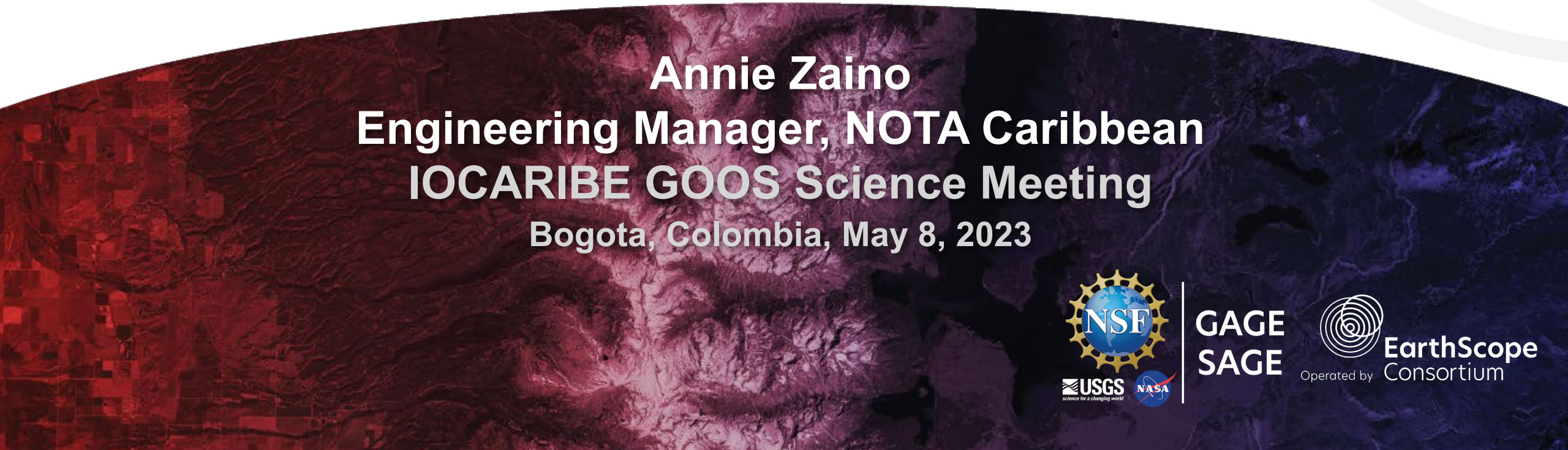
Network of the Americas
GNSS Network Operations in the Caribbean Basin



