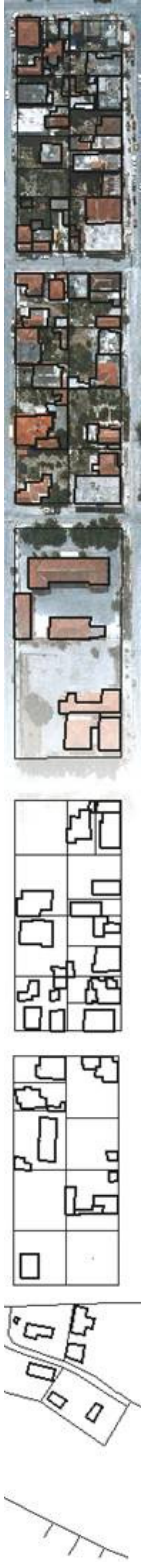

KTIMATOLOGIO S.A.

HEPOS
HEllenic POsitioning System

Tectonic deformations in Greece and the operation of HEPOS network

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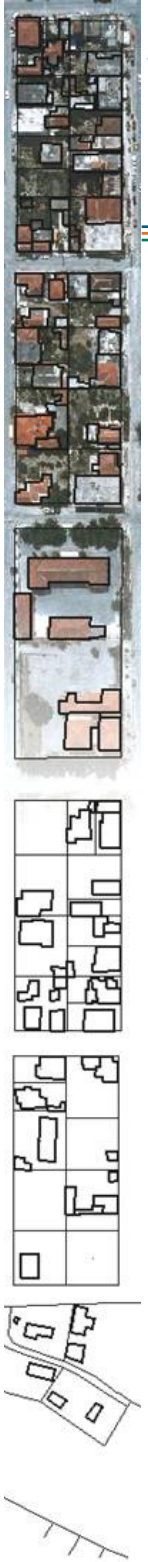
Outline

1. RTK-networks and coordinate stability
2. Tectonic activity in Greece
3. Tectonic displacements estimated using HEPOS
4. Discussion
5. Conclusions



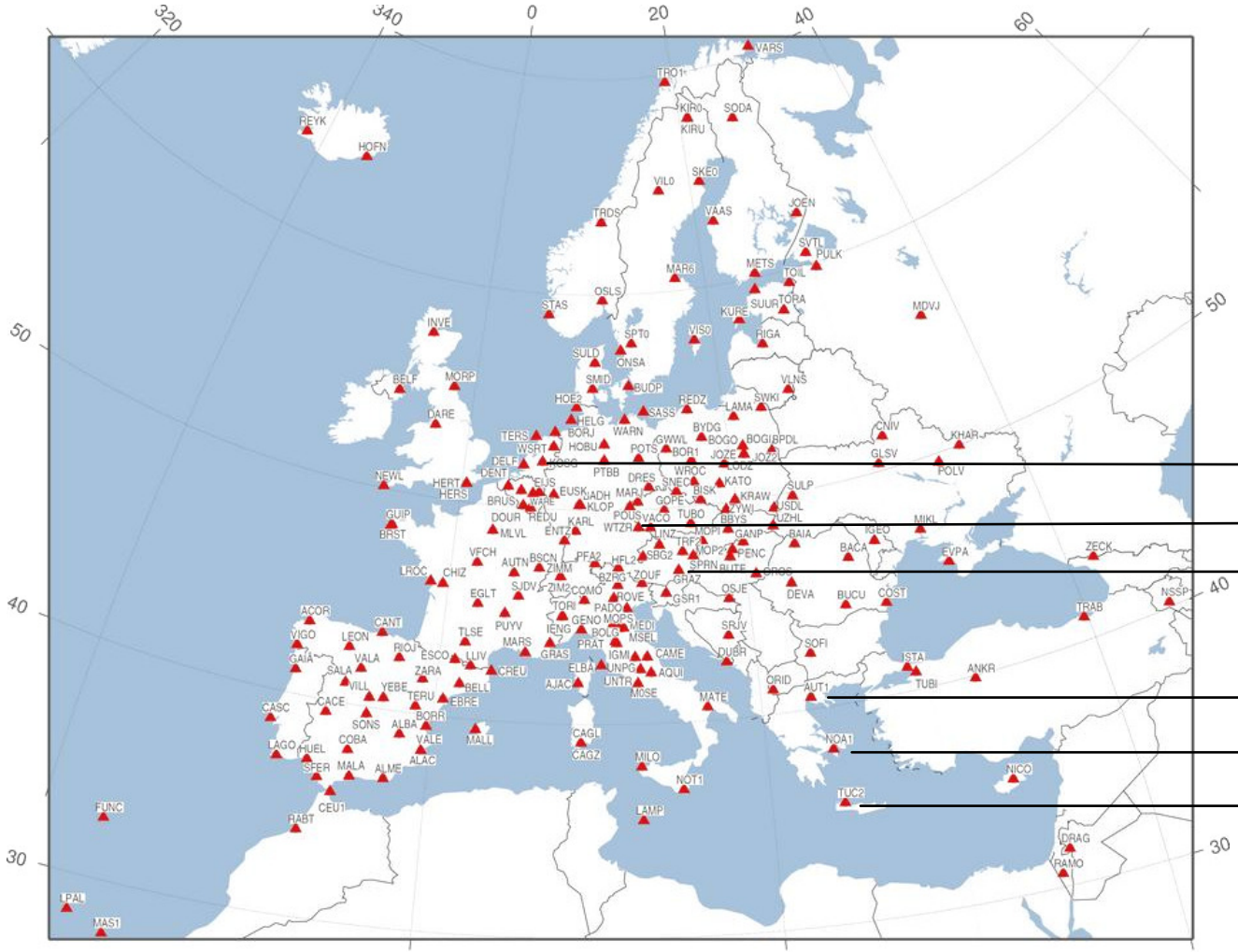
1. RTK networks and coordinate stability

