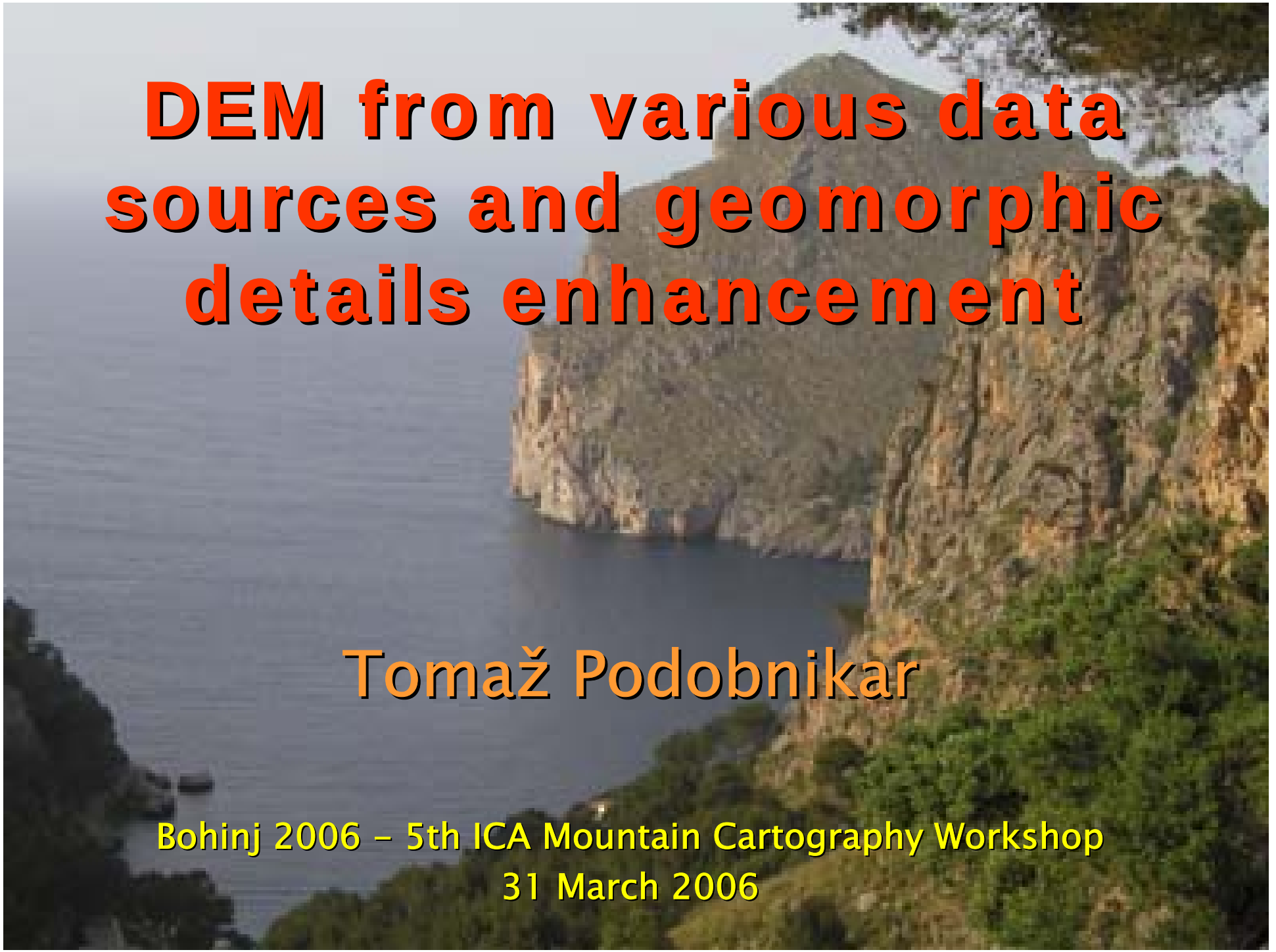

DEM from various data sources and geomorphic details enhancement

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2 DEM from different sources
3 Visualisation of DEM
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1 Introduction

Motivation

- DEM is one of the most important data sources (for cartography, effective GIS analyses…)
- for effective visualisation overall high quality DEM is required
  - higher quality
  - removing gross errors
- some visualization methods that emphases the exposition of geomorphologic details are presented
- DEM production method of data fusion of different quality is proposed
  - weighted sum
  - geomorphologic enhancement

2 DEM from different sources

Demands for DEM

- high quality DEM production is very expensive (data acquisition!)
  ←→ users demand high quality
- quality and quantity of digital spatial data is increasing
  ←→ 'classical' methods for DEM modelling do not consider available data sources (especially quality data not designed for DEM)
- → mixture of science and art
  = deep understanding of the landscape and required model

Demands for DEM - how?

- economical way
  - feasibility for easy DEM ‘upgrade’ up-to-date
  - secondary products (improved and new databases, analogue maps)
  - optimal cost of production
- fusion (combination, integration) data sources
  - existing data
  - various quality and type data
  - no additional data acquisition
- increasing quality
  - elimination of gross and systematic errors in data sources
  - consideration of data sources regarding their quality (numerical/statistical and visual/geomorphological criteria)

Hypothesis

- ***with appropriate approach is possible to expose the best properties of existing data sources and integrate them into model that is overall better than particular data sources***
  - **garbage into the model, high quality data out!!!**

4 phases of DEM production

- preparation for DEM processing
- pre-processing of data sources
- processing DEM from data sources
- evaluation of DEM

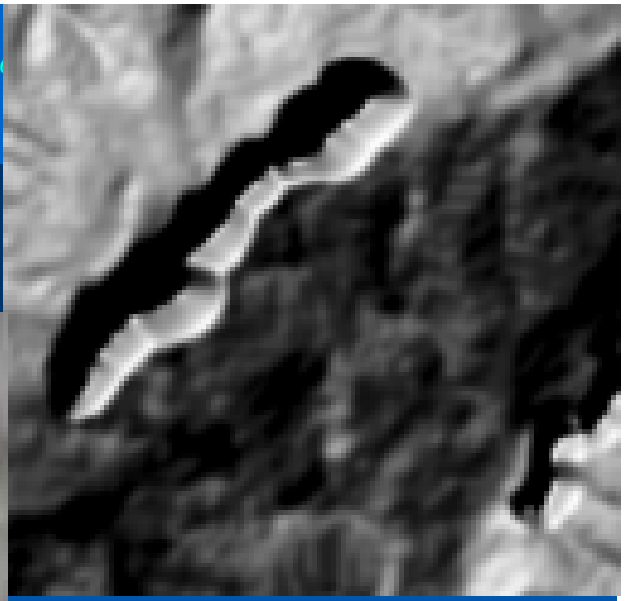
Errors on data sources

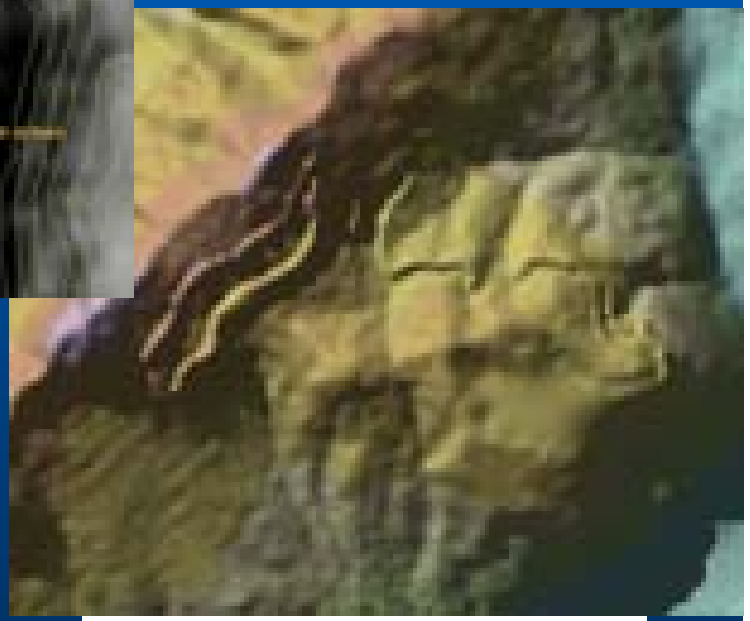
- evaluation of data sources, error detection and elimination
  - visual – reference data [– gross errors]
  - statistical – reference points [– gross errors]
  - statistical – continuous data [– systematic, gross errors]

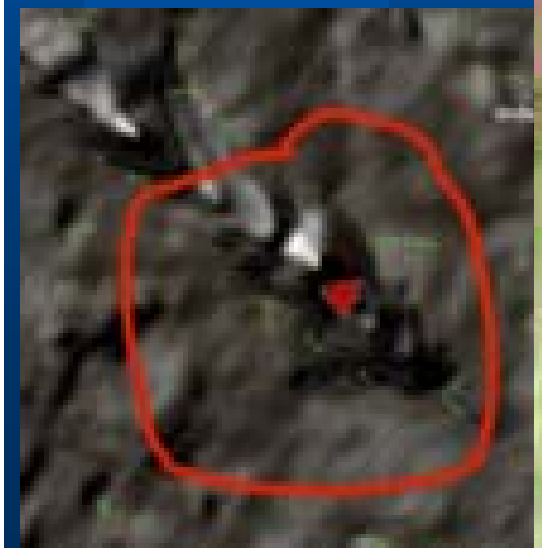
Contour lines – adding, connecting

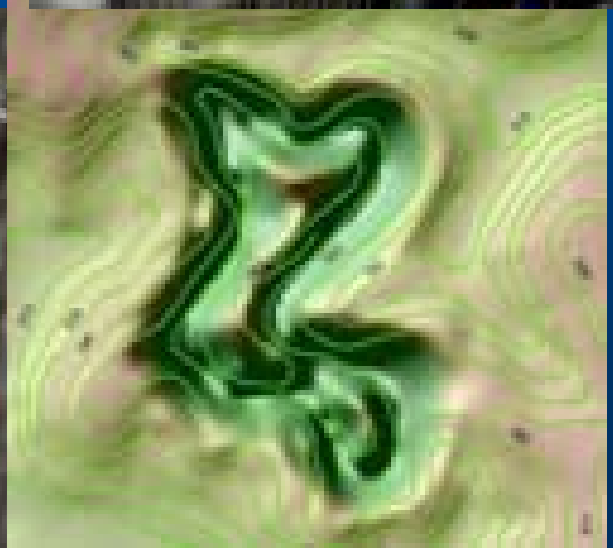
Contour lines

d geomorphic details

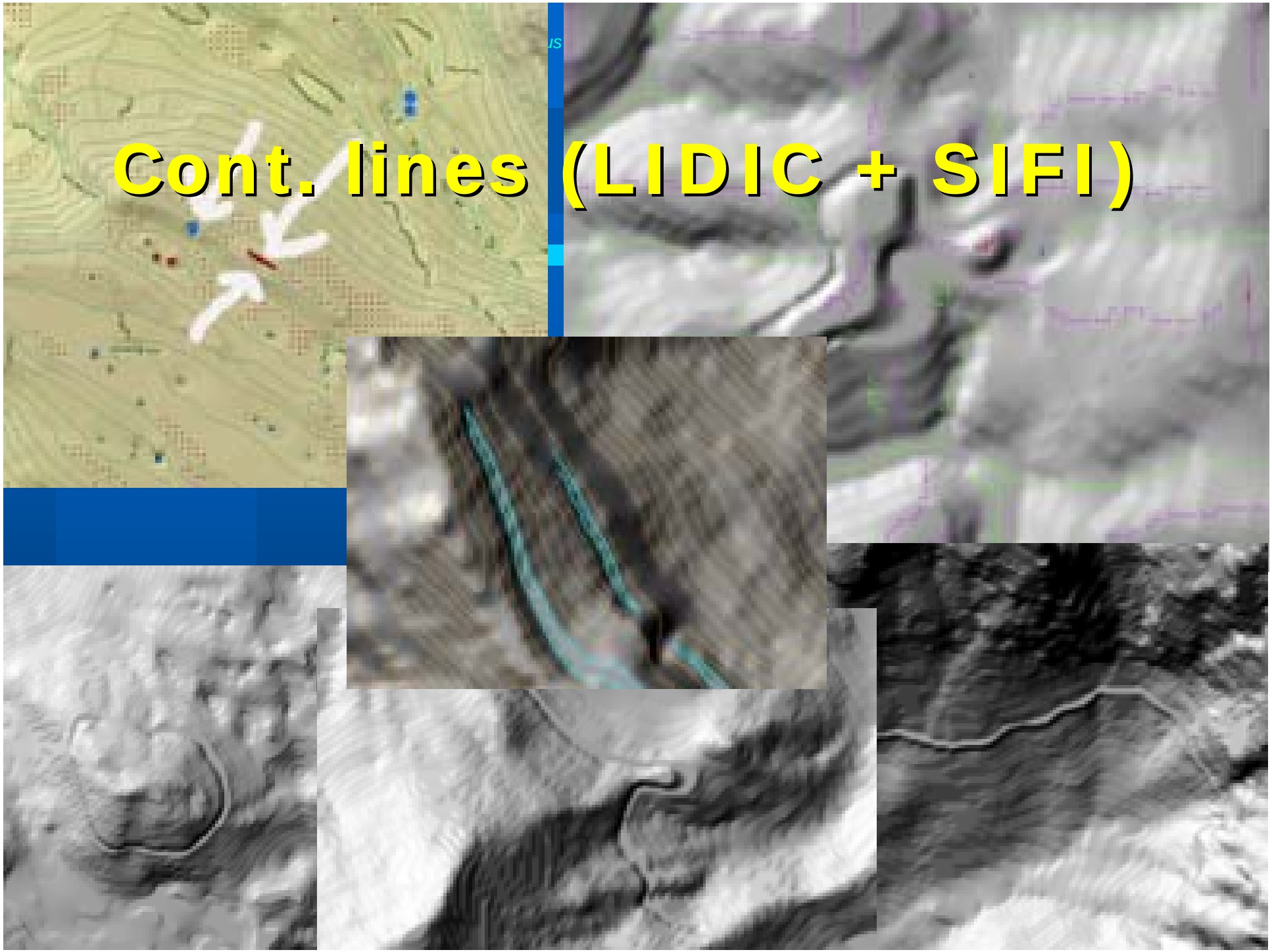




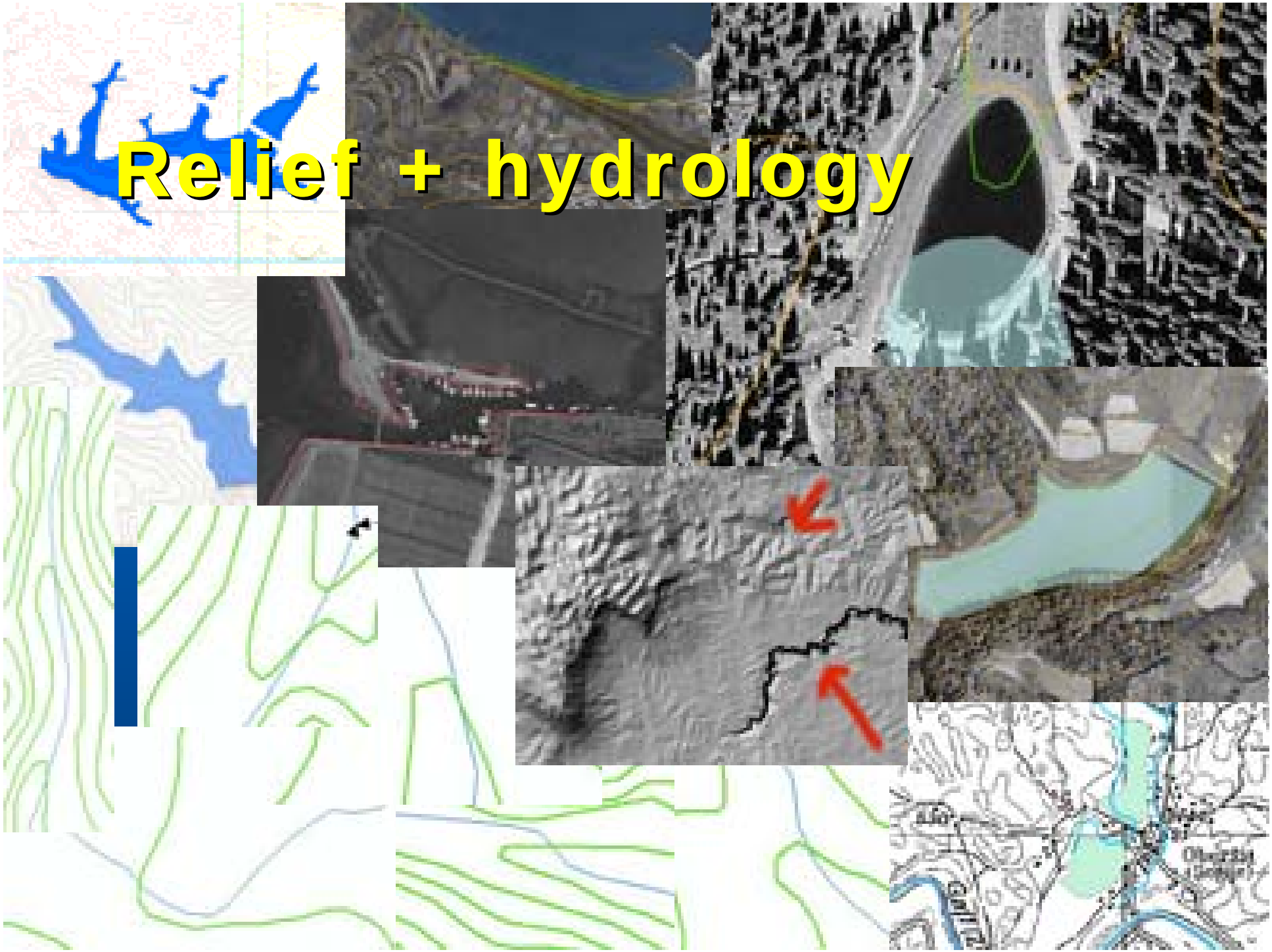




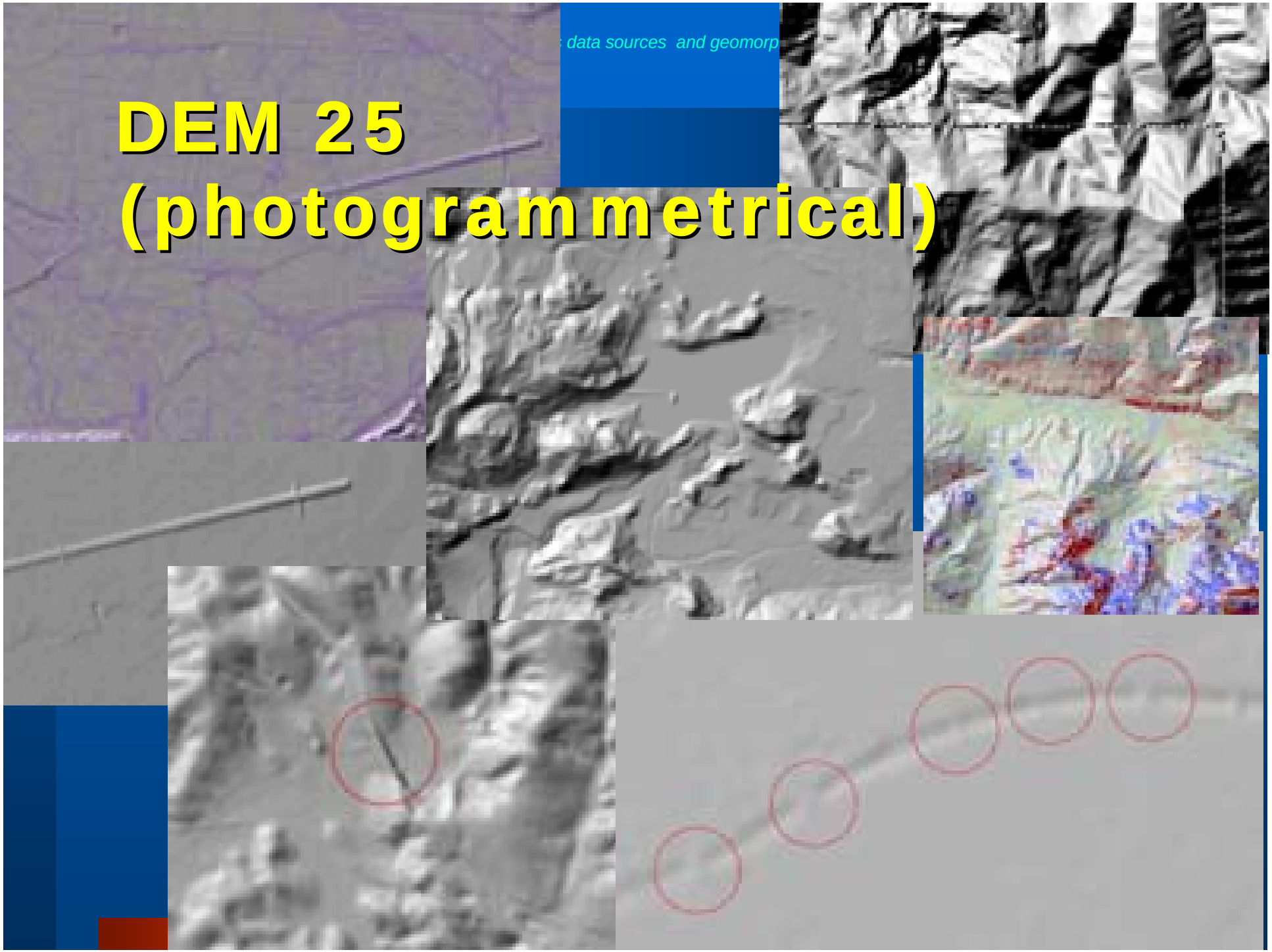
Cont. lines (LIDIC + SIFI)


