Add some Z to your mapping: open-source topography

opentopography.org

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Geogeeks Perth
October 2025 Meetup

What was my reason to explore open-source topography?

My study area was looking for 3D data on open pit mines, to reconcile deepening of the pit void against the growth in the waste rock dumps and tailings dams associated with the orebody

Could useful 'Z' be obtained from DEMs produced by remote sensing?

Mt Keith Nickel Mine, WA

Source: ESRI

What do we mean by ‘Z’?

- Raster grid (array) of topographic heights
- Use for 3D-realistic maps
- Enhance 2D maps by sun-shading the raster grid to simulate topographic relief
- Sourced from stereo-pair air-photos, stereo-pair optical satellite scenes, LIDAR, synthetic aperture radar (SAR)

Who are OpenTopography?

Distributed facility operated collaboratively by:

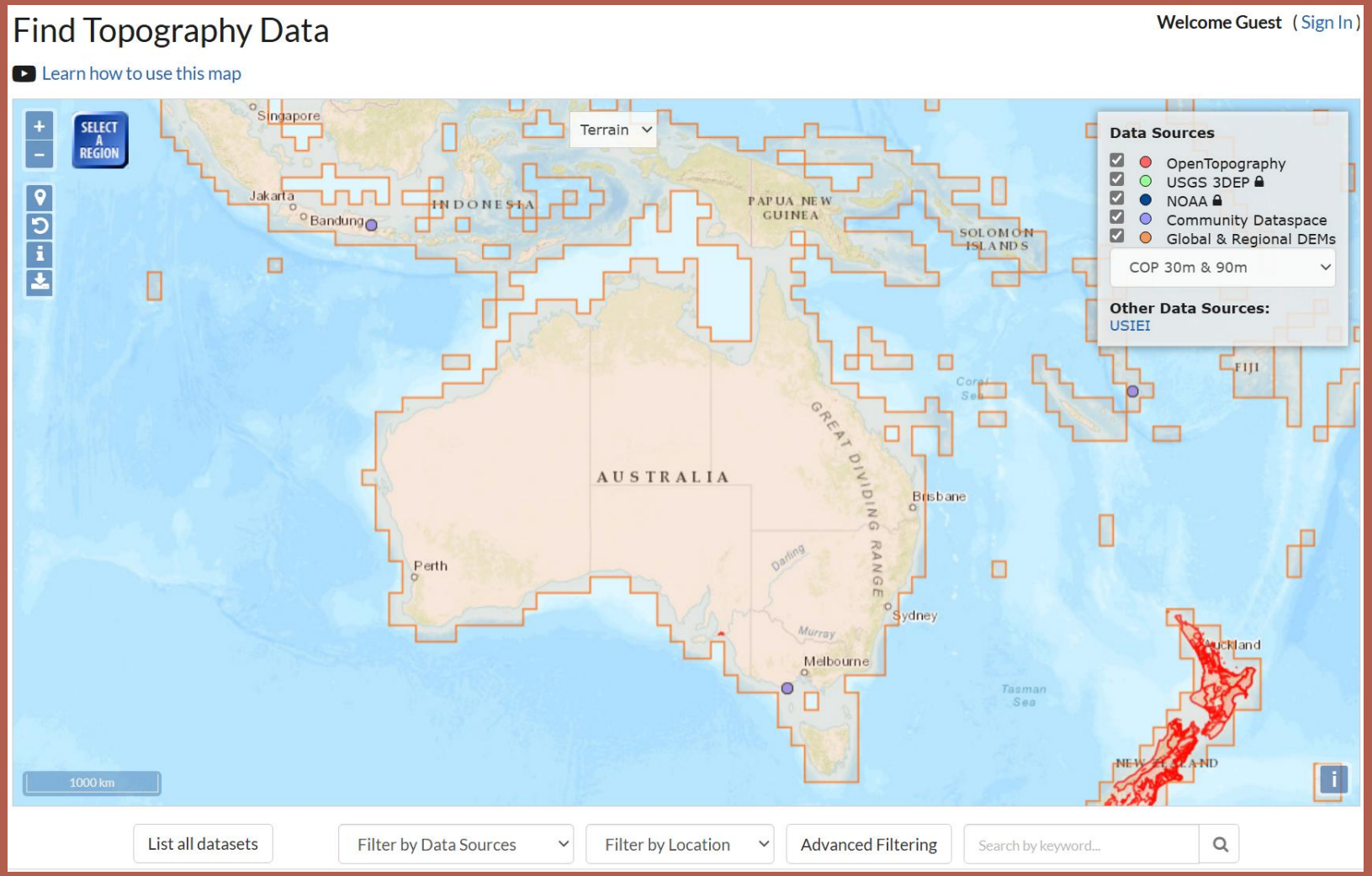
San Diego Supercomputer Center at the University of California San Diego,
EarthScope Consortium,

School of Earth and Space Exploration at Arizona State University.

