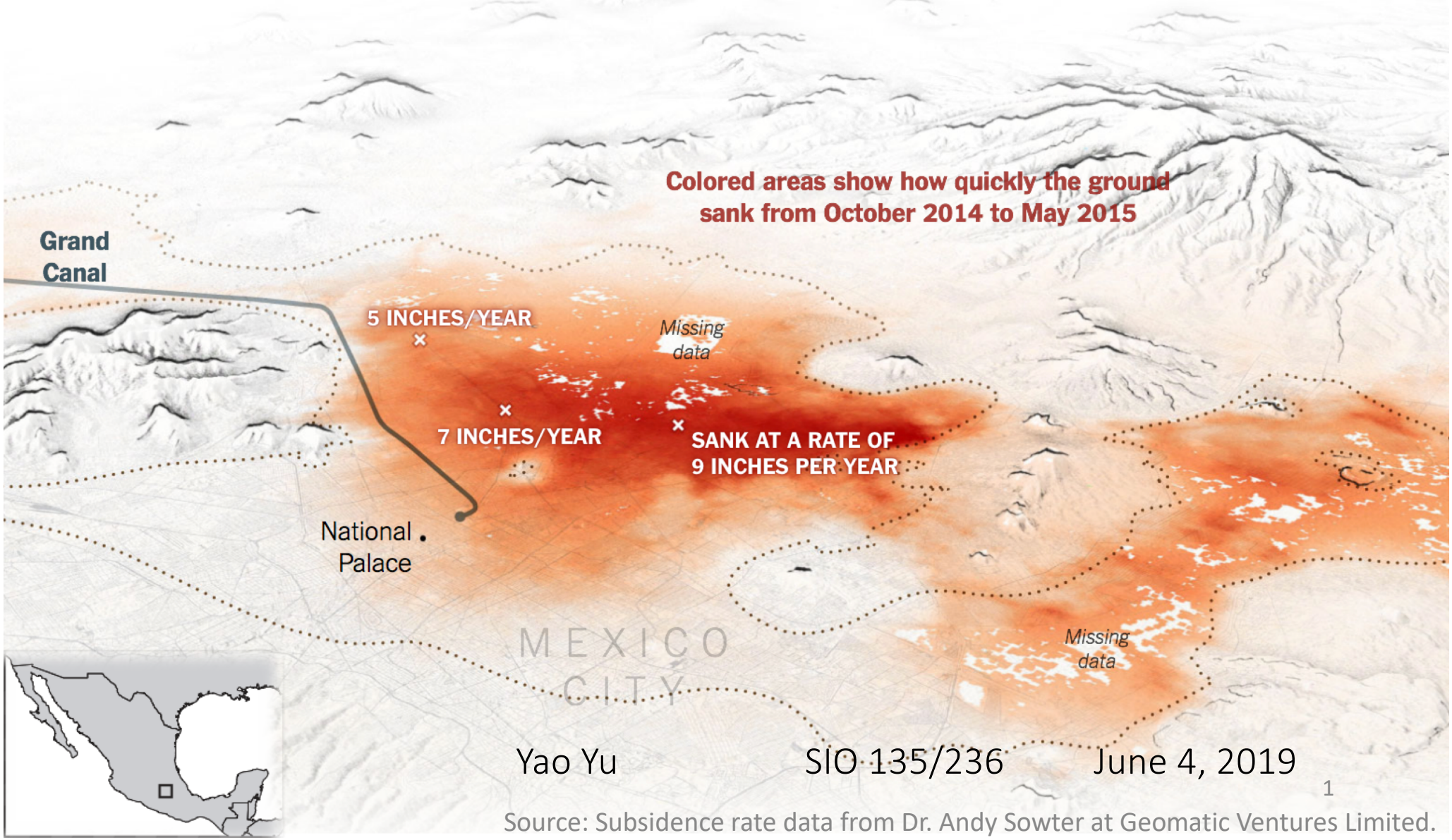
Land Subsidence in Mexico City Observed by InSAR

