The University of Arizona

Department of
Hydrology & Atmospheric Sciences
Presents

El Día del Agua y la Atmósfera

March 25, 2019
Student Union Grand Ballroom

"Lightning in the Clouds"
Captured on I-10, in Tucson, Arizona
By Yiyi Huang

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Message from HASSA

On behalf of the Hydrology and Atmospheric Sciences Student Association (HASSA) at the University of Arizona, we welcome you to our Annual Student Research Symposium, El Día del Agua y la Atmósfera, 2019. This joint symposium is the result of merging two events - El Día del Agua, established by the Department of Hydrology & Water Resources Student Association in 1990, and Atmospheric and Interdisciplinary Research (AIR), established by the graduate students from the Department of Atmospheric Sciences in 1999.

El Día del Agua y la Atmósfera is one of five symposia held during Earth Week 2019. El Día is managed and organized by students from the Department of Hydrology and Atmospheric Sciences. This event is the perfect opportunity for us to present our work. It provides all students the opportunity to meet and network with their peers, prospective students, faculty members, alumni, and working professionals in the fields of hydrology, atmospheric sciences, and other disciplines.

The success of El Día is made possible through the continued support of our sponsors, the efforts of students, faculty and staff members, the School of Earth and Environmental Sciences, and the University of Arizona College of Science.

Enjoy the symposium and thank you for attending El Día del Agua y la Atmósfera, 2019!

HASSA Officers

HASSA Officers

Back Row, Left to Right
Dr. Ty Ferré, Faculty Advisor
Patrick Bunn, Treasurer
Karl Pereira, Social Chair

Middle Row, Left to Right
Brianna Rupkalvis, Outreach Coordinator
Charlie Devine—Outreach Coordinator
Tiffani Cáñez, Secretary
Rebecca Stolar, Event Coordinator
Chandler Noyes, Co-Vice President

Front Row, Left to Right:
Sheila Solis-Arroyo, Undergraduate Representative
Neha Gupta, President
Adriana Arcelay - Social Media Chair

Not Pictured
Ted McHardy, Co-Vice President

El Día del Agua y la Atmósfera 2019 Schedule

8:00 Conference Registration, Breakfast and Opening

8:00: Registration and Breakfast

8:40: Opening and Welcome: Eric Betterton, Department Head, Hydrology & Atmospheric Sciences

8:50: HASSA President: Neha Gupta

9:00 Keynote Speaker: Kenneth Graham

10:00 Poster Session 1: Poster Session and Refreshments

11:00 Oral Session 1: Moderator: Garrett Rapp

11:00 Antônio Meira: Geophysical imaging of water ages within an experimental hillslope

11:15 Madelyn Powell: Synoptic Analysis of the epic rainstorm in Kauai on 14-16 April, 2018

11:30 Rebecca Stolar: Populus fremontii tree ring analysis and semi-arid river water source variability over time, San Pedro River, Arizona

11:45 Jorge Arevalo: Snowpack treatment in the CPC leaky bucket model

12:00 Luncheon: Buffet Lunch in the South Ballroom

12:20-1:00 Luncheon Speaker: David Jewett

1:00 Oral Session 2: Moderator: Jack Reeves-Eyre

1:00 Melissa Clutter: Robust design of field measurements for evapotranspiration barriers using universal multiple linear regression

1:15 Mostafa Javadian: Comparison of METRIC algorithm with WaPOR product for ET (Case Study: Urmia Lake basin)

El Día del Agua y la Atmósfera 2019 Schedule (continued)

1:00 Oral Session 2: Continued

1:30 Alissa White: Water routing through the critical zone: A hydrometric, hydrochemical, and isotopic investigation in northern NM

1:45 Jeremy Sousa: Assessing Time Step Sensitivity in the Department of Energy's Climate Model E3SM

2:00 **Poster Session 2:** Poster Session & Refreshments

3:00 **Oral Session 3:** Moderator: Tiffani Cáñez

3:00 Samantha Swartz: Infiltration rates of green infrastructure curb-cut basins: finding a balance between functionality and aesthetics

3:15 Timonthy Lahmers: Effects of horizontal redistribution of surface fluxes for a coupled atmospheric and hydrologic model

3:30 Sidian Chen: Pore-scale modeling of two-phase flow and multicomponent transport with phase change behaviors in nanoporous media

3:45 Li-Ling Chang: "Dry getting drier over land" the perspective provided by GRACE

4:00 Coffee Break

4:15 **Lightning Talks:** Moderator: Chandler Noyes

5:00 **Presentation of Awards**

Montgomery Prize—Mekha Pereira
Hargis Awards—Leo Leonhart
HAS Best Oral and Best Poster Presentation— Thomas Meixner
Donald R. Davis Undergraduate with Distinction—Neha Gupta
Eugene S. Simpson Best Undergraduate Poster—Neha Gupta

5:30 **El Día Reception:** No Anchovies, 870 East University Boulevard from 5:30 to 8:00 pm, for all El Día attendees, students, faculty and visitors. Pizza and refreshments are provided.

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The University of Arizona Green Fund

Awards, Prizes & Evaluation Committees

Students are recognized for their superior achievement in oral and poster presentations by juried committees. We are most grateful to the judges for volunteering their time and expertise in selecting award winners. Their energy, enthusiasm, and constructive feedback inspire us all to achieve our personal best.

Montgomery Prize

Best Oral Presentation ~ Certificate and Award of $2,000
Judges: Mekha Pereira, Martha Whitaker, Chris Magirl

Hargis Awards

Best Technical Presentation via Visual Communication
First Place Poster, Certificate and Award of $1,000
Second Place Poster, Certificate and Award of $400
Judges: Dennis Scheall, Tim Corley, Jim Davis

HAS Awards of Excellence

Best Oral and Poster
(excluding Montgomery and Hargis winners)
Certificate and Award of $400 for each award
Oral Judges: Dick Thompson, Laura Condon, Dale Ward
Poster Judges: Tom Galarneau, Katie Markovich, David Dziubanski

Donald R. Davis Undergraduate Distinction Award

Outstanding Undergraduate Award (Academic or Research)
Certificate and Award of $400
Judges: Antônio Meira, Josh Welty, Melissa Clutter

Eugene S. Simpson Undergraduate Poster Award

Best Undergraduate Poster in Hydrogeology, Subsurface Hydrology, or Groundwater
Certificate and Award of $400
Judges: Antônio Meira, Josh Welty, Melissa Clutter

The Montgomery Prize

We would like to thank Errol L. Montgomery & Associates, Inc., a

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for their support. For many years, Montgomery & Associates has sponsored the premier cash award, *The Montgomery Prize*, for the Best Oral Presentation at our annual student research symposium.

This "best of the best" prize is made in addition to the departmental Awards of Excellence for best oral and best paper presentations and is presented to the winner by a representative from Montgomery & Associates. The award symbolizes the company's commitment to encouraging and rewarding excellence in oral presentation of hydrologic research. Montgomery & Associates offers similar awards during annual events at the University of Arizona and Northern Arizona University Geology Departments.

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Errol L. Montgomery & Associates, Inc., founded by HWRS Alumnus Errol L. Montgomery, is a water resource consulting group with more than 25 years of experience addressing groundwater availability, sustainability, and quality issues for municipal, industrial, mining, and governmental clients. Professional services include:

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The firm's principal office is located in Tucson, Arizona, and branch offices are maintained in Scottsdale, Arizona, Lima, Perú, and in Santiago de Chile.

The Hargis Awards

We would like to thank Hargis+Associates, Inc., a

LEGACY SPONSOR

For many years, Hargis + Associates has sponsored two generous cash awards, The Hargis Awards, for the First and Second Place Best Poster Presentations at our annual student research symposium.

The Hargis Awards are made in recognition of the need for excellence in technical communication and serve as an incentive for participating students to demonstrate excellence in writing, visual presentation, and oral communication skills in support of their research projects. Evaluation of these awards is performed by a panel selected by HWR alumnus Dr. David Hargis, President and CEO. Fellow UA alumnus Dr. Leo Leonhart, Principal Hydrogeologist and Chief Technical Director, annually presents these awards.

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HYDROGEOLOGY • ENGINEERING
40th Anniversary
1979 - 2019

Hargis + Associates is an environmental consulting firm specializing in hydrogeology and engineering. Headquartered in San Diego, the company has offices in Sacramento, California and Tucson and Mesa, Arizona. At Hargis + Associates, our mission is to provide proactive: Expert advice and solutions to our clients with integrity and outstanding service. We deliver this mission with an unparalleled level of quality and service, inspired by collaboration and employee-ownership. For 40 years, the outcome has been practical and workable solutions, resulting in long-term client relationships. Learn more about us at www.Hargis.com.

Donald R. Davis
Undergraduate Distinction Award

Donald R. Davis joined the UA Department of Hydrology and Water Resources in 1972 and was one of the most senior members of the faculty at the time of his death in February 2009. His primary research focus was decision making under hydrologic and other uncertainties, and his basic approach utilized Bayesian decision theory in a general system setting.

