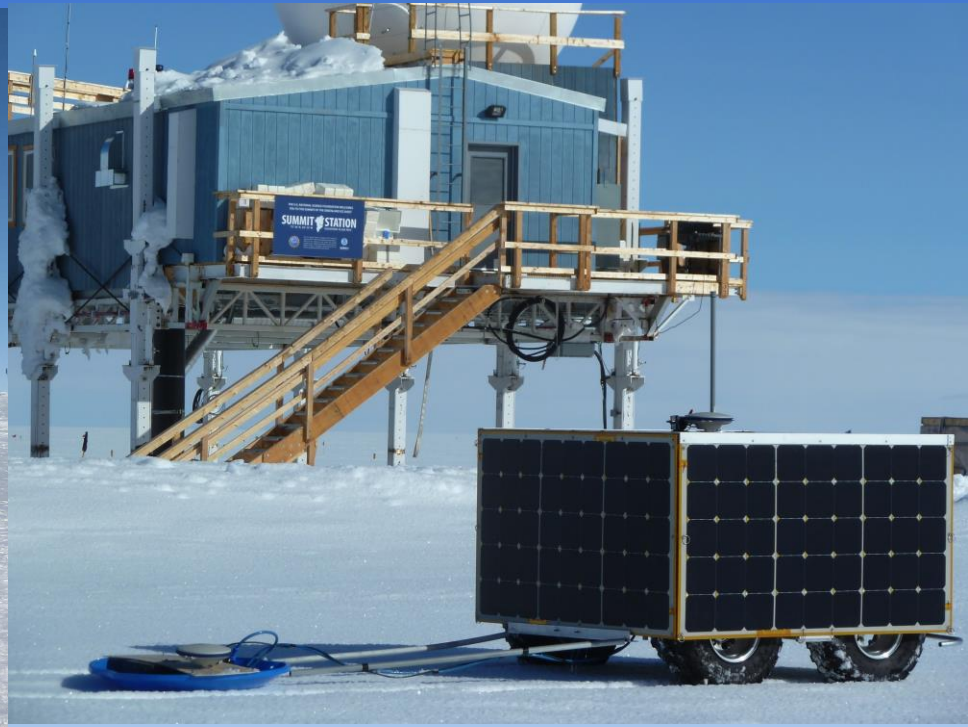


# Dashing through the snow: Polar rovers as autonomous science platforms



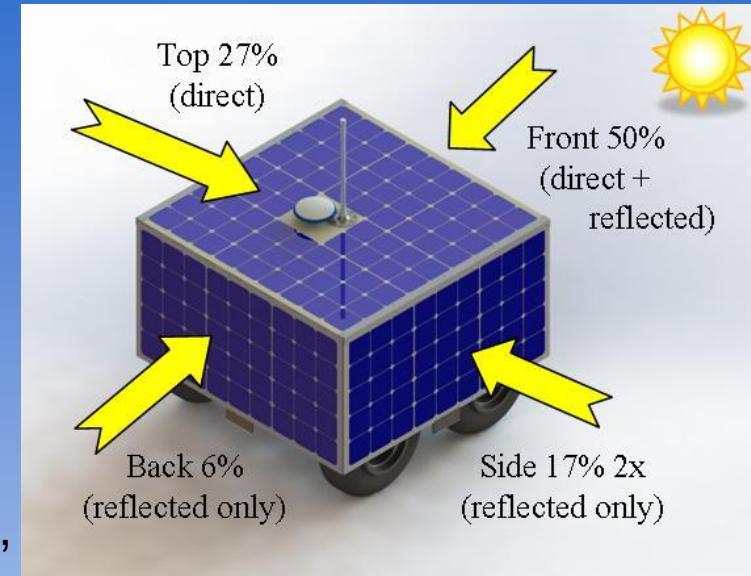
Laura Ray, Mary Albert, Dartmouth College  
Jim Lever, CRREL      Jack Dibb, UNH

