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# Monitoring of ground deformation around Lake Mead and Hoover Dam deformation with InSAR observations

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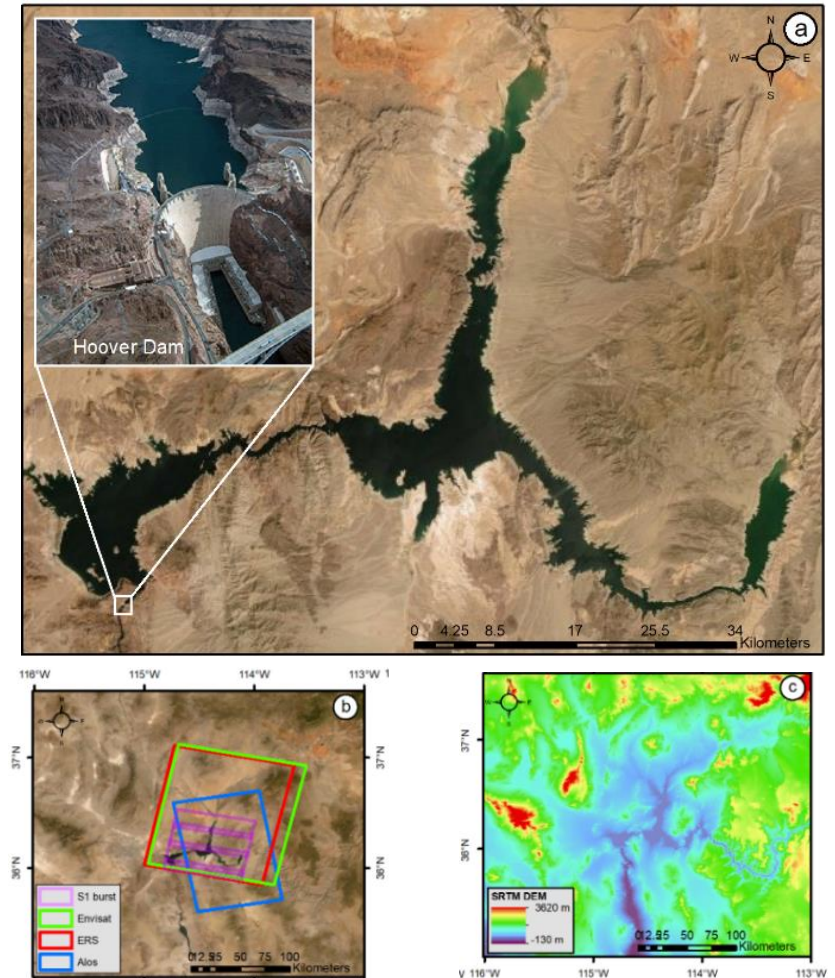
# Study area

## ❑ Lake Mead

- The largest man-made reservoir in the United States
- Fed by the water of the Colorado River
- Reservoir was impounded by the construction of the Hoover Dam in 1935

## ❑ Hoover Dam

- Concrete gravity-arch type
- Height: 221.4 m, length of 379 m, elevation at crest of 376 m.a.s.l.
- Control floods, supply water for irrigation and electricity to the states of Arizona



**Fig. 1.** Location of Lake Mead. (a) Lake Mead with the zoomed image of the Hoover Dam (Data source: <https://www.usbr.gov/lc/hooverdam>). (b) Extent of the four different SAR scenes used in this study over the Lake Mead area (i.e., ERS1/2, Envisat, Alos and S1), shown over a Google Earth image. (c) Digital Elevation Model (DEM) of the area

