on GPS-IR technique for measuring shallow sediment compaction

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Makan Karegar
Institute of Geodesy and Geoinformation,
Universit0y of Bonn, Germany
@MakanKaregar

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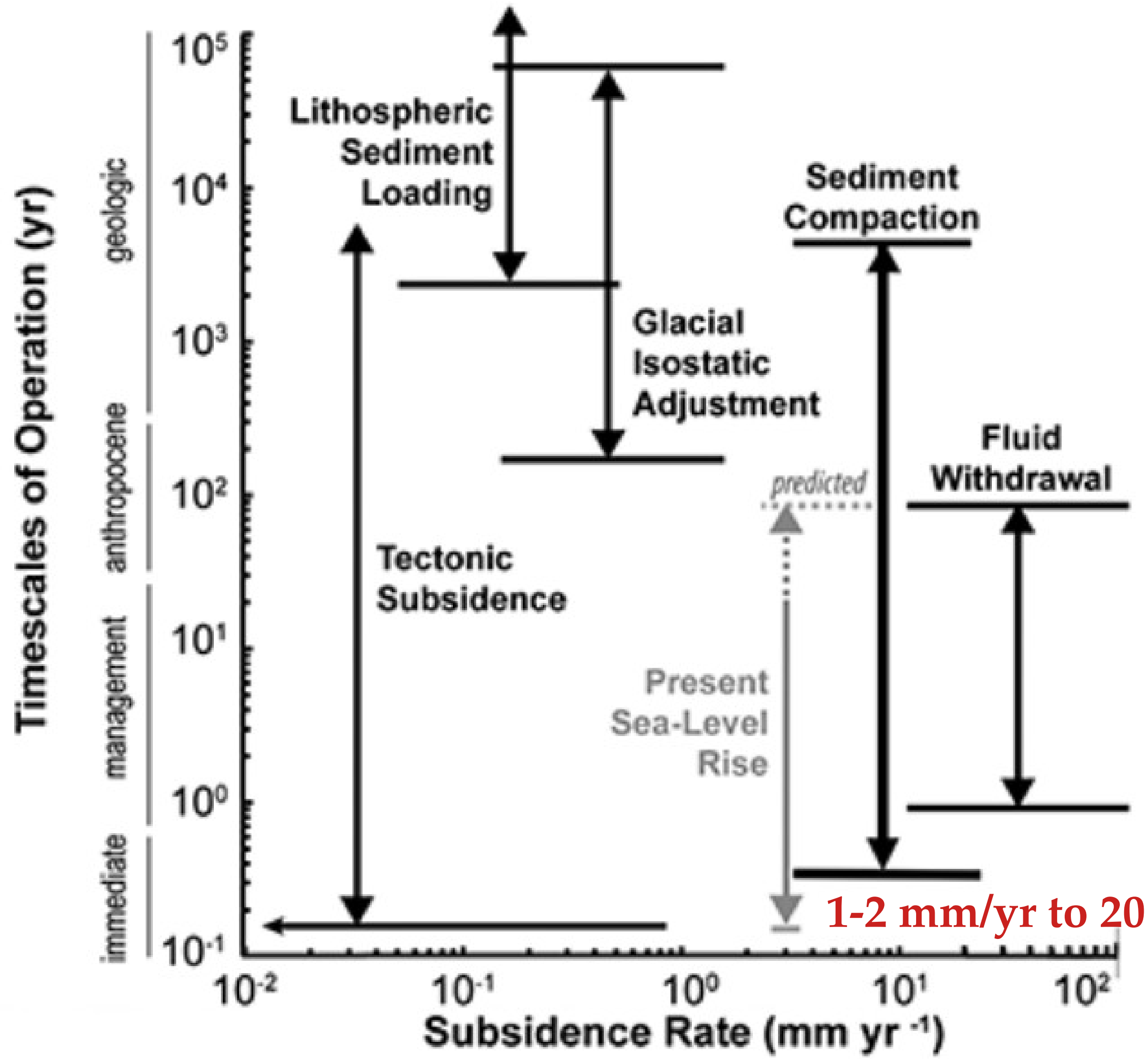
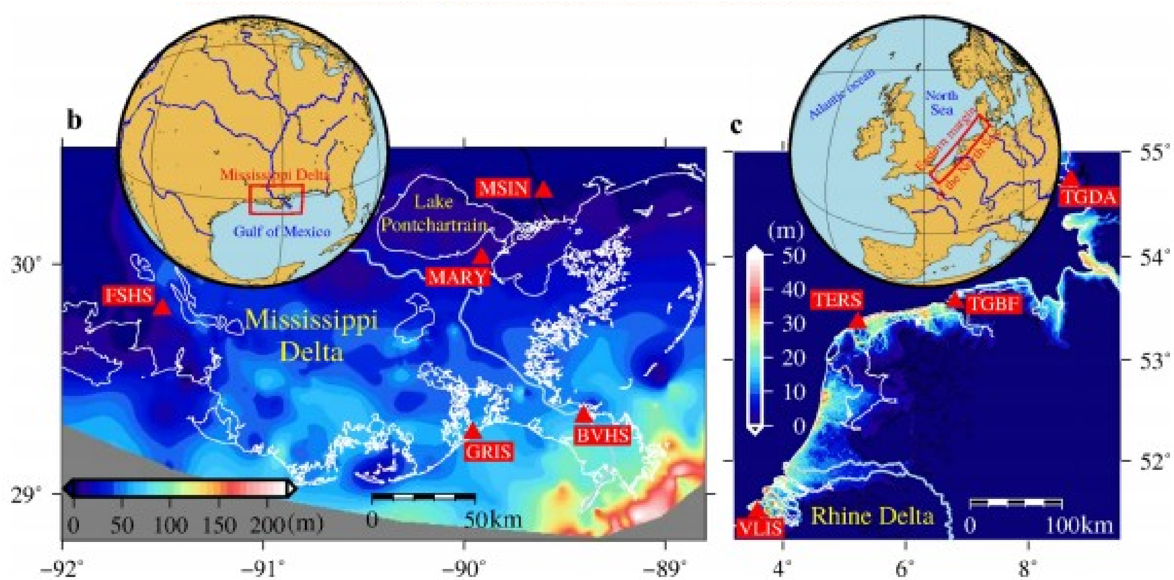
Sediment compaction: a main driver in regions of rapid Holocene sedimentation



