GEWEX QUARTERLY

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World Meteorological Organization | International Science Council

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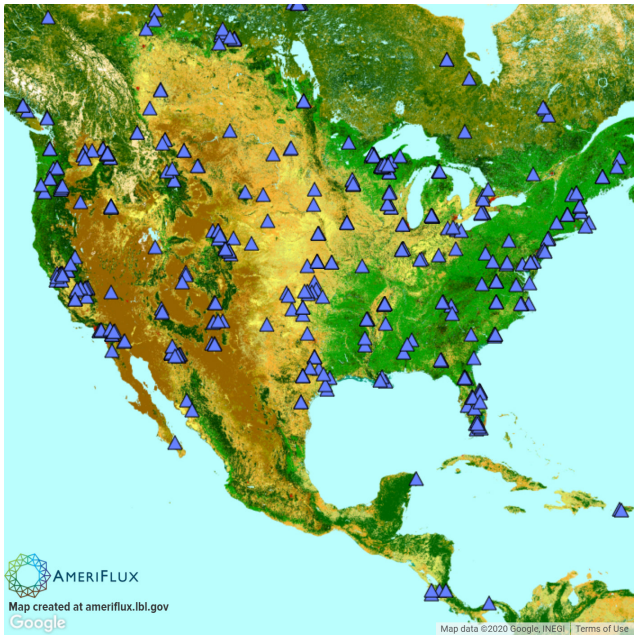
GEWEX is a Core Project of the World Climate Research Programme on Global Energy and Water Exchanges

Including AmeriFlux in the Proposed GEWEX U.S. Regional Hydroclimate Project



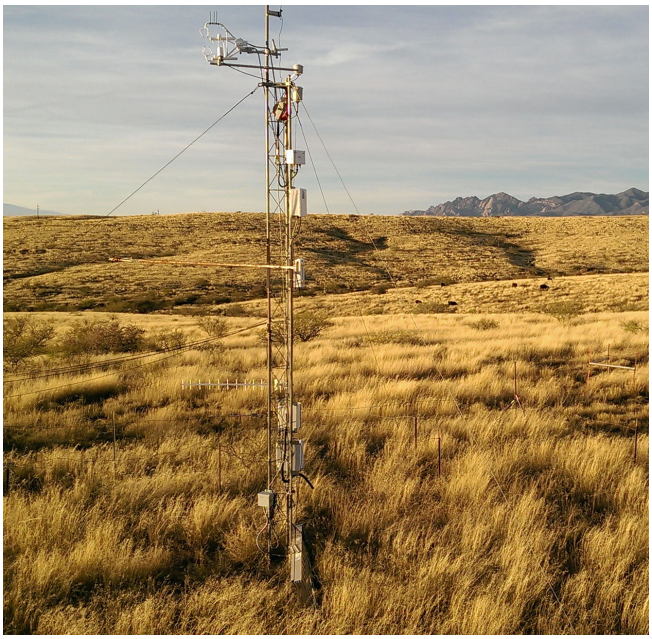


Figure 1: The left panel shows registered AmeriFlux sites in North America. The panel on the right is the AmeriFlux site at the United States Department of Agriculture-Agricultural Research Service (USDA-ARS) Walnut Gulch Kendall Grassland location in south-eastern Arizona, USA.

Inside This Edition

Commentary: A New Home

Peter van Oevelen
Director, International GEWEX Project Office

In June of this year, the International GEWEX Project Office (IGPO) relocated to George Mason University in Fairfax, Virginia. With this long-intended move, we hope to overcome some of the practical limitations we had at our previous home at the Universities Space Research Association (USRA). I thank USRA and its Goddard Earth Sciences, Technology and Research (GESTAR) leadership, in particular the late Bill Corso, for their support. Personally, the passing of Bill, already two years ago, was a great loss and I cannot express enough gratitude for all that he has done at both a professional and personal level.

We also say goodbye to our contract support at Science and Technology Corporation (STC). STC has been aiding GEWEX and in particular the IGPO in various ways since the beginning in the early 1990s. Many of our activities and accomplishments would not have been possible without them. One person in particular deserves special mention: Paul Try has been involved in GEWEX since its inception. As the first director of the IGPO, he established many of the practices we still adhere to today. After he stepped down as director, he remained actively involved as the main point of contact at STC, and we could always rely on him for sage advice and insight. It was a delight interacting with him and the staff at STC. And I do need to thank the staff at STC: Adarsh and Chand Deepak, Rink Wood, Elyse Webb, Missy Lyons, Delores Shackelford, Mike McGuire and John Sullivan. They provided assistance with finances, the technical details of website management and server hosting, production of mailings, arrangements for newsletter printing and many other things. They were an invisible but invaluable resource. Our heartfelt thanks to you!

At George Mason University, the IGPO is located within the Center for Ocean-Land-Atmosphere Studies (COLA), no doubt a familiar name to many of us in the community. We look forward working together with our COLA colleagues and thank them for their support in establishing the IGPO at GMU.

It always seems that when writing this commentary, big changes are on the horizon for GEWEX and WCRP. This time is no different, and it is not only the COVID-19 pandemic but also the implementation of the new WCRP strategy and how it will affect GEWEX and its community. I won't go into detail too much on what COVID-19 means for our operations other than to say we intend to support our community wherever we can in continuing our research to the best extent possible. Although many of us do appreciate the reduced pressures of travel, we notice how it affects the way we collaborate and interact. Many meetings, workshops and field experiments have been cancelled, postponed or moved to an online format. I expect most of these activities can be started or continued later in the coming year, when we anticipate meetings to be at least partially in-person again.

As part of its new implementation plan, WCRP is holding several regional consultations to engage with its community, partners, stakeholders and the larger Earth science community. These consultations will allow the latter group an opportunity to be actively involved in shaping the new WCRP agenda and its enactment. WCRP also plans to launch new Light House Activities, which will integrate its capabilities into major experiments or projects on themes such as "Explaining and Predicting Earth System Change" and "My Climate Risk". Workshops around the regional consultations and Light House Activities will now take place online, and more information on the consultations will be shared via our e-newsletter, Facebook and Twitter accounts. I do urge you to take active part and we look forward to your input!

With all these changes it could very well turn out that the IGPO and GEWEX will have found more than just a new home at GMU but also within WMO and WCRP.

Table of Contents

YESS Engagement in the International Science Community

Faten Attig Bahar[1], Shipra Jain[2], Carla Gulizia[3] and M. Adnan Abid[4]
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The Young Earth System Scientists (YESS) community is becoming larger and stronger in the international science community, and has achieved several milestones over the last few months. YESS Executive Committee (ExeCom) member Carla Gulizia has been selected to serve on of the GEWEX Global Atmospheric System Studies (GASS) Panel. The GASS Panel invited YESS member Penelope Maher to participate in the "Precipitation Diurnal Cycle over Different Climate Regimes" project. ExeCom members Gaby Langendijk and Yuhan Rao and YESS officer Valentina Rabanal attended the first virtual Joint Scientific Committee (JSC-41) meeting of the World Climate Research Programme (WCRP) on behalf of the YESS community. We are also very delighted and proud to share that YESS ExeCom member Faten Attig Bahar was invited by the World Meteorological Organization (WMO) to join the research board on Weather, Climate, Water and the Environment.

As part of our online activities from April to June 2020, the YESS-community and the Pan African University Institute of Water and Energy Sciences (PAUWES), in collaboration with Future Earth's Food-Water-Energy Nexus Knowledge-Action Network and the United Nations University Institute of Environment and Human Security (UNU-EHS), conducted the second edition of the webinar series on Sustainable Development in Africa. The panel included three invited experts from various disciplines and discussion focused on the importance of innovation in the region post-COVID-19 and ways to identify untapped opportunities in water, energy and climate change in Africa for youth and women. In addition, an interaction and evaluation session between YESS community and PAUWES was chaired by our two ExeCom members, Ms. Faten Attig Bahar and Dr. Claudia Volosciuk.

During the COVID-19 epidemic, YESS also initiated a science webinar series (*https://www.yess-community.org/yess-summer-science-webinars-2020/*). Dr. Min-Hui Lo of National Taiwan University presented the first of the series on 25th June 2020 on the topic "From global mean sea level changes to land-atmosphere interactions". Dr. Elizabeth Barnes of Colorado State University gave the second webinar on 1st July 2020 on "Detecting climate signals through an Artificial Intelligence (AI) lens".

