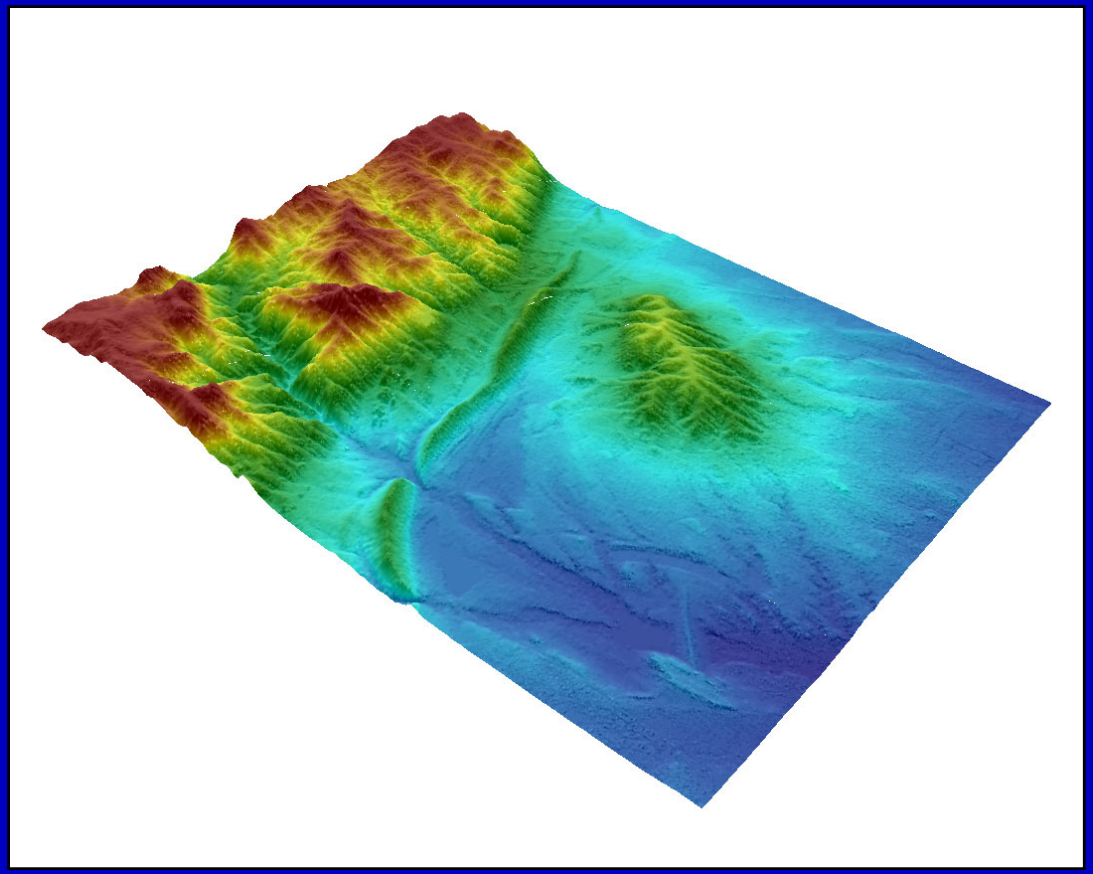
Evaluation and Accuracy Assessment of an IKONOS Digital Elevation Model



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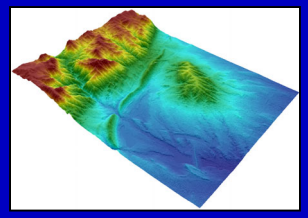
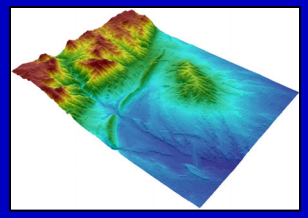
Presentation Outline

- Introduction / background
  - Objective
  - Dataset specifications
  - Test site characteristics
- Relative comparisons
  - Reference datasets
- Absolute vertical accuracy
  - Geodetic control points
- Derivative products
- Conclusions / further study



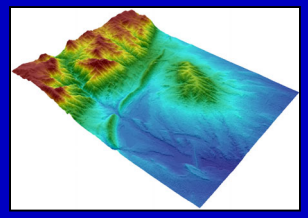
Introduction / Background

- Objective:
  - Assess the vertical accuracy and information content derived from IKONOS stereo-optical image data
  - How do IKONOS DEMs compare to other DEMs for meeting USGS elevation data requirements?



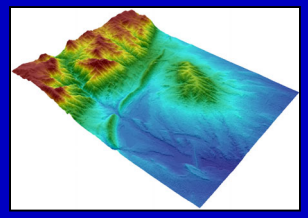
Introduction / Background

- Dataset specifications:
  - DEM derived from IKONOS panchromatic stereo pair acquired on May 26, 2001
  - Acquisition date falls within the “leaf-on” window for collection of NAPP aerial photography
  - Acquisition window chosen for higher sun angle to reduce terrain shadowing
  - DEM horizontal posting: 0.2 arc seconds (approximately 6 meters)

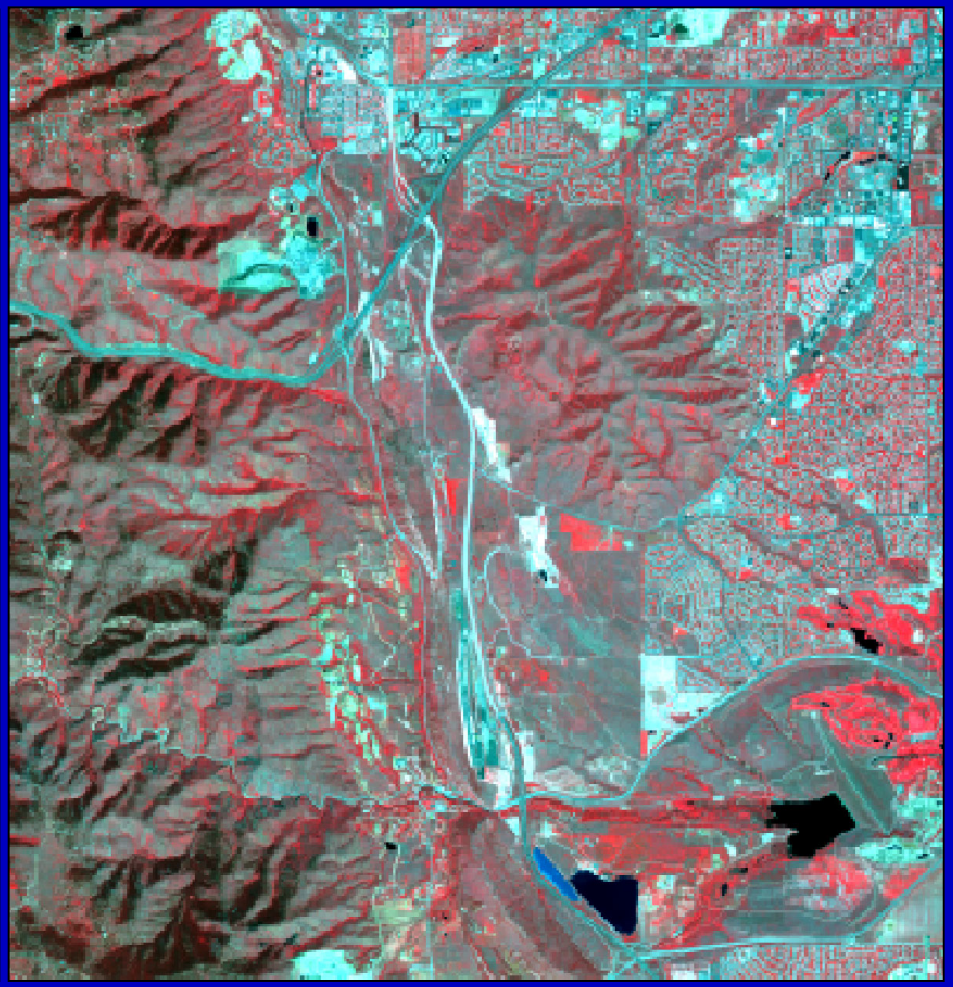


Introduction / Background

- Test site characteristics:
  - Morrison, Colorado 7.5-minute quadrangle
  - Wide variety of terrain and slope conditions
  - Wide variety of land use / land cover, including dense forest, urban/suburban, lakes, and active surface mines
  - USGS elevation research test site