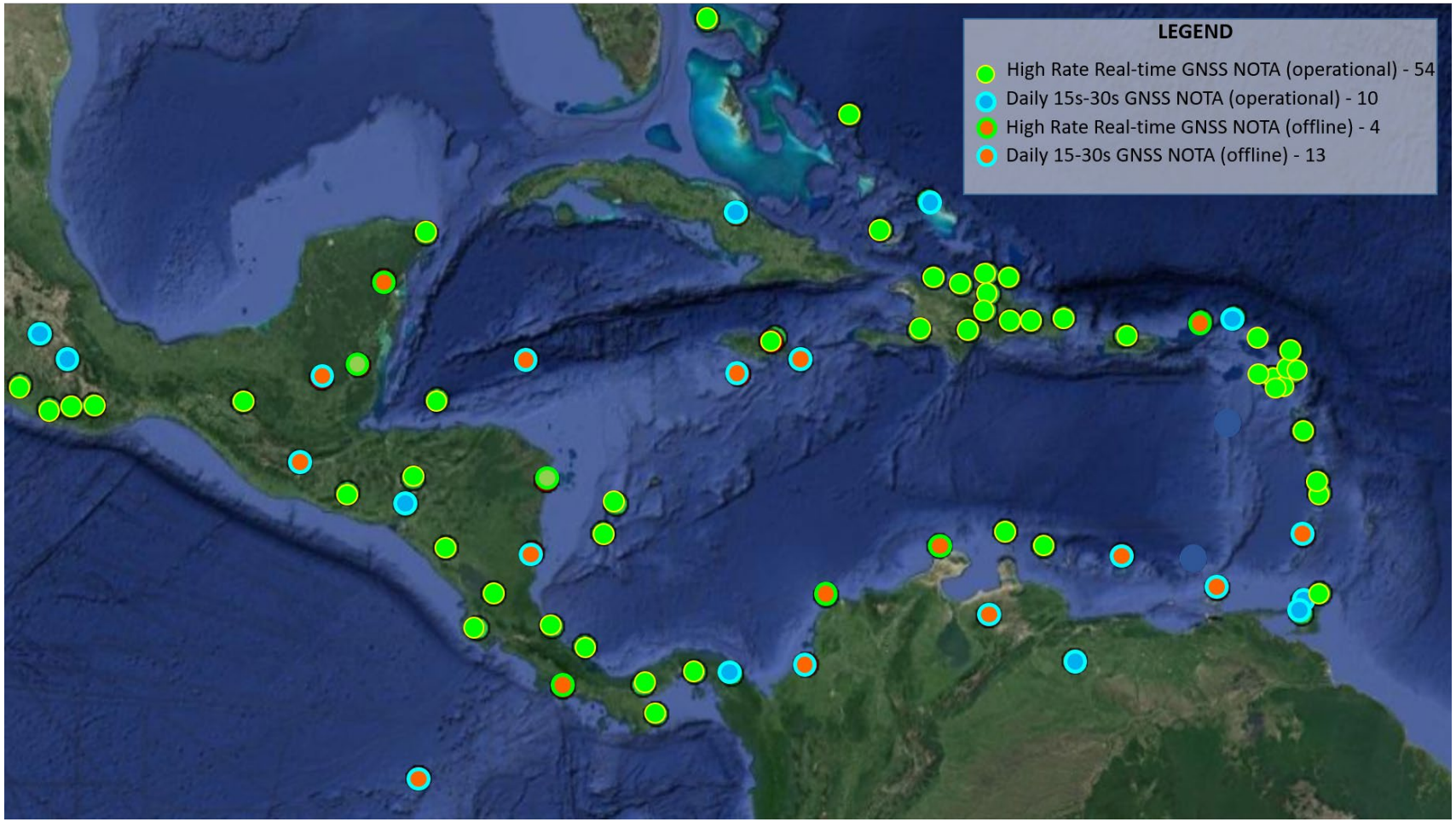
Annie Zaino
Engineering Manager, NOTA Caribbean

IOCARIBE GOOS Science Meeting

Bogota, Colombia, May 8, 2023

NSF USGS science for a changing world NASA GAGE SAGE Operated by EarthScope Consortium

Network of the Americas – Caribbean Region



- 80+ GNSS stations in 26 countries around the perimeter of the Caribbean Basin
- Funded by the NSF; work closely in partnership with local agencies
- 58 stations transmitting real-time 1Hz data stream
- All stations contributing 15s daily files to the EarthScope archive
- Approx 2/3 new builds with geodetic quality monumentation in 2012-2015
- Approx 1/3 refurbished stations original built by collaborator agencies, as early as 2000

