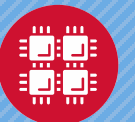# Xpert Network – Does this DEM look right?

Karen Tomko, Samuel Khuvis, Evan Danish, Xinyu Liu

Ohio Supercomptuer Center

Email me: ktomko@osc.edu

Collaborators: MJ Noh, Ian Howat, OSU BPCRC

EarthDEM Project Overview
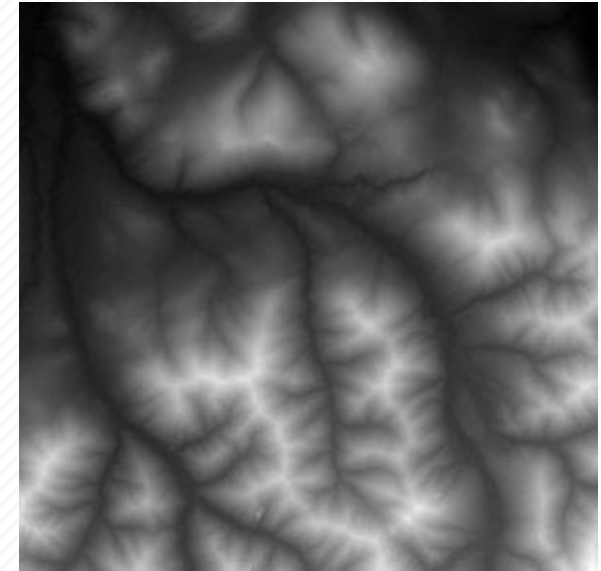
What is a DEM?

- Digital Elevation Model

- 2D image representation of terrain, where pixel value represents elevation
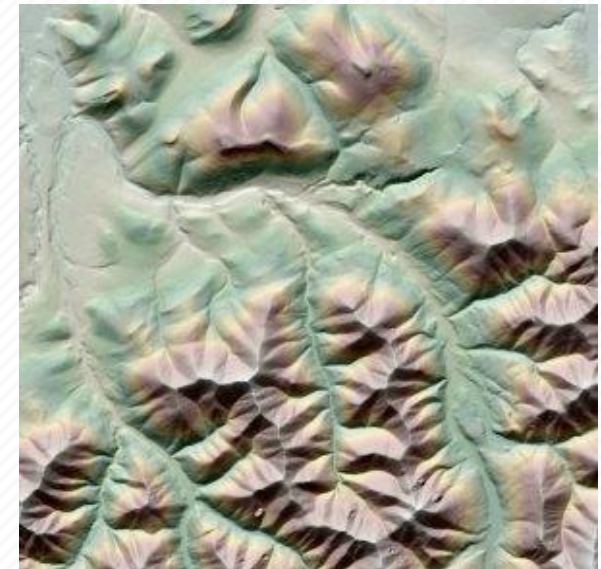
Project summary:

A collaboration between PGC at UMN, NCSA, OSU and OSC to produce high-resolution DEMs of the entire Earth.
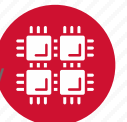
For more on the EarthDEM project see:

https://www.pgc.umn.edu/news/blue-waters-extended-to-produce-global-topography/

DEM image

Shaded relief image

Images from
https://www.pgc.umn.edu/data/elevation/

The SETSM Software

- The Surface Extraction from TIN-based Searchspace Minimization (SETSM) software is a fully automatic algorithm for deriving Digital Terrain Models (DTM) from pairs of satellite imagery.
- SETSM homepage: https://mjremotesensing.wordpress.com/setsm/
- ~40,000 lines of C/C++ code
- Dependencies: libtiff, libgeotiff, proj, GDAL
- Inputs and outputs
  - Input:
    - stereo image pair
    - default.txt for default command line arguments
  - Output:
    - <name>_dem.tif – the resulting DEM
    - <name>_meta.txt – meta data for the DEM
    - <name>_matchtag.tif – gridpoints with matched solutions
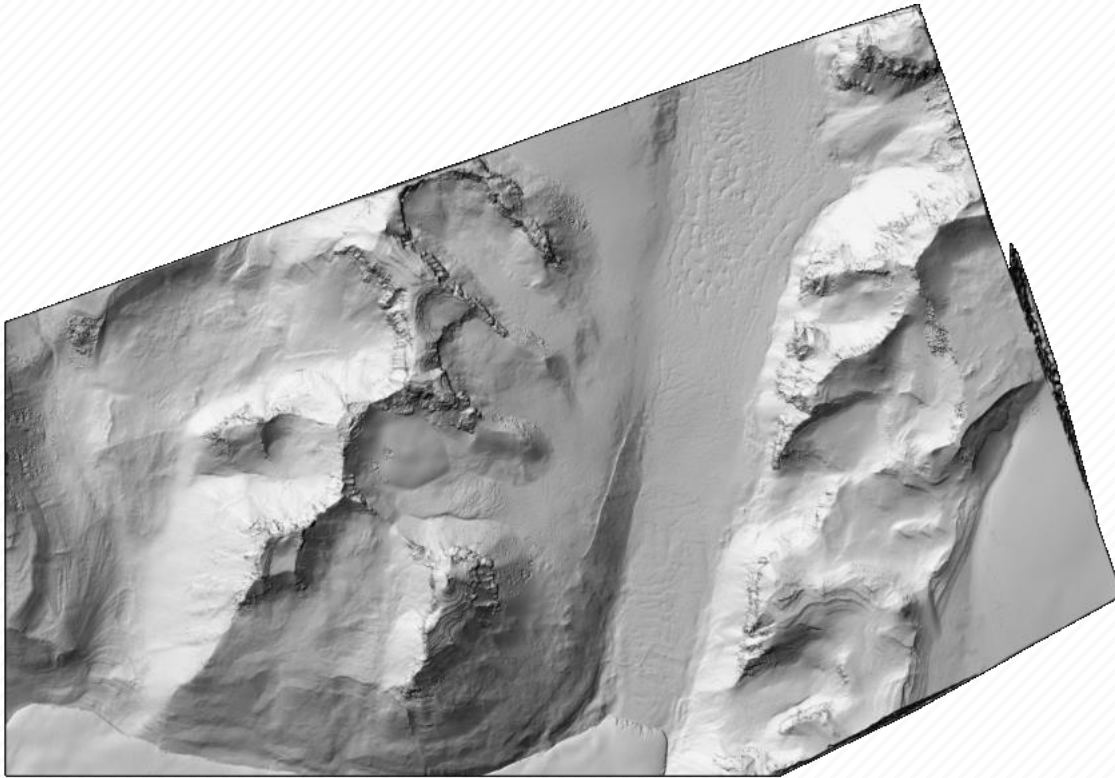   - Some text files with debug information and some scratch files
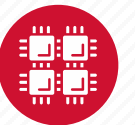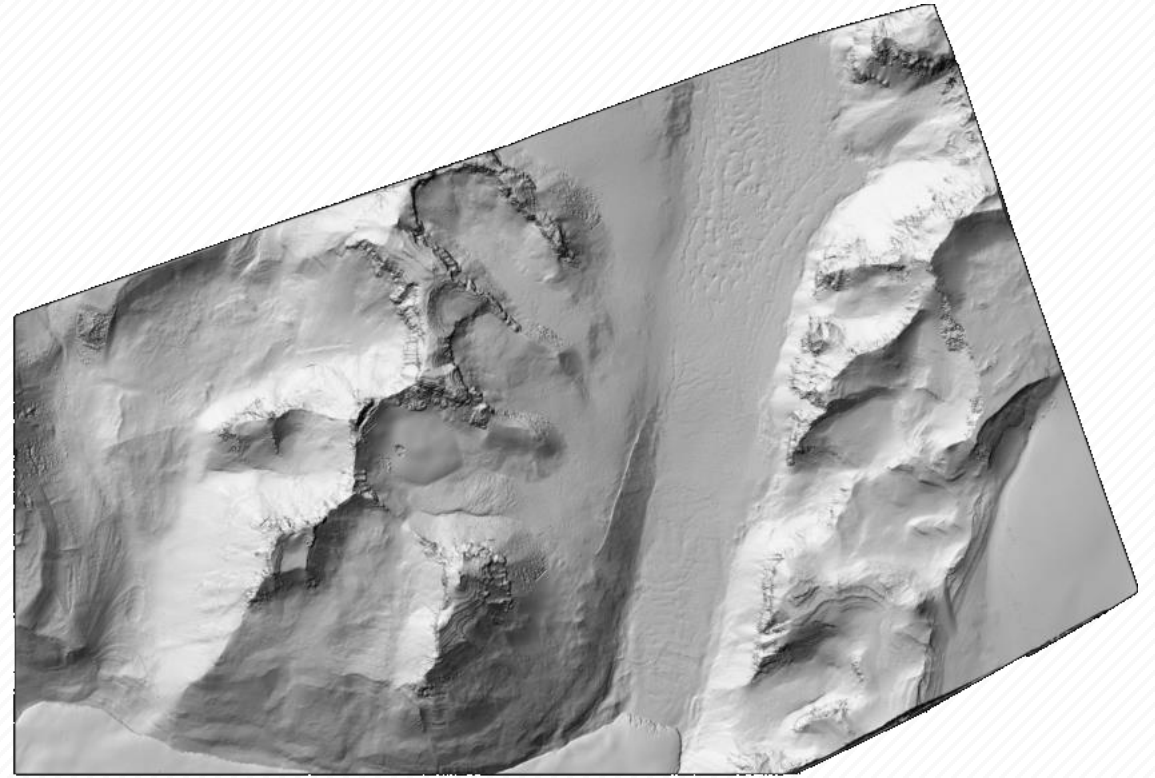
Project Challenges

