CEOS WGCV
Terrain mapping sub-group

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Overview

- **Sub-Group on “Terrain Mapping from satellites”**
- **Programmatic status & plans**
- **DEM production status & validation activities**
  - **SRTM (IfSAR)**
  - **ICESAT (lidar)**

CEOS WGCV Terrain Mapping

- **What is the mission of this sub-group?**
  - **To ensure that characteristics of digital terrain models produced from Earth Observation sensors at global and regional scale are well understood and that products are validated and used for appropriate applications.**
- **What are the specific objectives of this group?**
  - **To develop specifications for the generation of 'standardised terrain surface products with known accuracy' from similar sensing systems in the context of data continuity, and specify evaluation methods and statistics which give transparent information about the quality and heritage of terrain models.**
  - **To update the current dossier of test sites and identify new sites, particularly to satisfy the cal/val requirements of future missions and generally improve access to validation data sets.**
  - **To prepare recommendations for the establishment of a global ground control point network.**
  - **To consider how orbit validation could be developed.**
  - **To keep an up to date record of the current status of sensors which produce data for terrain mapping and of the DEMs available.**
  - **To produce a DEM requirements document with a science rationale, taking into account the output from SRTM.**

Programmatic Status

- **Workshop postponed from DLR X-SRTM PI meeting due to travel difficulties for participants.**
- **SPOT-5 launched on 3 May 2002 from the ESA Guiana Space Centre, Kourou on an Ariane 4**
- **ICESAT launched on January 12th, 2003 from Vandenburg Air Force Base**
- **Intermap technologies have created the 5m NextMap DEM using airborne IfSAR of England and Wales**
- **Membership of Sub-Group includes senior technical experts from civilian, military and commercial organisations. Currently representation is poor from the Far East (no ALOS point of contact)**

Programmatic Plans

- **Plan to hold postponed workshop in London either just before the EGU-AGU symposium in early April or before IGARSS03 conference in July**
- **SRTM/C-SAR DEM data released by NASA/JPL over North America (only, see later) and QA activities started (further example shown here)**
- **Best practice document to be updated in the light of SRTM and Lidar data**
- **Links to ISPRS WG on SPOT-5 DEM assessment using common test sites**
- **Interest in linking with WGISS activities (as well as LPV Sub-group) to provide easy web-access to test data-sets. Have requested that LPV select test sites with rugged topography**

SRTM Context

- C-SRTM data (C-band/JPL and X-band DLR/ASI collected 3 years ago)
- “Bleeding edge” technology particularly regarding orbit and attitude restitution resulted in substantial delays in the systematic processing of DEMs
- 3 arc-second (90m) postings (from NASA) for 80% of land surface to be placed in the public domain by 2004 (see later).
- 1” data (30m) only for the conterminous USA (lower 48 states) fromNASA. Available NOW.
- Initial NASA C-SRTM data - only DEMs which are unedited so that they still contain artefacts such as water bodies
- NIMA contractors working on cleaning up these artefacts and verification prior to NIMA releasing official DTED-2 product
- It is believed that a subset of this DTED-2 product will be distributed by NASA via EDC also at DTED-1 resolution

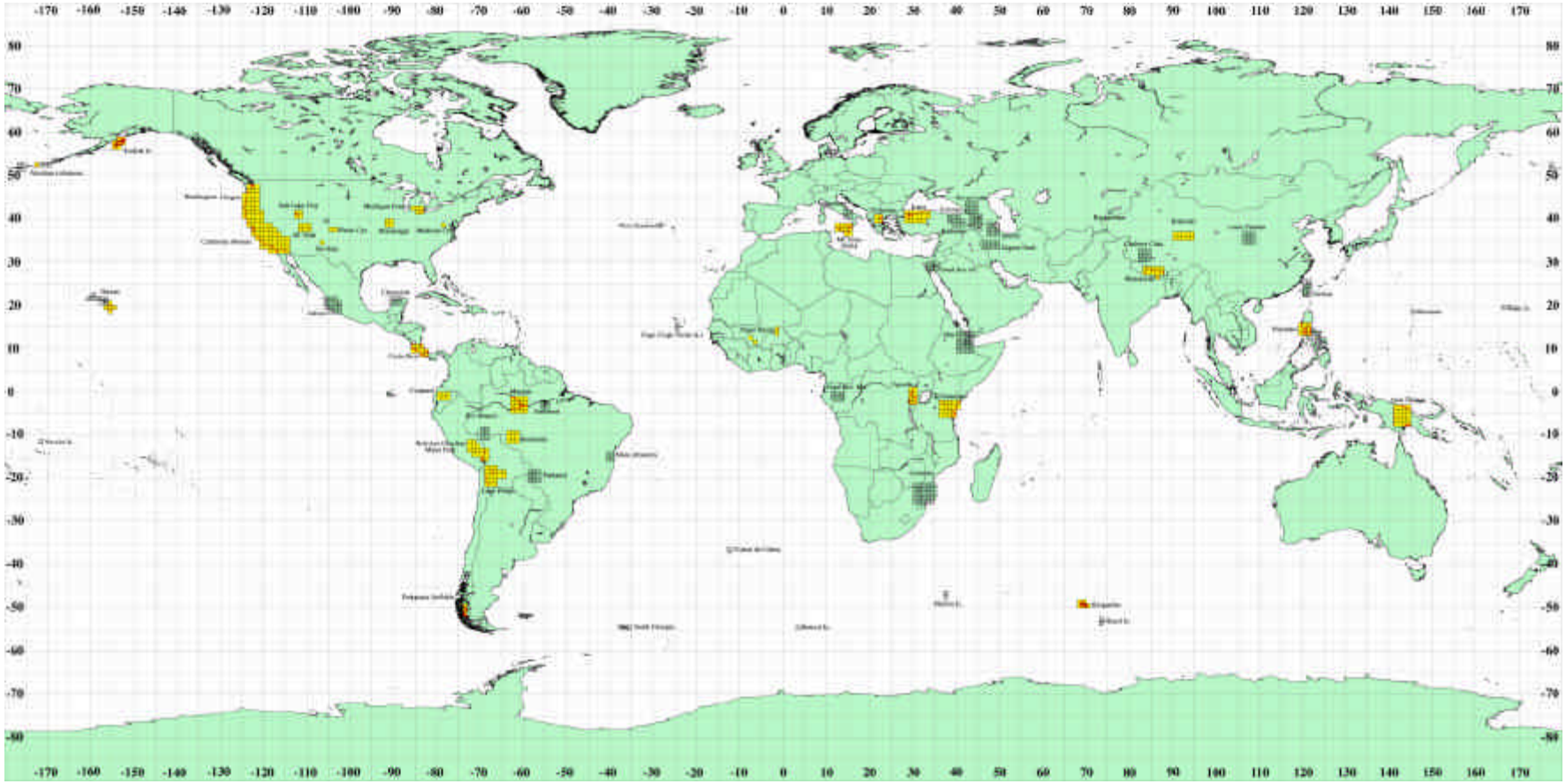
C-SRTM Status

- C-SRTM DEMs production completed at JPL end December 2002 and delivered to NIMA
- In mid-February 2003, public release of a reduced-resolution (3 arc-sec or about 90 m) DEM of all of North America (60 deg. N to 15 deg. S latitude) due to be released
- Dean Gesch at the US Geological Survey in Sioux Falls, has compared the SRTM DEM for the US with the USGS National Elevation Dataset (NED is 30 m resolution) and with 5,874 GPS-measured benchmarks.
- His results indicate that NED has an RMS vertical error of about 2.7 m and SRTM about 3.5 m. He also found a bias (as expected) when the SRTM - benchmark values were plotted vs. vegetation cover as the SRTM radar measured height values within the canopy.

