INTRODUCTION TO POLAR GEOSPATIAL CENTER
Webinar

pgc

Products, Services & Support

OUTLINE:

Basic introduction for newly funded polar researchers and logistics personnel, recent partners and the general public to learn about the Polar Geospatial Center, the nature of our work and who we support.

Background Information

- Mission
- Timeline
- Funding & Users
- Support Roles
- User Services

Products & Services

- Public vs Restricted Data
- Products & Services
- Support Examples
- Requesting Support

Q&A w/ PGC Staff

PGC.UMN.EDU

PGC website provides exhaustive information about PGC: background, data, services, news, and tutorials.

Check out our growing online Guides section

pgc.umn.edu/guides

PGC Introduction

The Polar Geospatial Center is a polar science and logistics support organization at the University of Minnesota with core funding provided by the National Science Foundation's (NSF) Office of Polar Programs (OPP).

MISSION

- Domain and institutional knowledge to solve a broad range of polar geospatial problems

- Access to sub-meter commercial satellite imagery for the Antarctic and Arctic and the expertise to task, manage, process, and deliver high-level, value-added products

- Educational courses and online material to transfer PGC's knowledge and experience to the community

Timeline

Quick Look

| 2007 | Founded as the Antarctic Geospatial Information Center (AGIC) for support to the U.S. Antarctic Program (USAP) |
2010	Transitioned to the Polar Geospatial Center (PGC) to support research and logistics for Antarctic and Arctic
2015	PGC receives supplemental $ to launch ArcticDEM
2020	Approximately 15 employees, EarthDEM project

PGC **Funding & Users**

General Public

Polar Logistics & Operations

Polar Grantees & Researchers

Other Agency Agreements
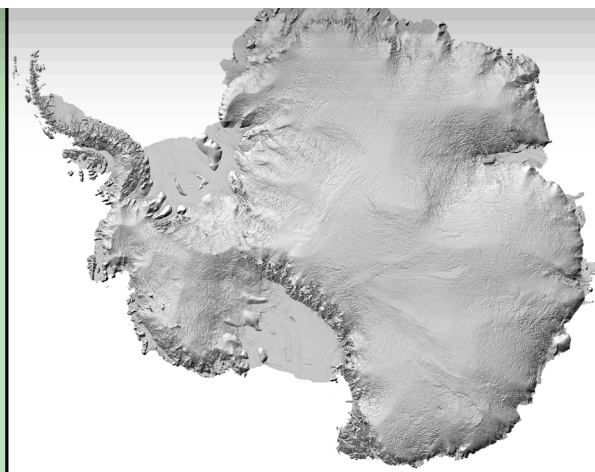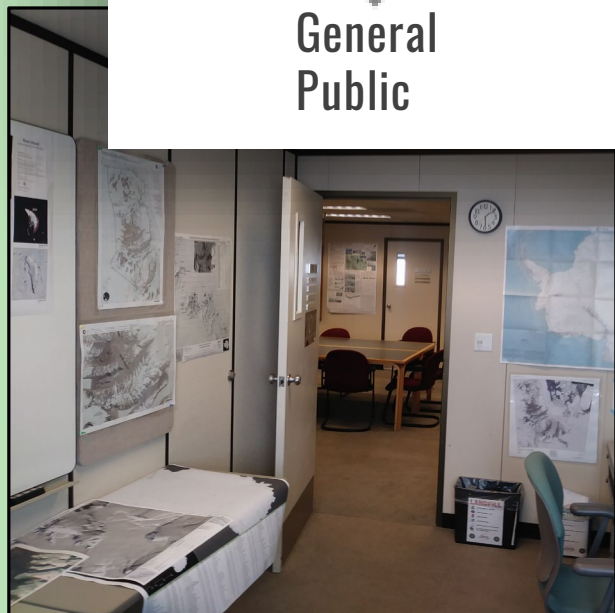
Funding

- National Science Foundation

  Primarily through Office of Polar Programs (OPP)

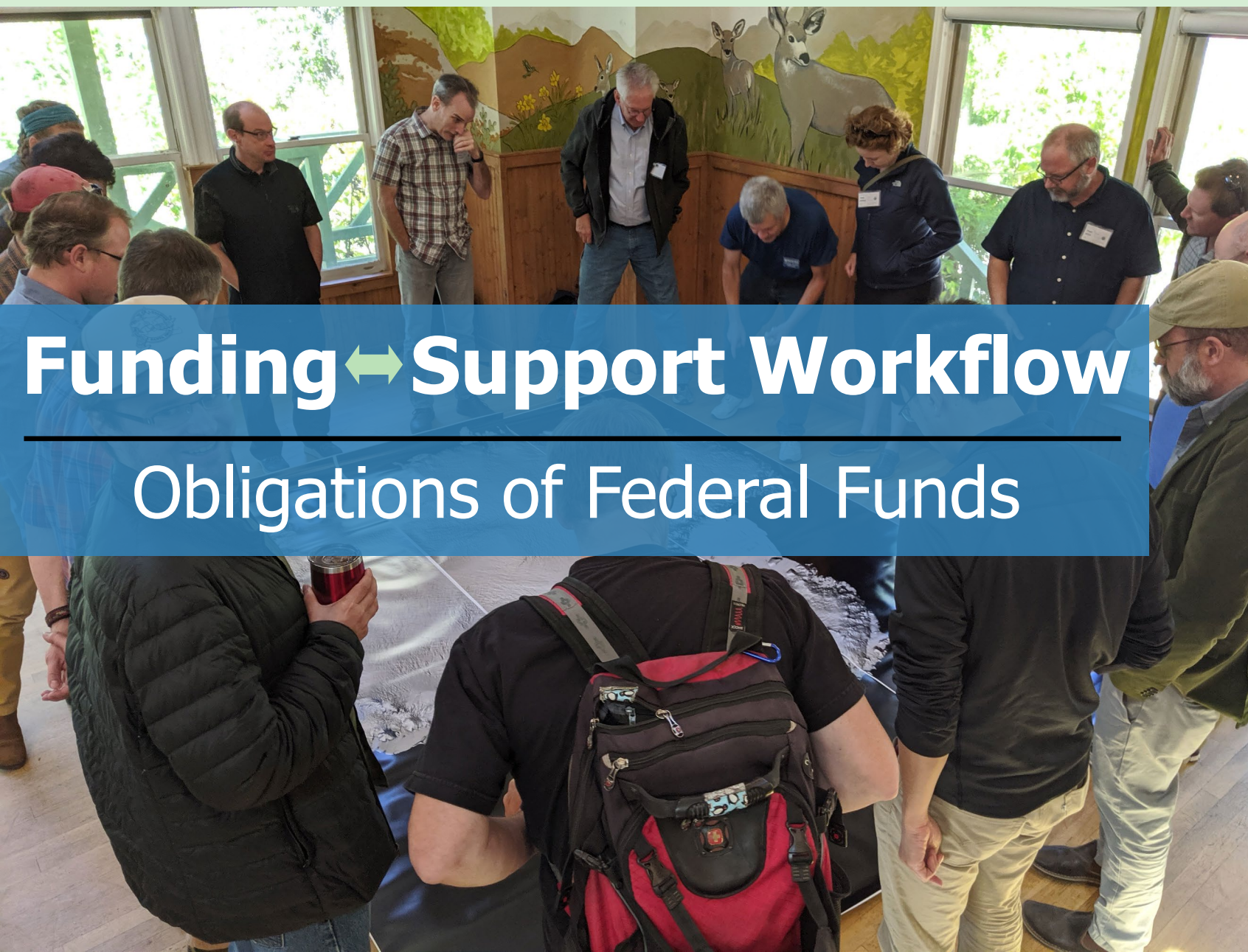 2016-2021 NSF Cooperative Agreement #1559591

Other Awards (Past & Present)

- ArcticDEM from NSF

- NASA Cryosphere, ABoVE, and High-Mountain Asia Programs

- U.S. Fish & Wildlife Service

- University of Minnesota

Funding ↔ Support Workflow

Obligations of Federal Funds

Funding ⬌ Support Workflow

Obligations of Federal Funds

Direct Users – Core

- NSF OPP and NASA Cryo funding provides specialized support for NSF OPP / NASA Cryo grantees as well as Arctic/Antarctic logistics & operations contractors

Indirect Users – Public

- Publicly available datasets:
  - ❖ High-resolution digital elevation models (DEM) *ArcticDEM / REMA / EarthDEM*
  - ❖ Aerial photography
  - ❖ Historical & contemporary polar maps

PGC's role to **SCIENTISTS**

- Provide geographic **data**

- Serve as a **conduit** to an archive of high-resolution commercial satellite imagery licensed for US. Federally-funded users

- Provide **expertise** relating to GIS, Mapping, Remote Sensing, Photogrammetry

- Process and manipulate data to **enable** scientific objectives

PGC's role to **LOGISTICS**

- Facilitate **safe** navigation and travel
- Provide satellite **imagery** and derivative cartographic materials to increase situational awareness
- Create **reference** materials for planning and movement objectives
- Reduce programmatic costs through remote site **monitoring** and reconnaissance
- **Assist** with emergency response and SAR scenarios

PGC's role to **COMMUNITY**

- **Transfer** PGC's knowledge and expertise

- Provide comprehensive materials to teach and **enable** use of PGC products

- Reach broad audience to facilitate **self-service**

- Reduce duplicated efforts w/ solutions **beyond** direct support

Antarctic Viewer
View the land of snow & ice of the southernmost continent.
WGS84 Antarctic Polar Stereographic Projection
Launch Antarctica »

Arctic Viewer
View the dynamic landscape of glaciers & permafrost for Greenland & Alaska.
NSIDC Sea Ice Polar Stereographic Projection North
Launch Arctic »

World Viewer
View the snowcaps, ice fields, & glaciers throughout the world.
WGS84 Web Mercator Projection
Launch World »

Decimal Degrees (DD)
Latitude:
-77.508333
Longitude:
164.754167

Degrees Decimal Minutes (DDM)
Latitude:
77   30.5   S ▼
Longitude:
164   45.25   E ▼

PGC Map Catalog
VIEW ANTARCTICA MAPS »   VIEW ARCTIC MAPS »

