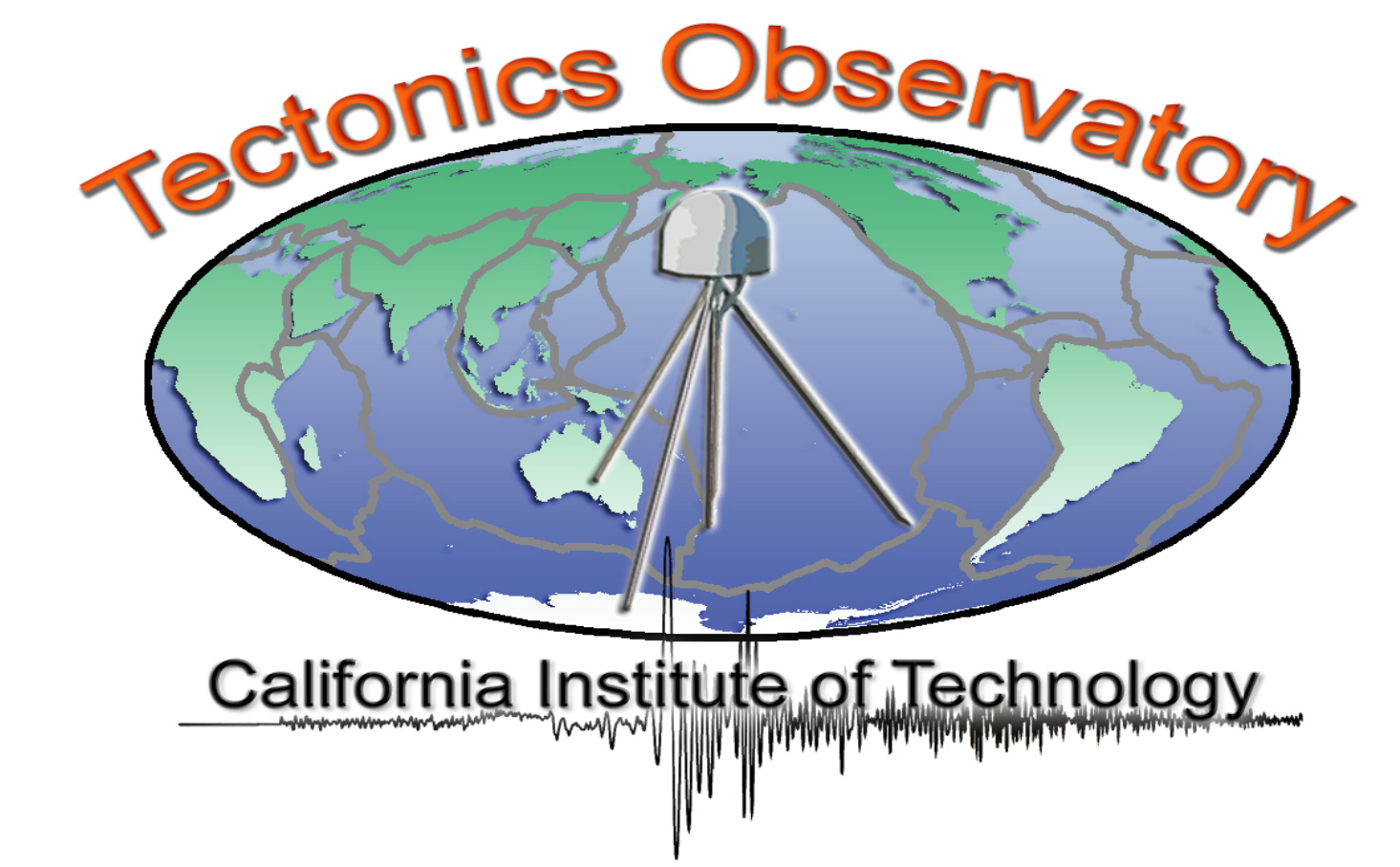




# Measuring Horizontal Co-seismic Deformations from Optical Images, Complementarity of Satellite and Aerial Data

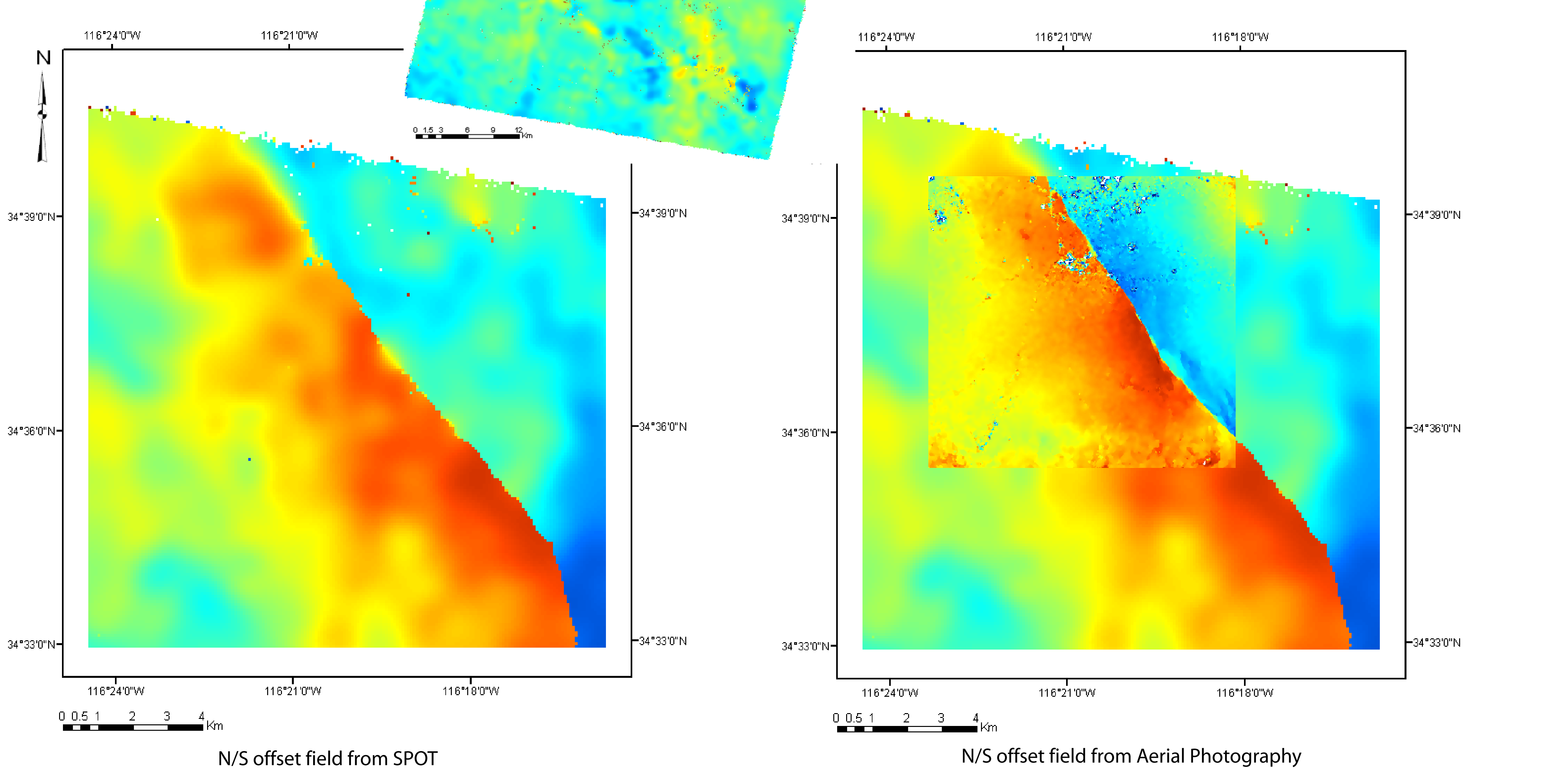
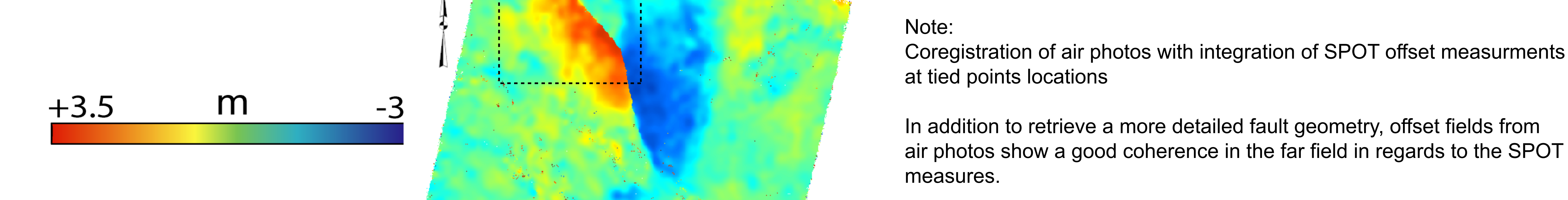
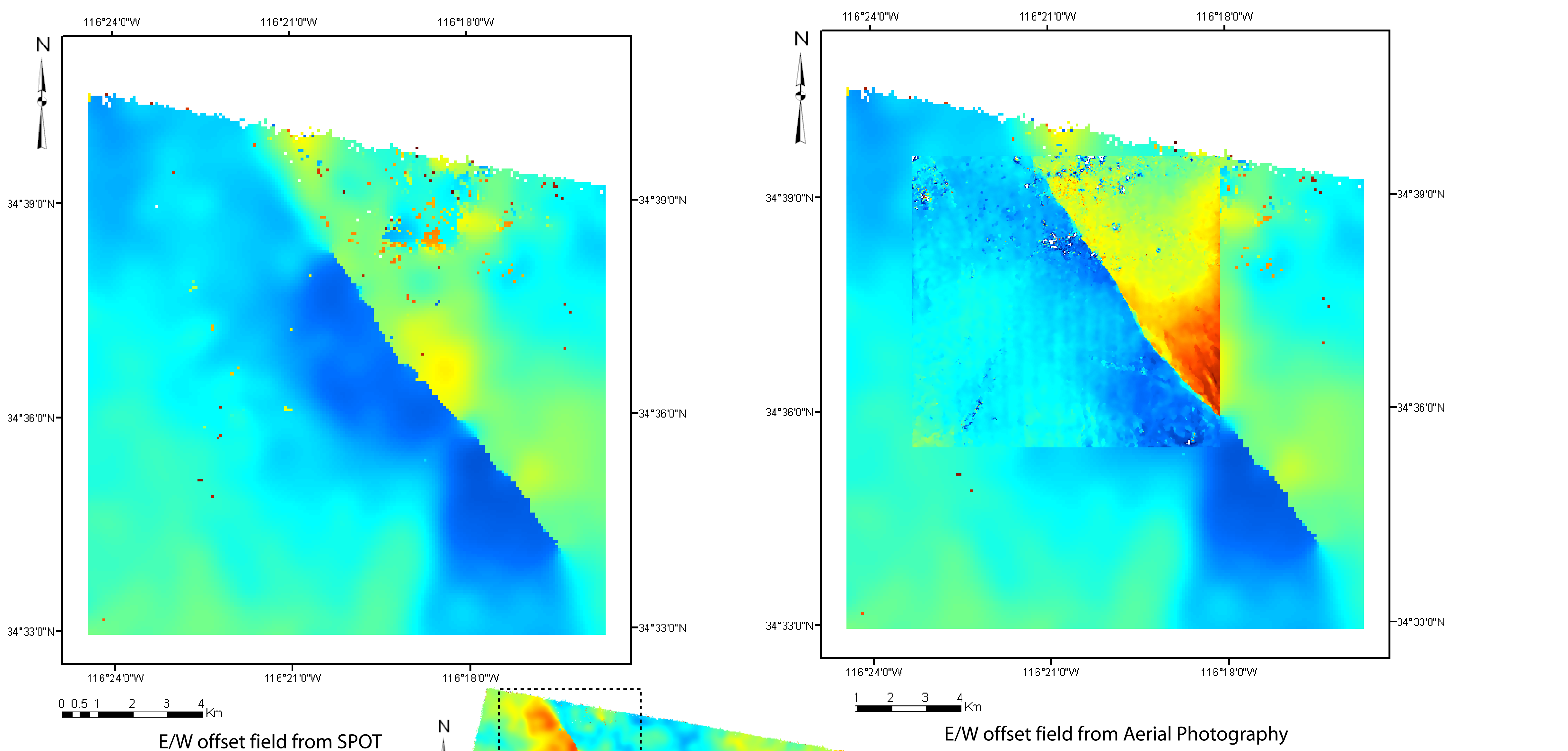
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In complement to seismological records, the knowledge of the ruptured fault geometry and co-seismic ground displacements are key data to investigate the mechanics of seismic rupture. This information can be retrieved from sub-pixel correlation of optical images. We are investigating the use of SPOT satellites images and aerial images. When used together, precise measurements close and further away from the fault zone area can be delivered. The techniques developed here are attractive due to the operational status of a number of optical imaging programs and the availability of archived data. However, uncertainties on the imaging system itself and on its attitude dramatically limit the technique. We overcome these limitations by applying an iterative corrective process allowing for precise image registration that takes advantage of the availability of accurate Digital Elevation Models with global coverage (SRTM). This poster presents three applications of this technique by showing accurate and dense horizontal co-seismic displacement field induced by the 1999 Hector-Mine earthquake in California (Mw 7.1), the 1999 Izmit earthquake (Mw 7.4), Turkey and the 1992 Landers earthquake in California (Mw 7.3).

