GEWEX WCRP

Global Energy and Water Cycle Experiment

NEWS

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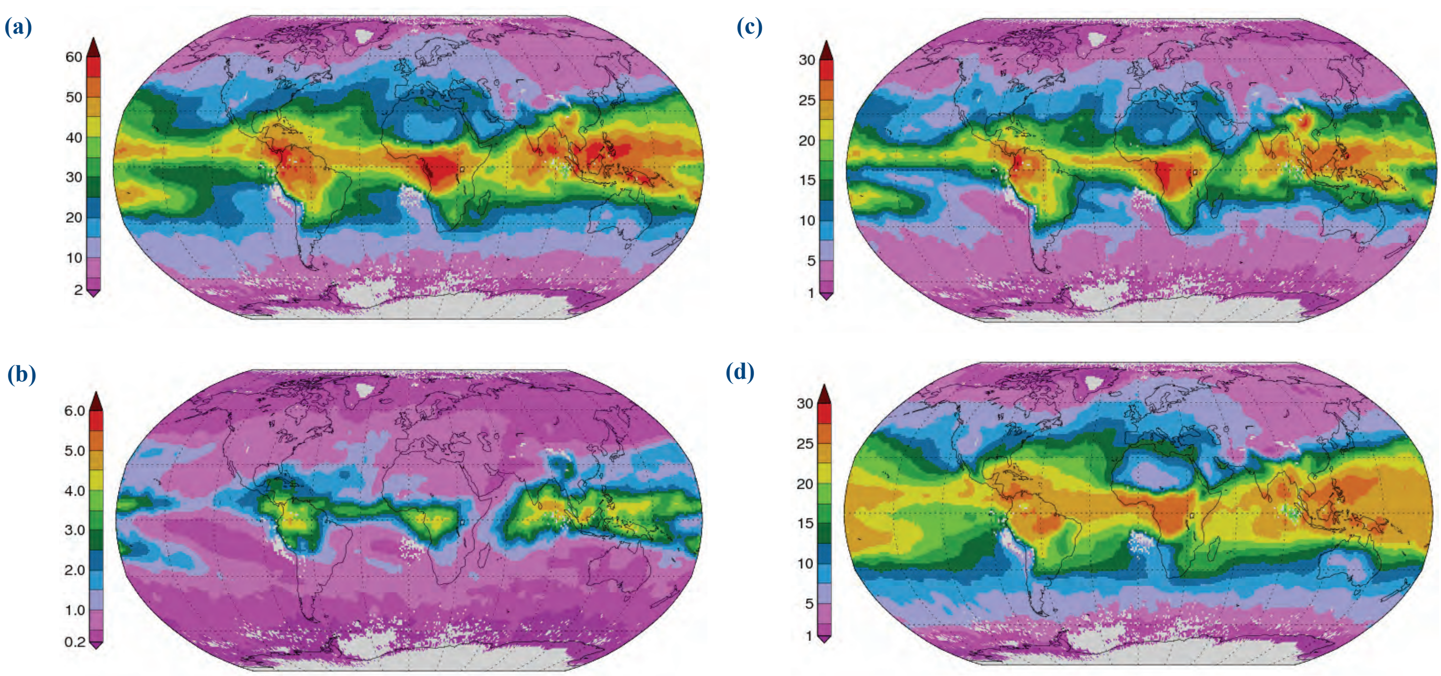
Assessment of Water Vapor Retrievals Provides Reference for GEWEX Assessments



An example of retrieval results from the Deutscher Wetterdienst (DWD) 1D-Var scheme, demonstrating the capabilities of the Infrared Atmospheric Sounding Interferometer (IASI) in resolving vertical structures of atmospheric water vapor. Shown are monthly means of vertical integrated atmospheric water vapor (given in kg/m^2) derived from IASI observations for October 2007. (a) is total column and (b) – (d) are different tropospheric layers: (b)200 to 500 hPa, (c) 500 to 850 hPa, and (d) 850 hPa to surface. The data were aggregated and averaged on a 1-degree latitude/longitude grid. Areas with no valid observations are grey-shaded. A smoothing filter of 5 degrees was applied to the data before plotting. *See article by M. Stengel et al. on page 4.*

Contents

Commentary

Data, Data, and More Data!

Peter J. van Oevelen
Director, International GEWEX Project Office

Today, a wealth of data and information is available from all kinds of media and its volume has increased unimaginably since the early days of the Internet. The numerous ways to access these data are no doubt an incredible accomplishment, and in many ways represent progress. For science, and in particular the research areas that GEWEX focuses on, that holds true as well. However, this blessing comes with numerous drawbacks and caveats. More information does not mean better information, and finding exactly what you need only gets harder as the amount of data to sift through grows. It is not, as the old German saying goes, "Man ist, was man isst" (you are what you eat) anymore, but you are what or who you are looking for. Our online behavior and the insight it provides with respect to our needs as consumers very much determines where companies will put their emphasis on services and improvements. We as consumers have become the product.

So what are the consequences of this environment for scientists? We hope that our research leads to improved understanding of processes and better theories, and on that basis leads to better predictions. With our observations, data sets, and model outputs, we contribute significantly to the increase of information and are also responsible for the quality and accessibility of it. Initiatives such as WaterML 2.0 and some of the Group on Earth Observations (GEO) actvities, which support encoding of hydrological and hydrogeological observation data in a variety of exchange scenarios for the hydrologic community, are very much needed to create order in this rather chaotic data world and help make it easier to share and find exactly what you need.

Data stewardship and continuity of data streams are another important aspect where we as scientists need to take responsibility. To ensure that this is in proper hands, we need to be proactive in collaboration with the appropriate entities, such as space and operational agencies. Regardless of how careful and meticulous we try to be, misuse and abuse of information and data generated by our communities cannot be entirely avoided. Some examples of this include the innocent (but sometimes with far reaching consequences) use of an observational data set with the wrong model assumption to the serious abuse of data set manipulation, and even inventing false data to obtain desirable but factually incorrect results. These are areas where projects such as GEWEX can play an important role in the climate science arena through self-regulation, assessments, discussion, and open access.

The primary role of the GEWEX Data and Assessment Panel (formerly the GEWEX Radiation Panel) has shifted from enabling data set generation to assessing data sets, which includes the process of transferring scientifically generated data products to operationally produced ones, and understanding how these data sets relate to one another. Comprehending what the data (from observations as well as models) represent is crucial, and perhaps even more important is ensuring that others do too.

To shift gears a bit, much of the past two years have been devoted to the development of new research directions within GEWEX and figuring out how these will be prioritized in conjunction with the other WCRP projects, as well as with other global research communities, such as the International Geosphere-Biosphere Programme (IGBP). The Planet under Pressure Conference, as well as the related Belmont Forum, provided much information on where funding agencies would like to see the focus of research develop and on the various programs' response to this (*http://igfagcr.org/index.php/belmont-forum*). With that in mind, four Grand Challenge Questions (see below) have been defined for GEWEX along with the new Imperatives (for more detail, see the Commentary in the November 2011 issue of *GEWEX News*).

The GEWEX Panels and working groups have been asked to identify where and how they can contribute to the four Grand Challenges and where new endeavors need to be developed. All of this is not set in stone but merely intended to guide our current and future efforts more efficiently and effectively. As part of this, we have been asked by WCRP to identify the need or desirability for a name change for GEWEX. I encourage everyone to partake in that discussion (see: *http://www.gewex.org*). Thank you all for your contributions to GEWEX and I look forward to your responses!

GEWEX Grand Challenges Post 2013

1. Observations and Predictions of Precipitation

How can we better understand and predict precipitation variability and changes?

2. Global Water Resource Systems

How do changes in land surface and hydrology influence past and future changes in water availability and security?

3. Changes in Extremes

How does a warming world affect climate extremes, especially droughts, floods, and heat waves, and how do land area processes, in particular, contribute?

4. Water and Energy Cycles

How can understanding of the effects and uncertainties of water and energy exchanges in the current and changing climate be improved and conveyed?

Recent News of Interest

4th WCRP Conference on Reanalyses Shows International Coordination is Crucial

About 250 participants from 26 countries attended the Conference held on 7–11 May 2012 in Silver Spring, Maryland. The daily poster sessions played a major role in the Conference program and were complemented by comprehensive oral sessions (see: *http://icr4.org*).

The program was multi-disciplinary by design and made possible the interaction among various reanalysis communities. It covered the many aspects of atmosphere, ocean, land and ice reanalysis, but also the developing field of Earth System reanalysis, a comprehensive review of various user-applications, and in-depth discussions on data assimilation, the statistical technique to merge models and observations into reanalysis.

