UNPACKING ArcticDEM v1.0

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THIS PRESENTATION

- I am not describing what the ArcticDEM is, why or how it was made
- I have not completed a rigorous evaluation of the ArcticDEM v1.0 product for any specific application
- This is:
  - a quick overview of my initial ArcticDEM exploration
  - responses to questions I have received
  - pointers to better explore the data so that you can understand it too
  - a work in progress…
- *Any scientific results and conclusions, as well as any views or opinions expressed herein, are those of the author(s) and do not necessarily reflect the views of NOAA or the Department of Commerce*

WHERE DO I FIND ALL THE COOL STUFF?

Polar Geospatial Center ArcticDEM site

Official PGC website for the project – includes project overview/status, links to bulk data and documentation

http://pgc.umn.edu/arcticdem

- Documentation and User Advice ← ← ← **READ IT!!**
- Esri Image Service, Change Viewer, OGC Service, Tiled Service, and Base Reference links
- NGA Open Data Application link (tricky to figure out)
- SUBSCRIBE to ArcticDEM updates (at the bottom of page)

ArcticDEM Explorer - Esri online web mapping application to explore ArcticDEM data

http://arcticdemapp.s3-website-us-west-2.amazonaws.com/explorer/

NGA Arctic Support 2016 (Story Map)

http://nga.maps.arcgis.com/apps/MapSeries/index.html?appid=cf2fba21df7540fb981f8836f2a97e25

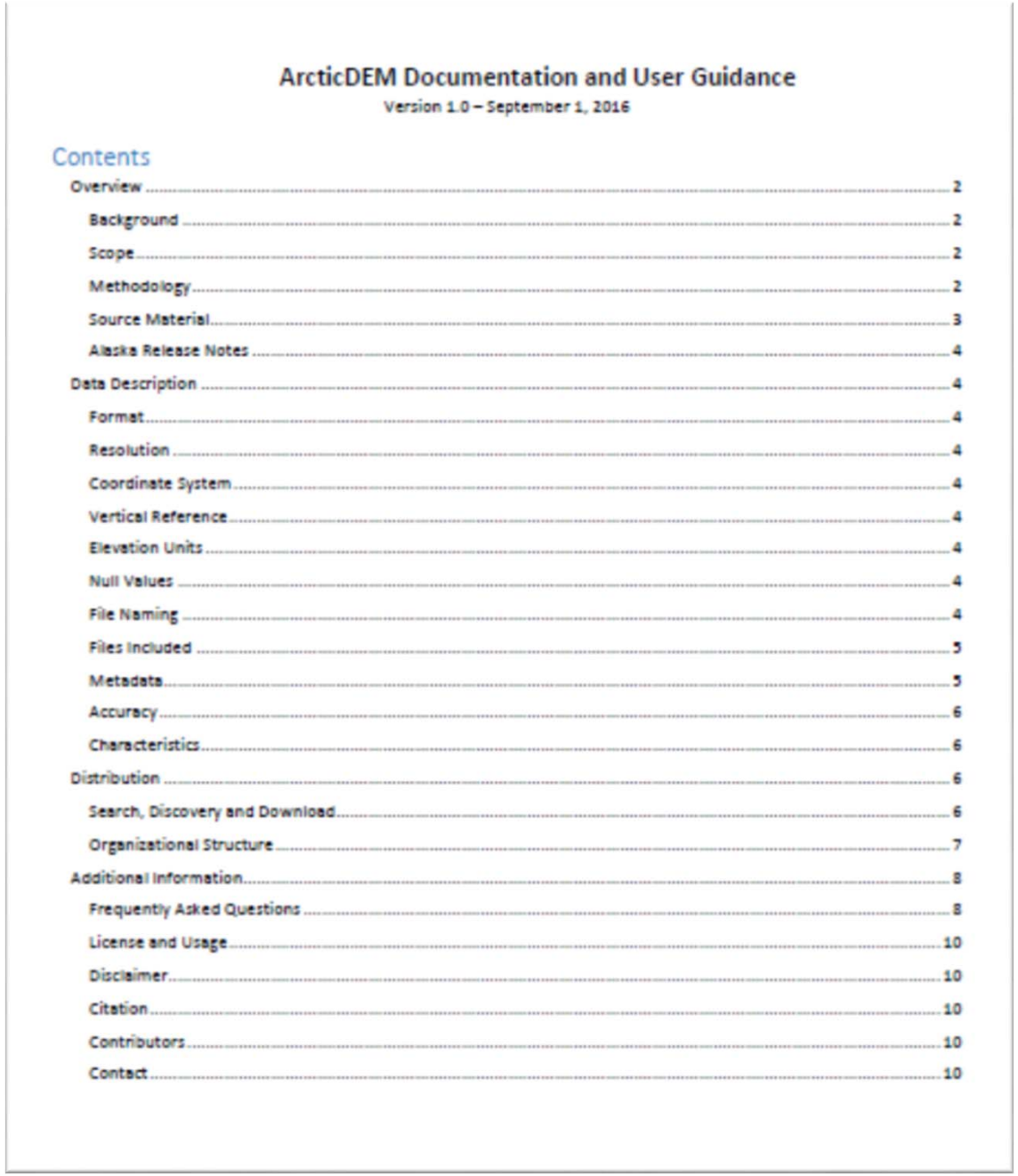
READ IT!!

The PGC-provided Documentation and User Guidance is only 10 pages!

Seriously, read it.

It is here:

http://pgc.umn.edu/system/files/ArcticDEM%20Documentation%20and%20User%20Guidance_2016sept01.pdf



ArcticDEM Documentation and User Guidance

Version 1.0 – September 1, 2016

Contents

ArcticDEM EXPLORER

Hillshades (w/ options)

