Use Sarscape for Data Processing to Obtain Deformation

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Abstract

This paper describes the technical principles of DInSAR and uses ENVI's SARscape plug-in for data processing to obtain variables.

Keywords

DInSAR; technical principle; SARscape; deformation.

1. DInSAR Deformation Measurement Principle

Differential interferometry is developed on the basis of interferometric measurements. Firstly, the interference information of the two phases of the same region across the deformation period and the phase information of the image is generated to generate the interference phase map which mainly contains terrain and deformation information. Then, by using the data of the same region or more of the image data, the terrain phase is removed from the interference phase to obtain the surface deformation phase. Finally, the deformation phase is used to invert the ground deformation. This section focuses on the basic principles of repetitive orbits applied to surface deformation measurements. Repeat the orbit measurement requires only one antenna, requiring the satellite to have a relatively stable track and accurate orbital parameters, the scanning direction and the direction of the satellite flight perpendicular to each other.

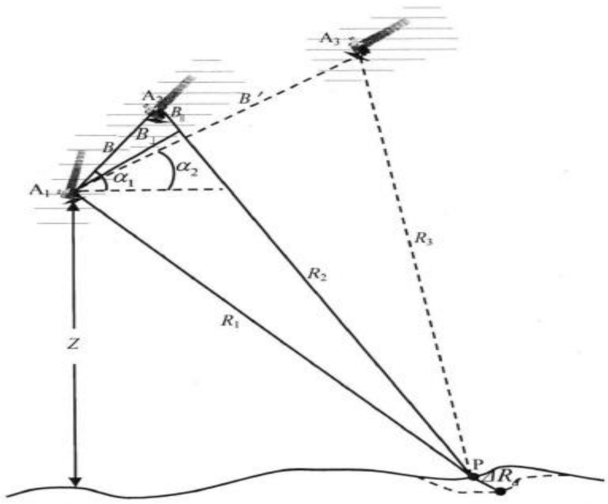

Figure 1. Differential interference measurement imaging geometry

As shown in Fig.1, A1 and A2 are the positions where the satellites are imaged twice in the same area.The first SAR image is obtained before the surface deformation,and the signal at this point is:

$$s_1(R_1) = |s_1(R_1)| \exp(-\frac{4\pi}{\lambda} R_1) \quad (1)$$

In the case of deformation after the surface to obtain the second sub-SAR images, under normal circumstances can be considered surface deformation and radar resolution unit is very small, so the radar signal can still be considered very relevant, then the signal returned by the P.

$$s_2(R_2) = |s_2(R_2)| \exp[-\frac{4\pi}{\lambda}(R_2 + \Delta R_d)] \tag{2}$$

After the two images are subjected to complex conjugate multiplication, the complex interference pattern can be obtained, in which the interference phase is:

$$\phi_1 \approx -\frac{4\pi}{\lambda} B_1 - \frac{4\pi}{\lambda}\Delta R_d = -\frac{4\pi}{\lambda} B\sin(\theta_1 - \alpha_1) - \frac{4\pi}{\lambda}\Delta R_d \tag{3}$$

Where the second part of the above equation is the phase change caused by the line of sight. It can be seen that the interference map formed by the two images across the deformation period contains both the terrain information of the coverage area and the deformation information of the surface during the observation period.

The phase contribution of InSAR interferometry, in addition to the terrain phase and deformation phase in the above equation, also includes the phase caused by the ground effect earth curvature mentioned above, as well as the sensor track error, atmospheric effect, noise information caused by space-time loss , The formula can be expressed as:

$$\phi = \phi_{def} + \phi_{topo} + \phi_{flat} + \phi_{orbit} + \phi_{atmos} + \phi_{noise} \tag{4}$$

To obtain surface deformation information, we must eliminate the impact of other phase information, DInSAR basic task is to extract the deformation phase information from the interference map. The ground effect can be formed by the rigorous geometric relationship between the satellite orbit and the ellipsoid of the earth. The orbit error can be reduced by using the precision orbit data, or corrected by the ground control point, the atmospheric effect and the noise information. Caused by the measurement error, the law is not obvious, there is no perfect solution. To eliminate terrain phase information, there are usually four ways:

1. Select the two SAR images of the 0 baseline to form an interferogram. This method does not need to consider the influence of the terrain, and the deformation information of the line of sight can be obtained by using the above equation directly. But the current 0 baseline interference image pairs rarely, the method is difficult to achieve;

2. The use of three SAR images, the use of interference methods to eliminate the impact of terrain, this method known as three or three differential differential interferometry, is the standard differential interferometry;

3. Using external DEM data, based on existing imaging parameters to simulate the interference map, in order to eliminate the impact of terrain factors, the so-called two-way or two-rail differential interferometry. This method has the advantage of being economically available in the data source relative to the current situation. The existing research shows that the interference measurement results obtained by the two methods are basically the same as the interference of the three methods.

4. The use of four SAR images, the use of deformation before and after the interference of the two methods to eliminate terrain effects, access to deformation, the method known as four-way differential interferometry, the accuracy of this method is more reliable, but suitable for interference data selection more difficult.And it is not reasonable.

After removing these phase effects, the relationship between the surface transformation interference phase and the radar line of sight and surface deformation can be obtained:

$$\phi_{def} = \phi'_{def} + 2N\pi = \frac{4\pi}{\lambda}\Delta R_d \cdots\cdots (N = 0, \pm1, \pm2, \pm3\cdots\cdots) \tag{5}$$

The phase difference after DInSAR processing is entangled, the existence of ambiguity, the need for phase unwrapping processing, the phase after the unwinding can be calculated according to the above formula to the line of sight to the variable.

2. SARscape for Data Processing

2.1 Dinsar Technical Process

In the phase transition to the step of deformation, the phase is converted to deformation and geocoded. The user can set a specific direction and inclination according to the direction in which the deformation occurs, and a known deformation area may be input.

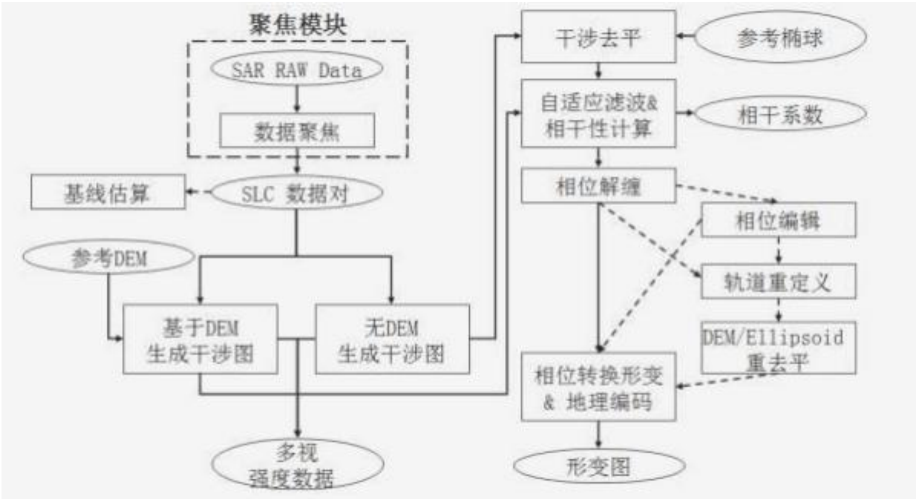

Figure 2. DInSAR technical process

2.2 Operation Steps

Step 1: Baseline Estimation

This step obtains the baseline information of the interferometric SAR image pair, and whether the baseline of the interference image pair is less than the critical value and whether or not a good interference result can be obtained. The result of this step is displayed on the baseline estimation panel for direct viewing.

SARscape - interferometry - Baseline Estimation, open the baseline panel. (2) Click Master file and select the main image. (3) Click Slave file, select from Image. (4) Baseline file, cannot set. (5) Click Start and the results are displayed on the panel.

