FALL 2017

# CUAHSI VIRTUAL UNIVERSITY

## SPECIAL TOPICS IN HYDROLOGY:
## CUAHSI SPECIALIZED ONLINE HYDROLOGY COURSES

## Overview

The Consortium of Universities for the Advancement of the Hydrologic Sciences Inc. (CUAHSI) has organized these inter-university courses 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 community.

The format of the course is designed to give you flexibility to select the three* topics most relevant to you from a list of Specialized Online Hydrology Course (SOHC) Modules that are being offered by leading faculty in these specialized research niches from across the country. Each SOHC module, which is equivalent to one-third of a semester course, 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 SOHC module instructor.

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

*As University of California-Santa Barbara is on the quarter semester system, students must select two topics from the October and November choices.

## Instructors

**Tufts University**
Richard Hooper | richard.hooper@tufts.edu
Course Number: CEE294-01

**University at Buffalo**
Christopher Lowry | cslowry@buffalo.edu
Course Number: GLY606

**University of California-Santa Barbara**
Naomi Tague | ctague@bren.ucsb.edu
Course Number: ESM 595NT

**University of Delaware**
Holly Michael | hmichael@udel.edu
Course Number: GEOL 667

**University of Michigan**
David Hyndman | hyndman@msu.edu
Course Number: GLG 893

**University of Nevada-Reno**
Scott Tyler | styler@unr.edu
Course Number: GEOL 701L

**University of Wisconsin-Madison:**
Steven Loheide | loheide@wisc.edu
Course Number: CEE 619

## SOHC Module Dates and Times

**Sept 6-Oct 3; M&W; 3:30-5 ET**
*Ecohydrology of Groundwater Dependent Ecosystems*

**Sept 6-Oct 3; T&Th; 3:30-5 ET**
*Coastal Hydrogeology and Land-Sea Water Exchange*

**Oct 4-Oct 31; M&W; 1:30-2:45 ET**
*Experimental Design in Hydrology: A Case Study of Streamflow Generation Mechanisms*

**Oct 4-Oct 31; M&W; 3:30-5 ET**
*Global Change, Crop Production, and Impacts on Hydrology*

**Oct 4-Oct 31; T&Th; 3:30-5 ET**
*Quantifying Groundwater and Stream Interactions*

**Nov 1-Nov 30; M&W; 3:30-5 ET**
*Advances in Drone-based Remote Sensing for Hydrologic Applications*

**Nov 1-Nov 30; T&Th; 3:30-5 ET**
*Hydrologic Modeling for Hypothesis Generation and Scenario Development: Tools in R*

## How to Register

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. CEE 294-01 for Tufts University).
    a. Registration is limited to 15 students per university.
2. CUAHSI will handle student registration for individual modules across universities. Contact instructor at your university to get a link for a Google Form to register with CUAHSI for the Virtual University.
3. 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.
4. Each student must login and sign up for the three* SOHC modules of interest in Canvas.
    a. SOHC module sign up is also limited and will be accommodated on a first-come, first-served basis. Registration for a module will closed when capacity is met. Each module is limited to 45 students.
    b. *As University of California-Santa Barbara is on the quarter system, students must select two topics from the October and November choices. UCSB students may sign up for a third SOHC module during the September time block as an auditor.

## Benefits to Students

- Access to national experts in specialized sub-disciplines of hydrology
- 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 three distinct advanced topics within hydrology
- Network and effectively collaborate virtually with peers across the country
- Share data and resources across the hydrologic community
- Specific learning objectives will be provided in the syllabus for each SOHC module

## Requirements

- Participate in on-campus organization, synthesis, and debriefing sessions held by instructor at home university.
- Register for and complete 3 SOHC modules. Each SOHC module will have an individual syllabus that outlines the expectations and requirements for that component of the course.

## 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.

## Evaluation

Your grade will be based on the following:

- 10% on-campus organization, synthesis, and debriefing sessions.
- 30% SOHC Module 1
- 30% SOHC Module 2
- 30% SOHC Module 3

The evaluation criteria for each SOHC Module will be outlined in the individual SOHC module syllabus. The SOHC module instructor will provide a score to each home university instructor for each student as well as the class distribution for their SOHC module.

## 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

## Students with Disabilities

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

## 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.

# SOHC Module Descriptions

### *Ecohydrology of Groundwater Dependent Ecosystems*

Steven Loheide, University of Wisconsin Madison

Ecohydrologic research investigates the effects of hydrological processes on the distribution, structure, and function of ecosystems, and the effects of biotic processes on elements of the water cycle. Groundwater dependent ecosystems are ecosystems that have their species composition and natural ecologic processes determined by groundwater processes. In this class, we discuss and quantify ecohydrologic processes in groundwater dependent ecosystems. We will develop techniques to exploit the signal contained within diurnal watertable fluctuations to quantify the groundwater component of ET. We will explore a variety of approaches for quantitatively describing how groundwater controls vegetation composition. We will integrate the understanding we develop about the ecohydrologic functioning of groundwater dependent ecosystems to simulate coupled hydrologic and ecologic processes for prediction of vegetation patterning.

**Prerequisites:** Course in hydrogeology or groundwater. Familiarity with, or willingness to learn to use basic Matlab functions with quick start tutorial from instructor.

