

# Rapid Groundwater-Related Land Subsidence in Yemen Observed by Multi-Temporal InSAR

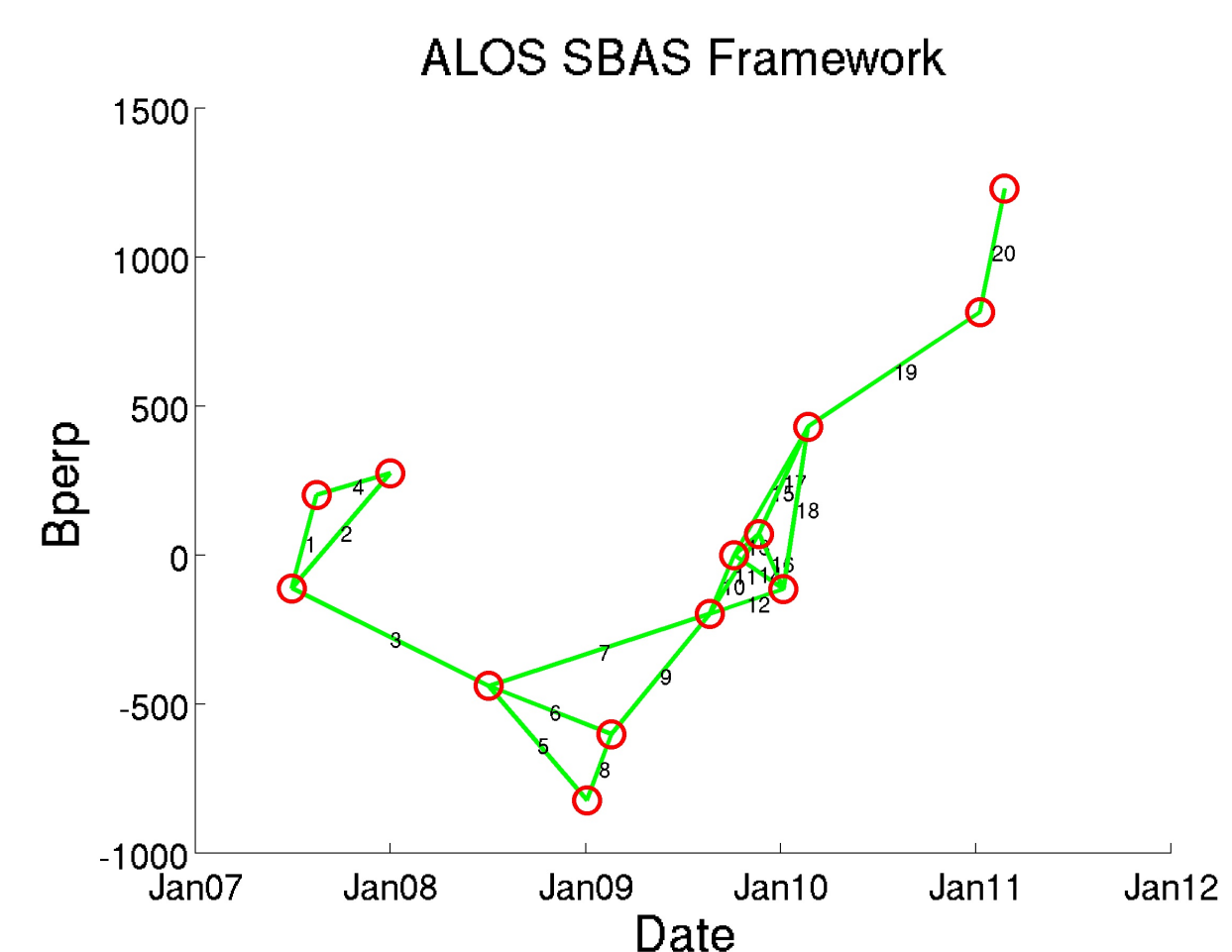
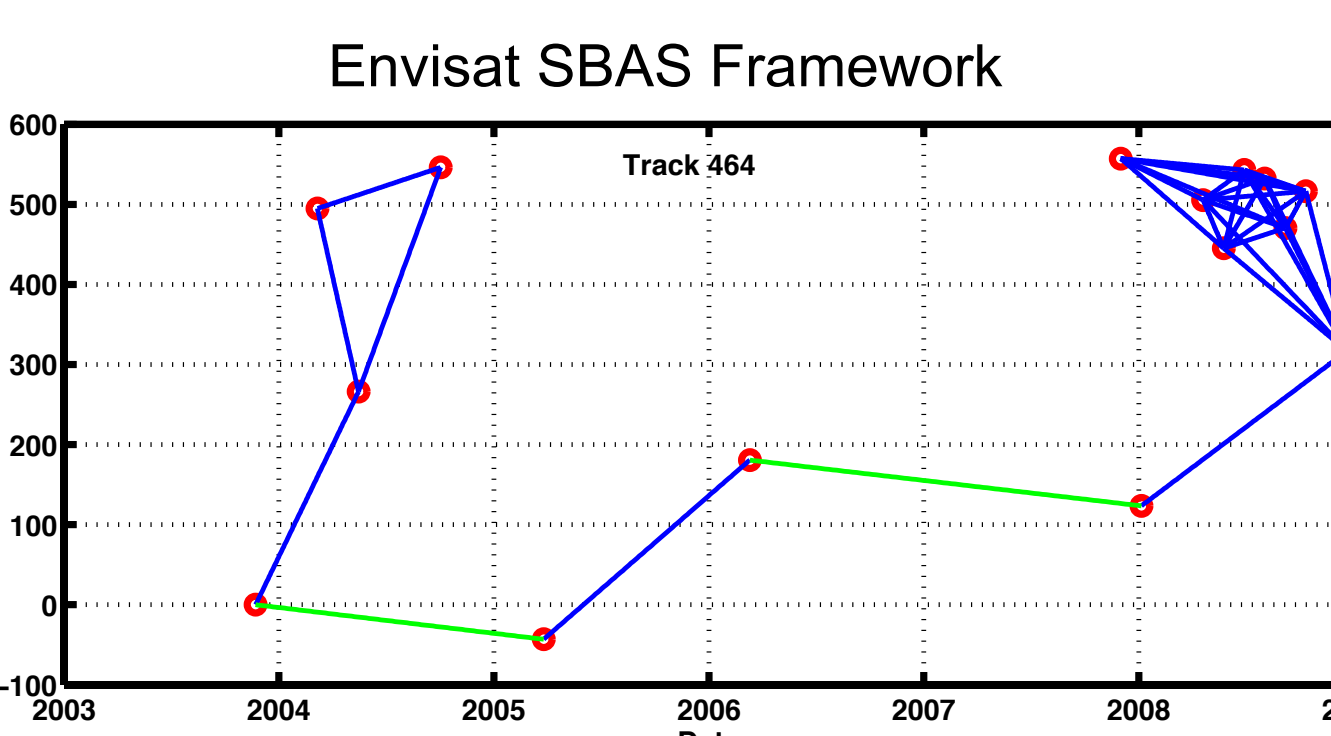
