The EPOS GNSS strain-rate product (Y2018) – status and open questions

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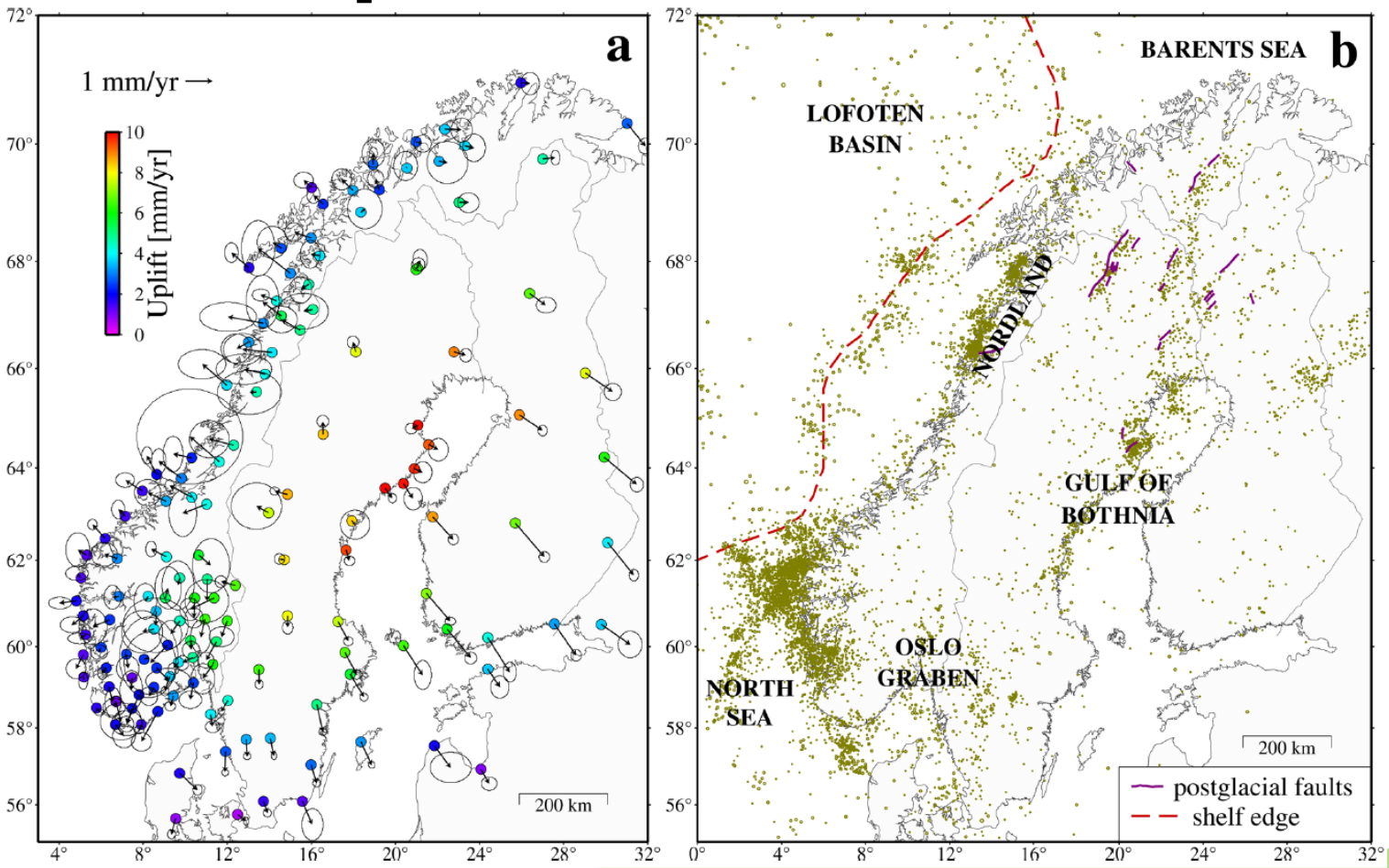
Introduction

- European Plate Observing System(EPOS) = a long-term plan to facilitate integrated use of data, data products, and facilities from distributed research infrastructures for solid Earth science in Europe
- EPOS currently in the Implementation Phase (IP, 2014-2019)
- Strain-rate product
  - Part of the thematic core services (TCS) of EPOS under work package (WP) 10 (GNSS Data and Products)
  - Collaborative effort from several European research institutions
  - Of major importance for the European Solid Earth community
- WP10-DDSS-017 “GNSS Strain Rate Maps” foreseen operational in near future (DDSS = data, data products, services and software)

Example: strain rate vs. seismicity in northern Europe – used data



(Keiding et al., 2015)