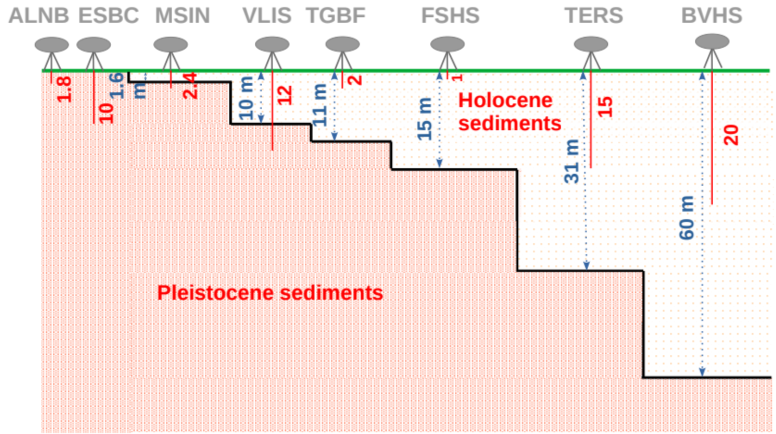
1-2 mm/yr to 20 mm/yr

Allison et al. (Eos, 2016)

Thicknesses of Holocene deposits in the Mississippi Delta and along the eastern margin of the North Sea:

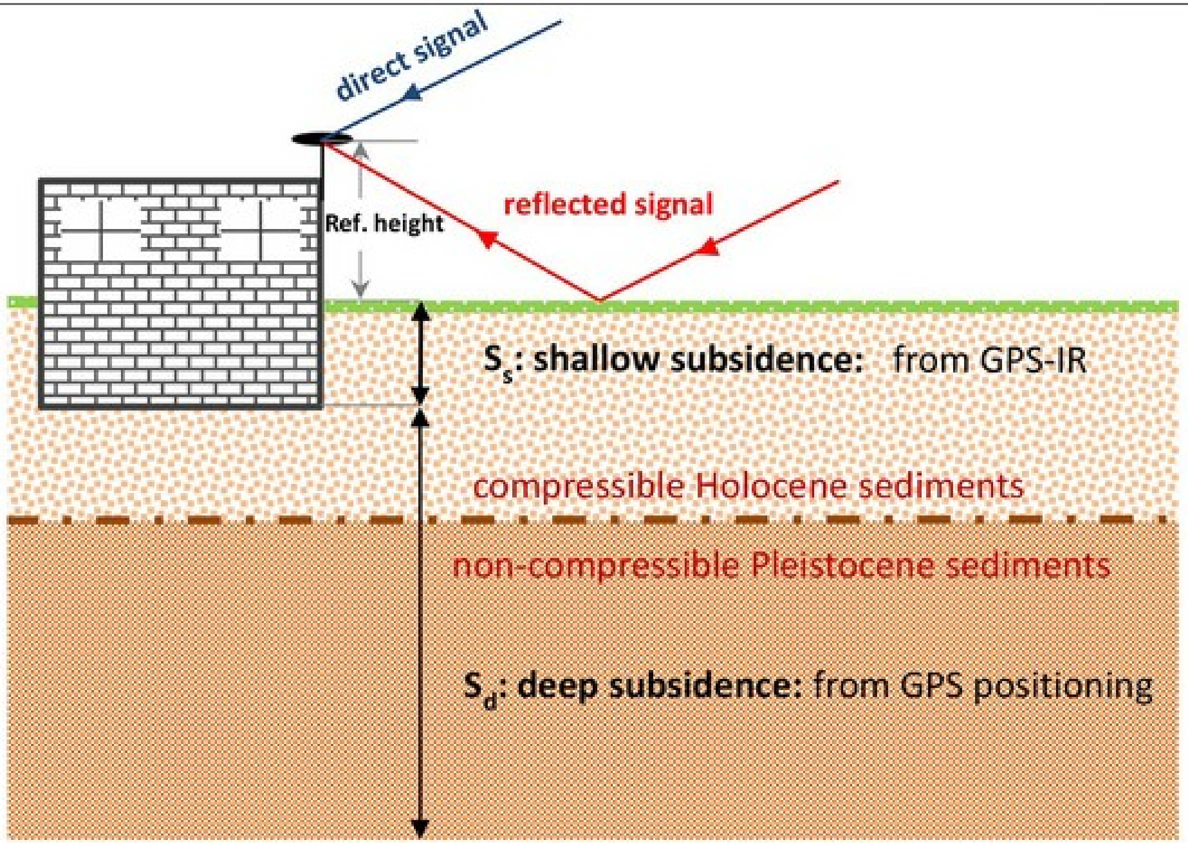


Schematic sketch of the stratigraphy and illustration of GPS foundation and Holocene sediment thickness



Can we develop a method to quantify VLM occurring within the foundation structure of a GPS site?

Schematic sketch of the stratigraphy in coastal plains and illustration of GPS installation.

