GEWEX NEWS

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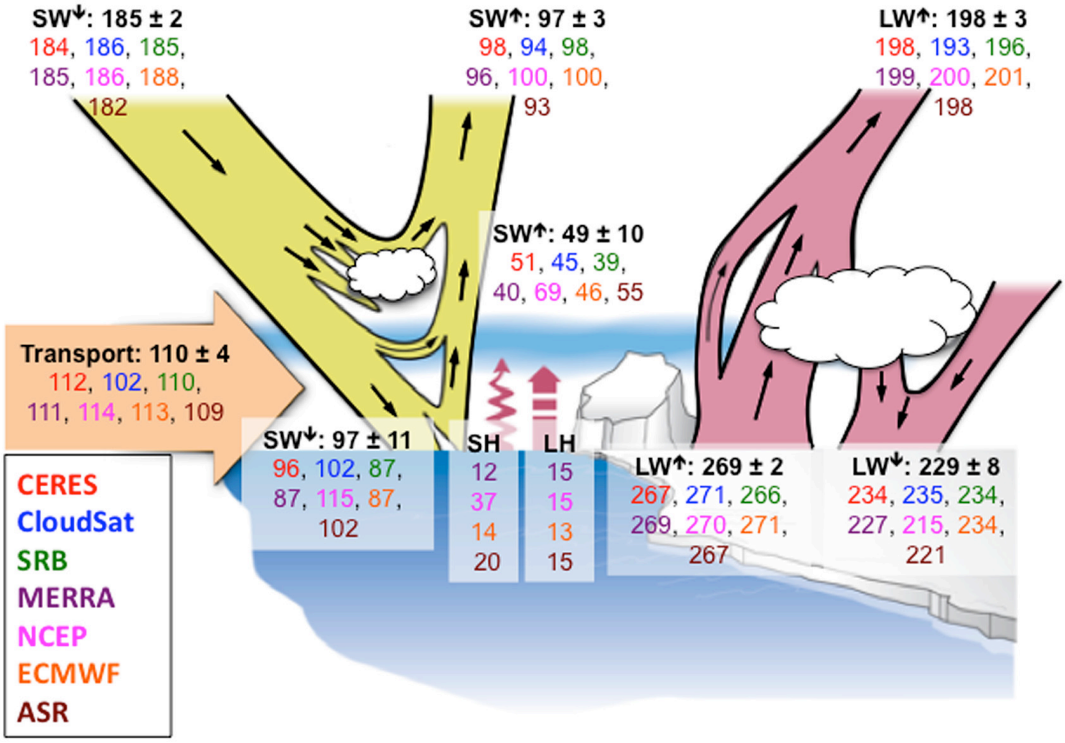
Arctic Observation and Reanalysis Integrated System (ArORIS)—A New Data Product for Validation and Climate Studies



Radiative energy fluxes for the Arctic (70–82°N) are shown for each of the integrated products in the ArORIS data set. *Yellow, pink and orange streams denote the shortwave (SW) and longwave (LW) radiative fluxes at the top and the bottom of the atmosphere upwelling (upward direction black arrow) and downwelling (downward direction black arrow). Squiggly and broken upward arrows denote the sensible heat (SH) and latent heat (LH) fluxes, respectively. The large orange arrow denotes the transport of fluxes to the Arctic to maintain radiative equilibrium. Annually averaged estimates of the radiative fluxes were calculated for the period 2007–2010 using satellite and reanalysis products from the Clouds and the Earth's Radiant Energy System (CERES, red), CloudSat (blue), GEWEX-Surface Radiation Budget (SRB, green), the Modern-Era Retrospective Analysis for Research and Applications (MERRA, purple), U.S. National Centers for Environmental Prediction (NCEP, pink), the European Centre for Medium-Range Weather Forecasting (ECMWF, orange) and the Arctic System Reanalysis (ASR, maroon). Black is the ensemble mean of all data sets, where available. Means and standard deviations were calculated from the ensemble of the products and listed in the diagram next to the radiative flux stream. See article by M.W. Christensen et al. on page 4.*

Also Inside

Commentary

New Areas of Collaboration in Climate Science

Peter van Oevelen
Director, International GEWEX Project Office

One of the biggest challenges for the World Climate Research Programme (WCRP) and GEWEX is not only to coordinate international climate-related research, but also create a cohesive framework that brings together the various research elements being carried out by the community. Historically, climate research was organized by "classical" geoscience disciplines, such as geology, oceanography, climatology and meteorology. However, as our knowledge of the Earth system and the importance of its many components has grown, especially regarding the roles that humans play, this approach is no longer entirely valid. WCRP and GEWEX are now addressing new areas of collaboration that fall outside the realm of geosciences, such as the social sciences. This effort will begin initially with small projects and will certainly expand to collaboration with our sister programs in Future Earth, such as the Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS). We are also investigating ways to work with scientific communities that we do not know very well, and we will be looking for scientists who are already working with those communities to help us bridge the gap. One of the first steps towards this is a workshop co-organized by the GEWEX Hydroclimatology Panel (GHP) and GEWEX Global Land Atmosphere System Studies (GLASS) Panel entitled "Including Water Management in Large Scale Models," which will be held in Gif-sur-Yvette, France on 28–30 September. In addition, as a part of our WCRP Grand Challenge on Water Availability, "Water for the Food Baskets of the World," GEWEX will be organizing several workshops with an emphasis on the human dimension of our Earth System, particularly related to water and water management. We will have articles on both our plans and progress in this area in upcoming editions of *GEWEX News*.

I am very pleased to announce that the Baseline Surface Radiation Network (BSRN) archive will continue to be hosted by the Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research (AWI) in Bremerhaven, Germany (see BSRN workshop report on page 8). Archiving and data centers are probably the least appealing parts of scientific research, yet they are the cornerstones of our work. Despite the increasing emphasis on big data and data science, as well as the commitment of many space agencies and other governmental agencies, it is still extremely difficult to continue this type of work. On behalf of GEWEX, I recognize AWI's commitment to data stewardship and thank the institute for its efforts.

It has been two years since the successful 7th International GEWEX Scientific Conference was held in The Hague, The Netherlands. Planning for the next conference has begun, with a likely location of Canada in May or June of 2018. The conference will cover the entire spectrum of GEWEX-related research, and will focus on two of the WCRP Grand Challenges that GEWEX is leading, namely Climate Extremes and Water Availability. As the details of the conference coalesce, we will provide updates via our electronic and printed newsletters as well as on our GEWEX website and Facebook pages. Please contact me if you are interested in contributing to the organization of the conference.

To showcase new articles related to GEWEX science (see page 3), selected research highlights that feature recent and interesting results relevant to the GEWEX mission will be published on the GEWEX website and in upcoming newsletters. For consideration, please summit your highlight at: *http://www.gewex.org/latest-news/research-highlights/*.

Finally, we are considering having a special edition of the newsletter with a focus on art and the climate sciences for later this year or early next year. We are looking for scientists who dip their toes in the arts, be it painting, photography, music or literature, who are willing to share their stories about their work, vision and drive and how their art relates to their scientific work. Please do not hesitate to contact us with your suggestions for this special edition.

