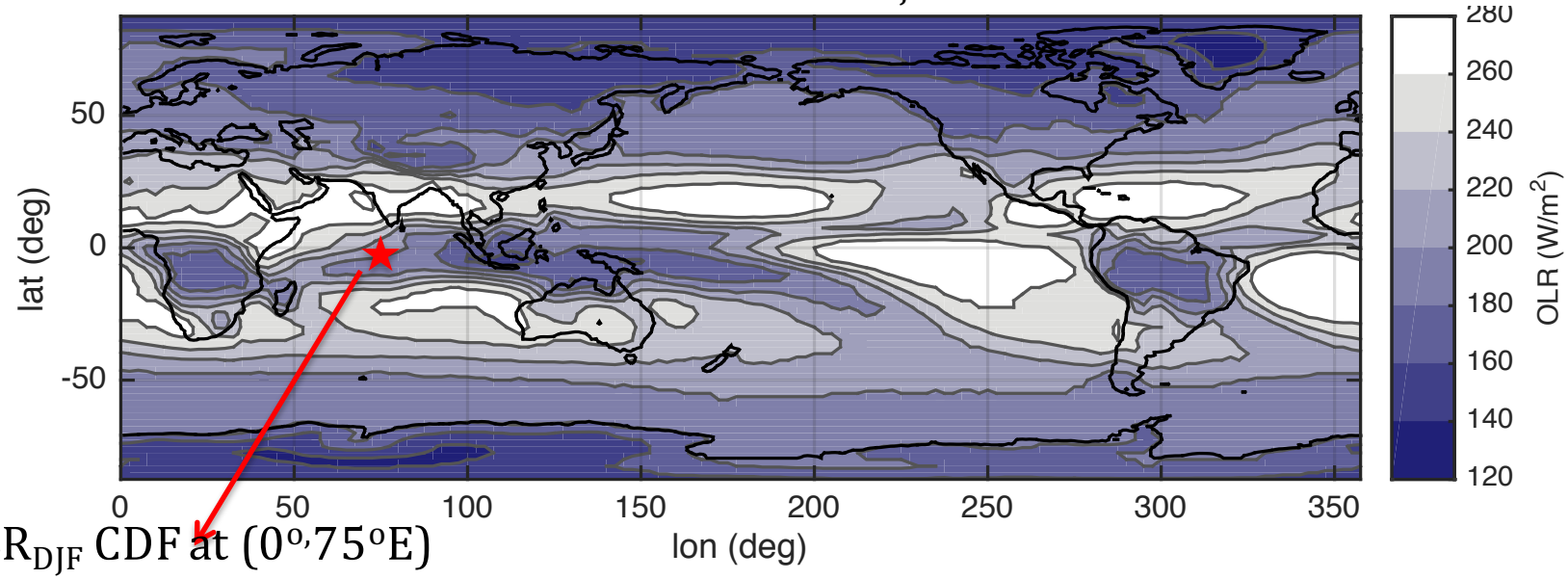
Climatological tropical OLR_{DJF} PDF

Tropical OLR_{DJF} PDF conditional on MJO (CE)

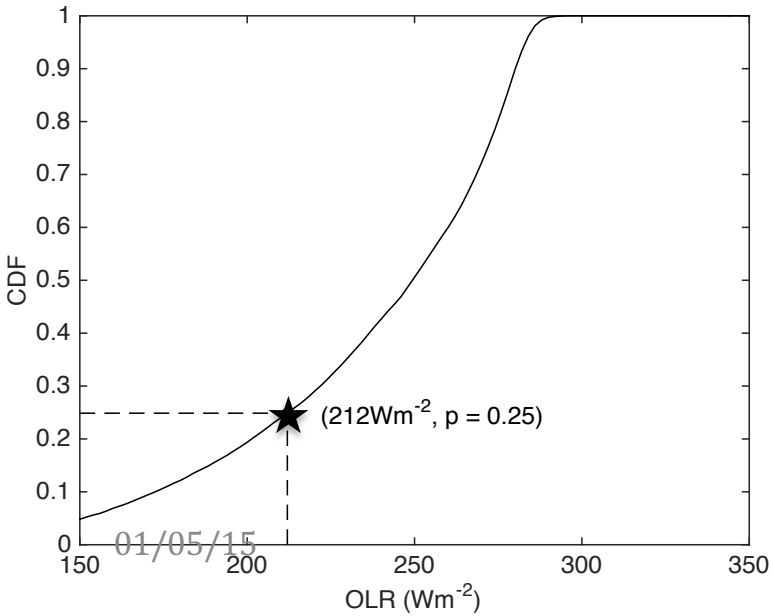
Tropical OLR_{DJF} PDF conditional on MJO (SE)

Does the MJO affect the **local** PDF of tropical convection?

