Report on the ICESat-2 Inland Water Focus Session

November 18, 2015
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American Water Resources Association Annual Water Resources Conference

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Introduction

This document reports on the Inland Water Focus Session held for the Ice, Cloud and land Elevation Satellite-2 (ICESat-2) mission in November 2015. This meeting was held as part of the American Water Resources Association (AWRA) Annual Water Resources Conference in Denver, Colorado, on November 18, 2015. The focus session explored the ICESat-2 mission data product and its uses for monitoring, managing and studying inland rivers, lakes and reservoirs. While hydrology is not a ICESat-2 mission requirement, as a global mission, ICESat-2 will collect data over inland water surfaces. The focus session, was therefore, an opportunity to both create awareness of the observations expected for inland water and to explore how useful these measurements can be for various water resources applications. The focus session agenda and list of participants are included as part of the appendices in this report (Appendix C and D, respectively). All focus session presentations were also posted in the event page created for the focus session: https://www.regonline.com/inlandwater.

This report was compiled by the ICESat-2 Applications Team and reflects the discussions and information gathered at the focus session. The document represents the results of the focus session, the feedback from the user community, and responses from the ICESat-2 Mission and NASA Headquarters.

ICESat-2 Mission Applications

The first generation Ice, Cloud and land Elevation Satellite (ICESat) provided the world with unprecedented accuracy for measuring the vertical distribution of the Earth's surface and atmosphere. ICESat's measurements have enabled major advances in a range of interdisciplinary applications and helped inform critical decisions, including determining the safest path for vessels navigating in the Arctic and establishing future changes in Arctic shipping potential. The second generation ICESat-2 Mission, scheduled to launch no later than April 2018 (currently scheduled for October 2017), will offer one of the most spatially dense and fine precision instruments for global measurement of the earth's surface elevation.

During the pre-launch phases of the ICESat-2 mission (through Phase D), the ICESat-2 Applications Team (Table 1) engages ICESat-2 end users and builds broad support for ICESat-2 applications through a transparent and inclusive process. The ICESat-2 Applications Coordinator designs and executes the pre-launch activities in coordination with the ICESat-2 Project Science Office. The ICESat-2 Project Science Office and ICESat-2 Science Definition Team provide support and guidance to the ICESat-2 Applications Coordinator for the proposed activities. NASA Headquarters is a valued partner in the Applications efforts providing guidance on how to work with outside institutions and how to propagate the program to other ESD missions. This document has been drafted in support of the ICESat-2 pre-launch activities and with guidance by the ICESat-2 Deputy Project Scientist, ICESat-2 Science Team Applications Liaison and NASA Headquarters Applied Sciences Representative.

Table 1. ICESat-2 Applications Team Members as of June 2015

Role in ICESat-2 Mission	**Members**	**Affiliation**
ICESat-2 Deputy Project Administrator (DPA)	Vanessa Escobar	NASA's Goddard Space Flight Center (GSFC)/SSAI
ICESat-2 Applications Coordinator	Sabrina Delgado Arias	GSFC/SSAI
ICESat-2 Program Applications Lead	Molly Brown	University of Maryland
ICESat-2 Science Team Lead for Inland Water Data Product & Early Adopter Liaison to ICEsat-2 Mission	Mike Jasinski	GSFC
ICESat-2 Deputy Project Scientist	Tom Neumann	GSFC
ICESat-2 Science Team Leader	Lori Magruder	University of Texas
NASA Headquarters Applied Sciences Representative	Woody Turner	NASA Headquarters (HQ)

The objective of the Applications Program is to provide a framework for building a broad and well-defined user community for ICESat-2 during the prelaunch phases of the mission to maximize the use of data products after launch. The focus of the ICESat-2 Applications Team, the current membership of which is listed in Table 1, is to explore the advantages of the photon-counting approach, by working with the users to identify opportunities for using the new measurements in specific applications. Mission Applications provides insight into the range of potential uses of new satellite observations and helps communicate the value and impact of mission products. The application activities facilitate collaboration with broad communities of data users involved in the following areas of interest to the Mission: ice sheets, sea ice, vegetation, atmosphere, inland water, and oceans. These thematic areas are intentionally chosen to correlate with the science objectives of ICESat-2 and are intended to help the people involved in the mission better understand the potential utility of the mission's data and foster innovative use of the measurements to inform actionable decisions that are relevant and of value to society.

The central element of the ICESat-2 Applications Program is communication and engagement used to discover and demonstrate innovative uses and practical benefits of ICESat-2. As such, one of the engagement activities the ICESat-2 Applications Team conducts at least once a year is a focus session tailored to a specific community to provide detailed information about a connected group of products or applications. This meeting was the second of these events conducted for the mission. The first in 2014 focused on sea ice research for operational and commercial applications. A report of the sea ice focus session can be found via the following: http://icesat-2.gsfc.nasa.gov/sites/default/files/applications/SMAP_ICESat2_SeaIceFocus_Session_Final.pdf.

Focus Session Description

The ICESat-2 Inland Water Focus Session, was held on November 18, 2015, as part of the AWRA Annual Water Resources Conference held in Denver, Colorado. The 2015 AWRA Annual Water Resources conference was chosen as the best venue due to its central location and for the opportunity to interact with the diverse group of water resources professionals that the conference brings together from across the nation. The Applications Team worked closely with the AWRA vice president, Ken Reid, who facilitated the mission's participation in the conference and provided valuable advice on how to target our language to better connect with the AWRA community.

To help us spread the word, AWRA announced the focus session in its Connections Newsletter (October 2015) and highlighted the event in its final program (http://www.awra.org/meetings/Denver2015/doc/Final-Program.pdf). Tom Neumann, Deputy Project Scientist for ICESat-2, also gave a five-minute lighting talk as part of the conference's "National Water Data Infrastructure Issues: Information Access and Interoperability" session, to encourage the AWRA community to attend the focus session and learn about ICESat-2. In total, the focus session brought together 23 participants from both academia and government. The intimate setting allowed for brief introductions by all the participants and encouraged a more casual discussion to take place throughout the meeting.

Purpose and Goals

The one-day focus session provided an overview of the ICESat-2 mission and discussed how the measurements of inland water surfaces will be developed into data products the scientific community can use. We invited the water resources community to join us in exploring how the data products will work (e.g. data density and resolution, operations), and discussed how water managers, conservation groups and others could use these data products to make decisions. In this focus session, we sought to provide the water resources community with an opportunity to talk to ICESat-2 mission scientists to identify opportunities for using the planned data products.

The goals of the focus session were to:

- Examine the opportunities and challenges related to using ICESat-2 data for inland water studies;
- Assess the potential efficacy of ICESat-2 data in operational and decision-making contexts;
- Explore possibilities for combining ICESat-2 and other data sources to develop better products for inland water applications; and
- Provide a demonstration on how to access and use the available ICESat-2 prelaunch data.

Meeting Framework

The inland water focus session was a one-day event aligned with the concurrent sessions of the AWRA Annual Water Resources Conference. As such, the focus session was divided into four parts each ending with a Q&A or discussion panel.

