Coordinated Enhanced Observing Period
An Element of the World Climate Research Programme (WCRP), initiated by the Global Energy and Water Cycle Experiment (GEWEX)
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CEOP Phase 1 Successes Documented as Contributions to Water and Energy Cycle Studies and a Basis for the Start of CEOP Phase 2: a view by the Chairman of the Joint Scientific Committee for the World Climate Research Programme (WCRP)

Peter Lemke, Chair, WCRP Joint Scientific Committe (JSC)


Peter Lemke

The initial successes of CEOP, up to the end of 2004, have led its Science Steering Committee, Chaired by Professor Hartmut Grassl, and its Advisory and Oversight Committee, Co-Chaired by Drs. Jack Kaye and Akimasa Sumi, to endorse plans for a second phase that will extend to the end of 2010. This decision has also been welcomed and supported by the broader WCRP climate research community.

The rationale for the extension of the CEOP effort comes directly from the success to date of the coordination of specially generated model output data products with in-situ and satellite data through the well organized CEOP integrated data archive system. The main elements of the system consist of the Model Output archive at the Max Planck Institute for Meteorology, Hamburg, Germany, the in-situ data archive being managed by the University Cooperation for Atmospheric Research (UCAR), Boulder Colorado, USA, and the satellite data archive provided by the University of Tokyo (UT) and the Japan Aerospace Exploration Agency (JAXA), Tokyo, Japan.

To facilitate the accessibility of the data collected from inhomogeneous information sources and maximize their use, international information sharing and dissemination have been established compliant with existing standards and capabilities, such as ISO (International Organization for Standardization). A Centralized Data Integration System administered by UT and a Distributed Data Integration System developed through a collaborative effort between UT, JAXA and the Committee on Earth Observation Satellites (CEOS) Working Group on Information Systems and Services (WGISS) has as its aim to enable a broad group of users to easily access, browse and analyze the CEOP data. Prototypes of both of these Systems were opened to the CEOP community on 1 June 2005.

I am pleased therefore to have this opportunity to stress that CEOP has now become widely acknowledged within the international research community. In particular: it has been selected as the first element of the Integrated Global Water Cycle Observations (IGWCO) theme under the Integrated Global Observing Strategy Partnership (IGOS-P); it is an important component of WCRP's scientific strategy as expressed in our new COPES (Coordinated Observation and Prediction of the Earth System) strategic framework for 2005-2015; and, it is also a demonstration project within the new Global Earth Observation System of Systems (GEOSS) of the Group on Earth Observations (GEO). It is essential to the research communities of WCRP, especially for our Global Energy and Water Cycle Experiment (GEWEX), and to the Earth observation communities represented in the IGOS-P and CEOS that CEOP, through a Phase 2 initiative, remains a stable, internationally coordinated effort that continues to meet its data, observational and research goals.

A key attribute of the existing CEOP data set is that the data have undergone additional quality control measures including visual inspection of all data and that the format of the data is essentially uniform across all providers. With these specific features, the CEOP data set is a unique tool that can be successfully exploited to advance research into the water and energy cycles as components of the global climate system as well as to implement various model validation and intercomparison studies leading to improvements of modelled physics. A number of such studies have been presented at specific meetings that have demonstrated benefits arising from the CEOP data set, which integrates a large amount of in-situ data from various reference sites with a common format and is easily accessible to users. A few specific examples are presented in this Newsletter along with special articles and diagrams that are intended to provide the basis for the culmination of the first Phase of CEOP and the starting point for Phase 2.

In this context, I appeal to all the contributing organizations and agencies for the continuation and extension of your help in providing your model, in-situ, and satellite data products to the international research community in cooperation with the CEOP data management and analysis scheme, at the present level and, to the extent possible, until 2010. The continuing success of CEOP depends critically on the active participation of Numerical Weather Prediction (NWP) and related global model and

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data assimilation groups, reference site data collection processing centres and satellite instrument data handling agencies.

At this year's session, the Joint Scientific Committee (JSC) for the WCRP noted with appreciation the completion of CEOP's main observation period and the on-going research and data collection activity. Professor Toshio Koike's role as CEOP Lead Scientist was highly acknowledged. For my part as the Chairman of the JSC, I am glad that the JSC has taken steps to ensure continued development of the unique attributes of CEOP by inviting Professor Koike to report to the WCRP Observations and Assimilation Panel (WOAP) on the progress of the observation and data component. In a similar manner, the JSC plans to ensure that the CEOP science focus remains closely integrated with and complementary to the overall objectives of GEWEX and the other core projects of WCRP. For this reason, the JSC has asked that GEWEX maintain oversight of the research component of CEOP. For its part, CEOP will provide a "next" draft of the Phase 2 Implementation/Science Plan that includes criteria for measuring progress and a statement of resource requirements, to be considered at JSC-XXVII, March 2006. It will be my pleasure to continue to work with CEOP in this way to provide the means for it to continue to evolve as a fully functioning integrative component of the WCRP and a leading contributor to water and energy cycle studies in the global climate research community.

