OMG: Oceans Melting Greenland

• How much are the Oceans Melting Greenland?

EV4S92

Warm water is melting glaciers that flow into the oceans, but it lies hundreds of meters below the surface, making remote sensing difficult.

- Need ocean obs. to track spread of warm water
- Need Ice obs. to quantify ocean impact on glacier loss

Proposed Observations:

Yearly aircraft campaigns to deploy expendable temperature/salinity profilers, measure ice loss at the continental margin & map shape and depth of the sea floor on the shelf and in fjords.



<u>Goals: Understand and characterize interactions between the oceans and ice loss on Greenland, pave the way for improved sea level predictions, and relate subsurface conditions to remotely sensed observables.</u>



OMG Mission Concept



Once per year surveys

Deploy expendable temp. & salinity profilers every 50 km in key self regions Elevation changes in 10km swath of marine terminating glaciers near ocean

One time surveys

Airborne gravity measurements (AirGRAV) Ship-based acoustic campaign to sample key fjords & ground truth AirGRAV

Ship-based

AXCTD probes

Aircraft eXpendable Conductivity Temperature Depth Probe (AXCTD)

- Air-launched expendable probes
- Off-the shelf (decades-long heritage)
- 1000 m depth range
- FM radio transmission of data to aircraft
- Approx. 5 kb per profile
- Cost: ~\$2k per probe.

PROBE SPECIFICATIONS

PROBE	PARAMETER	DEPTH	ACCURACY	ACQUISITION SYSTEM
AXCTD	conductivity, temperature	1000 m	-0.035 mS/cm,-0.035°C	MK 12

An AXCTD profile

<u>Ocean – AXCTD Survey</u>

Scientific need

Yearly T, S profiles with 50km spacing on shelf with 5m vert. res., 0.1°C, 0.05 psu accuracy

- Once per year AXCTD survey in summer near min. sea ice extent
- P-3, Alt 10,000 ft., 500 km/hr
- 4 flights (airports: Thule, Nuuk, Kulusuk, Constable)
- ~ 30 hours: \$166 k,
- 200 AXCTD deployments: \$340k
- 5 year program: \$2.5 M
- Resulting measurements: 50 km spacing, 0.1m vertical resolution 0.02 °C, 0.02 psu accuracy

GLISTIN-A

GLacier and Ice Surface Topography Interferometer – Airborne

Ka-band antennas on the NASA GIII for singlepass interferometry

- Glacier and Ice Surface Topography Interferometer (GLISTIN) will provide all-weather, high-resolution swath ice surface topography, not available through existing lidar (i.e. ICESAT-2) or radar (CryoSAT) sensors
- GLISTIN-A (airborne) engineering upgrades completed 2012
- Fully operational and campaign/science ready on GIII with no instrument development required (see data at right)

Results from GLISTIN-A engineering flight (ping-pong acquisition mode) for Rosamond area collected 8/6/12. The color represents height and one color cycle corresponds to 100m). Results posted at 10m.

Example GLISTIN-A topography mosaic collected as a proof-of concept during NASA International Polar Year activities on 5/5 and 5/6 2009. The height precision is 10cm-1m for a 10m horizontal resolution and 6km swath-width. The upgraded GLISTIN-A system has similar precision with swath in excess of 10km. **Recent campaign to Alaska (4/13) validated performance over ice in an OMG-like scenario (processing in progress).**

Science Implementation – Ice Loss

<u>Ice – GLISTIN Survey</u>

Scientific need

 Yearly elevation within 10km of terminus, for marine term. glaciers with 5-10m vert., 100 m, horiz. res.

- Once per year GLISTIN survey Gulfstream-III, Alt 10,000 ft., 795 km/hr
- 6 flights double coverage (airports: Thule, Kangerlussuaq)
- Flight cost: \$3k/hr
- Data processing: \$5k/hr
- ~ 36 hours (\$8k/hr): \$288 k,
- Including transit costs: \$400k/year
- 5 year program: \$ 2.0 M
- Provides 0.4m vertical accuracy, 5-10m horizontal resolution,

AirGrav – Airborne Gravity

Contractor – SGL

- Provides instrument and data processing
- Will lease, equip and operate aircraft as part of contract

Instrument accuracy vs line density

Science Implementation – AIRGrav

<u>Bathymetry – AIRGrav</u>

Scientific need

 Bathymetry survey in key regions on shelf with 0.5mGal (100 m vert.) res. 1km horiz. res.

- Once time AIRGrav survey
- Contract to SGL (TBD)
- Twin Otter, Alt 1,000 ft., 260 km/hr
- 39 flights (airports: Ilulissat, Kangerlussuaq, Nuuk, Thule, Upernavik, Uummannaq, Ittoqqortoorr (snow), Kulousuk, Narsarsuaq, Nerelerit)
- Flight cost: \$2.8k/hr
- ~ 324 hours (\$8k/hr): \$900 k,
- Including transit/rental costs: \$1.1 M

EV4S2

<u>Contractor – Ship Survey</u>

- Terrasond will lease, equip and operate ship
- Data processing services included
- Swath width depends on depth ~few hundred meters
- Vertical accuracy & resolution of a few meters

Science Implementation – Ship Bathymetry

Bathymetry – Ship-based

Scientific need

Bathymetry in key fjords for geometry & sill depth – 10 m vert., 10 m horiz res., 300 m beam swath

- Once time ship-based multibeam sonar survey
- Contract to Terrasond (TBD)