ICESat-2 Early Adopter Round Table Summary

In February 2018, the ICESat-2 Applications Team hosted three thematically directed virtual round tables, listed below, with the goal of getting all Early Adopters up to speed on the latest developments for their anticipated primary science data products of interest and on the same page with regards to what the data products will look like and how they are expected to perform over different ice, land, and water landscapes.

- **Round Table** I: ICESat-2 Sea Ice, Land Ice & Ocean Science Data Products; Thursday, February 15, 2018
- **Round Table II**: ICESat-2 Land-Vegetation and Atmospheric Science Data; Thursday, February 20, 2018
- **Round Table III**: ICESat-2 Inland Water Science Data Product; Tuesday, February 27, 2018

The round tables brought together the ICESat-2 Early Adopters with ICESat-2 Science Definition Team (SDT) members, representatives from the ICESat-2 Project Science Office, representatives from the National Snow and Ice Data Center (NSIDC) DAAC, and representatives from NASA Headquarters (see Appendix I breakdown for each round table). We also had participation from some of the Early Adopter end users, as well as from the NASA Applied Remote Sensing Training (ARSET) team.

The round tables provided an opportunity for the ICESat-2 SDT members to articulate the opportunities and challenges related to the functionality of their science data products. SDT members also had the opportunity to learn about the Early Adopter research and current progress of each team. Participation from the Science Definition Team was very strong and included 9 of the 12 ICESat-2 SDT members. Included were: -

1. Ben Smith, Polar Science Center, Applied Physics Lab, University of Washington (SDT Land Ice Data Product Lead)
2. Katherine Pitts, Applied Research Laboratories, University of Texas at Austin (on behalf of Amy Neuenschwander, SDT Vegetation Data Product Lead)
3. Lori Magruder, Applied Research Laboratories, University of Texas at Austin (Science Definition Team Lead)
4. Michael Jasinski, NASA Goddard Space Flight Center (SDT Inland Water Data Product Lead)
5. Ron Kwok, NASA Jet Propulsion Laboratory (SDT Sea Ice Data Product Lead)
6. Sinead Farrell, Earth System Science Interdisciplinary Center (ESSIC) (Sea Ice SDT)
7. Sorin Popescu, Texas A&M University (Vegetation SDT)
8. Steve Palm, NASA Goddard Space Flight Center (SDT Atmosphere Data Product Lead)
9. Yuikui Yang, NASA Goddard Space Flight Center (ICESat-2 SDT)

Lori Magruder, Science Definition Team Lead, discussed the mission status and key dates for the post-launch timeline in two of the round tables. Remaining SDT members discussed their respective products, as well as cal/val plans. SDT members helped develop the seed questions (shown in Appendix V) distributed to Early Adopters before the meeting, which helped guide the discussion during the round tables.

Out of the 22 Early Adopters currently hosted by ICESat-2, 13 attended the round tables (see Table in Appendix IV for a description). Appendix I shows the specific Early Adopters who attended each round table and reasons for why other Early Adopters did not participate. The round tables provided an opportunity for Early Adopters to share their research and progress, as well as to receive direct clarification from the SDT members. The round tables also allowed an opportunity for less active and new Early Adopters to learn about the latest data product developments and status of the mission.

Steve Tanner and Amy Steiker from the National Snow and Ice Data Center participated in all three of the round tables. They provided an overview of the planned DAAC services for ICESat-2 and demonstrated Earthdata Search and exploration of imagery using Worldview Applications. The round tables provided an opportunity for Steve and Amy to capture feedback on needs for data access, tools and services.

Overall, the round tables provided an opportunity for Early Adopters to:

1. align their expectations for the ICESat-2 data with the expected functionality of the data products described by the SDT members
2. learn about the mission status, expected plans for release of the data products, as well as planned support for data usage and tools
3. clarify what is expected moving forward and how their contribution fits into the bigger picture of NASA's Applied Sciences goals

SDT members and other participants were able to learn about the Early Adopter end-user goals and their current research milestones, and how ICESat-2 science data may contribute effectively.

Timing was an issue for each of the round tables, which were conducted as 2 to 3 hour webinars. While the goal was to keep the presentations at 5 minutes for Early Adopters and 10-20 minutes for other participants, some of the presentations ran longer or more time was allowed for Q&A. The NSIDC DAAC presentations and Worldview Applications demonstrations were cut short and only selected seed questions were discussed in each round table.

This document reports on the findings, outcomes and follow-on actions for each round table.