Cont. lines (LIDIC + SIFI)

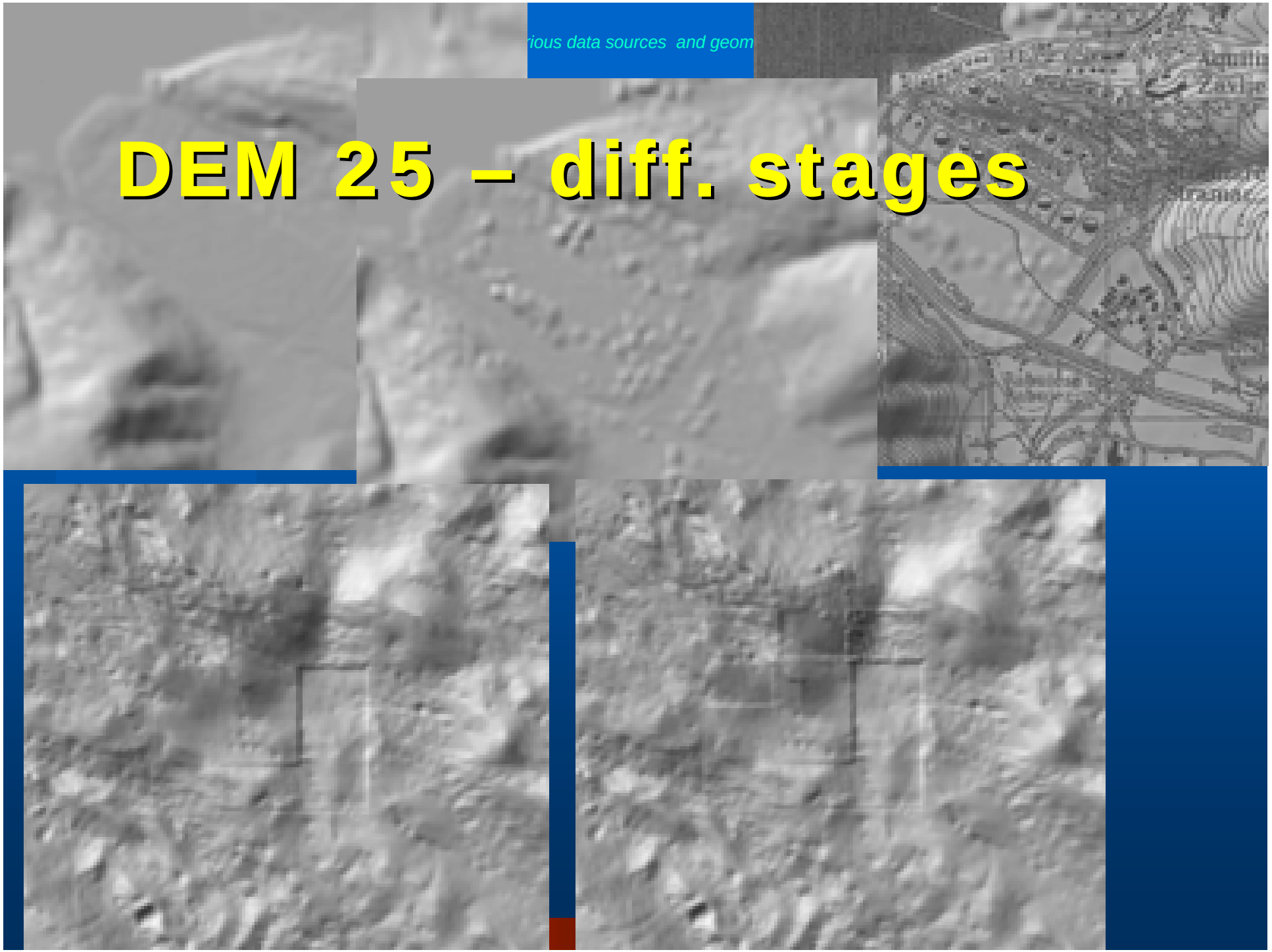
Relief + hydrology

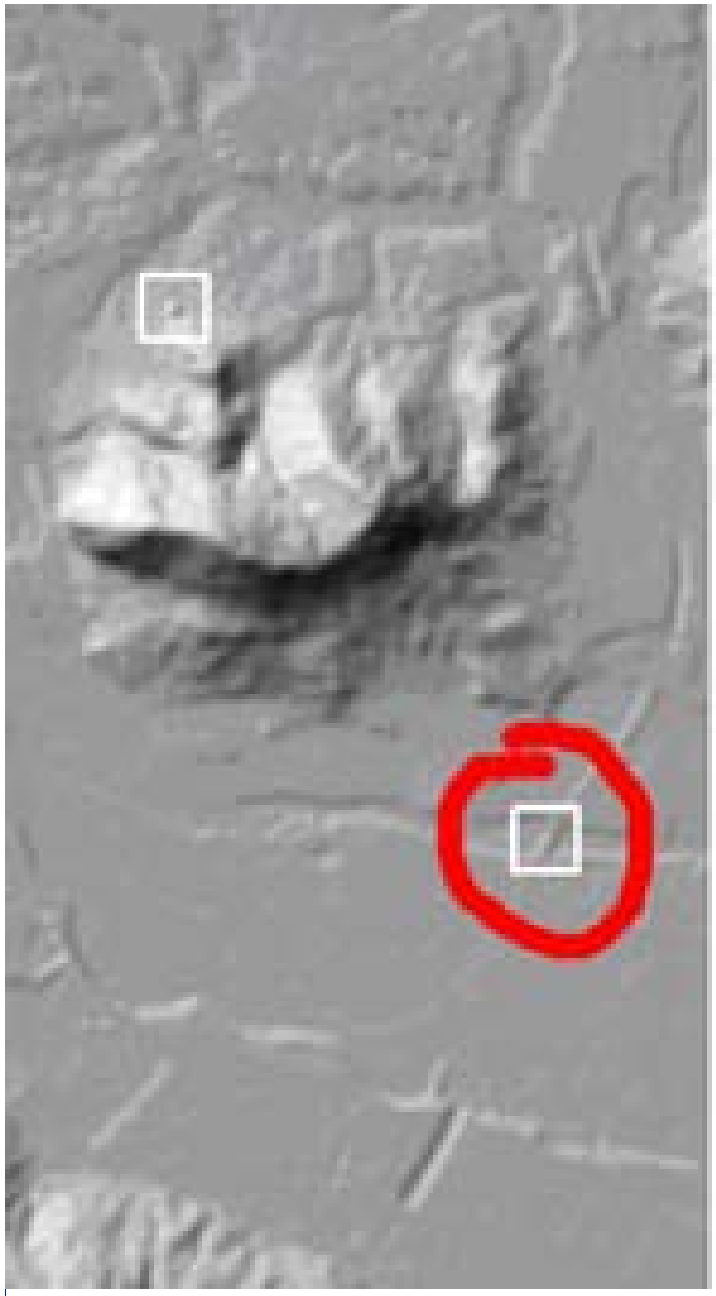


DEM 25 (photogrammetrical)



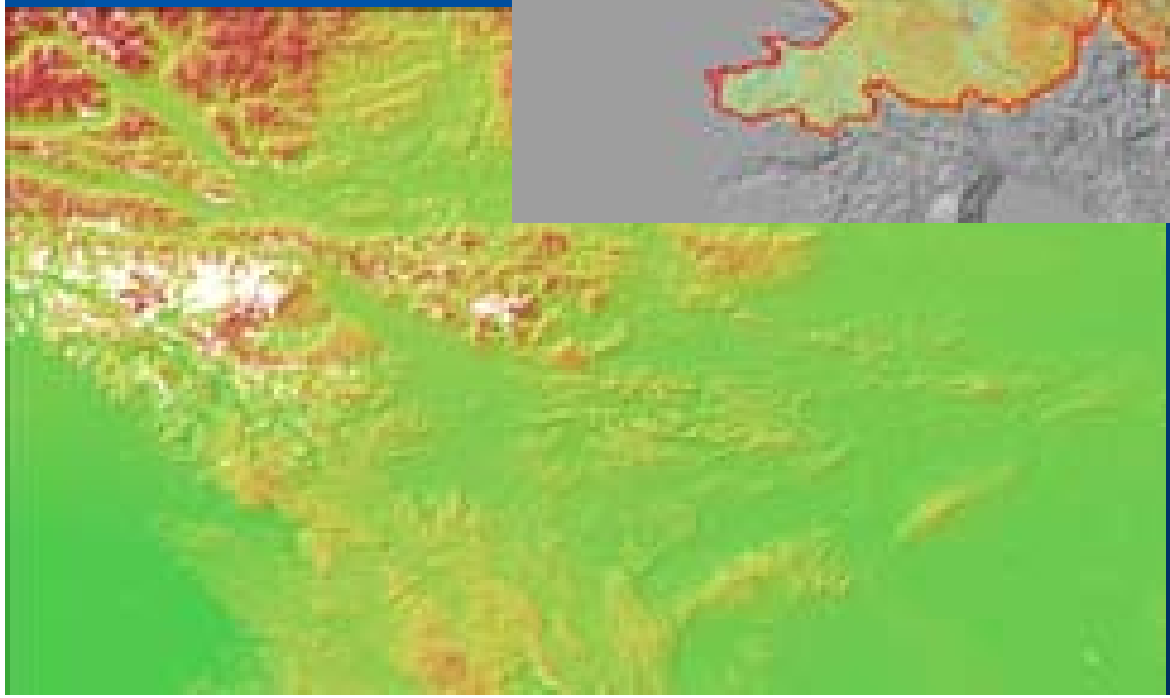
DEM 25 – diff. stages



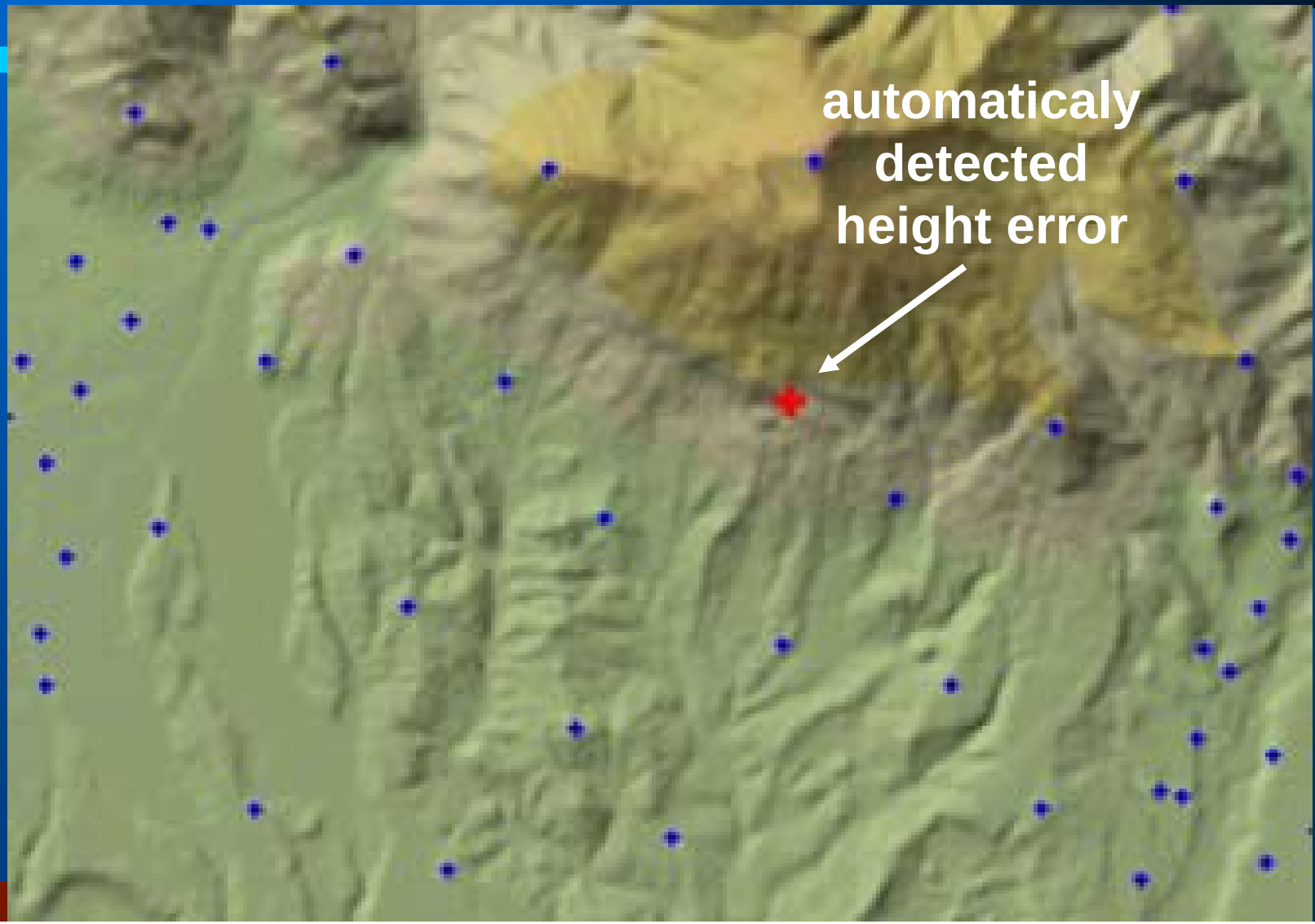


Potential gross error of DEM 25 – bridge!?

SRTM 90 –holes
DEM 100 horizontal shifts



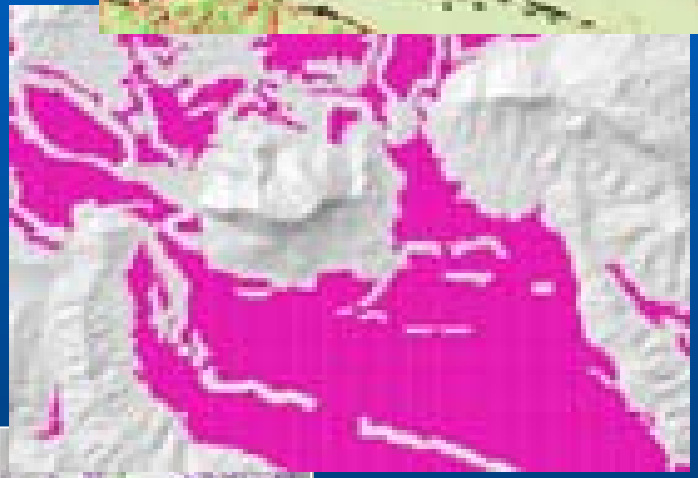
Points – stat. elimination



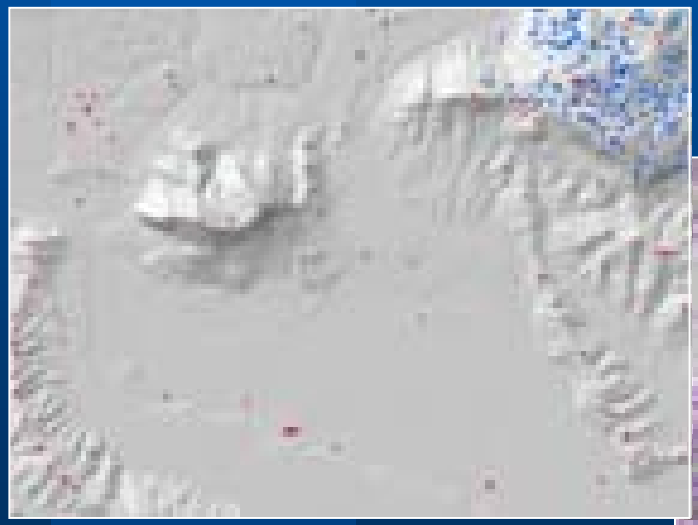
Enhanced interpolation Sampling of cont. lines

edges

flat areas



peaks, sinks



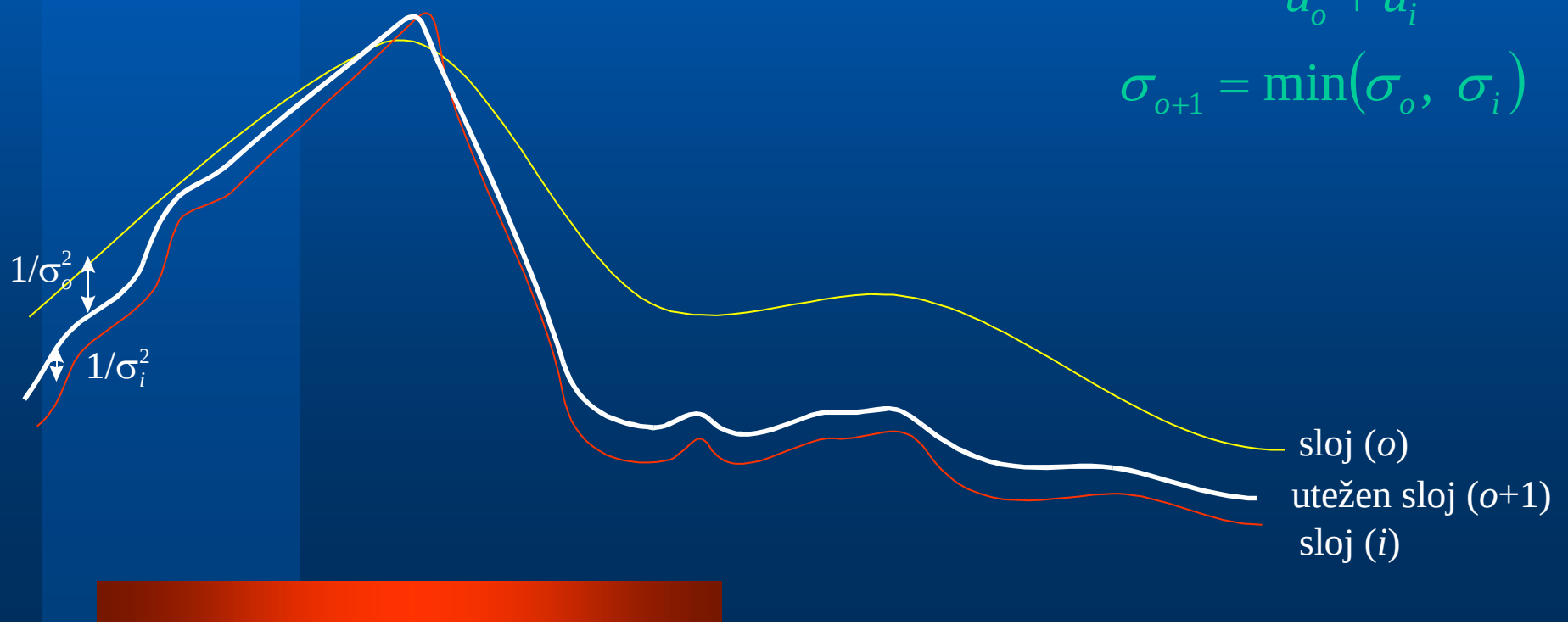
ridges, valleys

Weighted sum

- **weighted "parallel" sum of data sources (map algebra)**
  - **combining more data layers (DEMs that are differently interpolated or combining different data sources)**
  - **weights of particular data layers** $u_o = \frac{1}{\sigma_o^2},\ u_i = \frac{1}{\sigma_i^2}$
  - **calculating *H* regarding weights**