NSF-ARC 0806157

# Cool Robot: Design summary

## Lightweight, reliable, efficient

- 4WD (firm snow), low drivetrain losses, 2.5 psi ground pressure, zero emissions, -40 C
- GPS waypoint following, 3-4 km/hr
- 70 kg vehicle, 40 – 80 kg towed-payload capacity
- Passive solar, sufficient power for 500 km/week
- **Control and navigation**
- **Power system:** Lighter/more efficient, hinged panels, control code matches power input w/ demand.
- **Electronics:** More robust, GPS and radio upgrades
- **GIS survey design & mapping:** Start-to-finish geo-referencing
- **Payload support:** power, communication, user interface for setting sampling protocol



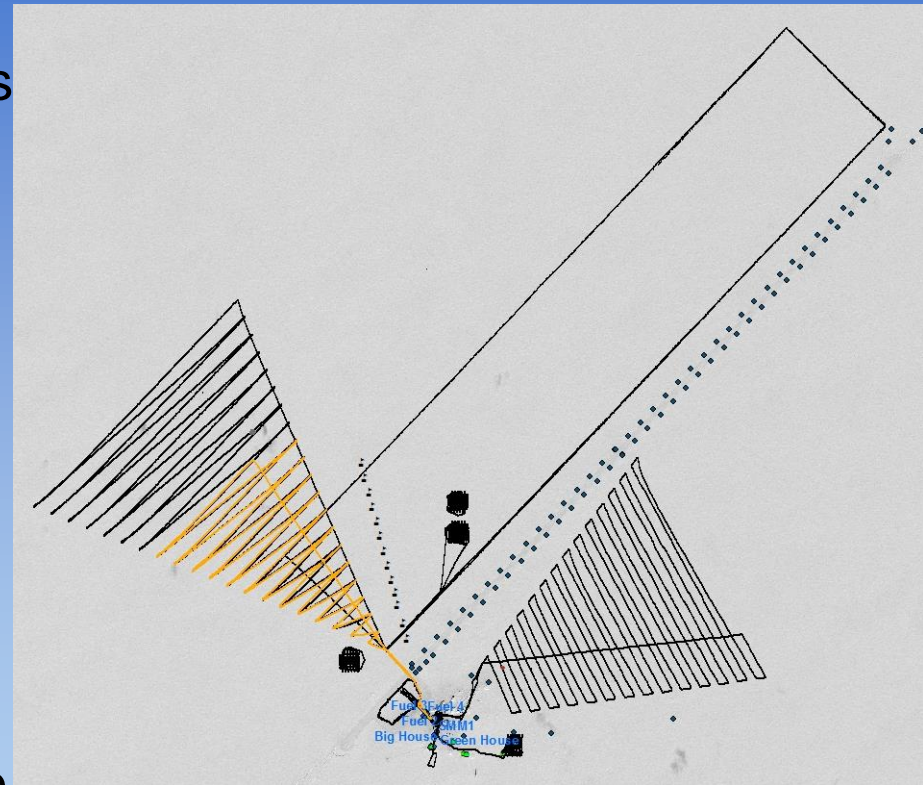
# June 2013 Deployment Summary

## Objectives

- Demonstrate reliable 24 hr operation (mobility & power control)
- Conduct meaningful science campaigns
  - radar surveys of 2012 melt layer & drainage channels
  - sample emissions plume from station

