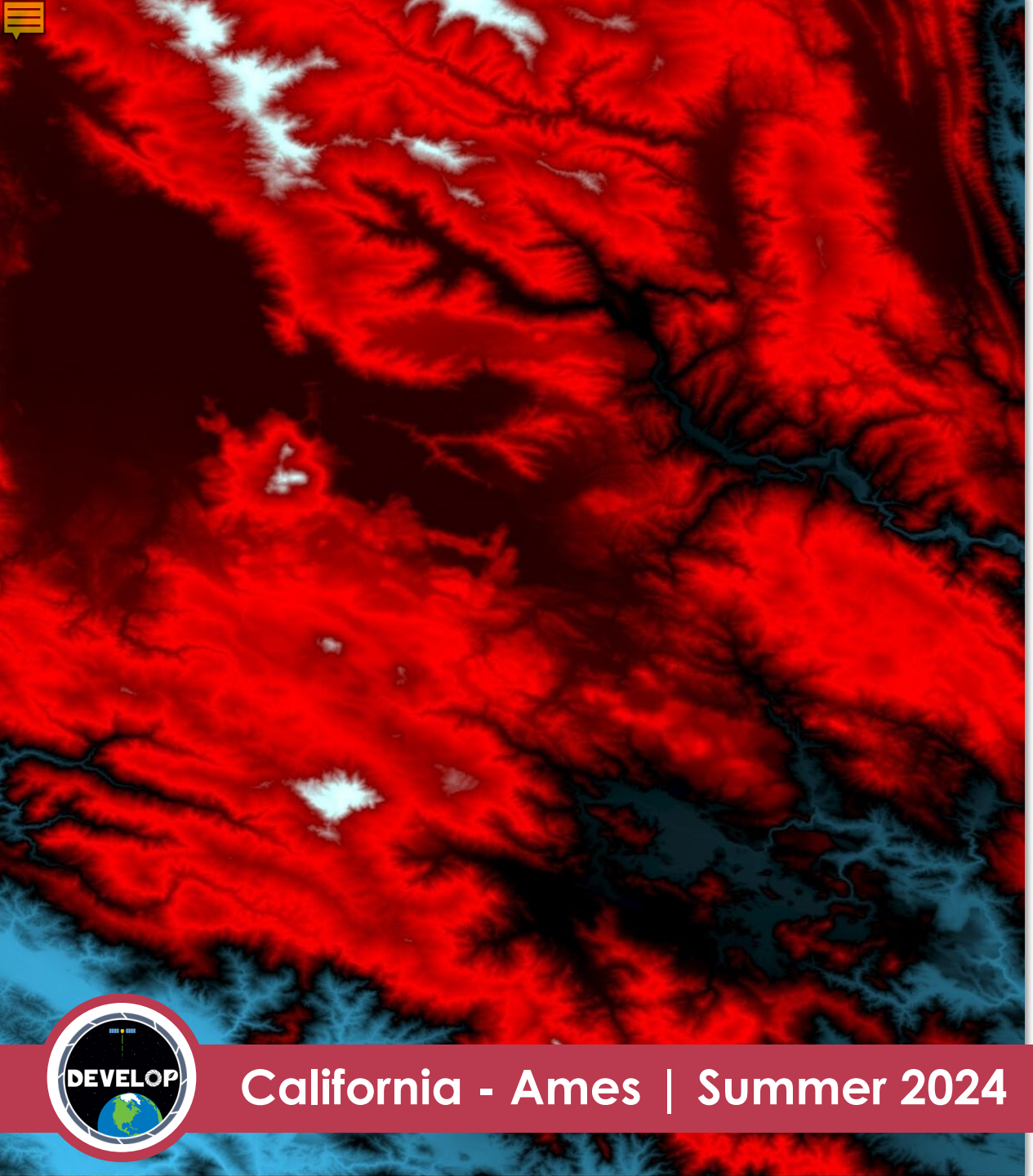


National Aeronautics and Space Administration

CLEAR LAKE VOLCANIC FIELD DISASTERS

Creating a Deformation Record Using InSAR to Assess Hazards and Detect Volcanic Unrest in Clear Lake Volcanic Field

Charlie Nuncio

Lexi Crilley

Shilpa Kannan

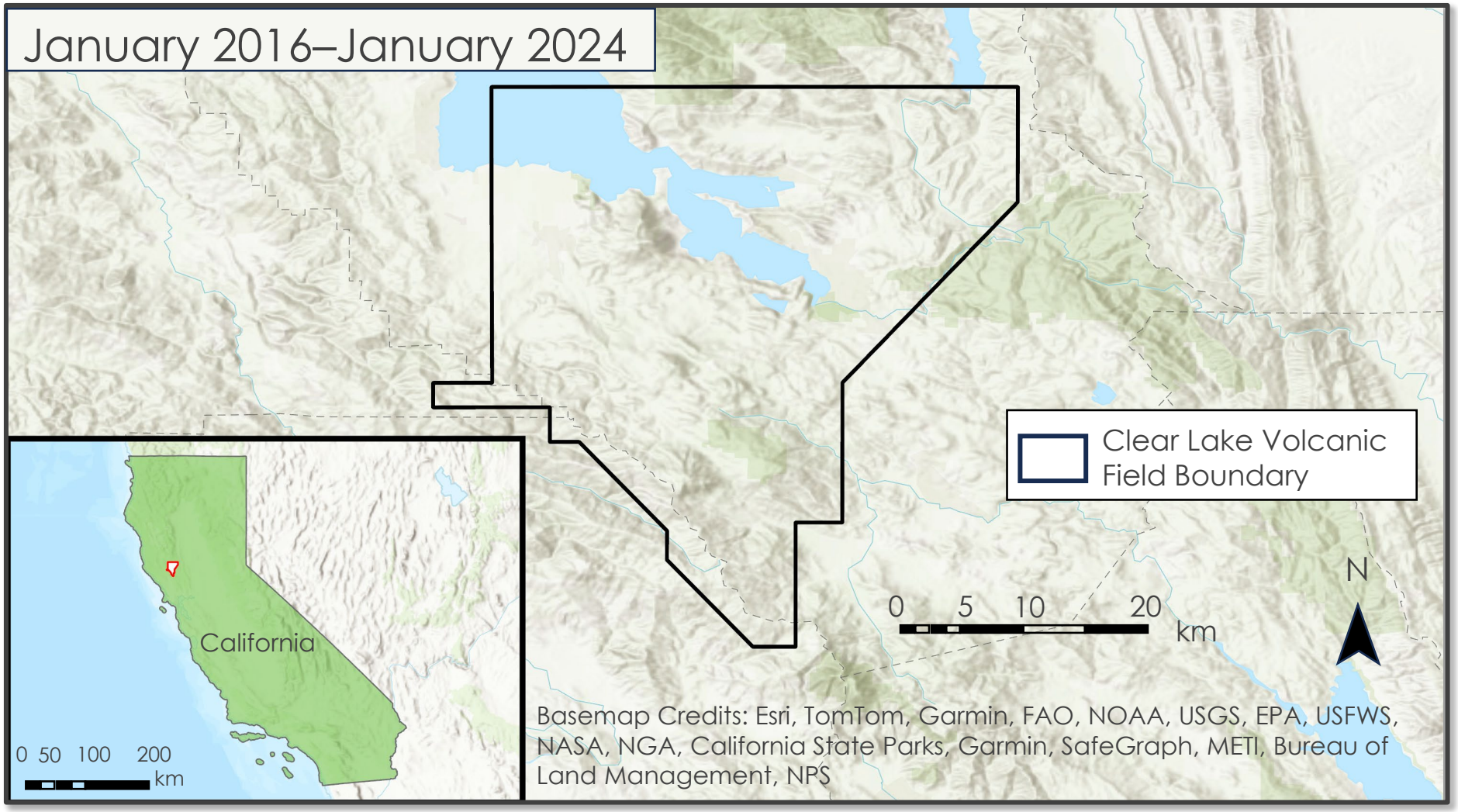
Ivan Tochimani-Hernandez

DEVELOP

California - Ames | Summer 2024

STUDY AREA & PERIOD

Clear Lake Volcanic Field, California, U.S.A



BACKGROUND

- Youngest California Coast range volcano
- Populated areas **near previous eruption** sites
- Faults running under the lake
- Potential for **explosive volcanism**



