

Minutes for WCRP/WWRP YOTC MJO Task Force Meeting, September 17, 2012 Boulder , Colorado, NCAR Damon Room

Attendance:

Task force members: Daehyun Kim, Eric Maloney, Rich Neale, Ken Sperber, Duane Waliser, Matthew Wheeler, Steve Woolnough, Prince Xavier

Other contributors: James Benedict, Cecile Hannay, Nick Klingaman, Mitch Moncrieff, Stefan Tulich

Agenda and Notes:

9:00 - 9:30 am: Coffee, pastries, assemble, and setup

9:30 am: Overview of TF activities and charge for meeting Matt Wheeler and Eric Maloney

Matt reviewed the task force membership and the motivation for the task force, including the overall goal and subprojects. Much of the initial discussion focused on the process-oriented diagnostics sub-project, as well as the subproject led by Ken and Daehyun to develop simplified MJO metrics for the Climate Metrics Panel that is being applied to CMIP models.

Discussion: Rich noted that the standard deviation of east/west variance ratio among CMIP5 models is less than that for CMIP3 models, and hence at least in some measures there may be convergence of model performance (although whether models are generally better is still a matter of debate). Daehyun commented on the application of relative humidity based process-oriented diagnostics that were applied by Xianan Jiang to the long integrations of models participating in the Task Force/GASS project on vertical structure and diabatic heating. The diagnostic was not very discerning in these models. Daehyun Kim noted that they might not have been applied correctly, and that normalization by the mean may be necessary before application of the pattern correlation between models and observations. Brief discussion of the boreal summer ISO forecast diagnostic project and the Task Force/GASS vertical structure and diabatic heating subproject also occurred.

Action item: Encourage the task force and others to use Ken and Daehyun's metric on model MJO performance as much as feasible.

9:40 a.m. Report to AAMP. Ken Sperber

Ken mentioned that AAMP was very appreciative of the presentation provided by Matt on behalf of the task force and was appreciative in general of the task force's efforts. Quite a bit of intraseasonal activity is ongoing within AAMP and was discussed at the meeting. The ISVHE hindcast experiments of Bin Wang and Jun-Yi Lee were one example of an effort that was highlighted at AAMP. Data from this project is now available and open to all who want to use it, and is obtainable by contacting Jun-Yi. Much discussion occurred at AAMP about the MOMSEI

experiment that has one focus on understanding the dynamics and prediction of the summer Asian monsoon and the first monsoon intraseasonal event. AAMP thought that with all of this good observational and modeling work going on within AAMP and the MJO Task Force, that it would be good to have a joint meeting between the AAMP and MJO task force (and possibly other efforts such as S2S) in late 2013 or early 2014.

Discussion: Eric asked about data availability for the ISHVE simulations, and it was noted that one should initially go to June-Yi Lee's website and potentially iterate with her, although some have had difficulties with data access in the past. Rich asked about initialization of ISHVE. ISVHE used ERA fields to initialize the integrations on the 1st, 11th, and 21st of each month.

9:45 am: Vertical structure and diabatic heating of the MJO

***Is there anything left to discuss/report after the Pan-GASS break-out?
Duane Waliser, Prince Xavier, Nick Klingaman, Steve Woolnough***

Duane presented an overview of the experiment design, and gave a brief overview of the YOTC-period MJO events that form the initial two case studies for the project. The models entrained so far into the effort were discussed. In response to a question by Eric, Cecile Hannay noted that CAM5 will join the effort, in addition to the modified version of CAM5 being contributed by Guang Zhang. Duane briefly described the timeline for the project. Following from the discussion at the Pan-GASS meeting, it was noted that the November 2011 DYNAMO case will likely be entrained as a second phase of the project. The excellent DYNAMO dataset will allow more process-oriented modeling to be conducted in association with this case. It was asked what this meant? Steve said the excellent DYNAMO forcing and other datasets available will allow increased work with CRMs and high resolution models. The exact experiment design of the DYNAMO portion may depend to some extent on what we think we are doing wrong from the first phase of the project. A timeline was presented for analysis covering the first two YOTC cases. Dec 2012 is a deadline for data to be submitted for inclusion in the initial papers. Duane suggested that rough drafts may be put out at some lead time in advance to motivate groups and give people some indication of where their model may lie in the overall project. In June 2013 all data will be publically available and more comprehensive papers will be drafted. It was noted that a comprehensive update and presentation of results from this effort should be included in the possible late 2013/early 2014 workshop.

