WR 406 - Seasonal Snow Environments

Offered: Spring Credits: 3
Lecture: Tuesday 12:30-14:20 (beginning of weeks of semester)
Laboratory/Field: Saturdays 8:00-17:00 and one or two Tuesdays 8:00-13:50 or 12:30-17:00
Prerequisite: upper level status (and preferably WR474 or WR574)
Instructor: Steven Fassnacht NR 335 <*steven.fassnacht@colostate.edu*>
Office Hours: MW 9-10 or by appointment

This course teaches the experimental method and field methods for snowpack measurements. Experiment design is presented using snow as the media of study. The course also focuses on data interpretation and analysis.

Class Topics:

1. Introduction	2. Experimental Method, Statistics, Replicas
3. Snow Environments and Climates	4. Snowpack Properties
5. Snowpack Measurements	6. Operational Snow Data
7. Snowfall	8. Accumulation
9. Snow-cover	10. Snowpack Metamorphosis
11. Snowpack Stability	12. Snow Structures
13. The Physics of Skis	14. Spatial Variability
15. Other Topics	16. Field Exercise Data Summary

Recommended Textbooks:

1. American Avalanche Association, 2009. *Snow, Weather, and Avalanches: Observational Guidelines for Avalanche Programs in the Unites States* (2nd ed.). The American Avalanche Association, Pagosa Springs, Colorado, 136pp.

Grading:

Adopted a SNOTEL Exercise	10%	
Metamorphism Experiment	10%	
Field Participation	5%	
Final Exam	10%	
Lab/Field Project	65%	
- Overview writeup (Hypothesis) (1 page)		5 (due Jan 27)
- Sampling Plan (Proposal) (3-5 pages)		10 (due Feb 3)
- Revised Plan		5 (due Feb 10)
- Datasheet (1-2 pages)		5 (due Feb 10)
- Participation/Summary of Data Collection		5 (next class after the exercise)
- Writeup (Final Report) (10-15 pages)		15 (due Apr 28)
- Project Presentation (15 min)		10 (due Apr 28)
- Digital Data Report (1p with data)		5 (due Apr 28)
- Metadata Report (2-3 pages)		5 (due Apr 28)
	100%	

Library & Research Help
The CSU Libraries Help Desk provides research and technical assistance either in person at Morgan Library or by phone at 970-491-1841. Jocelyn Boice is the librarian supporting this course. Contact her by email at <*jocelyn.boice@colostate.edu*> or by phone at 970-491-3882 to ask questions or set up an appointment for in-depth research help.

Adopted a SNOTEL
Each student will chose their own Snow Telemetry (SNOTEL) station and a corresponding streamflow forecasting location. The Joe Wright SNOTEL cannot be chosen. The SNOTEL station will be active, i.e., not discontinued, and have at least 10 years of continuous snow measurements/data. The streamflow forecasting location will be part of the NRCS network. See <*www.wcc.nrcs.usda.gov*>.

The exercise will be to summarize the SNOTEL station over the same period of record, and to use the real-time SNOTEL data to track the current snow year together with the streamflow forecast. Station selection will be completed by the second week of class. Monthly we will discuss the progression of the snowpack based on what SWE is doing.

Metamorphism Experiment
Each student will design and undertake a crystal metamorphism experiment. Measurements will be taken and a brief report will be written that includes figure(s) and/or table(s) with analyses as well as photographs illustrating processes.

Participation
Students are expected to attend class and field activities. Each student will be allowed to miss one field exercise without an official CSU explanation without a grade penalty. Each subsequent unauthorized field exercise absences will result in a grade of decrease of 10% (or one letter grade).

Final Exam
This will be a take home examination given out on the last day of class and due at 11am one week later.

Project
A majority of the grade in this course is for a group project. There will be 3-4 students per group. With the guidance of the instructor, a project topic will be selected and an overview/hypothesis statement will be written. Each group will lead one of the field exercises, including instructing students on data Collection Procedures, preparing Datasheets, and summarizing all the data that are collected. At the beginning of the class following the exercise, a summary of the data is due. The write-up of the project is due the week before the end of the semester. This will include the Final Report, the Digital Data Report, and the Metadata Report. The Final Report will be written similar to a professional (journal) paper, including any necessary figures and tables, and should have at least 4 peer-reviewed (journal) citations. The Digital Data Report includes all the data that have been collected and any necessary summarization of them. The Metadata Report will follow the Federal Geographic Data Committee (FGDC) or similar guidelines. All reports will be submitted electronically. The Overview, Sampling Plan, Revised Plan, Datasheet, and Final Report will be submitted as hard copies. Photographs should be included were appropriate.

