ARISE

Arctic Radiation-IceBridge Sea & Ice Experiment

Project Status

ARISE & IceBridge Project Manager: Christy Hansen

Project Concept & Assumptions

1. Deploy Dates:

- ✓ 8/25/14 – 10/3/14
- ✓ 200 science flight hours
- ✓ 6 weeks
- ✓ ~ 28 possible science flights

2. Platform: C-130

3. Location:

- ✓ Thule, Greenland
- ✓ Fairbanks, AK (Eielson or Wainwright base)
- ✓ Selected and approved by OIB sea ice lead and Rad. Bal. science team/lead

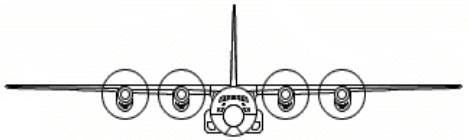
4. Science & Science Teams:

1. ***Mission Goal:*** *Develop a quantitative process level understanding of the relationship between changes in Arctic ice and regional energy budget as influenced by clouds*
2. Radiative Team was selected by NASA HQ
3. IceBridge Science Team (already exists)
4. Data Products definition – in definition phase
   - All data sets public and free

5. Sensors:

1. **SSFR** (solar spectral flux radiometer)
2. **BBR** (broad-band radiometer)
3. **4STAR** (Spectrometer for Sky-Scanning, Sun-Tracking Atmos. Research)
4. **LVIS** (land, vegetation, and ice sensor), + **Digital Camera** (geo-located)
5. **NAST-I** (National Polar-orbiting Operational Environmental Satellite System Airborne Sounder Testbed
6. **Data System** (x-chat, moving map, fwd/nadir video cam, basic air data - Static_Air_Temp, Dew_Point and Static_Pressure)
7. **In Situ Probes** (wing & window options): Microwave Radiometer, WM-2000 (TWC/LWC), optical imaging/scattering probes, TBD.

ARISE Science Objectives



Overall Objective:

Acquire well calibrated datasets using aircraft and surface-based sensors to support the use of NASA satellite and other assets for developing a quantitative process level understanding of the relationship between changes in Arctic ice and regional energy budgets as influenced by clouds.

Specific Objectives:

1. From the NASA C-130, measure spectral and broadband radiative flux profiles, quantify surface characteristics, cloud properties, and other atmospheric state parameters under a variety of Arctic atmospheric and surface conditions (including open water, sea ice, and land ice), and coinciding with satellite overpasses when possible.

2. Acquire detailed measurements of land and sea ice characteristics to help bridge a gap in NASA satellite observations of changing Arctic ice conditions.

3. Utilize surface-based targets of opportunity to complement ARISE sampling strategies with the NASA C-130, including long-term monitoring stations, research vessels, and other surface and aircraft in-situ measurement campaigns that provide corresponding information on surface conditions, radiation, cloud properties and atmospheric state.

Mission Goals

1. Work together to develop and define key, innovative science objectives to bring together Arctic radiation science and ice science; respect each other's background and science expertise. Prioritize science objectives.

2. Turn these science goals into executable flight plans; be success oriented and flexible to deal with multiple weather scenarios and challenges. Prioritize flight plans/objectives.

3. This is a fast turn-around mission; a lot of progress must happen in a short timeframe; If you have questions or run into any problems or confusion along the way, ask. Everyone must be on the same page, operating from the same assumptions.

