

ICEBridge Arctic 2013 September LVIS Flight Lines

Updated: August 5th 2013

Summary

# Flights	Base Airport	Flight Description	Priority
1	Thule	North-West Grid -Thule	Highest
2	Kangerlussuaq	North-West Grid - Kanger	Low
3	Transit Kanger to Thule	North-West Grid as a Transit to Thule	N/A
4	Thule	North-West Coastal - Thule	Medium
5	Thule	North Central Gap - Thule	High
6	Kangerlussuaq	North Central Gap - Kanger	High
7	Thule	Central-West Coastal	Medium
8	Thule or Kangerlussuaq	Atmospheric Calibration	Lowest
9	Thule	Cryosat	Highest
10	Kangerlussuaq	Cryosat - Kanger	
11	Kangerlussuaq	Cryosat South Greenland	
12	Kangerlussuaq	Jakobshavn: ICESat Grid	High
13	Kangerlussuaq	Jakobshavn: P-3 Grid	Medium
14	Kangerlussuaq	Jakobshavn: Total Mapping	Low
15	Kangerlussuaq	South West Grid	High
17	Kangerlussuaq	Helheim	High
18	Kangerlussuaq	South East 1	Low
19	Kangerlussuaq	South East 2	Low
20	Kangerlussuaq	Kangerdlugssuaq	Medium
21	Kangerlussuaq	South-SouthEast Grid	Low
22	Kangerlussuaq	Penny	Low

Document contributors: Michelle Hofton, Matt Beckley, Ben Smith, Ken Jezek, OIB Science Team

Overall mission design: based on OIB white paper on seasonal mapping strategy.

Mapped lines include:

- coast parallel lines
- Summit pass (**Update: July 30th** – line no longer in plan)
- September 2007 data repeats
- Spring 2013 data repeats
- Summer 2013 Mabel repeats (**Update: July 30th** – lines no longer in plan)

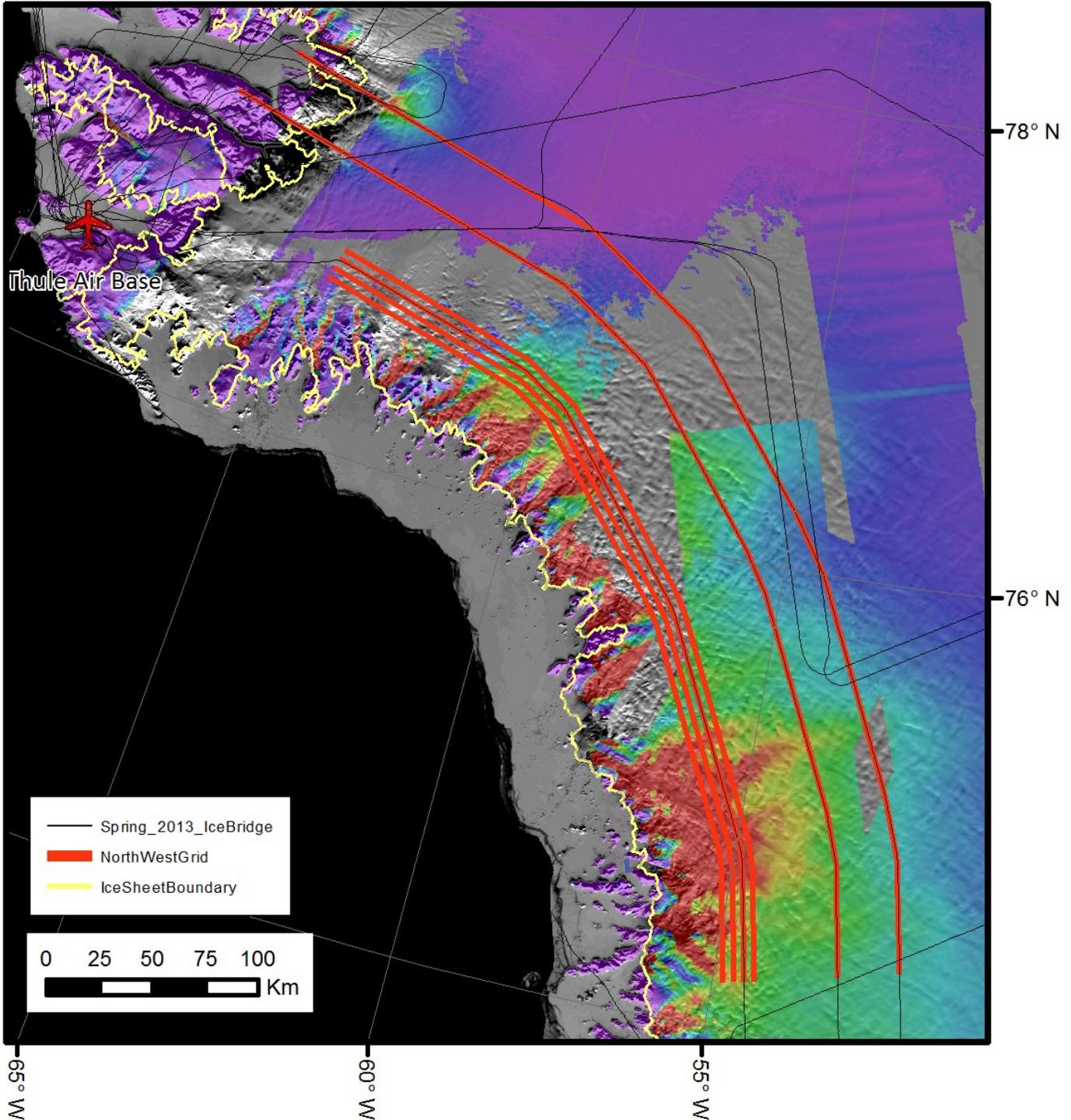
Overarching strategy for mission success:

- 1 line in NW
- 1 line in SE
- 1 line in SE
- Cryosat underflight
- Line across the divide
- Jakobshavn grid

North-West Grid - Thule			Priority: Highest	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
30 minutes	250 knots	468 minutes	none	P3 2013, LVIS 2012, ATM 2010, LVIS 2010

This plan repeats portions of tracks from P-3 in the Spring of 2013 and has been revised to remove the MABEL repeat lines. Other repeats are listed in table above. This flight assumes 30 minutes for the C-130 to ascend and descend to appropriate altitude.

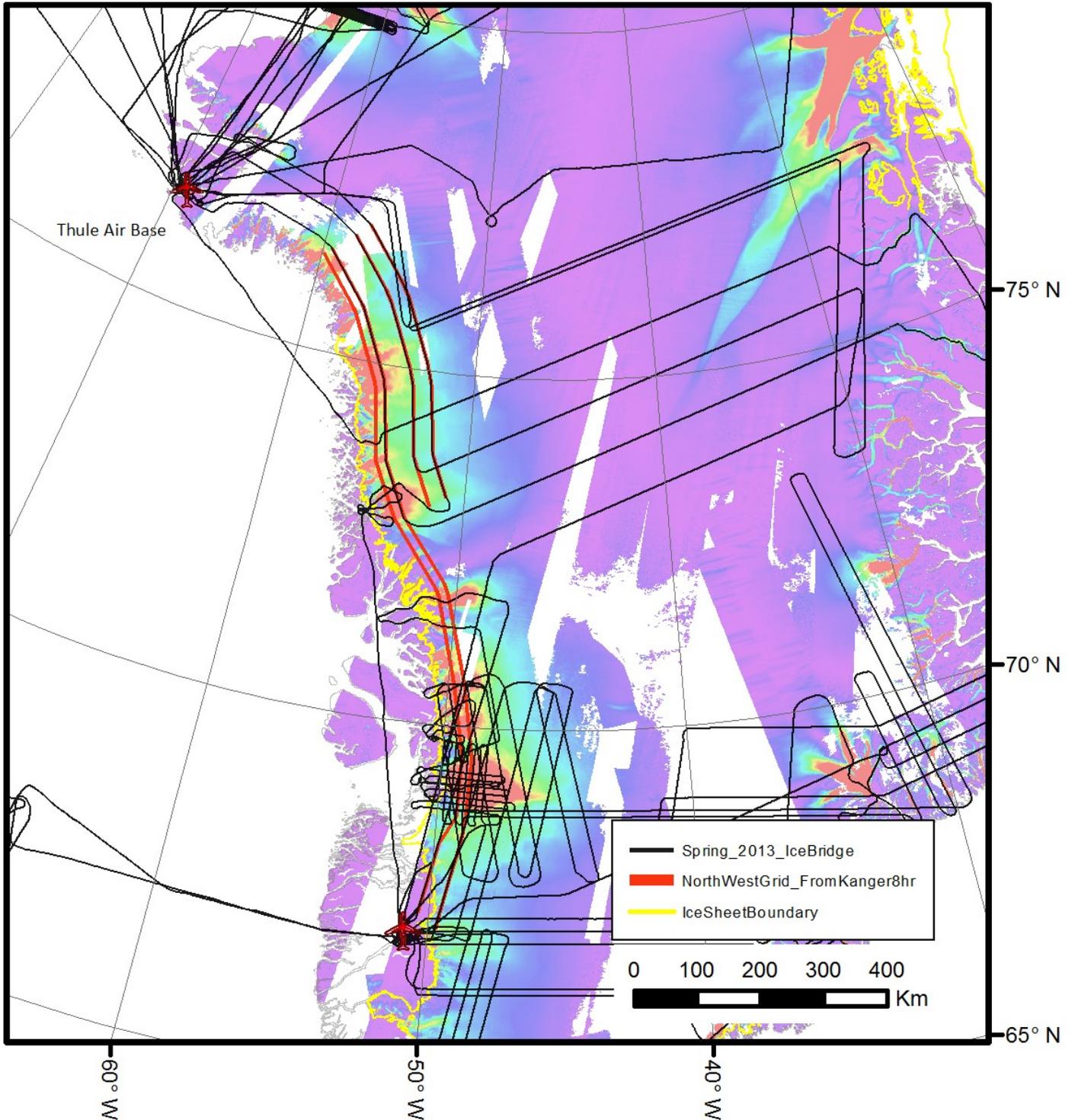
Notes: Priority for all NW grid line flights – repeat lowest Spring 2013 line first.



North-West Grid - Kanger				Priority: Low
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
30 minutes	250 knots	435 minutes	85,204	P3 2013

This is a version of the "North West Grid Thule" plan, but based out of Kanger.

Notes: Priority for all NW grid line flights – repeat lowest Spring 2013 line first

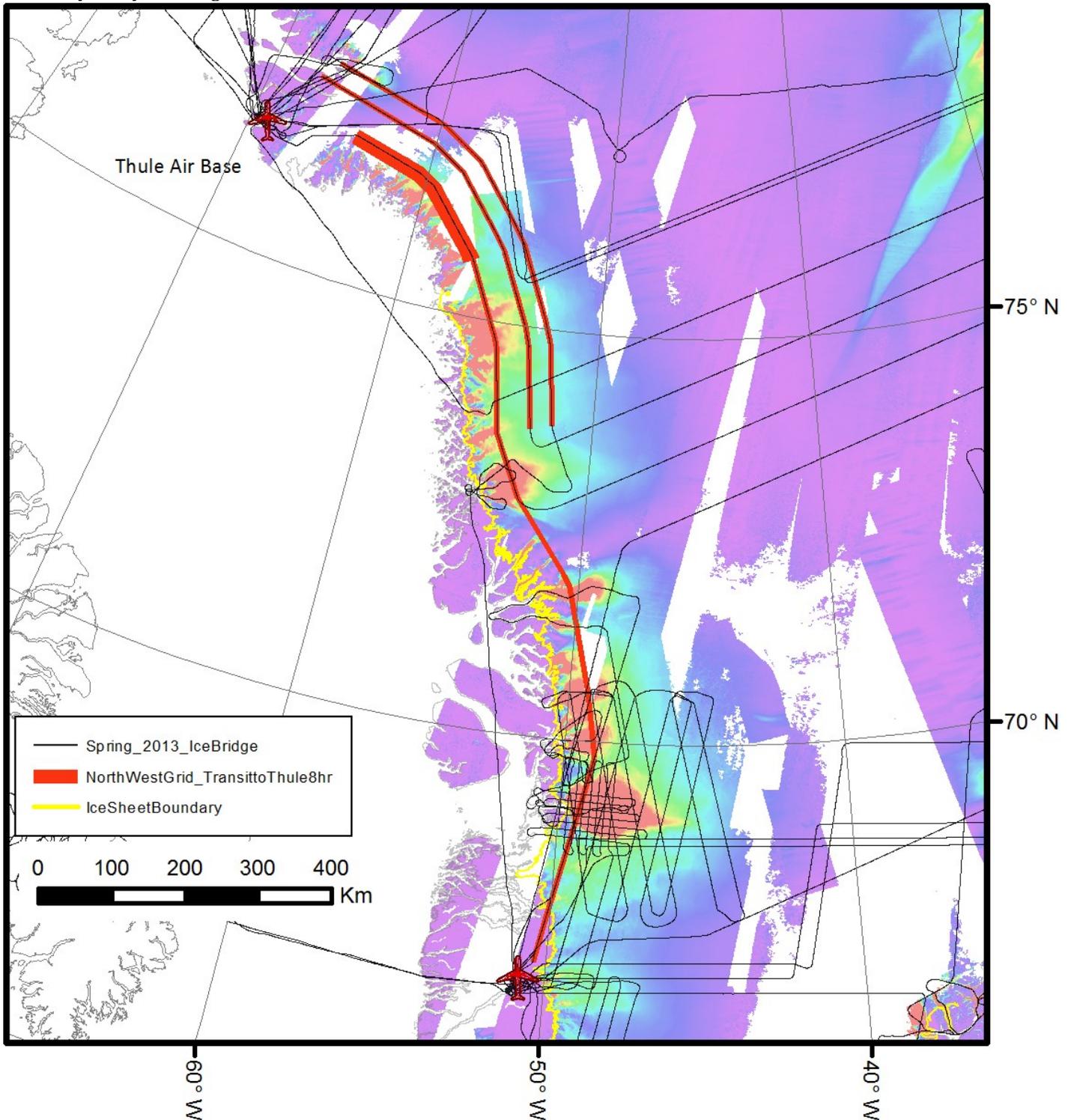


North-West Grid: Transit 8 hr			Priority: -	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
30 minutes	250 knots	461 minutes	85	P3 2013, LVIS 2012, ATM 2010, LVIS 2010

This is a version of the "North West Grid Thule" plan that transits from Kanger to Thule with an 8 hour maximum duration.