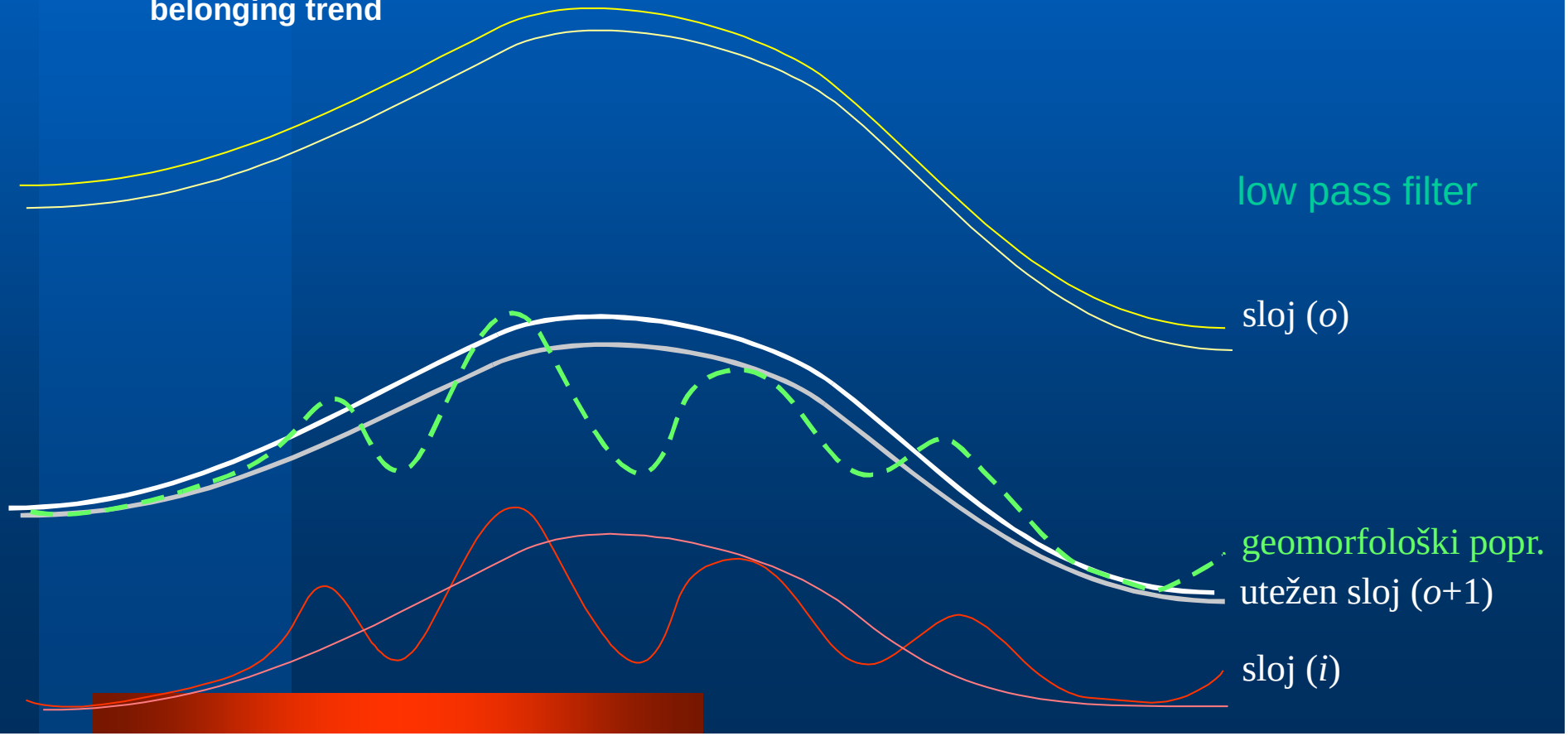
$$H = \frac{u_o H_o + u_i H_i}{u_o + u_i}$$

$$\sigma_{o+1} = \min(\sigma_o,\ \sigma_i)$$



Geomorphological correc.

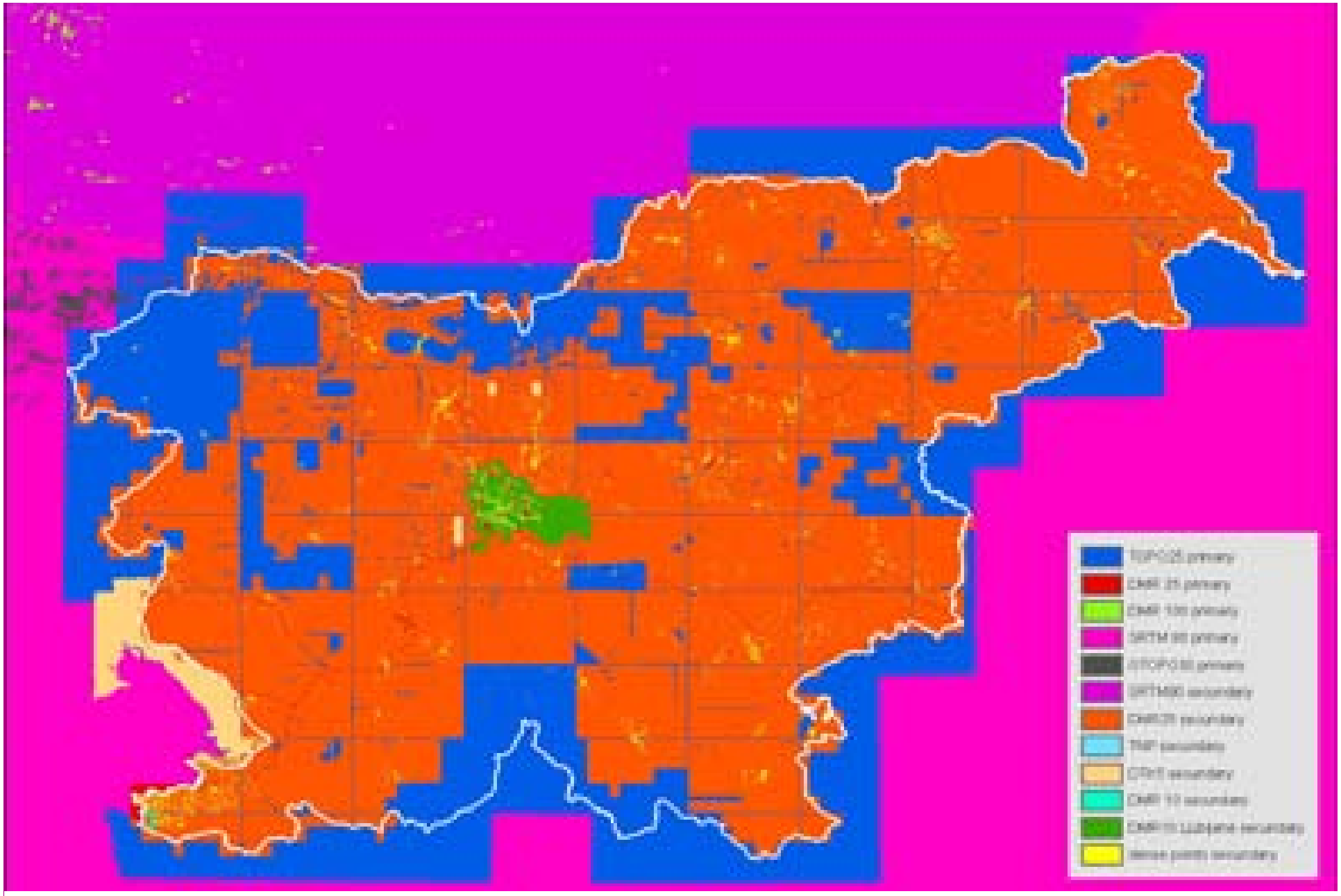
- **geomorphological corrections after weighted sum**
  - **reconstr. of the geomorphological charact. of weighted layer regarding better among both**
  - **low pass filter ➔ trend surfaces**
  - **to trend surfaces of weighted layer is added difference between value of better layer and belonging trend**



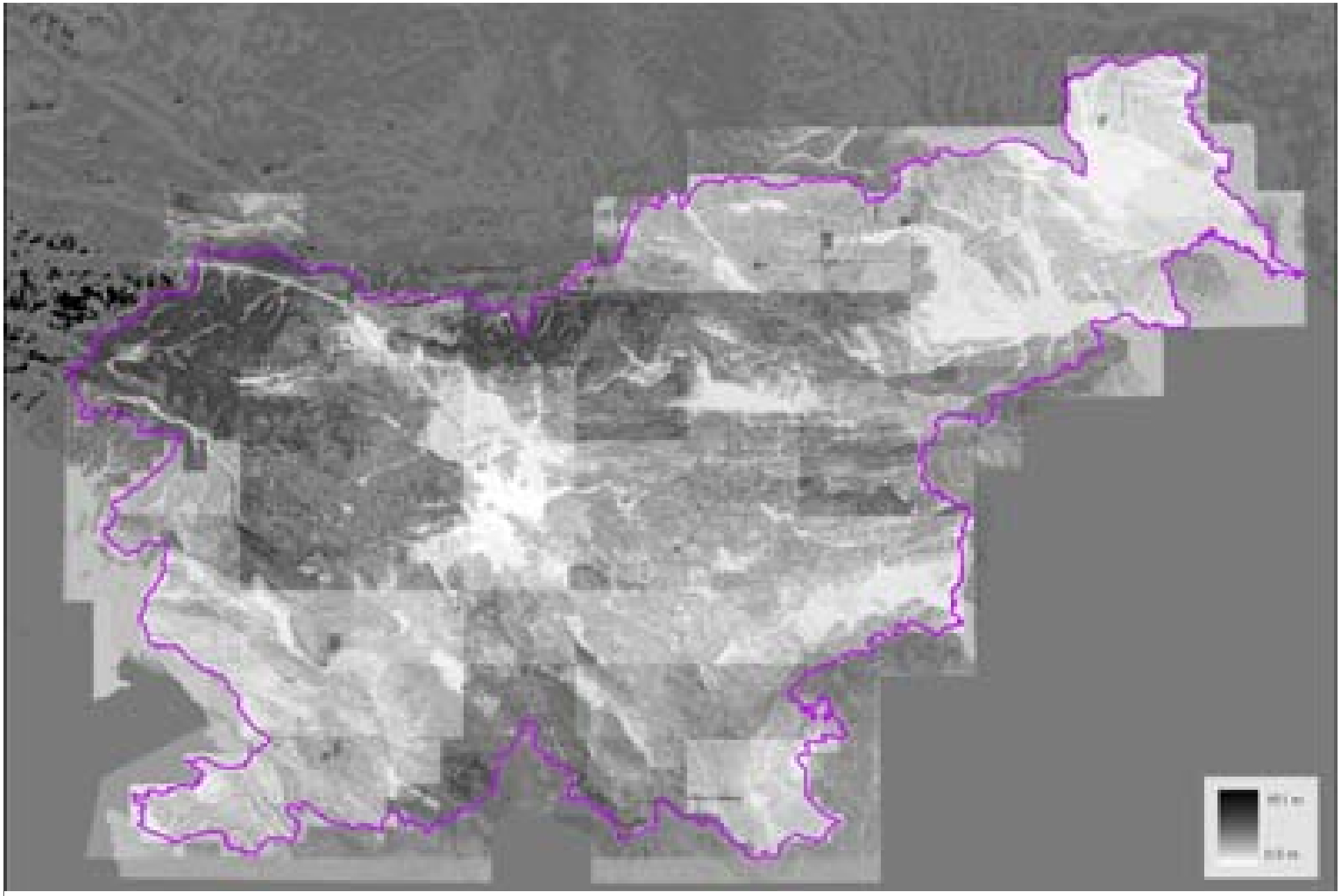
Result of data fusion for DEM production

- visual & geomorphological homogenous DEM
- statistically accurate and precise DEM

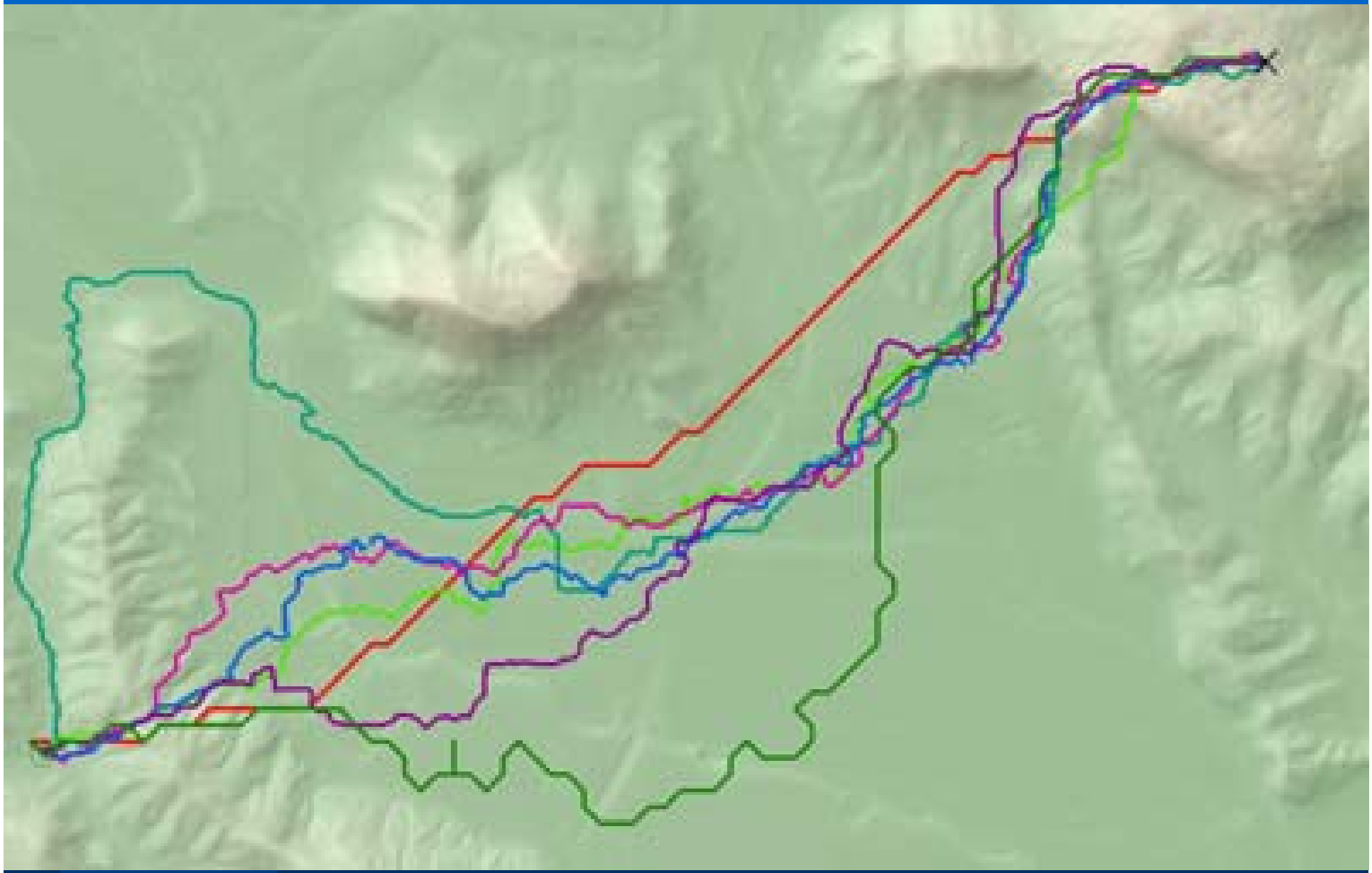
- applied methodology is useful for further improvement of DEM with new sources
- quality of DEM is evaluated for every data element
- portion of every data source used for DEM is known
- data sources are improved and corrected

