

MJO Task Force Meeting

Montreal

23rd June 2017, 1100-1800

11:00-13:00 Joint session with NOAA MAPP Model Diagnostics Task Force

Eric Maloney presented the MDTF development of a process orientated diagnostics package for use at NCAR and GFDL, and the wider model development community. The project aims to develop process orientated diagnostics which can be used to support model development in a flexible software package that can be applied to standard climate model output.

Ming Zhao described his work on developing online diagnostics of the moist-static energy (MSE) budget in the GFDL model, highlighting the particular challenges associated with changes in mass associated with precipitation/evaporation and careful consideration of which density to use within the timestep. He showed the application of these diagnostics to the MJO in the GFDL model, which, as in previous studies, highlighted the role of horizontal moisture advection in the eastward propagation of the MSE anomalies associated with the MJO.

Xianan Jiang presented some analysis of the MSE budget of the BSISO and again showed that the horizontal moisture advection is important in the BSISO propagation. For both the MJO and the BSISO the dominant term is the advection of the basic state moisture by the perturbation wind. For both the MJO and BSISO the MJO/BSISO simulation skill metrics are significantly correlated with pattern correlations of the basic state moisture, i.e. ISV performance is related to the basic state moisture field, consistent with the important role of the horizontal advection term in the propagation. Matt Wheeler raised the question of whether we should then expect to see the interannual variability of the MJO to be related to internannual variations in the moisture gradient. Xianan replied that in his analysis he had not seen that relationship.

Charlotte DeMott presented analysis on diagnostics of the air-sea interaction in the MJO. She introduced direct feedbacks of the coupling, through modification of the surface fluxes by intraseasonal SST variability, and indirect feedbacks, those which arise because of the changes in the mean state through the presence of coupling. Applying the diagnostics to 4 coupled model atmosphere only model pairs highlighted that the strength of the direct feedbacks in models can vary widely, related to both high amplitude SST variability or higher flux sensitivity to SST variability, and in some models is significantly stronger than is supported by observations.

14:00-18:00 MJO Task Force Meeting

TF Members: Daehyun Kim, Steve Woolnough, Nick Klingaman, Tieh-Yong Koh, Ken Sperber, Hyemi Kim, Charlotte DeMott, Matthew Wheeler, Prince Xavier (remotely), Eric Maloney (later)

Invited participants (for some/all the meeting): Franco Molteni (ECMWF), David Strauss (George Mason University), Cristina Stan (George Mason University), Hai Lin (Environment Canada), Huang-Hsiung Hsu (Research Center for Environmental Changes, Academia Sinica), Michel Rixen (WCRP), Keith Williams (WGNE Co-chair), Xianan Jiang (JPL)

MJO Tropical Extratropical Teleconnections

The discussion of the MJO tropical-extratropical teleconnections was framed around the subjects of the diabatic heating (the MJO); the Rossby-Wave source (RWS); the Rossby-Wave propagation; and the extratropical response, and some particular Research Questions:

- 1) How sensitive are the teleconnections to the horizontal and vertical structure of the diabatic heating and how well to models represent the structure of the MJO heating?
- 2) What is the nature of the RWS associated with the MJO heating? How do these depend on the speed of the MJO propagation?
- 3) How do errors in the basic state impact on the RWS, or the Rossby-Wave propagation?
- 4) How do slowly-varying modes of variability modify the diabatic heating, RWS and propagation?
- 5) What is the role of synoptic scale transients in determining the response of the mid-latitude response?

Cristiana Stan introduced the “Year of Tropics-Midlatitude Interactions and Teleconnections (YMTIT)” and S2S teleconnections subproject, which are also addressing these questions, including the design of some mechanistic experiments, e.g. to explore the role of tropical forcing in the mid-latitude variability, or the role of the stratosphere in the teleconnection. In this context, earlier in the day David Straus had shown some very nice ensemble experiments imposing an identical MJO forcing in a large ensemble to explore the “predictable component” of the response to the MJO forcing.

