

YUKON DEMS: PAST, PRESENT, FUTURE

Presented by:

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1992 – not elevated

- digitizing for CYI Lands Department

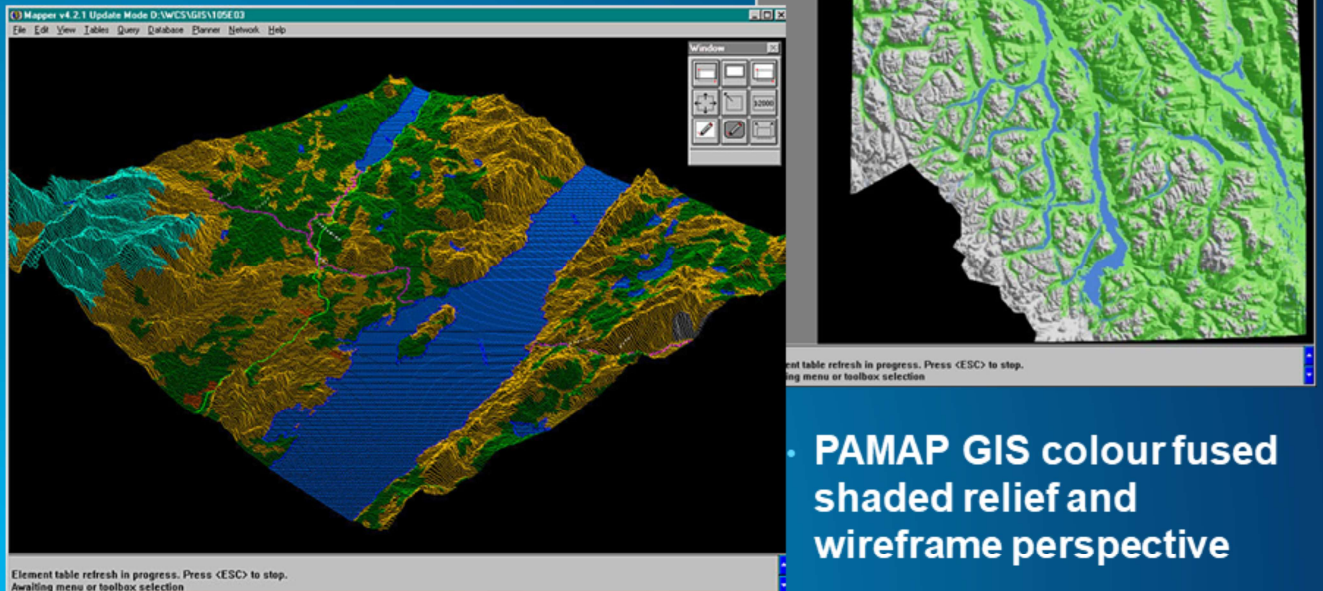


- a.k.a trading digitizing hours for gaming time on office computers



I started in GIS by trading time digitizing maps for gaming on office computers. That's a whole other story though, no time for that now. Let's just say that if you're a business and want your local area network to **really** sing, bring a multi-player game into the mix...

1993 – Getting a Taste – I

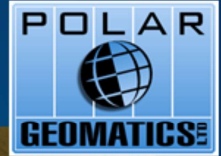


• PAMAP GIS colour fused shaded relief and wireframe perspective

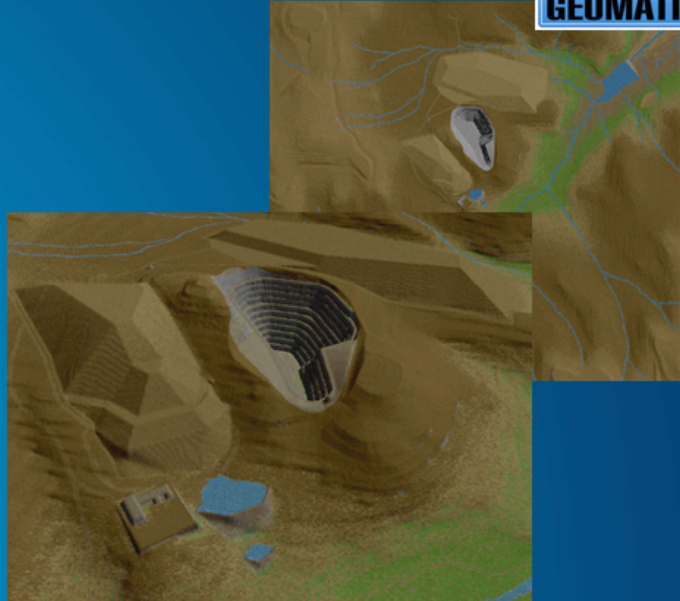
About 1993 I start getting a taste for elevation models. Here is Pamap GIS showing a fused shaded relief at upper right and a wireframe perspective view of Lake Laberge in center. That's Fox Lake at the top.

