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**Calibrated InSAR for Monitoring Salt Dome Subsidence  
Along the US Gulf Coast**

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## CALIBRATED INSAR FOR MONITORING SALT DOME SUBSIDENCE ALONG THE US GULF COAST

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### Abstract

Satellite Interferometric Synthetic Aperture Radar (InSAR) technology has been increasingly adopted in the solution mining industry over the past decade to monitor ground surface displacement. InSAR uses radar imagery collected by satellites, typically on a regular revisit frequency, processed to generate displacement measurements. A recent collaboration between TRE ALTAMIRA and the National Oceanic and Atmospheric Administration (NOAA) leveraged InSAR to investigate local displacement along the US East Coast including the US Gulf Coast, a region hosting the majority of North America's salt domes and storage facilities.

This paper focuses on the overall subsidence trends of various salt domes across the US Gulf coast from 2017 to 2023, highlighting the variability in displacement rates for the different salt domes. Factors that may potentially impact the rates include the nature of salt deposits, depth and morphology of storage caverns, human operations (e.g. injection, extraction, changing in cavern pressure) and the overall geology of these regions.

The broad-area InSAR results presented herein were derived from the processing of over 3,500 Sentinel-1 satellite images, collected from an ascending orbit across 17 distinct satellite tracks. This extensive dataset encompassed coastal zones from Maine to Texas, covering an approximate total area of ~500,000 square kilometers (~200,000 square miles). Unlike standard InSAR analysis, which measures displacement relative to a local reference point assumed to be stable, our study converted these relative InSAR measurements into absolute vertical displacement values. This was achieved through calibration and validation using 375 NOAA GPS stations distributed along the entire coast. The calibration process showcased the successful integration of InSAR and GPS technologies, yielding highly accurate results with residuals between the post-calibrated InSAR points and GPS data consistently within the millimetric range.

The dataset covers 21 salt domes across the US Gulf Coast. InSAR data density and coverage vary for each dome, depending on surface conditions like vegetation and the presence of surface water. Preliminary analysis reveals the presence of subsidence across all investigated sites, with the exception of Jefferson Island Salt Dome, where coverage is constrained by the presence of water, and Lost Lake Salt Dome, which displays stability under very limited coverage. The subsidence rates among the 21 salt dome caverns vary significantly, ranging from 3 mm/yr (0.12 in/yr) at Hoskins Mound Salt Dome to 116 mm/yr (4.57 in/yr) at Weeks Island Salt Dome. For most sites, subsidence rates remained consistent throughout the observation period, though a few locations exhibited either accelerating or decelerating trends.

The aim of this research is to spark further inquiry into key questions linking ground subsidence rates to: (i) differences in local geology and/or the mechanical properties of the caprock; (ii) the depth, shape, number, or spacing of the caverns; and (iii) other factors contributing to the stability observed at some sites. Furthermore, the present work highlights how the characteristics of InSAR, including its wide-area coverage

coupled with millimetric precision and high-frequency updates, make it an important tool for monitoring solution mining sites that can be integrated with other data and techniques.

**Key words:** Satellite InSAR, GNSS, Salt Domes, Subsidence, US Gulf Coast.