SWOT

The Surface Water and Ocean Topography Mission (SWOT): results of a multi-month assimilation for discharge estimation of the Ohio River using high-resolution simulated SWOT data

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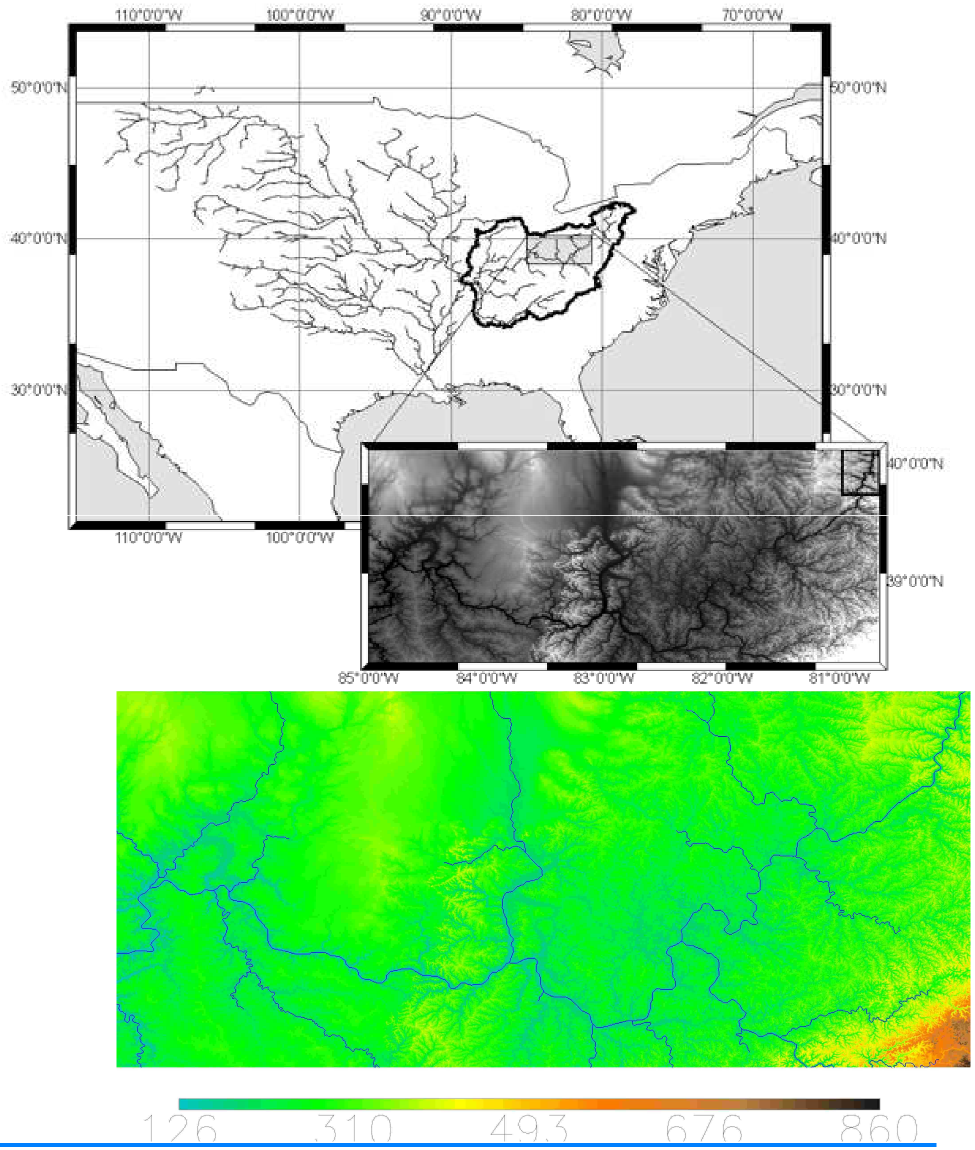
SWOT

Study Area

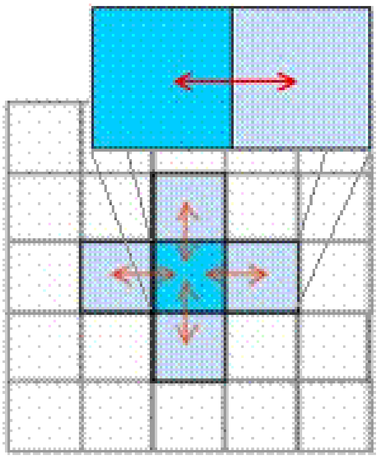
- ~1000 km reach of the Ohio River basin
- Drains an area of ~220,000
- Topography from National Elevation Dataset (30 m)
- River vector maps from HydroSHEDS
- Channel width and depth fro developed power-law relationships
- Explicitly modeled rivers with mean widths at least 50 m

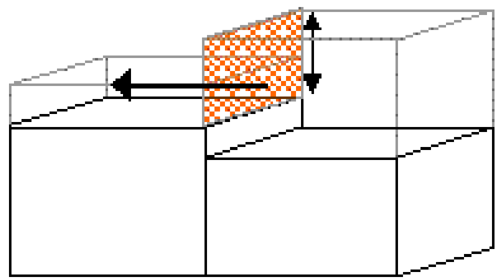


SWOT Hydrodynamic Modeling

- LISFLOOD-FP raster-based model
- 1-D solver for channel flow
- 2-D flood spreading model for floodplain flow
- Kinematic, Diffusive and Inertial formulations
- Requires information on topography, channel characteristics and boundary inflows
- Needed to coarsen spatial resolution to 100 m