This was awesome and the height of tech progress. Our biggest view, for Teslin Tlingit Council, took 4 days to run, and had to be done more than once because of power failure.

1995 – Getting a Taste – II



- The prospective Minto Mine
- Step up from wireframe to solid terrain modelling
- PAMAP GIS for DEM
- World Construction Set for rendering



A couple of years later and the CYI Lands department had metamorphosed into a corporation, Polar Geomatics Ltd, I had a growing interest in elevation models and 3D terrain modelling.

Here we see the main pit at the prospective Minto Mine, with the mill sight towards bottom center. Pat Johnson made it look good and Franklin Baptiste did much of the heavy lifting.

2014 digression – From Plan to As-built



Here we have the actual Minto Mine after about 7 years of operation. There's a fair amount of drift from the '90s plans, but that probably accords quite well with human's normal predictive ability. 😊

- **One of the things a terrain modeller is always in need of is bigger and yet bigger elevation models...**

Back to the program. One of the things a terrain modeller is always in need of is bigger, and yet bigger elevation models...

Mid 1990s

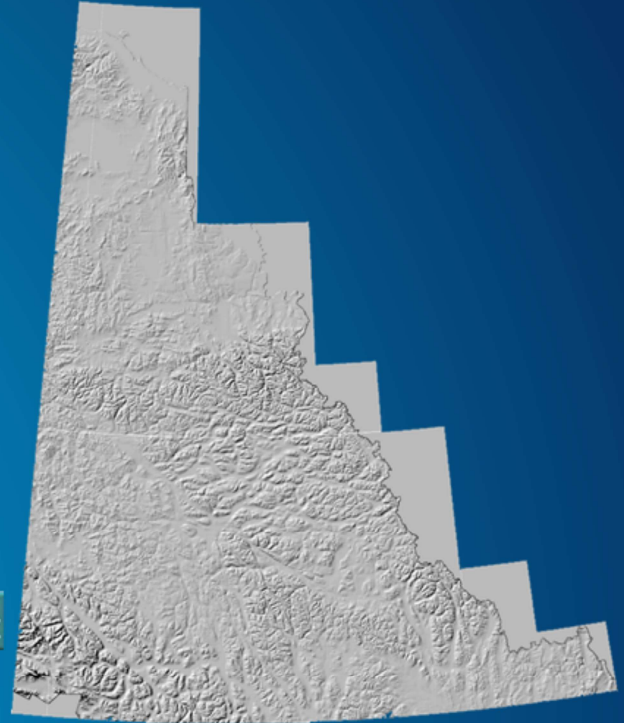
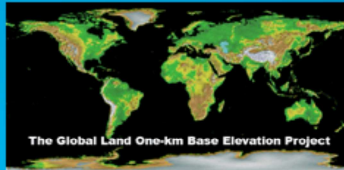
- Global 30 arc second model from NASA/USGS
- 1km pixel
- crude



...and in the mid 1990s this meant the global 30 arc second model from NASA/USGS, a precursor to GTOPO30, which was 1km pixels and very crude at the territorial level.

1997 – YT 180m DEM

- From 1:250,000 contours
- Pamap GIS
- Free
- Used by local scientists, NASA GLOBE project, and flight sim hobbyists

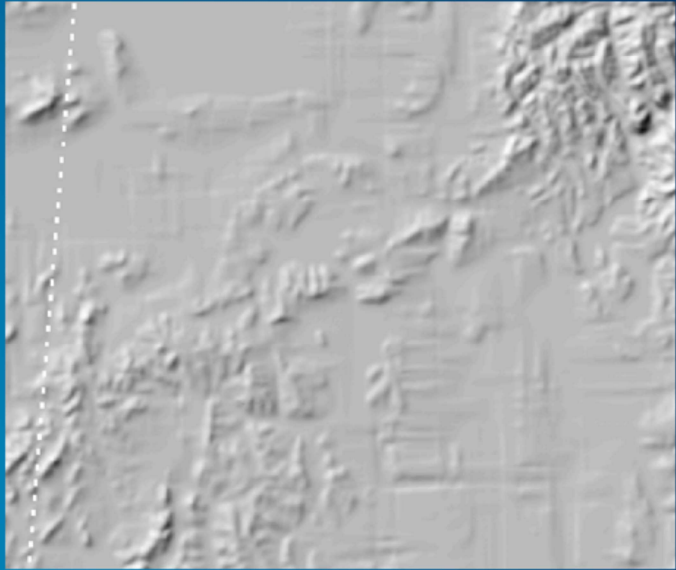


Now we come to 1997 and the first regional elevation model for the territory. I built this in Pamap GIS from 1:250,000 National Topographic Database (NTDB) contours and spot elevations.