CEOP Phase 1 Achievements

Toshio Koike, CEOP Lead Scientist, University of Tokyo

In agreement with the Implementation Plan for Phase 1 CEOP has established two sets of unique functional components:

- components to integrate observations based on coordination among field science groups, space agencies, and NWP centers in the local, regional and global scales;
- components to exchange and disseminate observational data and information including data management that encompasses functions such as Quality Assessment/Quality Control, access to data, and archiving of data, data integration and visualization, and information fusion.

Key agreements were initiated to obtain in-situ data from 35 selected globally distributed "reference" stations. These Reference Sites provide enhanced observations of sub-surface (soil profiles), surface (standard meteorological and radiation), near surface (flux tower), and atmospheric (rawinsonde and profiler) quantities, and also ancillary data sets (radar, special observations). The CEOP Reference Site data is archived by the UCAR/JOSS Central Data Archive (CDA).

The work associated with satellite data set development and integration has also progressed as planned. The satellite data sets that are accommodated at the Satellite and Data Integration Center at the University of Tokyo (UT), which is jointly administered by JAXA and UT, consist of the main water cycle parameters generated at three scales: 250 km rectangular, monsoon regional and global scales that are associated with product levels 1b, 2 and 3.

Nine operational NWP and two data assimilation centers (NCEP, UKMO, NASA-GMAO, NASA-GLDAS, JMA, BMRC, ECMWF, NCMRWF, ECPC, CPTEC/INPE, and CMC) are currently providing two types of model output: gridded global fields and site-specific time series designated as "Model Output Location Time Series" (MOLTS). The Max Planck Institute for Meteorology (MPIM) and the German Climate Computing Center (DKRZ) with the ICSU World Data Center for Climate (WDCC) undertook to serve as the CEOP model output archive.

The total amount of CEOP Phase 1 data is estimated to be approximately 300 Terabytes. As originally produced by the various sources the data was in a wide variety of formats and structures. In order to transform the observational data into scientifically and socially relevant information and allow for sharing of this knowledge on an international basis, CEOP has established two capabilities for data integration and information fusion one being a distributed data integration system developed by JAXA and NASA at http://jaxa.ceos.org/wtf_ceop, and the other a centralized data integration system established by UT, at http://monsoon.t.u-tokyo.ac.jp/ceop-dc/ceop-dc_top.htm. For data description, data indexing, and data services such as data mining, the CEOP metadata scheme has been developed to conform to the ISO TC/211 19115 standard.

The two overall science objectives of the Water and Energy Cycle Simulation and Prediction (WESP) and Monsoon System Studies drove the requirements for CEOP and its Phase 1 data sets. The WESP component of CEOP has begun to use these data sets to accomplish a comprehensive synoptic climatological case study of regional CSE and global water and energy budgets as a guide to the interpretation of longer-term global and regional analyses and data sets. Starting from the current efforts to close simplified vertically integrated water and energy budgets with observations and analyses and beginning efforts to simulate these budgets regionally, CEOP has commenced the effort to transfer this knowledge to global scales, include more water and energy cycle processes, and to examine special phenomena related to the land component and the vertical structure of the atmosphere.

For the Monsoon Systems Studies, CEOP Phase 1 requirements have led to the subsetting of the data into four major monsoon regions around the globe, namely the Asia-Australia Monsoon, North American Monsoon, South American Monsoon, and West African Monsoon. A regional monsoon experiment is underway, in the form of a CEOP Inter-Monsoon Study (CIMS) that considers all of these monsoon regions. The CEOP Monsoon Systems Working Group has undertaken a demonstration project with the EOP-1 dataset that shows that the specific features of such a dataset can be exploited in a process that will lead to meeting the objectives of CIMS at the first level.

Moreover, soon after the delivery of the EOP-1 in-situ dataset in early 2004, modeling center and space agency participants in CEOP became aware that the observations at CEOP reference sites could be used in studies to evaluate and validate land surface processes and other related aspects of models and satellite sensor algorithms.

In recognition of the unique benefits of the observation and data integration infrastructure that has evolved over CEOP Phase 1 CEOP is now considered one of the key elements of the Global Earth Observation System of Systems (GEOSS), as described in the GEOSS 10 Year Implementation Plan Reference Document:

A prototype data integration system is being demonstrated by the CEOP. An overall plan for in-situ and satellite water cycle observational systems is needed so that data can be readily exchanged, standards can be set, and data quality can be monitored.

The Fourth CEOP Implementation/Science Planning Meeting and the First IGWCO Workshop, Tokyo, Japan, from 28 February – 4 March 2005

Sam Benedict, CEOP International Coordinator

The fourth international implementation/science planning meeting for CEOP and the first Integrated Global Observing Strategy Partners (IGOS-P) Integrated Global Water Cycle Observations Theme (IGWCO) Workshop, were held jointly at the Sanjo Kaikan facility on the Hongo Campus, of the University of Tokyo (UT), in Tokyo, Japan, from 28 February – 4 March 2005. The agenda and all of the presentation material including the posters presented and displayed at the meeting can be found through the CEOP Home Page on the Internet at: http://www.ceop.net. The joint meeting was attended by a group of over 60 scientists from 15 countries.

The CEOP Lead Scientist reported that since CEOP had been identified as the first element of the IGWCO theme within the framework of IGOS-P the connections between the two communities had been strengthened leading to the joint meeting.

