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CLIVAR Asian-Australian Monsoon Panel Report to Scientific Steering Group-18

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Disclaimer

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CLIVAR Asian-Australian Monsoon Panel Report to SSG-18

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Gabriel Vecchi	NOAA/Geophysical Fluid Dynamics Laboratory, Princeton, USA
Bin Wang	IPRC, University of Hawaii, USA
Xubin Zeng	University of Arizona, USA
Tianjun Zhou	State Key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics, China
Carlos Ereno: ICPO contact	University of Buenos Aires

Asian-Australian Monsoon Panel

Major activities over the past year

(including contributions to CLIVAR science, and cooperation with other WCRP projects and outside bodies)

a) Establishment of the AAMP Monsoon Diagnostics/Metrics Task Team (Imperatives I, III, and V)

b) AAMP/MJOTF Workshop on Modeling Monsoon Intraseasonal Variability (Imperatives I, II, IV, and VII)

c) Proposed Workshop on Interdecadal Variability and Predictability of the Asian-Australian Monsoon (Imperatives I and II; CLIVAR cross-cut)

d) Development of MJO metrics/process-oriented diagnostics/model evaluation/prediction with YOTC MJOTF (Imperatives I, III, and IV)

e) Development of the YOTC MJOTF, GEWEX GCSS, AAMP MJO Diabatic Heating Experiment (Imperatives III and IV)

f) Hindcast Experiment for Intraseasonal Prediction (Imperative III)

g) Support for CINDY2011/DYNAMO observational campaign and development of numerical experimentation (Imperatives III, V, and VI)

h) Issue: Outreach to CORDEX (Imperatives I, III, and IV)

i) Issue: Interaction with FOCRAII (Imperatives III and VII)

j) Issue: WWRP/WCRP Multi-week Prediction Project (Imperatives III, V, and VII)

k) Revised AAMP Terms of Reference

a) AAMP Monsoon Diagnostics/Metrics Task Team

- **In-sik Kang, Akio Kitoh, Ken Sperber, Andy Turner, Bin Wang[1], and Tianjun Zhou[1], with contributions from monsoon experts H. Annamalai and A. Moise**
  - **Goals**
    - **Validation of models with observations**
    - **Model-Model intercomparison**
    - **Skill assessment for model development**
    - **Climate change impact**
  - **Approach**
    - **Prioritize comprehensive the list of diagnostics that was prepared for AAMP-10**
      - **Ad hoc task team meeting in Tsukuba, Japan on March 11**
    - **What would you include in a peer-reviewed paper?**
  - **Proposed Analysis (CMIP5 vs. CMIP3)**
    - **Boreal Summer Asian Monsoon (present-day, climate change)**
    - **Austral Summer Monsoon (present-day, climate change)**
    - **Monsoon-ENSO relationship (Interannual, decadal, interdecadal, climate change)**

[1] Also represent AMY

a) Boreal Summer Asian Monsoon

Fig. 1: JJAS Precipitation climatology/JJAS Precipitation standard deviation (20S-50N, 40E-160E)

Fig. 2: JJAS SST climatology/uv850 climatology (20S-50N, 40E-160E)

Fig. 3: Scatterplot of the pattern correlation pr clim vs. pattern correlation uv850

Fig. 4: Annual Cycle Monsoon domain and intensity (20S-50N, 40E-160E) (obs, mean model, range of model performance)

Fig. 5: MPI pattern correlation vs. MPD threat score

Fig. 6: Monsoon Onset using pentad rainfall

Fig. 7: Monsoon-ENSO relationship: Lead-lag AIR vs. NINO3.4 SST

Fig. 8: Monsoon-ENSO relationship: NINO3.4 correlations with local rainfall anomalies

Fig. 9: Intraseasonal Variability: 20-100 day variance

Fig. 10: Intraseasonal Variability: Northward propagation

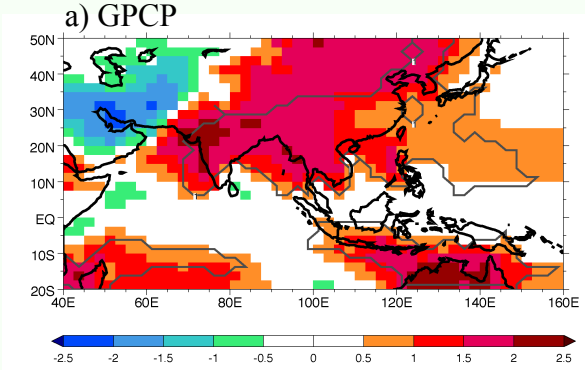
Fig. 11: Intraseasonal Variability: Tilted rainband

