

Fall 2012 IceBridge DC-8 Flight Plans
7 September 2012 Draft

compiled by

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Introduction to Flight Plans

This document is a translation of the NASA Operation IceBridge (OIB) scientific objectives articulated in the Level 1 OIB Science Requirements, at the June IceBridge Antarctic planning meeting held at the University of Washington, through official science team telecons and through e-mail communication and iterations into a series of operationally realistic flight plans, intended to be flown by NASA's DC-8 aircraft, beginning in mid-October and ending in late November 2012. The material is shown on the following pages in the distilled form of a map and brief text description of each science flight. Google Earth (KML) versions of these flight plans are available via anonymous FTP at the following address: <ftp://atm.wff.nasa.gov/outgoing/oibscienceteam/>. Note that some users have reported problems connecting to this address with certain browsers. Command-line FTP and software tools such as Filezilla may be of help in such situations.

For each planned mission, we give a map and brief text description for the mission. All of the missions are planned to be flown from Punta Arenas, Chile. At the end of the document we add an appendix of supplementary information, such as more detailed maps of certain missions and composite maps where several missions are designed to work together. On the maps for the land ice missions, the background image is from the Rignot et. al. 1-km InSAR-based ice velocity map. 2009-2011 OIB flight lines are depicted in yellow. A careful reader may notice that some of the mission maps in the main part of the document highlight flightlines in green, yellow, and red colors, while other only show the black lines. The colors are a refinement added to the flight plans at a late stage of design which help the field team navigate the aircraft properly to achieve specific science goals. The colors represent the degree of "straightness" of each flight segment, where straight segments are steered using an automated technique and curved sections using a specialized manual method. Not all of the flight plans shown here have necessarily reached that mature stage of design.

In fact, as a general rule the flight plans depicted here are all at varying stages of completeness. For each mission we note "Remaining Design Issues" to be resolved, if any exist. In most cases these are minor. CryoSat underflights are a major exception, since these have to be re-planned for each potential flight day (for sea ice) or within a window of several potential flight days (for land ice).

Note that this document shows 33 planned land ice and 8 planned sea ice missions, which is more than we expect to fly this year. The extra flight plans give us operational flexibility to fly as much as possible, and scientifically productive, while we are in the field.

This document does not include the flight plans for the OIB high-altitude flights to be conducted with the Land, Vegetation and Ice Sensor (LVIS) using the NCAR Gulfstream-V aircraft. Those missions are being designed under a separate effort.

IceBridge Mission Statement

Operation IceBridge will employ aircraft to monitor the most sensitive and critical areas of sea ice, ice sheets and glaciers during the gap in satellite coverage caused by the failure of ICESat-1, in 2009, and the launch of ICESat-2, planned for late 2015. Sensitive and critical areas include coastal Greenland and especially its outlet glaciers, coastal Antarctica including the Antarctic Peninsula and ice shelves, the sea ice of the Arctic and Antarctic and the southeast Alaskan glaciers. Data collected by IceBridge will improve our knowledge of the contribution of the Greenland and Antarctic ice sheets to sea level rise and will make fundamental contributions to the understanding of changes occurring in the extent and thickness of the polar sea ice cover. Given the societal importance of understanding changes in sea

level rise and sea ice extent, IceBridge data will monitor and improve modeling efforts for sea ice, ice sheet and glaciers. IceBridge will also prepare for the future of airborne monitoring efforts of the cryosphere by adapting existing instruments for high altitude unmanned aerial systems such as the NASA Global Hawk.

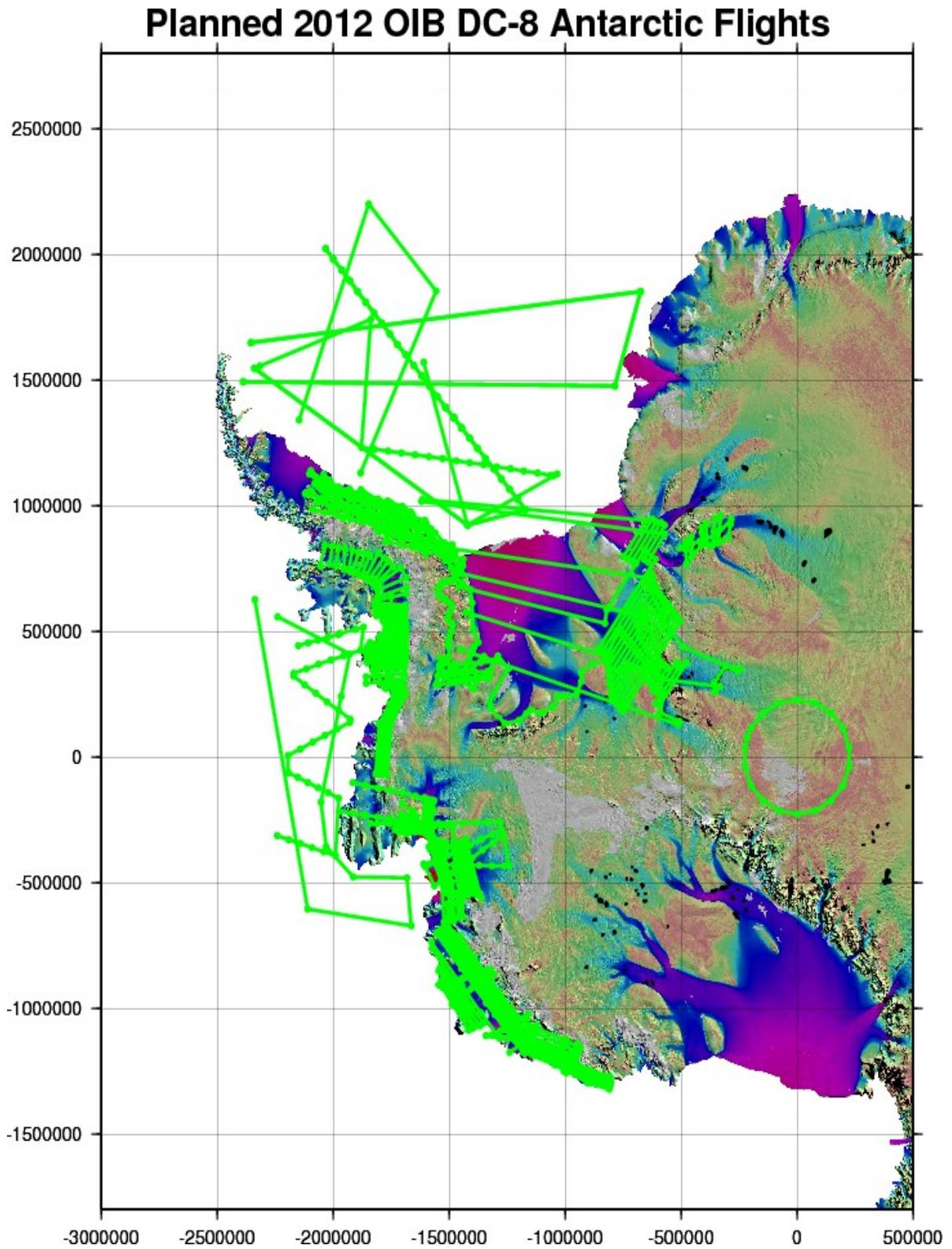
IceBridge Science Objectives

The following are the major science objectives of Operation IceBridge in priority order and are met by the following flight plans:

- 1) Make airborne laser altimetry measurements over the ice sheets and sea ice to fill in the data gap between the failure of ICESat-1 in 2009 and the launch of ICESat-2 planned for 2015.
- 2) Link measurements made by ICESat, ICESat-2, and CryoSat-2 to allow their comparison and the production of a long-term, ice sheet altimetry record.
- 3) Use airborne altimetry and radar to monitor key, rapidly changing areas of ice, including sea ice, ice sheets and glaciers, in the Arctic and Antarctic to maintain a long term observation record, improve understanding of glacial dynamics, and augment predictive models of sea level rise and sea ice cover.
- 4) In conjunction with altimetry measurements, collect other remotely sensed data to improve predictive models of sea level rise and sea ice cover, especially the following:
 - Ice sheet and sea ice thickness, structure and extent;
 - Bed topography underlying land-based ice;
 - Bathymetry beneath floating ice shelves;
 - Snow accumulation and firn structure; and
 - Other geophysical constraints that will improve estimates of the geothermal and oceanic heat flux
- 5) Adapt existing instruments for airborne remote sensing of ice by high altitude unmanned aerial systems such as the NASA Global Hawk.

Composite map of all planned flights

The map below depicts all 31 land ice and 6 sea ice planned flights for the 2012 Antarctica OIB DC-8 campaign.



Sea Ice – Bellingshausen 1

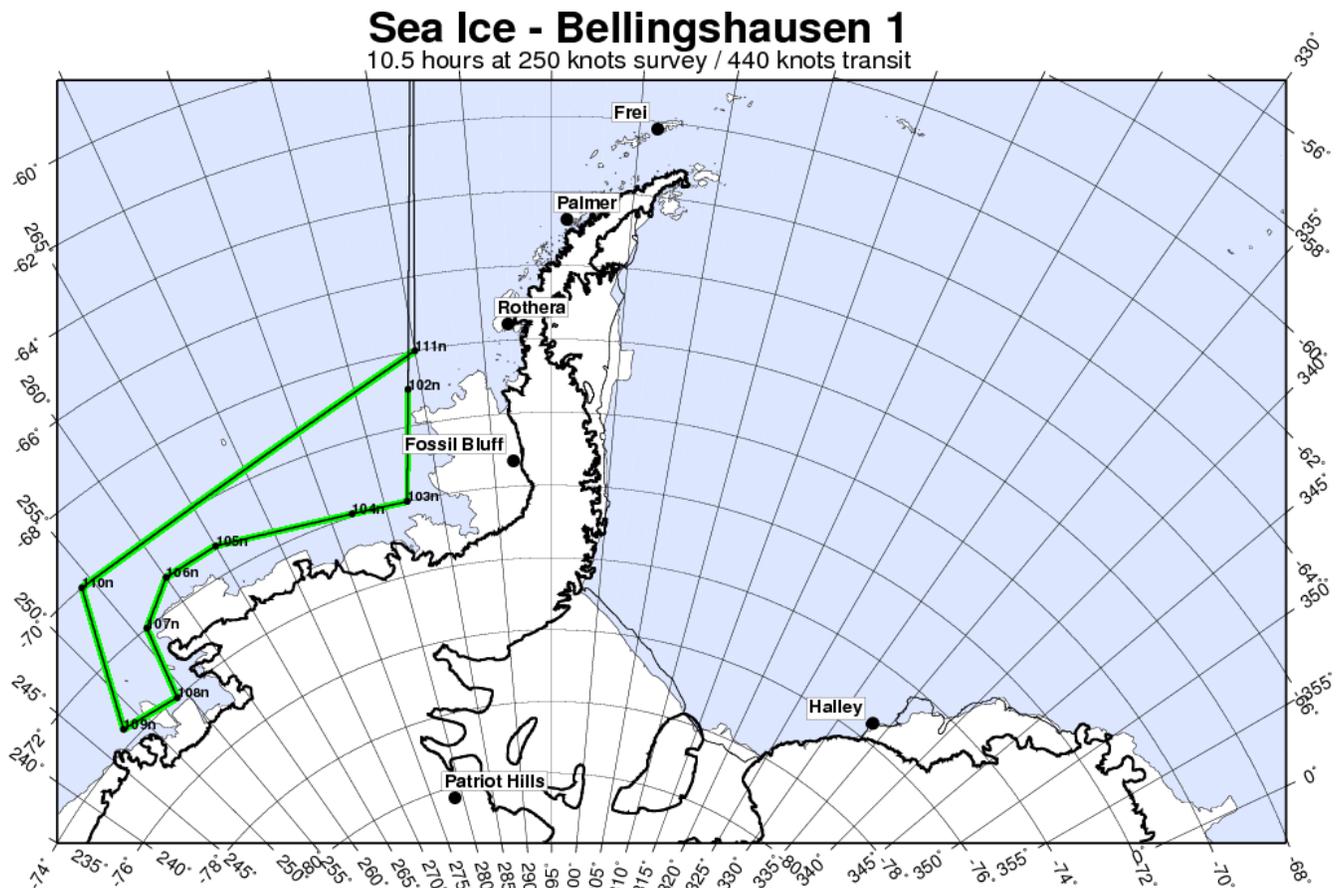
This mission represents a continuation of the IceBridge time series, repeating much of the 091021 and 101030 Sea Ice 01 flights and the 111023 Bellingshausen 1 flight. The northern portion of this flight (i.e. between WP110n and 111n) may be adjusted according to sea ice coverage reports obtained just prior to (or during) the deployment, specifically the location of the ice edge. Also note that that segment of the flight may have to be flown at high altitude, depending on fuel constraints. The 2011 mission has been modified from previous mission plans by removal of the PIG area flight lines, and addition of coverage in the Bellingshausen Sea region. This mission should be flown as early as possible, preferably before mid-Oct, because of the relatively early onset of melt of in this region.

Flight Priority: High

Instrument Priority: ATM, snow radar, DMS, Ku-band radar, gravimeter

ICESat Tracks: none

Remaining Design Issues: none



Sea Ice – Bellingshausen 2

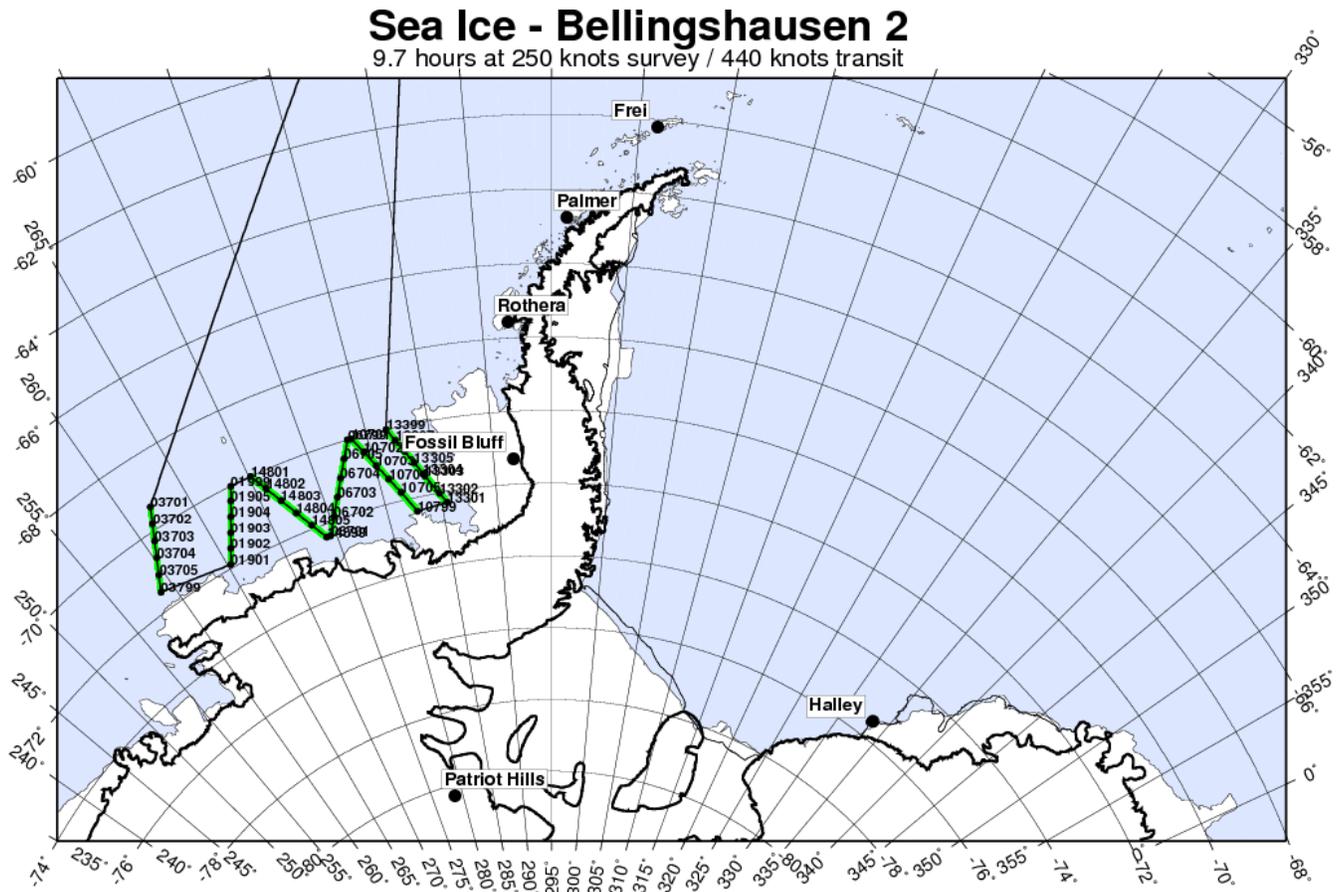
This mission represents a modification of Bellingshausen 1, to be flown in its place in the event that the ice edge in this region has retreated far southward. Adapting to “moderate ice” sea ice condition, the flight pattern is modified to (a) provide denser coverage (i.e. multiple north-south legs) over the smaller expanse of sea ice and (b) the opportunity to make multiple passes over the ice edge. The waypoints are derived from Envisat ground tracks. The specific location of the waypoints should be reviewed before the flight and adjusted based on the sea ice coverage reports obtained just prior to (or during) the deployment, specifically the location of the ice edge. Of medium priority on this mission is the opportunity for a coordinated under flight of a CryoSat-2 orbit along one of the north-south legs. This opportunity should not dictate the decision to fly the mission. Instead, the coordinated under flight should only be flown if, on the day selected for the mission, there is a CryoSat-2 ground track that is well-located relative to one of the planned grid lines and well-timed (plus or minus 2 hours). This mission should be flown as early as possible, preferably before mid-October, because of the relatively early onset of melt of in this region.

Flight Priority: High if Bellingshausen 1 is impractical because of light ice, otherwise medium

Instrument Priority: ATM, snow radar, DMS, Ku-band radar, gravimeter

ICESat Tracks: none

Remaining Design Issues: replace NS leg(s) with contemporaneous CryoSat ground track if nearby



Sea Ice – Endurance

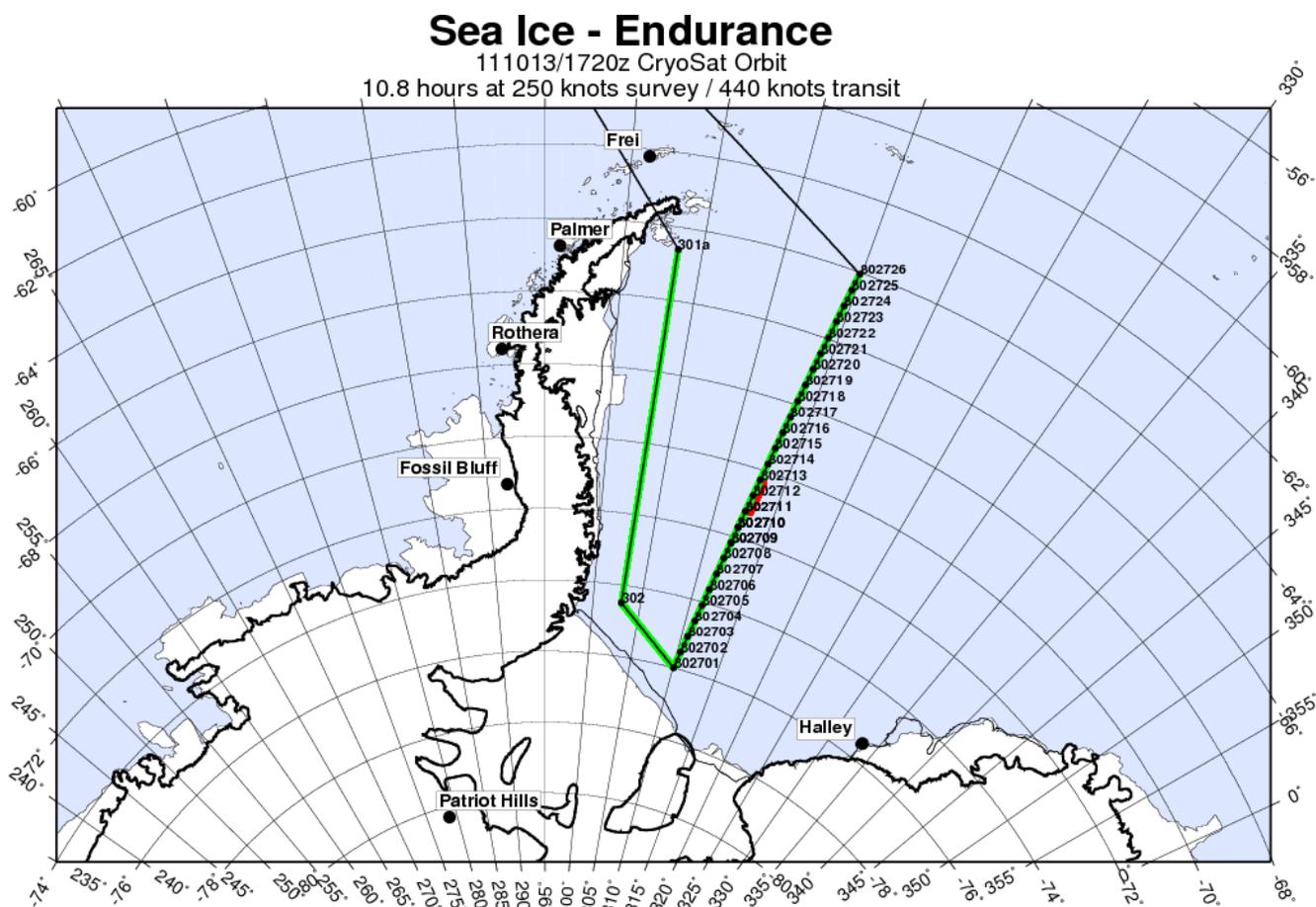
This mission represents a continuation of the IceBridge time series, repeating the “along shore” flight line (i.e. WP301a to WP302) flown in 2009 and 2010 and the Endurance flight line from 13 October 2011. It typically crosses rough sea ice. The western flight line (i.e. 301a to 302) is a repeat of a segment flown in October 28, 2010. The eastern flight line (802701-802726) will be adjusted to occupy a contemporaneous CryoSat-2 orbit. The CryoSat-2 orbit should be as close in time to the DC-8 underflight as possible, and the recommended maximum time offset is ~2 hours. The eastern flight line will also be adjusted to allow a 30 minute backtrack loop along the line, repeating a portion of the track to aid in the determination of sea ice drift rate. Finally we will continue the CryoSat track north past the ice edge, if time permits, for 25-50 km over the open ocean. This will permit intercomparison of OIB and CryoSat data over the transition region from the ice edge to open ocean.

Flight Priority: High (highest sea ice priority)

Instrument Priority: ATM, snow radar, DMS, Ku-band radar, gravimeter

ICESat Tracks: none

Remaining Design Issues: replace eastern leg with contemporaneous CryoSat ground track and add backtrack loop



Sea Ice – Endurance Prime

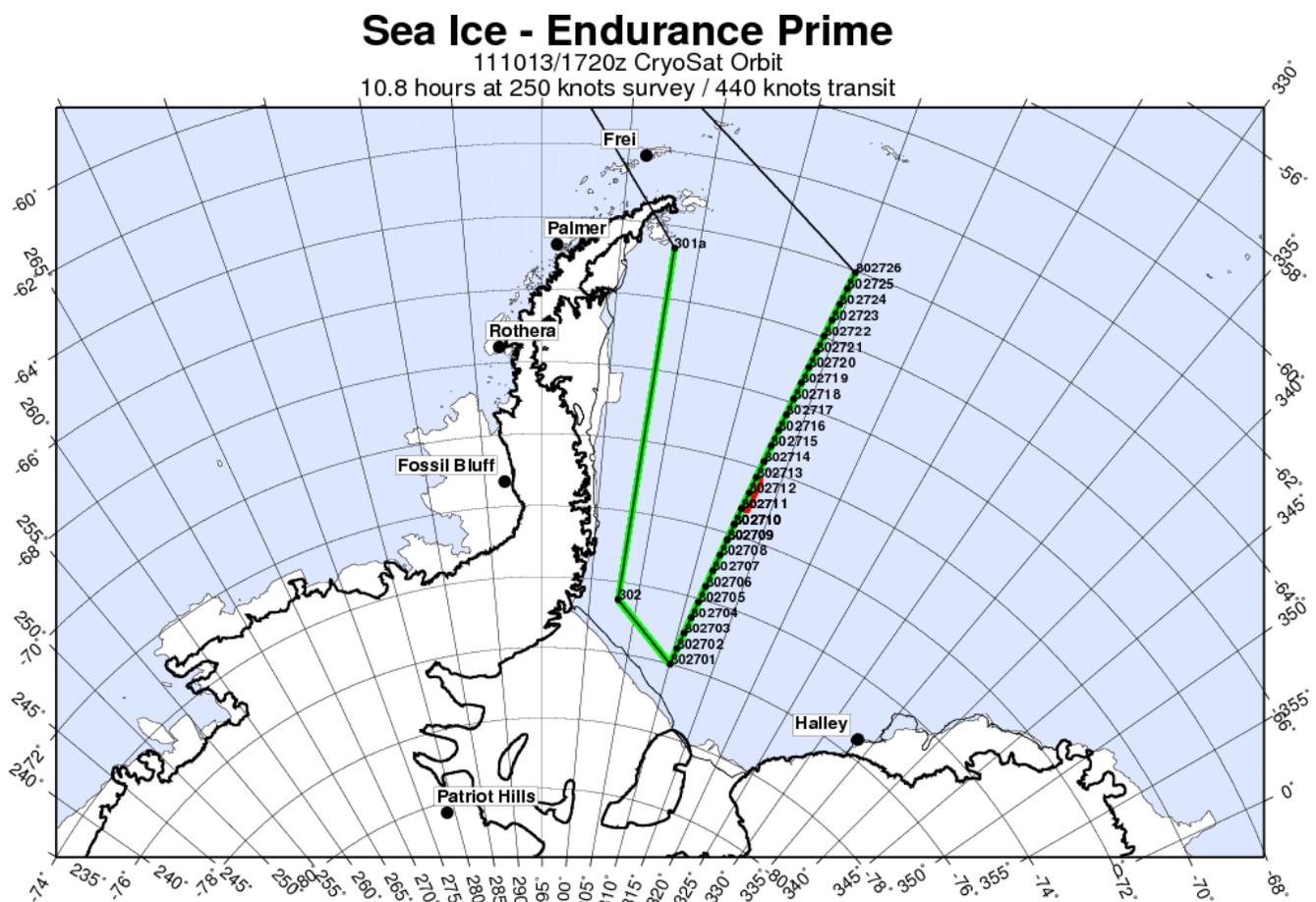
This mission is a near-repeat of the “Sea Ice Endurance” flight, with the exception of the eastern (CryoSat) leg. The purpose is to repeat the track of the Endurance flight after approximately 2 weeks have elapsed, to enable detection of change in the sea ice conditions over that time. The CryoSat leg, however, would be selected to be contemporaneous with the spacecraft on the day this mission is flown.

