



NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY
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ASTER V2 Evaluation

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NGA

UNCLASSIFIED





- **Purpose.** To describe the performance of ASTER V2 elevation dataset.
- **Background.** SNAT has been asked to perform a data quality review of a new version of ASTER elevation data. Review will be performed on the data as a stand-alone product, relative to version 1 ASTER, and relative to a truth DEM (SRTM). As resources within SNAT are limited, we are trying to develop tools to help automate, and thus speed up and reduce the number of bodies needed for, our review of the new ASTER data.
- **Bottom Line.**
 - ASTER review tools were developed to collect quality control statistics for the new ASTER data, the difference between the new ASTER data and version 1 of ASTER, and the difference between the new ASTER data and SRTM.
 - These tools allow us to see broad trends in the data and will guide the “eyes-on” review.
 - 284 cells (same cells NGA reviewed for V1) were reviewed using the automated tools.
 - A limited “eyes-on” review was also performed over known problem areas from version 1.



Tools Overview

- Two tools were developed for ASTER review.
 1. ASTER Metrics tool
 - The aster metrics tool looks at each ASTER tile individually and collects the following metrics: File Minimum, File Maximum, Number of Spikes and Wells, Number of Wells, Minimum Well value, Number of Spikes, Maximum Spike Value, Number of Void Posts, Percent Void, Number of Voids, Maximum Void Size, Minimum Void Size, Mean Void Size, Number of Zero Elevation Values, Type of Zero Elevation Value, Geographic Corners of Tile.
 2. ASTER Difference tool
 - The ASTER Difference tool compares each ASTER tile to either ASTER version 1 or SRTM.
 - It collects the following metrics: Filenames of tiles compared, Average Difference, Standard Deviation of Differences, Median Difference, Maximum Difference, Minimum Difference, E-W shift, N-S shift, Horizontal Shift Magnitude, Horizontal Shift Direction, Geographic Corners of Tile.
- Output from each of the tools is a table of values that can be viewed in excel or imported into ArcMap as a shapefile to be viewed graphically.



The following set of slides are based on analysis from the automated tools as described in previous slide.

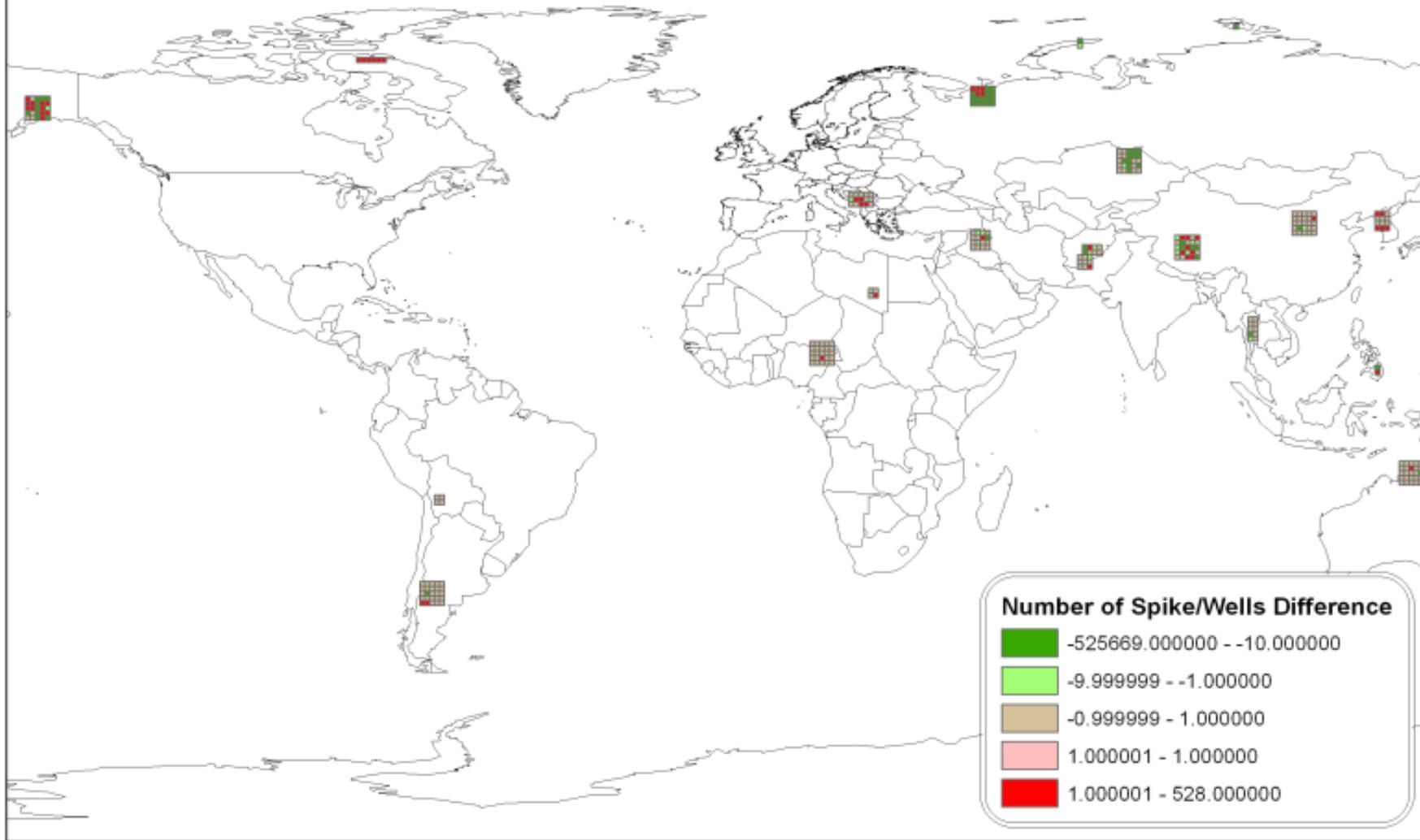


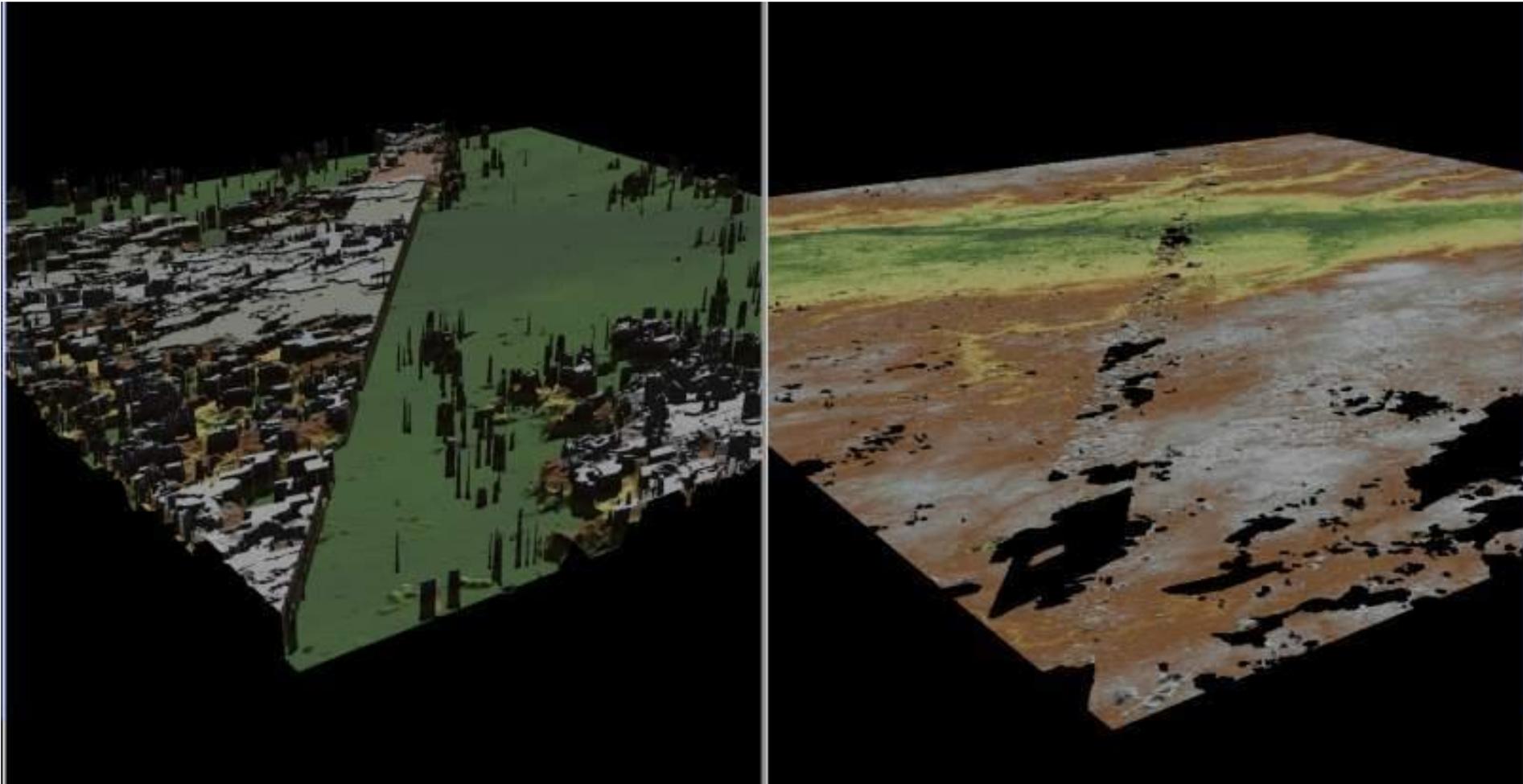
ASTER V2 – ASTER V1 – Difference in Number of Spikes/Wells

- Taking all 284 cells as a whole, ASTER V2 has fewer spikes/wells than ASTER V1.
 - The average change in the number of spikes/wells **per cell** is -7119.14 (i.e. v2 has fewer spikes/wells per cell than v1).
 - A large number of spikes/wells (1000+) were removed from 14 cells.
 - A total of 66 cells have fewer spikes/wells in V2 than in V1.
 - A total of 50 cells have more spikes/wells in V2 than in V1.
 - Additional spikes/wells not as visually egregious as those that were removed, but in some cases it can be shown that V1 better represents the true elevation (as compared to srtm).
 - The spatial distribution of where changes in the number of spikes/wells have been made appears somewhat random, though most of the large and most extensive changes occur above 50 degrees North.

