

LOS in Surface Deformation Mapping: A Case Study of the Kingdom of Bahrain

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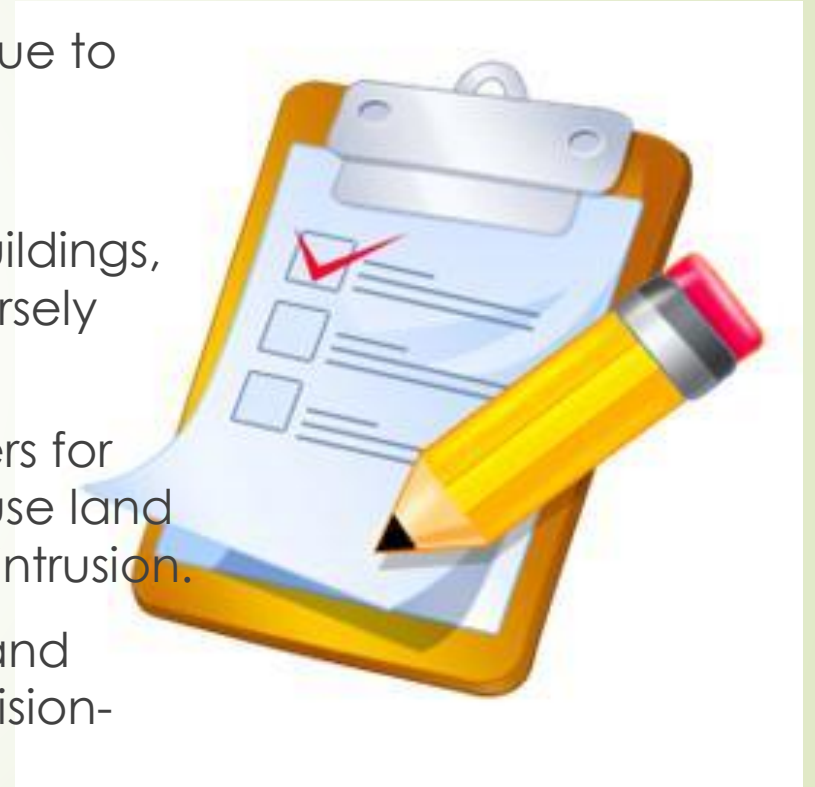
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Rationales:

- ▶ Land subsidence: experiencing significant land subsidence due to various factors such as excessive groundwater extraction, urbanization, and geological processes.
- ▶ Infrastructure monitoring: extensive infrastructure including buildings, roads, bridges, and pipelines. Surface deformation can adversely affect the integrity and performance of these structures.
- ▶ Groundwater resources: heavily relies on underground aquifers for freshwater supply. Excessive groundwater extraction can cause land subsidence, leading to infrastructure damage and saltwater intrusion.
- ▶ Data-driven decision-making: InSAR provides a quantitative and spatially extensive dataset, allowing for evidence-based decision-making.



Rationales:

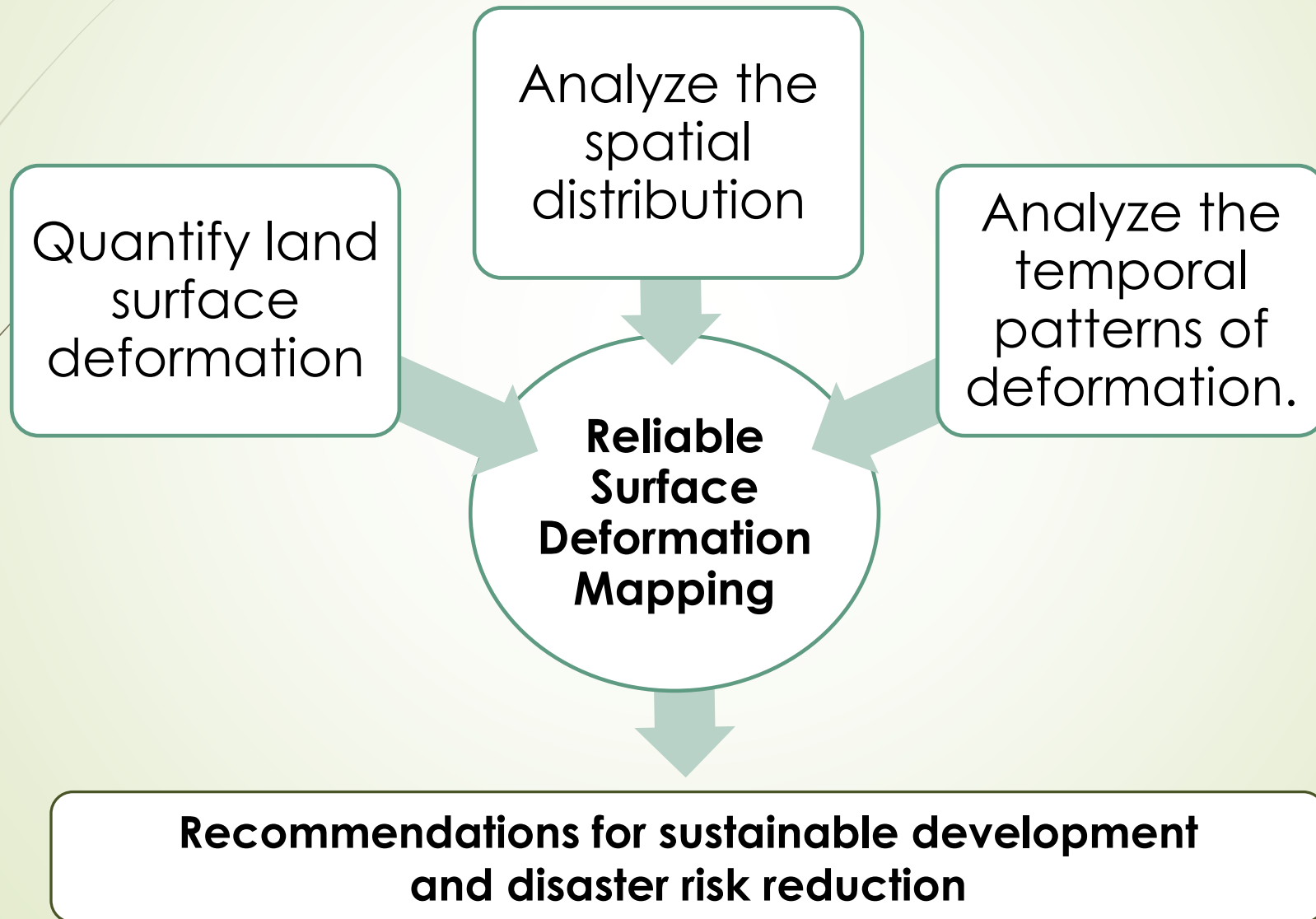
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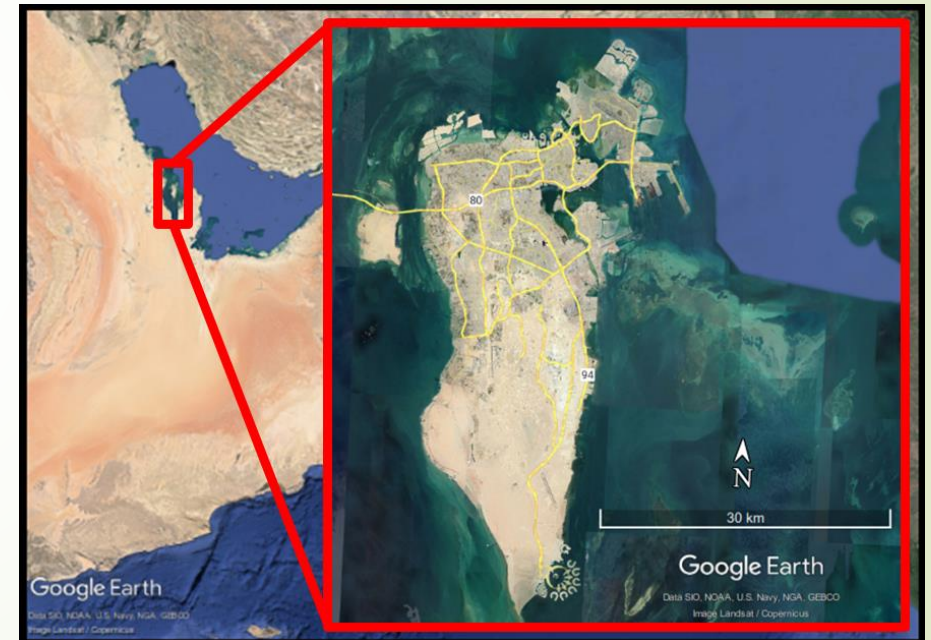
Objectives:



Data Sets:

Study area

- ▶ Bahrain is a small island country located in the Arabian Gulf.
- ▶ A flat and low-lying terrain characterizes the geomorphology of Bahrain.
- ▶ An average elevation of only 10 meters above sea level.
- ▶ It has several human-made features that have modified the island's geomorphology.



Data Sets:

InSAR Data (Estimation)

- Sentinel-1 data over the last 5 years.
- Total of 377 scenes in IW beam mode format and, in a descending orbit.
- Baseline of less than 150m and temporal of 12 days.
- SLC file type, VV, HV polarization and, S2A subtype.