## The Hector Mine earthquake seen from SPOT and Aerial images



**Pre-earthquake image:**  
SPOT 4, acquisition date: 08-17-1998  
Ground resolution: 10m

**Offsets measured from correlation:**  
- 320m x 320m correlation windows  
- 80m between two measurements

**Post-earthquake image:**  
SPOT 2, acquisition date: 08-18-2000  
Ground resolution: 10m

**Pre-earthquake image (USGS-NAPP):**  
Acquisition date : 7/25/89  
Ground resolution : 1m

**Offsets measured from correlation:**  
- 128m x 128m correlation windows  
- 16m between two measurements

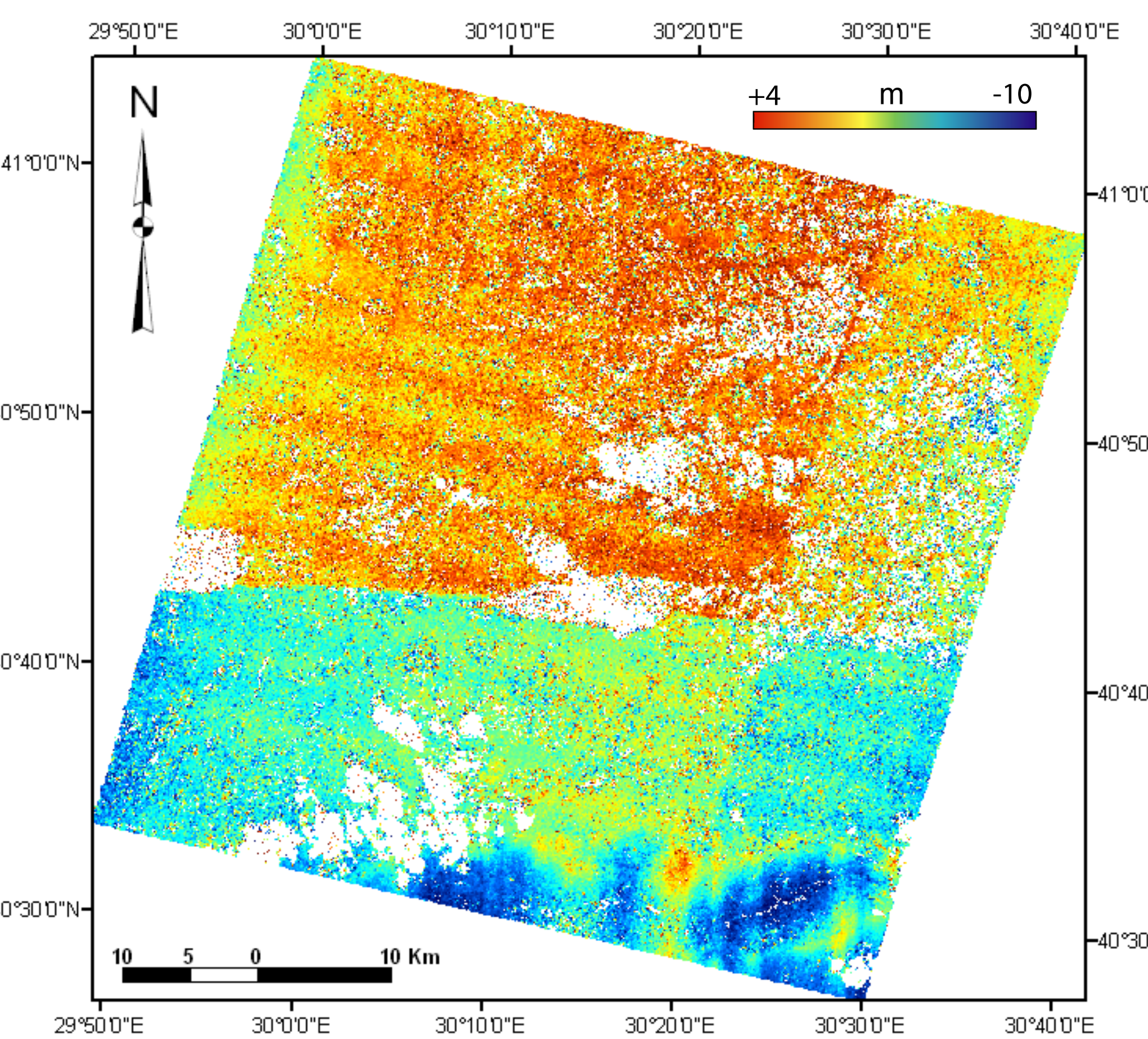
**Post-earthquake image (USGS-NAPP):**  
Acquisition date : 06/01/02  
Ground resolution : 1m