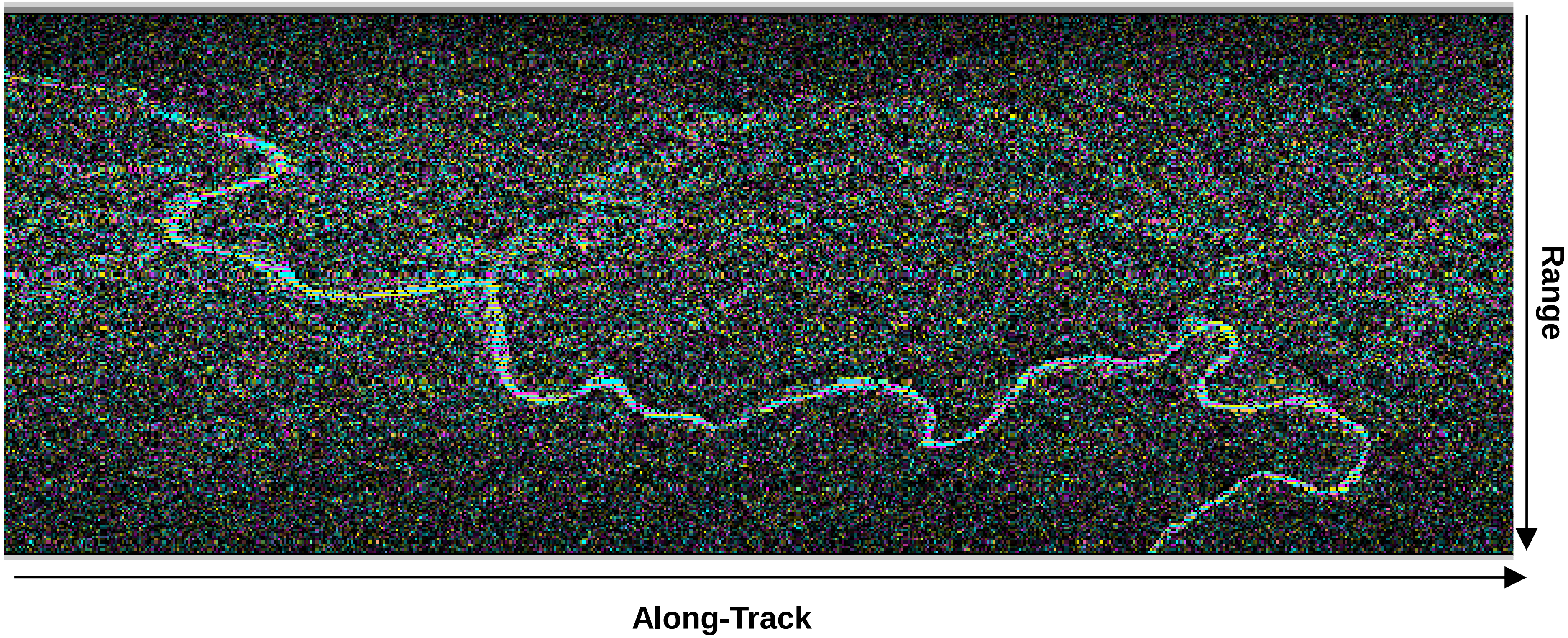
- Simulation period of 1 month
- Boundary inflows from USGS gauge measurements