Summary: ICESat-2 Sea Ice, Land Ice & Ocean Science Data Round Table

Round Table I Summary	**Round Table Name:**	**ICESat-2 Sea Ice, Land Ice & Ocean Science Data Products**
	Date:	**Thursday, February 15, 2018**
	Time:	**2:00-5:00pm (Eastern)**
Early Adopter Attendees:	• **Andrew Roberts, Naval Postgraduate School** • **Bradley Zavodsky, NASA Marshall Space Flight Center Earth Science Office/NASA SPoRT & Emily Berndt, Marshall Space Flight Center Earth Science Office/NASA SPoRT** • **Stephen Howell, Environment and Climate Change Canada** • **David A. Hebert, Naval Research Laboratory** • **Hongjie Xie, University of Texas at San Antonio** • **Guy Schumann, Dartmouth Flood Observatory, University of Colorado Boulder**	
Science Definition Team Member Attendees:	• **Lori Magruder, Applied Research Laboratories, University of Texas at Austin** • **Sinead Farrell, Earth System Science Interdisciplinary Center (ESSIC)** • **Ron Kwok, NASA Jet Propulsion Laboratory** • **Mike Jasinski, NASA Goddard Space Flight Center** • **Ben Smith, Polar Science Center, Applied Physics Lab, University of Washington**	
Other Attendees	• **See Appendix I; total attendees: 29**	
Agenda Items (refer to Appendix II for meeting agenda)		
Summary of 2/15 Meeting: 1. **Lori Magruder provided overall status of mission; an overview of the data production and data product evaluation; review of the on-orbit commissioning plan; and key dates during post-launch timeline.** 2. **Kate Ramsayer (NASA GSFC) discussed the NASA Earth Campaign 2018 and possible involvement of Early Adopters in the effort.** 3. **Participants reviewed the sea ice and land ice products.** ▪ **Ron Kwok provided an overview of the freeboard surface height retrieval scheme, ice water classification and along-track/gridded products.** ▪ **Ben Smith described the land ice height (ATL06), land ice height time series (ATL11) and digital elevation models and elevation change products (ATL15, ATL16), including the expected resolution and volume of each product.** 4. **Sinead Farrell described the post-launch validation and testing activities, both current and future.** 5. **Early Adopters discussed status of their research (objectives, approach, key milestones, schedule and issues).** 6. **Early Adopters reviewed seed questions and provided input as time permitted.** 7. **Steve Tanner provided an overview of the NSIDC DAAC and planned services for ICESat-2. Amy Steiker demonstrated Earthdata Search and exploration of imagery using Worldview Applications: https://worldview.earthdata.nasa.gov**		

Round Table I Summary	Round Table Name:	ICESat-2 Sea Ice, Land Ice & Ocean Science Data Products
	Date:	Thursday, February 15, 2018
	Time:	2:00-5:00pm (Eastern)
Findings	1. Nancy Searby inquired as to any Early Adopter research in the Hindu Kush. Sabrina to follow-up with Nancy on Steven Tseng's EA research. 2. Early Adopters discussed their latency requirements. These are shown in Appendix III. 3. Sean Helfrich (NOAA/NESDIS) and John Woods (NOAA National Ice Center) discussed use of the Navy's forecasting systems. Ice analysts in the National Ice Center predict were ice going: a. Openings b. Thinner locations c. Features perhaps not apparent The Navy's models (e.g. ACNFS) are a primary source of guidance for the Ice Center. 4. Stephen Howell (Environment and Climate Change Canada) is planning a field validation campaign associated with ICESat-2 in late April 2019 or April 2020 (to be coordinated with Thorsten, Sinead, and Ron). The campaign will be based out of Eureka, Nunavut. a. One objective of Stephen Howell's EA research is to monitor long-term changes in the Canadian Arctic by comparing and validating ICESat-2 thickness estimates with in-situ thickness observations at long-term monitoring sites. b. There are four stations with consistent records extending back to early 1950s. c. EA Team is using RADARSAT-2 and Sentinel-1AB with CryoSat-2 as test beds prior to the launch of ICESat-2. 5. Hongjie Xie is processing the MABEL data for the Arctic sea ice (collected April 8, 2012). 6. Guy Schumann: For SWOT, we are dealing with the same issue, i.e. latency of 45 days as well. a. Guy is on the applications working group for SWOT and latency is an issue for most of the flood-related applications, esp. during events or forecasts b. SWOT is maybe thinking of a "quick look" product of 6 days latency or so (not set or decided yet) 7. EA's expressed interest in data access prior to public release	
Outcomes	• Obtained updates on Early Adopter research. Early Adopters communicated their progress via updates to their quad charts. • Early Adopters communicated on their field validation campaigns and provided SDT members with the latency requirements. • Participation from EA end users (e.g. Sean Helfrich)	

Round Table I Summary	Round Table Name: Date: Time:	ICESat-2 Sea Ice, Land Ice & Ocean Science Data Products Thursday, February 15, 2018 2:00-5:00pm (Eastern)
	• Early Adopters provided feedback to NSIDC DAAC on data access	

Follow-up Action Items			
#	Item	Responsible Person(s)	Target Date
1	Share Steven Tseng's EA research with Nancy Searby.	Sabrina Delgado Arias	04/08/18