During the last decade of his life, even though the halcyon days of funded research were behind him, Don was still actively engaged in independent statistical studies with individuals both inside and outside the university. He continued to serve on MS and PHD exams and to advise masters and especially doctoral students who were majoring or minoring in Hydrology with the statistical aspects of their research projects. He was an active faculty examiner for the doctoral qualifying examinations in surface hydrology and water resources.

Don served as the Undergraduate Coordinator and was the primary advisor to undergraduates with a major or minor in Environmental Hydrology and Water Resources. He taught the year-long Senior Capstone and Senior Honors Thesis courses and, when the department was part of the College of Engineering, was a rotating instructor for the COE's freshman course, Engineering 102. With Gary Woodard, he designed and oversaw the Master of Engineering degree program in Water Resources Engineering and helped that fledgling program get off the ground.

Upon his death, he left an endowment to the Department of Hydrology and Water Resources specifically for undergraduates whom he especially supported and encouraged.

The evaluation for the Davis Undergraduate Distinction Award is made by a committee appointed by the department and recognizes an outstanding undergraduate who demonstrates excellence in writing, speaking, or technical communication or provides outstanding service through volunteerism or extracurricular activities that benefit the department or the profession.

Don will be remembered not only for his academic and advising contributions, but also for his love of the undergraduate program he nurtured.

Eugene S. Simpson
Undergraduate Poster Award

Eugene S. Simpson began his professional career with the U.S. Geological Survey in 1946 where he was involved with problems of migration and dispersion of radioactive wastes that might accidentally or operationally be discharged into groundwater.

In 1963, he was hired by Dr. John W. Harshbarger as a member of HWR's inaugural faculty, and he continued to pursue his research interests in aquifer mechanics, the migration of pollutants in groundwater, and the application of environmental tracers to problems of groundwater circulation. Simpson served as HWR Department Head from 1974-75 and 1979-81.

After his retirement in 1985, he remained active in the profession, serving the U.S. Chapter of the International Association of Hydrogeologists as Secretary-Treasurer from 1984-89 and as President from 1989-92. During his tenure as President, he became the Founding Editor and first Editor-in-Chief of the IAH journal, *Applied Hydrogeology*, which later became *Hydrogeology Journal* (Springer), the official journal of the IAH.

The Geological Society of America Hydrogeology Division honored him with the Distinguished Service Award in 1992, and the International Association of Hydrogeologists elected him an Honorary Member in 1993.

Following retirement, he resided in Tucson until his death at the age of 78 in December 1995. At that time, the Eugene S. Simpson Endowment was established to provide financial support for undergraduate and graduate students, especially those studying hydrogeology and subsurface hydrology.

In March 2012, the inaugural Eugene S. Simpson Undergraduate Poster award was made for the best undergraduate poster with priority given to hydrogeology, subsurface hydrology, or groundwater content, Simpson's areas of expertise. Evaluation for the award is made by a committee appointed by the department.

The department would like to thank the family, friends, and former students of Eugene S. Simpson for their continued support and contributions to this endowment fund.

El Día del Agua y la Atmósfera

Keynote Lecturer
9:00 - 10:00 am
Student Union North Ballroom

Kenneth Graham
Director of NOAA's National Hurricane Center

Abstract

Great strides in hurricane modeling has led to much better forecasts. In fact, the track error in 1990 at 24 hours is now equivalent at 3 days in advance. Intensity forecasting continues to improve, but not at the growth rate shown in track. As part of NOAA's Weather-Ready Nation effort, products and services have an increased level of concentration on communicating the impacts of threatening weather, water, and climate events. With Storm Surge historically the number one cause of fatalities resulting from tropical cyclones, the National Hurricane Center implemented the Storm Surge Watch/Warning and inundation graphics to communicate risk and ultimately save lives. Despite all of these improvements, challenges remain with communicating public risk in ways clearly actionable to protect life. The National Hurricane Center continues to involve social and behavior science in aspects of product development. This talk will cover these challenges and share operational examples where communicating atmospheric and hydrologic science in ways that are actionable are a matter of life and death.

Ken Graham, Director National Hurricane Center Bio

Ken Graham is the Director of the NOAA National Hurricane Center in Miami, Fla. He received his Bachelor of Atmospheric Science Degree at the University of Arizona, and earned a Master of Science Degree in Geosciences from Mississippi State University. While in Mississippi, he was a broadcast meteorologist for a CBS affiliate and was an agricultural meteorologist for the Mississippi Network Radio.

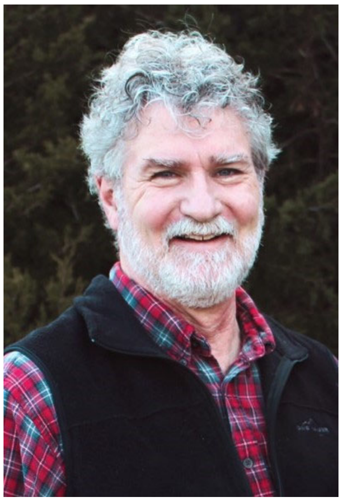
Ken began his career with NOAA in 1994 as an Intern Forecaster at the National Weather Service (NWS) in New Orleans. His career took him to agency's Southern Region Headquarters in Fort Worth, Tex., as the Marine and Public Program Manager during National Weather Service Modernization in the early 1990s. He became the Meteorologist-in-Charge (MIC) at NWS forecast offices in Corpus Christi, Tex., and Birmingham, Ala., where the office was awarded the Department of Commerce medal each year (2001-2005) for innovative services, such as Instant Messaging with television stations during critical events such as the Veteran's Day Tornado Outbreak.

He has served as Systems Operations Chief at Southern Region Headquarters where he won a Bronze Medal for leading a team to make critical repairs in New Orleans following Hurricane Katrina. He moved to Washington D.C. to be Chief of Meteorological Services where he worked closely with partners to improve services and briefed Congressional Committees. He then served as the MIC at the NWS New Orleans/Baton Rouge office, during which time the office won the Department of Commerce Bronze medal for innovative services during Hurricane Gustav and Ike, the National Weather Association's Operational Meteorology Award, and was included in the Department of Commerce Gold Medal Award for Decision Support Service that was presented to NOAA for the Deepwater Horizon oil spill. Ken received the National Weather Museum's Weather Hero Award for 2010.

Ken has extensive experience working directly with emergency managers during numerous high impact events, including nearly two decades along the U.S. coast. He has deployed to emergency operations centers, provided Impact Based Decision Support Briefings for emergency managers and elected officials, and delivered numerous training sessions and exercises related to tropical weather. Ken was elected a board member of the Louisiana Emergency Preparedness Association, is a member of the National Weather Association and the American Meteorological Society, and is a licensed HAM Radio Operator.

El Día del Agua y la Atmósfera

Luncheon Speaker
12:20 - 1:00 pm
Student Union South Ballroom



David G. Jewett

Acting Deputy Division Director of the U.S. Environmental Protection Agency's Groundwater, Watershed, and Ecosystem Restoration Division (GWERD), in the EPA's Office of Research and Development's National Risk Management Research Laboratory (ORD/NRMRL).

"The U.S. EPA's Groundwater, Watershed, and Ecosystem Restoration Division."

Dr. Jewett will discuss the USEPA/ORD/NRMRL Groundwater, Watershed, and Ecosystem Restoration Division (GWERD) and research conducted at the GWERD by scientists and engineers in the Subsurface Processes and Protection Branch (SPPB). This research includes several technologies and strategies, developed and refined by GWERD/SPPB researchers, to better characterize and remediate contaminated groundwater. Technologies and strategies such as flux-based site management (FBSM), monitored natural attenuation (MNA), permeable reactive barriers (PRBs), and the use of nanotechnology (using emulsified zero-talent iron, EZVI) will be presented and discussed.

David G. Jewett, Acting Deputy Division Director Bio:

Dr. David G. Jewett has over 35 years of experience as a hydrologist in government, academic, and environmental consulting settings. He currently is serving as the acting Deputy Division Director of the U.S. Environmental Protection Agency's Groundwater, Watershed, and Ecosystem Restoration Division (GWERD), in the EPA's Office of Research and Development's National Risk Management Research Laboratory (ORD/NRMRL). Dr. Jewett began his career of federal service as a research hydrologist in the GWERD's Technical Assistance and Technology Transfer Branch, providing technical support to resource managers on contaminated groundwater issues at hazardous waste sites across the United States. Dr. Jewett's position of record is Chief of the Subsurface Processes and Protection Branch at the USEPA/ORD/NRMRL/GWERD, where he leads a team of environmental engineers, geologists, geochemists, hydrologists, soil scientists, and computer modelers conducting research on the fate and transport of mass in the subsurface environment. He has served as the acting Division Director of the GWERD and as the co-Director of the EPA's Center of Subsurface Modeling Support. Dr. Jewett holds a BS degree in geology from Syracuse University, a MS degree in geology from The Wichita State University, and a PhD degree in hydrology from the Department of Hydrology and Water Resources at the University of Arizona.