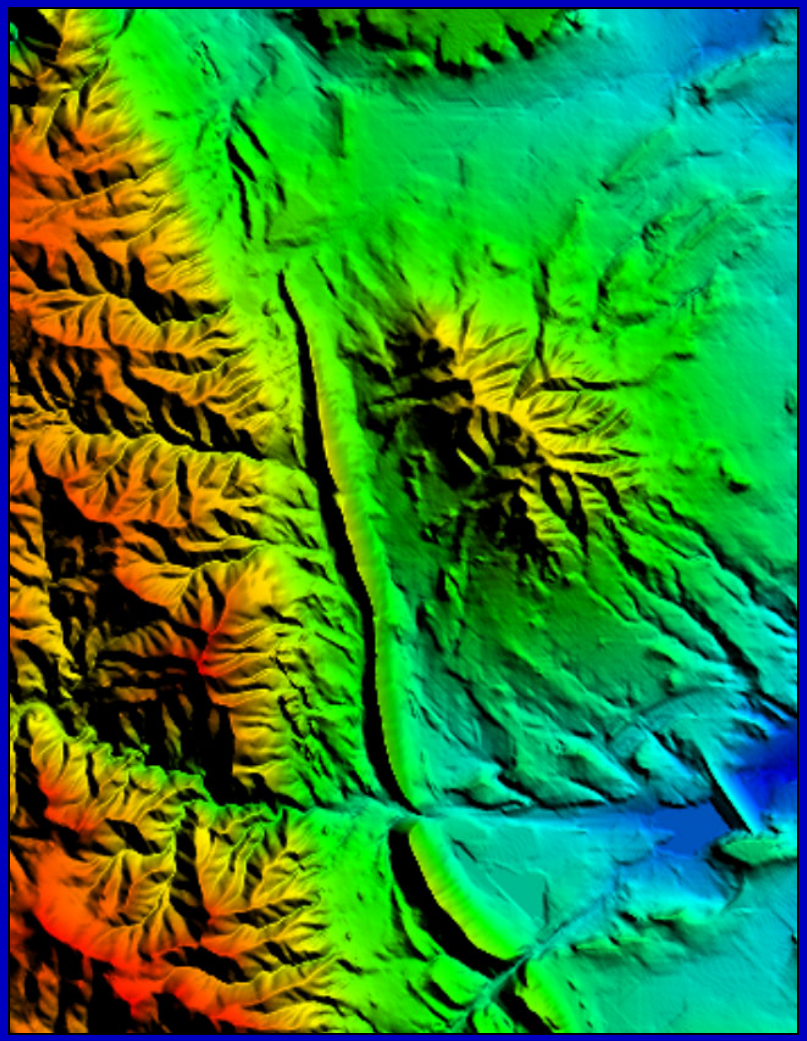


Morrison, Colorado test site

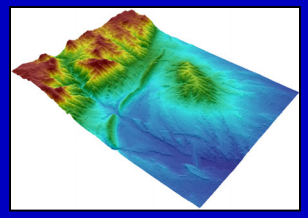


Elevation range: 1,667 – 2,404 meters (5,470 – 7,886 feet)

Relative Comparisons



- Reference datasets: USGS 10-meter and 30-meter DEMs, National Elevation Dataset (NED)
  - Gridded from hypsography (40-foot contours) and hydrography
  - Map compiled in 1964, limited update in 1994
  - Vertical accuracy: 20 feet (½ of contour interval; NMAS 90%)



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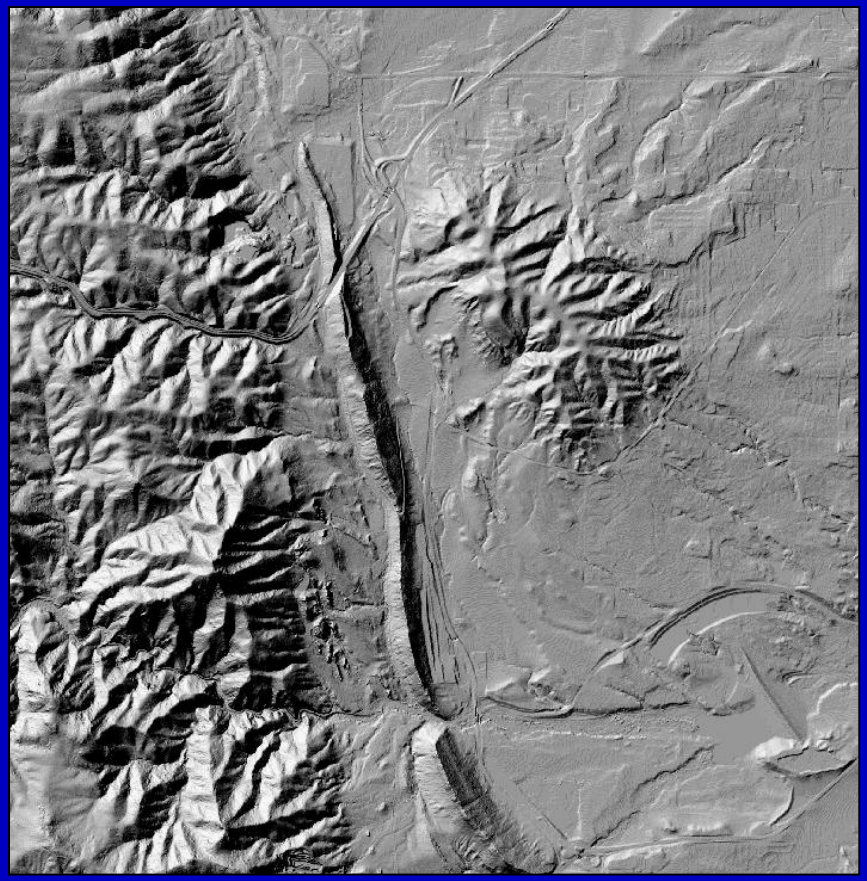
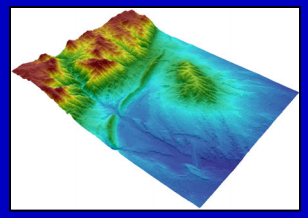
Relative Comparisons



- Reference dataset: 3DI-EagleScan LIDAR
  - 2-meter horizontal posting
  - “Bare earth” processed
  - Acquired June, 1999
  - Vertical accuracy: 15 cm (RMSE)
  - Horizontal accuracy: 0.5 m (RMSE)



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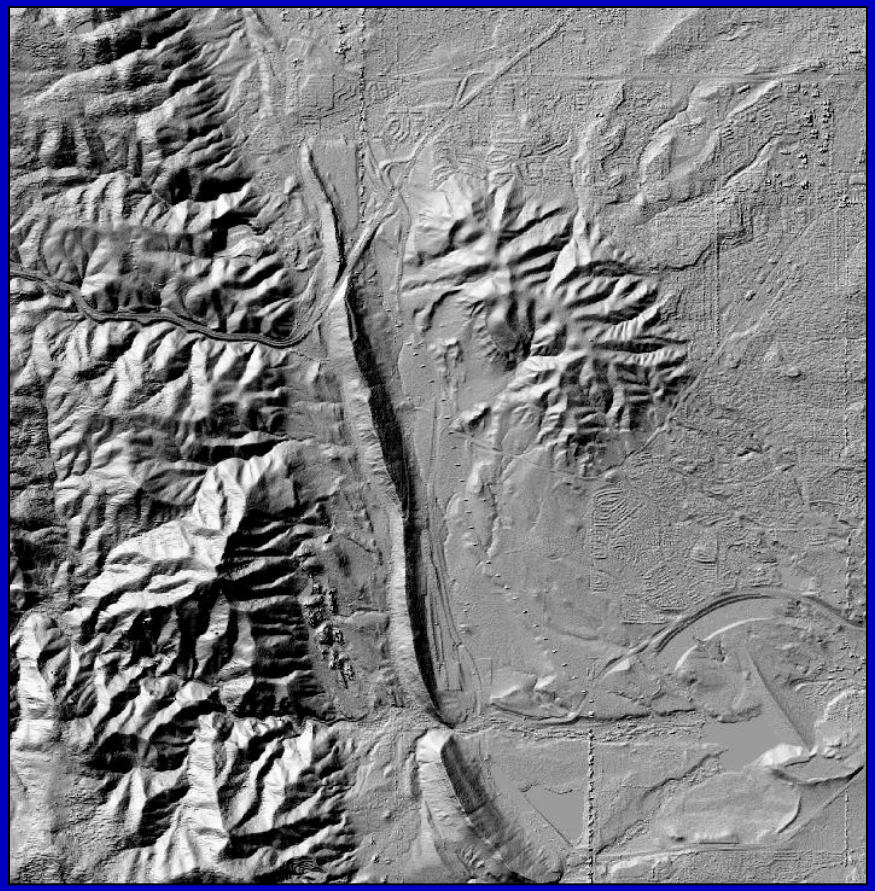
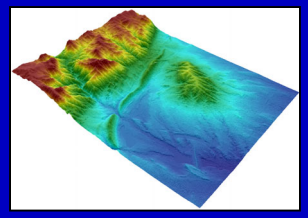
Relative Comparisons