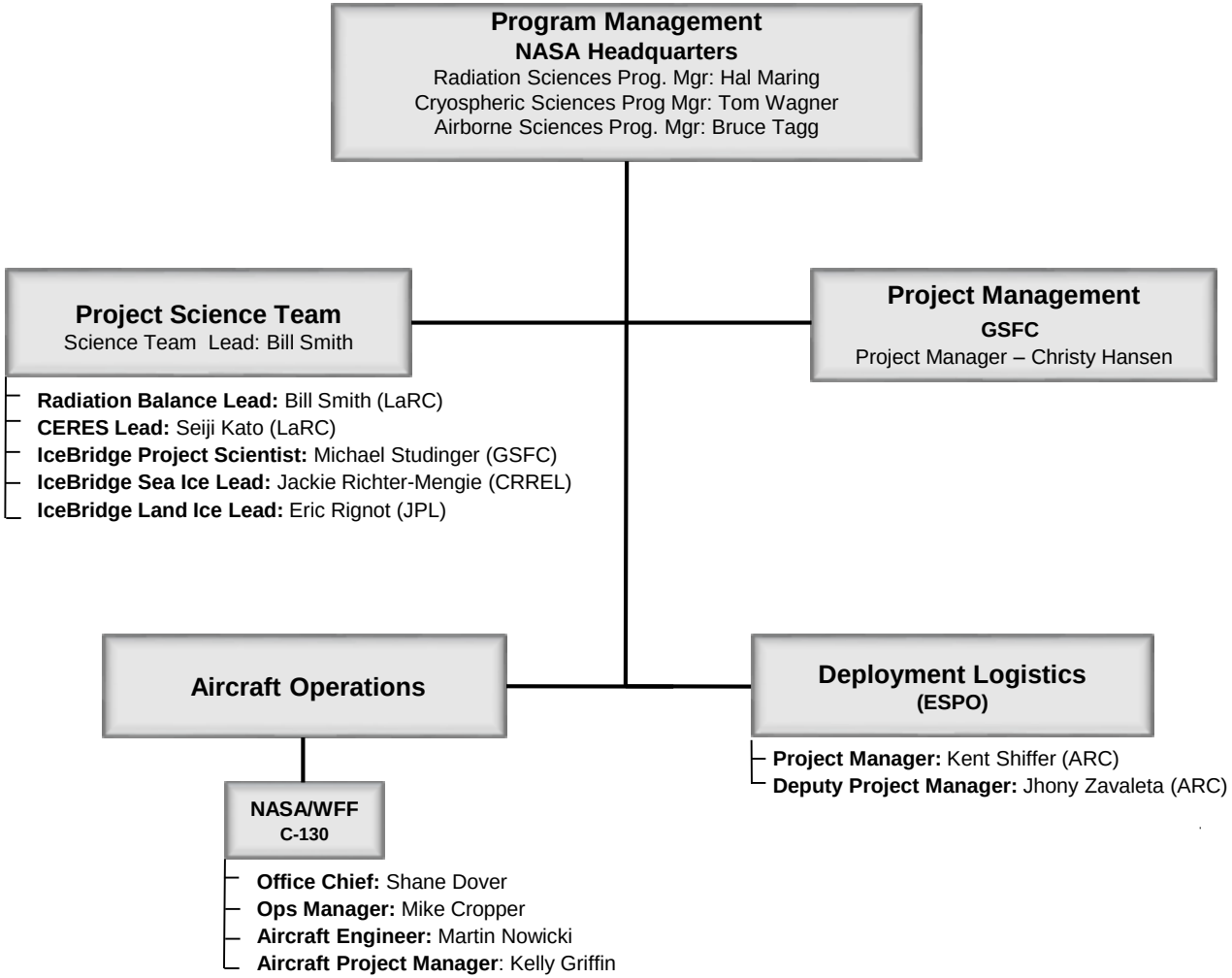
4. Identify and discuss problems as they arise, don't sit on them. Don't hesitate to ask questions.

5. Collect as much data as possible while in the field; be ready to draw upon a depth of flight options for various weather situations. We have 200 science hours and the opportunity to do great things.

6. Be on time, as a courtesy to others and so we maximize science productivity while planning, and data collected while in the field.

7. Be safe along the way.

ARISE Project Organization



Mission Planning Status

1. ***Initial*** **Science Definition and Direction** - **complete**
   - ✓ Provided by HQ, prelim input given by science team

2. **Project name selected: ARISE.** - **complete**

3. **Project logo under development –** will have team weigh in once prelim layouts come in **– in work**

4. **Science Team Introductions and Discussions**
   - ✓ First ARISE Science Team telecon conducted; discussed prelim science goals - **complete**
   - ✓ IceBridge and LVIS telecon - **complete**
   - ✓ Joint science team telecon (for leads) **- complete**
   - ✓ ** First face-face team meeting this Thurs/Fri** **- complete**
   - ✓ **On-going telecons and additional face-faces will be standard forward work**

5. **Instrument Selection 90% complete:**
   - ✓ HQ selected first round of instruments; science team added a few extras
   - ❑ Final decision on wing probes is currently underway
   - ✓ Instrument teams working with WFF to begin engineering and floor plan development
   - ✓ C-130 instrument upload prelim date is July 7th.