The participants addressed several important issues including (a) endorsement of a concept for finalizing the CEOP Phase 2 Implementation Plan; (b) ideas for maximizing the science and technology benefits from both CEOP and IGWCO; and (c) specific thoughts related to the framework for oversight of the science, implementation plans and results during the initial phase of IGWCO and CEOP Phase 2.

Of special interest were relationships to the World Climate Research Programme Coordinated Observation and Prediction of the Earth System (COPES) strategy, which is being established as a unifying and integrating experiment designed to capitalize on successes in the development of specialized observing networks that have been established around the globe for measuring and monitoring climate related parameters. Connections to the 10-year Implementation Plan for the Global Earth Observation System of Systems (GEOSS) were also highlighted.

Because the CEOP initial (Phase 1) Data Collection Period was completed, as planned, on 31 December 2004, a CEOP Phase 1 Science and Data Results Workshop was organized at the meeting. Forty-two technical papers and a corresponding number of posters were presented at the workshop and displayed during the meeting covering issues associated with model and satellite instrument algorithm validation; water and energy budget variations and their role in climate; monsoon characteristics studies including diurnal variations; model intercomparison and transferability studies; and downscaling. Extended abstracts of these presentations have been published as a separate meeting document. A list of the presentations has been summarized on page 8 of this Newsletter and plans for the technical papers to be published in a special issue of a peer reviewed journal are also provided below.

Many of the studies presented at the workshop used the CEOP coordinated in-situ, satellite and model output data sets, others were examples of research and data handling that need CEOP's unique capabilities to succeed. These capabilities, highlighted as part of the legacy of CEOP Phase 1, included:

- A prototype of the global water cycle observation system of systems based on the reference site network, the experimental and operational satellite systems, and the NWP model outputs.
- A well organized data archive system.
- A cooperative framework for providing distributed- and centralized-data integration functions.

The actions and recommendations related to the discussions at the meeting are being drafted into a report. The next meeting, which is also being planned as a joint CEOP/IGWCO event and will in addition include representatives of COPES, will be held from 27 February to 3 March 2006 in Paris, France.

Call for Papers to the CEOP Special Issue of JMSJ

Toshio Koike, CEOP Lead Scientist, The University of Tokyo

As presented at the CEOP Tokyo Meeting in March 2005 (see page 8), many encouraging results have been achieved in all components of CEOP through its initial phase. In this context, a special issue on CEOP of the Journal of the Meteorological Society of Japan (JMSJ) has been proposed. It is my great pleasure to invite you to publish your paper in this special issue of JMSJ. Currently, the following breakdown of topics is anticipated: *Water and Energy Simulation and Prediction (WESP) • Monsoon System Study (CIMS) • Data Archive, Interoperability, and Integration • Satellite Remote Sensing and Data Assimilation • Model Intercomparison*

Detailed information including a funding support policy and editorial board members will be announced through the CEOP home page in due course. The paper submission due is **31 December 2005** and the submission guideline is available at: http://wwwsoc.nii.ac.jp/msj/JMSJ/JMSJ_contrib.html/. Please take notice that manuscripts for this special issue **should be sent directly to:**

Dr. Toshio KOIKE
Department of Civil Engineering, School of Engineering, The University of Tokyo
Bunkyo-ku, Tokyo 113-8656, Japan

The Inter-CSE Transferability Study

B. Rockel[1], I. Meinke[2], J. Roads[2], W. J. Gutowski, Jr.[3], R. W. Arritt[4], E. S. Takle[3,4], C. Jones[5]

[1] GKSS Research Centre Geesthacht, Germany; [2] Scripps Institution of Oceanography, UCSD, USA; [3] Dept. of Agronomy, Iowa State University, USA; [4] Dept. of Geological and Atmospheric Sciences, Iowa State University, USA; [5] University of Quebec at Montreal, Canada

Introduction

The Inter-CSE (Continental-Scale Experiment) Transferability Study (ICTS) http://w3.gkss.de/ICTS is a joint project of (1) CEOP, (2) the Water and Energy Simulation and Prediction (WESP) and (3) the GEWEX Hydrometeorology Panel (GHP) Transferability Working Group (TWG) http://rcmlab.agron.iastate.edu/twg/.

Controlled numerical simulations of regional climates are currently being conducted over areas having fundamentally different climate regimes (e.g., tropical, midlatitude, polar) focused on particular climate characteristics (e.g., monsoons, low-level jets, mesoscale convective systems). In particular, ICTS contributes continuous multiple regional simulations to the CEOP model archive and in turn uses the CEOP global analyses, in-situ, and satellite data to evaluate these regional simulations.

Presently three centers are actively contributing to the ICTS: (i) GKSS is contributing output from a climate version of the German Lokalmodell (CLM; e.g. Steppeler et al. 2003); (ii) the Experimental Climate Prediction Center (ECPC) is providing output from the Regional Spectral Model (RSM; e.g. Roads et al. 2003); and (iii) the regional modeling group at Iowa State University provides output from the Regional Climate Model (RegCM3; e.g. Takle et al. 1999).

The goal of ICTS is to understand the physical processes underpinning the global water and energy cycles through systematic intercomparisons of regional simulations of diverse climates to CEOP observations and analyses. This way the best parameterizations will be localized to simulate certain regional scale meteorological conditions, which we believe will also help to improve future global climate models.

