ICEPOD

TEAM ICEPOD: Robin Bell, Nick Frearson, Kirsty Tinto, Chris Zappa, Chris Bertinato, Tej Dhakal, Scott Brown, Ling Ling Dong, Indrani Das, Mike Wolovick, Margie Turrin, Jim DeTemple

With Tremendous Support From NYANG especially Major Josh Hicks, Senior Master Sargent Joe Deamer

Lamont Doherty Earth Observatory
Columbia University
Up to 1000m Thick----50% of the Ice Sheet
Remote Field Camps
Crevasse Detection Radar (CDR)
CDR Image of Tres Hermanas (3 Sisters) Crevasses
Recovery Act Funding
Early Pod Design
IcePod Recovery Act Funding

Goal: Instruments, Data and Platform for Community Use through Piggyback Missions and Dedicated Flights
Icepod

• Pod Delivered January 7, 2013
• Flight Certified January 29, 2013
• Field Operation Test April 2013 - Greenland
• Instrument Test July/August 2013 – Greenland
• Commission Antarctica 2014
Icepod

• Operational Modes

  – Piggyback Missions
    • 10% regular missions Antarctica & Greenland
  – Dedicated Investigator Lead Missions
    • Recovery Catchment, Ross Ice Shelf
  – Instrument Development Platform
    • Air sampling, lave tube imaging
Icepod

A modular approach to Airborne Geophysics.

A Troop Door

An Arm

An LC-130

A Data Acquisition Rack

A Sensor Pod

A Skilled Team Including the Guard
IcePod Instrumentation

- Optical Instruments
  - IR Camera
  - Pyrometer
  - High Res Vis Wave Camera
  - Scanning Laser
- Radar
  - Deep Ice
  - Shallow Ice [100m]
- Georeference
  - GPS
  - IMU
IcePod Instrumentation

Laser:
- Type: RIEGL VQ-580 Swath scanning laser
- Range Resolution: 2mm Lidar + ~10cm GPS
- Swath width: ~3,000 ft at 3,000 ft altitude
- Applications: Surface Profiling/Glacier Mapping
- Max scanning altitude: 3,950 AGL feet
IcePod Instrumentation

Infrared Camera
Type: Sofradir IRE640L   LWIR: 7-9.5um
Accuracy: < 20 mK NEDT
640 x 512 pixels      100 frames/second
Rotary Sterling Cooler [i.e does not need external cooling]
Applications: Thermography
Swath width: 350 m at 1,000m
Resolution: 50 cm
Specifications:
• Temp: −40°C to +55°C
• Altitude: 30,000 ft
• Supply: +24Vdc
• Weight: 12lb
IcePod Instrumentation

Sky Pyrometer
Type: Heitronics KT-15
Response: 0.6 °C
Applications: Surface Reflection Correction
FOV: 3° upward-looking
Specifications:
• −40° C to 60° C
• 30,000 feet MSL
• Supply: +28Vdc
• Weight: 2.5lb
• Dimensions: 6” x 2” x 2”
Infra-Red

Visible wave

Scanning Laser
IcePod Instrumentation

Visual Camera

Type: Imperx Bobcat 6620
29Mpixel; 6600 x 4400; 12-bit
Accuracy: 20cm at 1,000m altitude
Swath width: 1,200 m at 1,000m
Applications: Photogrammetry

Specifications:
• $-40^\circ$ C to $+80^\circ$ C
• 30,000 feet MSL
• 2.5lb
• +12Vdc
IcePod Instrumentation

Deep Ice Radar

Type:
- High-Power Coherent Pulsed Radar
- Transmitter: 800W per channel; 2 channels
- Center Frequency = 188MHz
  Bandwidth = 60MHz
- 1us and 10us interleaved chirp signals

Depth Resolution:
- 2.8m

Applications:
- ice thickness, internal structure, bedrock mapping

Specifications:
- Dimensions: 18” x 18” x 18”
- Weight: 83lb
First Internal Layers Near Russell
IcePod Instrumentation

Positioning IMU and GPS
Type: L1/L2 GPS GLONASS
IMU: LN-200, Fiber-Optic Gyros
Accuracy: 10 cm
Applications: Position and attitude
Specifications:
  - GPS:
    - 10lb
    - +28Vdc
    - 10” x 8” x 3”
  - IMU
    - 8lb
    - +28Vdc
    - 7” x 5” x 5”
IcePod Instrumentation

Shallow Ice Radar [SIR]
Type:
• FMCW
• Transmitter Power = ~10W for Firn Ice and <1W for sea-ice
• Center Frequency = 2GHz
• Bandwidth = 600MHz

Range Resolution:
• 25 cm

Applications:
• Sea-Ice: Snow Pack, Ice Depth
• Firn internal structure to 100m
Shallow Ice Radar Returns
Lab Installation to Flight Ready in 2 days

1. Disassemble and pack system: ~3h
2. Unpack and install system: ~4h
3. Test System: ~2h
Installing the Navigation Rack
-13.2° C range 1.4° C

IR Camera
300m x 600m
(warm on North Side of Channel)
IcePod Imagery

Visible
1 km across
IcePod Imagery

Infrared

0.7°C difference sea ice
Moraine Structure
Visual Moraine Structure

Thermal Moraine Structure
Meltwater Plume
Visual Meltwater Plume

Thermal Meltwater Plume
Capturing The Seasonal Melt Cycle

Piggyback Missions on NYANG Missions

April-August

Benchmark Lines

- Summit to the Coast (Rink??)
- Jakobshavn
- Russell Glacier – Return from Raven

Ice Surface Elevation
Surface Temperature
Surface Imagery
Shallow & Deep Radar
Plume Structure
Flow in Fjords
Deploy XCTD
Expanding Instrument Suite
Magnetometer
Gravity meter
Next Steps

Resolve Technical Issues
Demonstrate Data Products
Commission System in Antarctica (Suggestions)
Commission in Greenland
Develop Community Plan for Piggy Back Missions – Greenland and Antarctica
Open Process for Dedicated Use Individual Investigators
Develop Process New Instrumentation