TECTONIC STRAIN DISTRIBUTION OVER EUROPE FROM EPN DATA

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INTRODUCTION

`StrainTool` is a software package that enables the estimation and visualization of Strain Tensor parameters, given list of data points on the earth's crust along with their respective tectonic velocities. It consists of three basic components:

- a python package (library) `pystrain`,
- a (main) program `StrainTensor.py` and
- a list of (shell) scripts to visualize results

`StrainTool` was developed in the framework of *HELPOS*; it is a free and open-source software project, distributed under the *MIT License*.

A detailed introduction to `StrainTool`, a how-to guide, usage examples and discussion on the implemented methodologies is available on the web, at `https://dsolab.github.io/StrainTool/`.

STRAINTOOL

`StrainTool` is a heighly customizable software package; users can configure the estimation process using a list of input options. The basic input is a data file containing station coordinates along with their respective volocity components.

Users can select the estimation of a single Strain Tensor (at the region's barycentre) or estimation of multiple Strain Tensors placed on a (regular) grid within the region limits. Grid formation details are fully customizable by the user.

Estimation of the Strain Tensor parameters follows a Least Squares approach, based either on **Veis et al., 1992** or **Shen et al., 2015**. In the latter case, a sophisticated weighting scheme is used, controlled by the user via a list of command-line-options.

The estimated Strain Tensor parameters along with their corresponding `sigma` values can be visualized with the distributed shell scripts `gmtstrainplot.sh` and `gmtstatsplot.sh`. Both programs use `GMT` **Ref here** to plot results, drived by a user-defined configuration file.

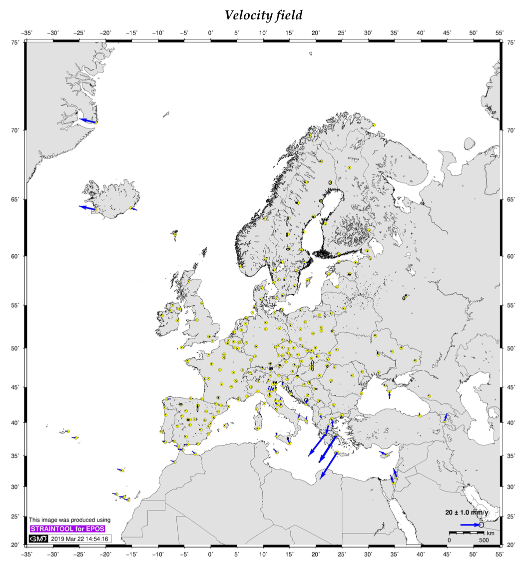
ALGORITHMS

Given a set of stations (aka point on earth's surface) with their corresponding east and north velocities, we can estimate (or compute) strain tensor parameters, by solving for the system

$$\begin{bmatrix} V_{x,S_1} \\ V_{y,S_1} \\ \dots \\ V_{x,S_n} \\ V_{y,S_n} \end{bmatrix} = \begin{bmatrix} 1 & 0 & \Delta_{y_1} & \Delta_{x_1} & \Delta_{y_1} & 0 \\ 0 & 1 & -\Delta_{x_1} & 0 & \Delta_{x_1} & \Delta_{y_1} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 1 & 0 & \Delta_{y_n} & \Delta_{x_n} & \Delta_{y_n} & 0 \\ 0 & 1 & -\Delta_{x_n} & 0 & \Delta_{x_n} & \Delta_{y_n} \end{bmatrix} \begin{bmatrix} U_x \\ U_y \\ \omega \\ \tau_x \\ \tau_{xy} \\ \tau_y \end{bmatrix}$$