6. **Mission Dates & Locations: 90% complete:**
   - ✓ Science team, HQ, and aircraft office have weighed in; 10% Thule-based, 90% Fairbanks-based
   - ❑ Site survey planned to determine whether FB base is Eielson AFB or Wainwright Army base
   - ✓ 200 science hours are funded, with the possibility to add more; chance final week could be extended by 1

Mission Planning Status - cont

7. Science Definition Status:

- ✓ Science definition and prioritization began in April – **complete**
  - IceBridge and Radiation science community input, plus HQ
- ✓ Primary Mission Science Objectives released – early May- **complete**
- ❑ Science Objective Prioritization - **in work**
- ❑ **Define data products and deadlines – meeting at HQ next week**

8. Flight Planning Status: on-going

- ✓ Initial flight planning requirements and criteria discussed at science team meeting in late May
- ✓ This will be on-going work over the next 1-2 months
- ✓ Initial flight planning includes the following teams:
  - ARISE Project scientist and Project manager
  - OIB science team and radiation/cloud team
  - OIB/LVIS flight planners, radiation/cloud flight planners, cloud modelers
  - Prelim sample flight plans for review in early June
  - **Note: cloud/radiation plans will show samples and boundary conditions, as the exact lines will not be known until morning of based on cloud locations, types, and weather; will include above clouds, through clouds, and under clouds, over various surfaces (sea ice, water, land ice)
- ❑ Will have an official field Flight Planning Book that captures mission profiles, priorities, and flight planning matrices that outline key targets (overflights, underflights, cloud types, sea ice, land ice, open water, etc.)

Satellite and Ground Target Coordination Summary

S/C									A/C	Ground Sites							
ICESat	ICESat-2	CryoSat-2	Mabel	TERRA	A-TRAIN	NPP	AVHRR	METOP	C-130 (SIZRS)	ONR MIZ	Barrow (ARM/NOAA)	Oliktok (ARM)	Eureka (CANDAC/ NOAA)	Alert (EC/NOAA)	Summit	Oden (vessel)	Mirai (vessel)
Ice Monitoring Satellites/simulators				*Radiation Monitoring satellites*					*FB base*	*Alaskan North Slope*			*Northern Canada*		*Central G/L*	*E. Siberian Sea*	*Chukchi Sea*

Flight Planning Matrix- early draft

SCIENCE OBJECTIVES	S/C								
	Ice Monitoring Satellites/simulators				*Radiation Monitoring satellites*				
	ICESat	ICESat-2	CryoSat-2	Mabel	TERRA	A-TRAIN	NPP	AVHRR	METOP
1. Measure Radiation Flux									
A. Broadband									
B. Spectral									
C. Cloud Location: under clouds									
D. Cloud Location: over clouds									
E. Cloud Location: through clouds									
F. Surface Type: Open water									
G. Surface Type: Sea ice									
H. Surface Type: Land ice									
I. Surface Type: MIZ/ice/water boundary									
2. Measure Sea Ice & Land Ice									
A. Sea ice: South Basin Transect									
B. Sea Ice: Zig/Zag East									
C. Sea Ice: North Pole Transect									
D. Sea Ice: Nansen Gap									
E. Jakobshavn: western most ICESat grid									
F. NW Glaciers: widely grid									
G. Jakobshavn: interior grid									
H. NW Glaciers: narrow grid near terminus									
3. TBD									
4. TBD									
	C-130 (SIZRS)	ONR MIZ	Barrow (ARM/NOAA)	Oliktok (ARM)	Eureka (CANDAC/NOAA)	Alert (EC/NOAA)	Summit	Oden (vessel)	Mirai (vessel)
	FB base	*Alaskan North Slope*			*Northern Canada*		*Central G/L*	*E. Siberian Sea*	*Chukchi Sea*
	A/C	Target s of Opportunity: Ground Sites							

FLIGHT TRAJECTORY KEY

1. high transit
2. straight & level
3. low
4. spiral pattern
5. grid pattern
6. racetrack pattern
7. sharp/quick/tight asent/descent
8. flat ascent/descent

SCIENCE PRIORITIES (not yet prioritized)

- High
- Medium
- Low

- Radiation Satellite Cal/Val
- Ice Satellite Cal/Val
- Radiation Flux over water
- Radiation Flux over sea ice
- Radiation Flux over land ice
- Radiation Flux over MIZ (water/ice)
- IceBridge Sea Ice
- Icebridge Land Ice
- Cloud Modeling
- Ground Target Overflights (TOA)

Planning Guidelines

1. If no other constraints, LVIS prefers 28,000 feet.
2. LVIS will need a ramp pass prior to every landing
3. BBR will need a cal pass over Barrow
4. LVIS prefers flying under clouds, when possible