- Single-base GNSS positioning is progressively being replaced by network-based techniques (VRS, FKP, MAC etc).
- These techniques model the error sources in order to eliminate the distance-dependent errors in relative GNSS geodetic positioning.
- The effective modelling of the error sources requires highly accurate coordinates of the reference stations.
- Typically, the coordinates must be consistent to the 1 cm level.
- Tectonic movements can seriously affect the consistency of the network.

2. Tectonic activity in Greece

Velocities of EPN stations in central EUROPE and in Greece

(3D velocity vectors computed in ETRF2000 using solution C1570)



2. Tectonic activity in Greece

The 17 EPN stations showing the highest 3D velocities

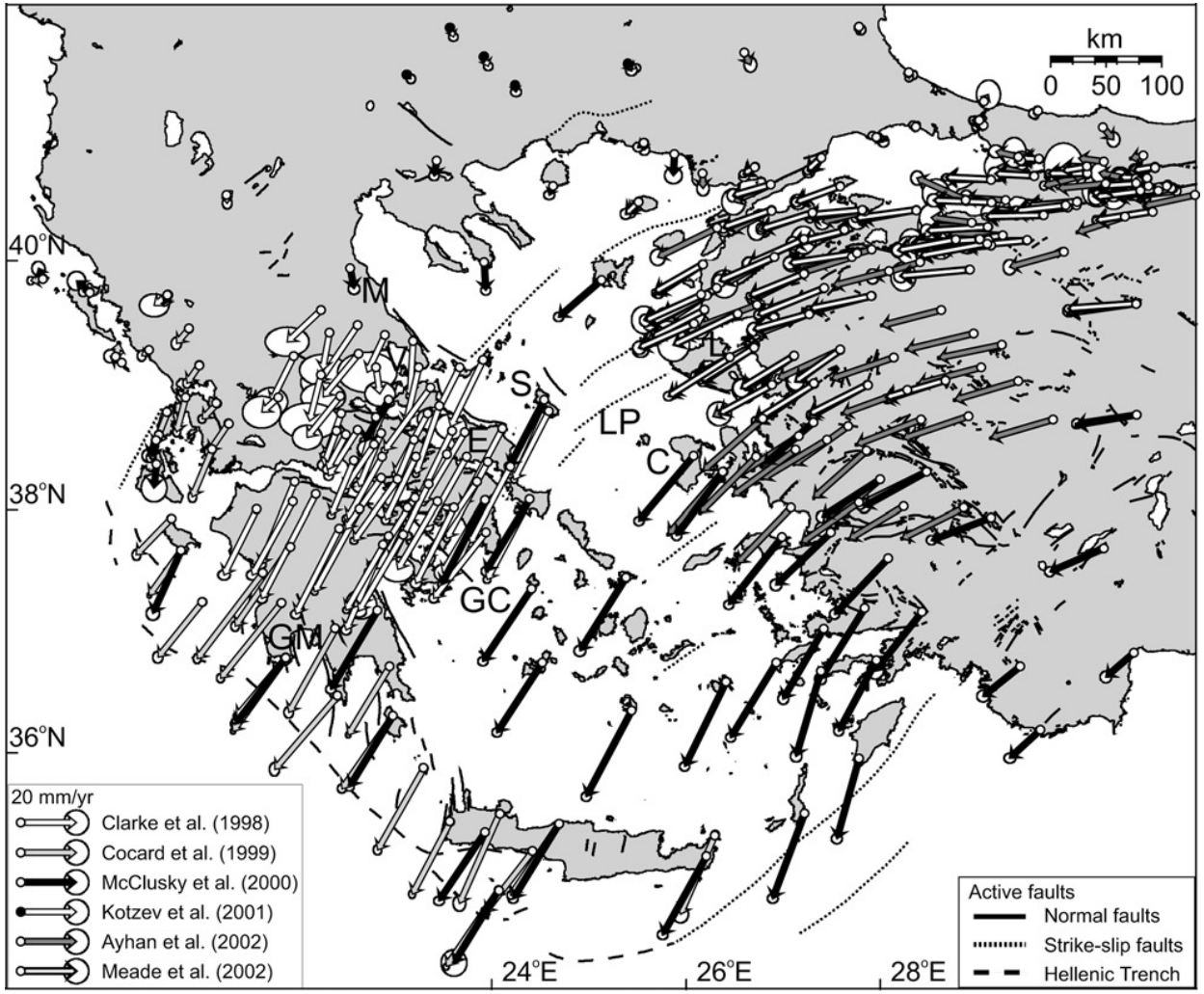
Station	Vx	Vy	Vz	V3D
RAMO	-0.0013	-0.0052	0.0069	0.0087
AUT1	0.0024	0.0021	-0.0086	0.0092
DRAG	0.0015	-0.0026	0.0092	0.0097
VAAS	0.0047	0.0016	0.0087	0.0100
VIL0	0.0040	0.0001	0.0095	0.0103
ALBA	-0.0084	-0.0017	-0.0073	0.0113
SKE0	0.0048	0.0010	0.0111	0.0121
HOFN	0.0076	0.0022	0.0114	0.0139
PDEL	-0.0114	0.0078	-0.0094	0.0167
THU3	-0.0123	-0.0102	0.0074	0.0176
KELY	-0.0140	-0.0114	0.0001	0.0181
REYK	-0.0118	-0.0155	-0.0011	0.0195
QAQ1	-0.0153	-0.0142	0.0009	0.0209
TUBI	0.0047	0.0190	-0.0089	0.0215
ANKR	0.0120	-0.0216	-0.0018	0.0248
NOA1	0.0196	-0.0096	-0.0212	0.0304
TUC2	0.0197	-0.0095	-0.0224	0.0313

