



**Atmospheric Sciences
Doctor of Philosophy (Ph.D.) DEGREE
Departmental REQUIREMENTS**

Fall 2017-Spring 2024

(Updated 12/11/24)

ADVISING

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APPLICATION & REQUIREMENTS

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DEGREE CHECK

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NOTE: This document is meant to guide the student through the complicated path of obtaining a graduate degree. It is not to be regarded as a legally binding contract. If you have any questions please ask.

TABLE OF CONTENTS

SECTION TITLE	PAGE No.
GENERAL REQUIREMENTS	3
GRADPATH FORMS & DEGREE DETAILS	8
HAS QUALIFYING EXAMINATION	12
THE COMPREHENSIVE EXAMINATION	14
THE FINAL ORAL DEFENSE	17
THE FACULTY	19

General Requirements

COURSES

All doctoral students are personally responsible for taking the following steps at the proper times. All forms must be submitted before the deadline dates as scheduled by the Graduate College. See the HAS Graduate Coordinator for information on these. For assistance with any problems, students are encouraged to meet with their Major Advisors, the Director of Graduate Studies, the Graduate Coordinator, the Department Head, and/or the Graduate Student Representatives.

All students seeking a Ph.D. must complete a minimum of 66 units of graduate credit.

36 units of graduate course work in Atmospheric Sciences
12 units of graduate course work in their minor field of study
18 units of dissertation credit
66 total credits

A. The following **core courses**, or their equivalents at other institutions, are **mandatory** for all students:

ATMO 541A	Dynamic Meteorology	I	3 units
ATMO 541B	Dynamic Meteorology	II	3 units
ATMO 551A	Physical Meteorology	I	3 units
ATMO 551B	Physical Meteorology	II	3 units

AND a minimum of 24 units of coursework in Atmospheric Sciences at the 500/600 level

B. PhD students are required to complete a doctoral minor. A doctoral minor gives students an opportunity to gain in-depth knowledge in a cognate field of interest and to expand interdisciplinary knowledge necessary for solving complex problems and addressing grand challenges. A Minor Program, which typically includes 9-15 credits of coursework. The requirements are determined by the minor department and may include a written minor examination. The credit earned toward a doctoral minor can only be counted toward the doctoral minor and not also counted toward the major (no double-dipping).

- C. Students are required to take a minimum of 18 units of ATMO 920 for dissertation credit. These units cannot be taken until after the Comprehensive Examination has been passed and are in addition to the 36 units of graduate course credit.
- D. Students are also required to take a minimum of 2 units of seminar. These credits are graded S, P, and F, and do not count toward the student's overall GPA. These credits DO NOT count toward the 66 total credits required for the dissertation.

A Typical Doctoral Program:

Semester	Course	Units
Fall: Year 1	ATMO 541A	3
	ATMO 551A	3
	ATMO XXX (elective)	3
Spring: Year 1	ATMO 541B	3
	ATMO 551B	3
	ATMO XXX (elective)	3
Fall: Year 2 Qualifying Exam	ATMO XXX (elective)	3
	ATMO XXX (elective)	3
	Seminar	1
	Minor Course	3
Spring: Year 2	ATMO XXX (elective)	3
	ATMO XXX (elective)	3
	Seminar	1
	Minor Course	3
Fall: Year 3	ATMO XXX (elective)	3
	Minor Course	3
Spring: Year 3 Minor Exam Comprehensive Exam	ATMO XXX (elective)	3
	Minor Course	3
Fall: Year 4	ATMO 920 (Dissertation)	9
Spring: Year 4 Final Oral Defense	ATMO 920 (Dissertation)	9
Total Units		68

MAJOR ADVISOR

During the first semester, the student should select a Major Advisor to chair their committee. The student and Major Advisor then select the doctoral Committee members for the student's comprehensive and final defense examinations.

MINOR ADVISOR

The minor department controls the minor portion of the written examination and may waive it at their discretion. The minor advisor must be present during the oral comprehensive examination.

CONTINUING STUDENT STATUS

After finishing all course requirements, students must continue to register each Fall and Spring semester for a minimum of 1 graduate research/thesis unit until all degree requirements are met.

FULL-TIME STUDENT STATUS

Students must meet the following **minimum** enrollment requirements:

- A. **Without University Funding/Graduate Assistantship:** Students must enroll with a minimum of nine (9) units of graduate credit each regular semester to maintain full-time student status.
- B. **With Graduate Assistantships:** Students must enroll with a minimum of six (6) units of graduate credit each regular semester. **However, it strongly recommended GAs hired under the Department of Hydrology and Atmospheric Sciences must enroll in minimum of nine (9) units of graduate credit during the first year to complete MS degree in two years.**
- C. **Below the 9-unit enrollment: student** will be considered a part-time student which can affect scholarship or fellowship obligations.
 - a. **International Students:** Must contact the International Student Services Office to request full-time enrollment exemption.
<https://international.arizona.edu/international-students/maintaining-status>

REQUIRED DEMONSTRATION OF COMPETENCE

- A. All students must demonstrate, to the satisfaction of each student's Major Advisor, proficiency in both statistics and computer programming (e.g. FORTRAN, MatLab, GrADS, and NCL), numerical atmospheric models and specialized instrumentation. Participation in

laboratory or field work may be a component. This may be demonstrated by the successful completion of approved courses in these subjects, either as an undergraduate or graduate student.