It is used by some local scientists researching wind turbines as power generating source in Kluane area, fed to the NASA GLOBE project, and a picked up by a few flight simulator aficionados.

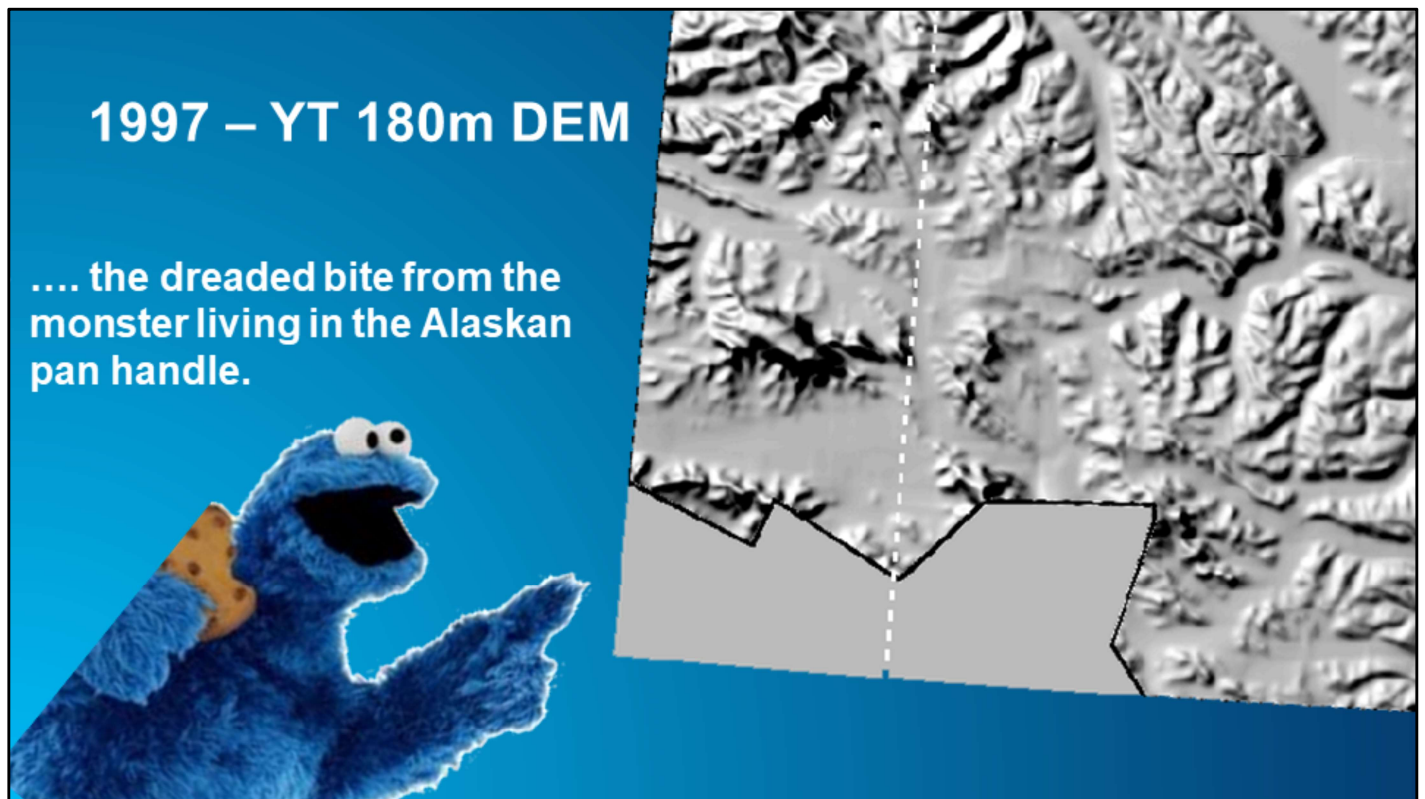
1997 – YT 180m DEM

- Seam lines
- Grid artifacts in the flats



It was a big achievement for me at the time, but had significant warts. Several very visible seam lines and grid artifacts in large flat areas, especially in the far north. We're looking at the Eagle Plains area here.

