Operation IceBridge

Response to Sea Ice Group Mid-Term Review Recommendations

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Note: Recommendations from the Mid-Term Review Team are in black font and responses from the Project Science Office are in blue font.

General Recommendations and Response

Project Science Office Response

The Mid-Term Review Team has done an outstanding job in reviewing all science relevant aspects of Operation IceBridge and has come up with an excellent list of recommendations. Many of the recommendations are part of outstanding science questions in the field of sea ice research and will require a much broader involvement of the science community as well as pooling of available resources in order to make significant progress on these issues. IceBridge can play a leadership role in some of these topics. However, IceBridge is a cost constrained mission, and available resources in terms of funding, personnel, and aircraft operations are already stretched thin. It is unlikely that additional funds will be made available for a cost constrained mission and therefore adding new tasks will likely require scaling back existing efforts or terminating them entirely. The Project Science Office agrees with all recommendations but is facing the reality of limited resources that are available to run the mission and take on new tasks. A growing concern from a mission management point of view is mission creep and the danger of losing focus on the main mission goals by trying to solve too many problems at once. With these constraints in mind, the Project Science Office, together with the IceBridge Science and Instrument Teams, NASA Headquarters, and if necessary, the science community, will develop a prioritized plan over the next couple of months of which recommendations can likely be implemented.

Response to Specific Recommendations

Mid-Term Review Team Recommendations

The Sea Ice Group recommends the following actions, listed in priority order, for the second half of OIB:

(1) Establish a working group charged with estimating snow depth and errors, from snow radar, altimeter, and other remote and in-situ measurements and models.

Response from Project Science Office: The Project Science Office fully supports this excellent recommendation. NASA Headquarters has already established the Snow Thickness Over Sea Ice Working Group (STOSIWIG) that will have its first meeting in September 2014.

(2) Pursue additional opportunities to expand the seasonal and spatial coverage of OIB sea ice and snow measurements, and strengthen connections between OIB and in-situ measurement programs.

Response from Project Science Office:

Spatial coverage: The Project Science Offices agrees with this recommendation. IceBridge has been actively pursuing expanding the survey areas in the Arctic and Antarctic within the existing financial, logistic and legal constraints. The Project Science Office will continue to pursue access to Russian air space but the US State Department indicates that it is unlikely that NASA or any other US government aircraft will obtain the necessary Diplomatic Clearance to enter Russian FIR in the foreseeable future.

Seasonal coverage: IceBridge has been collecting summer/fall data sets in the Arctic when additional funds became available in 2013 and 2014. The Project Science Office, together with NASA HQ and the IceBridge Science Team, will continue to pursue these additional opportunities when possible.

In-situ measurements: Since its beginning in 2009 IceBridge has successfully coordinated airborne data acquisition with 13 ground experiments in the Arctic (Appendix A). This is a tremendous data set that we plan to continue to grow when opportunities arise. The newly establish STOSIWIG working group will actively get involved in analyzing these data sets and making recommendations for the design of future experiments comparing in-situ and airborne data.

(3) Update the L1SR document and clarify how the baseline requirements follow from the science goals, especially the goals related to climate dynamics and forecasting.

Response from Project Science Office: The Project Science Office fully agrees with this recommendation. The IceBridge sea ice science team has been tasked to revisit the L1SR and address the issues raised by the review team.

(4) Formally establish the annual open meeting to enhance the effectiveness of input to OIB from the sea ice/snow research community on flight lines, instruments, data access and other topics.

Response from Project Science Office: This is an excellent recommendation that has the full support from the Project Science Office. The team lead of the IceBridge sea ice science team has already been tasked to expand on existing efforts to involve the broader science community and has agreed to run the first open meeting in January 2015 at NASA's Goddard Space Flight Center. The sea ice team lead has been given the mandate by NASA Headquarters to name and appoint members to the new NASA Sea Ice Working Group (NSIWoG, pronounced N-See-Wog). The IceBridge Project Science Office is looking forward to work with this new working group. IceBridge science instruments are selected by an open ROSES competition every 3 years. It is unclear how community input on instrumentation can be reconciled with the existing transparent process of competed, peer-reviewed instrument selection.

(5) Establish a working group charged with estimating sea ice thickness and errors from altimeter, radar and other remote and in-situ measurements and models, spanning the ICESat-ICESat2 era.

Response from Project Science Office: The Project Science Office agrees with this recommendation but has no mandate to establish such a working group. This is considered to be an action item for NASA Headquarters rather than the Project Science Office.

The following recommendations are specific to OIB datasets and data management:

1) Implement a plan for reprocessing the remaining legacy products.
2) Assure that OIB data formats are compatible with those of ICESat, ICESat-2 and CryoSat-2.
3) Evaluate how to enhance the use of OIB data by modelers.
4) Evaluate how ECS can better support OIB, and airborne missions generally.

Response from Project Science Office: As mentioned by the review team the Project Science Office, ESDIS, NSIDC and the IceBridge instrument teams are well aware of many of the issues associated with the mandatory format change half-way through the mission and have been actively working on solutions. As a result of this, most recommendations specific to IceBridge datasets and data management have already been accomplished. In particular:

1) Implement a plan for reprocessing the remaining legacy products.

