CEOP Panel Report to the 2010 GEWEX SSG Meeting

Full Name (Acronym): Coordinated Energy and water-cycle Observations Project (CEOP)

Reporting Period: 2009

URL: *http://www.ceop.net*

Chair(s) and term dates: Co-Chairs Drs. Toshio Koike and Ron Stewart. Two year terms beginning in 2007 renewable for additional two years and set to coincide with the endorsement of the GEWEX SSG at its annual meeting. At its January 2010 meeting, the SSG will be asked to endorse the nomination of Dr. Dennis Lettenmaier as a new CEOP Co-Chair to take the place of Dr. Ron Stewart who is stepping down.

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Overview

Objectives:

CEOP's goal is to understand and predict continental to local-scale hydroclimates for hydrologic applications. CEOP's strategic objectives, which are parallel with GEWEX objectives, include:

1. Producing consistent research-quality data sets complete with error descriptions of the Earth's energy budget and water cycle and their variability and trends on interannual to decadal time scales, for use in climate system analysis and model development and evaluation
2. Enhancing the understanding of and quantification of how energy and water cycle processes contribute to climate feedbacks
3. Improving the predictive capability for key water and energy cycle variables and feedbacks through improved parameterizations to better represent hydrometeorological processes, and determine the geographical and seasonal characteristics of their predictability over land areas
4. Undertaking joint activities with operational hydrometeorological services' hydrological research programs to demonstrate the value of GEWEX research, data sets and tools for assessing the consequences of climate predictions and global change for water resources

Some technical issues that are being addressed as part of the CEOP objectives are:

- Applying an integrated hydroclimate data set to address a variety of scientific topics, which must be advanced in order for the Project to meet its objectives
- Developing the capability to handle and disseminate a large amount of data from diverse sources

- Analyzing and comparing this diverse data with model simulations to understand the underlying mechanisms and model deficiencies
- Assimilating and integrating the data with newly developed models
- Transferring CEOP methodologies to other regions, sectors and applications

Status

Past year activities (status, significant changes, accomplishments):

A "Multimodel Analysis for CEOP" was published by M. Bosilovich, et al., in the August 2009 issue (Vol. 10) of the *Journal of Hydrology*.

The CEOP Cold Regions Study and several Regional Hydroclimate Projects (RHPs) are now coordinating activities with the WCRP Climate and Cryosphere (CliC) Project. The process of integrating data from CEOP cold region sites has begun. The characteristics of the cold regions data archive and data set have been defined to include snow cover/frozen ground from Asian regions that can be compared with CEOP sites.

The CEOP Water and Energy Budget Studies (WEBS) have been expanded to understand average conditions during the entire CEOP period, including the influence of aerosols and a study of water isotopes.

The CEOP Reference Site Data Management Internet page at: http://www.joss.ucar.edu/ghp/ceopdm/ was newly re-organized. The reference site characteristics have been cataloged on that page along with all of the information about the entire CEOP in-situ database. The data collection has been an on-going process and it is the role of the NCAR EOL as the CEOP Central Data Archive (CDA) to maintain the status of the contributions from the CEOP reference sites.

CEOP modelling studies now include explicit global, regional, land surface and Hydrologic Applications Project (HAP) efforts and have begun researching international models related to the CEOP reference sites.

A CEOP Model Output Management Document was drafted as a guide for the participating centers to use in setting up their processes for meeting their commitments to CEOP.

In order to better utilize available CEOP data sets for bridging the gap between the global and regional aspects of CEOP research, opportunities are being explored to integrate these efforts with other planned or ongoing initiatives in the broader climate research community, such as the WCRP-initiated COordinated Regional climate Downscaling EXperiment (CORDEX) effort.

A CEOP satellite data set has been populated with data from instruments flown on Japan Aerospace Exploration Agency, European Space Agency and National Aeronautics and Space Administration spacecraft. Tools for handling historical data were provided by the National Oceanic and Atmospheric Administration.

CEOP Satellite data were geo-coded (i.e. re-sampled to a regular lat/long grid) and provided at three scales, 250 km rectangular, monsoon regional and global scales. These data were also made of an image element and a metadata component that is compliant with the ISO-19115 standard.

The CEOP Satellite Gateway was established at the following Internet page: http://monsoon.t.u-tokyo.ac.jp/ceop2/satellite/. A contribution by JAXA in coordination with the University of Tokyo has been established that applies to an ongoing effort to provide CEOP satellite datasets for integration with the CEOP in-situ and model output data.

New directions

Longer term vision:

Many of the former GEWEX Continental Experiments (CSEs) have evolved to more complete Regional Hydroclimate Projects and even beyond in that more than GEWEX efforts are now needed to solve regional problems involving a climate prediction focus (CLIVAR) and a biological/environmental focus. Many now have an anthropogenic climate focus as well that CEOP will continue to encourage.

This development has prompted CEOP to begin investigating how to best enhance integration of data from in situ, satellite and model sources. In the same way, but on the broader international scale, CEOP is committed to investigating outreach initiatives with other Earth System Science Partnership elements such as the Group on Earth Observations GEO.

In addition to the RHPs, CEOP now includes groups focused on regional studies in cold regions, high elevation, monsoon and semi-arid regions. These groups are associated with the CEOP Monsoons Regional Study, which is working in concert with the Pan-WCRP Monsoon crosscut. CEOP will exploit this range of topics in unique ways that match the strengths and weakness of each community.