AND

- B. All students will be required to present the results of their research in a formal seminar or presentation at a scientific meeting in the form of an oral or poster presentation. Typically, a student presents at the annual El Día de Agua y la Atmósfera (Spring), AGU (December) or AMS (January) meetings.

CONTINUING UA MS DEGREE TO DOCTORAL DEGREE

There are limits on coursework that can be counted toward more than one degree earned by the student at the University of Arizona or elsewhere.

- If a student counts credits from a UA master's degree towards a UA Ph.D., then additional transfer credit may be limited to ensure that some UA coursework is taken while in the doctoral program. Thesis credits used for a master's degree cannot count toward the Ph.D. course credit requirements.
- Up to 30 units of credit counted toward one or more master's degrees earned at UA or elsewhere may be counted toward the Ph.D. requirements.
- No course may be counted toward the requirements for more than two plans (at UA or elsewhere).
- A student earning two UA doctoral degrees may use up to 9 units of coursework toward both doctoral degrees (as long as courses were not used toward any other degree). a minimum of 1 graduate research/thesis unit until all degree requirements are met.

TIME LIMITATION

Students must meet all requirements for the degree of Doctor of Philosophy within 5 years of passing the Comprehensive Exam or risk being dismissed from the program. Programs may have more stringent time to degree requirements. Should a student not finish within that time, the program may petition the Graduate College for an extension to time to degree. If the extension is approved, the student may be required to re-take the Comprehensive Exam before proceeding to complete requirements, e.g., the dissertation.

QUALIFYING EXAM

A qualifying examination or diagnostic evaluation may be required to demonstrate acceptability to pursue the doctorate as well as to determine areas of study where further course work is necessary.

COMPREHENSIVE EXAM

The student must pass a written and an oral Doctoral Comprehensive Examination that tests the student's knowledge of all major and minor coursework.

FINAL DEFENSE EXAM

All Ph.D. programs require the completion of a dissertation which meets the required standards of scholarship and demonstrates the candidate's ability to conduct original research.

GradPath Forms and Program Details

The Graduate College requires all graduate students to complete official forms in GradPath forms through UAccess Student. The department may require internal forms to be completed in addition to GradPath forms. Please see the Graduate Coordinator for more information.

- Responsible Conduct of Research
- Evaluation of Transfer Credit
- Doctoral Plan of Study (POS)
- Comprehensive Exam Committee Appointment
- Announcement of Doctoral Comprehensive Exam
- Results of Comprehensive Exam
- Prospectus/Proposal Confirmation
- Doctoral Dissertation Committee Appointment
- Commencement Verification Form
- Announcement of Final Oral Defense
- Results of Final Oral Exam/Defense

RESPONSIBLE CONDUCT OF RESEARCH

“Fostering a culture and expectation of responsible and ethical conduct of research is a critical component in the advancement of knowledge through research and scholarship. It is a key element in the maintenance of public trust in the research enterprise.” Source: UA Office of Research, Discovery, and Innovation. All students must complete the Responsible Conduct of Research (RCR) Statement form. Additionally, an RCR Workshop is required for any student who is financially supported by an NSF, NIH, or NIFA grant.

EVALUATION OF TRANSFER CREDIT

Submit this form during the first or second semester in residence to obtain approval for any potential Transfer Credit (graduate-level coursework already completed) for later use in the Plan of Study. Discuss details with the Director of Graduate Studies and major advisor.

Graduate credit earned at other approved institutions may be counted toward the requirements of the degree but will not be included in the calculation of the University of Arizona GPA.

Transferred units are subject to the following:

- The credits must be approved by the major or minor department and the Graduate College. Please submit a course syllabus to the Director Graduate Studies.
- The minimum grade for transferred credits must be an A or B or the equivalent at the institution where course was taken.
- Transferred units may not count toward more than one degree.
- No more than 12 units taken may be used toward the degree.
- Grades and the number of units for transfer credits may be adjusted so that they are consistent with the University of Arizona grading and credit system. Transfer credits used on a fully approved Plan of Study appear with a grade of “T” on the University of Arizona transcript and are not calculated in the University of Arizona GPA. The name of the transfer institution appears on the University of Arizona transcript with the number of transfer units from that institution that were brought in towards the graduate degree.

