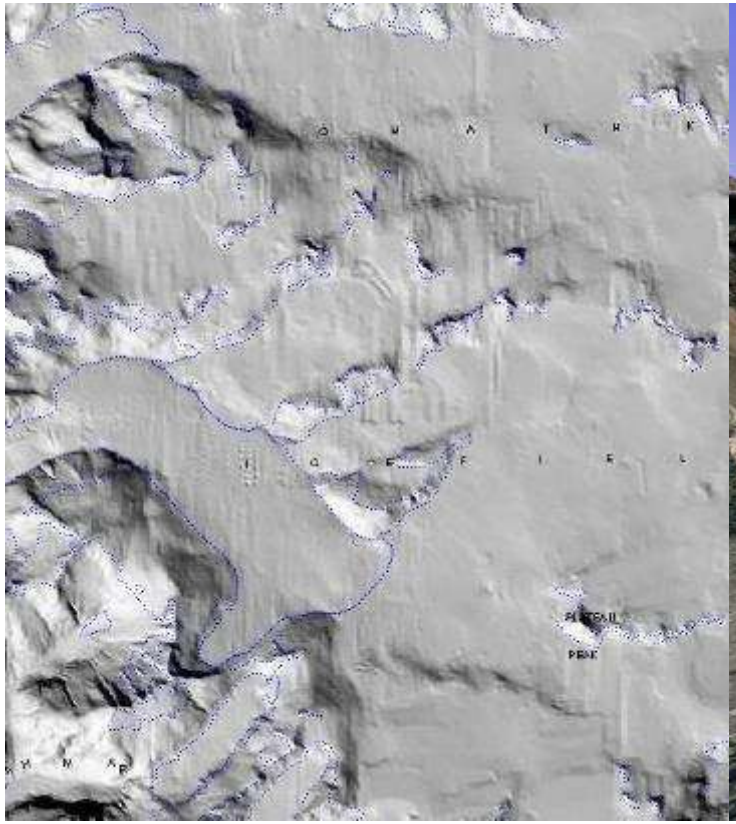
Digital Elevation Models (DEMs)

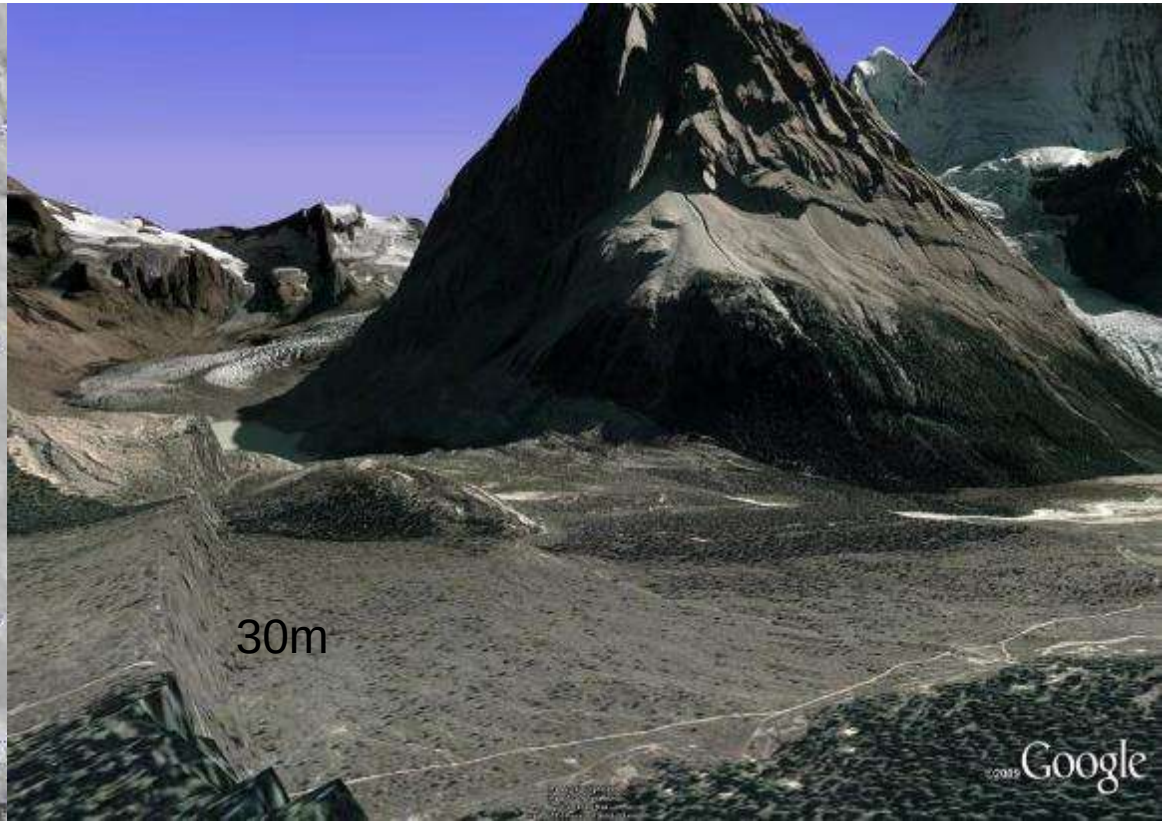
Digital representation of the terrain surface – enable 2.5 / 3D views

Rule #1: they are models, not true reality
Rule #2: they always include some errors

(subject to scale and data collection process)



Homathko Icefield, BC TRIM



Robson Glacier and AB/BC border, Mt. Robson Park

DEM applications in Geomatics

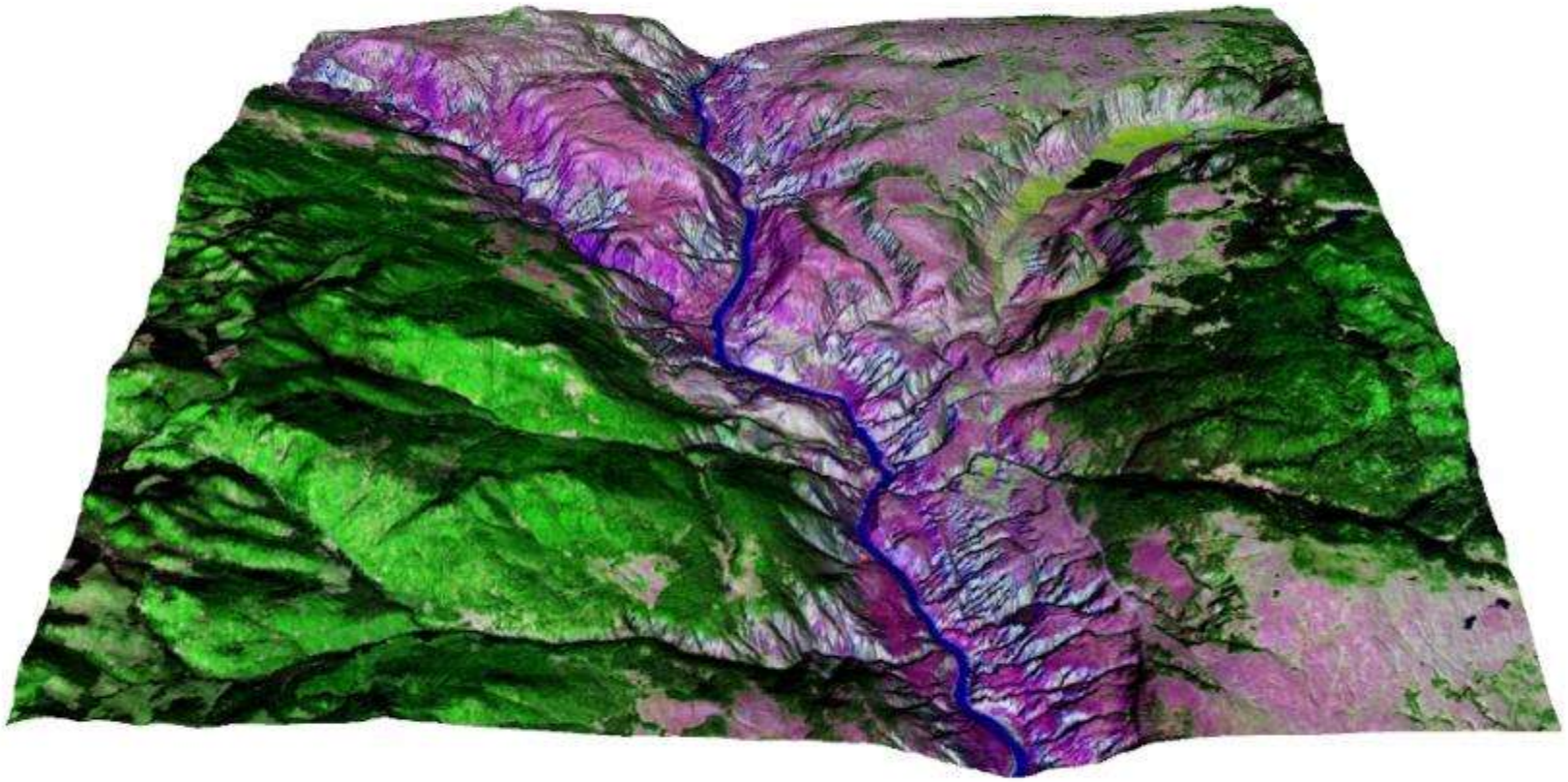
(remote sensing image analysis applications in **bold**)