Flight Priority: Low

Instrument Priority: ATM, snow radar, DMS, Ku-band radar, gravimeter

ICESat Tracks: none

Remaining Design Issues: replace eastern leg with contemporaneous CryoSat ground track within ~200 km of the “Sea Ice Endurance” track and add backtrack loop



Sea Ice – Seelye Loop

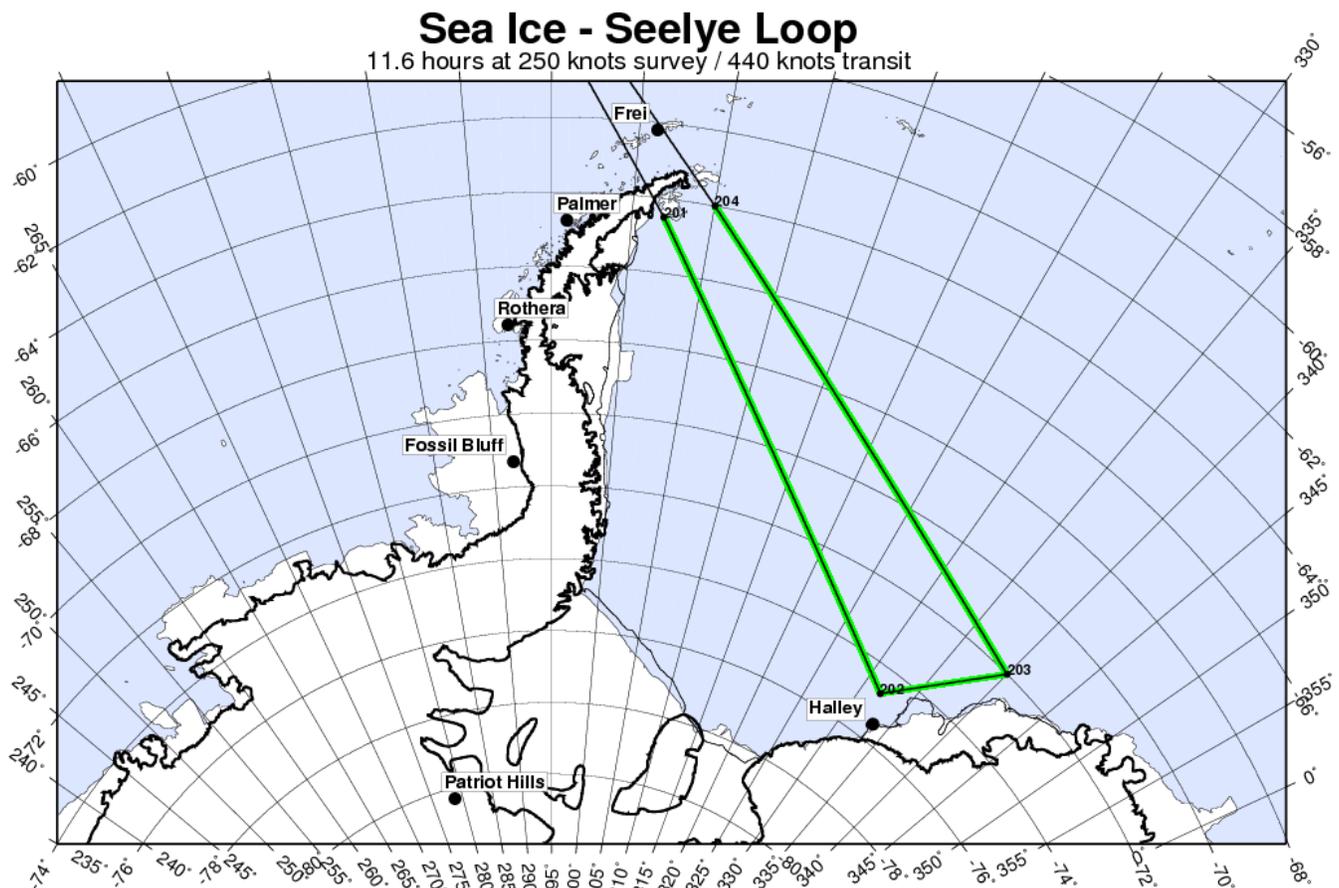
This mission represents a continuation of the IceBridge time series, repeating the 091024, 101026, 111012 and 111025 missions. It targets gradients in sea ice freeboard and thickness along the “gate” connecting the tip of the Antarctic Peninsula with Cape Norvegia. This mission may have to be shortened if dictated by fuel constraints.

Flight Priority: High

Instrument Priority: ATM, snow radar, DMS, Ku-band radar, gravimeter

ICESat Tracks: none

Remaining Design Issues: none



Sea Ice – Seelye Prime

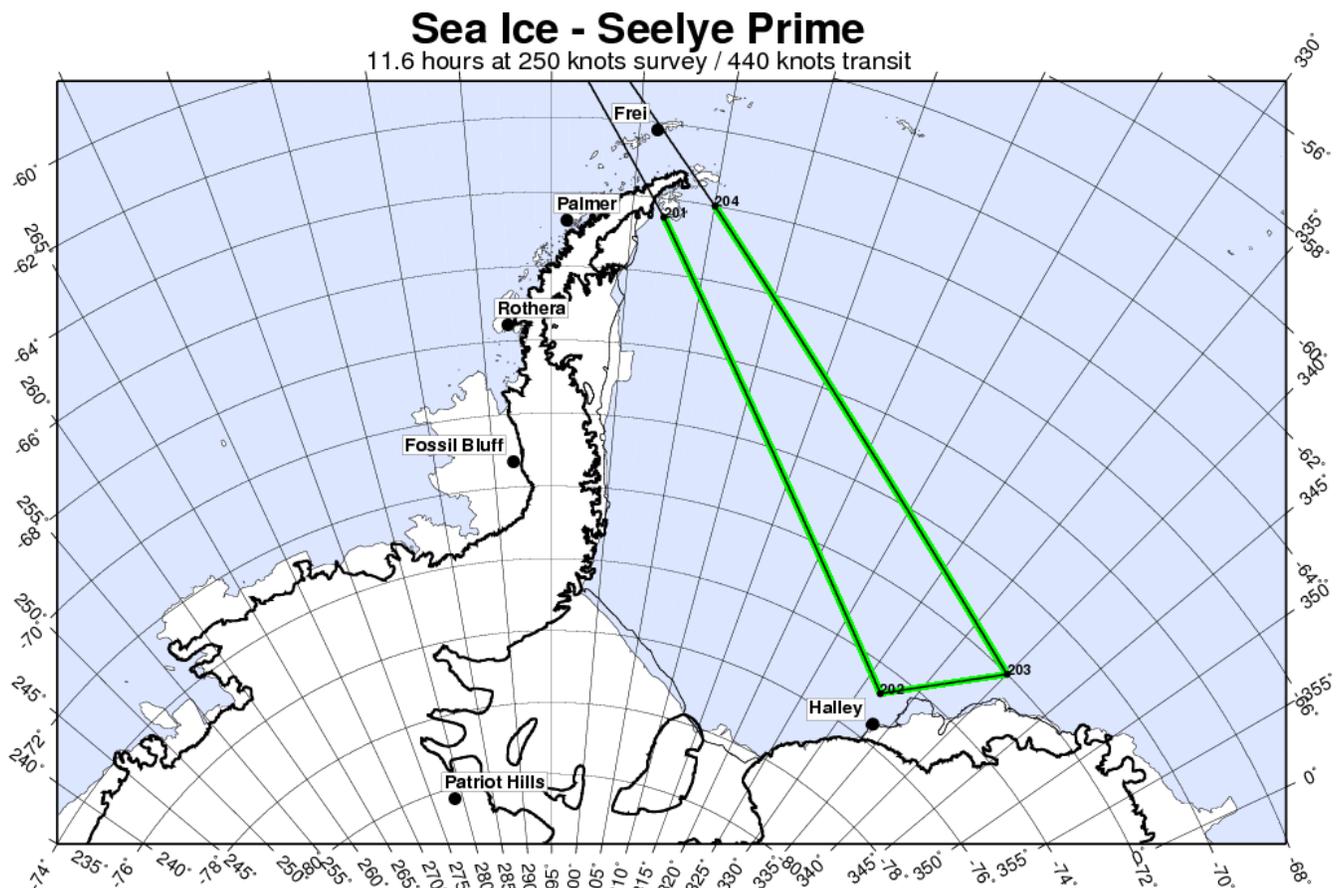
This mission would repeat the Seelye Loop above, but following at least two weeks after the first flight. This time period (in the Antarctic Spring) would allow a significant amount of snowmelt to occur and permit validation of the snow radar results. As is the case with the Seelye Loop mission, this mission may have to be shortened if dictated by fuel constraints.

Flight Priority: Medium

Instrument Priority: ATM, snow radar, DMS, Ku-band radar, gravimeter

ICESat Tracks: none

Remaining Design Issues: none



Sea Ice – Twisted

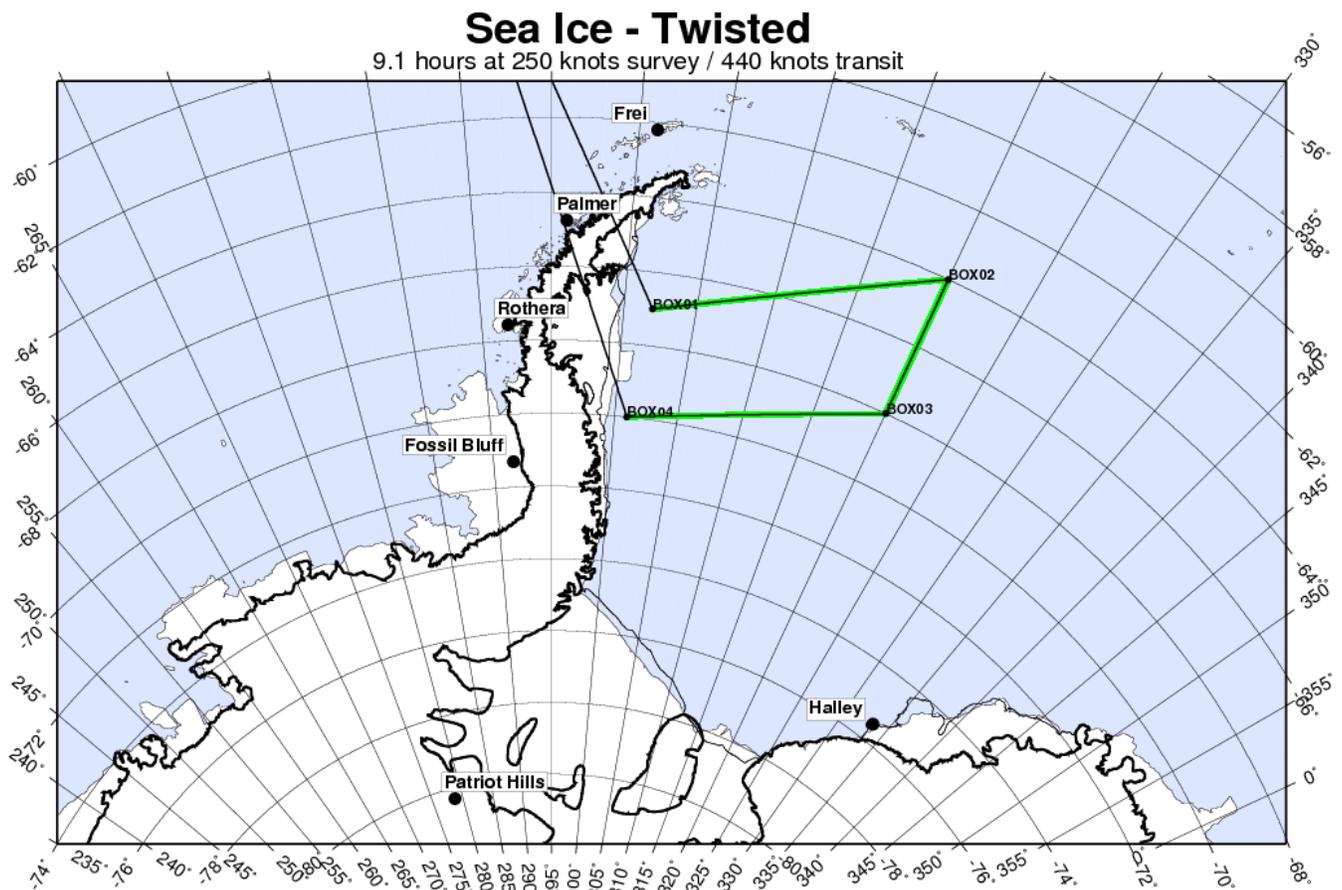
This mission represents an alternative pattern over the Weddell, generally rotating, or twisting, the Seelye Loop pattern northward, closer to ice edge. This is a repeat of the 18 October 2011 OIB flight. This is a medium priority mission to be considered in the event of poor weather at other sea ice mission sites.

Flight Priority: Medium

Instrument Priority: ATM, snow radar, DMS, Ku-band radar, gravimeter

ICESat Tracks: none

Remaining Design Issues: none



Sea Ice – Weddell Zigzag

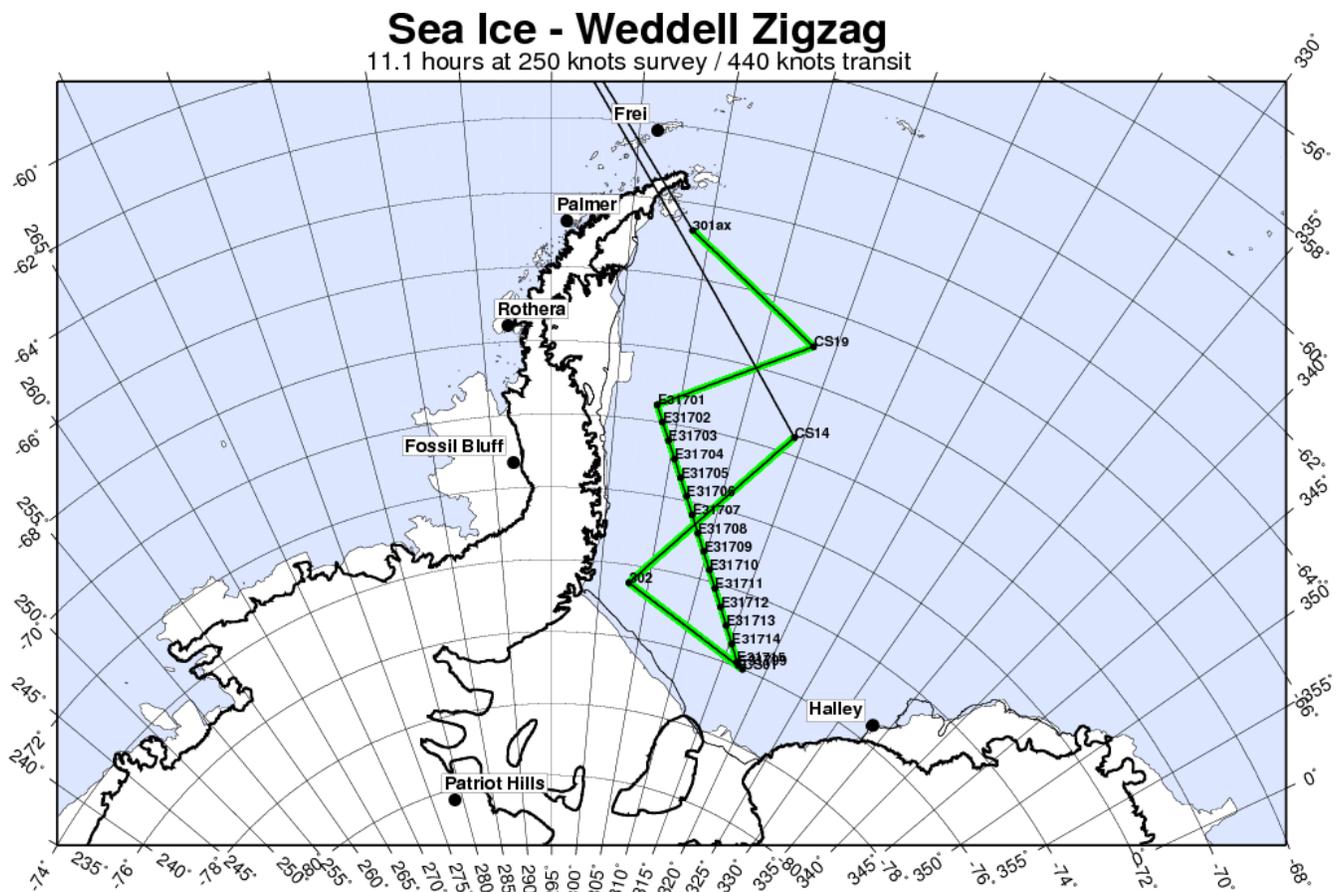
This is a new mission for 2012 with the aim of providing more detailed coverage over a region in the Weddell Sea characterized by a significant thickness gradient (the ice gets older and thicker closer to the Antarctic Peninsula). The zig-zag pattern crosses the space between the Endurance flight lines. The southernmost line is a repeat of the Endurance line, which is desired for comparisons between the two missions. The segment from E31701 to E31799 follows an Envisat ground track. This is a low-priority mission to be considered in the event of poor weather at other sea ice mission sites.

Flight Priority: Low

Instrument Priority: ATM, snow radar, DMS, Ku-band radar, gravimeter

ICESat Tracks: none

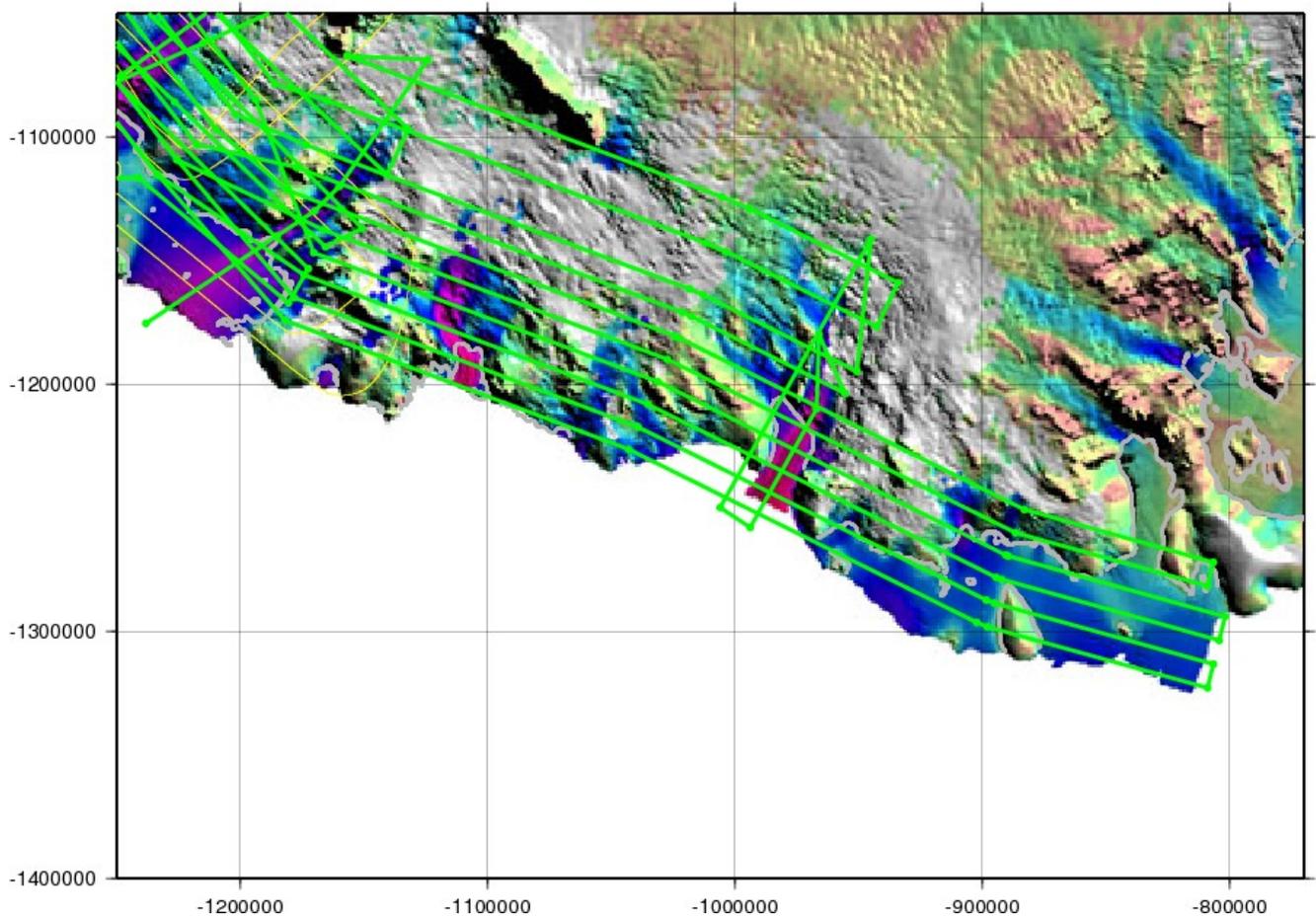
Remaining Design Issues: none



Hull-Land Region

The map below depicts the five flights planned for the Hull-Land area, which is a new area for Operation IceBridge. The flight lines are oriented along a 10-km coast-parallel grid, with the spacing increasing to 20 km upstream. The suite of missions also includes a dedicated tie line and glacier centerline flights of the Hull and Berry glaciers.

Hull-Land Composite 5 Flights, Regional Priority Low



Land Ice – Hull-Land 01

This is a new mission, one of a suite of five missions designed to map the coastal region encompassing the Hull and Land glaciers and surrounding areas to the west of the Getz Ice Shelf. The twofold purpose is to map the bathymetry and basal topography using the gravimeter and MCoRDS radar, and at the same time to establish surface topography measurements for dh/dt. This particular flight is the outboard-most of the five planned flights. We also overfly LVIS grid lines in the Getz area during transits at high altitude, to obtain high-altitude data on an opportunistic basis.