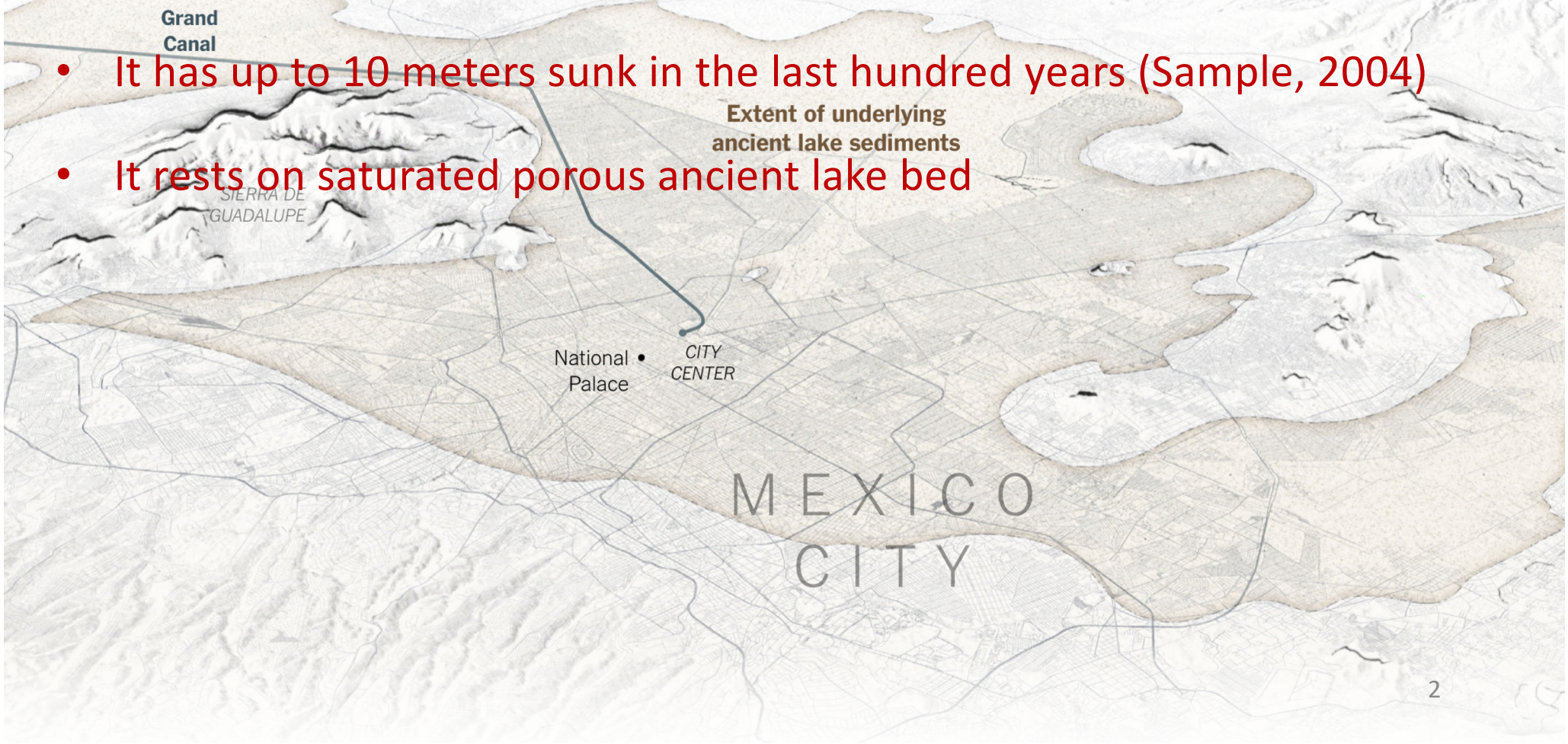


Yao Yu SIO 135/236 June 4, 2019

Source: Subsidence rate data from Dr. Andy Sowter at Geomatic Ventures Limited.

Mexico City

- Land subsidence due to excess groundwater withdrawal
- Current subsidence rates up to 40 cm/yr
- It has up to 10 meters sunk in the last hundred years (Sample, 2004)
- It rests on saturated porous ancient lake bed



Extra point

Ongoing drought-induced uplift in the western United States

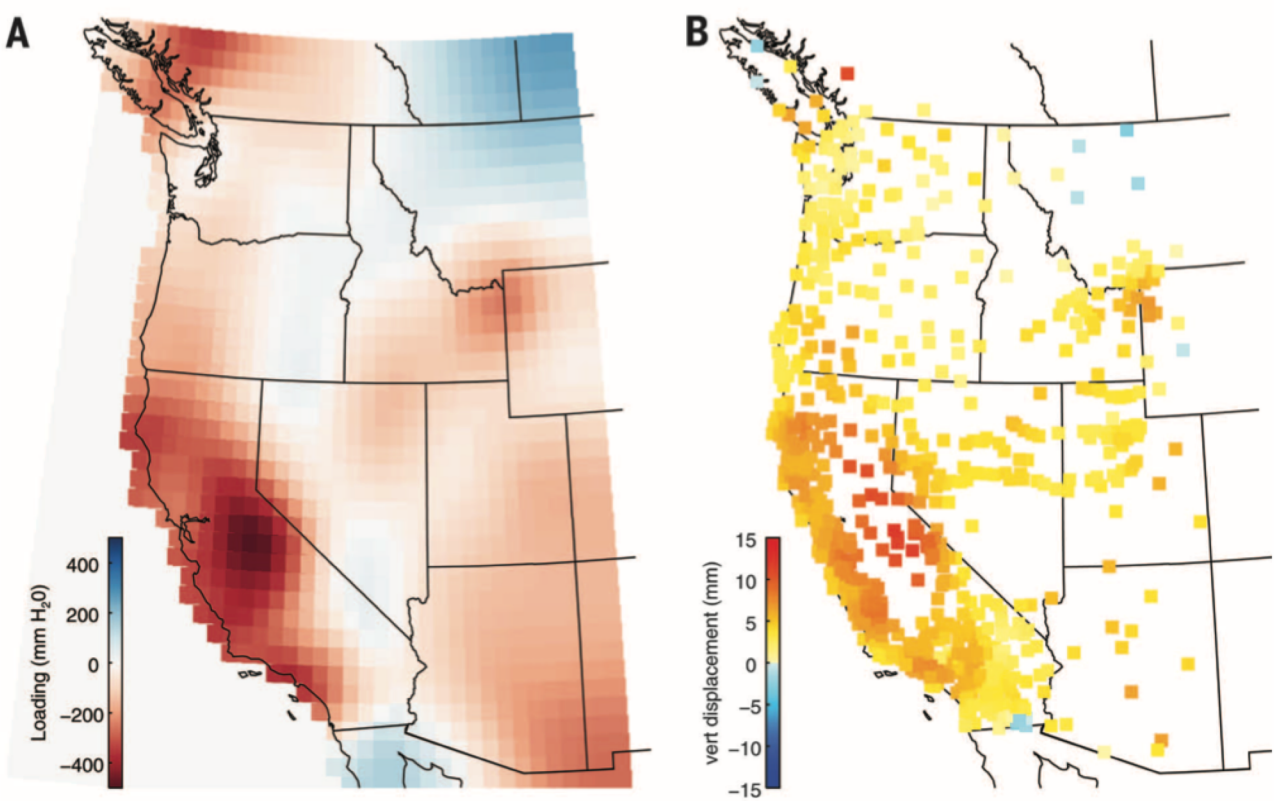


Fig. 3. Maps of estimated loads and predicted displacements. (**A**) Loading estimate for the WUSA in

