GACOS-Assisted InSAR Time Series Technique

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Abstract

Tropospheric effects represent one of the major error sources of repeat-pass InSAR, and limit the accuracy of InSAR derived surface displacements. We have developed and released the Generic Atmospheric Correction Online Service (GACOS) with notable features: (i) global coverage, (ii) all-weather, all-time useability, (iii) correction maps available in near real-time, and (iv) indicators to assess the correction performance and feasibility. The model integrates operational high resolution ECMWF data (0.125 degree grid, 137 vertical levels, 6-hour interval) and continuous GPS tropospheric delay estimates (every 5 minutes) using an iterative tropospheric decomposition model. GACOS's performance for correcting atmospheric effects on SAR interferograms was tested using globally-distributed SAR data, achieving a phase precision and displacement accuracy of approximately 1 cm for the corrected interferograms even with a wide coverage (e.g. 250 km x 250 km). Indicators describing the model's performance have been developed to provide quality control for subsequent automatic processing, and provide insights of the confidence level with which the generated atmospheric correction maps may be applied. To detect small amplitude and long term displacements such as post/inter-seismic motion or ground subsidence, a time series of interferograms is often needed to overcome the errors resulting from the atmosphere, DEM and orbit. In most of the currently available InSAR time series analysis packages, two fundamental assumptions are made, namely that (i) deformation signals are correlated in time, and (ii) atmospheric effects are correlated in space but not in time. Unfortunately, since atmospheric effects can be highly correlated with topography, the second assumption does not hold in most cases. The temporal correlation of atmospheric delays may completely mask or bias the geophysical signals and introduce unpredictable uncertainties on the velocity estimates. To overcome this, we propose a strategy which (i) employs GACOS to reduce atmospheric effects on each interferogram; (ii) utilizes a series of model performance indicators to identify the date(s) with poor correction performance; (iii) applies an atmospheric phase screening (APS) model to a sub-network consisting of partially corrected interferograms from step (i) to estimate atmospheric delays for each interferogram; and (iv) uses the conventional time series analysis approach to extract the mean deformation rate as well as displacement time series. Our experiments with the proposed method suggest it is particularly beneficial for InSAR time series over mountain areas, as the residual atmospheric errors after correction are more likely to be randomly temporally distributed, which allows an easier minimization through time series analysis.

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