# Data, water level, data processing

## □ Data

- 138 SAR images covering a time span of 24 years

## □ Water level of Lake Mead

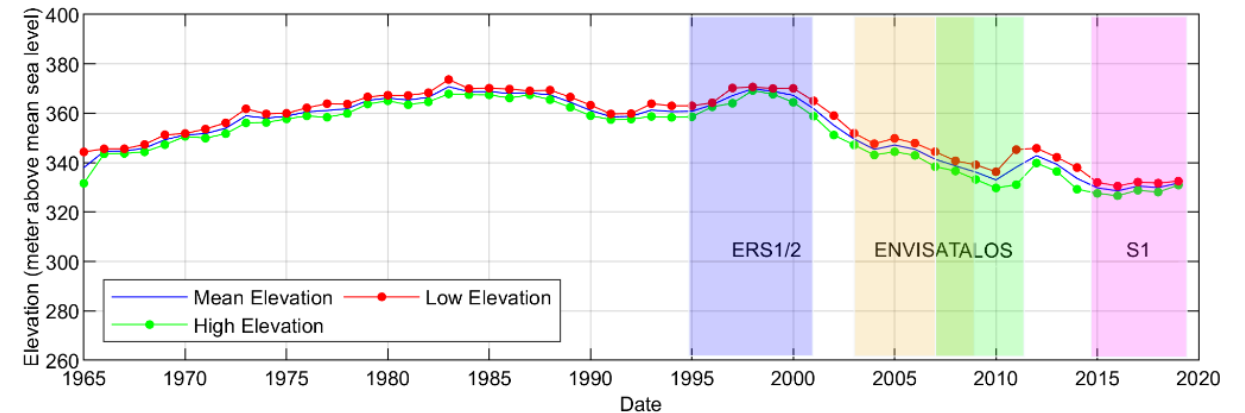
- 40 m height difference between 1995 and 2019

## □ Data processing

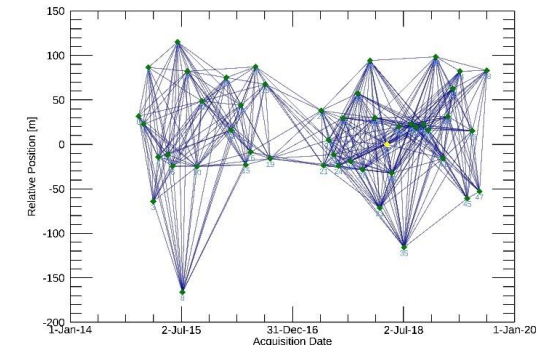
- SBAS technique

**Table 1.** Data specifications

Product Type	Period	No.	Mode	Po	R <sub>t</sub>
ERS1/2	1995-2000	30	Desc	VV	35
Envisat	2003-2010	40	Desc	VV	35
Alos	2007-2011	19	Asc	HH	46
S1A/B	2014-2019	49	Desc	VV	6/12