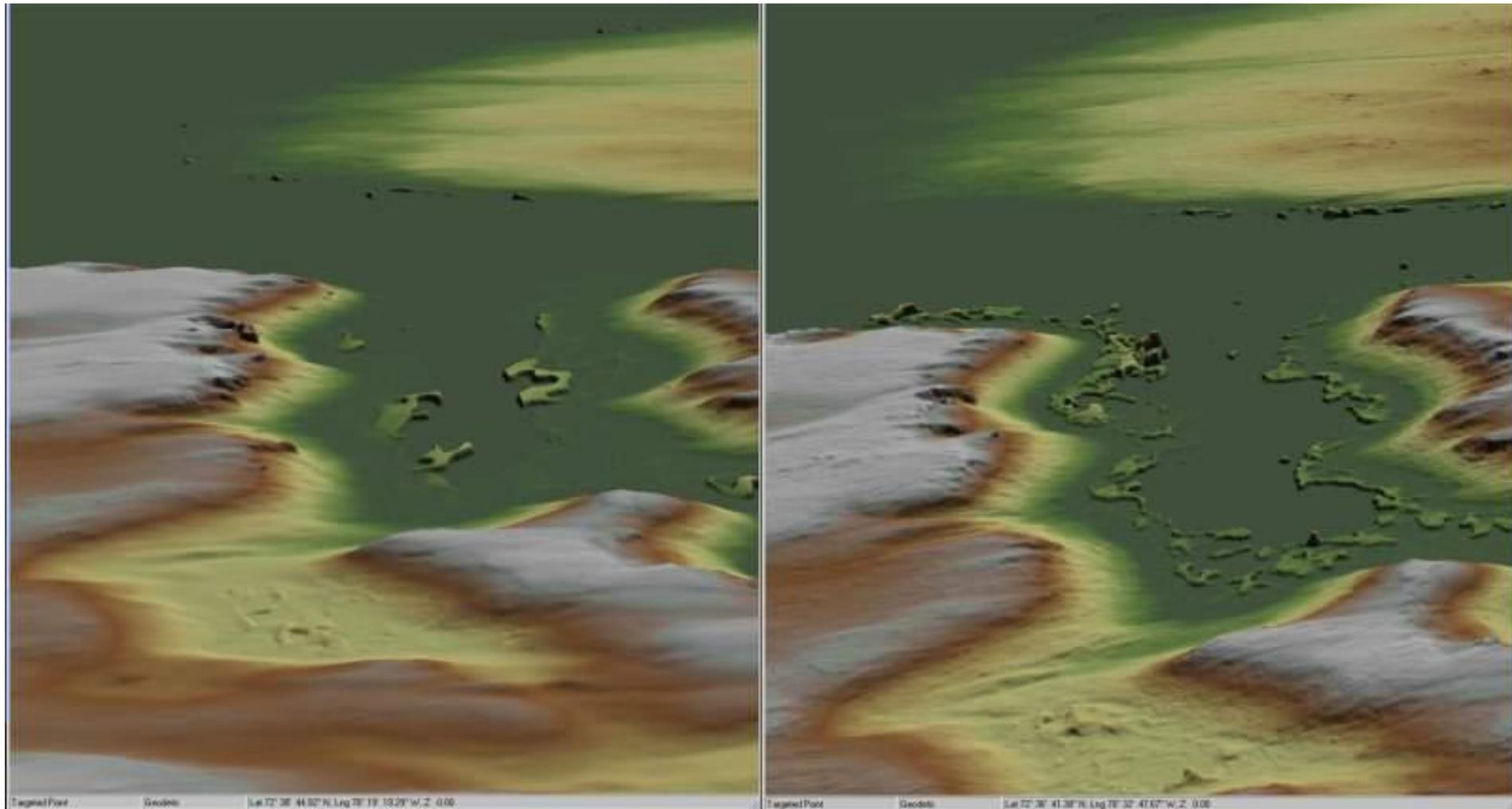


ASTER V2 - ASTER V1 - Difference in Numbers of Spikes/Wells

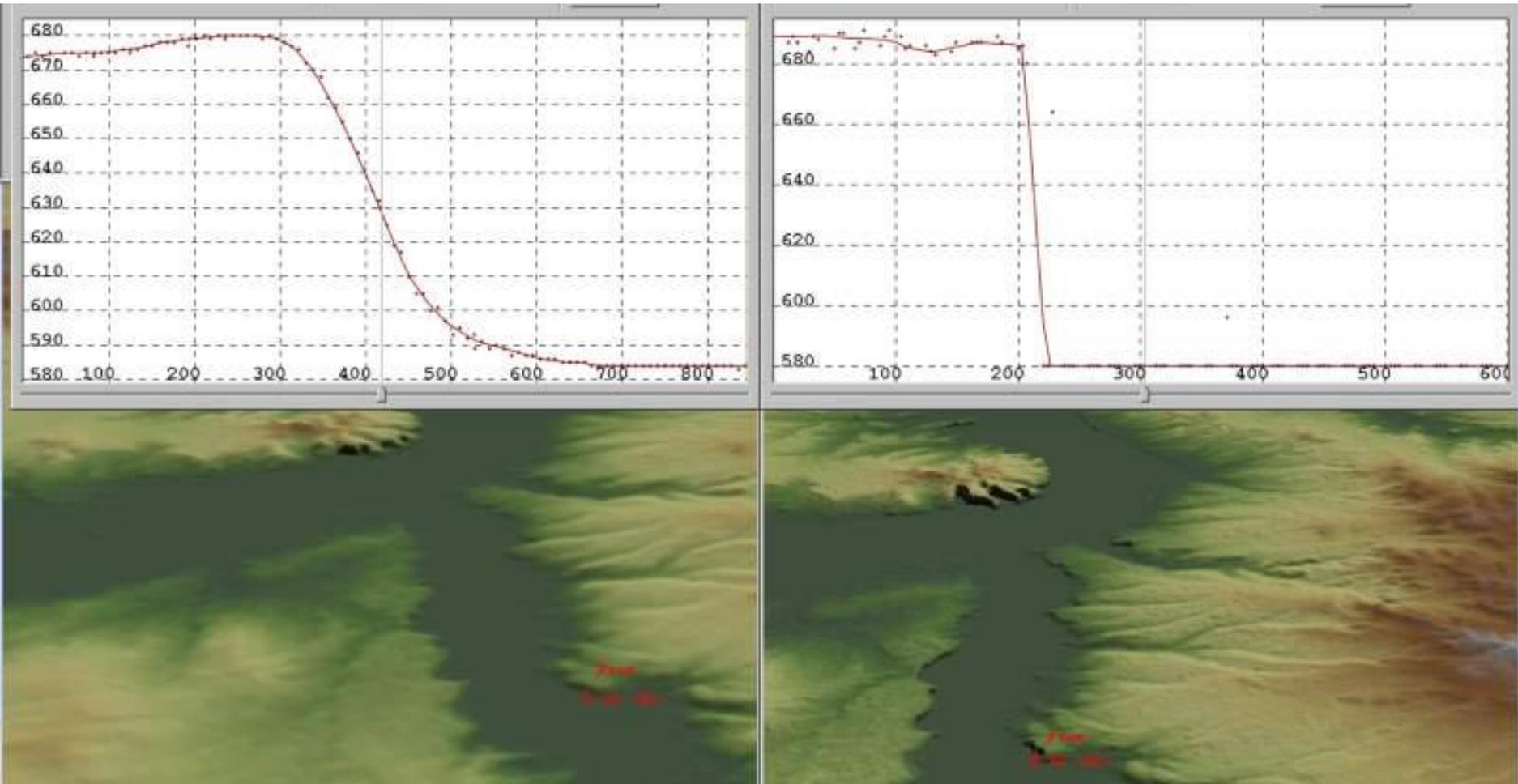




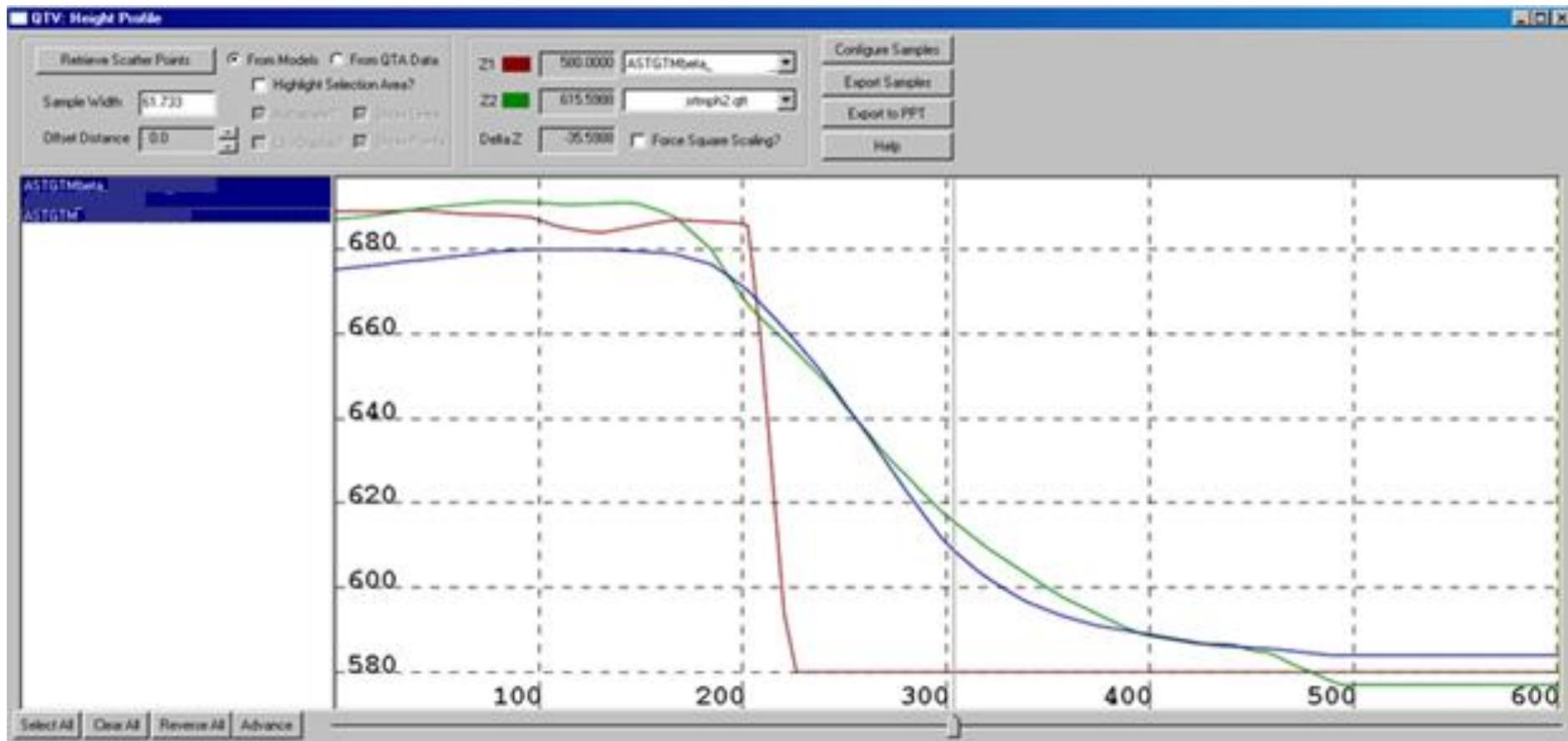
Example: Removal of >500,000 spikes from this cell in V2. Note that additional void is present. Shear was also diminished in this cell, though it is still visible in V2.



Example: Though the convolution implies 500 spikes/wells were added to this cell, they are not as obvious as in previous slide. Detail seems to be improved in V2.



Example: Additional Spikes/Wells in V2. Profile similar in V2 but steeper (s41w71).



(Continued from previous slide) V1 more closely matches SRTM in this area where additional wells were introduced by a more vertical cliff line.

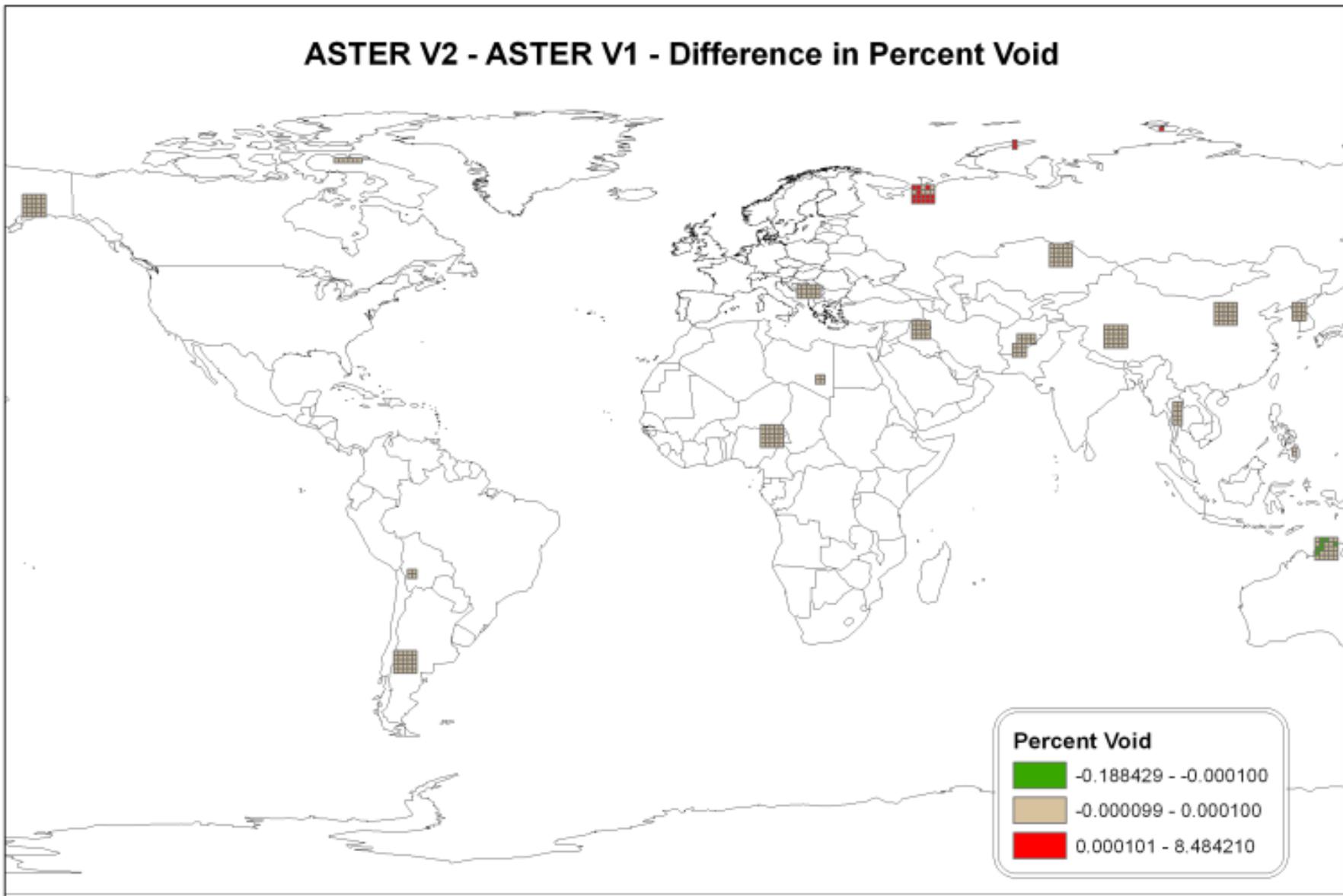


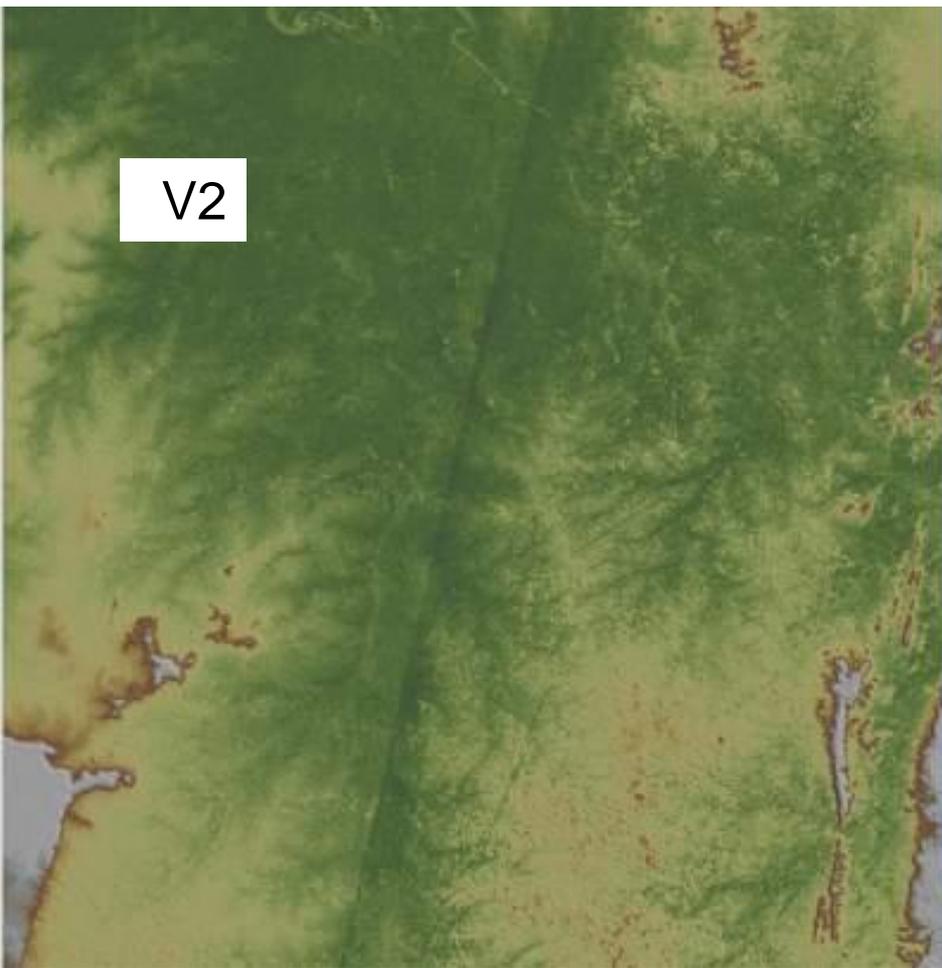
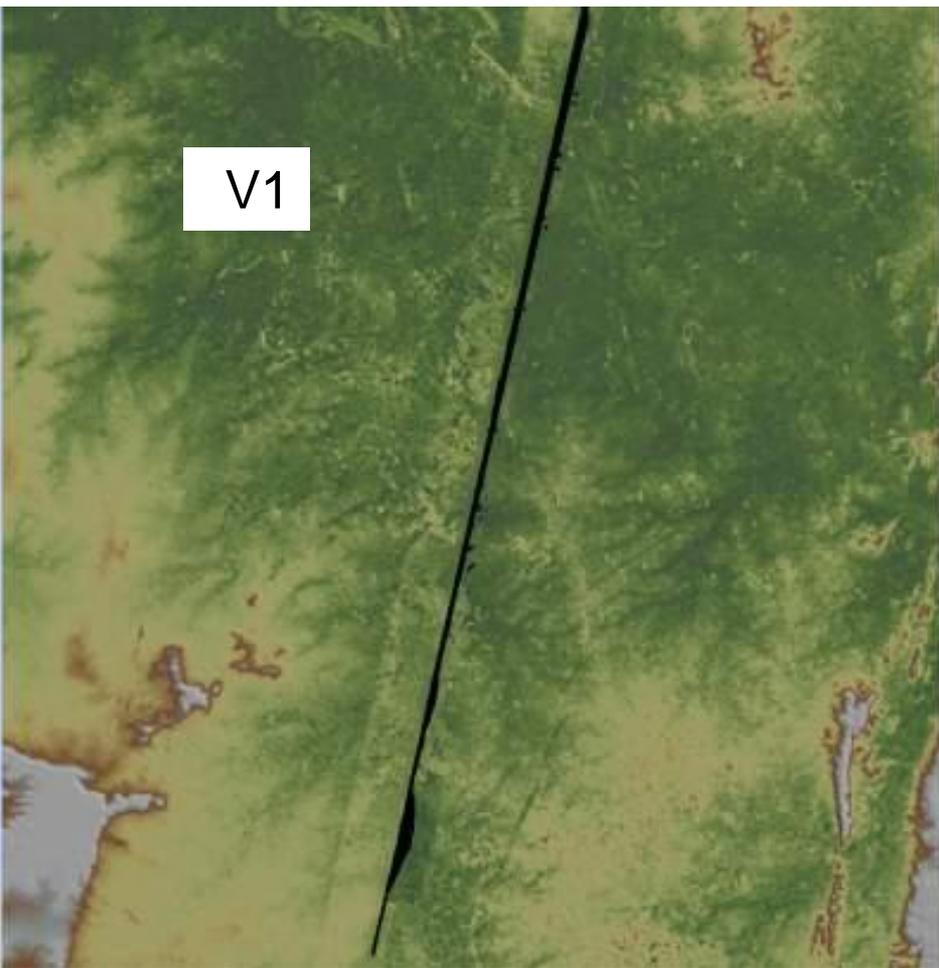
ASTER V2 – ASTER V1 – Difference in Percent Void