Regional Priority: Low

Flight Priority: Low

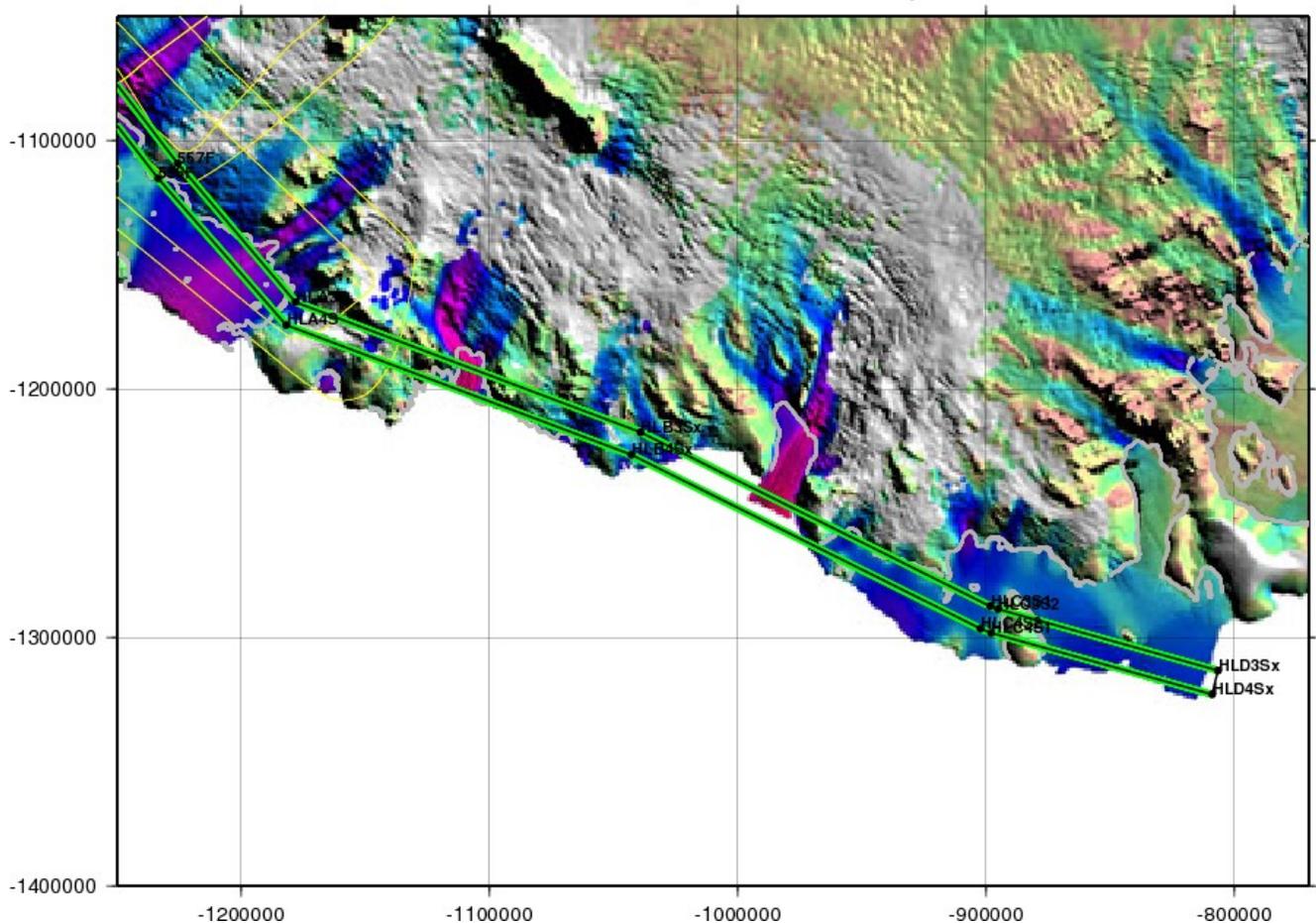
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Hull-Land 01

10.9 hrs total / 3.3 hrs survey
440 knots transit / 250 knots survey



Land Ice – Hull-Land 02

This is a new mission, one of a suite of five missions designed to map the coastal region encompassing the Hull and Land glaciers and surrounding areas to the west of the Getz Ice Shelf. The twofold purpose is to map the bathymetry and basal topography using the gravimeter and MCoRDS radar, and at the same time to establish surface topography measurements for dh/dt. This particular flight is the second most outboard of the five planned flights. We also overfly LVIS grid lines in the Getz area during transits at high altitude, to obtain high-altitude data on an opportunistic basis.

Regional Priority: Low

Flight Priority: Low

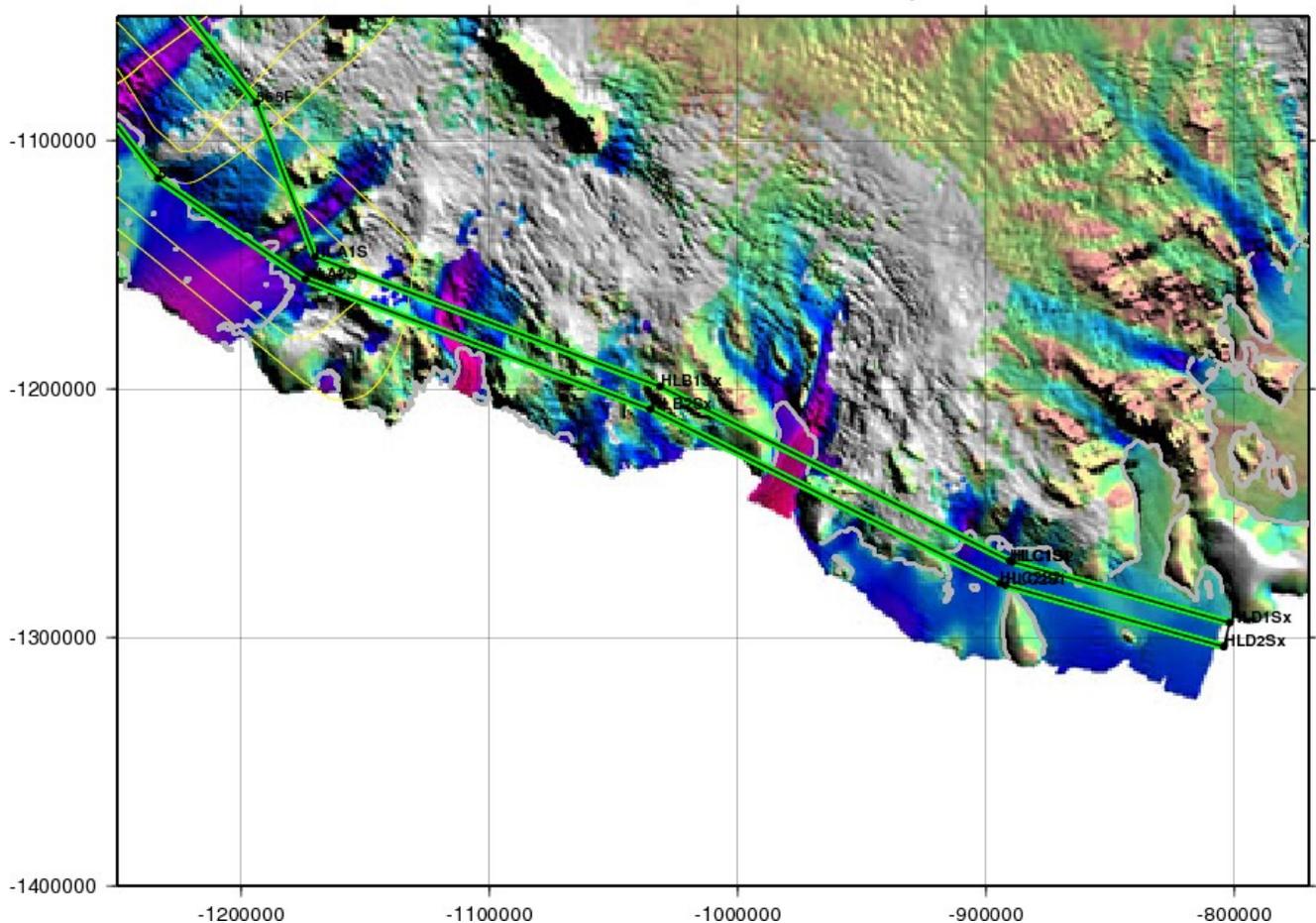
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Hull-Land 02

10.9 hrs total / 3.3 hrs survey
440 knots transit / 250 knots survey



Land Ice – Hull-Land 03

This is a new mission, one of a suite of five missions designed to map the coastal region encompassing the Hull and Land glaciers and surrounding areas to the west of the Getz Ice Shelf. The twofold purpose is to map the bathymetry and basal topography using the gravimeter and MCoRDS radar, and at the same time to establish surface topography measurements for dh/dt. This particular flight occupies the center of the area of study of the five planned flights. We also overfly LVIS grid lines in the Getz area during transits at high altitude, to obtain high-altitude data on an opportunistic basis.

Regional Priority: Low

Flight Priority: High

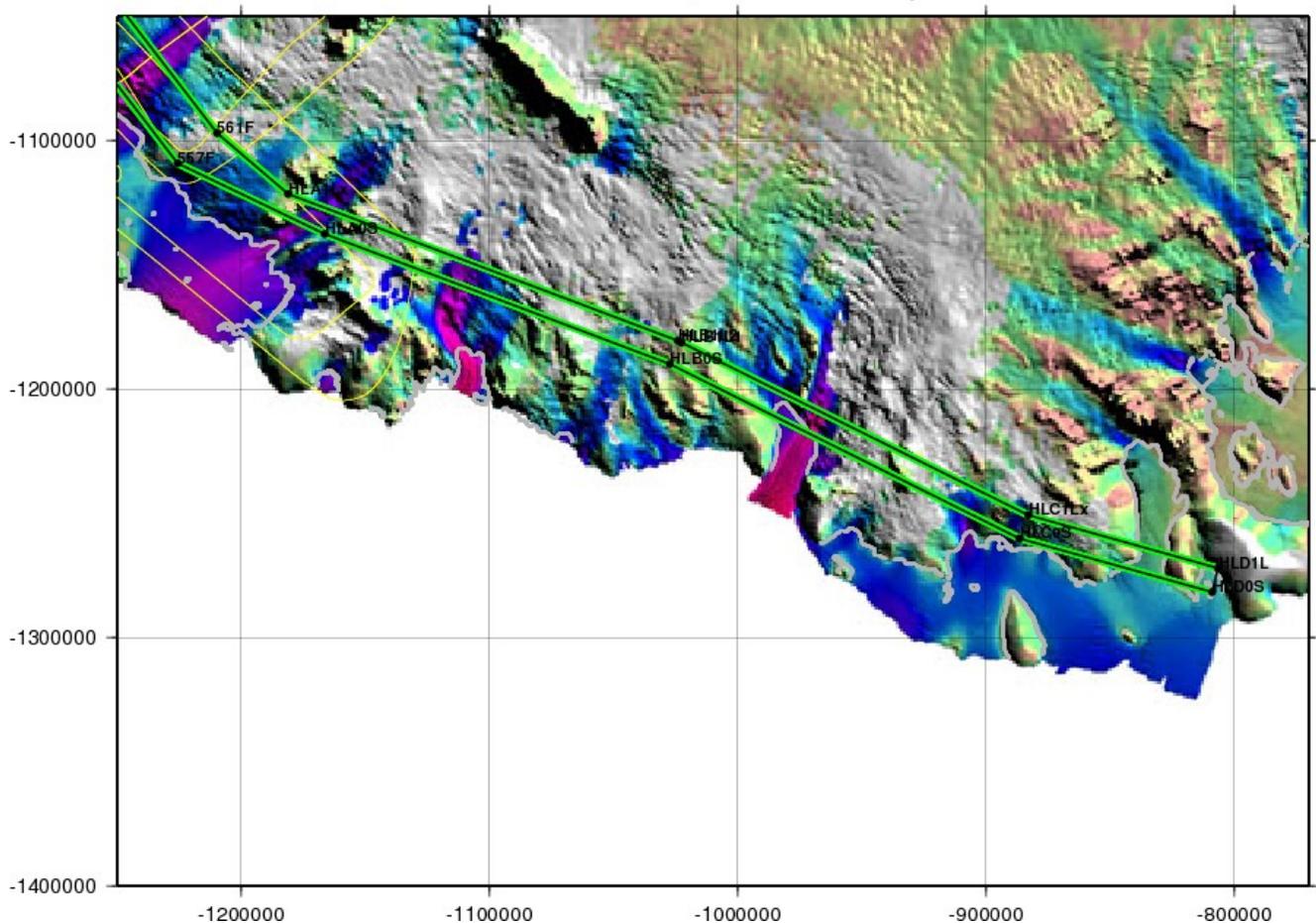
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Hull-Land 03

10.8 hrs total / 3.3 hrs survey
440 knots transit / 250 knots survey



Land Ice – Hull-Land 04

This is a new mission, one of a suite of five missions designed to map the coastal region encompassing the Hull and Land glaciers and surrounding areas to the west of the Getz Ice Shelf. The twofold purpose is to map the bathymetry and basal topography using the gravimeter and MCoRDS radar, and at the same time to establish surface topography measurements for dh/dt. This particular flight is the second most inboard of the five planned flights, and it includes a centerline run of the Land Glacier and a nearby tie line. Finally we overfly LVIS grid lines in the Getz area during transits at high altitude, to obtain high-altitude data on an opportunistic basis.

Regional Priority: Low

Flight Priority: Low

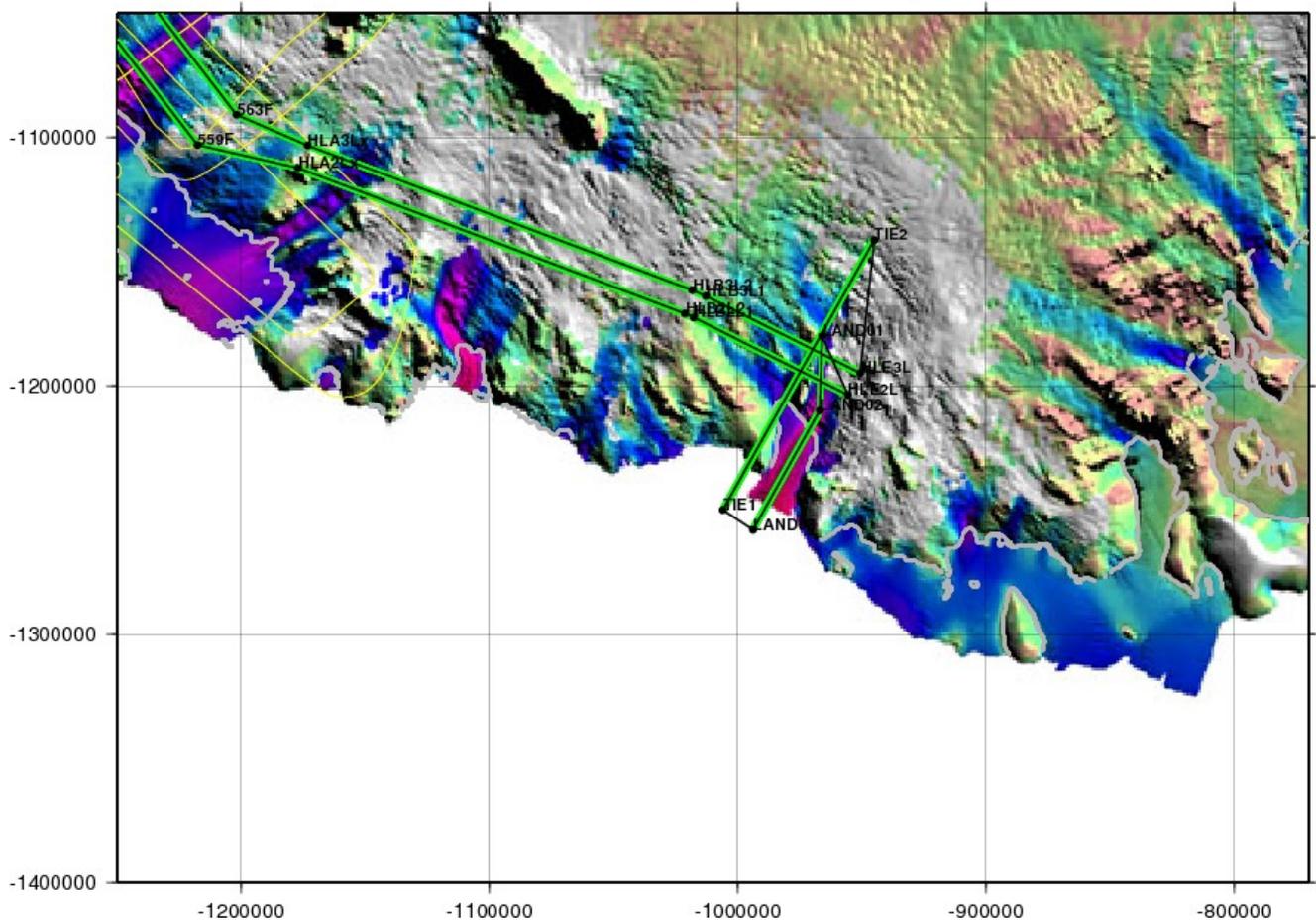
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Hull-Land 04

10.9 hrs total / 3.4 hrs survey
440 knots transit / 250 knots survey



Land Ice – Hull-Land 05

This is a new mission, one of a suite of five missions designed to map the coastal region encompassing the Hull and Land glaciers and surrounding areas to the west of the Getz Ice Shelf. The twofold purpose is to map the bathymetry and basal topography using the gravimeter and MCoRDS radar, and at the same time to establish surface topography measurements for dh/dt. This particular flight is the most inboard of the five planned flights, and it increases the spacing of the lines from 10 km to 20 km, mainly for the purpose of extending the surveys to the base of the Flood Range. It also includes a centerline survey of the Berry Glacier, and the curvature of this line may be small enough to enable the line to be suitable as a gravity tie line as well. Finally we overfly an LVIS grid line in the Getz area during the inbound transit at high altitude, to obtain high-altitude data on an opportunistic basis.

Regional Priority: Low

Flight Priority: Low

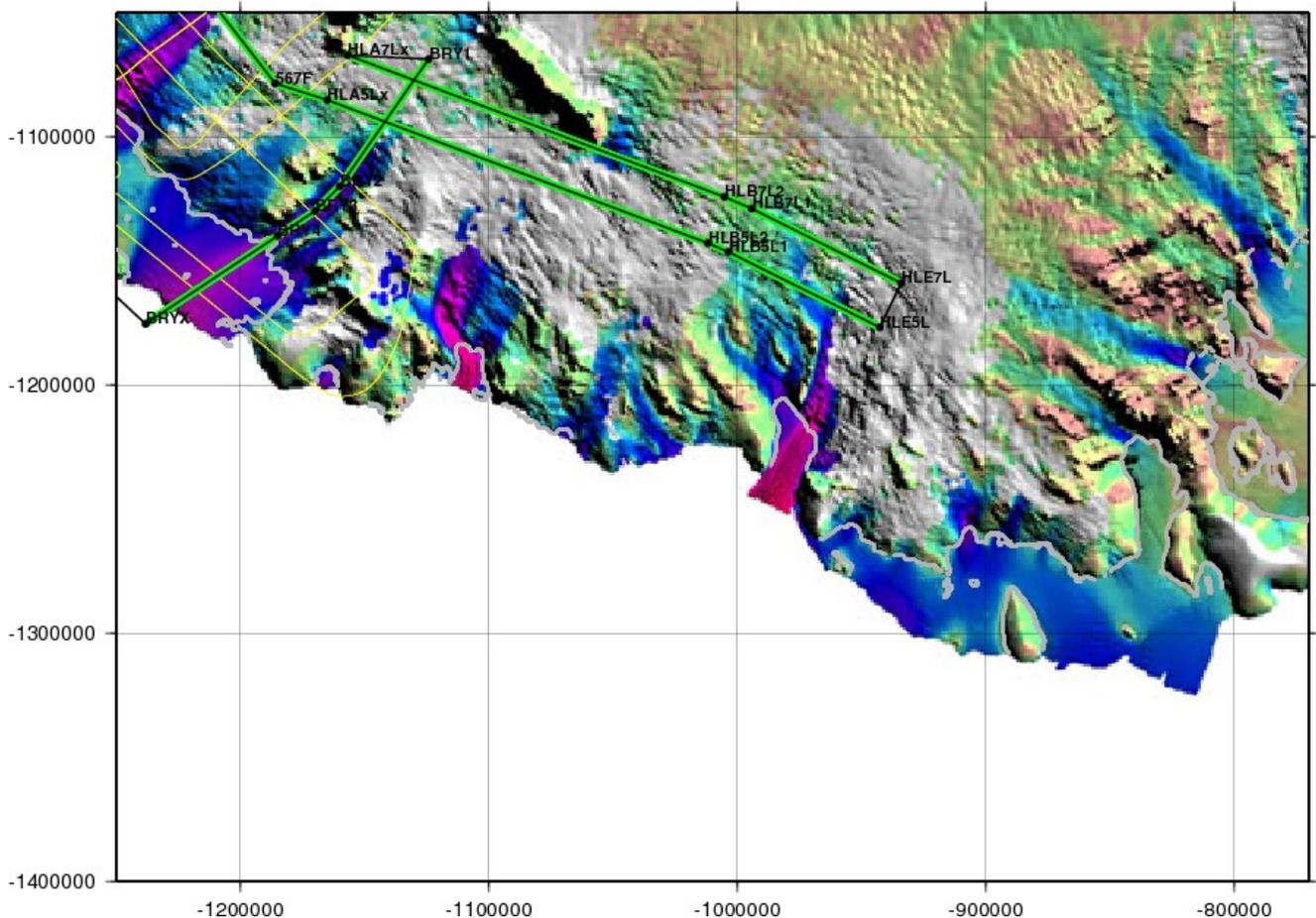
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Hull-Land 05

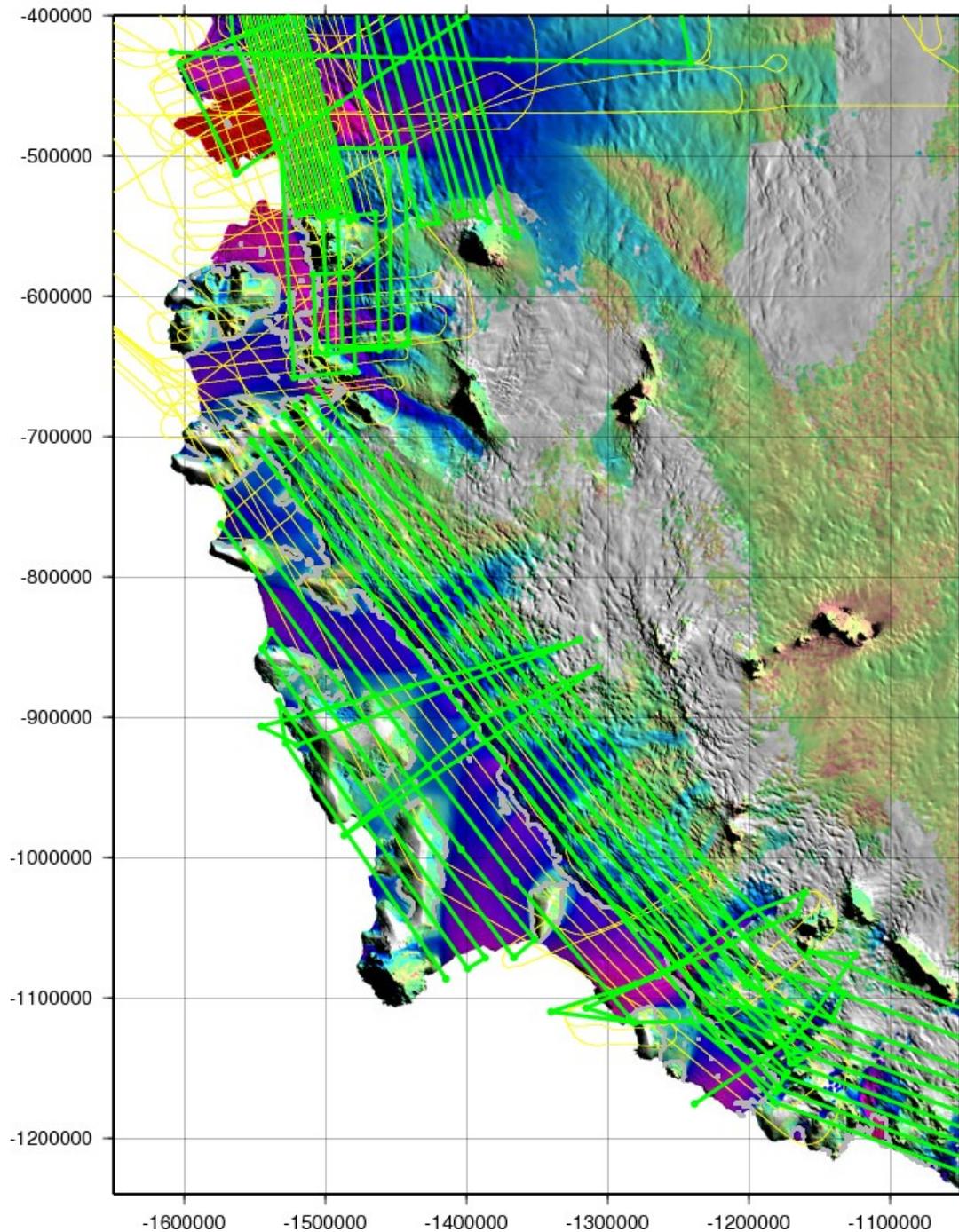
10.6 hrs total / 2.4 hrs survey
440 knots transit / 250 knots survey



Getz Ice Shelf Region

The map below depicts the four flights planned for the Getz Ice Shelf area. The flight lines are oriented along a coast-parallel grid and closely integrated with four OIB missions previously flown in the area. The suite of missions also includes three dedicated tie lines and a repeat glacier centerline flight of the Devicq Glacier and of another ice stream in the eastern portion.

Getz Composite 4 Flights, Regional Priority Medium



Land Ice – Getz 05

This is a new mission, one of a suite of four designed to supplement the 2009-2011 Getz Ice Shelf flights. The twofold purpose is to continue mapping the sub ice-shelf bathymetry using the gravimeter, and to continue mapping the ice surface and bedrock upstream of the grounding line. This particular flight includes a repeat centerline run of the Devicq Glacier and nearby ICESat track which should also serve as a tie line. The along-shore line near the grounding line is coincident with an LVIS track.