PLAN OF STUDY

In conjunction with your major advisor, each student is responsible for developing a Plan of Study as early as possible, to be submitted to the Graduate College no later than the fourth semester in residence. The Plan of Study must have the approval of the student's major professor and department head (or Director of Graduate Studies) before it is submitted to the Graduate College. All deficiencies must be satisfied before the Plan of Study is approved.

The Plan of Study identifies

1. Courses the student intends to transfer from other institutions.
2. Courses already completed at the University of Arizona which the student intends to apply toward the graduate degree; and
3. Future course work to be completed to fulfill degree requirements.
4. Expected Graduation Date

Your bursar's account will be billed candidacy fees of \$35.00 at the time your Plan of Study is approved by the Graduate Student Academic Services office. These are one-time fees, and you will not be billed again if you change your anticipated graduation date.

QUALIFYING EXAMINATION

There is no GradPath Form for this exam yet, it is noted the student's file by the Graduate Program Coordinator and the Director of Graduate Studies. The qualifying exam is a degree requirement and is proctored by the HAS faculty. Students who have received less than the 2As and 2Bs in core course requirements are required to take the qualifying exam. Failure either to take the exam or to pass the exam after two attempts means that students may not continue to advance in the doctoral program but continue the completion of the M.S. degree requirements upon discretion of your Major Advisor and committee members.

Student who received 2As and 2Bs in core course requirements can have the exam waived. Please notify the Graduate Program Coordinator.

COMPREHENSIVE EXAMINATION

After completion of all, or almost all, non-dissertation credits required at The University of Arizona including minor degree requirements, the student must take and pass the **Comprehensive Examination** **AND** submit a **Dissertation Proposal/Prospectus** to your advisor and committee members. The oral portion of the examination must cover both the major and the minor. All members must be present for the entire examination. Should special circumstances require a member to attend remotely, prior permission from the Graduate College is necessary. The Comprehensive Examination is considered a single examination, although it consists of written and oral parts.

Comprehensive Committee

The student is responsible for forming a comprehensive examination committee of faculty representing both the major and the minor programs. The examining committee must consist of a minimum of four members. The Major Advisor and two additional members must be members of the Graduate Faculty. The fourth member may be a member of the Graduate Faculty or an approved Special Member. Any members beyond the fourth can also be members of the Graduate Faculty, or approved Special Members.

ADVANCEMENT TO CANDIDACY

When the student has an approved doctoral Plan of Study on file with the Graduate Student Academic Services Office, has satisfied all course work, language, and residence requirements, and passed the written and oral portions of the Comprehensive Examination their bursar account will be billed the fee for candidacy, dissertation processing, and archiving. This is a one-time fee and the student will not be billed again if they change their anticipated graduation date. Copyrighting is optional and carries an additional fee.

DISSERTATION

Students must complete a written dissertation and defend their dissertation based on original research.

Dissertation Committee

Students will form a dissertation committee by the time of Advancement to Candidacy. Some departments require earlier committee formulation. Individual faculty members may decline membership on committees for academic reasons. Candidates must be able to develop a proposal of sufficient academic merit and on a topic that satisfies their committee. Candidates can be suspended if they do not have an approved dissertation chair and committee.

The Graduate College requires a minimum of three members, all of whom must be current University of Arizona faculty members that are tenured, tenure-track, or approved as equivalent. If a committee has only three members, all must approve the dissertation. In departments that require four or five members, there may be one dissenting vote. The fourth member may be tenured or tenure-track, or an approved special member. Special members must be pre-approved by the Dean of the Graduate College. Any members beyond the fourth can also be tenured or tenure-track, or approved special members. All dissertation committee members are expected to attend the entire final defense.

DIPLOMA

- Diplomas are not given out at Commencement. Diplomas are ordered individually for each student after the final degree audit of their academic record is completed. You should receive your diploma about four weeks after your official graduation date.
- Diplomas are issued using your name as it is listed on your official University of Arizona file. If you want your name changed you must request an official name change with the Registrar's Office. Note: If you set up a "preferred" name in UAccess, be aware that your official name on your diploma will be your official name and not your "preferred" name.
- Your diploma will not be ordered and mailed until you have paid any remaining balance on your UA account. Please contact the Bursar's office with questions or concerns.
- The diploma will be mailed to the address you have listed in Commencement Verification Form.

HAS Qualifying Examination

PURPOSE

- To test the student's basic understanding of their general field of study, ability to communicate their research interests, and potential for doing PhD-level research.
- Provide feedback on graduate coursework that may help in student's research and/or career goals.
- Increase students and faculty exposure to each other's research interests.

WHEN

Beginning of the third semester if the student joins the program without a master's degree.

Possible retake the same semester.