- Taking all 284 cells as a whole, ASTER V2 has slightly more void than V1.
 - Areas with more void occur exclusively above 60N and correspond to areas where large numbers of spikes/wells have been removed and replaced by void.
 - Areas with less void occur around the coast of Australia and fill in small linear voids or “scatter shot” voids.
 - In most instances the addition or subtraction of void is small relative to the size of the cell.



ASTER V2 - ASTER V1 - Difference in Percent Void





Example of a cell with less void in V2.



V1

V2

Example of decrease in void percent in V2.



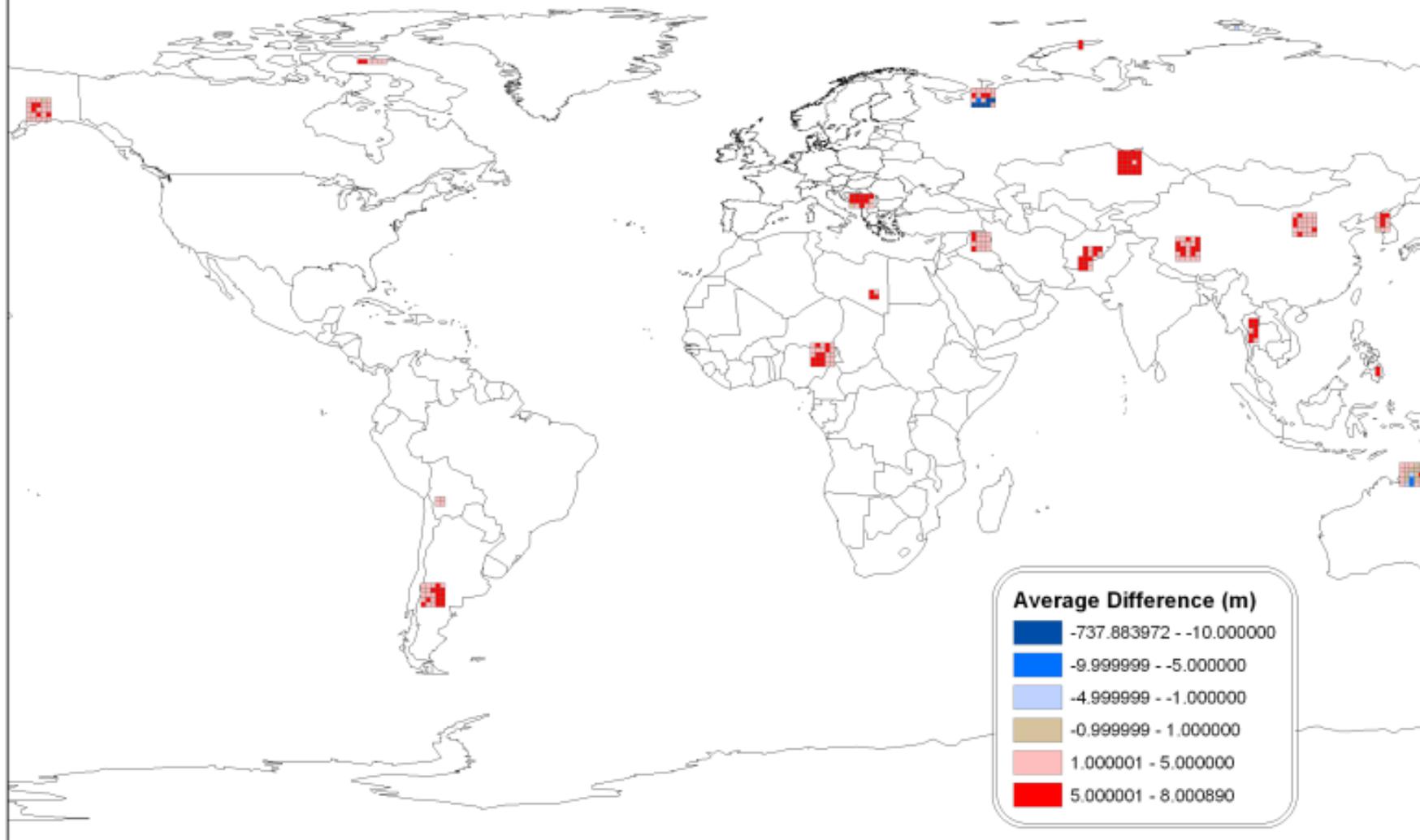
ASTER V2 – ASTER V1 – Average Difference in Elevation Data Values

- Some cells have a high negative difference (i.e. V2 lower than V1).
 - These areas correlate to cells in which large numbers of spikes have been removed.
- Removing the cells with a high negative difference due to removal of spikes from the statistics, V2 has been raised on average ~4.3m (which we were told by USGS would be the case), with a standard deviation of usually <10m. The average median difference is 2.5m.

ASTER V2 – ASTER V1 – Horizontal Shift



ASTER V2 - ASTER V1 - Average Difference in Elevation





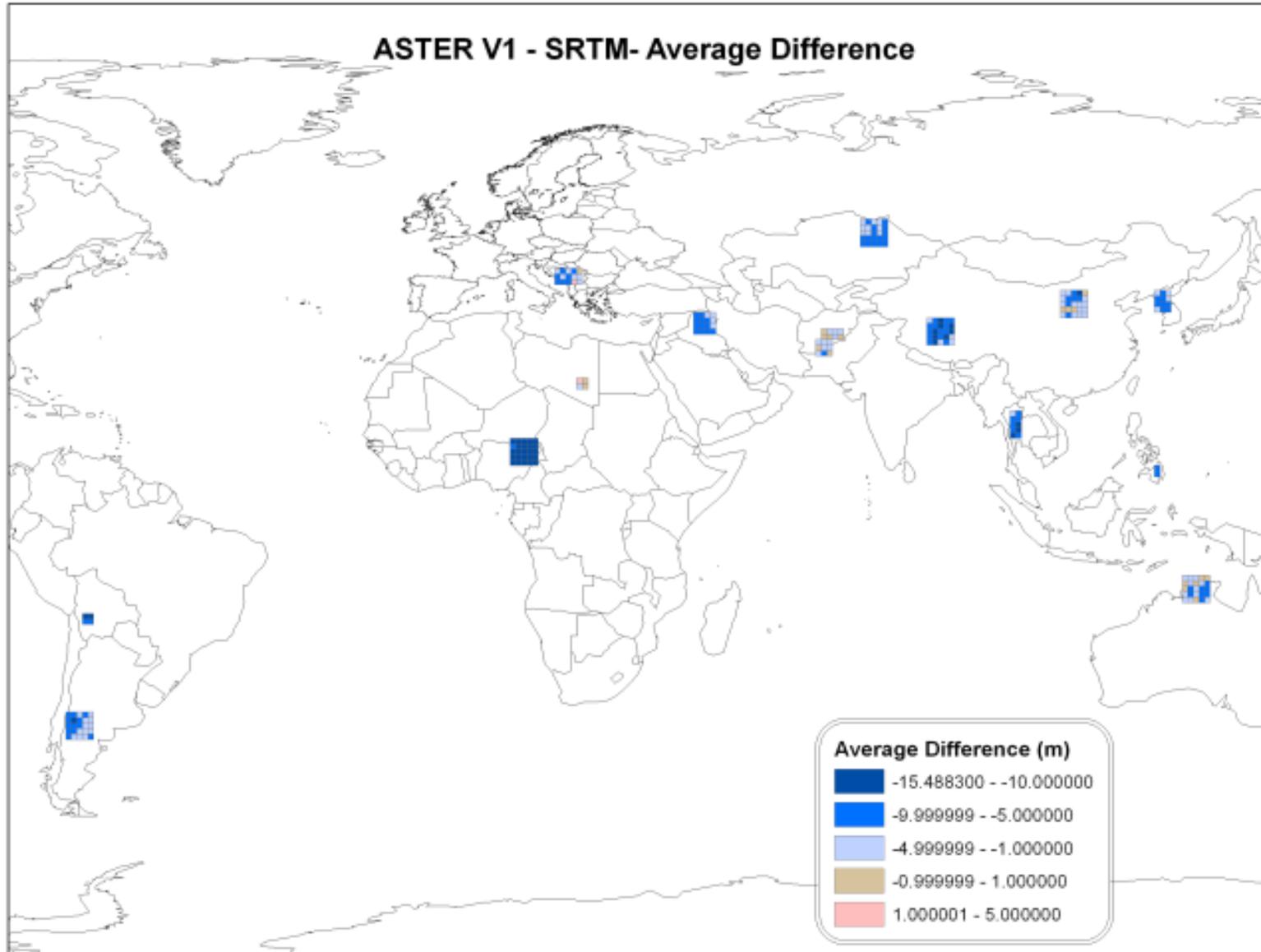
Differences with SRTM

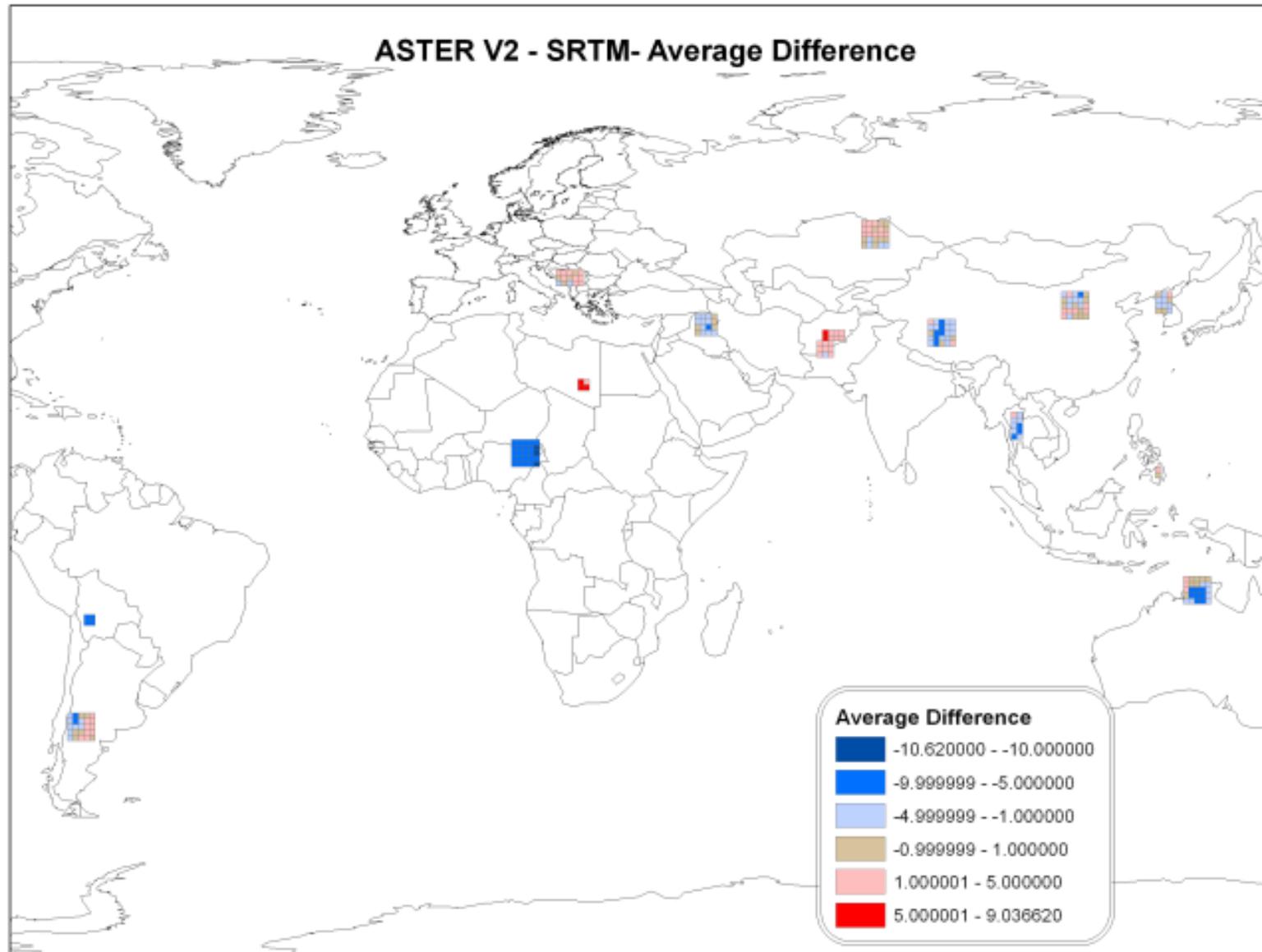
- Statistically, ASTER V2 elevation posts more closely match SRTM elevation posts when comparing the values post to post.
 - This probably reflects the fact that USGS raised V2 ~5m relative to V1.
- ASTER V1 and ASTER V2 show similar magnitudes of horizontal shift relative to SRTM. The shift is extremely small (less than a pixel on average).