Targets of Opp: Coordination - prelim

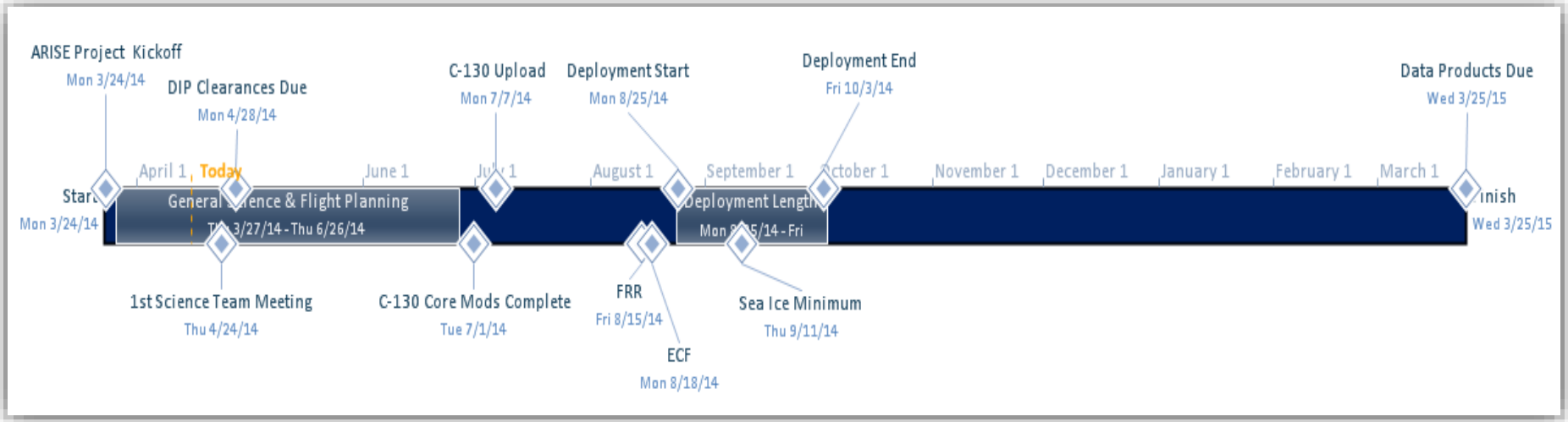
	A/C	Ground Site Coordination							
	C-130 (SIZRS)	ONR MIZ (sea ice-based)	Barrow (ARM/NOAA)	Oliktok (ARM)	Eureka (CANDAC/NOAA)	Alert (EC/NOAA)	Summit	Oden (vessel)	Mirai (vessel)
	FB base	*Alaskan North Slope*			*Northern Canada*		*Central G/L*	*E. Siberian Sea*	*Chukchi Sea*
Dates	9/23-9/26	Spring/Summer/Fall 2014							9/4 - 9/24
Contact	Jamie Morison, Axel Schweiger, UW APL	Martin Jeffries, ONR	Mark Ivey, DOE	Mark Ivey, DOE	Jim Drummond, Dalhousie Univ., Taneil Uttal, NOAA	Jim Drummond, Dalhousie Univ., Taneil Uttal, NOAA	Matt Shupe, CU/NOAA	Matt Shupe, CU/NOAA	Jun Inoue, NIPR Japan
Location	150W and 140W, 72N to the marginal ice zone at ~ 76N along these lines	Ice-based array of instruments drifting through the Beaufort and Chukchi Seas	Barrow/North Slope	Oliktok/North Slope	Eureka, Canada	Alert, Canada	Greenland Ice Sheet	East. Siberian Sea. Moving: 73N 175W (850 miles to FB) to 80N 130E	Chukchi Sea. Near 77N 168W
Measurements	1) Atmosphere properties via air-dropsondes. 2) Ocean properties via AXCTD, AXCP, and UpTempO buoys	Atmosphere, ice and ocean properties throughout the seasonal evolution of the marginal ice zone	1) 4 times daily soundings. 2) Measures everything. 3) scanning radar. 4) coastal	1) 2 times daily soundings. 2) Most instruments. 3) Potential balloon ops. 4) coastal	1) complex terrain. 2) radar, lidar, microwave rad. 3) 2 times daily soundings	1) radiation. 2) coastal with adj. multi-year ice 3) 2 times daily soundings	1) links with land ice. 2) cloud radar, lidars, microwave radiometer, spectral IR, surface fluxes, and more. 3)2 times daily soundings	1) In MIZ and ice. 2) cloud radar, lidar, microwave rad, wind profile, sfc flux. 3) 4 times daily soundings	1)scanning precip. Radar, rad, surface flux/cond. 2) 4-8 daily soundings
General Info	Done in coordination with the USCG Arctic Domain Awareness		500 miles to FB	400 miles to FB	340 miles to Thule	420 miles to Thule	600 miles to Thule	**cannot fly into Russian airspace**	not in pack ice. 905 miles to FB.


