



# Report from **EUREF w.g. on Deformation models**

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# Outline for this presentation

- Some background for this working group
- What do we understand as a “model”
- Proposed activities
- Done so far..
- Update of roadmap for further work!
- Summary

## Background .

- The w.g. on Deformation models was established in 2012
- It has a long term goal to establish a velocity model of the crustal deformations present in the EUREF area of interest
- I.e. both intra-plate and inter-plate velocities are of interest
- Tectonic events (earth quakes) are considered complicated and are therefore not yet of 1<sup>st</sup> priority

# The dual purposes of this working group

The purposes of this working group are twofold:

- There are pure scientific interests in improving the knowledge of surface deformations in Eurasia and adjacent areas

*and*

- Knowledge of the crustal deformations are of importance for maintenance and use of e.g. national realizations of the ETRS89, which motivates this w.g within EUREF.

# **Models of crustal deformations**

## **- so what is a model?**

a model:

provides explanations to observations, and allows for predictions also where observations are not available

in geodesy the model should also include estimated uncertainty of the model


# Proposed activities

1. Evaluation of GNSS station velocities (*to find out to what extent observed velocity at a station represent the crustal deformation in the area*)
2. Work towards models of crustal deformations in Europe
3. Consideration of a deformation model in maintenance and use of national realizations of ETRS89
  - As a first step, an inventory and analysis of published work on crustal deformations has been done -some 60 papers (*Steffen et al, EUREF symposium in Budapest 2013*)
  - and a mini-workshop in Marsh in connection to the TWG meeting in Gävle

# Example Western Alps: Alpine Uplift determined from levelling

## Alpine Uplift model RCM12

(E. Brockmann, D. Ineichen, U. Marti, S. Schaer, A. Schlatter)

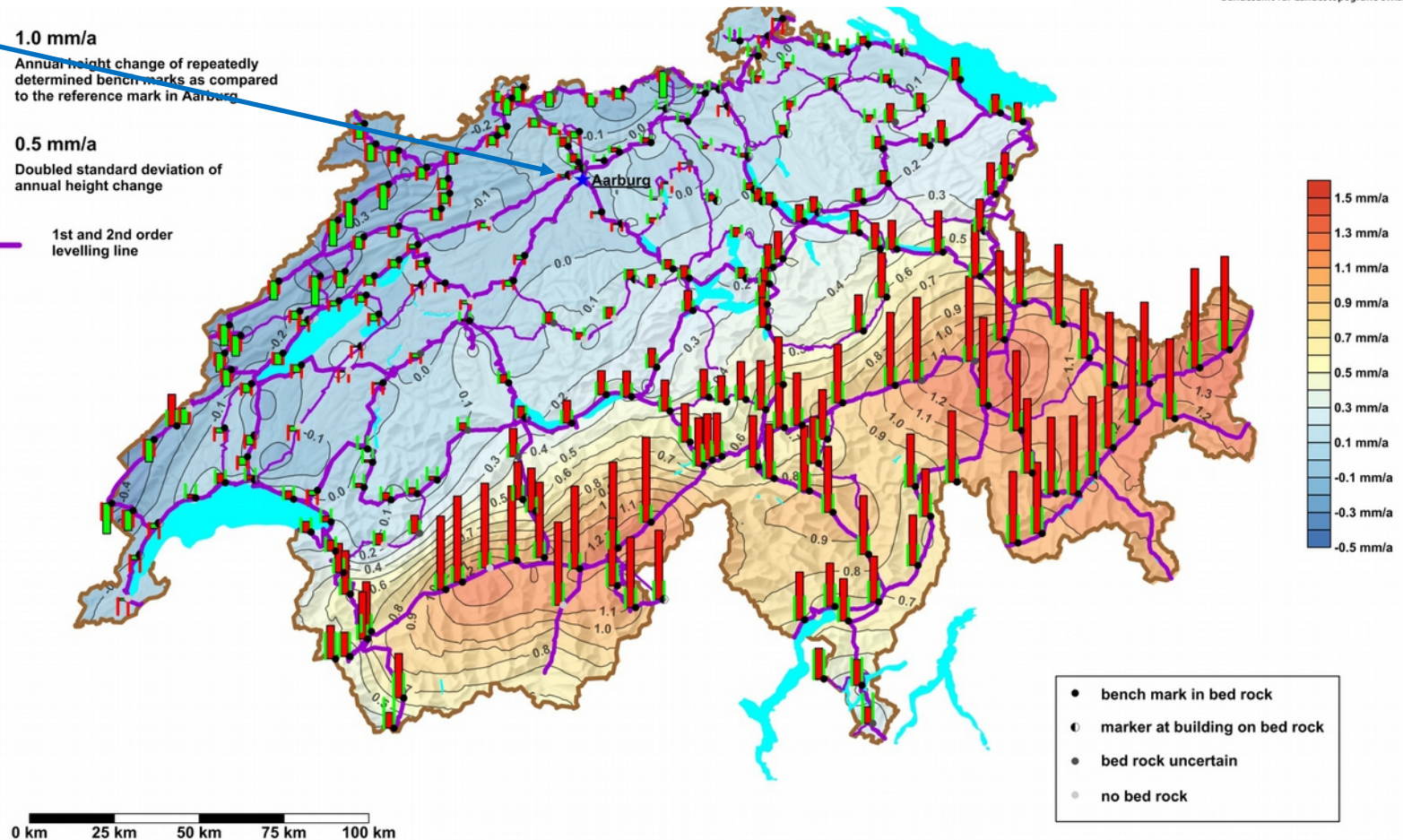
 Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Bundesamt für Landestopographie swisstopo