Summary: ICESat-2 Land-Vegetation and Atmospheric Science Data Round Table

Round Table II Summary	**Round Table Name:** **Date:** **Time:**	**ICESat-2 Land-Vegetation and Atmospheric Science Data** **Thursday, February 20, 2018** **11:00 am - 2:00pm (Eastern)**
Early Adopter Attendees:	• **Falk Huettmann, Institute of Arctic Biology, University of Alaska Fairbanks** • **Javier Fochesatto, Geophysical Institute, University of Alaska Fairbanks** • **Birgit Peterson, U.S. Geological Survey** • **Wenge Ni-Meister, The City University of New York** • **Ute Herzfeld, University of Colorado Boulder**	
Science Definition Team Member Attendees:	• **Katherine Pitts, Applied Research Laboratories, University of Texas at Austin** • **Sorin Popescu, Texas A&M University** • **Steve Palm, NASA Goddard Space Flight Center** • **Yuikui Yang, NASA Goddard Space Flight Center**	
Other Attendees	• **See Appendix I; total attendees: 17**	
Agenda Items (refer to Appendix II for meeting agenda)		
Summary of 2/20 Meeting: 1. **Tom Neumann provided overall status of mission; an overview of the data production and data product evaluation; review of the on-orbit commissioning plan; and key dates during post-launch timeline.** 2. **Vanessa Escobar (NASA HQ) provided an overview of the new guidelines for conducting mission applications and discussed how the ICESat-2 Early Adopter program has served as a prototype for integrating application considerations into overall science program.** 3. **Participants reviewed the land-vegetation and atmospheric science data products** ▪ **Steven Palm discussed the ICESat-2 atmospheric channel including its limitations, comparisons with ICESat's GLAS data, and atmospheric applications.** ▪ **Sorin Popescu discussed top of canopy and ground mapping objectives and methodology, and provided a map of all study sites for test-bed sensor data. He also presented on a biomass estimation study over the Sam Houston National Forest.** 4. **Katherine Pitts participated in the round table on behalf of SDT member, Amy Neuenschwander providing additional feedback to Early Adopter on land-vegetation data product.** 5. **Early Adopters discussed status of their research (objectives, approach, key milestones, schedule and issues).** 6. **Early Adopters reviewed seed questions and provided input as time permitted.** 7. **Steve Tanner provided an overview of the NSIDC DAAC and planned services for ICESat-2. Amy Steiker demonstrated Earthdata Search and exploration of imagery using Worldview Applications: https://worldview.earthdata.nasa.gov**		

Round Table II Summary	Round Table Name:	ICESat-2 Land-Vegetation and Atmospheric Science Data
	Date:	Thursday, February 20, 2018
	Time:	11:00 am - 2:00pm (Eastern)
Findings	1. Among other studies, Sorin highlighted the wall-to-wall biomass estimated through airborne data in Gabon's Modah Tropical Forest. a. Reference: Popescu, Sorin & Zhou, Tan & Nelson, Ross & Neuenschwander, A & Sheridan, R & Narine, L & M Walsh, K. (2018). Photon counting LiDAR: An adaptive ground and canopy height retrieval algorithm for ICESat-2 data. Remote Sensing of Environment. 208. 10.1016/j.rse.2018.02.019. 2. In response to Steve Palms' discussion of ICESat-2 cirrus cloud detection, Javier Fochesatto shared the following journal article on unusually deep wintertime cirrus clouds over the Alaskan Subartic written by James Campbell and David Peterson of the Naval Research Laboratory: https://journals.ametsoc.org/doi/full/10.1175/BAMS-D-17-0084.1 3. Birgit Peterson provided a description of how ICESat-2 data could be integrated in the new Fuel Characteristic Classification System (FCCS) of the LANDFIRE program. 4. Ute Herzfeld discussed two potential applications of her research: (1) climate modeling of tenuous cloud layers, subvisible cirrus, Asian dust, and volcanic ash; as well as (2) transportation hazard assessment from blowing snow data. a. Will work with Applications Team to continue reaching out to potential end users. Past attempts to engage the National Weather Service and Southwest Airlines as end users have been unsuccessful. 5. In addition to the Early Adopters expressing interest in the API and in Matlab guidance, they expressed interest in browse imagery, including the need for browse to be available and easy to access while searching for data.	
Outcomes	• Obtained updates on Early Adopter research. Early Adopters communicated their progress via updates to their quad charts. • Due to issues with accessing the Adobe Connect session, and running behind our round table scheduled agenda, Adrian Borsa was not able to present on the OpenAltimetry tool. • Early Adopters provided feedback to NSIDC DAAC on data search	

Follow-up Action Items			
#	Item	Responsible Person(s)	Target Date

Round Table II Summary		Round Table Name:	ICESat-2 Land-Vegetation and Atmospheric Science Data
		Date:	Thursday, February 20, 2018
		Time:	11:00 am - 2:00pm (Eastern)
1	Follow-up with Birgit Peterson with regards to a possible workshop for the Biomass working group	Sabrina Delgado Arias	04/08/18

Summary: ICESat-2 Inland Water Science Data Round Table

Round Table III Summary	**Round Table Name:** **Date:** **Time:**	**ICESat-2 Inland Water Science Data Product** **Tuesday, February 27, 2018** **1:00-3:00pm (Eastern)**
Early Adopter Attendees:	• **Guy Schumann, Dartmouth Flood Observatory, University of Colorado Boulder** • **Huilin Gao, Texas A&M University** • **Christopher Parrish, Oregon State University** • **Nick Forfinski-Sarkozi, Oregon State University** • **Charon Birkett, Earth System Science Interdisciplinary Center (ESSIC)**	
Science Definition Team Member Attendees:	• **Lori Magruder, Applied Research Laboratories, University of Texas at Austin** • **Michael Jasinski, NASA Goddard Space Flight Center**	
Other Attendees	• **See Appendix I; total attendees: 13**	
Agenda Items (refer to Appendix II for meeting agenda)		
Summary of 2/27 Meeting: 1. **Lori Magruder provided overall status of mission; an overview of the data production and data product evaluation; review of the on-orbit commissioning plan; and key dates during post-launch timeline.** 2. **Participants reviewed the inland water data product and cal/val plans** ▪ **Mike Jasinski discussed the inland water data product (ATL13), including coverage and preliminary results from MABEL experiments over Lake Mead and other sites (http://www.jcronline.org/doi/abs/10.2112/SI76-005?code=cerf-site)** ▪ **Mike Jasinski provided an overview of the cal/val and monitoring plans and strategy for collaboration with already planned field experiments. Mike shared a possible timeline for both field work and lake monitoring.** 3. **Early Adopters discussed status of their research (objectives, approach, key milestones, schedule and issues).** 4. **Early Adopters reviewed seed questions and provided input as time permitted.** 5. **Steve Tanner provided an overview of the NSIDC DAAC and planned services for ICESat-2. Amy Steiker demonstrated Earthdata Search and exploration of imagery using Worldview Applications: https://worldview.earthdata.nasa.gov**		
Findings	1. **Huilin Gao has developed an algorithm for deriving bathymetry over Lake Mead using ICESat-2. Mike Jasinski and Huilin Gao presented a poster at AGU and are in the process of submitting a journal paper on this work.** a. **AGU poster: https://agu.confex.com/agu/fm17/meetingapp.cgi/Paper/277105** b. **Journal paper (in prep) to be submitted to J. Geophysical Research Letters: "Generating High-Resolution**	