- Extracting terrain parameters
- Modeling water flow or mass movement
- Creation of relief maps and models
- Terrain analyses in geomorphology

- **Rendering of 3D visualizations**
- **Rectification of aerial / satellite imagery**
- **Image reduction (terrain correction)**
- **Classification layers in mountain areas**

http://www.satimagingcorp.com/svc/dem.html

UNBC example: Chilcotin



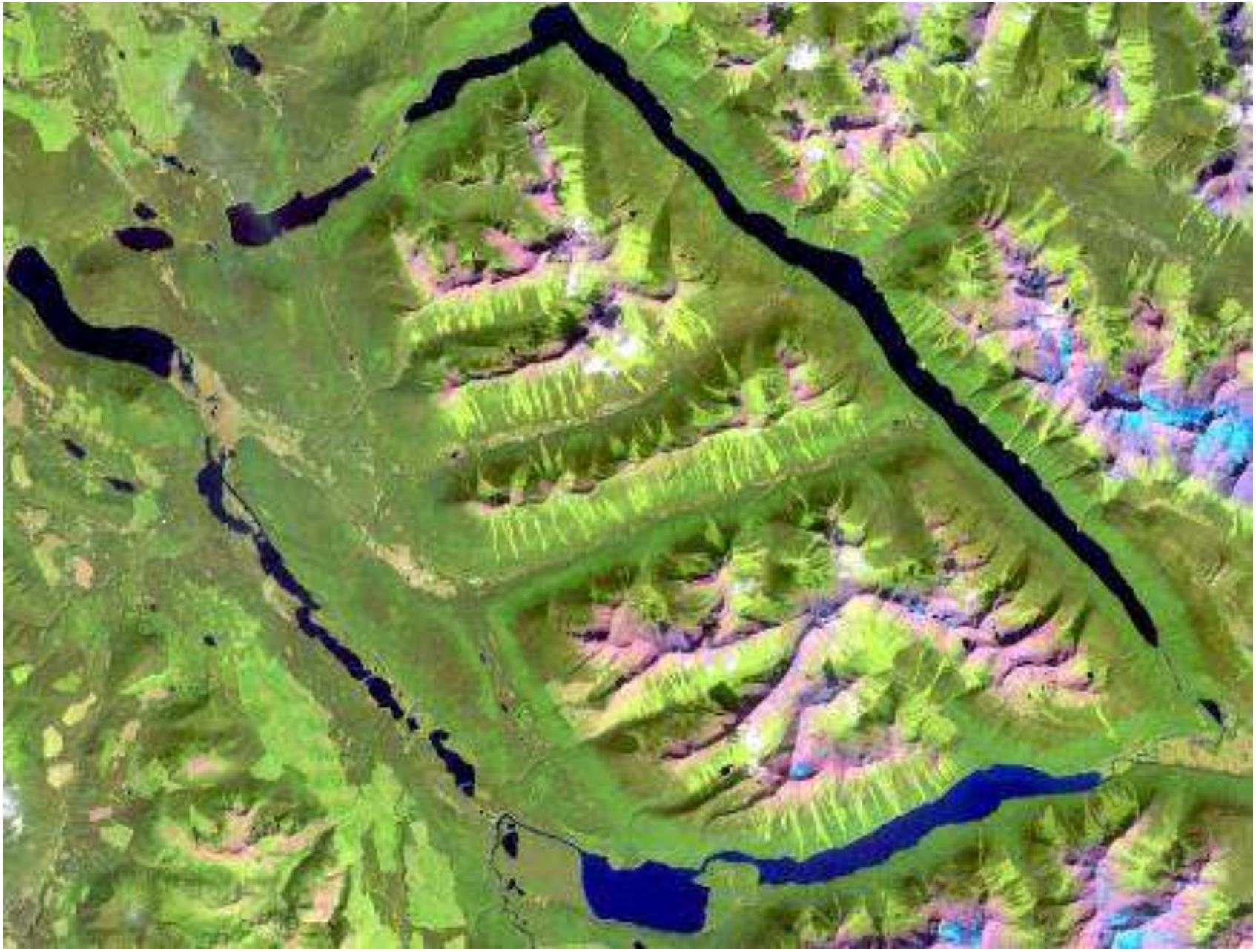
Chignecto, NS

Sentinel 2 / LiDAR

Marcel Morin,

‘Lost Art Cartography’

Classification needs to include topography



Evolution of DEM creation

1960s Digitisation of contours from stereo photos

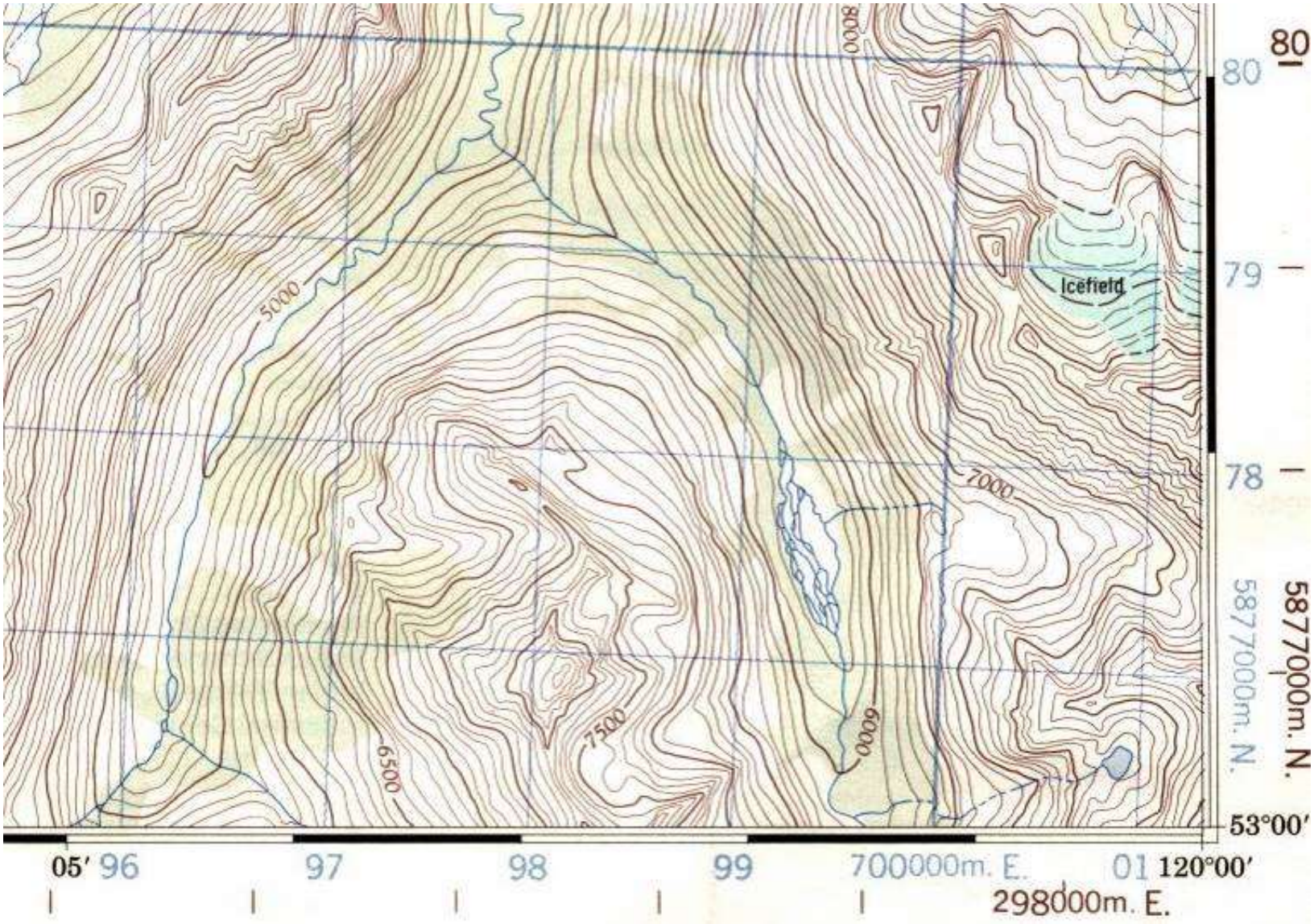
1980s Mass points from stereo photos

1990s Automated generation of mass points

2000s Direct generation of grids from stereo-imagery
e.g. high-res sensors, ASTER, RADAR