Core operational support for OpenTopography comes from the Division of Earth Sciences at the National Science Foundation

The OT Portal

- Map-based search portal
- Max 450,000 km^2 per AOI search window, or
- Pre-defined 1-degree tiles

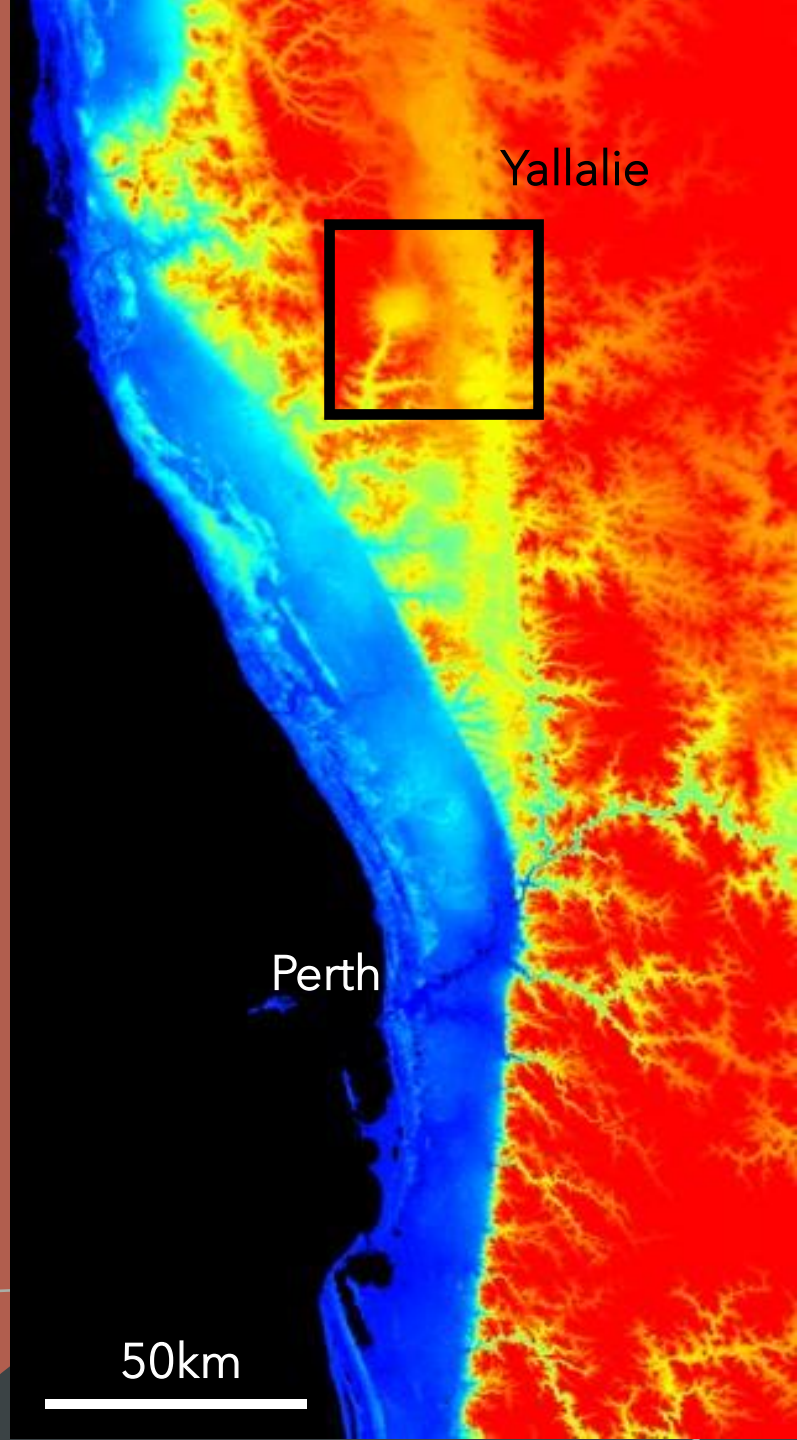


Open-source global DEMs
Only 30m resolution data available for Oz

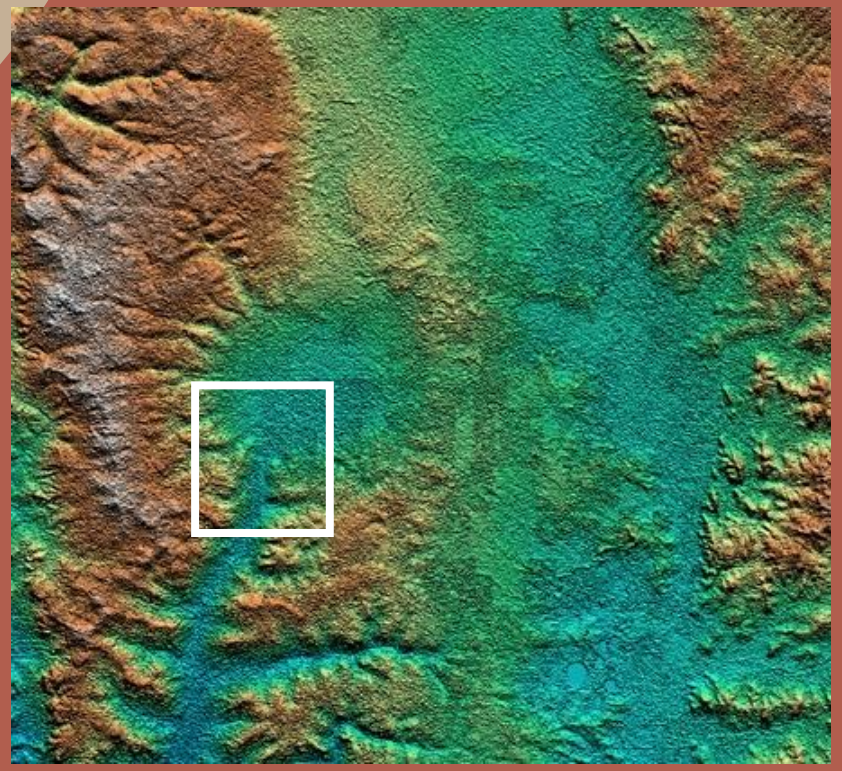
- SRTM *-11day mission during 2000 (SAR, C-band)*
- NASADEM *re-release of SRTM in 2020, re-processed with new algorithms and calibrated against ICESAT (LIDAR)*
- AW3D30 *– ALOS PRISM (stereo-optical) compiled from scenes captured 2006 – 2011, initial release 2016, updates to v4*
