

Supplementary File

Monitoring Land Subsidence at San Francisco International Airport Using Satellite Radar Interferometry

Oluwaseyi Dasho^{1,2} and Manoochehr Shirzaei^{1,2}

¹Department of Geosciences, Virginia Tech, Blacksburg, USA.

²Institute for Water, Environment and Health, United Nations University, Richmond Hill, Ontario, Canada.

Figures S1 – S4

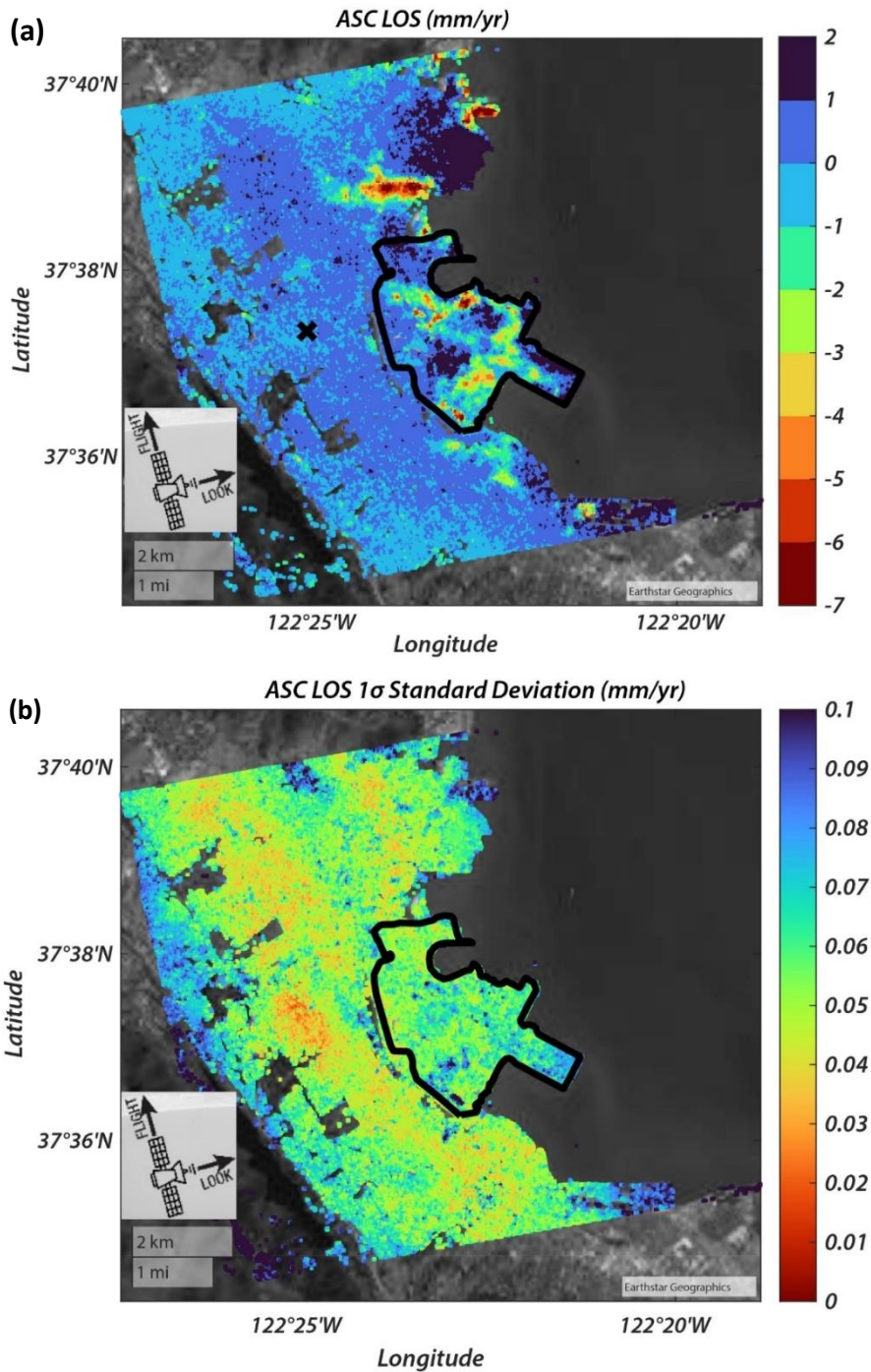


Figure S1. Ascending Track Line-of-Sight (LOS) Land Motion and associated uncertainty across the San Francisco International Airport (SFO) region.