USER Services

DIRECTOR

MANAGING DIRECTOR

DATA INFRASTRUCTURE

USER SERVICES

USERS

Data Management

System Administration

Programming & Development

Support & Education

Tasking

Analysis

Students

Students
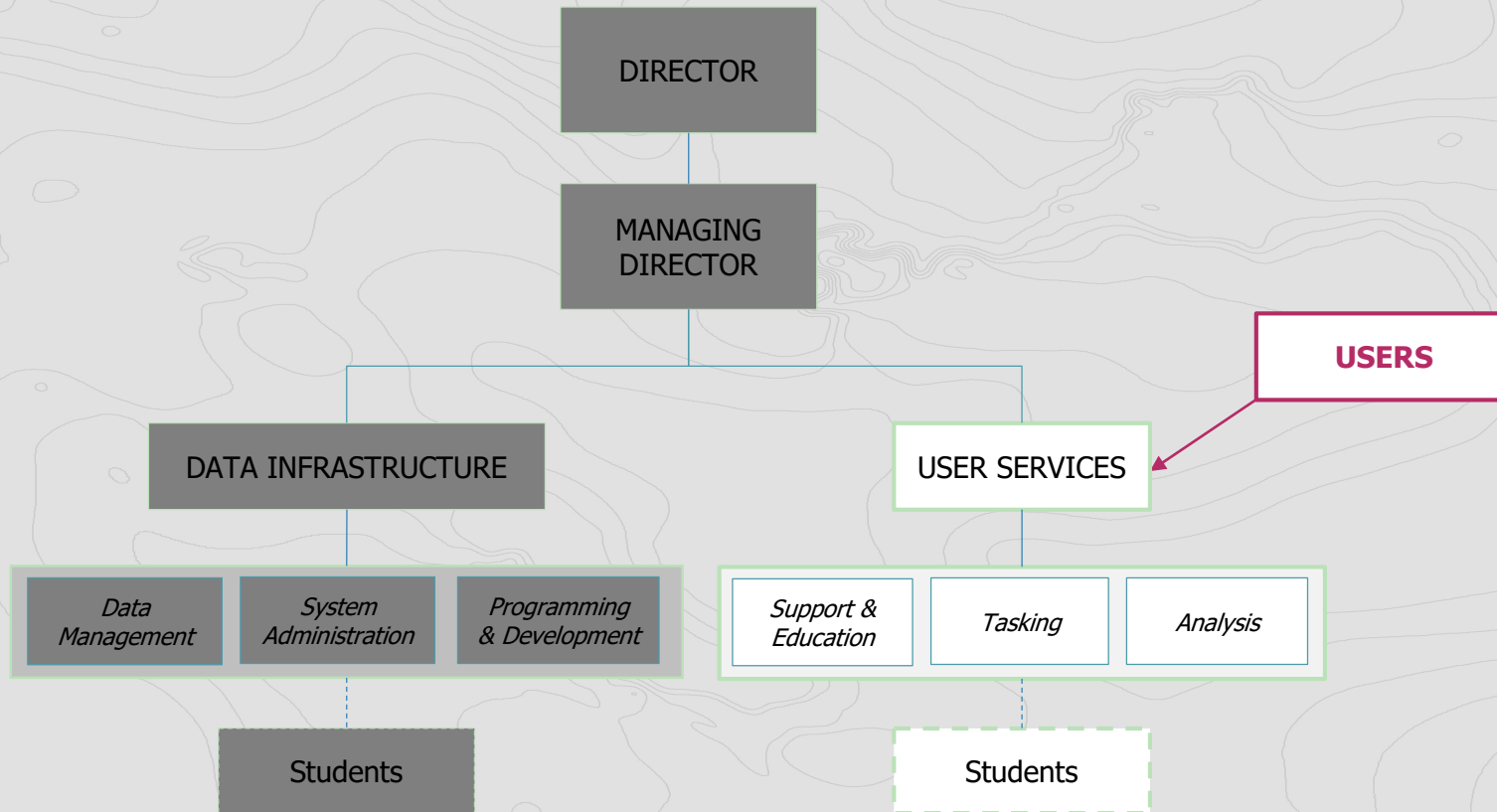
ABOUT

- Connection to the polar community
- PGC Team that provides dedicated support to our core users
- Responds to data & support requests
- Coordinates project responsibilities

USER SERVICES Staff

7 full-time staff members

3 graduate research assistants

Domain Expertise

GIS, geography, remote sensing, computer science, earth & atmospheric sciences, web development

Point-of-Contact System

Core Activities & **Primary Services**

User Services creates, locates, maintains, and aggregates information about requesting parties to provide the most efficient and effective support
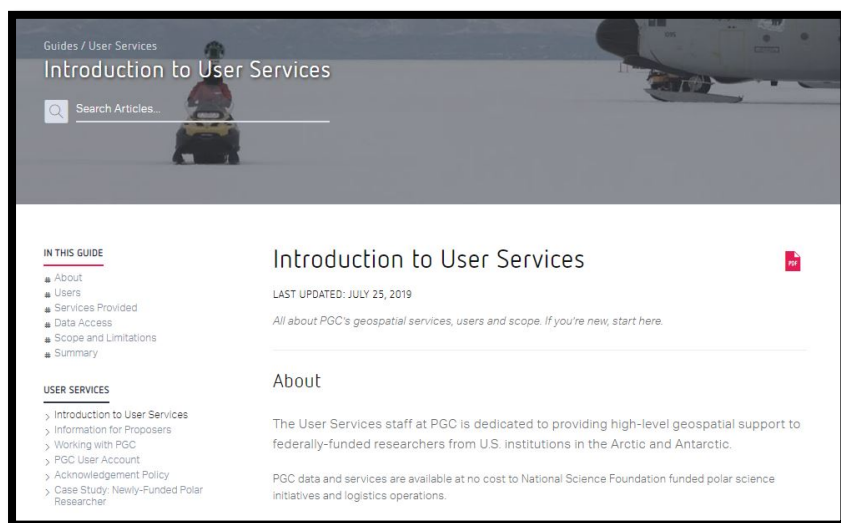
- Geospatial expertise & guidance
- Satellite imagery processing & analysis
- Custom mapping
- Digital elevation model (DEM) creation
- Seasonal on-site support at
  📍 McMurdo Station, Antarctica

PGC **Products & Services**

Satellite Imagery

High-resolution (sub-meter) commercial satellite imagery from DigitalGlobe available for the entire Arctic and Antarctic
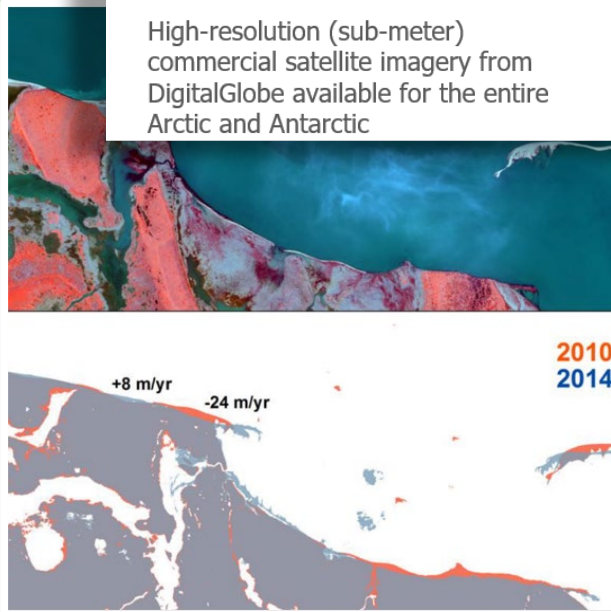
Terrain Models

High-resolution Digital Elevation Models (DEM) derived from Stereoscopic DigitalGlobe imagery

Digital Maps

Historical and custom map products for logistics planning, field site selection, publications, reference, etc.

Geospatial Support

Advanced solutions and expertise for novel or challenging remote sensing and geospatial problems

PUBLIC Data

Maps
Historical and contemporary polar maps from many organizations available in digital formats.

Includes
Antarctic maps
Arctic maps
Custom maps

Aerial Photography
Historic and contemporary aerial photography of the polar regions.

Includes
Antarctic TMA Project
Alaska AHAP Project

ArcticDEM
High-resolution, high-quality digital surface model (DSM) of the Arctic built with optical stereoscopic imagery, high-performance computing, and open source photogrammetry software.

Includes
2m posting scenes
2m posting mosaic

Reference Elevation Model of Antarctica (REMA)
High-resolution, high-quality digital surface model (DSM) of the Antarctic built with optical stereoscopic imagery, high-performance computing, and open source photogrammetry software.

Includes
2m & 8m posting scenes
8m posting mosaic

More Elevation Data
Spaceborne and airborne elevation datasets for the polar regions.

Includes
Antarctic LiDAR Campaigns
Stereo DEMs

RESTRICTED Data

- **Commercial satellite imagery** from Maxar's DigitalGlobe, Inc.

- Browser-based mapping application including **50 cm imagery mosaics** from PGC

- Restricted **maps** due to:
  - > formal copyright
  - > licensed imagery
  - > sensitive information
  - > authoring organization's request

WORLDVEW-1 (PANCHROMATIC)
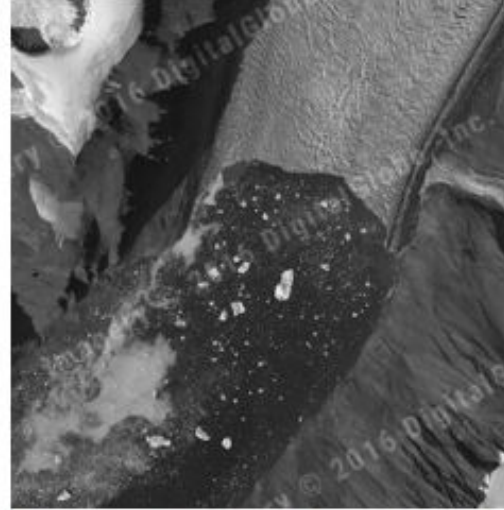
Íngia Isbræ, Greenland. *Imagery © 2016 DigitalGlobe, Inc.*

WORLDVIEW-2 (MULTISPECTRAL)

Herbert Volcano, Aleutian Islands, Alaska. *Imagery © 2012 DigitalGlobe, Inc.*

WORLDVIEW-3 (MULTISPECTRAL)

North Slope, Alaska. *Imagery © 2016 DigitalGlobe, Inc.*

WORLDVIEW-2 (MULTISPECTRAL)

