# The new CEGRN GPS campaign 2009 and CEGRN's Central European Research Activities

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and the CERGOP-2 Team

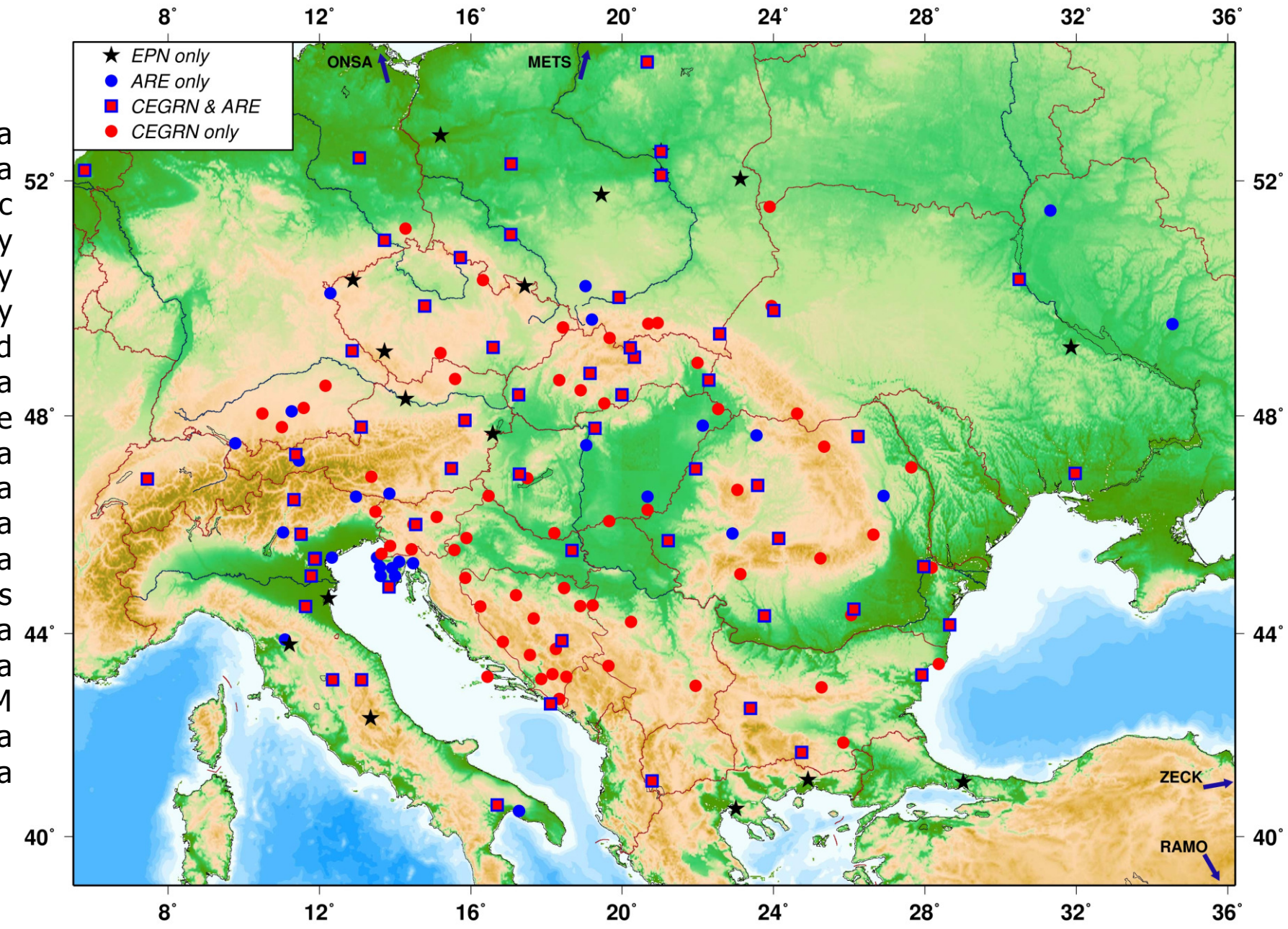

EUG 2010 Session G13

# Outline

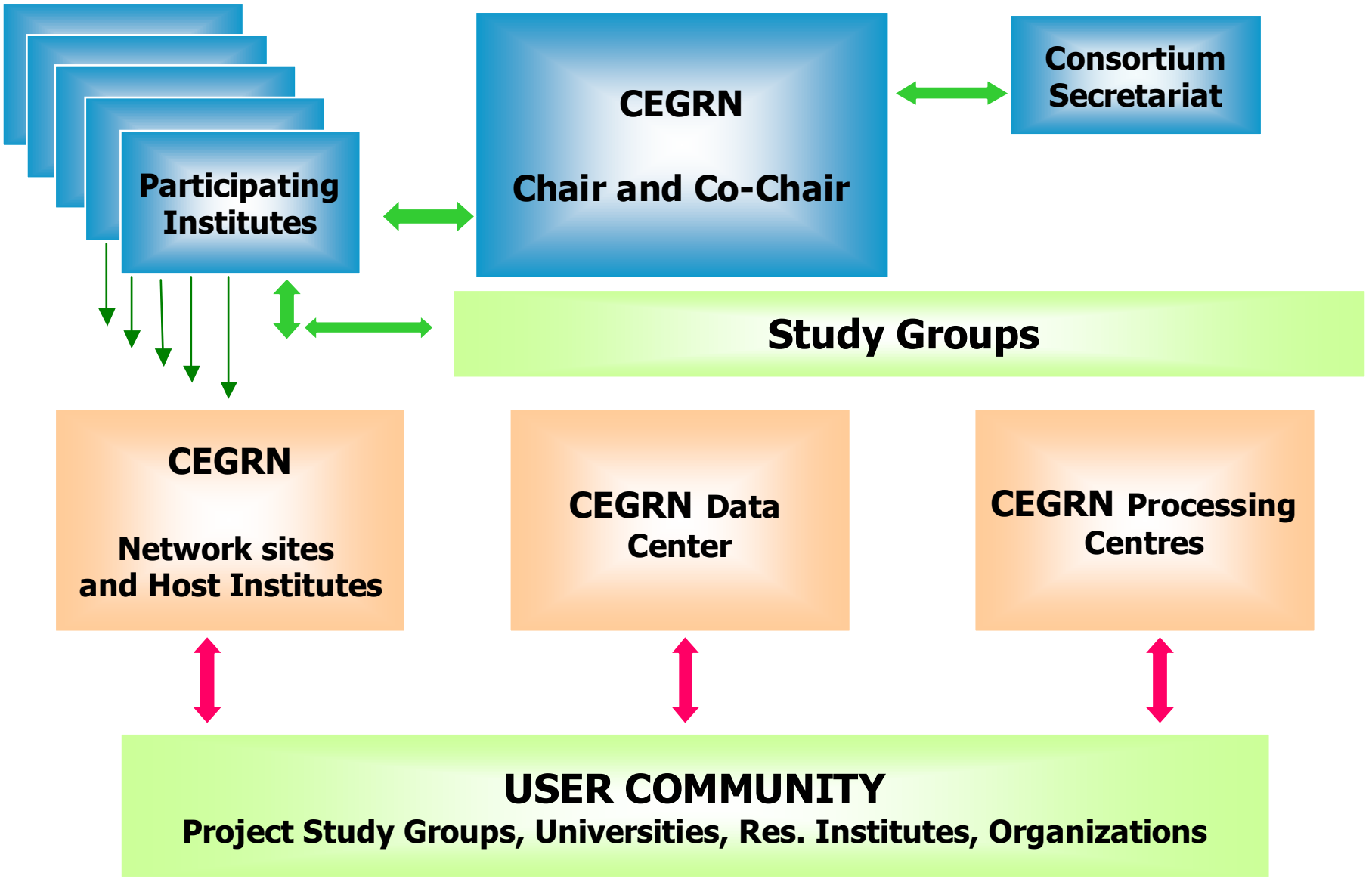
- Introduction
- Tectonic setting
- CEGRN Campaigns
- Data Base + Analysis
  - Velocity estimation
  - Geokinematical modeling and strain analysis
- Next Plans
- Conclusions

# CEGRN – International: CEI (Central European Initiative)

Austria
Croatia
Czech Republic
Germany
Hungary
Italy
Poland
Slovakia
Ukraine
Bulgaria
Romania
Slovenia
Albania
Belarus
Bosnia
Herzegovina
FYROM
Moldova
Serbia



