GETGAMM: Shallow-Borehole Array for Measuring Greenland Emission of Trace Gases as an Analogue for Methane on Mars (GETGAMM). This project is a 3-year, multimillion dollar grant funded by NASA Astrobiology Science and Technology for Exploring Planets (ASTEP).

Satellite photo showing southern portion of Greenland ice sheet. Red dot marks Kangerlussuaq which will be the base of operations for the GETGAMM project. Image: NASA Visible Earth, Goddard Space Flight Center.

COLLABORATORS
Indiana University
NASA Goddard SFC
NASA Jet Propulsion Lab
Honeybee Robotics
Princeton University
Planetary exploration of Mars is rapidly advancing with high-resolution data from orbiting and landed instruments upending the image of a monotonously arid red planet and raising interest in the search for evidence of extant Martian life. The plausibility of biotic influences on release and sequestration of water and other volatile molecules on Mars remains a highly contentious topic. Despite this uncertainty, treating volatile emissions as potential atmospheric biomarkers is prudent for planetary protection and is critical for refinement of exploration strategies aimed at life detection on Mars. Using deeply eroded Paleoproterozoic bedrock in southwestern Greenland as an analogue for Mars, a team of scientists from Indiana University, Princeton University, Goddard Space Flight Center, the Jet Propulsion Laboratory, and Honeybee Robotics is participating in a three-year field campaign to analyze seasonal and diurnal variation in concentration and isotopic composition of methane, ethane, and hydrogen sulfide in bedrock boreholes (0.5 to 2 m depth) and soil pipe wells (0.5 to 1 m depth) intersecting permafrost environments in a study site aligned with a highly fractured, regional shear zone.

NOTES FROM THE FIELD
FIELD CAMPAIGN JUNE 27- JUY 25 2012
July 3rd
Kevin Webster writes: We had a wonderful day in the field today. North Twin Lake was a surprising 11.5 m deep. The Los Gatos Instrument is running smoothly and the initial methane concentration data from the lakes looks great. We will be running more samples after dinner. My soil sampling project is underway and I will begin methane oxidation experiments tonight.

The density of mosquitoes this year is amazing. We have been wearing head nets in the field almost everyday and insect repellent is a must. The mosquitoes appear
to be dying and we were able to work without the head nets for part of the day. I
had 20 bites on my left hand before I figured out how to properly defend myself.

The nights are long. It has been daylight since we arrived. The sun drifts behind
the horizon near 12:00 am but even then the "nights" have always been blue
skies, with maybe a hint of orange in the North. I said to Jeff last night, "It feels like
4:00" – it was eleven pm.

**July 4th**
Kevin lifting peat plug in preparation for digging a soil pit down to the top of
permfrost. At last count, Kevin had completed some 40 of these soil pits with
depths as deep as 70 cm.

**July 5th**
Lisa Pratt writes: Greetings from the land of endless light and sleep deprivation.
Fortunately, the sun is starting to dip below horizon during the night and there is
some twilight.

We have had great success with our methane measurements in the first 10 days
of field work. We have three traverses with flagged waypoints on the tundra where
we are sampling gas from the top of the permafrost. The concentrations are
significantly below ambient air (soils gas 0.01 to 0.5 ppm). **We are planning to recalibrate our Los Gatos next week for very low concentrations.** Our current
calibration is optimized for 50-100 ppm. High signal noise causes unusable delta
values for subambient concentrations although the concentration values are good
down to 0.01 ppm. We hope that one of the incoming instruments will be able to
determine delta values for samples below 1 ppm. We anticipate subambient
concentrations in the bedrock boreholes that will be drilled next week into open
fracture zones. The concentration in the water samples for the epi-, meta-, and
hypolimnion in lakes at the study site are high, ranging upwards of 10,000 ppm. We are getting very good at doing dilutions with zero-air in order to get the samples in the range of 50 to 100 ppm for our Los Gatos. The delta values on the lakes samples are in the range -40 to -100 per mil.

You will have no problems with the logistics in Kanger for your heavy boxes. The guard will deliver the pallets directly to KISS and the instrument room and wet lab are only about 100 feet down the hall on the first floor from the drop point. Jeff and I will be here to greet the group arriving on July 11. Kevin and Seth will be waiting for the Goddard group later in July.

Primary Borehole site is the vegetated notch above the fracture zone in the center of the ridgeline in this photograph from Potentilla Lake.

We will run the Los Gatos every day for comparison with the other instruments. We are taking a subsample in a glass vial to run on the mass spectrometer back in Bloomington. We are able to process 10-20 samples in the evening and someone stays in the lab for a day if the number of samples gets out of hand. The biggest problem is the demanding hike into the research site we have selected for the bedrock boreholes. From the pullout where we leave the truck, it is 1 kilometer up and over a 400 ft ridge and then an additional 0.5 to 3 kilometers to the various lakes. The borehole sites are along a bedrock ridge that is about 1 km away and about 200 ft above the first ridge. I am looking into a helicopter lift for the borehole equipment but there is no helicopter currently positioned in Kanger and the cost to relocate an aircraft is probably prohibitive. We
are talking with other research groups about hiring a few strong young people to help carry gear on critical days.

Lake chemistry is highly variable. Tear Drop Lake is supersaturated with bicarbonate and the water immediately turns white when you bring up a sample from the meta or hypo. Upper EVV Lake has a sulfidic hypo with an ox/red potential around -200. The lakes range in pH from about 6.8 to 9.8.