Lightning Talks

4:15-5:00pm

For the first time during El Día, the Department of Hydrology and Atmospheric Sciences will include a round of lightning talks. These talks will showcase student research that is in progress as well as undergraduate senior capstone projects. This is also an opportunity for students to present on interesting science-related satellite projects.

Following are those students giving a lightning talk, along with their research topic:

- Neha Gupta ~ PhD Student ~ Water Resources
- Patrick Bunn ~ PhD Student ~ Atmospheric Modeling
- Yuan-Heng Wang ~ PhD Student ~ Hydrologic Modeling
- Josh Welty ~ PhD Student ~ Boundary Layer Meteorology
- Shweta Narkhede ~MS Student ~Surface Water Hydrology
- Kevin Strongman ~ BS Student ~ Mesoscale Meteorology
- Milad Panahi ~ MS Student ~ Atmospheric Composition
- Samuel Potteiger ~Accel. MS Student ~ Hydrometeorology
- Tiffani Cáñez ~ Accel. MS Student ~ Groundwater Hydrology
- Jack Reeves-Eyre ~ PhD Student ~ Hydrometeorology
- Ammon Cadogan ~ Accel. MS Student ~ Water Resources
- Bri Rupkalvis ~ MS Student~ Water Resources

Notes:

- Each talk is limited to four minutes.
- There is no question and answer period, instead we encourage you to attend the Post-Award Reception and Social to ask questions.
- Lightning talk presenters are not eligible for oral presentation awards.

ORAL

PRESENTATIONS

Geophysical imaging of water ages within an experimental hillslope

Antônio Alves Meira Neto, Minseok Kim[1], and Peter Troch[1]

Hydrology and Atmospheric Sciences
The University of Arizona

Correctly estimating ages of water within the landscape can provide insights and leverage our understanding of Critical Zone (CZ) internal functioning and structure. As opposed to traditional lumped-systems approach, the direct observation of the movement of water possible through the use of Electrical Resistivity Tomography (ERT) can leverage the understanding of the internal variability of water ages within the CZ.

In this study we estimate of the internal distribution of ages of water within a model hillslope subject to a periodic steady state regime. We developed an electrical resistivity tomography (ERT) approach to generate images of water ages through time. We compared these images with lumped estimates from isotopic analysis of discharge water under the framework of StorAge Selection (SAS) functions in order to investigate whether SAS functions can be used as descriptors of physical processes controlling ages of water at natural hillslopes.

[1]University of Arizona, Biosphere 2, The University of Arizona, Tucson, AZ

Synoptic analysis of the epic rainstorm in Kauai on 14-16 April 2018

Madelyn B. Powell, Thomas Galarneau, and Eric Betterton

Hydrology and Atmospheric Sciences
The University of Arizona

The extreme rainstorm that occurred in Kauai on 14-16 April 2018 is presented using a synoptic and mesoscale ingredients-based approach for heavy rainfall. A staggering 46.69 inches of rain fell in 24 hours on 14-15 April at Waipa Gardens, Kauai, setting the newly certified national 24 hour rainfall record, surpassing the previous record of 43 inches at Alvin, Texas, on 25-26 July 1979. This record breaking rainstorm flooded both the Hanalei and Wainiha river basins, producing flows that caused multiple stream gauge failures. Damage to public property is in excess of $20 million and nearly 530 homes sustained damage or were destroyed. Synoptic analysis revealed that an upper-level trough in the north Pacific jet exit region was positioned northwest of Kauai by 14 April. The upper-level cold trough was positioned above and just west of a low-altitude warm moist tropical air mass, resulting in anomalously low bulk column stability. A strong surface anticyclone positioned north of Kauai helped drive moist upslope northeasterly flow on the north and east side of Kauai's Mount Waialeale. The focused upslope flow provided a lifting mechanism for the continuous redevelopment of sustained heavy-rain-producing thunderstorms in a moist, unstable environment on the north side of Mount Waialeale.

Populus fremontii tree ring analysis and semi-arid river water source variability over time, San Pedro River, Arizona

Rebecca A. Stolar, Thomas Meixner,
Kiyomi Morino, and Steve Leavitt

Hydrology and Atmospheric Sciences
The University of Arizona

Summer floods are an important source of sustained streamflow in arid and semi-arid rivers of the American Southwest and Northwest Mexico. How much of this importance is a natural function of these systems versus an artifact of human alterations to the system is not known. Environmental information in the tree ring cellulose of Populus can be used to investigate the variation in water sources over time in these areas. Past research has shown that streamflow sources in the San Pedro Basin of Arizona vary isotopically between a source water of basin ground water and a summer flood water source. This study uses isotopic analyses of Populus fremontii and atmospheric data in the San Pedro Basin to determine the water source of the trees and the river water source condition. After analyzing weather data within the basin, an inversion of the Barbour model using tree ring cellulose isotopes was used to obtain the water source isotopic composition. The variation in water source composition as inferred from the model was then compared to the river composition over time. By drawing this comparison, it aides in anticipating consequences from human driven modification including climate change on the river systems.

Snowpack Treatment in the CPC Leaky Bucket Model

Jorge Arevalo, Josh Welty, and Xubin Zeng

Hydrology and Atmospheric Sciences
The University of Arizona

The CPC Leaky Bucket Model is used in the Climate Prediction Center (CPC) for monitoring and forecasting soil moisture (SM) anomalies for the assessment of drought status at a global scale. A new layer (besides SM) has been added to this model recently to account for Snow (actually Snow Water Equivalent, SWE) as a way to improve the SM representation in snow covered areas. Here we present an improved parameterization for the snow treatment, accounting for accumulation and ablation based in the same forcing variables as in the original model, i.e. Temperature and Precipitation. Results for the SWE prognostic variable are compared with the UA-Snow dataset (Broxton et al., 2016) and observations showing an overall good fitting. This led into an improved seasonal cycle of SM closer to observed data, with a more realistic timing for the SM peaks in areas influenced by snow.

Robust design of field measurements for evapotranspiration barriers using universal multiple linear regression

Melissa Clutter, Ty Ferré, and Fred Zhang[1]

Hydrology and Atmospheric Sciences
The University of Arizona

Surface barriers are commonly installed to reduce downward water movement into contaminated zones. Specifically, evapotranspiration (ET) barriers are used to store and release water (via ET) prior to percolation to an underlying waste zone. To measure the effectiveness of the Prototype Hanford Barrier (PHB), several neutron probes access tubes were installed throughout the cover to monitor store-and-release mechanisms. Our aim was to use existing PHB data, simulated model data, and a dimensionality reduction approach called universal multiple linear regression (uMLR) to optimize the number of sensors in the PHB field site. We compare the network designs based on the downsampling of existing data to the recommended sensor design based on model simulated data, to understand the usefulness of implementing uMLR prior to sensor installation. We found that uMLR, combined with robust decision making (RDM), provided a simple, robust network design for monitoring total water stored at the PHB site.

[1]Pacific Northwest National Laboratory, Richland, WA

Comparison of METRIC Algorithm with WaPOR Product for ET (Case Study: Urmia Lake basin)

Mostafa Javadian and Ali Behrangi

Hydrology and Atmospheric Sciences
The University of Arizona

Evapotranspiration is one of the main components of water and energy balance. In this study, we compare two ET products, suitable for regional analysis at high spatial resolution: WaPOR product developed by FAO and METRIC algorithm. WaPOR is based on ET-Look, which is a two-source model and relies on microwave images. WaPOR is unique as it has no limitation under cloudy days, but METRIC is limited by clouds. METRIC and WaPOR are more sensitive to land surface temperature and soil moisture, respectively. The results show that in most areas ET from METRIC is higher than WaPOR and the difference has an ascending trend with the elevation. The ET of lysimeter station is pretty close to METRIC based on a single observation. However, the fraction of ET to precipitation in rainfed agriculture areas shows that WaPOR is more accurate than METRIC, partly because annual ET cannot exceed annual precipitation in rainfed agriculture areas due to its limited water resources. This suggests that the spatial distribution of WaPOR might be better than METRIC, but not necessarily its amount. Furthermore, this study suggests that WaPOR might be a better scheme than METRIC in high-elevation areas.

Water routing through the critical zone: A hydrometric, hydrochemical, and isotopic investigation in northern NM

Alissa White, B. Moravec[1], Y. Olshansky[1], B. Paras, A. Sanchez, L. Ma[2], J. McIntosh, T. P. A. Ferre, T. Meixner, and J. Chorover[1]

Hydrology and Atmospheric Sciences
The University of Arizona

Mountain environments contribute substantially to basin aquifers and surface waters in the American Southwest and are an important component of water resources for large population centers downstream. Many of those mountainous environments are composed of complex geology and intricate hydrologic flow paths. One such mountainous system, the Valles Caldera National Preserve in northern NM is the location of the Jemez River Basin Critical Zone Observatory (JRB-CZO). In this talk, analysis of hydrometric, hydrochemical, and isotopic data are used to decipher water routing through the JRB-CZO and investigate groundwater contribution to streamflow, focusing on the role that subsurface structure, particularly fracture density and complicated lithology, plays at different scales. Specific attention to groundwater from two hillslopes with contrasting lithology and subsurface structure informs our understanding of hydrologic response to different hydrologic flow regimes. Distinctions in major ion chemistry and isotope signatures indicate that fractured groundwater dominantly contributes to streamflow. Furthermore, uranium-series and radiogenic strontium isotopes distinguish between fracture and matrix flow in springs and surface waters.