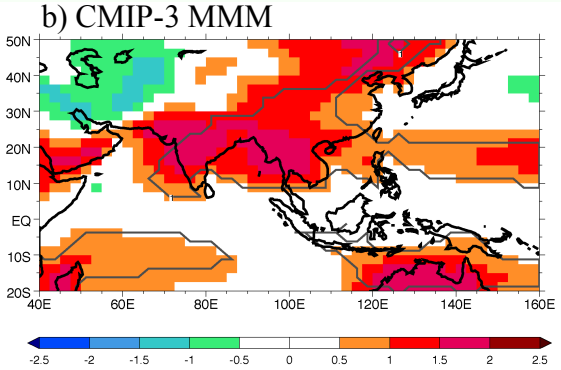
Fig. 12: Space-time correlation of simulated vs. observed life-cycle patterns of BSISV

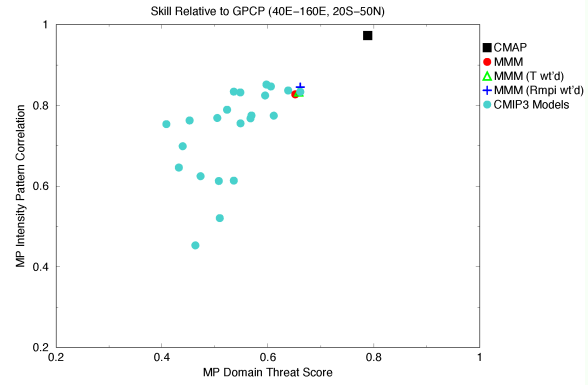
Fig. 13: Mei-yu, Baiu, Chang-ma sudden jump diagnostic

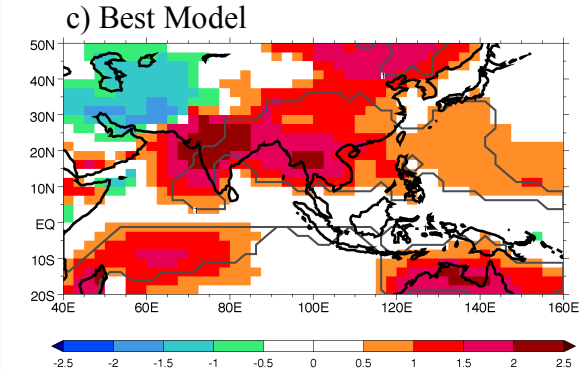
a) Boreal Summer Asian Monsoon: Figs. 4 and 5

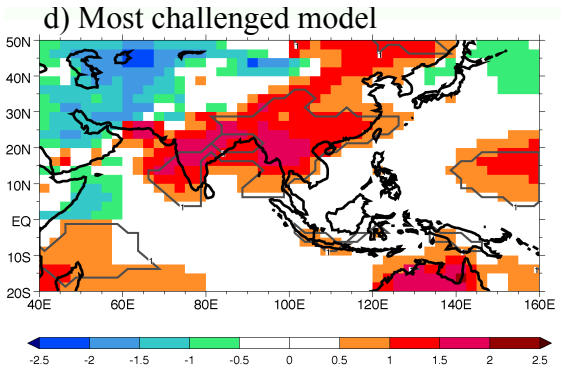
- **Monsoon Precipitation Intensity (shading) and Monsoon Precipitation Domain (isoline)**
  - Designed by Wang and Ding (2008) and used in Wang et al. (2010) and Kim et al. (2011)
  - Skill: MPD threat score vs. MPI pattern correlation
    - WGNE/WGCM Climate Model Metrics Panel