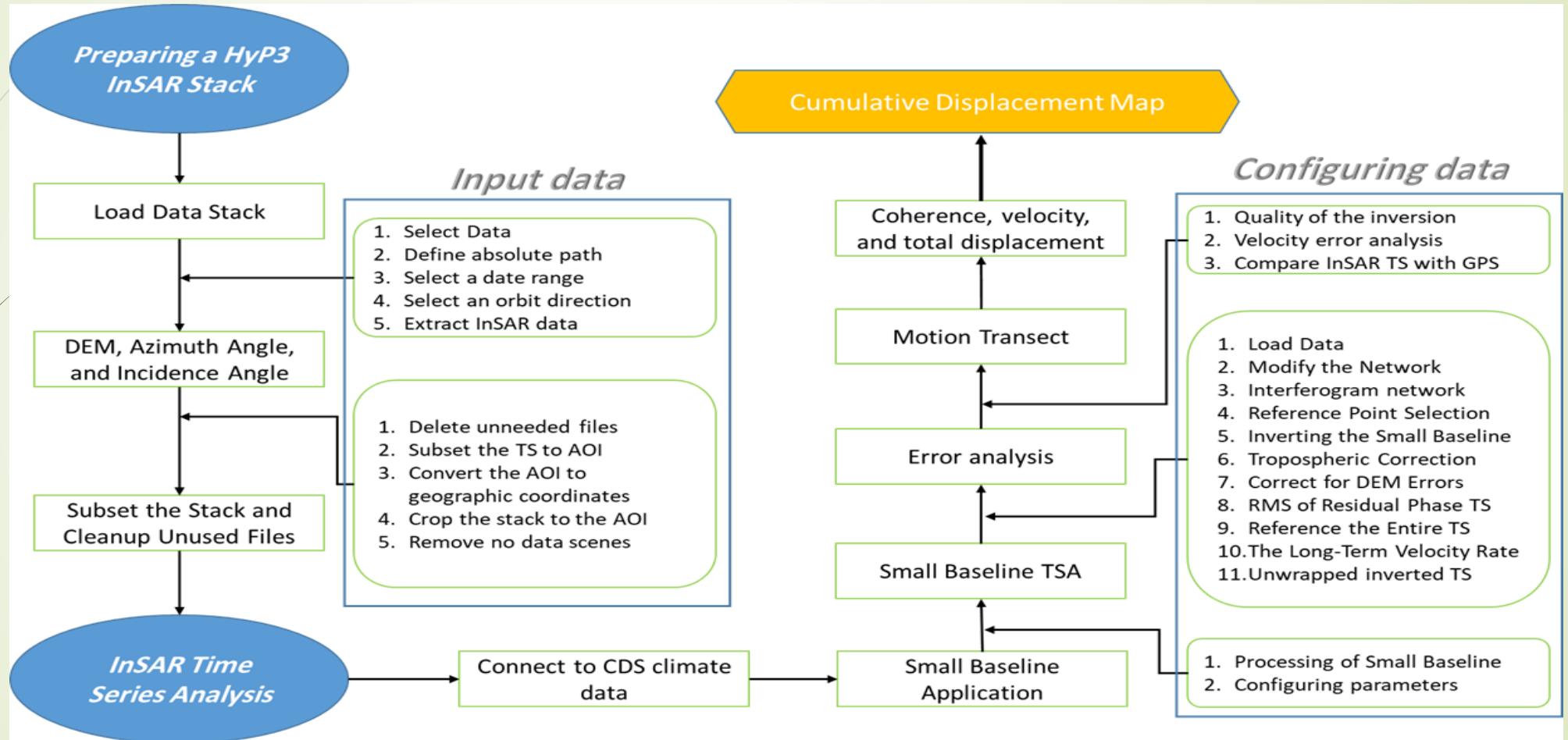


Geodetic Data (Validation)

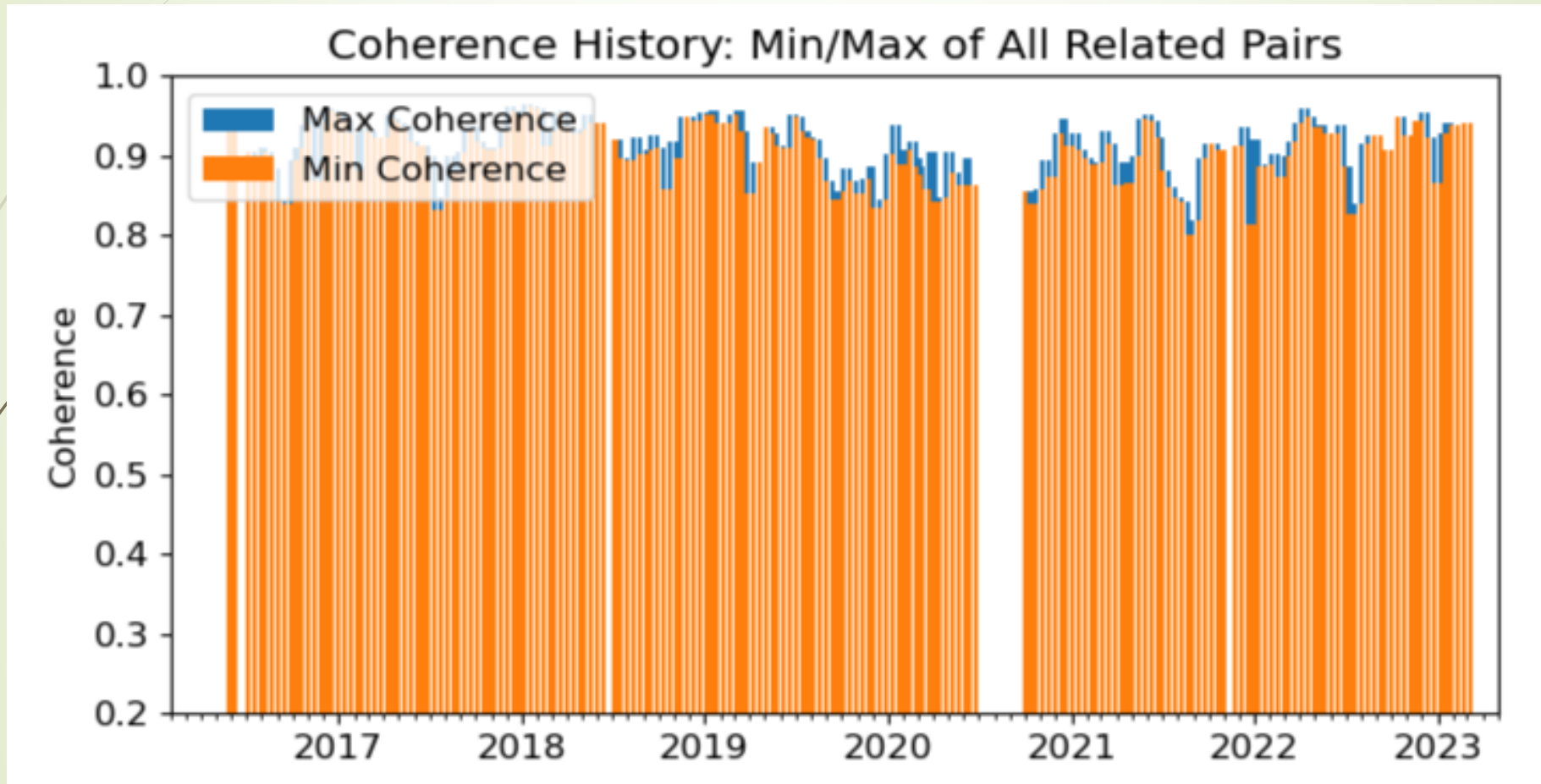
- Global Positioning Systems (GPS)
- MAGNET RINEX files
- Provide precise and accurate information about ground movements.
- Continuous geodetic monitoring helps in tracking and analyzing surface deformation over time.



