GEWEX WCRP

Global Energy and Water Exchanges

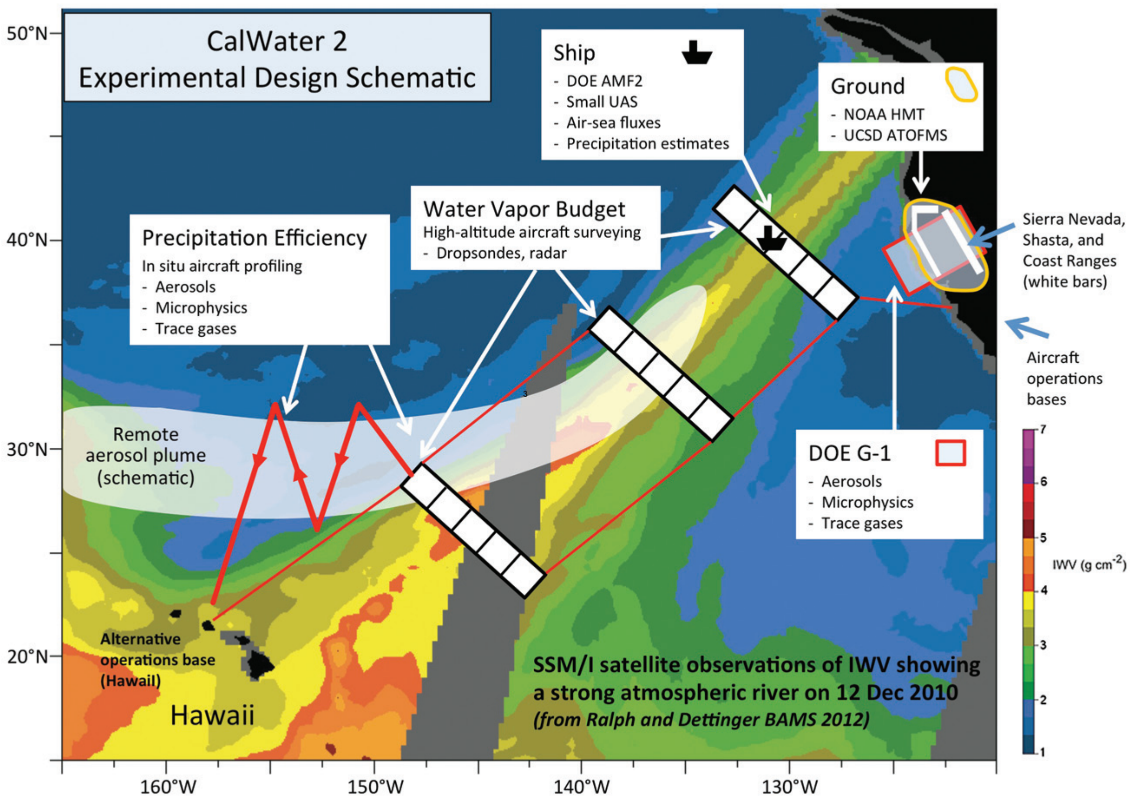
NEWS

Vol. 23, No. 1

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

February 2013

CalWater 2: Impacts of Pacific Atmospheric Rivers and Aerosols on Extreme Precipitation Events



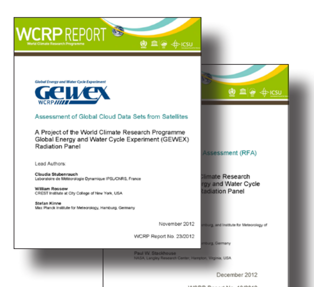
The CalWater 2 observational strategy shown above will employ high- and low-altitude aircraft platforms, a ship equipped with the ARM Mobile Facility 2, a ground-based network that includes the NOAA Hydrometeorology Testbed assets, and the aerosol time-of-flight mass spectrometer from Scripps Institution of Oceanography. The experimental design is superimposed on SSM/I satellite observations from a strong atmospheric river (AR) event discussed in Ralph and Dettinger (2012). An Asian aerosol plume is shown schematically in the context of the AR to conceptually show the sampling strategy for both the AR (transects and water vapor flux boxes) and aerosol (profiling to the north and west of the AR) objectives. During such an AR event, the ship would be vectored along an aircraft transect of an AR to coordinate the observations. As the parent storm moves to the east, the AR would move to the south and east (toward the G-1 research aircraft sampling region in the diagram). See article by Ryan Spackman et al. on page 5. Figure courtesy of F. M. Ralph, NOAA Earth System Research Laboratory.

Also Inside

Now Available

Radiative Flux and Global Cloud Data Assessments

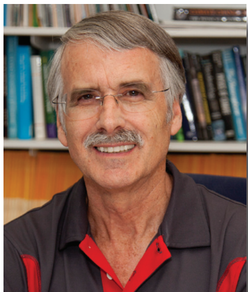
About: (Page 4)
Results: (Page 11)



Commentary

The New Normal

Kevin E. Trenberth
Chair, GEWEX Scientific Steering Group



The answers I frequently get to the question "What is climate?" are commonly along the lines of "the average weather" or "climate is what we expect and weather is what we get." Firstly, those are statistical statements, and secondly, an average is obviously dependent upon the time of the average. If it is a very "long-term" average to avoid interannual variability, then by definition there is no climate change. This conundrum was recognized back in the 1970s when it was proposed that we speak about "climate states." This perhaps relates to what is now commonly known as a "base period." The classic base period is a 30-year period (as defined by the World Meteorological Organization) that traditionally gets updated. Hence we went from the 1961–1990 normal to the 1971-2000 normal, and now 1981–2010 is the "New Normal."

For the U.S., the new normal is about 0.3°C warmer than the previous normal in minimum temperature and 0.1°C for maximum temperature overall. Globally, the new normal for sea-surface temperatures (SSTs) is over 0.3°C warmer in many places, although some regions have cooled. We must remember that the new normal vs. the old is actually the 2000s minus the 1970s divided by three. So, an overall change of about 0.2°C is actually a warming between those decades of 0.6°C.

Too little attention has been paid to the fact that the normals are now changing a lot (i.e., climate change is happening). When we speak about how anomalous the recent climate has been, we often fail to factor in the differences associated with the new normal. This clearly colors perceptions about the degree to which things are indeed anomalous or abnormal.

Given all of these considerations, how then can we talk about climate change in a more enlightened way? We have "climate dynamics" as a growing field, and the climate is indeed continually varying and changing. Therefore, I suggest that simply using statistics is not good enough. Instead I suggest that we think about and define climate in a different way, and we do this from a physical standpoint.

"Weather" happens in the atmosphere. Most of it is internal to the atmosphere and arises from instabilities, whether it is convective instability that gives rise to clouds and thunderstorms, or baroclinic instability that leads to major cyclones and anticyclones, cold and warm fronts, and all the associated day-to-day weather.

"Climate" happens when the atmosphere interacts non-trivially with the rest of the climate system and externalities. The climate system consists not just of the atmosphere, but also the oceans, land, land-surface water, and cryosphere. The externalities include the orbit of the Earth around the sun, changes in the sun, changes in the Earth (e.g., continental drift), changes in the composition of the atmosphere, and anthropogenic effects. The diurnal cycle is a climate phenomenon and so is the annual cycle of the seasons. The El Niño–Southern Oscillation (ENSO) is a climate phenomenon as it is inherently a coupled phenomenon.

The atmosphere is always being conditioned by climate influences. Hurricanes are treated as a weather phenomenon, but it is increasingly clear that the cold wake churned up behind a hurricane through strong winds, causing mixing and huge surface fluxes that produce evaporative cooling of the ocean, play a vital role in the hurricane's subsequent development and track. Therefore, is a hurricane really a climate phenomenon or a weather phenomenon? What about the Madden-Julian Oscillation?

All storms interact with the Earth's surface, but for years we have run atmospheric models with specified fixed SSTs for numerical weather prediction (NWP). This means that we are indeed dealing with weather. However, increasingly the evidence suggests that this is actually a limitation in NWP and that having the SSTs respond and feed back into weather systems is essential, especially for second week weather forecasts and those beyond.

Issues of Attribution and How We Talk about It

All too often we hear meteorologists say, "it was due to the jet stream," "it was a thunderstorm that stalled," "it was the blocking anticyclone," or "it was tropical storm Irene," and so on. The explanation is given in terms of the weather phenomenon. That is, in fact, not an explanation or attribution at all! Instead, it is a description of the other aspects of the event: a more complete description of the phenomenon. The flood was due to the storm and the drought was due to the blocking anticyclone, etc.

As an explanation, the question should be, "why did that weather phenomenon behave the way it did?" In particular, what influences external to the atmosphere were playing a role and what climate factors were in play? Why did the blocking anticyclone last as long as it did and why was it so intense? Why was there enough rain in this weather system to cause flooding? As soon as we ask these different kinds of questions, we can talk sensibly about attribution and causes through the external influences on the weather. The main cause we can point to is almost always anomalous SSTs and the predominant influence of ENSO on anomalous weather patterns.

For example, we can say that the reason we had "snowmaggedon" in Washington, DC in 2010 is: (1) we had winter and there was plenty of cold continental air; (2) there was a storm in the right place; and (3) the unusually high SSTs in the tropical Atlantic Ocean (1.5°C above normal) led to an exceptional amount of moisture flowing into the storm, which resulted in very large snow amounts. It is this last part that then relates to anomalous external influences on the atmosphere.

Human Effects on Climate and Weather

Without doubt, the SSTs in the Atlantic Ocean were warmer by about 0.5°C due to human influences, and so by itself that led to a 4 percent increase in moisture flowing into the storm. There is a lot of natural variability, and the Atlantic Multi-decadal Oscillation and other things are in play, at times adding to and at times subtracting from the human component. Human-induced climate change occurs on long timescales, and 20 years is a reasonable estimate for noticeable significant changes. Once we realize that, it becomes clear that the proper way to think about this is that there is an underlying new normal of a warmer background that the shorter-term variability is superposed upon. Of course, this is linear thinking and some effects are clearly nonlinear, but it works quite well and clears the mind on how to talk about and think of human influcences.