The YESS community would like to thank the Association of Polar Early Career Scientists (APECS) for providing the webinar tool and all its partners for their support in organizing and disseminating the online activities. The webinars are freely available at *https://www.yess-community.org/activities/past-webinars/*.

AmeriFlux Should be an Integral Part of a GEWEX U.S. Regional Hydroclimate Project

Russell L. Scott[1] and Timothy L. Schneider[2]
[1]USDA-ARS Southwest Watershed Research Center, Tucson, AZ, USA, and Co-chair of the AmeriFlux Science Steering Committee; [2]NCAR, Boulder, CO, USA, and GEWEX US-RHP Lead

As we enter our third decade of the 21st century, the effects of a rapidly changing climate are becoming ever more obvious. Temperature records are being broken at a faster rate, precipitation patterns are shifting, and the climate is "weirding"–becoming more extreme in terms of both temperature and precipitation. The current (2020) extreme fire season underway in the western United States is beyond all norms and exemplifies the implications of this weirdness. These changes combined with a growing population, changing demographics and ageing infrastructure result in a plethora of problems that would benefit from the best science available on the energy and water cycles. Accordingly, Schneider and van Oevelen (2020) argue the need for a Regional Hydroclimate Project (RHP) to improve the science, modeling and observations of the linked water and energy cycles for the contiguous United States (CONUS), in line with other GEWEX calls for RHPs elsewhere. Such a venture should be coordinated and linked with existing projects in the CONUS that would result in strong synergistic results. One such project is AmeriFlux, a network of scientists who share data from sites that collect in situ eddy covariance measurements of the turbulent exchanges of energy and gases between the Earth's surface and the atmosphere across the Americas (Novick et al., 2018). AmeriFlux is well positioned to be an integral part of this GEWEX RHP in the United States.

AmeriFlux data capture the combined cycles of energy and water exchanges along with the carbon dioxide (CO_2) exchange at the land-atmosphere interface. Just as the surface energy and water balances are linked through evapotranspiration (ET), so too is the carbon balance as plants transpire water when they take in CO_2 though leaf stomata. With the advent of new computer and sensor technologies in the late 20th century, continuous, multiyear eddy covariance observations became feasible (Baldocchi et al., 2001). AmeriFlux began with funding from the U.S. Department of Energy (DOE) in the 1990s, starting with just 15 sites (Hawkins et al., 2020). From there, the network grew from the bottom up with individual scientists across North and South America, initially funded by other agencies and institutions, joining in by contributing data to the AmeriFlux data repository and participating in annual science meetings and synthesis efforts. With renewed DOE funding in the 2010s, the network has continued to grow to more than 500 sites throughout the Americas (over 400 sites in CONUS; see cover) and has enabled continued support for the database, data QA/QC and standardized data releases (e.g., Pastorello et al., 2020), operational support of long-term sites and regular meetings and workshops. This sup-

port is provided by the AmeriFlux Management Project run out of the DOE's Lawrence Berkeley Laboratories. With its network of scientific expertise and near-continuous surface flux observations over a wide range of natural and agricultural ecosystems, AmeriFlux can contribute mightily to the science and observations of the U.S. RHP.

AmeriFlux's main focus has long been on the surface exchange of CO_2 to better understand the terrestrial carbon cycle. Yet, because the eddy covariance instrumentation has allowed for the simultaneous observations of turbulent energy exchanges (latent and sensible heat fluxes) and momentum, scientists have also used these data to improve our understanding of regional and global water and energy exchange. For example, machine learning techniques have combined the temporally-dense (often 30-minute resolution, available for years) but spatially-limited (sparse resolution of flux tower networks) with gridded meteorological, vegetation cover and satellite data to understand long-term trends in global and regional evapotranspiration (Jung et al., 2010). Regional networks that span gradients in vegetation cover, elevation and precipitation have been used to uncover fundamental controls on water and carbon cycling (Goulden et al., 2006; Jin and Goulden, 2014; Biederman et al., 2017). Furthermore, all AmeriFlux sites also measure standard meteorological variables and, often, non-standard ones like solar radiation, ground heat flux, soil moisture and temperature, etc. Because many of the sites now have multiyear records of more than one or two decades, AmeriFlux data can be used to begin defining a site's, or even a region's, hydroclimatology in new ways. For example, in addition to the traditional precipitation, temperature and humidity variables, the data can be used to generate monthly means and standard deviations of evapotranspiration, net radiation, solar radiation, sensible heat flux and carbon exchange (e.g., Biederman et al., 2017). Such long-term data records are greatly needed to assess the multi-decadal, high-resolution hydroclimate simulations now being conducted (as described in Schneider and van Oevelen, 2020). Thus, the AmeriFlux network can help define the hydroclimate space of the proposed RHP and act as a coordinator of additional eddy covariance measurement sites needed for the project.

AmeriFlux data has long been the gold standard for surface flux observations. This data has been used for calibration-validation efforts for numerous satellite data products (e.g., Turner et al., 2006; Jones et al., 2017; Karkauskaite et al., 2017; Fisher et al., 2020). Likewise, the data has been used to test and improve numerous weather forecasting and Earth system models (Chen et al., 2018; Decker et al., 2012; Keenan et al., 2012). These uses highlight the benefit of AmeriFlux to other U.S. agencies like the National Aeronautics and Space Administration (NASA), the National Center for Atmospheric Research (NCAR) and the National Oceanic and Atmospheric Administration (NOAA), yet the backbone of AmeriFlux is supported by DOE alone. A multiagency effort such as the proposed RHP could also benefit the efforts of AmeriFlux with increased recognition of the role that the group plays in improved understanding of the Earth's energy and water cycles as well as expanded eddy covariance data collection efforts within the RHP.

AmeriFlux's involvement with the proposed U.S. RHP would be a benefit for scientists already involved in AmeriFlux and those from other agencies and projects. And with the breadth of AmeriFlux covering both North and South America, the Global Water Futures RHP (Canada; *https://gwf.usask.ca/*) and prospective RHP ANDEX (South America; *https://www.gewex.org/project/andex/*) can benefit as well. AmeriFlux's long history of collaborative science and data sharing is a model for how interdisciplinary collaboration can result in science that is greater than the sum of its parts.

For more information about AmeriFlux, see: *https://ameriflux.lbl.gov/*.

References

Baldocchi, D., E. Falge, L. Gu, R. Olson, D. Hollinger, S. Running, P. Anthoni, C. Bernhofer, K. Davis, R. Evans, J. Fuentes, A. Goldstein, G. Katul, B. Law, X. Lee, Y. Malhi, T. Meyers, W. Munger, W. Oechel, K.T. Paw U, K. Pilegaard, H.P. Schmid, R. Valentini, S. Verma; T. Vesala, K. Wilson, and S. Wofsy, 2001. FLUXNET: A new tool to study the temporal and spatial variability of ecosystem-scale carbon dioxide, water vapor, and energy flux densities. *Bull. Am. Meteorol. Soc.*, 82(11), 2415-2434. https://doi.org/10.1175/1520-0477(2001)082<2415:FANTTS>2.3.CO;2.

Biederman, J.A., R.L. Scott, T.W. Bell, D.R. Bowling, S. Dore, J. Garatuza-Payan, T.E. Kolb, P. Krishnan, D.J. Krofcheck, M.E. Litvak, G.E. Maurer, T.P. Meyers, W.C. Oechel, S.A. Papuga, G.E. Ponce-Campos, J.C. Rodriguez, W.K. Smith, R. Vargas, C.J. Watts, E.A. Yepez, and M.L. Goulden, 2017. CO_2 exchange and evapotranspiration across dryland ecosystems of southwestern North America. *Glob. Chang. Biol.*, 23(10), 4204-4221. https://doi.org/10.1111/gcb.13686.

Chen, M., T.J. Griffis, J.M. Baker, J.D. Wood, T. Meyers, and A. Suyker, 2018. Comparing crop growth and carbon budgets simulated across AmeriFlux agricultural sites using the Community Land Model (CLM). *Agric. For. Meteorol.*, 256, 315-333. https://doi.org/10.1016/j.agrformet.2018.03.012.

