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

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

- 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

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

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