[1]The University of Arizona, Department of Soil, Water and Environmental Science, Tucson, AZ
[2]University of Texas at El Paso, Department of Geological Sciences, El Paso, TX

Assessing Time Step Sensitivity in the Department of Energy's Climate Model E3SM

Jeremy Sousa and Shixuan Zhang[1]

Hydrology and Atmospheric Sciences
The University of Arizona

In recent decades, increased spatial resolution has advanced the resolvability of physical features in earth system models; however, time step sensitivity has received less focus. This study investigates convergence of simulations at different time steps in the Department of Energy's climate model, the Energy Exascale Earth System Model (E3SM), where the simulation with the smallest time step is treated as the reference solution for all other simulations. A few basic surface variables in the model such as pressure and temperature are selected as the medium for assessing the time step sensitivity both regionally and globally. A ten-day simulation of the coupled atmosphere-land model in E3SM is performed at different time steps, and the solutions are compared using root mean square error (RMSE). In regions where RMSE is maximized, further statistical analysis is performed to determine the forcing for the differences. In-situ high-frequency data are used as a reference for model output accuracy. Results demonstrate that while some features are correlated in time over different time steps, amplitude is not preserved.

[1]Pacific Northwest National Laboratory, Richland, Washington

Infiltration rates of green infrastructure curb-cut basins: finding a balance between functionality and aesthetics

Samantha K. Swartz and Thomas Meixner

Hydrology and Atmospheric Sciences
The University of Arizona

In arid regions, sustainable water management practices are critical for a future under climate change. Several neighborhoods in Tucson, Arizona have implemented green infrastructure designs in order to collect the untapped, renewable resource of rainwater. Neighborhood-scale green infrastructure in the form of right-of-way rainwater-harvesting basins successfully capture polluted storm runoff and create appreciable green spaces.

However, the maintenance of curb-cut basins has been left to nearby homeowners, and after almost a decade, some basins show signs of neglect. Little is understood about how continued upkeep affects the function of a rainwater-harvesting basin. It appears that a degraded basin cannot properly capture rainwater, as well as being an eyesore for nearby residents. This presentation will assess how volunteer homeowner maintenance influences the functionality of Tucson's green infrastructure, as well as make recommendations to the City of Tucson for basin maintenance. Infiltration rates – measured with an air permeameter - will serve as a metric for basin function, while a qualitative analysis of the basin's appearance will gauge the apparent homeowner care. The results found that basins in fair condition and poor condition tended to have a statistically significant increase in average saturated hydraulic conductivity. Overall, well-maintained basins underperformed relative to unkempt ones.

Effects of horizontal redistribution of surface fluxes for a coupled atmospheric and hydrologic model

Timothy M. Lahmers, Christopher L. Castro, and Pieter Hazenberg

Hydrology Atmospheric Sciences
The University of Arizona

Evidence for surface and atmosphere coupling is corroborated in both modeling and observation-based field experiments. To evaluate these effects in the southwest US, The Weather Research and Forecasting (WRF) regional atmospheric model is coupled to the WRF-Hydro hydrologic model.

Both the uncoupled WRF and otherwise identical WRF-Hydro model are executed for the 2017 and 2018 North American Monsoon (NAM) seasons in central Arizona. In this environment, diurnal convection is impacted by precipitation recycling from the land surface. Understanding of NAM convection is critical to both the research and the operational communities, as extreme weather events can give rise to flash flooding, severe straight-line winds, and blowing dust.

The current work assesses the impact of the representation of hydrologic processes at the land surface, in both modeling setups, and how these affect 1) local surface energy budgets during the NAM throughout Arizona and 2) the spectral behavior of diurnally driven NAM convection. Model results suggest that adding surface and subsurface flow from WRF-Hydro increases soil moisture and latent heat near the surface. This increases the amount of instability and moisture available for deep convection in the model simulations, and enhances the growth of convection at the peak of the diurnal cycle.

Pore-scale modeling of two-phase flow and multicomponent transport with phase change behaviors in nanoporous media

Sidian Chen, Jiamin Jiang[1], Bo Guo

Hydrology and Atmospheric Sciences
The University of Arizona

Flow and transport of multiple fluid phases and components in porous materials are challenging to model, especially when thermodynamic phase change behaviors are involved. Porous materials with nanoscale pore spaces can further complicate the problem. The phase behavior of a multicomponent mixture in nanoscale pore spaces can significantly deviate from its bulk state, leading to very different triggering pressure and temperature for evaporation and condensation. This 'shifted' phase change behavior due to nanoconfinement—commonly observed during oil and gas recovery from shale formations—has posed significant challenges for accurate prediction of hydrocarbon production. Current theories either underrepresent the complex multiscale pore structures by using molecular simulations within a single pore, or oversimplify the nanoconfined flow mechanisms by using Darcy-scale continuum models, causing inconsistent predictions with experimental and field observations. To bridge the gap, we develop a novel pore-network model to examine how complex nanopore networks control phase change and compositional flow dynamics. The model allows us to derive new constitutive relationships for Darcy-scale continuum models by considering the interactions between phase change behaviors, two-phase compositional flow dynamics, and the multiscale nanopore structures, which can then be used for quantitative predictions of field-scale hydrocarbon production from complex shale formations.

[1]Stanford University, Department of Energy Resources Engineering, Stanford, CA

“Dry getting drier over land” the perspective provided by GRACE

Li-Ling Chang, Ruiqiang Yuan, Hoshin V. Gupta,
C. L. Winter and Guo-Yue Niu

Hydrology and Atmospheric Sciences
The University of Arizona

In a warming climate, the global water cycle fed with more atmospheric water vapor is expected to intensify, causing dry regions to become drier and wet regions wetter. This “dry gets drier, wet gets wetter” (DDWW) paradigm is robustly supported by evidence over the oceans but remains uncertain over land when using evaluations based on precipitation, evapotranspiration and soil moisture data, suffering from limited coverage and accuracy. Here we use terrestrial water storage (TWS) anomaly data from the Gravity Recovery and Climate Experiment (GRACE) satellites to assess the DDWW paradigm regarding changes in areal extent and water depth over the period 2003 to 2016. Excluding cold regions, our analysis indicates that 45% of the global land area follows the DDWW paradigm, while only 35% shows an opposite pattern. Dry regions lost ~12.6 mm of water over the period 2003–2016, a loss rate comparable to the warming-induced melt of ice observed in cold regions (excluding Antarctic and Greenland). Meanwhile, wet regions gained ~3.1 mm. Further, when compared with local annual amplitudes, TWS trends are more readily apparent in dry regions than in wet regions, supporting the “dry gets drier” (DD) part of the paradigm.

POSTER

PRESENTATIONS

Investigating impacts of projected climate change on flood risk in urban areas located along river channels

Adriana Arcelay and Hoshin Gupta

Hydrology and Atmospheric Sciences
The University of Arizona

Hurricane Florence, which generated flooding in the Carolinas in 2018, caused an estimated $38 - 50 billion[1] in property damage. There is scientific data supporting the hypothesis that the intensity of natural disasters is increasing, as are the associated damages. The goal of this project is to evaluate how increases in monsoon intensity might influence the risk of potential flooding in urban areas located along rivers. To accomplish this, an ArcMap model was created for a 588,800-acre watershed located approximately 90% in Pima County and 10% in Santa Cruz County. The river of interest in the watershed, Finger Rock Wash, runs through a residential area. In October 1983, Tucson received heavy rain and caused what is considered to be a 100-year storm. The watershed was generated using the automated geospatial watershed assessment (AGWA) tool in ArcMap. Data from this storm event was used to simulate the watershed in ArcMap via the kinematic runoff and erosion (KINEROS 2) model. Present and future precipitation data entered into the model were based on a 24-hour, 100-year event. KINEROS 2 returns flowrates from which water level depths can be determined. An assessment conducted on three different data sets obtained from various storms with the same occurrence interval provides indications of expected flood risk.