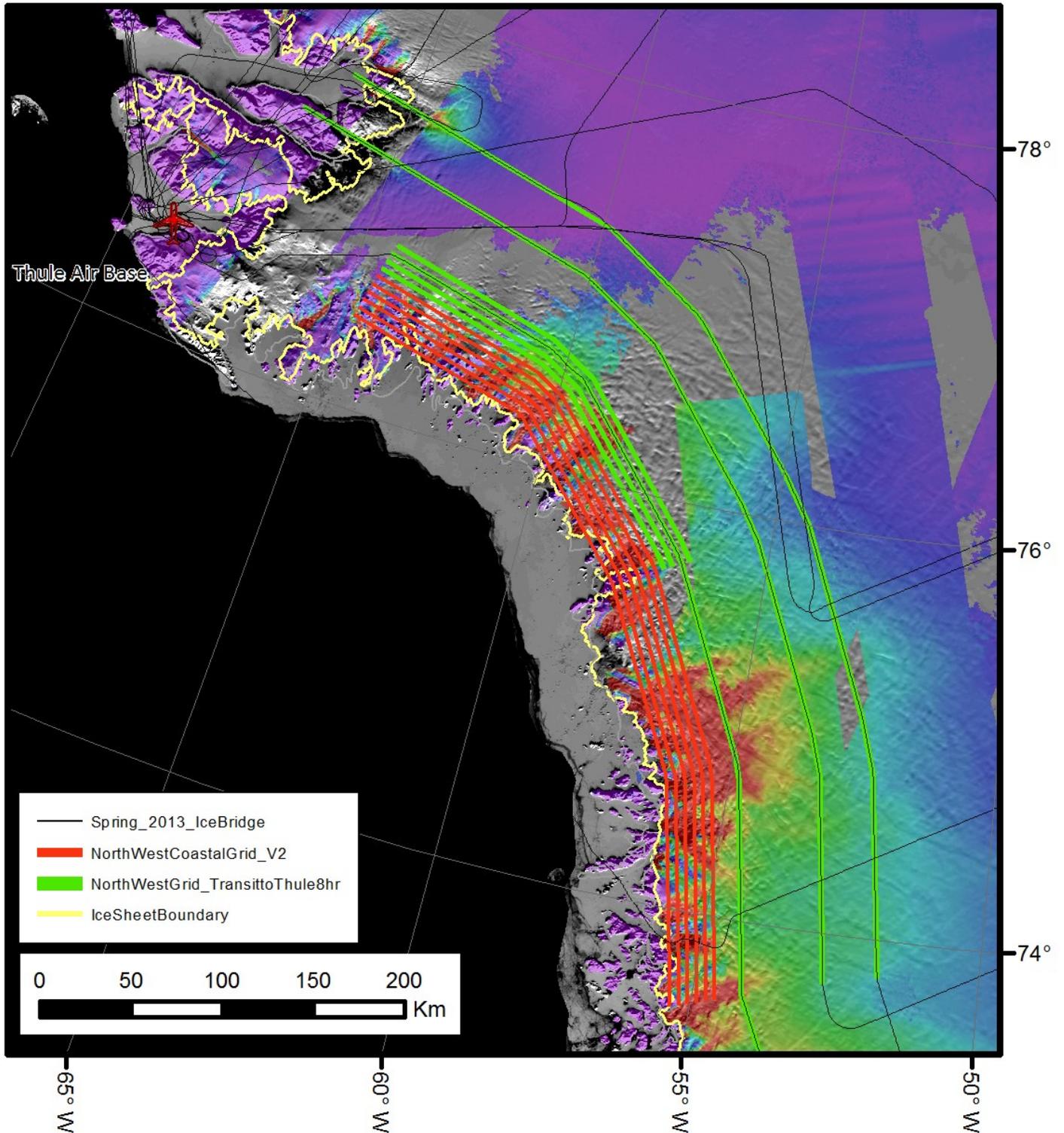
Follows ICESat lines over Jak, then picks up existing OIB grid lines to transit to NW to repeat 2013 P3 NW grid lines.

Notes: Priority for all NW grid line flights – repeat lowest Spring 2013 line first. Alternatives for clouds: grid lines over Jak, icesat lines over Jak before transit to Thule; interior icesat lines. ICESat tracks are a good option if the coast is cloudy. The ones that haven't been flown are at pretty high elevation, so if it comes to that, you might end up refllying a track or two that was covered early in OIB. As you say, data is good data.



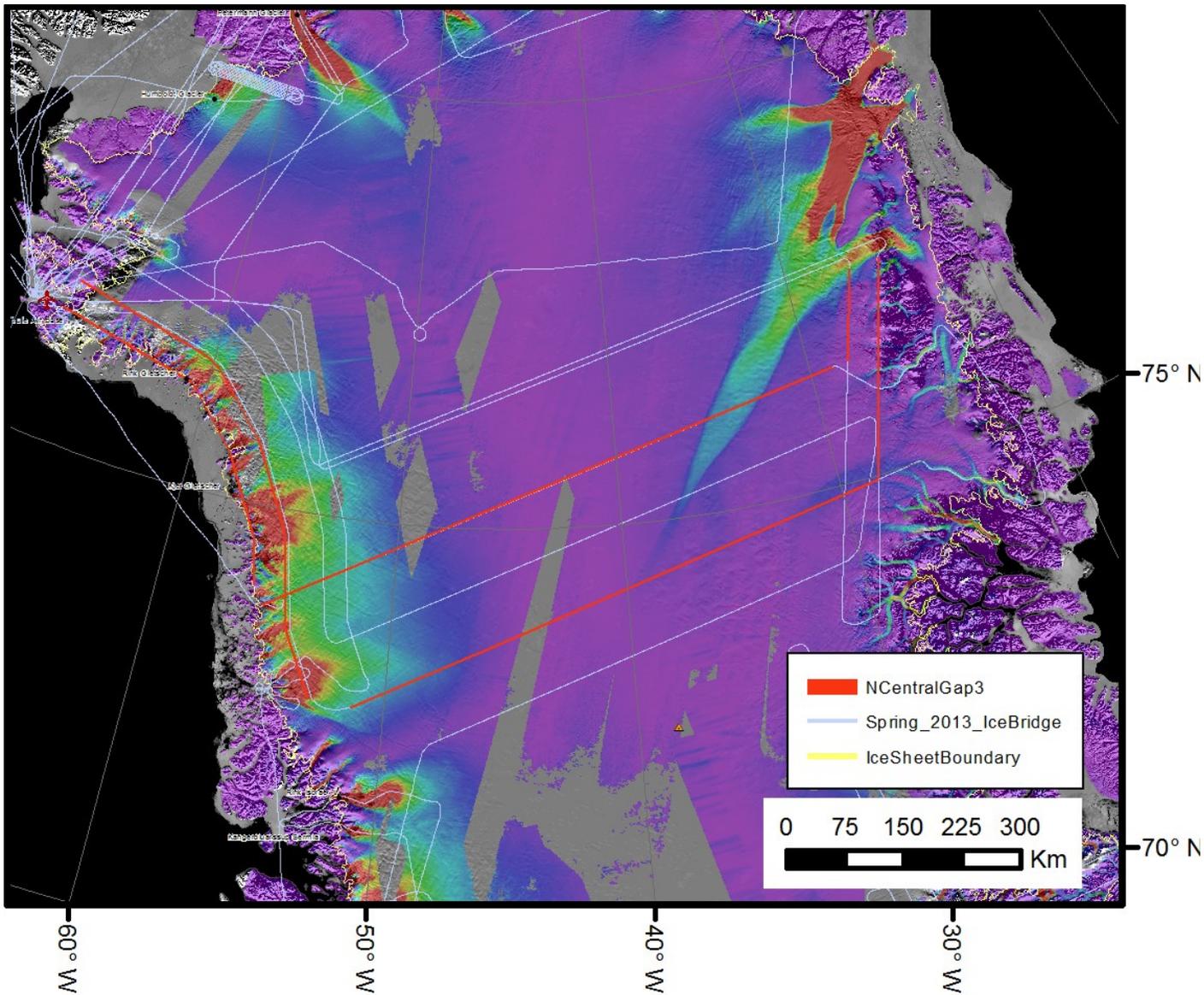
North-West Coastal -Thule			Priority: Medium	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 30 minutes	250 knots	467 minutes	none	Portions of: LVIS & ATM 2010.

This plan fills in the North-West region near Thule, using 2010, 2011, 2012 grid lines closest to coast. Higher priority Northwest Grid plan is in green. This Coastal plan is in red.



North Central Gap - Thule			Priority: High	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 37 minutes	250 knots	487 minutes	10, 248	Portions of: ATM 2013, LVIS & ATM 2010

This plan is a close copy of the P-3 "North Central Gap 03" plan from 4/23/13, with some adjustments: For the outbound transit, we've included a different NW grid line to the P-3 plan since that line is now included in "NW coastal grid". In the East, this plan follows portions of two ICESat tracks. Plan is slightly too long assuming 250knots for C130. Will shorten if need to by shortening lengths of icesat lines. Crosses the divide, so priority is high. Fly any of the 4 E-W lines that are clear.

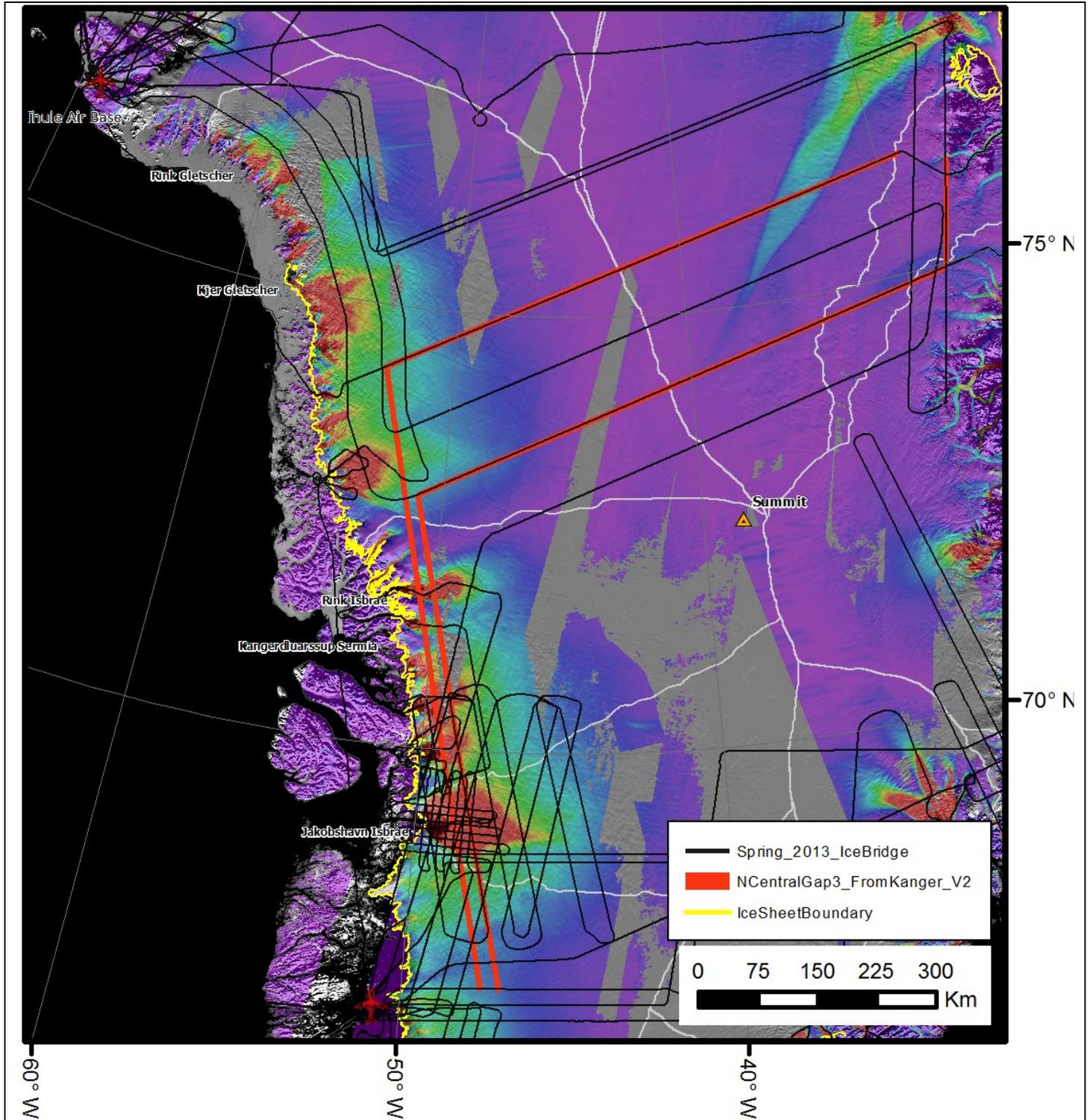


North Central Gap Kanger

Priority: High

Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 20 minutes	250 knots	468 minutes	419, 248, 47	Portions of: ATM 2013, LVIS 2007

This is another version of the P-3 "North Central Gap" plan but based out of Kanger. Also uses ICESat tracks to transit to/from Kanger. Q: If necessary, can we mix and match with the other 2013 Spring E-W lines? Crosses the divide, so priority is high.