Borsa et al., 2014

Loading Vs. Aquifer

Elastic response to a Water load

Mountains subside in elastic response to a snow or water load

81% of GPS sites

Porous response to Groundwater change

Aquifers expand as groundwater fills the pores between the silts, sands, and gravels comprising the aquifer

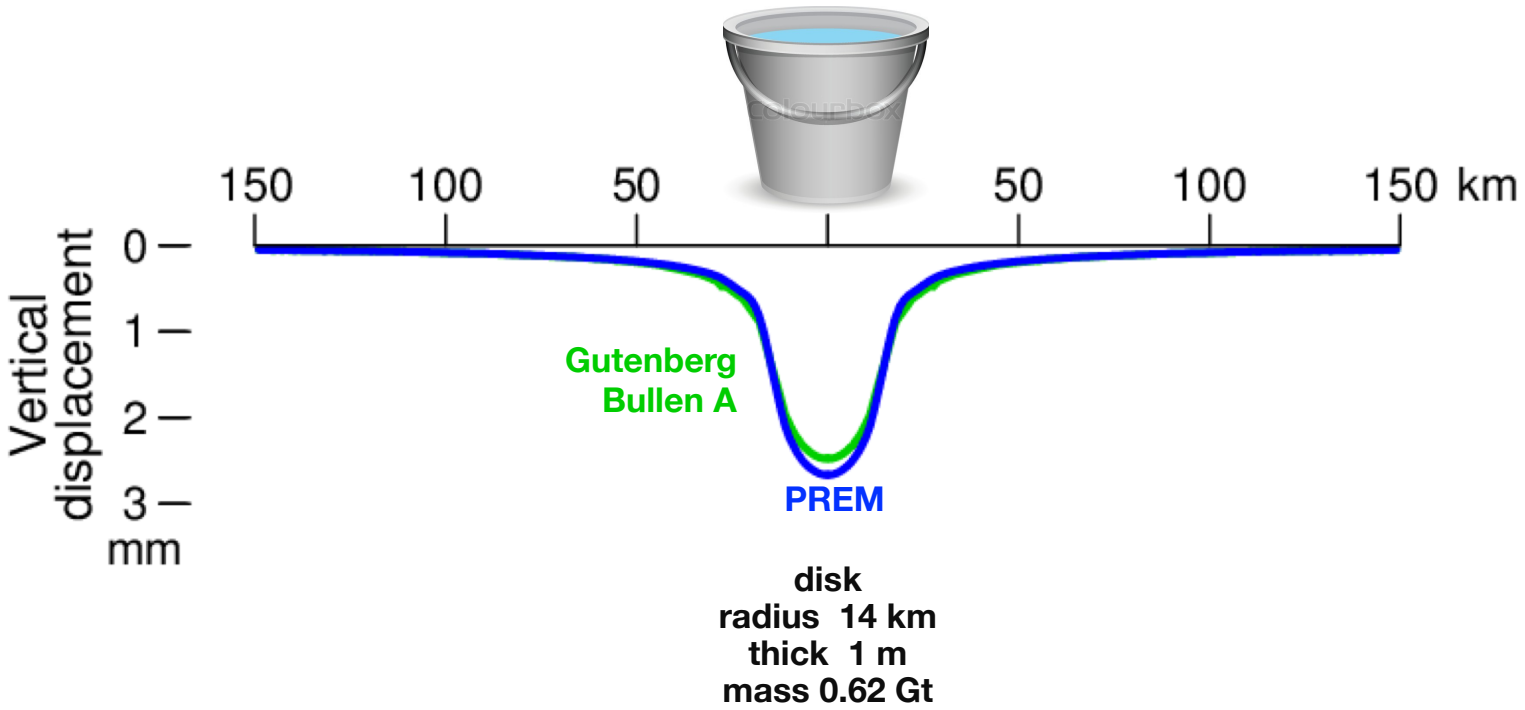
10% of GPS sites

Distinguish porous response on the basis of:

1. **Time of maximum height around April**
2. **Subsiding faster than 2.5 mm/yr**
3. **Within 10 km of a groundwater well**
4. **Episodic transients**

Source: Argus, Haines

Solid Earth's elastic response to a mass load is known



Solid Earth's elastic response is tight in space.

Elastic deformation is not sensitive to Earth's rheology.