[1]https://www.foxbusiness.com/economy/hurricane-florence-caused-up-to-50-billion-in-damage-report

Developing a rapid method to estimate near-surface hydraulic conductivity

Dylan Begley and Ty P.A. Ferré

Hydrology and Atmospheric Sciences
The University of Arizona

Estimating saturated hydraulic conductivity (K_s) at the ground surface is essential for quantifying infiltration. This is important for applications ranging from irrigation planning to flood forecasting. Current methods for estimating K_s require much time, water, and are semi-quantitative. This project is the first step in developing a rapid method to estimate near-surface K_s. The steady-state drip method was modified to develop a fixed-time drip method by dripping water on the surface at a measured rate for one minute. In designing the method, it was determined the wetted area depends on the slope of the surface. To test and document this phenomenon, experiments were conducted on clean, dry sand at multiple drip rates for several slopes. Analysis of a photograph of the wetted area is used to estimate Ks. Diameter of the wetted area and its uncertainty was determined with a python script that fits circles to points digitized on the perimeter of the wetted area. Uncertainty of the flow rate was determined by repeat measurement. Results show a linear dependence of the wetted diameter on drip rate and slope, allowing for simple correction of each factor when determining K_s. Results show the method is ready for testing on various soils.

Assessment of specific climate metrics using dynamically downscaled projections of the Lower Santa Cruz River Basin

Patrick Bunn, Hsin-I Chang and Christopher Castro

Hydrology & Atmospheric Sciences
The University of Arizona

The Bureau of Reclamation expressed a desire to understand the evolution of the climate in Lower Santa Cruz River Basin (LSCRB), Arizona, principally for current and future water resource management. Two specific climate metrics important for water resource management are the timing of the monsoon onset and the length of the preceding dry period. The CMIP5 General Circulation Models (GCMs) were dynamically downscaled using WRF in the LSCRB. The downscaled data were then evaluated to select those models that best represent the North American Monsoon (NAM) for the historic period 1979-2005. The MPI and HadGem2 models have the most pronounced winter season precipitation to monsoon signal so were used for this project. Metrics in temperature and precipitation are compared using the dynamically downscaled GCMs and statistical downscaling of the GCMs (LOCA), to highlight any differences between the two methodologies. Initial results show consistency in temperature projections but differences in precipitation. The timing of monsoon onset is shifting earlier in the season, which counters results from Cook & Seager (2013). The domain considered here is a small portion in the north-west of the domain in Cook & Seager and fewer models/members are considered here.

Estimating 2017 Groundwater Withdrawals For Agricultural Water Use In Arizona

Ammon Cadogan and Martha Whitaker

Hydrology and Atmospheric Sciences
The University of Arizona

United States Geological Survey, Tucson, Arizona

Crops grown in Arizona are found in grocery stores across the nation. With low levels of rainfall and high heat, groundwater is essential for the survival of agricultural plants and humans in Arizona. The goal of this project was to estimate groundwater withdrawals for agricultural use in several basin defined by Arizona Department of Water Resources in 2017. Withdrawals were calculated by multiplying crop consumptive use by field acreage then dividing by the corresponding irrigation efficiencies. Crop and irrigation efficiency data was collected via in situ visits and remote sensing methods. Crop consumptive use data was calculated using Prism Climate Group data (NACSE, 2017) with the Modified Blaney-Criddle equation. Total withdrawal values for 2017 ranged from 253,000 to fewer than 1,000 acre feet. The Gila Bend watershed used the most water (253,000 acre feet) followed by Willcox (208,000 acre feet) and Lower Gila (121,000 acre feet) watersheds. Compared with previous years' data, most of the basins show a trend of decreasing water use, indicating smarter irrigation practices and more strict regulations. This information has the potential to educate the public and help managers make more informed decisions with regard to the state's diminishing water resources

Investigation of the extent of fresh and brackish groundwater to inform better management of decreasing groundwater levels in the Willcox Basin, SE Arizona

Tiffani Cáñez, Jennifer McIntosh, and Grant Ferguson[1]

Hydrology and Water Resources
The University of Arizona

Adoption of the recent Lower-Colorado River Basin Drought Contingency Plan will make Arizona more dependent on groundwater to meet water resource demands. Knowing the extent and distribution of fresh and brackish groundwater in relation to existing wells and water table elevations would enable water managers and users better quantify how much water is feasibly available. This study focuses on the Willcox Basin in southeastern Arizona, where groundwater levels have experienced significant declines, yet there is continued high demand for groundwater for irrigated agriculture. In the early 1980s groundwater withdrawals decreased, however, in 2000 withdrawals began to increase again and have continued to increase since. The current water table is approaching depths of existing water wells in some locations. North of the Willcox Playa depth-to-water is about 400 ft at the deepest, about 350 ft south of the playa, and around the Willcox Playa closer to 150 ft. Freshwater extends to an average depth greater than 280 ft, except near the playa where brackish water extends to approximately 40 ft. It is still unknown how much deeper freshwater extends or if water becomes brackish with depth due to the lack of deep wells in the basin or geophysical surveys.

[1]Department of Civil, Geological & Environmental Engineering, University of Saskatchewan

The Remote Influence of Soil Moisture on Precipitation in the Salt River Basin during the North America Monsoon

Molan Choi, C.L. Castro, and P. Hazenberg

Hydrology and Atmospheric Science
The University of Arizona

The North American Monsoon (NAM) system governs the warm season over most of the southwestern North America. Even though monsoon flow is known for a seasonal change of air temperature difference between ocean and continental surfaces, it has been studied that a positive soil moisture - rainfall feedback exists within a monsoon region, which means wet soil in the monsoon area increases precipitation within a domain (Small 2001). However, previous research has been conducted and analyzed using model product, not with actual data, so results and conclusion can be unconfirmed and changeable. Also, not much study has been conducted for how much and where soil moisture would affect a precipitation of a certain basin. Therefore, this study will investigate correlation between soil moisture and precipitation within monsoon domain using actual soil moisture satellite data, SMAP for positive soil moisture – rainfall feedback on NAM to investigate how and where soil moisture would affect precipitation on Salt River basin.

The Utility of Predictive Hydrologic Modeling for Water Resources Planning and Negotiation

Breanna Clabourne, Ty Ferré and Chloé Fandel

Hydrology and Atmospheric Sciences
The University of Arizona

Hydrologic models enable scientists to predict aquifer responses to proposed anthropogenic activities. Models can inform decision-making, but it is not always clear how the interests of multiple stakeholders can be met while satisfying regulatory requirements. In this study, a town and an agricultural developer represent two hypothetical stakeholders with competing interests and a shared water resource. The agricultural developer proposed further use of water for irrigation; they want to minimize their pumping and water delivery costs. The town wishes to minimize drawdown in their municipal well due to the proposed pumping. This study shows how competing interests can be balanced based on predictive modeling. In the model, a pre-existing pumping well represents past, current, and future pumping from the town. For the proposed irrigation well, the pumping rate is fixed, but its location is a decision variable. The model was run for 30 well locations, and the combined costs of pumping and water delivery for the agricultural developer varied between $121,000 and $772,000. The projected water table depth in the town well varied between 10.2 to 11.4 m. Results are shown in a trade-off plot that could be used to negotiate a well location that is acceptable to both parties.

Groundwater basin boundary identification in a confined aquifer using hydraulic tomography method

Kwankwai Daranond and Tian-Chyi Jim Yeh

Hydrology and Atmospheric Sciences
The University of Arizona

The estimation of hydraulic properties is important in groundwater management and contaminant migration investigation. In this study, observed hydraulic heads at ten observation wells during pumping tests are simulated in synthetic aquifers using VSAFT2. This study employs the analytical solution and hydraulic tomography method (HT) to estimate T and S values of a homogeneous and a heterogeneous medium. The estimated values from the analytical solution is close to the assigned values in the homogeneous case but deviate from the specified values in the heterogeneous case. On the other hand, HT performs well in these two cases with the same boundary condition as specified in the forward model. However, the specified boundary condition has an effect on a parameter estimation, and it is difficult to define in the real world. Thus, this study also examines whether permeable or impermeable boundary can be detected in the inverse model by using drawdown data and initial guess of boundary condition. In particular, this study examines the effects of well network on the estimates of the boundaries and parameters.

Extent of salt dissolution and brine flushing to the Dolores River in the Paradox Valley, Colorado

Ambria P. Dell'Oro, Jihyun Kim,
and Grant Ferguson[1], and Jennifer McIntosh

Hydrology and Atmospheric Sciences
The University of Arizona

The Dolores River is a tributary to the Colorado River located in Paradox Valley, CO and is widely known for it's high salt loads. The Paradox Valley is an anticlinal salt valley, underlain by a salt wall of the Pennsylvanian Hermosa Formation. The valley began forming when mountain uplifts caused lateral stresses on the sedimentary formation. The weight from the overlying strata followed by stress relaxation forced salt from deep underground to flow up and create a diapiric anticline. Discharge of shallow brines (up to 43,300 tons/yr TDS) in the alluvial aquifer into the Dolores River is responsible for the significant increase in the salinity load. Prior research concluded the dissolution of halite and gypsum is the main contributor of salinity in shallow aquifers and the Dolores River. Our research aims to determine the volume of salt that has been dissolved and the amount of chloride that has been discharged to the Colorado River over geologic time. Results from this study will help further constrain mechanisms of salt valley formation in the Colorado Plateau. In addition, by investigating other world rivers underlain by salt deposits, we can estimate global riverine chloride fluxes from geologic sources.

