Report from the University of Alaska Fairbanks International Summer School in Glaciology

At the end of a bumpy, 60-mile dirt road, still strewn with hidden tyre-endangering railroad spikes, lies the small Alaskan community of McCarthy. According to the wishes of its residents, it is publicly accessible only via footbridge across the Kennicott River; no roads lead into the town itself. Above the town stands Kennicott Glacier, dominating the valley. Once a year, glacier-dammed Hidden Creek Lake bursts free and drains out from beneath the glacier, tripling the flow of the river for 24 hours.

What better setting could there be for the University of Alaska Fairbanks to spend a week imparting glaciological knowledge to a class of eager students? On 8 June 2010, with the weather obligingly sunny, 27 students and ten lecturers disembarked from their long road journey and marched down McCarthy's main street to the old hardware store that houses the Wrangell Mountain Center. Here they would spend the next week bathed in a sea of glaciological knowledge at the first University of Alaska Fairbanks International Summer School in Glaciology.

UAF faculty designed the summer school to give students a good base of knowledge in their field and an introduction to some of their future colleagues. Several sponsors provided the generous support that allowed students to travel from far away and spend two weeks concentrating on learning: the UAF International Arctic Research Center (IARC), the International Arctic Science Committee (IASC), the National Aeronautics and Space Administration (NASA), the International Union of Geodesy and Geophysics (IUGG), and of course our friends at the International Glaciological Society (IGS.)

The Wrangell Mountain Center (WMC) acted as classroom, kitchen, gathering-place and general summer school headquarters. Its unfailingly friendly staff cooked three meals a day for the glaciologists, whose intensive studies worked up quite an appetite ('We're making enough for sixty people,' the staff were heard to remark, 'and they're still eating it all!') The food was mostly vegetarian and vegan, yet of such quality (and quantity) that even the most dedicated omnivores barely missed the meat. The WMC was also the location of the only bathing facilities available to the students: a choice between washing in the glacier-fed stream out back, or filling a spigot-equipped bucket from the wood-fired water heater and then propping it up in a small outdoor enclosure to approximate a shower. Such shared deprivations were one of many ways in which students bonded.

UAF chose participants carefully to achieve a varied student body, with research interests stretching from ocean influences on tidewater glaciers to

Fig. 1. Don't be fooled by the Hardware Store's elderly facade; there's cutting-edge science in there.

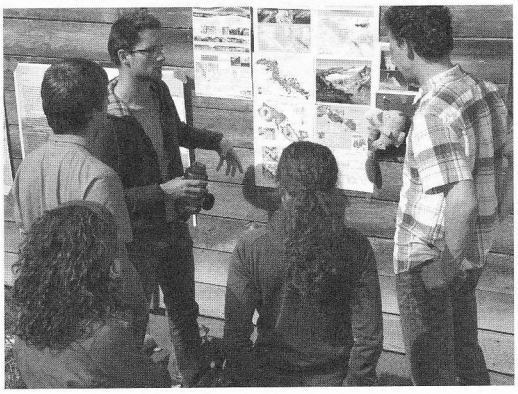

Fig. 2. Bernhard Hynek describes his research to an interested crowd.

Fig. 3. Solar-powered physics calculations.

glacial features on Mars. Ice core analysis, remote sensing, ice sheet modeling, subglacial dynamics, glacier–climate interactions, and a wide variety of other subjects filled out the list. The diversity of origins matched the diversity of interests, with students hailing from institutions in eight US states (Alaska, Arizona, California, Colorado, New York, Texas, Washington, and Wisconsin) and 12 different countries (Argentina, Austria, Belgium, Canada, Denmark, the Netherlands, New Zealand, Norway, Sweden, the Russian Federation, the UK and the USA). A poster session on the first day in McCarthy got students acquainted with each other's research topics, and was also well attended by interested townsfolk.

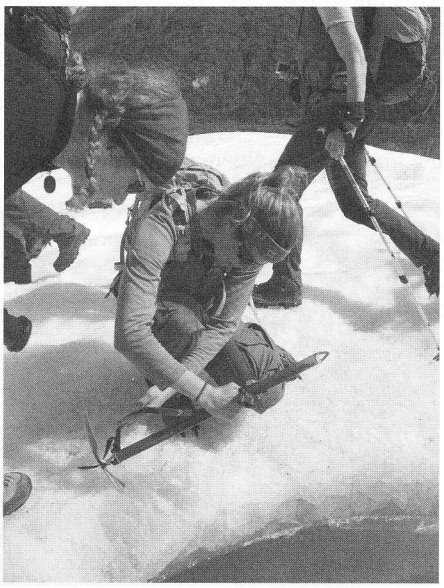

Fig. 4. Erin Pettit and Katie Boldt pry out a large ice crystal.