Contents

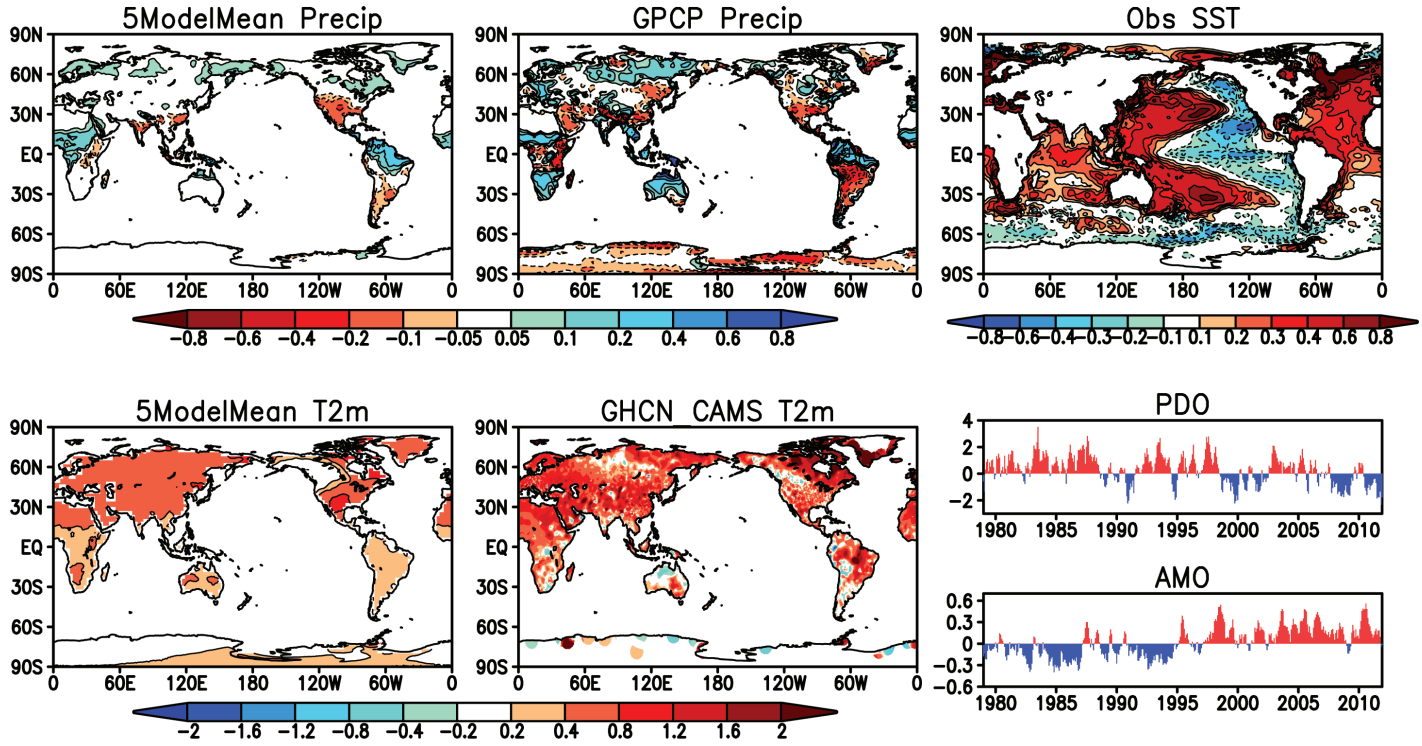
Research Highlights

Global Meteorological Drought: A Synthesis of Current Understanding with a Focus on SST Drivers of Precipitation Deficits

Reference: Schubert, S., R. Stewart, H. Wang, M. Barlow, E. Berbery, W. Cai, M. Hoerling, K. Kanikicharla, R. Koster, B. Lyon, A. Mariotti, C. Mechoso, O. Müller, B. Rodriguez-Fonseca, R. Seager, S. Seneviratne, L. Zhang and T. Zhou, 2016. *J. Climate*, Vol. 29, No. 11, doi:10.1175/JCLI-D-15-0452.1

Abstract: Drought affects virtually every region of the world, and potential shifts in its character in a changing climate are a major concern. This article presents a synthesis of current understanding of meteorological drought, with a focus on the large-scale controls on precipitation afforded by sea surface temperature (SST) anomalies, land surface feedbacks and radiative forcings. The synthesis is primarily based on regionally focused articles submitted to the Global Drought Information System (GDIS) collection together with new results from a suite of atmospheric general circulation model experiments intended to integrate those studies into a coherent view of drought worldwide. On interannual time scales, the preeminence of the El Niño Southern Oscillation (ENSO) as a driver of meteorological drought throughout much of the Americas, eastern Asia, Australia and the Maritime Continent is now well established, whereas in other regions (e.g., Europe, Africa and India), the response to ENSO is more ephemeral or non-existent. Northern Eurasia, central Europe and central and eastern Canada stand out as regions with few SST-forced impacts on precipitation on interannual time scales. Decadal changes in SST appear to be a major factor in the occurrence of long-term drought, as highlighted by apparent impacts on precipitation of the late 1990s "climate shifts" in the Pacific and Atlantic SST. Key remaining research challenges include: (i) better quantification of unforced and forced atmospheric variability as well as land and atmosphere feedbacks; (ii) better understanding of the physical basis for the leading modes of climate variability and their predictability; and (iii) quantification of the relative contributions of internal decadal SST variability and forced climate change to long-term drought.

Recently publish a paper related to GEWEX research? *We are interested in showcasing selected research highlights that feature recent and interesting results relevant to the GEWEX mission. For consideration, please summit your highlight at: http://www.gewex.org/latest-news/research-highlights/. If your article qualifies, it will be published on the GEWEX website and may be featured in GEWEX News.*



Top Left: Mean simulated precipitation differences (mm/day) between 1998–2011 and 1979–1993, based on results from five atmospheric general circulation models (AGCMs) forced by observed SST. Bottom Left: Corresponding differences in T2m (°C; land only). Center: As at (left), but for the observations. Top Right: The mean observed SST differences (°C) between 1998–2011 and 1979–1993. Bottom Right: The time series of the Pacific Decadal Oscillation (http://research.jisao.washington.edu/pdo/PDO.latest) and the Atlantic Multidecadal Oscillation (http://www.esrl.noaa.gov/psd/data/timeseries/AMO/).

Inspiring Young Scientists to Become Active in Community Service

Allison Goodwell, AGU H3S Member
University of Illinois Civil and Environmental Engineering, Urbana-Champaign, Illinois

Why should graduate students or early career researchers set aside time to participate in a service-oriented organization? By the time we finally achieve a delicate balance between research, classes, teaching and fieldwork, volunteering can seem like a proverbial fifth wheel to be lugged along on our academic journeys. But community involvement can be a fundamental component of a successful scientific career. Service engagement directly benefits the community by revealing research issues and leading to science that makes a greater impact on society. As part of a broader mission to represent, inform and support early career scientists in the field of hydrology, the American Geophysical Union Hydrology Section Student Subcommittee (H3S) aims to inspire students to serve their communities and help them find the volunteer opportunities to do so.

This year, H3S is initiating several activities to encourage students to participate in service. At the AGU Student Conference and Fall Meeting, sessions and pop-ups will feature researchers discussing their personal stories about community engagement. They'll share the rewards and pitfalls involved in volunteering, providing inspiration for students to find out how their scientific expertise can serve others (see: *http://fallmeeting.agu.org/2016/students/events/pop-up-talks/*). To help students find relevant activities, the Young Hydrologic Society is creating a web-based searchable repository at *http://www.younghs.com*. This database will grow as research community members add opportunities, acting as a valuable resource to students seeking options locally or abroad. Types of service can range from mentoring through Big Brothers Big Sisters of America or 4-H to designing and developing projects for Engineers Without Borders or Lifewater International. Each organization provides a different perspective on the meaning of service, as well as inspiration for those looking to develop their own activities. Please send an email to *goodwel2@illinois.edu* with your own service ideas or questions.

