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CEOP is Organized for the Future

Dr. Thomas Ackerman
Chairman, GEWEX Scientific Steering Group

As the newly appointed Chairman of the Global Energy and Water-cycle Experiment (GEWEX) Scientific Steering Group (SSG), I am pleased to have this opportunity to recognize the research being undertaken as part of the Coordinated Energy and Water-cycle Observations Project (CEOP) within GEWEX and the World Climate Research Programme (WCRP) International Climate Research Framework. The initial goal of GEWEX was to understand and quantify the global energy and water cycle. This led to the formation of three panels, the GEWEX Hydrometeorology Panel (GHP), the GEWEX Modelling and Prediction Panel (GMPP) and the GEWEX Radiation Panel (GRP), which were designed to address key elements of the global energy and water cycle. The need to understand regional processes produced the concept of combining water and energy datasets on the scale of large continental basins and sponsoring extended observing periods. These activities spawned the Coordinated Enhanced Observing Period. In 2007, the SSG agreed to the merger of the Coordinated Enhanced Observing Period and the GHP into the Coordinated Energy and water-cycle Observations Project (CEOP). The intent of bringing increased focus on the development of integrated datasets, their application to fundamental scientific research and their use by diverse stakeholders.

Two articles in this newsletter demonstrate the power of this approach. CEOP, extending the legacy of the GHP Continental Scale Experiments, continues to promote the study of regional climate issues in areas that are especially sensitive to climate change and weather using a combination of data and model prediction. The CEOP High Elevations effort, which is devoted to understanding climate conditions and assessing the impacts of climate change in these climatically sensitive locations around the globe is described on page 4. The success of CEOP regional studies continues to motivate international research groups to follow the design of the CEOP Regional Hydroclimate Projects (RHPs) in data rich zones. This approach is based on integrated data collection and handling and the use of coupled climate models to study regionally-specific climate problems. The Hydrological Cycle in the Mediterranean Experiment (HyMeX) described on page 5 is designed to address the critical issues surrounding the health of the Mediterranean Basin now and in the future. Climate projections suggest a much dryer basin and an increasingly negative water cycle (evaporation exceeding precipitation). The CEOP organizational model allows data to be shared in a multinational environment and provides a focus on research objectives that are broad in scope and reach beyond the boundaries of the experiment itself. HyMeX is in its early stages but promises to make an extremely important contribution to our understanding of the energy and water cycles in an environmentally sensitive and nationally diverse part of our world. CEOP, and GEWEX more broadly, contributes to the development of the experiment framework, provides continuing guidance for data management and campaigns, and, most importantly, encourages high quality research leading to scientific discoveries.

The merger of all regional GEWEX regional hydrology projects under CEOP has required CEOP to adjust its strategic vision to fit this expanded role. The CEOP science team has worked diligently to implement this larger vision encompassing data acquisition and storage, data quality control, data analysis, regional modelling and scientific discovery. This is a large portfolio for any organization and requires dedicated and continuing management. CEOP is also working to make its resources available to the broader scientific community for research and resource planning. The multi-national scope of many of the CEOP studies, such as HyMeX, makes this a great challenge, but also an extremely important facet of the ongoing program.

One of the WCRP mission objectives, described in the WCRP Strategic Framework 2005–2015, is to "support climate-related decision making and planning adaptation to climate change by developing science required to improve climate predictions, the understanding of human influence on climate, and use this scientific knowledge in an increasing range of practical applications of direct relevance, benefit and value to society." CEOP has developed a research framework and integrated datasets required to address these issues. Its 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. The GEWEX SSG continues to support the efforts of CEOP and seeks to ensure its continued vitality and encourage its research contributions to GEWEX and the WCRP.

Contents

WCRP World Climate Research Programme | WMO | IOC | ICSU International Council for Science

Microwave LDAS Improves Soil Moisture and Land Flux Estimates

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Soil moisture is a highly variable parameter in semi-arid regions, where strong coupling between soil moisture and precipitation are suggested by Koster et al. (2004). Assimilating microwave data into a land surface model (LSM) provides a promising approach to estimating spatial distribution of soil moisture. Uncertainties caused by specifying parameter values in a LSM or a radiative transfer model (RTM) still remain. Parameter specification in data assimilation remains a crucial issue. To remedy this, the University of Tokyo developed a new type of land data assimilation system (LDAS-UT), Yang et al. (2007).

