Text S1.

In order to test the method, an experiment with synthetic data sets was undertaken. We generated the 3D deformation over a 400 × 450 grid (as shown in Figure S1a–c). The LOS and AZI deformation measurements of multiple tracks were then generated using the parameters of ENVISAT ASAR datasets acquired over the Grove Mountains in the Antarctic and were used in the following 3D ice velocity measurements. For simplification, we used Gaussian noise as the InSAR observation noise and a zero-mean additive Gaussian noise with standard deviation (STD) of 10~20 mm and 70~150 mm was added into LOS and AZI, respectively, InSAR measurements from different baseline observations. The topographic residuals were also considered in the synthetic datasets: the DEM-induced errors of 0~100 meters were added into multibaseline and multiaperture InSAR measurements based on different baseline lengths.

The 3D deformations were estimated through baseline-combination and SM-VCE methods utilizing Equation (8). We also carried out the conventional WLS method to derive 3D deformations. An obvious difference could be observed between the results with the WLS method and our proposed method. In the vertical direction, the deformation signal was submerged due to the DEM-induced errors with the conventional WLS method (as shown in Figure S1(f)). Thanks to the induced baseline-combination method, the vertical deformation could be accurately estimated through our proposed method (as shown in Figure S1(i)). Furthermore, the DEM-induced errors also affected the horizontal results (as shown in Figure S1d,e). We found that there was overestimation and underestimation of deformation in both the east and north directions; especially in the north direction, the displacement along the north direction was submerged. As a result of the induced SM-VCE, the determination of the 3D deformation could overcome the observation noise by connecting adjacent points.

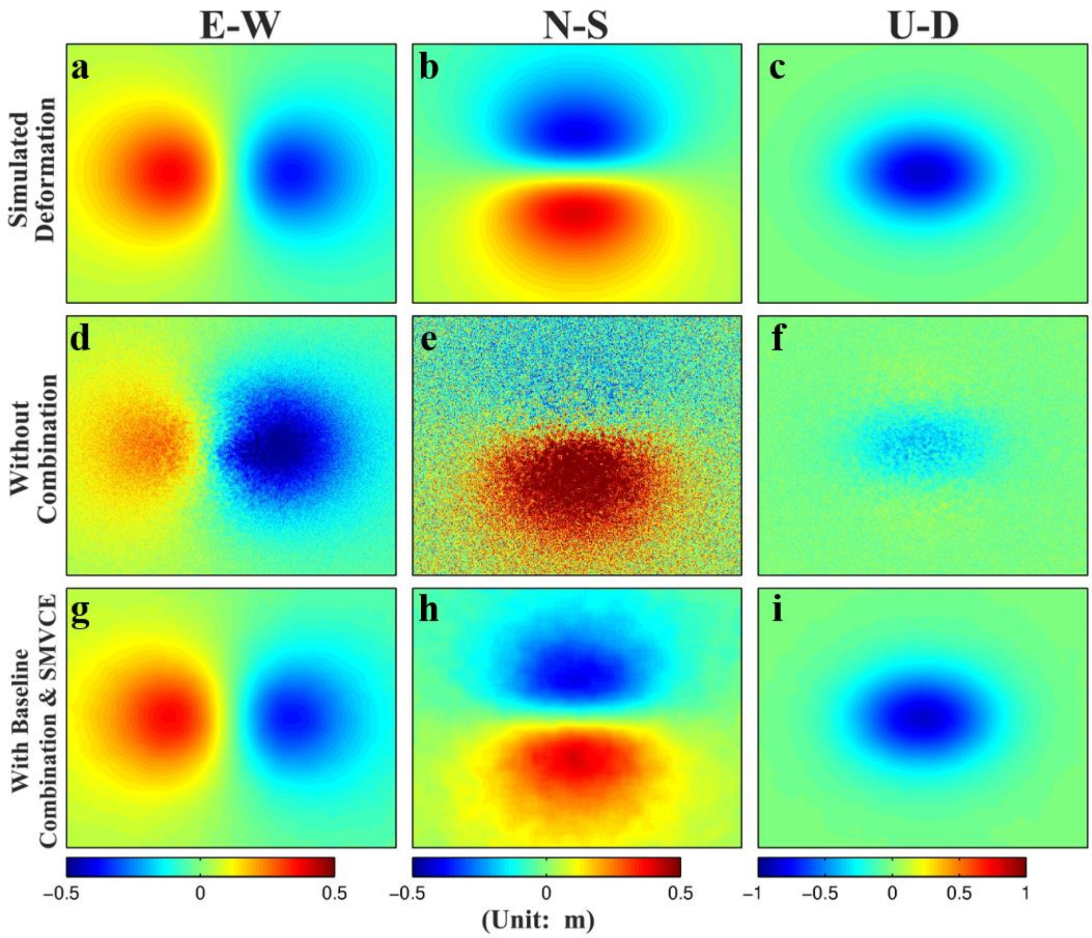

Figure S1. Simulated deformation (a)–(c), the results derived by conventional weighted least squares (WLS) (d)–(f), and the results derived the through baseline-combination method and SM-VCE method (g)–(i), along with results for the east (a, d, and g), north (b, e, and h), and vertical (c, f, and i) directions.

In order to quantitatively evaluate the performances of the methods, we calculated the root mean square errors (RMSEs) of the results of the simulated and the estimated 3D deformation listed in Table S1. Due to the effect of DEM-induced errors, the RMSEs of the conventional WLS method could reach 75.3, 199, and 139.4 mm along the east, north, and vertical directions, respectively. After carrying out the proposed method, the RMSEs of the 3D deformation were obviously improved, decreasing to less than 10 mm. Therefore, in order to estimate ice velocity accurately, we applied the proposed method in the Grove Mountains area of the Antarctic.

Table S1
RMSEs of the differences between the simulated and the estimated 3D deformation

Method	East (mm)	North (mm)	Vertical (mm)
WLS	75.3	199	139.4
Proposed	2.7	8.6	4.0