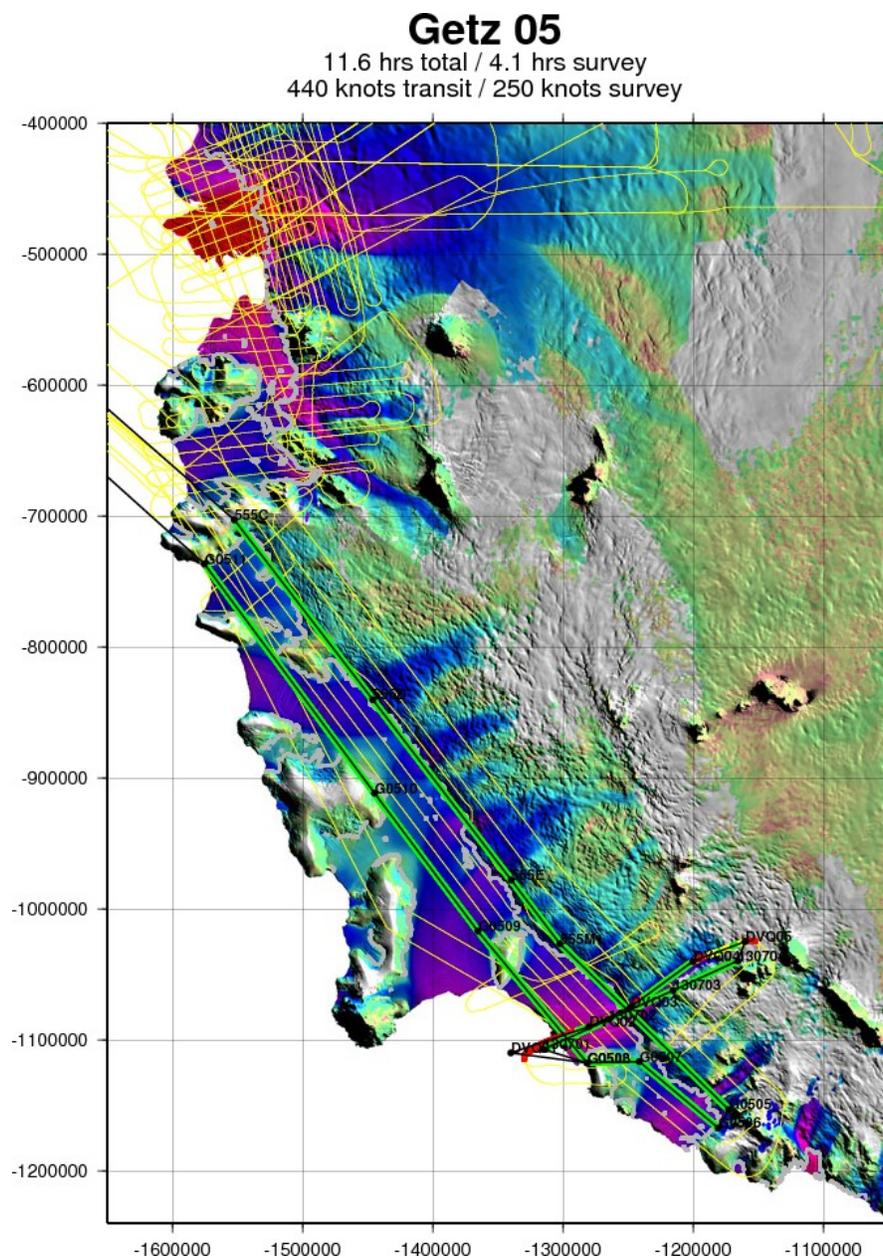
Regional Priority: Medium

Flight Priority: Low

Instrument Priority: not specified

ICESat Track: 1307

Remaining Design Issues: none



Land Ice – Getz 06

This is a new mission, one of a suite of four designed to supplement the 2009-2011 Getz Ice Shelf flights. The twofold purpose is to continue mapping the sub ice-shelf bathymetry using the gravimeter, and to continue mapping the ice surface and bedrock upstream of the grounding line. This particular flight focuses on the outboard-most portion of the ice shelf.

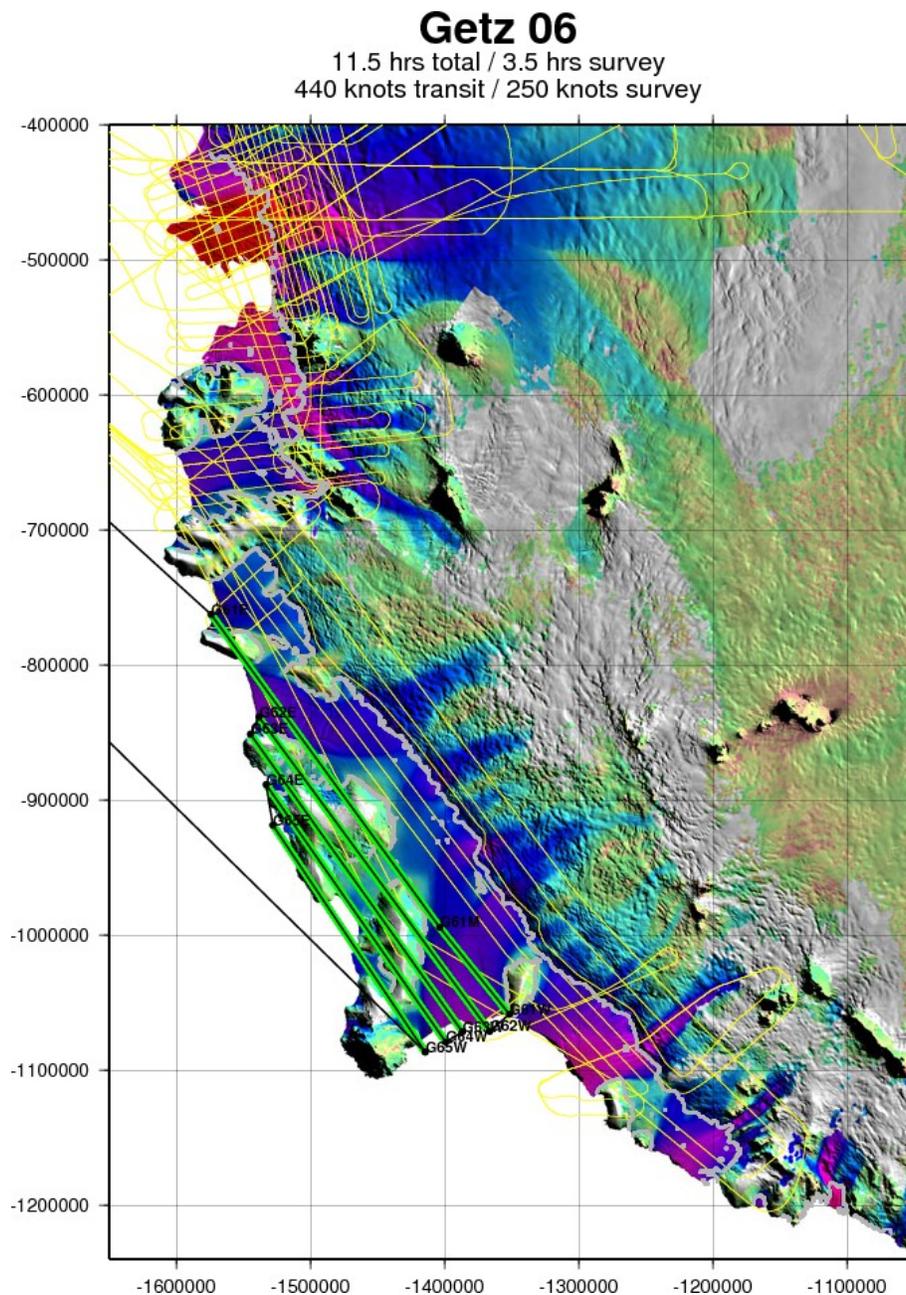
Regional Priority: Medium

Flight Priority: Medium

Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none



Land Ice – Getz 08

This is a new mission, one of a suite of four designed to supplement the 2009-2011 Getz Ice Shelf flights. The twofold purpose is to continue mapping the sub ice-shelf bathymetry using the gravimeter, and to continue mapping the ice surface and bedrock upstream of the grounding line. This particular flight focuses on the upper-most portion of the region, and it includes a pair of tie lines, one of which follows an ICESat track and the other of which is centered on a nearby ice stream. The main along-shore lines are coincident with LVIS lines.

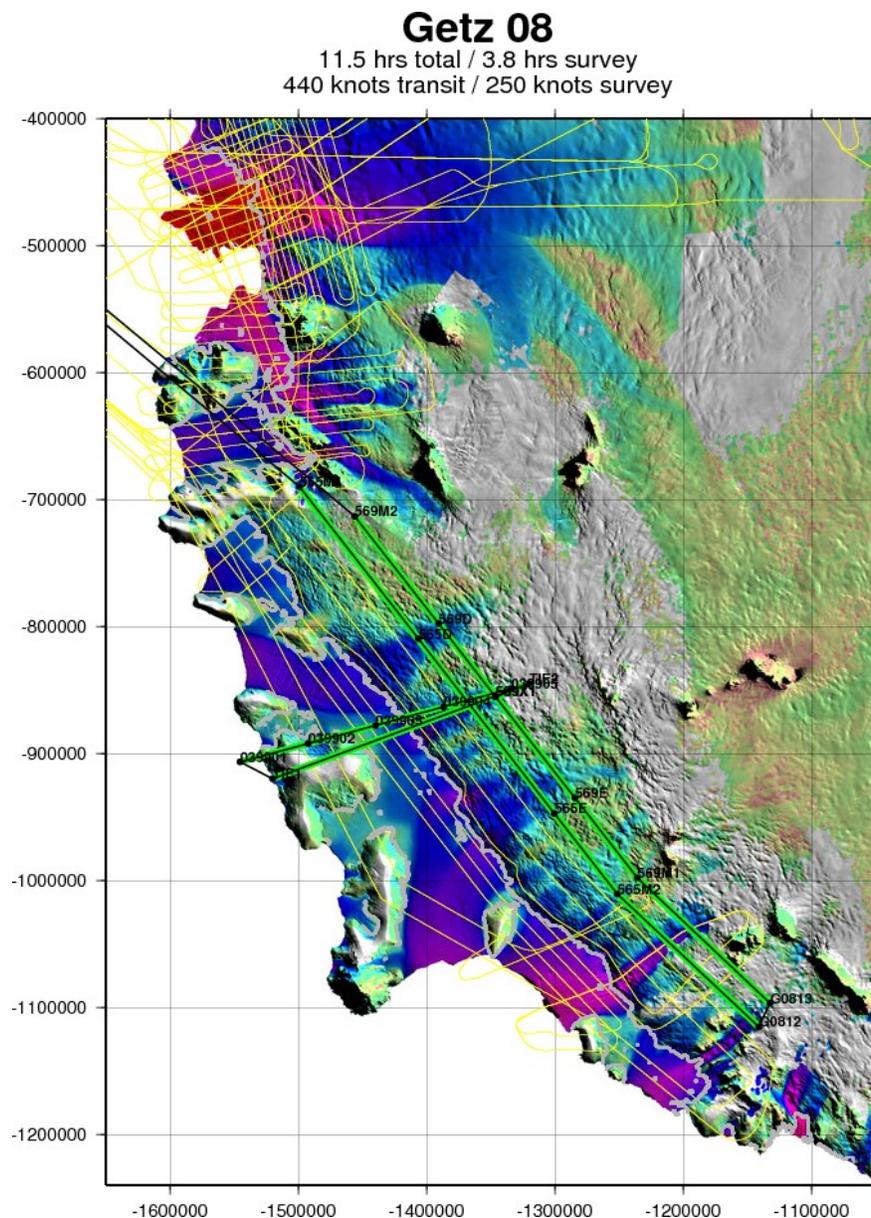
Regional Priority: Medium

Flight Priority: Low

Instrument Priority: not specified

ICESat Track: 0399

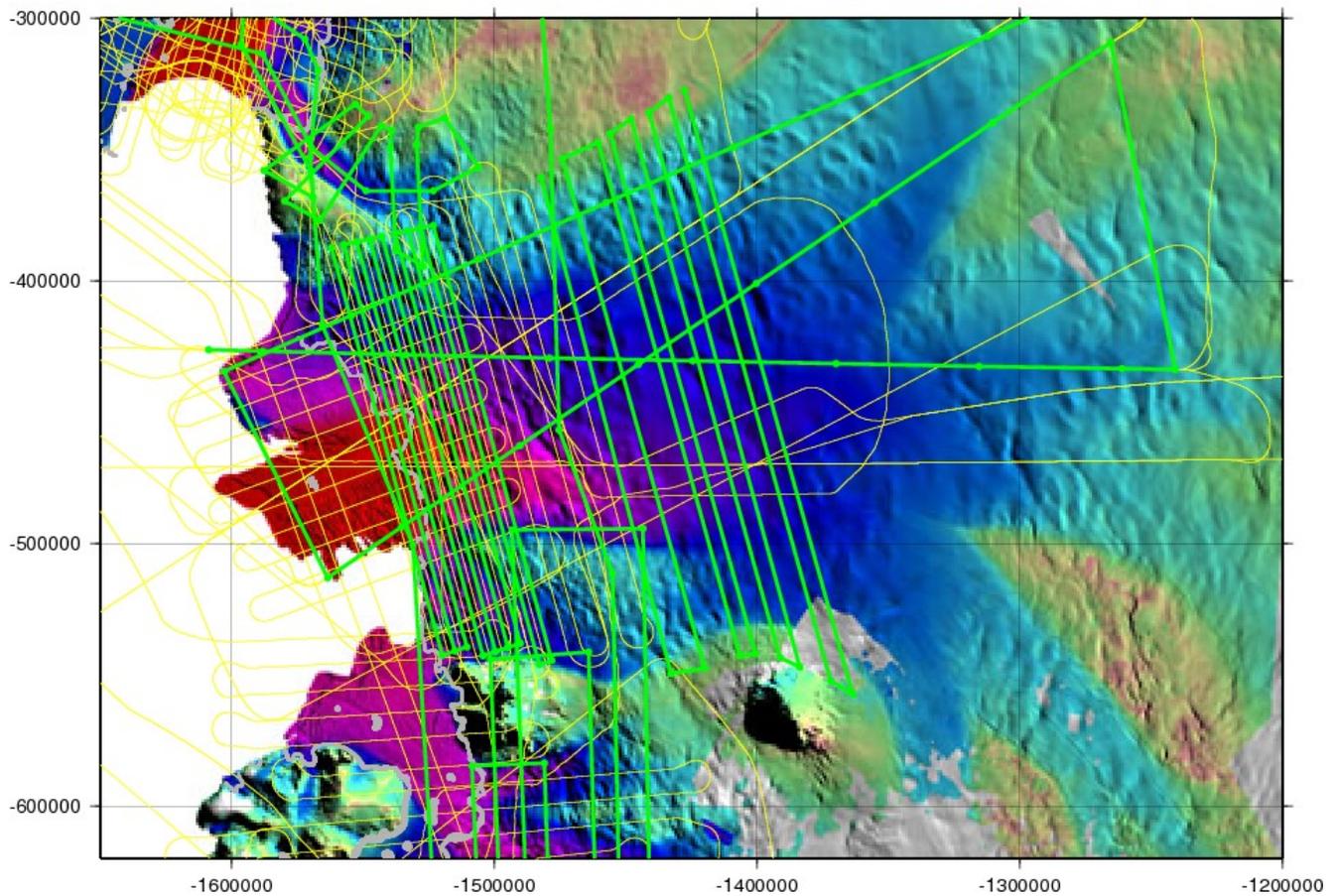
Remaining Design Issues: none



Thwaites Region

The map below depicts the three flights planned for the Thwaites Glacier area. The three flights include one targeted at the grounding line and another on a parallel grid farther upstream, and another centered on ICESat and CryoSat tracks. It also includes some high-altitude coverage from the PTSK-High mission.

Thwaites Composite
3 Flights, Regional Priority High



Land Ice – Thwaites Grounding Line 2

This is a new mission, designed in conjunction with the 2011 Thwaites Grounding Line 1 mission to map in detail much of the grounding line and area upstream of it, in order to inform predictions of its potential upstream migration. The pair of missions is aligned with the UTIG AGASEA grid, and one of the lines (E05-W05) is co-located with one of the UTIG cross-flow lines to facilitate intercomparison of the OIB and UTIG measurements. Each of these two missions creates a grid with 5 km spacing offset from each other by 2.5 km, so that once both missions are flown the resulting grid will be spaced at 2.5 km.

Regional Priority: High

Flight Priority: High

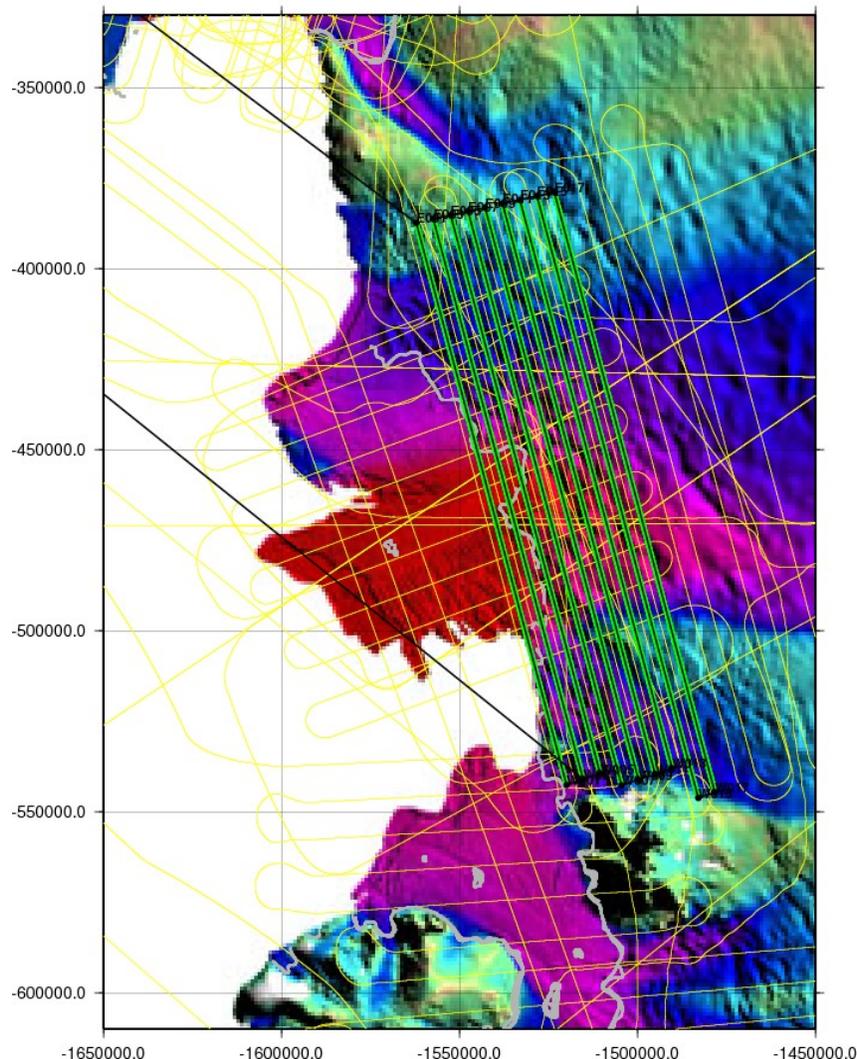
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Thwaites Grounding Line 2

11.4 hrs total / 4.2 hrs survey
440 knots transit / 250 knots survey



Land Ice – Thwaites Upstream 3

This is a new mission. It is intended to densify the existing AGASEA 15 km grid to a 5 km grid, to facilitate flux gate analysis and ice sheet modeling. It is designed in conjunction with 2011 mission Thwaites Upstream 1, to extend the grid started in that mission farther upstream.

Regional Priority: High

Flight Priority: High

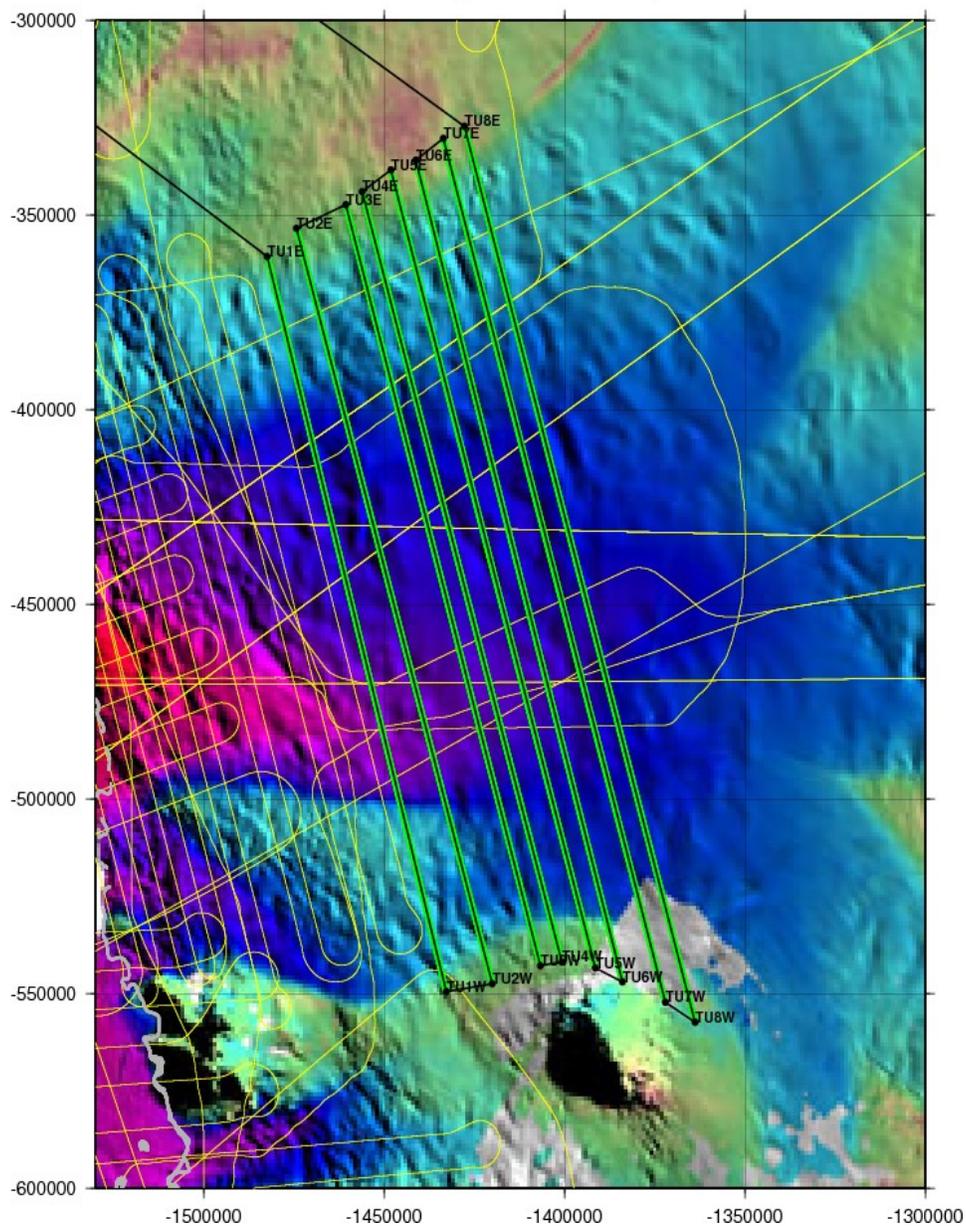
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Thwaites Upstream 3

11.8 hrs total / 4.6 hrs survey
440 knots transit / 250 knots survey



Land Ice – TSK2-CryoSat

This mission is similar to the 2010 TSK2 CryoSat mission, but with some changes. We replace one of the two ICESat lines flown in 2010 with another (from the 2009 TSK2 flight), to avoid duplication with a line occupied during the WAIS Cores flight. Also, the two CryoSat lines shown here are placeholders, since we will select CryoSat lines which the spacecraft will occupy within a few days of our own overflight, in order to minimize geophysical changes between the collection of the two datasets due to snow accumulation. Finally, the CryoSat underflight lines should be flown at 2000 m AGL, in order to broaden the lidar swath as much as possible while still collecting Ku-band radar data.

