Winter Camp: A Blog from the Greenland Summit, Part II

Lora Koenig, NASA Goddard Space Flight Center, lora.s.koenig@nasa.gov

*In the March-April 2009 [**Volume 21, Issue 2**, pp. 13-17] issue of **The Earth Observer**, we presented the first half of **Lora Koenig's** experience living and working at the National Science Foundation's (NSF) Greenland Summit Camp. Koenig—a remote-sensing glaciologist at NASA's Goddard Space Flight Center—took measurements that will be used to validate data collected by NASA's Aqua, Terra, and Ice, Clouds, and land Elevation Satellite (ICESat) satellites with ground-truth measurements of the Greenland Ice Sheet she made at Summit Camp from November 2008–February 2009. **The Earth Observer** is pleased to present excerpts from the second half of her stay here; the complete blog, along with color photos, is available at: **earthobservatory.nasa.gov/Features/GreenlandBlogKoenig/**.*

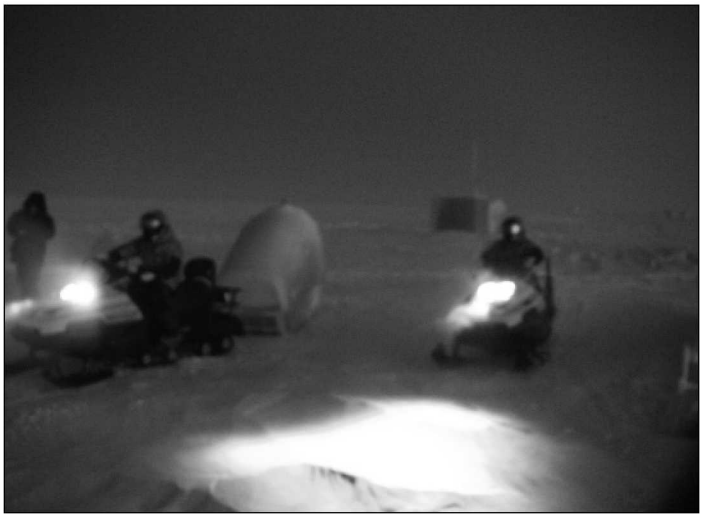
Week Eight
December 28, 2008

Temperature:
-45°C/-49°F

ICESat Transect

I hope everyone had a very Merry Christmas. Our Christmas morning started with a gift exchange and stockings. We figured we were one of Santa's first stops. Our dinner included lobster tails, mushroom fritters, German cabbage, and a chocolate cranberry tart. In the evening, the Northern Lights glowed green and swirled all the way across the sky.

Before Christmas, **Kat Huybers** and I completed one of our big monthly science tasks—a *Global Positioning Survey* (GPS) of the *ICESat transect*. The transect is a route just outside of Summit, marked by flag poles, that follows the "spots" measured by the Geoscience Laser Altimeter System (GLAS) instrument on board the ICESat satellite. In order to ground-truth the GLAS data, GPS and accumulation stake data are taken along the same transect, or ground track, of the satellite just to the north of Summit. The GPS data are corrected with the base station to give very accurate height measurements that are then compared to the satellite data. This is a very important project to make sure ICESat continues to give us good spatially-distributed science data.



Kat Huybers and Lora Koenig heading out of camp to take the GPS and accumulation measurements along the ICESat traverse line.

The transect is conducted on snowmobiles and takes us over three miles away where we often lose visual and radio contact with Summit Camp. We take two snowmobiles (in case one breaks down), hand-held radios, a satellite phone, two GPS units programmed with the camp's location, extra batteries, and a shelter sled—called the *polypod*—with two survival bags inside.

There is a flag line to follow on the ICESat transect but it is hard to see in the dark because the flags are spaced hundreds of feet apart. In the end we made it through the entire transect without losing the flag line. Had we gotten off the flag line we would have used the GPS units to lead us back to camp.

We were very happy to have completed our darkest ICESat transect. Next month finding the poles will be much easier with the additional sunlight and, hopefully, our hands will be a bit warmer.

Week Nine
January 4, 2009

Temperature:
-29°C/-22°F

The New Year and Passive Microwave Measurements

Happy New Year. The New Year brought the best weather we have seen yet at Summit Camp as well as some incredible Northern Lights. On Saturday, we saw shooting stars—the *Quadrantid* meteor shower—going through the aurora.

Kat and Lora taking *radiometer* measurements in a two meter snow pit. The radiometer measures the natural emission of the firn/snow column above. **Photo credit:** Brad Whelchel.