NOA1 & TUC2:

- **show the highest 3D velocities among the EPN stations**
- **are the only EPN stations with 3D velocities exceeding 3cm/y**

AUT1 is significantly more stable.

2. Tectonic activity in Greece



Velocity field resulting from various GPS campaigns for geodynamic research

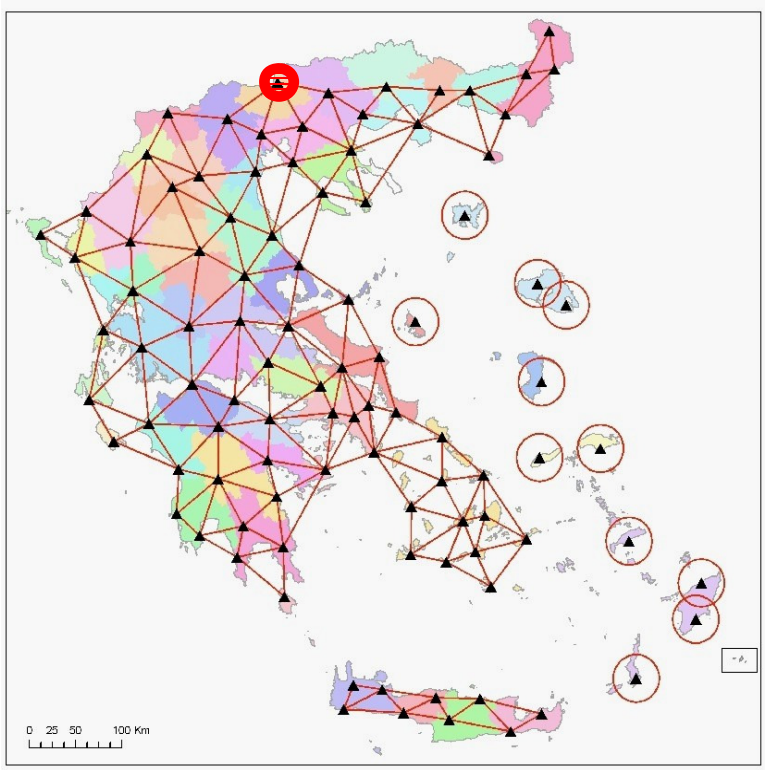
Source: Nyst & Thatser, 2004: "New constraints on the active tectonic deformation of the Aegean"

3. Tectonic displacements estimated by HEPOS

- The Reference stations of HEPOS are in operation since the end of 2007.
- All stations are equipped with TRIMBLE NetRS receivers and TRIMBLE Zephyr geodetic antennas with spherical domes.
- For this study data from the first two years of operation were processed to estimate tectonic deformations.
- One solution per month was computed using 48 hours of data collected at all stations.

