

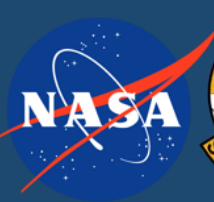
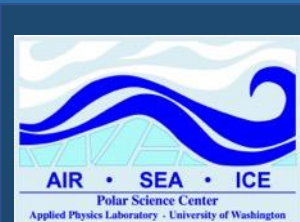
ICE-PPR Iceberg Tagging EXperiment (ITEX)

International Cooperative Engagement
Program for Polar Research (ICE-PPR)

US Interagency Arctic Buoy Program (USIABP)
International Arctic Buoy Programme (IABP)

DBCP-38, Geneva

2 November 2022



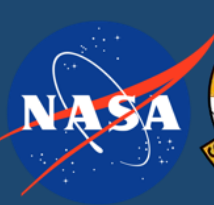
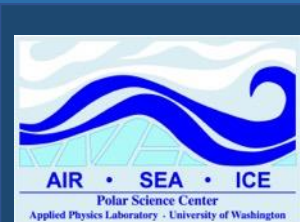
ICE-PPR ITEX Team

John Woods, ICE-PPR, ONR Global
Ignatius Rigor, IABP, U. Washington

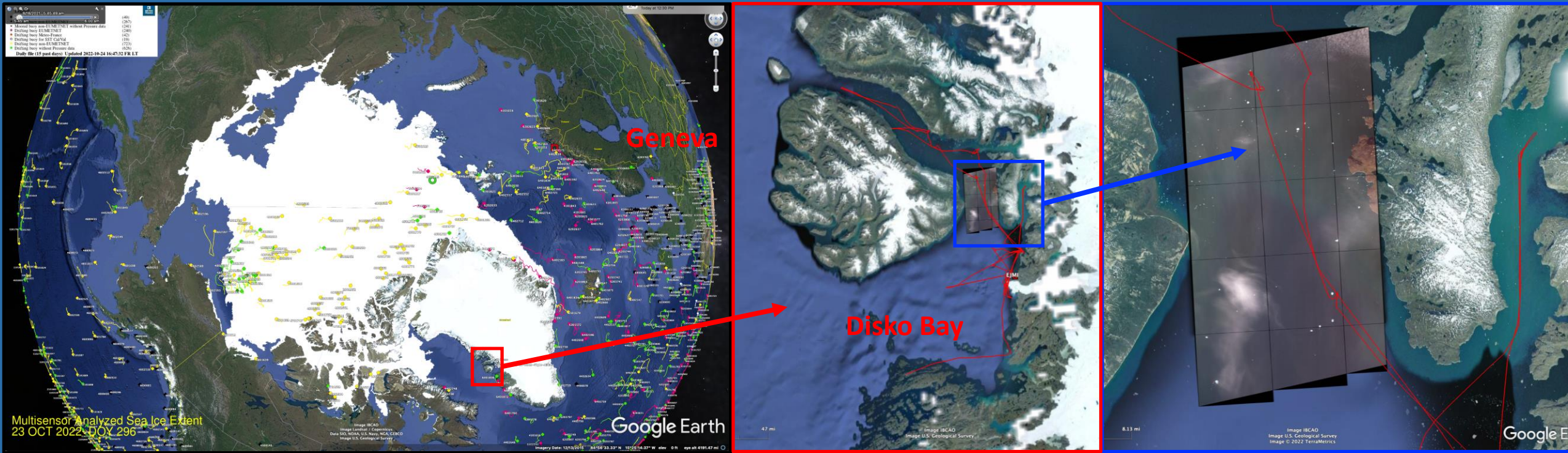
Cy Keener, U. Maryland

Keld Quistgaard, Danish Met. Institute

Other Collaborators: Univ. of Kansas, International Ice Patrol,
Naval Postgraduate School, Naval Research Lab, Canadian
Ice Service, Danish Defense/GeoMETOC