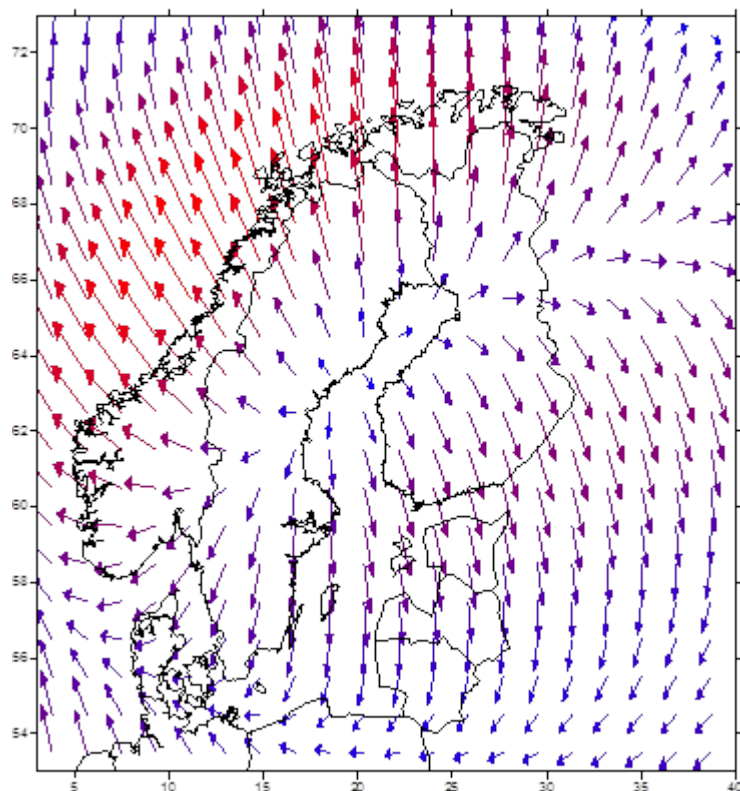
Defined with  
zero vertical  
motion

- 1.0 mm/a  
Annual height change of repeatedly  
determined bench marks as compared  
to the reference mark in Aarburg
- 0.5 mm/a  
Doubled standard deviation of  
annual height change
- 1st and 2nd order  
levelling line

