Variations in subsidence patterns in the Gulf of Mexico passive margin from Airborne-LiDAR data and Time Series InSAR: Baton Rouge Case Study (AGU23 - oral presentation)

Carolina Hurtado-Pulido[1], Reda Amer[1], Cynthia Ebinger[1], and Hayden Holcomb[1]

[1]Affiliation not available

April 16, 2024

Variations in subsidence patterns in the Gulf of Mexico passive margin from Airborne-LiDAR data and Time Series InSAR: Baton Rouge Case Study

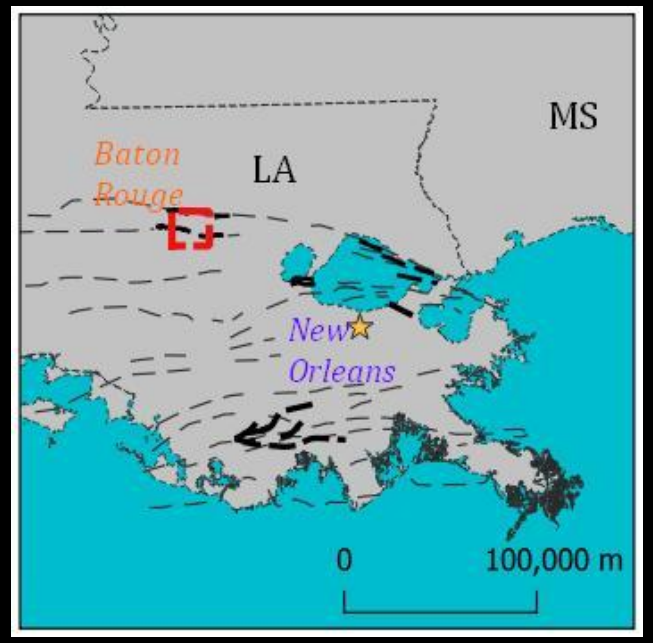
Hurtado-Pulido, C., Amer, R., Ebinger, C., Holcomb, H.

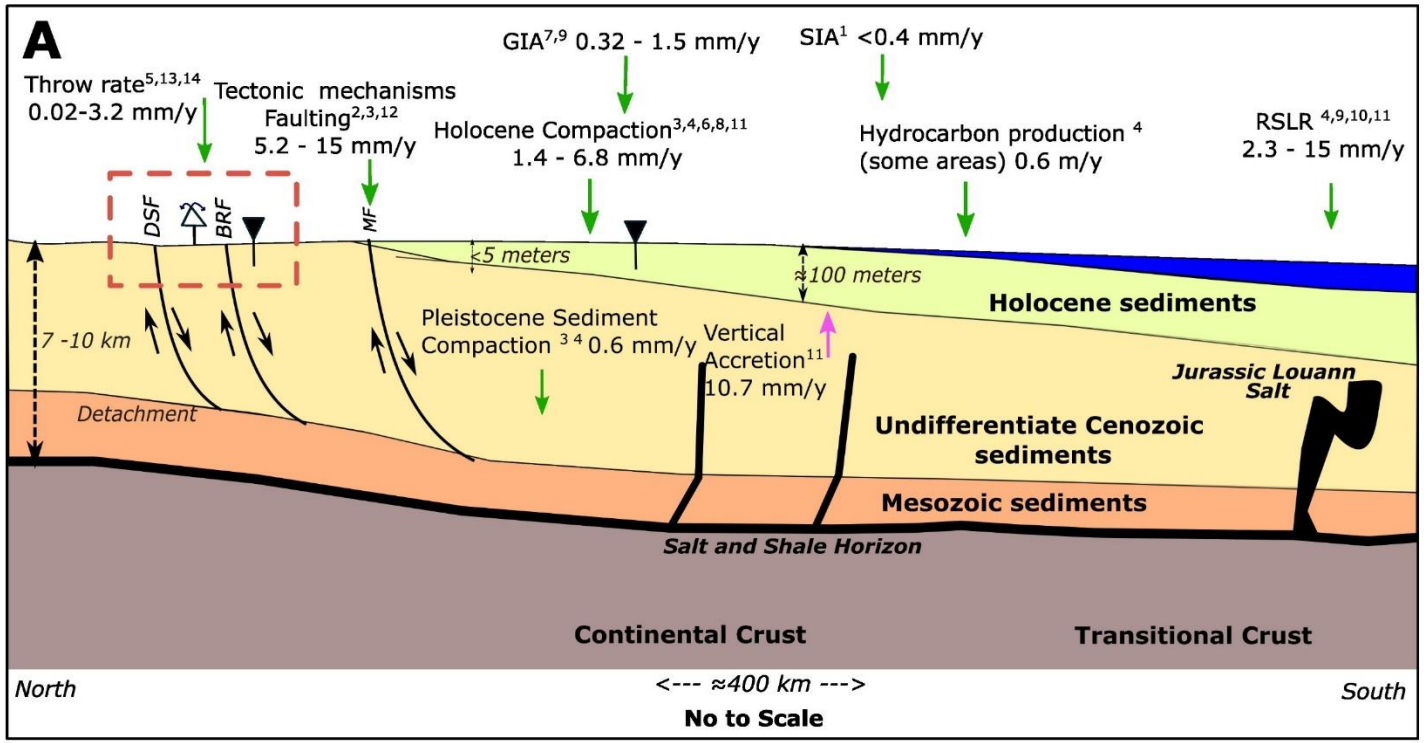
December 12, 2023

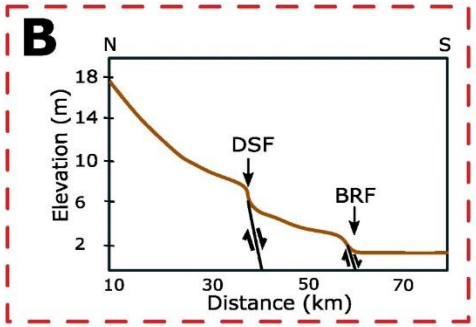
Context

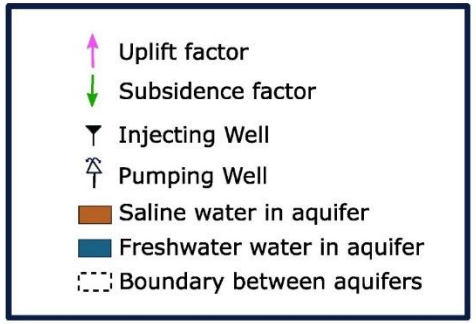
Coastal Louisiana is affected by high rates of sea level rise exacerbated by subsidence.

