

field notes

The VECO Polar Resources Newsletter



SHADES OF WHITE: SNOW, SUN, AND THE ENERGY BALANCE AT GREENLAND'S SUMMIT STATION

By Rachel Odell



One of the most tangible consequences of climate change is rising sea levels that result from melting glaciers. Even a lay audience can understand the simple equation: warmer temperatures cause ice to melt, and that water causes sea levels to rise.

But understanding glacial melting and sea level rise is anything but simple. The amount of melting depends on how much solar and thermal radiation the glacier absorbs and how much is reflected back into the atmosphere—a phenomenon known as albedo. And the institutional knowledge of albedo in Polar Regions is actually limited, according to Dutch scientist Peter Kuipers Munneke, a PhD candidate at the Netherlands's Institute for Marine and Atmospheric Research Utrecht.

"The problem with current global climate models is they do not have the capability to study the interaction between snow particles and the thermal and solar radiation," Kuipers Munneke says. "There's a parameterization that delivers a simplified picture of what is happening in reality. The energy balance between the snow and the atmosphere is crucial."

Specifically, Kuipers Munneke believes that a better understanding of the relationship between the snow and ice and radiation is crucial for developing accurate climate models. And the 27-year-old physicist-turned-atmospheric scientist is on the ice at Greenland's Summit Station this summer testing his theories about snow and radiation—both thermal (that which comes from gases trapped in the atmosphere) and solar (radiation from the sun).

What's missing from current models, and what Kuipers Munneke and his research team are collecting, are details about how the snow reacts to shortwave and longwave radiation. The researchers are measuring incoming and outgoing radiation fluxes

using a variety of instruments. They are also measuring cloud cover and atmospheric conditions with an automated weather station, a sky imager, and meteorological balloon soundings. Finally, they're analyzing in detail the snow cover and the size of snow crystals.

All of the information they gather will go into a specialized model Kuipers Munneke is developing to better estimate the albedo of a snow surface, he says. The albedo (or reflective power) of large ice caps like the one covering Greenland is commonly accepted to be about 85 percent of all incoming sunlight, with the remaining 15 percent being absorbed by the snow. But Kuipers Munneke says such estimates aren't always accurate.

"The problem with the global climate models is that they do not have the capability to study the interaction of the snow and the radiation," he says. "You can't go into the details, and you get a simplified picture of what is really happening."

Bright surfaces have a higher albedo than dark ones. But the albedo of bright areas is not constant. And the fluctuations of the albedo can have a profound effect on the amount of absorbed sunlight, Kuipers Munneke says. As the snow absorbs radiation, it is likely to melt, which can expose the darker ground underneath. Consequently that lowers albedo and increases the radiation absorption, which can further melting.

Moreover, the amount of radiation absorbed doesn't just determine if snow melts; it also determines how the snow pack develops. There's a two-way relationship between the snowy surface and the sun. Solar radiation provides energy for the snow crystals to grow. Larger

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Peter Kuipers Munneke weathers a blizzard on Norway's Nordenskiöldbreen Glacier to install a GPS base antenna. Photo: Veijo Pohjola

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crystals absorb more radiation, thereby decreasing the albedo. Kuipers Munneke hopes to measure that phenomenon in the field this summer.

His team is also studying the influence of clouds, which tend to block solar radiation and affect the amount of thermal radiation coming from the atmosphere to the snow.

“No one has quantified exactly what clouds do to the energy balance,” he says.



Even when he's not working, Peter Kuipers Munneke relaxes on rock and ice (here he's in the Canadian Rockies). Photo: Frank Wilschut

In short, Kuipers Munneke plans to develop a system of measurements that can more accurately predict the albedo of an area, and how it changes in time. With the proper albedo, scientists can hone their climate change models and produce more specific results.