Figure 1a shows the flowchart of the system, which assimilates the AMSR-E 6.9 GHz and 18.7 GHz brightness temperatures into a LSM, with a RTM as an observation operator. At first, the LSM produces the near-surface soil moisture (θ_{sfc}), the ground temperature (T_g), and the canopy temperature (T_c), which are then fed into the RTM to simulate the brightness temperatures. The difference between simulated T_b ($T_{bp,est}$) and observed T_b ($T_{bp,obs}$) is sensitive to the near-surface soil moisture,

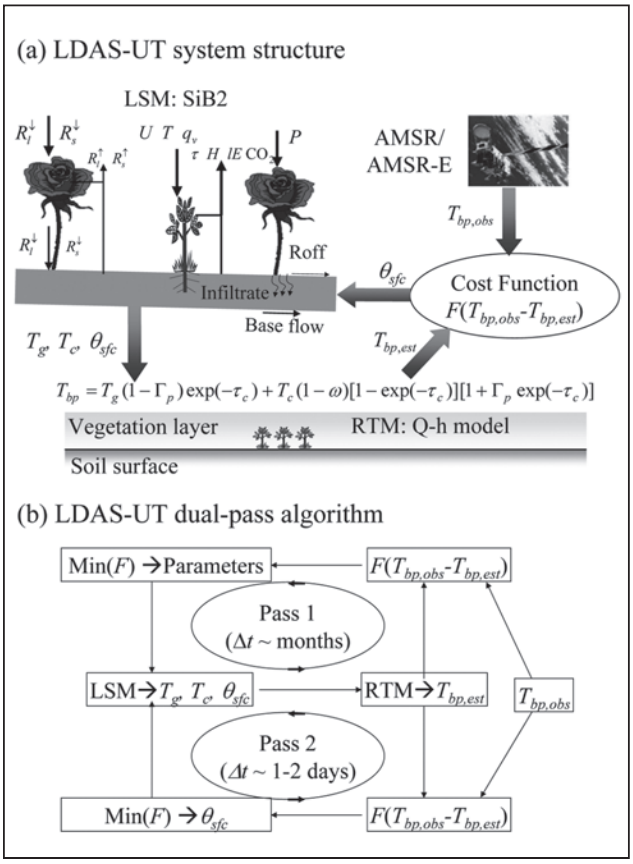

Figure 1. (a) LDAS-UT system structure and (b) schematic of the dual-pass assimilation technique. T_g, T_c, and θ_{sfc} are the ground temperature, canopy temperature, and near-surface soil water content, respectively. T_b is the brightness temperature, F the cost function, and Δt the data assimilation window. Γ_p is soil reflectivity, τ_c the optical thickness of the vegetation. The subscript p denotes the polarization, obs the observed value, and est the estimated value (Yang et al., 2007).

which is then adjusted to minimize the difference by a global optimization scheme (Duan et al., 1993).

Figure 1b shows a dual-pass assimilation algorithm adopted in LDAS-UT. Pass 1, the designated calibration pass, aims at tuning system parameters; Pass 2, or the assimilation pass, estimates soil moisture. The principle behind this algorithm is that the responding time scale of a system state to the system parameters is different from the responding time scale to the initial condition. The system parameters have a long-term impact on state variables (such as soil moisture), and therefore, a long time window (several months or longer) is required to calibrate the parameters. By contrast, initial near-surface soil moisture has a short-term effect on the system state variables, and therefore, a short time window (~1 day) is selected to estimate its value by minimizing a cost function. The parameter calibration presented in LDAS-UT relies on satellite microwave data instead of surface observations, and thus may have wide applicability.

Two applications of LDAS-UT at the CEOP Mongolian and Tibet reference sites (Koike et al., 2004) are described using SiB2 as the LSM and Q-h model as the observation operator.

Validation of Soil Moisture at a Semiarid Area in Mongolia

The CEOP Mongolia reference site covers a flat area of 120 km ×160 km in a semi-arid grassland region of Mandal Govi. A dense soil moisture network was deployed over the site as part of the AMPEX (Advanced Earth Observing Satellite II (ADEOS-II) Mongolian Plateau Experiment for ground truth) project in order to collect data for development and validation of AMSR/AMSR-E soil moisture retrieval algorithms (Kaihotsu, 2005). Soil moisture at 3 cm depth was measured at 16 stations and meteorological data at four stations.

Figure 2 shows that the observed soil moisture values are quite diverse in space. Figure 3 shows the comparison of soil moisture among the LDAS-UT estimates, LSM estimates, and the station-averaged observations. The LDAS-UT estimate agrees with the observations fairly well, whereas the LSM simulation, with default parameter values, overestimates soil moisture. Further analysis indicates that the improvement in the LDAS-UT soil moisture estimations is realized through both the parameter calibration and the data assimilation. The effect of the accuracy of the forcing data on the estimate was evaluated and a general decrease of accuracy was found when the forcing data was less exact. Nevertheless, LDAS-UT produces better estimates than the LSM does in all cases. LDAS-UT even produces a fairly good estimate of soil moisture when precipitation is set to be zero in the forcing data. More details of this type of application can be found in Yang et al. (2009).

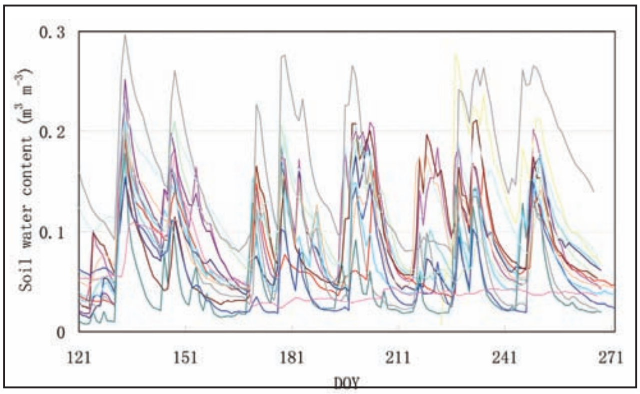

Figure 2. Observed daily-mean near-surface (3 cm depth) soil moisture variations at 16 Mongolian AMPEX stations during the period of 30 April 2003 to 30 September 2003.