LOGISTICS

The student is responsible for submitting the written component to the Graduate Coordinator no later than September 15th for Fall or February 15th for Spring. The student will receive a Qualifying Exam form to receive signatures from faculty after each meeting. The Graduate Coordinator will assign the four HAS core faculty, will notify each faculty, and send the student's written component to review. The student is responsible for contacting each faculty to arrange meetings. Please allow a minimum of two weeks for faculty to review your research proposal. You have until the last day of classes to complete the oral component of the exam and return the signature page to the Graduate Coordinator.

FORMAT

The qualifying exam is a combination of written and oral components.

Written Component: Graduate Fellowship Research Application (GFRA). Students must submit a short (typically 2-6 pages) research proposal in the format of one of the following graduate fellowship programs: NSF, EPA, NASA, or NOAA. Alternative fellowship formats may be used with prior approval by the HAS Graduate Committee. Proposals must be submitted no later than February 28th of the student's 2nd semester, if

starting in August; Proposals are due Sept. 30th if starting in January. Students are encouraged, but not required to submit the fellowship application to the funding agency.

*All written components for the PhD Qualifying or Comprehensive exams should have 1” margins, 12 point New Times Roman font (or similar), and be single-spaced.

Oral Component: Q&A with 4 Faculty following submission of GFRA. Two weeks after submission of the Graduate Fellowship Research Application, students must schedule 20-minute individual meetings with 4 tenured/tenure-track faculty members in the department (3 in their program of study, and 1 from another PhD program within HAS). The meetings should all take place within 1 week if at all possible. The Graduate Academic Advisor will assign the 4 faculty members to the PhD Qualifying Exam Committee. Those faculty members will evaluate the student’s research application prior to the meeting, and ask the student questions during the Q&A related to their research to test the breadth of their knowledge about their field of study and provide feedback on coursework potentially relevant for their PhD research and career goals.

GRADING

The written and oral exam will be graded Pass/Fail. Students must receive a “passing” grade from at least 3 of the 4 faculty members on both the written and oral components to pass the qualifying exam. If students fail the written exam, they may submit a revised research proposal within one month of receiving notice that they failed the first exam. If students fail the oral exam, they may retake the oral exam within one month of receiving notice that they failed the first oral exam.

The Comprehensive Examination

PURPOSE

- Evaluate student's breadth of understanding across degree.
- Evaluate student's depth of understanding in their chosen field of research, writing and presentation ability, and ability to conduct original research.
- Enable student's PhD Committee members (or Comprehensive Examination Committee) to provide feedback on research directions.

WHEN

Should be completed as soon as all major and minor coursework requirements have been completed (usually in the 3rd year or 4th year).

LOGISTICS

The student is responsible for completing their GradPath Forms and submitting the written components directly to their major advisor and comprehensive committee members. Please allow a minimum of two weeks for faculty to review your written components. No more than 6 weeks allowed between the written and oral component of the examination.

GradPath Forms to Complete:

- A. Comprehensive Exam Committee Appointment Form:** Committee members must include a minimum of 3 HAS tenured or tenure-track faculty. A fourth member may be a UA tenured or tenure-track faculty member or an approved Special Member. A special member could be a UA non-tenured research scientist, a non-UA faculty member from another university, or an approved scientist from an external agency or laboratory. See the program coordinator for advice about obtaining Special Member approval.
- B. Announcement of Doctoral Comprehensive Exam Form:** This form is submitted upon approval of your written components for your comprehensive exam. Must include the exact date and time of your oral component.
- C. Results of Comprehensive Exam Form:** Submitted electronically by your faculty advisor and/ committee chair. Candidacy fees are charged to your student Bursar Account upon advancement to doctoral candidacy.

- D. Prospectus/Proposal Confirmation Form:** Send a copy of your dissertation abstract to the program coordinator when you initiate the Comprehensive Exam process. The verification form is submitted by the Graduate Coordinator.

FORMAT

The comprehensive exam is a combination of written and oral components.

Written Components:

- Dissertation abstract. Students must submit a 1-page abstract of their dissertation to their PhD comprehensive examination committee and the Graduate Academic Advisor to have on file with the Graduate College to initiate their PhD comprehensive exams.
- Manuscript/Publication or Research Proposal. Student must submit either a first-authored research manuscript (“in prep”, “in review” or “published”), or a research proposal.
 - Research manuscript (“in preparation” or “in review”) formatted to be submitted to a peer-reviewed scientific journal. If the student already has a paper published from their PhD research, they can submit the paper to their examination committee and automatically pass this portion of the exam.
 - Research proposal (at least 10 pages, including figures/tables, but not including references; formatted in typical NSF EAR directorate style).

Oral Component:

Presentation of student’s research manuscript/paper or proposal (~30 minute presentation), followed by Q&A by committee members. 2 hours maximum. All members must participate in the entire examination. The oral examination is the occasion when faculty committee members have both the opportunity and obligation to require the student to display a broad knowledge of the chosen field of study and sufficient depth of understanding in areas of specialization.