Image Credit: Jessica Ball (USGS)

COMMUNITY CONCERNS

"Residents, infrastructure, agricultural, water, and recreational resources would be at **significant risk** in the event of explosive phreatomagmatic activity. " (Ball, 2022)



18,000+ People



1,000+ Acres of Agriculture



20+ Community Service Facilities

GROUND DEFORMATION

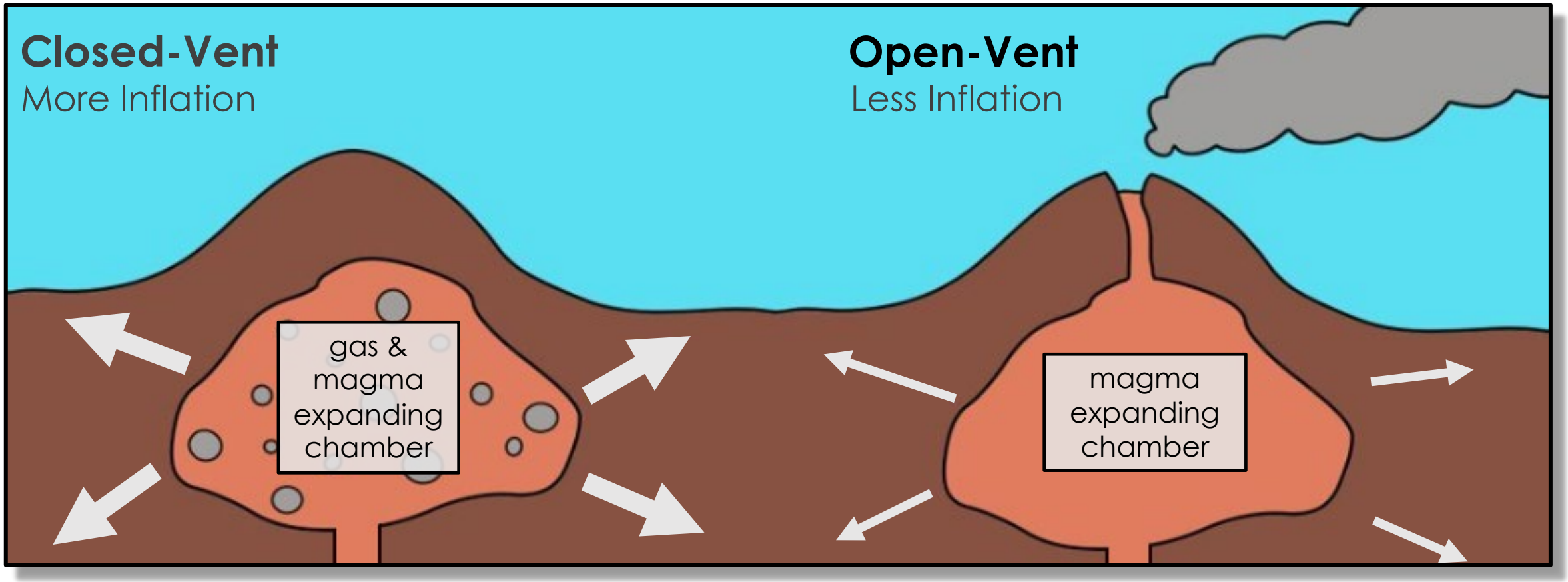


Image Credit: Charlie Nuncio

PARTNERS

United States Geological Survey

California Volcano Observatory



Image Credit: Julie Donnelly-Nolan

USGS
science for a changing world

- Support **hazards assessment** related to Clear Lake Volcanic Field (CLVF)
- **Investigate** the area's eruptive history
- Inform on local **disaster mitigation**

OBJECTIVES

OUR GOAL: Assess feasibility of using Sentinel-1 C-SAR data and Digital Elevation Models (DEMs) to create a historic time series of deformation with interferometric analysis.



Provide the USGS with a **deformation baseline** at CLVF to assist hazard identification and inform future decision making