(a) Grid point lower quartile of OLR_{DJF}

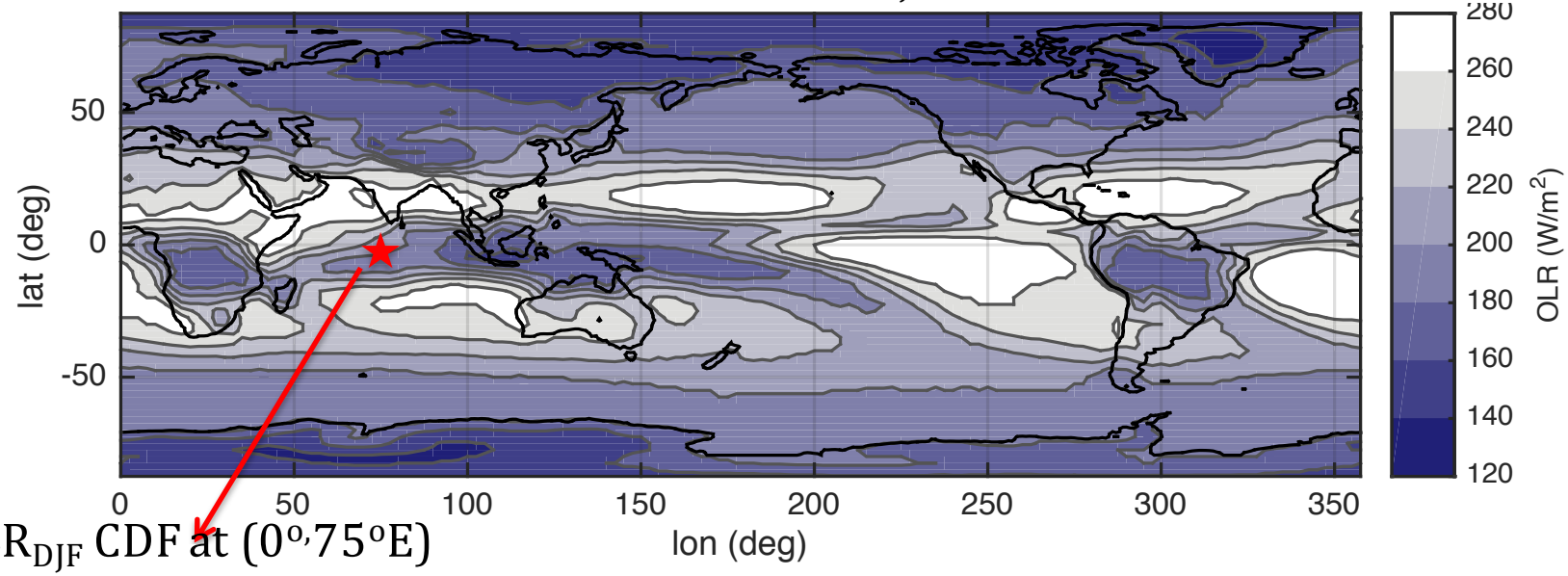


(b) OLR_{DJF} CDF at (0°,75°E)

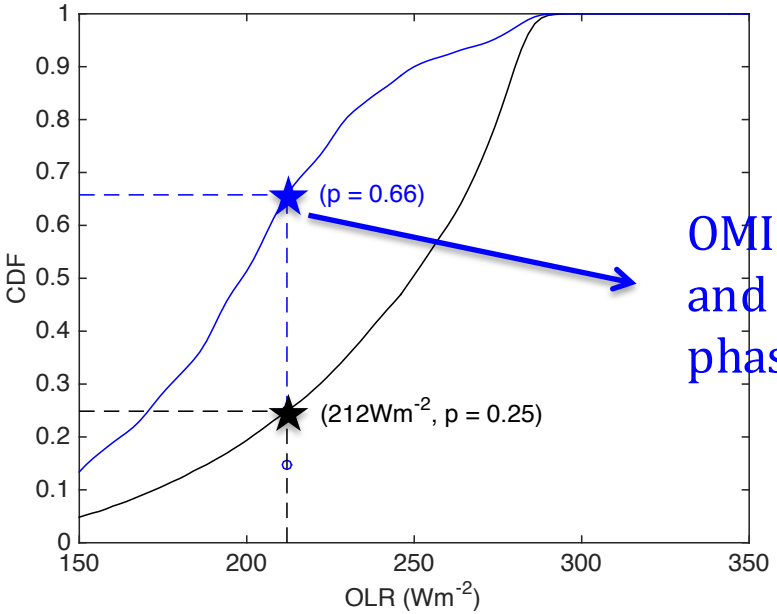


Does the MJO affect the **local** PDF of tropical convection?

(a) Grid point lower quartile of OLR_{DJF}

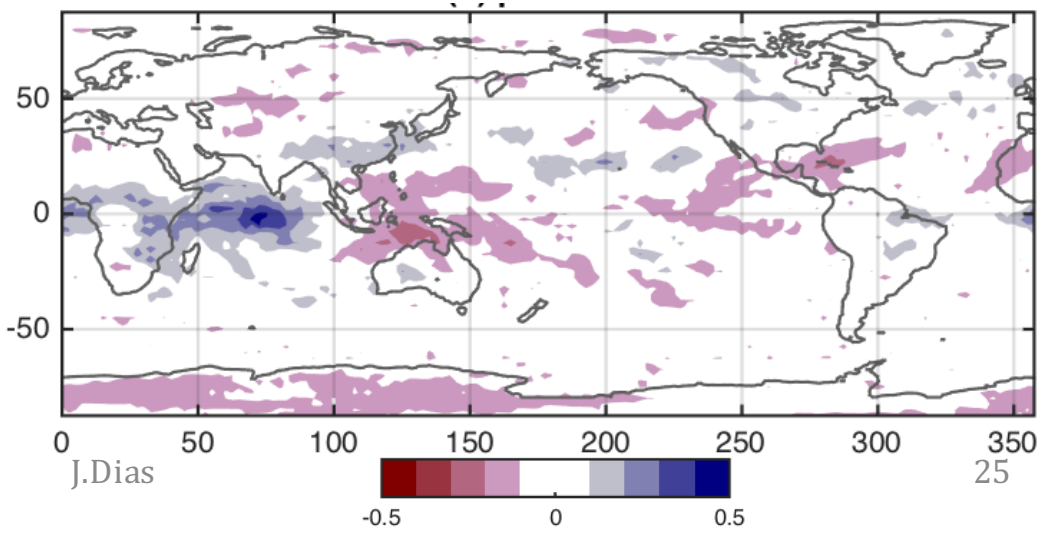


(b) OLR_{DJF} CDF at (0º,75ºE)

