Multiscale Terrain Representation

Andy Stauffer

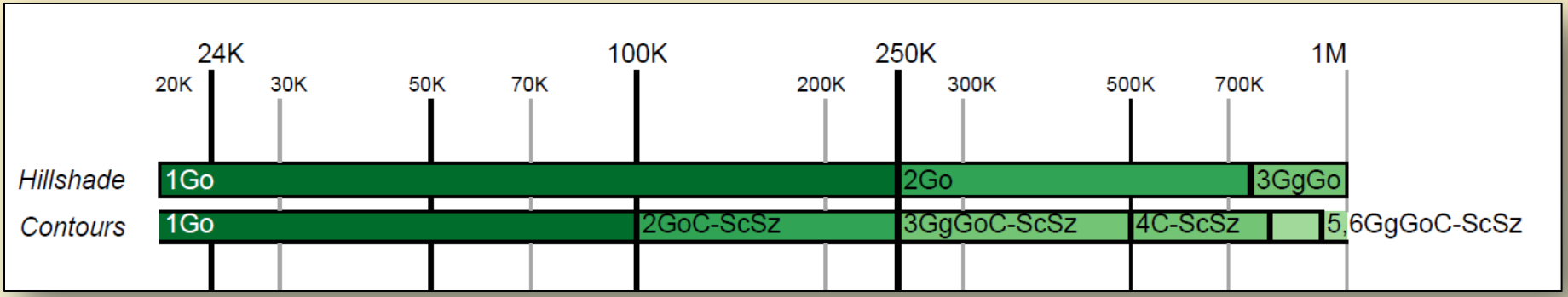
Cindy Brewer

Penn State

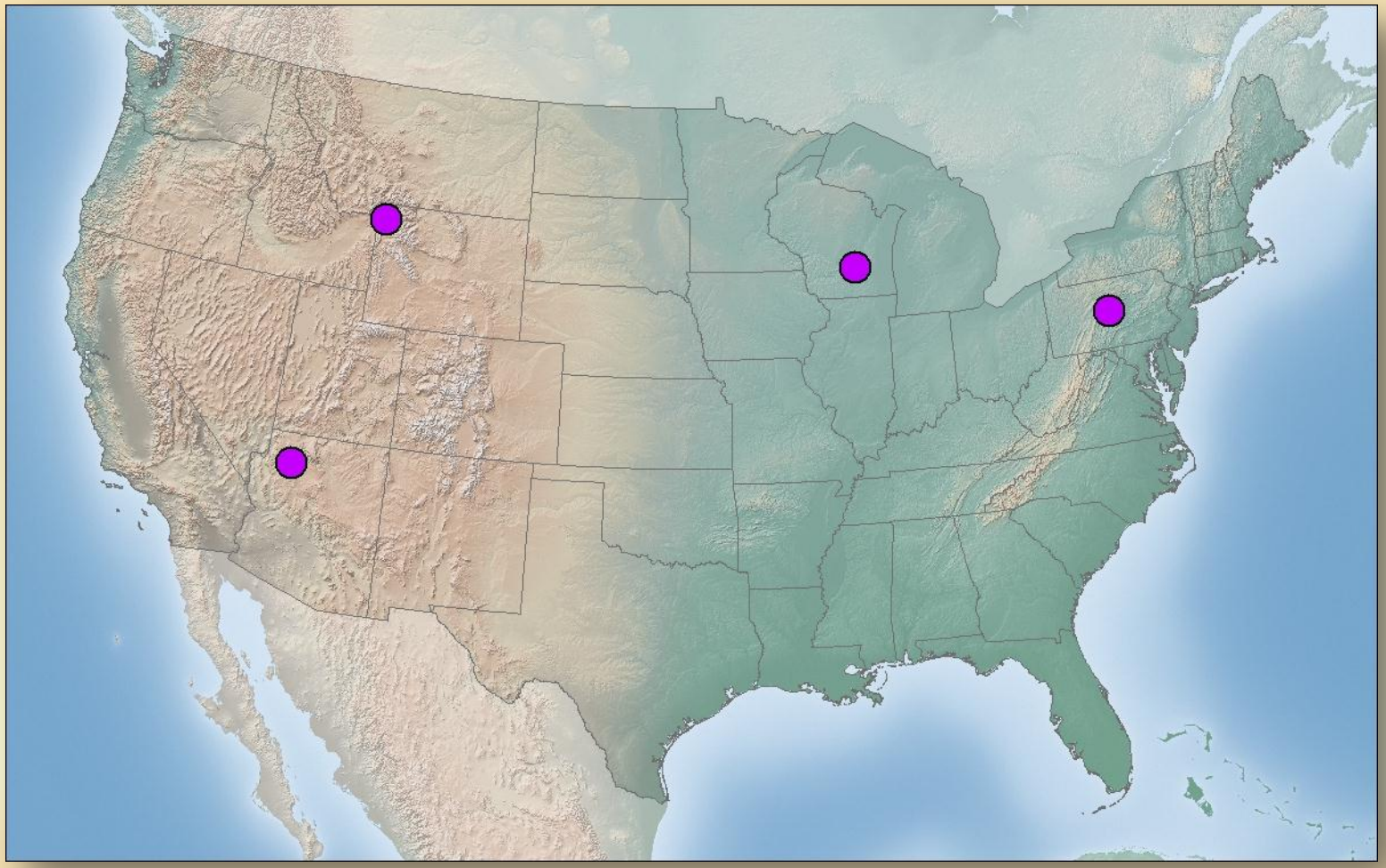
NACIS 2011

Objectives

- Generalize terrain for multi-scale mapping
- Create contours for multi-scale mapping
- Find a solution that will work for entire US (or most of it)
- Implement in ScaleMaster



Terrain Generalization : Study Areas



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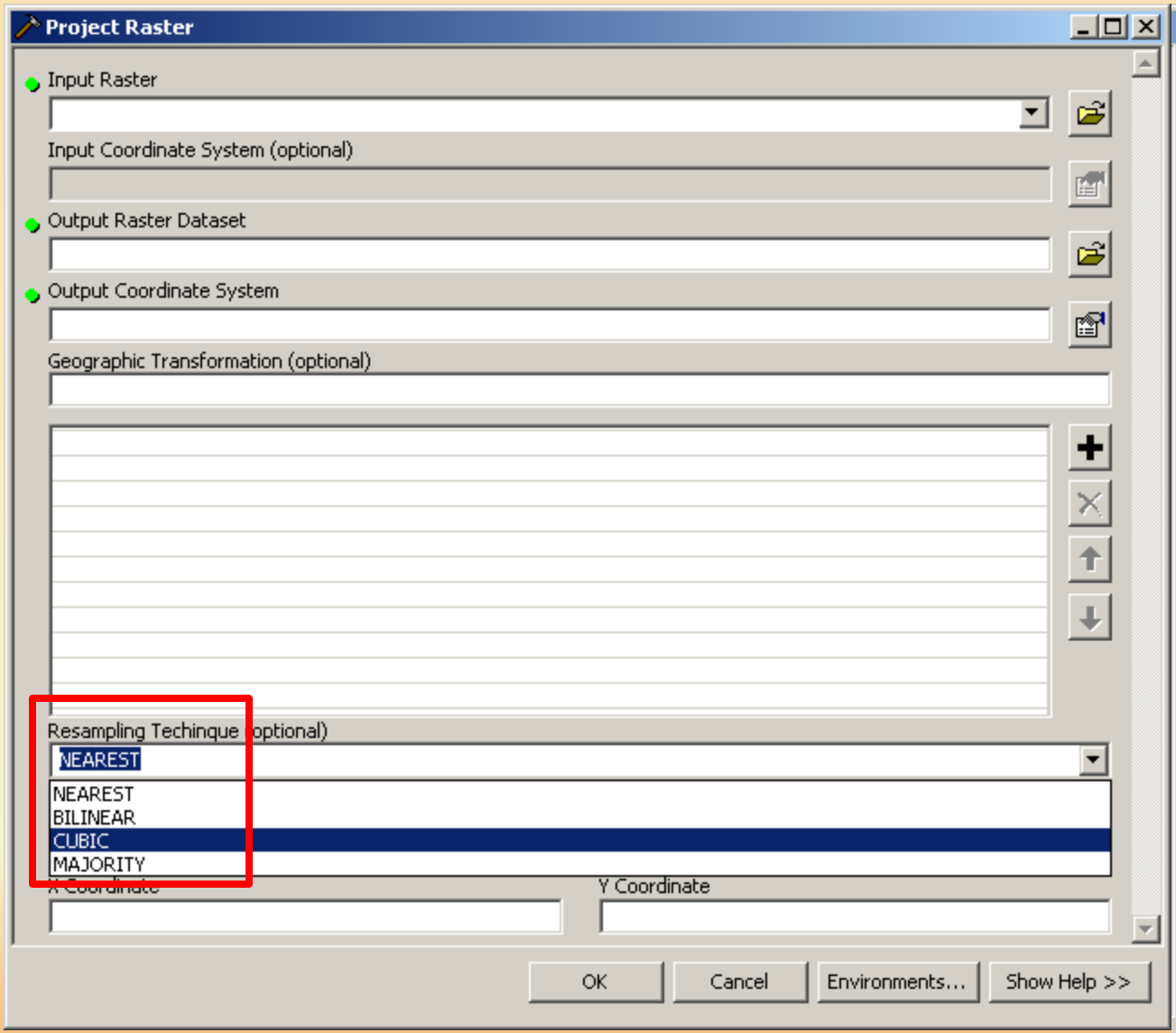
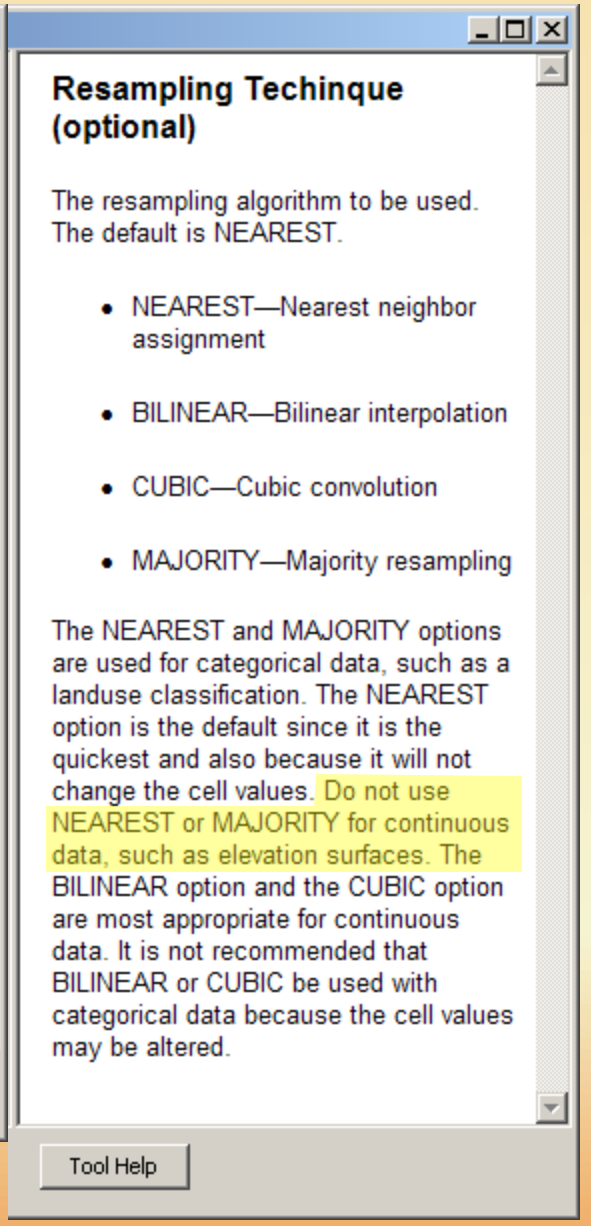
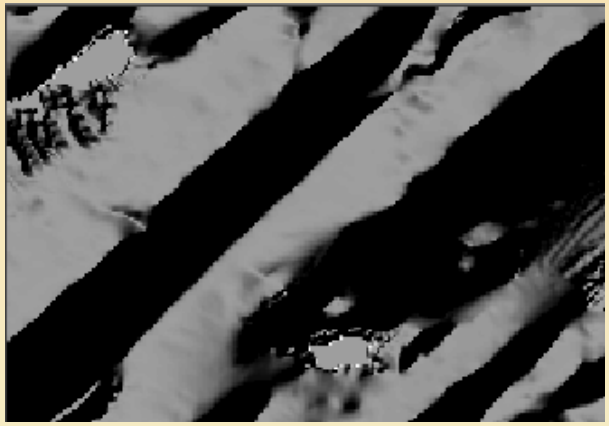
Terrain Generalization : Projecting Rasters



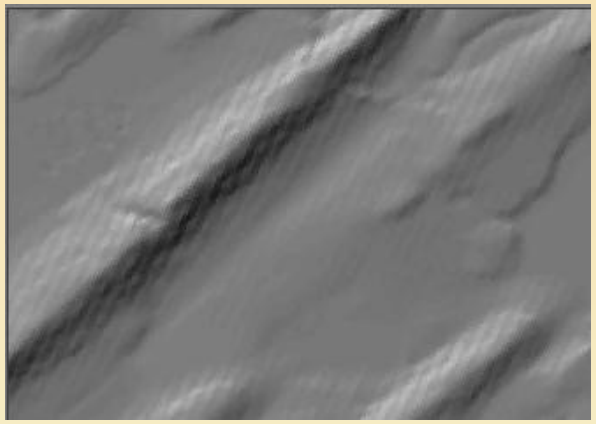


Terrain Generalization : Projecting Rasters

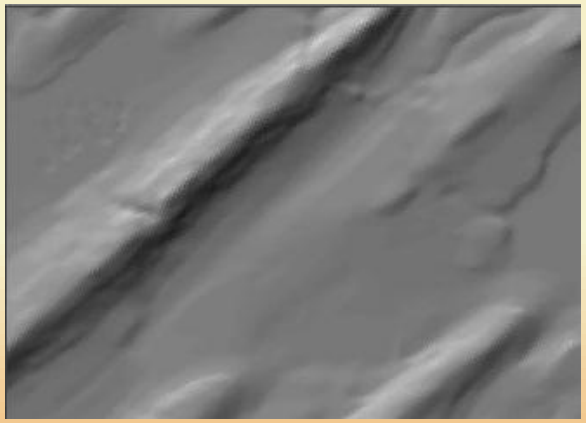
Unprojected Raster



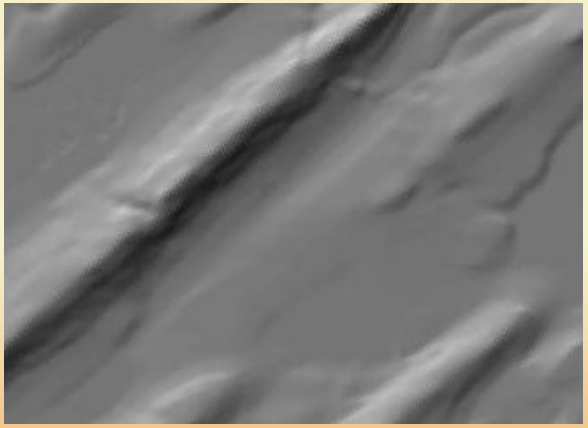
Projected, Nearest



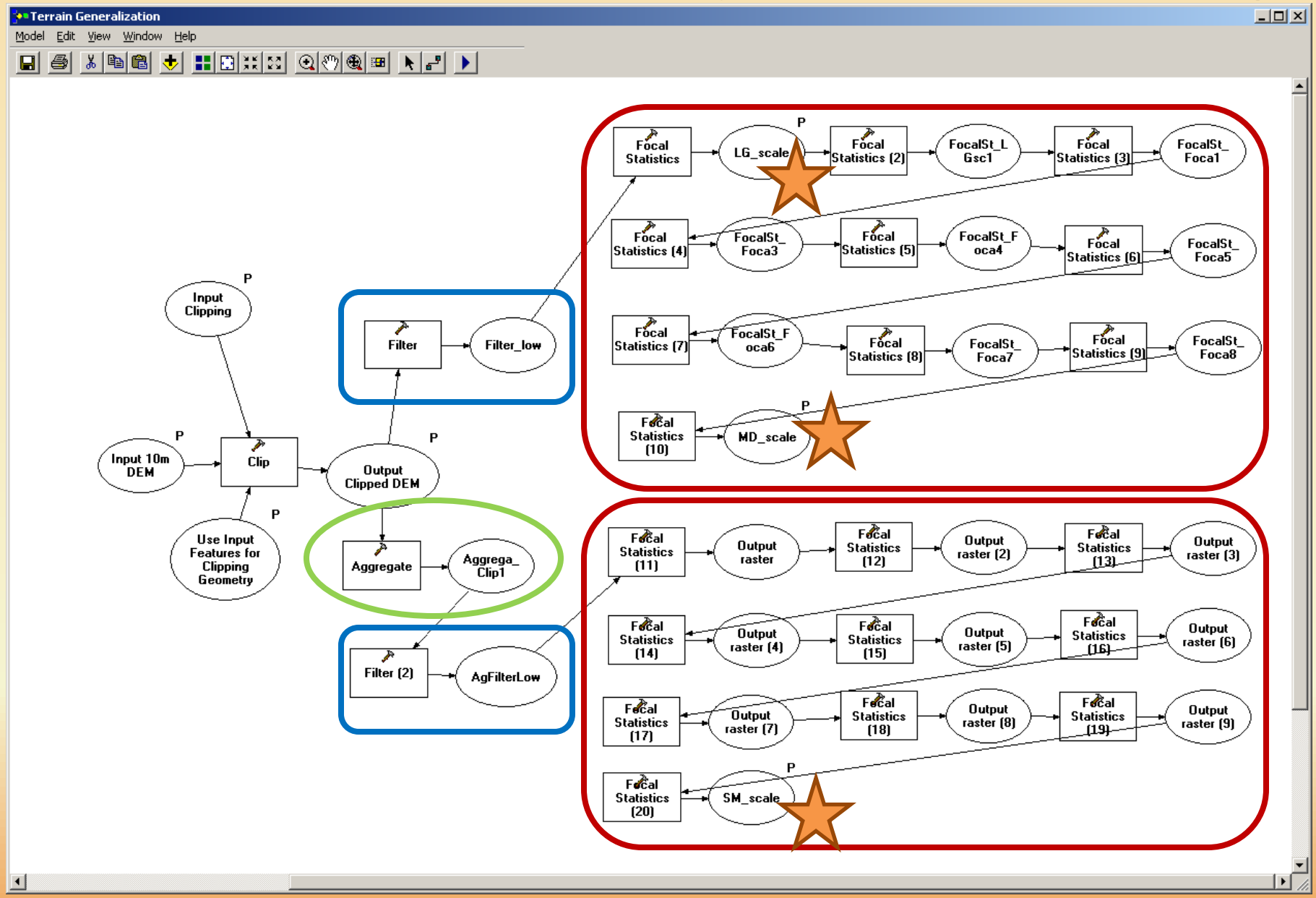
Projected, Cubic

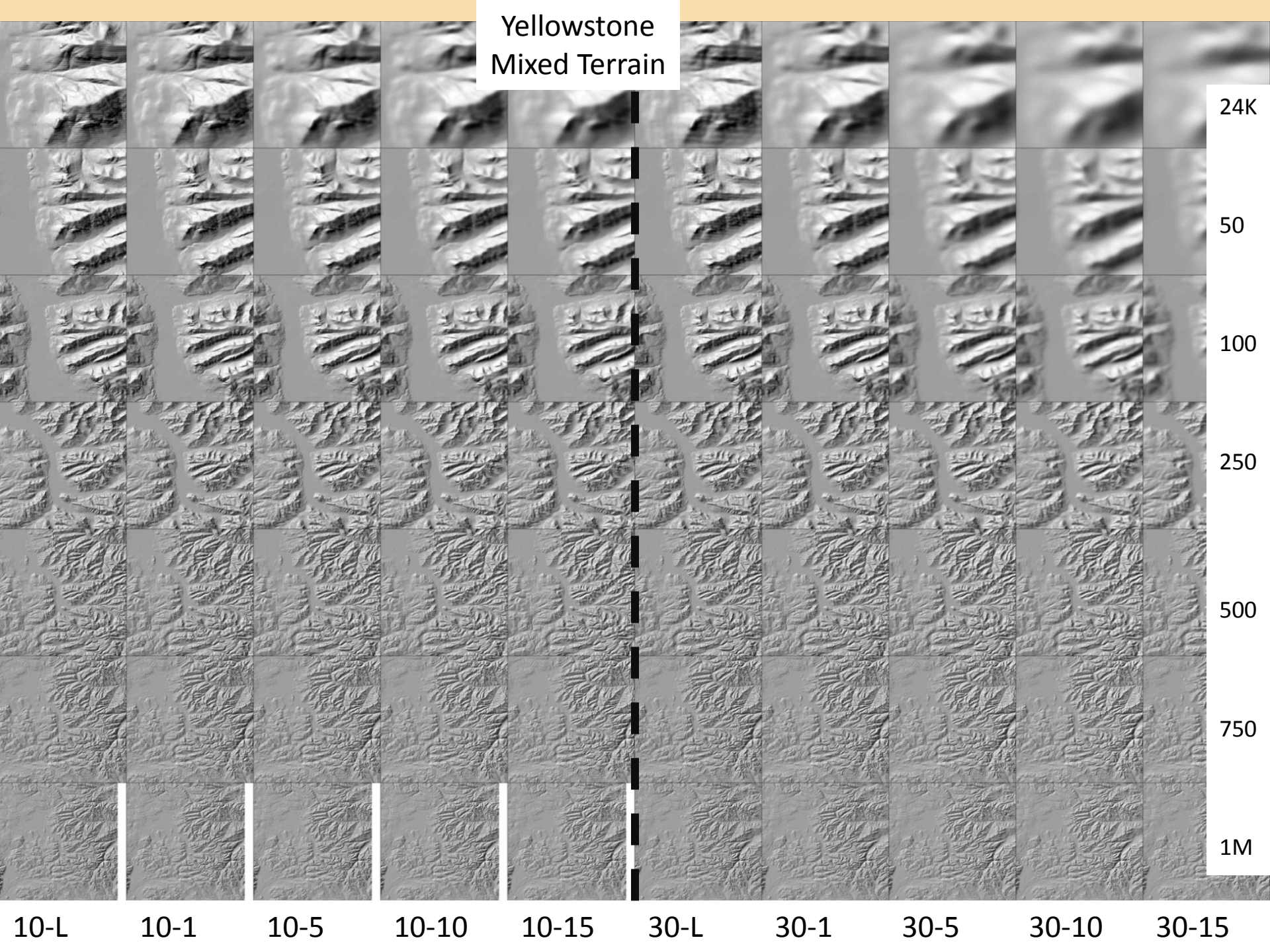


Projected, Bilinear



Terrain Generalization : Repetitive Mean filtering




Yellowstone
Mixed Terrain
24K
50
100
250
500
750
1M
10-L
10-1
10-5
10-10
10-15
30-L
30-1
30-5
30-10
30-15

