	Class 1	**Lab**	***Between***	**Class 2**	***Between***
Week 1 **(13-17 Sept)**	Intro, syllabus, learning agreements	OGGM web apps + WGMS data	*Annotate New Yorker piece re: Okjökull*	• Discussion on what classifies a glacier • Short lecture on types of glacier and other parts of Earth's cryosphere • Gallery walk with pics/art of glaciers	*NOVA video*
Week 2 **(20-24 Sept)**	[SMB - how to build a glacier] • Short lecture on accumulation, ablation, ELA, notion of flow vs. advance/retreat • Group worksheets - case studies of glacier/ice cap/ice sheet, what mass balance processes are likely dominant	Glacier goo **Lab report (fill in)**	• *Annotate van der Veen Ch 1* • ***Low stakes problem set on math prelims***	• Short lecture on mathematical preliminaries - partial derivatives, coordinate systems • Partner work to practice interpreting partial derivatives • Brief highlight of MISI: why do we want math like this?	• *Annotate van der Veen Ch 2* • *YouTube video re: stress tensor*

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Week 3 **(27 Sept-1 Oct)**	• Short lecture on solid deformation, relevant to ice • Poll activities: why six components of stress tensor? What factors can you think of that are not accounted for in Nye-Glen flow law? • Write on index cards: what is your most important question remaining?	"Theory workshop" (tutorial): continuum mechanics -Go through published papers and take note of their methods. Jigsaw and teach to another group • ***"Lab report" reflection on theory workshop***	*Annotate van der Veen Ch 3*	• Catch-up day: Q&A round for all • Summarize "remaining question" responses on index cards and distribute to student pairs. Students work together to respond and present • Short step-through of Stokes equation • Small groups: diagram force balance for a given glaciological setting • Intro of final project	• *Annotate van der Veen Ch 4* • *YouTube video re: Stokes equations*
Week 4 **(4-8 Oct)**	• Foundations of ice sheet modelling • Discussion: how do you handle a (math) problem you can't solve? —>Navier-Stokes not guaranteed to have solution, need for approximation • Derive Cauchy Momentum equation from Newton's 2nd law • SIA/SSA intro	"Theory workshop": special cases of glacier flow. Develop a plan to solve a problem, reflect on process of problem solving. Problems drawing on stress balance, finding right eqns, etc.	*[no reading]*	• Short lecture on types of model • All models are wrong but some are useful • Jigsaw: Getting to know several models from snippets of documentation, then selecting best one for different questions. Pairs make a slide, then split into 2 groups where each person presents a slide	***Low stakes problem set (due Friday)*** *Annotate The Maori Vision of Antarctica's Future (NYT)*

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Week 5 (11-15 Oct)	• Indigenous people's day - special reading & discussion • Short lecture on intersection of indigeneity & environmental action • Pair analysis of a figure re: black carbon from Maori burning. Parachute science discussion.	Computer lab: setting up OGGM and getting going with Jupyter	*Annotate OGGM-Edu SMB page*	• Lightning review of SMB processes • OGGM practice: modelling glacier mass balance • Check-ins - what are the main results generated in notebook? • Short lecture on relevant climate effects (marine/ continentality, orographic lifting)	***Lab report (templated)***
Week 6 (18-22 Oct)	[NO CLASS/LAB - BREAK]		• *Annotate van der Veen Ch 6 (focus on early part)*	• Lecture on thermo effects (pressure melting, strain heating) • Partner problem: how much energy required to melt all ice sheets? Why do we still have ice sheets? • Compute freezing/ melting at base of an ice shelf	• *Annotate van der Veen Ch 7* • ***Project topic selection (Friday)***