Regional Priority: High

Flight Priority: Low

Instrument Priority: not specified

ICESat Track: 0190,0288

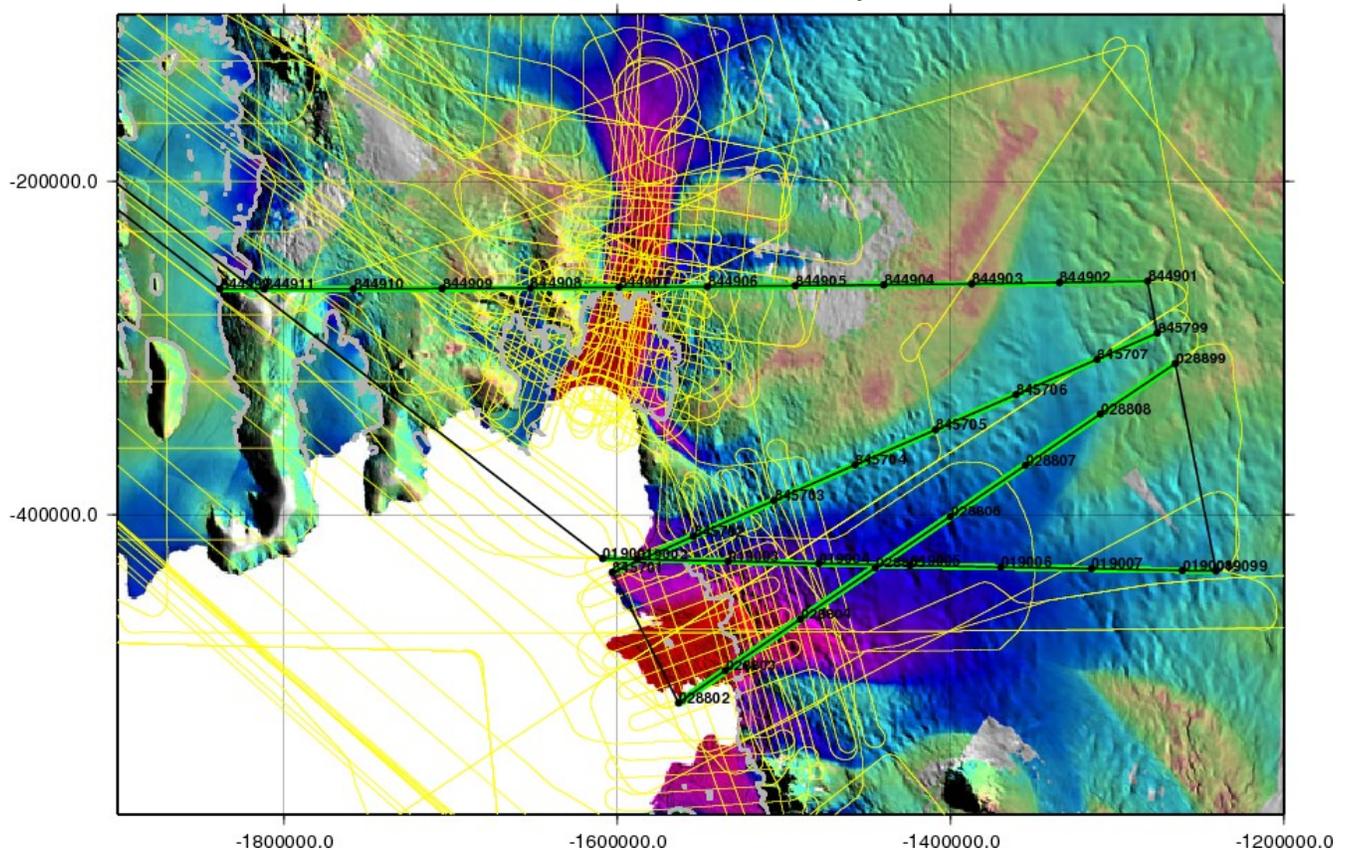
Remaining Design Issues: replace CryoSat placeholder lines with actual groundtracks to be occupied within a few days of OIB underflight

TSK2 - CryoSat

111111 and 111112 CryoSat Orbits

11.0 hrs total / 4.3 hrs survey

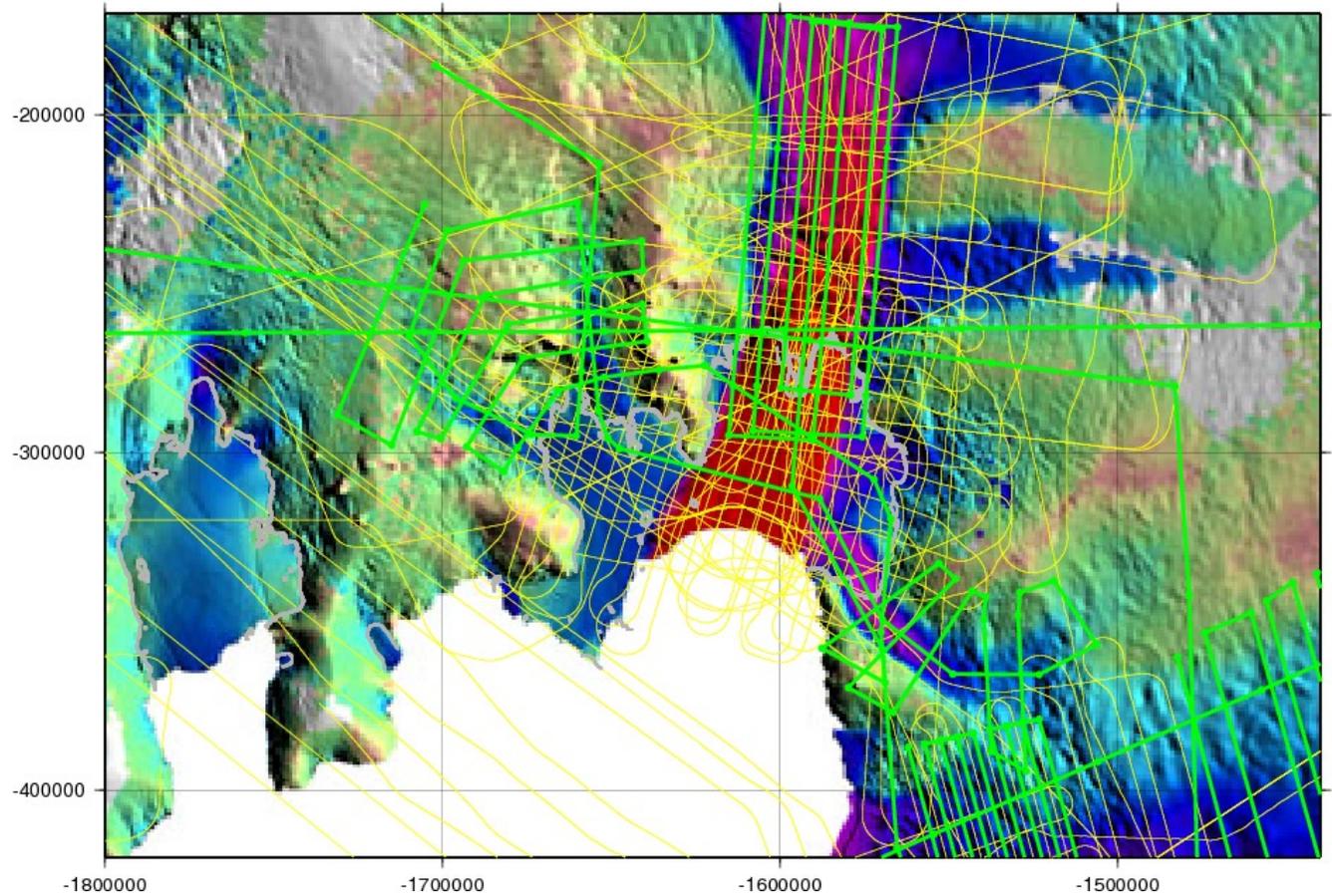
440 knots transit / 250 knots survey



Pine Island Region

The map below depicts the two flights planned for the Pine Island Glacier area.

Pine Island Composite 2 Flights, Regional Priority High



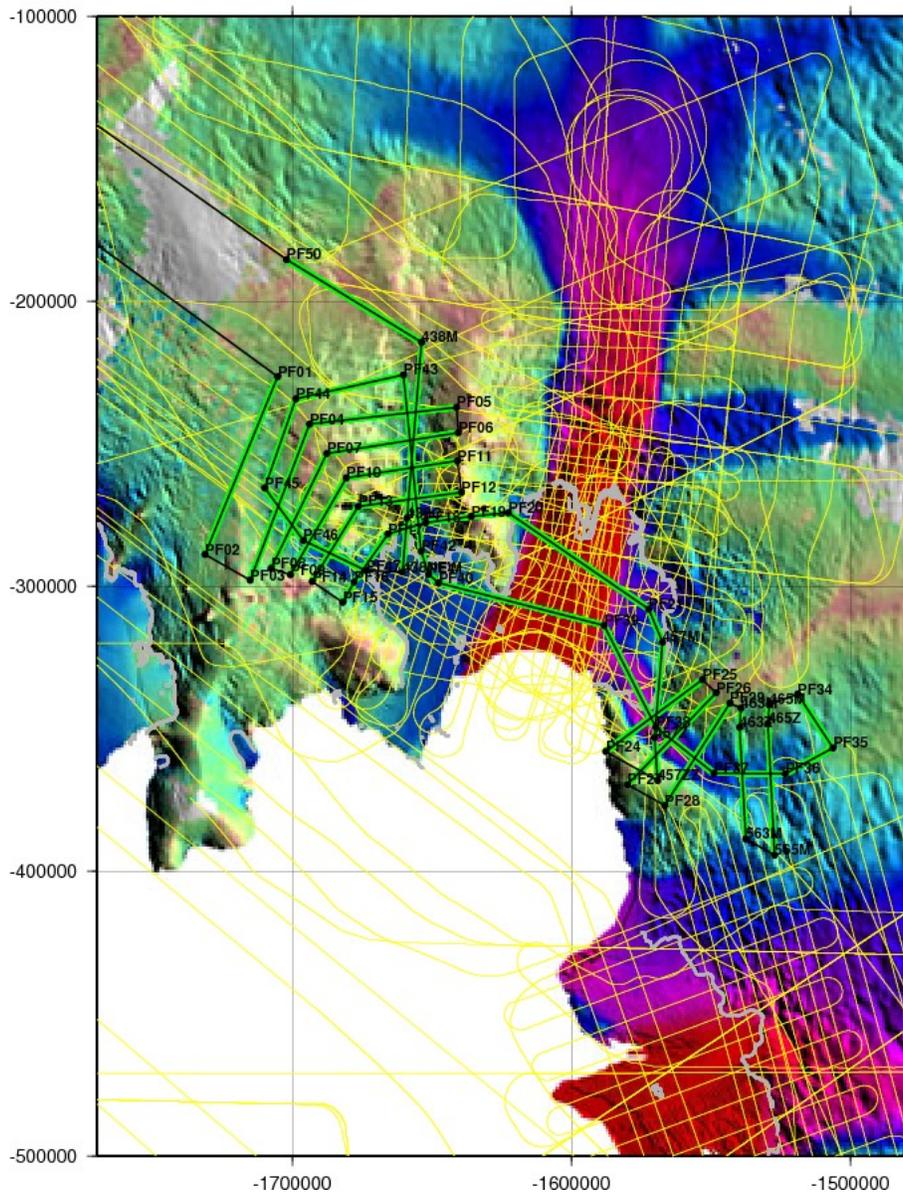
Land Ice – PIG Flanks 01

This flight is a new design, intended to sample areas of this glacier basin which have received little attention thus far. The flight samples the fast-flowing tributary flowing into the Pine Island Glacier ice shelf from the southwest, and the smaller tributaries flowing into the northern part of the ice shelf from the Hudson Mountains. Several flight lines are aligned with LVIS flight tracks,

- Regional Priority:** High
- Flight Priority:** Medium
- Instrument Priority:** not specified
- ICESat Track:** none
- Remaining Design Issues:** none

PIG Flanks 01

10.9 hrs total / 4.4 hrs survey
440 knots transit / 250 knots survey



Land Ice – PTSK High Altitude

This flight is a new design, intended to sample the Pine Island, Thwaites, Smith and Kohler glaciers along lines from the LVIS grid and along ICESat tracks. The mission is to be flown entirely at high-altitude, using the ATM narrow-swath scanner in high-altitude mode.

Regional Priority: High

Flight Priority: High

Instrument Priority: not specified

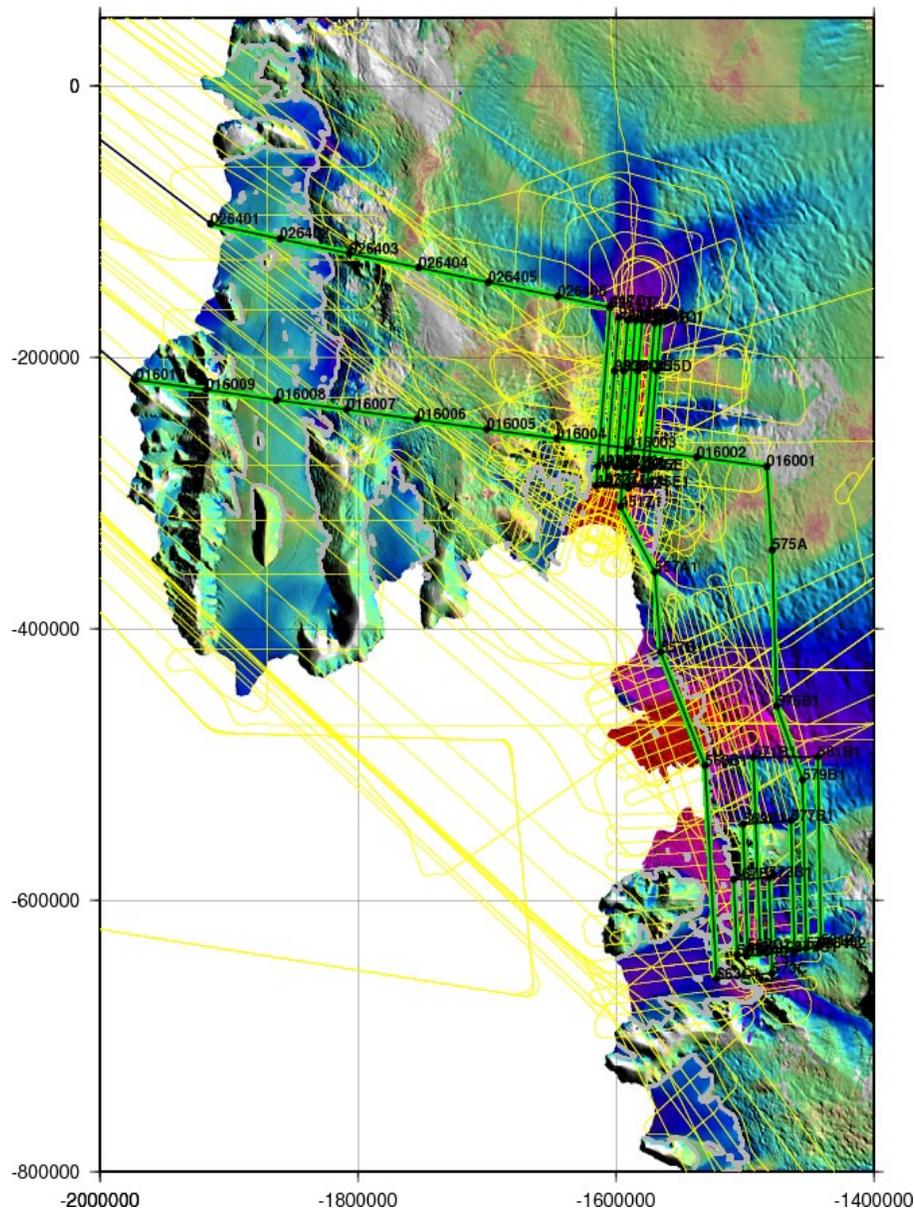
ICESat Track: 0354,0264,0160

Remaining Design Issues: none

PTSK High Altitude

11.4 hrs total

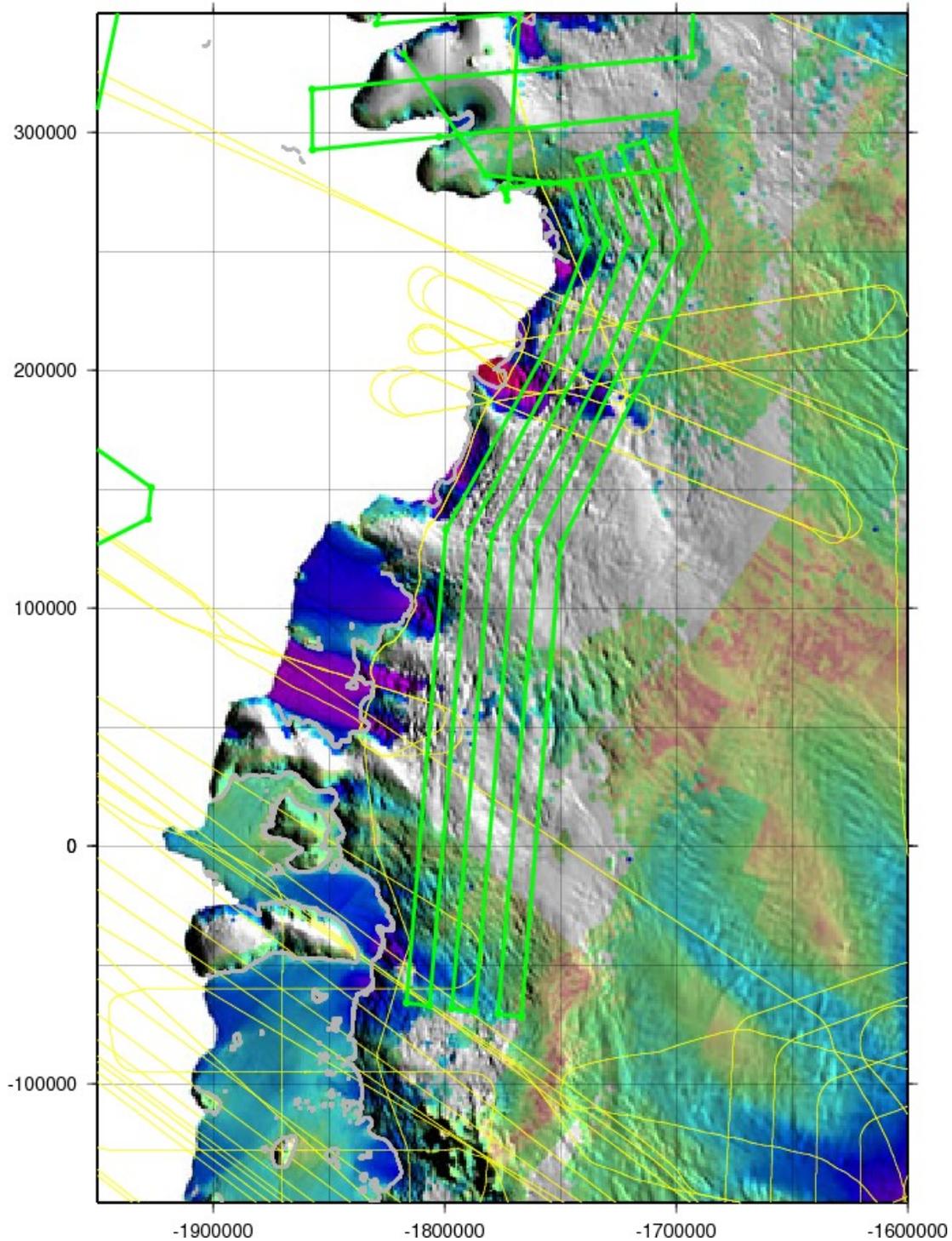
440 knots groundspeed



Ferrigno-Alison Region

The map below depicts the single flight planned for the coastal area encompassing the Ferrigno and Alison ice streams.

Ferrigno-Alison Composite 1 Flight, Regional Priority High



Land Ice – Ferrigno-Alison 01

This flight is a new design, intended to sample the region surrounding the Ferrigno and Alison ice streams, well upstream of the grounding line. We sample the area on 10 km coast-parallel grid. The western portion of each line coincides with an LVIS grid line.

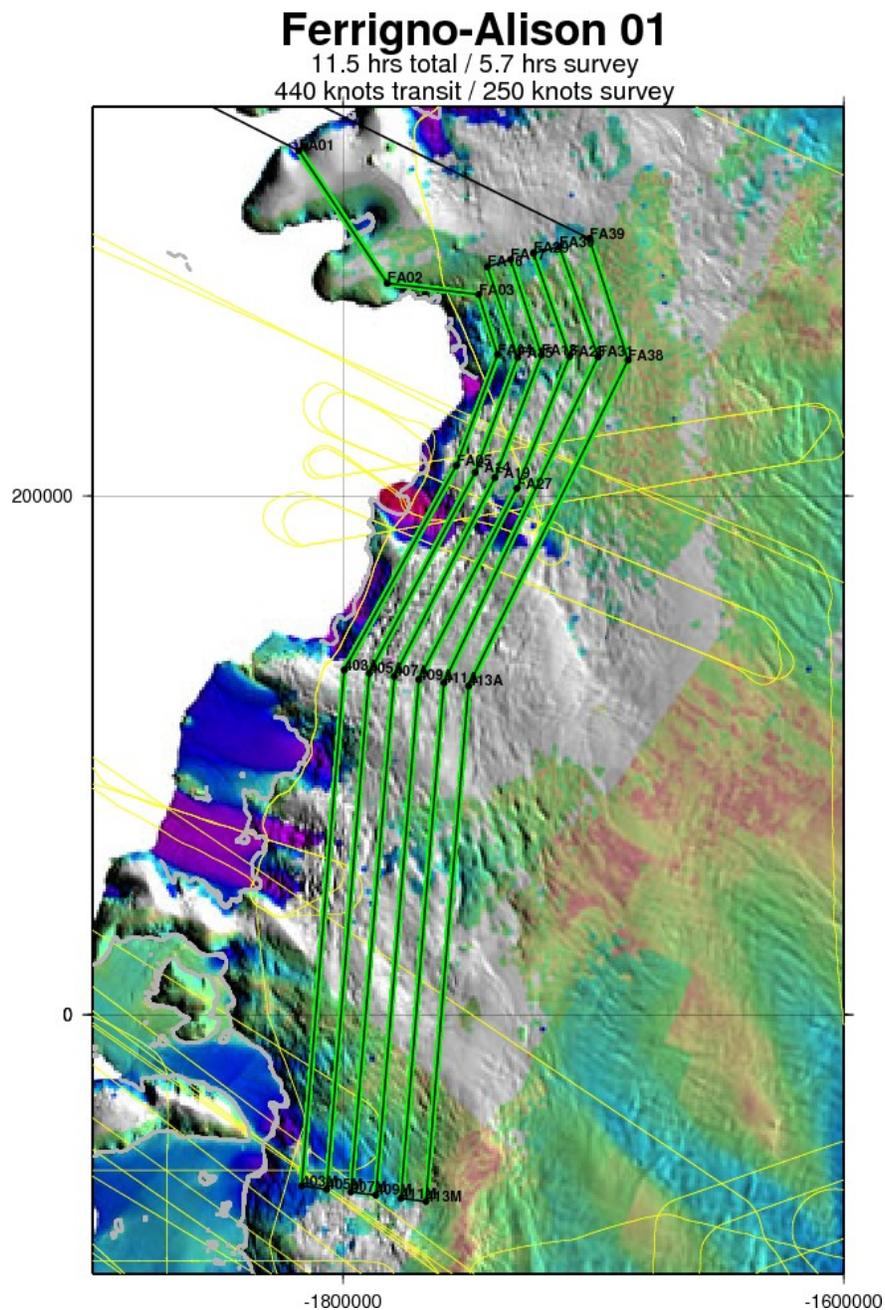
Regional Priority: High

Flight Priority: High

Instrument Priority: not specified

ICESat Track: none

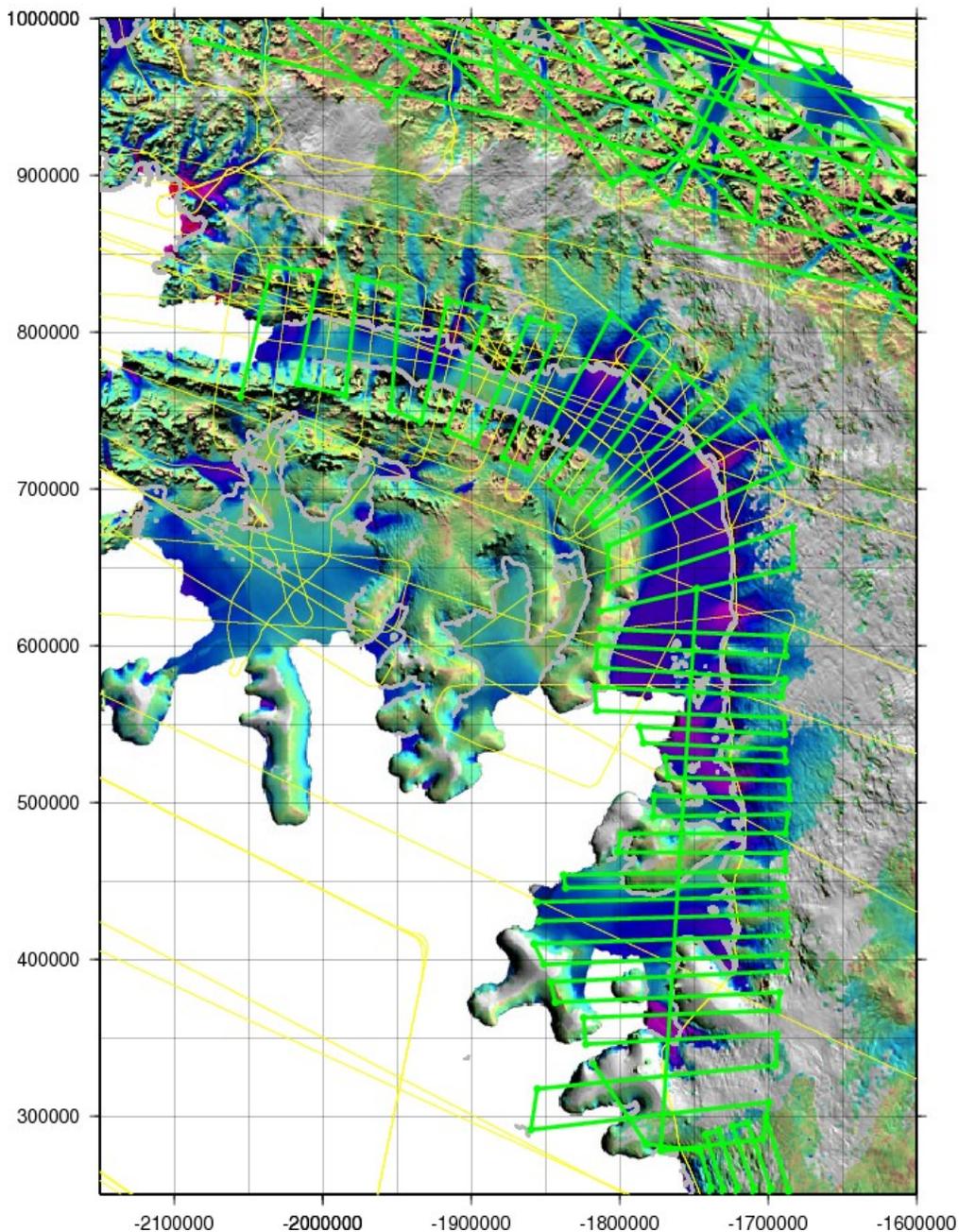
Remaining Design Issues: none



George VI Region

The map below depicts the three flights planned for the George VI Ice Shelf area, which includes the area to the west of the proper George VI ice shelf which encompasses a number of smaller ice shelves. The flight lines in the northern part of this region are designed around previous flight lines and are intended to densify the existing measurements there. The lines to the west are designed along ICESat ground tracks.