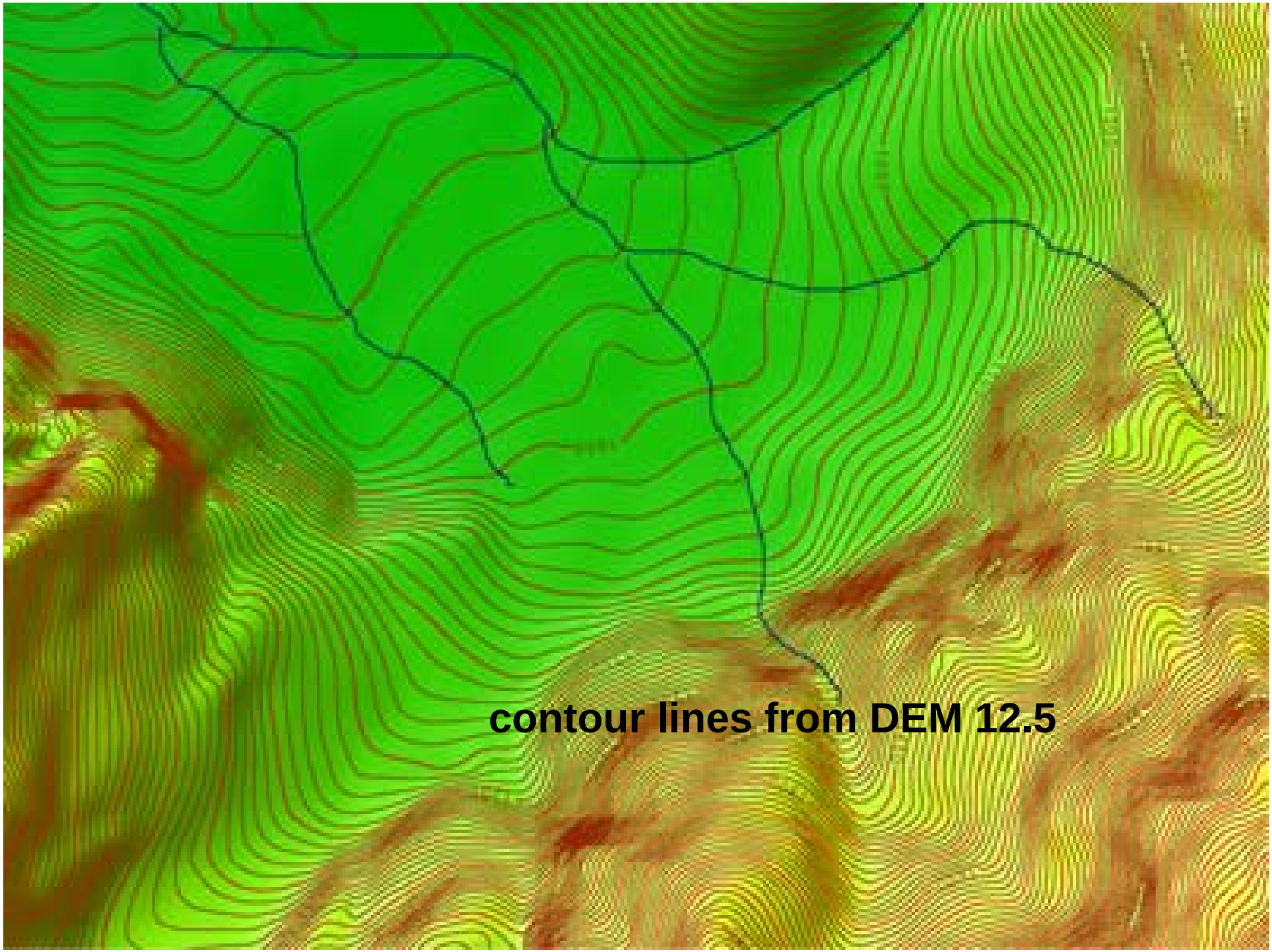


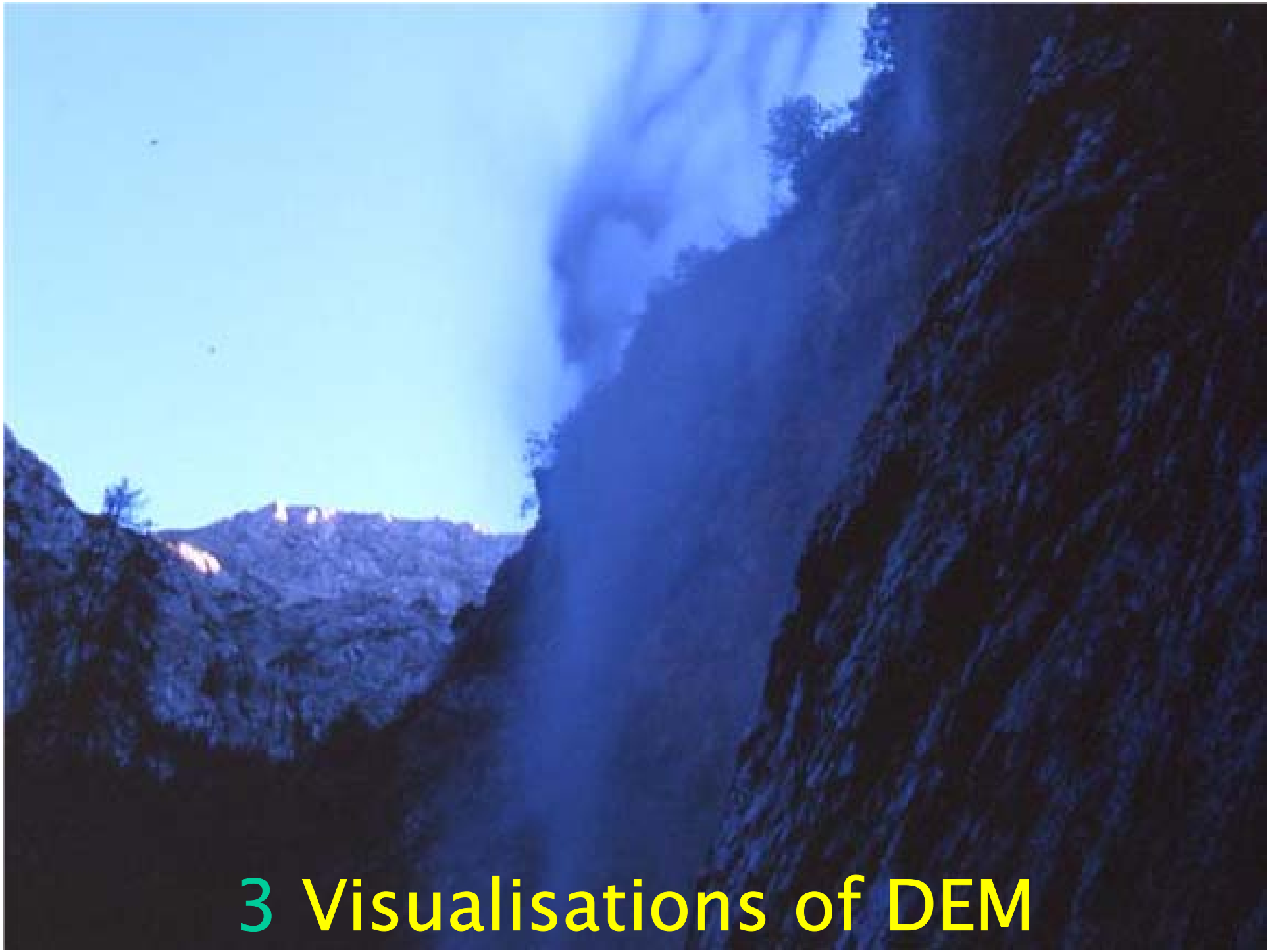
RA predominate data sources



RV potential errors




contour lines from DEM 12.5

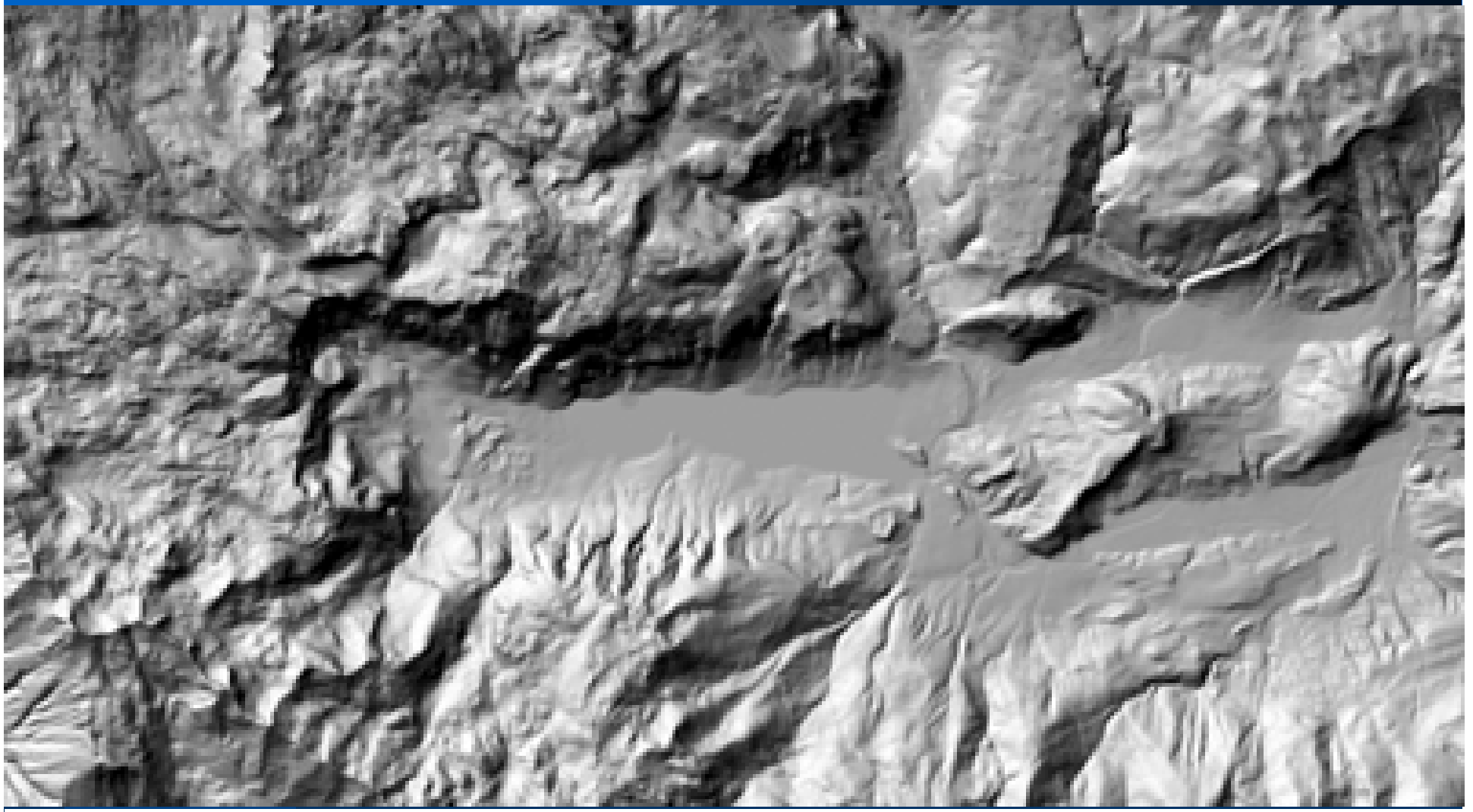

3 Visualisations of DEM

Selected methods for topographic maps visual.

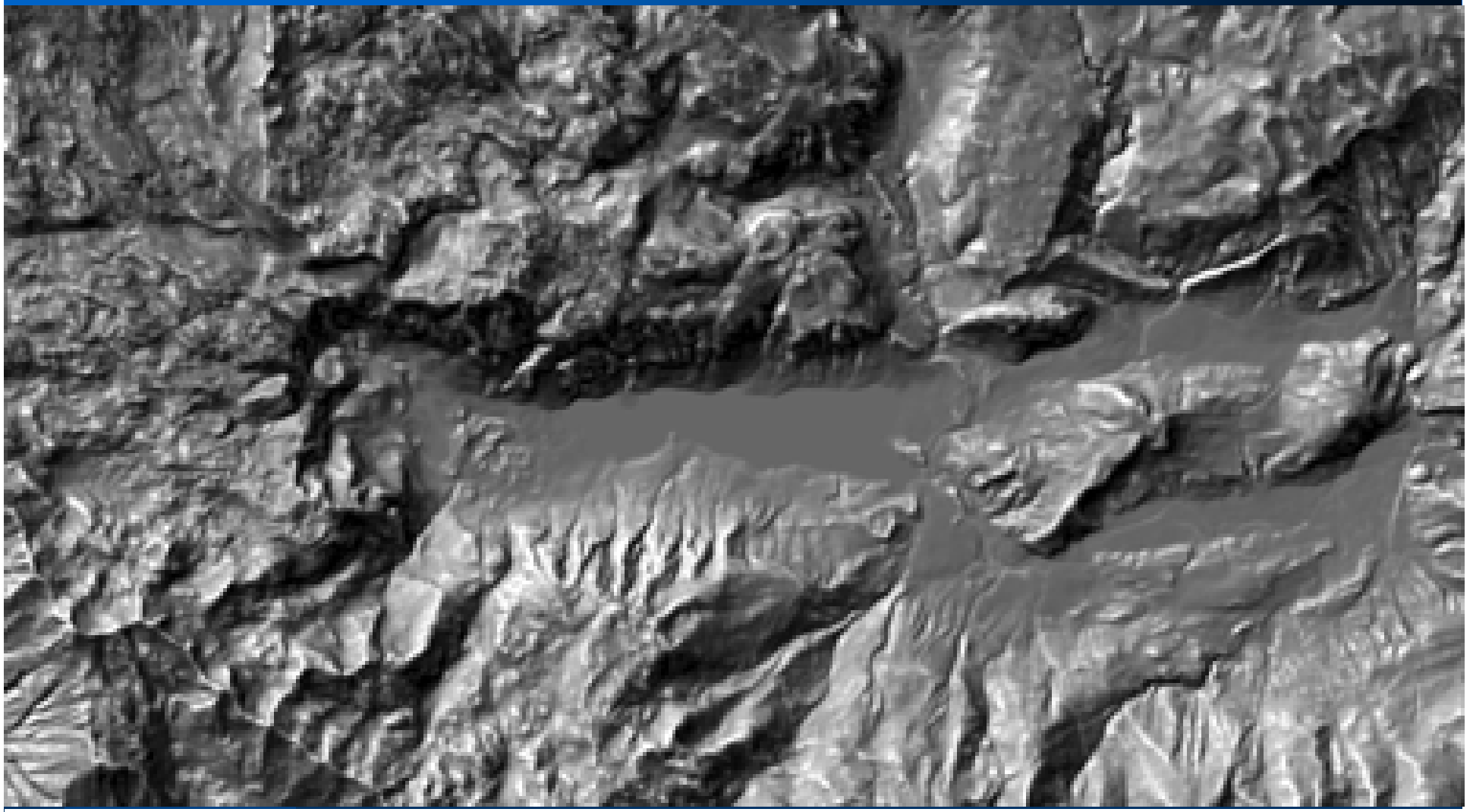
- contours
  - particular elevations
- hypsometrical
  - regarding elevations
- bipolar differentiation
  - relative intervals of hypsometry between the contours
- enhancing of the edges
  - increasing contrast similar to worn out edges
- hill shading
  - similar to natural sun lighting

Combination of the methods

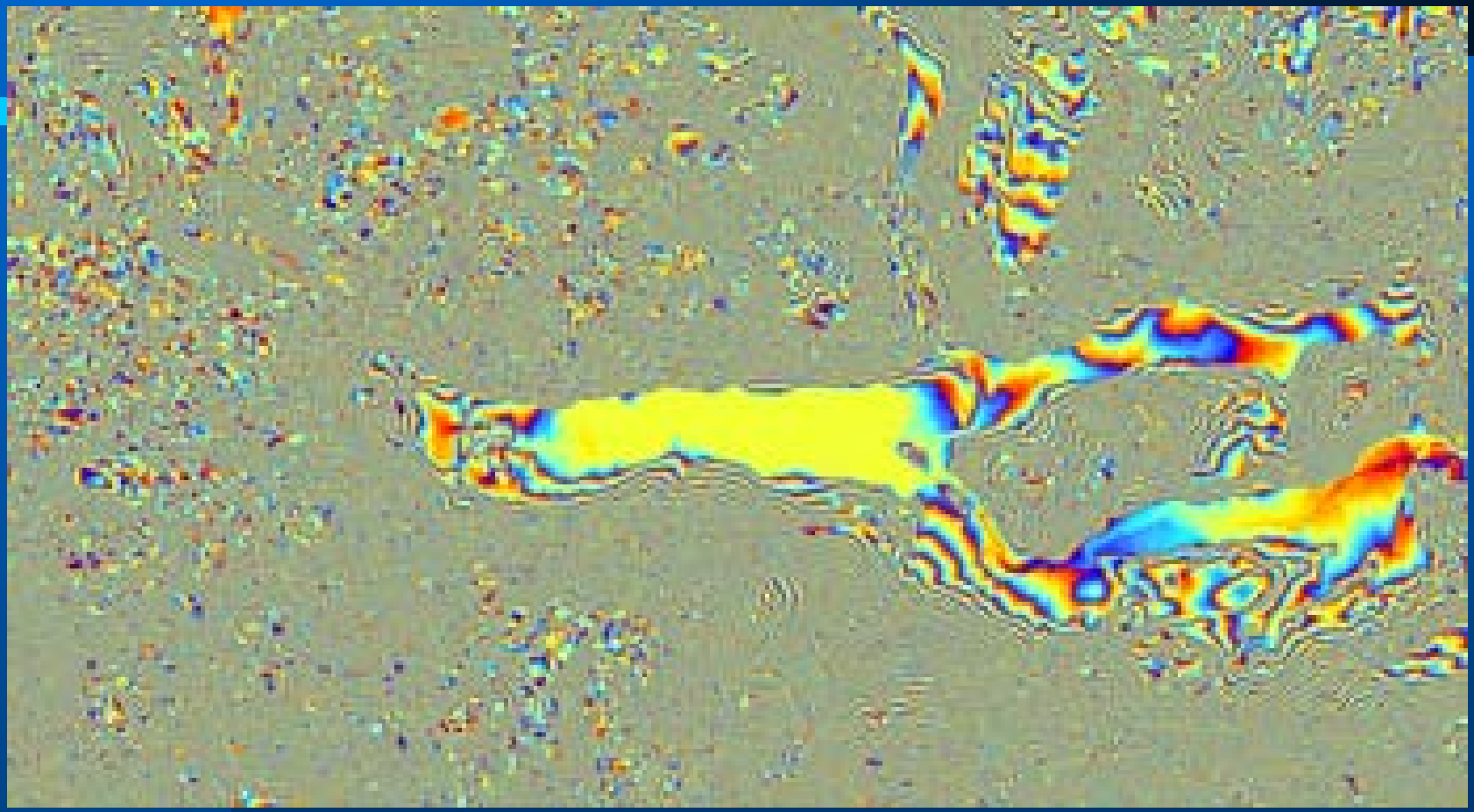
- better impact for
  - realism
  - precision/accuracy
  - understanding of the landform
  - multi scale