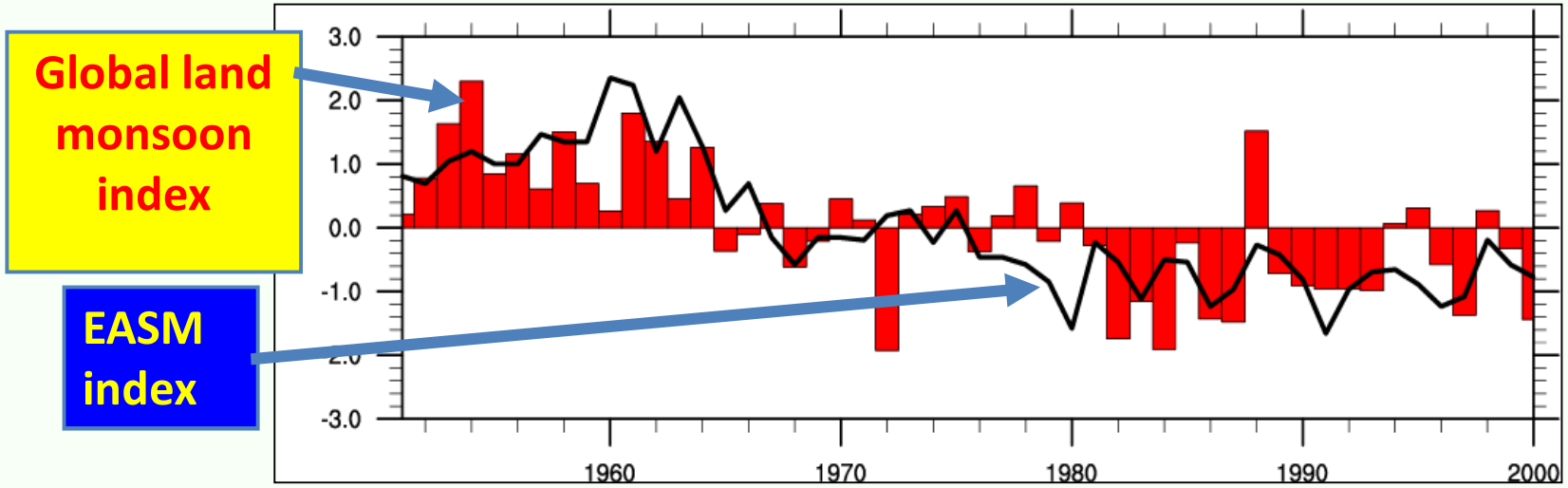
b) Workshop on Modelling Monsoon Intraseasonal Variability (Busan, Korea, 15-18 June 2010)

- **AAMP/WWRP YOTC MJOTF Joint Activity (hosted by APCC)**
  - http://www.ucar.edu/yotc/documents/mjo/KoreaWkshp.html
  - **MJO/ISO Modelling (demonstrated GCM improvement, GCSRMs resolving multi-scale interactions)**
  - **MJO/ISO Process-Oriented Diagnostics/Metrics (convection, rainfall and environmental moisture, diabatic heating, …**
  - **Simplified Models and Theory (complete theory lacking, but SMM suggests useful process-oriented diagnostics)**
  - **Diagnostics/Metrics for Boreal Summer ISV (selecting alternative basis functions to better capture northward propagation)**
  - **MJO/ISV Forecasting (real-time assessment ongoing, endorsed by WGNE)**
  - **MJO/ISV Interactions and Impacts (near-worldwide impacts, e.g., NAO, SAM, ACC, TC's, … potential extended-range predictability)**
- **WCRP, WWRP/THORPEX, and U.S. NSF supported travel grants for 15 graduate students/early career scientists attendees**
- **BAMS Workshop Summary (Hendon, Sperber, Waliser, Wheeler, 2011, in press, Early Online Release)**
  - http://journals.ametsoc.org/toc/bams/0/0

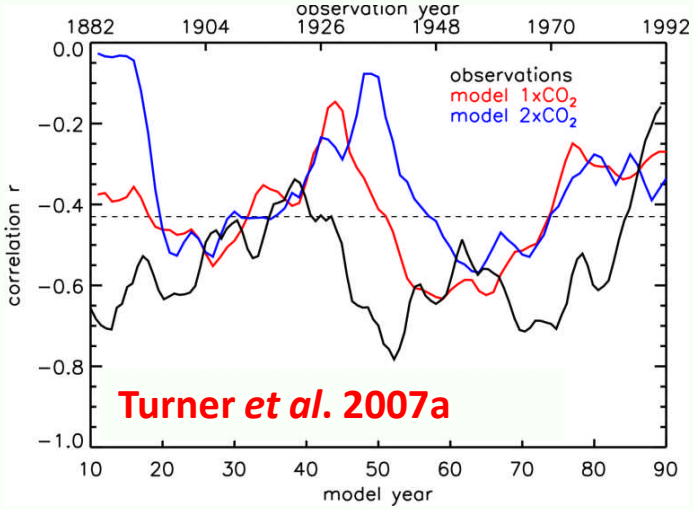
c) Workshop on Interdecadal Variability and Predictability of the Asian-Australian Monsoon