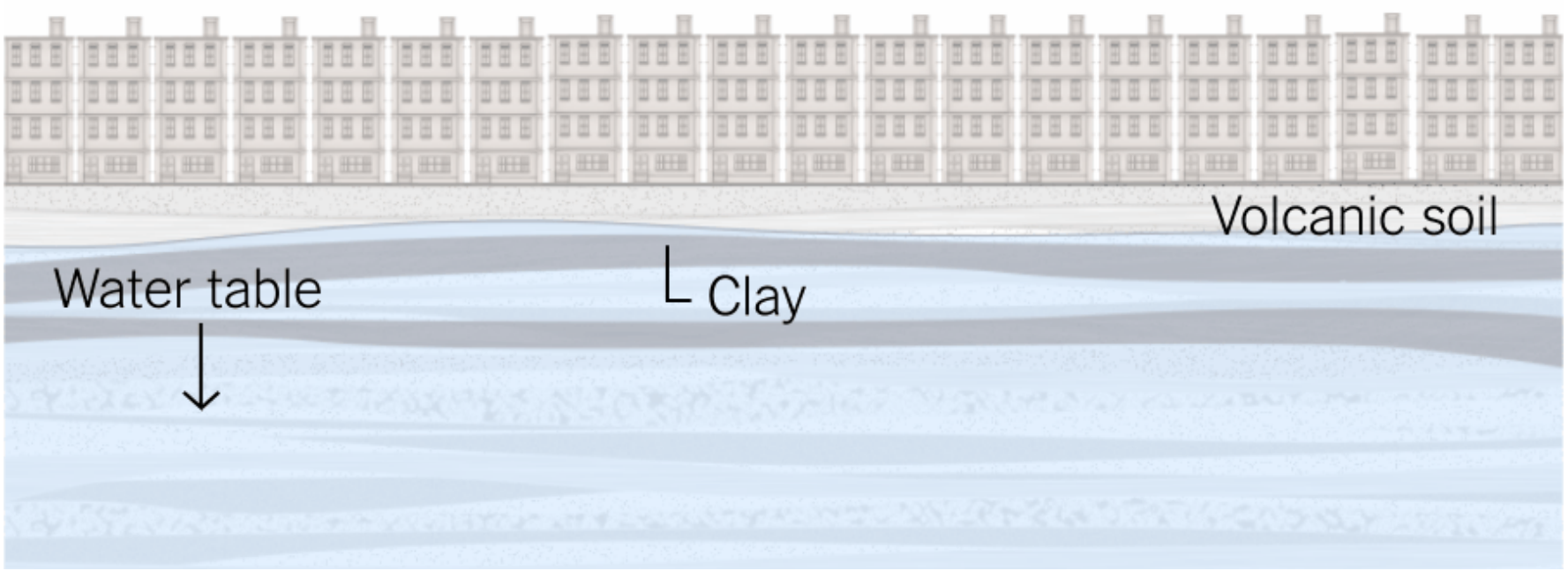
for surface loads
more than 50 km across

not for a
non-gravitating
half space

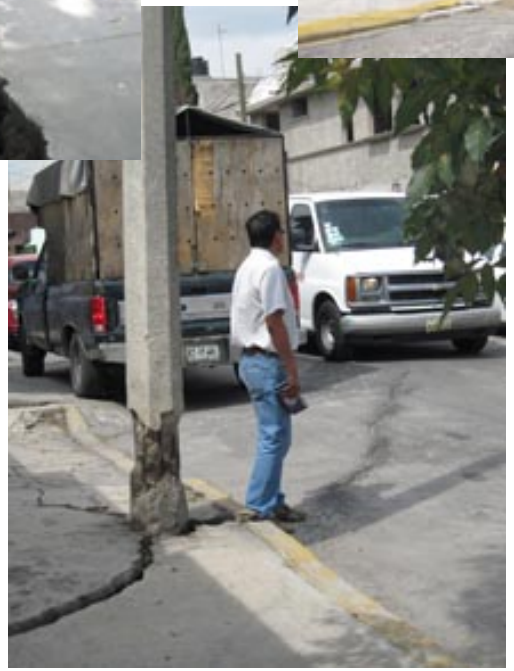
The elastic response is calculated for a gravitating, spherical, stratified Earth.