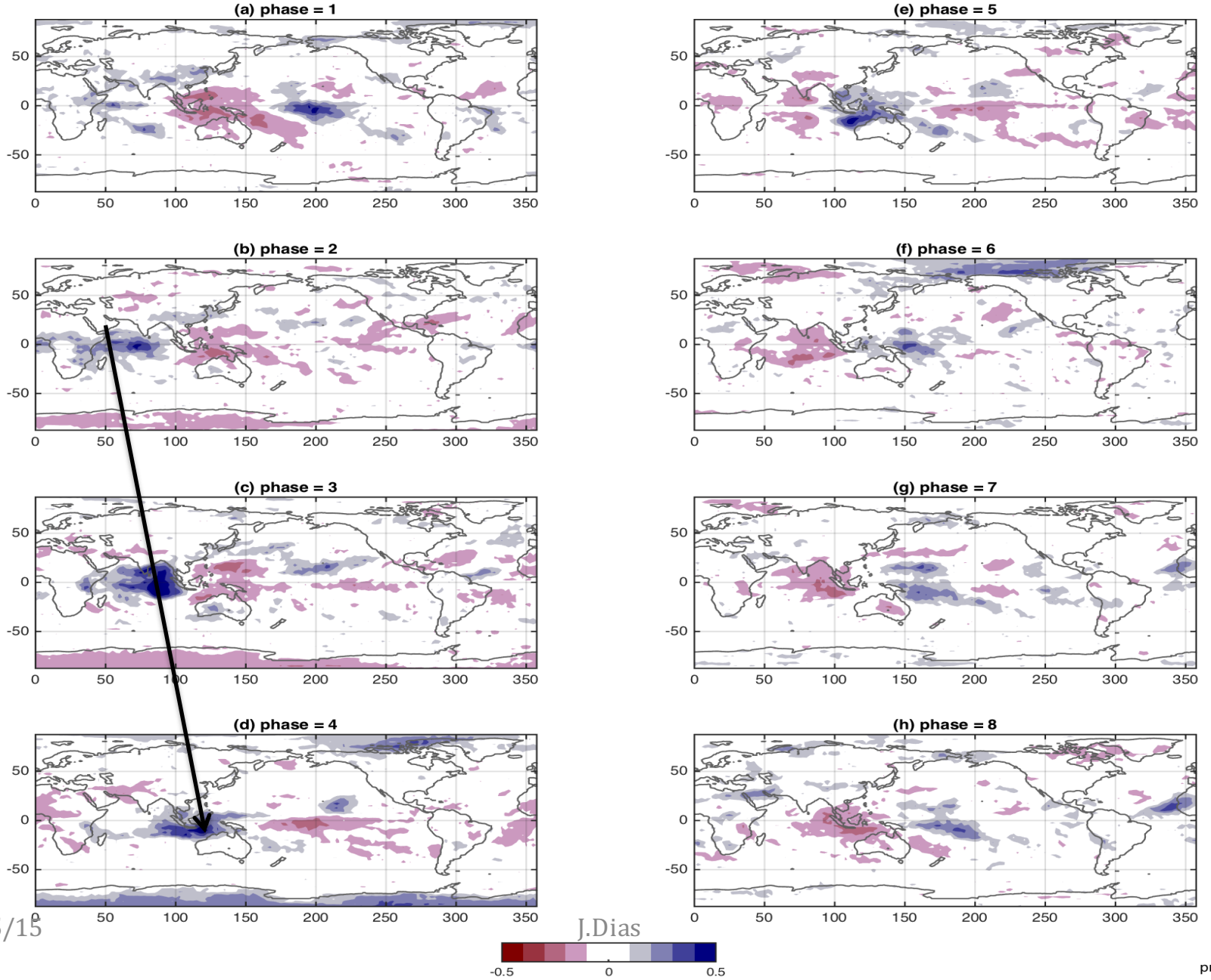


OMI (A) and in phase 2

(c) Changes in OLR_{DJF} percentile (phase 2)



Does the MJO affect the **local** PDF of tropical convection?



Summary

- Synoptic OLR variance is not very sensitive to MJO activity, but it is sensitive locally in both convective (CE) and suppressed (SE) phases.
- MJO activity does not affect the OLR PDF;
- There are significant changes in the OLR PDF within the MJO CE and weaker changes within the MJO SE;
- Results 2-20 days filtered OLR PDFs are similar (not shown).