Kuipers Munneke and his crew chose Greenland for its pure, unpolluted environment. Far from the roads, and trucks, and coal plants that routinely send soot and fine particles into the nearby snow pack, Summit Station is located on the highest point of the Greenland Ice Sheet, at 9,600 feet above sea level. The clean atmosphere and the homogeneous surface provide a unique opportunity to focus on the snow and its interaction with radiation. Eventually, Kuipers Munneke's work could be applied to glaciers near more industrial locals, such as those in the Alps or the Rockies, where the atmospheric pollution can congregate in the snowpack and affect the albedo. But initially, the team needs the cleanest, most unscathed outdoor laboratory to establish baseline data, he says (remember, bright snow has the highest albedo, darker snow absorbs more radiation). Ultimately, a better understanding of albedo will result in more accurate



Peter uses a weather station like this to measure thermal and solar radiation, temperature, humidity, wind speed and direction, pressure and snow temperature. This unit is on the Greenland ice sheet, about 100 kilometers inland from Kangerlussuaq. Photo: Wim Boot

climate change predictions, he says.

“We care about the rising of future sea levels,” he says. “That's going to come from the melting of glaciers, and the melting needs energy, and the energy has to come from somewhere. We're studying the energy balance. Really, it all starts with radiation.”

alaska

Fairbanks

For many Arctic research program participants, July 4th meant halting professional pursuits to join the parade—if just for a day. But for researchers on Feng Sheng Hu's two projects--his [fire](#) and [climate reconstruction](#) studies--the date signaled a return to field work after about a week of rest. After assembling in Fairbanks, the teams traveled north to Central by truck while a contract helicopter shuttled project gear up from Fairbanks. From there, the climate team flew in to Keche Lake where they are camping and conducting sediment coring and other measurements. Meanwhile, colleagues on the fire study first

did a helicopter-borne reconnaissance of the area to choose their sites, and should be sampling at this writing.

Toolik

On Independence Day, after “a delicious lobster and prime rib dinner,” Toolik residents “dispersed to make costumes and decorate their floats for the annual Toolik 4th of July parade,” wrote VPR helicopter coordinator Mimi Fujino from the field station. Among others, the procession featured noted University of Alaska scientists Donie Bret-Harte and Peter Ray, AKA “Tussock Terrorists” Mother Plucker and Head Hawg. Parade participants (including the Rocky Horror Picture Show troupe) paused before the reviewing stand to perform for the judges.

Celebrants later enjoyed the ceremonial burning of the “Toolik Fire Man.”



The Tussock Terrorists celebrate July 4th. Photo: Mimi Fujino

Made of wood, yes.

Fair skies and strong customer demand kept the VPR contract helicopter busy at Toolik Field Station last week, mostly flying co-PI Chris Luecke and others to lake sampling sites for his

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lake-productivity [project](#) (Anne Hershey, University of North Carolina, PI). Other clients included researchers on the (University of Maryland) Byron Crumpled variations in freshwater microbiology [project](#). The team will continue sampling lakes and streams around Toolik through August.

Around the State

Down in southern Alaska, researchers studying the evolution of the St. Elias Mountains via the massive St. Elias Erosion and Tectonics Project ([STEEP](#), Terry Pavlis, University of Texas, El Paso, Lead PI) began their major summer effort last week when a team of geologists arrived in Cordova on July 6th. A day or so later, the team flew to nearby Katalla, an abandoned oil industry town in the Chugach National Forest, and after establishing a base camp, began to fly to remote sampling sites. Later this month, these researchers will move from Katala to Cape Yakataga, where they also will establish a base camp from which to continue collecting material.

Other STEEP researchers arrived in Valdez this week. From there, they will visit the project's more than 20 field stations to work on monitoring experiments, including Global Positioning System instruments (which pinpoint location and elevation) and seismic stations (which monitor earth and glacier quakes).



GPS station. Photo: Eva Enkelmann, 2006

greenland

Kangerlussuaq

VPR's Kangerlussuaq-based team of two used the pause in Air National Guard flights to/from the island during the July 4th week to prepare for an onslaught that began this past Monday. The staff staged cargo for researchers entering the field this week, and for the July 13th planned flight of ice samples to New York. This carefully stuffed "cold deck" (unheated) flight will carry 5 pallets of ice consisting of 172 boxes of ice cores (~22,000 lbs). On arrival in New York, the cores will be shipped on freezer trucks to researchers' institutions and to the National Ice Core Laboratory in Denver, Colorado.