Typical NOTA GNSS Station Design

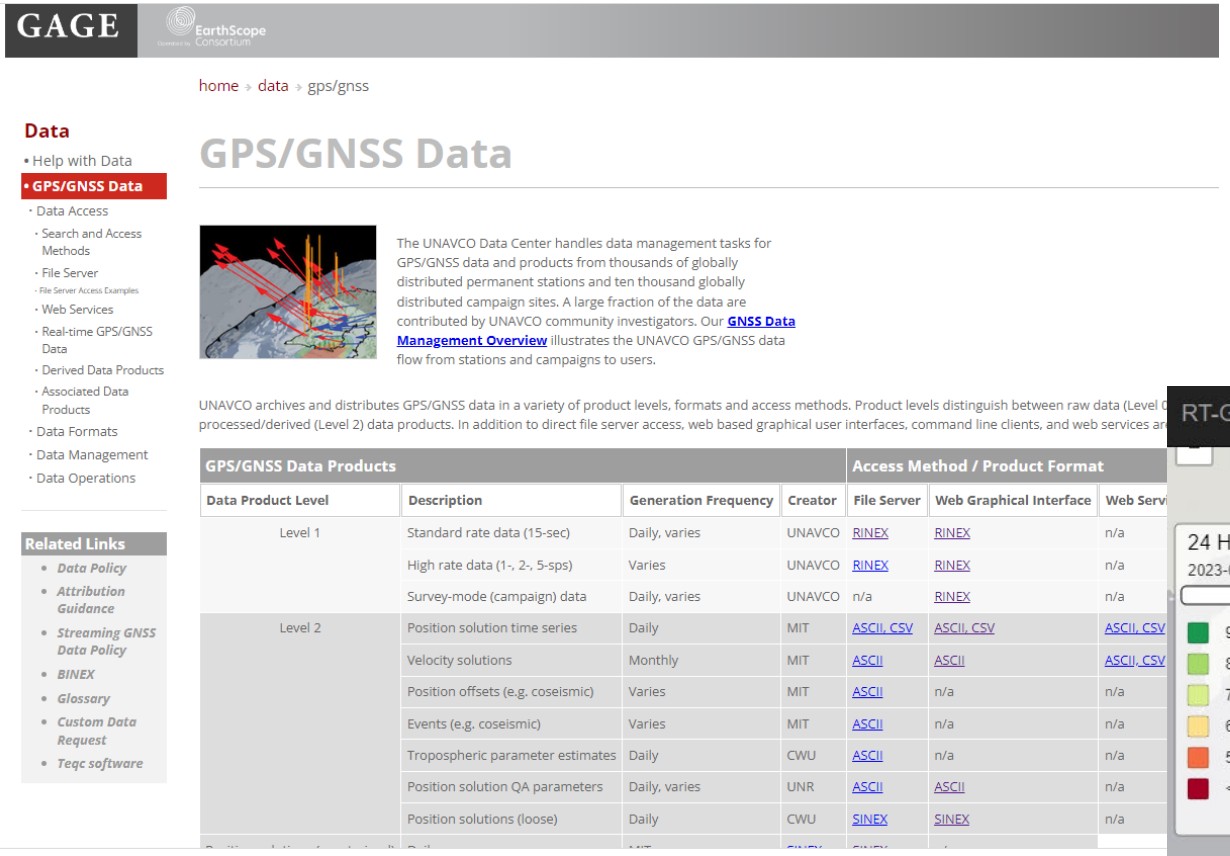
GAGE SAGE Operated by EarthScope Consortium

- Solid monumentation which is well coupled to the bedrock
- GNSS antenna and receiver
- Power system
- Communications/telemetry
- Meteorology sensor
- Environmental enclosure