- Reference dataset: Intermap Star-3i IFSAR (X-band)
  - 5-meter horizontal posting
  - Acquired October, 1999
  - Vertical accuracy: 2 m (RMSE)
  - Horizontal accuracy: 2.5 m (RMSE)



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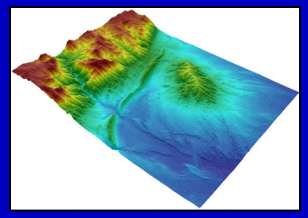
Relative Comparisons

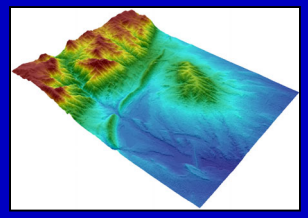
- IKONOS DEM subtracted from reference datasets to create difference surfaces
- Differencing done at resolution of IKONOS DEM
- Horizontal and vertical datums and coordinate units standardized before differencing
- Difference statistics expressed in meters



Relative Comparisons

DEM	Min	Max	Mean	StdDev	Mean*
10-m	-41.0	92.0	4.0	4.3	4.7
30-m	-68.0	149.0	3.7	8.4	4.4
NED	-41.3	91.3	3.7	4.6	4.5
LIDAR	-32.0	52.0	3.6	2.7	4.4
IFSAR	-39.8	52.6	5.7	3.1	6.4

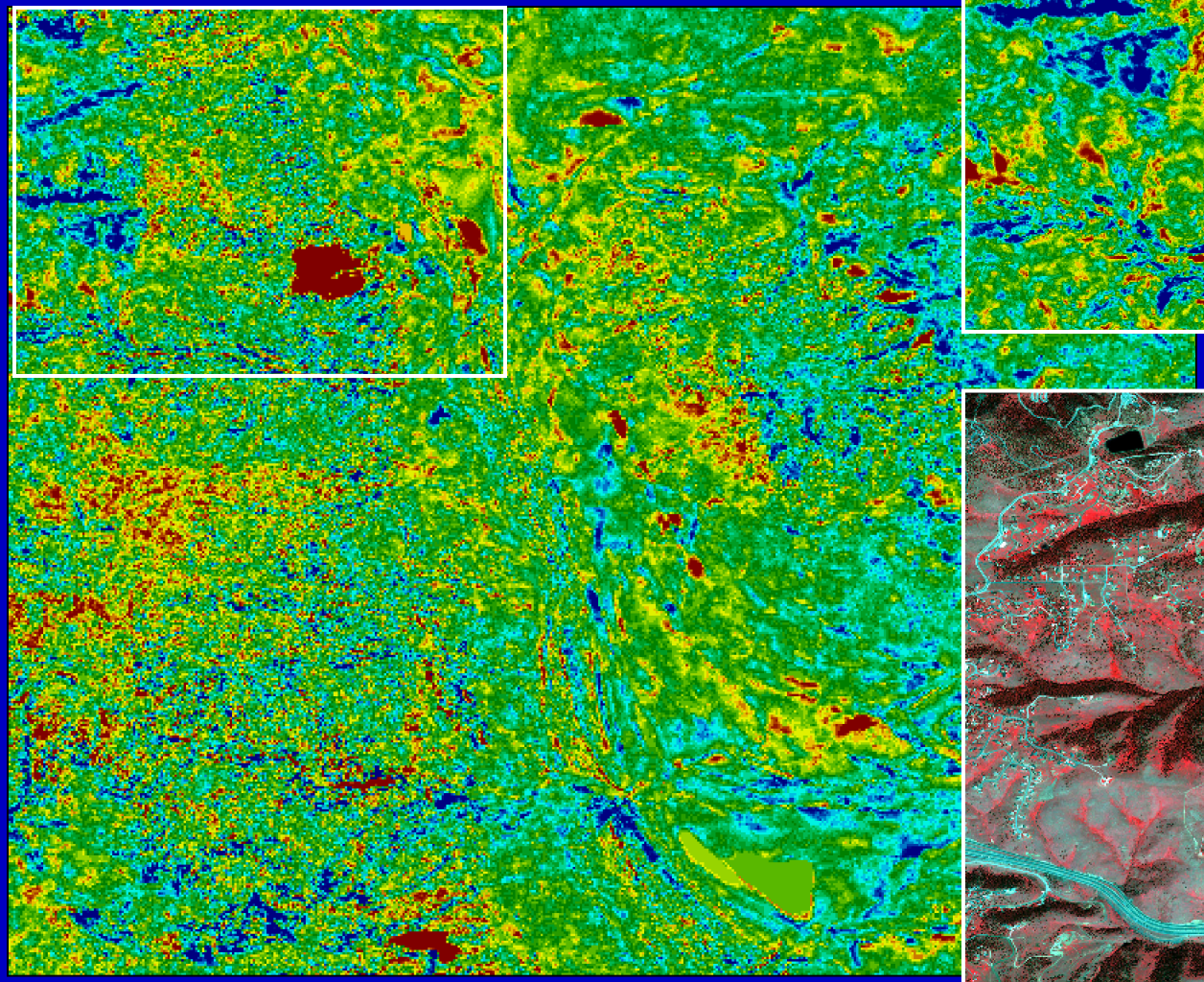
** After adjustment for difference between EGM96 and Geoid96 used to convert to orthometric heights*