[1] Department of Civil and Geological Engineering; The University of Saskatchewan, Saskatoon, Canada

Hydrochemical evolution of nitrogen species in semi-arid urban catchments

Lori C. Emler and Thomas Meixner

Hydrology and Atmospheric Sciences
The University of Arizona

The water quality of urban runoff is uniquely significant to arid and semi-arid regions, such as southern Arizona, which count urban runoff among the limited renewable resources for a continued water supply. Despite the essential nature of this resource, the hydrochemical evolution of urban runoff over the course of a storm and a rainy season overall is less well understood than is ideal for researchers and resource managers alike. In particular, nitrogen species contribute to many of the highest priority water quality concerns for water managers. This research project addresses the evolution of nitrogen over the course of individual storm events that occurred during the winter rainy season and the summer monsoon season in two urban catchments in the semi-arid city of Tucson, Arizona. This poster discusses analytical methods and presents preliminary data for a subset of sampled storms and the associated hydrochemical results.

Runoff increases due to urbanization in a semi-arid city

Neha Gupta, Thomas Meixner,
Erika Gallo, Evan Canfield[1], Rachel Spinti

Hydrology and Atmospheric Sciences
The University of Arizona

In the southwestern United States, water is available in the form of discontinuous seasonal precipitation events associated with the North American Monsoon and the winter rainy season (Gallo et al., 2012). These wet seasons, particularly the North American Monsoon, are characterized by heavy rainfall events that lead to urban flooding issues, separated by periods of dryness. The rapid nature of change (hydrographs on the order of minute) combined with intense spatial heterogeneity in rainfall patterns leads to unique temporal and spatial data needs and considerations to assess urban flooding issues and associated solutions such as green stormwater infrastructure.

Due to the spatial heterogeneity of stormwater infrastructure within a single municipality, urban flooding issues observed in one watershed may not be applicable to others due to varying watershed size, types of stormwater infrastructure, and contributing land cover. Urban hydrological data has been collected in the city of Tucson, Arizona to assess the variability in runoff volumes and flood hydrographs across multiple urban ephemeral washes and compared across watersheds with similar and varying contributing area and contributing land use cover. Analyses show that as urbanization increases, runoff frequency and duration increase compared to undeveloped watersheds.

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[1] Pima County Regional Flood Control District

Evolution of paleofluids and hydrochemical processes in the Paradox Basin

Jihyun Kim, Ambria Dell'Oro, Chandler Noyes, Jennifer McIntosh, Lin Ma[1] and Zheng-Tian Lu[2]

Hydrology and Atmospheric Sciences
The University of Arizona

The Paradox Basin in the Colorado Plateau has diverse manifestations of paleofluid flow, including widespread sandstone bleaching and ore mineralization, distinctive salt deposits and abundant hydrocarbon accumulations. Forty-six fluid samples were collected in 2018 to evaluate the hydrochemical distribution and sources of modern fluids as an indicator of the long-term evolution of paleofluids in the Paradox Basin. Surface waters and shallow groundwater in the Paradox and Sinbad salt valleys contain Na-Cl type brines from meteoric water dissolution of halite and gypsum. Sr and S isotopic signatures of the Na-Cl type brines confirm that dissolution of evaporites is the dominant source of solutes. Holocene to Pleistocene age shallow groundwaters outside the salt valleys are Na-Ca-HCO3 type dilute meteoric waters with S and Sr isotope ratios indicative of interaction with sulfides and carbonates. Deeper Ca-Cl type basinal fluids come from remnant paleo-evaporated seawater that has dissolved evaporites, reacted with radiogenic minerals, and oxidized sulfides. The distribution of trace metals in fluids is being interpreted with the concomitant sedimentary record. Radio-krypton (81Kr) is also being analyzed to date relatively old (0.05 to 1.3 Ma) formation water.

[1]University of Texas at El Paso, Department of Geological Sciences, El Paso, TX

[2]University of Science and Technology of China, Hefei, China

Development of Database of Tucson Green Infrastructure Sites

Mandla Kunnie and Thomas Meixner

Department of Hydrology and Atmospheric Sciences
The University of Arizona

The implementation of Green Infrastructure (GI) can be studied in myriad ways using Geographic Information Systems (GIS). In particular, GIS is a useful, readily-accessible tool to easily visualize patterns of land-use. Seventeen cities in the United States have started using GIS and more specifically ArcMap to catalogue their green infrastructure sites to assess the effectiveness of rainwater catchments and the impact of green infrastructure on other water-related studies such as flood control. There are approximately 1500 GI sites ranging from private to public sites throughout the Tucson Basin. A major part of this project included contacting numerous government agencies to collect the data, which took just as much time as the database creation. One of the more important aspects of the database creation was developing a standardized nomenclature for the various categories of GI sites that are different for every government organization. Using this new database, the Urban Water Innovation Network can conduct comparisons on how Green Infrastructure is used in Tucson compared with cities in other areas of the country. This project is beneficial to people because it will allow researchers to study the impact of GI on human health as well as the greenhouse effect, water conservation, flood control, and future water use planning.

Can the Tropical Easterly Jet be used to predict when droughts will occur in the West African Sahel?

Richard Marcelain and Xubin Zeng[1]

Department of Geosciences
The University of Arizona

Droughts in the West African Sahel cause devastating consequences to inhabitants of the region. Predicting when droughts will occur, however, continues to elude scientists. This research analyzes the relation between the African easterly jet (AEJ), the tropical easterly jet (TEJ), and seeks to explore the predictability for precipitation in the West African Sahel region. To evaluate the relation between the AEJ and TEJ, five anomalously wet years and five anomalously dry years were identified using the Sahel Precipitation Index. The composites were then plotted using National Centers for Environmental Prediction reanalysis data sets. During wet (dry) years, the TEJ revealed a high (low) core velocity and the AEJ responded with a poleward (equatorward) shift. The same relation was also revealed when using the TEJ at its generation over India. A weak trend was shown in a regression analysis when using TEJ's core speed at its origin during June, and the average precipitation during the summer months. The results of this research suggest the TEJ's core velocity at its generation may assist in developing a dynamic drought prediction model for the West African Sahel.

[2]Department of Hydrology and Atmospheric Sciences

Evaluating strontium isotopes as a tracer of fluids in subsurface reservoirs and possible brine contamination in shallow aquifers related to oil/gas production

Mohammad Marza and Jennifer McIntosh

Hydrology and Atmospheric Sciences
The University of Arizona

Previous studies using limited data have suggested that Sr isotopes can provide a unique fingerprint of basinal brines from specific geologic formations at depth in the earth's crust and leakage of brines into shallow aquifers. In basins, where hydrocarbon production can come from multiple geologic formations with similar lithologies (e.g., organic-rich shales), it is unclear if Sr isotope signatures are indeed a unique tracer of formation water sources. This study systematically evaluates the utility of Sr isotopes as a tracer of natural or anthropogenic contamination in shallow aquifers related to oil/gas production. Strontium isotopes, together with other solute and isotopic chemistry, were investigated for two major oil/gas producing regions in the United States: Williston, and Appalachian basins. Initial results suggest that multiple oil/gas bearing formations with depth can have overlapping Sr isotope ratios. For example, in the Appalachian Basin, the Marcellus and Utica shales have overlapping $^{87}Sr/^{86}Sr$ values. Likewise, in Williston Basin, the Bakken Shale has overlapping Sr isotope ratios with other hydrocarbon-bearing formations (e.g., Winnipegosis and Dawson). Alternative tracers and multiple tracer approaches will be investigated to better constrain sources of salinity in oil/gas producing regions.

Geochemical and Isotopic Assessment of Regional Groundwater Flow and Aquifer Connectivity in the Lisbon Valley, Utah

Chandler E. Noyes, Mark Person[1], Grant Ferguson[2], Jihyun Kim, and Jennifer McIntosh

Hydrology and Atmospheric Sciences
The University of Arizona

Understanding aquifer connectivity is an important water resource management practice to mitigate migration of contaminants from a mined aquifer (e.g. in-situ copper mining) to adjacent aquifers. This study focuses on the metal-rich Lisbon Valley of the Paradox Basin in southeastern Utah where numerous faults may act as conduits or barriers to cross-formational flow. All geochemical and isotopic results show that these distinct aquifers are hydrologically isolated. The upper Burro Canyon (BC) aquifer has a calcium-sulfate signature with high TDS, while the lower Navajo (N) aquifer has a sodium-bicarbonate water with low-to-moderate TDS. Corrected radiocarbon ages in the BC-aquifer of 3,300-11,000 BP coupled with higher $\delta^{18}O$ and δD values are indicative of Holocene recharge. Corrected radiocarbon ages in the N-aquifer of 15,000-38,000 BP coupled with lower $\delta^{18}O$ and δD values are indicative of Late Pleistocene recharge, likely from the La Sal mountains based on regional hydraulic head gradients. Near-zero to negative values of $\delta^{34}S$-SO_4 and $\delta^{18}O$-SO_4 in the BC-aquifer are consistent with sulfide oxidation in the mineralized aquifer, while positive values of $\delta^{34}S$-SO_4 and $\delta^{18}O$-SO_4 and lower [SO_4] in the N-aquifer are indicative of bacterial sulfate reduction. Groundwater in the N-aquifer is generally more radiogenic (higher $^{87}Sr/^{86}Sr$) than in the BC-aquifer.