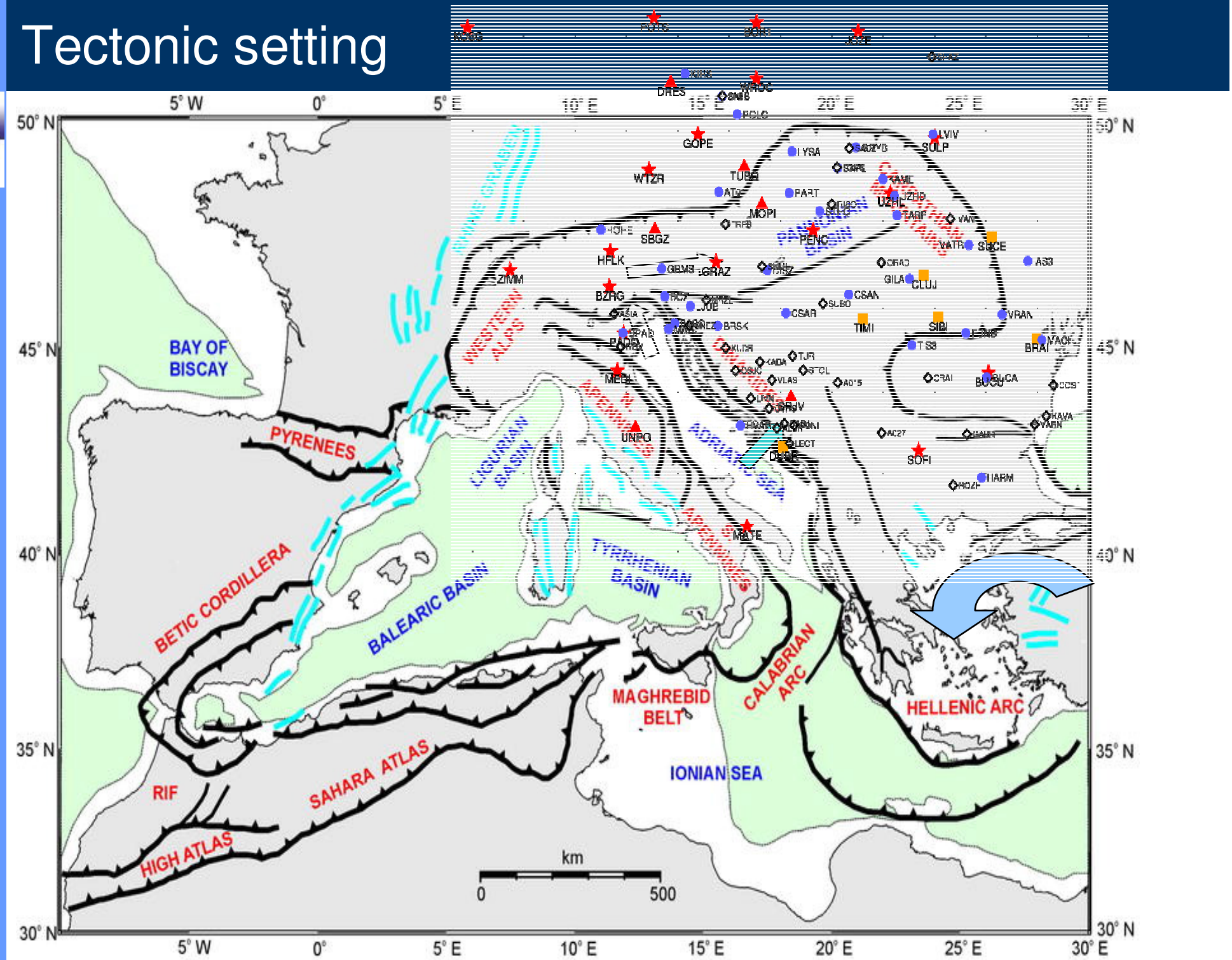
# CEGRN Consortium of participating countries



# CEGRN Study groups (CSG):

- Stations – Network – Campaigns-Data:
  G. Stangl
- GNSS Analysis and Interpretation
  J. Hefty
- Gravity Field
  J. Simek
- Real Time-New Sensors-InSAR
  F. Vespe/G. Grenerczy
- Geokinematics and Seismotectonic modelling
  A. Caporali/G. Grenerczy
- Funding Projects and Reachout
  D. Medak

