The University of Arizona
Department of
Hydrology & Atmospheric Sciences
Presents

El Día del Agua y la Atmósfera

April 9, 2018
Student Union Grand Ballroom

"Sunset cloud and downdraft at UA"
Tucson, Arizona
By Daile Zhang

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Join us Next Year
for
El Día del Agua y la Atmósfera
on
Monday, March 25, 2019

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, 2018. 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 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 2018. 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, 2018!

HASSA Officers

HASSA Officers

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Not pictured:
Jessica Lynum, Undergraduate Representative

El Día del Agua y la Atmósfera 2018 Schedule

8:00-9:00 Conference Registration, Breakfast and Opening

8:00-8:45 Registration and Breakfast

8:45-8:55 Opening and Welcome: Eric Betterton, Department Head, Hydrology & Atmospheric Sciences

8:55-9:00 HASSA President: Victoria Hermosilla

9:00-10:00 Oral Session 1: Beneath the Surface
Moderator: Erin Gray

9:00-9:15 Alissa White: Characterizing hydrologic flow paths and groundwater-surface water dynamics in a high elevation volcanic catchment

9:15-9:30 Libby Kahler: Application of feedback analysis in hydrological modeling

9:30-9:45 Tim Lahmers: Enhancements to the WRF-Hydro Hydrologic Model Structure for Semi-arid Environments

9:45-10:00 Rodrigo Valdés-Pineda: Intensified Atmospheric Rivers due to a Warmer Climate: What are the potential hydrological changes in the SRP Basins?

10:00-11:00 Poster Session 1: Poster Session—All Hydrology and Atmospheric Science Fields.

11:00-12:00 Oral Session 2: Between the Mediums
Moderator: Rebecca Stolar

11:00-11:15 Ravindra Dwivedi: Importance of soil and fractured bedrock storage in sustaining vegetation productivity and streamflow for sub-humid mountainous catchments

El Día del Agua y la Atmósfera 2018 Schedule (continued)

11:00-12:00 Oral Session 2: Continued

11:15-11:30 Jack Reeves Eyre: Ocean Salinity Stratification in Models and Observations

11:30-11:45 Antonio Meira: Hydrologic assessment of bio-geochemical interactions at the sub-meter scale

11:45–12:00 Jack Anderson: Bioswales: Benefit or Burden?

12:00-1:00 Luncheon: Buffet Lunch in the South Ballroom

12:20-1:00 Luncheon Speaker Lt. Col. Stephen Maile - "Mission of the 25th Operational Weather Squadron"

1:00-2:00 Poster Session 2: All Hydrology and Atmospheric Science Fields

2:00-3:00 Oral Session 3: Up in the Air
Moderator: Samantha Schwartz

2:00-2:15 Travis Harty: Irradiance Forecasting Using Advected Satellite Images and Data Assimilation

2:15-2:30 Yiyi Huang: A survey of the atmospheric physical and dynamical processes key to the onset of Arctic sea ice melt in spring

2:30-2:45 Ryan Dennis: The Skill of Statistically Forecasting the Early Monsoon Onset in the Southwestern United States at a Sub-Seasonal to Seasonal Time Scale

2:45-3:00 Malori Redman: QBO/Solar modulation of the Madden-Julian Oscillation: A composite analysis

El Día del Agua y la Atmósfera 2018 Schedule (continued)

3:10-3:50 **Panel Discussion:** Students and professionals participate in a Q&A session about career paths and choices.

Featured Guests: Lt Col. Maile, Mekha Pereira, Margaret Snyder, and Amber Sullins

Moderated by: Thomas Galarneau

4:00-5:00 **Keynote Speaker: Sherri Goodman,** "Climate Security for the 21st Century"

5:00-5:30 **Presentation of Awards and Prizes - Katarena Matos**
Central Arizona Project Award Information
Montgomery Prize
Hargis Awards
HAS Best Oral and Best Poster Presentation
Donald R. Davis Undergraduate with Distinction
Eugene S. Simpson Best Undergraduate Poster
HAS Most Outstanding Instructor Awards, Aqua Person
Earthweek Information
Plenary Oral and Poster Presenter Winners

6:00-8:00 **Post-Award Reception and Social** at No Anchovies, 870 E. University Boulevard, for all El Día attendees, students, faculty and visitors.

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Earthweek Plenary Session

Wednesday, April 11, 2018
Student Union North Ballroom
2:00-4:30 PM

Nominated Student

Representing the Department of
Hydrology & Atmospheric Sciences
with a talk between
2:00 - 3:30 pm

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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: Ben Paras, 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, Kyle Rine

HAS Awards of Excellence

Best Oral and Poster (excluding Montgomery and Hargis winners)
Certificate and Award of $400 for each award
Oral Judges: Hsin-I Chang, Dick Thompson, Ali Behrangi
Poster Judges: Brittany Ciancarelli, Michael Brunke, Luis Gustavo De Goncalves

Donald R. Davis Undergraduate Distinction Award

Outstanding Undergraduate Award (Academic or Research)
Certificate and Award of $400
Judges: Timothy Lahmers, Alissa White, Jack Reeves Eyre

Eugene S. Simpson Undergraduate Poster Award

Best Undergraduate Poster in Hydrogeology, Subsurface Hydrology, or Groundwater
Certificate and Award of $400
Judges: Timothy Lahmers, Alissa White, Jack Reeves Eyre

Aqua Person Awards

HAS Most Outstanding Instructor Awards
Judges: HAS Students

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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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.