Part I: Introduction to ICESat-2 and NASA Applied Sciences

An introduction to the focus session was provided by John C. Tracy, 2015 AWRA President, followed by an overview of the ICESat-2 mission by Tom Neumann (ICESat-2 Deputy Project Scientist), of the Applications Program by Molly Brown (ICESat-2 Applications Lead) and of the NASA Applied Sciences Program for Water Resources by Christine Lee (Associate Program Manager). This first part of the focus session described ICESat-2's data product spatial coverage, the timeline for product generation, and how the products developed from the satellite observations work. It also introduced participants to the goals, initiatives, and research projects of both the ICESat-2 Applications Program and NASA Applied Sciences Program Element for Water Resources.

Part II: ICESat-2 Inland Water Data

Mike Jasinski, Science Definition Team Member for Hydrology, opened the second part of the session with a detailed review of the inland water data product and other ICESat-2 data products that are relevant to the water resources community. The session then moved to an overview of the 3D Elevation Program (3DEP) by Jeff Simley (U.S. Geological Survey), which he gave on behalf of Jason Stoker (National Geospatial Program, USGS). The goal of this presentation was to promote a discussion on how ICESat-2 observations and measurements can contribute to 3DEP and other national initiatives that aim to provide the public with high-quality, fine resolution, elevation data. To conclude, Margaret Srinivasan (Jet Propulsion Laboratory) provided an overview of NASA's Surface Water Ocean Topography (SWOT) mission and NASA's Gravity Recovery and Climate Experiment (GRACE) satellites. Margaret provided insights into possible cross-mission development between ICESat-2, SWOT and GRACE. The NASA SWOT and GRACE missions offer new measurement capabilities for hydrology, including for storage change, river discharge, and dynamic changes of groundwater.

Part III: ICESat-2 Prelaunch Opportunities for the Water Resources Community

The third part of the focus session began with an overview of the ICESat-2 Early Adopter program by Sabrina Delgado Arias (ICESat-2 Applications Coordinator), followed by a presentation by an ICESat-2 Early Adopter, Guy Schumann from the Joint System for Regional Earth System Science and Engineering at the University of California, Los Angeles. Guy provided participants with a look at the current assessment his team is conducting using ICESat-2 pre-launch data for assessing the value of the ICESat-2 inland water data product for flood event activities. George Leshkevich from the NOAA's Great Lakes Environment Research Laboratory followed with an overview of current efforts to characterize and map Great Lakes ice and measure lake ice thickness. The final presentation by Huilin Gao from Texas A&M University addressed using satellite altimetry for global water storage estimations. Huilin used ICESat observations in previous work to monitor reservoirs; therefore, she provided insights into the advantages that ICESat-2 has over its predecessor.

Part IV: ICESat-2 Prelaunch Data with Live Demonstration

The last part of the focus session focused on prelaunch data access and use with the goal of familiarizing participants with the documentation, product readers, camera images, and prelaunch data files available from the mission. Mike Jasinski provided an overview of the ICESat-2 prelaunch data currently available and highlighted early results of relevance to the water resources community obtained from the Multiple Altimeter Beam Experimental Lidar (MABEL)—ICESat-2's airborne data simulator. Steve Tanner, Data Management Lead, presented on behalf of the National Snow and Ice Data Center (NSIDC), which is ICESat-2's NASA Distributed Active Archive Center (DAAC). Steve discussed plans for ICESat-2 data distribution and tools being developed for searching and selecting data. The focus session finalized with a demonstration by Tom Neumann on how to access and use the data for a particular case.

At the end of each of the above described sections of the focus session, the Applications Team invited the speakers to form a panel to answer any questions from participants and to raise further questions for discussion. Seed questions (shown in Appendix A) were developed by the Applications Team for each of the discussion panels with the goal of kick-starting conversation and to inspire participants to engage and ask more questions.

Outcomes

The ICESat-2 inland water focus session provided the opportunity for participants to learn about the observations that the ICESat-2 mission is expected to make globally over inland water and to discuss how these observations can enhance monitoring of lakes, rivers and reservoirs worldwide. The focus session also allowed the mission scientists and application leads to establish new relationships with participants and build upon existing relationships, which led to a new nomination for the Early Adopter program. The panel sessions encouraged discussion of opportunities for inter-satellite comparison studies, calibration and validation, as well as for monitoring reservoir storage, lake ice thickness and breakup, and flood forecasting and planning. The focus session was also a perfect opportunity to learn from and connect with participants and organizers of the AWRA Annual Water Resources Conference. The Applications Team expects that with continued interaction, future participation by the AWRA community in mission events will increase and also foster opportunities to learn about the utility of ICESat-2 in decision support scenarios not previously identified.

Overall, the inland water focus session fulfilled the expected outcomes outlined by the Applications Team for the event in that it provided:

1. A clear and thorough understanding of functionality of the ICESat-2 inland water data product;
2. A better understanding of opportunities and limitations in using mission products operationally;
3. A link from the mission to operational end users to help improve decision-making efforts; and
4. Established opportunities for new Early Adopter research.

The next section provides a synthesis of the presentations provided by the mission scientists, NSIDC DAAC, and guest speakers. We highlight any feedback collected from speakers and other participants regarding possible uses of ICESat-2, including suggestions for calibration and validation, as well as recommendations of people or organizations to whom the Applications Team should reach out.

The ICESat-2 Applications Team will continue engagement with the USGS/3DEP program and Early Adopters in order to support real and measurable application outcomes.

ICESat-2 Mission

This section syntheses the information provided by Tom Neumann and Mike Jasinski on the ICESat-2 mission and data products of relevance to the water resources community. It also provides a summary of the efforts by the DAAC, as presented by Steve Tanner, to develop tools for searching, selecting and accessing ICESat-2 data post-launch.

Mission Overview & Updates

In its first Decadal Survey for Earth Science in 2007, the National Research Council prioritized a follow on mission to ICESat, which operated from 2003-2009, leading to the creation of ICESat-2. ICESat-2 will continue the observations of ice sheet height changes begun by ICESat, which have proven critical for advancing our understanding of key scientific questions related to sea-level rise and improved climate predictions.

ICESat-2 has four science objectives for ice sheets, sea ice and vegetation, which drive the Mission design:

- Quantify polar ice-sheet contributions to current and recent sea-level change and the linkages to climate conditions.
- Quantify regional signatures of ice-sheets to assess mechanisms driving those changes and improve predictive ice sheet models; this includes quantifying the regional evolution of ice sheet change, such as how changes at outlet glacier termini propagate inward.
- Estimate sea-ice thickness to examine ice/ocean/atmosphere exchanges of energy, mass and moisture.
- Measure vegetation canopy height as a basis for estimating large-scale biomass and biomass change.

No overall mission requirements exist for hydrology, oceanography or atmospheric science. However, as a global satellite mission, ICESat-2 will collect data over all of earth's surfaces. The mission, therefore, is developing products specific to the ocean, atmosphere, vegetation, and inland water environments to maximize the value of the observations.

The sole instrument of ICESat-2, the Advanced Topographic Altimeter System or ATLAS, will use a multi-beam, micro-pulse, photon-counting approach. ICESat-2 will extract elevation change in the polar regions on an orbit-to-orbit basis using six pairs of beams. This design also allows scientists to determine slope in both the along-track and across-track directions. ATLAS will have a high laser pulse repetition frequency of 10 kHz, emitting relatively low energy pulses. This high repetition rate allows for really dense along track sampling (1 footprint every 70 cm along-track of each of the six beams). ATLAS will detect up to 10 individual photons from each footprint as they come back from the surface of the earth instead of digitizing the returning waveform, as was done on ICESat.