How big is the human component? The natural flow of energy through the climate system is equivalent to about 240 Wm^{-2}. The carbon dioxide radiative forcing is about 1.6, greenhouse gas forcing is about three, and net forcing with aerosols is about 1.6 Wm^{-2}. Water vapor feedback roughly doubles that, so the net value is 1–2 percent of the natural flow. Of course the system has responded and the water vapor feedback is part of that response, so that the net imbalance in energy at the top of the atmosphere is closer to 1 Wm^{-2} or less than 1 percent. It is small on a day-to-day basis and negligible, but it is always in one direction. It builds up in time and accumulates; hence the main effect on climate and weather is not the instantaneous effect but the changed environment in which all weather systems are operating in the "new normal." In particular, the main memory is in the oceans, and the oceans have warmed by 0.5°C since the 1970s and the atmosphere above the oceans is warmer and moister as a result. On average the water vapor has increased by 4 percent since the 1970s over the oceans.

Since all storms reach out about four times the radius of their precipitating area to grab moisture and bring it into the storm, most storms are influenced by ocean changes. The storms are bigger in winter and a storm dumping snow in the Ohio River valley is bringing in moisture from 3500 km away from the Gulf of Mexico and the subtropical Atlantic. In summer the storms are smaller and there is greater dependence on land moisture and recycling.

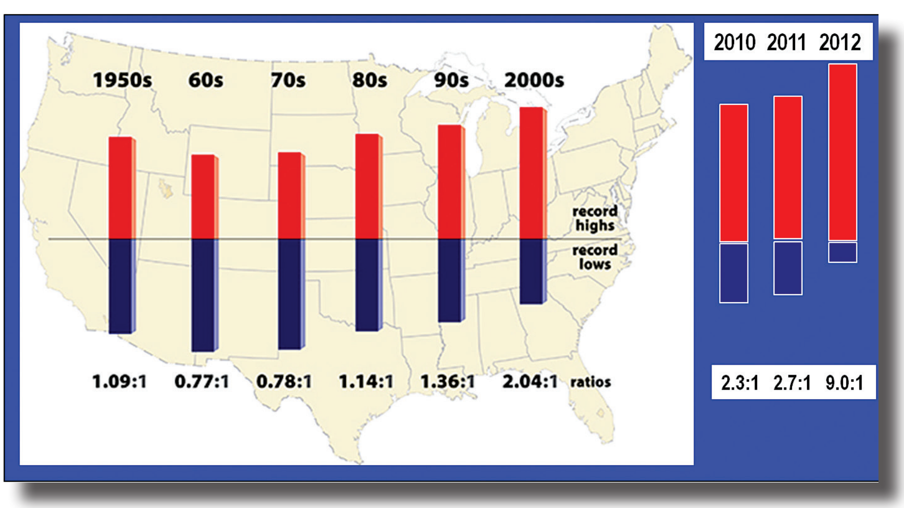
What does the science community say? "You can't blame a single event on climate change." As a result the media loses interest and the public immediately turns off. What nonsense! When we break records like we did in 2012 in the U.S., at a rate of nine hot records to one cold one for the first 6 months, it is a clear signal of climate change. Just because we zoom in on one of those records or events doesn't make it otherwise. The odds are that most of these records would not have occurred without climate change! It won't be the same this year, but the odds are that similar events will occur somewhere (currently it seems in Australia). We are experiencing climate change in action.

We can talk about it in terms of changing odds, as many others have done. The odds have increased for these kinds of extremes to occur. But we can also talk about it in physical terms. In particular, we have a new normal! The environment in which all weather events occur is different than it used to be. All storms, without exception, are different. Even if 95 percent of them look just like the ones we used to have, they are not the same.

In that respect, another way of looking at it is to regard the new normal as a shift in the seasons. The amplitude of the annual cycle of SSTs is only 2°C in the Southern Hemisphere and up to 5°C in the Northern Hemisphere. So a 0.6°C increase is like moving the seasons by 1–3 weeks toward summer. The resulting weather is familiar but it occurs at a somewhat different time of year. In 2012 we had June temperatures in March in the U.S.! This means that we may be missing the core winter and in summer we venture into unknown territory.

This commentary is intended to provide food for thought and encourage readers to think seriously about how to better communicate these issues of changing climate and changing risk of extremes with climate change.

The above commentary is the text of a banquet speech Kevin Trenberth delivered at the NOAA 37th Climate Diagnostics and Prediction Workshop in Fort Collins, 22–25 October 2012.



The ratio of record daily highs (red) to record daily lows (blue) at about 1,800 weather stations in the 48 contiguous United States from January 1950 to September 2009 (Meehl et al., GRL, 2009). Updated at right using NOAA data through June 2012; from climatecommunication.org.

New GEWEX SSG Members

GEWEX welcomes the following new members of the GEWEX Scientific Steering Group (SSG), whose terms began in January 2013. For a listing of all GEWEX SSG members, see: *http://gewex.org/gewexssg.htm.*

Rene Garreaud

Dr. Rene Garreaud is a Professor in the Department of Geophysics and Center for Climate and Resilience Research at the Universidad de Chile in Santiago, Chile. His areas of interest are climate dynamics, and synoptic and mountain meteorology.

Richard O. Anyah

Dr. Richard O. Anyah is an Assistant Professor of Atmospheric Science in the Department of Natural Resources and the Environments at the University of Connecticut in Storrs, Connecticut, U.S.A. His areas of interest are regional climate dynamics and modeling, and land surface-atmosphere interactions: regional climate-hydrology-land use connections (over the Nile River sub-basins), interactions between large inland lakes and regional climate processes, and regional climate change impacts and adaptation mechanisms for the water and agricultural sectors.

New Address and Phone Number for the International GEWEX Project Office

10015 Old Columbia Road
Suite E-250
Columbia, MD 21046 USA

Tel: 1-202-527-1927

Recent News of Interest

Radiative Flux and Global Cloud Data Assessments Now Available

Radiative Flux Assessment

The GEWEX Data and Assessments Panel (GDAP) Working Group for the Radiative Flux Assessment evaluated the overall quality of available, global, long-term radiative flux data products at the top-of-atmosphere and surface. Special emphasis was placed on evaluating the overall fidelity with which the GEWEX Surface Radiation Budget (SRB) Project data set captures seasonal to interannual variability, as well as longer-term trends. The SRB data set is approaching 28 years and has established itself as one of the benchmarks against which other products are measured. The objectives of this assessment were twofold: (1) to characterize the uncertainties in SRB and similar products from both a quantitative as well as qualitative perspective; and (2) to develop a better understanding of the strengths, weaknesses, and assumption that define the SRB product and its uncertainties. Volume 1 contains results, recommendations and conclusions. Volume 2 contains supplementary information.

Assessment of Global Cloud Data Sets

The GDAP Cloud Assessment Working Group has completed its evaluation of the overall quality of available global, long-term cloud data products. The Working Group went beyond simple product comparisons at fixed space and time resolutions to provide expert insight into whether or not a specific cloud product is accurate enough to meet a specific application. While all the assessed products were covered, special emphasis was placed on the International Satellite Cloud Climatology Project (ISCCP) product that is the GEWEX standard product for clouds.

See page 11 for some of the results from both assessments. The complete reports are available at: http://gewex.org/gdap/gdap_assessment_wgs.html.

Soroosh Sorooshian
Member of WCRP Joint Scientific Committee

Prof. Soroosh Sorooshian, former Chair of the GEWEX Scientific Steering Group, Director of the Center for Hydrometeorology and Remote Sensing, and Distinguished Professor of UC Irvine, is a new member of the Joint Scientific Committee of the World Climate Research Programme.

CalWater 2: Precipitation, Aerosols, and Pacific Atmospheric Rivers Experiment

Ryan Spackman[1,2], Marty Ralph[2], Kim Prather[3], Dan Cayan[3,4], Chris Fairall[2], Ruby Leung[5], Daniel Rosenfeld[6], Steve Rutledge[7], and Duane Waliser[8]

[1]Science and Technology Corporation, Boulder, CO; [2]NOAA Earth System Research Laboratory, Boulder, CO; [3]University of California San Diego, La Jolla, CA; [4]U.S. Geological Survey, La Jolla, CA; [5]Pacific Northwest National Laboratory, Richland, WA; [6]The Hebrew University of Jerusalem, Jerusalem, Israel; [7]Colorado State University, Fort Collins, CO; [8]NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA

Emerging research has identified two phenomena that play key roles in the variability of the water supply and the incidence of extreme precipitation events along the West Coast of the United States. These include the role of: (1) atmospheric rivers (ARs) in delivering much of the water vapor and precipitation associated with major storms along the U.S. West Coast; and (2) aerosols—from local sources, as well as those transported from remote continents—and their modulating effects on western U.S. precipitation.

A better understanding of these two processes is needed to reduce uncertainties in weather prediction and climate projections of extreme precipitation and its effects, including the provision of beneficial water supply. The CalWater 2 science plan, which has been circulated in the weather, climate, and water cycle communities, describes the science gaps associated with (1) the evolution and structure of ARs, including cloud and precipitation processes and air-sea interaction; and (2) aerosol interaction with ARs and the impact on precipitation offshore and at landfall, including intercontinental transport from remote source regions and locally generated aerosol effects on orographic precipitation along the U.S. West Coast. The scientific basis and the development of decision support tools for these studies align well with GEWEX projects, such as the Global Atmospheric System Studies Panel and the North American Water Program, a potential GEWEX Regional Hydroclimate Project.