The science of CEOP will continue to provide a traditional focus on Water and Energy budgets, which will extend the efforts to understand average conditions to conditions during the time period of 2002 to present. This extension will have a special focus on extremes during the same period, which will be another connection to WCRP crosscut activities. New crosscutting CEOP science efforts include a study of the influence of aerosols and the study of water isotopes, which is also connected to efforts in other international research communities.

CEOP has added explicit global, regional, land surface and hydrologic applications as part of its group activities, including a specific Hydrologic Applications Project (HAP) that is cooperating with other similar efforts such as the Hydrologic Ensemble Prediction Experiment (HEPEX).

All of the CEOP modelling groups are looking at an ensemble of international models in many different regions focused on the new CEOP reference sites. Some of these modelling projects expect to show not only their capability to simulate the present climate but also to predict at seasonal (HAP) scales and also be useful for global change assessments in some of the RHPs.

By 2012, a functioning CEOP data center will be in use by all of the CEOP science groups. It should be noted that this CEOP data is already open to outside groups. CEOP data management is also in the process of developing links to a number of associated groups, such as the Global Runoff Data Centre and Global Precipitation Climatology Centre.

Future

2010 activities:

The main actions/recommendations for 2010 that were formulated at the CEOP Third Annual Meeting at Melbourne, Australia, during the period 19-21 August 2009, included:

The Data Management Working Group will submit a proposal with an implementation scheme and schedule for defining and organizing a CEOP 10 year data set. This action is to take the data periods associated with the Coordinated Enhanced Observing Period and to meld them with the expanded data requirements of the “new” CEOP as a means of integrating the overall CEOP data requirements with the available CEOP data resources.

Develop a concise summary of CEOP activities especially covering the work that has taken place since the successful integration of the RHPs to be submitted to the Bulletin of the American Meteorological Society (BAMS). A draft of the initial CEOP Synthesis Document will be ready by the end of March 2010, with submission set for later in 2010.

Ensure further integration of the CEOP Hydrological Applications Project (HAP) with other synergistic parts of the CEOP science community. This activity has been selected as a high priority effort for 2010. A number of action items are currently being worked including ways to ensure this effort will address both seasonal forecasting, mainly drought, in cooperation with Hydrological-Atmospheric Pilot Experiment

(HAPEX) and flood prediction and climate change impact analyses in cooperation with the Global Earth Observation System of Systems (GEOSS)/Asian Water Cycle Initiative (AWCI).

CEOP Land Modeling activities will be given “Fast Track” status during 2010. Moving this work up in priority will allow the HAP Task Team to advance the common goal of generating physically coherent fields of land surface states and fluxes through the integration of disparate data products. The Land Modeling effort will avail itself of available datasets such as those at NASA/GSFC (http://disc.gsfc.nasa.gov/hydrology/) and Princeton (http://hydrology.princeton.edu/data.pgf.php) that have been identified as relevant and will seek opportunities to integrate its work with that being undertaken as part of the planning for the third Global Soil Wetness Project (GSWP-3) and with work underway as part of the GEWEX Global Land Atmosphere System Study (GLASS) and the LandFlux activity that has been launched recently by the GEWEX Radiation Panel (GRP), in collaboration with GLASS. LandFlux wants to develop the needed capabilities and to produce a global, multi-decadal surface turbulent flux data product, which is consistent with the goals proposed for the CEOP Land Modelling Task Group.

CEOP will advance existing collaboration between CEOP Cold Regions and High Elevation Studies in 2010. Existing collaboration between the CEOP Cold Regions Study (CRS) and the CEOP High Elevations Study (HE) will be better organized and more formally established. International conference calls designed to further the existing dialog between these groups related to work on these specific topics will continue in 2010. The CEOP International Coordination function has the action to work with the CRS and HE Lead persons (O’Hata and Tartari) to initiate more regular interactions and communications between these existing groups to improve their collaboration and show additional results in a number of areas where there are already existing interactions, including:

- The convergence of observations and data integration from CEOP Cold Regions and HE reference sites,
- Long-term variation of snow distribution in northern regions and Its Impact on atmospheric circulation,
- Water and energy budgets (WEBs) in cold regions and
- High mountain hydrology, including glaciers.

CEOP will ensure that Global to Regional Scale Analysis will be given priority in 2010 in order to better utilize available CEOP datasets for the purpose of addressing the matter of bridging the gap between the global and regional aspects of CEOP research. The BALTEX RHP, the Tibet region of MAHASRI and parts of the AMMA RHP are the initial candidate regions to be included in this work. Key individuals from the CEOP Cross Cutting Study area and the CEOP Model Output Working Group who are doing work at both the Global and Regional scales will make use of datasets that have already been produced under CEOP-initiated studies in each case. These would include:

- Model Analyses for CEOP (MAC) subset products for CEOP RHPs,
- CEOP Inter-Continental Transferability Study (ICTS) co-analysis products and
- CEOP Stable Water Isotope Intercomparison Group (SWING) subset products for RHPs.

CEOP will take on the formulation of “adaptation” as a main theme. Although it is agreed that the broadest aspects of Anthropogenic Climate Change (ACC) are not consistent with the current CEOP Strategic Implementation Plan they are not wholly outside the scope of the work CEOP has been involved in on a day to day basis. It has, therefore, been agreed that CEOP would embrace some of the main tenets of ACC and would look into ways of contributing to those in direct fashion. Some ideas related to this consensus were:

- Identifying regional to local Impacts of ACC on the hydroclimate in RHP basins,
- Quantifying uncertainty by using CEOP data infrastructure,
- Testing models and ACC scenarios by applying WEBS analysis techniques and
- Exploiting CEOP/RHP connections to local/basin scale model Centers to assist in ACC work.