Response from Project Science Office: All legacy data sets will be reprocessed and re-ingested at NSIDC. Some instrument teams require additional funding which has been secured for FY15. The Project Science Office together with NSIDC, ESDIS, and the instrument teams have developed a plan and timeline for conversion of the legacy data products that will be completed in Spring 2015.

2) Assure that OIB data formats are compatible with those of ICESat, ICESat-2 and CryoSat-2.

Response from Project Science Office: The IceBridge ATM and LVIS laser altimeter data are in HDF5, which is the same format used by ICESat and ICESat-2. CryoSat-2 has its own format (a mixture of ASCII header information and binary data) that does not adhere to any standards. It is not advisable to provide IceBridge data in a format that would be compatible to the non-standard CryoSat-2 format definition, which was specifically designed for CryoSat-2 data products.

3) Evaluate how to enhance the use of OIB data by modelers.

Response from Project Science Office: The Project Science Office together with the Science Team is constantly looking for ways on how to enhance the use of IceBridge data not only for modelers but for other user communities as well. The Project Science Office has already synthesized the Level 1B instrument data, which is likely of little use to modelers, and created a new data product containing important geophysical parameters such as snow depth and sea ice thickness which should be of use to the modelling community. These products have been used in recent studies investigating model parameterizations and seasonal forecasting capabilities. These efforts are ongoing and will continue. For example, the sea ice modeling community had indicated the need for an Arctic wide sea ice thickness product on a regular grid that is compatible with the grid formats and map projections that are widely used. In a response to this the Project Science Office has created a CryoSat-2 based sea ice thickness product that meets the above criteria. Many of the IceBridge data products have already confidence estimates directly in the data files while others have these estimates in the documentation. The most important data set for sea ice is the sea ice thickness product that includes many error estimates in the data file. See http://nsidc.org/data/docs/daac/icebridge/idcsi2/index.html.

4) Evaluate how ECS can better support OIB, and airborne missions generally.

Response from Project Science Office: The Project Science Office fully agrees with this recommendation. ESDIS has already initiated an activity under the auspices of the Earth Science Data Systems Working Group (ESDSWG) to conduct an assessment of the state of airborne science data management across NASA. Once this assessment is available, ESDIS will use it as an input to develop a set of plans and recommendations for how ESDIS can better support data providers and improve the state of airborne data management across NASA. The experience with IceBridge will be enormously helpful in the development of those plans. The Project Science Office, ESDIS and NSIDC have bi-weekly telecons to monitor progress and resolve any existing issues. To our knowledge the support from ECS has been good and it is unclear what the review team means. ESDIS and NSIDC task ECS to support data ingest and other things. The Project Science Office sees only very little of this process.

General response: IceBridge provides over 60 different data products through NSIDC that range in size and complexity from simple ASCII data files of several Megabytes to Giga byte sized complex radar and laser data products. It has been pointed out that IceBridge is the most detailed large scale survey of the Arctic ever done. There are no other projects that are remotely comparable. The data products allow scientists to solve complex problems in Earth system science. The data products are necessarily equally complex as the science problems. The glaciology community has nicely embraced the challenges that are associated with handling massive volumes of complex data sets that are required to solve complex problems in Earth system science. The new data standard for IceBridge has reduced the number of data formats to 5 ESDIS approved formats, two recommended formats (OGC KML and geotiff) and two more formats (IceBridge ASCII and LAS standard) that are IceBridge specific and are currently in the process of getting approved as ESDIS standard. Given more than 60 data products 9 different formats is a comparably small number.

Appendix A

Arctic

Year	Area	Organizations/PI	Experiment
2009	Fast ice north of Cape Morris Jesup	CRREL, DTU Space	GreenArc
2011	Beaufort Sea	NRL, CRREL	ICEX 2011
2011	North of Alert	ESA, UCL, York Univ	CryoVEx
2012	Barrow, AK Elson Lagoon	JPL, CRREL, UW APL	BROMEX
2012	North of Alert	ESA, DTU Space, York U	CryoVEx – no ground data
2012	Fram Strait	ESA, DTU Space, York U	CryoVEx – no ground data
2012	Qaanaaq Fjord, Greenland	J Wilkinson (SAMS), S Hanson (DMI), P Elosegui (ICE), H Singh, P Kimball (WHOI)	Qaanaaq Sea Ice Field Campaign
2013	Barrow, AK	UW APL, NRL, U Delaware	NRL/BROMEX/AOX/NAICEX/MERLIN
2014	Barrow, AK	CRREL, NRL	NRL DISTANCE
2014	Canada Basin	CRREL, ONR, NRL, ESA, York University	ONR MIZ, CryoVEx
2014	North of Alert	ESA, DTU Space, York U	CryoVEx – no ground data
2014	Cape Morris Jesup	ESA, York University	CryoVEx
2014	Eureka Sound	Environment Canada	In support for NASA/CSA agreement

Antarctic

Note: both attempts have been unsuccessful due to weather, time and other constraints.

Year	Area	Organizations/PI	Experiment
2010	Bellingshausen	BAS, DTU Space	ICEBell
2013	McMurdo Sound	Gateway Antarctica, York University	Antarctic Sea Ice Thickness Mapping 2013 in McMurdo Sound (K063)