A common thread among agency centers and disciplines clearly indicates that although the work of reanalysis is difficult, it has been steady and quantifiable progress has been made in recent years. International coordination seems to be crucial in sharing knowledge and best practices in data development and production. Initial work in using reanalyses in climate service related studies is encouraging, but requires more serious attention from the developing centers. There is also a clear budding younger generation of interested scientists who need a minimum of guidance to prosper and continue their efforts.

Development of Global Drought Information System Moves Forward After Workshop

The WCRP Drought Interest Group, together with CLIVAR, GEWEX, and various agencies, sponsored a WCRP Global Drought Information System (GDIS) workshop in Frascati, Italy on 11–13 April 2012 that focused on determining the needs and the steps necessary for the development of a GDIS.

The key recommendation from the Workshop was that the community should move forward with the development of the basic elements of the GDIS consisting of: 1) an experimental real-time global monitoring and prediction system; 2) a drought catalogue summarizing our understanding of drought world-wide, and 3) a research component centered on internationally coordinated cases studies of recent high profile droughts, with strong ties to users.

Recommendations on specific steps for moving forward on each component included the critical role of pilot studies that target existing national and other regional drought information systems in the validation and evaluation of the global products (e.g., in the highly vulnerable AGRHYMET-Sahel and Greater Horn of Africa areas). The need to gain institutional commitments to contribute products to the GDIS was emphasized, including various satellite and in situ observations, reanalyses, and global predictions that are required to conduct real-time global drought monitoring and prediction.

Announcements

Celebrating 30 Years of ISCCP

Several dates from August 2012 through July 2013 will mark the 30th anniversary of the events that began the International Satellite Cloud Climatology Project (ISCCP), from the first formal international meeting to the beginning of data collection. "ISCCP at 30," a 3.5 day conference to be held on 22–25 April 2013 at The City College of New York, will review and assess what we have learned about the role of cloud processes in weather and climate, and discuss where cloud research should go next. For more details, see: *http://isccp.giss.nasa.gov/*.

Topical Sessions:
1A: ISCCP Overview [Schiffer, Rossow]
1B: Clouds-Radiation [Stubenrauch]
1C: Clouds-Radiation [Oreopoulos]
1D: Clouds-Precipitation [Kummerow]
2A: Clouds-Precipitation [Houze]
2B: Liquid Cloud Microphysics [Stevens]
2C: Ice Cloud Microphysics [Lohmann]
2D: Clouds-Aerosols [TBD]
3A: Cloud Dynamics [Del Genio]
3B: Cloud Dynamics [Jakob]
3C: Cloud Feedbacks [Stephens]
3D: Cloud feedbacks [Tselioudis]
4A: Future Satellite Missions [Maring, Schmetz, Bates, Turino]
4B: Next Research Directions and/or Technology [TBD]

Deadlines (submit to wbrossow@ccyn.cuny.edu)**:**

Paper Title:	17 August 2012
Abstract Submittal:	8 February 2013

1st Pan-Global Atmospheric System Studies (GASS) Conference

10–14 September 2012
Boulder, Colorado, USA

http://gewex.org/2012gass_conf.html

The Conference will focus on observing, understanding, and modeling atmospheric physical processes.

Topics:
- Progress in Representing Atmospheric Processes in Weather and Climate Models
- Stable Boundary Layers
- Radiation Modeling in Weather and Climate Models
- Land-Atmosphere Interactions
- High-Resolution Modeling, the Gray-Zone, and Stochastic Physics
- Boundary Layer Cloud Processes and Feedbacks
- New Observations and Recent Field Campaigns
- Cloud Microphysics, Precipitation, and the Interactions of Clouds and Aerosols
- Polar Cloud Processes
- Large-Scale Organization of Tropical Moist Convection

Assessment of Infrared Atmospheric Sounding Interferometer Water Vapor Retrievals by the ESA DUE GlobVapour Project

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The ultimate goal of the European Space Agency (ESA) Data User Element (DUE) GlobVapour Project was to provide long-term coherent water vapor data sets exploiting different Earth observation missions, allowing for reduced uncertainties and enhanced temporal and spatial sampling compared with those provided by single sensor data sets. The Project used the increasing potential of the synergic capabilities of past, existing, and upcoming European missions [e.g., ENVironmental SATellite (ENVISAT), the Meteorological Operational Satellite (METOP), METEOSAT Second Generation (MSG)], and relevant non-European missions and in situ data.

The successfully executed objectives of the GlobVapour Project include:

- Development of multi-year, global total column water vapor data sets that include error estimates based on carefully calibrated and intercalibrated radiances.
- Validation of water vapor products against ground-based, airborne, and other satellite-based measurements, taking into account the error characteristics of the individual observations as far as possible.
- Provision of a first assessment of the quality of five different Infrared Atmospheric Sounding Interferometer (IASI) water vapor profile algorithms developed by project contractors and external groups.
- Provision of a complete processing system that can assist operational creation of the products developed.
- Demonstration of the use of the products in the field of climate modeling and an exploration of alternative ways to validate climate models.

The Project, which ended in March 2012, provided validated global total column water vapor data sets with uncertainty estimates for input to water vapor climate data records using measurements from a variety of different satellite sensors. Each water vapor data set has different characteristics depending upon the type of measurements. Final data sets and related documentation can be downloaded at: *http://www.globvapour.info.* The successful completion of this project supports a sustainable provision of high quality data records in the framework of the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)'s Satellite Application Facility for Climate Monitoring (CM SAF).

During the GlobVapour IASI Assessment, different IASI water vapor profile retrievals were investigated, their properties intercompared, and their characteristics and performances catalogued with respect to reference observations of water vapor evaluated. While a few qualitative assessments exist (e.g., Hilton et al., 2009), to date, no quantitative assessment of IASI retrievals has to our knowledge been reported. The aim of the GlobVapour IASI Assessment was also to find the best retrieval in terms of accuracy and computational efficiency and to assess the improvements against the background if used. With respect to the outlined guidelines for an assessment of geophysical products as in Kummerow et al. (2012), this assessment focused mainly on the direct comparison to in situ observations and, to a smaller extent, on the comparison of the satellite products. The complete comparison results can be found in Stengel et al. (2012). A summary of what information and data are needed, which collocation and validation approaches are promising, and how results are to be interpreted, as well as a list of conclusions and recommendations, is presented here. The outcome of this Project also serves as reference and basis for future assessments of similar kinds, such as the recently initiated GEWEX Data and Assessments Panel (GDAP) assessment of atmospheric temperature and water vapor.

The IASI retrieval results of five different retrieval schemes provided by EUMETSAT, Deutscher Wetterdienst (DWD), the Met Office, the National Oceanic and Atmospheric Administration, and the German Aerospace Center were considered. The schemes represent all types of retrievals, ranging from regression retrievals to 1D-VAR type schemes employing both fast and line-by-line radiative transfer models. As an example, monthly averaged retrieval results of the DWD 1D-VAR scheme are shown on the cover, demonstrating IASI's capabilities in resolving vertical structures of atmospheric water vapor.

As a reference for the validation, ground-based observations of atmospheric water vapor were taken at Atmospheric Radiation Measurement (ARM) sites (ground-based microwave radiometer and radiosonde) and Global Climate Observing System (GCOS) Upper-Air Network (GUAN) stations (radiosondes). It should be noted that all of the IASI retrieval schemes were developed with different purposes and dedicated application areas, ranging from climate monitoring, over pre-processing in operational Numerical Weather Prediction (NWP) model assimilation, and near-real time processing for pure scientific exploitation. With respect to the different purposes of the retrievals, varying inversion approaches were chosen in the course of development and different background information is incorporated as well. Thus, the retrieval schemes are expected to perform differently when compared to in situ reference measurements, even though the schemes might in principle be of the same quality. Despite the different purposes of the retrieval schemes, the focus of this study was to evaluate their performances when compared to in situ measurements, including comparison of the differences among the schemes, as well as comparison against the individual background information used. Since only a snapshot of all results can be presented in this article, the labels were discarded and interpreted with respect to the spread occurring among their results.