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

Lt Col Stephen J. Maile
Commander
25th Operational Weather Squadron
Davis-Monthan Air Force Base

Lt Col Maile is the commander of the 25th Operational Weather Squadron at Davis-Monthan AFB, Tucson AZ. He leads a 173-member squadron responsible for executing weather operations in support of Department of Defense military operations and installations across the western United States and the US Southern Command areas of responsibility. Lt Col Maile received his Bachelor of Science in Meteorology from Penn State, commissioning through the Reserve Officer Training Corps program in 2000. His previous assignments include operations support to Air Force Special Operations Command flying squadrons and serving as the Staff Weather Officer to US Army's 2nd Infantry Division in Korea. He was also the Director of Operations for the 23d Weather Squadron at Hurlburt Field FL as well as the 33d Student Squadron at Maxwell AFB AL and has deployed in support of Operations ENDURING FREEDOM and IRAQI FREEDOM. Prior to his current position, Lt Col Maile was the Executive Officer to the Air Force Director of Weather, Mr Ralph Stoffler, at Headquarters U.S. Air Force, Pentagon, Washington

"Mission of the 25th Operational Weather Squadron"

Lt Col Maile will provide a presentation on the organization of Air Force weather and the scope of responsibilities of the 25th Operational Weather Squadron (25 OWS), which encompass a 16 million square-mile forecast area covering the western United States, as well as all of Central and South America. He will also discuss some of the unique missions that the Airmen of the 25 OWS directly support. Additionally, Lt Col Maile will discuss Air Force climate services and how that information is leveraged in Department of Defense decision-making.

El Día del Agua y la Atmósfera
Keynote Lecturer
4:00 - 5:00 pm
Student Union North Ballroom

Dr. Sherri Goodman
Woodrow Wilson International Center and Center for Climate & Security

Sherri Goodman, Senior Fellow at the Wilson Center's Environmental Change and Security Program and Polar Initiative, is credited with educating a generation of U.S. military and government officials about the nexus between climate change and national security, using her famous coinage, "threat multiplier," to fundamentally reshape the national discourse on the topic. A former first Deputy Undersecretary of Defense (Environmental Security) and staff member on the Senate Armed Services Committee, Goodman has founded, led, or advised nearly a dozen research organizations on environmental and energy matters, national security and public policy.

See next page for Seminar Abstract.

"Climate Security for the 21st Century"

Climate change directly affects America's national security in key ways: First, climate instability is a complicating factor in deploying America's military in increasingly unstable climate conditions, from rising sea levels to drought to extreme weather events. America's military needs to prepare to operate in a variety of new conditions, from hotter temperatures across the Middle East and Africa, to colder and harsher conditions in the Arctic Climate change acts as a "threat multiplier" for instability in some of the most volatile regions of the world. Climate change leads to food and water insecurity, and increasing migration flows, all of which can lead to instability. America's military is the global "911" disaster response force, and is increasingly called upon to provide humanitarian assistance and disaster response in climate stressed regions.

Second, climate change is forcing changes in the way our military trains, equips the force and operates its major bases. Military installations are vulnerable to sea level rise, storm surge and coastal inundation. Many key coastal bases will be at risk in coming decades, from Norfolk to San Diego. Many bases in the West and Southwest face higher wildfire risk and longer wildfire seasons, also requiring military support to civilian authorities to combat wildfires. More severe and frequent hurricanes compromise the readiness of military bases and require the force to support civilian first responders and provide emergency response. Higher temperatures and water stress compromise military readiness.

The world in the 21st century is characterized by both unprecedented risk and unprecedented foresight. Climate change, population shifts and cyber-threats are rapidly increasing the scale and complexity of risks to international security, while technological developments are increasing our capacity to foresee those risks. This world of high consequence risks, which can be better modeled and anticipated than in the past, underscores a clear responsibility for the international community: A "Responsibility to Prepare." This responsibility, requires a reform of existing governance institutions to ensure that critical, nontraditional risks to international security, such as climate change, are anticipated, analyzed and addressed systematically, robustly and rapidly by intergovernmental security institutions and the security establishments of nations that participate in that system.

Panel Discussion
Career Paths and Choices
3:00-3:45

The Departments of Hydrology and Atmospheric Science students will participate in a panel discussion related to career paths and choices made by hydrologist and atmospheric scientist. There are no concurrent oral or poster sessions during this time so all HAS graduate and undergraduate students are encouraged to participate.

This year's panel discussion will cover the career paths and choices made by our featured guests:

- Thomas Galarneau—Assistant Professor, Hydrology & Atmospheric Sciences, Moderator
- Lt Col Maile, Commander 25th Operational Weather Squadron, Davis-Monthan Air Force Base
- Mekha Pereira, Recent HAS Graduate with a Bachelor"s in Hydrology
- Margaret Snyder, Tucson Water, Clear Water Program Manager
- Amber Sullins, ABC 15 News, Phoenix Chief Meteorologist

Students will have prepared questions, and panel will receive more questions during discussion.

The focus topics are:
- Personal experiences in the panelists jobs
- Work/life balance
- Role of networking in career paths

ORAL PRESENTATIONS

HAS STUDENTS

Characterizing hydrologic flow paths and groundwater-surface water dynamics in a high elevation volcanic catchment

Alissa White, Bryan Moravec[1], Yaniv Olshansky[1], Jennifer McIntosh, and Jon Chorover[1]

Department of Hydrology and Atmospheric Sciences
The University of Arizona, Tucson, Arizona

In a high elevation volcanic catchment in the Jemez River Basin Critical Zone Observatory within the Jemez Mountains of Northern New Mexico, a bimodal precipitation pattern creates different hydrologic flow regimes during spring snowmelt and summer monsoon events. Previous work using concentration-discharge relationships and end member mixing analyses has suggested that hydrologic flow paths vary seasonally. This study tests that hypothesis and explores the hydrologic connection of surface water and groundwater from various depths by examining their major ion chemistry and elemental ratios. Downhole neutron probe surveys in three groundwater wells are used to investigate how wetting fronts propagate through the vadose zone via vertical infiltration or lateral subsurface flow. This study also combines observations of groundwater table elevations, streamflow, and precipitation accumulation to test the hypothesis that the highly heterogeneous structure of the subsurface controls its hydrologic response and the response time of surface water and groundwater to precipitation events. I further hypothesize that fracture versus matrix flow controls water chemistry as water transports solutes through different weathering environments as water table depths rise and fall seasonally.