(Top panel) Map showing the average LOS velocity between 2017 and 2024 derived from ascending Sentinel-1 (Path 35 Frame 117) Interferometric Synthetic Aperture Radar (InSAR) observations. Positive values (cool colors: green to blue) indicate motion toward the satellite (uplift or westward motion), while negative values (warm colors: red) indicate motion away from the satellite (subsidence or eastward

horizontal movement). The outlined polygon delineates the SFO airport boundary. LOS deformation rates vary from approximately -7 mm/year to $+2$ mm/year, with pronounced movement towards the satellite in the north and west of the airport. Inset schematic shows the radar look direction and flight path geometry for ascending tracks.

(Bottom panel) Map of the 1σ standard deviation of the LOS velocity estimates, indicating measurement uncertainty. Standard deviation values range from near 0 to 0.1 mm/year, with lower uncertainties observed in areas of high radar coherence, and elevated uncertainties near vegetation, open water, and areas of deformation-induced decorrelation. The background grayscale image provides geographic context (source: Earthstar Geographics).

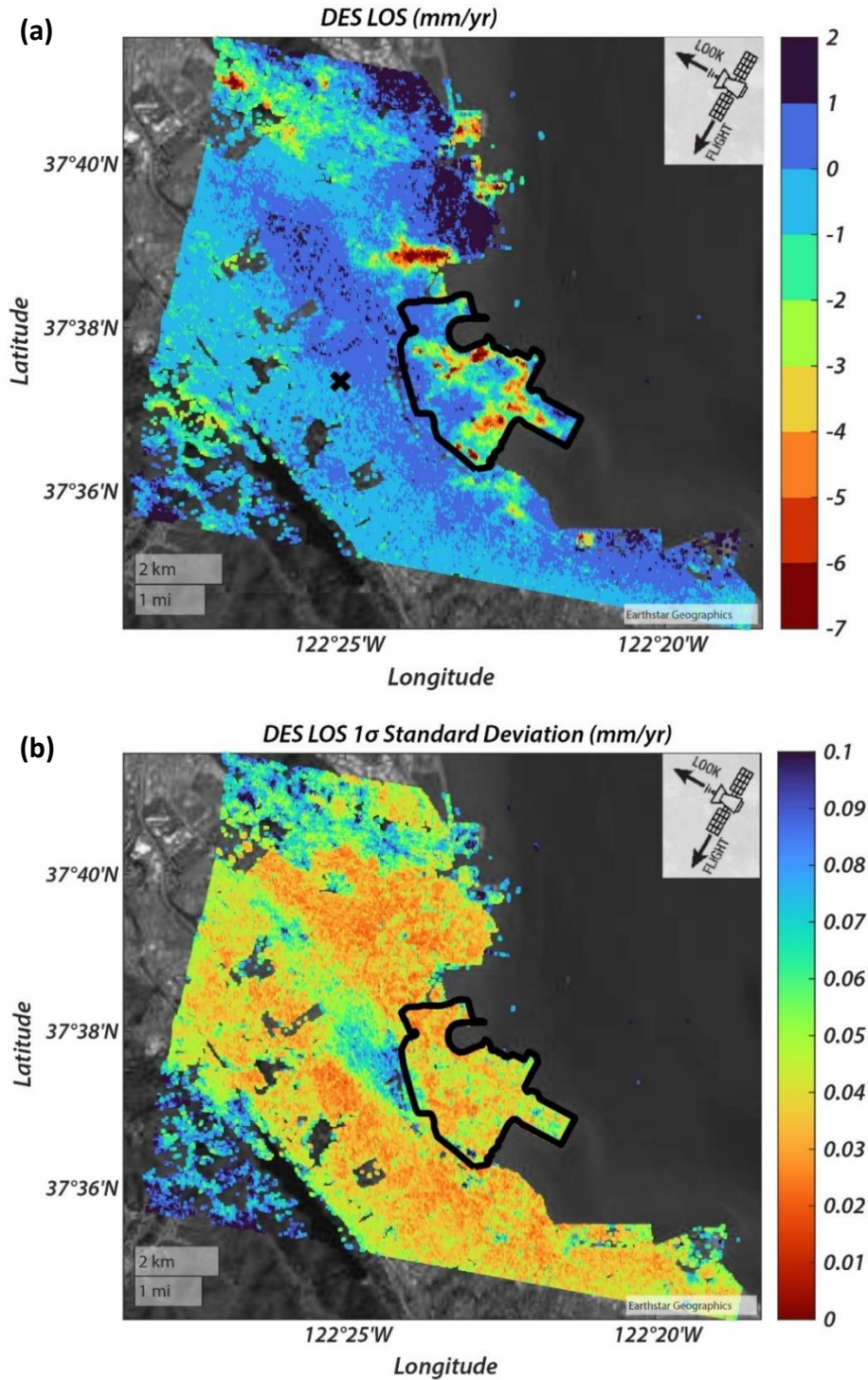


Figure S2. Descending Track Line-of-Sight (LOS) Land Motion and associated uncertainty for the San Francisco International Airport (SFO) region.

(Top panel) Map of average LOS velocity between 2017 and 2024 derived from descending Sentinel-1 SAR imagery (Path 115 Frame 467) using Interferometric Synthetic Aperture Radar (InSAR) processing. Positive values (cool colors: green to blue) indicate motion toward the satellite (uplift or eastward motion), while negative values (warm colors: red) indicate motion away from the satellite (subsidence or westward

horizontal movement). The SFO airport boundary is outlined in black. Subsidence is concentrated both within and surrounding the airport, with rates reaching up to -7 mm/year. An inset schematic illustrates the radar acquisition geometry for descending tracks.

(Bottom panel) Standard deviation (1σ) map of the LOS velocity estimates, representing spatial variability in measurement uncertainty. Uncertainty values are lowest (~ 0 mm/year) in high-coherence urban areas and highest (~ 0.1 mm/year) over vegetated, water-covered, or actively deforming regions. Background grayscale imagery provides geographic reference (Earthstar Geographics basemap).

