## STUDENT PROJECTS 2014

PROJECT 1: **Kinematic GPS processing**

*STUDENTS*: Grace Barcheck, Laura Thomson

*ADVISOR*: Martin Truffer

*DESCRIPTION*: We will learn how to interpret GPS data from moving ice to derive glacier velocities and variations thereof. Students could use their own GPS data, but should inform the instructor prior to the course if they wish to do so.

*SOFTWARE REQUIREMENTS*: Matlab or similar software

*REQUIRED STUDENT BACKGROUND*: We will analyze data in Matlab or similar software.

PROJECT 2: **Inverse modeling**

*STUDENTS*: David Lilian, Florian Ziemen

*ADVISOR*: Martin Truffer

*DESCRIPTION*: We will explore inverse models to derive conditions at the base of a glacier from surface data. The project requires an interest in mathematical methods and some familiarity with Matlab programing.

*SOFTWARE REQUIREMENTS*: Matlab

*REQUIRED STUDENT BACKGROUND*: Some familiarity with a Linux/Unix operating system is beneficial. Also we will analyze data in Matlab or similar software.

PROJECT 3: **Seasonal variations in flow speed of Jakobshavn Isbrae**

*STUDENTS*: Alistair Everett, Laura Kehrl, Mark Pittard

*ADVISOR*: Andy Aschwanden

*DESCRIPTION*: While Jakobshavn Isbrae, Greenland's largest and the world's fastest outlet glacier, showed no seasonal variations in flow speeds in the mid-1980's, strong seasonal variations coinciding with a cycle of summer thinning and winter thickening have been observed since 2004. Compared to winter velocities, speed-ups of up to 40% near the terminus are measured. It has been suggested that these seasonal near-terminus variations can be explained by seasonal variations in terminus position via changes in back-stress. Experiments with a numerical ice sheet model, however, indicate that the annual cycle of thickening in the winter and thinning and thinning in the summer effects the basal resistance by modulating effective pressure (i.e. the difference between ice overburden pressure and basal water pressure. This can cause seasonal variations in flow speeds of similar magnitude compared to observations. Is the observed seasonality in flow speeds terminus–driven, surface mass balance-driven, or a combination of both? In this project we will combine observations and existing numerical simulations to gain a better understanding how seasonal load changes modulate longitudinal stresses and, thus, flow speeds, and compare to a terminus-driven model.

*SOFTWARE REQUIREMENTS*: Any software that can read and analyze netCDF data will do (Matlab, python, QGIS, etc). NCO (http://nco.sourceforge.net/) and CDO (https://code.zmaw.de/projects/cdo) are essential command-line tools. The instructor mostly works with python and QGIS but can assist with Matlab as well. Please install these tools prior the the course. If you have questions regarding installation, please contact the Instructor.

*REQUIRED STUDENT BACKGROUND*: Familiarity with basic data analysis and visualization is beneficial.

PROJECT 4: **Exploring the vertical dimension of a glacier with FEniCS**

*STUDENTS*: Soroush Rezvanbehbahani, Heidi Sevestre

*ADVISOR*: Andy Aschwanden

*DESCRIPTION*: The FEniCS project (http://fenicsproject.org/) is a powerful open-source package to solve PDE's using the Finite Element Method that is becoming increasing popular in glaciology. Its core strength is the close similarity between the FEniCS syntax and the weak form of a PDE written out on paper. The instructor is very keen on learning this promising tool. We will start off with implementing the heat diffusion equation which we can verify against an analytical solution. Next we'll move to a 1D enthalpy advection-diffusion-production equation to study processes in the firn or at the base of a glacier where phase changes occur. From there, the field is wide open. This project is as much about learning a useful tool for glaciological research as it is about glaciology.

*SOFTWARE REQUIREMENTS*: A working FEniCS installation, see http://fenicsproject.org/download/ for details. Packages exist for Debian and Ubuntu-like OS. If you're using a Mac with MacPorts, there is also a port for dolphin (can be a bit tricky).

*REQUIRED STUDENT BACKGROUND*: Working knowledge of Python and PDEs.