I took advantage of the nice weather to do a science project that had been postponed because of weather conditions. I am very interested in *passive microwave remote sensing* on the ice sheets. *Passive microwave sensors* record the natural long-wavelength energy that is emitted by the Earth. The Advanced Microwave Scanning Radiometer-Earth Observing System (AMSR-E) is the *passive microwave sensor* on NASA's Aqua satellite (*aqua.nasa.gov/about/instrument_amsr.php*). You may have seen images from AMSR-E showing the sea-ice extent in the Arctic Ocean; this is one of the most newsworthy applications of *passive microwave remote sensing*.

Passive microwave data can also be used on the ice sheets to measure melt extent, the temperature of *firn*—snow on ice sheets that has persisted through one melt season or year old snow—and *firn* properties like grain size, grain type, and density. My project takes field measurements of how deep the passive microwave satellites measure into the *firn*. I use a *radiometer*—a sensor that records passive emission similar to sensors on-board satellites—to measure the *natural emission* of *firn*.

This weekend was the first time the temperatures were warm enough to be able to move the *radiometer* without breaking wires. The winds were low enough to ensure no blowing snow would get into the electronics of the instrument. I dug a two meter (6.6 ft) snow pit, placed the *radiometer* in the pit below a column of *firn*/snow, and measured the *radiance*. I then shortened the column of snow and measured again.

Week Ten
January 11, 2009

Temperature:
-56°C/-69°F

Our Cold Week/Answers to Some Questions

This week was downright cold—even for the Arctic! The extremely cold temperatures bring clear skies which make the few hours of light we get brighter. Our science week this week was fairly standard so I thought I would answer some questions from blog readers.

What do you do in an emergency?

If we were to have a medical emergency, we would call for a *Twin Otter* aircraft. Weather dependent, we can get a flight into Summit and to medical attention within

12–24 hours. If the generator and back up generator both died, we can use small generators to heat specific areas in camp while we wait for a plane. If all the buildings in camp were to burn down, there are emergency shelters and bags with tents, food, fuel, and stoves. If we lost all forms of communication (the Internet, phones, satellite phones, and high frequency radios), we would miss our check-in call with personnel at Kangerlussaq and would be rescued within 24 hours.

What kind of medical supplies do you have?

We always have a designated medic at Summit as well as a fully stocked medical room. **Bill McCormick** is the medic this winter. Additionally, all of us are certified Wilderness First Responders (WFRs). We have a 24-hour phone number that links us directly to a doctor. Each week we have a safety meeting where we practice our medical skills with real scenarios. These training scenarios familiarize us with our medical gear and prepare us for a real emergency.

How are the buildings heated?

The buildings are heated with electrical heaters powered by the generator, diesel furnaces, or waste heat from the generator. We have a diesel generator that we run off *AN8*—a type of propellant modified with a deicing agent for use in cold climates—to power all of camp.

Week Eleven
January 18, 2009

Temperature:
-30°C/-23°F

The NOAA Observations

Happy Birthday, Brad! On Wednesday we celebrated **Brad Whelchel's** 28th birthday with corned beef and cabbage, pasta, and a chocolate triple layer cake. Brad admits it was his coldest and darkest birthday.

Lora launching an *ozonesonde* weather balloon. The balloons this winter at Summit have been reaching heights of over 20 km before they burst and the *ozonesonde* then parachutes back to the ground. A parachute attached to the balloon helps to guide the *ozondesonde*—in the box below it—on the way down.

On Monday Kat and I launched a weather balloon to measure atmospheric ozone levels; balloons were launched from around the world at the same time. After the launch we went to the Temporary Atmospheric Watch Observatory (TAWO) tower to complete the daily checks of the National Oceanic and Atmospheric Administration (NOAA) instruments.

NOAA maintains many instruments at Summit that are taking *baseline* observations of atmospheric conditions. These observations are used to monitor gases in the atmosphere including ozone, greenhouse gases, and carbon levels. These measurements are duplicated at other sites around the world.

On a daily basis instruments record wind speeds, wind directions, and temperature at 2 and 10 meters above the surface. These data are recorded every minute. We also check three NOAA instruments that are constantly sampling the atmosphere—an *aethalometer*, a *surface ozone machine*, and a *gas chromatograph*. The *aethalometer* measures "black" carbon in the atmosphere by pumping in outside air and collecting the carbon on a quartz tape inside the machine. The *surface ozone machine* measure surface ozone levels and the gas *chromatograph* measures trace gases, including nitrous oxide, chlorofluorocarbons, and chlorinated solvents.