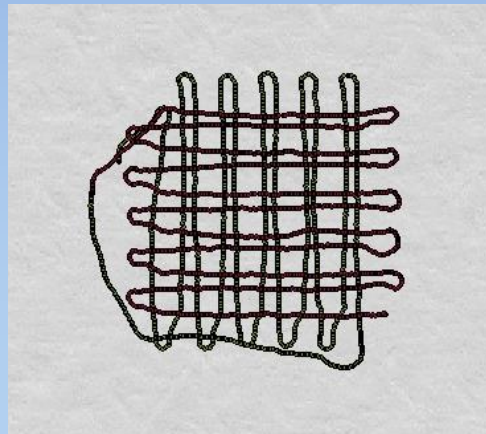
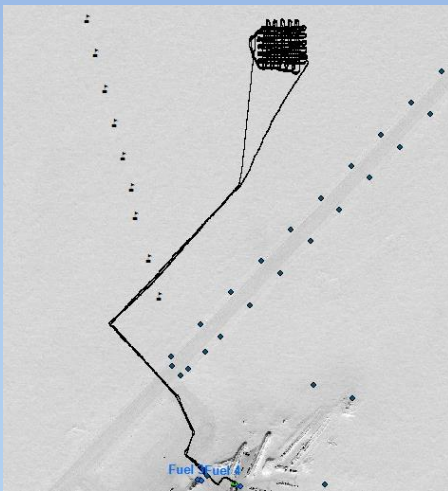
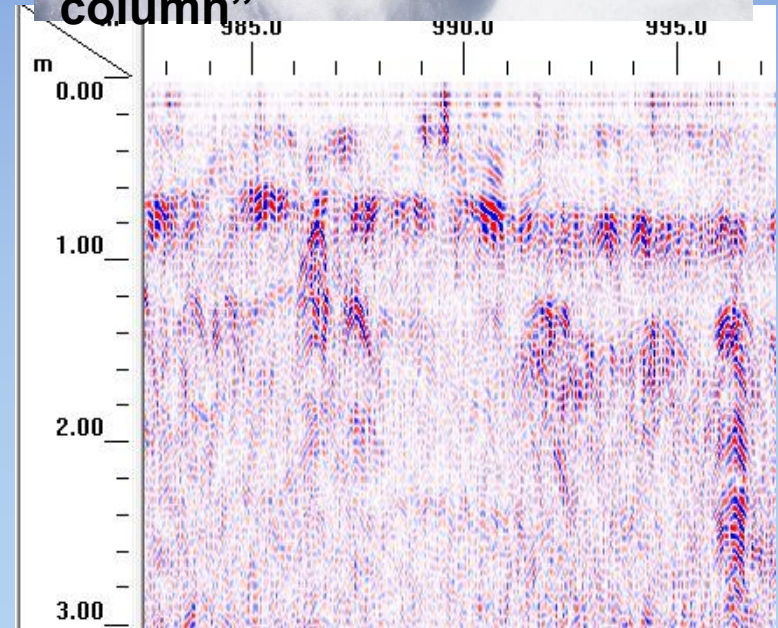
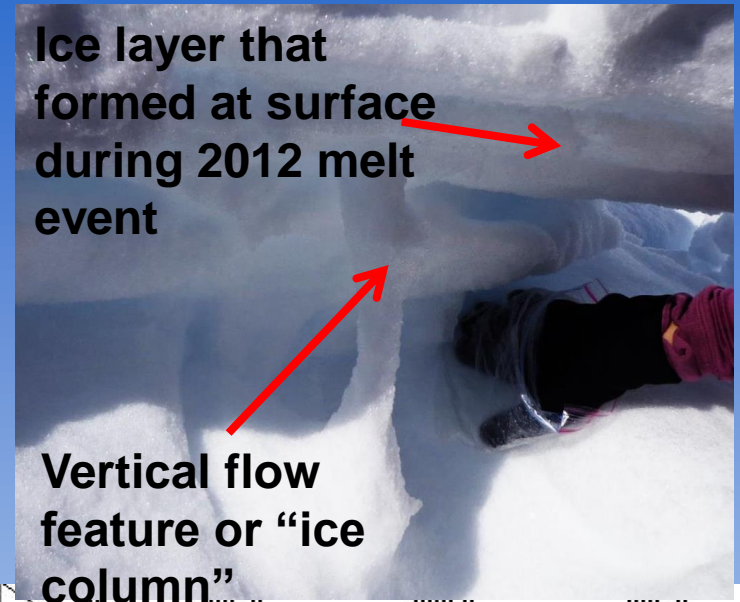
## Results

- 200+ km over natural snow, 97% autonomous,  $-11^{\circ}\text{C}$  to  $-26^{\circ}\text{C}$
- 5 GPR grids towing 900 MHz radar
  - Manual 0.5 – 5 GHz CRESIS radar surveys following our tracks
- 4 box surveys + 3 triangular surveys to sample emissions plume
- Overnight operation

