SAR interferometric processing

Rüdiger Gens

UNIVERSITY OF ALASKA FAIRBANKS

ASF

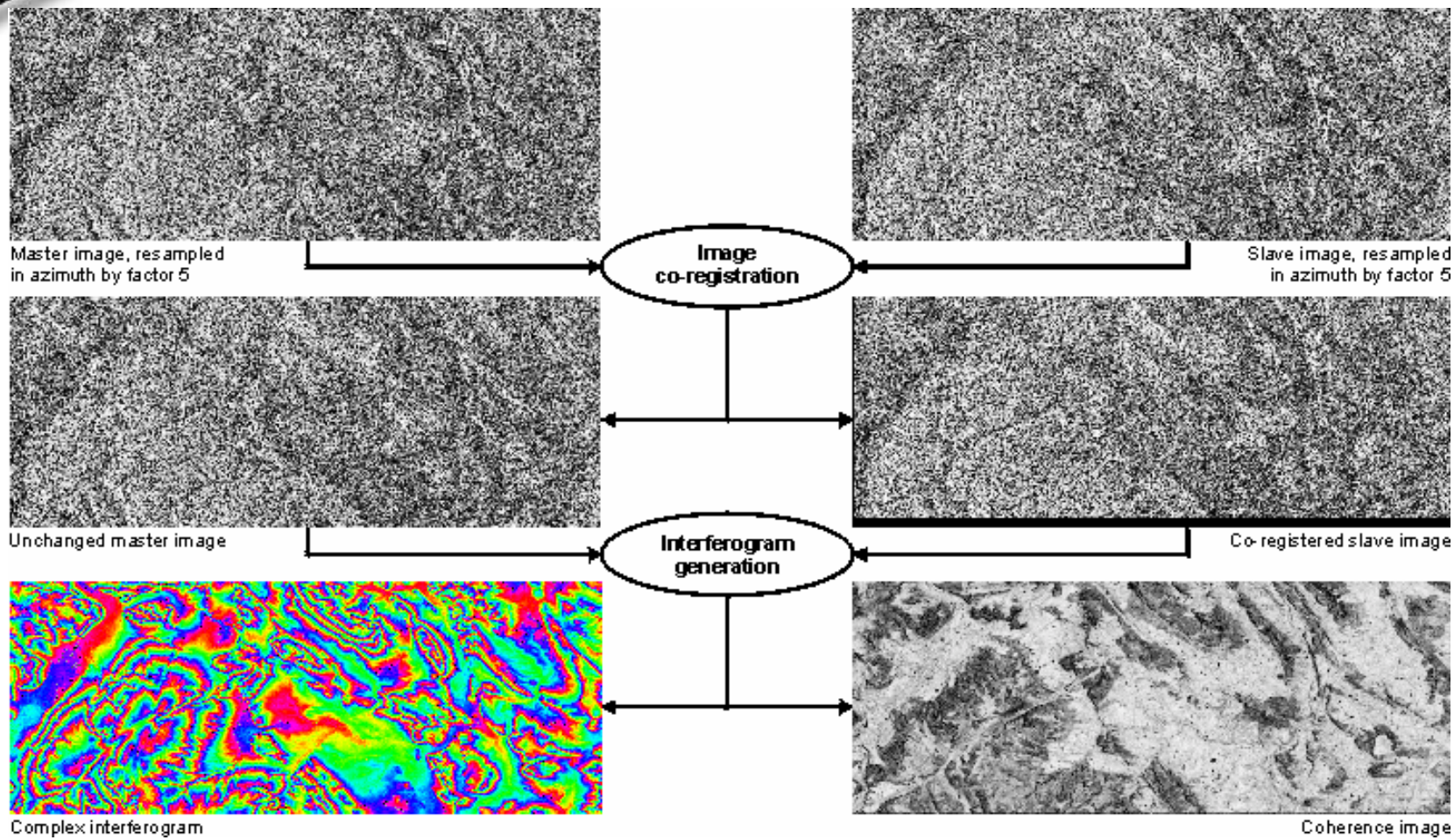
Outline

- Why InSAR processing?
- Processing chain
- Data sets
- Coregistration
- Interferogram generation
- Phase unwrapping
- Conversion from phase to height
- Geocoding

Why InSAR processing?

