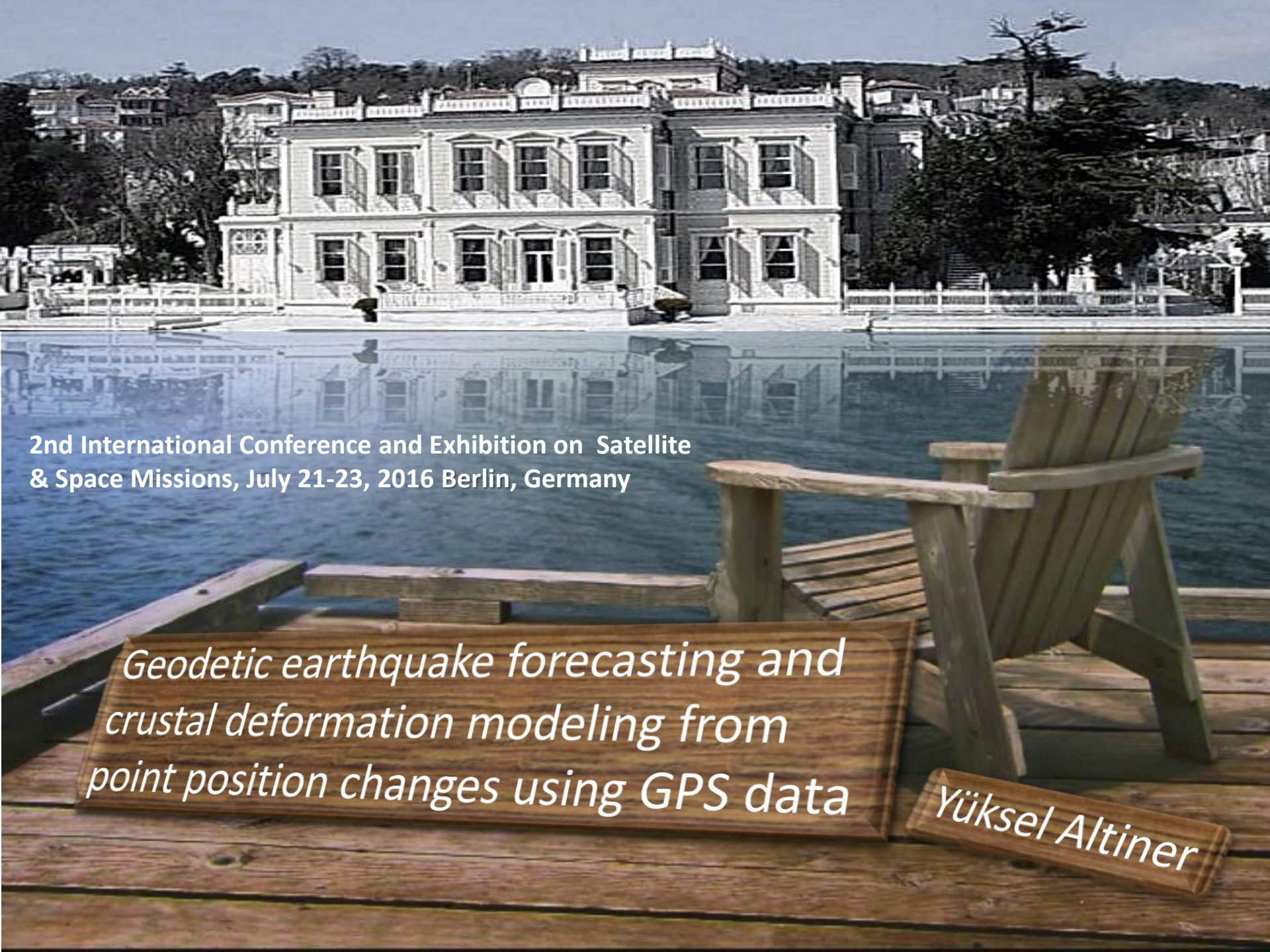

2nd International Conference and Exhibition on Satellite & Space Missions, July 21-23, 2016 Berlin, Germany
Geodetic earthquake forecasting and crustal deformation modeling from point position changes using GPS data
Yüksel Altiner

True or not true?

Can an earthquake be predicted?

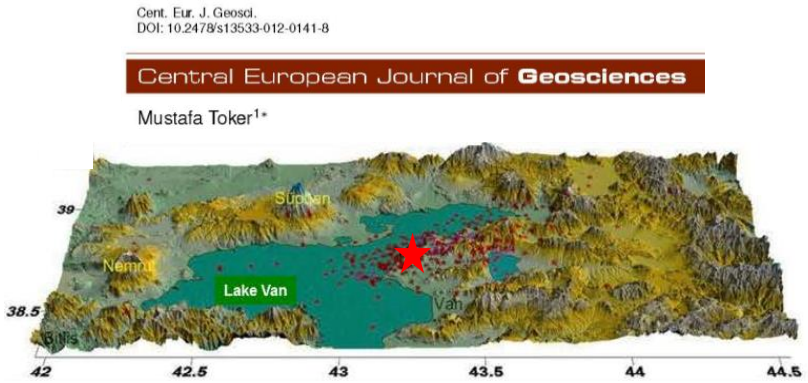
Can a tectonic plate boundary be proposed?

General Characteristic of the Van Earthquake

REPUBLIC OF TURKEY
Prime Ministry
Disaster And Emergency Management Presidency,
Earthquake Department, Ankara – TURKEY

Report-on_October_23_2011_Van_Earthquake_Mw7.0.pdf

On 23.10.2011 at 10:41:00 (UTC);
moment magnitude (Mw) 7.0;
focal depth 19,07 km
(using SEISAN from Jens Havskov)



Visible effects

No apparent faulting, but some ruptures

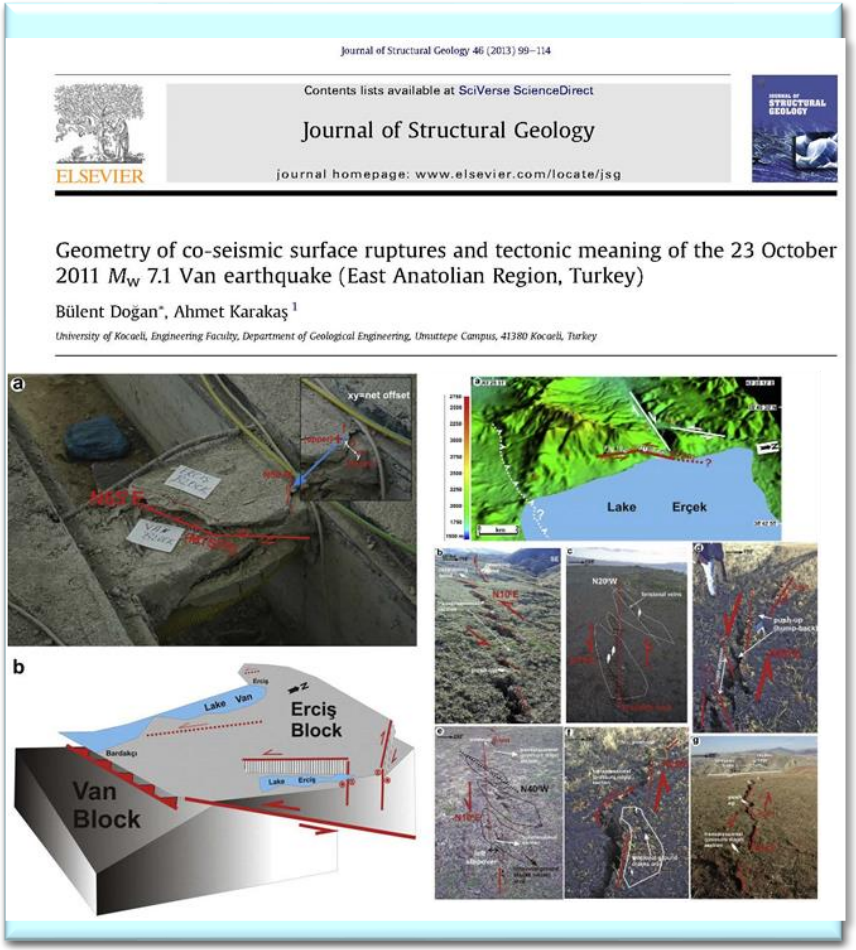


Journal of Geophysical Research, Volume 118, Issue 4, April 2013, Pages 1619–1637