Terrain Generalization : Analyzing Hillshades

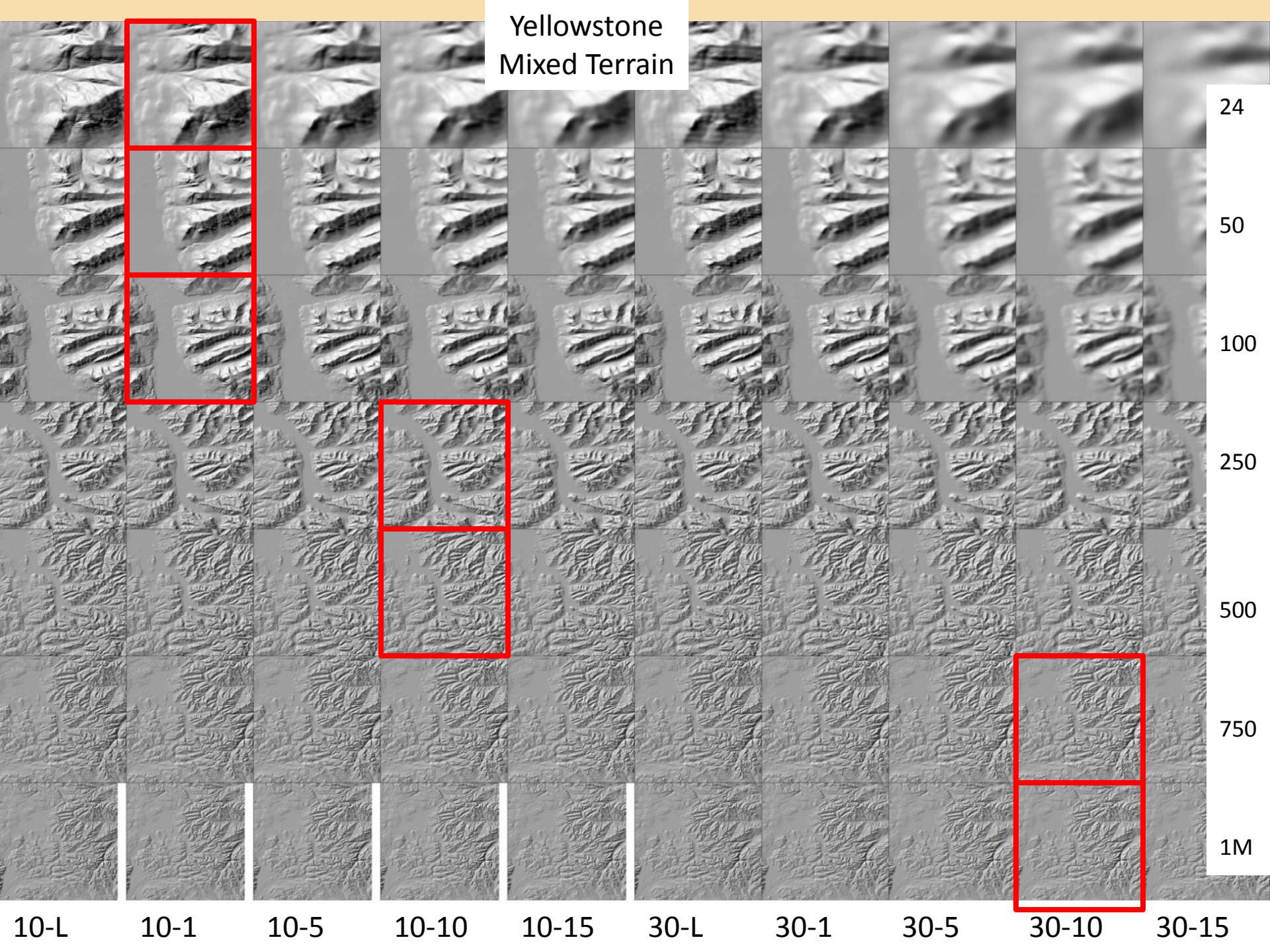
- Hillshades evaluated through **smoothing** repetition and **scale**
  - -10 (blurry) – +10 (sharp)

	10-L	10-1	10-5	10-10	10-15	30-L	30-1	30-5	30-10	30-15
24K	-2	-3	-5	-7	-10	-10	-10	-10	-10	-10
50K	0	-1	-3	-3	-5	-5	-7	-10	-10	-10
100K	1	0	-1	-3	-2	-2	-2	-7	-5	-7
250K	5	3	0	0	0	0	0	-3	-3	-3
500K	10	5	3	0	0	3	1	0	-1	-1
750K	10	10	5	3	1	3	3	0	-1	0
1M	10	10	7	5	2	7	5	2	1	0

Terrain Generalization : Recommendations

- 3 breaks
  - 24K – 250K
  - 250K – 750K
  - 750K – 1M

- Processing Steps
  - 10m DEM, smoothed once (LGDEM)
  - 10m DEM, smoothed 10 times (MDDEM)
  - 30m DEM aggregated, smoothed 10 times (SMDEM)


Yellowstone
Mixed Terrain
24
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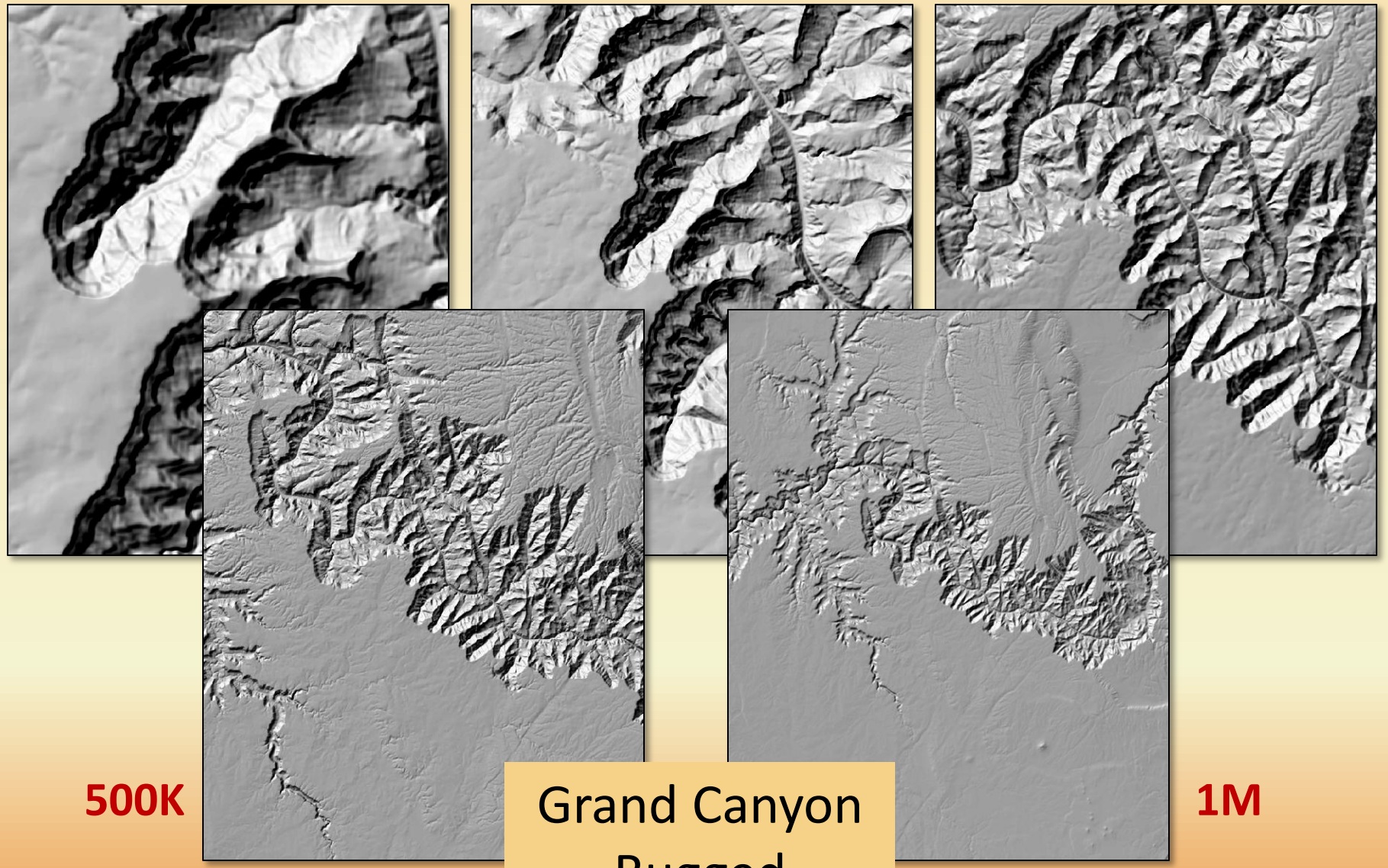
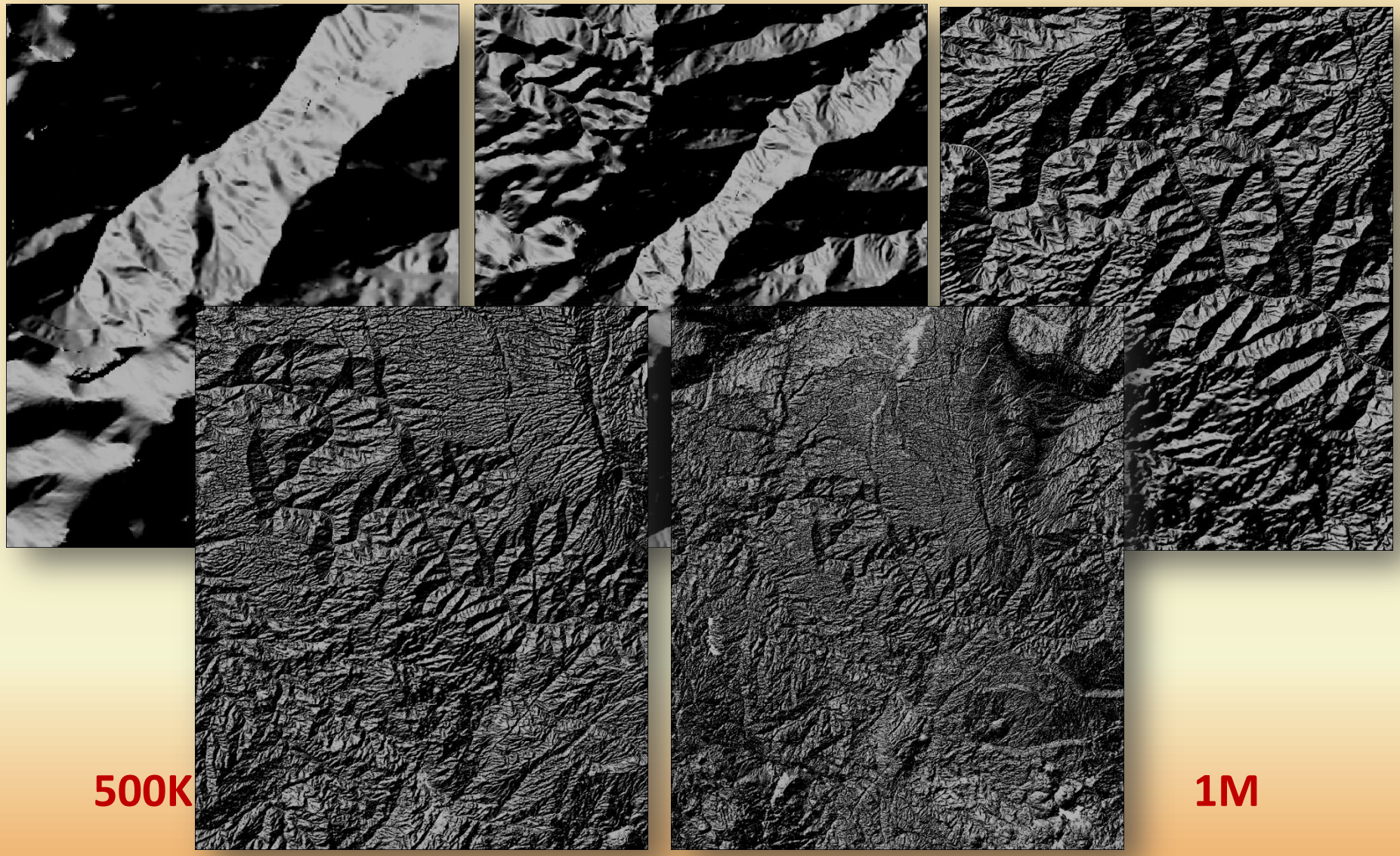
1M
10-L
10-1
10-5
10-10
10-15
30-L
30-1
30-5
30-10
30-15

Close up Example of Decisions

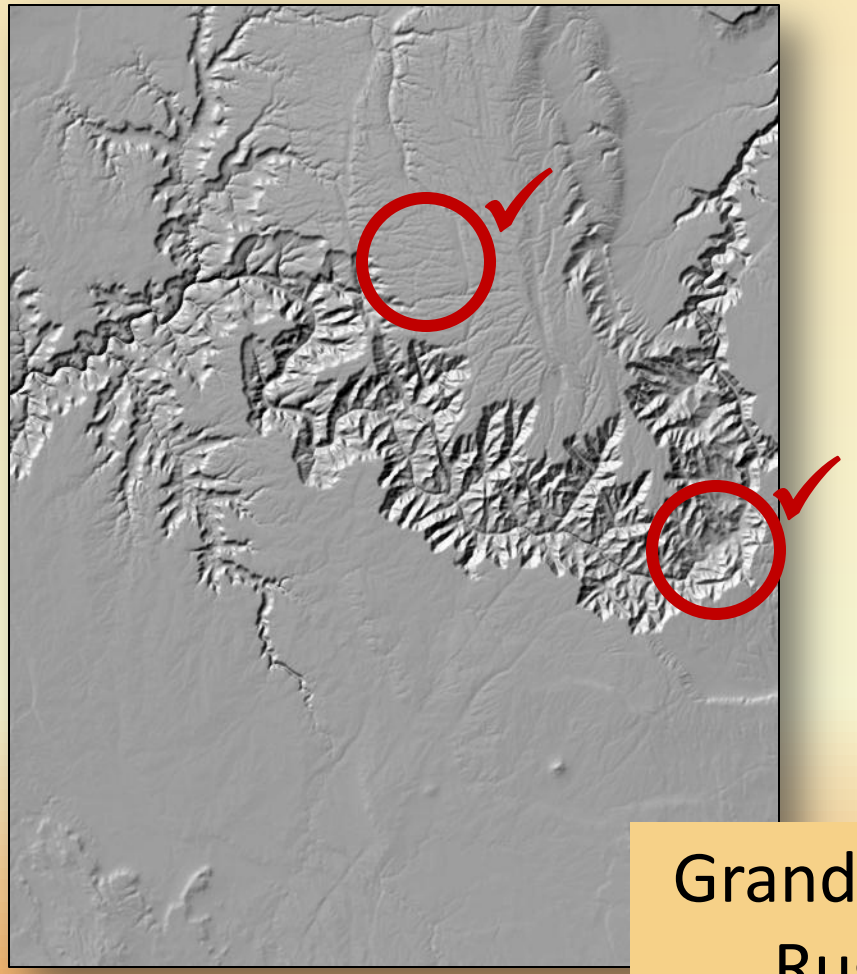


Close up Example – Unprojected, Default Hillshade

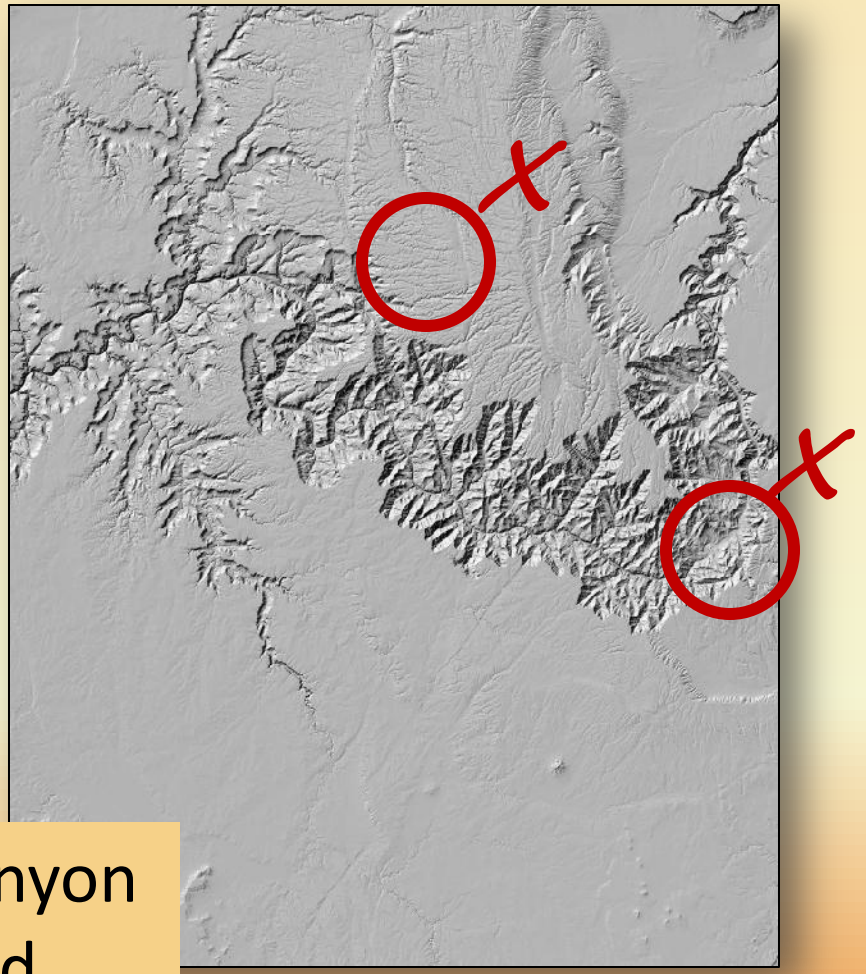


Was it Successful?