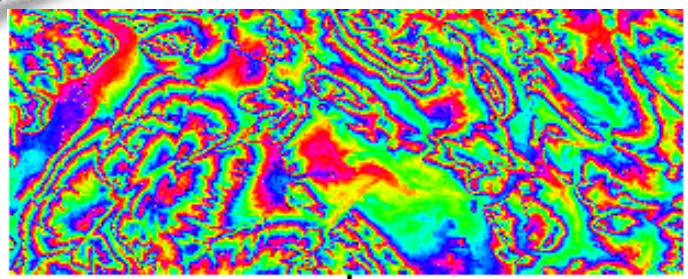
- extracting three-dimensional information out of a radar image pair covering the same area
  - digital elevation model
  - change detection

Processing chain

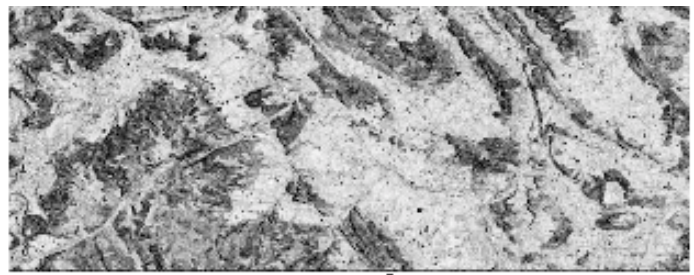


InSAR processing

Processing chain

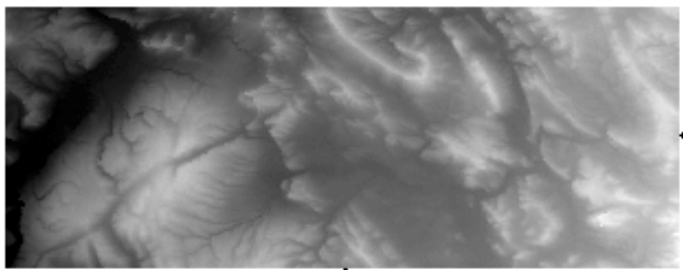


Complex interferogram



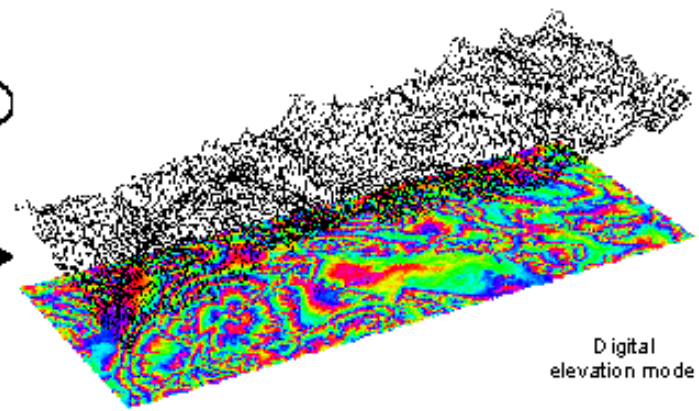
Coherence image

Phase unwrapping



Unwrapped phase

Conversion to height



Digital elevation mode

InSAR processing

UNIVERSITY OF ALASKA FAIRBANKS

ASF

Data sets

- analog raw data on tape
- capture file
  - telemetry stripped off, digital → computer compatible
- level zero data
  - *SKY telemetry format (STF)*
  - *CEOS raw format*
- level one data
  - run through a SAR processor (e.g. AISP, PP, Focus)
  - *CEOS single look complex*