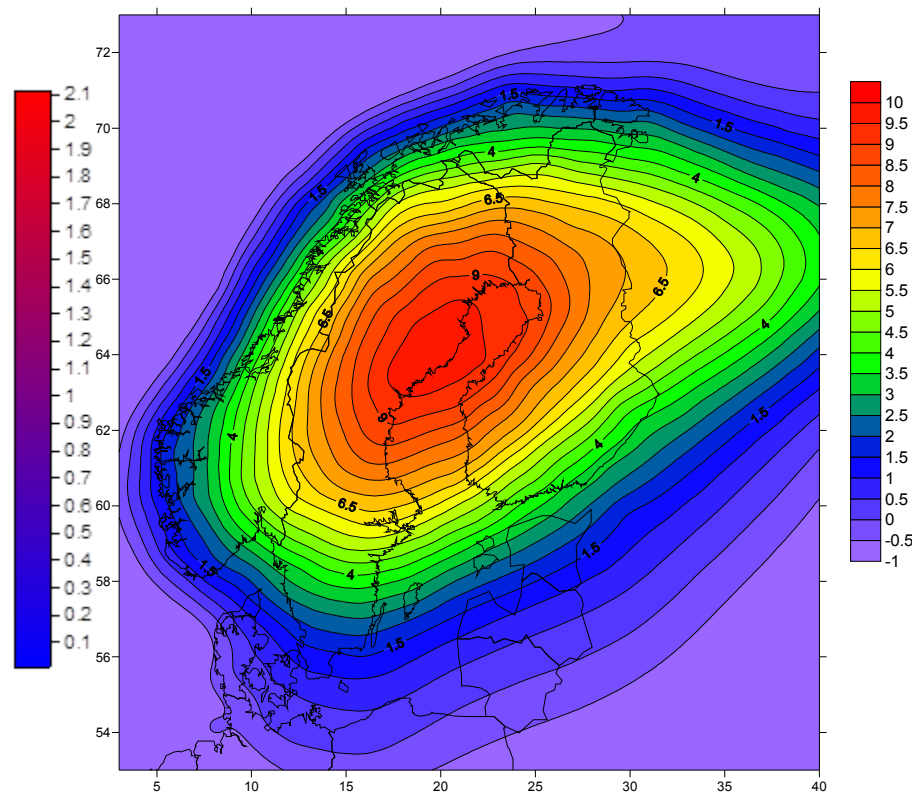
Levelling:  
Alps are rising  
1.5 mm/yr



