Result of Modeling Discussions:

Modeling group had long discussion with some tentative conclusions and requirements, but it was decided that would be fruitful at this stage to engage observationalists for some joint brainstorming. Thought it both useful to directly engage parameterizations with observational diagnostics, but also importantly using CSRM and high resolution global models as an intermediary

Getting field data into GTS rapidly for those doing real-time simulations.

Need to inquire about possibility of getting a block of computer time for DYNAMO applications.

Real need to do ensemble hindcast/forecast integrations of MJO events to assess predictability of MJO events and dependence of physical state and cloud population evolution on initial conditions. Operational centers and other large existing efforts may be required to foster such ensemble experiments with individual models given the computing requirements and interest. Serial integration (before, during, and after) MJO events may be useful in this endeavor. Multimodel ensemble could be considered in predictability studies. Existing efforts such as those associated with YOTC and led by Waliser and Bin Wang could aid in such efforts.

Data denial experiments would be extremely useful to assess impact of high quality DYNAMO observations on MJO initiation forecasts.

***Accurate forcing dataset with error bars is necessary for use on forcing SCM and limited domain CSRM for use in process studies and parameterization development.

For parameterization purposes,
More concentration on surface pressure and momentum flux are required, which was limitation of TOGA COARE dataset. Aircraft can provide in-cloud pressure perturbations to constrain cumulus momentum transport. TOGA COARE also provided limited information on mass flux, entrainment rate, cloud radius etc, which would be useful to have in DYNAMO effort. Boundary layer TKE retrieval from high resolution models and observations would be useful as a check on some global and regional models.

In addition to these (and those in the appendix), these would also be useful fields to validate ATMOSPHERIC models:
1) Cloud type and organization classification as function of MJO regime
2) Surface, TOA, and vertical profile radiation data
3) 3-D distribution of temperature, humidity, and hydrometeors
4) entrainment and detrainment rates
5) Vertical velocity, mass flux, including at cloud base

6) Cloud base q and T and their variability and relationship to cloud properties above (aircraft, radiometer, radar?)
7) Cloud base radii
8) Statistics on cloud size versus MJO regime
9) Echo top height
10) Microphysical properties as source of stratiform anvil.
11) CCN concentration
12) Cloud temporal evolution

See also the two appendices below.

***Statistical representations of multiple variables, including joint PDFs of such properties as function of MJO regime, would be useful.

OCEAN:
1) Accurate air-sea fluxes or heat and momentum (also useful for forcing atmospheric limited domain models)
2) Precipitation
3) Mixing profiles
4) Penetrative solar radiation and ocean optical properties
5) Can aircraft provide larger spatial-scale ocean state information? (SST?)

***A useful product to come out of DYNAMO effort would be a set of process-oriented diagnostics (emergent properties) that modelers could use to validate their parameterizations and assess MJO initiation in the Indian Ocean. Including cloud-scale parameters.

Atmospheric and oceanic observations should be as collocated as possible.

Some interest in using aerosol retrievals to validate models, but some thought that many models we are using do not have detailed enough aerosol processes and their interactions with clouds to make good use of these. (or at least this was unknown by those present). However, it was noted that many IPCC AR5 models have prognostic aerosols (see above comment on CCN concentration though).

Some Key Conclusions

***Humidity/temperature retrievals from radiometer are extremely important to provide continuous temperature and humidity information. Also of particular use is cloud base information with such instruments coupled with mm wavelength cloud retrieval information and collocated cloud information produced by radars at other sites.

***Want vertical velocity information at cloud scale from non-precipitating through deep clouds, particularly important for parameterization development. This is in addition to other desired variables as listed above.

***What constitutes a well-validated CRM simulation? This question could be posed to observationalists in addition to modelers. If well-validated, CRMs can go places that observations cannot in providing fields to improve conventional parameterization. Hence, proper validation may help us exploit these tools to their full potential

*** For setting large-scale context for DYNAMO, high resolution analysis datasets such as those to be provide by NCEP that ingest DYNAMO observation (T574) are crucially important. This includes other large-scale efforts using oceanic and atmospheric high resolution and also conventional global models using data assimilation and (e.g. global WRF with data assimilation) also initialized by common initial conditions.

** Some interest in further discussion of what aircraft measurements may be available and the potential for us to help us improve parameterizations. In some cases, aircraft may help indicate that certain processes (e.g. stochastic mixing) are important in clouds, but tell us little about how to constrain these. What will the aircraft flight path be? How many tracks? How long? Will they have radiation information?

Appendix

Observational Products thought to be useful for CSRM and parameterization development (some fantasy):

- thoroughly quality-controlled soundings
-energy budgets, e.g. apparent heating, apparent drying, radiative cooling, etc.
-clearer error estimates on radar-derived latent heating/vertical motion profile diagnoses
-cloud top height/thickness statistics
-condensate fluxes
-how much condensate is being missed due to thresholds on radars -updraft strength statistics on range of scales
-statistics on convective organization
-pdfs of reflectivity/rainfall on km+ scales
-pdfs of moisture variability

Number of clouds in domain
- Cloud radius at cloud base
-Temperature, humidity, vertical velocity at base of each cloud
-In-cloud distributions of condensate, vertical velocity, cloud radius, temperature, humidity as function of height
-Near-cloud environmental conditions as function of height

-Cloud top height
-Accurate large-scale averaged conditions
-High resolution surface fluxes and boundary layer conditions (T, q, 3-D wind)
-Uncertainties of measurments
-Condensate fluxes for each cloud
-High time resolution
-Purity tracer