The science plan for CalWater 2 (*http://www.esrl.noaa.gov/psd/calwater/*) emerged from the results of the original CalWater study (2009–2011), which examined the impact of dynamics and aerosols on orographic precipitation when ARs make landfall in California. CalWater 2 has been proposed to address an expanded set of scientific objectives with targeted aircraft and ship-based observations and associated evaluation of data over land with special emphasis off the coast of California in the central and eastern Pacific for an intensive observing period from December 2014 to March 2015, with possible follow-on winter seasons. Recently, as a complementary component of the proposed CalWater 2 study, the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Program awarded airborne and ship-based facilities to a CalWater-related team of investigators as part of a new project called the ARM Cloud Aerosol Precipitation Experiment (ACAPEX, *http://www.arm.gov/campaigns/amf2014apex*).

Expected outcomes for CalWater 2 include:

- Improvements in prediction systems for the water cycle at weather and climate time scales
- Distribution of an unprecedented meteorological, microphysical, and chemical data set collected in atmospheric river environments, both onshore and offshore, for advancing the understanding and prediction of aerosol effects on precipitation
- Development of decision-making tools for water resources management (e.g., extreme precipitation events, water supply)

Introduction

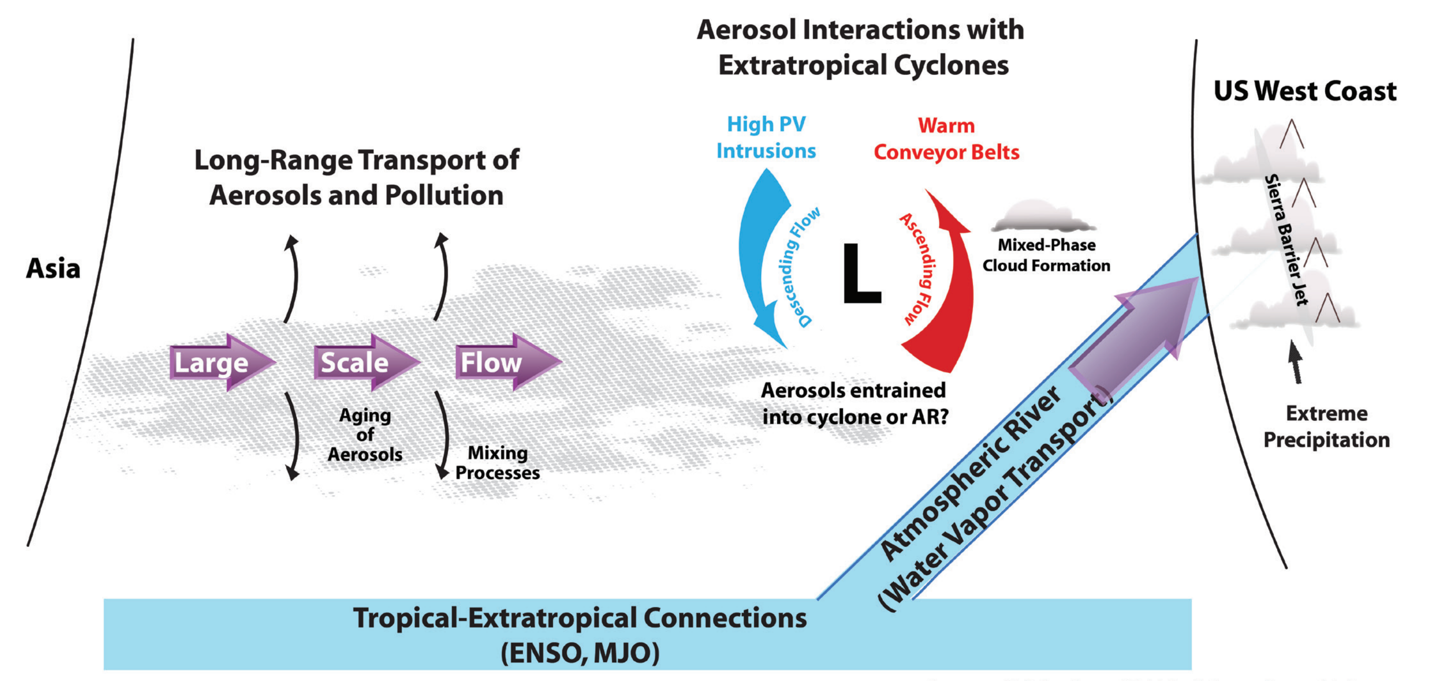
Variations in the intensity, distribution, and frequency of precipitation events on intraseasonal to interannual timescales lead to uncertainties in water supply and flood risks [National Academy of Sciences (NAS)-Climate, 2010; NAS-Hydrology, 2012]. As headlined by a number of the GEWEX projects, the potential impact of climate change on precipitation characteristics poses a challenging new dimension for water resource planning. The management of water resources requires the informed attention of policy makers concerned with future infrastructure needs for disaster mitigation, hydropower generation, agricultural productivity, fisheries and endangered species, consumptive use, and a multitude of other needs.

Extreme precipitation events can lead to major societal impacts and are often difficult to predict accurately. These events pose some of the greatest challenges in weather and climate research. Atmospheric rivers, major features of the global water cycle, are narrow regions of enhanced water vapor transport in the lower troposphere associated with the warm sector of extratropical cyclones that can lead to extreme precipitation totals when they make landfall and can both produce hydrological hazards and supply valuable water resources (Ralph and Dettinger, 2012; Leung and Qian, 2009; Zhu and Newell, 1998). Guan et al. (2010) and Dettinger (2011) documented the major roles that ARs also play in California's water supply, providing from 25–50 percent of a entire water-year's precipitation in just a few events. Studies in Europe (Stohl et al., 2008; Lavers et al., 2011) and South America (Viale and Nuñez, 2011) have developed similar conclusions for the west coasts of these other continents as well, and the work of Moore et al. (2012) has documented the role of an AR in major flooding in the southeast U.S. Dettinger (2011) analyzed Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4) climate projections to assess changes in AR characteristics off the California coast. He showed that recent climate change projections typically include more extreme ARs in the 21st Century and this is largely due to greater atmospheric water vapor content.

Passive microwave satellites provide integrated water vapor observations of ARs but they do not provide the wind information necessary to quantify the integrated vapor transport. This gap in information leads to an uncertainty in how much water vapor is transported by ARs. Aerosols carried in the large-scale flow aloft have been shown to play an important role when ARs precipitate upon landfall in California (Creamean et al., 2013; Ault et al., 2011). However, these and other observations of cloud-aerosol-precipitation interactions are based on very limited observations. The size and type of aerosols and their interactions with different types of clouds ultimately determine whether nucleation processes enhance or inhibit precipitation.

Some of the largest uncertainties in predicting these events propagate from our limited understanding of the water vapor transport in ARs, the flows and meteorology in complex terrain, microphysical processes in the formation of clouds and precipitation, and the impact of aerosols on precipitation efficiency. Improvements in our predictive capability of extreme weather and climate events depend on advances in observational resources, process understanding, and model fidelity. For ARs, the high-priority challenges include advancing our knowledge of the transport and orographic forcing of moisture-laden air masses in ARs, the interaction between aerosols of different sizes, and how the composition of water vapor in clouds promotes or suppresses precipitation. The impact of aerosols on the intensity, distribution, and frequency of precipitation in a changing climate with increasing emissions from Asia poses major challenges for water resource management and food security. Uncertainties in climate model projections of the storm track and of ARs, as well as the modulating effects of tropical low-frequency variability, such as the Madden-Julian Oscillation (MJO) and the El Niño–Southern Oscillation (ENSO), represent other key challenges.

CalWater 2 is a proposed large-scale, multi-platform study that will address the links between precipitation and aerosols. Landfalling ARs are now routinely studied by observational networks, but their behavior over the oceans is poorly observed and the quantitative contributions of evaporation, convergence/divergence, and rainfall have not been adequately documented. Aerosol and microphysical measurement techniques have advanced and are capable of providing new information on the role of aerosols in precipitation. Improvements in numerical weather and global aerosol models require the offshore observations to better model and parameterize cloud and precipitation processes, including interactions with aerosols and their removal. Most importantly, our society needs this information to manage and plan for risks, especially with the increasing pressure on water resources. The figure below shows the conceptual framework for CalWater science with an emphasis on the offshore component. The figure on the next page addresses the onshore impact and the related observables of the water cycle that contribute to extreme precipitation events. The Northern Hemisphere Pacific troposphere is a dynamically active region of the atmosphere that often fuels the rapid development of extratropical cyclones and, at the same time, conveys the most polluted air masses found in the atmosphere. As shown schematically in the figure below, the large-scale flow advects dust and anthropogenic and biomass-burning pollution from Asia into the central Pacific, where it can then be entrained into an extratropical cyclone or its associated AR.



Conceptual framework for CalWater 2 science objectives. The proposed observational strategy includes airborne and ship-based assets over the central and eastern Pacific complemented by ground-based measurements along the U.S. West Coast.