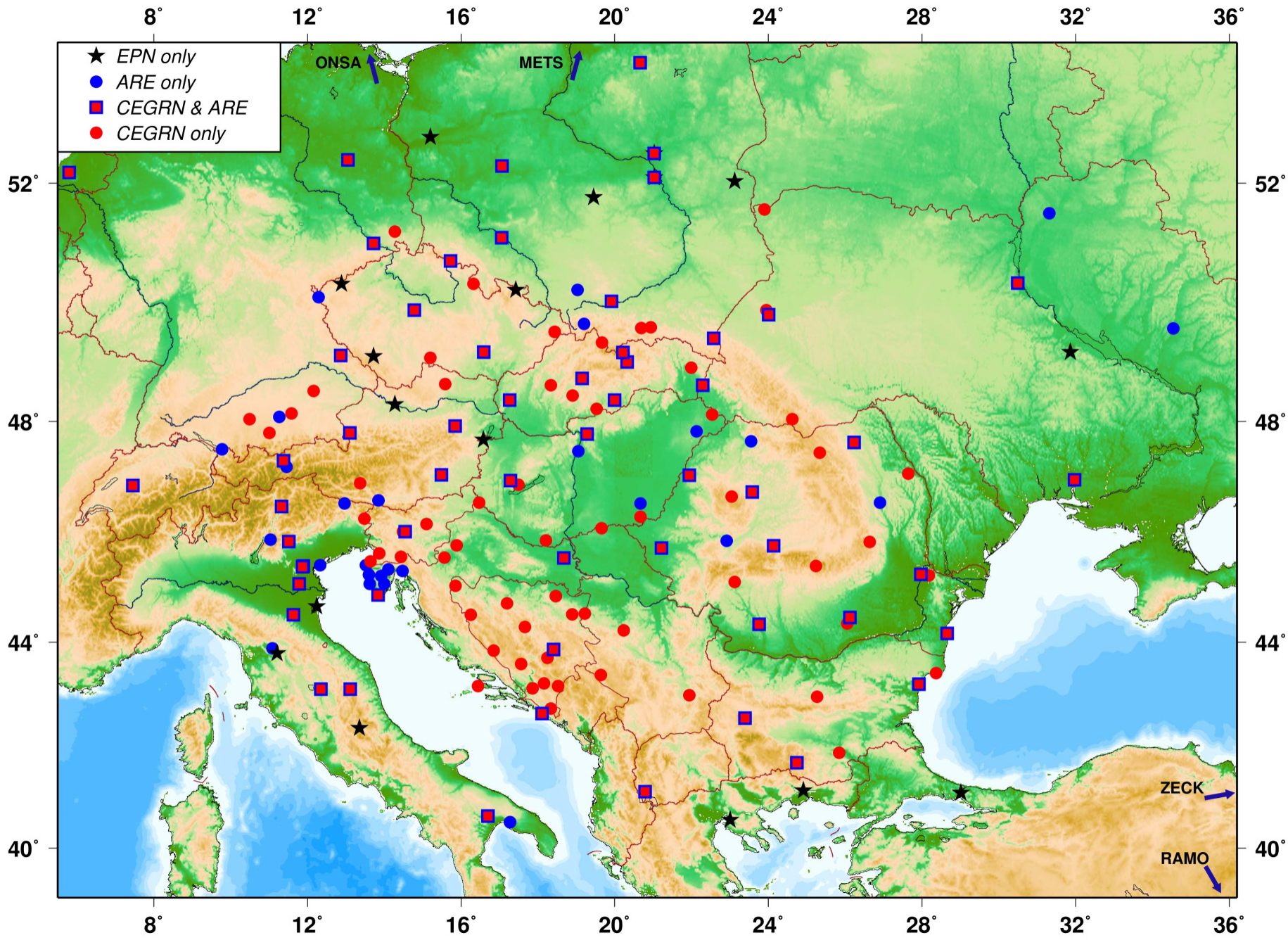
# Tectonic setting



# CEGRN Campaigns

| Campaigns | Period | Country | Sites |
|---|---|---|---|
| CEGRN'94 | 2-6 May 1994 | 10 | 30 |
| CEGRN'95 | 29 May-3 June 1995 | 11 | 36+5 |
| CEGRN'96 | 10-15 June 1996 | 11 | 35+6 |
| CEGRN'97 | 4-10 June 1997 | 12 | 35+10 |
| CEGRN'99 | 14-19 June 1999 | 13 (extended network) | 57 (19P+38E) |
| CEGRN'01 | 18-23 June 2001 | 13 (extended network) | 51 (28P+23E) |
| CEGRN'03 | 16-21 June 2003 | 13 (extended network) | 51 (28P+23E) |
| CEGRN'05 | 20-25 June 2005 | 14 (extended network) | 97 |
| CEGRN'06 | 12-18 June 2006 | Only CGPS | 47 |
| CEGRN'07 | 18-23 June 2007 | 19 (extended network) | 81 |
| CEGRN'09 | 22-27 June 2009 | 19 (extended network) | 85 |