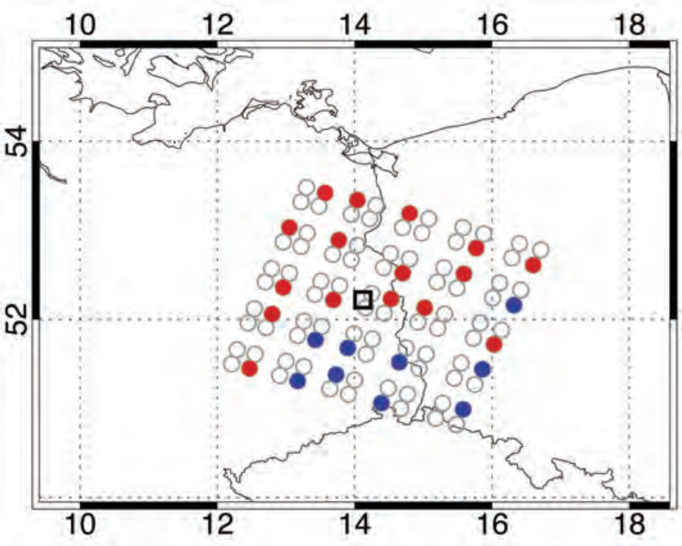
Two strategies for creation of comparison databases were followed to make the data available to the assessment evaluation team at DWD:

1. Local extraction of the collocated IASI retrieval data was conducted at each processing center as far as possible. Locations considered included three ARM sites (Barrow, Nauru, Lamont) and two GUAN (Lindenberg, Sodankylä) stations for six months in 2007 and 2008. Hereafter referred to as the "local approach."
2. Delivery of complete IASI orbits to the evaluation team, followed by the consistent extraction of the collocated IASI retrieval data with respect to all considered locations, consisting of approximately 160 globally distributed GUAN stations for the month of December 2008. Hereafter referred to as the "global approach."

During the collocation procedure, IASI retrievals of a 12-by-12 IASI footprint, centered at the considered site, were extracted from those IASI orbits that occurred in a ±3-hour window around the radiosonde launch. An example collocation is illustrated in the figure on this page. Based upon these data, various subdata sets were composed containing the water vapor profiles and total columnar water vapor inferred from both ground measurements and collocated IASI retrievals. The large variety descended from the spatial and temporal availability of the retrievals and ground measurements and multiple spatial and temporal collocation criteria that were exploited.

A problem with the comparison arose because all the retrieval schemes used different filtering, cloud masking, and quality flagging, which dramatically minimized the intersections among the valid collocation sets of all schemes. Due to this, the idea of achieving so-called multi-collocation, for which all retrieval schemes at the same time and place provide valid retrievals, needed to be discarded. Thus, a careful interpretation of results presented here is advisable; the results serve more as a quality indicator for each scheme rather than a quantitative analysis of all schemes against each other. The following description concentrates on the results for two data sets, each representing one of the two outlined approaches for comparison.

In the figure on page 6 (Panels A and B), the vertical information for water vapor of the retrieval schemes is compared to the radiosonde measurements using the data inferred by the "local approach." For nearly all schemes and heights, a small bias is found with the largest values in the bottom layers. The standard deviation is increasing with absolute humidity values downwards to the low levels. Here, a significant spread is found among the schemes with deviations being nearly twice as large as for other schemes.

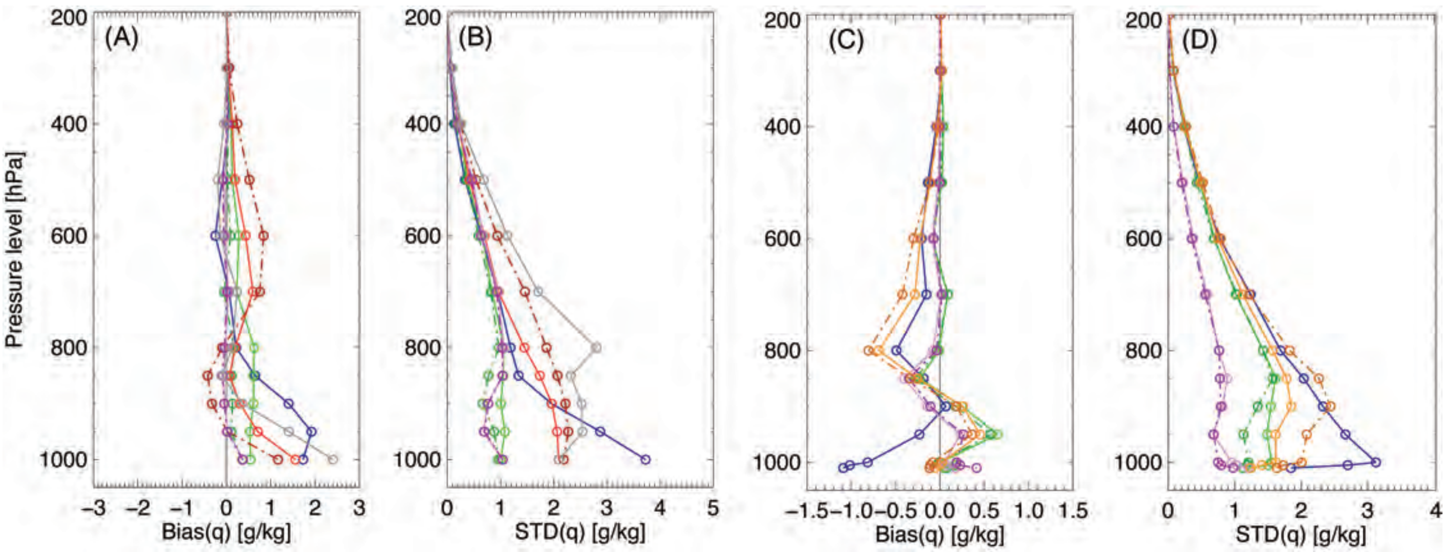


Example of the extracted Infrared Atmospheric Sounding Interferometer (IASI) fields of vision (FOVs) at the Lindenberg site in Germany. Red symbols indicate cloudy FOVs, blue are clear-sky, while the grey circles indicate the location of the original IASI resolution.

Panels C and D show the results for the global approach. Here, the results seem similar in general, but a few deviations can be found. The bias in the mid-troposphere is clearly negative for almost all schemes, while the lower levels are again characterized by a small positive bias, except for one scheme. The spread among the different schemes is again large in the near-surface layers. This is not surprising and it shows that an improvement of the treatment of surface temperature and emissivity within retrieval schemes is needed, although challenging.

In all the comparisons, it became obvious that an improvement for the used background field cannot always be found, particularly if the background is based on a short-range NWP forecast. When using a poorer background, such as regression-based or climatology, an improvement can be obtained; however, it will not reach the agreement with radiosondes that is found for NWP background and corresponding IASI retrievals. It should be noted that in this context, the radiosonde measurements cannot always be considered an entirely independent reference.

A more detailed discussion of the results together with more conclusions can be found in the final assessment report. This report, and in general the experience gained in the course of this effort, will supply highly valuable information and build a good basis for the necessary infrastructure and the development of software and other tools for the recently initiated GEWEX water vapor assessment (see: *http://www.globvapour.info./GEWEX-Workshop.html*).



Panels (A) and (B) show profiles of bias and standard deviation (of specific humidity) against radiosondes for the local approach, and (C) and (D) the global approach. Light colors are retrievals and dark colors are background if existent.

Lessons learned in the GlobVapour IASI assessment have led to a list of recommendations for future comparison assessments that can serve as practical guidance for upcoming assessments. A few of the recommendations are:

- More independent reference measurements (e.g., flight campaigns) should be included, because these are often not assimilated in NWP/reanalyses frameworks, which are often used as background information.
- Use of a common set of background and auxiliary and ancillary data, as well as of radiances, should be mandatory.
- A prescribed common cloud mask is desirable to facilitate multi-collations.
- Final conclusions should be based on clear definitions of the underlying criteria.
- Approaches to determine the error budgets following Pougatchev (2008) and Pougatchev et al. (2009) should be utilized. Their advantages are: (1) accounting for differences in horizontal, vertical, and temporal resolution as well as noise level of the instrument and reference observations, and (2) allowing an assessment of the error information deduced from validation.

In addition to the given recommendations, a proper technical infrastructure as well as excellent teamwork and common willingness of all developers and providers are required for a high-end solution.

Acknowledgements

This assessment was funded by the ESA DUE Program (*http://www.esa.int/due*). The authors would like to thank all colleagues who were involved in the IASI assessment and who helped to make this project a success in the broadest sense.

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CEOS Water Portal

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The Committee on Earth Observation Satellites (CEOS) Water Portal (*http://waterportal.ceos.org/*) provides access to a variety of hydrological and water relevant data including satellite, in situ, and model output data. The Water Portal is being developed by a project under the CEOS Working Group on Information Systems and Services (WGISS) led by the Japan Aerospace Exploration Agency (JAXA). It began as a prototype system that was collaboratively developed within WGISS as a Test Facility (WTF) project to support the science community of the Coordinated Energy and Water Cycle Observations Project (CEOP), providing user-friendly access to CEOP data. The CEOS Water Portal expands these functions, available data, and target users.