McMurdo Station, Antarctica. *Imagery © 2015 DigitalGlobe, Inc.*

Source: Aerial photo of Taylor Valley by PGC

Commercial
Satellite Imagery
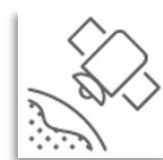
SPECS

ACCESS

VALUE – ADDED PROCESSING

APPLICATIONS

DigitalGlobe Overview

IKONOS®
.82 meter resolution
9 m CE90

QuickBird®
.65 meter resolution
23 m CE90

WorldView-1®
.50 meter resolution
<4 m CE90

GeoEye-1®
.46 meter resolution
<3.5 m CE90

WorldView-2®
.46 meter resolution
<3.5 m CE90

WorldView-3®
.31 meter resolution
<3.0 m CE90

CURRENTLY IMAGING IN ORBIT

AVAILABLE VIA DIGITALGLOBE ARCHIVE through G-EGD

Source: DigitalGlobe, Inc.
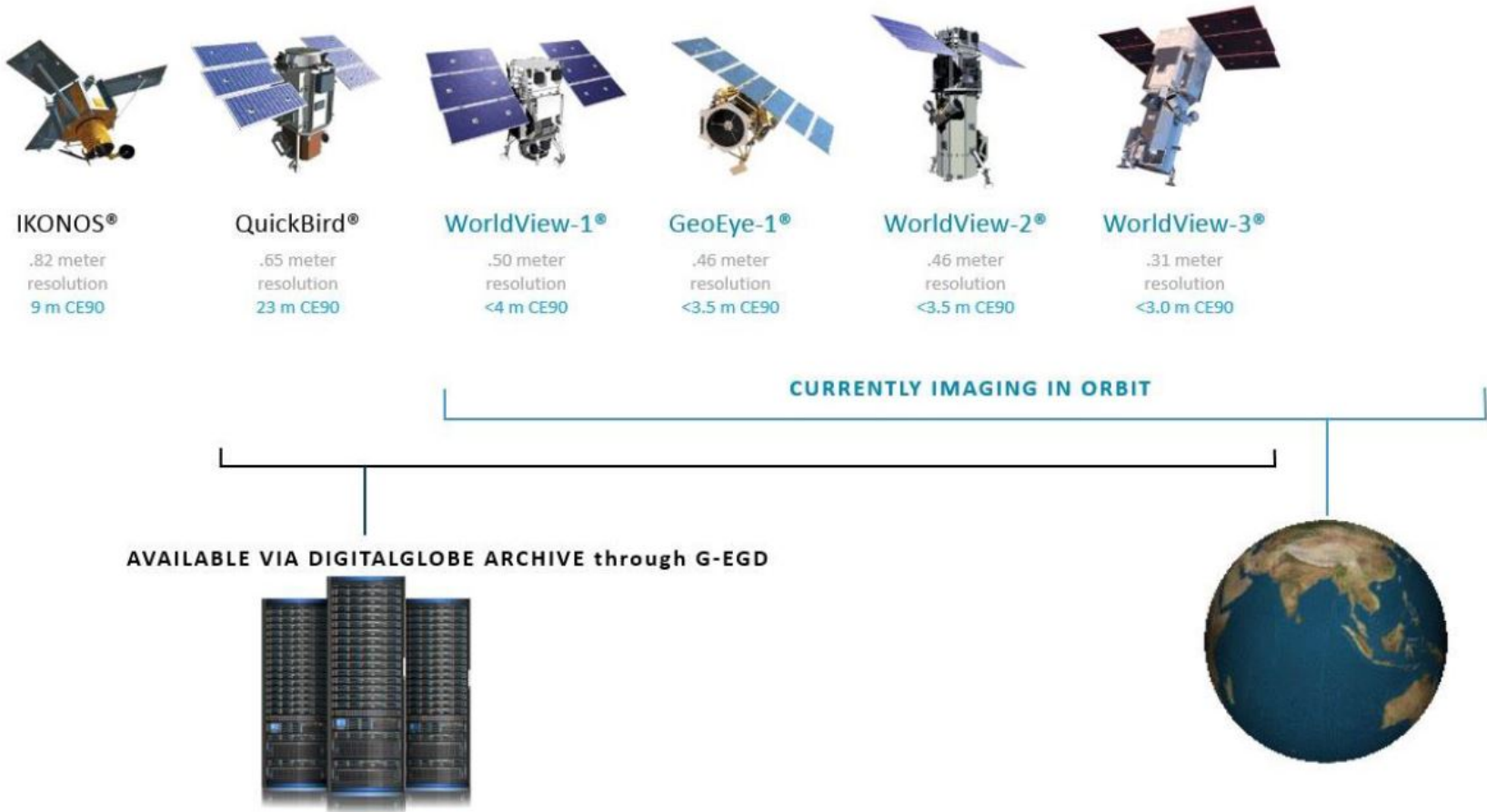
About:
DigitalGlobe, Inc., is a commercial satellite imagery company founded in 2001 and merged into the Maxar Technologies family in 2017. They are currently headquartered in Westminster, CO

Imagery Specifications:
- Resolution of 32-50 cm panchromatic and 1.2-2 m multispectral
- 4 and 8 multispectral bands in visible and near-infrared
- 17 km wide images up to 100 km long (postage stamps vs strips)
- Polar orbiting satellites with ~100 min orbits

NextView License

LICENSE TERMS

- Imagery available for a U.S. Government purpose only (civilian researchers, contractors included)
- Derived Products (e.g. DEMs, NDVI, feature extraction) are <u>not</u> subject to the license, but must include acknowledgement
- Must not compete with the "commercial interest" or shared publicly

USER REQUIREMENTS

- Supply proper copyright and acknowledgement
- Use for the intended purpose (project) only while actively funded

PGC'S ROLE

- Provide the imagery to NSF-OPP actively-funded researchers & contractors
- Provide approachable reference documentation (e.g. PGC Acknowledgement Policy, Imagery Eligibility, Usage Guidelines guides online)
- Coordinate "Public Release" approval with NGA (required)

NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY
Know the Earth... Show the Way... Understand the World

UNCLASSIFIED

NextView License and You

You must:
- Properly attribute (mark) all NV imagery and imagery derived products (IDP) with its Copyright information and educate anyone shared with on the license terms. Example of proper attribution:

Copyright 2011, DigitalGlobe, Inc.

You may:
- Share imagery or any IDPs with anyone directly working with/for the USG, including:
  - U.S. Government Employees/Contractors*
  - Universities supporting USG via contract(s)
- Share imagery or IDPs with those supporting USG interests
  - State/Local Governments
  - Foreign Governments
  - Intergovernmental Agencies
  - NGO's & Non-profit Organizations
- Post properly attributed reduced-resolution non-manipulatable imagery on public web sites
- Post/disseminate imagery using <u>access-controlled</u> web/FTE sites
- *Contractors' Government sponsor must provide oversight and approval for this sharing arrangement.

You must not:
- Provide/share imagery or IDPs made from NV licensed imagery with anyone planning to sell it or use it for commercial gain
- Post-full resolution imagery on a web site

You should seek clarification (see POC list) before:
- Publically releasing or openly disseminating imagery or IDPs with image metadata
- Sharing with Educational Institutions for strictly educational/research purposes (not connected with the Government)
- Sharing with a company or other entity that might profit from the imagery shared
- Posting imagery to a web site without access controls
- Allowing Imagery or IDPs to be shared with a third party
- Sharing Imagery or IDPs with Universities with USG grant(s)
- Contacting the Vendors directly

Definitions
- Imagery is the image and associated metadata. Imagery can be further manipulated, enhanced, & processed. Example: GeoPDF, GeoTiff, NITF.
- Image Derived Product (IDP) – any product created from raw imagery – could include metadata, but generally does not and often referred to as "dumb-image"
- Third Party Partner – Party otherwise affiliated with the <u>original</u> USG sharing partner, but not the USG directly.

UNCLASSIFIED

Commercial Imagery | **Value Added Processing**

- Terrain & radiometric correction

  most commonly: orthorectification, TOA

- Terrain extraction from stereo imagery
- Web-applications for non-GIS users: viewers.apps.pgc.umn.edu
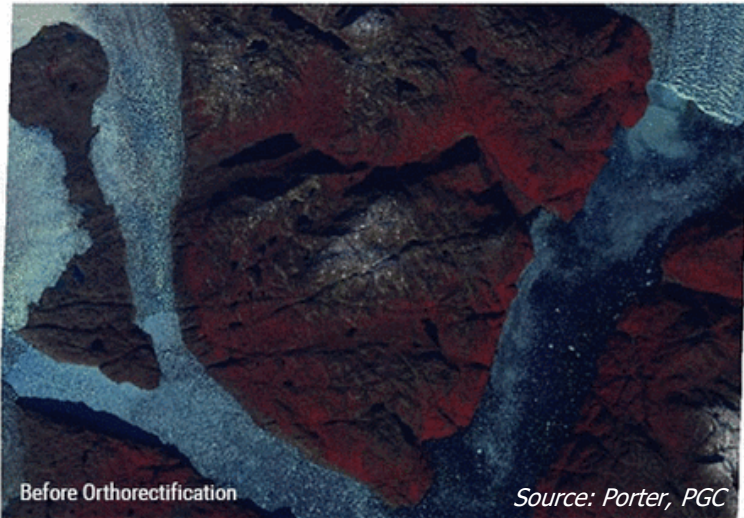
- Automated custom orthomosaics

- Pansharpening

Before Orthorectification

Source: Porter, PGC

Source: Medium

Source: USGS Landsat 8
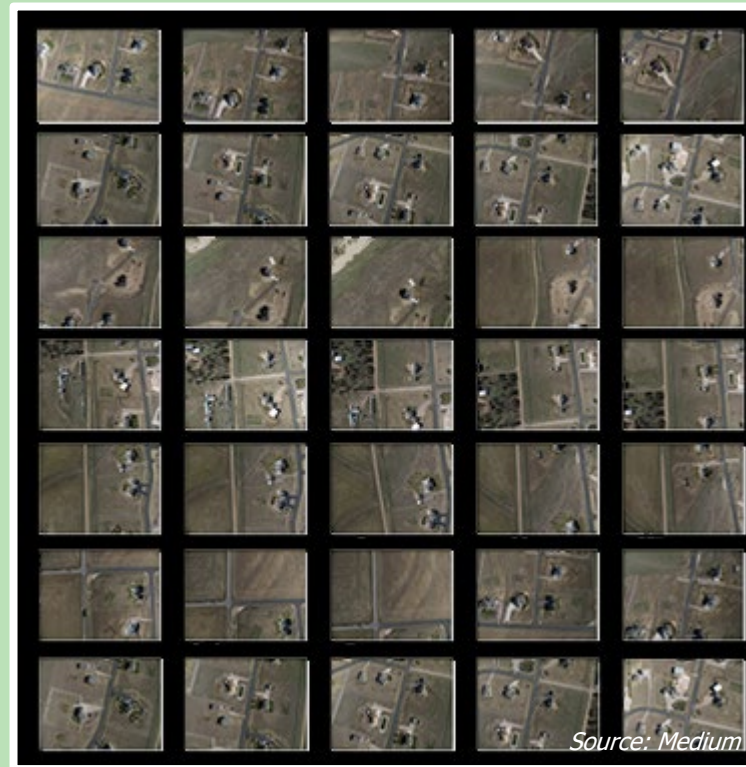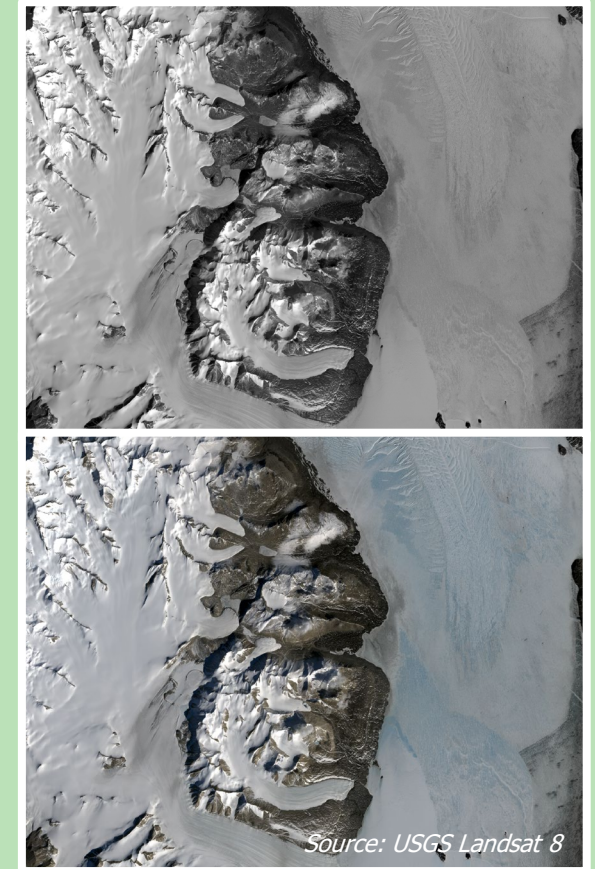
PGC Imagery Mosaic Viewers

Antarctic Viewer
View the land of snow & ice of the southernmost continent.

WGS84 Antarctic Polar Stereographic Projection

Launch Antarctica »

Arctic Viewer
View the dynamic landscape of glaciers & permafrost for Greenland & Alaska.

NSIDC Sea Ice Polar Stereographic Projection North

Launch Arctic »

World Viewer
View the snowcaps, ice fields, & glaciers throughout the world.

WGS84 Web Mercator Projection

Launch World »

- High-resolution **0.5-meter** panchromatic Arctic, Antarctic & High-Mountain Asia orthomosaic

- PGC User Account **credentials required**
  - (actively NSF-OPP & NASA-Cryo funded)

- Available online as a **web-map** application at https://viewers.apps.pgc.umn.edu/

- Available in **image service** on ArcGIS online and ArcGIS server

- **Multispectral** version in select Antarctic areas

- **Updated** imagery approximately once a year

Tasking Capabilities

EXPECTATIONS

- Under DigitalGlobe & NGA control

- PGC does not guarantee collection

- Nearly impossible to task collection on specified day *(even +/- 3 days)*

- Limited on-demand tasking & imagery for SAR

PGC assembles a tasking plan, submitted to NGA, for new imagery acquisition from the DigitalGlobe sensors.