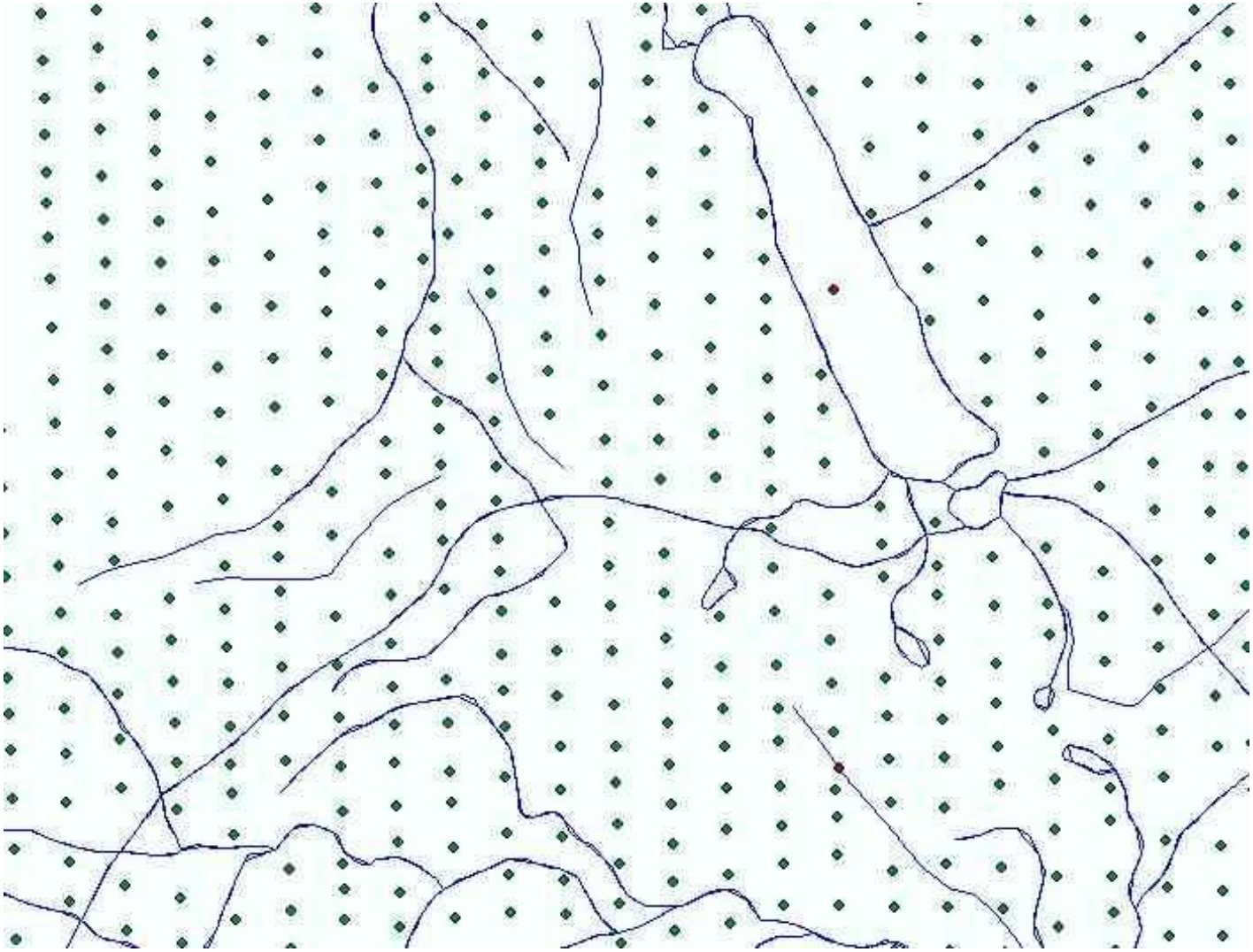
2010s LiDAR / digital photography / UAVs
– cloud of millions of points -> high-res grid

Early DEM generation:
pick regular points or digitise contours



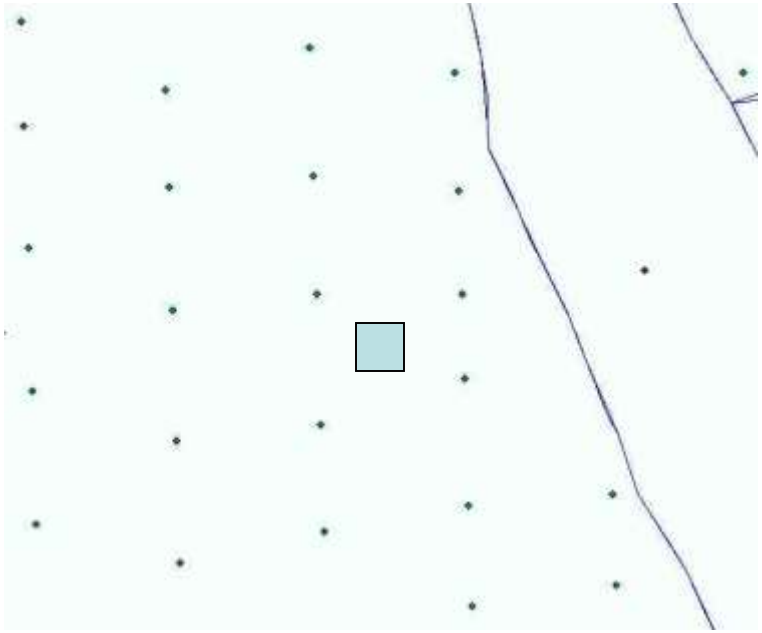
TRIM DEM – masspoints ~70m spacing

captured onscreen from stereo-photography 'soft copy'
(prior to fully automated image matching)



LiDAR / digital photography have multiple points per square metre

DEM creation by interpolation



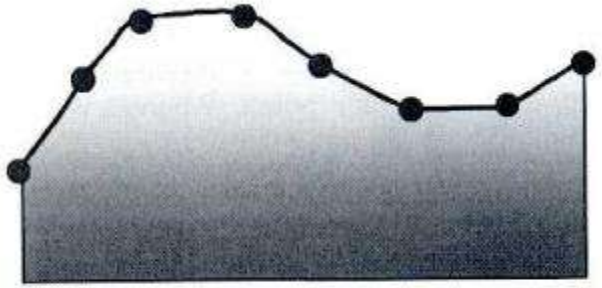


Figure 1.13. Cross section of linear natural neighbors interpolated surface.

- **Inverse distance weighted** - simple
- **Nearest neighbour** – honours raw values
- **Spline** – minimizes curvature -> smooth surface
- **Kriging** – uses spatial correlation of points

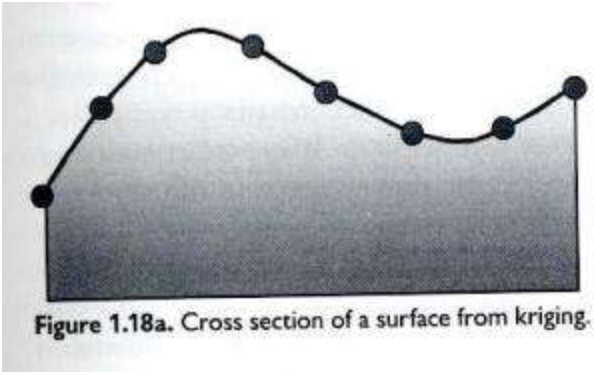


Figure 1.18a. Cross section of a surface from kriging.

DEM data types

A. Discrete elevation data

Contour lines – from maps or digital files

Mass points …. and break lines

These are interpolated into GRIDS (PCI etc..)