H3S is also planning workshops on complementary issues such as effective science communication, building stakeholder partnerships and addressing the needs of communities. These events will equip students for success in their volunteer activities.

We encourage young researchers and students to explore how their expertise can benefit society and how they can integrate service into their future careers. Scientists have the ability to solve problems and improve our future wellbeing by obtaining and disseminating information. At times, the links from new knowledge to perceived relevance are tenuous or act on long time scales. Volunteering can provide a direct link where scientific expertise benefits short-term humanitarian needs. Broad participation in service and outreach is a valuable way to strengthen ties between science and the community, and can lead to more informed and relevant research.

Arctic Observation and Reanalysis Integrated System (ArORIS)— A New Data Product for Validation and Climate Studies

Matthew W. Christensen[1,2], Graeme L. Stephens[2], Tristan L'Ecuyer[3] and Nicole-Jeanne Schlegel[2]
[1]Colorado State University, Fort Collins, Colorado, USA; [2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA; [3]Department of Atmospheric and Oceanic Sciences, University of Wisconsin-Madison, Madison, Wisconsin, USA

GEWEX provides oversight on a number of important global data records that have been developed and maintained over many years. A majority of these data products are managed under the GEWEX Data and Assessments Panel (GDAP, *http://www.gewex.org/panels/gewex-data-and-assessments-panel/*) and are focused on critical climate variables. Other GEWEX data activities are related to regions and processes that are relevant to other GEWEX Panel activities, including surface radiation, climatologies (aerosol, precipitation, cloud), land and sea fluxes, and several radiation-related intercomparison projects.

A new integrated effort now brings together a variety of data sources to focus on the Arctic region. The past three decades have seen rapid and troubling changes in the Arctic. Sea ice and snow cover extent have significantly declined across this region while considerable melting has been confirmed using numerous observational tools. Climate models mostly predict melting trends in the coming decades but with a wide range of projections due to uncertainties in Arctic processes. Causes for the rapid loss of sea ice are complex and have been linked to the surface radiation budget through cloud and sea-ice feedbacks. The Arctic Observation and Reanalysis Integrated System (ArORIS) was developed to improve assessments of the Arctic energy and water balances. ArORIS merges together numerous state-of-the-art satellite, reanalysis and in situ data sets from peer-reviewed products using a conventional grid (2.5° spatial resolution averaged over a monthly timescale interval) and name-labeling framework. Primary variables include state-of-the-art satellite-retrieved cloud properties, radiation fluxes (top and bottom of atmosphere), surface precipitation rates and snow and sea ice extents. The data set is geared for scientific inquiry, product validation and assessment of the radiation and moisture budgets in the Arctic. Data have been compiled over the satellite period of 2002–present, although different data exist over different periods of time within this timeframe.

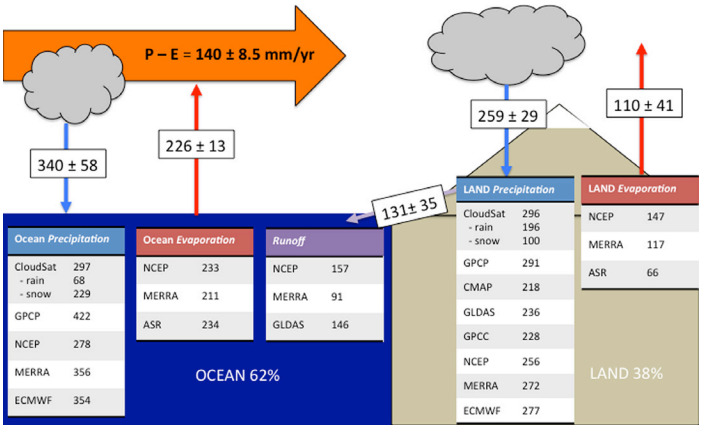
The broad scope of the assembled data is highlighted in the figure on the cover and the one on the next page (from Christensen et al., 2016). The figure on the cover shows the radiative energy fluxes for the Arctic for each of the integrated products in the ArORIS data set. The top of atmosphere radi-

ative fluxes in model data are well constrained to the observations, whereas surface downwelling longwave radiation tends to be underestimated in reanalysis products. Other details are discussed by Christensen et al. (2016). The figure below shows the dominant processes of the hydrological cycle over land and ocean regions in the Arctic. General features include the following: precipitation outweighs evaporation, thereby leading to net transport of moisture from lower latitudes into the Arctic; precipitation and evaporation tend to be larger over the ocean compared to land; and more precipitation falls on the land than is lost via runoff and evaporation/sublimation, thereby leading to accumulation during the period of 2007–2010. The range of uncertainty in oceanic precipitation rate among the products is estimated to be ±32% using two standard deviations divided by the mean value.

The ArORIS data set is maintained at the University of Wisconsin and can be downloaded at: *http://www.cloudsat.cira.colostate.edu/community-products/arctic-observation-and-reanalysis-integrated-system*.

Reference

Christensen, M., A. Behrangi, T. L'Ecuyer, N. Wood, M. Lebsock and G. Stephens, 2016. Arctic Observation and Reanalysis Integrated System: A New Data Product for Validation and Climate Study. *Bull. Amer. Meteor. Soc.,* 97, 907-915.



Schematic diagram of the hydrological cycle depicted for the Arctic (70–82°N). Precipitation (downward blue arrow) and evaporation (upward red arrow) were estimated over land and ocean regions separately. Calculations were weighted by both the cosine of the latitude and fraction of land in each grid. Runoff (purple arrow) is estimated over land and precipitation minus evaporation was estimated over the entire Arctic region. Annually averaged estimates of the moisture fluxes were calculated for the period 2007–2010 using data from CloudSat, the Global Precipitation Climatology Project (GPCP), the Global Precipitation Climatology Centre (GPCC), the Global Land Data Assimilation System (GLDAS), the U.S. Climate Prediction Center (CPC) Merged Analysis of Precipitation (CMAP), the U.S. National Centers for Environmental Prediction (NCEP), the Modern-Era Retrospective Analysis for Research and Applications (MERRA), the European Centre for Medium-Range Weather Forecasting (ECMWF) and the Arctic System Reanalysis (ASR), where available.

