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## Exploring Effects of GPS Processing on Atmospheric Responses of Earth Deformation

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# Exploring Effects of GPS Processing on Atmospheric Responses of Earth Deformation

Presenter: Cody Norberg

Advisor: Hilary Martens

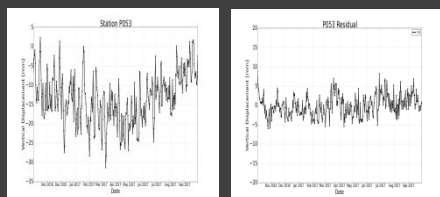
## BACKGROUND:

The Earth's crust moves up to several millimeters every day due to changes in atmospheric pressure. The motion of the crust can be measured using GPS receivers. However, there are several GPS processing centers using different methods to process GPS signals, creating different estimates of GPS positions that reflect differently the Earth's response to atmospheric pressure. We aim to find causes for differences in products, to help make GPS products more precise.

## METHODS

1. Downloaded data from over 1100 GPS stations in the Western US
2. Removed all known signals in GPS to isolate atmospheric signal
3. Calculated root mean square (RMS) scatter after step 2.
4. Modeled the crust response due to atmospheric pressure changes using software program LoadDef
5. Subtracted modeled signal (step 4) from observed signal (step 2)
6. Calculated RMS after step 5.
7. Calculated percent change in RMS
8. Repeat for all stations!

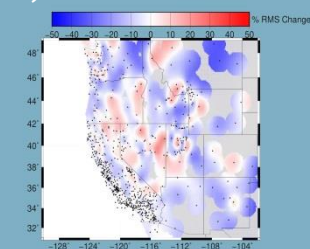
Data before step 2      Data after step 5



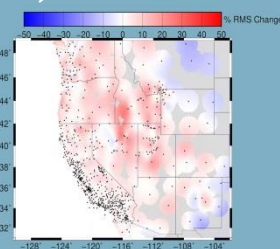
# CONCLUSIONS:

- Changes in surface pressure deform the Earth's crust.
- GPS stations can measure mm surface displacements
- Atmospheric mass loading can contribute up to 50% of the signal present in the residual GPS time series, but contribution varies based on location and GPS data product.
- We compared five different data products, and found reductions in RMS after applying atmospheric loading corrections for the UNAVCO, JPL old, and NGL new GPS data products, with UNAVCO yielding the largest reductions.
- Resolution of Troposphere Delays Used during initial processing affects atmospheric pressure contributions in GPS time series, and we recommend using high resolution delays for best precision

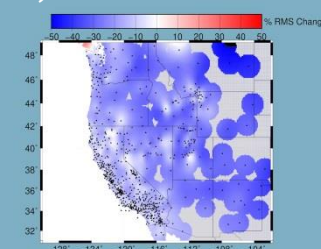
a) JPL old



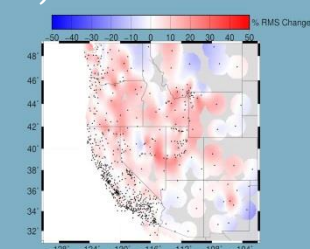
c) NGL old



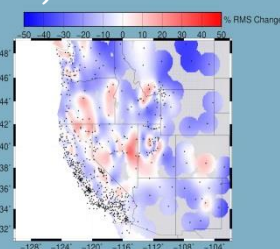
e) UNAVCO



b) JPL new



d) NGL new



JPL = Jet Propulsion Laboratory  
 NGL = Nevada Geodetic Laboratory  
 UNAVCO = University NAVSTAR Consortium  
 old = older data product, new = newer data product

Black triangles are GPS stations. Blue is a decrease in RMS scatter after removing model for atmospheric pressure loading from the residual time series, while red is an increase in RMS scatter. UNAVCO has the largest %RMS reduction, while JPL new and NGL old have increases in RMS scatter

## RESULTS

- A decrease in RMS scatter after applying atmospheric pressure corrections means that modeled signal fits observed signal well.
- We find a max 50 % reduction in RMS scatter after removing the atmospheric pressure response. The table shows average % RMS change for each GPS data product

Processing Center	Average % RMS Change
a) JPL old	- 3.6 %
b) JPL new	+4.6 %
c) NGL old	+4.6 %
d) NGL new	- 4.8 %
e) UNAVCO	- 16 %

## Discussion

- Some assumptions must be made when processing GPS data, such as signal delay through the troposphere, and these assumptions affect estimates of GPS positions
- Troposphere relates directly to atmospheric pressure, so if troposphere assumed wrong, then it partially removes atmospheric pressure signal.
- JPL old, NGL new, and UNAVCO use higher resolution troposphere delay models than JPL new, NGL old.

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