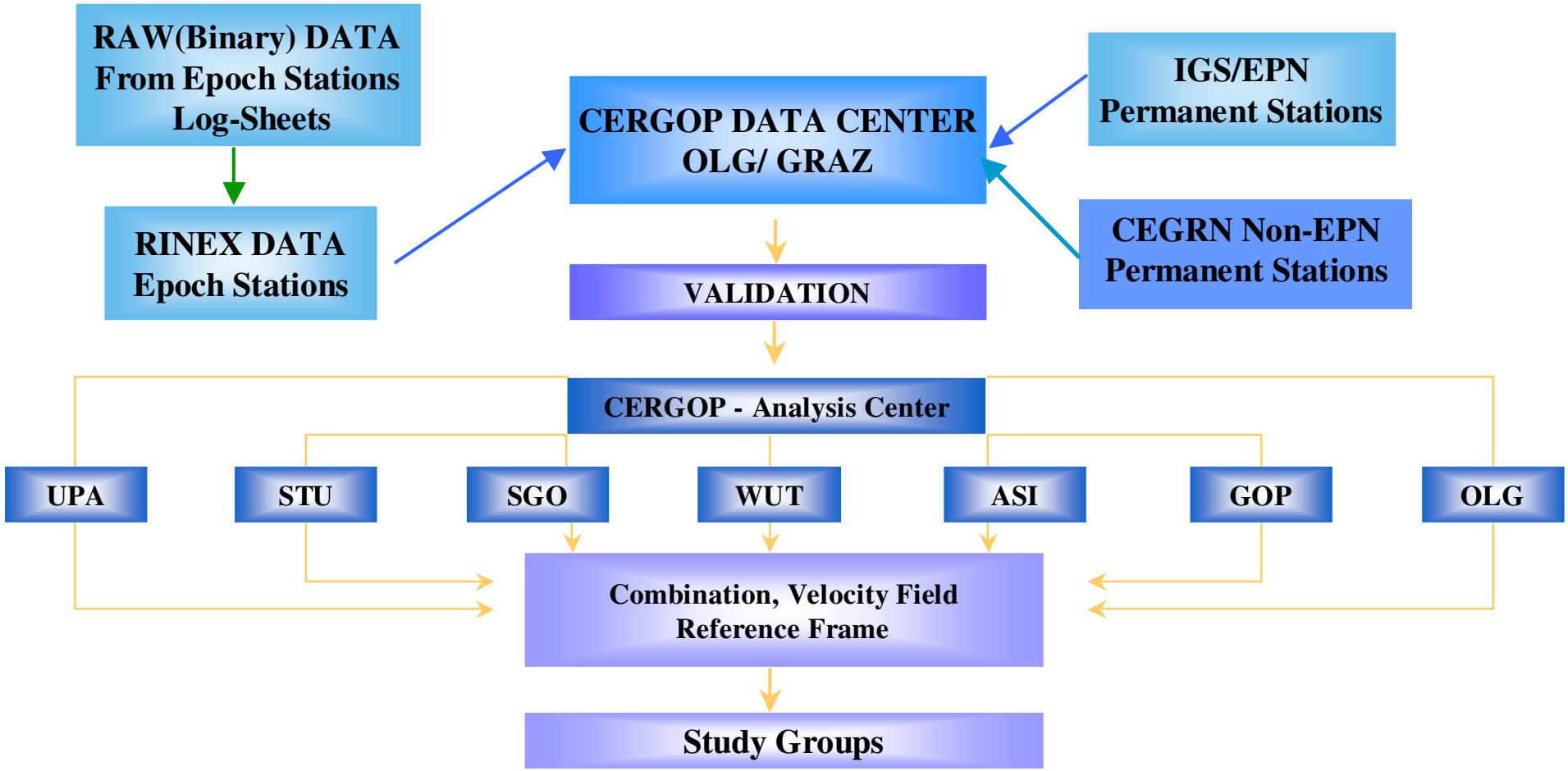
# CEGRN: Regional densification of IGS/EPN




GMT 2010 Apr 21 11:14:11 Epoch and Permanent GPS stations in the region of the CEGRN network

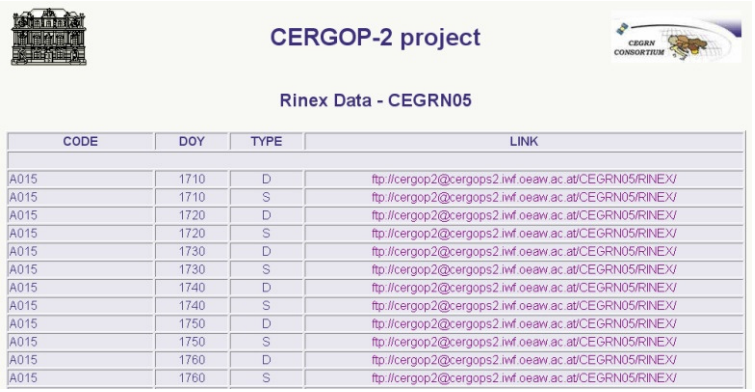
*created by Krauss Sandro, SRI/AAS under GNU GPL*

# CEGRN Data Flow



# The CERGOP2 database

- **CEGRN campaign information (maps, equipment, observed stations),**
- **ftp access to observations**
- **Epoch solutions of the campaigns (SINEX)**
- **daily and hourly RINEX files of the non-EPN permanent stations**
- **links to work packages and the CEGRN Consortium**
- **Public and Project area**



CERGOP-2 project

Rinex Data - CEGRN05

| CODE | DOY | TYPE | LINK |
|---|---|---|---|
| A015 | 1710 | D | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1710 | S | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1720 | D | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1720 | S | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1730 | D | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1730 | S | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1740 | D | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1740 | S | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1750 | D | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1750 | S | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1760 | D | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |
| A015 | 1760 | S | ftp://cergop2@cergops2.iwf.oeaw.ac.at/CEGRN05/RINEX/ |

# Main Objectives

Modelling of regional intra-plate 3D velocity field at millimetre level

- Combination of solutions of individual analysis centres
- Combination of repeated epoch networks, coordinate and velocity estimates
- Evaluation of accuracy and reliability of obtained information
- Velocity maps, regular grid velocities, deformations, geo-kinematical interpretations
- Evaluation of statistical significance of derived quantities
- Visualisation of products, geo-kinematical maps
- Strain analysis and detection of velocity changes for dynamical investigations and special study areas with national or regional densification networks