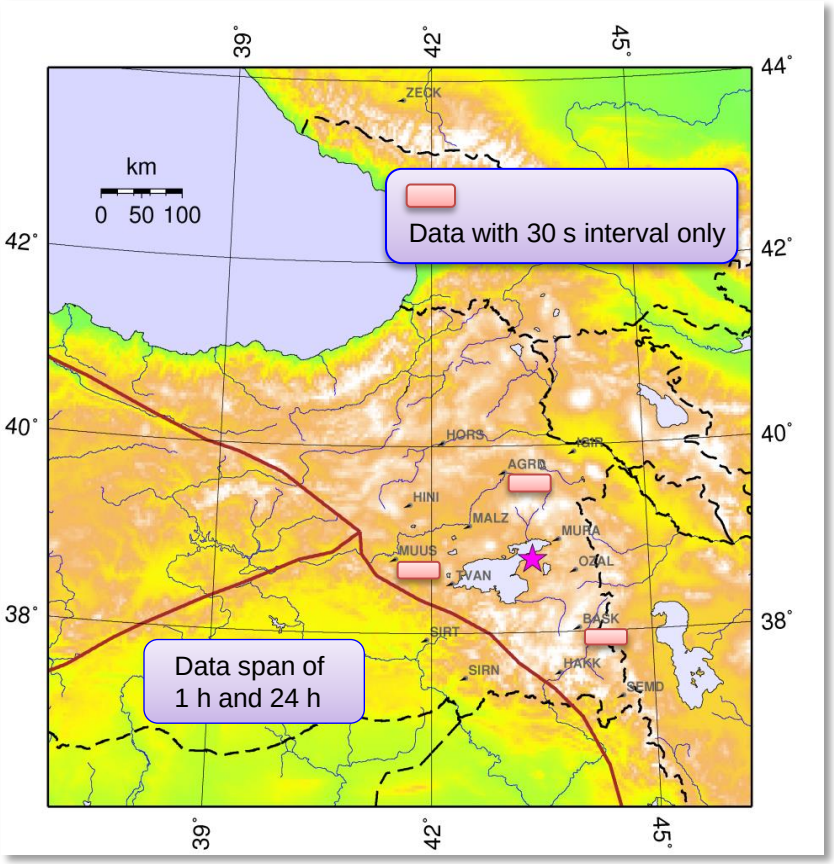
The 2011 Mw 7.1 Van (Eastern Turkey) Earthquake

J.R. Elliott,[1] A.C. Copley,[2] R. Holley,[3] K. Scharer,[4] and B. Parsons,[1]





GPS data available within the CORS-TR network



Daily data of 14 stations
at 30 s interval (00:00 to 23:59)

One-hour data of 11 stations
at 1 s interval (10:00 to 11:00)

Data evaluation

At one-second epoch (10:00 to 11:00) using PPP method;

Software: RTNet (GPS Solution, Inc.,)

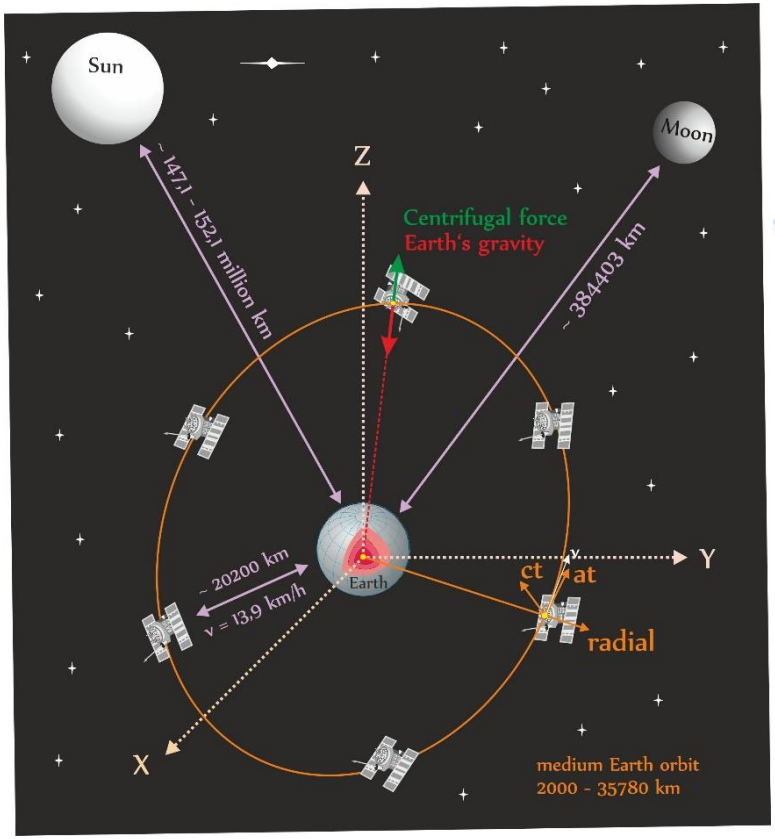
→ Co-seismic motions

On daily basis (one value for each day) processing of 30 s data;

Software: BSW from the Univ. of Bern.

→ Pre- and post-seismic motions

Precise Point Positioning (PPP)

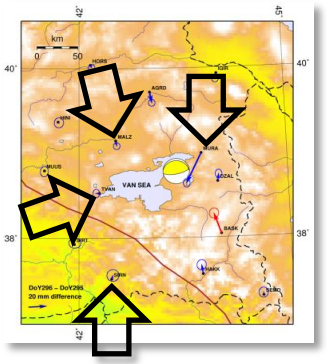


Perturbed motions:

- orbit corrections in radial, along-track, and cross-track directions of an ECEB-Frame.

With a single receiver using satellite orbit and clock corrections.

