



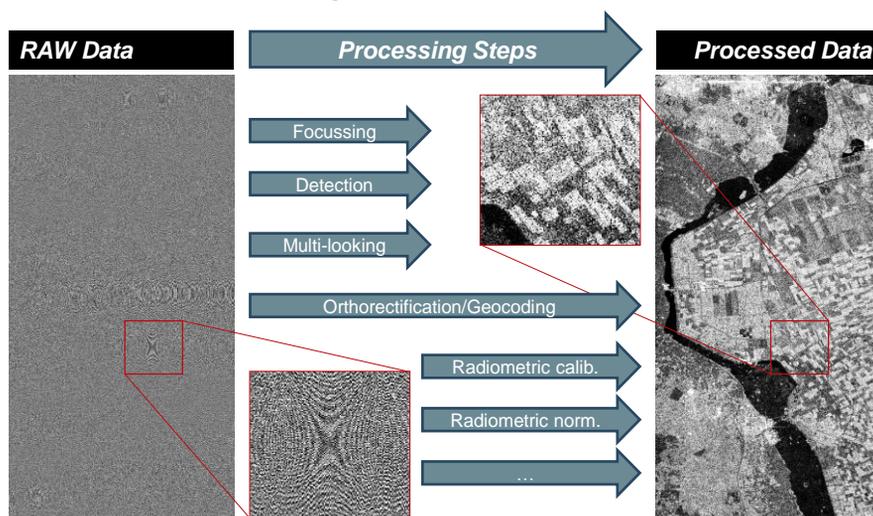
Data processing

SAR Specific Data Formats & SAR Data Processing

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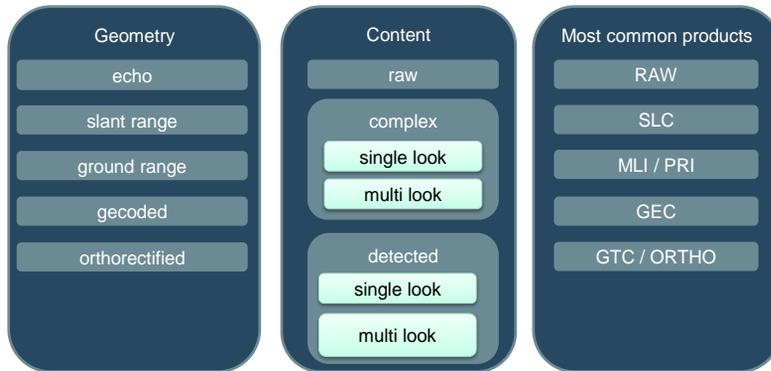
Educational objective



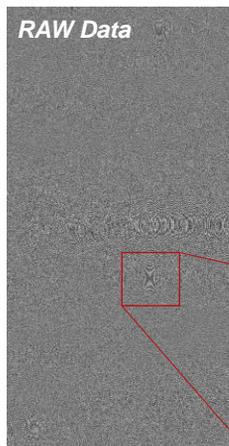


SAR-specific data formats

- Data formats are classified according to their Geometry and the data content:



What is received by the Sensor?



- RAW data is what has been received by the sensor
- Each line is an echo of the radar signal, that has been scattered back to the sensor by targets along the along track position
- Each pixel is a complex value (that consists of a real part and an imaginary part)

Fig. 1: This is Flevoland, a part of the Netherlands from ERS-1.

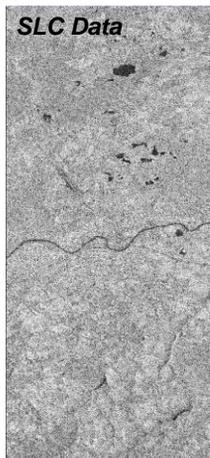


SAR processing

In the raw data, the signal energy from a point target is spread in range and azimuth, and the purpose of SAR focussing is to collect this dispersed energy into a single pixel in the output image (Single Look Complex, or SLC image).