3. Tectonic displacements estimated by HEPOS

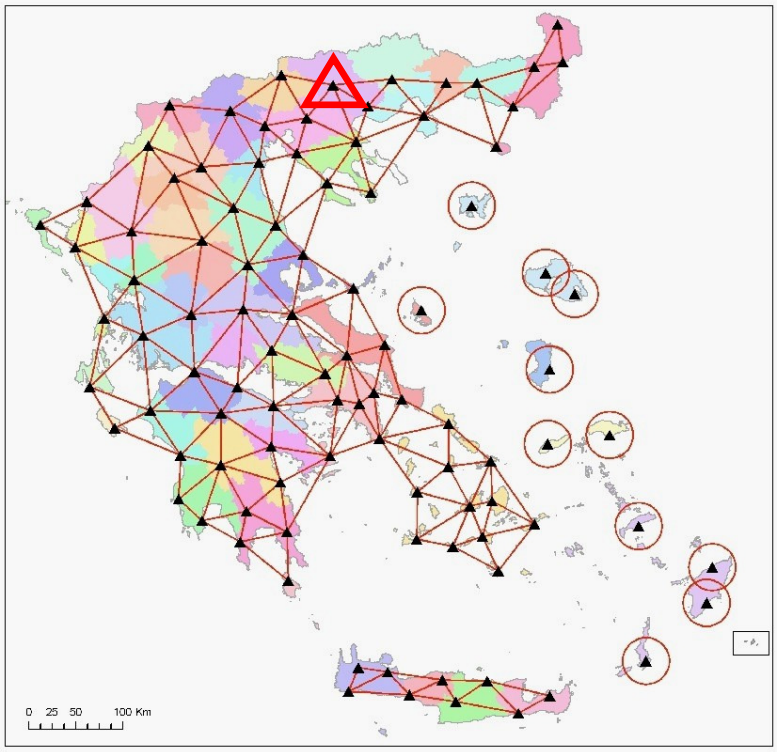
- As a first step, the data are analyzed in ITRF2005.
- Displacements are computed with respect to station 041A.

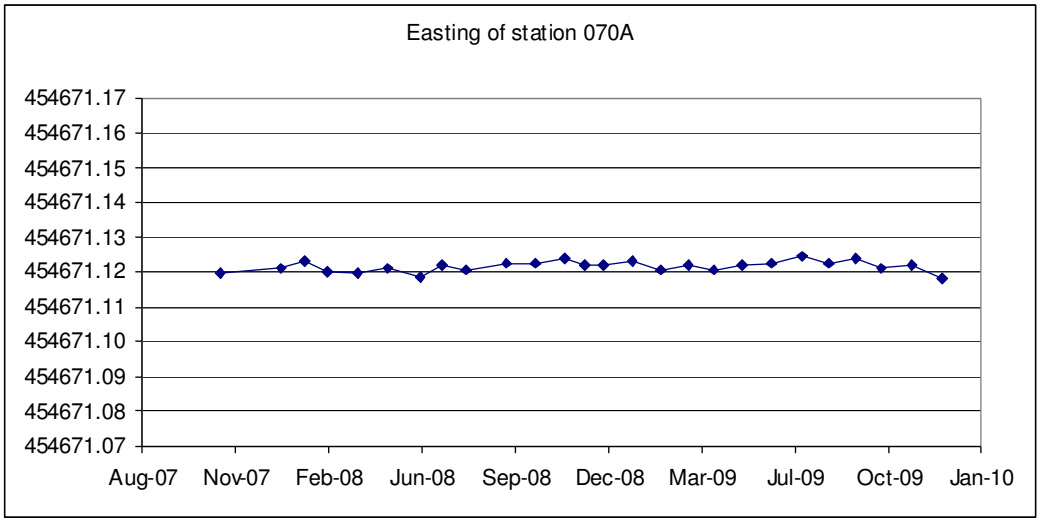


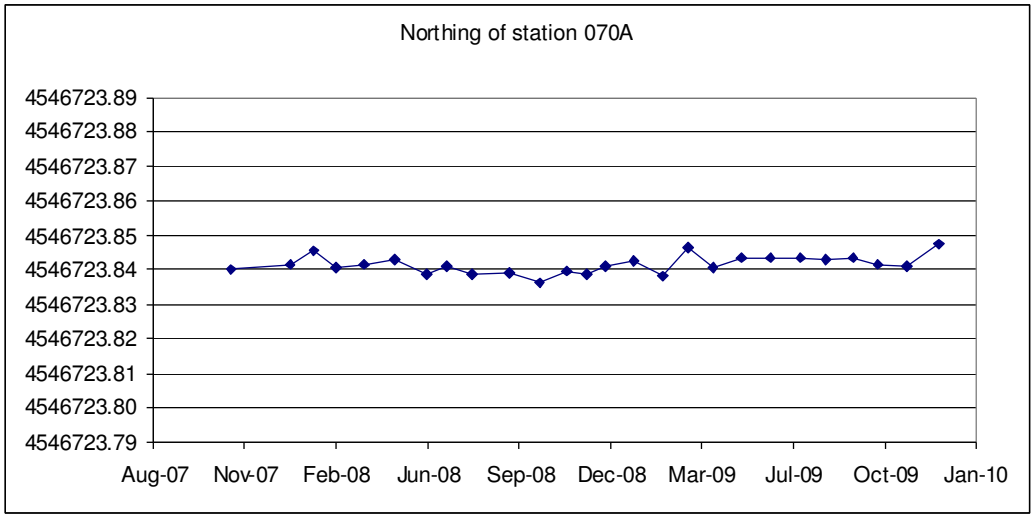
3. Tectonic displacements estimated by HEPOS