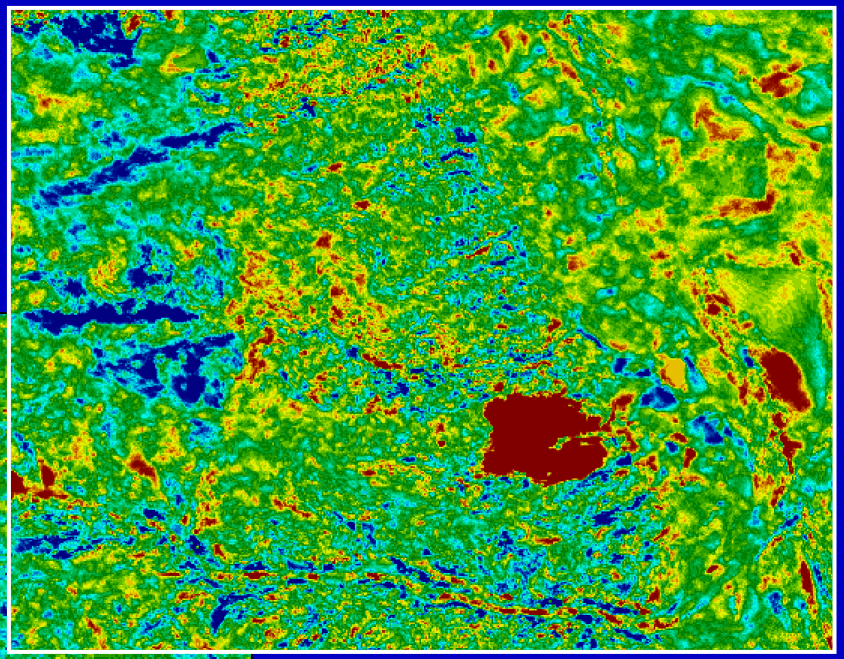


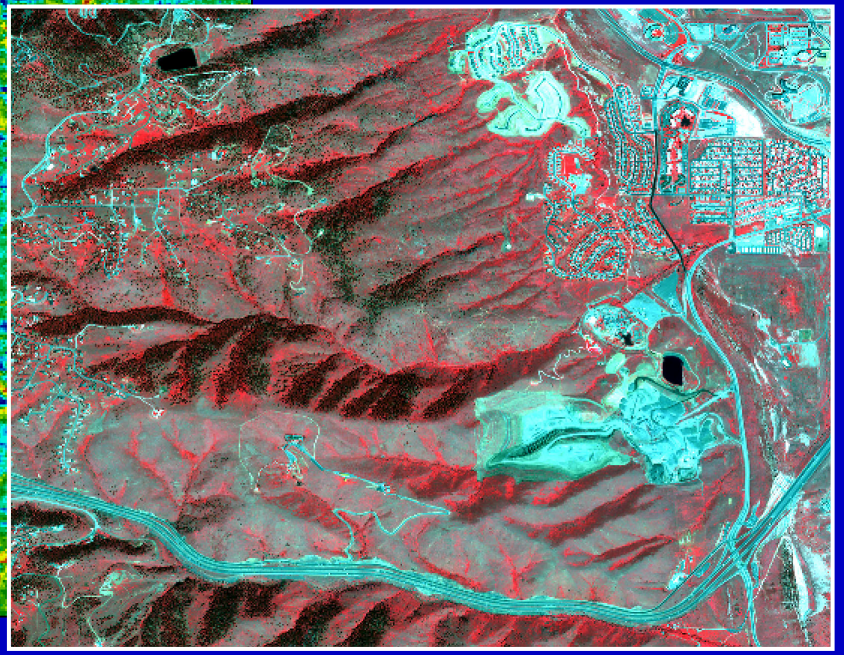
USGS 10-m DEM – IKONOS DEM

Blue: < -4.6 meter difference

Red: > 12.6 meter difference



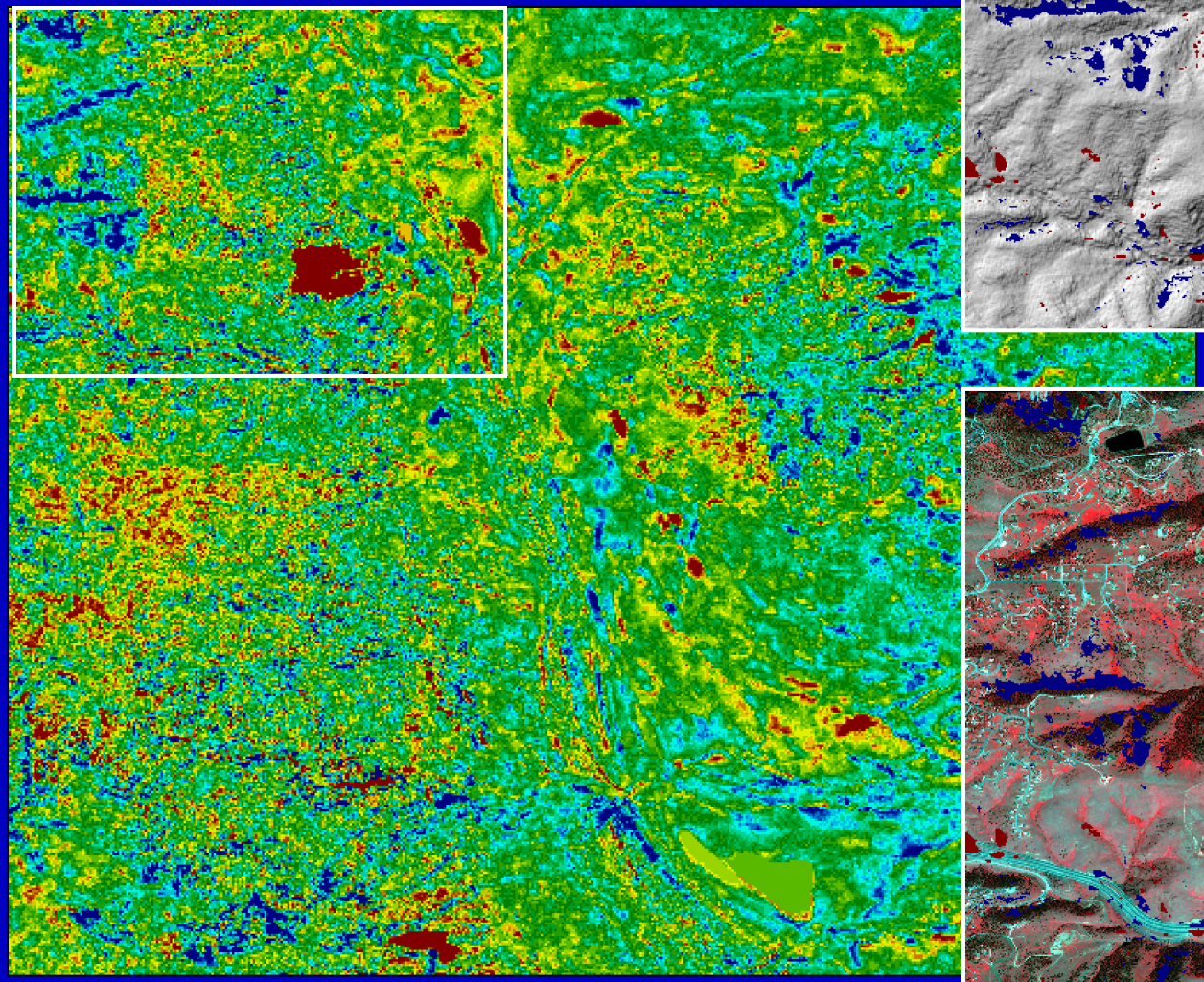


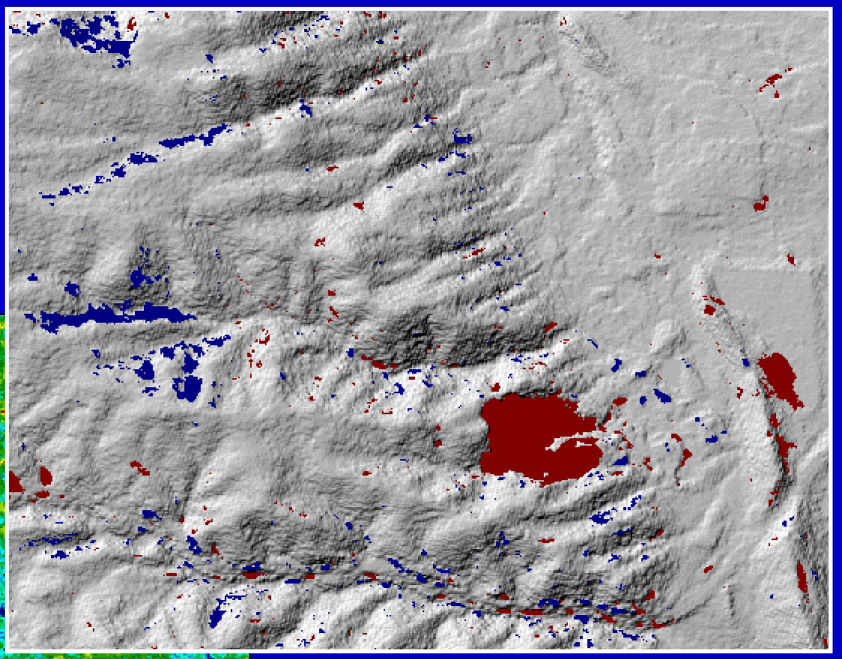


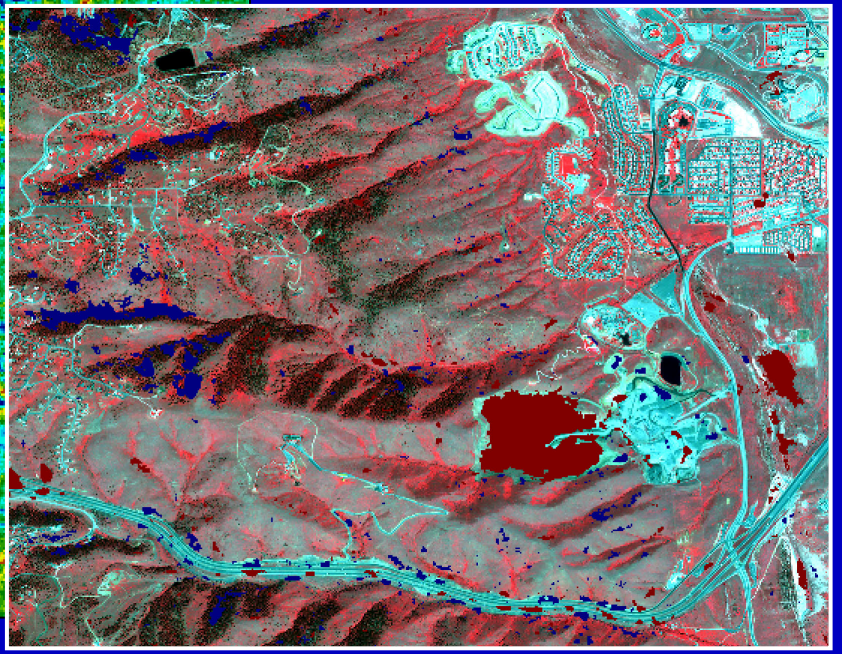
USGS 10-m DEM – IKONOS DEM

Blue: < -4.6 meter difference

Red: > 12.6 meter difference



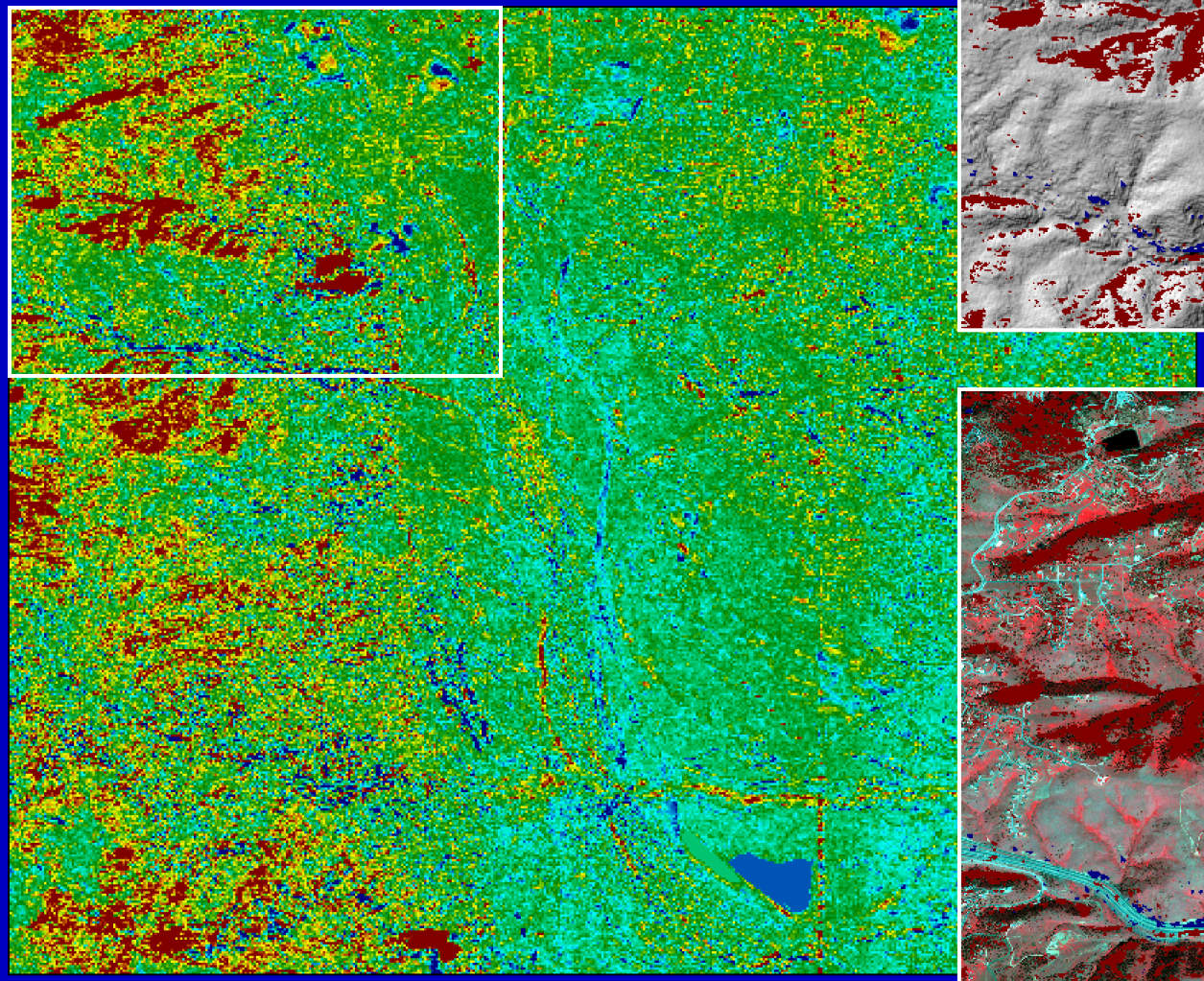