[1]Department of Soil, Water and Environmental Science, The University of Arizona, Tucson, AZ

Application of feedback analysis in hydrological modeling

Libby Kahler[2], Jesse Dickinson[2], and T.P.A. Ferré

Department of Hydrology and Atmospheric Sciences
The University of Arizona, Tucson, AZ

Feedback analysis has been a standard element of the design of electrical systems for almost one hundred years and has been an important tool in climate change studies for decades. This study is motivated by the lack of feedback analysis in hydrologic science. We propose that feedback analysis can be applied to hydrologic models to identify the most and least stable parts of a hydrologic system. In this study, we focus on modeling groundwater flow systems and quantify a feedback strength, which is a relative index of the importance of a feedback mechanism in regulating the system response to an external stress. Resource managers may use the feedback strength as a tool to identify and protect the least stable areas, or identify the feedback mechanisms in stable areas that could be developed to enhance stability in more vulnerable areas. This project builds on feedback analysis of simple electronic circuits, borrows from advances in the atmospheric sciences, and develops a new feedback analysis for groundwater systems and models.

[2]U.S. Geological Survey, Tucson, Arizona

Enhancements to the WRF-Hydro Hydrologic Model Structure for Semi-arid Environments

Timothy M. Lahmers, Hoshin Gupta, Pieter Hazenberg, Christopher L. Castro, David J. Gochis[1], David Yates[1], Aubrey Dugger[1], David C. Goodrich[2]

Department of Hydrology and Atmospheric Sciences
The University of Arizona, Tucson, Arizona

The NOAA National Water Center (NWC) implemented an operational National Water Model (NWM) in August 2016 to simulate and forecast streamflow and soil moisture throughout the Contiguous US (CONUS). The NWM is based on the WRF-Hydro hydrologic model architecture, with a 1-km resolution Noah-MP LSM grid and a 250m routing grid. The operational NWM does not currently resolve infiltration of water from the beds of ephemeral channels, which is an important component of the water balance in semi-arid environments common in many portions of the western US. This work demonstrates the benefit of a conceptual channel infiltration function in the WRF-Hydro model architecture following calibration. The updated model structure and parameters for the NWM architecture, when implemented operationally, will permit its use in flow simulation and forecasting in the southwest US, particularly for flash floods in basins with smaller drainage areas. Our results show that adding channel infiltration to WRF-Hydro can produce a physically consistent hydrologic response with a high-resolution gauge based precipitation forcing dataset in the USDA-ARS Walnut Gulch Experimental Watershed. NWM WRF-Hydro is also tested for the Babocomari River, Beaver Creek, and Sycamore Creek catchments.

[1]National Center for Atmospheric Research, Boulder, Colorado
[2]USDA-ARS, Southwest Watershed Research Center, Tucson, Arizona

Intensified Atmospheric Rivers due to a Warmer Climate: What are the potential hydrological changes in the SRP Basins?"

Rodrigo Valdés-Pineda, Itinderjot Singh[1], Eleonora Demaria[2], Francina Dominguez[1], and Juan B. Valdés

Department of Hydrology and Atmospheric Sciences
The University of Arizona, Tucson, Arizona

Recent studies have found that Atmospheric Rivers can be intensified as a consequence of a warmer climate. These intensified narrow bands of enhanced water vapor transport lead to spatio-temporal changes in precipitation and temperature; and these changes are strongly related to the spatio-temporal distribution of hydrologic fluxes at catchment scale i.e. streamflows, snow water equivalent, evapotranspiration, and soil moisture distribution, among others. The objective of this talk is to describe and quantify the hydrological changes derived from the five most intense ARs events that affected the Salt and Verde River basins in Central Arizona between 1980 and 2010. These two basins are important for the Salt River Project (SRP) that produces hydroelectricity and store water for the megacity of Phoenix. The intense ARs events were simulated for a control and a future scenario using the WRF regional climate model. Deltas in precipitation and temperature were calculated for each AR event, and then used to generate perturbed daily precipitation and temperature fields to feed the Variable Infiltration Capacity (VIC) Model. The model was calibrated and validated to simulate control and future scenarios of daily streamflows for both basins. The changes of the hydrological fluxes derived from the VIC model results (control versus future scenario) are analyzed and discussed in terms of their spatio-temporal distribution, and their potential effects in the storage capacity of the SRP system.

[1]Department of Atmospheric Sciences, University of Illinois Urbana-Champaign
[2]USDA-ARS, Southwest Watershed Research Center, Tucson, Arizona

Ocean salinity stratification in models and observations

Jack Reeves Eyre and Xubin Zeng

Department of Hydrology and Atmospheric Sciences
The University of Arizona, Tucson, Arizona

Salinity plays an important part in ocean vertical mixing processes, and therefore affects exchange of heat, momentum and moisture between the atmosphere and ocean. In turn, the atmosphere affects (surface) salinity through precipitation, which decreases salinity, and evaporation, which increases salinity. Some regions of the ocean, for example rainy regions in the tropics, have increasing salinity with depth in the upper ocean, which inhibits vertical mixing and may affect the propagation of internal waves that can play a role in climate variability.

The portrayal of such features, termed barrier layers, in coupled earth system models has not been widely studied, and here we present results from several models and observations. The questions we attempt to address are: Do models represent barrier layers in agreement with observations? Are biases in salinity related to biases in precipitation and/or sea surface temperature? Are there connections between salinity biases and SST and precipitation variability - for example El Nino Southern Oscillation or the Madden-Julian Oscillation?

