Course Details:

Course Rationale:	"Land-Atmosphere Interactions in Hydrology" examines in detail the surface water components of the hydrologic cycle and their connection to the atmosphere. More specifically, we discuss the role of hydrology in the climate system, precipitation and evaporation processes, atmospheric radiation, the exchange of mass, heat, and momentum between the soil and vegetative surface and the overlying atmosphere, and the flux and transport of water within the turbulent boundary layer. In addition, the role of satellite-based remote sensing observations in land-atmosphere analysis as well as sustainable hydrologic applications will be discussed.
Course Description:	Introduction to basic concepts of land-atmosphere exchange; hydrologic processes in the climate system; precipitation and evaporation; turbulent fluxes
Prerequisites (or equivalent):	1. Fluid Mechanics [ENCE 305] and 2. Multivariate Calculus [MATH 241] and 3. Numerical Methods [ENCE 201] ... or a *willingness* to learn Matlab©
Course Schedule:	Tuesday and Thursday 4:00-5:15 PM MTH 0106
Instructor:	Professor Barton Forman 1159 Glenn L. Martin Hall Office Hours: Monday and Wednesday 4:30-5:30 PM (or by appt.) Email: `baforman@umd.edu` Canvas: `https://umd.instructure.com/`
Recommended Reference:	Shuttleworth, *Terrestrial Hydrometeorology*
Additional On-Reserve References:	Arya, *An Introduction to Micrometeorology* Dingman, *Physical Hydrology* Liou, *An Introduction to Atmospheric Radiation* (on reserve in the Engineering and Physical Science Library)
Grading Basis:	Homework: 40% (Undergraduate students) 30% (Graduate students) Reading Assignment 10% (Graduate students only) Quizzes (2): 10% Midterm Exam 20% Final Exam 30%

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Honor Pledge:	The university has a nationally recognized Honor Pledge, administered by the Student Honor Council. The Student Honor Council proposed and the university Senate approved an Honor Pledge. The University of Maryland Honor Pledge reads: *"I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination."* This pledge was designed to promote academic integrity within the student body and emphasize importance of the university academic policies.
Class Logistics:	The tentative class schedule, including topics to be covered, is listed below. The course is organized into three parts: 1) lecture-based survey of the basics of land-atmosphere interactions, 2) literature-based survey of the state-of-the-art remote sensing of land-atmosphere interactions, and 3) a series of quizzes, homework assignments, and examinations designed to test your mastery of the material. The lectures will be the focus of the majority of the course.

Tentative Course Schedule (subject to change):

#	Lecture Date	Topics Covered
1	Tuesday, September 1	Course introduction and motivation, concept of hydrologic cycle, global hydrologic cycle, conservation of mass [Read Chapter 1]
2	Thursday, September 3	Climate system, atmospheric composition, atmospheric thermodynamics: Ideal Gas Law (equation of state) for moist atmosphere, descriptors of moisture content [Read Chapter 2]
3	Tuesday, September 8	Conservation of energy (1^{st} Law of Thermodynamics), Clausius-Clapeyron equation [Read Chapter 3]
4	Thursday, September 10	Virtual temperature, adiabatic processes, hydrostatic equation, potential temperature
5	Tuesday, September 15	Atmospheric stability, moist adiabatic lapse rate, tephigrams [Read Chapter 4]
6	Thursday, September 17	Level of free convection, level of neutral buoyancy, energy budget near the surface
7	Tuesday, September 22	**Quiz #1**, Bowen ratio, evaporative fraction, radiation physics [Read Chapter 5]
8	Thursday, September 24	Surface radiation budget, shortwave radiation, longwave radiation
9	Tuesday, September 29	Radiation in the Earth system, net radiation
10	Thursday, October 1	Simple shortwave radiative flux model, simple longwave radiative flux model