The Das team studies meltwater lakes like this one. Photo: Jay Johnson

VPR's Ed Stockard flew to Ilulissat July 5th on a Twin Otter that was en route to Thule Air Base. At Ilulissat, he oversaw delivery and staging of gear and final preparations for the (Woods Hole Institute of Oceanography) [Sarah Das-led](#) team, scheduled to arrive in Greenland and go in to the field this week. Das and co-PI Ian Joughin (from U Washington's Applied Physics Lab) are studying the aquamarine meltwater lakes on Greenland's ice sheet; they wish to describe how runoff from these lakes affects the flow of outlet glaciers and the overall mass balance of the ice sheet. The team will spend several weeks camping, installing long-term monitoring instruments and collecting water, weather, and GPS information on two lakes in the Jakobshavn drainage basin.

The plane that dropped Ed and the Das/Joughin cargo in Ilulissat traveled on to Thule, and then flew two round-trip flights from Thule to Cass Fjord to stage fuel drums for the [GNET project](#), which begins fieldwork in August. Cass Fjord is one of more than 35 sites around the perimeter of Greenland where a team led by Michael Bevis (The Ohio State University) will place Global Positioning System receivers. The project is part of [POLENET](#) (the Polar Earth Observing Network) an international consortium of geophysicists collecting seismic, magnetic, and other information about polar Earth for the IPY.

The Bevis-led effort will establish the Greenland Network ("GNET") to measure (among other things) post-glacial rebound—how much the island (some of which is below sea-level due to the weight of the ice sheet) bounces back as the ice sheet thins.

This season, teams will base from seven operational hubs along the coast—Thule, Upernavik, Uummannaq, Qarsut, Ilulissat, Narsarsuaq, and Kulusuk—and travel to specific locations to install the GPS monuments. Next year, they'll finish their installations.

Meanwhile in the field, "six members from Joel Harper's [research](#) group enjoyed good weather during their second week working out of Crawford Point," wrote VPR's Robin Abbott from Kangerlussuaq a few days ago. "They have requested an earlier pull-out now on 11 July."

In Kangerlussuaq at this writing: researchers on the University of Copenhagen-led international drilling effort called NEEM (the [US contribution](#) is led by James White, University of Colorado). The Air National Guard attempted to put the team in last month, but terrible ski-way conditions and foul weather foiled the effort. Two hours into the flight, a second put-in was cancelled this week on July 10th when an engine failed. At this writing, the NEEM team hopes to try again at 3AM on the 12th. For an Air National Guard perspective on the first attempt, read a conversation with the XO in this newsletter.

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Postcard from Ilulissat

Words and Pictures by Ed Stockard

VPR cargo coordinator Ed Stockard worked up in Ilulissat last week. Lucky for us, he brought his camera.

Ilulissat still has more mosquitoes and more dogs than people even when you add in the tourists. There is a new hotel which now brews icefjord ale, a step ahead of the bottled beer but two steps ahead of my pocketbook at 42DK (~\$7.70 US) for about a twelve ounce glass. They're pretty proud of that stuff. Weather was splendid and I ran across a few kids not quite swimming in a pond just out of town. I bucked up and took the evening icefjord cruise only to find out that new regulations forbid the boats to sail amongst the huge bergs in the fjord itself as they did when I was there six years ago. Still, the fog and bergs created quite the dreamscape.



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Camp Raven

Silver Williams, one of two VPR staffers keeping the Raven skiway operational, reports that temperatures have cooled at night, "and then warm up to around +3C in the late afternoon into the early evening. Sometimes the snow is very 'hollow' and at times it is very 'mushy.' Either way we often sink to our knees, which makes getting around on skis ideal."



Tough going at Raven. Photo: Silver Williams

Summit

Among the holiday festivities on top of the world, Summit Station's "4th of July parade was the biggest hit this week," VPR station manager Kathy Young reported. "Everyone in camp was encouraged to make a float."