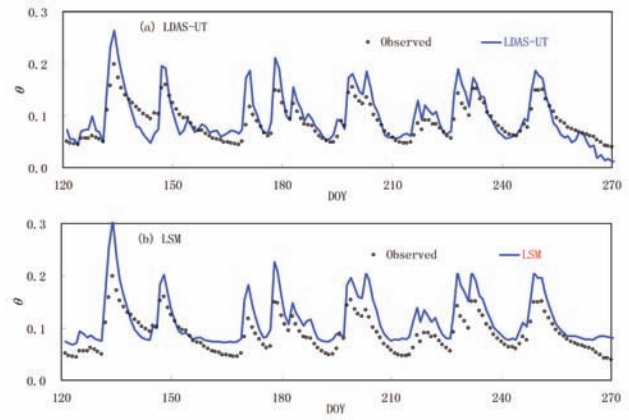

Figure 3. Comparisons of AMPEX daily-mean station-averaged near-surface soil volumetric water content with (a) LDAS-UT output, and (b) LSM (SiB2) simulation at the CEOP Mongolian site during 30 April 2003 to 30 September 2003.

Validation of Surface Energy Budget at an East Tibet Site

The CEOP East Tibet reference site is located at 91.75˚E, 31.25˚N and is relatively flat and covered with sparsely distributed short grass during the rainy season (June–August).

Figure 4(a) shows the precipitation data from observations and the Global Precipitation Climatology Project (GPCP). The distinction is seen during the day of year (DOY) 151-171 when several rainfall events were observed but are not in the GPCP data. When both LDAS-UT and the LSM are driven by the GPCP precipitation data, variations during DOY 151-171 are seen in Figure 4b. The LSM yields a drying process while the LDAS-UT shows a wetting process. The LSM soil moisture exhibits a reasonable response to the input (GPCP) precipitation, whereas the LDAS-UT soil moisture responds well to the observed precipitation. One conclusion is that errors resulting from the low-quality input the LDAS-UT performs better than the LSM does, when both are driven by identical forcing data. The details of this case can be found in Yang et al. (2007).

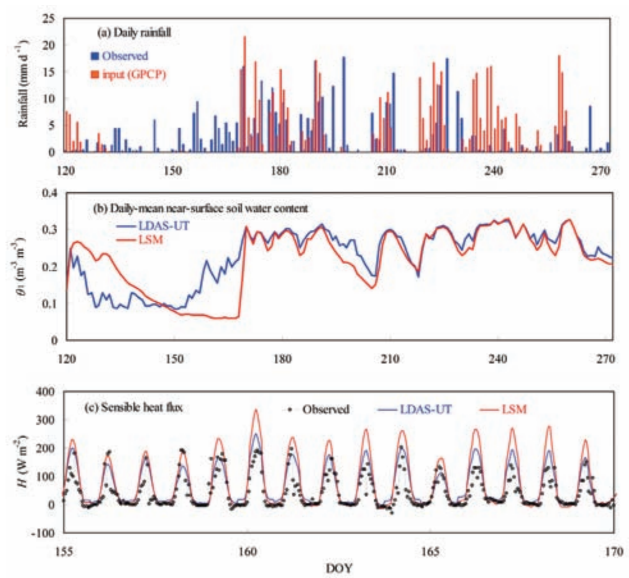

Figure 4. (a) Daily mean precipitation in terms of both measurements and LDAS-UT/LSM input (GPCP), (b) Daily mean near-surface soil water content estimated by LDAS-UT and LSM (SiB2), and (c) Surface sensible heat fluxes derived from LDAS-UT and LSM (SiB2) for the CEOP East Tibet site. DOY is 2003.

In summary, LDAS-UT uses a unique dual-pass assimilation technique to assimilate AMSR-E data for the estimation of regional soil moisture. The system's strength is its ability to perform better than a LSM when both are driven by low-quality forcing data. Since the accuracy of precipitation data is generally not high in remote regions such as Tibetan Plateau and Mongolian Plateau, the LDAS-UT has a high potential to provide improved soil moisture and land flux data for studies of agricultural, hydrological, and atmospheric processes, as well as applied research for these regions. The development of LDAS-UT is ongoing (Lu et al., 2009), and it will be used to provide data for the CEOP Water and Energy Budget Studies (WEBS) project and for the Asian Monsoon Year (AMY) project.