- GLO30 / Copernicus 30 *– TANDEM-X mission, two satellites in tandem (SAR X-band), 2010 – 2015, DSM not DEM*

Comparing the 30m DEMs

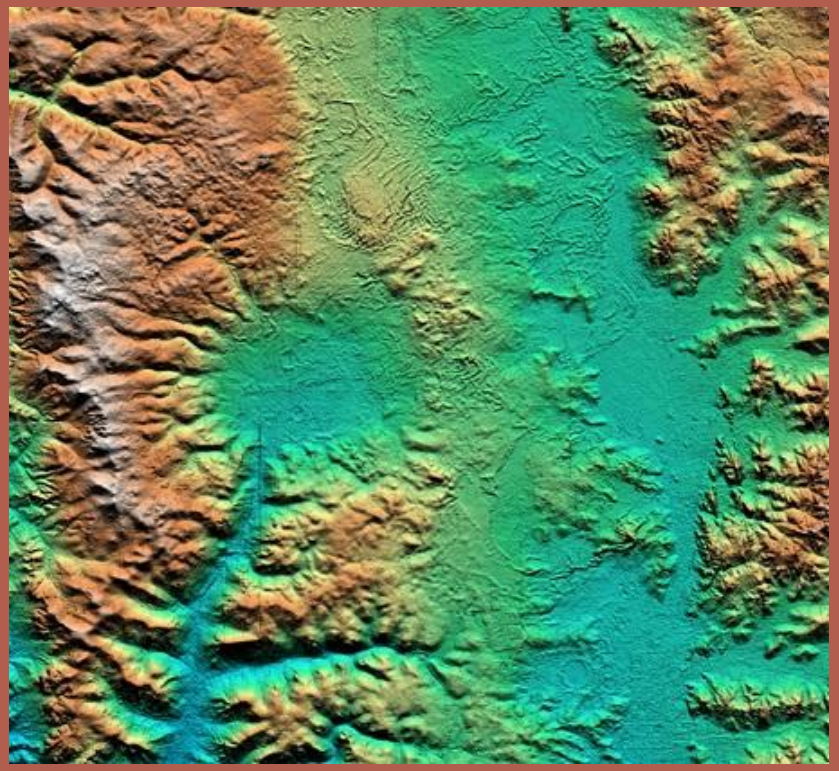
- An example from Western Australia – the Yallalie Impact Site
- Grid/array of heights (Z) mapped to 'pseudocolor' LUT
- Low heights = colder colours, high elevations = hotter colours
- Next slide compares DEMs over the Yallalie feature:
  - NASADEM (2000)
  - AW3D30 (compilation 2006 – 2011)
  - GLO30 (compilation 2010 – 2015)
- All data sourced from OpenTopography.org (see final slide for attributions)