- **AAMP-11 Proposal for a mid-/last quarter 2012 Workshop**
  - **Solicited input from WGSIP, the CMIP-WGCM-WGSIP Decadal Climate Prediction Panel, and the US CLIVAR Decadal Predictability Working Group**
  - **Expect interest from CLIVAR IOP and PP, IBGP PAGES and ACRE (Atmospheric Circulation Reconstructions over the Earth)**
- **Objectives**
  - **To review the present observational evidence of monsoon interdecadal variability collectively and on a regional basis**
  - **To discuss how these variations are linked to other major modes of interdecadal variability such as PDO, IPO, AMO, and to climate change**
  - **To examine possible mechanisms underlying these interdecadal variations, including simulation and numerical experiments that address the physical processes that drive these interdecadal changes with the ultimate goal of assessing the predictability of monsoon interdecadal variations**

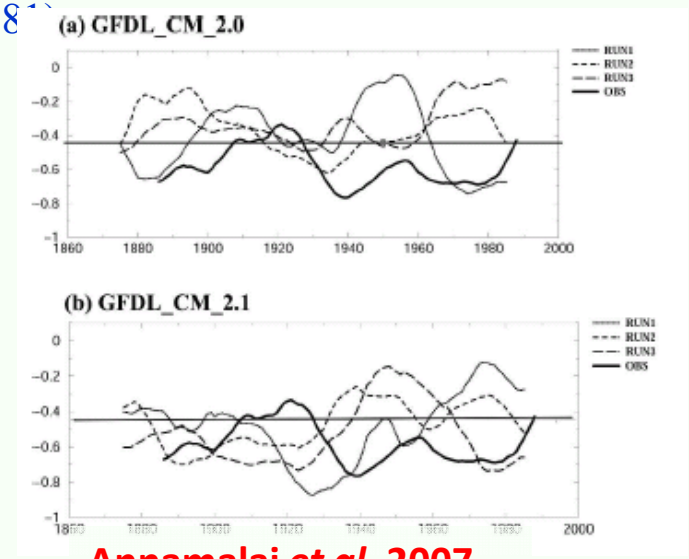
c) Evidence of Interdecadal Variability of the Asian-Australian Monsoon



(Zhou et al. 2008 Changes in global land monsoon area and total rainfall accumulation over the last half century, ***GRL***, 35, L16707, doi:10.1029/2008GL03488[illegible]



Turner *et al*. 2007a



Annamalai *et al*. 2007

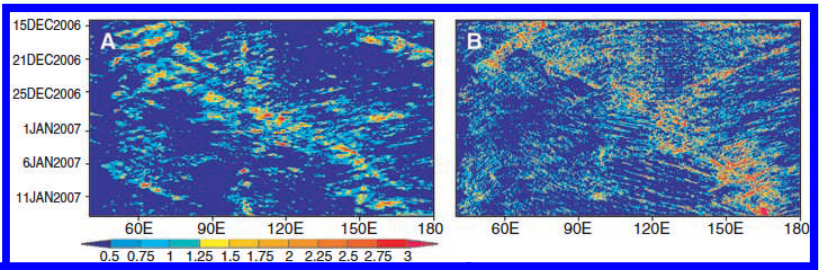
d) Development of MJO metrics/process-oriented diagnostics/model evaluation/prediction with MJOTF and GCSS