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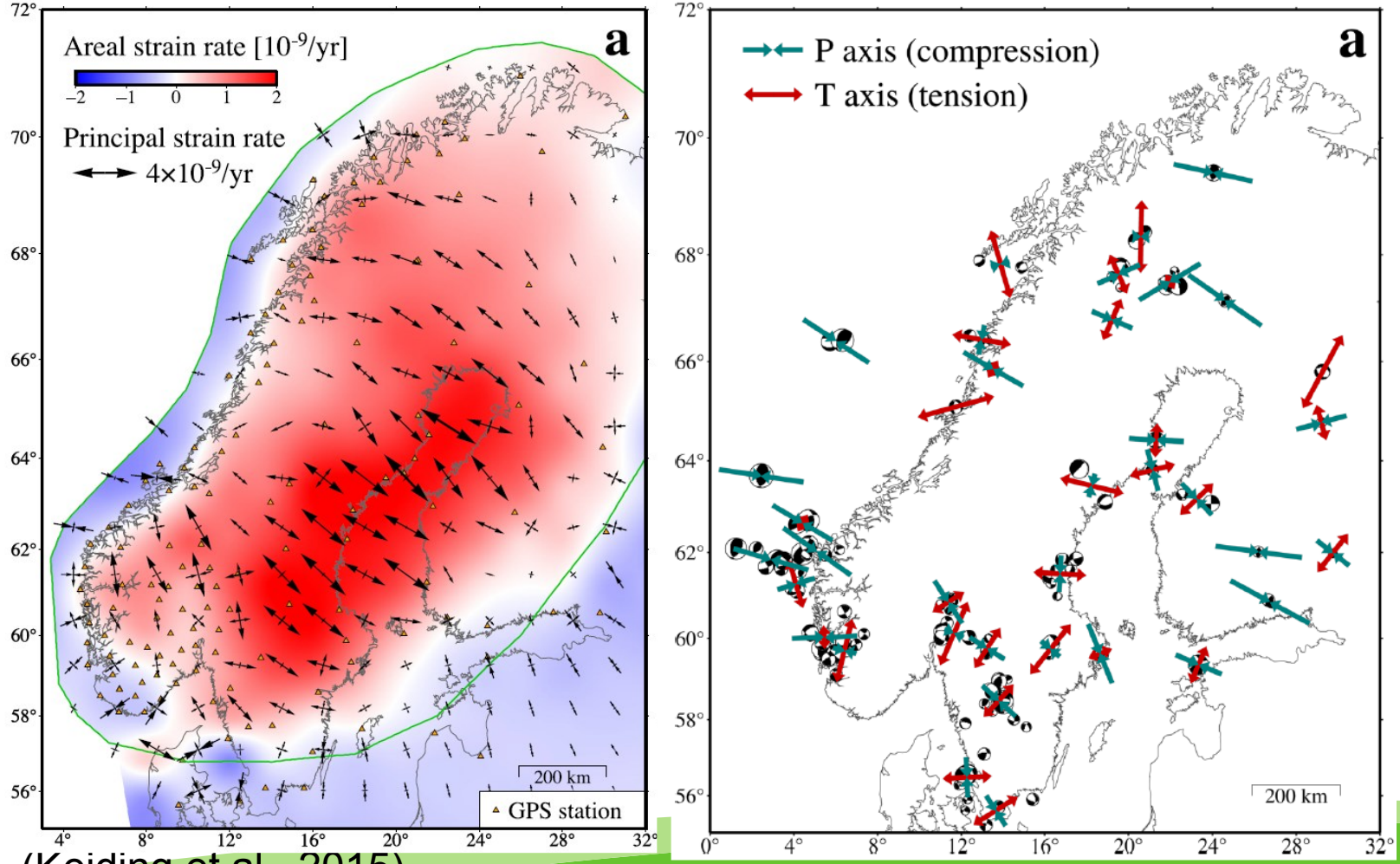
Example: strain rate vs. seismicity in northern Europe - results



(Keiding et al., 2015)