1M correct

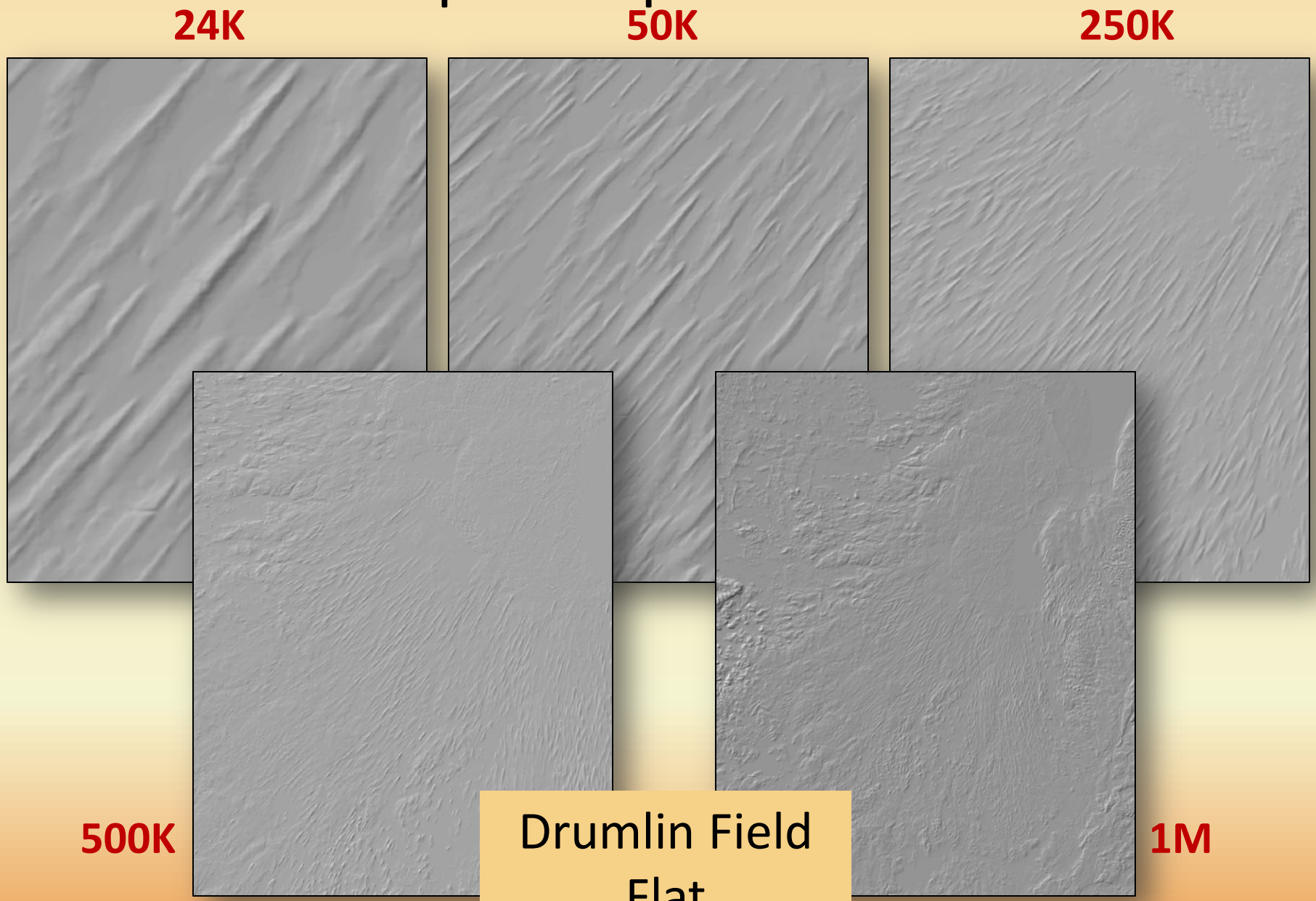


1M using 24K processing



Grand Canyon
Rugged

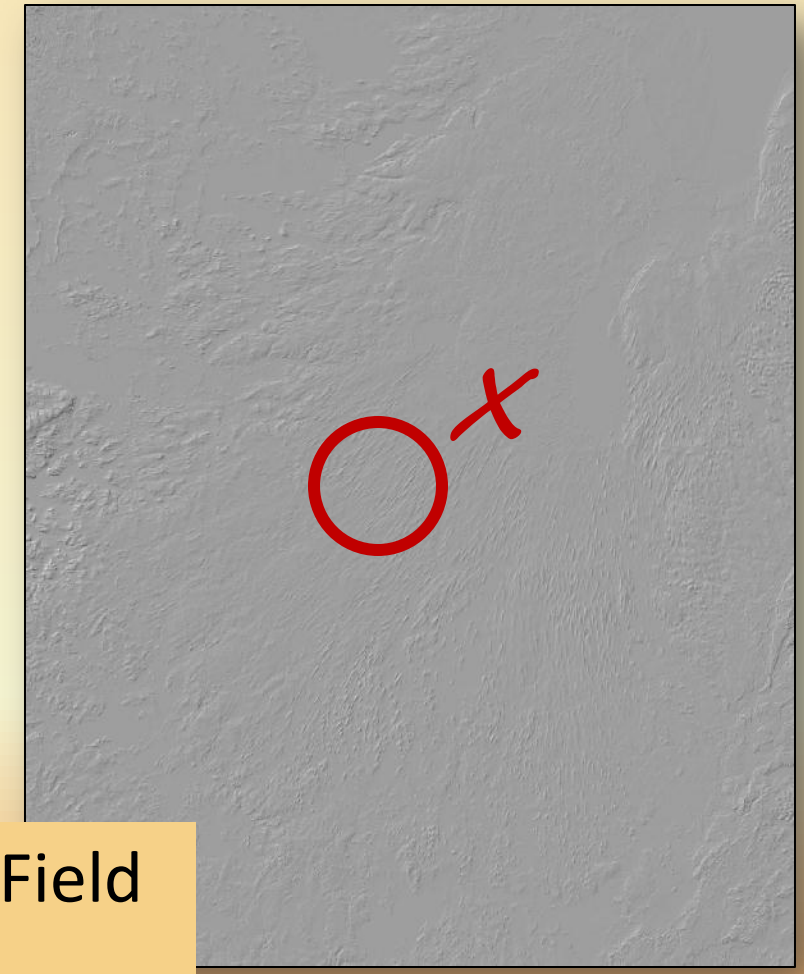
Close up Example of Decisions



Was it Successful?

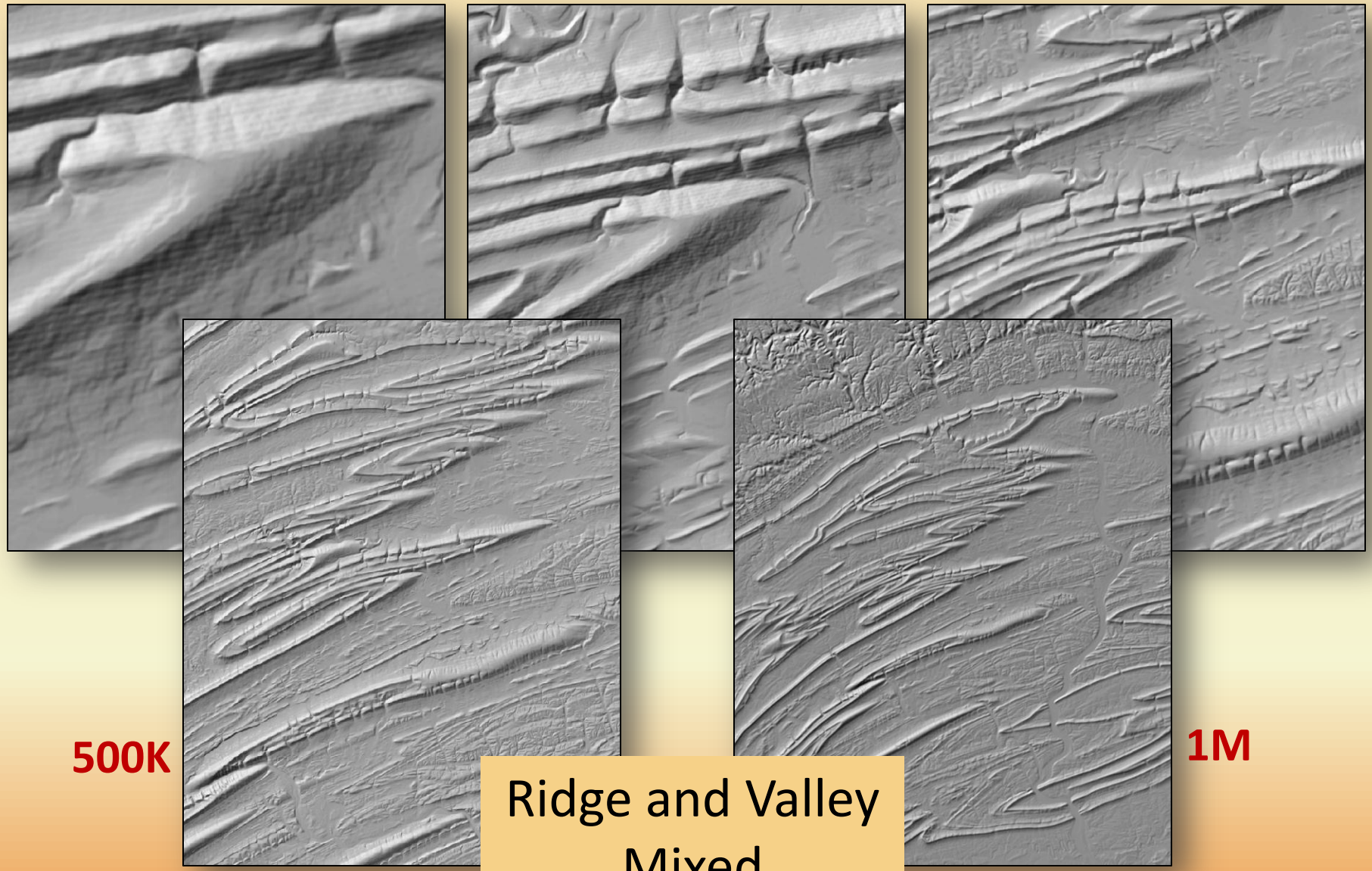
1M correct

1M using 24K processing



Drumlin Field
Flat

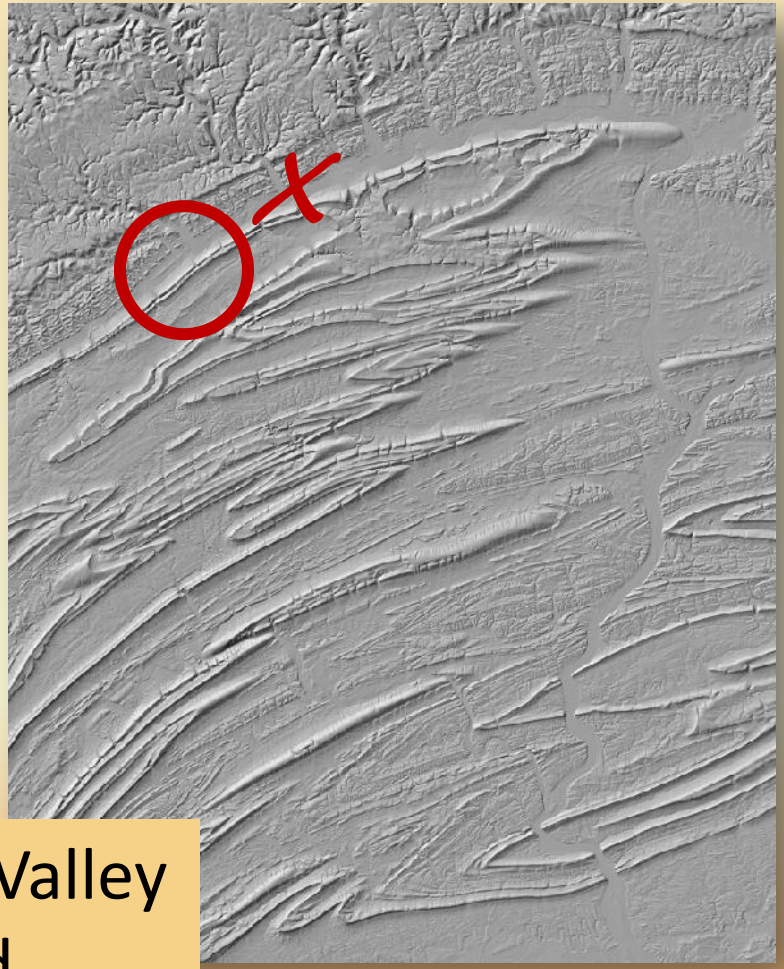
Close up Example of Decisions



Was it Successful?

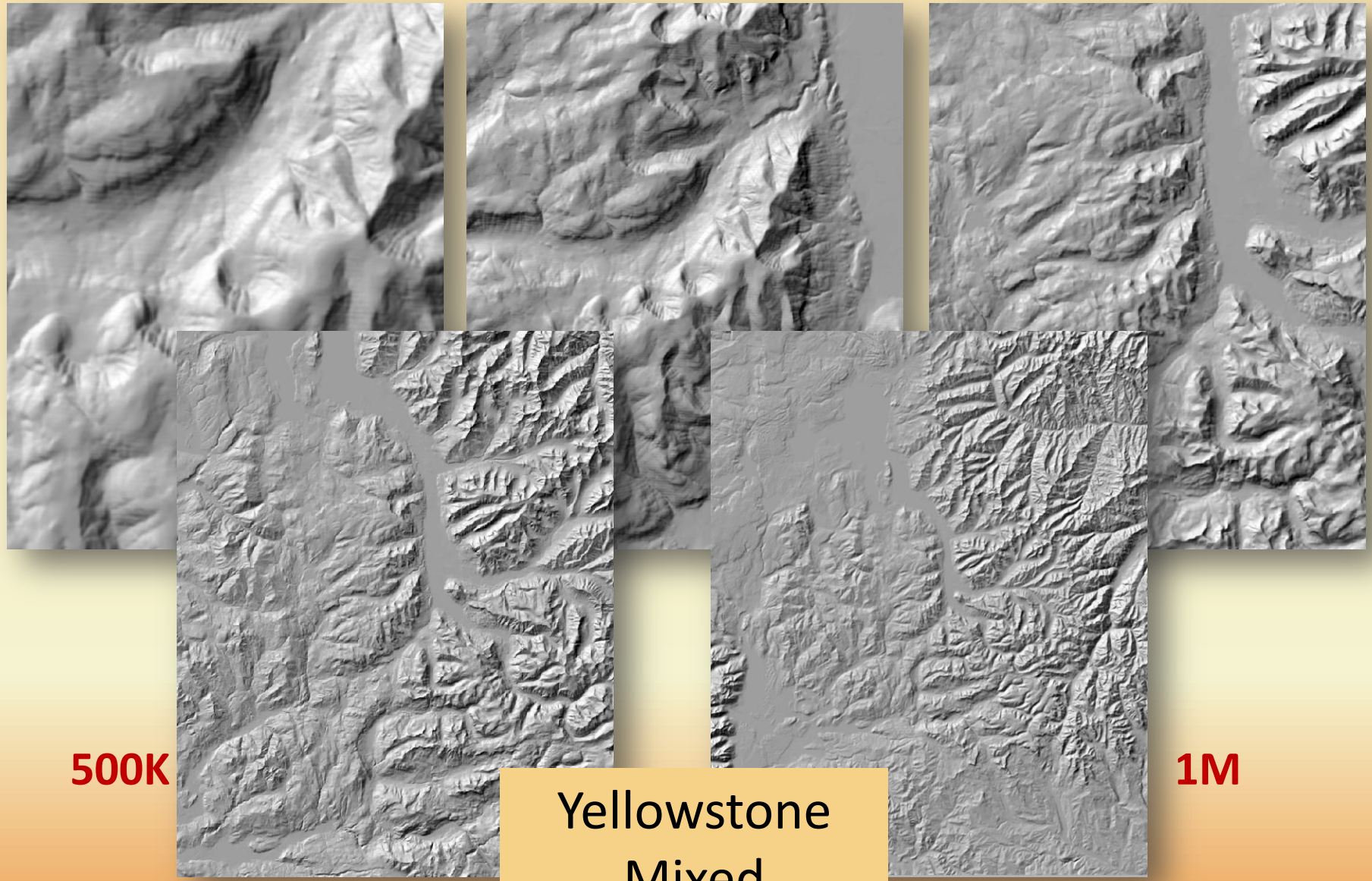
1M correct

1M using 24K processing



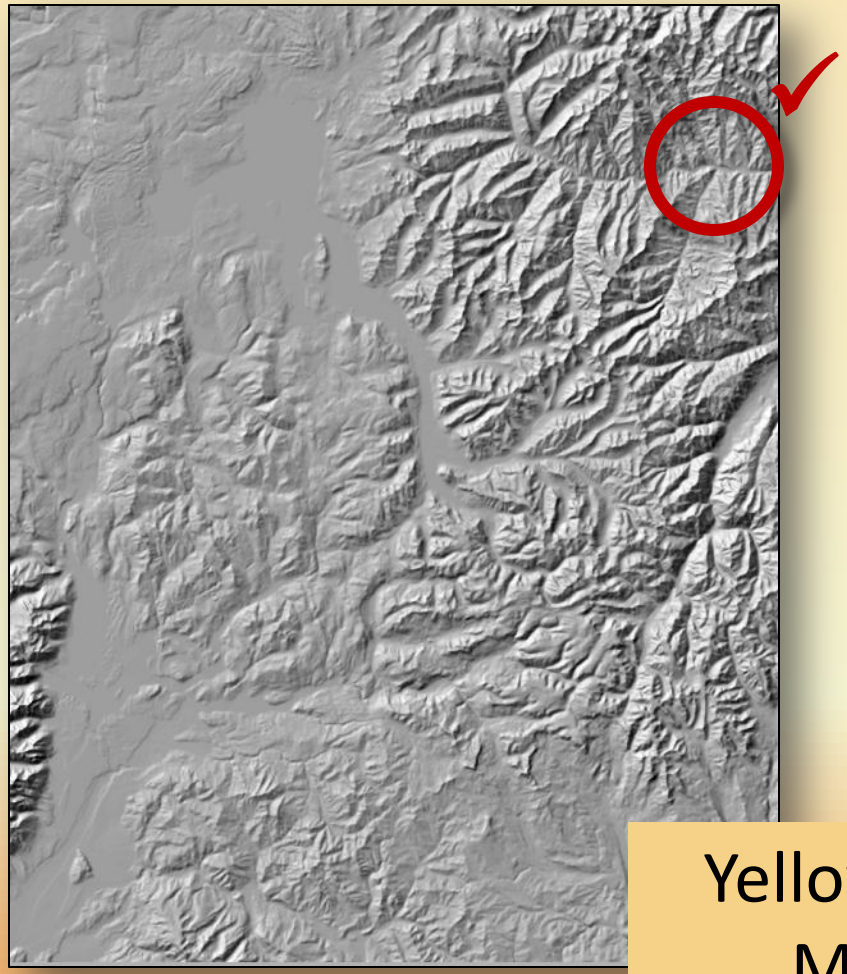
Ridge and Valley
Mixed

Close up Example of Decisions

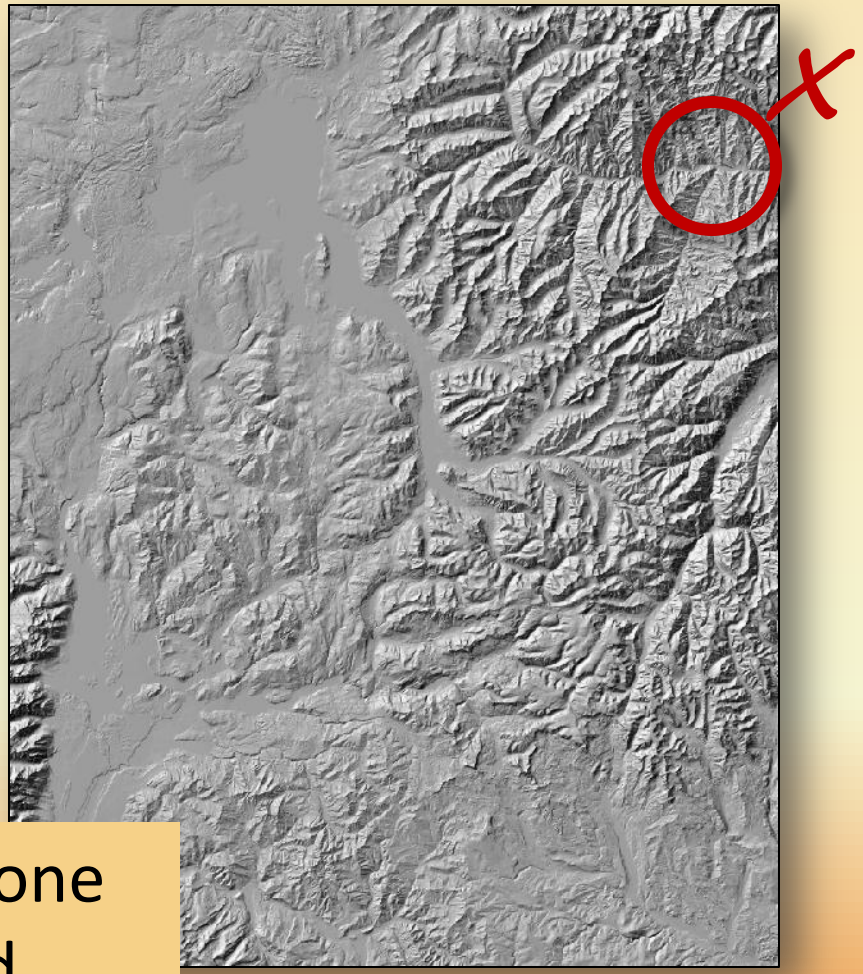


Was it Successful?