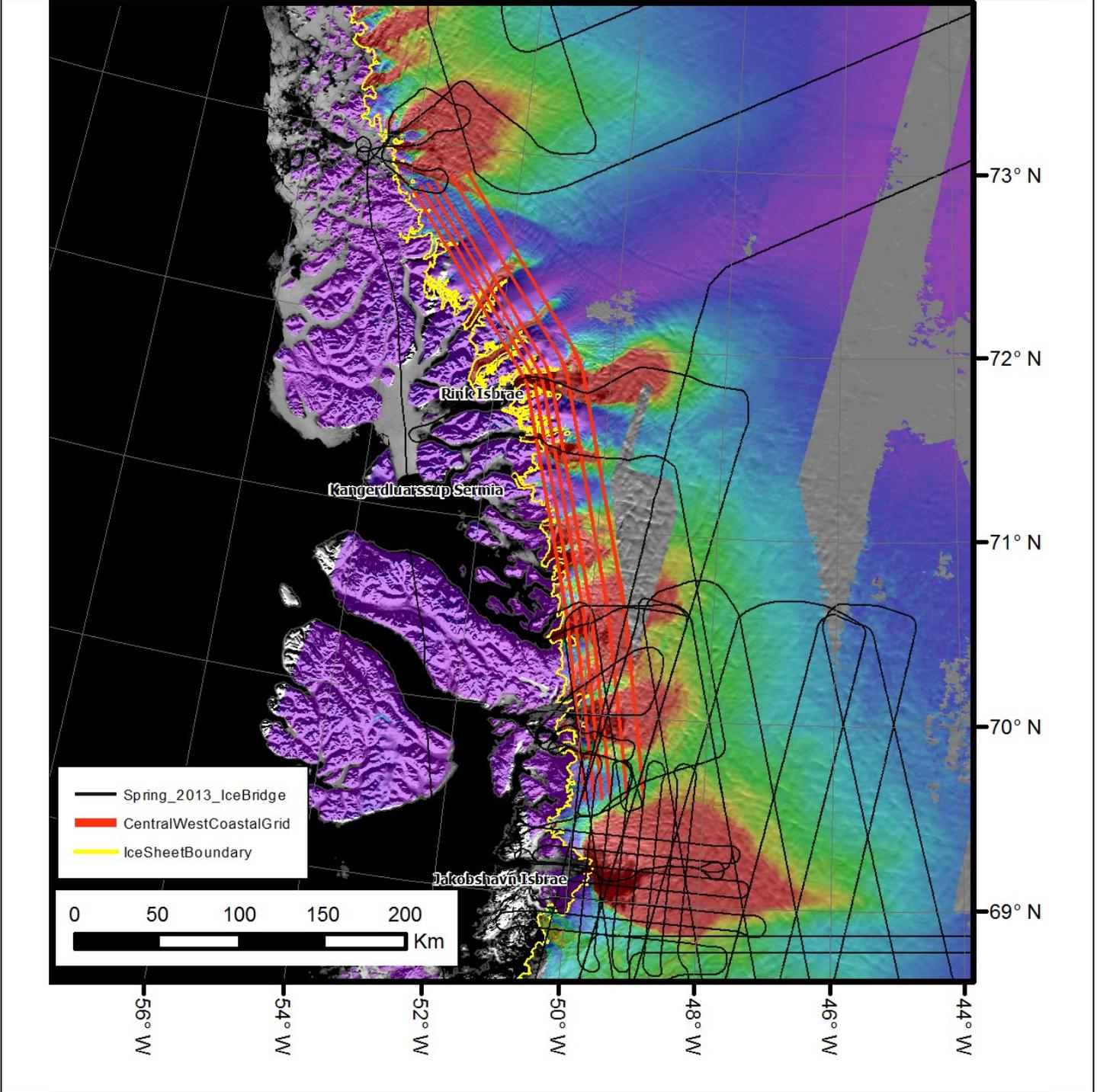


Central-West Coastal Grid

Priority: Medium

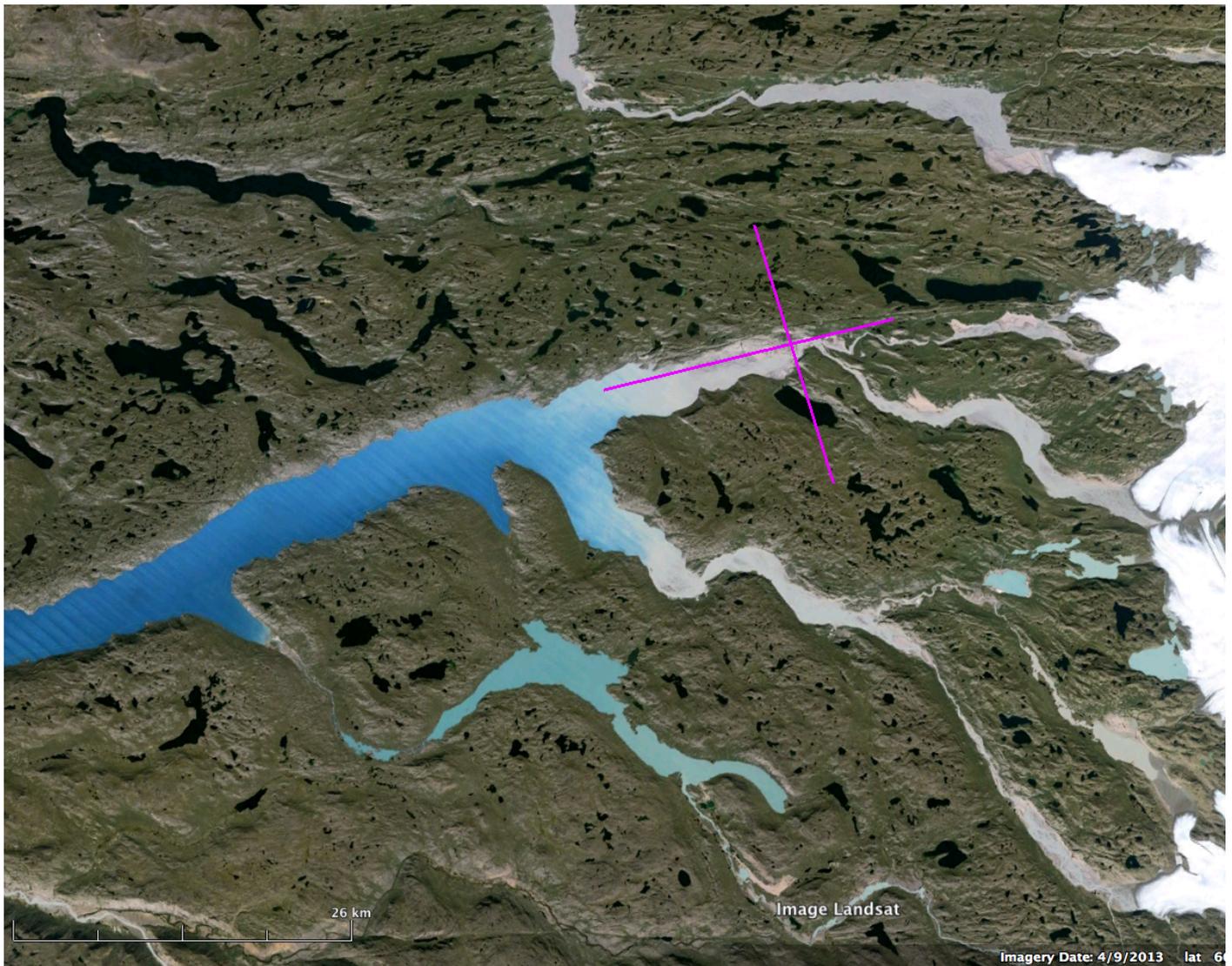
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 37 minutes	250 knots	432 minutes	none	Portions of: ATM 2011.

This plan follows existing OIB grid lines north of Jakobshavn. Grid spacing is a nominal 5km/10km spacing. Flight is based out of Kangerlussuaq. Start at coast, work inland. **Notes:** Flying a smaller section ok – extend lines inland with remaining time.



Atmospheric Delay			Priority:?	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
	250 knots	180 minutes	none	none

Investigate lidar atmospheric delay (Icesat-1, icesat-2, LVIS, ATM, etc). Scott Luthcke. Fly perpendicular lines over known DEM at 28,000', 23,000', 17,000', 15,000', 13,000', 10,000' to characterize the atmosphere delay and assess existing model accuracy. Over Thule or Kanger airports. Preferably repeat different day. Short flight. Lowest Priority.

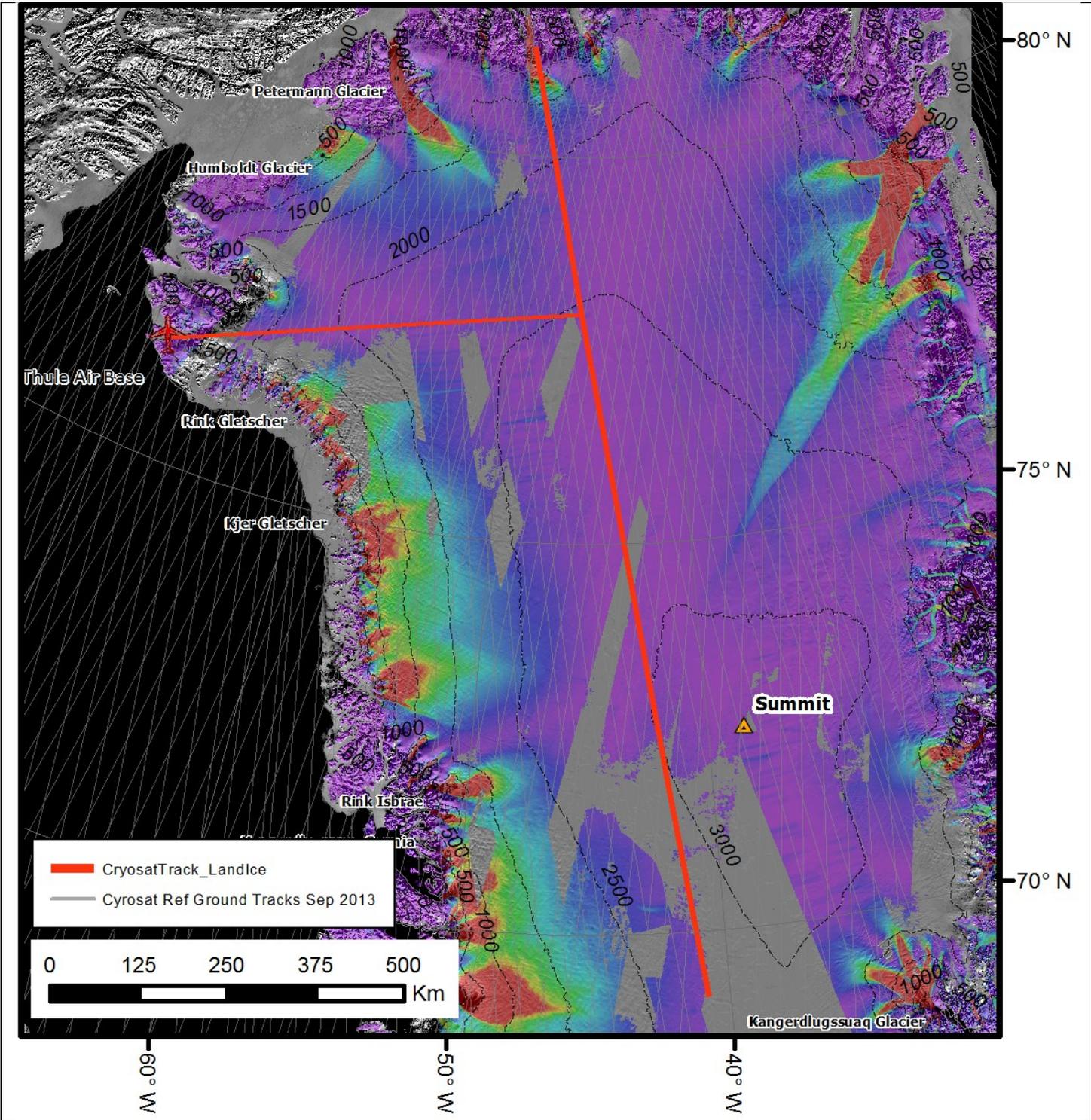


Cryosat Underflight - Thule

Priority: High

Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 10 minutes	250 knots	460 minutes	none	Cryosat orbit 18317(from ref tracks)

Follow Cryosat orbit that is roughly perpendicular to contours. Repeat flight path on return with 300m overlap of outgoing track.
 Question: Is there a time element for which Cryosat track to pick? i.e. does this need to be flown within 2 hours or same day as Cryosat??

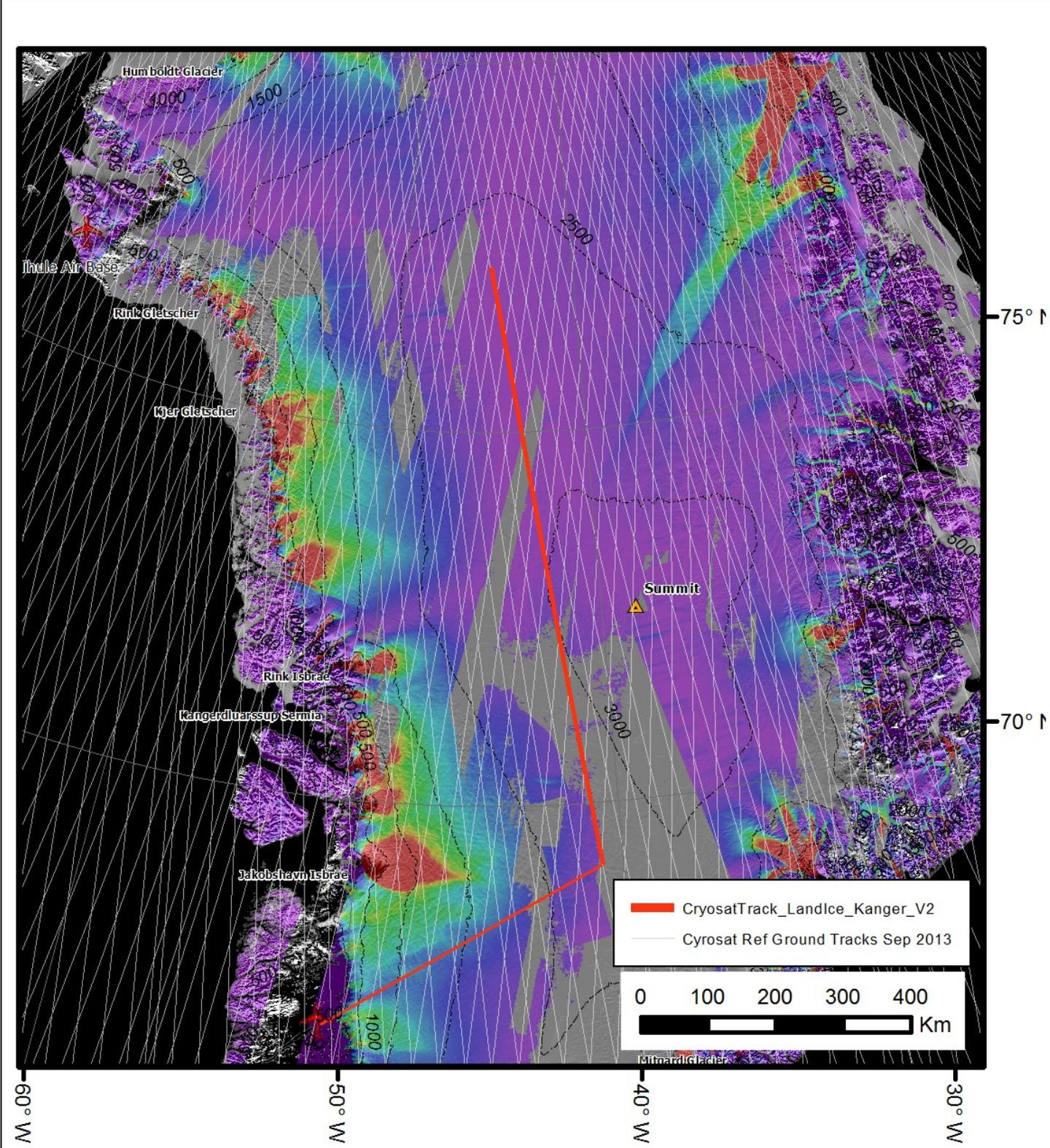


Cryosat Underflight - Kanger

Priority: High

Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 10 minutes	250 knots	472 minutes	none	Cryosat orbit 18317(from ref tracks)

Shows portion of "Cryosat underflight Thule" that can be done based out of Kanger.