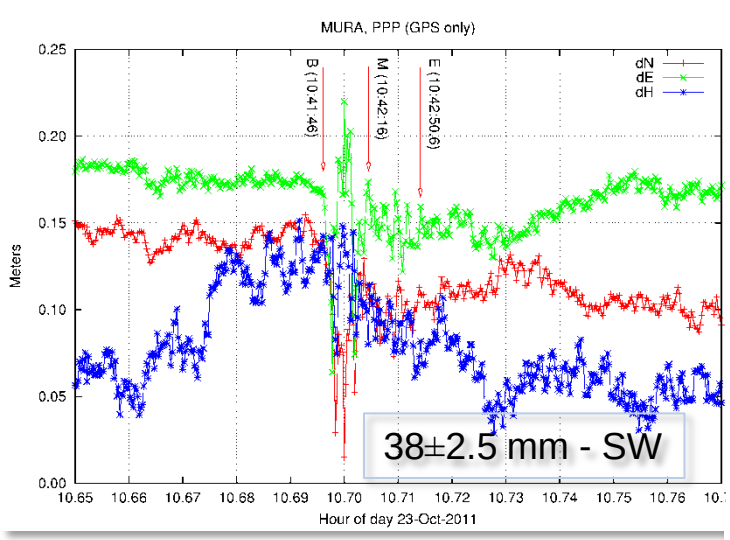
Co-seismic motion at one-second-epoch

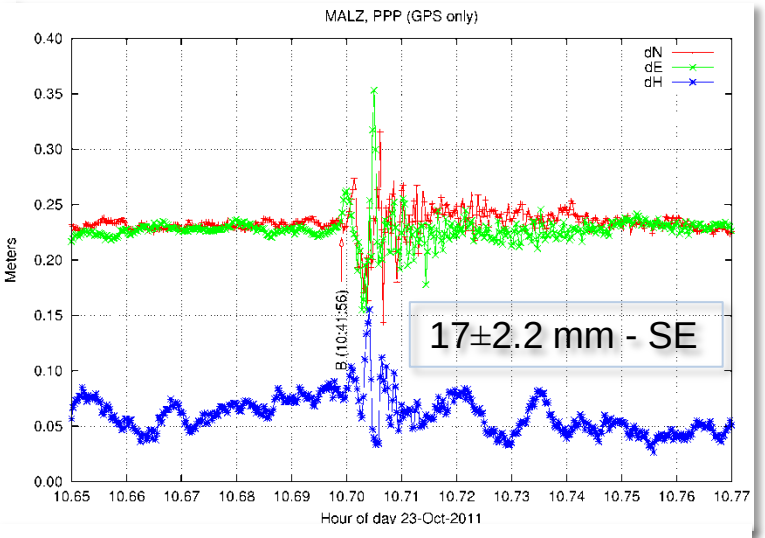


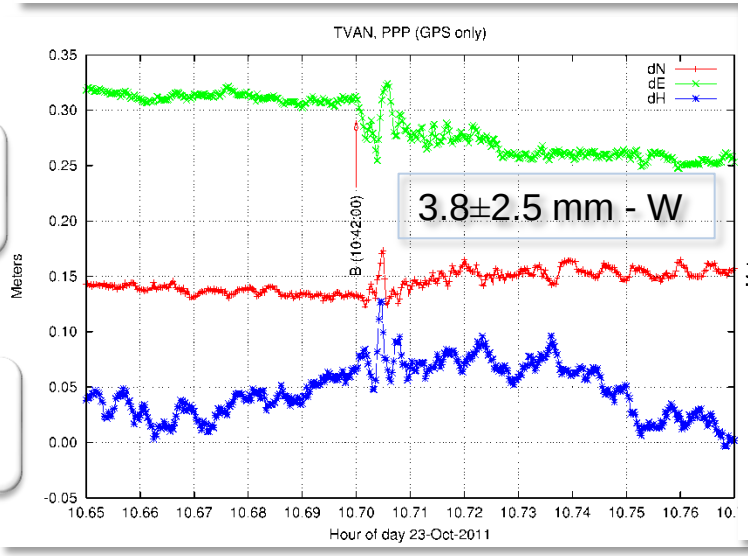
MURA ~ 43 km to the epicenter

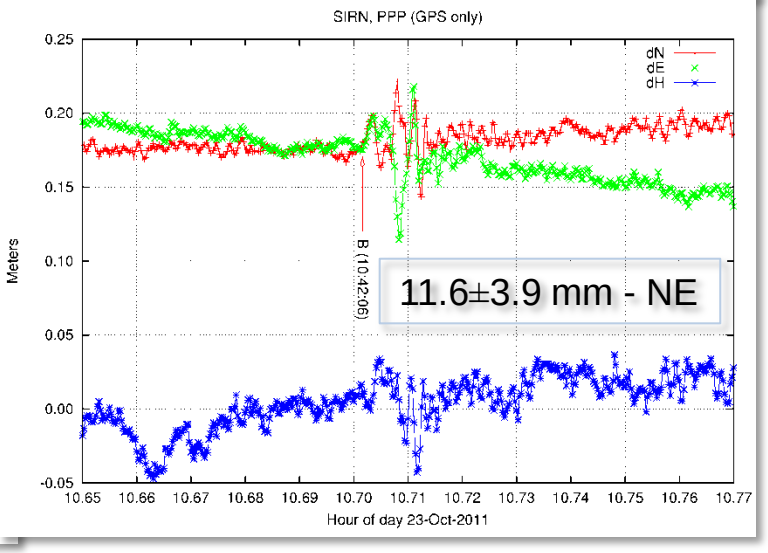
Orbit and clock from the IGS

RTNet from the GPS Solution









Occurence time using propagation of P-waves

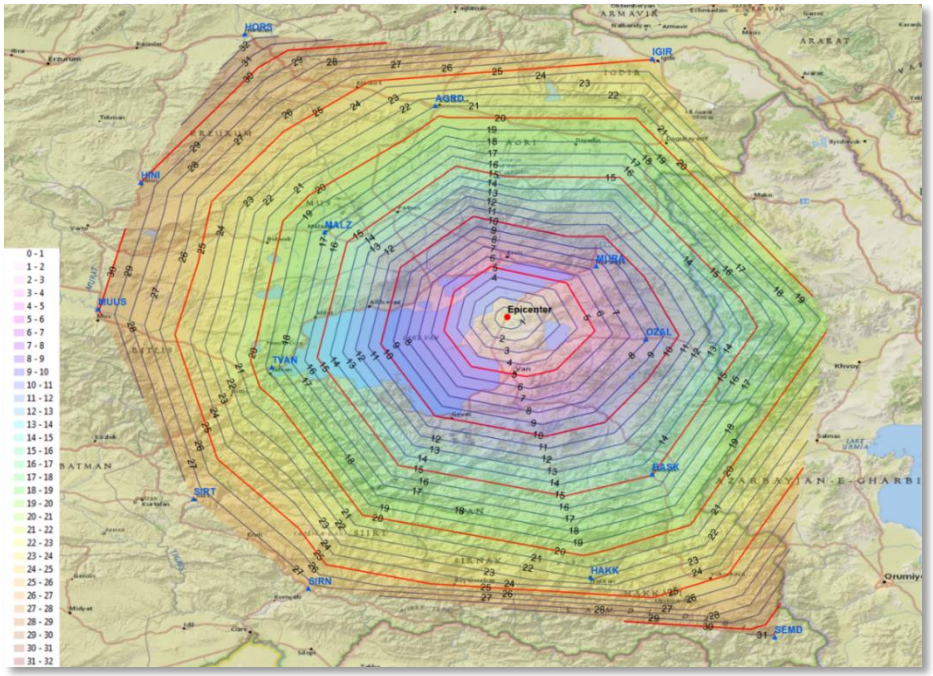
Occurrence time: 10:41:37 at GPS
GPS time was ahead of UTC by 15 s

Agency	Time (UTC)
AFAD	10:41:00
KOERI	10:41:21
USGS	10:41:21.73
GFZ	10:41:22
EMSC	10:41:22
INGV	10:41:00
PPP	10:41:22*

* from co-seismic motions

http://earthquake.usgs.gov/

Seismic travel time values



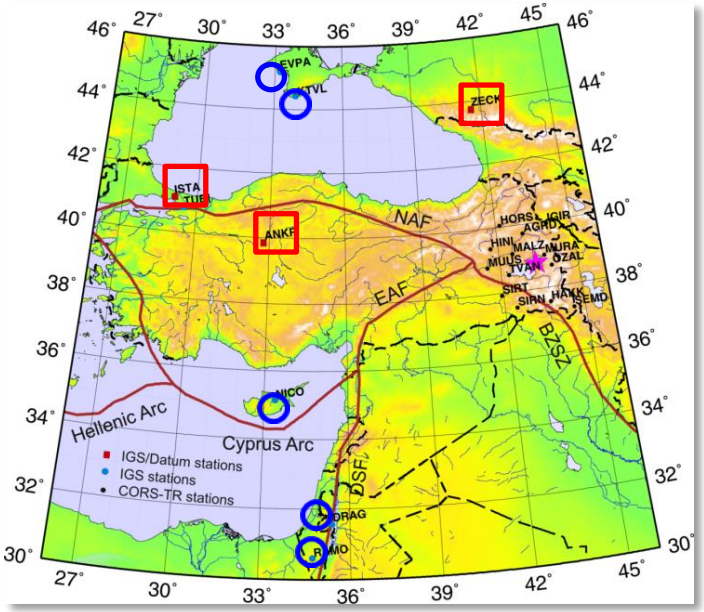
EQ travel time calculator from the USGS

Accuracy of estimated dislocations

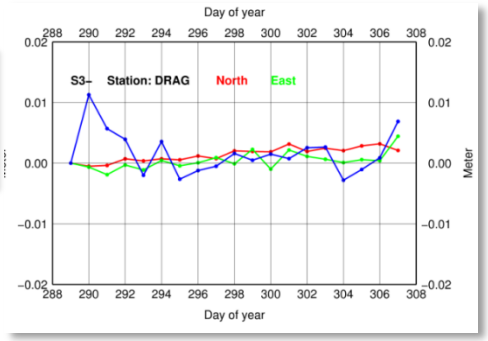
Daily solutions from GPS data (30 s) with BSW
DoY: 289 – 307 (19)

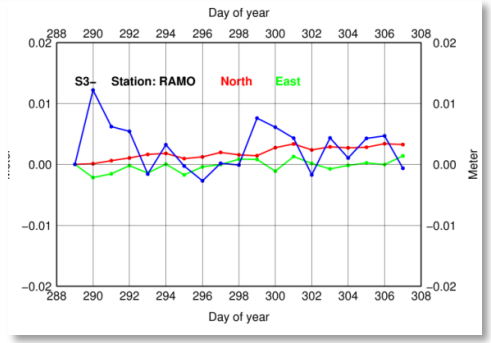
Stations far away from the epicenter, not affected

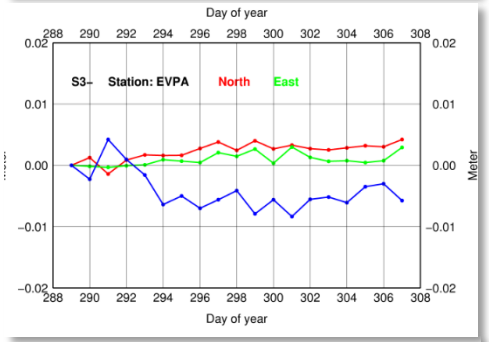
Variation between
4 mm (h) and 10 mm (v)

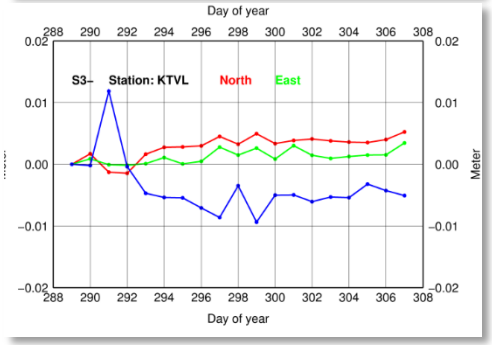


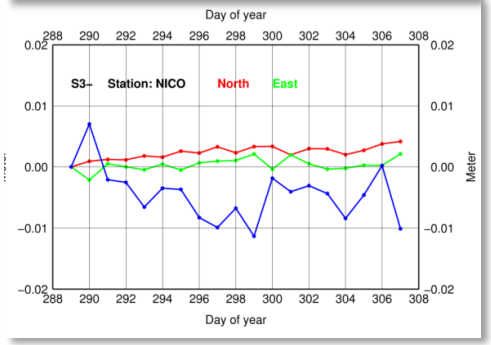
IGS08 (ISTA, ANKR, and ZECK)











