FALL 2024

CUAHSI VIRTUAL UNIVERSITY

CUAHSI Specialized Online Hydrology Modules

Overview

The Consortium of Universities for the Advancement of the Hydrologic Sciences Inc. (CUAHSI) has organized these inter-university modules to enhance the depth and breadth of graduate course offerings at universities across the nation, increase the rate of uptake of new research, and facilitate networking among our hydrologic sciences community.

The format of the course is designed to give students flexibility to select up to three topics most relevant to you from a list of modules that are being offered by leading faculty from across the country in these specialized research niches. Each module, which is equivalent to one-third of a semester course[1], is designed to facilitate interaction among the instructor and students and contain some evaluation elements (problem sets, projects, presentations, exams etc.). The instructor at each student's home university will assign a grade based on the student scores and class distribution provided by the module instructor.

The course will run from September to December with each module being conducted for 4 weeks.

Instructors

Auburn University
Sanjiv Kumar **|** szk0139@auburn.edu

Boise State University
Alejandro Flores | lejoflores@boisestate.edu

University of California – Los Angeles
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University of Idaho
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University of Nevada – Reno
Justin Huntington | justinh@dri.edu

University of Washington
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University of Wisconsin – Madison
Daniel Wright | danielb.wright@wisc.edu

University of Zurich
Jan Seibert | jan.seibert@geo.uzh.ch

Utah State University
David Tarboton | david.tarboton@usu.edu

[1] As University of Washington is on the quarter semester system one module is equivalent to half a quarter.

Modules dates and times

Module 1: September 4 through October 1
Module 2: October 7 through October 31
Module 3: November 4 through December 3

	Module 1 Sep. 4 - Oct. 1	**Module 2** Oct. 7 - Oct. 31	**Module 3** Nov. 4 - Dec. 3
Monday/Wednesday 11:00am - 12:30 pm ET	Climate modeling for hydrologists Instructor: Kumar	Hydrological Catchment Modeling Using Bucket-Type Models Instructor: Seibert	Modeling Watershed Dynamics Using Landlab Instructor: Istanbulluoglu
Monday/Wednesday 2:30pm - 4:00 pm ET	Applying Geographic Information Systems for Terrain and Watershed Analysis in Hydrology Instructor: Tarboton	Hydrologic Remote Sensing Instructor: Gebremichael	Seminal Papers in Flood Hydrology Instructor: Wright
Tuesday/Thursday 2:30 - 4:00 pm ET	Modeling Coupled Water, Energy, and Carbon Cycles Instructor: Flores	Sensing and modeling hydrology of irrigated agriculture Instructor: Kukal	Applications of Climate and Remote Sensing Data in Hydrology Instructor: Huntington

ET: Times are given in the US Eastern Time Zone.

Registration and Credit

To register for the CUAHSI Virtual University modules, students must follow these steps:

1. Register with your university during the normal registration period for the course number listed for your university (e.g. CivEng 619 for University of Wisconsin - Madison). Registration is limited to 45 module registrations per university.
2. CUAHSI will handle student sign up for individual modules across universities. Fill out this form to sign up with CUAHSI for the Virtual University. Module sign up is also limited and will be accommodated on a first-come, first-served basis. Registration for a module will close when capacity is met. Each module is limited to 45 students.
3. Students should sign up for one to three modules based on their learning needs and interests, recognizing that three modules typically equate to a full semester course (University of Washington two modules equal a full quarter course). Students should recognize the time demands of these modules and avoid multiple modules in the same four week block unless they are fully confident in having the time to commit to this.
4. The number of university credits given for each module taken will be determined by the home university instructor as credit systems vary among institutions (e.g quarter vs. semester system).
5. Each student will be notified when a Canvas account is established for them. Canvas is the online learning management system that will be used for CUAHSI Virtual University.