Differences with SRTM

ASTER V1								
	Average Difference	Standard Deviation	Median Diff	Max Diff	Min Diff	Xshift (EW)	Yshift (NS)	Horizontal shift magnitude
AVERAGE	-6.087	8.673	-14.365	180.765	-215.769	0.0759	-0.187	0.616
MIN	-15.488	1.282	-140	14	-900	0	0	0
MAX	2.535	22.171	2	2333	-32	1.333	0.777	2.236
ASTER V2								
	Average Difference	Standard Deviation	Median Diff	Max Diff	Min Diff	E-W shift	N-S shift	Horizontal shift magnitude
AVERAGE	-1.572	8.826	-9.004	127.465	-161.052	0.104	-0.175	0.601
MIN	-10.620	1.065	-132	23	-763	0	0	0
MAX	9.036	20.204	6	425	-32	1.0877	1	2.37



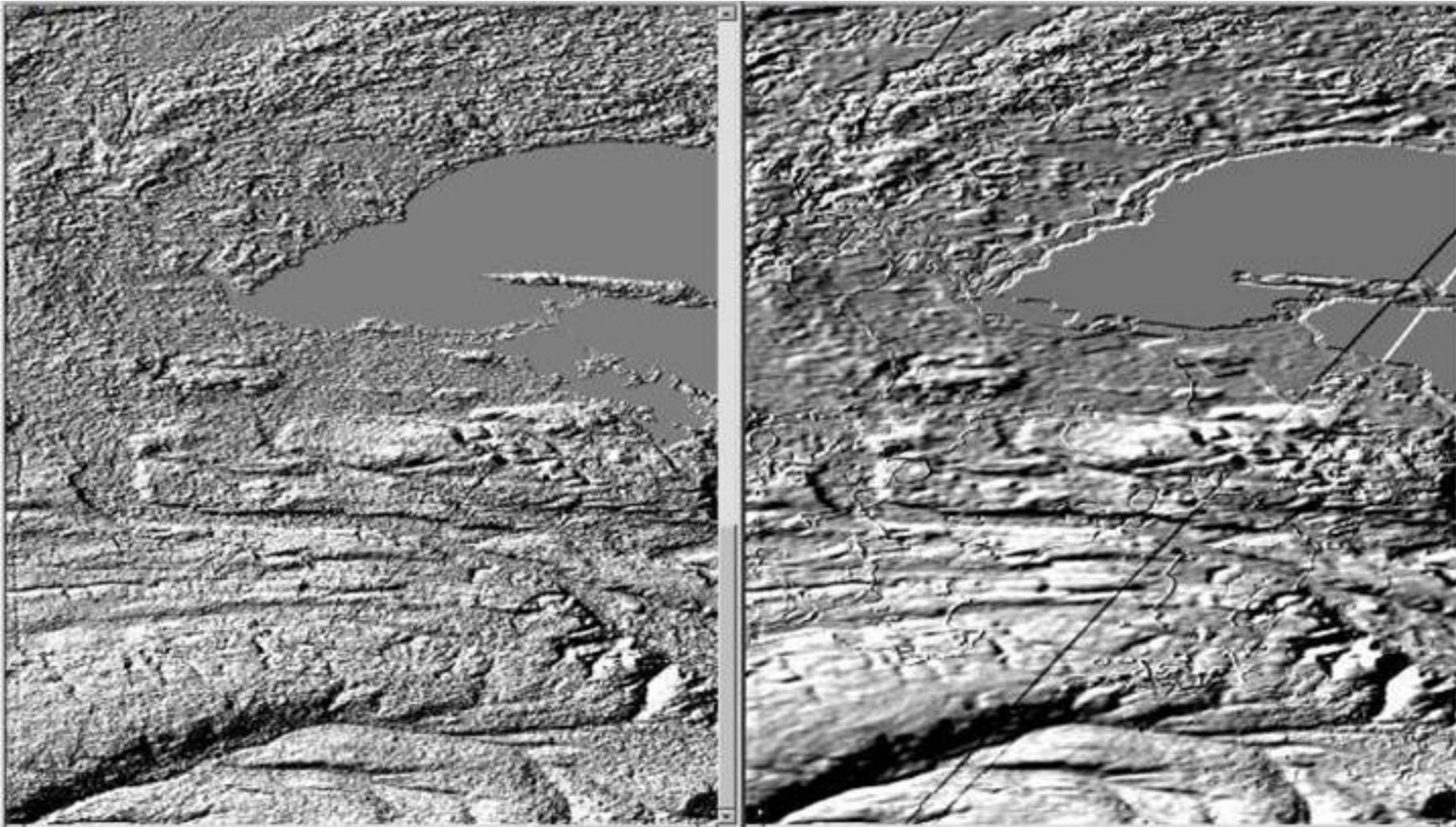




The following set of slides are some screenshots from a quick and limited “eyes-on” review/comparison of problem areas that were identified in the NGA review of ASTER V1.



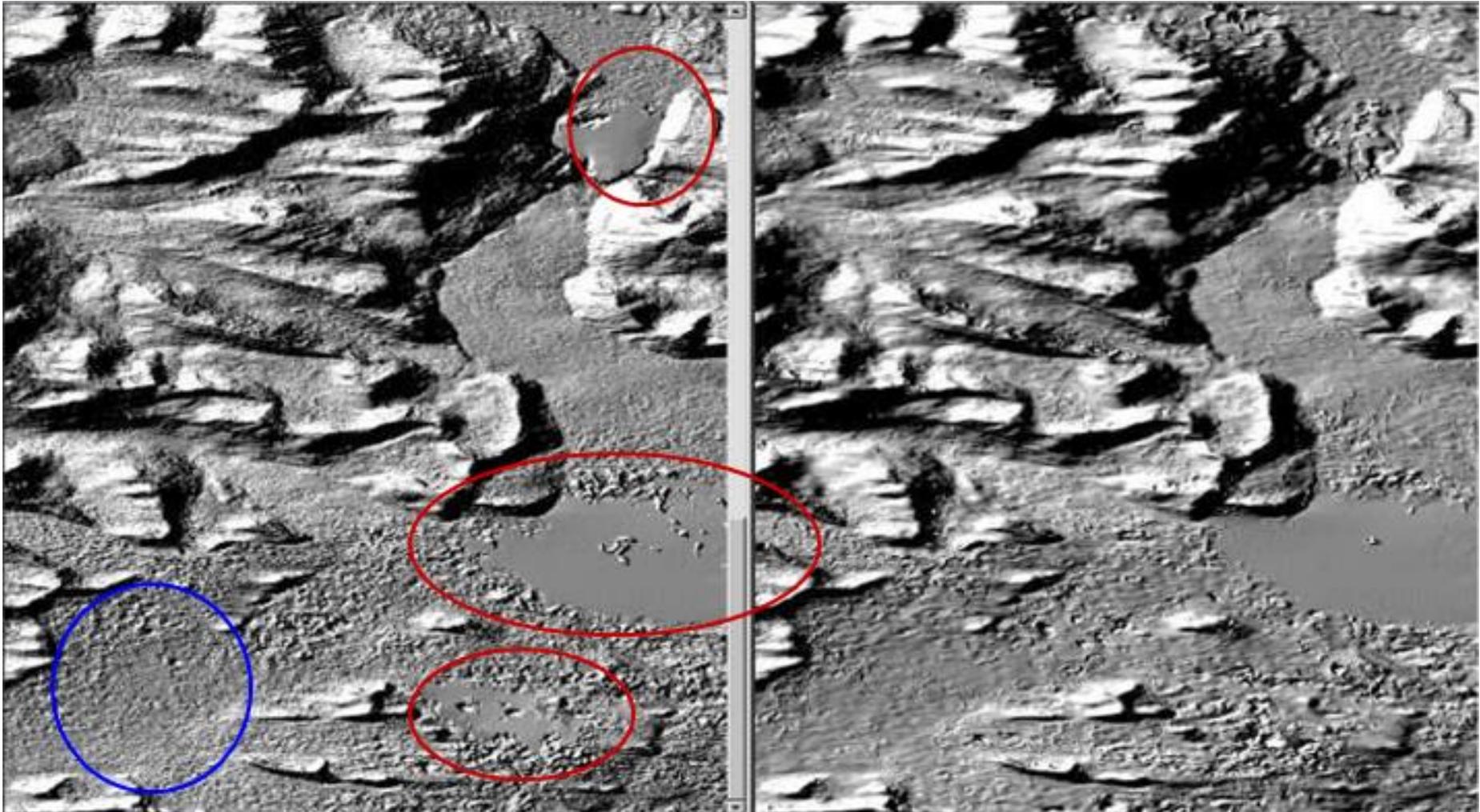
Alaska : Improved hydrology (red) /surface (blue)/scene boundary (green)



- Specific hydrology examples are identified by red, non-hydrology identified by blue, scene boundary (green)
- ASTER V2 (left viewer) vs. ASTER V1 (right viewer)
- The scale of the viewer is @ 75,000.



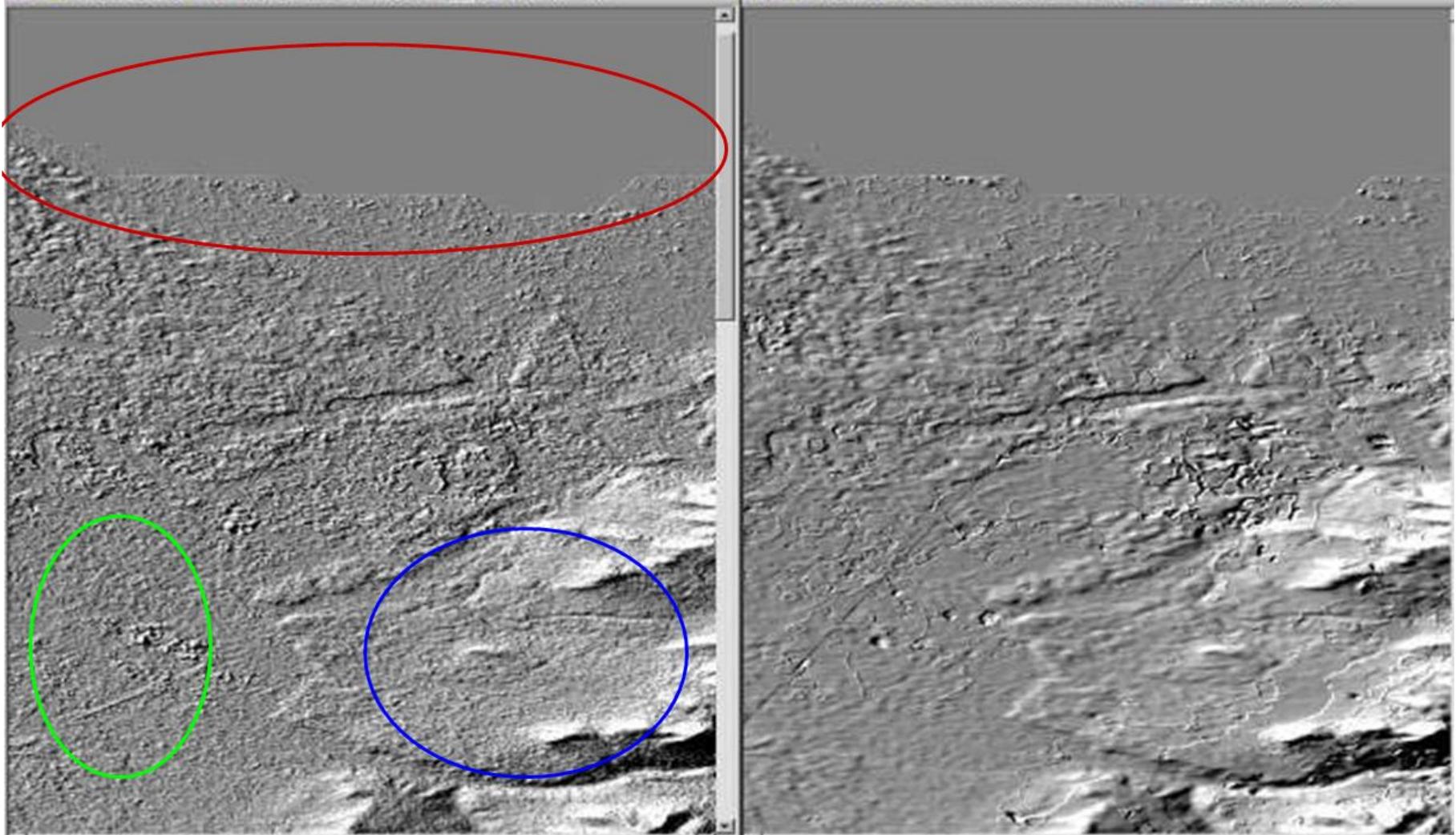
Alaska : Improved surface rendering / possible hydrology issue (red)



- Specific hydrology examples are identified by red, non-hydrology identified by blue, scene boundary (green).
- ASTER V2 (left viewer) vs. ASTER V1 (right viewer)
- The scale of the viewer is @ 75,000.