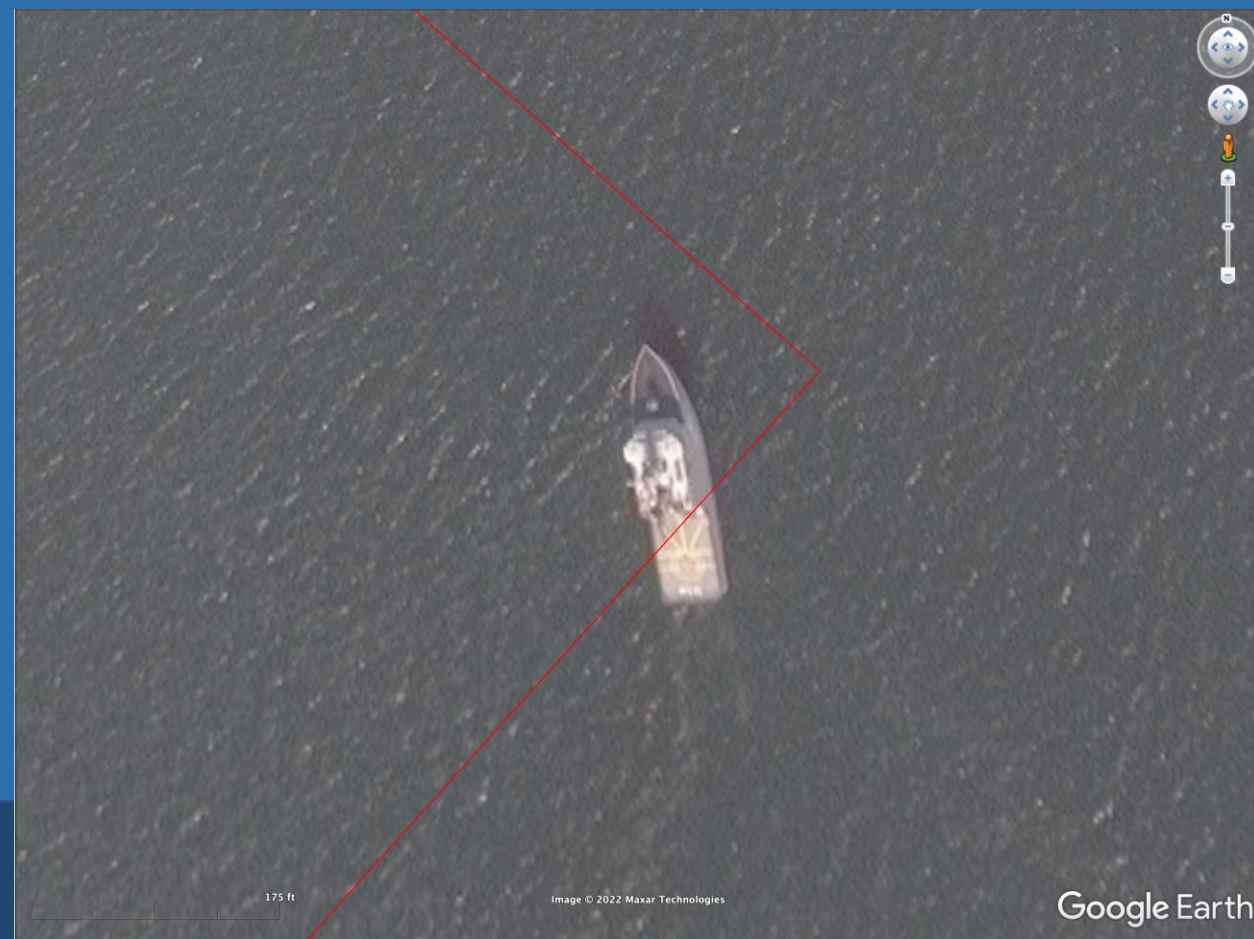


ICE-PPR Iceberg Tagging EXperiment (ITEX)



Motivation: Global warming has been melting the ice sheets, speeding the flow of icebergs into the global oceans. Observations of iceberg drift are critical for safe navigation, research, and predicting the drift and melt of these hazards.

Worldview Images



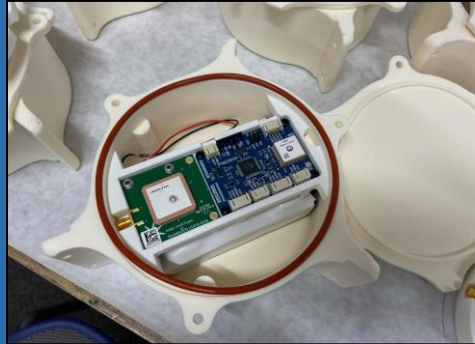
International Cooperative Engagement Program for Polar Research (ICE-PPR)



John Woods
coordinating with
RDAF C-130 pilots
from Mt Dundas,
Thule, Greenland

- Participants include defense departments from the United States, Canada, Denmark, Finland, **New Zealand (bi-polar)**, Norway and Sweden
- MOU between defense departments to support cooperation on Polar Research, Development, Testing and Evaluation.
- 25 Year duration will allow for generational engagement.

ITEX Trackers and AUVs



- Arduino micro-electronics.
- Easily programmable to report at any time frequency.
- GPS and Meteorological Sensors incorporated on electronics board.
- Reports via Iridium (true global coverage).

Iceberg Tagging Strategy



Mavic flying over to DSE 13 to scout out a drop site on the iceberg, then X6 deploys Spider 9.8.

Iceberg Tagging Strategy



Mavic flying over to VSO 41 to scout out a drop site on the iceberg, then K8 deploys Trace 5260.