Benefits to Students

- Access to national experts in specialized sub-disciplines of hydrologic sciences
- Wider selection of course offerings with greater depth than typically available at a single university
- Networking and collaboration with students and faculty nationwide
- Greater collaboration and community awareness of research activities

Goals

- Evaluate the literature, theory, and/or models associated with distinct advanced topics within hydrologic sciences
- Network and effectively collaborate virtually with peers from multiple institutions
- Share data and resources across the hydrologic community
- Specific learning objectives will be provided in the syllabus for each module

Requirements

- Participate in on-campus organization, synthesis, and debriefing sessions held by instructor at home university.
- Register for and complete one to three modules[2]. Each module will have an individual syllabus that outlines the expectations and requirements for that component of the course.

Evaluation

The evaluation criteria for each module will be outlined in the individual module syllabus. The module instructor will provide a score to each home university instructor for each student as well as the class distribution for their module. Grades at each institution are the responsibility of the home institution instructor, based on input from the instructors for each module. In addition to scheduled modules, there may be campus coordination and synthesis meetings at the beginning and in between modules. Home institution instructors may assign a portion of the grade based on participation in these meetings.

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[2] Flexibility in the number of modules is limited at some universities.

Students with Disabilities

If you need accommodations for a physical or learning disability, please see the instructor at your home university.

Academic Integrity

The Honor Code is a cornerstone of this course. It is an undertaking of the students, individually and collectively:

1. that they will not give or receive aid in examinations; that they will not give or receive unpermitted aid in class work, in the preparation of reports, or in any other work that is to be used by the instructor as the basis of grading;
2. that they will do their share and take an active part in seeing to it that others as well as themselves uphold the spirit and letter of the Honor Code.

Guidelines for Online Etiquette

The goal of these guidelines is to encourage online interaction in a positive and engaging manner. They will be posted and discussed in greater detail on the course website.

- Participate
- Report glitches
- Help others
- Be patient
- Be brief
- Use proper writing style
- Cite your sources
- Refrain from emoticons and texting lingo
- Respect diversity
- No YELLING!
- No flaming
- You can't un-ring the bell

Non-discriminating Environment

CUAHSI is committed to creating a dynamic, diverse, and welcoming learning environment for all students and has a non-discrimination policy that reflects this philosophy. Disrespectful behavior or comments addressed toward any group or individual, regardless of race/ethnicity, sexuality, gender, religion, ability, or any other difference is deemed unacceptable in this class, and will be addressed by the professor.

Code of Conduct

All CUAHSI Virtual University participants are expected to adhere to the CUAHSI Code of Conduct. The full Code can be found here.

Module Descriptions (in alphabetical order)

Applications of Spatial Climate and Satellite Remote Sensing Data in Hydrology

Justin Huntington, University of Nevada – Reno
Module 3 (Nov. 4 - Dec 3)
Tuesday/Thursday 2:30 - 4:00 pm ET

This module focuses on the integration of spatial climate and satellite remote sensing data into hydrology, specifically addressing the combined use of these data to assess and separate impacts from climate vs. management. We will begin with an overview and background of different climate and remote sensing datasets, fundamental concepts, and tools to access, process, and visualize the datasets. . Next, we explore various climate and land surface model datasets, multi-timescale drought indices, and satellite derived vegetation indices and evapotranspiration products in the context of changing climate, vegetation, and the complementary relationship of evaporation. In the final module we focus on application of different datasets and tools for use cases of student interests, and that are common in basic and applied research such as atmospheric-land surface feedbacks, riparian restoration, drought, and agricultural water use. Students will have access to GIS and remote sensing software as well as a suite of data sets. Google Earth Engine and Climate Engine will be the primary software tools and data catalogs used.

Prerequisites: Students should be familiar with geospatial data and software (e.g. ArcGIS, raster data, vector data), and previous use or a class in remote sensing would be ideal.