CEOP expects to make progress toward its first objective to produce consistent research quality data sets. To provide the framework in which this progress can be made, CEOP has identified the following three specific technical issues:

- Development of an integrated hydroclimate data set that can be used to answer the CEOP main scientific questions

- Development of the capability to handle and disseminate a large amount of data from diverse sources
- Analysis and comparison of a diverse but “standardized” dataset with model simulations to understand the underlying mechanisms and model deficiencies

These technical issues will drive work in the coming year in the context of the CEOP interoperability scheme for achieving its scientific objectives through organization, handling and analysis of its specialized research datasets.

One of the key activities of CEOP going forward is to establish an integrated observation system by combining different types of observations, in situ and satellite. In addition, the numerical weather prediction model outputs are merged with the observed data to provide spatially and temporally continuous coverage in a complementary way.

Key agreements will be pursued to obtain in situ data from 52 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), atmospheric profiles (rawinsonde and profiler) and ancillary data sets (radar, special observations).

Almost all components of the water cycle among atmosphere, land and ocean can be observed by currently available satellite sensors. The CEOP satellite data set, which consists of the main water cycle parameters, will be exploited to accomplish CEOP’s own scientific goals.

The nine operational and one experimental NWP centers and two data assimilation centers that archive specific model output data for CEOP will continue to be coordinated and the data archived for application in the follow-on to both the Multimodel Analysis for CEOP and the CEOP Inter-Continental Transferability Study (ICTS).

Other Global Data Centers have sought collaboration with CEOP. The GRDC and the GPCC have had long-term affiliation with GEWEX and this synergistic affiliation will be continued through CEOP in the future. At the core of the collaboration between CEOP and these Centers is their potential contribution to CEOP studies through provision of quality controlled datasets that the CEOP database would not otherwise have available.

To make maximum use of the multi-temporal, spatial scale and multi-source data sets covering global climate diversity, CEOP has established a global interoperability arrangement. This agreement which covers the in situ, satellite and model output from all contributing groups will be made more efficient in the coming year to ensure that there will be a consistent long term source of quality data products required by CEOP’s expanded science agenda.

The work associated with satellite data set development, integration and dissemination will continue to evolve as planned.

Key results

Cold Region Study: The process of integrating data from CEOP cold region sites has begun. The characteristics of the cold regions data archive and data set have been defined to include snow cover/frozen ground from Asian regions that can be compared with CEOP sites. Information, data and analysis within the activities of the glacier group of Asia-CliC and CliC are being gathered and formatted for application toward meeting the goals of the CEOP Cold Regions study.

Work is progressing with good success for CEOP to produce a well-calibrated solid precipitation dataset in cooperation with CliC. The effort will continue using CEOP northern latitude reference site data with data from CliC sites. BALTEX is playing an important role in this effort by contributing relevant data and improved understanding of how to more accurately determine snow amount and type from radar data.

High Elevation Study (HE): CEOP-CRS, CEOP-WEBS, CEOP-Extremes, CEOP-Model, MAHASRI, NEESPI and GMPP-GLASS, CliC and GWSP have begun cooperating to contribute to the understanding

of water and energy cycles in high elevation regions and study their role within the climate system by means of globally integrated analysis of CEOP reference sites data, remote sensing observations and models analysis and application.

Monsoons: CEOP has evolved components to integrate observations based on coordination among field science groups, space agencies and Numerical Weather Prediction (NWP) centers in the local, regional and global scales to assist in advancing the CEOP Monsoon Study (MONS) effort. This initiative now includes multiple observation and science activities within the fields of hydrometeorology and hydroclimatology. Elements of GEWEX, WCRP and ESSP initiatives including CEOP-Aerosols, CEOP-WEBS, CEOP-Extremes, CEOP-Model, MAHASRI, LBA, LPB, AMMA, GMPP, and GRP; CLIVAR; and GWSP and MAIRS are being urged to contribute to the Monsoon Studies in CEOP.

Semi-Arid Region Study: As a result of a CEOP inspired International Workshop on Semi-arid Land Surface-Atmosphere, four task groups have been formed and are working on the following issues in the context of the CEOP SRS study framework:

- Observation standards and data quality control,
- Application of remote sensing information,
- Intercomparison of land surface models and
- Feedback mechanism between aerosol-cloud-precipitation.

Water and Energy Budget Study: The microwave land data assimilation system developed by the University of Tokyo was evaluated with the Mongolian soil moisture network. Soil moisture and soil porosity estimated by this system were comparable with observations. With respect to the application of CEOP satellite data, a satellite data algorithm was developed to utilize high-resolution Landsat-7 ETM and ASTER to estimate surface energy budget on Tibet for clear-sky conditions. The estimates agree with in situ observations, and all their absolute percent difference is less than 10%.

The diurnal cycle of water and energy (both surface and integrated column) was compared over the continental United States from three analyses, showing consistent phases despite varying amplitude. Two evaluations are conducted, respectively, for dominant balances and exchanges of the atmospheric water cycle in the NCEP/DOE Reanalysis-2 and the temporal variability of the water cycle's sensitivity to pairings of land-surface schemes and convective parameterizations.

A recent key result in the CEOP WEBS crosscutting science foci was that the University of Maryland developed a high-resolution shortwave radiation product. This product is proved superior to GEWEX-SRB and ISCCP-FD for the Tibet region.

