REPORT OF THE TENTH SESSION

OF THE GEWEX HYDROMETEOROLOGY PANEL (GHP)

(Montevideo, Uruguay, 13-16 September 2004)

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1.0 INTRODUCTION

The tenth annual meeting of the GEWEX Hydrometeorology Panel (GHP) was held near the Río de la Plata and was hosted by Rafael Terra of the Instituto de Mecánica de los Fluidos e Ingeniería Ambiental, Universidad de la República, and chaired by John Roads in Montevideo, Uruguay. The La Plata Basin (LPB) Project was approved as a GEWEX Continental Scale Experiment (CSE) at the 2004 meeting of the GEWEX Scientific Steering Group. During the first two days of the meeting, the CSE and affiliated CSE representatives, GEWEX and affiliated global projects, and GHP working groups made summary presentations on their progress and plans for the upcoming year. Two focused workshops were held on the last day.

GHP coordinates the regional Continental-Scale Experiments (CSEs): the Mackenzie GEWEX Study (MAGS), the GEWEX Americas Prediction Project (GAPP), the Large-Scale Biosphere-Atmosphere Study in Amazonia (LBA), the La Plata Basin (LPB), the Baltic Sea Experiment (BALTEX), the GEWEX Asian Monsoon Experiment (GAME), and the Murray Darling Basin (MDB). The GHP also has an affiliated large-scale experiment, the Analyses Multidisciplinaires de la Mousson Africaine (AMMA), which has now requested CSE status. There are also a few hydrometeorologically relevant projects such as the Global Runoff Data Centre (GRDC), the International Satellite Land Surface Climatology Project (ISLSCP), Global Precipitation Climatology Project (GPCC) and the Coordinated Enhanced Observing Period (CEOP), which make contributions to GHP activities. The International Association of Hydrologic Sciences (IAHS) and International Atomic Energy Agency (IAEA) are an organization and agency that are making substantial contributions to GHP activities.

The GHP is interested in moving affiliated regional experiments toward full CSE status. The main technical requirements are that each CSE should:

1. Have the co-operation of an NWP center;
2. Have a commitment of resources for the development of atmospheric-hydrological models, assimilation, and a program of numerical experimentation and climate change studies;
3. Have a regional scientific co-operation mechanism for collecting and managing hydrometeorological data sets;
4. Promote international exchange of scientific information and data;
5. Have interactions with water resource agencies or related groups;
6. Help in the evaluation of GEWEX global data products; and
7. Contribute to CEOP and transferability databases.

In addition, GHP has requirements that each of the CSEs should undertake the:

1. Simulation of the diurnal, seasonal, annual and interannual cycles;
2. Closure of water and energy budgets;
3. Determination and understanding of climate system variability and critical feedbacks;
4. Demonstration of improvements in the prediction of water-related climate parameters; and
5. Demonstration of the applicability of techniques and models to other regions.

At the meeting it was noted that GEWEX Phase II activities must fit within the goals for the new WCRP strategy called the Coordinated Observation and Prediction of the Earth System (COPES). Activities where GHP could make a strong contribution include water and energy budget studies, precipitation measurement and modeling, and simulation and prediction of the diurnal cycle. There is also an increased emphasis on the integration of activities between the GEWEX panels.

Some highlights from the meeting include the following:

- A review article, “Advancing Global and Continental- Scale Hydrometeorology: Contributions of the GEWEX Hydrometeorology Panel (GHP),” that summarizes the past 8 years of GHP activities will be published in the *Bulletin of the American Meteorological Society* in November 2004.
- Of special concern are the pending completion of GAME (2004) and MAGS (2005) CSE activities. The current plan is to develop a new GAME CSE that would merge CLIVAR and GEWEX activities, similar to the US GAPP and Pan American Climate Studies (PACS) efforts under the NOAA Climate Prediction Program for the Americas (CPPA) and the WCRP Coordinated Observation and Prediction of the Earth System (COPES).

- T. Lebel presented the status of the developing African Monsoon Multidisciplinary Analysis (AMMA) Project, a GHP affiliate program that is likely to become the next CSE as African scientists are entrained into the project.
- A new GHP working group sponsored by IAEA, the Stable Water Isotope Intercomparison Group (SWING) was announced at the meeting. SWING will develop a comparison of models simulating global water isotopes as depicted by the IAEA global database.
- The development of the CEOP *in situ* database, which began under the GHP/DMG and is now beginning to set global standards for archiving and disseminating *in situ* hydrometeorological data.
- The Transferability Working Group (TWG) is making several regional model intercomparisons over the various CSE regions. A summary of this group's activities will be presented to the Working Group on Numerical Experimentation (WGNE)/GEWEX Modeling and Prediction Panel (GMPP) meeting in October and at the GEWEX Scientific Steering Group Meeting in January 2005.

This report summarizes the meeting of GHP-10 and the main issues, actions (Appendix A) and recommendations taken under advisement by the Panel. The meeting agenda can be found in Appendix B and the list of participants in Appendix C.

2.0 STATUS REVIEW

2.1 Continental Scale Experiments (CSEs) Contributions Matrix

The GHP CSE Matrix of Contributions to GEWEX has been set up to gauge CSE contributions to specific technical/logistical and scientific needs of GHP/GEWEX. The criteria that have been set are associated with work that is necessary for GHP/GEWEX to accomplish its global objectives including the successful accomplishment of CEOP especially that aspect associated with the transferability of results across regions of differing climatic regimes. The matrix is given in Figure 1. Action is on the CSE POCs to review and advise the GHP Chair of any updates to the matrix in the time leading up to the next GHP meeting.

Status of Continental-Scale Experiments (September 2004)

TECHNICAL CRITERIA	MAGS	GAPP	LBA	LPB	BALTEX	GAME	MDB
NWP centre atmospheric and surface data assimilation and estimates of hydro-meteorological properties.	F	F	F	F	F	F	F
Suitable atmospheric-hydrological models and numerical experimentation and climate change studies.	F	F	F	Pr	F	F	F
Mechanism for collecting and managing adequate hydrometeorological data sets.	F	F	F	Pr	F	F	I
Participate in the open international exchange of scientific information and data.	F	F	F	F	F	F	F
Interactions with water resource agencies and related groups to address the assessment of impacts on regional water resources.	F	F	F	I	F	F	I-F
Evaluation of GEWEX global data products	F	F	F	I	F	F	I-F
Contributions to CEOP and transferability databases.	F	F	F	I	F	F	F

SCIENTIFIC CRITERIA	MAGS	GAPP	LBA	LPB	BALTEX	GAME	MDB
Simulate the diurnal, seasonal, annual and interannual cycles.	Pr	Pr	Pr	Pr	Pr	Pr	B
Close water and energy budgets.	Pr	Pr	Pr	Pr	Pr	Pr	Pr
Determine and understand climate system variability and critical feedbacks.	Pr	Pr	Pr	Pr	Pr	Pr	Pr
Demonstrate improvements in predictions of water-related climate parameters.	Pr	Pr	Pr	B	Pr	B	Pr
Demonstrate the applicability of techniques and models to other regions.	Pr	Pr	Pr	Pr	Pr	B	B

Table 1 shows the technical and scientific criteria for CSE assessment. Technical criterion rated as functioning (F), initiating (I), or planned (P); scientific criteria rated as completed (C), progressing (Pr), or beginning (B). Again, MAGS, GAPP, LBA, BALTEX, GAME, MDB, and LPB have demonstrated that they have either already or will soon be able to fulfill these criteria. Of major concern are the end of GAME in Dec. 2004 and the pending end of MAGS at the end of 2005. However, it is recognized that AMMA will be a major addition to the current CSEs. These scientific and technical requirements were reviewed at the 10th GHP meeting and it was agreed that they were still valid and should be applied to current and future proposed experiments. In that regard, AMMA has now requested CSE status and the GHP is beginning its review before recommending to the GEWEX SSG whether AMMA should change from its affiliate status to CSE status.

2.2 Consolidated Status Review

The current consensus of the status of the key components of GHP is as follows:

- Water/Energy Budget Closure "Pr"
- Hydrological Modelling (full Coupling) "Pr"
- CEOP "Pr"
- Transferability "B-Pr"
- Predictability "B-Br"
- Water-Resource Community Interactions "Pr"

3.0 STATUS SUMMARIES

3.1 Continental Scale Experiments (CSEs)

3.1.1 Baltic Sea Experiment (BALTEX)

The science plan for BALTEX Phase II (2003-2012) states the following major goals and objectives for the programme:

1. Better understanding of the energy and water cycles over the Baltic Sea Basin;
2. Analysis of climate variability and change since 1800, and provision of regional climate projections over the Baltic Sea Basin for the 21st century;
3. Provision of improved tools for water management, with an emphasis on more accurate forecasts of extreme events and long-term changes;
4. Gradual extension of BALTEX methodologies to air and water quality studies;
5. Strengthened interaction with decision-makers, with emphasis on global change impact assessments; and
6. Education and outreach at the international level.

The objectives of BALTEX Phase I continue to be valid, in particular in those areas, where further progress is expected in the years to come. This is reflected in objective 1 for Phase II.

The science plan for BALTEX Phase II (2003 to 2012) has been published and it reinforces the application of BALTEX Phase I achievements to areas such as climate variability and climate change studies, including scenarios of potential future climate, and environmental investigations related to nutrients and pollutants. Impact studies responding to social needs and supporting decision makers in a broader context of global change issues related to the Baltic Sea basin are envisaged to accompany the research efforts during BALTEX Phase II. Activities will more closely be discussed with, and are expected to be applied by, larger user communities, going beyond WCRP's science community, including water resource managers and intergovernmental bodies for the Baltic Sea and its catchments. It is also important to note that future BALTEX research will continue meeting objectives of Phase I, in particular reducing uncertainties of estimates of water and energy cycle components in the Baltic Sea basin.

More than 110 scientists from 15 countries participated in the 4th Study Conference on BALTEX, which was held on the Danish Baltic Sea island Bornholm, 24-28 May 2004. The Conference was organized jointly by the Risø National Laboratory, the Technical University of Denmark and GKSS Research Centre. 114 scientific presentations (78 oral and 36 posters) were organized in the following sessions:

- Improved understanding of water and energy cycle processes: remote sensing applications, diagnostic studies and field experiments, numerical modeling;
- Trends and variability in the regional climate during the past two centuries;
- Development and validation of advanced modeling tools for regional climate studies;
- Projection of future climate change at river catchment and basin scales during the 21st century;
- Applications for water resources management, including extreme events, long-term changes, and studies on air and water quality.

A dedicated writing team presented a draft implementation plan for BALTEX Phase II at the 17th BALTEX SSG meeting in November 2004. The SSG approved the draft plan conditional upon several improvements to be included under supervision of the BALTEX SSG co-chairs. The final plan is expected to be published in Spring 2005. A dedicated workshop on "Programmes and Projects relevant for BALTEX Phase II" was held in conjunction with the 17th BALTEX SSG meeting to explore in detail future linkages between BALTEX and other projects such as WCRP-COPES, GWSP, LOICZ, HELCOM, MARE and COSMOS.

A review on the achievements of the BALTEX programme is under way. While a report under the guidance of the BALTEX Working Group on Water and Energy Cycles is progressing towards completion in early 2005, parts of this report have already been published, in particular Crewell et al. (2004) with a summary on cloud investigations during the BALTEX BRIDGE period and Lehmann et al. (2004) with a first application of one of the coupled modelling systems developed in BALTEX.

Progress in BALTEX, as was reported at the 4th Study Conference on BALTEX may be summarized as follows:

1. Improved understanding of the processes in the air (such as land surface and air and sea surface and air) and sea ice boundary layers through the exploitation of a variety of new and excellent experimental data sets and the use of models;
2. Exploration and quantitative use of both ground-based and space-borne remote sensing data for various energy and water cycle parameters such as precipitation, cloud properties, water vapor, soil moisture and radiation budget components;
3. Improved precipitation data sets for both the sea and over land based on both gauge and radar data;
4. New measurements and improved understanding of the water mass exchanges within the deep basins of the Baltic Sea and of turbulent mixing in the Baltic Sea;
5. A better understanding of major Baltic Sea inflow events and an improved modeling of extreme inflow events;
6. The water and heat budgets of the Baltic Sea have been investigated with increasing detail; the accuracy of the individual terms needs to be addressed, and further efforts towards analyzing the budgets as well as their long-term trends and variability for the entire Baltic Sea basin are still necessary;
7. Two coupled model systems, RCAO and BALTIMOS, are progressing from their development and validation phases to applications, the potential of these systems has been demonstrated;

8. The necessity of studying and understanding processes at different scales has been highlighted;
9. The need for a stronger focus on uncertainty assessment, including ensemble runs of future scenarios, has been evident; and
10. The trend towards the new objectives of the BALTEX Phase II Science Plan has already been highly visible, new results were presented in particular for:
    - Analysis of climate variability and change since 1800, and provision of regional climate projections over the Baltic Sea basin for the 21st century
    - Provision of improved tools for water management, with an emphasis on more accurate forecasts of extreme events and long-term changes
    - Gradual extension of BALTEX methodologies to air and water quality studies.

The Max Planck Institute for Meteorology, Germany jointly with other institutes is initiating a new community effort towards the development of an integrated Earth System Model. This model system, called "COSMOS" (Community Earth System Models), will represent physical, chemical and biological processes in the atmosphere, ocean and on land. Within the COSMOS program the development of a global earth system model is planned. The aim is to set up a system model out of tested model components which will be coupled via the Programme for Integrated earth System Modeling (PRISM) standards. COSMOS contains a regional component, which will be the Baltic Sea catchment. BALTEX will thus establish a regional pilot component to COSMOS. Based on the two coupled model systems developed independently in BALTEX Phase I (RCAO and BALTIMOS), an earth system model including bio-geo-chemical model components will be developed and applied to Northern Europe including the Baltic Sea basin.

BALTEX website: http://www.gkss.de/baltex

3.1.2 GEWEX Asian Monsoon Experiment (GAME)

The major focus of discussion was on the follow-on activity to the GAME Project. GAME has successfully clarified the basic processes of land-atmosphere interactions through regional experiments and monitoring. However, the mechanisms and the variations in the Asian monsoon are still not clearly understood and those involved in the discussion recognized the necessity for understanding these variations.

GAME (1996-2004) accomplishments in process studies include:

- Important role of topography and diurnal cycles in developing mesoscale systems;
- Important role of land surface conditions (particularly, vegetation and soil wetness) on seasonal change of energy and water balance;
- Large seasonal change of ABL and its impact on convections and rainfall systems; and
- Large radiative forcing of aerosols in east and Southeast Asia (- 50W/m2).

GAME data sets for energy and water cycle processes in monsoon Asia include:

- GAME reanalysis data (global);
- GAME/HUBEX regional reanalysis data;
- Surface radiation/energy flux data:
    - AAN data set (in-situ) and
    - Satellite-based data sets;
- High quality/resolution rainfall data;
- Surface soil moisture/snow cover data; and
- Comprehensive data sets for IOP 1998-2000.

Examples of GAME data studies:

- Diurnal change of surface temperature over the Tibetan Plateau (April 1998) time/space distribution and seasonal cycle of surface temperature (Jan-Dec 1998);
- Surface temperature yearly variation–long-term trend of increasing minimum temperature. Possibly due to global warming;

- Rainfall producing cloud systems are very different from place to place and from time to time, which may be due to differences in soil moisture; and
- Orographic forcing seems to be important in the early stage in the diurnal cycle of convective systems over the Tibetan Plateau.

Recent activities in cloud and precipitation processes:
- GAME/HUBEX and
- Structure of heavy rainfall system.

Post GAME activities will include assessing and predicting changes in the hydrological cycle associated with global warming and other anthropogenic impacts. A new international initiative and framework for promoting these studies is needed. GAME has provided a good opportunity to initialize or initiate this activity in monsoon Asia.

The GAME follow-on project will be restructured to focus on the *ad hoc* Group on Earth Observation (GEO), the IGOS Water Cycle Theme structures, and the WCRP/COPES. Other international coordination and collaboration is planned with the CLIVAR A-A Monsoon Panel, the START/TEACOM Monsoon Asian Integrated Regional Study (MAIRS), and the Asian-Pacific Society for Hydrology and Water Research (APHW).

Plans for a post-GAME project include further collaboration in Asia to assess and predict changes in the hydrological cycle associated with global warming and other anthropogenic impacts.

Scientific Issues to be addressed by post GAME:
- How the hydrological cycle and hydro-climate in monsoon Asia is changing (or has changed) associated with "global warming (GHG increase)" and
- How regional-scale anthropogenic impacts (e.g., land cover/use changes, forest fire, dust increase etc.) affect changes in hydrological cycle and the hydro-climate in Asia?

Strategies for a post GAME project include:
- Simulation of Asian monsoon variability by high-resolution GCMs and CCMs (as part of the Earth-Simulator Program);
- Evaluation of large-scale vs. local-scale field impacts on various monsoon hydro-climate processes using area-variable RCMs;
- Establishment of super site network;
- Integrated data center for hydrometeology in Asia; and
- Application of Asian monsoon hydro-climate prediction to human activities (agriculture, health, disasters etc.).

The 9th GAME International Science Panel (GISP) Meeting, 1-2 December 2004 and the 6th International Study Conference on GEWEX in Asia and GAME, 3-5 December 2004 will be held in Kyoto, Japan.