# Example from Fennoscandia/Baltic area: The deformation model NKG\_RF03vel (*NKG2005LU*)



Horizontal:  
Milne 2001 transformed to Lidberg  
2004

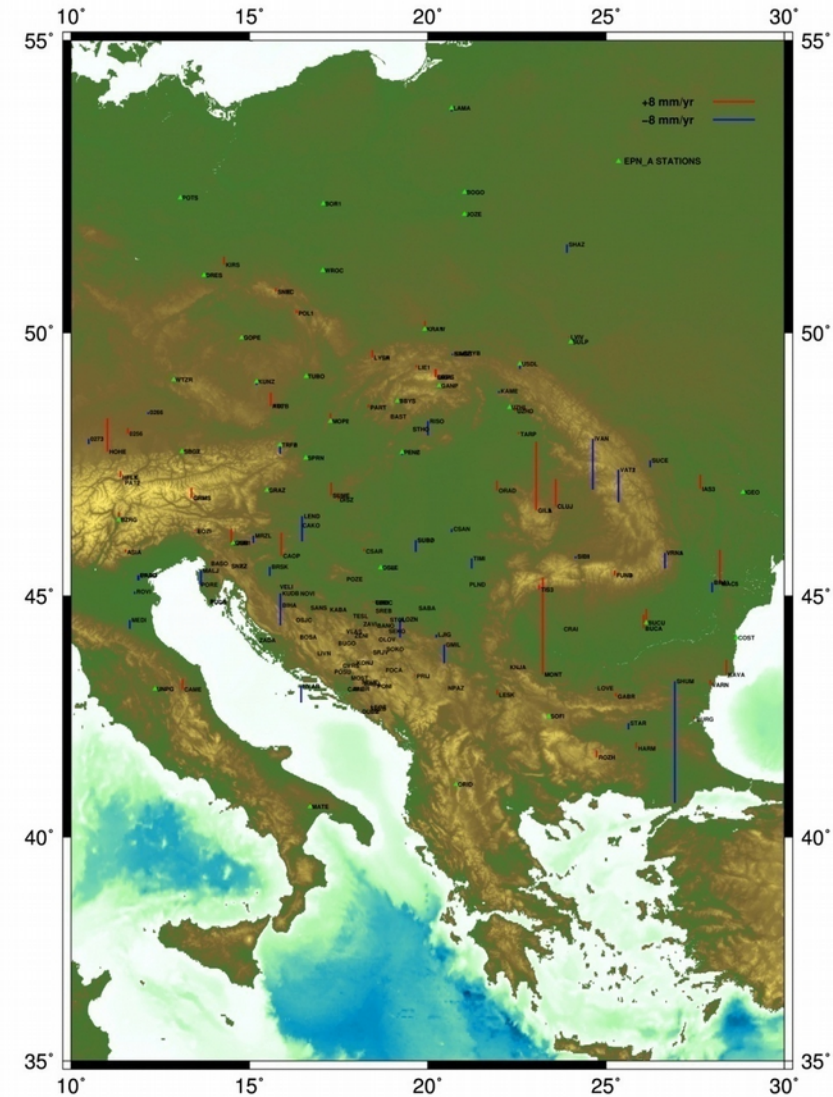
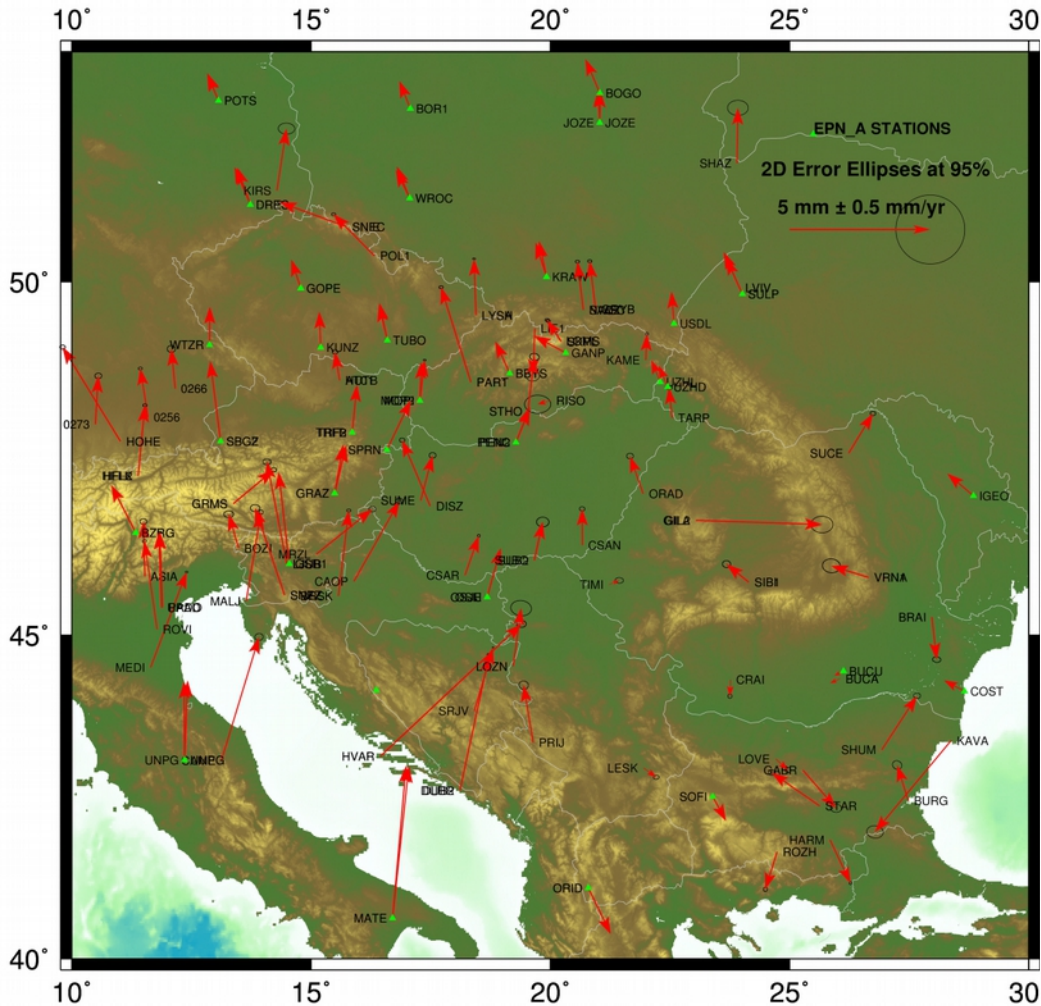


