

THORPEX/WCRP/ICTP Workshop
**Organisation and Maintenance of Tropical
Convection and the Madden Julian Oscillation**

Hosted by the International Centre for Theoretical Physics (ICTP)

13-17 March 2006, Trieste, Italy

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Meeting Website: http://cdsagenda5.ictp.trieste.it/full_display.php?ida=a04205



1. Summary

Fundamental barriers to advancing weather and climate prediction on timescales from days to years are attributable to gaps in knowledge and very limited capability to simulate multi-scale organised convection in the tropics, especially the Madden Julian Oscillation (MJO). The active phase of the MJO often provides the environment for high-impact weather events (e.g. tropical cyclones; monsoon precipitation anomalies). There is substantial observational evidence, combined with results from empirical prediction schemes that the MJO may provide the dominant source of predictability beyond 2 weeks. Furthermore, there is increasing evidence that surface-wind forcing from organised convection, particularly the MJO, may play a crucial role in the initiation and amplification of El Niño.

For these reasons, THORPEX and WCRP promoted a workshop to assess the current state of knowledge and predictive skill of multi-scale organised convection, with the aim of setting in place priorities for collaborative research between THORPEX and WCRP leading to advanced knowledge and predictive skill of organised convection, and the MJO. The group of world-leading scientists, which was convened at ICTP, produced the following recommendations and opportunities for addressing this problem that are emerging from: (i) recent diagnostic studies and observations, (ii) increased computing power and the ability to run high-resolution cloud-system resolving models (CSRM), and (iii) new remotely sensed (space borne and surface based) and *in situ* observations of clouds and precipitation.

Workshop Recommendations

- Develop metrics/description of the sub-seasonal, seasonal, and interannual characteristics of the MJO and organised convection that encapsulate our knowledge, enable model/forecast validation and guide future research.
- Promote collaboration on the use of NWP-type experiments for exploring error growth in simulations of organised convection and the MJO.
- Promote international collaboration on high-resolution CSRM studies for exploring the upscale energy cascade associated with organised convection, in order to optimize use of computing resources and to share the development of data analysis tools.
- Integrate physical process studies of observed organised convection based on satellite and ground-based remote sensing (including 3D Doppler radar), and *in situ* measurements to provide improvements and validation of high-resolution models.
- Promote collaboration on forecast demonstration experiments (including hybrid dynamical-empirical approaches and statistically-based systems) to assess the value of improved MJO/organised convection simulations for prediction on timescales up to 4 weeks.
- Consider the feasibility of, and develop a strategy for, a field experiment on organised convection (possibly over the Indian Ocean), guided by high-resolution modeling studies.
- Endorse the need to maintain and enhance existing and planned satellite missions that measure tropical cloud and precipitation systems in order to provide a long-term capability for process studies, data assimilation and prediction.
- Develop the concept of seamless prediction in the particular context of the MJO, by forging links between THORPEX and WCRP.
- Promote the transfer of new knowledge and predictive skill of organized convection into improvements for operational NWP and climate models through links with key groups within GEWEX and CLIVAR and operational prediction centres.

The Workshop also outlined two specific proposals that THORPEX/WCRP may wish to promote to ensure that successful simulation and prediction of the MJO in weather and climate models may be achieved, within the next 5 years:

- Shared development of a 'Computational Laboratory' for advancing knowledge and predictive skill of organised convection from cloud scales upwards, involving case studies, idealized simulations and theoretical interpretations. Collaboration in developing efficient numerical cores, designing experiments and in developing best practice for data handling and analysis will reap significant rewards, as will sharing experience in achieving computational efficiency.
- 'THORPEX/COPES Year' of coordinated observing, modeling and forecasting of organised tropical convection and its influences on predictability (an 'IOP' every day concept). This is intended to exploit the vast amounts of new data and computational resources becoming available in conjunction with the development of new/high-resolution modeling frameworks, in order to better characterise, diagnose, model and forecast multi-scale convective/dynamic interactions and processes, including the two-way interaction between tropical and extra-tropical weather and climate circulations .

2. Workshop Announcement: Solicitation for participation

This workshop will review the current status of knowledge of tropical organised convection, with specific reference to the MJO, by bringing together scientists working in both weather and climate within the combined communities covered by THORPEX and the WCRP. It will consider what research needs to be accomplished as an international collaborative effort in order to improve knowledge, the simulation and prediction of tropical organised convection and the MJO, and the resulting socio-economic benefits. The workshop will facilitate the participation of scientists from developing countries in recognition of the profound effects of tropical weather systems and the MJO on regional and global weather and climate.