Analyzing the dynamic characteristics of the stations

Example of "zero" trend:
Station 070A



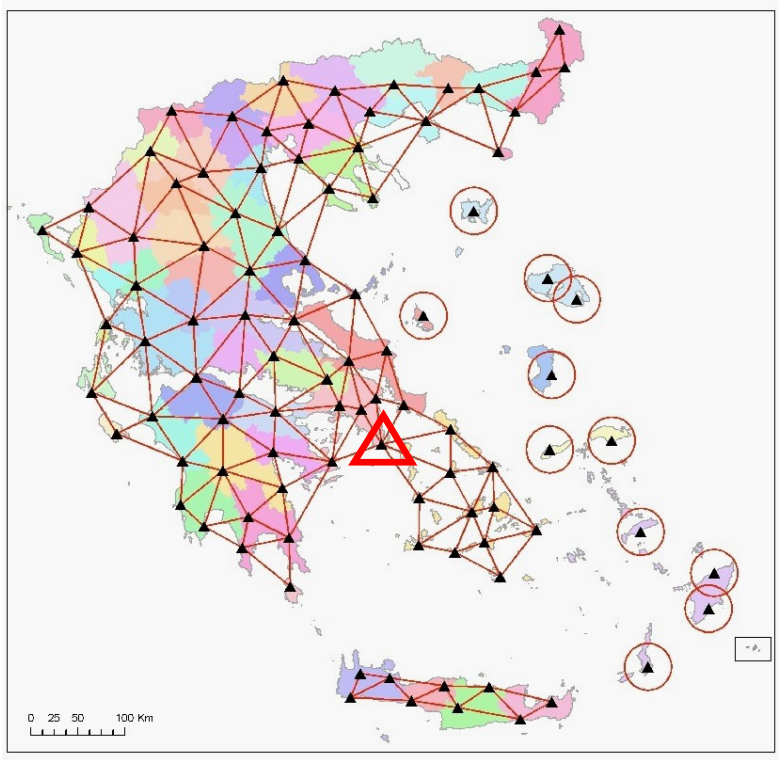


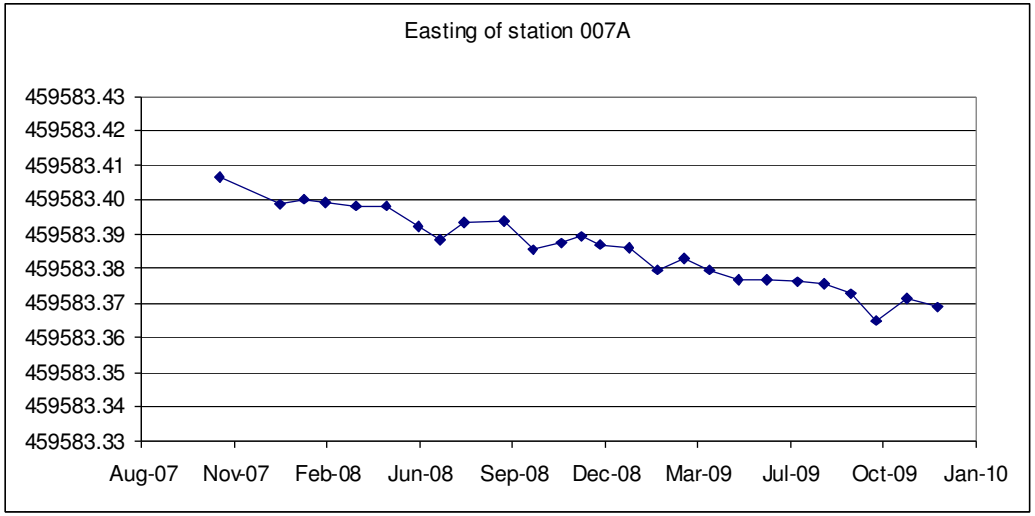


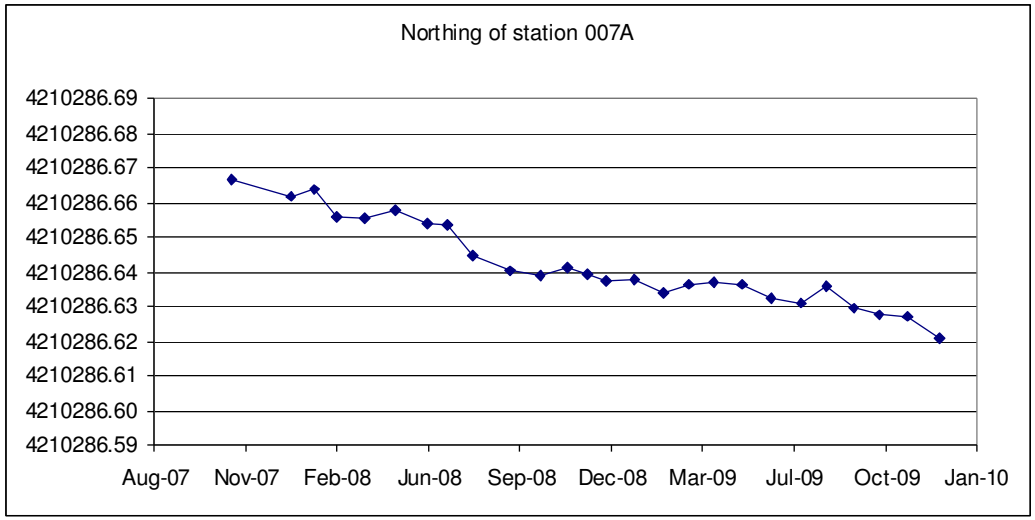
3. Tectonic displacements estimated by HEPOS

