

EGU22-2114

<https://doi.org/10.5194/egusphere-egu22-2114>

EGU General Assembly 2022

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Multi-annual InSAR solution of vertical land motion in 2021 lethal building collapse site in Miami

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NOAA reported that the sea level has risen by 203-228 mm since 1880 and the rates accelerated to 3.556 mm/year during 2006-2015. Coastal regions, home to about half of the world's population (~3 billion), are subject to erosion from wind and waves and subsidence from natural compaction and artificial exploitation of subsurface resources, and are at high risks of floods from accidental storms and inundations from prolonged sea level rise. The vertical land motion (VLM) directly determines the relative sea level rise. To be specific, locally upward VLM can help alleviate the risks while locally downward VLM may hasten the arrival of inundation. Therefore, monitoring coastal VLM is fundamental in coastal resilience and hazard mitigation.

One 12-floor building, Champlain Towers South, in the Miami suburb of Surfside collapsed catastrophically and claimed 98 lives on June 24th, 2021. No confident conclusion has been drawn on the cause of the collapse, but it might be related to multiple processes from the ground floor pool deck instability, concrete damage, and land subsidence.

Subsidence has been noted in populous Surfside since 1990s. However, we still lack a detailed mapping of the contemporary coastal subsidence. Here we focus on multi-source Synthetic Aperture Radar (SAR) datasets from C-band Sentinel-1 and X-band TerraSAR-X satellite imagery.

We use the time-series SAR interferometry of ascending Sentinel-1 path 48 to extract the VLM from 2015 to 2021. A comparatively stable GPS station ZMA1 obtained from the Nevada Geodetic Laboratory acts as the reference site to calibrate InSAR results. Long-wavelength atmospheric phase screen and orbit errors are approximated by the low-order polynomial fitting. The average subsidence rates derived from stacking can help reduce the temporarily high-frequency noise. A comparison with the GPS network solution can help verify InSAR measurements. Beyond that, we will also rely on high-resolution X-band TerraSAR-X data (Path 36, strip_014) to elaborate VLM details in the building clusters. Beyond that, NOAA reported that the relative sea level increase in Florida is 2.97 mm/year from 1931 to 2020, i.e., >0.3 m in one century. The 2019 Unified Sea Level Rise Projection in Southeast Florida predicted that the sea level in 2024 will rise by 254 to 432 mm in Florida compared to the level in 2000. We aim to extract the high-accuracy VLM to provide scientific evidence for more safe urban planning and effective adaptation strategies in coastal cities, for an ultimate goal of coastal resilience during global climate change.