Each morning the students woke to a sun already well up in the sky and made their way from the riverside tent city to the Wrangell Mountain Center for a hearty breakfast and a cup or three of coffee to kick-start their mental faculties. Mornings were devoted to classes on glaciological topics both theoretical and practical, from the mathematical rigors of continuum mechanics to more practical discussions of glacial geomorphology and hydrology. After lunch, eaten outdoors except in the rainiest of weather, students would complete exercises based on the morning's lessons and gather in small groups to work on projects. These bite-sized research projects, designed to be completed within the week, included data analysis projects, modeling exercises and one or two tasks involving fieldwork.

Not every day was taken up with coursework. The Kennicott glacier and its tributaries, visible from almost every part of town, demanded closer investigation. The whole school hiked up one sunny day to clamber across one tributary, the Root, and observe its properties firsthand. For some students, who specialized in remote sensing or modeling, the trip represented their first opportunity to experience a glacier 'in person'. The Root Glacier provided examples of crevasses and moulins, cryoconite holes, supraglacial streams and other icy phenomena; the trip also gave students a chance to observe the debris-covered foot of the Kennicott, climb over the Root's large medial moraine, and investigate a small mostly-dry lake next to the glacier whose level rises 40–50 meters when the yearly outburst flood traverses the subglacial hydrological system.

After a long day of classes, students had no trouble filling their evenings. A long-time McCarthy resident gave a talk on the town, its character and its peculiar history, from its geological creation to the present; the local saloon's open mic night drew participation from both summer school students and WMC staff; INSTAAR's Bob Anderson gave a public lecture in Kennicott on glaciology and its application to the local glacier's particular morphology and annual outburst floods; a Europe vs. North America soccer game competed for space with the local softball team. On nights when no organized activity presented itself, students (and sometimes faculty) gathered around the bonfire in the midst of Tent City, talking, singing, and occasionally breaking out into fits of dancing, long into the twilit Alaskan night.

On the last day in McCarthy students presented the results of their projects, most of them having made gratifying progress with just a few days' hard work. A banquet at the McCarthy Lodge capped things off, providing students with their first red meat in a week and an opportunity to win

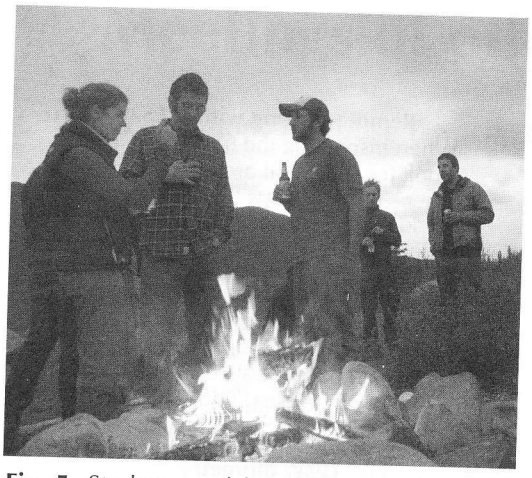

Fig. 5. Students and lecturers chat about the day's classes, or perhaps about which students the bears will get first.

one of four student memberships kindly donated by the International Glaciological Society by demonstrating their talent, skill or luck. From the songs, poems, and other performances presented, Dr Hock selected four winners: one for a set of excellent Russian refrigerator jokes; one for a suite of limericks based on the week's lecture subjects; one for the design of a t-shirt to commemorate the camp; and one selected by a lottery.

The camp participants embarked on the long drive back to Fairbanks in good spirits, despite their sadness at leaving McCarthy behind and tiredness from a week of mental and physical exertion. The school ended with a one-day conference at UAF covering a variety of icy topics, going beyond the glaciology covered in the camp to encompass permafrost, natural disasters and other related fields of study. Along with the lectures, students visited the CRREL Permafrost Tunnel to learn about permafrost phenomena and investigate the intriguing icy structures therein.

The first UAF International Summer School in Glaciology was a rousing success by any measure. Students left with a better and more comprehensive grounding in their chosen field of study, as well as solid hands-on experience in collaborative projects. We had a great opportunity to get to know a classic Alaskan town while developing a little more hands-on familiarity with glaciers and the landscapes around them. And each of us was privileged to be able to work and socialize with so many excellent scientists, both the accomplished faculty from University of Alaska, University of Colorado, and University of Washington and the dedicated students from around the world. We're all looking forward to the next one!