There was some discussion about the appropriate MJO index to use for exploring MJO teleconnections recognizing that the RMM index was not necessarily the best index of the MJO-related diabatic heating, and that an OLR or precip based index may be more appropriate.

Cristiana also showed some analysis from NMME hindcasts looking at the mid-latitude response to MJO forcing, in SPCCSM and CCSM, including some analysis of the lead-time dependence of the teleconnection.

Franco Molteni showed some results from ECMWF reforecasts from the 2015-16 system vs 2016-17 system, showing stronger response in new system to similar amplitude anomalies. He showed that stratospheric response was weak in the older system and related this to errors in stationary v anomalies which lead to errors in v^*t^* flux into stratospheric polar vortex.

David Straus presented his work on deriving estimates of the diabatic heating from residuals in the thermodynamic budget from ECMWF reanalysis, to allow for estimates of the vertical profiles of diabatic heating. He showed that there are differences between estimates when using 4 hourly, rather than daily data.

David's products will be going into S2S database.

Tieh-Yong Koh, asked whether the reanalysis products have enough observational data to properly constrain model thermodynamics. There is little to compare to, but one possibility is to use observational based heating estimates from field campaign data, although these data may have already gone into the reanalysis products.

Huang-Hsiung Hsu commented that computing from thermodynamic budget residuals in CFSR looked much more realistic than model diagnosed heating.

Daehyun asked how do we separate forcing and response, in RWS term, i.e. how much of the divergent wind is part of the response, Prince referred us to Seo and Lee (JAS, 2017) which also addresses this question.

Hyemi Kim presented her work and plans on the modulation of the MJO teleconnection by the basic state (both interannual variability and model error), with a focus on the North Pacific. In particular she highlighted that the modulation of the North Pacific Storm Track by the MJO is sensitive to WBO phase, but the MJO itself is also modulated by the QBO.

Steve Woolnough presented planned work on the MJO teleconnection to the North Atlantic again exploring the role of the basic state (both interannual variability and model error) on the MJO teleconnection, and the role of the pre-existing state of the North Atlantic on the response.

Hai Lin noted that we had not discussed the role of the mid-latitudes in forcing the MJO and Nick Klingaman noted that we had not discussed teleconnections to the Southern Hemisphere.

Years of Maritime Continent

Matt Wheeler and Steve Woolnough provided an update on the YMC project. The implementation plan is being finalized, and some projects are going ahead, but some US, the UK, and Australian planned contributions did not get funded. Both the Australian and UK projects are being resubmitted, but timing means that neither will be able to conduct their field campaigns until winter 2019-20 outside the original YMC project time frame. Both the Australian and UK projects have developed plan B in Australian waters/air space if logistics make operating in Indonesian waters/air-space impossible.

MJO-Maritime Continent Interactions

Steve Woolnough reported on the S2S sub-project on the MJO-MC interactions. S2S is coming towards the end of Phase 1 and the S2S projects are preparing a report on Phase 1 and a proposal for Phase 2 activity. Phase 2 activities will focus on improving forecast systems and developing user products.

Action: SW to circulate MJO-MC subproject report for contributions from TF on activities and progress.

Action: CS to circulation Teleconnections sub-project report for contributions from TF on activities and progress.

Action: SW to circulate plans for Phase 2 for comments on proposed work.

Tieh-Yong presented results from some experiments with a tropical channel version of WRF, including some modifications to the reference humidity profile in the BMJ to improve the tropical performance, and noting the need for frequent calls to the radiation scheme to properly capture the diurnal forcing. In winter ENSO and IOD have little effect on MJO amplitude, in summer El Nino (La Nina) tends to enhance (weaken) MJO amplitude. In summer IOD influence on MJO is phase dependent.