Objectives:

- i) To review our fundamental understanding of the initiation and maintenance of organised tropical convection and how it relates to tropical weather systems, its 2-way interaction with extra-tropical weather systems through propagation and Rossby-wave dispersion, and how its simulation in weather and climate prediction models can be improved leading to advances in predictive capability;
- ii) To review the state of knowledge and future directions in observing, simulating, modelling and predicting the MJO and its socio-economic implications; and
- iii) To prepare a Workshop report that includes priorities for THORPEX/WCRP research and forecast demonstration projects.

Background

Tropical convection contains variability on a variety of space and time-scales, ranging from the individual clouds, to cloud clusters associated with synoptic-scale disturbances, to super clusters or ensembles of clusters. Synoptic activity in the tropics is often associated with waves which can be related to the preferred equatorially-trapped modes of the atmospheric circulation based on shallow water theory, but it is only in the last few years that it has become increasingly clear that these modes account for much of the organisation of tropical convection and of the development of tropical weather systems. Key questions have been raised about how convective activity is modulated by these modes, the degree to which convection is the forcing agent of these modes, and whether there is a positive feedback between the convection and dynamics of these modes. Nevertheless, in much the same way that mid-latitude, frontal cyclones are the building blocks of the extratropical weather/climate system, so these convectively coupled equatorial waves can be regarded as the building blocks for the tropics.

The development and maintenance of equatorial waves is crucial for forecasting in the tropics, since these waves are the precursors for hurricanes and typhoons. Tropical weather systems may also influence the extratropics by their direct migration polewards into the mid-latitude storm tracks and their initiation of Rossby wave trains. The failure of present-day weather forecast and climate-prediction models to correctly capture the initiation of equatorial waves and their associated organised convection is largely due to inadequacies in the interaction of physics and dynamics, and is arguably one of the most fundamental errors in models used for weather and climate prediction. It compromises our ability to make skilful forecasts on timescales of days and weeks, as well as meaningful projections of climate change, including potential changes in the intensity of tropical weather systems.

Of the various modes of tropical organised convection, the Madden Julian Oscillation (MJO) is one of the most critical. It dominates tropical variability on sub-seasonal timescales, it is known to have global influences through tropical-extratropical interactions, it is intimately related to active/break cycles of the Australian and Asian Monsoons, and is increasingly recognised as influencing high-impact weather and climate variability. Yet adequate knowledge of the processes involved in the initiation and maintenance of the MJO and

3. Workshop Programme and Presentations

The Workshop Programme is provided in Annex 1 and the list of Participants in Annex 2. Presentations are available on http://cdsagenda5.ictp.trieste.it/full_display.php?ida=a04205 along with the summary of the workshop presented to the THORPEX Steering Group on 20 March 2006.

The Workshop consisted of presentations addressing the following 5 major topics and considered both the boreal winter and summer intraseasonal variability. There was a particular emphasis on active/break cycles of the Asian Summer Monsoon, since they have profound socio-economic impacts.

A. Current understanding of tropical organised convection

- Observational studies of tropical convection and its organisation
- Convectively coupled equatorial waves – theory and observations
- Simulating organised convection in cloud system resolving models

B. Current understanding of the MJO

- Initiation and life cycle of the MJO
- Scale interactions and the MJO
- Role of air-sea interaction
- Monsoon active/break cycles
- Large scale modes of climate variability and their influence on MJO activity

C. Tropical-extratropical interactions associated with organised convection and the MJO

- Extratropics as a driver of organised convection and the MJO
- MJO effects on the extratropics: Rossby-wave generation and dispersion
- Extratropical Transitions (ET) of tropical cyclones and their influence on the extratropical baroclinic wave guide

D. Simulating and predicting organised convection and the MJO

- Assessment of MJO simulations in atmosphere-only and coupled climate models
- High resolution, cloud system resolving modelling studies including super-parametrization
- Dynamical prediction methods and levels of skill out to 4 weeks
- Empirical prediction methods for extended range prediction of the MJO

E. Impacts of organised convection and the MJO

- MJO as a fundamental source of predictability beyond 10 days.
- Organised convection, the MJO and extreme hydro-meteorological events
- MJO, El Nino and other large-scale modes

4. Summary of Working Group Discussions

Three working groups, with a mix of expertise in each, were asked to address the following three questions and to form recommendations for future research activities, including coordinated studies for THORPEX and WCRP. These questions and consensus recommendations are:

What are the gaps in our knowledge of organised convection and the MJO, including their global impacts? Can we prioritise these gaps in terms of their importance for future progress?