Analyzing the dynamic characteristics of the stations

Example of constant trend:
Station 007A



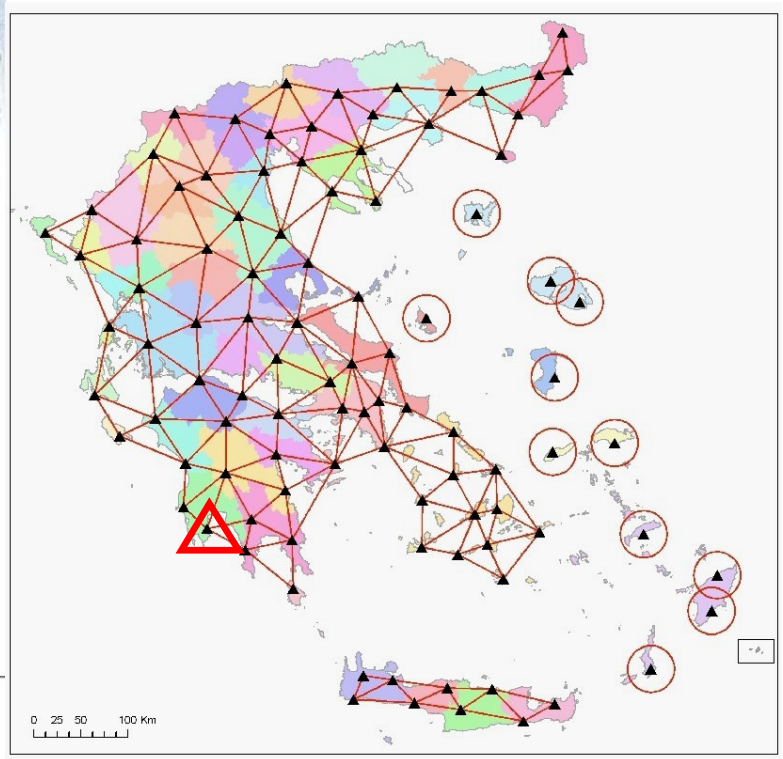


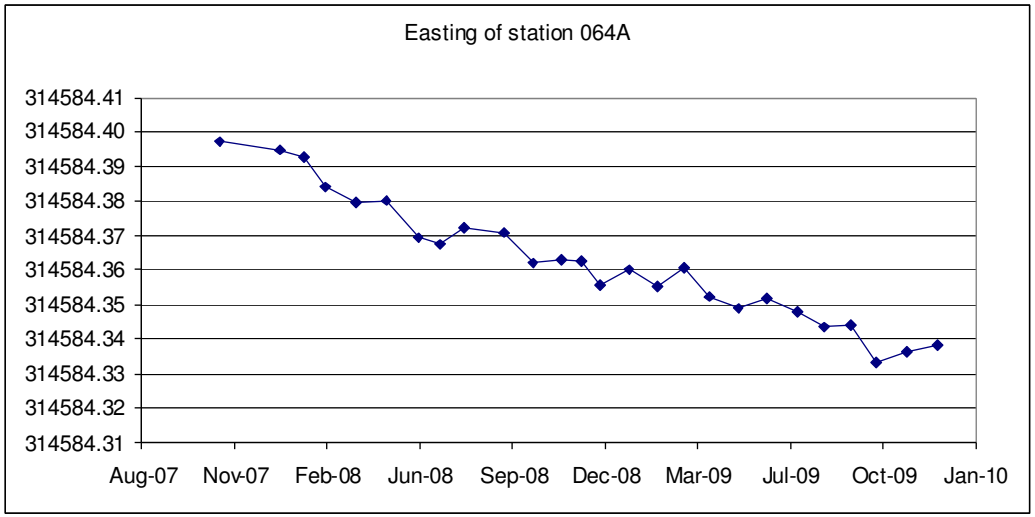


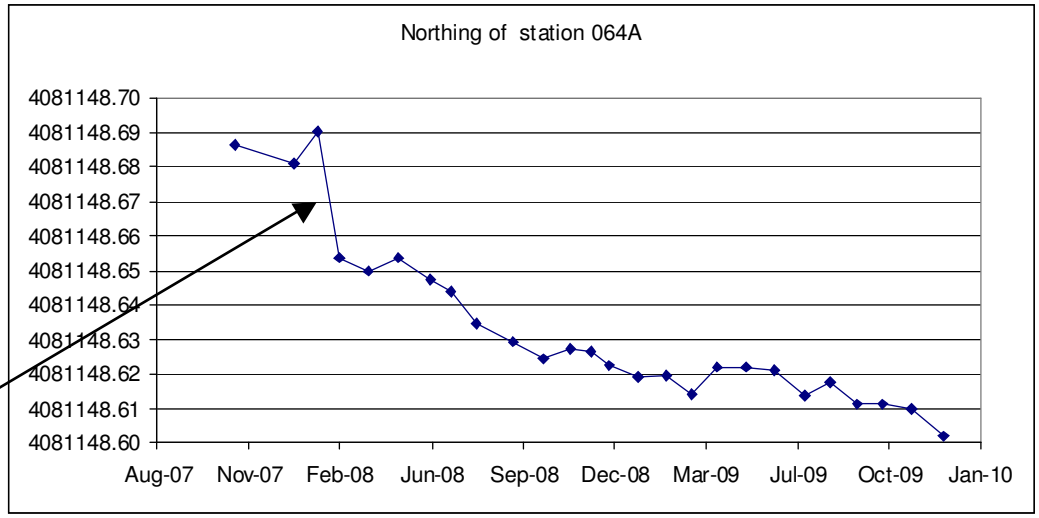
3. Tectonic displacements estimated by HEPOS