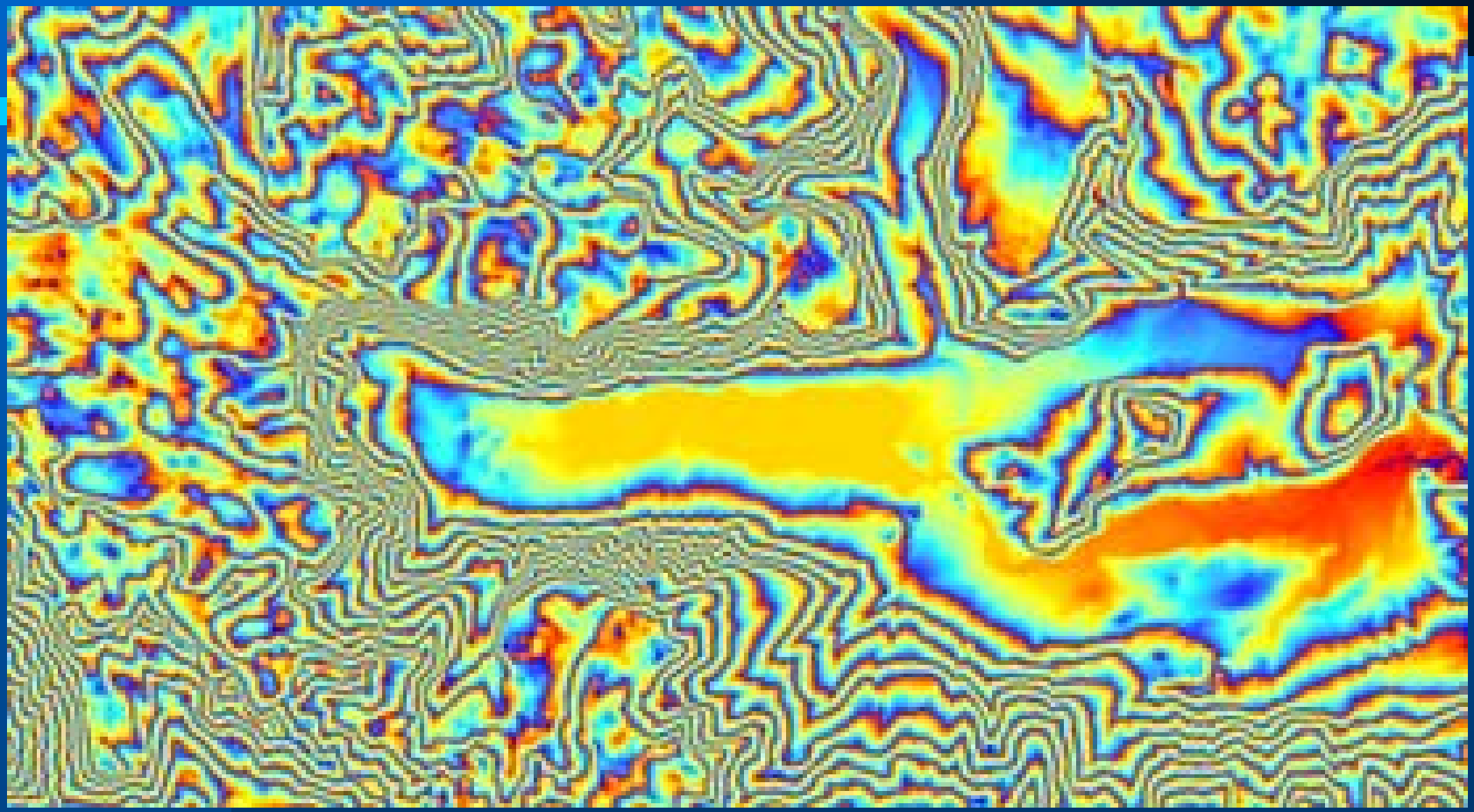
hill shading (two different horiz. angles and scales



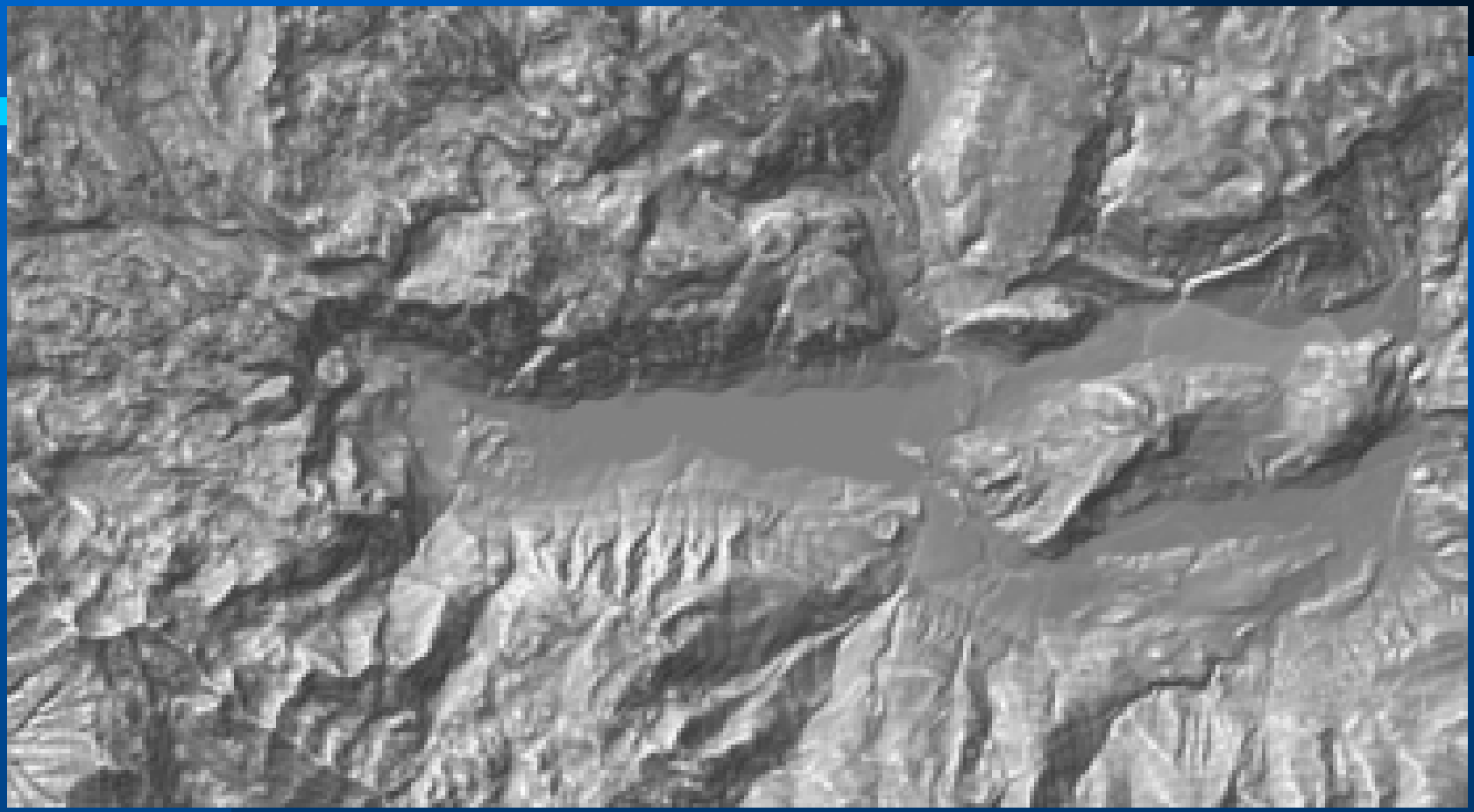
combination: hill shading + enhanced edges



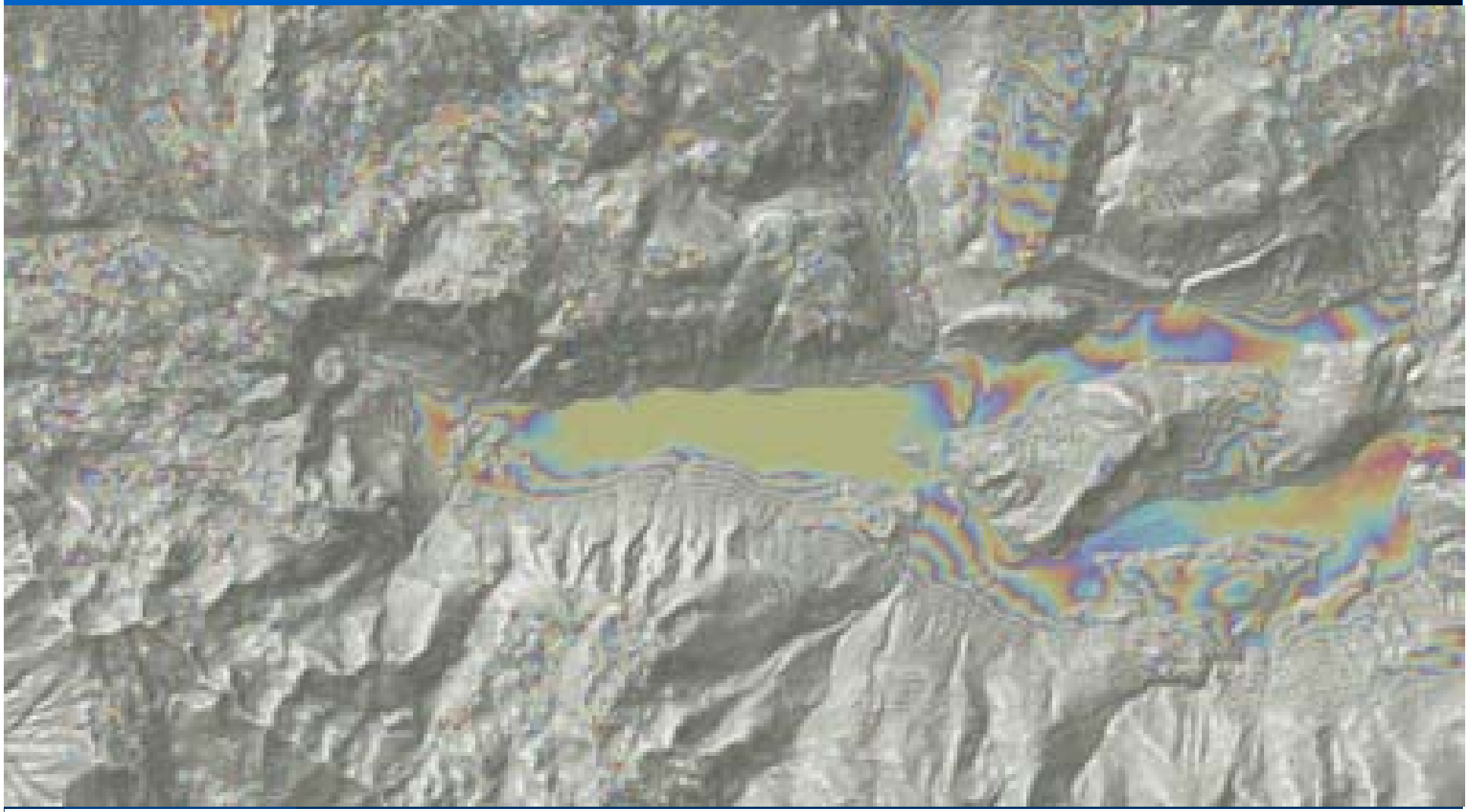
bipolar differentiation 20 m interval



bipolar differentiation 100 m interval



hill shading + enhanced edges + bipolar different. (B&W)



hill shading + enhanced edges + bipolar different.

hill shading + enhanced edges + bipolar different.

hill shading + enhanced edges + bipolar different.

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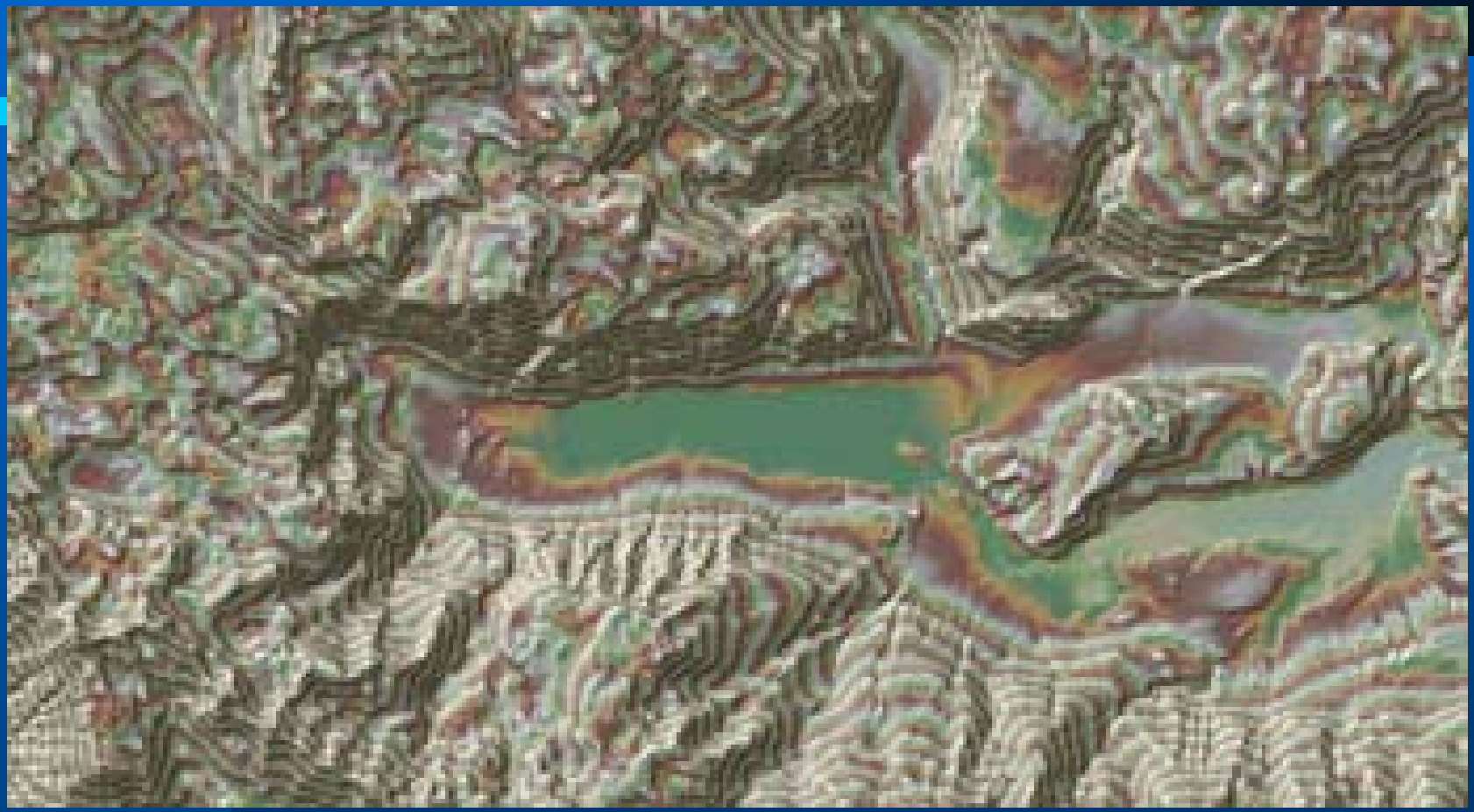
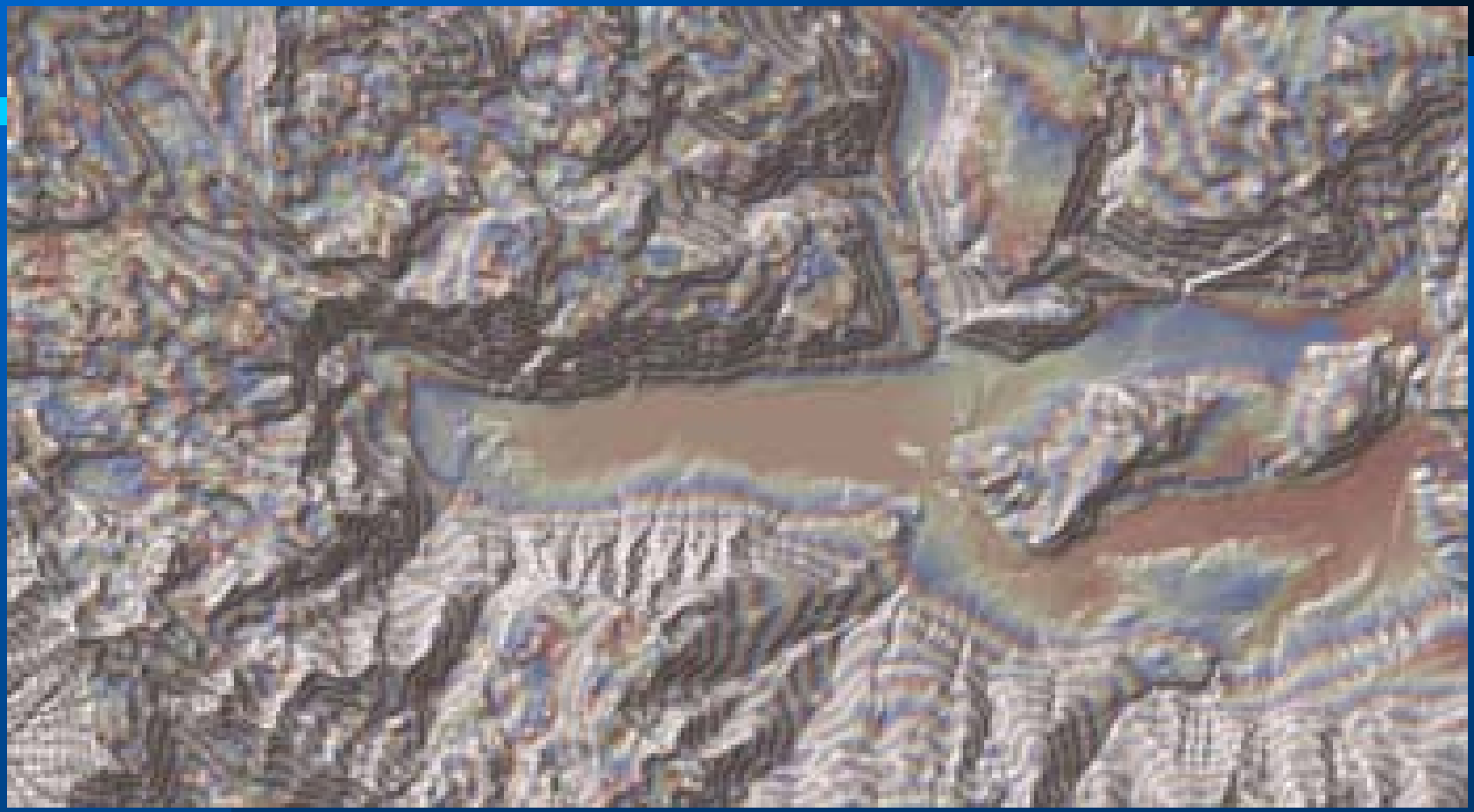
hill shading + enhanced edges + bipolar different.

