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Internal versus boundary forced MJO variability in the DYNAMO region

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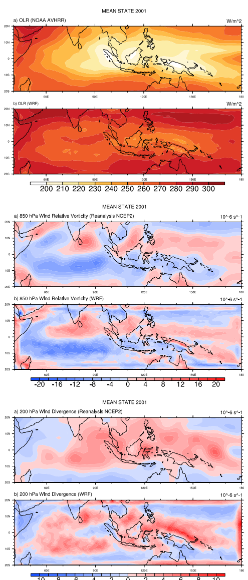
1-Introduction

Understanding the influence of the extra-tropics on MJO variability:

The Madden Julian Oscillation (MJO) is the dominant mode of intra-seasonal variability in the tropical atmosphere. Zonal wind and convection anomalies propagate eastward within the tropical band. Numerous mechanisms have been proposed to account for the space-time characteristics of this phenomenon. In this study we investigate the potential influence from the extra-tropics on various timescales, focusing on the CINDY-DYNAMO region in the autumn. We use an ensemble of regional simulations to separate internal and boundary-forced variability.

2-Model

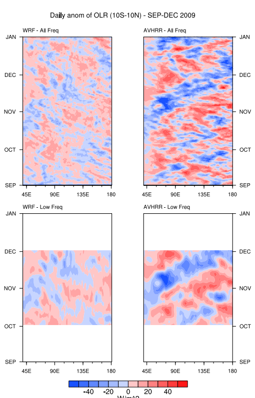


2001 mean for OLR, 850 hPa vorticity and 200 hPa divergence.
(top : reanalysis, bottom : WRF)

WRF 3.3.1 configuration:

- *1°x1° tropical Indian Ocean and West Pacific with 32 vertical levels.*
- *lateral boundary forcing: NCEP2 reanalysis.*
- *Betts-Miller-Janjic (BMJ) convection scheme.*
- *Yonsei University (YSU) planetary boundary layer.*
- *SST skin temperature diurnal cycle.*

- *Validation data: AVHRR (OLR), NCEP2 (wind)*

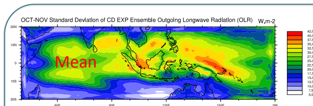


Hovmoller of daily anomalies of OLR averaged between 10S and 10N 1 September – 31 December 2009. (left : WRF, right : AVHRR, top : unfiltered, bottom : low frequency (T>10 days) signal)

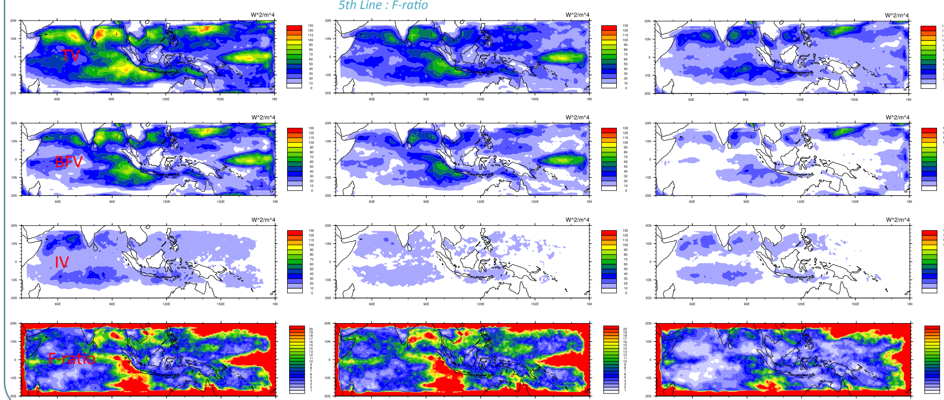
3- Experimental Design

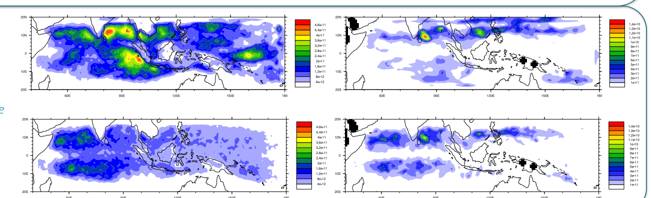
Ensemble simulations : 10 ensemble experiments are run, from 1 Sep to 31 Dec.
Each ensemble contains 10 members.
The experiments differ in their prescribed boundary conditions, taken from ten years of reanalysis data: 2002 - 2011.
Individual ensemble members are generated by varying the initial condition, selecting from the same ten years.
The internal variability is assessed within the ensembles.
The boundary forced variability is assessed between the ensembles.
We partition Total Variance (*TV*) between Boundary Forced Variance (*BFV*) and Internal Variance (*IV*): *TV = BFV + IV*
Null hypothesis *Ho* : No boundary forced variability
For *J* ensembles with *n* members: if the ratio *(BFV/(J-1))/(IV/(J(n-1)))* > 2.61 then *Ho* is rejected at the 99% significance level.

4- Results



One Way ANOVA on standard deviation of ensemble OLR
Left : unfiltered. Centre : high pass (T<10 days). Right : low pass (T>10 days).
1st Line : Total mean
2nd Line : Total variance TV
3rd Line : Boundary forced variance BFV
4th Line : Internal variance IV
5th Line : F-ratio





Top : BFV Bottom: IV of standard deviation of 200 hPa divergence (left) and 850 hPa vorticity (right) (s^{-2})

5-Conclusion

The model is able to simulate climatological features of the tropical circulation associated with convection as revealed by OLR, including propagating patterns that resemble the MJO.

Boundary forced variability is significant at 99% over most of the domain for the unfiltered signal. At high frequencies (synoptic disturbances) the influence of the boundary is strong. At lower frequencies (including the MJO band) the boundary influence remains significant but is weaker, implying some internal model-generated contribution even in this relatively small domain. This distinction between high and low frequency behavior is only apparent in the divergent part of the flow.