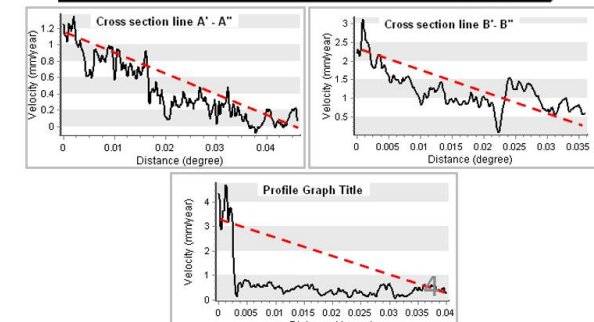
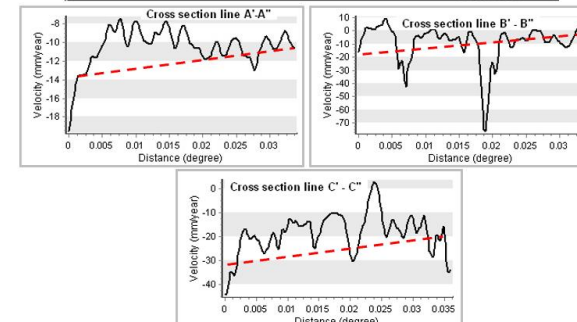
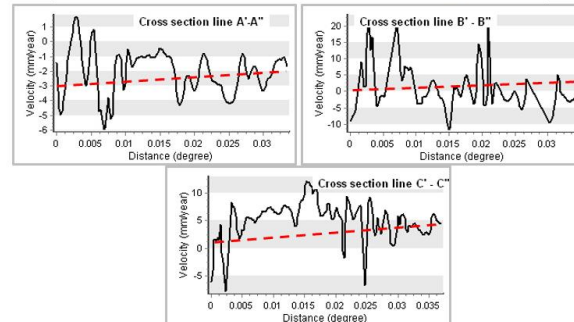
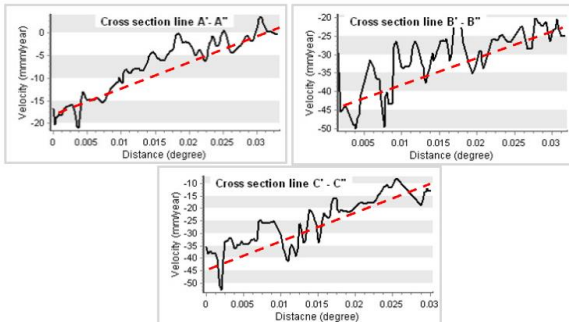
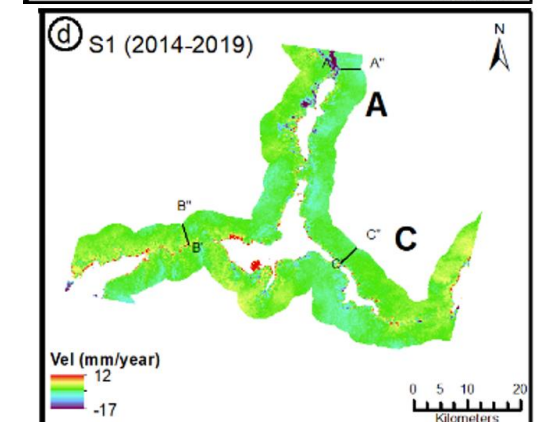
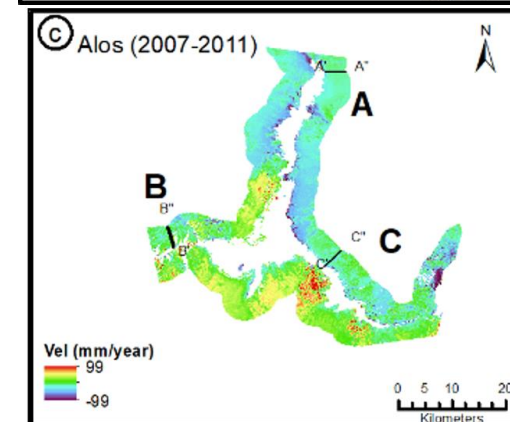