Aspect Map

Slope Map

Contour Map

Landsat Basemap Tools

Time Control

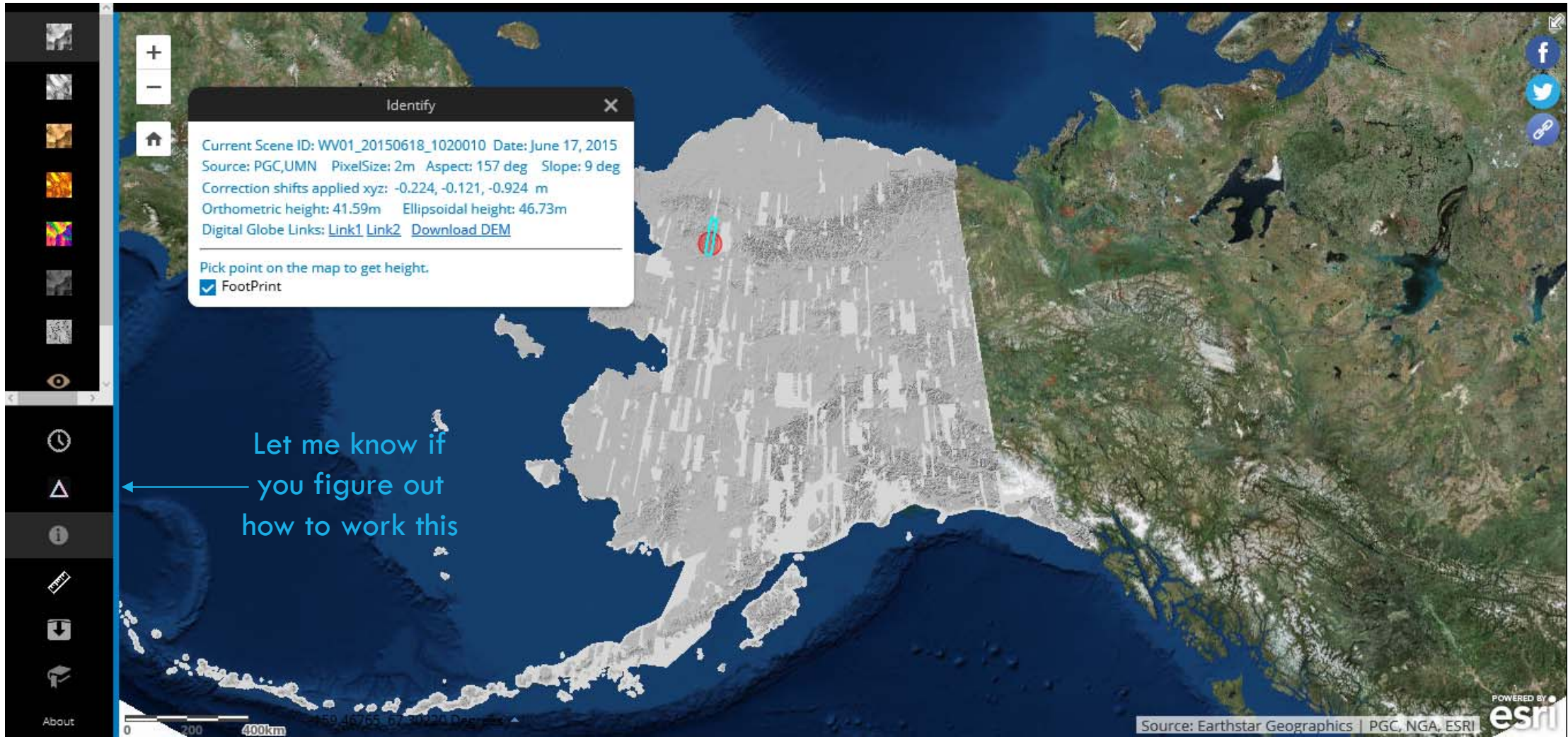
(Change Detection Tool)

Point ID Tool (shown)

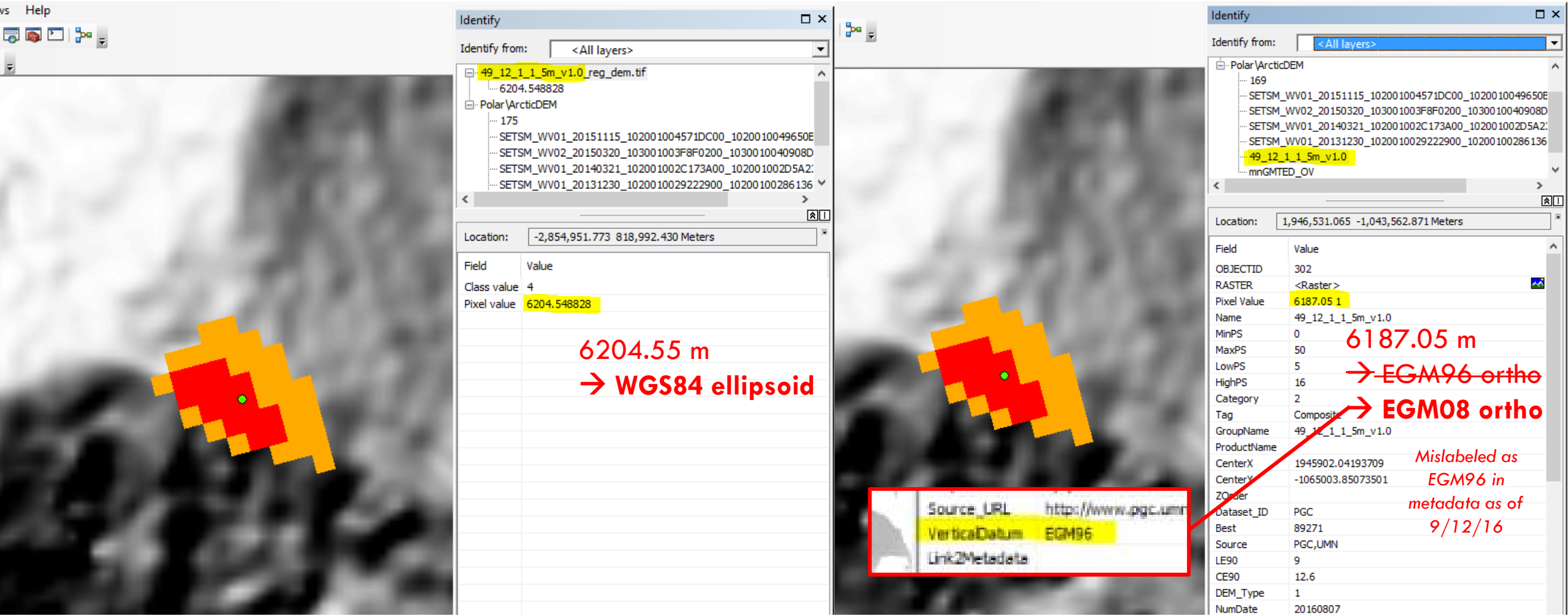
Measure

Export Data

Bookmark



MOSAIC VS. ESRI IMAGE SERVICE VALUES

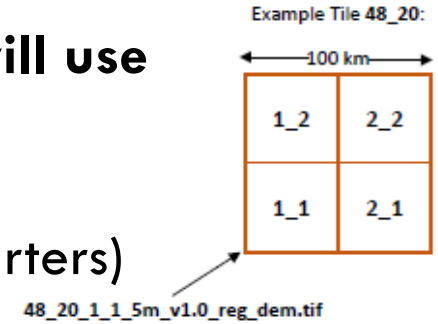


MOSAIC vs. STRIPS – *WHA?*

MOSAIC – what most will use

5 m GSD (subsampled)

100x100 km tiles (in quarters)



Compiled from multiple strips that have been co-registered, blended, and feathered to reduce edge-matching artifacts (mostly automated)

Adjusted to IceSAT (and other control)

You can get an index of the ArcticDEM mosaic tiling grid

index	9/7/2016 5:13 AM	File folder	
49_12_1_1_5m_v1.0_reg_dem.tif	8/10/2016 10:37 AM	TIF File	290,005 KB
49_12_1_1_5m_v1.0_reg_dem.tif.aux.xml	9/7/2016 5:21 AM	XML Document	1 KB
49_12_1_1_5m_v1.0_reg_dem.tif.ovr	9/7/2016 5:21 AM	OVR File	62,511 KB
49_12_1_1_5m_v1.0_reg_matchtag.tif	8/10/2016 10:37 AM	TIF File	1,219 KB
49_12_5m_v1.0_dem_meta.txt	8/10/2016 10:30 AM	Text Document	3 KB
49_12_5m_v1.0_reg.txt	8/10/2016 10:30 AM	Text Document	3 KB