B. Continuous DEM data

Raster grids – for remote sensing … ideally ~same pixel size

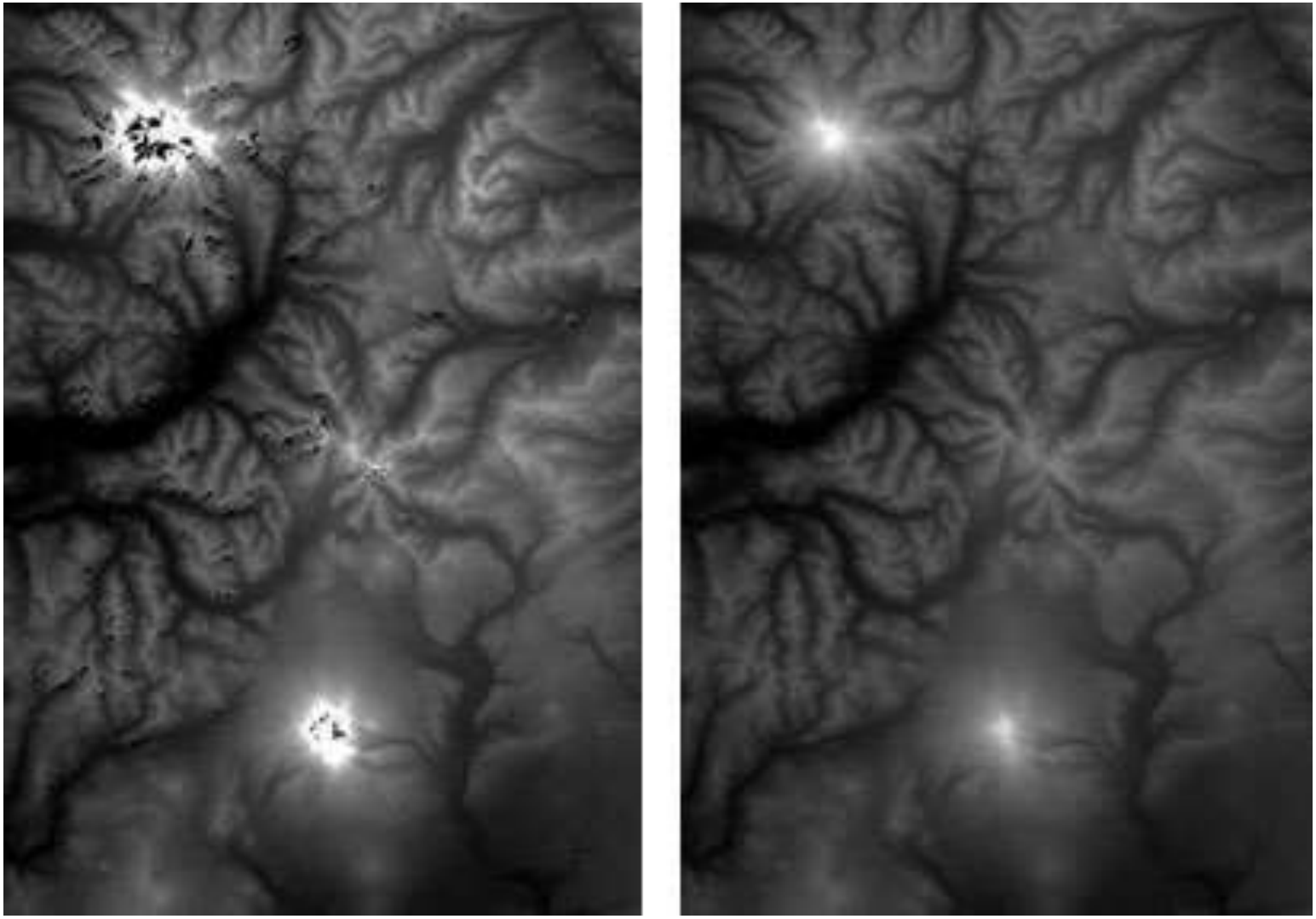
also *Triangulated Irregular Networks (TIN) – not useful in remote sensing*

DEM -DSM sources 2000+

Shuttle Radar Topographic Mission (SRTM) Feb 2000
Data affected by steep slopes, Download by 5° x 5° area

Available for 60°N – 56°S resolution 3 arc seconds (90m)

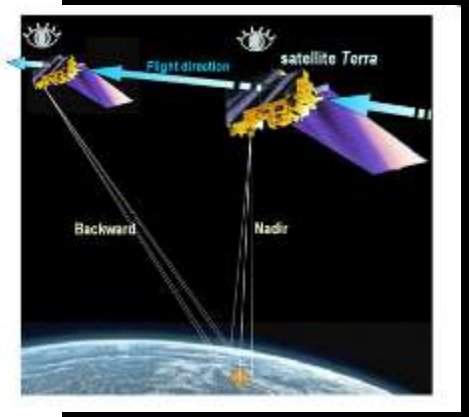
These browse images of Mt. Rainier and Mt. Adams in the Cascade Range show SRTM (left) and Void-Filled data



ASTER Global DEM (GDEM) 2000-08

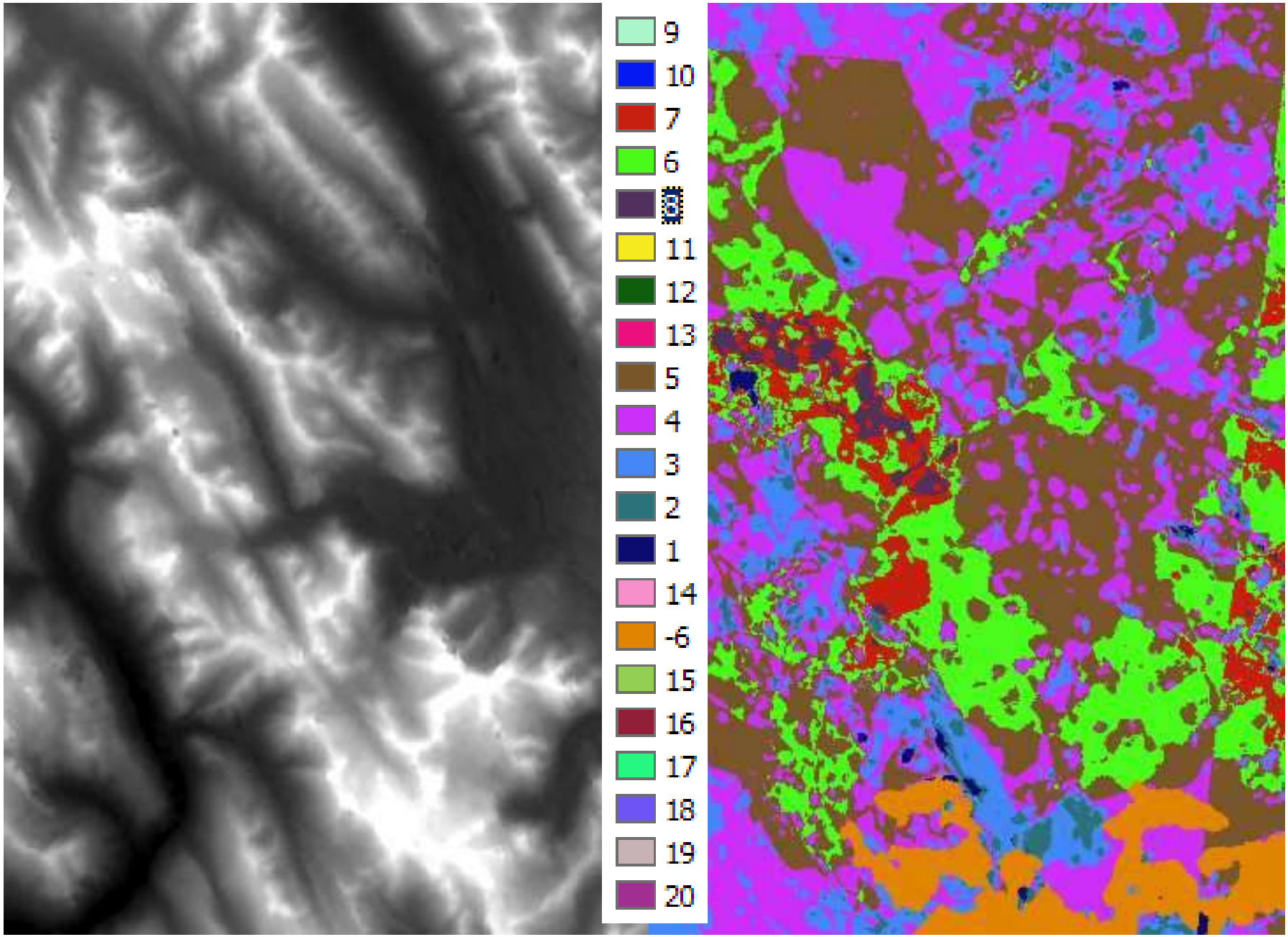
Near IR band, affected by cloud cover

Download by 1° x 1° area pixels: 1 arc second (30m)



http://asterweb.jpl.nasa.gov/gdem.asp

ASTER Global DEM : Kananaskis Park area DEM and #scenes used (2000-08)

