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Editorial: Advanced big SAR data analytics and applications

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Editorial on the Research Topic
Advanced big SAR data analytics and applications

As remote sensing and imaging geodesy technology, Synthetic Aperture Radar (SAR), which can be spaceborne or airborne, has shown unique Earth observation capacity in recent decades. Compared to optical remote sensing technology, SAR can work day and night without the need for visible light, and possesses the capacity to penetrate cloud, fog, and some ground cover (e.g., vegetation, ice, desert) to a certain degree. In particular, Interferometric SAR (InSAR) technology can be used to monitor subtle ground surface deformation over large areas with unprecedented resolution and accuracy, and has evolved into a routine method in the field of disaster and environmental monitoring.

The volume of SAR data is growing at ever-increasing rates thanks to the launch of numerous radar satellites that can image the Earth under high resolution, multi-polarized, and wide swath mode at short repeat cycles. Such big SAR data, on one hand, challenge the conventional processing routines and present opportunities for data-driven analysis technologies (e.g., machine learning); on the other hand, they enable the extraction of information at an ultra-fine or extremely large scale, allowing for innovative applications in the fields of seismology, geology, hydrology, and ecology.

This Research Topic aims to promote a deeper understanding of innovative algorithms and exciting applications based on big SAR data. Seven articles related to the processing, mining, analysing, and application of SAR data are contributed by 38 authors. We selected highlights from each paper as follows:

The paper by Zhang et al. presents a new method of adaptive fusion of multi-source tropospheric delay estimates derived from different models (including ERA5, GACOS, WRF, MERRA2, NARR, MODIS, Linear model, and Powerlaw model) for atmospheric propagation delay correction in InSAR deformation measurements. In the experiments over Los Angeles, the proposed method shows better performance than any single model for InSAR atmospheric propagation delay correction.

The article by Bao et al. investigates the surface deformation and source mechanism associated with the 2022 Mw 6.7 Menyuan earthquake in China by integrating the InSAR and teleseismic measurements. It is found that the ground settlement/uplift caused by the

earthquake can be up to half a meter, and the junction of the Lenglongling and Toulaishan faults is the seismogenic fault. Further analysis indicates that the 2022 Menyuan earthquake is related to the earthquakes that occurred on the Lenglongling Faults in 1986 and 2016.

In the article by Liu et al., a novel phase unwrapping (PU) algorithm for dual baseline InSAR is proposed based on the similarity between the ambiguity solving and pure integer programming problem. In the proposed method, graphical means and the axis symmetry theory are exploited to solve the ambiguity number and improve PU efficiency, respectively. Simulation and real data experiments both demonstrate that the proposed method outperforms the classical PU methods in accuracy.

The paper by Sun et al. proposes to monitor the surface deformation over the wind-water erosion crisscross region in the Loess Plateau, China by developing an improved small baseline subset (SBAS) InSAR algorithm. The classical linear and period models used in SBAS-InSAR is substituted by a new model which considers the internal and external factors of soil erosion. It is found that the new model has ideal performance and accuracy in estimating the surface deformation associated with soil erosion.

The article by Fadhillah et al. presents a study exploiting a machine learning algorithm, i.e., convolutional neural network (CNN), for detecting the surface deformation induced by volcanic activity based on the simulated InSAR unwrapped phase products. The experiments over the Hantangang River volcanic field in the Korean Peninsula shows a satisfactory accuracy of the detection (>80%). More important, this study provides a positive example of combining of InSAR data and machine learning method.

In the paper by Fu et al., a novel approach is proposed to detect slow-moving landslides by employing a deep-learning network based on YOLOv3 and a phase-gradient stacking algorithm. It is found that the stacked InSAR phase gradients are more sensitive to the localized deformation and are immune to the phase unwrapping errors. The proposed approach is applied to southwestern China covering an area of about 180,000 km^2, from which a total of 3,366 slow-moving landslides are automatically detected, which agree well with those from optical imagery and the previously published landslides.

The paper by Cao and Wang focuses on the investigation of the surface deformation in Heifangtai loess terraces, China with time series InSAR measurements acquired by the Sentinel-1 satellite. In particular, the relation between the surface deformation and the factors (i.e., precipitation, temperature, and irrigation) is analysed by using a wavelet-based algorithm. The results reveal that the natural and anthropogenic factors are both responsible for the acceleration of the retrogressions of the terraces in the study area.

In conclusion, this Research Topic selected seven contributions to present the latest advances and developments of the methodologies and applications based on big SAR data. The novel methods and new findings of the authors are highlighted in this editorial. Finally, we would like to express our sincere gratitude to all the reviewers and the authors for their contribution to this Research Topic. We hope you enjoy the reading and can be inspired by this Research Topic.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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