- i. The upscale cascade of energy from the cloud-system scale (~1-100km) to the synoptic and planetary scales, involving convective organisation and its influence on momentum transport and heating, is poorly understood and not successfully addressed in current convective parametrizations. Organised convection represents a fundamental building block of tropical weather, its interaction with the extra-tropics and climate, and yet is poorly captured in many models suggesting major issues with the interactions between the model's "column" approach to physical processes and its dynamical "fields". This is regarded as the problem with the highest priority.
- ii. The interaction between multi-scale, organised tropical convection and the extra-tropics is central to achieving greater predictive skill on all timescales, both within the tropics and for the extra-tropics. These interactions include (i) extra-tropical forcing of tropical organised convection and convectively coupled equatorial waves through propagation of wave energy into the Pacific and Atlantic westerly wave ducts; (ii) extra-tropical transitions of tropical cyclones and their influence on downstream development; and (iii) excitation of Rossby waves by divergent outflow from tropical convection and their dispersion into the extra-tropics. The use of a potential vorticity (PV) framework for diagnosing these interactions is advocated.
- iii. New observations, particularly from satellite and surface based remote sensing, are challenging our traditional views of the vertical heating profiles and rain-producing clouds in tropical convective systems, such as the MJO. These imply a radical re-think of the roles of, for example, cumulus congestus clouds, stratiform versus convective precipitation, meso-scale downdrafts, and cloud-radiation interactions in the evolution of organised convection.
- iv. Despite a large body of research, we still have little understanding of the spontaneous initiation of the MJO and whether there are large-scale precursors. This has implications for predictability on both monthly and seasonal timescales.
- v. Although a more complete conceptualisation of the 3-dimensional structure of the MJO is gradually emerging, there are still significant gaps in knowledge of the vertical structure of diabatic heating, clouds and microphysics, as well as of the processes that govern its periodicity, its amplitude and the concentration of power on the 30-60 day timescale. Although the eastward propagating mode associated with the MJO during boreal winter and spring has received considerable attention, the more complex, quadrupole structure of boreal summer intra-seasonal variability, often associated with monsoon active/break cycles, requires more study.
- vi. There is a consensus that air-sea interaction processes are a necessary, but not sufficient, component to understand, model and predict intra-seasonal variability. It has been studied extensively for the boreal winter MJO, and TOGA-COARE and the TAO array have provided new insights into high-frequency air-sea interaction processes in the tropical Pacific, but our understanding of similar processes in the Indian Ocean is much more limited.

- vii. The planetary-scale context of multi-scale organised tropical convection and its relationship with low frequency modes of climate variability (e.g. ENSO, NAO/AO) has implications for predictability on timescales from days to centuries.

What modelling and observationally based studies are needed to fill these gaps? What are the priorities?