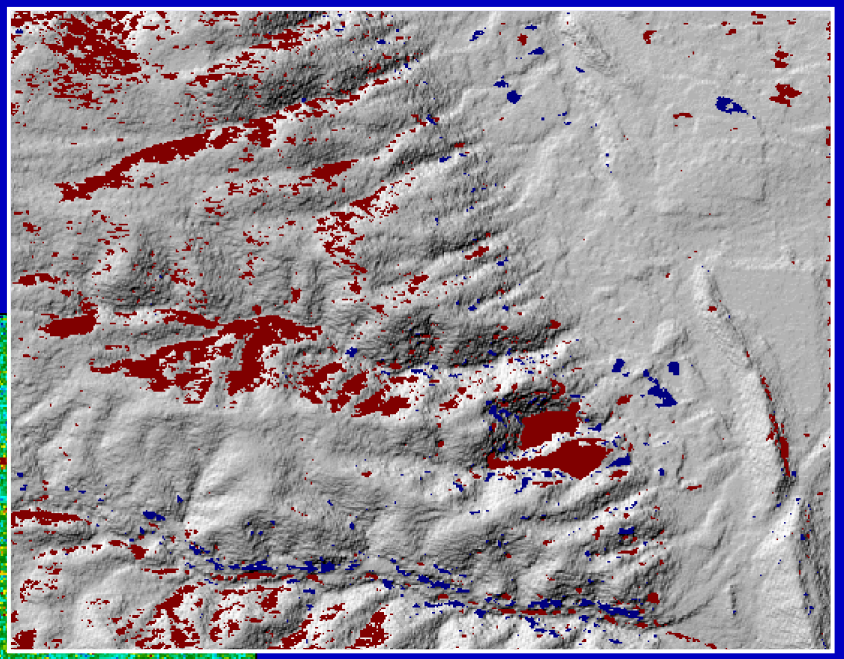


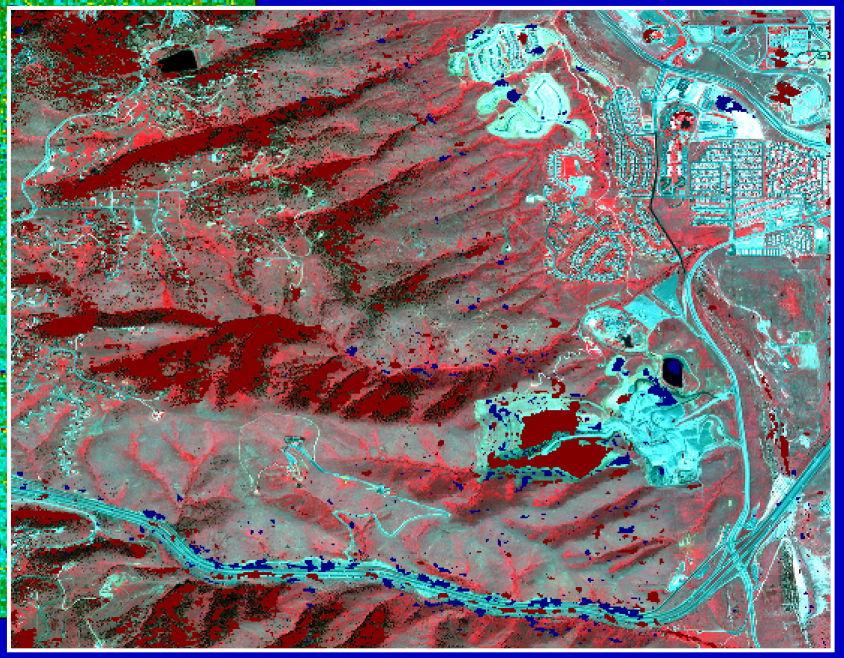
IFSAR DEM – IKONOS DEM

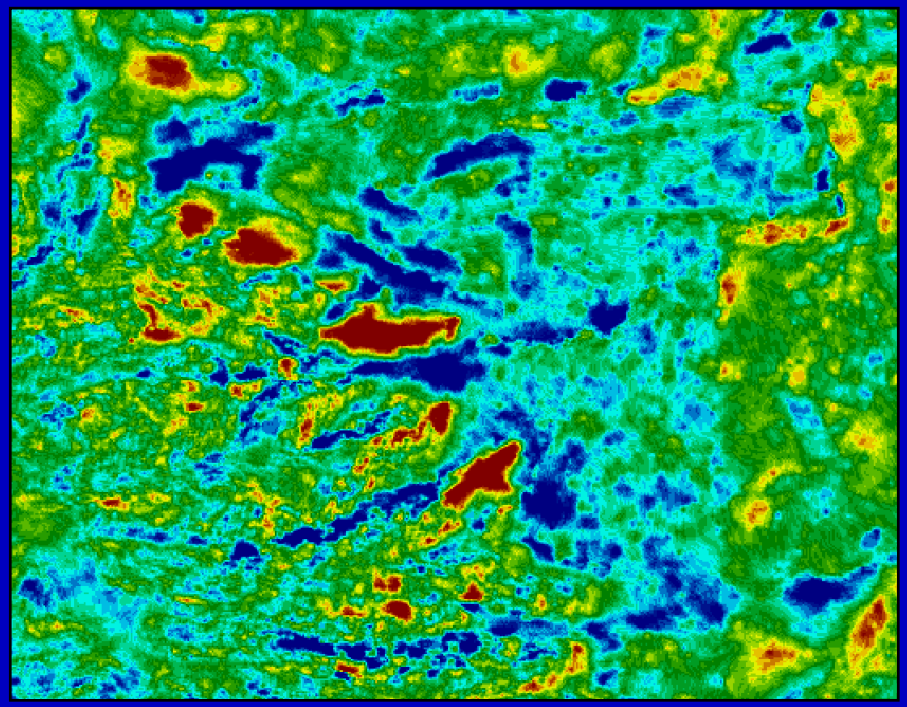
Blue: < -0.5 meter difference

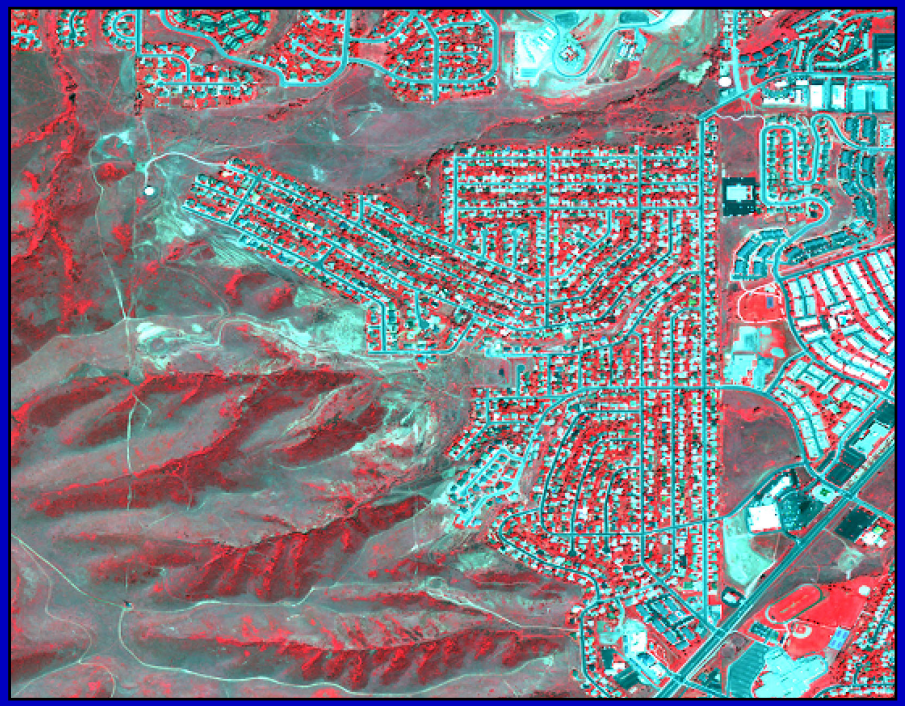
Red: > 12 meter difference

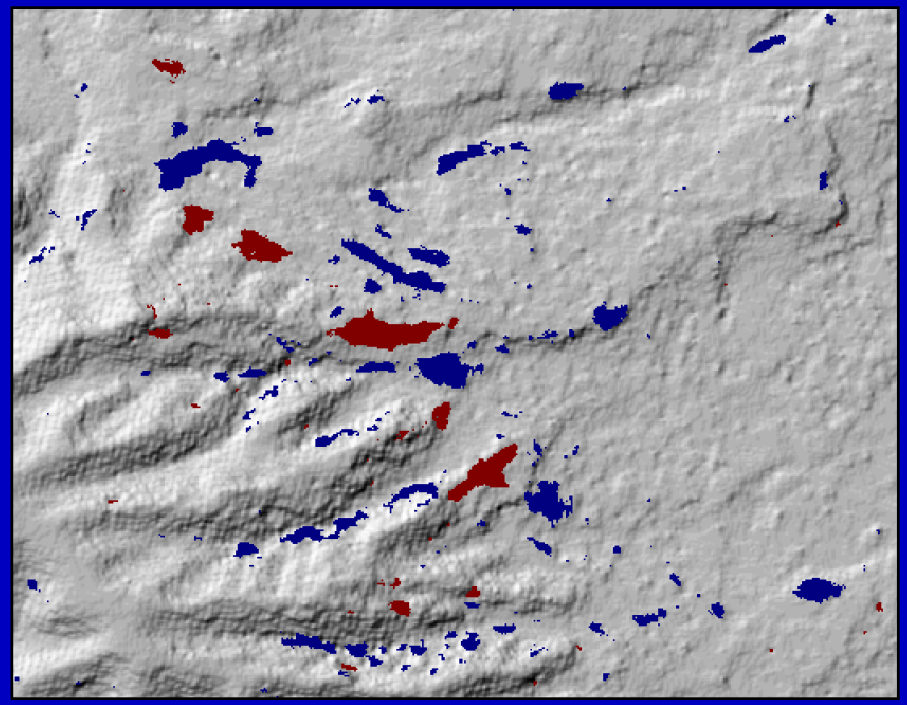


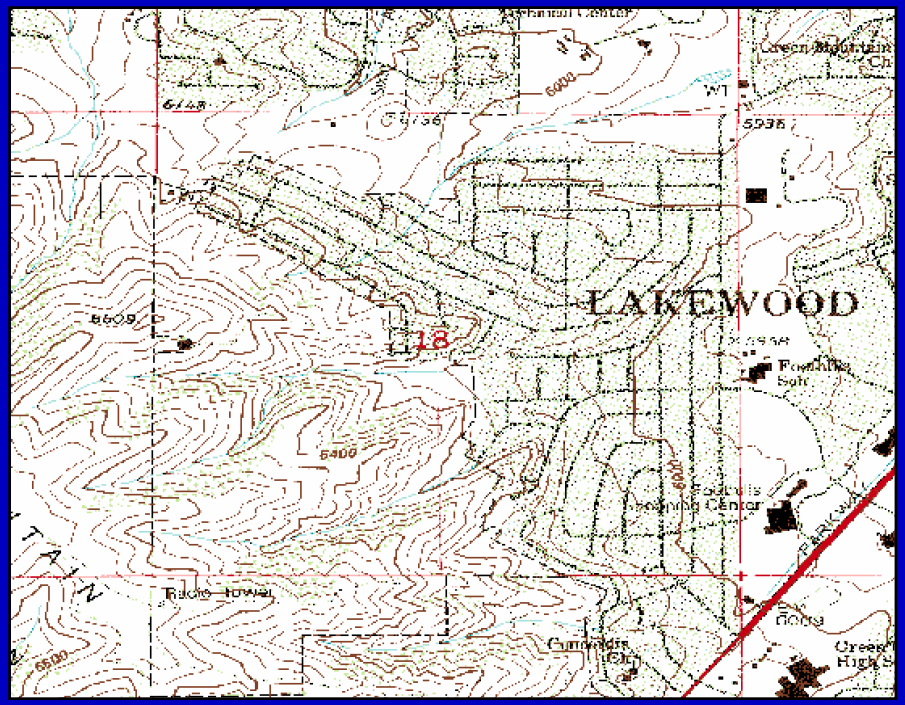




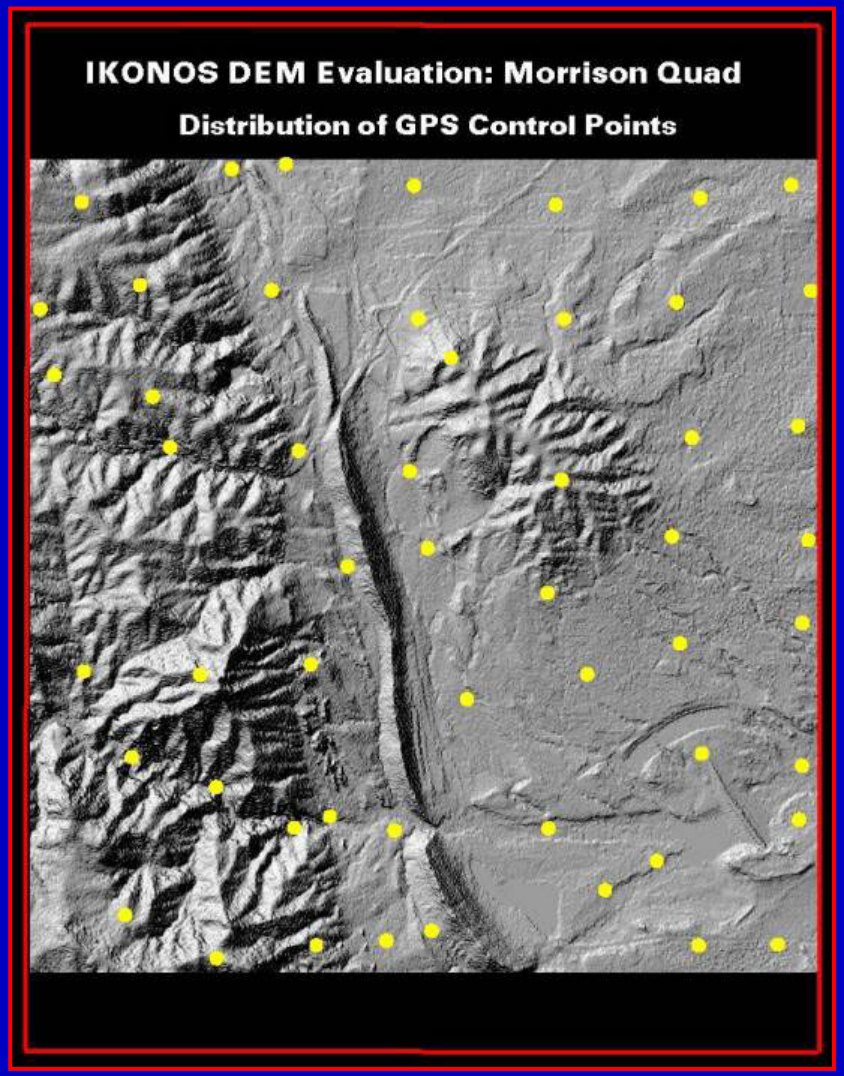







LAKEWOOD
6400
6500
Radio Tower

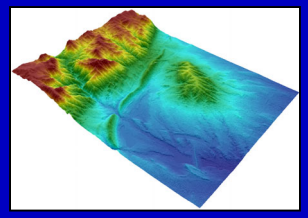