Acknowledgements:
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CEOP High Elevations initiative

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Although mountain environments are one of the Earth's most important ecosystems (Beniston, 2003), our knowledge of climate, physical and dynamical processes at high elevations is incomplete, primarily due to the lack of monitoring activities (see Figure 1). The High Elevations (HE) initiative was launched and is coordinated by the Ev-K2-CNR Committee in the framework of Stations at High Altitude for Research on the Environment (SHARE) Project and it is an element of "regional focus" within the Coordinated Energy and Water Cycle Observations Project (CEOP). CEOP-HE aims at providing an interdisciplinary and global understanding of the water cycle, climate dynamics and related processes in high elevation areas (elevations above 2500 m a.s.l.). These sites represent about 20 percent of the world's mountain areas, excluding Antarctica *(http://www.unep-wcmc.org/habitats/mountains/region.html)*.

The goal of CEOP-HE is to create a global network of representative sites of all of the Earth's high elevation areas. Data collected from CEOP-HE research stations and from other HE environmental monitoring stations will be organized in a synergic database for use by scientists in hydrology, glaciology, ecology and paleolimnology studies to reconstruct environment characteristics and to refine models for forecasting the impacts of future climatic changes.

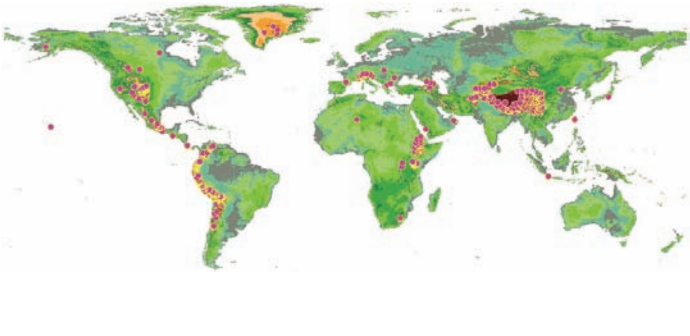
The current CEOP network is comprised of 52 globally distributed Reference Sites. Among these sites only the CEOP Asia-Australia Monsoon Project (CAMP)/Tibet, CAMP/Himalayas and Pakistan Karakorum Network are located above 2500 m a.s.l. Recently, the Automatic Weather Station (AWS) of Forni Glacier (Italian Alps) and the Mt. Cimone observatory (Italian Apennines) were included as new CEOP Reference Sites.

The network of monitoring stations operating in the Khumbu Valley (Mt. Everest area), Nepal, have monitored climate conditions
for over 15 years in the framework of the Ev-K2-CNR's SHARE Project. Many ongoing research activities have contributed to the understanding of climate changes impacting the Himalayan area (Baudo et al., 2007). For example, using this data Ueno et al. (2007) observed that monsoon rainfall is initiated simultaneously along the Khumbu Valley.

To better understand and evaluate the impact of human activities on the atmospheric at the regional and global scale, the Nepal Climate Observatory-Pyramid was installed near the Pyramid Laboratory-Observatory in February 2006. Under the framework of the United Nations Environmental Programme (UNEP) Atmospheric Brown Clouds Project, the data are providing information on the atmospheric composition of the Himalayan area between India and China and are expected to contribute to understanding these effects on the monsoon (Bonasoni et al., 2008).

Within the framework of the Ev-K2-CNR-SHARE Project, monitoring activities and environmental research are also beeing conducted in the Pakistan-Karakorum region. In Mihalcea et al. (2008), a distributed surface energy-balance study was performed to determine subdebris ablation across a large part of the Baltoro glacier. This work was performed using meteorological data continuously collected since 2004 at the Urdukas AWS (4,022 m a.s.l.), which is located on a lateral moraine of the Baltoro. These types of studies are providing the background information necessary for CEOP-HE to develop science strategies for a better understanding of high elevation dynamics.

In this context collaborations with the CEOP Regional Hydroclimate Projects elements are also being planned and include the Monsoon Asian Hydro-Atmospheric Science Research and Prediction Initiative (MAHASRI), the Climate Prediction Program for the Americas (CPPA), and the Northern Eurasian Earth Science Partnership Initiative (NEESPI). In addition, other CEOP Regional Studies (Cold Region, Monsoons, Semi-Arid Studies) and cross-cutting working groups (Water and Energy Budget



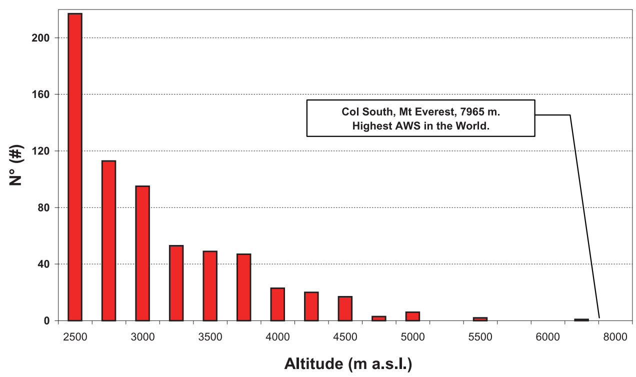


Figure 1. Distribution of about 650 sites above 2500 m a.s.l. by a preliminary survey of AWSs in the World (excluding Antarctica) considering GTS, GPCP, FAO, NOAA, GAWSIS, GOSIC and SHARE networks. The graph provide an overview of measurement sites density distribution per 1% of mountain areas (300000 km²). Data elevation derives from U.S. Geological Survey National Mapping Division, EROS Data Center (EDC) (1996) Global 30 Arc Second Elevation Data (GTOPO30) from UNEP's World Conservation Monitoring Centre (http://www.unep-wcmc.org/habitats/mountains/region.html).