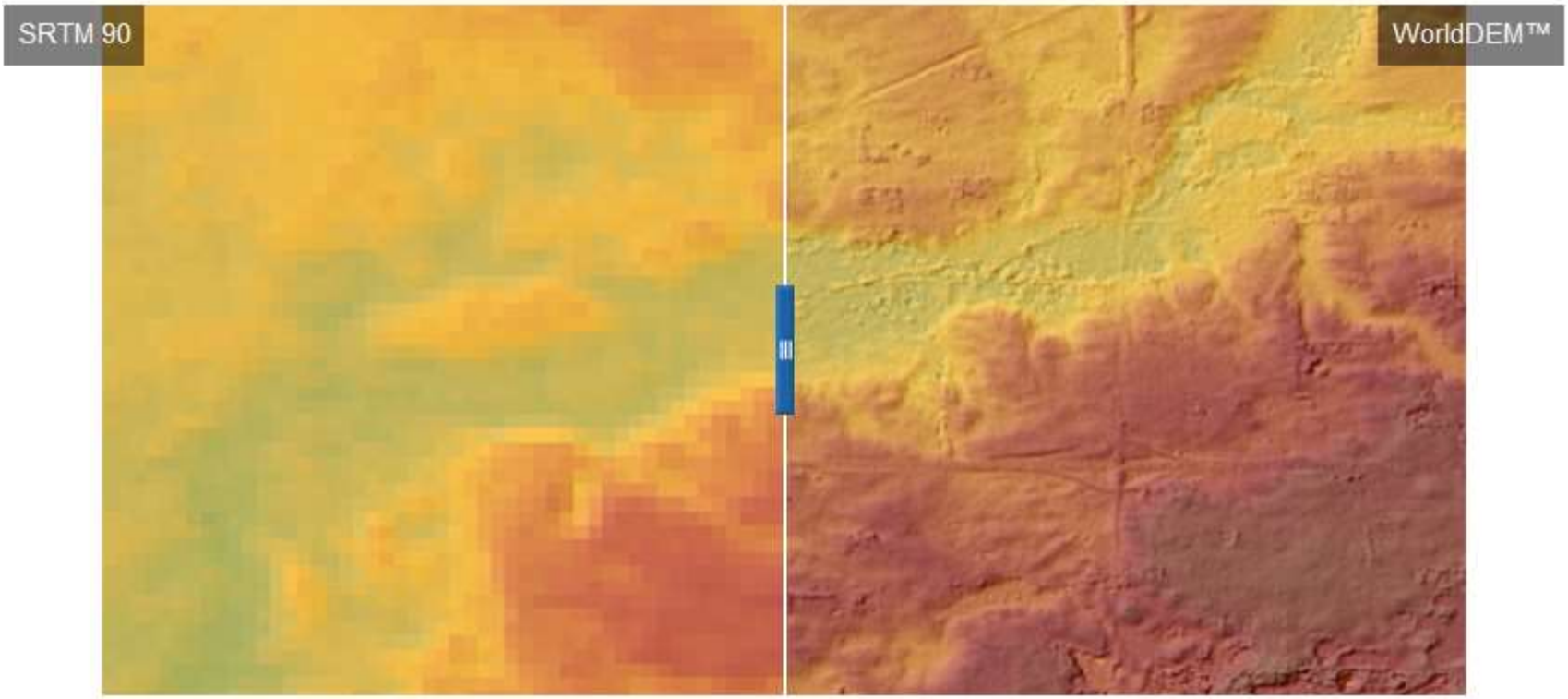


http://www.astrium-geo.com/en/168-tandem-x-global-dem

Accuracy of a New Dimension - Pole-to-Pole

The WorldDEM™ is intended to be the replacement data set for SRTM and will unique feature:

- Vertical accuracy: 2m (relative) / 10m (absolute)
- 12m x 12m raster
- Global homogeneity
- Highly consistent dataset thanks to data collection within 2.5 years only
- High geometric precision of the sensors make ground control information redundant



DEM summary

Resolutions and datasets available for Canada/Global:

NTDB 25m (Federal)

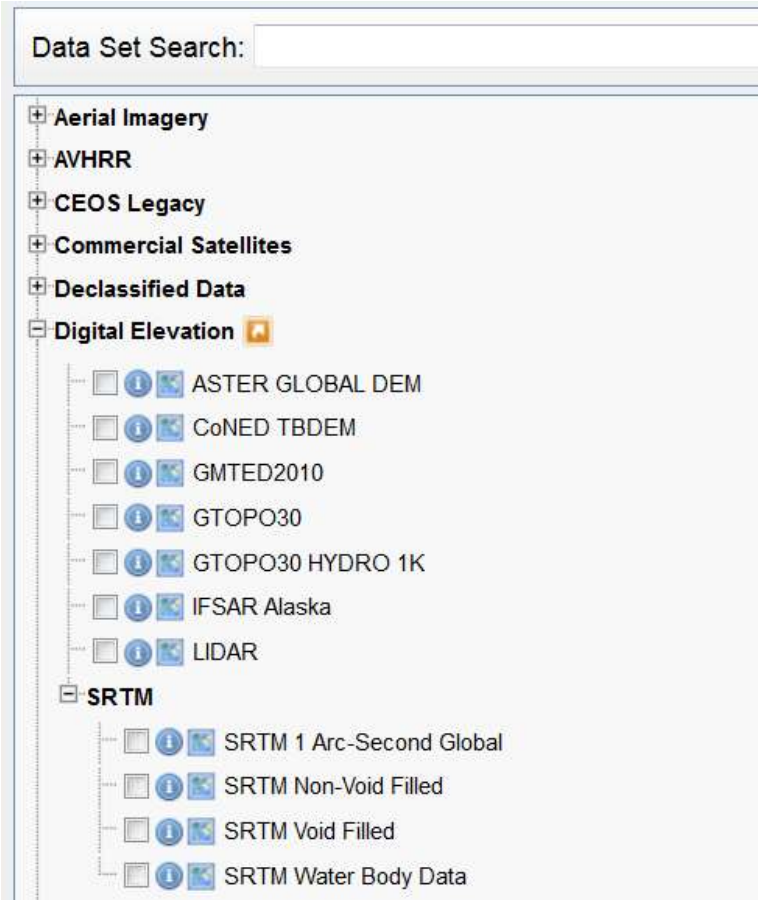
TRIM 25m (BC only)

ASTER 30m (global) GDEM

SRTM 90m (near global)

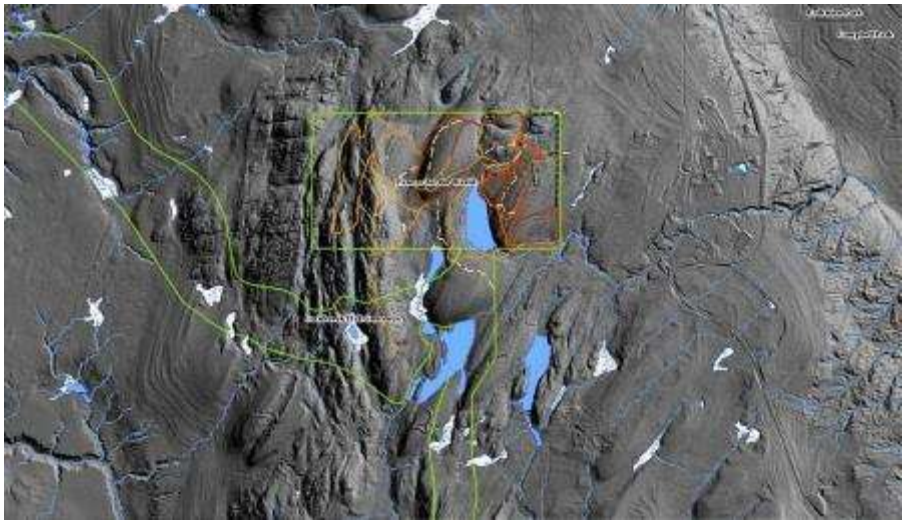
ALOS 30m (global)

TanDEM 12-30-90m (global)

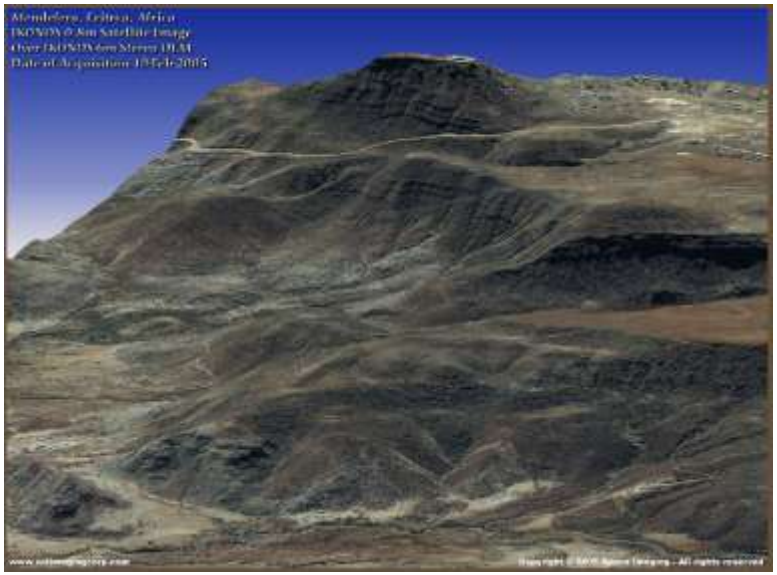


High resolution DEMs – regional (new millennium)