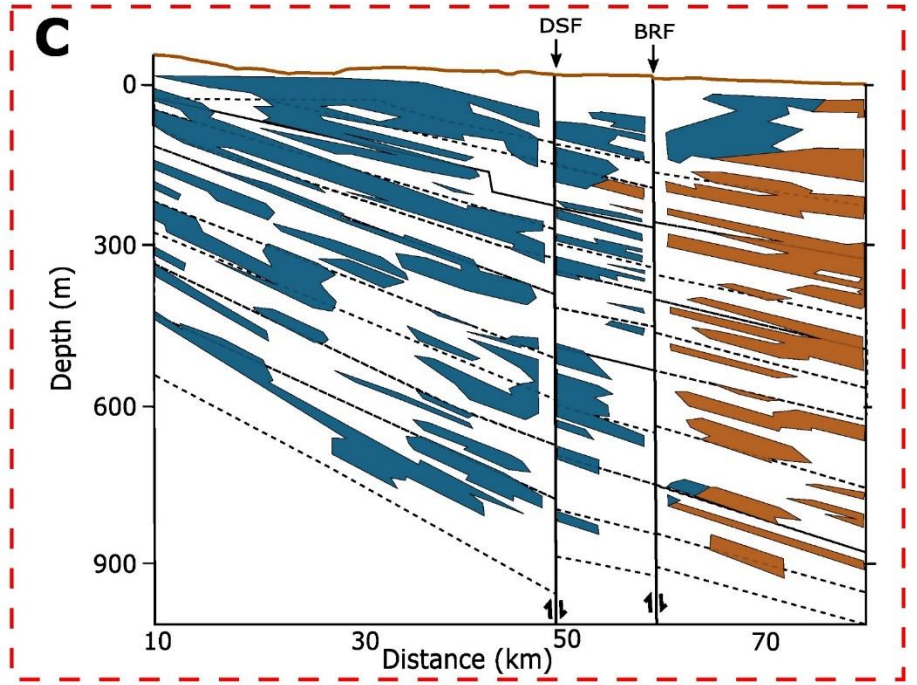
Human activities such as fluid extraction/injection can increase subsidence.