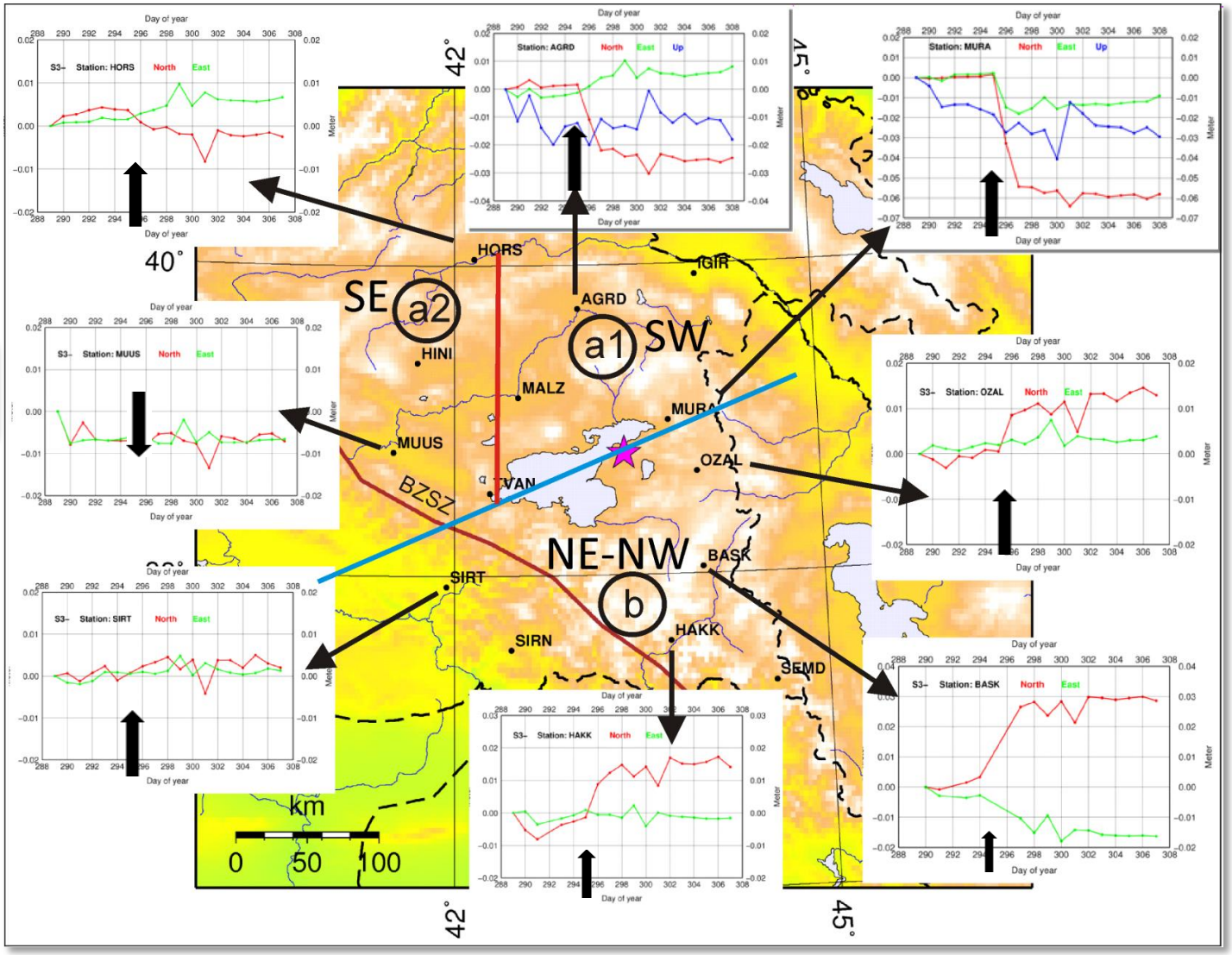
Precursor signal before the EQ?

DoY = 296, 23.10.2011

Accuracy from 19 daily solutions

↑ DoY = 295

No signal



Source models: Teleseismic vs. Geodetic

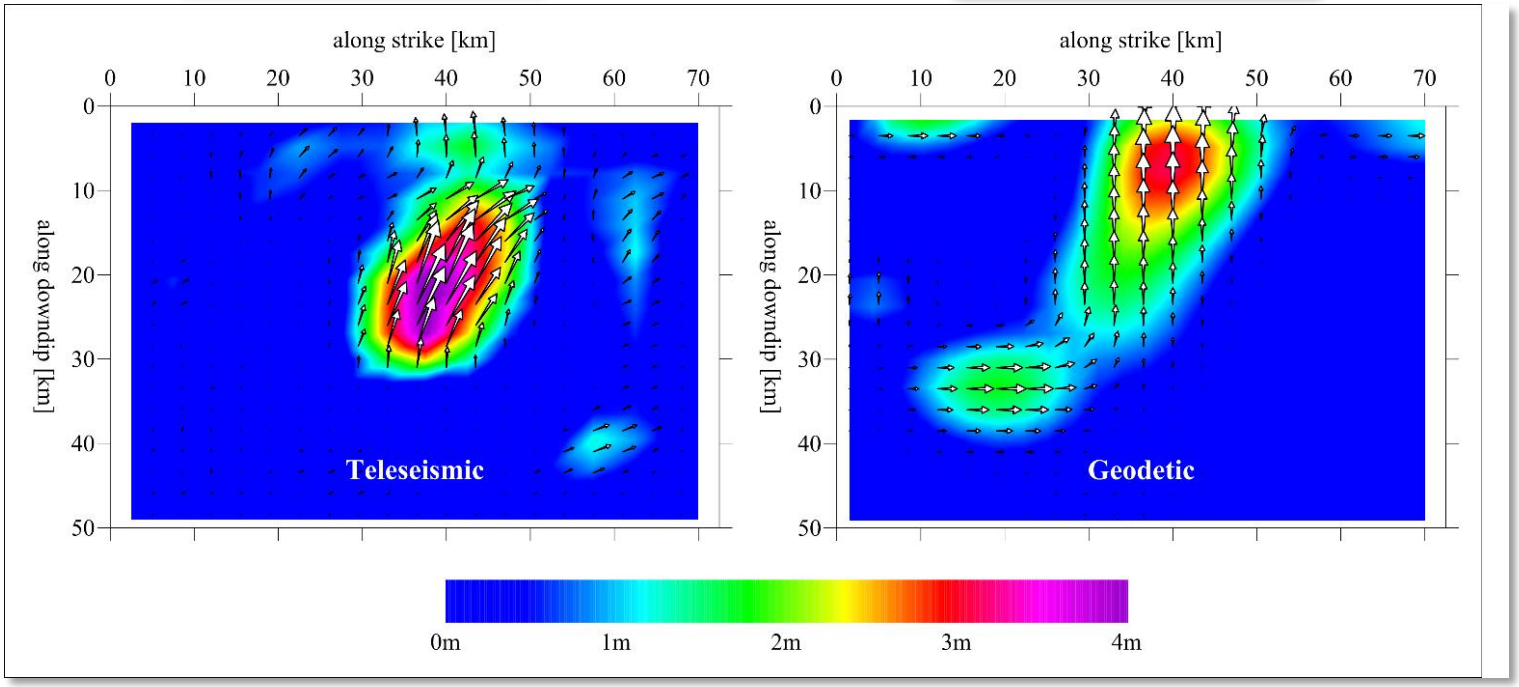
Same fault plane location and geometry, same moment magnitude of M_w7.1

Finit fault model by Gavin Hayes (USGS)

No. of sta. : 159

Rongjang Wang (GFZ – Potsdam)

No. of sta. : 14



Warning or not warning?

- Reliable prediction of a quake in location, time, and magnitude?

A wrong alert may create more conflicts!

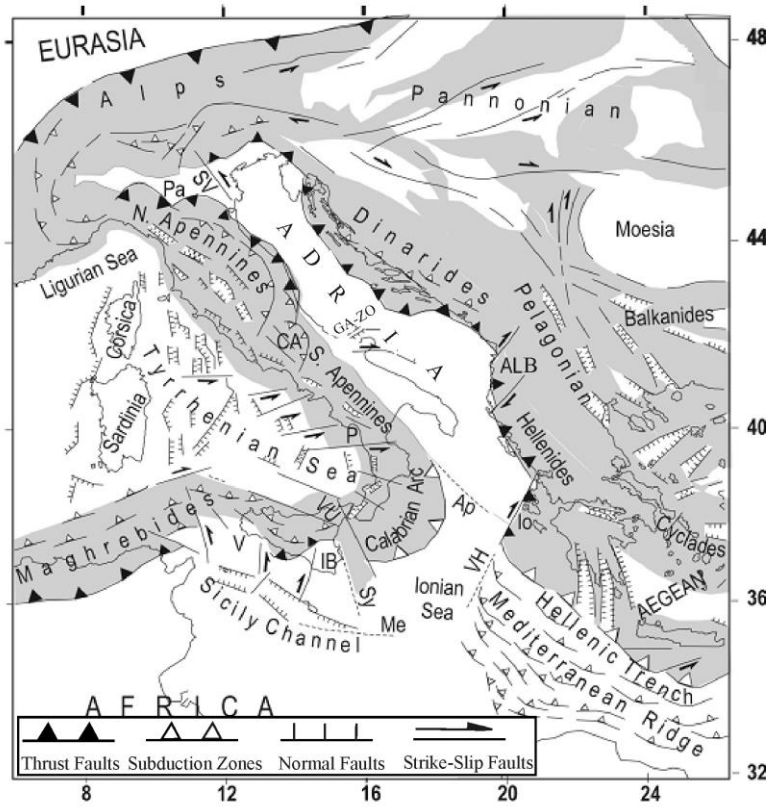


Plate tectonics: ~ 99% of EQ energy at plate boundaries; ~ 90% of wich at convergence plate boundaries.

