Overview & Importance of InSAR Applications and Services for Texas

By: Danielle Smilovsky, PhD
Geospatial Research Scientist – InSAR Program Lead

Conrad Blucher Institute at Texas A&M University-Corpus Christi

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What do we do at CBI?

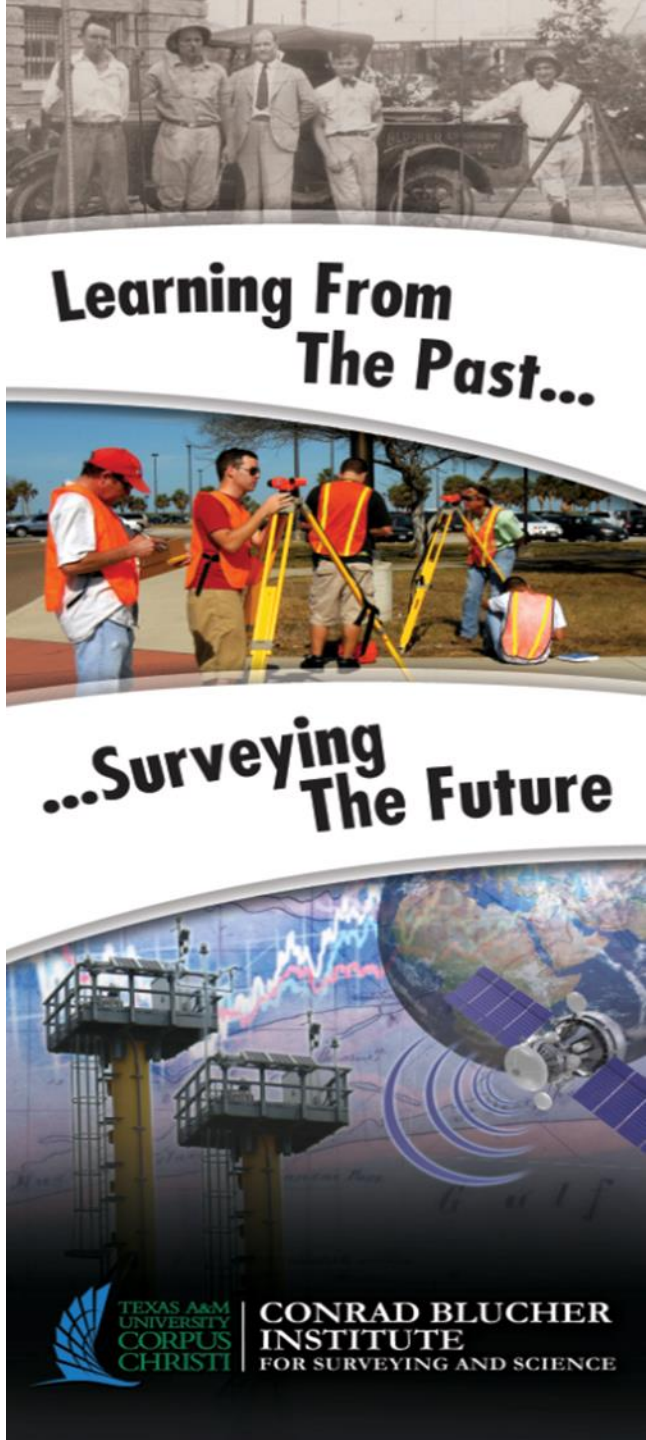
The institute was founded on the principle of geospatial education and research

Academics:

- B.S. in Geographic Information Science
- M.S. in Geospatial Systems Engineering
- Ph.D. Geospatial Computer Science

Research Operations & Laboratories:

- Installation, operation, maintenance, and repair of various environmental data collection stations along the Gulf Coast
- Collects and disseminates near real-time data to decision-makers and the public



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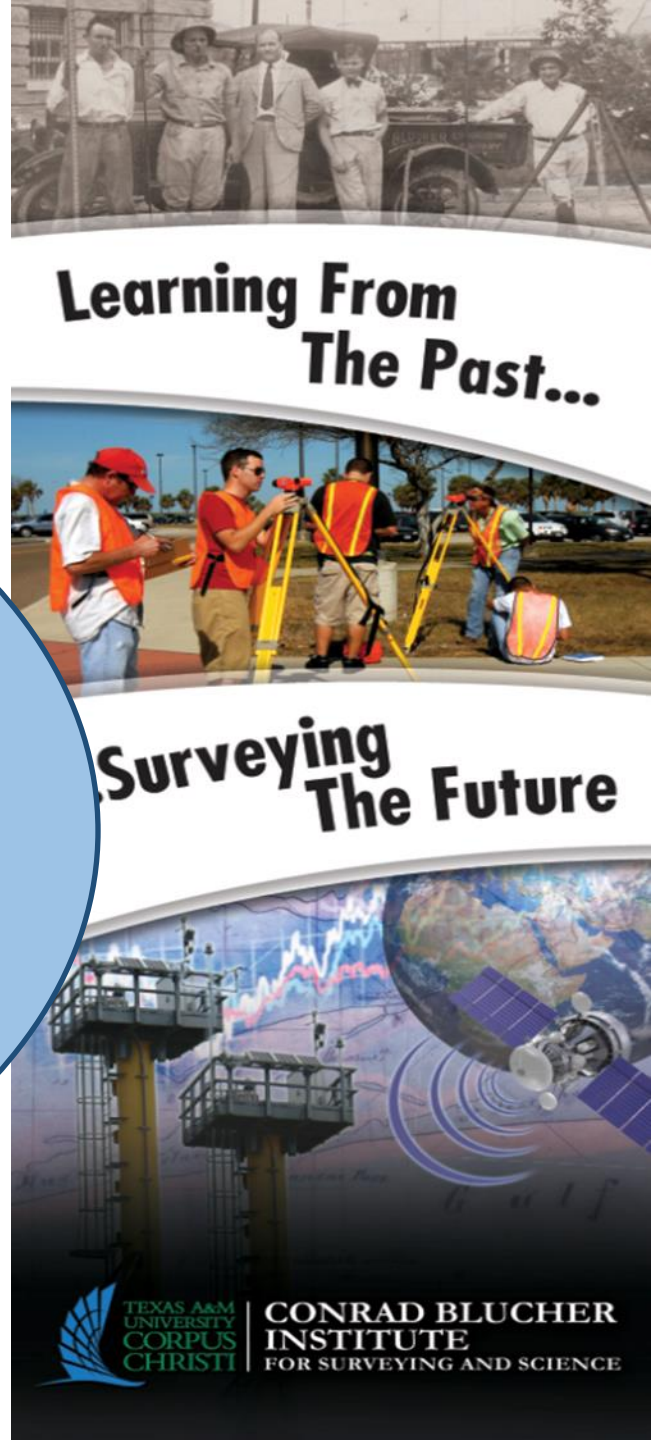
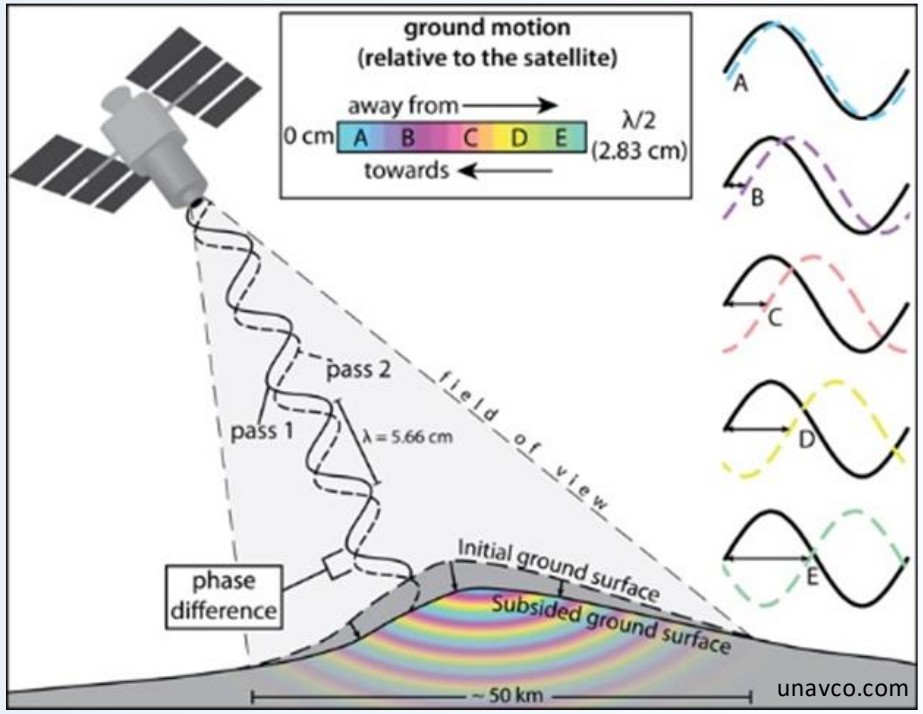
Dr. Rick Smith –CBI Director…

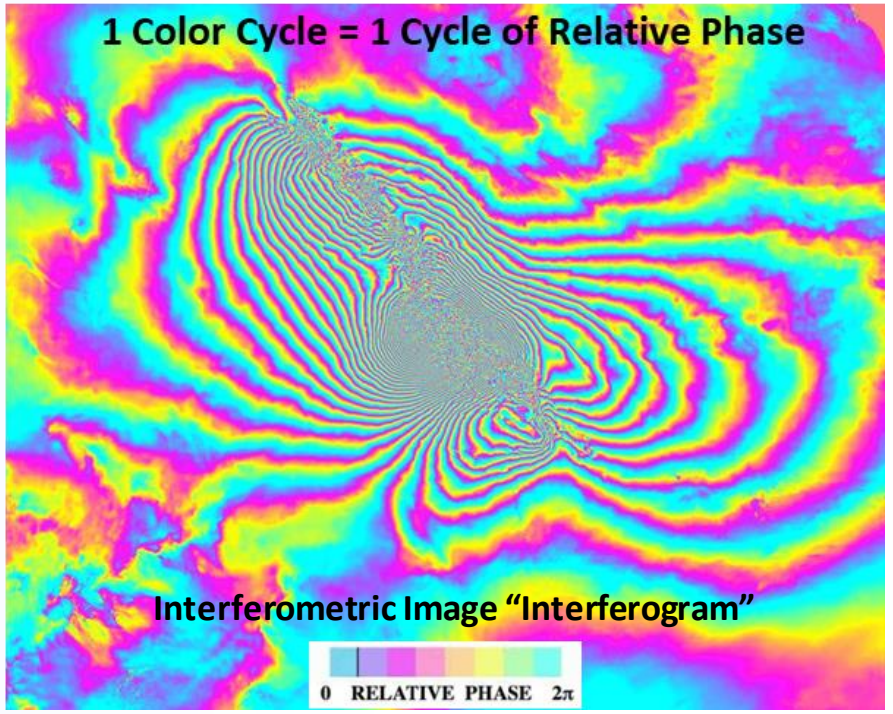
CBI is comprised of measurement scientists focusing on the production of high-quality spatial scientific data. The institute's roots are in land surveying and grew to include applications of artificial intelligence, geomatics, near real-time environmental monitoring, and remote sensing. We serve the needs of our sponsors, and the public, by developing and applying trusted and accurate methods to provide data and guidance to study our dynamic world.