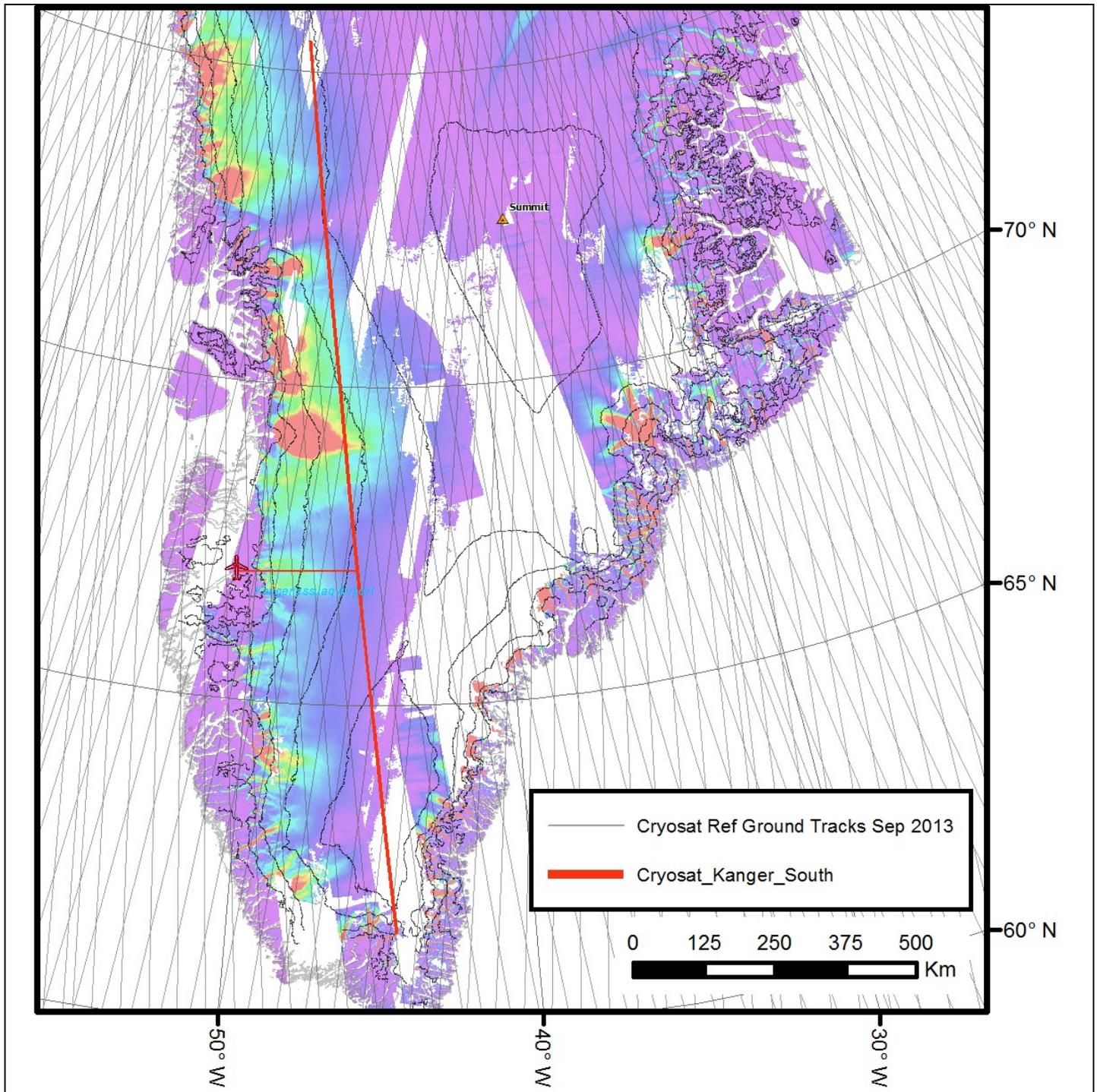


Cryosat S Greenland-Kanger

Priority: High

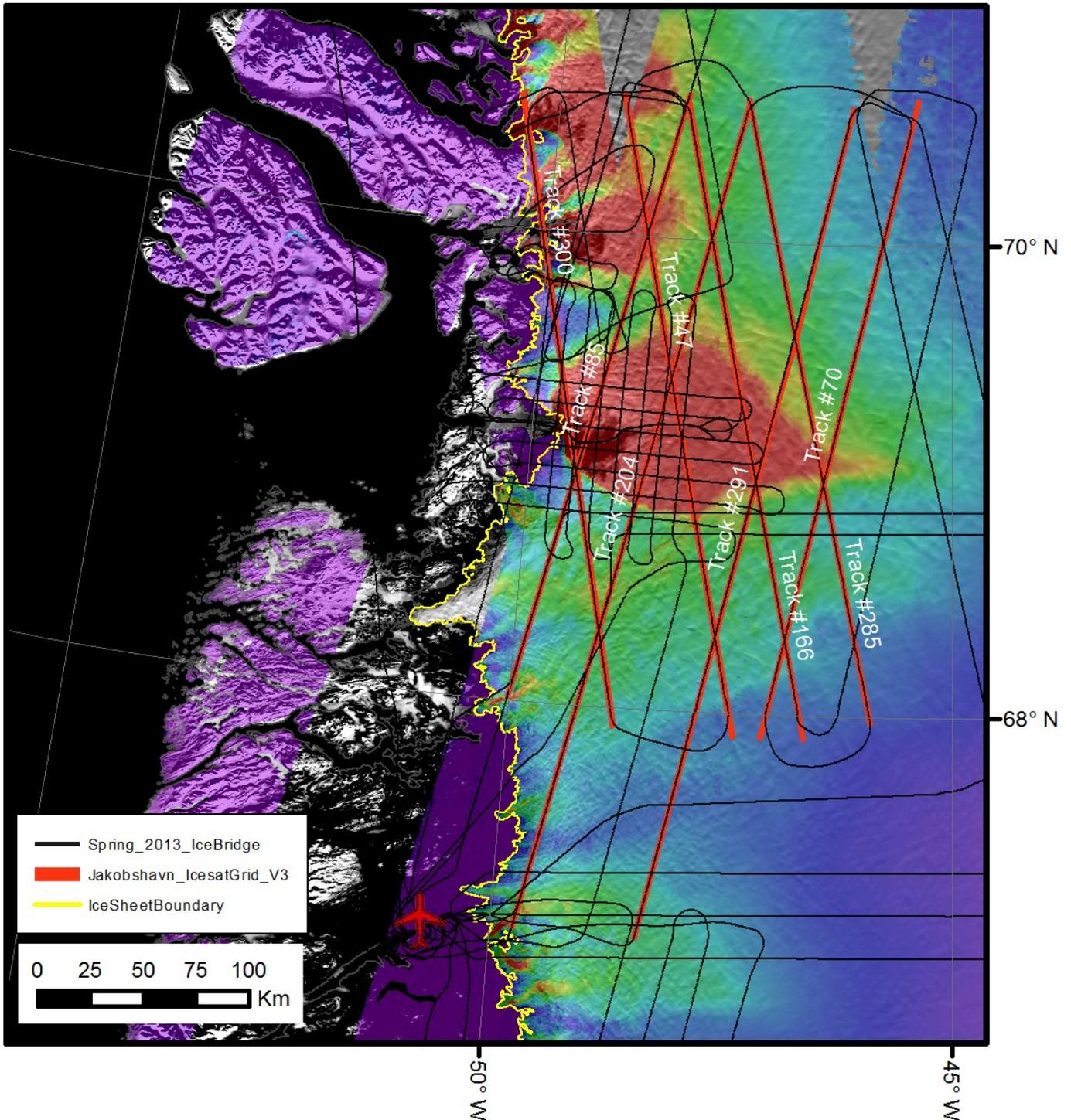
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 15 minutes	250 knots	451 minutes	none	Cryosat orbit 18158

Return pass overlaps outgoing by ~300m. Line in plan is closest match to line flown in Spring 2012 by P3. KJ I think in the interest of seeing seasonal signals, the Cryosat-Kanger options look best, and the northernmost of the two is going to be the easiest to interpret, since it will cover generally flatter terrain and will cover places that we've seen before with Cryosat underflights. There will also be some value added to the previous underflights, in terms of being able to splice the LVIS swath together with the ATM profiles that have been measured before. MS measure coast to inland. Highest priority flight. Interval since cryosat depends on weather. Could be up to 2 days (but beware of snowfall, coastal change). Avoid day after a cryosat maneuver in order to allow orbit to stabilize.



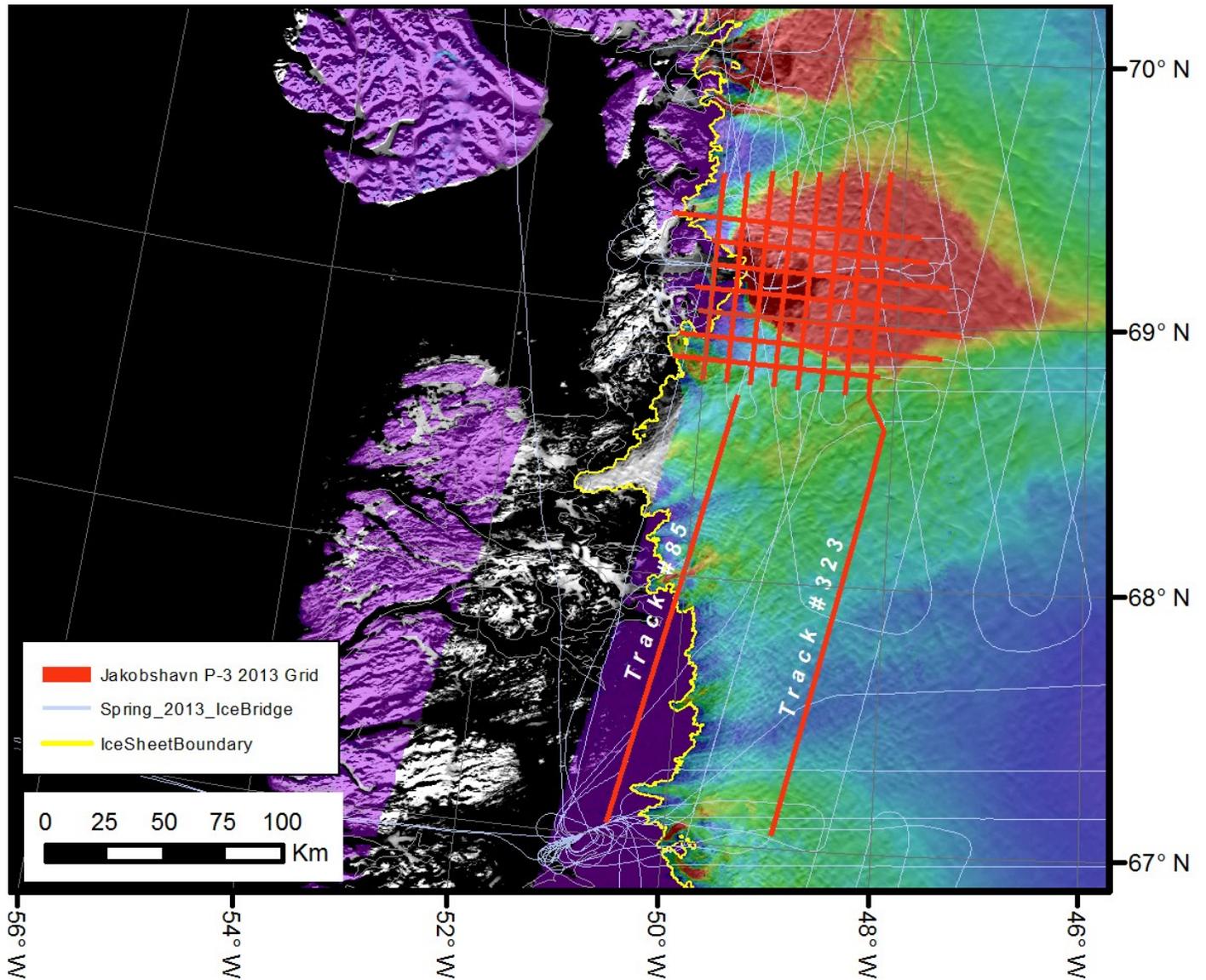
Jakobshavn: ICESat Grid			Priority: High	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 10 minutes	250 knots	474 minutes	300,85,285,47,204,291,70,166	ATM 2013. LVIS 2007 (icesat tracks 47 and 204). Portions of: ATM 2012, 2011, 2010, 2009, & 2007. Portions of LVIS 2011, 2009.

This plan follows the ICESat lines flown by the P-3 in 2013. Also includes tracks flown by LVIS in 2007. Icesat tracks closer to coast are prioritized over tracks further inland.



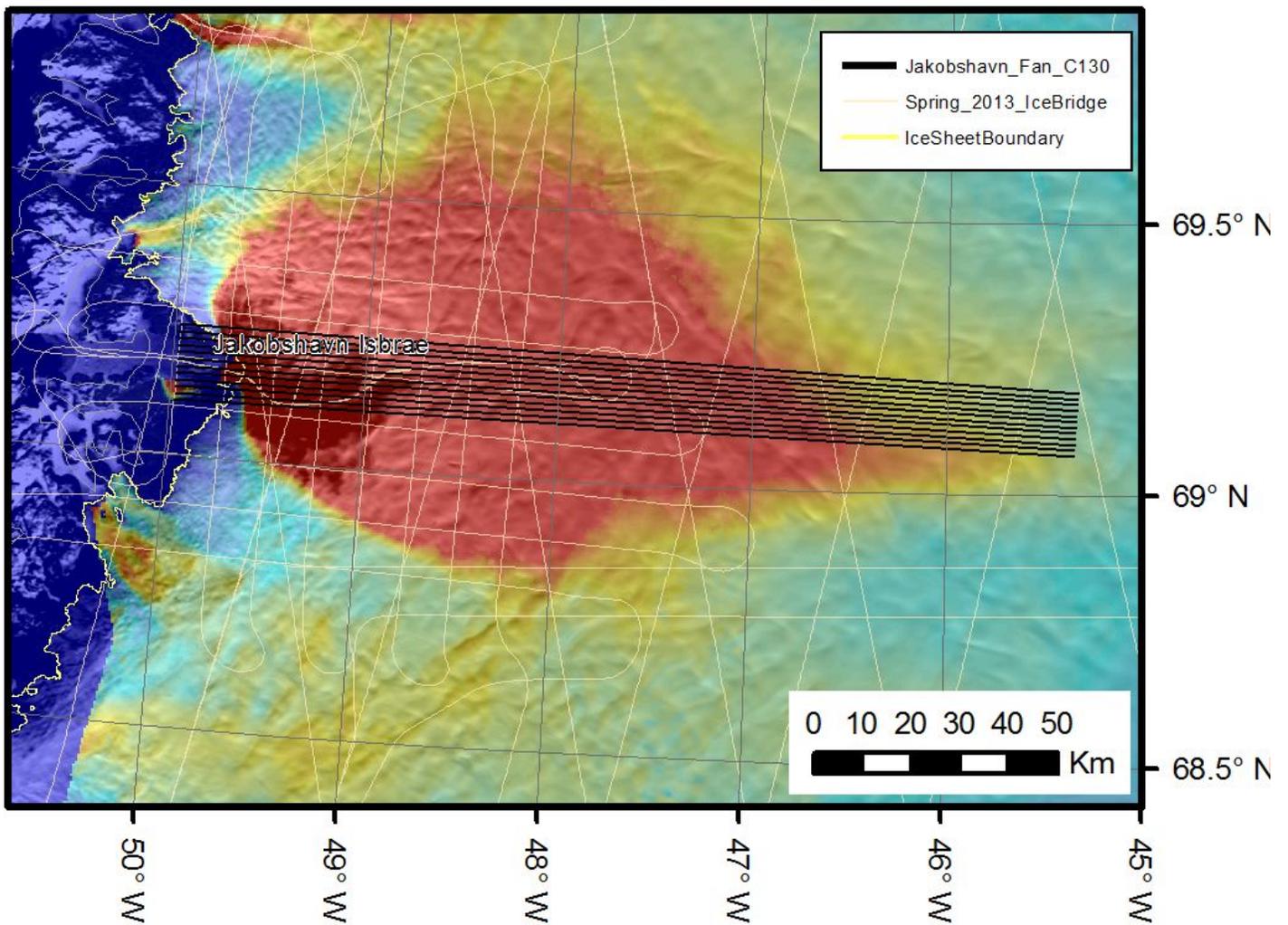
Jakobshavn: P-3 Grid			Priority: Medium	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 20 minutes	250 knots	459 minutes	85,323	ATM 2005, 2006, 2009 – 2013

This plan repeats the P3 2013 10km grid lines in the Jakobshavn region. Uses ICESat tracks flown in 2013 to transit.



Jakobshavn: Total Mapping			Priority: Lowest	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 20 minutes	250 knots	458 minutes	various	various

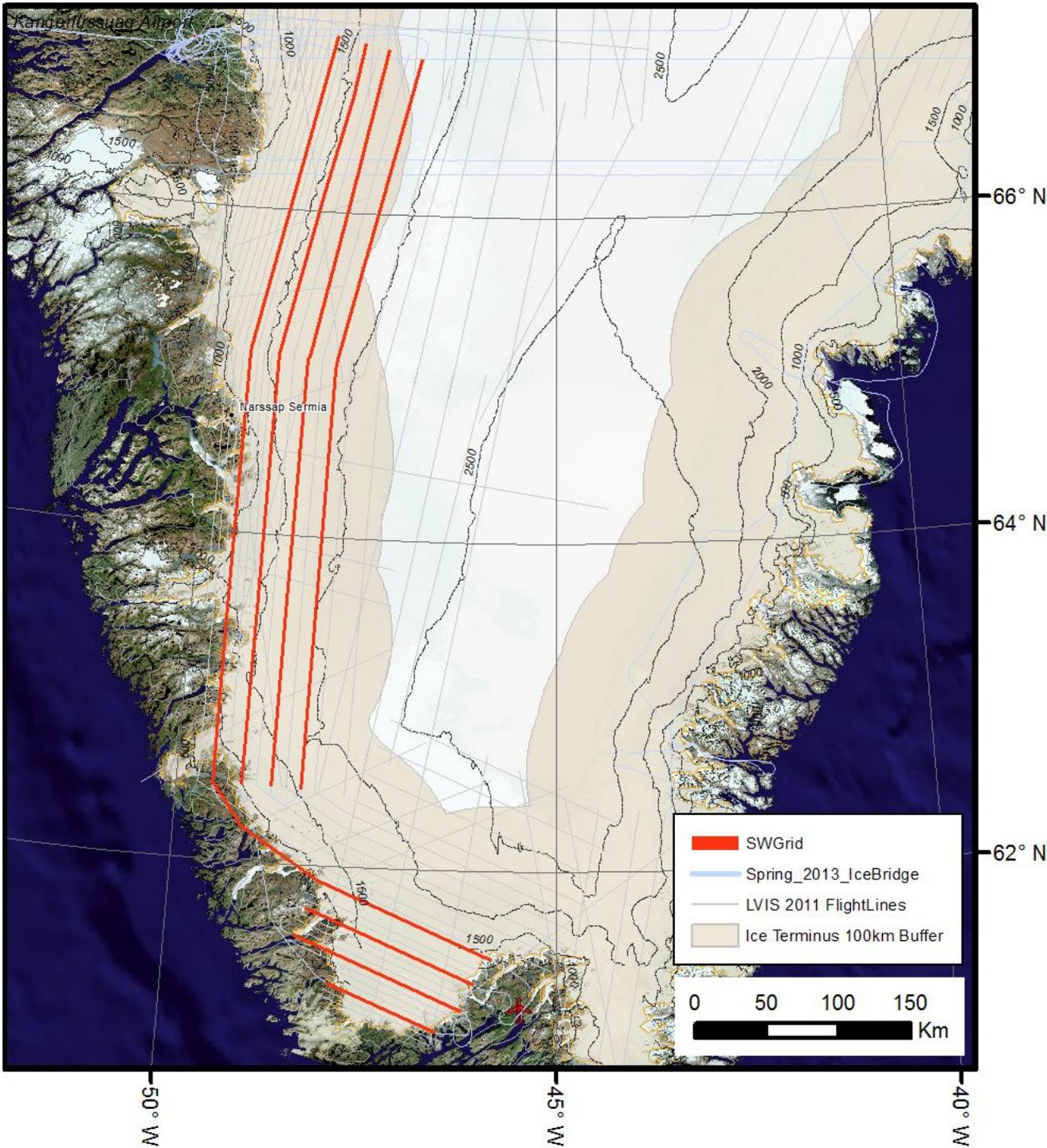
Example to show area that could be completely mapped in 1 flight: roughly 185 km x 15km area centered on the center flowline of the glacier. Assumes single LVIS instrument only. If LVIS GH also flies we double the swath to get twice the area.