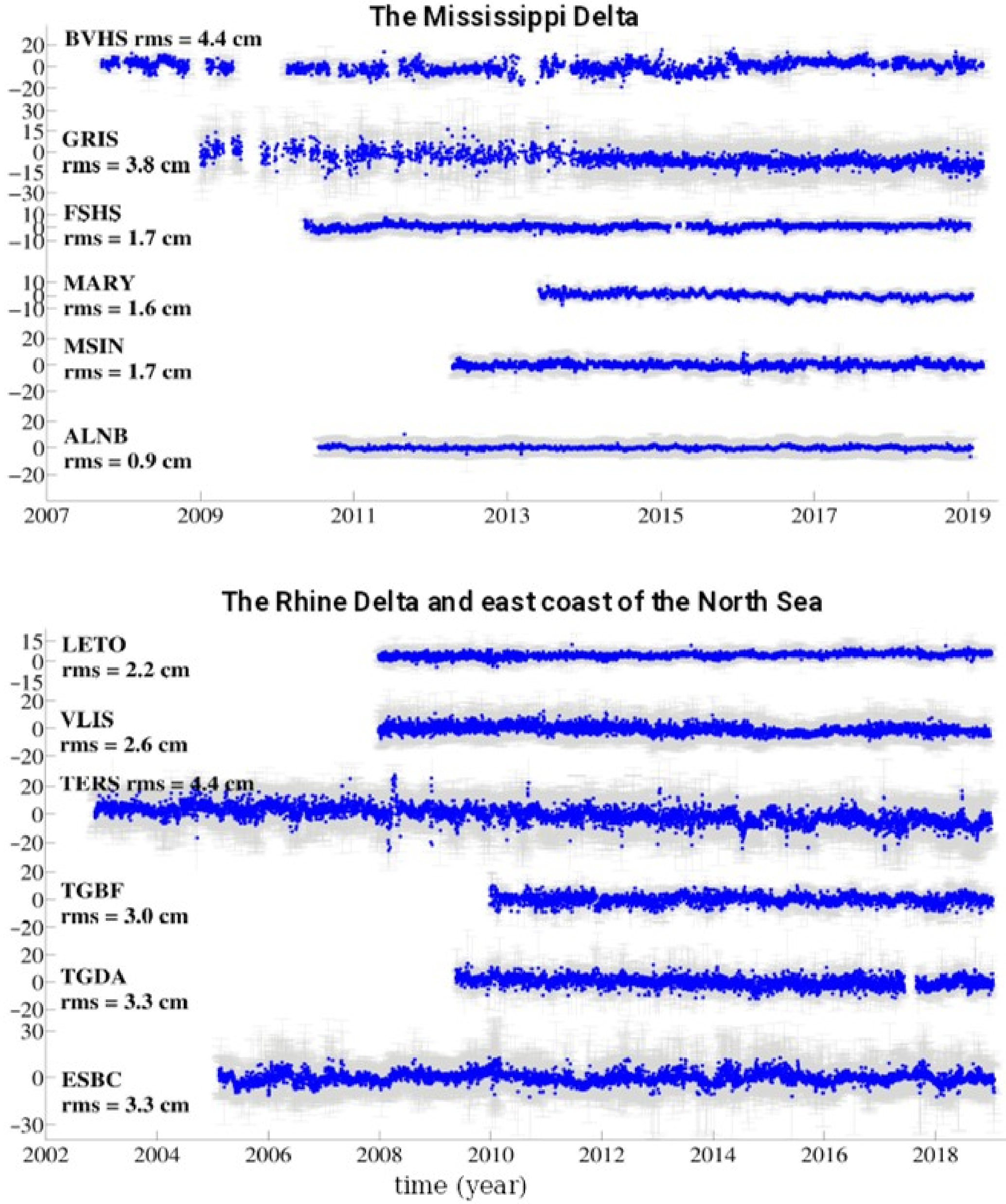


Karegar et al. (GRL, 2020)

*** GPS-IR for estimating shallow VLM**

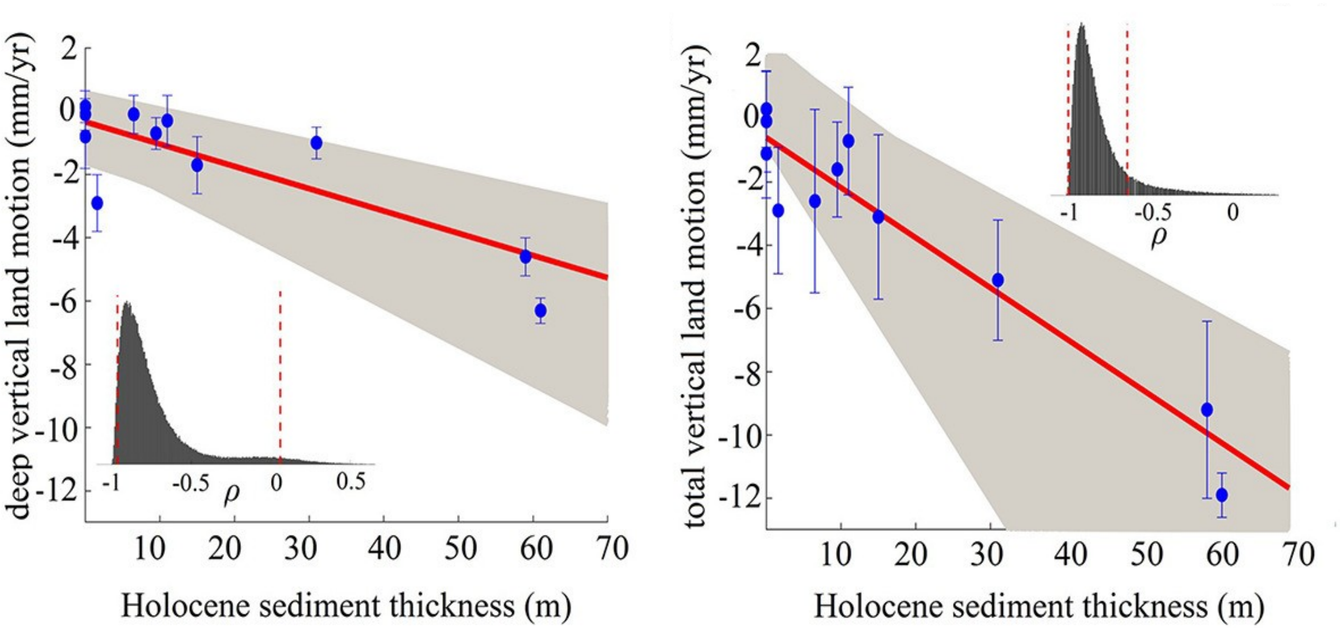
*** Conventional GPS positioning for estimating deep VLM**