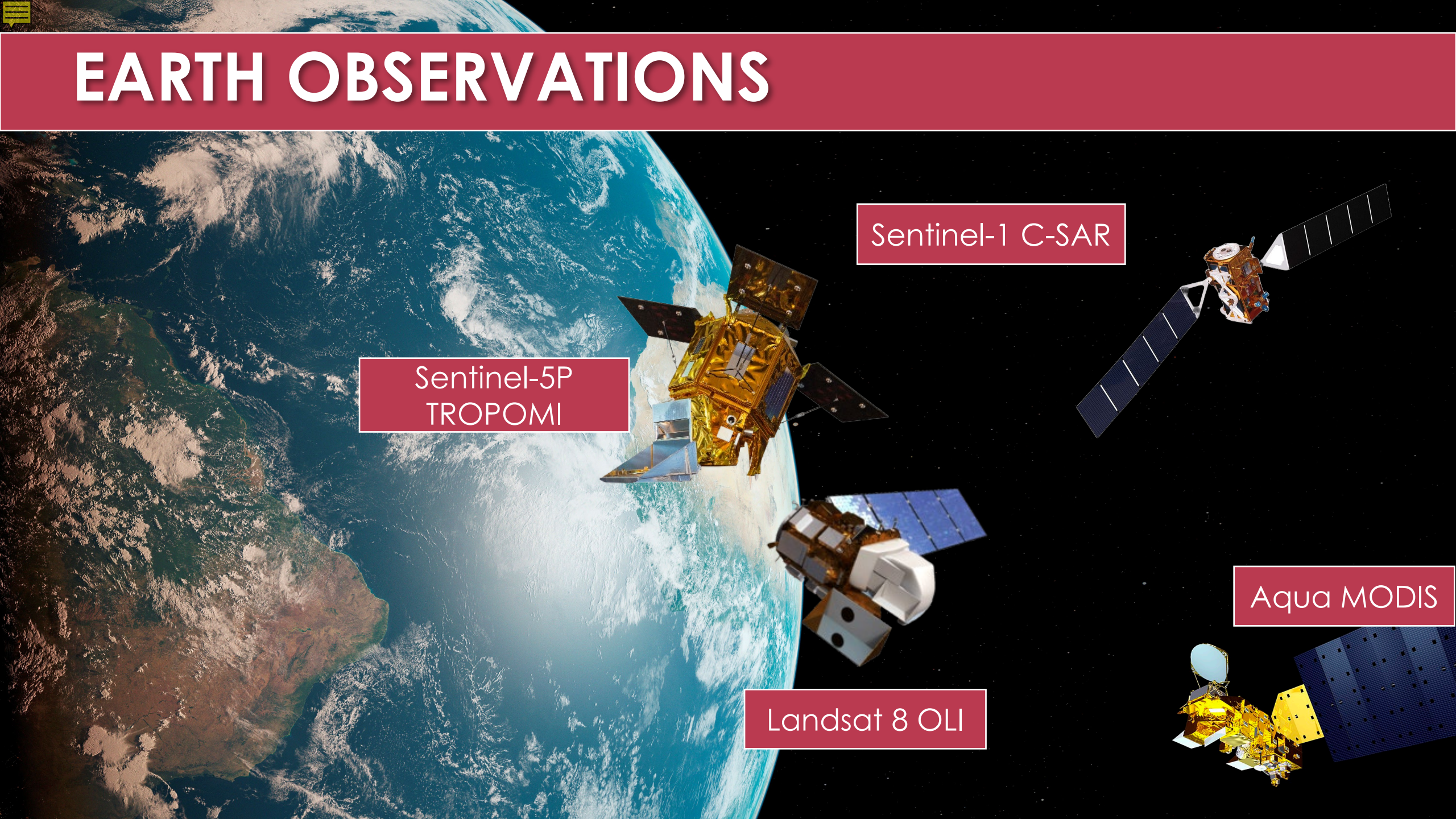


Contextualize **deformation patterns** using supplemental study area data

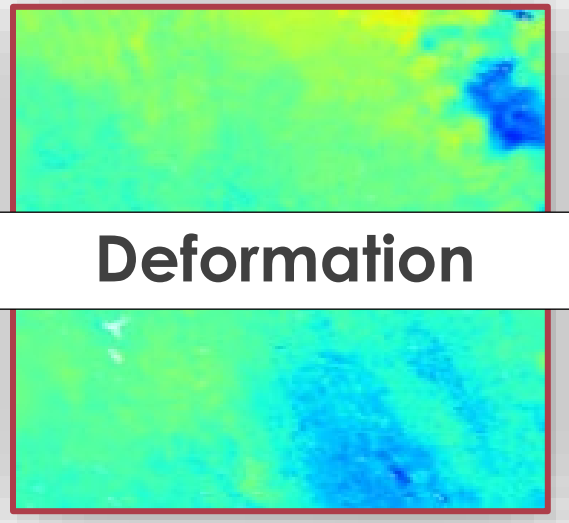


Use social media to communicate the **capabilities of InSAR** to monitor volcanoes & potential hazards at CLVF

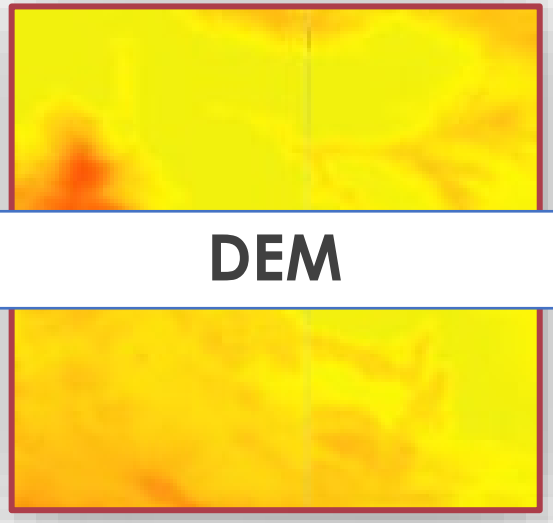
EARTH OBSERVATIONS



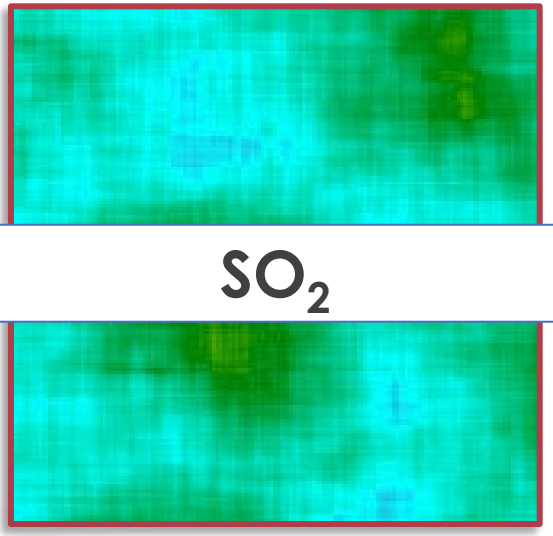
METHODS



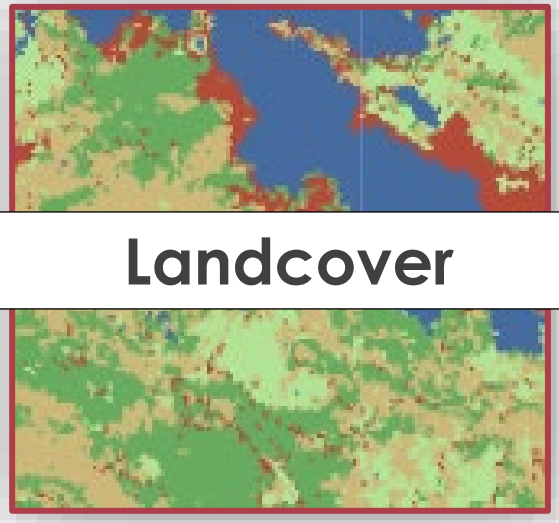
Deformation



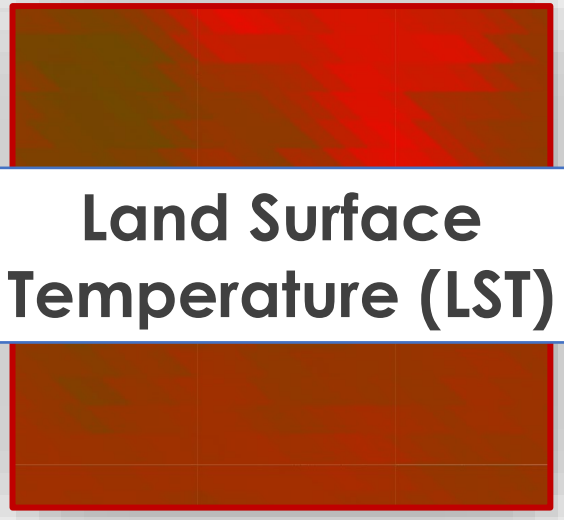
DEM



SO_2



Landcover



Land Surface Temperature (LST)