Brief Introduction to InSAR

InSAR – Interferometric Synthetic Aperture Radar





- Radar interferometry uses phase measurements to measure the relative distance from a satellite sensor to an object when imaged by synthetic aperture radar from 2 or more observations separated in time
- Radars operate at microwave frequencies (invisible) and have wavelengths in the millimeter to meter range
- Phase measurements are made with degree level accuracy, with radar wavelengths in 3-80 cm range, this corresponds to relative range measurements having centimeter to millimeter accuracy
- Phase measurements are reflected as color cycles in interferograms, where 1 color cycle represents 1 cycle of relative phase or land change relative to the satellite

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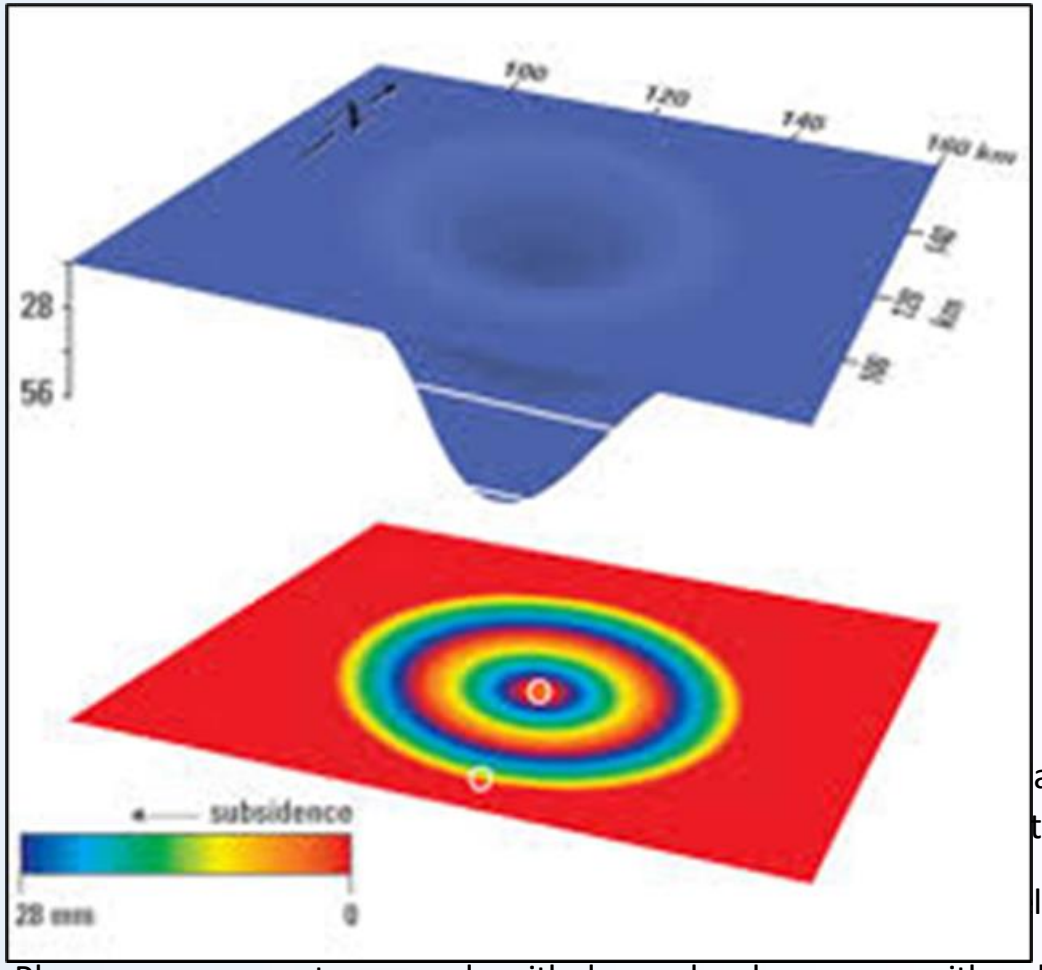

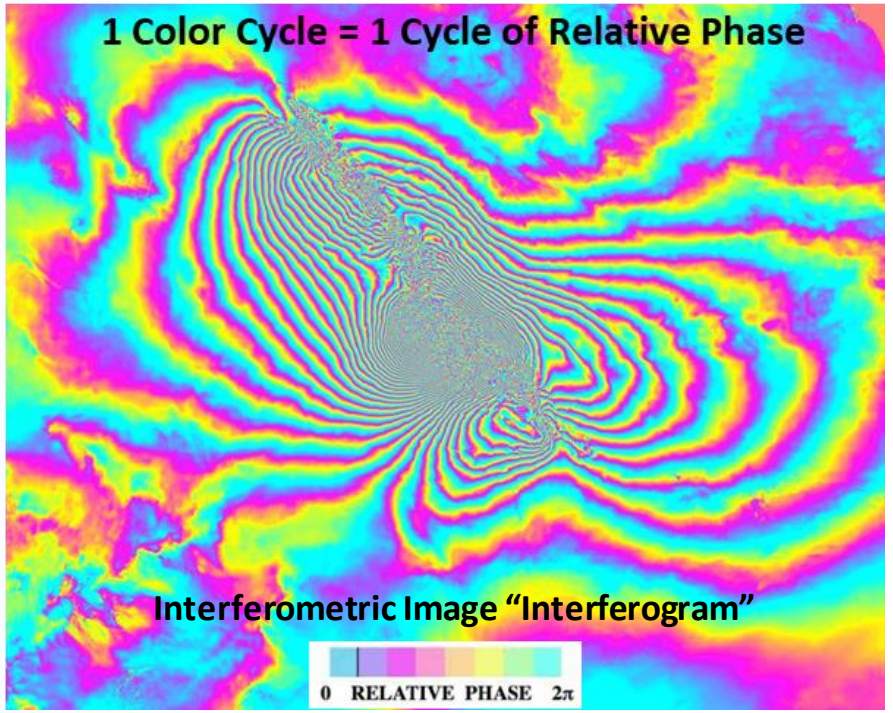

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What Can Radar Tell Us?

Characteristics From Transmitted Radar to Help us Understand and Characterize Objects of Interest

- Wavelength (Frequency)
- Phase & Time values
- Polarization
- Amplitude

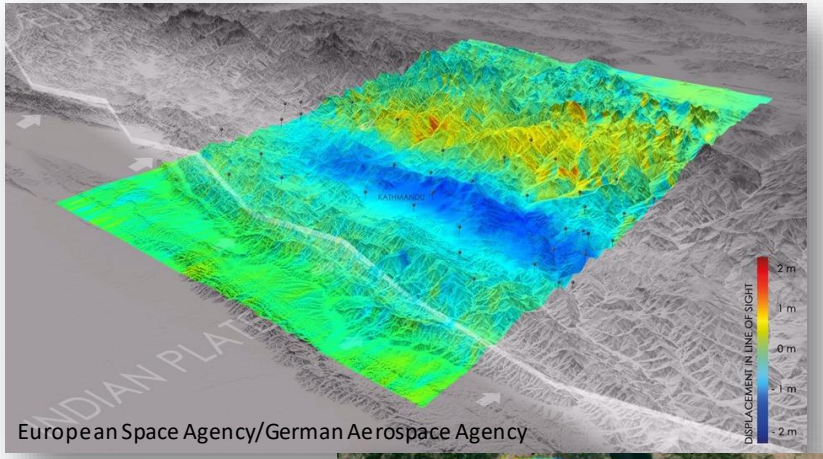
Applications & Production

- Topographic change maps –Digital Displacement Models
- Deformation & Change Detection Mapping
- Monitoring and Management of Earthquakes, Volcanoes, Subsidence & Recharge, Coastal Environments, Landslides, Disasters, Deforestation, Wildfires, Glacier and Ice sheet Dynamics

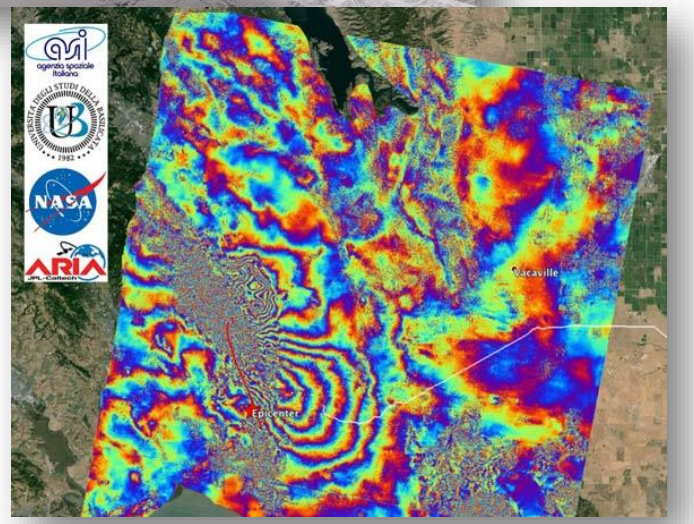
Repeat Pass Radar Interferometry Displacement Models