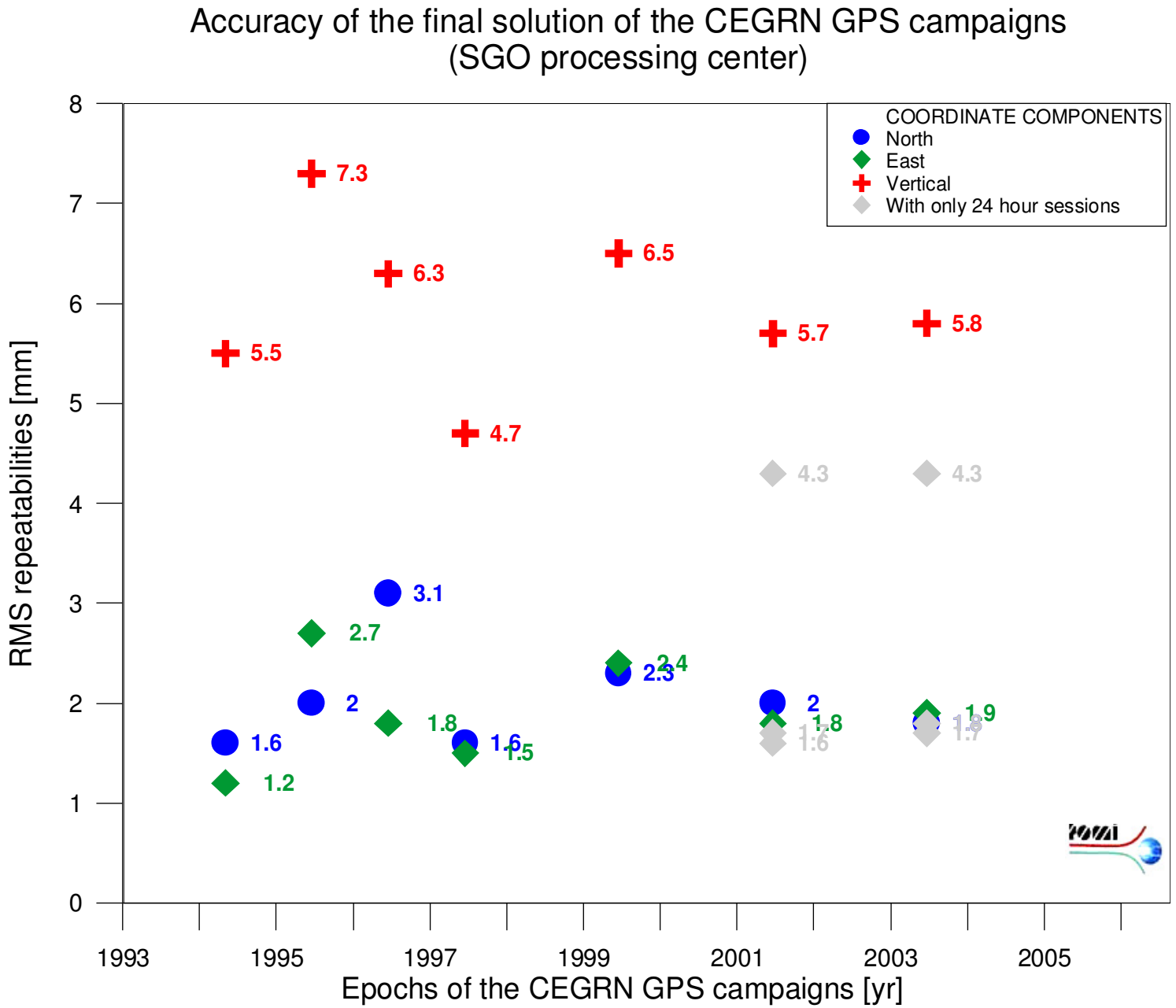
# (Re-)Processing of CEGRN campaigns


Rinex files of 71 stations prepared by CERGOP WP1 (Guenter Stangl) together with other files (antenna eccentricities, log sheets, meteo files)

- Processing strategy: ITRF2005, daily solutions, outside IGS stations included (ONSA, ZIMM, KOSG, METS, MATE),
- Reference point GRAZ (0.0001 m)
- 6 Analysis Center Solutions: << 10 mm congruence
- Exceptions -> Antennas

Residuals of individual analysis centers in the combined product for 2005
DUT, GOP, OLG, SGO, SUT, WUT

# Data Processing and Accuracy Evolution



# CEGRN sites according to accuracy of coordinates and velocities

- **Time span of observations up to 16 years (20 CEGRN sites)**

  – $s_{ne}$ of horizontal coordinates ~1.0 mm, $s_{up}$ of height ~2 mm,
  – $s_{vne}$ of horizontal velocities ~0.4 mm/y , $s_{vup}$ velocity in height ~1.5 mm/y