- High resolution stereo satellite imagery
- Digital photogrammetry
- LiDAR



LiDAR PG – UNBC, 1m



Ikonos 5m DEM Eritrea

Digital Photogrammetry:
Tatras, Slovakia 2m

260,741

TOTAL SCENES

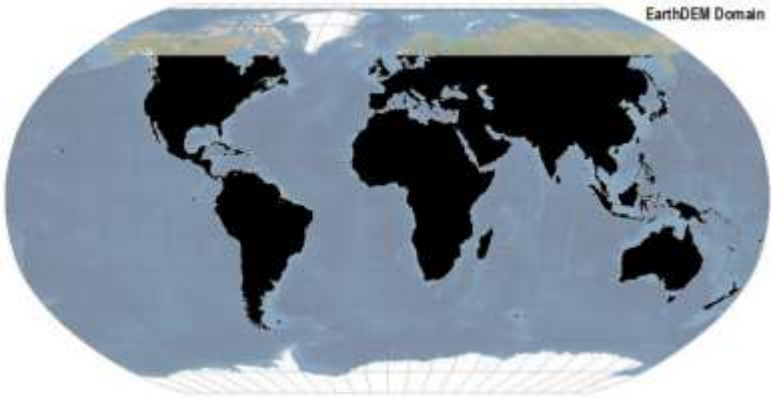
260,741

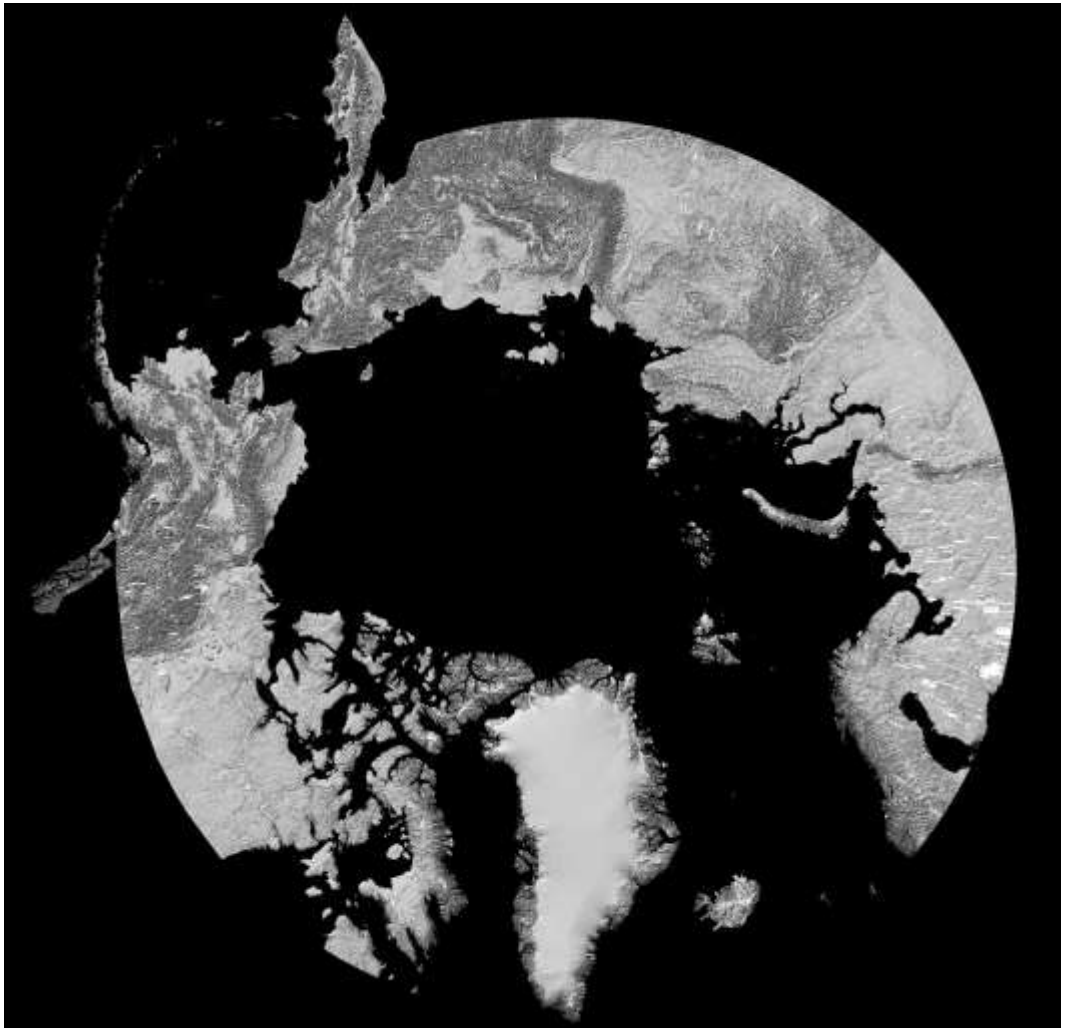
ArcticDEM 2007->

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

The Polar Geospatial Center and collaborating institutions are producing over 20 trillion 2-by-2 meter elevation cells over an area of 20 million square kilometers. (= the area SRTM did not cover north of 60)

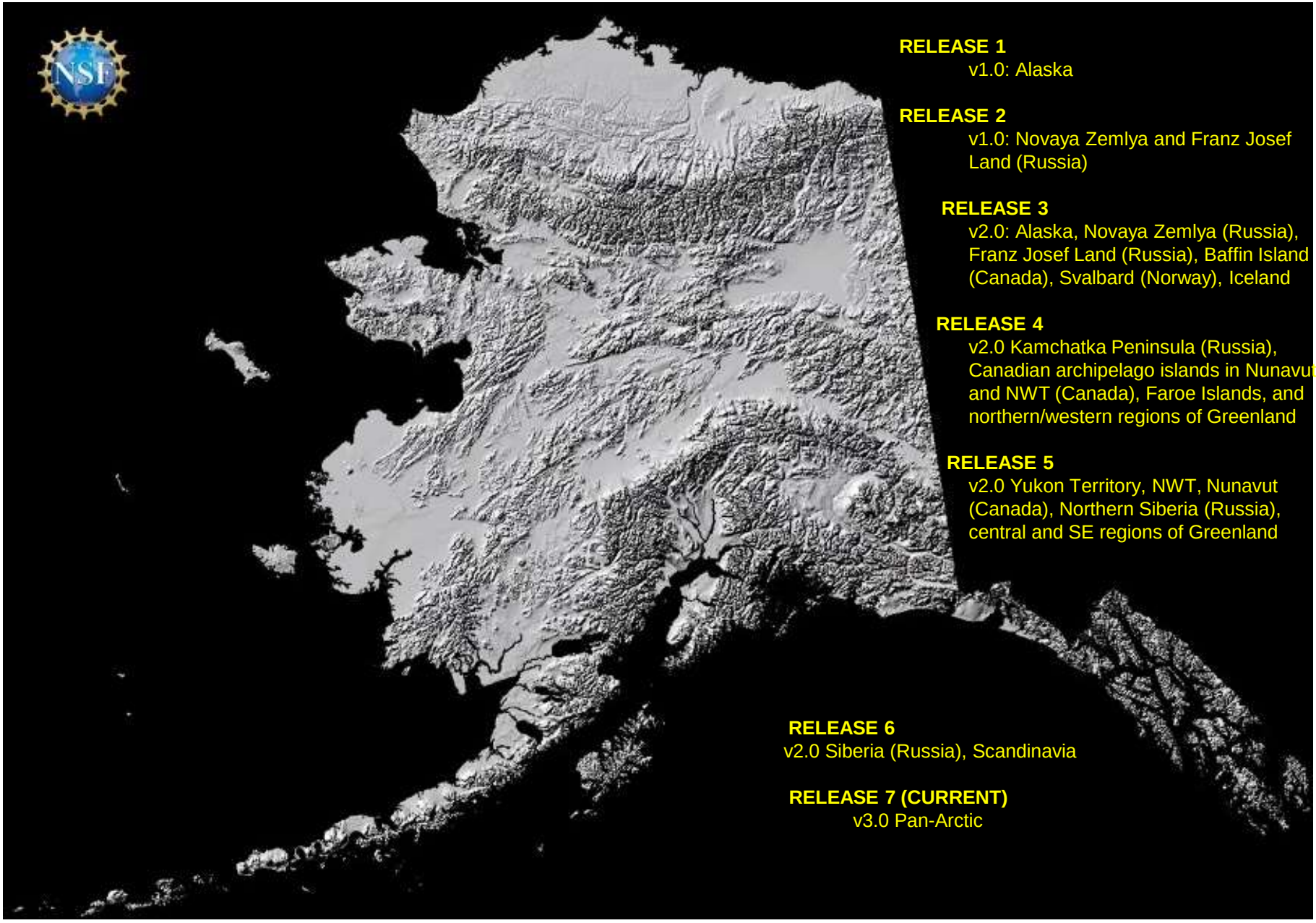
DigitalGlobe's WorldView-1, 2, 3 satellites collect stereoscopic imagery of the Arctic. The computation is performed on a petascale supercomputer.