Decker, M., M.A. Brunke, Z. Wang, K. Sakaguchi, X. Zeng, and M.G. Bosilovich, 2012. Evaluation of the reanalysis products from GSFC, NCEP, and ECMWF using flux tower observations. *J. Clim.*, 25(6), 1916-1944. https://doi.org/10.1175/JCLI-D-11-00004.1.

Fisher, J.B., B. Lee, A.J. Purdy, G.H. Halverson, M.B. Dohlen, K. Cawse-Nicholson, D.D. Baldocchi, et al., 2020. ECOSTRESS: NASA's next generation mission to measure evapotranspiration from the International Space Station. *Water Resour. Res.*, 56(4), e2019WR026058. https://doi.org/10.1029/2019WR026058.

Goulden, M.L., G.C. Winston, A.M. McMillan, M.E. Litvak, E.L. Read, A.V. Rocha, and J.R. Elliot, 2006. An eddy covariance mesonet to measure the effect of forest age on land–atmosphere exchange. *Glob. Chang. Biol.*, 12(11), 2146-2162. https://doi.org/10.1111/j.1365-2486.2006.01251.x.

Hawkins, L.R., J. Kumar, X. Luo, D. Sihi, and S. Zhou, 2020. Measuring, Monitoring, and Modeling Ecosystem Cycling. *Eos* (Online), 101. https://doi.org/10.1029/2020EO147717.

Jin, Y., M.L. Goulden, 2014. Ecological consequences of variation in precipitation: separating short-versus long-term effects using satellite data. *Glob. Ecol. and Biogeogr.*, 23, 358–370. https://doi.org/10.1111/geb.12135.

Jones, L.A., J.S. Kimball, R.H. Reichle, N. Madani, J. Glassy, J.V. Ardizzone, A. Colliander, J. Cleverly, A.R. Desai, D. Eamus, E.S. Euskirchen, L. Hutley, C. Macfarlane, and R.L. Scott, 2017. The SMAP Level 4 Carbon Product for Monitoring Ecosystem Land–Atmosphere CO 2 Exchange. *IEEE Trans. Geosci. Remote Sens.*, 55(11), 6517-6532. DOI: 10.1109/TGRS.2017.2729343.

Jung, M., M. Reichstein, P. Ciais, S.I. Seneviratne, J. Sheffield, M.L. Goulden, A.J. Dolman, et al., 2010. Recent decline in the global land evapotranspiration trend due to limited moisture supply. *Nature*, 467(7318), 951-954. https://doi.org/10.1038/nature09396.

Karkauskaite, P., T. Tagesson, and R. Fensholt, 2017. Evaluation of the plant phenology index (PPI), NDVI and EVI for start-of-season trend analysis of the Northern Hemisphere boreal zone. *Remote Sens.*, 9(5), 485. DOI: 10.3390/rs9050485.

Keenan, T.F., I. Baker, A. Barr, P. Ciais, K. Davis, M. Dietze, D. Dragoni, C.M. Gough, R. Grant, D. Hollinger, K. Hufkens, B. Poulter, H. McCaughey, B. Raczka, Y. Ryu, K. Schaefer, H. Tian, H. Verbeeck, M. Zhao, and A.D. Richardson, 2012. Terrestrial biosphere model performance for inter-annual variability of land-atmosphere CO_2 exchange. *Glob. Chang. Biol.*, 18(6), 1971-1987. https://doi.org/10.1111/j.1365-2486.2012.02678.x.

Novick, K.A., J.A. Biederman, A.R. Desai, M.E. Litvak, D.J. Moore, R.L. Scott, and M.S. Torn, 2018. The AmeriFlux network: A coalition of the willing. *Agric. For. Meteorol.*, 249, 444-456. https://doi.org/10.1016/j.agrformet.2017.10.009.

Pastorello, G., C. Trotta, E. Canfora, H. Chu, D. Christianson, Y.W. Cheah, P. Isaac, et al., 2020. The FLUXNET2015 dataset and the ONEFlux processing pipeline for eddy covariance data. *Sci. Data*, 7(1), 1-27. https://doi.org/10.6084/m9.figshare.12295910.

Schneider, T., and P. van Oevelen, 2020. A Proposed Regional Hydroclimate Project for the United States. *GEWEX Quarterly*, 30(2), 8-12.

Turner, D.P., W.D. Ritts, W.B. Cohen, S.T. Gower, S.W. Running, M. Zhao, M.H. Costa, A.A. Kirschbaum, J.M. Ham, S.R. Saleska, and D.E. Ahl, 2006. Evaluation of MODIS NPP and GPP products across multiple biomes. *Remote Sens. Environ.*, 102(3-4), 282-292. https://doi.org/10.1016/j.rse.2006.02.017.

Meeting/Workshop Reports

The Asian Precipitation Experiment (AsiaPEX) Kick-off Conference

Sapporo, Japan
28–30 August 2019

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The Asian Precipitation Experiment (AsiaPEX) (*http://iceds.cc.kagawa-u.ac.jp/asiapex/*) was launched in May 2019, as the successor to the GEWEX Asian Monsoon Experiment (GAME) and the Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative (MAHASRI). The first AsiaPEX conference was held from 28 to 30 August 2019, at Hokkaido University in Sapporo, Japan.

We organized an opening session for the discussion of GEWEX, two poster sessions, and six oral sessions pertaining to six different AsiaPEX-related topics, as defined in the draft Science Plan. The six topics, identified during the launch of AsiaPEX and all currently being studied by the research community, are:

1. Observation and Estimation of Asian Precipitation
2. Process Studies of Asian Land Precipitation
3. Subseasonal to Interdecadal Variability of the Asian Monsoon
4. Land Surface Hydrological Modeling: Human Impact on the Cryosphere
5. Coordinated Observation and Modeling Initiatives
6. Climate Change Detection and Projections

Research Topics Discussed during the Sessions

The opening session was entitled "AsiaPEX as a GEWEX RHP". The basic principles and questions of the AsiaPEX Science Plan and the current status of GEWEX projects were discussed. It was made clear that AsiaPEX is part of the GEWEX Hydroclimatology Panel (GHP) and GEWEX framework. A presentation by the International GEWEX Project Office provided useful suggestions for the AsiaPEX research community to facilitate the coordination of its research activities with numerous other projects.

Group photo of the AsiaPEX Kick-off Conference

Session 1 was the largest session. The first presentation was a comprehensive report on precipitation and its impacts on Bangladesh. Thirteen presentations focused on the observation and estimation of Asian precipitation, with the topics ranging from in situ precipitation observations to remote sensing precipitation estimates determined from ground-based and satellite radar data, as well as a variety of long-term geostationary satellite data sets. A newly developed ultra-high resolution (0.01°) precipitation data set (Hirose and Okada, 2018) demonstrated the potential of the radar precipitation data set. The Borderless Radar Information Networking (BRAIN) project, which coordinates Asian and international real-time ground-based radar data networks, was also described. The critical importance of high-resolution, globally homogeneous spatial precipitation data was revealed by a study on the role of coastal precipitation in the global hydrological cycle (Ogino et al., 2017). A local hydroclimatological project, called the JAkarta Heavy precipitation Experiment (JAHE), was also described, which focuses on the effects of climate change in urban Jakarta. Presentations on oceanic spray provided new insight into boundary-layer precipitation occurring near and above the ocean. Furthermore, studies on the regional spatiotemporal distribution of precipitation over Southeast and South Asia were presented.

Session 2, which included seven presentations, focused on process studies of Asian land precipitation. Various important processes near the land surface were modeled and observed to understand the role of land-atmosphere-biosphere coupling in water and energy exchange. Mesoscale convection over complex terrain was shown to be a key process in Asian land precipitation. The biosphere was discussed by both Chinese and Japanese researchers. A well-designed model demonstrated the possibility of detecting mesoscale convection over Eastern and Northeastern Asia, probably arising from topographical factors and land surface heterogeneity (Teramura et al., 2019). The critical importance of a mesoscale model of water vapor transport toward the Tibetan Plateau (Zhou et al., 2019) was also discussed in this session. A study on correcting error in rain gauge data arising from various sources, such as wind flow, was also presented.