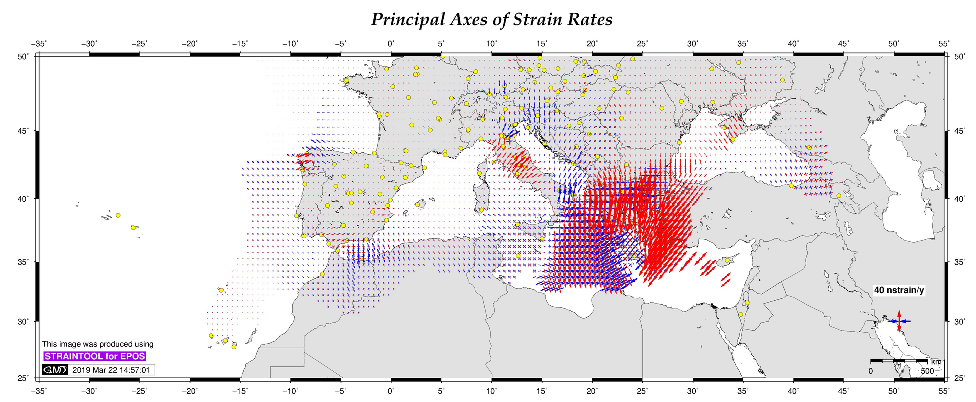
at any given location R; Δ_{x_i} and Δ_{y_i} are the displacement components between station i and the point R. A minimum of 3 stations is required to compute the parameters; if more than 3 stations are used, then the parameters are estimated using a least squares approach. Assuming that we have variance information for the station velocities (and a Gaussian distribution), we can add the covariance matrix C of the velocity data in the system. In the simplest case, C is a diagonal matrix, with the velocity component standard deviations as its elements. Shen et al, 2015, propose a more elaborate approach, reconstructing the covariance matrix by multiplying a weighting function to each of its diagonal terms. The weighting function $G_i = L_i \cdot Z_i$, in which L_i and Z_i are functions of distance and spatial coverage dependent, respectively. The final covariance matrix becomes then, $C = C \cdot G^{-1}$ or, since its diagonal, $C_i = C_i \cdot G_i{}^{-1}$.