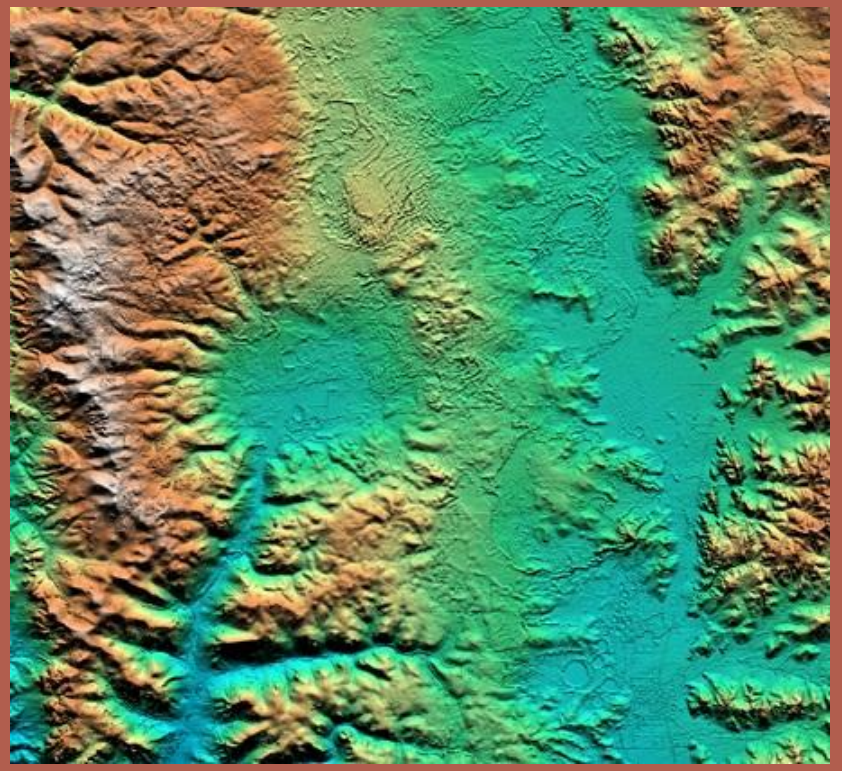
NASADEM
2000 Space Shuttle Mission



AW3D30
JAXA's ALOS PRISM (Optical)



COP30 (or GLO30)
ESA/Airbus' TANDEM-X (SAR)