Icebergs Tagged

ILU 04
Small Tab
13m x 6m



VNO 30
Small Wedge
20m x 18m



ILU D
Small
50m x 35m



DSE 07
Small Dome
40m



VSO 16
Medium Blocky
84m x 40m



VSO 47
Medium Drydock
91m x 70m



VSO 41
Large Pinnacle
140m x 110m



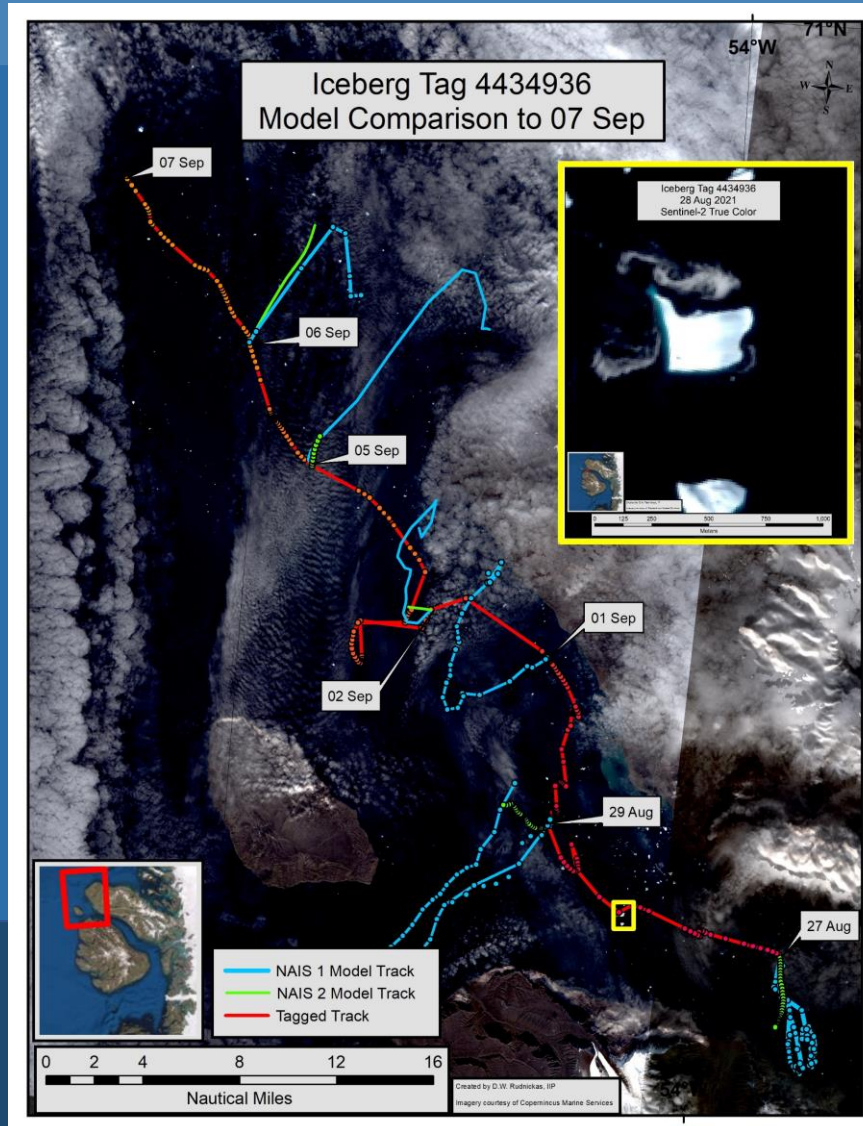
VSE 33