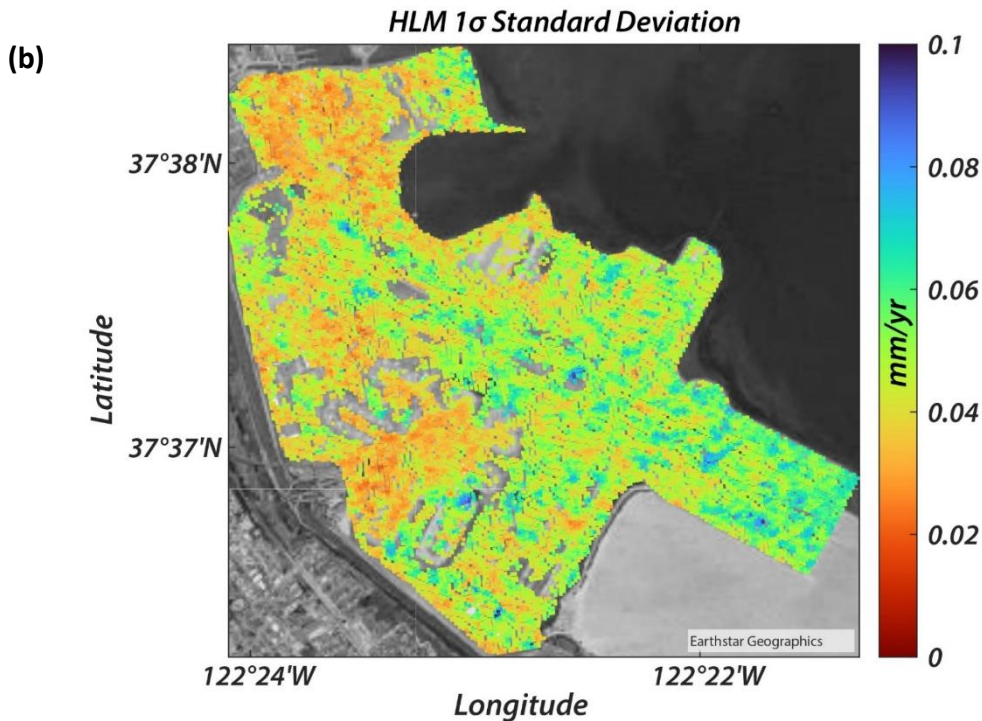
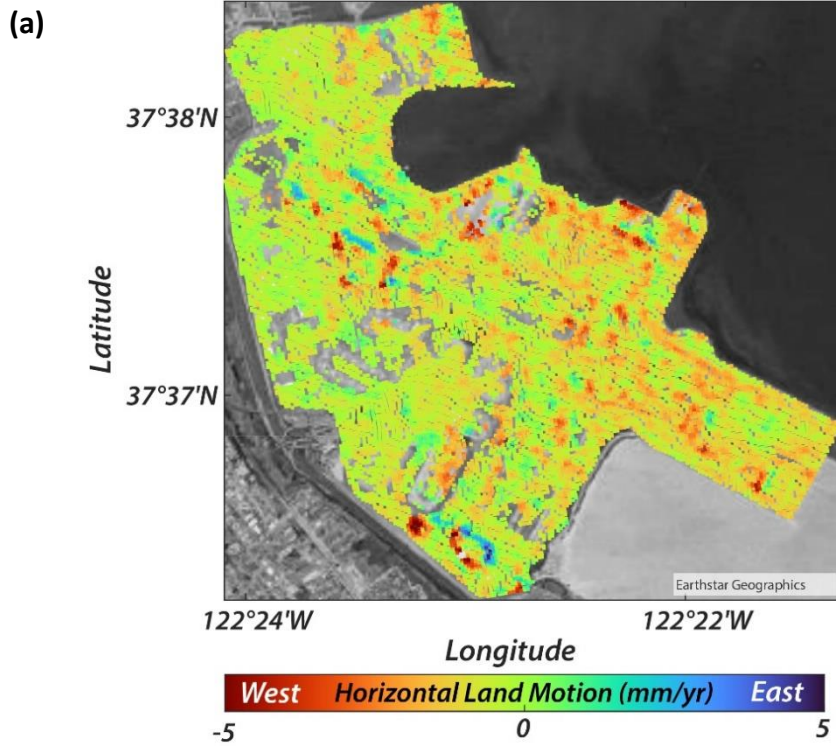


Figure S3. Horizontal Land Motion (HLM) and associated uncertainty across SFO area.
(Top panel) Map showing the average horizontal land motion rate between 2017 and 2024, derived from satellite radar interferometry. Motion towards the west is shown in warm colors (red to yellow) while motion towards the east is indicated in cool colors (green to blue). The underlying grayscale imagery provides contextual basemap information (source: Earthstar Geographics).

(Bottom panel) Map of the 1σ standard deviation of the horizontal land motion estimates, representing the measurement uncertainty. Lower uncertainties (0–0.02 mm/year) occur in stable areas, while higher uncertainties (up to 0.1 mm/year) are primarily localized around regions with active deformation or lower coherence.