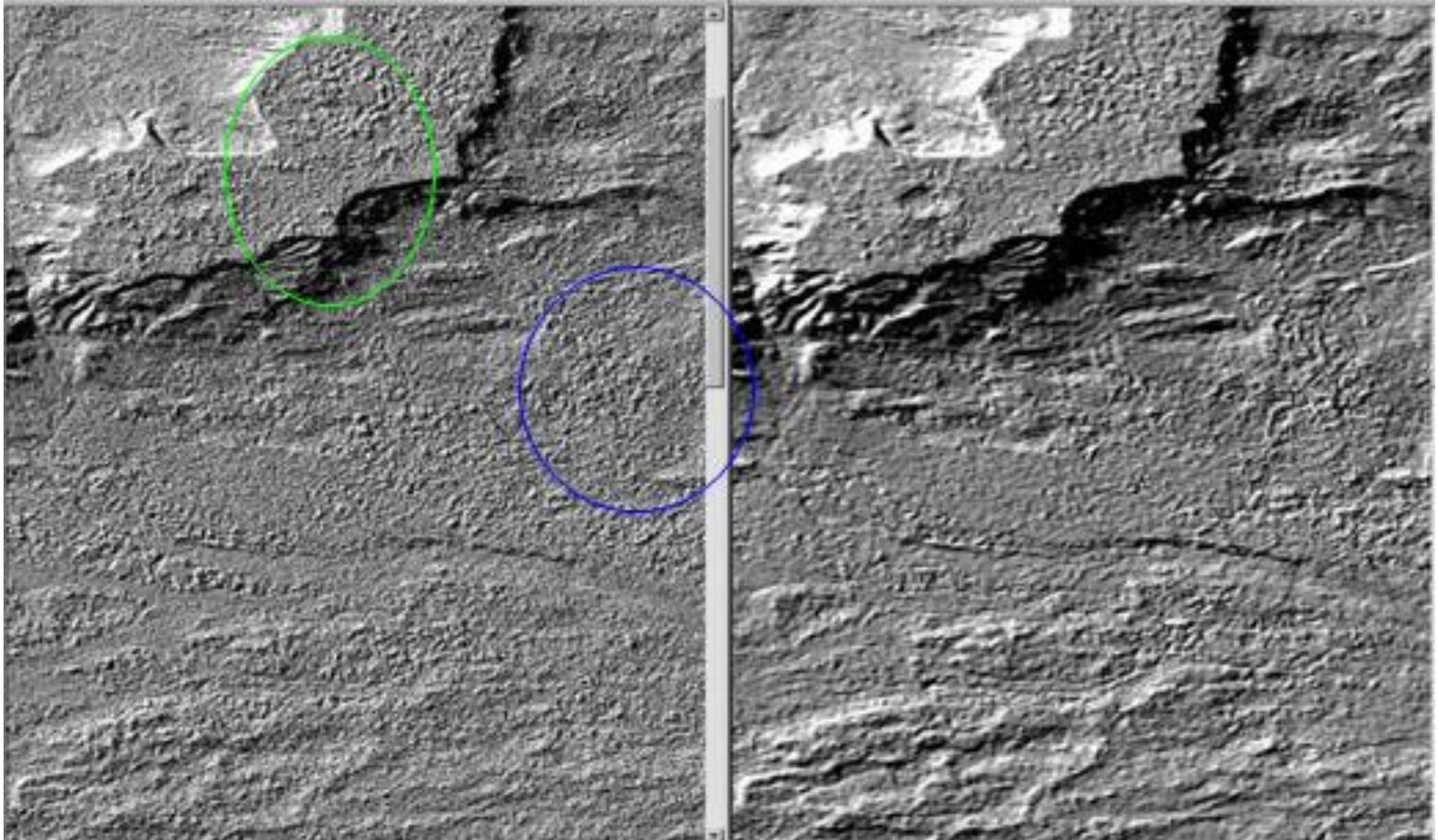
Alaska: Improved surface rendering / forced non SRTM shoreline (red)



- Specific hydrology examples are identified by red, non-hydrology identified by blue, scene boundary (green).
- ASTER V2 (left viewer) vs. ASTER V1 (right viewer)
- The scale of the viewer is @ 75,000.



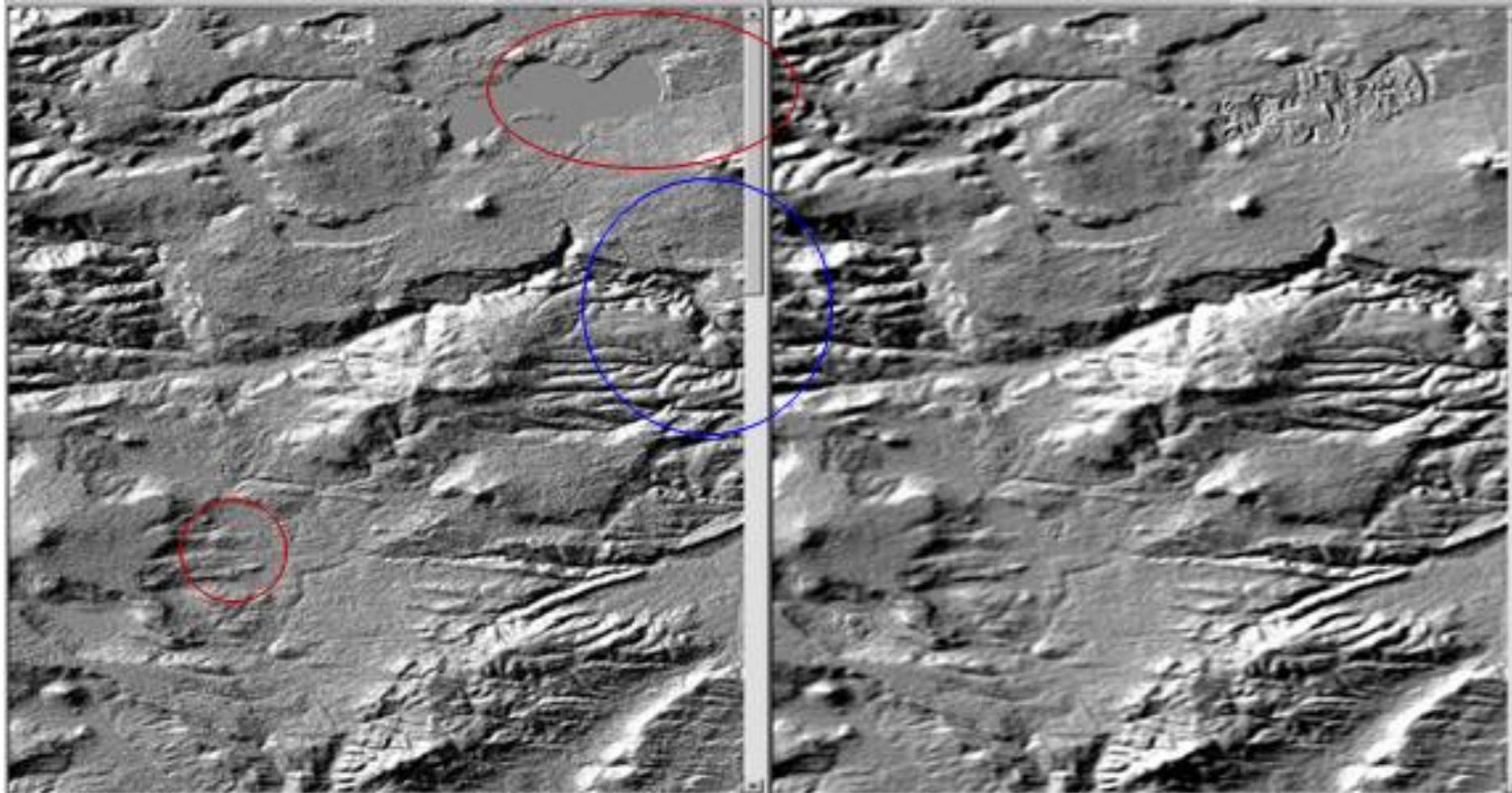
Argentina : Improved surface (blue) / scene boundary (green)



- Specific hydrology examples are identified by red, non-hydrology identified by blue, scene boundary (green).
- ASTER V2 (left viewer) vs. ASTER V1 (right viewer)
- The scale of the viewer is @ 75,000.



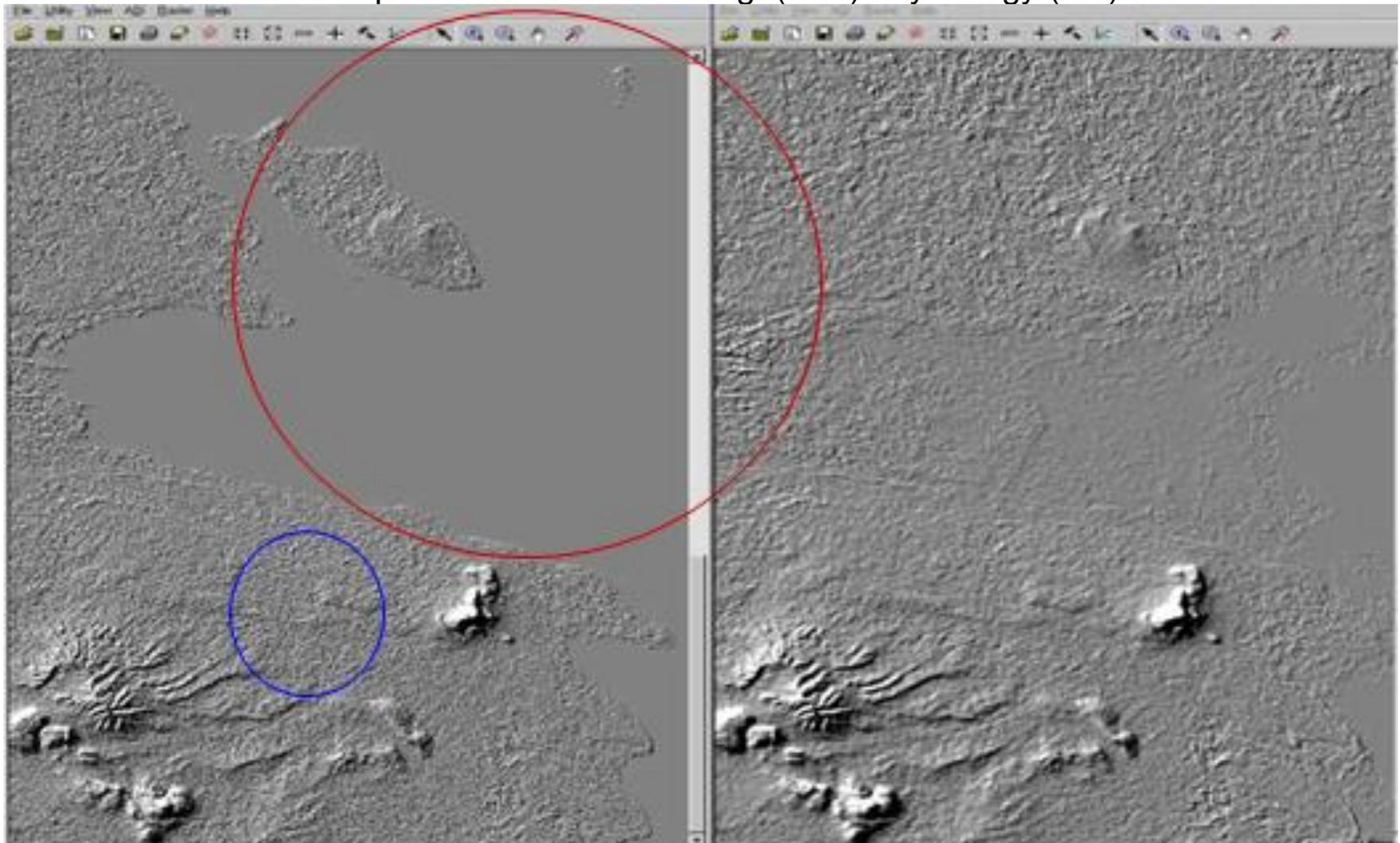
Argentina: Improved surface (blue) / hydrology rendering (red)



- Specific hydrology examples are identified by red, non-hydrology identified by blue, scene boundary (green).
- ASTER V2 (left viewer) vs. ASTER V1 (right viewer)
- The scale of the viewer is @ 75,000.



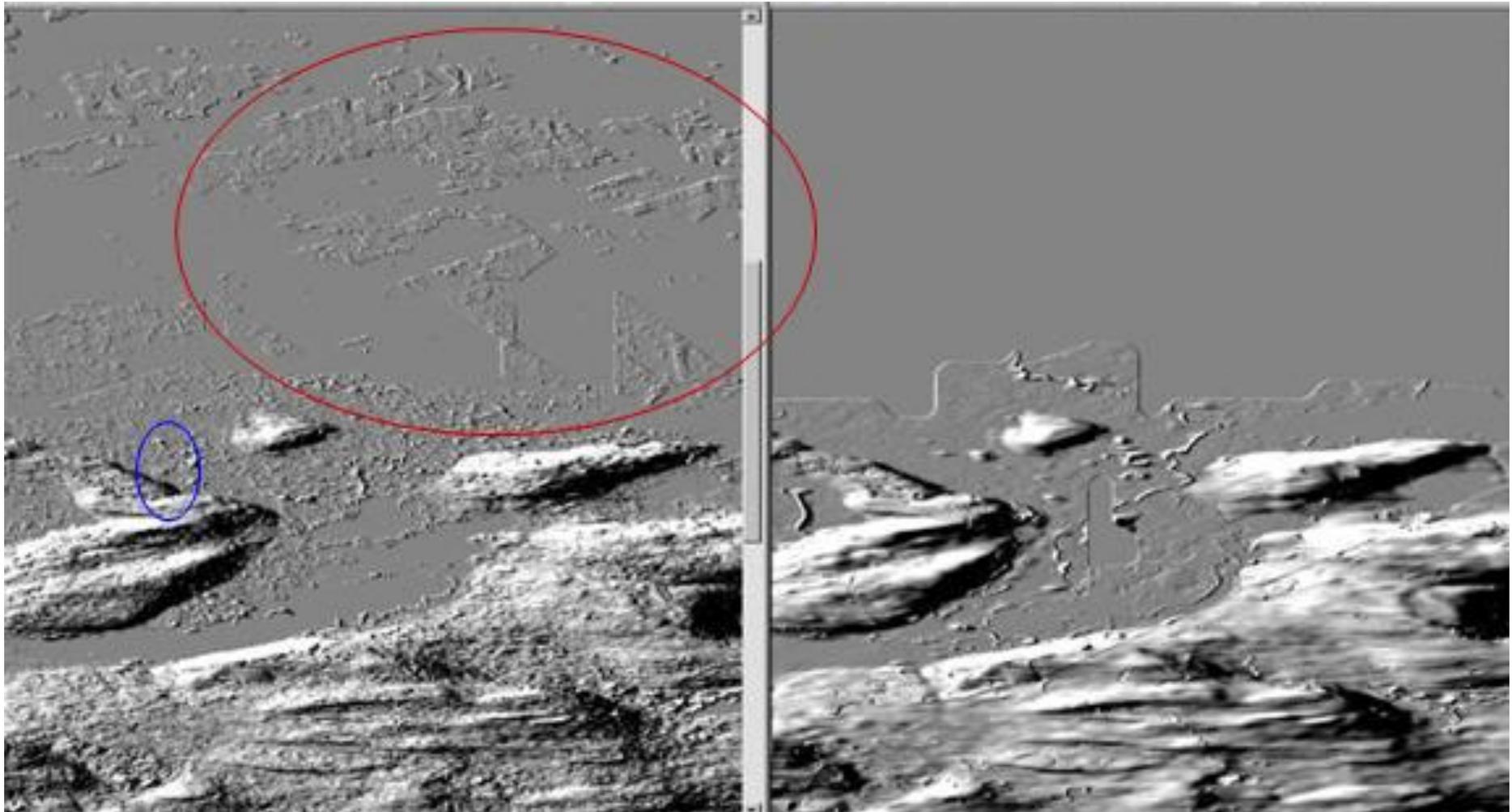
Bolivia: Improved surface rendering (blue) / hydrology (red)



- Specific hydrology examples are identified by red, non-hydrology identified by blue, scene boundary (green).
- ASTER V2 (left viewer) vs. ASTER V1 (right viewer)
- The scale of the viewer is @ 75,000.



