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Simultaneously measuring Total Electron Content with InSAR and GNSS

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The ionosphere affects the propagation of the low frequency signals transmitted by space-borne Synthetic Aperture RADAR (SAR). Indeed, free electrons and ions modify phase and group velocity as well as the intensity and the polarization of the radio waves passing through them. Such modifications introduce errors in the SAR images that depend on the Total Electron Content (TEC). Thus, these errors could be used to provide information on the ionospheric conditions during the image acquisition.

This work aims at a twofold scope: mitigate the ionospheric impact on SAR images using external information and assess the capability of SAR in retrieving ionospheric information. Pairs of SAR images observing the same area of the Earth's surface are exploited to estimate the interferograms by applying SAR Interferometry (InSAR) technique. These interferograms can be used to retrieve TEC space-time variations (ΔTEC_{SAR}) from SAR data. The initial conditions to be satisfied are the absence of ground motions (e.g., earthquakes) and/or the absence of heavy rain events. Then, if correlation exists between the integral of the azimuth shifts and the interferometric phase, the tropospheric contribution to the InSAR image can be assumed as negligible with respect to the ionospheric one and, finally, ΔTEC_{SAR} from InSAR images can be retrieved.

In addition, ΔTEC_{GNSS} measurements are also derived from a dense regional networks of GNSS (Global Navigation Satellite Systems) receivers at mid-latitude, here considered as the reference "true" ionosphere. For this purpose, the RING (Rete Integrata Nazionale GPS) network, managed by Istituto Nazionale di Geofisica e Vulcanologia (INGV), is used.

Examples of the study carried out at mid latitude under quiet geospatial conditions are shown and critically discussed in relationship with the different roles of troposphere and ionosphere impacts on SAR data. Correlation between these two independent TEC measurements, from InSAR images and from the RING network, has been found in some case events, enabling also the mitigation of the ionospheric effects on the SAR images.