Department of Civil, Construction and Environmental Engineering – Spring 09
CE 796A: Hydroclimatology

Section 001: Tuesdays and Thursdays; 1:30-2:45

Instructor: Dr. Sankar Arumugam (sankar_arumugam@ncsu.edu), 314A Mann Hall; (919)515-7700
Office Hours: Fridays: 9:00-11:00.

Syllabus:
Introduction to Hydroclimatology – Global water and energy balance – Global distributions of precipitation, temperature, runoff and their seasonality – Interannual variability in precipitation – El-Nino Southern Oscillation and Pacific Decadal Oscillation.

Forecast Verification – Probabilistic Forecasts – Skill Measures –Brier Score and its Decomposition – Reliability and ROC Diagrams – Rank Probability Score and Continuous Rank Probability Skill Score – Non-probabilistic forecasts –Correlation and Mean Square error.

Overview of operational forecasts development: Weather to Climate time scales –IRI Climate Forecasting Process – Skill assessment of seasonal climate forecasts –NOAA Weather forecasts and their skill assessment – NWS Streamflow forecasts – Downscaling techniques

Space-time scale issues in hydrology – Long-term water balance – Budyko's Framework – Physical Hydroclimatology – Conservation equations – monthly and annual water balance – Evapotranspiration Modeling and Estimation.

Prerequisite: CE 586 or equivalent.

Course Purpose: The course, CE 796A Hydroclimatology, discusses in detail about the space-time variability of hydrological processes in the context of weather, climate and land surface attributes. The course emphasizes developing multi-time scale hydrologic forecasts utilizing weather and climate forecasts along with initial land surface conditions. The course will cover primarily four topics: (a) Global Hydroclimatology (b) Forecast verification (c) Overview of Forecasting in Hydroclimatology (d) Physical Models of Hydroclimatology.

Course Objectives: By the end of the course, you should be able to:
(a) detail the steps involved in developing operational forecasts of precipitation at weather and climate time scales
(b) Analyze the operational forecasts using various probabilistic forecasts verification and validation metrics.
(c) explain the importance of atmospheric and oceanic conditions in influencing runoff generation and the associated hydrologic processes
(d) perform integrated water balance considering both atmospheric and terrestrial water budgets and develop physical models of hydroclimatology
(e) relate the surface water – groundwater interaction to climatic conditions such as sea surface temperature

Grading:

Four Quizzes	-	40%
Two Presentations	-	30%
Group Discussions (on Presentations)	-	10%
Project	-	20%

Tests: Four quizzes will be conducted one for each module. Typically quizzes will be conducted based on either the discussed research papers or on the assigned reading material. Each quiz will be conducted in class and will be of 30 minutes duration.

Presentations and Discussions: Each student has to give two presentations during the course. It will be a short presentation for 20 minutes based on a research article selected well in advance. Each presentation carries 15% of your course grade. Once the research articles are selected by the due date, a discussion forum will be opened in WebCT vista (http://vista.ncsu.edu/index.php). A copy of all research articles related to presentations will be available in WebCT vista under each student name. Each student has to post questions on other's presentation and all the students in the class should look at those questions and prepare your answers for discussion in the class. Everyone has to read research articles on other's presentation and prepare well enough for in-class discussion. Discussions during the presentation and prompt posting of questions on the discussion forum carry a total grade of 10%. Forum on a particular presentation will close sharply two days (5 PM) before each scheduled presentation.

Project: Project constitutes the major portion of grade accounting 20%. You can select a project topic that is of interest to you. Each student has to talk to the instructor in the beginning of the course and agree upon a topic. Students are encouraged to discuss with the instructor on the progress of the project on a regular basis. This will ensure proper guidance on the methodology, analyses and selection of appropriate data set. At the end of the course, each student has to submit a written report on the project. Detailed instructions will be given on project report preparation during the course.

Academic Integrity: Students should refer to the University policy on academic integrity found in the Code of Student Conduct. The policy can also be obtained at:
http://www.ncsu.edu/policies/student_services/student_discipline/POL11.35.1.php
Policies and procedures detailed in the above website will be strictly enforced in the class. It is the responsibility of the students to read it and follow those procedures in the class.

Office of Disability Services: This class will enforce all the guidelines related to services for students with disabilities. More information can be found at http://www.ncsu.edu/dss/. Students in need of service are requested to get permission from the Office of Disability Services located at 1900 Student Health Center, (919) 515-7653.

Tentative Schedule

Date	Topic	Reading
01/08-01/29	Introduction to Hydroclimatology • Global energy and water balance • Global distribution of pressure, temperature, precipitation, evapotranspiration and runoff • Interannual Variability in Precipitation and temperature • ENSO and PDO	Dingman and additional Handouts.
02/10	Quiz 1: Hydroclimatology Introduction • Due Date for deciding on the paper for 1st presentation	
02/03-02/19	Probabilistic Forecasts – Skill Measures • Correlation and Root Mean Square Error • Brier score and its Decomposition • Reliability and ROC Diagrams • Rank Probability Score and CRPS	Handouts from Wilks
02/24-02/26	First Series of Presentations • Discussion forum for the first presentation opens on 02/19	
02/26	Quiz 2: Topic – Precipitation Forecasting and downscaling • Due Date for a brief write up on project topic	
03/01-03/07	Spring Break	
03/10-03/24	Overview of Operational Forecasts Development • Weather to Climate scales – Forecast Process • Skill Assessment of Weather and Climate Forecasts • Downscaling Techniques • NWS Streamflow Forecasting	Georgakakos Paper, IRI climate forecasting tutorial and additional technical papers
03/31	Quiz 3: Operational Forecasts Development • Due Date for deciding on the paper for 2nd presentation • Due Date for a brief write up on the progress of the project	
03/26-04/02	Physical Models of Hydroclimatology • Sivapalan Paper Review • Budyko's Framework, long-term water balance • Conservation Equations • Monthly and Annual water balance	Sivapalan and Chris Milly Papers
04/07- 04/16	Evaporation, Modeling and Estimation • Transport in Boundary Layer • Terrestrial and Atmospheric Water balance • Fluxes of Mass, Momentum and Heat, Stability Correction • Role of remote sensing in soil moisture and evaporation estimation.	Handouts from Stull, Arya; Ropelewski and Halpert Paper.
04/21-04/23	Second Series of Presentations • Discussion forum for the first presentation opens on 04/16	
04/23	Quiz 4: Hydroclimatology and Evaporation	
05/01	Final Project Report Due	