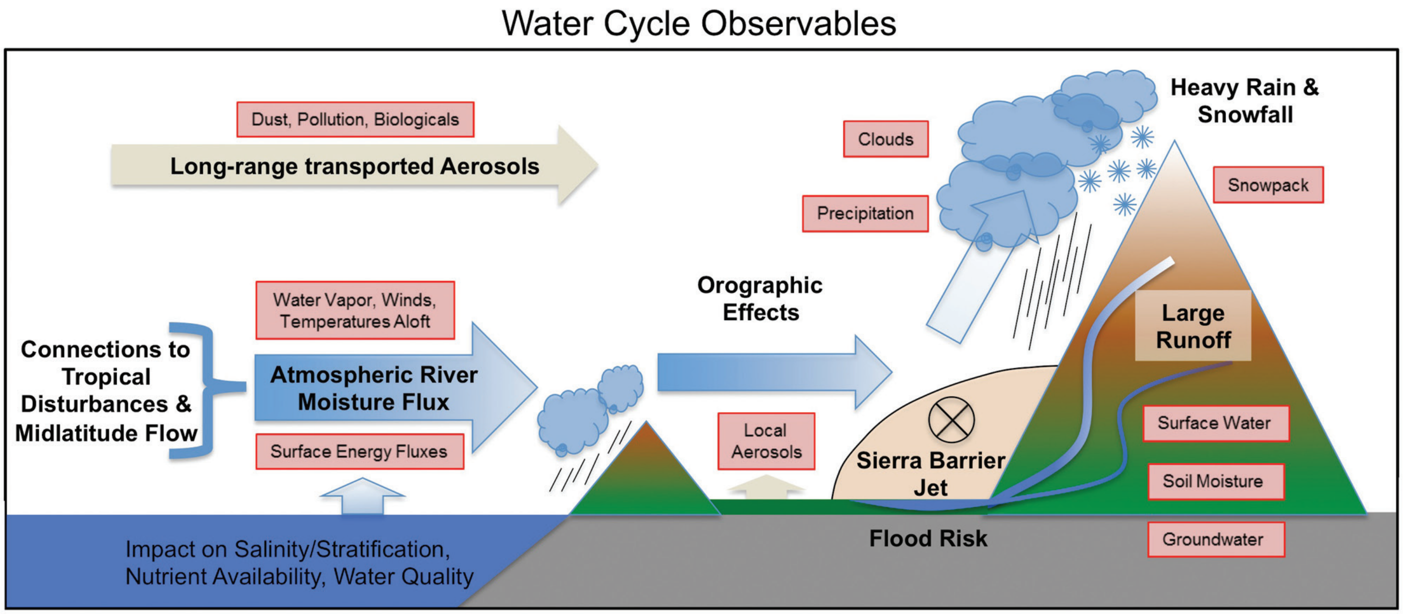


Illustration of the atmospheric and hydrological processes associated with atmospheric rivers (ARs) based on a northward view of an east-west cross section depicting a landfalling AR in a region akin to north/central California. On shore low-level moisture flux over the ocean is shown impinging first on the coastal range and secondly on the Sierra Nevada mountains, with each orographic barrier producing copious amounts of precipitation. Long-range and local transport of aerosols are depicted over the ocean and onshore, respectively, and affect clouds and precipitation. Also shown are the low-level northward barrier jet on the western side of the Sierra Nevada mountains, a depiction of the enhanced river runoffs and flood risks in low lying areas, and the impacts on water quality and other physical characteristics in the coastal ocean. Shown in the pink boxes are those components of the water cycle that are observable with modern measurement technologies, including satellite and airborne remote sensing and in situ instruments. Courtesy of D. E. Waliser, NASA Jet Propulsion Laboratory.

New Advances and Capabilities

Several new observational and modeling capabilities that have recently been developed and demonstrated are uniquely capable of addressing relevant new scientific hypotheses and science gaps for CalWater 2. The National Oceanic and Atmospheric Administration's (NOAA) Hydrometeorology Testbed (HMT, *http://hmt.noaa.gov*) has demonstrated how meteorological observations, including vertically pointing radar and wind profiler measurements, can be used to improve monitoring of key aspects of the water cycle and develop new methods in operational weather forecasting (Ralph et al., 2005). New decision support tools have emerged from HMT findings that water resource authorities now rely on during heavy rain and flooding events (Neiman et al., 2009; Wick et al., 2012). CalWater 2 will be able to leverage an altogether new set of advanced, land-based observations of the water cycle and ARs that are deployed as part of HMT and its legacy network for Enhanced Flood Response and Emergency Preparedness of 93 ground-based observing sites in California.

The original CalWater project provided new insights into the structure and evolution of ARs and the impact of aerosols on precipitation in landfalling ARs. Ground-based and supporting airborne measurements and modeling studies suggest that increased ice nuclei concentrations (e.g., from dust) enhance precipitation in the form of snow and increased concentrations of boundary layer cloud condensation nuclei suppress precipitation. Additionally, ground-based meteorological radar and wind profiler observations along the West Coast and Central Valley of California showed that the Sierra Barrier Jet plays a major role in modulating precipitation during AR events and in transporting aerosols.

At the same time, aerosol and trace gas measurements from the High-performance Instrumented Airborne Platform for Environmental Research (HIAPER) Pole-to-Pole Observations (HIPPO) study have provided insight into the role of synoptic-scale variability of the intercontinental transport of pollutants between Asia and North America, and offer relevant upstream context for the CalWater 2 study region. Five HIPPO campaigns with the National Science Foundation/National Center for Atmospheric Research (NCAR) G-V aircraft have been completed over all four seasons and include over 600 vertical profiles from 0.15 to 14 km altitude between 85°N and 67°S latitude in the remote Pacific and Arctic regions. Observations in the northern hemisphere Pacific show aerosols exhibit large variability between and also within each season. Very polluted conditions were encountered over a deep portion of the troposphere in large-scale plumes in the springtime north Pacific midlatitudes and subtropics from anthropogenic and biomass-burning sources in Asia. The presence of these large aerosol loadings, comparable to loadings observed in the boundary layers of large U.S. cities, magnifies the concern of possible aerosol modification of clouds and precipitation especially in extreme major precipitation events along the West Coast of the U.S. Retrieved aerosol, cloud, and trace gas products from satellite measurements are particularly relevant to examining the broader impact of aerosol-cloud-precipitation interactions.

Atmospheric rivers were recently studied during the Winter Storms and Pacific Atmospheric Rivers (WISPAR) campaign with the National Aeronautics and Space Administration (NASA) Global Hawk (GH) unmanned aircraft system. The NOAA-led WISPAR campaign demonstrated the research and operational applications of a new dropsonde system, developed for NOAA by NCAR, on the GH aircraft. The GH flew three research flights for a total of almost 70 hours during February–March 2011, deploying almost 150 dropsondes from about 18 km altitude into ARs and extratropical cyclones. The dropsonde system provided high-resolution thermodynamic and wind data between the lower stratosphere and the surface of the ocean. Retrieved radiances from the High Altitude Monolithic Microwave Integrated Circuit (MMIC) Sounding Radiometer (HAMSR) operated by the NASA Jet Propulsion Laboratory, provided vertically resolved temperature and water vapor data between the aircraft and the surface over a larger spatial domain. Together, the data acquired from these instruments have been used to improve the understanding of the structure and evolution of ARs and extratropical cyclones. The observations from four different AR transects and a coordinated NOAA G-IV flight during this campaign have provided important new information on how water vapor is transported from the tropics to midlatitudes in ARs and characterized how well the operational and reanalysis data products represent AR conditions. Relatedly, small unmanned aircraft system (UAS) observations have also broken new ground on air-sea flux and aerosol measurements. A new method has been developed over the last several years to measure boundary layer turbulent eddy fluxes of heat and momentum, as well as aerosol loading and radiation terms from small UASs. This capability has the potential to be operated from a ship within AR conditions offshore.

Long-lead prediction capabilities for skillful modeling and prediction of low-frequency variability in the tropics that have impacts on U.S. West Coast extreme events are making important advances. For example, forecast skill of the MJO has advanced considerably over the last 5 or more years with a number of models displaying useful MJO prediction skill with lead times of around 2–4 weeks (Waliser, 2011). A number of community efforts are taking advantage of these developments in order to develop and disseminate experimental and even operational MJO predictions (*http://www.ucar.edu/yotc/mjo.html*). These capabilities provide an increasingly stable and valuable foundation from which to embark on large-scale field campaign research, allowing timely and robust deployment of airborne assets. A noteworthy effort that will afford substantial research resources for CalWater 2 is the Subseasonal 2 Seasonal (S2S) Prediction Projection that is being developed by the World Weather Research Programme (WWRP)/THe Observing-system Research and Predictability EXperiment (THORPEX) and the World Climate Research Programme (Vitart et al., 2012). This activity will provide delayed ensemble prediction output, with 45-day lead times, from a number of participating weather/climate forecast centers in a manner similar to the THORPEX Interactive Grand Global Ensemble (TIGGE) for 15-day weather forecasts. This activity is expected to begin by the fall of 2013, and be well underway by the time of CalWater 2.

Scientific Objectives

A coupled modeling-observational strategy has been proposed to address a set of scientific objectives central to aerosol-precipitation research. A multi-platform observational approach including airborne and ship-, satellite-, and ground-based assets would be designed to specifically:

- Assess the key physical processes (i.e., rain out, vapor convergence, air-sea interaction, evaporation, and orographic effects) that control the water vapor transport budget in ARs over the ocean and at landfall.
- Quantify the extent that aerosols influence precipitation efficiency in ARs by: (i) identifying the types of aerosols that nucleate water or ice; and (ii) determining how the phase of the clouds affects aerosol tendency to nucleate water droplets or ice crystals.
- Evaluate the extent to which the large-scale flow influences the interaction of aerosols and precipitation.
- Determine the role of ARs in providing precipitation that ends drought conditions in key regions.
- Study the impact of absorbing aerosols (e.g., dust and black carbon) deposited on snow and how they affect the hydrological cycle in the Western U.S. due to early melt associated with the decrease in surface albedo.