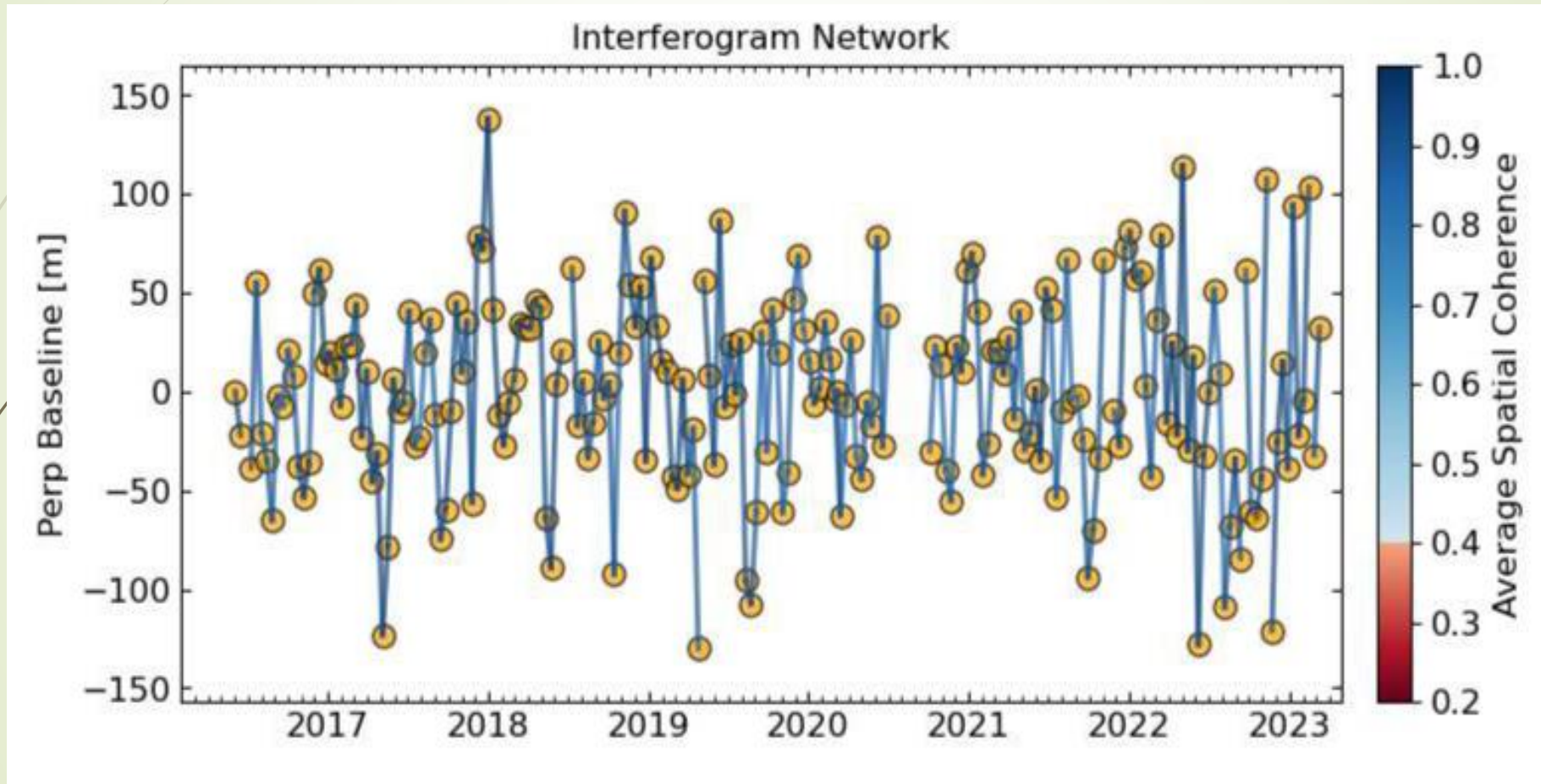
Methodological Framework:



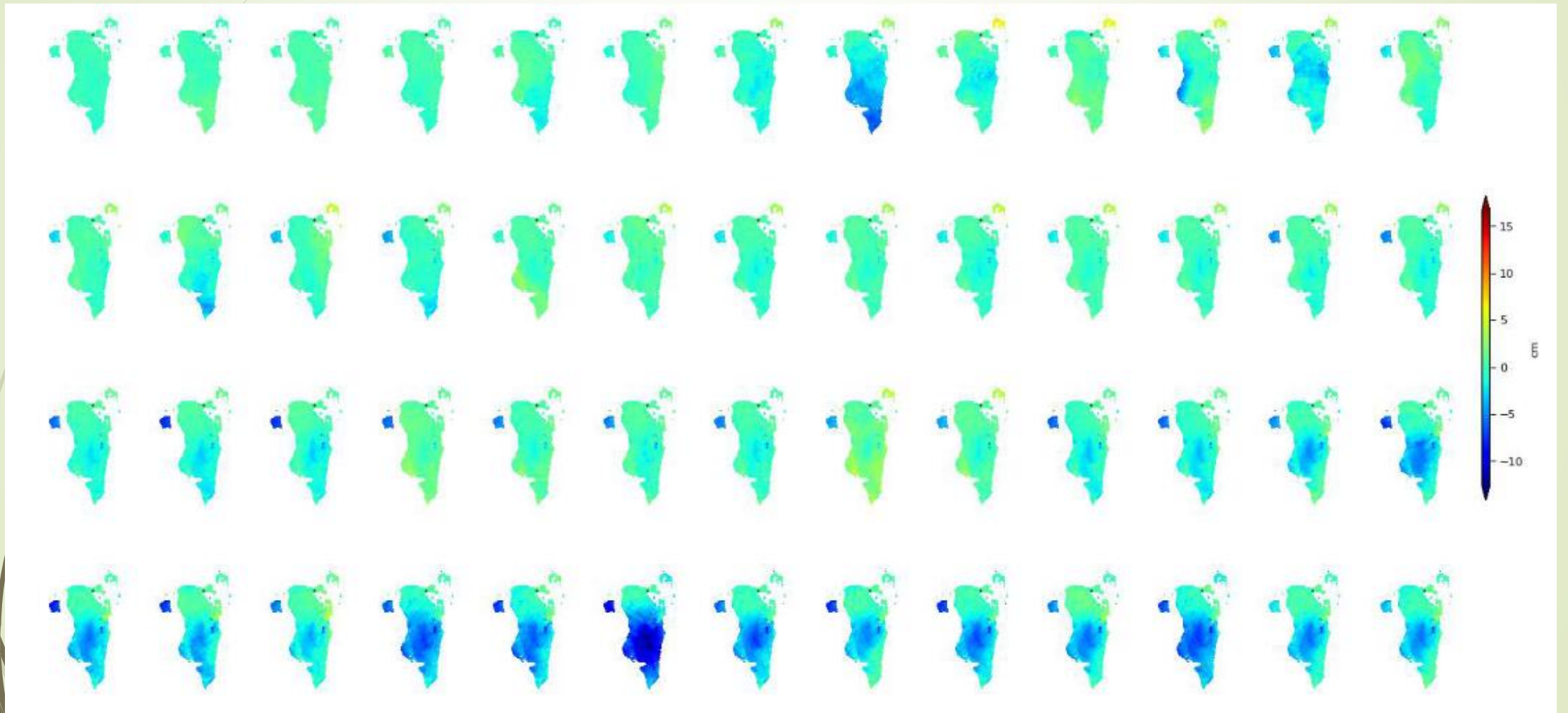
Results (Estimation):