For additional information and data on these NOAA observations check out: *esrl.noaa.gov/gmd/index.html*. At this site you can also look at the data gathered here at Summit and from other sites around the world.

Week Twelve
January 25, 2009

Temperature:
-44°C/-46°F

Wow, Time Flies!

Our time at Summit is flying by. We are less than two weeks from the new crew arriving for *turnover* on February 6, 2009—weather permitting. With *turnover* rapidly approaching, our focus this week was on *End of Season* projects.

One task is to write an *End of Season* report that details what we accomplished and lists problems we encountered and the solutions we found. This report passes knowledge on to the next crew. In the *End of Season* report we discussed how to keep inlet and outlet tubes clear of blowing snow on the buried Green House roof.

Lora using the backpack GPS to survey large drifts around camp.

A second *End of Season* task we completed this week was a GPS survey of camp. This survey is used to monitor drifting caused by the camp buildings. In March, operators come into camp and clear the drifts to flatten out camp for the summer swelling of scientists and staff. To complete the camp survey, we mounted the GPS system onto a sled and drove a snowmobile at 10 km per hour in a grid pattern over the camp. Because we had such large drifts this winter, we did an additional GPS survey of camp with the GPS system loaded into a backpack. This week we also measured the *ICESat transect* for the final time this season.

The inauguration of President Obama was not missed at Summit Camp. A nice benefit of Summit Camp is the availability of the Internet. On Tuesday we gathered around Bill's computer to listen to the inaugural speech. We enjoyed being able to take part in the historic event even though we were far from home.

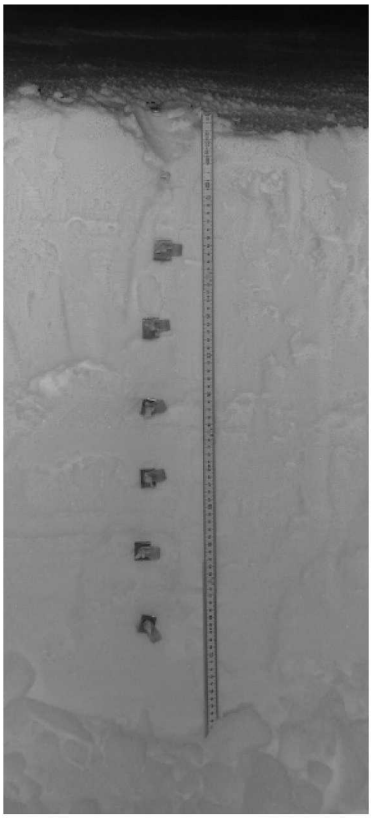
Week Thirteen
February 1, 2009

Temperature:
-47°C/-52°F

The Sun Appears

On January 29, 2009, we saw the sun for the first time since November 13, 2008. We watched the sun come up over the horizon and then set 1 hour and 59 minutes later. When the sun came up Bill made a jubilant radio call to make sure we all saw it. Kat and I were already outside cleaning the TAWO tower. We stopped working to take a nice walk in the sun. Today we had 3 hours and 9 minutes of sunlight. We discussed pulling our sunglasses out from the back of our closets and then decided we still need to take our Vitamin D tablets until we reach more southerly latitudes.

This week I finished my science projects. On Monday, I did a final *radiometer* pit. On Saturday, I dug up some *ibuttons* that I had buried in the snow. I wanted to monitor how surface temperatures diffuse into the *firn*. Snow is an insulative material so as the surface temperature varies that variation is damped as it travels deeper into the snow. The temperature profiles in the *firn* that the *ibuttons* were recording tell about the *thermal diffusivity* of the *firn*, and can be used to validate modeled temperature profiles when modeling *passive microwave brightness temperatures*. Another reason for burying the *ibuttons* was to see if they could survive the cold, harsh conditions. They did! I was able to recover all the *ibuttons* and get good, quality data.



A row of buried *ibuttons* that measure the vertical temperature profile in the snow. These data can be used to determine snow *thermal diffusivity*, as well as to validate models of *passive microwave brightness temperatures*.