Importance of soil and fractured bedrock storage in sustaining vegetation productivity and streamflow for sub-humid mountainous catchments

Ravindra Dwived, T. Meixner, J. McIntosh, T. Ferré, C. Eastoe[1], C. Castro, GY Niu, R. Minor[2], J. Knowles[2], GA Barron-Gafford[2], N. Abramson[3], B. Mitra[5], M. Stanley[6], J. Chorover[4]

Department of Hydrology and Atmospheric Sciences, The University of Arizona, Tucson, Arizona

Mountainous catchments provide critical water and ecosystem services for adjacent lowlands in xeric regions, yet a better understanding of the role of catchment water storage in provisioning these services remains a grand challenge for hydro-ecologists. Here, we performed catchment-scale water balance and baseflow recession analyses for understanding the role of ecohydrologic and hydraulic storages on ecosystem and streamflow sustainability within the high-elevation Marshall Gulch catchment in the Santa Catalina Critical Zone Observatory. Using long-term (2009-2017) observations of hydraulic fluxes and shallow water stores, results indicate that the ecosystem is not in a steady-state and is still responding to recent fire, i.e. Aspen fire in 2003. During the dry season, following spring snowmelt and before the summer monsoons, most of the vegetation productivity is maintained by shallow water storage providing water at a rate of 0.9 (±0.23) mm/day. A comparison of ecohydrologic and hydraulic storage estimates further shows a strong relationship (r^2=0.70) between the two reservoirs, with ecohydrologic storage being greater by a factor of 2.5. Finally, the results indicate groundwater storage available for vegetation productivity in this mountainous catchment is larger than the storage available for sustaining streamflow, which suggests greater resiliency of the terrestrial ecosystem to climate-induced water stresses.

[1]Department of Geosciences (retired), The University of Arizona
[2]School of Geography and Development, The University of Arizona
[3]Biosphere-2, The University of Arizona
[4]Department of Soil, Water and Environmental Science, The University of Arizona
[5]College Station, University of Texas
[6]Mt. Lemmon Water District, Tucson, AZ

Hydrologic assessment of biogeochemical interactions at the sub-meter scale

Antonio Alves Meira Neto, Aditi Sengupta[1], Yadi Wang[2], Jon Chorover[2], Ty Ferré, Peter Troch

Department of Hydrology and Atmospheric Sciences
The University of Arizona, Tucson, Arizona

The understanding of processes in the critical zone (CZ) is dependent on studies linking the fields of hydrology, microbiology, geochemistry and soil development. Additionally, there is needed to integrate hydrologic information into biogeochemical analysis of subsurface environments. This study investigated potential hydrological indexes that help explaining spatial biogeochemical patterns observed at the submeter scale. The miniLEO is a 2 m^3, 10 degree sloping lysimeter located at Biosphere 2 - University of Arizona. The lysimeter was initially filled with pristine basaltic soil and subject to intermittent rainfall applications throughout the period of 18 months followed by its excavation, resulting in a grid-based sample collection at 324 locations. As a result, spatially distributed microbiological and geochemical patterns as well as soil physical properties were obtained.

A hydrologic model was developed to simulate the history of the system until its excavation. Following the model calibration, the resulting distributed fields of flow velocities and moisture states were retrieved and translated into hydrologic indices. This study explores what are the relevant hydrologic mechanisms controlling the biogeochemical signatures at the sample scale.

[1]Biosphere 2, The University of Arizona
[2]Department of Soil, Water and Environmental Sciences, The University of Arizona

Bioswales: Benefit or Burden?

Jack Anderson and Thomas Meixner

Department of Hydrology and Atmospheric Sciences
The University of Arizona, Tucson, Arizona

Green infrastructure has been a tool used by cities to mitigate runoff and improve water quality. However there are dozens of guides, both official manuals and informal neighborhood workshops, leading to a wide variety of design choices. This lack of uniformity can be seen in Tucson with the recent advent of bioswales: vegetated basins intended to capture and clean street runoff during precipitation events. With the lack of comprehensive studies, it is unclear if the hundreds of bioswales, representing thousands of dollars and many of hours of maintenance each year, are performing as their original designers envisioned. In order to test performance, bioswales were subjected to a combination of qualitative and quantitative tests. Based on preliminary results there is evidence that supports the use of large boulders and coarse soil for maximizing infiltration, while basins with high organic matter content may actually reduce overall infiltration. When attempting to balance runoff mitigation with street aesthetics in the form of mature vegetation, there is no single "best" bioswale, but standardization of a few designs can lead to better use of city and neighborhood resources.

Irradiance forecasting using advected satellite images and data assimilation

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Satellite images provide a basis for estimating global horizontal irradiance and solar power output over areas on the scale of a city or larger. In this work, we aim to improve satellite derived irradiance forecasts by correcting cloud motion vectors which are used to advect an irradiance or clear sky index (CSI) field. In a data assimilation framework, we improve cloud motion vectors derived from the Weather Research and Forecasting (WRF) model (available every hour) by assimilating satellite images taken from the GOES-15 geostationary satellite (available every 15 minutes), and sparse optical flow vectors derived from successive satellite images. We use a data assimilation technique known as the Local Ensemble Transform Kalman Filter (LETKF). The LETKF is a square root filter in which calculations are performed in the space spanned by ensemble members, a lower dimensional subspace of the state space. This allows for a reduction in computational complexity because the number of ensemble members (around 50) is significantly lower than the dimension of the state space (hundreds of thousands or larger). We present preliminary results showing the effectiveness of this method to produce forecasts as well as to quantify the uncertainty inherent within these forecasts.

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A survey of the atmospheric physical and dynamical processes key to the onset of Arctic sea ice melt in spring

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September sea ice concentration (SIC) is found to be most sensitive to the early melt onset over the East Siberian Sea and Laptev Sea (73°-84°N, 90°-155°) in the Arctic, a region defined here as the area of focus (AOF). Then four early melting years and four late melting years were selected and compared over this area. In the early melting years, the positive Arctic Oscillation (AO) phase is dominant during springtime, which is coupled with a poleward shift of storm tracks, intensified storm activity in the AOF and consequently enhanced northward transport of moist and warm air. As a result, positive anomalies of precipitable water vapor (PWV) and/or cloud fraction and cloud water path were found over the AOF, increasing downward longwave radiative flux at the surface. The associated warming effect further contributes to the initial melt of sea ice. In contrast, the late melt onset is linked to the negative AO phase in spring accompanied with negative anomalies of PWV and downward longwave flux at the surface. The increased downward shortwave radiation during middle to late June plays a more important role in triggering the melting, aided further by the stronger cloud warming effects than normal.