Extremes Working Group: Since this effort officially began in 2007, significant steps have been taken. These include maintaining a listing of extremes-related activities within CEOP, arranging a workshop to address common and unique issues, organizing special sessions at annual CEOP meetings to address these issues and developing specific activities to move the effort ahead. In this regard a number of specific steps are currently underway, including:

- Assessing existing extreme event catalogues and incorporate this into the Extremes information base,
- Producing a high resolution dataset on global precipitation,
- Pulling together at least one comprehensive, continental-scale dataset on multi-year drought and
- Prepare a review article on extremes.

Aerosols Working Group: Major recent activities for the CEOP Aerosol Study included AMY/JAMEX. Through this work the CEOP Aerosol Element has been able to provide an opportunity to attract other resources to conduct joint aerosol-monsoon research. The 6th Workshop of Asian Monsoon Years, which was held 30 November to 1 December 2009 in Kunming, China, was supported by CEOP. The data collected in earlier field observations initiatives is now part of the AMY 2007-2012 and CEOP data archive. Collaborations have been developed with groups that will allow assessment of the direct and indirect radiative forcing and water cycle feedback processes.

Isotopes Working Group: The Isotope Cross Cut Study (ICCS) contributes to CEOP by facilitating isotope studies, which augment and enhance the predominant non-isotope studies within GEWEX/CEOP. The ICCS includes a modeling research group called Stable Water Isotope Working Group (SWING;

http://atoc.colorado.edu/~dcn/SWING). The SWING has been using water isotope information to understand water cycle processes and to quantify their role in climate and climate feedbacks. Since the first SWING, several new isotope implementations in climate models have emerged (currently nine or more operational models). Nudging techniques (*c.f.* Yoshimura et al., 2008) have been introduced that allow direct comparisons between the simulations and the GNIP database.

Global Model Working Group: The global modelling effort within CEOP has been providing global analyses and forecasts supporting CEOP science goals, including MOLTS for local process studies. It has also been evaluating the uncertainty of models and analyses with the intent of having the science activities provide feedback into understanding the global NWP systems. Most recently this effort has achieved a number of accomplishments, not the least of which has been achieved through the MAC initiative including the finding that MAC Ensemble data compare well to Global P (GPCP), Global OLR and Basin scale precipitation.

Regional Model Working Group: CEOP Inter-Continental Transferability Study (ICTS) Phase 1 finished in 2009. Six regional climate models (RCMs) from different institutions participated in the ICTS Phase 1 experiment. Continuous simulations for the time period 2000-2004 were performed for seven domains on the globe. These domains were chosen to reflect the CEOP RHPs. The time period covers the CEOP coordinated enhanced observation period 2002-2004 which gives the opportunity to compare model results with observations collected within CEOP. Model results from ICTS can be used within the CEOP regional and crosscutting studies. This work has provided a basic data set that can be used in studies on extreme events like floods and droughts that are of great importance.

Regional Hydroclimate Projects: The regional studies associated with GEWEX/CEOP are major regional studies that have already been tasked by the GEWEX SSG with satisfying a number of scientific and technical criteria that can only be established by large projects involving a multitude of investigators. The CEOP focus on regional basins and climatically sensitive regions of the world encourages researchers to study these areas, understand their regional hydrological and radiation budgets, and ensure that these are well represented in global climate system models.

AMMA (http://amma-international.org/)**:** The AMMA Third International Conference was held in Ouagadougou, Burkina Faso, on 20-24 July 2009. The AMMA data page is on the Internet at: http://database.amma-international.org/home.jsf. A new point of contact has been provided to CEOP for discussions on data sharing and research priorities. Dr. Thierry Lebel is now the main contact point for AMMA.

The AMMA policy to communicate and report to the various international programs and bodies was revised in October 2009. AMMA is currently preparing the science plan for its second phase (2010-2020). The plan is to forward that document to CEOP for comments, in the hope that fruitful collaborations with AMMA will continue to contribute to CEOP.

BALTEX (http://www.baltex-research.eu/): Recent technical findings from BALTEX reported at the CEOP Third Annual meeting include:

- Kjellström and Lind, 2009: Changes in the water budget in the BALTEX area in future warmer climates as simulated in a regional climate model, BER 14 (1).

- The regional climate model RCA3 has been used to downscale results from two general circulation models, with three different emissions scenarios, for the years 1961–2100.

- The future climate change signal shows a gradually warmer and wetter climate during the 21st century with increased moisture transport into the region via the atmosphere. This leads to an intensification of the hydrological cycle with more precipitation and evaporation, except for the summer.

- The net precipitation increases in all scenarios in the entire region. The changes are of the order 15%–20% for annual and areal mean fluxes.

- The control climate in the late 20th century is too wet as compared with observations. This wet bias in the simulations is partly attributable to biases in the global forcing models but is also amplified in the regional climate model.

CPPA (http://www.climate.noaa.gov/cpo_pa/cppa/)**:** CPPA moved ahead on a number of initiatives, one of which was a core modelling project undertaken in concert with NCEP, outlined below.

CPPA NCEP Core Project: 2009

Coupled Climate Modelling

- Completed summer and winter seasonal forecasts (25 different years during 1979-2006) using the NCEP Climate Forecast System (CFS).
- Upgrading from previous generation *OSU* to advanced *Noah* land-model physics necessary in both Global Land Data Assimilation System (GLDAS) and in CFS for consistent and proper spin-up of land-state initial conditions.
- Modest gain in CFS precipitation skill during summertime over US for ENSO-neutral (vs. ENSO-active) years.