## The Izmit earthquake seen from SPOT images

The Mw 7.4 1999 Izmit earthquake, Turkey, has produced purely strike-slip motion along an East - West trending fault. For this reason, only the East - West component of the deformation is presented.

The two images show how appropriate filtering can help recovering noisy information.

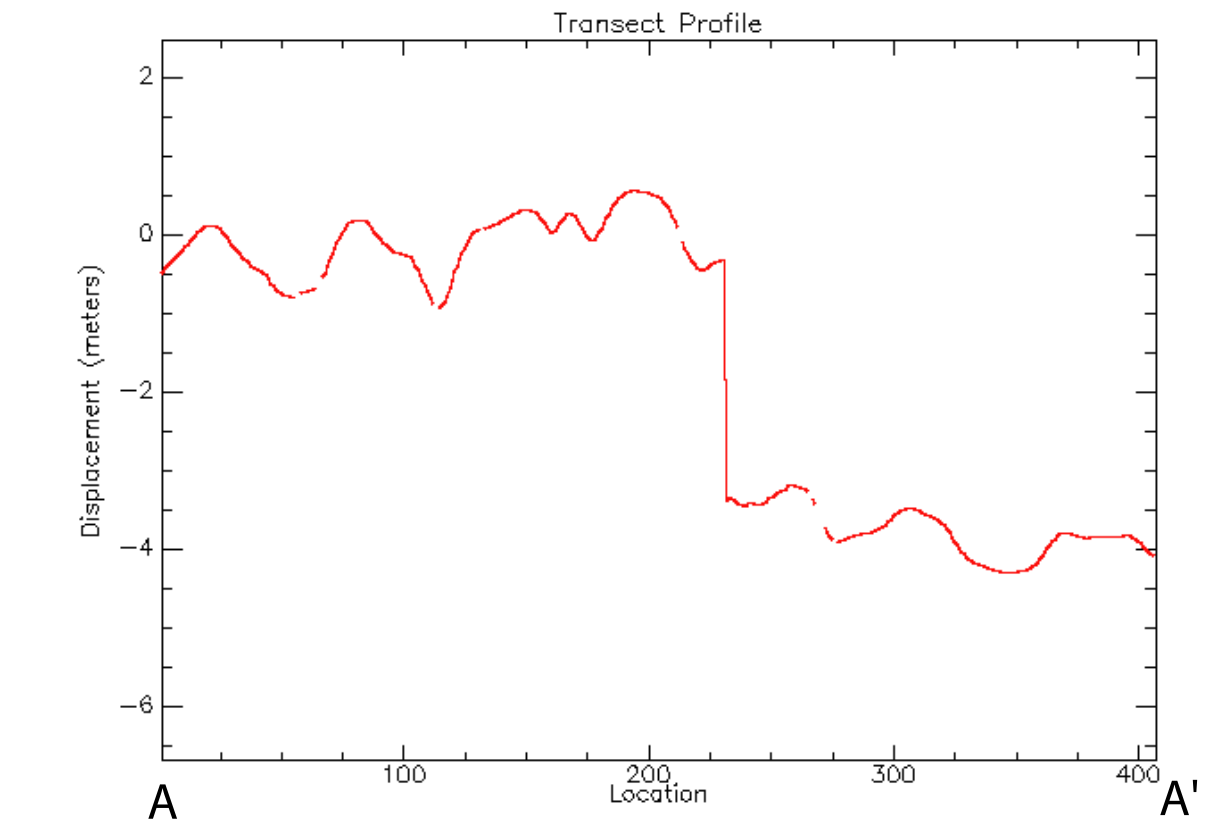
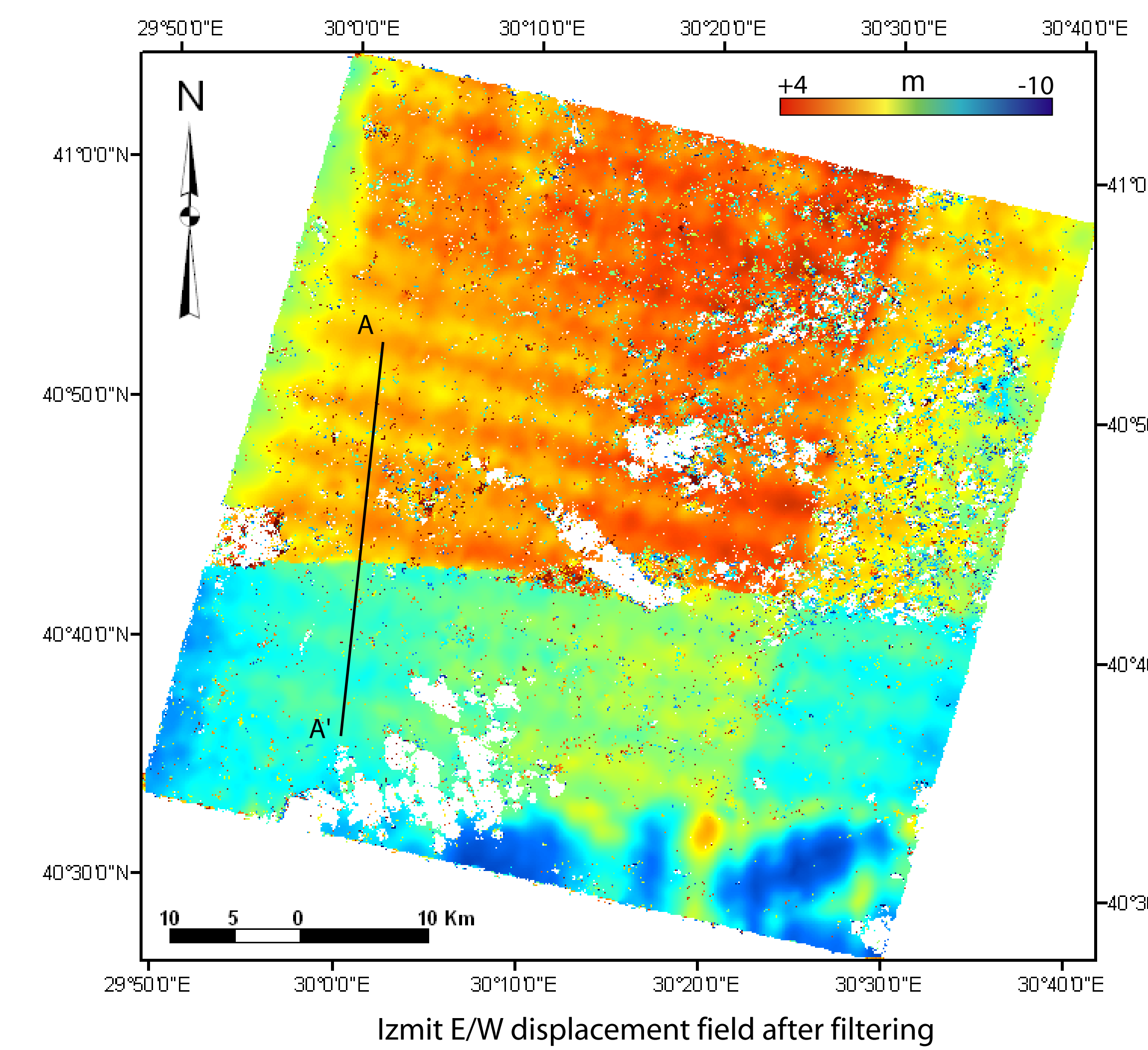
Oscillations in the satellite along track direction are clearly visible. They characterize vibrations of the satellite pitch during the images acquisition. Of an amplitude of 1.5m on the ground, these oscillations are too small to be recorded by the onboard gyroscopes.