C-SRTM Data types and access

- **Two types of SRTM data available:**
  - **PI processed (on WGS84 ellipsoid) using local spot heights for orbit adjustment includes DEM, height quality map, SAR amplitudes, polarisation and incidence angle maps**
  - **General Data Processed System (GDPS) - only DEM available at present DEMs have not been edited for artefacts such as water bodies.**
- **JPL processed SRTM GDPS DEM data on WGS84 geoid as well as NED (National Elevation Data down to 1/3rd"/10m) and NLCD (1" land cover derived from LANDSAT) data available via a webGIS (ARCims) which is Wintel_only at http://seamless.usgs.gov**
- **SRTM (PI and GDPS) available via anonymous ftp bundled in 1^{o} tiles from**
  - **ftp://edcsgs9.cr.usgs.gov/pub/data/srtm/PI_Processor/**
  - **ftp://edcsgs9.cr.usgs.gov/pub/data/srtm/GDPS/**

C-SRTM PI product coverage (as of 5 May 2002)



X-SRTM Status

- **X-SRTM processed data available for some 30% of the area covered by C-Band in DTED Level 2 format on 15” x 15” tiles**
- **X-SRTM DEM production due to be completed by end 2003**
- **X-SRTM DEM tiles are COPYRIGHT and currently can only be obtained by non-PIs upon payment of 400 euros/complete tile. See http://www.dfd.dlr.de/srtm/index_en.htm for more details**
- **Commercial distributors selected - see list at http://www.dfd.dlr.de/srtm/produkte/vertrieb_en.htm**
- **PI workshop held at DLR on 17-18 October 2002. Presentations can all be downloaded from http://www.dfd.dlr.de/srtm/neu/pi_171002/pi_171002_en.htm**

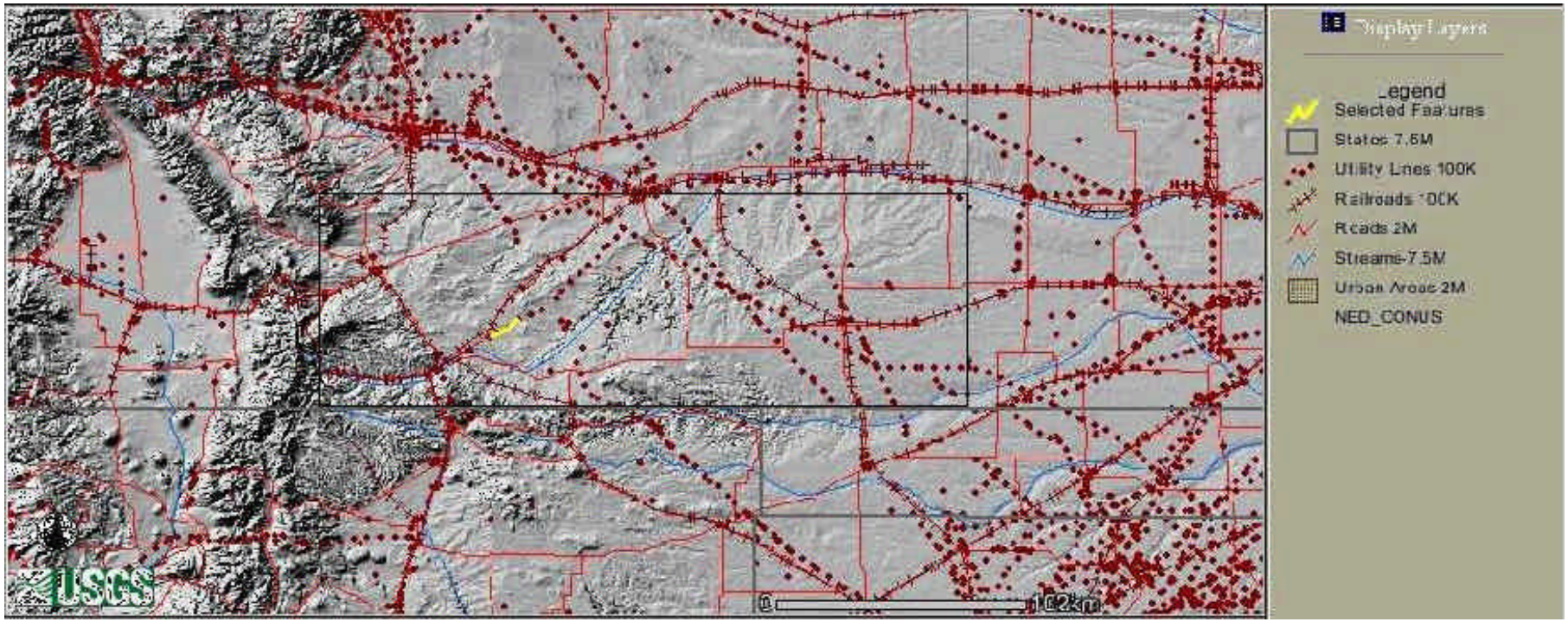
Objectives of validation study

- **Quality assessment of the first C-SRTM DEMs using “bare earth” DEMs and land cover information**
- **Assess whether they meet the design specification for DTED-1 (Zrms 18m)**
- **Interpret height differences in terms of topographic variables, other SRTM (PI) products and land cover**