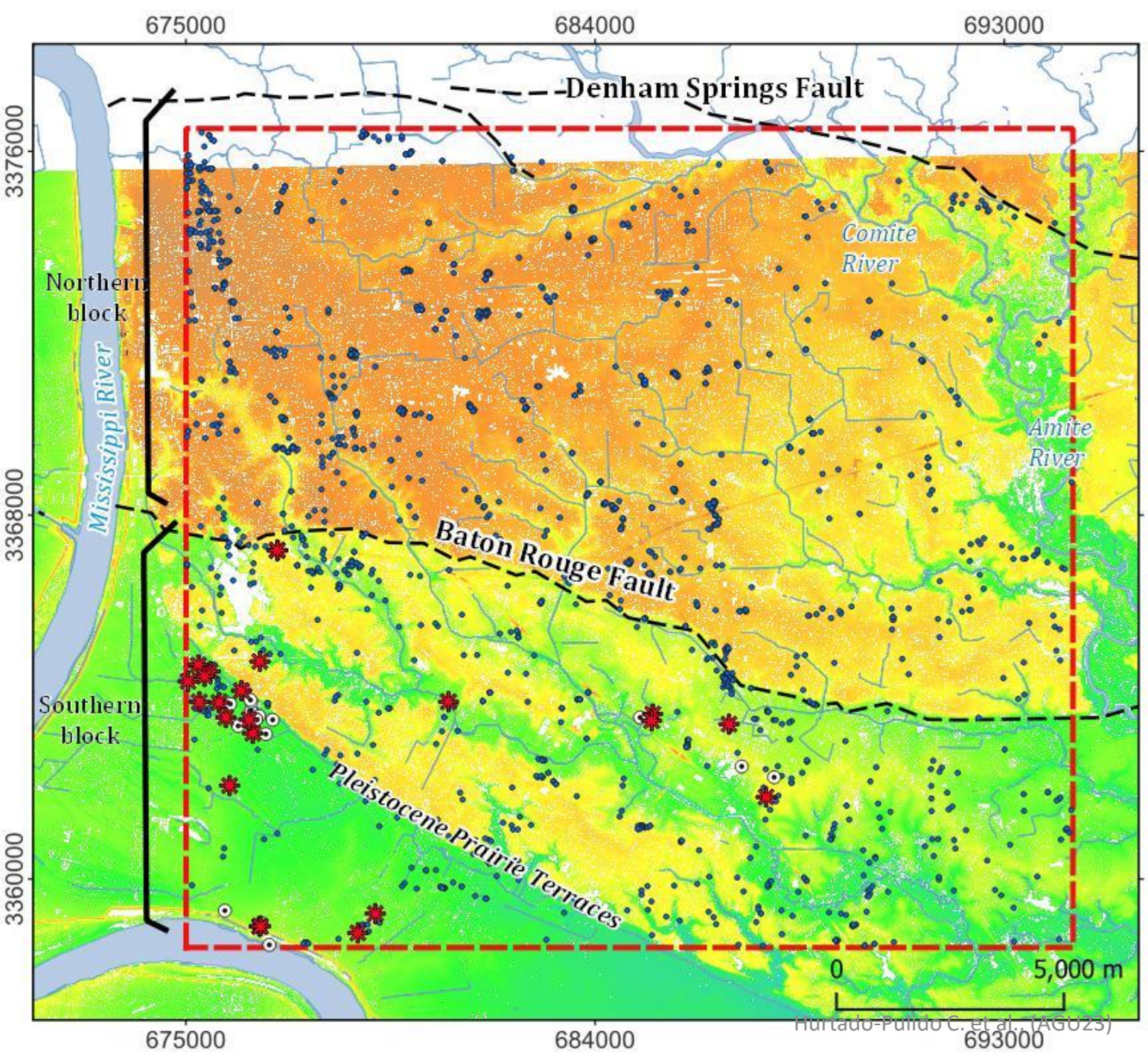


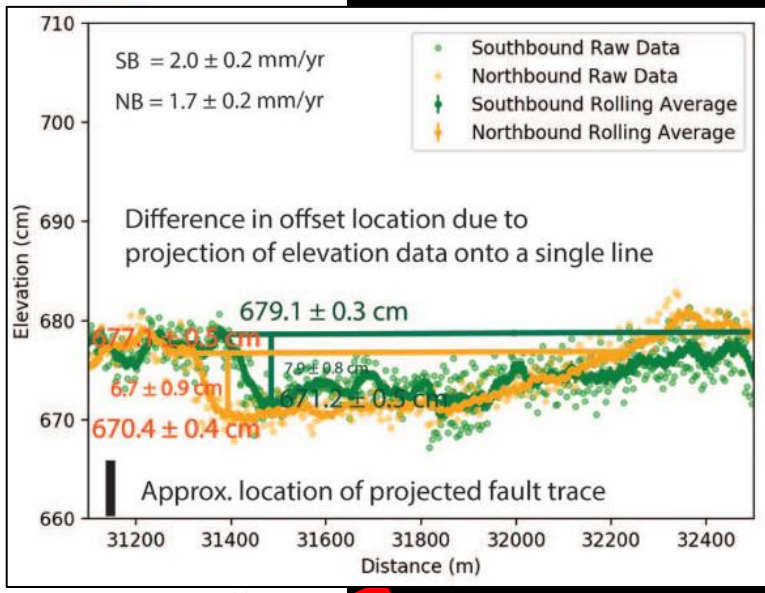




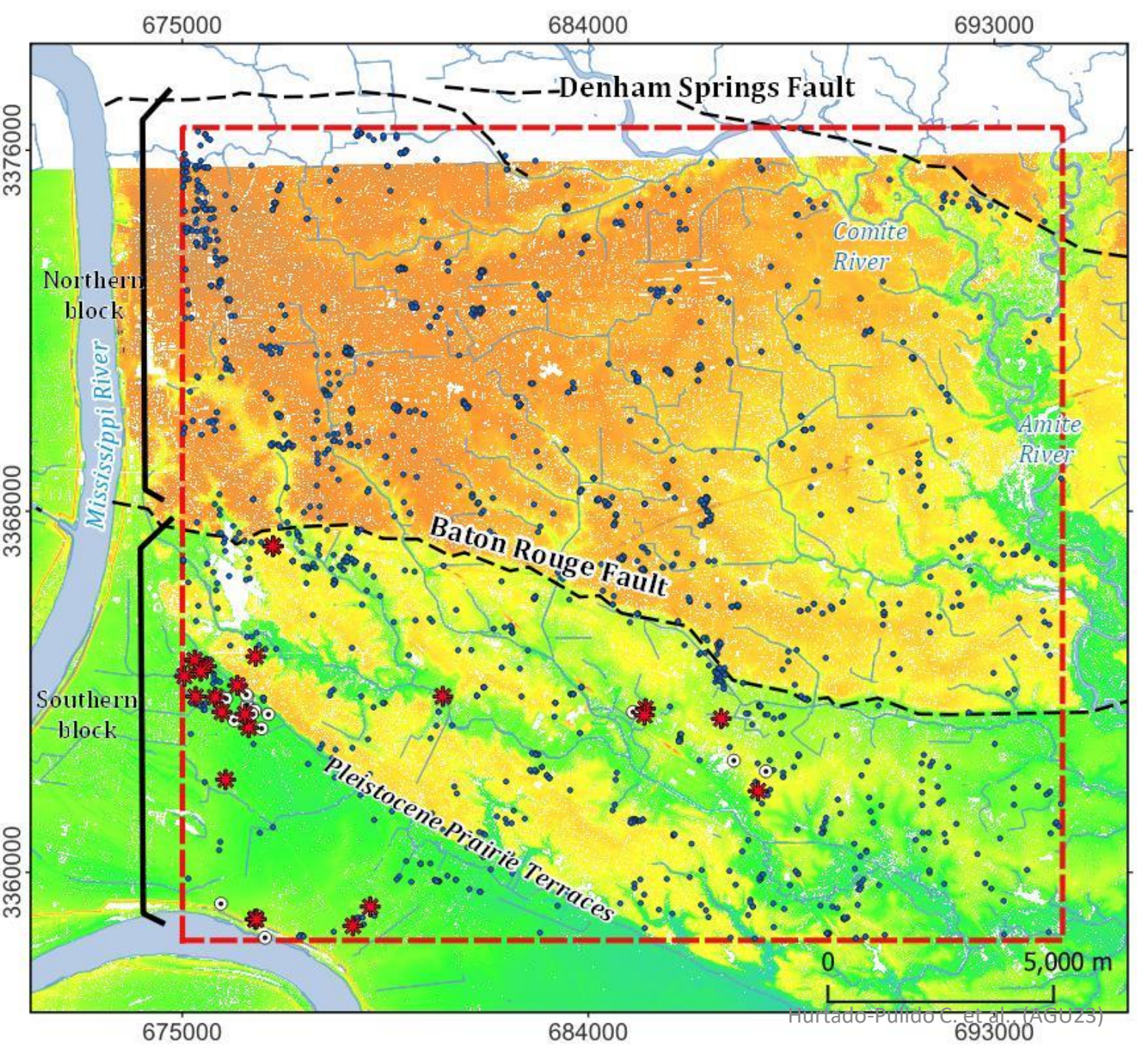








Hopkins et al., (2021)



Questions and Hypothesis

1) Are subsidence rates caused by fault slip significant and **measurable using one or both LiDAR and SAR**?
2) What areas are affected by **fault-controlled subsidence** in the Baton Rouge area?
3) Do patterns of **vertical crustal movements correlate with fluid extraction and/or urban development**?

Hurtado-Pulido C. et al., (AGU23)

InSAR

DATA

EnviSAT (2004-2010)

Sentinel-1 (2017-2020)

METHODS

Persistent Scatterer Interferometry time series.
Coherence: 0.66

Hurtado-Pulido C. et al., (AGU23)

InSAR

DATA

EnviSAT (2004-2010)

Sentinel-1 (2017-2020)

METHODS

Persistent Scatterer Interferometry time series.
Coherence: 0.66

LiDAR

DATA

Survey 1999 (RMSE= 15 cm, PS= 4 m)

Survey 2018 (RMSE= 3.6 cm, PS=0.33 m)

METHODS

Iterative Closest Point (ICP)

Vertical DEM differencing (GCD)

Hurtado-Pulido C. et al., (AGU23)

InSAR

DATA

EnviSAT (2004-2010)

Sentinel-1 (2017-2020)

METHODS

Persistent Scatterer Interferometry time series.
Coherence: 0.66

LiDAR

DATA

Survey 1999 (RMSE= 15 cm, PS= 4 m)

Survey 2018 (RMSE= 3.6 cm, PS=0.33 m)

METHODS

Iterative Closest Point (ICP)

Vertical DEM differencing (GCD)