Ground Site Targets of Opportunity (TOA)
Observatories
Russia
End Sept: 1800 miles
Oden
180
Late Aug: 850 miles
Mirai 4-24 Sept
Atqasuk
950 miles
Barrow
500 miles
Alaska
Fairbanks
Oliktok
400 miles
135
90
85
1100 miles
Ny-Alesund
(Svalbard)
80
75
420 miles
340 miles
Alert
Eureka
Greenland
600 miles
Thule
Summit
45
90
Canada
Note: slide created by Matt Shupe

Weather Forecast Support

Location	Weather Support - prime	Weather Support – alternate option
Thule	• Use Thule weather office; confirmed	• Bring a wx person with us – TBD/GMAO or other
If Eielson AFB	• Get permission to use base weather team; verify they are skilled in Arctic wx • ESPO will look into this at site survey	• Use NWS Fairbanks (NOAA office); may just be a phone call, etc.; Bill/Christy to inquire about this • Bring a wx person with us – TBD/GMAO or other
If Wainwright Army base	• Get permission to use base weather team; verify they are skilled in Arctic wx • ESPO will look into this at site survey	• Use NWS Fairbanks (NOAA office); may just be a phone call, etc.; Bill/Christy to inquire about this • Bring a wx person with us – TBD/GMAO or other

Mission Planning Calendar



Deployment Calendar

Has been evaluated by science team leads, and weighed against aircraft and logistical requirements

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 1	25-Aug-2014	26-Aug-2014	27-Aug-2014	28-Aug-2014	29-Aug-2014	30-Aug-2014	31-Aug-2014
	WFF - Thule	(no fly day) unpacking and set up acces to plane	1	2	3	weekend airfield closure ask Thule to open	weekend airfield closure
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Week 2	1-Sep-2014	2-Sep-2014	3-Sep-2014	4-Sep-2014	5-Sep-2014	6-Sep-2014	7-Sep-2014
	4 labor day	5	Thule - Fairbanks Transit (collect data)	hard down day unpacking and set up	6	7	hard down day placeholder
	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14
Week 3	8-Sep-2014	9-Sep-2014	10-Sep-2014	11-Sep-2014	12-Sep-2014	13-Sep-2014	14-Sep-2014
	8	9	10	11	12	13	hard down day placeholder
	Day 15	Day 16	Day 17	Day 18	Day 19	Day 20	Day 21
Week 4	15-Sep-2014	16-Sep-2014	17-Sep-2014	18-Sep-2014	19-Sep-2014	20-Sep-2014	21-Sep-2014
	14	15	16	17	18	19	hard down day placeholder
	Day 22	Day 23	Day 24	Day 25	Day 26	Day 27	Day 28
Week 5	22-Sep-2014	23-Sep-2014	24-Sep-2014	25-Sep-2014	26-Sep-2014	27-Sep-2014	28-Sep-2014
	20	21	22	23	24	25	hard down day placeholder
	Day 29	Day 30	Day 31	Day 32	Day 33	Day 34	Day 35
Week 6	29-Sep-2014	30-Sep-2014	1-Oct-2014	2-Oct-2014	3-Oct-2014	4-Oct-2014	5-Oct-2014
	26	27	28	packing	Fairbanks - WFF	download?	
	Day 36	Day 37	Day 38	Day 39	Day 40	Day 41	Day 42

Assumptions & Key

1. Assume **8- hr.** science flights
2. Possible Science Flts: **28**
3. Assume 2/3s are AK based; 1/3 Thule based
4. Alaska Based Flights Opp: **23**
5. Thule Based Flight Opp: **5-6**
6. **Possible Science Flights**
7. **Transit Flights**
8. **Airport Closures**
9. **Pack/Down Days**