July 5th
(photo right) Sarah fighting strong winds in the RV (research vessel) GETGAMM (inflatable red boat) to bring her water samples back to shore on North Twin Lake.

July 9th
(photo right) Lisa Pratt writes: Nils in mosquito headnet getting ready to sample a stratiform gossan less than 0.5 km from the edge of the ice sheet. Who, you are asking, is Nils? He is my new 14 year old field assistant from Copenhagen.
**July 10th**
The bridge in Kanger that holds the fresh water line is likely to be washed away tonight with very, very high dischage from the ice cap. It is a dramatic scene with all the people in town standing above the bridge watching trucks and bulldozers try to pile rocks on the bridge to keep the torrent of water from undercutting the foundation. Tomorrow I will send you a photo of the water plunging and crashing around the bridge.

**July 11th**
Kevin Webster writes: It's currently 12:31 AM Greenland Time. I'm exhausted. The meteorological station and Seth arrived tonight. I spent the back half of the day setting up the met station after spending the front half of the day in the field. The met station is up and running along with the open path laser for the first time this year. I'm excited. It'll be great to dissect the influence of wind speed, temperature, and pressure on CH$_4$ concentrations at our field sites. Currently, I'm looking forward to bed. We're up at 7:00 AM tomorrow.
Smiles around, - Kevin

**July 12th**
Another excellent day in the field. We hiked the open path laser and met station into the field sites today. It was a tough hike but all the equipment made it in good condition. The team also completed its first collection bathymetric data, drilled its first borehole, and pulled its 6th core. – Kevin

**July 18th**
New arrivals at the GETGAMM Kangerlussuaq base site on 7/18/2012 were Paul Mahaffy and Pete Morey from NASA Goddard and Yuheng Chen from Princeton. They joined Seth Young and Kevin Webster entering their final week of the 2012 campaign. The KISS personnel welcomed the new arrivals just off the C-130 transport plane with a hot dinner of delicious Thai food. – Paul Mahaffy

**July 19th**
Successfully measured CH$_4$ concentrations in a sub–glacial cave today. The methane concentration was above the concentration of methane in the atmosphere. This confirms what other authors have noted about finding CH$_4$ enriched environments below ice sheets. Tomorrow I will begin a 3 day measurement of the concentration of methane in the air surrounding Potentilla Lake. The transect will parallel the long axis of the lake and the laser will be close to 10 – 30 cm above the height of the water.
The sunsets are becoming more pronounced and there is now a distinct purplish pink on the horizon at 1:00 AM. The mosquitoes have completely vanished from the landscape. – Kevin

**July 21st**

Today Peter Morey accompanied Seth and me into the field. Potentilla East Borehole was loose and Peter and Seth mixed a concrete solution to solidify the drill/borehole–gas–samplers position in the rock. We will be sampling the EVV, Potentilla West, and Potentilla East Boreholes tomorrow. The laser is approximately 0.9 m above the surface of Potentilla Lake and is currently recording data. – Kevin

**July 19th:** Three trace gas instruments accompanied the travelers on the C-130 transport planes from the Scotia Air National Guard base. The new arrivals spent the day first finding the instruments on their pallet in the Kangerlussuaq airport warehouse and then setting up the commercial LosGatos CO$_2$ cavity ringdown instrument and the Princeton and Goddard breadboards. Yuheng had better luck getting started than Pete as an amplifier on the Goddard instrument failed on turn–on putting that instrument out of commission for the week. In spite of some quirks the LosGatos instrument worked as well as expected and numerous carbon dioxide samples were run not only from boreholes but also from various soil and above ground samples taken by Kevin and others. – Paul Mahaffy

**July 20th:** Paul was introduced by Seth to the borehole sites at Potentilla and EVV and gas samples were taken at each site for the methane and carbon dioxide trace gas measurements of abundance and carbon isotope ratios. Kevin set up a long path length cross–lake methane sensor instrument on Lake Potentilla, set to record data every minute.

The KISS research facility is a busy hub with researchers in for a day or two and then out to various field sites on the Russell Glacier or to lake research sites. – Paul Mahaffy

**July 21st:** Pete accompanied Seth and Kevin to the field site. They returned late in the day with borehole samples from all sites and analysis on the LGR continued well into the evening. A Mad Max party distracted a subset of the team in the late evening but all returned to KISS safely. Yuheng kept his nose to the breadboard CRDS all day long and into the night tuning the instrument in preparation for his first field samples. – Paul Mahaffy

**July 22nd:** A drizzly day – the first for quite a while in Kangerlussuaq. We were not optimistic about the status of Kevin’s cross lake methane measurement with
rain droplets on the retro–reflector. Seth and Paul went to sample EVV borehole
gas samples while Kevin checked out his gear. On arrival at Potentilla lake Kevin
indeed found that the rain had put an early stop to his data recording. Seth
secured additional carbon dioxide and methane samples from Pontella East and
West Boreholes while Kevin packed up his instrumentation. Back at KISS the IU
team is busy organizing their gear for the return trip on Wednesday and Paul busy
analyzing the carbon dioxide samples collected during the day.

July 24th
Just thought I’d pass along a few photos of our field gear on the ANG pallet. The
first large–scale summer campaign comes to an end! – Seth Young