The biggest annoyance was...



.... the dreaded bite mark from the monster living in the Alaskan pan handle.

BTW, **web.archive.org is awesome**. It let me resurrect my old web page where I published the DEM after leaving Polar Geomatics INCLUDING replacing some corrupt tiles. Check it out:

http://web.archive.org/web/20000817045810/http://polarcom.com/~patawi/GIS/index_gis.html

1998



DEPARTMENT OF RENEWABLE RESOURCES GEOGRAPHIC INFORMATION SYSTEM

- Exit PAMAP and enter ArcView 3, ArcInfo Workstation, and GRID

```

Arc: describe fishnet
Description of SINGLE precision coverage fishnet

FEATURE CLASSES
Feature Class      Subclass      Number of      Attribute      Spatial
                   Features      data (bytes)   Index?         Topology?
-----
ARCS                20196         34
POLYGONS            10001         16
NODES               10197
                   Yes

SECONDARY FEATURES
Tics                4
Arc Segments        20200

TOLERANCES
Fuzzy =             310.000 U     Dangle =       0.000 U

COVERAGE BOUNDARY
Continue?
Xmin =              -3420000.000   Xmax =          -320000.000
Ymin =              -783400.000   Ymax =          2316600.000

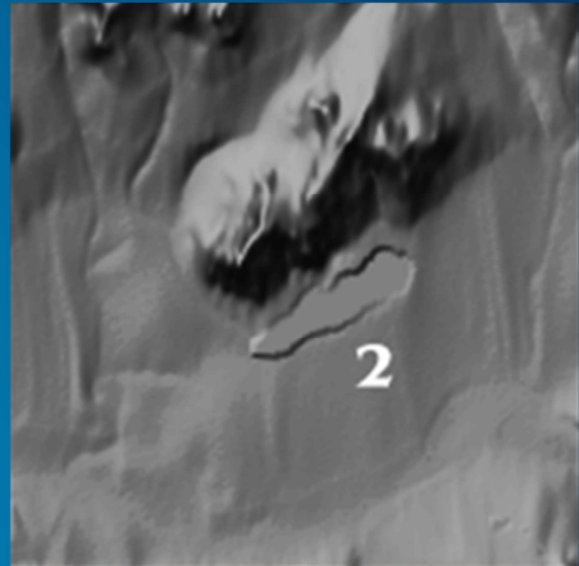
STATUS
The coverage has not been Edited since the last BUILD or CLEAN.

NO COORDINATE SYSTEM DEFINED
  
```

In 1998 I joined Yukon Government's Renewable Resources department and embarked on a crash course in command line weenie-ness. A few months of swimming through daily swirling confusion and chaos, and then I'm right at home.

1999 – Challenges with NRCAN's CDED

- Price, several tens of thousands
- Striations from generating in unprojected geographic coordinates
- “ice panning” from flattening lakes post-process instead of inline



This is the time period when NRCAN - Natural Resources Canada - charged for base data *by the vertex*, something around 1 penny for each node in a line. About \$400 for a tile and >\$200k for the territory. We were also supposed to pay royalties on every printed map we distributed containing the base data, and to pay \$15k/yr for distributors rights to do so.

Naturally they were going to charge accordingly for the newly introduced nationwide DEM (built from 205k base). As I recall the entire Yukon was several tens of thousands. Affordable for a government, but there would be a fair amount of wheedling and proposal writing and persuading and so on to get it through the channels.

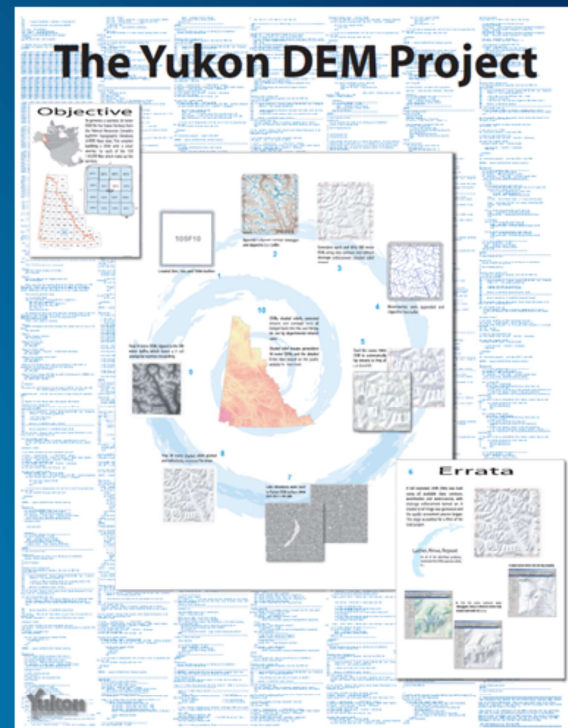
Plus, on the technical level it had problems we weren't ready to accept. I won't go into them all, that's a talk on it's own, but the two main ones are:

- a) the feds had generated the models in unprojected geographic coordinate space, so features were elongated east-west, which results in north-south striations when used in projected space like UTM or Albers,
- b) and lakes were flattened *after* the fact rather than during model generation.