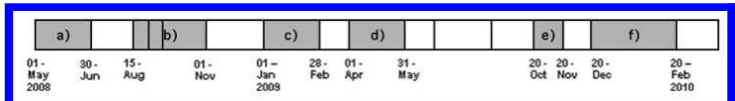
- To be discussed in tomorrow's YOTC MJOTF briefing
- **MJO Forecasting and Impacts**
  - Experimental real-time MJO forecasts being made
  - Skill assessment, multi-model approach, etc.
- **Boreal summer monsoon ISV diagnostics and metrics**
  - Goal of better capture the northward propagating component (especially over the western Pacific)
- **Development of process-oriented diagnostics**
  - To better understand the physics of the MJO/ISO
  - Develop metrics to stratify model performance
  - Develop metrics to be used for quick look diagnosis and as a contribution to the WGNE/WGCM Metrics Panel

e) YOTC MJOTF, GEWEX GCSS, AAMP MJO Diabatic Heating Experiment

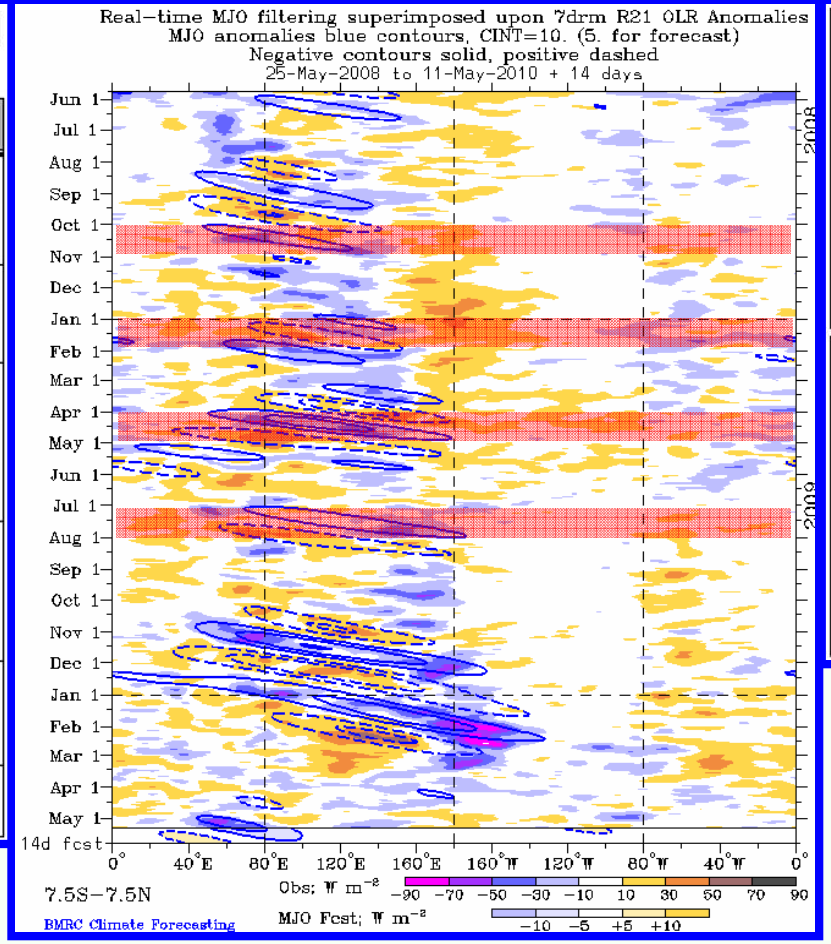
- **Long-Term Simulations & Initialized Hindcasts During YOTC MJOs**
- **Focus on Diabatic Heating Structure**
- **Utilize TRMM & Reanalyses Q1, QR**
- **Encourage HiRes**