Datasets

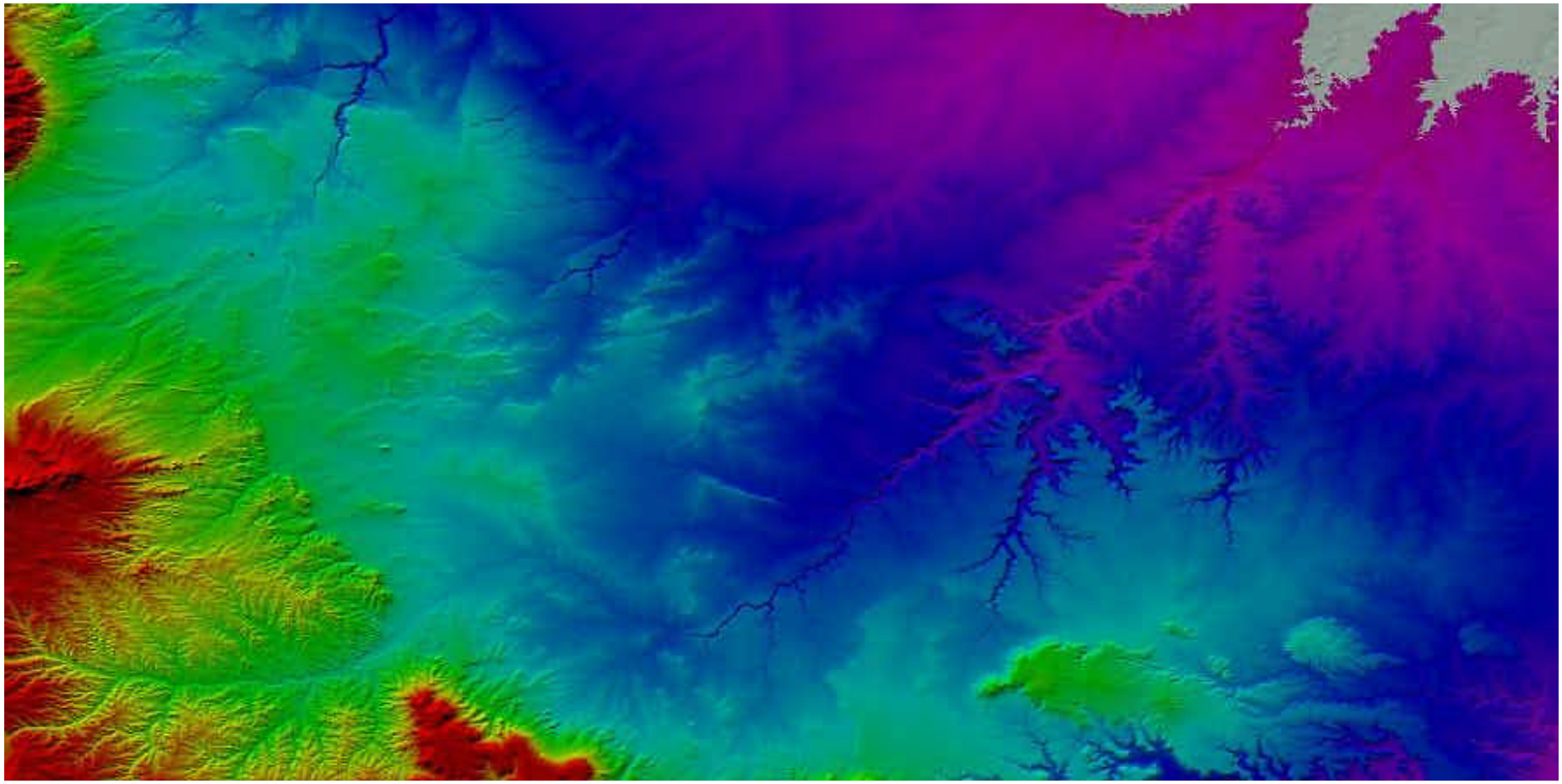
- **SRTM PI 3” and 1” DEMs were released for two 1ºx1º cells in central Colorado (N35-36, W103-105) on the WGS84 ellipsoid in January 2002**
- **SRTM 3”GDPS DEMs were subsequently released in June 2002**
- **30m USGS National Elevation Data (NED) were projected to the same datum and projection**
- **30m USGS National Land Cover Data (NLCD) were similarly co-registered to the SRTM data**

Geographical context of Pinyon Canyon, 35-36N, 103-105W

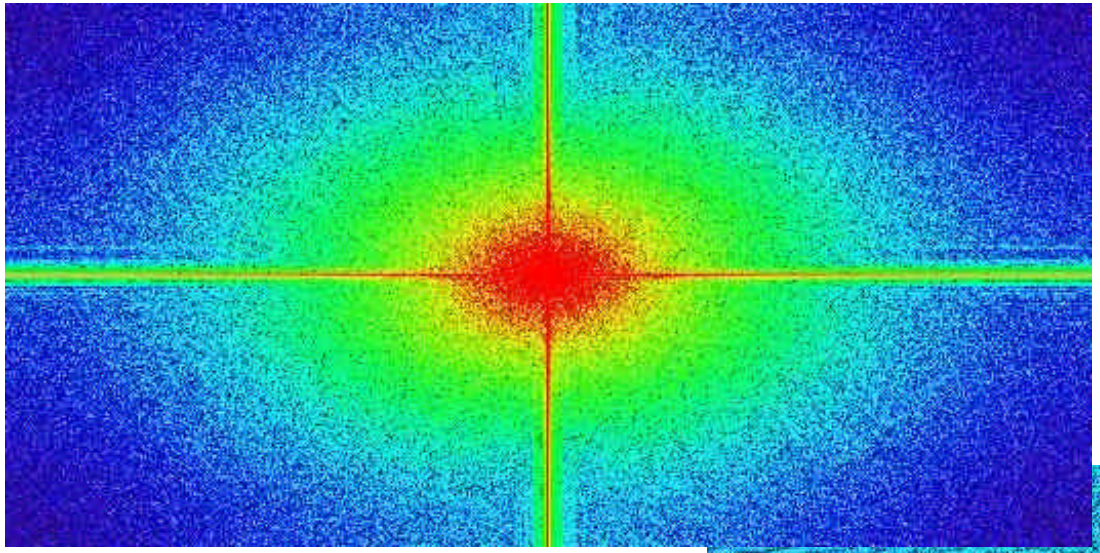


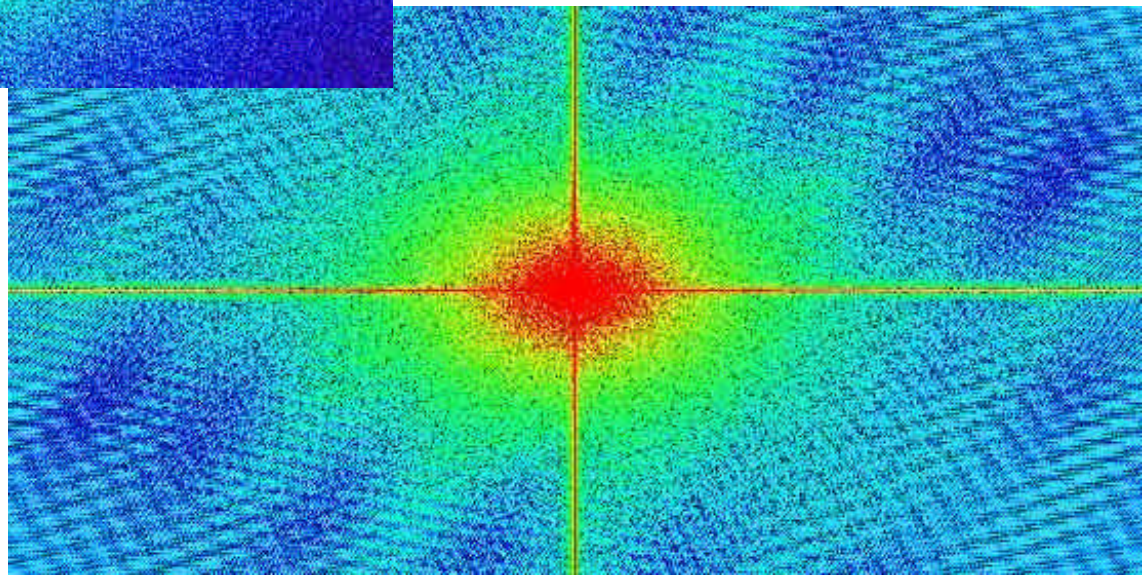
N.B. No evidence of utility lines even in 1” (30m) product