Round Table III Summary	Round Table Name:	ICESat-2 Inland Water Science Data Product
	Date:	Tuesday, February 27, 2018
	Time:	1:00-3:00pm (Eastern)

Bathymetry over Lake Mead using Data Collected by the ICESat-2 Airborne Simulator" (Yao Li[1], Huilin Gao[1]*, Michael Jasinski[2], Shuai Zhang[3], Jeremy Stoll[2])

2. **Huilin Gao will work with Mike Jasinski to engage reservoir managers as potential end users for her research. Mike Jasinski will leverage established relationships with reservoir managers.**
    a. **Huilin and Mike discussed the completed project over Lake Mead with the Bureau of Reclamation to engage them as potential end users of the data.**
    b. **Upper management at the Bureau of Reclamation did not allow their participation as end users in the EA research due to security concerns of having reservoir water level data in the public domain.**
3. **Guy Schumann reported that the Dartmouth Flood Observatory Interoperable Web Service for flood disaster assistance is ready to ingest ICESat-2 water level data.**
    a. **DFO WMS operational system is used by governments in Africa (local) and for UN determination of hazards**
    b. **Guy asked Mike Jasinski to consider a mask for large rivers. Mike is already intending to do this and mask would offer SWOT mission complementarity.**
    c. **Global Flood Partnership research slow moving (no funding)**
4. **Mike Jasinski discussed expected resolution and accuracy of the inland water data product, as well as definition of coastline.**
    a. **5-10 cm water surface elevation accuracy per 100m segment length over most water bodies, depending on atmospheric conditions. Bottom identification in low-turbid water.**
    b. **Buffering all coasts to 7 km so as to include estuaries. Reference** Jasinski, M.; Stoll, J.; Cook, W.; Ondrusek, M.; Stengel, E., and Brunt, K., 2016. Inland and near-shore water profiles derived from the high-altitude Multiple Altimeter Beam Experimental Lidar (MABEL). *Journal of Coastal Research*, SI, No. 76.
5. **Chris Parrish and Nick Forfinski-Sarkozi discussed latency needs:**

[1] Zachry Department of Civil Engineering, Texas A&M University, College Station, TX 77843.

[2] Hydrological Sciences Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD 20771.

[3] Department of Geological Sciences, The University of North Carolina at Chapel Hill, Chapel Hill, NC 27514.

Round Table III Summary	Round Table Name:	ICESat-2 Inland Water Science Data Product
	Date:	Tuesday, February 27, 2018
	Time:	1:00-3:00pm (Eastern)
	a. Latency is not a huge deal; a vertical accuracy of 10 cm or better is ideal. Bathymetry is not necessarily done in real time. Day-to-day decision will not be possible. b. Reference: Forfinski-Sarkozi, N.A., and C.E. Parrish, 2016. Analysis of MABEL Bathymetry in Keweenaw Bay and Implications for ICESat-2 ATLAS. Remote Sensing, Vol. 8, No. 9. 6. Charon Birkett, while on the call, did not participate, but offered the following comments after the meeting: a. It is unlikely that data will be used operationally by the USDA unless ICESat-2 can offer 2-3 day delay. b. The USDA will focus on several "continuity" radar altimetry mission data sets (Jason-3, Sentinel-3A, Sentinel-3B) c. There are aspects of ICESat-2 data that could prove really useful to lakes (and rivers) research - that can feed indirectly to the USDA lakes program - but these are geodynamics aspects and that would fall under "science investigations" d. USDA is not paying extra to look at ICESat-2 data in any way. 7. Chris Parrish discussed dearth of data for coastal mapping and charting. a. Highly interested in ICESat-2's Inland Water's column attenuation coefficient data product; expressed that whole airborne community would be interested in having this information. b. Chris has a single beam eco-sounder that Mike Jasinski could borrow (~$6,000-7,000) for CAL/VAL.	
Outcomes	• Early Adopters reported on their key milestones, schedule and issues via updates to their quad charts	

Follow-up Action Items

#	Item	Responsible Person(s)	Target Date
1	Guy will send Mike (cc: Sabrina) what Global Flood Partnership and Dartmouth Flood Observatory want in terms of latency, preferred data formats, and aspects of the water level product that are important for them.	Guy Schumann	02/28/18

Round Table III Summary		Round Table Name: Date: Time:	ICESat-2 Inland Water Science Data Product Tuesday, February 27, 2018 1:00-3:00pm (Eastern)
2	Encourage EAs to propose to ROSES 2018 A.8: "Life on Land" and "Life Below Water"	Sabrina Delgado Arias	04/08/18
3	Send feedback from Guy Schumann on preferred data formats to Amy Steiker and Steve Tanner (NSIDC DAAC)	Sabrina Delgado Arias	04/08/18