Session 3, entitled "Subseasonal to Interdecadal Variability of the Asian Monsoon", featured studies that take a wider view. A review of boreal summer intraseasonal variation (BSISO) was presented, and the utility of historical surface observational data for understanding the behavior of tropical cyclones (typhoons) and interannual variability in Indian-Pacific Ocean conditions was demonstrated. Atmospheric chemistry researchers discussed the major potential importance of the Asian monsoon circulation. Data-driven weather pattern recognition was also shown to be useful in the analysis of heavy rainfall events. The highlight of this session was the discussion of the usefulness of atmosphere-ocean models and seasonal ensemble forecasts for making predictions; it was shown that research on the Asian summer monsoon region has benefitted from this. Collaborations with the Working Group on Subseasonal to Interdecadal Prediction (WGSIP), the Subseasonal-to-Seasonal Prediction Project (S2S) and the Climate and Ocean: Variability, Predictability and Change (CLIVAR) monsoon projects were also suggested.

Session 4, "Land Surface Hydrological Modeling: Human Impact on the Cryosphere", focused on the hydrological cycle near and over the Himalayan region. Current issues in hydrological modeling that should be addressed by the AsiaPEX project were discussed. Hydrological processes occurring over diverse land types, relevant to the monitoring of floods in Jakarta, lakes over the Third Pole region, the Brahmaputra Basin and the Nepal Himalaya were discussed. The Himalaya Precipitation Study (HiPRECS), a new hydroclimatological project focusing on the southern slope of the Himalayan range, was introduced. This project aims to analyze precipitation processes in high mountain regions, one of the major areas of interest for AsiaPEX, through in situ observations and subsequent data analysis.

In Session 5, we examined the "Coordinated Observation and Modeling Initiatives" of AsiaPEX. The advances and challenges of the Years of Maritime Continent (YMC) project were discussed, and Indian projects on the impact of land surface

moisture on extreme weather were introduced. Review of the Atmospheric Circulation Reconstructions over the Earth (ACRE) data rescue project suggested many potential areas of study for the AsiaPEX project.

Section 6, "Climate Change Detection and Projections", focused on the impact of climate change on global monsoon and hydrological processes over the western and eastern Tibetan Plateau based on climate model calculations. The impact of climate change on the current and future regional climate was discussed in the context of Northern Japan, metro Manilla, Vietnam, Nepal and India. A climate change adaptation project being conducted in Thailand was comprehensively discussed.

The Alliance of International Science Organizations (ANSO) project was introduced, and several avenues for collaboration with the international research community were suggested.

We organized poster sessions designed especially for young researchers. Many presenters were from Hokkaido University. Sixteen posters were presented and, somewhat surprisingly, there were no cancellations. We thank the presenters for their valuable contribution and appreciate the educational guidance provided by senior researchers. We presented "best poster" awards to encourage the young researchers.

Participants in front of the statue of Dr. Clark on Hitsujigaoka Observation Hill, Sapporo, Japan

In the closing session, attendees discussed the appropriateness of the six major conference topics for guiding future research. This conference emphasized the significant contribution that can be made by younger researchers of the AsiaPEX community, which has a history spanning three to four generations. AsiaPEX has its roots in international collaborations among Asian countries arising from the first Asian GHP, namely the GAME project. Many researchers from Northeast and East Asia, including Southeast and South Asian countries and China, have contributed to AsiaPEX following the MAHASRI project. One of the most important functions of AsiaPEX is to cultivate a network of researchers. As shown in a presentation by Dr. van Oevelen, there are many research frameworks, projects and initiatives that can help realize our goal of greater research cooperation.

History and Ambition

We held a reception in the "Restaurant Elm" of Hokkaido University. The most impressive speeches made at the reception were those of Prof. Yamanaka and Dr. M.L. Shrestha, who are "first-generation" Asian GHP community members. They discussed the long history of collaboration that started with the GAME project. Many Chinese community members spent the early parts of their careers in Japan, as doctoral students or post-doctoral researchers. The reception speeches emphasized that longstanding relationships facilitated current collaborations.

After the closing session, participants enjoyed excursions into Sapporo. First, we visited the Mt. Okura ski-jump facility, which provides good views of the Sapporo Plain and a mountainous environment. At the Hitsujigaoka Observation Hill, some community members took a group photo with a statue of Dr. W.S. Clark, who was the main advisor during the establishment of Sapporo Agricultural College (now Hokkaido University). Dr. Clark is believed to have exclaimed "Boys, be ambitious!" when he left Sapporo. Ambition must remain a byword for AsiaPEX.

This conference was supported by the local organizing committee and by many staff members and students of Hokkaido University. We express our gratitude to all these people. The conference was supported financially by Nagoya University, the Japan Aerospace Exploration Agency (JAXA) and Kagawa University. We also thank the TPE (Third Pole Environment) project for its significant contributions, sending many researchers to the conference. The International Consortium for Earth and Development Sciences (ICEDS) and the Institute of Education, Research and Regional Cooperation for Crisis Management Shikoku (IECMS) at Kagawa University functioned as the secretariat of the organizing committee.

References

Hirose, M., and K. Okada, 2018. A 0.01° Resolving TRMM PR Precipitation Climatology. *J. Appl. Meteor. Climatol.*, 57, 1645-1661, doi:10.1175/JAMC-D-17-0280.1.

Ogino, S.-Y., M.D. Yamanaka, S. Mori, and J. Matsumoto, 2017. Tropical Coastal Dehydrator in Global Atmospheric Water Circulation. *Geophys. Res. Lett.*, 44, 11,636–11,643, doi:10.1002/2017GL075760.

Teramura, H., T. Sato, and K. Tamura, 2019. Observed Evidence of Enhanced Probability of Mesoscale Convective System Initiations due to Land Surface Heterogeneity in Semiarid East Asia. *SOLA*, 15, 143-148, doi:10.2151/sola.2019-026.

Zhou, Z., K. Yang, A. Beljaars, H. Li, Ch. Lin, B. Huang, and Y. Wang, 2019. Dynamical impact of parameterized turbulent orographic form drag on the simulation of winter precipitation over the western Tibetan Plateau. *Clim. Dyn.*, 53, 707-720, doi:10.1007/s00382-019-04628-0.

2019 GEWEX Data and Analysis Panel (GDAP) Meeting

Tucson, AZ, USA
22–24 January 2020

International GEWEX Project Office and GDAP Panel Co-Chairs Rémy Roca and Tristan L'Ecuyer

Hosted by Ali Behrangi, the 2019 GDAP Meeting took place at the University of Arizona in Tucson, Arizona, USA, from 22–24 January 2020. During the meeting, participants shared and reviewed the status of current projects, discussed potential new initiatives and heard about the activities of collaborating partners. We evaluated the progress of GDAP's transition to its new identity, a process that began in 2018 and that forms the basis for GDAP's input to the GEWEX Science and Applications Traceability Matrix (SATM). We welcomed Eui-Seok Chung from the IBS Center for Climate Physics as a new panel member, and thanked Tianjun Zhou as his service as panel member ended after his second four-year term.

GDAP seeks to describe the complete water and energy budgets using consistent, long-term, global data sets of radiative fluxes and surface energy and water exchanges as well as the atmospheric parameters affecting them. With a focus on establishing consistency, GDAP oversees a number of assessments of key parameters related to Earth's energy and water cycles as well as the development of a GEWEX Integrated Product (IP). The IP incorporates several previously-supported energy and water flux data sets into a long-term product on a common grid for energy and water cycle closure studies. Additionally, GDAP sponsors ground-based observing networks that provide high-quality, calibrated observations for evaluating satellite data sets and coordinates the formation of a new international effort to advance the next generation International Satellite Cloud Climatology Project (ISCCP-NG). GDAP's new identity, developed in 2018, concentrates on i) reformulating and restructuring the terms of reference for panel members and projects, ii) increasing focus on and linking to Process Evaluation Studies (PROES), iii) providing a new paradigm for assessments and iv) repositioning GDAP with other bodies like the World Meteorological Organization (WMO)/ Coordination Group for Meteorological Satellites (CGMS), the World Climate Research Programme (WCRP) Data Advisory Council (WDAC), the Task Team for Intercomparison of Reanalyses (TIRA) and the Global Climate Observing System (GCOS).