[1]New Mexico Institute of Mining and Technology, Department of Earth and Environmental Science, Socorro, NM

[2]University of Saskatchewan, Department of Civil and Geological Engineering, Saskatoon, Canada

Investigating In-situ, Satellite, and Reanalysis for Snow Accumulation over CONUS

Milad Panahi and Ali Behrangi

Hydrology and Atmospheric Sciences
The University of Arizona

Quantifying snowfall and its accumulation is important for regional and global hydrology and water resources planning. However, accurate measurement of this important variable is difficult from both in-situ and remote sensing observations. In this paper, we focus on snowfall-only conditions, by setting the maximum surface temperature conservatively to 1oC, and compare snow accumulation estimated by 10 different products, including in-situ, satellite, reanalysis, and UA- SWE. The outcomes suggest an overall close agreement in terms of accumulation trends between the studied products, but large differences exist in their accumulated values. Future investigation is underway to quantify uncertainties, systematic errors, and explore ways that can potentially be used for bias correction of satellite products.

Constructed recharge monitoring evaluation: Santa Cruz River, Cortaro Road to Avra Valley Road

Karl A. Pereira, Thomas Meixner, and Evan Canfield[1]

Hydrology and Atmospheric Sciences
The University of Arizona

The Pima County Regional Flood Control District is developing a multi-benefit management plan for the effluent dependent Santa Cruz River, located in Southern Arizona. In the Cortaro Road to Avra Valley Road reach, the District has ongoing maintenance problems as the result of effluent flow up against the bank protection. The District and other stakeholders are interested in multi-objective solutions that would; move flow away from the soil-cement bank protection, increase infiltration and generate more recharge for water owners, improve habitat for species of interest, and improve the recreational experience of Loop users. Channel modifications have been carried out downstream of Cortaro Road which include; bendway weirs to direct flow away from the bank protection, creation of multiple channels to increase the infiltration footprint, rock fords to slow the water. This project will evaluate the infiltration and recharge at the site and evaluate the monitoring network necessary to document increased recharge. Surface flow data obtained from USGS gages at Cortaro and Avra Valley, will be evaluated to determine the changes in infiltration before and after the installation of the channel modifications. Groundwater data from nearby monitoring wells will be evaluated to determine the possible impact on groundwater levels.

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[1]Pima County Regional Flood Control District, Tucson, Arizona

Characterizing the Relation between Snow Water Equivalent and Flow in the Colorado River from 1981-2016

Sam Potteiger and Xubin Zeng

Hydrology and Atmospheric Sciences
The University of Arizona

The Colorado River is one of the most important rivers in the world, supplying water to 40 million people in seven states in the United States, and two states in Mexico. However, the river is threatened by impending climate change which may limit the availability of water resources in the basin. The purpose of this analysis was to investigate the relation between average snow water equivalent (SWE) and naturalized flow in the Colorado River. Data was analyzed from the high- resolution University of Arizona SWE product (Dawson; Broxton; Zeng, 2018) over the Upper Colorado River Basin and compared to naturalized flow in the Colorado River at Lee's Ferry. A Pearson correlation test was then performed on the five-year moving averages of each dataset to establish the statistical relation between the two continuous variables. The Pearson correlation coefficient was 0.90, indicating a strong positive correlation between SWE and naturalized flow. Additional correlation tests were performed on the raw (unaveraged) data to further characterize this association and explore the potential for seasonal flow forecasting. SWE data was analyzed when unlagged, and then lagged one to three months. The correlation tests resulted in coefficients of 0.10 when unlagged to 0.80 at three months.

Assessment of Sensitivity of Mountain-Block Hydrology to Heterogeneous Soil Depth and Recharge

Garrett Rapp, Laura Condon and Katie Markovich

Hydrology and Atmospheric Sciences
The University of Arizona

Understanding the subsurface hydrology of mountain-block systems is vital to assessing the impacts of climate change on valley-fill groundwater basins that depend on recharge originating from the mountain block. To date, groundwater modeling studies of mountain-block recharge (MBR) have represented the mountain-block system with homogeneous soil and bedrock layers and constant recharge rates over the mountain block. The effects of heterogeneous precipitation and mountain-block geology on the partitioning of recharge between baseflow and MBR have not yet been examined. This study's goal is to understand how subsurface structure and spatiotemporal variations in recharge affect MBR flowpaths, using a watershed in the Santa Catalina mountains north of Tucson, AZ as a case study. We use the fully integrated hydrology model ParFlow coupled with the EcoSLIM particle-tracking code to map flowpaths and hydrologic residence times to assess the sensitivity of MBR flowpaths to these heterogeneities. Once baseline homogeneous scenarios are simulated, several scenarios will be run varying the depths of the upper layers of the subsurface and later varying the spatiotemporal recharge forcings on the mountain block to simulate the range of physically realistic conditions. Results of this work can inform future modeling efforts and guide data collection in mountain-block systems.

A Satellite View of Land-Atmosphere-Ocean Interactions In The Amazon Basin

Jack Reeves-Eyre and Xubin Zeng

Hydrology and Atmospheric Sciences
The University of Arizona

The Amazon river system has by far the largest runoff of any river on Earth. Annual mean rainfall of over 2000 mm/yr (Tucson receives ~300 mm/yr) is fed by atmospheric convergence of moisture from the tropical Atlantic, as well as recycling of evapotranspiration. A significant fraction of this precipitation runs off into river channels and is routed to the ocean. Amazon discharge into the Atlantic Ocean affects ocean salinity over a significant area, with consequent effects on sea surface temperature and ocean-atmosphere interactions.

Past studies have suggested that, perhaps surprisingly, interannual Amazon discharge variability has relatively little effect on interannual ocean salinity variability. However, these studies have typically used only a subset of available salinity information and have relied on inland river gauges. Here, we use a range of satellite, reanalysis and in-situ data to create a holistic picture of the Amazon water cycle and better understand the discharge-salinity relationship.

Applying thermal infrared imaging to calculate spatial and temporal evaporation rates at the Landscape Evolution Observatory

Brianna Rupkalvis and Peter Troch

Hydrology and Atmospheric Sciences
The University of Arizona

Since the 1970's, scientists have seen the potential for thermal infrared imaging to deduce soil moisture and soil evaporation. Progress in remote sensing and satellite development has applied this theory into site specific soil moisture projects, including application through the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). Global projects, like the Soil Moisture Active Passive (SMAP), rely on microwave wavelengths to measure water content in the top 5cm of soil. Currently, only aerial and satellite imagery provides a 2m to 1km resolution over their kilometer swaths, which vary in topography, land type, vegetation, and geology.

The Biosphere 2, and more specifically the Landscape Evolution Observatory, offers a unique opportunity to study thermal imagery over a 0.7cm fine resolution on a homogeneous, zero order drainage basin. An ICI 9640P infrared camera will acquire 4.6m x 3.4m spectral images from 7μm - 14μm wavelengths of this bare soil hillslope. From these spectral images, spatial and temporal surface temperature variations can determine surface variations in soil moisture content and evaporation rates. This future research would provide comparison between remote sensing images and insitu measurements, and further our understanding of the surface water budget.

Impact of Wildfire on Solute Fluxes in Forested Catchments, Jemez River Basin, New Mexico, USA.

R. Andrés Sánchez, Thomas Meixner,
Jennifer McIntosh, and Jon Chorover[1]

Hydrology and Atmospheric Sciences
The University of Arizona

High severity wildfires of conifer forests are thought to be responsible for the majority of long-term landscape erosion. As post-fire erosion occurs, mineral surfaces are exposed to the environment intensifying weathering processes, and consequently altering nutrient cycling. Furthermore, similarly to what occurs in a wildfire, catchments that experience harvesting or deforestation show shifts in net fluxes of elements such as calcium, silicon and aluminum. Additionally, the burned vegetation releases nutrients and other elements that are transported down gradient via overland flow, shallow subsurface flow, and/or groundwater flow.

In 2013, the Thompson Ridge wildfire burned headwater catchments in the Jemez River Basin Critical Zone Observatory (JRB-CZO) within the Valles Caldera National Preserve, New Mexico USA. This study investigates the impact of the wildfire on solute fluxes to the surface water, including how these disturbances evolve with time, and how biogeochemical processes control post-fire solute concentrations in the surface water.

