PGC SETSM “Version 4” Strip DEMs

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At PGC, we use SETSM to produce DEMs from *stereo pairs* of pieces (or "scenes") from two separate stereo swath (or "strip") image acquisitions. We do this because (a) the imagery is already cut into scenes when we receive imagery from DigitalGlobe and (b) it is more efficient to have SETSM work on smaller pieces of the stereo acquisitions in parallel. We call the raw DEMs produced by SETSM "scene DEMs". After all scene DEMs for a single pair of stereo swath image acquisitions have been produced, these scene DEMs can then be merged together in an attempt to create a single, unbroken DEM that captures the full extent of the stereo swath image acquisition. (When adjacent scene DEMs cannot be automatically merged due to algorithm failure, the resulting strip is broken into one or more "strip segments".) We call the results of this merging process "strip DEMs".

The raw scene DEMs that come out of SETSM will almost always contain spots of erroneous elevation data (or "blunders"). SETSM struggles to produce correct results over water, cloud cover, dark vegetation, or in areas of shadow. Additionally, it will often produce bad data at the edges of the DEM extent. During the merging process that turns scene DEMs into strip DEMs, attempts are made to automatically identify blunders in the scenes and mask them out as NoData before merging into strips. Strips released as part of ArcticDEM releases 1-7 and REMA 1/1.1 had all areas that were automatically identified as water or cloud masked out. This automatic blunder removal was designed to more generously remove bad data from the DEMs in order to alleviate much of the manual quality control work put into building the ArcticDEM and REMA mosaic datasets. After a more thorough consideration of the DEM strip-building process, we have decided to change the way we leverage this automatic blunder removal in future strip production and release.

In future releases of new “version 4” SETSM strip DEMs, strips will no longer have the automatic water and cloud masks applied. (The edge mask must always be applied to remove bad data where the scene DEMs are joined.) However, these automatic masks are still created and preserved as different layers within new a new **_bitmask.tif* raster that is included with every released strip. We are currently developing simple processing workflows in Python, QGIS, and ArcGIS that will allow users to selectively apply the water and/or cloud masks from the bitmasks to mask out the corresponding areas in the strip DEM rasters you have downloaded. However, we know that many users would like to continue receiving strip DEMs that come with this mask pre-applied in the fashion of previous ArcticDEM and REMA strip releases. **We will continue to ask PGC users if they would like the new *unmasked version* or the old *masked version* strips.** We would be happy to pre-apply the mask in your strip DEM delivery, or include both versions if you would like to compare them yourself.

Additionally, **we will now include downsampled 10-meter horizontal resolution hillshade images (as georeferenced GeoTIFFs) of both the unmasked and masked versions of the DEM** with each strip DEM delivery, which you can easily browse through using your computer's default image viewer application.

PGC has begun using SETSM’s Local Surface Fitting (LSF) option to minimize error from noise in all SETSM DEMs. Visually, the LSF version DEM looks like the result of applying a Gaussian filter to the non-LSF DEM. The application of LSF has shown to reduce the magnitude of artificial “spike” and “well” errors in the elevation data. While the strip DEMs in the first REMA release had LSF applied, strips released as part of ArcticDEM releases 1-7 did not. Moving forward, PGC will chiefly be producing only LSF version strips to be used in our mosaicking efforts. However, **legacy non-LSF version strips can be created upon user request for strip DEM deliveries**.

2-meter Strip DEM Delivery Contents

***_bitmask.tif**	Contains the automatic EDGE, WATER, and CLOUD masks created during the scene DEM merging process. Zero-value pixels indicate data in *_*dem.tif* that was not identified as potentially bad data. A visual explanation is given on the next page of this document. Complete technical specification is available here.
***_dem.tif**	The *unmasked version* DEM (only the necessary EDGE mask from *_*bitmask.tif* was applied). Elevation units are meters and are referenced to the WGS84 ellipsoid. NoData value is -9999. **Can be excluded from strip DEM delivery if the masked version DEM is instead requested.**
***_dem_masked.tif**	Like *_*dem.tif*, this is the *masked version* DEM (beyond the necessary EDGE mask, the WATER and CLOUD masks have also been applied). Can be derived by masking *_*dem.tif* where non-zero values exist in *_*bitmask.tif*. **Included in strip DEM delivery only upon request.**
***_dem_10m_shade.tif**	Hillshade of *_*dem.tif* raster after being downsampled to 10-meter resolution.
***_dem_10m_shade_masked.tif**	Like *_*dem_10m_shade.tif*, but with added application of the WATER and CLOUD masks from *_*bitmask.tif*.
***_matchtag.tif**	Raster produced by SETSM indicating DEM pixels derived from a stereo match (1) or those that have been interpolated (0).
***_meta.txt**	Text file metadata document.
***_ortho.tif**	2-meter horizontal resolution 16-bit panchromatic orthorectified image produced by SETSM. *Included only upon request in strip DEM deliveries to federally-funded researchers.*
***_ortho2.tif**	Like *_*ortho.tif*, this is the second of two panchromatic orthorectified images produced by SETSM. This second image is only retained for cross-track stereo strip DEMs. *Included only upon request in strip DEM deliveries to federally-funded researchers.*