Very Large Tabular
450m x 330m



DSE 13
Very Large Wedge
480m x 340m



Iceberg Drift Models: Preliminary Results

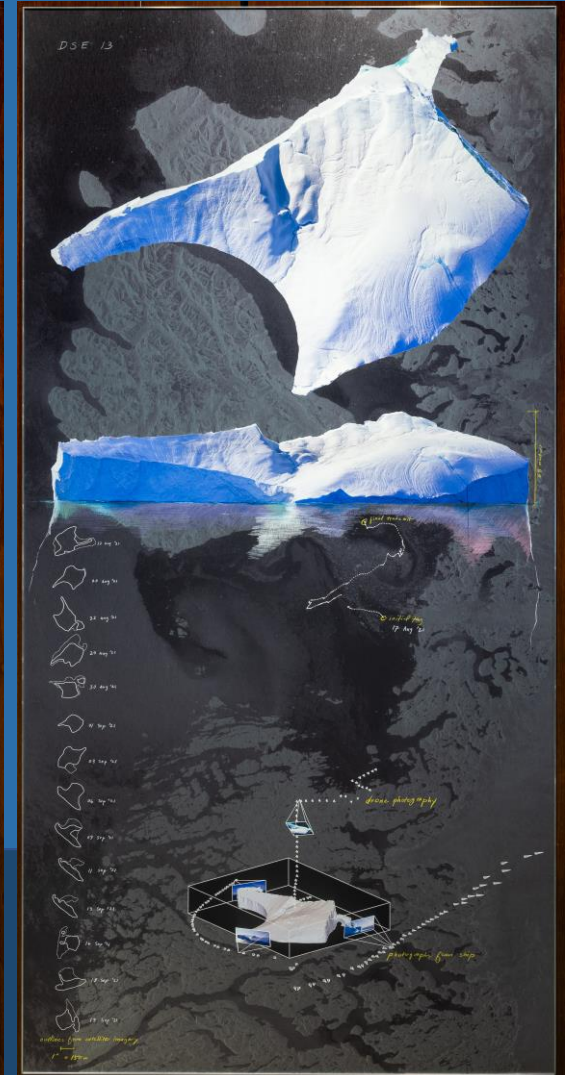
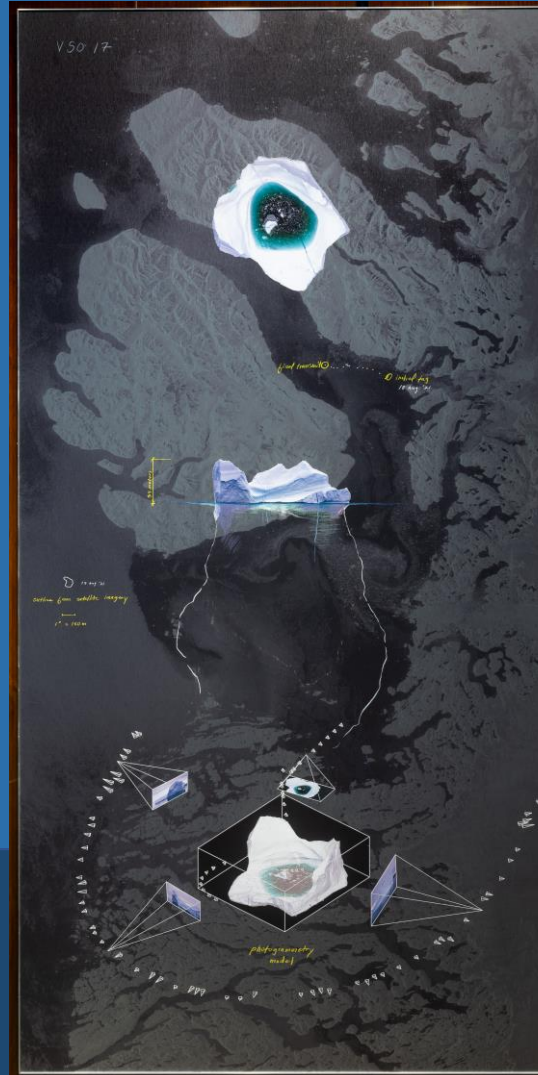
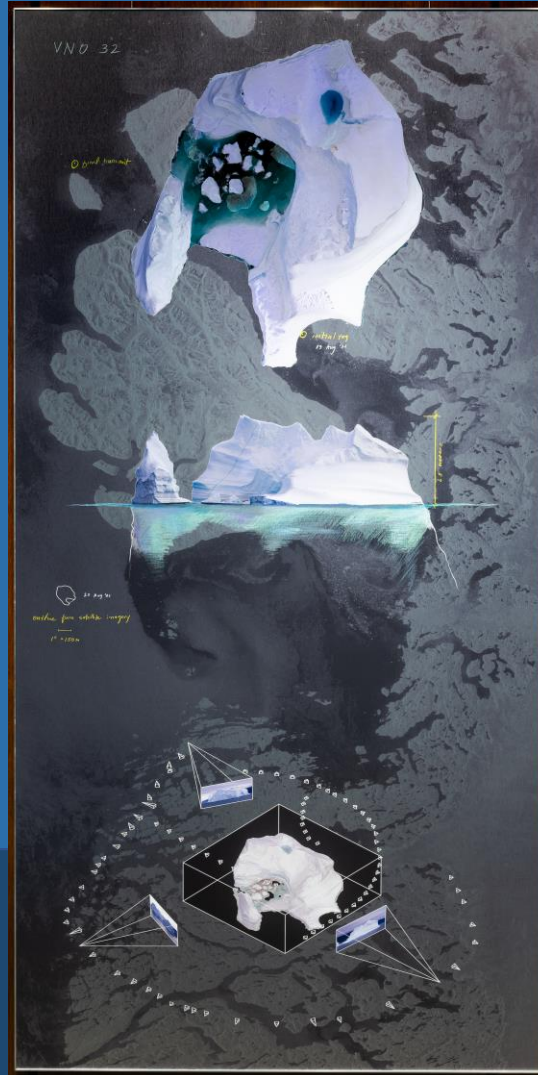
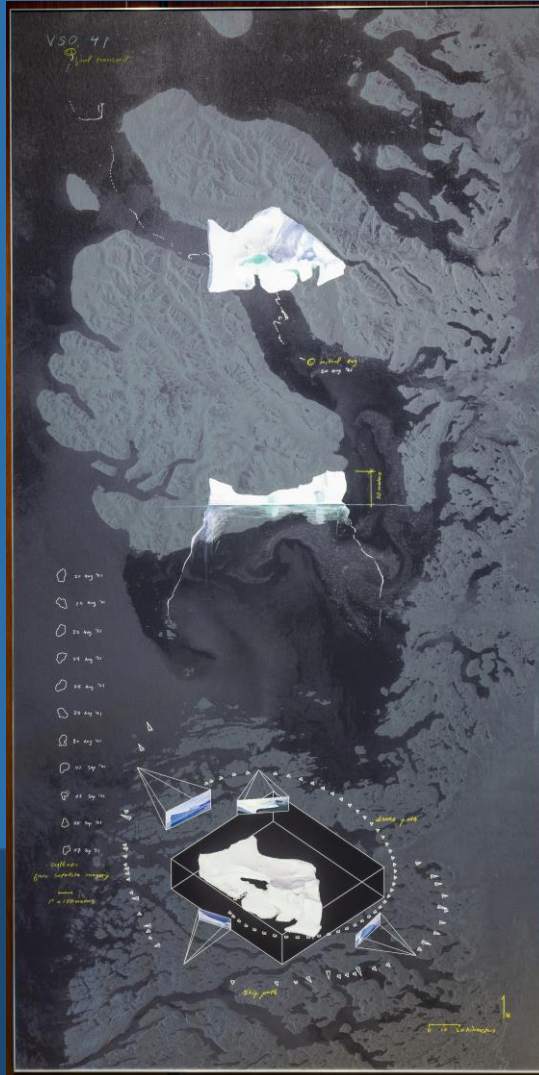


