



## Ice Sheet Mapping

Bearing a slight resemblance to a tank and going where most humans cannot, MARVIN trudges across snow and ice to fulfill a sole goal: to collect data about sheets of ice. On top of that, he's also intelligent, at least according to his designers at the University of Kansas—intelligent enough that he can operate without having a person on board to navigate him.

The Mobile Arctic/Antarctic Robotic Vehicle with Intelligent Navigation, or MARVIN for short, is one of two robotic vehicles developed as a part of the Polar Radar for Ice Sheet Measurements (PRISM) project headed by Prasad Gogineni, Deane E. Ackers Distinguished Professor of Electrical Engineering and Computer Science at the University of Kansas. The information collected by sensors operated on MARVIN and his companion, a crewed Sno-Cat Tucker, will provide important insight into how thick polar ice sheets are and whether a layer of water exists between the underlying bedrock and the sheets. Just like a melting ice cube will slide faster over a table top due to the lubrication provided by the water than a completely frozen cube, a layer of water between the ice sheet and bedrock is suggestive of a faster flowing ice sheet. Taken further, this means that more ice is making its way to the ocean where it then breaks off, melts, and raises the level of the seas. The PRISM research will develop tools and techniques to help scientists address the rate at which the polar ice sheets are melting, how the ice sheets affect sea level changes, and the estimated magnitude of the sea-level rise—however large or small.

Armed with a suite of sensors, including a synthetic aperture radar (SAR), MARVIN and the Sno-Cat collaborate to detect contrasting electrical properties that distinguish

bedrock from ice, ice from water, and different layers of ice within the ice sheet. Similar to tree rings that demarcate annual growth, layers of ice differ with regard to their density, impurities, and ice crystal orientation, which alter the reflection of the radar beam. "By examining the pattern of accumulation, we can discern patterns and get a sense of how the ice sheet is changing over time. For example, if the layer identified with a particular year appears at one level in one area and at another level in another area, that reveals information about how the ice sheet has moved or shifted," says John Paden, a Ph.D. student and NASA Fellow who is working on the project.

The SAR is designed to operate in monostatic or bistatic modes. In the monostatic mode, the transmitter and receiver are located on the same vehicle, usually the Tucker, but MARVIN can also go it alone to form a monostatic radar system. MARVIN's data collection route is generally predetermined by the research group, but his intelligent design allows him to deviate from this course by perceiving the environment and navigating around any obstacles he may encounter. In the bistatic mode, MARVIN carries the receiver, the Tucker carries the transmitter, and the vehicles are separated by a few kilometers. The radar has to be operated in the bistatic mode whenever the ice-bed interface is smooth, since in the monostatic mode, scattered signals are too weak to produce a useful

radar image. The onboard intelligence system must decide when to operate in the bistatic mode, coordinate the movements of both vehicles, and select the optimum radar parameters. Gogineni states that "SAR has great potential to determine the bed topography with fine resolution, as well as its condition—whether or not ice is frozen to the bed."

This July, basing at Summit Station, Greenland, the team will collect data over a 20-km wide strip of ice between the Greenland Ice Sheet Project (GISP) and Greenland Ice Core Project (GRIP)



*This prototype was created by modifying an all-terrain vehicle with a metal shell and adding various sensors and actuators to provide autonomous capability.*

*Photo: Dennis Sundermeyer*

sites, where researchers drilled deep ice cores in the early 1990's. The team will use the data to generate a map of the ice-bed interface, determine the ice thickness, and map internal ice layers with fine resolution. The data collected will be used to support scientific investigations and fine-tune the sensors

# GREENLAND News From the Field...

## Kangerlussuaq

The arrival of the C-130s in Kangerlussuaq on Sunday, 1 May marked the beginning of a very busy week. About 40 people transited through the KISS facility throughout the week on their way to and from sites in Greenland and northern Canada.

The Kenn Borek Twin Otter arrived in Kangerlussuaq on Monday to begin the Steffen team's Swiss Camp / AWS maintenance field season. By Tuesday Swiss Camp put-in and Crawford Point AWS maintenance were complete. A film team from the PBS series NOVA, who had been conducting NSF-sponsored aerial filming around Ilulissat, intended to join the Steffen team at Swiss Camp on Wednesday via the same Otter, but the weather did not cooperate. They managed to make it in on Thursday for an overnight before returning to Kangerlussuaq on Friday.

12 European project GreenIce participants transited through Kangerlussuaq as well. Six traveled on to Thule/Alert the following day via C-130, while six overnighted in Kangerlussuaq to await the next flight north. Three of the latter (Naja Mikkelsen – GEUS, Peter Wadhams - University of Cambridge, and Georgious Amanacidis – EU Scientific Committee for Polar Research) took advantage of the downtime with a turn-around visit to Summit Station in the morning and a trip to the ice edge outside Kangerlussuaq later in the day.