Vertical:  
NKG2005LU(ABS)  
Ågren&Svensson 2006



# Example CEGRN repro2 (A. Caporali et al 2014)

## Velocity Map ETRF2000

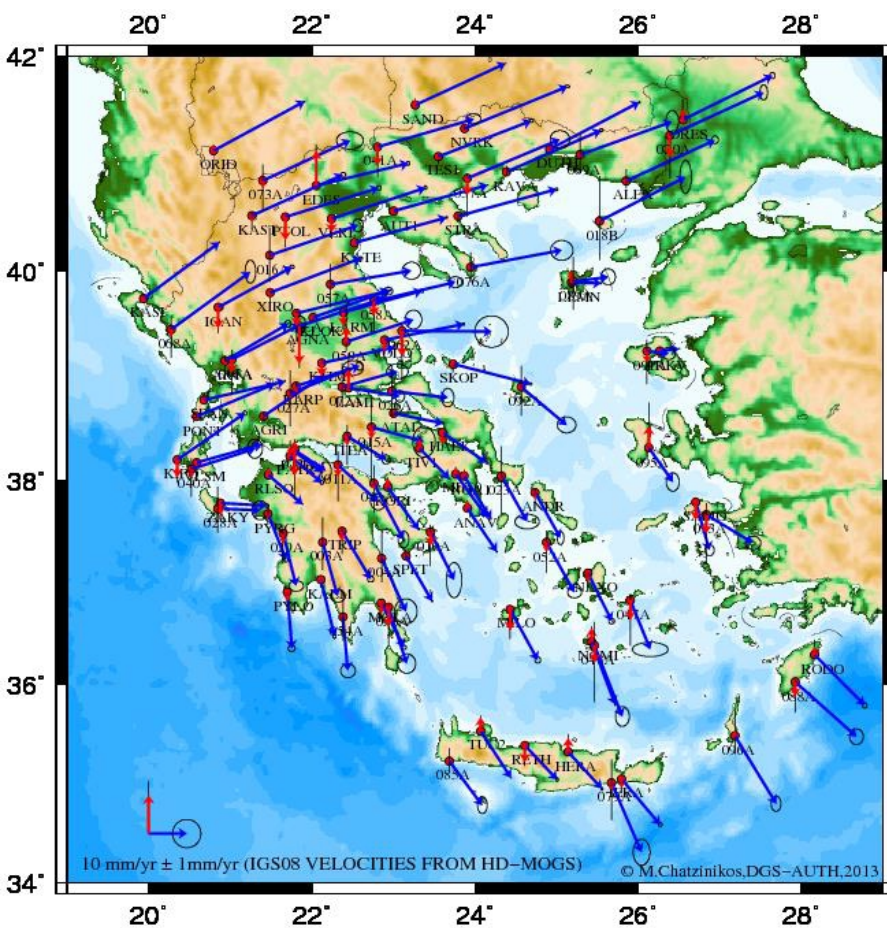




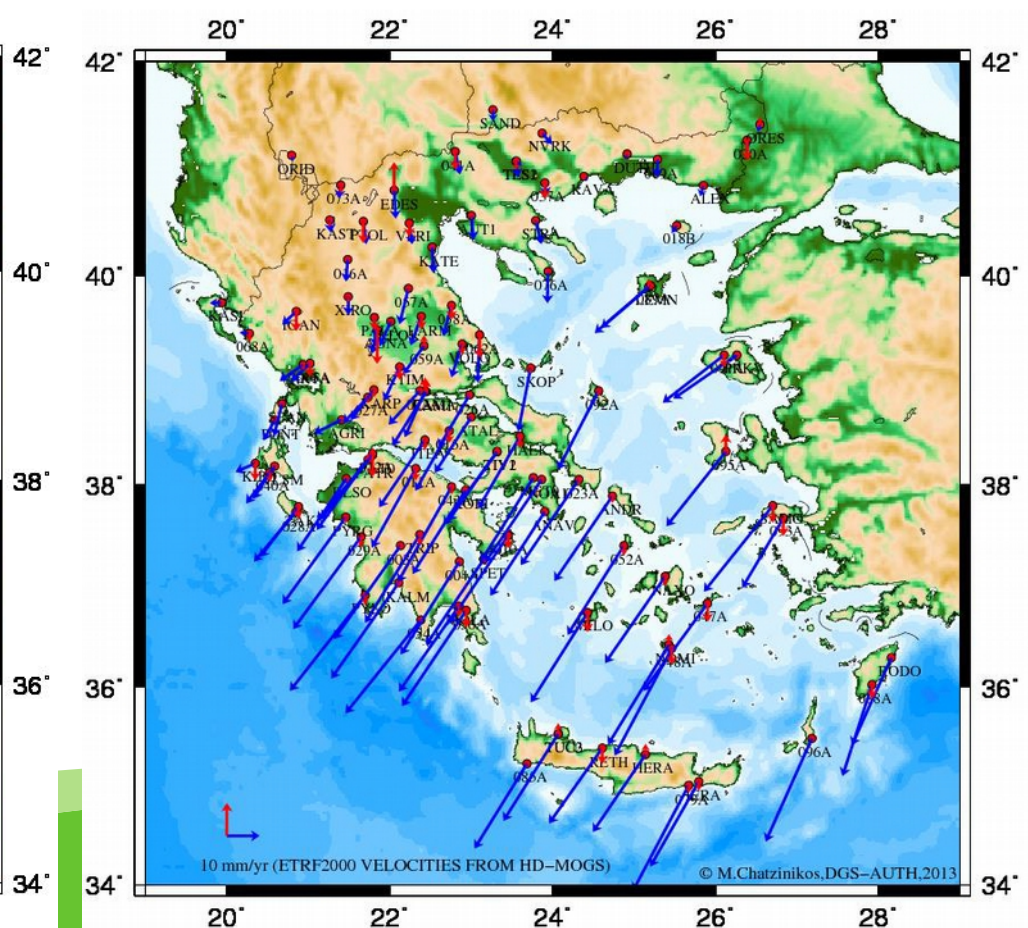
(M. Chatzinikos, A. Fotiou, C. Pikridas and D. Rossikopoulos,  
EUREF Symposium Budapest 2013)