**Pre-earthquake image:**  
SPOT 2, acquisition date: 08-17-1998  
Ground resolution: 10m

**Post-earthquake image:**  
SPOT 2, acquisition date: 08-18-2000  
Ground resolution: 10m

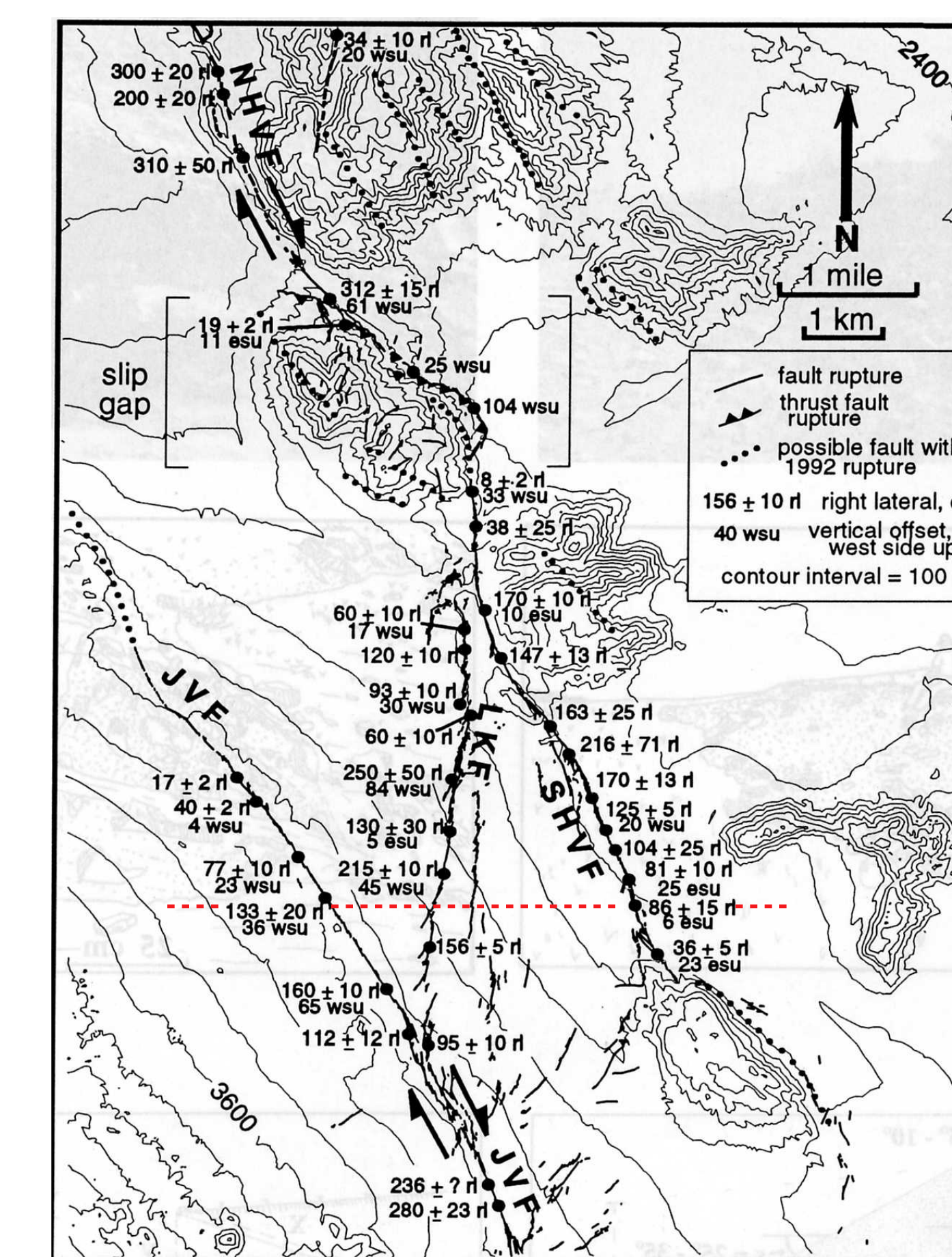
**Offsets measured from correlation:**  
- 320m x 320m correlation windows  
- 80m between two measurements