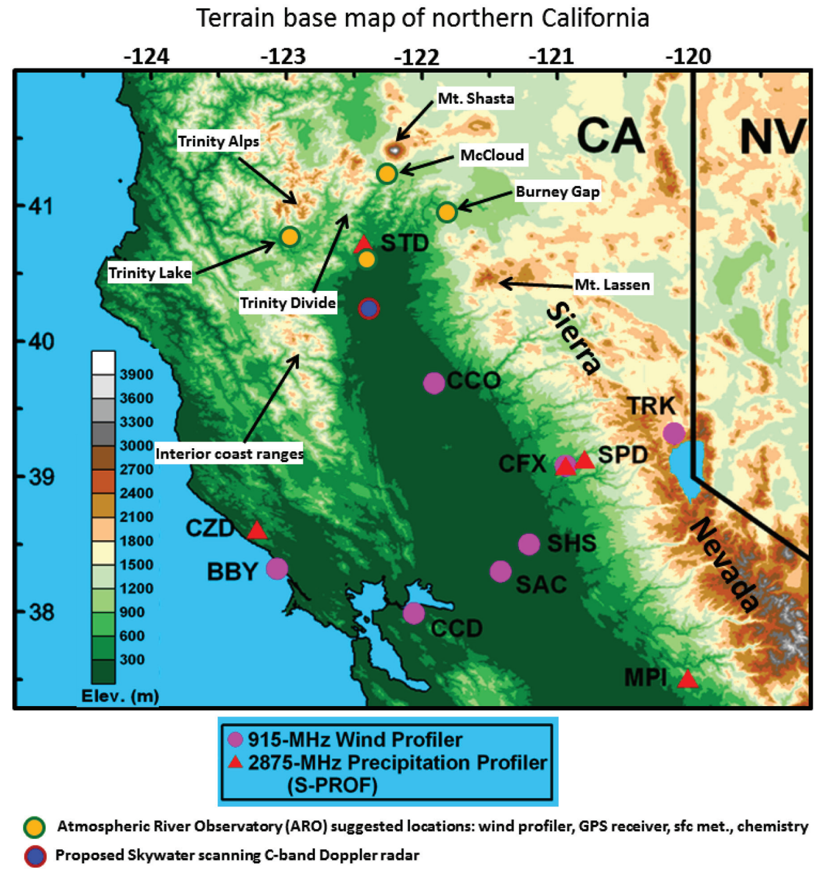
A set of modeling and analysis studies has been targeted to broaden the relevance of the outcomes from the observations and to address additional scientific objectives of climate significance:

- Assessing the key physical processes in weather and climate models that control the water vapor transport budget in ARs
- Characterizing and simulating the dynamical processes (e.g., barrier jets) that modulate the precipitation associated with landfalling ARs using numerical downscaling techniques
- Determining the extent to which climate models represent ARs and the associated distribution and frequency of precipitation
- Quantifying how well global aerosol models simulate the emission, transport, and removal of aerosols. Assessing and refining the representativeness of microphysical parameterizations for the processes associated with nucleation scavenging in different types of clouds (e.g., mixed-phase)
- Studying the impact of aerosols on quantitative precipitation estimates and using the observations from the CalWater 2 study to improve quantitative precipitation forecasts

- Exploring medium-to-seasonal range predictability and present-day prediction skill of frequency and intensity of ARs for key geographic regions

Observational Strategies for CalWater 2

The proposed measurement strategy would consist of land and offshore assets, supplemented by existing satellite observations, to monitor the evolution and structure of ARs from near their regions of development and interaction with aerosol plumes to the U.S. West Coast where ARs make landfall. The onshore impact of aerosols from local sources and long-range transport on precipitation inland would be similarly investigated, especially in the context of orographic precipitation on the coastal and inland mountain ranges. As shown in the figure on the cover, observational approaches would employ two aircraft offshore. High altitude observations would include remote sensors and deploy dropsondes over the AR. A second, profiling aircraft would then provide aerosol and trace gas measurements across the AR and in a clear-air region upstream of the associated cold front to sample the background aerosol before entrainment into the AR. The CalWater 2 observation strategy has been designed to complement the ARM Mobile Facility (AMF2) and DOE G-1 research aircraft from the ARM Cloud Aerosol Precipitation Experiment (ACAPEX) provided for the winter 2014–15. The G-1 aircraft would target the onshore science and the AMF2 would be installed on a ship performing transects across the AR. The ship would also provide precipitation and cloud radar and wind profiler measurements in addition to eddy correlation turbulent fluxes and radiative fluxes.



Terrain base map (meters, see color scale) of Northern California showing wind profiler sites and S-band radar precipitation profilers (S-PROFs) operation during the HMT and CalWater2 field campaigns (pink circles and red triangles, respectively). The proposed locations of atmospheric river observatories (i.e., wind profiler, GPS receiver, and surface meteorology) are marked with yellow circles, and the location of the proposed Skywater scanning Doppler radar is portrayed with a blue circle. Key air streams are also labeled (courtesy of P. J. Neiman, NOAA Earth System Research Laboratory).

The airborne and ship-based assets would leverage the extensive mesoscale observing network already available as part of NOAA's HMT-West. As shown in the figure on this page, this network of atmospheric river observatories (AROs) and supporting ground-based measurements for northern California provides a unique ability to monitor AR conditions at landfall and as they penetrate inland. The AROs include a 915-MHz wind profiler, surface meteorological tower, GPS receiver, and surface chemistry sampler. In precipitating conditions, the wind profilers can detect the height of the precipitation melting level on an hourly basis. The meteorological towers provide 2-minute measurements of surface wind, temperature, moisture, pressure, and rainfall. Data collected from GPS receivers in tandem with collocated surface temperature and pressure measurements allow for the retrieval of integrated water vapor through the full atmospheric column.

Satellite observations would be integrated into the data set to characterize the large-scale environment and supplement the analyses over the oceans where airborne data are unavailable. Polar-orbiting observations from the Atmospheric Infrared Sounder (AIRS), Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO), CloudSat, and Multi-angle Imaging SpectroRadiometer (MISR) would provide important context for the observations in aerosol-cloud-precipitation regions. Passive microwave observations from the Special Sensor Microwave Imager/Sounder (SSMI/S) have been a key component of previous AR studies and would be supplemented by the recently launched Advanced Microwave Scanning Radiometer 2 on the Japanese Global Change Observation Mission-Water satellite. Satellite-derived estimates of the air-sea heat flux would be integrated and evaluated in studies of the influence of air-sea interactions on AR evolution. The proposed airborne and ship-based measurements could also support calibration and validation of critical satellite products.

Results Expected from CalWater 2

Anticipated scientific and technical outcomes for the CalWater 2 study include:

- Improved physical understanding of the relative roles of tropical water vapor entrainment, horizontal moisture convergence, air-sea moisture fluxes, rainout, and orographic effects (at landfall) in modulating the water vapor transport in atmospheric rivers

- Quantification of errors in current reanalysis products, and weather and climate models associated with water vapor transport over the Pacific

- Quantification of present-day forecast-skill of AR events and their low-frequency modulations

- Determination of the roles of aerosol transport from Asia in modulating the water cycle offshore

- Determination of the roles of aerosols from local and remote sources on the precipitation over land, especially over the coastal and inland mountain ranges

- Distribution of an unprecedented meteorological, microphysical, and chemical data set targeting the dynamics and aerosol-cloud-precipitation interactions in ARs and extratropical cyclones to the broader research community

In the broader context, the advances created by CalWater 2 would lead to a number of outcomes outside the immediate project:

- Numerical weather and climate model improvement efforts to target key gaps in performance

- Improvements in predictive models of weather and climate through advances in the knowledge of: (i) water vapor transport budget in ARs; and (ii) impact of aerosols on precipitation efficiency

- Reduced uncertainty in climate projections of extreme precipitation and water supply in the Western U.S.

- Improved predictability in medium-to-seasonal range forecasts of frequency and intensity of landfalling AR events

- Understanding the possible impacts of aerosol emissions and their precursors on the availability of water resources

- Development of decision support tools for extreme precipitation events for more effective flood control and water resources management

References

Ault, A. P., C. R. Williams, A. B. White, P. J. Neiman, J. M. Creamean, C. J. Gaston, F. M. Ralph, and K. A. Prather, 2011. Detection of Asian dust in California orographic precipitation. *J. Geophys. Res.*, 116, D16205, doi:10.1029/2010JD015351.

Creamean, J. M., et al., 2013. Dust and Biological Aerosols from the Sahara and Asia Influence Precipitation in the Western US. *Science*, in press.

Dettinger, M. D., 2011. Climate change, atmospheric rivers, and floods in California–A multimodel analysis of storm frequency and magnitude changes, *J. Am. Water Resour. Assoc.*, 47, 514–523.

Guan, B., N. P. Molotch, D. E. Waliser, E. J. Fetzer, and P. J. Neiman, 2010. Extreme snowfall events linked to atmospheric rivers and surface air temperature via satellite measurements. *Geophys. Res. Lett.*, 37, L20401, doi:10.1029/2010GL044696.

Lavers, D. A., R. P. Allan, E. F. Wood, G. Villarini, D. J. Brayshaw, and A. J. Wade, 2011. Winter floods in Britain are connected to atmospheric rivers. *Geophys. Res. Lett.*, 38, L23803, doi:10.1029/2011GL049783.

Leung L. R, and Y. Qian, 2009. Atmospheric rivers induced heavy precipitation and flooding in the Western U.S. simulated by the WRF regional climate model, *Geophys. Res. Lett., 36*, L03820, doi:10.1029/2008GL036445.

Moore, B. J., P. J. Neiman, F. M. Ralph, and F. Barthold, 2012. Physical processes associated with heavy flooding rainfall in Nashville, Tennessee and vicinity during 1–2 May 2010: The role of an atmospheric river and mesoscale convective systems. *Mon. Wea. Rev.*, 140, 358–378, doi:10.1175/MWR-D-11-00126.1.

NAS-Climate, 2010. Assessment of Intraseasonal to Interannual Climate Prediction and Predictability, Board on Atmospheric Sciences and Climate, The National Academies Press, Washington, D.C., *http://www.nap.edu/catalog.php?record_id=12878*.