North American Ice Service (NAIS) Models

- Initial comparisons of model results vs. tagged tracks inspire many questions:
 - Environmental Inputs
 - Near-Shore dynamics
- Much more work to be done.

Donald.W.Rudnickas@uscg.mil

Science Technology Engineering Art Math(STEAM)



Current/Future Directions

- Data Documentation Pub (APL Technical Report, and/or Journal?)
 - Methods (Trackers, AUVs, Tagging)
 - Iceberg Tracks and Metadata
 - Satellite Imagery
 - Many lessons learned
- Masters Thesis, Ph.D. Dissertations:
 - Adam Garbo, U. Ottawa,
 - Megan Toomey, USCG, U.W. Oceanography ?
 - Naval Postgraduate School, Comparing NAIS Iceberg Model with observed drift ?
 - Students of Jim Carton, Tim Canty, UMD ?
- STEAM Photogrammetry Above/Below Waterline
 - Cy Keener, Ben Cohen
- KU Future Remote Sensing Work
 - Apply machine learning techniques to high-resolution optical imagery to quantify the distribution of small icebergs, to complement the DMI SAR work.
 - Apply multi-object tracking algorithms (Yolo, DeepSort) to track individual icebergs in sequential images.
 - Explore the link between glacier behavior and iceberg size distributions to ultimately model how iceberg distributions (and trajectories) might change in a warming climate.

ICE-PPR Iceberg Tagging EXperiment (ITEX)

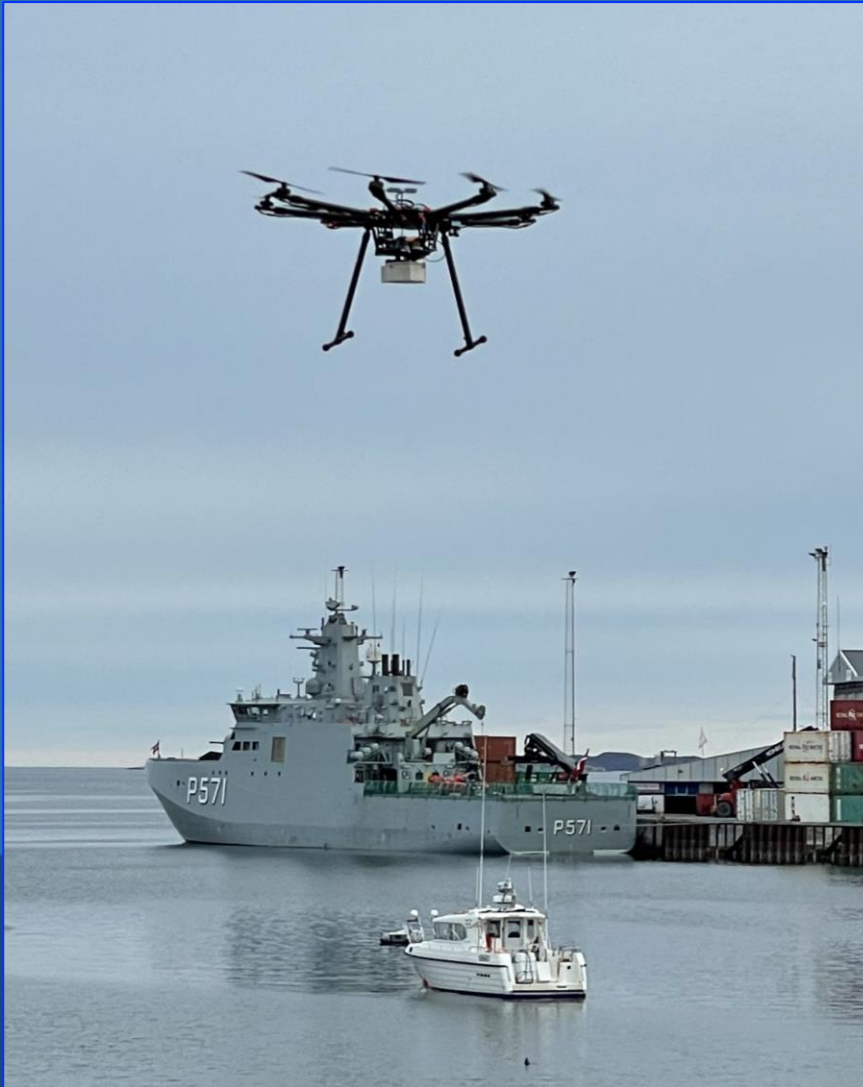


Left-Right: Keld Quistgaard, Alex Zugazagotia, Kushal Kedia, Cy Keener, Ignatius Rigor, and John Woods