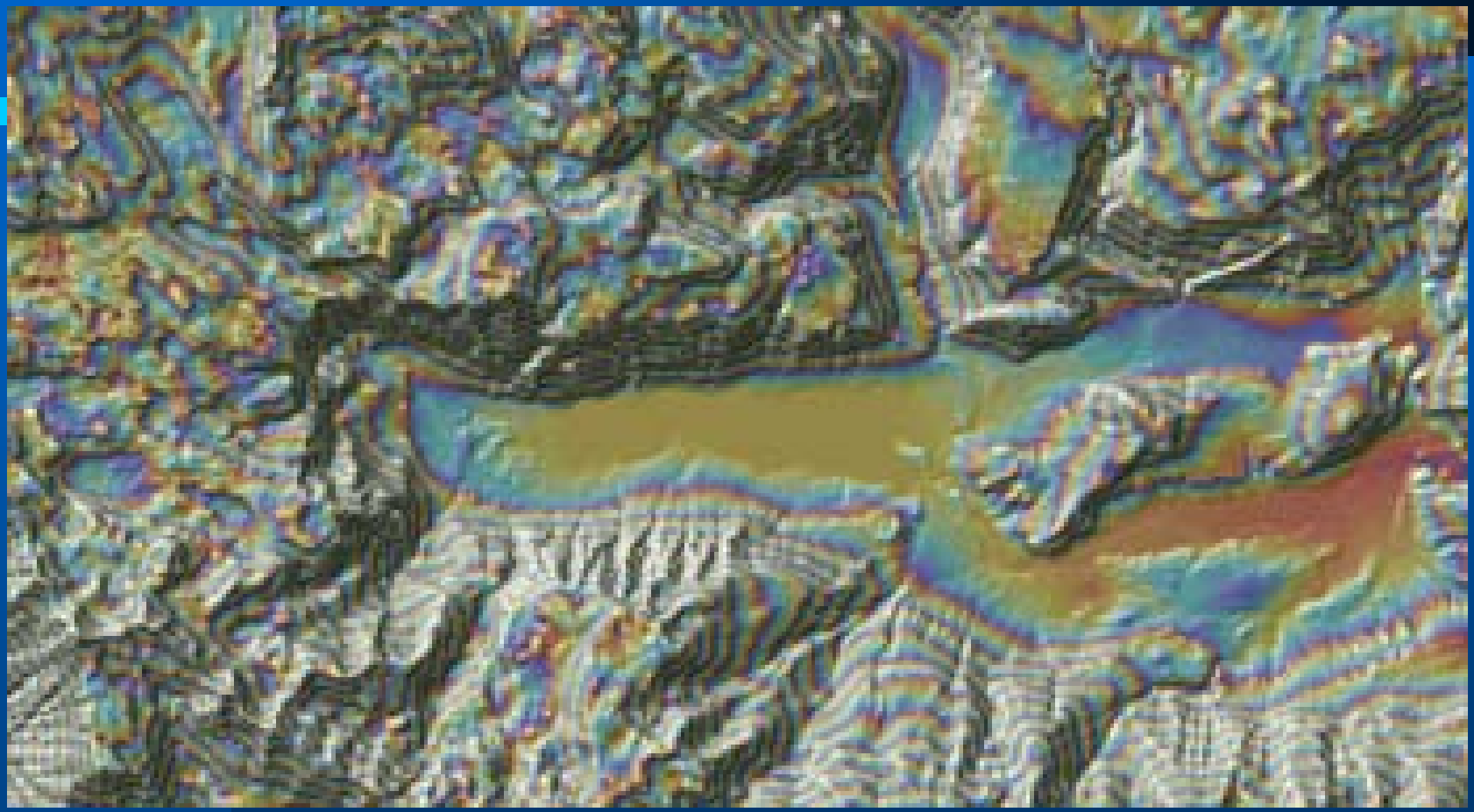
hill shading + enhanced edges + bipolar different.



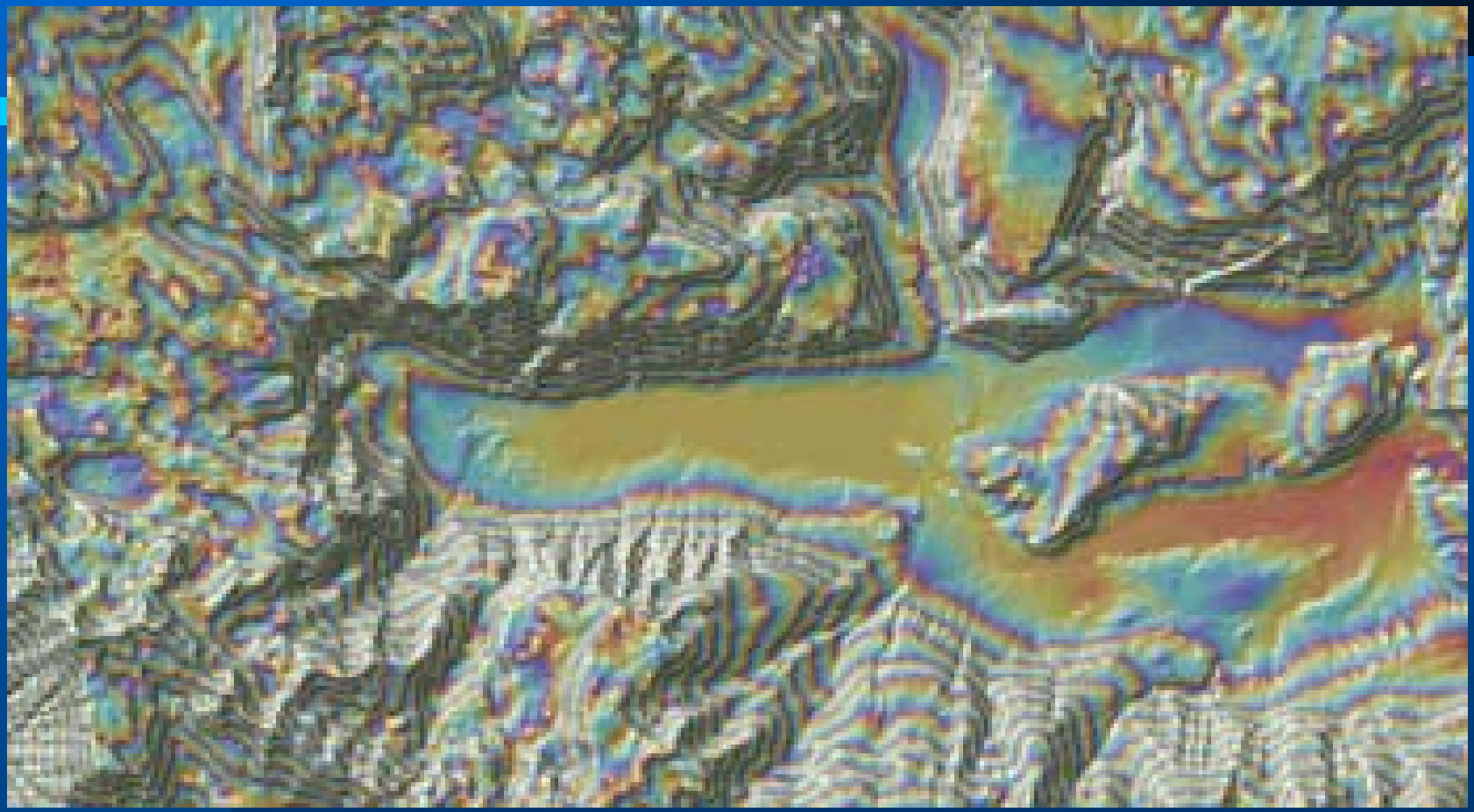
hill shading + enhanced edges + bipolar different.



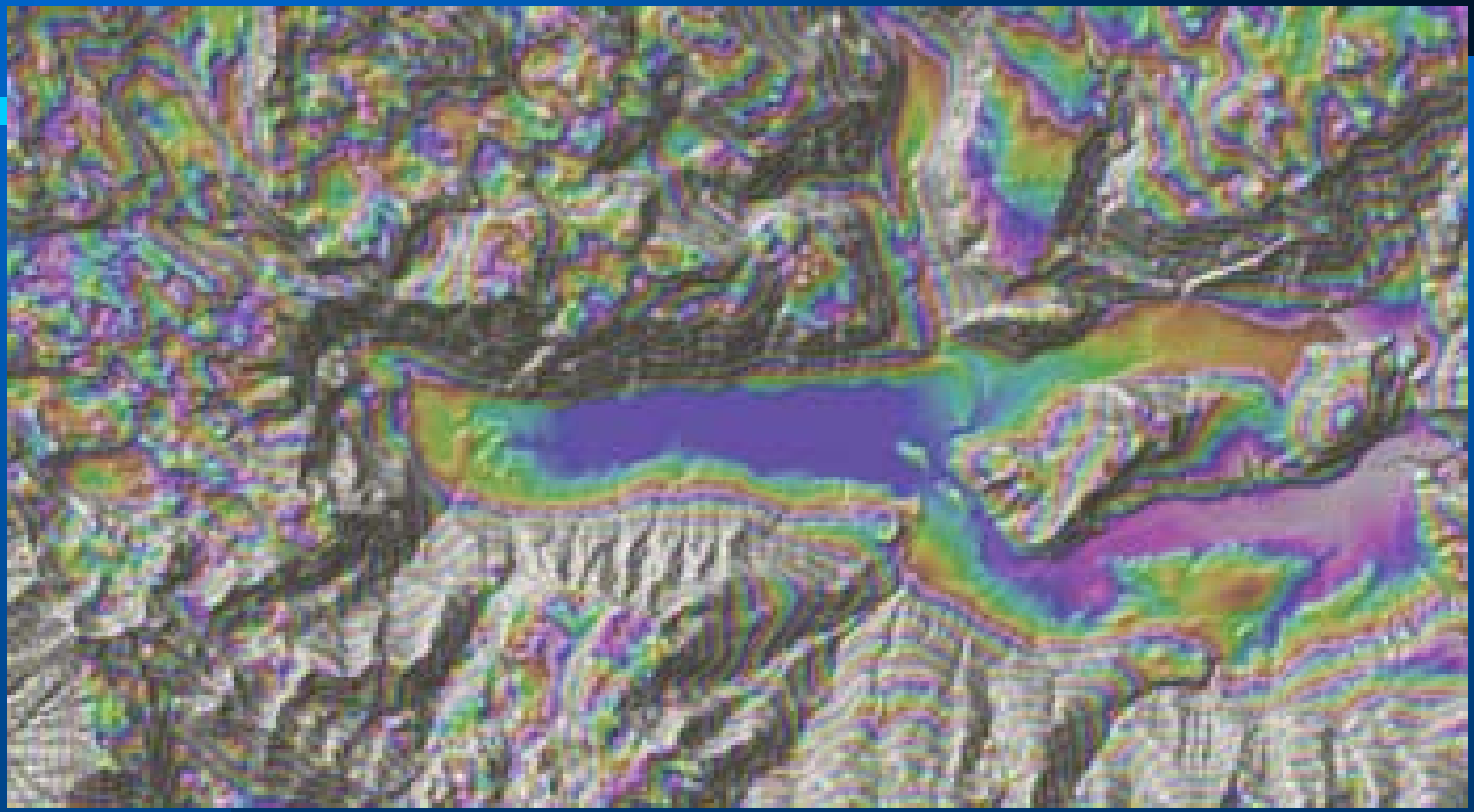
hill shading + enhanced edges + bipolar different.



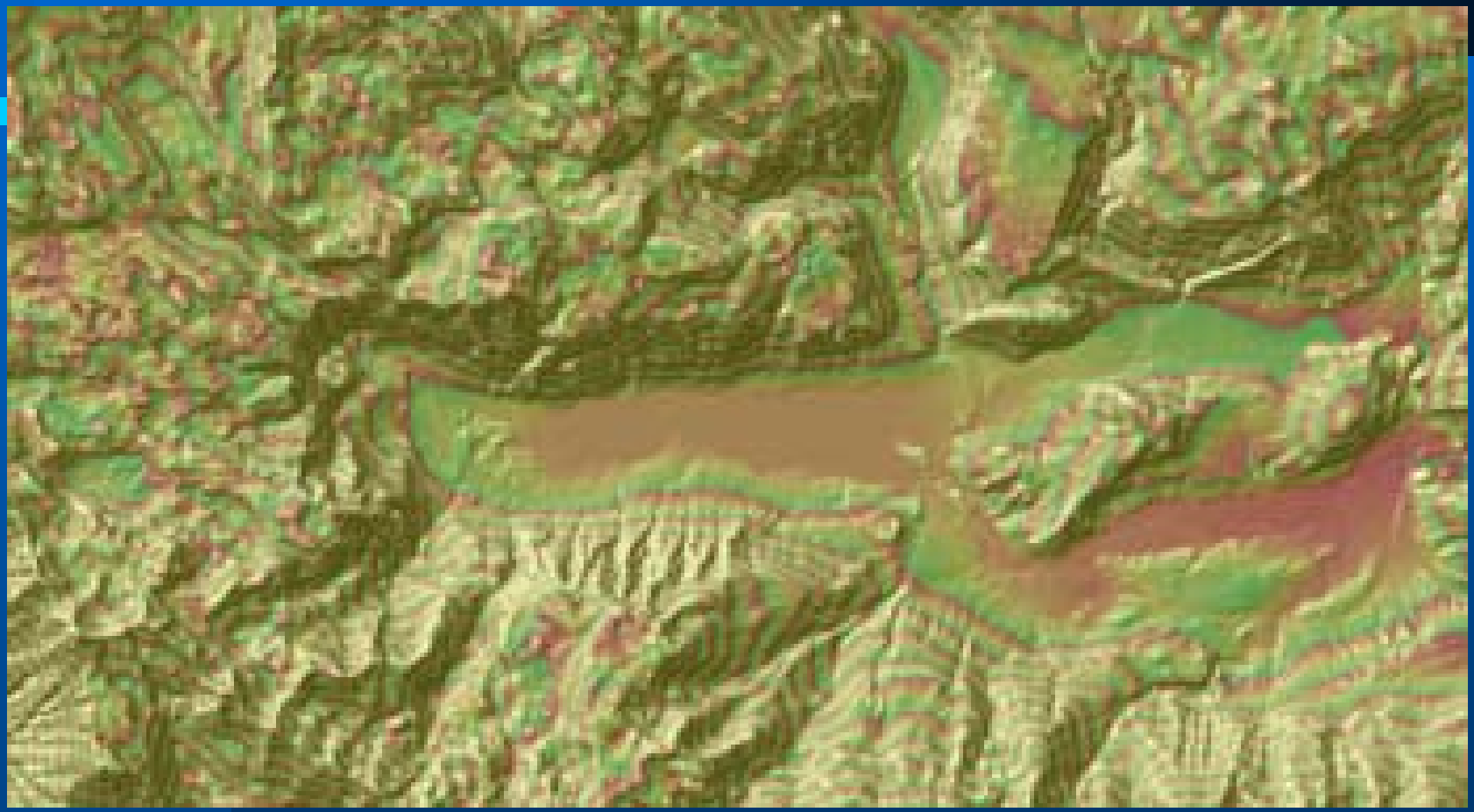
hill shading + enhanced edges + bipolar different.



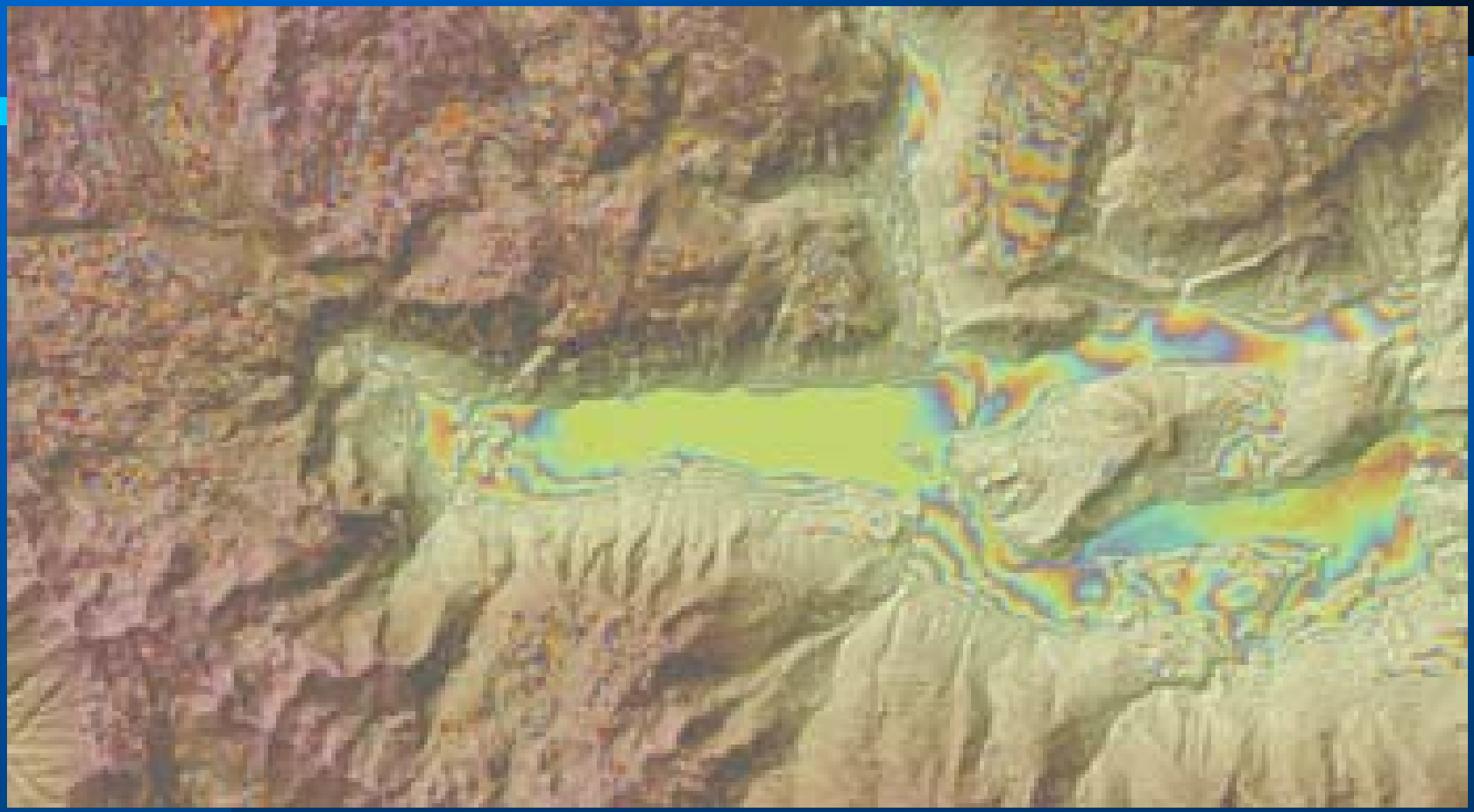
hill shading + enhanced edges + bipolar different.



hill shading + enhanced edges + bipolar different.



hill shading + enhanced edges + bipolar different.