Time series of shallow vertical land motion



*** The shallow displacements show a range of RMSE from 0.8 cm to 4.1 cm.**

Rate vs. Holocene sediment thickness



* GPS rate from conventional approach (deep rate) inversely correlate with thickness of Holocene sediments. Highest subsidence rates occur at sites where the Holocene sediments are substantial.

* Total subsidence rates (deep+shallow) show very stronger linear relationship with Holocene sediment thickness.

The higher dependence of total vertical land motion on Holocene thickness suggests that:

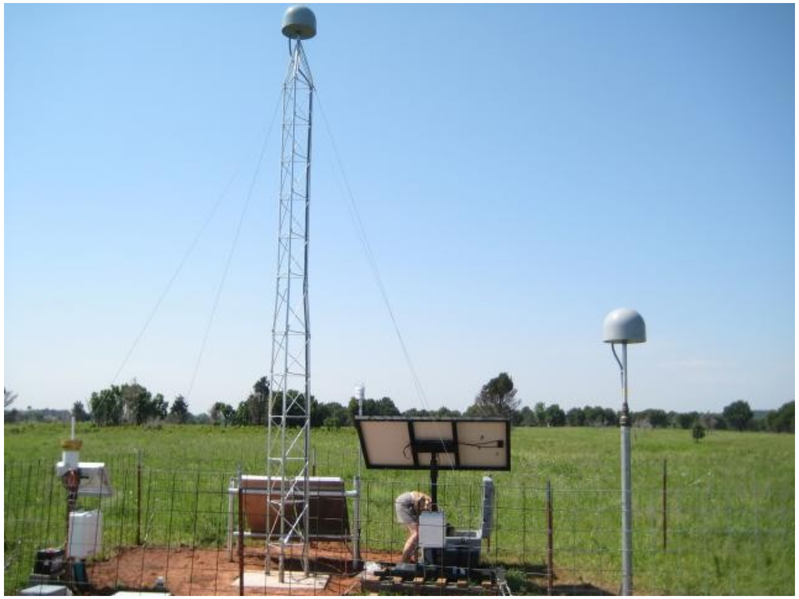
1. Shallow vertical motion derived from GPS-IR is mainly caused by sediment compaction.