Water Portal system data are archived in globally distributed centers, including the National Center for Atmospheric Research (NCAR) Earth Observing Laboratory in Boulder, Colorado, USA. Numerical Weather Prediction (NWP) station time series and global gridded model output data are archived at the Max Planck Institute for Meteorology (MPIM) in cooperation with the World Data Center for Climate in Hamburg, Germany. Some of the satellite data are archived at the Data Integration and Analysis System (DIAS) at the University of Tokyo, Japan. The Portal processes user requests and retrieves the data, including rendered images and plots, from the distributed data centers using the OPeNDAP protocol.

Data Partners

In order to become an "attractive" portal system for users, one of the most important features is to offer a variety of data to meet user needs. Table 1 shows the current data partners and available data lists. There are plans to collaborate with eight or more data centers over the course of the next four years. New data partners, especially those that have the OPeNDAP interface, are encouraged to participate.

Features

The portal system aims to provide one-stop-service and access to a variety of hydrological and water relevant data and also supports data integration. By aggregating multiple types of data (in situ, satellite, and model output), the data will have more value than they had individually. This portal has several features that can support data integration, including:

- Single user interface to get the various types of data (satellite, in situ, and model output)
- Selecting data by time range, variable, and station
- Viewing data in image format
- Downloading data [available formats: NetCDF, ASCII, and GRIB (only for model output)]

In the search feature, the portal provides two kinds of searches to facilitate easy access, category search, and map search (see Figure 1). Users can either start from a category list (such as

Table 1. Data Partner List (as of April 2012)

Data Partner	Data Types	Variables	Server Locations
CEOP	Satellite*	PR, TMI, AMSR, AMSR-E, MODIS, GLI, SSMI, VISSR.	University Of Tokyo (Japan)
	Model (Time Series)	Surface pressure, skin temperature, hourly precipitation amount, surface brightness, temperature, specific humidity, and u- and v-components of wind.	MPI (Germany)
	Model (Gridded)	Air pressure, surface air pressure, air temperature, precipitation rate, and snowfall amount.	MPI (Germany)
	In situ**	Surface meteorological and radiation data set, flux data set, soil temperature and soil moisture data set, and meteorological tower data set.	NCAR (USA)
AWCI	Model (Time Series)	Surface pressure, skin temperature, hourly precipitation amount, surface brightness, temperature, specific humidity, and u- and v-components of wind.	MPI (Germany)
	In situ	Precipitation amount, river discharge, and river water level.	University of Tokyo (Japan)
NASA	Satellite	AIRS Level 3 data (daily, 8-day, or monthly averaged, global data).	NASA GSFC (USA)
NOAA (GPCC)	In situ	Precipitation data.	NOAA (USA)
NASA	Satellite	GRACE Level 3 (Monthly averaged, global data).	NASA/JPL (PO.DACC)
NASA (FLUXNET)	In situ	FLUX data (fluxes of carbon dioxide, water vapor, and energy exchange).	NASA ORNL DAAC (USA)

**Data available as 250 km x 250 km subset scenes regridded to Latitude/Longitude grid and centered over more than 50 in situ data sites, as well as monsoon area regions. Users can select bands and time period, and download multiple scenes.*

***Four types of CEOP in situ data from over 50 Reference Sites are available. Nineteen surface variables are available and nine variables from Towers are also available. In addition to these, soil and flux data (sensible heat, latent heat, CO_2, soil heat flux) are also available. Quality check flags can be downloaded embedded in the data.*

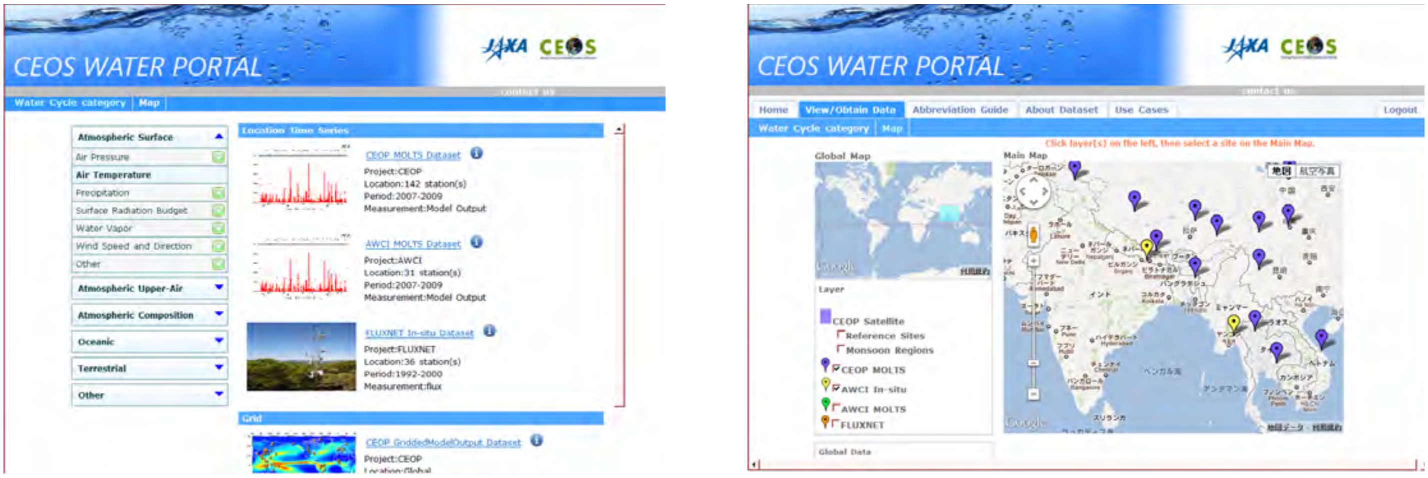

Figure 1. CEOS Water Portal search interface (left: category search; right: map search).

surface, upper air, or oceanic) or a world map to get to their data of interest. Users may specify time range, a variable name, and an observation station to refine the search results. Data can be viewed (as gif image) and downloaded [by NetCDF format, ASCII format, or GRIB (only model output)], as described above.

Target Users and Feedback Loop

Target users of the original WTF-CEOP prototype system were mainly scientists. The CEOS Water Portal plans to extend its user community to include decision makers and officials such as river administrators by facilitating a feedback loop as shown in Figure 2.

Figure 2 shows one example of data and information flow centered on the CEOS Water Portal.

1. Scientists get various data needed for model calculation (WEB-DHM, for example) via the portal.
2. Scientists use model output data and complete their analyses.
3. Scientists register their use cases into the portal.
4. Decision makers and officials can refer to and acquire use cases and data easily.

This feedback loop will encourage communication within and across communities. In order to realize this feedback loop, the portal has a function that enables users to register use cases. Users can register the results of their research obtained by using data via the portal as a use case, which then becomes available for other users to reference in their data search on the portal.

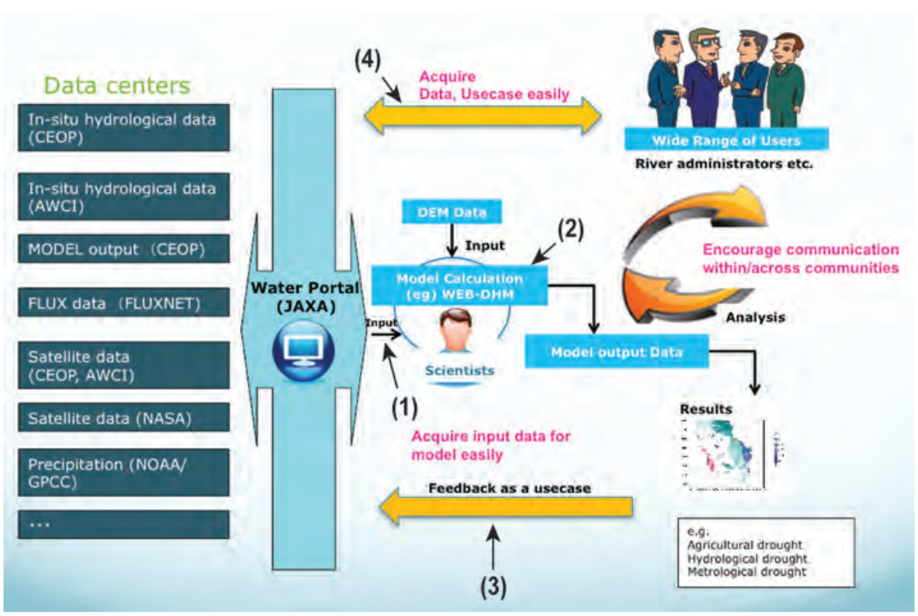

Figure 2. Data and information flow related to the CEOS Water Portal.

Future Work

CEOS Water Portal development started in 2010 and will continue until 2016. During the next four years, the following features will be implemented:

- User authentication function (in order to respect each data partners' data policy)
- Statistical analysis function
- Use case registration and search function enhancement
- Free text search function

Other enhancements will be implemented, depending on user and data partners' requests.