STRIPS

2 m GSD (from ~0.5 m source image GSD)

Assorted sizes/shapes

Raw output from SETSM (Surface Extraction from TIN-based Searchspace Minimization, *Noh and Howat in preparation, OSU*)

Not adjusted to control, matadata has IceSAT & NGA control xyz offsets

index	9/6/2016 6:41 AM	File folder	
SETSM_WV02_20150426_103001003ECF7200_10300100405F3300_seg1_2m_v1.0_dem.tif	7/12/2016 3:48 PM	TIF File	1,174,845 KB
SETSM_WV02_20150426_103001003ECF7200_10300100405F3300_seg1_2m_v1.0_isreg.txt	7/21/2016 1:17 PM	Text Document	1 KB
SETSM_WV02_20150426_103001003ECF7200_10300100405F3300_seg1_2m_v1.0_matchtag.tif	7/12/2016 3:48 PM	TIF File	7,351 KB
SETSM_WV02_20150426_103001003ECF7200_10300100405F3300_seg1_2m_v1.0_mdf.txt	8/8/2016 10:24 PM	Text Document	14 KB
SETSM_WV02_20150426_103001003ECF7200_10300100405F3300_seg1_2m_v1.0_ngareg.txt	7/21/2016 11:13 AM	Text Document	1 KB
SETSM_WV02_20150426_103001003ECF7200_10300100405F3300_seg1_2m_v1.0_readme.txt	8/8/2016 10:24 PM	Text Document	1 KB

WHICH PRODUCT?

Mosaic

- Convenient
- Lower resolution (5m GSD)
- Not seamless: holes/artifacts/noise

Strips

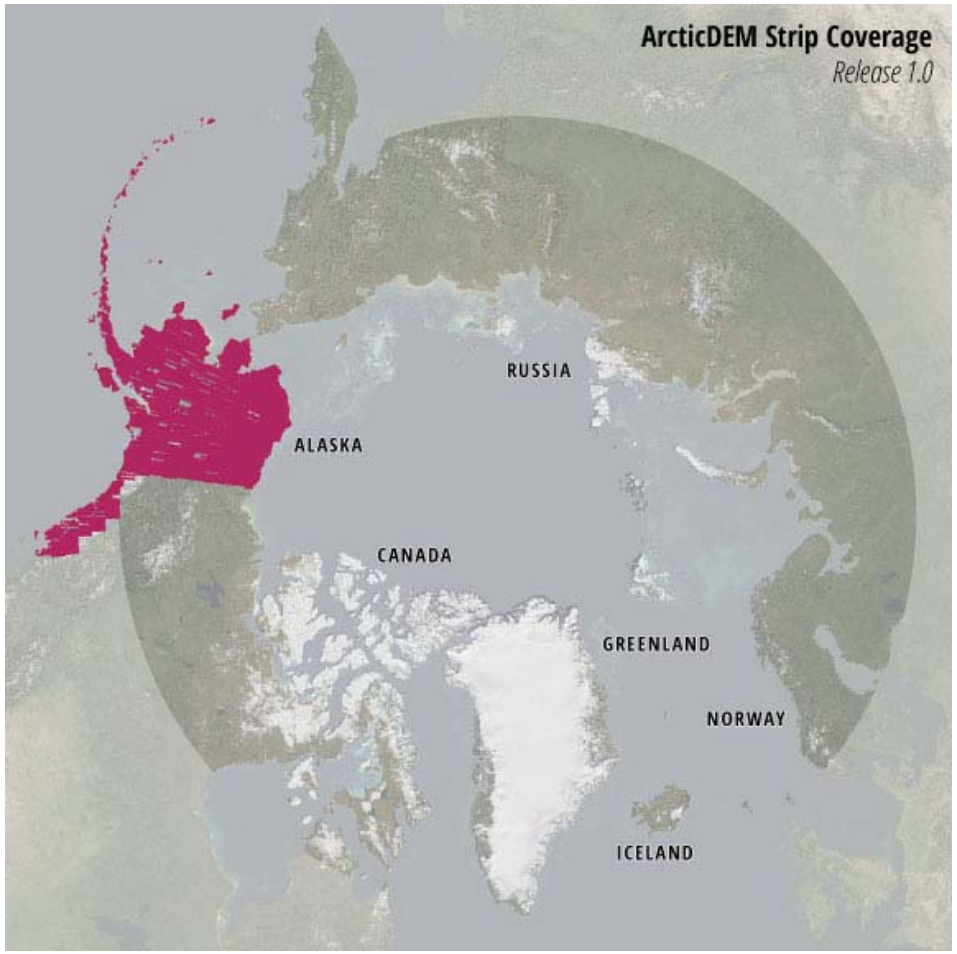
- Small coverage for each
- Higher resolution (2m GSD)
- ‘Cleaner’ DSM (specific time, no merge artifacts)
- Req. a ‘hands-on’ investment of knowledge and resources (time, control, processing) to make them suitable for most applications

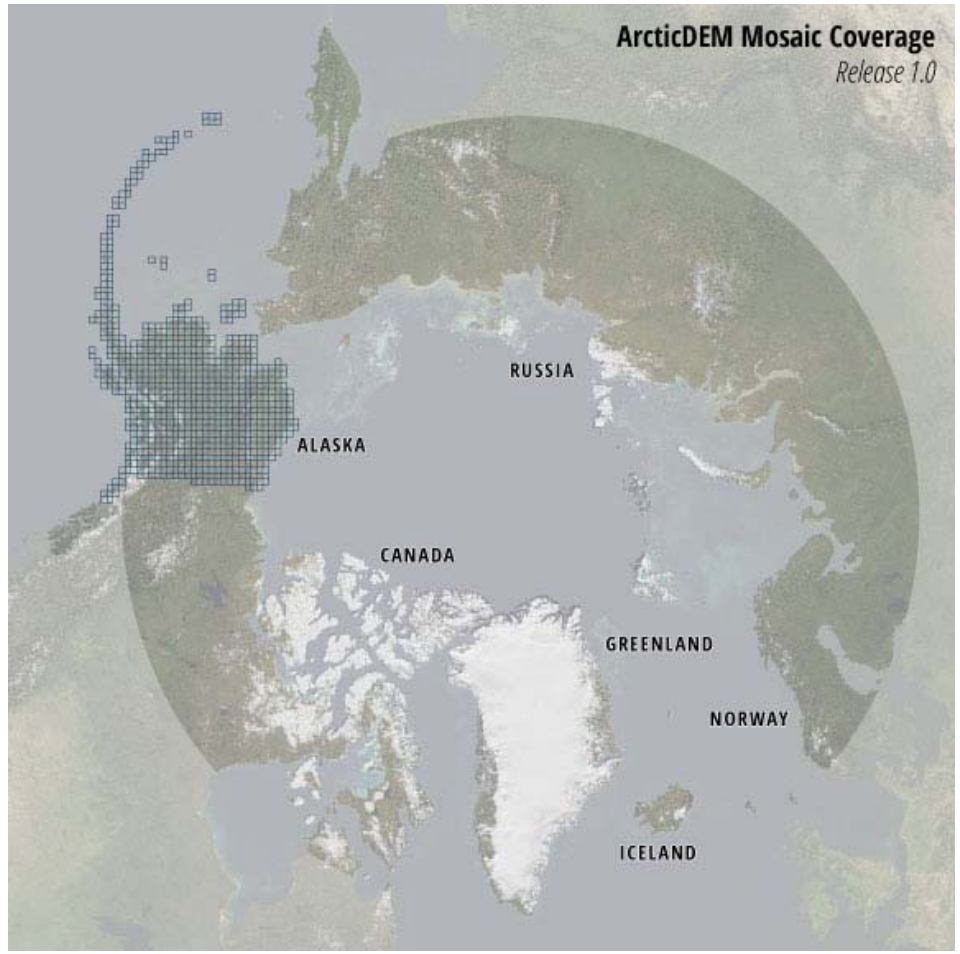
STRENGTHS/WEAKNESSES (CRIBED DIRECTLY FROM PGC)