2. Conventional GPS positioning underestimates the rate of VLM since it misses shallow sediment compaction.

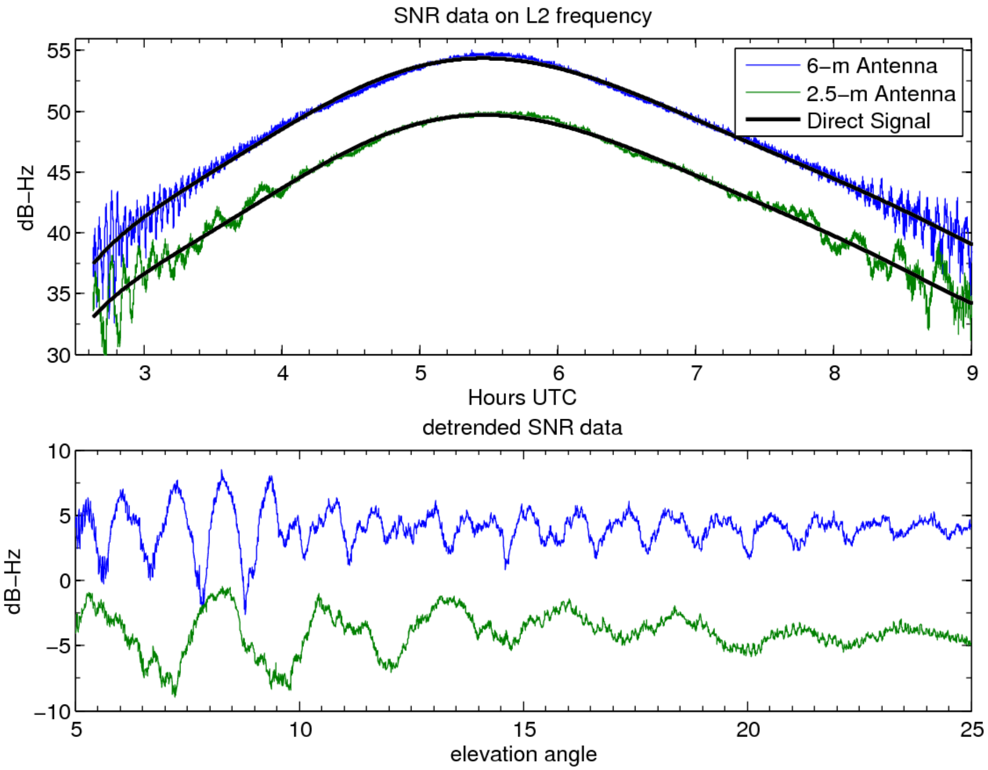
3. Regions with thicker and younger sediments experience faster subsidence.

Two limitations with GNSS-IR technique:

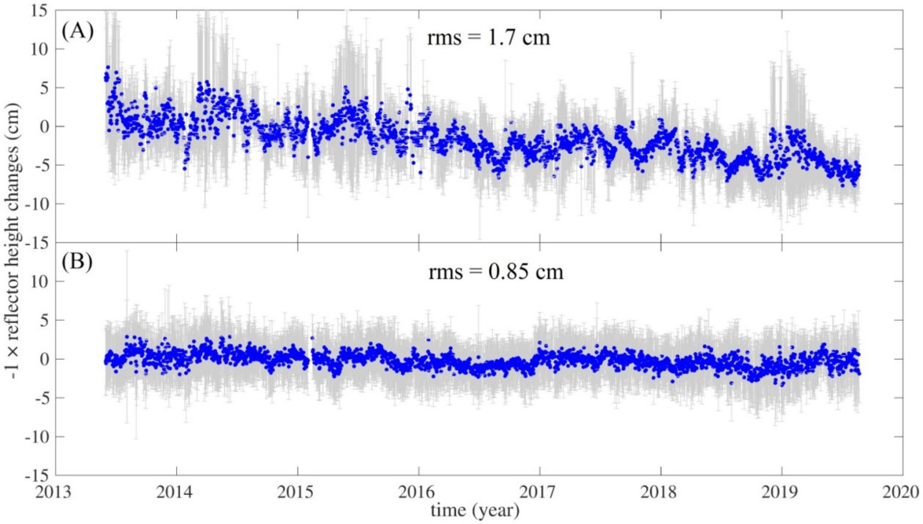
1) The primary aim of existing geodetic GPS networks is accurate positioning for geophysical studies and survey engineering so the SNR observable are not always archived in metadata associated with sites.