Model Setup

For ICTS seven computation areas over the different CSEs were defined (**Figure 1**). Several aspects were considered in this process (e.g. orography at the boundaries of the simulation areas; inclusion of main typical synoptic features). One area is over the MAGS (Mackenzie GEWEX Study). The second covers GAPP (GEWEX Americas Prediction Project) and was defined by the Project for Intercomparison of Regional Climate Simulations (PIRCS; Takle et al. 1999). Another area covering both the LBA (Large-Scale Biosphere-Atmosphere Experiment in Amazonia) and the La Plata region was used for a previous South America intercomparison (e.g. Roads et al. 2003). Over Europe we chose an area that includes the BALTEX catchment, taken from the definition of the CLM area used for the European Union Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects (PRUDENCE) project (e.g. Hesselberg Christensen et al. 2005). The area over Africa covers the African Monsoon Multidisciplinary Analysis (AMMA) region. The area over Asia covers the GEWEX Asian Monsoon Experiment (GAME) region, expanded to cover the Himalayan CEOP reference site. The selection for the MDB (Murray-Darling-Basin Water Budget Project) area was based on a previous case study from the GEWEX Cloud System Study (Ryan et al. 2000).

The horizontal resolution of the regional models was initially chosen to be 50 km. The initial simulation period was from July 1999 to December 2004. Although the desired CEOP time period only covers Jul. 2001 – Dec. 2004, an additional two years were needed to ensure the land surface model in the regional models had equilibrated. Currently the National Center for Environmental Prediction (NCEP) Department of Energy (DOE) Reanalysis II is being used for the lateral boundary condition for these regional simulations. Additional simulations with higher horizontal resolution and alternative global analyses will be eventually undertaken.

First Results

Figure 2 shows the mean monthly precipitation for July and August 2001 from several reference sites. For the models and the GPCC (Global Precipitation Climatology Centre, e.g. Rudolf et al. 2003) data, the mean of the grid box containing the reference sites and its eight adjacent grid boxes are shown. The lowest variations between the five data sets occur at grid boxes surrounded by shallow orography like Cabauw, Lindenberg, BERMS, and Pantanal. Grid boxes surrounded by high orography or heterogeneous surface, like Himalayas, Ft. Peck, Rondonia, and China Sea, have larger variations. Except for Rondonia and Himalayas the CEOP observations and the GPCC data have similar precipitation amounts, which indicate that the uncertainty in the observations is probably much smaller than the model variations.

RSM simulated precipitation has mostly (77.7% cases) larger values than the observations, while CLM simulated precipitation has mostly (66.6% cases) smaller values. RegCM3 simulations have the smallest differences with respect to the measurements. At two sites the values of the RegCM3 simulated precipitation are between CEOP and GPCC measurements. At four sites the simulated values are smaller (44.4%), and at three sites they are higher (33.3%) than the observed values. At the China Sea reference site, the simulated precipitation amounts for all models are much smaller than the observed precipitation, which is an indication that 50 km resolution is too coarse for this region.

In **Figure 3** global analyses (red) and regional simulations (blue, green) are compared to CEOP and GPCC observations at the Lindenberg reference site. The precipitation amounts of the global models differ between 15 to 105 mm/month. In general, the global models have larger variations than the regional climate simulations and observations. Additional sites are currently being examined to see if this is true in general.

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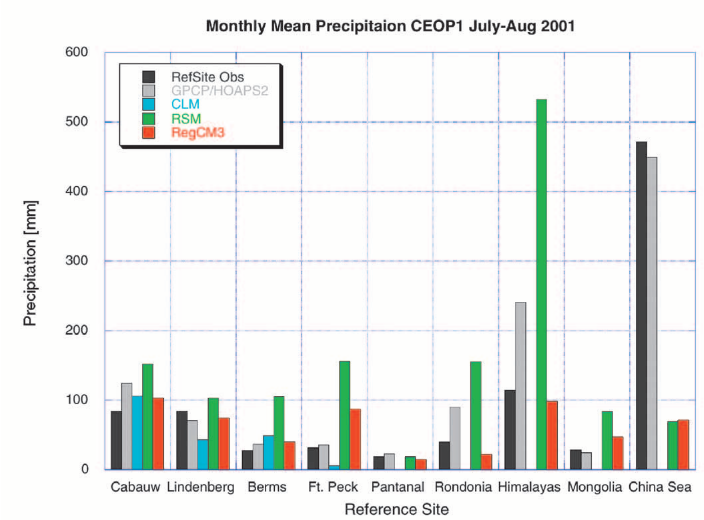

Figure 2: Monthly mean precipitation during CEOP EOP-1 (July - August 2001) at CEOP reference sites, for CEOP observations, GPCC data and simulations (CLM simulations for the GAME reference sites Himalayas, Mongolia, and China Sea have not been finished yet).