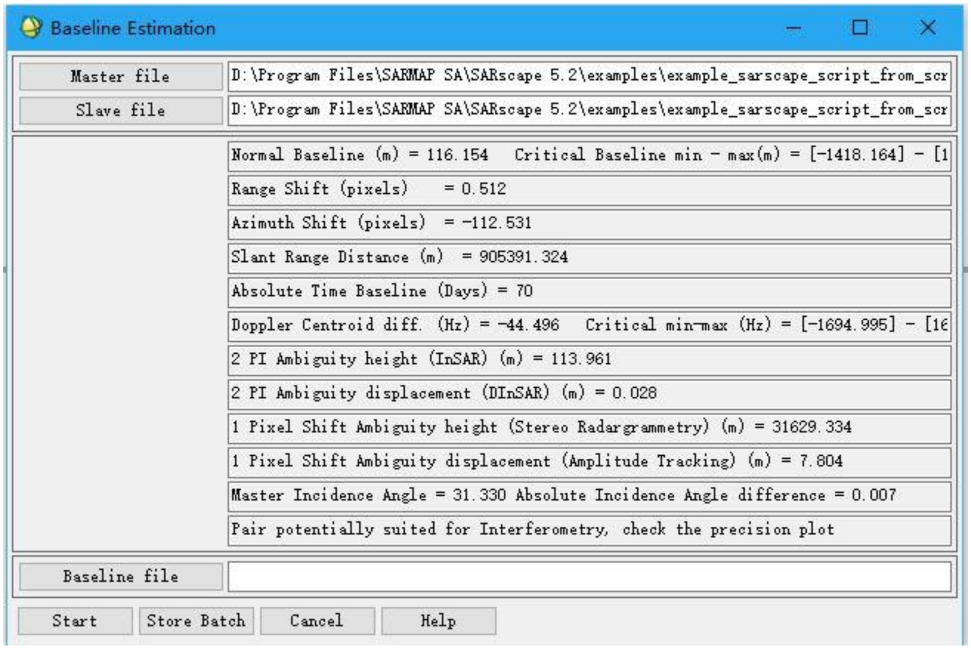

Figure 3. Baseline estimation

Step 2: Interferogram generation

This step is to generate the interference map, input two ALOS data, the output data is through the registration and multi-view of the two data residual phase diagram, and the master and slave image intensity map. For this data set, the distance from 1 to 5 for the multi-view, about 25 meters of ground resolution can be obtained.

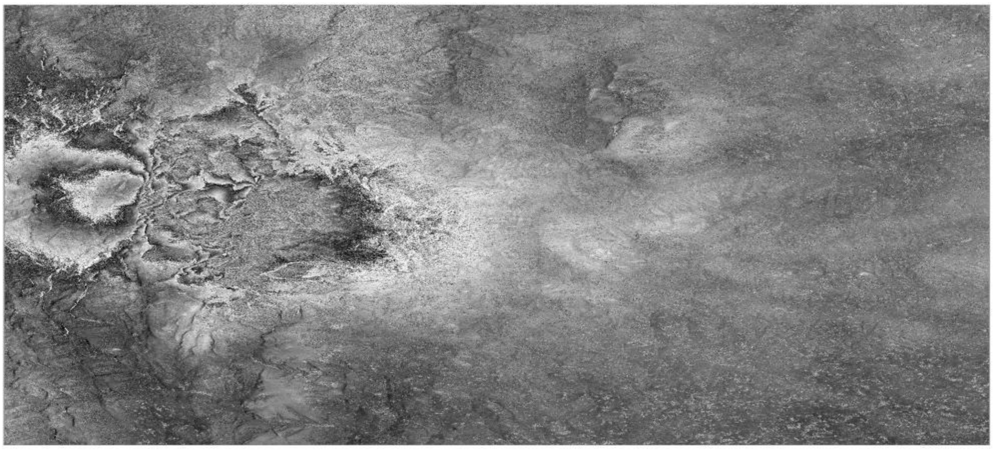

Figure 4. Generation of interferograms

Step 3: Adaptive filtering and coherence generation

Boxcar filtering is performed on the interferogram of the previous step, generating the filtered interferogram and the interference coherence graph describing the phase mass with a value between 0 and 1.