Source: Argus, Haines

Land subsidence

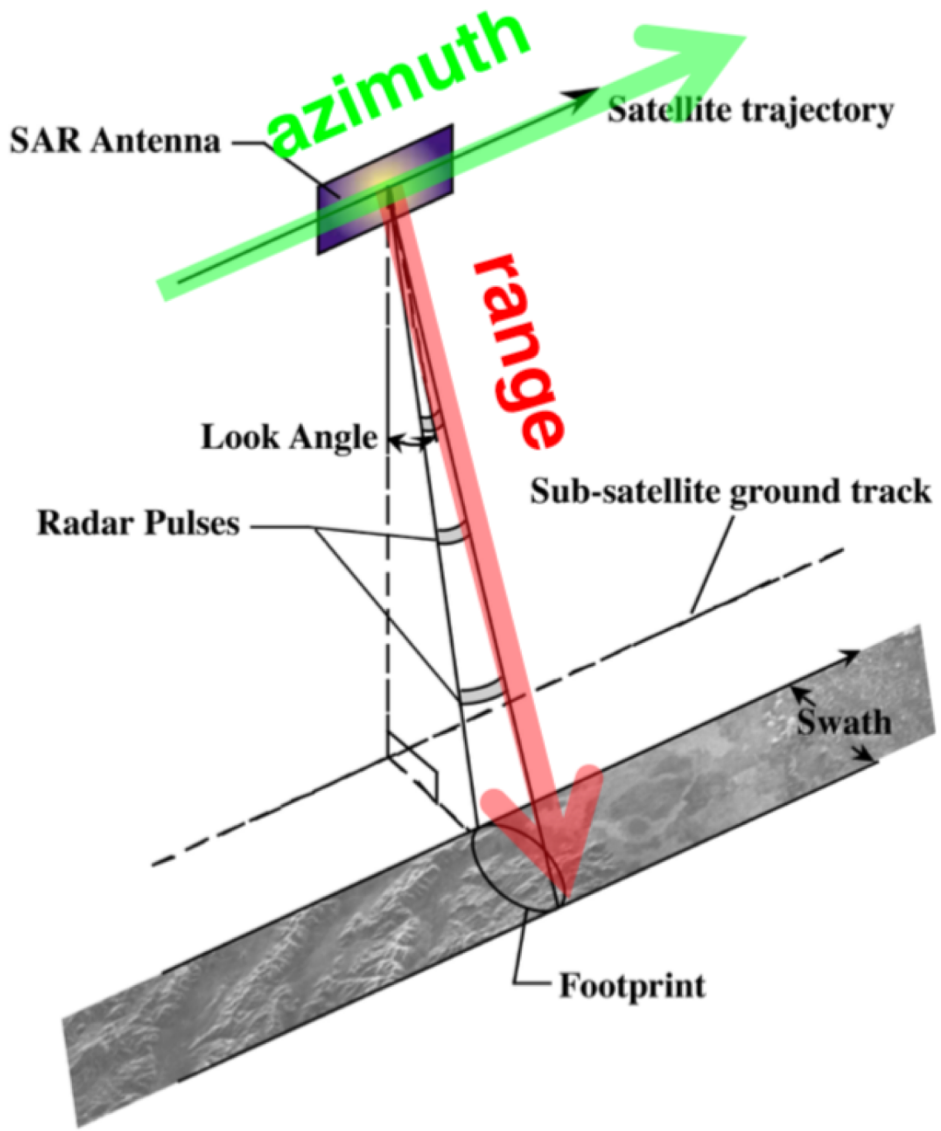


Subsidence and the associated shallow fracturing and faulting



Source: FIU Geodesy Lab http://geodesy.fiu.edu/MexSubsidence/index.html

SAR (Synthetic Aperture Radar)



Sentinel-1

1A/1B: launched in 2014/2016
C-band ($\lambda = 5.54\ cm$)

~700 km altitude

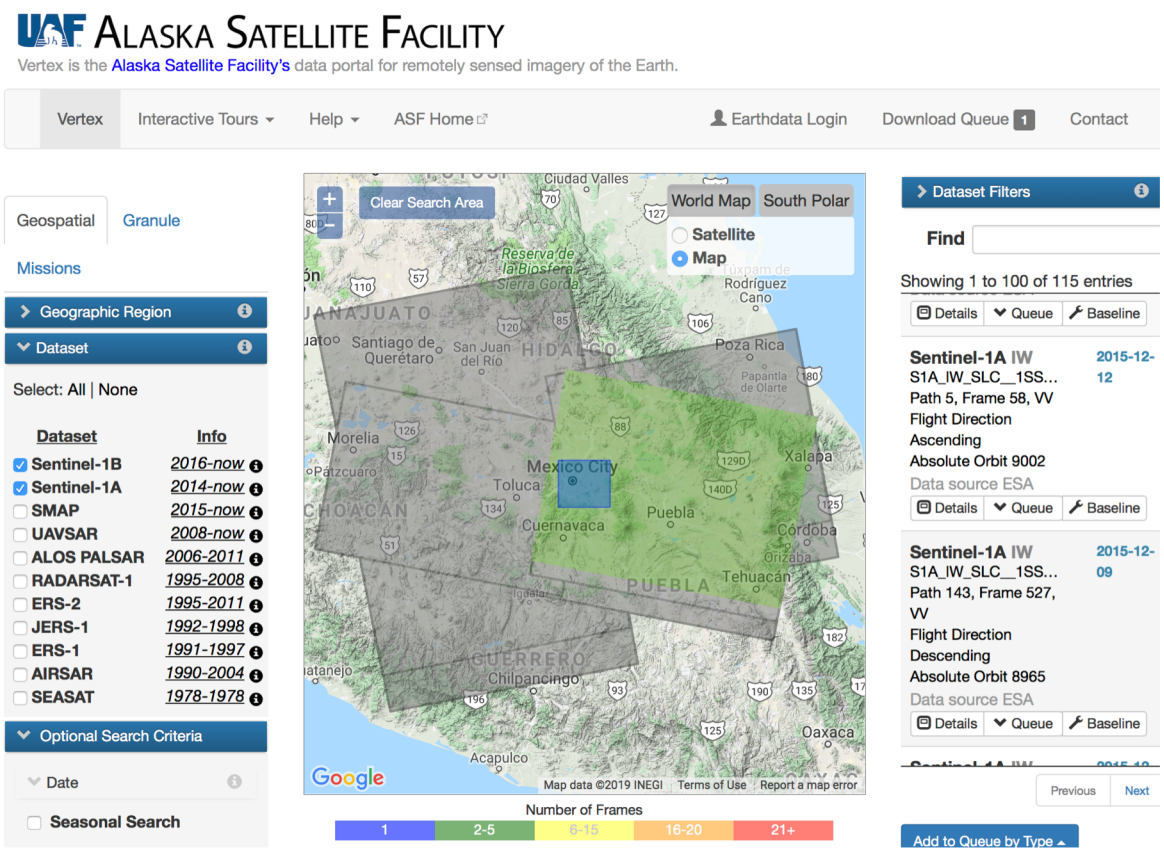
Repeat cycle 12 days

Terrain Observations by Progressive Scans (TOPS)

Interferometric Wide swath mode (IW)
250 km swath
5m × 20m resolution

Level-1 Single Look Complex (SLC)