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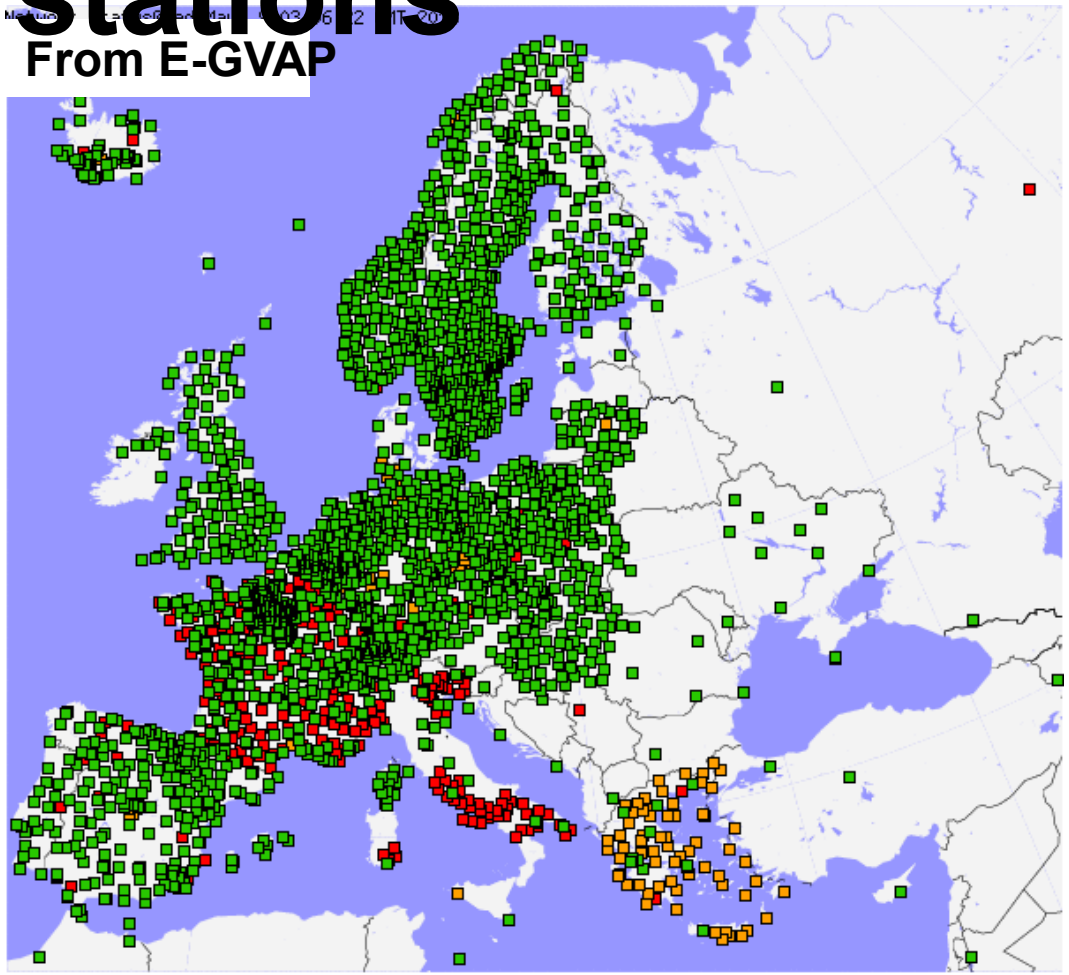
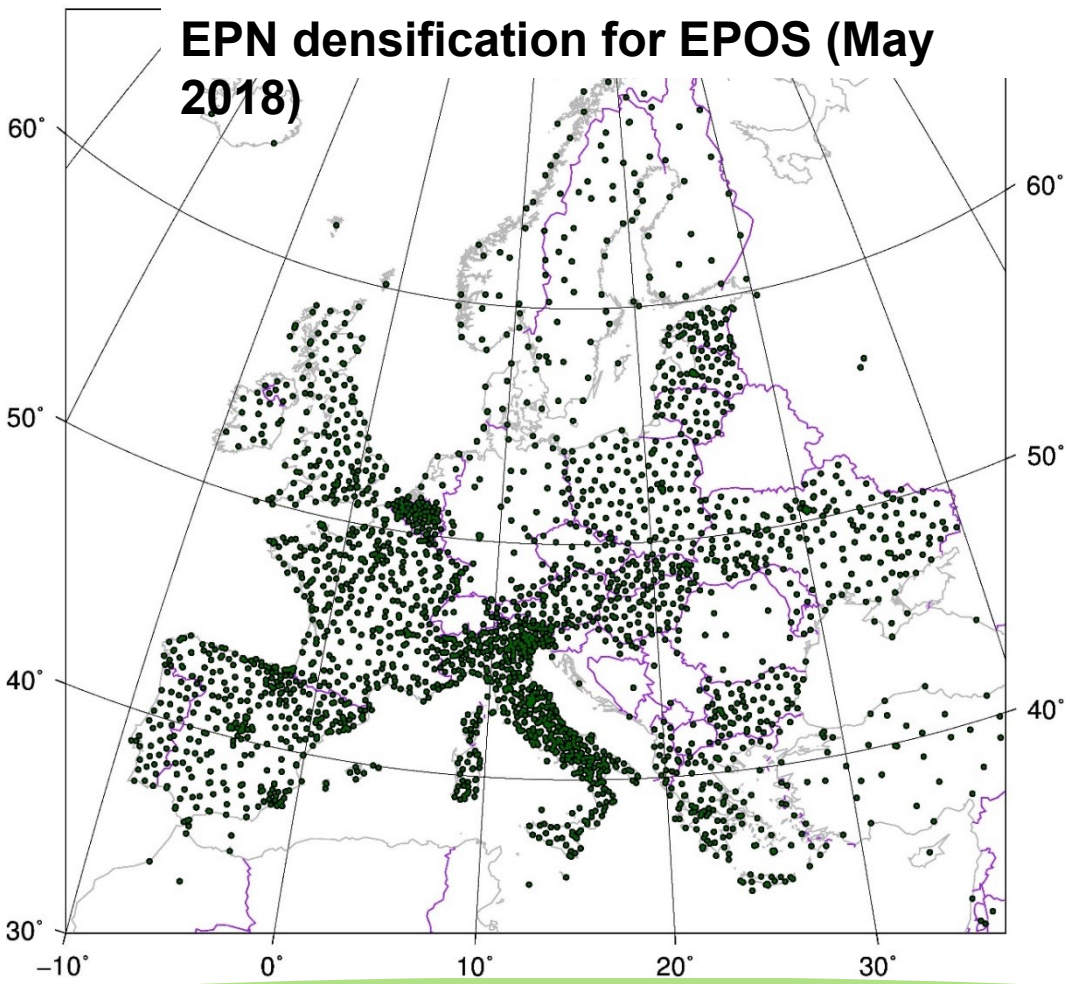
Possibly useful permanent GNSS stations

From E-GVAP



http://egvap.dmi.dk

EPN densification for EPOS (May 2018)



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Possible software tools for processing