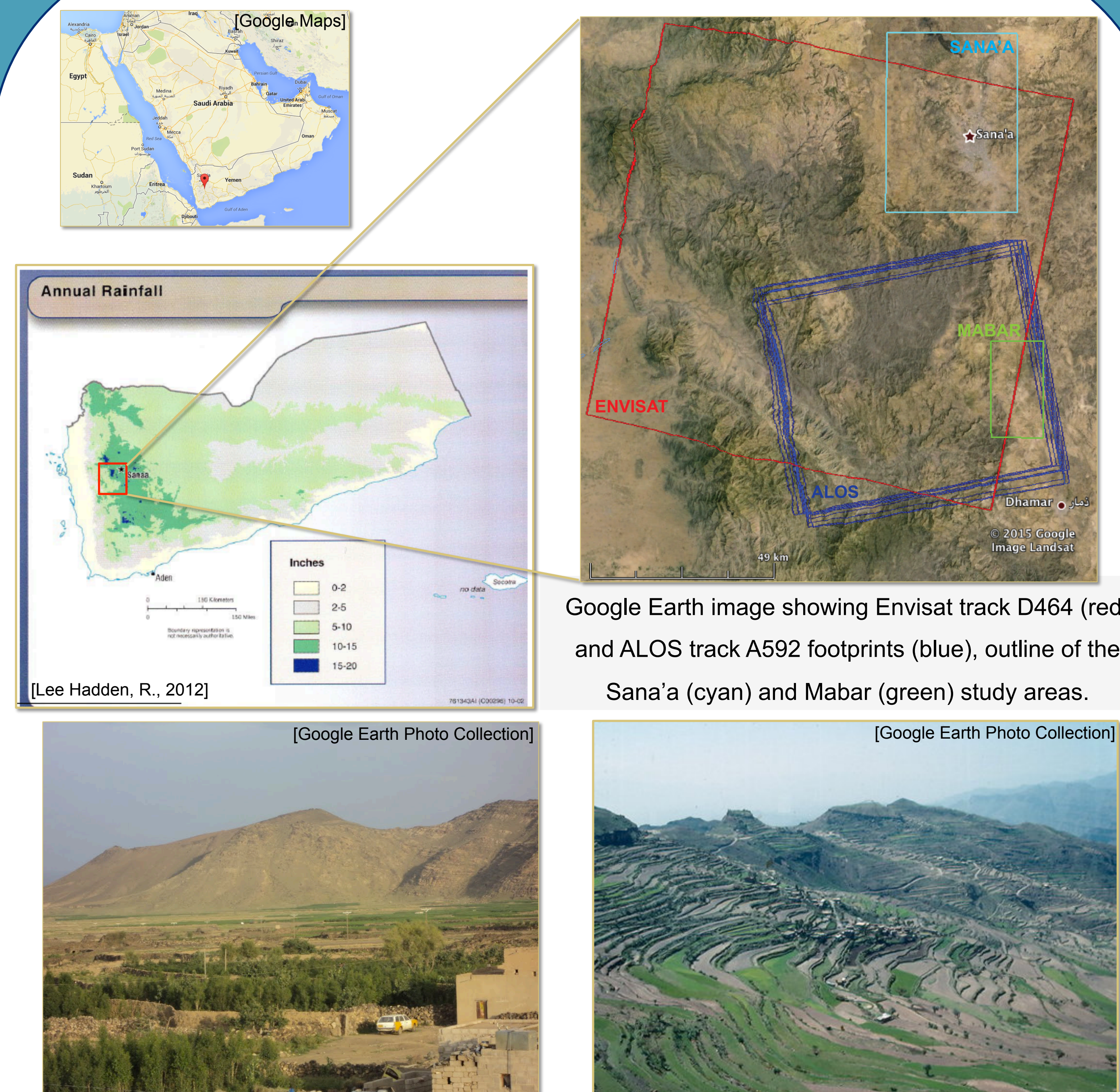
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## 1. Summary