Appendix I: Round Table Attendees

ICESat-2 Sea Ice, Land Ice & Ocean Science Data Products Round Table

Name	Organization
NASA Headquarters	
Andrew Parks	International Programs
John Jones-Bateman	Applied Sciences Program
Nancy Searby	Capacity Building Program
Pamela Bond	Applied Sciences Program
Vanessa Escobar	Applied Sciences Program
Woody Turner	Applied Sciences Program
NASA ICESat-2 Science Definition Team	
Lori Magruder	Applied Research Laboratories, University of Texas at Austin
Sinead Farrell	Earth System Science Interdisciplinary Center (ESSIC)
Ron Kwok	NASA Jet Propulsion Laboratory
Mike Jasinski	NASA Goddard Space Flight Center
Ben Smith	Polar Science Center, Applied Physics Lab, University of Washington
NASA ICESat-2 DAAC: National Snow and Ice Data Center	
Amy Steiker	National Snow and Ice Data Center
Steve Tanner	National Snow and Ice Data Center
NASA ICESat-2 Early Adopters	
Andrew Roberts	Naval Postgraduate School
Guy Schumann	Dartmouth Flood Observatory, University of Colorado Boulder
Bradley Zavodsky	NASA Marshall Space Flight Center Earth Science Office/NASA SPoRT
Stephen Howell	Environment and Climate Change Canada
David A. Hebert	Naval Research Laboratory
Hongjie Xie	University of Texas at San Antonio
Emily Berndt	Marshall Space Flight Center Earth Science Office/NASA SPoRT
Other Guests	
Sabrina Delgado Arias	NASA Goddard Space Flight Center
Kate Ramsayer	NASA Goddard Space Flight Center
Joshua McCurry	Earth System Science Interdisciplinary Center (ESSIC)
Brock Blevins	NASA ARSET, UMBC
Edil Sepulveda Carlo	NASA Goddard Space Flight Center
John Woods	NOAA National Ice Center
Laurance (Larry) Connor	NOAA/NESDIS
Sean Helfrich	NOAA/NESDIS
Ellen Buckley	University of Maryland

ICESat-2 Vegetation and Atmospheric Data Products Round Table

Name	Organization
NASA Headquarters	
Vanessa Escobar	Applied Sciences Program, NASA Headquarters
NASA ICESat-2 Science Definition Team	
Katherine Pitts	Applied Research Laboratories, University of Texas at Austin
Sorin Popescu	Texas A&M University
Steve Palm	NASA Goddard Space Flight Center
Yuikui Yang	NASA Goddard Space Flight Center
NASA ICESat-2 DAAC: National Snow and Ice Data Center	
Amy Steiker	National Snow and Ice Data Center
Steve Tanner	National Snow and Ice Data Center
NASA ICESat-2 Early Adopters	
Falk Huettmann	Institute of Arctic Biology, University of Alaska Fairbanks
Javier Fochesatto	Geophysical Institute, University of Alaska Fairbanks
Birgit Peterson	U.S. Geological Survey
Wenge Ni-Meister	The City University of New York
Ute Herzfeld	University of Colorado Boulder
NASA ICESat-2 PSO	
Tom Neumann	NASA Goddard Space Flight Center
Other Guests	
Adrian Borsa	Scripps Institution of Oceanography, UC San Diego
Amita Mehta	NASA ARSET, NASA Goddard Space Flight Center
Edil Sepulveda Carlo	NASA Goddard Space Flight Center
Sabrina Delgado Arias	NASA Goddard Space Flight Center

ICESat-2 Inland Water Science Data Products Round Table

Name	Organization
NASA Headquarters	
Vanessa Escobar	Applied Sciences Program, NASA Headquarters
NASA ICESat-2 Science Definition Team	
Lori Magruder	Applied Research Laboratories, University of Texas at Austin
Michael Jasinski	NASA Goddard Space Flight Center
NASA ICESat-2 DAAC: National Snow and Ice Data Center	
Amy Steiker	National Snow and Ice Data Center
Steve Tanner	National Snow and Ice Data Center
NASA ICESat-2 Early Adopters	
Guy Schumann	Dartmouth Flood Observatory, University of Colorado Boulder
Huilin Gao	Texas A&M University
Charon Birkett	Earth System Science Interdisciplinary Center (ESSIC)
Christopher Parrish	Oregon State University
Nick Forfinski-Sarkozi	Oregon State University
Other Guests	
Brock Blevins	NASA ARSET, NASA Goddard Space Flight Center
Sabrina Delgado Arias	NASA Goddard Space Flight Center
Stephanie Uz	NASA Goddard Space Flight Center

Appendix II: Round Table Agendas

Agenda 02/15/18 (Eastern Time): ICESat-2 Sea Ice, Land Ice & Ocean Science Data Products Round Table

