Generic Atmospheric Correction Models for Radar Measurements

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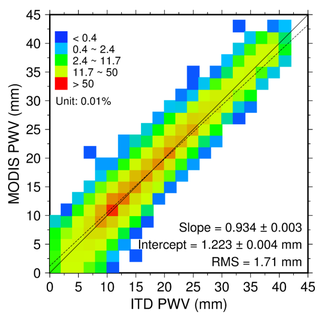
1. Objectives

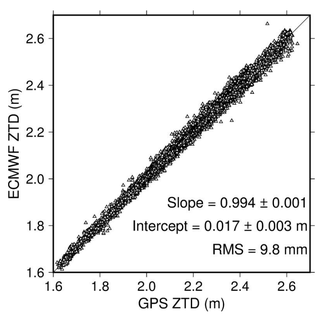
1. To develop a generic InSAR atmosphere correction model useable worldwide and at all times, in near real time. Release **Generic Atmospheric Correction Online Service for InSAR (GACOS).**
2. Account for the troposphere stratification and turbulence by Iterative Tropospheric Decomposition (ITD).
3. Integration High Resolution ECMWF and GPS data.
4. Design statistic factors for quality control and model performance indicator.

2. Iterative Tropospheric Decomposition（ITD）

$$ZTD_k = Stratified(h_k) + Turbulent(x_k) + \varepsilon_k$$

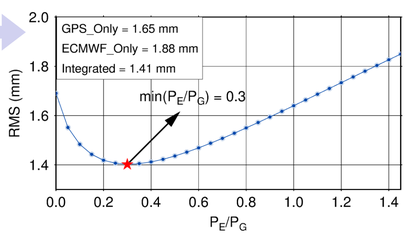
- A stratified component highly correlated with topography;
- A turbulent component resulting from disturbance processes in the troposphere.

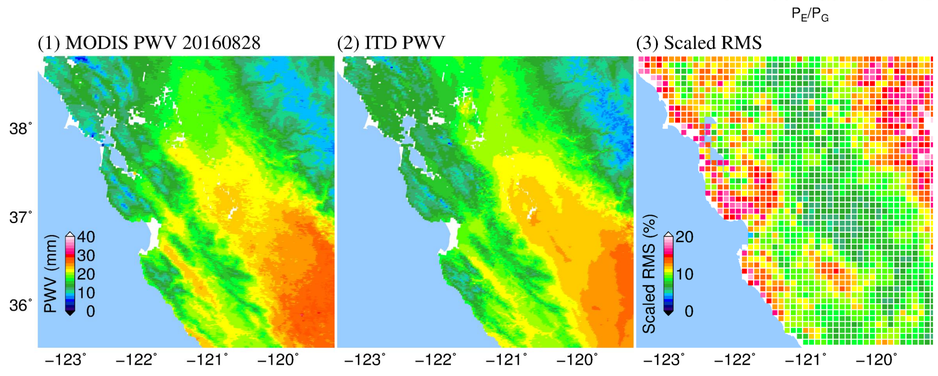




- **GPS** provides real time, high accuracy, high rate ZTD estimates, but a dense network may not be available in most of areas.
- **High Resolution (HRES) ECMWF** has worldwide coverage with a spatial resolution of 12 km and a temporal resolution of 6 hours.
- **MODIS** provides 1 km resolution PWV fields only under cloud free conditions. offers a way for external validation.

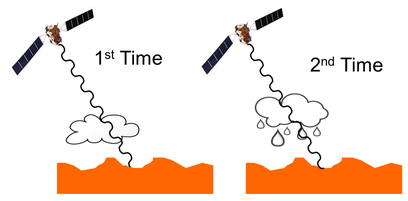
GPS and HRES-ECMWF are properly weighted in the integrated model.