Figure 2. The ABC-Pyramid Observatory (5079 m a.s.l,. Nepal) located in the Khumbu Valley, Mount Everest region (left) and the Urdukas AWS (4022 m a.s.l.) installed along the Baltoro Glacier, Baltistan region, Pakistan (right).

Studies, Extremes, Aerosol) will be involved. A primary focus will be on the factors that directly influence (monsoon circulation, aerosols) or characterize HE areas (arid conditions, cold temperatures, etc.).

The HE Initiative will contribute to the Global Earth Observation System of Systems (GEOSS) within the framework of the Group on Earth Observations (GEO) initiative which is coordinating international efforts to build an infrastructure for monitoring and forecasting changes in the global environment. For more information about CEOP-HE see: *http://www.ceop-he.org.*

*Acknowledgments***:**
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HyMeX, a Potential New CEOP RHP in the Mediterranean Basin

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The Mediterranean Basin features a nearly enclosed sea surrounded by very urbanized littorals and mountains from which numerous rivers originate (Figure 1). This results in many interactions and feedbacks between ocean-atmosphere-land processes that play a predominant role in climate and high-impact weather. The area concentrates the major natural risks related to water cycle which include heavy precipitation and flash-flooding during the fall season, severe cyclogeneses associated with strong winds and large swell during the winter, and heat waves and droughts accompanied by forest fires during the summer. The capability to predict such high-impact events remains weak for many reasons, including the limited availability of experimental data and the consequental limited understanding of the underlying fine scale and large scale physical processes and their non-linear interactions.

Water resources are a critical issue for a large part of the Mediterranean basin. Freshwater is rare and unevenly distributed in time and space with few short duration heavy precipitation events and long drought periods. Moreover, this happens in a situation of increasing water demands and climate change. Mediterranean regions have been indeed identified as one of the two main "hot-spots" of the predicted climate change, confirming that climate is especially responsive to global change in Mediterranean. A large decrease in mean annual precipitation and increase in precipitation variability during the dry (warm) season are expected as well as a significant generalized warming. There are still however large uncertainties in the future evolution of the Mediterranean climate. Progress is needed in the monitoring and modelling of the Mediterranean coupled climate system (atmosphere-land-ocean) in order to better quantify the ongoing changes and to better predict their future evolution which will help policy makers apply mitigation and adaptation strategies.

These societal and science issues motivate the HYdrological cycle in the Mediterranean Experiment (HyMeX), an international program to better quantify and understand the water cycle in the Mediterranean Basin - with emphases on intense events.

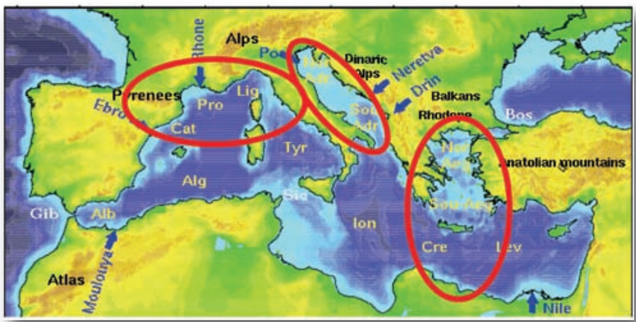

Figure 1. Major sites of strong winds, dense water formation over the Mediterranean basin (red ellipses).

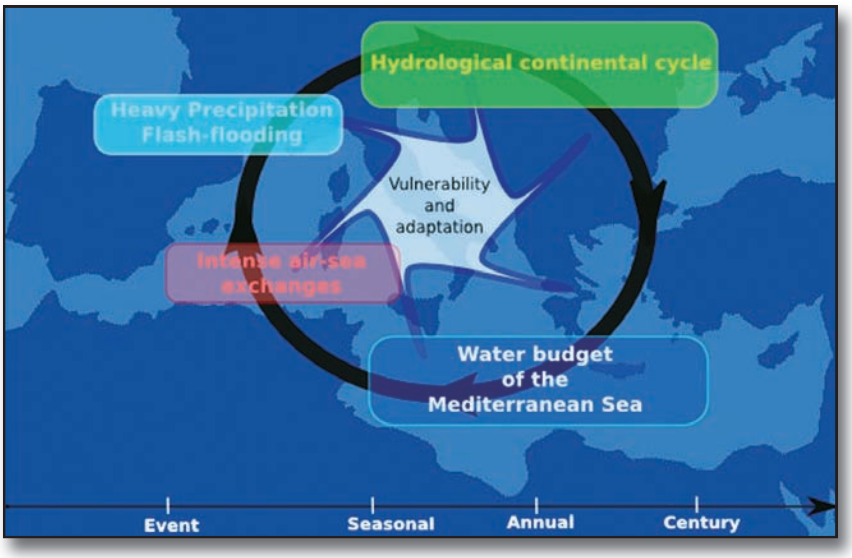

Figure 2. Main scientific topics of the HyMeX project.