- 2:00 pm (5 minute) Welcome and Introduction
- 2:05 pm (5-10 min) Mission Status and expected timeline for release of specific science data products
- 2:15 pm (10 min) *Tentative* NASA Earth Campaign 2018[NASA HQ]
- 2:30 pm (30 min) SDT Members discuss advances in the development of the science data products (e.g. expected resolution, advances in measurement concept) [Sinead Farrell (University of Maryland), Ron Kwok (NASA Jet Propulsion Lab), and Ben Smith (University of Washington)]
- 3:00 pm (45-90 min) Round Table: discussion on status of each EA research and expectations for the use of ICESat-2.
    - Richard Allard/Dave Herbert, U.S. Naval Research Laboratory
    - Emily Berndt, SPORT Center, NASA MSFC
    - Stephen Howell, Environment Canada
    - Andrew Roberts, Naval Postgraduate School
    - Hongjie Xie, University of Texas at San Antonio
- 4:00 pm (15-30 min) DAAC discusses new features in development for accessing and manipulating ICESat-2 data

Agenda 02/20/17 (Eastern Time) ICESat-2 Vegetation and Atmospheric Data Products Round Table

- 11:00 am (5 minute) Welcome and Introduction
- 11:05 am (5-10 min) Mission Status and expected timeline for release of specific science data products
- 11:15 am (10 min) The Future of Early Adopters [Vanessa Escobar, NASA HQ]
- 11:30 am (20 min) SDT Members discuss advances in the development of the science data products [Sorin Popescu (Texas A&M), Stephen Palm (SSAI-NASA GSFC), Katie Pitts will join us on behalf of SDT member Amy Neuenschwander]
- 12:00 pm (60 min) Round Table: discussion on status of each EA research and expectations for the use of ICESat-2. For those Early Adopters not included below, please let me know if your availability has changed!
    - Javier Fochesatto, University of Alaska Fairbanks
    - Ute Herzfeld, University of Colorado Boulder
    - Wenge Ni-Meister, Hunter College of The City University of New York
    - Birgit Peterson, USGS
- 1:00 pm (15-30 min) DAAC discusses new features in development for accessing and manipulating ICESat-2 data
- 1:30 pm (15 min) Introduction to OpenAltimetry tool for visualizing and accessing NASA's ICESat and ICESat-2 data.

Agenda 02/27/18 (Eastern Time) ICESat-2 Inland Water Science Data Products Round Table

- 1:00 pm (5 min) Welcome and Introduction

- 1:05 pm (10 min) Mission Status and expected timeline for release of specific science data products [Lori Magruder, SDT Lead, University of Texas]
- 1:15 pm (10 min) The Future of Early Adopters [Vanessa Escobar, NASA HQ]
- 1:25 pm (20 min) Mike Jasinski [ICESat-2 SDT Member for Hydrology] discusses advances in the development of the Inland Water science data product
- 1:45 pm (5 min) BREAK
- 1:50 pm (30 min) Round Table: discussion on status of each EA research and expectations for the use of ICESat-2.
    - Huilin Gao, Texas A&M University
    - Rodrigo C.D. Paiva, Federal University of Rio Grande do Sul
    - Christopher Parrish & Nick Forfinski-Sarkozi, Oregon State University
    - Guy Schumann, Dartmouth Flood Observatory, University of Colorado Boulder
- 2:20 pm (20 min) NSIDC DAAC discusses new features in development for accessing and manipulating ICESat-2 data [Amy Steiker & Steve Tanner, NSIDC]
- 2:40 pm (15 min) Introduction to OpenAltimetry tool for visualizing and accessing NASA's ICESat and ICESat-2 data [Adrian Borsa, University of California, San Diego] CANCELLED

Appendix III: Early Adopter Latency and Accuracy Requirements

ICESat-2 Sea Ice, Land Ice & Ocean Science Data Products Round Table

1. Lead and Hummock Detection (NOAA/NESDIS)

Early Adopter: Hongjie Xie (PI), University of San Antonio, Texas

Summary Objectives: Develop a strategy for rapidly processing ICESat-2 data, once available, to retrieve sea ice freeboard and thickness for the Ross Sea. The overall objective is to integrate ICESat 2 derived freeboard, ice thickness, and leads into an operational ice charting environment (US National Ice Center). EA's developed and/or improved algorithms for leads, freeboard and ice thickness retrievals from the high density point cloud of ICEsat-2 could greatly benefit the accuracy and integrity of ice charts for operational purpose.

End-User(s): Sean Helfrich (**NOAA Center for Satellite Applications and Research (STAR)**)

Application: Improving observations and forecasting of freeboard, ice thickness, and leads in NOAA operational ice charts and products.

Latency/Accuracy/Precision Requirements (source: Sean Helfrich):

Lead Detection			
SSH anomaly	**Precision**	**Accuracy**	**Data Latency**
Ice Freeboard height FYI	20%	10 cm	< 2 days
Ice Freeboard height MYI	20%	20 cm	< 2 days
Hummock Detection			
SSH anomaly	**Precision**	**Accuracy**	**Data Latency**
Terrain Surface Height	20%	50 cm	< 3 days
Ice Thickness FYI	20%	30 cm	< 3 days
Ice Thickness MYI	30%	50 cm	< 3 days

Details:

The ability to detect the leads from the SSH anomaly is dependent on A) height difference of the average mean elevation and the min mean elevation and B) the net gain/loss in the Height difference.

2. Comparisons between measured and modeled sea ice freeboard

Early Adopter PIs: Andrew Roberts [Naval Postgraduate School], **Alexandra Jahn** [University of Colorado at Boulder], **Adrian Turner** [Los Alamos National Laboratory]

Summary Objectives: Develop an ICESat-2 emulator for the Los Alamos Sea Ice Model (CICE) to facilitate detailed comparisons between measured and modeled sea ice freeboard in Earth System Models. The emulator will sample modeled sea ice freeboard and snow cover at the same time of day and proximity as ATLAS measurements.