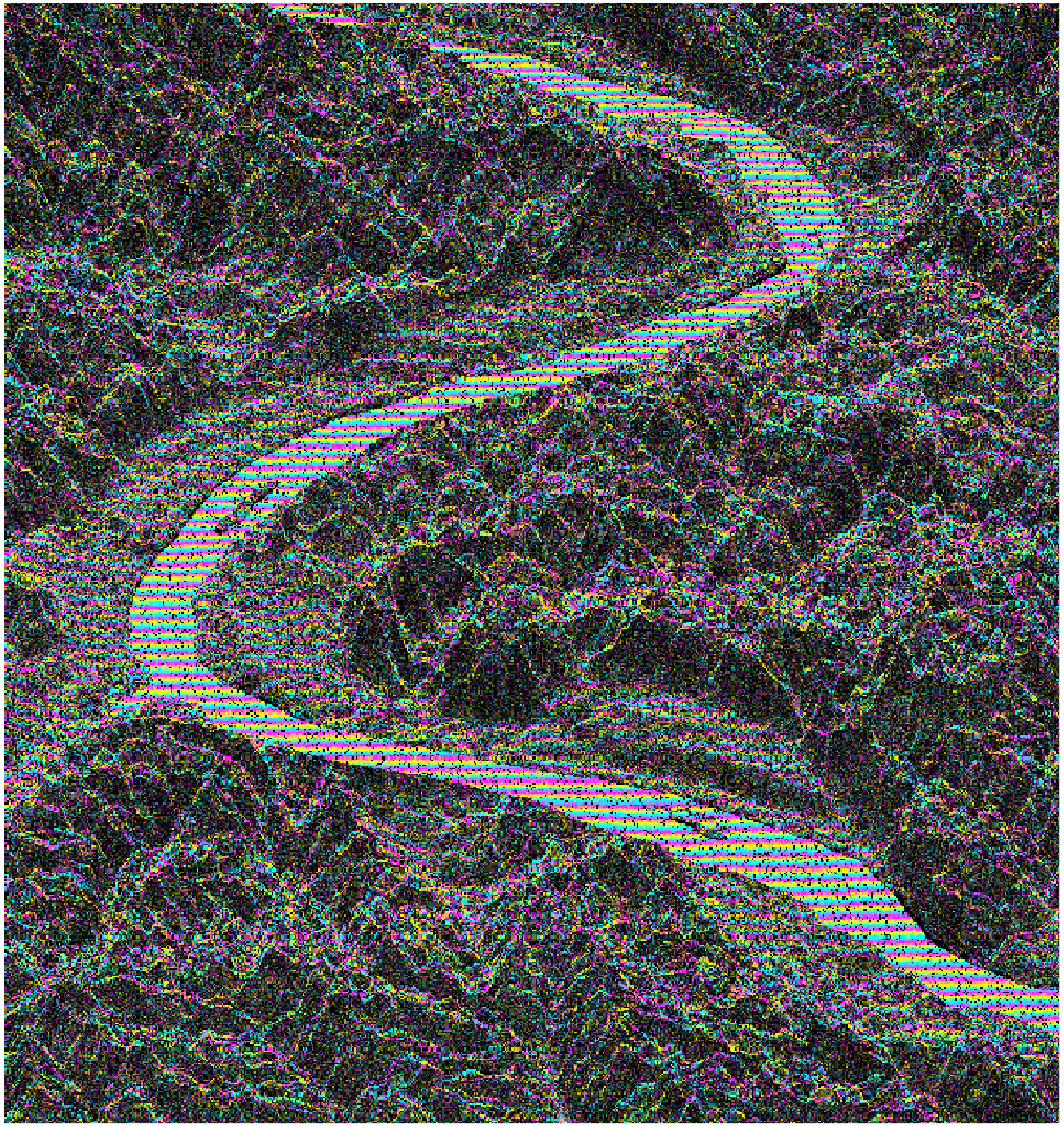
SWOT

Data from the SWOT Land Simulator



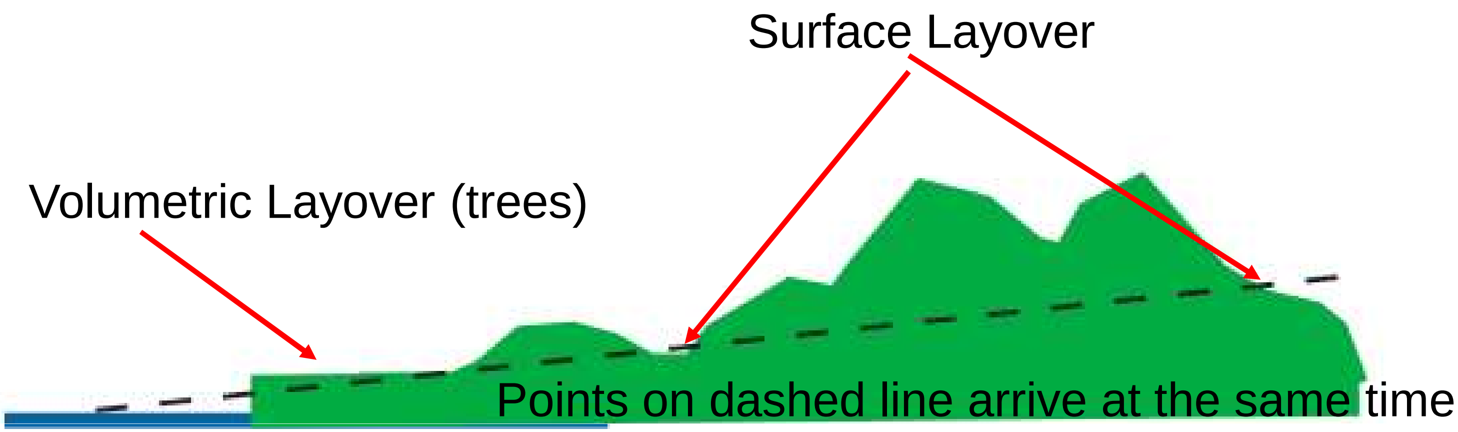
The SWOT simulator produces data with the correct signal to noise ratio, layover and geometric decorrelation scattering properties. Notice for SWOT the land SNR is low, while surface water stands out.

Challenges for near-nadir interferometry over land



- Topographic layover and low land SNR makes conventional phase unwrapping approaches unfeasible
- Notice that fringes are well defined over the water, since the water is flat and quite bright at nadir incidence.
- The signal from topography may contaminate the signal over the water (see next slide)

Radar Layover and its Effect on Interferometry



Correlation Ratio (land less correlated than water)

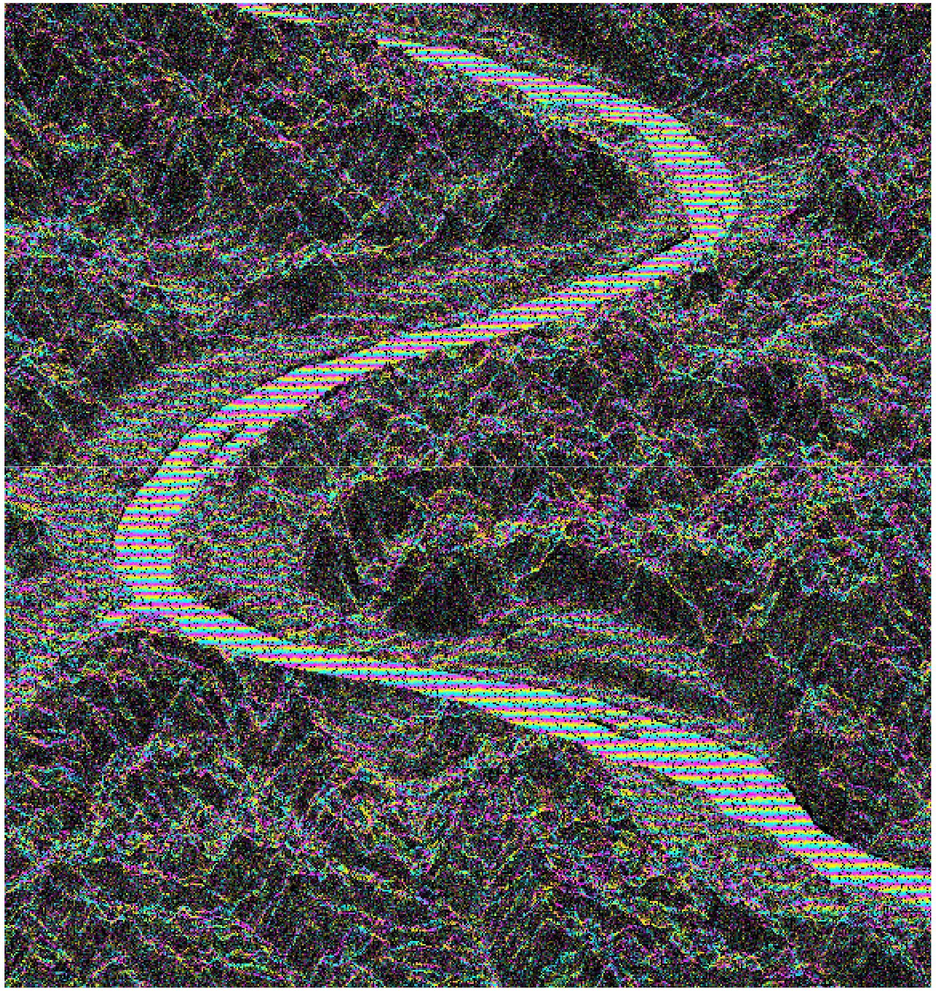
$$\delta\Phi = \arg\left[1 + \frac{P_{Land}}{P_{Water}} \frac{\gamma_{Land}}{\gamma_{Water}} \exp\left[i\left(\Phi_{Land} - \Phi_{Water}\right)\right]\right]$$