HyMeX Science Objectives:

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

HyMeX will address key issues related to:

- the water budget of the Mediterranean basin,
- the continental hydrological cycle and related water resources,
- heavy precipitation and flash-flooding, and
- intense air-sea exchanges produced by severe regional winds and cyclogeneses.

In addition, it will monitor vulnerability factors and adaptation strategies developed by different Mediterranean societies to accommodate the impacts of climate change and intense events. The Project's main scientific topics are shown in Figure 2. A comprehensive description of the underlying science of HyMeX is provided in the project white-book (Béranger et al., 2008; see *http://www.hymex.org*).

A series of coordinated observation periods are planned during the period of 2010-2020. They will be based on measurement campaigns (a series of 2-month special observing periods), the deployment of dedicated instrumentation, and the enhancement of existing operational observation systems (enhanced and long observing periods) (Figure 3).

Expected results of the multi-disciplinary research conducted in HyMeX include:

- the improvement of observational and modelling systems, especially of coupled (ocean-atmo sphere-land) systems,
- improved prediction capabilities of high-impact events,
- more accurate simulation of the long-term water-cycle, and
- a better definition of adaptation measures, espcially in the context of global change.

As a CEOP Regional Hydroclimate Project (RHP) HyMeX would contribute to the GEWEX objective of improving the understanding of the global hydrological cycle and prediction of its evolution by a coordinated set of studies targeted at the Mediterranean region, a region not currently covered by any RHP. In terms of hydrometeorological modelling, HyMeX would contribute to the improvement of atmospheric and hydrological models through hindcast and real-time forecasting applications during coordinated observation periods. In terms of observations, the HyMeX strategy includes easy access for scientists to already-archived data and to new datasets collected. These data can in turn serve as validation for GEWEX global data products such as Global Precipitation Climatology Project (GPCP).

Planning for HyMeX will continue at the CEOP Meeting to be held 26-28 August 2009 in Melbourne, Australia . It is anticipated that CEOP will present a proposal for HyMeX to be accepted as a RHP to the GEWEX Scientific Steering Group for approval at their next meeting in January 2010 .

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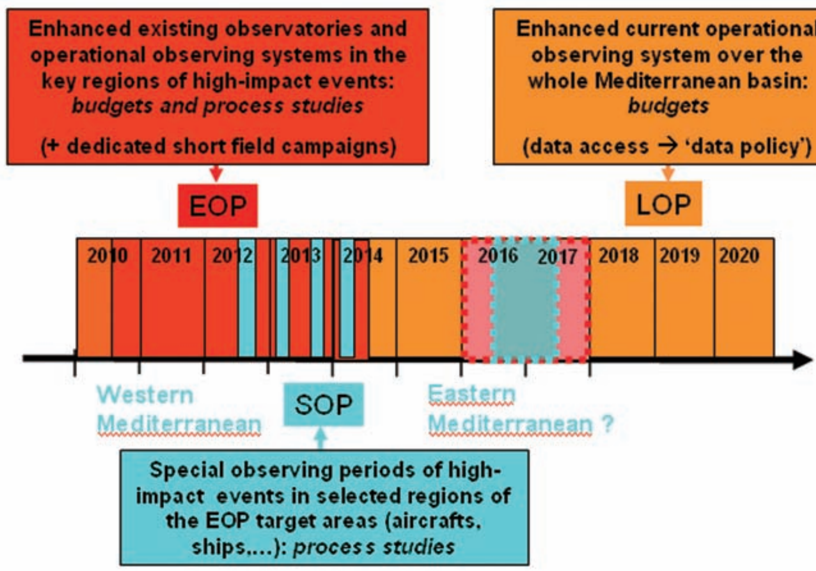

Figure 3. HyMeX implementation timeline.

A Prototype Observing System for the Qinghai-Tibet Plateau in Southeast Asia

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The CEOP Asia-European long-term Observing system of Qinghai-Tibet Plateau hydrometeorological processes and the Asian-monsoon systEm with Ground satellite Image data and numerical Simulations (CEOP-AEGIS) Project was launched in 2008. CEOP-AEGIS has a two-fold objective: (1) use existing ground measurements and current/future satellite observing systems to determine and monitor the water yield of the Qinghai-Tibet Plateau; and (2) monitor the evolution of snow, vegetation cover, surface wetness and surface fluxes, and analyse linkages between these and the Asian Monsoon.

Estimates of the Tibetan Plateau water balance (Figure 1) rely on sparse and scarce observations that cannot provide the required accuracy, spatial density, and temporal frequency. CEOP-AEGIS is designed to demonstrate the use of satellite and ground observations to support water resources management in southeast Asia and to clarify the interactions between the land surface and the atmosphere over the Tibetan Plateau in the Asian monsoon system (Figure 2).

