Terrain correction

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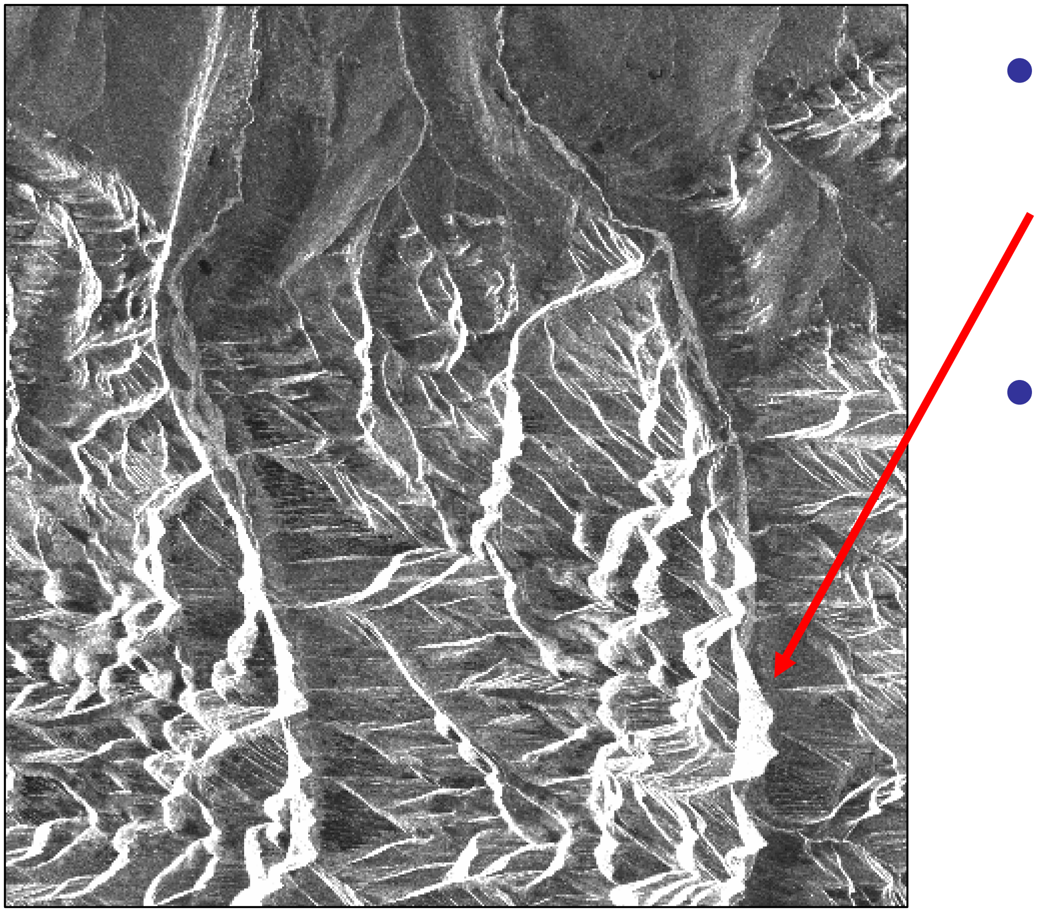
Outline

- processing stages
  - geocoded ellipsoid corrected (GEC)
  - geocoded terrain corrected (GTC)
  - radiometric terrain corrected (RTC)
- geometric terrain correction
- radiometric terrain correction
- composites
- example of combining optical and radar data

Why geometric terrain correction ?