Uncoupled Land Modelling

- Completed 30-year (1979-2008) retrospective for North American Land Data Assimilation System (NLDAS) land models (Noah, VIC, Mosaic and SAC).
- Quasi-realtime monitoring of model hydrological land-states (soil moisture, evaporation, runoff, streamflow, etc).
- Routine execution of Princeton University CFS-forecast-based national (US) seasonal hydrological forecasts.
- Monitoring and seasonal forecasts used in drought support (National Integrated Drought Information System, NIDIS).

LBA (http://daac.ornl.gov/LBA/lba.html)**:** LBA focused a great deal of time and resources in 2009 on improving on their commitment to provide CEOP with specialized datasets. The main accomplishments in this respect include:

- Manaus Surface Meteorology and Radiation submitted on July 2009.
- Manaus Soil Temperature and Moisture submitted on August 2009.
- Manaus Flux data submitted on August 2009.
- Processes and procedures now in place allow us to start delivering data at a much faster pace than before!

LPB (http://www.eol.ucar.edu/projects/lpb)**:** Progress in 2009 was focused on three specific activities underway within the LPB framework:

- A Europe-South America Network for Climate Change Assessment and Impact (CLARIS)
- IAI/LPB Ecosystems, Biodiversity, Land Use and Cover, and Water Resources
- NASA/LPB Remote Sensing/Data assimilation - Capacity Building

MAHASRI (http://mahasri.cr.chiba-u.ac.jp/; http://www.wcrp-amy.org/)**:** An important part of the progress with MAHASRI in 2009 was further cooperation with the Asia Monsoon Years (AMY) initiative:

- Coordination with AMY has been going well. New coordination with YOTC has started.
- AMY-IOP (2008-2009) has been successfully conducting.
- MAHASRI has come into a new epoch, starting two new projects in Thailand and Indonesia by JICA/JST fund.
- Interactions among diurnal variations, ISO, monsoon
- Warming processes, data assimilation over the Tibetan Plateau
- Long-term data rescue in SE Asia

MDB: Progress in 2009 was summarized at a workshop that was held in Sydney on 6-7 April 2009 that involved research groups working on the hydrology, meteorology and climate of the Murray-Darling Basin (MDB). The workshop web page is online at: http://web.maths.unsw.edu.au/~jasone/mdb_rhp/workshop09/aims.html. Many of the action items from the workshop were activities for the newly forming Bureau of Meteorology Water Division to perform. The division is up and running, and progress is being made. They are actively developing the Australian Water

Resources Information System (AWRIS), which is expected to be operational by the end of 2009. This system addresses a number of the action items focused on data collection, quality control and dissemination. Another development has been the formation of the Water Information Research and Development Alliance (WIRADA), which in collaboration with the Centre for Australian Weather and Climate Research (CAWCR) is addressing a few more action items including a comparison of evapotranspiration estimation methods and the potential for real-time rainfall predictions. The Terrestrial Ecosystem Research Network (TERN), which recently gained funding, will address other action items including supporting the monitoring of fluxes through the Australian flux network and observational super-sites within the MDB.

NEESPI (http://neespi.org)**:** More than 560 scientists from over 200 institutions of 30 countries are working on more than 130 individual funded projects under the Initiative umbrella (with annual budget of ~$15M), and several more projects are in the process of joining NEESPI. Additionally, NEESPI receives in-kind assistance from the EU, US, Russian, Chinese, Japanese, Ukrainian and International Agencies and Institutions. Two studies that were reported on at the CEOP Third Annual meeting in August 2009 were:

- Observed sea ice retreat associated with more atmospheric moisture in early winter over usually dry continent leading to deeper snow cover over Eurasia (Bulygina et al. 2009) and
- Dramatic warming in Siberia associated with projected land cover change (*c.f.* Vygodskaya et al. 2007) that begins more quickly/earlier following forest fire and permafrost thaw leading to the forest being replaced by steppe.

HyMeX (http://www.hymex.org/)**:** The Hydrological cycle in the Mediterranean Experiment (HyMeX) is the newest RHP. It is an international project which aims to

- Improve our understanding of the water cycle, with emphases on extreme events by monitoring and modelling the Mediterranean coupled system (atmosphere-land-ocean), its variability (from the event scale, to the seasonal and interannual scales) and characteristics over one decade in the context of global change and
- Evaluate societal and economical vulnerability and adaptation capacity to extreme meteorological and climate events.

Series of coordinated observation periods are foreseen during the 2010-2020 time window. They will be based on measurement campaigns, the deployment of dedicated instrumentation and the enhancement of existing operational systems. A comprehensive description of the HyMeX underlying science is provided by the project white-book available through its web page. First versions of the International Science and Implementation Plans are expected for the end of 2009. Outcomes of the multi-disciplinary research conducted in HyMeX should be beneficial to the improvement of

1. Observational and modelling systems, especially of coupled (ocean-atmosphere-land) systems,
2. The prediction capabilities of high-impact events,
3. The accurate simulation of the long-term water-cycle,
4. The definition of adaptation measures, especially in the context of global change.

Issues

Recommendations/Issues for the SSG:

(1) CEOP recommends that the SSG endorse the nomination of Dr. Dennis Lettenmaier to become the CEOP Co-Chair replacing Dr. Ronald Stewart effective at the end of the 2010 SSG meeting.