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The skill of statistically forecasting the early monsoon onset in the southwestern United States at a subseasonal to seasonal time scale

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Forecasts at the subseasonal to seasonal timescales have been recognized by the scientific community as having significant socioeconomic value. However, although these forecasts are skillful at forecasting warm season atmospheric teleconnection patterns, they are less skillful at forecasting warm season precipitation, which puts in question their practicality. In this study, the observed 500-hPa atmospheric circulation anomalies in the Northern Hemisphere are related to the dominant patterns of the observed two-month standard precipitation index (SPI) in the continental United States during the early warm season (June and July) from 1979-2011. An empirical orthogonal function analysis and canonical correlation analysis are then applied to determine the dominant coupled modes between the observed teleconnection patterns and SPI with a focus on the southwestern United States. Next, the same procedure is performed on five ensemble members of the CFSv2 reforecast data at a week four to five forecast period from 1999-2010 to determine the dominant coupled modes between the modeled geopotential height anomalies and SPI. These modeled coupled modes are then correlated with the observed coupled modes to determine the statistically significant pattern correlations and whether the CFSv2 reforecast data has any skill in forecasting the early monsoon onset four to five weeks out.

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QBO/Solar modulation of the madden-julian oscillation: a composite analysis

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The Madden-Julian Oscillation (MJO) is the primary driver of intraseasonal weather and climate variability in the tropics, and has been linked to weather variability in the midlatitudes. Recent studies have shown that the stratospheric quasi-biennial oscillation (QBO) modulates the amplitude of the MJO in Northern Hemisphere winter, where larger amplitudes occur during the easterly phase of the QBO (QBOE) compared to the westerly phase (QBOW). Evidence has also been presented that indicates changes in vertical motion in the lower stratosphere are linked to the 11-year solar cycle, where increased (decreased) ascent and reduced (increased) static stability occurs during solar minima (maxima). The largest MJO amplitudes and occurrence rates, and weakest static stabilities in the lower stratosphere occur during the QBOE phase at solar minimum conditions, while the opposite is true during QBOW at solar maximum conditions. The aim of this presentation is to compare MJO events during the above conditions using atmospheric dynamic diagnostics. Preliminary results suggest that the MJO influence on midlatitude flow may be modulated by the QBO and solar cycle. It is suggested that these results are potentially useful for weather and climate applications regarding the effects of stratospheric processes on tropical deep convection and seasonal-to-subseasonal variability.

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POSTER PRESENTATIONS

HAS STUDENTS

Sensitivity Analysis on the Hybrid 3D Hillslope Hydrological model

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Earth System Models (ESMs) are evolving to resolutions of a few kilometers. In this context, one challenging task is to update the parameterizations used to represent the subgrid processes. In particular, Land Surface Models (LSM) included in the ESMs, traditionally have been represented as 1D-columns accounting for fluxes inside the column just in the vertical direction. The subgrid heterogeneity of the soil properties greatly influences the boundary fluxes, hence Hazenberg et al. (2015) developed a computationally efficient hybrid 3D hillslope hydrological model (h3D) for rainfall-runoff processes at hillslope scale, coupling a 1D-column with a pseudo-2D lateral flow (for overland and the saturated zone). The h3D model brings more realistic results for subsurface and overland water flows than the LSMs currently used in the ESMs. This study presents a sensitivity analysis (for an idealized study case) of the h3D model to the initial conditions and to several soil characteristics, including Hydraulic conductivity, rooting depth, soil anisotropy, hillslope shape and slope among others. Quantification of the sensitivity of the h3D model will allows to better conducts the efforts in the implementation of this model into a full LSM, the development of its initialization datasets, and the adjustment of its parameters.

Using neutrons as a rain gauge: new method for hectare-scale average rainfall estimation

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Rainfall distribution has been shown to be highly heterogeneous and therefore point measurements can poorly represent rainfall when applied to field scales. We modified a cosmic ray neutron detector (CRD) to produce soil moisture data for a 10-cm control volume. From the soil moisture time series, we developed an empirical relationship relating soil moisture to the flux of moisture leaving the control volume due to drainage. Using mass conservation principles, a model was developed using superposition of drying curves to inverse model the rainfall fluxes needed to produce the soil moisture time series. This approach was applied to the monsoonal period for three years, from 2010 to 2012, at the Manitou research site. The model has trouble predicting the exact timing of events on an hourly scale but performs better at 6-hour, 12-hour, and 24-hour integrated scales. The model tends to overpredict the magnitude of events smaller than 5 mm and underpredict larger magnitude events. Applying a scaling function that takes into account the changes in the CRD sensitivity as a function of water content improves results. These estimations represent rainfall, spatially averaged at a hectare scale, and further research is needed to assess the validity of these estimations.

The effect of initial irrigation conditions on heap leaching efficiency

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Heap leaching is an unsaturated flow metal recovery process, in which mined ore is irrigated with a lixiviant to dissolve metal contained in the ore. The metal is then extracted from solution. Heterogeneities within the stacked ore can lead to uneven wetting and the formation of preferential flow pathways, which reduces solution contact and lowers metal recovery. Many mine operators believe that slow initial irrigation rates help minimize permeability loss and increase metal recovery rates, but it has not been studied in detail. Experiments were conducted with three different initial irrigation rates in large columns (1.5 m high, 0.5 m in diameter) packed with crushed ore samples that are known to have permeability constraints. Columns were monitored to assess changes in physical and hydraulic properties spatially and temporally. Water content was measured capacitance soil moisture sensors at 9 depths; a neutron probe to periodically log every 30 cm from four different directions; and electrical resistivity sensors to create a 2-dimensional tomography profile of water content over time. A non-reactive tracer was used to characterize advective-dispersive transport under unsaturated conditions. A dye solution was introduced at the end of each experiment to map preferential pathways.