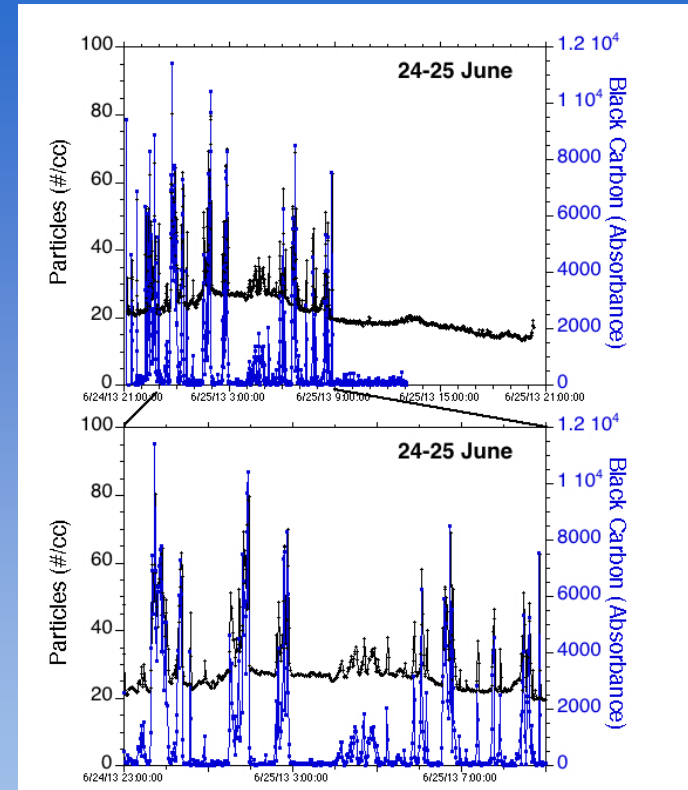
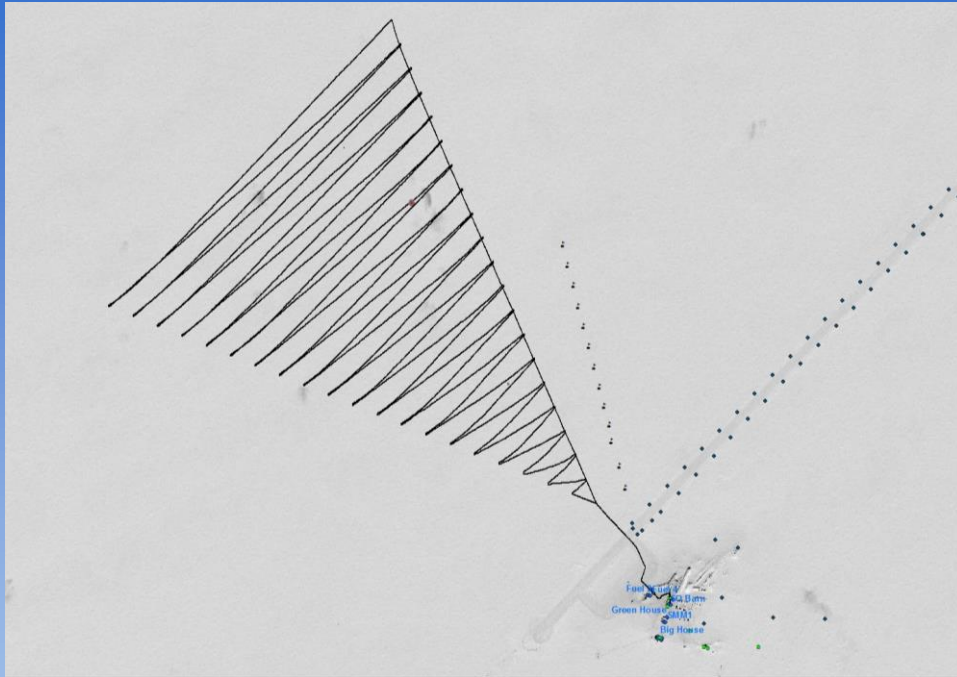


# GPR Surveys of 2012 Melt-Freeeze Features at Summit, Greenland

- Robot executed grid GPR surveys of melt-freeze features
- Physics of melt water percolation through snow and firn in dry snow zones
- Link GPR surveys to snow pit observations of melt features