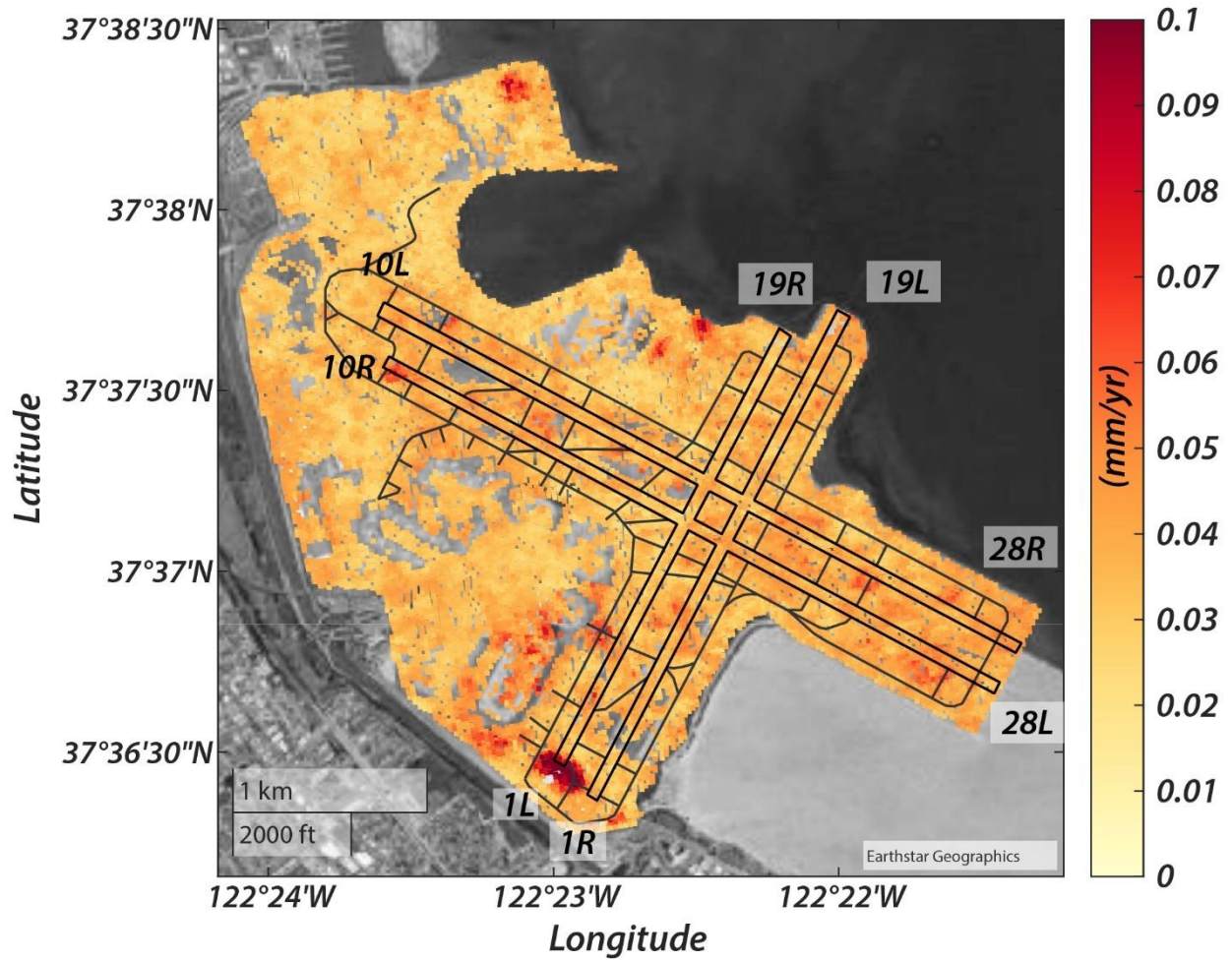


Figure S4. Spatial distribution of the 1σ standard deviation of vertical land motion (VLM) across the San Francisco International Airport (SFO), derived from multi-year InSAR time series analysis. Warmer colors indicate areas of higher uncertainty, with values reaching up to 0.1 mm/yr. The background is a high-resolution satellite image from Earthstar Geographics, overlaid with annotated airport runways and taxiways for spatial reference.