- YAY! We are getting data from the poles and getting it quickly from space
- Recollects = gap fill & change detection
- Automated process = FAST
- Can re-make as we get better/smarter
- No planes = remote & high-latitude
- Custom mosaics are possible (e.g. 2015, or All Summer)

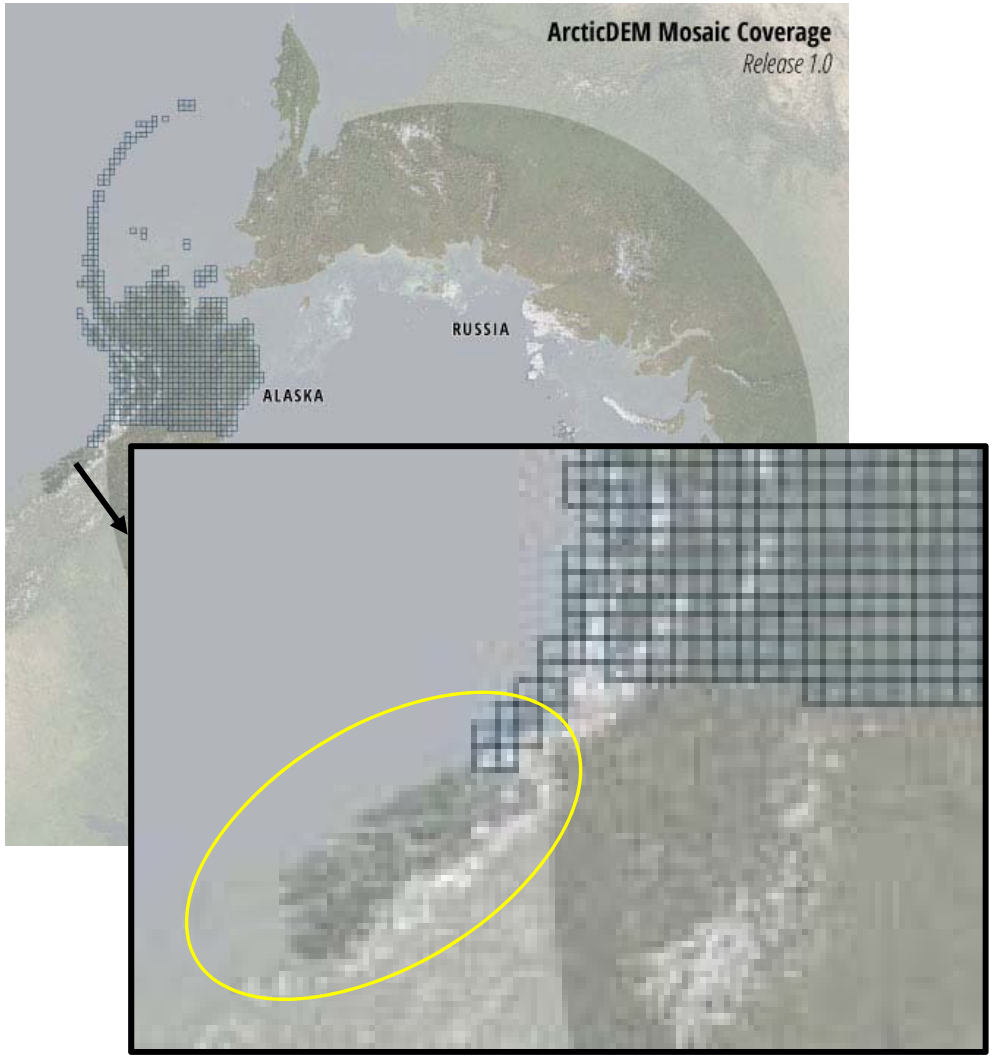
- Not "Bare Earth"
- No manual editing (minor edits in v1.0)
  - Pits, Spikes, false land, other anomalies exist
  - No manual hydro-flattening or hydro-enforcing
- Optically derived = things move, clouds…
- Strip files do not align
- BIG data files
- Versioning is an adventure (1.1, 2.0…)
- A quilt of many years and seasons – not a static, uniform snapshot! (snow/ice, veg.)
- We will get to absolute accuracy…

COVERAGE


ArcticDEM Strip Coverage
Release 1.0
RUSSIA
ALASKA
CANADA
GREENLAND
NORWAY
ICELAND


ArcticDEM Mosaic Coverage
Release 1.0
RUSSIA
ALASKA
CANADA
GREENLAND
NORWAY
ICELAND

GAPS



ArcticDEM v1.0 excludes mosaic tiles for southeastern portions of the state where terrain data of sufficient quality to be mosaicked was unavailable at the time of initial release.

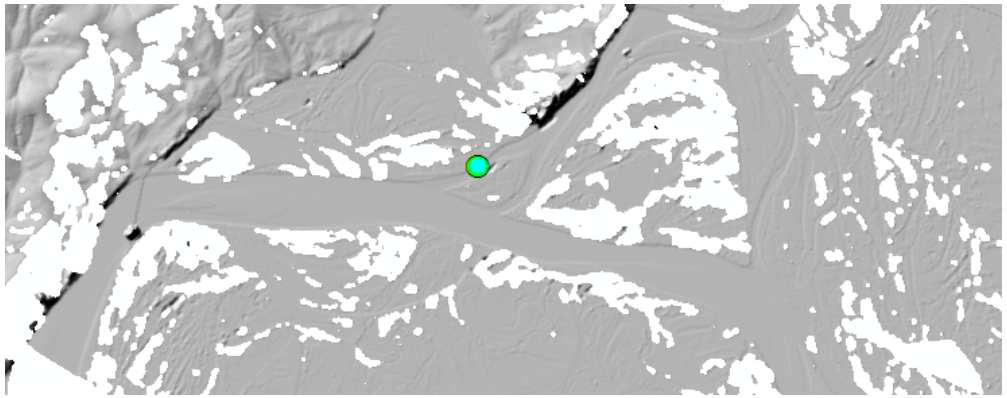
Strip DEM files for Southeast Alaska *are available* for download.