NAS-Hydrology, 2012. Challenges and Opportunities in the Hydrologic Sciences. 150 pp., The National Academies Press, Washington, DC. *http://www.nap.edu/catalog.php?record_id=13293*.

Neiman, P. J., A. B. White, F. M. Ralph, D. J. Gottas, and S. I. Gutman, 2009. A water vapour flux tool for precipitation forecasting, *Water Management*, 162, 83–94.

Ralph, F. M., et al., 2005. Improving short-term (0–48 hours) Cool-season quantitative precipitation forecasting: Recommendations from a USWRP Workshop. *Bull. Amer. Meteor. Soc.*, 86, 1619–1632.

Ralph, F. M., and M. D. Dettinger, 2012. Historical and national perspectives on extreme west-coast precipitation associated with atmospheric rivers during December 2010, *Bull. Amer. Meteor. Soc.*, 93, 783–790, doi:10.1175/BAMS-D-11-00188.1.

Stohl, A., C. Forster, and H. Sodemann, 2008. Remote sources of water vapor forming precipitation on the Norwegian west coast at 60°N—a tale of hurricanes and an atmospheric river. *J. Geophys. Res.*, 113, D05102, doi:10.1029/2007JD009006.

Viale, M., and M. N. Nuñez, 2011. Climatology of Winter Orographic Precipitation over the Subtropical Central Andes and Associated Synoptic and Regional Characteristics. *J. Hydrometeor,* 12, 481–507, doi:10.1175/2010JHM1284.1.

Vitart, F., A. W. Robertson, and D. T. Anderson, 2012. Subseasonal to Seasonal Prediction Project: bridging the gap between weather and climate, *WMO Bulletin*, 61, 23–28.

Waliser, D. E., 2011. Predictability and Forecasting in Intraseasonal Variability of the Atmosphere-Ocean Climate System. 2nd Edition. edited by W. K. M. Lau and D. E. Waliser, p. 613, *Springer*, Heidelberg, Germany.

Wick, G. A., et al., 2012. Automated AR detection tool. IEEE Transactions on *Geoscience and Remote Sensing*, in press.

Zhu, Y., and R. E. Newell, 1998. A proposed algorithm for moisture fluxes from atmospheric rivers. *Mon. Wea. Rev.*, 126, 725–735.

1st GEWEX Data and Assessments Panel (GDAP) Meeting

Paris, France
1–3 October 2012

Christian Kummerow
Colorado State University, Fort Collins, Colorado, USA

The 1st meeting of the GEWEX Data and Assessments Panel (GDAP), formerly the GEWEX Radiation Panel (GRP), was hosted by the Laboratoire de Météorologie Dynamique (LMD) and the French National Space Centre (CNES). Dr. Claudia Stubenrauch, LMD, was the local host for the meeting, which was chaired by Professor Christian Kummerow, the GDAP Chair. Dr. Thierry Phulpin of CNES, opened the meeting and presented the CNES activities that are related to GDAP, particularly the instrument and algorithm work with the Infrared Atmospheric Sounding Interferometer (IASI), the Polarization and Anisotropy of Reflectances for Atmospheric Science coupled with Observations from a Lidar (PARASOL), and the MEGHA-TROPIQUES satellite.

Dr. Jörg Schulz, the GDAP Vice-Chair, reported on the first meeting of the new WCRP Data Advisory Council, where the inventory of Essential Climate Variables was reviewed. He also reported on the Sustained Coordinated Processing of Environmental Satellite Data for Climate Modeling (SCOPE-CM) that coordinates product development with reprocessing and transfer to operations. The initial network and structure of the activity has been established, along with principles, standards, and the selection of pilot projects to validate the practices.

Integrated GEWEX Product

GDAP is developing data sets of global energy and water variables and conducting assessments of these products. An "Integrated GEWEX Product" with a common grid, ancillary data, assumptions, and space and time grids is being developed with a planned release date of mid-2013. There will be at least two versions of this product, one for algorithm developers that will contain as much diagnostic information as feasible, and a version for users who require only the most basic diagnostics. The processing will initially focus on 2007 before processing both forward and backwards in time to encompass the entire GEWEX time series. Colorado State University will combine the products into a single NetCDF4 file for initial assessments. After the product is finalized, GDAP will conduct an assessment of the state of the water and energy budgets to document the state of the Earth's observing systems. This will be the first assessment in a series of periodic re-evaluations consisting of global scale closure tests, temporal variability in the fluxes and states, attribution of changes to observed forcings, and a maturity index of various components based upon ongoing assessments of individual components of the budget.

Radiative Flux Assessment

The recently completed Radiative Flux Assessment (see also page 4) showed that ancillary data are important in deriving surface radiative fluxes, and that although top-of-atmosphere solar irradiance is commonly known to be 1360.8 Wm^{-2}, many data sets and models still use an incorrect value for this quantity. For the cloud radiative effect, the study concluded that it is critical to have consistent definitions of "clear sky" before products can be compared in any meaningful way. Optical thickness values of 0.1–0.3 were determined to be a good working definition of "clear sky." Perhaps the most important result of the Assessment is that while there are differences between products, they tend to be significantly smaller than the differences between observations and climate models. As such, surface flux and atmospheric divergence products are still seen to be useful for climate model validation. The Radiative Flux Assessment is available at *http://gewex.org/gdap/gdap_assessment_wgs.html*. A summary of results has been submitted to the *Bulletin of the American Meteorological Society*.

Assessment of Global Cloud Data Sets

Dr. Claudia Stubenrauch reported on the recently completed Cloud Data Assessment, which is available at *http://gewex.org/gdap/gdap_assessment_wgs.html*. A database was created for the Assessment that allowed for the first time an intercomparison of Level 3 cloud products of 12 global "state of the art" data sets (available at: *http://climserv.ipsl.polytechnique.fr/gewexca)*. Analyses show how cloud properties are perceived by instruments measuring different parts of the electromagnetic spectrum, and how cloud property averages and distributions are affected by instrument choice and methodological decisions. A key result from the Cloud Assessment is that absolute values, especially those of high-level cloud statistics, strongly depend on instrument (or retrieval) capability to detect and/or identify thin cirrus (decreasing from active lidar to infrared sounding to solar spectrum alone), and relative to geographical and seasonal variations in the cloud properties, agree very well with only a few exceptions, such as deserts and snow-covered regions. Probability density functions of radiative and bulk microphysical properties also agree well, when one considers retrieval filtering or possible biases due to partly cloudy pixels and due to ice water misidentification. When comparing one of these data sets to climate models, it is important to remember its specific sensitivity (even when using an observation simulator). A detailed description can be found in the report. Results are summarized in an article in the *Bulletin of the American Meteorological Society* (in press).

Water Vapor Assessment

Dr. Marc Schroeder, who co-chairs the Water Vapor Assessment (G-VAP) activity with Drs. Lei Shi and Antonia Gambacorta, reported that the objectives of the assessment have been established and include total precipitable water, the water vapor profile, and upper tropospheric humidity. Prior to the recent G-VAP workshop held in Offenbach on 26–28 September 2012, data fact sheets were distributed to gather information on data records. Eighteen data fact sheets were received and more than 30 participants, mainly from ground-based observation and satellite retrieval communities, attended the meeting which focused primarily on consolidating the G-VAP strategy and technical implementation. A summary of the meeting was published in the November 2012 issue of *GEWEX News*. Anyone wishing to participate in G-VAP should contact one of the three assessment organizers.

Aerosol Assessment

Dr. Stefan Kinne presented an update on the Aerosol Assessment, which is co-chaired by Drs. Sundar Christopher and Jeffrey Reid. The Assessment defines the nature of aerosol measurement problems and includes a synthesis of the literature and commentary on verification methods and findings. Subchapters on the use of satellite data in modeling and on aerosol optical depth trends have been added. Phase 2, a detailed independent evaluation, will start when the Moderate Resolution Imaging Spectroradiometer (MODIS) Collection 6, Level 1 Profile Products and the new Multi-Angle Imaging Spectro-Radiometer (MISR) products are released. The number of aerosol data sets has grown exponentially, with many products developed for different applications. Most of the products are somewhere between research, development, and production, which makes it difficult to find distributed versions that exist long enough to make a meaningful assessment. This situation is in part reinforced by funding that provides far more money for product development than maintenance and verification.

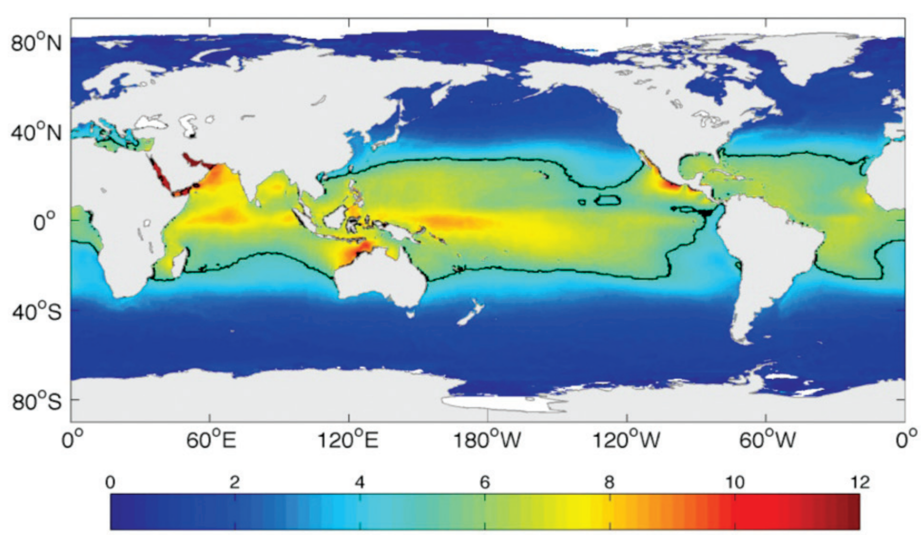
LandFlux Assessment

Dr. Carlos Jimenez presented the status of the LandFlux Assessment, which held its fourth workshop immediately after the GDAP meeting (see report in November 2012 issue of *GEWEX News*). Products for this Assessment were divided into three categories: (1) satellite-based; (2) diagnostic (satellite data combined with ancillary input data to diagnose latent and sensible heating); and (3) land-surface models (that use satellite data but derive fluxes from models and reanalyses). All the assessed products captured the seasonality of the heat fluxes and the expected spatial distributions (major climatic regimes and geographical features). The products correlated well with each other in general, aided by the fact that some of them use the same forcing data. There are, however, large evaporative fraction differences that suggest different partitioning of the radiative fluxes. The correlations are considerably lower when the seasonal component is removed from the fluxes, as seasonal variability is largely responsible for the high correlations. The LandFlux Assessment considered a common set of ancillary inputs to examine the relative impact of the method versus the impact of the input data. These common input data sets are being used to evaluate Version 0 of the LandFlux product to be used in the Integrated GEWEX Product.