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Week 7 (25-29 Oct)	• Short lecture on basal processes • Conductive wire demo of regelation • Guided literature search: in small groups, find and summarize a paper that studies these processes (assign subglacial hydro, hard-bed sliding, deformable beds). Present at end of class.	Computer lab: the glacier sliding law in OGGM	• *Annotate Egholm et al re: glacial buzzsaw* • *GeoScience videos: Glacial landforms*	• Photo highlight from goo lab - transport/ erosion • Short lecture on glacial erosion mechanisms & landforms • Photo ID activity - glacial landforms. What is it? How do you know? How did it form? What does it tell us?	*Annotate Colgan review* ***Lab report (templated)***
Week 8 (1-5 Nov)	• Why fractures are hard to model - back to how ice sheet models work • Fracture propagation in processed cheese product	• Library workshop - finding resources and constructing an annotated bibliography	*Annotate Nick et al 2009, Greenland paper*	• Photo annotation of glaciers - where were the principal stresses? What kind of crevasse? • Short lecture on iceberg calving, tidewater glaciers, TWG cycle • Discuss key findings and questions on Nick et al 2009	*Alex Robel IGS seminar video* ***Problem Set 3 - thermal effects, model selection, collapse hazards***

	Class 1	Lab	*Between*	Class 2	*Between*
Week 9 (8-12 Nov)	• Short lecture on ice sheet instabilities • Thoughts/ Questions/ Realizations from Alex Robel seminar talk • SLR activity with Surging Seas map	• Poster scaffolding: develop and deliver a pitch about your poster topic and why it matters [Oratory Now visit]	• *Annotate Huss & Hock paper* • *Annotate Immerzeel et al 2020*	• Short lecture on glacial water resources and peak water OGGM lab - runoff and peak water	***Poster annotated bibliography (by Friday)*** • *Annotate Soruco paper re: water resources in La Paz* • *Annotate Kaufman PopSci piece re: La Paz drought*
Week 10 (15-19 Nov)	• YouTube video re: Tuni glacier • Case study discussion: drought in La Paz. Complications from (small groups study) El Niño, World Bank-imposed privatization, GCM error in precip forecasting	OGGM lab - self-designed projection of water resources for specific area. Site selection, experimental design, initial troubleshooting.	• ***Lab report (templated)*** • *Lemos et al review of usable climate info*	• Brainstorm: who are decision-makers who could use glacio information? • Select one decision-maker & describe how they get info, factors influencing whether info is usable for them • Discussion of Lemos et al • Mini-lecture on examples from Ultee et al 2018 • Exit ticket: To produce usable glaciology, we should…	• *Annotate In the Shadow of Melting Glaciers Ch 2*

	Class 1	Lab	*Between*	Class 2	*Between*
Week 11 **(22-26 Nov)**	• Short lecture on mechanisms of jokulhlaup and collapse hazards • Small group activity brainstorming hazards of marine/ land-terminating glaciers • Individual: choose a place and write an assessment of glacial risks under a changing climate (fill pages in a GDoc)	OGGM lab - develop methods, test scenarios	***Assignment 4: City council briefing*** *Annotate Orlove 2009 adaptation paper*	[NO CLASS - THANKSGIVING]	
Week 12 **(29 Nov-3 Dec)**	[adaptation to glacier change] • Gallery walk: example adaptation actions, pros/cons, coping/incremental/ transformative • Small group/pair work: Discuss your assessment of glacial risks in the context of adaptation. What could be done? What related problems might arise?	OGGM lab - tie up loose ends and write report	*Annotate Carey et al 2013, hydro-social*	• Science usability and interdisciplinary - what are the other relevant concerns? • Minute paper: how would you revise your hazard assessment based on our discussion today?	***Lab report 5*** *Annotate Qoyllur Rit'i images*

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Week 13 **(6-10 Dec)**	• Film: Utuqaq • Discussion: what are the important considerations in doing glaciology? Who decides?	Poster presentation session - assign half of students to present for each half, others circulate and fill out a peer assessment card	***Reflection on experience of poster presentation***	• Lightning review of whole semester • Course evaluations (25min) • Write one thing you'll take forward and discuss in small groups	