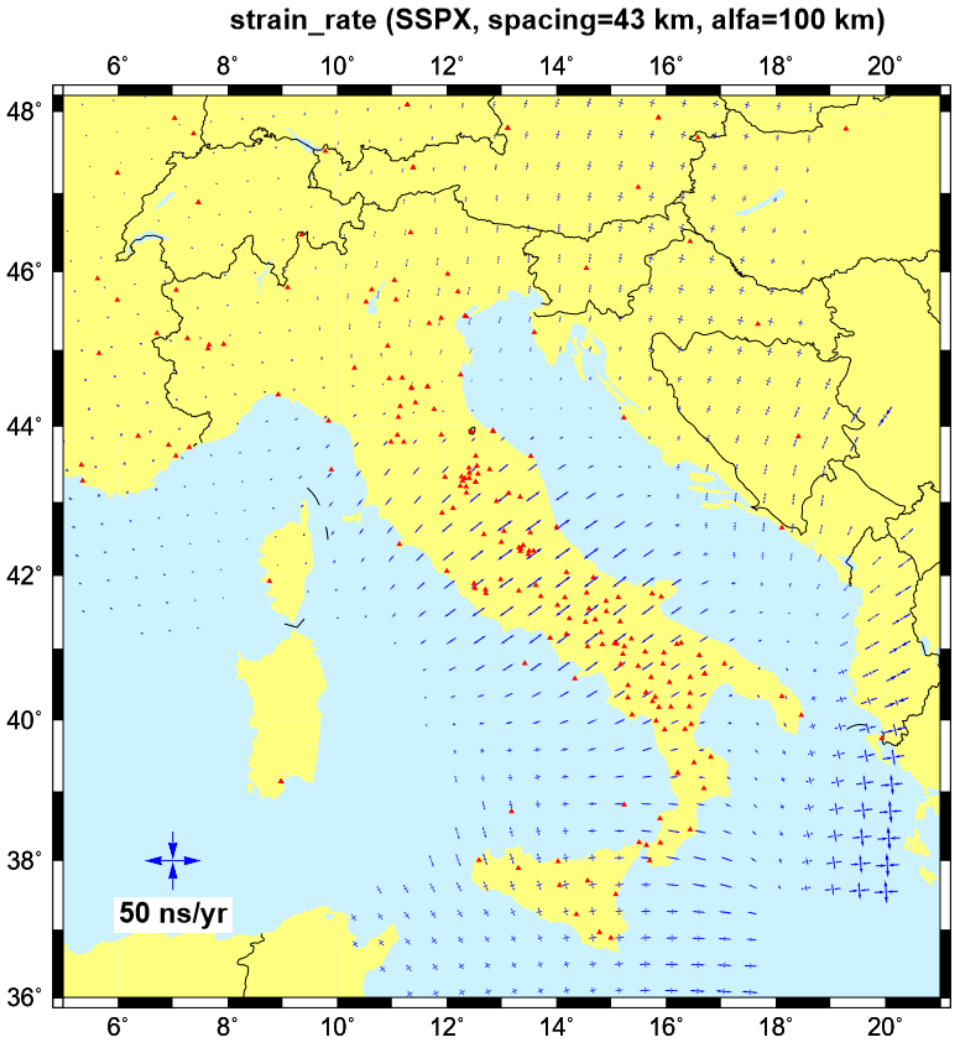
Already available software for strain analysis (no re-invention of the wheel):

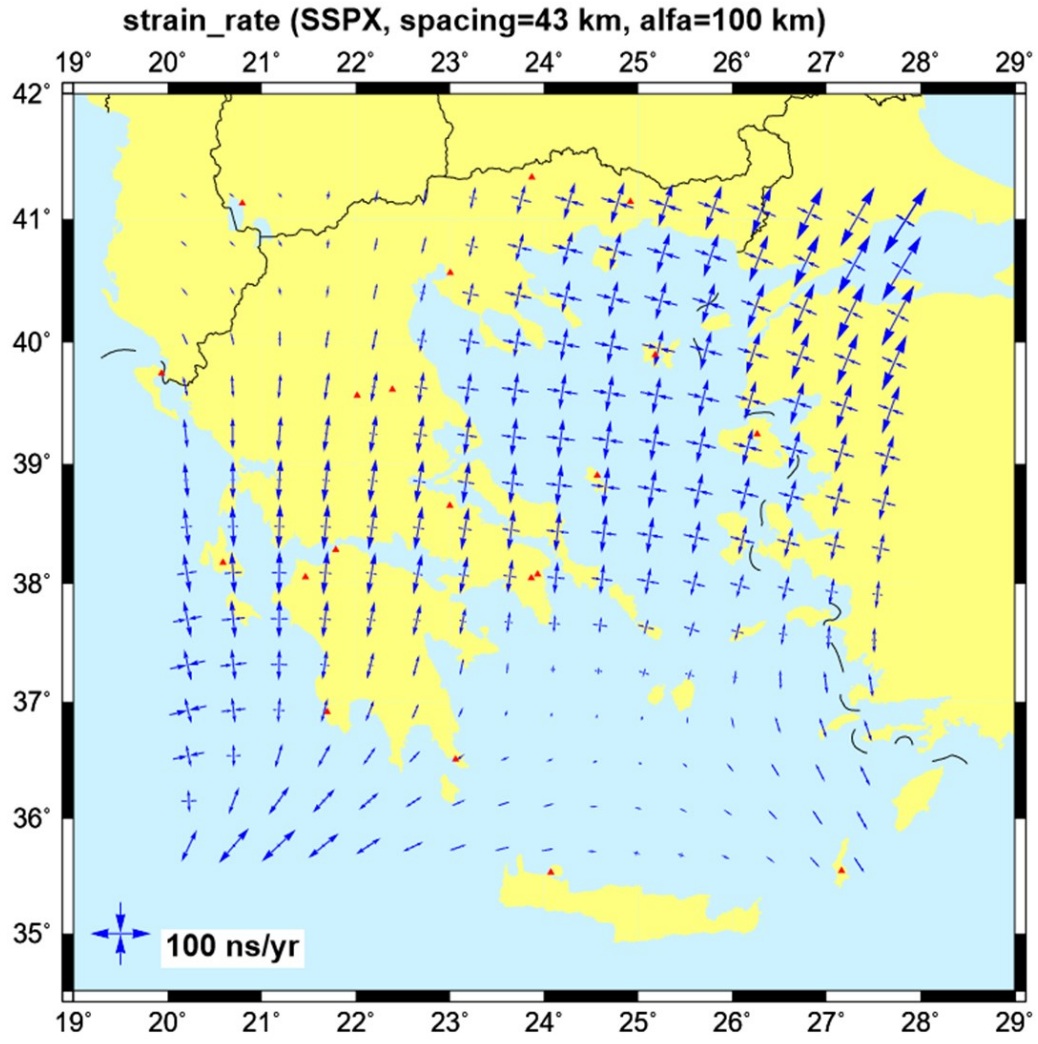
- VISR/VISR2 (Shen et al. 1996, JGR; 2015, BSSA), free, 2D and 3D strain, Linux-based, needs own scripting of plotting tools
- SSPX (Cardoso & Allmendinger 2009, Comp. Geosci.), free, 2D and 3D strain, Mac-based, VISR method
- Geostrain (Goudarzi et al. 2015, Comp. Geosci.), free, uses Matlab, least-square collocation method
- *Grid_strain & Grid_strain3 (Teza et al. 2008, Comp. Geosci.), free, needs request, uses Matlab, least-squares method*
- STIB (Masson et al. 2014, GJI), needs request, python-based, Spakman & Nyst method (SNM)