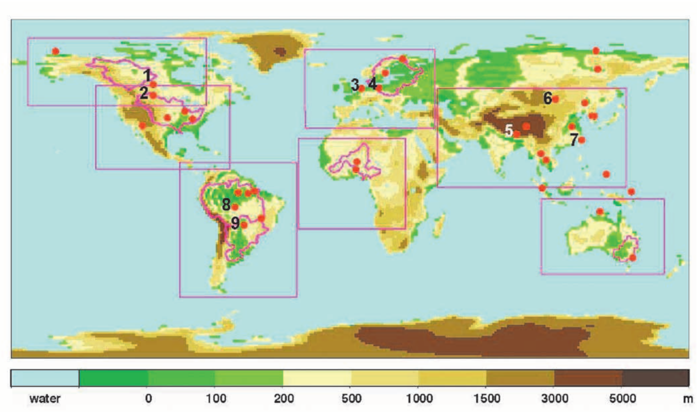

Figure 1: Model areas (magenta outlines) and reference sites (red dots: 1 BERMS, 2 Ft. Peck, 3 Lindenberg, 4 Cabauw, 5 Himalayas, 6 Mongolia, 7 China Sea, 8 Rondonia, 9 Pantanal).

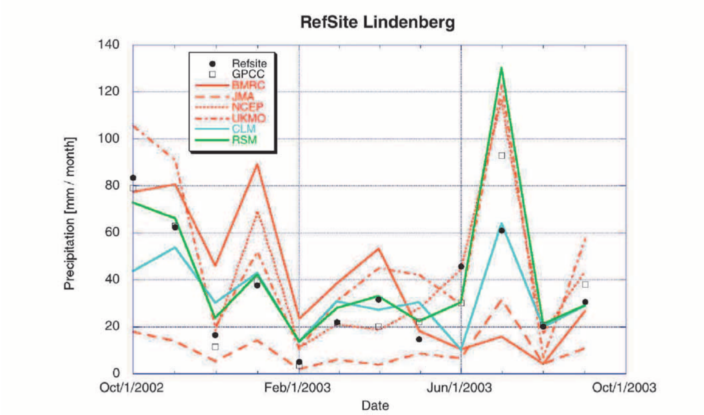

Figure 3: Monthly precipitation during EOP-3 and EOP-4 at Lindenberg / BALTEX

Characterizing Monsoon Systems using CEOP Data

William K. M. Lau, and **Kyu-Myong Kim**, Laboratory for Atmospheres, NASA/Goddard Space Flight Center

The CEOP Inter-Monsoon Study (CIMS) is one of the two main science drivers of CEOP that aims to (a) *provide better understanding of fundamental physical processes in monsoon regions around the world, and* (b) *demonstrate the synergy and utility of CEOP data in providing a pathway for model physics evaluation and improvement.* As the data collection phase for EOP-3 and EOP-4 is being completed, two full annual cycles (2003-2004) of research-quality data sets from satellites, reference sites, and model output location time series (MOLTS) have been processed and made available for data analyses and model validation studies. This article presents preliminary results of a CIMS study aimed at the characterization and intercomparison of all major monsoon systems. The reference site data provided by CEOP showed value in such exercises by being a powerful tool to cross-validate the TRMM data, and to intercompare with multi-model results in ongoing work.

Six years (1998-2003) of pentad CEOP/TRMM data with 2º x 2.5º latitude-longitude grid, subsetted to the domain of interests were used to define the monsoon climatological annual cycles for the East Asian Monsoon (EAM), the South Asian Monsoon (SAM), the West Africa Monsoon (WAM), the North America/Mexican

Monsoon (NAM), the South American Summer Monsoon (SASM) and the Australian Monsoon (AUM). As noted, the TRMM data used in the study were cross-validated using CEOP reference site data, where applicable.

Regional features

Figure 1 shows the latitude-time sections of climatological pentad rainfall from TRMM data, and from NASA NSIPP GCM simulation for EAM, and SAM respectively. Clearly seen in Fig. 1a is an abrupt northward propagation of the first summer dynamics-driven Intraseasonal Oscillation (ISO) from 10ºN to 35ºN, signaling the onsets of EAM, starting in mid-May over the South China Sea, to the *Mei-yu* [25-30ºN] in June, and the *Baiu* or *Changma* [35-40ºN] in July. A distinct break is found immediately after the first major ISO pulse, and then followed by less regular ISO along the latitude belt 10-25ºN. A weaker second pulse of ISO reaching north of 25ºN can be detected in August. The withdrawal phase occurs rather slowly compared with the onset phase. In addition, there is a well-defined pre-monsoon rainy phase in southern China [25-30ºN] in April-May. The model captures the broad features of the slow component of the annual cycle, i.e. onset and withdrawal, but is less successful in simulating the fast components. It produces excess rainfall over the tropical western Pacific [10-20ºN] from June to October (Fig. 1b).

In case of SAM (Fig. 1c), the first northward propagating ISO occurs in May, followed by another one in June. The first ISO is associated with the bifurcation of convection in the Bay of Bengal preceding the onset of the South China Sea monsoon (Lau et al. 1998), and the second one is related to the Indian monsoon onset over the west coast of India. Unlike EAM, which has a large latitudinal span, the monsoon rain of SAM is limited at the foothills of the Himalayas near 25ºN. Here, the ISO northward propagation signals are detectable, but not as well-defined as in EAM. The NSIPP model simulates relatively well the EAM evolution (Fig. 1d) but there are some discrepancies including the too far north extent of the monsoon rain; lack of definition of ISO; and excessive rainfall in the Intertropical Convergence Zone (ITCZ) in other seasons.