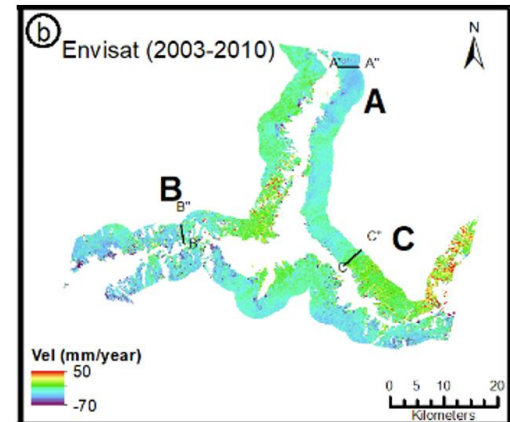
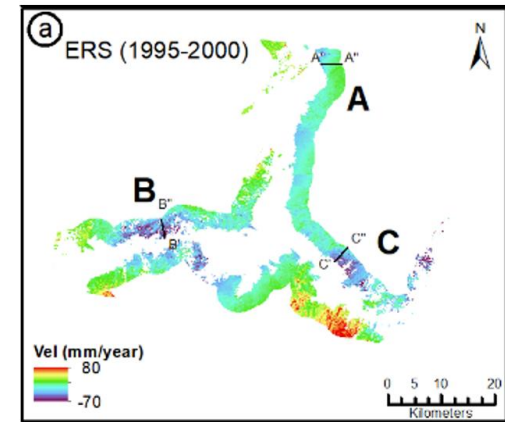
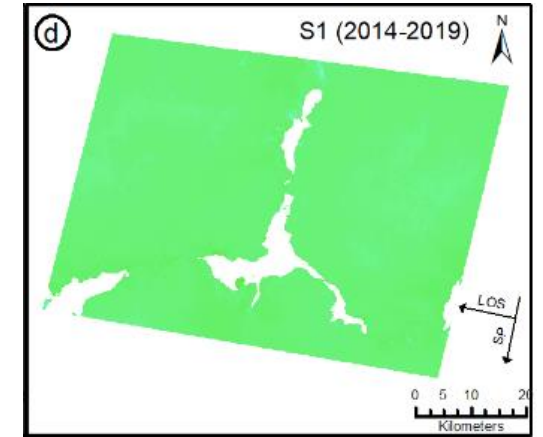
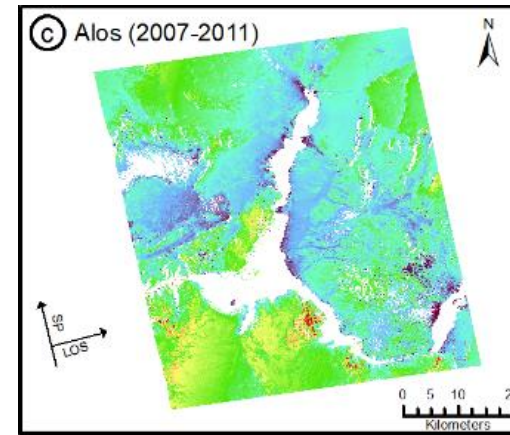
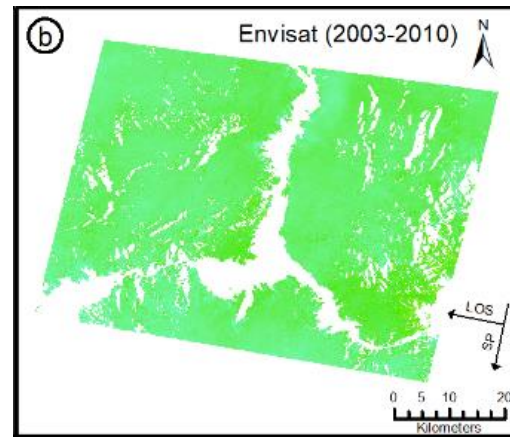
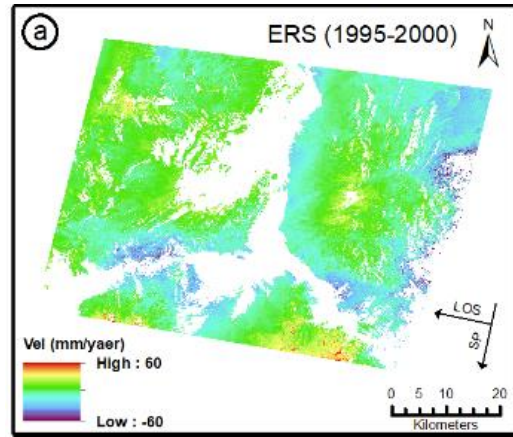