ICESat-2's six beams are organized into a 3x2 array, with the pairs spaced by 3 km from left to right (with one pair roughly at nadir) in order to increase the coverage of the instrument. A beam pair consists of a weak and strong energy beam, spaced by ~90m. High energy beams will do better with low reflectivity targets such as ocean water, and the low energy beams will do better with highly reflective surfaces (e.g. snow or ice sheets). Each beam is expected to illuminate a circular area approximately 14 m in diameter.

ICESat-2 will have a 91-day repeat orbit to allow for seasonal ice-sheet measurements and a 92-degree inclination orbit, allowing data collection to 88 degrees north and south latitudes. Every 91 days ICESat-2 will repeat the same tracks in the polar areas to measure ice sheet change. In contrast, the mission goal in mid-latitudes is to maximize the measurement density using systematic off-pointing to increase track density and optimize coverage over land.

The new photon counting approach used by ICESat-2 will offer a huge degree of freedom in how data are analyzed. Data can be aggregated over user-determined length-scales to study a wide range of phenomena. ICESat-2 will measure individual photons with a precision of approximately 30 centimeters; this precision can be improved by aggregating many photons. In steeply sloping terrain, the accuracy degrades correspondingly as the surface slope broadens the return pulse.

ICESat-2 is scheduled to launch no later than 2018 and is currently scheduled to launch in October 2017 from Vandenberg Air Force Base using a Delta II rocket. The instrument is currently in Integration & Testing (I&T) and delivery to the spacecraft (Orbital ATK; Gilbert, Arizona) is planned for summer 2016. ICESat-2 has been assembled and tested at NASA's Goddard Space Flight Center (GSFC). The processing of the ICESat-2 data will be done at GSFC and data products will be distributed to the public via the NSIDC DAAC in Boulder, Colorado.

More about ATLAS and the ICESat-2 mission measurements and design can be found at: http://icesat-2.gsfc.nasa.gov/science

Data Product Plan & Operations

ICESat-2 will provide 20 data products as shown in the mission product table found in Appendix B. The project science office is coordinating primarily the lower level data products including the Level 1B data product, which consists of instrument corrections, and the Level 2A data product, which provides a latitude, longitude and height for each received photon. The mission expects that the Level 2A (ATL03) data product is the lowest product end-users will be interested in.

The higher-level geophysical data products are led by scientists with the corresponding specialty from the Science Definition Team. Each higher-level data product has unique assumptions that are relevant to the specific surface being considered (e.g. sea ice, ice sheets, land, ocean, atmosphere, or inland water). Depending on the surface being considered, there are different assumptions on how to best extract the most precise surface elevation.

As with ICESat, target of opportunity requests for study sites of interest will also be considered by the ICESat-2 Mission. Plans for where the satellite will be pointing on a specific day will be made available prior to launch via a project website that will made active about 3 months prior to launch. This site will be linked from the main mission website (http:

//icesat-2.gsfc.nasa.gov/mission) and the mission welcomes participants to provide feedback on their area of interest.

Much of the data product latency will be due to the time needed to get precise ephemeris from the GPS constellation. It is expected that it will take approximately two weeks after data collection and additional time for quality control and quality assessment will also be needed before final data is released by the NSIDC. Timing will depend on what level of data a person is interested in: initial and rapid Level 2 data products will be available approximately 5 days after data collection. These initial rapid products may have large error bars on longitude, latitude and height. Users should expect about 3 weeks for more precise L2A products. As shown by Early Adopter research, it is expected that users who require near real time data products, will use ICESat-2 for mainly for hindcasting, model evaluation, and model improvements.

Inland Water Data Product for ICESat-2

The ICESat-2 inland water data product or ATL13 will provide along track water surface height statistics in approximately 100 photon segments, such as the mean height, slope and standard deviation, for each of the six 532 nm beams. Lakes will be identified using a lake mask and then verified with ATLAS data. The inland water product is currently being tested using MABEL data. Several examples were presented during the session.

ICESat-2 will operate, during the first two years, under a mapping scenario for latitudes between 65 deg N and 65 deg S, but with repeat tracks above 65 deg N/S. Exact repeat will not occur during the first two years below 65 deg N/S except for special off-pointing targets. However, as a polar orbiter, ICESat-2 will have numerous crossover tracks that converge and increase observation density as it moves further north.

Analysis using MABEL data over lakes has shown the potential for observations up to 10 m deep under ideal water and sky conditions (clear night skies and non-turbid water). Since ICESat-2 is a global mission, inland water retrievals will also occur over near-shore and coastal areas.

A number of lakes already have been identified for calibration/validation purposes, but Mike Jasinski is accepting suggestions from the community for other potential sites.

Pre-launch Data for ICESat-2

MABEL was built at GSFC and is designed as a simulator for the ICESat-2 ATLAS instrument. MABEL data are currently being used as prelaunch data for the mission applications and the ICESat-2 Early Adopter Program.

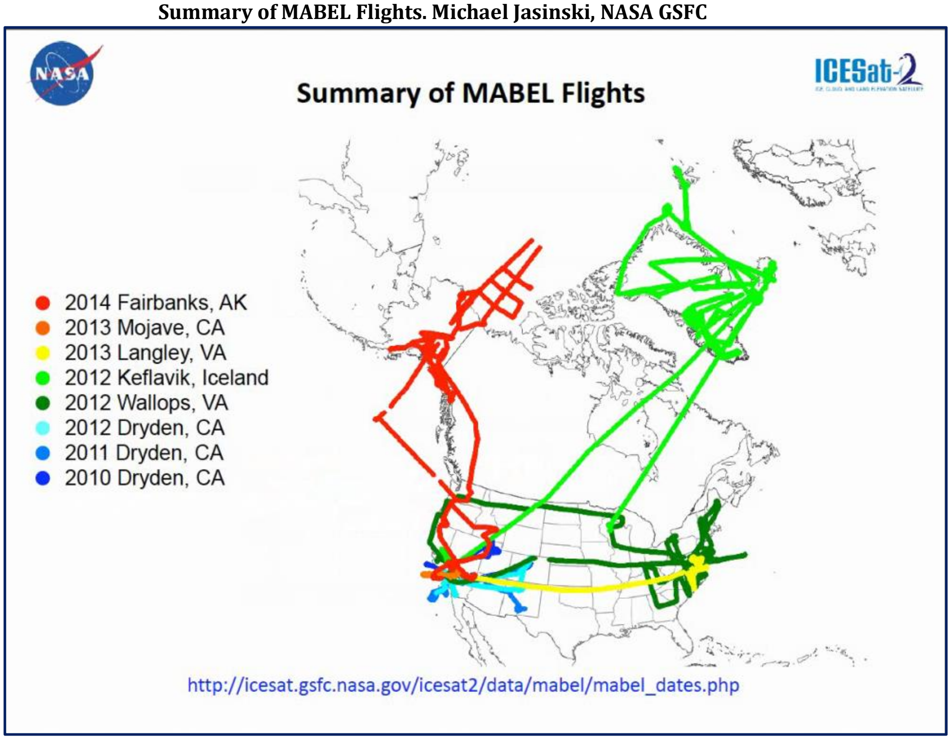
The goals for the MABEL data are to:

1) Validate the ICESat-2 models that are used to predict ATLAS instrument performance,
2) Evaluate the ICESat-2 photon counting (532 nm) measurement concept,
3) Be used to develop retrieval algorithms for ice sheet height, sea ice freeboard, canopy height, atmosphere, ocean and inland water surface heights; and

4) Be used to develop the ICESat-2 data Algorithm Theoretical Basis Documents (ATBDs), which describe how elevations were retrieved.