END

Iceberg Tagging Strategy

Platforms: K8



- Built by Kushal Kedia, Aero. Engr. undergrad at CU, and Intern at PSC/APL/UW.
- Payloads + 5 kg (11 lb.)
- Herelink or Control Zero Flight Controller
- Standard with Ardupilot Flight Control
- Flight time ~20 minutes with TSA checkable 5Ah 22V LiPo (55 minutes with stock 20Ah LiPO).
- 29 # in case (w/o batteries).
- 5 ft. wide, 2.5 ft. tall

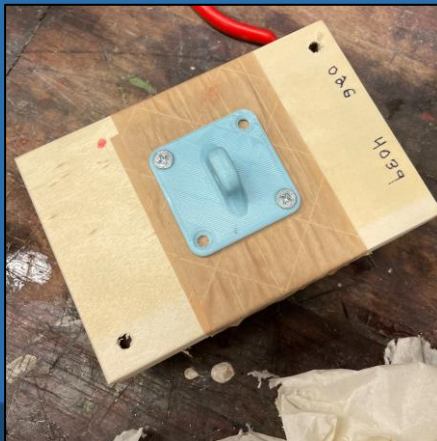
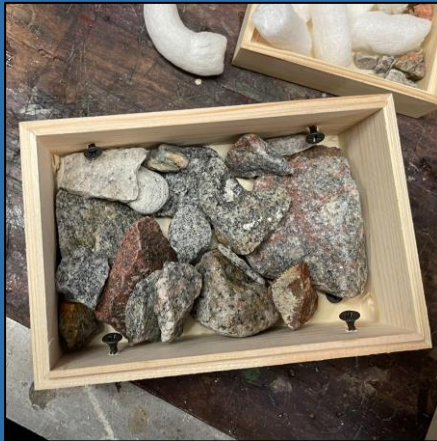
Iceberg Tagging Strategy

Platforms: Aurelia X6



- Spares!
- UAV Systems International
- Payloads up to 5 kg (11 lb.)
- Herelink or Control Zero Flight Controller
- LIDAR accuracy +/- 2.5 cm
- Fully customizable
- Standard with Ardupilot Flight Control
- Flight time ~20 minutes with TSA checkable 5Ah 22V LiPo (55 minutes with stock 20Ah LiPO).

SPOT Traces



- Provides hourly reports for 45 days on 4 AAA Lithium Batteries.
- Deployed in a wooden box with locally sourced rocks and biodegradable parts.

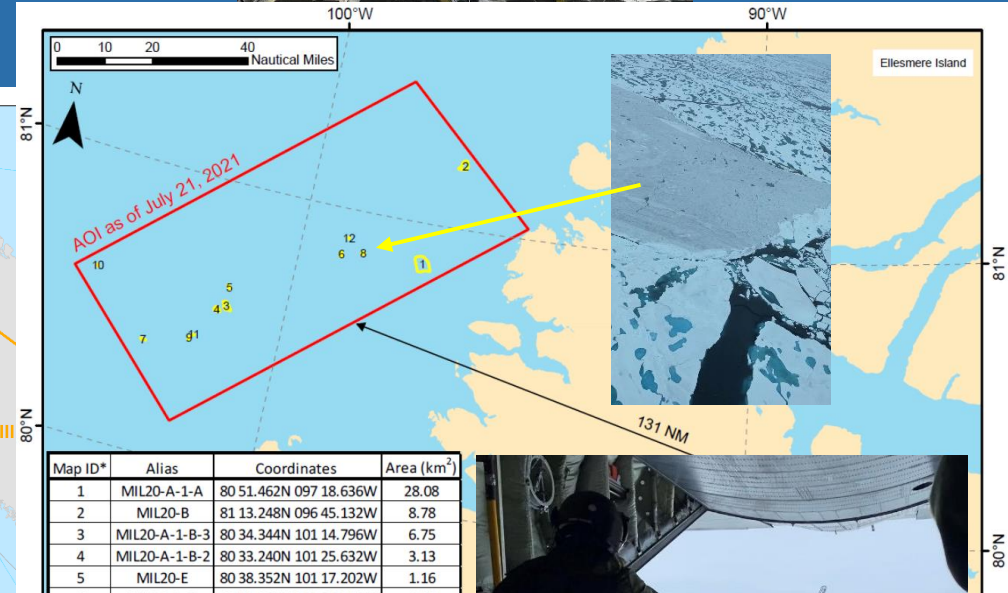
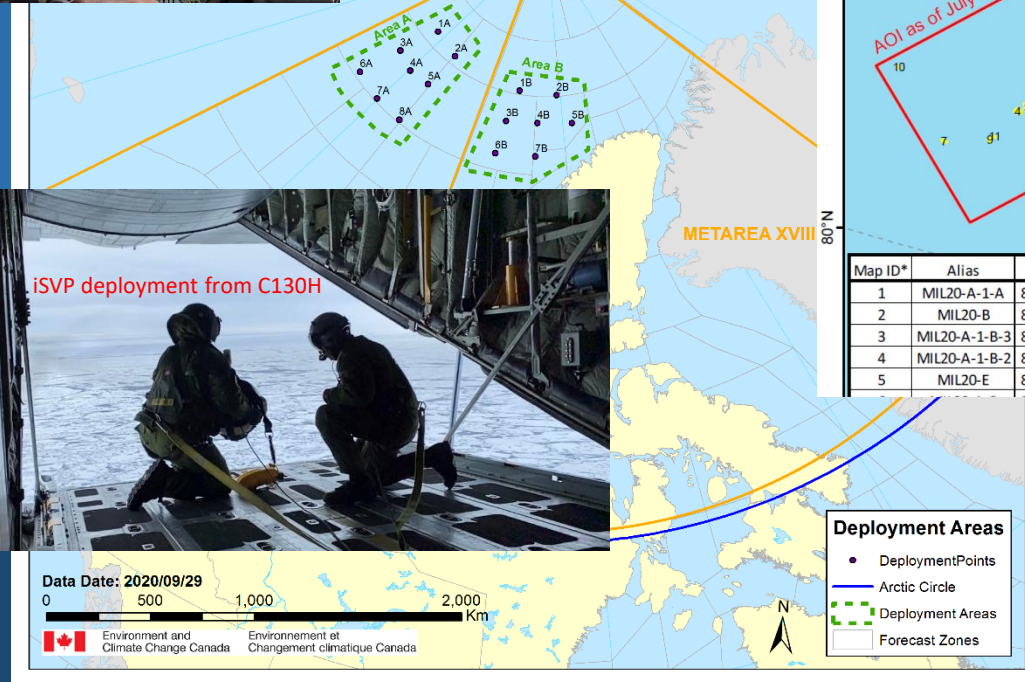
Icebergs Tagged: High Arctic, ICE-PPR RCAF