Brightness Ratio (land darker than water)

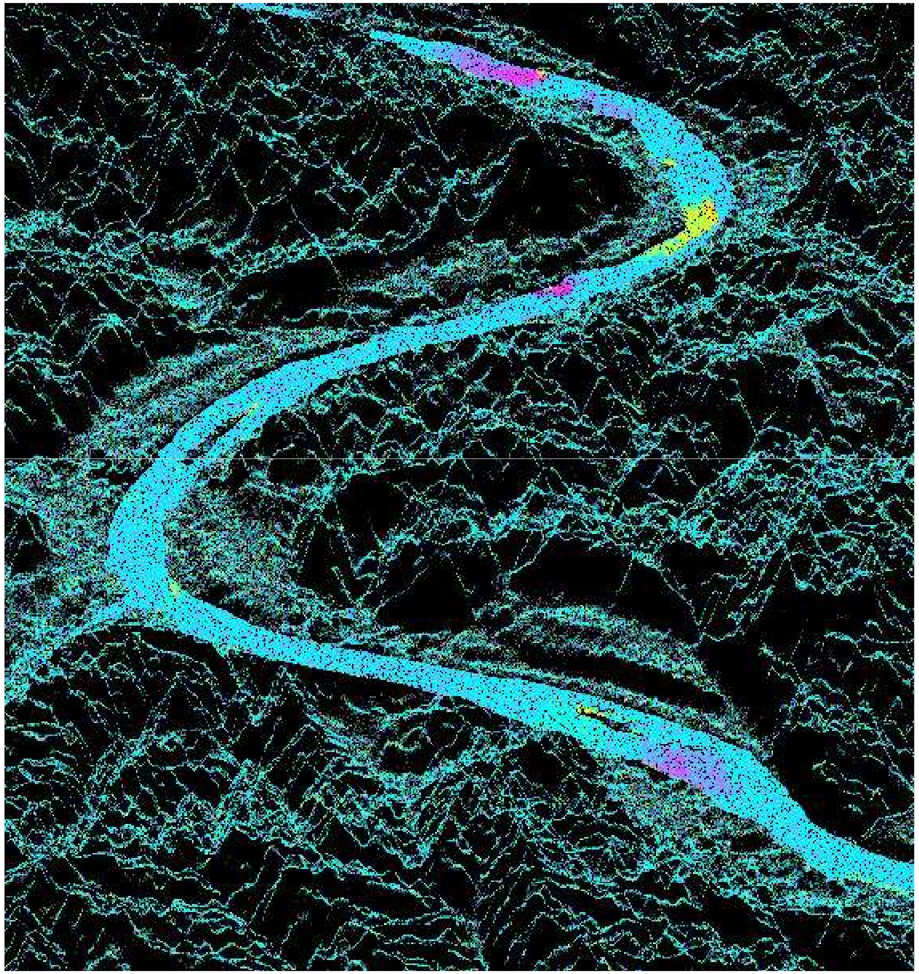
- Processing approach relies on having a fair estimate of topography and water body elevation
  - Estimate can be derived from a priori data or previous SWOT passes (to account for dynamics)
- *A priori* information is used to generate reference interferograms for phase flattening and estimation of layover (to avoid averaging in land)

Interferogram after phase flattening with reference interferogram

Noisy interferogram



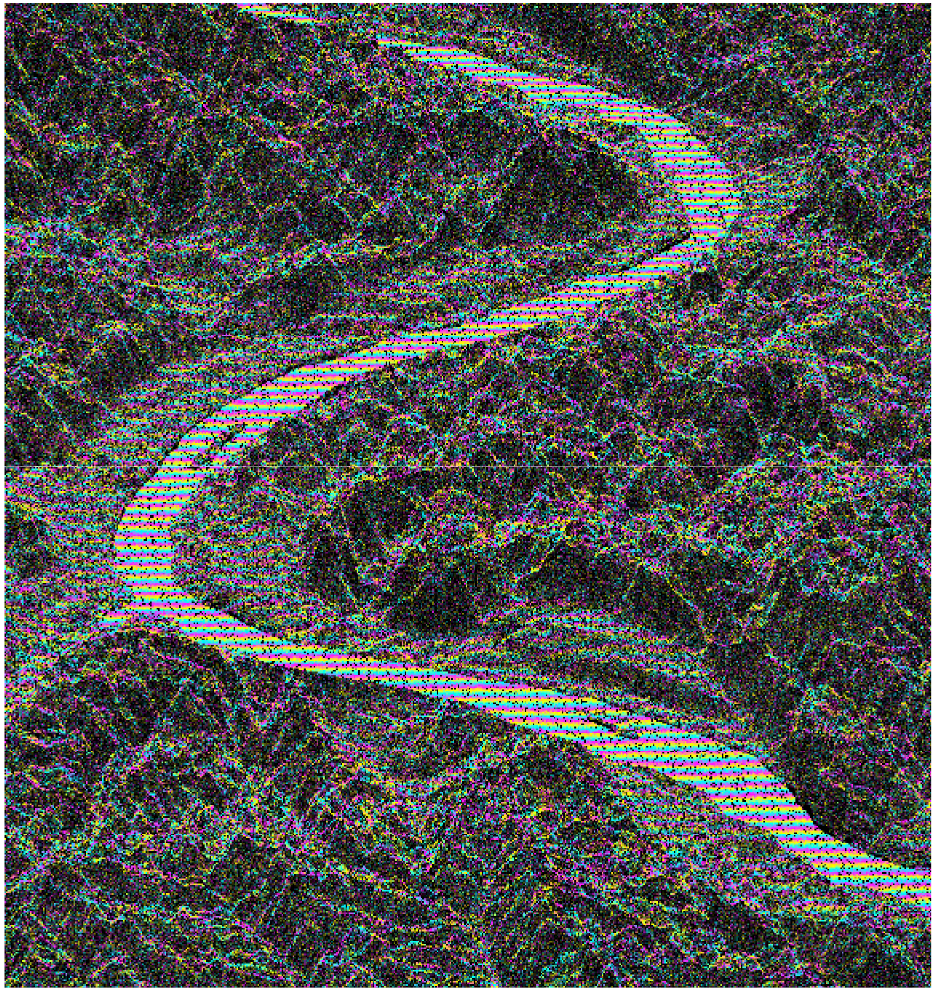
Noisy interferogram after flattening with reference