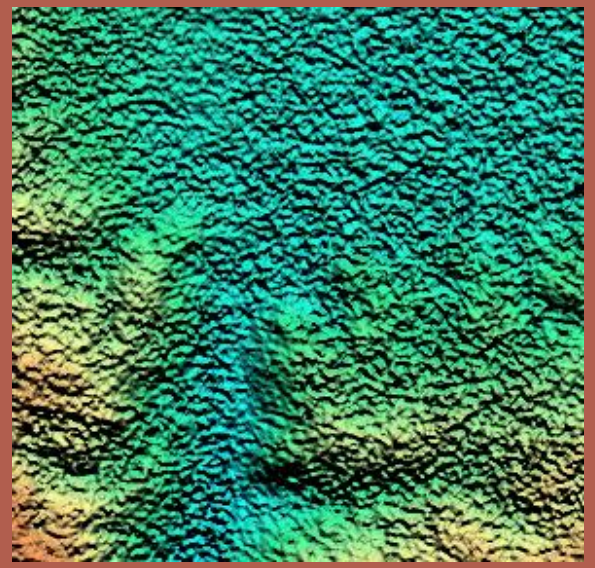


White box is approx. 8km x 8km
Enlargement for next slide

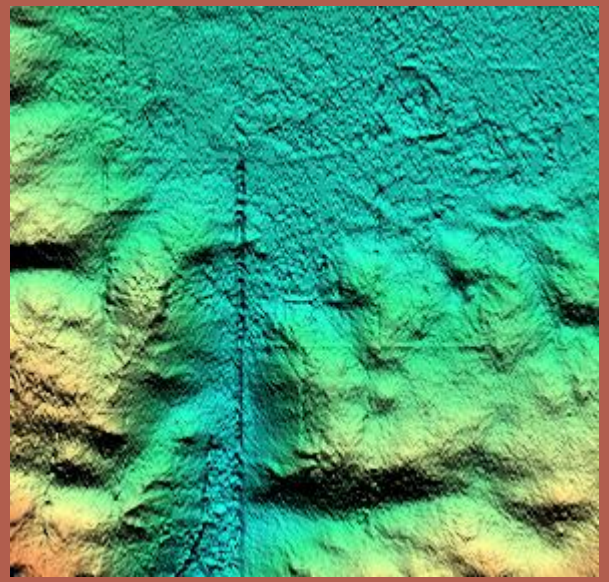
8km x 8km scene,
south rim of Yallalie

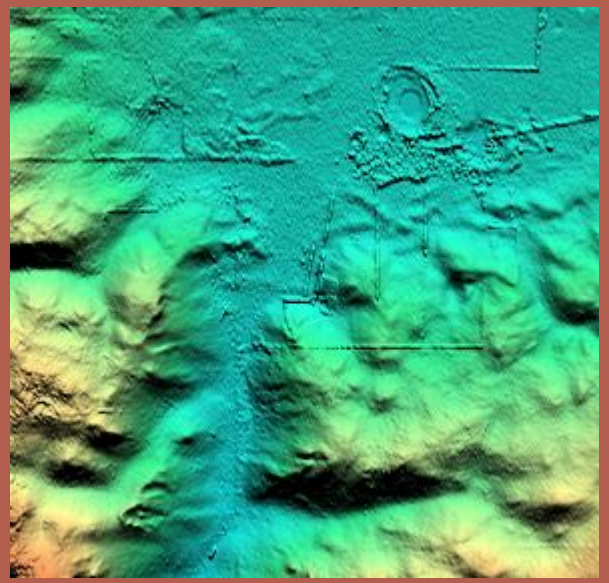
30m cell size and
data quality are great
for 1:100,000 maps,
sufficient for 1:50,000

NASADEM (SAR)



AW3D30 (optical)





GLO30 (SAR)

Landgate
Mosaic

Which DEM is ‘best’ for mapping?

- Both the AW3D30 and GLO30/Copernicus 30 are equally good for mapping topographic features and ‘nice’ aesthetics/smoothness
- Both AW3D30 and GLO30 are DSM (top of vegetation) versus NASADEM, which is closer to a DEM, (vegetation is partly transparent to C-band radar)

- Mention must be made of Geoscience Australia’s (GA) excellent work on the original SRTM, to ‘hydrologically condition’ the DEM using mapped stream-lines and catchments.
- Also see GA’s ELVIS portal for Australian foundational elevation and bathymetry data - elevation.fsdf.org.au/

What about ‘change in Z’?

Subtract ‘oldest’ DEM from ‘youngest’ DEM:
GLO30 minus NASADEM

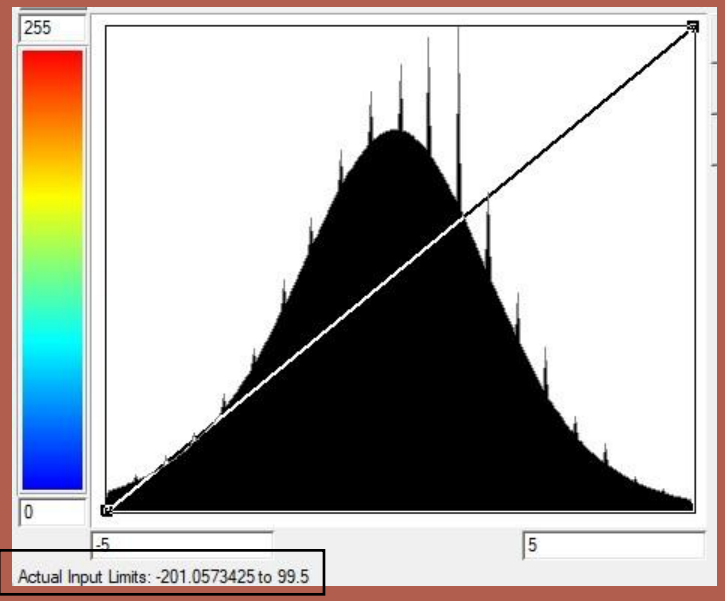
‘Change in Z’ between the 2000 SRTM mission and the 2010 – 2015 captures from TANDEM-X

Noise is additive, the residual Z has noise from SRTM plus the noise from TANDEM-X

