Texts: *The Avalanche Handbook* (2006), 3rd ed., by David McClung & Peter Schaerer, + assigned papers

Monday, March 27, 2017		**Lecture**	**Reading**
	Morning lectures – albedo, energy balance		
8:15	Welcome to SNARL	Carol Blanchette	http://vesr.ucnrs.org/
8:30	*What's albedo and why should you care?* Optical properties of ice and water; reflectance of snow in visible and near-infrared wavelengths.	Jeff Dozier	Dozier, Mountain hydrology, snow color, and the fourth paradigm.
9:45	*Energy balance of the mountain snow pack:* solar and longwave radiation, sensible and latent heat exchange, movement of heat and water vapor in the snow pack.	Jeff Dozier	Fierz et al., Energy balance models.
11:00	*Instrumentation on Mammoth Mountain* : Description of *CUES* (CRREL/UCSB Energy Site)	Ned Bair	Bair et al., CUES http://www.snow.ucsb.edu/cues
11:30	*Avalanches and snow properties* : how snow fails, fracture mechanics and models.	Ned Bair	*Avalanche Handbook,* chapter 4 (now out of date). Sigrist, chapters 1 & 2.
13:00	**Lunch break**		
	Afternoon lectures – snow accumulation		
14:00	*Properties of ice and snow crystals in the atmosphere and the ground:* crystal structure; triple point; saturation vapor pressure; shapes of crystals; effects of curvature.	Jeff Dozier	Avalanche Handbook, chapter 2. Furukawa and Wettlaufer, Snow and ice crystals
15:00	*Storms in the Sierra Nevada:* how atmospheric circulation affects precipitation	Jeff Dozier	Rosen, Atmospheric rivers Lundquist et al., Barrier jets & orographic precipitation Roe, Orographic precipitation
16:00	Q&A on day, break		
18:30	**Dinner**		
Evening	Calculations and experiments with energy balance model and data	Ned Bair	SNOWPACK download http://www.snow.ucsb.edu/cues
Tuesday, March 28, 2017			
	Morning lectures – remote sensing		Nolin, Remote sensing of seasonal snow Lettenmaier et al., Hydrologic remote sensing (just the material on snow)
8:00	*Why the US Army cares about snow*	Bert Davis	http://www.crrel.usace.army.mil/
9:00	*Remote sensing of mountain snow:* What we can tell in the visible through infrared spectrum. Practical experience with various sensors.	Jeff Dozier	Dozier et al., Snow and imaging spectrometry
10:00	*Remote sensing, part 2:* Radar remote sensing of snow depth and water equivalent	Eli Deeb	Marshall et al., FMCW radar Rott et al., CoReH2O
11:00	*Remote sensing, part 3:* Passive microwave remote sensing	Bert Davis	Vuyovich & Jacobs, Passive microwave Shi et al., SWE remote sensing
12:00	**Lunch**		
13:00	*Mammoth Mountain instrumentation and avalanche control:* tour of CUES	**Mammoth Mtn**	http://www.snow.ucsb.edu/cues

	instrument site. Analysis of snow properties in snow pits: density, temperature, grain Avalanche control demo: guns & explosives.		Greene et al., *Snow, Weather, Avalanches* http://patrol.mammothmountain.com/
18:30	**Dinner**		
Evening	Ski patrol perspective and avalanche airbag demo	West Vane Ned Bair	
Wednesday, March 29, 2017			
8:30	*Field measurements of snow properties:* Extended column tests; snowpit analysis for stratigraphy and SWE, metamorphism; observations of liquid water in snow (if it's wet).	**Mammoth Pass**	*Avalanche Handbook,* chapter 8.
19:30	Dinner		
Thursday, March 30, 2017			
10:00	*Remote sensing, part 3:* Passive microwave remote sensing	Bert Davis	Vuyovich & Jacobs, Passive microwave Shi et al., SWE remote sensing
11:00	*Snow hydrology in mountain basins:* how snow affects aquatic ecology in the Sierra Nevada.	John Melack	Sickman et al. Mechanisms for N export.
12:30	Plotting pit data, SnowPilot		
13:00	**Lunch**		
14:00	*Dirty snow:* how contamination affects albedo and runoff	Tom Painter	Painter et al., Dust radiative forcing 1 Skiles et al., Dust radiative forcing 2
15:30	*Airborne Snow Observatory:* measurements of snow albedo and depth, and a tour of the plane.	Tom Painter	http://aso.jpl.nasa.gov/ Painter et al., Airborne Snow Observatory
18:30	**Dinner**		
Evening	Avalanche runout modeling: introduction to RAMMS, group exercise	Ned Bair	*Avalanche Handbook,* chapter 5. http://ramms.slf.ch/ http://www.snowpilot.org
Friday, March 31, 2017			
9:00	*Mammoth Mountain instrumentation:* tour of CUES instrument site, avalanche control routes	**Mammoth Mtn**	http://www.snow.ucsb.edu/cues Greene et al., *Snow, Weather, Avalanches*
14:00	*Snow hydrology in the Sierra Nevada:* water supply; runoff forecasting; droughts, trends; errors.	Jeff Dozier	Bales et al., Mountain hydrology of western U.S. Bair et al., SWE reconstruction http://cdec.water.ca.gov/
15:30	Economic value of snow forecasts	Timbo Stillinger	
16:30	Advanced topics in snow metamorphism: effect of energy balance on avalanche hazard; theoretical basis of change in albedo; sintering; modeling of snow metamorphism at the grain scale.	Ned Bair	Avalanche Handbook, chapter 3. Fierz et al., International classification of snow.
18:30	**Dinner,** course evaluations		
Evening	Review and discussion		

Saturday, April 1, 2017	
9:00	Final Exam, 3 hours, open notes, Internet
12:30	Lunch, clean up dorm, move out