South West Grid			Priority: High	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 20 minutes	250 knots	467 minutes	none	ATM 2013, LVIS 2011

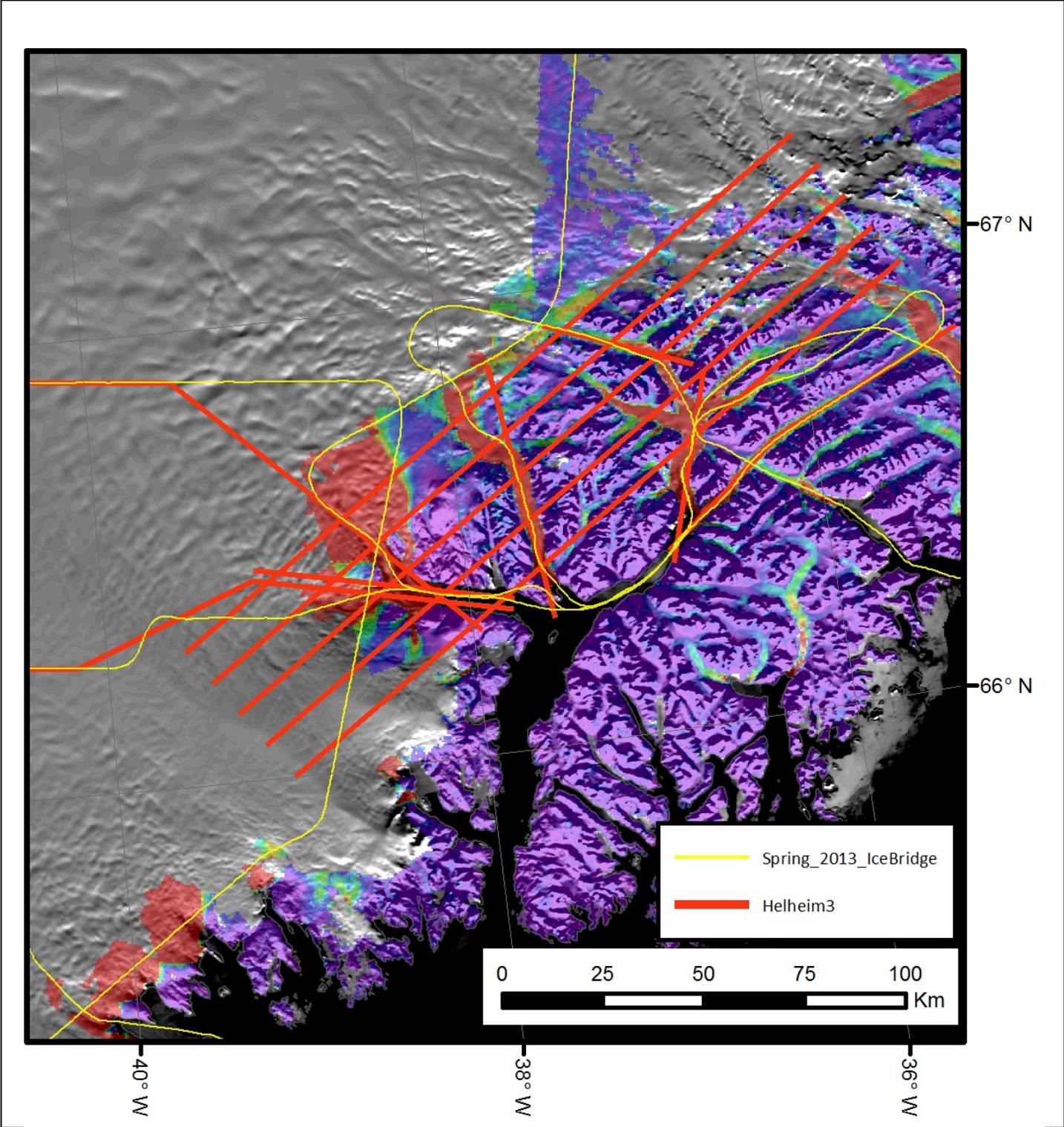
This plan follows the P-3 2013 lines, which are based on the LVIS 2011 grid lines. Note that initial portion of first line will probably be used to get to altitude.

Notes: Requires large area to be cloud free. If we need to split the flight: area to south of first kink is most exciting. With extra time, work way up to divide rather than fill between grid lines.



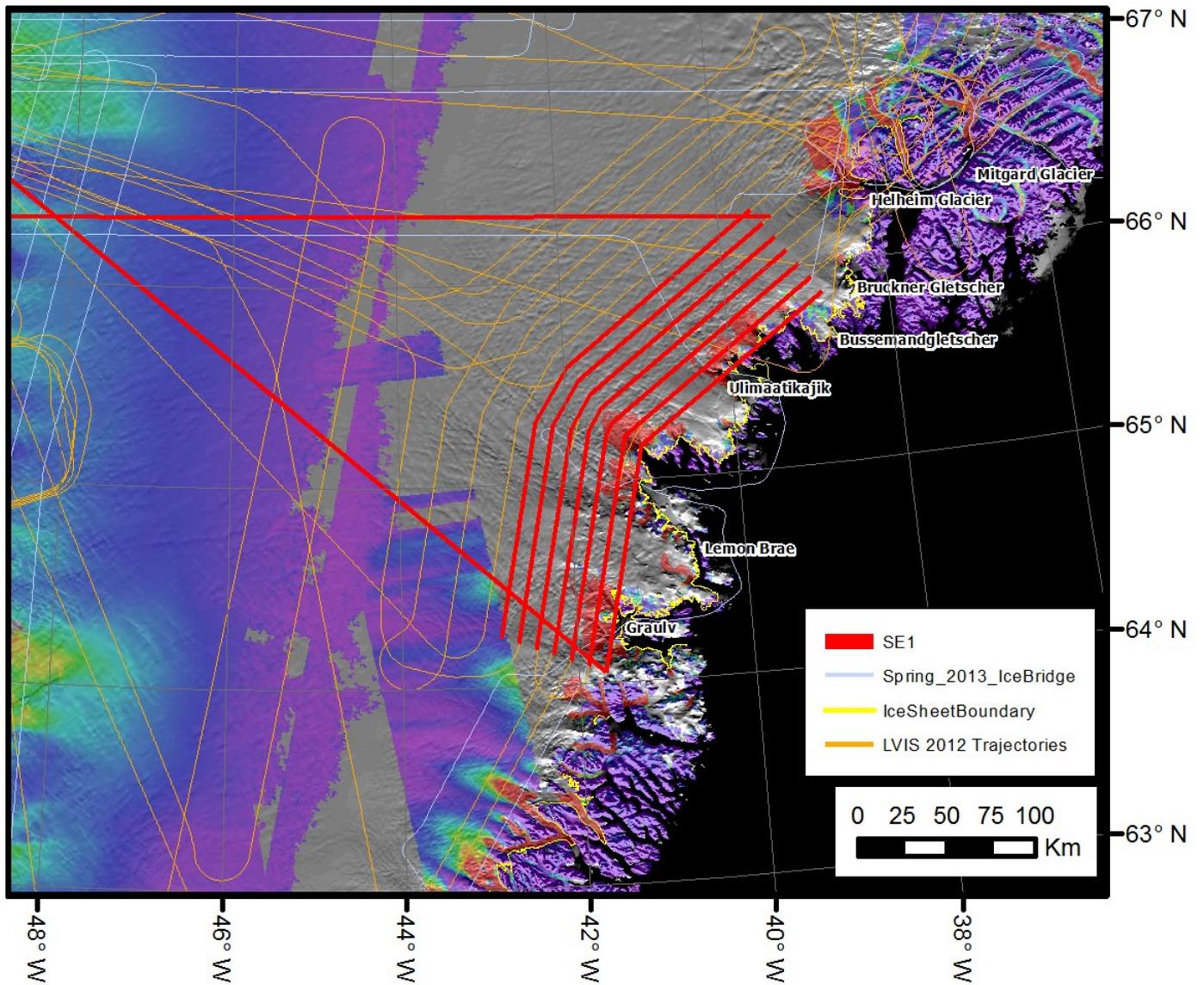
Helheim			Priority: High	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 10 minutes	250 knots	457 minutes	none	Portions of: ATM 2013, LVIS 2012, ATM 2011, LVIS 2010, ATM 2010

Follows the P-3 2013 transit line from 130409 (also flown by LVIS in 2012), straight line approximations of 2013 P-3 centerlines then existing/extended OIB grid lines for remainder of flight. Offset repeat line on southern tributary of Helheim before return home. Priorities on glacier lines: The HH trunks are highest priority, the lower parts of the adjacent glacier trunks are high priority, the upper parts of the glaciers are mid priority.



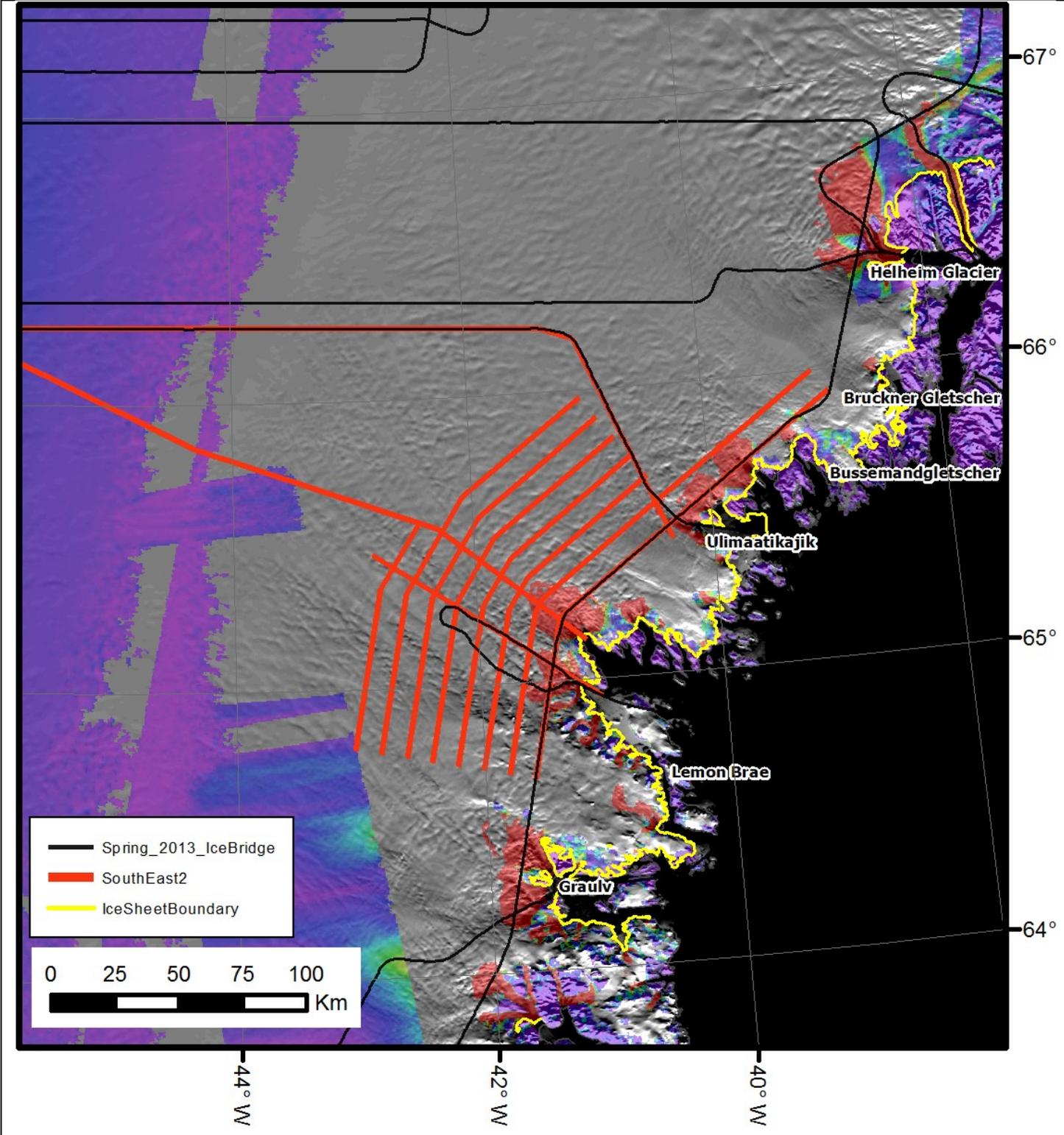
SouthEast1			Priority: Low	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 10 minutes	250 knots	448 minutes	none	Portions of: ATM 2013, LVIS 2012, ATM 2011, ATM 2010

This plan covers coast parallel grid in south-east Greenland. It follows the P-3 transit for flight on 130405, then repeats existing LVIS/ATM grids. Back up plan if higher-priority plans are clouded. 10km grid.



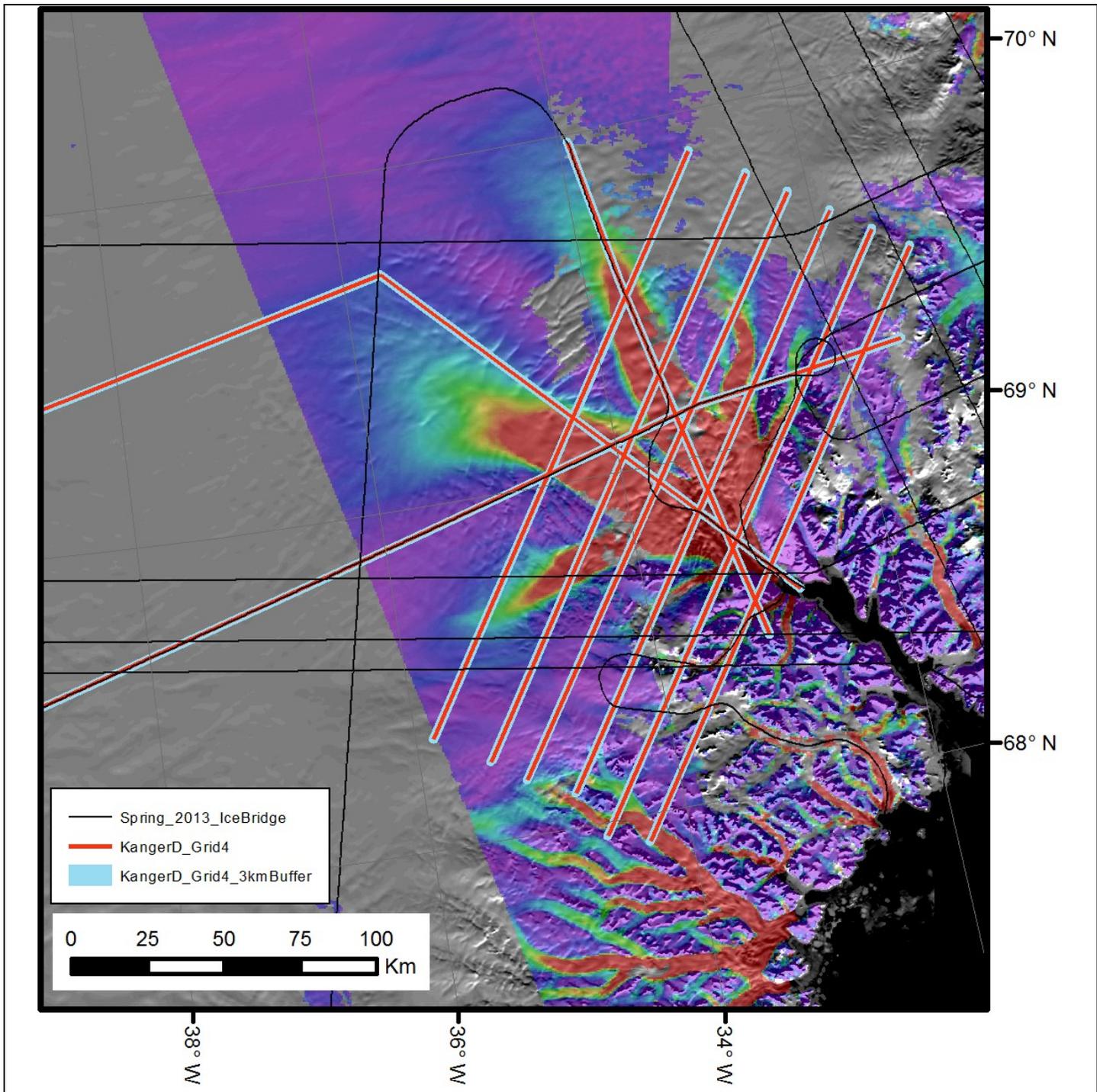
SouthEast2			Priority: Low	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 10 minutes	250 knots	472 minutes	none	Portions of: ATM 2013, LVIS 2012, ATM 2011, ATM 2010

Alternative version of Southeast1 (requires smaller cloud hole). It follows the P-3 transit for flight on 130409, repeats two glacier tracks from the 2013 P-3 mission and then repeats existing OIB grid lines. Remove inland grid line if too long. Back up plan if higher-priority plans are clouded. 10km grid.