- **Time span of observations 5-9 years (24 CEGRN sites)**

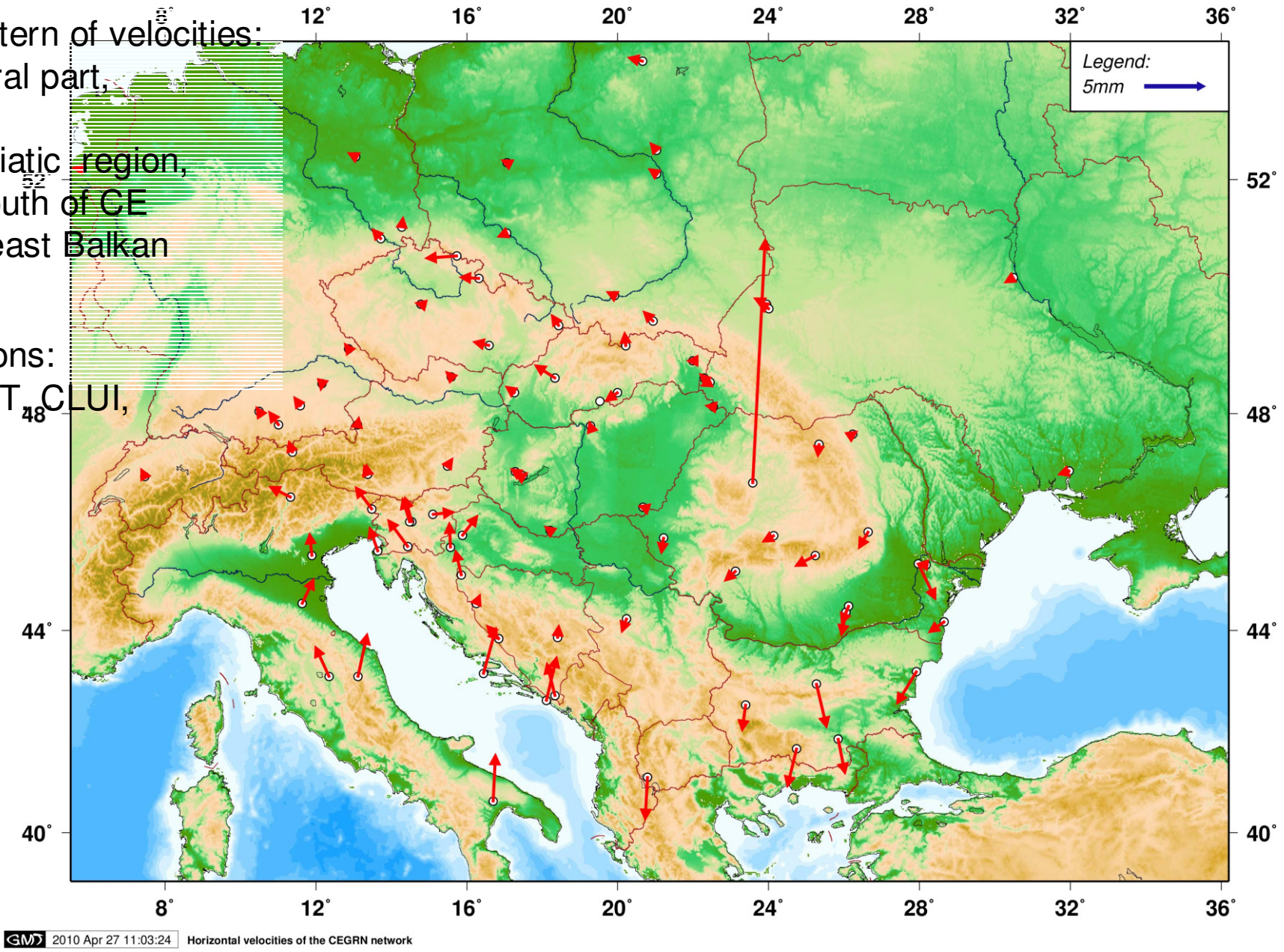
  – $s_{ne}$ of horizontal coordinates ~2.5 mm , $s_{up}$ of height ~7 mm,
  – $s_{vne}$ of horizontal velocities ~0.8 mm/y , $s_{vup}$ velocity in height ~3 mm/y

- **Time span of observations less than 5 years (16 CEGRN sites)**

  – $s_{ne}$ of horizontal coordinates ~4 mm , $s_{up}$ of height ~ 10 mm,
  – $s_{vne}$ of horizontal velocities ~1.2 mm/y , $s_{vup}$ velocity in height ~6 mm/y