GRADING

The written and oral exam will be graded Pass/Fail. Students must receive a “passing” grade from at least 3 of the 4+ faculty members on both the written and oral components to pass the comprehensive exam. If students fail the written exam, they may submit a revised manuscript or proposal within two months of receiving notice that they failed the first exam. If students fail the

oral exam, they may retake the oral exam within two months of receiving notice that they failed the first oral exam.

THE UA NONDISCRIMINATION AND ANTI-HARASSMENT POLICY

The qualifying and comprehensive examination are subject to the University of Arizona non-discrimination and anti-harassment policy. If you have any concerns or questions, please see <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>, and/or contact the HAS Director of Graduate Studies.

The Final Oral Defense

LOGISTICS

The student is responsible for scheduling with committee members a day and time of the exam and reserving a room and completing their GradPath Forms and submitting the written components directly to their major advisor and committee members. Please follow the Zoom Defense Protocol for HAS. Please allow a minimum of two weeks for the faculty to review your written component. No more than 6 weeks allowed between the written and oral component of the examination. **Please send the title of your thesis, abstract, exam date/time, room location/Zoom number the Graduate Coordinator to send out the defense announcement to the listservs.**

GradPath Forms to Complete:

- A) **Doctoral Dissertation Committee Appointment Form:** The Graduate College requires a minimum of three members, all of whom must be current University of Arizona faculty members that are tenured, tenure-track, or approved as tenure equivalent. If a committee has only three members, all must approve the dissertation. In departments that require four or five members, there may be one dissenting vote. The fourth member may be tenured or tenure-track, or an approved special member. Special members must be pre-approved by the Dean of the Graduate College. Any members beyond the fourth can also be tenured or tenure-track, or approved special members. All dissertation committee members are expected to attend the entire final defense.
- B) **Announcement of Final Oral Defense Form:** (Must be submitted and approved at least 10 business days before the exam date.)
- C) **Results of Final Oral Defense:** (Submitted electronically by your faculty advisor.)

FORMAT

The final oral consists of a 45 minute public presentation with Q & A. Following the presentation, the remainder of the session will closed to public and include the student and their doctoral committee members. There is no minimum time limit for the Final Oral Examination, but the entire proceedings may not exceed three hours. Members of the committee must be present for the entire examination.

GRADING

If the committee requires revisions, those must be done in a timely manner, not to exceed one year. If the revisions are not completed by the dissertation submission deadline for the term when the student defends, the student will be required to register for the next semester and will graduate in the semester when the revisions are complete and approved. If revisions are not done by the end of the time to degree period, the student will have to re-take comprehensive examinations to demonstrate currency of knowledge.

Upon successful completion of the Final Oral Defense examination and having gained final approval from the dissertation committee after completing any revisions needed following the defense, the candidate submits the dissertation electronically via the submission website maintained by ProQuest/UMI. This submission must be made by the submission deadline for the desired graduation term. The Graduate College will check the formatting of the submitted dissertation and may request changes before accepting the submission. When the dissertation has been accepted by the Graduate College, completion of requirements has been fulfilled, and all other final items are accounted for, the degree will be awarded provided the degree conferral date for the graduation term has been reached. Please refer to the Academic Calendar for the relevant semester for the conferral date.

The Doctoral Dissertation approval page (signature page) can be initiated by the student or by the department's Graduate Coordinator through Adobe Sign and routed for signatures for the student and their committee members complete.

Faculty

HAS faculty members are active in the following areas in Hydrology and Atmospheric Sciences:

- Atmospheric dynamics
- Atmospheric chemistry
- Atmospheric physics
- Atmospheric remote sensing
- Climate science
- Hydrometeorology
- Environmental hydrology
- Human-water interactions
- Planetary hydrology
- Subsurface hydrology
- Surface hydrology
- Catchment hydrology
- Hydrogeochemistry and water quality
- Machine learning and Artificial intelligence applications in Hydrology and Atmospheric Sciences

Highlights of HAS faculty research and scholarly contributions are provided below. The activities described are representative of the faculty's contributions to research and science.

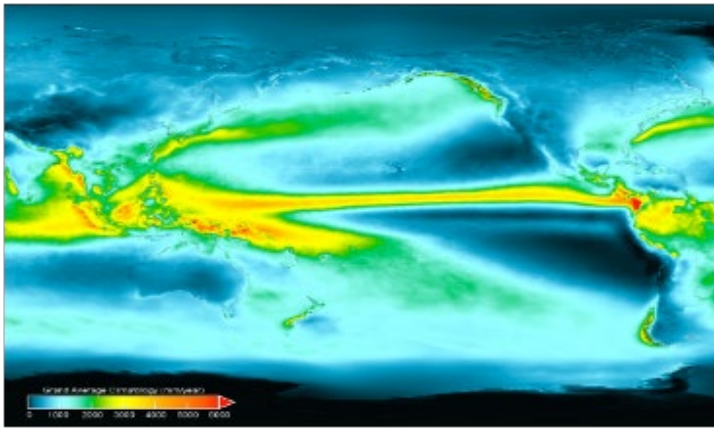


Ave Arellano has received funding from NASA and NOAA to tackle the complex interplay of Air Quality and Greenhouse Gases across scales. By integrating Earth system models with ground-based, aircraft, and satellite data, his research group advances our understanding of how AQ/GHG influences weather, climate, and our environment. They collaborate with UA/Public Health to assess pesticide drift impacts on vulnerable communities and support

the Arizona Department of Environmental Quality (ADEQ) and ASU in addressing ozone non-attainment in Phoenix and Yuma.