MABEL has been flown on high altitude aircraft, for the most part using NASA's ER-2 aircraft operated by NASA's Armstrong Flight Research Center. The MABEL beam configuration consists of different angles from nadir and different energies to simulate ATLAS beams. The beams can be aggregated to approximate an ATLAS-like footprint. A summary of all the MABEL Flights to date (April 2015) is shown in the next diagram.

Summary of MABEL Flights. Michael Jasinski, NASA GSFC



The 2010 and 2011 flights were engineering flights. The first major flight from Armstrong to Greenland was flown in 2012 and collected data sets over land ice and sea ice, as well as over in-transit vegetation and inland water targets. The Alaska MABEL campaign was carried out in July 2014, and included transit flights over a number of lakes, summer snow, glaciers, and sea ice. More details on MABEL can be found on the mission website: http://icesat-2.gsfc.nasa.gov/icesat2/data/mabel/mabel_docs.php

MATLAS vs. MABEL Data

An ATLAS-like data product generated using MABEL data, called MATLAS (http://icesat-2.gsfc.nasa.gov/icesat2/data/matlas/matlas_docs.php), was created by David Harding of NASA GSFC. MATLAS aggregates various tracks of the MABEL instrument and also adds the appropriate background photon rate or changes the reflectance of the surface to simulate the radiometry of the ATLAS 14 m footprint. A comparison between ATLAS and MABEL parameters is provided in the diagram below:

MABEL vs. ATLAS. Michael Jasinski, NASA GSFC

parameter	ATLAS	MABEL
Operational altitude	500 km	20 km
Wavelength	532 nm	532 and 1064 nm
Telescope diameter	1 m	6 inches
Laser PRF	10 kHz	5 kHz
Laser pulse energy	25µJ (weak) & 100µJ (strong) beam	3-5 µJ per beam
Receiver technology	Photon counting	Photon counting
Laser footprint diameter	17 µrad (14 m)	100 µrad (2 m)
Swath width	+/- 3 km	+/- 1.05 km

All pre-launch data are provided via the ICESat-2 website (http://icesat-2.gsfc.nasa.gov/data). Currently, four datasets are available: MABEL, MATLAS, SIMPL, and Sigma Space MPL. For MABEL, camera images, documentation, and readers to navigate through the data are all provided. A general description of the site and data collected can also be found for MABEL. KML files for each MABEL flight and each segment of the flights are also available for visualization.

National Snow and Ice Data Center (NSIDC) DAAC

The NSIDC will act as the archive and holder of the data coming from ICESat-2 and will provide data products to the general public. The expected daily data size for ICESat-2 is approximately 900 GB/day. NSIDC is currently exploring a new suite of tools and capabilities to reduce data volume and perform on-demand analysis, including using subsetters, reprojections, reformatting and visualizations. It asks the water resources community to provide input into tool requirements. NSIDC is also currently working on exploring new ways of bringing information into the Global Imagery Browse Services (GIBS) browser (https://earthdata.nasa.gov/labs/worldview/), which provides a way to browse through full-resolution imagery before downloading. It continues actively assessing the user community for ICESat-2 and collaborating with the ICESat-2 Applications Team to apply feedback into their data services.

Guest Speaker Presentation Overview and Feedback

Guest speakers to the focus were asked to provide comments on the potential utility of ICESat-2 for their water resources applications. They also highlighted the data gaps and challenges they face with the existing information and provided suggestions for the use ICESat-2 data products in applied research and operations. The following provides an overview of the guest speaker presentations and their comments on the use of ICESat-2.

Christine Lee, [NASA Applied Sciences Water Resources, Jet Propulsion Laboratory]

The Applied Sciences Program funds projects that enable practical on-the-ground uses of NASA Earth sciences data in organizations' policy, business, and management decisions. The program has two formal programs—Applications Areas and Capacity Building—for its six Applied Sciences areas, namely: ecological forecasting, disasters, water resources, health & air quality, wildland fires, and capacity building. For water resources, the Applied Sciences Program funds projects and workshops focused on climate impacts, drought, streamflow/floods, water quality, and agriculture/irrigation.

Christine is interested in feedback from the water resources community regarding 1) the kinds of data they are currently using, 2) their perspective on use of and access to NASA data for their application, and 3) learning how NASA data can enhance what people are doing within their organization. She sees potential for ICESat-2 in helping expand water resources projects that use altimetry data for lake or reservoir height monitoring as well as streamflow height (for water supply projections) and flood applications. Two specific projects are:

- Global Reservoir Height – Lake Powell height variations [PI: Charon Birkett, University of Maryland]: ICESat-2 could constrain and validate how good the height variation predictions are.
- Snow from Satellite Observations in the Red River of the North Basin [Carrie Vuyovich, CRREL, and Jennifer Jacobs, University of New Hampshire]: ICESat-2 could inform the year to year comparison of snowpacks used to improve flood predictions.

Jeff Simley on behalf of Jason Stoker [U.S. Geological Survey]
The 3D Elevation Program or 3DEP is one of three key initiatives supporting the development of The National Map—a national topographic mapping program produced and managed by the USGS National Geospatial program. 3DEP is being developed to respond to the needs for consistent high-quality topographic data. 3DEP, working in collaboration with various partners, will systematically collect LiDAR data over the conterminous US, Hawaii, and U.S. territories, as well as interferometric synthetic aperture radar (ifsar) data over Alaska. The USGS is interested in collecting data with quality level specifications that are equal or higher to the following:

[Abbreviated table] 3D Elevation Program – Quality Levels – A New "Floor". Jason Stoker, USGS National Geospatial Program

Quality Level	Source	Vertical Accuracy RMSEz	Nominal Pulse Spacing (NPS)	Nominal Pulse Density (NPD)	DEM Post Spacing
QL2	Lidar	10 cm	0.7 m	2 points/sq. meter	1 meter
QL5	Ifsar	185 cm	N/A	N/A	5 meters Alaska

As of October 2014, only 6.8% of the lower 48 states had LiDAR coverage satisfying the 3DEP quality goals (QL2 or higher); half the State of Alaska also required ifsar data to complete the 3DEP goal for coverage. Due to the quality level goals for the 3DEP program, Jason does not believe ICESat-2 will be brought directly into 3DEP; however, there is the potential that 3DEP and ICESat-2 could be used together for calibration and validation efforts. ICESat-2 also has the potential to contribute to the data collected for Alaska. Further discussion on how 3DEP and ICESat-2 can better link-up efforts is needed.

Margaret Srinivasan [Deputy Program Applications Lead for NASA SWOT, JPL]
The expected launch dates for SWOT and GRACE offer opportunities for overlap with ICESat-2 in the range of 2 to five years. GRACE-FO is scheduled to launch in October 2017, while SWOT is scheduled to launch in 2020. The SWOT mission will take inventory of global surface water. For hydrology, the SWOT mission will help address how much volume of water is stored in lakes and wetlands over space and time; and help fill the gap in our understanding of fresh water availability. SWOT will observe lakes with an area greater than 250 m^2, or approximately 68% of the global lake storage change, to about 10 cm of accuracy.