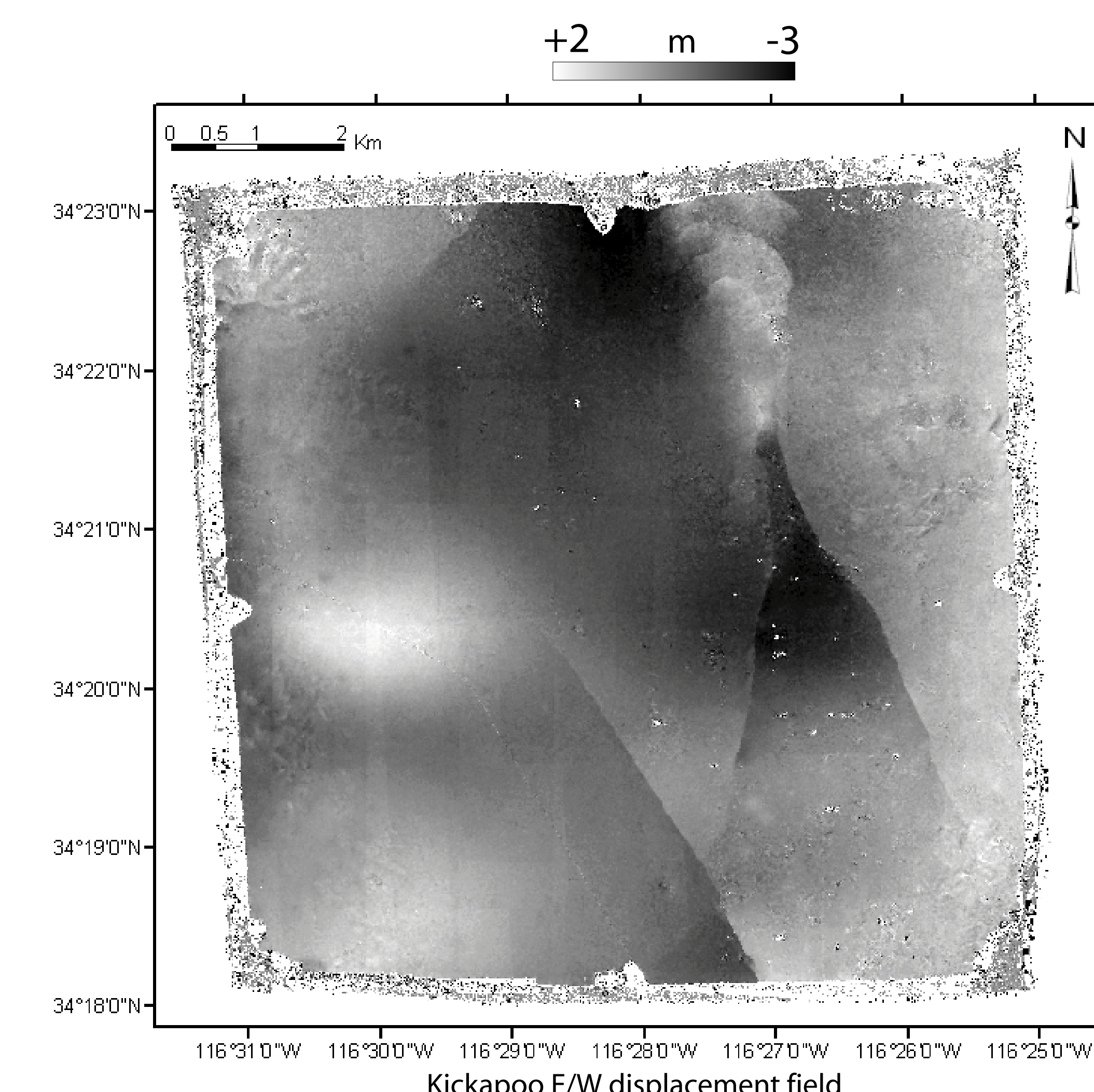
## The Landers earthquake seen from Aerial images

Landers Kickapoo stepover deformation imaged from air photos correlation

Note:  
- Scan artefacts visible mostly on the N/S component  
- Film distortion visible on the E/W and N/S component



Sieh K. et al, "Near field investigations of the Landers earthquake sequence, April to July 1992", Science 260, 171-176 (1993)



**Pre-earthquake image (USGS-NAPP):**  
Acquisition date : 7/25/89  
Ground resolution : 1m

**Post-earthquake image (USGS-NAPP):**  
Acquisition date : 06/01/02  
Ground resolution : 1m

**Correlation image:**  
- 64m x 64m correlation windows  
- 16m step between windows  
----> 16m displacement resolution