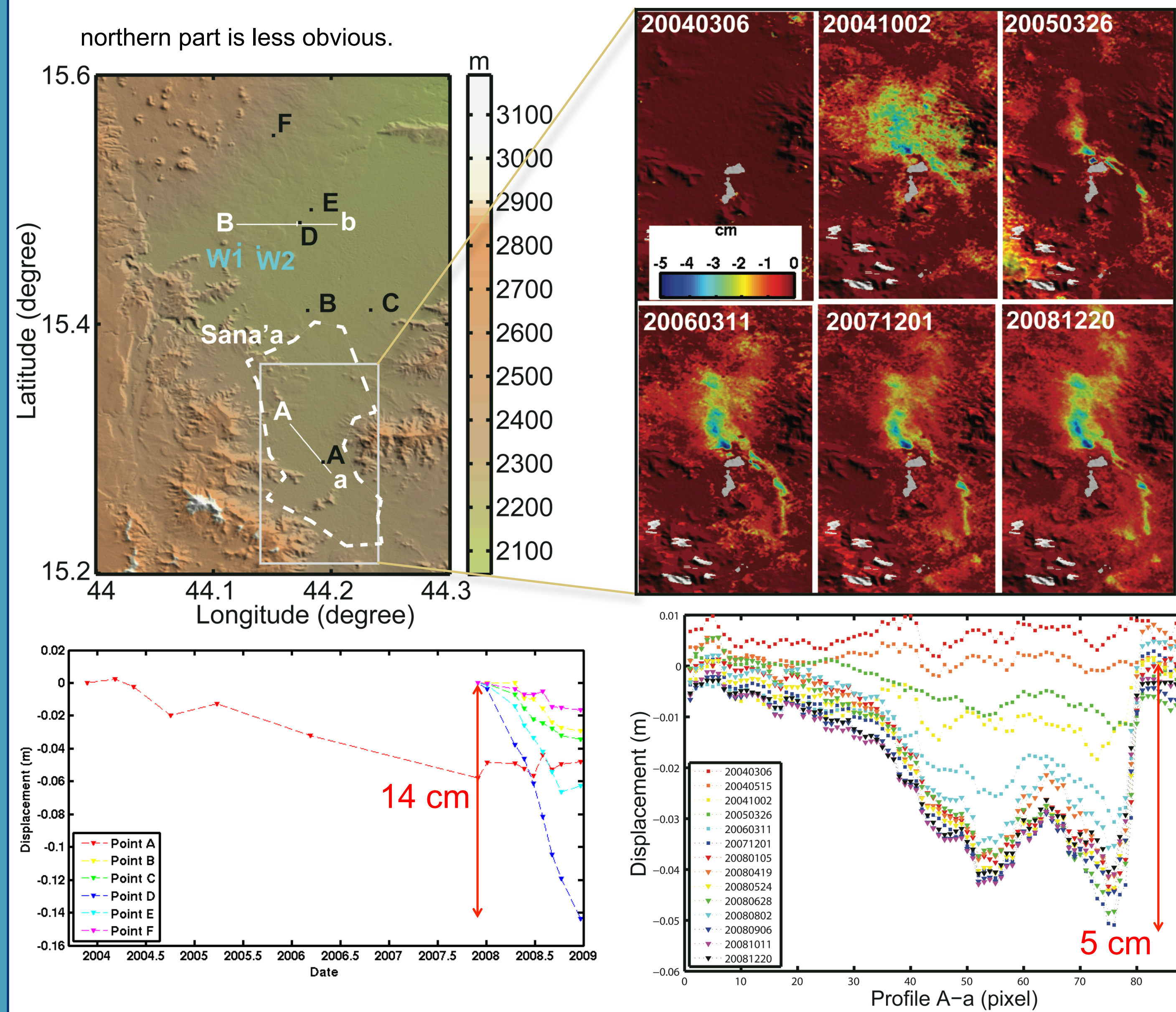
- Several basins in Yemen are suffering from a rapid drawdown of groundwater.
- 13 ascending ALOS and 15 descending Envisat images from November 2003 to February 2011 are used to examine spatiotemporal behavior of the subsidence induced by depletion of groundwater aquifer systems.
- Excessive water pumping has already led to extensive ground fracturing at the edge of some of the basins.