Each year, PGC solicits locations and AOIs from the science and logistics community
(Arctic in January & Antarctic in July).

PGC User Services coordinates requests in a standard template and our Satellite Tasking Coordinator aggregates into a cohesive plan in accordance with NGA requirements.

Commercial Imagery
Applications

- Imagery as a **basemap**
- **Classification** – vegetation, ice, water, etc.
- **Change detection** – here today, gone tomorrow
- Observation and **measurement**
- **Visual** interpretation of the Earth's surface
- Locating and **identifying** spatial distribution of features
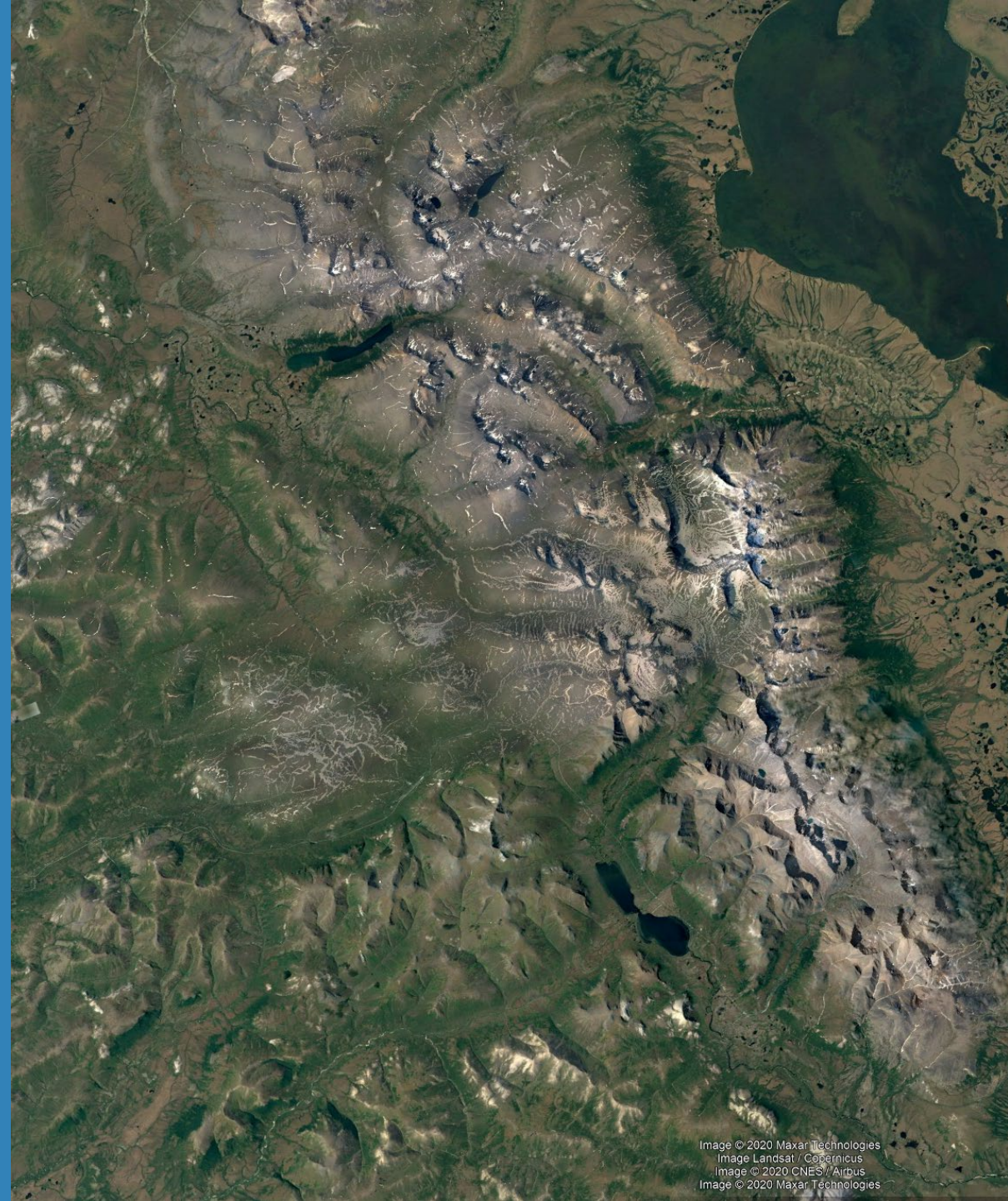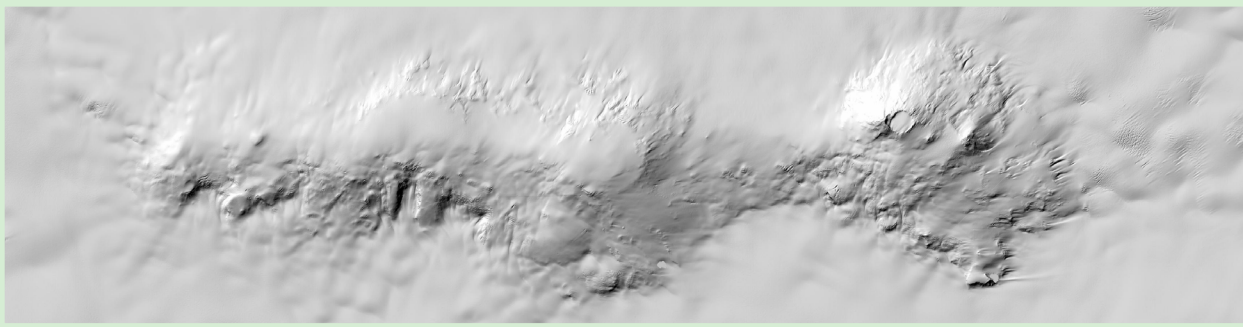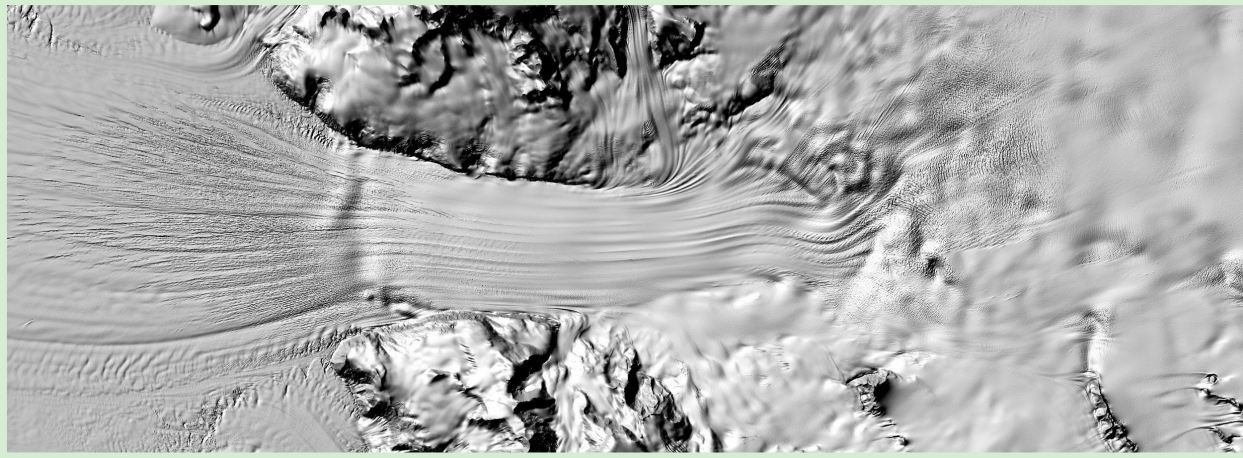
Terrain Models

PGC-CREATED DEMs

LiDAR

AIRBORNE THEMATIC MAPPER

ACCESS & APPS

DEM Strips

- Overlapping area of input stereoscopic images

- Provided at 2m & 8m 32-bit GeoTIFFs

- Elevation units are meters and referenced to WGS84 ellipsoid

- Time stamps preserved

DEM Mosaic Tiles

- 100x100 km tiles at 2m, 8m

- Resampled versions available at 100m, 200m, 1km resolutions

- Best quality strips mosaicked with coregistration and feathering between tiles

> Derived from DigitalGlobe, Inc. stereoscopic imagery

> Photogrammetric extraction algorithm – SETSM

> Free from license restrictions

> Typical elevation errors <1 m

PGC Elevation Products
_____
Specs & Regions
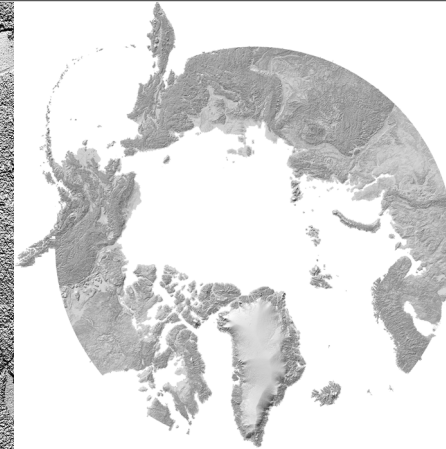
ArcticDEM

REMA
Reference Elevation Model of Antarctica
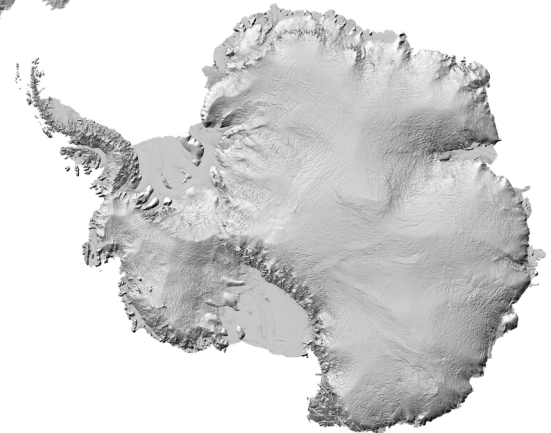
EarthDEM *coming soon*

Airborne Products| LiDAR & ATM

External acquisition campaigns over polar regions

available on PGC server
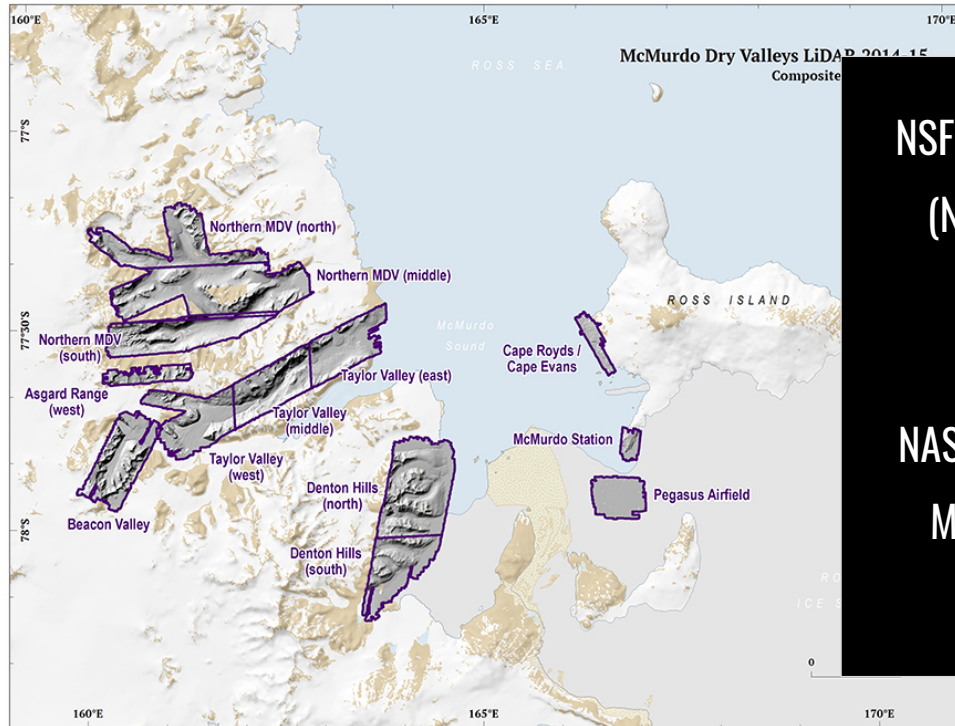
NSF Center for Airborne Laser Mapping (NCALM) 2014-15 Composite Grids (left)