Absolute Vertical Accuracy



- IKONOS DEM (and other DEMs) compared to 53 GPS surveyed control points
- Accuracy specifications for points:
  - Horizontal: better than 0.2 meters
  - Vertical: better than 0.15 meters
- Min / Max / Mean / StdDev:

  1677, 2313, 1890.2, 178.6 - GPS

  1660, 2401, 1910.2, 177.3 - DEM
- Statistics in meters: (GPS – DEM)



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Absolute Vertical Accuracy

DEM	Min	Max	Mean	StdDev	RMSE	NMAS 90%	NSSDA 95%
IKONOS*	0.5	7.4	4.2	1.3	4.4	7.2	8.6
10-m	-8.9	8.1	1.5	1.4	3.2	5.3	6.3
LIDAR	-1.7	2.4	-0.1	0.1	0.5	0.8	1.0
IFSAR	-2.6	4.0	-0.8	0.8	1.3	2.1	2.5

** After adjustment for difference between EGM96 and Geoid96 used to convert to orthometric heights*

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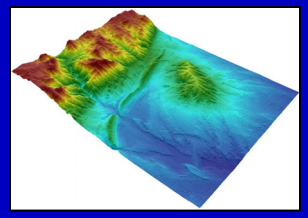
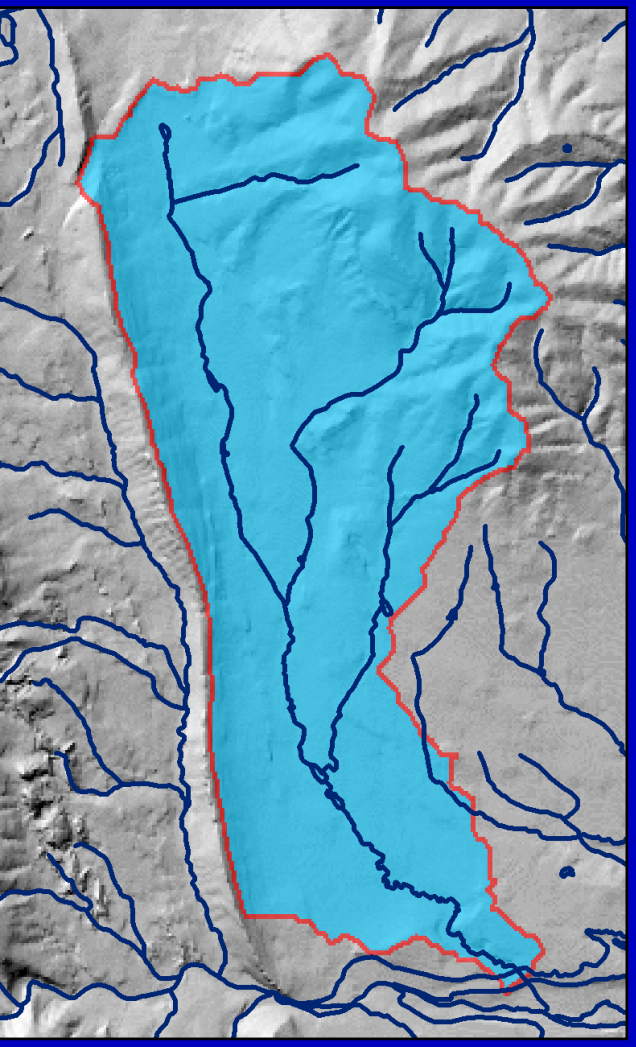
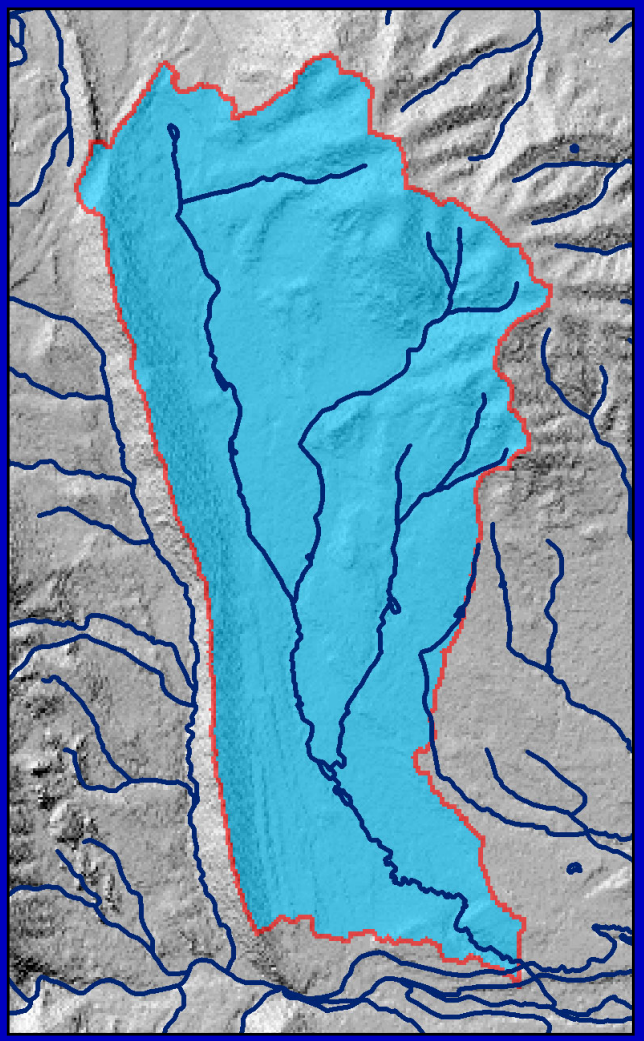