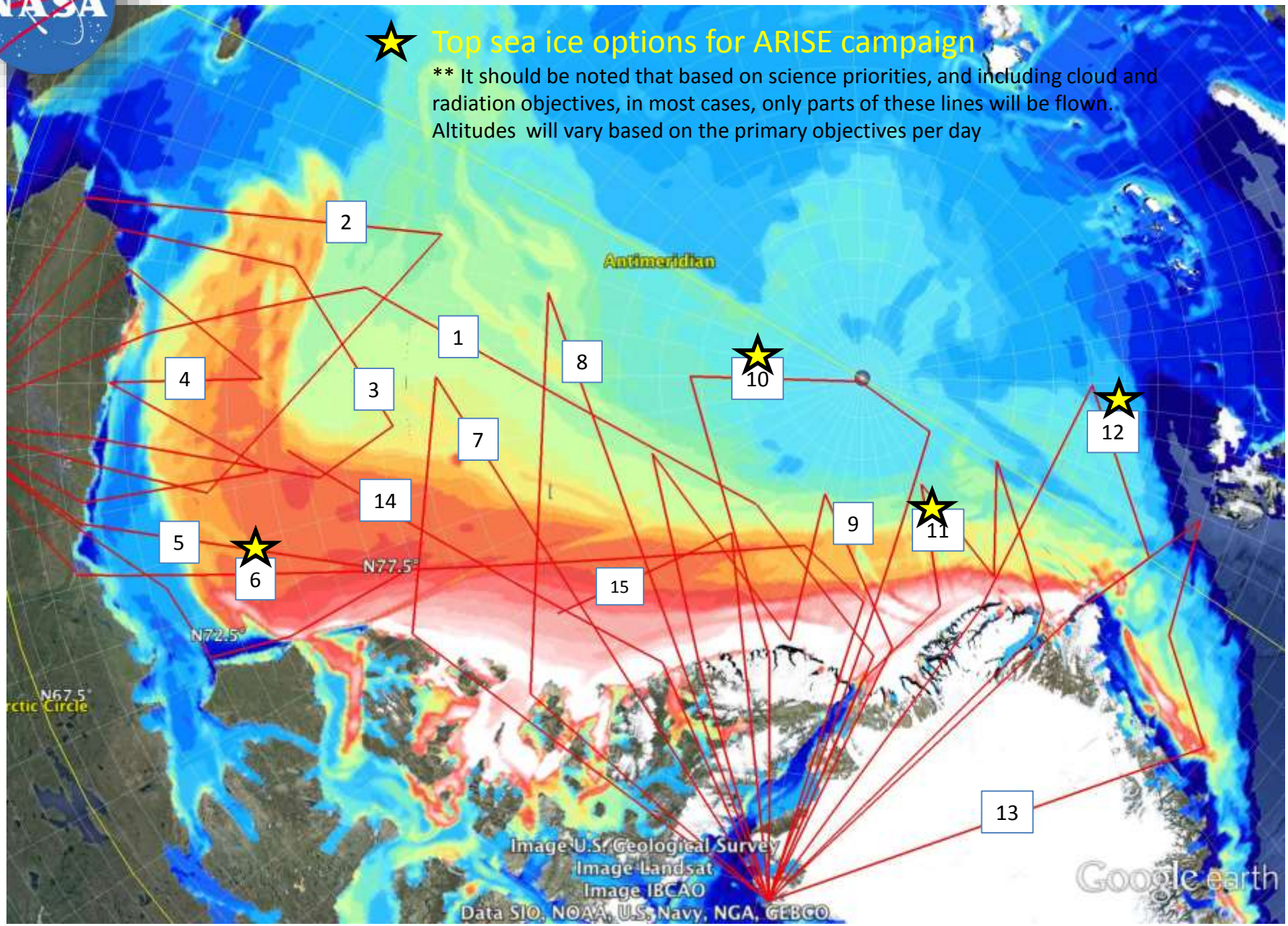
Daily Field Schedule - Draft

TIME	ACTIVITY			TIME
	CREW	Instrument Teams	Science & Mgmt Leads, Flight Planners	
6:00 am	Crew day starts: **Power on C-130; access to airplane**	Prep instruments: Clean, N2 purge, warm up, collect GPS data, etc.	Weather office ops: check weather, select flight plan for the day	6:00 am
6:30			Inform team of daily flight plan	6:30
7:00				7:00
7:30		C-130 doors closed; team ready	Science lead, Proj Mgmt, and Wx/Satellite POC remain on ground; tracking wx, mission following, and support	**7:30**
8:00	**TAKEOFF**	**TAKEOFF**		**8:00**
4:00	**LAND**	**LAND**		**4:00**
4:30		Post Mission Instrument work		4:30
5:00		Post Mission Instrument work		5:00
5:30		Post Mission Instrument work ** Team Tag-up for next Day**	**Team Tag-up for next Day**	5:30
6:00 pm	Crew day ends; **aircraft is powered down and closed for evening**	Post Mission Instrument work	Science Lead –science report Proj/Mission Mgr-aircraft report & flight metrics	6:00 pm

1. **Prelim flight plan options – sea and land ice (slides 15-17)**

2. **Radiation/Cloud and Joint Flight Plan samples – under development**
   - ✓ To include various meteorological conditions
   - ✓ Lines shown over clouds, under clouds, through clouds
   - ✓ Over sea ice, water, and land ice
   - ✓ Various altitudes
   - ✓ Various patterns: racetrack, grid, flat ascents/descents, straight and level, satellite and TOA lines