Assessments

Cloud Assessment

The GEWEX Cloud Assessment (2005–2012; Stubenrauch et al., 2013) provided the first coordinated intercomparison of publicly-available, standard global cloud products (gridded, monthly statistics). Phase II of the assessment, which will end in 2020, saw several teams improve their data sets and new global long-term data sets emerge. In general, the data sets agree well, within the retrieval uncertainties. Differences in average cloud properties are mostly explained by the inherent instrument capability for detecting or identifying or both detecting and identifying optically-thin cirrus. Ancillary data affect low-level cloud amount. Even if instantaneous cloud properties are not very accurate, the synergy of different variables provides invaluable potential for improving our understanding of clouds. This synergy is also important for model evaluation to compare correlations of physical variables or statistics organized by weather states or cloud system. The GEWEX Cloud Assessment database now contains seven updated and four new data sets.

Water Vapor Assessment

The GEWEX Water Vapor Assessment (G-VAP) initiated in 2011 aims to quantify the state-of-the-art in water vapor products being constructed for climate applications. G-VAP supports GDAP's selection process of water vapor products for its generation of globally-consistent water and energy cycle products. The water vapor data records exhibit significantly different trend estimates. These differences are at least partly caused by break points, which typically coincide with changes in the observing system and are a function of region. Already highly successful, this is a work in progress, which will be further consolidated in the near future.

Precipitation Assessment

The Precipitation Assessment is carried out jointly between GDAP and the International Precipitation Working Group (IPWG). The joint assessment considers a large ensemble of observational sources for precipitation. It aims to evaluate the performance of these new products across multiple topics and a set of various metrics ranging from the extreme to climate model evaluations. The assessment benefited from the momentum of the earlier start from the GDAP precipitation effort and organizers now anticipate a release in late 2020 (postponed by a few months, owing to the COVID-19 pandemic). Consistent with the GDAP approach to assessments, a multi-product database was built and released as part of the assessment. More information on the Frequent Observations of Rain on GridS (FROGS) can be found at http://frogs.ipsl.fr.

Earth's Energy Imbalance Assessment

Following the Earth's Energy Imbalance (EEI) meeting in Toulouse, France, in 2018, the idea came about to run a new integrated assessment on EEI. EEI is defined as the global annual mean of top-of-atmosphere net irradiance. More than 90% of EEI heats oceans. The goals of the EEI assessment are to:

- provide quantitative assessments of EEI uncertainty associated with different methods;
- use this assessment to produce our most definitive estimate of EEI, its annual to decadal variability and the trend in EEI;
- quantify the contributions from the different components of the Earth system to EEI, including from the cryo-

sphere, atmosphere, land storage and ocean heat content changes; and

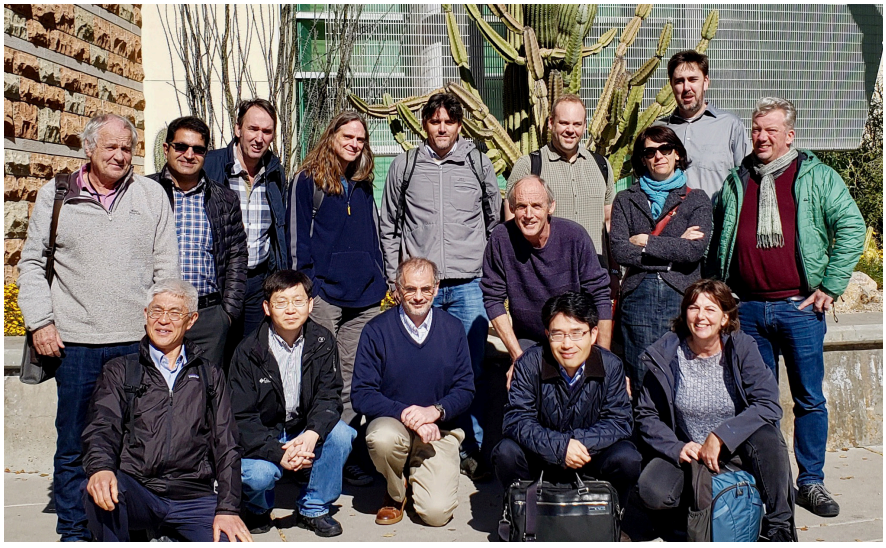
- compare current with historical EEI.

Soil Moisture Assessment Tools

New tools have been introduced for independent and transparent assessment of satellite soil moisture products. The Quality Assurance for Soil Moisture (QA4SM) online validation platform provides the user with an interface for comparing satellite soil moisture data against land surface models and the International Soil Moisture Network.

Integrated Product

The Integrated Product (IP) Working Group seeks to integrate the various water and energy cycle products as consistently as possible and focuses on physical consistency among the products. The first version of IP was released in 2019 and can be found at *ftp://rain.atmos.colostate.edu/ftp/pub/pbrown/GEWE_X_IP_2019/*. Results were published in *GEWEX Quarterly* (Kummerow et al., 2019) and a journal article is being prepared. The objective of the IP Workshop scheduled for March 2021 is to broaden the community, discuss the utility of the product and get feedback on how to proceed.



Participants of the 2019 GDAP Meeting

Networks

BSRN

The Baseline Surface Radiation Network (BSRN) aims at detecting important changes in the Earth's radiation field at the Earth's surface that may be related to climate change. It provides observations of the best possible quality for short- and long-wave surface radiation fluxes with a high sampling rate, implementing instrument calibration traceability and up-to-date quality controls.

In 2019, 69 stations submitted Logical Records (LR)0100 data. Five of these stations were accepted as candidates during the 2018 BSRN Workshop and are now flagged as operational sites. Indonesia, Cyprus, Romania, China, Korea-Italy (Ross Sea, Terra Nova Bay, Antarctic) and Argentina-Italy have expressed interest in joining BSRN. The imbalance between the number of northern (approximately 71%) and southern (approximately 29%) stations persists. At the GCOS Joint Panel Meeting in March 2019, BSRN representatives and Ocean Observations Panel for Physics and Climate (OOPC) members established contact to coordinate best practices. A splinter meeting to enhance the interaction between the land and ocean radiation communities was planned for the European Geosciences Union 2020 (EGU 2020) conference. Most of the station scientists participated in the poll on common practices of operational BSRN sites. The suggestion to appoint a BSRN co-chair will be discussed at the next BSRN meeting.

Sadly, 2019 was marked by the passing of Chuck Long, the former Project Manager of BSRN from 2014–2018. His contributions to BSRN activities, radiation measurement and the exploitation of surface-based data to determine cloud radiative effects on shortwave and longwave radiation are invaluable. Chuck will be remembered as an inspiring scientist, mentor and friend to many.

GPCC

Since 1989, the Global Precipitation Climatology Centre (GPCC) has provided global precipitation analyses based on in situ rain gauge measurements for monitoring and researching Earth's climate. GPCC is archiving the data from different sources separately in source-specific slots in its relational database management system (RDBMS) to enable intercomparison of data from the different sources.

In 2019, GPCC increased the database with regard to the number of quality-controlled stations to more than 121,500 stations through the integration of large data sets from Australia, Canada and Brazil among other methods. The quasi-operational monthly Monitoring Product and First Guess Products (daily and monthly) have been updated regularly. The next release of the GPCC precipitation data product portfolio of daily and monthly full data analyses was scheduled for March 2020. Furthermore, GPCC contributed to the most recent WMO annual and 5-year statements on the status of the global climate, and the *Bulletin of the American Meteorological Society*'s "State of the Climate".

ISMN

The International Soil Moisture Network (ISMN) is an international cooperative effort to establish and maintain a global in situ soil moisture database. This database is an essential means for validating and improving global satellite products, and land surface, climate and hydrological models. It currently includes 60 networks with over 2500 measurement stations.

Assessment of citizen science sensors are to be included. It is funded by the European Space Agency Quality Assurance for Earth Observations program (2019–2022). At this time, ISMN is not linked to the U.S. Soil Moisture Network. Efforts to reconnect are suggested.

ISCCP-NG

The Earth observing capabilities from geostationary orbit have advanced substantially over recent years. The ISCCP-NG effort will: i) maintain continuity of the original ISCCP, ii) develop a new global radiance data set that exploits the increased spatial and temporal resolution, spectral diversity and improved calibration afforded by advanced geostationary imagers, and iii) develop more advanced cloud products and support new research and application. The first ISCCP-NG workshop was held at the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) headquarters in Germany in 2019. There was consensus among participants to move forward with this project and to start by defining the scope of ISCCP-NG. The current ISCCP processing will be maintained in parallel to ISCCP-NG. Synergy with the aerosol climate data processing should be explored. To engage the space agencies, and to develop terms of reference for ISCCP-NG and its relationships to other international bodies, a report was planned for presentation at the Coordination Group for Meteorological Satellites 48 (CGMS 48) in August 2020.