Similar cross-sections (Fig. 2) for WAM and NAM yield very different characteristics compared to EAM and SAM. For WAM (Fig. 2a), the monsoon rainbelt in July-August-September (JAS) appears at the tip of a bow-shaped ITCZ structure, which can be identified with the northward migration of the rainbelt from the Gulf of Guinea to the land region of the West Africa immediately to the North. While there is an indication of an abrupt shift from oceanic to land convection in early July, there are no clear signals of monsoon breaks, and ISO. These features are captured reasonably well by the NSIPP model (Fig. 2b).

For NAM, the dominant feature is the ITCZ variation associated with the Mexico monsoon, which migrates northward to 10-15ºN during JAS (Fig. 2c). The North American (NA) portion of NAM (>25-30ºN) appears barely as perturbation. A 15-20 day ISO seems to be quite prominent along the axis of the ITCZ with some limited, but ill-defined northward propagation. The NSIPP simulation of NAM is reasonable, getting the ITCZ in the right latitude and reproducing the northward bulge of the Mexican monsoon. However, an insufficient signal of the NA contribution (Fig. 2d) and a discrepancy in the ISO pulse clearly indicate that the NA portion of NAM is not well resolved by the coarse resolution of the model.

Figure 3a shows that SASM is governed by two major convective systems: over the land and over the ocean. The land-driven component becomes active in November near 10-15ºS, and splits into a northward and a southward propagating branch. The southern branch consists of land convection, which penetrates to the extratropics up to the La Plata Basin (25-30ºS). The northern branch merges with the Atlantic ITCZ and rainfall over northeastern Brazil in March-April. ISO also appears in SASM but is rather intermittent compared to EAM. Although there is not a major break over the land during NDJ, rainfall lulls are present. The NSIPP model captures the main features comparatively well but the simulated ITCZ portion appears to be more connected to the oceanic component throughout the year, but not as much to the land convection as the observed (Fig. 3b).

Similar to SASM, AUM (Fig. 3c) shows strong control by an ITCZ anchored to the maritime continent of Indonesia and Papua New Guinea, and a land-driven rain system over northern Australia in DJF. The ITCZ is active from November through May. The ISO signals propagating southward from the ITCZ to northern Australia are clearly visible in DJF. The model simulates the land-locked ITCZ rainfall quite well and to a lesser degree the southward propagating ISOs, but underestimates the monsoon rainfall over northern Australia (Fig. 3d).

Inter-monsoon comparisons

The above analyses show that common to all the monsoon systems is the presence of oceanic-driven ITCZ-type convection in the deep tropics (10ºS-10ºN), and convective systems outside the tropics. The latter includes subtropical and extratropical atmospheric and land, as well as oceanic influences outside the tropics, stemming from the presence of the Continental Land Mass (CLM) outside the deep tropics. The monsoon characteristics appear to be dependent on the degree by which the system is controlled by the ITCZ vs. the CLM processes. While the former tends to confine the monsoon system within the deep tropics, the latter inclines to draw it away from the tropics.

To quantify the relative strengths of these two controls, we define the ITCZ convection as the seasonal mean rainfall between the zone from equator to 10º N or S, and the CLM convection as that between 10-35º N or S, on the same hemisphere as the monsoon system in question. Figure 4 shows a scattered plot for all six monsoon systems as a function of the ITCZ and CLM strength. For comparison, data points for two pure ITCZ systems over the central Pacific and the central Atlantic are also plotted. We also define a continentality index Ω, as the ratio of the CLM to the ITCZ rainfall.

The grouping with respect to Ω is indicated by the regression lines. Here, it is evident that SAM and EAM belong to a group that have strong control from both CLM and ITCZ processes, but with slightly stronger contribution from the former, with Ω=1.34, and 1.16 respectively. This is mostly likely associated with the large Asian continent situated to the north of both monsoons, drawing the monsoon towards the continent. Interestingly the American monsoons, i.e. SASM and NAM have similar values of Ω =0.78 and 0.87 respectively, indicating slightly stronger ITCZ compared to CLM control. Here, the similarity may be connected to the relative controls of low level jet produced by N-S oriented steep orography in the Altiplano vs. Atlantic ITCZ for SASM, and the Sierra Madre Occidental vs. eastern Pacific ITCZ for NAM. Compared to the others, WAM (Ω=0.4) and AUM (Ω=0.53) have the least continentality. The similarity of the relative control of these two monsoons may be related to the presence of the desert regions poleward of the monsoon region, i.e. the great Sahara desert north of WAM, and the Australian deserts south of AUM. These deserts are overlain by low level anticyclonic flow with strong large scale subsidence, which tend to inhibit the poleward extension of the monsoon. It should be stressed that a low continental index does not necessarily imply a lack of continental influence, but expresses the fact that the monsoon has a limited meridional continental reach (e.g. Xie 2005).

It is obvious that there is much to be learned regarding individual monsoons and the monsoon systems as a whole from inter-monsoon and intercomparison studies as proposed by CIMS. Further studies are called for and CEOP data will be extremely useful to validate new findings, thereby, making the results as reliable as possible.