- Sub-centimeter relative displacement accuracy
- 10-100m post spacing & resolution

Kathmandu Earthquake – Displacement Model



European Space Agency/German Aerospace Agency



Napa Valley Earthquake – Interferogram (Phase Difference)

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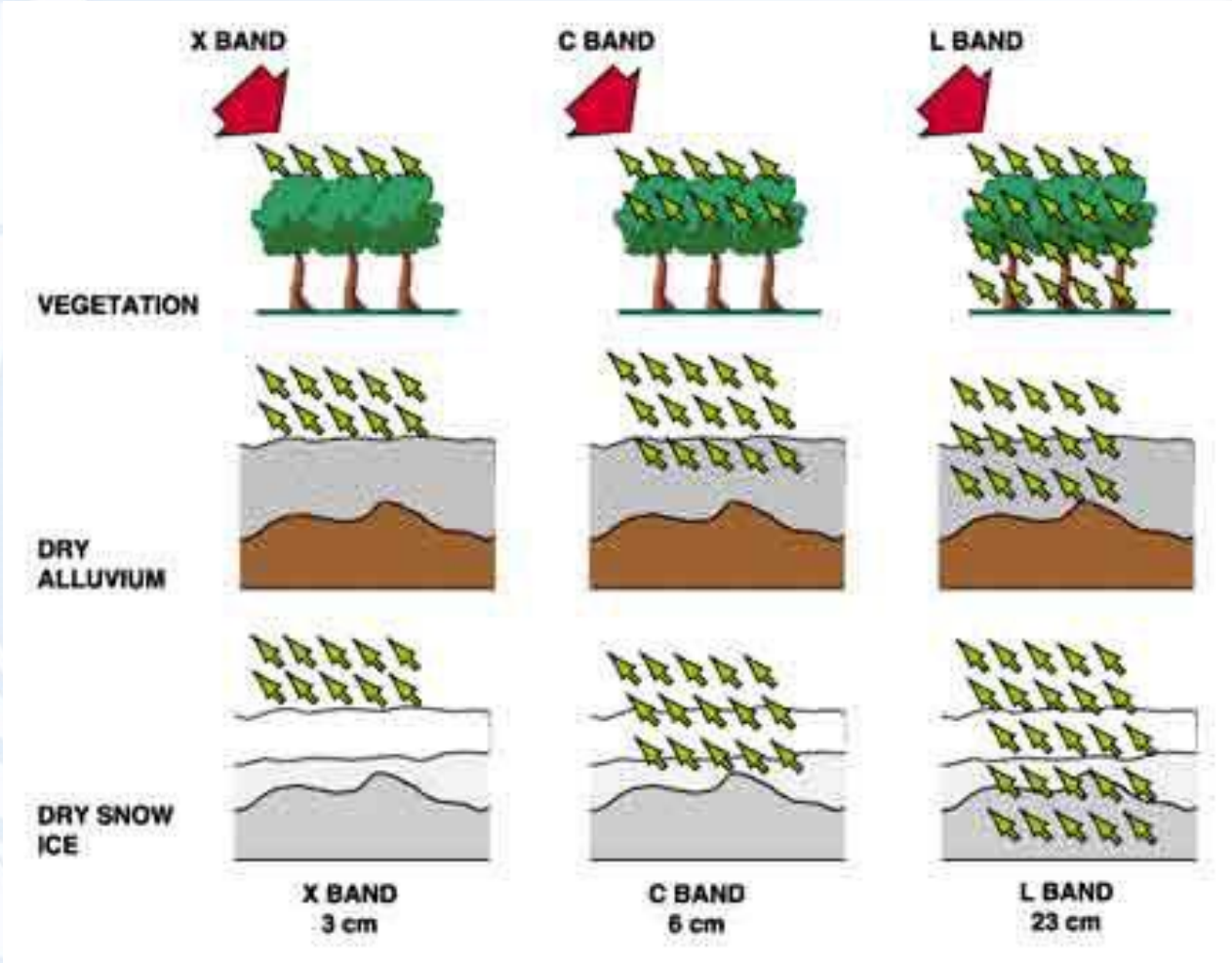

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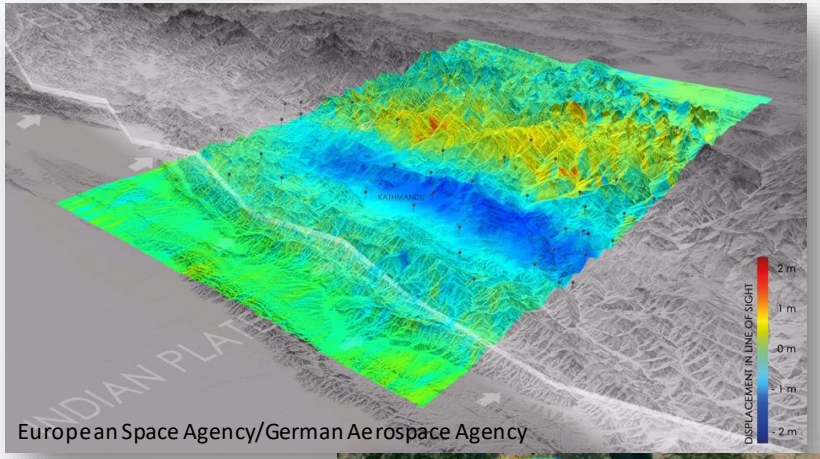

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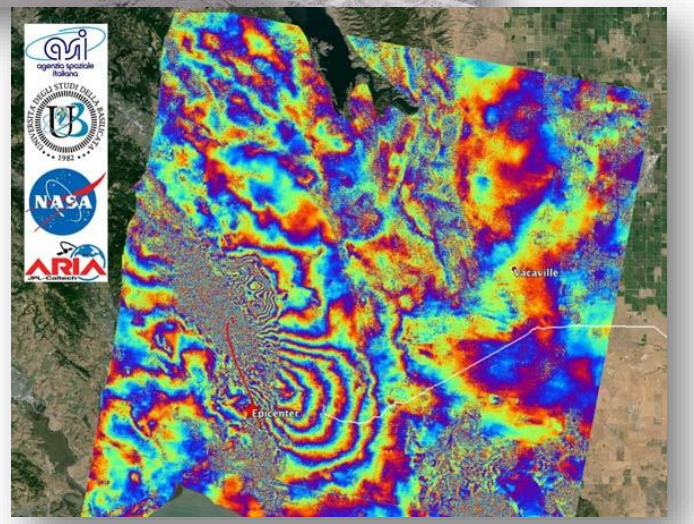
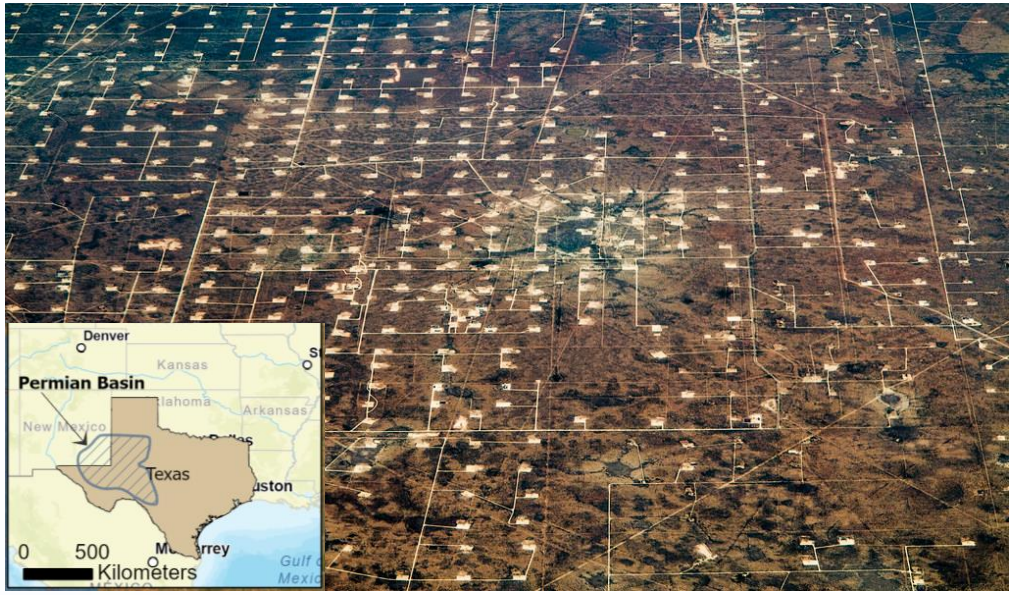


Napa Valley Earthquake – Interferogram (Phase Difference)