These were judged. Among the entries, the electric Bad Boy Buggy, transformed into the Bad Girls Buggy, and the Ice Core Drilling Services (ICDS) team float, whose slogan was "Make core, not war." The Dutch team (this week's cover story) paraded a snowy interpretation of the Statue of Liberty, which was "pulled in a banana sled and collapsed right in front of the review stand." This stunt won the Dutch team first prize for most creative float.

"A BBQ followed the parade and later that night the dancing lights came on," Kathy concludes.

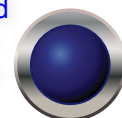
The ICDS crew finished drilling for South Dakota State University's [JiHong Cole Dai](#) (parade drum major) last week, quieting the rig at 217 meters in depth.

On Saturday Summiteers assisted the ICDS crew in taking down the drill camp. These last Summit ice core boxes will join those harvested earlier on the cold deck flight south this week.



Dutch researchers Peter Kuipers Munneke (left) & associate Michiel Helsen enjoy their float's first-place win at Summit's July 4th parade. Photo: Kathy Young.

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When “Kool School” Pays Off

University of Copenhagen’s Dorthe Dahl-Jensen leads a five-year, international effort to collect another deep ice core for climate history analysis. This project is called NEEM, for North Eemian—Eemian being the present interglacial era, which began over 130,000 years ago.

This first season of fieldwork features a traverse from NGRIP, the site of a previous deep coring operation, to the new site. But just getting into NGRIP has been problematic. An attempt in June was cancelled when the first plane got stuck for several days at the site, take-off foiled by sticky snow and poor weather. We heard from Lt. Col Peter Thalheimer, the New York Air National Guard 109th Greenland Programs Officer, who commanded the crew that flew the plane to NGRIP last month.



The first NGRIP put-in crew digs out a tracked vehicle for skiway grooming (L-R): Lt Col Pete Thalheimer, Maj Blair Herdrick, Maj Steve Yandik, Lt Col Joe Zotto, MSgt Brian Alix.

We heard that a soft skiway at NGRIP combined with strong crosswinds prevented you from getting the plane in the air. Were you surprised?

We suspected that we would have difficulty in our first takeoff attempt because this camp had not been open in 3 years and there was a lot of snow that had accumulated in that time. We were pretty much planning on 1 overnight. However, the snow was much deeper than we expected. Even with the skis on the plane we sunk into the snow ~ 18 inches. The

larger surprises came with the weather. We had a storm roll in on our second day with high winds and blowing snow. Then we lost the following day because of bad weather at Summit camp.

Do you train for these kinds of events?

Yes, we train for events such as this. In order to be fully qualified as an aircrew member, we all must go through a week of Arctic Survival training; what we call “Kool School.” We are required to complete that training within the first 2 years of flying within the unit. This gives us the training and knowledge to survive in the snow for days at a time.

What did you and your crew do while waiting for the weather window that came on Saturday?

After our crew took care of the aircraft and survival necessities, we spent our time helping the camp members ‘dig-out’ their camp and get things open again. We had to help get vehicles out and moving, help get the station generator working and also help with other duties, including ‘making’ water for everyone. Our work was slowed due to the 9700 ft altitude of the camp and the cold. When we first entered the ‘dome’ it was -5C INSIDE on the second floor and -15C on the first floor.

What was it like to get airborne again on Saturday?

We were all tired and elated, but cautious; we still had to stop at another field camp to get fuel before returning to Kangerlussuaq. We had worked very hard and also gotten up early so that we could launch while it was still cold (~0600 takeoff). I think that we were also happy to have done so much and worked well together as a crew, especially in unison with the camp members. Although we did not plan on staying as long as we did, we accomplished and learned a lot. We were all happy to have had our training and experiences of all of our crew members.



ANG crew members dig out at NGRIP. Photos: CMSgt Dan Roberson ANG CEA/EA

The next NEEM put-in flight--nervous?

We spoke to many of the follow on crew members and, although cautious, I do not think that they are nervous. When we left, we had a WELL groomed skiway that will only have 2 weeks of weather to deal with, not the 3 yrs that we did. Therefore, they should not have the same difficulties we did. We also made sure that the next crew had all of our ‘lessons learned’ so that they do not have to learn as they go.

Thanks for your comments, Lt. Col Thalheimer.

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