Developments during IP

- Ganas & Chousianitis provided ”Guidelines for DDSS Strain-rate derivation maps” in 2016
  - Suggest VISR/VISR2 method (Shen et al. 1996, 2015) approach for calculation
  - Define meta-data, input and output formats
- Three analysis centers (Läntmäteriet, INGV, CNRS) interested in performing strain-rate analysis
- Lantmäteriet leads analysis now, strong collaboration with NOA, scientific exchange with INGV and CNRS
- Software tests ongoing
  - Ganas & Kapetanidis (2018), report on “NOA Document on EPOS strain rate, V1.0”, selected two target zones, Italy and Greece, and estimated the strain rates using VISR2 and STIB methods
  - Nilfouroushan et al. (submitted) compare VISR results with SSPX software results
  - Same velocity fields used to estimate the strain rates

SSPX strain rates for Italy (left) and Greece (Right)





Red triangels show the GNSS stations used in SSPX

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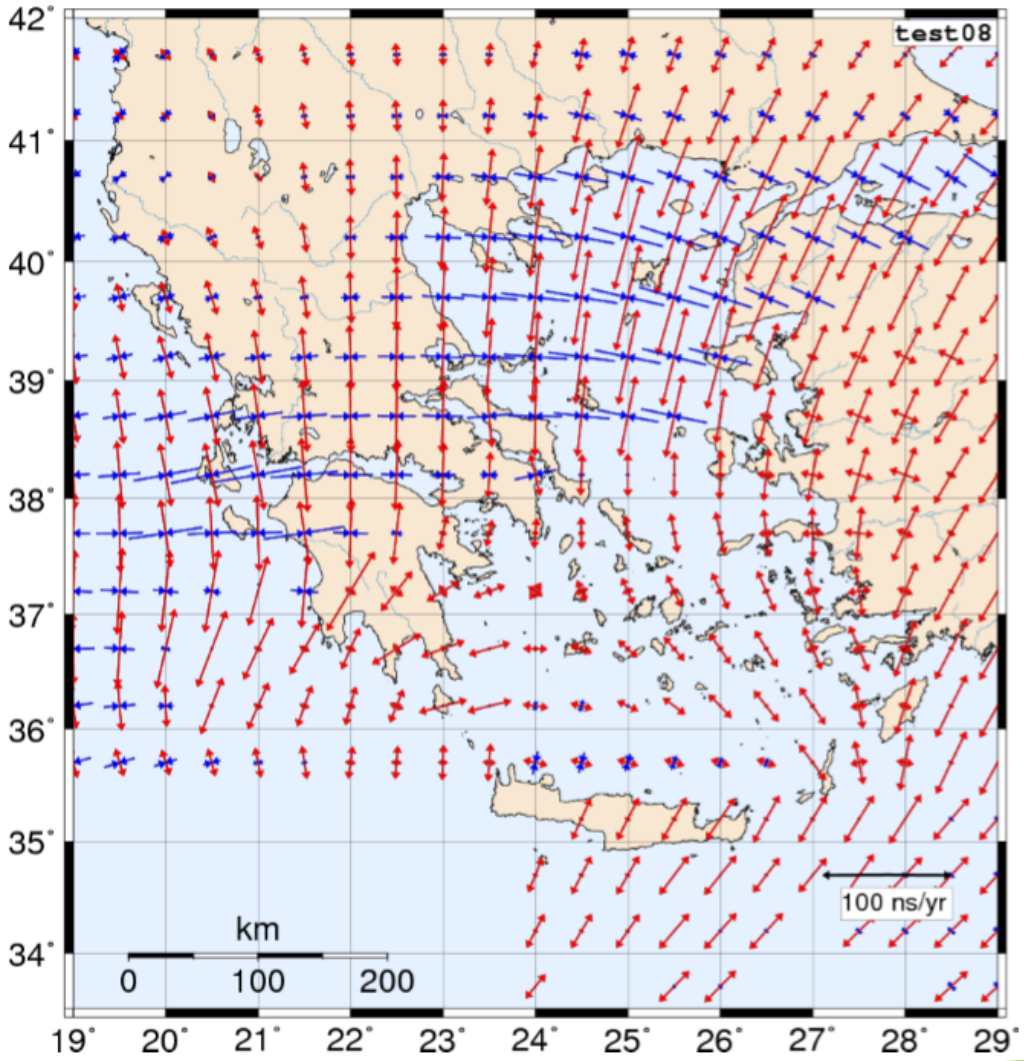
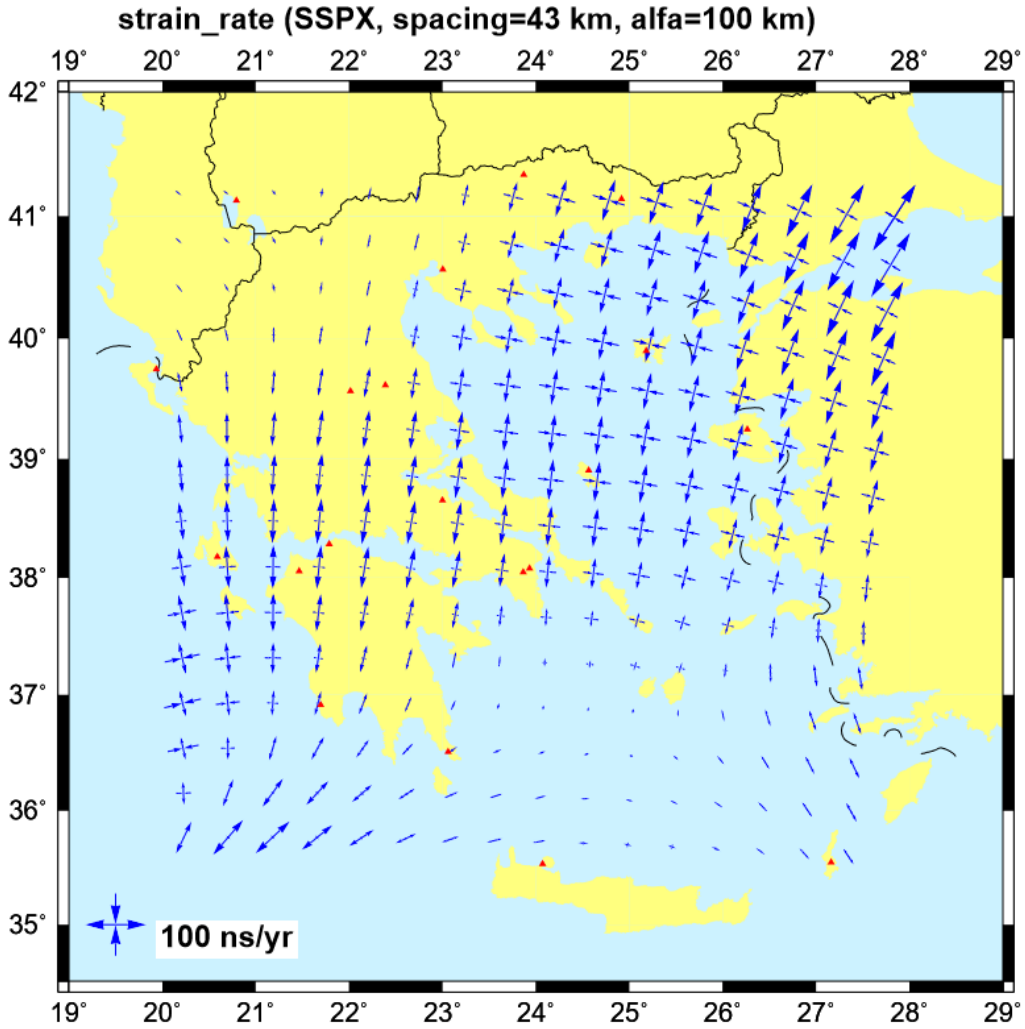
Comparison of results for Greece (left figure from Ganas & Kapetanidis report)