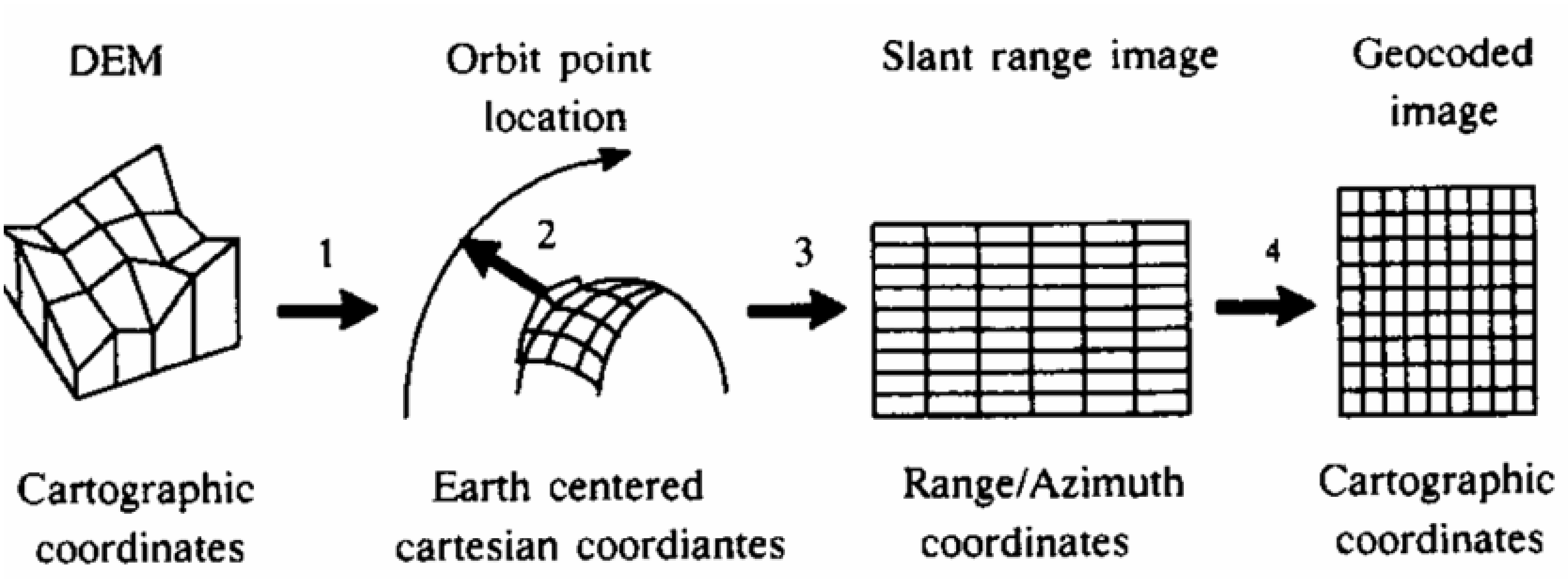
- necessary step to allow geometric overlays of remotely sensed data from different sensors and/or geometries

Why geometric terrain correction ?



- remove effects of side looking geometry of SAR images
- necessary step to allow geometric overlays of remotely sensed data from different sensors and/or geometries

Backward geocoding



Source: Bayer et al., 1991, Terrain influences in SAR backscatter and attempts to their correction. IEEE Transactions on Geoscience and Remote Sensing, 29(3):451-462.

Backward geocoding

- DEM coordinates are transformed into the earth-centered rotating (ECR) Cartesian coordinate system
  - orbit modeled by second degree polynomial
  - orbit grid point for each DEM grid point needs to satisfy SAR range equation and SAR Doppler equation
  - Radarsat orbits might need substantial refinement using tie points

Backward geocoding

- solution non-linear system
  - iteration along orbit for each DEM pixel
  - iteration results (image time and range coordinates) are linearly transformed into coordinate system of slant range image
- resampling assigns image grey value of slant range image to output pixel of geocoded image
  - depending on the relation between DEM and radar resolutions interpolation methods important
  - bilinear interpolation appropriate (Small et al., 1997)

Forward geocoding

- DEM coordinates (latitude, longitude, height) conversion into SAR image coordinates (line, sample)
  - solving the Doppler shift equation – relates relative velocity between point on the Earth and satellite to measured frequency shift of returned radar pulses
  - shift equation only dependent on time
  - equation solved using Newton-Raphson iteration

Forward geocoding

- generation of simulated SAR image
  - using ephemeris data as input to satellite model
  - using DEM information for a given location as input to Earth model
  - backscatter values from simple backscatter model
  - results in simulated SAR image in real SAR image geometry

Forward geocoding

- correlation of real and simulated SAR image
  - matching of points on a regular grid
  - calculation of mapping function that relates points in simulated and real image
- geocoding using mapping function
  - geolocating SAR image while correcting for terrain related distortions

Layover / Shadow masks

- can be derived from DEM
- useful to provide information about problem areas
  - shadow regions – no information available
  - layover and foreshortening – reduced spatial resolution

Why radiometric terrain correction ?