- i. Recent studies of organised convection and equatorial waves in cloud system resolving models (CSRM) and in global climate models using super-parametrization have demonstrated the potential for using high resolution models to study the processes through which the upscale organisation of convection is achieved. With the increases in computer power expected over the next few years it is now possible to envisage extended integrations of large domain CSRMs where the synoptic scale is not imposed by the boundary conditions. These studies are viewed as the top priority for making progress in understanding and simulating multi-scale organised convection and the up-scale cascade of energy from the cloud scale to the synoptic and planetary scales.
- ii. The fact that NWP and monthly forecast systems show a dramatic loss of skill in representing the MJO suggests that these systems provide a good framework for exploring the growth of errors and for identifying critical factors that lead to this loss of skill. The application of forecast techniques for understanding climate model systematic errors is emerging as an important new tool and is regarded as a high priority for tackling problems associated with simulating convectively coupled equatorial waves and the MJO.
- iii. New remote sensing platforms, both surface-based and space-borne, have the potential to offer new insights into the space-time characteristics of tropical precipitation, and the vertical structure of clouds and rain-bearing systems. These observations will provide essential validation for the CSRM and forecast error growth studies, identified as priorities above. New techniques for extracting appropriate information from these platforms for use in process studies and model evaluation will need to be developed. The importance of better utilizing and maintaining these observational platforms (e.g. ARM, TRMM, CloudSat and the A-train) for the long term was noted.
- iv. It is expected that the proposed modelling studies will raise questions about fundamental physical processes in the coupled ocean-atmosphere system which may require a focused field experiment to address. Whilst a new field experiment was not considered a priority in the short term, due to the need for guidance from the modelling studies, a major field campaign in the Indian Ocean, potentially drawing on the proposed Indian Ocean Observing System (see <http://www.clivar.org/organization/indian/indian.php>), should be considered in the longer term. The Indian Ocean is a major part of the Warm Pool, but the processes taking place there may differ significantly from those in the West Pacific, which was a focus of TOGA-COARE. This is especially the case because the Indian Ocean domain is intimately associated with the Asian-Australian Monsoons.
- v. The potential benefits of skilful extended range forecasts (2 weeks and beyond) have already been demonstrated using statistical methods and need to be extended to include dynamical systems. Coordinated forecast demonstration experiments, which encompass probabilistic methods based on multi-model ensembles and empirical-dynamical hybrid approaches, will be an important activity for demonstrating the skill and value of extended range prediction. Metrics for evaluating forecast skill will need to be developed.
- vi. Very little research has currently been undertaken on the effects of regional and global climate change on tropical organised convection, its contribution to high-impact weather (e.g. cyclones, monsoon droughts and floods) and its effects on low-frequency modes of climate variability, especially El Nino. The implications of the modelling and

observational studies proposed above for the robustness of future predictions of global and regional climate change should be addressed.

What are the implications of improved simulations of organised convection and the MJO for prediction on all timescales? How can we make improvements in extended range predictions in the short/medium term?

- i. Improved simulations of multi-scale organised convection will have implications for tropical cyclone prediction and the effects of extra-tropical transitions on medium and extended range forecasts.
- ii. The ability to carry the signal of the MJO in extended range and monthly forecasts will be important for Rossby -wave generation and extra-tropical predictability.
- iii. Subseasonal variability of the Asian Summer Monsoon (e.g. active/break cycles, monsoon depressions) can have profound socio-economic impacts, and the benefits of increased skill in forecasts with lead times up to 4 weeks could be huge. As the skill of dynamical methods, possibly combined with statistical approaches, improves, it will be important to demonstrate the value of these forecasts across various sectors, such as water, food and health.
- iv. On seasonal and longer timescales, westerly wind events (WWE) associated with organised tropical convection, especially the MJO, are known to be important for the life cycle of El Nino. The potential to include stochastic wind forcing, typical of the MJO and WWEs, within seasonal forecast ensembles could be investigated.

Annex 1: Workshop Programme

Monday, 13 March 2006

09:15 - 10:00 Opening

- Welcome / Workshop objectives (J. Slingo - CGAM, Univ. Reading, UK)
- THORPEX/WCRP interactions (M. Shapiro - NCAR, UCAR, USA)
- Tropical convection: a new era (M. Moncrieff - NCAR, UCAR, USA)
- Organizational aspects (F. Molteni - ICTP, Trieste, Italy)

10:00 - 10:40 Chair: Julia Slingo

Understanding tropical organized convection

- *Keynote Talk:* Observations of Organized Tropical Convection (R.H. Johnson - Dept. of Atmospheric Science, Colorado State Univ., USA)

11:10 - 12:30 Chair: Julia Slingo

Understanding tropical organized convection

- *Keynote Talk:* Convectively coupled equatorial waves in re-analysis data (B. Hoskins - Dept. of Meteorology, Univ. Reading, UK)
- Thoughts on the convectively-coupled wave paradox: discrepancy between observed and theoretical wave propagation (L. Pakula - Dept. of Atmospheric Science, Colorado State Univ., USA)
- Indo-Pacific SST perturbations associated with intraseasonal oscillations of the tropical convection (J. P. Duvel - Laboratoire de Meteorologie Dynamique, ENS, France)