1M correct



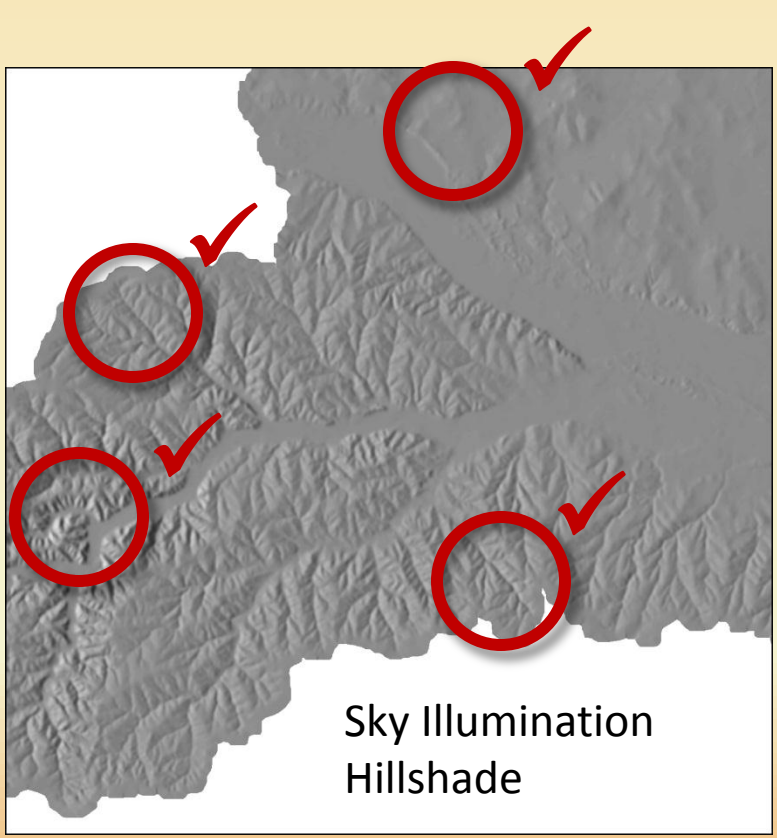
1M using 24K processing

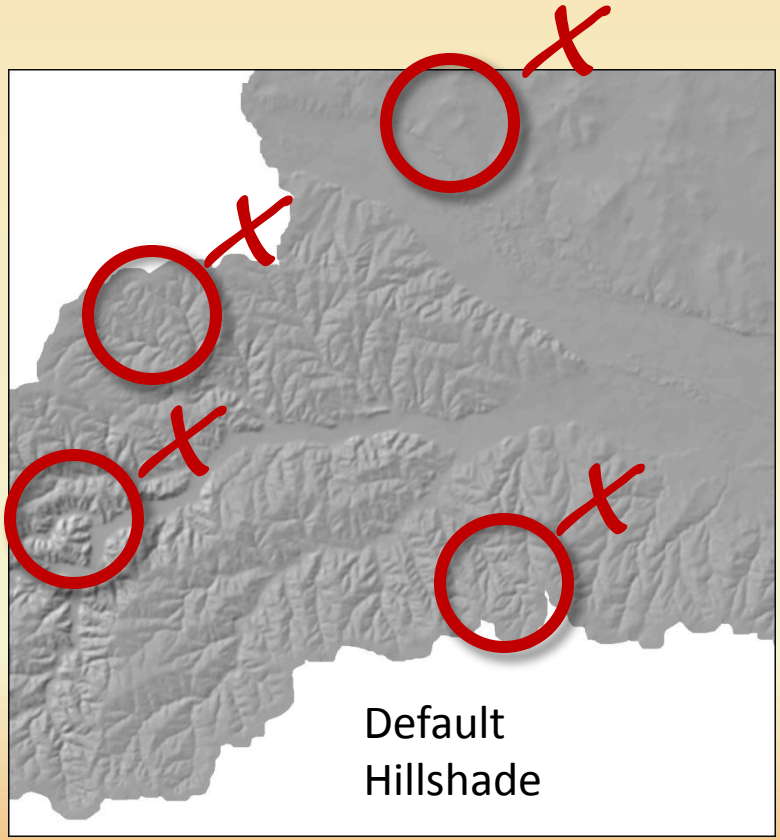


Yellowstone
Mixed

Adjustment to Hillshading

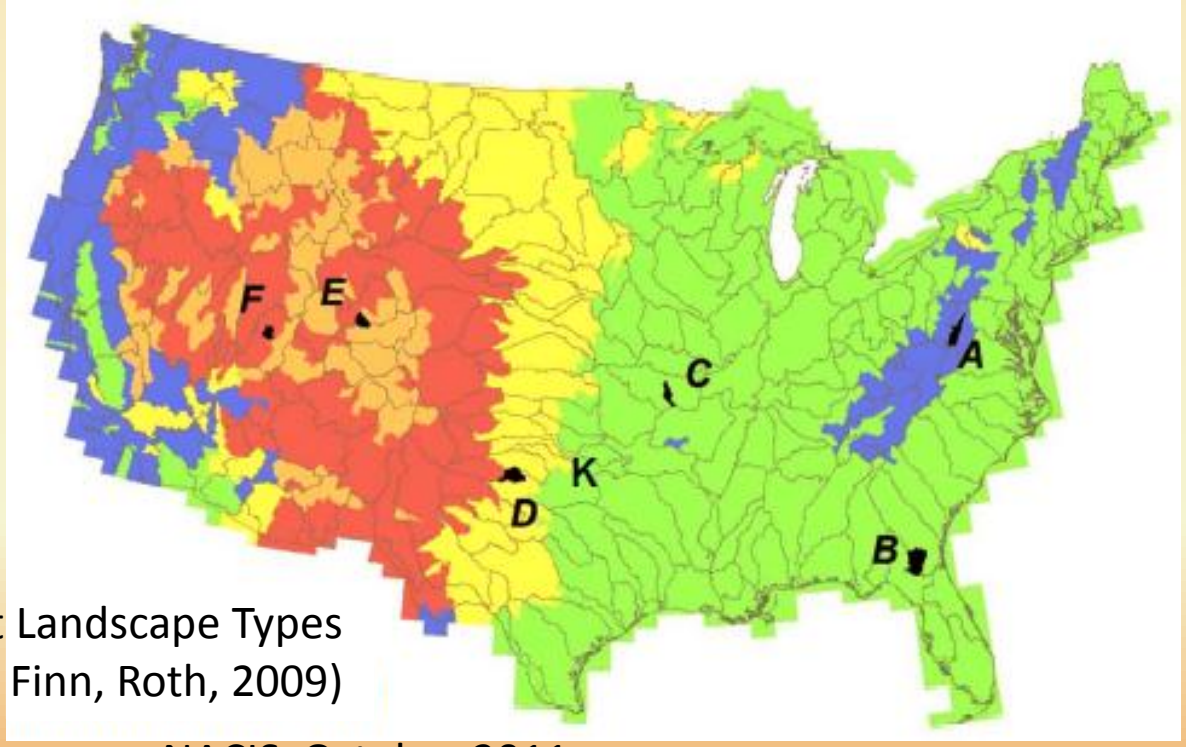
- Sky Illumination Model hillshade (Kennelly, 2006)
  - Combine multiple hillshades with different azimuths





Contours : Study Areas

- 8 subbasins
  - ATL
  - CO
  - FL/GA
  - MO
  - STL
  - TX
  - UT
  - WV
- Terrain Classifications
  - Mountainous
  - Hilly
  - Flat



Draft Landscape Types
(Stanislawski, Buttenfield, Finn, Roth, 2009)

Contours : Intervals

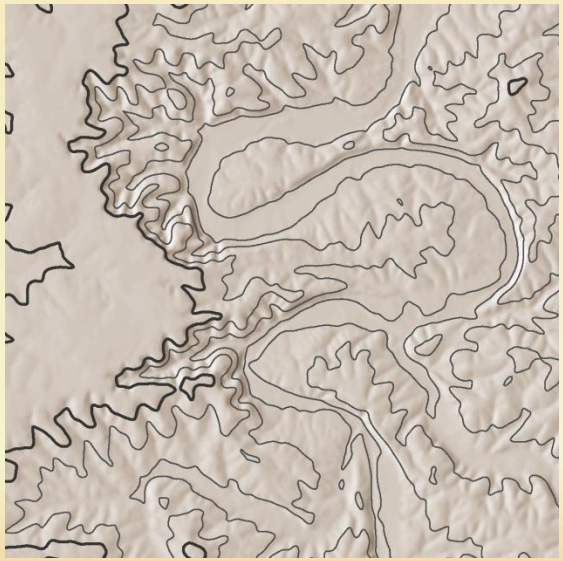
Map Scales	Predominant Terrain Type[1]					
	High Mountains		Low Mountains		Flat or Undulating	
	Feet	Meters	Feet	Meters	Feet	Meters
1:1,000	5	1	3	0.5	1-2	0.25
1:2,000	5-10	2	5	1	2-3	0.5
1:5,000	10-20	5	5-10	2.5	3-5	1
1:10,000	20	10	10	5	5	2
1:20,000	20-40	10-20	20	10	5-10	2.5
1:25,000	20-50	10-20	20-25	10	5-10	2.5
1: 50,000	50-100	20-40	40-50	10-20	10-20	5
1:100,000	100	40-50	50-80	25	10-25	5-10
1:200,000	200-250	100	100	50	20-40	10
1:250,000	200-400	80-120	100-200	50-80	25-40	10-20
1:500,000	400-500	100-200	200-250	100	40-50	20
1:1,000,000	500-800	200	250-400	100	50-100	20-50

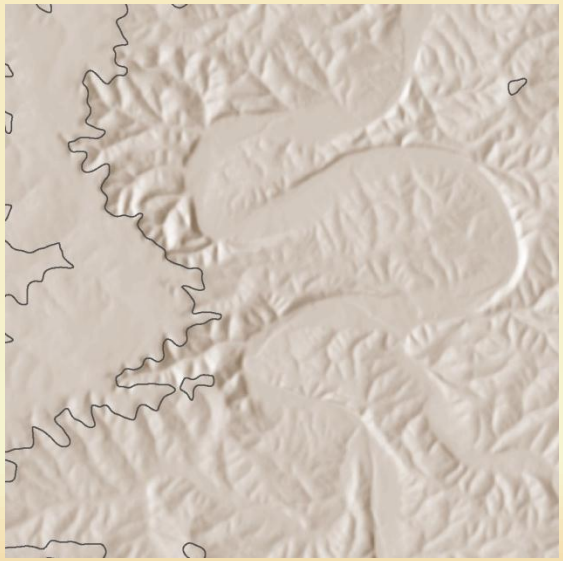
[1]Predominant terrain type should be representative of over 50% of the area on a given map. When an even distribution of all three terrain types or between high mountains and flat or undulating (with a relatively low area of low mountains), then consider using supplementary contour lines as well.

Imhof, 2007 and
Frye, 2008

Contours : Analyzing contours

- Looked at each subbasin to determine:
  - Contour density
  - Contour complexity

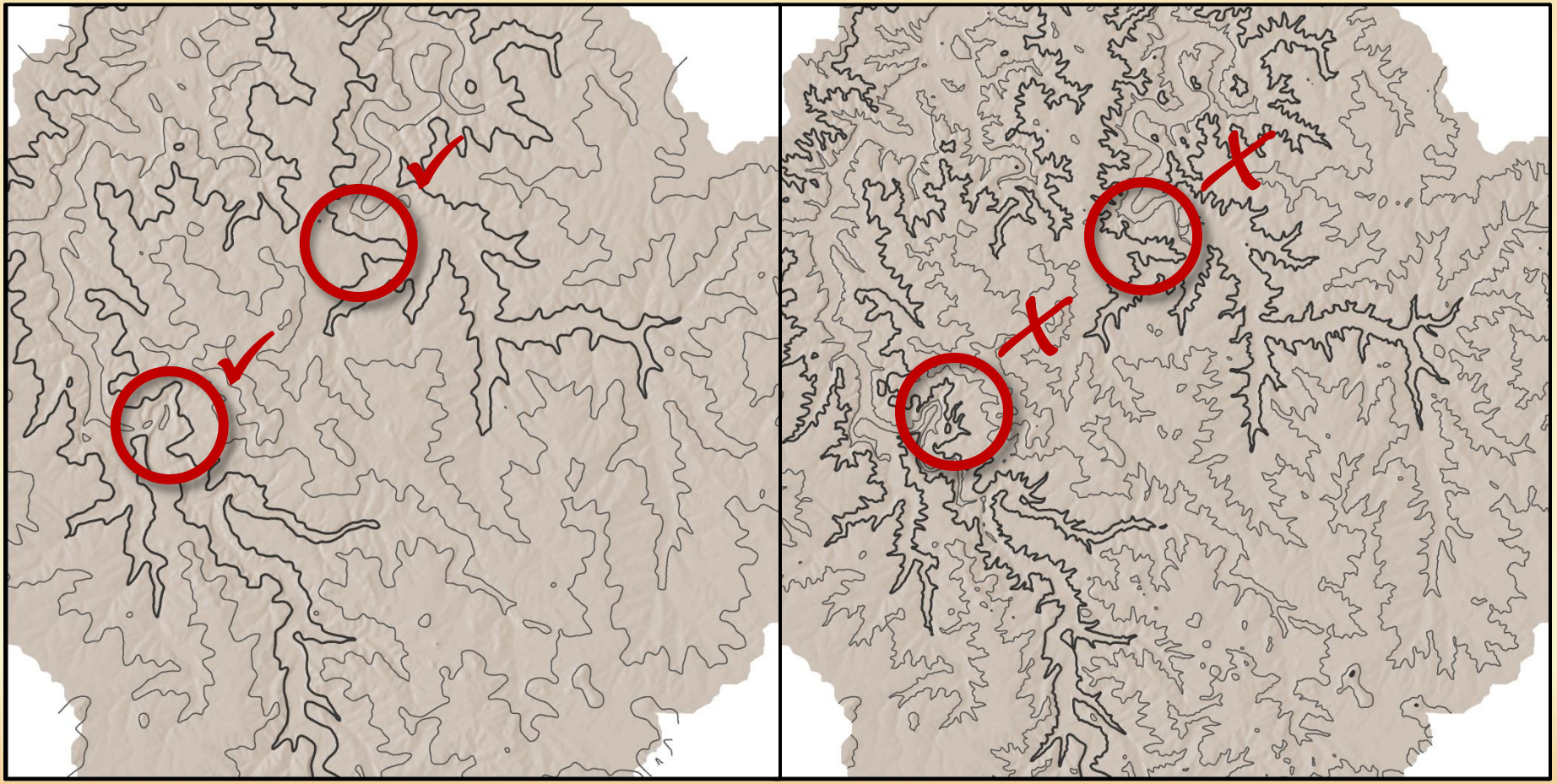




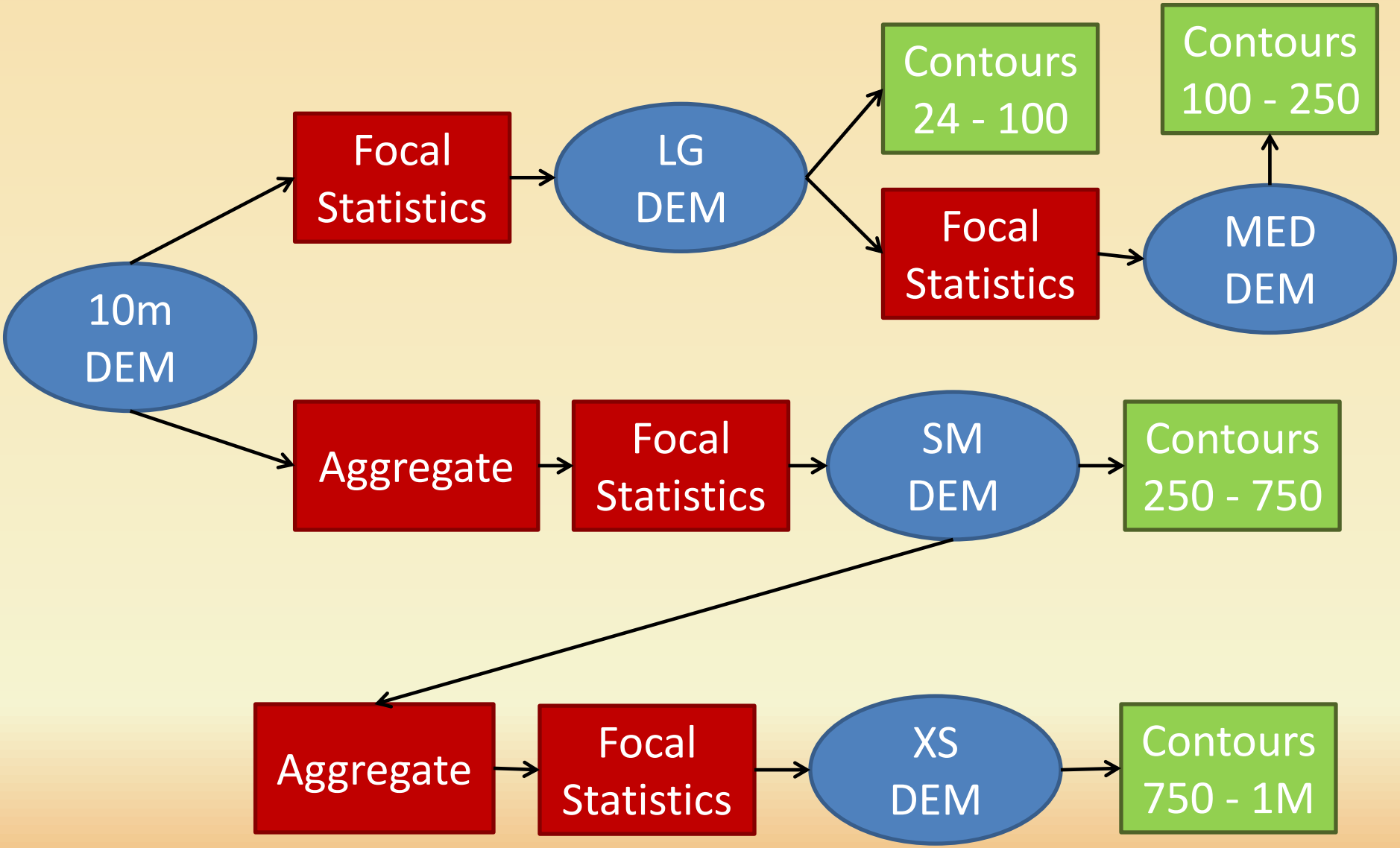
Contours : 250K, 25m intervals

Derived from sm scale DEM

Derived from md scale DEM



Contours : Creation



Location: _____

Contour Interval	Scale: 24	50	100	250	250	500	750	750	1000
5	Sparse	y	too dense in areas			n	n	n	n
10		y		too dense in areas	maybe	n			
25		n	Sparse	y	y	too dense in areas	n	too dense in areas	n
50	n	n	n	y	y	y	too dense in areas		
100	n	n	n	n	n	y	n	y	y
250	none	none	none	n	n	n	n	n	n
500				none	none	n	n	n	n
1000									