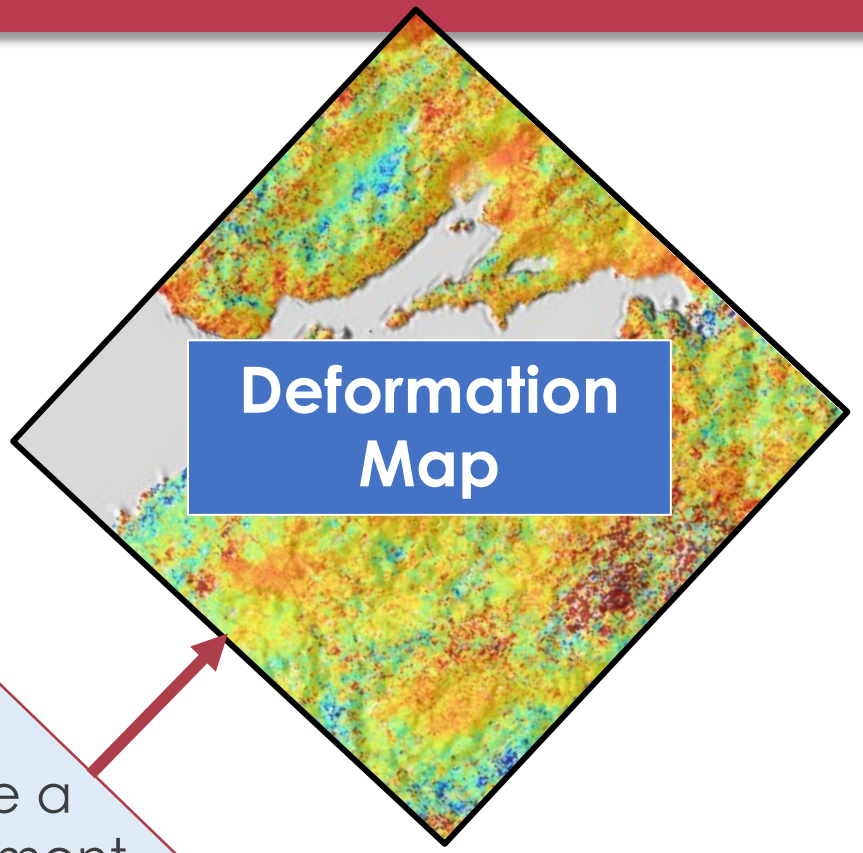
DEFORMATION MAP

Extract and Clean Sentinel SAR Data

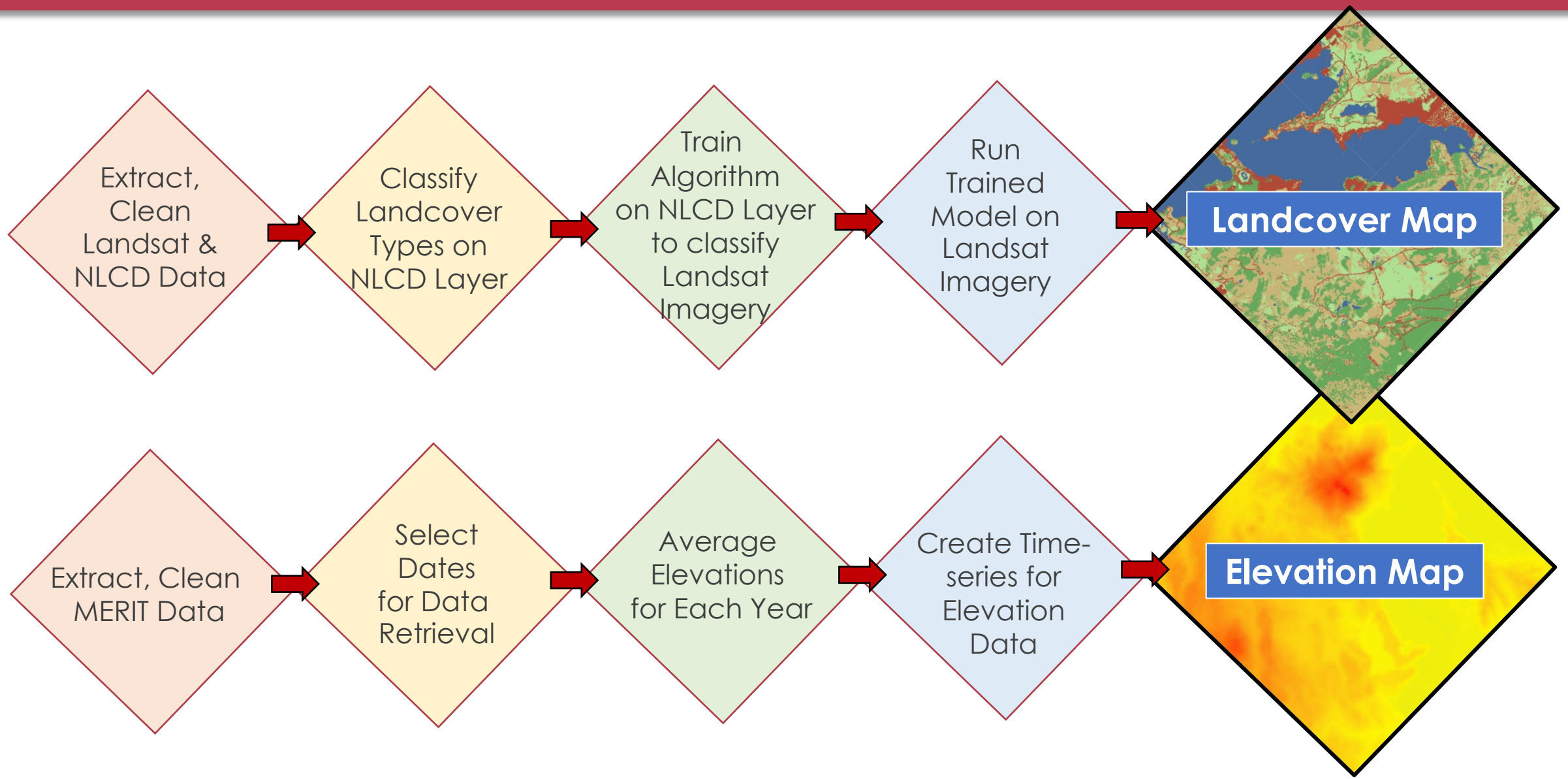
Invert for a Phase Time-Series

Correct for Noise and Possible Errors

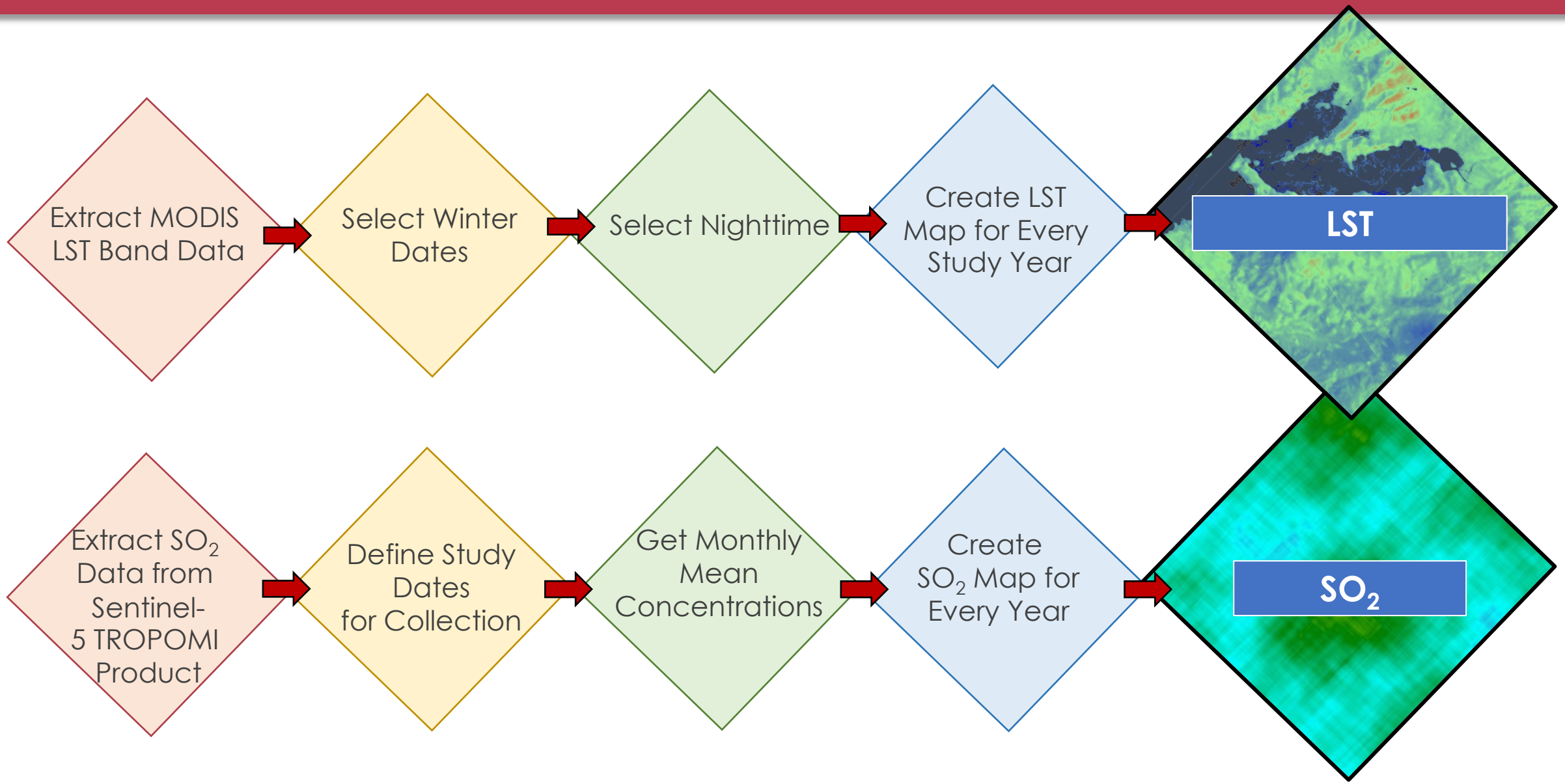
Create a Displacement Time-series for Each Season