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Helping a town with culvert design and small-scale flooding issues over a roadway critical to emergency services

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For my Master's report, I am working with the small mining town of Superior, Arizona to help with the small-scale flooding issues and a culvert design to mitigate said issues. Every year during the monsoon season the crossing of Queen Creek over Mary Drive floods and is impassable for around eight to ten days in total. This presents a serious problem for emergency services, as the town's only fire station lies on the south side of the crossing. When the crossing floods, the fire trucks or law enforcement have to take a detour lasting at minimum five minutes. These few minutes are very precious in an emergency situation. Seeing a problem and wanting to help find a solution, I got into contact with the county engineer and the town manager to come up with a plan. The first step was to determine the peak flow values for storms of various return intervals. This involved the SCS Curve Number method and HEC-HMS. The next step was to use FHWA's HY-8 program to create some preliminary culvert designs. And the last and current step is to use HEC-RAS to better model Queen Creek with the peak flows and the culvert designs.

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

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The Dolores River in Colorado is a tributary to the Colorado River and is widely known for its high salinity content, particularly in the Paradox Valley where the salt-containing Paradox Formation comes close to the surface. Previous research has identified dissolution of halite and gypsum as the main contributor to salinity in the shallow aquifers and Dolores River. This study aims to determine the contribution of deeper fluids such as, connate brines, associated with the Paradox Formation into shallow aquifers and the river. In addition, we aim to constrain the extent of halite and gypsum dissolution and removal of salt over geologic time; and circulation patterns and rates of solute transport associated with the salt diapir. Water samples will be collected from brine pumping wells maintained by the Bureau of Reclamation, natural springs, and the Dolores River in the Paradox Valley. Samples will be analyzed for their salinity content, solute and isotope chemistry and age tracers (^{4}He, ^{81}Kr, ^{14}C). Results are expected to increase understanding of fluid and solute transport associated with salt diapirism, and salinity loading to the Dolores and Colorado rivers.

Using water isotopes and solute chemistry to investigate the hydrology of surface water in the Cienega Creek Watershed

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Analysis of water stable isotopes and solute chemistry can reveal the source of water in surface water systems, and the nature of the hydrologic connection between surface water and local and regional groundwater. This research uses water stable isotopes (18O, 2H, 34S, 13C), solute chemistry, and tritium to investigate the seasonal sources of water in wetlands (cienegas), Cienega Creek, and the riparian aquifer within the Las Cienegas National Conservation Area (LCNCA) in the upper Cienega Creek Watershed, an area of unique biodiversity in Southern Arizona. Seasonal samples of streams, springs, and shallow groundwater from piezometers along the length of Cienega Creek were analyzed. Wells tapping into basin groundwater were also sampled. Preliminary results suggest that surface water and water in the shallow alluvial aquifer is a mixture of primarily basin groundwater recharged prior to the 1950's with a smaller component of more recent recharge. The apparent reliance on basin groundwater implies that surface water in LCNCA could be impacted by changes in the regional water table. This insight, as well as baseline hydrologic data that this research provides, will aid research efforts and help inform groups interested in the preservation of surface water within LCNCA regarding future management decisions.

Comparison of Runoff Data to Assess Impact of Stormwater Green Infrastructure

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To address impacts of stormwater on water quality and quantity, urban areas have developed policies and approaches to increase stormwater capture for use and/or infiltration (Miles and Band, 2015). Infrastructure used to promote on-site retention of stormwater for infiltration, harvesting, and/or evapotranspiration is referred to as green infrastructure, or more specifically, stormwater green infrastructure (SGI, e.g. Jaffe et al., 2010, Pennino et al., 2016). In arid and semi-arid environments such as the southwestern United States, SGI is implemented to address issues related to water retention, groundwater recharge, urban heat island effects, and nuisance flooding as a result of intense rainfall. Taking advantage of the City of Tucson as a living laboratory, the impact of SGI on stormwater runoff is investigated. Stormwater infrastructure in Tucson is dominated by drainage from roadways to ephemeral stream channels. In order to assess the affect of SGI on hydrological processes, runoff stage data is being collected in two urban, ephemeral washes, both upstream and downstream of SGI installation. This poster discusses methods and preliminary results of assessing variability in runoff volumes and hydrographs of these washes attributed to contributing area, contributing land use cover, and contributing area SGI installation.

Modern fluid indicators of sources and migration of paleofluids in the Colorado Plateau

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The Paradox Basin, located in SE Utah and SW Colorado, contains iconic regional sandstone bleaching, evidence of basinal-scale hydrocarbon and metal migration, and extensive evaporite deposits. Brines associated with the Paradox Formation (salt) are mostly connate waters derived from evaporated paleoseawater. There is also evidence of brines formed by salt dissolution associated with meteoric recharge. As part of a large, interdisciplinary project recently funded by the Keck Foundation, we aim to identify the sources, residence time, and migration mechanisms of modern (remnant) fluids in the Paradox Basin to better understand the paleofluid flow history of the Colorado Plateau. Our study will focus on characterizing the chemical and isotopic composition of formation waters and associated hydrocarbons, noble gases, and carbon dioxide. Krypton isotopes (^{81}Kr) will be used for the first time to 'date' near-surface saline fluids and better constrain crustal ^{4}He fluxes and 'ages' of deeper fluids. Various sample locations and depths will be considered to characterize the spatial and depth distribution of modern fluids. Results will be used to validate a basin-scale hydrodynamic model and coupled to evidence of paleofluid flow in the rock record.

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Towards understanding hydrologically-significant geologic connectivity

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I am investigating how geologic structures can influence subsurface flow behavior. Using MODFLOW, I simulate flow through randomly-generated, heterogeneous conductivity fields. Then, I investigate the relationship between geologic connectivity and effective hydraulic conductivity. The goal is to identify how structure impacts flow. Ultimately, this could allow for the use of geophysical images to better predict field-scale subsurface flow behavior.

