InSAR with Multiple Baselines—Comparison of Height Retrieval and Phase Unwrapping Techniques

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This study investigates both interferometric SAR (InSAR) post processing height retrieval techniques as well as phase unwrapping techniques when we use three satellites (and hence three baselines). Potential advantages of this configuration are explored and compared with the original 2-satellite method. For height retrieval, 3 methods were compared. The first approach is data averaging—3 interferograms retrieved per look are grouped into pairs, with the 2 best selected to be averaged to produce a better estimate of the digital elevation map (DEM). The second approach is the unambiguous range magnification (URM) method, which expands the unambiguous wrapped phase range by taking advantage of the observation that phases for different satellites wrap at different rates because of different distances and geometries relative to the same terrain pixel. Thus, the wrapped phase range is increased multiple fold from 2π without doing any phase unwrapping. This eases the reliance on phase unwrapping when performing height retrieval. The third approach is the maximum likelihood estimator (MLE), which uses URM to predict the closest phase estimate which best fits most of the data sets available.

It is shown that for multiple flyover looks, the data-averaging method is an efficient and computationally inexpensive method to obtain improved retrieved heights. The MLE technique is asymptotically favorable over the data averaging method, which may or may not be the case in a real situation. The URM method performs the worst among the 3, since it relies on the shortest baseline for unwrapping—unfortunately, the shortest baseline is most susceptible to noise.

For 3D phase unwrapping, we introduce the 3D Projection method, which uses the geometry of the satellite configuration to create constraints for the values of the phase differences. Noise, which moves phase points away from the "line segments" which define such constraints, can be filtered out if we manually adjust the phases such that they once again obey the constraints. The results show that this method works better than if such a processing step was not taken.