Victor Baker's expertise in paleohydrology reaches beyond Earth. He applies hydrological principles to understanding (1) the most extreme flooding phenomena on Earth and (2) the ancient hydrological conditions for the planet Mars. Though the greatest freshwater flooding on Earth involved ice-age conditions, understanding these phenomena led to paleoflood hydrology, a nature-based approach to understanding the flooding that can impact humankind in the current era of exacerbated extremes. This methodology is being applied to risk analyses for dams and nuclear power plants. His Mars research has documented massive megaflood phenomena that generated episodic formation of ocean-like water bodies that were associated with periods of Earth-like hydrological cycling.





Ali Behrangi and his group are leading the development of the next generation Global Precipitation Climatology Project (GPCP) product under NASA support (2017-2028). GPCP precipitation products have been used in over 5000 scientific journal articles and have become a science community standard for the global precipitation observation record. The GPCP products are used in many major climate reports, such as the Intergovernmental Panel on Climate Change (IPCC) and the annual “State of the Climate”, published by the Bulletin of

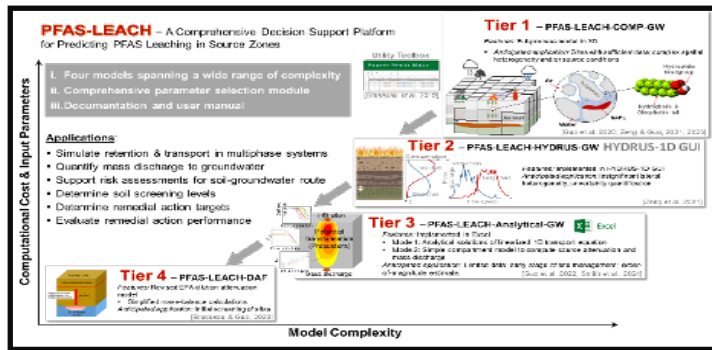
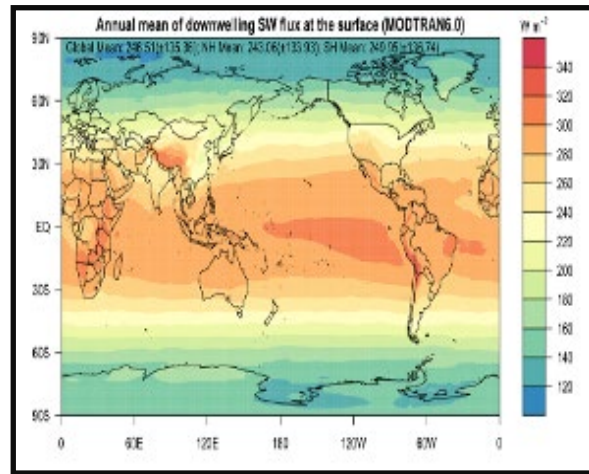
the American Meteorological Society. Behrangi is also a member of the proposing team for the recently selected \$30 M NASA mission “Snow4flow” to study glaciers and precipitation impact on them.

Andrew Bennett is researching cutting edge methods for hydrological modeling, with a focus on developing deep learning methods. His work seamlessly integrates powerful deep learning methods into physically based models of the land surface. He has improved prediction of land-atmosphere interactions and the ability to model long-term water balance by coupling neural networks to process-based hydrologic models. He also developed novel architectures for the emulation of integrated hydrologic models which run a thousand times faster than the original simulators, and is currently developing advanced hybrid modeling techniques that will leverage a wide range of large-scale datasets to improve our understanding and predictions of the hydrologic cycle.



Laura Condon (Laura Lotter) leads a \$6M NSF convergence accelerator project called HydroGEN. Her multi-institutional team of hydrologists, computer scientists and machine learning experts are developing a unique national hydrologic forecasting platform that combines advanced physical hydrology models with national observation networks and machine learning to provide unprecedented views into hydrologic behaviors from the bedrock to the treetops.

Xiquan Dong is the UA-PI for NASA EVC-1 (Earth Venture Continuity-1) project with a total of \$150M during 2021-2031 with UA portion of \$3.5M. In this project, Dr. Dong’s group will provide the global solar fluxes from the Top-of-Atmosphere and the land surface to study the global radiation budgets and their associated global climate changes. This project partially supports two faculty and fully supports two PhD students.