Ref: CDED-RRGIS_DEMs_Compared.doc

1999 – the Yukon 90m DEM

- Completed in 4 months. NRCAN projected a year (and were going to charge \$\$\$)
- Generated at 30m, released at 90m due to up-stream license restrictions



We thought *"by {diety}! we can do better than that!"*
So we did.

The result was the first "Yukon 30m DEM", but ...the license agreement with the source 1:50,000 NTDB asserted that because contours matching source could be regenerated from the DEMs with high fidelity, therefore the 30m DEM was a copy and not a derivative work.

So, we resampled and distributed it as the "Yukon 90m DEM" instead, for free.

See all that pretty blue text in the background? ...

1999 – a detail

- In lovely
easy to
type say
AML, for
five
thousand
lines,
plus
commentary
and
helpers

```
&RETURN
/*-----
/* other routines go here
&routine uhoh
    &run beep; &run beep; &run beep
    &set msg = '*** UhOh! An error has occurred. Do we continue? (y,N) '
    &if [locase[response %msg% n]] = y &then &return
&return &error *** Exiting %aml$file% by user request after an error ***

&routine bail
    &run beep; &run beep; &run beep; &run beep; &run beep; &run beep
    &if not [variable str] &then &s str Bailing out of %aml$file%...
    &return; &return &error %str%
/*=====
/* End Of WHOLE-HOG.aml
/*=====
```

That's the code that built the DEMs. In lovely easy to type say AML, for five thousand lines, plus commentary and helpers.

All you newbies should kiss the ground and hoo-rah the sun everyday for Guido Van Rossum and Python and the nameless entity(ies) at Esri who brought them in. You seriously don't know how good you have it.

(...and the veteran fortran and cobol users probably said the same thing about AML when it arrived!)

2001 – Yukon 30m DEM public release

- New NRCAN licensing model, framework data is now libre and gratis: free to acquire, modify, and redistribute
- RRGIS liberates YT 30m DEM and distributes publicly



In a couple of years NRCAN changed their policy. Now free from up stream restrictions, the "Yukon 30m DEM" became generally available as well.

2003/4 – YT 30m DEM v2, a.k.a. YT CDED

- **NRCAN ortho-corrected the 1:50,000 base to match satellite imagery (eventually became CanVec)**
- **Built by RRGIS using the RRGIS method for flattening lakes and other improvements**
- **Released to world in 2004 via Geobase.ca**

By 2003 we eventually persuaded NRCAN that our method really was better, though it took a trip to Sherbrook, Quebec and Ottawa, Ontario before acquiescence completely landed. Because of our experience with previous Yukon models, NRCAN agreed to outsource the Yukon CDED to us, rather than their stable of qualified contractors.

NRCAN had created the next generation 50k base by ortho-rectifying the old stuff to match Landsat 7 imagery, and in cooperation with NRCAN we built a new model using the not-yet released planimetrically corrected base. This was known internally as "Yukon 30m DEM v2" and when completed made available to general public in 2004 through Geobase.ca as CDED - Canadian Digital Elevation Dataset (yt portion).

...different versions, different uses

- NTDB vectors → YT DEM 30m v1
- CanVec, GPS, or Imagery → YT DEM 30m v2 // CDED
- Most Yukon Government features are still based on NTDB

A small side trip on the v1 and v2 30m models, worth a 30+ minute presentation on it's own, so just as snapshot.

For shaded relief backdrops, it largely doesn't matter. Pay attention to where watercourses vectors follow (or not) and you'll be fine.

NTDB is largely from late 1990s, for both 50k and 250k. Use v1.

For combining with data collected newer than circa 2000 use v2 or CDED. This includes things from instruments and sensors, such as GPS and satellite imagery.

Government users: CSW_BASE.ORTHO layer is the same as Canvec.
Anything else is NTDB -- for base features. Surveyed data etc. are different.
Talk to Geomatics Yukon for further clarification.