GAME website: http://www.hyarc.nagoya-u.ac.jp/game/

3.1.3 GEWEX Americas Prediction Project (GAPP)

The GEWEX Americas Prediction Project (GAPP) was approved and initiated in 2001 and is expected to continue until 2007. GAPP has two scientific objectives: 1) to improve intra-seasonal to interannual climate prediction focused on improved understanding and modeling of land-atmosphere interactions; and 2) to improve decision support through interpretation of climate forecasts and use of GAPP research results for water resource management applications.

Status of GAPP Activities:
- The GAPP Science and Implementation Plan (S & IP) has been completed and has been sent to the National Research Council for review. The GAPP S & IP has also been reviewed and

discussed in the 2004 GAPP PIs meeting held in Boulder, Colorado and modified based on the PIs recommendations;

- The special GCIP/GAPP JGR issue has been completed. The articles can be accessed at the website at http://www.agu.org/journals/ss/GCIP3/. The hard copies have been distributed;
- In FY04, GAPP funded 22 new projects;
- After merged with CLIVAR/PACS, GAPP continued to support GEWEX Phase-II objectives under the NOAA Climate Prediction Program for the Americas (CPPA) program. The GAPP-PACS merger put GAPP in a better position to contribute to WCRP/COPES initiative;
- GAPP participated in many international GEWEX activities, such as NAMAP, PILPS, GSWP-2, and GLACE;
- GAPP supported CEOP through CEOP Reference site data management and participating various research activities such as WESP and monsoon studies;
- The North American Monsoon Experiment (NAME) 2004 field campaign was primarily sponsored by NOAA/OGP (PACS and GAPP programs) has been successfully completed. The field campaign, the PACS/GAPP support and NWS/OAR collaboration were greatly praised by the new NWS director DL Johnson in his recent email to OAR director Rick Rosen.
- Under the support from GAPP, NCEP Environmental Modeling Center (EMC) has completed its 25-year North America Regional Reanalysis (NARR). The real time NARR system has been transferred to NCEP's Climate Prediction Center (CPC) as a climate–monitoring tool. The NARR data can be accessed from NCEP and NCDA. The NARR User Workshop will be held in January 2005 in conjunction with the 2005 AMS meeting.

3.1.4 Large-Scale Biospheric Experiment in Amazonia (LBA)

LBA is a multi-disciplinary, international research effort, designed to understand the climatological, ecological, biogeochemical and hydrological functioning of Amazonia, its interaction with the Earth system, and its response to land use change. Over 1200 investigators are involved in about 90 studies in the LBA related to physical climate, atmospheric chemistry and composition, carbon storage and exchange, biogeochemical cycles, land-surface hydrology and water chemistry, and land use and land cover changes and human dimension programs.

Special issues of the Journal of Geophysical Research, Theoretical and Applied Climatology, Global Biogeochemical Cycles, Remote Sensing of the Environment, Ecological applications, Global Change Biology and Acta Amazonica have been or will be published with papers presented at the First and Second LBA Science conferences during 2002-2004. The Third LBA Science Conference took place in Brazil in July 27-29, 2004. About 720 participants were registered at this conference, and there was a significant number of students from Brazil and abroad. An extensive set of scientific results of LBA field experiments (LBA-TRMM, LBA-RACCI, SALLJEX-CLAIRE, LBA/SMOCC, and others) were presented in a special session of the EGS-AGU-EUG Joint Assembly in Nice, France, and the IUGG science meeting in Sapporo, Japan in 2003, the Brazilian Congress of Meteorology in August 2004, and at the AGU Meetings in 2004.

Some of the subjects discussed during the Third LBA Science Conference included*:* Climate-Vegetation Interactions in Amazonia, Deforestation and Biomass Burning as Drivers of Regional Climate Change in Amazonia, Smoke Aerosols, Clouds, Rain and Climate, Patterns of land cover change and land use intensification, Population Dynamics in the Amazonian Frontier, Compositional Changes in Undisturbed Neotropical Forests and Their Implications for Carbon Dynamics, Carbon stocks and sequestration in above-ground wood biomass of Central Amazonian white-water floodplain forests*,* Water and Energy and Balances of the Amazon Basin, Ecophysiological and Biochemical Responses of Tropical Plants to Elevated CO2, Carbon Exchanges Between Aquatic Environments, Land, and Atmosphere, and new initiatives that include Role of Amazon Ecosystem in Determining Regional and Global Climate Variabilities, Terra/Aqua MODIS Data and Products for LBA Science: Current Results and Opportunities for Data Integration and Synthesis, Accuracy Assessments and their Implications for Fire and Deforestation Monitoring, Disturbance Events and Tropical Forest Ecology and Biogeochemistry.

The overall timeframe for LBA Phase I is 1996–2005. In 2002 and in the first half of 2003, several activities took place including the installation of the measurement and monitoring components at the LBA

research sites (reference sites in flux towers and one hydrological site). During LBA Phase I, the LBA-DRY-TO-WET field campaign took place in Rondonia during September-November 2002, during the transition season from dry to wet season in Amazonia. This project was a cooperation between Brazil, Europe, and the United State. The objective was to analyze the evolution of cloud microphysics and rainfall from a very polluted atmosphere loaded with a high concentration of aerosol and trace gases from biomass burning to a pristine condition typical of the rainy season. The second major field campaign was the SALLJEX-Brazil that took place during the austral summer of 2003. This SALLJEX-Brazil is a Brazilian component of the SALLJEX initiative from the CLIVAR-VAMOS program on the South American monsoon, and represents a collaboration between GEWEX and CLIVAR. The focus of the experiment is to understand the low level jet to the east of the Andes and the moisture transport between the Amazon Basin and the La Plata Basin in southeastern South America. During 2004, LBA scientists are in the process of data analyses and synthesis of results from these field experiments, and observational and model analysis are and will be performed to accomplish the objectives of these field experiments in the context of LBA science questions.

LBA/BARCA

One of the major activities of LBA Phase II will be Regional Atmospheric Carbon Budget in Amazonia Balanço Atmosférico Regional de Carbono na Amazônia (LBA/BARCA). The specific objective of LBA/BARCA is to address the basin-wide budgets of CO2, CH4, and water, and to define the origin of the signal of CO_2. Major field campaigns as part of BARCA/LBA are planned for 2005. BARCA is a proposal emerging from Brazilian scientists for two intensive aircraft measurement campaigns to collect data that is quantitatively and qualitatively different from current data for atmospheric concentrations measured over the entire Amazon Basin and adjacent waters. This document requests a Scientific Expedition License for US colleagues to participate, to complement the aircraft instrumentation, and to aid in data interpretation. A new modeling framework designed to determine spatially resolved sources and sinks of CO_2, CO, and other gases at short and long time scales will be applied, which combines high-resolution atmospheric transport with models of surface fluxes. The framework merges data and models to derive the state of the atmosphere and the carbon cycle that is consistent with the aircraft observations as well as a variety of other data streams, such as soil properties, remotely-sensed vegetation data, and flux measurements. These optimally constrained models will provide the most reliable diagnostic and predictive capability for surface-atmosphere fluxes of CO_2 and CO in the data-rich environment of LBA.

Extensive airborne measurements over Amazonia are envisioned to cover horizontal scales of 100~1000 km, altitudes of 0.15-12 km, and of most daytime hours that closely coordinated with ground measurements at LBA towers and at the coastal station, INPE-Natal. Flight planning will be guided by transport simulations using high-resolution assimilated meteorological fields, currently under development at the Universidade de São Paulo (USP) and the CPTEC. In this way, BARCA will:

- Directly quantify regional to Basin-scale fluxes in Amazônia using airborne measurements of CO_2 and other tracers in and above the planetary boundary layer (PBL);
- Establish relationships between vertical concentration gradients and exchange fluxes observed at the eddy flux towers, started in LBA, and over adjacent regions;
- Test hypotheses central to the Brazilian Millenium Institute that Amazonia is a major net source or sink for CO_2; and
- Characterize horizontal and vertical distributions of atmospheric CO_2 over Amazonia for the purposes of planning remote sensing instrumentation.

BARCA plans to conduct airborne measurements during both the wet and dry seasons to characterize the seasonal variability of carbon fluxes. Proposed regional experiments over natural and disturbed ecosystems will deliver regional carbon fluxes over different land surfaces, especially the developed and undeveloped districts of Rondonia and Pará, while the large-scale transects yield Basin-scale flux over all of Amazonia.

BARCA is inherently a collaborative effort that combines a range of disciplines and spans multiple spatiotemporal scales. The Millennium Institutes, with a tradition of cross-discipline, cross-border collaborations, will provide the institutional foundation. BARCA will enhance and be enhanced by key selected projects started in LBA and continued as collaborations between Brazilian, US, and European educational and scientific institutions. Eddy covariance data from towers provide a continuous time series

of fluxes and concentrations, allowing for the correction of the fair-weather bias inherent in low-level aircraft operations and to generalize conclusions based on two seasonal studies. BARCA measurements of regional and Basin-scale exchange fluxes provide the scaling-up of tower data.

LBA reference sites

As part of the GEWEX efforts, six LBA references sites have been included in the CEOP strategy and they have started to report data for some particular periods (EOP-1 and 3), for intercomparison with other references sites from other GEWEX CSEs. The modeling component of CEOP has allowed the release of model output from global models from menu numerical centers of the world, so intercomparison can be made between the reference sites data-upper air profiles foe each reference site and model output for a grid box nearest to the reference sites. In relation to the GHP, studies on water and energy balances have been performed using observations from the LBA reference sites, the CPTEC COLA AGCM, the NCEP reanalyses and various rainfall girded data sets. Issues like prediction and predictability in the water and energy balances as well as hydrological predictability are currently being investigated.

A hydrological reference site has been implemented in northern Amazonia nearby Manaus (Igarapê Asu). The Asu catchment is located at approximately 40 km NNW of Manaus, at 3 08N, 60 07 W. The catchment, with a drainage area of a 6.37 km2, collects the discharge of the five first order streams, encompassing the most common landscape forms that occur in the region.

Main scientific results of LBA Phase I

Some of the main scientific results of the different field campaigns and LBA studies are summarized below:

1. The daily cycle of the energy budget at the pasture and forest shows differences between morning and afternoon behavior. Rn is larger at the forest in the morning and larger in the pasture in the afternoon. This result would imply cloudier skies over forest in the afternoon. It would also mean there is a lower cloud base in the morning over the forest since LE is always larger at the forest while H is similar during the morning, as in the afternoon, and larger over the pasture in the afternoon.
2. In a day that starts sunny and clear, the temperature evolution favors a faster evolution of the mixed layer over forest. After rains start at different times over the forest and the pasture in a particular day, the continuous evolution is broken.
3. The character of precipitation over Amazonia varies from a very continental behavior in the pre-rainy season to a more maritime regime during the rainy season. More importantly, during the rainy season there is an alteration between a more maritime to a more continental regime associated with large scale controls, such as the presence or absence of a large scale, low-level convergence provided by approaching mid-latitude, frontal boundaries or even the establishment of the South Atlantic Convergence Zone.
4. Studies on the diurnal cycle of rainfall have shown that there is an apparent preference for maximum rainfall intensity to occur between 1200 and 1600 LST, and sometimes 1800 LST, while in some periods a second maximum is seen between 0000 and 0400 LST.
5. Seasonal variability in the Amazon Basin has been observed for concentrations of aerosol particles, cloud condensation nuclei (CCN), and trace gases. This seasonal variability is mostly caused by emissions from biomass burning in the dry season (July–October). In terms of aerosol optical depth measurements using a network of sun-photometers, background aerosol column amounts to 0.10–0.15 at 550 nanometers in the wet season. In the dry season, values of 2.5–3 are observed over large areas.
6. All of the above features in the different wind regimes can be organized into two modes of convection. During the easterly regime, convective systems are more continental, with vigorous convective cells, more isolated, with a well-defined mix of ice water regions and frequent lightning. During the westerly phase, the systems are larger and more stratiform, there is no mixed ice water phase region and almost no lightning. To incorporate the role of CCN into this picture requires examining the dynamic/thermodynamic forcing provided by different regimes.
7. The atmospheric water balance in the Amazon basin, based on rainfall observations in the region, show that there is a seasonality and interannual variability of the water balance that varies across the basin. Because of its larger size, southern Amazonia dominates the seasonal cycle of the water balance of the entire region, while at interannual time scales rainfall anomalies in

northern Amazonia modulate the water budget of the entire basin. In the entire Amazonia, precipitation exceeds evaporation representing a sink of moisture (P>E). Our estimates of the Amazon region's water balance do not show a closure of the budget, with an average imbalance of almost 50%, meaning that some of the moisture that converges in the Amazon region is not unaccounted.

8. A new version of the Hydro-NET (C. Vorosmarty, personal communication) or Hydrological Routing Network is being developed for the Amazon, which will simulate time-varying flow and storage of water in hydrological systems, including rivers, floodplains, wetlands, lakes, and human-made reservoirs.
9. A hydrological model for Brazilian macro basin of the Igarape Asu is also being developed which will integrate existing meteorological, topographic, vegetation and pedological data, together with remote sensing derived products. The model will be used primarily as a real-time monitoring tool capable of providing updated information about soil moisture and river discharges to support several economic activities related to water management.
10. Research is underway to understand and model the influence of land-cover change on the stream flow of Amazonian river basins with areas of approximately 10,000 km^2. To achieve that goal, the research will try to quantify the influence of both climate and land-cover change on river flow in mesoscale Amazonia to understand processes governing those influences, and to define the range of basin size over which land use affects the hydrology of rivers. The Experimental catchment is located nearby Manaus, and has been implemented close to Manaus to gain understanding of the carbon exchanges between soil vegetation and atmosphere on a pristine forest.
11. Continuous activities such as the FLUX TOWER monitoring (started in 1999) and the SIVAM project (started in October 2002), are integral part of LBA and derived high quality observations needed in support of LBA studies in climate, Hydrology and ecology.
12. In relation to LBA-DIS, during 2004 LBA experienced significant gains in both metadata and data submission. A total of 269 new metadata records (net gain of 42%) were created by LBA PIs and 90.1 Giga bytes (net gain of 74.8%) of new data were submitted and archived in the LBA-DIS server at CPTEC/INPE. Although this growth is substantial, continued effort is made by LBA-DIS personnel to make sure that every byte of information collected by LBA research teams is cataloged (via metadata records) and stored at CPTEC. Modeling studies on the role of vegetation on climate and climate change indicate that the Amazon basin may become a savanna during middle 2050's, where temperatures may increase by up to 8C and rainfall during the summer and autumn seasons would decrease by almost 50%. The results obtained from the HadCM3 model with iterative vegetation are still uncertain and there is a need for similar experiences using other models.

Additional information about LBA activities is available at http://lba.cptec.inpe.br/lba/; including LBA Data sets.

3.1.5 La Plata Basin (LPB)

The long-term goal of La Plata Basin (LPB) CSE is to improve understanding and prediction of the basin's climate and hydrology based on their unique regional features and sensitivity to the variability of remote climates. Specifically, LPB addresses the following questions:

- How predictable are the regional weather and climate variability and their impact on hydrological, agricultural and social systems of the basin?
- How are droughts and floods in the basin characterized from a climatological and hydrological point of view?
- What is the role of global climate change and land use change on regional weather, climate, hydrology and agriculture?

LPB has many unique features:

- Large area with important influences of the South American monsoon and extra-tropical weather systems;
- Large bodies of water, both on the surface and underground;
- Very strong convective storms and associated floods;

- Hydroclimatology strongly affected by ocean conditions in the Pacific and Atlantic oceans;
- River stream flow time series with quasi-periodicities in several timescales (interannual-ENSO, interdecadal);
- Major shift in precipitation and the discharge of many rivers in the late 1970s; and
- A considerable land cover change in the last 50 years confounds interpretation and explanation of climate and hydrology signals.

LPB is coordinated in its initial stages by the PLATIN Science Study Group (SSG), which is currently co-chaired by C.R. Mechoso representing CLIVAR/VAMOS and P. L. Silva Dias representing the GHP. CLIVAR and GEWEX formed the PLATIN SSG in recognition that LPB is a climate-hydrology system with components that are potentially predictable with useful skill from seasons in advance, and whose variability has important impacts on human activities. For more information please visit the PLATIN website (www.atmos.ucla.edu/~mechoso/platin).

Summary of Progress

Floods
There has been significant progress towards a better understanding, modeling and prediction of flood events in the Uruguay River. In Salto Grande, on the Uruguay River, floods in the second half of the past century lasted between 3 and 10 days. The highest river levels occurred mostly during the cold semester due to intense rainfall 9 to 12 and from 1 to 4 days before the flood. Almost half of the extreme flood events were associated with enhanced precipitation and moisture flux convergence in the SALLJ region. It was also shown that most extreme events of monthly discharge at Paso de los Libres occurred during El Niño. I. Camillioni and R. Caffera reported these findings in *AIACC.*

CLARIS
CLARIS is a European Union funded project aimed at the development of a network in South America for climate change assessment and impact studies. The project principal investigator is Jean-Philippe Boulanger (Institute Pierre Simon Laplace, Paris, France). CLARIS will promote coordinated work in the LPB. The project's kick-off meeting was held in Foz de Iguazu, Brazil, 20-24 September 2004.

Specifically, CLARIS will promote and facilitate the technical transfer of expertise in Earth System and Regional Climate Modeling between European and South American researchers and institutions, as well as strengthen communications between climate researchers and stakeholders. The project will develop a high-quality database for studies on extreme events and long-term trends of the South American climate, and create scenarios for regional climate/hydrology change. LPB research will clearly benefit from a planned survey of land use and reservoir management, including impacts on the socio-economic and ecology systems, and the hydrodynamical modeling of stream flows in order to assess impacts of changes in climate/hydrology and land use on river stream flow. Other activities include the coordination and integration of regional operational systems for climate/hydrology, and the development of strategies and procedures to facilitate the use of predictions in the integrated management of water resources in the basin.