George VI Composite 3 Flights, Regional Priority Medium



Land Ice – George VI 02

This flight is a new design, intended to densify the existing the sampling of the northern part of the George VI ice shelf, mainly for the purpose of mapping the bathymetry under the ice shelf with gravimetry. We intersperse the existing lines from previous OIB campaigns, crossing the George VI channel between Alexander Island and the Antarctic Peninsula.

Regional Priority: Medium

Flight Priority: Low

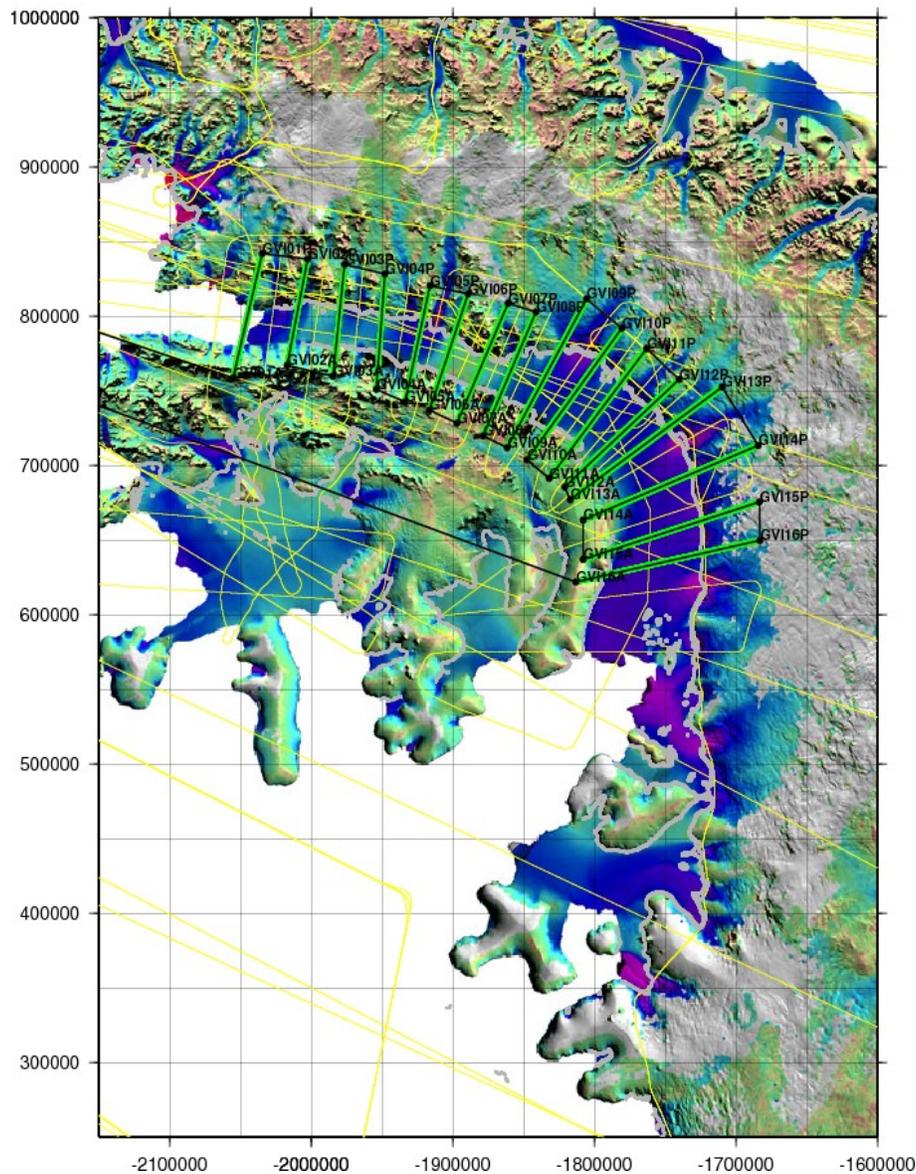
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

George VI 02

10.9 hrs total / 5.9 hrs survey
440 knots transit / 250 knots survey



Land Ice – George VI 03

This flight is a new design, intended to extend the sampling of the George VI ice shelf to the west, mainly for the purpose of mapping the bathymetry under the ice shelf with gravimetry. Every other flight line is designed to follow an ICESat ground track.

Regional Priority: Medium

Flight Priority: High

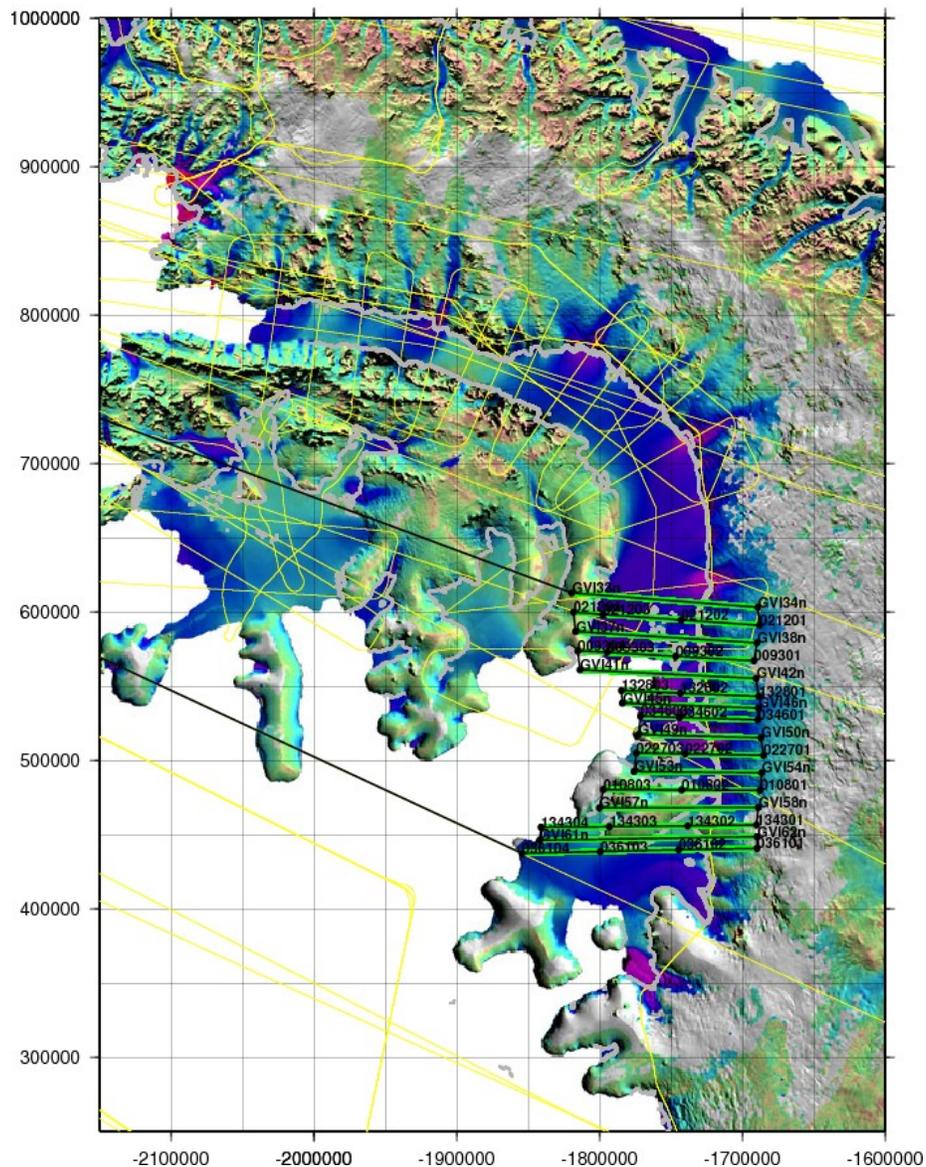
Instrument Priority: not specified

ICESat Track: 0212,0093,1328,0346,0227,0108,1343,0361

Remaining Design Issues: none

George VI 03

11.3 hrs total / 5.9 hrs survey
440 knots transit / 250 knots survey



Land Ice – George VI 04

This flight is a new design, intended to extend the sampling of the smaller ice shelves to the west of the George VI, mainly for the purpose of mapping the bathymetry under the ice shelves with gravimetry. Most flight lines are designed to follow ICESat ground tracks. We also include a tie line in this particular flight, which connects all of the lines flown in this mission and in the George VI 03 flight.

Regional Priority: Medium

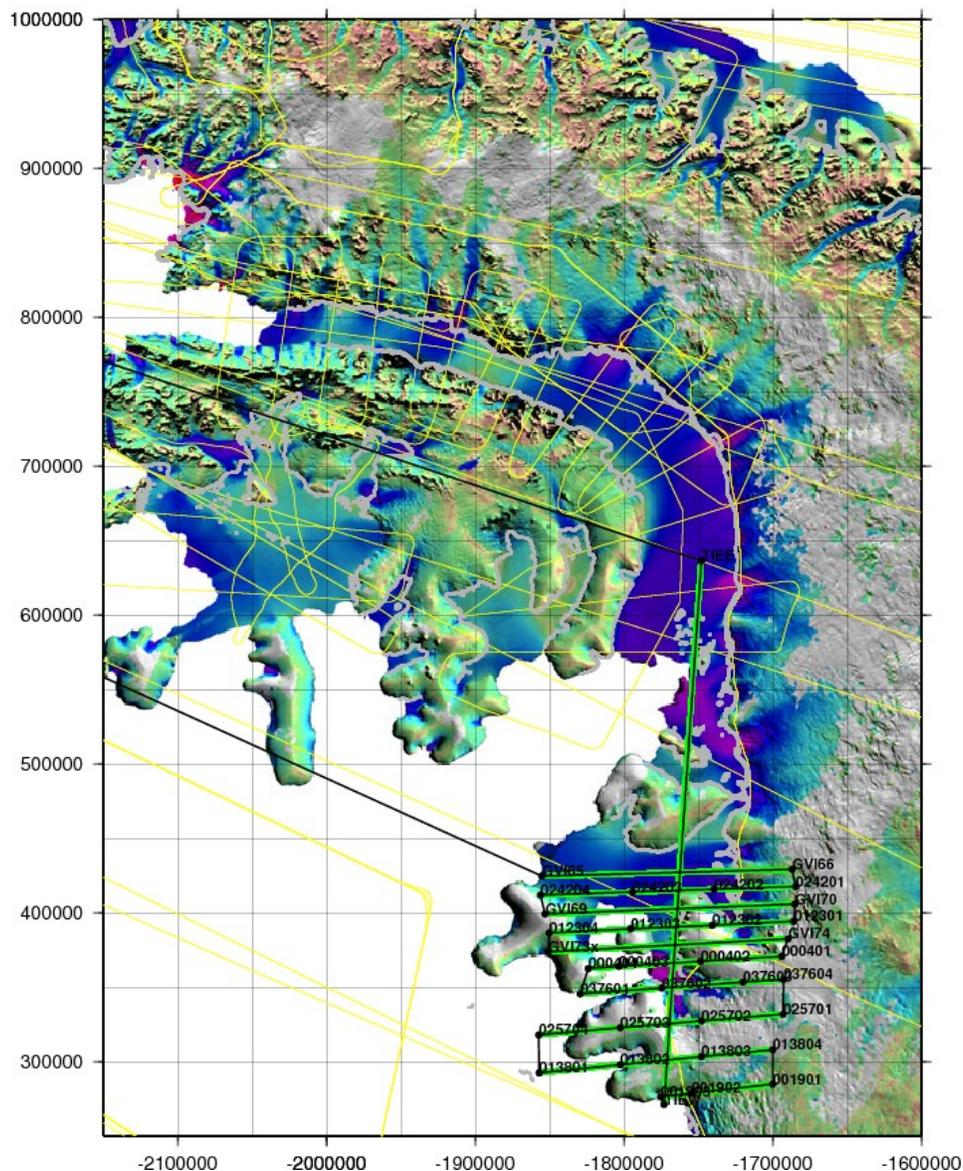
Flight Priority: Medium

Instrument Priority: not specified

ICESat Track: 0242,0123,0040,0376,0257,0138,0019

Remaining Design Issues: none

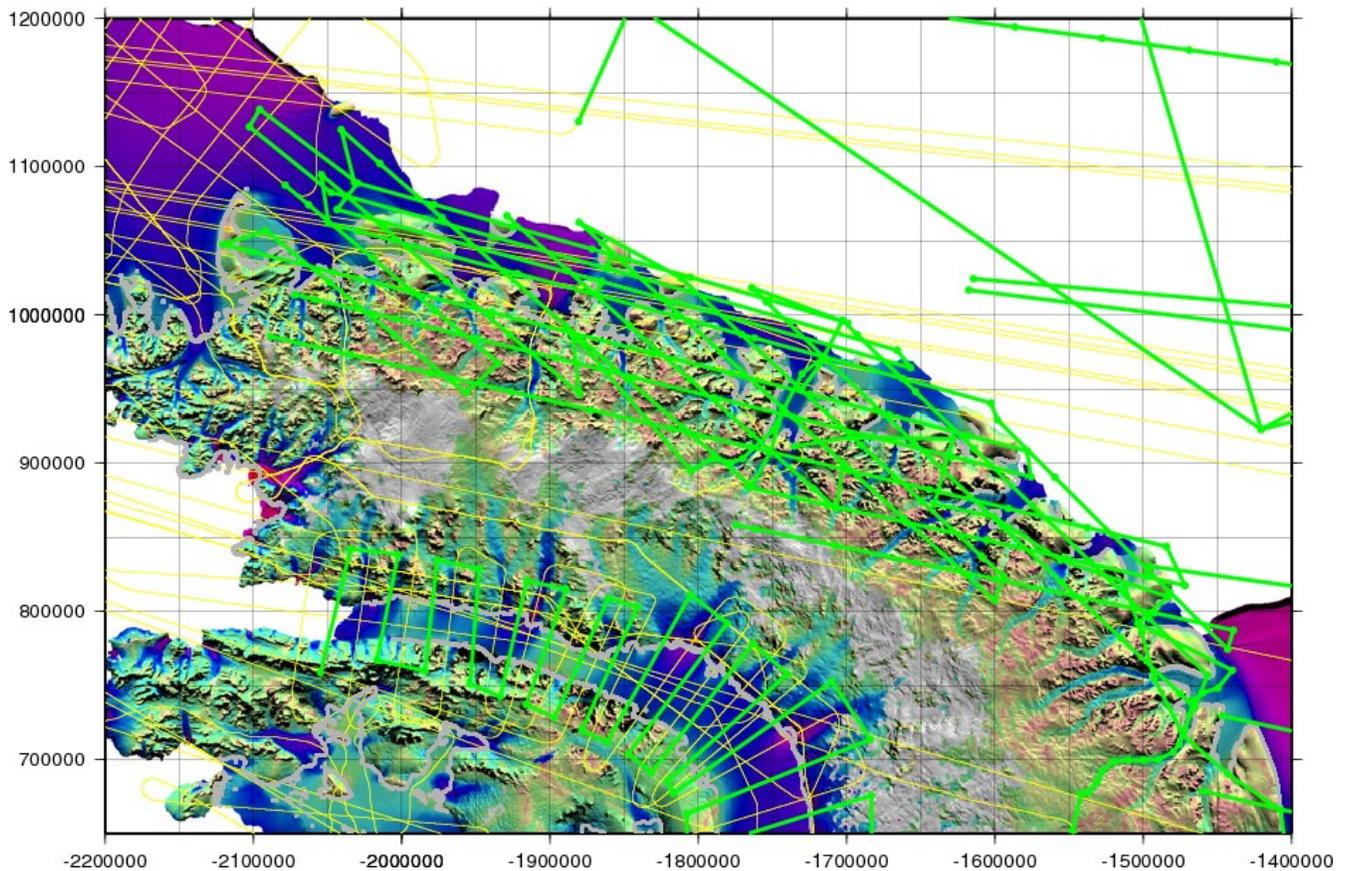
George VI 04
10.8 hrs total / 5.4 hrs survey
440 knots transit / 250 knots survey



Larsen-D Region

The map below depicts the three flights planned for the Larsen-D Ice Shelf area, which includes the area between the Larsen-C and Ronne ice shelves. These lines are mostly designed along ICESat ground tracks. We also include a few other lines, including a pair of long lines between ascending ICESat tracks along the main axis of the Larsen-D shelf which are intended to densify the gravity measurements in that area.

Larsen D Composite
3 Flights; Regional Priority Low



Land Ice – Larsen D North

This flight is a new design, intended to sample the basal topography of the grounded ice and bathymetry beneath ice shelf areas while also collecting altimetry measurements mainly along ICESat tracks. This particular mission concentrates on the northern part of this region. It includes a pair of shorter lines, parallel to descending ICESat tracks, in the southern part of the Larsen-C shelf. These are intended to fill a gap in existing coverage in that area.

Regional Priority: Low

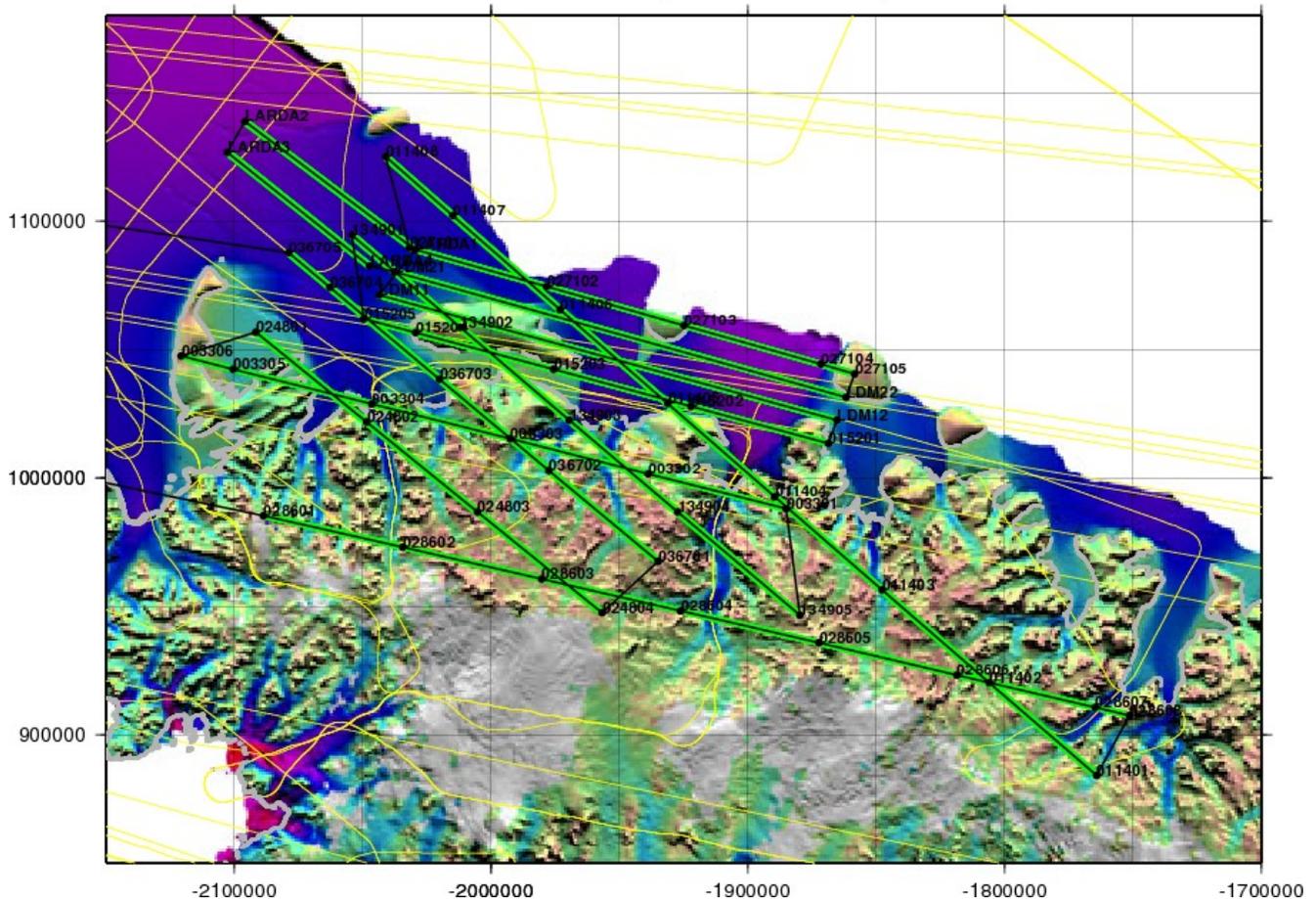
Flight Priority: Medium

Instrument Priority: not specified

ICESat Track: 0286,0114,0271,0152,1349,0033,0248,0367

Remaining Design Issues: none

Larsen D North
11.2 hrs total / 6.8 hrs survey
440 knots transit / 250 knots survey



Land Ice – Larsen D South

This flight is a new design, intended to sample the basal topography of the grounded ice and bathymetry beneath ice shelf areas while also collecting altimetry measurements mainly along ICESat tracks. This particular mission concentrates on the southern part of this region, which connects with the Ronne Ice Shelf at its southern extremity.

Regional Priority: Low

Flight Priority: High

Instrument Priority: not specified

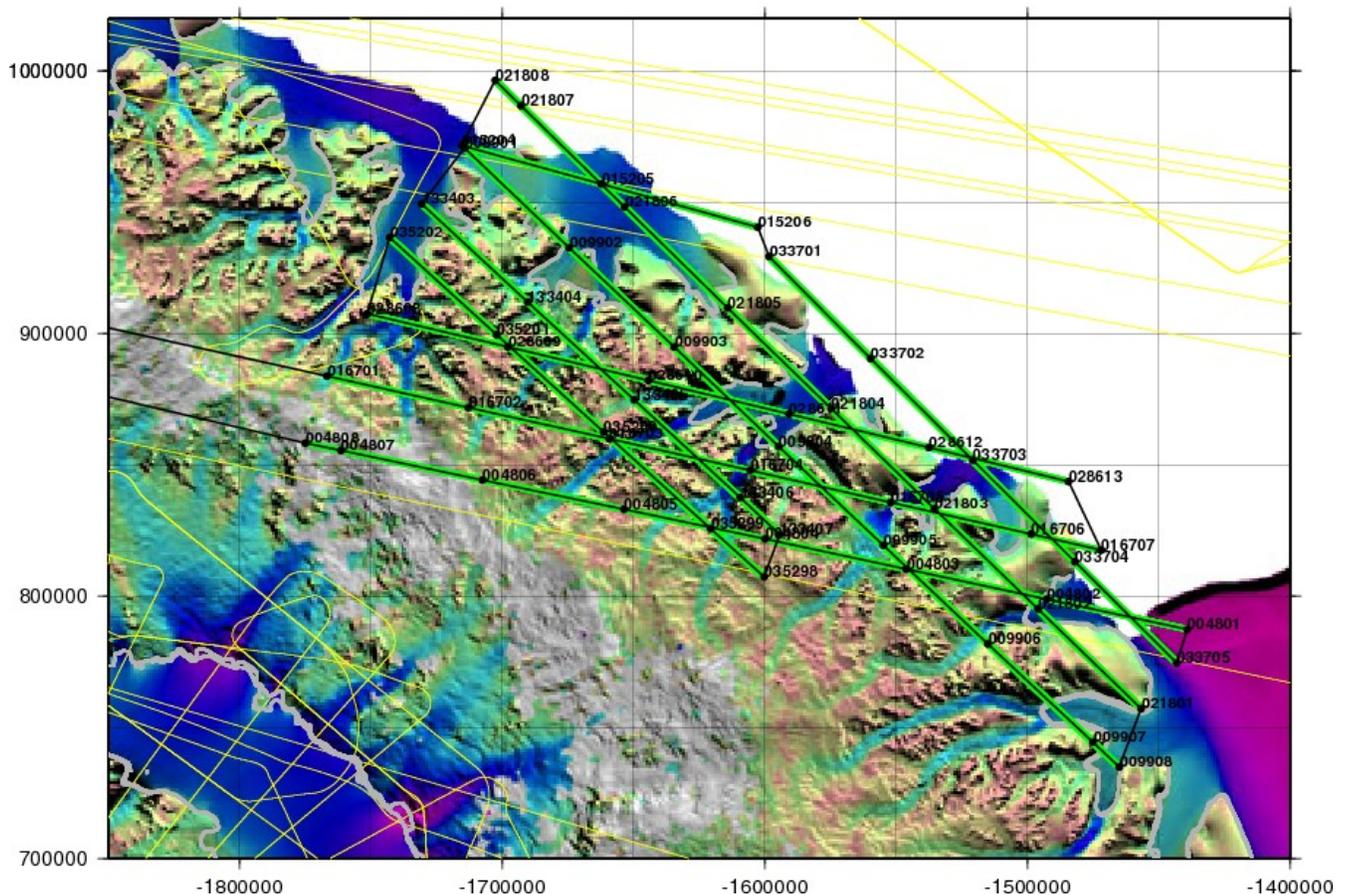
ICESat Track: 0167,0286,0352,1334,0099,0218,0152,0337,0048