- Software is under development
- Many data dependent code paths
- Numerical sensitivities
- Complex output
- Runtimes vary, but non-trivial for suite of tests
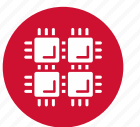- No right answer for comparison
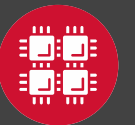
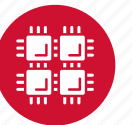# Does the DEM look right?

SETSM version 4.3.0

SETSM version 4.2.2

Test Space

- Degrees of freedom
  - Systems
    - Development systems at OSU and OSC
    - Production system(s) at NCSA, NASA, …
  - Compilers
    - Intel, Gnu, Cray
  - Inputs
    - Image pair
    - DEM resolution: 8M, 4M, ..
    - Other parameters
  - Software versions
- Performance aspects
  - Runtime
  - Memory requirements

Approach

- Not one test
  - Quick check – one "tile" of one image
  - Suite(s) of image pairs
    - 6 image pairs varied terrain (Greenland, Nepal, ..)
    - 10 image pairs from Antarctica
- Automation
  - Reduce testing errors
  - Spend less time launching and monitoring jobs
  - Data management
- Quantify and Visualize differences
  - Statistics and image differences
- Truth data
  - Compare with Lidar data

Image difference SETSM and Lidar reference


Version 4.3.0

Version 4.2.2
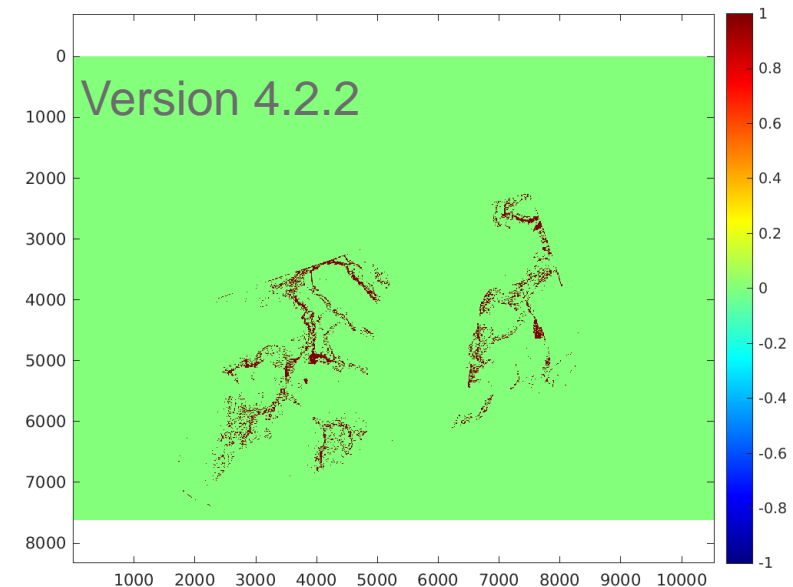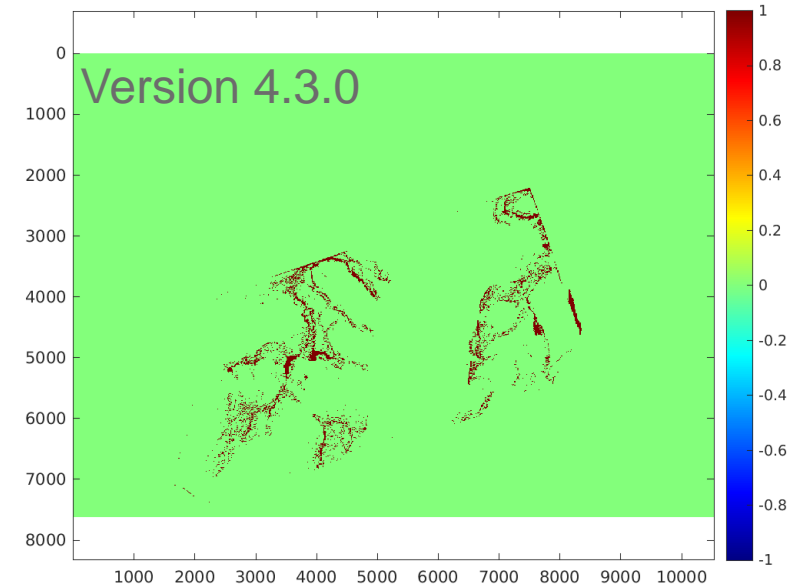
Scripts and Tools

- Stand alone python scripts
  - Submission
    - Unique working directories
    - Template submission scripts
    - Sweeps – e.g. different compilers, test cases, code commits
    - Option to run with performance monitoring tools
  - Analysis of results
    - Post processing (hillshade images, performance statistics, …)
    - Compare 2 DEMs (both from SETSM or SETSM vs LIDAR)
    - Complex script with dependencies on GDAL and Matlab