SALLJEX
A review paper was submitted to the Bulletin of the American Meteorological Society. This paper describes the motivation for a field activity in the region, the special SALLJEX observations, and SALLJEX modeling and outreach activities. Preliminary results indicate significant impact of SALLJEX observations upon a case study, as well as improvement in the precipitation structure of an MCS in Northern Argentina. Model experiments will focus upon the origin and maintenance of the East Andes LLJ, and study a variety of mechanisms, including: topographic impact on trade winds; orographic effect in the absence of latent heating; impact of latent heat release upon the LLJ; impact of surface thermal heating relative to upper level forcing associated with transient perturbations of the westerlies; propagation of low-level wind bursts from the North Atlantic towards the Plata Basin; cold surges (southerly case); and synergism among the previous mechanisms. SALLJEX also provided important information concerning the future recommendation to the operational services on the data platforms necessary to improve weather forecasts. The SALLJEX data basis contains, in addition to the special observations, the full GTS data flow.

The CLIVAR-Exchanges Newsletter No. 29 (March 2004) contains a series of short papers on SALLJEX preliminary results on the impact of the additional data on the quantification of the moisture transport and on the improvement of weather forecasts due to more accurate data assimilation.

GEF Program
The United Nations Development Program (UNEP), Organization of American States (OAS) and Intergovernmental Coordinating Committee for La Plata Basin (CIC), with the participation of PLATIN, requested funds to the Global Environmental Facility (GEF) to support planning and implementation of strategic actions to be taken by the governments of countries in La Plata Basin for the environmentally and socially sustainable economic development of the basin. Areas specifically targeted are protection and integrated management of water resources and adaptation to climatic change and variability. The request was allocated Block A and Block B funds.

Under the GEF Framework Program, PLATIN produced surveys of the LPB's hydroclimate, including the systems used for its prediction and monitoring. There are reported in four documents:

1. Characterization of the Climate and Hydrology of LPB, Variability and Extremes;
2. Numerical Models for Prediction of Climate and Hydrology Variability and Change in LPB and other Large River Basins;
3. Methods for Prediction of Extreme Climate and Hydrology Events in LPB and other Large River Basins; and
4. Technical and Instrumental Basis for Implementation of an Integrated Climate and Hydrology Prediction System in the LPB.

The PLATIN-related activities in the same program are currently focusing on the development of plans on different aspects of the LPB's hydroclimate. These plans can be an integral part of the LPB CSE implementation plan, and contribute to their funding in a significant way.

Web Site and Database
The LPB website can be accessed through the GEWEX page (www.gewex.org), the CLIVAR page (www.clivar.org) or directly at www.atmos.ucla.edu/~mechoso/platin). The website includes an extensive list of references to papers of relevance to LPB. Significant upgrades have been made to the LPB CSE Database (www.ucar.joss.edu/platin)

Other Activities
The current activities are conductive to the development of a comprehensive implementation plan for the basin. GHP and VAMOS are encouraging the set up of an organizational structure for the CSE based on strong regional leadership and participation. It has been suggested that the PLATIN co-chairs will continue as CSE coordinators until the new structure is in place. An e-mail discussion on these matters was started. LPB is part of the MESA/VAMOS program. The MESA/SWG has recently appointed and the first MESA SWG meeting will be held in Mexico between 9 and 11 March 2005. The MESA implementation plan will be discussed in that meeting and it is expected that MESA will also be co-sponsored by CLIVAR and GEWEX.

3.1.6 Mackenzie GEWEX Study (MAGS)

The major objectives of MAGS-2 are to:

- Integrate knowledge of atmospheric and hydrologic cycles into a unified system;
- Develop a suite of models for a range of spatial and temporal scales; and
- Apply improved predictive ability to climatic, environmental and social issues.

The MAGS International Advisory Panel (IAP) comprising Dennis Lettenmaier (Chair), Tetsuo Ohata, and John Roads was asked by the MAGS Project to review our progress at the end of 2003 as part of a "self-evaluation" exercise. The review was based on a scientific status report prepared to facilitate the review, presentations at our annual scientific meeting, posters, and discussions with MAGS scientists. In its review of MAGS, the IAP stated "that MAGS-2 has made impressive progress, as measured by accomplishments relative to the 5 goals and 11 objectives (of MAGS), by publication of research in archival journals, support of graduate students, and by participation in international GEWEX activities".

Summary of progress for 2004
MAGS research in 2004 has been focused on activities to attain the major objectives 2 and 3 above. Three major activities include MAGS WEBS, finalizing the development of MAGS suite of models, and transferring science to society (operations; other scientists; private sector) via links with stakeholders.

MAGS WEBS:
- All calculations are complete and
- Synthesis article and data CD now under preparation

MAGS suite of models
At the forefront of MAGS modeling activities is the development of a fully-coupled atmospheric-land surface-hydrologic model:
- CLASS 3.0 hydrologic land surface scheme is now complete and is being tested on research sites.
- The hydrologic land surface scheme has now been fully-integrated with the CRCM and is being validated.

Other MAGS models, such as river models (runoff, spring break-up), lake models (evaporation, storage), frost model (permafrost), runoff models (for Canadian Shield), and blowing snow models are incorporated into the coupled model to improve its performance, but are also being used in isolation to address specific issues.

Transferring science to society
- MAGS is applying its improved predictive ability to climate, environmental and social issues through "Demonstration Projects" (projects established at the first scientist-stakeholder workshop held in June 2003 to demonstrate how MAGS results can be transferred to stakeholders).
- MAGS 2nd Scientist-Stakeholder Workshop is being held 15-17 September 2004. Specifically, the purpose of this meeting is to:
- report on collaborative experiences in "demonstration projects" from both scientists' and stakeholders' perspectives;
- consolidate, broaden, and establish new links between stakeholders and scientists for collaborations to address problems of mutual interest;
- increase public awareness of where MAGS is at with regards to transferring its science to society.

Other highlights of the MAGS scientific activities during 2004 have been:
- Research on large northern lakes expanded to include Great Bear Lake;
- MAGS continues it outreach activities by (1) training and hiring local aboriginal people to assist in monitoring the environment (climate, weather, lake ice growth and decay, etc.) at Great Bear Lake, and (2) giving talks at schools and town hall meetings in northern communities;
- Gridded climate change scenarios for the Mackenzie Basin (changes in surface P and T), based on output from several GCMs, have been constructed and added to MAGS data archive;
- MAGS co-sponsored with PUBS (IASH), CSHS and WSC the workshop "Predicting Ungauged Stream flow in the Mackenzie Valley: Today's Techniques and Tomorrow's Solutions (Yellowknife, March, 2004);
- Joint MAGS/GAPP Sessions at the 2004 AGU-CGU Joint Assembly (Montreal, May, 2004);
- MAGS Special Session and Workshop entitled "Toward a Deeper Understanding of the Regional Climate of the Mackenzie River Basin" (with participants from CLIVAR-Canada) at the 2004 CMOS Congress (Edmonton, June, 2004); and
- 1998/99 CAGES Water Year data CD is being prepared.

MAGS also continues its strong contribution to GHP initiatives such as WEBS, WRAP and Water Sources and Cycling as well as its interaction at national and international levels with other organizations and agencies with common interests (e.g., GAME-Siberia, CEOP, CLiC, and CASES).

In summary, the MAGS scientific program is on or ahead of schedule in meeting its objectives. The establishment of strong linkages between stakeholders and scientists, and reaching out to the northern communities continue to be key elements of our ongoing activities.

Steps needed to achieve objectives:

1. Complete validation of the fully-coupled model;
2. Consolidate, broaden, and establish new links between MAGS scientists and stakeholders;
3. Orchestrate a collective effort among MAGS investigators to synthesize results to enhance; and understanding of the basin's climate system.

Milestones:

1. Delivery of the fully-coupled model;
2. Workshops and articles summarizing the results and achievements of the collaborative projects with stakeholders; and
3. Workshops and publications summarizing improved physical understanding of the basin's climate system.

Wrap-up and Future Considerations

The MAGS project funding under the Natural Science and Engineering Research Council (Canada) Research Network Grant program ends Dec 31, 2006. Considerable effort is currently being focused on developing a set of wrap-up that include the establishment of a data legacy structure, a major scientific meeting in the national capital, a series of press releases on major findings, a book on cold regions hydro-climate science based on MAGS research, and the development of future research directions and programs.

Several follow-up research projects have already arisen from the MAGS initiative and several others are in development. Some recent changes in the Natural Science and Engineering Research Council (Canada) Research Network Grant program under which MAGS was supported, mean that it is not currently possible to initiate a new research network in support of GEWEX goals. However, there is a need to build on the scientific findings of MAGS and to address new issues. Toward this end, MAGS is proposing the development of a Canadian GEWEX coordinating committee and secretariat to support the development and implementation of new research focused on improved understanding of the global water and energy cycle.

MAGS website: http://www.usask.ca/geography/MAGS/

3.1.7 Murray-Darling Basin (MDB) Project

The major objectives of Murray-Darling Basin (MDB) are to:

1. Monitor and predict the daily water budget;
2. Develop real-time products for water agencies;
3. Observe, understand and model processes controlling soil moisture;
4. Improve the representation of land surface processes in weather and climate models which can assist in the prediction of land salinization and water resource management; and
5. Estimate carbon and moisture exchanges between the atmosphere and the land surface in the MDB, with an emphasis on emissions from salinity affected areas.

For each objective the following progress has been made:

1. Monitor and predict the daily water budget
   - A study to calculate the water and energy balance of the Murray Darling Basin as been initiated.
   - A study using naturally-occurring radioactive and stable isotopes together with nuclear techniques characterizing key processes driving cycles of interaction between the land surface and the atmosphere boundary layer on diurnal and seasonal timescales continued.
2. Develop real-time products for water agencies
   - A project to provide an irrigation authority with forecasts of rainfall and evaporation continues.

- Workshop on the use of rainfall, soil moisture, and evaporation forecasts in the Australian water industry and the application of isotopic techniques has been scheduled for October 2005.

3. Observe, understand and model surface processes
   - The network of soil moisture sites has been expanded.
   - Flux tower observations continue.
   - Funding for a field campaign of aircraft measurement of boundary layer fluxes has been secured.
   - A study applying isotopic techniques to water balance studies in regional basins continues under the GNIR (Global Network for Isotopes in Rivers) project.
4. Improve representation of land surface processes
   - Land surface scheme used by the Bureau for NWP has been evaluated and an assessment of the impact of large irrigation areas has been completed.
   - IPILPS (Isotopes in the Project for Intercomparison of Land-Surface Parameterization Schemes) has been initiated to contribute to an international intercomparison of current state-of-the-art isotope parameterization efforts in coupled climate, atmospheric and earth system models by promoting comparison among land-surface schemes that incorporate isotopic representation under the auspices of GLASS.

Steps needed to achieve objectives:

- Establish the MDB web site and
- A multi-agency project to achieve the MDB objectives is being developed and we expect to finalize this during 2005.

Milestones:

- Delivery of improved rainfall forecasts due to better initialization and/or models of surface processes;
- Workshops and articles summarizing the results and achievements of the demonstration projects;
- Workshops and publications summarizing improved physical understanding of the basin's climate system; and
- Dissemination of outputs to national/international collaborators and the scientific community via communications in peer-reviewed journals, reports and presentations on a) quantification of physical mechanisms underlying exchange, mixing and transport processes and feedback in the lower atmosphere on diurnal and seasonal timescales in the MDB, b) characterization of the dynamics of carbon and moisture exchanges in salinity affected areas, and c) experimentally-based evaluations of atmospheric transport and dispersion models, and land surface schemes.

3.2 CONTINENTAL-SCALE AFFILIATES (CSAs)

3.2.1 African Monsoon Multidisciplinary Analysis (AMMA)

AMMA is an international project to improve the knowledge and understanding of the West African monsoon (WAM) and its variability with an emphasis on daily-to-interannual timescales. AMMA is motivated by an interest in fundamental scientific issues and by the societal need for improved prediction of the WAM and its impacts on West African nations. Vulnerability of West African societies to climate variability is likely to increase in the next decades as demands on resources increase in association with one of the World's most rapidly growing populations. Vulnerability may be further increased in association with the effects of climate change and other factors linked to the fast growing population such as land degradation and water pollution. Recognizing the societal need to develop strategies that reduce the socioeconomic impacts of the variability of the WAM, AMMA will facilitate the multidisciplinary research required to provide improved predictions of the WAM and its impacts. AMMA has three major objectives:

- To improve our understanding of the WAM and its influence on the physical, chemical and biological environment regionally and globally.
- To provide the underpinning science that relates variability of the WAM to issues of health, water resources, food security and demography for West African nations and defining and implementing relevant monitoring and prediction strategies.

- To ensure that the multidisciplinary research carried out in AMMA is effectively integrated with prediction and decision making activity.

AMMA will promote international coordination of ongoing activities, basic research and a multi-year field campaign over West Africa and the tropical Atlantic. The Project will develop close partnerships between those involved in basic research of the WAM, operational forecasting and decision making, and it will establish blended training and education activities for African technical institutions and schools.

Scientists from more than 20 countries, representing more than 40 national and pan-national agencies are involved in AMMA. In addition to international structure which has been set up, a network of African scientists linked to AMMA has been established (AMMANET), which will help to consolidate existing collaborations in Africa and to federate initiatives through a pan-African partnership. At this time, funding is largely secured in Europe (mainly in France, Germany, UK and the European Union) up to 2010. Other international efforts are underway to help mobilize the extra funding needed to achieve all the AMMA aims.

We are currently hindered in providing skillful predictions of WAM variability and its impacts. There are still fundamental gaps in our knowledge of the coupled atmosphere-land-ocean system, at least partly arising from lack of appropriate observational data sets but also because of the complex scale interactions between the atmosphere, biosphere and hydrosphere that ultimately determine the nature of the WAM. The monitoring system for the WAM and its variability is inadequate with many gaps in the standard routine network and lack of routine monitoring of some key variables. While the next generation of satellites will undoubtedly help with routine monitoring and prediction efforts, more research is required to validate and exploit these data streams. Dynamical models used for prediction suffer from large systematic errors in the West African and tropical Atlantic regions; current models have problems simulating fundamental characteristics of rainfall such as the diurnal, seasonal and annual cycles. Finally, there is a lack of integrative science linking the work on WAM variability with work on food, water and health impacts. More effort needs to be made to integrate scientists working in these different areas.

Further motivation for a research project concerned with WAM variability and predictability comes from recognizing the role of Africa on the rest of the world. Latent heat release in deep cumulonimbus clouds in the ITCZ over Africa represents one of the major heat sources on the planet. Its meridional migration and associated regional circulations impact other tropical and mid-latitude regions, as is exemplified in the known correlation between West African rainfall and Atlantic hurricane frequency. In addition to the large-scale interactions, we know that a majority of hurricanes that form in the Atlantic originate from weather systems over West Africa; however we know little about the processes that influence this and why only a small fraction of these “seedlings” actually become hurricanes.

The WAM system provides an ideal framework for considering scale interactions in a monsoon system: it possesses pronounced zonal symmetry with characteristic jets and associated well-defined weather systems. Research on such scale interactions and in particular those linking dynamics and convection with the land surface will be relevant to other monsoon systems and is needed in order to improve coupled atmosphere-ocean-land models used for weather and climate prediction. In order to carry out this research extra observations are needed.

West Africa is also an important source region for natural and anthropogenic emissions of precursors to key greenhouse forcing agents (e.g. ozone, aerosols). For example, Africa contributes around 20% of the global biomass burning fires. These emissions are modulated by the activity of the WAM, but in contrast to other surface impacts they feedback directly on the climate. Long-range transport of trace gases out of West Africa has important implications for the global oxidizing capacity of the atmosphere (which controls the level of many greenhouse gases), global climate change and the transport of key constituents (e.g. water vapor, ozone depleting substances) into the stratosphere. The fires also produce huge quantities of particles, complex mixtures of organic materials and black carbon.

Tropical Africa is the world’s largest source of atmospheric dust. Both the fire aerosols and dust play a major role in radiative forcing and in cloud microphysics, and thus are an important part of WAM system. A key priority is to determine the transport of trace gases and aerosols from the surface to the upper

atmospheric layers and the subsequent transport by the WAM. It is thus necessary to study the dynamics and the chemistry of the atmosphere in the same framework.

To deal with all the major issues raised above will require a major coordinated international effort involving a multidisciplinary approach to the West African monsoon linking observations, data analysis and modeling on a wide range of space and time scales.

To address the multiple scales that characterize the WAM, AMMA is structured around four interacting spatial scales:

1. Global scale. This is the scale at which the WAM interacts with the rest of the globe; emphasis is given to improving our understanding of the role of global SST patterns on WAM variability; seasonal-to-decadal variability are the main time scales of interest.
2. Regional scale. This is the scale at which we consider monsoon processes and scale interactions; emphasis is given to improving our understanding of the interactions between the atmosphere, land and tropical Atlantic Ocean (especially the Gulf of Guinea). It is important to study the role of land surface feedbacks on variability of the WAM at this scale including the key roles of vegetation and soil moisture. The annual cycle and seasonal-to-interannual variability are the main time scales of interest.
3. Mesoscale. This is the scale of the typical rain-producing weather systems in the WAM. It is central for studying the variability of rainfields at the seasonal scale and the coupling between hydrology and the atmosphere at the catchment scale.
4. Local scale or sub-mesoscale. From an atmospheric point of view, this is the convective rain scale; it is central to the hydrology of the Sahel and of small watersheds to the south; it is the main scale of interest for agriculture.