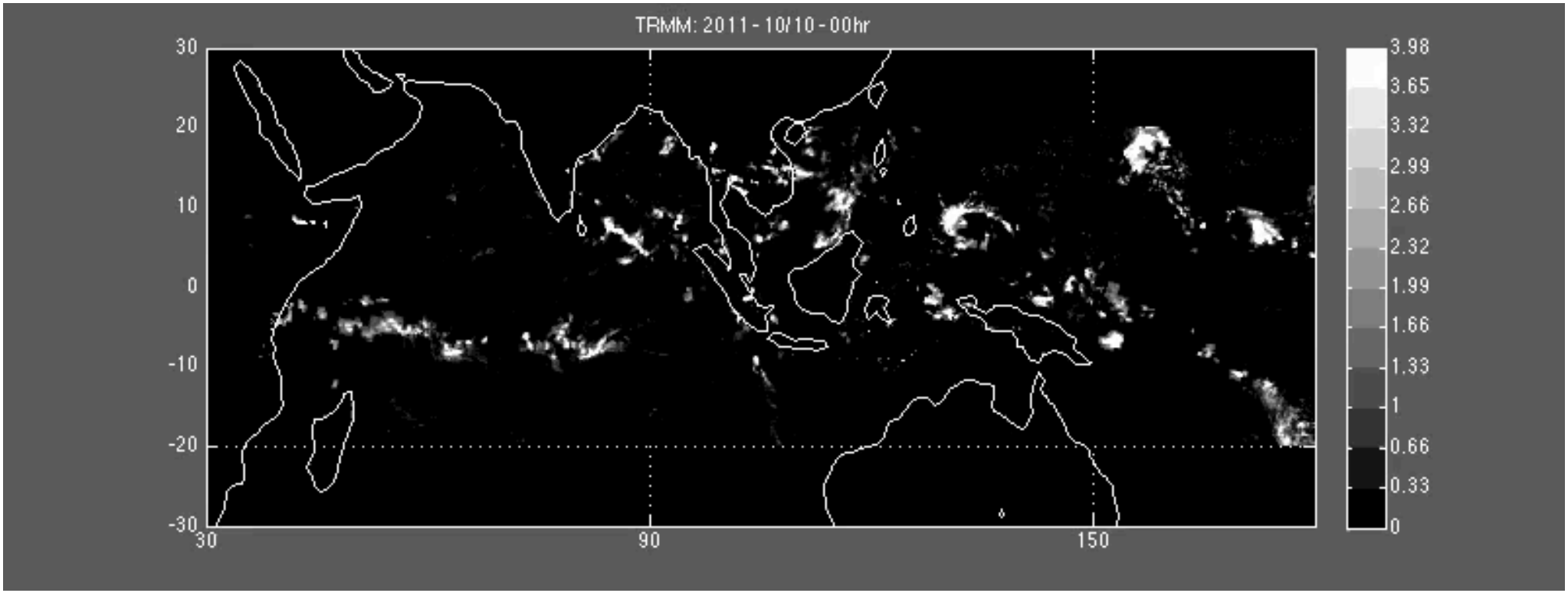
Part 2:

How about mesoscale convective organization?

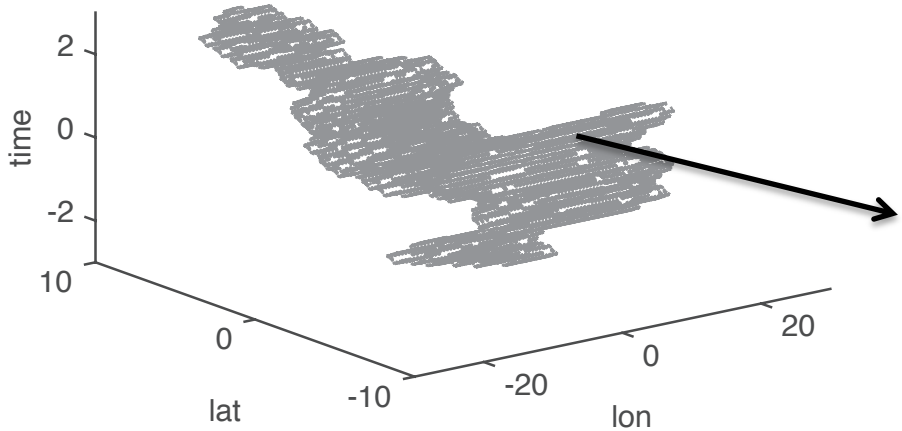
Approach

- object tracking method (Dias et al 2012, JAS);
- algorithm is applied to TRMM 3B42 at 0.25^{o} x 0.25^{o} and 8 x daily;
- mesoscale objects are classified depending on OMI phase and amplitude;