Please visit and use the portal. Any comments and requests will be highly appreciated.

A Regional Hydroclimate Project for Lake Victoria Basin (HYVIC)

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This article was inspired by the East African Community (EAC, 2011) feasibility study that made the recommendation for the creation of HYVIC. The feasibility study was funded by EAC. Authors: Fredrick Semazzi (lead), Sandra Yuter, James Kiwanuka-Tondo, Lian Xie, Casey Burleyson, Bin Liu, Kara Smith, Pascal Waniha (NC State University); Lynn Rose (Atmospheric Technology Services Company, Norman, OK); Ruben Barakiza (Institut Geographique du Burundi), Peter Ambenje (Kenya, Meteorology Department), Anthony Twahirwa (Rwanda Meteorological Service), Hamza Kabelwa (Tanzania Meteorological Agency), Ronald Wesonga (Uganda Meteorological Department), Laban Ogallo and Joseph Mutemi (University of Nairobi and ICPAC, Kenya) and Francis Kirudde (Uganda, UMEME).

Lake Victoria is the commercial and socioeconomic "nerve center" of East Africa and is Africa's largest and the world's second largest freshwater lake, with an area of 69,000 km^2 spanning the countries of Tanzania, Uganda, and Kenya. The Lake Victoria Basin (LVB) supports over 30 million people and is one of the two water sources for the Nile River, thus impacting several hundreds of millions of people who live in the Nile River Basin.

The Lake Victoria hydrologic balance is composed of five primary components:

$$P+Q_{in}-E=Q_{out}+\Delta_{lake\ level}$$

where Q_{in} is tributary inflow (15%), P is rainfall over the lake (85%), E is evaporation (80%), Q_{out} is abstraction or outflow through the Nile River (20%), and $\Delta_{lake\ level}$ is the change in lake level (Yin and Nicholson, 1998). Comparison of the decreasing trend of LVB rainfall (and corresponding lake levels) with the projected amounts in the later period of the century (see Figure 1) indicates that the trend of declining water resources should bottom out in the next few decades.

HYVIC Mission Statement

The Lake Victoria Basin is proposed as a GEWEX Hydroclimatology Panel (GHP) Regional Hydroclimate Project (RHP). The goal of the Hydroclimate Project for Lake Victoria (HYVIC) is to understand the relative role of the hydrological components of the water balance over the LVB in determining the trend of decreasing water resources during the recent decades and to determine the timing of the anticipated reversal during the next few decades in response to the projected increase in rainfall over the region. Equipped with this knowledge, stakeholders will be able to make optimal decisions to minimize hydroclimate-related risks in the management of hydroelectric power generation, water, agriculture, and other leading sectors.

Climatology

To understand the variability of the hydrological components of the LVB, it is necessary to investigate the root climate physical processes involved. The primary feature of the regional hydrological system over LVB is a distinct dry-wet-dry-wet pattern of the annual rainfall (Asnani, 2009). Over the eastern sector of the lake, rainfall is at a minimum (less than 800 mm per year; Asnani, 1993), and over the western sector, rainfall is at a maximum (over 2000 mm per year). There is a well documented rainfall maximum (more than 1500 mm) over the land immediately to the east of the lake, and a rainfall minimum (less than 1000 mm) immediately to the west of Lake Victoria. Previous studies have demonstrated that this primary feature of the regional hydrology is determined by a combination of orographic forcing, the lake's thermodynamics, and the interaction between the prevailing flow and lake-land breeze circulation.

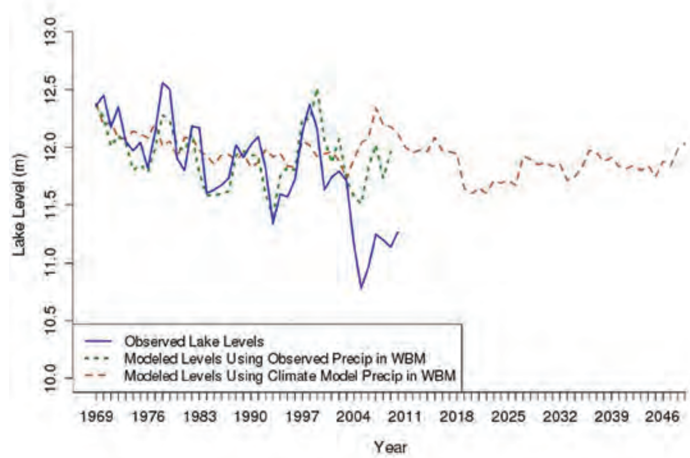

Figure 1a. Observed levels of Lake Victoria (blue); Lake Victoria levels estimated using a water balance model (WBM) (green; Tate et al., 2004); and Lake Victoria WBM-derived levels using rainfall data provided by Richard Grahams (UKMO, personal communication) from a five member multi-ensemble PRECIS UKMO regional climate model (brown).

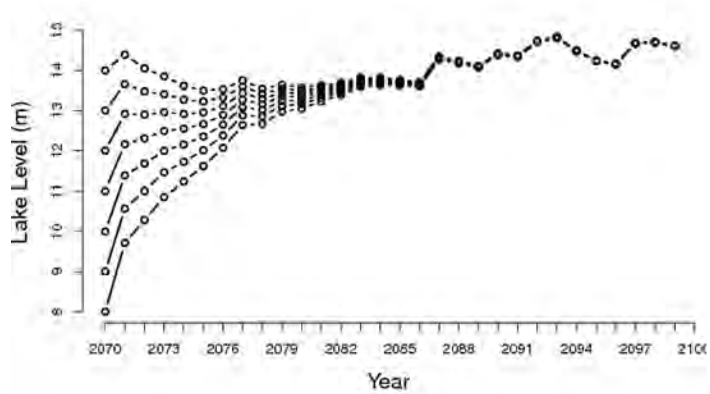

Figure 1b. RegCM downscaled rainfall for 2071–2100 used as input for the Tate et al. (2004) WBM to compute the lake level (LL). Since we do not know the starting LL in 2071, several initial values were used, but all cases converged to the same level of about 2 meters increase above the present LL by 2100 (Smith, 2011).

The influence of orography begins with the easterly zonal flow that descends down the slopes of the eastern mountain range before reaching Lake Victoria (Anyah et al., 2006; Lin, 2007; 2006; Asnani, 2009). After crossing the lake, it is forced to ascend the slopes of the mountain range lying to the west.

Anyah and Semazzi (2004) proposed a thermodynamic mechanism to explain the climatological rainfall pattern in terms of the bathymetry of Lake Victoria, with a maximum depth over the eastern sector of the lake (approximately 70 m) and shallow depth over the southwest (approximately 40 m). They concluded that the southwestern region is an important source of warm water because it is relatively shallow and the water column is heated much more quickly during the day than the rest of the lake.

A third mechanism that could partially account for the dry-wet-dry-wet climatological rainfall distribution across the LVB arises from the interaction of mesoscale land-lake breezes and large-scale easterly prevailing flow. At night, the net result of the converging low-level land-breeze flow and the large-scale easterly flow is to shift the region of maximum convergence toward the western sector of Lake Victoria (Asnani, 2009). The processes in Figure 2 represent both the primary hydrological balance components and the relevant physical climate processes. These will be discussed in detail in the Project Science Plan from the perspective of the primary time scales of interest intraseasonal, interannual, decadal, and climate change.

Interannual Variability

The El Nino Southern Oscillation (ENSO) and the Indian Ocean Zonal Mode (IOZM) are the dominant sources of variability for LVB. The maxima in lake levels are clearly evident for the ENSO and IOZM warm years, such as 1961, 1982, and 1997 (see Figure 3). The commissioning of the Owen Falls dam at the source of the Nile in 1959 has also been implicated in the sudden rise in the lake level in 1961. Other potential contributing factors include sedimentation accumulation at the bottom of the lake (Kayombo and Jorgensen, 2007; Swallow et al., 2001), changes in groundwater (Piper et al., 1986), and thermal expansion. These should also be considered in the estimation of LVB water balance.

Intraseasonal Variability

Song et al. (2004), using the RegCM3-POM coupled regional climate model, identified internal hydrodynamical wave forms which propagate around the coastal perimeter waters of Lake Victoria in clockwise direction with a periodicity of approximately 20 days. These transient disturbances could significantly contribute to both the rainfall that falls over the tributary basins (Q_{in}) and directly over Lake Victoria as rain (P). Csanady (1982) has shown that Kelvin and Poincare waves in the Great Lakes in America exhibit variability on the intraseasonal time scale. Similar research is needed for Lake Victoria. On this timescale the interaction of the LVB climate with the Matsuno-Gill tropical solutions and inertial instability triggered variability (Hsieh et al., 2005; Paeth and Hense, 2006) could also be significant, and their roles should be investigated.