LandFlux Evaluation

Dr. Sonia Seneviratne reviewed activities related to the LandFlux merged synthesis data sets. Given the large uncertainties and lack of a "true" reference estimate, this activity focuses on constructing a benchmark product that provides a range of existing estimates from several sources. Diagnostic, land-surface model-based, and reanalysis products are being considered for the time periods of 1989–1995 and 1989–2005. Monthly products with 1-degree resolution are used and from these, mean and standard deviations are constructed to provide an envelope of reasonable solutions. Outliers can generally be traced back to specific problems with the data. Also, it is clear from these studies that reanalysis fluxes are generally higher than the diagnostic and land-surface model-based estimates. Likewise, Coupled Model Intercomparison Project 5

The Impact of Diurnal SST Variations on Surface Energy Losses



Mean impact of diurnal sea-surface temperature variations on longwave radiation, sensible, and latent heat fluxes combined (Clayson and Bogdanoff, 2012, Journal of Climate).

(CMIP5) evapotranspiration (ET) measurements generally overestimate the fluxes compared to observations. The high bias in ET may be related to excess shortwave downwelling radiation that is consistent with a low bias in clouds from these models.

The excess ET found in CMIP5 in Africa, Western North America, North of the Himalayas, and Western Australia can be linked to the excess precipitation (P) over these regions. This may explain a large underestimation of temperature in these regions as well. The opposite is true in South America, where ET and P are underestimated, while the temperature is overestimated. These analyses are powerful incentives to not validate fields individually as was done in the past, but to instead focus on integrated validation that can provide significantly more insight.

...although top-of-atmosphere (TOA) solar irradiance is commonly known to be 1360.8 Wm^{-2}, many data sets and models still use an incorrect value for this quantity.

SeaFlux Assessment

SeaFlux produces ocean turbulent fluxes that are an element of the GEWEX reference products. The Climate Variability and Predictability (CLIVAR) Project is also interested in ocean fluxes, but from a salinity and ocean circulation perspective. Dr. Carol Anne Clayson reported that while GDAP and CLIVAR are fundamentally interested in the same parameters, because their focus and approaches are sufficiently different, their activities cannot be easily merged. Where GEWEX is trying to maintain separation between models and observations such that the GEWEX products can be used to diagnose model processes and overall fidelity, CLIVAR is focusing on a "best" flux data set that includes multiple input data sets and reanalyses. Dr. Clayson is the liaison between the two activities.

Assessments White Paper

The product assessments portion of the meeting concluded with the status of the Assessments White Paper**.** The Paper begins with the statement "that it is often difficult to define a single best climate data source" and then provides the key steps that any assessment should consider. It is available from the GDAP website. The group also discussed possibilities for websites, such as *http://rain.atmos.colostate.edu/CRDC,* that allow simple comparisons among a number of available precipitation products, and could serve as a template for other assessment efforts, providing not only the data, but also simple online tools for general users to compare products.

GDAP Reference Products

Updated cloud microphysics data have improved most of the **International Satellite Cloud Climatology Project (ISCCP)** cloud products; however, polar clouds still remain a challenge. Recent results show very stable cloud amounts as a function of incidence angle. Research regarding the calibration of VLT Imager and Spectrometer for the mid-Infrared (VISIR) data suggests that visible radiances have an absolute accuracy of 3 percent while infrared (IR) radiances are somewhat better quantified with an absolute accuracy of 2 percent. The latest version of ISCCP data for the Integrated GEWEX Product is well underway. The biggest changes in the product will likely come from the common ancillary products described below, and in particular, the new High Resolution Infrared Radiation Sounder (HIRS) product.

Release 3 of **Surface Radiation Budget (SRB)** data is available at the Atmospheric Science Data Center at Langley (*http://eosweb.larc.nasa.gov/PRODOCS/srb/table_srb.html*), and National Aeronautics and Space Administration (NASA) and National Climatic Data Center (NCDC) sites. Release 3 has improved the geosynchronous rings that were artifacts from the geostationary viewing geometry, increased polar fluxes that were known to be too low, and improved desert fluxes, increasing these over bright surfaces, while decreasing them over dark surfaces. Validation of Release 3 continues using Baseline Surface Radiation Network fluxes. The biggest impact is the large downwelling longwave radiation relative to some model-based studies, which further unbalances the water and energy budgets estimated from the GEWEX Reference Products. However, the larger surface downward longwave flux is consistent with new Clouds and the Earth's Radiant Energy System (CERES) and CERES/Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)/CloudSat fusion products.

SRB Version 4 will be used in the Integrated GEWEX Product and aside from using the same grids as Release 3, will use common total solar irradiance, ozone, snow/ice, topography, and surface types. Version 4 will evaluate the new HIRS temperature and humidity product being used by ISCCP and will use ISCCP radiances and cloud products, as well as the Aerosol Comparison (AEROCOM) aerosol product. Incorporating and testing the impact of these new products should be completed early 2013 with a baseline run completed by April 2013.

Version 1.0 of the **SeaFlux** product is available at *http://seaflux.org* and a paper describing the product and the work done to quantify the uncertainties introduced by various components of the bulk flux formulation is being finalized. Latent heat fluxes still have an increasing trend from approximately 90 Wm^{-2} in 1998 to nearly 95 Wm^{-2} in 2007. The impact of changes in the input radiances from the Special Sensor Microwave Imager (SSM/I) is still being investigated. SeaFlux is now focused on the feedbacks between atmospheric states and turbulent fluxes. Version 2 of the product will represent the Integrated GEWEX Product and is now being tested. Aside from the common grids and sea ice data, it will include clouds from ISCCP and radiation from SRB to drive the diurnal cycle of the sea surface temperature.

There are many challenges associated with producing **LandFlux** products, chiefly that there are a large number of dependencies that must first be parameterized. There are three basic techniques—Penman-Montieth, Priestly-Taylor, and energy balance methods—each requiring slightly different ancillary data. When each of these methods is compared to ET inferred from P minus the Water Vapor Divergence, the results looked consistent for each of three methods. Validation over AmeriFlux sites showed a slightly positive bias with correlations generally above 0.7 for most of North America. A possible explanation for this could be the lack of reporting from the Canadian stations during or immediately after rain. Current issues with the LandFlux product that must be resolved include: (i) snow evaporation; (ii) grid averages that show no differences between tall trees and the underlying surface temperature; (iii) land use and land cover change; and (iv) evaluation with 160+ FluxNET sites.

AEROCOM **aerosol products** are to be used instead of GEWEX Global Aerosol Climatology Project (GACP) products because the GACP data are only available over the ocean and cannot be made consistent with the AEROCOM land products. The AEROCOM product consists of a monthly 1° x 1° climatology for mid-visible aerosol properties of aerosol optical depth, single scattering albedo, and ångström exponent (related to the asymmetry factor). The product is constructed by starting with a median field of 15 models to eliminate extremes, which is then enhanced with Aerosol Robotic Network (AERONET) data to bring the model fields in alignment with observations where these exist. Simulations are used to scale the product forward and backwards in time based upon source information estimates. CALIPSO data are used to add vertical distribution to the aerosols. The net result is a spatially complete data set over the 30 years covered by the GEWEX products.

After some delays due to the change from SSM/I to the Special Sensor Microwave Imager/Sounder (SSMIS) as the microwave reference satellite, **Global Precipitation Climatology Project (GPCP)** Version 2.2 products are current through June 2011. It is important to note that the latest version of bias uncertainties is based upon variability between well-known and often-used global precipitation estimates that yield an uncertainty of about 8 percent for the global mean rainfall. This uncertainty is significantly less than the uncertainty ascribed to the product described in a recent water and energy budget study published by G. Stephens et al., 2012 in *Nature Geosciences*.

The National Oceanic and Atmospheric Administration (NOAA) is supporting transfer of the GPCP Version 2 products for operational processing at NOAA/NCDC. Version 3 of the GPCP product (see example on next page) corresponds to the Integrated GEWEX Product and will be produced with monthly, 0.5° resolution from 1979 onward; daily, 0.5° resolution from 1998 onward; and 3-hourly, 0.25° resolution from 1998 onward to match the other GEWEX products.