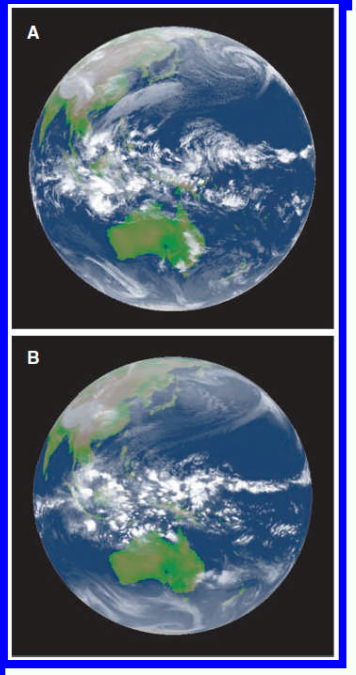
Miura et al. 2007





Target Periods (priority)	Features
a) 01MAY2008 - 30JUN2008 (4)	- fast propagation of MJO into Bay of Bengal. - caused strong modulation of eastern Pacific ITCZ, including some embedded TCs.
b) 15AUG2008 - 01NOV2008 (5)	- MJO convective onset (in central IO) about Aug 15, followed by suppressed period in mid-Sept, the second convective onset in Indian Ocean occurred around Oct 12.
c) 01JAN2009 - 28FEB2009 (3)	- Weak sequence of the MJO that started with a suppressed phase in the IO from about 10-20 Jan. - MJO convection onset then followed in the IO on about Jan 25, propagating into N Australia in early Feb; coincident with floods in N. Australia; strong compensating descent to south exacerbated record high temperature in NSW/Victoria that affected the wild fires; several tropical cyclones, i.e., association with severe weather (floods, fires. TCs).
d) 01APR2009 - 31MAY2009 (2)	- strongest MJO in the YOTC period up to Hawaii workshop but confined to Indian Ocean and Tropical Western Pacific; fast eastward propagation; convectively coupled Kelvin wave activity; strong surface westerly anomalies in Pacific; basin-wide SST increase; transition period for MJO between La Nina and El Nino; MJO possibly triggered El Nino.
e) 20OCT2009 - 20DEC2009 (1)	- strong MJO onset in Indian ocean; propagation into E. Pacific; El Nino conditions; effects on N-hemispheric weather seasonal climate.
f) 20DEC200 - 20FEB2009 (1)	- strong MJO onset in Indian Ocean; propagation into E. Pac and southward in mid-Pacific region.





Dec 2006 MJO

f) Hindcast Experiment for Intraseasonal Prediction

One-Tier System

	Model	Control Run	ISO Hindcast		
			Period	Ens No	Initial Condition
ABOM	POAMA 1.5 (ACOM2+BAM3)	CMIP	1980-2006	10	The first day of every month
CMCC	CMCC (ECHAM5+OPA8.2)	CMIP (20yrs)	1989-2008	5	Every 10 days
ECMWF	ECMWF (IFS+HOPE)	CMIP(11yrs)	1989-2008	15	The 15th day of every month
GFDL	CM2 (AM2/LM2+MOM4)	CMIP	1982-2008	10	The first day of every month
JMA	JMA CGCM	CMIP (20yrs)	1989-2008	6	Every 15 days
NCEP/CPC	CFS (GFS+MOM3)	CMIP (100yrs)	1981-2008	5	Every 10 days
PNU	CFS with RAS scheme	CMIP (13yrs)	1981-2008	3	The first day of each month
SNU	SNU CM (SNUAGCM+MOM3)	CMIP (20yrs)	1989-2008	1	Every 10 days
UH/IPRC	UH CM (ECHAM4+IOM)	CMIP	1989-2008	6	The first day of every month

Two-Tier System

	Model	Control Run	ISO Hindcast		
			Period	Ens No	Initial Condition
CWB	CWB AGCM	AMIP (25yrs)	1981-2005	10	Every 10 days
MRD/EC	GEM	AMIP (21yrs)	1985-2008	10	Every 10 days

f) Hindcast Experiment for Intraseasonal Prediction (Data)

- **2-D FIELDS: total precipitation rate (preferably, the convective and stratiform separately), OLR, geopotential, horizontal wind fields (u and v) at 850, 500, and 200 mb, surface (2m) air temperature, SST, mean sea level pressure, surface heat fluxes (latent, sensible, solar and longwave radiation) and surface wind stress**
- **3-D FIELDS (optional but strongly recommended): humidity, temperature, horizontal and vertical wind, and diabatic heating rates (e.g., shortwave, longwave, stratiform, deep convective, shallow convection) at standard levels**
- **Upper Ocean output: temperature, heat content, salinity, and ocean currents (u and v), and vertical motion from surface to 300m**