ACPC Initiative to Identify Signatures of Aerosol-Cloud Interactions in High-Resolution Modeling and Observations

Johannes Quaas[1], Danny Rosenfeld[2], Ann Fridlind[3], Rob Wood[4], Graham Feingold[5], Sue van den Heever[6] and Philip Stier[7]

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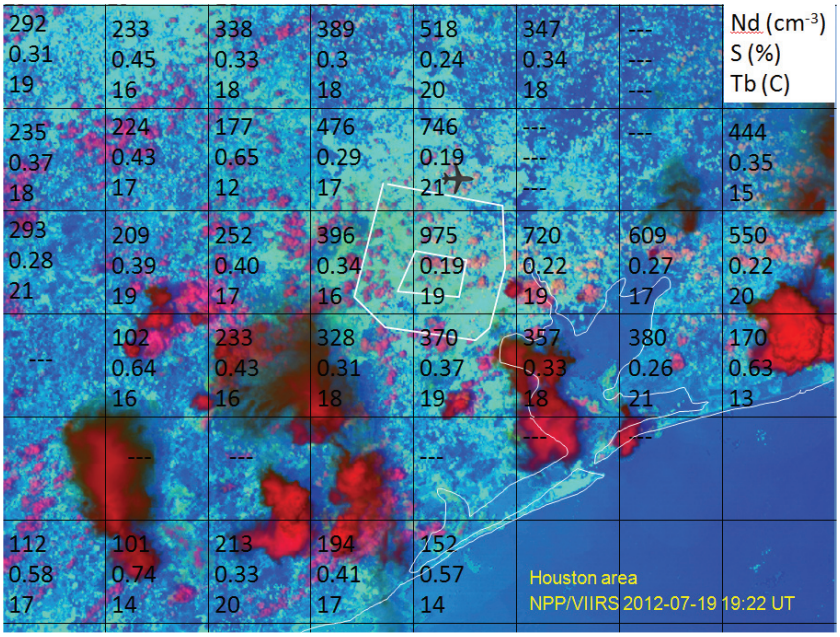
The goal of the Aerosols-Clouds-Precipitation-and-Climate (ACPC) Initiative is to assess processes involving aerosol-cloud-precipitation interactions. ACPC holds a series of annual workshops, with the most recent having taken place at the University of Oxford on 13–15 April 2016.

The current ACPC science approach follows the recommendations from its first phase (Rosenfeld et al., 2014), using a hierarchy of models to assess the observational requirements for a quantitative understanding of the impact of aerosol perturbations on clouds given the dominant influence of variable meteorological conditions on cloud and precipitation properties. The working hypothesis is that such a modeling approach becomes feasible when simulating domains and time periods that cover the full life cycle of cloud systems in time and space using cloud-resolving models that account for the two-way interaction of aerosols with clouds and precipitation.

At last year's annual ACPC workshop held in New York, it was decided that the project would pursue separate studies for a shallow cloud regime and a deep convective cloud regime. Two cases were selected: (i) marine stratocumulus clouds off the west coast of South America as observed during the Variability in the American Monsoon Systems (VAMOS) Ocean-Cloud-Atmosphere-Land Study (VOCALS) field campaign from mid-October to mid-November 2008; and (vii) deep convective clouds in the area of Houston, Texas in August and September 2013. The approaches for investigating impacts of aerosol perturbations differ for the two cases.

For the deep convective case, cloud condensation nuclei (CCN) concentrations derived from satellite data were used to identify the CCN perturbation from Houston, Texas in the otherwise unpolluted onshore flow. This perturbation yielded an augmentation of near-surface CCN concentrations by a factor of 5–10 (see figure on next page). The group investigating this case is working on the hypothesis that a perturbation in deep convective cloud processes may become detectable when microphysical signatures in retrievals from polarimetric radar and lightning networks for perturbed vs. unperturbed clouds are statistically analyzed. To the extent that such differences are matched by the results from different models, the understanding of how aerosols and deep convective clouds



Analysis of satellite data to infer cloud condensation nuclei concentrations. Much higher CCN concentrations are retrieved in the air masses impacted by the Houston emissions. ACPC will analyze high-resolving model results and NEXRAD radar observations to investigate the possible impacts of the elevated CCN concentrations on convective clouds for this and other similar cases. The color scheme is microphysical RGB, where red is modulated by the visible reflectance, green by 3.7 μm solar reflectance, and blue by thermal temperature. After Rosenfeld et al., 2016.

interact may be enhanced. For the shallow cloud case, the first objective is to explore the spatial gradient in aerosol concentrations and assess the covariability of aerosol concentrations and cloud properties, in comparison to satellite data and in situ observations from the VOCALS campaign. The group is currently assessing the extent to which aerosol-cloud interaction metrics (Feingold, 2003) can be used for determining aerosol-cloud interaction processes, and for evaluating these in models. The challenge is to analyze cause-effect relations on the basis of aerosol and cloud covariability and to account for measurement uncertainties. Joint histograms rather than scalar linear regression coefficients may be a useful alternative (Gryspeerdt et al., 2016). Secondly, in the regional models, a perturbation of the aerosol emissions is performed to assess the extent to which the cloud fields and aerosol-cloud interaction processes differ in a perturbed scenario. First results from the University of Leeds and the UK Met Office at a horizontal resolution of 1 km (see figure on next page) suggest that a strong reduction in aerosol concentrations leads to a simulated cloud liquid water path distribution that is inconsistent with the observations. In turn, an increase in aerosol concentrations even by an order of magnitude yields results that are almost indistinguishable from the control simulation. In addition to exploring the behavior of regional models (which range from non cloud-resolving to marginally cloud-resolving), the group will also use the regional models to drive Lagrangian large eddy simulations (LES) of aerosol-cloud evolution. The behavior of the LES can be compared with those from the regional models to ascertain the extent to which the regional models are skillfully capturing the key interactions between aerosols and clouds required to accurately constrain the indirect radiative forcing. The analysis of LES will also help to assess influences of parameterizations and model resolution.

It was decided at this year's annual ACPC workshop to continue working on these two cases, which will serve to provide guidance to aid the planning of future field experiments designed to better constrain the aerosol influence on regional clouds and climate.

The group is also very interested in other ongoing and planned field campaigns. Several contributors to ACPC are involved in these campaigns, especially in the Observations of Aerosols above Clouds and their Interactions (ORACLES) and Cloud-Aerosol-Radiation Interactions and Forcing (CLARIFY) projects that investigate aerosol-cloud-radiation interactions off the coast of Southern Africa; the Southern Ocean Clouds, Radiation, Aerosol Transport Experimental Study (SOCRATES) and the Antarctic Circumnavigation Expedition: Study of Preindustrial-like Aerosol-Climate Effects (ACE-SPACE) campaigns aimed at targeting the southern ocean clouds; and the Aerosol-Cloud-Experiments over the Eastern North Atlantic (ACE-ENA) aircraft campaigns. In addition, there was particular interest in the Cloud and Aerosol Monsoonal Processes-Philippines Experiment (CAMP2Ex), which examines a region where distinct, very large aerosol perturbations occur, and in the Elucidating the Role of Cloud-Circulation Coupling in Climate (EUREC4A) campaign, since it aims at a comprehensive characterization of the large-scale budgets. Along with these field campaigns, ACPC is also interested in the results from modeling studies that several participants contribute to, such as high resolution simulations with perturbed aerosol for the Convective Precipitation Experiment (COPE) cases over Southwest England performed by the team at the University of Leeds and UK Met Office, various model intercomparison studies in the EU project "Impact of Biogenic versus Anthropogenic emissions on Clouds and Climate: towards a Holistic UnderStanding" (BACCHUS), and a perturbed-aerosol simulation over Germany from the High Definition Clouds and Precipitation for Climate Prediction [HD(CP)^2] Project.

In the coming year, our goal is close collaboration within the modeling teams. This will involve the generation of compatible model diagnostics of observable quantities and the joint assessment of aerosol, cloud and precipitation variability for the two cases. The observational analysis will specifically address options to improve satellite retrievals of relevant quantities (in particular cloud droplet concentrations), and to better exploit and couple the innovative observations by satellites and polarimetric radar.