**Fig. 2.** Water level variations



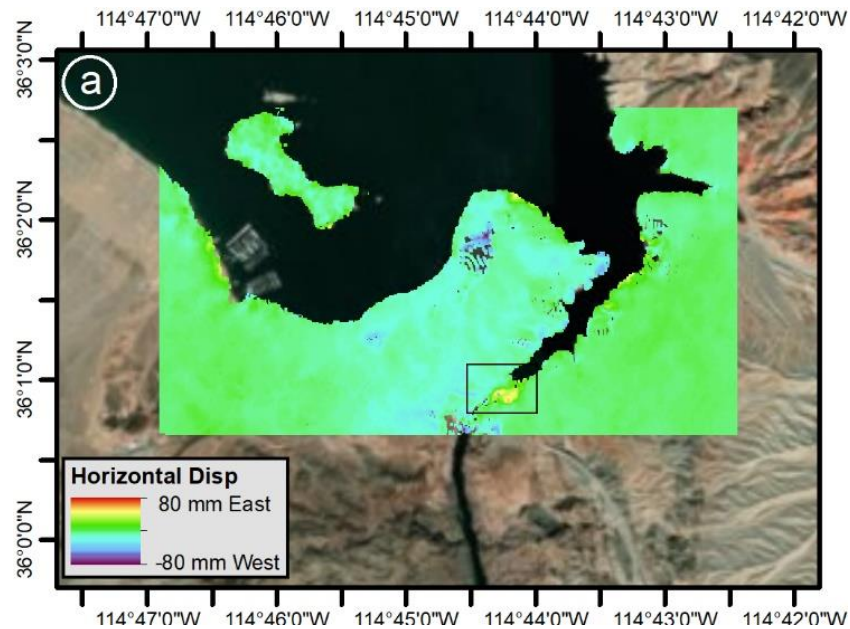
**Fig. 3.** SBAS connection graph

# Results: Displacement maps (Lake Mead)

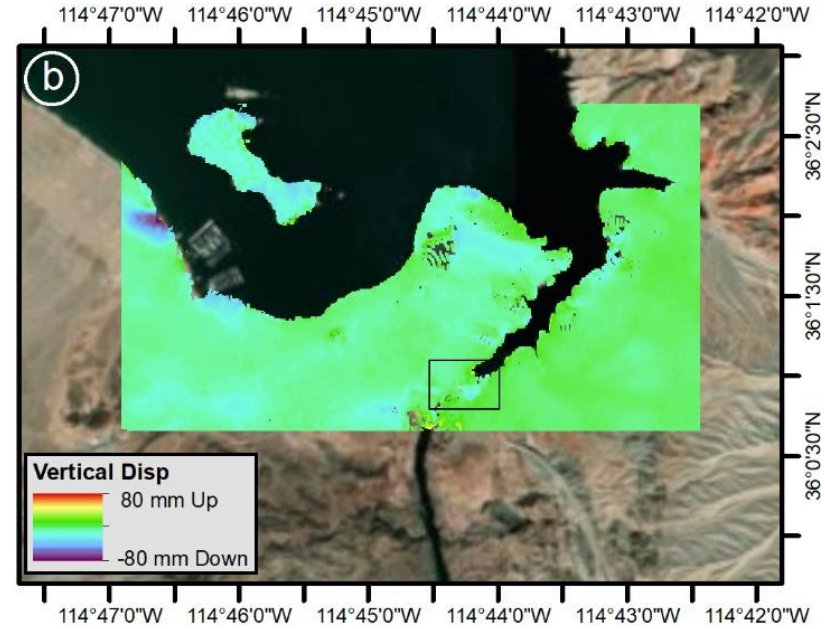




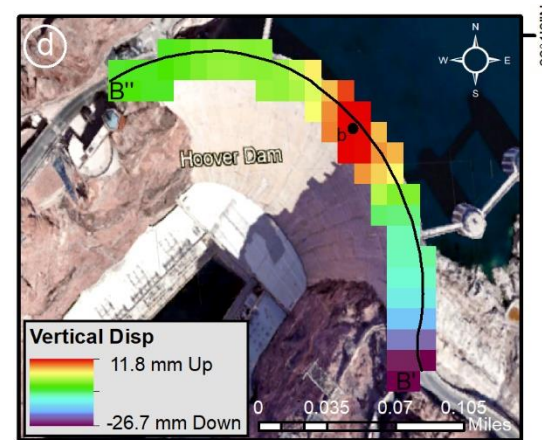
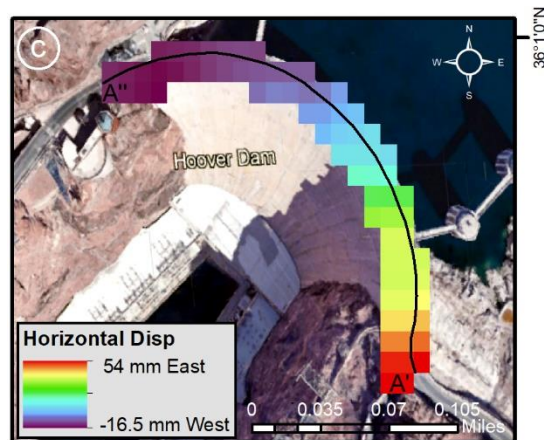
# Results: 2D Displacement map (Hoover Dam)