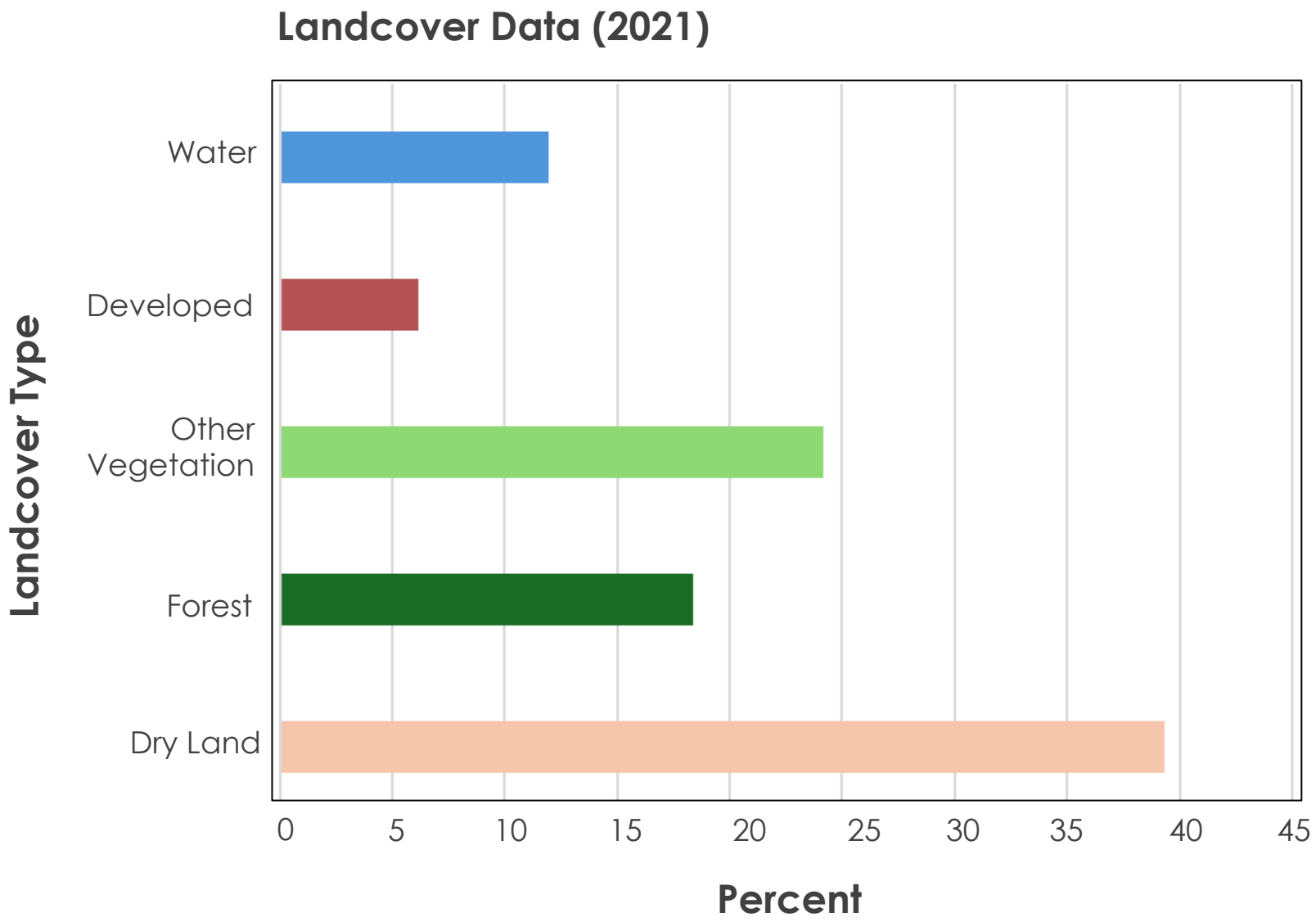
LANDCOVER AND DEM MAPS



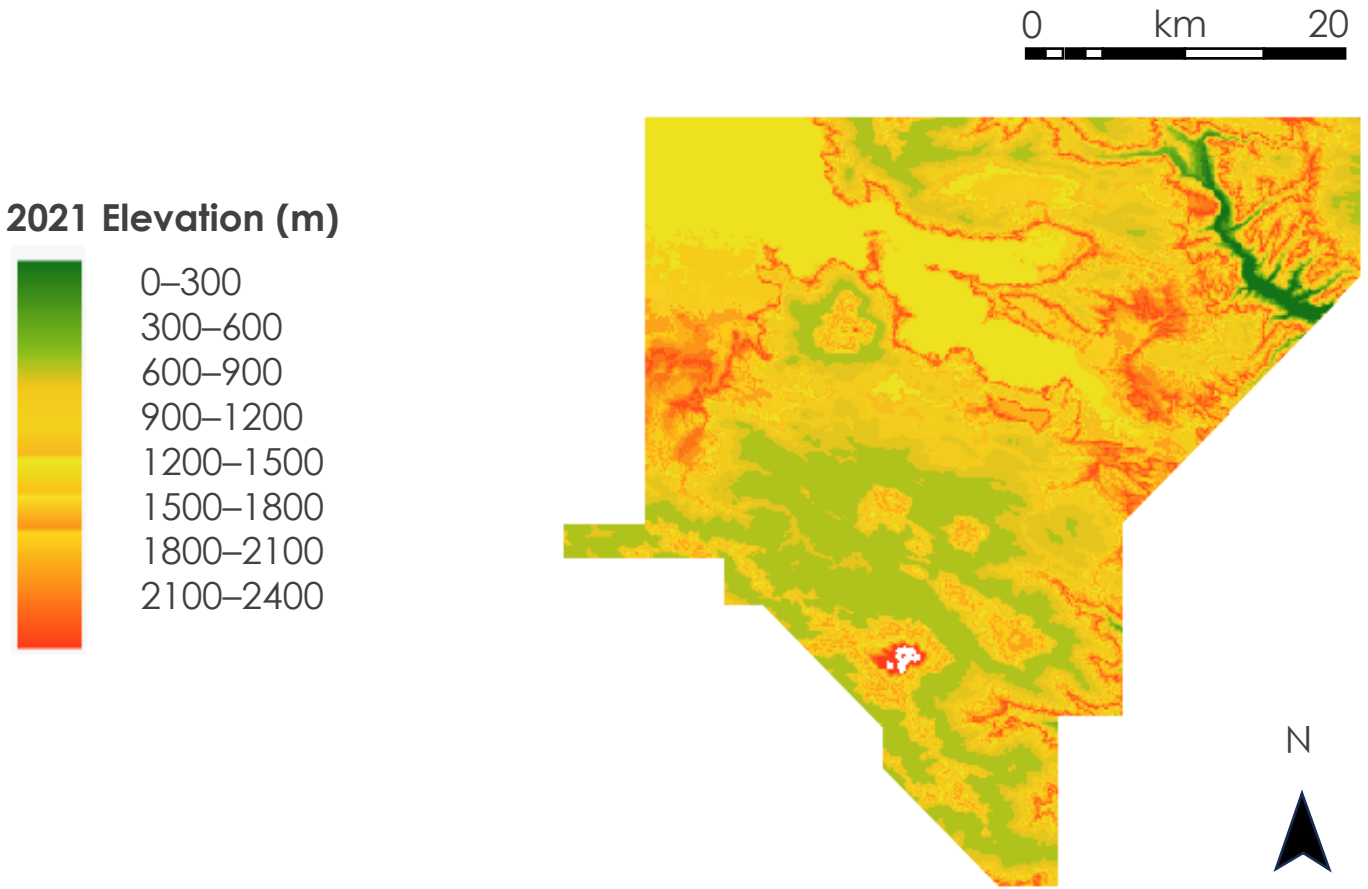
LST AND SO2


Extract MODIS LST Band Data
Select Winter Dates
Select Nighttime
Create LST Map for Every Study Year
LST
Extract SO_2 Data from Sentinel-5 TROPOMI Product
Define Study Dates for Collection
Get Monthly Mean Concentrations
Create SO_2 Map for Every Year
SO_2