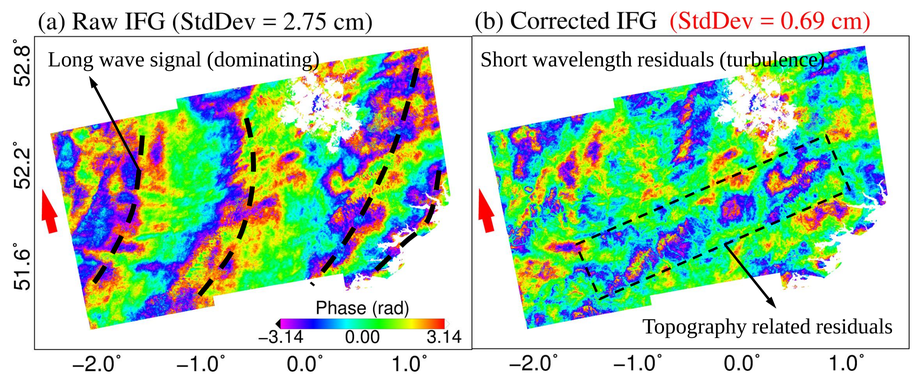


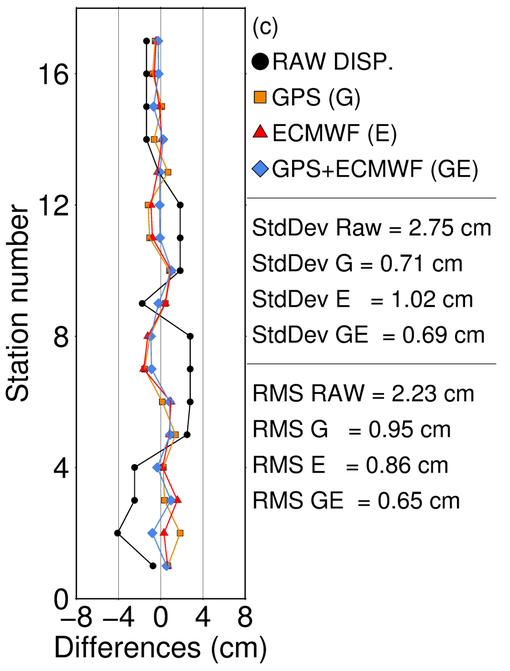
3. InSAR Atmospheric Correction Model Performance

- Spatiotemporal variations in atmosphere represent one of the major limitations of repeat-pass InSAR.
- Requires correction models worldwide and at all times.



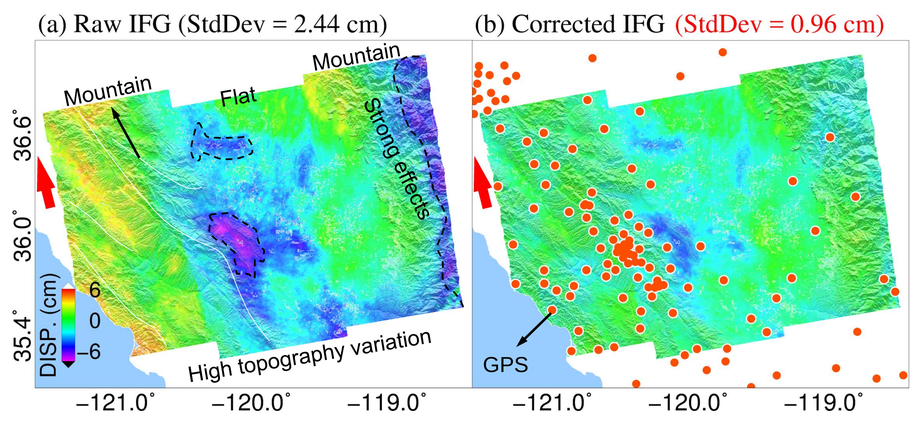
Southern England, United Kingdom

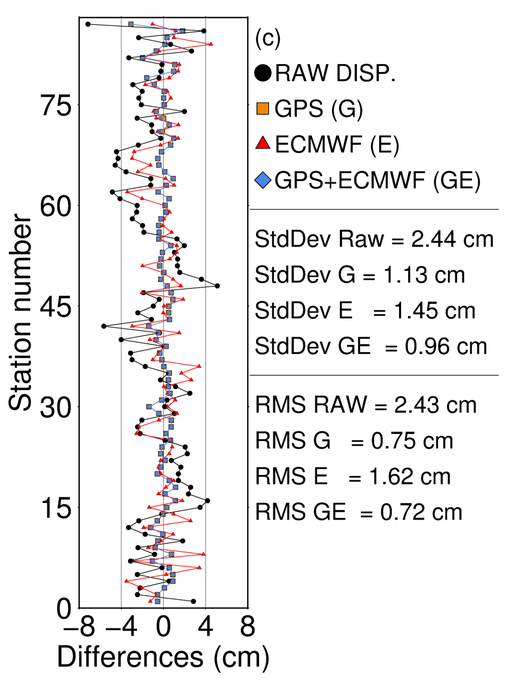




Standard Deviations (STD) indicates phase variations across the whole interferogram. RMS differences are computed between InSAR and GPS displacements in the radar LOS direction.