Paleoflood hydrology on the lower Green River, upper Colorado River, Utah

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Through a comprehensive paleoflood investigation, employing the abductive mode of inference, we document natural evidence of 70 paleofloods at six sites on the Lower Green River, Utah. Hydraulic analysis, using the Sedimentation and River Hydraulic-2D model (SRH-2D), shows that the responsible peak paleoflood discharges ranged between 507 and 7499 m^3/s. At least 14 of these paleoflood discharge peaks exceed a level twice that of the maximum systematic gauged flow of 1929 m^3/s. Geochronological analysis, employing optically stimulated luminescence (OSL) and radiocarbon dating techniques, demonstrates that these 14 paleoflood peaks occurred in the past 700 years. Integrated of these paleoflood data into flood frequency analyses (FFA) showed higher values for the upper tails of the flood distribution than did an FFA based only on the systematic record, showing that extreme floods are more frequent than indicated by the relatively short gauged records. Through philosophical examination the three approaches to extreme flood estimation, FFA, probable maximum flood estimation, paleoflood hydrology, we show the significance of the natural evidence for advancing the scientific understanding of extreme floods.

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Investigation of hydrological response of three identical artificial hillslopes at the Landscape Evolution Observatory

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Hydrological processes at the hillslope scale are complex and monitoring hillslopes with a large number of sensors or replicate experimental designs is rarely feasible. The Landscape Evolution Observatory at Biosphere 2 consists of three, large (330 m^2) artificial hillslopes packed with 1-m depth of initially homogeneous, basaltic soil. Each landscape contains a spatially dense network of sensors capable of resolving meter-scale lateral heterogeneity and sub-meter scale vertical heterogeneity in moisture content and water potential, as well as the hillslope-integrated water balance components. The three hillslopes are thought to be nearly identical, however recent data showed significant differences in discharge and storage behavior. A 45-day periodic-steady-state tracer experiment was conducted in November and December of 2016, where a 3.5-day long, identical irrigation sequence was repeated 15 times. Each sequence's rainfall, runoff, and storage dynamics were recorded, and distributed moisture characteristics were derived using paired moisture content and matric potential data from 496 positions in each hillslope. In order to understand why the three hillslopes behave hydrologically different, we analyzed soil water retention characteristics at various scales ranging from individually paired moisture and matric potential to whole-hillslope soil water retention characteristics. The results confirm the distinct hydrological behavior between the three hillslopes.

Comparison of Daytime Low-Level Cloud Properties Derived from GOES and Surface Instruments at ARM SGP

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The daytime single-layered low-level cloud properties retrieved by the Geostationary Operational Environmental Satellite system (GOES) are compared with ground-based observations and retrievals over the Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) Central Facility (SCF) from June 1998 through December 2006. The GOES retrievals are made via the Visible-Infrared Solar-infrared Split-window technique (VISST). Collocated pairs of GOES and ARM cloud properties are produced and comparisons are made for monthly means, diurnal means, and one-to-one for GOES and ARM collocated pairs. The parameters of interest are cloud temperature (T_{eff} for GOES and T_{top} for ARM), height (H_{eff} and H_{top}), cloud-droplet effective radius (r_e), optical depth (τ), and liquid water path (LWP). GOES retrieved T_{eff}, τ, and LWP have excellent agreement with ARM retrievals. Results also show that GOES retrieved mean r_e, τ and LWP values increase with increased solar zenith angle (SZA).

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Using Fresh Water Algae to Remove Lead from Water

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Human exposure to lead (Pb) is a global-priority environmental health concern. Lead(Pb) is a known neurotoxin, and has been linked to diminished IQ and serious health problems, affecting the welfare of millions of people worldwide through natural and anthropogenic contamination of drinking water sources. This project will investigate metal-microbe phytoremediation (removal) of Pb from drinking water using common freshwater algae. The preliminary data show that wet algae packed on filter paper can remove nearly 100 μg Pb per gram of algal biomass. Removal of lead increased with algae availability, as 1.0 mg Pb in a 1-liter water sample was reduced to Pb = 0.45, 0.30, 0.26. Furthermore, a kinetic response was observed for increased reaction durations, indicating that control of Pb sequestration in algae is driven by both diffusion and biochemical interactions. Lead removal by algae showed an inverse relation with free-sulfur, possibly indicating that the mechanism of Pb bioremediation by fresh water algae involves sulfur functional groups. This project investigates contact time, algal species, and removal mechanisms under expected water chemistry conditions of drinking water to further characterize Pb removal, information that will be critical to the development of cost effective and sustainable bioremediation strategies.

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Utilization of environmental isotopes, water geochemistry, and hydrogeologic properties to assess the interconnectedness of shallow aquifers at a copper mining site

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Assessing the interconnectedness of aquifers is an important water resource management practice to mitigate potential migration of contaminants from a mined aquifer (e.g. in-situ copper mining) to adjacent aquifers. This study is focused in the metal-rich Lisbon Valley of the Paradox Basin in south-eastern Utah where numerous faults may act as conduits or barriers to cross-formational flow. Tritium, ^{14}C, and ^{81}Kr lay a foundational groundwork to assess the relative 'ages' of two distinct aquifers separated by an aquitard of varying thickness. Analysis of isotopes such as $\delta^{18}O/\delta D$, $\delta^{34}S\text{-}SO_4$, and $\delta^{18}O\text{-}SO_4$ provide insight into the climate during recharge, regions of source-water recharge, and groundwater flow-paths. Assessment of geochemistry data extending back decades indicates that these two aquifers have distinct geochemical signatures; the upper Burro Canyon aquifer has a calcium-sulfate signature with high TDS and basic pH, while the lower Navajo aquifer has a sodium-bicarbonate water with low-to-moderate TDS and near-neutral pH. Uncorrected radiocarbon 'ages' from 16,000-20,000 BP in the Burro Canyon aquifer and 32,000-42,000 BP in the Navajo aquifer, coupled with low $\delta^{18}O/\delta D$ values relative to modern precipitation, suggests both aquifers contain fossil groundwater recharged during the Pleistocene. Future work may include noble gas age tracers and hydrologic modelling.