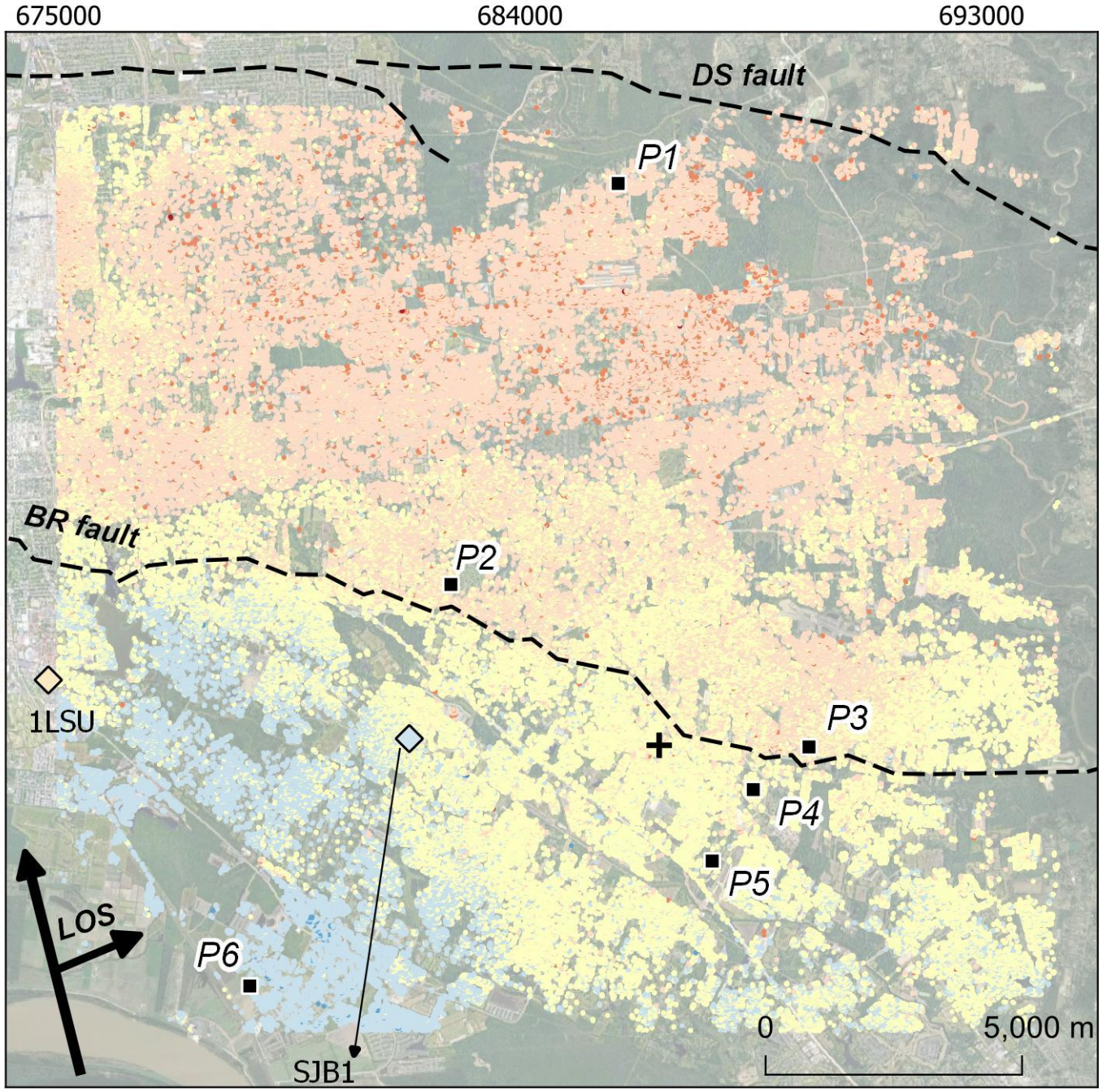
Hurtado-Pulido C. et al., (AGU23)

Well data

DATA

Injection and extraction of fluids on the area.

	GW	Oil-gas	Injection
Total	821	368	24
1999 – 2021	592	47	13
Vol info		23	9



Velocities in the LOS direction

Hurtado-Rincón et al., (AGU23)

Results 1 -

InSAR velocities show more "subsidence" in the northern block than the southern block, with the BRF as a boundary between the blocks