14:10 - 15:30 Chair: Brian Hoskins

Understanding the MJO: theory, explicit convection, super-parametrization

- *Keynote Talk:* Fundamental Processes in the Tropical Intraseasonal Oscillation (B. Wang - Dept. of Meteorology, Univ. Hawaii, USA)
- Investigating the complexity of the Madden-Julian Oscillation (C. Jones - ICESS, Univ. of California, USA)
- Spontaneous, successive and terminal Madden-Julian events (A. Matthews - Schools of Environmental Sciences, Univ. of East Anglia, UK)

16:00 - 17:40 Chair: Ken Sperber

Understanding the MJO: theory, explicit convection, super-parametrization

- *Keynote Talk:* Space time variations in MJO activity using wavelet analysis (G. S. Bhat - CAOS, Indian Institute of Science, Bangalore, India)
- Vertical structure of tropical cloud systems associated with the MJO (J. Haynes - Dept. of Atmospheric Science, Colorado State Univ., USA)
- The initiation of the Madden-Julian Oscillation (P. Ray - MPO/RSMAS, Univ. of Miami, USA)
- Transition between suppressed and active phases of intraseasonal oscillations in Indo-Pacific warm pool (P. A. Agudelo - EAS, Georgia Institute of Technology, USA)

Tuesday, 14 March 2006

09:10 - 10:30 Chair: Graeme Stephens

Understanding the MJO: theory, explicit convection, super-parametrization

- Impact of explicit atmosphere-ocean coupling on tropical intraseasonal oscillations (W. W. Grabowski - NCAR, UCAR, USA)
- Upper-ocean response to the MJO in the Indian and Pacific Oceans from Argo floats (P. Singhruck - Schools of Environmental Sciences, Univ. of East Anglia, UK)
- Evaluation of the intraseasonal and interannual variability of climate simulated by a GCM with superparametrization (M. Khairoutdinov - Dept. of Atmospheric Science, Colorado State Univ., USA)
- A multi-scale structure of tropical convection simulated with the 3.5-km-mesh global cloud-resolving model (M. Satoh - Center for Climate System Research, Univ. of Tokyo & FRCGC, JAMSTEC, Japan)

11:00 - 12:40 Chair: Mel Shapiro

Tropical-extratropical interactions

- *Keynote Talk:* The impact of tropical cyclones undergoing extratropical transition on the downstream midlatitude flow (S. Jones - Institut fuer Meteorologie und Klimaforschung, Univ. Karlsruhe, Germany)
- Intraseasonal variations in the tropical circulation and implications for the extratropical lower

- stratosphere (L. V. de Carvalho - Dept. Atmospheric Sciences, University of Sao Paulo, Brazil)
- Seasonal variation of the extratropical response to the MJO: observations and modelling (O. Charlesworth - Schools of Environmental Sciences, Univ. of East Anglia, UK)
- Upper-level extratropical disturbances as a driver of organized convection in the tropics and subtropics: The role of inertial instability (P. Knippertz - Institute of Atmospheric Physics, Univ. of Mainz, Germany)

14:10 - 15:30 Chair: Jean-Philippe Duvel

Intraseasonal variability and monsoons

- *Keynote Talk:* Quadrupole Structure in Convection and Its Implications on the Asian Summer Monsoon Intraseasonal Variability (H. Annamalai - IPRC/SOEST, Univ. of Hawaii, USA)
- Coupled air-sea interactions in the tropical Indian Ocean environment (K. K. Raghavan - Indian Institute of Tropical Meteorology, Pune, India)
- Intraseasonal variability of the SST in the Arabian sea during the Indian Monsoon (J. Vialard - LOCEAN, France)

16:00 - 17:20 Chair: H. Annamalai

Intraseasonal variability and monsoons

- Intraseasonal variability of summer monsoon over the South China Sea (J. Mao - LASG, IAP, CAS, China)
- Intraseasonal variations of upper tropospheric water vapour over the Asian monsoon region (J. Li - LASG, IAP, CAS, China)
- The role of intraseasonal variability in the nature of monsoon precipitation (C. Hoyos - EAS, Georgia Institute of Technology, USA)
- Intra-seasonal oscillations during contrasting monsoons (A. Kulkarni - Indian Institute of Tropical Meteorology, Pune, India)

Wednesday, 15 March 2006

09:10 - 10:30 Chair: Duane Waliser

Organized convection and tropical variability in full-physics GCMs

- *Keynote Talk:* Asian summer monsoon intraseasonal variability in ECHAM4/OPYC (K. Sperber - Lawrence Livermore National Laboratory, USA)
- Research at ECMWF concerning the simulation of the Madden-Julian Oscillation (A. Tompkins - ECMWF, Reading, UK)
- Sensitivity of Unified Model tropical performance to convection parametrization (S. Derbyshire - Met Office, Exeter, UK)

