Course Description:
This course addresses the use of computer simulation to study hydrological processes and to generate predictions. The perspective of the class is, primarily, that of the earth system scientist: models will be approached as tools that we want to use and, on occasion, build ourselves, for the pragmatic purpose of representing processes of interest. In this context, we will study various approaches to "physically-based" model design and implementation, explore methods for model application, evaluation, and improvement, and consider what models can (and cannot) tell us about the hydrological system. Through weekly computer exercises, students will gain practical skills in designing simple models, applying more sophisticated models, and working with common data types. In the term project, students will be asked to perform an informed application of a model or model analysis technique to address a research question.

While the course will address multiple components of the hydrological cycle, the emphasis will be on terrestrial hydrology.

Objectives:
1. To introduce the principles and methodologies associated with modeling hydrological process.
2. To survey a range of model types, approaches, and applications.
3. To empower students to create simple models and to use common advanced models.
4. To address practical aspects of input data, parameterization, calibration, and evaluation.

The course is offered to graduate students and to advanced undergraduates.

Readings will be drawn from journal articles and the following textbooks:

All readings will be provided on Blackboard, but you should have access to a good hydrology text on hand for your own use (e.g., Dingman, Brutsaert, or Hornberger).

Requirements:
The course consists of lectures, weekly exercises, and a final project.

Evaluation:
Exercises (60%), Project (30%), Participation (10%)
Course Schedule:

Week 1: Jan 27, Jan 29
Lectures: Philosophy and practice of Hydrological Modeling
Exercise 1: Conceptual 1-d water balance model
Readings: Beven: Environmental Modelling, Chapter 2; Singh & Frevert, 2002

Week 2: Feb 3, 5
Lectures: Modeling the distributed terrestrial water balance
Exercise 2: Infiltration
Readings: Xu & Singh 1998;
Shuttleworth Chapters (4), (5), (23)

Week 3: Feb 10, 12
Lectures: Advanced Land Surface Models
Exercise 3: TOPMODEL
Readings: Cook et al., 2008; Dai et al., 2003,

Week 4: Feb 17, 19
Lectures: Watershed Models
Exercise 4: Nash Cascade
Readings: Beven Chapters (2), (5)

Week 5: Feb 24, 26
Lectures: Routing and Floods
Exercise 5: BASINS
Readings: Horritt & Bates, 2002

Week 6: Mar 3, 5 [Ben/Amin]
Lectures: Model Calibration and Evaluation
Exercise 6: GLUE
Readings: Beven Chapter (7)

Week 7: Mar 10, 12 [Amin]
Lectures: The Atmospheric General Circulation
Readings: Donald Chapter (10)

Week 8: Mar 24, 26
Lectures: Statistical Downscaling
Exercise 7: Regression-based Downscaling
Readings: Benestad 2004, Benestad et al., 2007

Week 9: March 31, April 2 [Amin]
Lectures: Objective Regionalization
Exercise 8: HiClimR
Readings: Wilks, Chapter (15), Badr et al., 2015

Week 10: Apr 7, 9 [Amin]
Lectures: GCMs
Exercise 9: Working with CMIP5 data
Readings: Trenberth

Week 11: Apr 14, 16 [Amin]
Lectures: Precipitation processes
Exercise 10: Radiative Convective Equilibrium
Readings: Shuttleworth Chapters (10), (11), Trapp Chapters (5), (8)

Week 12: Apr 21, 23 [Amin]
Lectures: Regional Climate Modeling
Exercise 11: WRF Model
Readings: Trapp Chapter (4), WRF User Manual

Week 13: April 28, 30
Lectures: Future Directions
Readings: Verbist et al., 2011; Milly et al., 2008

Exam Period: Papers due May 14; Presentation date TBD
Project presentation and paper