Memorandum to CAFF Board 02/01/2017

Pan-Arctic Digital Elevation Map (Pan-Arctic DEM)

BACKGROUND:

ArcticDEM is a National Geospatial-Intelligence Agency (NGA)-National Science Foundation (NSF) public-private initiative to automatically produce a high-resolution, high quality, digital surface model (DSM) of the Arctic using optical stereo imagery, high-performance computing, and open source photogrammetry software. The ArcticDEM project is a response to the need for high quality elevation data in remote locations, the availability of technology to process big data, and the need for accurate measurement of topographic change.

The Iqaluit Declaration 2015 and the CAFF 2015-2017 Work Plan in the SAO Report to Ministers identified encouragement of a Digital Elevation Map (DEM) for the Arctic, or Pan-Arctic DEM, as an activity under the U.S. Arctic Council Chairmanship. The CAFF Work Plan states that work will be undertaken with the Arctic Spatial Data Infrastructure (Arctic SDI) with the U.S. as lead and the U.S. Geological Survey (USGS) serving as the lead U.S. agency (the US currently Chairs the Arctic SDI as well).

In June 2016, the ArcticSDI Board endorsed the ArcticDEM project of the U.S. National Science Foundation, implemented through the Polar Geospatial Center (PGC) at the University of Minnesota, as a first generation Pan-Arctic DEM product to fulfil the Arctic Council's Pan-Arctic DEM Initiative.

All ArcticDEM data are available free to the public for any use. Links to download ArcticDEM data are found on PGC's ArcticDEM website located at http://pgc.umn.edu/arcticdem.

STATUS: DECEMBER 2016

ArcticDEM Status and Planned Deliveries:

As of December, 2016, data for Alaska, Iceland, Baffin Island (Canada), Svalbard (Norway), and Franz Josef Land and Novaya Zemyla (Russia) have been completed. In the first quarter of 2017, PGC anticipates delivering the western half of Greenland, Kamchatka, Ellesmere Island (Canada), and the Faroe Islands (Denmark). Work will then focus on processing and delivering the remainder of Canada and Russia, followed by processing and delivery Sweden, Finland and Norway. Data users should anticipate quarterly deliveries through the summer of 2017 until initial project delivery is complete.

Data Download:

2-meter resolution data can be downloaded from the PGC website in 17km x 120km strips. PGC also creates and delivers a 5-meter mosaic in 50km x 50km tiles. The mosaicked DEM tiles are compiled from the bet quality strip DEM files, which have been blended and feathered to reduce void areas and edge-matching artifacts.

Web-based ArcticDEM Viewer and GIS Image and Data Services:

ESRI (an international supplier of geographic information system software, web GIS and geodatabase management applications) has developed an online web mapping application called the ArcticDEM Explorer for users to explore ArcticDEM data. The full-resolution ArcticDEM strips and mosaics are presented in this web map to quickly preview and explore the elevation data. With this web map, users can visualize the ArcticDEM data, preview the spatial coverage, and download simple exports. The ArcticDEM Explorer is the best way to preview the datasets if no GIS or remote sensing software is available, or a user simply wants to explore the entire dataset quickly. ArcticDEM can be also be accessed via web mapping services provided by ESRI. The raster elevation data (strips and tiles) are served via an ESRI Image Service. ESRI also provides an ArcGIS Online Feature Service for the ArcticDEM mosaic tile scheme. The GIS layers can be used directly in desktop GIS software. Links to the ArcticDEM Explorer and the various image and data services are found on PGC's ArcticDEM website located at http://pgc.umn.edu/arcticdem.

NEXT STEPS

- Arctic nations have supported improvement of ArcticDEM by providing support data and data evaluations.
- Arctic SDI nations will evaluate final PGC data and delivery mechanisms once data are formally released. Based on these evaluations, Arctic SDI will consider next steps for potential delivery of enhanced authoritative Arctic SDI elevation products and services after final PGC results are confirmed.
- Arctic SDI has tentatively scheduled a third Pan-Arctic Elevation workshop for fall of 2017 to consider next steps for the Arctic SDI nations to advance Arctic elevation data development and distribution.
- ArcticDEM can be demonstrated at targeted SAO or Ministerial gatherings if desired.