The spring 2016 Canvec release includes 250k moved to match 50k. It is not yet ingested into any YG holdings outside of testing (and there's another presentation or two in *that!*).

2004 – 2014, idling along

- The existing models are good enough for most purposes, no new territory wide elevation endeavours
- “Postage stamp” collection here and there with LiDAR shows the 1970s contour data is actually very good (in areas we checked). Near 100% agreement vertically.

For the next decade not much happened territory wide elevation wise. Lidar arrived in small postage stamps here and there. From a regional perspective one of the great things we learned from the lidar is that the old contour data from the 1970s is actually really good, with near 100% agreement vertically between it and Lidar (in the few areas we checked, mostly in Dawson area).

Speaking of LiDAR

- Just too cool not to share: LiDAR in the browser
- Example here using <http://plas.io/>
- Government of Yukon's Lidar holdings are public, contact Geomatics Yukon to acquire



[Lidar in the browser](#) is very very cool. Here's downtown Whitehorse from a 342mb file, rendered entirely client side, no server side processing.

Government of Yukon's Lidar holdings are public, contact me or Geomatics Yukon.

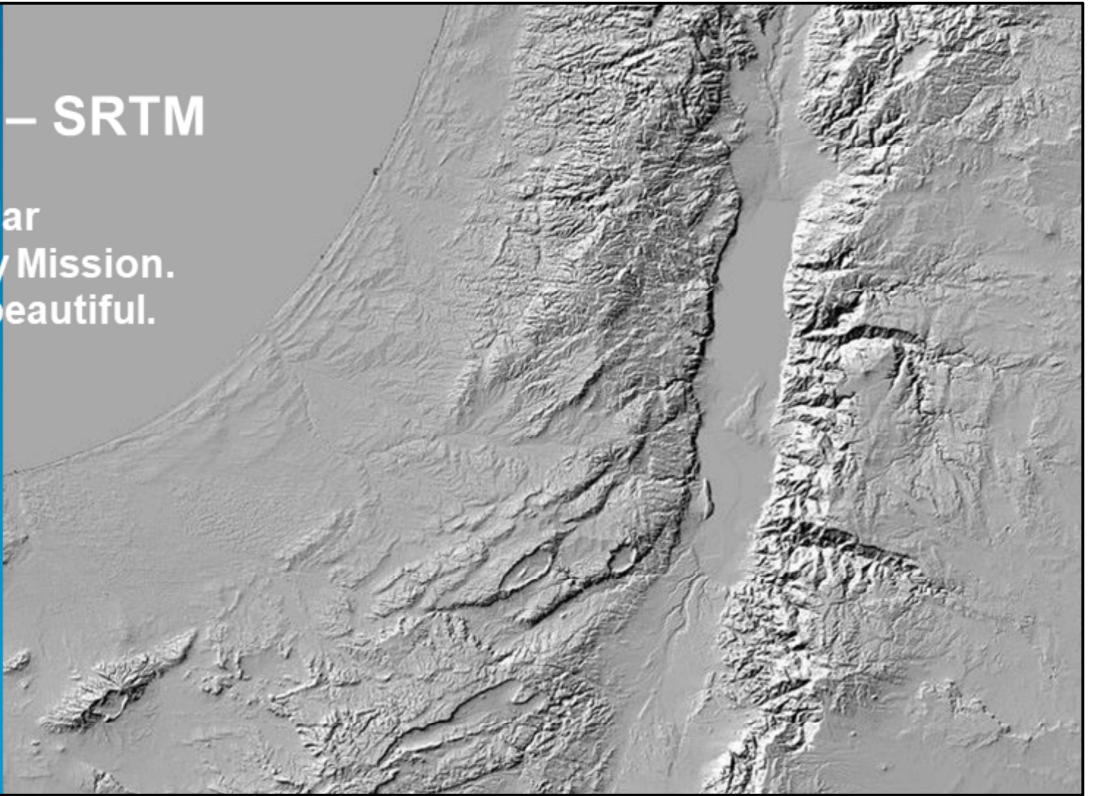
Here's a url, but it's going to change soon:

<ftp://ftp.geomaticsyukon.ca/DEMs/LiDAR/>

Lidar in browser: <http://plas.io/>

Also Ran – SRTM

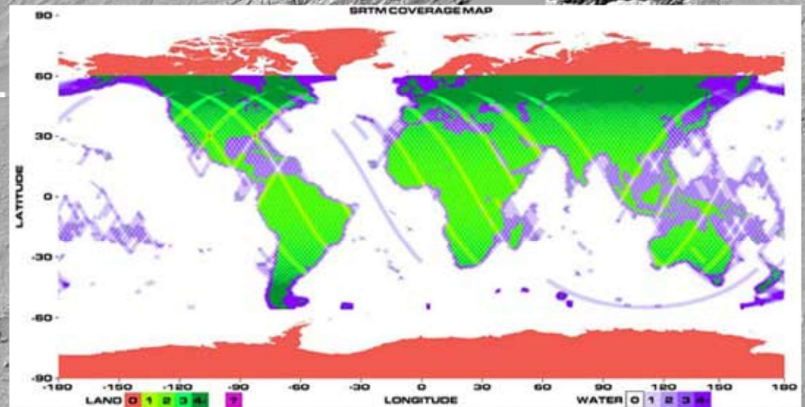
- Shuttle Radar Topography Mission.
30m cells, beautiful.



In the *Also Ran* department, we have the Shuttle Radar Topography Mission.
30m cells, beautiful

Also Ran – SRTM

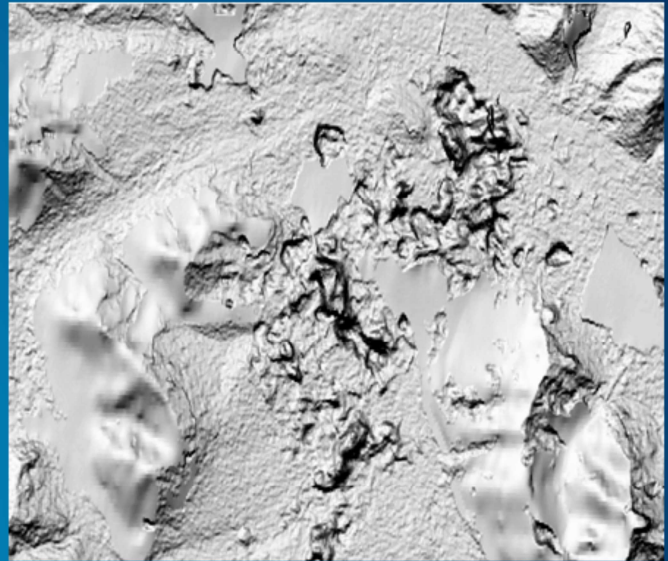
- Shuttle Radar Topography Mission. 30m cells, beautiful.
- ...and stops at 60 degrees north and south. Hmph!



...and it stops at 60 degrees north and south. Hmph.

Also Ran – Aster GDEM v2

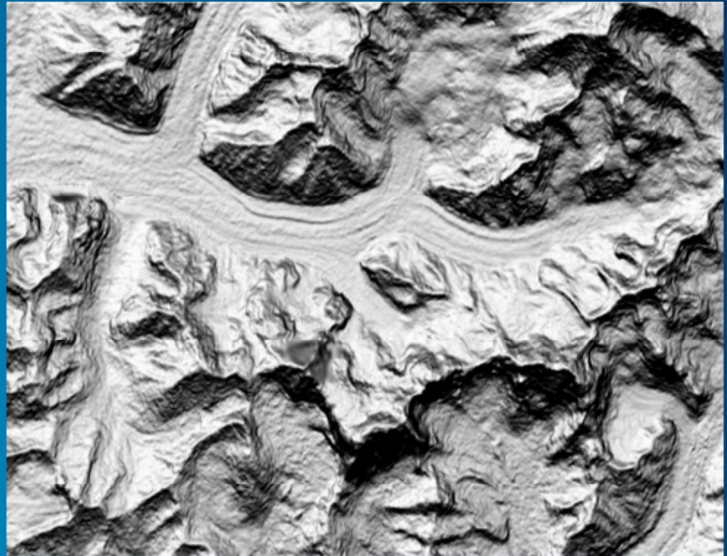
- 30m cells, global coverage, but very noisy, and with the holes plugged from lower res sources



Our next Also Ran is Aster GDEM v2. It has 30m cells, global coverage but very noisy, and with holes plugged from lower res sources → which turn out to be yttended ;-)

Also Ran – Aster GDEM v2

- Some areas wonderful, like this glacier



Some areas are wonderful, like this glacier.

When working on the unfinished YT DEM v3 I did successfully manage to use Aster to supplement in areas of lakes and big rivers of no known elevation. It was patchy though, requiring operator intervention to select and apply the areas.

Don't have time for another significant "also ran": the Esri World Elevation web service, which is definitely worth exploring, but doesn't work well at the regional scale because it dynamically and unpredictably changes the pixel size issued for different parts of the same image in the same export. Maybe it'll be fixed in a future update.