Other Activities

Several groups reported on achievements, developments and future plans during the 2019 GDAP Meeting. These included updates from the Atmospheric Radiation Measurement (ARM) User Facility of the Pacific Northwest National Laboratory (PNNL), the "Evaluation of modeled precipitation in oceanic extratropical cyclones using satellite observations" project, the International Clouds Working Group (ICWG), the Global Precipitation Climatology Project (GPCP), TIRA and a study of warm rain process through newly-retrieved marine boundary layer (MBL) cloud and drizzle microphysical properties.

The next GDAP meeting will be held virtually due to the COVID-19 pandemic and will be shortened to accommodate time zone constraints.

References

Kummerow, C., P. Brown, R. Adler, S. Kinne, W. Rossow, P. Stackhouse, C.A. Clayson, M. McCabe, D. Miralles, and C. Jimenez, 2019. The GDAP Integrated Product. *GEWEX Quarterly*, Vol. 29 No. 3, Quarter 3, 3–6. https://www.gewex.org/gewex-content/files_mf/1568309644Aug2019.pdf.

Stubenrauch, C.J., W.B. Rossow, S. Kinne, S. Ackerman, G. Cesana, H. Chepfer, L. Di Girolamo, B. Getzewich, A. Guignard, A. Heidinger, B.C. Maddux, W.P. Menzel, P. Minnis, C. Pearl, S. Platnick, C. Poulsen, J. Riedi, S. Sun-Mack, A. Walther, D. Winker, S. Zeng, and G. Zhao, 2013. Assessment of Global Cloud Datasets from Satellites: Project and Database Initiated by the GEWEX Radiation Panel. *Bull. Amer. Meteor. Soc.*, 94 (7): 1031–1049. https://doi.org/10.1175/BAMS-D-12-00117.1.

32nd Meeting of the GEWEX Scientific Steering Group

27–31 January 2020
Pasadena, CA, USA

Peter van Oevelen[1], Jan Polcher[2] and Graeme Stephens[2]
[1]Director, International GEWEX Project Office; [2]Co-Chair, GEWEX Scientific Steering Group

The 32nd Meeting of the GEWEX Scientific Steering Group (SSG-32) was hosted by the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) at the Cahill Center for Astronomy and Astrophysics in Pasadena, California from 27–31 January 2020. In addition to GEWEX Scientific Steering Group (SSG) members and GEWEX Panel Co-Chairs, delegates from collaborating organizations attended the meeting, including representatives from the U.S. Department of Energy (DOE); the European Space Agency (ESA); the Japan Aerospace Exploration Agency (JAXA); NASA; the National Oceanic and Atmospheric Administration (NOAA); the U.S. Global Change Research Program (USGCRP); the United Nations Educational, Scientific and Cultural Organization (UNESCO); the World Climate Research Programme (WCRP); WCRP's core programs and working groups and other partners of GEWEX.

SSG-32 reviewed the major results, goals and plans of GEWEX and its four Panels for the 2019 calendar year. Activities ranged from installing new Panel members and initiating new projects to fostering current projects, developing and marketing products and organizing meetings and workshops. An important aspect of this meeting in anticipation of Phase IV of GEWEX (2023–2032) is the "Science and Applications Traceability Matrix" (SATM), which is being drafted with the input of all SSG and Panel members. The GEWEX SATM will provide traceability from WCRP strategies to core science, defined metrics, applications and programs. It will serve as the backbone of, and provide direction to, the revision of the GEWEX strategic plan and science questions for the coming years.

Each Panel presented its annual overall report, which is based on the annual reports of the individual working groups and coordinated by the Panel. More information on all the activities and these reports can be found at www.gewex.org.

The Global Atmospheric System Studies (GASS) Panel is doing well after its restructuring, and added two new members in 2019, a representative of the WCRP Grand Challenge on Clouds, Circulation and Climate and an Early Career Scientist. GASS has four active projects that are entering their productive stage: Constraining Orographic Drag Effects (COORDE); Demistify: a Large Eddy Simulation (LES) and numerical weather prediction (NWP) fog modeling intercomparison; Impact of Initialized Land Temperature and Snowpack on Sub-Seasonal to Seasonal Prediction (LS4P) and Improving the Simulation of Diurnal and Sub-Diurnal Precipitation over Different Climate Regimes. The GEWEX Atmospheric Boundary Layer Study 4 (GABLS-4) is the fifth active GASS project. It is in its final stage and the project is discussing follow-up activities. In addition to

the previous five projects, GASS also presented on two affiliate projects, the GEWEX Upper Tropospheric Clouds and Convection Process Evaluation Study (UTCC PROES) and The GEWEX Aerosol Precipitation process study (GAP).

The GEWEX Data and Analysis Panel (GDAP) is following through on recommendations from a 2018 discussion on the identity of GDAP, transitioning away from its concentration on data to a more process- and science-oriented focus. The Panel's format has changed after reevaluation and consolidation of some projects. GDAP's science activities are now process-oriented and concentrate on: i) the Earth's Energy Imbalance (EEI) and climate sensitivity, ii) cloud dynamics and feedbacks, iii) global land-atmosphere interactions, iv) global energy and water cycle variability and v) precipitation extremes. Some of the wide range of GDAP's undertakings are older than GEWEX itself, such as the International Satellite Cloud Climatology Project (ISCCP). The new Next Generation ISCCP (ISCCP-NG) project is based on the recently-enhanced observational capability of the geostationary meteorological satellite ring. GDAP also continues to play an important role in supporting various observational networks and centers such as the World Radiation Monitoring Center-Baseline Surface Radiation Network (WRMC-BSRN), the International Soil Moisture Network (ISMN) and the Global Precipitation Climatology Centre (GPCC).

Participants of the 32nd Session of the GEWEX SSG

The GEWEX Hydroclimatology Panel (GHP) has strengthened its Panel membership with six new members, increasing gender and geographic diversity. There are four types of projects within GHP: Regional Hydroclimate Projects (RHPs), Cross-Cut Projects (CCs), Global Data Centers (GDC) and GHP Networks. Currently there are four active, three prospective and four envisioned RHPs. It is clear that the regional activities within GHP are truly flourishing. The RHP Networks are a new activity that foster regional networks of researchers, either as an independent undertaking or as a way to maintain the connections cultivated by an RHP that has ended. The Cross-Cut projects are seen as a topical connection between the various RHPs and other GHP activities. Three CCs are coming to a close in 2020: the International Network for Alpine Catchment Hydrology (INARCH), the INTElligent use of climate models for adaptation to non-Stationary hydrological Extremes (INTENSE), and Near 0oC Precipitation. Two new CCs are ramping up: The mulTi-scale transport and Exchange processes in the Atmosphere over Mountains–programme and eXperiment (TEAMx) and the activity on Determining EvapoTranspiration (ET). There are three Global Data Centers linked to GHP that collect and distribute important hydrology-related data: the Global Runoff Data Center (GRDC; https://www.bafg.de/GRDC/EN/Home/homepage_node.html), the International Data Centre on Hydrology of Lakes and Reservoirs (HYDROLARE, http://hydrolare.net/) and the Global Precipitation Climatology Center (GPCC; https://www.dwd.de/EN/ourservices/gpcc/gpcc.html). The latter also reports to GDAP.

The Global Land/Atmosphere System Study (GLASS) Panel has eight active and one forthcoming project, while one activity is still on hold. GLASS supported successful field campaigns with increased instrumentation focused on the Planetary Boundary Layer (PBL) and continues to promote the importance and the development of improved observations of the land-atmosphere system, particularly in the PBL. In this context, GLASS proposed supporting the development and operation of multiple GEWEX/GLASS Land-Atmosphere Feedback Observatories (GLAFOs). These observatories should record long-term, high-frequency observations of soils, vegetation, surface fluxes and the planetary boundary layer. Benchmarking of models (e.g., https://modelevaluation.org/) and the Model Intercomparison Projects (MIP) continue to be two of the other important pillars of GLASS.