- some SAR applications require absolute radiometric calibration accurate to within 1 dB
  - e.g. biomass estimation

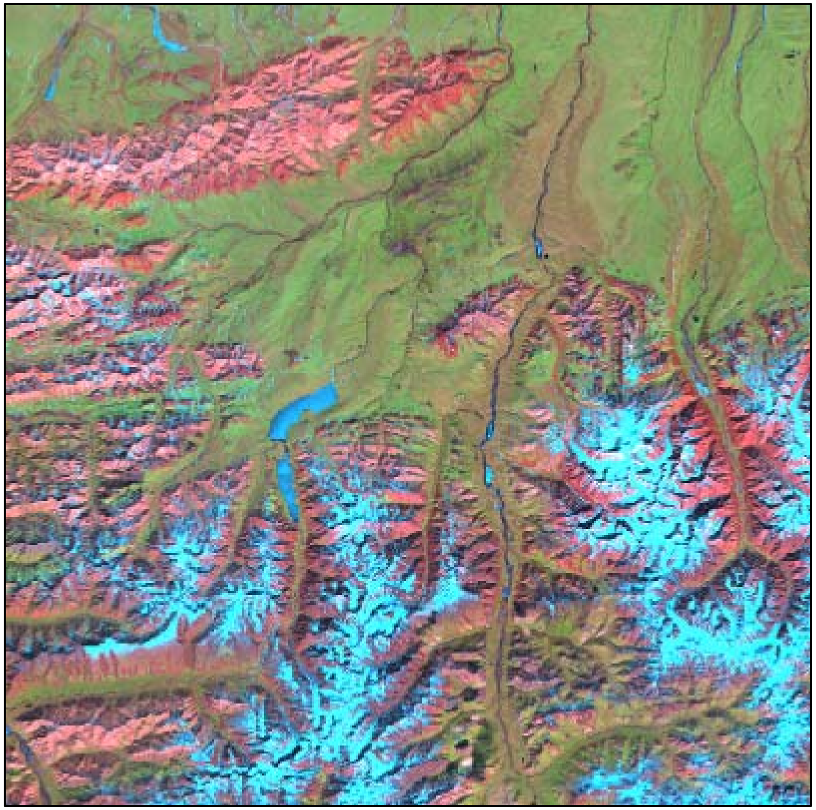
→requires generalization of many assumptions widely made in the SAR literature
  - radar equation
  - area effect