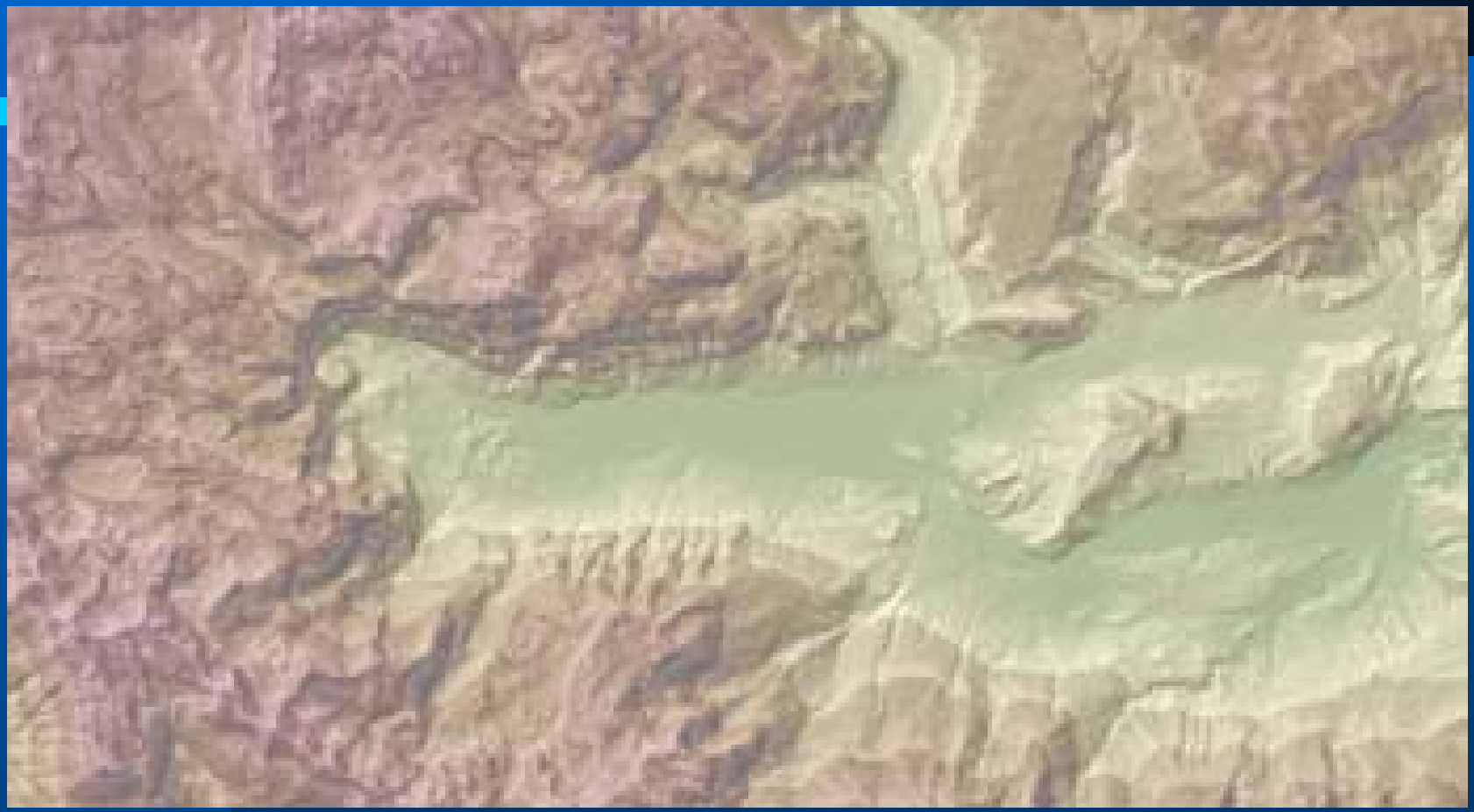
hill shading + enhanced edges + bipolar different. + hypsometry

hill shading + enhanced edges + bipolar different. + hypsometry

hill shading + enhanced edges + bipolar different. + hypsometry

hill shading + enhanced edges + bipolar different.

hill shading + enhanced edges + (light) bipolar different. + hypsometry



hill shading + enhanced edges + B&W bipolar different. + hypsometry

hill shading + enhanced edges + (B&W) bipolar different. + hypsometry

hill shading + enhanced edges + (B&W) bipolar different. + hypsometry

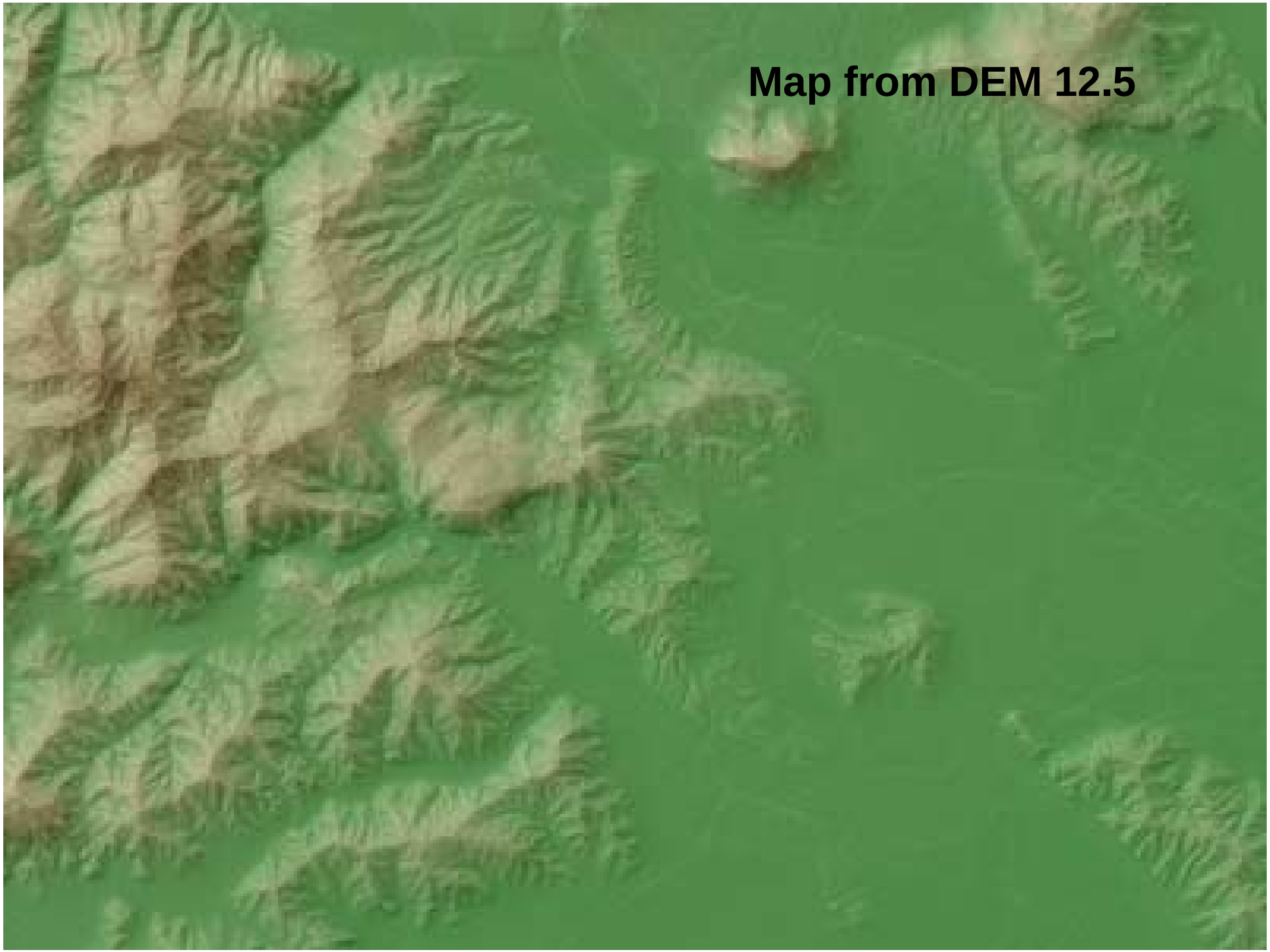
hill shading + enhanced edges + (B&W) bipolar different. + hypsometry

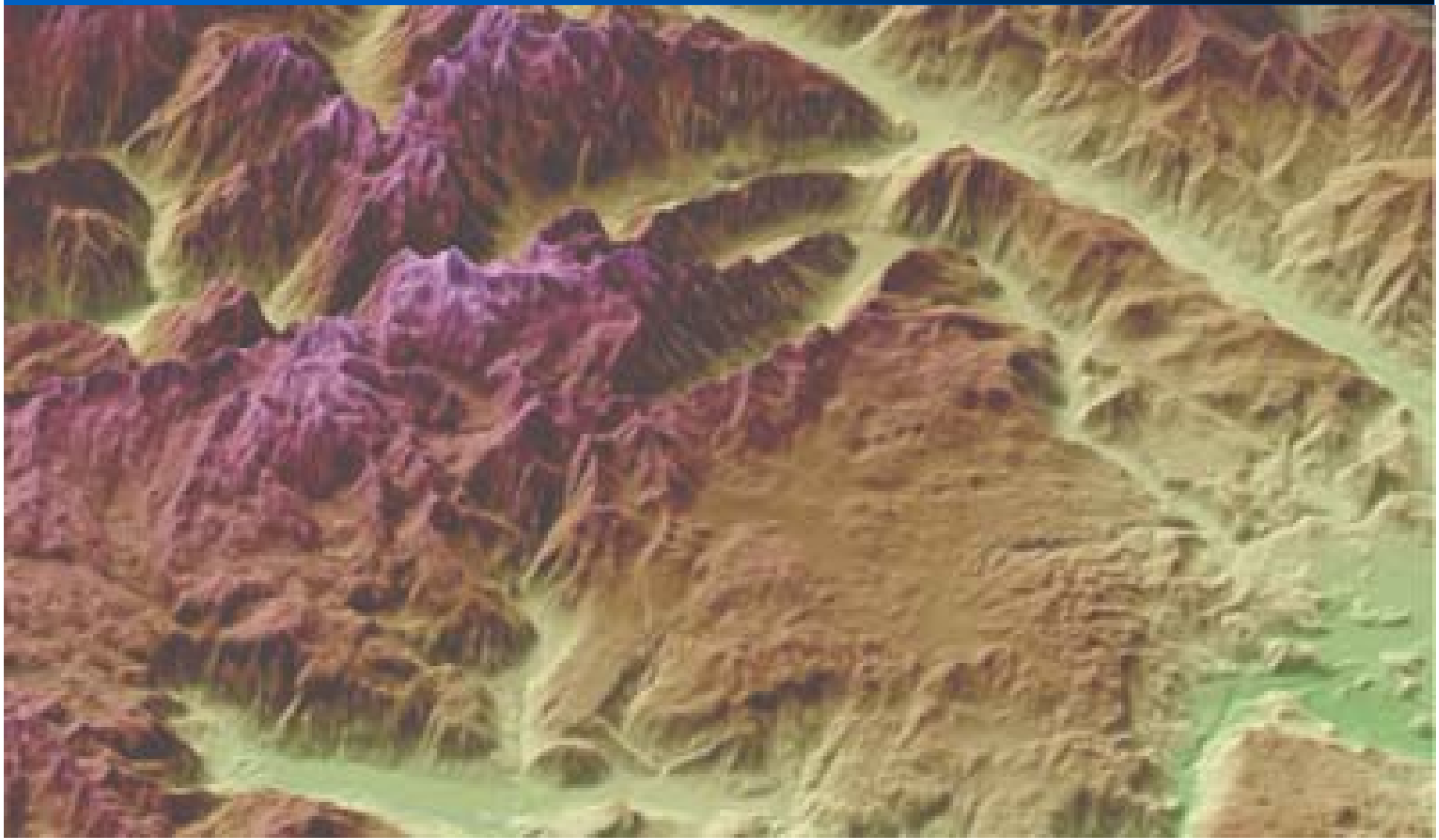
hill shading + enhanced edges + (B&W light) bipolar different. + hypsometry

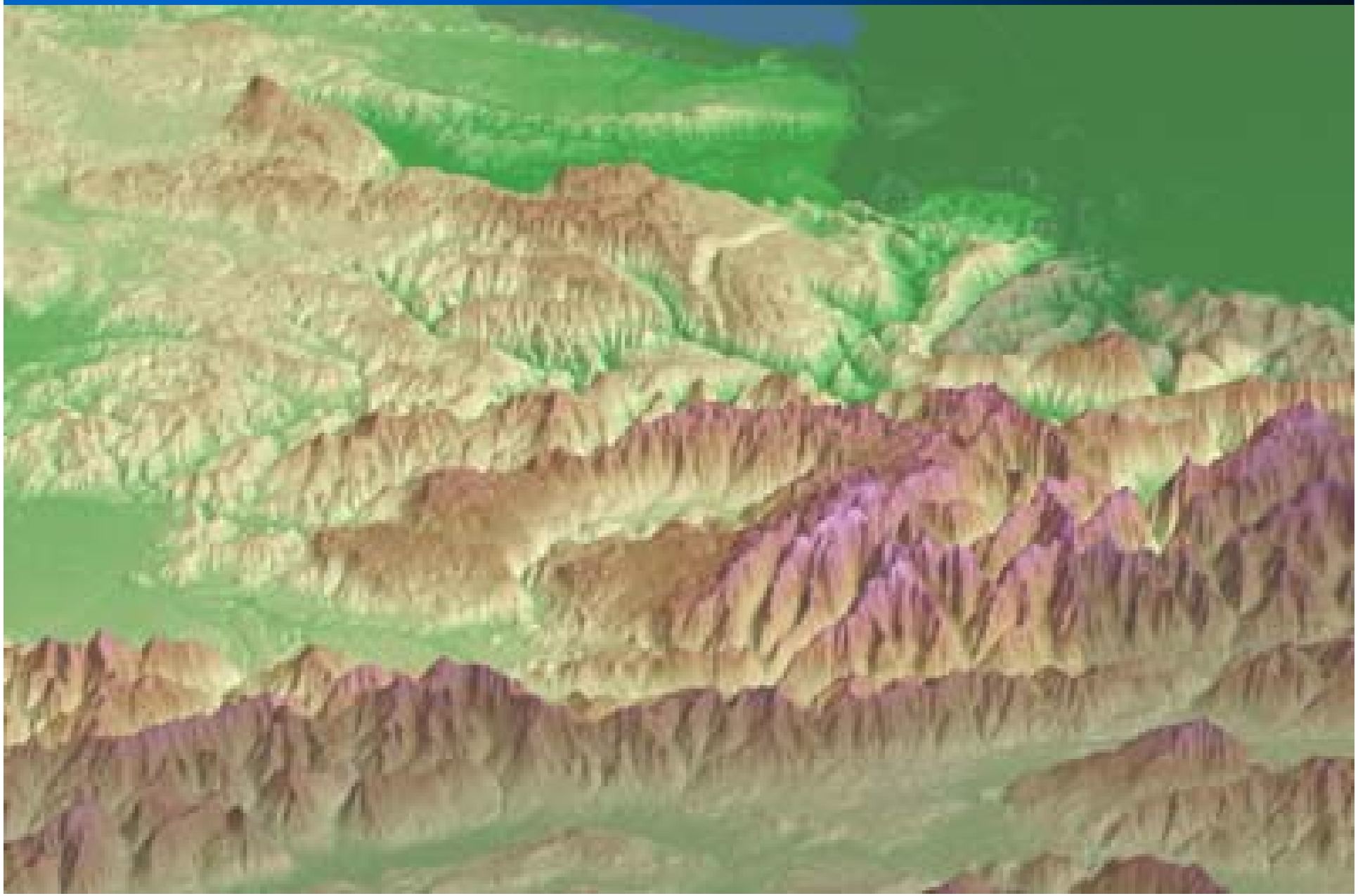
hill shading + enhanced edges

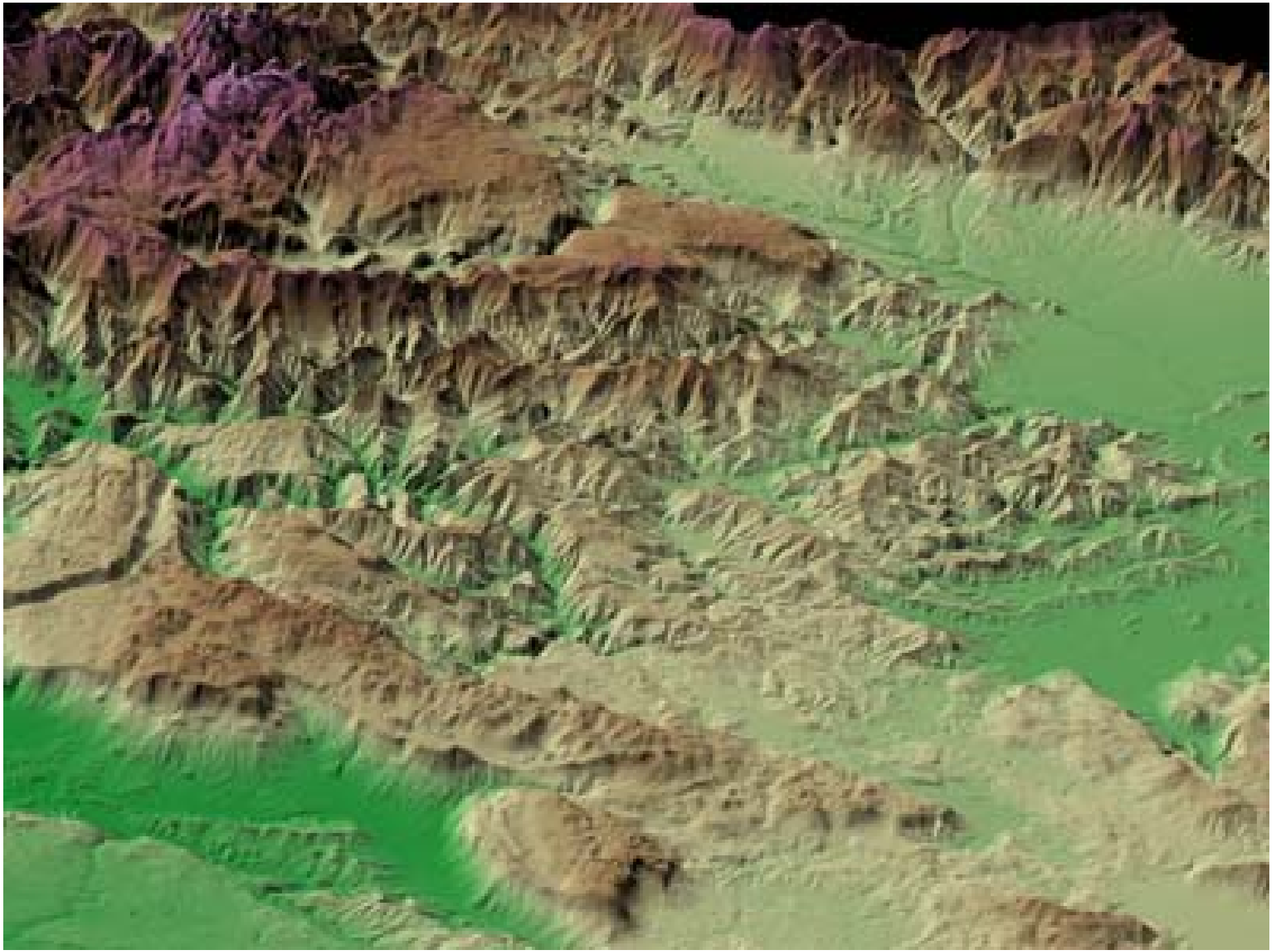
Some more examples

- different techniques for
  - different geomorphology
  - understanding the nature of landscape