### *Coastal Hydrogeology and Land-Sea Water Exchange*

Holly Michael, University of Delaware

This module explores the physical processes of variable-density groundwater flow in coastal aquifers, submarine groundwater discharge, and mechanisms of seawater circulation. Processes considered will span spatial and temporal scales associated with waves, tides, seasons, and glacial cycles. Advancement of understanding through theory, numerical modeling, laboratory experimentation, and field measurements will be discussed. Implications and strategies for management of seawater intrusion and excess nutrient loading to nearshore aquatic ecosystems will be addressed. Parallels to groundwater-surface water exchange in rivers and lakes as well as inland variable-density problems such as brine migration will also be considered.

**Prerequisites:** Course in introductory hydrogeology or groundwater hydrology.

### *Experimental Design in Hydrology: A Case Study of Streamflow Generation Mechanisms*

Richard Hooper, Tufts University

This module explores the implications of applying the scientific method to environmental systems which are uncontrolled—that is only observed rather than subject to a controlled experiment. This topic will be considered in the context of a long-term field observatory with a focus on how tracers are used to infer streamflow generation mechanisms. Hypothesis formulation and the use of simulation models to test hypotheses will be examined as will the interplay between field data and hydrologic theory. Methods of data analysis, such as principal components analysis, will be analyzed to explore how the mathematics can be used to test underlying physical mechanisms. The strengths and weaknesses of long-term field sites, such as those in the Critical Zone Observatory Network or Long Term Ecological Research Network, will be considered.

**Prerequisites:** Familiarity with hydrologic processes involved in runoff generation. No specific modeling experience required.

### *Global Change, Crop Production, and Impacts on Hydrology*

David Hyndman & Anthony Kendall, Michigan State University

This module explores the influence of crop production and global change on fluxes of water across the surface and through the subsurface. The course will span the interdisciplinary nexus of food, energy, and water in a manner that examines process based models of land surface processes, along with the data that are required to drive these models, and the types of analyses that can be performed. These analyses include quantifying the likely impacts on hydrologic systems of projected global change drivers, water use of agricultural systems under different irrigation technologies, and production of first- and second-generation biofuels. Data inputs include remotely sensed products such as Leaf Area Index (LAI), soil maps, estimates of the hydraulic properties of subsurface aquifers, and climate data. A range of process-based models that simulate streamflows and groundwater levels will be discussed that are capable of calculating water and energy balances across large domains.

**Prerequisites:** Course in hydrogeology or groundwater. Familiarity with, or willingness to learn to use basic Matlab functions with quick start tutorial from instructor.

### *Quantifying Groundwater and Stream Interactions*
Christopher Lowry, University at Buffalo

This module will explore field and numerical modeling techniques to quantify the movement of water between groundwater and streams. Students will be exposed to the current literature on groundwater stream interactions and get hands on experience with real world data sets. Techniques will include differential stream gaging, seepage meters, solute tracers, temperature tracers, and nested piezometers. Issues of scale, logistical difficulty, and method uncertainty will be addressed. Numerical modeling will focus on quantifying flux, flowpaths and residence time within the context of groundwater stream interactions. At the conclusion of this module students will be able to identify and implement the best methods at their specific field application.

**Prerequisites:** Graduate level course in hydrology or hydrogeology.

### *Advances in Drone-based Remote Sensing for Hydrologic Applications*
Scott Tyler & Wendy Calvin, University of Nevada-Reno

This module focuses on the integration of remote sensing data into groundwater/surface water exchange, specifically addressing recent advances in unmanned aircraft systems (UAS), or drones, to obtain high resolution, repeat imagery. We will begin the course with an overview of remote sensing capabilities and their integration in UAS platforms. We will then explore topographic analysis from photogrammetry and the development of high-resolution Digital Elevation Models (DEMs) to compliment in-stream and groundwater measurements. The module will next focus on infrared sensing, both near-IR for vegetation density and stress, as well as repeated thermal IR for both stream and land surface temperature. Students will have access to photogrammetry and other remote sensing software as well as a suite of data sets.

**Prerequisites:** Courses in basic differential equations, physics, and chemistry.

### *Hydrologic Modeling for Hypothesis Generation and Scenario Development: Tools in R*
Naomi Tague, University of California, Santa Barbara

Eco-hydrology is the study of interactions among climate, hydrology and ecological productivity and biogeochemical cycling. One of the main tools used in eco-hydrology is computer based simulation modeling. These models combine data and theory to understand how plants and water interact and how decisions that people make alter water resources and plant and ecosystem health. This section will provide a brief overview of hydrologic and eco-hydrologic models and their applications. We will then examine, using in a class exercise, how ecohydrologic models can be used for testing hypothesis. We will consider both existing hydrologic models and simple model developed - on the fly - as approaches to quantify the implications of multiple controls on eco-hydrologic processes. The course will cover both designing a new model and selecting, calibrating and evaluating existing models. This is a skills based course and we will use R (a data analysis and programming environment) and student will undertake a model application project.

**Prerequisites:** Upper-division undergraduate or graduate course in earth system science or hydrology. The course will use R. Instructor will provide links to tutorials that provide an introduction to R. Students who are unfamiliar with R should complete these prior to the module.

Examples of topics students are expected to have familiarity with:

- http://www.bren.ucsb.edu/academics/documents/ESM202-KellerandMelack.pdf
- http://www.bren.ucsb.edu/academics/documents/ESM203-DozierandDunne.pdf

## Questions?

For questions on the SOHC module content, please contact your university instructor.

For general questions, please contact Elizabeth Tran at etran@cuahsi.org.