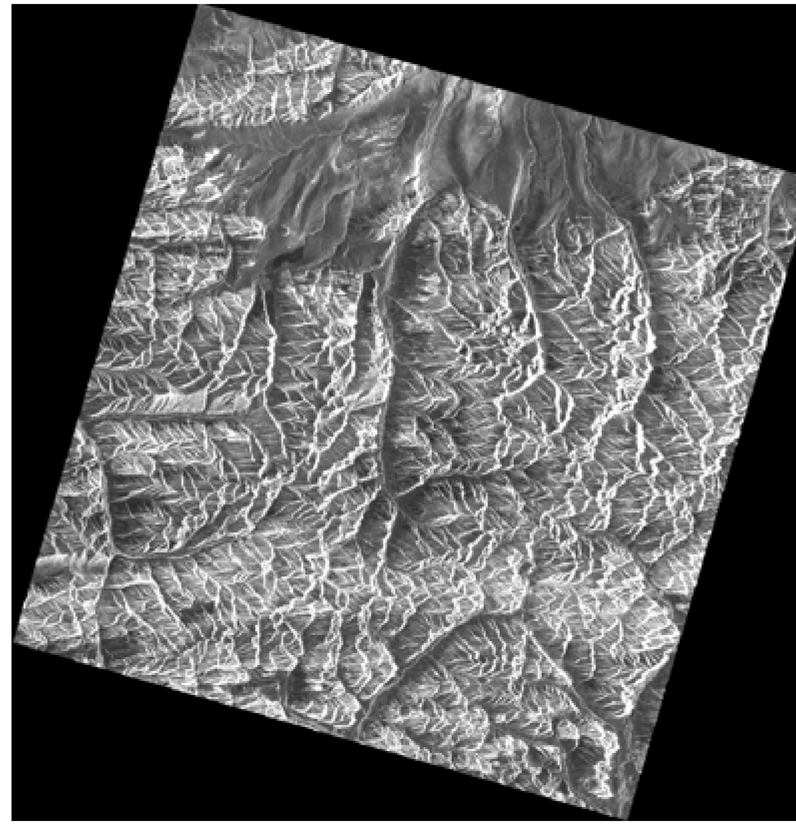
Terrain corrected composites

- combining ascending and descending data
- multiple contributions have weights according to their local resolution

