Spatially Variable Solid Earth Deformation in Southwest Greenland

Jasmine Hansen* Michael Willis
Joel Johnson Kristy Tiampo
* jasmine.hansen@colorado.edu

University of Colorado Boulder
Earth Science & Observation Center
THE UNIVERSITY OF COLORADO AT BOULDER
CIRES

Objectives

The melting of the Greenland Ice Sheet is transferring huge quantities of mass across the Earth surface, deforming the crust and mantle. **Understanding how this deformation varies over short wavelengths remains highly challenging**, particularly in Greenland.

Global Satellite Navigation System (GNSS) sites record solid Earth deformation but only provide point measurements – so what is happening between these points?

The key aims of this work are to:

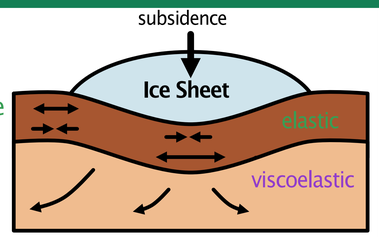
- Produce high resolution DInSAR time-series of surface deformation
- Identify seasonal and spatial patterns
- Understand how representative GNSS sites are of regional motion

We focus initially on the Kangerlussuaq region in SW Greenland.

Why Surfaces Deform

Elastic
Short wavelength caused by contemporary surface change

Viscoelastic
Dominant in mantle occurs over longer spatiotemporal scales



Schematic of the different forms of solid Earth deformation caused by ice sheet loading

Total Deformation = Viscoelastic Deformation – Elastic Deformation

Why do we care about deformation?

Solid Earth corrections required for GRACE ice mass loss estimates to account for deformation

Large uncertainties and offsets between glacial isostatic adjustment (GIA) models used and GNSS site records[1]

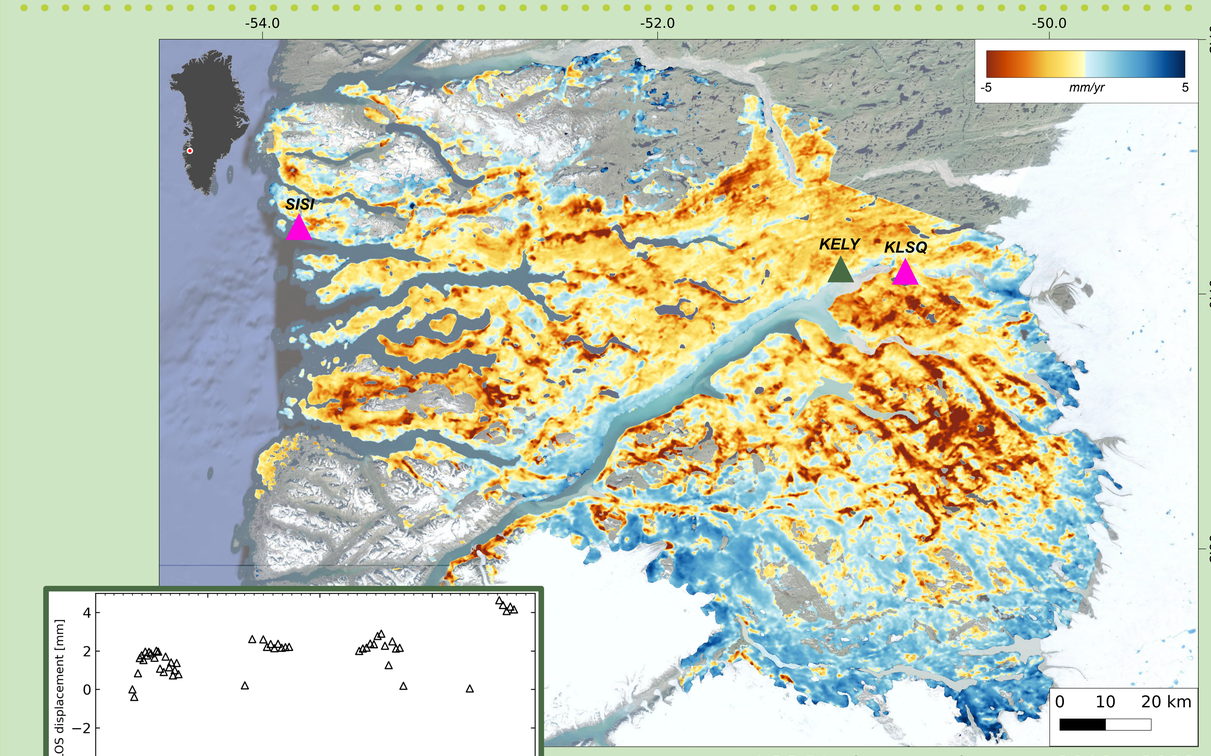
Improving deformation understanding will improve GRACE ice mass loss estimates

Understanding Surface Deformation

Process Sentinel-1 Data

- Collate Sentinel-1 SLC files from ASF
- Generate interferograms using the ISCE Sentinel stack processing module[2]
- Correct data for topographic, orbital and ionospheric[3] effects
- MintyPy[4] used to create timeseries DInSAR
- Output LOS displacement using weighted least-squares inversion[4]
- Tropospheric, DEM & other error corrections applied[4]
- Reference to KELY GNSS site

Identify How the Earth Deforms – DInSAR Timeseries



LOS Displacement timeseries at KELY GNSS

LOS Displacement between 2018 – 2022
Red = Subsidence
Blue = Uplift

PROCESS DATA FROM SENTINEL-1 → **IDENTIFY HOW THE EARTH DEFORMS** → **WHAT IS CAUSING THIS MOTION?** → **HOW DOES THIS ALIGN WITH GNSS DATA?**

What is Causing this Motion?

- Ice Sheet Mass Change?
- Glacial Isostatic Adjustment?
- Fluvial transport – sediment & water?

Are there seasonal trends?

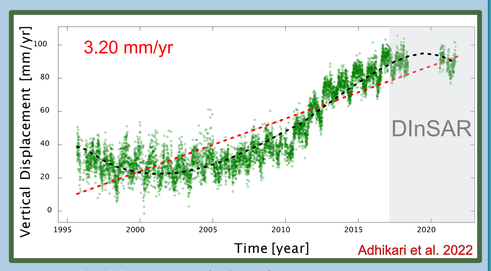
What happens if we vary inversion parameters?

Can we extend the record back further?

How Does this Align with GNSS Data?

Compare to existing GNSS records

How regionally representative are GNSS sites?



KELY GNSS vertical displacement timeseries

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For references please scan the QR code