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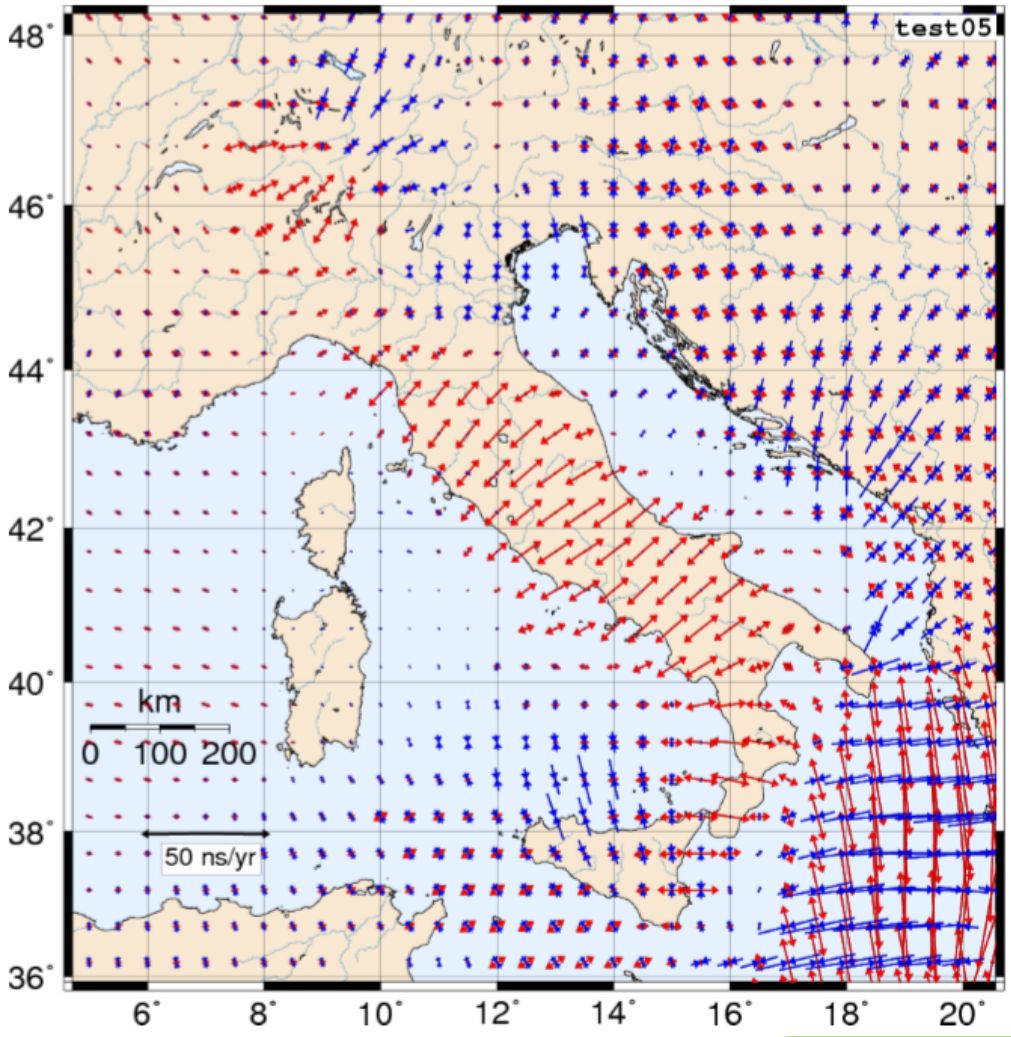
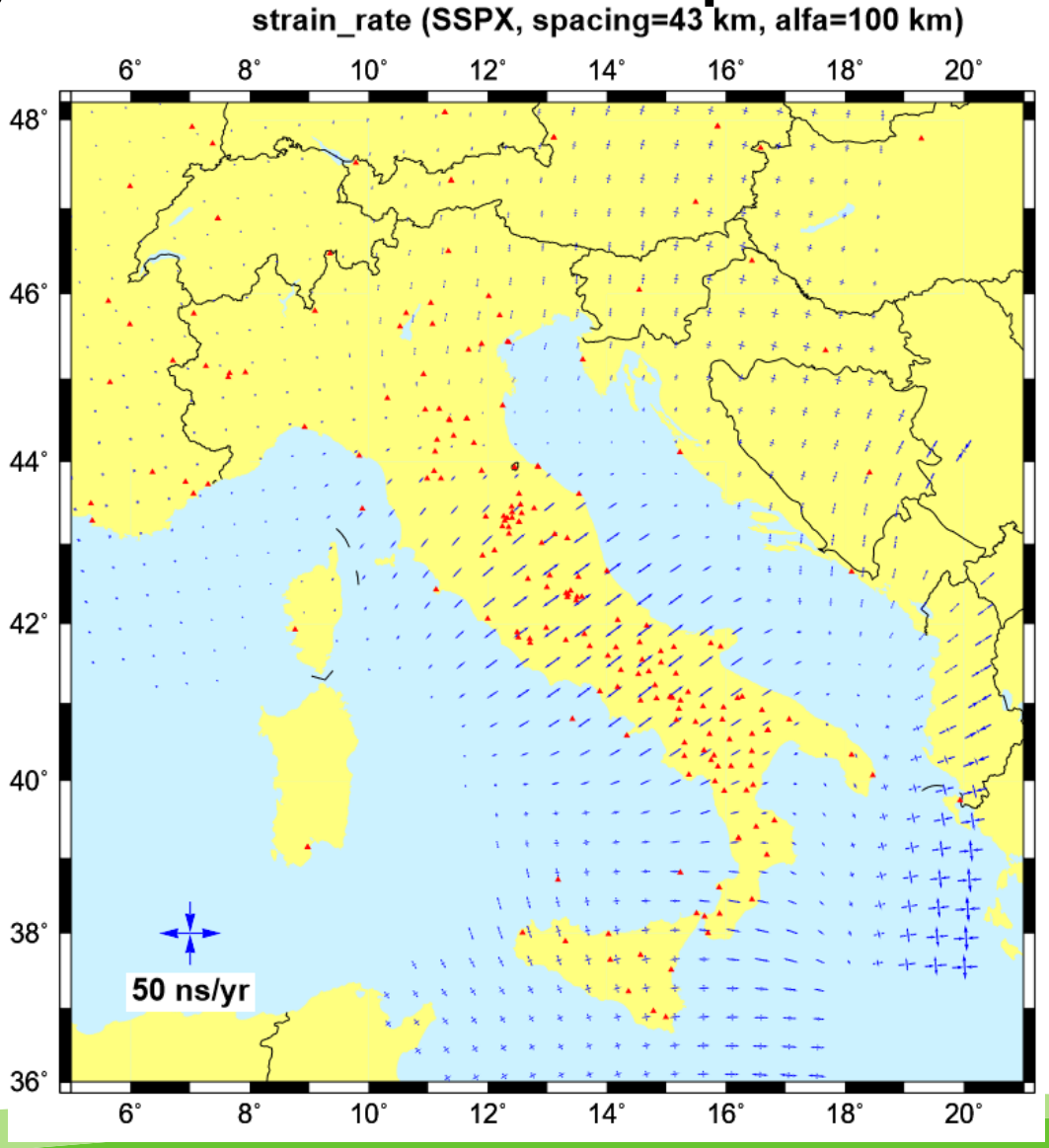
Comparison of results for Italy (left figure from Ganas and Kapetanidis report)