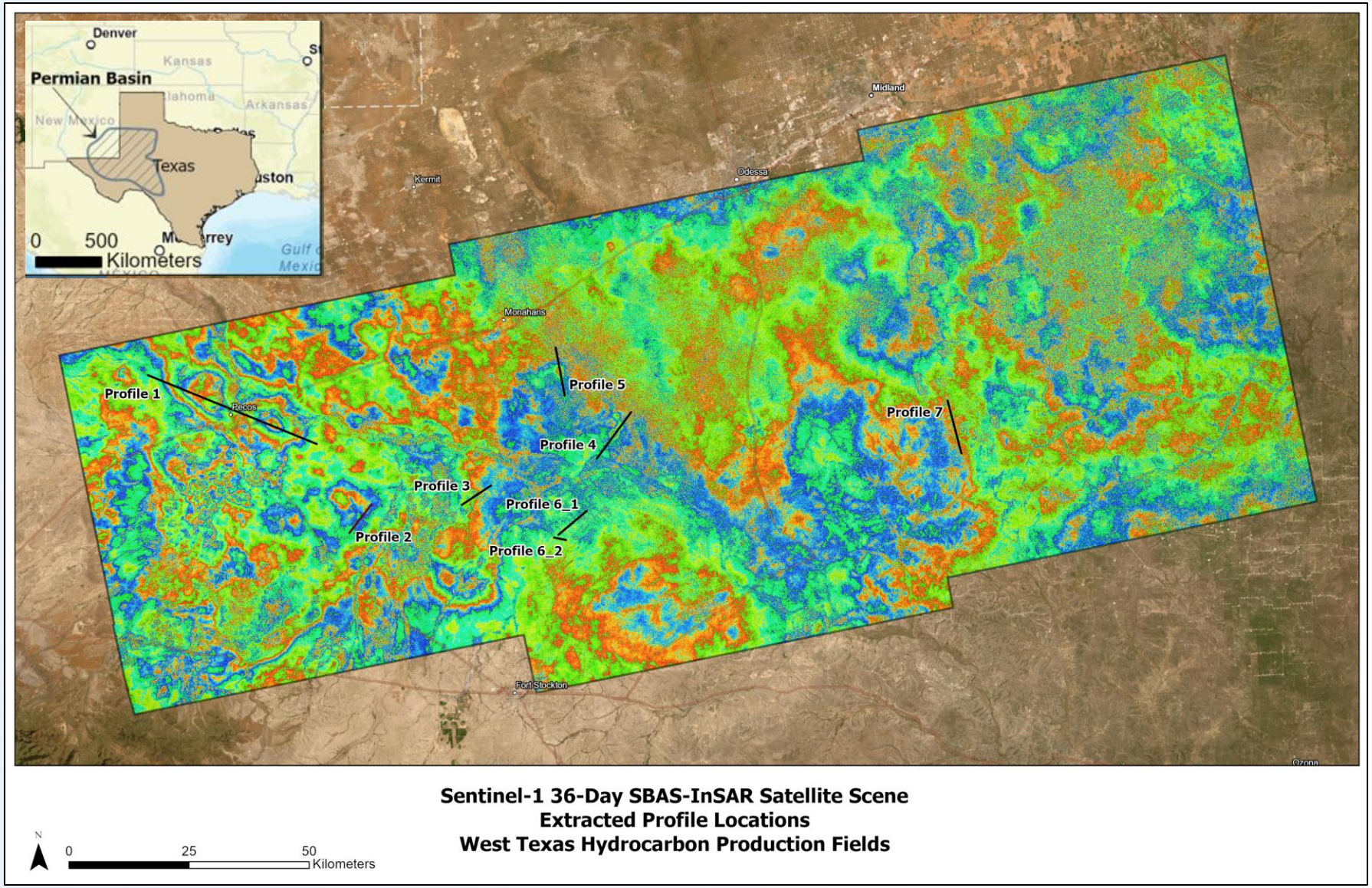
West Texas Hydrocarbon Production Fields

- Permian Basin – Dense hydrocarbon production fields in West Texas
- Hydraulic Fracturing & Horizontal Drilling – Skyrocketing production activities
- Drilling boom – Good for business with environmental and social consequences attached
- Fluid injection and extraction processes – land deformation
- Increased seismicity and earthquakes each year
- Land deformities can go unnoticed – Remote Sensing InSAR technology can help