Huang-Hsiung Hsu presented experiments in ECHAM5-SIT (1D ocean model, 1m resolution in upper 10m, T213), in which he had (a) flattened the Maritime Continent and (b) replaced the Maritime Continent land by a 200m deep ocean

No orography makes very little difference to basic state, but no land makes a big difference:

The presence of the Maritime Continent enhances precipitation in the MC region; leading to an enhanced E-W overturning circulation with stronger westerlies in Indian Ocean region. In the absence of the Maritime Continent there is less MJO activity and it tends to lower wavenumber – possibly due to a role of the topographic locking of precipitation in the control and flat experiment. The presence of the MC helps the MJO (at least in this model)

The vertical structure of the MJO in the flat MC and no MC experiments showing increasing reduced westward tilted structures

Mean state and the MJO

Throughout the week there had been a number of posters presenting work showing the role of horizontal moisture advection (of the basic state moisture by the anomalous winds) in maintaining the MJO, and Xianan Jiang presented work in the joint meeting in the morning relating MJO skill to the basic state moisture field.

Daehyun Kim introduced 3 research questions.

- 1) What are the key features of the mean state that effect MJO propagation?
- 2) What are common systematic biases in models that effect MJO simulation and what can be done to correct them?
- 3) What are the relative contributions of the basic state and the representation of MJO-convection interactions in the simulations of the MJO, and how can disentangle the contribution of parametrizations to these separately?

Prince Xavier showed results from recent UM configurations in atmosphere-only experiments (bad MJO), coupled experiments (good MJO), and atmosphere-only with coupled model SSTs (intermediate MJO). The coupled model has small humidity bias, MJO humidity structure is better (moistening a head of convection). The coupled model has a warm SST bias in the MC region and Prince is conducting some sensitivity experiments with SST perturbations. Xianan Jiang noted that CNRM coupled and uncoupled versions have similar differences in mean state.

Hyemi Kim showed results from ECMWF hindcast datasets. A dry bias near the Maritime Continent, especially over the eastern Indian Ocean develops quickly in the early forecast lead times. The dry bias weakens the background horizontal MSE gradient, reducing horizontal MSE advection.

Daehyun Kim presented some analysis showing skill in the MJO forecasts in the S2S database was also correlated with the horizontal moisture gradients in the model basic state.

Nick Klingaman presented a series of experiments with SPCAM-KPP with SSTs constrained to various climatologies from observations, SPCCSM models and SPCSSM's ENSO cycle.

In a long run of SPCAM-KPP active MJO years have positive precipitable water, water anomalies in the Maritime continent region and negative anomalies in the Indian Ocean and West Pacific, and vice-versa in low MJO activity years

Nick further showed that the simulation of the MJO in SPCAM-KPP with the SPCCSM climatological SSTs is poor compared to the SPCCSM and related that to the lack of

interannual variability in SSTs in SPCAM-KPP which has no ENSO cycle. Replacing the climatological SST with a repeating ENSO cycle recovers very similar MJO performance to SPCSSM.

Nick further showed the sensitivity of the MJO simulation to the configuration of the CRM in SPCAM-KPP (8 or 32 columns) could be explained by the different SST biases that develop in the model. The simulations are sensitive to both the mean SST and the gradient, with the largest sensitivity to the gradient.

Daehyun pointed out that many models tend to develop a dry bias near the Maritime Continent. Hyemi Kim showed the vertical structure of moisture bias in the ECMWF hindcast, which exhibits a dry bias in the lower troposphere, and a shallow wet bias near the surface. Two possible causes of the dry bias are discussed. Lack of vertical moisture transport by shallow convection might be responsible for the dry bias, or it might be because convection scheme tends to produce too much rain.

It is clear that there is increasing evidence from theory, observations and models that the background MSE and moisture gradient is important for the MJO propagation in the real world and models and we should consider whether it would be appropriate to right a review article (or a Nature paper?) on this topic.

Any Other Business

A several members of the Task Force informally discussed a possible venue for the Task Force meeting next year. AOGS annual meeting (3-8 June) was mentioned as a possibility.