Contours : Recommendations

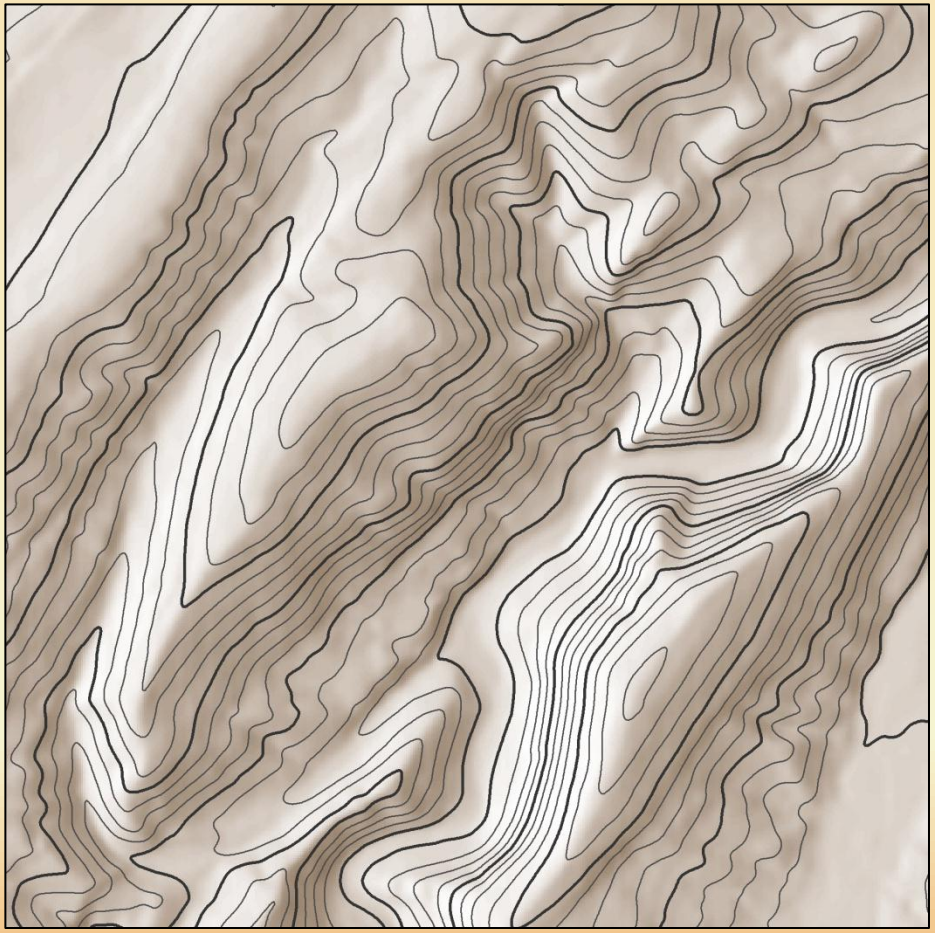
Scale	Contour Smoothing	Mountainous Contour Interval	Hilly Contour Interval	Flat Contour Interval
24K	LG DEM	25m	10m	5m
50K	LG DEM	25	10	5
100K	MED DEM	25	25	5
250K	SM DEM	100	25	25
500K	SM DEM	100	50	50
750K	XS DEM	250	100	50
1M	XS DEM	250	100	100
		CO WV	ATL MO STL TX	FL/GA UT

Contours : Mountainous Results

24K, 25m intervals

CO

WV



Contours : Mountainous Results

50K, 25m intervals

CO

WV

Contours : Mountainous Results

100K, 25m intervals

CO

WV

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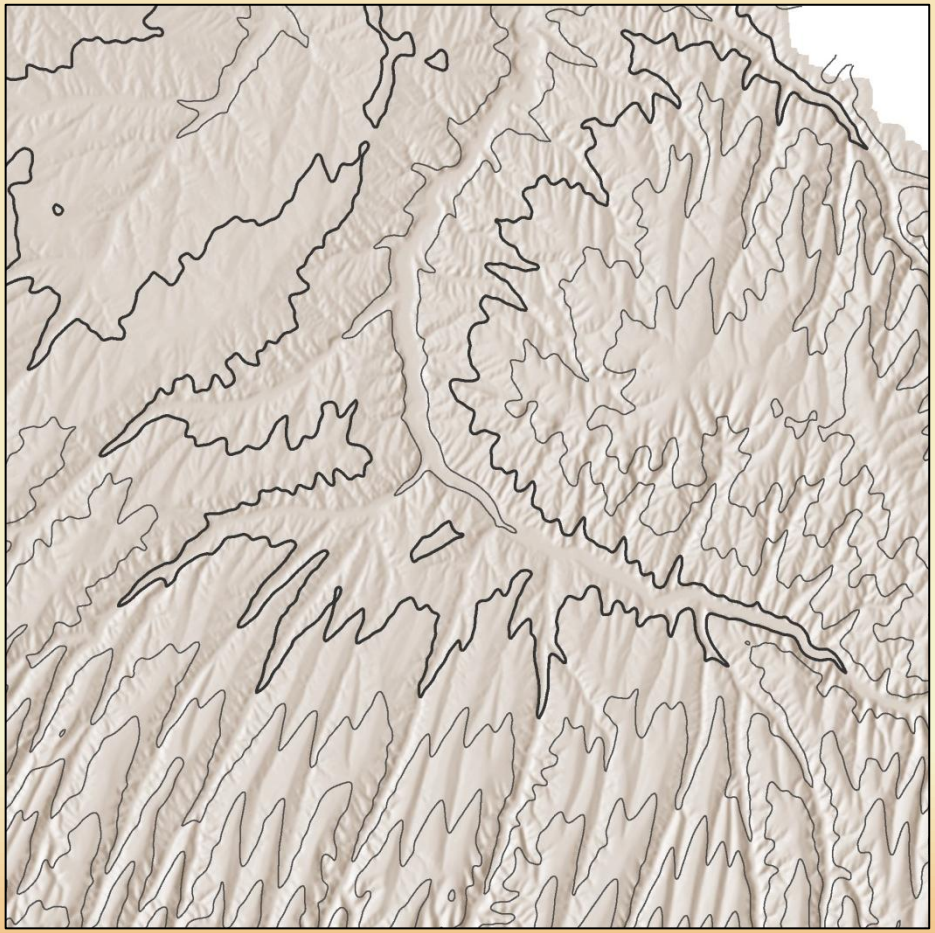
Contours : Mountainous Results

250K, 100m intervals

CO



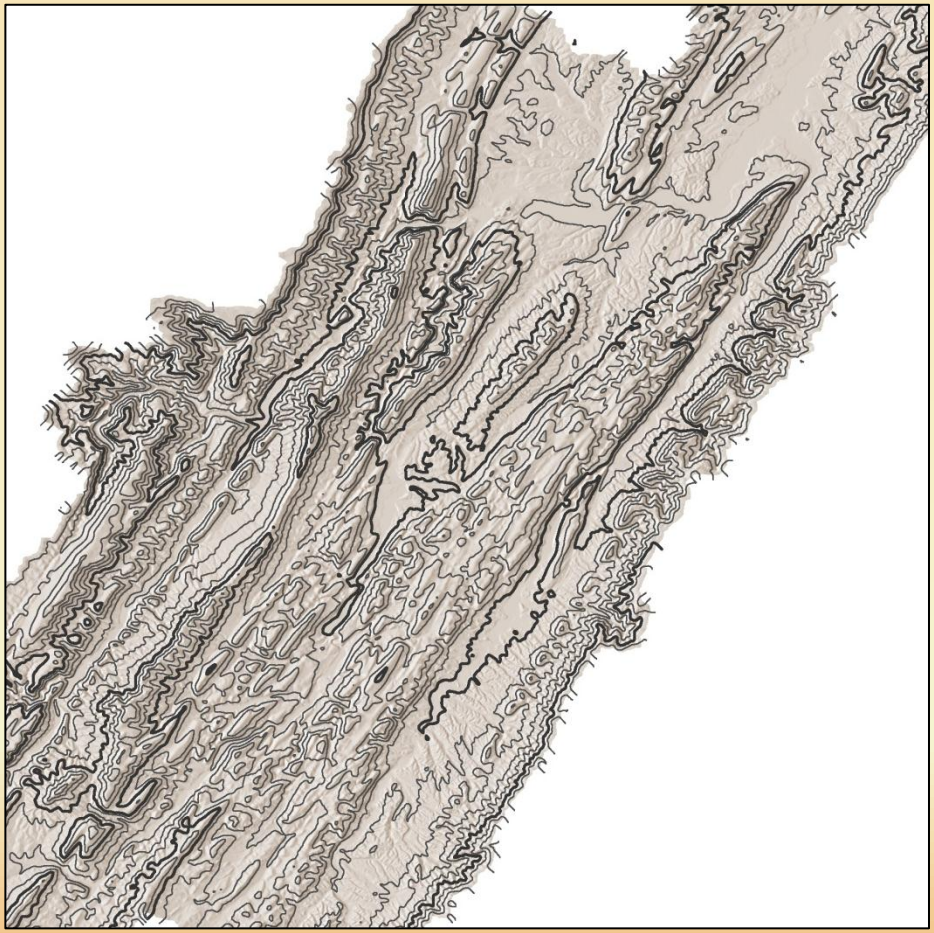
WV

Contours : Mountainous Results

500K, 100m intervals

CO

WV

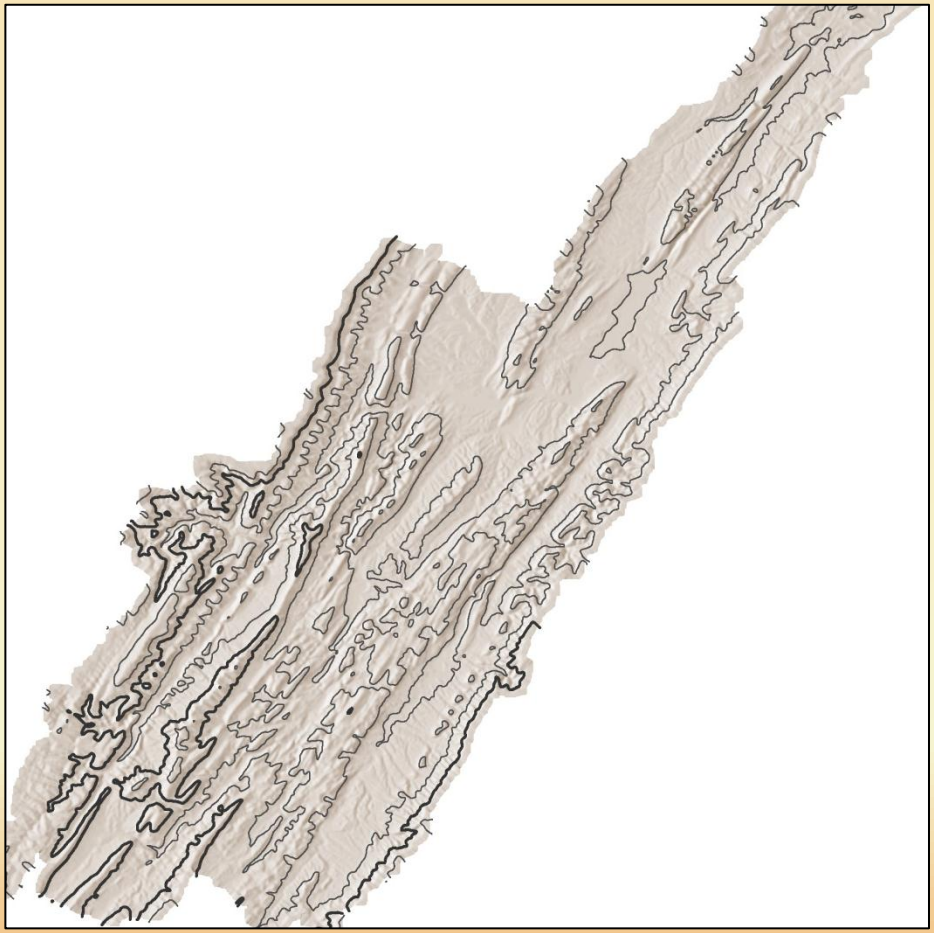


Contours : Mountainous Results

750K, 250m intervals

CO

WV



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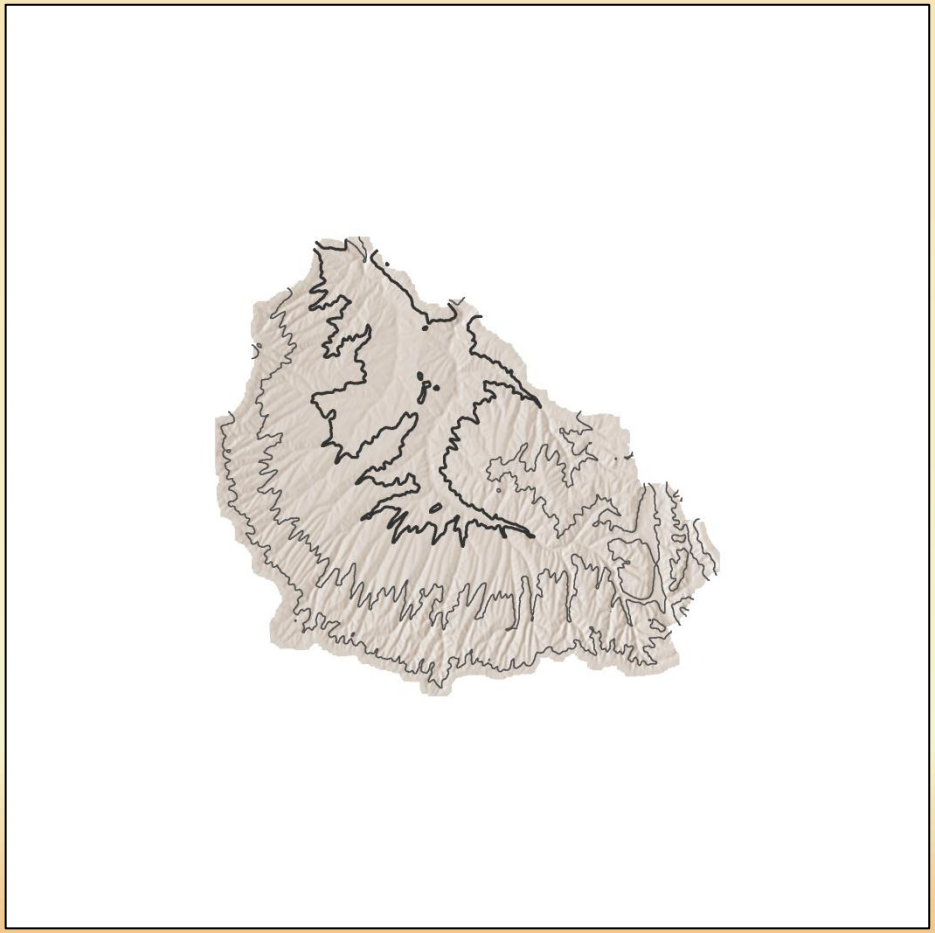
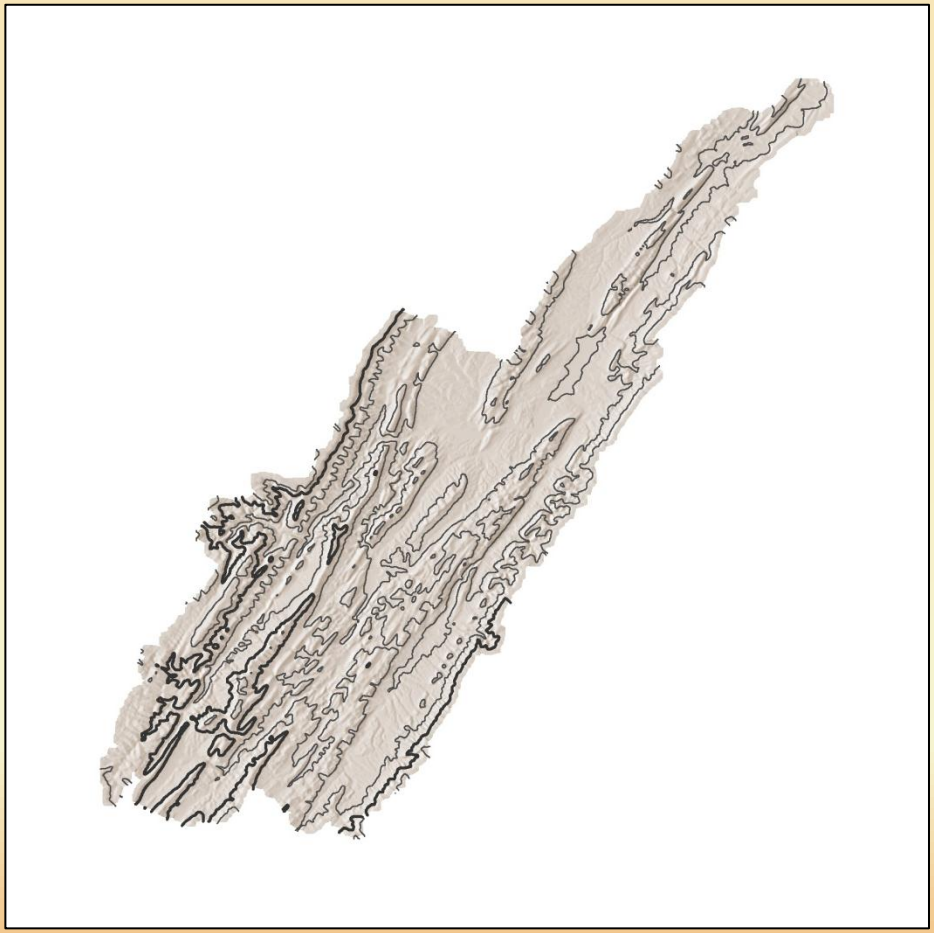
Contours : Mountainous Results