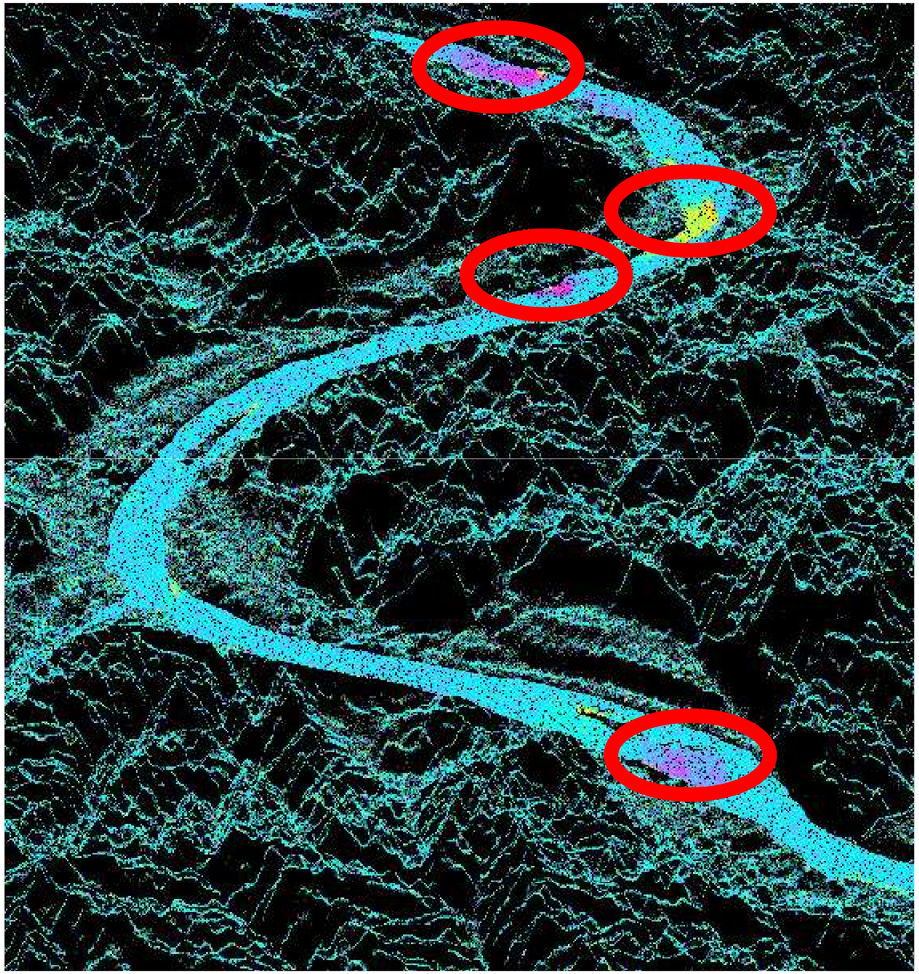
SWOT

Layover region identification

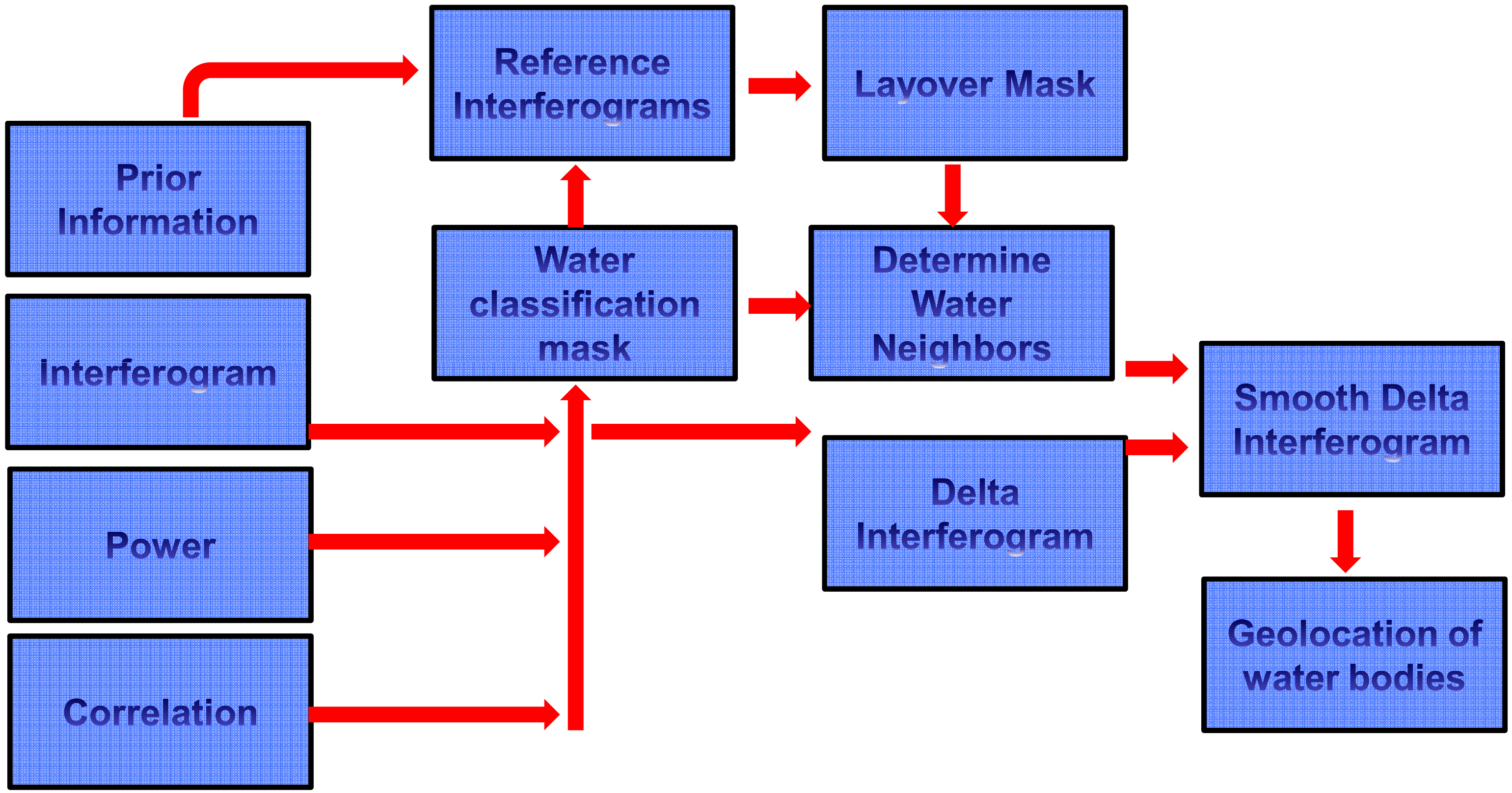