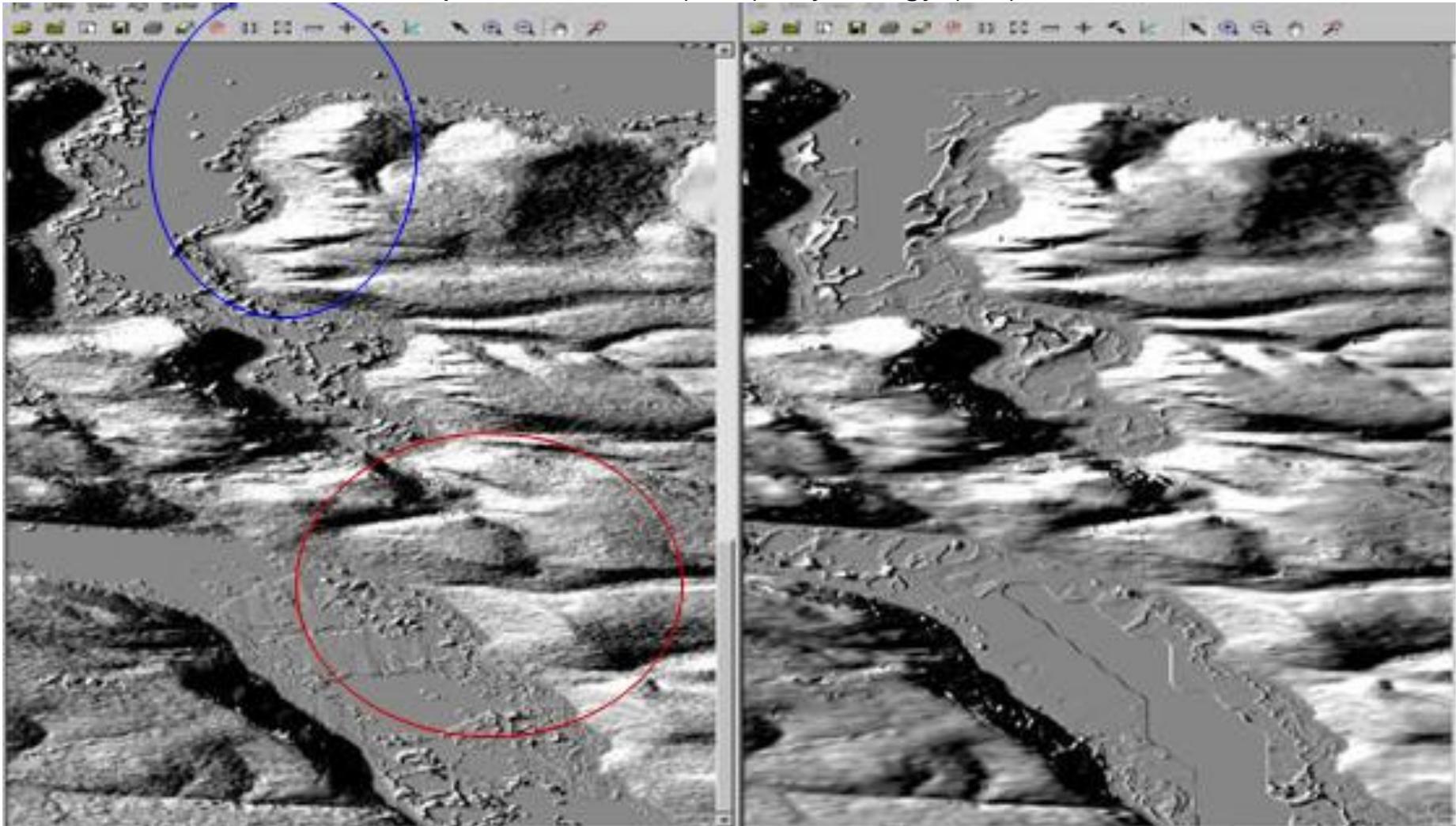
Canada: Improved surface rendering (blue) / questionable hydrology (red)



- Specific hydrology examples are identified by red, non-hydrology identified by blue, scene boundary (green).
- ASTER V2 (left viewer) vs. ASTER V1 (right viewer)
- The scale of the viewer is @ 75,000.



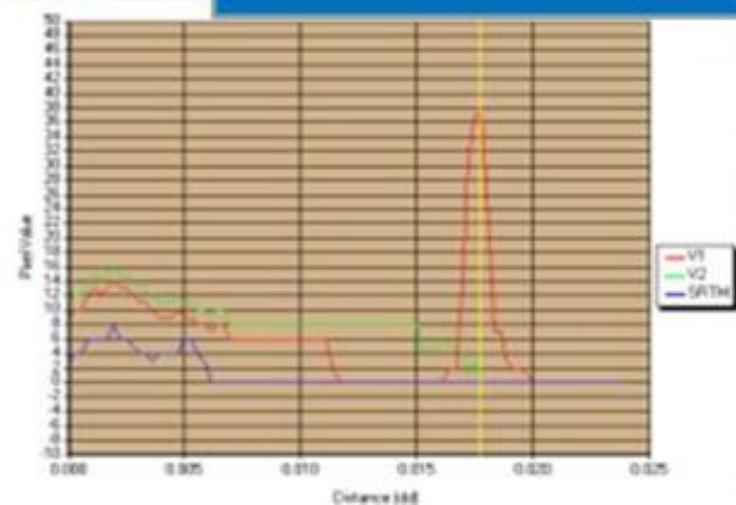
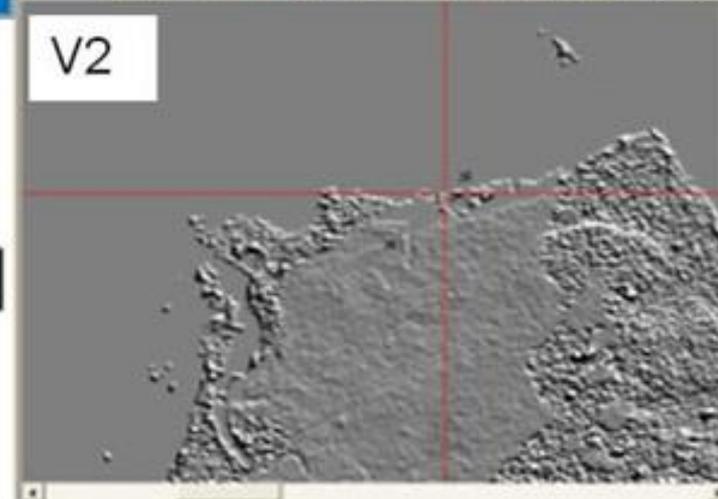
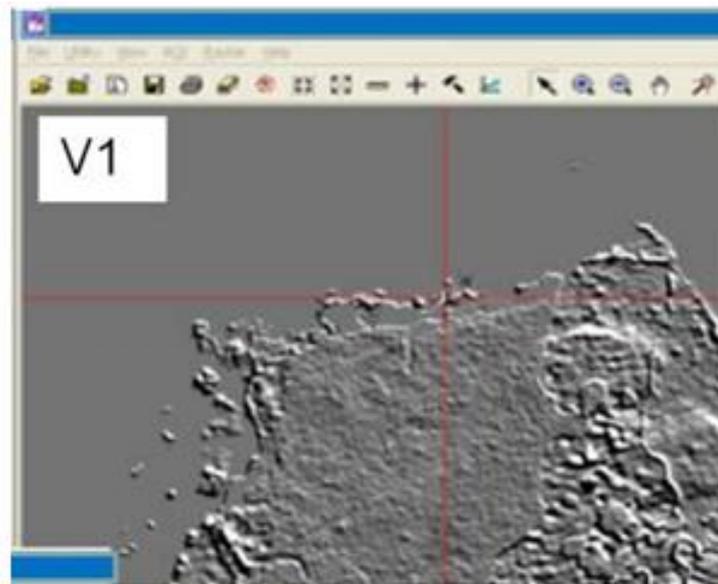
Canada: Improved surface (blue) / hydrology (red)



- Specific hydrology examples are identified by red, non-hydrology identified by blue, scene boundary (green).
- ASTER V2 (left viewer) vs. ASTER V1 (right viewer)
- The scale of the viewer is @ 75,000

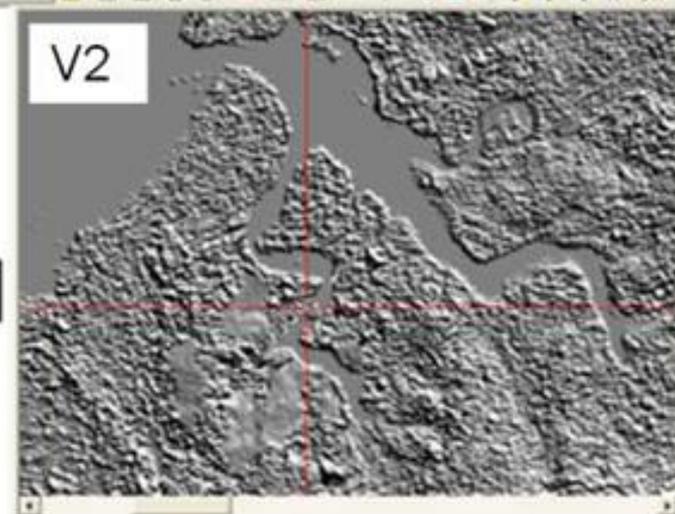
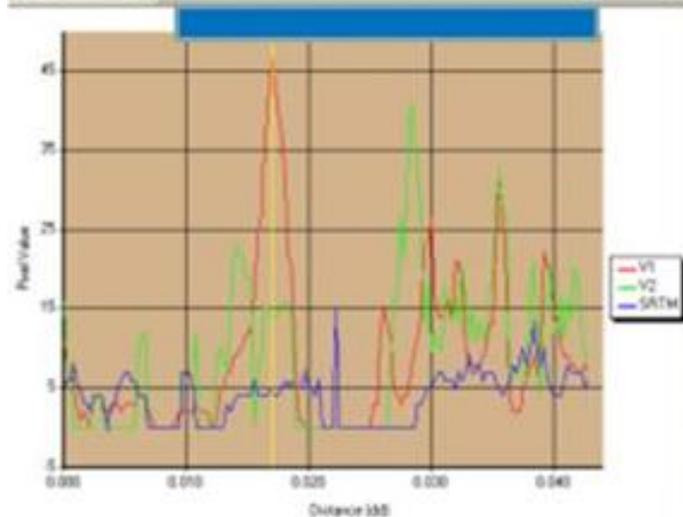
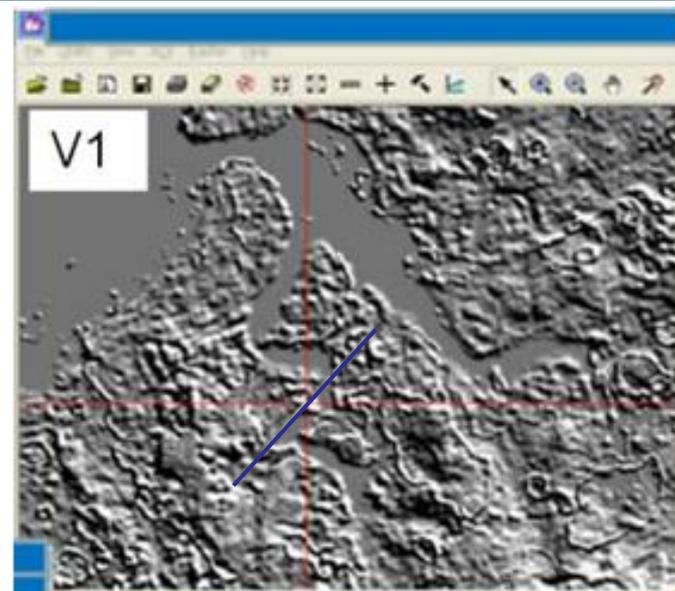


Depiction of coastline and surface texture improved



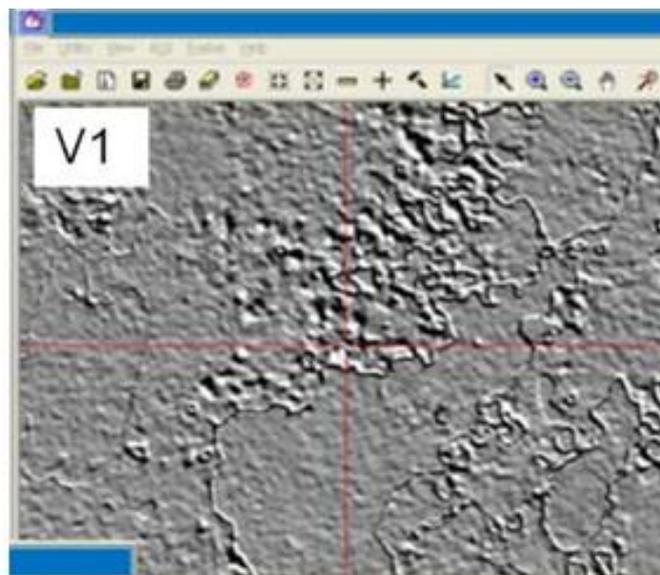


Improved surface (removal of "mole runs")