CEOP-AEGIS is a cooperative effort of 18 organizations in eight countries, giving shape to a Europe-Asia partnership to address issues in land-atmosphere interactions and water resources of global relevance (Figure 3). The kick-off meeting was hosted by the Institute for Tibetan Research in Beijing, China from April 21st to May 3rd, 2008. CEOP-AEGIS is a Project within a Specific International Cooperation Action financed by the European Commission under FP7 Topic ENV.2007.4.1.4.2 "Improving observing systems for water resource management." The First Progress Meeting was organized jointly with CEOP-HE in Milano, Italy on June 29th through July 2nd, 2009.

The Qinghai-Tibet Plateau is the headwater of rivers that flow down to 47 percent of the Earth's population. At altitudes of nearly the half of the troposphere and 2.5 million km^2, the Himalayas and the Qinghai-Tibet Plateau have significant dynamic and thermodynamic effects on the atmospheric circulation and on the climate of China and South-East Asia. Among the issues of greatest interest are the thermal and dynamical influences of surface topography and cover (Figure 2) on the Atmospheric Boundary Layer, particularly their monthly variation (Figure 4) in relation to the onset, maintenance, and withdrawal of the monsoon (Ueno et al., 2001; Ueno et al., 2006; Yamada and Uyeda, 2006; Yasunari and Miwa, 2006). A good understanding of the linkage of land processes on the Plateau with monsoon onset and precipitation is of major interest from both a societal and environmental point of view for many Asian countries, in particular in terms of flood and drought monitoring, but also in the perspective of the global change.

Analysis of time series of Land Surface Temperature (LST) and Normalized Difference Vegetation Index (Figure 5) reveals the influence of vegetation to regulate land-atmosphere exchange of energy and water,

(Continued on Page 8)

Figure 1. Satellite composite image of the Plateau and watershed boundaries of the main rivers in South-East Asia.

Figure 3. Permanent observatory on Everest at 5200 m a.s.l. (courtesy of the Institute for Tibetan Plateau research, Chinese Academy of Sciences).

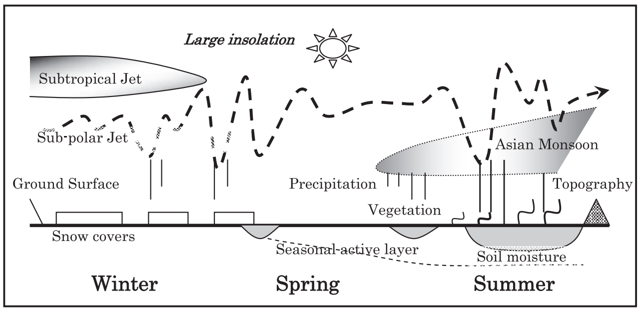

Figure 2. Land-atmosphere interactions, convective activity, and onset of Asian Monsoon (courtesy of Kenichi Ueno, University of Tsukuba).

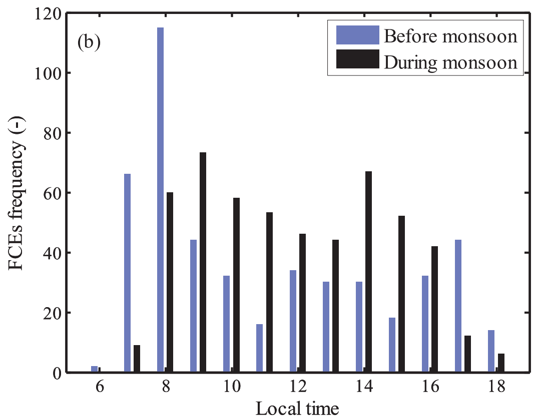

Figure 4. Observed Free Convection Events: Before the monsoon, FCEs mostly occur in the morning hours. During the monsoon, the distribution is bi-modal with an afternoon mode closely related with cloud cover (courtesy of Kenichi Ueno, University of Tsukuba, Japan).

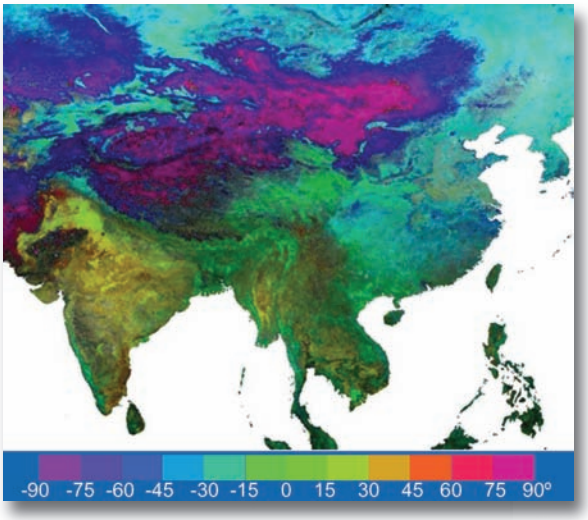

Figure 5. Correlation of yearly amplitudes of Land Surface Temperature vs. NDVI over the period 2000 - 2006; positive angles indicate positive correlation of LST and NDVI (courtesy of J.A.Sobrino, University of Valencia, Spain).