End-User(s):

- **U.S. Department of Energy** (POC: Elizabeth Hunke);
- **National Center for Atmospheric Research** (POC: Marika Holland, Jennifer Kay);
- **U.S. Department of Defense** (POC: Wieslaw Maslowski, Ruth Preller);
- **University of Colorado Boulder** (POC: John Cassano)

Application(s): e.g., Sea ice forecasting; national defense environmental forecasting; coordinated disaster response: oil spill mitigation, field campaigns; improved climate projections at all latitudes

Latency: There are no latency issues with this work because it is primarily concerned with seasonal scale variations in sea ice mass in the Arctic.
Details: Since Early Adopter will be using every available individual sample of sea ice freeboard to concoct freeboard distributions comparable to model thickness distributions, which they will turn into model freeboard distributions, they prefer the highest possible accuracy. In other words, **Early Adopter will take what NASA can give them, but the more accurate the better**.

3. Operational Sea Ice Forecasting

Early Adopter: Richard Allard and David Hebert (PIs), Naval Research Laboratory
Summary Objectives: Evaluate performance and potential to assimilate ICESat-2 sea ice thickness and/or freeboard data into Arctic Cap Nowcast Forecast System (initially)
End-User(s):

- **U.S. Navy**, POC: Mark Cobb, Fleet Numerical Meteorology and Oceanography Center;
- **U.S. National/Naval Ice Center**, POC: LT Emily Motz

Application: e.g., Navigation; Arctic Shipping
Latency Requirement: Forecasts: daily and up to 7-days. Need data as soon as possible→ Incorporation into ACNFS: 72 hours; MIZ: 21-day and 45-day products for validation; Ice thickness (improvement of real time): 45-day data with twin hindcast approach
End-User Requirements (2012) (extracted only for NAVOOCEANO/NIC for relevant parameters; provided by Pamela G. Posey, 2017)**:**

Originator	Parameter	Measurement				Refresh		Latency	
		Range		Accuracy					
		T	O	Tropical: 0.25 mm Midlat: 0.15 mm Polar: 0.1 mm	O	T	O	T	O
NAVOCEANO	Sea Surface Height			4 cm	2 cm	20 days **	10 days	12 hr	3 hr
NAVOCEANO	Coastal Sea Surface Height			4 cm	2 cm	20 days **	10 days	12 hr	3 hr
NAVOCEANO	Ocean Currents (Surface)	0 - 5 m/s, 360°	0 - 5 m/s, 360°	+/-0.25 m/s; +/- 15°	+/-0.1 m/s; +/- 5°	12 hr	6 hr	120 min	15 min
NAVOCEANO	Ocean Wave Height	0.0 to 30 m	0.0 to 30 m	0.2 m	0.1 m	12 hr	6 hr	120 min	15 min
NAVOCEANO/ NIC	Sea Ice Concentration	0/10 - 10/10	0/10 - 10/10	1/10	0.5/10	24 hr	6 hr	250 min	15 min
NAVOCEANO/ NIC	Snow Cover/Depth	> 0 cm	0 - 10 m	10%	10%	12 hr	3 hr	90 min	15 min

4. Operational Sea Ice Forecasting

Early Adopter: Stephen Howell (PI), Environment Canada

Summary Objectives: (1) Validate and compare ICESat-2 thickness estimates with in situ thickness observations at long-term monitoring sites in the Canadian Arctic which extends back to the early 1950s –monitor long term change. (2) Integrate ICESat-2 ice thickness estimates into ECCC's RADARSAT Constellation Mission (RMC) sea ice motion products to provide ice volume flux estimates for the Canadian Arctic and Pan-Arctic regions. (3) Use ICESat-2 to initialize ECCC's state-of-the-art land, ice and ocean models and data assimilation systems (e.g. CONCEPTS; GIOPS; RIOPS, CaLDAS)

End-User(s):

- **Climate Research Division** (POC: Howell);
- **Canadian Meteorological Centre** (POC: Belair);
- **Canadian Ice Service** (POC: Arkett);
- **Canadian Centre for Climate Modelling and Analysis** (POC: Derksen)

Application: e.g., Climate data records; operational sea ice forecasting for Arctic shipping; sea ice info for mariners; weather hazards; prevention/mitigation of atmospheric catastrophes

Latency Requirement: Six weeks is fine for what EA has proposed doing. Latency will be an issue for near real-time data assimilation of ice thickness/sea surface height.

5. Decision Support Services in Alaska and in the Arctic

Early Adopter: Bradley Zavodsky (PI), NASA Marshall Space Flight Center/Short-term Prediction Research and Transition (SPoRT) Center

Summary Objectives:

- Use ICESat-2 observations as validation datasets for National Weather Service (NWS) in Alaska sea ice (e.g., NCEP EMC) and land ice/snow extent (e.g., NOHRSC) models. This can be done by either 1) developing a database of observations for understanding the quantitative variability of the models or 2) using these observations to give confidence in what is seen in the models.
- Leverage a collaborative partnership between SPoRT and the NOAA/NWS Alaska Region and Arctic Testbed to address forecasting issues in Alaska.

End-User(s):

- **Carven Scott & Becki Heim (NWS Alaska Region HQ)**
- **Gene Petrescu & Nate Eckstein (NWS Alaska Region HQ/NOAA Arctic Testbed)**

Application: e.g., Commercial fishing and offshore oil; Operational use by Alaska forecasters

Latency Requirement: not practical for operations; 12 hour latency window for operations.