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#	Lecture Date	Topics Covered
11	Tuesday, October 6	Satellite-based estimation of downwelling shortwave and longwave radiation
12	Thursday, October 8	Global-scale atmospheric motions [Read Chapter 9]
13	Tuesday, October 13	Events inducing vertical atmospheric motion [Read Chapter 10]
14	Thursday, October 15	Formation of clouds
15	Tuesday, October 20	Cloud microphysics, precipitation processes, remote sensing of precipitation [Read Chapter 11 and Chapter 12]
–	Thursday, October 22	**Midterm Examination**
16	Tuesday, October 27	Remote sensing of precipitation (continued)
17	Thursday, October 29	Introduction to atmospheric transport, conservation of momentum [Read Chapter 16]
18	Tuesday, November 3	Conservation of mass, conservation of moisture, conservation of energy, Navier-Stokes equations
19	Thursday, November 5	General characteristics of turbulence, basic mathematical concepts and tools [Read Chapter 15]
20	Tuesday, November 10	Surface turbulent fluxes, governing equations of turbulent flow, boundary layer profiles, mixed layer model [Read Chapter 17]
21	Thursday, November 12	**Quiz #2**, ABL growth [Read Chapter 18]
22	Tuesday, November 17	ABL growth (continued), turbulent kinetic energy
23	Thursday, November 19	Turbulent fluxes between the surface and ABL, eddy diffusivity approximation
24	Tuesday, November 24	Turbulent closure, surface layer scaling [Read Chapter 19]
–	Thursday, November 26	No Lecture (Thanksgiving Day Holiday)
25	Tuesday, December 1	Efficiency of heat dissipation mechanisms [Read Chapter 20]
26	Thursday, December 3	Surface evaporation processes, resistance analogy, canopy interactions, transpiration, equilibrium evaporation [Read Chapter 21]
27	Tuesday, December 8	Graduate Student Presentations
28	Thursday, December 10	Graduate Student Presentations

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#	Lecture Date	Topics Covered
–	TBD	Soil-vegetation-atmosphere transfer (SVAT) schemes [Read Chapter 8 and Chapter 24]
–	Saturday December 19	**Final Examination (10:30 AM - 12:30 PM)**

Homework:

Eight (8) homework problem sets will be assigned as shown below. These assignments are designed to reinforce your basic understanding of the theory covered in the lectures so that you can apply them to your data assimilation project. Due to limited lecture time, some concepts and applications may be introduced in the homework assignments. It is your responsibility to know the material covered not only in lectures, but in all assignments. Several of these assignments will contain problems involving numerical computing using Matlab© . Matlab© access is provided through the Virtual Computing Lab (`http://www.it.umd.edu/vcl`) and is available for remote use. Additionally, Matlab© is found on the workstations housed in the CEE Design Laboratory located in 1156 Martin Hall.

Assignments:

#	Subject Matter	Assigned Date	Due Date
1	Land surface forcing (Introduction to Matlab©), global hydrologic cycle	Thursday, September 3	Thursday, September 10
2	Atmospheric water balance, atmospheric density, atmospheric characteristics, Clausius-Clapeyron	Thursday, September 10	Thursday, September 17
3	Tephigram, Bowen ratio	Tuesday, September 22	Tuesday, September 29
4	Land surface albedo, black body radiation, atmospheric longwave emission	Thursday, October 1	Thursday, October 8
5	Solar radiation, surface energy balance, atmospheric circulation	Thursday, October 8	Thursday, October 15
6	Drop size distribution, hydrometeors, rainfall rate	Tuesday, October 27	Tuesday, November 3
7	Conservation equations, surface turbulent fluxes, virtual heat flux	Tuesday, November 3	Tuesday, November 17
8	Stability correction, ABL model, micrometeorological measurements	Tuesday, November 24	Thursday, December 3

Literature Reading Assignment (Graduate Students Only)

For the reading assignment you are asked to choose one (1) paper from the literature on a particular aspect/application of environmental remote sensing. Potential topics for discussion are provided in Table 4. Once chosen, everyone in class will read the paper and you will be responsible for presenting the paper and leading the class discussion of it as part of a 15-minute presentation.

Table 4: Potential topics for graduate student-led discussions.

Number	**Topic**
#1	Downwelling Longwave Radiation
#2	Downwelling Shortwave Radiation
#3	Evapotranspiration
#4	Precipitation
#5	Snow
#6	Soil Moisture
#7	Surface Water Elevation
#8	Vegetation Cover

Reading Assignment Schedule (Graduate Students Only):

Item	**Due Date**
Submit paper selection (List of top 3-5 choices)	September 22
Present paper and lead in-class discussion session	TBD