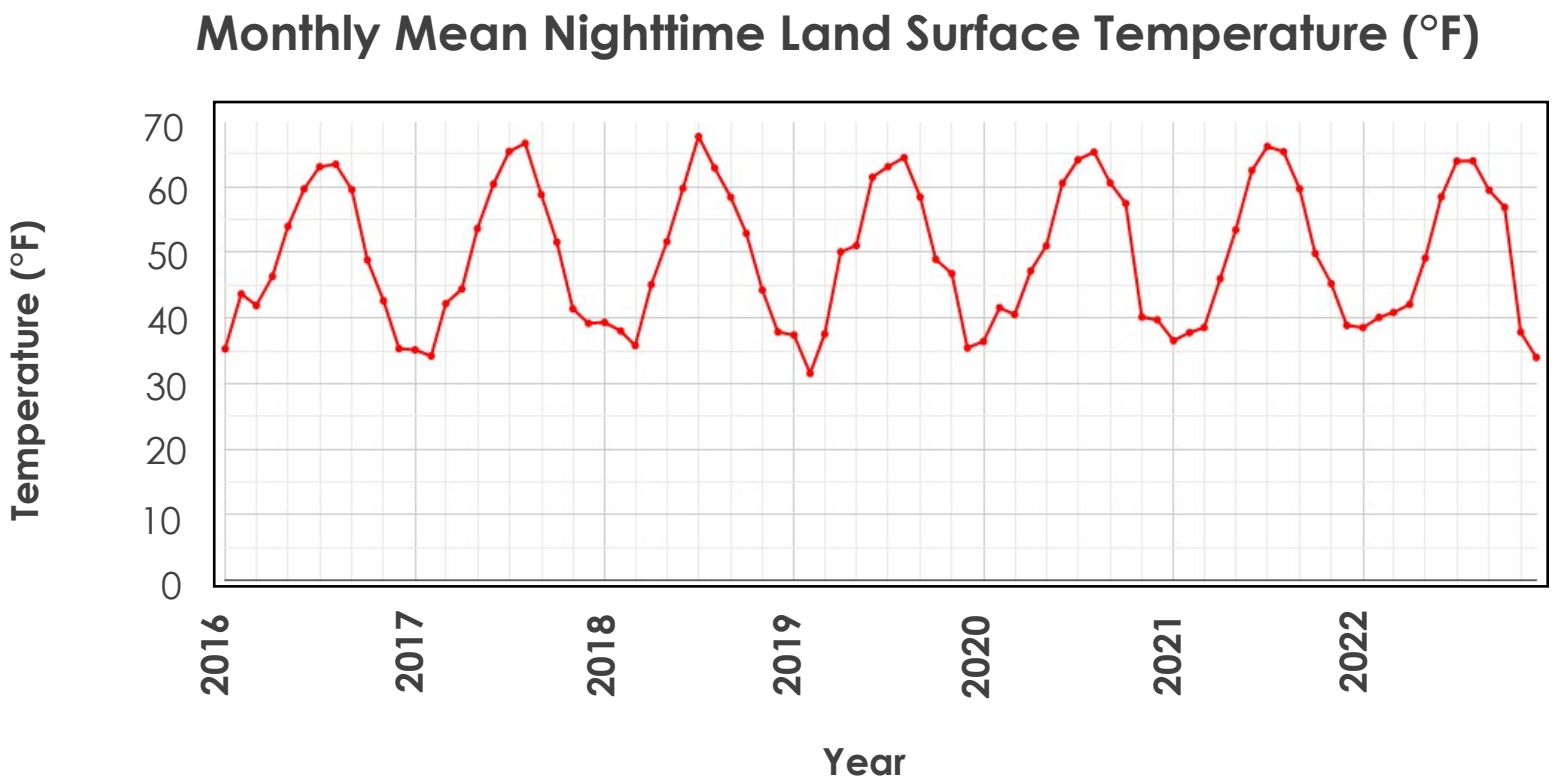
RESULTS: LANDCOVER DATA



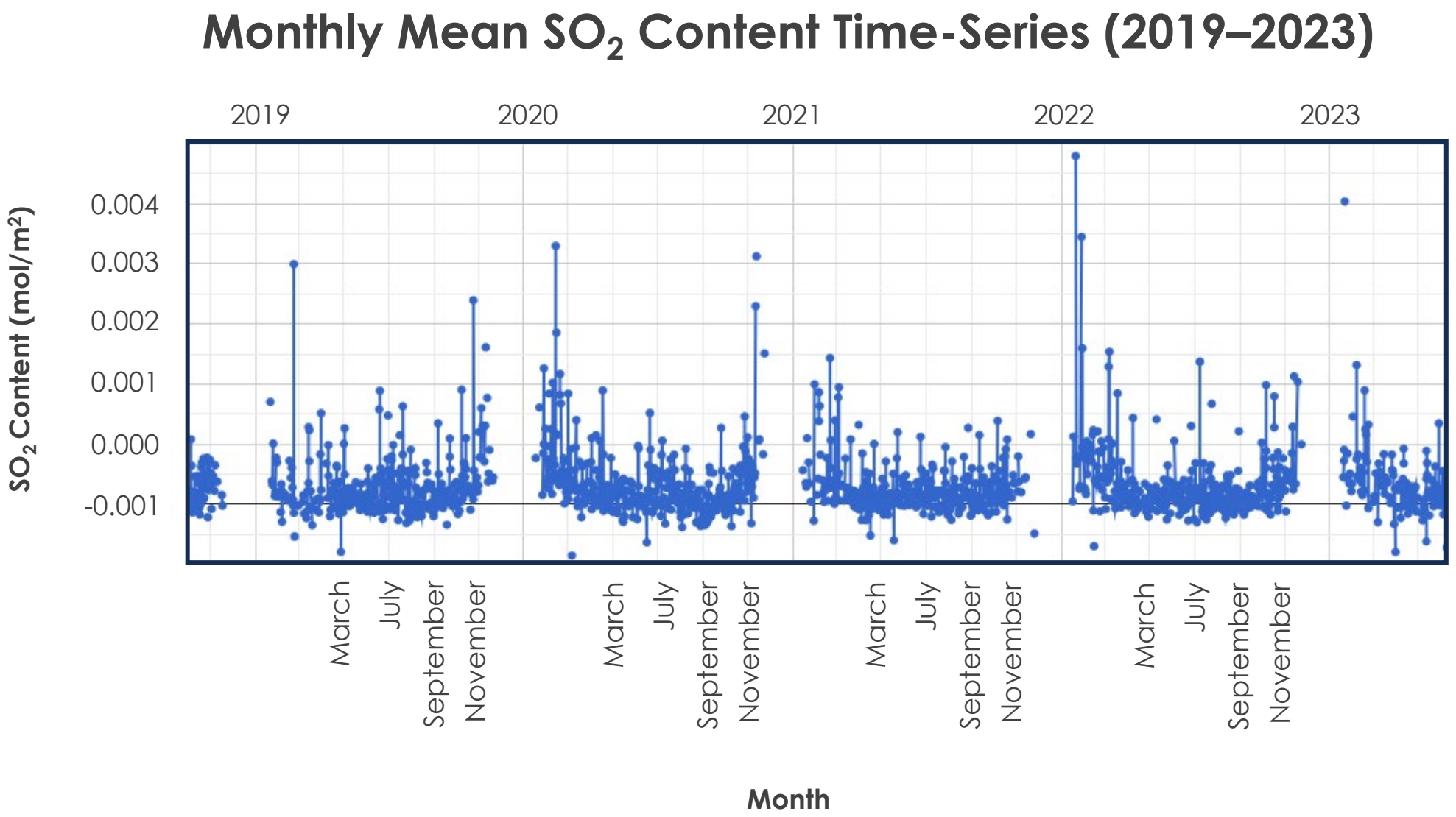
RESULTS: ELEVATION DATA



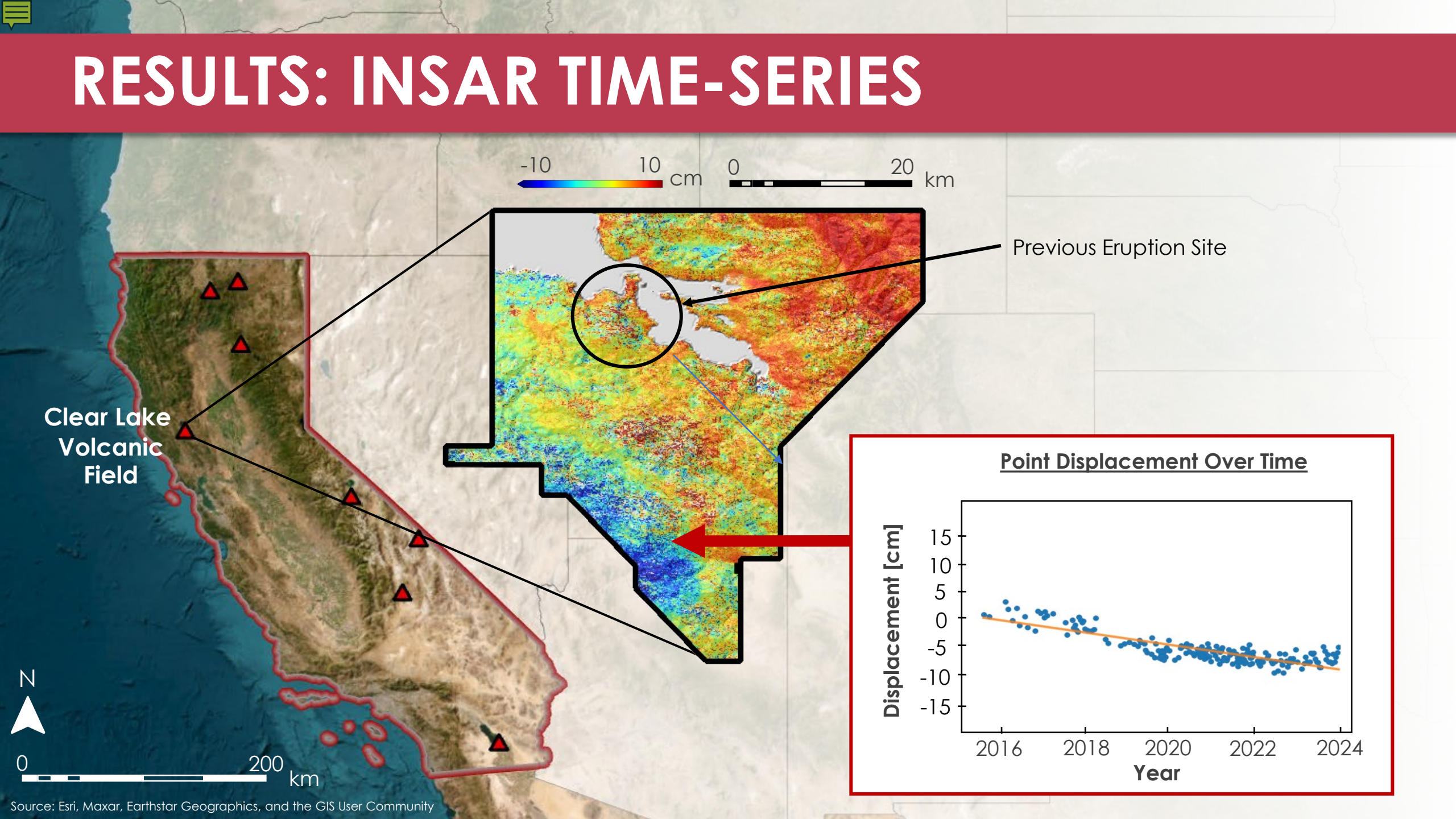
RESULTS: LAND SURFACE TEMPERATURE DATA



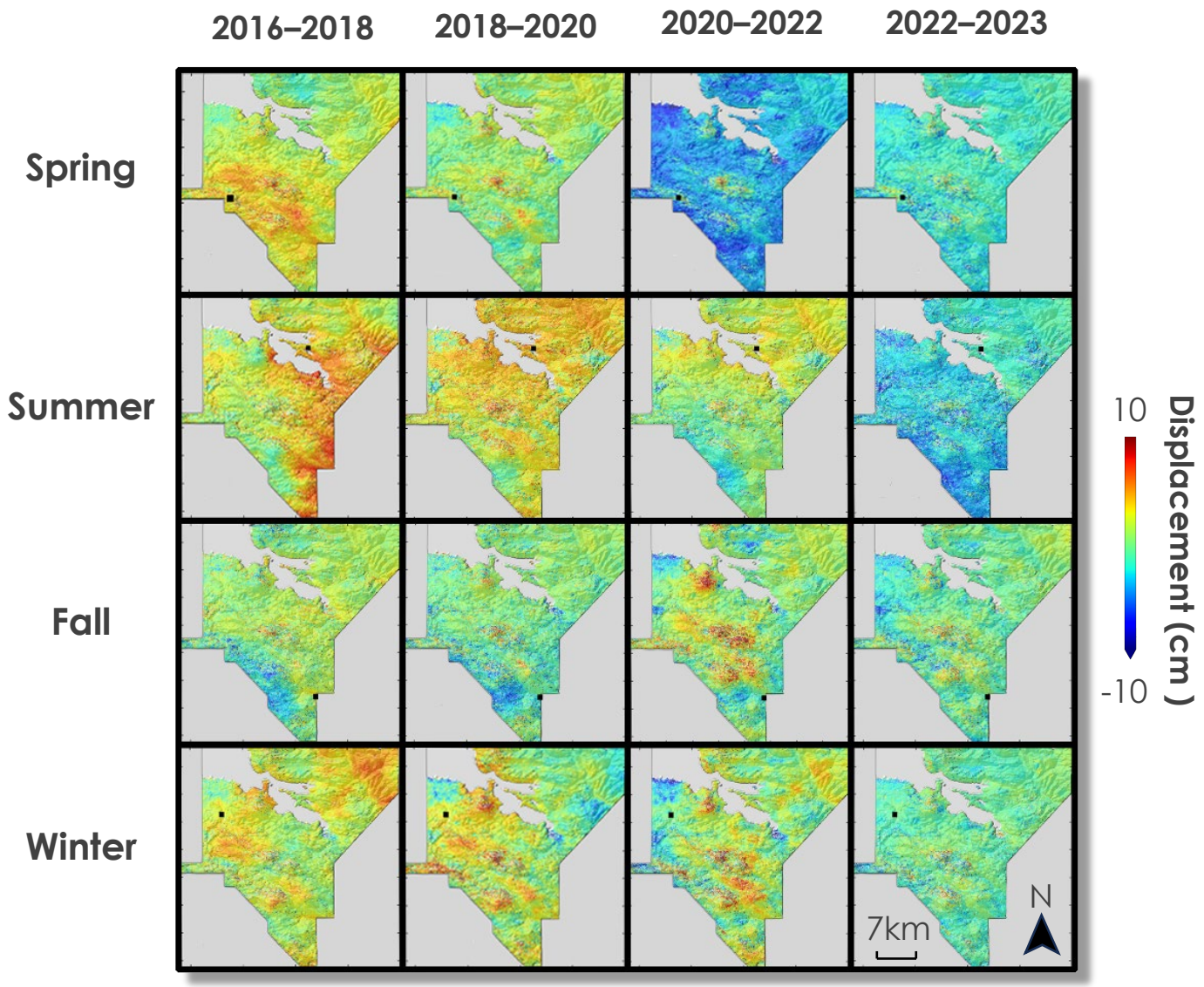
RESULTS: SO_2 DATA



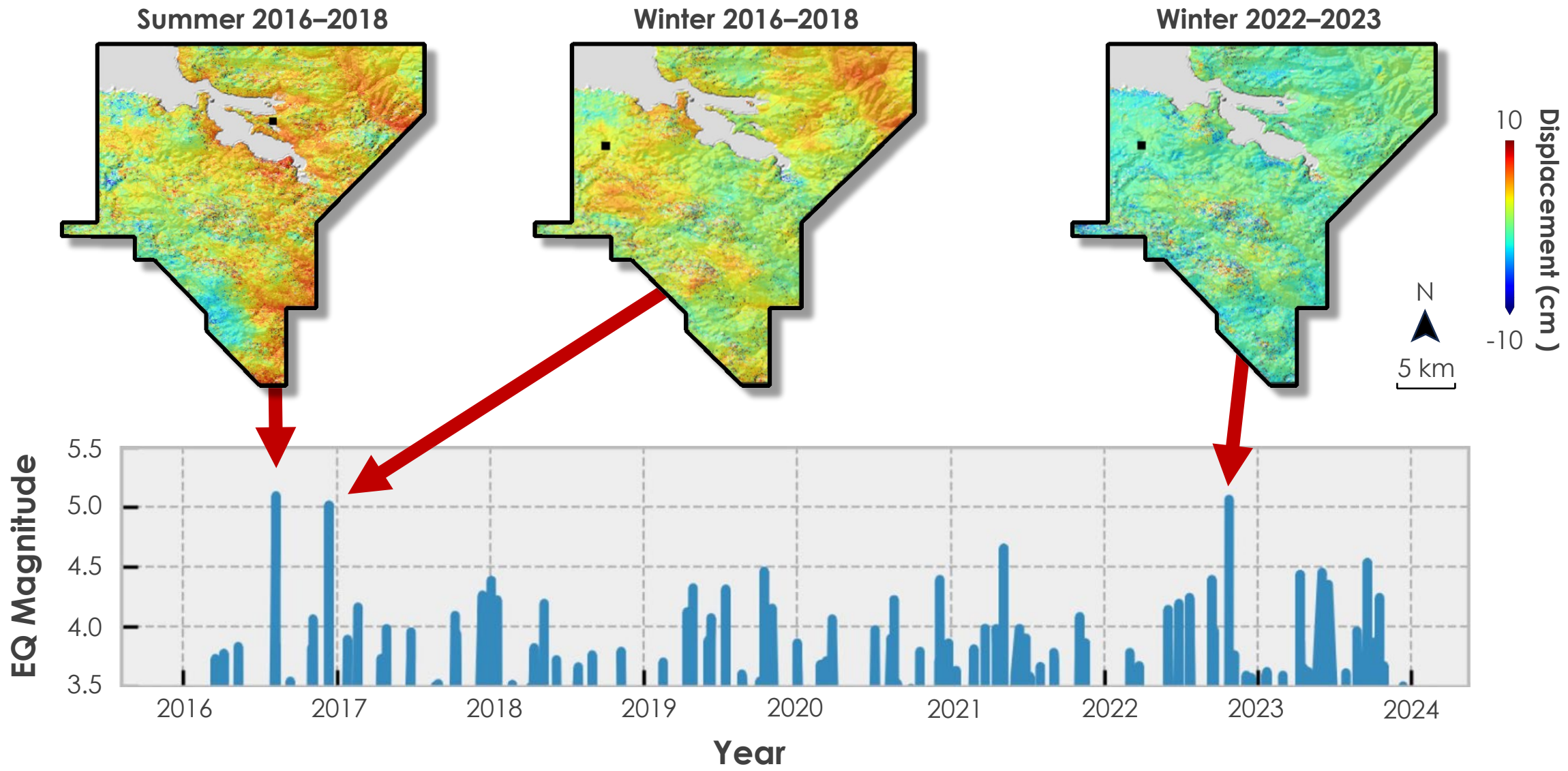
RESULTS: INSAR TIME-SERIES



RESULTS: SEASONAL TRENDS



RESULTS: SEISMIC OBSERVATIONS

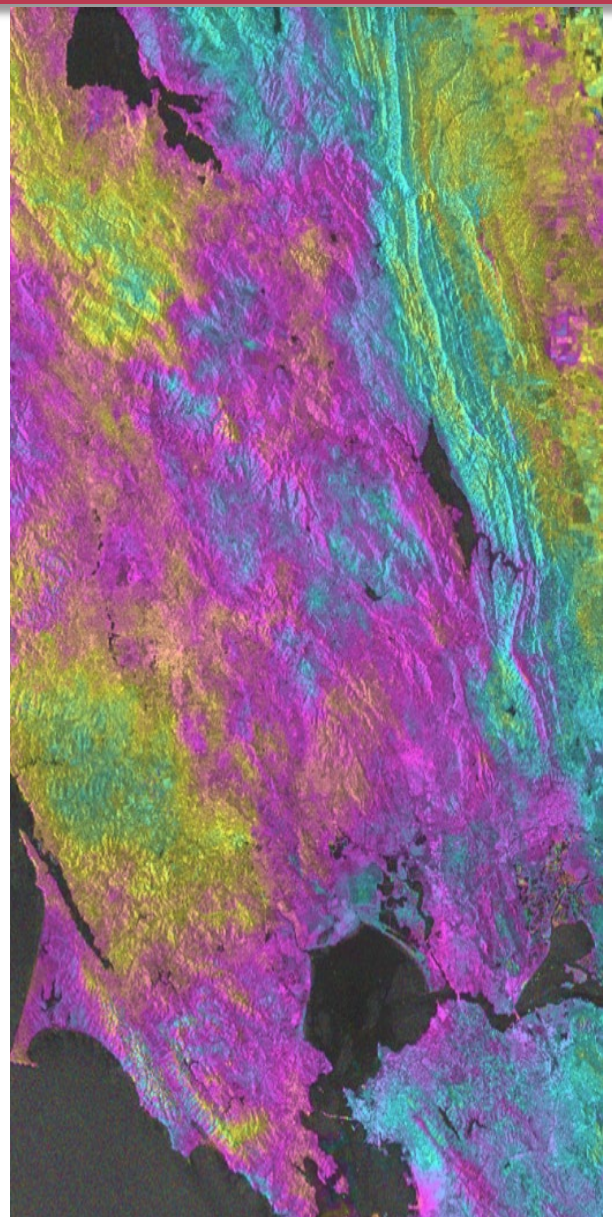


LIMITATIONS & ERRORS

- Limited Satellite Data
- Coarse Elevation Data
- Atmospheric Distortion
- Temporal Omissions



CONCLUSION



- **Considerable deformation** of Clear Lake Volcanic Field detected