3” SRTM DEM (PI) of complete area



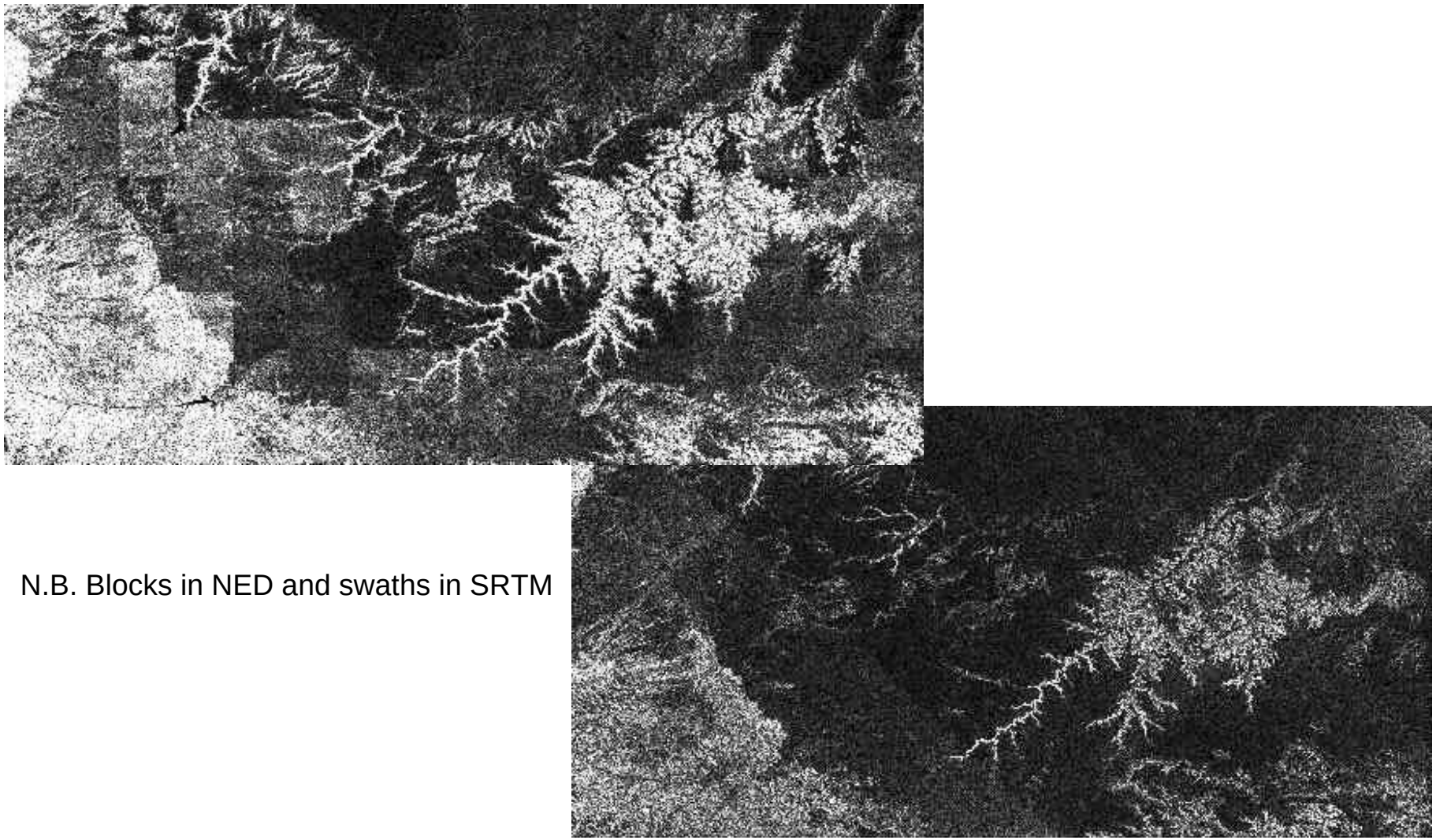
SRTM cf. NED (2D FFT)





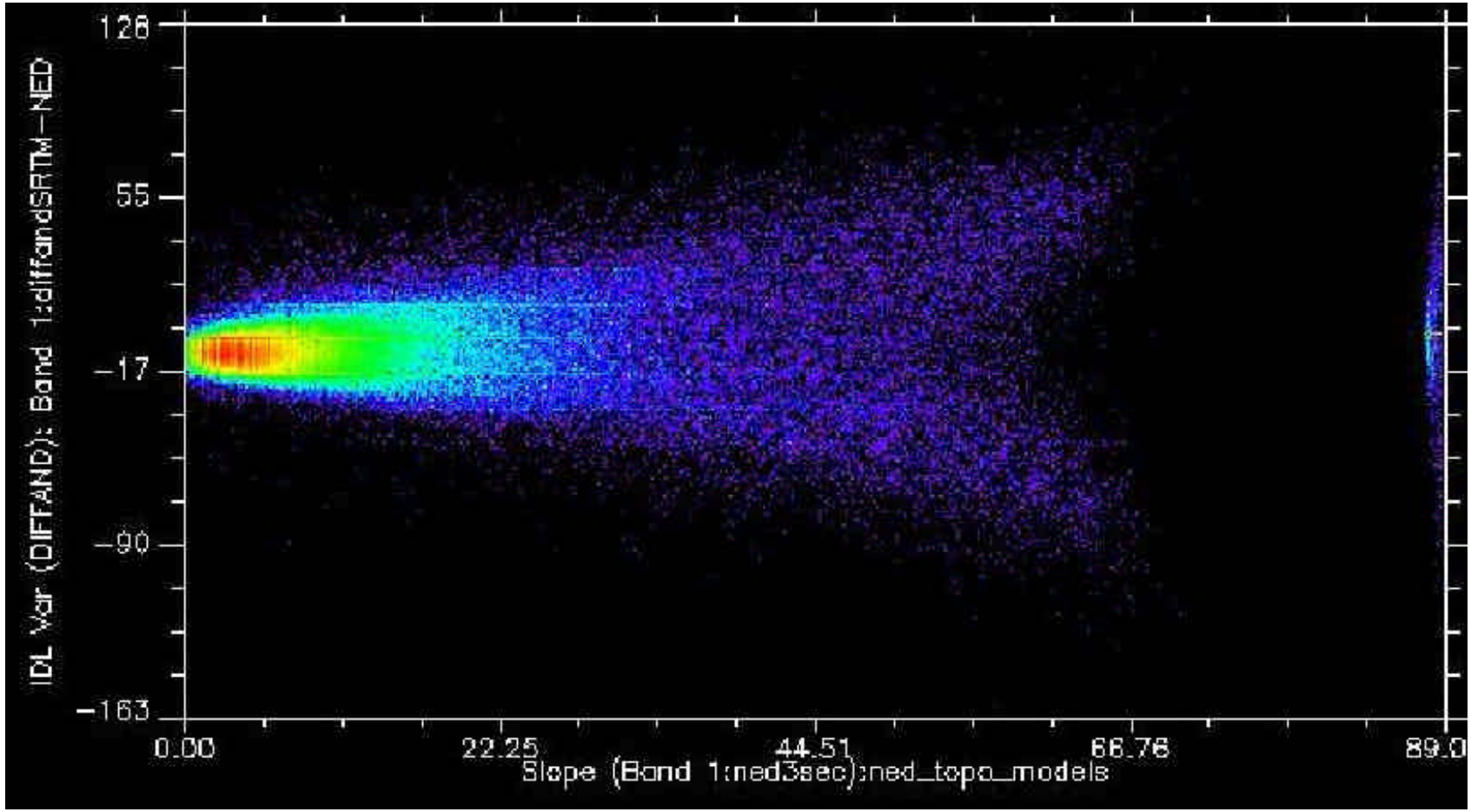
N.B. Diagonal stripes in SRTM

SRTM cf. NED (RMS)