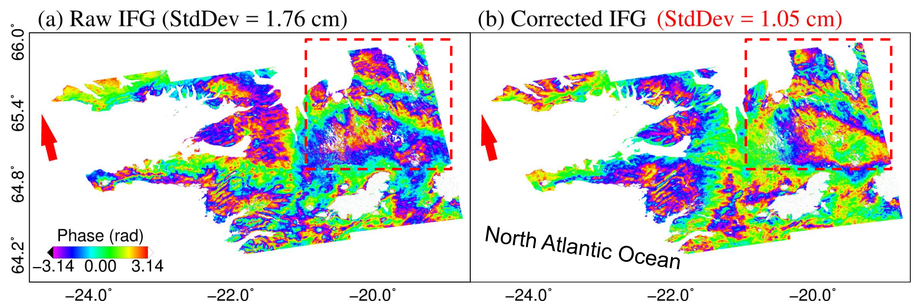
Central California, United States



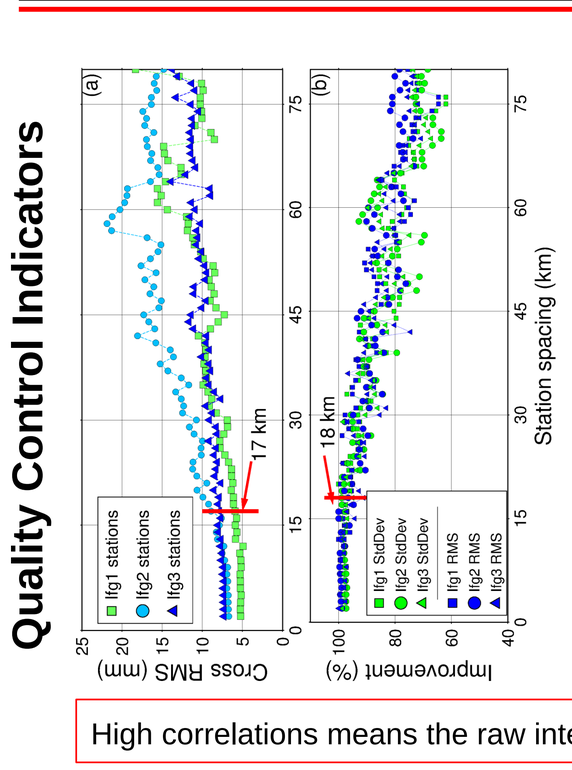


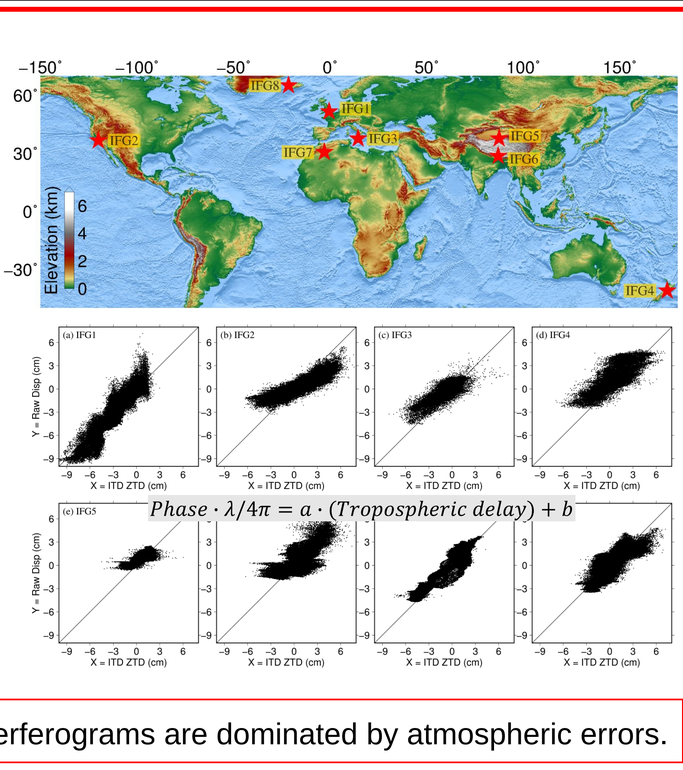
This area suffers from strong topography variation and the central and eastern part of the interferogram were strongly affected by atmosphere. About 61% noise was obtained after correction.

Iceland, High latitude region



The integrated mode is globally available, e.g. 40% improvement was received in high latitude region (Iceland).





High correlations means the raw interferograms are dominated by atmospheric errors.

Conclusions

1. Integration of GPS and ECMWF using ITD achieves over 50% improvement with RMS < 1 cm in terms of InSAR displacement, and provides a near real time worldwide, all time usable correction model.
2. Indicators such as correlation analysis, cross test and time differences were computed to assess model performances which enable an flexible correction procedure installed in an automatic processing chain.
3. An **Generic Atmospheric Correction Online Service for InSAR (GACOS**) is released for research usage with unlimited access. Please visit (http://ceg-research.ncl.ac.uk/v2/gacos/) and contact C.Yu3@ncl.ac.uk in case any changes/updates of the websites.

- Yu, Chen, Nigel T. Penna, and Zhenhong Li. "Generation of real-time mode high-resolution water vapor fields from GPS observations." *Journal of Geophysical Research: Atmospheres* 122.3 (2017): 2008-2025.
- Li, Zhenhong, et al. "Interferometric synthetic aperture radar (InSAR) atmospheric correction: GPS, Moderate Resolution Imaging Spectroradiometer (MODIS), and InSAR integration." *Journal of Geophysical Research: Solid Earth* 110.B3 (2005).