Example of TRMM objects from DYNAMO



Diagnostics of object morphology



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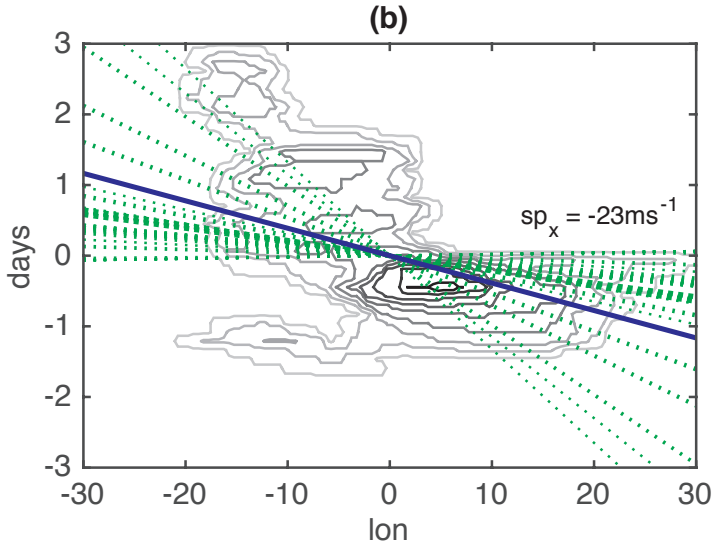
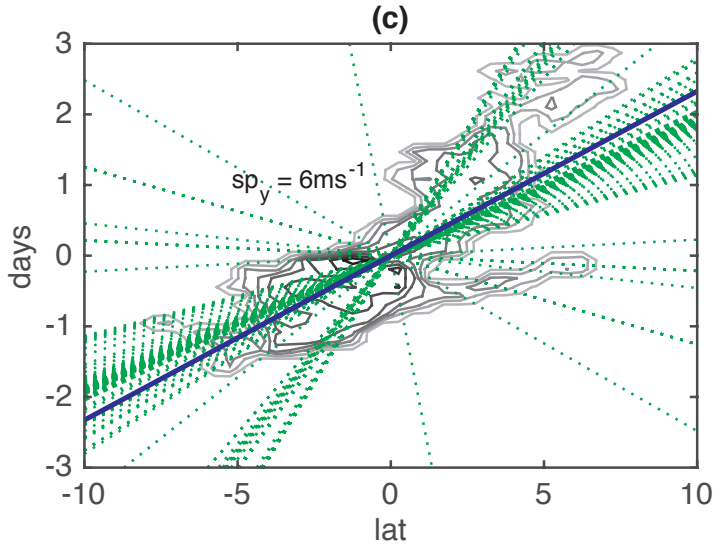
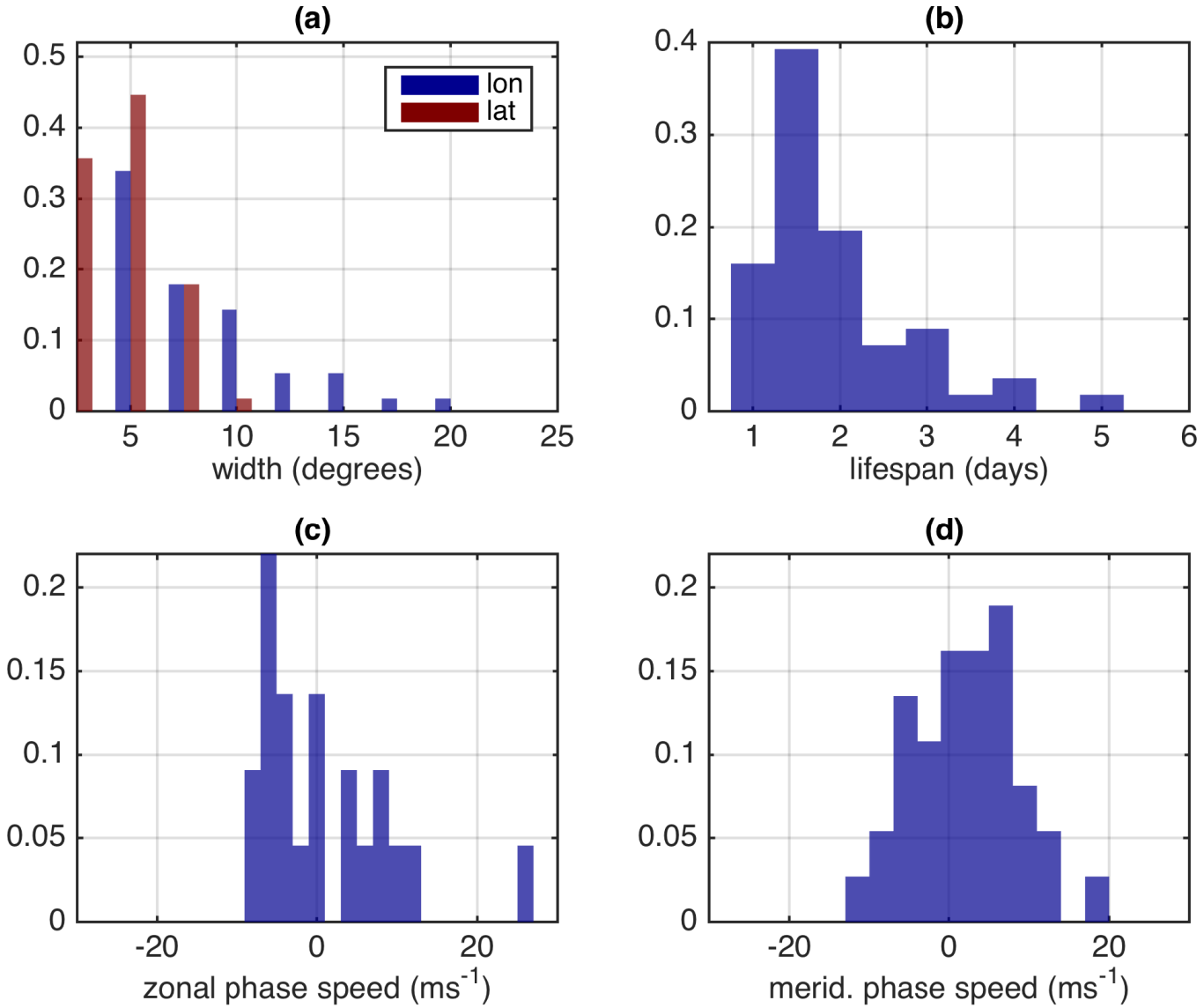




propagation coherence/direction is estimated based on spread across cross sections (lat x time and lon x time)