The following is an example set of files you can expect to receive in a strip DEM delivery:

W2W2_20111105_103001000E615F00_103001000F4F7900_2m_lsf_v030208
Folder containing 2-meter LSF strip DEM results produced from the stereo swath image acquisitions 103001000E615F00 and 103001000F4F7900 using SETSM version 3.2.8.

(folder contents below)

W2W2_20111105_103001000E615F00_103001000F4F7900_2m_lsf_seg8_bitmask.tif
W2W2_20111105_103001000E615F00_103001000F4F7900_2m_lsf_seg8_dem.tif
W2W2_20111105_103001000E615F00_103001000F4F7900_2m_lsf_seg8_dem_10m_shade.tif
W2W2_20111105_103001000E615F00_103001000F4F7900_2m_lsf_seg8_dem_10m_shade_masked.tif
W2W2_20111105_103001000E615F00_103001000F4F7900_2m_lsf_seg8_matchtag.tif
W2W2_20111105_103001000E615F00_103001000F4F7900_2m_lsf_seg8_meta.txt

Note that the above example shows only the strip DEM results for strip segment number 8 (see "_seg8_" in the filenames). This means that the scene DEMs from this particular set of stereo image acquisitions could not be automatically merged into a single strip DEM raster, and the resulting strip DEM was broken into at least 8 separate segments. If this was a DEM request made with a set of point coordinates, this single intersecting strip segment #8 may or may not be large enough to cover your entire area of interest. **It is for this reason that we recommend drawing a polygon to define the true extent of your area of interest.**

Visual interpretation of the *_*bitmask.tif* raster

The following figures display hillshade images of the strip DEM W2W3_20160706_1030010059D6B800_104001001F6FBD00_2m_lsf_seg2_dem.tif with the *_bitmask.tif raster ("bitmask") overlaid.

(a) *_dem_10m_shade.tif: Hillshade of the unmasked strip DEM raster (*_dem.tif) after being downsampled to 10-meter resolution.

(b) *_dem_10m_shade.tif with semi-transparent bitmask symbology overlaid.

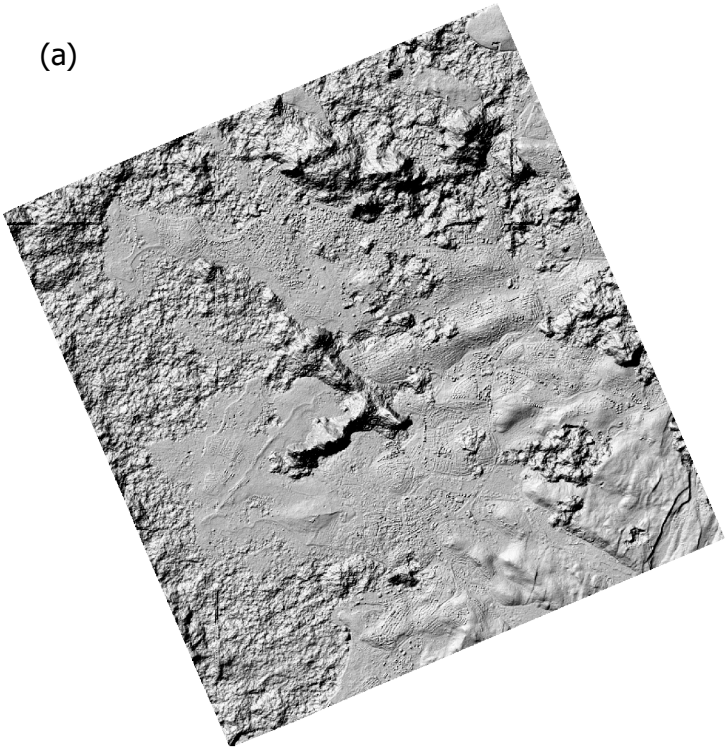
(c) *_dem_10m_shade.tif with opaque bitmask symbology overlaid.