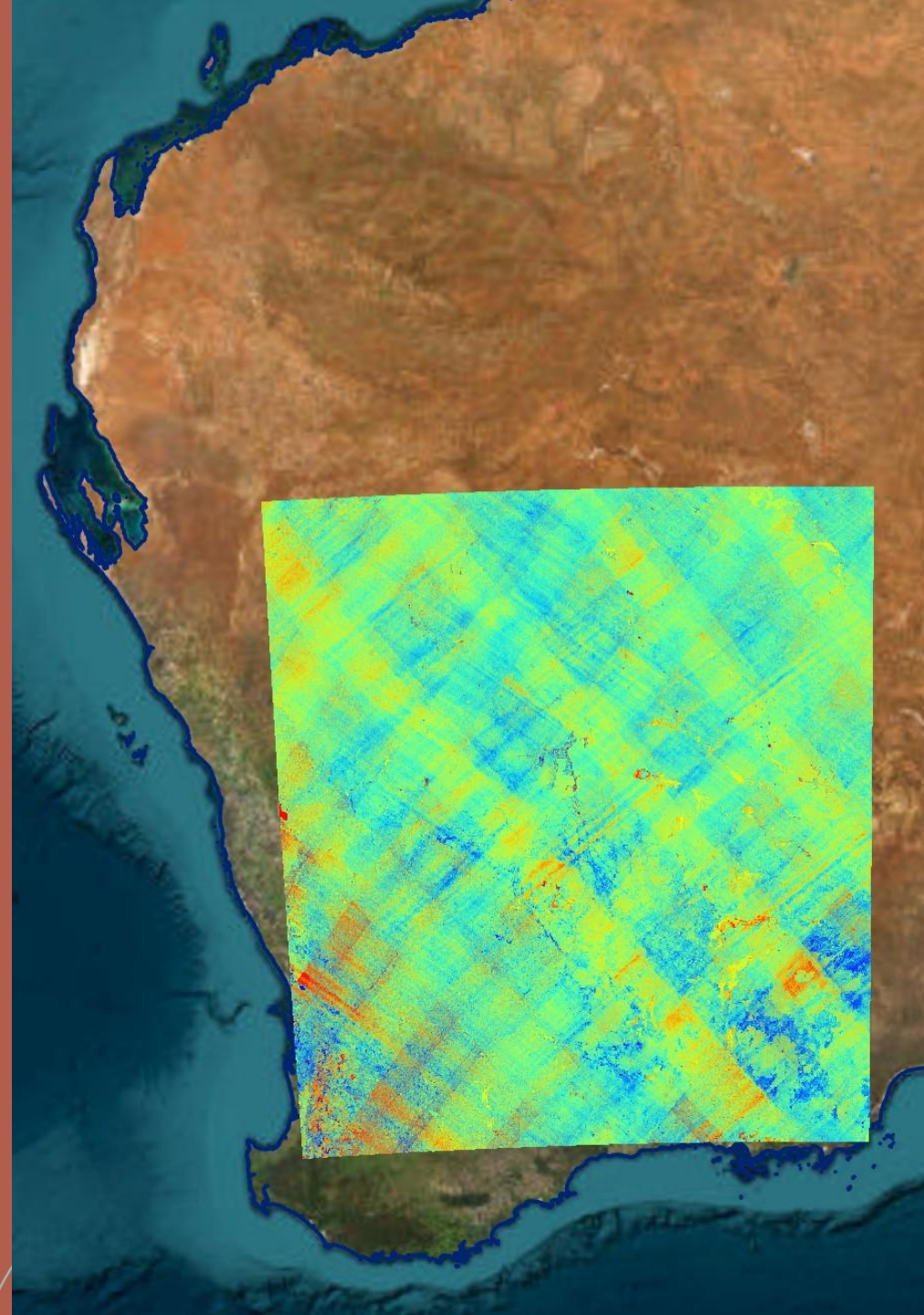
Colour-map of the residual Z, over the range -5m to +5m

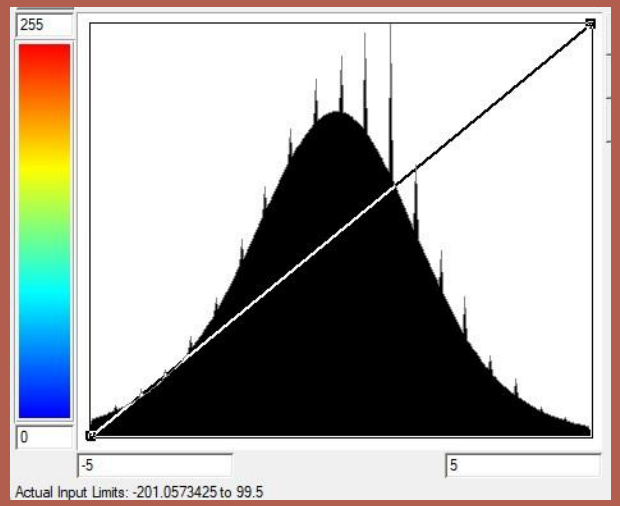
Every value gets a colour, even when the value is 0