This week was also marked with preparing for the arrival of the *Twin Otter* on February 6. Seven more people will be joining us for our final week at Summit Camp. Included in the seven are three new crew members for *Phase III* (February–May 2009). There will be two supervisors coming up to help with training, one scientist from the University of Colorado, and one NOAA scientist. Only three of the seven arriving will stay past February 13. Kat will be staying for *Phase III* and will complete the next team of four at Summit. Brad, Bill, and I will be replaced with a new mechanic, manager, and science tech, respectively.

Week Fourteen
February 8, 2009

Temperature:
-39°C/-38°F

Still Waiting

The Summit Camp population is still four. We had expected the population to be 11 by now but we are still waiting for the arrival of the *Twin Otter*. The weather in Kangerlussaq has canceled the inbound flight for the past three days. Delays are not uncommon on an ice sheet, but they are always a bit hard on morale. It is especially difficult to understand the delays when we have great weather on our end. We are making the best of the situation; today we replaced the incoming flight with a leisurely brunch of homemade sourdough pancakes by Bill.

It is not only our flight to Summit that has been canceled. On Saturday, no commercial planes came or went from Kangerlussaq. The winds were too high. This is not uncommon for travel in Greenland. *Air Greenland*, the only commercial carrier in Greenland is used to delayed and cancelled flights.

Since the first anticipated flight day, we've been getting up earlier. Bill starts calling in the Summit weather observations to Kangerlussaq at 6:00 A.M. He reports every half hour the temperature, humidity, cloud heights, obscurtions—which include freezing fog or ice crystals, wind speed and direction, horizon definition, and the visibility distance. To report the visibility distance we have markers at a half, one, two and three miles. The three mile marker is fun—it's shaped like a polar bear.

While Bill is busy with the weather observations, Kat and I are rushing to finish the daily science tasks before 10:00 A.M. We finish our daily tasks early on anticipated flight days because when the flight arrives it is all hands on deck. Kat and I will be responsible for driving the snowmobiles with sleds to the plane to pick up the passengers and gear. Brad and Bill will refuel the plane by hauling out a refueling sled and

Bill at the three mile "polar bear" marker preparing to clean the *rime* off for weather observations. **Photo credit:** Brad Whelchel.

hooking up the fuel hose, which is always frozen, stiff, and very difficult to move. The planes do not like to be on the ground any longer than they have to be, so this process is completed as quickly as possible.

Week Fifteen
February 17, 2009

On Our Way!

Our final week turned out to be our busiest. On February 9, the *Twin Otter* finally arrived on a beautiful sunny, but rather cold day. With it came Amy, the new science tech; Ken, the new camp manager; Dan, the new mechanic; Sandy and Russ, Summit Camp supervisors from Polar Field Services; and Jacques and Andy, scientists from the University of Colorado and NOAA, respectively. The plane also brought fresh milk, lettuce, bell peppers, mushrooms, and care packages, which were greatly appreciated.

Lora standing on solid ground in Kangerlussaq with her husband who came to greet the crew.

Once the plane landed, we unloaded the passengers and cargo. Brad and Bill refueled the plane as we loaded the retro cargo and the plane left about 40 minutes after it had arrived.

Kat and I started training Amy just a few hours after she got off the plane. (We did let her eat lunch first.) We started with a safety briefing on working at Summit, including tower climbing and working in the cold conditions. As the week progressed we worked our way through snow sampling, snow pits, accumulation measurements, *ozonesondes* and balloon launches, atmospheric sampling equipment, and more. By the end of the week, Amy assumed her role as science tech armed with a new paint brush to fight off the *rime* on the instruments.

On February 15, the *Twin Otter* arrived again, bringing in more fresh food for the new crew and taking Bill, Brad, and I back to Kangerlussaq and off "the ice" for the first time since November 3, 2008. We said our goodbyes to Kat; she will stay at Summit as a science tech until mid-May. (Sandy, Russ, Andy, and Jacques also left on the flight.) About three hours after boarding the plane, we were standing on the ground in Kangerlussaq being greeted by friends and family. On February 16, our winter team split again. Bill stayed in Kangerlussaq for a few more days before leaving for Iceland and the Farrow Islands. Brad and I boarded a plane to Copenhagen. From Copenhagen, Brad caught a flight to New Zealand where he will work on a boat. I will spend one more day in Copenhagen (where I'm at as I write this) before heading back to Goddard.

I want to thank everyone for checking in and reading this blog. I hope you have enjoyed hearing about life and science at Summit, Greenland this winter. Please check the NASA Cryospheric Sciences Branch website (*neptune.gsfc.nasa.gov/csb/*) often for updates on news and science from the Polar Regions. Until next time. ■