The GRACE twin satellites have been in orbit for over 13 years providing time variable gravity observations. With respect to hydrology, the mission has enabled scientists and water managers to observe the dynamic changes of ground water over large regions; contributed to our understanding of seasonal and inter-annual river basin water storage, as well as drought. The follow-on mission or GRACE-FO will extend the GRACE time series and improve the precision of the measurement system via a new Laser Ranging Interferometer.

Margaret identified a number of potential synergies for using ICESat-2 in combination with GRACE and SWOT, as listed below, and suggested looking into opportunities with the National Flood Interoperability Experiment.

- Inland water surface body heights from ICESat-2 river crossings as proposed by Guy Schumann, RSS/U. Bristol
- Wetlands and inundation
- Near shore and coastal oceans. Potential to bridge with SWOT ~15km resolution in coastal ocean.
- Polar ice-sheet topography/changes and sea ice freeboard
- USDA/FAS/OGA crop production estimates – Charon Birkett, UMD; Charon Birkett's work on lake heights is at the sweet spot between SWOT and ICESat-2 – select rivers that are wide enough

Guy Schumann [University of California, Los Angeles, Joint Institute for Regional Earth System Science and Engineering]
The goal of the Early Adopter research, led by Guy, is to make the ICESat-2 inland water data available to the Global Flood Partnership (GFP). This requires understanding both 1) how the ICESat-2 inland water data can be useful to the GFP and 2) what the GFP wants from ICESat-2. The GFP is a network of scientists and practitioners (end-users and decision makers) from public, private and international organizations interested in global flood monitoring, modeling and forecasting. The GFP explores what the decision maker wants in terms of flood forecasting and disasters, then uses this knowledge to derive science data products that are then made available in a useful format to decision makers via a database.

Two case studies conducted as part of the Early Adopter prelaunch research—a large-scale Niger Inland Delta study and a small-scale study over an existing or potential MABEL target area—will help assess the value of ICESat-2 water level data product for GFP and help Guy communicate to the mission how data can be provided to them. Guy expects that GFP will have a data latency requirement for flood events and near-real time river monitoring of under or within 24 hours; a latency much shorter than that for ICESat-2. However, the GFP could use ICESat-2 with any latency as archiving for historic analysis, re-analysis and calibration/validation studies. Guy also expects that the GFP will prefer X Y Z point vector data and the ability to know where the ICESat-2 tracks are and how often they cross a given river.

As a next step in the Early Adopter research, Guy will put together a survey to confirm the data format and latency needs of the GFP and plans to conduct model comparison or assimilation of any MABEL flights with water targets in them. Guy is interested in setting up potential target regions over the U.S. for coinciding existing model domains and MABEL flights. Guy also believes that ICESat-2 could be used in a project to be funded by the NASA Advanced Information Science & Technology Program to create a prototype Global Flood Model Platform with Google technology. This effort will ensure model parameter updating as new ICESat-2 ALT13 data become available over different regions of the world.

George Leshkevich
George began with overview of methods used to classify ice types in the Great Lakes and their transition over time. Early attempts to classify ice types in the ice cover, important operationally to both the Coast Guard and shippers for safe navigation, were conducted using spectral signature reflectance from Landsat-1 images. However, this type of classification was not very useful operationally due to cloud cover. Launch of the first Synthetic Aperture Satellites (SARs) provided all weather, day and night remote sensing that allowed measurements of the backscatter signature from different ice types. Wind speed direction over open water proved problematic for that type of classification since open water could be misclassified as ice. Other efforts included ice classification and wind-field mapping using QuickScat scatterometer data at 12.5 km pixels.

Current efforts to classify ice types, now being validated, use a method that involves mapping ice and open water separately and applying the library of signatures to the ice. Transects of ice thickness on the Great Lakes are also being mapped in collaboration with the Canadian Coast Guard using airborne ground penetrating radar.

Possible Uses of ICESat-2 Data in the Great Lakes:

- **Ice Thickness** – While ideally in real-time, transects of ice thickness would be extremely useful for operational use and for ice growth and dynamics models. An ice thickness climatology could be developed for each of the Great Lakes to complement ice concentration and type.
- **Water Levels** – Create water level data for the Great Lakes to supplement current measurement methods. Water levels are very important, especially to the shipping industry, but are continuously fluctuating.

- **Possible combining ICESat-2 with other data sources:** Perhaps combined with NASA/ISRO NISAR for a classification of "thickness category" associated with different ice types.

Huilin Gao, [Texas A&M University]
Huilin discussed remote sensing of reservoir storage using altimetry data and satellite imagery. She provided her thoughts about reservoir storage variations and conclusions on opportunities as presented below.

A few thoughts about reservoir storage variations

- We know the storage variations very well in some regions (e.g. U.S)
- We hardly know anything about the reservoir storage in some regions (e.g. developing regions with conflict of interests)
- Different reservoirs are operated using different rules, but information about operating rules are usually not shared
- Without considering the water management practices, hydrological monitoring and predictions are often biased
- The best way to acquire this information at a global scale is through satellite remote sensing.

Conclusions:

- Satellite remote sensing offers a unique opportunity for monitoring reservoir storage variations
- A 19-year consistent global reservoir dataset (including storage, surface area, and water level) was derived using MODIS based area estimations and radar altimetry data for water elevations
- By improving the MODIS area classification algorithm and using water elevations from ICESat/GLAS, 21 reservoirs in South Asia were monitored from 2000 to 2012
- The remotely sensed reservoir storage estimations can be used for operational applications and hydrologic modeling of water management
- ICESat-2 and other future satellite missions will bring unprecedented opportunities for investigating reservoir/lake storage variations

Q&A and Feedback from Water Resources Community

The panel discussions provided participants with the opportunity to ask questions of the mission scientists and guest speakers, as well as to jointly explore new opportunities for collaboration and ideas for using the inland water data product. The ideas and insights collected and shown next provide the mission perspective as to the impact the inland water data product can have within the water resources community.

Community Questions & Answers

Questions are organized into two sections: mission operations and data products.

Q&A: Mission Operations

Q: Will the mission operate at an all green wavelength?

A: Yes, all green or 532 nm.

Q: Will seasonal snow recovery be possible to estimate with ICESat-2?
A: ICESat-2 will measure the ground height in the absence of snow and then (91 days later) could provide a measurement of the height of ground with snow, which will enable users to derive snow pack thickness by taking difference (subject limitations of knowing the surface slope). By doing targeted pointing toward SNOTEL sites or other well monitored sites the mission should be able to calibrate how well we can measure snowpack thickness.

Q: What will be the target of interest request process?
A: If there is a particular study site or calibration site that people are interested in working with, the Project Science Office (Tom and others), will be able to let users know when and specifically where ICESat-2 will be pointing at a particular time. So if users can coordinate on the ground measurements or aircraft measurements, they will know well in advance where ICESat-2 will be pointing when to allow for that kind of coordination.

The ICESat-2 mission website on targets of interest will be put up in the next year or so to allow for users to request that the instrument be pointed at a particular target. This will include:

- login for each user
- request for targeting for time/place
- explanation of why

This input will allow for a dialogue between the requestor and the project office to determine the existence and the resolution of any conflicts between requests.