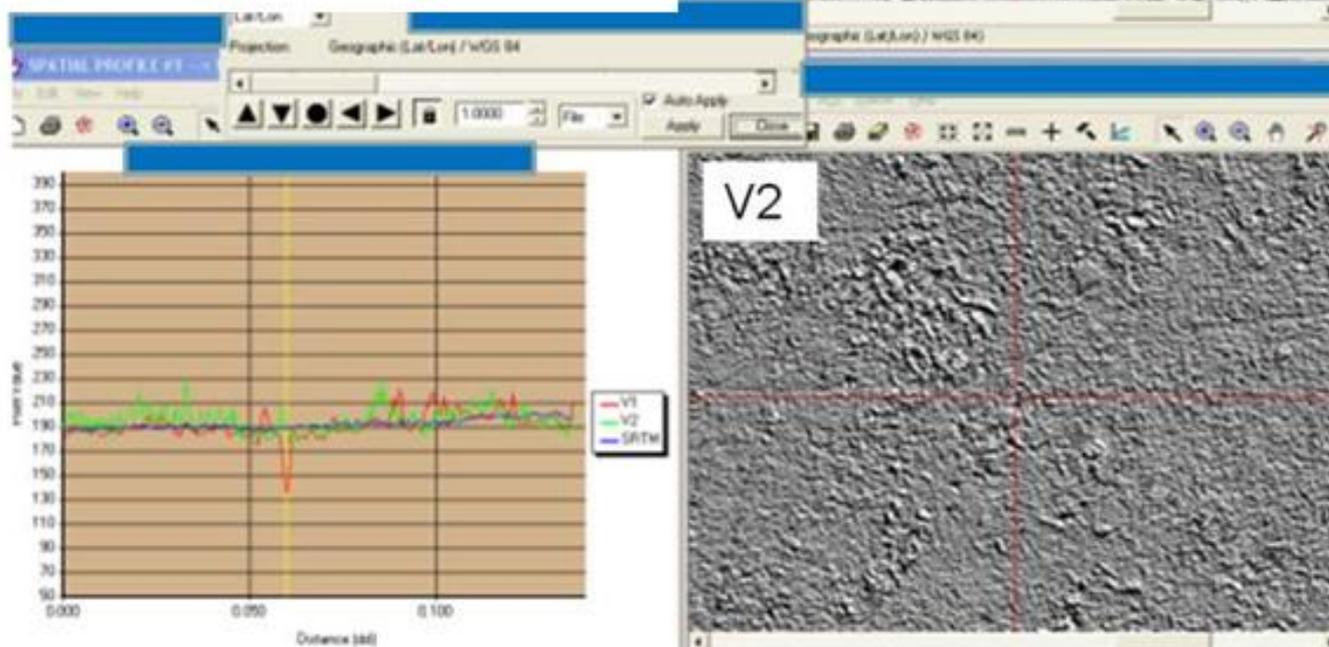




Improved surface (mole runs and pits diminished)

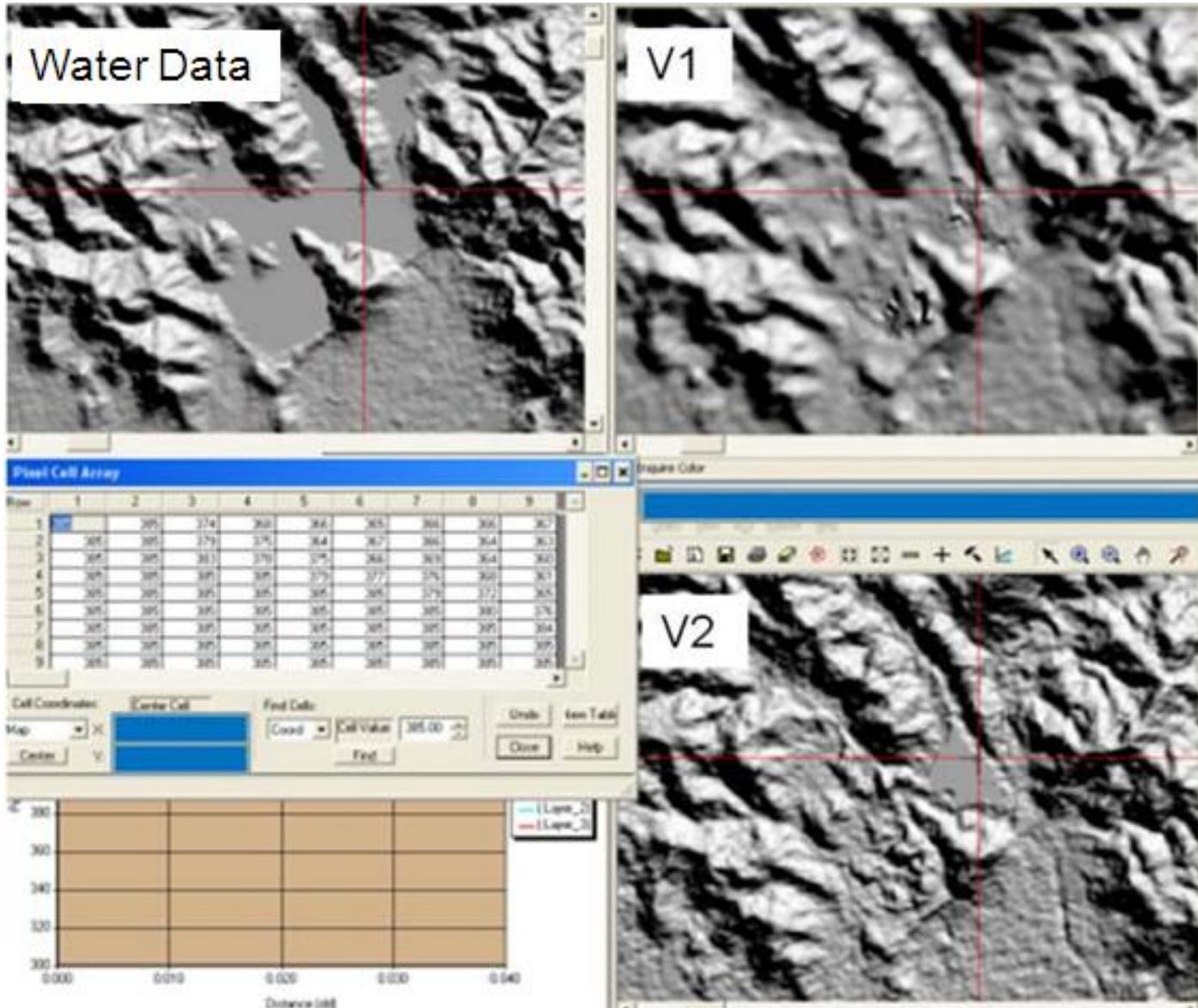


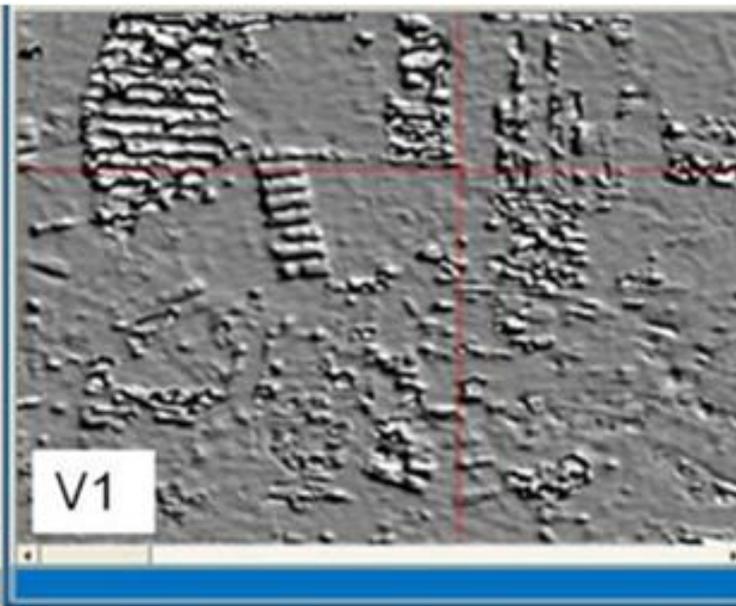
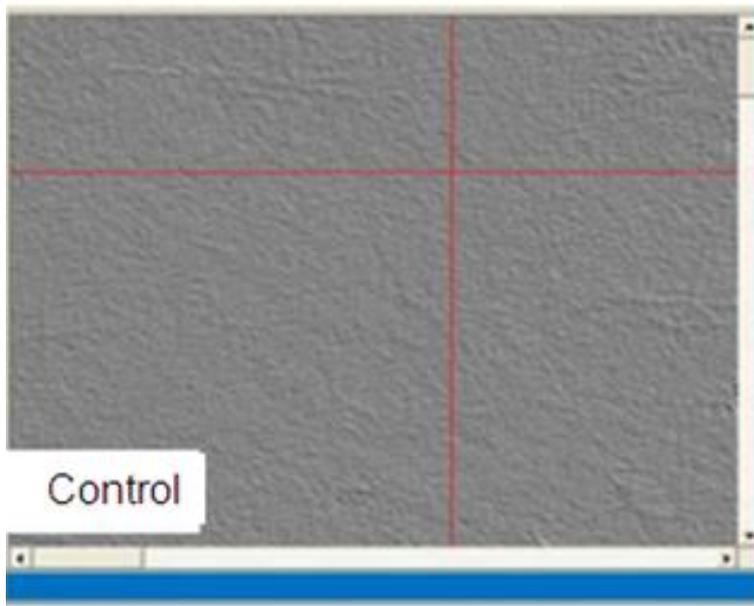
V1



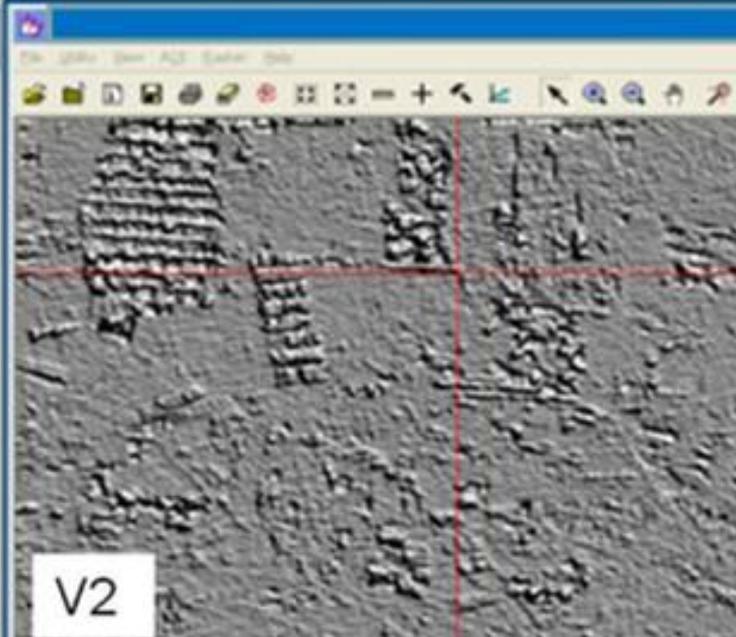


Questionable hydrology



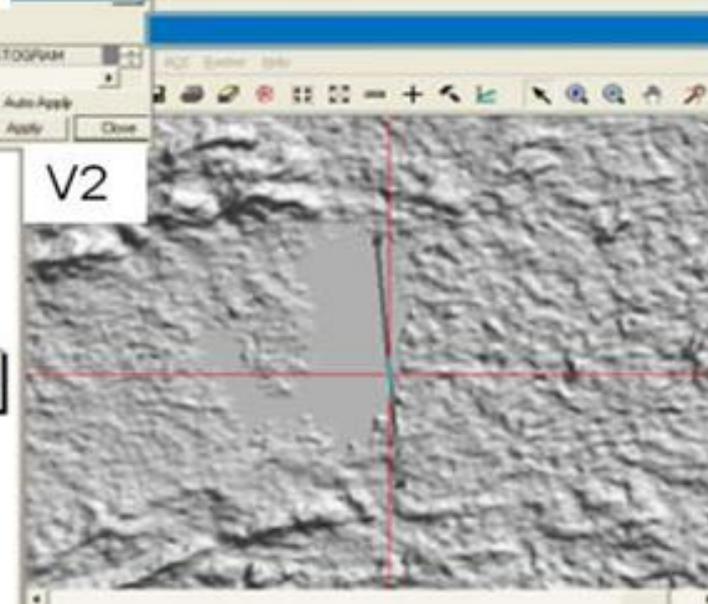
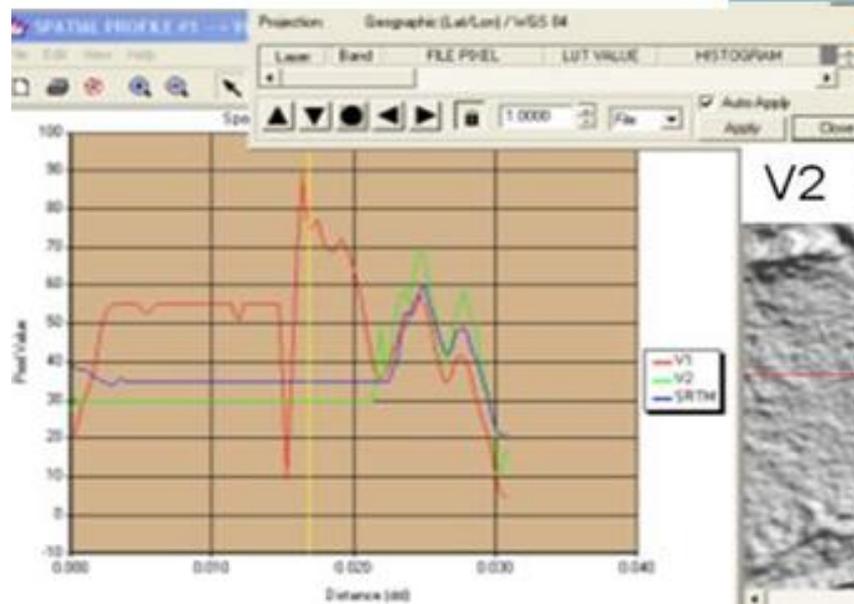
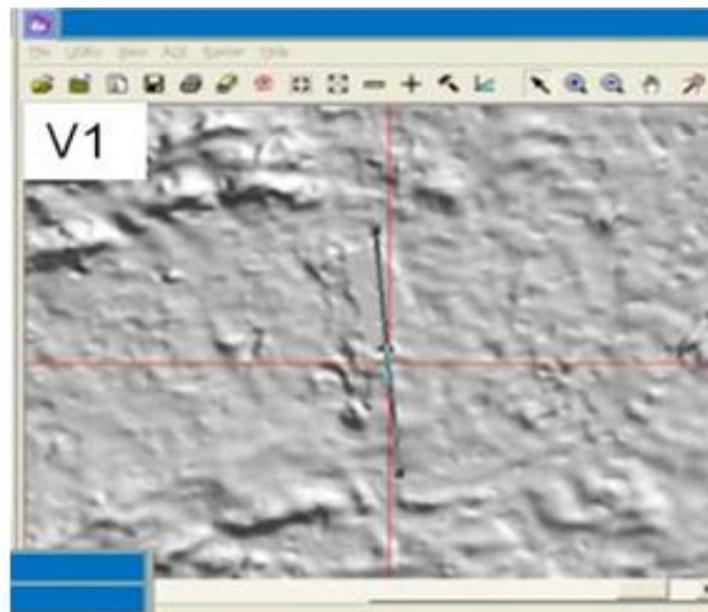


Incorrect portrayal
of landforms as
confirmed by
control data set
and imagery as
well.