FURTHER INFORMATION

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ANNEX 1: ArcticDEM Overview Report

ArcticDEM

A First Generation Solution to the Arctic Council's Pan-Arctic Digital Elevation Map Initiative

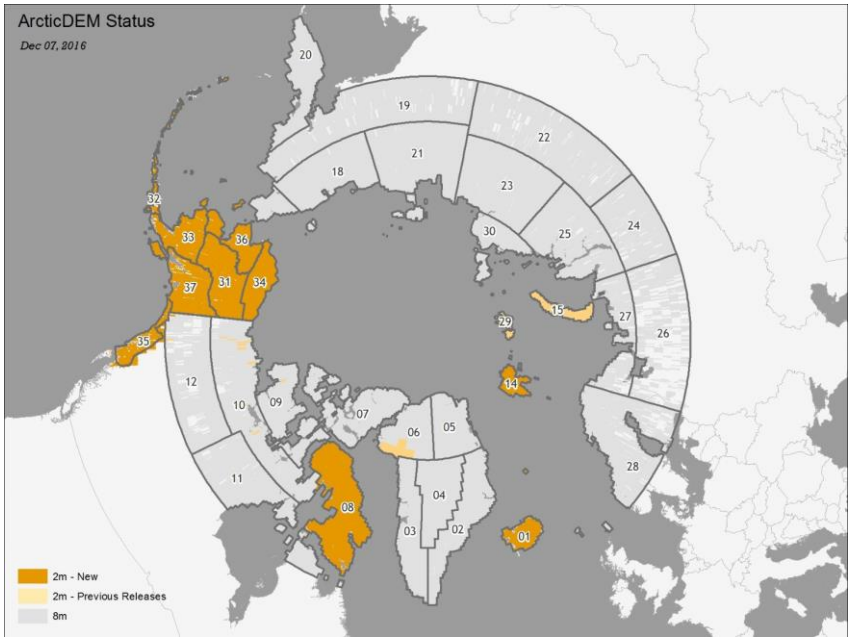
Description of a Digital Elevation Model (DEM): A DEM is a computer representation of the height of the earth's surface. Elevation models are used in a multitude of science, mapping, and resource management applications.

Description of ArcticDEM: ArcticDEM is funded by the United States National Science Foundation (NSF) and is generated using source satellite imagery licensed through the United States National Geospatial-Intelligence Agency (NGA). Software has been developed through the Polar Geospatial Center (PGC) at the University of Minnesota to use the source imagery to generate a 2-meter resolution grid of elevation points representing the surface of the Arctic. The optical imagery source data results in an elevation model that displays the first surface reflected by daylight, such as tops of vegetation and physical structures. ArcticDEM is being generated for all Arctic terrain above 60-degrees north in latitude, and will also cover some areas south of 60-degrees to include all of Alaska, Greenland, and the Kamchatka Peninsula. The image license between NGA and DigitalGlobe does not allow for public release of the imagery, but the derived ArcticDEM product can be made freely available to the public.

DEM Uses: Where available, ArcticDEM is already being used to calculate change seen over time in earth, ice, snow, rivers and forests. As ArcticDEM is completed, scientists and resource managers will use the data in a wide range of applications such as wildfire management, climate change, coastal erosion monitoring, landslide and avalanche prediction, flora and fauna studies, and human safety, just to name a few. Because the satellites that provide the source imagery are constantly imaging the earth, ArcticDEM can be re-generated any time new imagery is tasked over a target area and the skies are free of clouds. Multiple DEMs are being made over the same terrain throughout this project as clear imagery becomes available, and new DEMs can be refreshed to monitor targeted areas if required.

ArcticDEM Status and Planned Production: ArcticDEM represents a tremendous volume of data processing, and truly represents a Big Data initiative. Efficiencies in data management and high-end computer processing, through cooperation with the Blue Waters supercomputer team at the University of Illinois at Urbana-Champaign, have recently resulted in much greater throughput than previously realized. As of December, 2016, Alaska, Iceland, Baffin Island (Canada), Svalbard (Norway), and Franz Josef Land and Novaya Zemyla (Russia) have been delivered. In the first quarter of 2017, PGC anticipates delivering the western half of Greenland, Kamchatka, Ellesmere Island (Canada), and the Faroe Islands (Denmark). Work will then focus on processing and delivering the remainder of Canada and Russia, followed by processing and delivery of Sweden, Finland and Norway. Data users should anticipate quarterly delivers through the summer of 2017 until initial project delivery is complete.

ArcticDEM Status Map as of December 28, 2016



Data Download Deliverables: Strip DEM files that correspond to the overlapping area of the input satellite stereo-pair image swaths, are made available for download by PGC. Downloadable strips are approximately 17 km in width and 120 km in length. Strip DEM files are provided at 2-meter spatial resolution in 32-bit GeoTIFF format. Elevation units are meters and are referenced to the WGS84 ellipsoid.