N.B. Blocks in NED and swaths in SRTM

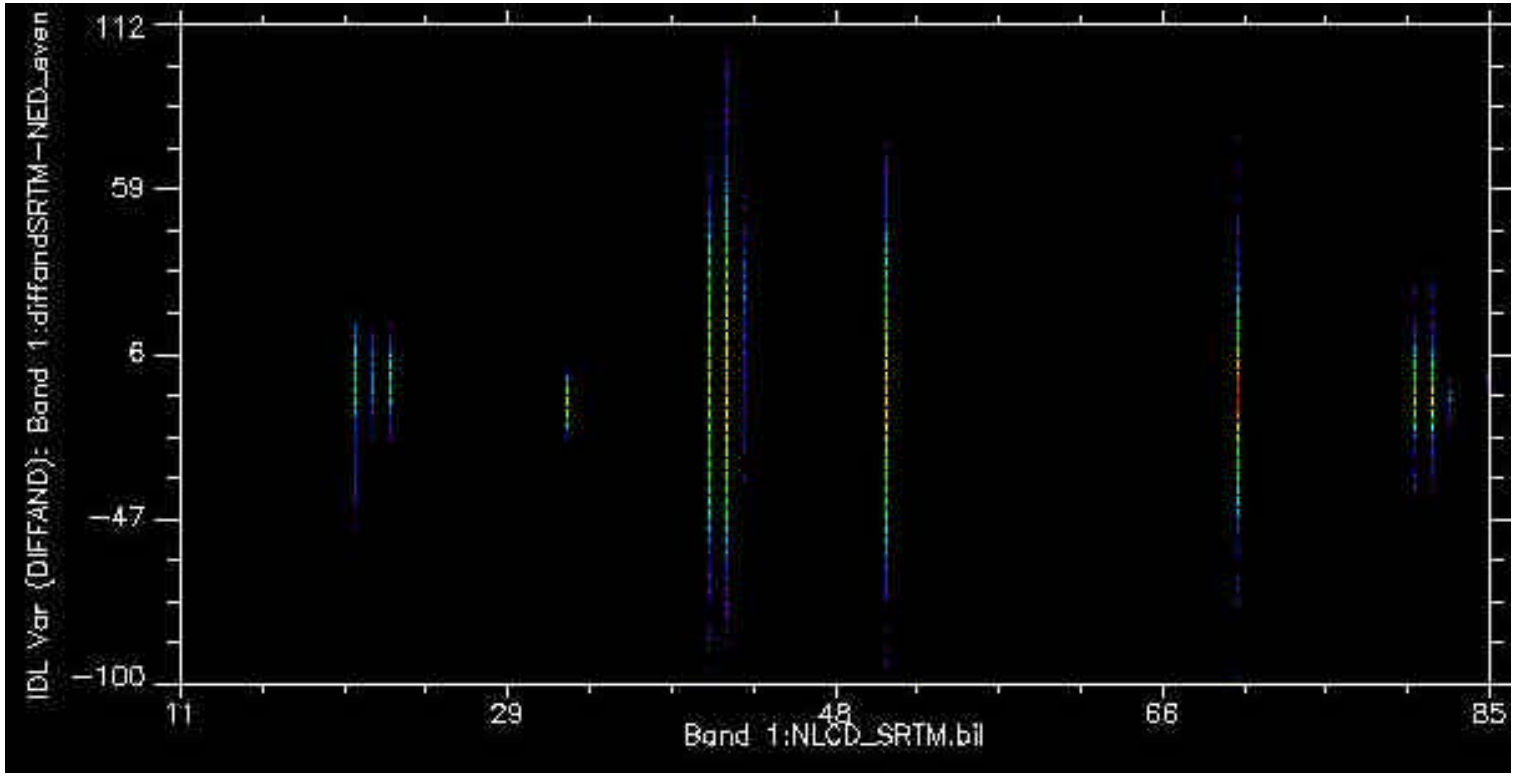
SRTM-NED vs NED derived slope



N.B. Strong slope effects apparent in SRTM-NED

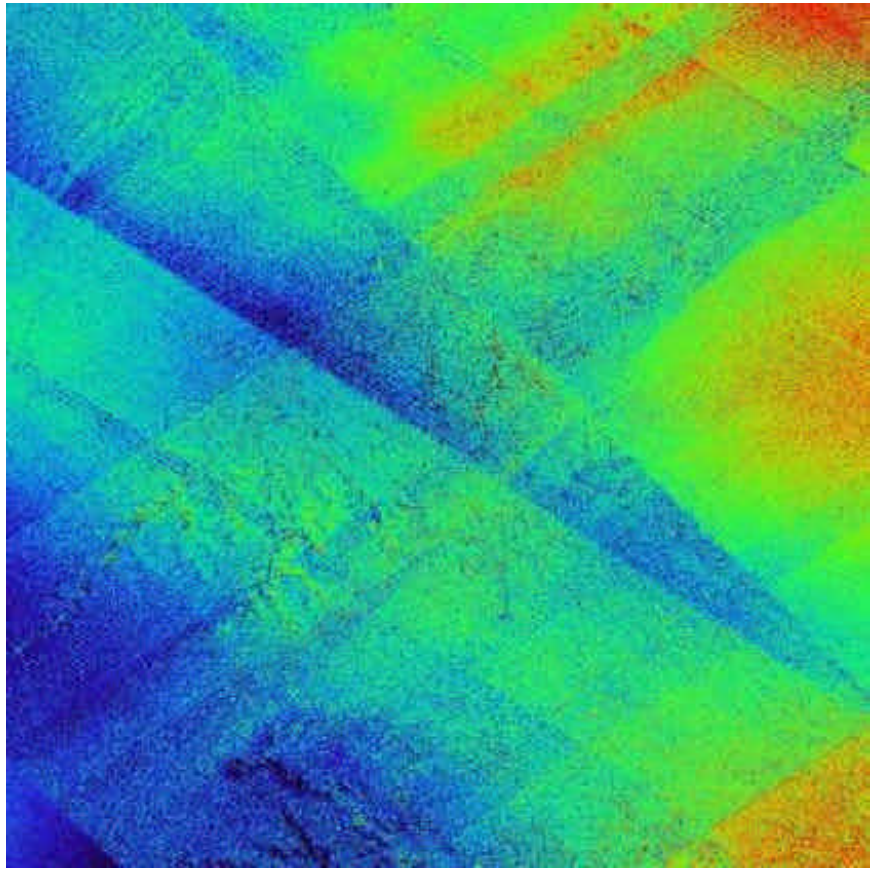
NLCD derived from LANDSAT classification