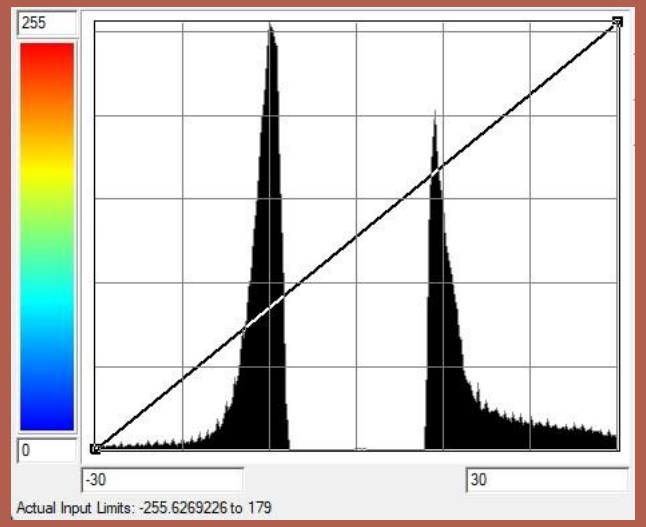
Much of the colour-mapped residual Z is only +/ 2m



Full range is -200m to +100m







As a balance between signal and noise, set values within +/- 4m to ‘null’ (transparent)

Colour map the filtered residual Z over wider range of -30m to +30m

Put the filtered, colour-mapped residuals over a backdrop of sun-shaded GLO30 (greyscale)

The ‘residual DEM’ is one test of quality for topography measured by satellite

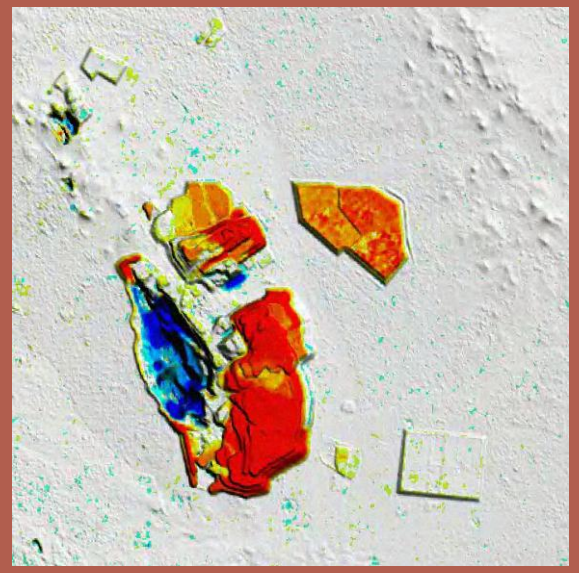
Some noise in rugged topography (Pilbara) and thick vegetation (SW),but no swathes of large mis-match

The Voila moment!

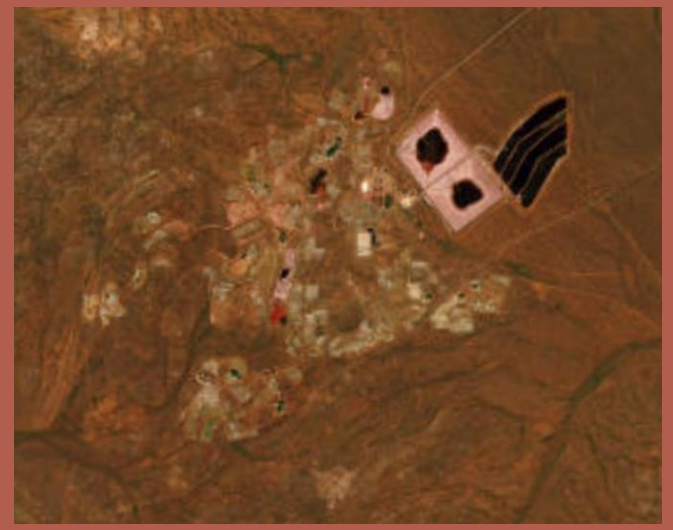
Time-series DEMs can map changes in mining footprints by mapping the change in height of the land

There is a good ‘signal to noise’ ratio for height-changes measured from global DEMs, despite the ‘orange–peel’ texture of the SRTM base layer, and the 30m resolution of the open-source DEM grids