A new GEWEX Aerosol Precipitation (GAP) initiative was presented at the workshop. The overarching goal of GAP, which is co-chaired by Sue van den Heever and Philip Stier, is to provide a global-to-regional assessment on the impacts of aerosol on precipitation, complementing ACPC's process-focused activities. GAP will seek to work collaboratively with ACPC, as well as all four GEWEX Panels on aerosol-precipitation interactions.

The next ACPC workshop is planned for 2–6 April 2017 in Bad Honnef, Germany. Interested persons are welcome to join the activities.

References

Gryspeerdt, E., J. Quaas and N. Bellouin, 2016. Constraining the aerosol influence on cloud fraction. *J. Geophys. Res.*, 121, 3566-3583, doi:10.1002/2015JD023744.

Feingold, G., 2003. Modeling of the first indirect effect: Analysis of measurement requirements. *Geophys. Res. Lett.*, 30(19), 1997, doi:10.1029/2003GL017967.

Rosenfeld, D., M.O. Andreae, A. Asmi, M. Chin, G. Leeuw, D.P. Donovan, R. Kahn, S. Kinne, N. Kivekäs, M. Kulmala, W. Lau, S. Schmidt, T. Suni, T. Wagner, M. Wild and J. Quaas, 2014. Global observations of aerosol-cloud-precipitation climate interactions. *Rev. Geophys.*, doi:10.1002/2013RG000441.

Rosenfeld, D., Y. Zheng, E. Hashimshoni, M.L. Pöhlker, A. Jefferson, C. Pöhlker, X. Yu, Y. Zhu, G. Liu, Z. Yue, B. Fischman, Z. Li, D. Giguzin, T. Goren, P. Artaxoi, H.M.J. Barbosai, U. Pöschl and M.O. Andreae, 2016. Satellite retrieval of cloud condensation nuclei concentrations by using clouds as CCN chambers. *Proc. Natl. Acad. Sci. USA*, doi:10.1073/pnas.1514044113.

BACCHUS: *http://www.bacchus-env.eu/*

CAMP2Ex: *https://espo.nasa.gov/missions/sites/default/files/documents/CAMP2Ex-overview-27NOV2015.pdf*

CLARIFY: *http://blogs.exeter.ac.uk/clarify2016/*

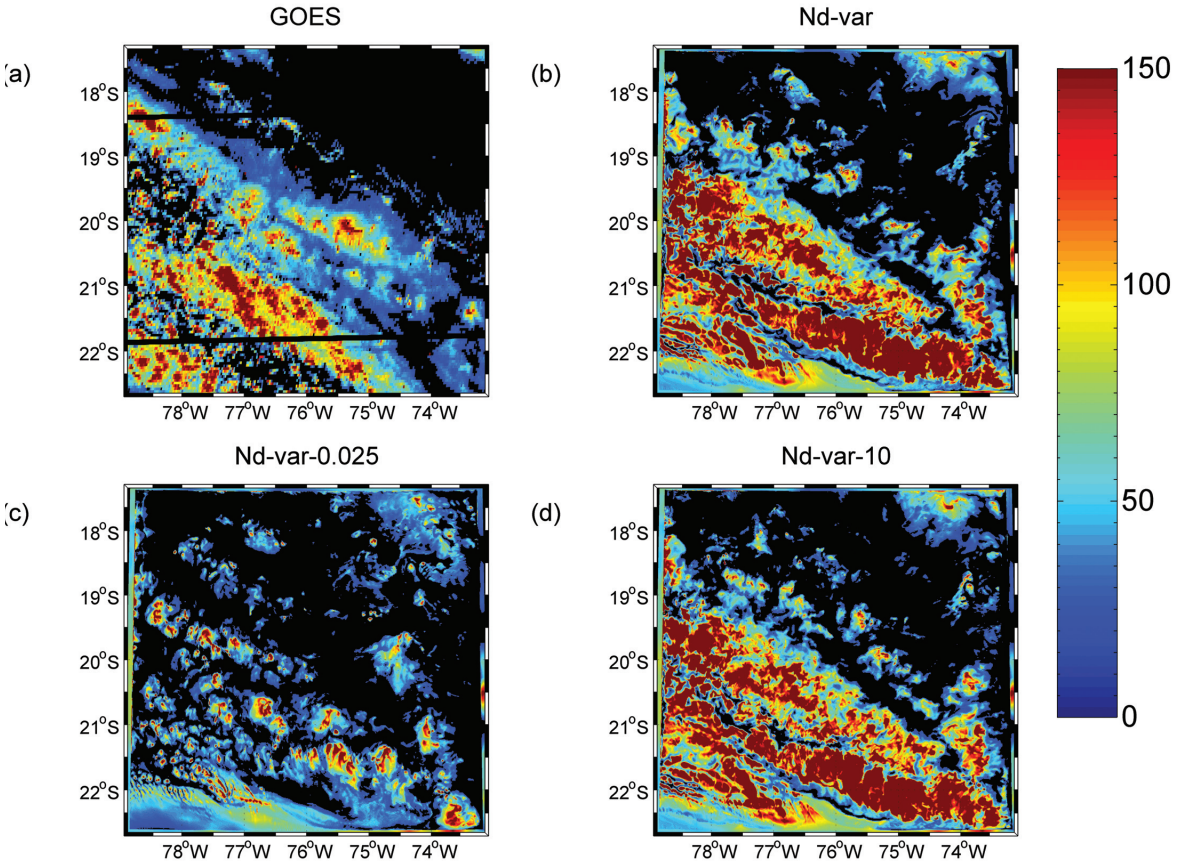
EUREC4A: *http://www.mpimet.mpg.de/en/science/the-atmosphere-in-the-earth-system/narval-eurec4a/*

HD(CP)²: *http://hdcp2.eu*

ORACLES: *http://science.nasa.gov/missions/oracles/*

SOCRATES: *http://www.atmos.washington.edu/socrates*

VOCALS: *https://www.eol.ucar.edu/projects/vocals/rex.html*



Simulation of the VOCALS case using the UK Unified Model, including the aerosol scheme CASIM. The cloud liquid water path (g/m²) is shown in comparison to satellite retrievals from the GOES satellite. In two sensitivity simulations, the aerosol concentration is reduced by a factor of 40, and augmented by a factor of ten. Results from Daniel Grosvenor (University of Leeds), Paul Field, Adrian Hill and Ben Shipway (UK Met Office, Exeter).

Meeting/Workshop Reports

14th Baseline Surface Radiation Network Scientific Review and Workshop

26–29 April 2016
Canberra, Australia

Chuck Long
NOAA Earth System Research Laboratory (ESRL) and University of Colorado, CIRES, Boulder, Colorado, USA

Fifty scientists, station managers and data users presented 44 talks and 32 posters at the BSRN Workshop, which was hosted by Nicole Hyett at the Australian Bureau of Meteorology (BoM). Topics covered included a review of BSRN observations, improvements in instrumentation and data reduction methods, data management and quality control issues, ways the data are used by the larger community, and candidates for new BSRN sites.