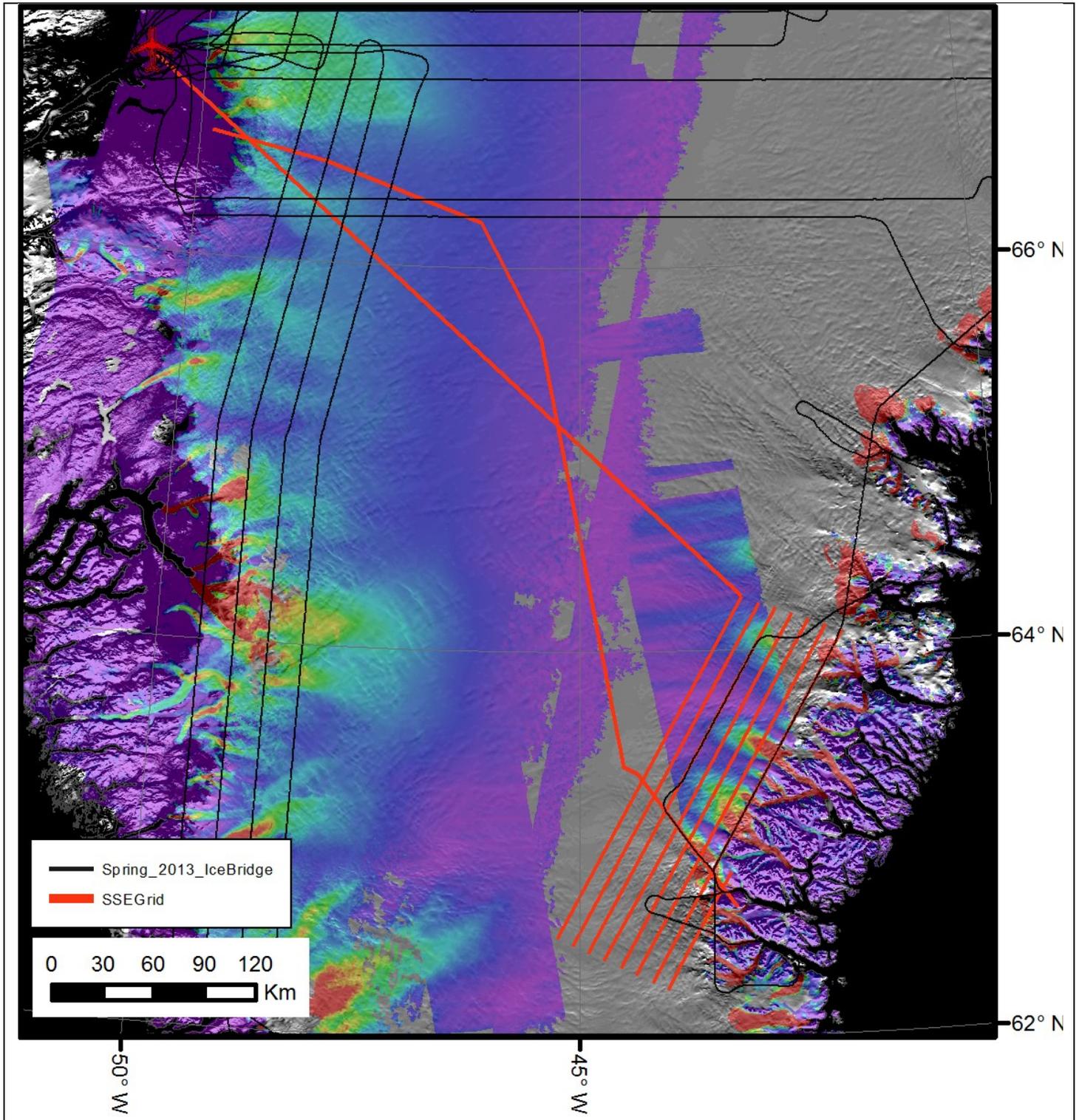
Kangerdlugssuaq			Priority: Medium	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 10 minutes	250 knots	480 minutes	none	Portions of: ATM 2013, LVIS & ATM 2012, LVIS & ATM 2010.

Kangerdlugssuaq area plan that incorporates straight line fits to P-3 centerlines then fills remaining time with existing OIB grid lines. Blue portion of line shows a nominal 3km buffer to simulate swath width with 2 LVIS instruments. Transits in/out on P3 2013 transits



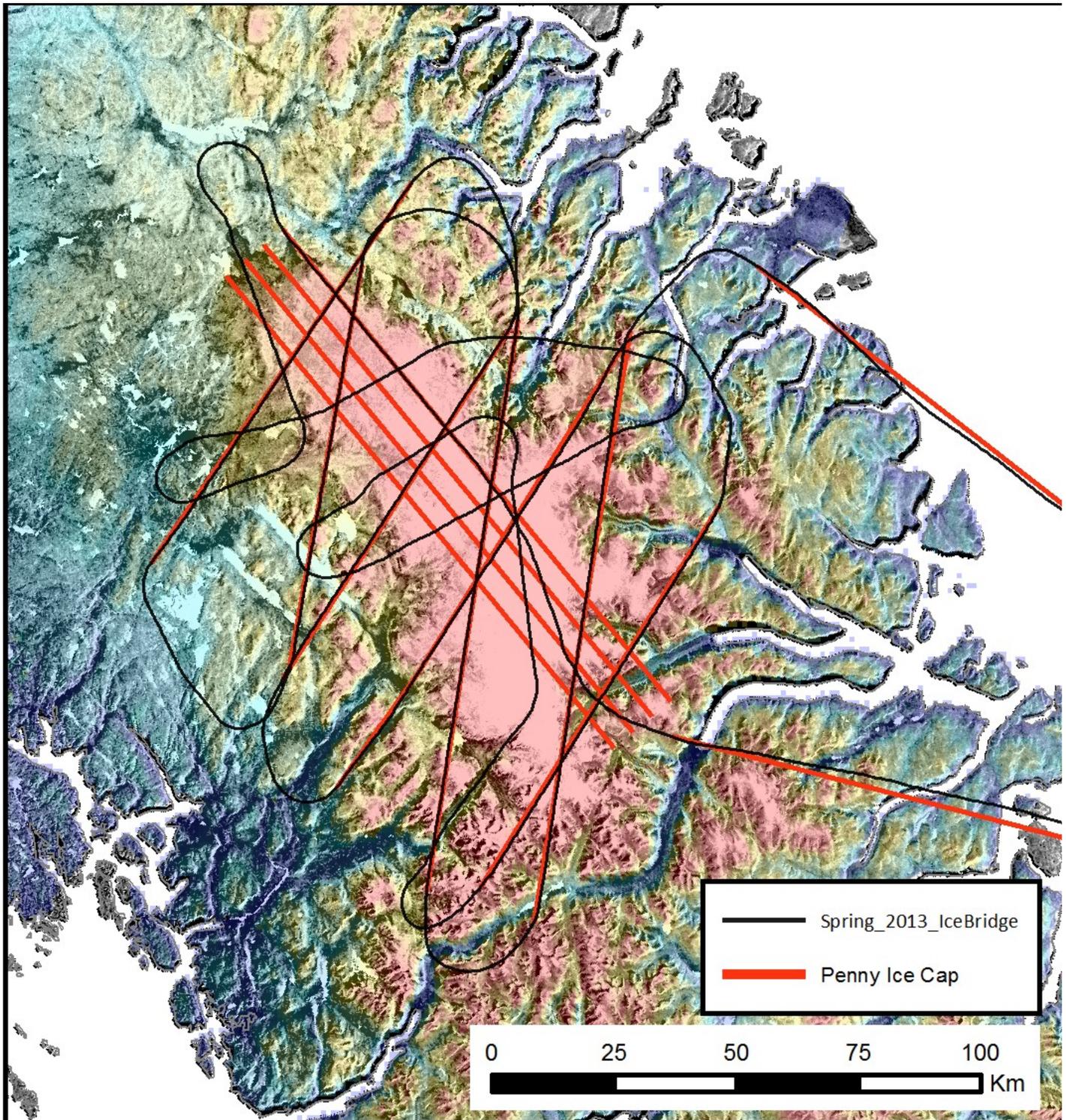
South-SouthEast Grid			Priority: Low	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 10 minutes	250 knots	443 minutes	166	Portions of: ATM 2013, LVIS & ATM 2012, LVIS & ATM 2010.

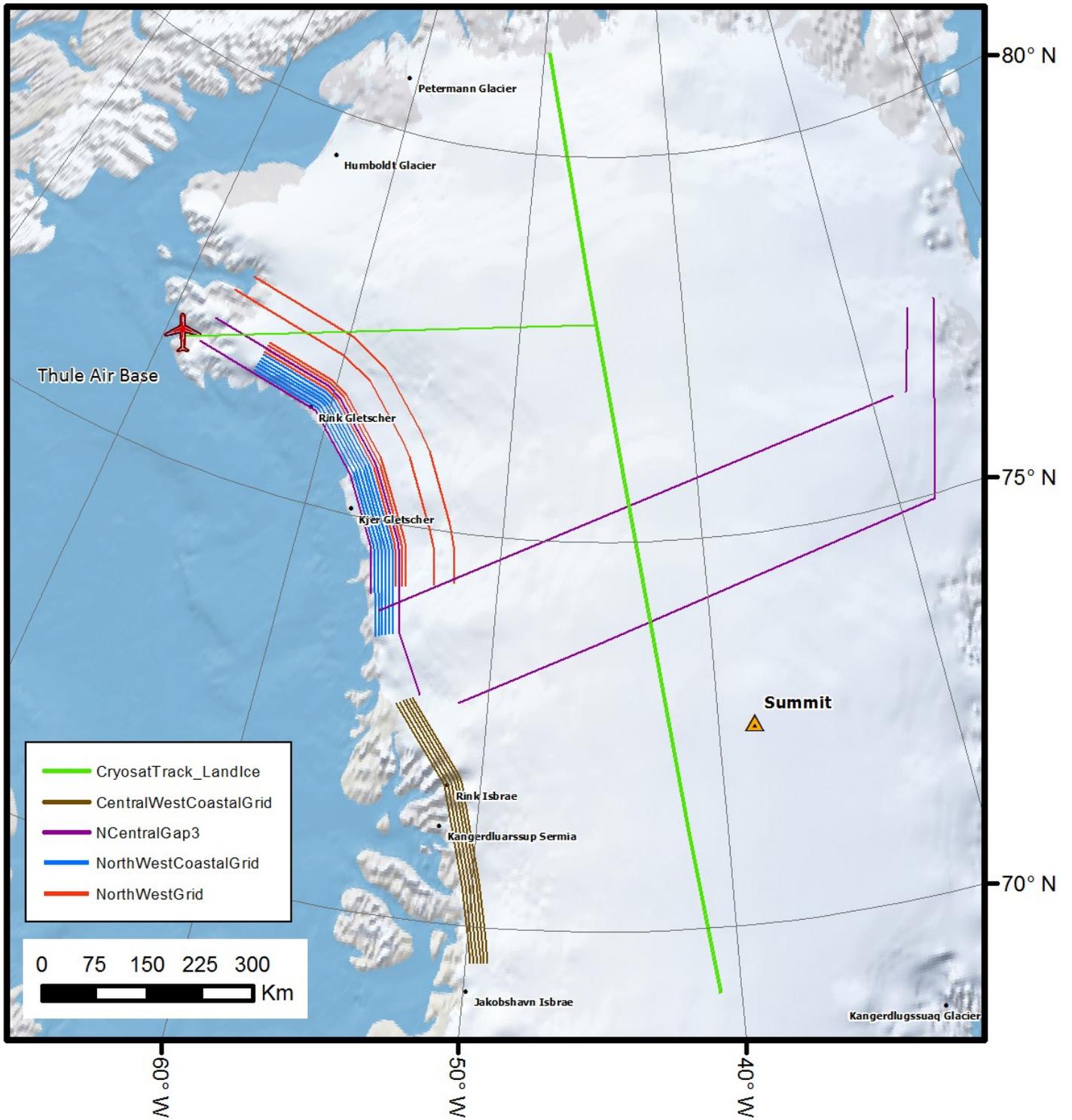
This plan repeats two P-3 lines that were flown in Spring 2013, as well as a P-3 centerline flightline. Uses ICESat 0166 to transit back. Back up plan if higher-priority plans are clouded. 10km grid spacing.