PROJECT 5: **Models for hydrology and sliding on the Kennicott glacier**

*STUDENTS*: Douglas Brinkerhoff, Colin Meyer

*ADVISOR: Ed Bueler*

*DESCRIPTION*: We will follow Bartholomaus and others (2011) in building a "lumped" numerical model of the hydrology and sliding of the Kennicott glacier during summer conditions, especially considering the sliding generated by the annual flood from the drainage of Hidden *Creek* Lake. Their model involves ordinary differential equations and is well-constrained by data. Then we'll look at either inverting the model for subglacial parameters or extending the model to a flowline where different parts of the glacier can respond at different rates.

*SOFTWARE REQUIREMENTS*: Matlab or Octave

*REQUIRED STUDENT BACKGROUND*: Minimal exposure to differential equations and use of *Matlab* or similar.

PROJECT 6: **From ice shelves in the lab to good numerical models**

*STUDENTS*: Karen Alley, Alexander Lhose

*ADVISOR*: Ed Bueler

*DESCRIPTION*: Ice shelves and ice streams meet at grounding lines. One of the keys to effective modelling of the evolving Antarctic ice sheet is capturing the way grounding lines move. New laboratory models using glycerine and salt water give well-measured moving grounding lines and ice shelves. For a strong-lateral-confinement-case laboratory model (Pegler et al. 2013) we will build simple numerical schemes for the shallow equations which describe the dynamics. Bypassing the speculative literature of numerical grounding line modelling, we'll have the chance to be actually wrong: we will know the misfit between the numerical model and the observations.

*SOFTWARE REQUIREMENTS*: Matlab or Octave

*REQUIRED STUDENT BACKGROUND*: Minimal exposure to differential equations and use of Matlab or similar.

PROJECT 7: **On the mass balance of the Austfonna Ice cap, Svalbard**

*STUDENTS*: Aurora Roth, Stathiyaseeland R

*ADVISOR*: Jon Ove Hagen

*DESCRIPTION*: The project involves analysing the surface mass balance from stake data over a ten years period 2004 – 2013. Main focus will be on one drainage basin, Etonbreen (630 km2), that has the best data set. The aim is to calculate winter, summer and net specific balance in each stake location, then in the entire basin and discuss problems and uncertainties. The analysis could be extended to give estimates for the entire ice cap (7800 km2).

*SOFTWARE REQUIREMENTS*: Data is provided in an Excel spreadsheet and can be analysed in Excel or transferred into the student's preferred program, Matlab or similar.

PROJECT 8: **Surface energy balance and sensitivity of melt to climate change**

*STUDENTS*: Shawn Eaves, Noel Fitzpatrick**,** Andrew Melone, Kathrin Naegeli

*(Note that this project will be devided into 2 separate projects with 2 students working on each)*

*ADVISOR*: Regine Hock

*DESCRIPTION*: The project involves calculating the energy balance at the surface of a glacier comparing different parameterizations for various components. We will explore the sensitivity of energy components and glacier to melt to changes in meteorological input variables. Details will evolve with student interests.

*SOFTWARE REQUIREMENTS*:: Any programming language, e.g. Matlab. Project can in principle also be done using spreadsheets (e.g. Excel)

*REQUIRED STUDENT BACKGROUND*: Basic knowledge of any of the software requirements above

PROJECT 9: **Geodetic mass balance of Svalbard valley glaciers**

*STUDENTS*: Caitlyn Florentine, Samiah Moustafa

*ADVISOR*: Nick Barrand

*DESCRIPTION*: This project will use a variety of airborne remote sensing datasets to measure area and surface elevation changes of two valley glaciers in Svalbard. These measurements will be used to calculate long-term glacier volume and mass changes and will be compared with / placed in the context of, in situ measurements of mass balance and temperature and precipitation.

*SOFTWARE REQUIREMENTS*:: Matlab, and any GIS software (ArcGIS, QGIS, etc)

*REQUIRED STUDENT BACKGROUND*: Basic familiarity with data analysis and visualisation within the software listed above.