Noisy interferogram



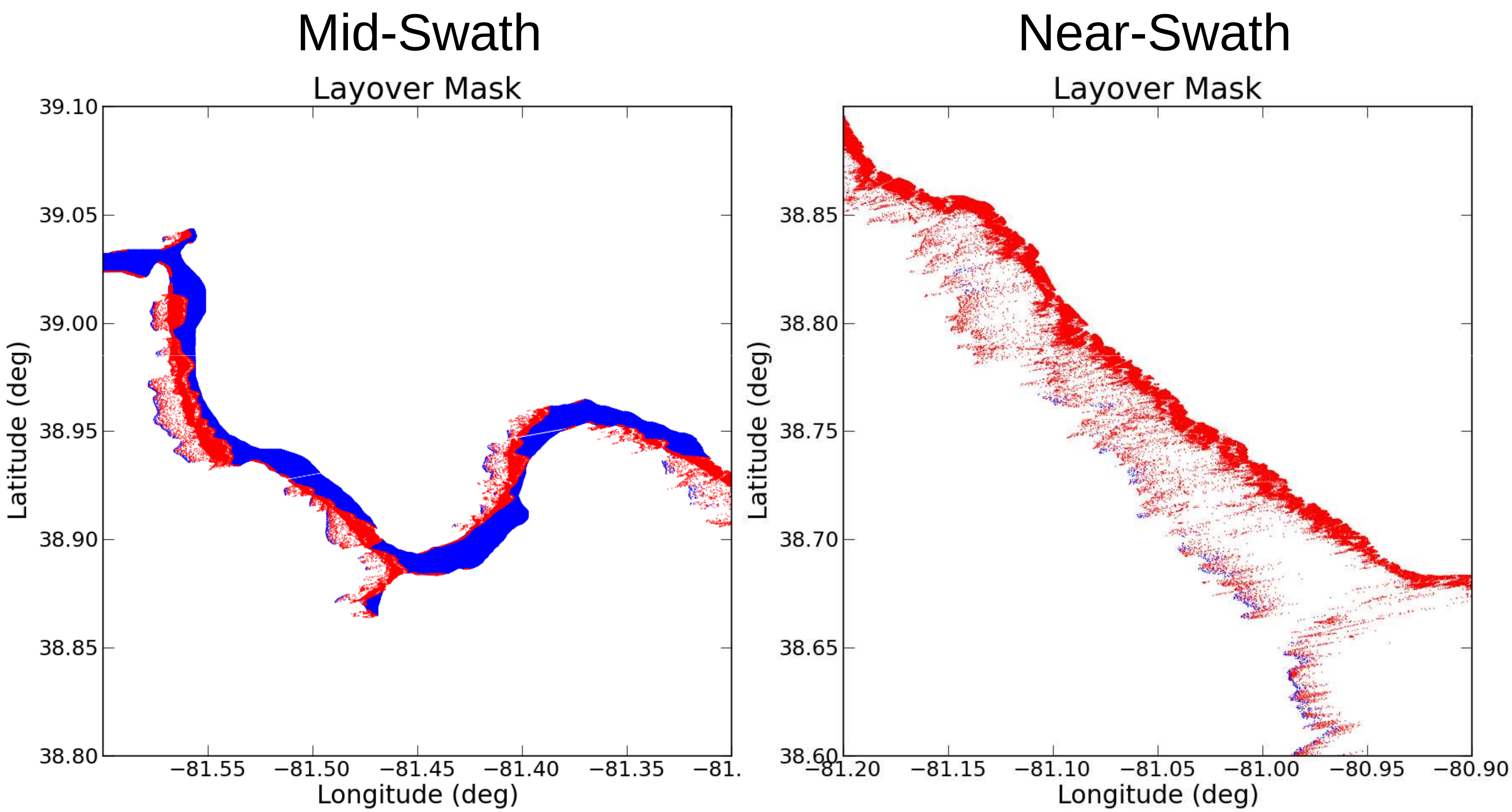
Noisy interferogram after flattening with reference