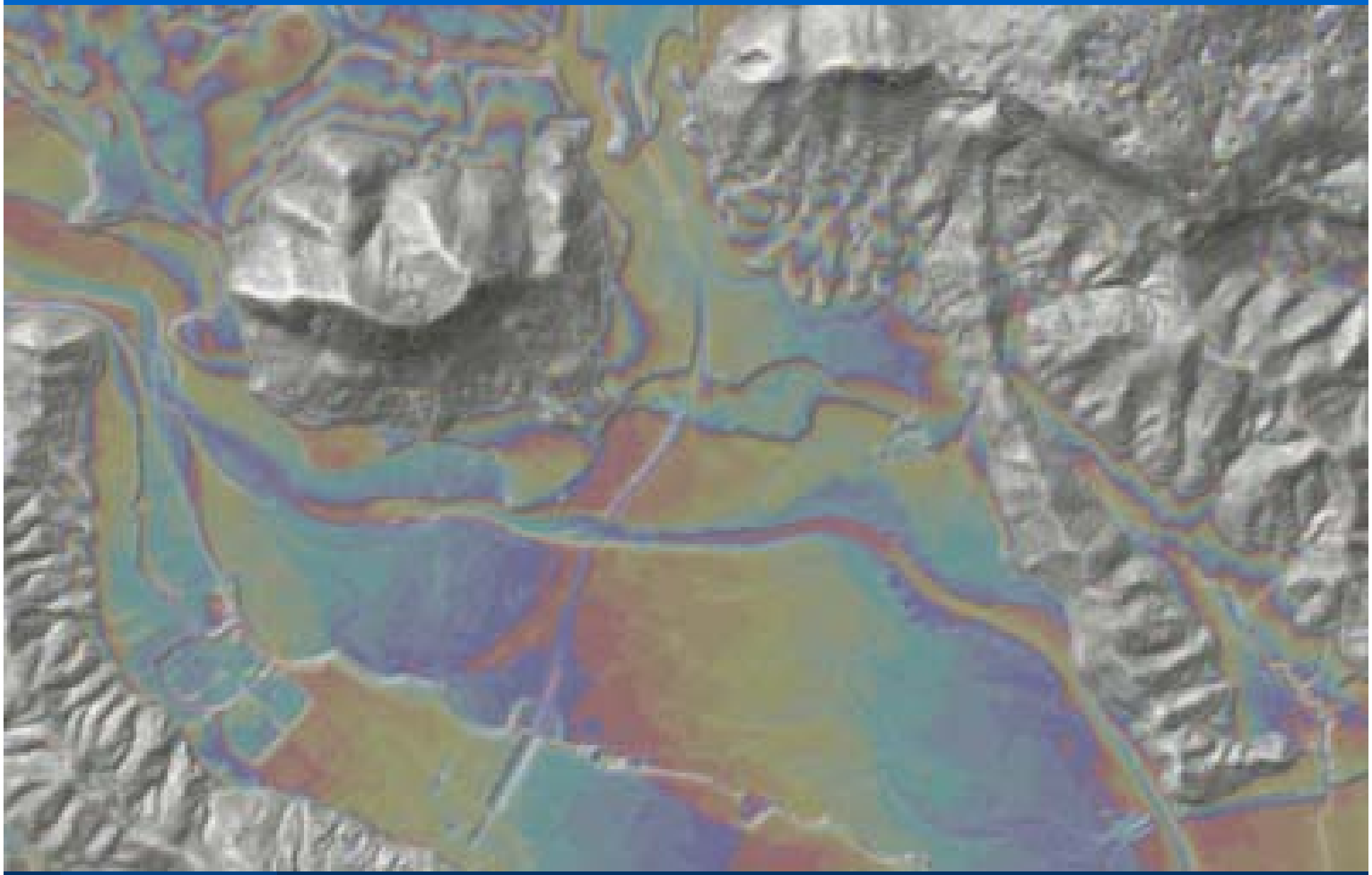

Map from DEM 12.5

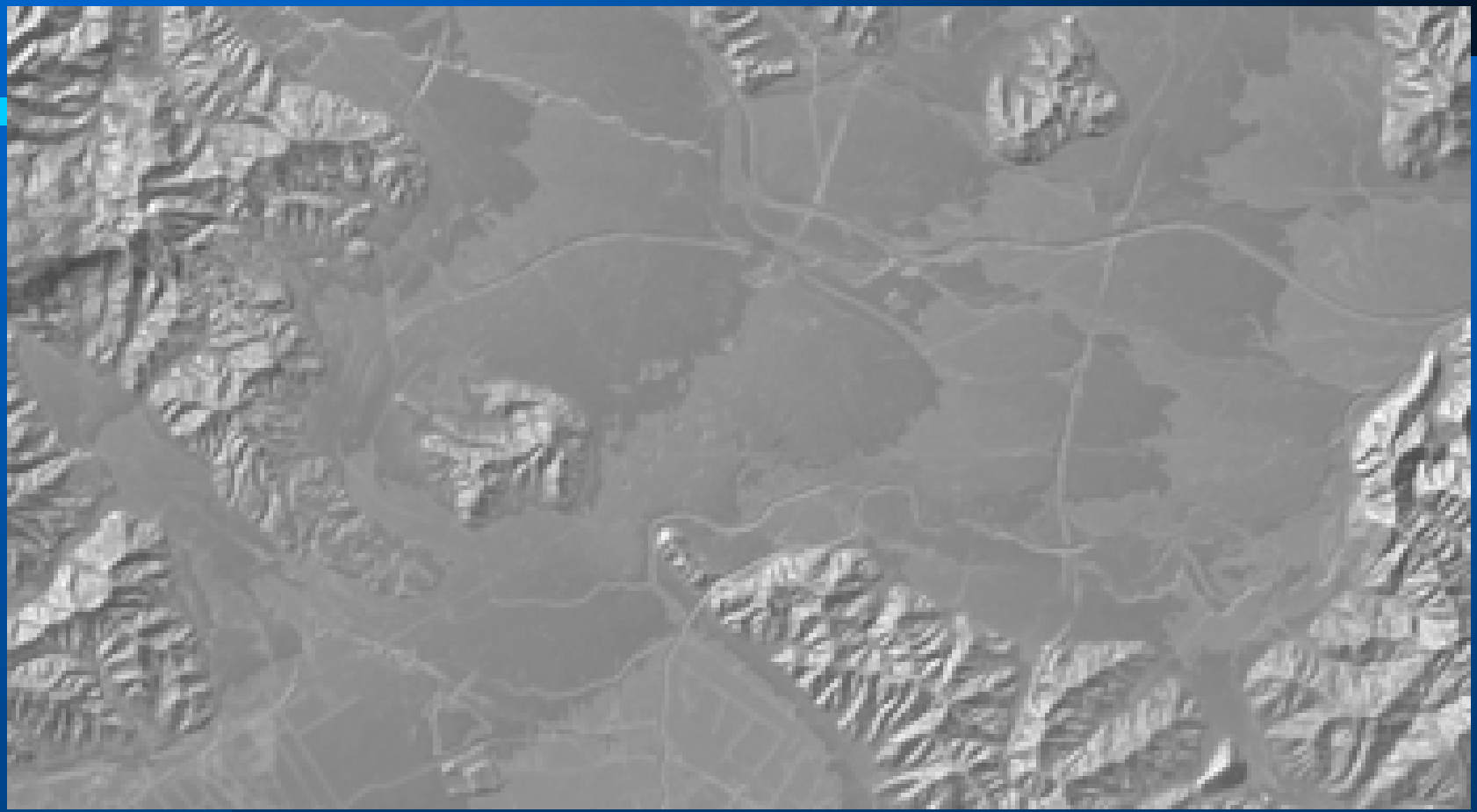


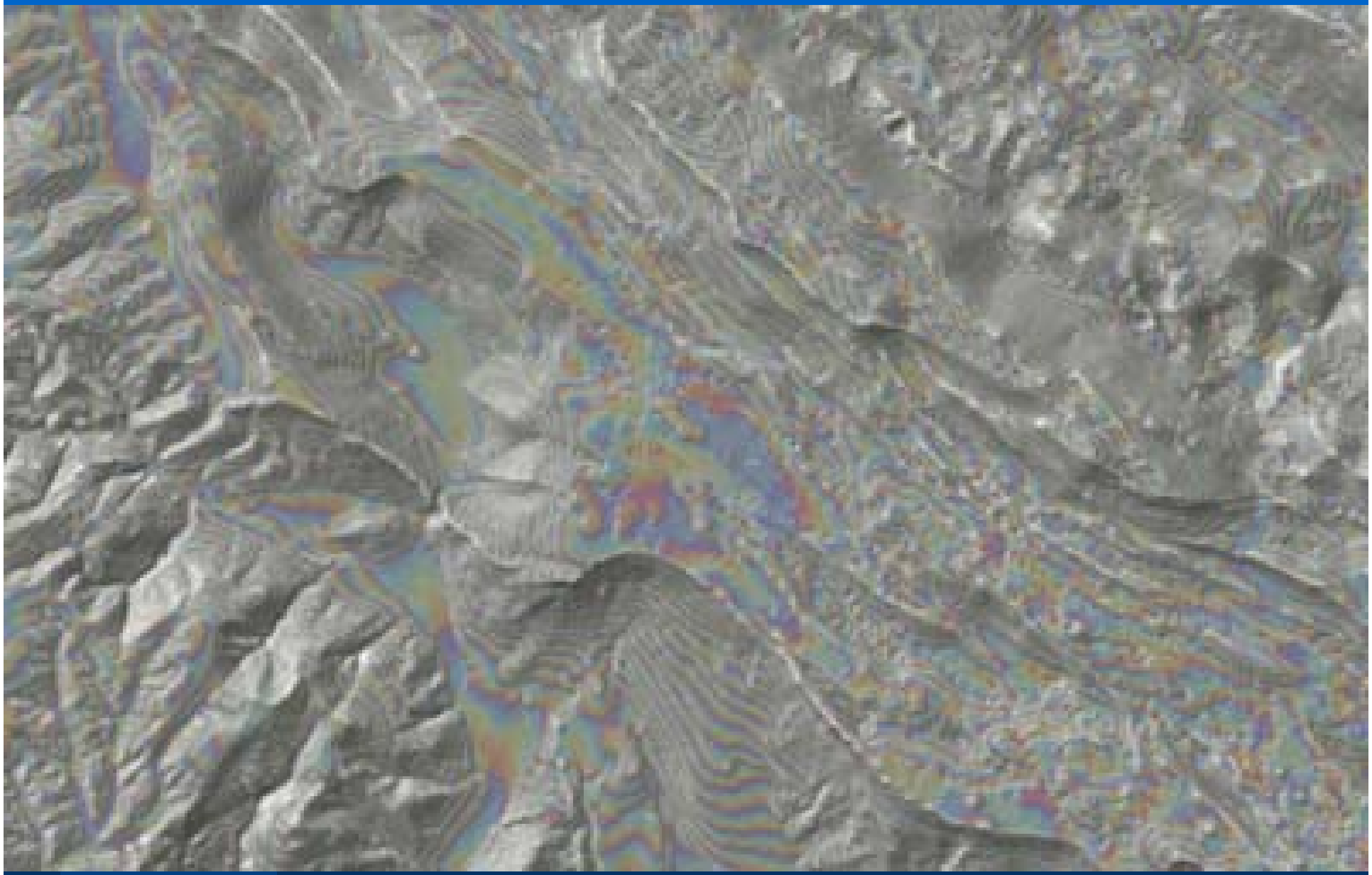


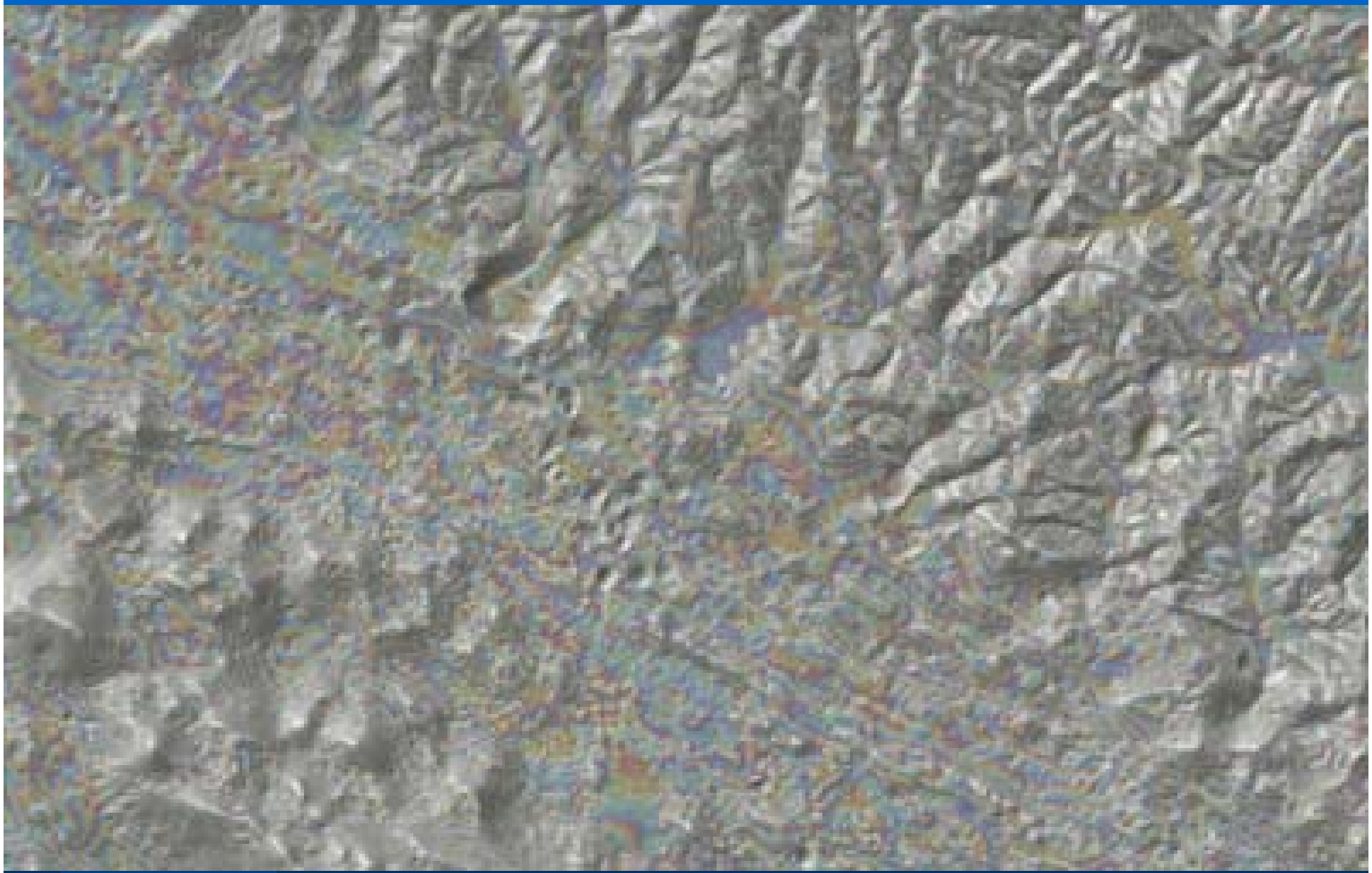


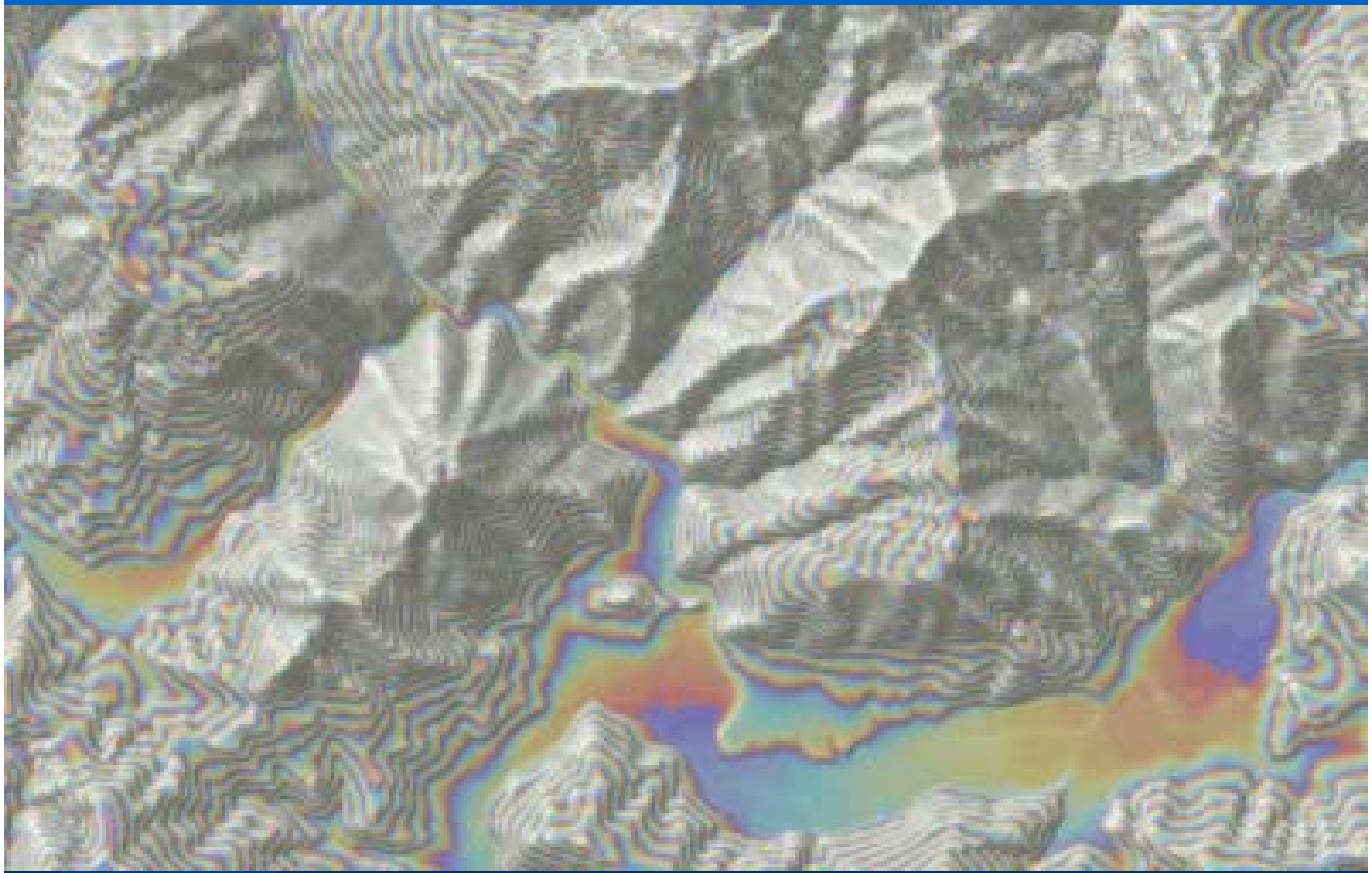
DEM 12.5GU – map











4 Conclusions

Conclusions

- multi scale visualisation techniques
- better understanding of the lanscape
- the DEM should look reasonable!
- It is not enough to produce the best DEM on the world if users:
  - can not find it
  - do not know possible purposes of use, its quality...

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