Data sets

- satellite data
  - ERS-1, ERS-2, RADARSAT-1, ENVISAT (C-band)
  - JERS-1 (L-band)
- airborne data
  - AirSAR, TOPSAR (research)
  - E-SAR, DOSAR, Star3i (commercial)
- shuttle
  - SIR-C / X-SAR mission (NASA + DLR)
  - Shuttle Radar Topography Mission (SRTM)

Coregistration

- alignment of master and slave image
- trade off between processing time and accuracy of technique applied
- coarse coregistration
  - matching images on a pixel level (shift in x and y)
- fine coregistration
  - sub-pixel alignment of images
  - large variety of techniques

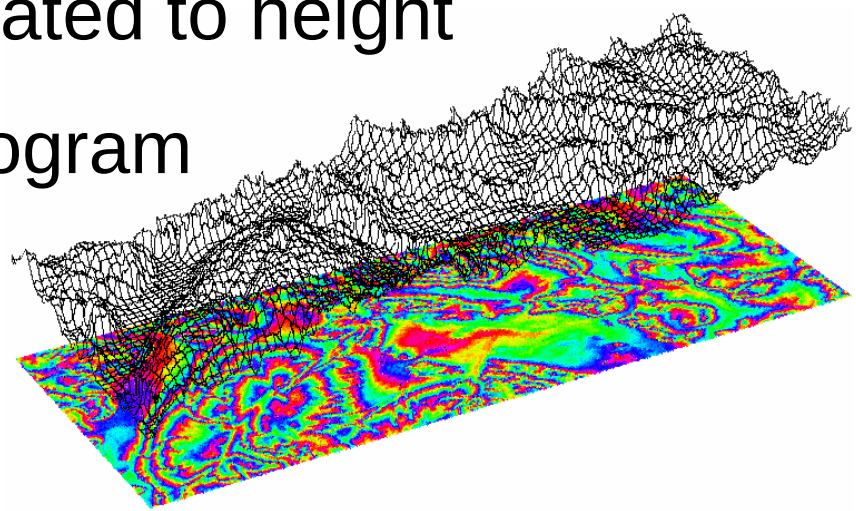
Coregistration

- quality requirement to avoid phase errors
  → ⅛ of a pixel
- interpolation method
  - nearest neighbor, bilinear, cubic splines, sinc
- quality measure: coherence

Interferogram generation

- complex multiplication of the two images
- corresponding amplitudes have to be averaged
- corresponding phases have to be differenced at each point in the image

  $\rightarrow$ phase difference related to height
- multilooking of interferogram



Phase unwrapping

- looking for the correct integer number of phase cycles that needs to be added to each phase measurement to obtain the correct slant range distance
- absolute phase is wrapped into the interval $(-\pi,+\pi] \rightarrow$ ambiguity problem
- solving ambiguity referred to as phase unwrapping

Phase unwrapping

- no standard procedure to solve the phase unwrapping problem
- large variety of algorithms developed
- generally trade off between accuracy of solution and computational requirements
- two types of strategy to solve the phase unwrapping problem
  - path-following methods (local approach)
  - minimum-norm methods (global approach)

Phase unwrapping

- ways of simplifying the problem
  - filtering the phase before unwrapping
  - removing topographic phase before unwrapping
    $\rightarrow$ requires reference DEM
  - choice of geometry: short baseline

Conversion phase to height

- adding of topographic phase (in case removed before phase unwrapping)
- creation of the elevation map
- estimating an error map based on coherence image, baseline and unwrapped phase
- mapping from slant range to ground range geometry

Geocoding

- defines the transformation between local coordinate system and global Cartesian coordinates
- two different ways of implementation
  - Doppler frequency calculated on DEM positions and satellite orbit (requires reference DEM)
  - refinement of baseline and imaging geometry (no reference DEM required)

Questions

?

UNIVERSITY OF ALASKA FAIRBANKS

ASF