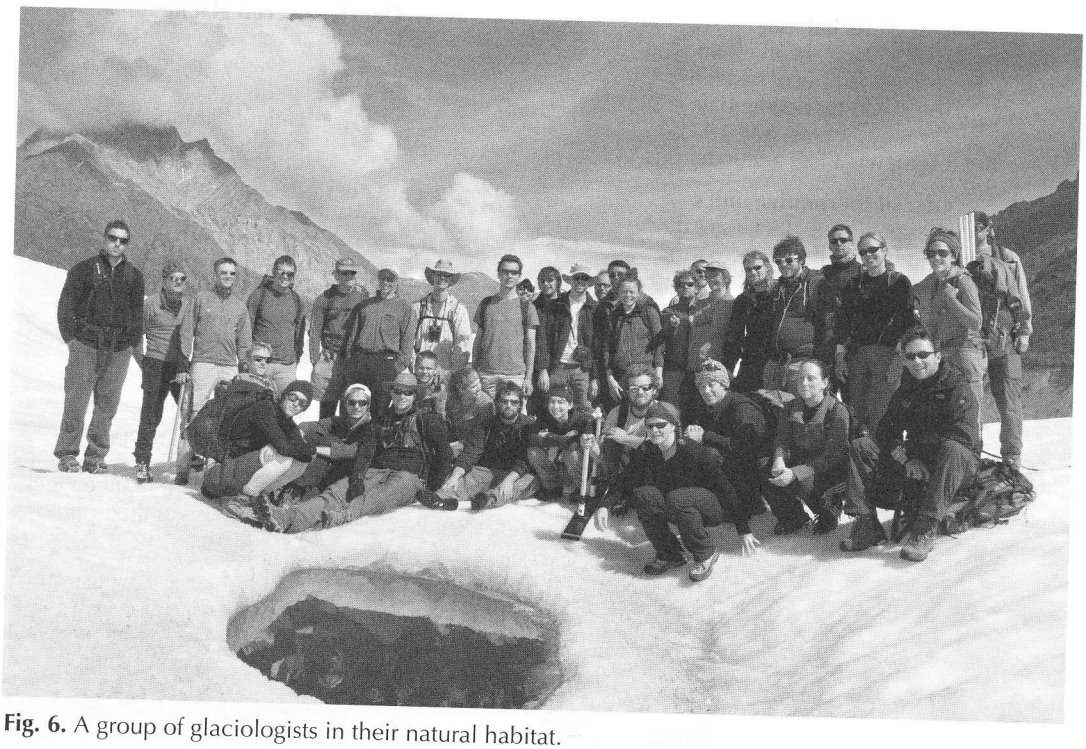

Fig. 6. A group of glaciologists in their natural habitat.

In closing, by popular demand, here are a few of the limericks written by me describing some of the subjects taught at the school.

Ice dynamics
Though its speed is exceedingly low,
Ice is fluid, as glacier shapes show.
Non-Newtonian viscosity
Determines velocity
According to Glen's law of flow.

Ice fabric and anisotropy
At the microscale, ice grain migrations
Derive from crystalline dislocations
Anisotropies cause
New constitutive laws
To account for in our simulations.

Subglacial hydrology
Water flows through the glacier like blood
Makes it slide over bedrock and mud
When a tunnel melts through
Or ice dam breaks in two
Out comes pouring a Biblical flood

Tidewater glaciers
When these tidewater glaciers retreat
The destruction's both fast and complete
It advances again
On a borrowed moraine
Like a leveraged bank on Wall Street

Mass balance
Adding up rain, wind, heat, cloud and sun
To get melt isn't very much fun
You could try degree-day
It's an easier way
But a somewhat less accurate one

Glacial thermodynamics
Now the species of glacier are three
Cold is fully below zero C
Temperate's always at freezing
Polythermal's a pleasing
Combination of types A and B

Remote sensing with ICESat
When inspecting the tracks of ICESat
Look for spots that are curiously flat
Or locations that flex
From concave to convex
It's a subglacial lake doing that!

Gravitational remote sensing
For the weighing of glaciers, a scale
Is inevitably much too frail
But science saves face
By celestial GRACE
Which delivers the mass-balance Grail

Laser altimetry
To determine an ice-surface height
Send out regular pulses of light
Measure time to bounce back
Then, repeating your track
Demonstrates warming glaciers' dire plight

Inverse methods
To extrapolate former conditions
Using presently measured positions
Although methods inverse
May inspire you to curse
They'll reveal past climatic transitions

Debris-covered glaciers
Grand white Kennicott looms above town
But its foot is all filthy and brown
If we clean off the sand
It'll look mighty grand
Till, uncovered, it melts, and we drown.

The consequences of setting forty glaciologists loose on a small town's alcohol supply
There's a flow law for ice strain and shear
What we need is a flow law for beer
Given glacier grads, *N*,
And a drink rate *X*, when
Will all booze on the shelves disappear?

Regina Carns
University of Washington, Earth and Space Sciences Department
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