"Future releases may include improved and additional mosaic tiles for Southeast Alaska."

- ArcticDEM Documentation and User Guidance v1.0

HOLES/VOIDS AND NOISE/BLUNDERS

Koyukuk

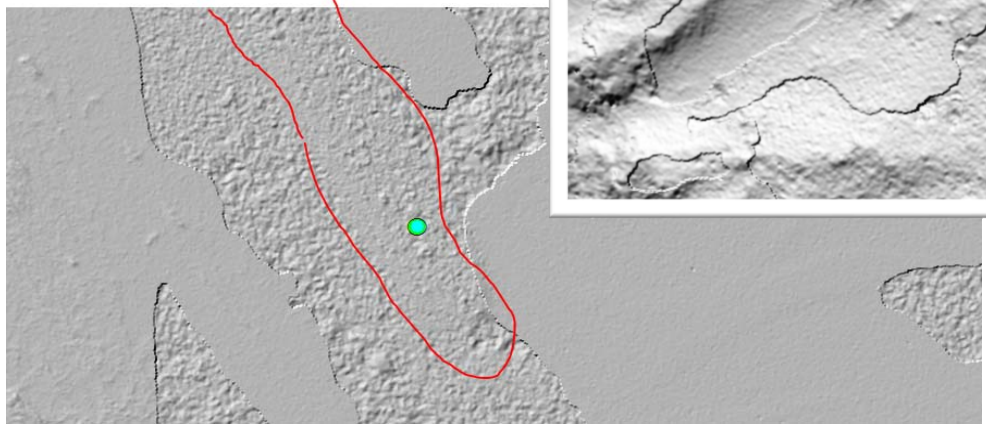


TIN -> Raster:

A default filter is applied using the matchtag raster that excludes pixels where >70% of the neighboring pixels in a local search window (21 x 21 or 5 x 5, depending on resolution) were interpolated.

- ArcticDEM Documentation and User Guidance v1.0

Kivalina



As with any optical imagery-derived elevation product, void areas or artifacts may appear where cloud cover, shadows, and unfrozen water bodies exist in the source imagery, or in regions of low radiometric contrast where pixel correlation cannot be resolved by the software. Open water, swaying trees, and homogeneous terrain can also cause voids or unpredictable results.

- ArcticDEM Documentation and User Guidance v1.0

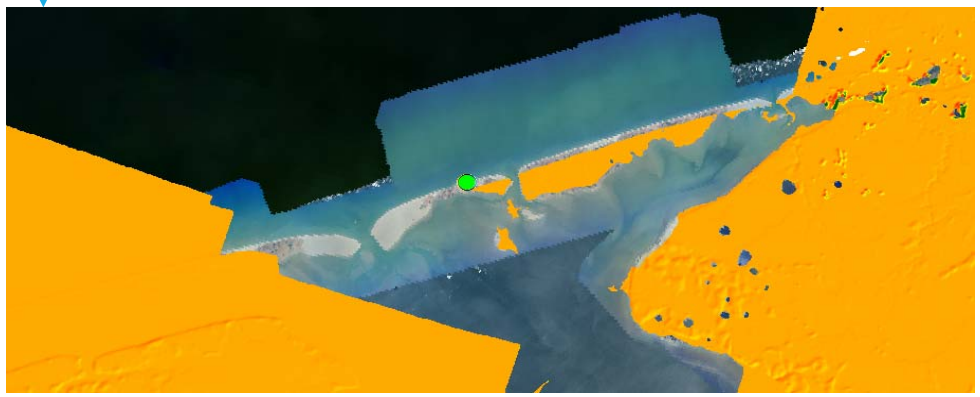
SHISHMAREF – ANOTHER GAP

"That includes people in Kotzebue, which sits on a gravel peninsula roughly ten feet above an increasingly destructive Chukchi Sea. Or in Shishmaref, whose residents voted last week to relocate their tiny, flood-prone village, which has been occupied for more than 400 years. A ~~recent~~ [2009] study by the ~~nonprofit Arctic Institute~~ [GAO] reported that 31 Alaskan villages faced "imminent threat of destruction" from flooding and erosion.

The new maps should make it easier for those villages both to monitor the threat and plan their future. "I can't wait to see the results," said Noah Naylor of Kotzebue, planning director for the vast Northwest Borough."

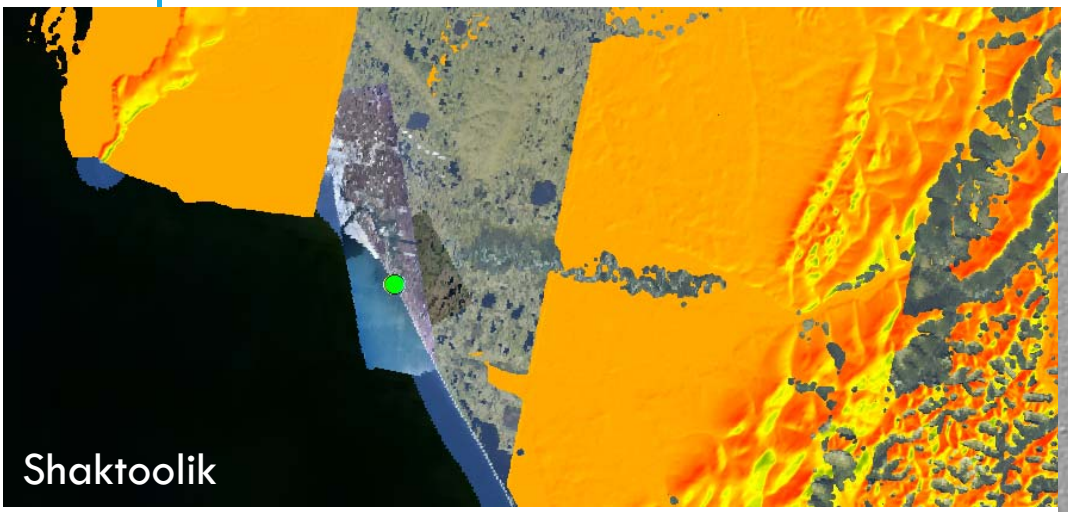
- National Geographic, Alaska Has Finally been Mapped as precisely as Mars, Sept. 2016