NASA – NSF – USGS Airborne Thematic Mapper (ATM) 2001 Gridded DEMs (right)

ELEVATION Access & Apps

Esri ArcticDEM Viewer

Esri REMA Viewer

Stereo Elevation Guides

NGA ArcticDEM Web App

NGA REMA Web App

PGC Server to Airborne Elevation Products

Source: USGS, Accessed from PGC, Reference ID: ARC REF-GP2513-001
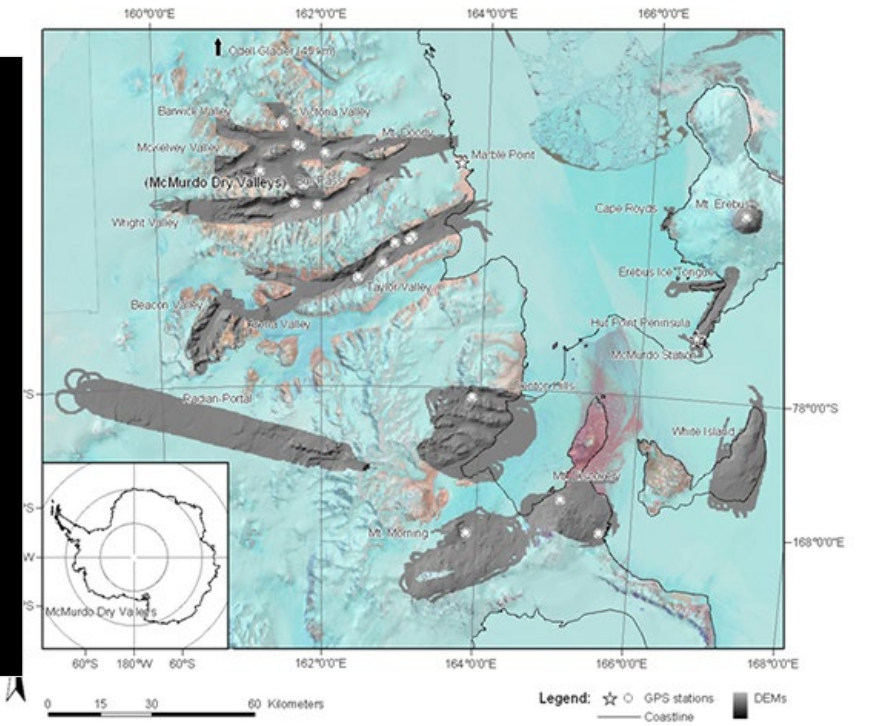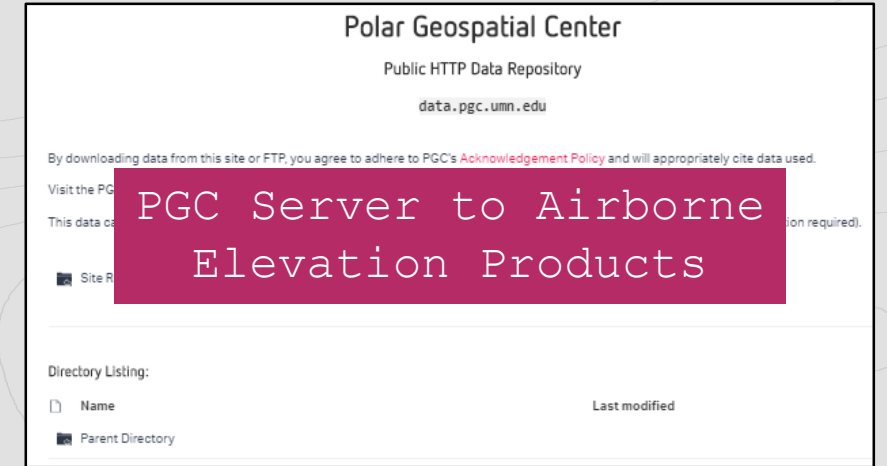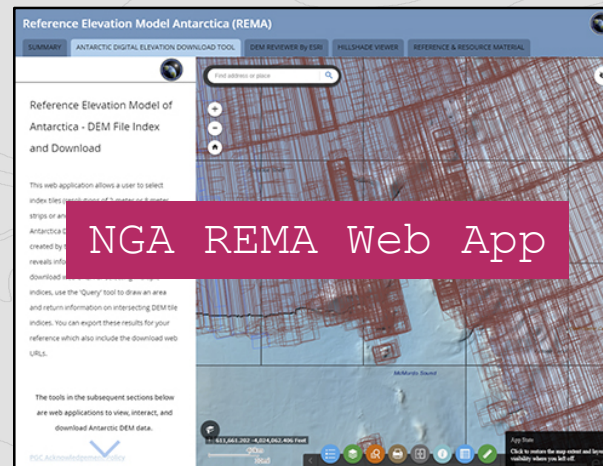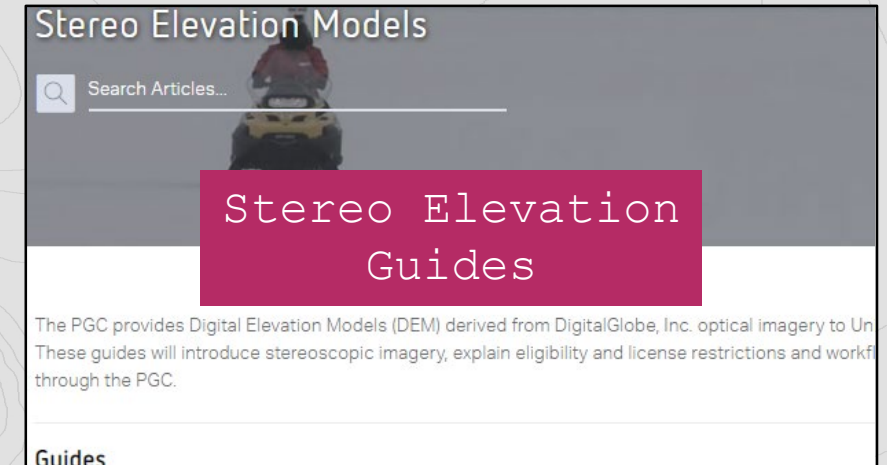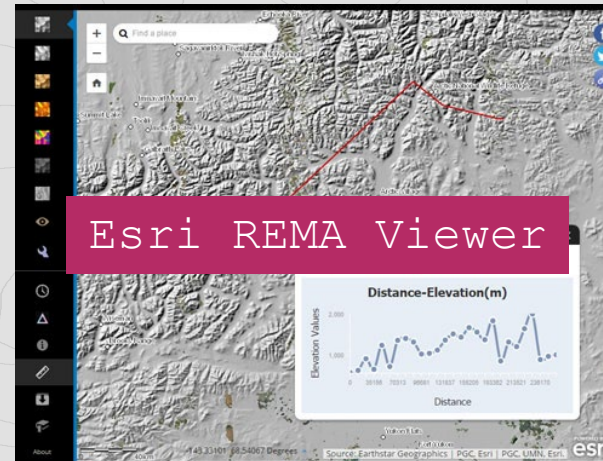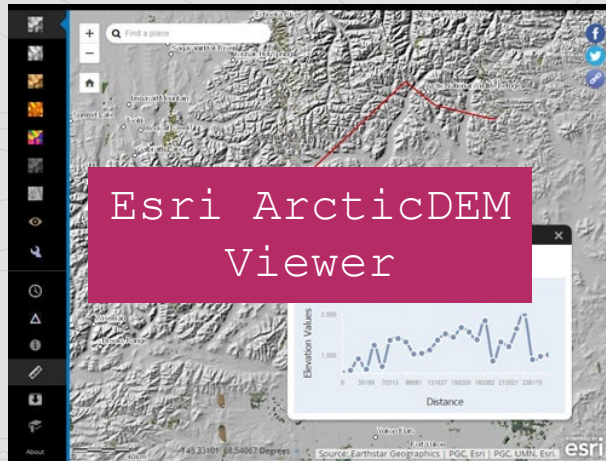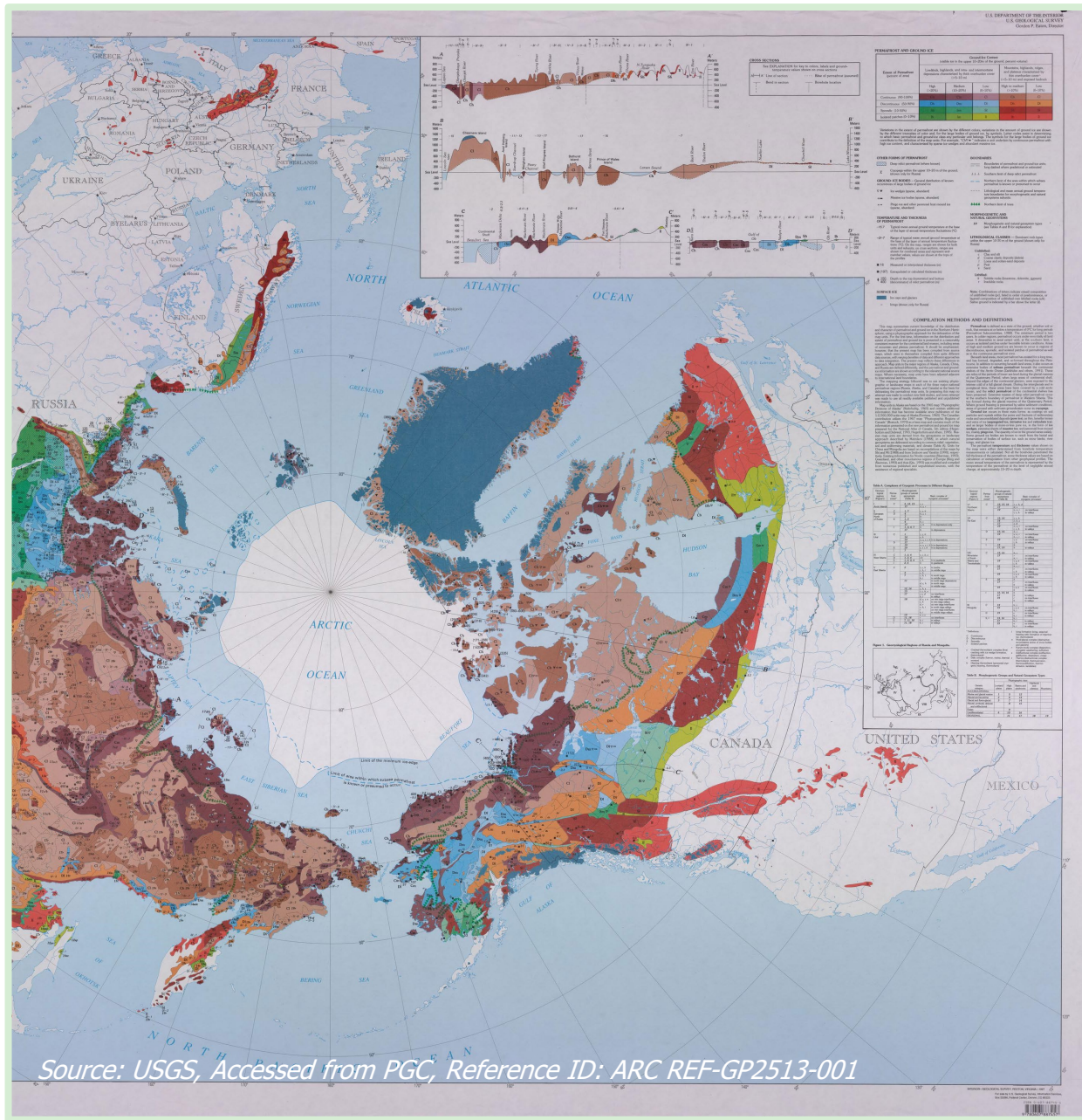
Digital Maps