AMMA emphasizes the importance of improved understanding of how these scales interact and combine to characterize the WAM and its variability, including how these interactions impact sources and transport of water vapour, aerosol and key chemical species (e.g., key greenhouse gases, ozone and aerosol precursors) in the West African region and globally.

From the geophysical perspective, the fundamental science underpinning the AMMA Project can be viewed as the various disciplines coming together within broader integrative science topics: i) the interactions between the WAM and global climate from a physical as well as a chemical perspective, ii) the water cycle of the WAM from the regional to the local scale and iii) the coupled atmosphere-land-ocean system and its multiple scales.

To feed these integrative topics with sound disciplinary knowledge of the processes and their scale dependence detailed studies of the processes are needed: i) atmospheric processes with a focus on the convective processes which are key to the rainfall production, ii) oceanic processes as they contribute and depend on the WAM, iii) biophysical processes over the continent from the regional to the local scale and iv) aerosol and chemical processes in the atmosphere.

To study the human dimension of the variability and possible trends in the West African Monsoon AMMA aims to address the direct impact of the environmental conditions on three limiting conditions for the African societies: i) Land productivity, ii) water resources and iii) health impacts. This activity will be coordinated to achieve a better understanding of how weather and climate variability impact food security and human processes in the region.

To achieve the AMMA scientific objectives and to master the challenge of multi-scale and multi-disciplinary aspects, a consistent set of tools and methods adapted to the problem of the West African Monsoon will be used: i) models and data assimilation, ii) field campaigns, iii) satellite remote sensing and long-term atmosphere/land/ocean data collection and iv) data base. These activities are key to transferring knowledge from the geophysical community in AMMA to the activities in the human dimension. These tools will collect and consolidate knowledge, integrate the knowledge and materialize the predictive skill gained with this knowledge.

AMMA is planned to be a multi-year project and involves three nested observation periods:

- The long term observing period (LOP) is concerned with observations of two types: 1) historical observations to study interannual-to-decadal variability of the WAM (including currently unarchived observations, and (2) additional long term observations (2002-2010) to document and analyze the interannual variability of the WAM.
- The Enhanced Observing Period (EOP) is designed to serve as a link between the LOP and the SOP. Its main objective is to document over a climatic transect the annual cycle of the surface conditions and atmosphere to study the surface memory effects at the seasonal scale. The EOP will be 2-3 year duration (2005-2007).
- The Special Observing Period (SOP) will focus on detailed observations of specific processes and weather systems at various key stages of the rainy season during three periods in the summer of 2006.

Satellite observations will strongly contribute to the objectives of the project by providing key variables of the surface – atmosphere system (e.g. Meteosat/MSG, ENVISAT, TRMM, AURA, AQUA-Train, TERRA). AMMA provides a unique set of integrated atmosphere/land/ocean observations for validation of the satellites. It will also provide the framework to build a reliable
monitoring strategy combining satellite and in situ atmosphere/land/ocean networks, to make up for the low density of routine observations in and offshore Africa.

Models will be combined with observations to investigate the nature of the WAM at daily, seasonal-to-interannual and decadal timescales, including how the different scales interact. As throughout the AMMA program, the linkages between weather and climate variability will be emphasized. This approach is particularly pertinent to improving models for climate prediction since scale interactions and processes not handled well by GCMs used for climate predictions are best studied in the same GCMs at the weather system scale. Thus, while AMMA recognizes the need for different modeling strategies for studying and predicting weather and climate variability, it will seek to develop a strong synergy between them especially with respect to understanding representation of key scale interactions and systematic errors.

AMMA web site: http://amma.africa-web.org/

3.3 GHP WORKING GROUPS

3.3.1 GHP Data Management Working Group (DMWG)

The DMWG was formed in 1999 to assist in the coordination and facilitation of observational data sets from the Continental-Scale Experiments (CSEs) and ISLSCP. The broader modeling community will use coordinated ground, atmospheric and satellite measurements of the type taken during these experiments to test such formulations as prognostic cloud schemes and the representativeness of related interactions being implemented in their global models. This process can be made much more efficient if these data sets are gathered into a uniform database easily accessible by the various modeling centers represented across the CSEs.

DMWG Tasks for 2003-2004

1. Maintained the DMWG Web Page located at: http://www.joss.ucar.edu/ghp/. Each member was asked to update their data policy, access, and protocol. The DMWG page(s) were re-organized and additional information was provided. New data management web pages for the La Plata Basin were added this year including a prototype GIS-based map server tool. In addition, a DMWG e-mail alias was maintained to facilitate communication between DMWG members (ghp-dmwg@joss.ucar.edu).
2. The GAPP CSE submitted updated gridded data sets for distribution as GHP data sets. These data sets were archived and are available from the DMWG web page (under “data access”). However, more work is needed to define and expand additional GHP data sets (see DMWG discussion item #3 below).
3. Discussions continued with the CLIVAR and CLIC programs to keep data activities better coordinated. Appropriate web page data activities links were maintained to the respective programs and to the DMWG Home page.

4. Discussions continued to coordinate GHP data management activities with the other GEWEX Projects (i.e. GRP, GLASS, and ALMA). The DMWG Chair (Steve Williams) may attend (and present GHP data activities to) the GEWEX Working Group on Data Management & Analysis meeting (October 2004) to better improve cross reference/access to and coordination of project data sets within GEWEX.
5. Most of the DMWG work this year involved the organization of CEOP data management between the various CSEs. The CEOP Data Management web page was maintained and is available directly at: http://www.joss.ucar.edu/ghp/ceopdm/. Links are available to CEOP satellite data, model output and data sets/metadata, documents, information regarding Reference Sites and Model Location Time Series (MOLTS) profiles (both global and regional), and other pertinent links. This web page is linked to the CEOP, GHP, and the DMWG home pages.
6. The inventory and metadata of CEOP Reference Sites were maintained. A dynamic matrix table is located directly at: http://www.joss.ucar.edu/ghp/ceopdm/rsite.html and summarizes specific information and metadata about the individual Reference Sites (locations, descriptions, maps, site contacts, sample data sets, instrumentation, parameters measured, etc.).
7. The DMWG continues to work on the EOP-3 "composite" Reference Site dataset. Each Reference Site was requested to submit their data in a common format as described in the data submission requirements report for the CEOP Reference Sites which was approved by the CEOP SSC in July 2003 (see http://www.joss.ucar.edu/ghp/ceopdm/refdata_report/). As data/metadata were submitted, UCAR/JOSS performed consistency checks and applied a final quality assurance review to the final data. Any resulting problems or issues were interactively solved with the respective data providers. Completed datasets were then posted to the on-line CEOP archive for distribution to the scientific community http://www.joss.ucar.edu/ghp/ceopdm/archive/eop3_data/. Details (and status) of the EOP-3 Reference Site "composite" data set processing was prepared and published in the CEOP Newsletter #6 (July 2004). In summary, EOP-3 data were received from 31 Reference Sites for review and final processing. At the time of this meeting, completed on-line data are available from 16 of these Reference Sites (including the full annual cycle data from 4 sites).
8. UCAR/JOSS has been coordinating with the CEOP Data Integration efforts to establish a DODS *in-situ* server for the interactive distribution of Reference Site data. It is hoped this will facilitate the data exchange between CEOP Data Centers and allow for the seamless integration of data between these centers. JOSS has established a beta-version DODS server operating with test data sets. Remaining issues to be solved include linking this server to the existing JOSS CODIAC Data Management System (i.e. CEOP *in-situ* archive) through the NCAR firewall and establishing a metrics information capability to track users who download the datasets. It is hoped that an operational DODS *in-situ* server will be available to the scientific community by late 2004.

DMWG Action Items and discussion issues with the GHP for 2004-2005

1. The DMWG will continue the compilation of CEOP Reference Site data/metadata. This information will be maintained on the CEOP data management web page(s), directly at: http://www.joss.ucar.edu/ghp /ceopdm/rsite.html. More support from the CSE management is needed.
2. The DMWG members will be requested to maintain updated CSE information on data policy, data inventory, data access, and data contacts. This information will continue to be linked from the DMWG Home Page. A new DMWG member needs to be added from the Murray Darling Basin (Australia) and the Murray Darling Basin CSE has the action to appoint a new member.
3. Continue contact with CSEs on what additional regional data sets and products might be available. This will be accomplished through GHP/CEOP conference calls and off-line discussions with the CSEs. The DMWG needs feedback from GHP (and in particular the GHP working groups) regarding their data requirements (i.e. gridded data sets, "composites", products, subsets, etc). Also, work needs to be initiated to include hydrology data/metadata into the GHP database (primarily through the CEOP activities). The CEOP Hydrology working group has the action to provide these data.
4. Continue coordination with the Baseline Surface Radiation (BSRN) program (Zurich) to incorporate BSRN data/access with the GHP/CEOP database.

5. UCAR/JOSS will submit a proposal to continue work on the continued compilation of the CEOP EOP-3 and EOP-4 "composite" Reference Site data set incorporating common parameters, format, and temporal resolution. The DMWG will work with the CSEs and reference sites to coordinate the data submission, quality assurance, and posting of data to the scientific community.
6. In the longer term, the DMWG needs to draft a GHP Data Policy. One suggested strategy is to use the approved CEOP Reference Site data policy as a "prototype". GHP needs to improve the integration of GHP datasets with GEWEX and other WCRP projects. One first step might be the development of a method to cross-link CSE databases (i.e. data portals, OpeNDAP, GIS, XML, digital libraries, etc).

3.3.2 Water and Energy Budget Synthesis (WEBS)

During the past several years, Continental-Scale Experiments (CSEs) began to develop what might be thought of as the "best available" water and energy budget synthesis (WEBS). Since few hydroclimatological observations were available when these studies began WEB studies have had to include global and regional atmospheric and macroscale hydrologic model simulations and analyses to supplement the meager observations (see e.g. Roads et al. 2002, 2003, Marengo 2003).

However, additional satellite data is now available and can provide validation fields for a number of more model-based variables. In particular, there are a number of GEWEX data sets now available for a new WEBS evaluation. Perhaps the best known is the global precipitation data set (GPCP), but there are also others such as the new International Satellite Cloud Comparison Project (ISCCP), Surface Radiation Project (SRB) available through the International Satellite Land Surface Climatology Project (ISLSCP), the Global Runoff Data Centre's observationally based monthly mean globally gridded runoff, and the NASA water vapor project (NVAP) monthly means. There are also additional reanalyses available including the NCEP/NCAR Reanalysis I, NCEP/DOE Reanalysis II, ERA40, and the pending JMA reanalysis. Besides the atmospheric based reanalyses, the Global Land Data Assimilation System (GLDAS), which is a system of multiple, sophisticated land surface models forced with in situ, reanalysis, and remote sensing data, has recently become available.

Therefore, the goal of this project is to now develop the best available global water and energy budget synthesis, focused initially on the coupled land-atmosphere regions and then later on to ocean and global budgets. Besides describing the budgets from the available observations, we want to determine just how accurate the available global reanalyses are at describing these budgets, since they provide a means to assess errors in the relevant global and regional models that must eventually predict hydroclimatological processes. We are therefore utilizing currently available atmospheric and land based reanalyses for this comparison beginning with the budgets over the global land regions for a recent period (1996-2000) when the CSEs were active and can help to assess the quality of the regional comparison. Our goal is to eventually extend this limited period to a longer period (1985-2000) in order to assess the quality of interannual variability, and then ultimately extend this study to cover the ocean and globe. By developing this comparison, we will better understand the uncertainty associated with each relevant process and thereby understand better just how well we can currently close water and energy budgets over specific regions.

Our initial effort to characterize the budget terms and their uncertainty will make use of observation based and reanalyses (including GLDAS) global data sets for the period 1996-2000. From these data sets all of the water and energy budget processes can be obtained or deduced from the budget equations. For the observations we will use the following auxiliary relationships:

Evaporation $$E = P - MC + \frac{\partial Q}{\partial t}$$

Sensible Heating $$SH = -QRS - L(E)$$

For the reanalyses, we can diagnose the moisture and heat convergence by:

Moisture Convergence $MC = P - E + \frac{\partial Q}{\partial t}$

Heat Convergence $HC = -QR - SH - LP + C_P \frac{\partial \{T\}}{\partial t}$

We previously computed the moisture and heat convergence explicitly for the NCEP/NCAR Reanalysis I, and will initially use these values here for "observations", since they depend on 6 hourly surface pressure and sigma level winds, humidities, and temperatures, which are probably best provided by reanalyses. In fact, these terms do seem to be more constrained than other water and energy processes (see Roads 2003). However, we now believe we can compute more exact moisture and heat convergence by taking into account the model increments. That is, we must download the differences between the analyses and 6-hour forecasts. Unfortunately, model increments are not readily available from the public WWW sites but are available as part of the general data sets. We will then assess the differences among the water and energy convergences and hopefully come up with a reasonable mean quantity. Again, we believe the differences among the model convergences should be relatively small, at least in comparison to the differences between the other model physical terms.

The goal of this effort is to develop a synthesis of water and energy budgets over land regions in general with a focus on the GEWEX CSEs in particular and the global land regions in general. This synthesis will thus basically involve a comparison of a number of observationally based (GEWEX) water and energy budget processes and variables to corresponding processes and variables from global reanalyses (and GLDAS). Such a comparison will provide an overall assessment of the accuracy to which we can quantitatively characterize bulk water and energy cycle processes including understanding their potential error and the potential error of the overall water and energy budget "closure".

Year 1: Gather together the observation and reanalysis data for the period 1996-2000. Observations will be taken initially mainly from the GEWEX data sets. Begin comparisons of various parameters on annual time scales
Year 2: Continue comparison of various water and energy cycle variables to monthly to seasonal time scales. Develop an on-line atlas of processes and variables. Begin to extend this short period analysis (1996-2000) back to early 80's in order to examine interannual variations.

Year 3: Submit papers for publication describing the global and regional comparisons. Begin to extend this land-based analysis to ocean and global analyses.

3.3.3 Water Resources Application Project (WRAP)

WRAP has a mandate is to dialogue with hydrological modeling community and operational environmental services; demonstrate skill in predicting changes in water resources and soil moisture on time scales up to seasonal and annual and collaborate with water resources agencies to develop better hydrometeorological predictions.

WRAP includes representatives from all of the Continental Scale Experiments (CSE) and Associates (CSAs), and from ISLSCP, HELP, WWAP, IAHS, and WMO. The current WRAP working group members are:

MAGS	Lawrence Martz (Chair)	MDB	Alan Seed
BALTEX	Phil Graham	HELP	Bob Varady
CATCH	Christian Depraetere	IAHS	Alan Hall
GAME	Taikan Oki	ISLSCP	Pavel Kabat
GAPP	Rick Lawford, Dennis Lettenmaier	WMO	Wolfgang Grabs
LBA	Javier Tomasella	WWAP	Bhanu Neupane

WRAP Activities to Date

- Development of a WWW site (http://ecpc.ucsd.edu/projects/ghp/Wrap_web/) for communication purposes
- Workshops to dialogue with water resource community:
  - Application of GEWEX Scientific Research to Water Resources Management, ICWRER, Germany, July 2002
  - GEWEX Hydrometeorological Science in Improved Water Resources Management, IUGG, Japan, July 2003
- Participation in planning exercises and consultation with other programs and agencies with HELP, WWAP, IAHS, PUB, GWSP, IGOS-P Water.
- Collaboration with WWAP on development of scientific indicators for global water resources assessment
- Review of Chapter 4 (global water balance and water resources) for next edition of WWDR.
- Promotion of CSE scoping and demonstration projects (i.e. MAGS)
- Articles in GEWEX and IAHS newsletters
- WRAP paper presentation at CEOP special session at AGU (Montreal, May 2004).

Upcoming Workshops

- Transferring Hydrological Data Across Spatial and Temporal Scales
  - Workshop W6 at IAHS Scientific Assembly (Foz do Iguaçu, Brazil, 4-9 April 05)
  - Goal is to assess suitability of available "downscaling" methods to support hydrological analysis / modeling and water resource decision-making in mesoscale basins.
  - WRAP in collaboration with GEWEX WG, PUB, ICCLAS, ICRS, ICSI.
  - Response to earlier WRAP workshops that identified the need to specify predictive uncertainty and downscale data for water resource applications.
  - incorporate a special paper set and discussion on HEPEX
- Joint WCRP-UNESCO workshop on applicability of climate research and information for water resource management in semi-arid and arid regions
  - Cairo, Egypt, April/May 2004 (18-21 Mar 2005)
  - Co-chairs: Lawrence Martz (Chair, WRAP) and Mohamed Abdulrazzak (Director, UNESCO Cairo Office)
  - Relationship between earth climate system and water resources of particular interest to decision makers and stakeholders in arid/semi-arid regions.
  - Workshop to assess whether current state of knowledge about climate system has reached a level of maturity to provide information useful for water resources management in arid/semi-arid regions.
  - Structured around stakeholder and expert presentations and dialogue.
  - Will be seeking GEWEX participants

Water Resource "Indicators" and GEWEX/WRAP

- Possible contributions identified through discussion with WWAP and participation in MTM IV Conference
  - Monitor global trends
  - Assess regional impacts of global observations
  - Develop and use indices
  - Identify and predict impacts of climate variability (El Nino)
  - Extend short-term climate records
  - Provide model (GLDAS) outputs in areas where only sparse data exist.
  - Develop links between water cycle and other biogeochemical cycles.
- Continuing discussion with WWAP concerning a GEWEX-specific contributing project.
- Potential for links to CEOP.