1M, 250m intervals

CO



WV

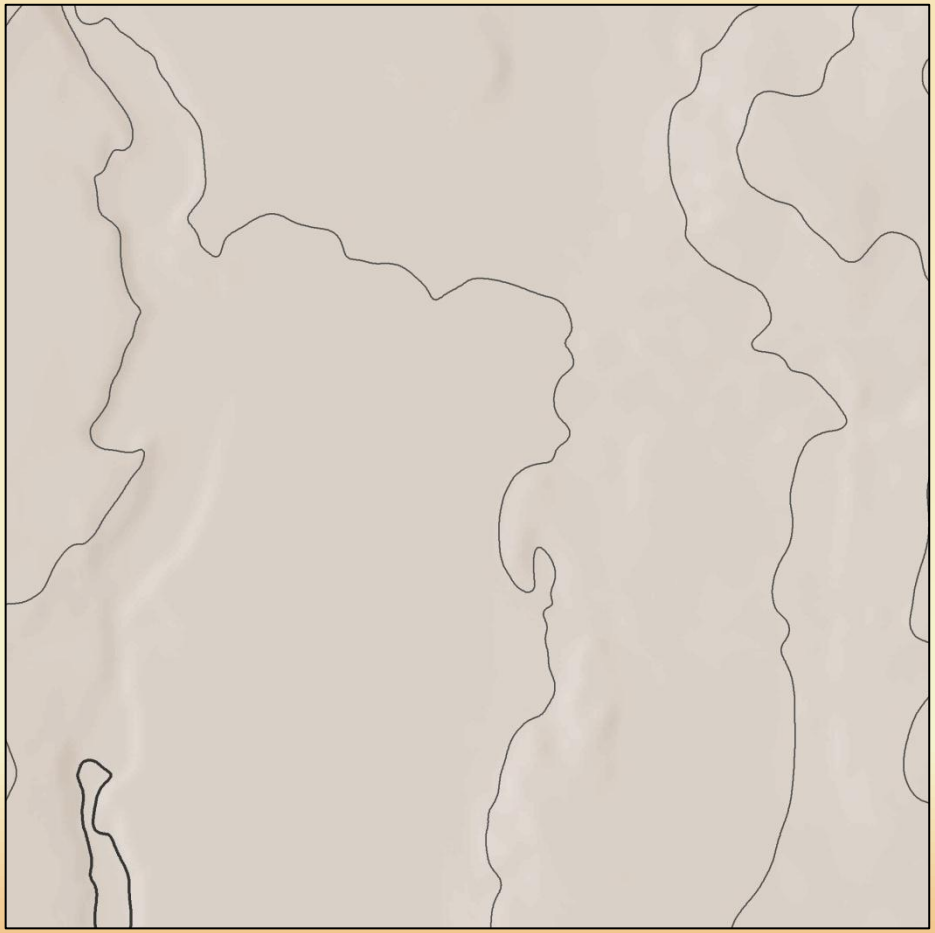


Contours : Hilly Results

24K, 10m intervals

TX

MO



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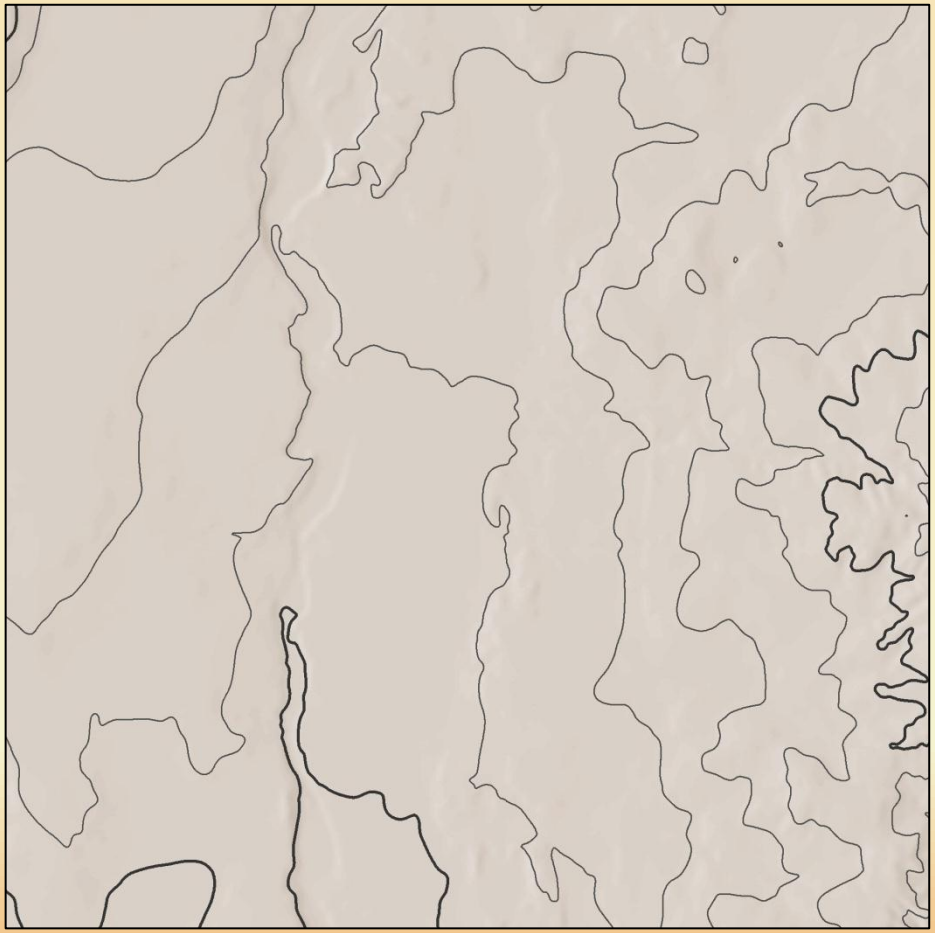
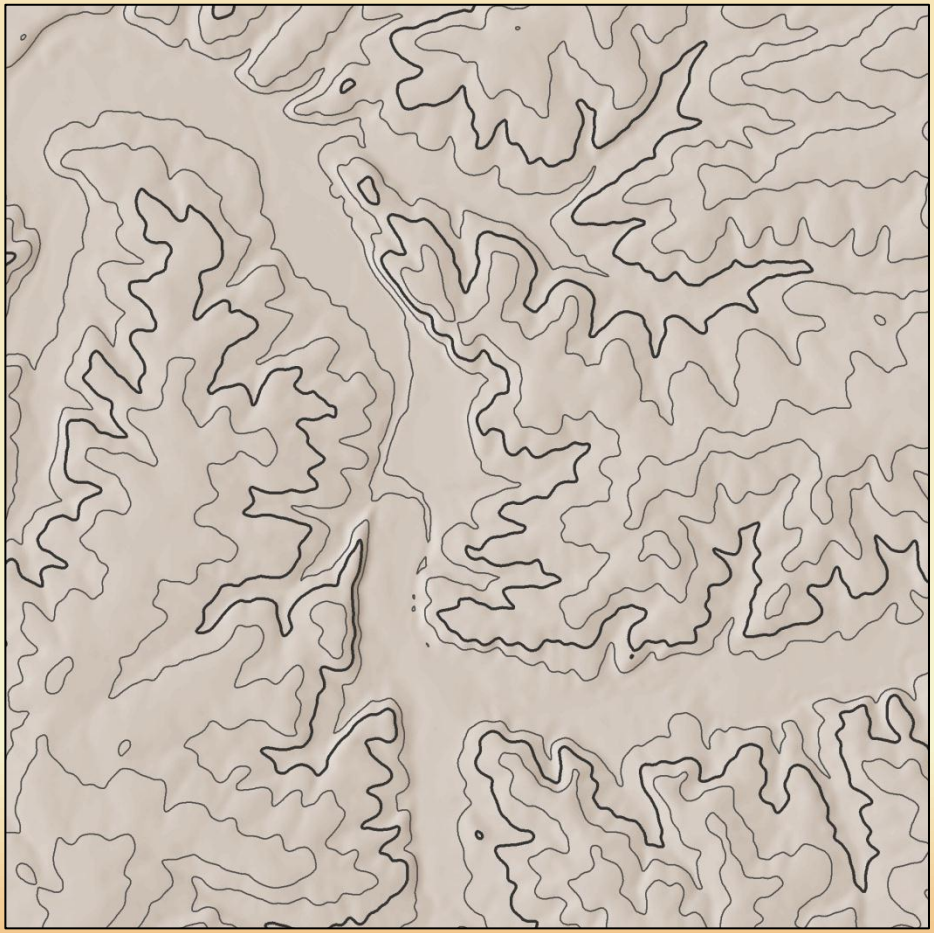
Contours : Hilly Results

50K, 10m intervals

TX



MO



Contours : Hilly Results

100K, 25m intervals

TX

MO

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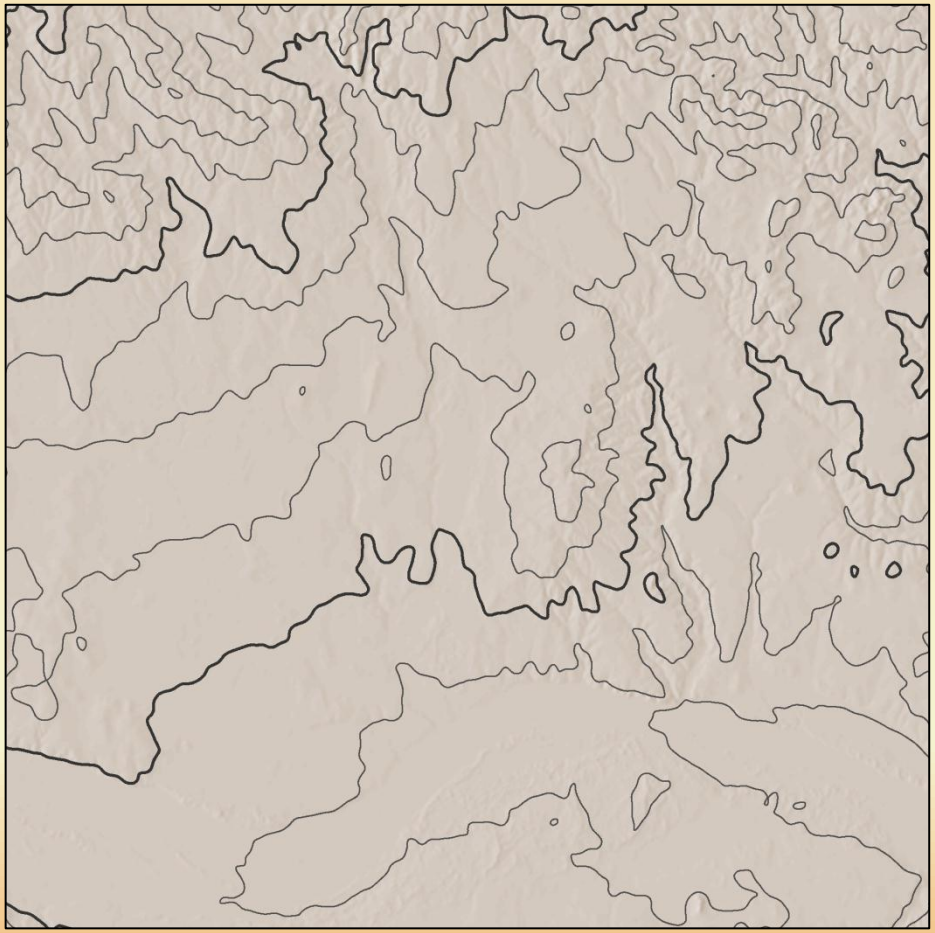
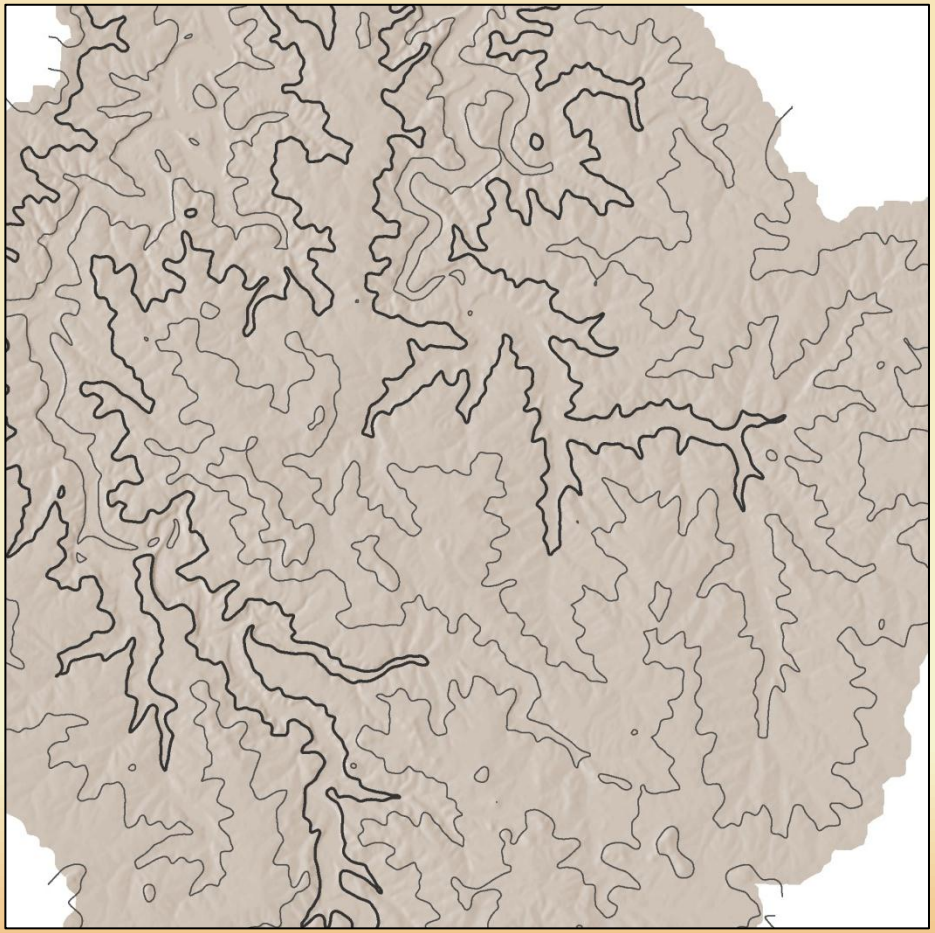
Contours : Hilly Results