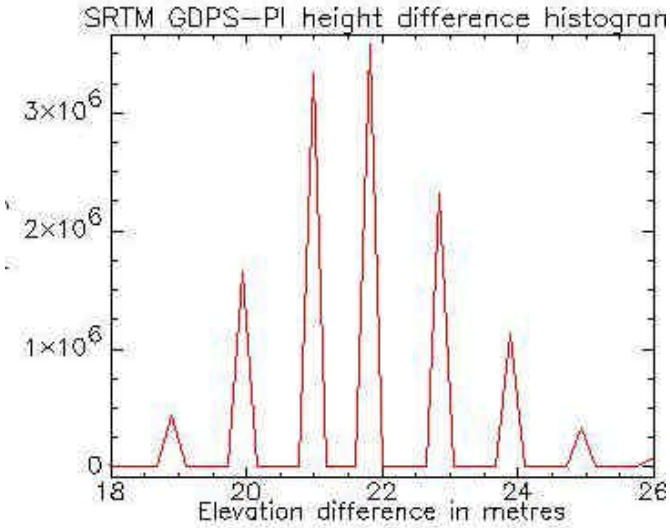
SRTM-NED vs NLCD



N.B. larger differences for woodland and shrubland but probably dominated by slope effects

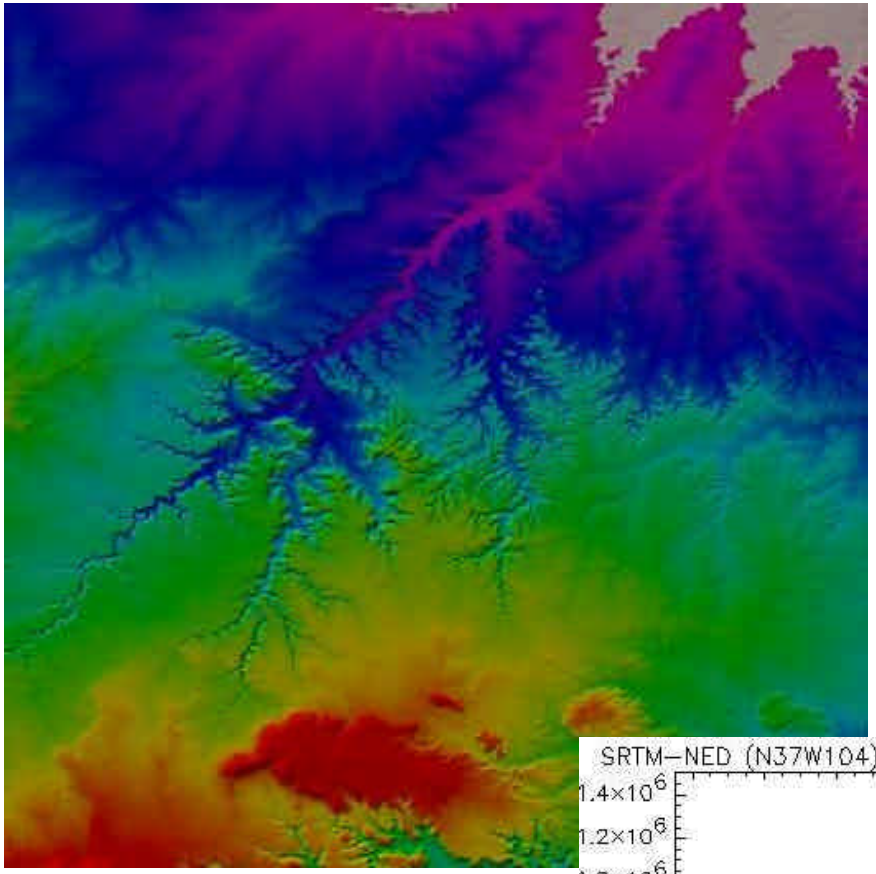
SRTM (GDPS) intercomparison to SRTM (PI) at 1” (30m)

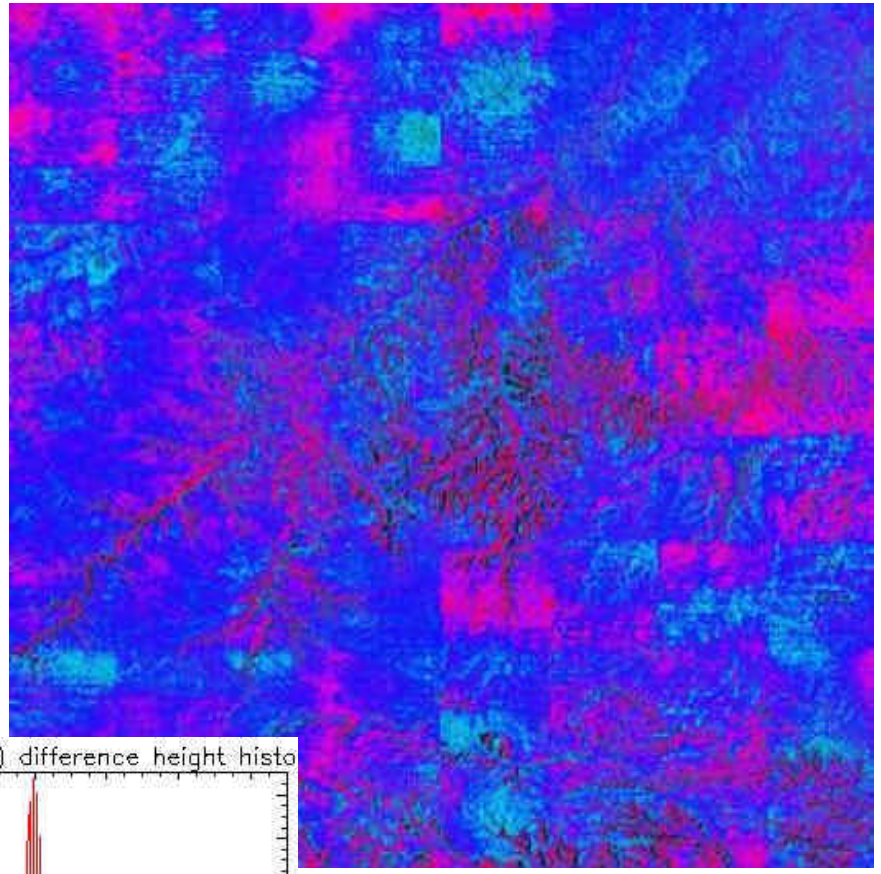


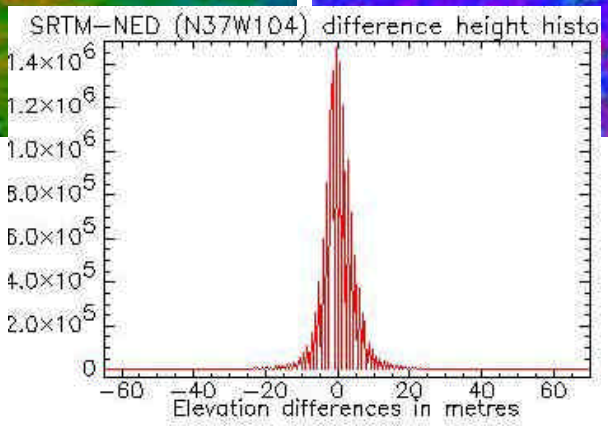


N.B. Artefacts due to swath boundaries and differences due to ellipsoid-geoid separation

SRTM (GDPS) intercomparison to NED at 1” (30m)