Combining radar and optical data – Example Brooks Range

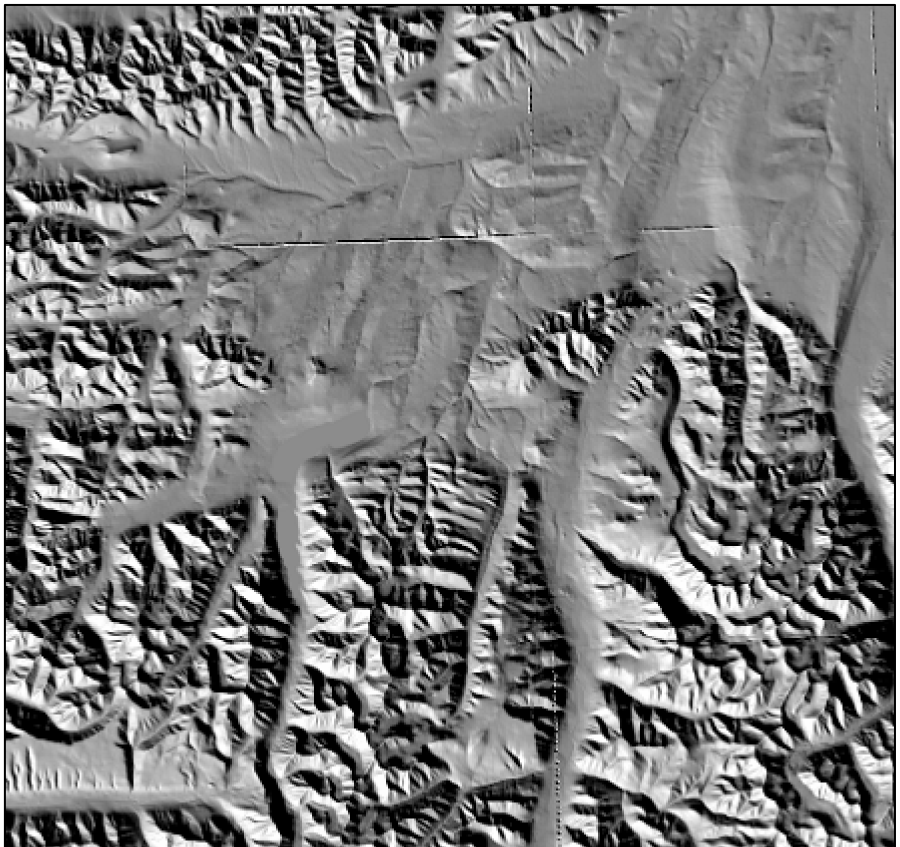
That is what you have


Landsat ETM-7


ERS-1

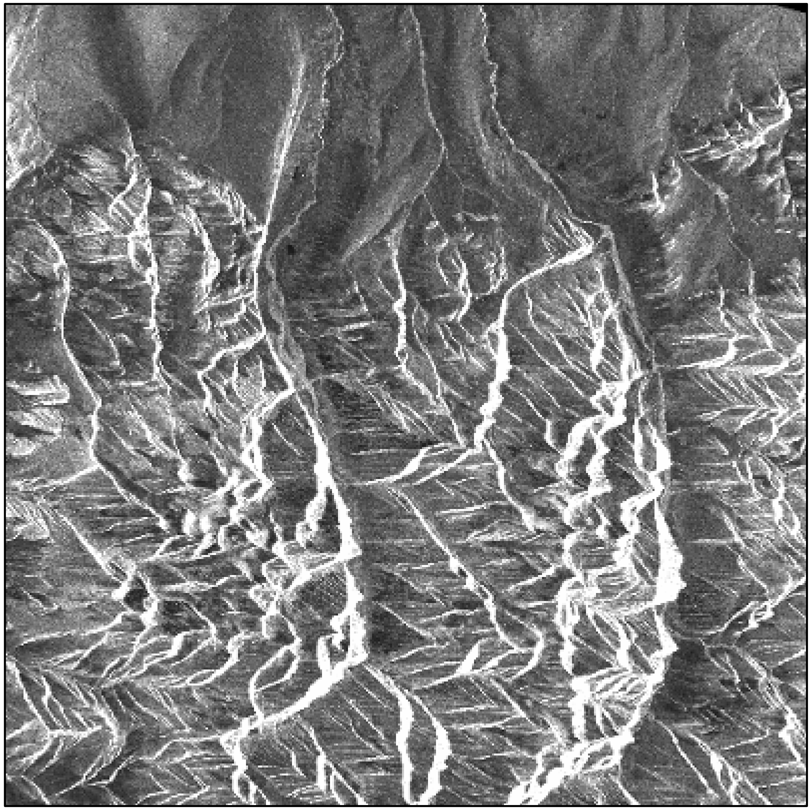
Reference DEM

Terrain correction



- shaded relief of the reference DEM
- average height used for geocoding
- used for terrain correction