(2) The SSG may wish to revisit the matter of the selection and integration of new Regional Hydroclimate Projects (RHPs) into the GEWEX/CEOP International Framework. It should be reconfirmed that all the current RHPs will remain designated as full partners in GEWEX/CEOP. Limitations exist in some aspects of all of the RHPs' abilities to meet their commitments to address every aspect of the criteria established by GEWEX for them to be fully recognized as a GEWEX/CEOP Regional Hydroclimate Project. When do such limitations constitute a large enough breach to prevent recognition of a new project or to change the designation of an existing project?

Contributions to WCRP strategic framework

As noted in **1. Overview** above, the CEOP Objectives parallel those of GEWEX and CEOP believes that by fulfilling its commitment to provide deliverables that meet its objectives it will make significant contributions to the WCRP/GEWEX strategic framework.

Objective 1: Produce consistent research quality data sets complete with error descriptions of the Earth's energy budget and water cycle and their variability and trends on interannual to decadal time scales, for use in climate system analysis and model development and evaluation.

Specific Technical Issues:

- Developing an integrated hydroclimate data set that can be used to answer the main CEOP scientific questions.
- Developing the capability to handle and disseminate a large amount of data from diverse sources
- Analyzing and comparing with model simulations this diverse data to understand the underlying mechanisms and model deficiencies.

Specific Deliverable (2011-2012): A "state-of-the-art" suite of global energy and water cycle products complete with error bars for closing the global water and energy budgets for the period 1980 to 2010.

Objective 2: Enhance the understanding of and quantification of how energy and water cycle processes contribute to climate feedbacks.

Associated Science Questions:

- What are the average hydroclimate conditions over various regions and seasons?
- How do water and energy flow into and through individual regions as well as being redistributed within these regions by local mechanisms?
- How do extremes occur and what is their role in the hydroclimate?
- How do aerosols affect the hydroclimate?
- Does knowledge of water isotopes help us to understand the water cycle?

Specific Deliverable (on-going): By making work on these questions its highest priority, the CEOP community is advancing in a step-wise manner the understanding of the contributions of water and its highly coupled non-linear interactions in regulating feedbacks to the climate system.

Objective 3: Improve the predictive capability for key water and energy cycle variables and feedbacks through improved parameterizations to better represent hydrometeorological processes, and determine the geographical and seasonal characteristics of their predictability over land areas.

Associated Science Question:

- Can we simulate and predict the hydroclimate cycle?

Specific Technical Issues:

- Assimilating and integrating the data with newly developed models.

Specific Deliverable (TBD): CEOP expects to assist in providing a final review of the success of GEWEX in improving parameterization at operational NWP and climate modeling centers and its impact on the predictive capabilities for key energy and water cycle variables, including hydrological prediction.

Objective 4: Undertake joint activities with operational hydrometeorological services' hydrological research programs to demonstrate the value of GEWEX research, data sets and tools for assessing the consequences of climate predictions and global change for water resources.

Associated Science Question:

- What is society's benefit from this increased knowledge about the hydroclimate?

Specific Technical Issues:

- Transferring CEOP methodologies to other regions, sectors, and applications.

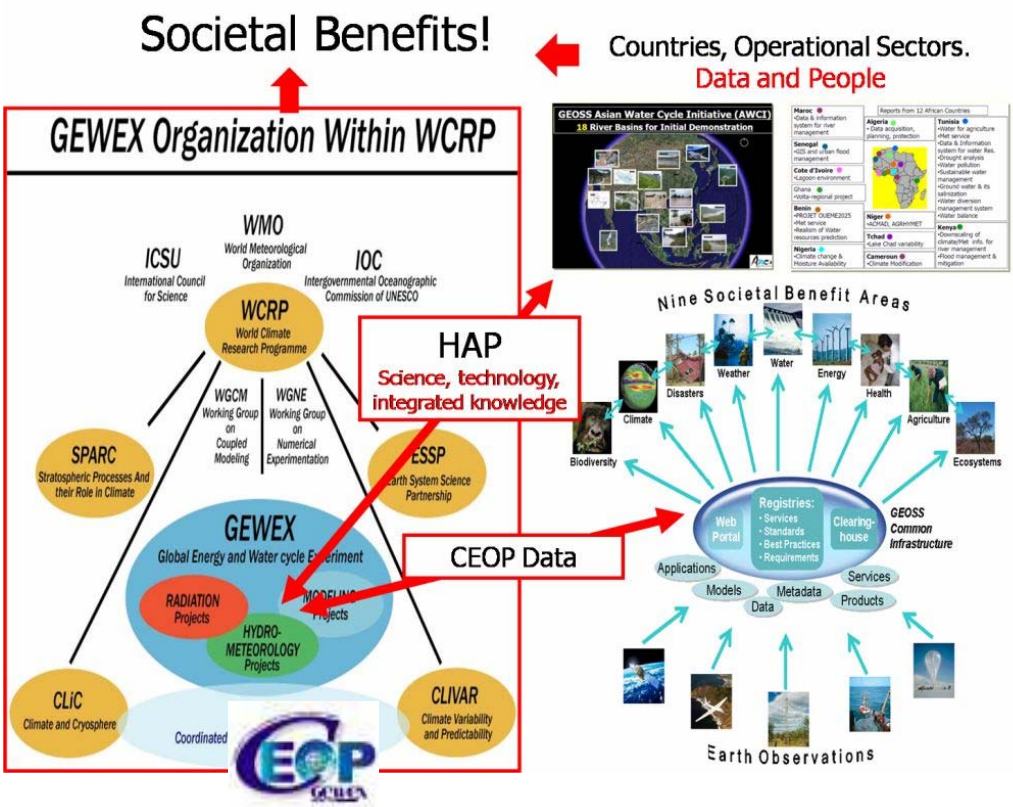
Specific Deliverable (TBD): CEOP expects to assist with providing metrics that will clearly demonstrate the benefits of improved hydrometeorological predictions for water resources.