Source:
UNAVCO

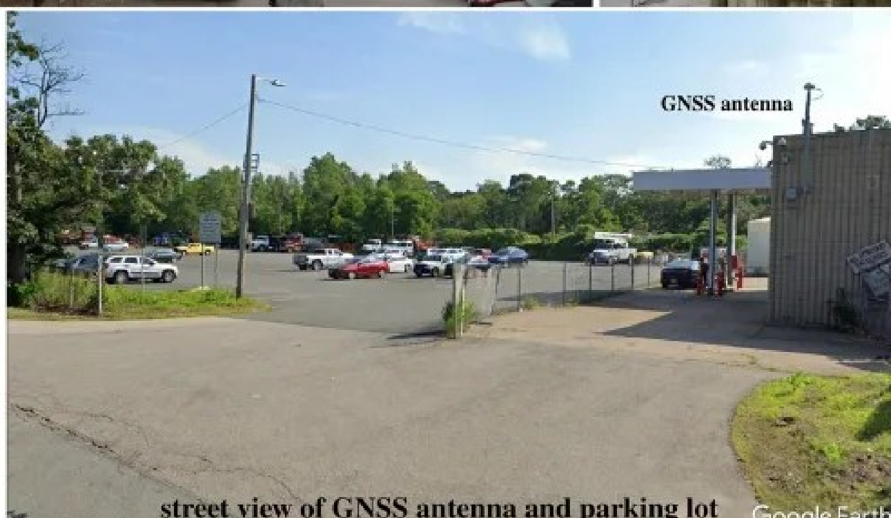


2) The GPS antenna must be located close to a fairly **planar natural surface** (preferably bare ground), so that with minimum imposed azimuth and elevation angle masks, desirable reflections from the area of interest are obtained.



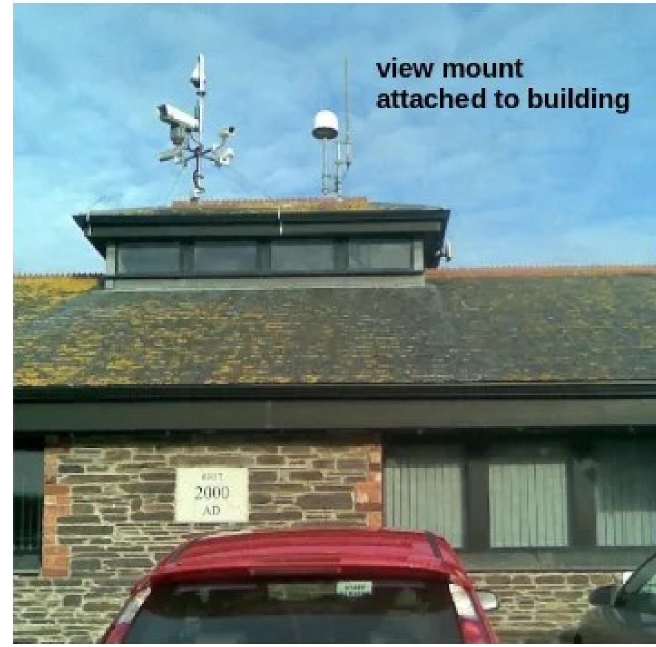
Caveat: implication for shallow VLM during 2020 lockdown

