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Towards a new generation of Generic Atmospheric Correction Online Service for InSAR (GACOS 2.0)

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The tremendous development of InSAR missions (e.g., Sentinel-1A/1B, ALOS-2, TerraSAR-X/TanDEM-X, COSMO-SkyMED, RADARSAT-2, and Gaofen-3) in recent years facilitates the study of smaller amplitude ground deformation using longer time series and over greater spatial scales. This poses new challenges for correcting interferograms for atmospheric (tropospheric) effects especially the dominant long wavelength effect and the spatial-temporal correlated topographic related effect, resulting the atmospheric effect being distance-dependent with larger interferograms experiencing greater contamination and preventing deformation mapping of large scales deformation phenomena such as inter-seismic tectonic strain accumulation, post-seismic relaxation of fault systems and Glacial Isostatic Adjustment (GIA).

To overcome this, we have released the Generic Atmospheric Correction Online Service (GACOS) whose notable features comprise: (i) global coverage, (ii) all-weather, all-time usability, (iii) correction maps available in near real-time, and (iv) indicators to assess the correction performance and feasibility. The model applies operational high resolution ECMWF data (0.125-degree grid, 137 vertical levels, 6-hour interval) using an iterative tropospheric decomposition model and its performance for InSAR atmospheric correction was tested using globally-distributed interferograms, encompassing both flat and mountainous topographies, mid-latitude and near-polar regions, monsoon and oceanic climate systems, achieving a phase precision and displacement accuracy of approximately 1 cm for the corrected interferograms. Indicators describing the model's performance including (i) ECMWF cross-RMS, (ii) phase-delay correlations, (iii) ECMWF time differences, and (iv) topography variations, were 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 further improve the performance of GACOS to better serve the InSAR community, a new generation (GACOS 2.0) is being developed by: (i) improving the temporal resolution by integrating the newly published 1-hour ERA-5 weather model and the 5-minute GPS tropospheric delay estimates; (ii) developing an API system to facilitate automatic data processing; and (iii) enhancing GACOS based on regional/local datasets (such as national weather model and regional GPS network). The ERA-5 product and global GPS tropospheric delay estimates are carefully validated in order to achieve a robust integration. Based on the globally distributed GPS network and the MODIS PWV product, the performance of GACOS 2.0 in different regions of the world is evaluated with its elevation and latitude dependency being concluded which could be served as another performance indicator. All these features will contribute to a simplified time series analysis method (i.e. relying less on spatial-temporal filters) to reduce the computational burden, provided that the majority of the atmospheric error has been mitigated by GACOS 2.0.