(d) *_dem_10m_shade_masked.tif: Hillshade preview of the application of the water and cloud components of the bitmask to create a fully masked strip DEM.

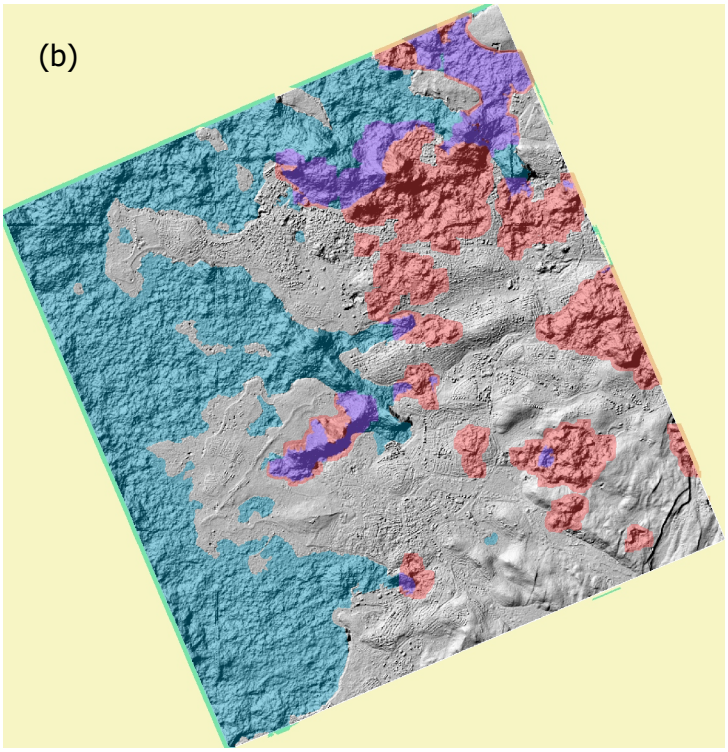
bitmask value

- 0: "good data"
- 1: bad edge data
- 2: water
- 3: water and edge
- 4: cloud
- 5: cloud and edge
- 6: cloud and water
- 7: cloud, water, and edge

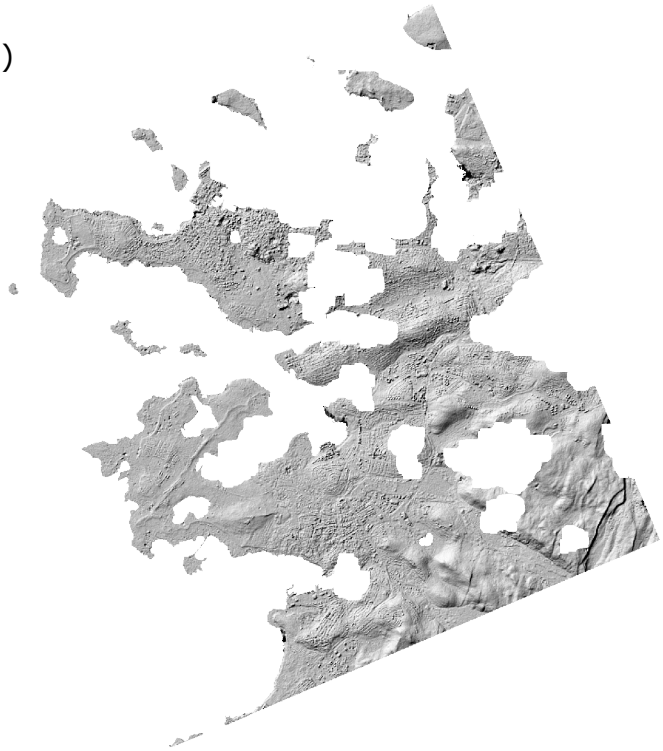
(a)



(b)



(d)



(c)