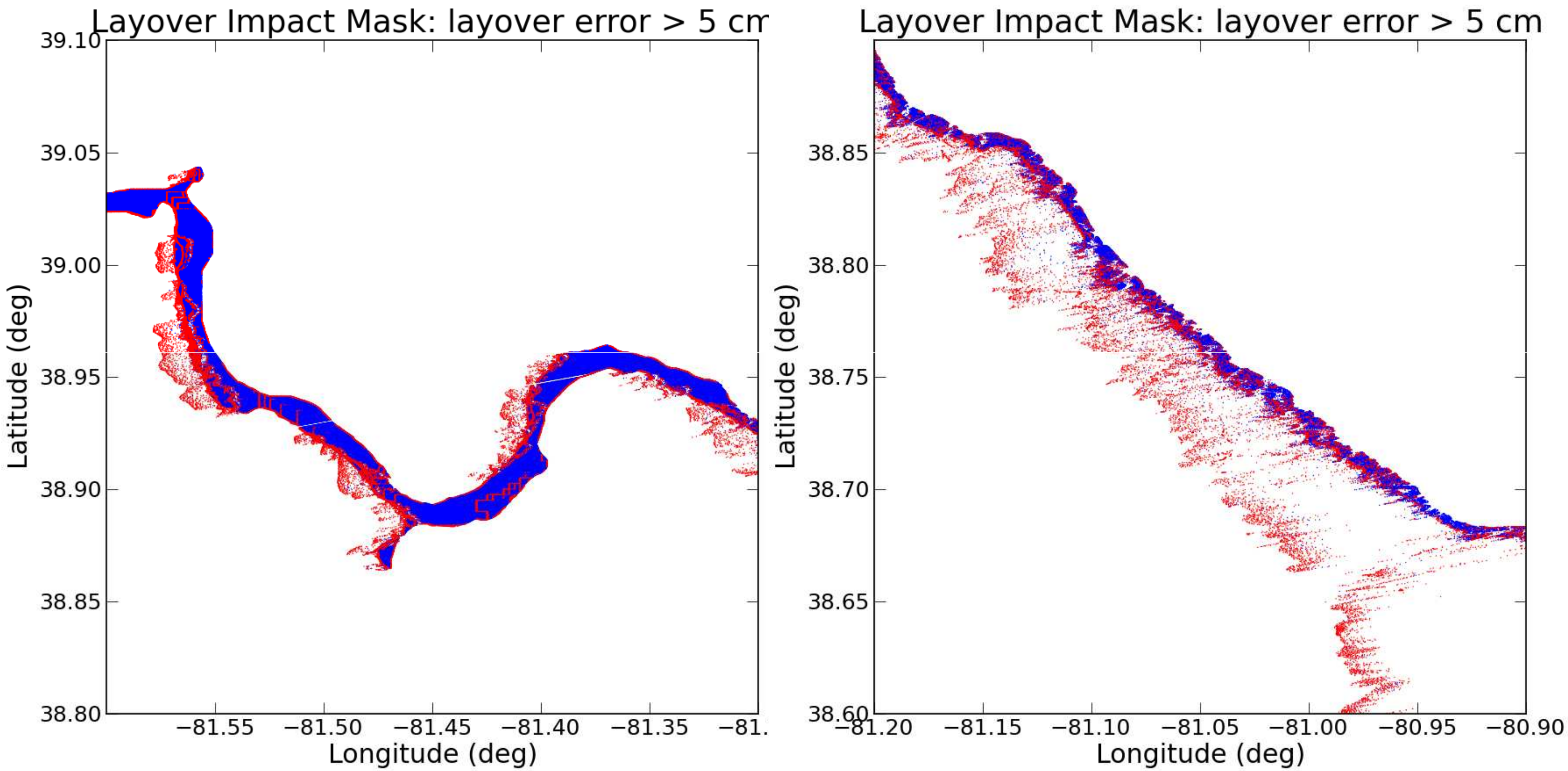
SWOT Land Processing Flow to Geolocation



Layover mask
All pixels with *any* layover are red



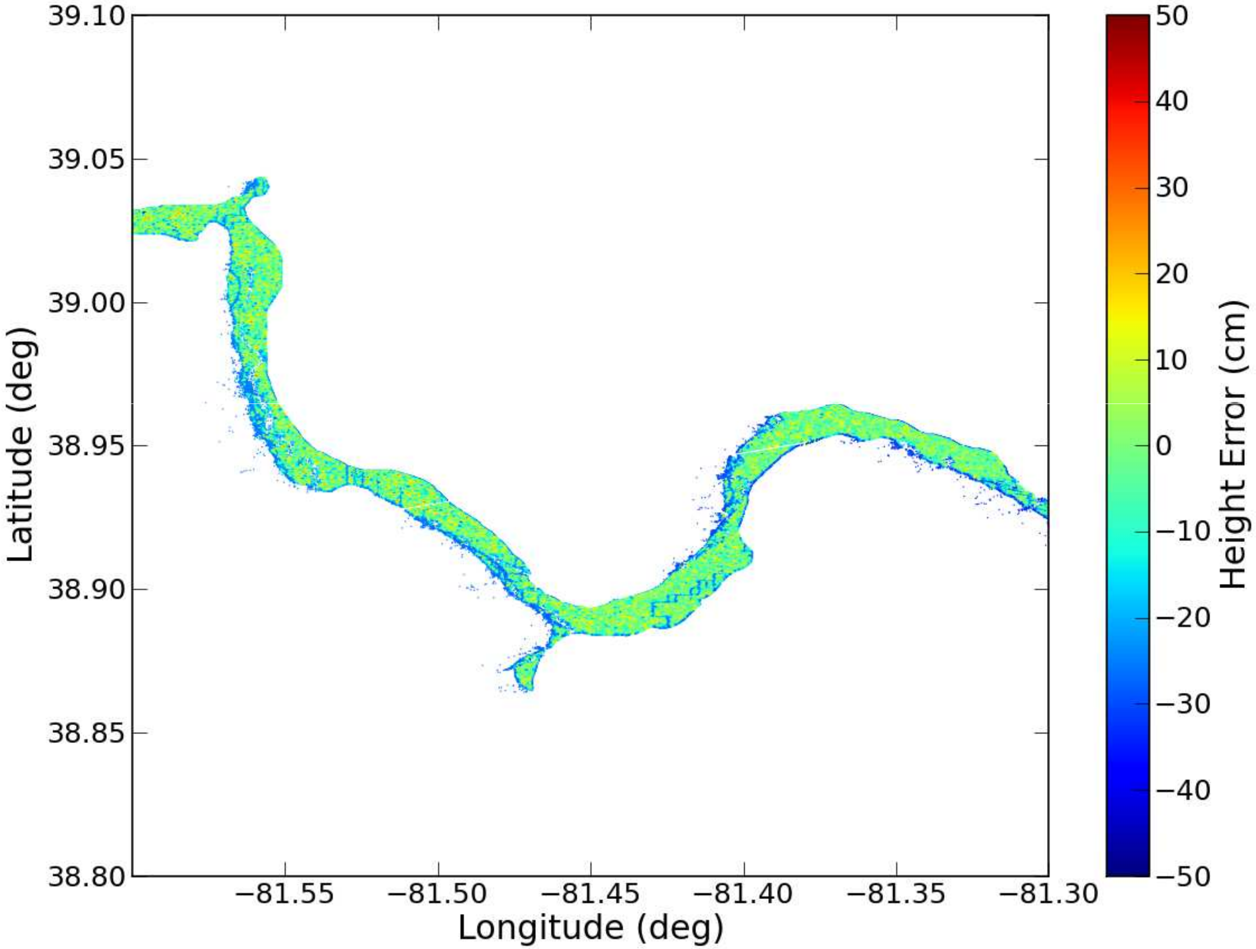
What if we accept pixels whose expected error is < 5 cm?



