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Comparison of Doppler-Derived Sea Ice Radial Surface Velocity Measurement Methods From Sentinel-1A IW Data

The near-instantaneous radial velocity of a target can be obtained using the Doppler effect of SAR. In this article, based on Sentinel-1A IW data, three Doppler centroid estimation algorithms applied to ocean current retrieval are selected. Combined with the characteristics of the TOPS mode, made two applicability adjustments to each algorithm, and finally applied the three algorithms to sea ice radial surface velocity measurements. By analyzing and comparing the results of each algorithm, it is found that the results of the three algorithms are relatively consistent, among which the CDE algorithm has the advantages of high efficiency and high precision and is the most suitable method for sea ice drift measurement among the three methods. However, for SAR images with abnormal speckles caused by human activities, the SDE algorithm can effectively remove abnormal speckles and ensure the smoothness of the image with better adaptability

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Introduction

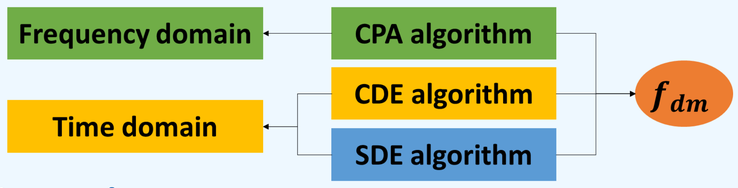
- Compared with the time-series algorithm that requires two images to match each other, Doppler centroid estimation algorithm can obtain the near-instantaneous radial surface velocity using a single SAR image, which makes up for the shortcomings of low SAR temporal resolution.
- There are few studies on sea ice drift measurements using the Doppler centroid estimation algorithm, and there are few studies based on Sentinel-1 data.
- The Doppler effect of SAR is widely used in ocean current retrieval. However, in sea ice drift velocity measurements, only a Doppler centroid estimation algorithm in frequency domain has been studied, so whether there is a better algorithm is worth exploring.

Work Process

- **Data Preprocessing**

  Before Doppler centroid estimation, data deramping and deburst processing are performed for the unique IW data imaging mode.

- **Measured Doppler Centroid Estimation**



- **Bias Correction**

$$f_{dm} = f_{phy} + f_{geom} + f_{bias}$$

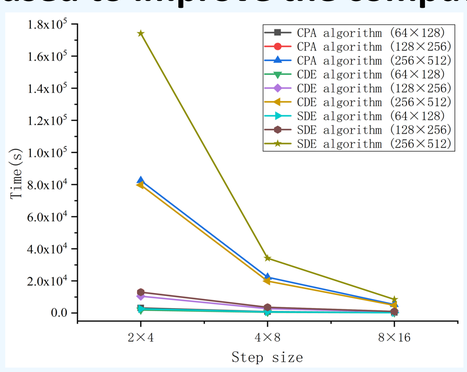
f_{phy}: reserve; f_{geom}, f_{bias}: remove

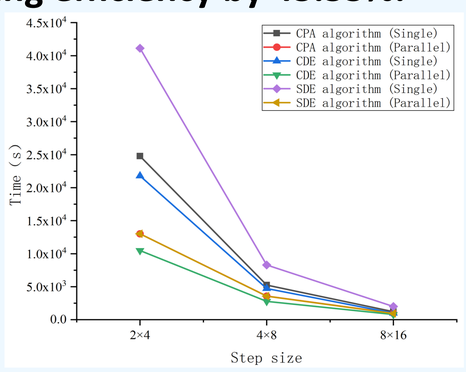
- **Radial Surface Velocity Calculation**

$$v_{rel} = \frac{\lambda f_{phy}}{2sin\theta}$$

Results and Analysis

- **Parameter selection.** The optimal parameter combination is 128×256 block size and 4×8 step size.
- **Parallel computing.** A block method for parallel computing is presented which is consistent with the results of the single machine calculation. A 4-core CPU is used to improve the computing efficiency by 43.55%.





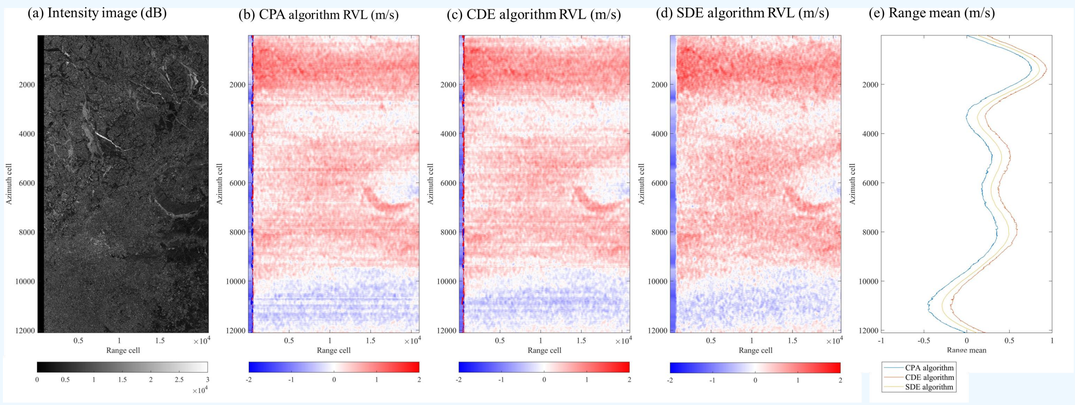
- **Bias correction deviation analysis.** The deviation of bias correction was verified using rainforest data and was approximately 3Hz,and the corresponding velocity at a 39° incident angle was 0.07-0.09 m/s.
- **Analysis of the radial surface velocity results.** Based on these three algorithms, this article carried out five sets of experiments, analyzed and compared the results of each algorithm, and provided optimal algorithm adaptation suggestions.

Conclusion

By analyzing and comparing the results of each algorithm in the five experiments, this article found that the results of the three algorithms are relatively close.

Among them, the CDE algorithm has the advantages of high computational efficiency and high precision, and is the best Doppler centroid estimation algorithm among the three.

However, for data with abnormal speckles in SAR images caused by human activities, the SDE algorithm can effectively remove abnormal speckles and directly obtain smooth Doppler centroid estimation images, which has better adaptability.



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