EARTH AND SPACE SCIENCES **Autumn 2017**
431 *PRINCIPLES OF GLACIOLOGY* 4 Credits, SLN 14841
505 *THE CRYOSPHERE* 4 Credits, SLN 14862

M-W-F, 1:30 - 2:50 pm. ***Room:*** JHN 022
Mon.-Wed.: Lectures, Fri: Lab/Discussion

Week 1 –

W, 09/27 Unit 1	**Natural Occurrences of Ice:** Distribution and environmental factors of seasonal snow, sea ice, glaciers and permafrost Marshall, S., 2012. *The Cryosphere.* Chapter 1.	Holschuh
F, 09/29	*Lab/Discussion – Field trip preparation*	Holschuh/Kehrl

Field Trip, Saturday, 09/30 - Mt. Baker

J. Harper. 1993. Glaciers on Mt Baker. *Arctic and Alpine Research* 25(4), 332–340.

Week 2 –

M, 10/02 Unit 1	**Measuring Occurrences of Ice:** Observation techniques that inform us about the extent of the cryosphere Bamber and Payne. *Mass Balance of the Cryosphere: Observations and Modeling of Contemporary and Future Changes* (Ch. 4) 59-77.	Holschuh
W, 10/04 Unit 2	**Physical Properties of Ice:** Phase relationships, crystallography, basic properties Marshall, S., 2012. *The Cryosphere.* Chapter 2. Runnels, L.K., 1966. Ice. *Scientific American*, Dec 1966, 118–126.	Holschuh
F, 10/06	*Lab/Discussion*	Holschuh/Kehrl

Week 3 –

M, 10/09 Unit 2	**Accumulation I:** Snow Formation in the Atmosphere McClung, D., and P. Schaerer, *The Avalanche Handbook*, 21-31, 43–52. Marshall, S., 2012. *The Cryosphere.* Chapter 4, p.65–72.	Warren
W, 10/11 Unit 2	**Accumulation II:** Deposition, wind transport, metamorphism, physical properties McClung, D., and P. Schaerer, *The Avalanche Handbook*, pp. 52-72. Marshall, S., 2012. *The Cryosphere.* Chapter 4, pp. 72–89.	Holschuh
F, 10/13	*Lab/Discussion*	Holschuh/Kehrl

Week 4 –

M, 10/16 Unit 3	**Ablation:** Mass and energy balance in cryosphere systems. Cuffey and Paterson: *The Physics of Glaciers* Chapter 5.	Holschuh
W, 10/18 Unit 4	**Ice Dynamics I:** Ice Deformation Marshall, S., 2012. *The Cryosphere.* Chapter 6.	Holschuh
F, 10/20	*Lab/Discussion*	Holschuh/Kehrl

Week 5 –

M, 10/23 Unit 4	**Ice Dynamics II:** Basal Sliding	Holschuh
	Drewry, 1986 pp. 10–14, 20–32.	
W, 10/25 Unit 4	**Ice Sheets, Ice Streams, and Ice Shelves:** Temperature in cold ice masses and special problems of ice sheets	Holschuh
	Joughin and Alley, Stability of the West Antarctic ice sheet in a warming world, *Nature Geoscience* 2011.	
F, 10/27	*Lab/Discussion*	Holschuh/Kehrl

Week 6 –

M, 10/30 Unit 4	**Alpine Glacier Systems:** Climatic response times and rapid changes	Christian
	Raymond, C.F., 1987, How do glaciers surge? A review: Journal of Geophysical Research, v. 92, p. 9121 Roe, G.H., Baker, M.B., and Herla, F., 2016, Centennial glacier retreat as categorical evidence of regional climate change: Nature Geoscience, v. 1, doi: 10.1038/ngeo2863.	
W, 11/01 Unit 4	**Recent Changes in the Cryosphere:** Elevation changes, retreat of ice shelves, speedup of outlet glaciers, sea-level change	Kehrl
	Reading from IPCC AR5 (2013)	
F, 11/03	*Lab/Discussion*	Holschuh/Kehrl

Week 7 –

M, 11/06	**Midterm Exam**	Holschuh
W, 11/08	**Exam Discussion + Avalanches**	Conway
F, 11/10	**[Veterans Day]**	

Week 8 –

M, 11/13	**Paleoclimate and Ice Ages I:** Ice core science and climate reconstruction. Jouzel, J., 2013. A brief history of ice core science over the past 50 years *Climate of the Past* Vol. 9, 2525–2547.	Holschuh
W, 11/15	**Paleoclimate and Ice Ages II:** Theories of the Ice Age Cycles. http://www.sciencecourseware.org/eec/globalwarming/tutorials/milankovitch/ Imbrie, J., 1993. On the structure and origin of major glaciation cycles. *Paleooceanography* 8, (Pages Reduced).	Roe
F, 11/17	*Lab/Discussion*	Holschuh/Kehrl

Week 9 –

M, 11/20 Unit 3	**Paleoclimate and Ice Ages III:** Evidence of former glaciers Porter, S.C., 1985: Glaciological evidence of Holocene climatic change, In *Climate and History*, 82–110.	Spector
W, 11/22 Unit 4	**Glacial Erosion:** Temperature in cold ice masses and special problems of ice sheets Ritter, D.F., 1986: *Process Geomorphology*, Chapter 10.	Hallet
F, 11/24	**[Thanksgiving]**	

Week 10 –

M, 11/27 Unit 4	**Sea Ice I:** Formation, structure, and relation to the climate Marshall, S., 2012. *The Cryosphere*. Chapter 5, p.104–126. Maykut, G., 1985: *An Introduction to Ice in the Polar Oceans*. Report APL-UW 8510. p 1–42. Also see the tutorial on sea ice at: http://www.nsidc.org/seaice/intro.html	Light
W, 11/29 Unit 4	**Sea Ice II** Maykut, G., 1985: *An Introduction to Ice in the Polar Oceans*. Report APL-UW 8510. p 78–92. Marshall, S., 2012. *The Cryosphere*. Chapter 5.	Light
F, 12/01	*Lab/Discussion*	Holschuh/Kehrl

Week 11 –

M, 12/04 Unit 3	**Permafrost:** Distribution, relationship to climate, physical processes and structure/engineering problems Marshall, S., 2012. *The Cryosphere*.Chapter 7, p. 165–179. Lachenbruch, A.H., 2001: Permafrost. *Oxford Encyclopedia of Global Change*	Hallet
W, 12/06 Unit 4	**Modern Investigation of the Ice Sheets:** Antarctica and Greenland in the news. Student selected readings	Holschuh
F, 12/08	*Graduate Student Presentations*	Holschuh/Kehrl

Final Exam
Monday, December 11th 2:30-4:20