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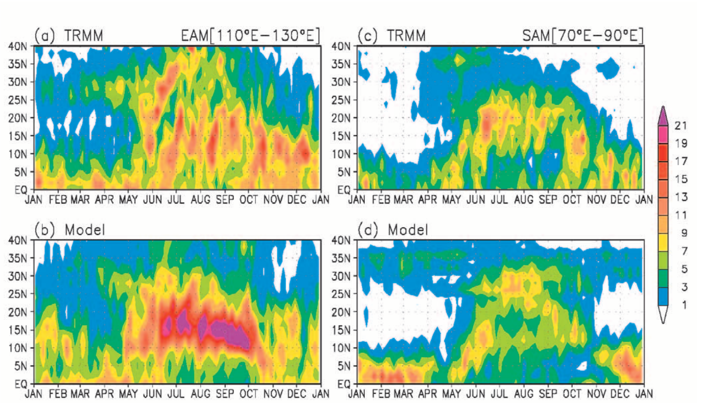

Figure 1 Time-latitude cross-sections from pentad rainfall data for EAM [110ºE-130ºE]: (a) TRMM and (b) NSIPP GCM, and for SAM [70ºE-90ºE]: (c) TRMM and (d) NSIPP. Units are in mm/day.

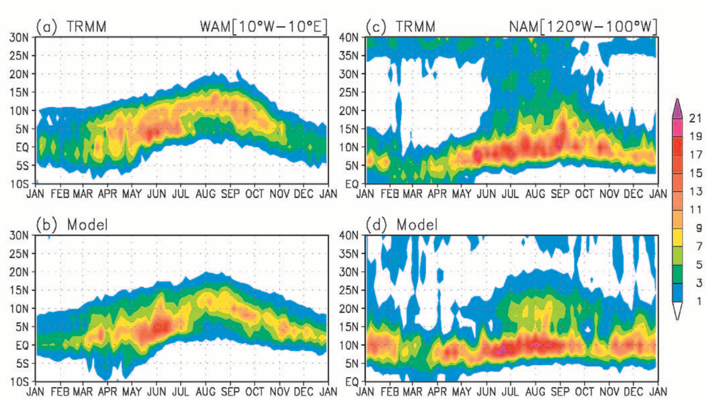

Figure 2 Time-latitude cross-section from pentad rainfall data for WAM [10ºW-10ºE]: (a) TRMM and (b) NSIPP GCM, and for NAM [120ºW-100ºW]: (a) TRMM and (b) NSIPP GCM. Units are in mm/day

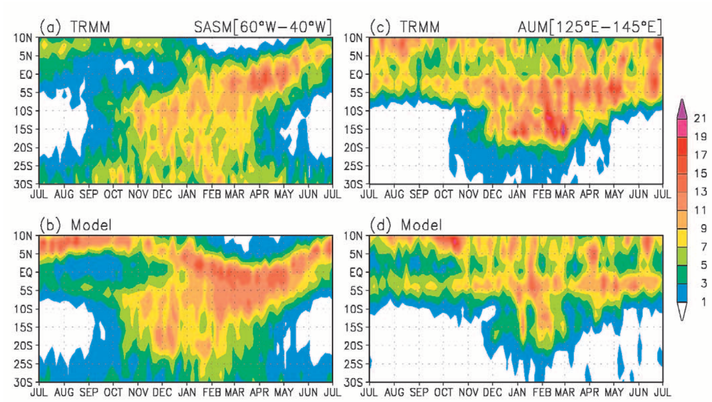

Figure 3 Time-latitude cross-section from pentad rainfall data for SASM [60ºW-40ºW]: (a) TRMM and (b) NSIPP GCM, and for AUM [125ºW-145ºW]: (a) TRMM and (b) NSIPP GCM. Units are in mm/day.

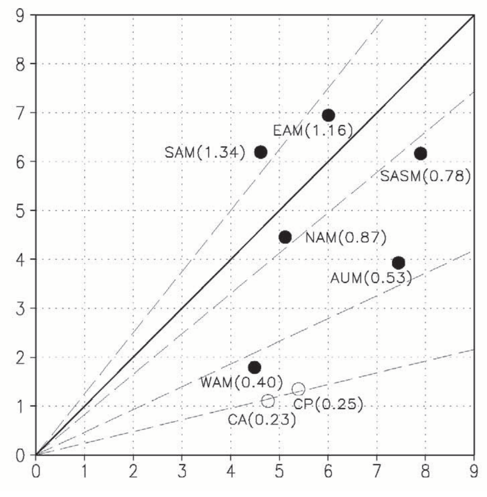

Figure 4 Scattered plot showing the strength rainfall intensity associated with ITCZ-type control on the abscissa and CLM-control on the ordinate, of all six major monsoon systems (solid circles). For comparison, the data points for the same-size domains over the central Pacific (CP) and the central Atlantic (CA) are also shown (open circles). Units are in mm/day. The continentality index (Ω) is shown in parenthesis.

