Ionospheric Effects and Mitigation for DESDynI

Paul A. Rosen
MS 300-227Q
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91109

Email:Paul.A.Rosen@jpl.nasa.gov
Tel:(818) 354-0023

Elaine Chapin, Jet Propulsion Laboratory
Curtis Chen, Jet Propulsion Laboratory
Scott Hensley, Jet Propulsion Laboratory
Xiaoqing Pi, Jet Propulsion Laboratory

DESDynI is a mission specified in the National Research Council Decadal Survey of Earth Science and Applications completed in 2007 to address important scientific and societal questions in Deformation, Ecosystem Structure, and Dynamics of Ice. DESDynI exploits repeat-pass interferometric L-band synthetic aperture radar techniques to measure deformation of solid earth and ice surfaces globally systematically, with rapid and comprehensive mapping to capture motion on time centers as short as two days and up to the duration of the mission, which is nominally five years. L-band synthetic aperture radar (SAR) polarimetry and vertical profiling lidar measurements are used determine ecosystem structure on unprecedentedly fine spatial scales over the globe to greatly improve biomass estimates and knowledge of biodiversity and habitats. The ionosphere can affect radar observations through phase and group delays, Faraday rotation, local scintillations, and apparent refraction affecting pointing and image registration. Many of these effects have been observed in existing ALOS PALSAR data [Meyer et al. 2008], and studies are underway to characterize and mitigate the ionosphere using these data.

Previous studies have explored characteristics of the ionosphere and effects on L-band SAR such as DESDynI [Chapin et al. 2006]. Chapin and colleagues quantified the impact of the ionosphere using a combination of simulation, modeling, Global Positioning System (GPS) data collected during the last solar maximum, and existing spaceborne SAR data, and concluded that, with the exception of high latitude scintillation related effects, the ionosphere will not significantly impact the performance of an L-band InSAR mission in an appropriate orbit. Their examination of ionospheric artifacts in C-band InSAR data has revealed that the scintillation effects that lead to azimuth registration shifts occur primarily in the polar cap data, not auroral zone data as was previously thought. However, a more recent study [Meyer et al., 2008] using more ubiquitous L-band PALSAR data strongly suggests local TEC enhancements in the auroral zone as the cause of phase and distortion effects in polarimetric data. In this study, we attempt to reconcile these analysis results.

We examine a number of PALSAR data sets, including fully polarimetric, single-polarization 28 MHz bandwidth data, and ScanSAR data, where anomalous effects in phase, amplitude and image registration have been observed. We compare the performance of several mitigation techniques, including polarimetric determination of Faraday rotation and consequent estimates of TEC, and split spectrum techniques for estimating TEC, whereby a radar waveform is transmitted over the full 80 MHz allowable spectral band and widely separated portions of the receive spectrum are processed independently and compared for dispersive effects.

References:

E. Chapin, S. F. Chan, B. D. Chapman, C. W. Chen, J. M. Martin, T. R. Michel, R. J. Muellerschoen, X. Pi, and P. A. Rosen, “Impact of the ionosphere on an L-band space based radar,” in 2006 IEEE Radar Conference, Verona, NY, April 2006.

F. Meyer, K. Papathanassiou, J. Nicoll, “The impact of the ionosphere on interferometric SAR processing,” CEOS SAR Calibration/Validation Workshop, Oberpfaffenhofen, Germany, November 27, 2008.

This paper was written at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.