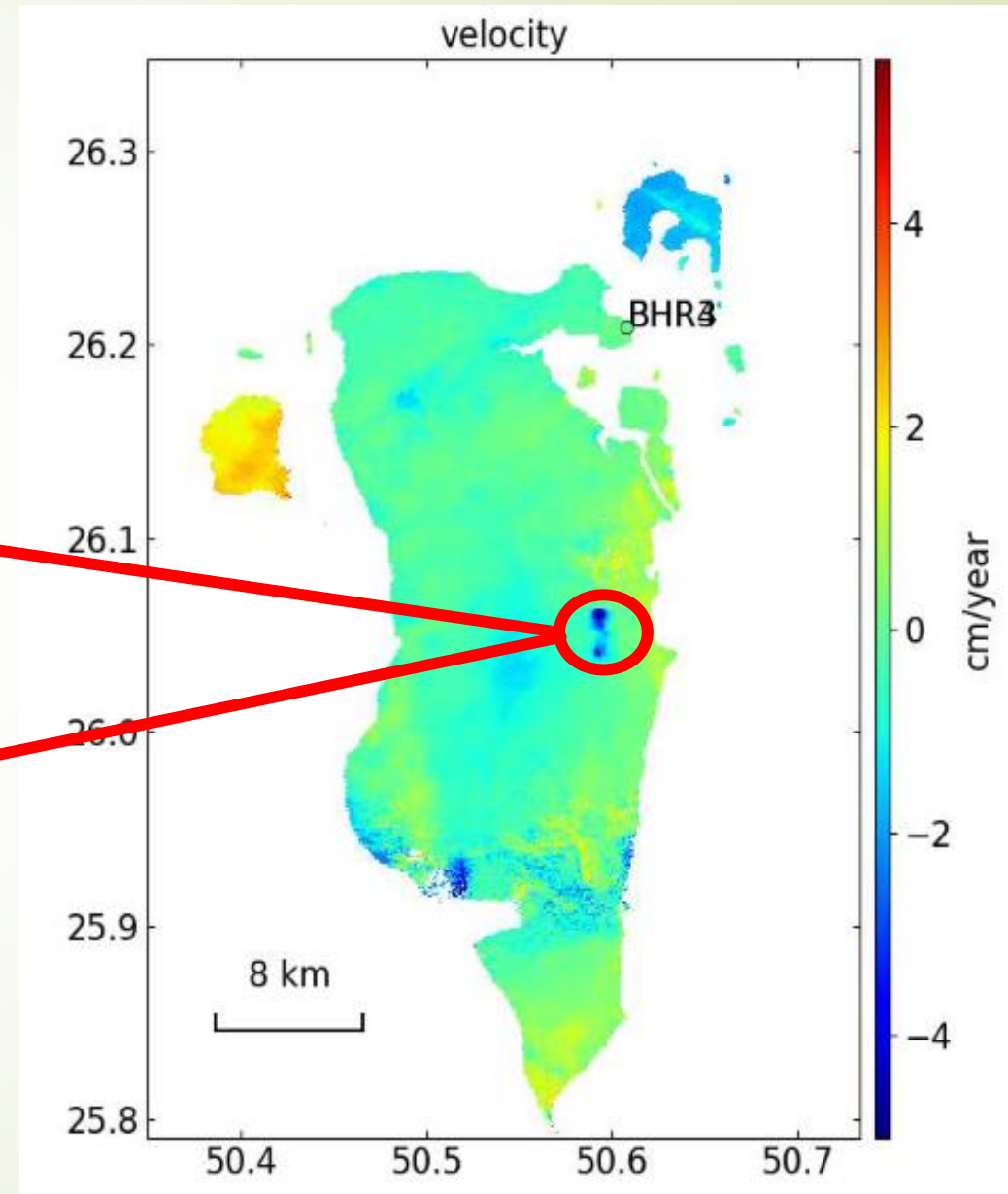
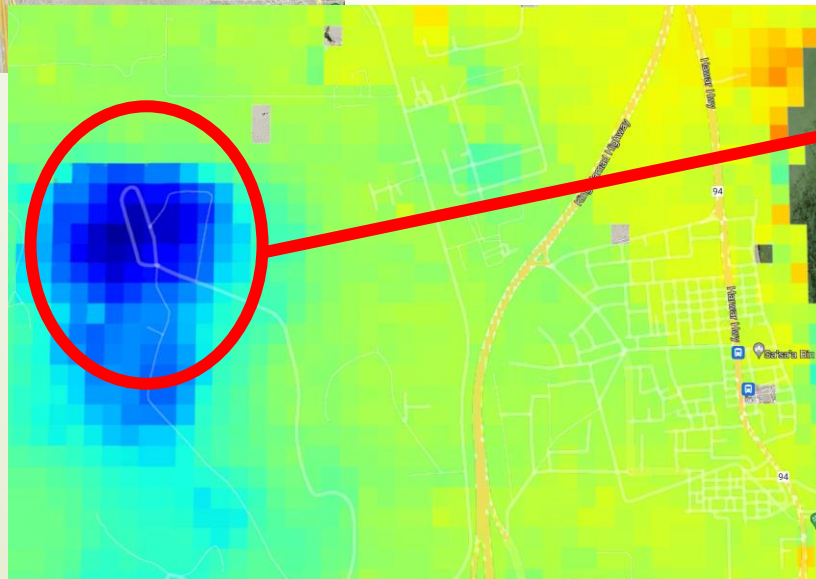
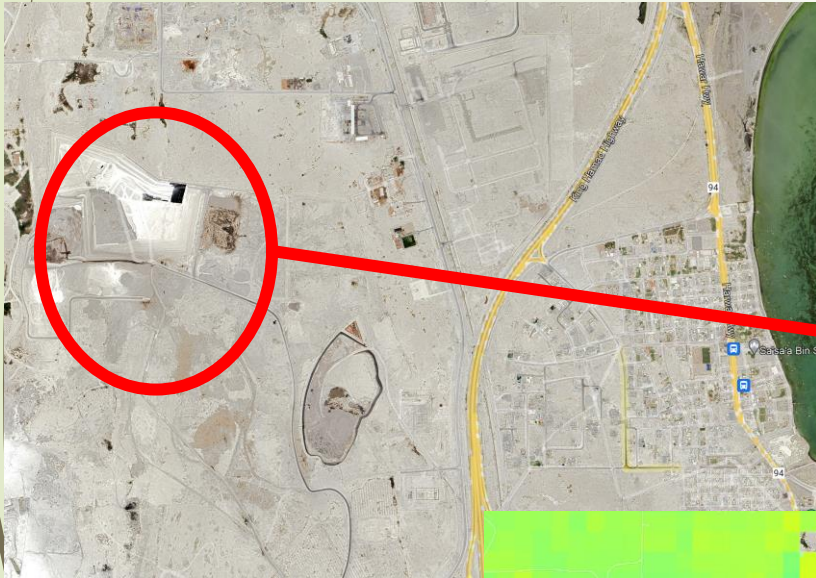
Results (Estimation):