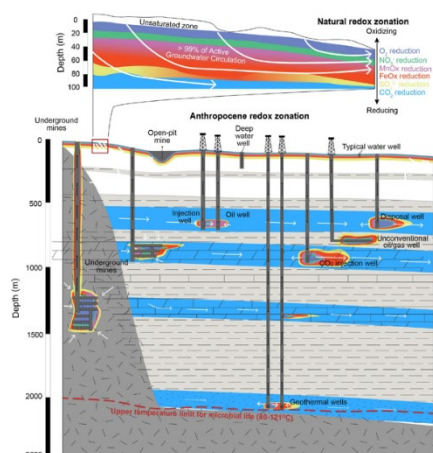


Bo Guo published one of the first papers (Guo et al., 2020, WRR) that provided the foundational understanding of the fate and transport of PFAS in the vadose zone. Building upon this pioneering work, Bo’s group has developed a suite of practical modeling tools (packaged as “PFAS-LEACH”, supported by a \$1.35M DoD project) spanning a wide range of complexities for supporting risk assessment and remediation efforts at

PFAS-contaminated sites. These PFAS-LEACH simulators have been widely used by practitioners in the US and internationally (30+ consulting firms and regulatory agencies to date) for assessing contamination risks at many PFAS-impacted sites.

Hoshin Gupta’s long-term focus has been the theory and practice of Learning with Models and Data, with a particular interest in facilitating scientific discovery. He currently works on bridging “Information Theory” and “Machine Learning” with hydrological science. Rather than an emphasis on predictive accuracy, he focuses on interpretability, generalizability, and support for scientific hypothesis testing. With recent student Yuan Heng Wang, he developed the “Mass Conserving Perceptron” as a foundational unit for interpretable machine-learning of geoscientific systems from data. With current students, he is further exploring the hydrologically interpretable HydroLSTM machine-learning architecture that facilitates improved understanding and predictions in ungauged basins.





Jennifer McIntosh's research contributes to our understanding of sources of water, solutes, and gasses in the Earth's shallow crust, from the near surface to over several kilometers depth. She leads an NSF FRES project (\$3M) on how fluids and co-existing microbial communities have evolved in response to changes in geologic and hydrologic forcings across the Colorado Plateau. Her work informs production of subsurface resources (e.g., Li, H₂, He), storage of energy waste-products (e.g., anthropogenic CO₂), and human health (e.g., geogenic contaminants) and has led to several invited talks and advisory groups for the US National Academy of Sciences, UK Royal Society, International Atomic Energy Agency, and US Nuclear Waste Technical Review Board. Results from this work are included in the Earth Science Discovery Program that brings over 600 schoolchildren to UA Flandrau's Science Center

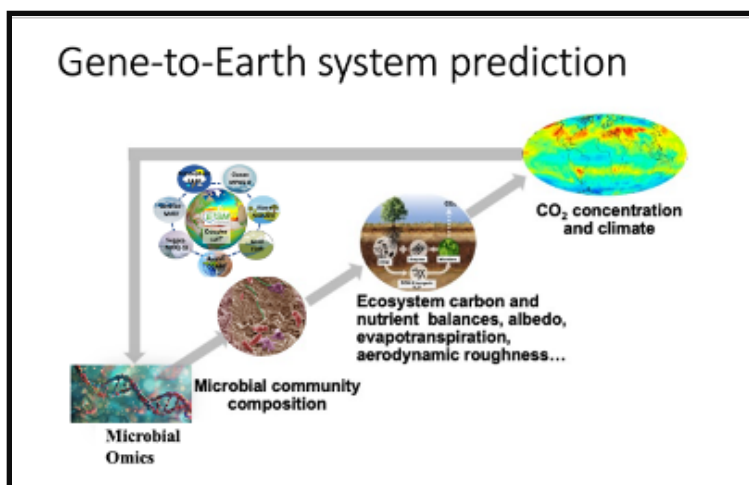
from local title I schools and trains 11 undergraduate students each year to deliver hands-on activities.



Guo-Yue Niu is addressing the question: Why have global drylands been drying? He tested the hypothesis of "dry gets drier, wet gets wetter" globally using the GRACE terrestrial water storage change data and found that global drylands have been drying with the hyperarid and

arid regions showing the most significant decreasing trend. However, the wet regions did not show an apparent wetting trend. These results further suggest that Earth System Models (ESMs) for use in future climate projections and S2S predictions should further include plant adaptation mechanisms.

Soil carbon-climate feedback has been considered one of the big uncertainties in projecting future climate. **Yang Song's** BIO-ESM lab group is addressing this challenge using gene-to-ecosystem scale data, artificial intelligence, and process-based Earth system models. As the lead PI, she is leading a DOE-sponsored project that collaborates with scientists from DOE Sandia National Lab and Oak Ridge National Lab to investigate the role of microbial functional diversity on soil carbon-climate feedback at the global scale and advance the prediction power of DOE E3SM, which is one of Earth system model participating in the Climate Model Intercomparison Project Phase 6 (CMIP6).