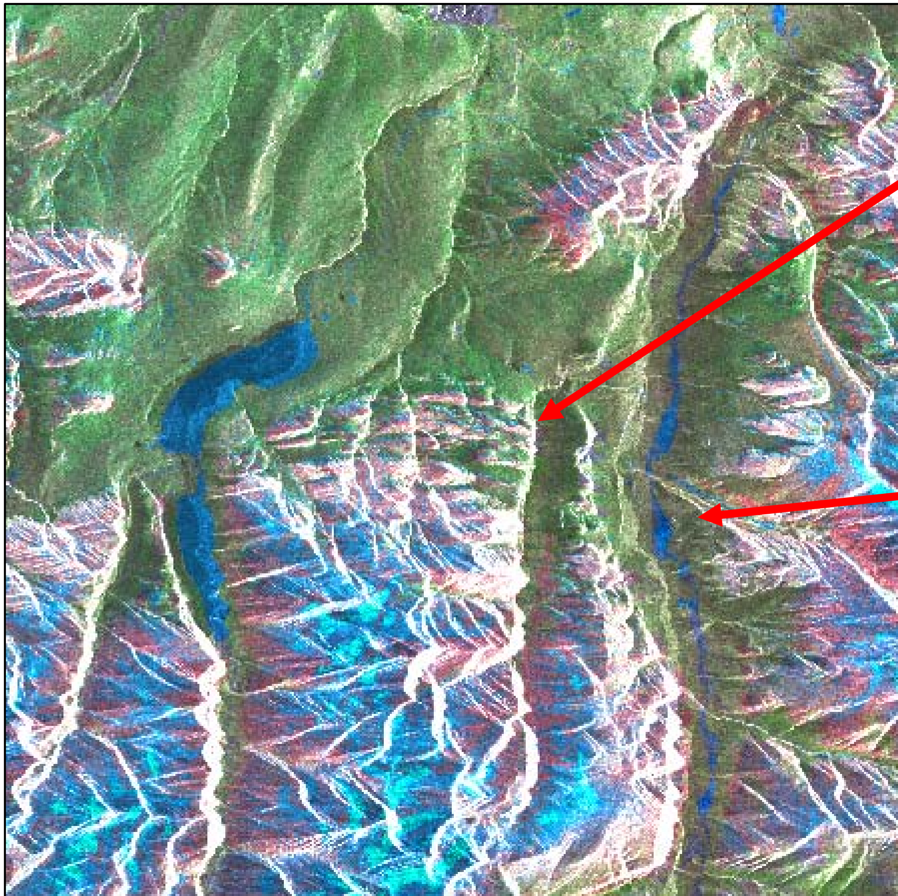
Terrain correction



Geocoded image

Terrain corrected image

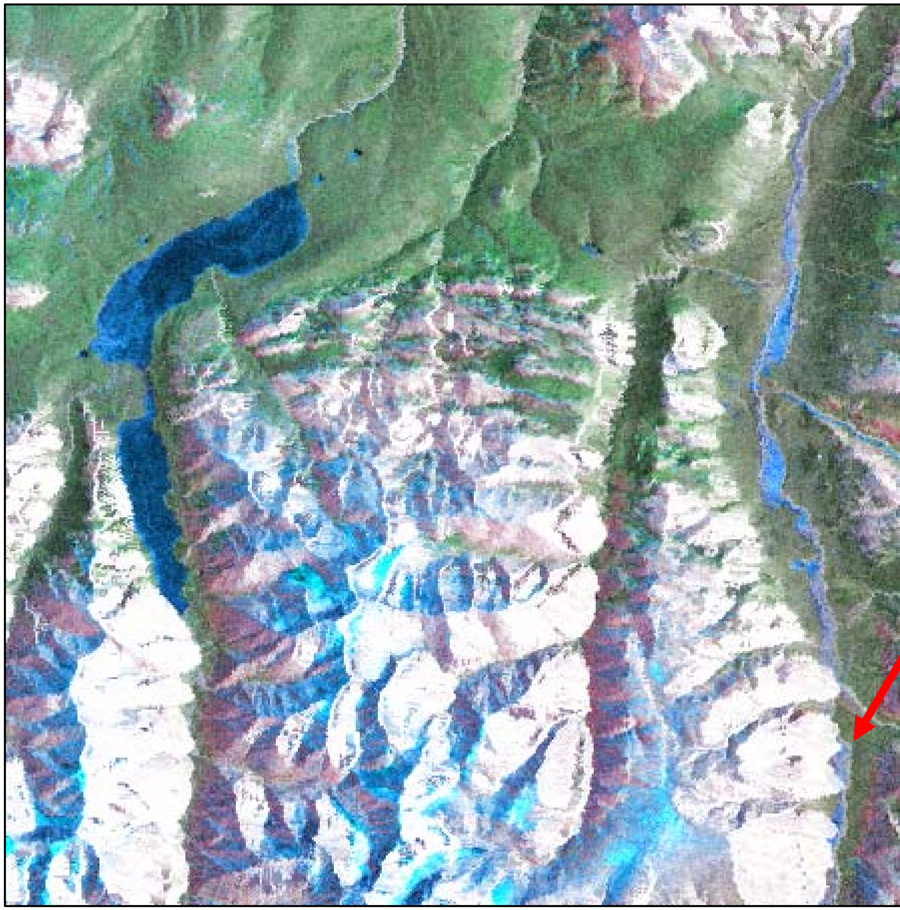
IHS transformation without TC



- Areas with correct reference height line up
- Areas with significant height differences show large offsets