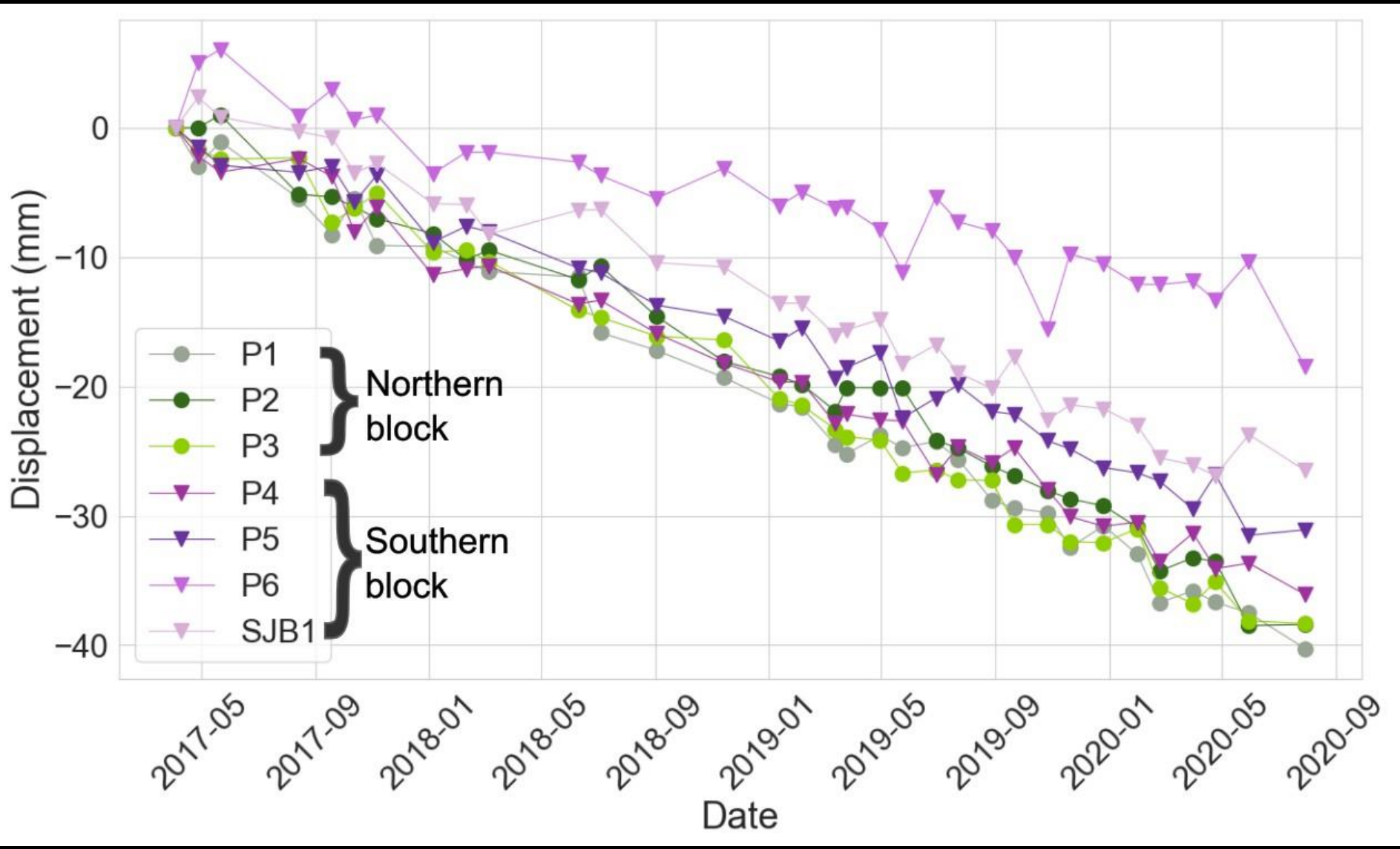
InSAR Velocities 2017-2020

Results 1 -

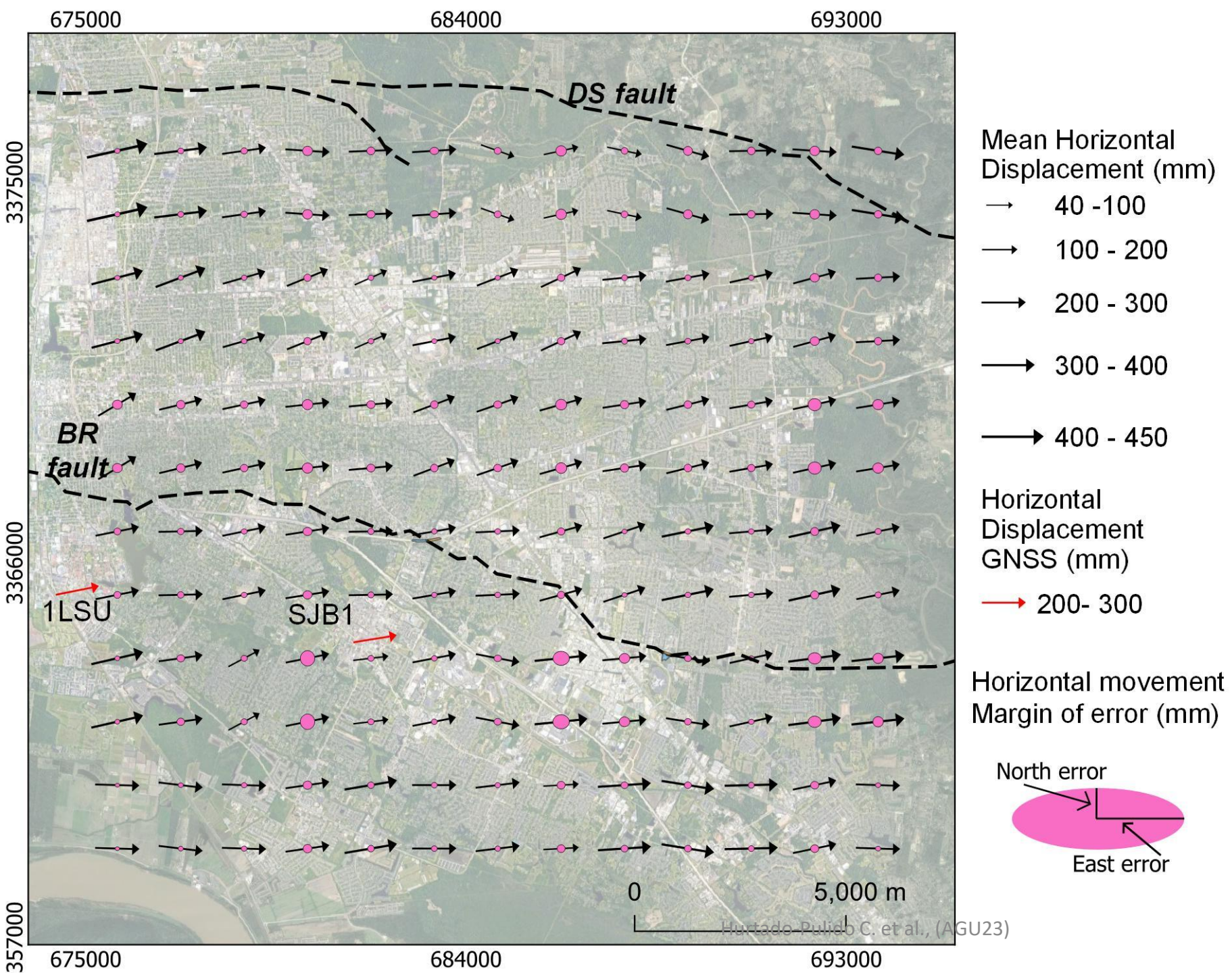
InSAR time series near BRF are similar.

Time series near injection wells have slower displacement.

InSAR Velocities 2017-2020



Hurtado-Pulido C. et al., (AGU23)



Results 2 -

Horizontal motion from LiDAR agree with GNSS stations in the area.

The area "moved" mostly E-NE.

LiDAR ICP with ground points

1999-2018

Hurtado-Pulido C. et al., (AGU23)

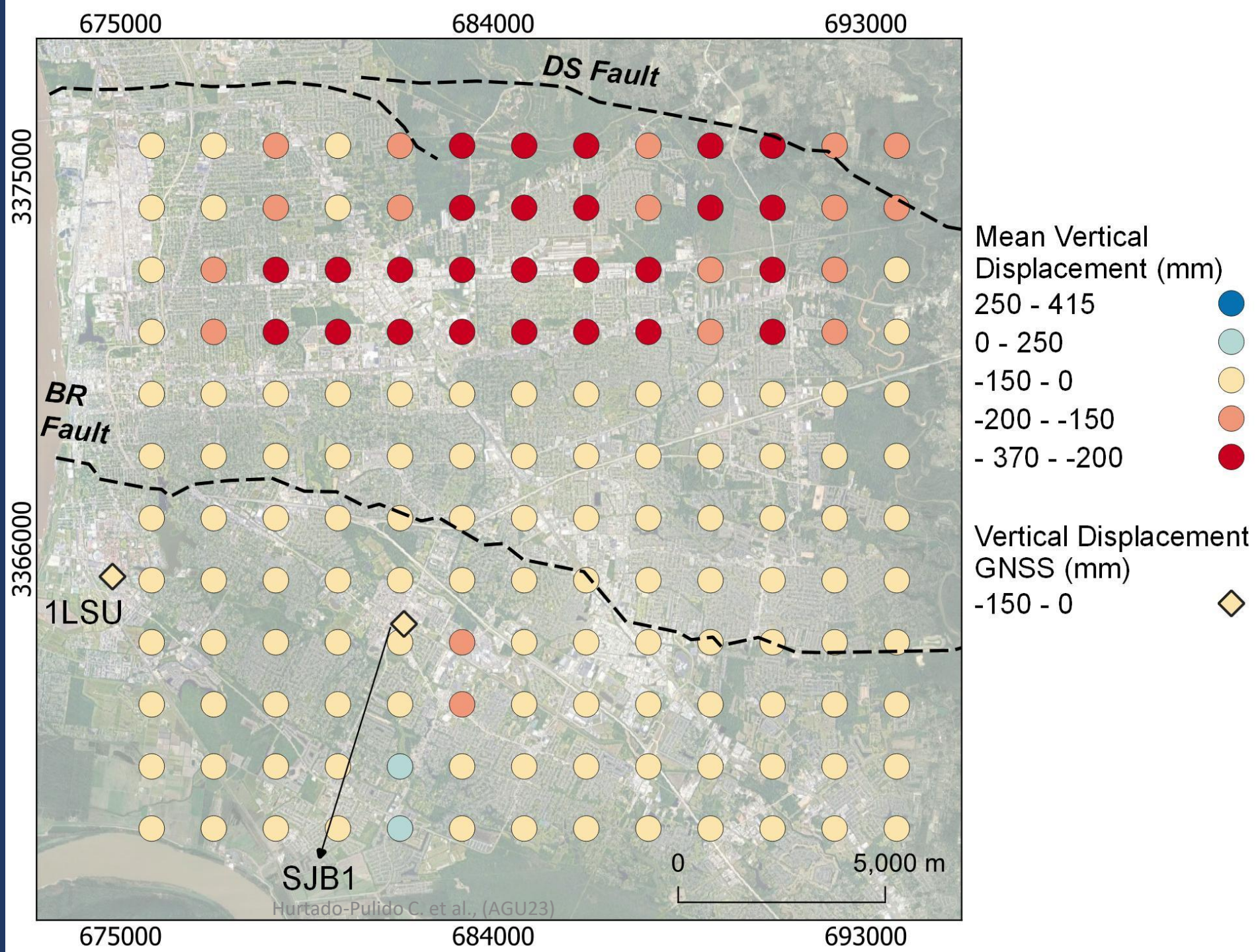
Results 2 -

Vertical motion from LiDAR agree with GNSS.