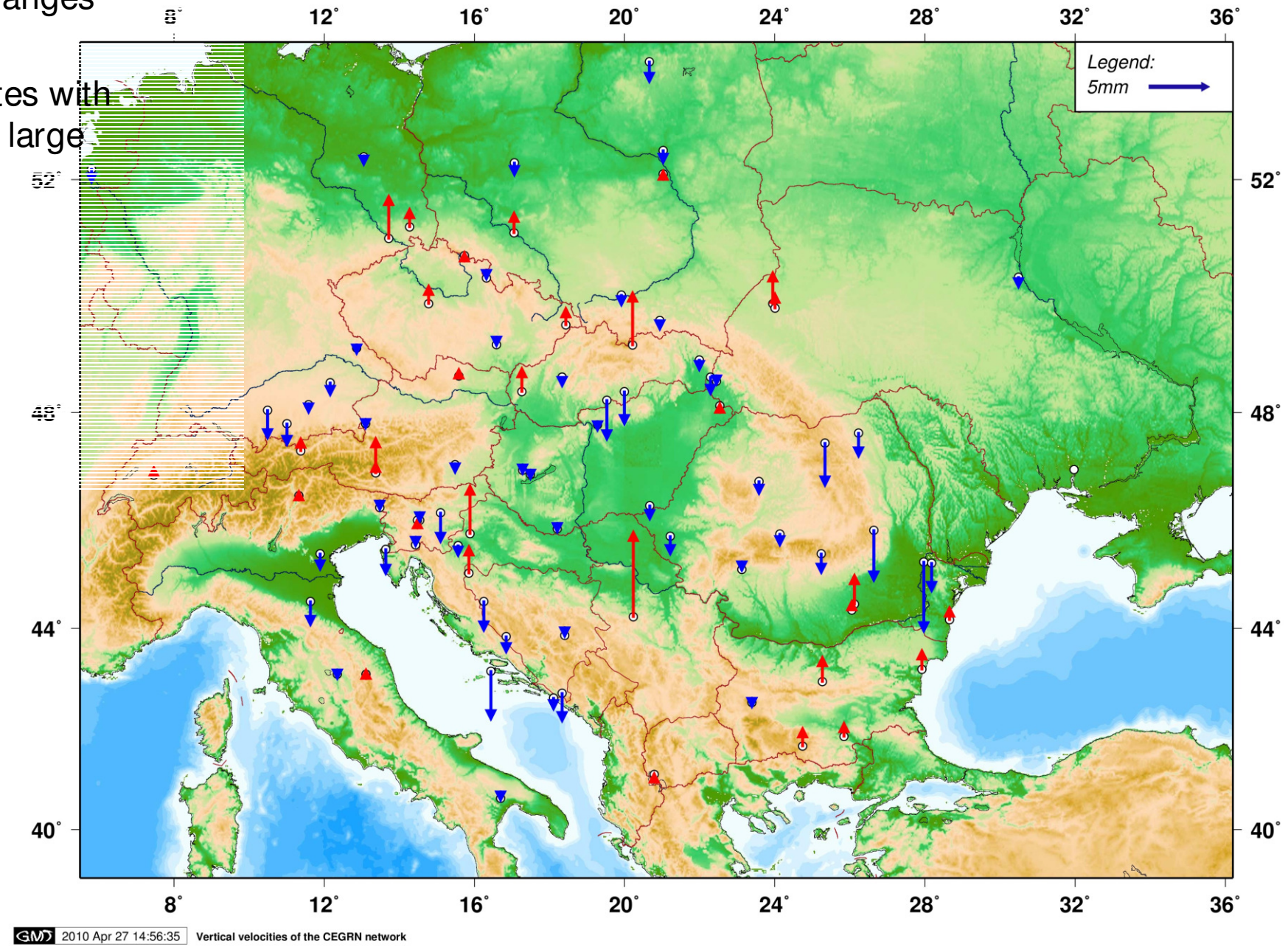
# Horizontal velocities from CEGRN 1994 – 2009 campaigns

- Consistency of velocities of east Balkan stations
- Regional pattern of velocities:
  - Stable Central part,
  - Northward Alpine-Adriatic region,
  - Eastward south of CE
  - Southward east Balkan
- Few exceptions: SNIE, PART, CLUI,



# Vertical velocities from CEGRN 1994 – 2009 campaigns

- No significant height changes
- Single Sites with relatively large values



# New Challenges

- The new challanges of CEGRN focus on Science and Applications
  - Science:
    - support the IAG project on Dense Velocity Fields by providing Epoch Sinex files resulting from state-of-the-art processing standards (IGS-EPN guidelines), update to future campaigns
    - Geokinematical interpretation of the velocity field (TopoEurope project, Wegener) and characterization of areas subject to the largest deformation (Balkans, Dinarids, Vrancea, Eastern Alps)
  - Applications (direct relation to FP7/FP8 Calls)
    - INSPIRE: the CEGRN network can serve as geospatial infrastructure for harmonization of geodetic standards across Europe
    - NEREUS (Network of European Regions Using Space Technologies): has one WG on GNSS and one on GMES; powerful lobby in Brussels
    - EUPOS: requires stations with high qualification and trained personnel
    - Extension to other regions not yet covered (Albania, Belarus, FYROM, Moldova, Montenegro, Northern Greece, European Turkey)

# Summary and Outlook

- Unique Reference frame – blend of Permanent and Epoch Stations
- (Intra-) Plate velocities at the < 0.5 mm/yr level
- Re-Processed with ITRF2005 and Absolute Antenna Phase Centers
- Present tectonics in Central and SE Europe:
  crustal motion, deformation, strain accumulation
- CEGRN is planning continuation in new frames / projects:
  GNSS + Seismology
  GMES – Environment and Security
- Potential cooperation :
  - Densification of ITRF2005 + Dense Velocity Field in Europe
  - Topoeurope, Geohazard
  - INSPIRE, NEREUS FP7/8
  - EUPOS
  - WEGENER GEODAC – Database