Contributions to society and to WCRP/GEWEX visibility

CEOP has continually maintained a vision within its community of making specific contributions to those aspects of the WCRP/GEWEX International framework that will have the greatest impact on improving societal conditions. Through a series of organizing workshops and meetings starting in November of 2005 CEOP has initiated the Asian Water Cycle Initiative (AWCI) as a CEOP/GEWEX contribution to GEOSS.

The data shared through this initiative will not only benefit researchers and populations in their own region, but will populate the CEOP Data Integration and Analysis System (DIAS) making it available to a broader group of researchers and thereby extending its visibility and value to the entire WCRP/GEWEX community. More directly CEOP's Hydrological Applications Project (HAP) will utilize the data to advance the common goal of generating physically coherent fields of land surface states and fluxes through the integration of disparate data products.

A similar process was begun in 2009 to begin the African Water Cycle Initiative (AfWCI), raising the visibility of GEWEX and CEOP in another climatically important region of the globe. This paradigm is illustrated in the figure below.



CEOP contribution to society and to the visibility of WCRP/GEWEX Internationally

Summary

CEOP has gone through the process of the merger of the Coordinated Enhanced Observing Period with the GEWEX Hydrometeorology Panel (GHP) and the development and thorough review of the initial draft of the CEOP Strategic Implementation Plan (SIP) by the GEWEX SSG in 2008. In addition, CEOP addressed all of the SSG's comments and concerns in a final draft of the SIP, which is now available on the Internet at: http://www.ceop.net. As a result of this vetting, CEOP has now reconciled its

implementation plans with all of the other elements of GEWEX and WCRP. This process has provided the basis for CEOP to make its unique and separate but equal contributions to the success of the overall objectives of the broader International Climate Research community represented by GEWEX and WCRP. CEOP, therefore, feels it is now the international focal point for WCRP/GEWEX Global Hydrometeorological Research. CEOP welcomes all interested researchers to participate and contribute to the development of current hydrometeorological observations, simulations and predictions, and to those endeavors that will be undertaken in the CEOP framework in the future including those that may be part of the longer term legacy of WCRP/GEWEX and prototypes of elements of GEOSS.

List of key publications

(1) Chen et al., 2009: Improving Noah Land Surface Model in Arid Regions with an Appropriate Parameterization of the Thermal Roughness Length. *J. Hydrometerol*., submitted.
(2) Ferguson, C. R. and E. F. Wood, 2009: An evaluation of satellite remote-sensing data products for land surface hydrology. *J. Hydrometerol*., submitted.
(3) Ferguson, C. R., J. Sheffield, E. F. Wood, H. Gao, and D. P. Lettenmaier, 2009: Quantifying uncertainty in remote sensing based estimates of evapotranspiration due to data inputs over the continental United States. *Int. J. Rem. Sens*., in review.
(4) Qin, J., S. Liang, K. Yang, I. Kaihotsu, R. Liu, and T. Koike 2009: Simultaneous estimation of both soil moisture and model parameters using particle filtering method through the assimilation of microwave signal. *J. Geophys. Res*., 114, D15103, doi:10.1029/2008JD011358.
(5) Sheffield, J., C. R. Ferguson, T. J. Troy, E. F. Wood, and M. F. McCabe, 2009: Closing the terrestrial water budget from satellite remote sensing. *Geophys. Res. Lett*., 36, L07403, doi:10.1029/2009GL037338.
(6) Yang et al., 2009a: Validation of a Dual-pass Microwave Land Data Assimilation System for Estimating Surface Soil Moisture in Semi-arid Regions, *Journal of Hydrometeorol.*,10,780-793.
(7) Yang et al., 2009b: Some practical notes on the land surface modeling in the Tibetan Plateau. *Hydrol. Earth Syst. Sci*.,13, 687–701.
(8) Yang, K, 2009d: Diurnal variations of thermal roughness length and its importance for land surface modeling in dry regions. *AsiaFlux Newsletter*, No. 30, 10-14.
(9) Yang, K, H. Lu, T Koike, 2009e: Microwave LDAS improves soil moisture and land flux estimates. *GEWEX News* 19(3), 2-3.
(10) Yang et al., 20010a: Method Development for Estimating Sensible Heat Flux over the Tibetan Plateau from CMA Data. *J. Appl. Meteor. Clim*., doi: 10.1175/2009JAMC2167.1
(11) Yang et al., 2010b: On downward shortwave and longwave radiations over high altitude regions: observation and modeling in the Tibetan Plateau. *Agric. Forest. Meteorol*, doi:10.1016/j.agrformet.2009.08.004
(12) Stoy, P.C., Richardson, A.D., Baldocchi, D.D., Katul, G.G., Stanovick, J., Mahecha, M.D., Reichstein, M., Detto, M., Law, B.E., Wohlfahrt, G., Arriga, N., Campos, J., McCaughey, J.H., Montagnani, L., Paw U, K.T., Sevanto, S. and Williams, M., 2009. Biosphere-atmosphere exchange of CO2 in relation to climate: a cross-biome analysis across multiple time scales. *Biogeosciences*, 6(10): 2297-2312.
(13) Mercado, L.M., Lloyd, J., Dolman, A.J., Sitch, S. and Patino, S., 2009. Modelling basin-wide variations in Amazon forest productivity - Part 1: Model calibration, evaluation and upscaling functions for canopy photosynthesis. *Biogeosciences*, 6(7): 1247-1272.
(14) Grant, R.F., Hutyra, L.R., de Oliveira, R.C., Munger, J.W., Saleska, S.R. and Wofsy, S.C., 2009. Modeling the carbon balance of Amazonian rain forests: resolving ecological controls on net ecosystem productivity. *Ecological Monographs*, 79(3): 445-463.
(15) Malhi, Y., Aragao, L., Metcalfe, D.B., Paiva, R., Quesada, C.A., Almeida, S., Anderson, L., Brando, P., Chambers, J.Q., da Costa, A.C.L., Hutyra, L.R., Oliveira, P., Patino, S., Pyle, E.H., Robertson, A.L. and Teixeira, L.M., 2009. Comprehensive assessment of carbon productivity, allocation and storage in three Amazonian forests. *Global Change Biology*, 15(5): 1255-1274.
(16) Acevedo, O.C., Moraes, O.L.L., Degrazia, G.A., Fitzjarrald, D.R., Manzi, A.O. and Campos, J.G., 2009. Is friction velocity the most appropriate scale for correcting nocturnal carbon dioxide fluxes? *Agricultural and Forest Meteorology*, 149(1): 1-10.
(17) Campos, J.G., Acevedo, O.C., Tota, J. and Manzi, A.O., 2009. On the temporal scale of the turbulent exchange of carbon dioxide and energy above a tropical rain forest in Amazonia. *Journal of Geophysical Research-Atmospheres*, 114: 10.