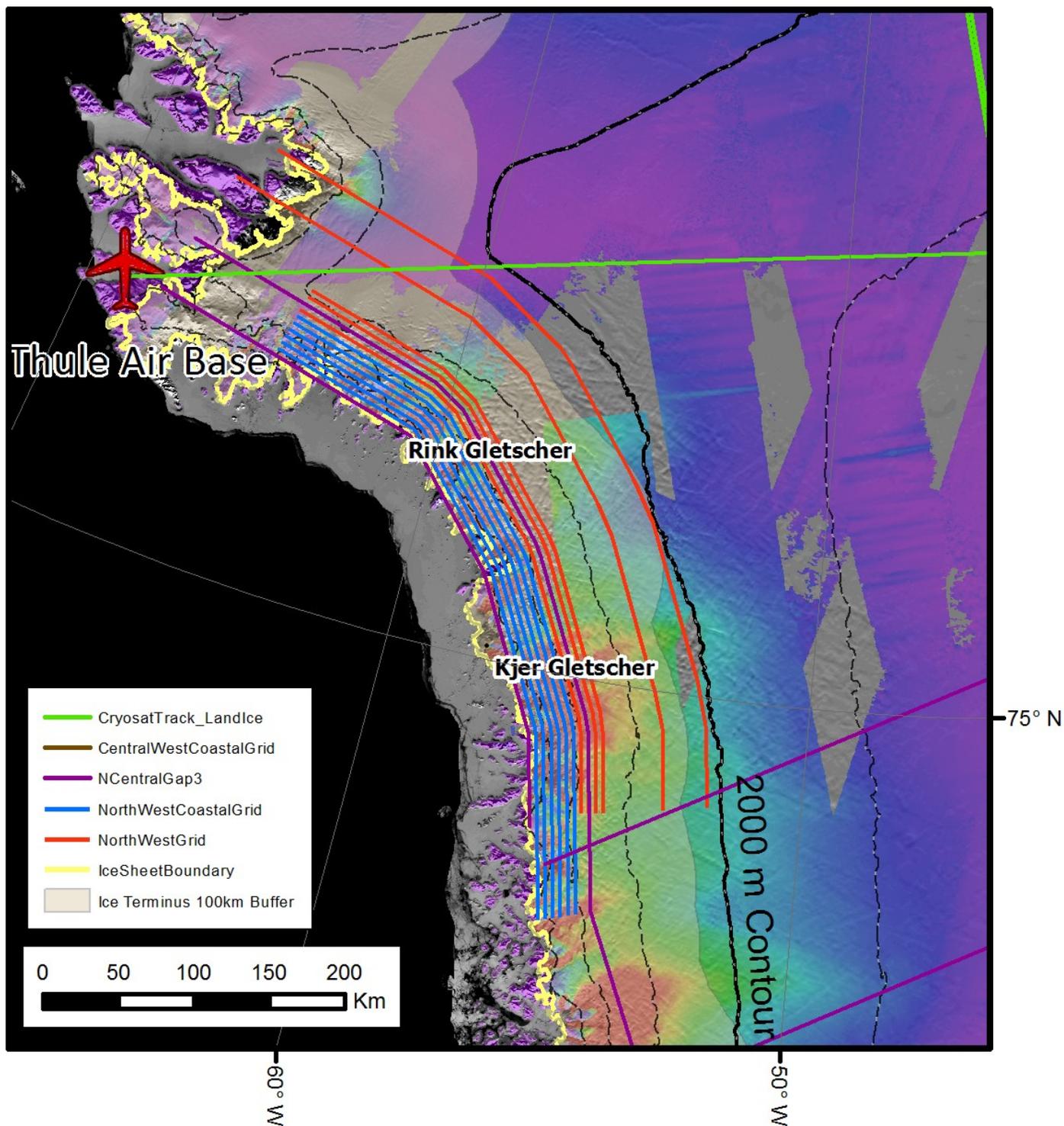


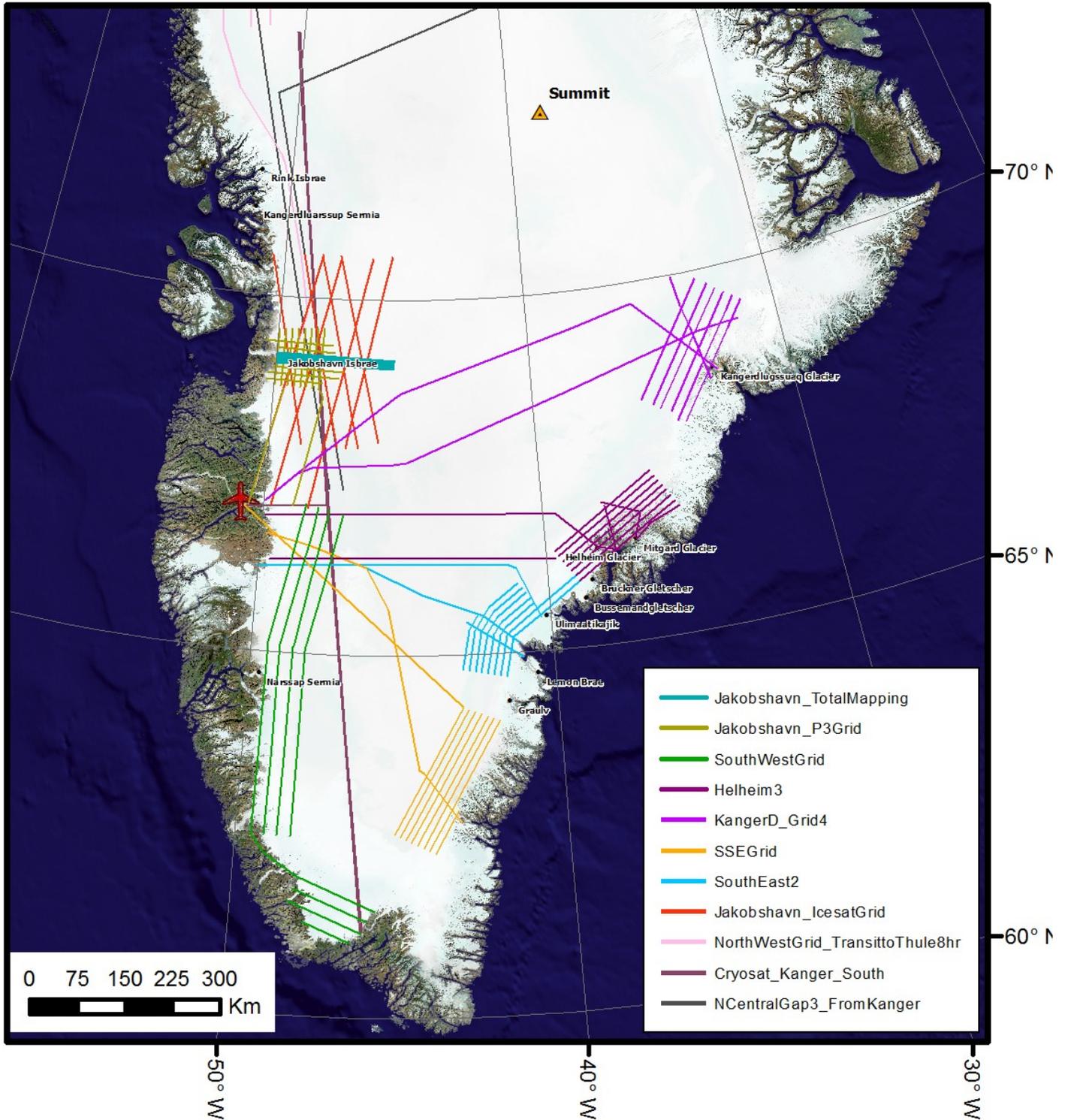
Penny Ice Cap			Priority: Low	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 10 minutes	250 knots	431 minutes	271, 294, 390, 413,18, 41, 160	Portions of: ATM 2013.

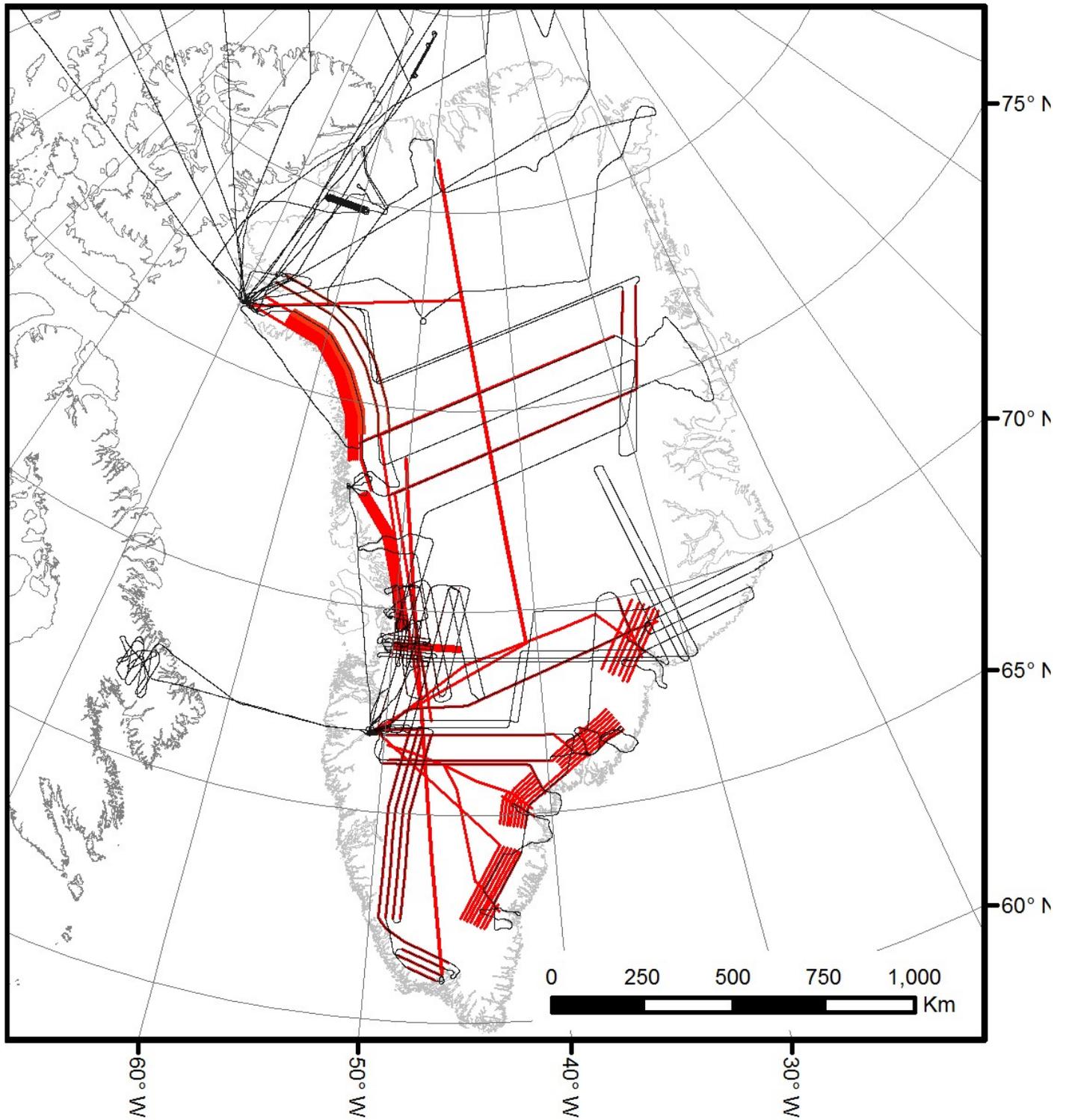
This plan follows the majority of the P-3 lines from 2013 over the Penny Ice Cap. With extra time, added 3 parallel lines over the central portion of the ice cap.











ICEBridge Arctic 2013 LVIS Flight Lines for Sea Ice

Updated: Aug 15th 2013

The following document presents a preliminary set of potential LVIS flight lines for the Summer 2013 Greenland OIB deployment on the C-130.

Working assumptions:

(a) LVIS on C130: ~1.6km-wide swath, 20m footprints

(If LVIS-GH instrument flies on the C130 as well, this swath width will be doubled (update: as of 7/18 funding confirmed but not yet received)

(b) Camera data collected, but not geolocated

(c) ~8 hour range on C130, assuming 250knots

(both #'s could update once C130 is flying; plans will be made using conservative numbers and include options for lengthening)

(d) Initial flight priorities based on Irvine Team meeting. Rethink with new Thule dates?

Questions:

(1) Any minimum mission criteria possible? E.g., X km of cryosat track.

(2) Is it possible to define important areas of each flight in case we have smaller cloud holes, do shorter flights or mix and match lines etc, e.g., is there a minimum overlap distance with cryosat data.

Summary

# Flights	Flight Name	Priority
1	Cryosat Underflight	Highest
2	South Basin Transect	High
3	Fram Gateway	Medium
4	North Canada Basin	Medium
5	Lincoln Sea Lawn Mowing	Low
6	Lincoln Sea Lawn Mowing repeat	High if 5 is flown
	Nares Strait	Build into another flight

Michelle Hofton, Matt Beckley, OIB Sea Ice Science Team

Update from science team:

(1) Given that we are down to such few days working out of Thule (3 days), I we recommend dropping the low priority "Lincoln Sea Lawn Mowing" mission since there will be no opportunity to repeat it.

(2) A key goal of the LVIS missions for sea ice is to evaluate the utility of the observations. As such, flying ANY place over the sea ice cover that is clear is beneficial. Following the recommended flight lines is preferred, but is not mandatory. And, if you do follow a flight line, there is no preference for one part of a given line over another. We realize that clouds are going to be a challenge and trust that you will work around them as best you can.

Bottom line: We'll work with what we get, we are just hoping for something to work with!

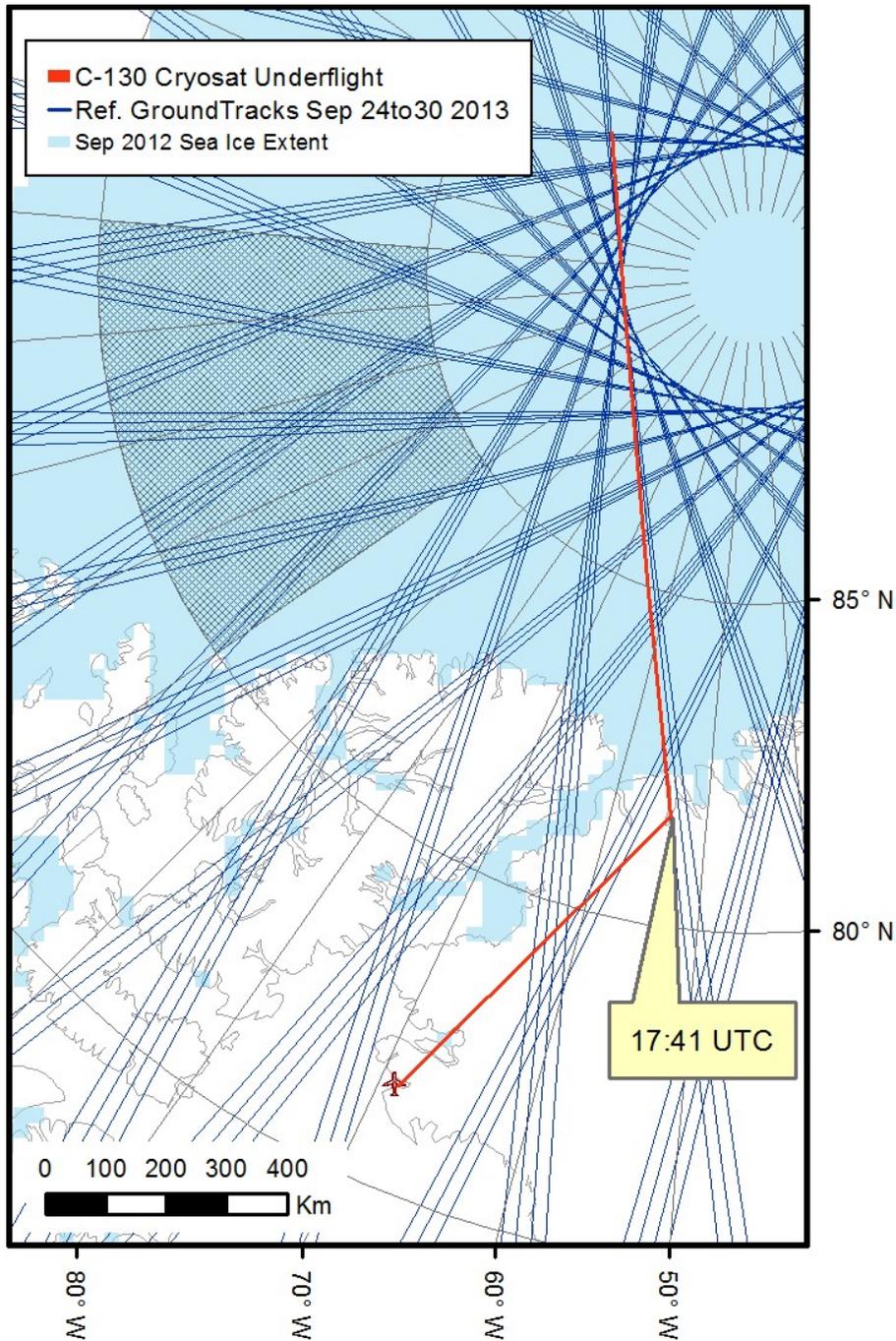
(3) Regarding a minimum length for a CS-2 under flight, the answer from the team is a resounding (and not surprising): The longer the better. Pushed to provide a number, the guidance is 300 km.

Cryosat Underflight			Priority: Highest	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
	250 knots	463 minutes	none	none

This plan is an example to show potential coverage based on the Reference Ground Tracks. An underflight of ~800 km one way over sea ice is possible. Blue lines show the orbits that will be available from September 24th – 30th.