  - Ranges from approximately 5 to 10 centimeters
  - Notable differences in surface displacement across seasons
- Deformation is predominantly associated with **seismic activity** and **geothermal changes** in the geyser field
  - Limited evidence suggesting deformation is due to volcanic activity within study area
- **Baseline of deformation** created will help inform USGS CA Volcano Observatory in detecting **future volcanic hazards**

Acknowledgments

Project Partners and Advisors

- Lauren Webster (NASA DEVELOP Node Lead – Ames)
- Maya Hall (NASA DEVELOP Impact Analysis Fellow)
- Dr. Morgan Gilmour, NASA Ames Research Center
- Dr. Mike Poland, USGS Yellowstone Volcano Observatory
- Dr. Brianna Corsa, USGS California Volcano Observatory
- Dr. Jessica Ball, USGS California Volcano Observatory
- Dr. Seth Burgess, USGS California Volcano Observatory
- Jonathan Stock, USGS National Innovation Center
- Dr. Franz Meyer, University of Alaska Fairbanks & Alaska Satellite Facility
- Lisa Tanh, ESRI

This material contains modified Copernicus Sentinel data (2024), processed by ESA.

This material is based upon work supported by NASA through contract 80LARC23FA024. Any mention of a commercial product, service, or activity in this material does not constitute NASA endorsement. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration and partner organizations.