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Some remarks from the comparison

- The distribution of the stations, the smoothing factor (how far the velocities are included) and the grid spacing for strain rate calculations are important factors which can change the results.
- The most reliable strain rates are derived in the zones where velocities are interpolated not extrapolated. SSPX mark uncertain strain rates and remove them, especially in the zones where the velocities have been extrapolated. Therefore, the gap zones are different between SSPX and VISR.
- This work is under progress. The input and output files and the GMT scripts are shared to facilitate the future works and to better compare the results.

Issues to solve

- What product(s) will be provided to users?
- Spatial resolution? – Probably different products (several Europe-wide tables or additional tables for selected areas) with “adapted” spatial resolution dependent on area?
- Area of interest for the strain-rate products, e.g. shall we include parts of North Africa or Middle East? Greenland? Svalbard?
- What do the users actually expect?

Feedback from possible users

Strain-rate-interested colleagues with different background (geodesy, geology, seismology) prefer:

- Download data with lat/lon and strain rates, whenever possible the full tensor; station info if data are not gridded; areal and shear strains currently not a major wish; *some may prefer the principal strains with magnitude and directions* relative to the geographical coordinate system
- Grid instead of station locations, but info on locations of used stations should be available (e.g., plot this info in the figure)
- Grid size ”fine enough” but ”not too fine”, thus varying grid size depending on geodynamic characteristics of a region and station distribution
- Region selection via shape AND entered coordinates (like GEBCO)
- Automatic figure generation (geography, different backgrounds, strain info) and possible download (see e.g. World Stress Map project), *perhaps also country-wise maps*

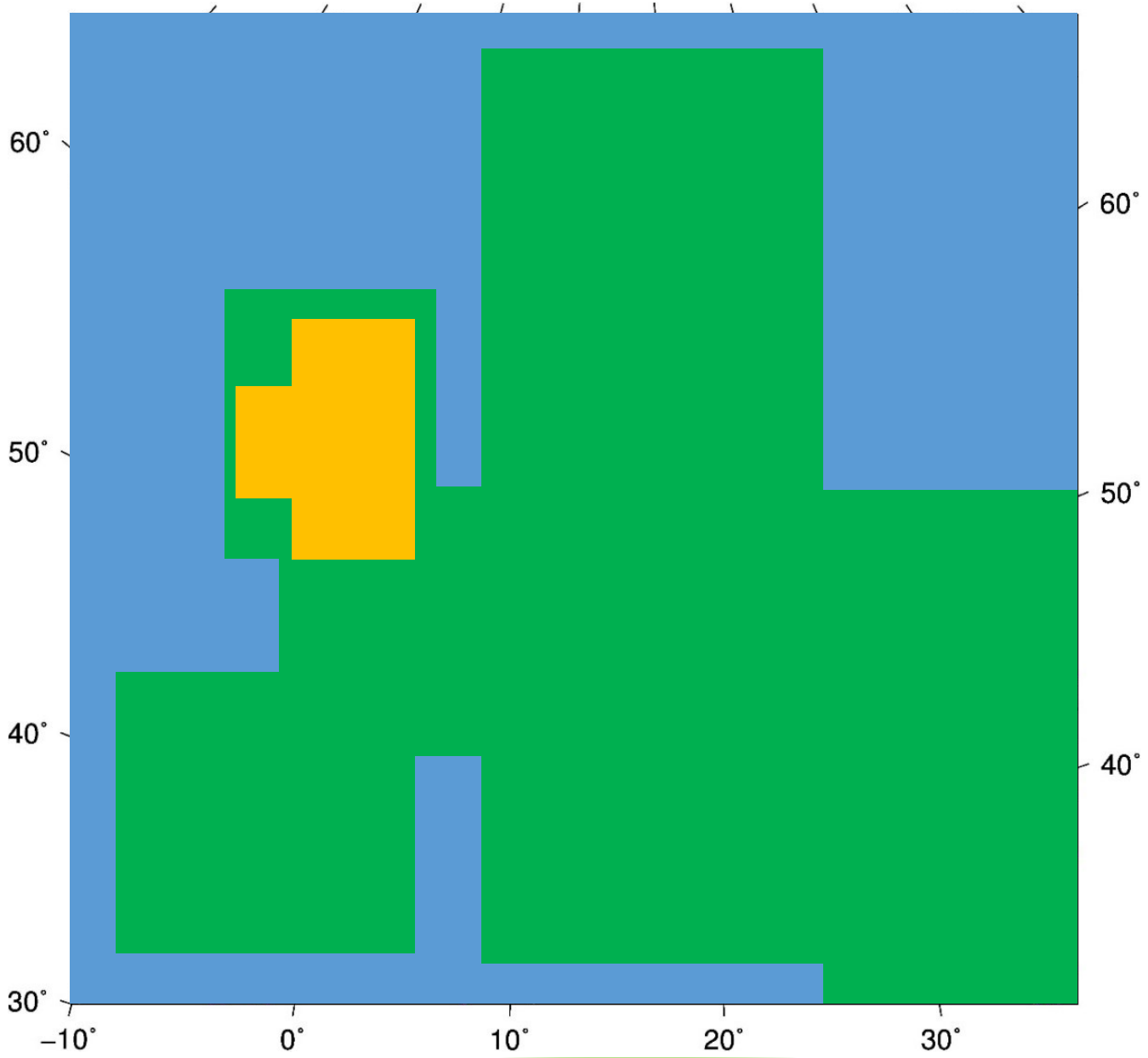
Spatial resolution and area example

200 km

100 km

50 km

25 km



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Issues to solve (cont.)

- How is the product implemented from an IT-perspective within the EPOS environment?
- How will the requirements from the CC-BY license (to have all contributing organizations visible) be fulfilled?
- Frequency of updates? (strongly dependent on frequency of updates of velocities, maybe different frequency in different areas?)
- Quality estimate of the products?

Summary

- EPOS strain-rate product in progress
  - Test and selection of processing software
  - Automatization of strain-rate calculation
  - Selection of high-resolution areas
  - Work on permissions and synchronization with online tools
- The first public presentation of this product will be in Malta during the European Seismological Commission conference in September 2018.