- Week 2 – Week 6 forecasts are critical to determine feasibility of maintaining operations or the ability to respond to an event due to lack of infrastructure nearby (source: Carven Scott, 2014).
- Feedback from **Becki Heim**, Regional Program Manager, Environmental and Scientific Services Division (ESSD), NWS Alaska Region, **NOAA National Weather Service**:
    - Generally speaking, we will be happy to take anything we can get, as long as we know the accuracy/precision information our sea ice analysts can use the data accordingly for decision making.
    - **Latency**: optimally data latency of <3 days would be preferred, but <7 days would still be useful

- **Accuracy and Precision**: Focused on binning sea ice into various stages (new to muti-hear listed below. As such, **being within +/- 10 cm** would be an approximate requested accuracy. **Would be happy to work with whatever data was available**.
    - New (0-10 cm)
    - Young (10-30 cm)
    - First Year Thin (30-70 cm)
    - First Year Medium (70-120 cm)
    - First Year Thick (120 + cm)
    - Multi-year/Old (varies in thickness)
- With the exception of the seasonal transition from new to young to first year thin, these transition times between ice types are relatively slow (can be several months to transition from First Year Thin to Medium).
- The stages of New to Young to First Year Thin are relatively easy for experienced ice analysts to interpret based on visible satellite characteristics.

Appendix IV: Early Adopter Participation in Round Tables

	Early Adopter PI	Participation at Round Table	Reason for not Participating
1	Andrew Roberts, Naval Postgraduate School	Round Table I	
2	Andy Mahoney, University of Alaska Fairbanks	--	Could not be reached
3	Birgit Peterson, USGS	Round Table II	
4	Bradley Zavodsky, SPORT Center, NASA MSFC	Round Table I	
5	Charon Birkett, ESSIC-University of Maryland	Round Table III	Was in the call, but did not participate (see Round Table III findings)
6	Christopher Parrish, Oregon State University	Round Table III	
7	Greg Babonis, State University of New York at Buffalo	--	Availability changed; Recently started a new job in industry
8	Guy J-P Schumann, Dartmouth Flood Observatory, University of Colorado Boulder	Round Table I & III	
9	Hongjie Xie, University of Texas at San Antonio	Round Table I	
10	Huilin Gao, Texas A&M University	Round Table III	
11	Javier Fochesatto, University of Alaska Fairbanks & Falk Huettmann, Institute of Arctic Biology	Round Table II	
12	Kuo-Hsin Tseng, National Central University, Taiwan	--	Time Difference (China Standard Time)
13	Lucia Mona, National Research Council of Italy	--	Could not be reached; Time difference also difficult (Central European Time)
14	Nancy F. Glenn, Boise State University	--	Panel Meeting on the 20th (travel day)
15	Randy Wynne & Lynn Abbott [Virginia Polytechnic Institute and State University]	--	Not available on the 20th at the time of the round table
16	Richard Allard, U.S. Naval Research Laboratory	Round Table I	
17	Rodrigo C.D. Paiva, Federal University of Rio Grande do Sul	--	Got confused with the agenda and missed it.
18	Stephen Howell, Environment Canada	Round Table I	
19	Subrata Nandy, Indian Space Research Organization	--	Could not be reached. Time zone also difficult (Indian Standard Time)
20	Sudhagar Nagarajan, Florida Atlantic University	--	Had to work on a request for proposal

	Early Adopter PI	Participation at Round Table	Reason for not Participating
21	Ute Herzfeld, University of Colorado Boulder	Round Table II	
22	Wenge Ni-Meister, Hunter College of The City University of New York	Round Table II	

Appendix V: Round Table Seed Questions (Final Version)

Topic 1: Data Attribute Requirements

- What is the spatial and temporal coverage needed to support your work?
- What ICESat-2 product parameters are most important?
- What is the level of accuracy required for the measurement?
- How will differences in signal quality (day vs night) affect your work?

Topic 2: Field Observations: do you expect to have field observations that could support cal/val/assessment during the mission?

Topic 3: Latency: How does the latency of the ICESat-2 science data products affect your proposed applications(s) or transition to application(s)?

- What approaches/methodologies are you exploring to deal with the expected latency?
- How is your proposed application of the data limited by the expected latency?

Topic 4: Needs and challenges for data discovery, access, and analysis workflow.

- What is your data discovery, access, and analysis workflow?
- What is your ideal workflow for working with ICESat-2 data?
- What type of browse products would help you in data selection?

Below are additional questions to help guide you:

Discovery:

- Do you use Google or do you know to come to NSIDC or another data portal?
- Data types/formats needed or desired?

Access:

- Pull data once and work on it locally?
- Continuous pull?
- Web-based access? Command line access?

Analysis:

- Overview of preprocessing steps: Subsetting, reformatting, restructuring needed? What tool(s) do you use for this?
- Combining data with other sources or models?
- Incorporate in modeling code? GIS?

Share:

- How do you work with data within your team?
- Do you use, or are you interested in, cloud resources?

Topic 5: Early Access to ICESat-2 sample data service. Are you interested in early access to ICESat-2 sample data services? These services include reformatting and spatial, temporal, and parameter subsetting.

Topic 6: In response to a HQ inquiry, our Applications Team is exploring how applications for ICESat-2 may inspire science advancement and new science questions. What are some new science questions that have come out of your applications research?