Horizontal Displacement



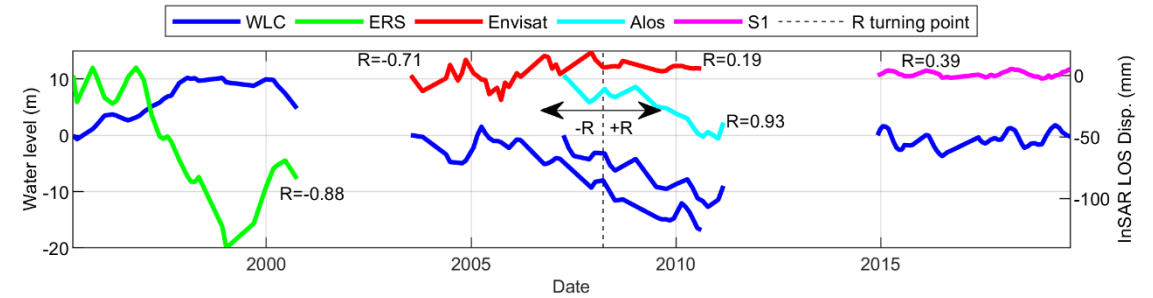
Vertical Displacement



# Discussion

## □ Lake Mead

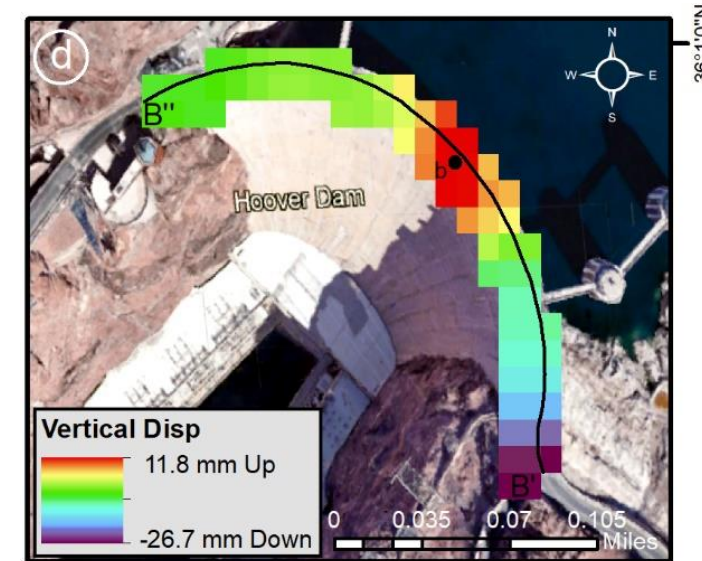
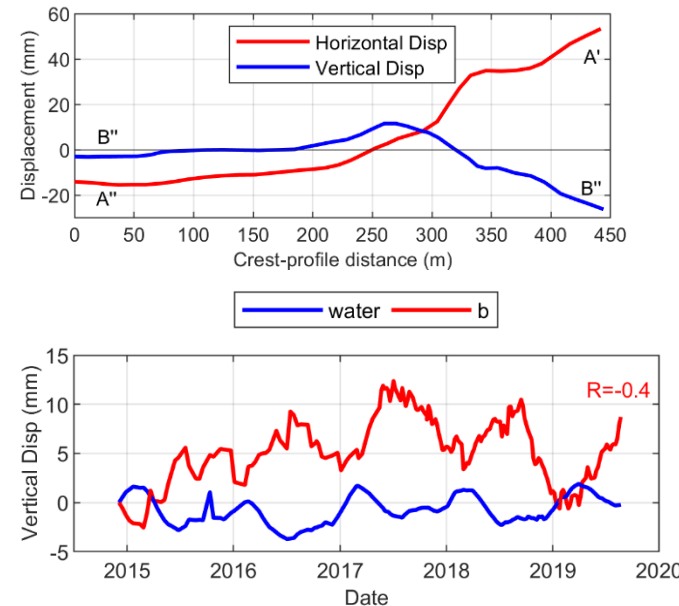
- High negative correlation coefficient during the ERS
- Correlation change in 2008
- Positive correlation in S1 period



Water level vs. InSAR Displacements

## □ Hoover Dam

- Invers correlation with water elevation changes



Vertical Displacement

# Conclusion

- ☐ Ground around the Lake Mead has been affected by the load water variations and the deformation pattern has direct relationship with water load fluctuations.
- ☐ The deformation occurred by the water load not only influenced the surrounding areas but also the Hoover dam structure near by the dam affected by deformation-induced by the water load.
- ☐ The inverse agreement between the vertical movements in the middle-section of the dam crest and the water elevation changes is an evidence that confirmed the influence of water variations on the dam deformation.