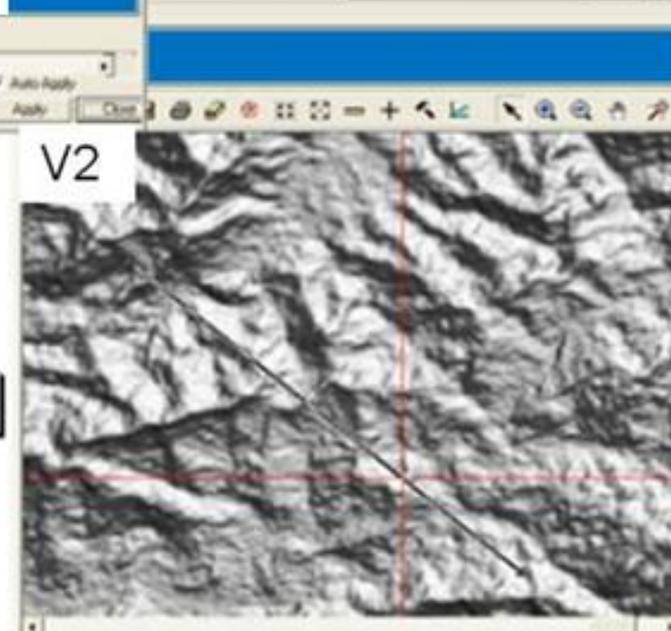
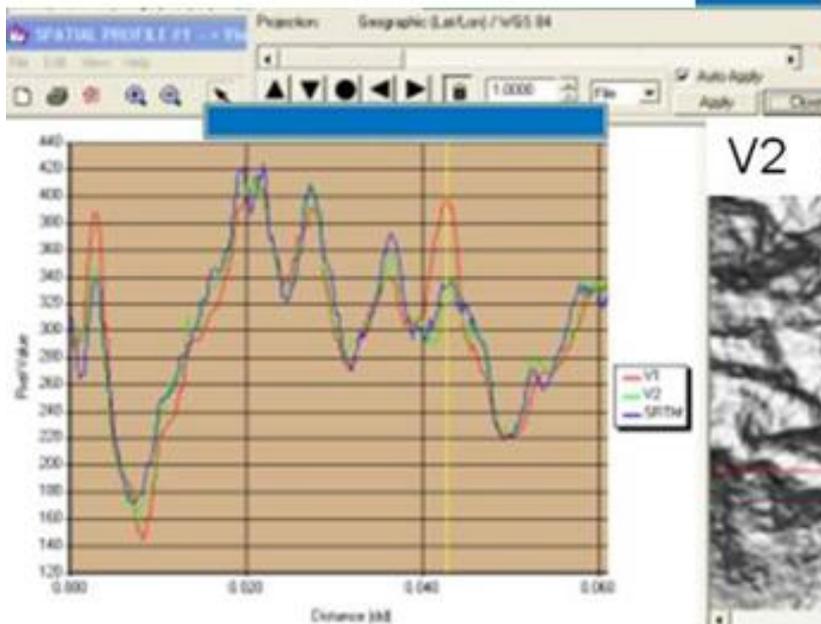
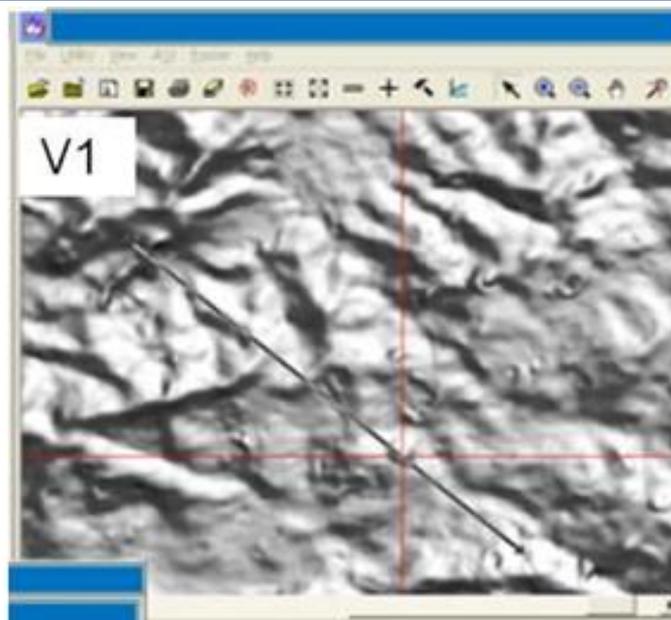


Improved hydrology



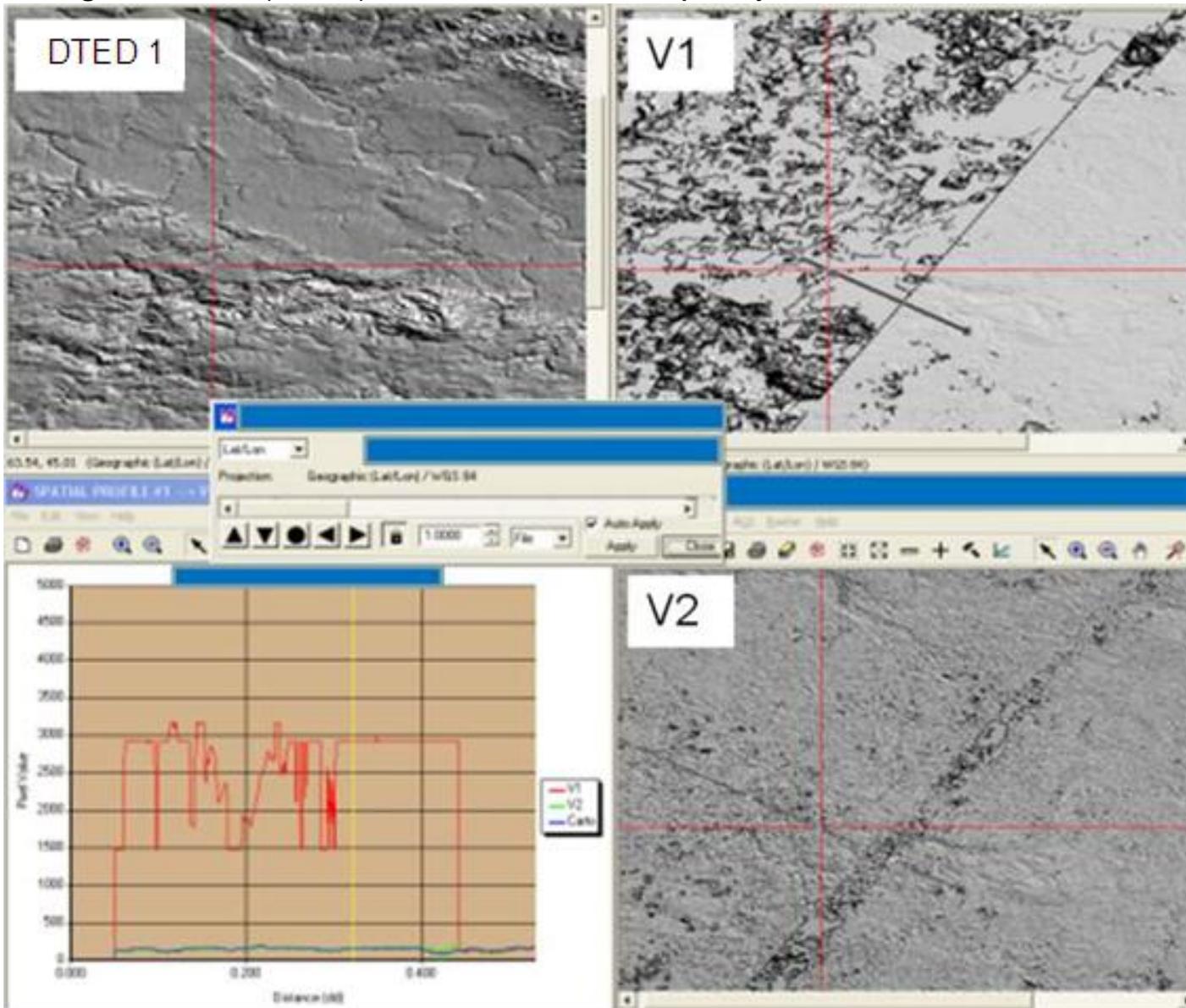


Improved surface (removal of pits and bumps)



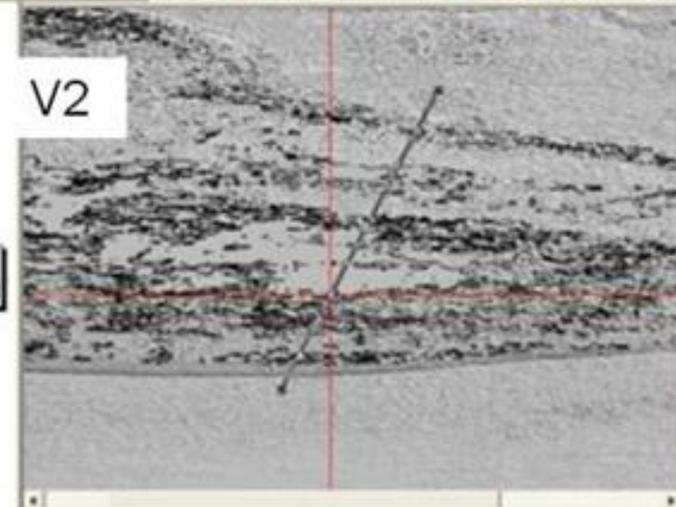
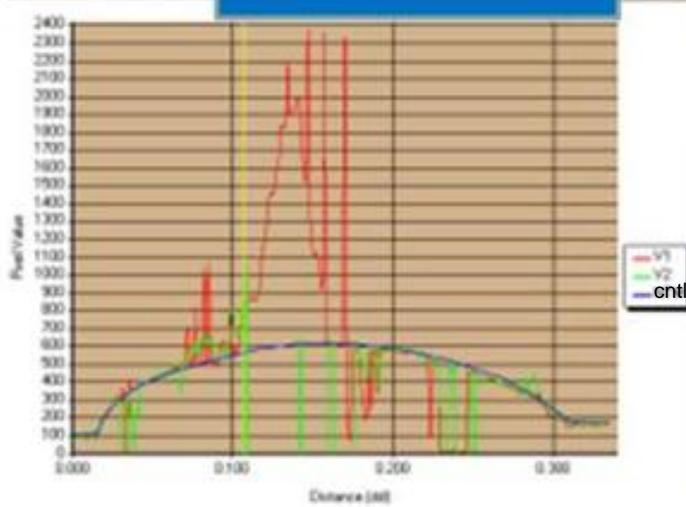
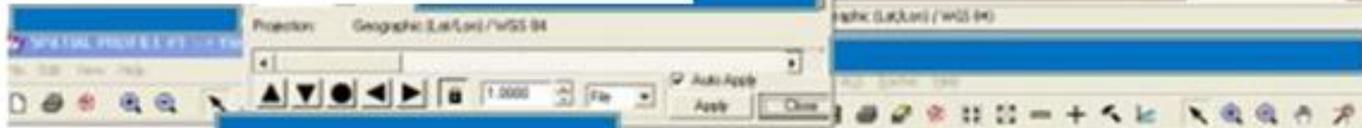
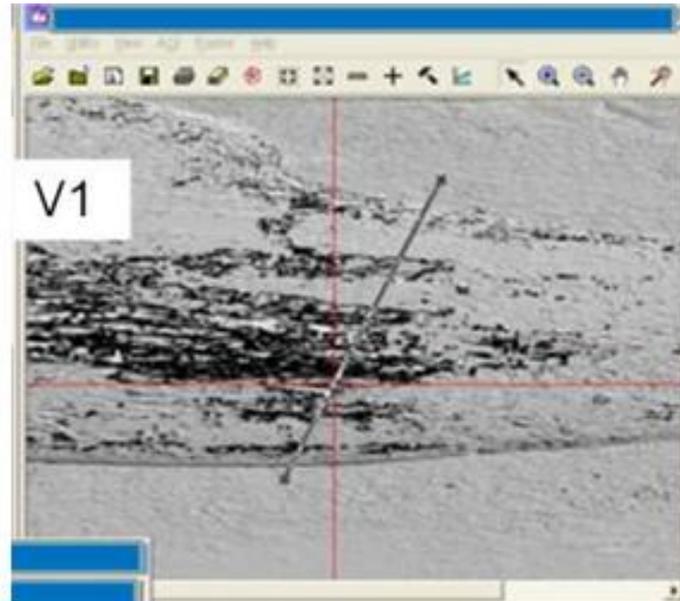


Huge blunder (cloud) fixed, but surface quality still inferior to DTED





Surface depiction improved but additional void introduced





Take-Aways

- V2, in general, has slightly more void than V1.
 - Void was mainly introduced in areas in Russia where large numbers of spikes/wells were removed.
 - Some voids in Australia have been successfully filled.
- V2, in general, has fewer spikes/wells than V1.
 - Large numbers of spikes/wells were removed north of 60deg.
 - Small numbers of spikes/wells were introduced in certain tiles due to the steepening of cliff lines. Cliff lines in V1 appear to match SRTM better than in V2. (could this have something to do with additional water finishing?).
- V2 has been raised on average ~4m above V1.
- No significant horizontal shifts between V1, V2, and SRTM were observed using statistical methods (**did not do vertical profile comparisons).
- Statistically, V2 more closely matches SRTM when comparing elevations post to post.



Take-Aways cont.

- The resolution / depiction of non hydrology surfaces in V2 has improved.
- Hydrology surfaces which fall “within” the SRTM SWBD coverage footprint have improved.
- Hydrology surfaces which fall “outside” the SRTM SWBD coverage footprint in general have improved, however shoreline noise, non containment issues along with artificial islands (ice?) are still present.
- Non hydrology artifacts (pits, spike, mole runs/ steps) identified in V1 generally are either diminished or removed.
- **While it is fairly clear from this high-level review that the quality of ASTER V2 is superior to ASTER V1, especially above 60 degrees north, NGA believes the data would still have to be assessed and edited on a case-by-case basis before use in specific applications.**



Comment on 22 Jun 2011.

It should be noted that some very minor additional review of a few cells still show some of the Non-Hydro anomalies such as some “mole-runs”.



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