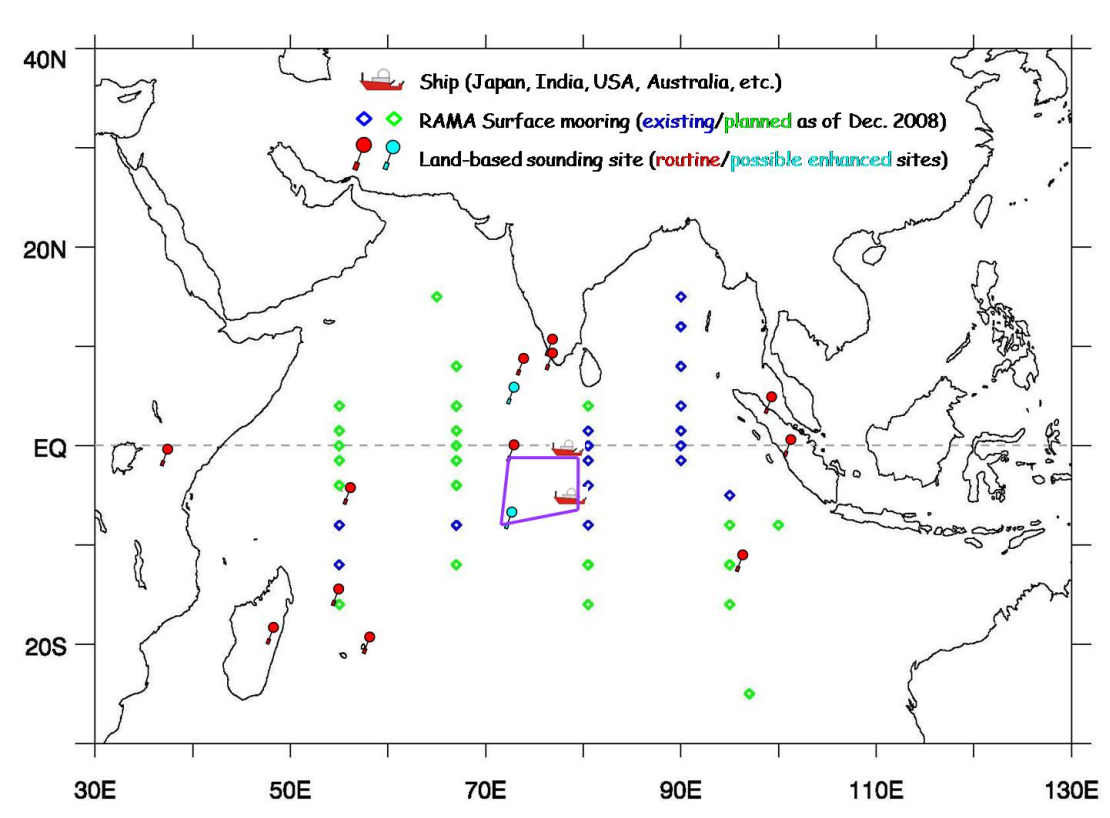
g) Support and coordination for CINDY2011/DYNAMO

Program Objective: Collecting in situ observations through an entire MJO life cycle

Scientific Hypothesis: Moistening and diabatic heating in the lower troposphere by shallow convective processes play key roles in MJO initiation and maintenance

Planned major observations: ship-borne Doppler radar and radiation/surface flux package, air-sea boundary layer turbulence and mixing measurements, GPS sonde array, extended surface and subsurface mooring array (RAMA), ARM Manus site + cloud radar (AMIE)

Modeling component: regional and global models for operation and research



AAMP Issues: CINDY needs to clarify what it wants in terms of forecasts (used to plan flights in near real-time); AAMP to request (1) forecasts from ECMWF and (2) "YOTC-comprehensive" analyses for the observational period with enhanced diabatic heating output; coordinate modeling with MJOTF and YOTC

h) Outreach to CORDEX (Issue: Engagement)

- First Contact: WGCM 2009 meeting
  - Filippo Giorgi interested in the diagnostics that AAMP could supply
  - AAMP suggests refinement to the Asian Monsoon CORDEX domain
- Ruby Leung contributed a regional modeling presentation to AAMP-10, but did not attend
- Based on her presentation AAMP recommended
  - South Asian Regional Reanalysis (SARR) be extended through the YOTC period (April 30, 2010), and ideally through the CINDY2011/DYNAMO observational period (October 1, 2011 – March 31, 2012)
  - RCM community interface with AMY to use their field data for assimilation in the regional reanalysis and for evaluation of regional model process studies over the monsoon domain
  - CORDEX participate in the Regional Climate Outlook Fora, held in April and November, since RCOF'a are interested in regional downscaling of the forecasts
  - Caution on use of SST boundary forcing experiments, as air-sea interaction is an important component of monsoon variability
- To foster interaction
  - Need in-person cross-representation at AAMP/CORDEX meetings
  - Contact CORDEX team(s) responsible for AAMP relevant regions

i) Interaction with FOCRAII (Issue: Training)