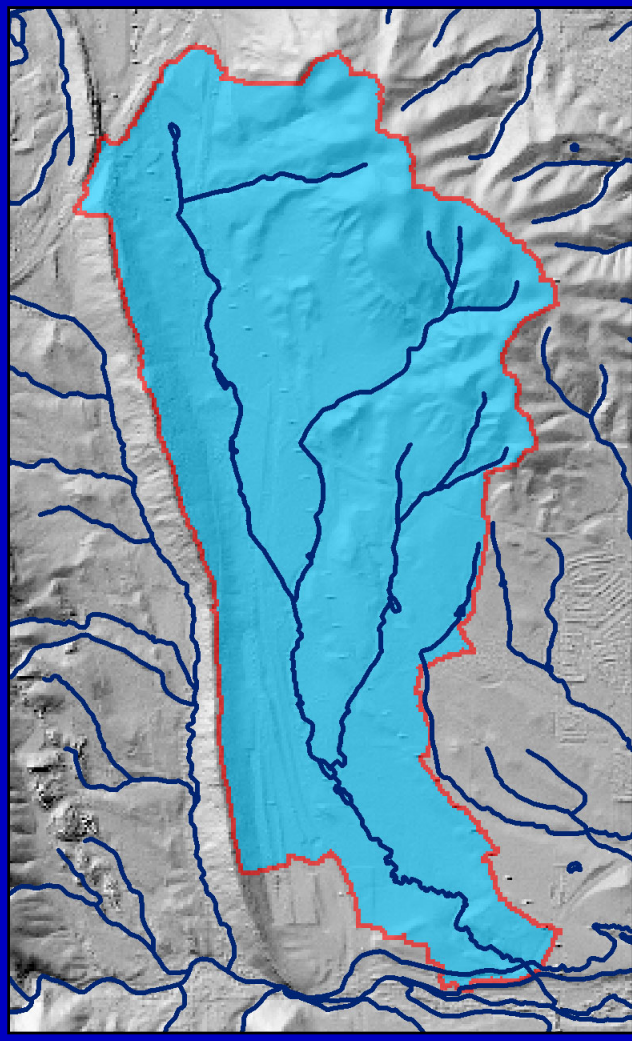
Derivative Products



USGS 10-m DEM

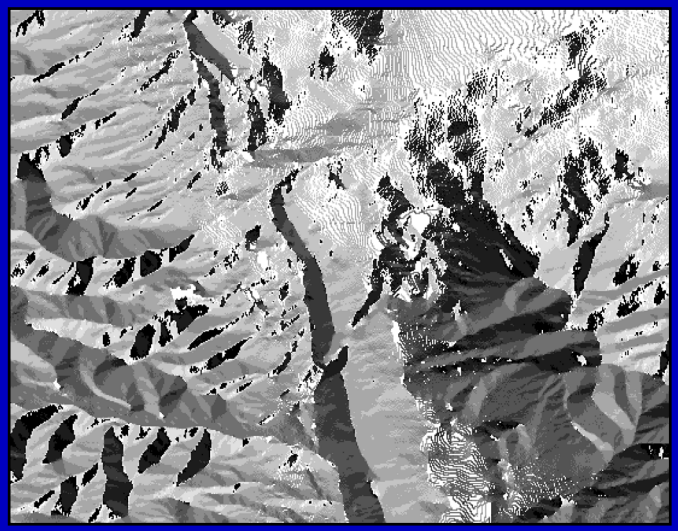


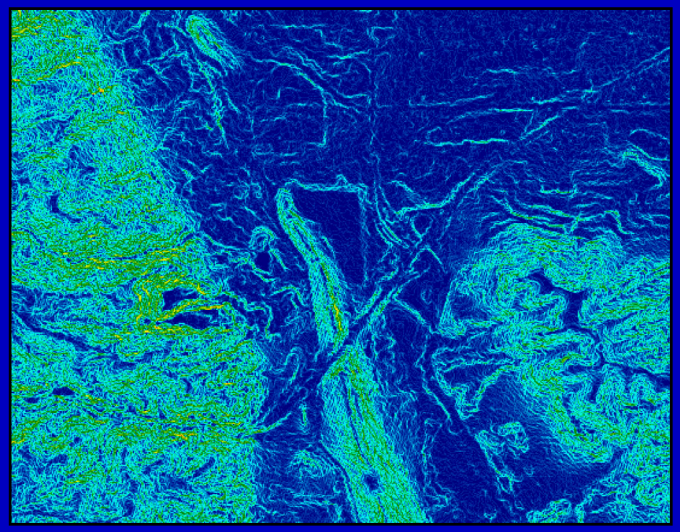
IKONOS DEM

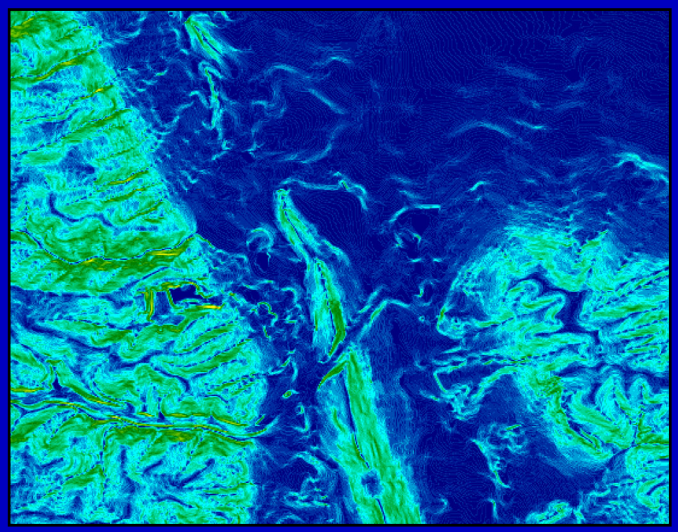


IFSAR DEM

Derivative Products





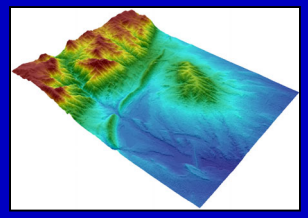
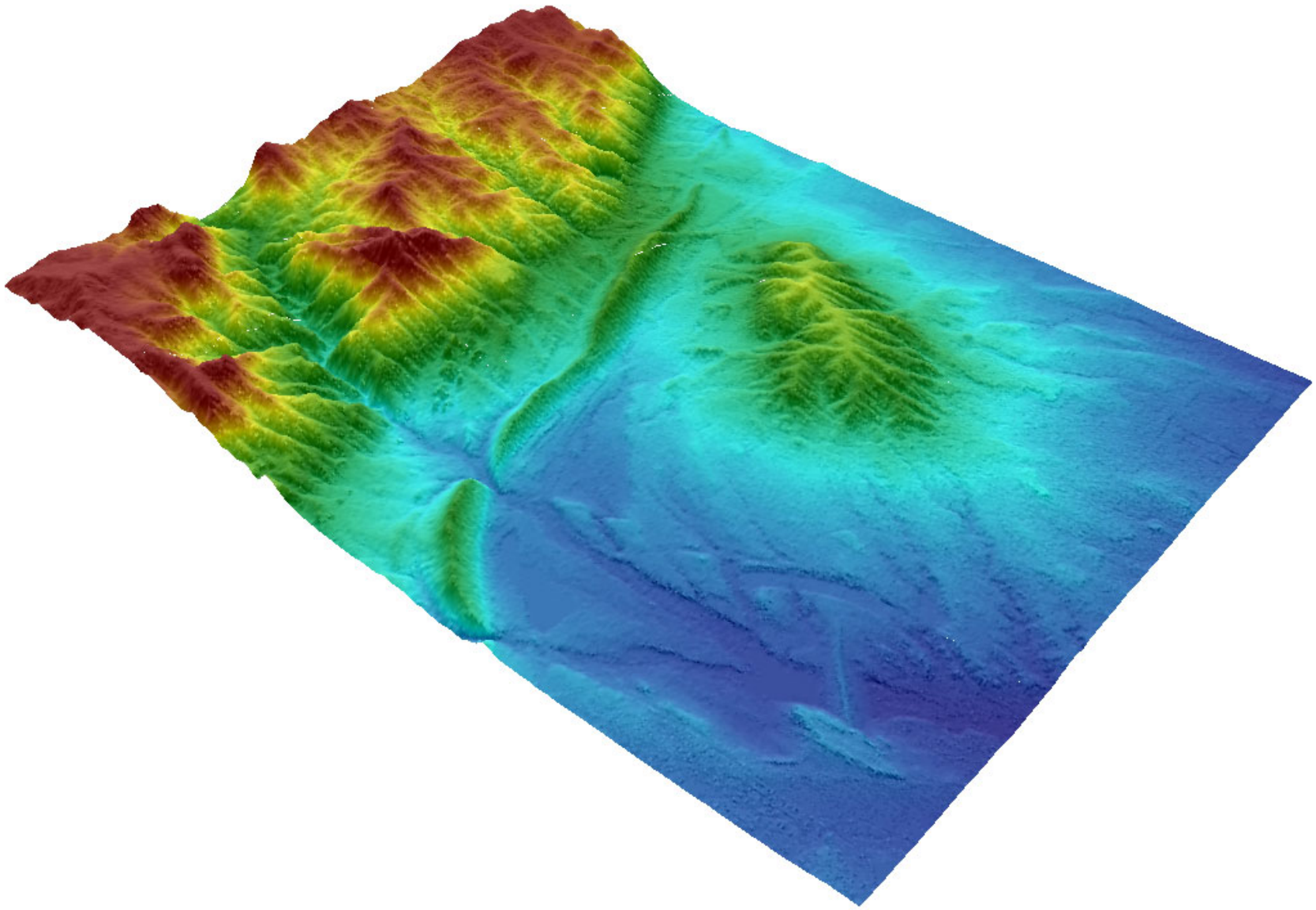


IKONOS DEM

USGS 10-m DEM

Conclusions / Further Study

- IKONOS DEM of Morrison, CO quad:
  - Accuracy is within expected range
  - Elevation bias when compared with other DEMs and GPS control points
  - Derivative products comparable to other DEMs
  - Recent acquisition dates useful for topographic change detection
- Further relative comparisons:
  - SRTM, ASTER, future sensors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