Decadal Variability

The leading regional mode of climate variability for LVB corresponds to ENSO followed by the multidecadal frequency East African dipole mode (Schreck and Semazzi, 2004) which may be associated with the Atlantic Multidecadal Oscillation (AMO) through the Indo-Pacific component of the global thermohaline circulation (Bowden et al., 2005). Another important source of decadal variability is the adjustment time (τ) required by the lake level to equilibrate to the new rainfall climatology. τ and the corresponding equilibrium level are independent of the starting level. Salas et al. (1982) found τ for Lake Victoria to be approximately 10 years. Sene and Plinston (1994) found it to be 19 years for the levels to reach 1 cm from equilibrium for an initial departure from equilibrium of one meter. While their calculations give a range of possibilities and suggest a need for further investigation, it is clear that the adjustment time occurs on the decadal time scale.

Climate Change

The change in land cover (Semazzi and Song, 2001; Heuser and Semazzi, 2008), is in part driven by the high population growth of the LVB, which could significantly impact the hydrological balance through the modification of stream inflow, reduced evapotranspiration, increased albedo, and reduced surface friction. Understanding the role that land cover change and urbanization play in modulating the water resources in the LVB will be a subject of the HYVIC research agenda, employing the recent advances in the formulation of distributed hydrological processes (Miguez-Macho et al., 2007).

Global warming is projected to have a significant impact on the LVB climate. An example of hydrological information that would be highly valuable for policy makers in the management of hydroelectric energy is illustrated in Figure 1a. Since

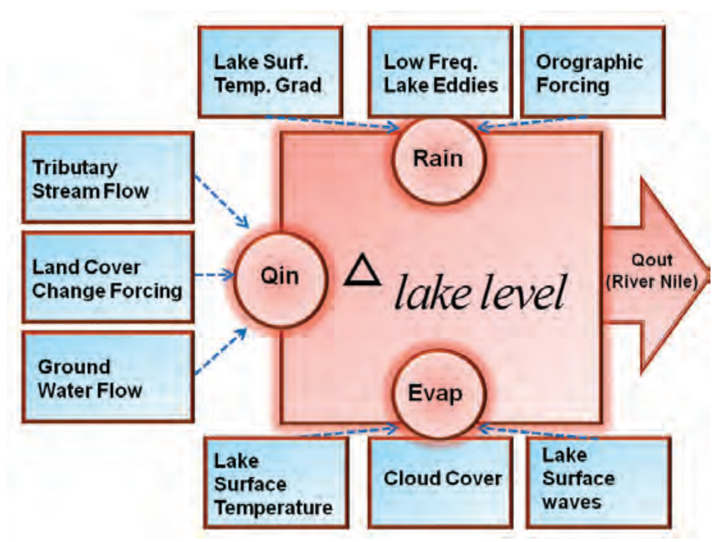

Figure 2. The primary hydrological balance components and relevant physical climate processes.

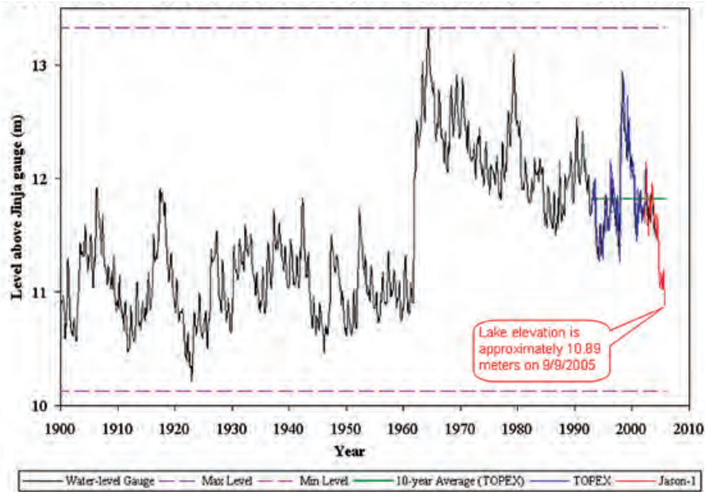

Figure 3. Lake Victoria water level in meters (from USDA, 2005); 0 meters is at 1122.86 m above sea level.

late 2005, the water level of Lake Victoria has been lower than it has been since before 1960. One explanation is that the release from the hydroelectric power dams at the source of the River Nile exceeded the Agreed Curve and resulted in lake levels dropping far beyond drought-only levels (Kull, 2006). An alternative or complimentary explanation is that the lake's hydrology is simply returning to the norm and the levels seen since 1960 were unusually high (WWF, 2010). On the decadal time scale the individual ensemble member's performance is still highly deficient and needs further research. Full explanation of the causes of the decline is clearly warranted to demonstrate that we fully understand the LVB hydrological system. The COordinated Regional climate Downscaling EXperiment (CORDEX) model assembles simulations and should be used to obtain more robust results and estimation of uncertainty.

Proposed HYVIC Observational Field Project

A comprehensive observational network is required to address the critical science questions stated throughout this article. Recently, the East African Community (EAC, 2011) conducted an extensive feasibility study primarily focusing on the development of meteorological services for the fisheries industry over the LVB. The EAC study is an important first step for a full assessment that should be undertaken by HYVIC to address the relevant research questions for the other stakeholders. The EAC study reviewed surface and upper air installations near Lake Victoria and throughout the LVB, and consulted with regional meteorological personnel and with officials of the fisheries industry. The team considered options for numerous instrumentation systems—both atmospheric and hydrological—and concluded that the addition of radar observations would have the highest probability of immediate improvement of the navigation safety of Lake Victoria and to support research by providing critical observations. A summary of the EAC (2011) recommendations for sensors follows.

Land and Atmospheric Observations

Key sensors required include:

- 2–3 radars around Lake Victoria to monitor the location of precipitation, storm movement and intensity, rainfall estimates, and wind patterns;
- 4–5 lightning detection sensors around the lake for estimating the location and frequency of lightning;
- 15–20 automated surface observation sensors around the lake to fill in information gaps within the existing network and to enhance the effectiveness of the observation network around the lake;
- 5–10 automated surface weather observation sensors installed on some of the 5000 islands in the lake;
- 7–10 GPS Occultation Systems based on signal delay due to differential propagation in moist/dry air for atmospheric moisture monitoring;
- a lightning prediction routine (radar) to estimate the probability of a lightning strike with approximately 15 minutes lead time; and
- stream gauges along each of the major tributaries to improve estimates of amount of water flowing into and out of the lake.

Marine Observations

A complimentary lake observational network was recommended by the EAC (2011) feasibility study to support research, navigation safety, and exploitation of natural resources, and would include:

- the MV Jumuiya EAC Research ship for conducting observational cruises and deployment of buoys;
- six moorings (10 m; 30 m; >40 m) secured to fixed buoys with marine and above water observation sensors in the lake;
- 18 acoustic doppler current profilers;
- 12 water level sensors and wave measurement sensors;
- visibility sensors;
- integrated weather pak observational instruments similar to those used over land and mounted on top of floating buoys, which can be secured at fixed points in the interior of Lake Victoria; and
- a large number of small fishing boats fitted with inexpensive temperature and currents sensors paks, and GPS to determine location.

Proposed HYVIC Workshop

A workshop is being planned in cooperation with the relevant WCRP communities, including GEWEX and CLIVAR, to develop a comprehensive plan for HYVIC. A preliminary draft of the HYVIC Science Plan is being prepared and will provide background information for the workshop agenda. A partial list of institutions and organizations that might be expected to participate in the workshop include: the African Development Bank (ADB) and other Development Banks, DANIDA/Denmark, the EAC, the European Union (EU), the Food and Agricultural Organization (FAO) of the United Nations, Global Lake Ecological Observatory Network (GLEON), Google, the Intergovernmental Authority on Development (IGAD), the International Civil Aviation Organization (ICAO), the International Council for Science (ICSU), the Korea Meteorological Agency (KMA), National Geographic, Nile Basin Commission (NBC), representatives of the mobile phone service industry, SysTem for Analysis Research and Training (START), UK Department For International Development (DFID), the United Nations Environment Programme (UNEP), US Agency for International Development (USAID), the United States Department of Defense (DOD), the US Department of State (US-DOS), the United States Geological Survey (USGS), the US National Oceanic and Atmospheric Administration (NOAA), utility companies, the World Bank, the World Meteorological Organization (WMO), and the World Wildlife Fund (WWF).