- **Eight AAMP members made science presentations at FOCRAII (April 2011) on modeling and predicting monsoon intraseasonal variability, the MJO, and decadal and interdecadal monsoon variability**
- **To AAMP-11, Kiyoharu Takano gave his perspective on future RCOF (FOCRA)-AAMP interactions**
  - **Need advise on seasonal outlook**
  - **How to improve predictions?**
  - **Communication between research and operational community**
  - **Capacity building**
- **AAMP's POV**
  - **Estimates of forecast skill were lacking**
  - **Consensus across the different forecast products was *ad hoc***
  - **Training is essential for producing useful forecasts; this could be achieved by engaging IRI (and possibly the Asian Pacific Climate Center), and following "best-practices" for seasonal forecasting (Kirtman and Pirani, 2009, BAMS, DOI:10.1175/2008BAMS2707.1)**
- **Takano and AAMP will iterate on how to move forward**

j) WWRP/WCRP Multi-week Prediction Project (Issue: AAMP contribution)

- **Recommendation from Exeter workshop (UKMO, Dec 2010) was to form a high level coordinating panel across THORPEX/CLIVAR/WGNE**
  - **AAMP is well positioned to provide scientific leadership**
    - **Evaluation of model simulations of the MJO/ monsoon**
    - **Underpinning multi-week predictability science**
    - **Methods/techniques to score the multi-week forecasts**
  - **Recommend that AAMP have membership on this panel**

Asian-Australian Monsoon Panel

Major future plans/activities

- AAMP development of standard diagnostics and metrics for monsoon
  - Evaluation/validation in CMIP5 and other numerical experiments
  - Preparation of papers that use these diagnostics for evaluation of the Indian, East Asian and Australian monsoons
  - Presentations for the CLIVAR OSC
  - Analysis of MJO/MISO hindcast experiments
- MJO real-time forecasting (in conjunction with YOTC MJOTF)
  - Skill assessment, including that based on initial phase, …
  - Improved representation of boreal summer MISO
  - Beneficial to WWRP/WCRP Multi-week Prediction Project
- Workshop on Interdecadal Variability and Predictability of the Asian-Australian Monsoon
- Diabatic heating experiment (in conjunction with YOTC MJOTF and GEWEX/GCSS)
- Promote a better understanding of the role of land surface processes in monsoon variability

k) Revised AAMP Terms of Reference (DRAFT)

1. Evolve and coordinate strategies to increase understanding of climate variability, predictability and predictions of the coupled ocean-atmosphere-land system in the Asian-Australian monsoon on timescales from intraseasonal to decadal and longer
2. Promote and coordinate activities that lead to the improvement of model simulations, predictions, and projections of monsoon, especially recognizing the fundamental role of multi-scale interactions for monsoon variability and change
3. Contribute to design and implementation of monitoring strategies, including process studies and sustained long term observations, for the Indian Ocean, Western Pacific and surrounding marginal seas and land regions necessary for monitoring and investigating the structure and mechanisms of monsoon variability and change
4. Co-ordinate and promote interactions among meteorologists, oceanographers and hydrologists from interested nations to work on AAM science and capacity building through training activities
5. Work in co-operation with other existing and planned regional and multinational programs directed at improving our understanding of the monsoon system, which include investigations on regional weather forecasting, seasonal climate prediction and impacts on human activities

1: tie into WGSIP, AMY, and THORPEX
2: tie into WGCM, WGNE, and GCSS/GEWEX
3: tie into IOP and PP
4: tie in to AMY and FOCRAII
5: tie in to CLIVAR, THORPEX, WGNE, and FOCRAII

Asian-Australian Monsoon Panel

Issues and challenges (h-j)

- **h) Issue: Outreach to CORDEX**
  - **Need in-person cross-representation at AAMP/CORDEX meetings**
  - **Contact CORDEX team(s) responsible for AAMP relevant regions**
- **i) Issue: Interaction with FOCRAII**
  - **Training is essential for producing useful forecasts**
  - **Engaging IRI (and possibly the Asian Pacific Climate Center)**
  - **Follow "best-practices" for seasonal forecasting (Kirtman and Pirani, 2009, BAMS, DOI:10.1175/2008BAMS2707.1)**
- **j) Issue: WWRP/WCRP Multi-week Prediction Project**
  - **AAMP representation on this panel given experience in MJO forecasting and skill assessment**