Remaining Design Issues: none

Larsen D South

11.4 hrs total / 6.1 hrs survey

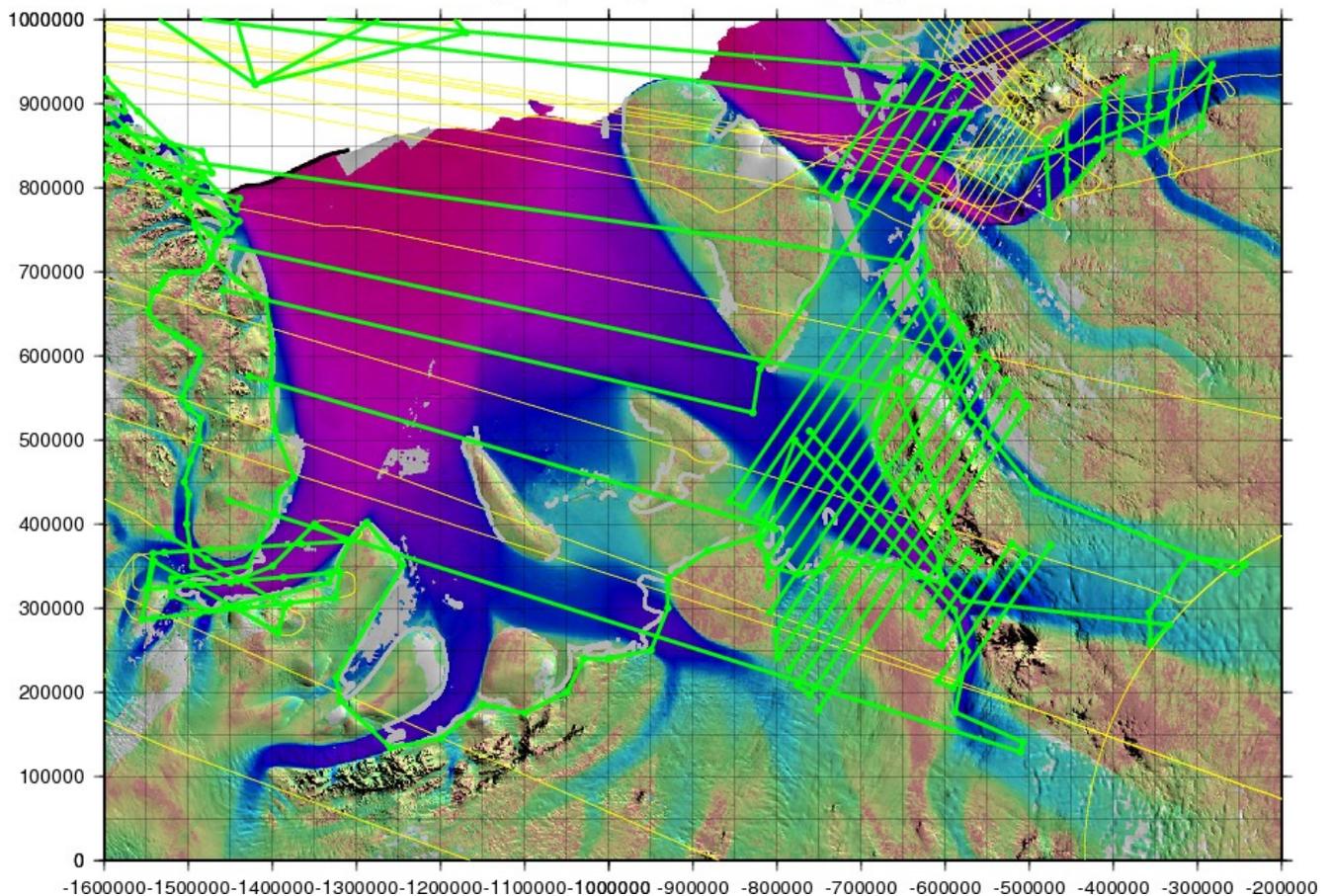
440 knots transit / 250 knots survey



Ronne-Filchner Region

The map below depicts the 11 flights planned for the far-flung Ronne-Filchner area. We include a flight centered on the Evans Ice Stream, flights covering most of the Ronne grounding line, flights over the grounded parts of the Foundation, Support Force and Recovery ice streams, and several more flights mostly centered over the upper portions of the Ronne and Filchner ice shelves. Finally we specifically target several high-altitude lines over the Ronne Ice Shelf. These have the purpose of distributing coarse high-altitude gravimetry measurements over an ice shelf whose bathymetry is almost totally unknown.

Ronne-Filchner Composite
11 Flights, Regional Priority High



Land Ice – Evans 1

This flight is a near-repeat of the 091115 IceBridge flight (called “Pen 4” at that time). It is intended to track changes in the Evans Glacier area, by comparison mainly along ICESat ground tracks. In addition, we add a portion of the grounding line along the southeastern side of the Peninsula, and a centerline flight up the Ketchum Glacier. The mission is slightly long but can readily be shortened by cutting the ends of pairs of the ICESat lines if necessary in real-time.

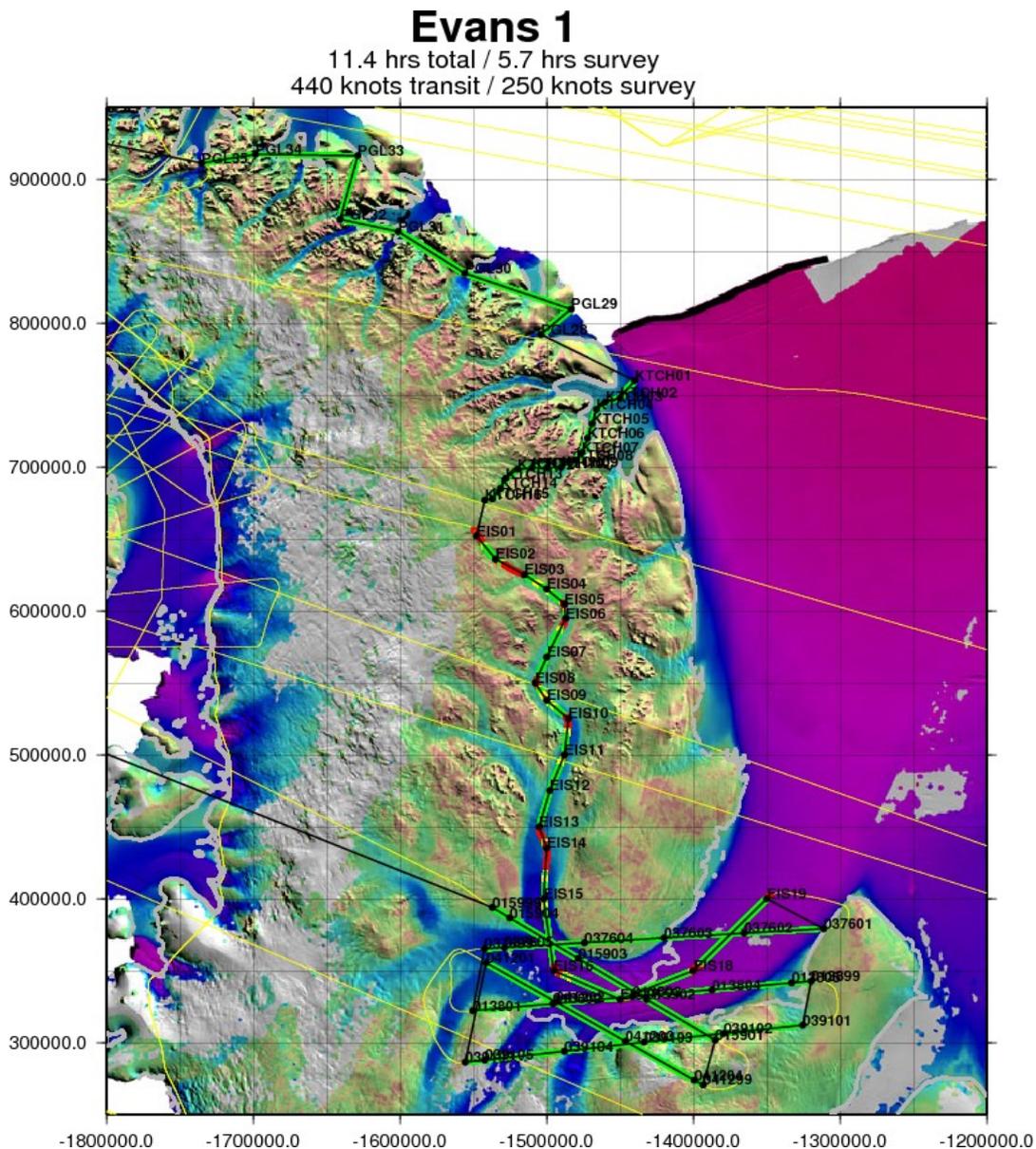
Regional Priority: High

Flight Priority: Low

Instrument Priority: not specified

ICESat Track: 0138,0159,0376,0391,0412

Remaining Design Issues: none



Land Ice – Ronne Grounding Line West

This flight is a new design. It extends the grounding line survey from the southeastern base of the Antarctic Peninsula much of the way around the Ronne Ice Shelf.

Regional Priority: High

Flight Priority: High

Instrument Priority: not specified

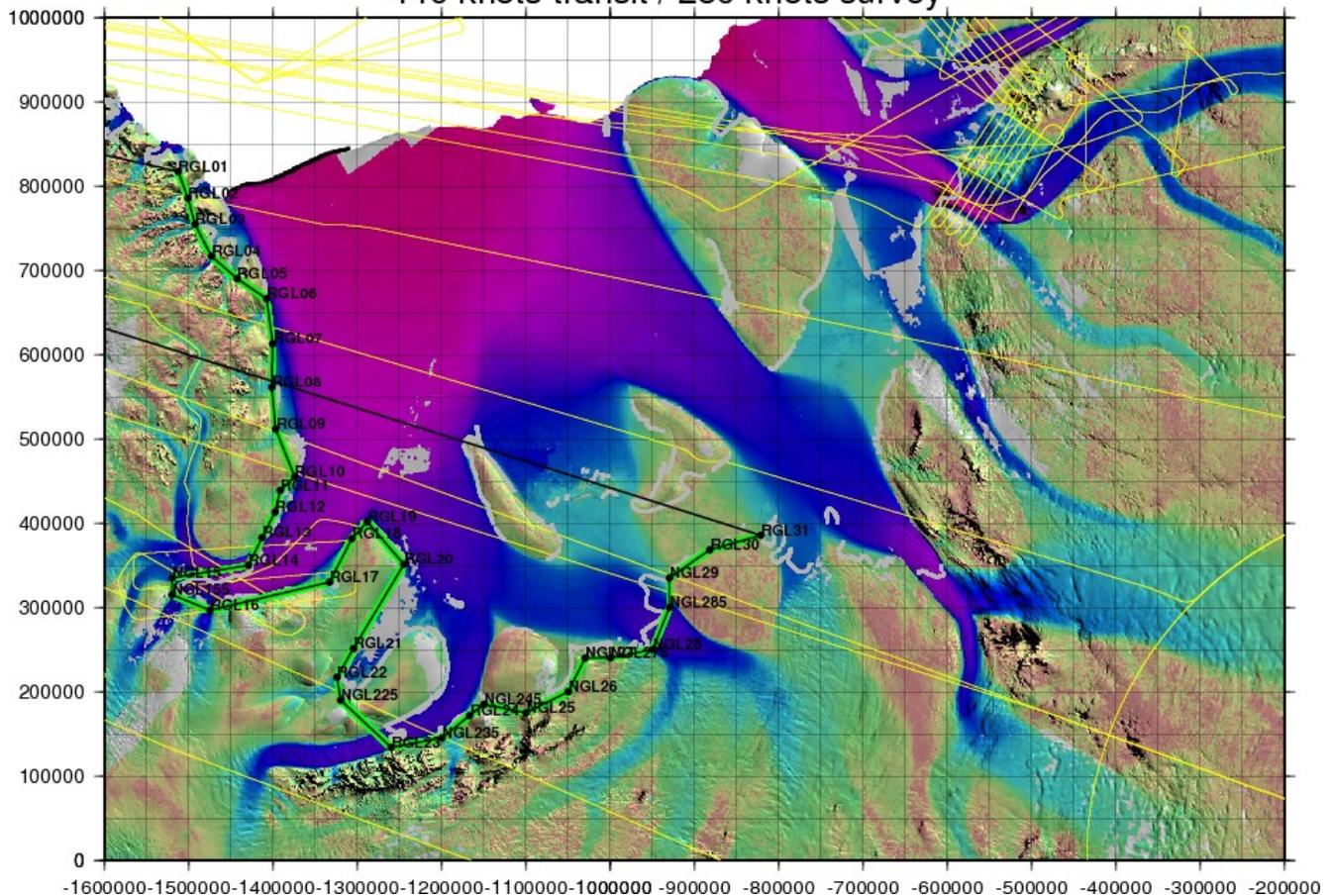
ICESat Track: none

Remaining Design Issues: none

Ronne Grounding Line West

10.9 hrs total / 4.0 hrs survey

440 knots transit / 250 knots survey



Land Ice – Ronne Grounding Line East

This flight is a new design. It extends the grounding line survey from the eastern end of the Ronne Ground Line West mission to past Berkner Island. It also incorporates a line down the trunk of the Foundation Ice Stream, which was originally proposed as a part of the Foundation Lakes mission. The end of this line on the Ronne Ice Shelf overflies a seismic survey site. We also collect high-altitude gravity data en-route to the area.

Regional Priority: High

Flight Priority: High

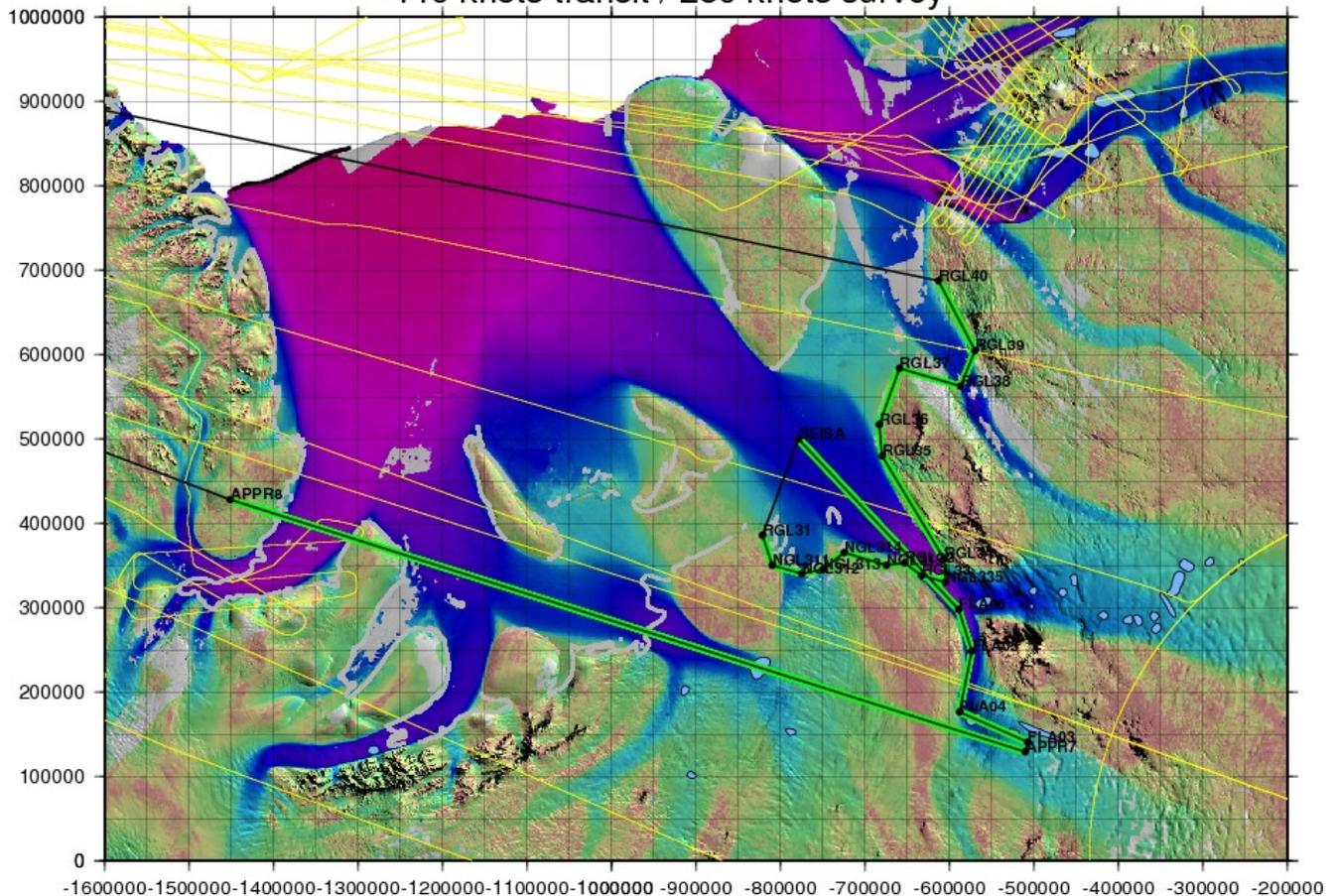
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Ronne Grounding Line East

11.7 hrs total / 4.5 hrs survey
440 knots transit / 250 knots survey



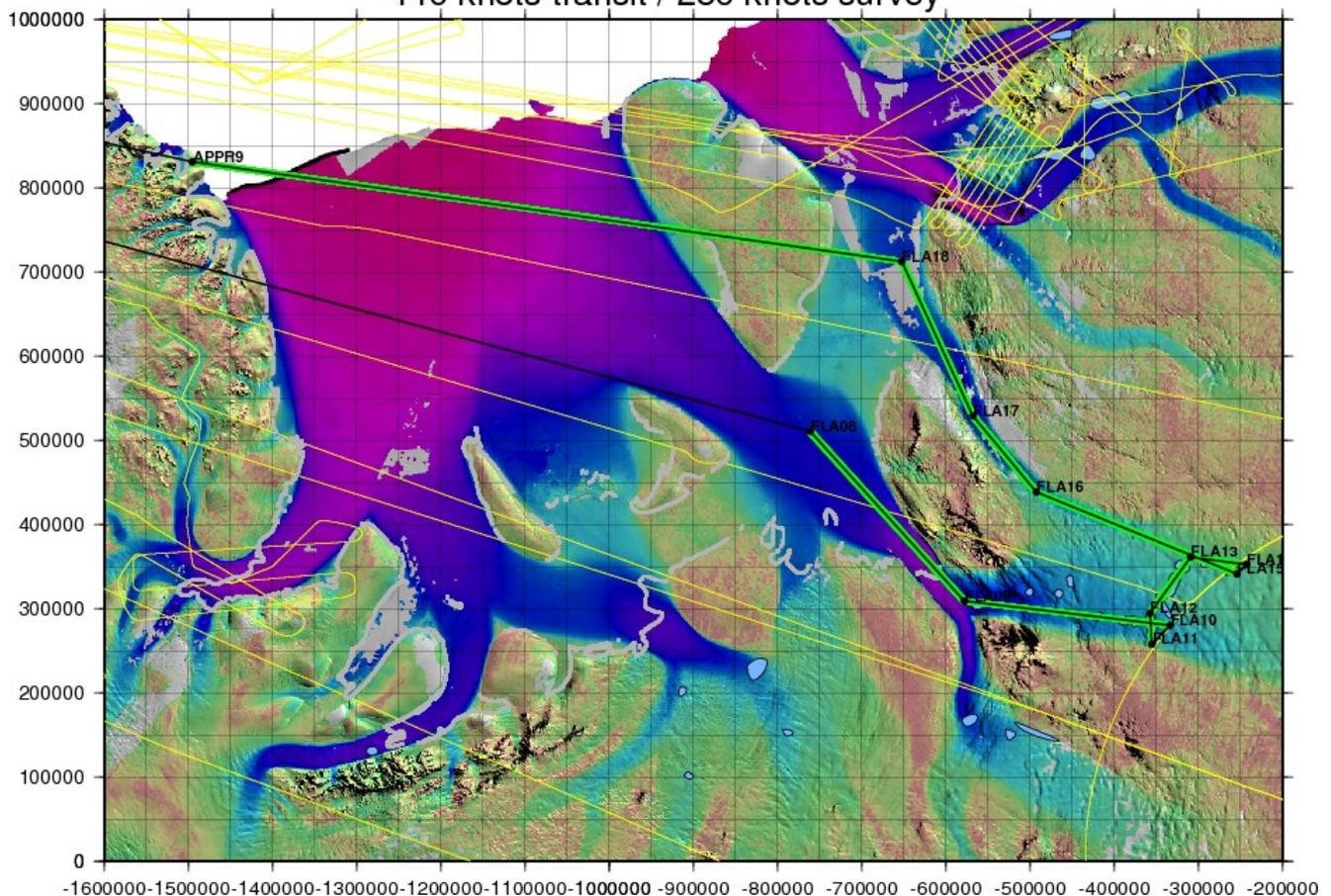
Land Ice – Foundation Lakes 01

This flight is a new design. It occupies straightened approximations of the Foundation and Support Force ice streams, and crosses several subglacial lakes in their upper portions. We also collect high-altitude gravity data en-route to the area.

Regional Priority: High
Flight Priority: High
Instrument Priority: not specified
ICESat Track: none
Remaining Design Issues: none

Foundation Lakes 01

11.1 hrs total / 4.2 hrs survey
440 knots transit / 250 knots survey



Land Ice – Foundation – Support Force 01

This flight is a new design, one of a suite of five flights designed to sample the bedrock, sub-ice shelf bathymetry and surface topography of the Foundation and Support Force ice streams on a 20 km grid. This particular flight targets the portions of the Foundation Ice Stream at and above the grounding line. We also collect high-altitude gravity data en-route to the area.

Regional Priority: High

Flight Priority: High

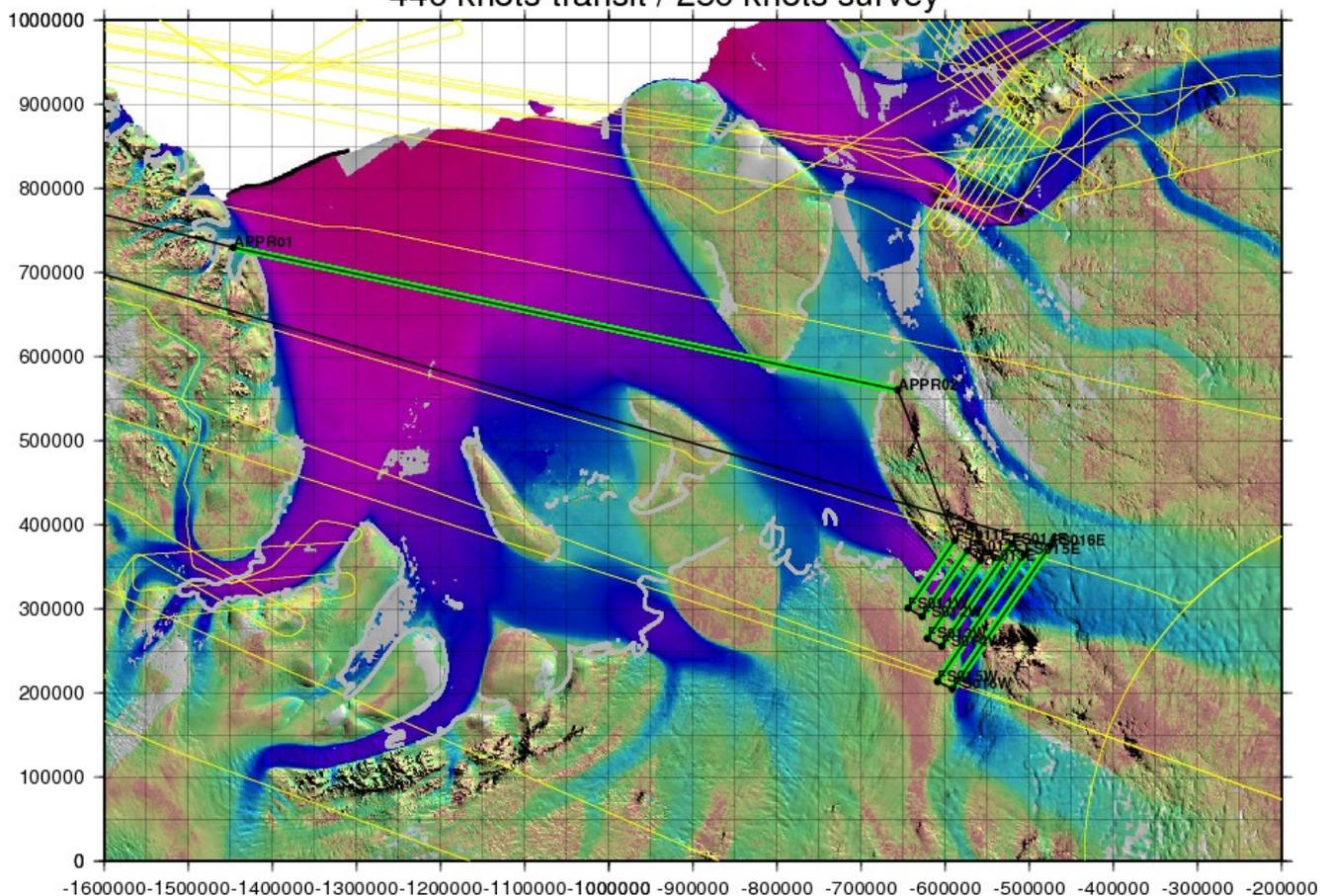
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Foundation-Support Force 01

11.2 hrs total / 3.8 hrs survey
440 knots transit / 250 knots survey



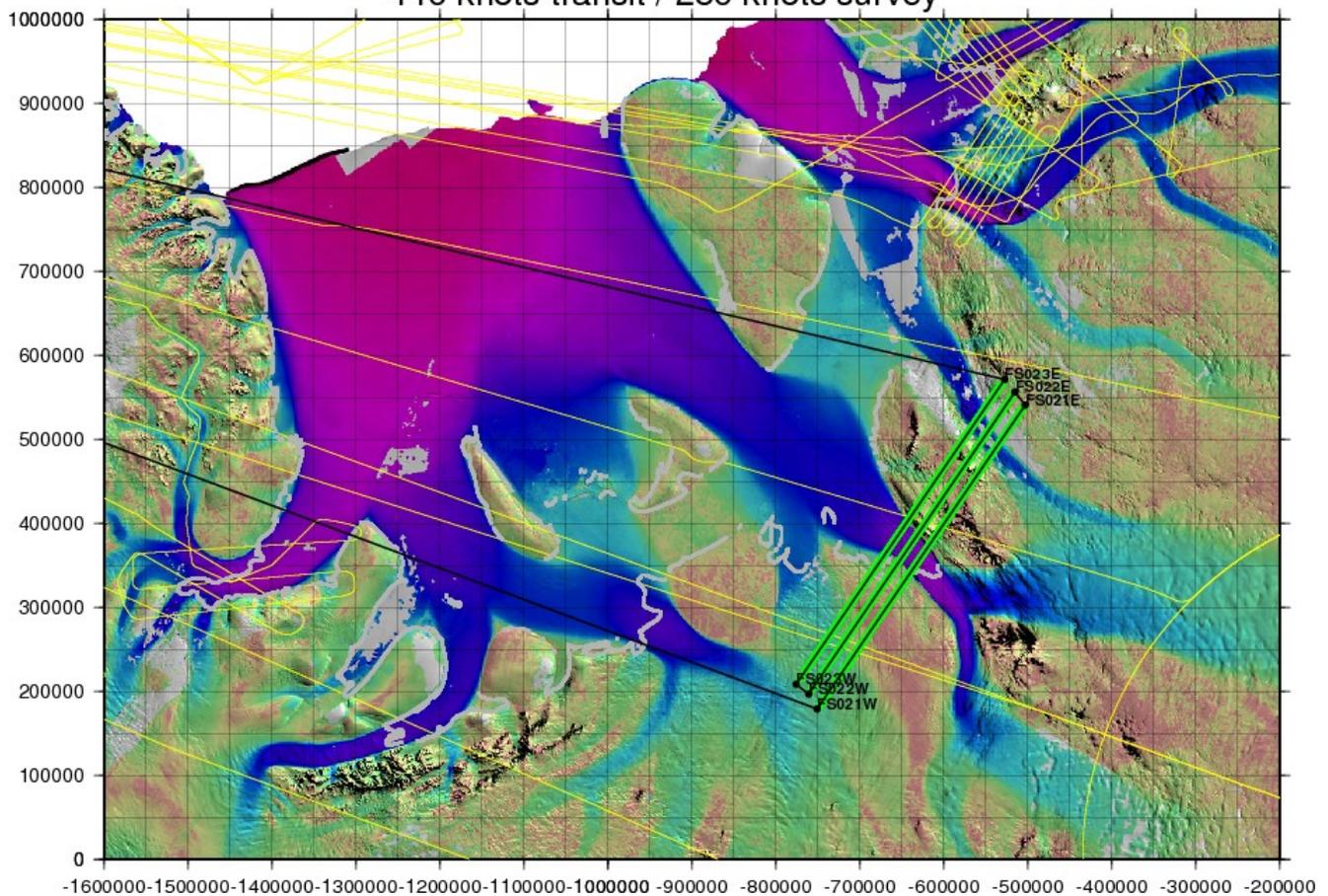
Land Ice – Foundation – Support Force 02

This flight is a new design, one of a suite of five flights designed to sample the bedrock, sub-ice shelf bathymetry and surface topography of the Foundation and Support Force ice streams on a 20 km grid. This particular flight targets the area at and just below the grounding lines of these ice streams.