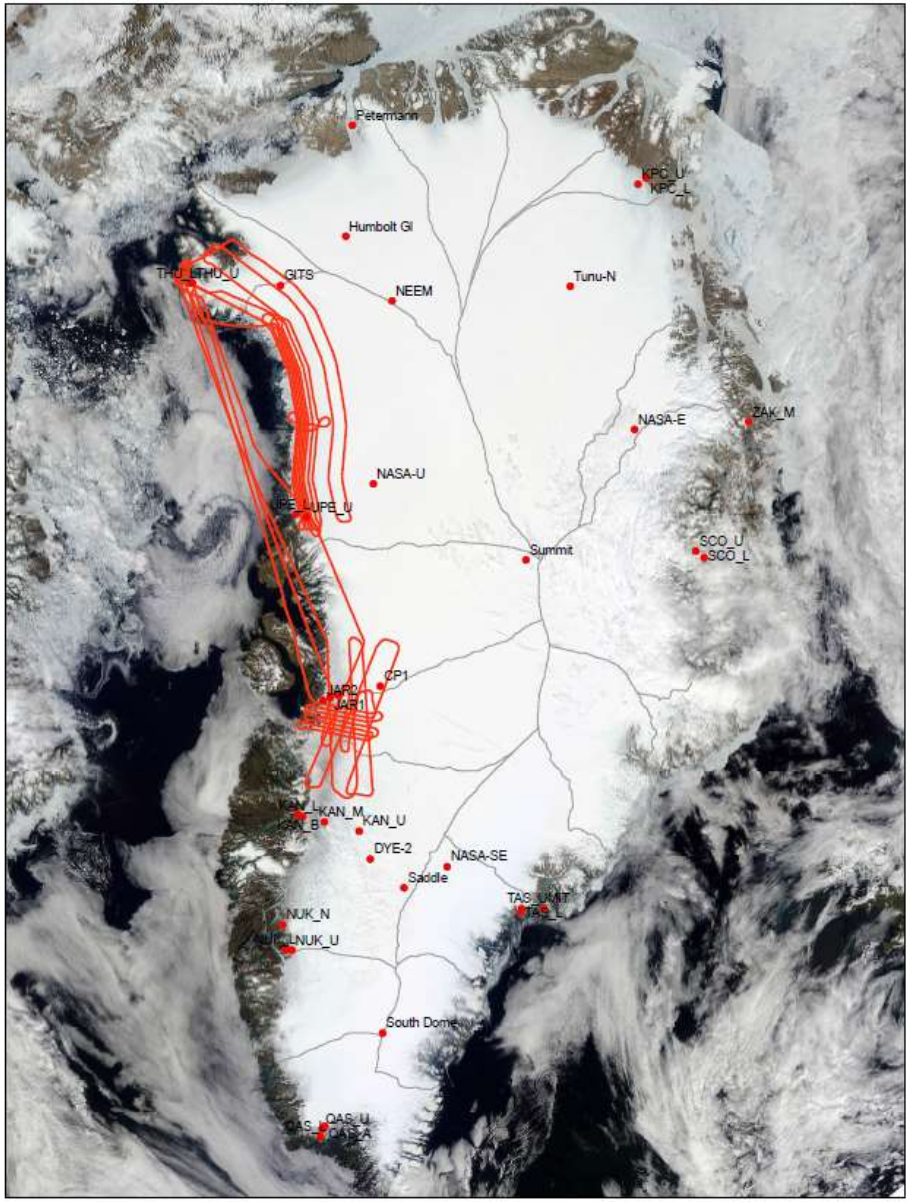
IceBridge Sea Ice Flight Line Examples - prelim