Other Reports

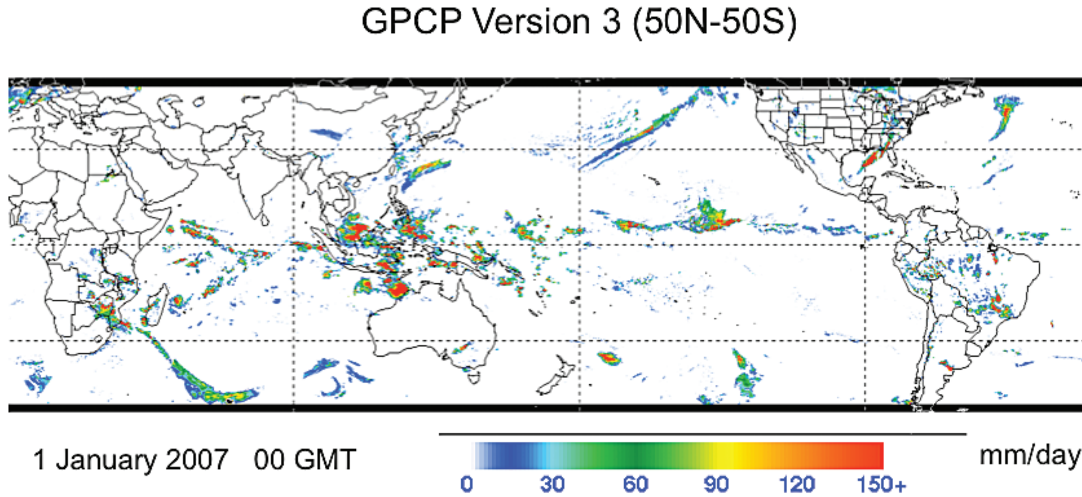
Journal articles on Global Precipitation Climatology Centre (GPCC) data sets and their verification have been submitted and the GPCC community has started the acquisition and processing of daily precipitation amounts. While GPCC cannot distribute these data directly because of agreements with data providers, it is aware of the need for daily precipitation data and is considering options.

Dr. Crevoisier presented an overview of work being done at LMD to retrieve climate variables from the Infrared Atmospheric Sounding Interferometer (IASI), particularly clouds, greenhouse gases, aerosols, and surface properties. The cloud property retrieval is similar to the one developed for the Atmospheric Infrared Sounder (AIRS) and leads to similar results, with a good sensitivity to thin cirrus during day and night. The improved spectral resolution from IASI allows the derivation of relative humidity with respect to ice in thinner atmospheric layers than AIRS, which should result in better predictions of potential contrail occurrence. The IR spectrum is particularly sensitive to large (e.g., dust) aerosols and the retrieval of dust aerosol properties (optical depth, height, effective particle size) consists of proximity recognition to pre-computed Look Up Tables. Good results have been shown in comparison to AERONET and CALIPSO retrievals.

In an update on the Atmospheric Radiation Measurement (ARM) sites, it was noted that all new instruments are now operating, and the data are available from the Department of Energy ARM archive. The ARM measurements of clouds, radiation, turbulent fluxes, and precipitation could be very useful in making point measurements of the Integrated GEWEX Products. Having similar products and formats from the two efforts would serve to anchor the global satellite product.

Participants at the 1st GDAP Meeting.

Example of New Integrated GDAP Product



Example of the next generation Global Precipitation Climatology Project (GPCP) product being developed for the "Integrated" GDAP product.

Data related to the GEWEX Hydroclimatology Panel (GHP) efforts in the Murray-Darling River Basin in Australia (OzEWEX) could be used to validate some of the GDAP global products. The Australian Bureau of Meteorology collects extensive data on rainfall, temperature, humidity, solar downwelling radiation, and vegetation over the river basin. The Water Availability Project has monitored the terrestrial water balance on a monthly basis since 1900 and operationally on a weekly basis beginning in 2007. In addition, a regional Weather Research Foundation climate model that is currently being evaluated against satellite data is run over the river basin and can serve as common forcing data for many of the land turbulent flux schemes. Aside from the observations and models being run in the region, current analysis tools are being developed to evaluate different products that could easily be extended to include the GDAP products. There was broad consensus at the meeting that GDAP should move to exploit the available data, tools, and the desire of the GHP community to collaborate on this project.

Results from the 1st Pan-Global Atmospheric System Studies (GASS) Meeting held in September 2012 emphasized the need to develop a more unified voice for articulating critical measurement needs to the observation community. Although computed radiation data are considered to be "good enough" for climate models, detailed observations of the Southern Ocean are needed because models do not produce enough clouds and are generally too warm. Other critical measurements needed include: (i) vertical velocity (everywhere—but with particular need in tropical convective cores); (ii) profiles of condensate, especially ice properties (sizes, scattering); (iii) ice nuclei characteristics and concentrations; and (iv) soil moisture.

A report on assessing the increasing number of satellite simulator packages noted that these simulators are often used beyond the original cloud comparisons. Most of the users are not specialized in interpreting the Level 1 radiances and often the developers are not familiar with the real goals of the modeling community. Creating a satellite simulator portal that would allow users to interactively test the different packages was discussed and an invitation has been sent to all the satellite simulator developers to participate in this activity. The next step is to use a real example in the portal to determine its usefulness.

Monsoon studies represent a place where models and observations could be better coordinated. Comparisons between precipitation accumulations from models and various observation data sets clearly show a strong overestimation by all the reanalyses. Sensible heat fluxes over the Tibetan Plateau have a strong decreasing trend in nearly all the reanalyses. While the temperature difference between surface and atmosphere seems to be increasing in this region, the wind speed has decreased significantly to slow the sensible heat flux. It was also noted that the net cloud radiative forcing in CMIP5 appears to be significantly better over the Tibetan Plateau than CMIP3 models; however, most models still underestimate the strength of the forcing. This bias is caused by fewer clouds than in the ISCCP data, and biases in the cloud vertical structure as observed from CALIPSO. Both of these studies illustrate the usefulness of integrated validation to provide insight into observed discrepancies.

Finally, it was agreed that the next parameters that GDAP should focus on are the terrestrial water budget with soil moisture, runoff, and total storage [e.g., Gravity Recovery and Climate Experiment (GRACE)-type measurements]. The next GDAP meeting will be held jointly with GHP at the Universidade Federal do Rio de Janeiro (UFRJ) in Rio de Janeiro, Brazil on 2–6 September 2013.

GEWEX/WCRP Calendar

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

2–5 April 2013—18th Session of WCRP-GCOS Atmospheric Observation Panel for Climate—Geneva, Switzerland.

7–12 April 2013—European Geosciences Union General Assembly—Vienna, Austria.

12–13 April 2013—iLEAPS SSC Meeting—Vienna, Austria.

15–19 April 2013—4th WGNE Workshop on Systematic Errors in Weather and Climate Models—Met Office, Exeter, UK.

16–19 April 2013—AquaConSoil: 12th International UFZ-Deltares Conference on Groundwater-Soil Systems and Water Resource Management—Barcelona, Spain.

21–26 April 2013—8th IAHS Groundwater Quality Conference—Gainesville, Florida, U.S.A.

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

26–30 April 2013—International Workshop on Terrestrial Water Cycle Observation and Modeling from Space—Beijing, China.

29–30 April 2013—Workshop on Water Cycle Missions for the Next Decade—Baltimore, Maryland, U.S.A.

6–9 May 2013—20th Session of the CLIVAR SSG—Kiel, Germany.

21–24 May 2013—GWSP Conference: Water in the Anthropocene—Challenges for Science and Governance—Bonn, Germany.

27–31 May 2013—34th Session of the WCRP Joint Scientific Committee—Brasilia, Brazil.

5–7 June 2013—WCRP Strategy Workshop for Global Water Resource Systems—Sasakatoon, Canada.

10–14 June 2013—7th Study Conference on BALTEX—Borgholm, Sweden.

10–14 June 2013—CFMIP/EUCLIPSE Meeting on Cloud Processes and Climate Feedbacks—Hamburg, Germany.

24–27 June 2013—WWRP Polar Workshop—ECMWF, Reading, UK.

27–28 June 2013—WCRP Strategy Workshop on Observations and Predictions of Precipitation—Fort Collins, Colorado, U.S.A.

1–3 July 2013—Satellite Soil Moisture Validation and Application Workshop—ESRIN, Frascati, Italy.

6–7 July 2013—2013 Gordon Research Conference and Gordon Seminar on Radiation and Climate—Colby-Sawyer College, New Hampshire, U.S.A.

15–17 July 2013—Workshop on Using GRACE Data for Water Cycle Analysis and Climate Modeling—Pasadena, California, U.S.A.

21–26 July 2013—IGARSS 2013—Melbourne, Australia.

22–26 July 2013—IAHS/IAPSO/IASPEI Joint Assembly—Gottenburg, Sweden.

23 August–2 September 2013—SOLAS Summer School—Xiamen, China.

2–6 September 2013—Joint GEWEX Hydroclimatology (GHP)/Data and Assessments (GDAP) Panel Meetings—Rio de Janeiro, Brazil.

iLEAPS and GEWEX Special Issue
"Land-Surface Modeling—Bridging the Gaps"
now available at
http://www.ileaps.org/* and *http://gewex.org/

9–13 September 2013—13th European Met Society Annual Meeting and 10th European Conference on Applied Climatology—Reading, UK.

9–13 September 2013—ESA Living Planet Symposium—Edinburgh, UK.

16–20 September 2013—2013 EUMETSAT Meteorological Satellite Conference and 19th AMS Satellite, Meteorology, Oceanography, and Climatology Conference—Vienna, Austria.

19–20 September 2013—Joint GEWEX LandFlux and SeaFlux Meetings—Vienna, Austria.

28–31 October 2013—26th Session of the GEWEX SSG—Boulder, Colorado, USA.

GEWEX NEWS

Published by the International GEWEX Project Office

Peter J. van Oevelen, Director
Dawn P. Erlich, Editor
Shannon F. Macken, Assistant Editor

International GEWEX Project Office
10015 Old Columbia Road, Suite E-250
Columbia, MD 21046, USA

Tel: 1-202-527-1827
E-mail: gewex@gewex.org
Website: http://www.gewex.org