Hydrological Ensemble Prediction Experiment (HEPEX)

- Objective is to demonstrate use of hydrological ensemble forecasts to support water resource decision-making that has important consequences for economy and public health & safety

- Initiated at the lead of John Schaake
- Supported by GEWEX-WRAP, WMO-Hydrology, IAHS-PUB
- WRAP role in coordination and promoting CSE participation.
- GAPP and MAGS participation confirmed

CSE demonstration projects

- WRAP is promoting the development of CSE based demonstration projects
- MAGS example
  - Science meets Society workshops with stakeholders in 2003 and 2004
  - Mackenzie Basin Climate: Linking Traditional Knowledge and Science: a workshop series scheduled for July 2005.
  - Demonstration projects
    - Stream flow forecasts for NWT Power Corporation
    - Lightning and forest fire prediction for Canadian Forest Service
    - Ice breakup and flood forecasting for Town of Hay River
    - Data and models for wildlife habitat and distribution study
    - Short-term snow forecasting with Prairie Aviation & Arctic Weather Centre. Community participation in Great Bear Lake thermodynamics study

WRAP 2004-05 Activities

- Scheduled/ongoing activities
  - IAHS and WCRP/UNESCO workshops
  - WWAP-GEWEX indicators activity development (potential link with CEOP)
  - Submission of journal article on GEWEX water resource activities (by early 2005).
  - Collaboration with HEPEX
  - CSE-based demonstration projects
- New/proposed initiatives
  - Relationship with GWSP: Lawford to present papers at International Conference on Integrated Assessment of Water Resources and Global Change: a North-South Analysis (23-25 Feb 2005, Bonn, Germany)
  - Mountains as water sources: GEWEX capacity to contribute to be explored at the suggestion of SSG.
  - Web site catalogue of GEWEX water resource application activities (arising out of journal article lit review).
  - A theme session (Advances in Understanding the Global Water and Energy Cycle) at GSA/GAC Earth System Processes 2 Conference

3.3.4 Transferability Working Group (TWG)

The TWG seeks answers to questions such as:

- How portable are our regional climate models?
- How much does “tuning” limit the general applicability to a range of climatic regions?
- Can we recover some of the generality of “first-principles” models by examining their behavior on a wide range of climates?

The overall objective of the TWG is to understand the physical processes underpinning the global energy budget, the global water cycle, and their predictability through systematic intercomparisons of regional climate simulations on several continents and through comparison of these simulated climates with coordinated continental-scale observations and analyses. Transferability experiments are carried out by use of ensembles of regional climate models on multiple domains with all modeling parameters kept fixed during model transfer among domains.

TWG recognizes that:

- The water cycle introduces exponential, binary, and other non-linear processes into the climate system;
- Water cycle processes occur on a wide range of scales, many being far too small to simulate in

global or regional models;
- The water cycle creates spatial heterogeneities that feed back strongly on the energy budget and also the circulation system; and
- Major advances in climate modeling hinge on advances in understanding and being able to simulate processes of the water cycle.

From this we conclude that transferability is inherently a GHP activity.

The strategy of TWG is to:
- Identify key processes relating to the water cycle and energy budget that express themselves to different degrees in different climatic regions and
- Create hypotheses that can be tested by use of ensembles of models on more than one climatic domain.

Expected outcomes include:
- Improved understanding of the water cycle and its feedbacks on the energy budget and circulation system and
- Improved capability to model climate processes at regional scales.

The work plan for TWG is:
- Phase 0: Write an article for the Bulletin of the American Meteorological Society summarizing lessons learned from various model intercomparison experiments and how "transferability experiments will provide new insight on the global climate system, particularly the water cycle and energy budget, and report results of preliminary studies;
- Phase 1: Conduct pilot studies; and
- Phase 2: Perform sensitivity studies on key processes relating to the water cycle. Create and test hypotheses.

The timetable for TWG is:
- October 2004: Presentation at WGNE;
- December 2004: Paper submitted to BAMS; and
- February 2004: Organizational meeting (AMS Annual Meeting).

Transferability consolidates lessons from modeling and observations:
- Models: Use experience gained from simulating "home domains" and
- CEOPS: Use dominant features of the water cycle and energy budget of each CSE to generate testable hypotheses
    - Review what has been learned
    - Identify unique climate features

Further points:
- Transferability contributes to "horizontality" by pulling together modeling groups and CSEs and contributes to GEWEX Phase II objectives.
- Transferability experiments can entrain the capacity and expertise of regional modeling communities (e.g., RegCM3 community) to provide the support needed to perform experiments, especially for Phase 2. Large communities like the RegCM3 community are globally distributed, so transferability testing offers the opportunity to engage climate scientists from many countries, especially developing countries.
- Simple sensitivity tests, however, emphasize the importance of having well-structured, tightly controlled simulation programs when engaging large groups. Sensitivity to obvious modeling issues, such as choice of convection routine, and not so obvious issues, such as time-step size and computer processor, can yield differences between simulations that are comparable to model-observations differences. There is need to control carefully simulation design so that all simulations by one model use an identical version.

Progress report on the pilot study ICTS (Inter-CSE Transferability Study)
After the GHP meeting in Lüneburg (2003) representatives from two centers (John Roads and Insa Meinke from ECPC and Burkhardt Rockel from GKSS) came together at the Scripps Institute in March 2004 for a start up meeting. Later this year William Gutowski, Eugene Takle and Raymond Arritt from the Iowa State University joined the ICTS. Simulations are being carried out with three regional models: the regional spectral model (RSM / ECPC), the climate version of the Lokalmodell (CLM / GKSS), and the Regional Climate Model (RegCM3 / ISU).

With the expertise of regional modelers from each CSE currently five target areas CSEs have been defined: two areas in North America for (GAPP and MAGS), one each in South America (LBA and LaPlata), Europe (BALTEX), Australia (MDB), and Africa (AMMA).

The horizontal resolution of the regional models is about 50 km. Forcing data are from NCEP/NCAR re-analysis. A time period from July 1999 to December 2004 was chosen for the model simulations where the first 6-month were considered as model spin up. The same model setup (physics, numerics) are to be used for all CSEs. Results of model simulated precipitation compared with data from GPCP and CEOP reference sites for the CEOP1 period (July – September 2001) were presented for those areas analyzed so far.

3.3.5 Worldwide Integrated Study of Extremes (WISE)

Extremes have always been a concern of GHP. At its first meeting in 1995, one of GHP's overall scientific issues was given as "What feedback mechanisms affect the water cycle and how do these influence wet and dry periods?" The possible development of a GHP working group addressing this issue was discussed and it was suggested that this effort be linked with prediction-predictability.

With this background, a small working group will be established with the objective: "To advance our understanding of extremes including their distributions, trends, and inter-connections and to contribute to their better prediction."

The effort is mainly focusing on droughts and extended wet periods and is initially being led by Jose Marengo (mainly for prediction-predictability) and Ron Stewart (mainly for the occurrence of extremes). Activities will include: a) Categorizing extremes that occurred during the CEOP period, and b) Determining current activities addressing these extremes. A web site will be developed at UCAR which summarizes plans and also lists numerous other web sites that contain information on extremes and hazards.

There are numerous issues that need to be addressed. Some of these include:

- Extremes
  - Inventory of events and studies in each CSE
  - Updated definitions of extreme events
  - Distribution of extremes and possible changes
- Predictions
  - Analysis of some of these extreme events using previous ensemble simulations
- White paper on extremes and predictions
- CEOP and extremes: inter-connections, ensemble predictions and uncertainties

3.3.6 Stable Water Isotope Intercomparison Group (SWING)

Since more than four decades the isotopic composition of water stored in various archives (e.g. ice cores, ground water) has been used to study changes in the hydrological cycle on timescales from glacial-interglacial to short term variations. However, the interpretation of isotopic variations in terms of climate change is often handicapped by an observational lack of other relevant climate parameters (e.g. temperature, relative humidity, precipitation) both in space and time. Modelling the isotopic composition of water within the hydrological cycle of general circulation models (GCM) may help to overcome this deficit on available climate data. Isotope GCMs simulate the $^{18}O/^{16}O$ (and/or $^{2}H/^{1}H$) relation as an independent quantity within a closed "model world" where all other relevant climate parameters are

known, too. This enables an improved analysis of (simulated) isotope variability in terms of climate change. Modelling of stable water isotopes also offers the potential to improve our understanding of current-day tropospheric and stratospheric water vapour and cloud processes.

Aims and Objectives of SWING

The Stable Water Isotope Intercomparison Group (SWING) is a working group of the GEWEX Hydrometeorology Panel (GHP). Its general purpose is an international intercomparison of current state-of-the-art general circulation models with stable water isotope ($H_2{}^{18}O$, HDO) built into the hydrological cycle (so called Isotope GCMs) and related observational isotope data. The SWING project serves as a platform exploring the following topics:

- Enable an overview about ongoing isotope GCM modelling capabilities
- Serve as a platform for common isotope simulation experiments of the various research group (model-model-intercomparison)
- Identify the most important need of new observational isotope data in space, time and the various aggregate forms of water (model-data-intercomparison)
- Strengthen the linkage between the modelling community and the key contributors of observational water isotope data
- Serve as an interface to other isotope model intercomparison studies, e.g. IPILS (Isotopes in Project for Intercomparison of Land-surface Parameterization Schemes)

Members of SWING

The SWING project brings together scientists with a common wide range of interest in both modelling and measuring stable water isotopes and its application to the Hydrological Cycle and Earth System problems. Active members (in alphabetical order) are:

- Pradeep Aggarwal (IAEA, Austria)
- Vaughan Barras (University of Melbourne, Australia)
- Josephine Brown (University of Reading, UK)
- Laurence Gourcy (IAEA, Austria)
- Ann Henderson-Sellers (ANSTO Env., Australia)
- Georg Hoffmann (LSCE, France)
- Kimpei Ichiyanagi (Frontier Obs. Res. System, Japan)
- Maxwell Kelley (LSCE, France)
- David Noone (University of Colorado, USA)
- John Roads (Scripps Institution Oceanography, USA)
- Gavin Schmidt (NASA-GISS, USA)
- Kristof Sturm (LGGE, France)
- Julia Tindall (University of Bristol, UK)
- Paul Valdes (University of Bristol, UK)
- Kei Yoshimura (University of Tokyo, Japan)
- Martin Werner (MPI Biogeochemistry, Germany)
- Vyacheslav Zakharov (Ural State University, Russia)

SWING Activities in 2004

The SWING project has been officially launched at a first workshop, hosted by the IAEA, Vienna, in February 2004. The project efforts are just beginning and modest activities have been started (main contributors are given in brackets):

- SWING overview presentation at the 10th GHP meeting, Montevideo, Uruguay, September 2004 (J. Roads)
- SWING overview presentation at the BASIN/SIBAE workshop on “Oxygen Isotopes as a Tracer Linking Global Oxygen, Carbon Dioxide and Water Cycles”, Marshall, USA, September 2004 (M. Werner)
- Performing and analyze first common SWING simulations under present-day boundary conditions using 3 different state-of-the-art Isotope GCMs: GISS, ECHAM4 and MUGCM (G. Schmidt, J. Brown, M. Werner)
- Presenting first results of the SWING project at the AGU Fall Meeting, San Francisco, USA, December 2004 (M. Werner)

- Development of a internet website (http://www.bgc-jena.mpg.de/projects/SWING) for communication purposes (M. Werner)

Future SWING Activities
The SWING roadmap lists several issues that need to be addressed in the near-time future. Some of these include:

- Define and perform the second common SWING simulation, covering changes of the present-day hydrological cycle and its isotopic signature for the period 1870-2000
- Perform detailed analyses of available observational records and model simulation output focusing on the use of stable water isotopes as a reliable tracer labelling different water vapour source regions and water recycling events
- Collect model output of present-day control simulations of the different isotope GCMs in a common database, available to the public
- Build up a pool of available forward proxy isotope models (e.g. for coral records, foram records, lake carbonate, tree-ring cellulose) to close the gap between global isotope simulations and (more) local observational data

3.4 GHP AFFILIATE PROJECTS

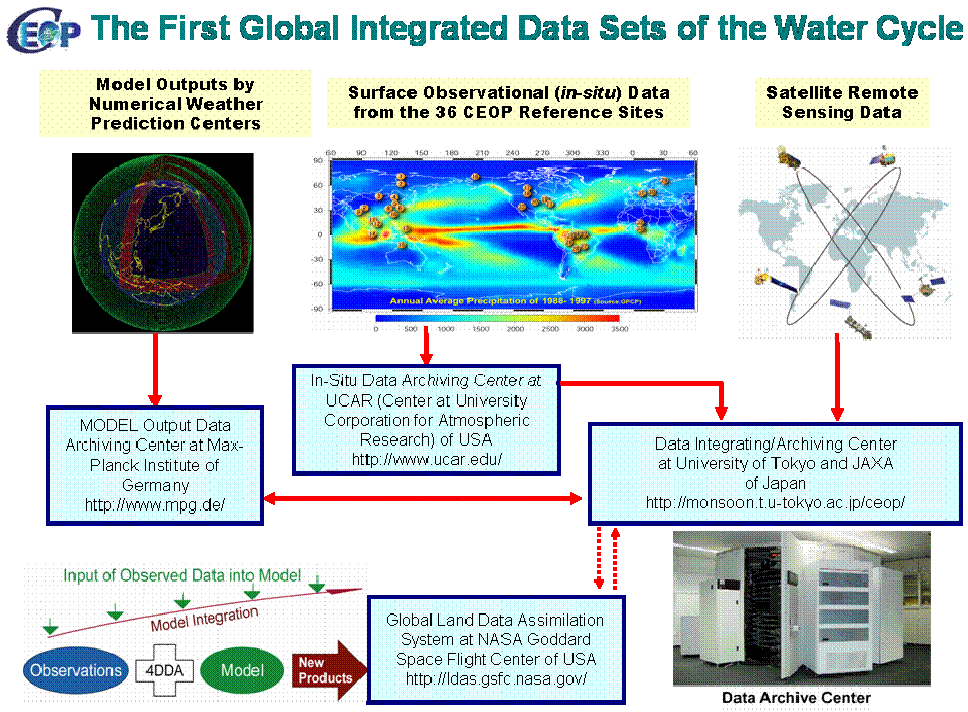
3.4.1 Coordinated Enhanced Observing Period (CEOP)

Data from CEOP reference stations is being delivered to the CEOP Central Data Archive (CDA) at UCAR/JOSS. The CEOP sites are linked closely with the existing network of observing sites involved in the GEWEX Continental Scale Experiments (CSEs) distributed around the world. The CDA has put information concerning the characteristics of the CEOP reference sites on the Internet at: http://www.joss.ucar.edu/ghp/ceopdm/rsite.html. An initial (seasonal) CEOP data set, designated EOP-1, is also available at that site.

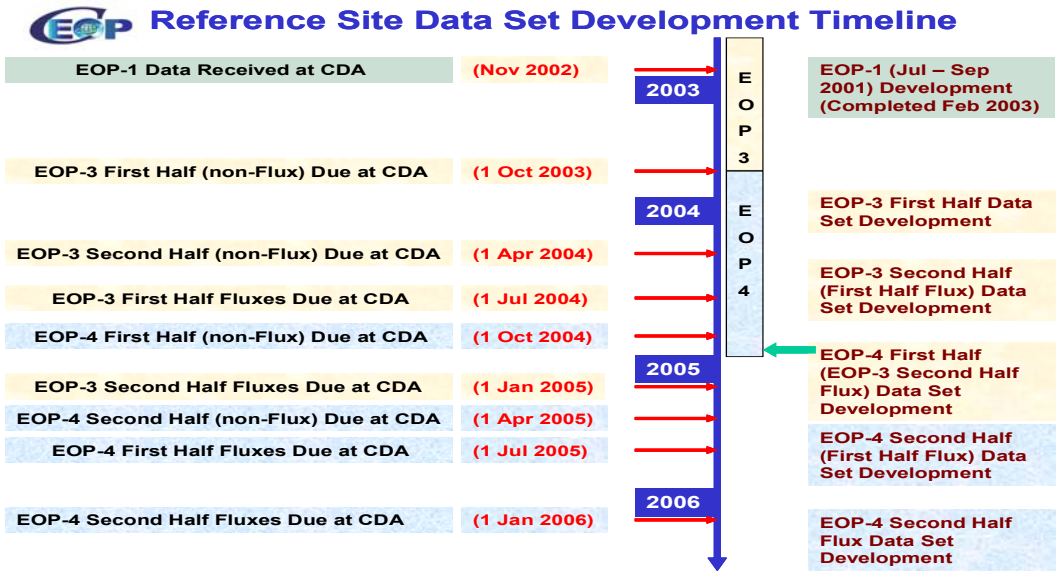
Model products are being received from ten major national and multi-National Numerical Weather Prediction Centers around the globe. A CEOP model products archive and distribution center operated by the Max Planck Institute (MPI) is handling the data. A CEOP Satellite Data Integration Center at the University of Tokyo (UT) is receiving and storing satellite data. A network that links the CEOP reference site, model and satellite data archives is being developed with joint JAXA and NASA support (see figure below).

The Committee on Earth Observation Satellites (CEOS), Working Group on Information Systems and Services (WGISS), is developing the CEOP WGISS Test Facility for the purpose of integrating the CEOP data centers and making the data available to the broader user community. The collection, archive and distribution of coordinated, quality checked, in-situ, satellite and model data sets relates closely to the success being achieved in meeting CEOP science goals. With these new data sets and integration/visualization tools, CEOP WESP has begun to examine the vertical structure in the atmosphere and the impact of land processes on closing and simulating vertically integrated water and energy budgets with observations and analyses at global scales. In CIMS, a hierarchy of models including general circulation models (GCM), regional climate models (RCM) and cloud resolving models (CRM) is being examined to run numerical experiments that target simulation of fundamental physical processes and lead to identification of basic errors and biases in model physics.