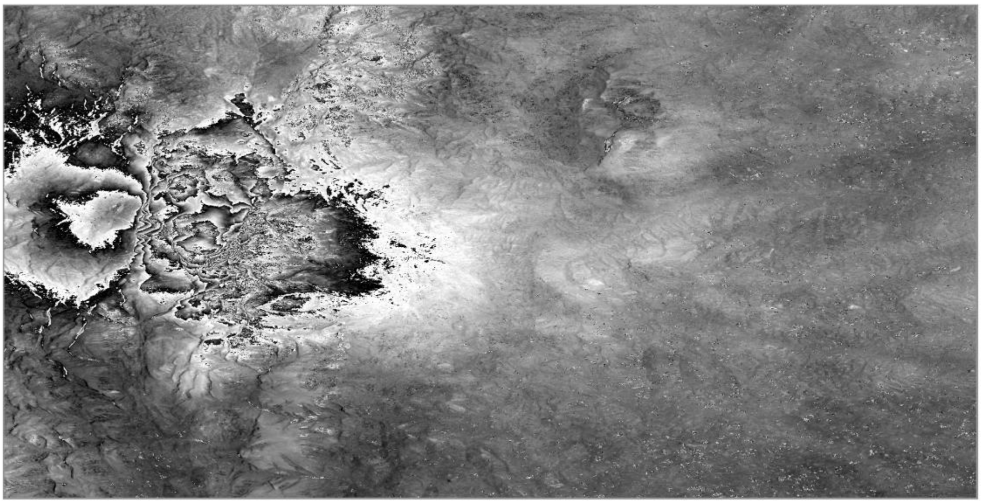

Figure 5. filtered interference map

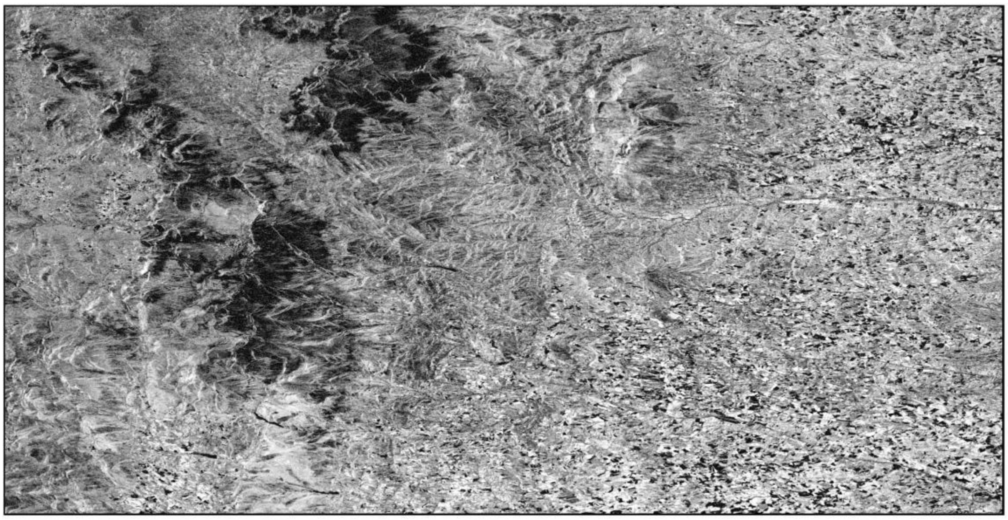

Figure 6. Coherence coefficient diagram

Step 4: Phase unwrapping

The phase difference is used to avoid the unwrapping error, which is usually set to 0.15-0.2 m to limit the phase mutation in the process of regional growth. In this case,