SAR-specific data formats

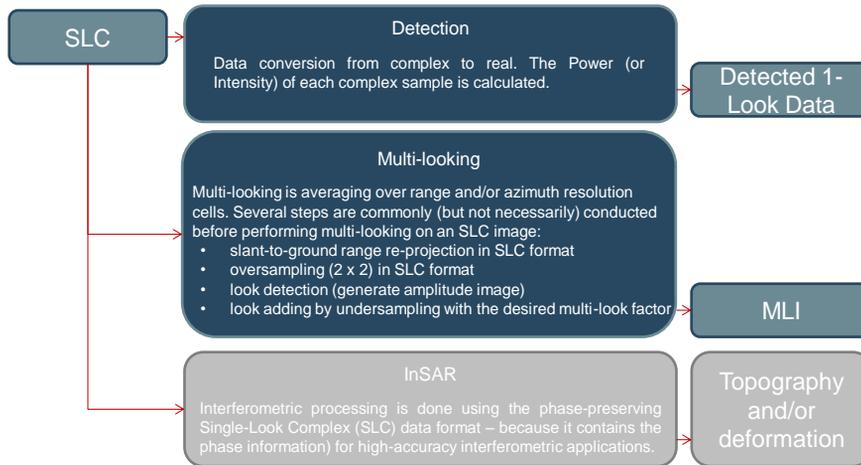


- Single Look Complex (SLC) is the basic single look product of the focused radar signal
- It contains the highest azimuth spatial resolution, but maximum speckle
- Each pixel is a complex number (with a real and an imaginary part)
- SLC images look extremely elongated because of rectangular resolution cell on the ground (range resolution is not constant)
- SLC data remain in slant range coordinates, they are commonly not projected onto any reference surface
- SLCs are intended for use in SAR quality assessment, calibration, and applications requiring the phase

*TSX data are delivered as **Single Look Slant Range Complex (SSC)** products, which are equivalent to the common SLC products available from other SAR satellites, like ERS-1/2, ENVISAT ASAR, RADARSAT-1 and X-SAR/SIR-C.*



SAR processing



SAR processing

Multi-looking

Goal: Speckle reduction and obtaining approximately squared pixels (in ground range resolution).

Recommendation: In order to avoid over- or under-sampling effects in the geocoded image, it is recommended to generate a multi-looked image corresponding to approximately the same spatial resolution foreseen for the geocoded image product.





SAR processing

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How to select an appropriate number of looks?

The number of looks is a function of:

- pixel spacing in azimuth
- pixel spacing in slant range
- look angle at scene center

ground range resolution = pixel spacing range / $\sin(\text{look angle})$

An Example (ERS-1/2 SAR data):

= 3.99 m

= 7.90 m

= 23°

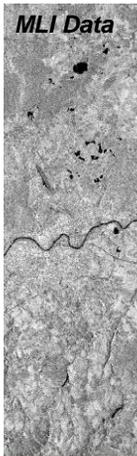
ground resolution = $7.90 / \sin(23^\circ) = 20.21\text{m}$

-> resulting pixel spacing azimuth: $3.99 \times 5 = 19.95\text{m}$

-> recommended pixel size of geocoded image 20 m



SAR-specific data formats



MLI Data

MLI – Multi-look Intensity

- Produced with commonly between 2 and 6 looks
- Multi-looking is done to find a good trade off between spatial resolution and radiometric variation due to speckle
- Multi-looking is an incoherent procedure
- Each pixel is a real (digital) number that represents the average amplitude of the signal within the pixel
- Commonly in ground range (e.g. TerraSAR-X **MGD - Multi-Look Ground Range Detected Format**)
- Reference surface for ground-projection used to produce MLI (no full geocoding though!), but range resolution is constant

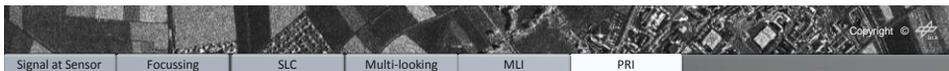




SAR-specific data formats

Satellite/ Mode	RAW	SLC	MLI	PRI	GEO	ORTHO
TerraSAR-X		SSC		MGD	GEC	EEC
JERS-1	JERS_1_RAW level 0	JERS_1_SLC level 1				
ALOS PALSAR	FBS, FBD, PLR level 1.0	FBS, FBD, PLR level 1.1		FBS, FBD, PLR level 1.5		
ENVISAT ASAR		ASA_APS_1P		ASA_APP_1P		
COSMO-SkyMed		SCS (Single Look Complex slant range)	DGM (Multi-look ground range)		GEC (Geocoded Ellipsoid Corrected)	GTC (Geocoded and Terrain Corrected using a DEM)
RADARSAT-1		SLC level 1		SGF level 1		
RADARSAT-2						

For the current radar satellites the generic radar products are very similar in their characteristics, but have different names and acronyms.



Metadata

- Metadata include all important image and image acquisition parameter
- Metadata are stored in text format, e.g. xml format
- SAR image files always come with a metadata file
- Some examples of important information contained in a metadata file:
 - sensor (e.g. TerraSAR-X, PALSAR HH, ...)
 - acquisition date
 - range samples
 - azimuth lines
 - range looks
 - azimuth looks
 - image format (e.g. FCOMPLEX)
 - image geometry (e.g. slant range, ...)
 - range pixel spacing
 - azimuth pixel spacing
 - radar frequency
 - doppler polynomial
 - ...