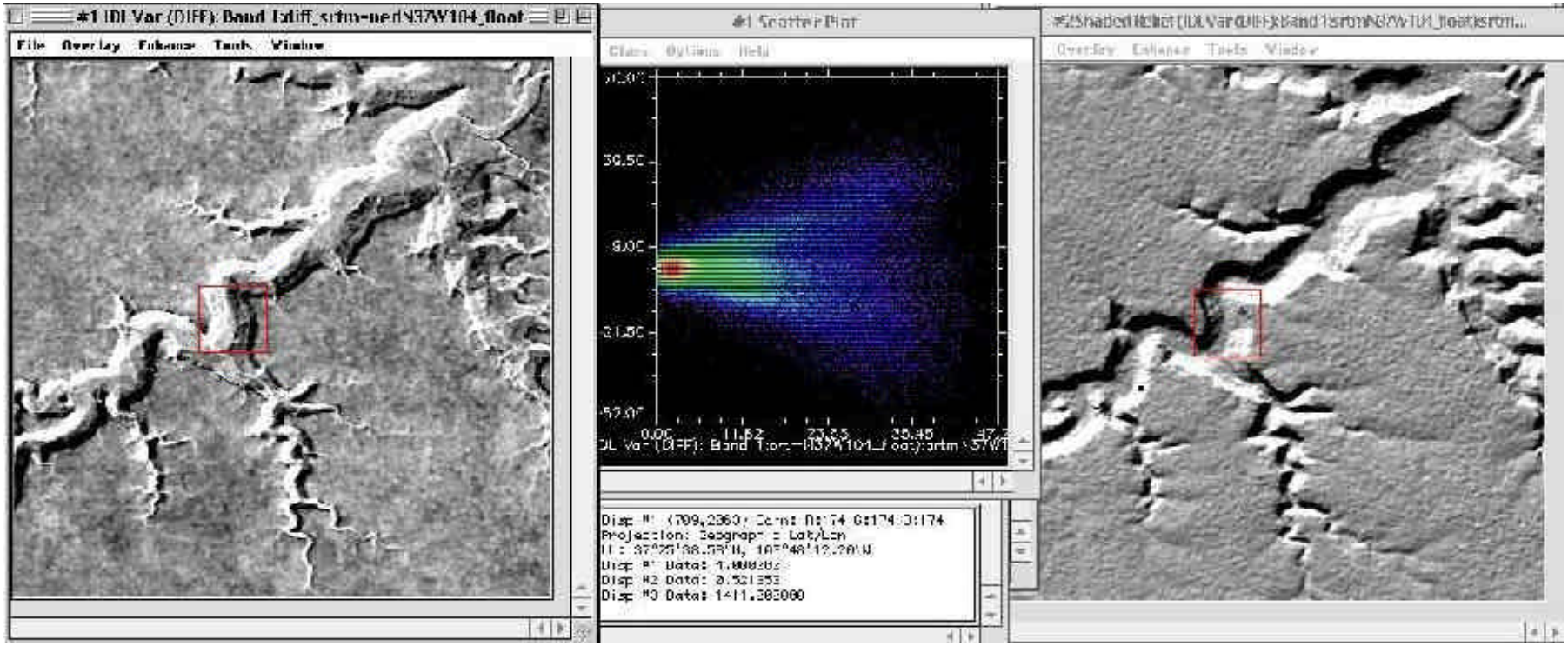




GDPS quality much higher than PI processed data. NED artefacts now an issue.

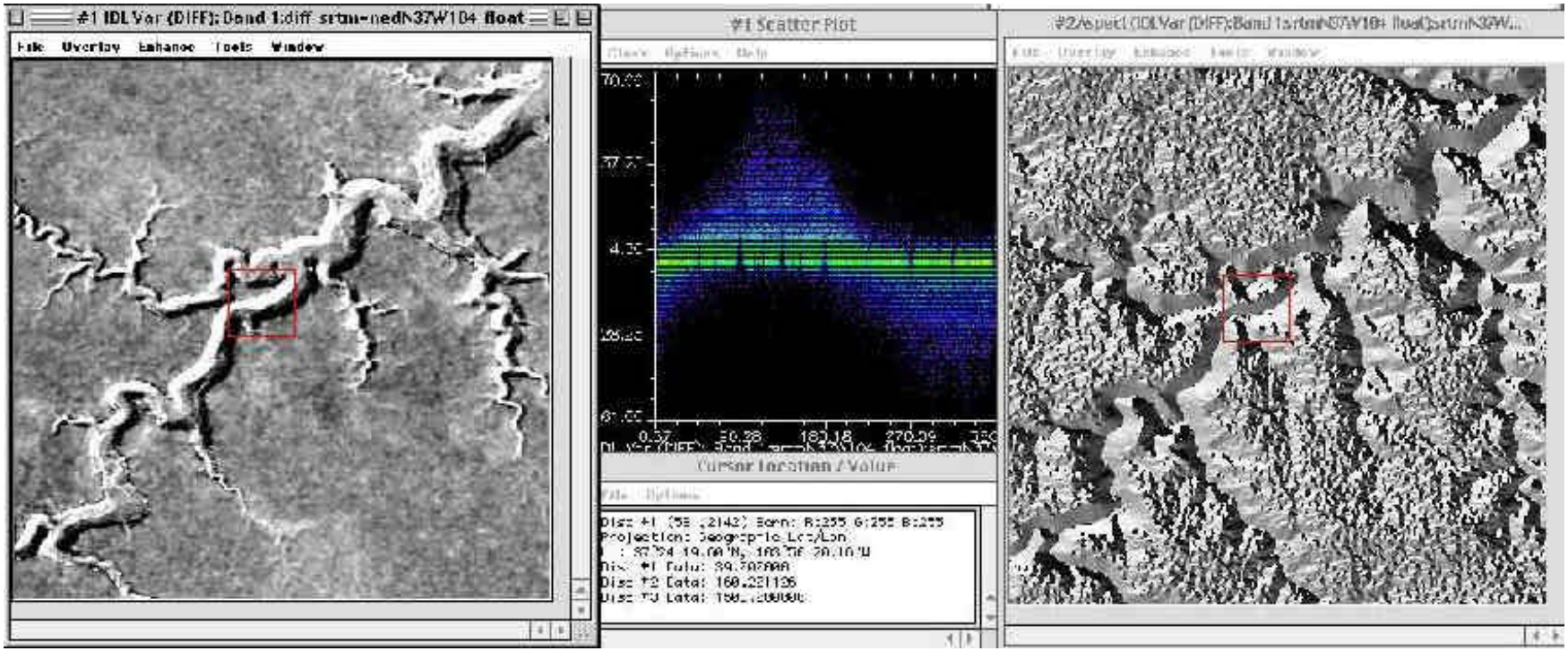
Min	Max	Mean	Stdev
-65.00	70.00	0.42	5.24