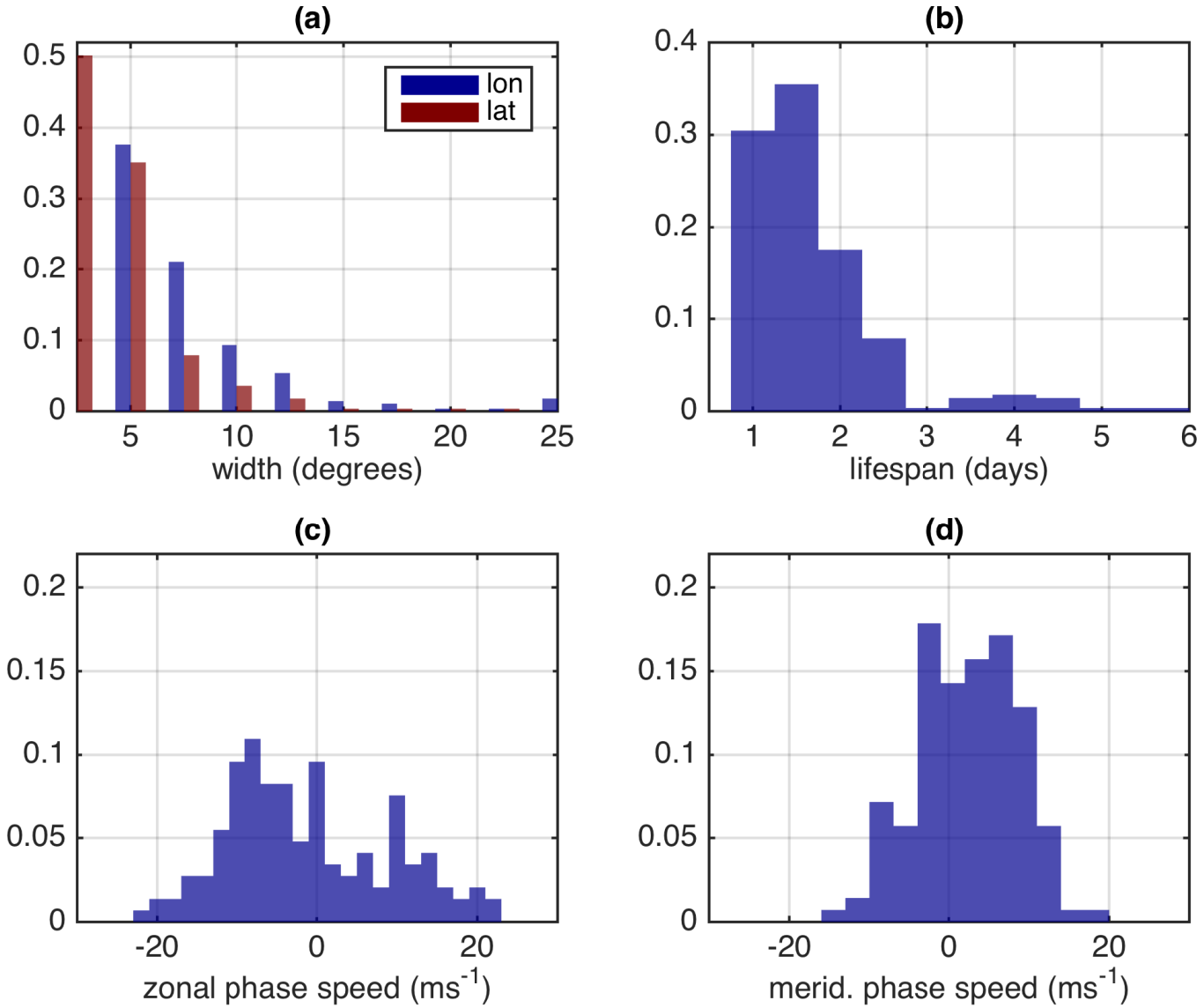
Does the MJO influence tropical mesoscale organization?