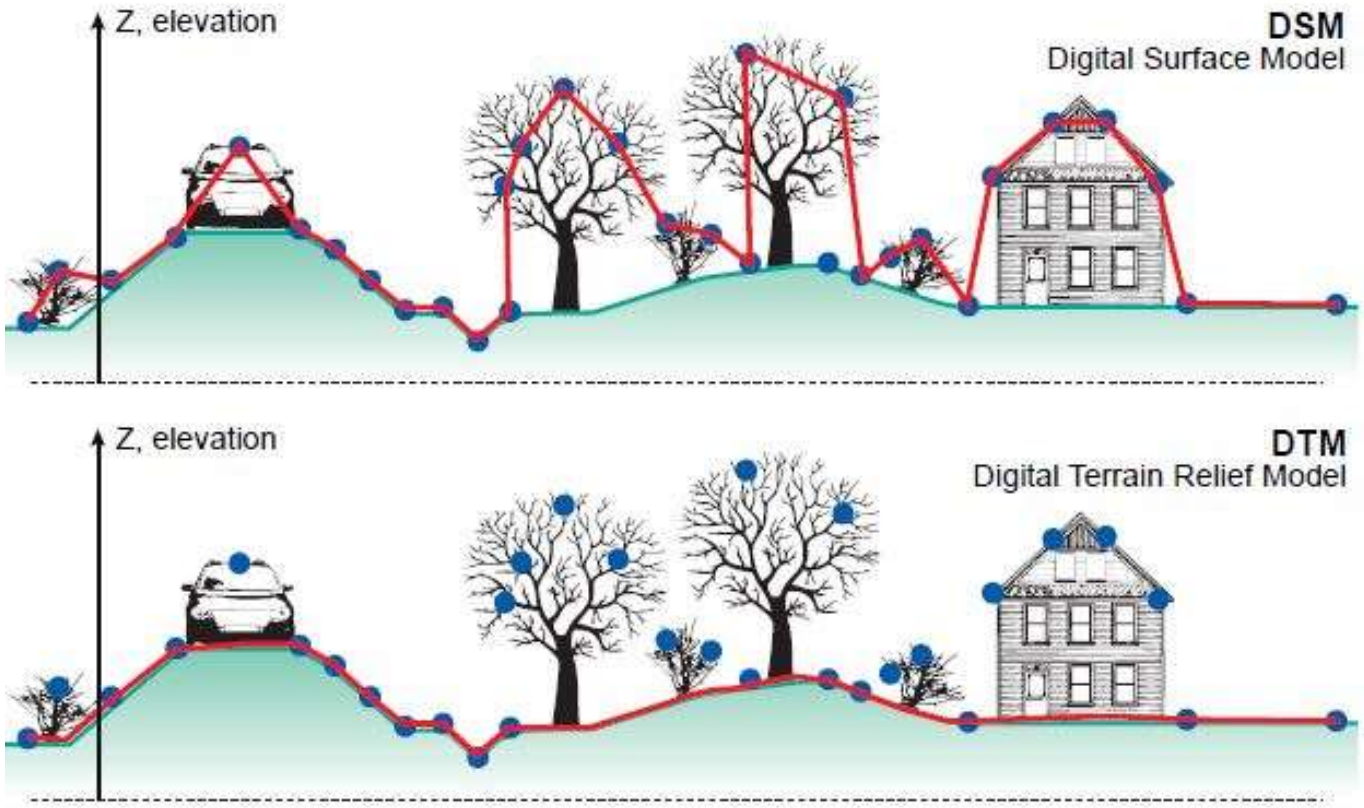
A hillshade rendering of ArcticDEM Release 7, Total scenes: 260, 741

Alaska - ArcticDEM



TDB (Prince George) was awarded the project to provide control surveys, acquire precise aerial photography and create detailed Orthophotos for the entire Canada / USA (BC/Alaska) border corridor. This project was administered by Natural Resources Canada for the International Boundary Commission.

DEM, DTM and DSM



Digital Terrain Models

Photogrammetric

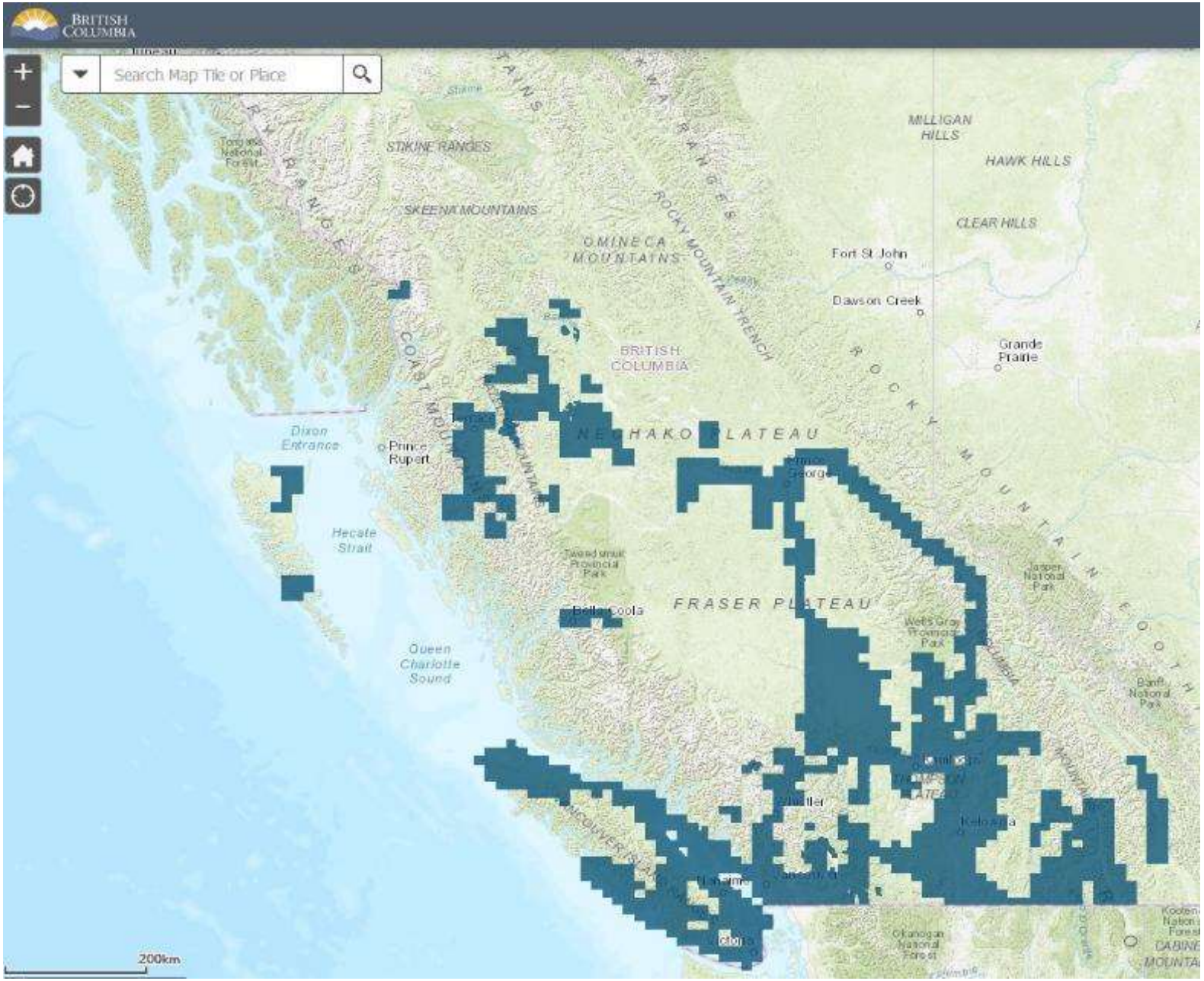
LiDAR - 'Bare Earth'