Long-Term Expectations

HYVIC will create a new body of knowledge and information about the variability and future states of water resources for the LVB region to support the needs of stakeholders. The Project will partner with WCRP communities, international funding institutions, and stakeholders to meet its goals. HYVIC science and implementation plans will be guided by the GEWEX imperatives and science questions, and other WCRP core program research agendas to improve the status of data sets, analysis, processes, modeling, applications, technology transfer, and capacity building for the LVB. HYVIC will serve as a nucleus and proof of concept for an expanded initiative in the future to understand the water regimes for the rest of the African deep tropical region, including the Congo and Nile basins.

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HyMeX: Towards Special Observations Periods

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The Hydrological Cycle in the Mediterranean Experiment (HyMeX) is an international program that contributes to the GEWEX objectives of improving our understanding of the global hydrological cycle and the prediction of its evolution through a coordinated set of studies in the Mediterranean Sea Basin (see: *http://www.hymex.org*). More specifically, HyMeX contributes to the GEWEX Hydroclimatology (as a Regional Hydroclimate Project) and the Global Land/Atmosphere System Study (GLASS) Panels.

HyMeX uses a three-level nested observation scheme and a consistent modeling strategy (numerical weather research and prediction models, and regional climate system models). The Long-term Observation Period (LOP) began in September 2010 and will continue until 2020, and includes the whole Mediterranean Sea region. The data will be used in developing a long-term time series that is required to study seasonal and interannual variability. An Enhanced Observation Period (EOP) for both budget and process studies began in September 2011 and will continue until 2013. EOP observations may only include specific parts of a year (e.g., autumns for heavy precipitation and floods, winters for strong regional winds and ocean convection). Special Observation Periods (SOPs) will last for several months in fall 2012 and winter 2013 to provide detailed and specific observations for studying key processes of the water cycle in the HyMeX target areas. In addition to the EOP observation framework, dedicated groundbased, shipborne, and airborne means will be deployed during the SOPs.

6th HyMeX Workshop: Last Preparation for the Special Observation Periods

More than 130 participants attended the Workshop, which was held in Primosten, Croatia on 7–10 May 2012. The objectives of the Workshop included: (1) the presentation and discussion of the recent scientific advances made from the analysis of the data collected, and simulations performed in the framework within HyMeX; (2) the coordination at the international level of detailed plans for the SOPs; and (3) the reinforcement of the collaborations at the international level to make full use of the data collected within HyMeX.

This year the Workshop ran four days (instead of three days as in past years). The program consisted of plenary oral and poster sessions featuring presentations on recent scientific progress concerning the Mediterranean water cycle that meets the objectives of the HyMeX Science Plan, and working sessions dedicated to the implementation of the HyMeX program with a special focus on the SOPs.

Fall 2012: Heavy Precipitation and Flood SOP

Recurrent heavy precipitation events and floods cause extensive damage and casualties on both sides of the western Mediterranean. The dramatic events of fall 2011 in the Liguria region of Italy and in Var, France in 2010 and 2011 are recent examples that have been documented in the framework of the HyMeX LOP and EOP, and are currently being investigated. Strong sea winds often blow during these events and can exacerbate coastal flooding. Studies of these events are at the heart of the HyMeX program.

In addition to the observing networks deployed for the EOP (2011–2013) and LOP (2010–2020), SOPs are scheduled in 2012 and 2013 with intensive field campaigns. These campaigns aim to provide a better understanding of atmospheric, and oceanic circulation and of transfers in hydrology that explain the formation of intense hydrometeorological events in the Mediterranean. The first intensive measurement campaign, which runs from September 5 to November 6, 2012, is devoted to the observation and modeling of heavy rainfall and flash floods that affect the northwestern Mediterranean in the fall. Its purpose is to document the weather conditions upstream of precipitating systems, the air-sea interactions, and processes of initiation and maintenance of deep convection and to provide a better description of surface and subsurface processes controlling the hydrological response of Mediterranean rivers.

A wide range of instruments will be deployed to observe simultaneously the three components of the Earth system (atmosphere, ocean, land) with a special focus on the thermodynamical, microphysical and electrical properties of storm systems, and the oceanic and atmospheric boundary layers upstream of these systems. The experimental set-up includes airborne measurements using two French research aircraft (SAFIRE/F-20 and ATR-42) and the German KIT/Do-128, as well as an enhanced radiosonding network, Centre National d'Etudes Spatiale (CNES) balloons drifting within the boundary layer, and measurements of air-sea fluxes and ocean properties from boats, gliders and drifting buoys. Hydrometeorological monitoring will be reinforced at eight sites (Cévennes-Vivarais and Corsica in France; the Balearic Islands and Catalonia, and Valencia regions in Spain; Rome, northeast-Tuscany and Liguria in Italy) with the deployment of radars, lidars, wind profilers, radiometers, disdrometers, and lightning detectors. Several watersheds of these sites are instrumented to document runoff processes and specifically the impact of the spatial distribution of rainfall and soil moisture across the watershed and transfer processes in rivers during flood events.

These operations will be coordinated from a primary HyMeX operation center (HOC) located in Montpellier, France, where the French research aircraft will be operated. The primary HOC will work in connection with secondary HOCs in Corsica, Spain and Italy. Real-time modeling systems will be implemented during the SOPs to guide the deployment of mobile instrumented platforms or to assess their contribution to the prediction of hydrometeorological events (*http://sop.hymex.org*).

A list of HyMeX funding agencies can be obtained from: *http://www.hymex.org*.

Meeting/Workshop Reports

AGU Chapman Conference on Remote Sensing of the Terrestrial Water Cycle

19–22 February 2012
Kona, Hawaii, USA

Peter van Oevelen[1] and Venkat Lakshmi[2]

[1]International GEWEX Project Office, Silver Spring, Maryland,USA; [2]Department of Earth and Ocean Sciences, University of South Carolina, Columbia, South Carolina, USA

Under the auspices of the American Geophysical Union (AGU) and led by Venkat Lakshmi, the Chapman Conference was organized to review the latest science of the terrestrial water cycle in relation to current and planned Earth observing satellite missions, as well as to identify future requirements and directions. The specific water cycle components considered included soil moisture, precipitation, evapotranspiration, snow, ice, groundwater, and surface water. Remotely sensed data were the primary focus of the meeting, but ancillary data and in situ resources were also discussed, as all these are crucial components for terrestrial water cycle science.

There were 300 abstract submissions with 230 registered participants from 18 countries, including 30 students and around the same number of early career scientists. The Conference was sponsored in part by the National Aeronautics and Space Administration (NASA) and the National Science Foundation (NSF) in the form of travel grants, which were awarded to six early career scientists and 17 students. The meeting format included in-depth morning oral presentations to develop the background for the topics followed by afternoon breakout sessions where the topics were further discussed.

An important part of the meeting was to review the current status of satellite missions that have been launched and those being planned by national and international space agencies. A key conclusion from the Conference was that community-wide planning and organization will be needed to better define objectives, renew group momentum, and develop modeling and integration systems. These will be critical to initiating and developing future satellite systems that will provide continuity in the scientific data records that the current and near-term missions will generate.

In addition, in situ networks were identified that provide resources for each of the water cycle components. Allowing open and free access to these data was encouraged, as was the standardization of data collection and archiving. Across the range of water cycle parameters, researchers emphasized the need for consistent, long-term support for both remote sensing and in situ observing systems and the resulting data archives as data sources diversify and grow. Furthermore, the data centers should continue, or if not doing so already, then consider enabling episodic reprocessing of entire data sets as algorithms evolve as an integral part of their data stewardship.

A key conclusion of the Conference was that two types of terrestrial water cycle observations are particularly in need of innovation and advancement: the monitoring of snow, both when falling and as snowpack, and evapotranspiration. Moreover, consistent and reliable global scale estimates of hydrologic fluxes (precipitation, evapotranspiration, runoff, streamflow) and storage terms (groundwater, soil moisture, lake/reservoir levels, snow water equivalent) have been elusive, requiring more accurate satellite observations of radiation, precipitation, snow cover, soil moisture, and land-surface temperature.

The modeling and data assimilation community encouraged the development of a community toolbox that would include remote sensing–aware hydrologic models and data streams with spatially and temporally varying error estimates. This would provide consistent and valuable information to decision and policy makers.

The list of participants, agenda, and summaries of the breakout groups are available at: *http://www.agu.org/meetings/chapman/2012/acall/index.php*.

Co-conveners of this meeting were Venkat Lakshmi, Michael Cosh, Douglas Alsdorf, Jared Entin, George Huffman, Peter van Oevelen, Matt Rodell, Chris Rudiger, William Kustas, Martha Anderson, and Juraj Parajka. Lynn Hayes and Cynthia Wilcox of AGU helped with Conference logistics.

Participants at the AGU Chapman Conference on Remote Sensing of the Terrestrial Water Cycle. (Photo courtesy of Michael Cosh.)