Texasobserver.org

West Texas Hydrocarbon Production Fields



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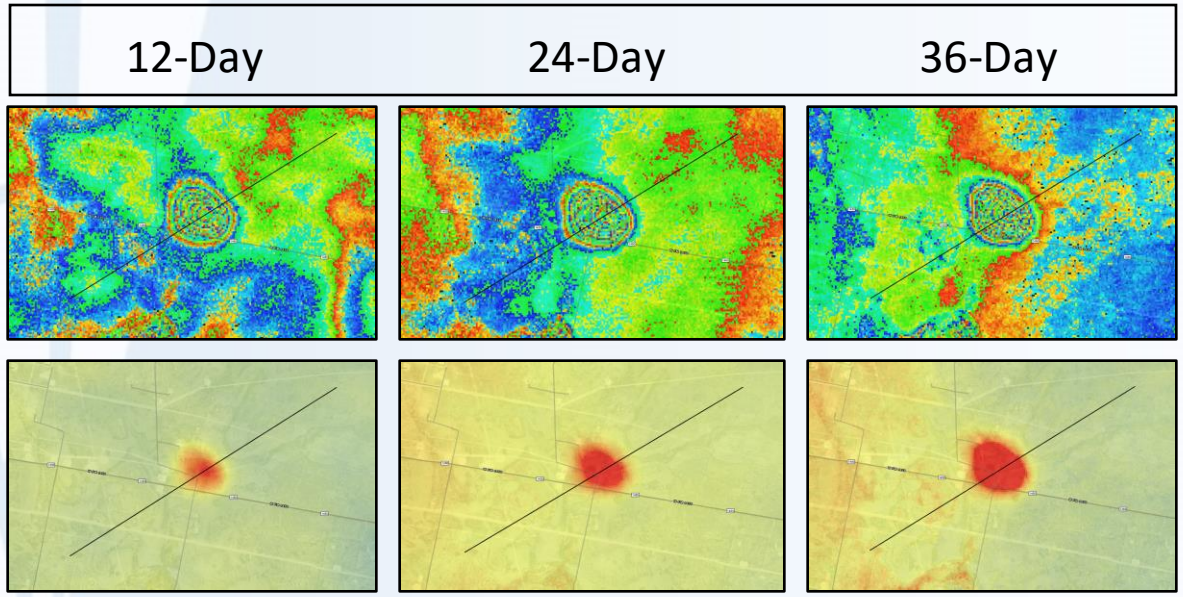
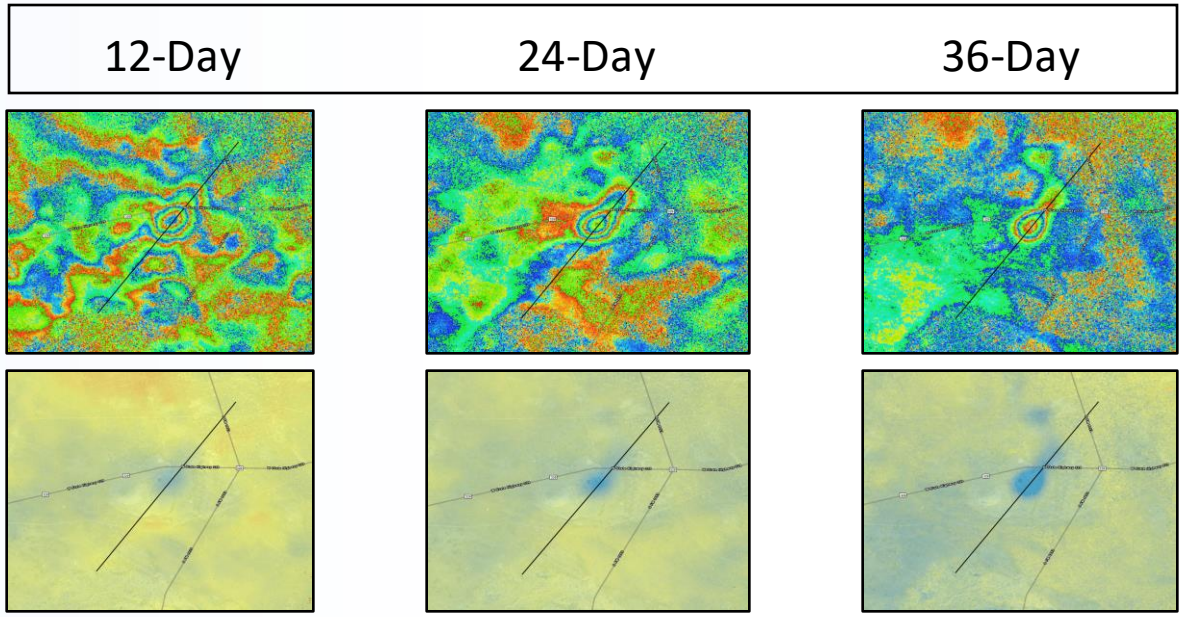
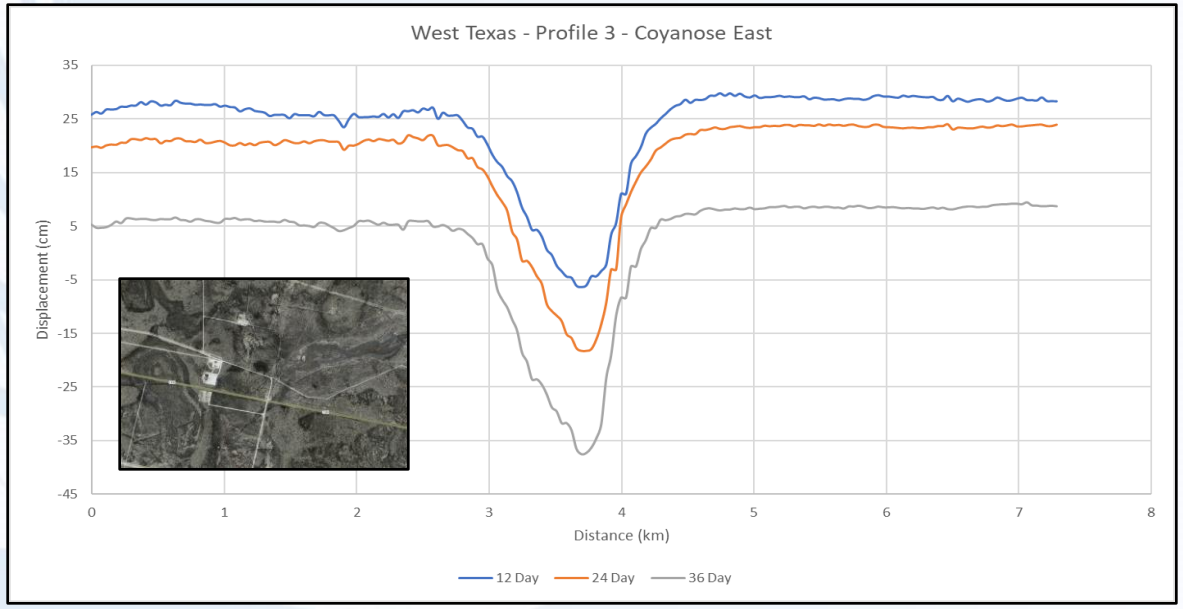
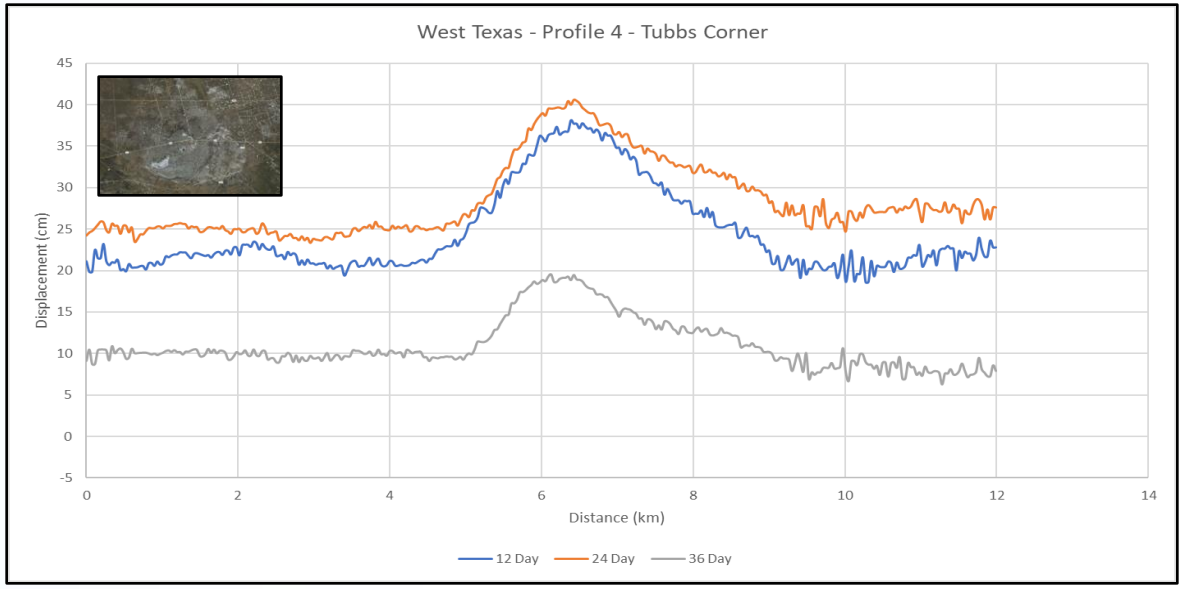
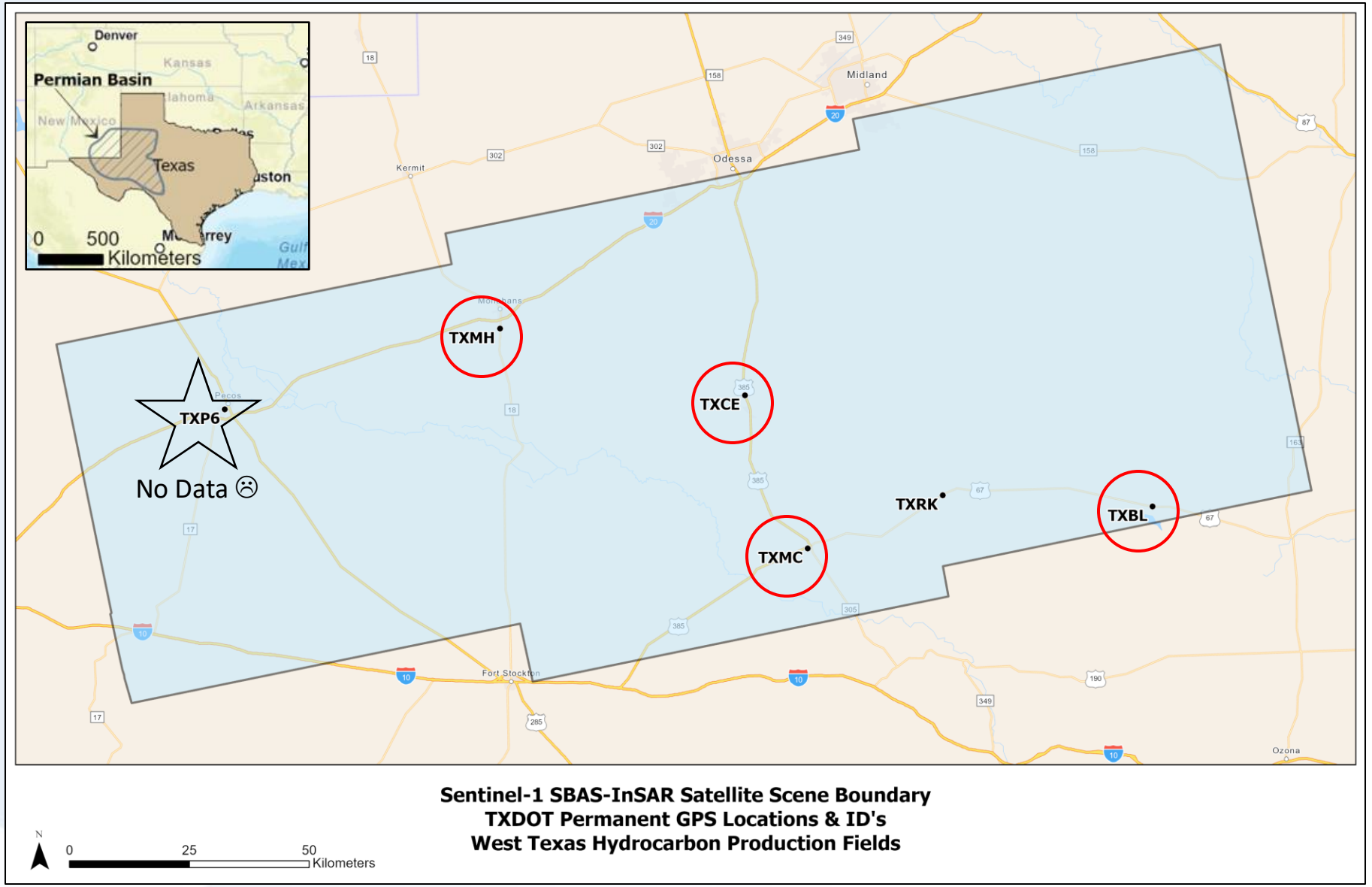