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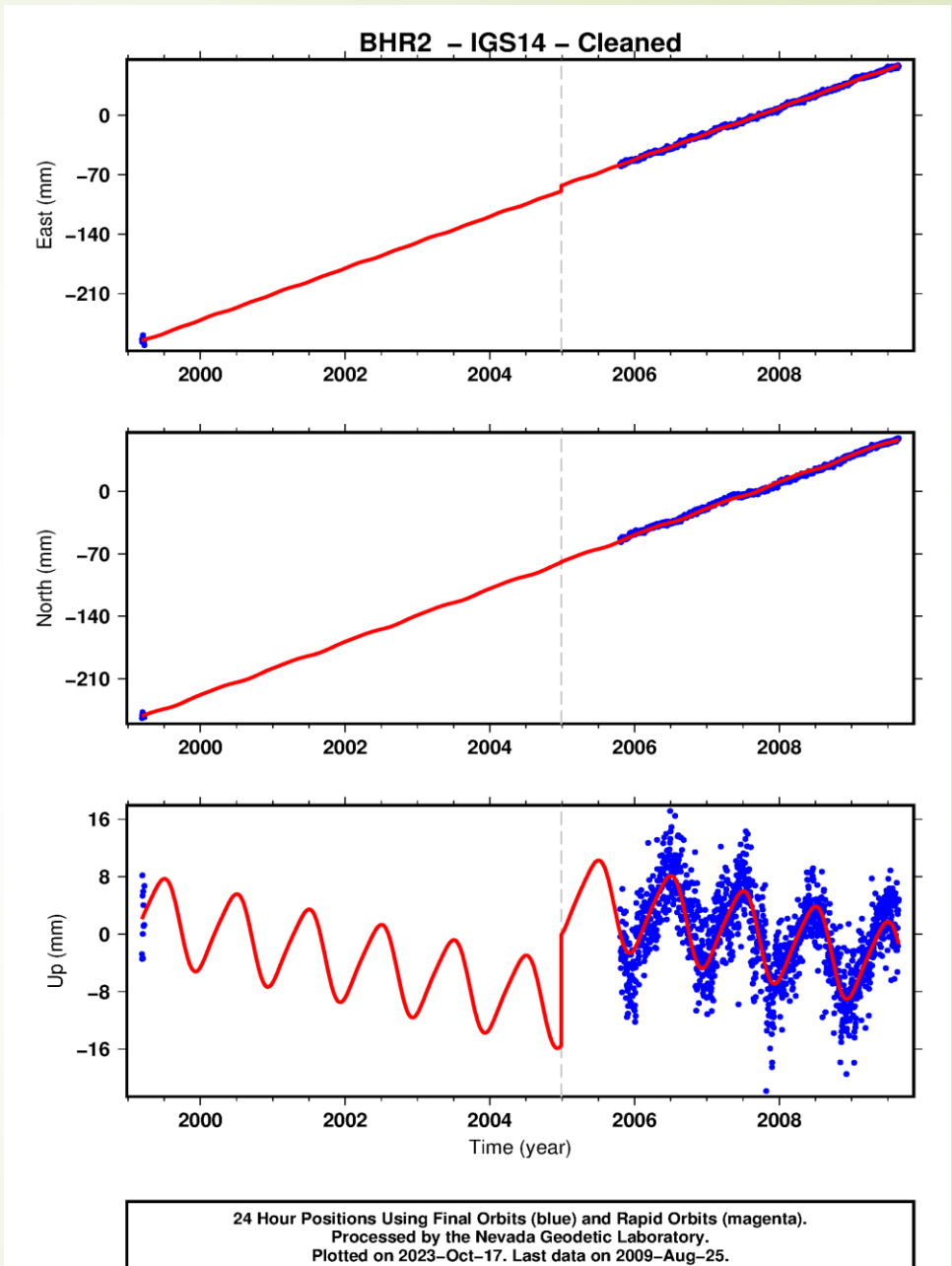


Results (Validation):

IGS14 is basically an extract of well-suited reference frame stations

“Cleaned” time series are provided. These have had outlying position solutions removed to clarify the plots in cases where the presence of outliers expand the vertical scale of the plots, making it difficult to see details of most of the data.

Each blue dot is an individual estimate of site position, the plot axes are scaled automatically to accommodate the data time span and range of positions



Results (Validation):

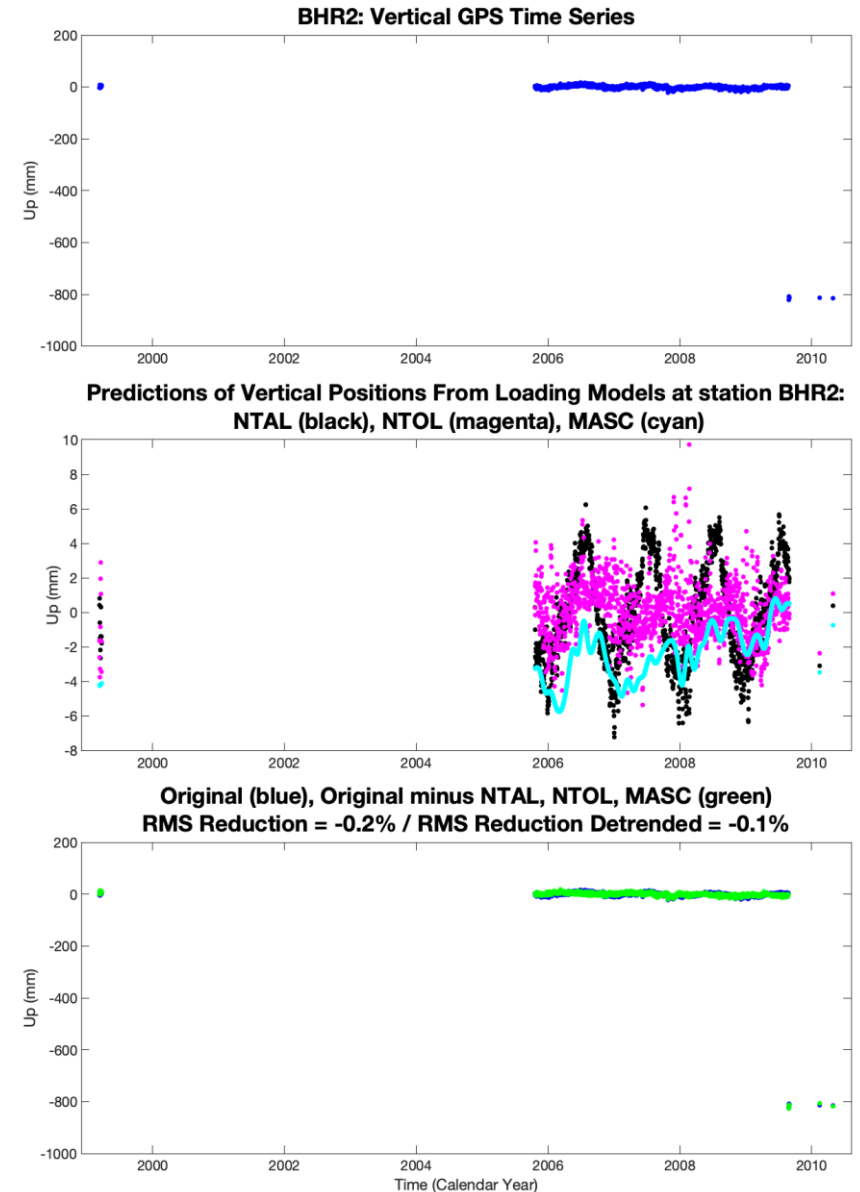
Predictions

Carried out by a three-dimensional Cartesian coordinate system that is typically used to describe the displacement or movement of a point on the Earth's surface.