Figure 7. Reloaded phase diagram

Step 5: Track refinement and heavy flattening

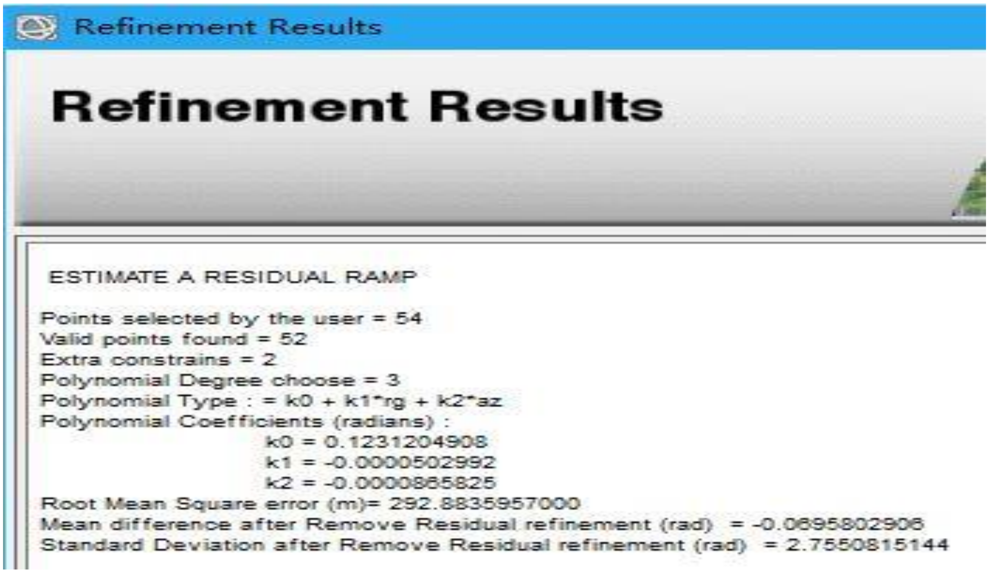

Figure 8. Track refining results output

Step 6: Deformation map generation

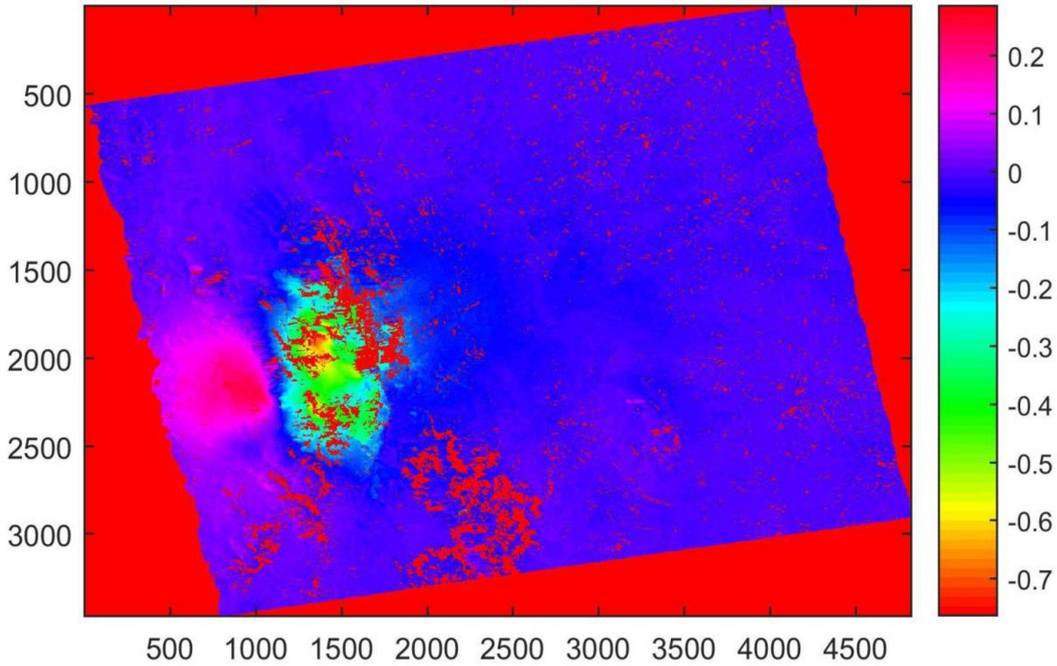

Figure 9. Deformation map

3. Concluding Remarks

This paper mainly describes the theory of DInSAR, based on the use of SARscape on the ALOS data processing, the initial grasp of ENVI-SARscape function of the use of time constraints on the late analysis has not done more in-depth study, in the next Of the study will also be in this direction to deepen understanding and application.

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