11:00 - 12:20 Chair: Bin Wang

Organized convection and tropical variability in full-physics GCMs

- Tropical Scale Interactions from a High-resolution Nested Climate Model (G. Holland - NCAR, UCAR, USA)
- Dependence of simulation of boreal summer tropical intraseasonal oscillations on the simulation of seasonal mean (A. M. Ravindran - FRCGC, JAMSTEC, Japan)
- Model performance in representing convectively-coupled equatorial waves in the Hadley Centre climate model (G. Yang - CGAM, Univ. Reading, UK)
- Preliminary results of comparisons between CPTEC/COLA GCM and observations in terms of convectively coupled equatorial waves (Ramirez Gutierrez - CPTEC/INPE, Sao Paulo, Brazil)

14:10 - 15:30 Chair: Chidong Zhang

Predictability and forecasting issues

- *Keynote Talk:* Empirical, numerical and empirical-numerical prediction of tropical intraseasonal variability (P. Webster - EAS, Georgia Institute of Technology, USA)
- Some predictability research objectives of THORPEX (I. Szunyogh - Dept. of Atmospheric and Oceanic Science, Univ. of Maryland, USA)
- Predictability and forecast issues associated with the Madden-Julian Oscillation (D. Waliser - JPL, California Institute of Technology, USA)

16:00 - 17:20 Chair: Peter Webster

Predictability and forecasting issues

- The role of the ocean in the Madden-Julian Oscillation: Sensitivity of an MJO forecast to ocean coupling (S. Woolnough - CGAM, Univ. Reading, UK)
- Statistical prediction of intraseasonal climate variability (B Love - Schools of Environmental Sciences, Univ. of East Anglia, UK)
- An ensemble approach to assess initial condition sensitivity of growing MJO prediction errors (S.

Majumdar (given by C. Zhang) - RSMAS, Univ. of Miami, USA)

- Numerical prediction of the heavy rainfall event of 26 July 2005 over Mumbai: A case study using NCAR MM5 (S. Bishoyi Ratna - Department of Meteorology & Oceanography, Andhra Univ., India)

Thursday, 16 March 2006

09:10 - 09:30 Chair: Adrian Matthews

Predictability and forecasting issues

- Impact of high-res. modeling of organ. deep convection on Asian high-impact weather events and downstream predictability: preliminary results with GEM (G. Brunet - NPR, MSC, Canada)

09:30 - 10:30 Chair: Adrian Matthews

Interactions with interannual variability and climate change

- *Keynote Talk:* The impact of MJO and tropical weather on El Nino (M. Lengaigne - LOCEAN, France)
- Multi-scale interaction in the generation process of equatorial westerly wind bursts (Y. Takayabu - Center for Climate System Research, Univ. of Tokyo, Japan)

11:00 - 12:00 Chair: Mitch Moncrieff

Interactions with interannual variability and climate change

- *Keynote Talk:* The MJO-ENSO problem (C. Zhang - MPO/RSMAS, Univ. of Miami, USA)
- Impact of climate change on the intraseasonal oscillation of the Indian summer monsoon (K. Krishna Kumar - Indian Institute of Tropical Meteorology, Pune, India)

12:00 - 12:30 Poster Session

- The VASCO-CIRENE experiment (J. P. Duvel - Laboratoire de Meteorologie Dynamique, ENS, France)
- Red herrings in the quest for a successful MJO simulation (A. Tompkins - ECMWF, Reading, UK)
- MJO related to the rainfall anomaly over West Sumatra, Indonesia, with the equatorial Atm. Radar (EAR),
- Boundary-layer radar (BLR) and GPCP data analysis (E. Hermawan - LAPAN, Indonesia) Isotopic composition of rainfall in Sumatra island related to the MJO (K. Ichianagi - JAMSTEC, Japan)
- A comprehensive study on tropical mesoscale convective systems (with VHF/UHF radars) (K. K. Karanam - Space Physics Laboratory, Vikram Sarabhai Space Center, India)
- Observational strategy for diurnal to intraseasonal rainfall variability study over Sumatra Inland using the JEPP/GEOSS radar-profiler network (S. Mori - JAMSTEC, Japan)
- Multi-scale organization of tropical convection simulated by a global non-hydrostatic model (T. Nasuno - JAMSTEC, Japan)
- The effect of cumulus suppression scheme in the simulation of convectively-coupled equatorial waves in a GCM (T. Suzuki - JAMSTEC, Japan)
- Upper tropospheric water vapour variations associated with the MJO over the Tibetan Plateau (R. Zhan - LASG, IAP, CAS, China)