Duane presented some very preliminary results for the 20 year integrations. One case was noted where coupling greatly improves the simulation. Matt encouraged Xianan Jiang (who is doing much of the analysis for the 20-year integrations) to try to apply Ken and Daehyun's simple MJO metric to these models to determine how well it does relative to more complex diagnostics.

ACTION ITEM: Apply the simple MJO metric for the Climate Metrics panel to the 20-year simulations of the diabatic heating experiment.

Nick talked about 20 day hindcasts. Some models tend to not produce a good simulation when started with no MJO in the initial state (e.g. SP CAM). It was noted by Duane that these could be good cases to understand model problems and MJO initiation in general. Models that do well in hindcast mode do also tend to perform better in long 20 year integrations. Stefan asked about whether model drift in these simulations had been corrected. Nick said that no, it has been not, although other individual efforts are more focused on this (e.g. Mike Pritchard's). How easy it is to remove drift is model dependent, and the drift is much greater in some models than others. SP-CAM is one model with huge drift. It was noted by Nick that certain models do better at reproducing RMMs in hindcasts (e.g. MRI), although he has not done a phase-dependent analysis yet. A password protected site set up for access to the 20-day hindcasts, with access currently granted to modeling centers and the task force.

Prince Xavier discussed initial results from 2-day forecasts, which may highlight physical parameterization deficiencies and how they relate to poor MJO simulations. Duane said would be nice to have cloud profiles included in the analysis of these runs, although these were not available as output data. It was noted that we could get these from climate simulations. MRI has issues with vertical moistening profiles that we need to sort out. Again, it was noted that these results were highly preliminary.

It was noted that the activity appears to be going along very well, and so the discussion was cut short to talk about more pressing items of business (e.g. process-oriented diagnostics).

10:15 am: Process-oriented diagnostics/metrics Daehyun Kim and Jim Benedict

Daehyun first presented a clarifying slide on what is meant by "process-oriented diagnostics" Daehyun talked about the distinction between microscopic processes such as entrainment and microphysics, and macroscopic processes which more so reflect emergent behavior (e.g. cloud-radiation interactions, wind-evaporation feedback). It was noted that process-oriented diagnostics are a set of diagnostics that help to identify key microscopic processes that affect the simulation of the MJO through modulation of macroscopic processes.

Daehyun then reviewed development of humidity-based diagnostics. Rich asked whether east and west variance used to compute an east/west ratio are correlated, and Daehyun indicated very strongly so, and also showed a scatterplot making this point.

Discussion then centered on how the current diagnostics could be modified to improve them. One possibility would be a different definition of precipitation binning, for example using deciles rather than a fixed binning based on precipitation

amount. Also, it was thought that we should consider examining RH and circulation measures together. It was also asked whether the observational products used affect the results. It was noted that a potentially promising means of future development might be to look at segregating increasing versus decreasing precipitation phases when applying the diagnostics. This might be particularly useful for examining vertical velocity composites binned by precipitation rate, where shifts in vertical heating modes before and after peak MJO convection may have profound impacts on the vertical structure of vertical velocity, which might get washed out in a greater average. It was noted that the RH diagnostic does not seem to discern differences between coupled and uncoupled models that produce good and bad MJOs, and hence it was suggested that getting this diagnostic might be necessary but not sufficient for a good MJO simulation. This is similar in sense to the saturation fraction versus precipitation diagnostic the task force previously explored. Steve agreed with using the decile method since it would be good to use model's own precipitation bins, rather than those based on observations, to assess the quality of the RH vertical profile simulation. An interesting question was raised as to what extent there is interannual variability in observational process-oriented diagnostics that might discriminate strong and weak MJO periods, and whether models that produce good MJO produce consistent variability from one year to the next, and whether diagnostics would fundamentally change their behavior from one year to the next. Matt suggested that a proposal to Xianan might be to compute process-oriented diagnostics for good and weak years for the 20-year simulations from the diabatic heating project, and characterize the nature of interannual variability in the diagnostics. Ken thought that there would be significant utility to this.