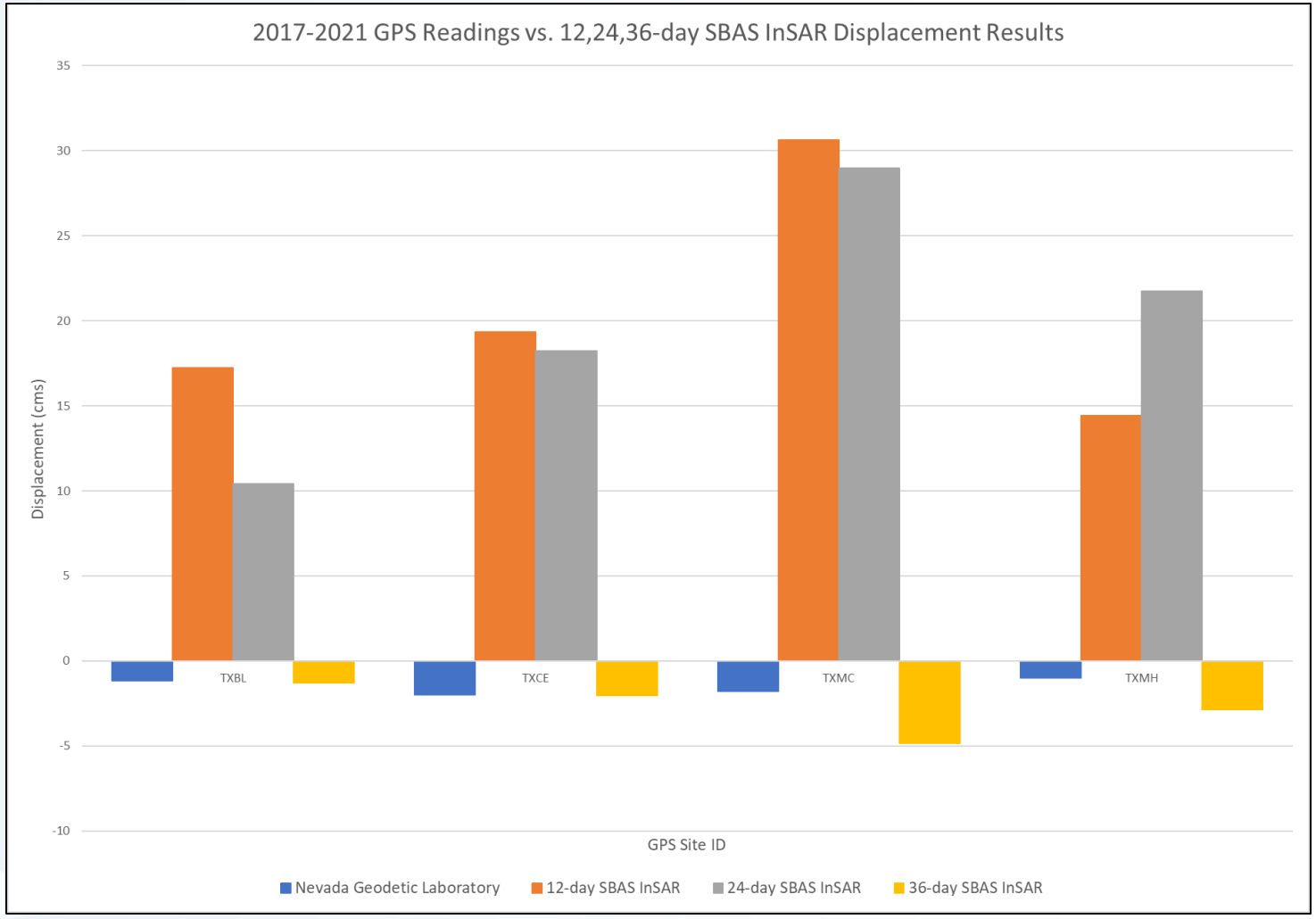


West Texas Permanent GPS Locations



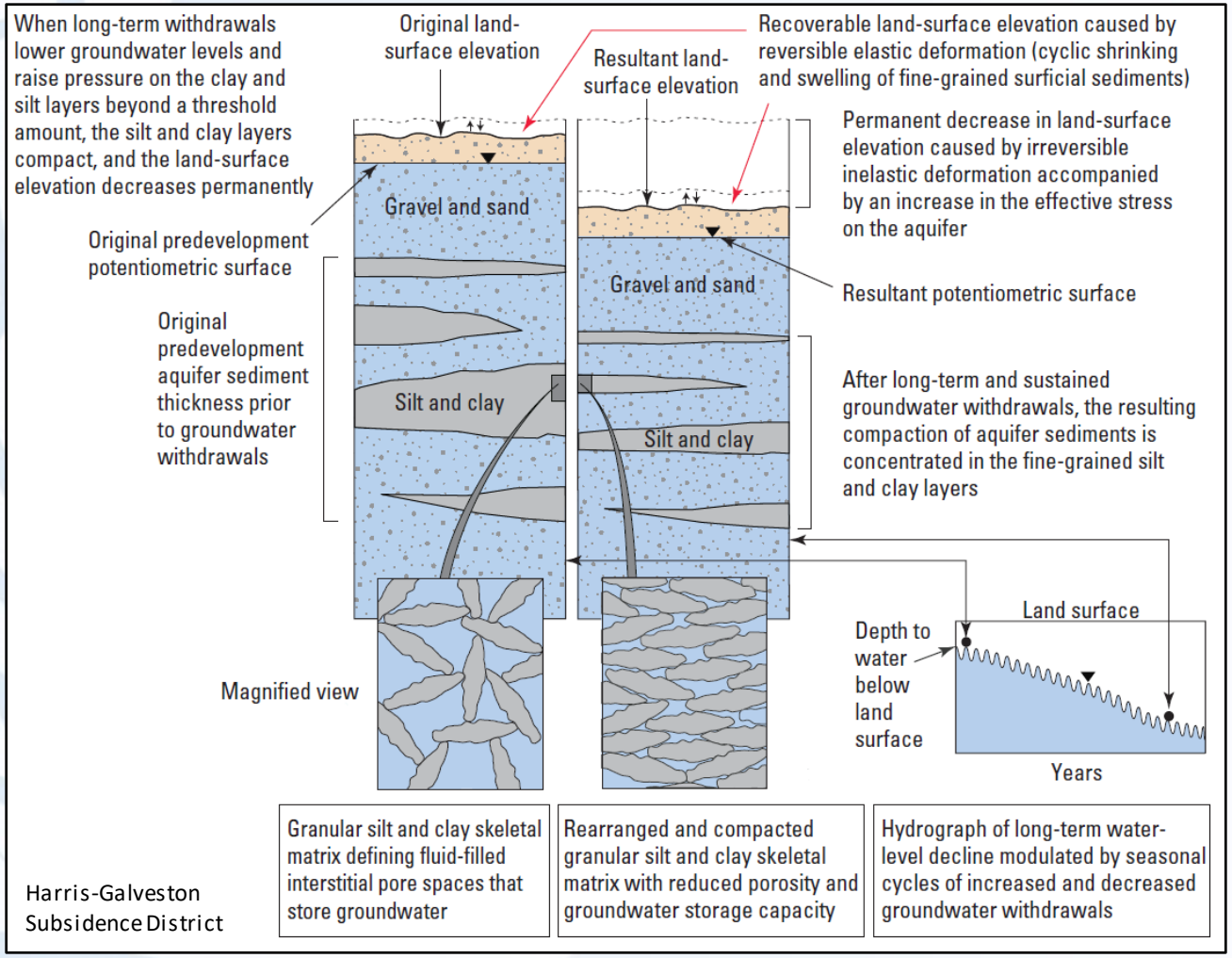
GPS Site ID	Nevada Geodetic Laboratory Displacement (cm)	12-day InSAR SBAS Displacement (cm)	24-day InSAR SBAS Displacement (cm)	36-day InSAR SBAS Displacement (cm)
TXBL	-1.160	17.233	10.415	-1.287
TXCE	-2.002	19.324	18.227	-2.045
TXMC	-1.790	30.643	28.969	-4.834
TXMH	-1.007	14.409	21.736	-2.860

West Texas



GPS and Displacement Results

Groundwater Extraction & Land Subsidence



Harris-Galveston Subsidence District

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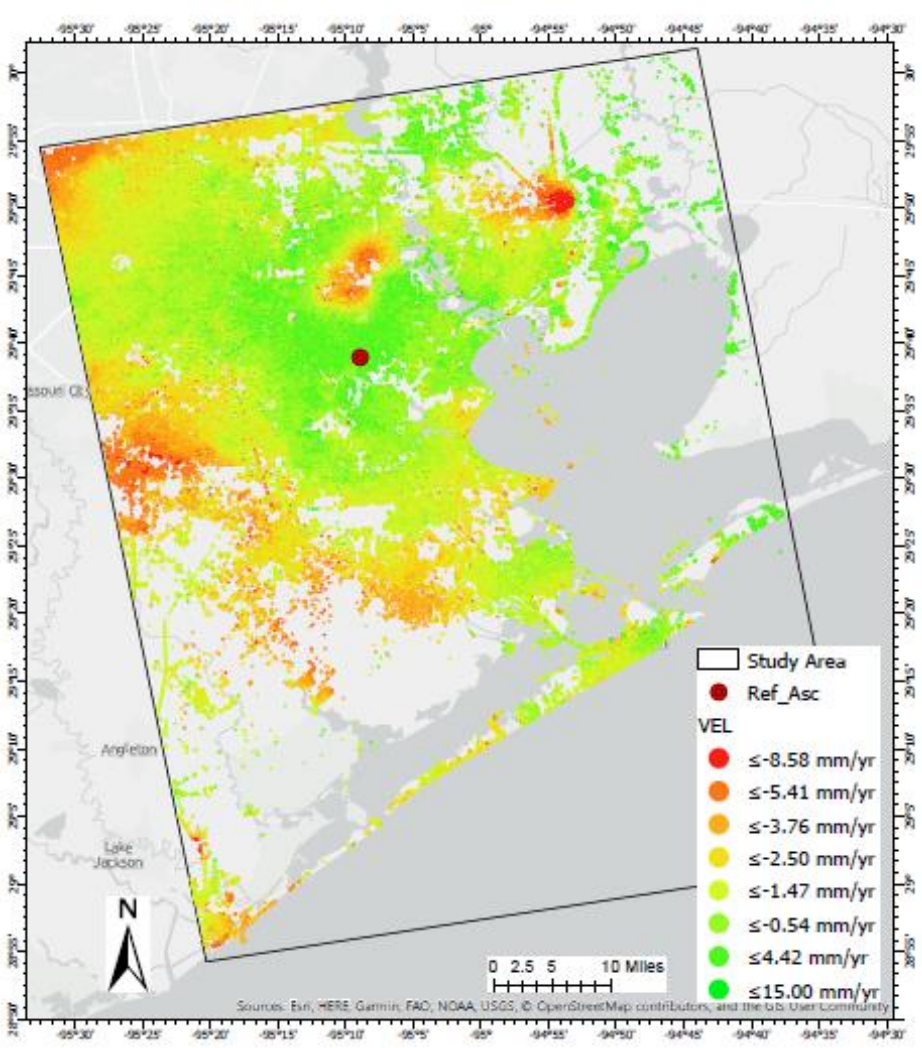
Relative Sea Level Change (RSLC)