Public data availability

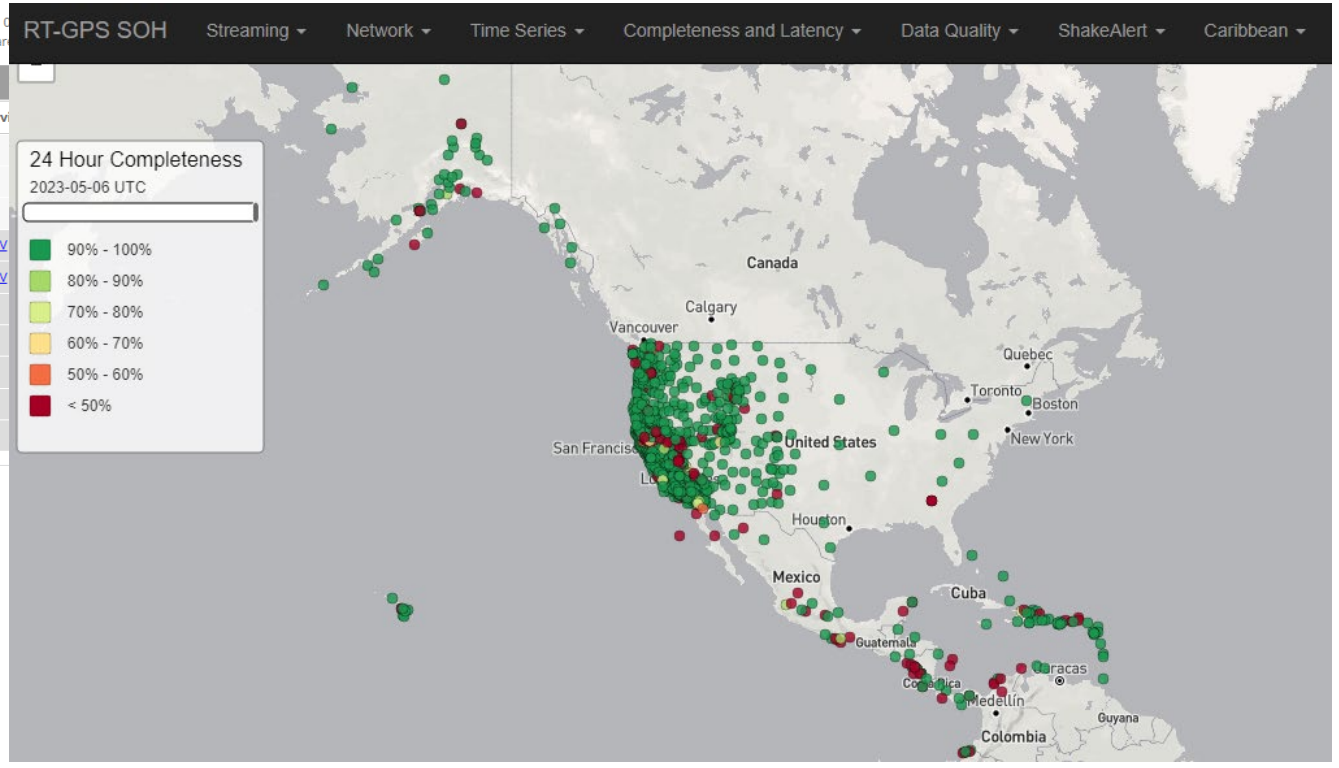
GAGE SAGE

Operated by EarthScope Consortium



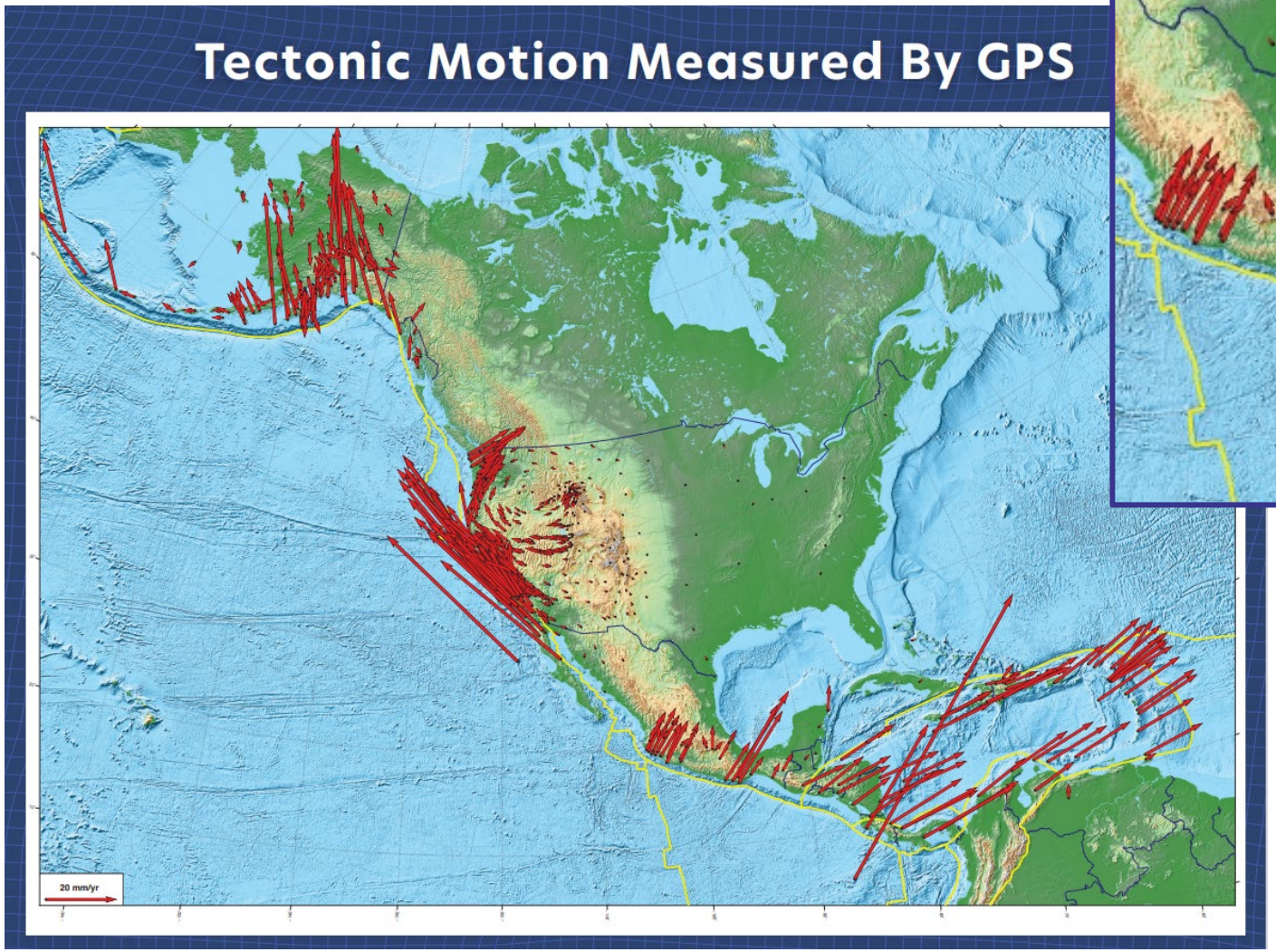
Access to archived data:
https://www.unavco.org/data/gps-gnss/gps-gnss.html