The CEOP Model Output Working Group plans to apply CEOP data sets/tools to specifically focus on the ability of current global data assimilation systems, individually and in ensemble, to reproduce all of the components of the water and energy cycles (precipitation, evaporation, transports, water and energy content, and radiation). They will investigate processes related to the diurnal cycle and seasonal progression (e.g. monsoons).



A 2-day workshop on CEOP Model Output development took place at the University of California, Irvine Campus (UCI) in Irvine California, USA from 8 to 9 March 2004. The third annual CEOP International Implementation Planning meetings took place from 10-12 March 2004 at UCI. The main outcome of the meeting was that the CEOP Science Steering Committee (SSC) and the CEOP Advisory and Oversight Committee (AOC) each endorsed the establishment of a CEOP Phase II that extends the existing data and observation processes and adds greater emphasis on the research and analysis components of CEOP, providing for CEOP to meet its commitments to CEOS/IGOS-P Water Theme, WCRP/COPES and GEOSS. This next Phase of CEOP will proceed in two stages that run from 1 January 2005 to 31 December 2010. The outline below puts this concept in perspective with the overall design of CEOP.



3.4.2 International Satellite Land Surface Climatology Project (ISLSCP)

The International Satellite Land-Surface Climatology Project (ISLSCP) Initiative II data collection is now complete and can be accessed at http://islscp2.sesda.com. The ISLSCP Initiative II data collection contains 50 global time series spanning the ten-year period 1986 to 1995 (selected data sets span even longer periods) considered by members of the GEWEX community as required to support investigations of the global carbon, water and energy cycle. Over the course of 3 years, the data were acquired from investigator teams within a number of U.S. and international agencies, universities and institutions, quality checked, some reprocessed to correct problems, then co-registered to equal-angle grids of one degree, one-half and one-quarter degree resolution, a common land-water mask applied, gaps filled and reformatted into a common ASCII format. Each data set has been uniformly documented. Both data and documentation has undergone two peer reviews for quality and ease of use. Overview and user guidance documentation and not yet complete, but will be furnished with the final DVD product.

While the ISLSCP Initiative II collection is complete and available on line, the final product will be published on DVDs. In 2005 GEWEX will invite an even broader participation in the use and evaluation of the on-line collection, which will bring to the broader community's attention this important data collection, provide some good science and a thorough evaluation across the entire collection and its user interface. A science and evaluation workshop is being planned to present and discuss the results on May 4-6, 2005 in the Greenbelt, Md. area. At that workshop the DVD set will be released and a journal special issue organized to publish the science results. The Initiative II collection will be augmented in the months following the workshop with findings from the workshop. GEWEX community members are particularly encouraged by GEWEX management to participate in the evaluation of the Initiative II data collection. For more information contact: fghall@ltpmail.gsfc.nasa.gov.

The science and evaluation workshop is in the early planning stages. Members of the ISLSCP community have initially suggested science topics, such as land-surface-cloud albedo feedbacks, soil moisture-precipitation feedbacks, land cover-atmospheric boundary layer feedbacks snow cover, atmospheric boundary layer feedbacks, climate-carbon feedbacks. The ISLSCP Science Working Group will review proposed submissions and develop a preliminary agenda.

3.4.3 Global Runoff Data Centre (GRDC)

GRDC was established on request of WMO at the Federal Institute of Hydrology in Koblenz, Germany in 1988, in order to support Global Change Research and Water Resources Assessment by collecting and storing river discharge data obtained from observations by National Hydrological Services (NHS) world-wide and disseminating it to the research community. GRDC provides a mechanism for international exchange of data pertaining to river flows on a continuous, long-term basis, in the spirit of WMO Resolutions which call for free and unrestricted exchange of hydrological data (WMO Resolution 25 (Cg-XIII), 1999) and support of GRDC's mission (WMO Resolution 21 (Cg-XII), 1995). The scope of data collection is global, regional and river basin scale. So far, 153 countries have contributed to the development of the database which currently comprises monthly discharge data from over 7200 stations and daily discharge data from around 4700 stations. The average time series length is about 36 years.

Scientific objectives of GRDC comprise the analysis of spatial-temporal distribution of river discharge on global scale, with emphasis on two goals, (a) the quantification of the global water cycle, and (b) the determination of climate variability (inclusive trends and extremes). Due to GRDC's limited staff resources analysis is often carried out in collaboration with universities (currently 10 projects that have reported or will report in the GRDC Report Series) and in the framework of international programs and projects (ACSYS, GTN-H, FRIEND, etc.)

Update on GRDC Activities
New GRDC web site went online 2 June 2004. More than 1000 individual pages report now on all aspects of GRDC (including a link list, alphabetic glossary with more than 400 entries). See http://grdc.bafg.de

GRDC increased its outreach to the National Hydrological Services. A support letter from the WMO Secretary General to the Permanent Representatives of the Member States of WMO and their associated

Hydrological Advisors in summer 2004 helped to trigger data flow towards GRDC in some cases. Also the extension of the European Union apparently had positive impact on GRDC acquisition rate.

Almost all NHS have been contacted during 2004, making use of the opportunity to meet delegations from all over the world during the 12th Session of the WMO Commission for Hydrology (CHy) that took place from 20-29 October 2004 in Geneva, Switzerland.

GRDC has identified a priority network of around 380 river discharge reference stations that constitute the first version of Global Terrestrial Network for River Discharge (GTN-R) (http://gtn-r.bafg.de). During the summer of 2004 the core application for GTN-R has been developed by a Canadian student of computer science working for GRDC, i.e. a software that draws together near-real-time (NRT)-discharge data from distributed servers in the internet (GRDC NRT-Monitor), harmonises and summarizes it, and makes it available again in one standard format via a FTP-server. Yet, the bulk of work will follow, i.e. adding step by step interface routines to whatever heterogeneous data source GRDC gets access.

One application of the harmonised data will be another piece of software, that graphically displays the collected and harmonised NRT-discharge stations in an interactively scaleable world map at a web page by means of an Internet map server (IMS). Absolute and relative current discharge values will be displayed as attributes.

On the mid to long term, it will be necessary to overcome such tedious approaches and to arrive at internationally agreed standards for the exchange of metadata and data on measurements of geophysical and biogeochemical processes in general.

GTN-R will serve an increasing number of projects, among them:

- River discharge contribution to the GTN-H project (see http://gtn-r.bafg.de) sponsored by GCOS and HWRP of WMO
- GCOS baseline river discharge network, supported by the Implementation Plan for the Global Observing Systems for Climate in Support of the UNFCCC (GCOS IP, see http://www.wmo.int/web/gcos/gcoshome.html)
- Basis for future versions of the GRDC product "Long Term Mean Annual Freshwater Surface Water Fluxes into the World Oceans" (see http://grdc.bafg.de/?1034)
- Basis for GRDC cooperation with the UN GEMS/Water Programme Office of UNEP/DEWA in Burlington/Ontario for biogeochemical flux computations (see http://www.gemswater.org).
- GRDC contribution of a map layer within the WHYMAP project (sponsored by UNESCO and others, see http://www.iah.org/whymap)

Data product: GIS Layers of Major River Basins of the World, at http://grdc.bafg.de/?7787 GRDC provides:

- Polygons of 358 basins from the river mouth at the erosion base
- Lines of the associated 358 river networks
- Points and metadata of the 377 gauging stations within the 358 basins
- Polygons of the associated 377 station-based basins

Data product: Long Term Mean Annual Freshwater Surface Water Fluxes into the World Oceans
Freshwater discharge from continents into the oceans is of major interest in research concerned with global monitoring of freshwater resources, the flux of matter into coastal areas and the open oceans, and the influence of freshwater fluxes on circulation patterns in the ocean and the atmosphere on regional and global scales.

Following two previous publications of estimated Mean Annual Freshwater Surface Water Fluxes into the World Oceans based on 161 and 181 discharge stations, respectively (GRDC, 1996 and GRDC, 1998) the GRDC has reworked this exercise for a third time, now based on 251 discharge stations close to the estuary, featuring basin areas greater than 25.000 km². A report will be published in a few months.

Discharge from land areas not integrally captured by GRDC stations has been determined via estimating mean annual runoff coefficients (RC) by means of regionalisation from nearby monitored areas taking into

account data from another 1378 GRDC stations and applying precipitation data from the Global Precipitation Climatology Centre (GPCC).

Application of GIS analysis on a 0.5 degree elevation grid optimised for flow path detection (Doell and Lehner, 2002) allowed to determine the catchments of all the individual grid cells that form the fringe of the continents (11.853), i.e. all continental grid cells were co-registered with their respective fringe grid cell through which they drain to the oceans. Furthermore, each grid cell was assigned either a calculated or estimated RC. Thus, it is possible to calculate for each fringe grid cell the integral flux from its adjacent catchment as the spatially weighted product of RC and precipitation over all co-registered grid cells. Summarising the fluxes of subsets of continental fringe cells allows to estimate fluxes for arbitrary coastline sections.

Fluxes have thus been determined e.g. for global 5 and 10 degree latitude zones intersected with continents and oceans. The results are compared to estimates by other authors and methods among them the global water balance of Baumgartner and Reichel (1975). Results and comparisons are available from the GRDC web site (start from http://grdc.bafg.de/?1034)

Collaboration Projects

Out of the many data users receiving GRDC data for their research, special collaboration projects have been negotiated with some 10 institutions, see http://grdc.bafg.de/?981. Some of them have already resulted in GRDC Reports or publications (cf. references).

Perspectives for GRDC operation

There are three principal options/measures to improve GRDC's performance:

1. Increase of internal capacity
    - e.g. fund raising allowing to employ additional staff for a multiplication of the current data acquisition practice ("brute force" approach)
    - e.g. fund raising allowing to employ additional staff for increased communication efforts necessary for the advancement of innovative projects as e.g. near real time discharge data integration in the framework of the Global Terrestrial Network for Hydrology (GTN-H).

2. Increase of external capacity, outsourcing of tasks (however some managerial capacity cannot be outsourced):
    - Data acquisition: proactive involvement of all kinds of international organisations, programmes and projects, as e.g. GEWEX and its CSEs
    - Data analysis: proactive involvement of all kinds of international organisations, programmes and projects and proactive cooperation with research institutions analysing GRDC data (currently 6 under way)
    - Data products: proactive cooperation with research institutions using GRDC data

3. Foster automation (see also related publications below)
    - Automation of internal and external processes
    - Inevitably linked to standardisation of data formats and transfer and storage schemes, needs to be coordinated internationally, a good start is the recently proposed WMO-metadata standard (see http://www.wmo.int/web/www/WDM/Metadata/documents.html)
    - Experiences gained in the field of Geomatics, which came up with a suite of ISO standards on geographic information objects (e.g. ISO 19115 on metadata) may serve as a basis and template (regarding the standards as well as the organisational processes leading to the standards)

GRDC's role in GEWEX and CSEs, issues

The GRDC acquires, stores and disseminates discharge data and acts as the global discharge inventory with an official UN-mandate and data policy (see first section). The GRDC is committed to this task on a long-term basis rather than project oriented. Thus GRDC can readily serve participants of projects like GEWEX with data and - possibly in collaboration with others - with data products (as e.g. through ISLSCP, in collaboration with the University of New Hampshire).

On the other hand, GRDC aims at extending its discharge data collection to continuously improve its service to GRDC clients. GRDC provides a mechanism that can ensure that the legacy of discharge data collected in the scope of projects is perpetuated behind an individual project' s life span, including that of GEWEX respectively its CSEs. Thus, given the considerations of the previous sections 5 and 6, it is crucial to ensure the commitment of each group participating in GEWEX, to support GRDC in data acquisition, i.e. in project-related contact with National Hydrological Services (NHS) and other national institutions it would be helpful/essential to:

- Generally promote GRDC' mission and encourage NHS to release their data to GRDC
- Make sure that whenever project money is being spent for data collection to NHS or other institutions a constituent part of any agreement or contract should be the free and unrestricted release of it to international data centres such as the GRDC.

Unfortunately, some CSE's that maintain their project specific data centres also have their own (restrictive) data policies. Thus, so far it was e.g. impossible to synchronise discharge data collected at the BALTEX Hydrological Data Center (BHDC, see http://www.smhi.se/sgn0102/bhdc) with the GRDC data holdings, though considerable efforts were spent to settle this unfortunate situation. (This is only one illustrative example of the problems discussed in section 5). There are also positive examples, e.g. GRDC has got data from the USGS and also from GAME-Thailand.

3.4.4 Global Precipitation Climatology Centre (GPCC)

The task of the Global Precipitation Climatology Centre (GPCC) is the evaluation of precipitation and snow data obtained from observations by hydrometeorological networks worldwide. The GPCC is operated by the Deutscher Wetterdienst (NMS of Germany, Offenbach) following a formal invitation by WMO.

Scientific objectives comprise the analysis of spatio-temporal distribution of land-surface precipitation on global scale, with emphasis on two goals, (a) the quantification of the global water cycle, and (b) the determination of climate variability (inclusive trends and extremes). Activity fields being inalienable are data quality control and quantification of observation and analysis errors,

The primary products of the GPCC are monthly gridded data sets of global land-surface precipitation, which are used as the ground truth within the complete global satellite-gauge combined data sets of the GEWEX Global Precipitation Climatology Project (GPCP) as well as of NCEP CMAP (Adler et al. 2003, Xie & Arkin 1997). The scientific framework being most important for the GPCC is given, within GEWEX, by the hydrometeorological components, i.e. the Continental Scale Experiments and the global projects GRDC and ISLSCP.

Within the GHP, the GPCC actively collaborated with BALTEX (GPCP-BALTEX Precipitation Comparison Study, development of a new error correction method, Fuchs 2001, Rubel 2001, Ungersboeck 2000) and GRDC (Precipitation-Runoff Comparison Study, unpublished). Furthermore, GPCC prepared special data sets to ISLSCP I and II initiatives, and it participated in the GHP WG for Data Management.

Besides GEWEX, the GPCC fulfils tasks in the framework of ACSYS respectively CliC in future (operation of the Arctic Precipitation Data Archive APDA, and analysis of snow data), CLIVAR (analysis of time-series), and GCOS (climate monitoring). GPCC products entered the World Water Development Report (WWDR) of UNESCO, and a new near realtime GPCC analysis is used within the drought monitoring routine of the FAO. The monthly gauge observations have been integrated for selected river basins. Time-series of the monthly area-mean precipitation have been compared to corresponding river discharge data in cooperation with the Global Runoff Data Centre (GRDC).

Link between GPCC and CSEs
GPCC has following suggestions for co-operation between GPCC and CSEs:

- Transfer of CSE precipitation data and methods to GPCC
- Integration of CSE gridded data sets into a global patchwork, daily and/or monthly accumulated on a 0.5°x 0.5° lat/long grid
- Comparison studies of the global CSE patchwork and the GPCC global monthly products

- Evaluation of the differences between the products with respect of data density, quality and analysis methods used

Based on the interaction of GPCC and CSEs, the analysis methods used by GPCC and thus the global precipitation products of GPCP can be improved.

GPCC Product Overview
With respect of the various user requirements and priorities with respect of timeliness and accuracy, the GPCC provides a set of different products for the global land surface, i.e. gridded data sets based on in situ gauge observations:

- First Guess of monthly precipitation anomaly, based on synoptic reports (SYNOP) received near real-time from about 6,000 stations, automatically quality-controlled, available within 5 days after observation month.
- Monitoring Product of monthly precipitation for near real-time climate monitoring, based on SYNOP and monthly CLIMAT reports from totally 7,000 stations, high-level QC, available within about 2 months after observation month. This product is included in the satellite-gauge combined data sets of GPCP and CMAP.
- Full Data Product, higher spatial resolution, for hydrological studies and verification, based on all available data from up to 40,000 stations, high level QC, available about 5 years after observation. Version 1 included 2 years only and Version 2 covering the period 1986 to 1995 is published on the ISLSCP Initiative II Website, Version 3 is in preparation and covers the period 1951-2000.
- 50 Year Climatology (gridded time-series) for studies on climate variability and trend, based on selected 6,000 stations for a mostly homogeneous data coverage over time, 1st version 1951-2000 available by end of 2004.
- Monthly Precipitation Normals (gridded long-term mean data), based on normals from about 30,000 stations.

Variables provided on the grid (grid cell area 1.0° by 1.0° or 2.5° by 2.5° lat/long):

- Area-averaged monthly precipitation total (mm/month)
- Area-averaged precipitation anomaly (mm/month)
- Area-averaged precipitation percentage of normal (%)
- Data Coverage (number of stations located in the grid cell)
- Area-averaged mean gauge-bias correction (mm/month and %)

Products being directly accessible via Internet (http://gpcc.dwd.de):

- Monitoring Product (gridded data 1.0° and 2,5° lat/lon resolution)
- Monthly Precipitation Normals (gridded data 1.0° and 2,5° lat/lon resolution)
- First Guess Anomaly Maps (image format only)

All other products are available on email request (gpcc@dwd.de).

GPCC Data Policy
All GPCC products (gridded data sets) are freely available. Station-related precipitation data are not available via the GPCC because the use of most of these data is restricted by the data owner (originator). Those data being generally available can be taken from NCDC/GHCN.

Milestones of 2003/2004 and of 2006 (as planned)

2003/10 Establishment of a new operational GPCC near real-time product, a first guess of monthly precipitation, being available within 5 days after observation month.