14:10 – 17:30 Working Group Break-out sessions

Friday, 17 March 2006

09:00 - 10:00 Working Group Break-out sessions

10:30 - 12:30 Plenary session to discuss recommendations

Annex 2: List of Participants

Organising Committee:

Julia Slings (WCRP/ICTP; NCAS, U. Reading, UK)
Mitch Moncrieff (THORPEX; NCAR)
Franco Molteni (WCRP/ICTP; ICTP)
Mel Shapiro (THORPEX; NCAR)

Participants:

Brian Hoskins (U. Reading, UK)
Peter Webster (Georgia Tech, USA)
Duane Waliser (SUNY, USA)
Ken Sperber (PCMDI, USA)
Adrian Matthews (UEA, UK)
Steve Woolnough (NCAS, U. Reading, UK)
Matthieu Lengaigne (IPSL, France)
Bin Wang (IPRC, USA)
H. Annamalai (IPRC, USA)
Jean Philippe Duvel (LMD, France)
Jerome Vialard (IPSL, France)
Krishnan Raghevan (IITM, Pune, India)
Sarah Jones (U. Munich, Germany)
Greg Holland (NCAR, USA)
Chidong Zhang (U. Miami, USA)
Dick Johnson (CSU, USA)
Istavan Szugnug (U. Maryland, USA)
Gilbert Brunet (CMA Montreal)
G. S. Bhat (IISC, Bangalore, India)
Leila Carvalho (U. San Paulo, Brazil)
Steve Derbyshire (Met Office, UK)
Wojciech Grabowski (NCAR, USA)
Charles Jones (ICES, U. California, USA)
K. Krishna Kumar (IITM, Pune, India)
Marat Khairoutdinov (CSU, USA)
Jianping Li (IAP, Beijing, China)
Jiangyu Mao (IAP, Beijing, China)
A.C. Pandey (U. Allahabad, India)
Masaki Satoh (CCSR, Tokyo, Japan)
Graeme Stephens (CSU, USA)
Adrian Tompkins (ECMWF, UK)
Paul Agudelo (Georgia Tech., USA)
Bishoyi Ratna (Andhra University, India)
Oliver Charlesworth (UEA, UK)
Francesca Di Giuseppe (SMR, Bologna, Italy)
Suneet Dwivedi (U. Allahabad, India)
Jay Fein (NSF, USA)
Tomas Halenka (Charles University, Prague, Czech Republic)
John Haynes (CSU, USA)
Eddy Hermawan (LAPAN, Bandung, Indonesia)
Carlos Hoyos (Georgia Tech., USA)
Kimpei Ichianagi (JAMSTEC, Japan)
K. Kishore Kumar (VSSC, Kerala, India)
Peter Knippertz (U. Mainz, Germany)
A. A. D. Kulkarni (IITM, Pune, India)
Barnaby Love (UEA, UK)
Mylord Mendoza (Ateneo de Manila University, Philippines)
Shuichi Mori (JAMSTEC, Japan)
Tetsuo Nakazawa (MRI, Japan)
Tomoe Nasuno (JAMSTEC, Japan)
Lyle Pakula (CSU, USA)
Kathy Pegion (COLA, USA)
Ramirez Guterrez (INPE, Brazil)
A.M. Ravindran (IISC, Bangalore, India)
P. K. Ray (U. Miami, USA)
Aglia Savtchenko (U. Sofia, Bulgaria)
Ayako Seiki (JAMSTEC, Japan)
Patama Singhruck (UEA, UK)
Tsuneaki Suzuki (JAMSTEC, Japan)
Yukari-Nakagomi Takayabu (CCSR, Tokyo, Japan)
Wataru Yanase (CCSR, Tokyo, Japan)
Gui-Ying Yang (NCAS, U. Reading, UK)
Ruifen Zhan (IAP, Beijing, China)