IHS transformation with TC

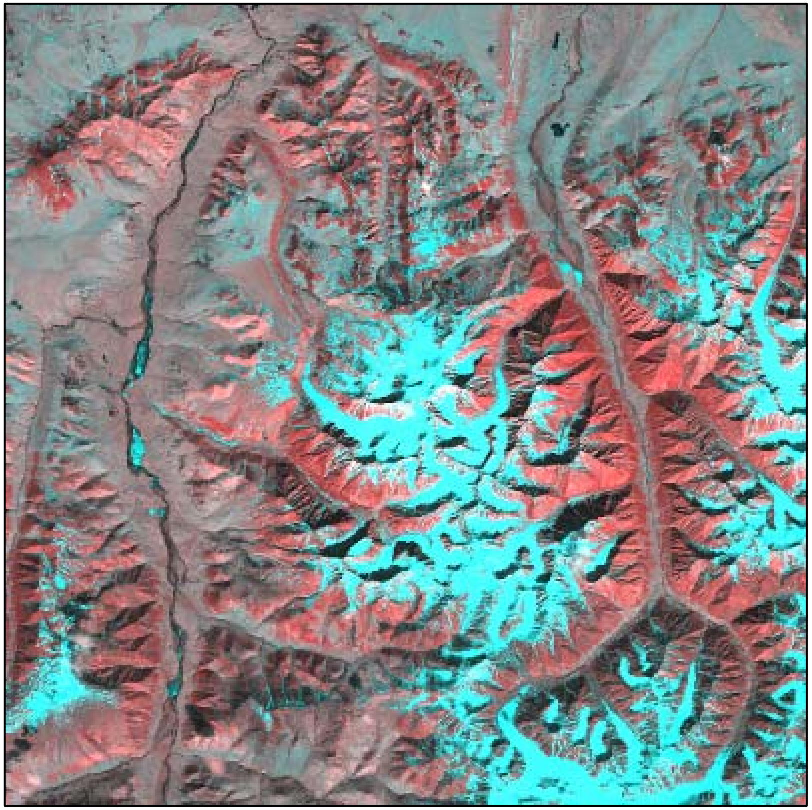
Terrain correction



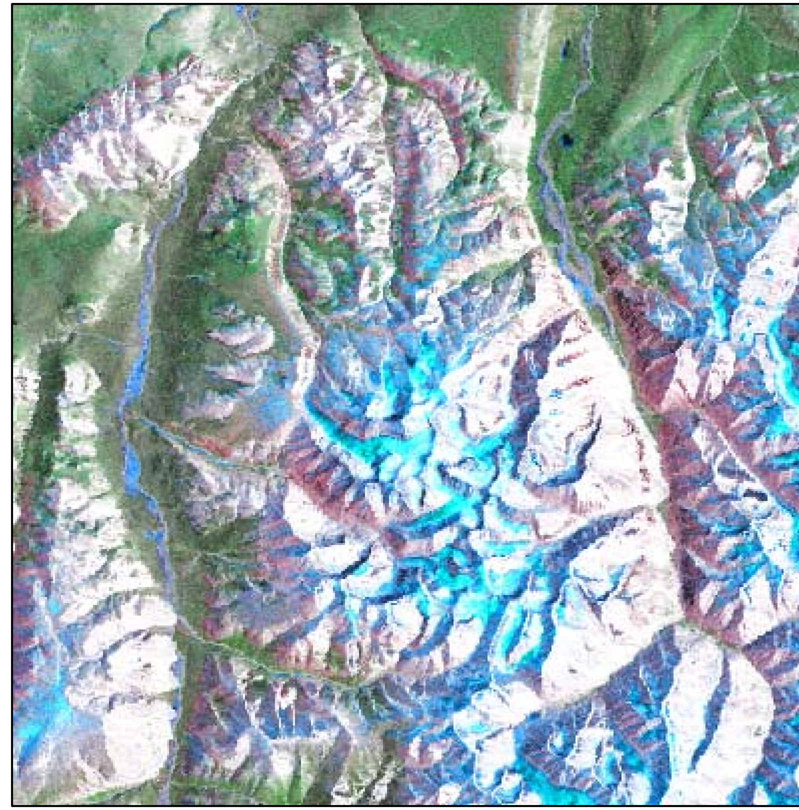
- Things line up !
- Areas where mountains tops created severe layover can be corrected but not fully recovered

Combination – more information

Terrain correction



Optical image



Optical + radar combined

Bottom line

- need to terrain correct radar imagery in order to properly combine with optical images
  - for moderately steep to steep terrain
  - on a case by case basis for low slopes