Anticipation or Prediction?

Tectonic features in the central Mediterranean

Adria, a microplate or a block of continental lithosphere covering eastern Italy and the Po Plain, and the Adriatic Sea, west of Dinarides, which behaved as a tectonic indender during convergence between the Africa and Eurasia plates (Channel and Horvath, 1976)



(After Mantovani et al., 2005)

Statements about the Adriatic block

Based on

geological studies:

A promontory of the Africa plate (Argand, 1924)

geological and seismological studies:

A distinct microplate

(Dewey et al., 1973; Manzoni and Vandenberg, 1982; ...)

A rigid, almost aseismic block

(Anderson and Jackson, 1987; Mantovani et al., 2005; ...)

geodetic studies (GNSS data):

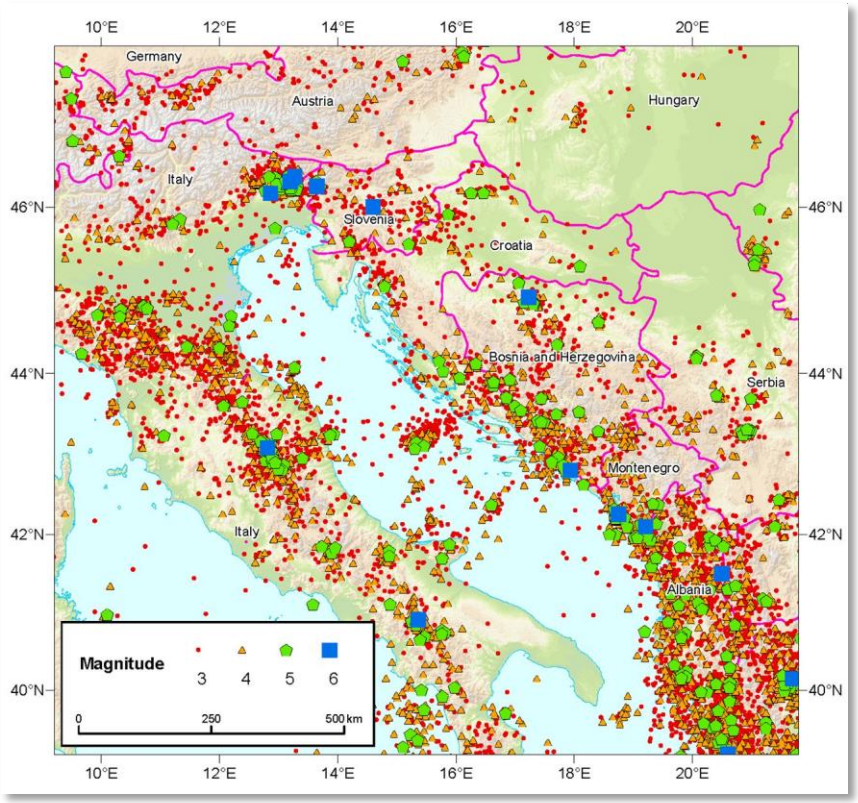
A single block

(Altiner et al., 1999; Battaglia et al., 2004, Hollenstein et al., 2005; Weber et al., 2005, Hefty, 2007; Caporali et al., 2009; ...)

Divided into subblocks (Oldow et al., 2002; ...)

Recorded earthquake epicenters

ANSS (Northern California Earthquake Data Center)



Seismicity crosses the central Adriatic is evidence for

a southwest-northeast-oriented decoupled zone between the African plate and Adria (Westaway, 1990)

a tectonic boundary separating Adria into north and south blocks (Favali et al., 1993)

a proof of an active tectonic region, but not of a tectonic boundary (Mantovani et al., 2005)

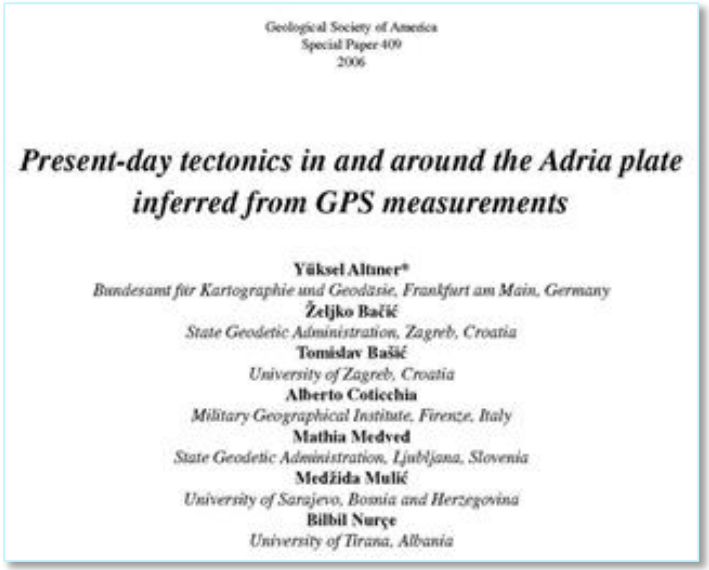
GPS measurement in and around Adria

GPS measurements in 1994, 1996, and 1998

Data evaluation using BSW; Velocities in ITRF1996 / ITRF2005

Present-day tectonics in and around Adria inferred from GPS measurements

Geological Society of America, Special papers 409, 2006



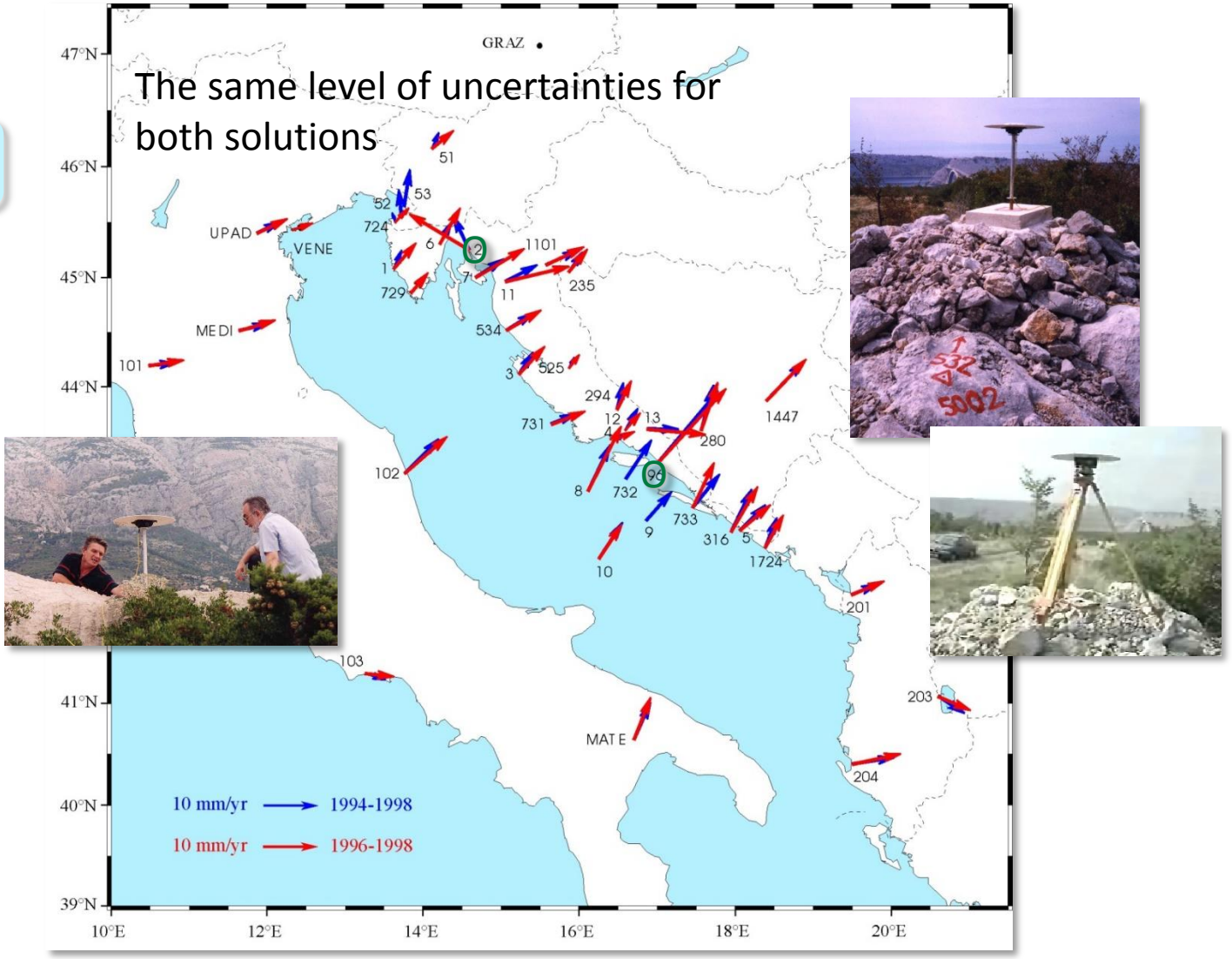
Geological Society of America
Special Paper 409
2006