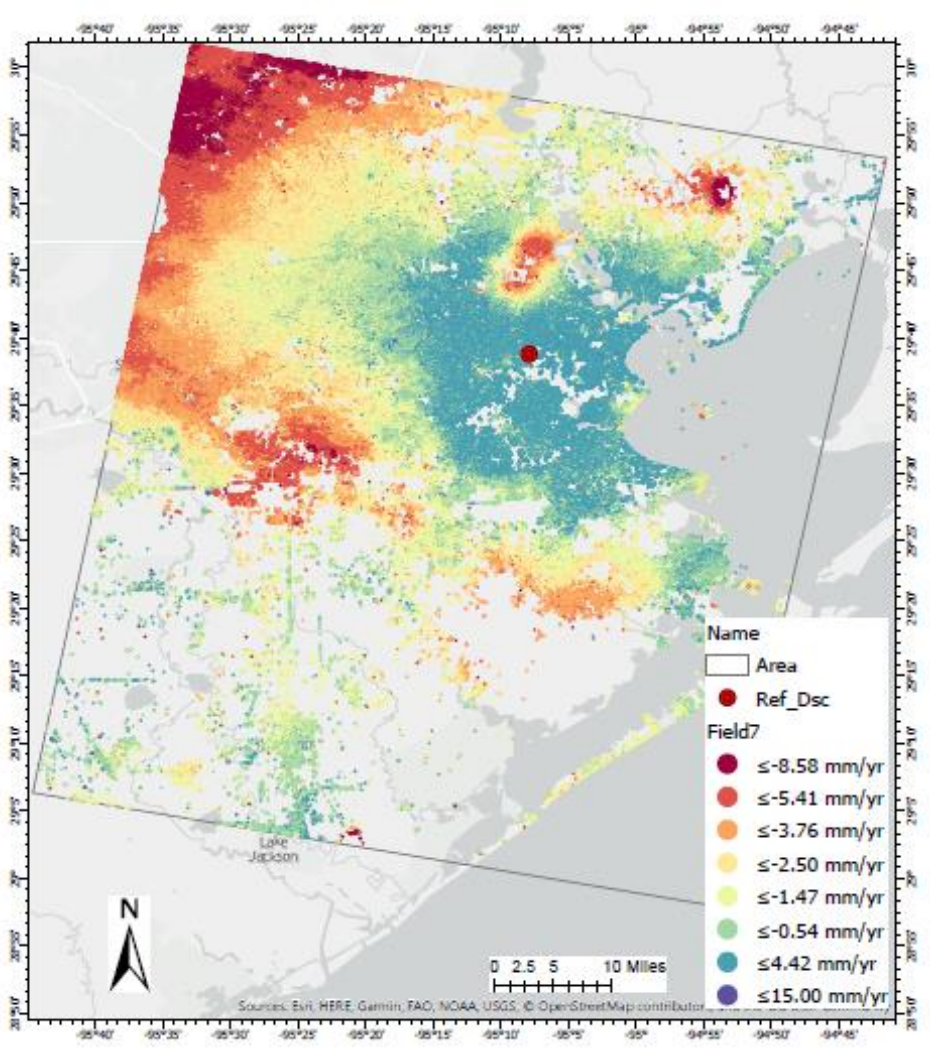
https://sealevelrise.org/causes/

Coastal Impacts and Consequences

InSAR Land Deformation Results of the Houston-Galveston Area



Ascending LOS land deformation



Descending LOS land deformation

- Persistent Scatter (PS) InSAR Results 2015 - 2022
- Results were validated using 29 GNSS stations

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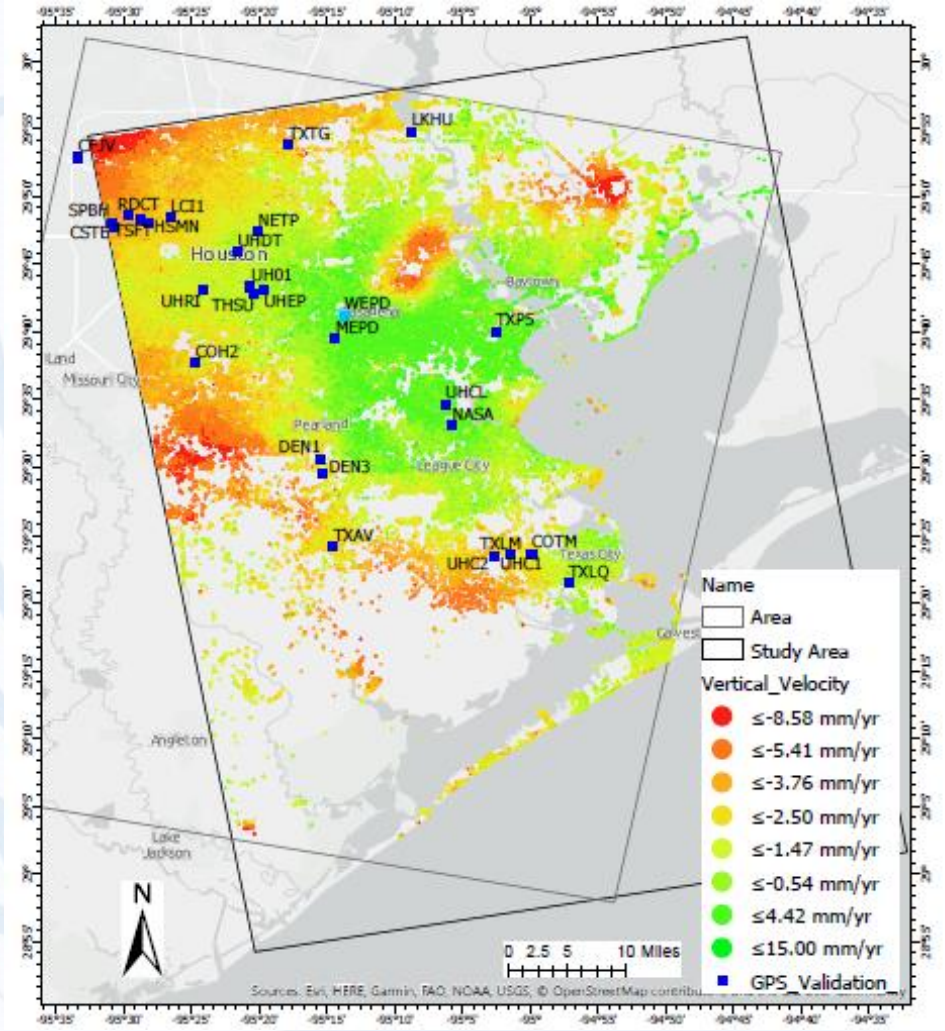
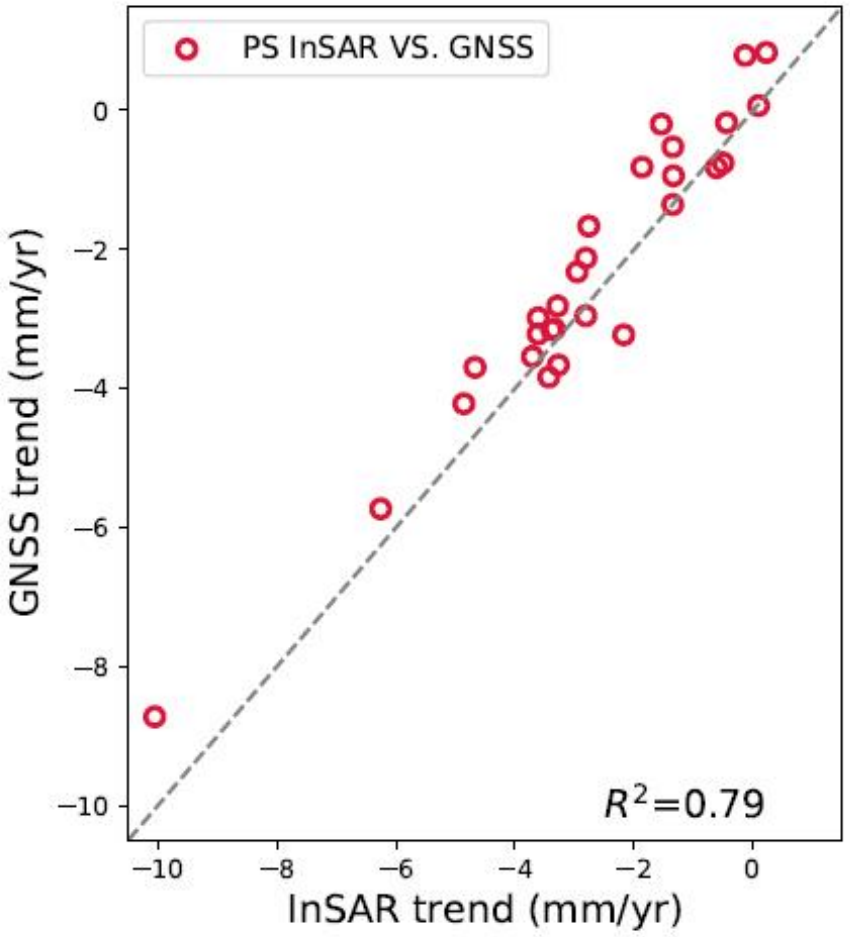


Vertical Land Motion (VLM)