Guidelines:

- Underflight within 2 hours of Cryosat
- Track within Lincoln Sea preferable (minimal ice drift and refreezing likely to be underway)
- Transit along a track to the ice edge (if range and conditions allows, continue for a segment over open water where refreezing has yet to begin), then turn and overlap the swath back
- Preferred overlap in swath: 33%



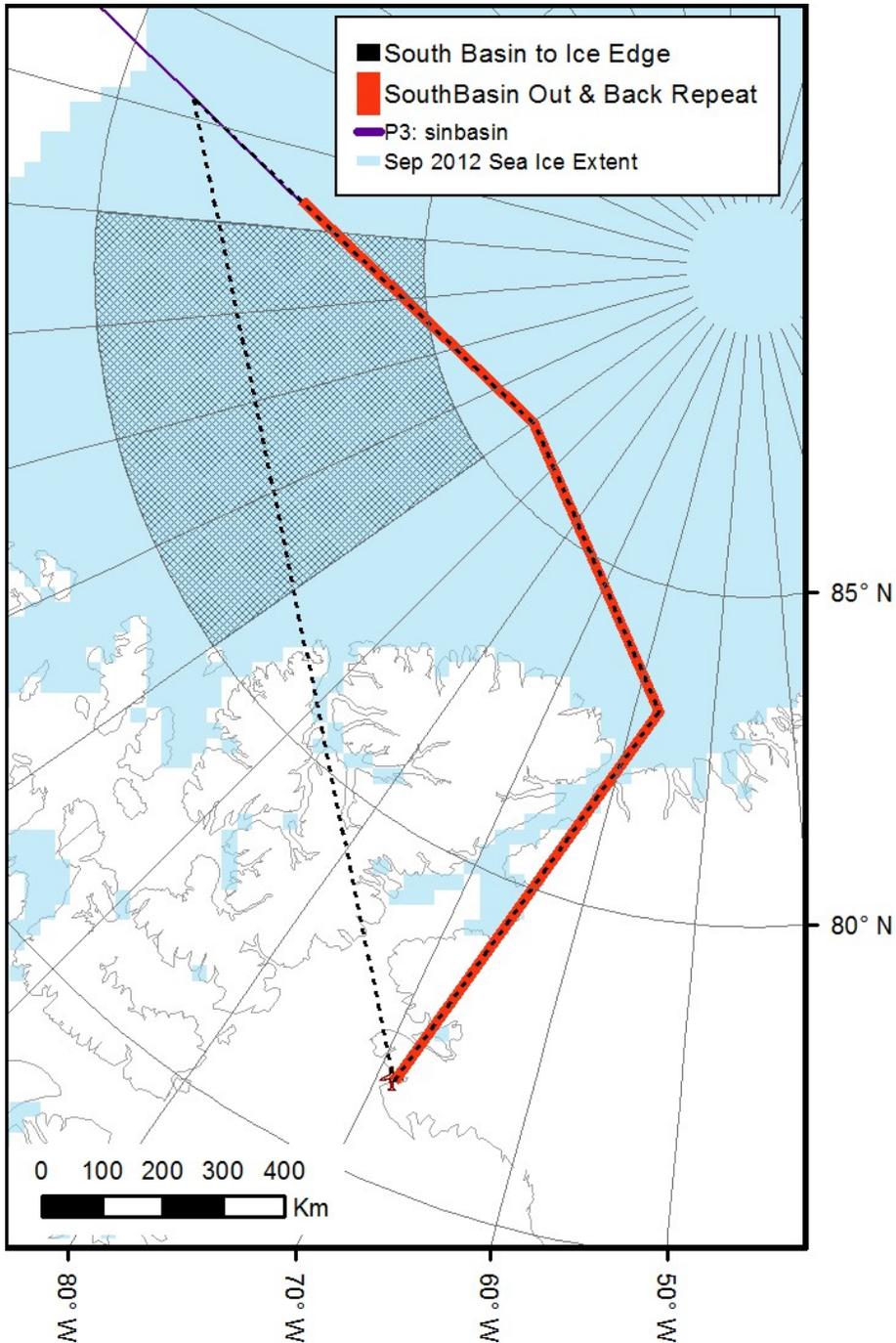
South Basin Transect			Priority: High	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
	250 knots	476 minutes	none	ATM 2013, 2012, 2010, 2009

This plan is a copy of the P-3 plan from 2013 (P3 used this to transit to Fairbanks). Two versions shown – dashed (gets as close to ice edge as can), and red (follows same track on the return).

Q: alter outgoing track to get to ice edge? Prioritize any sections as higher than others ?

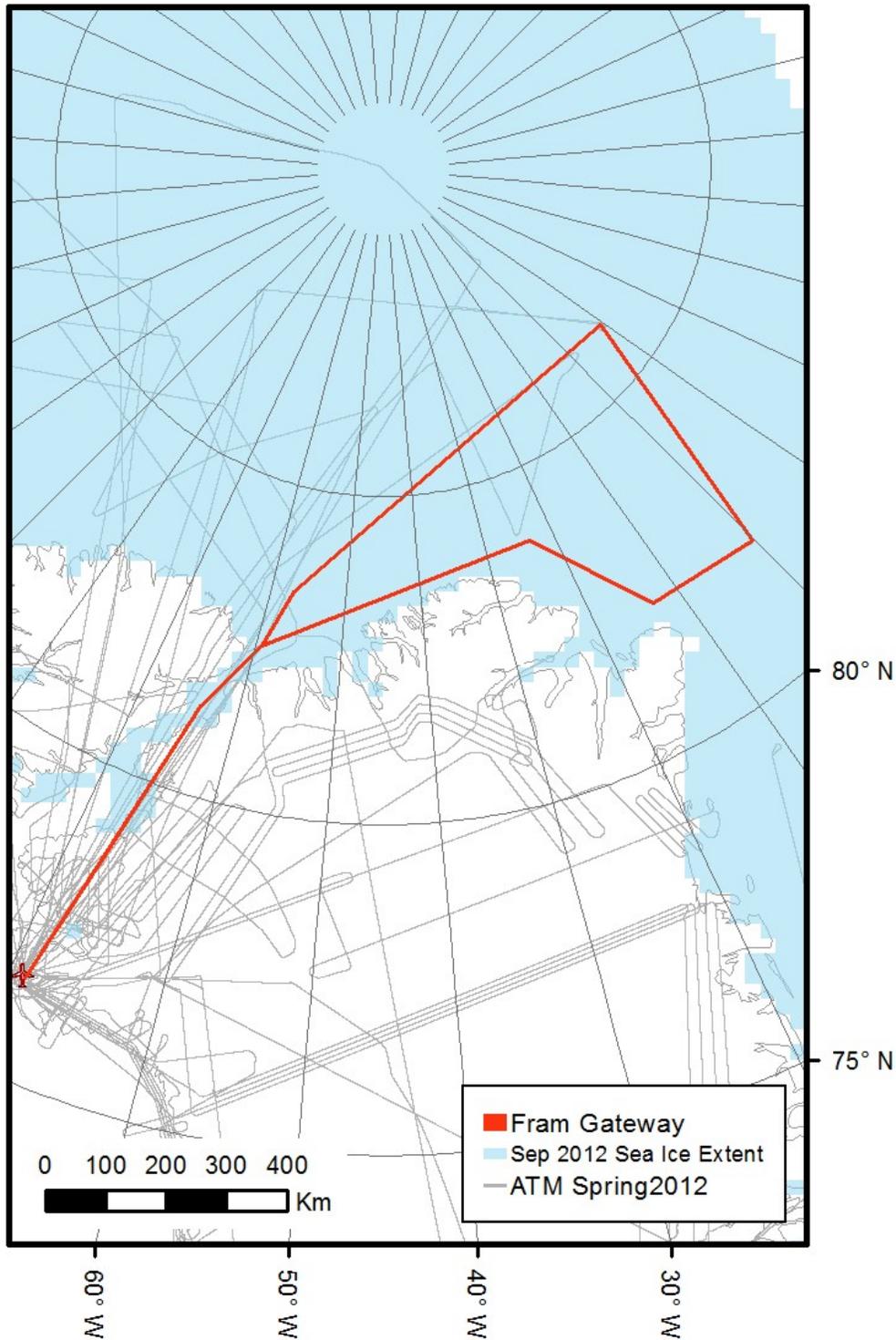
Guidelines:

- Continue flight line 10-20 km beyond the edge of the sea ice cover
- Could use this to repeat 2009 LVIS Nares strait track on outbound or return, probably not both though.



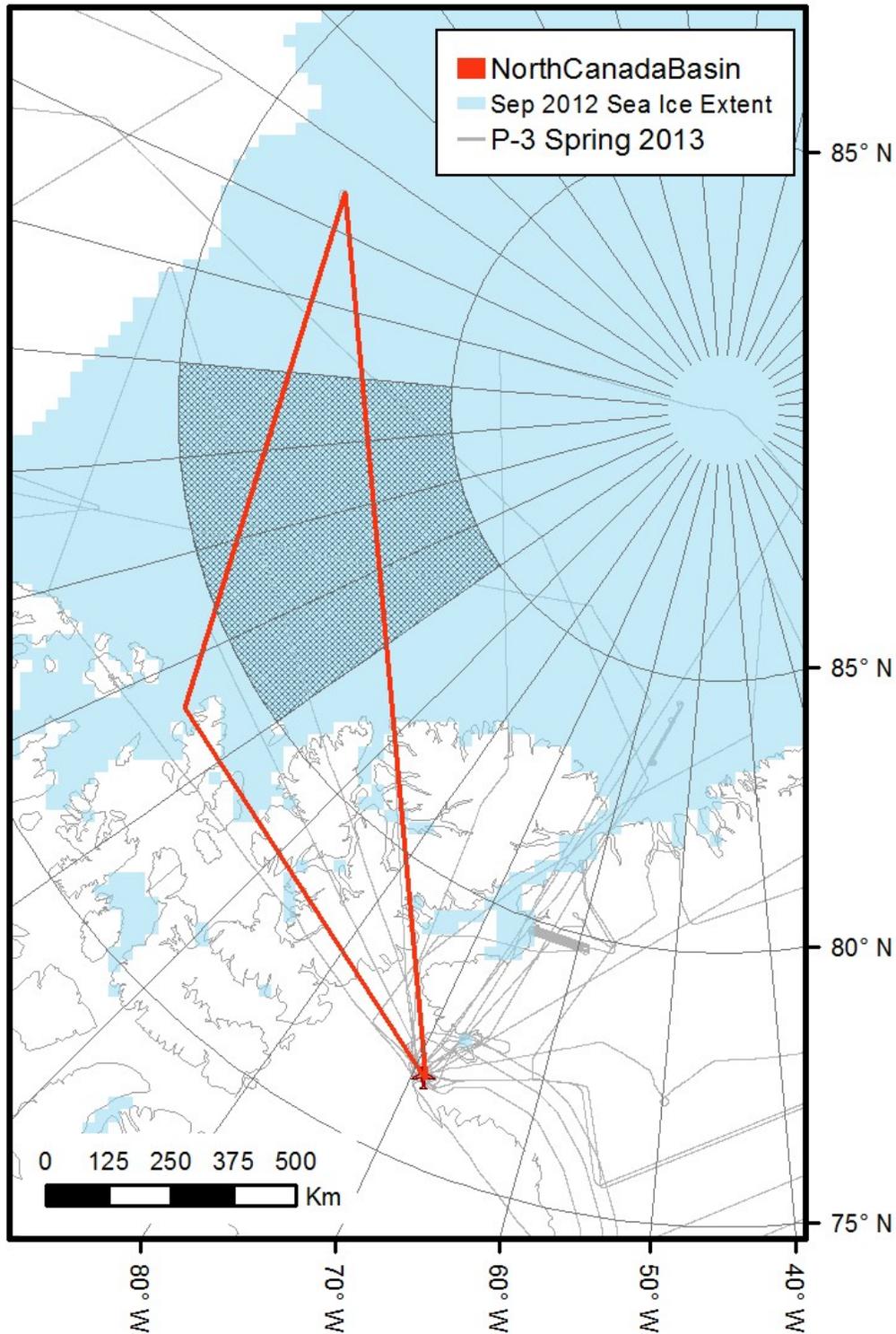
Fram Gateway			Priority: Medium	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
	250 knots	470 minutes	none	ATM 2012, 2011, part of 2010 & 2009

This plan is a copy of P-3 plan for the Fram Gateway mission. This plan as designed is close to 8 hours, may need shortening (**Q – any preferences on how we should shorten this?**). Could repeat 2009 LVIS Nares Strait track on outbound and return.



North Canada Basin			Priority: Medium	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
	250 knots	496 minutes	none	ATM 2013

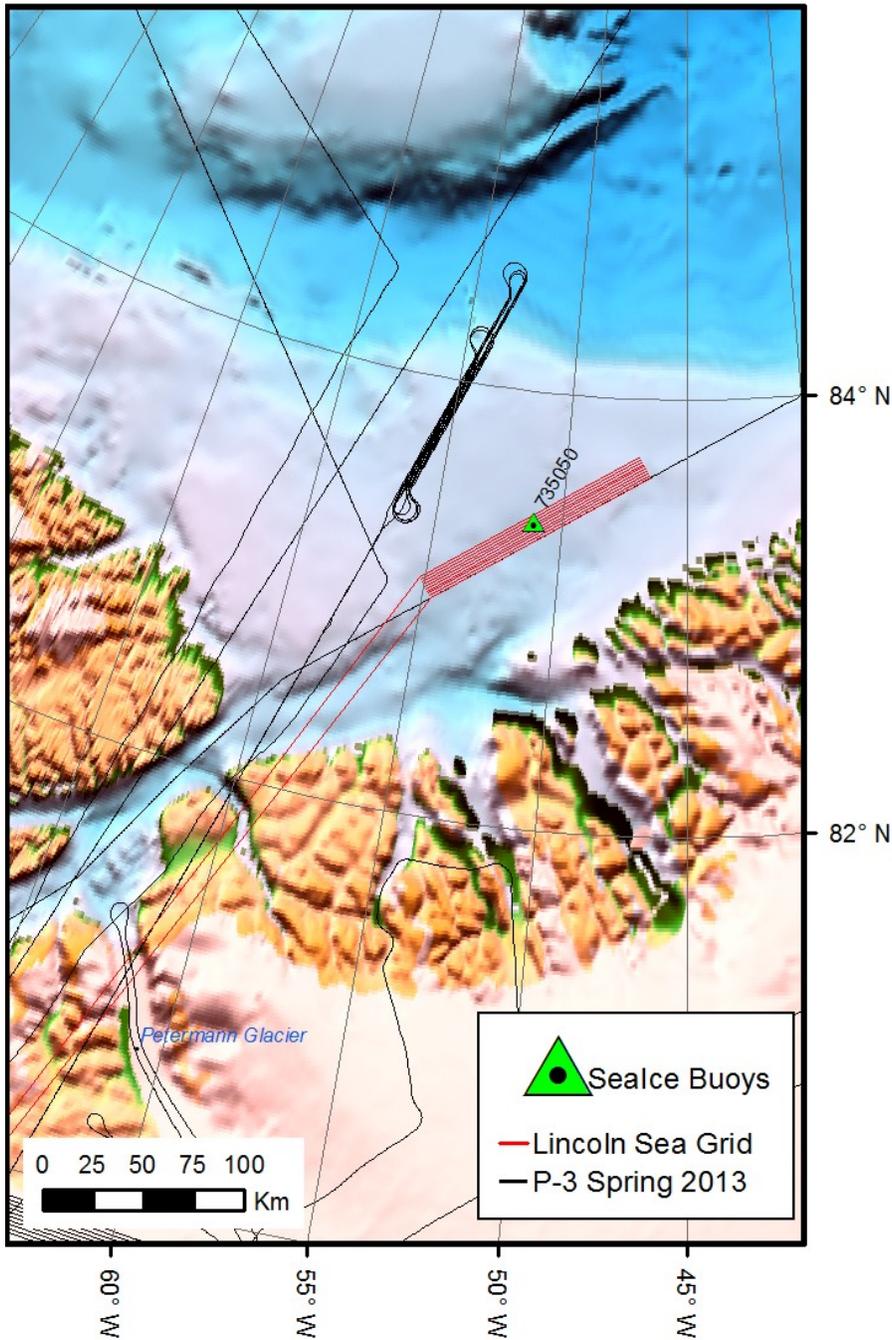
This plan follows the P-3 North Canada Plan flown by the P-3 in 2013. Plan is too long as is. Depending on plane speed, etc, this may need to be cut short as was done in Spring 2013. **Question:** verify that this is the North Canada Basin. How to cut short if we need to?



Lincoln Sea Lawn Mowing			Priority: Flight1=Low, Repeat=high if flight1 successful	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
~ 100 minutes	250 knots	474 minutes	none	

This flight plan generates 100% coverage of an area centered over IABP Buoy 735050 (position as of 7/17/2013) (in Lincoln Sea, not too far off shore). This example grid consists of ten, 125km-long lines, overlapping by 300 meters for coverage of a 125 km x 13 km area. Shorter, fatter area also possible, e.g., fourteen, 85km-long lines for 85 km x 18km area. Using LVIS+GH-LVIS, width of mapped box would double.

The plan would be repeated a minimum of 7 days after the first flight. Repeat requires at least half of the original survey area to be repeated.



Nares Strait			Priority: General request	
Time to 1 st Pt	Plane speed	Total Flight Time	Icesat Tracks	Repeats
	250 knots		none	Portions of LVIS 2009

This plan follows the LVIS 2009 trajectory, with the intent on collecting an ice-free pass over the Nares Strait for geoid studies.

- Most useful if passes can be exactly repeated (e.g. on the out and back flight from Thule)
- If possible, repeat LVIS flight in Nares Strait in April 2009
- Areas of no ice or thin ice preferred; in years past the northern end of Nares Strait (e.g. Robeson Channel) has had a fair amount of ice in September, whereas the southern end (e.g. Kane Basin) has been ice free.