2004/07 Dissemination of a new WMO Letter supporting GPCC's data acquisition.

2004/07 Submission a major article on global precipitation (Rudolf and Rubel, 2005).

2004/12 Presentation of the GPCC Full Data Product Version 3 including up to 43,000 stations from the CRU, FAO and GHCN historical data collections and additional GPCC data for the period 1951-2000.

2005/03 Publication of a new gridded preciptation climatology based on time-series selected from the GPCC Full Data Product Version 3 database with special respect of homogeneity for the period 1951-2000.

2005/06 Establishment of a new method for assessment of the systematic gauge measuring error based on daily observations and meta data.

2005/06 Termination and publication of the results from the GPCP – BALTEX precipitation comparison study.

2005/12 Compilation of gridded data sets for precipitation, air temperature and snow depth, and statistical analyses for climate variability, trends and frequency of extremes.

2006/06 Final report on the project ”Development of an observational data basis (Europe and global) for DEKLIM and related statistical analysis with regard to climate variability on a decadal to centennial time scale”.

Within this project, all station meta data will be checked and harmonized, all hydrometeorological data will be quality-controlled. The data used within the gridded products will be selected with regard to product homogeneity.

3.4.5 IAHS/WMO Working Group on GEWEX

IAHS/WMO Working Group on GEWEX was established to provide links to the hydrological scientific community and, through WMO, the operational hydrological services. Past WMO Commissions of Hydrology (CHy) have acknowledged the importance of GEWEX and established rapporteurs/experts to report on its activities. The October 2004 meeting of CHy included presentations on GEWEX and PUB (see below) and again supported the WCRP GEWEX activities. This is reflected in the report of the CHy, “ 7.1.10 The Commission, noting the close relationship between HEPEX (see below) and the WMO flood forecasting initiative as well as projects of the Commission such as the projects on risk management and Short-/long-term Hydrological Forecasting System recommended that close collaboration should be sought with the GEWEX Water Resources Applications Project and in particular with HEPEX to benefit from synergies resulting from these activities to improve medium range flood forecasting services.

MOPEX-4 Workshop, Paris, 1-3 July 2004. The fourth Model Parameter Estimation Experiment Workshop was organised by CEMAGREF which obtained seven years of data for 65 basins in the south of France for participants to run their models and parameter estimation procedures. Around 40 participants attended and the results from some 15 models were presented. Some of the analyses made use of the MOPEX 438 US basins data set. Two breakout working groups focussed on:

1. Forcing uncertainty and parameter estimation in hydrologic modelling, and
2. Alternative approaches to prediction in ungauged basins.

Input from PUB “top down” and uncertainty working group members ensured a close link with the developing PUB initiative. Tentative plans for a MOPEX-6 Workshop held in conjunction with relevant PUB working groups in Australia in 2006 were put forward. A number of recommendations came out of the discussions and a report is available. This and the presentations are available on the Workshop web pages: http://www.cemagref.fr/Informations/Actualites/colloque/Mopexweb/MOPEXParisWorkshop.htm or www.seas.ucla.edu/~thogue/MOPEX.

Sixteen papers from the MOPEX-3 Workshop held as part of the IUGG in Sapporo in July 2003 are in the final stages of review for a Special MOPEX Issue of the Journal of Hydrology.

HEPEX, ECMWF, Reading, UK, 8-10 March 2004. This Workshop was organized jointly by ECMWF and the US National Weather Service to establish the Hydrological Ensemble Prediction Experiment

(HEPEX). HEPEX aims to bring the international hydrological and meteorological communities together to demonstrate how to produce reliable hydrological ensemble forecasts that can be used with confidence by the emergency management and water resources sectors to make decisions that have important consequences for the economy, for public health and safety. The main scientific theme of HEPEX will be how hydrologic forecast uncertainty can reliably be quantified at each step of the forecast process and then communicated to, and applied by the end users. Around 80 participants from Europe and North America displayed considerable interest and enthusiasm for this project whilst reporting on the current research and developing applications and needs. Members of the HEPEX Scientific Steering Group are being appointed and a User's Council is being initiated. Special sessions on hydrologic ensemble prediction are being held at the Fall AGU meeting in December in San Francisco and at the EGS meeting in April in Vienna. Several projects are being formulated in Europe and in North America that will make important contributions to the HEPEX goal in addition to the work being undertaken in PUB see below). The initiator of this project, John Schaake, reported to GHP-10 on the status of HEPEX and future plans which are covered in a summary report of the meeting. Refer: http://www.ecmwf.int/newsevents/meetings/workshops/2004/HEPEX/index.html.

IAHS PUB. This 10-year project, Prediction in Ungauged Basins (PUB) has been previously presented to the SSG and is now in the implementation phase. The Science and Implementation Plan has been published with a summary paper in the Journal of Hydrological Sciences, December 2003 issue. Already some 13 scientific PUB events have been held this year with nine more to come. PUB Workshops have been held in Japan, Australia and Canada and the latter two are to be published as is this September workshop in Moscow. Additional workshops are planned for China and India. PUB has created considerable enthusiasm, particularly amongst younger scientists, and is seen as a possible framework to build upon national programmes, eg discussions in Canada and the US. Particularly relevant is the interests in non-CSE/GEWEX countries which may assist in helping GEWEX hydrology go global. PUB Working Groups aim to identify common hydrological objectives with its members to evaluate a range of methodologies for achieving a common objective. Compatible output is required to enable testing and intercomparison of methodologies. Working Groups are self-organising with their activities constrained by common objectives and predictions are made with the associated uncertainty quantified. The approach taken is based on the successful experience of PILPS and AMIP. There are now 18 working groups with around 30 hoped for by the next IAHS Scientific Assembly in April 2005. Most relevant to GEWEX thus far are: MOPEX, HEPEX, orographic precipitation, model uncertainty, downscaling, top down modelling, and remote sensing and data assimilation. A PUB website exists (link through www.iahs.info). Links have been established with the UNESCO IHP, HELP and WMO CHy. Capacity building is a PUB function and at the Australian PUB Workshop participants were supported from developing countries. A Japanese PUB centre has been established to work in the Asian Monsoon region. In summary PUB is keen to link to and work with GEWEX to meet our many common aims.

CEOP IAHS has offered its assistance in establishing hydrological reference basins associated with the CEOP flux towers with basins close to the two Australian sites currently being negotiated. There are differences of opinion within CEOP as to the usefulness of basins at some sites, however one view is that all possible sites should be investigated. It is relevant to note that the operators of some sites would welcome the opportunity to examine the water budget in a neighbouring basin.

IAHS Scientific Assembly, Foz do Iguaçu, Brazil 2-9 April 2005. Seven symposia and eight workshops are to be held in conjunction with a major theme based on PUB. Considerable interest in this Assembly has been shown by the scientific community with over 120 abstracts submitted for the GEWEX relevant Symposium on Regional Hydrological Impacts of Climate Variability and Change with Emphasis on Less Developed Countries. The eight workshops will include MOPEX-5 and the IAHS/WMO Working Group on GEWEX and WRAP sponsored Workshop on Transferring Hydrological Data Across Spatial and Temporal Scales. The latter is to include a HEPEX part and reference to the Brazilian hydropower users of ensemble predictions.

3.4.6 International Atomic Energy Agency (IAEA)

The IAEA's program in Water Resources aims to improve the scientific knowledge base and scientific capacity for water resource management, including the impact of climate change on water availability.

Improved scientific understanding of the water cycle is a major focus area for this program and related activities consist of global isotope databases, coordinated research projects, symposia and technical workshops in cooperation with other UN and international scientific organizations, and research institutions worldwide. Some of the recent activities in support of or relevant to the objectives of GHP include:

- The IAEA initiated and has maintained (jointly with WMO) a global network of isotopes in precipitation (GNIP) since 1961. Continued isotopic monitoring of precipitation provides an ability to understand the processes influencing the amount and geographic distribution of precipitation, hydroclimate variability, as well as providing a baseline for other hydrological applications. Such global reference data for the hydrologic cycle are increasingly important for modeling the atmospheric moisture source and transport processes and the impact of climate change on water resources.
- The IAEA has supported coordinated research projects on carbon cycling, namely "Isotope Variations of Carbon Dioxide and Other Trace Gases in the Atmosphere" (1992-1994), and "Isotope-aided Studies of Atmospheric Carbon Dioxide and Other Trace Gases" (1996-1999) For climate change applications, isotope labeling of CO_2 and trace gas exchange is critical for carbon inventory assessment and for evaluating direct climate change impacts of anthropogenic greenhouse gas emissions as well as indirect impacts arising from land use changes which alter the terrestrial biosphere. In collaboration with the CO_2 experts group of WMO, the Agency is currently developing global reference standards for analysis of isotope composition of CO_2 and other greenhouse gases.
- A coordinated research project on "Isotopic Composition of Precipitation in the Mediterranean Basin in Relation to Air Circulation Patterns and Climate" (2000-2003) examined the interactions between climatic conditions and isotopic composition of precipitation in Mediterranean Basin. The project data are now being synthesized to assess the controlling parameters for isotope distributions and their significance in understanding climate variability and change.
- A coordinated research project on "Isotope tracing of hydrological processes in large river basins" (2002-2005) is supporting the development of a global network of isotope monitoring in large river basins. A complimentary project to assess the age distribution of base flow in river basins was initiated in 2004. The objective of this project is to provide a global database on the mean residence time of base flow in different river basins with a view to improve the simulation of hydrological processes at the basin and continental scales.
- Another coordinated research project initiated in 2004 aims at improving the knowledge base of simulating land surface-atmosphere interactions. In this project, the Moisture Isotopes in the Biosphere and Atmosphere (MIBA), a sampling network of leaf, soil and air moisture is being established worldwide. The motivation for this effort stems from the scarcity of experimental data on stable isotopes in biospheric and atmospheric moisture. Routine measurements of stable oxygen and hydrogen isotopes are crucial to the advancement of hydrological and climate research at the ecosystem, regional and global scales. The product of this effort will help provide an alternative to our present dependency on model output for some key variables, and further advance research efforts in several interdisciplinary areas such as: regional scale hydrological budgets, the partitioning of carbon fluxes, interpretations of isotopes in organic matter (e.g. tree rings), and past global responses to climate change.

Participating sites in this network will provide stem, leaf and soil water samples (and ultimately atmospheric water vapor) twice a month, totalling 16 samples per month. Sampling will, ideally, be coordinated with other climatic and flux measurements and would require no more than an hour of time to complete. The IAEA isotope laboratory and that of several group members will provide isotopic analyses for those participants who do not have the availability or capacity to perform the required analysis. Our initial aim was to have 90 continental and 10 oceanic sites within the network. Since the inception of our campaign in June 2004, we have identified willing participants in more than 50 sites worldwide.

3.5 RELEVANT GLOBAL PROJECTS

3.5.1 NASA Surface Water Working Group (SWWG)

Observations of river water heights have been collected across many of the world's densely inhabited basins for well over a century, however despite this effort a number of hydrologic questions remain. These questions result from: (1) the inability of existing in-channel gauging stations to characterize both the local and broad-scale hydrologic processes throughout the basin; (2) the absence of gauge measurements in many parts of the world that critically affect global climate – for example, over 20 percent of the freshwater discharge to the Arctic Ocean is ungauged; and (3) a recent and ongoing reduction in the observational hydrographic network due to commercialization, removal of government support for monitoring programs, and legal and institutional restrictions on release of such data in many parts of the world.
Remote sensing has provided potential avenues toward answering these hydrologic questions. Among the most promising are active radar and lidar methods that measure inundation area, water heights, and changes. Based on microwave radar observations, braided river discharge, as well as the volumetric change in flood plain storage have been remotely estimated. Lidar altimeters are being readied for launch that will measure surface heights to a few centimeters. Multi-spectral instruments have also been successfully used to measure suspended sediment concentrations and temperature variations. Each of these approaches has capabilities and advantages over other methods such that an integrated methodology using a conjunction of sensors may be necessary.

The objective of the NASA Surface Water Working Group (SWWG) under the NASA Terrestrial Hydrology Program is to address the potential of remote observations to answer scientific questions related to the hydrology of rivers and wetlands and consequent effects on the climate system. SWWG is focused on the following hydrologic questions: 1) What are the observational and data assimilation requirements for measuring surface storage and river discharge that will allow us to understand the dynamics of the land surface branch of the global hydrologic cycle, and in particular, to predict the consequences of global change on water resources? 2) What are the roles of wetlands, lakes and rivers as regulators of biogeochemical cycles (e.g., carbon and nutrients), and in creating or ameliorating water related hazards of relevance to society?

Problems with the current operating technology:

- The spatial resolution of currently operating radar altimeters is low and not capable of accurately measuring water surface elevations across water bodies smaller than ~1 km. The GRACE mission spatial resolution is ~200,000 km^2. Between track spacing of radar and lidar altimeters is much greater than 100 km, thus easily missing many important lakes and reservoirs
- Interferometric SAR temporal resolution is low and requires two data-takes, thus the typical Δt is one month or much greater. In addition, the measurements of dh/dt only work with "double-bounce" travel path which results from inundated vegetation and Interferometric SAR does not work over open water (i.e., dh/dt measurements are not possible).

What needs to be done:

- Determine spatial and temporal sampling resolutions required to answer hydrologic questions.
- For example, the regular Amazon floodwave may need a Δt of just a few weeks, but the sudden Arctic Spring melt requires a much more frequent observation.
- Are profiles of h from an altimeter sufficient to measure hydraulics, or do we need an image of h values? How wide of image is required?
- What are the cost vs. science trade-offs represented by varying spatial and temporal resolutions? Is there a cut-off below which no valuable science can be gained?
- Are both discharge and storage change required?
- Surface water velocities measured from space will be flawed by wind-induced waves, instead use water slope and Manning's equation. But, still requires some knowledge of water depths (i.e., channel cross sectional area).
- ΔS is a simple spaceborne measurement, but is ΔS sufficient to constrain water and energy cycle models?

Technology Demonstrations:

- What is the capability to penetrate clouds and vegetation?
- Does the instrument provide reliable off-nadir measurements of h?
- Need funding opportunities for such demonstrations via programs such as NASA's IIP and internal agency monies.
- Is surface water science sufficient to support an entire satellite mission?
- What is the cost of an SWWG mission?
- Which U.S. and international groups would participate, with funds?
- If other science is joined with an SWWG mission, what technology and orbital compromises are required to ensure a healthy mission for all participating science groups?

SWWG is developing a Virtual Mission (VM), a synthetic hydrologic model of a continental-scale basin with an embedded floodplain and channel hydraulics model that would identify the resolutions required to answer important hydrologic science questions. By controlling the various hydrologic parameters (precipitation, evaporation, infiltration, energy balances, etc.), the runoff related boundary conditions of the channel and wetlands hydraulics models are known, which allows a known relationship between samplings of various channel and wetland morphologies to water cycle science. Science, technology, and cost trade-offs would be determined by sampling the modeled water surface at various resolutions related to alternate configurations of existing and space-ready technologies. The VM would identify exact water cycle, carbon cycle, and natural hazards questions that can be answered from hydraulic measurements collected by a space based platform. The VM would evaluate the feasibility of near real-time processing and classification of SAR and of optical imagery for surface water extents over large, continental scale areas.

3.5.2 Hydrological Ensemble Prediction Experiment (HEPEX)

HEPEX aims to bring the international hydrological and meteorological communities together to demonstrate how to produce reliable hydrological ensemble forecasts that can be used with confidence by the emergency management and water resources sectors to make decisions that have important consequences for the economy, for public health and safety.

The main scientific theme of HEPEX will be how hydrologic forecast uncertainty can reliably be quantified at each step of the forecast process and then communicated to, and applied by the end users. HEPEX is an independent, cooperative international scientific activity that is affiliated with several international organizations and with many other organizations interested in hydrologic ensemble prediction as well. Participation in the HEPEX project will be open to anyone who may wish to contribute to help meet its goal. The project will maintain a list of participants and will keep them informed about HEPEX activities that may be of interest to them. Primary leadership of the HEPEX project is the responsibility of a science steering group that will be composed of representatives of organizations affiliated with the project. A User Council composed of representatives of organizations with a strong interest in using or applying HEPEX results will oversee HEPEX activities.

Many scientific questions need to be addressed for operational hydrological ensemble forecasts to be used to their full potential. Meteorological aspects of ensemble prediction include issues such as:

- What are the requirements of ensemble weather forecasts to support hydrologic prediction?
- Do the existing meteorological forecasts account for important meteorological and climate uncertainties?
- What is the role of operational forecasters?
- What are the scientific questions and issues that need to be addressed to meet requirements?

Hydrologic ensemble prediction involves integrating many sources of uncertain information and accounting for how hydrologic processes would behave in response to this information. Sources of uncertainty include future weather and climate forcing, initial hydrological conditions and uncertainty in model representations of hydrological processes. Because hydrological models are imperfect and because of limitations in representing important sources of uncertainty, the raw ensemble forecasts produced by hydrological ensemble forecast systems may contain complex biases that must be removed to meet user requirements for reliable ensemble forecast information.

Data assimilation is required in hydrological ensemble prediction to process available observations to produce the best possible probabilistic estimates of initial hydrological conditions. These estimates must include ensemble members as well as probabilistic distributions of individual state variables. The ensemble members must represent the appropriate joint variable structure, both among state variables at a given location and spatially, of equally likely possible initial states.

Hydrologic modeling issues that are important to HEPEX include: What are the sources of uncertainty in hydrological models? What are the implications of hydrological models being imperfect representations of real hydrological systems? How can uncertainties in hydrological models, model parameters and hydrological initial conditions be represented in hydrological ensemble prediction?