In addition to evaluating the reports from the Panels, the attendees discussed the reorganization of the World Climate Research Programme (WCRP) and the World Meteorological Organization (WMO) and consequences for and the role therein of GEWEX. That process is still ongoing, but one thing that is clear is that the current WCRP Grand Challenges will end by 2022. By that time, the activities will either be incorporated into other parts of WCRP or will disappear. The presentations of both WCRP and WMO focused on the transition they are going through and gave insight into their new Strategic Plans and ideas for implementation. The presentations from GEWEX's sister projects [the Climate and Ocean–Variability, Predictability, and Change (CLIVAR) project, the Climate and Cryosphere (CliC) project, the Stratosphere-troposphere Processes And their Role in Climate (SPARC) project and the Coordinated Regional Climate Downscaling Experiment (CORDEX)] showed their recent achievements and plans for the near future. Special attention was paid to plans regarding the CLIVAR/GEWEX Monsoon Panel that will broaden its scope and create stronger links with entities such as the World Weather Research Programme (WWRP).

Interactions with and reports from other GEWEX sponsors and partners focused on recent achievements and future plans and showed many areas of interest where joint efforts with GEWEX might be initiated or intensified. The need and desire for a re-strengthening of the collaboration between GEWEX and the various space agencies (NASA, ESA, JAXA, NOAA) was clearly shown in the various presentations.

This year's first scientific talk concerned the influence of the human aspect on the water cycle and how big data can support smart infrastructure decision. The second scientific talk dealt with the Earth Explorer mission for water cycle science, G-Class Hydroterra. Both presentations were very well received as they each showed new exciting possibilities for GEWEX to continue its role in supporting the international climate science community.

The Sixth Aerosols-Clouds-Precipitation-and-Climate (ACPC) Workshop: The First Virtual Meeting

23–24 April 2020

Minghuai Wang[1], Daniel Rosenfeld[2], Michael P. Jensen[3], Jiwen Fan[4], Scott Collis[5], Matthew Christensen[6], Andrew Gettelman[7], Philip Stier[6], Meinrat O. Andreae[8,9], Graham Feingold[10], Sue van den Heever[11], Ralph Kahn[12], Johannes Quaas[13], Kentaroh Suzuki[14] and Rob Wood[15]

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The Aerosols-Clouds-Precipitation-and-Climate (ACPC; http://www.acpcinitiative.org) initiative organized its first virtual meeting from 23–24 April 2020 to discuss progress towards understanding the role of aerosol perturbations on clouds and precipitation. This was the sixth ACPC annual meeting since the first annual meeting held in New York in 2015. The event was originally planned to take place in Houston, Texas, USA, but due to the COVID-19 pandemic, the format was changed to a virtual meeting. In recent years, ACPC has focused on two cloud regimes, shallow marine clouds and deep convective clouds. This year's meeting focused on research advancements on aerosol influences on both cloud types, and updated roadmaps for research within the shallow and deep clouds working groups.

The new "natural laboratories" approach (see the report in *GEWEX News*, Quaas et al., 2019) for the detection and attribution of aerosol effects on clouds has seen remarkable first results. These natural laboratories aim at the analysis and modeling of cloud responses to distinct aerosol perturbations that occur naturally, such as volcanic eruption, or are inadvertently caused by human activities, such as ship emissions, emission reduction from the COVID-19 pandemic or long-term emission control measures. Lagrangian approaches were shown to be valuable for examining cloud response to aerosol perturbation from ship and volcanic emissions in both satellite observation and models (Christensen et al., 2020). Shipping corridors were found to be useful for identifying the regional-scale impact of aerosol perturbation on clouds (Diamond et al., 2020), and the effects of aerosol perturbation can be dependent on background droplet number concentration. The long-term declining trend in aerosol loading over major industrial regions together with the synergetic observations of cloud and radiative properties was shown to be another way to study cloud and radiative response to aerosol perturbation, and to further evaluate and constrain climate models (Bai et al., 2020). Spatial and temporal scales involved in these natural laboratories can be an important consideration in studying different aspects of cloud response to aerosol perturbation (Toll et al., 2019). The potential large-scale impact of shipping emissions and reduction in shipping emissions on cloud and radiative fluxes due to recent shipping fuel regulations were examined based on climate model results. A special session was dedicated to preliminary results of the potential impact of the emission reduction from the COVID-19 pandemic. It was recognized that, while pollution emission reduction was evident in many parts of the world, the effects on clouds and radiative forcing requires additional research, and isolating the meteorological impact could be critical to examining the effects on clouds and radiation for this relatively short-term perturbation due to the pandemic. The shallow cloud group planned to synthesize and review work on natural laboratories for aerosol-cloud interactions, including comparison of different natural laboratories, different cloud regimes and on different types of cloud perturbation and radiative fluxes, etc.

Another theme of the shallow cloud group is to examine aerosol-cloud interactions using satellite-retrieved cloud condensation nuclei (CCN) (Rosenfeld et al., 2019). This is further used for a process-level understanding of aerosol-cloud interactions in climate models. For two cloud microphysics schemes examined in the regional climate model Weather Research and Forecasting-Chemistry (WRF-Chem), it was found that the conversion rate of cloud water to rain is overestimated at lower cloud droplet effective radius. This conversion is found to be less sensitive to cloud droplet number concentration in models than in satellite and aircraft observations.

For deep clouds, ACPC efforts are divided between simulations and observations of aerosols and clouds near the Houston area. The workshop reported the recent progress in both aspects and discussed the roadmap for deep cloud group activities. The deep cloud group focused on an extensive model intercomparison of convective clouds over Houston with different models and microphysical schemes. It showed similarities in the sign of the aerosol effects on rainfall accumulation, cloud water mass, low-level vertical velocity and anvil characteristics. However, despite large aerosol effects indicated in most of the models, the differences among models were much larger than the differences between runs with "clean" and "polluted" aerosol conditions within a given scheme (van den Heever et al., 2020; Marinescu et al., 2020). A more constrained comparison between a two-moment bulk and a bin scheme using the same WRF-Chem model showed the saturation adjustment approach used for parameterizing droplet diffusional growth in the bulk scheme is mainly responsible for the much smaller aerosol effects compared with the bin scheme (Zhang et al., 2020). Those model studies suggest that much additional work is needed to improve the underlying physics representation before a satisfactory model for quan-

***Fig. 1**. The planned TRACER campaign slated to take place in the Houston area during summer 2021. A deployment of the Atmospheric System Research (ASR) Mobile Facility, radars and research aircraft will allow the study of aerosol and urban effects on deep tropical convective clouds with the marine Golf air mass as a background.*

tification of aerosol-convection interactions is available. This situation underlines the importance of observational studies that would constrain the simulations. Analysis of radar cell tracking over the Houston region indicates an increase in observed radar echo top height and lightning flash count with increasing cloud condensation nuclei. Such studies need to be done in ways that would isolate more clearly the aerosol from meteorological and urban effects on the clouds. This will be hopefully achieved by the upcoming Tracking Aerosol Convection Interaction Experiment (TRACER), supported by the Department of Energy Atmospheric Radiation Measurements (DOE ARM; https://www.arm.gov/research/campaigns/amf2021tracer), which was conceived based on the ACPC activities. The field campaign will provide ample data to evaluate model performances and understand convective cell properties and their interactions with associated environmental conditions, including aerosols. A deployment of the ARM Mobile Facility is planned in Houston for 15 April 2021 to 15 April 2022, with an intensive observational period during June–September (Fig. 1). TRACER will include multiple radars and aerosol measurements in the polluted urban and clean background air masses. Participation of research aircraft and mobile surface measuring platforms is also planned.

In addition, the workshop included talks with a focus on planetary boundary layer (PBL) properties and how aerosols and urban land from Houston can influence them and then impact convective cloud activities (e.g., Fan et al., 2020). We had a dedicated session for the proposals considered or being considered to support or complement TRACER from various aspects such as aerosols, PBL, clouds and precipitation.