"NTAL" stands for "Normal-Tangent-Along"

"NTOL" stands for "Non-Tidal Ocean Loading .

"MASC" stands for "Multi-Application Support Center." The Multi-Application Support Center (MASC) is a concept that refers to a centralized facility or organization that provides support and resources for various geodetic applications and services.



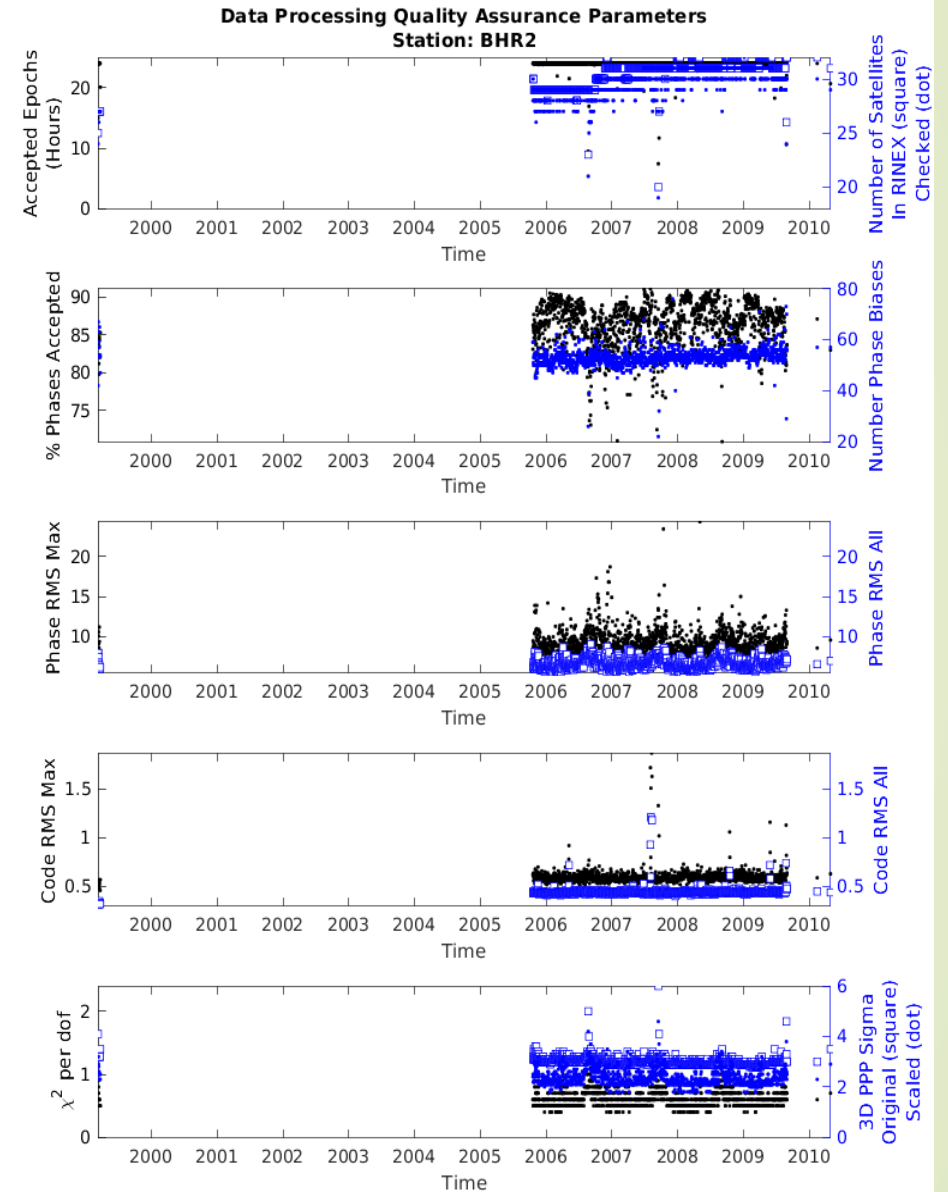
Last data point on 2010-Apr-29.
Plotted on 2023-Jul-30.

Results (Validation):

Quality Assurance Parameter

MIDAS rates are estimated for all stations with at least one year of data and sufficiently dense time series.

Modern Integrated Database for Acquisition and Solutions.



Red dashed line = time of known equipment change.
Black symbols = left axis parameters. Blue symbols = right axis parameters
For explanation of parameters see: http://geodesy.unr.edu/gps_timeseries/QA.pdf

Conclusions:

- Most of the country shorelines are subjected to subsidence.
- The new man-made islands are endangered.
- The central area of the Kingdom also suffers from subsidence due to agricultural practices.
- The causeway island is subjected to surface uplifting.



IT IS THE AGE OF BIG DATA

Thanks for your attention