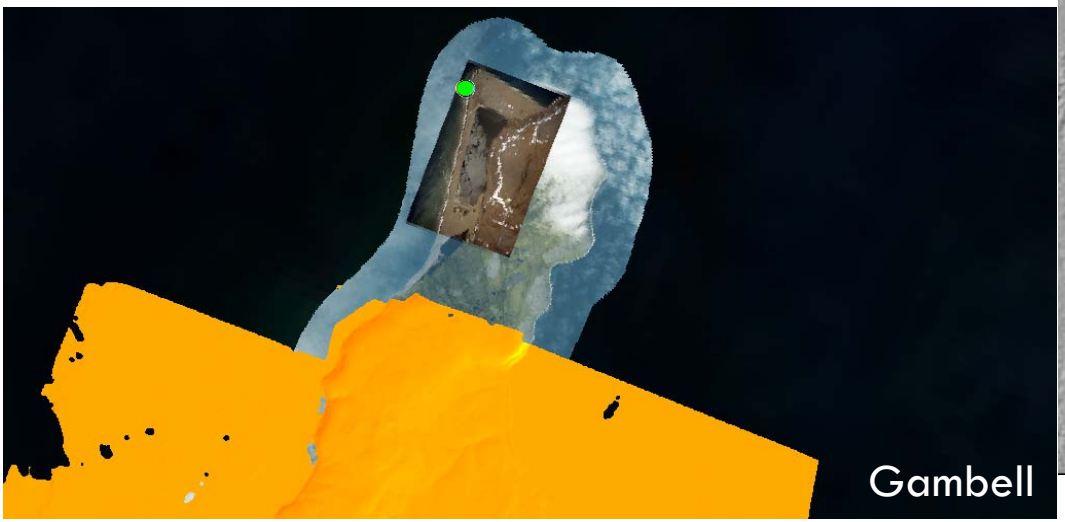
(Thank you to Jaci Overbeck, DGGS Coastal Hazards for noticing this)



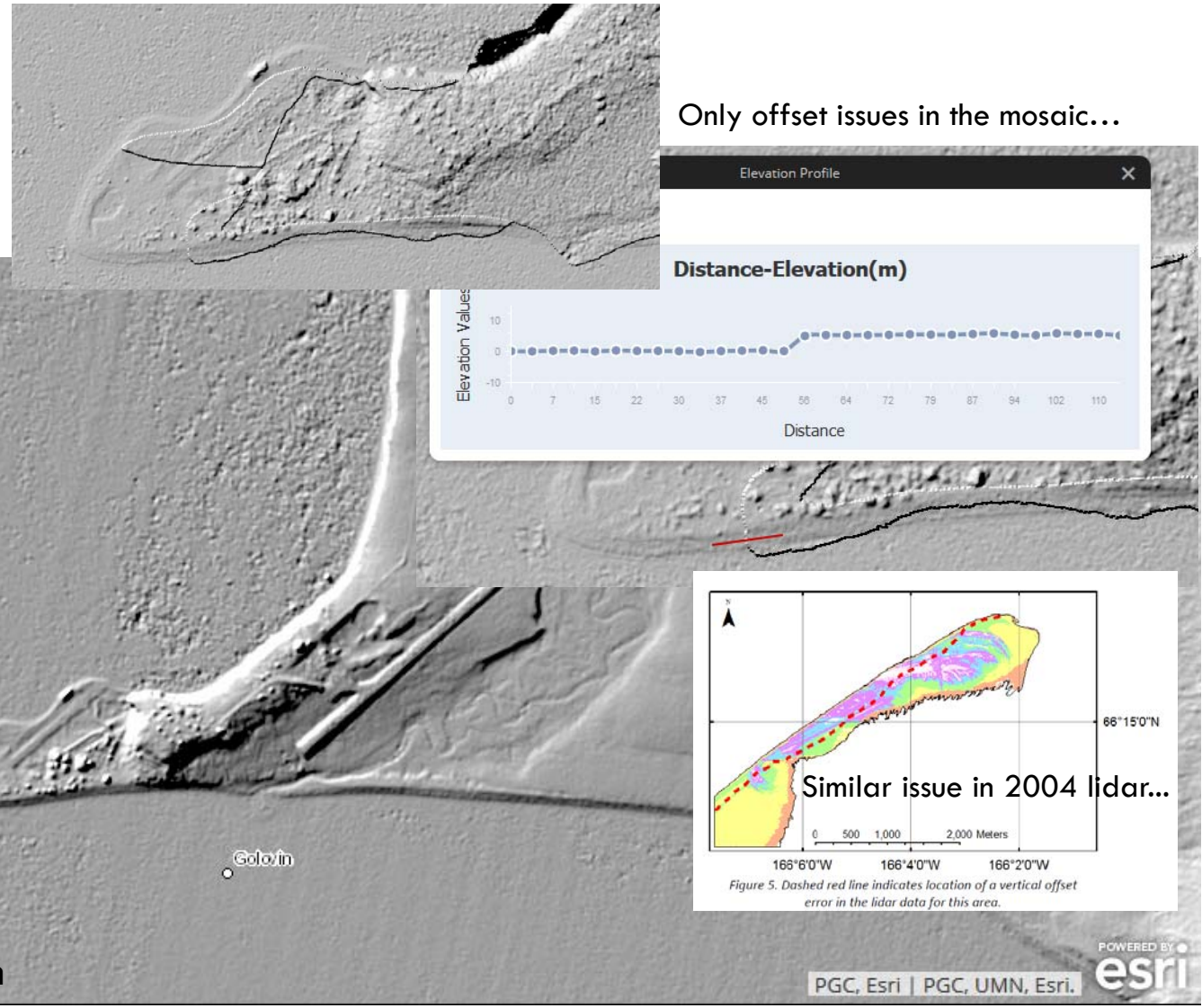
Shishmaref, NOAA Semi-Oblique Image, June 1 2016
http://geodesy.noaa.gov/storm_archive/coastal/viewer/index.html

OTHER COASTAL GAPS IN v1.0?





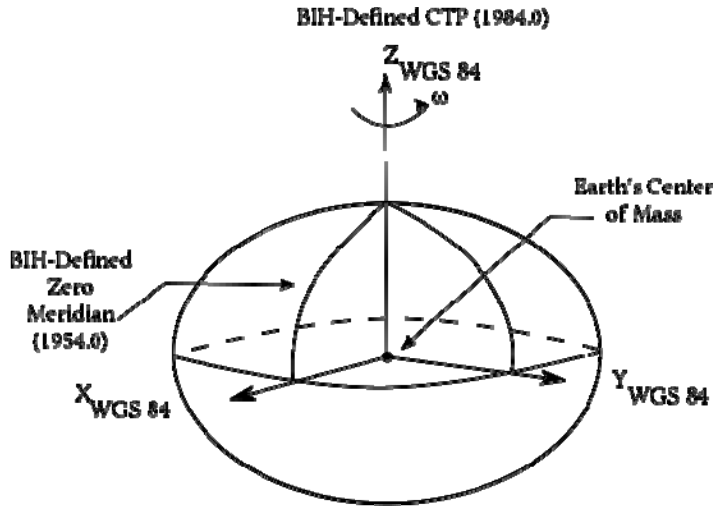
Only offset issues in the mosaic…



SPATIAL REFERENCE (I DON'T SPEND TIME ON PROJECTIONS)

Coordinate System:

- WGS84 (≠ NAD83)
- World Geodetic System of 1984
- Maintained by DoD/NGA



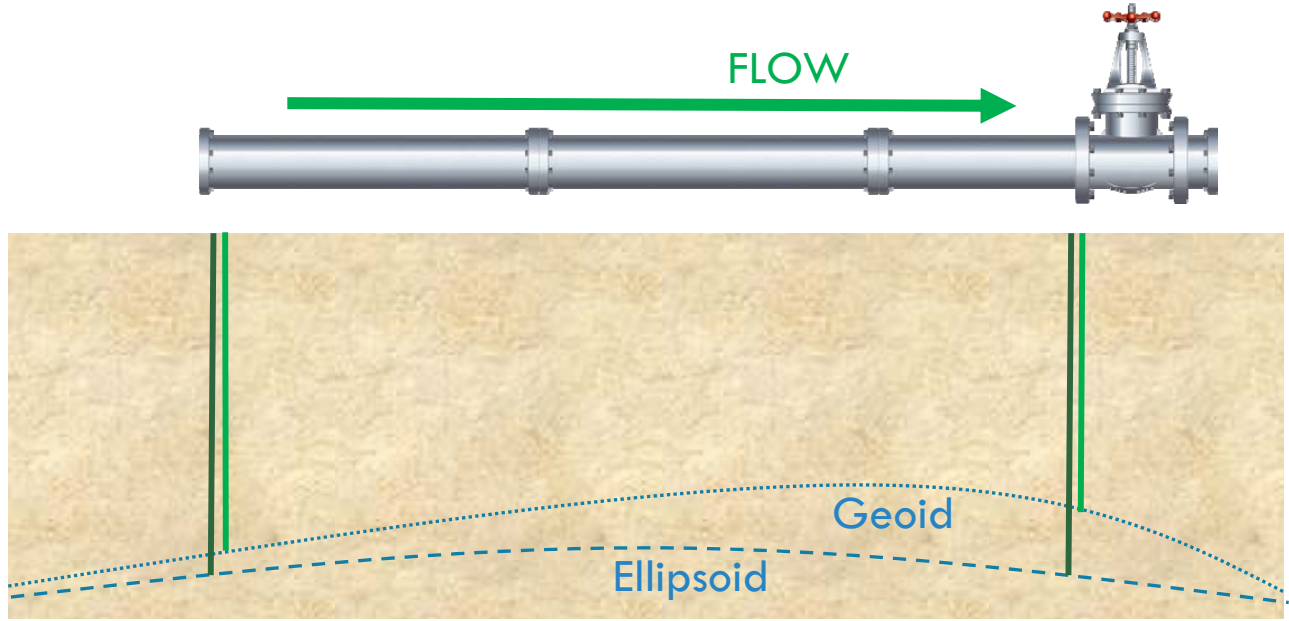
DMA TECHNICAL REPORT TR8350.2-b

Vertical Reference (of direct-PGC ArcticDEM products):

- Height above the WGS84 Ellipsoid (meters)
- Ellipsoidal heights are not gravity-corrected to sea level (important if used for hydro-mapping)

210 m Ellipsoid Height
208 m Orthometric Height

210 m Ellipsoid Height
202 m Orthometric Height



PRECISE-SCHMISE…HOW ABOUT ACCURACY?

Without ground control points absolute accuracy is approximately 4 meters in horizontal and vertical planes. Uniform ground control must be applied to achieve higher accuracy. Laser altimetry data from the NASA IceSAT spacecraft has been applied to the ArcticDEM mosaic files.

"Absolute horizontal and vertical accuracy specifications of ArcticDEM data have not been verified. Future work may include accuracy validation."

- ArcticDEM Documentation and User Guidance v1.0

In terms of geospatial data, the ArcticDEM is a very highly precise product, but accuracy is on the user.

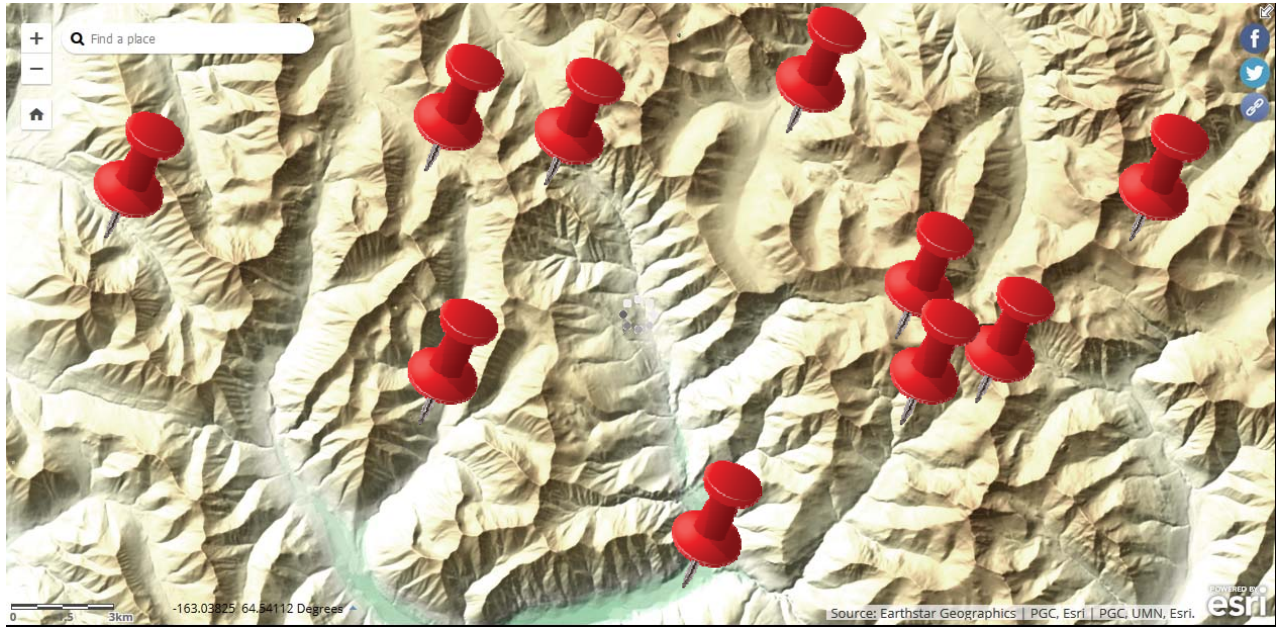
The quick take-aways:

- Elevations and heights in this dataset are very good relative to one another (great for slope analysis, for example)
- Relative elevations and height are specific to the time of collection (great for change detection!)
- 'Grab and go' absolute positions are not consistently reliable (introduces challenges when trying to combine with outside geospatial datasets)

Do it YOURSELF!

Users may wish to use other sources for smaller areas, particularly on ArcticDEM strip files. Strip DEM files contain IceSAT altimetry offsets within the metadata, but have not had these values applied to the DEM files.

- ArcticDEM Documentation and User Guidance v1.0



DENALI SUMMIT! - BECAUSE, WHY NOT?