(I) normalized histograms for objects during DYNAMO



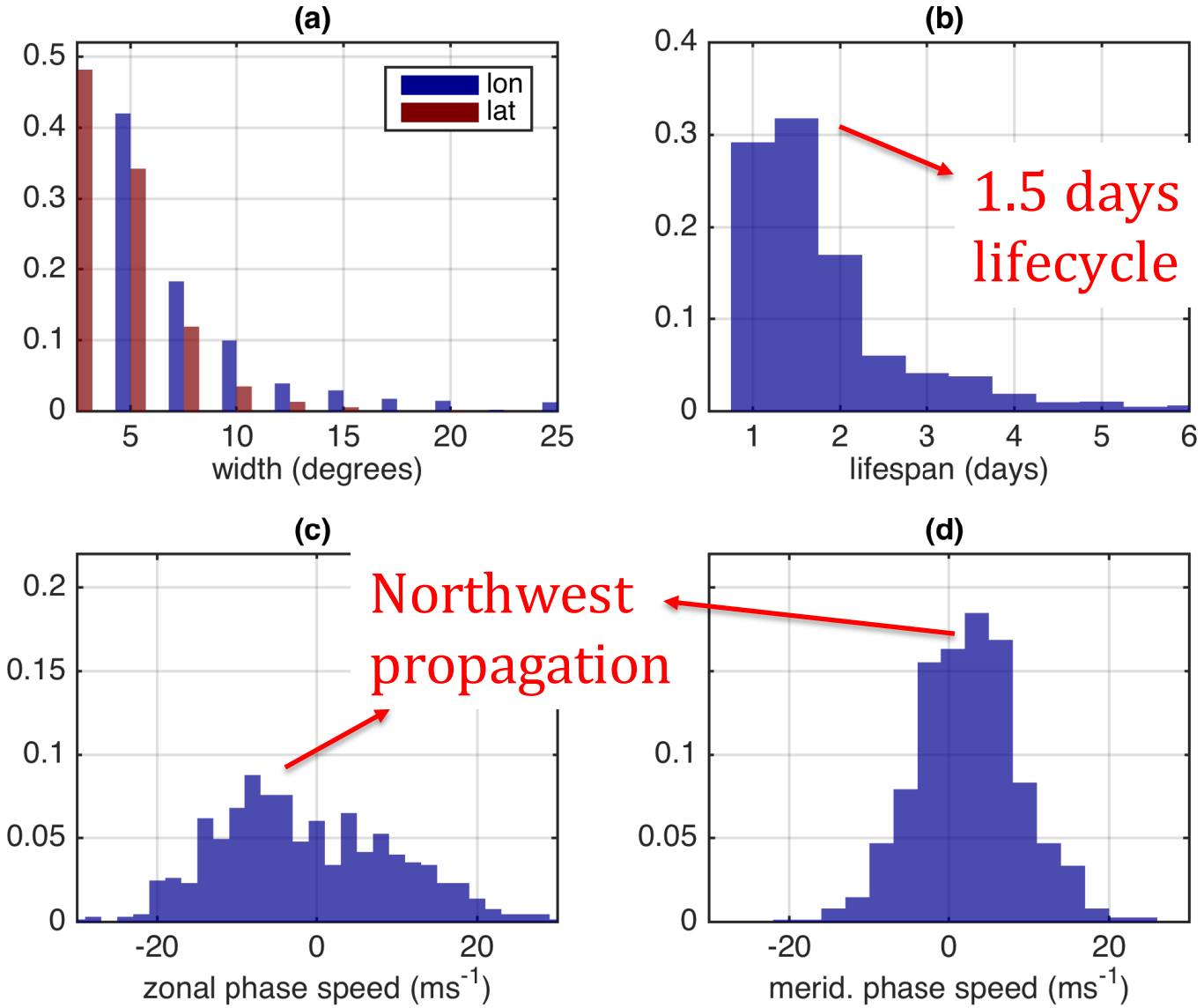
Does the MJO influence tropical mesoscale organization?

(II) normalized histograms for objects during OMI>1.0 and phases 2 & 3



Does the MJO influence tropical mesoscale organization?

(III) normalized histograms for objects for [climatology – OMI>1]



Does the MJO influence tropical mesoscale organization?

- There are more mesoscale objects inside the MJO CE than inside MJO SE in comparison to climatology;
- However, the morphology of these mesoscale objects are not particularly sensitive to the MJO.

Conclusions

- The MJO appears to aggregate meso- to synoptic scale organized tropical convection, but not to impact their global space-time distribution;

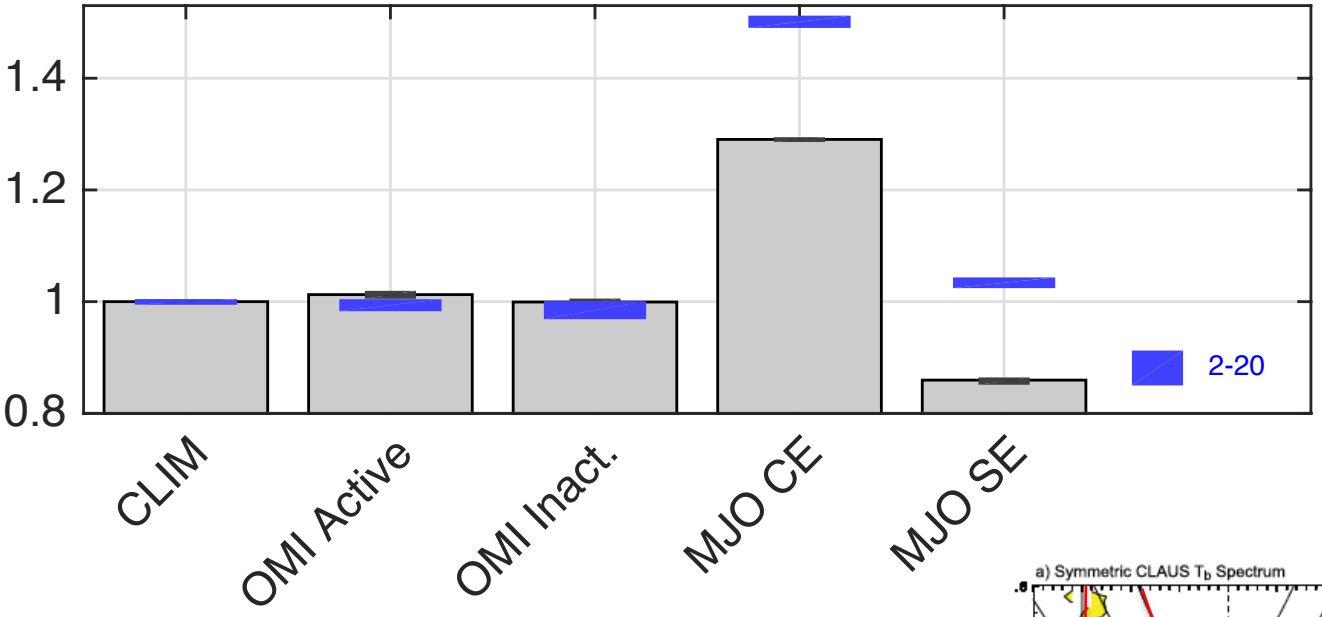
- That the space-time OLR distribution is affected locally to the MJO, but not globally, suggests that *in a model with no organization along CCEW dispersion curves, improvement of intraseasonal variability will not necessarily lead to better representation of CCEWs;*