Applying Geographic Information Systems for Terrain and Watershed Analysis in Hydrology

David Tarboton, Utah State University
Module 1 (Sep. 4 – Oct. 1)
Monday/Wednesday 2:30 – 4:00 pm ET

Digital mapping of hydrology and water resources information using content from publicly available sources such as the US national map, and other climate and hydrography datasets. Hydrologic terrain analysis using digital elevation models (DEMs) and DEM based delineation of channel networks and watersheds. Flood hydrology modeling and inundation mapping based on height above the nearest drainage derived from digital elevation models. There will be four detailed computer exercises that introduce (1) Building a watershed basemap using publicly available hydrography and watershed boundary data in the US; (2) Spatial analysis. Calculation of slope, land use and precipitation over subwatersheds; (3) Watershed delineation from digital elevation models; and (4) Basic GIS Programming using Python, using calculation of river hydraulic properties using height above the nearest drainage (HAND) as an example.

Prerequisite: This course will use ArcGIS Pro from ESRI. The prerequisite is basic knowledge of GIS through any prior GIS course or self-preparation through the 3 hour free Predict Deforestation in the Amazon rain forest online lesson from ESRI at https://learn.arcgis.com/en/projects/predict-deforestation-in-the-amazon-rain-forest/. Arrangements will be made for students to use ArcGIS Pro through their university site license.

Climate Modeling for Hydrologists

Sanjiv Kumar
Module 1 (Sep. 4 – Oct. 1)
Monday/Wednesday 11:00 am – 12:30 pm ET

This course offers practical training in the running and modification of the Community Earth System Model for hydrological applications, encompassing tasks such as the exploration of land use change and climate feedback processes. Participants will gain proficiency in handling multi-dimensional data formats, such as netCDF, for the purpose of climate and hydrological analysis. The acquired skills will enable students to conceive and execute hypothesis-driven climate/land-use sensitivity experiments, thereby enhancing the analysis of existing data archives like CMIP6. This, in turn, will yield fresh insights into the intricate processes governing land-climate interactions. Furthermore, the course will introduce a point-scale model configuration, allowing students to run the community land model on their personal laptops and analyze the ensuing results.

Prerequisite: Some programming experience, including working in a UNIX/LINUX environment, is beneficial.

Hydrologic Remote Sensing

Mekonnen Gebremichael, University of California - Los Angeles
Module 2 (Oct. 7 – Oct. 31)
2:30 - 4:00 pm ET

The course introduces the fundamentals of remote sensing, remote sensing data, and data processing tools for land and water resource management. Topics include: fundamental of remote sensing, visible and near infrared, thermal infrared, microwave, and various applications (vegetation index, change detection, soil moisture, evapotranspiration, and rainfall). Practical sessions involve various software/tools (Python, GEE)

Prerequisites: None

Hydrological Catchment Modeling Using Bucket-Type Models

Jan Seibert, University of Zurich
Module 2 (Oct. 7 – Oct. 31)
Monday/Wednesday 11:00 am – 12:30 pm ET

Hydrological models are essential tools for decision making at the catchment scale. These models are crucial for forecasting hydrological conditions, ranging from the short-term forecasts of flooding in the coming hours or days to long-term forecasts of hydrological climate change impacts. This module will focus on bucket-type models as a representation of catchment hydrology using the HBV model as an example. After a general overview and motivation, the history of catchment models and a detailed introduction to the HBV model, we will address issues like model uncertainties, automatic model calibration, model-performance measures, multi-criteria calibration, the value of data. Furthermore, we will address the use of models to quantify land-use and climate changes and will discuss how tracer data can be included into this type of models. Hands-on modeling exercises will provide further opportunities to get familiar with typical modeling issues.

Prerequisites: Undergraduate course in hydrology. Ability to process data in a computing program (e.g., Matlab, Python, R).

Modeling Coupled Water, Energy, and Carbon Cycles

Alejando Flores, Boise State University
Module 1 (Sep. 4 - Oct. 1)
Tuesday/Thursday 2:30 - 4:00 pm ET

The overarching goal of this module is to familiarize you with modern land models used to describe the coupled evolution of terrestrial water, energy, and carbon cycles within Earth System Models (ESMs). We will: (1) explore the theoretical underpinnings of how water, energy, and carbon cycles are linked, (2) run simple point-scale simulations in which vegetation can establish, grow, and die, (3) learn about data to benchmark these models, and (4) design numerical experiments to test scientific hypotheses. Importantly, we will examine and discuss open questions about how these models treat important biogeochemical processes, variability in critical zone structure and properties, and limitations with respect to spatial resolution with a particular emphasis on topography. This module invites students looking to be informed readers of ESM literature, contextualize the relevance of their fieldwork for the ESM community, and/or be users of ESM models or their output.