SPECS

ACCESS

VALUE – ADDED FORMATTING

APPLICATIONS

PGC **MAPS**

Historical | Contemporary | Custom

- PGC Map Catalog is **searchable** online

- Libraries of **paper** maps, scanned at high-resolution and provide digital copies in many file formats

- **Restricted & custom** maps can be requested by *Core Users* via Data + Services page or from your **PGC POC**
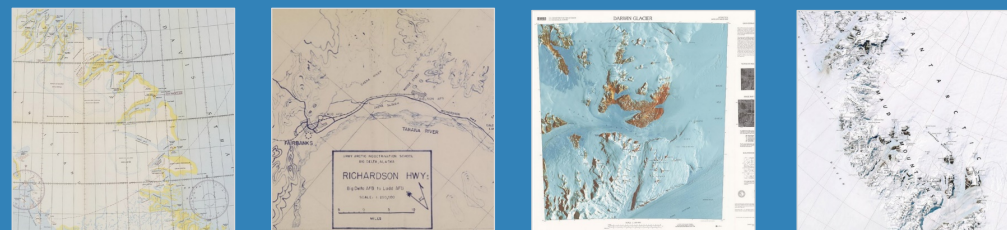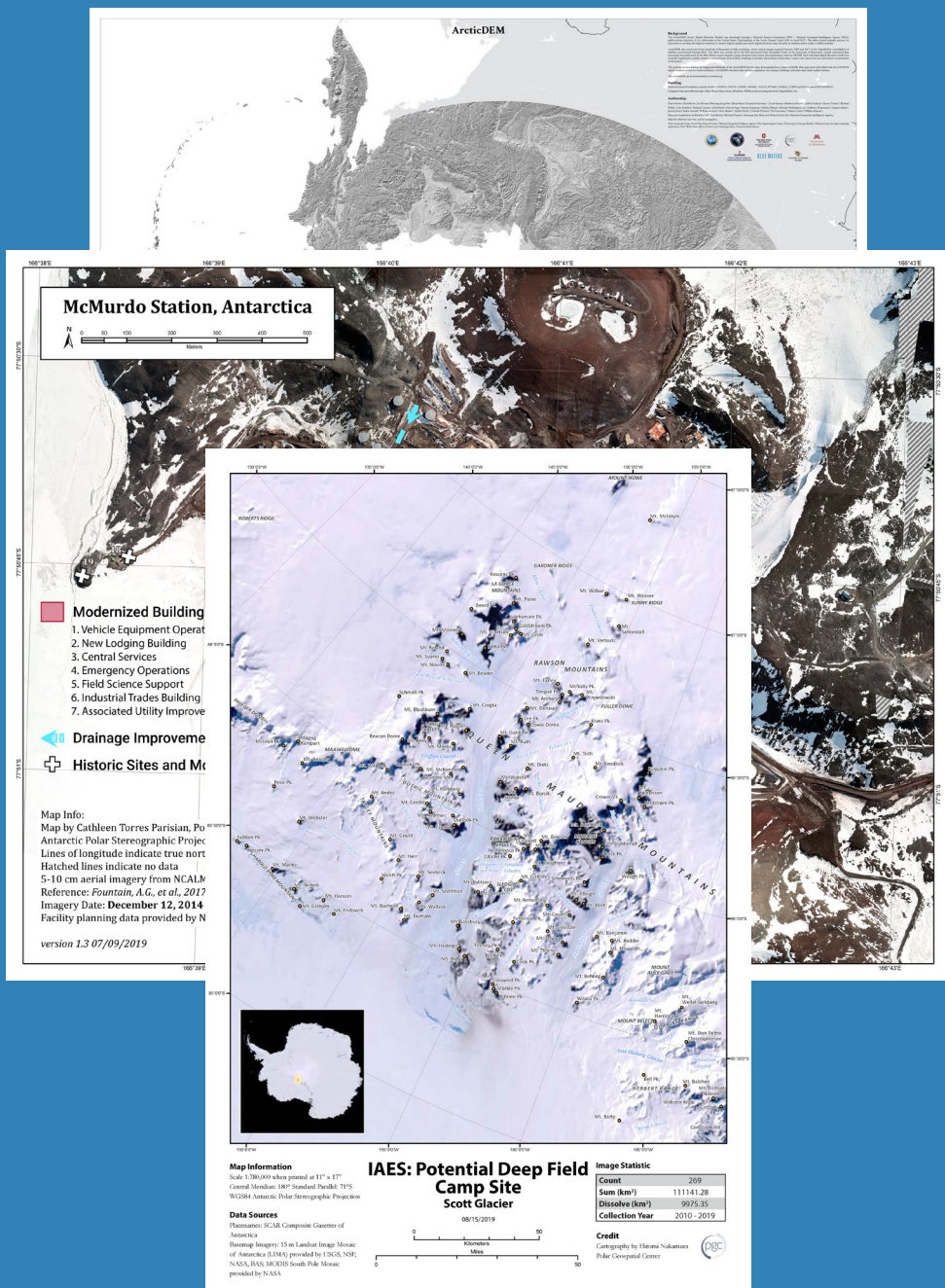
PGC MAP CATALOG

- Archive of historical and contemporary polar maps

490

- Antarctica
- Arctic

1789
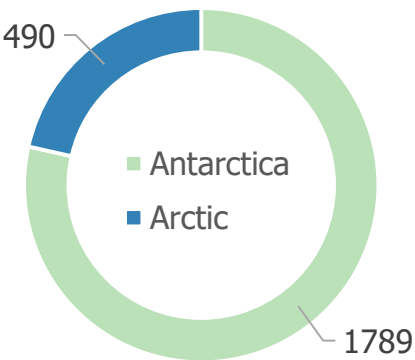
File Formats
PDF
Preview JPG
TIF
GeoTIFF
Cropped GeoTIFF

Map Purpose	# Maps
Reference	1427
Navigation	347
Summary	346
Planning	128
Index	31

PGC MAPS
Catalog & Custom

PGC CUSTOM MAP REQUESTS

- <u>Only</u> NSF-OPP & NASA-Cryo
- Example of uses:

  > Non-GIS users: scientist's field-site selection or surface characteristics for traverse planning and logistics

  > Change detection

  > Publications and presentations

  ** **NGA Approval** **

  https://www.pgc.umn.edu/guides/commercial-imagery/citation-and-publication-approval/

- Data dependent on audience – *it's a legal matter!*
- Request to POC or https://www.pgc.umn.edu/data/request/

Geospatial Support

OTHER SERVICES

GUIDES

ANTARCTIC OFFICE

SUPPORT INFORMATION PACKAGES

Other Services & Guides

DATA CONVERSION

Manipulation of geospatial data file formats, projections, datums to suit the user and purpose

TERRAIN ANALYSIS

Slope / aspect geoprocessing

ADVICE

Where can I find this data?
How do I use this tool?
What are the capabilities of…?
Why are there large offsets, holes, etc. in the data?

GUIDES

Over 30+ guides & growing!
Topics ranging from DEMs, GitHub and satellite imagery
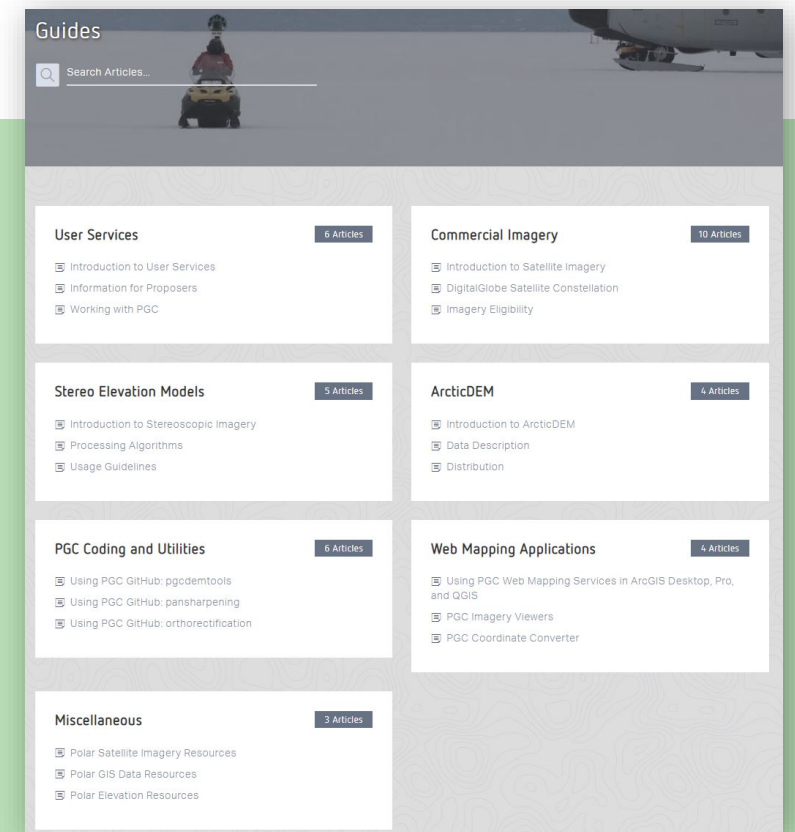
On-Ice
Support

- Since '08 User Services staff deploy to McMurdo Station, **Antarctica**

- Typically 1-2 person presence in **Crary Laboratory** from mid-October to late-January

- Provide **on-site** geospatial support to science and logistics groups

  ❖ Custom, on-demand mapping

  ❖ Hazard and risk management

  ❖ Site selection and movement planning

  ❖ Distribution of annual map products

  ❖ Provide archive of recent satellite imagery

Source: Photo by Suzan, ASC

Support Information Packages (SIPs)

Strictly for researchers deploying to Antarctica:

Please include PGC in your SIPs if you know or even suspect you may need support for the upcoming field season whether prior to deployment or on the ice.

PGC prepares for each field season according to SIP requests to prepare the proper data. We reach out to SIP participants prior to each field season to ensure the most effective and efficient support.