Northern block is subsiding faster and there is deceleration in the southern block.

LiDAR ICP with ground points

1999-2018



Hurtado-Pulido C. et al., (AGU23)

Discussion -

The northern block is subsiding faster than the southern block during the last decades.

This contradicts the long-term displacement.

Discussion -

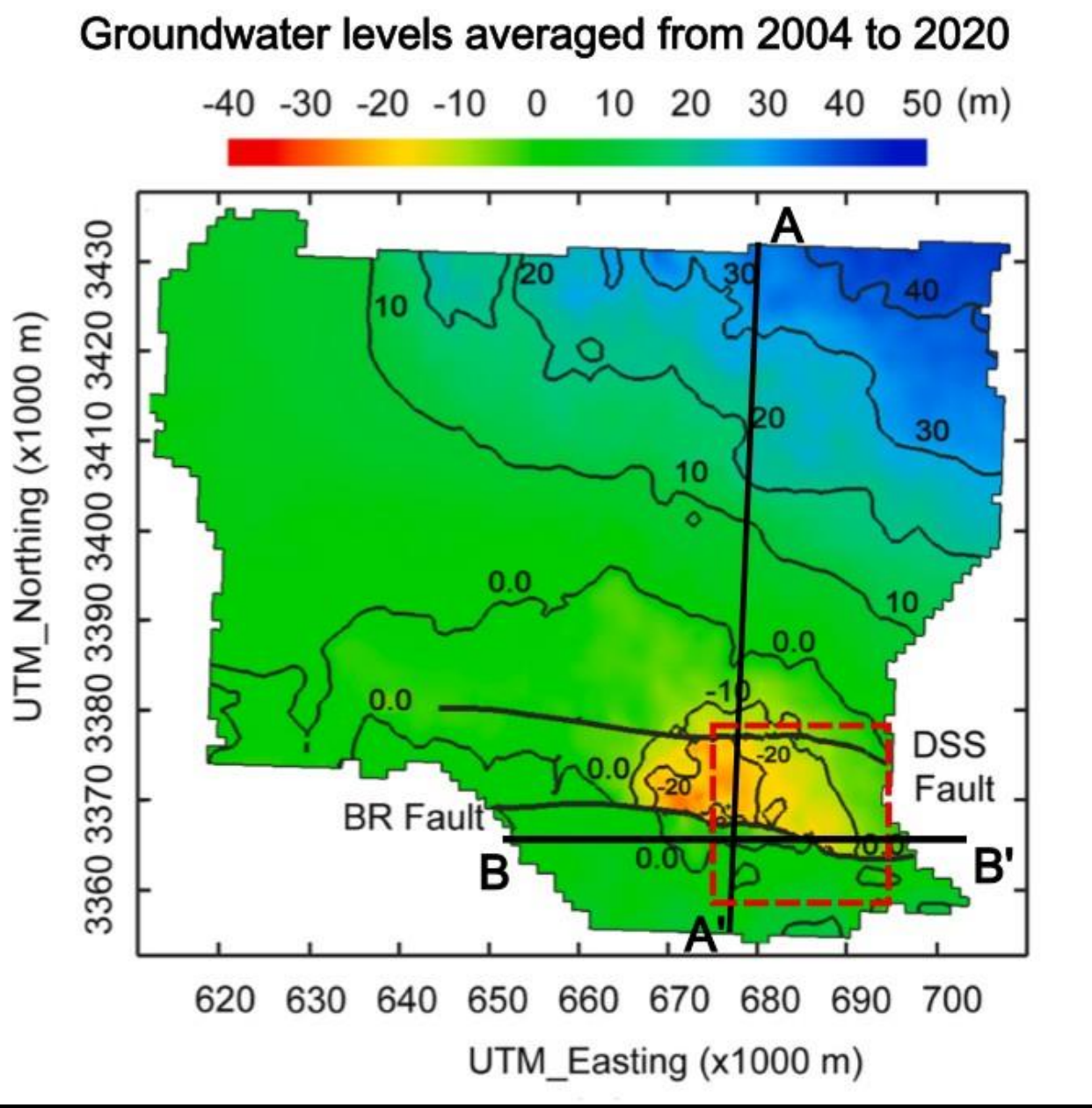
The northern block is subsiding faster than the southern block during the last decades.

This contradicts the long-term displacement.

Discussion -

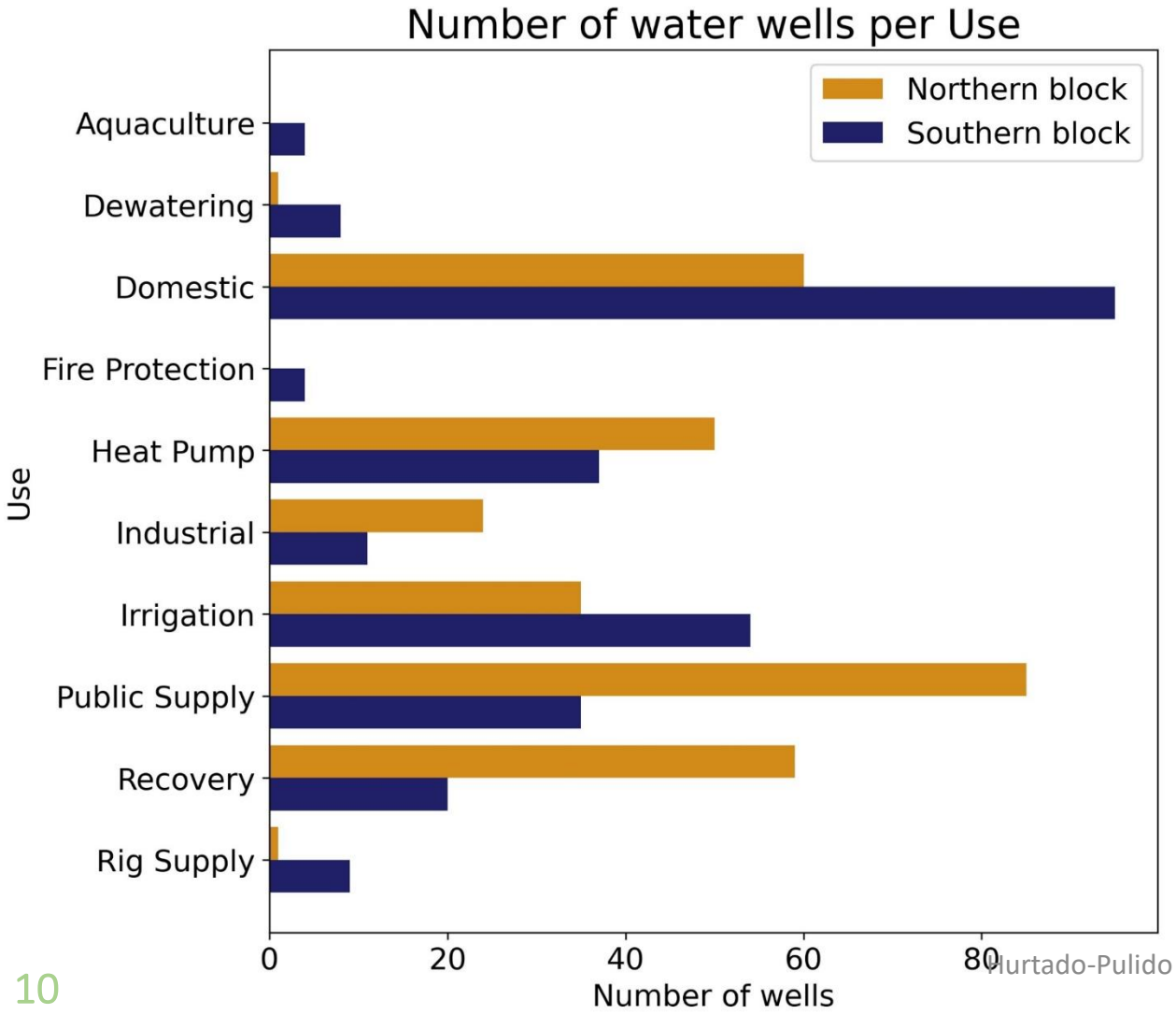
Groundwater levels are low in the area between the faults.