250K, 25m intervals

TX



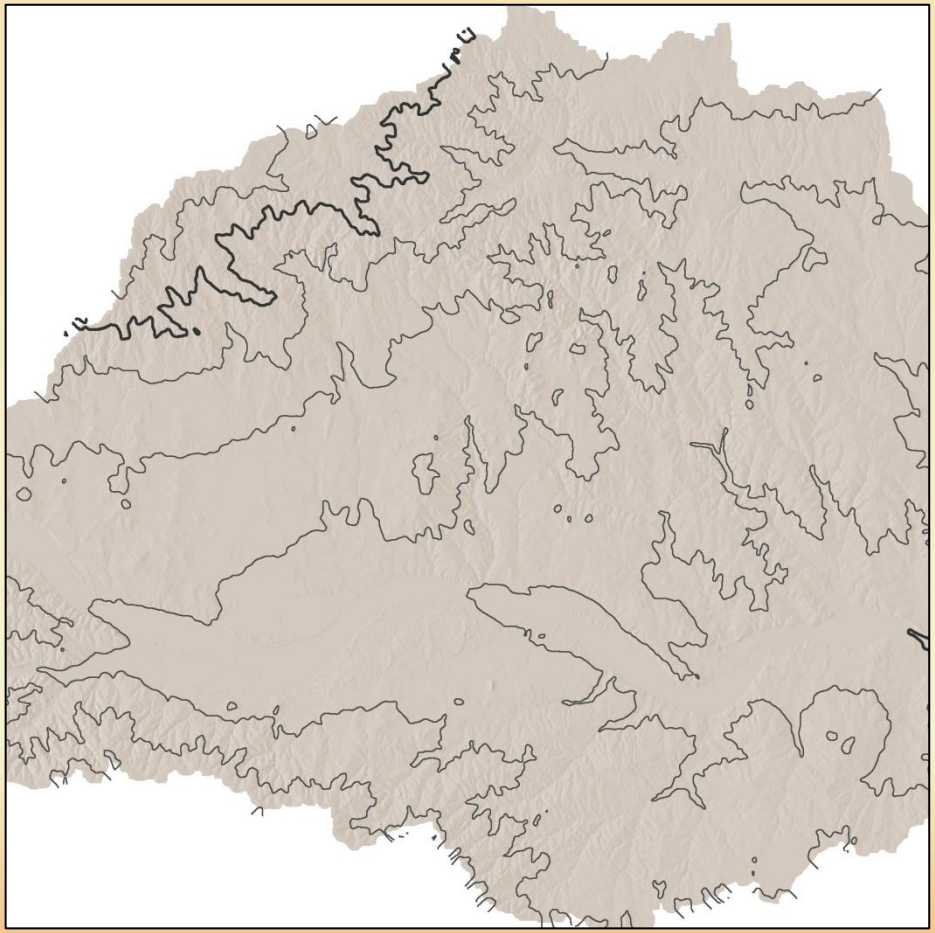
MO



Contours : Hilly Results

500K, 50m intervals

TX

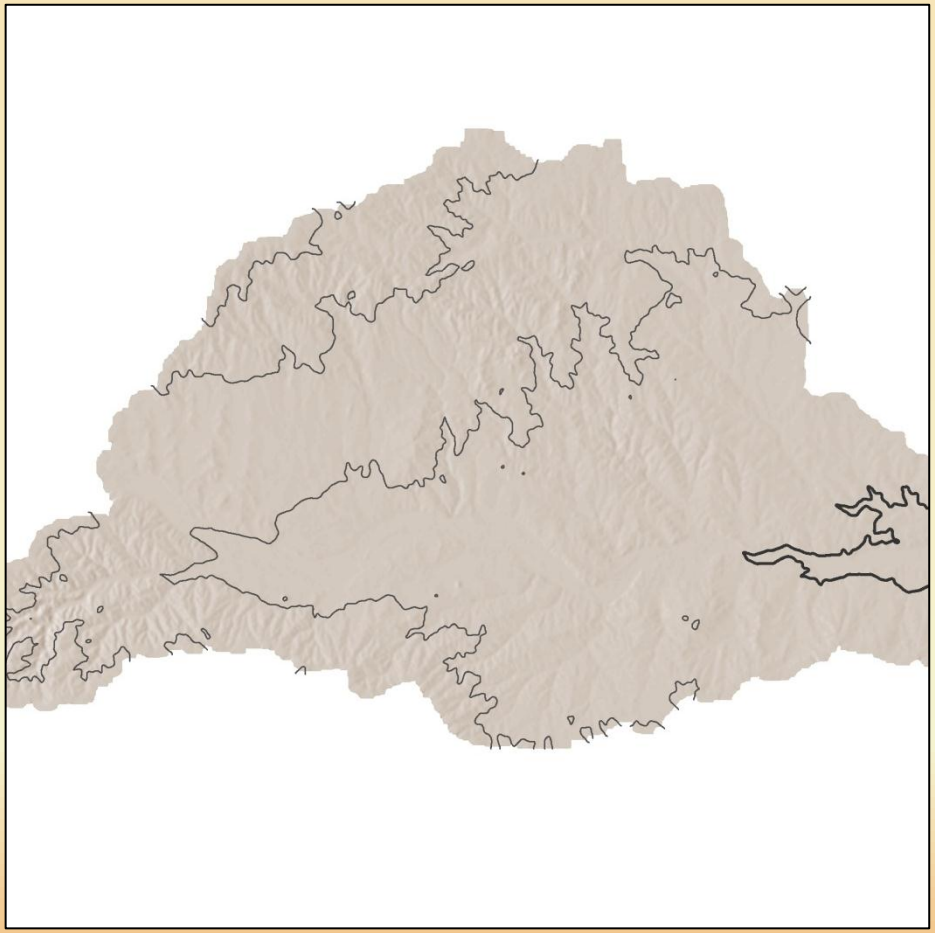


MO

Contours : Hilly Results

750K, 100m intervals

TX

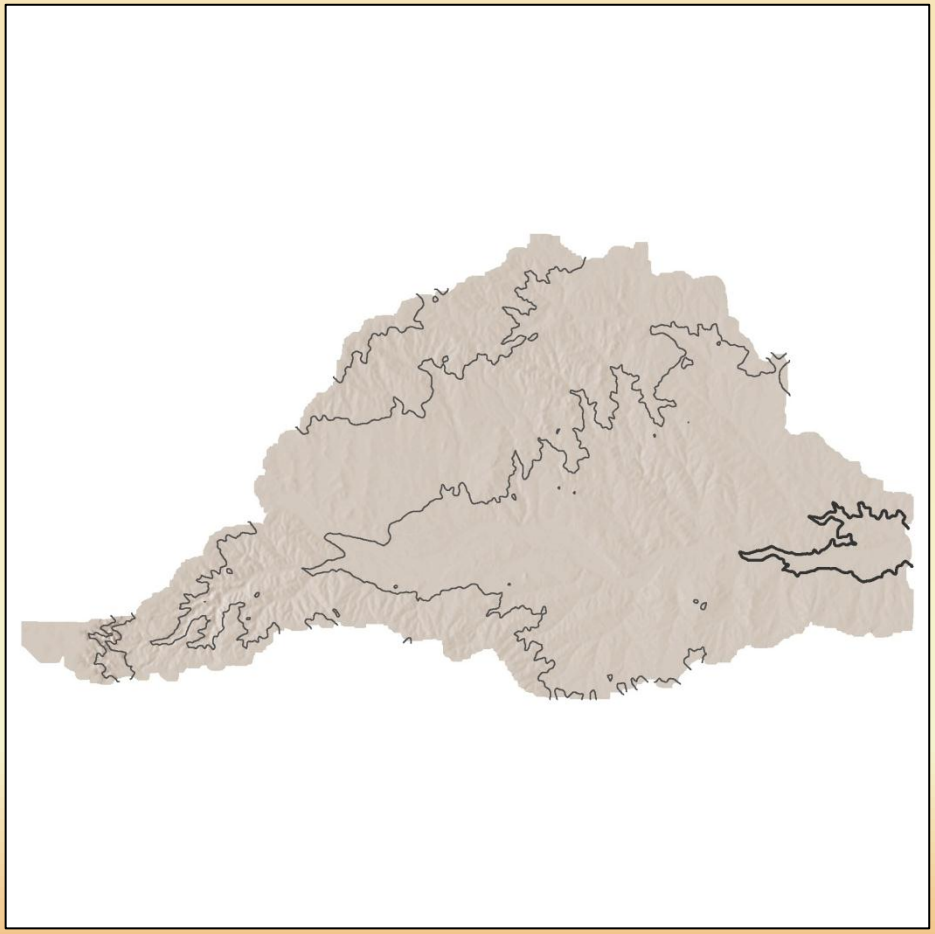


MO

Contours : Hilly Results

1M, 100m intervals

TX



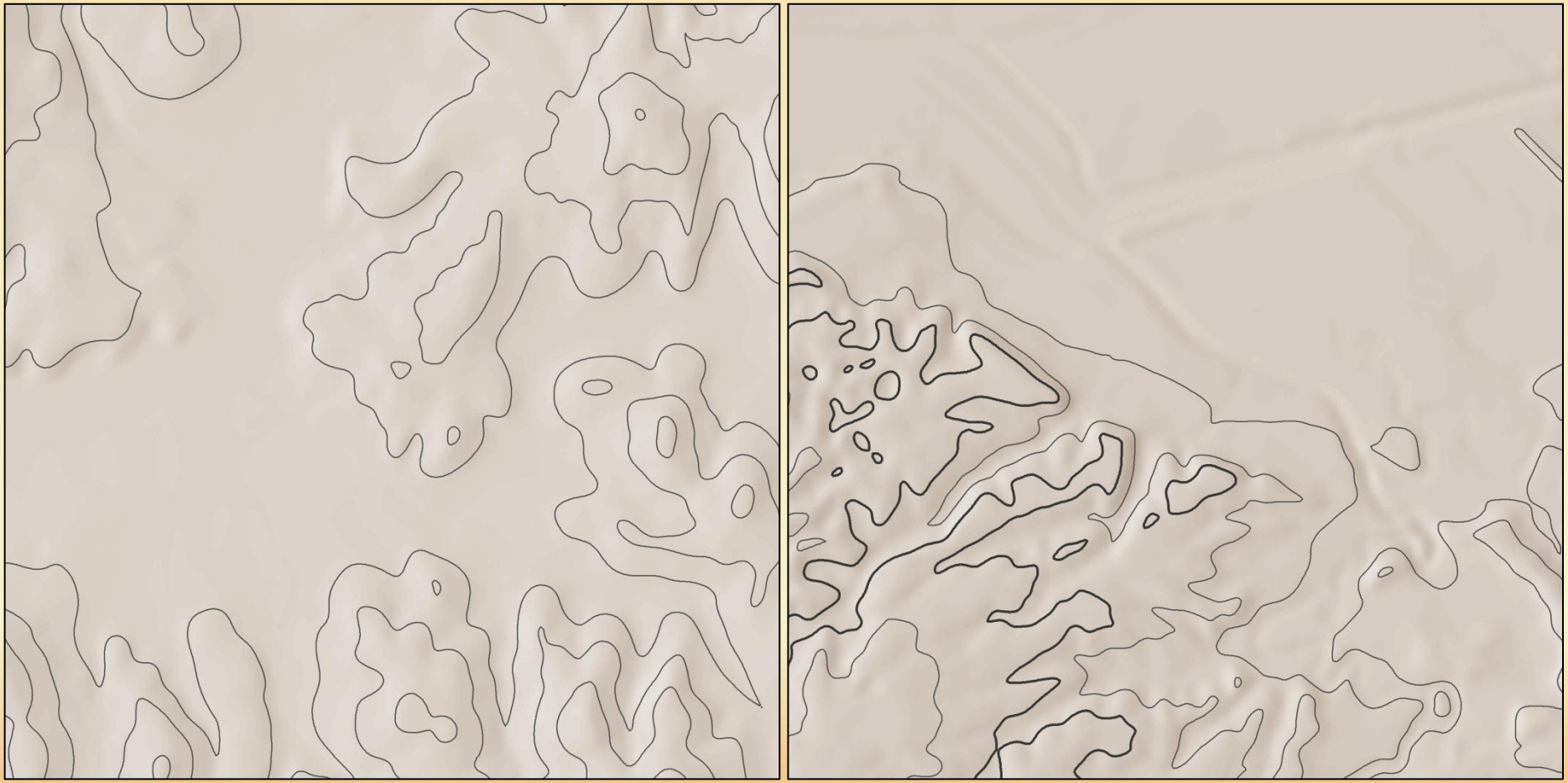
MO

Contours : Urban (Hilly) Results

24K, 10m intervals

ATL

STL

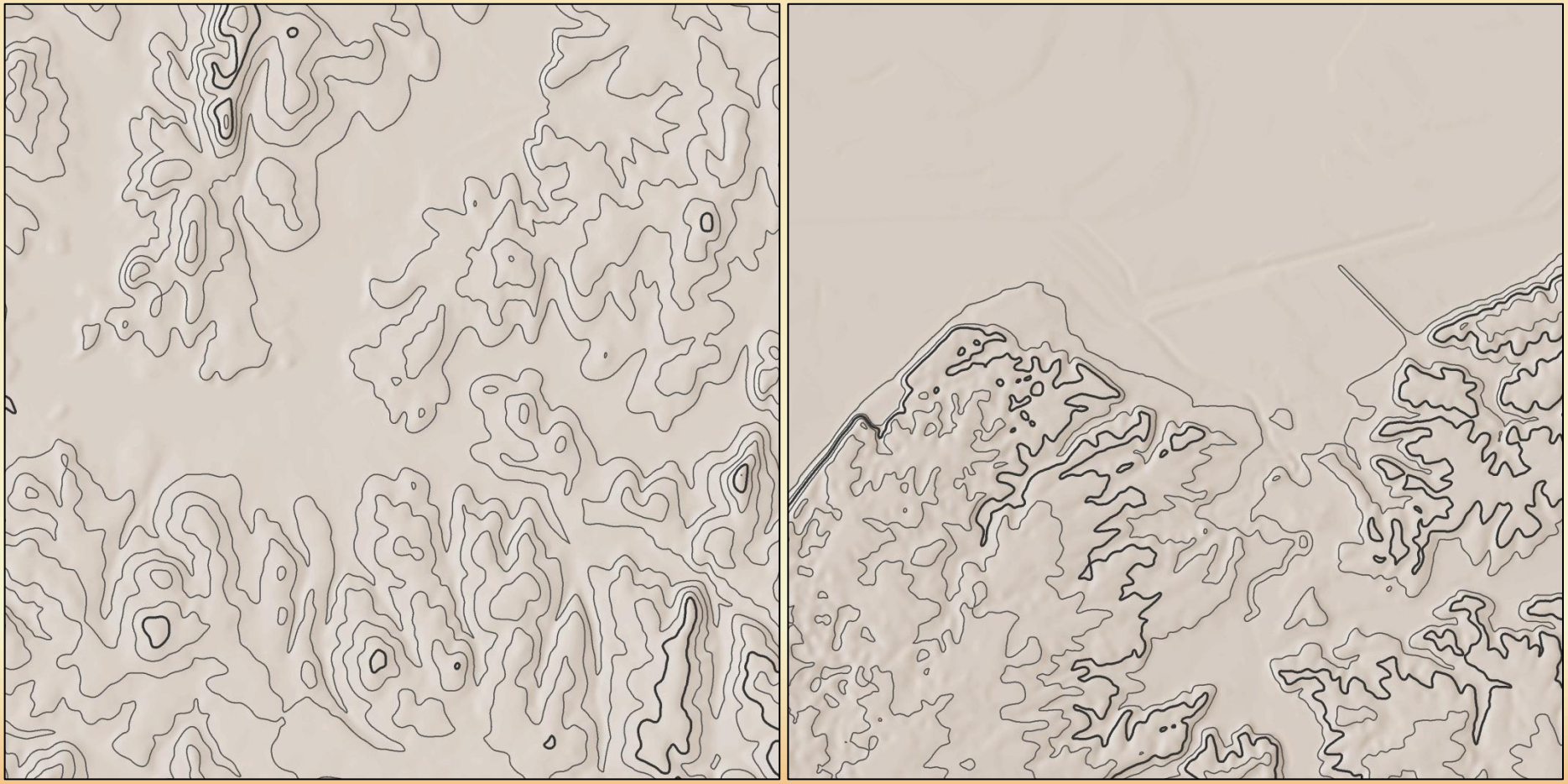


Contours : Urban (Hilly) Results

50K, 10m intervals

ATL

STL



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Contours : Urban (Hilly) Results

100K, 25m intervals

ATL

STL

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Contours : Urban (Hilly) Results

250K, 25m intervals

ATL

STL

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Contours : Urban (Hilly) Results