Present-day tectonics in and around the Adria plate inferred from GPS measurements

Yüksel Altıner*
Bundesamt für Kartographie und Geodäsie, Frankfurt am Main, Germany
Željko Bačić
State Geodetic Administration, Zagreb, Croatia
Tomislav Bašić
University of Zagreb, Croatia
Alberto Coticchia
Military Geographical Institute, Firenze, Italy
Mathia Medved
State Geodetic Administration, Ljubljana, Slovenia
Medžida Mulić
University of Sarajevo, Bosnia and Herzegovina
Bilbil Nurçe
University of Tirana, Albania

Checking of local movements

GRAZ

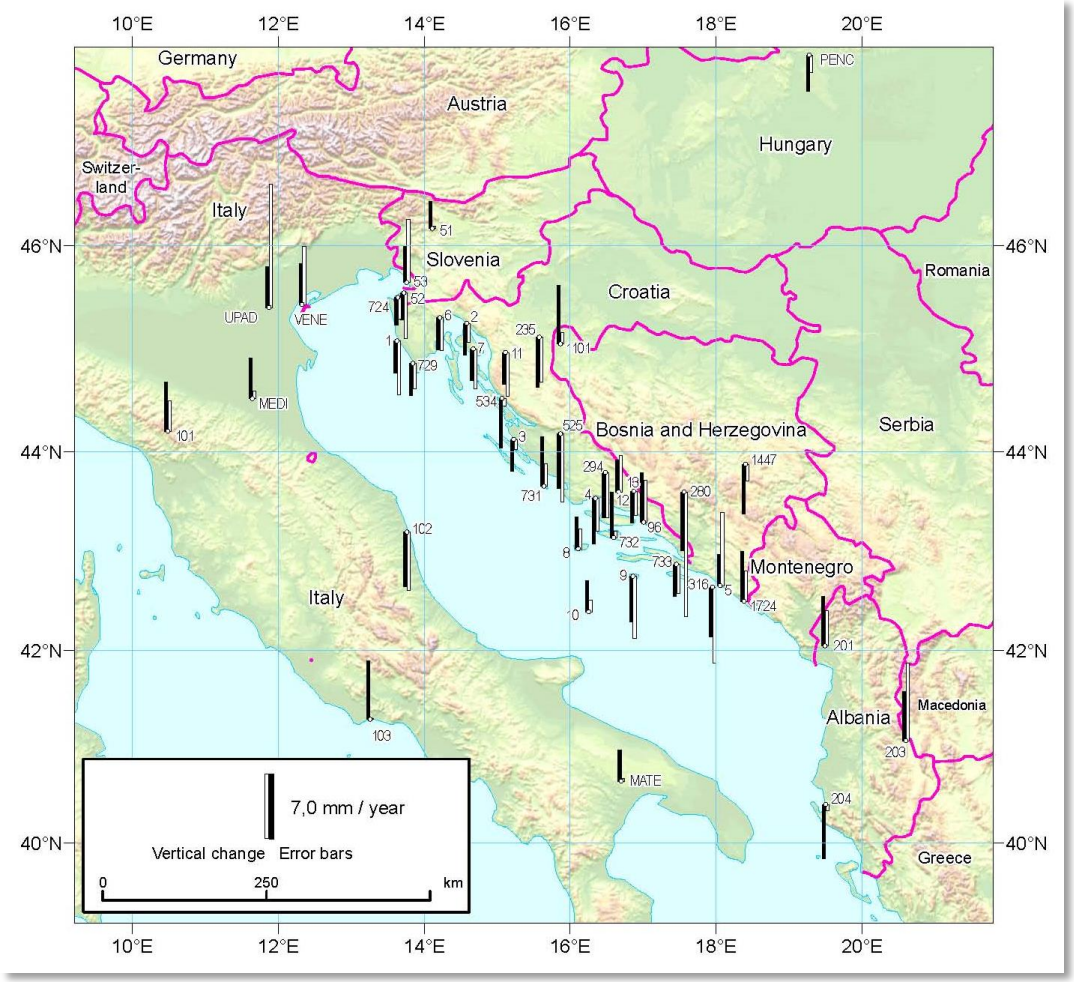


Annual horizontal velocities with a probability of 95%

Significant velocities at 0.95 confidence level - excepting the five stations encircled in green

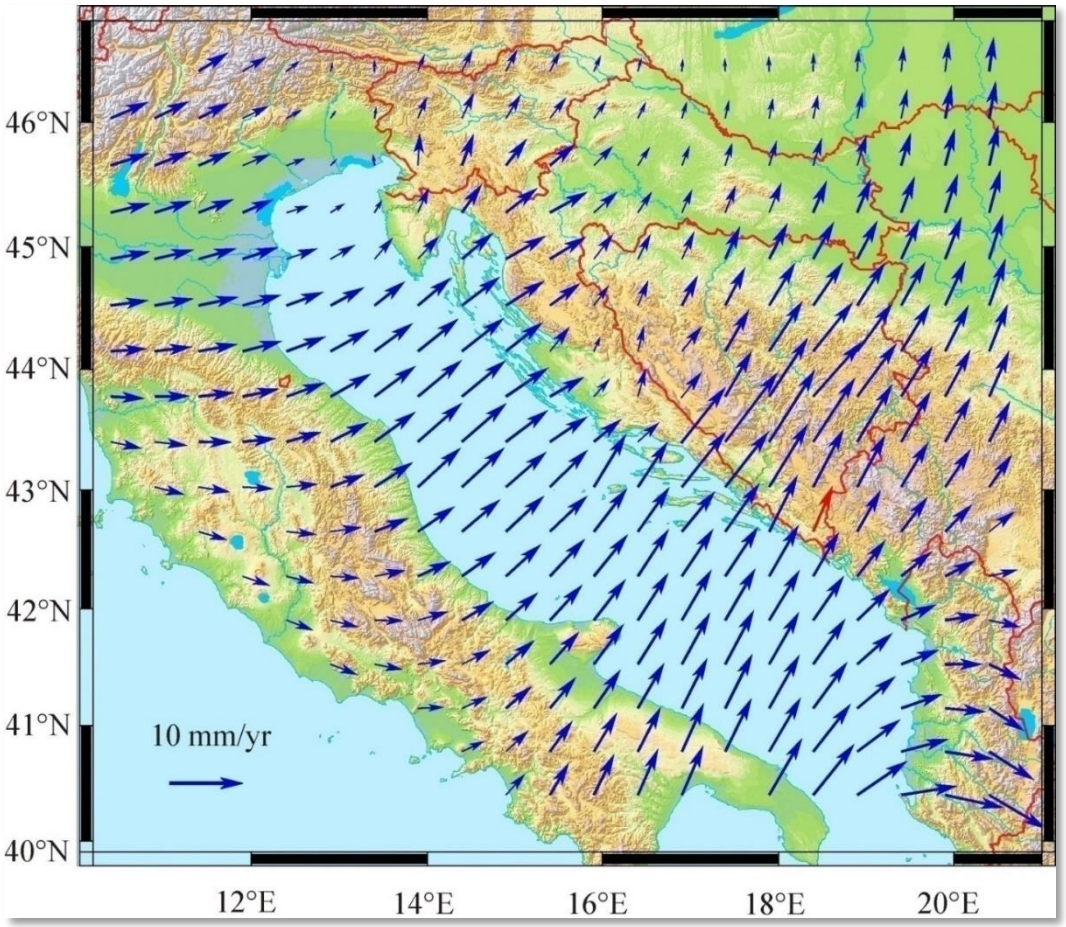


Annual vertical movements and their error bars with a probability of 95%



Annual horizontal model velocities

Interpolation of annual velocities by the spline method

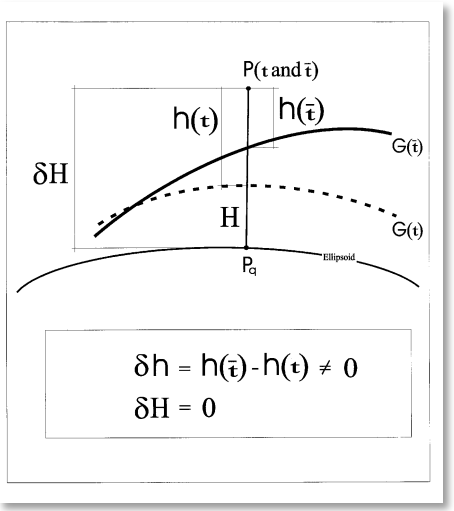


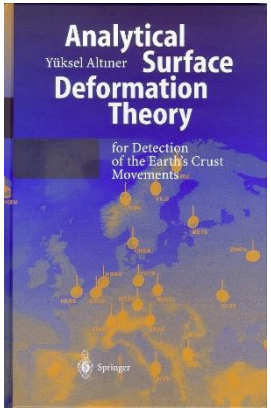
Why applying ASDT?