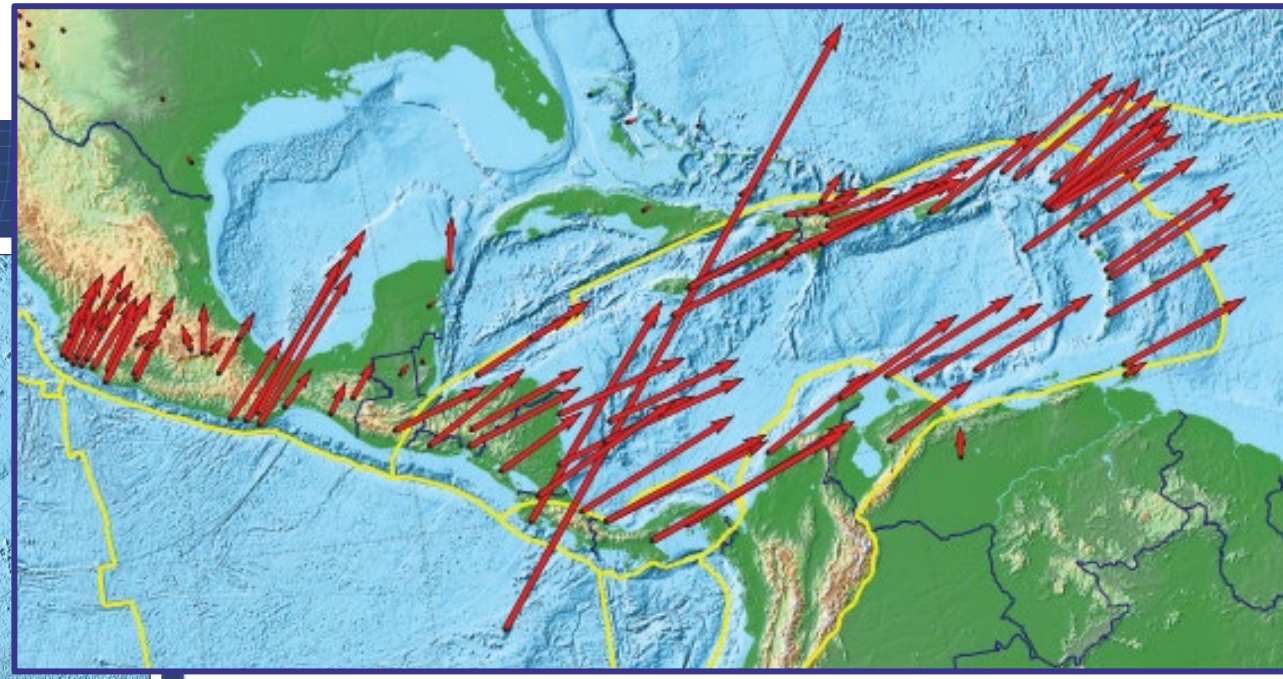
Access to real-time data stream:
https://www.unavco.org/data/gps-gnss/real-time/real-time.html



All Caribbean archived and real-time GNSS data is publicly accessible and currently free to all users.