## 2. Study Area Background

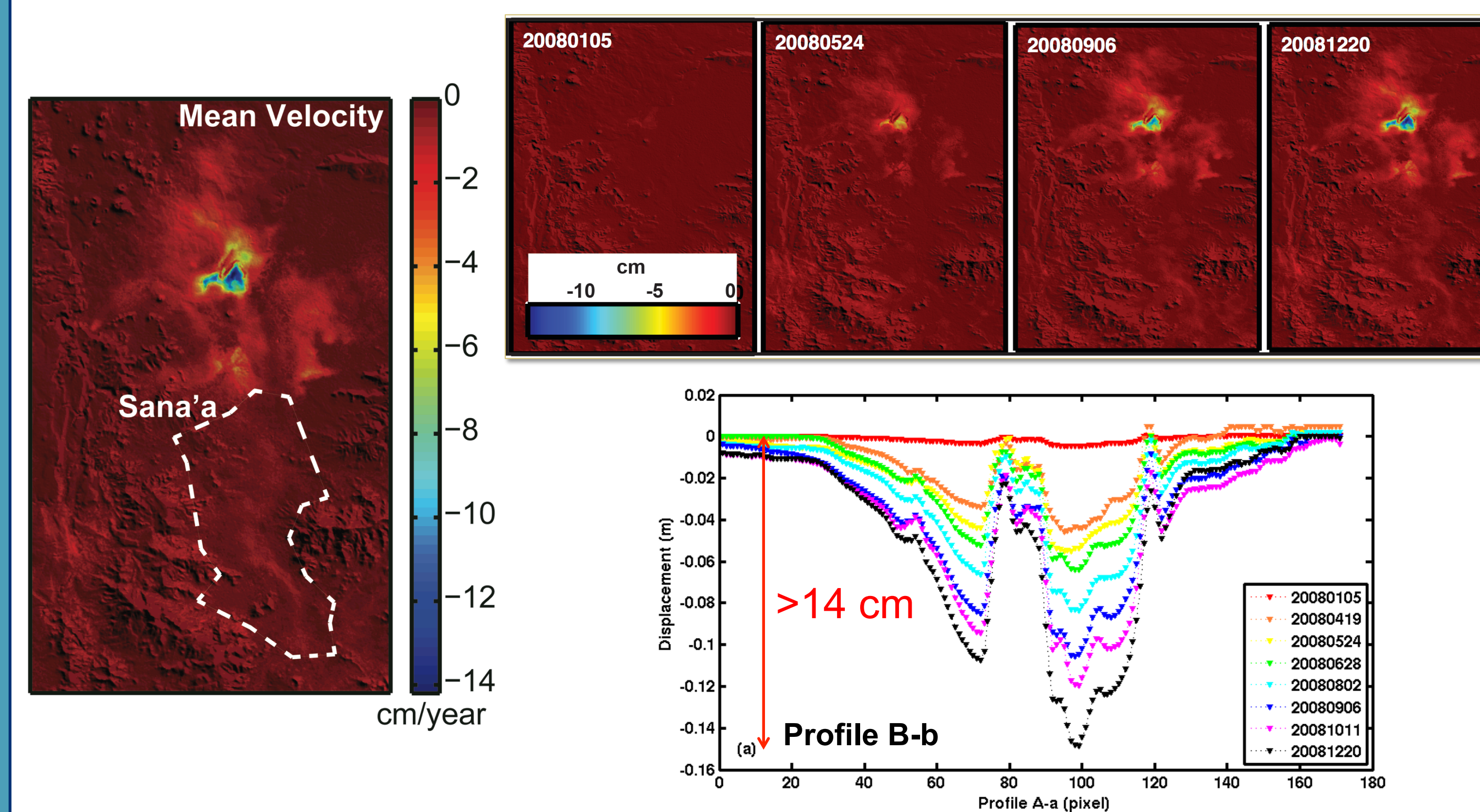


## 3. Sana'a Basin Subsidence

- High coherence in the Sana'a city allows us to derive a detailed land deformation evolution from November 2003 to December 2008.
- The subsidence rate within the Sana'a city was approximately 1 cm/year in the radar line-of-sight (LOS) direction between 2003 and 2008.
- The main subsidence was found in the center and southern parts of the city, while deformation in the northern part is less obvious.