VPR staff pulled an overnighter on Sunday to perform an upgrade to the new VPR wireless network. The new wireless LAN, which provides internet access to Arctic Program participants in many areas of the KISS facility, is already a huge hit.

*Participants traveling to/from Greenland with the Air National Guard this summer will notice customs requirements that are more stringent than ever before. These requirements will include random inspections of baggage and cargo returning to the US from Greenland.*

## Summit Station

Summit population is currently holding for the week at 19 campers but during last week's busy flight period it reached a peak of 28. Those coming to Summit to stay awhile included Jason Seifert, a full-time NOAA employee and Summit summer science technician, as well as a number of construction personnel. Transient visitors included several members of the Ohmura team, at Summit to pack up instrumentation in the Greenhouse and move it to a

weatherport until the building is relocated, two engineers whose main goal was to evaluate the Big House raising mechanism, as well as two VPR staffers there to complete computer and network upgrades. In addition, Summit saw several distinguished visitors; including an artist in Greenland on an Thomas J Watson Fellowship grant, who painted some beautiful water-

Visit the following web sites for more information about research and operations at Summit Station:

<http://summitcamp.org>  
<http://www.geosummit.org>

color base pictures of the camp, and three Project Green Ice Members. The winter over crew departed on Monday's flight – we wish them all the best in their travels to points south.

Summit construction continues at a rapid pace. The seasonal weatherports are up and powered, and the DISC generator module (being pre-staged for next year's intensive drill test project) is ready to go. The enclosure for the new power distribution system is almost done, as is the laying of the



From left: Peter Wadhams, Georgious Amanacidis, Robin Abbott & Naja Mikkelsen.

For more on the Steffen project see:

[http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=NASAAWS](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=NASAAWS)

For more on the NOVA grant see:

[http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=0229297](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0229297)

For more on GreenIce go to:

<http://www.greenice.org/> or <http://www.awi-bremerhaven.de/Modelling/SEAICE/GreenICE/>

## Nutaaliorneq (New Beginnings)



VPR Construction Manager Jay Burnside and his wife Keri welcomed Brooke Isabelle into the world on May 3rd. She weighed 6 lbs. 13 oz. at birth and was 19.5" long. Congratulations to the Burnside family!

new feeder to the science trench, and foundations for the building relocation. Next in line is moving the Little House.

With all of the construction this summer, Summit staff members have been working closely with on-site researchers to maintain the station as a clean air/clean snow facility. In addition to encouraging a pedestrian culture and limiting operations on days when the wind directions cause exhaust to blow into the clean air sector, the Summit crew developed a protocol for managing and documenting any necessary visits into the clean air sector. For more information regarding construction projects at Summit this summer, visit <http://www.vecopolar.com> and navigate to Greenland > Science Project Plans.

Weather at Summit has been delightful. While folks in the US were celebrating Cinco de Mayo, tent campers at Summit had a celebration of a different sort. Just after midnight on the 5<sup>th</sup> Summit saw its last sunrise until early August, and the advent of warmer temperatures at the station – music to the ears of tent campers who have experienced some cold nights when the sun dipped below the horizon. Temperatures for the week ranged from -20C to -40C with the chilliest night arising when Summit had the highest population (and the most people outside in tents).

## Raven

Raven flights went well this week even with two days being cancelled due to white-out conditions at the camp. Fortunately on Monday the weather cooperated and the VPR put-in crew was able to return to Kangerlussuaq. The new Raven crew reports that they are enjoying their time and really honing their skiway grooming skills.

# ALASKA News From the Field...

## Fairbanks

The current focus for the VPR Fairbanks office is preparing for an extremely busy summer air and field camp support schedule. In addition, the team is scouting co-located warehouse/office space in Fairbanks.

VPR issued equipment for Matt Nolan's spring trip to the McCall Glacier. His team travels to the McCall on May 16<sup>th</sup>. For more on this project go to:

[http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=0229705](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0229705)

A 3-person VPR construction crew flew to Barrow to install boardwalks for the Walt Oechel - led Biocomplexity project. [http://www.vecopolar.com/arlss\\_reports/arlss\\_projectsdetail.asp?cbPropNum=0421588](http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0421588)

## Toolik Field Station

The VPR construction crew finished most of the Weatherport set up and began work on the Arctic entry for the dining hall and walk-in cooler/freezer.



*Dan Lindberg and Annalisa Gross working construction at Toolik.*



*Four KU students connect radar antennas to a Tucker Sno-Cat (large orange tracked vehicle) that will then be used to drag the antennas over the ice and collect data. MARVIN is in the background. Photo: Dennis Sundermeyer*

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for later deployment at the ice core site on the West Antarctic Ice Sheet. In the end, the findings from the PRISM project will help advance scientists' understanding of whether long-term global climate change is driving increased melting of polar ice sheets while also informing the general public through numerous educational outreach activities.

—Kara Nyberg, PhD

*Many thanks to Prasad Gogineni and Kelly Mason for providing information and photos.*