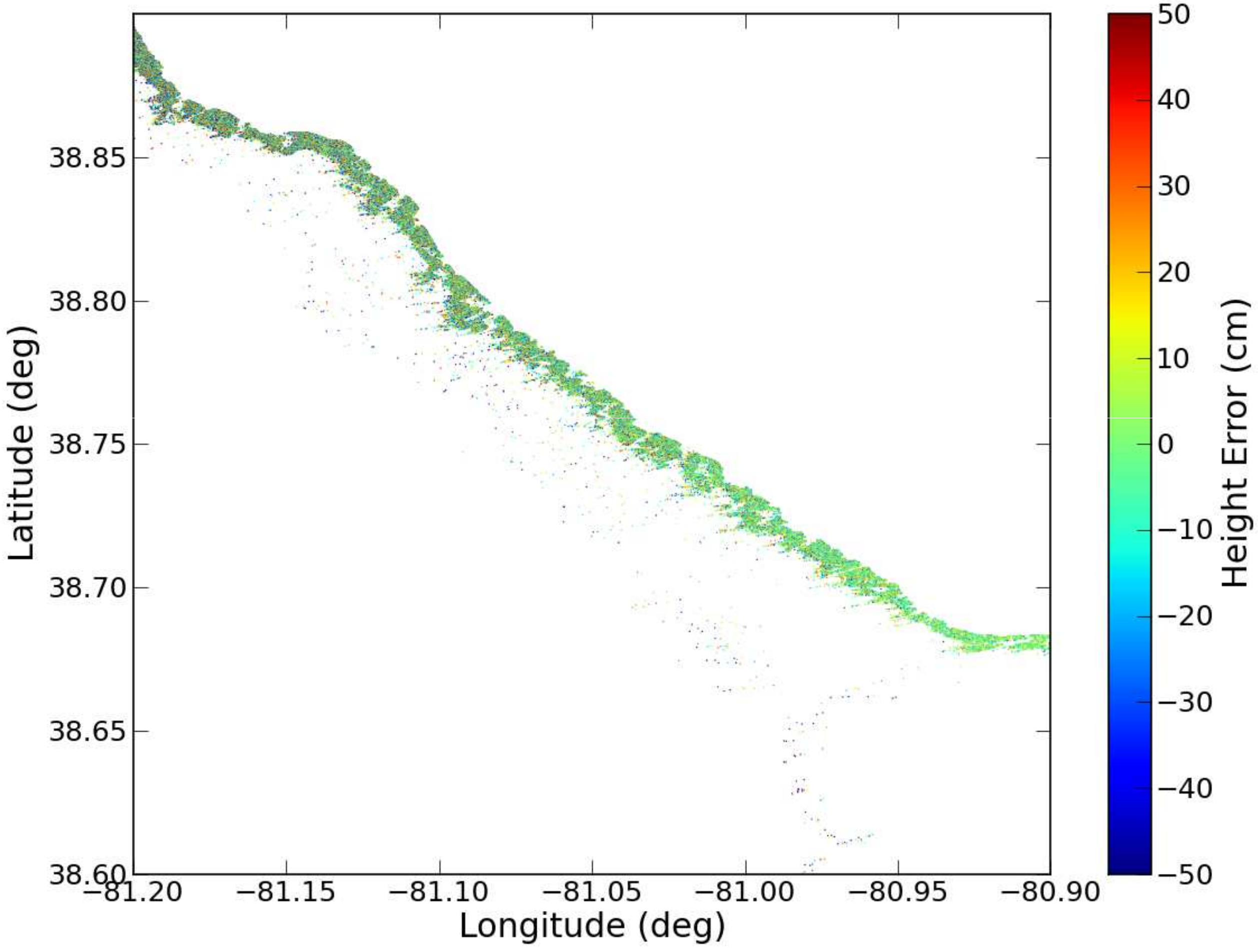
Layover mitigation approach

- Identify layover sites with high error impact and remove them from processing
- For each point, select a small neighborhood of nearby points
- Iteratively smooth phase until desired variance is achieved
- Geolocate smoothed data
- Perform further smoothing on the geolocated points

Estimated Height Examples
Mid-Swath



Estimated Heights Near Swath



Ongoing Work

- Improvements in smoothing and layover exclusion
- Basin scale simulation of SWOT over the Ohio River basin for many SWOT passes
- Assimilation of data into EKF to investigate impact of SWOT precision and sampling on discharge measurements