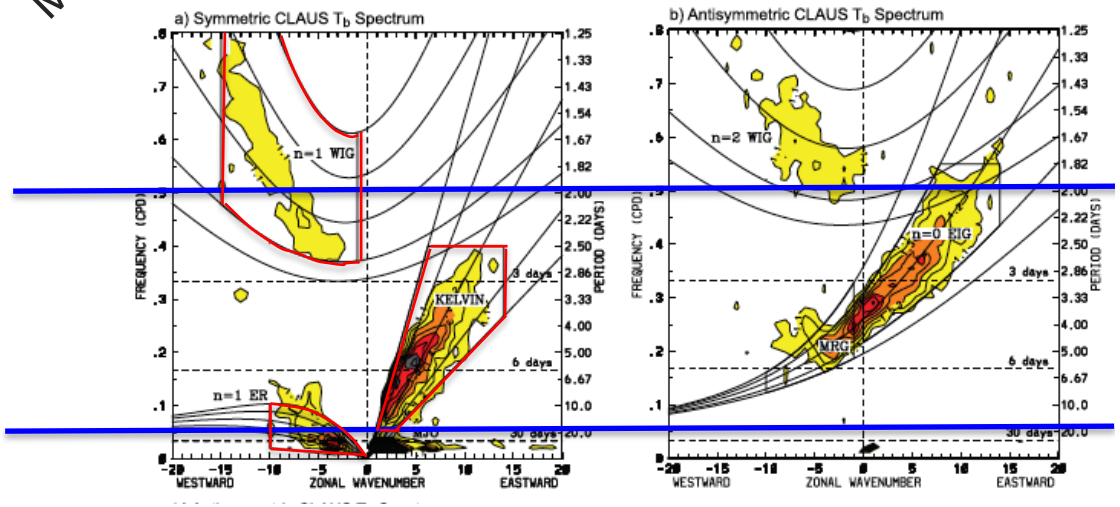
- Similarly, a model with no mesoscale organization will not necessarily get more organized at those scales (if they were resolved);

- Conversely, our results support the idea that *MJO representation in models might be possible in a coarse resolution global model with no higher frequency space-time organization.*

How about convectively coupled equatorial waves variance?

(a)Normalized DJF OLR variance





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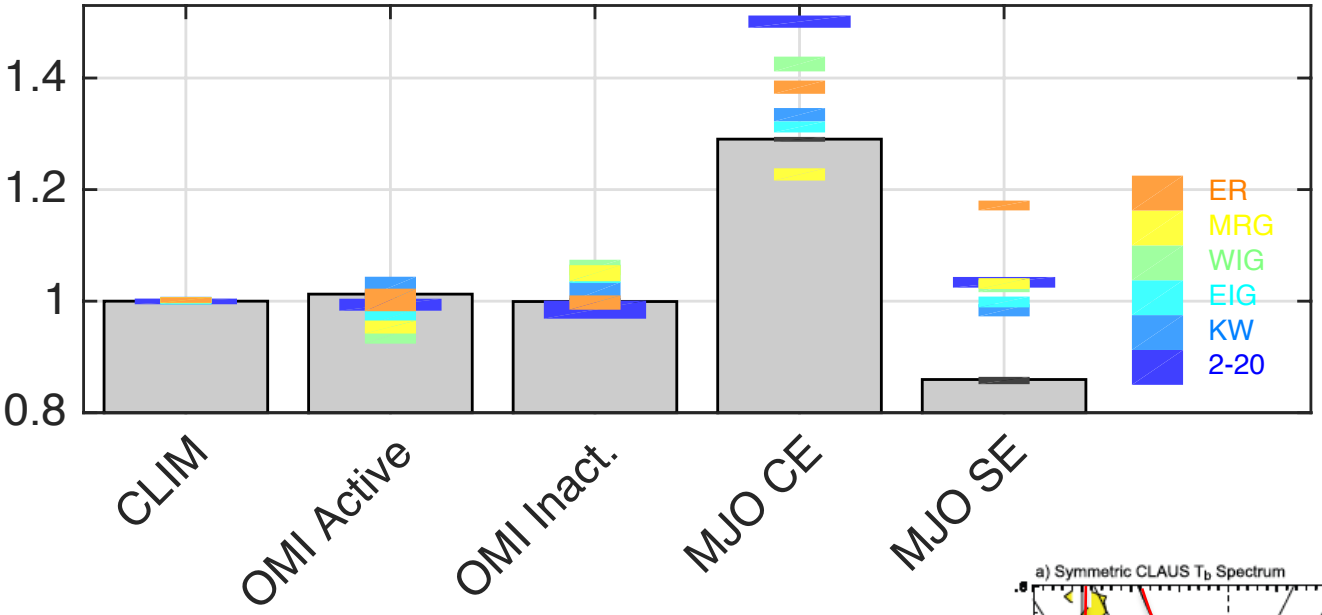

CCEWs variance are "mostly" consistent with 2-20 variance

2-20 days