Mosaicked DEM files are compiled from the best quality strip DEM files, which have been blended and feathered to reduce void areas and edge-matching artifacts. Filtered IceSAT altimetry data has been applied to the raster files to improve absolute accuracy. Mosaicked DEM files are distributed in 50 km x 50 km sub-tiles. Mosaicked DEMs are provided at 5-meter spatial resolution in 32-bit GeoTIFF format. Elevation units are meters and are referenced to the WGS84 ellipsoid.

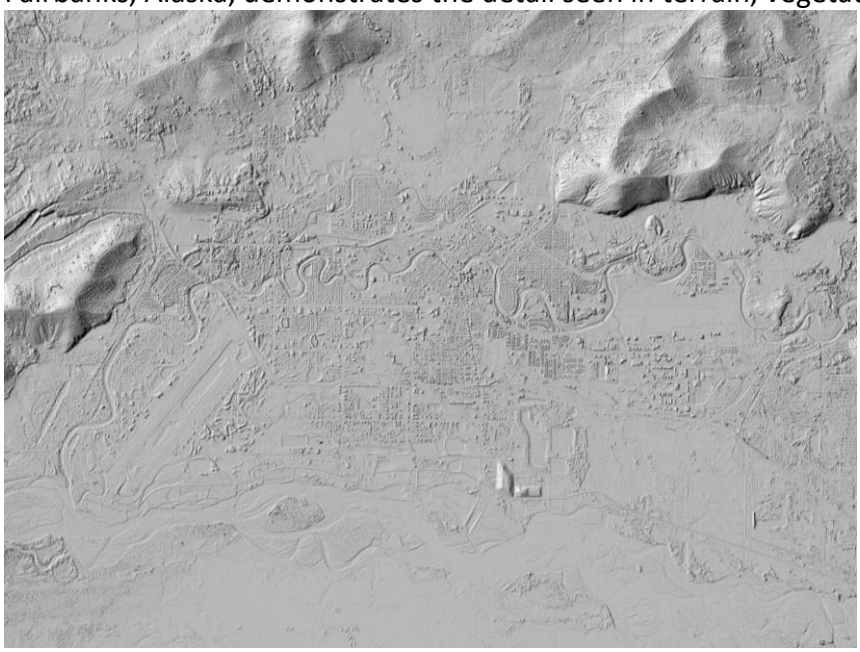
Web-based DEM Viewer and GIS Image and Data Services: Esri has developed an online web mapping application called the ArcticDEM Explorer for users to explore ArcticDEM data. The full-resolution ArcticDEM strips and mosaics are presented in this web map to quickly preview and explore the elevation data. With this web map, users can visualize the ArcticDEM data, preview the spatial coverage, and download simple exports. The ArcticDEM Explorer is the best way to preview the datasets if no GIS or remote sensing software is available, or a user simply wants to explore the entire dataset quickly.

ArcticDEM can be also be accessed via web mapping services provided by Esri. The raster elevation data (strips and tiles) are served via an Esri Image Service. Esri also provides an ArcGIS Online Feature Service for the ArcticDEM mosaic tile scheme. The GIS layers can be used directly in desktop GIS software. Links to the ArcticDEM Explorer and the various image and data services are found on PGC's ArcticDEM website located at http://pgc.umn.edu/arcticdem.

Arctic National Mapping Agency and Arctic Spatial Data Infrastructure Involvement: PGC acknowledges support from the Arctic National Mapping Agencies in development of this ArcticDEM

product. The Arctic Spatial Data Infrastructure organized two workshops between Arctic nation elevation experts and PGC to explore early releases of the data. Arctic nations provided review and feedback on pre-release data versions. As ArcticDEM data are released, several Arctic nations plan on evaluating the ArcticDEM for its potential use as an element within their authorized national datasets. ArcticDEM is produced automatically with no direct human interaction, so these Arctic nations will evaluate the amount of effort required to ensure the data will meet core national elevation data standards.

Visual Example of ArcticDEM: The following example of a shaded-relief portrayal of ArcticDEM over Fairbanks, Alaska, demonstrates the detail seen in terrain, vegetation and structures.



Report Date: December 28, 2017. Material adapted from PGC website and as communicated through PGC Director Dr. Paul Morin. Contact Tracy Fuller at [tfuller@usgs.gov].