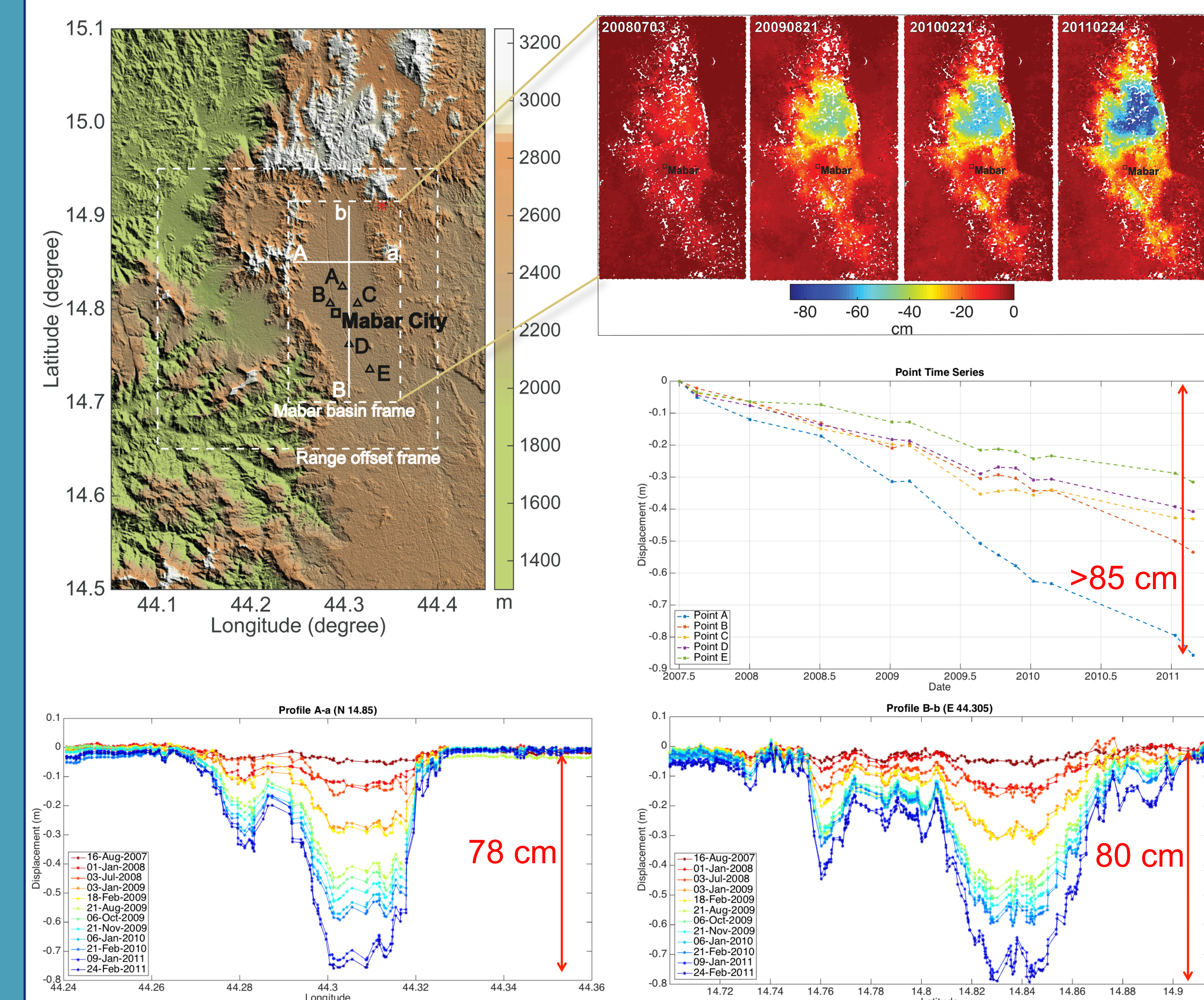


- Due to the strong impact of vegetation on radar signal, we have to carefully choose the data to avoid decorrelation. We can only construct time series of surface displacement in agricultural irrigation region north of Sana'a city using the data from December 2007 to December 2008.
- The subsidence rate here was much faster than within the city: it exceeded 14 cm/year. The local water wells have been drying up according to the well data.
- Time evolution of surface deformation and a series of profiles and points reveal spatially and temporally variable aquifer compaction.