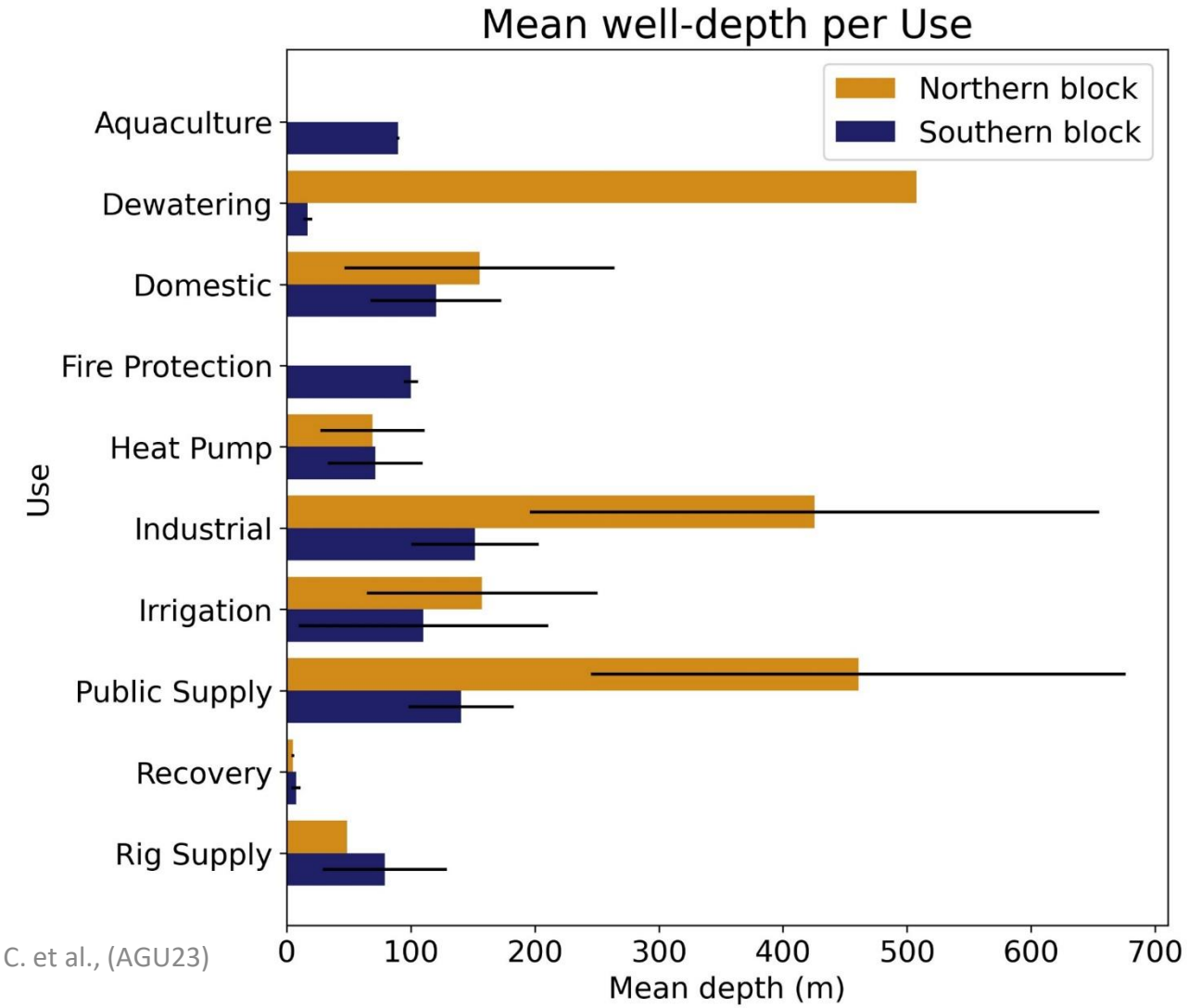
There is a large cone of depression due to high pumping.