Analyzing the dynamic characteristics of the stations

Example of constant trend plus abrupt variation:
Station 064A

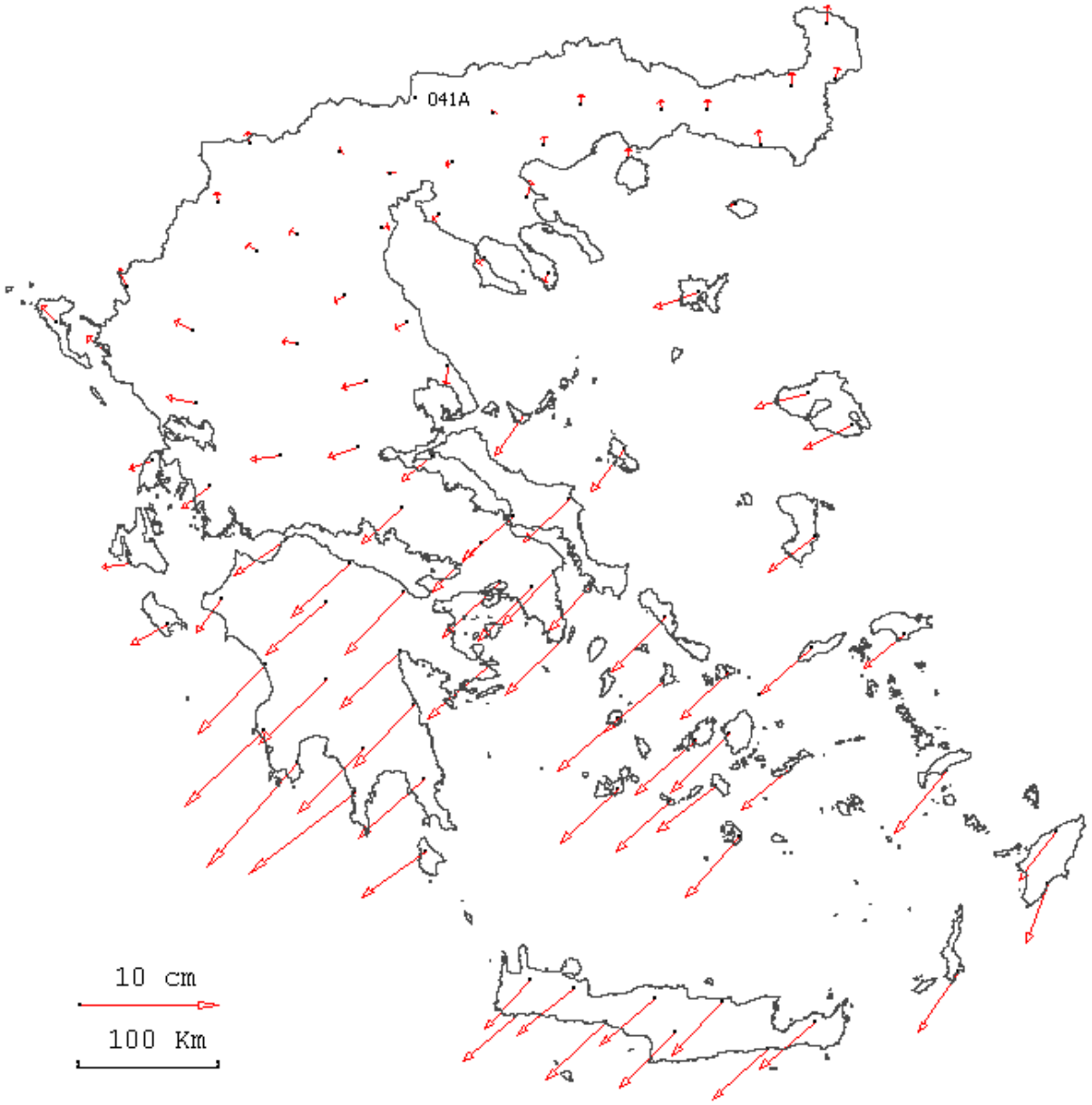




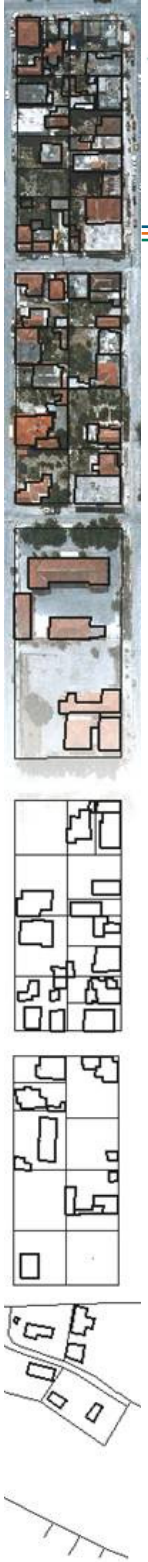


Variation caused by an earthquake

3. Tectonic displacements estimated by HEPOS

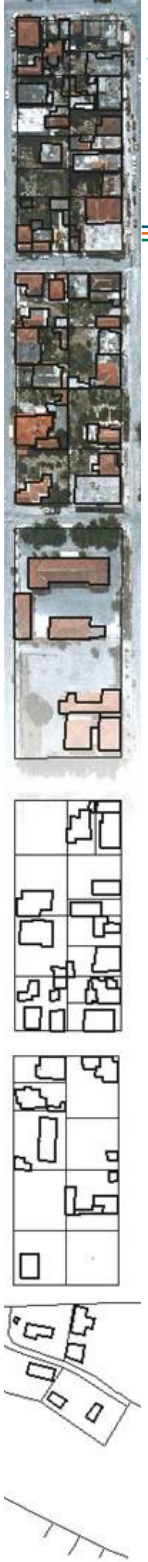


Displacements (in ITRF2005) of the HEPOS stations with respect to station 041A occurred from 11/2007 to 11/2009
(preliminary results)



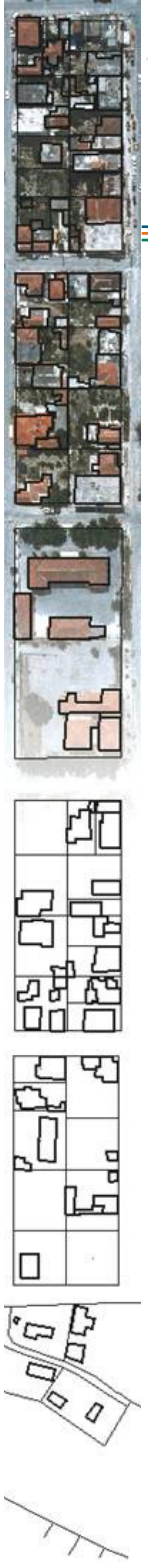
4. Discussion

- The velocity field in Greece is inhomogeneous.
- This fact has to be considered in the operation of HEPOS.
- From a strictly scientific point of view, the solution would be the regular update (e.g. every 1-2 years) of the HEPOS stations coordinates.
- This approach would lead to a dynamic or semi-dynamic geodetic datum.



4. Discussion

- **From a practical point of view, the use of a dynamic or semi-dynamic geodetic datum is inconvenient because:**
  - A complex velocity model is needed.
  - This model should be implemented in geodetic receivers and office software, which requires the intervention of GNNS vendors and the distribution of the model to ALL users.
  - No experience exists in Europe. Little international experience exists (e.g. New-Zeeland), imposing very carefully planned strategies.
  - Of many other reasons.
- **Several scenaria are being examined, keeping in mind that ETRS89 was introduced to ensure coordinate stability.**
- **Collaboration with the EUREF-TWG.**



5. Conclusions

- **HEPOS can be used for reliable estimation of tectonic movements.**
- **The results obtained by HEPOS confirm results from geodynamic studied based on GPS campaigns and geological models.**
- **The density and homogeneity of the HEPOS network allows the estimation of a very precise and detailed deformation field for the complete country.**

Acknowledgments

The HEPOS project is part of the Operational Program "Information Society" and is co-funded by the European Regional Development Fund.