Q: Do clouds affect ICESat-2 observations?
A: Clouds do affect ICESat-2 observations. If the optical depth is equivalent to 2 or greater, then we would only see through gaps in the clouds. Precipitation and thick clouds will not allow for observations.

Q: What will be the loss in attenuation?
A: Attenuation through optical depth 2 or greater is nearly complete; as the cloud gets thinner you could calculate what that transmissivity would be. There is an atmospheric science data product that will measure cloud height and transmission through clouds in various places; the goal of that data product is, in essence, to act as a cloud flag or cloud filter for other data to help guide a user to cloud-free data?

Q: What is the observation strategy for Hawaii? There is a lot of Pacific islands in USGS jurisdiction for forecasting.
A: ICESat-2 will be in mapping mode over Hawaii; islands would be great targets – it would not take away from the routine measurements to target certain islands. If you have too many targets along the track, you have to figure out what the highest priority is.

Q: Why do you get only 10 photons back from millions of photons sent to the surface?
A: While the beam emitted by ATLAS is very focused, interaction with the atmosphere and the surface of the earth scatters photons out of the ATLAS field of view. Out of the billions of

photons emitted, we expect only up to about 10 photons to make it back into the ATLAS telescope and be detected by the electronics.

Q: - Geodesy – what is the accuracy of ICESat-2 data elevations, given the nature of the kind of information relative to a geoid? Is the mission providing actual data or estimates?

- Elevation photons are provided with regard to the WGS-84 ellipsoid
- Not many geodesy people attached to the mission – we plan on having a geodesy focus session in the spring.

Q&A: Data products

Q: What is the data accuracy?
A: Accuracy will depend on the surface you are looking at: over flat bright surfaces where you are getting a lot of photon signals back the accuracy is on the order of a couple of centimeters. When you get into mountainous terrain, i.e. terrain that is steep, the return pulse will spread so that not much signal is returned back and accuracy will decrease correspondingly into the many tenths of centimeters. So, accuracy will depend on both the surface characteristics (slope, roughness) and surface reflectivity.

Q: What sort of accuracy is expected for the inland water data product?
A: TBD. Really high precision is expected over lakes; a 37 meter precision for each photon is expected for the ATL03 starting by aggregating at 100 photons. As you go up in scale, with polygons of 3km on the side, precisions on the order of centimeters or so are expected.

Q: How much data are you collecting per day?
A: about a Terabyte per day.

Q: Will the data quality information be provided along with the data product?
A: ATL03 will provide latitude, longitude and height and uncertainty in those parameters; i.e. height uncertainty on individual photons as well as their location uncertainties. For geophysical products (e.g. ice sheets), the data products aggregate photons together to make elevation measurements at the tens of meter scale. Each product will have metadata and Q/A data to allow a user to easily assess the suitability of a given data granule for their purposes.

Q: What is the estimated lifetime of the mission?
A: The requirement is for 3 years; however, there is fuel onboard for 7 years

Q: Regarding orbits over a given area: the next orbit would be offset by how much?
A: 15 orbits a day, 92 degree inclination orbit is about 30 degrees of longitude on each successive pass.

Q: How to put data in a data viewer, such as the one provided by the USGS. Which ones will have access or use ICESat-2 data?

A: Because of the type of mission ICESat-2 is, a climatology of ice thickness or water surface height over a period of time can be built. The mission plans on producing monthly or seasonal data products for just this use.

ICESat-2 Applications Team Action Items

- Suggestions for Mike Jasinski on additional water bodies to add to the validation dataset:
    - Lake Athabasca: interest in political hydrology; climate change signal in Athabasca delta has high societal significance. Has a long fetch with Water Survey of Canada gauges at both east and west ends; more importantly it has ice cover. There are only a couple of measurements at Lake Athabasca so anything that supplements is very valuable.
    - Lake Williston has many observations, but NASA may need to 'buy' or otherwise obtain them from Water Canada, not in the public domain
    - Salton Sea in California – very high focus by the California regulators/managers, but may not be adequately representational for a validation data target
    - Great Slave Lake for ice height.

- River keepers should be a key partner for Applications Team projects: http://www.riverkeeper.org/about-us/our-allies/

- NOAA and other organizations that monitor the ice thickness and break up in the Great Lakes in the US should be users of ICESat-2 data. There is an 'ice atlas' and many different organizations and government institutions working on Great Lake ice concentrations – ICESat-2 should work with them.

- The National Water Center is a good way to tap a lot of different federal and state agencies and would be interested in having a 'water condition map' for today, but will require that it bring models of water status, which are a few weeks/month out of date, into the present. Steve Burges suggested that ICESat-2 mission and the National Water Center's summer program for students work together on how to use ICESat-2 data in this map creation.

- ICESat-2 data will be particularly important for
    - Alaska glacial lakes that are tied to glacial retreat and to regional hydrology
    - filling the NEXRAD data gaps in Texas
    - in mountainous and remote terrain, to identify and map debris flow, landslides and fire scars
    - earthquake height change detection – opportunistic use of the data

- Work with USGS/3DEP program to identify ways ICESat-2 data can be integrated.

- Community is interested in learning how much overlap there is between MABEL flights in 2014 and AirSWOT in 2015 in Alaska.

- Margaret suggests a collaboration with various owners of geospatial framework data networks as a target of interest for ICESat-2 applications. Systematic linking of data to systematic geospatial frameworks
  - National flood interoperability database – bringing different datasets together is an important goal – talk to Ed Clark of NOAA National Water Center.
  - Open water data initiative – Open Water Data Initiative (OWDI, http://acwi.gov/spatial/owdi/) and National Flood Interoperability Experiment (NFIE) should be explored as to how ICESat-2 data can be included
  - NHDPlus – version 2.1 is higher resolution - national hydrology dataset framework

- Key networks should include disasters and flood partnerships – return period for flood is important. Improved maps that came out of models with ICESAT GLAS data and MODIS surface area data will be important.

- Users and other flood analysts know their own rivers and basins of interest, thus the ICESat-2 data should be provided by basin instead of by lat/lon coordinates. Recommend providing an easy way to search on information, such as display graphically or subset geographically, to ease the ability of technical analysts to retrieve the data.

- UCAR Comet group may be a key network to connect with in the coming months.

- Seasonal snow recovery for ICESat-2 offers huge potential in California/Western part of country; Suggestion: NOAA national – airborne calibration right underneath the ground track. Background airborne gamma ray radiation snow survey program for snow water content http://www.nohrsc.noaa.gov/snowsurvey/ NOAA, National Weather Service, National Operational Hydrologic Remote Sensing Center

- Molly Brown/Mark Carroll Study: what is return frequency? How often does ICESat-2 go over your particular spot on the ground? Assigning a time to each of the crossovers at different spatial resolutions. What is the time series? We cannot do that until the orbits have been finalized. Forthcoming.

- SIMPL flew Greenland and Northeast Canada over some glacial melt water lakes that you could see as crystal clear. Suggestion: perhaps ICESat-2 can overlap in Alaska with SWOT flights.

Appendix A: Focus Session Seed Questions

The following seed questions were developed by the Applications Team for each of the discussion panels with the goal of kick-starting conversation and to inspire participants to engage and ask more questions. A copy of the seed questions was distributed to all speakers prior to the meeting. Answers to these questions are reflected in the Q&A and Item Action sections of this report.