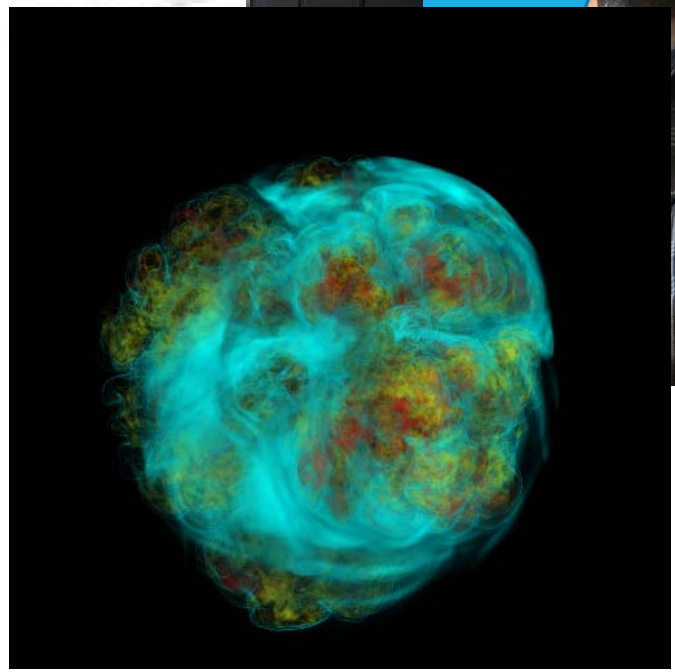
Source	Height (m)	Height (ft)	Datum
2015 Summit Survey	*6,206.1*	*20,361*	*NAD83(2011)*
	6,190.5	**20,310**	**NAVD88**
	6,189.3	20,306	USGG2012
PGC 2m strip (no control)	*6,200.53*	*20,343*	*WGS84*
PGC 5m mosaic (control applied)	*6,204.55*	*20,356*	*WGS84*
Esri	6,187.05	20,299	EGM~~96~~…08
Geoid Calculator	6,189.7	20,307	EGM84
Geoid Calculator	6,187.8	20,301	EGM96
Geoid Calculator	6,187.2	20,299	EGM08

Note:

- Orthometric (gravity-corrected) heights in darker blue
- Significant change from addition of control
- The geoid model used makes a difference →
- Not *too* shabby for positioning a 5m patch from space…

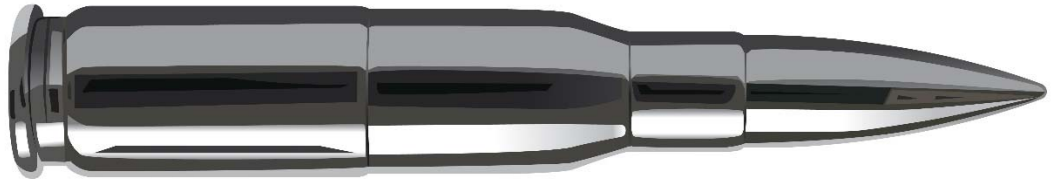
WHAT IS NEXT?

- Data will be released on a rolling basis through 2017
- Flexible schedule because of availability of computer time on the Blue Waters supercomputer, and the computer cluster required to post process the data →
- "We manually clipped out some bad data or areas with excessive voids to make a cleaner product. We expect to only do this in this version of Alaska. Future versions of Alaska will not have this manual attention, and other areas of the Arctic are expected to have sufficient coverage so manual clipping will not be required."
  - from NGS website: http://nga.maps.arcgis.com/apps/MapSeries/index.html?appid=cf2fba21df7540fb981f8836f2a97e25



General relativistic radiation hydrodynamics simulation of an exploding star

USER ~~BEWARE~~ BE AWARE



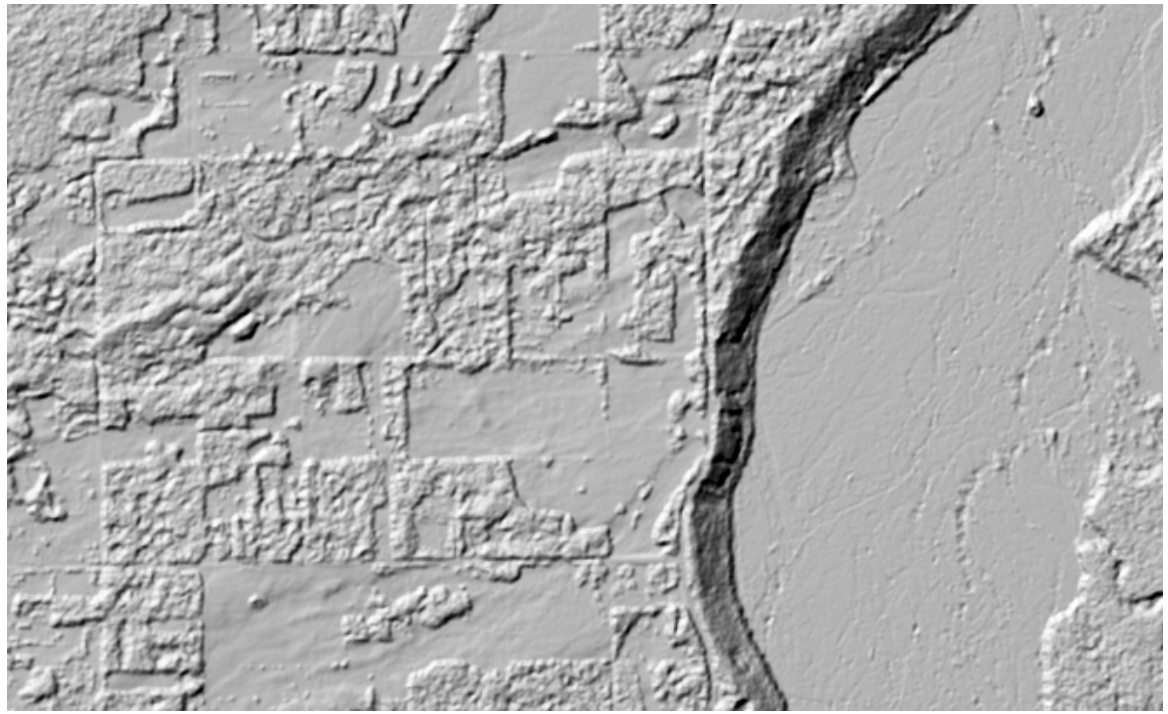
BE INFORMED and the ArcticDEM can deliver.

ArcticDEM v1.0 is an *amazing accomplishment* and a *highly impressive geospatial product* that is appropriate for many applications in our region… when used properly.

Recommendations:

- Pay attention to the source product (type, time, GSD)
- Add control if absolute accuracy matters to you
- Understand the product and think critically about possible source of noise, blunders, anomalies, etc.

Not a silver bullet – the ArcticDEM/DSM compliments our State's elevation data needs.



Sept. 2015 → MatSu Farming & pre-2016-erosion riverbank

Have fun!