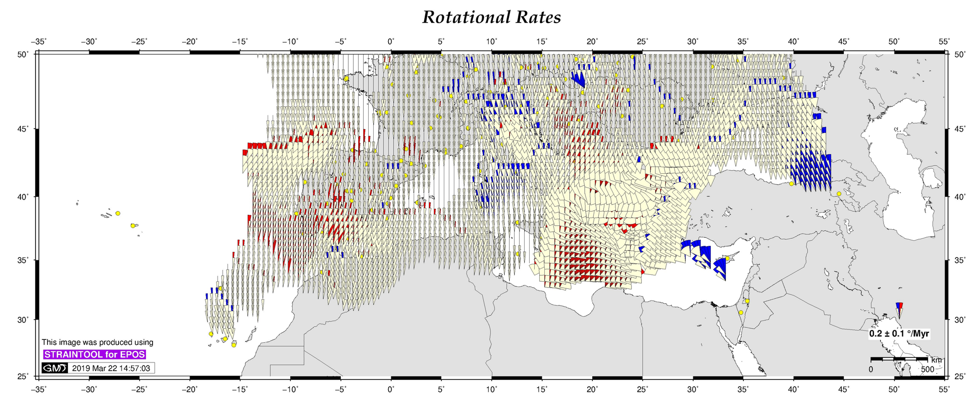
VELOCITY FIELD

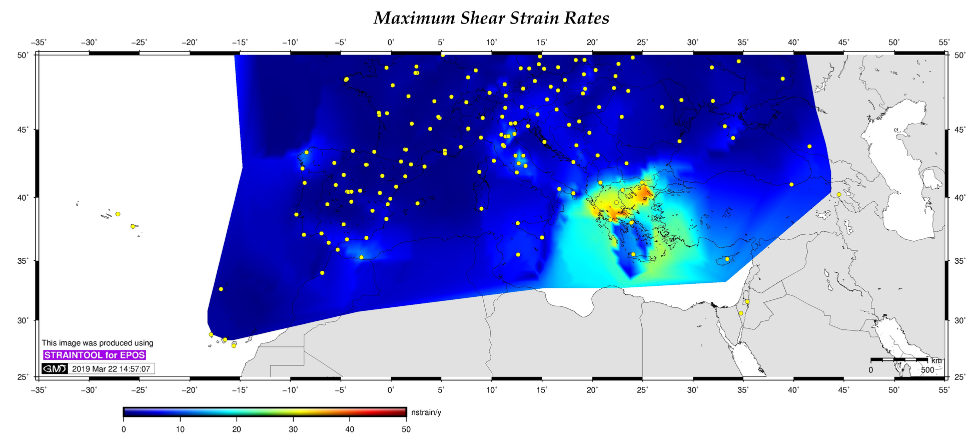


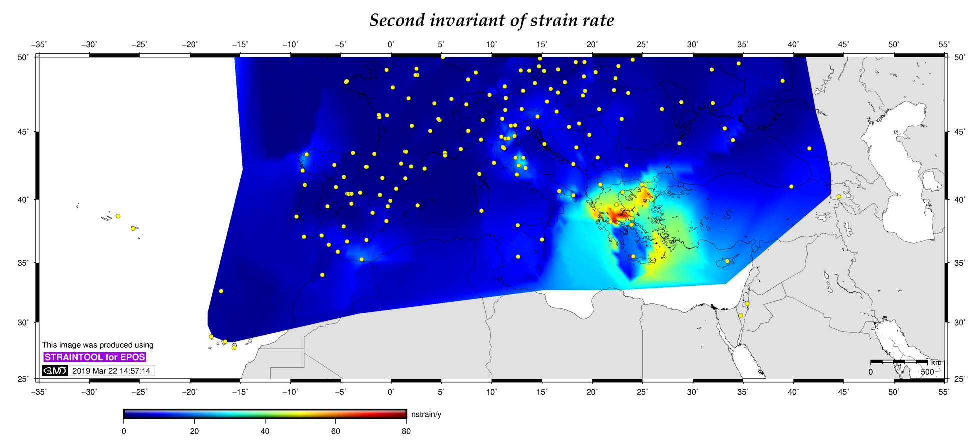
DIFFERENT MODELS SETUP

RESULTS AND DISCUSSION

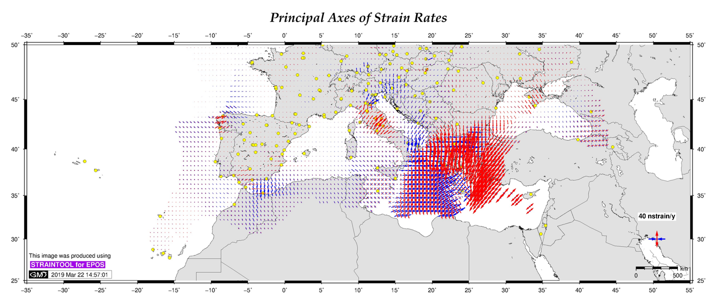


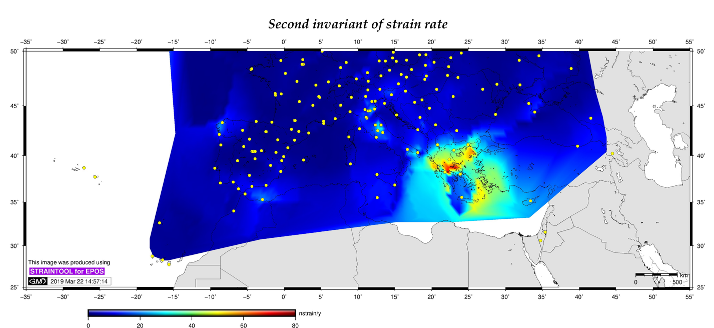






left part





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FUTURE RESEARCH

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Photography encouraged

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