Verification is essential to HEPEX because we must be able to measure the accuracy and reliability of our results. This is important to our users. It is important to measure progress toward our scientific objectives. And it important to assure that improvements are being made to operational forecast systems.

To address user needs and science issues to meet these needs, HEPEX will organize a set of cooperative activities that include test-beds, inter-comparison experiments as well as scientific workshops and meetings. One objective of the project will be to develop a pilot capability for hydrological ensemble prediction that could be used by hydrological services throughout the world. The results would be demonstrated through test beds, inter-comparison projects and by application by operational hydrological services, water resources agencies and other users.

For HEPEX to achieve its goal it must have strong mutually supportive ties to other international programs. These include programs to: improve weather and climate forecasts; to provide new global sources of data and improve existing sources, especially satellite data and surface observations; to develop improved data assimilation techniques, and to improve hydrological forecasts.

The HEPEX program from its inception must be an evolutionary and adaptive program. The program needs to be responsive to funding opportunities, proactive in fostering collaborative partnerships among academia, operational centers and the private sector (e.g. THORPEX, USWRP, etc.), and aware of relevant breakthroughs and their impact on defining new directions for the program. The foundation of such a program starts with its governance. HEPEX must implement governance that reflects one of a true international effort, with leadership drawn from its global “stakeholders” who are actively involved in hydrometeorological prediction and use of such predictions.

3.5.3 Coordinated Observation and Prediction of the Earth System (COPES)

COPES is a new overarching and integrating strategic framework for WCRP projects. The goal of COPES is to facilitate prediction of the climate/earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society. The primary objectives of COPES are to:

- Determine the feasibility and expected skill of seasonal climate prediction in all regions of the globe with currently available models and data (this important exercise should be repeated periodically as observational systems and models evolve);
- Further develop and test the techniques for ensemble prediction of climate variability and change;
- Determine the scientific basis for, the best approaches to, and current skill of projections of regional climate change at several time-scales;
- Develop well-tested, detailed chemistry-climate prediction and projection models and related procedures (with the International Global Atmospheric Chemistry (IGAC) Project of IGBP).

COPES will:

- Provide a framework for ensuring collaboration among nations and synergy across activities
- Build new tools to describe and analyze climate variability & change, and their combined effects
- Assess why these effects are occurring

- Build improved and more comprehensive climate system models
- Make climate predictions of greater utility from weeks to centuries and on global to regional scales
- Enable improved climate change assessments on the effects of humans, changes in extremes, and impacts on water resources.

COPES will use the 1979-2009 period to develop reference climate data sets and advanced forecasting techniques. This period will be used for retrospective forecasts of weekly, seasonal, inter-annual and decadal variations. The period 2010-2019 will serve as a testbed for real time forecasts. The definition and planning of COPES will be finalized at the 2006 Global Change Conference which coincides with WCRP's 25th anniversary.

Examples of specific COPES objectives include:

- Regional climate change
- Systematic errors in AGCM and CGCM
- Arid and desert climates
- Predictability of monsoons
- Contribution to IPCC WG1 report
- Improve prediction of sea level rise
- Production of climate data sets

WCRP Project Contributions to COPES will include:

- Observing system components
- Process understanding
- Model components
- Interaction with global system (impact and response)
- Assimilation and reanalysis
- Prediction and scenarios

A task force co-chaired by B. Hoskins and J. Church was formed to define and initiate a process plan and to implement COPES. They will report to JSC-26 in 2005. Structural changes that will take place within WCRP include a new Modeling Panel and Working Group on Observations and Assimilation (WGOA).

The WGOA, which replaces the Working Group on Satellite Matters, will coordinate the synthesis of global observations through analysis, reanalysis, assimilation across WCRP and facilitate interaction with WMO, IOC, GCOS,GOOS, etc. with respect to optimization of observing systems. WGOA will coordinate information and data management across WCRP. The chair of WGOA is K. Trenberth. Members include G. Sommeria (secretariat), J. Shukla, J. Key, W. Rossow (GEWEX), B. Randel, A. Lorenc, A. Simmons, G. Duchossois, M. Manton, E. Harrison. Other members, including a representative from CLIVAR, will be added to the Working Group.

The Modeling Panel, which is chaired by J. Shukla, will coordinate across WCRP and focus on climate system prediction. The Panel will liaise with WGOA (assimilation, initialization, reanalysis, data gaps) and oversee data management in modelling activities. J. Polcher is the GEWEX member on Modeling Panel.

Specific contributions expected from each WCRP project for COPES:

- GEWEX:
  - Provide Guidance on How to Initialize Land Surface
  - Proposes/Implements Diagnostic Studies and Numerical Experiments: Understanding Land Surface Feedbacks
- CliC:
  - Provide Guidance on How to Initialize Cryosphere
  - Propose/Implement Diagnostic Studies and Numerical Experiments

- CLIVAR:
  - Provide Guidance on How to Initialize Ocean-Atmosphere
  - Propose/Implements Diagnostic Studies and Numerical Experiments: Understanding Atmosphere-Ocean Coupling and Variability

- SPARC:
  - Provide Guidance on How to Prescribe Atmospheric Composition
  - Provide Guidance on How to Initialize Stratosphere
  - Proposes/Implements Diagnostic Studies and Numerical Experiments

Some potential contributions that GEWEX Hydrometeorology Panel can make to COPES include:

- definition of present climate;
- development of parameterizations,
- validation of models,
- development of regional models,
- data management,
- applications

3.5.4 IGOS Water Theme Connections

The Integrated Global Water Cycle Observations (IGWCO) theme was developed by the Integrated Global Observing Strategy Partnership (IGOS-P) to address the needs of society for better observation and management of the world's water resources. IGWCO has been developed to guide decisions on water cycle observations for: 1) monitoring climate variability and change, 2) effective water management and sustainable development, 3) resource development and environmental management applications, 4) numerical weather, water forecasts, and intraseasonal-to-interannual climate predictions, and 5) critical climate research. CEOP continues to be a central part of IGWCO. In addition, IGWCO initiatives are being launched in high-resolution global precipitation product evaluation, global soil moisture product development, remote sensing and bio-indicators, support to the Global Water System Project (GWSP), capacity building, and support to sustainable development. There are many opportunities for building linkages between IGWCO and GHP particularly in the areas of precipitation, soil moisture and GWSP.

3.5.5 EO/GEO Framework

On July 31, 2003, thirty-three nations plus the European Commission adopted a Declaration that signifies political commitment to move toward development of a comprehensive, coordinated, sustained Earth observations system(s). The Earth Observation Summit attracted a distinguished group of government dignitaries from around the world who are committed to significantly advancing our collective ability to gather Earth observation data.

The Summit participants affirmed the need for timely, quality, long-term global information as a basis for sound decision making. In order to monitor continuously the state of the Earth, to increase understanding of dynamic Earth processes, to enhance prediction of the Earth system, and to further implement environmental treaty obligations, participants recognized the need to support the creation of a comprehensive, coordinated, and sustained Earth observing system of systems.

To further this goal, the Summit participants launched the intergovernmental ad hoc Group on Earth Observations (GEO) to develop a 10-year implementation plan. The group, co-chaired by the U.S., the European Commission, Japan and South Africa and joined by more than 21 international organizations, began its work by organizing five subgroups, as well as a secretariat to support its activities.

Ministers met for Earth Observation Summit II in Tokyo, Japan on 25 April 2004, where they adopted the Framework Document for a 10-year implementation plan for this initiative. The plan itself will be presented at Earth Observation Summit III in February 2005.

3.5.6 Global Water System Project (GWSP)

The Global Water System Project (GWSP) is one of four sector specific initiatives under the Earth System Science Partnership which brings four global change research program together (IGBP, WCRP, IHDP, Diversitas) for the integrated study of the Earth System, the changes that are occurring to the System and their implications for global sustainability. The GWSP is studying the question of how humans are changing the global water cycle, the associated biogeochemical cycles, and the biological components of the Global Water System in ways that have not been experienced before. Factors causing this change include Hydroclimatological Changes, Biogeochemical Changes, Hydrobiological/Ecological Changes, Changes in Water Quantity and Stress Ecological Changes and Governance Changes. GEWEX has opportunities to help address this issue by studying Land Cover/Water Use/Climate Interactions, the Detection of the Impact of Climate Change on Water Supply and the Scope and Impact of Water Diversions on River Systems.

GWSP is also addressing the question, what are the main linkages and feedbacks within the earth system arising from changes in the global water system? In this area GEWEX interests include study of the Legacy of Human and Natural Interactions in the GWS, Teleconnections in the Global Water System, Integrated Models of the Global Water System and Global to regional / regional to global linkages. A third theme with fewer obvious GEWEX linkages deals with he question, How resilient and adaptable is the global water system to change, and what are sustainable water management strategies? GWSP Cross-Cutting Activities include the building the GWSP Information Base, the Integration of ESS and Socioeconomic Approaches and the development of Integrative GWSP Models.

The program has put in place a framework plan has been accepted by ESSP (with some Modifications) and has established a GWSP project office in Bonn with two employees including the director, Eric Creswell. Plans are progressing for a GWSP conference early in 2005. In addition a science team is being established which will include the co-chairs, Charles Vorosmarty and Joe Alcamo and Dennis Lettenmaier who serves as the GEWEX representative. Within GEWEX, guidance is needed on who will speak for GEWEX (WRAP?), how GEWEX will provide its inputs on the physical aspects of the Global water system, what WRAP will contribute to GWSP, and who will monitor and provide feedback to GWSP on GEWEX views on the implementation of their plans.

Appendix A

LIST OF ACTIONS

GENERAL

A.1. CSEs and Global Projects will provide inputs about their potential contributions to COPES that will be consolidated into a report that GHP will make to the GEWEX SSG in January (All CSE Contacts, All Working Group chairs)

A.2. The extent to which climate models are used in GHP should be reviewed to determine if there is a need for a regional climate modeling group. (ACTION: This already established as a part of TWG)

A.3. A revised set of criteria for becoming a CSE will be developed and presented to the GEWEX SSG. These criteria will reflect the existence of COPES and the progress of CEOP (ACTION: John Roads in consultation with GHP subsequently recommended keeping the historical criteria)

A.4. All presenters will provide a one-page summary of their GHP presentation and one power point slide summary of their activities. These will be provided to John Roads and the GEWEX project office by September 30, 2004. (All CSE contacts, Working Group chairs and global Project leads, and all other presenters)

A.5. GHP projects/CSEs will review the opportunities to work with GMPP and GRP, initiate contacts and report on progress at the next GHP meeting. (All CSEs and project leads)

A.6. The GHP chair will send a note to all GHP members reminding them of the expectations for their contributions to GHP in terms of attendance at meetings, contributions to reviews and contributions to GHP projects. (ACTION: John Roads)

WORKING GROUP ISSUES

B.1. WRAP will review the following issues and submit a written report to the GHP Chair by December 31, 2004: a) Contributions of WRAP to GWSP, b) Mountains and water resource management issues, c) WRAP involvement in HEPEX, d) possible new science activities that could be undertaken in response to application needs? (ACTION: Lawrence Martz)

B.2. Chairs of the Working Groups are asked to develop plans that outline: a) the scope of their research activity, b) the goals and underlying hypotheses for their research, c) the timelines for the activity, d) contributions to GEWEX Phase II objectives and e) the outputs they will deliver. [ACTION: Gene Tackle (transferability), John Roads (WEBS), Lawrence Martz (WRAP), Ron Stewart (Extremes), Steve Williams (DM), Martin Werner (SWING)).

B.3. CSEs should identify hypotheses they would like to see examined in transferability studies and advise the Transferability Working Group of their priorities (ACTION: CSE contacts)

B.4. CSEs will nominate individuals interested in working on predictability. This list should be supplied to Jose Marengo. (Subsequent responses indicated that this working group activity should be subsumed under other international activities and thus the GHP Predictability Working Group has been subsumed under WRAP and various CLIVAR initiatives)

B.5. The Extremes Working Group will submit a white paper scoping their activity to the next GHP meeting. (ACTION: Ron Stewart, Jose Marengo)

B.6. Each of the working groups will establish a www page (ACTION: working group leaders)

CSE SPECIFIC

C.1. In cases where reference site data have been slow arriving in the CEOP data base, the appropriate CSE leads will contact the reference site operators to explore reasons for late delivery and to take steps to reduce the delays. (ACTION: CSE contacts)

C.2. The MDB Implementation Plan will be completed and reviewed at next GHP (ACTION: Alan Seed)

C.3. The Canadian policy regarding the disposition of MAGS data will be explored and reported to the GHP. MAGS will present possible activities for a follow-on program. (ACTION: Ron Stewart).

C.4. In view of the lack of involvement of BALTEX in European proposals for GWSP, a letter will be written to Pavel Kabat and Joe Alcamo requesting that BALTEX interests be considered. (ACTION: John Roads with input form Hans Isemer)

C.5. The Chair of GHP should advise the La Platin team that it wishes to see both strong international and regional components in the structure of LPB. (ACTION: John Roads)

C.6. GAPP is requested to begin developing plans for a post-2007 activity to support GEWEX Phase II objectives and GHP priorities. Some options for a future activity should be brought to the next GHP meeting (ACTION: Jin Huang)

C.7.GAME is requested to develop a plan for developing a follow-on project that will support the new COPES paradigm and draw the CLIVAR and GEWEX communities closer together. (ACTION: T. Yasunari)

C.8. The Chair of GHP will contact the appropriate authorities in the LBA BRACA experiment with a request that a clear hydrometeorological component that supports the carbon program. (ACTION: John Roads)

C.9. The Chair of the GEWEX SSG and IGPO will take steps to establish meeting(s) between the AMMA science leaders and program managers in Africa who could play a leadership role in the project. (ACTION: Soroosh Sorooshian, IGPO)

GLOBAL PROJECTS

D.1. A letter will be sent by the GHP Chair to the ISLSCP Chair (with cc to IGPO and F. Hall) asking ISLSCP to develop a broader ISLSCP NEXT initiative with more involvement from other agencies and provide an evaluation and integration center for remote sensing products. (ACTION: John Roads)

D.2. The feasibility of preparing global CSE data sets using data from all CSES and thereby satisfy the expectations of other groups will be assessed (ACTION: Steve Williams)

D.3. The possibility of launching a project for collecting historical runoff data in Southeast Asia for the GRDC will be explored. (ACTION: Tetsuzo Yasunari, IGPO)

D.4. Interested CSEs will explore the possibilities of using radioisotope data in studies in collaboration with IAEA (ACTION: Tetsuzo Yasunari)

D.5. John Schaake will invite Jose Marengo and Lawrence Martz to serve as GHP representatives on the HEPEX SSG (ACTION: John Schaake)

D.6 Send formal letter to John Schaake that GHP wishes to participate in HEPEX. Include in the letter that Lawrence Martz and Jose Marengo will be the GHP representatives.

OTHER

E.1. The policy about regarding data sets developed as a result of WCRP projects will be explored (ACTION: Gilles Sommeria).

E.2. To facilitate the timely review of documents, the GEWEX Office will put document submitted for review on the web for anyone interested to review. (ACTION: IGPO)

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AGENDA

GLOBAL ENERGY AND WATER CYCLE EXPERIMENT
World Climate Research Programme

10th GHP Meeting
PROVISIONAL AGENDA
WITH TOPICS AND CONTRIBUTORS

MONTEVIDEO, URUGUAY, 13-16 SEPTEMBER 2004

3rd Draft: June 23, 2004

Objective: To review progress, to re-focus on our objectives, and to re-chart our future.

SEPTEMBER 13

0830 OPENING

Welcome, Local Logistics and Overview	Roads/Terra
Local Science Issues	Genta/Terra
GEWEX Developments	Sorooshian/Lawford
GHP Objectives, Status and Plans	Roads

1030-1100 BREAK

1100-1230 CSE Contributions to GEWEX Phase II Objectives

(30 minutes total for presentation and discussion)

LPB	Mechoso
LBA	Marengo
GAPP	Huang

1230-1400 LUNCH

MAGS	Stewart
BALTEX	Isemer
GAME	Yasunari
CEOP	Koike

1530-1600 BREAK

MDB	Seed/Manton
AMMA	Lebel/Polcher

SEPTEMBER 14

0830-1030 GHP Working Group Summaries

Data Management	Williams
WEBS	Roads
WRAP	Roads
Transferability	Gutowski/Rockel

AGENDA

10:30-11:00 BREAK

Stable Water Isotope Intercomparison	Aggarwal
Predictability	Marengo
Extremes	Stewart

1230-14:00 LUNCH

1400-1530 Global Projects

GPCC	Maurer
GRDC	Maurer
ISLSCP	Lawford

15:30-16:00 BREAK

IAHS	A. Hall
IAEA	Aggarwal
CEOP	Koike

SEPTEMBER 15

0900 Relevant Global Projects

NASA Surface Water Working Group	Famiglietti
HEPEX	Schaake
WCRP COPES	Sommeria

1030-1100 BREAK

IGOS Water Theme Connections	Lawford
EO/GEO Framework	Koike
GHP/CliC interactions	Goodison
GWSP	Lawford

1230-1400 LUNCH

1400-1500

GHP Contributions to GEWEX Phase 2	Sorooshian/Lawford/Roads

15:00-15:30 BREAK

Open Discussion of GHP future	ALL

1700 ADJOURN

SEPTEMBER 16

0830

Parallel Working Group Meetings, TBD
Transferability?
Others?

1200 ADJOURN FOR SPECIAL EVENT ON THURSDAY AFTERNOON