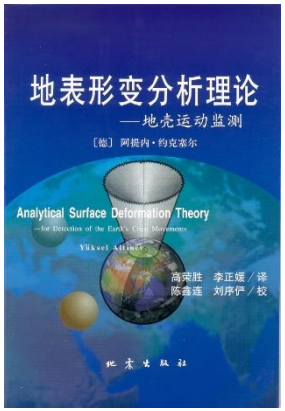
Rigid body motion causes no deformation!

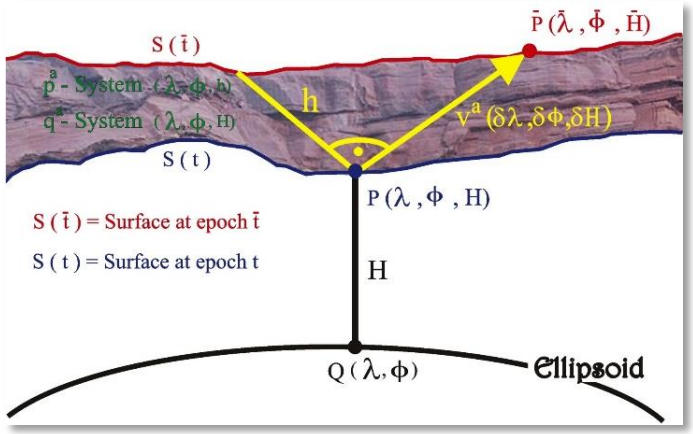
Ellipsoidal height - reference ellipsoid
Orthometric height - mean see level as reference surface

Change of mean and principal curvatures
- area-wise change, slope direction of external changes