Regional Priority: High
Flight Priority: Medium
Instrument Priority: not specified
ICESat Track: none
Remaining Design Issues: none

Foundation-Support Force 02

11.5 hrs total / 3.2 hrs survey
440 knots transit / 250 knots survey



Land Ice – Foundation – Support Force 03

This flight is a new design, one of a suite of five flights designed to sample the bedrock, sub-ice shelf bathymetry and surface topography of the Foundation and Support Force ice streams on a 20 km grid. This particular flight continues the sampling toward the Ronne and Filchner ice shelves, downstream of the grounding lines.

Regional Priority: High

Flight Priority: Low

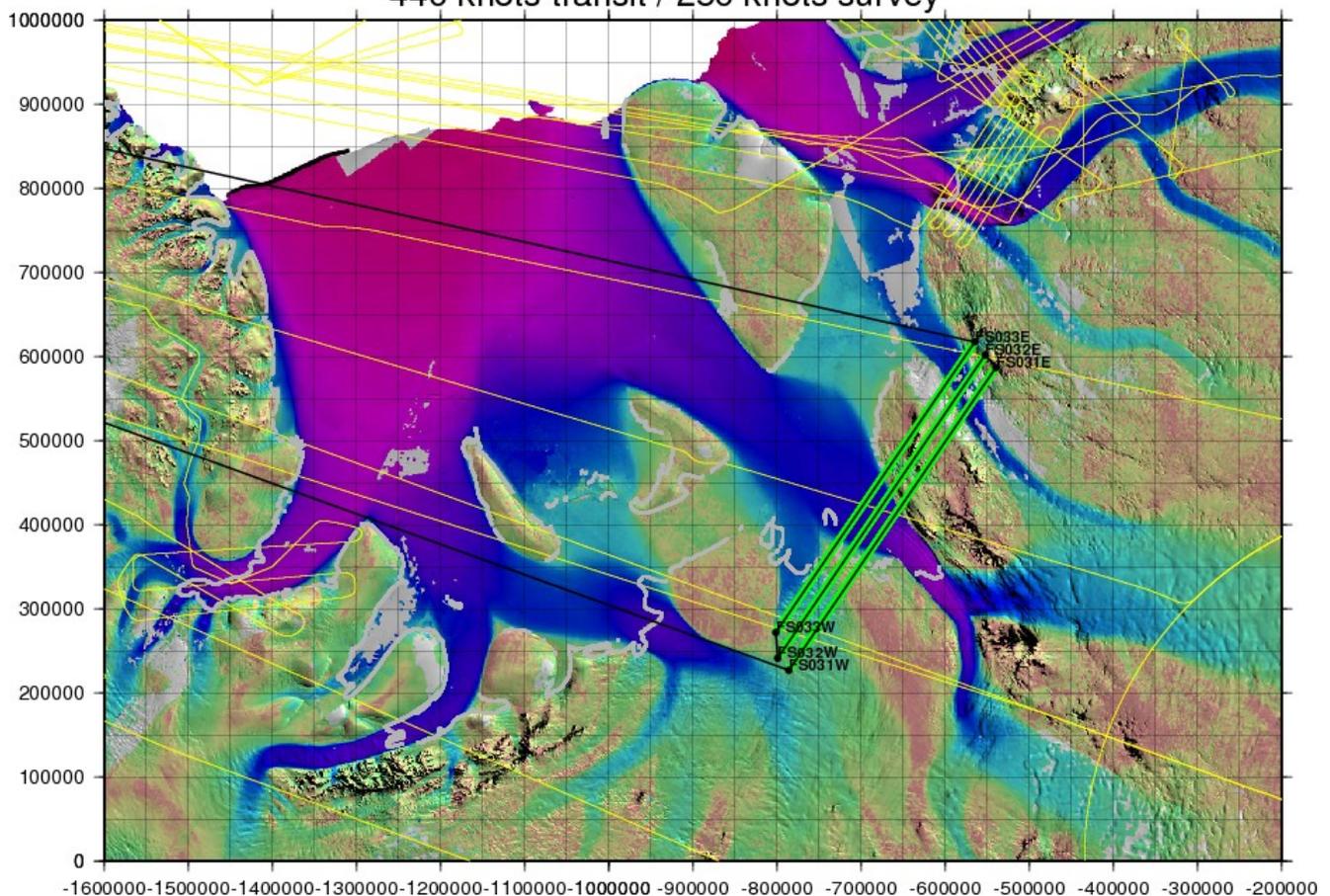
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Foundation-Support Force 03

11.3 hrs total / 3.2 hrs survey
440 knots transit / 250 knots survey



Land Ice – Foundation – Support Force 04

This flight is a new design, one of a suite of five flights designed to sample the bedrock, sub-ice shelf bathymetry and surface topography of the Foundation and Support Force ice streams on a 20 km grid. This particular flight continues the sampling toward the Ronne and Filchner ice shelves, downstream of the grounding lines.

Regional Priority: High

Flight Priority: Medium

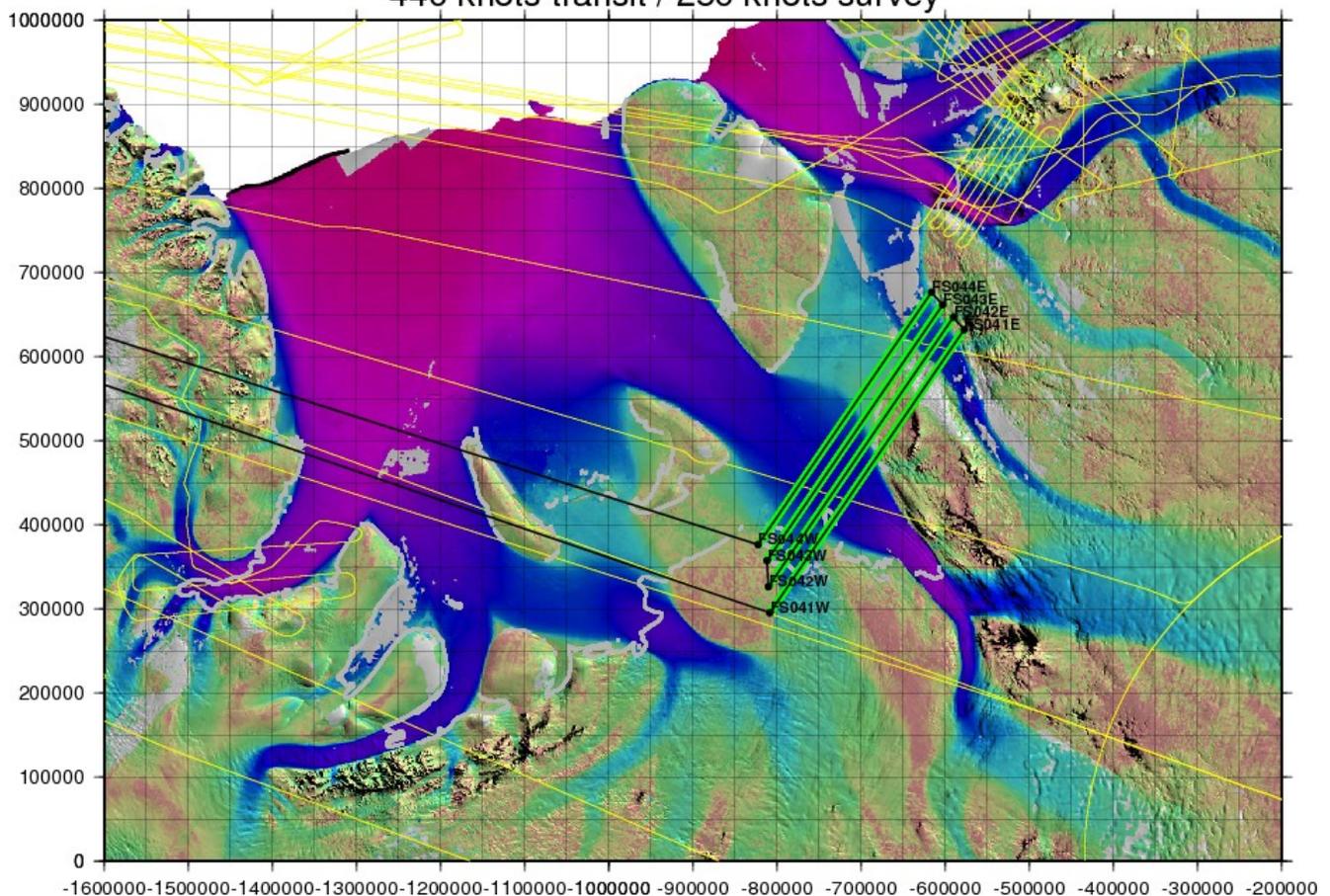
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Foundation-Support Force 04

11.7 hrs total / 3.8 hrs survey
440 knots transit / 250 knots survey



Land Ice – Foundation – Support Force 05

This flight is a new design, one of a suite of five flights designed to sample the bedrock, sub-ice shelf bathymetry and surface topography of the Foundation and Support Force ice streams on a 20 km grid. This particular flight is the most downstream of the five missions, and its outboard-most line is displaced to Berkner Island coast specifically to sample a small embayment in the grounding line there. Finally we collect high-altitude gravity data over the Ronne Ice Shelf en-route to the area.

Regional Priority: High

Flight Priority: High

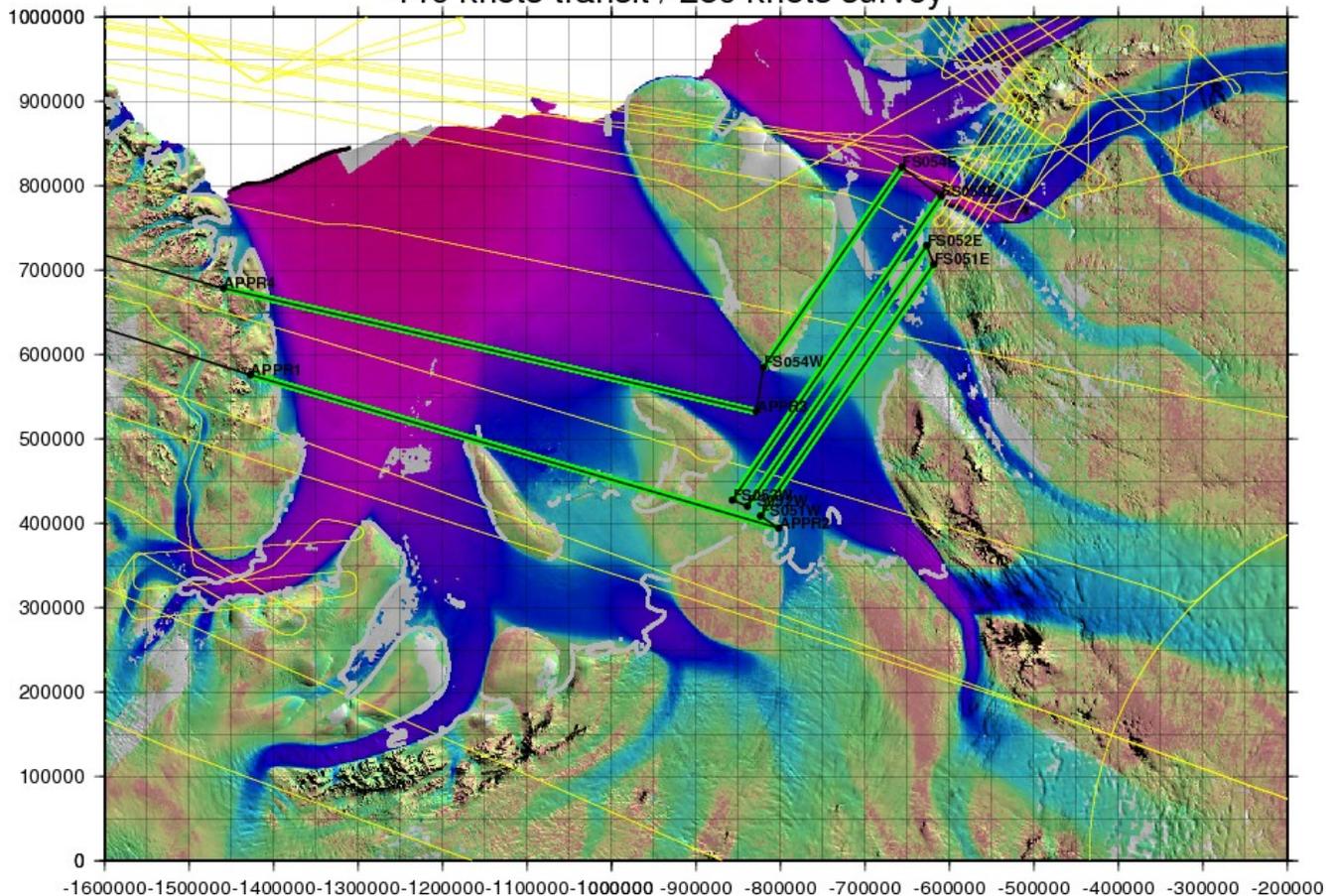
Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none

Foundation-Support Force 05

11.7 hrs total / 5.5 hrs survey
440 knots transit / 250 knots survey



Land Ice – Recovery Offshore 01

This flight is a new design, and its purpose is to map the bathymetry of the upper part of the Filchner Ice Shelf, just offshore of the Recovery and Slessor grounding lines, on a 20 km grid. We also collect high-altitude gravity data of the southern Weddell Sea during our approach to the Recovery-Slessor area.

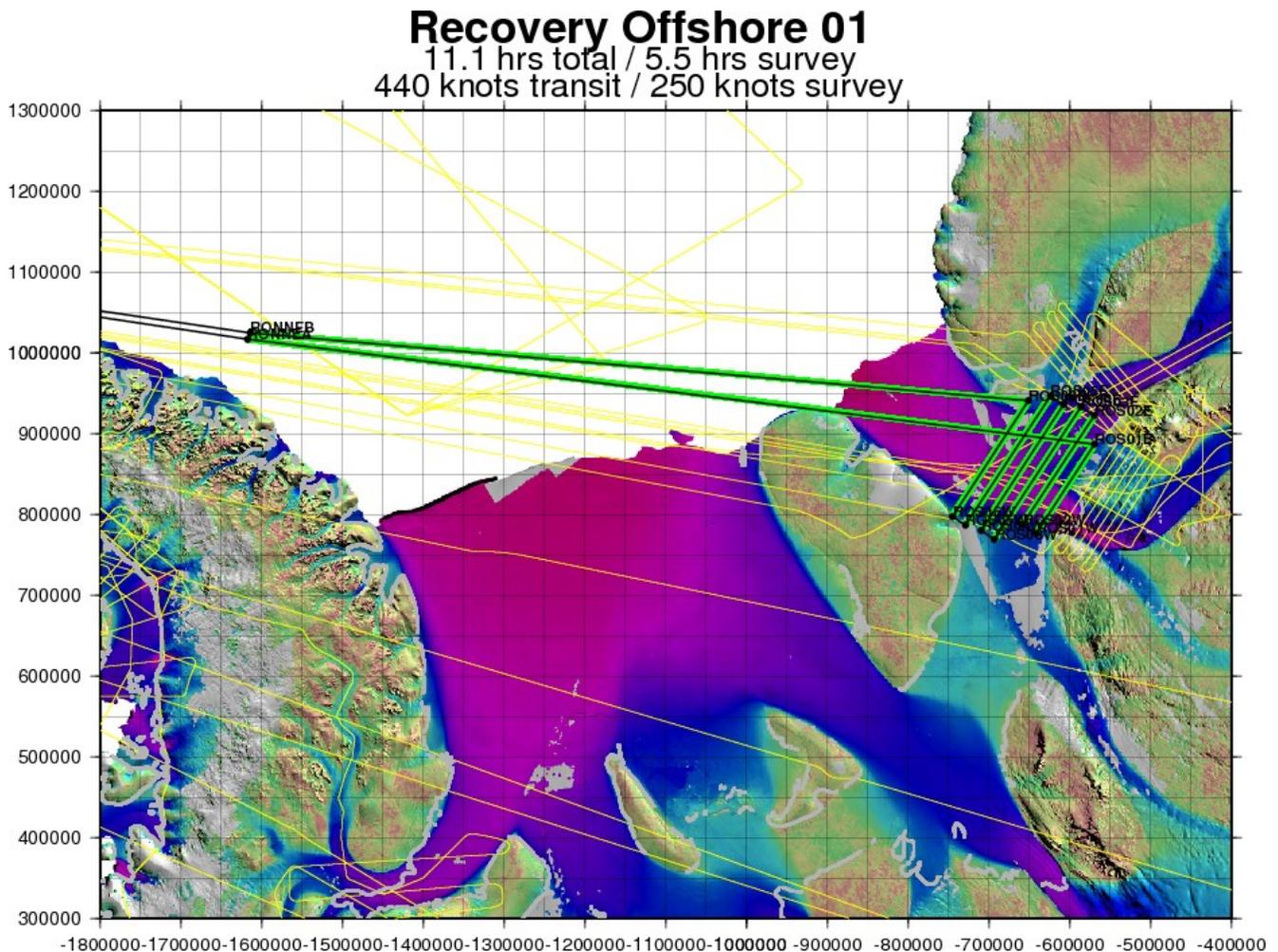
Regional Priority: High

Flight Priority: High

Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: none



Land Ice – Recovery Channel 01

This flight is a new design, and its purpose is to supplement the surveys conducted on the lower Recovery Glacier channel by OIB in 2011. We increase the density of the 2011 surveys by repeatedly crossing the channel along descending ICESat ground tracks. We also fly a crossing of the tributary channel entering the main Recovery channel from the west.

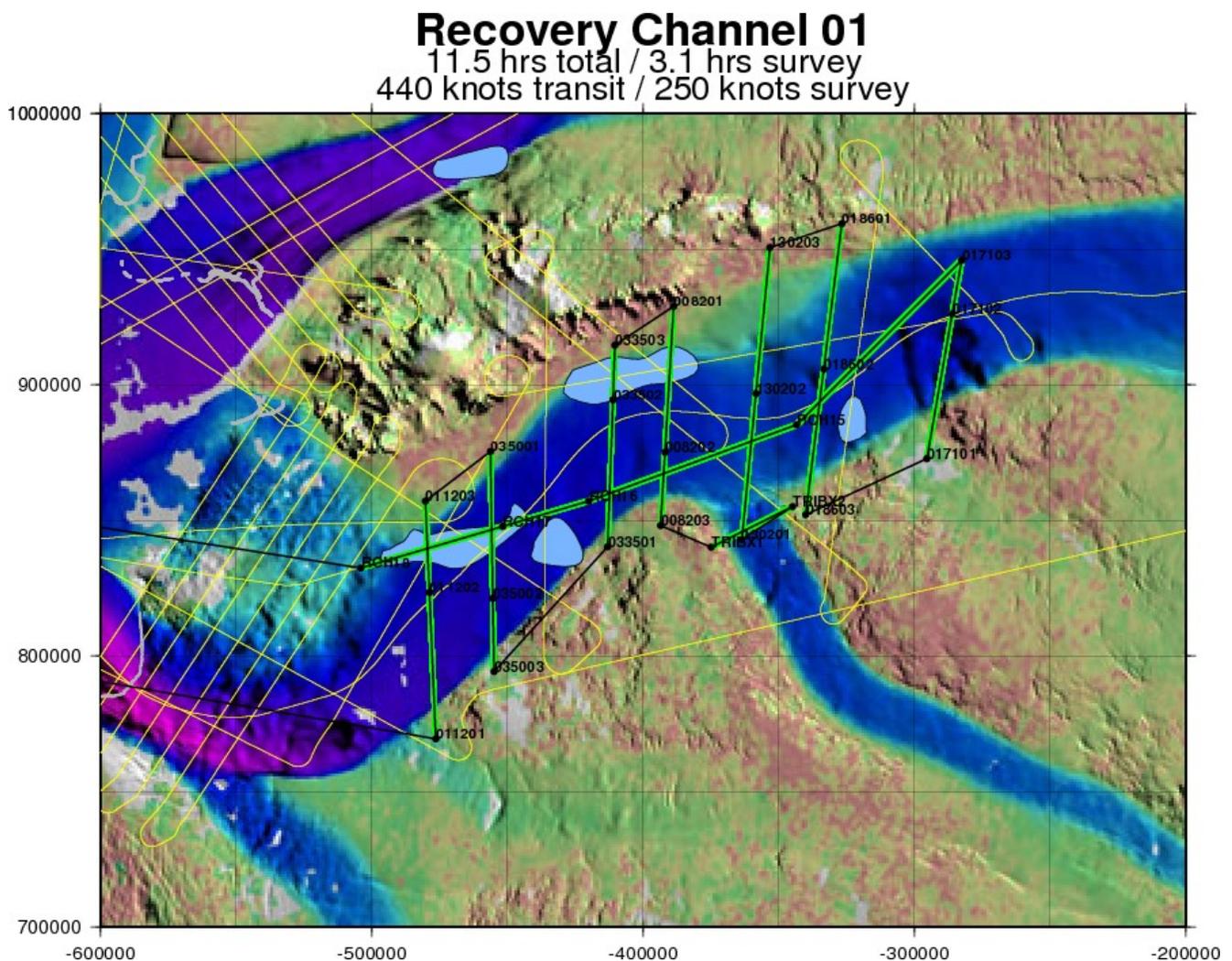
Regional Priority: High

Flight Priority: High

Instrument Priority: not specified

ICESat Track: 0112,0350,0335,0082,1302,0181,0171

Remaining Design Issues: none



Land Ice – Pole Hole 88

This flight is a new design, and its purpose is to sample the surface topography at the southern apex of each planned IceSat-II orbit. In this way, we can provide “ground truth” for every IceSat-II orbit with a single flight. The vertical stability of the surface must also be quantified for this approach to succeed, and this flight provides a baseline measurement for this purpose.

Regional Priority: Low

Flight Priority: Low

Instrument Priority: not specified

ICESat Track: none

Remaining Design Issues: optimize waypoint spacing to best approximate rhumb-line navigation