Science applications – Tectonic motion

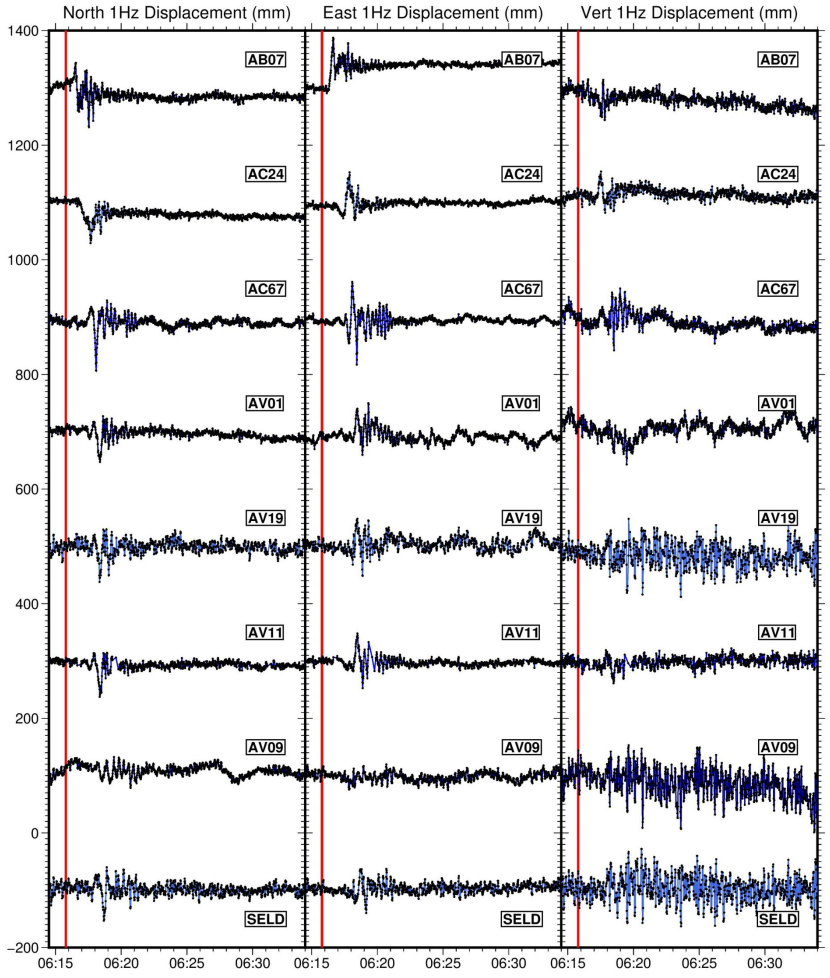




Long time series from stations provides mm scale accuracy of tectonic motion, subsidence/uplift, etc

Reference stations for local mapping projects (ex: coastline mapping)

Science Applications – Earthquake Response



M8.2 Chignik, AK
July 28, 2021

Peak Ground Motion

- Using high rate data, GNSS sensors can detect actual ground displacement in real time

Rapid Magnitude Solutions

- Seismometers may saturate during high intensity shaking, especially close to the earthquake source
- GNSS data may be used to supplement, and generate more rapid earthquake magnitude estimations
- Can be particularly useful for earthquake and tsunami early warning systems

Science applications – Tide gauge reflectometry

- GNSS antennas detect both direct signals coming from GNSS satellites and indirect signals which may reflect off of nearby bodies of water
- GNSS stations located close to shoreline can be used to supplement existing tide gauge networks
- GNSS stations may be lower cost and more robust against storm damage, due to the passive, contained station requirements

Collocated EarthScope GNSS site and PRSN tide gauge in Barahona, Dominican Republic