ACTION ITEMS: Pursue refined diagnostics based on binning by precipitation decile, increasing or decreasing precipitation states, and by including vertical velocity. Xianan is to compute process-oriented diagnostics separately for strong and weak MJO years in models of the diabatic heating experiment.

Jim Benedict presented work on application of the gross moist stability diagnostic (GMS) to three pairs of good and bad models (versions of CAM3, GFDL AM2, GFDL AM3). It was shown that models with strong MJOs systematically produce lower GMS, which entices further application of these diagnostics to a broader set of models. Duane asked whether it make sense to compute such diagnostics on short integrations? It was deemed feasible, as long as sufficient spatial averaging is done in the computation of this quantity, or the diagnosis were presented as a scatter plot from which a least squares fit could be determined for the purposes of calculation stability.

Steve said that it would be nice to explicitly control for the change in diabatic vertical velocity profile versus moist entropy profile when determining why GMS varies from one model to the next. In general, it was thought that plotting the numerator as a function of the denominator in a scatter plot would be a possible

satisfying way of looking at variations in GMS as a function of MJO phase, and might help minimize divide by zero errors that sometime affect the diagnostic.

It was also thought that it would be useful to simply take just take mean velocity and entropy profiles and see how well their product reproduces the actual mean value of GMS calculated from daily data. It was noted by Eric that past attempts like this have not worked, but it might be worth another attempt. A possible action item would be to calculate these diagnostics for a few more models from the diabatic heating experiment, maybe using examples of good and bad models.

It was brought up again that an analysis or partitioning the GMS change into eddy and mean state contributions and plotting as a function of MJO phase would be an enlightening way to determine whether vertical heating profile variations or moisture and temperature variations are more important for producing GMS variations as a function of MJO phase. The exact method for such decomposition needs to be carefully considered. It was noted by Duane that there is not a lot of detailed process-oriented diagnostic work like this in Pan-GASS community, and thus our work is extremely useful and appreciated by the Pan-GASS community.

ACTION ITEMS: Apply the GMS-based diagnostics to a few more models from the diabatic heating experiment. Develop a method to determine whether variations in vertical velocity profiles or moist entropy profiles are most important for variations in GMS between models and as a function of MJO phase. Explore scatter diagrams as an alternate means of computing GMS statistics.

Daehyun then presented some further diagnostics. He first showed an analysis of the MSE budget in ERA-I. Horizontal advection was a key process in moistening in advance of MJO deep convection. Steve asked how much of contribution from horizontal advection comes from divergent part of flow? Daehyun argued that none. Daehyun also argued based on this analysis that evaporative and radiative fluxes help to destabilize the MJO.

Daehyun then presented a proposal to develop evaporation-based and cloud-radiation feedback diagnostics. Daehyun finished his presentation with a comprehensive list of action items that are to be pursued within the next several years by the process-oriented diagnostics subproject. In addition to what is listed above, they include keener focus on intermediate rain rates when examining RH behavior, and making sure that diagnostics are computed at the finest vertical resolution available.

Steve presented several helpful comments at the end. He thought it would be good to get papers out now on process-oriented diagnostics so that these techniques can be better justified in application to the diabatic heating experiment models.

Steve mentioned that it would also be nice to develop some momentum-based budgets including some diagnostics from DYNAMO. It was noted by Duane that

Xianan Jiang has some of this on his to-do list. Steve mentioned that it would also would be nice to look at EKE and EAPE budgets.

ACTION ITEMS: Get initial papers on process-oriented diagnostics into publication, led by Jim, Daehyun, and Prince. Extend diagnostics to wind-evaporation feedback, cloud-radiation feedback, energetics, and cumulus momentum transport. Refine current diagnostics to focus on intermediate rain rates and higher vertical resolution.

11:45 am: Physical parameterizations and resolution and their impact on MJO prediction *Stefan Tulich*

Stefan Tulich gave an interesting invited talk on what do you do if your high resolution model doesn't have an MJO. The models analyzed (HiRAM, GEOS-5, and WRF Hires) couple too strongly to rotational disturbances, and also produce poor MJO simulations. Stefan argued that lack of prognostic microphysics in the HiRAM and GEOS-5 models may contribute to their poor MJO simulations. He also intends to conduct nudging experiments to expose the model physical deficiencies underlying the biases.