PART I

- What are the potential ICESat-2 contributions to water resources research applications (water supply, agriculture, navigation, etc.)?
- How important is latency and high spatial resolution for water resources applications?
    - Water levels (inland wetlands, rivers, lakes, reservoirs)
    - Water volume estimations
    - Other?
- What are the main observational gaps?

PART II

- What are potential collaboration opportunities between the ICESat-2 mission and water resources community?
- Does the planned ICESat-2 inland data product meet the requirements (temporal, geospatial) of the user communities present? What are some operational requirements? Who could host an operational product using ICESat-2?
- What are possibilities for combining cross-mission and other altimetry data products to fully address application needs? What are the foreseen advantages and disadvantages of ICESat-2 compared to current and future altimetry products (Jason 2, SWOT, GRACE)?

PART III

- What are the key networks that we should be engaging with regard to water resources?
- What data services would the water resources community like to see from the NSIDC DAAC (e.g. search and find, visualizations)?
- HDF5 product readers are available for Fortran, IDL and Matlab. Would other headers be useful?

PART IV

- What data services would the water resources community like to see from the NSIDC DAAC (e.g. search and find, visualizations)?
- HDF5 product readers are available for Fortran, IDL and Matlab. Would other headers be useful?

Appendix B: ICESat-2 Mission Product Table

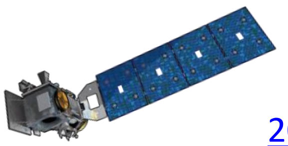
ICESat-2 Science Data Products

Product Number	Name	Short Description	Latency*
ATL00	Telemetry Data	Raw ATLAS telemetry in packet format.	Downlinked 8 times per day
ATL01	Reformatted Telemetry	Parsed, partially reformatted into HDF5, generated daily, segmented into several minute granules.	2 days
ATL02	Science Unit Converted Telemetry	Photon time of flight, corrected for instrument effects. Includes all photons, pointing data, spacecraft position, housekeeping data, engineering data, and raw atmospheric profiles, segmented into several minute granules.	2 days
ATL03	Global Geolocated Photon Data	Precise latitude, longitude and elevation for every received photon, arranged by beam in the along-track direction. Photons classified by signal vs. background, as well as by surface type (land ice, sea ice, land, ocean), including all geophysical corrections (e.g. Earth tides, atmospheric delay, etc…). Segmented into several minute granules.	21 days
ATL04	Calibrated Backscatter Profiles	Along-track atmospheric backscatter data, 25 times per second. Includes calibration coefficients for polar regions. Segmented into several minute granules.	21 days
ATL06	Land Ice Height	Surface height for each beam with along- and across-track slopes calculated for each beam pair. Posted at 40m along-track; segmented into several minute granules.	45 days
ATL07	Arctic/Antarctic Sea Ice Elevation	Height of sea ice and open water leads at varying length scale based on returned photon rate for each beam presented along-track.	45 days
ATL08	Land Water Vegetation Elevation	Height of ground including canopy surface posted at fixed length scale, for each beam presented along-track. Where data permits include canopy height, canopy cover percentage, surface slope and roughness, and apparent reflectance.	45 days
ATL09	ATLAS Atmosphere Cloud Layer Characteristics	Along-track cloud and other significant atmosphere layer heights, blowing snow, integrated backscatter, and optical depth.	45 days
ATL10	Arctic/Antarctic Sea Ice Freeboard	Estimate of sea ice freeboard over specific spatial scales using all available sea surface height measurements. Contains statistics of sea surface and sea ice heights.	45 days
ATL11	Land Ice H(t) Series	Time series of height at points on the ice sheet, calculated based on repeat tracks and/or cross-overs.	45 days from receipt of last data in product
ATL12	Ocean Elevation	Surface height at specific length scale. Where data permits include estimates of height distribution, roughness, surface slope, and apparent reflectance.	45 days from receipt of last data in product
ATL13	Inland Water Elevation	Along-track inland water elevation based on specific inland water mask. Where data permits, include roughness, slope and aspect.	45 days from receipt of last data in product
ATL14	Land Ice Gridded Height	Height maps of each ice sheet for each year based on all available elevation data.	45 days from receipt of last data in product
ATL15	Antarctica / Greenland Ice Sheet dh/dt Gridded	Height change maps for each ice sheet, for each mission year, and for the whole mission.	45 days from receipt of last data in product
ALT16	ATLAS Atmosphere Weekly	Polar cloud fraction, blowing snow frequency, ground detection frequency.	45 days from receipt of last data in product
ATL17	ATLAS Atmosphere Monthly	Polar cloud fraction, blowing snow frequency, ground detection frequency.	45 days from receipt of last data in product
ATL18	Land/Canopy Gridded	Gridded ground surface height, canopy height, and canopy cover estimates.	45 days from receipt of last data in product
ATL19	Mean Sea Surface (MSS)	Gridded ocean height product.	45 days from receipt of last data in product
ATL20	Arctic / Antarctic Gridded Sea Ice Freeboard	Gridded sea ice freeboard.	45 days from receipt of last data in product
ATL21	Arctic/Antarctic Gridded Sea Surface Height w/in Sea Ice	Gridded monthly sea surface height inside the sea ice cover.	45 days from receipt of last data in product

* Latency is defined as the approximate time it takes from the data acquisition on a satellite until it reaches an individual in a usable format.

Appendix C: Inland Water Focus Session Agenda

FINAL AGENDA



NASA Ice, Cloud and land Elevation Satellite-2
Inland Water Focus Session

Wednesday, November 18, 2015

2015 AWRA Annual Water Resources Conference

Grand Hyatt Denver, Denver, Colorado

An upcoming NASA satellite mission will measure the height of lakes, reservoirs and other water bodies – and scientists want to ensure that water resource managers get the most useful information possible from the data.

At-A-Glance Agenda	Meeting Room: Mount Elbert A
8:30 am -10:00 am	PART I: ICESAT-2 MISSION & INLAND WATER DATA PRODUCT OVERVIEW
10:30 am – 12:00 pm	PART II: ICESAT-2 INLAND WATER DATA IN-DEPTH
12:00 pm - 1:30 pm	LUNCH BREAK
1:30 pm – 3:00 pm	PART III: ICESAT-2 PRELAUNCH OPPORTUNITIES FOR THE WATER RESOURCES COMMUNITY
3:30 pm – 5:00 pm	PART IV: ICESAT-2 PRELAUNCH DATA OVERVIEW
4:10 pm – 4:50 pm	LIVE DEMONSTRATION: USE OF ICESAT-2 PRELAUNCH DATA
4:50 pm – 5:00 pm	CLOSING REMARKS

NASA's Ice, Cloud and land Elevation Satellite-2 (ICESat-2) mission will orbit the planet to measure elevation changes in our Earth's surface. With a target launch in 2017, ICESat-2 will continue important observations of ice sheet elevation change, the above-water height of sea ice, and vegetation canopy height begun by the first ICESat mission, which operated from 2003 to 2009. It will also take height measurements over inland water bodies, including lakes and reservoirs. ICESat-2 will advance our knowledge on key observations for ecosystem, climate, and water applications.

This focus session provides an overview of the ICESat-2 mission and discusses how the measurements of inland water surfaces will be developed into data products the public can use. We invite the water resources community to join us in exploring how the data products will work, and discuss how water managers, conservation groups and others could use these data products to make key decisions. In this focus session, we hope to provide the water resources community with an opportunity to talk to ICESat-2 mission scientists, so that both identify opportunities for using and leveraging the use of the planned data products.