Improving Monsoon Precipitation Forecast in Northwestern Mexico and Southwestern US: A Project of Consortium of Arizona-Mexico Arid Environment 2017

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North American Monsoon Precipitation that annually occurs from early July to mid September impacts the water supply, severe weather, droughts, and wildfires in the arid regions of Southwestern US and Northwestern Mexico (Adams and Comrie 1997). The challenge has been how to better forecast the precipitation when the monsoon season comes. Consortium of Arizona-Mexico for Arid Environment (CAZMEX) conducted a field campaign in Sonora, Mexico from June to September 2017 by collecting meteorological data from 15 installed GPS meteorological sites. We look closely at two cases of precipitation, i.e. precipitation generated by inverted trough (27 to 28 July) and precipitation without inverted trough (9 to 10 August). We run WRF model for both cases with data input from GFS and NAM. For validation we use rain gauge data from 25 meteorological sites including our GPS sites in Sonora, four satellite products, i.e GPM-Early, GPM-Final, CMORPH, and PERSIANN, and radar data of NEXRAD in Tucson. The preliminary results show that GPM-Early has less bias against the rain gauge measurement, and WRF-NAM performs better than WRF-GFS in forecasting the 24 hour total of precipitation and hourly precipitation. Data assimilation is being conducted to achieve better forecast.

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

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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 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 will be used to invert tree ring cellulose isotopes to obtain the water source isotopic composition. The variation in water source composition as inferred from the model will then be compared to the river composition over time. By drawing this comparison, it will aide in anticipating consequences from human driven modification including climate change on the river systems.

Evaluating Rainwater-Harvesting Basin Curb-Cuts: How Volunteer Maintenance Impacts Infiltration Rates

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In arid regions, sustainable water management practices are critical for a future with 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 curb cuts connected to rainwater-harvesting basins have been shown to successfully capture storm runoff and create appreciable green spaces. However, the maintenance of curb-cut basins have 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. 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. Numerous curb-cut basins in three Tucson neighborhoods will be evaluated, and the results will be compared to assess any potential correlation between a basin's routine maintenance and its ability to infiltrate water.

What Defines the Effective Hydraulic Conductivity of a Heterogeneous Medium?

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Most geologic processes produce heterogeneous porous materials; therefore, these media have different characteristics, which make them complex systems to analyze. This research, is focused on the bulk behavior of these heterogeneous media, which mostly depends on the particle size distribution and the spatial distribution of the particle size fractions. Thus, we study a medium comprised of two particle sizes as simplest of heterogeneous systems, in order to examine the effect of the percent composition of small and large particles on the bulk hydraulic properties, which are characterized by the effective hydraulic conductivity (Keff). The methods are based on upscaling of an alpha or connectivity parameter to weight the Keff. For this, we examine the full range of geometries that lies between the two end members of a binary medium, when the conductivity (K) is distributed parallel and perpendicular to the flow direction. The results are computed by using groundwater numerical model (MODFLOW) and they validate the hypothesis that one important method analyzed (energy dissipation) explains the Keff by computing the volume weighting of K. This energy dissipation, the alpha parameter, and the changes in the fraction and the distribution of the K inclusions, could make significant changes in Keff results.

Natural tracer study to constrain transit times and flowpaths of groundwater from Davidson Canyon to Lower Cienega Creek

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Multiple reaches of Cienega Creek and Davidson Canyon Wash, located in the Cienega Creek Watershed, Arizona, have been designated as "Outstanding Arizona Waters." These surface waters, riparian areas, and underlying groundwater in alluvial basins are under pressure from threats of increasing groundwater pumping, land use and climate change, and potential mining. Yet, little information is known about the regional hydrogeology, which is important for accessing and protecting the sustainability of natural resources in the area. This study investigates the hydrologic connection between the Santa Rita mountains and lower Cienega Creek, along the Davidson Canyon subwatershed. Davidson Canyon is an intermittent stream with seasonally sustained baseflows and is a large tributary to Lower Cienega Creek. This research aims to: (1) identify areas of recent recharge; (2) determine the relative age and transit time of groundwater; (3) better constrain the Local Meteoric Water Line; and (4) use hydrochemistry and isotopes to evaluate the flowpaths and mixing of groundwater and interaction with surface waters. To address these aims, groundwater and surface water samples were collected seasonally in 2017-2018 and analyzed for major ion chemistry, stable isotopes ($\delta^{18}O$, δD, $\delta^{13}C$, $\delta^{34}S$) and radioactive isotopes (^{3}H and ^{14}C).

Does Soil Moisture Affect Warm Season Precipitation Over the Southern Great Plains?

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Numerous observational and modeling studies have addressed the impact of soil moisture on subsequent precipitation (primarily its initiation), yet consensus remains elusive. Here we quantify the effect of soil moisture on precipitation amplification over the U.S. Southern Great Plains, long considered as one of the global "hot spots" of land-atmosphere interaction, though more recent studies have questioned this designation. Warm season (June-September) days for the 2002-2011 period (with ~1220 total days) are partitioned into low, medium, and high dynamic regimes, among which certain days are identified as afternoon rainfall event days based on simple criteria. We find that antecedent soil moisture conditions are negatively correlated with subsequent afternoon precipitation magnitude for low dynamic regimes, but this correlation becomes positive for high dynamic regimes. In contrast, this correlation is markedly reduced in magnitude and becomes insignificant when all regime days are considered. These results are also confirmed by simple statistics and examination of the diurnal cycle. Furthermore, different pathways are provided for precipitation amplification for low and high dynamic regimes.

Changing Water Sources in Agriculture: Impacts in the Pinal AMA

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As the amount of excess CAP water available to farmers shrinks and the possibility of a shortage declaration on the Colorado looms, farmers in Central Arizona face a loss of Central Arizona Project water. Many will have the ability to replace CAP water by pumping groundwater, which will have an impact on reductions in groundwater overdraft in the region. This study looks at how the economics of farming cotton in the Pinal Active Management Area are affected under different water sources. Crop-water production functions for cotton in the Pinal AMA are estimated using Aquacrop and the profit maximizing level of water applied is calculated under different scenarios.

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