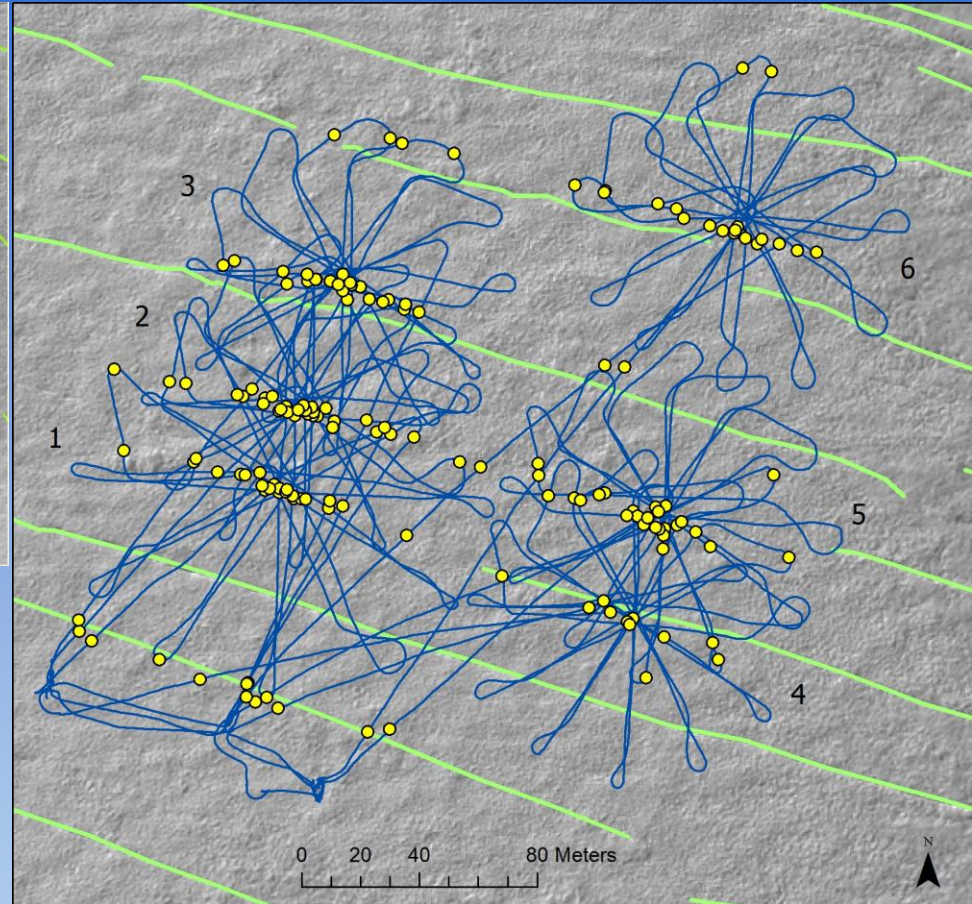


# Example Air Sampling Results



- 43 km autonomous course
- 2 hr stop near midnight, then resume
- No immobilizations
- Wind shifted plume away from survey

# Georeferencing: Yeti 2012 Survey



- 34 km of survey lines
- Demonstrated various survey patterns, including rosettes
- Geo-referenced to WorldView-2 satellite imagery
- High reliability, good mobility

# Partners and Collaborators

## **Dartmouth**

- Prof. Laura Ray
- Prof. Mary Albert
- Eric Trautmann
- Kevin Olds
- Suk Joon Lee
- Tom Lane
- Robert Collier
- Sean Hammett
- Rebecca Williams
- Ben Walker
- Allison Morlock
- Alden Adolph
- Josh Cook
- Alex Zeibell

## **UNH**

- Jack Dibb

## **U. Maine**

- Gordon Hamilton
- Peter Koons

## **New Mexico State Univ.**

- Phillip Kyle

## **CRREL**

- Jim Lever
- Doug Punt
- Amy Burzynski
- Allan Delaney
- Lynette Barna
- Steve Arcone
- Monica Preston

## **NSF**

- George Blaisdell
- Renee Crain
- Peter West
- SPoT crew
- GRIT crew
- S. Pole crew

*We are wishing you a*  
**Happy Solstice!**

*from the Summer Crew and the Cool Robot Team at  
Summit, Greenland  
72°34'N 38°28'W 3,209m*

Ready to  
play?