Digital Surface Models

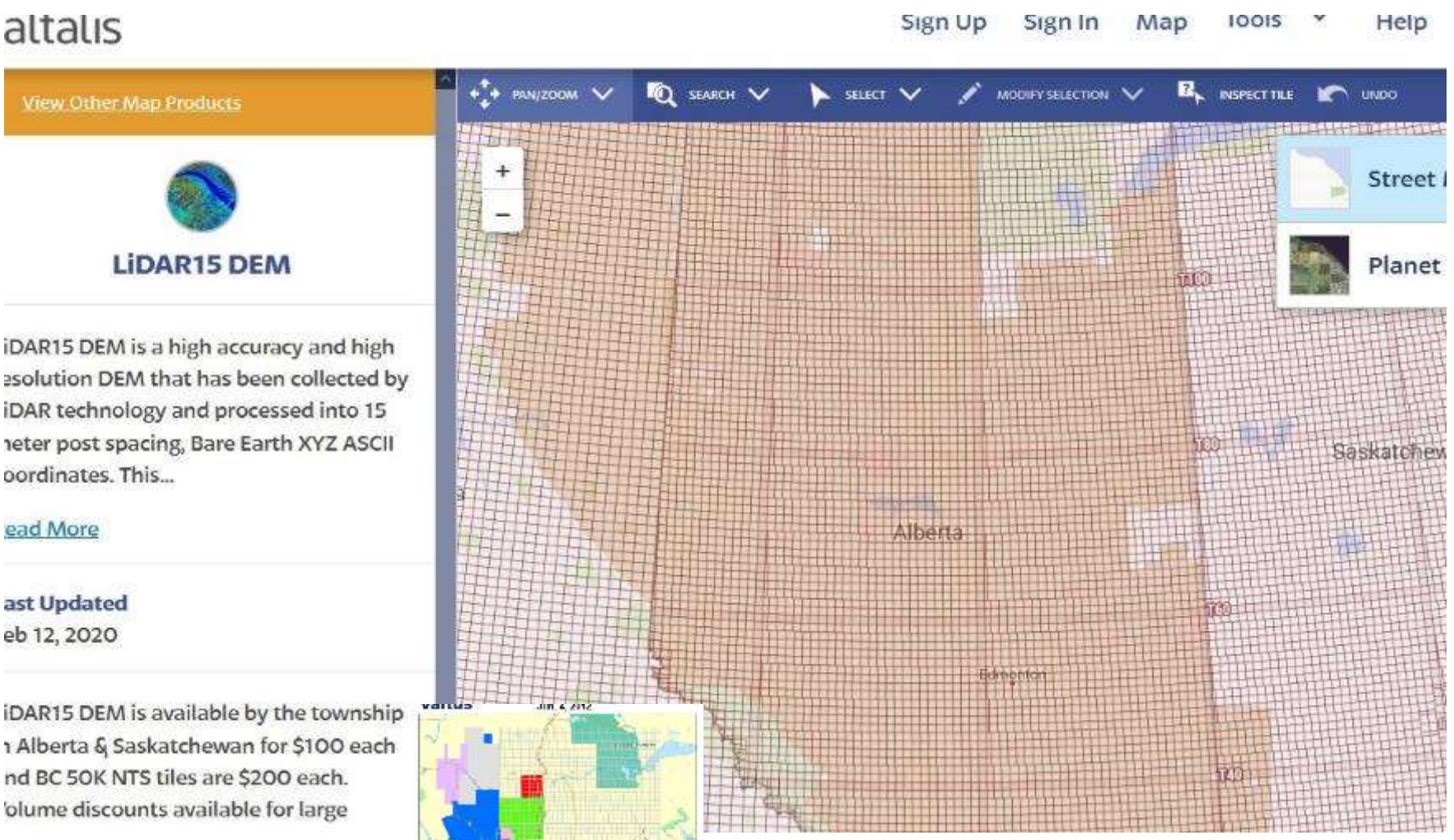
Spaceborne

LiDAR - surface

LidarBC - Open LiDAR Data Portal (2022)



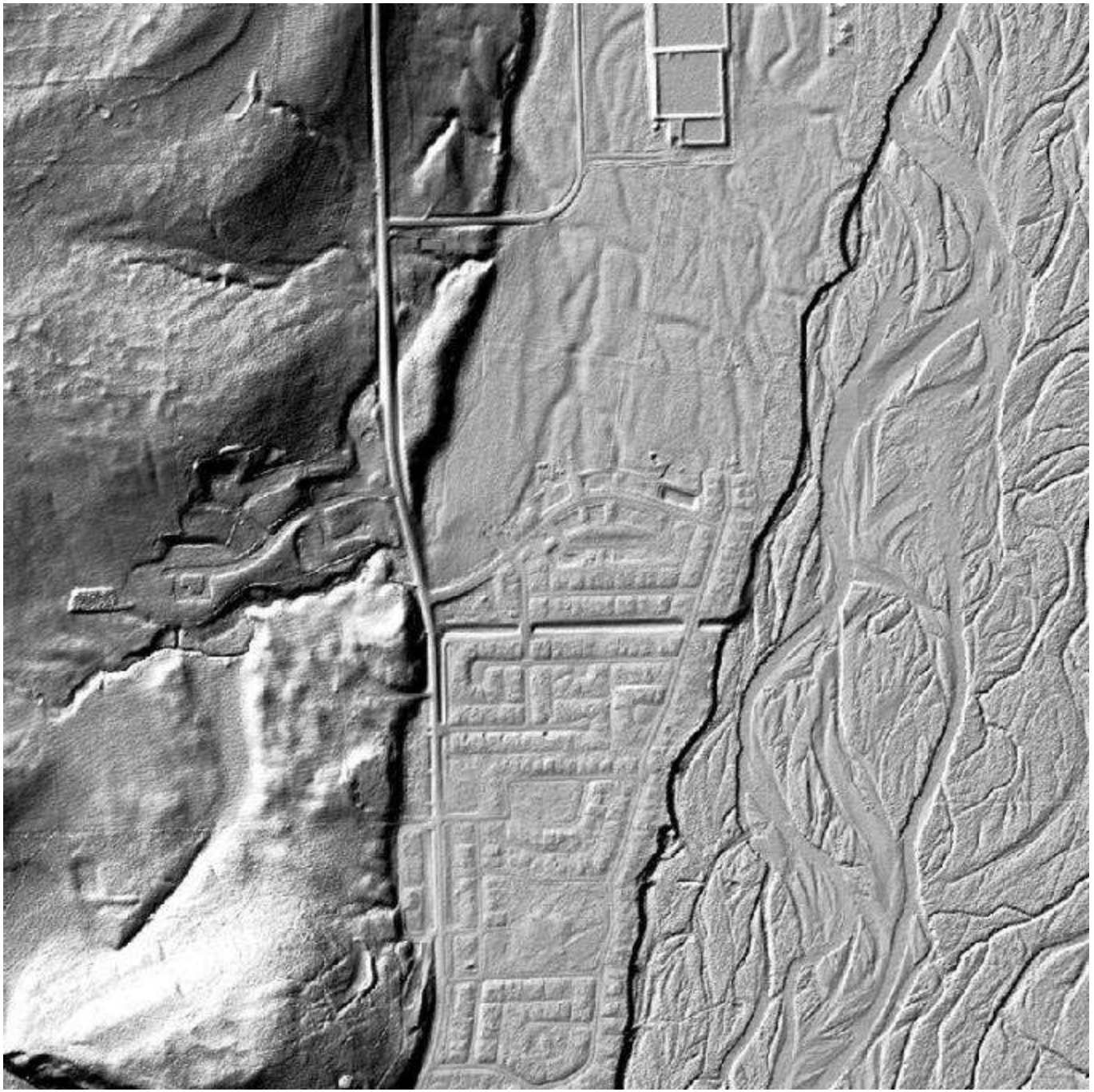
Alberta LiDAR coverage ~ complete 7.5m and 15m except national parks



Alberta
2 x 2km
sample

Bare
Earth
DEM
(BEM)

Not sure
where it is!



Canopy surface model

Summary: DEM data sources

National Topographic maps	1945-95
BC provincial TRIM data	1981-89
SRTM (Shuttle Radar)	2000 (Feb.)
ASTER Global DEM	2000-08
ALOS Global DEM (AW3D30)	2006-11

<u>Additional sources</u>

Historic and glacier maps	1890-1975
Air photos (analogue / digital)	1945-present
LiDAR / high-res photo/imagery	2000-present