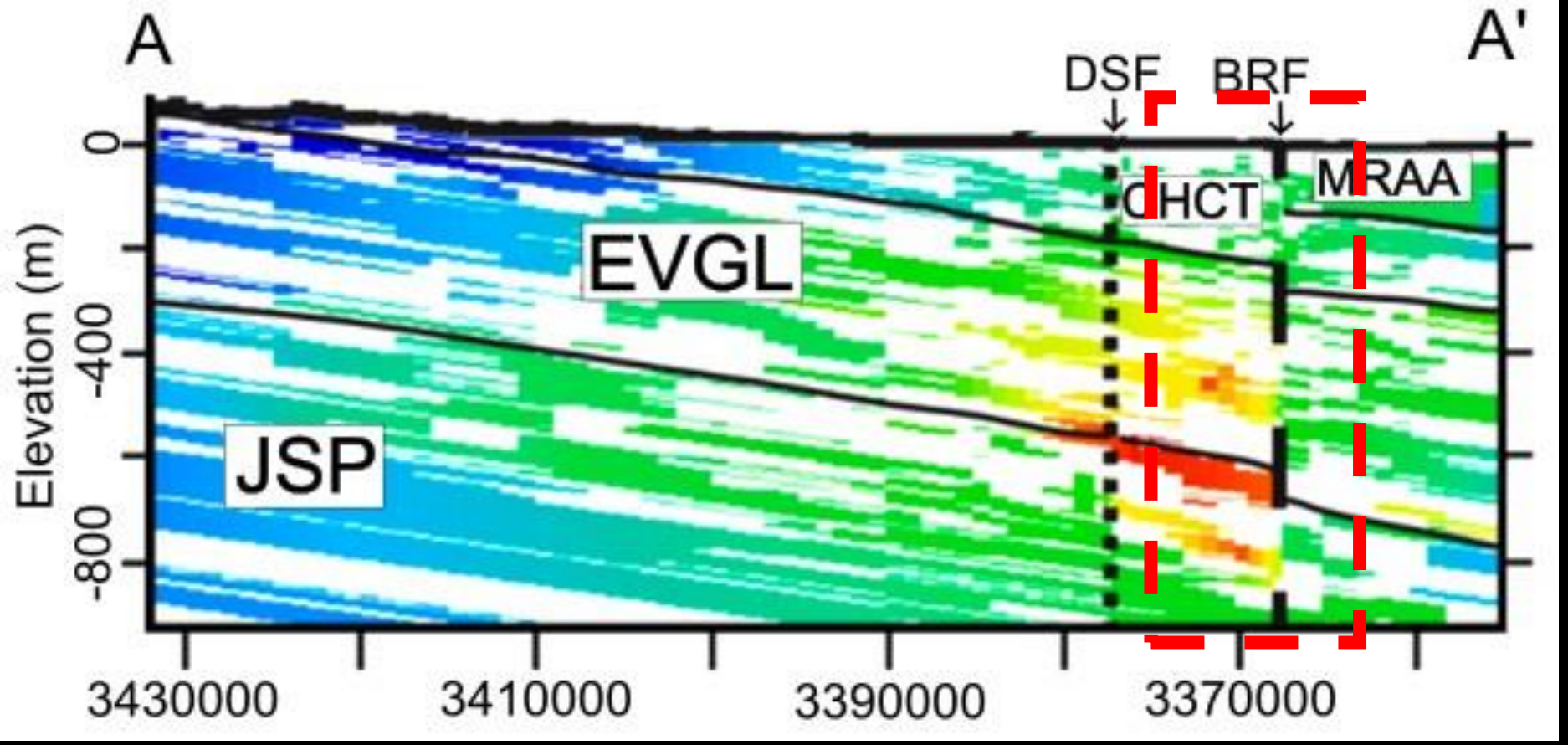
Chen et al., (2023)

Discussion - Northern block has more and deeper wells than the southern block.





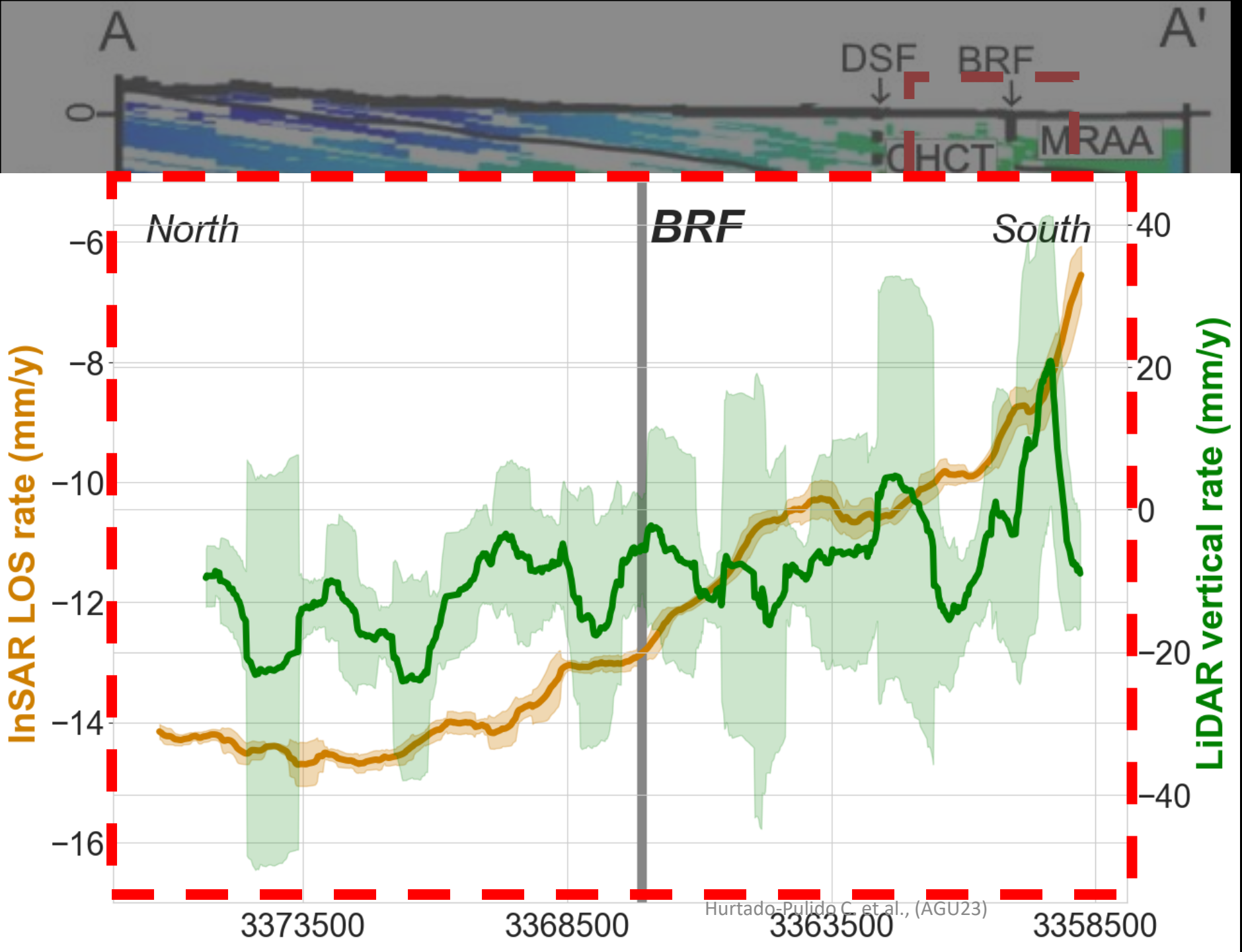
Hurtado-Pulido C. et al., (AGU23)



Modified from Chen et al., (2023)

Discussion -

Low groundwater level at deep aquifers.



Hurtado-Pulido C. et al., (AGU23)

Discussion -

Low groundwater level at deepest aquifers.

Coincides with higher subsidence rates.

Main conclusions

Fluid extraction/injection are dominant processes driving surface displacement in East Baton Rouge.

The BRF divides the area into 2 regions of human-controlled subsidence.

- Northern block controlled by groundwater level changes
- Southern block influenced by injection at shallow depths

There is subsidence in the entire area, ***but it is reversing the long-term down-to-the-south displacement.***

LiDAR is a powerful geodetic tool to estimate 3D slow motion agreeing with GNSS and InSAR time series.

Hurtado-Pulido C. et al., (AGU23)

**The results of this research are under review*

Next Steps

1. Analysis of subsidence caused by seasonal variation caused by hydrological loadings.

2. Numerical model for future predictions (*with Pritom Sarma, Hebrew University*)

Next Steps

1. Analysis of subsidence caused by seasonal variation caused by hydrological loadings.

2. Numerical model for future predictions (*with Pritom Sarma, Hebrew University*)

Contact

I am looking for a Job/postdoc!

dhurtadopulido@tulane.edu

SCAN ME

LinkedIn

SCAN ME

Personal Website