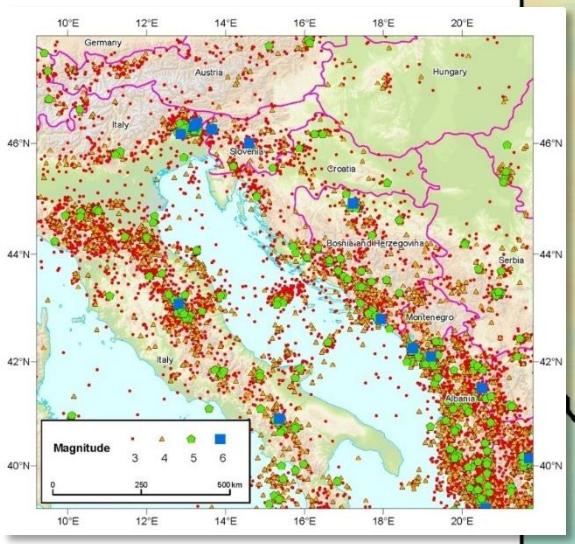


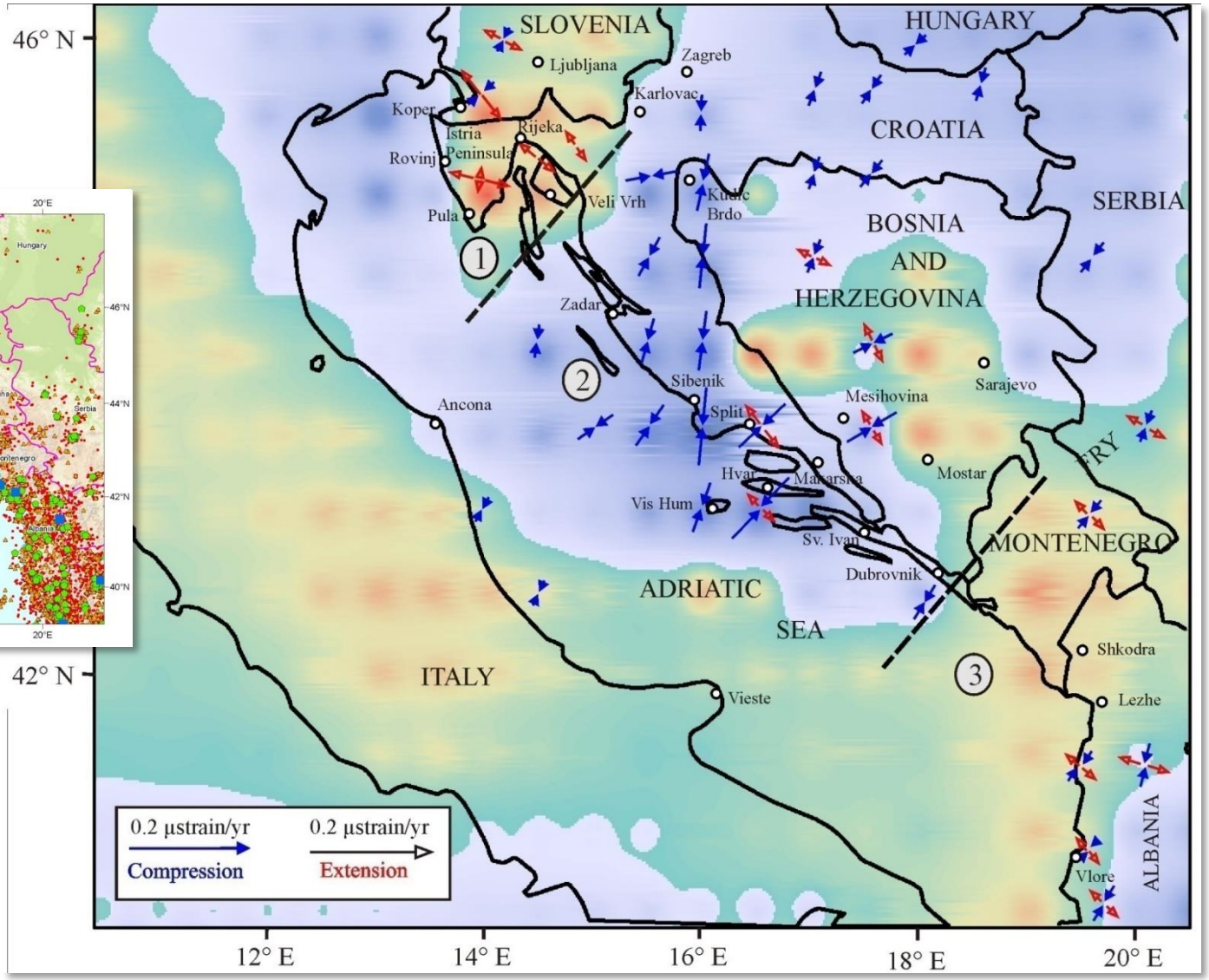






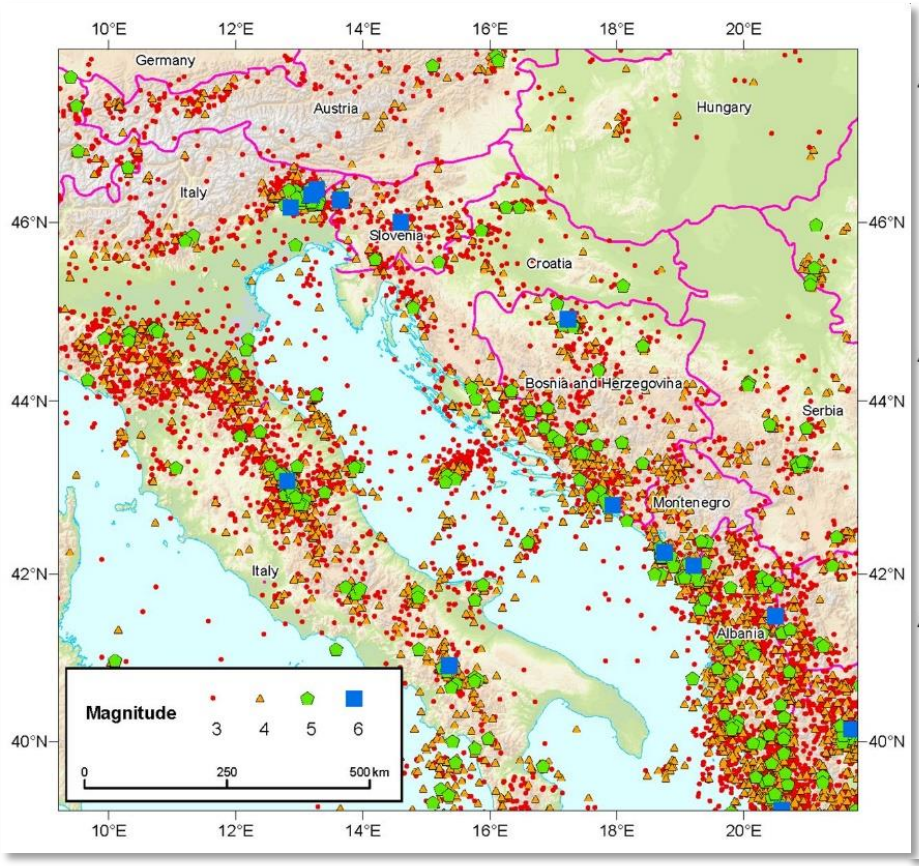
Principal strain rates





Changes of the principle curvatures

Change of slop direction



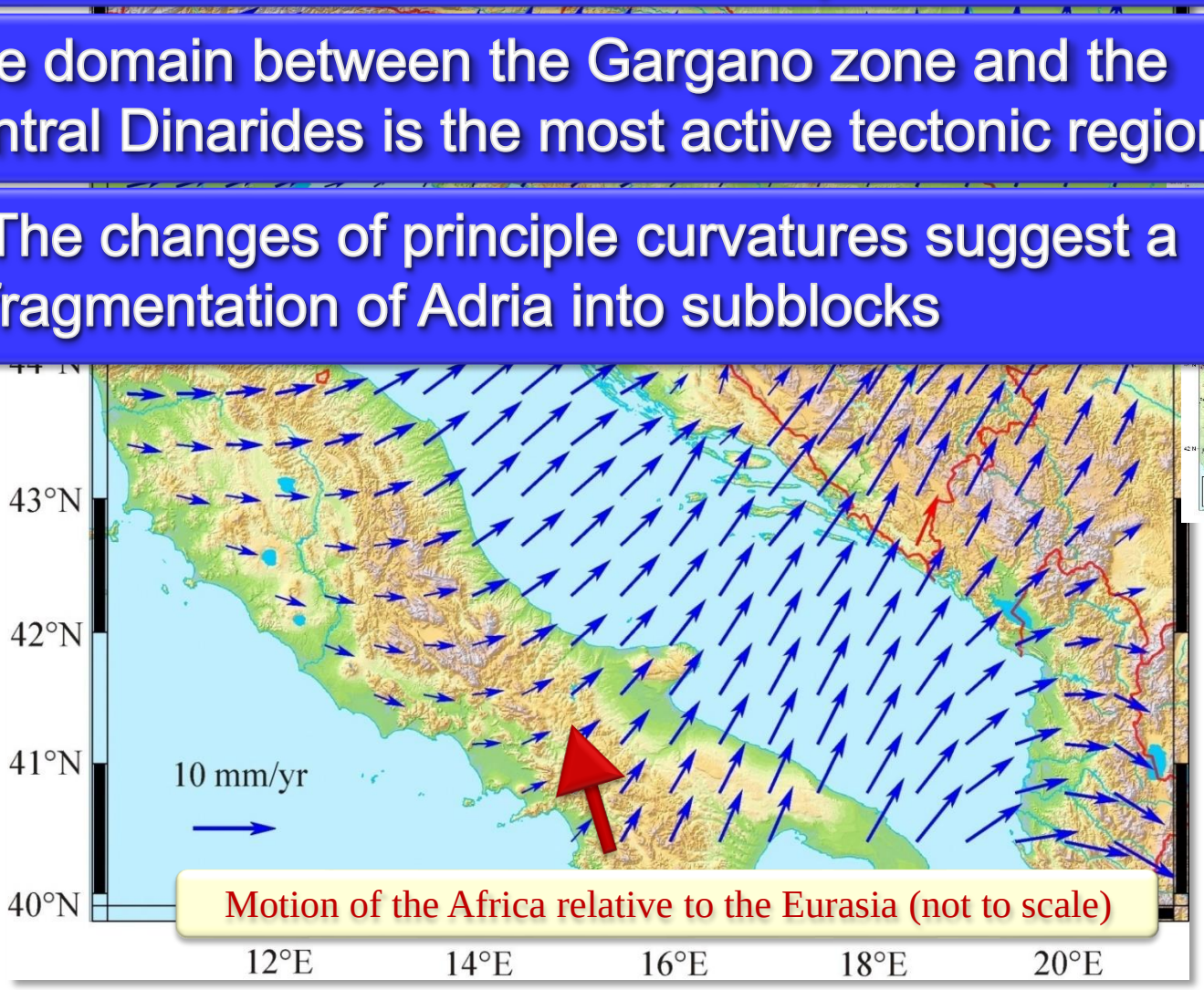


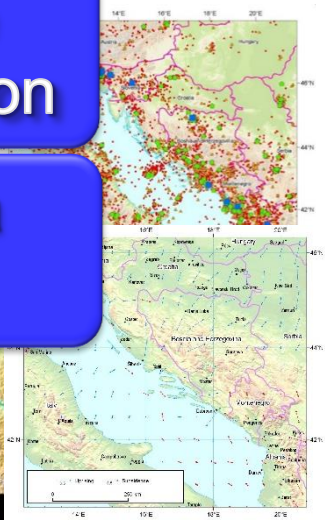
Conclusion

Adria is a distinct microplate

The domain between the Gargano zone and the central Dinarides is the most active tectonic region

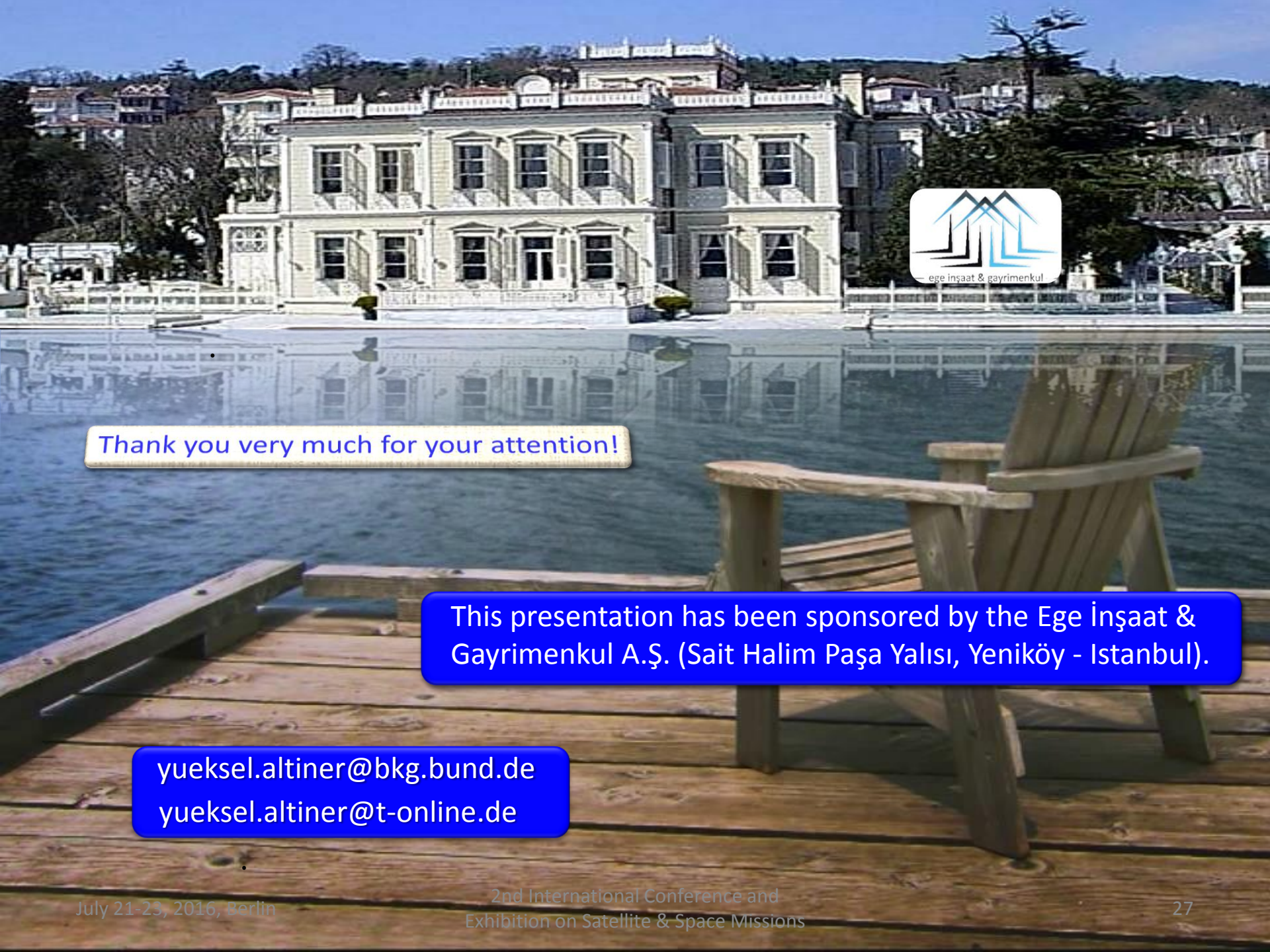
The changes of principle curvatures suggest a fragmentation of Adria into subblocks





The last sentence

Adria is not a promontory of the Africa plate now, but may have been in the past (*Jackson and McKenzie, 1988)*



Thank you very much for your attention!

This presentation has been sponsored by the Ege İnşaat & Gayrimenkul A.Ş. (Sait Halim Paşa Yalısı, Yeniköy - Istanbul).

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