Nina.Bigras@forces.gc.ca

- 16-22 August 2021 – DRDC/ECCC/RCAF
- 3x Ice Islands Tagged (2 CALIBs reporting)
- 15x Buoys Dropped (14 iSVPs reporting)



ECCC-MSC-METAREAs Potential Deployment Locations

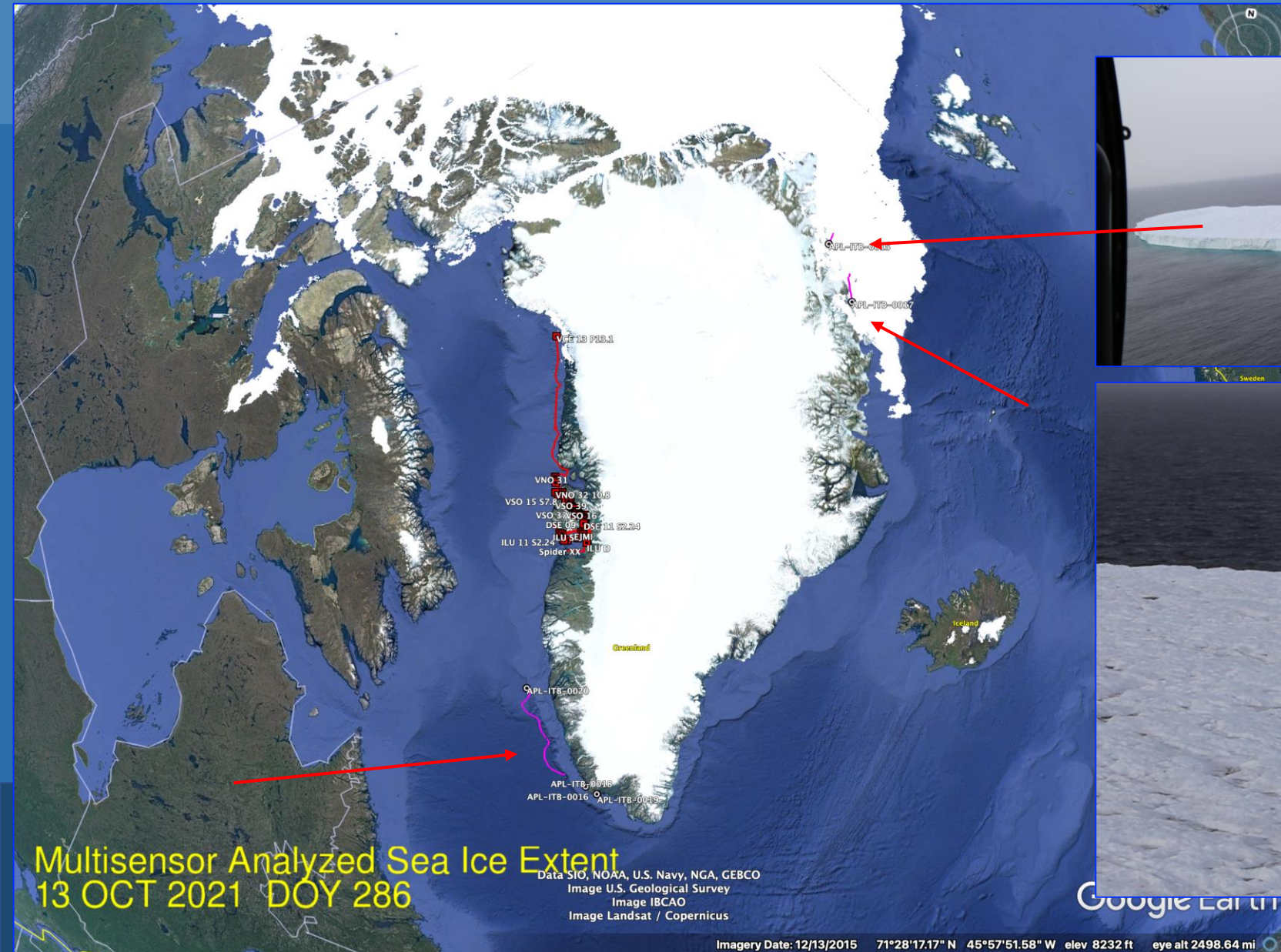


iSVP deployment from C130H



CALIB deployment from C130H

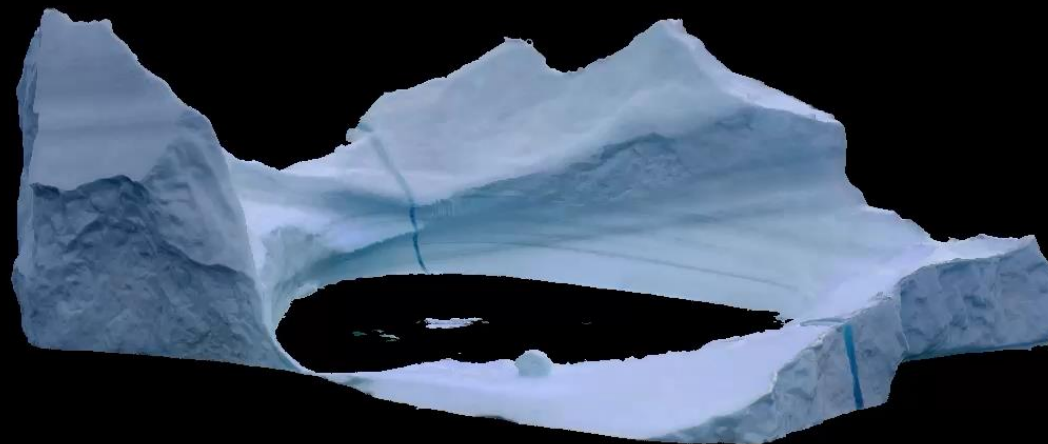
Icebergs Tagged: HDMS Triton



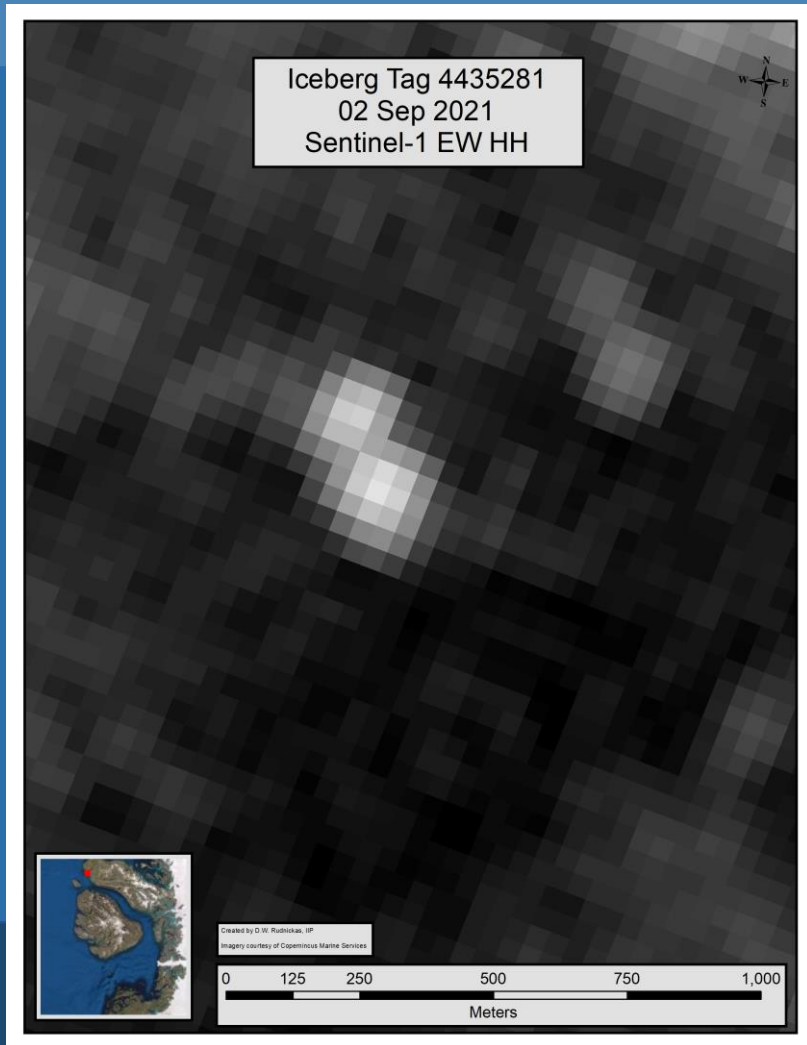
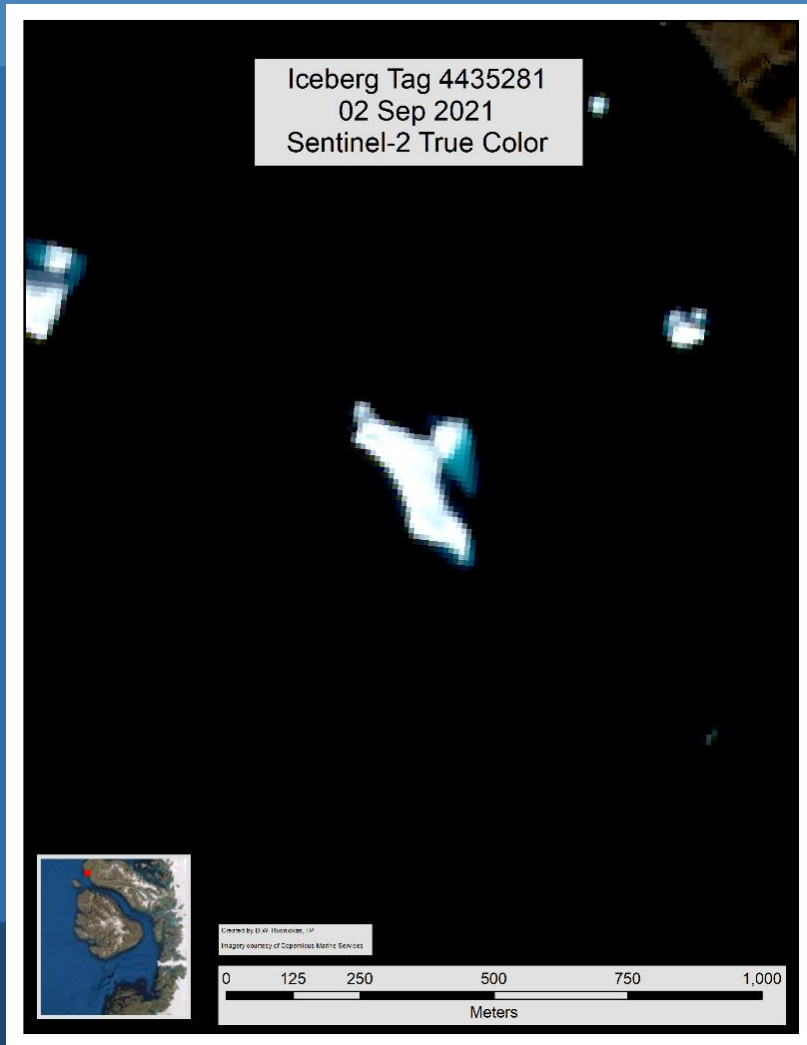
3D Photogrammetry