While it is unfortunate that this year's ACPC meeting was held virtually due to the COVID-19 pandemic, the virtual meeting provided great opportunities for ACPC to reach a broader audience. More than 200 participants registered for the virtual

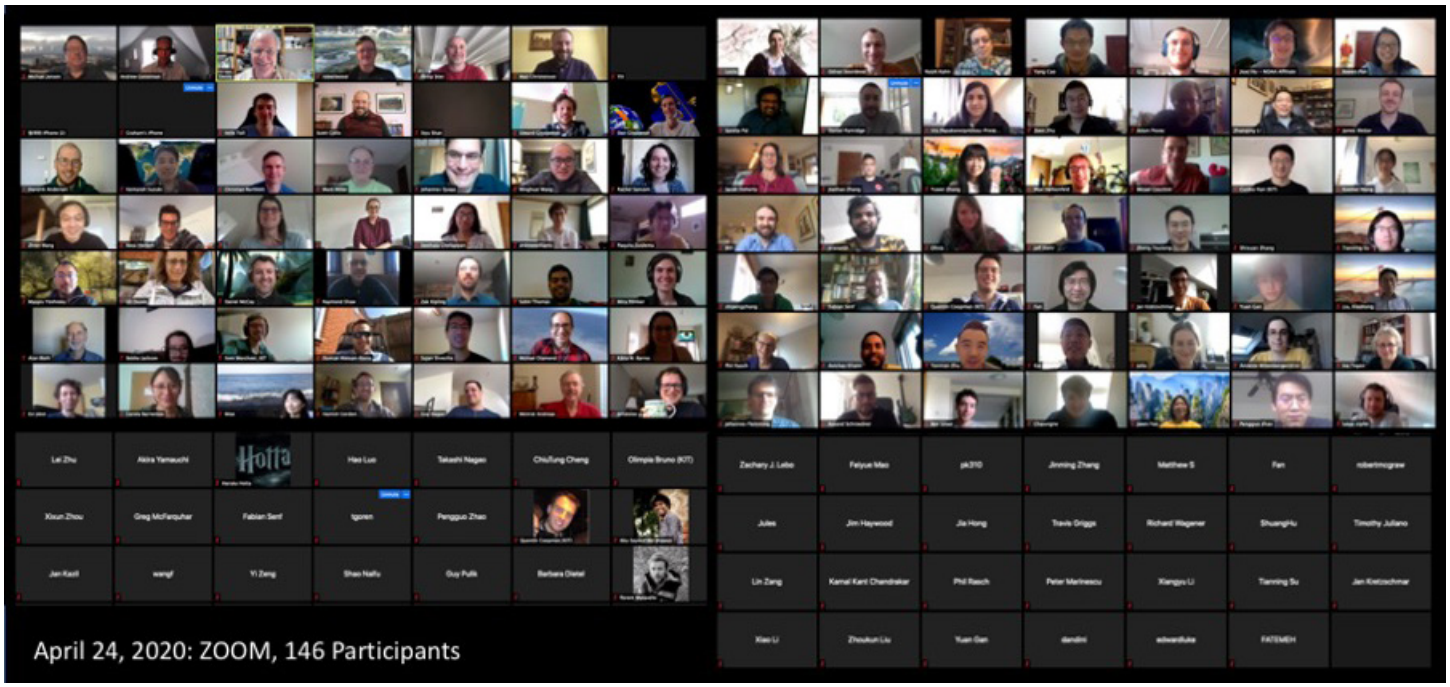

***Fig. 2**. Attendees of the ACPC workshop*

meeting from around the world, compared with around 60 participants for a physically-attended meeting. While opportunities for informal and external meetings typical of in-person events were not possible, the chat feature allowed participants to post comments and questions anytime they wanted, which helped to facilitate discussion and interactions among participates. Given that the virtual meeting was a great success and allowed more people to participate, ACPC has decided to include a virtual component for future meetings. ACPC has also decided to draft a set of bylaws to govern the rotation of its leadership, including co-chairs and members of its scientific steering committee (SSC). ACPC will release a call for nominations and self-nominations of new SSC members this fall. The next ACPC meeting is planned for April 2021.

References

Bai, H., M. Wang, Z. Zhang, and Y. Liu, 2020. Synergetic Satellite Trend Analysis of Aerosol and Warm Cloud Properties ver Ocean and Its Implication for Aerosol-Cloud Interactions. *J. Geophys. Res-Atmos.*, 125(6). doi:10.1029/2019jd031598.

Christensen, M.W., W.K. Jones and P. Stier, 2020. Aerosols enhance cloud lifetime and brightness along the stratus-to-cumulus transition. *P. Natl. Acad. Sci. USA*, 117 (30) 17591-17598; DOI:10.1073/pnas.1921231117.

Diamond, M.S., H.M. Director, R. Eastman, A. Possner and R. Wood, 2020. Substantial Cloud Brightening from Shipping in Subtropical Low Clouds. *AGU Advances*, 1, e2019AV000111. https://doi.org/10.1029/2019AV000111.

Fan, J., Y. Zhang, Z. Li, J. Hu and D. Rosenfeld, 2020. Urbanization-induced land and aerosol impacts on sea breeze circulation and convective precipitation. *Atmos. Chem. Phys. Discuss.*, https://doi.org/10.5194/acp-2020-411, in review.

Marinescu, P.J., S.C. van den Heever, M. Heikenfeld, A.I. Barrett, C. Barthlott, C. Hoose, J. Fan, A.M. Fridlind, T. Matsui, A.K. Miltenberger, P. Stier, B. Vie, B.A. White, Y. Zhang, 2020. Impacts of Varying Concentrations of Cloud Condensation Nuclei On Deep Convective Cloud Updrafts – A Multimodel Assessment. *J. Atmos. Sci.*, in review.

Quaas, J., M. Wang, D. Rosenfeld, M. Andreae, M. Christensen, M.P. tResearch Roadmaps for ACPC Initiative: Volcanic and Ship Aerosol Laboratories and TRACER Observations. *GEWEX News*, 29 (3), 14–15.

Rosenfeld, D., Y. Zhu, M. Wang, Y. Zheng, T. Goren and S. Yu, 2019. Aerosol-driven droplet concentrations dominate coverage and water of oceanic low-level clouds. *Science*, 363, doi:10.1126/science.aav0566.

van den Heever, S.C., P.J. Marinescu, M. Heikenfeld, B. White, P. Stier, M. Andreae, A. Barrett, C. Barthlott, J. Fan, A. Fridlind, C. Hoose, T. Matsui, A. Miltenberger, J. Quaas, D. Rosenfeld, J. Shpund, B. Vie and Y. Zhang, 2020. A multimodel assessment of aerosol impacts on deep convective clouds systems. In preparation.

Toll, V., M. Christensen, J. Quaas, and N. Bellouin, 2019. Weak average liquid-cloud-water response to anthropogenic aerosols. *Nature*, 572, 51–55.

Zhang, Y., J. Fan, Z. Li and D. Rosenfeld, 2020. Impacts of Cloud Microphysics Parameterizations on Simulated Aerosol–Cloud-Interactions for Deep Convective Clouds over Houston. *Atmos. Chem. Phys. Discuss.*, https://doi.org/10.5194/acp-2020-372, in review, 2020.

In Memoriam: Dr. Kenneth Mooney

Dr. Kenneth Mooney, a force in organizing and coordinating climate science research, passed away on 17 August 2020. Spending much of his career in the U.S. federal government, he worked in the National Oceanic and Atmospheric Administration (NOAA) Climate Program Office (CPO), where he received awards for his program and project management skills. He led and supported numerous field campaigns that tackled some of the big challenges in atmospheric, oceanic and climate system sciences. Dr. Mooney's many notable contributions as a scientist and program manager include helming the Tropical Ocean and Global Atmosphere (TOGA) project, a WCRP program that laid the physical basis for predicting El Niño temperature signals and associated changes in global climate. TOGA exemplified his passion for taking on large-scale endeavors that answered complicated questions. Over a thousand scientists from countries around the world contributed, and some of them are part of the GEWEX community today. Ken, a steadfast supporter of GEWEX, was also involved in the GEWEX Continental Scale International Project (GCIP) and the GEWEX Americas Prediction Project (GAPP).

Global-scale issues require global cooperation, and Dr. Mooney was an advocate for interagency and interdisciplinary cooperation. His collaborative approach emphasized the importance of advancing climate research, and he was known as a staunch advocate of science who focused on its contribution to society.

Dr. Mooney's enthusiasm for engaging with complicated science made him an invaluable contributor to GEWEX and countless other programs. He will be missed for his generosity and wry sense of humor. Many counted him as an ally and mentor early in their careers, as his clear-eyed judgement and supportive nature helped them find their professional footing. Dr. Mooney was an institution, a pillar of federal science program management, and he will be warmly remembered by his friends and colleagues.

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