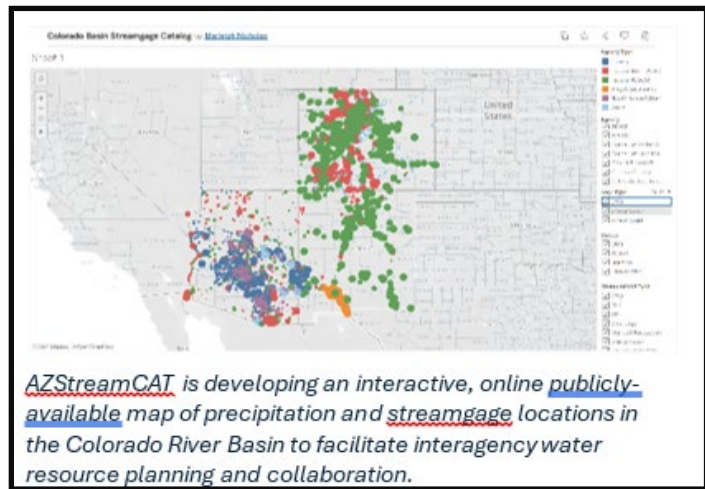




Peter Troch is leading multiple efforts to use the \$40M LEO (Landscape Evolution Observation Laboratory; <http://leo.b2science.org/>) to conduct controlled rainfall-runoff experiments at a unique scale. Each of the three hillslopes of LEO contains a spatially dense sensor and sampler network capable of resolving meter-scale lateral heterogeneity and sub-meter scale vertical heterogeneity in moisture, energy and carbon states. These bare soil landscapes have

been studied for the past 12 years (2013-2024) through hydrologic, geochemical and microbiological foci, resulting in 25 of 43 peer-reviewed papers led by faculty, postdocs and students from HAS. We are now preparing for the next phase of the experiment, when vascular biota in the form of heat- and drought-tolerant plant communities will be introduced to the landscapes.

Martha Whitaker brings authentic research experiences to undergraduates. She is the PI and co-PI for two undergraduate research teams known as vertically-integrated projects (VIPs): 1) Arizona Streamgage Catalog (AZStreamCat); and 2) Integrated Climate Research: Ecology, Water, Weather (ICREWW). She has also developed a course-based undergraduate research experience (CURE) in HWRS 350 Principles of Hydrology. These programs help undergraduates develop research and communication skills, and the CURE class democratizes students' access to a research experience.



Baike Xi is the co-investigator for the NASA Libera project (2021-2031): \$3.5 million research funding at UA with PI, Dr. Xiquan Dong), providing shortwave, visible, and near-infrared (NIR, 0.7–5 μm) irradiances at the Top-Of-the-Atmosphere and the land surface via radiative transfer models and associated atmospheric profiles, surface, aerosol and cloud properties. The primary goal is to perform the NASA's Earth Radiation Budget climate data record continuity proposed by NASA Libera team. The software can be also used to clean energy (especially solar energy) forecasting. The other research focus is funded by NSF to study the aerosol-cloud-precipitation interaction.

Jim Yeh has been simulating spring discharge using deep learning, considering the spatiotemporal variability of precipitation. This work uses a generative variational autoencoder and is applied to augment precipitation data and improve a long-term memory network for spring discharge prediction. Augmenting precipitation data improves various deep learning models' learning generalization and predictive capability. The generative variation autoencoder offers a novel solution to address data scarcity issues across diverse research domains.



Xubin Zeng is the deputy PI (with PI Armin Sorooshian, chemical engineering professor with a joint appointment in HAS) of the \$30M/6 year NASA Earth Venture suborbital Mission (ACTIVATE) on the aerosol-cloud -meteorology interactions over the northeast Atlantic. This project includes multiple universities, a NASA center (LaRC), and an international partner. For instance, a recent paper led by Zeng's graduate student (Xu et al. 2024) under this project, on the retrieval of both mixed-layer height and planetary boundary height from airborne high spectral resolution lidar (HSRL-2), got a news release from our university.

<https://news.arizona.edu/news/peeking-invisible-world-atmosphere>).

Marek Zreda has developed a way to measure stream discharge using sound. The derived sound-discharge rating function is linear over a wide range of discharges and has a remarkably high correlation coefficient. Measurements with a hand-held sound level meter take seconds to acquire, allowing for high-resolution, long-term monitoring of stream discharge, campaign surveys, and ad hoc measurements. The method is attractive because: the instrumentation is simple and inexpensive; field deployment requires no built infrastructure; the instrument is suitable for rapid or emergency deployment; the measurements are non-invasive and non-contact, made at a distance from the stream.