The GEWEX Data and Assessments Panel (GDAP) oversees and gives general guidance to BSRN, which consists of volunteers operating stations that measure surface solar and infrared (IR) radiation according to a set protocol. Many stations also make ancillary measurements, such as aerosol optical depth (AOD), ultraviolet radiation, photosynthetically active radiation and meteorological parameters. Currently, 59 stations are submitting data to the BSRN Archive located at the World Radiation Monitoring Center (WRMC) of the Alfred Wegener Institute of Polar and Marine Research (AWI) in Bremerhaven, Germany. BSRN has been an official surface radiation network of the World Meteorological Organization (WMO) Global Climate Observing System (GCOS) since 2004.

Dr. Rob Vertessy, the Director of BoM in Canberra, opened the first session of the workshop with welcoming remarks. Nicole Hyett provided local logistics information and Chuck Long, the BSRN Project Manager, gave the meeting charge. Tim Oakley, the Network Manager for GCOS, welcomed everyone on behalf of the GCOS Director, Dr. Carolin Richter, and gave an update on the overall GCOS program. Nozomu Ohkawara, a member of the GCOS Atmospheric Observation Panel for Climate, reported on the status and implementation plan of BSRN within GCOS. The surface radiation budget was designated as one of the Essential Climate Variables in GCOS to contribute to the United Nations Framework Convention on Climate Change (UNFCCC). The GCOS steering committee completed its report, "Status of the Global Observing System for Climate," and submitted it to the UNFCCC secretariat in October 2015.

BSRN Archive Status

Gert König-Langlo, Director of WRMC and the BSRN Archive (*http://www.bsrn.awi.de*) at AWI, reported that a total of 8761 station-month data sets from 59 stations were collected at WRMC in April 2016. All submitted station-to-archive files are read-accessible from any user who accepts the BSRN data release guidelines (*http://www.bsrn.awi.de/en/data/conditions_of_data_release/*). Data may be retrieved via ftp or via the PANGAEA information system (*http://www.pangaea.de/*), which provides more user-friendly services. Of particular note was the announcement that Dr. König-Langlo will be retiring in mid-2017 and stepping down as the Director of WRMC. A commitment by Karin Lochte, the Director of AWI, to continue to host the WRMC and BSRN Archive was heartily welcomed by the workshop participants. Many thanks were extended to Dr. König-Langlo for his dedicated years of participation in BSRN and his excellent leadership in establishing and improving the WRMC. He was asked to convey the BSRN community's sincere thanks to Dr. Lochte and AWI for their past and continued support of WRMC.

Proposed BSRN Stations

Twelve new sites were proposed for consideration as stations and all of these address data-scarce areas in BSRN coverage. Stefan Kinne presented the proposal by the Max-Planck-Institut für Meteorologie to establish a BSRN site on Barbados. The Barbados Cloud and Radiation Observatory site has cloud radars, lidars, ceilometers and sky cameras. Its sister site, operated by the University of Miami at nearby Ragged Point, specializes in aerosol measurements. Carlo Wang from the National Central University, Taiwan, proposed four Taiwanese sites: Lulin, Yushan, Lanyu and Dongsha. These sites are each unique and have their own scientific implications due to different environments and locations, including altitude and remoteness. Benjamin Duck of the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) proposed a BSRN station at Newcastle, Australia, which would be located in a region that is representative of the mid-eastern coastal climate of Australia. The site is a hub for energy research operated by CSIRO with over 10 years' experience measuring and using solar resource data to a standard that is compliant with BSRN specifications. Béatrice Morel of the Laboratory of Energy, Electronics and Process of the University of La Réunion proposed a site on Réunion Island in the Southwest Indian Ocean that would be on a dedicated platform on the roof of the University's Faculty of Sciences Building. Karthik Ramanathan of the National Institute of Wind Energy of India proposed four Solar Radiation Resource Assessment (SRRA) Stations in India located at Thiruvallur, Gurgaon, Gandhinagar and Howrah. These sites cover locations in the north, south, east and west regions of the country, with all the sensors traceable to the WMO World Radiometric Reference (WRR) and well-established quality assurance and archiving procedures. Lastly, Vasilii Kustov of the Arctic and Antarctic Research Institute in St. Petersburg, Russia presented a proposal for a new Arctic site at Cape Baranova (79°N, 101°E). The location of the ice base is at one of the least-investigated regions of the Arctic Ocean. Plans include a complex of meteorological instrumentation to be installed that is similar to the Tiksi Station, with the prospect for becoming the second regional station in the Russian Arctic and a station in the Global Atmospheric Watch

Programme. All of these proposals were discussed during the business meeting on the last day and decisions on provisional acceptance are given at the end of this report.

WCRP and BSRN

A video presentation by Jörg Schulz, the GDAP Chair, reviewed the relationship of BSRN to the World Climate Research Programme (WCRP), GEWEX and GCOS. He discussed the WCRP Grand Challenges and the four GEWEX Science Questions underpinning the two GEWEX-related Grand Challenges for Changes in Water Availability and Climate Extremes. His talk concluded by noting that systematic BSRN measurements are needed for monitoring climate variability and change, and for evaluating products based on satellite data (radiation fluxes, surface albedo and AOD) and for reanalyses and climate model runs. He noted that the extension of spatial and temporal coverage remains an issue and that continuous calibration of BSRN instruments across the sites and knowledge of uncertainty for the measurements is essential.

Instrumentation Discussions

The first day of the workshop ended with a poster session that featured status updates for 36 BSRN stations.The second day focused on instrumentation. Presentations included a comparison of the different solar calibration methods and resulting measurement differences by Ibrahim Reda. Michael Milner gave a demonstration on zenith angle bias in pyranometer calibration and a presentation on pyrheliometer alignment testing. Nicole Hyett presented an evaluation of the Delta-T SPN1 as a sunshine meter. Natalia Kouremeti presented results from the Fourth Filter Radiometer Comparison and Julian Gröbner sumarized the IPgC pyrgeometer comparison, both of which were held in Davos, Switzerland in October 2015. Ursula Weiser gave a presentation on the Austrian radiation monitoring network ARAD, of which the BSRN Sonnblick station is a part. Ibrahim Reda discussed "Quantifying Spectral Error in Thermopile Radiometers and Measuring Broadband IR Irradiance in the Direct Solar Beam," the latter in reference to using open cavity radiometers as solar reference instruments. Ian Dollery gave his assessment of pyrgeometer uncertainty calculations that showed that the largest contributors to uncertainty in longwave measurements are the thermistors' temperature measurements. John Augustine reviewed a method for recovering longwave irradiance measurements tainted with bad thermistor data, and Klaus Behrens provided an assessment of long-term stability for two Eppley and Kipp & Zonen pyrgeometers.

Observations and Analysis

The second poster session of the Workshop was dedicated to improvements and scientific uses of BSRN observations, and spanned topics that included evaluation and validation of satellite products and retrievals and demonstration of biases in both satellites and modeling. Other subjects included quality control and assessment, automated cleaning systems, a new pyranometer design and facilities for calibration of radiation networks. Also presented were assessments of surface radiation budgets and cloud radiative forcing, radiative energy flow in the atmosphere and radiative effects of a total solar eclipse over the BSRN Station Ny-Ålesund.

The morning of the third day of the Workshop was dedicated to Working Group (WG) breakout meetings, and for those interested, small group-training sessions given by Dr. König-Langlo on how to use the BSRN-Toolbox and PanPlot to handle BSRN data before submission and as a user.