Comparison of pre- and post-fire surface water solute chemistry among the three watersheds shows increases in major cations following fire. Base cation concentrations (e.g., Ca, K and Na), increased immediately within a few weeks after the fire, likely related to leaching from combusted organic matter. These high fluxes persisted for approximately two months, and returned to pre-fire levels only for Na, while Ca and K concentrations stayed high for over two years.

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[1]Soil, Water and Environmental Sciences, University of Arizona, Tucson, Arizona

A citizen science approach to monitoring water resources in a vulnerable aquifer

Sean Schrag-Toso, Kristine Uhlman, RG[1],
and Jennifer McIntosh

Hydrology and Atmospheric Sciences
The University of Arizona

Changing groundwater recharge conditions due to climate change and increasing demand of groundwater have residents that live within the boundaries of the Sonoita Creek Watershed in Southeastern Arizona concerned about future groundwater availability and dwindling spring flow. The Patagonia Mountains, which provide nearly a quarter of Sonoita Creek's flow, are composed of fractured bedrock and little is known about how changing recharge conditions and increasing demand will affect spring flow and groundwater levels. To address these concerns, and advance the hydrologic understanding of the mountains, a two-phase project is proposed. The first phase is analysis of isotope ratios and the geochemistry of local springs to better understand water's movement within the mountain's fracture systems. These insights, coupled with available data and knowledge on the area's hydrology will guide the development of a conceptual model of groundwater flow within the Patagonia Mountains. The second phase is the creation of a monitoring plan that is within a local citizen science group's resources, capabilities, and level of enthusiasm. Regular collection of data by the group will contribute to future hydrologic studies within the basin, and aid in making management decisions around water use by the Town Council.

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[1]Bureau of Economic Geology, University of Texas at Austin, Independent Consultant

Comparing different sounding parameters at KTUS to flood reports during the monsoon across Southeast Arizona from 1990-2017

Kevin J. Strongman, Aaron Hardin[1],
and Daniel Leins[1]

Hydrology and Atmospheric Science
University of Arizona

The Southwest Monsoon brings many forecast challenges for the Tucson Weather Forecast Office (WFO) between the June to September months. One of the forecast challenges the WFO faces during the season is how active the monsoon will be on that particular day and what impact storms will have on the area such as flooding. Upper air sounding data provides a snapshot of the structure of the atmosphere, and is a very useful tool to forecasters in determining how active storms will be and what their impacts to life and property will be.

This study looks to investigate how upper air sounding parameters vary based on the number of flooding reports during the monsoon using upper air data from KTUS between 1990-2017. Some of the parameters considered include precipitable water (PWAT), surface-700mb mixing ratio, convective available potential energy (CAPE), and wind direction. The goal is to evaluate each parameter and determine which parameters could be an indicator of increased chances of heavy rainfall and flooding. This knowledge could greatly increase the forecaster's confidence when issuing Advisories, Watches, and Warnings during the monsoon season.

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[1]National Weather Service

Implementing the wet-bulb temperature snowfall parameterization in Noah-MP land surface model over CONUS

Yuan-Heng Wang, Patrick Broxton[1], Guo-Yue Niu,
Ali Behrangi, and Xubin Zeng

Hydrology and Atmospheric Sciences
The University of Arizona

Snow constitutes a valuable water resource and plays an important role both for regulating hydrological processes as well as affecting the earth's climate system. Accurate estimation of snowpack states is important for improving numerical weather prediction forecasts, climate prediction, and water resources management. Therefore, it is essential that models used to simulate global climate and hydrological processes can accurately describe the evolution of snowpack. This study evaluates a new snowfall scheme using the wet bulb temperature in the Noah-MP land surface model (versus the original dry bulb temperature scheme) against the ground-based, UA snow data products from 1982 to 2015 across the conterminous United States (CONUS). We a) compared the climatological mean and temporal trend between the model and the UA data product, b) evaluated the model skill for two snowfall schemes for each USGS Hydrologic Unit Code 2 (HUC2) basin, and c) examined topographic effects on the modeling biases. The results indicate that using the wet bulb temperature as a criterion for snowfall improves the simulation over the mountainous US West and hopefully may improve the snowmelt runoff prediction by WRF-Hydro, the hydrological model at the core of the National Water Model.

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[1]School of Natural Resources and the Environment, The University of Arizona.

Enhanced hydroclimatic variability over California post-1950: A synthesis of observed and reconstructed trends

Diana Zamora-Reyes, Valerie Trouet[1] and Bryan Black[1]

Hydrology and Atmospheric Sciences
The University of Arizona

Most of the rainfall over California occurs from November to March and is highly dependent on the frequency of winter storms steered towards the state. Thus, the annual amount tends to vary every year; this was evident in the recent extremely dry-to-extremely wet cycle that caused more than $6 billion in damage throughout California from 2012-2017 through drought, wildfires and floods. The 2015 Sierra Nevada snowpack reached a 500-year low due to below average precipitation and above average temperatures, while in 2017 it was above average due to record-high precipitation totals. Is this extreme-to-extreme pattern normal, or has it occurred in the past?

First, by using 1901-2016 precipitation data, we found that Central and Southern California have a significant positive trend in variability starting in the 1950s. We then extended these results by using hundreds of years of data derived from annual tree-rings, which showed that the variability in both precipitation and streamflow over the same region has been steadily increasing since the 1950s reaching unprecedented levels at present. This has substantial implications for water resources and management, as they will become more unstable and extreme natural hazards will become more frequent in the future as suggested in previous studies.

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[1]Bryant Bannister Laboratory of Tree-Ring Research, University of Arizona, Tucson, Arizona

Investigating How Water Vapor Emission Impacts the Temperature of the Troposphere

Annalisa Minke

Junior, Immaculate Heart High School, Oro Valley AZ

SARSEF Grand Award: 1st Place;
ISEF Finalist and UA Scholarship

Human industry and transportation releases 3.3E+10L of water vapor through chemical reactions every year. As the released water vapor rises, it may contribute to the warming of earth's atmosphere, because it has a uniquely high specific heat allowing it to carry significant energy. In this project, a scaled model of the atmosphere was built to test the effect of water vapor on temperature. A dry ice and acetone mixture was used as a refrigerant at the top of the model to simulate low temperatures at very high altitudes. Pressure variation was simulated by varying the volume of the model to correlate to the number of molecules in the atmosphere. To test the research question, controlled amounts of water vapor were injected into the model in 1 milliliter increments. The temperature of the zone, where the temperature was 0ºC, increased by 0.7ºC per milliliter of water added. The water vapor caused a lasting temperature effect at about 6500 m or 0.65 scale meters, because the water vapor releases its energy when it freezes. Water vapor only had a transient and minimal effect at the top and bottom of the laboratory model, because the total energy introduced was small compared to the column thermal mass. On a global scale, 1 milliliter of water in the model is equivalent to 1.46E+14 liters in earth's atmosphere. At the current rate of hydrocarbon combustion the mid atmosphere temperature could rise about 0.7ºC every 12 years because of water vapor that is produced.

EARTHWEEK

EarthWeek at the University of Arizona, March 25-29, 2019, is organized by the graduate students of the combined departments of the School of Earth and Environmental Sciences, a powerhouse of environmental research focused on natural resources, soil and water, geological sciences, hydrology, atmospheric sciences and tree-ring research.

Monday | 25 March
El Día del Agua y la Atmósfera
Annual Hydrology and Atmospheric Sciences (HAS)
Student Research Symposium

Tuesday | 26 March
Laboratory of Tree Ring Research (LTRR)

Wednesday | 27 March
School of the Environment and Earth Sciences (SEES)
EarthWeek Plenary Schedule

Thursday | 28 March
School of Natural Resources and the Environment (SNRE)
GeoDaze - Departments of Geosciences (GEO)
Soil, Water and Environmental Science (SWES)

FRIDAY | 29 March
GeoDaze - Departments of Geosciences (GEO)

PLENARY SCHEDULE

WEDNESDAY | 27 March
School of the Environment and Earth Sciences (SEES)

2:00 - 3:00 pm
Grad Student Lightning Talks
Student Union - North Ballroom

3:00 - 3:15 pm Coffee Break

3:15 - 4:15 pm Keynote Speaker
Antonio Busalacchi, President
University Corporation for Atmospheric Research
a nonprofit consortium of North American universities
collaborating on earth systems research
North Ballroom

4:30 - 6:00 pm Happy Hour/Poster Session
Join us for a combined happy hour and poster session
featuring student research from across the
School of Earth and Environmental Sciences
North Ballroom

EARTHWEEK KEYNOTE SPEAKER

Antonio J. Busalacchi

President of UCAR

Wednesday, March 27, 2019
3:15 – 4:15 pm
Student Union North Ballroom

Dr. Busalacchi will be giving his keynote speech for the School for Earth and Environmental Sciences' (SEES) Earth-Week Plenary Session on March 27th at 3:15 – 4:15pm at the Student Union North Ballroom. Join us for Graduate Student Lightning Talks from all SEES departments from 2:00—3:00 pm, along with a Happy Hour and Poster Session after Dr. Busalacchi's Keynote talk.

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