Support **Examples**

Arctic Logistics: *Image processing & machine learning*

Arctic Science: *Custom DEM example*

Pan-Arctic Science: *Large scale support*

Antarctic Logistics: *Custom map*

Antarctic Science: *Web-application*

Pan-Antarctic Science: *Large scale support*

5 km

Potential crevassed areas show up more clearly in the crevasse detection algorithm results (above) than in the source imagery

Green TrACS Traverse
Route Planning Support

- Planned for 2nd field season (April – June **2017**) to develop snow accumulation and firn density records

- PGC processed **839** satellite images dated from 2009 – 2016 (**~800 GB**) covering **70,000** km²

- Used high-resolution satellite imagery and custom crevasse detection algorithm to **safely map** a route across Western Greenland
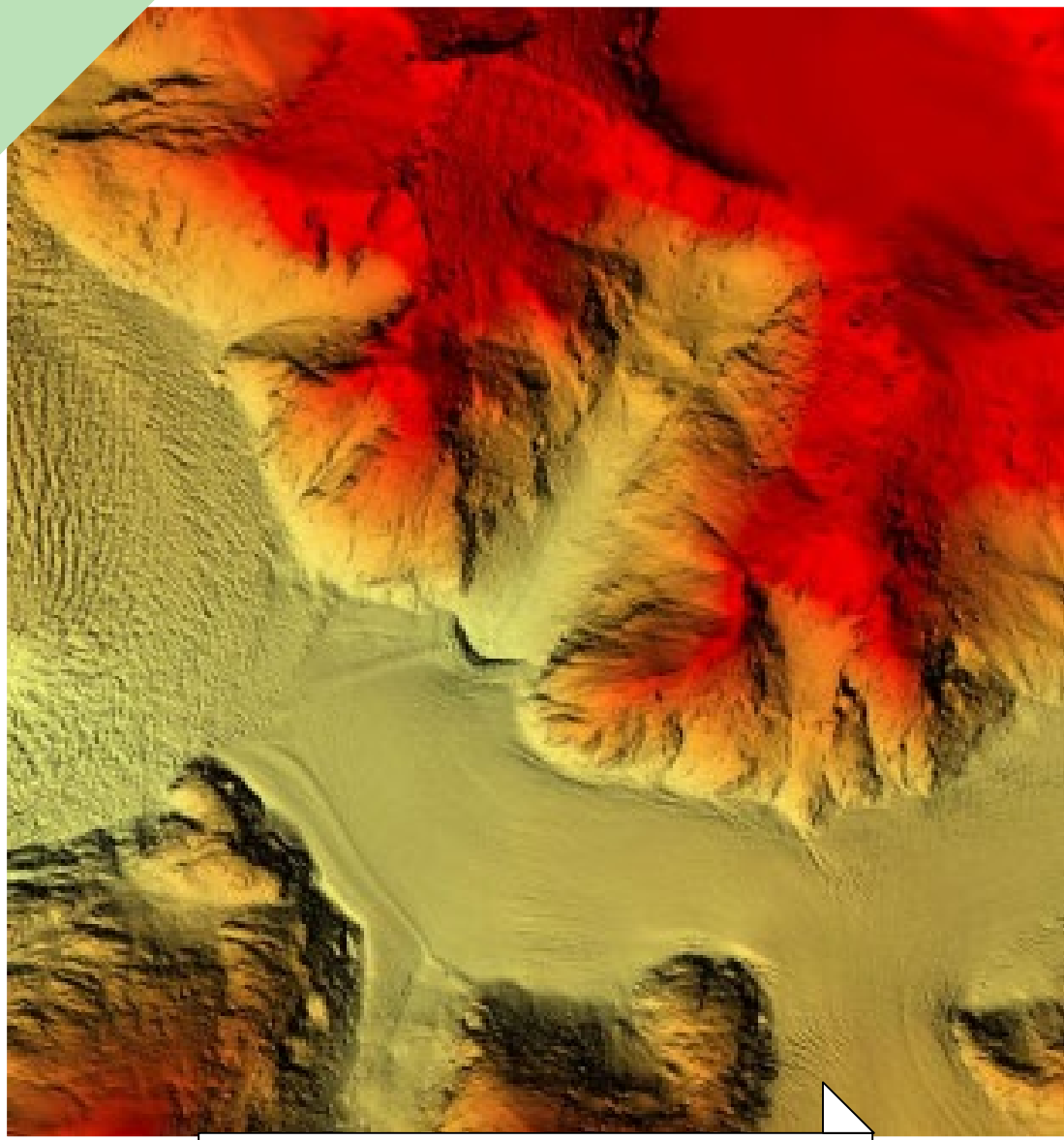
2m resolution stereo-derived elevation model of LeConte Glacier

LeConte Glacier, Alaska
Seasonal DEMs

- **Tracked** movement and retreat of LeConte Glacier, Alaska

- Each year since 2015, PGC generated **DEMs** from stereo WorldView satellite imagery over spring, summer and fall months

- Imagery collection was requested during each annual PGC Arctic Imagery **Tasking Solicitations**
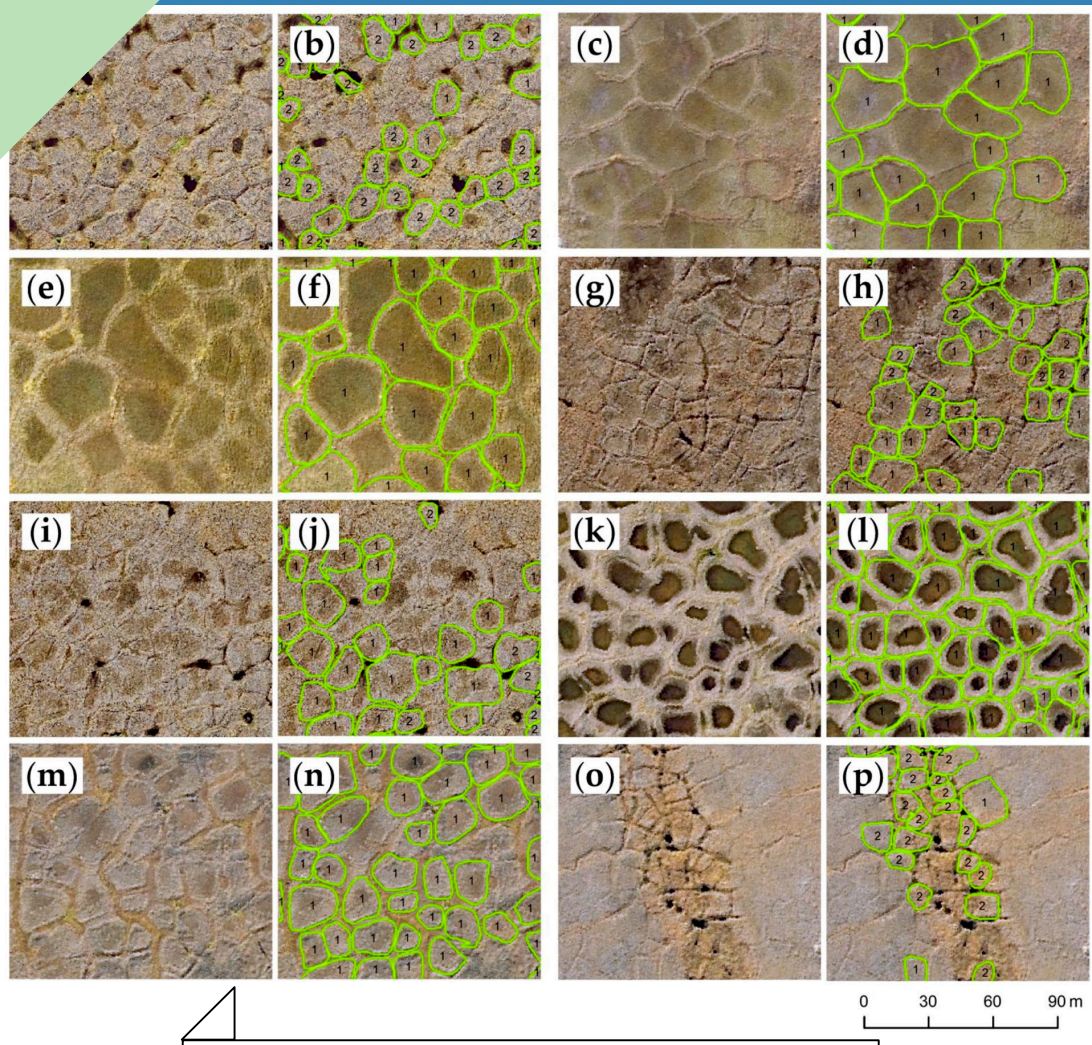
Example of ice wedge polygon delineation on very high-resolution aerial imagery, Nuiqsut, Alaska

Zhang, et al. (2018). Deep convolutional neural networks for automated characterization of arctic ice-wedge polygons in very high spatial resolution aerial imagery. *Remote Sensing*, *10*(9), 1487, Figure 8.

Arctic Ice Wedge Polygon **Detection from Remote Sensing Data**

- Conducting **Arctic-wide survey** of ice wedges to help researchers understand the spatial and temporal dynamics

- PGC supports this project with image selection, processing (**pan-sharpening**) and delivery

- Using convolusional neural network to **automatically** delineate in imagery

NSF McMurdo Report
Custom Map Figures

- NSF Comprehensive Environmental Evaluations **public report** for McMurdo modernization activities

- Assorted **purposes** for 8 maps:

  ❖ Reference

  ❖ Compare change from historical imagery

  ❖ Illustrate planned demolition

  ❖ Record present-day

  ❖ Bring awareness to regions w/ environmental value
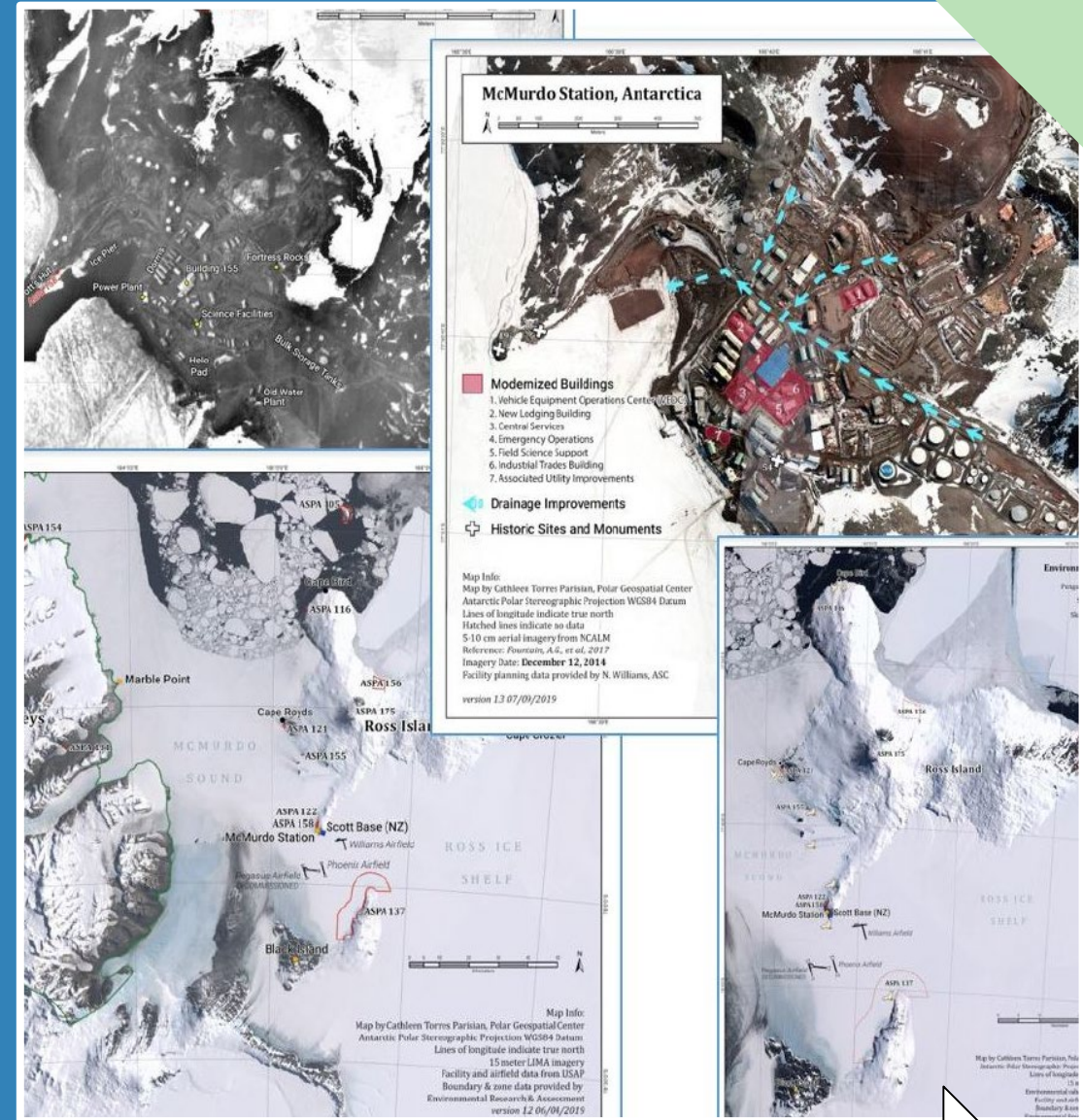
Custom maps using open sourced data for easy publication and dissemination