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EUREF Symposium Budapest 2013)

## IGS08 site velocities

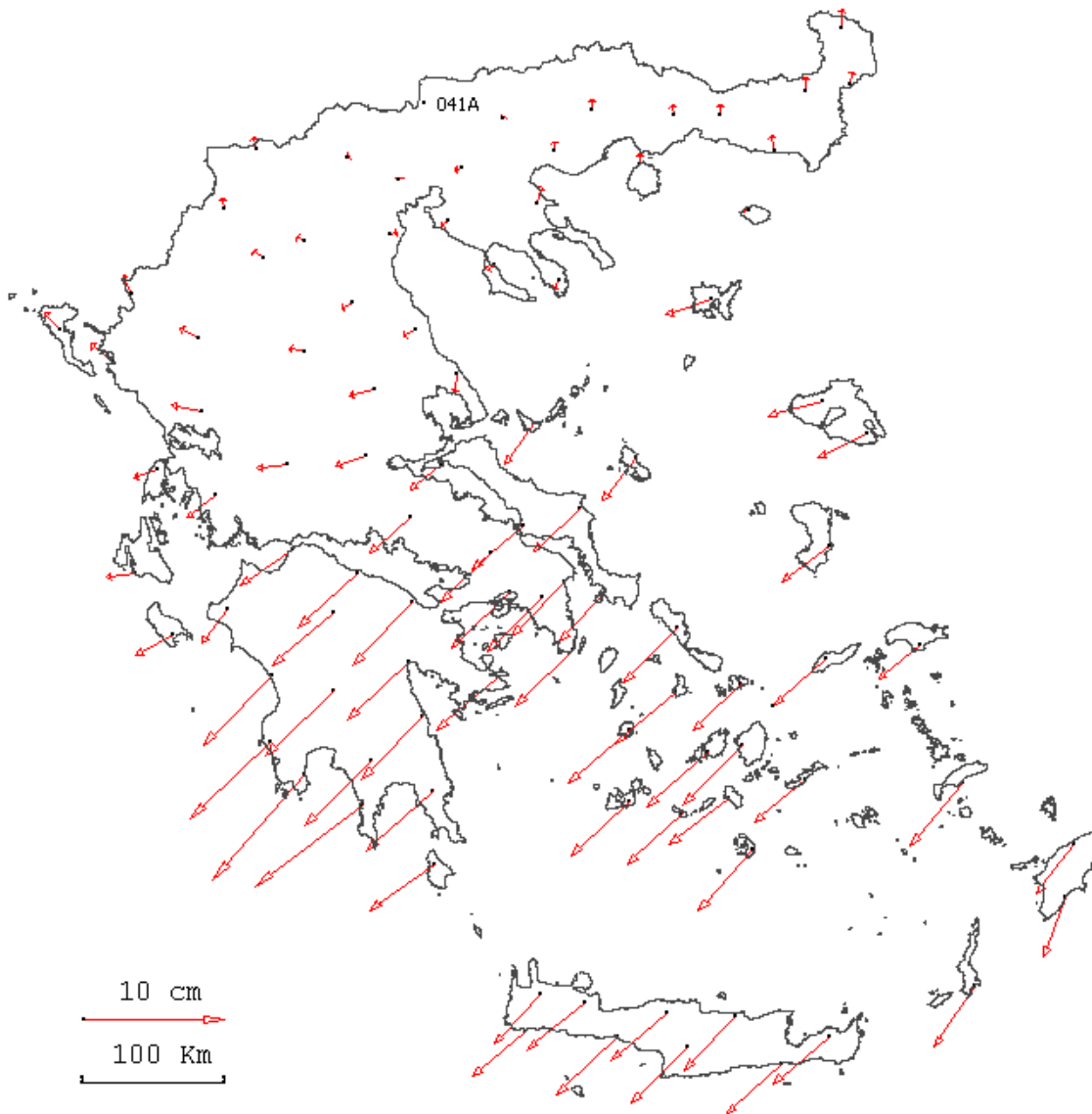


## Velocities in ETRF2000



## Example from Greece (2)

*(M. Gianniou, E. Mitropoulou, I. Stavropoulou, EUREF Symposium Budapest 2013)*