12:15 pm: Lunch in NCAR cafeteria

1:30 pm: MJO metrics and CMIP5 analysis
Ken Sperber and Daehyun Kim

It was concluded that it would be useful to do our own analysis on CMIP5 models and their ability to produce a realistic MJO that uses the full power of the CLIVAR MJO Working Group diagnostics to complement the recent Hung et al. analysis that was submitted to Journal of Climate. Nick asked Daehyun if he agrees with the conclusions of the Hung et al. paper that CMIP5 models have improved MJO simulations over those of CMIP3. Daehyun does not agree with this conclusion, based on his own independent diagnostic analysis. Steve notes that in the likely event that the task force does indeed do a complementary follow-up analysis, it would be good to compare different generations of models from CMIP3 to CMIP5. Rich argued that given Daehyun's conclusion on CMIP5 models not being an improvement over CMIP3 models in their MJO simulations that modeling groups should be more cognizance of MJO quality in their models sooner in the development cycle than has been done in the past. Duane stated that if the task force does its own analysis of CMIP5 models that we could also apply some of our process-oriented diagnostics to the models in the study. Ken although thought it a good idea to look at the climate change runs for some of the better models to assess how MJO activity will change in future climate. Mitch thought that a good outcome of the CMIP5 analysis would be to articulate reasons for improved MJO simulations. Nick agreed, and said that the task force's process-oriented diagnostics would allow this to happen. Mitch and Rich thought that one way to proceed might be to segregate CMIP5 models by resolution, entrainment rate, microphysics, etc. to see if

any systematically changes in MJO behavior can be seen. Regardless, the sense of the task force was that we should start to make more definitive statements about what causes MJO improvement in models.

Then, the task force began to discuss the important topic of who is available to conduct a more thorough analysis of MJO activity in CMIP5 models. Matt asked whether we should offer MJO task force membership to any external members we might identify as potential collaborators to entice them to join this effort? Steve asked whether we should write a research proposal to get money to fund such an activity? Duane asked maybe NSF would fund something? However, it was soon decided that the timeline for proposal writing and waiting for a funding decision might be prohibitively long relative to the timeline of the project.

Duane then suggested asking Jialin Lin and collaborators whether they might want to help lead such an effort in collaboration with the task force. Ken mentioned he might consider undertaking such an effort on his own, although his time is limited. Rich thought we might contact Bin Wang as an option, to see if he might have an interested group member. The task force thought this a good idea. In-Sik Kang and his students would also be another group to ask if they have any interest, although Daehyun mentioned that he might not have students working on MJO. Ken will contact Bin Wang. Matt offered to contact Jialin Lin, after Ken's inquiries. In making these contacts, the task force strongly thought that we need to let people know upfront the magnitude of diagnostics that will be needed, since the amount of analysis will likely be extensive. Further along in the process, Steve thought it ideal to eventually condense some of the extensive diagnostics of the MJO Working group to fewer numbers, and in the process linking our process-oriented Task Force diagnostics to the working group MJO diagnostics. Duane noted that we could do that as a task force, but maybe not the outside person working with us given their general lack of familiarity with our effort and the computational burdens on this person. Duane asked what carrot could be used to entice the outside person? Possibly a name on a notable paper and chance to work with such a distinguished task force will be enough? It was noted that maybe we can also entice Aneesh Subramanian at Scripps to look at climate change simulations for some of the better models?

ACTION ITEMS: Ken will contact Bin Wang to see if he and his group are interested in collaborating on applying MJO Working Group Diagnostics to CMIP5 models. Matt will follow up with Jialin Lin if Bin does not have an interest. Ken will consider whether he himself has time to pursue application of the diagnostics.