The Super Pit, Kalgoorlie

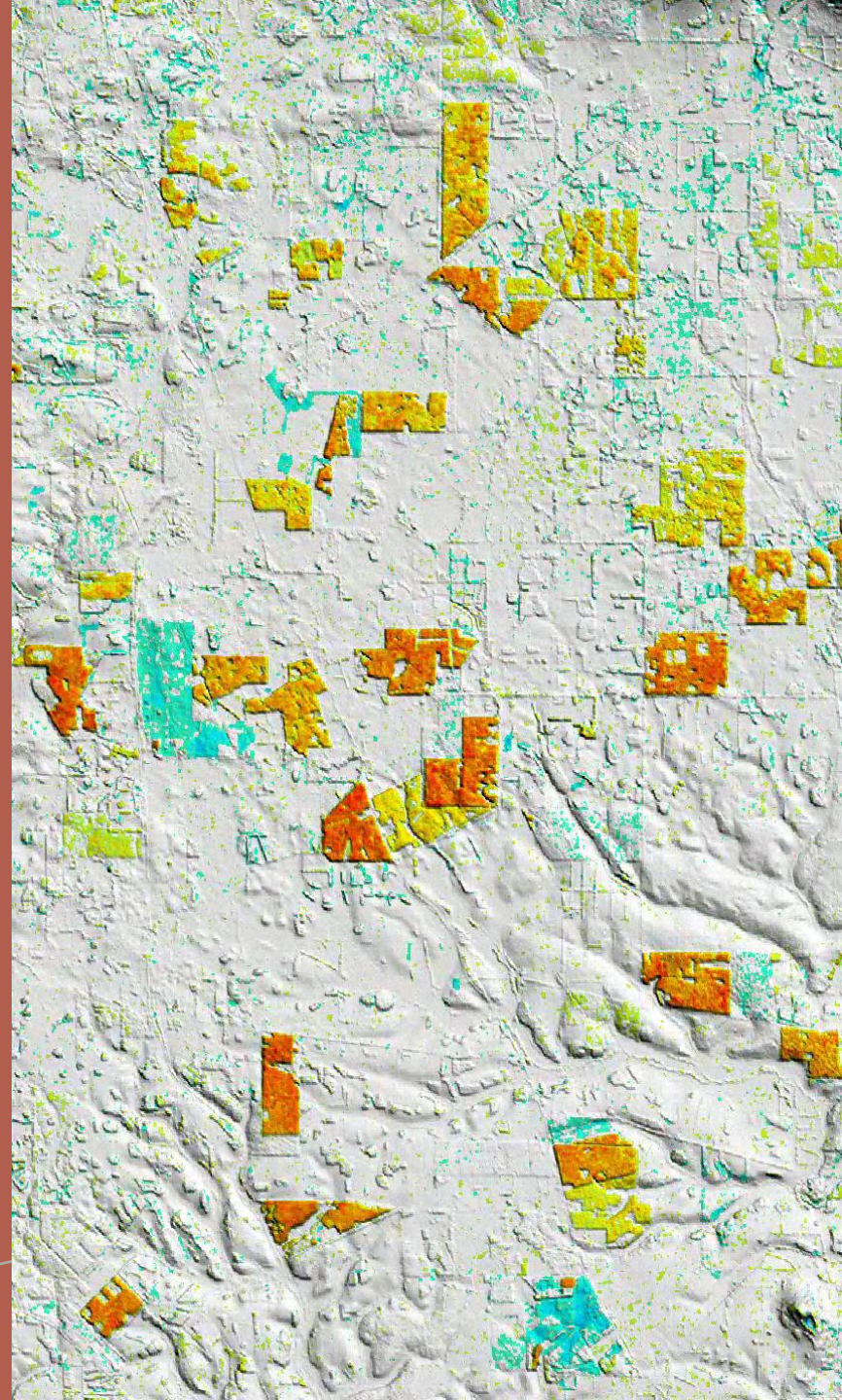


Murrin Murrin Nickel Mine, WA



The younger *DSM* (TANDEM-X, X-band SAR), also maps change in vegetation height when compared to the base *DEM* (SRTM, C-band SAR)

Example from rural land, NW of Albany, Western Australia



Thank You

Data Attribution:

NASA Shuttle Radar Topography Mission (SRTM)(2013). *Shuttle Radar Topography Mission (SRTM) Global*. Distributed by OpenTopography. https://doi.org/10.5069/G9445JDF. Accessed 2025-09-10

NASA JPL (2021). *NASADEM Merged DEM Global 1 arc second V001*. Distributed by OpenTopography. https://doi.org/10.5069/G93T9FD9. Accessed 2025-09-10

Japan Aerospace Exploration Agency (2021). *ALOS World 3D 30-meter DEM. V3.2*, Jan 2021. Distributed by OpenTopography. https://doi.org/10.5069/G94M92HB. Accessed 2025-09-10

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