**Differential  
displacements of the  
HEPOS stations over  
two years(w.r.t. station  
041A, 11/2007 -11/2009)**  
*(Gianniou, 2010)*

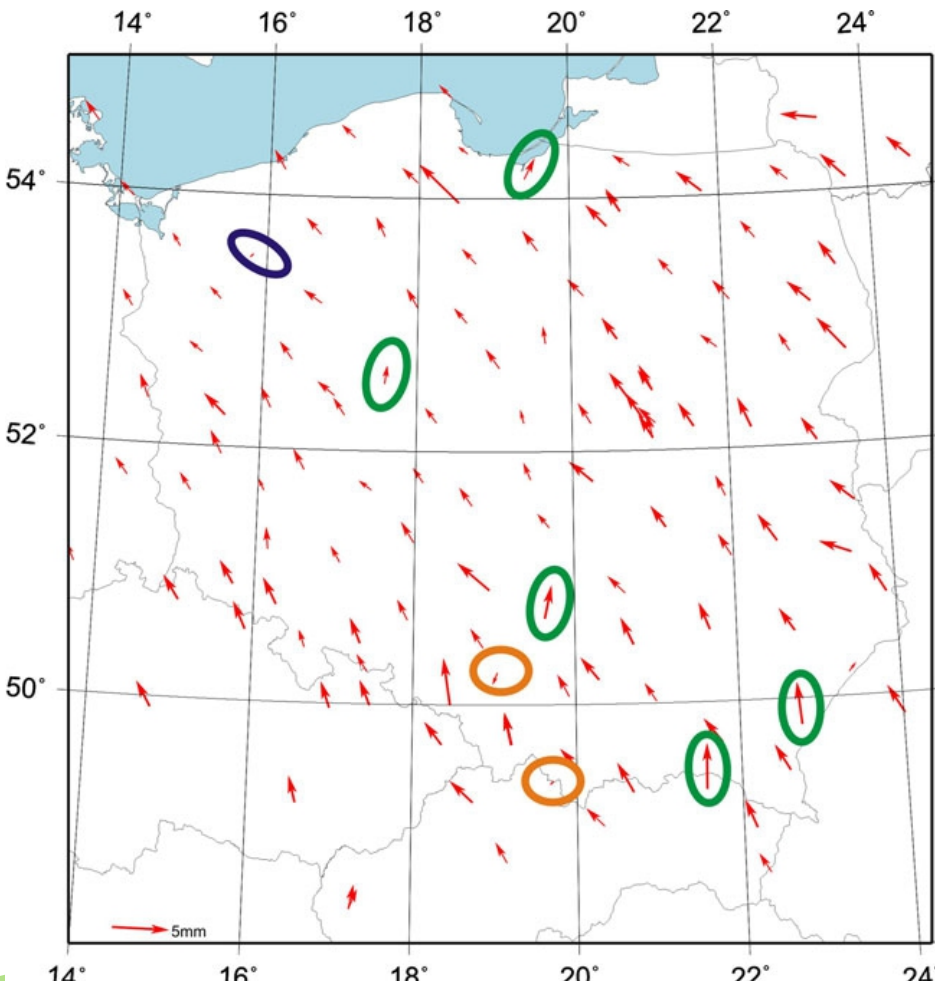
*Implementation of 2 plate  
rotation models for use in  
RTK-services!*