500K, 50m intervals

ATL

STL

Contours : Urban (Hilly) Results

750K, 100m intervals

ATL

STL

Contours : Urban (Hilly) Results

1M, 100m intervals

ATL

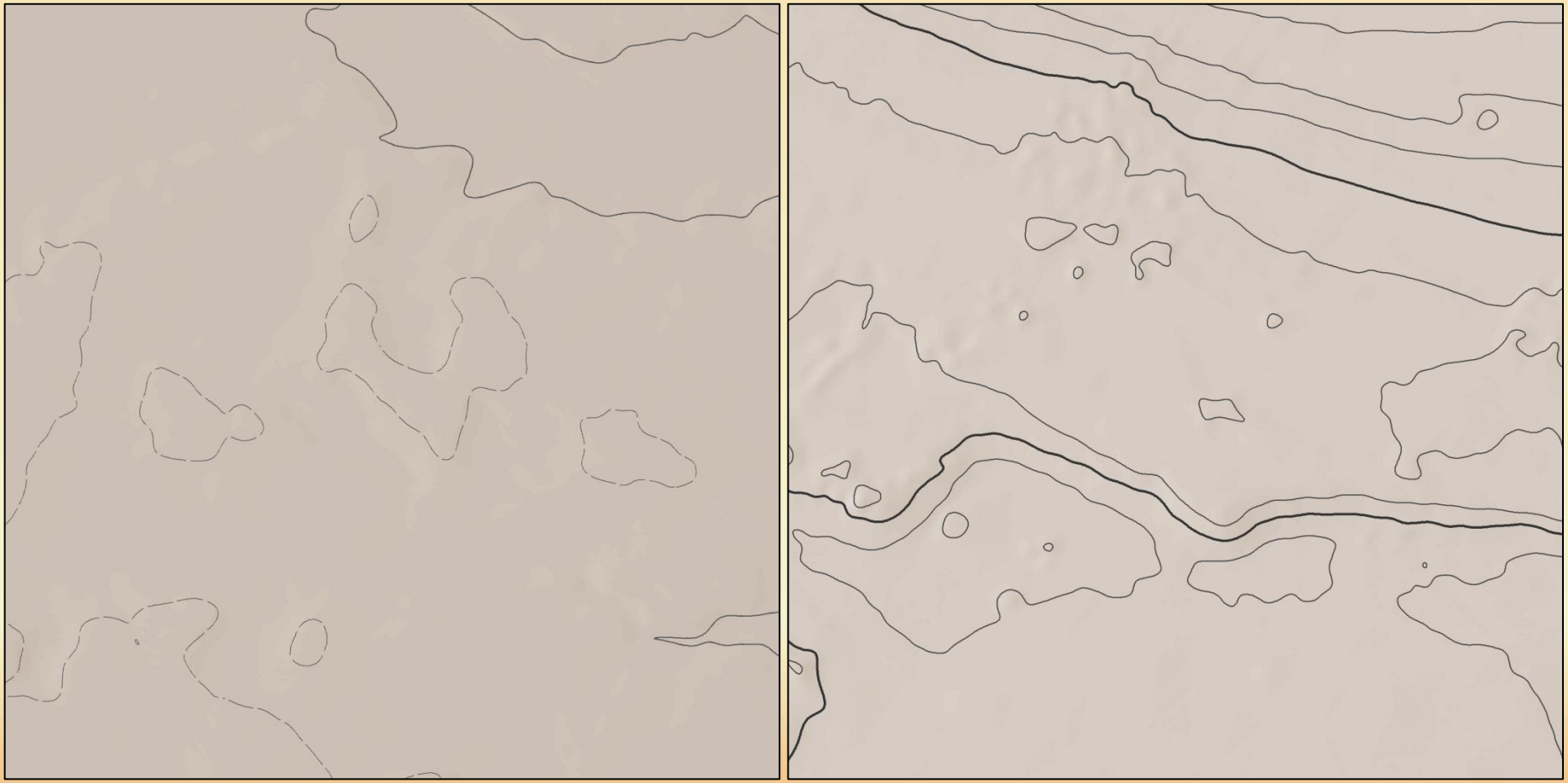
STL

Contours : Flat Results

24K, 5m intervals

FL/GA

UT



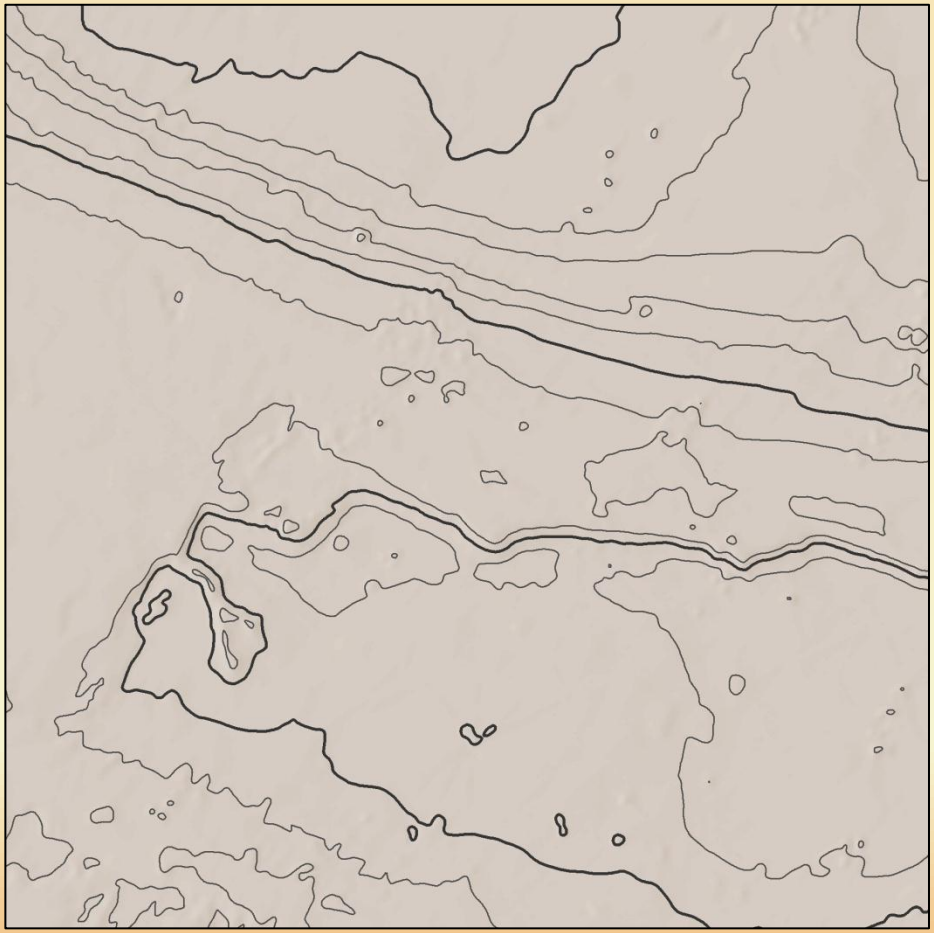
NACIS October 2011

Contours : Flat Results

50K, 5m intervals

FL/GA

UT

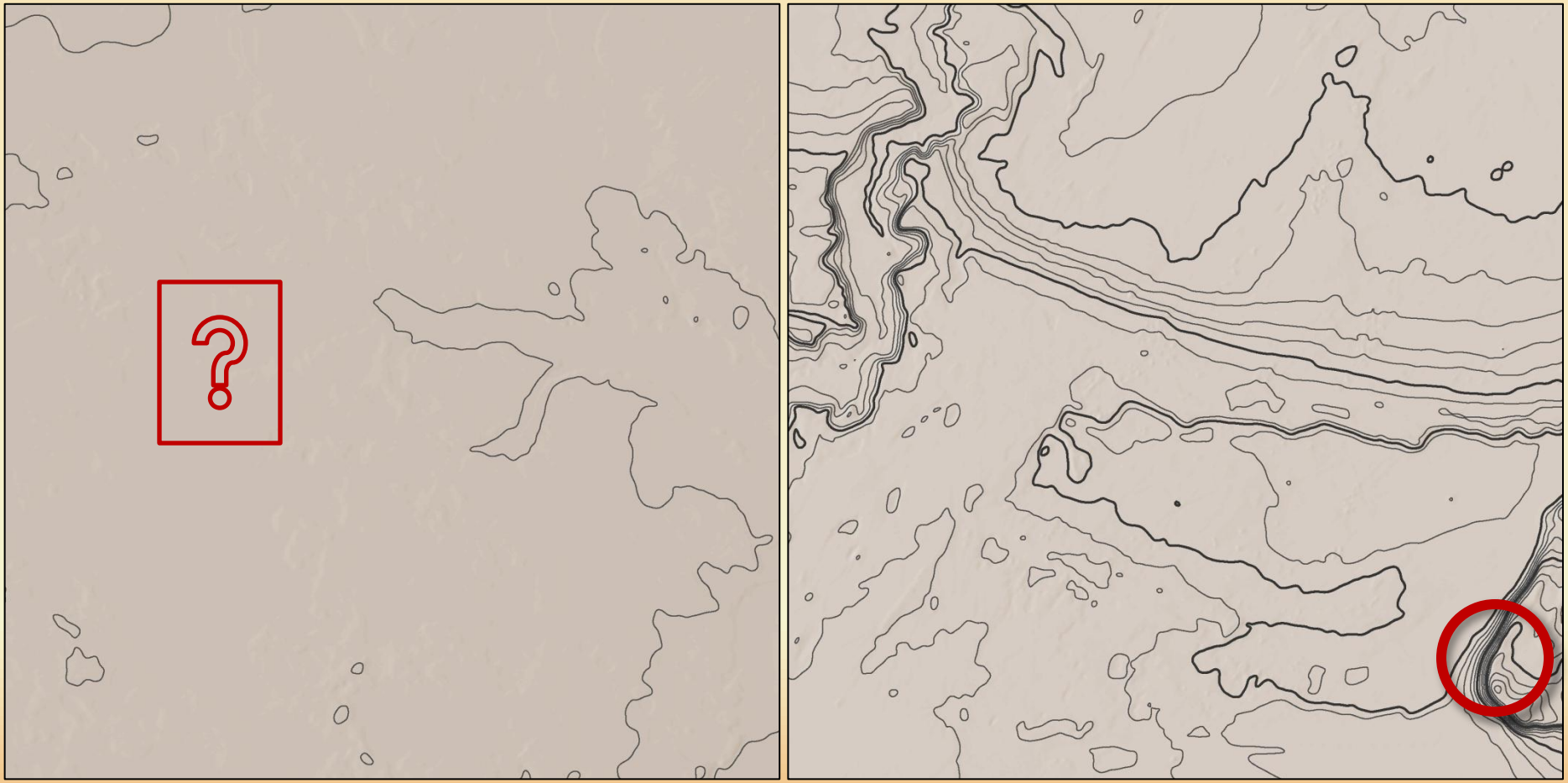


Contours : Flat Results

100K, 5m intervals

FL/GA

UT



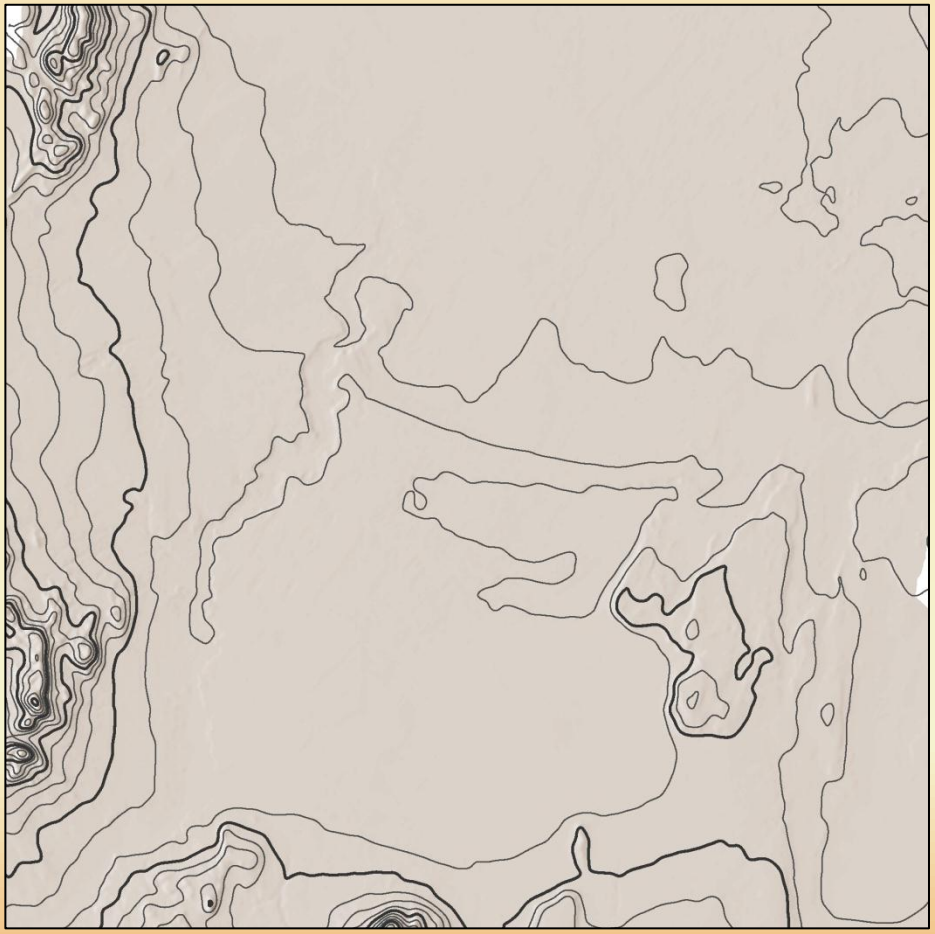
NACIS October 2011

Contours : Flat Results

250K, 25m intervals

FL/GA

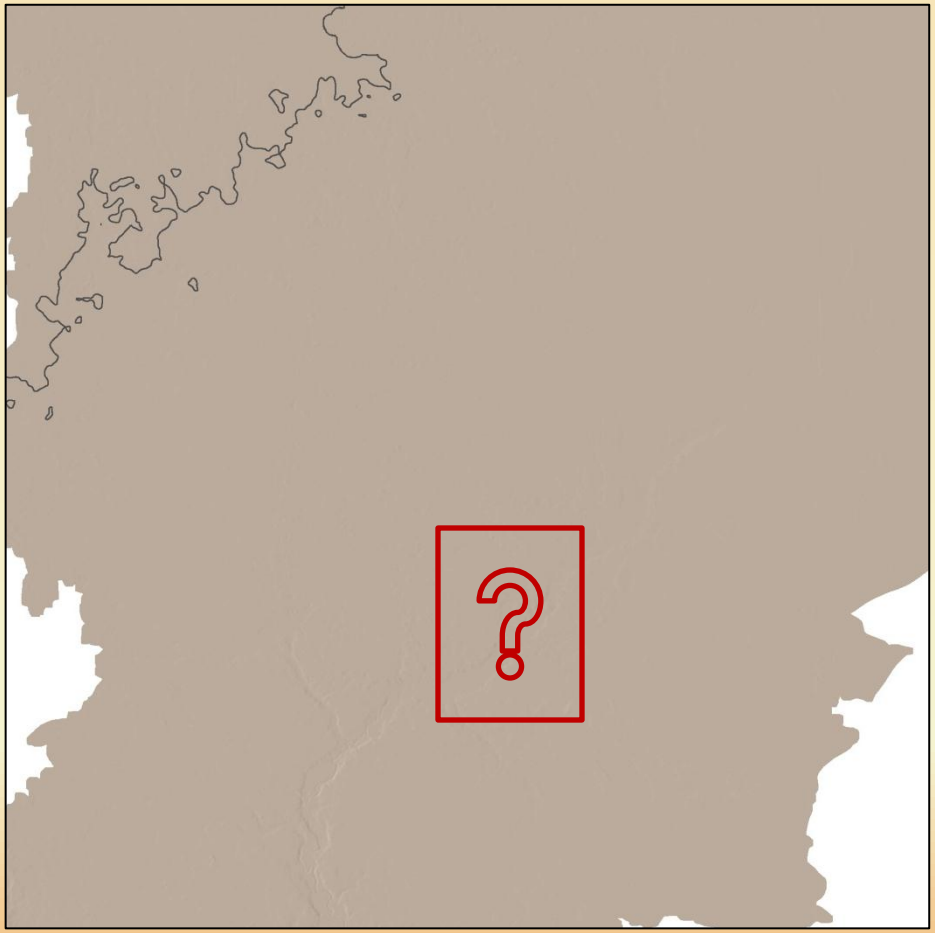
UT



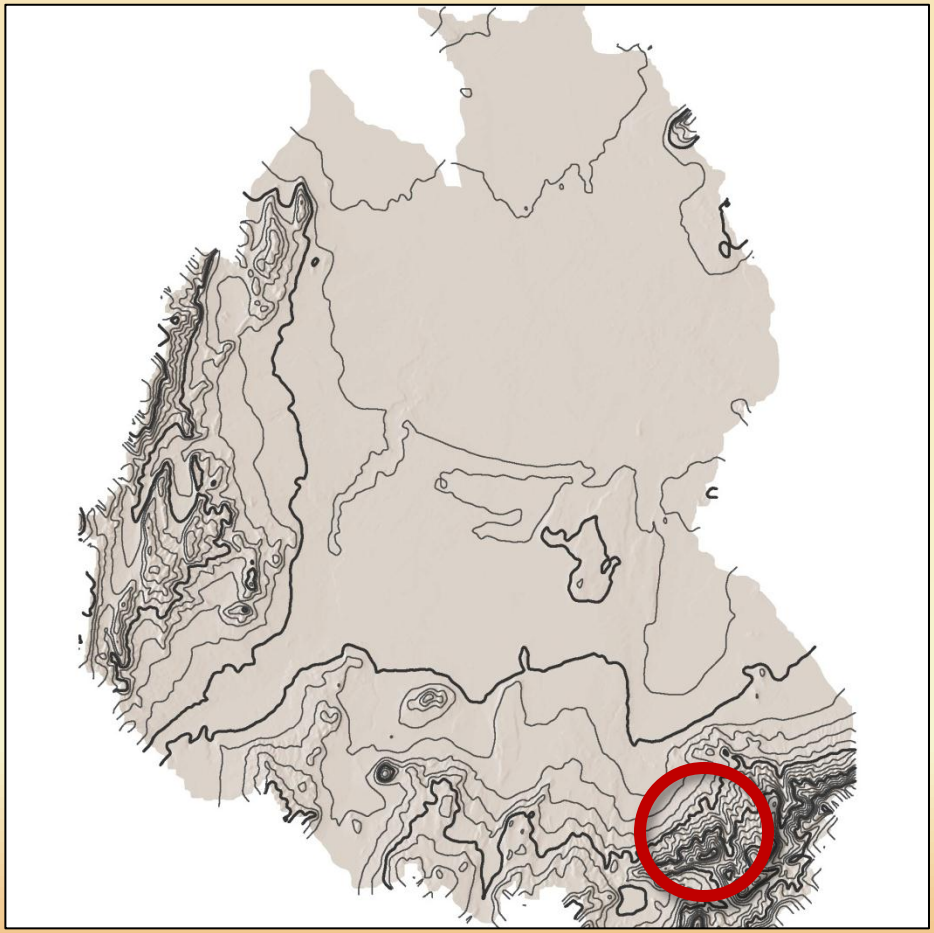
Contours : Flat Results

500K, 50m intervals

FL/GA



UT



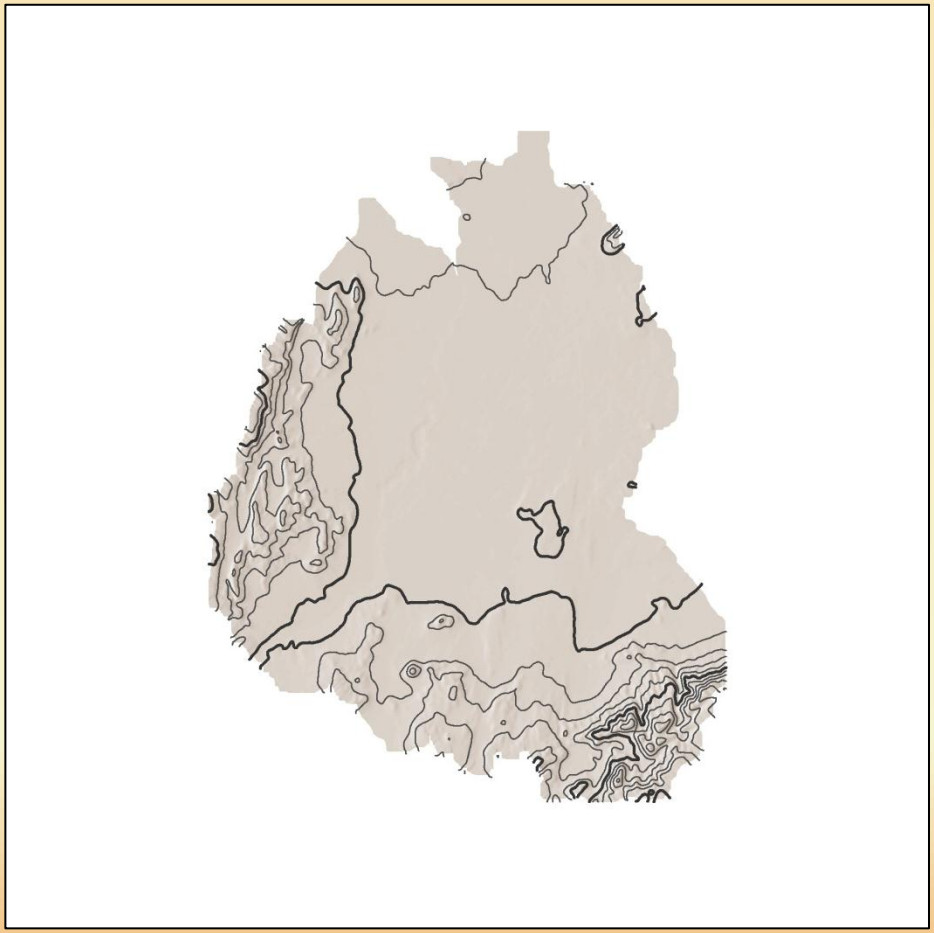
NACIS October 2011

Contours : Flat Results

750K, 50m intervals

FL/GA

UT

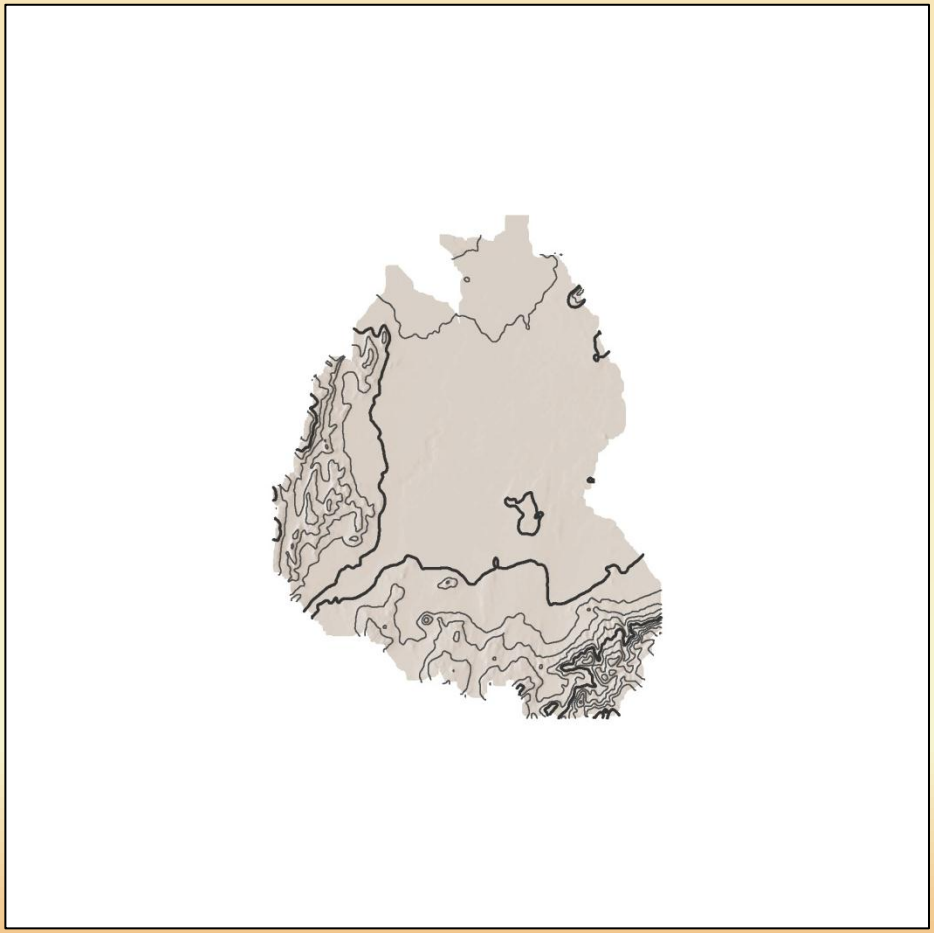


Contours : Flat Results

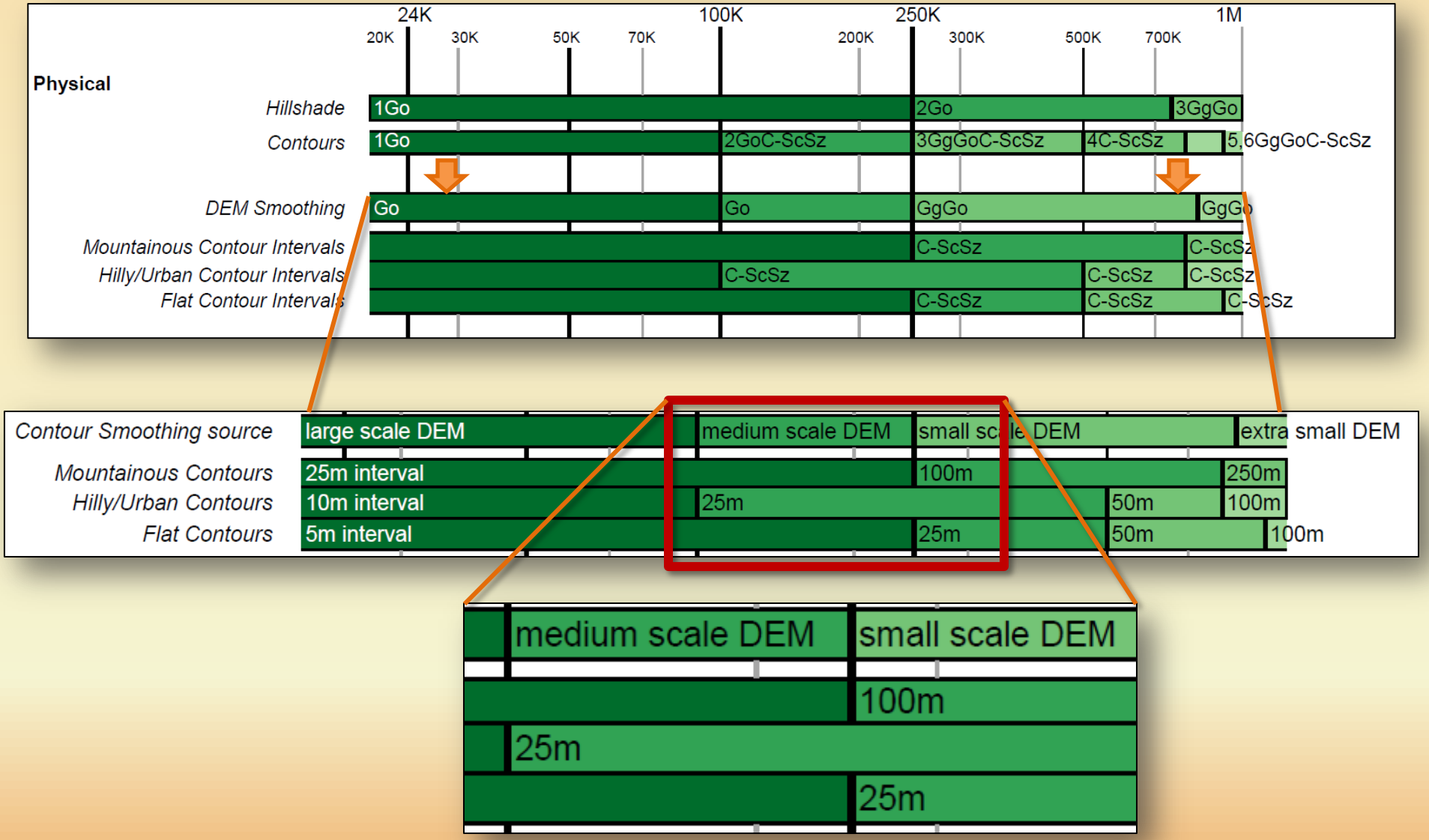
1M, 100m intervals

FL/GA

UT



Putting it all together : ScaleMaster



What's Next?

- Refine Contours – more detailed landscape types
- Identify what is being done to the DEM from filtering

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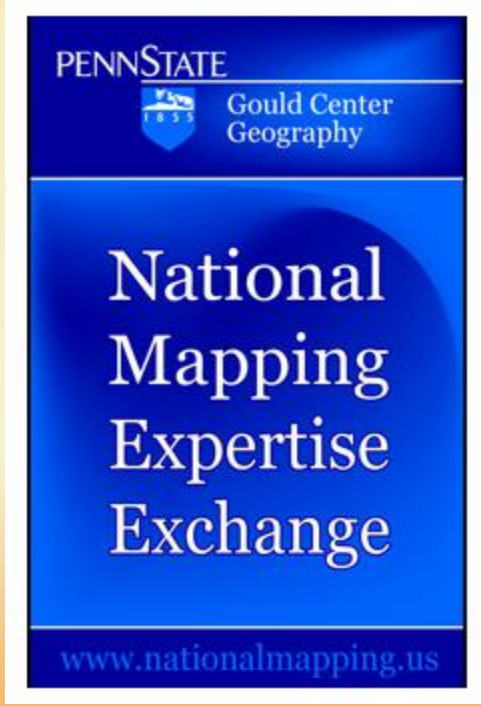

Questions??

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