Capturing Reality

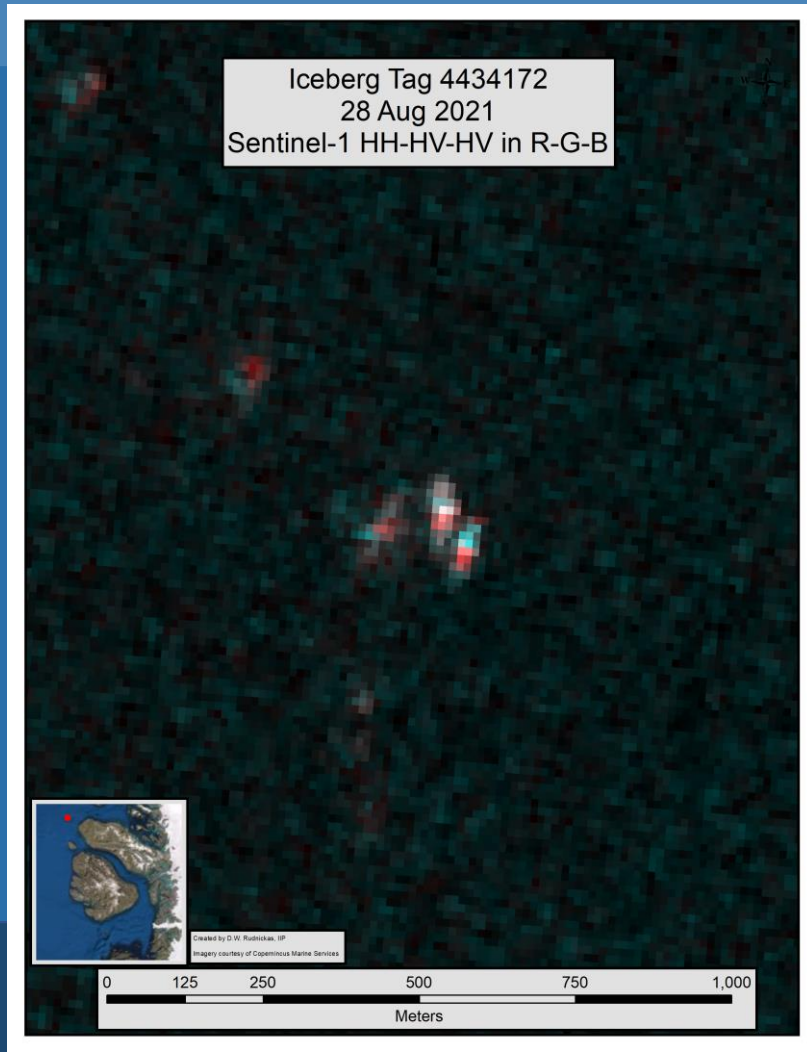
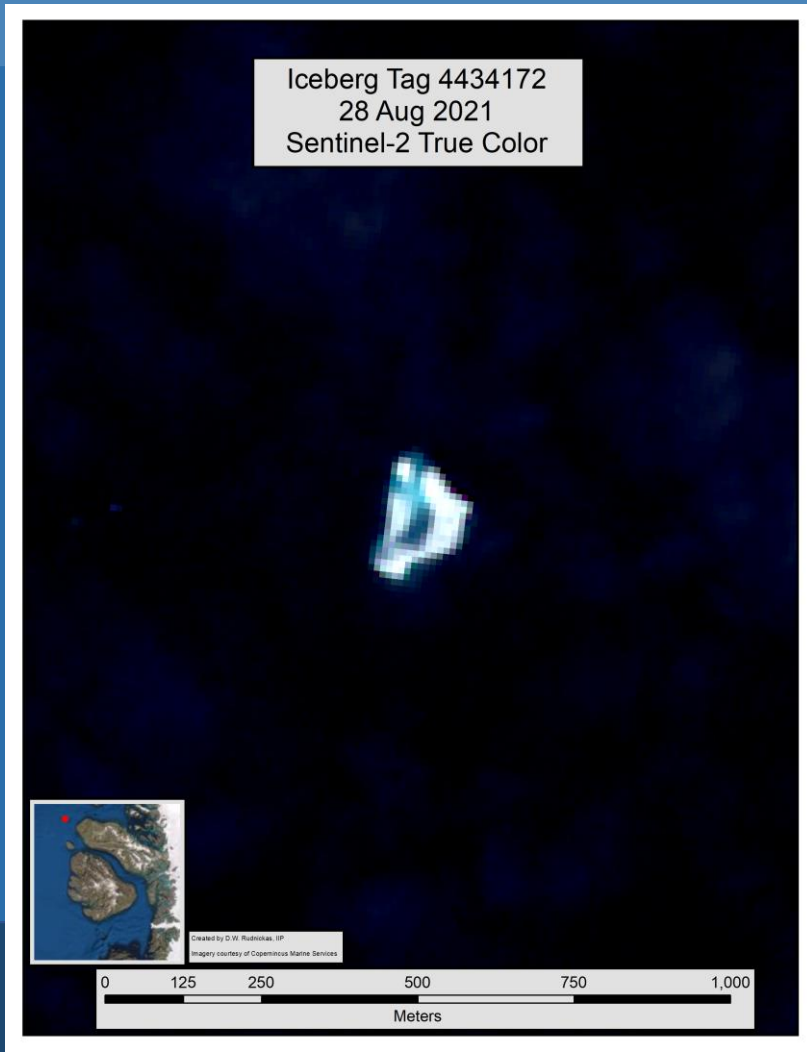


International Ice Patrol (IIP) Validation of Satellite Detections



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International Ice Patrol (IIP) Validation of Satellite Detections



Worldview Images