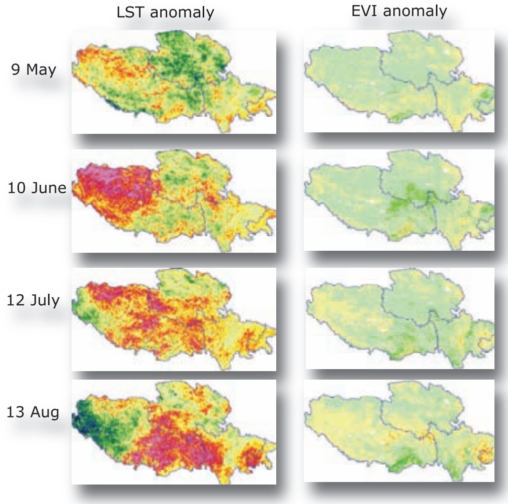

Figure 6. Early detection of drought by time series analysis of LST and EVI MODIS data (Courtesy of L. Jia, Wageningen University and Research Centre, The Netherlands).

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identifying areas where land evaporation is controlled by water availability and radiative forcing respectively.

In shorter periods of time both LST and fraction Absorbed Photosynthetically Active Radtion (fAPAR) provide reliable and timely information for the early detection of droughts, with LST being a better indicator than fAPAR (Figure 6).

The project will contribute to land surface science in two ways. On one hand, the hydrometeorological data sets on the Plateau water balance will be based on the integration of satellite and ground measurements, including a detailed analysis of the footprint of turbulent flux measurements by eddy covariance and scintillometer systems. On the other hand, the time series of hydrological data products will be used to identify interesting cases in terms of linkages between land surface conditions in the Plateau, convection, and extreme precipitation events elsewhere. Such cases will be used to design numerical experiments to test hypotheses on such linkages. The experiments will be performed with a new research modeling and data assimilation system at the Chinese Academy of Meteorological Sciences. For more information about CEOP-AEGIS, see: *http://www.ceop-aegis.org*.

References

Menenti, M., L. Jia, J. Colin, et al., 2008. Coordinated Asia-European long-term Observing system of Qinghai-Tibet Plateau hydro-meteorological processes and the Asian-monsoon systEm with Ground satellite Image data and numerical Simulations (CEOP-AEGIS). *Description of Work*, Contract FP7 ENV 212921. Universitè de Strasbourg, France, 107 pp.

Current Status of IBUKI (GOSAT)

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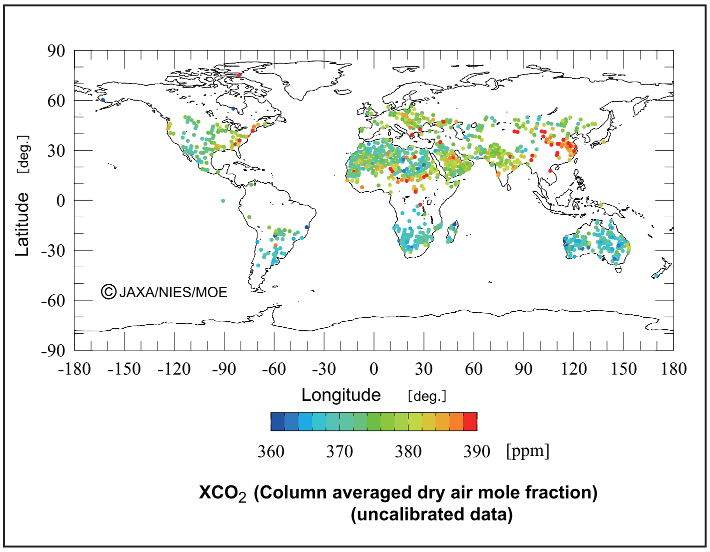
The Greenhouse Gases Observing Satellite IBUKI (GOSAT) was launched on January 23, 2009 (UT) and is currently operating in an initial calibration and validation operation phase which should be completed in July 2009. During this phase the calibration and tuning of the computer processing system is underway at the Japan Aerospace Exploration Agency and the National Institute for Environmental Studies.

First analysis results of CO_2 and CH_4 column averaged dry air mole fraction over land using clear-sky observations for April 20-28, 2009 were obtained from the TANSO-FTS shortwave infrared bands on the IBUKI and show that the data is mostly consistent with conventional data observed on the ground.

The TANSO-FTS data and observation image data (TANSO-CAI data) (Level 1 product) should be ready for distribution to registered users in October 2009 and the validated CO_2 and CH_4 column abundances and cloud coverage flag data (Level 2 product) ready in January 2010.



The CO_2 column averaged dry air mole fraction distribution. Data are excluded where the associated radiance spectra are saturated and where noise is relatively large due to weak ground surface reflection.