Goals

- Examine the opportunities and challenges related to using ICESat-2 data for inland water studies
- Assess the potential efficacy of ICESat-2 data in operational and decision-making contexts
- Explore possibilities for combining ICESat-2 and other data sources to develop better products for inland water applications
- Provide a demonstration on how to access and use the available ICESat-2 prelaunch data

Part I: Mission Overview and Potential Water Resources Applications

To begin the focus session, NASA ICESat-2 scientists provide an overview of the mission, including details on what the water resources community can expect. The scientists will outline the mission's spatial coverage, the timeline for data product generation, and how the data products developed from the satellite observations work.

The session will include an overview of the mission in the context of the NASA Applied Sciences Program for Water Resources, which aims to discover, demonstrate, and transfer – to the water-resource community – innovative uses and practical benefits of NASA's Earth observations for improved water management. We will also discuss the ICESat-2 Applications Program, which works in conjunction with the ICESat-2 Project Science Office to build a broad and well-defined user community before the satellite's launch.

ICESAT-2 MISSION & INLAND WATER DATA PRODUCT OVERVIEW				
Subject	**Time**		**Topic**	**Speaker**
November 18, 2015	A.M.	8:30-8:35	Logistics	
ICESat-2 MISSION OVERVIEW & APPLICATIONS STRATEGY	A.M.	8:35-8:45	Welcome	John C. Tracy, American Water Resources Association President, Idaho Water Resources Research Institute
		8:45-9:05	Mission Applications Overview and Strategy for Focus Sessions	Molly Brown, ICESat-2 Program Applications Lead, University of Maryland
		9:05-9:30	Mission Design, Orbits Schedule, and Data Products	Tom Neumann, ICESat-2 Mission Deputy Project Scientist, NASA GSFC
		9:30-9:45	ICESat-2 in the context of NASA's Water Resources Applications Area	Christine Lee, Associate Program Manager, NASA Applied Sciences Water Resources, Jet Propulsion Laboratory (JPL)
		9:45-10:00	Q&A	
BREAK	A.M.	10:00-10:30	Morning Break	

Part II - ICESat-2 Inland Water Data Product

Scientists for the ICESat-2 Mission are developing a data product that will help identify global inland water bodies, including lakes and rivers, of various shapes and sizes. This session will review in detail the inland water data product and other ICESat-2 data products that are relevant to the water resources community. It will also describe how ICESat-2 observations and measurements can contribute to current national initiatives that aim to provide the public with high-quality, fine resolution, elevation data.

PART II: ICESAT-2 INLAND WATER DATA IN-DEPTH				
Subject	**Time**		**Topic**	**Speaker**
November 18, 2015	A.M.	10:30-10:35	Logistics	
ICESAT-2 INLAND WATER DATA PRODUCTS & OPPORTUNITIES FOR CROSS-MISSION DEVELOPMENT	A.M.	10:35-11:05	The ICESat-2 Inland Water Body Height Data Product: Description and anticipated results	Mike Jasinski, ICESat-2 Science Definition Team Member, NASA GSFC
		11:05-11:20	The 3D Elevation Program: Overview	Jeff Simley, National Geospatial Program, U.S. Geological Survey
		11:20-11:35	Development opportunities between NASA's SWOT, GRACE and ICESat-2 missions	Margaret Srinivasan, Deputy Program Applications Lead for NASA SWOT, JPL
		11:35-12:00	Q&A Panel Discussion: ICESat-2 altimetry opportunities for the water resources community	
BREAK	P.M.	12:00-1:30	LUNCH BREAK	

Part III - ICESat-2 Prelaunch Opportunities for the Water Resources Community

The ICESat-2 Early Adopter Program (http://icesat-2.gsfc.nasa.gov/early_adopters) is an initiative of the ICESat-2 Applications Team that encourages potential data users to become familiar with the ICESat-2 products, and demonstrates how it could be useful within different decision-making contexts. Latency, spatial and temporal resolutions are key data characteristics that vary with individual decision processes and operations; the ICESat-2 Early Adopter program facilitates the necessary communication between the mission and user communities to clarify these characteristics for particular applications. The program helps redefine the paths for how the mission products can become actively relevant. This session highlights the research being conducted by Early Adopters focusing on inland water applications and provides an opportunity for attendees to share what would be most useful for them.

PART III: ICESat-2 Prelaunch Opportunities for the Water Resources Community				
Subject	**Time**		**Topic**	**Speaker**
November 18, 2015	P.M.	1:30-1:35	Logistics	
ICESAT-2 EARLY ADOPTERS & POTENTIAL WATER RESOURCES APPLICATIONS	P.M.	1:35-1:45	Early Adopter Program Strategy	Sabrina Delgado Arias, ICESat-2 Applications Coordinator & POC, SSAI/NASA GSFC
		1:45-2:00	Assessing the value of the ICESat-2 inland water level product for the Global Flood Partnership	Guy J-P. Schumann [University of California, Los Angeles (UCLA), Joint Institute for Regional Earth System Science & Engineering]
		2:00-2:15	Operational Applications of Multiple Satellite Sensors to Map Ice Types and Wind Vectors Across the Great Lakes	George Leshkevich, Great Lakes Environmental Research Laboratory, National Oceanic and Atmospheric Administration
		2:15-2:30	Remote sensing of reservoir storage using altimetry data and satellite imagery	Huilin Gao, Texas A&M University
		2:30-3:00	Q&A and Panel Discussion	
BREAK	P.M.	3:00-3:30	AFTERNOON BREAK	

Part IV - ICESat-2 Prelaunch Data with Live Demonstration

We conclude the ICESat-2 Inland Water focus session with a discussion by the ICESat-2 Mission on prelaunch data access and use. ICESat-2's instrument will collect data that is different from its predecessor, so the mission has collected documentation, product readers, camera images, and prelaunch data files to demonstrate how the ICESat-2 data may function. All this is currently available to the water resources community for analysis. This session will also cover current plans for user services by the NASA Distributed Active Archive Center at the National Snow and Ice Data Center, and includes a live interactive demonstration of how to access and use the data for a particular case example.

PART IV: ICESAT-2 PRELAUNCH DATA WITH LIVE DEMONSTRATION				
Subject	Time		Topic	Speaker
November 18, 2015	P.M.	3:30-3:35	Logistics	
ICESAT-2 PRELAUNCH DATA: DISCOVER, ACCESS AND USE	P.M.	3:35-4:00	ICESat-2 pre-launch airborne data for Inland Water: Early results from the Multiple Altimeter Beam Experimental Lidar (MABEL)	Mike Jasinski, ICESat-2 Science Definition Team Member, NASA GSFC
		4:00-4:15	User Data Services provided by the National Snow and Ice Data Center (NSIDC)	Steve Tanner, ICESat-2 Data Management Lead, NSIDC
		4:15-4:50	Interactive Live Demonstration: Use of ICESat-2 Prelaunch Data	Tom Neumann, ICESat-2 Mission Deputy Project Scientist, NASA GSFC
CLOSING	P.M.	4:50-5:00	CLOSING REMARKS	

Appendix D: List of Participants

List of Participants		
Name	Organization	Email
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