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Phase propagation delay and ground movement signal in InSAR time series of Afar

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The signal produced by the radar phase propagation delay through the troposphere is one of the largest sources of error in SAR interferometry measurements of ground movements. In the absence of large earthquake or volcano inflation, the phase delay generally exceeds the phase change produced by surface deformation, even when it is integrated over several years. Interferograms stacking can help mitigate the problem but can be applied only where the deformation signal is stationary. Where transient processes occur, time series analysis and appropriate filtering of the data are required. We studied the Asal Rift in Djibouti (Afar) using an 8-year InSAR data set acquired by the Canadian satellite RADARSAT. A timeline of the surface movement in the rift area was constructed using the small baseline subset approach, defining a multi-year sequence with a time step of 24 days. The linear trend extracted from the sequence reveals the uplift of the Fieale volcanic dome over a ˜20 km radius and the subsidence of the rift floor accommodated by creep on the bordering faults. The series shows that fault movement is not steady and occurs episodically in coincidence with bursts of micro-earthquakes distributed in the rift. Tracking the movement of individual pixels imaged by the data reveals a strong residual signal resembling a sine function with a 12 months cycle. The amplitude of the sine function is approximately 3-5 radians at sea level and decreases with elevation at a rate of 2.4 rad/km, suggesting a tropospheric phase delay origin. However, the maximum delay is observed in winter, when the precipitation is mimumum and cannot be directly related to the presence of water vapor in the atmosphere. Temporal characteristics of the hydrostatic and wet components of the phase delay can be estimated from atmospheric pressure and dew point

temperature records at ground meteorological stations. The 2002-2006 record available from the Djibouti airport station shows a hydrostatic signal oscillating between 2.47 and 2.51 m with a maximum in winter. The wet delay estimated from the meteorological record varies over a wider range (1-4 m) than the hydrostatic delay but shows a daily variability of up to 2 m, making it inconsistent in time when sampled a radar acquisition epochs. The small temporal smoothing applied in the computation of the displacement time series tends to remove the highly variable (wet) signal, leaving the temporally consistent (hydrostatic) signal in the solution. Digital filters can then be applied to clean the surface movement signal from the residual tropospheric phase delay.