The sessions on observations and analysis were held in the afternoon. Chris Cox gave an assessment of cloud radiative forcing from pan-Arctic BSRN stations that included applications for climate monitoring and seasonal-scale sea ice forecasting. Gert König-Langlo summarized a study of how increasing carbon dioxide is cooling Antarctica. Xiangao Xia presented a parameterization of clear-sky surface irradiance and its implications for estimation of aerosol direct radiative effect and aerosol optical depth. Carlo Wang gave a talk on long-term measurements of solar radiation and aerosol radiative forcing at Mt. Lulin (2,862 meters) in East Asia, and Frederick Denn summarized a 5-year long determination of aerosol optical depth using a Multi-Filter Rotating Shadowband Radiometer. Stefan Kinne gave a presentation Kinne on AOD estimates from broadband BSRN data. Joe Michalsky described spectral irradiance and optical depth retrievals from the Rotating Shadowband Spectroradiometer (RSS) instrument. A 15-year climatology of BSRN measurements from the Chesapeake Light station was presented by Bryan Fabbri, and Taiping Zhang talked about the application of BSRN data in the National Aeronautics and

Participants at the 14th Baseline Surface Radiation Network Scientific Review and Workshop.

Space Administration (NASA) GEWEX Surface Radiation Budget (SRB) and Prediction of Worldwide Energy Resource (POWER) projects. Karthik Ramanathan presented an assessment on solar resource activities in India, which was followed by a talk by Jordi Badosa on the quality of solar irradiance measurements for photovoltaic module efficiency studies. Sergio Colle presented a validation of the broad-line region diffuse model against BSRN Florianopolis data, and Ben Liley reviewed 25 years of spectral UV measurements from Lauder, New Zealand. The day ended with a presentation on inferring photolysis rates from solar radiation measurements at Cape Grim given by Stephen Wilson.

Working Group Reports

The last day of the Workshop began with reports of the working groups. Julian Gröbner, chair of the **Infrared WG**, proposed the following tasks for his WG: (i) address the consistency between pyrgeometers under wet climates with regard to high integrated water vapor; (ii) investigate the use of either World Infrared Standard Group of Pyrgeometers (WISG) or Blackbody-based calibrations of pyrgeometers used to measure upwelling longwave irradiance; (iii) gather information and investigate different methodologies for re-evaluation of BSRN irradiance data sets in view of an eventual recalibration of BSRN radiometers; (iv) compare pyrgeometer calibrations from different institutes and investigate their consistency; and (v) evaluate the stability of pyrgeometers over time in view of applying recent calibrations to past data sets.

Kathy Lantz of the National Oceanic and Atmospheric Administration (NOAA) Global Monitoring Division was announced as the new Chair for the **Spectral WG**. The WG is considering planning a field campaign to compare and calibrate Photosynthetically Active Radiation (PAR) sensors, PAR-weighted spectra and a UV broadband filter radiometer campaign at the World Calibration Center-Ultraviolet Section at the Physikalisch-Meteorologisches Observatorium Davos (PMOD)/World Radiation Center (WRC) from June to August 2017. The Filter Radiometer Comparison (FRC-IV) held at PMOD/WRC in October 2015 will be published as a WMO report and condensed in a peer-reviewed publication. Participants planning to attend the next FRC will be contacted to re-evaluate their data with common parameters supplied by the FRC organizer. In addition, a questionnaire will be circulated to BSRN site operators to obtain information on their AOD products, if applicable.

The **Cold Climate Issues WG** also announced a new Chair, Chris Cox of the University of Colorado Cooperative Institute for Research in Environmental Sciences (CIRES). Topics proposed by the WG were focused on how BSRN could contribute to the upcoming Year of Polar Prediction (YOPP). They intend to urge all BSRN polar sites to keep their data as up-to-date as possible in the BSRN Archive and will establish a webpage link to YOPP. In addition, a "traveling comparison" of well-characterized radiometers is planned. The idea is to investigate how measurements compare from site to site in order to facilitate area-wide compositing and comparisons. The WG also recognized the need for a radiometer dome icing mitigation strategy intercomparison campaign.

Nicole Hyett, Chair of the **Uncertainties WG**, reported that the WG will develop two documents. The first would give guidance to new and existing station scientists in the form of a "checklist" of things that should be considered in determining measurement uncertainties in BSRN data. The second document would provide an estimate of uncertainties for different BSRN time series. In addition, BSRN users will be surveyed as to which time series they most commonly use. After these activities are completed, the WG will concentrate their efforts in a direction that would provide the greatest value to BSRN users.

Several older WGs were consolidated into the new **Broadband Shortwave Radiometry WG** chaired by Allison McComiskey of the NOAA Global Monitoring Division (GMD). The group discussed several potential projects, including examining the effects of height on broadband surface albedo measurements and the possibility of using a sky-blocked, vertically mounted pyranometer to estimate upwelling shortwave radiation, which might allow mountings where the substructure interferes with the nominal measurement protocol. Discussions also included the issue of heterogeneity and a possible study using sampling from local sites over a larger area. It was suggested that experiments like the various conditions pyrheliometer comparison (VCPC) that was carried out in 2009 be repeated because of the newer pyrheliometers, and that new comparisons could also be performed for diffuse and global horizontal measurements made with pyranometers.

Candidate Stations Accepted

After a discussion on the proposed BSRN sites, the following candidate sites were given provisional acceptance: the Taiwan Lulin and Dongsha Atoll sites; the Newcastle, Australia site; the four SRRA sites (Gurgaon, Howrah, Gandhinagar and Tiruvallur) in India; and the Arctic Cape Baranova site. These new sites will be designated as full-fledged BSRN sites upon successful acceptance of quality assessed data files into the BSRN Archive. It was agreed that the Barbados site in the western tropical Atlantic, the Taiwan Yushan and Lanyu sites and the Réunion Island site in the western Indian Ocean all need further development before being acceptable as BSRN stations. They were invited to attend the next BSRN meeting, which is to be held in 2018, to present their progress towards becoming BSRN sites.

New Guidelines for Data Submission

It was noted that a number of previously proposed candidate sites were still listed, yet had not further interacted or corresponded with BSRN for many years. Two sites had been provisionally accepted as BSRN sites more than a decade ago, but never submitted any data to the BSRN Archive. Three other sites proposed joining, but never followed up in any way. None of these sites were ever noted on the BSRN maps or station listings. After discussion, it was decided to drop all five sites and notify their listed contacts. They may re-

propose for consideration as BSRN sites at upcoming BSRN meetings.

A related discussion concerned the timely submission of data to the BSRN Archive. It was noted that organizations such as GCOS, WCRP and GDAP depend upon BSRN for its reputed high quality surface radiation data and that BSRN has a serious responsibility to make the high quality data it collects available to the community in a timely manner. A review of BSRN station data showed that over 25% of the BSRN sites were more than 5 years behind in their data submission, and many others more than 2 years in arrears. It was decided that a new paradigm for monitoring and addressing lagging data submissions to the BSRN Archive would be enacted. Any station scientist whose site data submission to the Archive lags by two or more years will be contacted by the BSRN Project Manager, and the scientist will have one year to catch up on data submission. If progress is still lacking at the end of a year, the site may be classified as "inactive." These sites would be encouraged to reach "active" status with timely submissions to the archive.