Prerequisites: You will be most comfortable in this class if you have a working ability to use Python or R for data analysis and visualization, and some basic familiarity with the Linux computing environment.

Modeling Watershed Dynamics Using Landlab

Erkan Istanbulluoglu, University of Washington
Module 3 (Nov. 4 - Dec 3)
Monday/Wednesday 11:00 am – 12:30 pm ET

This course will present key processes that shape watershed echohydrologic and geomorphic response and their interactions using Landlab, a Python-based modeling toolkit for building, coupling, and exploring numerical models of Earth-surface dynamics (http://landlab.github.io/#/). We will first review the model structure of Landlab, and its raster and network model grid classes with examples. In each lesson, we will introduce theory and give examples of watershed hydrologic, ecologic and geomorphic processes and their implementation in Landlab. Examples will include mapping evapotranspiration, soil moisture and runoff on terrain, overland flow routing; simulations of vegetation dynamics using cellular automation rules for plant competition; mapping landslide risk, and landscape evolution modeling. Model forcing of climate will be retrieved from existing gridded data sets using Landlab utilities, local weather stations, or through stochastic storm generation. Homework assignments will utilize Landlab models in examples that will require some basic code manipulation to incorporate additional process loops and data input and output.

Prerequisites: Undergrad course in hydrology/environmental sciences and some basic Python skills

Seminal Papers in Flood Hydrology

Daniel Wright, University of Wisconsin - Madison
Module 3 (Nov. 4 - Dec 3)
Monday/Wednesday 2:30 - 4:00 pm ET

High-impact floods are of enormous—and growing—societal importance. Drawing on a recent U.S. Army Corps of Engineers training document by the same name, this short course will examine twelve foundational papers in riverine flood hydrology within the broader evolution of flood research and practice in the United States. These papers provide the grounding to examine frequency estimation methods, the hydrology and hydraulics of extreme floods, the hydroclimatology of flooding, and the core hydrologic measurements that lie at the center of flood hazard characterization. Students will provide critical syntheses, drawing on the foundational papers, more recent scientific advances, and their own understanding of hydrological and hydrometeorological processes. Specific concepts will be reinforced through analyses of real datasets using the R programming language.

Prerequisites: Undergraduate course in hydrology or water resources engineering required; data analysis experience using R or similar programming language strongly recommended but not required.

Sensing and Modeling Hydrology of Irrigated Agriculture

Meetpal Kukal, University of Idaho
Module 2 (Oct. 7 – Oct. 31)
Tuesday/Thursday 2:30 - 4:00 pm ET

This module will educate students on the standardized approaches to simulate water use of irrigated agriculture, which is usually the largest and most uncertain component of the hydrologic budgets in many ecosystems. The module will start with an overview of hydrologic budgets in agricultural fields and how they are impacted by variation in soils, environment, and management. Next, each student will select a field of interest and obtain open source datasets of soils (Web Soil Survey) and weather (Climate Engine) for their sites. They will simulate hydrologic budget components for their sites, including effective precipitation, evapotranspiration, and deep percolation under different water management regimes and stress conditions. The students will also interface with OpenET data to compare their simulations of crop evapotranspiration. To maximize reach, the simulations will be carried out using both spreadsheet models as well as Python-based tools. The intent of the module is that the students understand soil-crop-atmospheric relationships and its relationships with typical management practices on an agricultural field.

Prerequisites: None. All physical processes will be explained with sufficient detail in class. As for coding skills, these are not required. There will be an option to use spreadsheets to model the hydrological budgets, as well as Python-based coding to achieve the same.

Questions?

For questions on the module content, please contact the instructor.

For questions related to specifics about your Institution (such as grading policies), contact the CVU instructor at your home Institution.

For general questions, please Veronica Sosa Gonzalez at vgonzalez@cuahsi.org