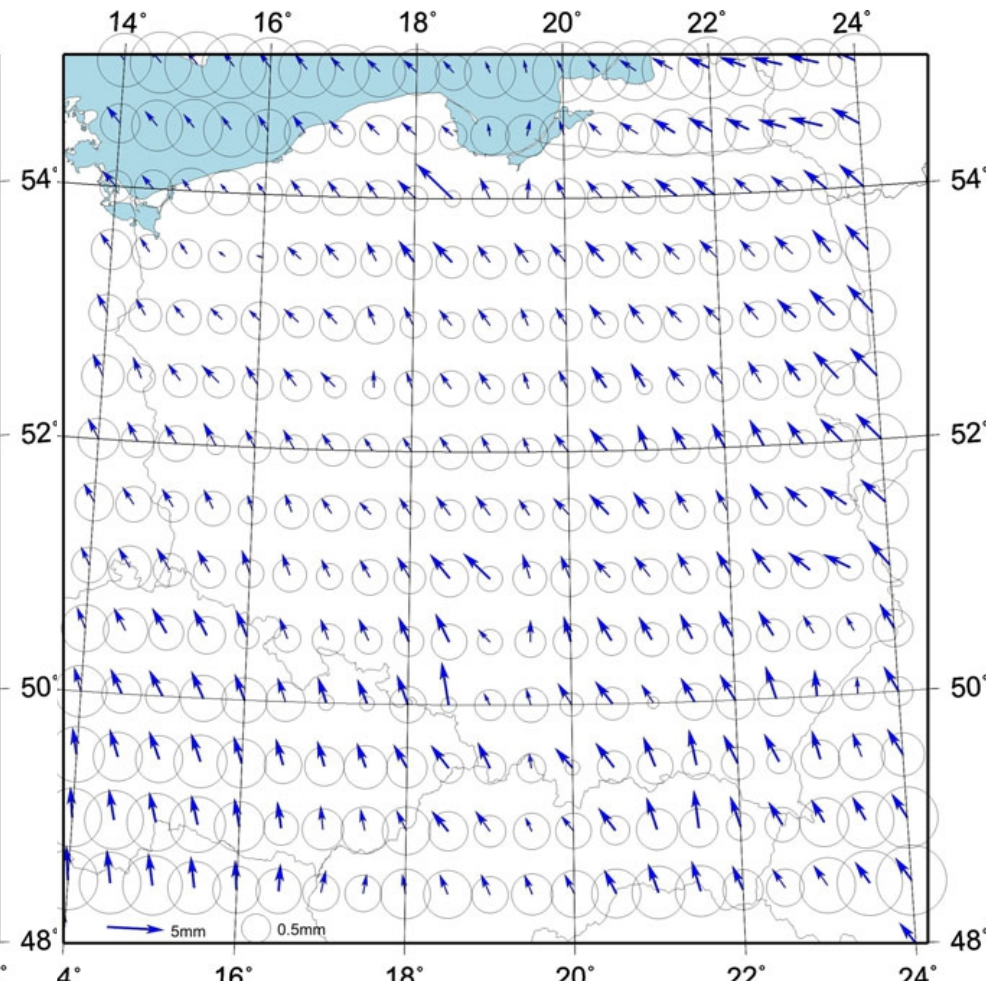
# Example from Poland on interpolation methods

(J Bogusz, A Kios, P Grzempowski, and B Kontny, Pure an Applied Geophysics, 2013)

Intraplate velocities of the ASG-EUPOS stations



Kriging with the linear variogram model, the interpolated values and the interpolation errors



## Other areas of interest

Specific areas of interest in this w.g.

- Mediterranean area
- Fennoscandia
- Iceland - Greenland

Example of missing area so far are Iberia

...to be completed...

# Proposal for update of roadmap 1(2)

- The “Integration of dense velocity field into the ITRF” activity will deliver by the end of the year (2014)
  - Then “evaluation of station velocities” should be done ([how well do the computed GNSS velocity represent the crustal deformation in the area](#))
- EPN-Repro2 have started some activities and will deliver improved station velocities of the EPN stations, possibly in 2015?
  - But many activities in the updated roadmap do not need to be dependent on EPN-Repro2
- Continue with the inventory of work regarding crustal deformations in the EUREF area of interest

## Proposal for update of roadmap 2(2)

- Models are developed and used (e.g. Fennoscandia, Switzerland, Greece).
  - Would be of value to collect these models, and see how they could be used in the development of a European model of crustal deformations
  - May require some study on how to handle possible differences in reference frame between the models and EVRF2000
- Methods for interpolation and gridding would be needed probably. The Kriging/Collocation method seems promising
- Consideration of a deformation model in maintenance and use of national realizations of ETRS89
- Open on how to document the work?