- Reframe
  - Test framework from CSCS, see: https://github.com/eth-cscs/reframe
  - Python based tool for software testing for HPC systems
  - Use with SETSM has continuous integration approach
    - Integrate with local gitlab instance, compare two branches
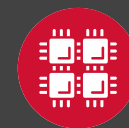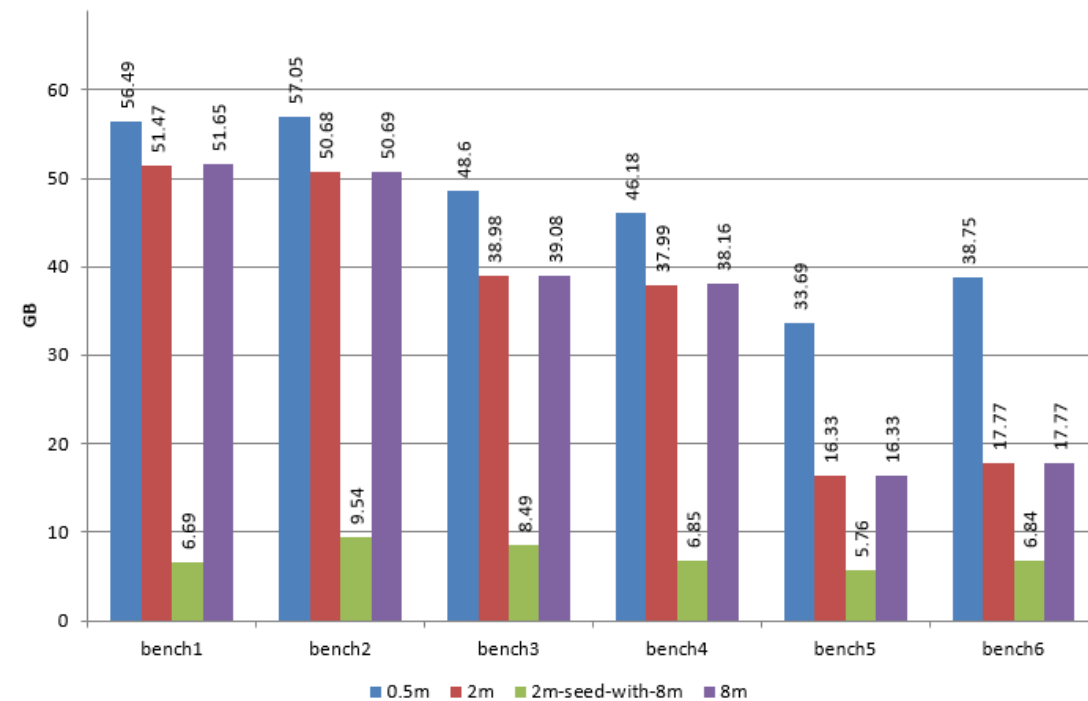   - Shared analysis script with standalone scripts
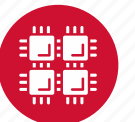
Example Statistics
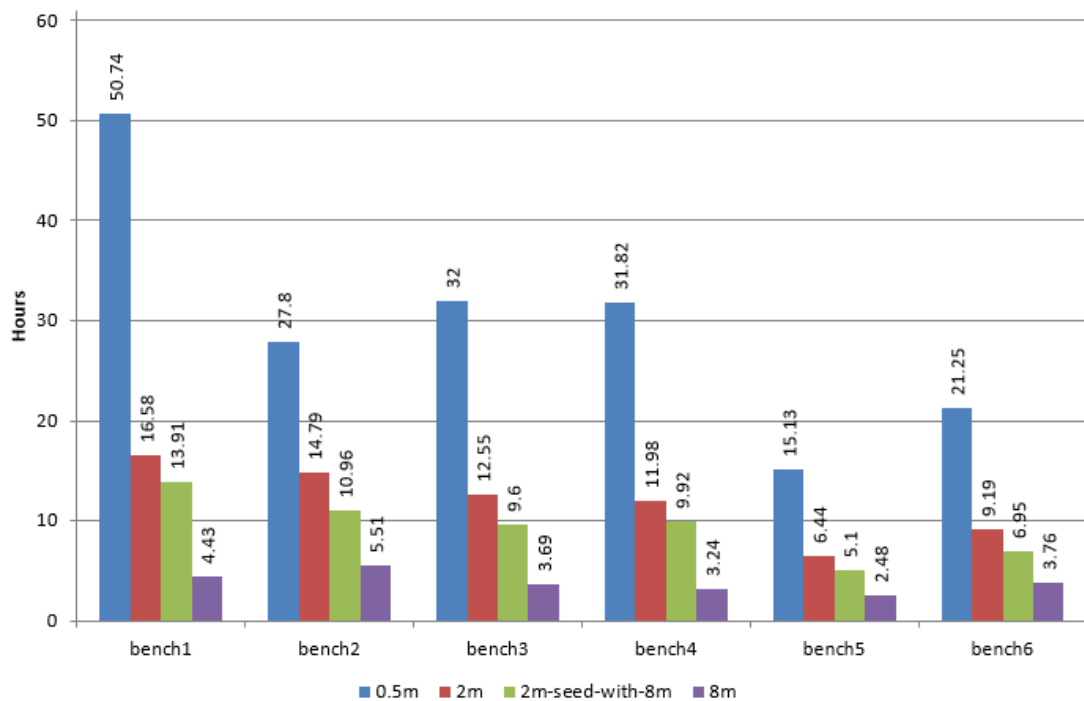
Summary

- Extensive testing has helped increase software stability
- Ongoing development to get closer to a pass fail test
  - E.g. Masking of edges or areas with poor image quality
- Maintenance of test scripts
  - Non-trivial code base for the scripts themselves
  - More than 2000 lines of code