This course will adhere to the Academic Integrity Policy of the Colorado State University General Catalog and the Student Conduct Code. For more information, see the TILT website: <*http://tilt.colostate.edu/integrity*>. For assignments, projects, writeups, and examinations, *a student shall not have given, received, or used any unauthorized assistance,* and *a student shall not give, receive, or use any unauthorized assistance*. Academic integrity also refers to citing references properly.

Instructors shall follow the following procedures when they feel academic misconduct has occurred:

- If a course instructor has evidence that a student has engaged in an act of academic misconduct in his or her course, prior to assigning any academic penalty, the course instructor shall notify the student of the concern and make an appointment with the student to discuss the concern. The student shall be given the opportunity to give his or her position on the matter. After being given this opportunity, if the student admits to engaging in academic misconduct, or if the course instructor judges that the preponderance of evidence supports the allegation of academic misconduct, the course instructor may then assign an academic penalty. The course instructor may refer the case to the Office of Conflict Resolution and Student Conduct Services for a Hearing before deciding on a penalty. The course instructor shall notify the student in writing of the infraction and the academic penalty to be imposed. A copy of this notification shall be sent to the Office of Conflict Resolution and Student Conduct Services. Examples of academic penalties include assigning a reduced grade for the work, assigning a failing grade in the course, removing the Repeat/Delete option for that course, or other lesser penalty as the course instructor deems appropriate.
- If, after making reasonable efforts, the course instructor is unable to contact the student or is unable to collect all relevant evidence before final course grades are assigned, he or she shall assign an interim grade of Incomplete and notify the student in writing of the reason for this action.
- If evidence of academic misconduct is discovered after the final course grades have been submitted, the course instructor shall follow the above procedure in properly notifying the student and providing an opportunity for the student to give his or her position on the matter before making a decision about any academic penalty. The course instructor must notify the student in writing of the infraction and any academic penalty subsequently imposed. A copy of this notification shall be sent to the Office of Conflict Resolution and Student Conduct Services.
- If the course instructor so desires, he or she may request that the Office of Conflict Resolution and Student Conduct Services conduct a Hearing to determine whether additional disciplinary action should be taken by the University, or if the offense warrants the addition of the "AM" (Academic Misconduct) notation to the student's transcript.

Field Experiments

1. The snow sampling equipment
2. The properties of the snowpack/snowpit: ds, SWE, density, temperature, layer characteristics (crystal shape and size), hardness (ram penetrometer), force resistance (force gauge)

For the following, need initial density, grain shape and size (photograph).

3. Mechanical properties of snow: i) compaction as a function of grain characteristic. Layer snow in a rectangular box / clear plexiglass tube, and measure the amount of compaction as a function of load applied, ii) strength (force applied to a compressed slab - like a beam experiment), and iii) impact of water (add water mist - increase or decrease strength). Use fresh (of different types and sizes), rounded (of different grain sizes), and facetted (of different grain sizes) grains. Measure initial density, add different depths of snow into a rectangular box with marked depth increments around them, how much does it compress - compute new density.

4. Thermal properties of snow: i) albedo and penetration of different snowpacks (fresh - different types, rounded, and facetted, all of different grain sizes).

Thermal conductivity (see CRREL plot).

5. Friction (static and dynamic) of snow:

Past projects:

1. How does shape affect the velocity of falling snow?
2. How does the snow affect how we ride (ski or board)?
3. What crystal characteristics produce the best snowball?
4. How does dust influence the surface characteristics and the melt rates of a snowpack?
5. How much dust or soil is required to insulate snow and thus retard snowmelt?
6. What is the optimal snow fence porosity?
7. How do trees affect snow accumulation? What is the influence of tree mortality? How does wind interact with a sparse canopy?
8. How does topography change the distribution of snow?

Possible Labs (Note these are weather dependent):

1. Introduction to Snow Sampling Methods and Tools (Joe Wright)
2. Introduction to Operational Snow Measurement Data (computer lab)
3. The Fall Velocity of Fresh Snow (on campus)
4. Efficiency of Snow Fences (volume and mass measurement - Hwy287 Wyoming)
5. Snow Surface Roughness Variability (Hwy287 Wyoming)
6. Canopy Interception Efficiency (on campus)
7. Depth of Penetration of Solar Radiation: Beer's Law (on campus)
8. Structural and Insulative Properties of Snow (Snow Structures lab on campus)
9. Basin-scale Spatial Snow Variability (Cache la Poudre - March 28 or April 4)
10. Alpine Snowpack Distribution (GLEES, Wyoming - April 21)
11. Snowmelt Timing over the day Using Small-scale Lysimeters
12. Snowmelt Infiltration through the Snowpack Dye Experiment
13. Representivity of a Snow Telemetry Station (Joe Wright - May 2)