2:30 pm: Update on the recent MJO forecast skill of the operational models
(Jon Gottschalck), Matt Wheeler

Matt first reviewed the ability of operational models to simulate MJO events during the DYNAMO period, Sept 2011- March 2012, based on Jon Gottschalk's analysis. He

discussed skill assessment based on RMM1 and RMM2 bivariate correlations. One interesting aspect was that one can take a poor model in a long climate simulation and show that it produces reasonable skill in hindcast mode. Another interesting finding is that the Canadian model looks much better in this DYNAMO analysis than in Nick's 20-day hindcasts for the diabatic heating project. Maybe this is because it uses its own data assimilation process and improved initial conditions when used in forecasts shown for the DYNAMO? If so, this might add a caveat to some of the results from the diabatic heating project hindcast efforts, since the skill of some of the models might be changed with an improved initial condition. **Action item:** Nick will ask Canadians how their model is initialized in Jon's analysis during DYNAMO, whether through their own data assimilation system or simply using ECMWF fields (for example) as an initial condition.

Matt noted that the results look similar for longer 2008-2010 record as for the DYNAMO period, except for the Canadian model which has improved during the DYNAMO period relative to the earlier period. In general, correlations for all models seem higher for the DYNAMO period than before. This could be because stronger MJO activity occurred in the DYNAMO period, along with possible model improvements. Steve said it would also be useful to look at RMS error in addition to bivariate correlations. Models do slightly worse for the portion of the DYNAMO period with little MJO activity compared to the October, November period. Models also do great in last part of DYNAMO period (i.e. February-March) when a huge MJO event occurred. Some models exhibit 0.95 correlations 15 days out. Steve asked whether you get better forecast skill if your model MJO looks close to observations in structure, timescale, etc? Duane notes that a blockbuster MJO event is what Japanese used with NICAM, and so their skill might be a bit overstated relative to if they had used a period with weaker activity. Stefan thought it would be good to examine whether midlatitude skill is improved under conditions with an extremely strong MJO. Phase 3 tends to have a minimum in skill in most models when initialized there. This is when convection is in the east Indian Ocean about to go into Maritime continent. Steve asked how far in advance a model can forecast the transition from no MJO to MJO greater than 1 sigma, and that this would be an excellent diagnostic of skill. In general, this would be a good test of which models can forecast MJO amplification best, which might lead to some interesting process-oriented diagnosis of why. It was also noted that the individual member higher resolution GFS version comes out worse than a lower resolution ensemble. It would be useful for Jon to pick one member of the GFS ensemble at lower resolution as a comparison. Matt thought that with the overall analysis done so far that Jon should write this into a paper soon. Ken thought that it would be good to have all NWP centers as authors, as in the Gottschalk BAMS article (2010). Duane asked whether we should do a similar analysis that applies boreal summer diagnostics? Eric asked whether Jon has subset the 2008-2010 period to see whether he can reproduce the high model skill of the DYNAMO period in any given interval. Steve said the figures that Matt is showing would be good to show the Canadians when Nick talks to them.

ACTION ITEMS: Nick will ask the Canadians about the initialization method for their model during the DYNAMO period. We will encourage Jon to write up results of the extensive analysis he has provided so far for the DYNAMO period. Skill assessment that includes RMS error and the lead time with which models can simulate the onset of one-sigma MJO conditions should be considered as extensions of the analysis.

3:10 pm: Boreal summer forecast and monitoring metrics
Matt Wheeler, (June-Yi Lee), (Augustin Vintzileos)

Matt provided an update on boreal summer ISO monitoring metrics developed by Jun-Yi Lee and collaborators. The paper based on this work has just some very minor additional revisions needed, and then should be accepted for publication. Jun-Yi also has a monitoring website along with EOFs and some code. The new boreal summer diagnostic is better at capturing variance further north in Asia than with RMM1 and RMM2. The PCs of the leading boreal summer mode are highly correlated with RMM1 and RMM2, although the phase diagrams of the boreal summer modes do not show as nice of circular behavior as compared to those of RMM1 and RMM2, which might be explained by the more complicated and varied behavior of the boreal summer modes. June-Yi plans to implement this boreal summer monitoring system at APCC in Korea, but it is not known whether their plans are to include the display of forecasts of the new PCs derived from other forecasting centers. Duane indicated that he can take recommendations for follow-up activity to the operational centers to the WGNE meeting in November. Previously it has been Jon at NCEP who has coordinated the activity of receiving forecasts from the operational centers for the computation of the RMM indices aimed at their MJO theme web page. However, the interest of NCEP in the BSISO is less, so there may be others (e.g. APCC) who have a greater incentive for operationalising the new indices.