Sentinel-1 data



5 scenes

20150212
20160207
20170201
20180121
20190209

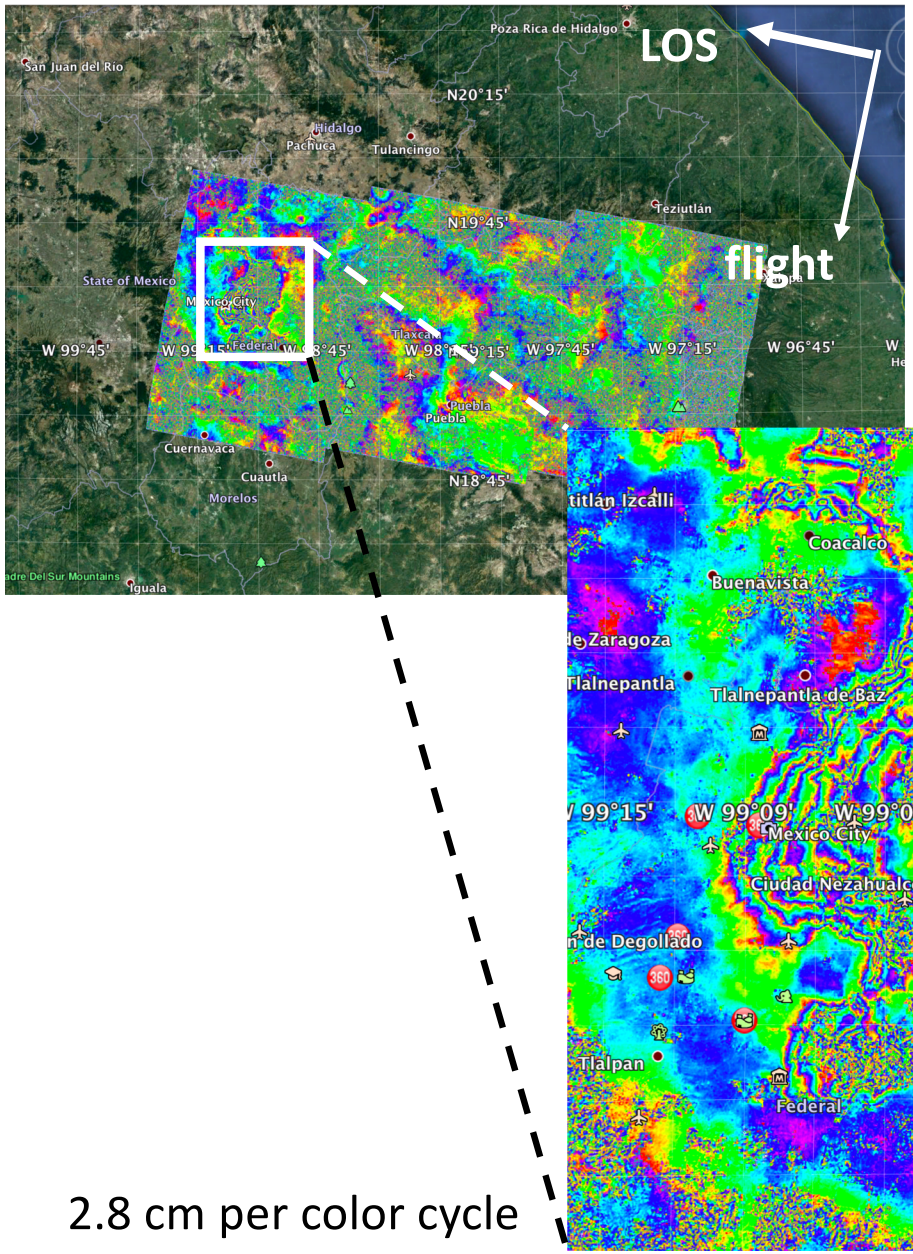
4 interferograms

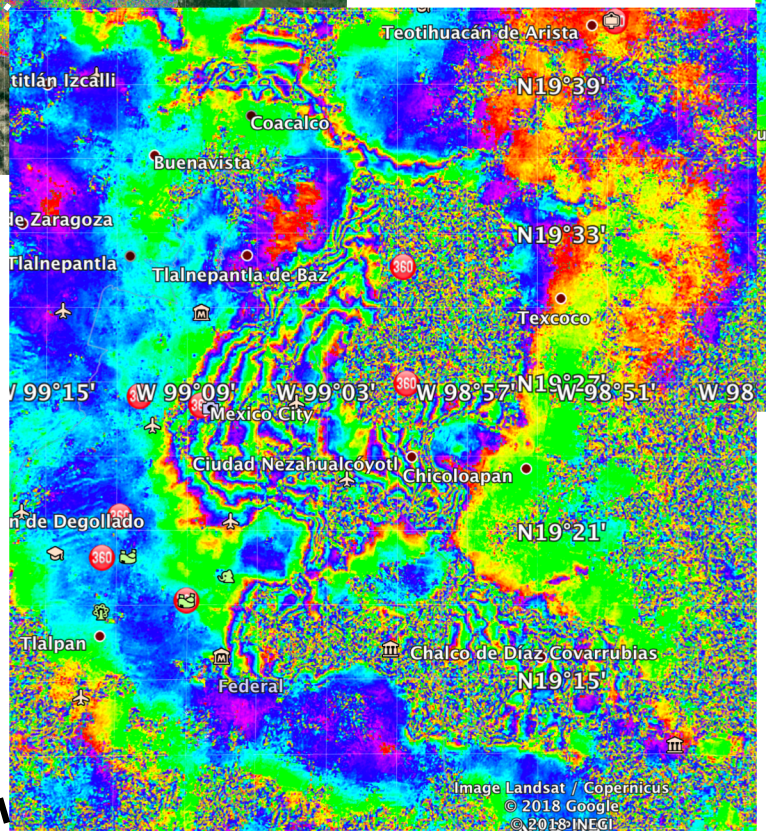
Annual deformation

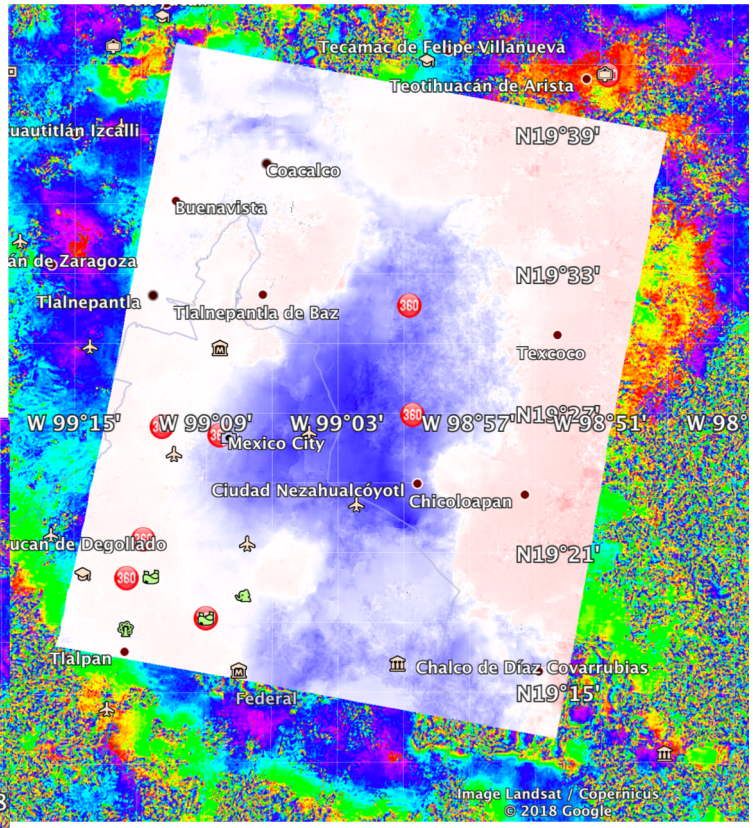
https://vertex.daac.asf.alaska.edu

Data processing

GMTSAR





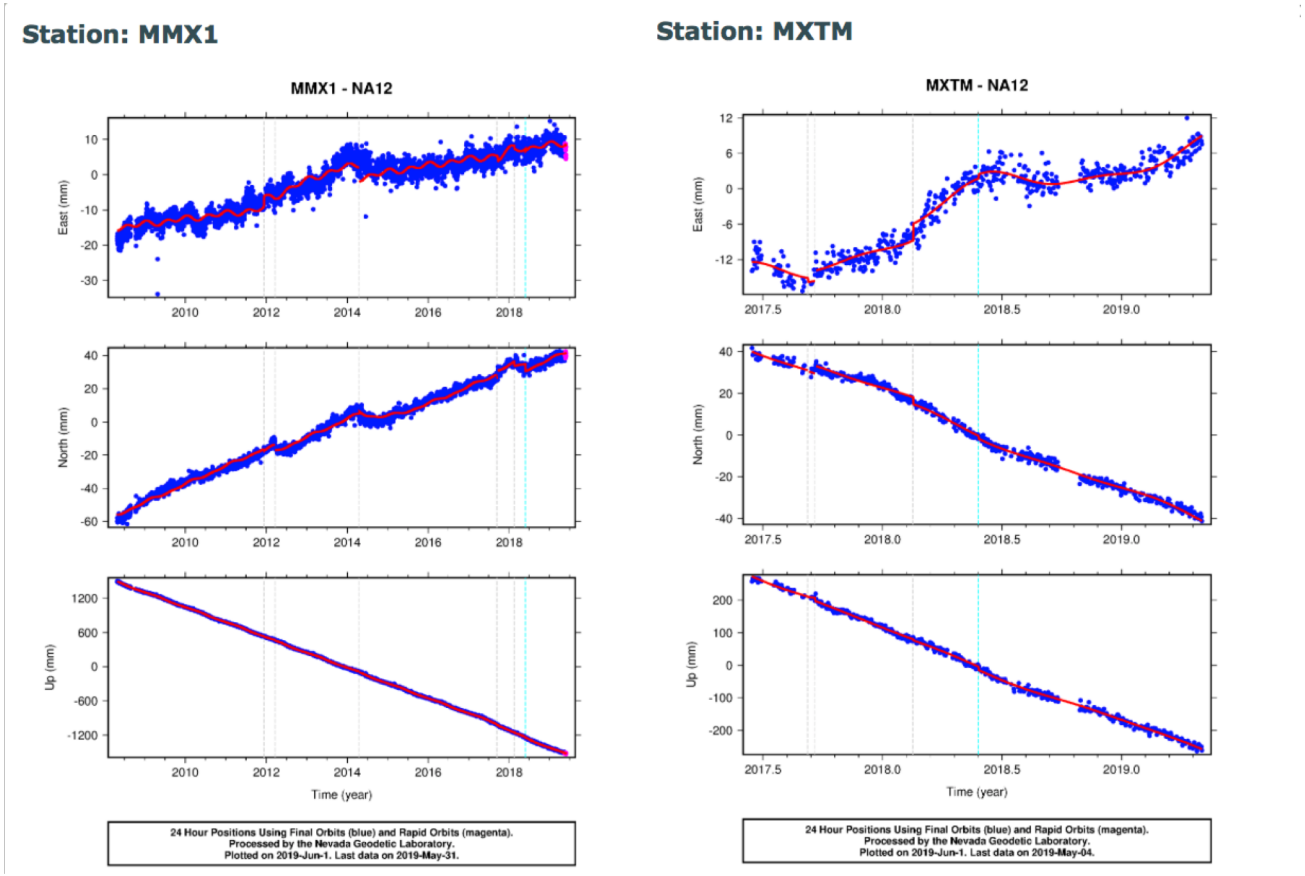


Deformation in LOS direction.
Roughly times 1.3 to get the vertical deformation

2.8 cm per color cycle

https://topex.ucsd.edu/gmtsar/

GPS time series



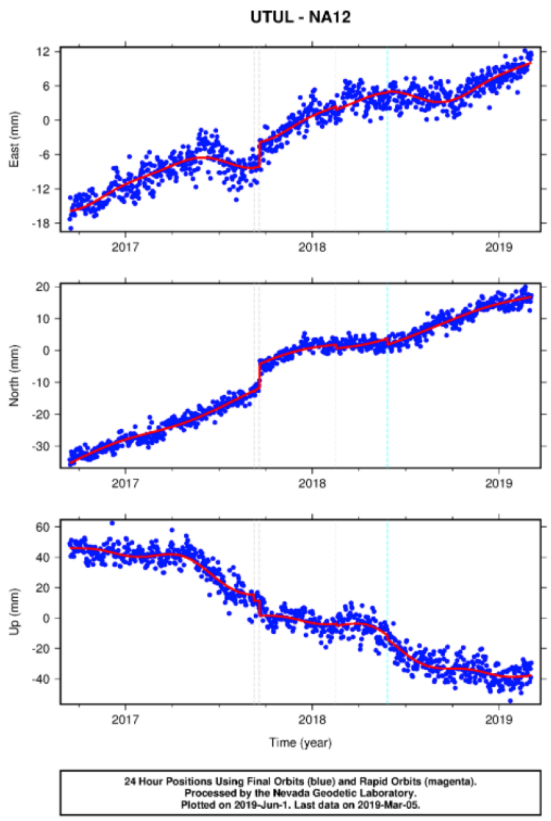
North: 8 mm/yr
Up: -270 mm/yr
LOS: -192 mm/yr

North: -45 mm/yr
Up: -285 mm/yr
LOS: -190 mm/yr

http://geodesy.unr.edu/NGLStationPages/gpsnetmap/GPSNetMap.html

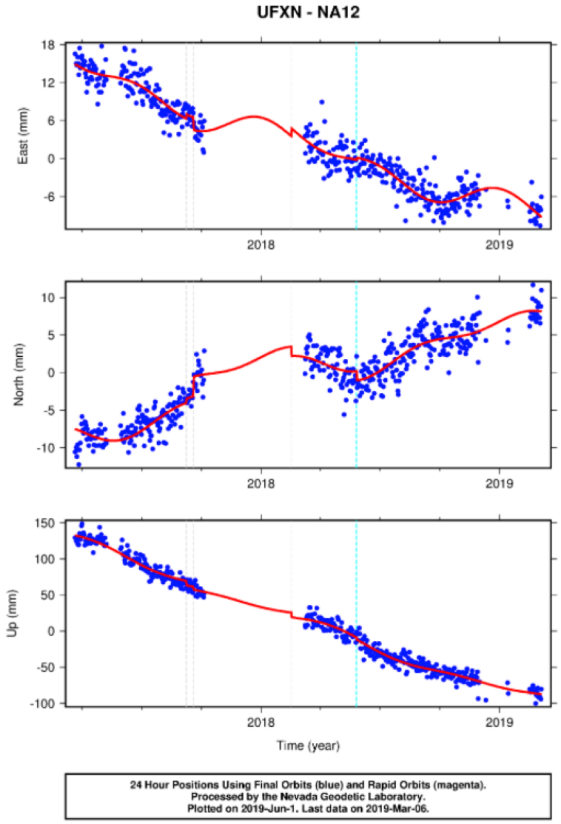
GPS time series

Station: UTUL



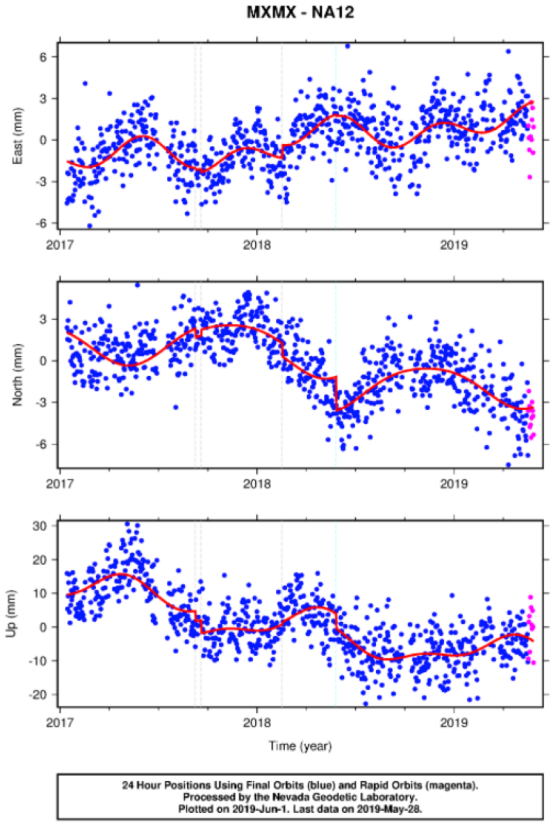