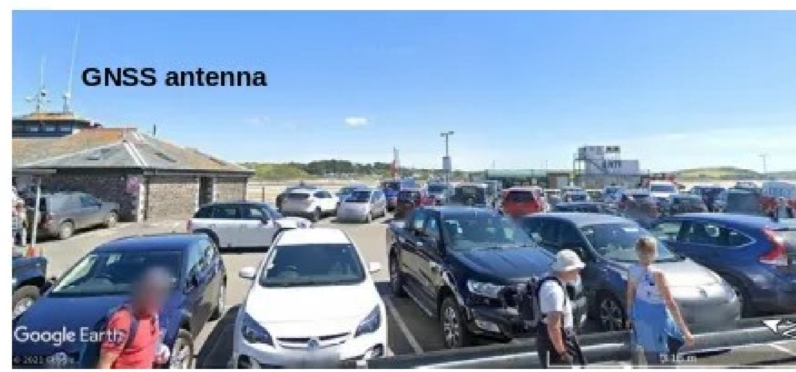
Boston, USA



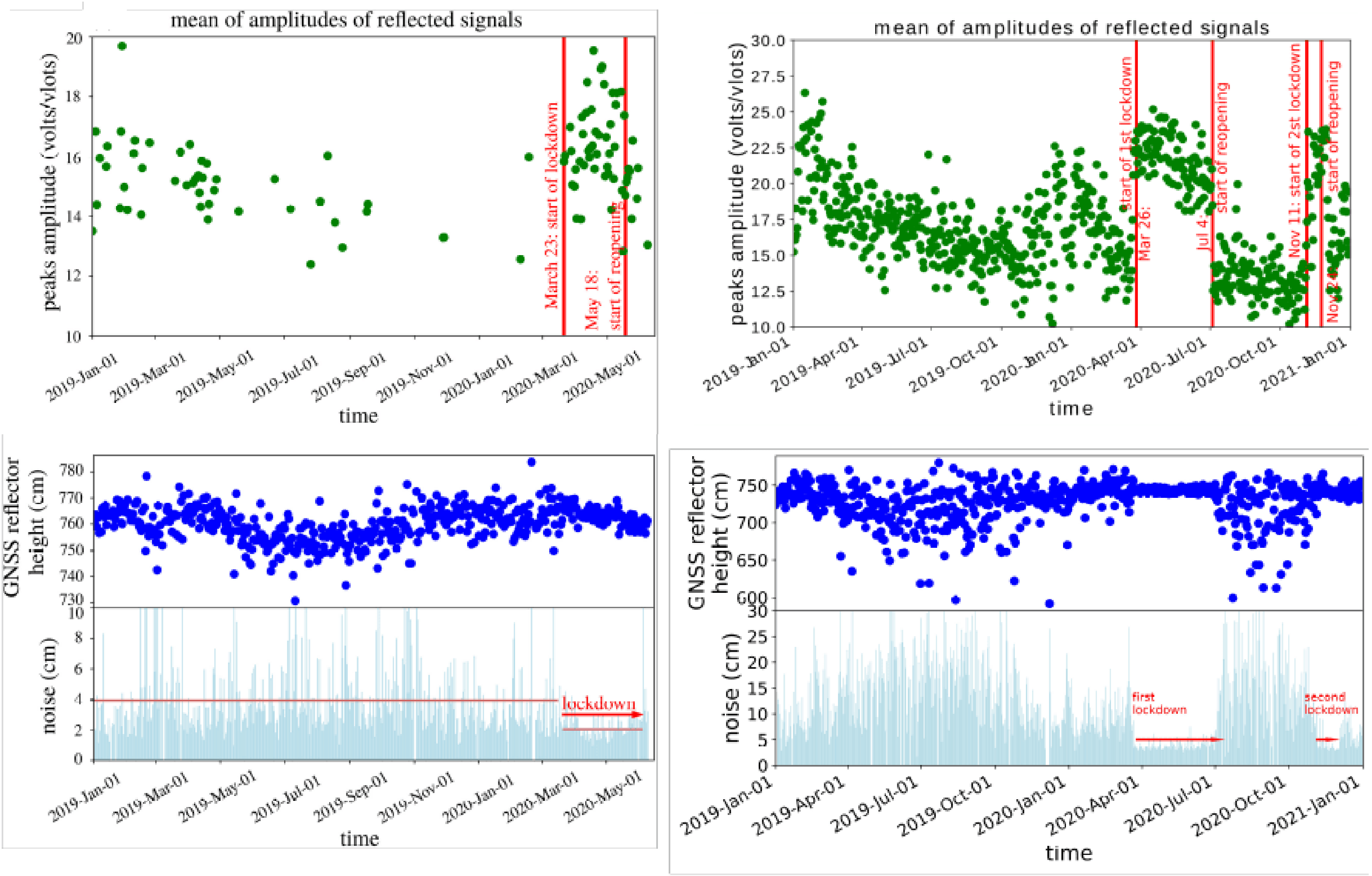
Karegar&Kusche (GRL, 2020)

Cornwall, England





Karegar et al., (AGU Fall Meeting, 2021)



* The coherent power of reflecting signals from parking lots increase with beginning of COVID-19 lockdown

* The uncertainty of GNSS antenna height drops with the beginning of lockdown, allowing more accurate estimate of reflector height

Summary and Remarks

- ✓ The shallow vertical displacements occurring within the foundation structure of GPS antenna is measured for the first time using GPS-IR technique.

- ✓ Our results highlight the importance of shallow subsidence for tide-gauges collocated with GPS in the LECZs. Note that many tide gauges in LECZs are discarded for global sea-level study. GPS-IR method can be used to quantify shallow subsidence and correct the rate of relative SLR at colocated tide gauges.

- ✓ Knowing shallow subsidence helps to better know if sediment accumulation could compensate the rate of sea-level rise.

- ✓ Clear evidence of environmental impact of parking lots and street surrounding monitoring sites on GNSS-IR measurements