SRTM (GDPS) intercomparison to NED slope



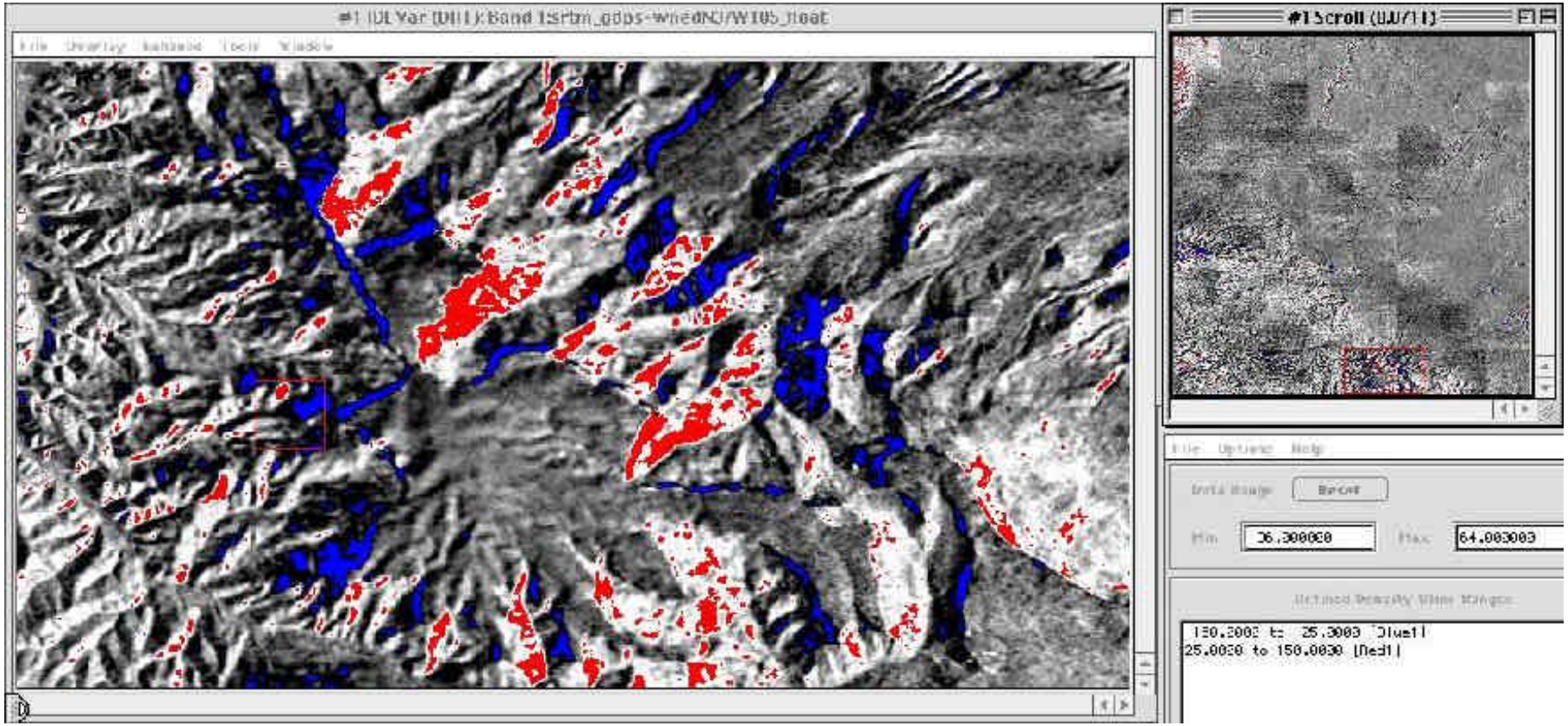
N.B. SRTM-NED height differences at 1” also related to slope

SRTM (GDPS) intercomparison to NED aspect



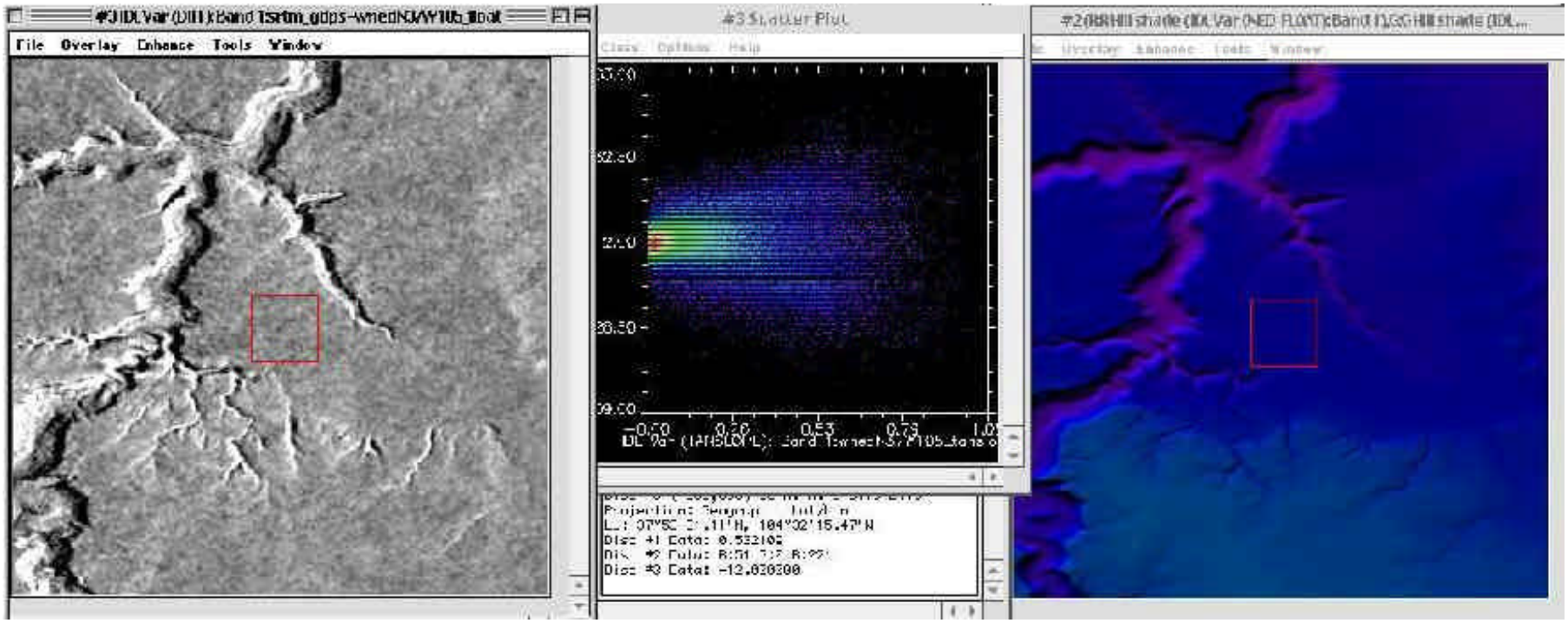
N.B. SRTM-NED height differences at 1” related to SAR look angle

SRTM (GDPS)-NED height differences related to SAR look angle



N.B. SRTM-NED height differences at 1” related to SAR look angle
(positive differences towards SAR, negative on backside slopes)

SRTM (GDPS) intercomparison to tangent of NED slope



N.B. The slope of the tan(slope) to SRTM-NED depends on the roughness of the terrain

Conclusions

- **C-SRTM GDPS DEM products of much higher quality than equivalent PI processor products**
- **C-SRTM - NED height differences appear to be correlated with Tan(slope) and aspect probably due to SAR look angle effects**
- **Not possible to confirm this as only incidence angle provided with PI products**
- **No strong relationship between C-SRTM - NED and land cover for this area (different for subsequent areas)**
- **Artefacts dominate the NED but are well detected using local RMS measure**
- **Quality much higher than nominal DTED-2 specification**
- **Spatially variable shifts between SRTM and NED (magnitude 0.5-1 grid) still present (not shown here)**