(18) da Rocha, H.R., Manzi, A.O., Cabral, O.M., Miller, S.D., Goulden, M.L., Saleska, S.R., Coupe, N.R., Wofsy, S.C., Borma, L.S., Artaxo, P., Vourlitis, G., Nogueira, J.S., Cardoso, F.L., Nobre, A.D., Kruijt, B., Freitas, H.C., von Randow, C., Aguiar, R.G. and Maia, J.F., 2009. Patterns of water and heat flux across a biome gradient from tropical forest to savanna in Brazil. *Journal of Geophysical Research-Biogeosciences*, 114: 8.
(19) Borma, L.S., da Rocha, H.R., Cabral, O.M., von Randow, C., Collicchio, E., Kurzatkowski, D., Brugger, P.J., Freitas, H., Tannus, R., Oliveira, L., Renno, C.D. and Artaxo, P., 2009. Atmosphere and hydrological controls of the evapotranspiration over a floodplain forest in the Bananal Island region, Amazonia. *Journal of Geophysical Research-Biogeosciences*, 114: 12.
(20) Fisher, J.B., Malhi, Y., Bonal, D., da Rocha, H.R., de Araújo, A.C., Gamo, M., Goulden, M.L., Hirano, T., Huete, A.R., Kondo, H., Kumagai, T.O., Loescher, H.W., Miller, S., Nobre, A.D., Nouvellon, Y., Oberbauer, S.F., Panuthai, S., Roupsard, O., Saleska, S., Tanaka, K., Tanaka, N., Tu, K.P. and Randow, C.V., 2009. The land-atmosphere water flux in the tropics. *Global Change Biology*, 15(11): 2694-2714.
(21) Schneider, M., K. Yoshimura, F. Hase, and T. Blumenstock, 2009: The ground-based FTIR network's potential for investigating the atmospheric water cycle, *Atmos. Chem. Phys. Discuss*., 9, 26199-26235. [Discussion paper]
(22) Frankenberg, C., K. Yoshimura, T. Warneke, I. Aben, A. Butz, N. Deutscher, D. Griffith, F. Hase, J. Notholt, M. Schneider, H. Schrijver, T. Röckmann, 2009: Dynamic processes governing lower-tropospheric HDO/H2O ratios as observed from space and ground, *Science*, 325, 1374-1377. [AAAS]
(23) Yoshimura, K., M. Kanamitsu, and M. Dettinger, Regional downscaling for stable water isotopes: A case study of an Atmospheric River event, submitted to *JGR*.
(24) Abe, O., S. Agata, M. Morimoto, M. Abe, K. Yoshimura, T. Hiyama, and N. Yoshida, 2009: A 6.5-year continuous record of sea surface salinity and seawater isotopic composition at Harbor of Ishigaki Island, southwest Japan, *Isotopes in Environmental and Health Studies*, 45, 247-258. [IW]
(25) Sturm, C., Q. Zhang, and D. Noone, 2009: An introduction to stable water isotopes in climate models: benefits of forward proxy modelling for paleoclimatology. *Climate of the Past Discussion*, 2009. [Discussion paper]
(26) Noone, D., and C. Sturm, 2008: Comprehensive dynamical models of global and regional water isotope distributions**.** *In: West, J., G. Bowen, T. Dawson and K. Tu (eds.) Isoscapes: Understanding movement, patterns, and process on Earth through isotope mapping.* Springer, 2009. [Manuscript]
(27) Noone, D., 2009: A kink in the thermometer. *Nature*, 492, 295-296, doi:10.1038/462295a [News&Views]

Planned meetings, workshops

TBA

List of members and their term dates

The list below is current and all leaders are in place for one more year of their three-year terms that will be reviewed at the fourth CEOP Annual Meeting in August/September 2010. Renewals or changes at that time will be valid up to the time of the CEOP Annual Meeting in August/September 2013.

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