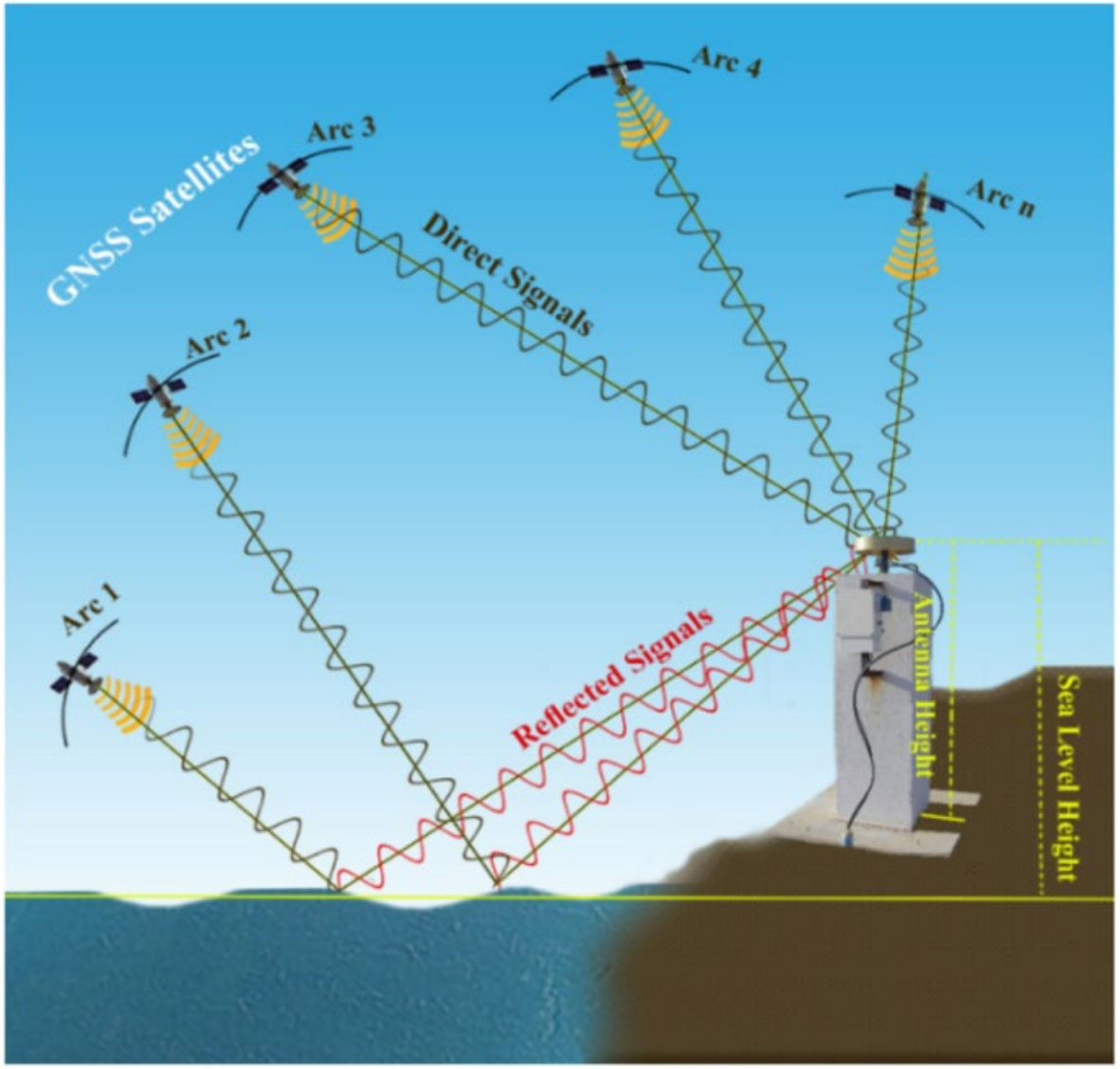
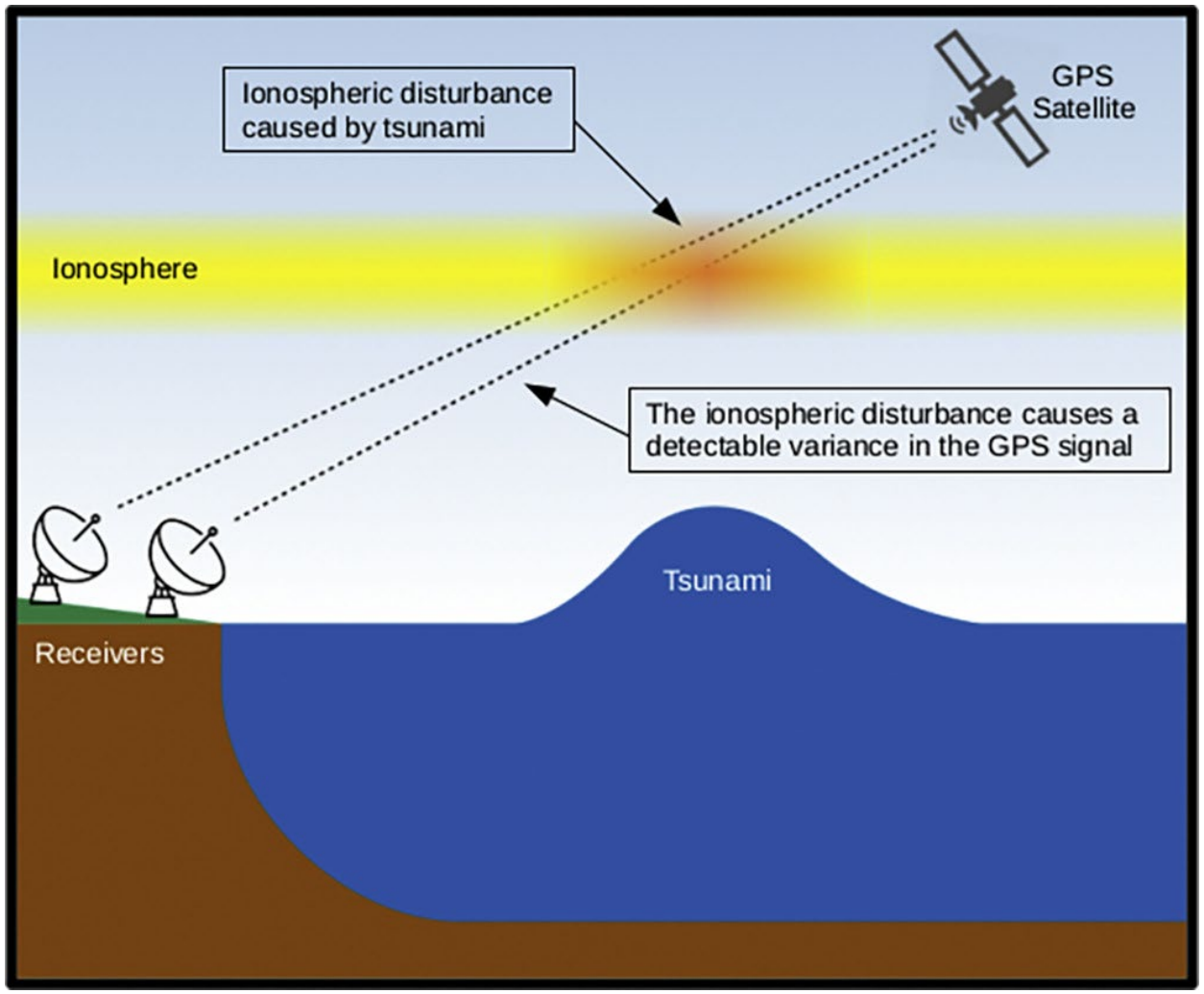


Figure source: Farzaneh, S., Parvazi, K. & Shali, H.H. GNSS-IR-UT: A MATLAB-based software for SNR-based GNSS interferometric reflectometry (GNSS-IR) analysis. *Earth Sci Inform* **14**, 1633–1645

Science applications – Tsunami Wave Detection



Grzan et al, 2021
doi.org/10/1016/j.pdisas.2021.100191

- A tsunami creates a gravity wave that is amplified in the ionosphere. This creates a disturbance in the total electron content of the ionosphere, which slows the transmission time between the satellite and GNSS receiver
- This anomaly can be tracked by multiple GNSS stations and characterized
- Detection of this anomaly may occur far from the current location of the wave

Recommendations

First EarthScope participation in an IOCARIBE GOOS meeting

- How can this data be of benefit to this community?
- What opportunities do we have for future collaboration?

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