Up: -40 mm/yr

Station: UFXN



Up: -120 mm/yr

Station: MXMX



Want to learn InSAR processing?

Course Information | InSAR Processing and Theory with GMTSAR

Dates: July 24-26, 2019

Times: Course will begin at 9:00 a.m. on July 24 and end at 12:00 p.m. on July 26

Location: Scripps Institution of Oceanography, La Jolla, CA

Registration: April 1 - May 15 **Registration is closed**

Course Navigation

- Registration closed 2019-05-15
- Request financial support

This 2.5 day course will cover the theory and application of InSAR processing with GMTSAR. Lectures and exercises will be given to teach the basic theoretical aspects of InSAR. Labs will include software installation, running test data sets for standard interferogram formation as well as more advanced processing for time series with Sentinel-1A TOPS-mode data. Those unfamiliar with the software package GMT are encouraged to also attend the Generic Mapping Tools (GMT) for Geodesy short course at the same location on July 22 and 23.

Brief Agenda

- Install UNIX on laptop and complete UNIX tutorial prior to workshop.
- Install and test Generic Mapping Tools GMT5 prior to workshop.
- Day 1: Install and test GMT5SAR. Presentations of theory on SAR and InSAR.
- Day 2: Process interferograms for presentation. Presentations on accessing the SAR data archives at UNAVCO and ASF.
- Day 3: Students present their InSAR results.
- See course materials and student presentations from last year: 2018 Course Materials

https://www.unavco.org/education/professional-development/short-courses/2019/insar-gmtsar/insar-gmtsar.html