IceBridge Sea Ice Flight Lines for Spring – baseline for summer/fall planning

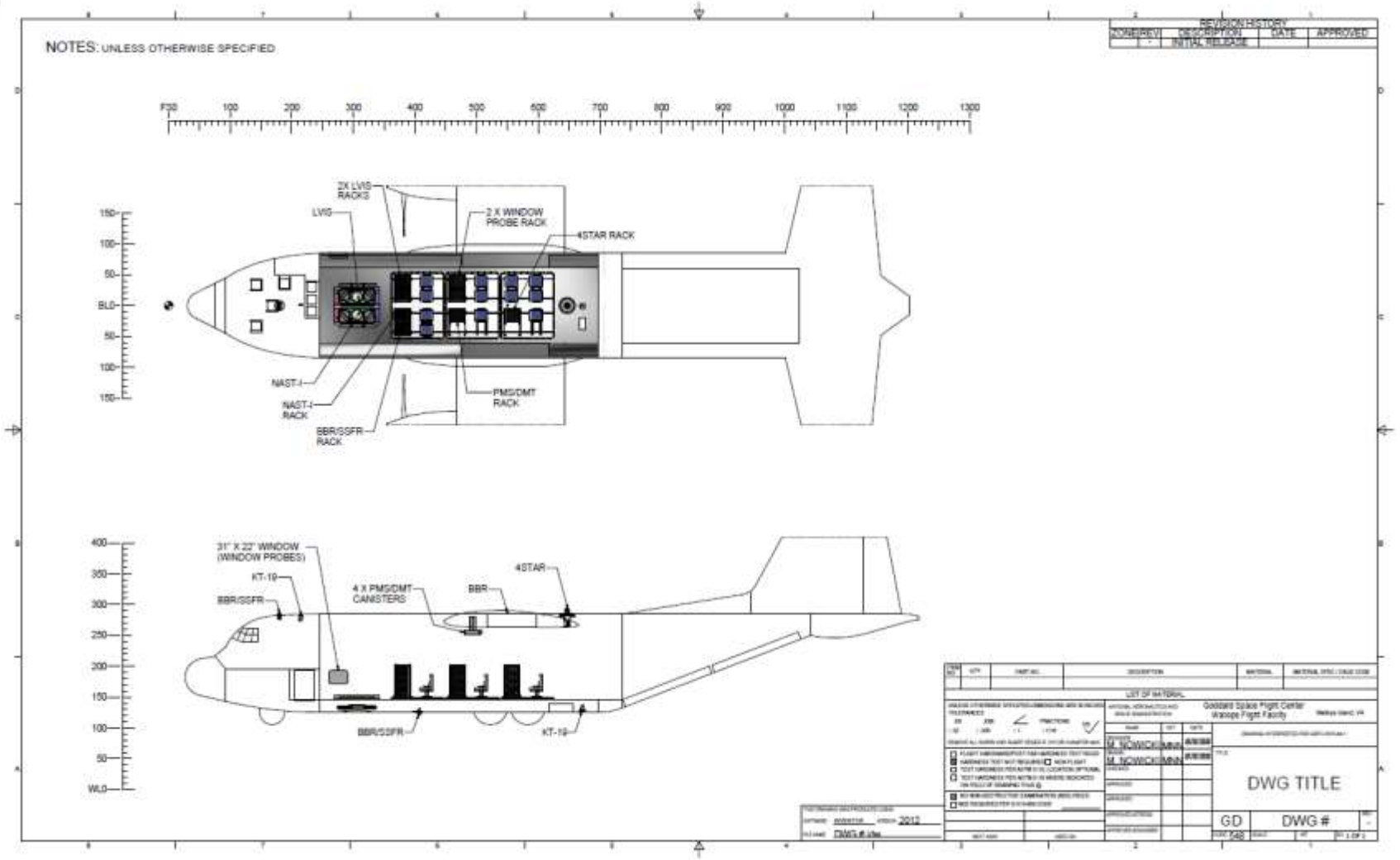
Name	Comments	Map Number	Base	Last flown	Priority (2013)	Priority (2014)
Laxon Line		1	Thule	2013	H*	H
Beaufort-Chukchi Diamond		2	Fairbanks	2013	H	H/M
North Beaufort Loop	Priority drops to 'Medium' once Beaufort-Chukchi Diamond is flown	3	Fairbanks	new		H/M
SIZRS ZigZag	NRL Barrow (15-26 March)	4	Fairbanks	2013	M	H
Eastern Beaufort Sea	CryoVEx 2014/ONR MIZ (19-23 March)	5	Fairbanks	2103	H	H
South Basin Transect		6	Fairbanks	2013	H*	H
Canada Basin South	MEDEA (?); Priority drops to 'Medium' once Canada Basin North is flown	7	Thule	2013	H	H/M
Canada Basin North*	MEDEA (?)	8	Thule	2013	H	H/M
ZigZag West (modified)*	CryoVEx2014/Alert C2 under flight; option for ascending orbit (25-28 March); Priority drops to 'Medium' once NP Transect is flown	9	Thule	2012	Not recommded in 2013	H/M
North Pole Transect*	CryoVEx2014/Alert C2 under flight; option for descending orbit (25-28 March)	10	Thule	2013	H	H
ZigZag East		11	Thule	2013	H	H
Nansen Gap		12	Thule	new		H
Giles Gateway	Modified to extend eastward in Fram Strait	13	Thule	2102	M	M
Connor Corridor	AltiKa under flight	14	Thule	2012	M	M
CryoVEX2014/Nord	Ice camp over flight and backup for C2 under flight (29 March – 2 April)			new; one time only		H
Cryosat underflight / Wingham Box		15	Thule	2013	H	L
Eureka! Grid	Eniv. Canada (24 March – 2 April); good opportunity to cover Nares Strait		Thule	new; one time only		H

IceBridge Land Ice Line Examples - prelim



C-130

Floor Plan Layout Drawing



Note: slide created by Martin Nowicki