PROJECT 10: **Active microwave remote sensing of Antarctic Peninsula melting**

*STUDENTS*: Thomas Mosier, Tyler Sutterley

*ADVISOR*: Nick Barrand

*DESCRIPTION*: This project will analyse time-series and raster images of temperature and microwave backscatter across the Antarctic Peninsula to investigate snowmelt dynamics. A threshold relation between positive air temperatures and changes in microwave backscatter will be used to calculate the timing and duration of melting. Melt maps will be used to investigate interannual variability and calculate decadal averages in melting, and will be compared to output from simulations of a state-of-the-art regional climate model.

*SOFTWARE REQUIREMENTS*:: Matlab, and any GIS software (ArcGIS, QGIS, etc)

*REQUIRED STUDENT BACKGROUND*: Basic familiarity with data analysis and visualisation within the software listed above.

PROJECT 11**: Glacier change detection using (drone-acquired) orthophotographs**

*STUDENTS*: Denis Felikson, Alexander Wamsley

*ADVISOR*: Michael Loso

*DESCRIPTION*: There is a rapidly growing interest in the use of unmanned aircraft systems (UAS, or more commonly, drones) for scientific applications. UAS may eventually rival traditional (aircraft, satellite) sensor platforms, but at present the technology and legal framework for UAS operation are still developing, and many investigators (like me) are still trying to figure out what can be safely and realistically accomplished. We will work with previously-collected and new imagery (we'll fly the drone if the weather cooperates and I haven't crashed it yet) of the Kennicott Glacier terminus region to construct georeferenced orthophotographs, calculate changes over time, and compare our results with predictions of melt and motion. (Note, due to a recent (20 June !) ban of drones in Alaska's Nationalparks this project may need some adjustments if permission can not be acquired).

*SOFTWARE REQUIREMENTS*: Instructor will provide a computer with Agisoft and ArcGIS (for orthophoto construction and visualization) installed. We can analyze results in matlab, excel, or similar software.

*REQUIRED STUDENT BACKGROUND*: None, but some familiarity with basic data analysis and visualization is beneficial. Willingess to do a little fieldwork a plus.

PROJECT 12: **Comparative glacier hydrology** ***(cancelled)***

*ADVISOR*: Michael Loso

*DESCRIPTION*: One reason the public cares about glaciers is because the public cares about water. Sea level rise, salmon habitat, hydropower: in Alaska, they all depend on glaciers. We will examine five years of stake data from heavily and not-so-heavily glaciated basins of the Eklutna River, near Anchorage, and construct, then compare, the mass balance records of the two basins with concurrent measurements of stream discharge from the two basins. We will use the results to gain insight into the role that glaciers of different sizes play in controlling downstream discharge in a variable climate.

*SOFTWARE REQUIREMENTS*: Matlab

*REQUIRED STUDENT BACKGROUND*: None, but some familiarity with basic data analysis and visualization is beneficial.

PROJECT 13: **Glacial processes and sediments**

*STUDENTS*: Patricia Eugster, Jenna Zechmann

*ADVISOR*: Doug Benn

*DESCRIPTION*: Glaciologists routinely measure variables such as ice temperature, surface acumulation and ablation, ice velocity, and so on. These variables are also of great importance for understanding former glaciers and ice sheets, and are often reconstructed from various types of proxy data. Glacial sediments and landforms are a major source of such data, and palaeoglaciological and palaeoclimatic reconstructions are often based on interpretations of sediments with reference to modern analogues. However, when glaiers vanish, here is a mjor loss of information, and glacial sediments represent an impoverished archive of former glacier activity. Understanding this information loss is of central importance to reliable interpretation of the glacial geological record. This project will examine the relationship between glacial processes and the sediment record at Ruth/Kennicott Glacier. Field measurements will be made of sediment properties such as clast shape, fabric, facies type, and sediment-landform architecture, and interpreted with reference to observable or otherwise known processes. The data will be used to construct conceptual models of glacial sedimentation at the site, and to assess how well these models represent the richness and diversity of glacier behaviour.

*SOFTWARE REQUIREMENTS*: none

*REQUIRED STUDENT BACKGROUND*: none