Eric asked why the northern bound to the EOF analysis is so far north at 40N, since the might affect the nature of the EOFs? Ken said that this was to capture transitions associated with the Mei Yu front and other related features.

ACTION ITEM: Matt should follow-up with June-Yi, Jon, and Augustin on the best options for operationalising the new BSISO indices. Duane will take our recommendations to the WGNE meeting in November. Matt can also talk to Christian Jakob who is one of the current WGNE co-chairs

3:30 pm: Coffee and cookies arrive!

4:00pm – end: Discussion and way forward

Future meetings

Miscellaneous items

Update on S2S activity as endorsed by WCRP (Duane)

Feedback from US-CLIVAR on their mission statement

The future of the task force

Ken provided some further input from the AAMP meeting. Late 2013 or early 2014, WCRP/WWRP should be able to provide some money to support a joint meeting with the MJO Task Force if we found this desirable. It was strongly indicated by the task force that we should entrain the S2S prediction project into this as well.

Duane talked a bit more about the proposed S2S (Subseasonal to Seasonal) Prediction program of THORPEX WWRP/WCRP. Duane emailed a draft of the implementation plan to the task force. Following from TIGGE protocols, the project will generate a multimodel database consisting of ensembles of subseasonal forecasts. Much of the emphasis will be placed on the applications community.

Thus far, WWRP and WCRP JSCs have expressed support for implementation. The WMO executive council has approved a project office and trust fund (at the least the notion of a trust fund, which still needs to be populated with funding). Creation of a steering committee for S2S is expected soon. The first steering group meeting is anticipated in 2013. Approval by the WMO secretary general has recently occurred. The S2S project will start in 2013 and have a term of 5 years with possible extensions. Right now, a letter is being drafted to the Permanent Representatives of WMO to populate the trust fund. Some representation from the MJO Task Force is desired and likely. Right now, the draft committee of S2S envisions the MJO task force as being a research arm for this activity, since this group is not a research operation in itself, but helps to guide research.

Duane also mentioned that the legacy of THORPEX will be discussed at next International Core Steering Committee meeting. Three options are being considered for the fate of THORPEX: 1) Close down the operation with simply some wrap-up exercises, 2) continue THORPEX in essentially the present form for 10 years, 3) discontinue THORPEX in its present state, but reincarnate it with focus on subseasonal and polar. This latter is the preferred option. We are the most tangible example of who might do research under S2S (likely part of a reorganized THORPEX), and so the task force will have a stake in this reorganization.

We talked about the need to start generating a proposal for MJO Task Force renewal. The form will likely be a one page list of our accomplishments, a one page proposal for the next 3 years of activities, and then letters of support from the leaders of the S2S effort (Vitart, Brunet), GEWEX, AAMP, and other relevant international bodies citing the important role of the task force to these other activities. Matt also circulated our recent workshop plans and agenda to Valery and others to let them know we are doing good things, to help make the case for renewal.

Ken noted that at AAMP International CLIVAR listed the intraseasonal timescale as a grand challenge, which further highlights the important work of the task force and provides a key place to gain support for task force extension (Harry Hendon and

Ken could write on our behalf). For the future of our task force, it seems key to maintain our WWRP/WRCP sponsorship, and continue links to GASS and AAMP.

A draft proposal of activities during our next 3 years was proposed:

- Vertical structure and diabatic heating project
- Process-oriented diagnostic development
- Boreal summer intraseasonal variability
- Reasons for CMIP5 Model improvement (if any) relative to CMIP3
- Air-sea interaction
- Providing research support to S2S e.g. subseasonal with applications for power generation and other applied aspects.

| Future membership of the task force was then discussed.

ACTION ITEMS: Eric and Matt will begin drafting a renewal proposal for the task force. Eric and Matt will begin contacting potential future task force members. Nick Klingaman, Xianan Jiang, and Jim Benedict will be added to the MJO task force email list as they have been making seminal contributions to the research of the task force over the last several months.