User-derived GIS
# **Web-App Development**

- PGC develops online **web mapping** interfaces and applications for interactive user-derived GIS

- **Combination** of PGC source datasets (imagery/elevation layers) and User's spatial data

- **ICE-D** is a browsing interface for the Berkley Geochronology Center's cosmogenic nuclide Antarctic database

Check out the web map at:
http://hess.ess.washington.edu/iced/map/
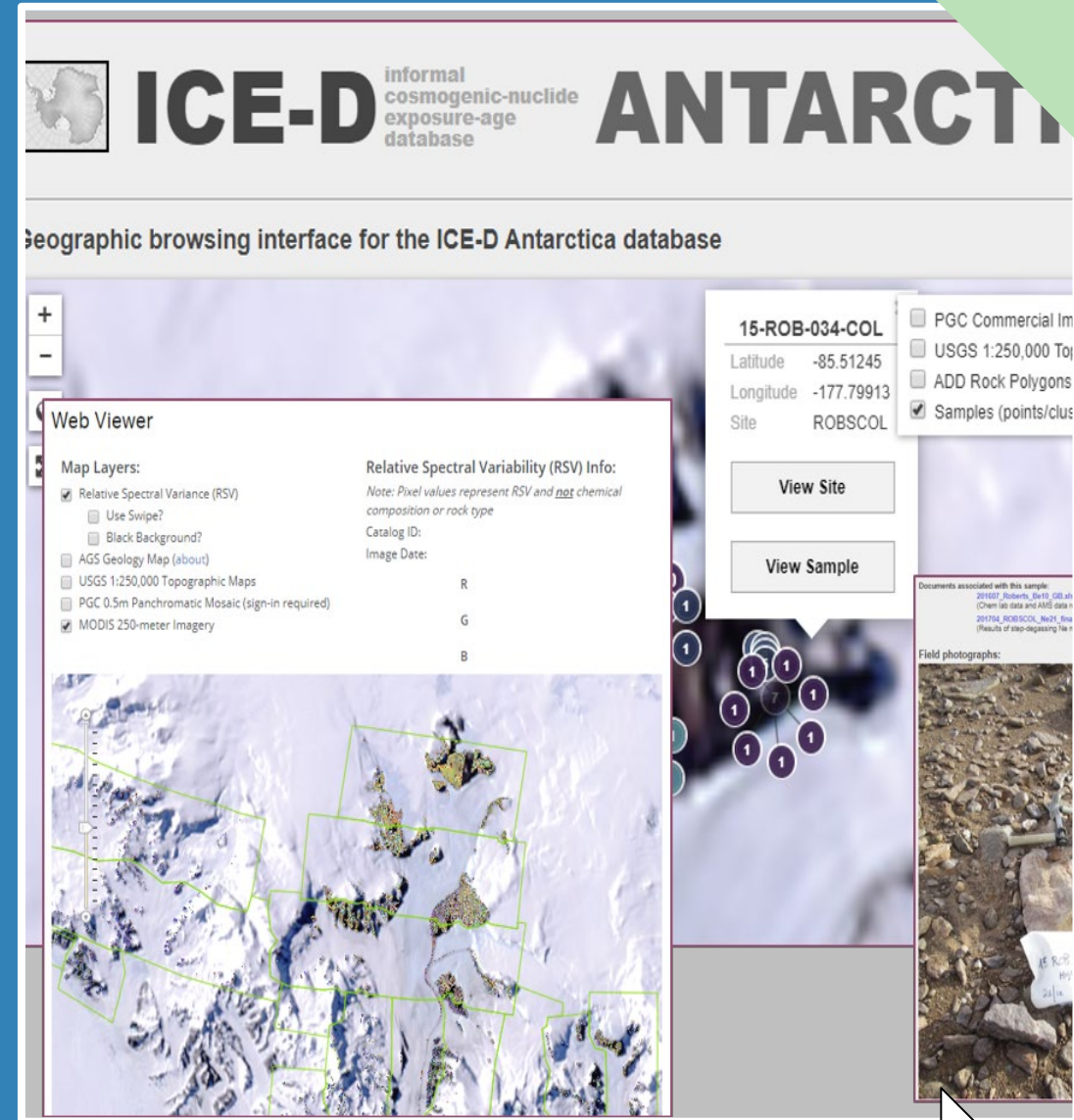
Quantifying Seabirds
Parameterized by Sub-meter Imagery

- Quantified coastal Antarctic seabird populations of previously uncounted colonies with **automated** algorithms

- PGC provided **cluster compute** resources to process and orthorectify over **10,000** discrete scenes of sub-meter satellite imagery
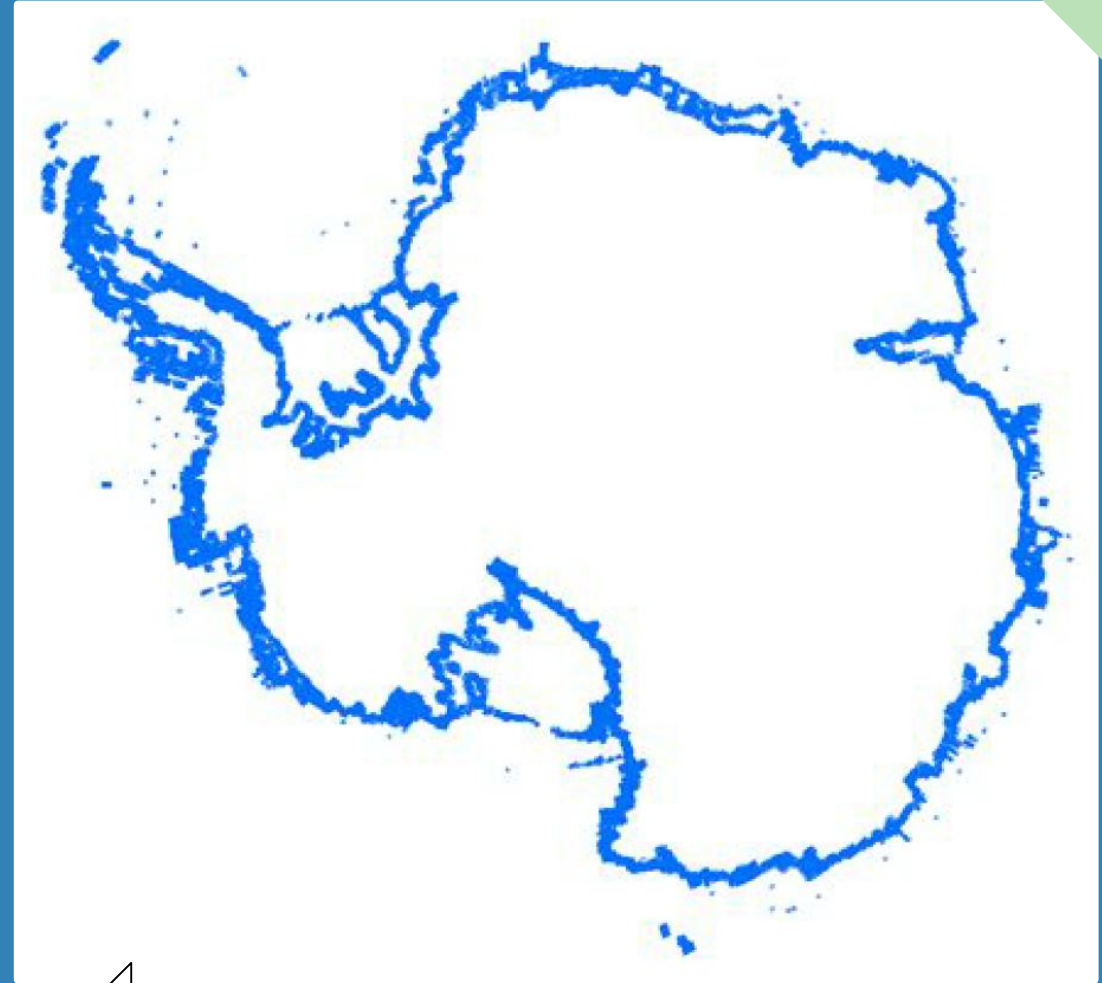
Polygonal footprint of all 2017-2018 WorldView-3 imagery near and over coastal waters

PGC Account Registration

Eligible users (actively NSF OPP & NASA Cryo funded) gain access to:

- PGC services (imagery, DEM, map requests)
- Restricted imagery layers in PGC Viewers
- FTP data deliveries
- and future FRIDGE

(Federal Researcher Imagery Download & Geodata Exploration system)

https://users.pgc.umn.edu/request

Are you eligible for PGC support?

U.S. Federally-Funded?

No ❌

Yes ✔️

PGC is only able to provide dedicated support to researchers and contractors funded through the NSF-OPP and NASA-Cryo programs.

Please check out our many **open source** datasets such as ArcticDEM, REMA, unrestricted maps in our Map Catalog, and dozens of guides related to geospatial data at **www.pgc.umn.edu**!

NSF-OPP or NASA-Cryo award?

No ❌

Yes ✔️

You are eligible for dedicated PGC support (high-resolution satellite imagery, custom maps, and more). Contact us at **pgc@umn.edu** for assistance.

Q&A

✉@

ctorresp@umn.edu

PGC Point-of-Contact

pgc@umn.edu

🌐

https://www.pgc.umn.edu/data/request/

THANK YOU

Useful Links

PGC   https://www.pgc.umn.edu/

PGC Guides   https://www.pgc.umn.edu/guides/

Intro to User Services Guide   https://www.pgc.umn.edu/guides/user-services/introduction/

PGC Commercial Imagery Usage Guidelines   https://www.pgc.umn.edu/guides/commercial-imagery/usage-guidelines/

PGC Acknowledgement Policy   https://www.pgc.umn.edu/guides/user-services/acknowledgement-policy/

PGC User Account Sign-Up   https://users.pgc.umn.edu/request