Intercomparison of Infrared Radiation References

A recommendation was made to carry out an intercomparison of IR references in October 2017 so that the observed differences between the newly proposed absolute IR radiometer references (the Infrared Integrating Sphere Radiometer from PMOD/WRC and the Absolute Cavity Pyrgeometer from the Natural Resource Ecology Laboratory at Colorado State University) and the WISG could be studied more extensively. The Southern Great Plains site of the Atmospheric Radiation Measurement Program was chosen as a potential host for this intercomparison, as it was used for a similar intercomparison in September 1999. For the intercomparison to be fully valuable in investigating the reported differences, it is recognized as critical that the absolute reference used during the 1999 intercomparison (Absolute Sky-scanning Radiometer) should also take part in the intercomparison. All efforts are encouraged to make the ASR available for inclusion in the proposed intercomparison.

Workshop Wrap-Up

The BSRN Operations Manual was last updated in 2005 as WMO Technical Document No. 1274. Given the significant advances that have recently been made in radiometric measurements, understanding, and operational and calibration paradigms, it was agreed that it is time to update the Manual. Gary Hodges of NOAA GMD volunteered to lead the effort and will seek other volunteers from the BSRN membership to assist him. This task is a significant effort and those who participate will be gratefully recognized.

The level of expertise and enthusiasm of the participants at the 14th BSRN Scientific Review and Workshop was especially noteworthy. A more detailed report of the Workshop will be published as a WCRP document. Workshop presentations and posters are available at: *http://www.esrl.noaa.gov/gmd/grad/meetings/bsrn2016.html*.

International Conference on Soil Modeling

Austin, Texas, USA
29 March–1 April 2016

Harry Vereecken[1] and Michael H. Young[2]

[1]Forschungszentrum Jülich GmbH, Jülich, Germany; [2]Jackson School of Geosciences, University of Texas at Austin, USA

More than 110 scientists from 25 countries participated in the inaugural international conference to establish the International Soil Modeling Consortium (ISMC), which was held at the University of Texas at Austin. The mission of this newly formed Consortium is to integrate and advance soil systems modeling, data gathering and observational capabilities. During the conference, more than 40 presentations and over 80 posters covering a broad range of soil modeling activities were presented and intensively discussed. Four working groups addressed key topics dealing with the ISMC mission, governance and outreach; model development and intercomparison; linking data with models; and crosscutting topics on soil research and modeling. Harry Vereecken (Forschungszentrum Jülich GmbH) and Michael Young (University of Texas at Austin) were elected as ISMC Chair and Co-Chair, respectively, for a two-year term.

The first working meeting of the ISMC was held on April 1st, leading to the establishment of an executive board, a scientific advisory board and five science panels. The panels, which were loosely organized using the framework of the meeting and dedicated to specific topics, are:

1. Model Development and Intercomparison (MDMIP)
2. Data and Observations (DO)
3. Crosscutting Topics (CROSS)
4. Interfacing with Science and Society (CONNECT)
5. Linking Models and Data (MLINK)

Leaders and co-leaders for each panel were identified during the meeting (or shortly thereafter) with the leaders encouraged to identify 1–3 year goals and approaches for achieving those goals and developing the science mission. From discussions within the ISMC and collaborators outside the Consortium, there is a consistent need across the scientific community for organized data sets that can be used for model intercomparisons, scientific experiments at different scales that can be used for upscaled and downscaled models, and a more robust representation of soil processes for global-scale models, especially those used by the GEWEX community.

The Consortium understands the breadth of its goals, and that this endeavor will take time to get fully up to speed. However, the enthusiasm at the Austin conference and the discussions that followed, as well as potential collaboration with GEWEX, are important indications that the ISMC will provide real value to the scientific community. Information on the outcome of the working groups and details on the science panels and executive board will be posted on the ISMC website at: *https://soil-modeling.org/*.

Workshop on the Earth's Hydrological Sensitivity to Climate Change

20–22 June 2016
Exeter, UK

Graeme L. Stephens[1] and F. Hugo Lambert[2]

[1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA; [2] Exeter Climate Systems Group, College of Engineering, Mathematics and Physical Sciences, University of Exeter, Exeter, UK

The vast majority of available fresh water comes from precipitation—either directly or indirectly from runoff in distant locations. Moreover, freshwater resources are substantially depleted through evapotranspiration, which can be a major driver of droughts. Both these factors affect climate extremes, which generally relate to how much or how little precipitation falls over time and to fluctuations in land evapotranspiration. From a climate perspective, it is imperative to understand the natural variability of precipitation and land water exchanges and storage, as well as susceptibility to change by external forcings.

A small workshop was convened at the University of Exeter, where researchers aimed at understanding the susceptibility of the hydrological cycle to forcings associated with climate change. It focused on the topic of "hydrological sensitivity," or how precipitation is expected to change in a warming world, and reviewed our comprehension of it from multiple fronts, including observations, model, and theoretical perspectives. The workshop assessed what is understood on various time and space scales, from energetic controls at global scales to regional controls. Non-dynamical (i.e., energetic) controls of precipitation, as well as local and dynamical controls, were examined. Reasons why we might expect progress on understanding fresh water availability in a changing climate were also underscored and gaps in progress were identified.

The presentations collectively explored the reasonable bounds on estimates of hydrological sensitivities and whether there is evidence for these sensitivities to be different in the real Earth system than those derived from models. Selected highlights of the meeting results and discussion include:

- Real progress on cold region changes in precipitation has recently been made from a number of sources, indicating that advances in understanding the water balance of these climate sensitive regions may be near at hand.
- Decades of observations of the freshening and salinization of oceans, providing an invaluable view of decadal changes in precipitation over oceans, have not been fully explained. Also, we now have multiple years of higher resolution surface salinity data that clearly show the influence of river freshening of coastal waters. With the series of land-process model intercomparison projects now underway, such data offer a unique diagnostic opportunity for the evaluation of river runoff as represented by current generation land surface models.
- No significant global trends in precipitation have been observed from current multi-decadal data records; however, the data show distinctly shorter-term changes regionally. The intensification and narrowing of the Pacific Intertropical Convergence Zone emerges from the observational record. Theories for why this is the case were discussed at the meeting and seem to be consistent with the observations, suggesting they are robust.

Other topics included what types of advances might be expected with convectively resolving models; understanding extremes, aerosols and other specific process related influences on precipitation; global controls and potential feedbacks on these controls; and gaps in observations and understanding.

Based on the success of the workshop, a series of others is being planned. In addition, a report for *Nature Climate Change* is being prepared that more fully describes the outcomes of the workshop.

GEWEX/WCRP Calendar

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

6–8 September 2016—GEWEX Convection-Permitting Climate Modeling Conference—Boulder, Colorado, USA

12–16 September 2016—WGNE/SPARC Workshop on Drag Processes and Links to Large Scale Circulation—Reading, UK

16–25 September 2016—CLIVAR OSC—Qingdao, China

21–22 September 2016—3rd Satellite Soil Moisture Validation and Application Workshop—New York, NY, USA

28–30 September 2016—Including Water Management in Large Scale Models—Gif-sur-Yvette, France

3–5 October 2016—Annual Meetings of the GEWEX Hydroclimatology and Global Land/Atmosphere Study Panels—Gif-sur-Yvette, France

17–19 October 2016—INARCH Workhop—Grenoble, France

24–27 October 2016—3rd Open Science Meeting of the Global Land Project—Beijing, China

25–27 October 2016—8th EGU Leonardo Conference—From evaporation to precipitation: The atmospheric moisture transport— Ourense, Spain

31 October–4 November 2016—24th SPARC Scientific Steering Group Meeting—Berlin, Germany

GEWEX NEWS

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