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Satellite and Data Integration Tools Development and Application

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Standardization Framework for CEOP Metadata Development and Application,
R. Xie, R. Shibasaki

A Basic Study on a New Satellite Algorithm for Snow,
H. Tsutsui, T. Koike, T. Graf, K. Tamagawa, H. Fujii

A 2-D Process Study Through The Development of A Satellite Data Assimilation By A Land-Atmosphere Coupled System,
S. Boussetta, T. Koike, M. Pathmathevan, K. Yang

Integrated Snow Observation During the Cold Land Processes Field Experiment and its Application for the Development of Radiative Transfer Model for Snow,
T. Graf, T. Koike, H. Fujii, R. Armstrong, M. J. Brodzik, M. Tedesco, E. J. Kim

Globally Distributed Evapotranspiration using Remote Sensing and CEOP Data,
E. F. Wood, M. F. McCabe, H. Su, K. Tu

The Development of a 1-D Cloud Microphysics Data Assimilation System (CMDAS) by using AMSR-E Data,
M. Cyrus Raza, T. Koike, K. Yang, T. Graf

Production of CEOP Satellite Dataset by JAXA,
K. Umezawa, T. Mutoh, M. Miyake

Development of a Visual Data Mining Application for Earth Environmental Data,
E. Ikoma, K. Taniguchi, T. Koike, M. Kitsuregawa

CEOP Data Server and Browse/Analysis Interface,
T. Nemoto, M. Kitsuregawa

CEOP Data Archive Distributed Data Mining System,
B. Burford, O. Ochiai, T. Koike, I. Hasegawa

WTF-CEOP Satellite Integration for Global Water Cycle,
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Global Land Data Assimilation System (GLDAS) and Land Information System (LIS) MOLTS Analyses of CEOP-EOP1,
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Land Surface in Numerical Weather Prediction Models: Surface and Atmospheric Evaluation,
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Implementation of Coupled Skin Temperature Analysis and Bias Correction in a Global Atmospheric Data Assimilation System,
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Evaluation of a New Land Surface Model for JMA-GSM- using CEOP EOP-3 Reference Site Dataset,
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Land Surface Processes Simulated in the NCEP Global Model: A Comparative Study using the CEOP Reference Site Observations,
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Hydrological Improvement of the Land Surface Process Scheme using the CEOP Observation,
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The Water Cycle of North American Basins and Related Land Surface-Atmosphere Interactions in the Regional Reanalysis Data,
Y. Luo, E. H. Berbery, K. E. Mitchell

Inter-CSE Transferability Study (ICTS),
B. Rockel, J. Roads, I. Meinke, W. J. Gutowski Jr., R. W. Arritt, E. S. Takle

Global Evaluation of the RSM Simulated Energy and Water Budgets through Transferability Studies during CEOP,
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Study on Energy and Water Cycle over the Central Tibetan Plateau Area,
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Land-Atmosphere Interactions on the Tibetan Plateau: From Turbulence to Monsoon,
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The Role of Vegetation Roots in Controlling Surface Soil State and Energy Partition,
K. Yang, T. Koike, B. Ye, L. Bastidas

CEOP Monsoon Systems Studies Milestones and Accomplishments

CEOP Inter-Monsoon Studies (CIMS),
W. Lau, J. Matsumoto, R. Mechoso, J. Marengo, H. Berbery, M. Bollasina, T. Yasunari, Y. K. Xue, T. Satomura, P. Glecker, Y. Wang, J. Potter, B. K. Basu, B. Burton

A Regional Atmospheric Inter-Model Evaluation Project (RAIMEP) with the Focus on Sub-daily Variation of Clouds and Precipitation,
Y. Wang

Orography and Monsoons: Winter Snow-storms over the Himalayas,
M. Bollasina, L. Bertolani

Cloud Convection and Atmospheric Temperature Rising over the Eastern Part of the Tibetan Plateau in Pre-monsoon season,
K. Taniguchi, T. Koike

Features of Indian Summer Monsoon 2004,
B. K. Basu, G. Iyengar

Numerical Experiments on the Diurnal Variation of Precipitation in the Northeastern Bangladesh,
A. Kataoka, T. Satomura

Inter-comparisons of Seasonal Changes between East Asian and South American Monsoons,
J. Matsumoto, H. Takahara

Regional Circulations and the Diurnal Cycle of the American Monsoons,
E. H. Berbery, D. Gutzler, D. Gochis

La Plata Basin: CLIVAR/GEWEX CSE,
R.Mechoso

Calendar of CEOP Meetings:

- **The 5th CEOP Implementation Planning Meeting** and the **2nd IGWCO Workshop** will be held jointly with the support of the WCRP/COPES Support Unit:
  Paris, France 26 February – 3 March 2006

Brief timeline:

Sunday 26 February:	CEOP working group chairs meeting
Monday 27 – Tuesday 28 February:	CEOP sessions
Wednesday 1 March:	CEOP and IGWCO joint session
Thursday 2 – Friday 3 March:	IGWCO sessions

Contact Address of International Coordination Body:

Sam BENEDICT (International Coordinator)
742 “H” Avenue
Coronado, CA, 92118, USA
Phone: +1-619-437-7904
Fax: +1-619-437-6814
E-mail: sam.benedict@gewex.org

Petra KOUDELOVA, Akiko GODA
Department of Civil Engineering, The University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan
Phone: +81-3-5841-6132
Fax: +81-3-5841-6130
E-mail: ceop@monsoon.t.u-tokyo.ac.jp

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