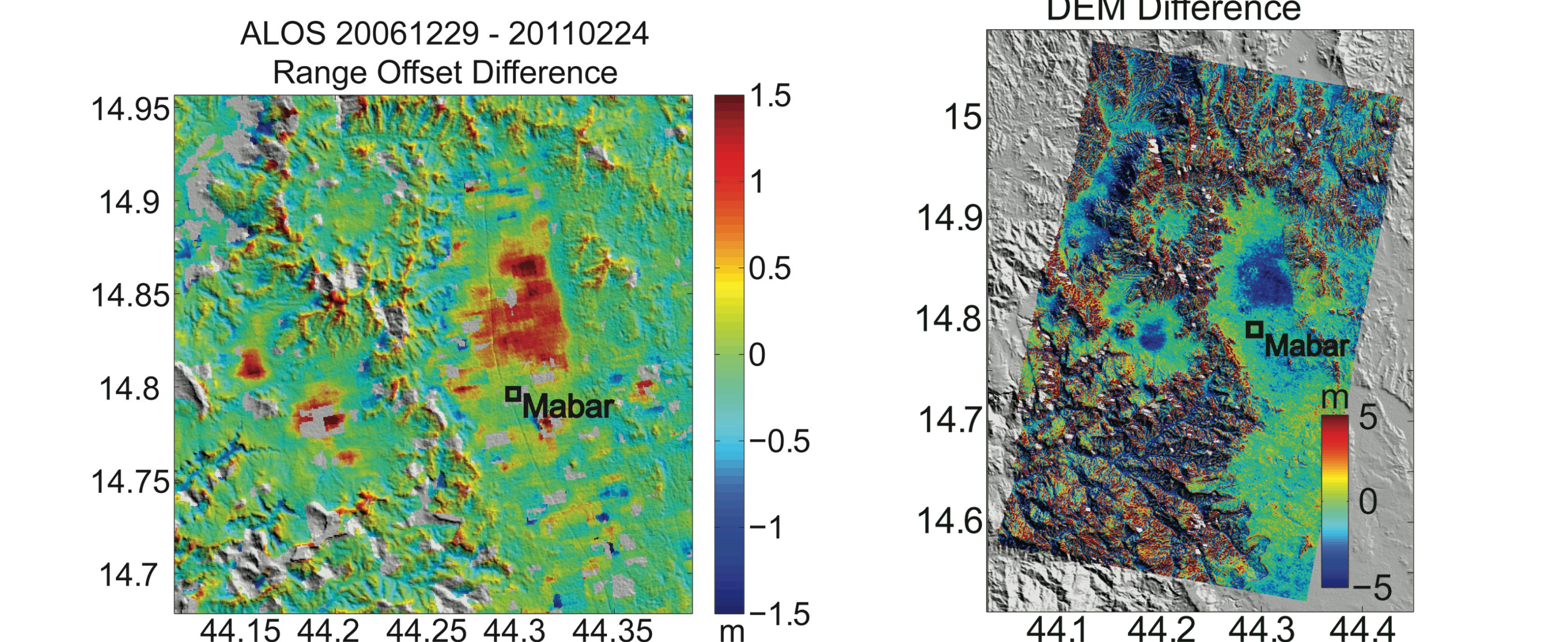


## 4. Mabar Basin Subsidence

- The subsidence rate exceeded 30 cm/year in the agricultural area north of the town of Mabar during 2007 – 2011 according to ALOS PALSAR L-band data.
- The southern part of the Mabar basin also experienced high subsidence rates, although somewhat lower than to the north – 5 cm/year.
- The seasonal fluctuations of ground deformation show that the subsidence rate in summer is faster than in winter.



- Two smaller agricultural basins to the west of the Mabar basin experienced subsidence with rates of about 37 cm/year according to ALOS PALSAR amplitude range offset calculations and difference between SRTM and Tandem-X DEMs.



## 5. Conclusions

- Several basins in Yemen show significant amount of ground deformation.
- The agricultural basin north of the Sana'a city experienced subsidence of 14 cm in 2008.
- The basins north and west of the town of Mabar have much larger subsidence rates exceeding 30 cm/year in 2006-2011.