VLM validation

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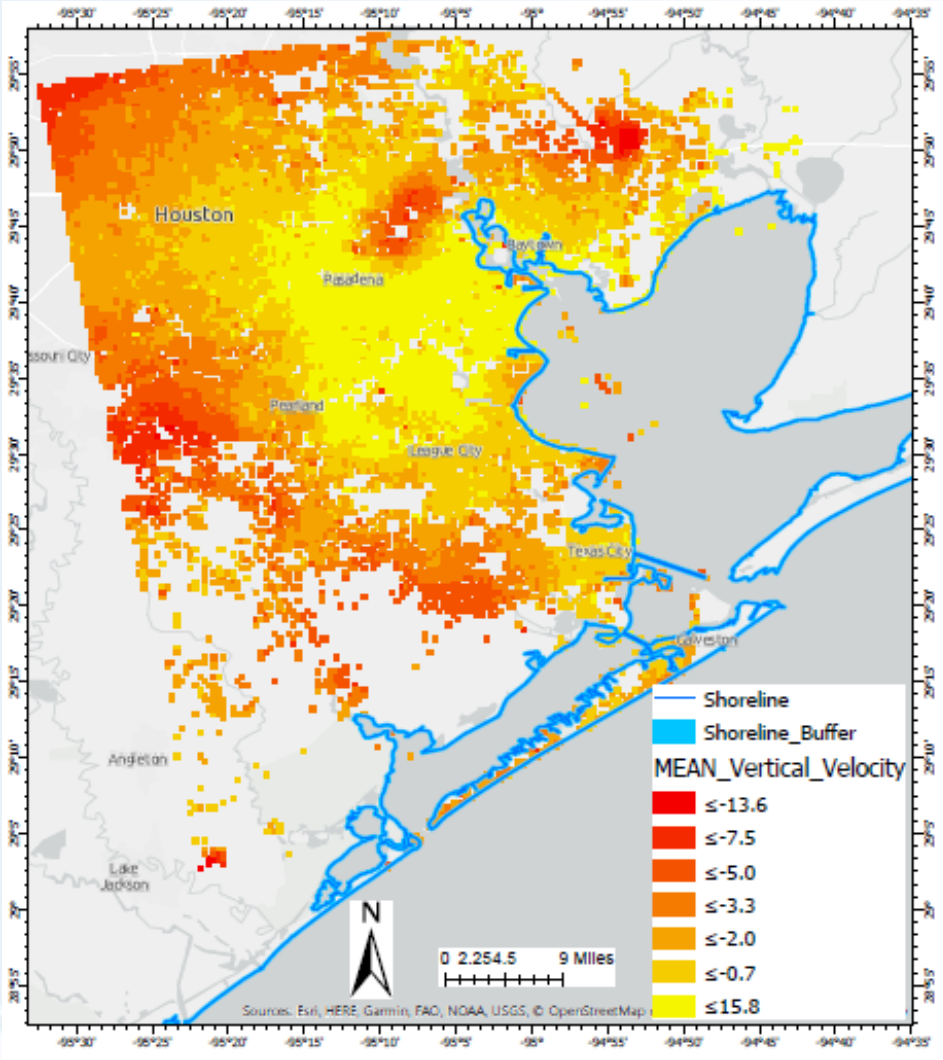
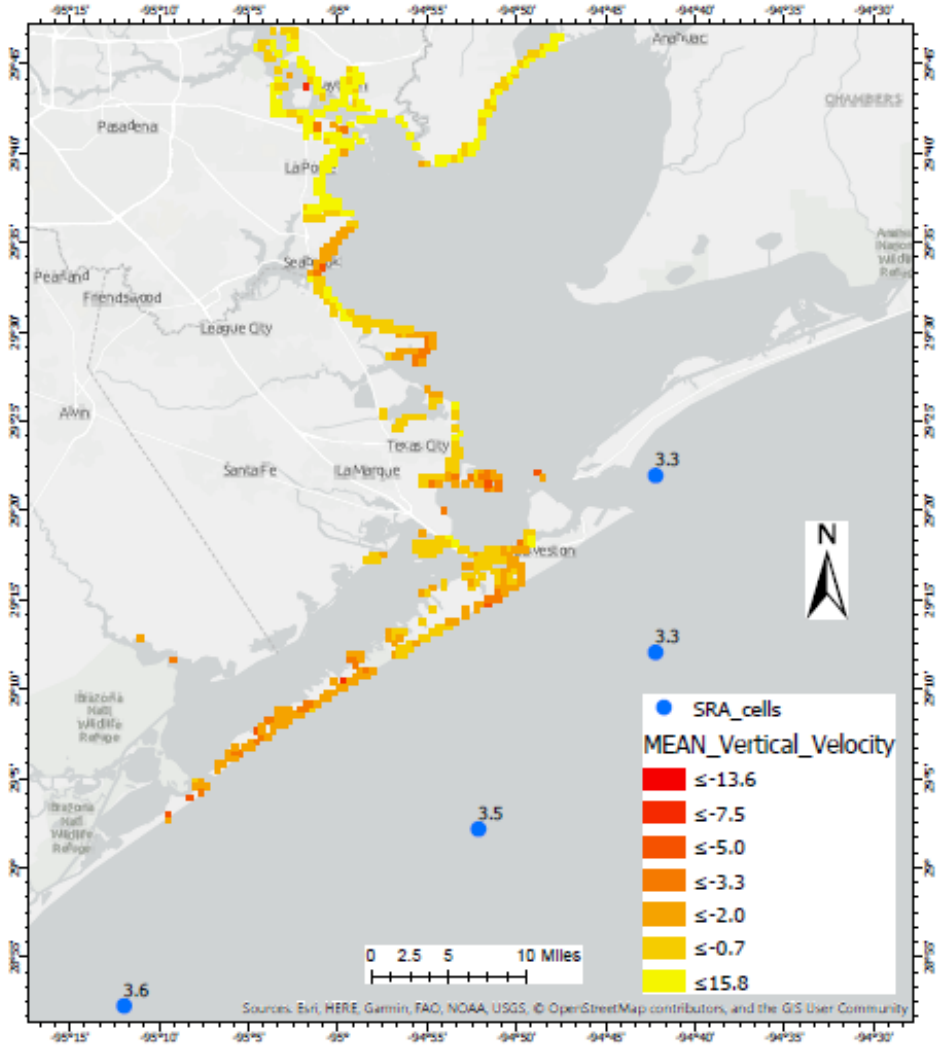
Gridded Estimation for VLM and RSLC

Gridded VLM



Gridded VLM map along the coastline



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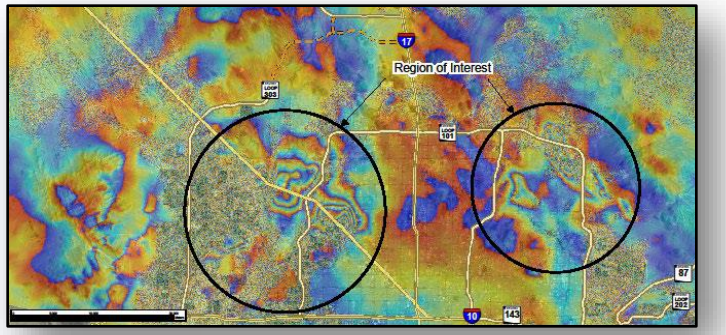
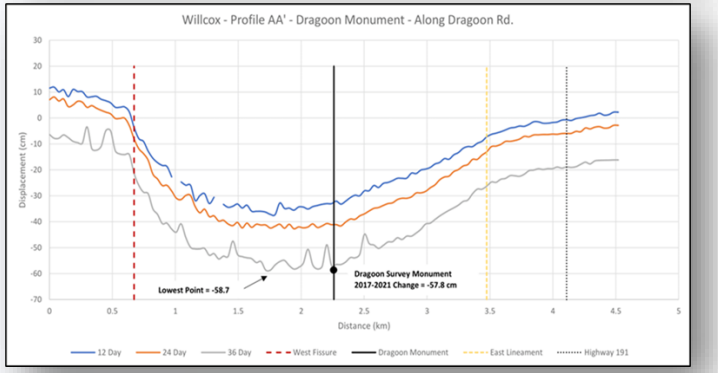
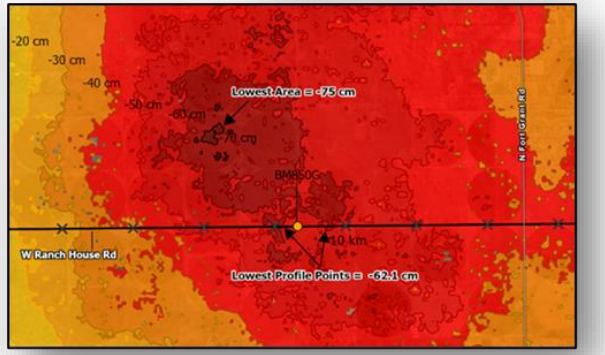
InSAR Services & Applications

Geomatics Service Center (GSC) at CBI

- SAR/InSAR data processing, advisement, and training
- GIScience analysis & applications
- General mapping and instrumentation services
- Research and development projects and case studies (comparative instrumentation and Ai)
- Conference and online workshops
- Opportunities for undergraduate and graduate students
- Installation and incorporation of corner reflectors to prepare for the upcoming NISAR mission to help produce highly accurate data products



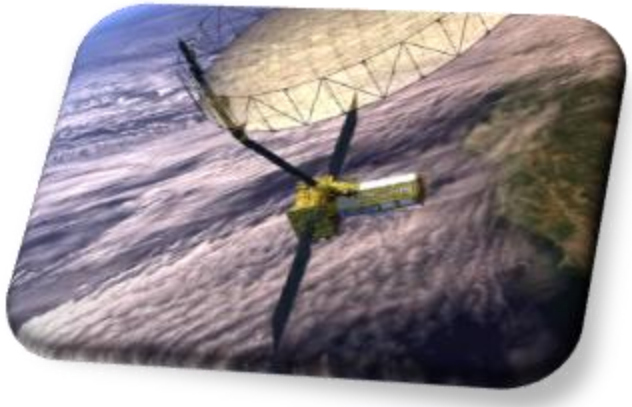


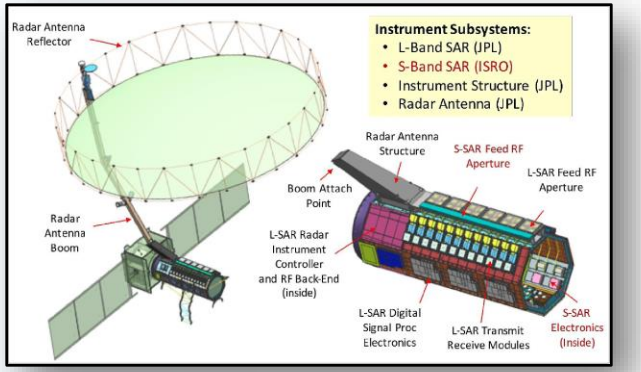


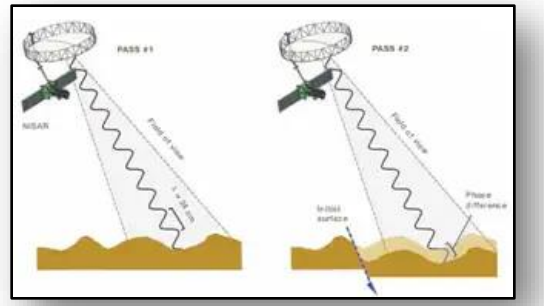
Future Vision of InSAR Services & Applications

The launch of the NASA-ISRO NISAR mission!!!

- Planned to launch at the end of March…delayed…but soon
- L & S-band applications: land deformation, agriculture, water resources, vegetation/forestry, natural disasters, infrastructure, urban and coastal monitoring
- Great opportunities to leverage this technology to improve land deformation monitoring and management in Texas and beyond
  - Penetrate vegetated areas
  - Coastal studies
  - Oil & gas
  - Karst features
  - Water resource management
  - Much more…







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For More Information Please Contact:

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