Up and Coming – YT DEM v3

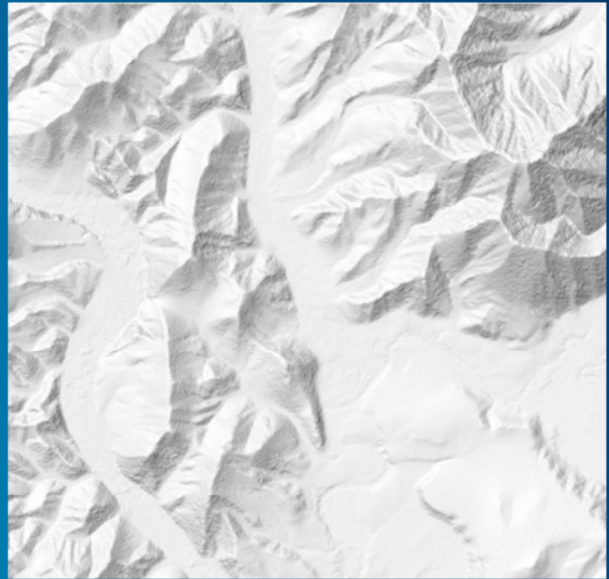
- Another partnership with NRCAN
- Builds on everything learned in previous efforts
- Currently dormant

Another partnership with NRCAN, Builds on everything learned in previous efforts, In progress but stalled due to staffing resources, software bugs, and competing demands. Currently dormant

Unable to use Topogrid for first half year due to critical error with multiple input files (am I the only person to ever use it at v10.3????), followed by similar experiences with underlying ANUDEM.

Up and Coming – Arctic DEM

- Circumpolar, North of 60
- 2m pixels
- *Surface* model, not Terrain (has trees etc.)
- Free
- University of Minnesota's Polar Geospatial Center



Very exciting. University of Minnesota's Polar Geospatial Center is working on a 2m DEM for the entire circumpolar world north of 60. The completed result, expected end of 2017, will be publicly available for all.

This shaded relief is from the 8m beta, near Summit Lake on the YT-NWT border.

Up and Coming – Arctic DEM

- interim 8m beta right now
- promising, subject to same issues Aster GDEM
- not as severe



We have the 8m beta for a couple of Yukon areas, looks very promising, but does have issues. We're looking at how we might contribute back UMN, probably by highlighting problem areas, but as with other things this will be constrained by resources and other commitments. Main message though is watch that space!

Beginning of the End

- Might call this presentation *History of Yukon Shaded Relief*, because that's what's been shown

Called the history of DEMs, but is more accurately be called *History of Yukon Shaded Relief*, because that's all I've shown you.

Up to this point we haven't actually seen a "DEM". Why is that? No it's not because I'm shady and relieved to be almost at the end of this...

This is what a DEM looks like straight up.

Whee.

Beginning of the End

- Might call this presentation *History of Yukon Shaded Relief*, because that's what's been shown
- Here's a raw DEM:
Whee.



Called the history of DEMs, but is more accurately be called *History of Yukon Shaded Relief*, because that's all I've shown you.

No not because I'm shady and relieved to be almost at the end of this...

This is what a DEM looks like straight up. (In Photoshop it'd be completely black.)

Whee.

· **My job:**

**Take neutral
grey data and
turn it into
something
worth looking
at**



This might be the single best definition I've arrived at to describe my job become vocation:
taking neutral grey data and turning it into something worth looking at.

I like that.

Postscript

- Excepting Arctic DEM all models in this talk are publicly available
- Can't find them? Talk to me, I have a trove
- *Referenced Raster Mosaic Datasets and Virtual Raster Tables* might the best spatial invention of the decade
 - ...except for Vector Tile Caches
 - ...and drones, perhaps drones are best (but only when they get good enough to build BIG dems, and not these piddly little things they can do now).
 - ...oh, and 3D printing
 - ... okay, maybe mosaic datasets and VRTs are just one cool thing. You'll kick yourself if you don't introduce yourself to them though.
- – Matt.Wilkie@gov.yk.ca

With the exception of ArcticDEM all of the elevation models mentioned in this talk are publicly available, contact me if you want one of them and can't find it. I have a trove.

Referenced Raster Mosaic Datasets and Virtual Raster Tables might the best spatial invention of the decade

...except for Vector Tile Caches

...and drones, perhaps drones are best (but only when they get good enough to build BIG dems, and not these piddly little things they can do now).

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