8th Group on Earth Observations Integrated Global Water Cycle Observations Community of Practice Meeting

22–24 February 2012
Kona, Hawaii, USA

Richard (Rick) Lawford
International GEWEX Project Office, Silver Spring, Maryland,USA

Following the very successful American Geophysical Union (AGU) Chapman Conference on Remote Sensing of the Terrestrial Water Cycle (see page 13) held at the same venue, the Group on Earth Observations (GEO) Integrated Global Water Cycle Observations (IGWCO) Community of Practice (COP) met to explore ways to strengthen its contributions to GEO. Ideas discussed included integrated data sets, information systems, capacity building, expanding user engagement, and securing commitments for the preparation of the Global Earth Observation System of Systems (GEOSS) Water Strategy for the 2013 GEO Summit.

The first session featured overviews by representatives of organizations that provide guidance for IGWCO activities and included the Committee on Earth Observing Satellites (CEOS) (Shizu Yabe), GEWEX (Peter van Oevelen), and the National Aeronautics and Space Administration (NASA) (Jared Entin). Although the IGWCO COP has contributed to progress on a number of fronts, a review of the status of the IGWCO COP activities by Rick Lawford indicated that the challenge of developing a substantive global water initiative involving Earth observations remains. An overview of the AGU Chapman Conference provided by George Huffman gave some direction for future IGWCO activities. Chapman Conference participants agreed that while substantial progress has been made for specific variables, such as soil moisture and precipitation, work outside discipline boundaries is spotty and would benefit from coordination across variables and serious user interactions. Furthermore, coordination between agencies (national and international) is frequently problematic, particularly as it relates to long-term data-sharing and stewardship.

Douglas Cripe described the new management structure and revision of the 2012–2015 GEO Work Plan. The Water Task now consists of 5 components and 22 activities. Reports on these activities were the basis for discussion during the first full day of the meeting. Wolfgang Grabs reported that the World Meteorological Organization (WMO) has made progress in activities related to the implementation of the World Hydrological Cycle Observing System (WHYCOS) flood initiatives, such as the new flash flood guidance material, and a plan to develop a Global Hydrological Network. WMO is also considering shifting the focus of coordination for the Global Terrestrial Network for Hydrology (GTN-H) to the Global Runoff Data Centre.

Review of the GEO Water Task

Thanks to GEWEX, NASA, and the Japan Aerospace Exploration Agency (JAXA), precipitation activities related to the Tropical Rainfall Measuring Mission (TRMM) and the Global Precipitation Mission (GPM) have continued to make steady progress. Soil moisture activities are progressing within the GEWEX framework through the continued expansion of the in situ soil moisture data archive, which supports the production of calibrated satellite and model data products. New initiatives are needed to advance the integrated aspects of runoff, surface water store, and groundwater. Progress is being made in the development of tools for accessing and analyzing groundwater data, however, the challenge of developing integrated surface water and groundwater products remains. Evapotranspiration, a new activity within GEO, is still being defined, and a small working group is being established to explore possible new initiatives and clarify the scope of the activity.

Some integrated data services discussed included the GEO Water Cycle Integrator being developed by the University of Tokyo and the Data Integration and Analysis System (DIAS) water portal being implemented by JAXA. Toshio Koike presented the conceptual plan for the Water Cycle Integrator, a system that would integrate a range of systems and services (including data sets, information systems, training programs, and modeling systems) across appropriate Societal Benefit Areas. Yoshiyuki Kudo demonstrated how the CEOS Water Portal (see page 7) and DIAS systems function and support research activities. Other integrated GEO products and services included an end-to-end water resource assessment product being developed at the City College of New York and a bilateral system information system in the Great Lakes region, led by Canada and the U.S.

The hydrometeorological extremes effort, an emerging collaboration among GEO, WCRP, WMO, and the US National Integrated Drought Information System (NIDIS) was described by Will Pozzi. It is anticipated that the relative roles of programs and agencies within this component will be further clarified at a spring drought workshop in Europe. GEO plans include the development of a system for obtaining relevant drought indices and maps as outputs from different countries and blending them into a regional or global product. Flood activities under this component are led by WMO.

The capacity building component of the Water Task continues to advance. In Latin America, a Centre of Hydrologic and Spatial Information for Latin America and the Caribbean workshop held in Cartagena, Columbia in November 2011 resulted in both freshwater and oceanographic initiatives including a project on monitoring ocean acidification in the Americas. The African Water Cycle Coordination Initiative (AfWCCI) has also made substantive progress in the past year, with at least seven proposals for basin studies being developed by a number of African River Basin authorities. Many of these proposals were discussed at a January 2012 workshop held in Nairobi, Kenya and were further advanced at the Third AfWCCI Symposium in Libreville, Gabon. The Libreville meeting resulted in a statement that was submitted to the RIO+20 meeting for discussion. Toshio Koike reported that progress is being made in the development of a Phase II implementation plan for the Asian Water Cycle Initiative. It will build upon the country and basin data sets acquired during Phase I.

(continued from page 15)

GEOSS Water Cycle Strategy

A plan was proposed for the preparation of a report (tentatively titled "GEOSS Water Strategy: From Observations to Decisions"). CEOS and the CEOS Strategic Implementation Team are supporting this initiative and see it as an opportunity to update the IGWCO plan published in 2004. It was agreed that the IGWCO COP would take the lead on this initiative. A fall workshop will be planned to discuss Version 1 of the GEO Water Cycle Strategy document. Sessions will also be planned at scientific conferences to obtain expert input for the document.

Hans Peter Plag provided an overview of the User Requirements Registry and the procedures for entering information into the system (*http://www.scgcorp.com/urr*). A number of members of the IGWCO COP agreed to contribute entries and participate in a "Challenge of Ten." (Although the initial deadline has passed, readers of this newsletter are invited to contact Rick Lawford at lawford@gewex.org if they are interested in contributing.)

Related Projects

The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) supports the water science community by developing, supporting, and operating research infrastructure; improving access to data, information, and models; articulating priorities for community-level water-related research and observations; facilitating interactions among the diverse water research community; promoting interdisciplinary education centered on water science; and translating scientific advancements into effective tools for water management and policy. Jennifer Arrigo described the CUAHSI Hydrologic Information System as an internet-based information exchange system for data discovery and access, analysis, and publication, as well as Water ML, which is being discussed as a new international standard for hydrologic time series.

The Global Water Scarcity Information Service (GLOWASIS), presented by Rogier Westerhoff, combines governmental and statistical water demand data with standardized in situ and satellite data and hydrologic forecast models to provide information to strengthen water managers' water scarcity countermeasures. The system builds on water use trend analyses for different parts of the world and the European Drought Analysis System for water scarcity analysis.

The Global Geodetic Observing System described by Hans Peter Plag is developing into a monitoring system for the global water cycle. A geodetic infrastructure is currently being explored and developed in order to help monitor the water cycle and plan observations and products for assimilation in predictive models. A conference is planned for Africa in the autumn of 2012 to assess the potential of geodetic techniques to meet the needs for water security for Africa. Readers interested in more details can contact Rick Lawford or view the presentations at *ftp://ftp.earthobservations.org/Presentations/7th-IGWCO/*.

GEWEX/WCRP Calendar

For the complete Calendar, see the GEWEX website:
http://www.gewex.org/

16 July 2012—First sessions of WCRP Data Advisory Council and Modeling Advisory Council—Beijing, China.

16–20 July 2012—33rd Session of the WCRP Joint Scientific Committee—Beijing, China.

1–3 August 2012—12th Meeting of the GEWEX Baseline Surface Radiation Network (BSRN) Project—Potsdam, Germany.

6–10 August 2012—International Radiation Symposium 2012—Berlin, Germany.

3–7 September 2012—2012 EUMETSAT Meteorological Satellite Conference—Sopot, Poland.

6–7 September 2012—BACC II Conference—Tallinn, Estonia.

10–14 September 2012—1st GEWEX Pan-Global Atmospheric System Studies (GASS) Meeting—Boulder, Colorado.

10–14 September 2012—GEWEX/GLASS LoCo Workshop and Panel Meeting—Boulder, Colorado.

16–21 September 2012—World Water Congress—Busan, Korea.

17–21 September 2012—3rd International Conference on Earth System Modeling—Hamburg, Germany.

26–28 September 2012—GDAP Water Vapor Assessment Workshop—Frankfurt, Germany.

1–3 October 2012—GDAP Meeting—Paris, France.

11–13 October 2012—GHP Meeting—Sydney, Australia.

15–19 October 2012—25th Session of the GEWEX SSG—Sydney, Australia.

5–9 November 2012—28th Session of WGNE—Toulouse, France.

3–7 December 2012—AGU Fall Meeting—San Francisco, California, USA.

22–25 April 2013—ISCCP 30th Anniversary Conference—The City College of New York, New York, U.S.A.

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