



Estimation of the present-day deformation of the Western Alps

Juliette Grosset, Stephane Mazzotti, Philippe Vernant

► To cite this version:

Juliette Grosset, Stephane Mazzotti, Philippe Vernant. Estimation of the present-day deformation of the Western Alps. 5èmes Rencontres Scientifiques et Techniques Résif, Nov 2021, Obernai (67210), France. hal-03440372

HAL Id: hal-03440372

<https://hal.science/hal-03440372>

Submitted on 22 Nov 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Estimation of the present-day deformation of the Western Alps

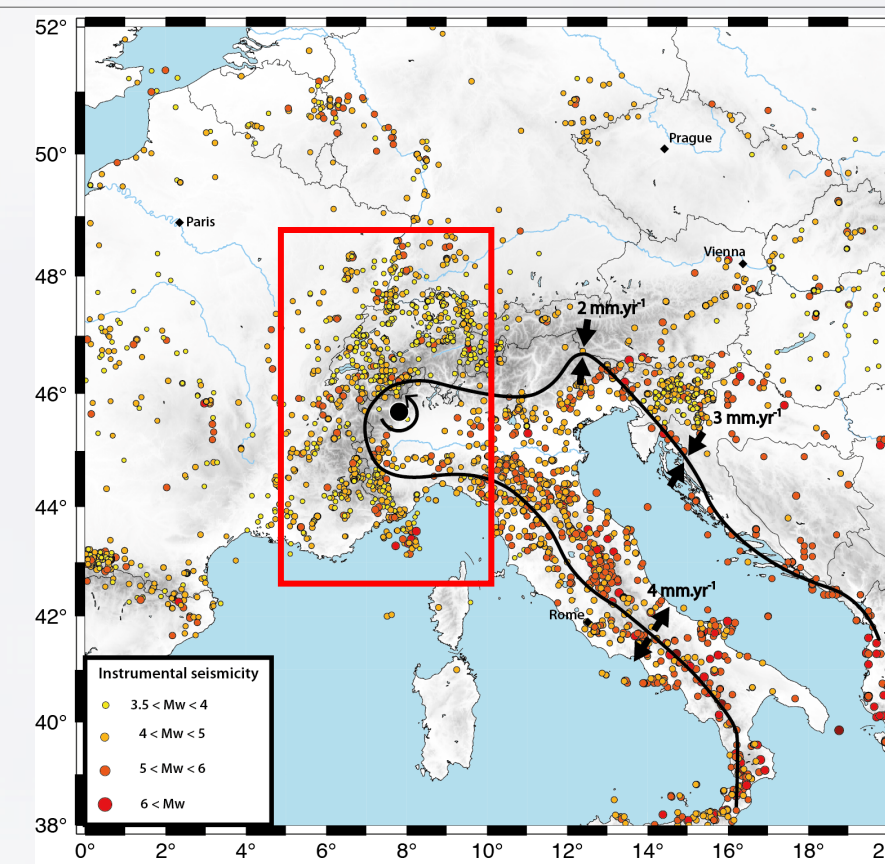
Juliette Grosset* ; Stéphane Mazzotti ; Philippe Vernant

Géosciences Montpellier, CNRS, Université de Montpellier, Montpellier, 34000, France

*Corresponding e-mail : juliette.grosset@umontpellier.fr

Introduction

The Western Alps is one of the most seismically active regions in western Europe with a large density of earthquakes and some historical damaging earthquakes (example: Bâle earthquake, 1356). The seismic strain computed from focal mechanisms shows a E-W to NW-SE extension in the French Alps, and a N-S extension in Southern Switzerland (Delacou et al., 2004).

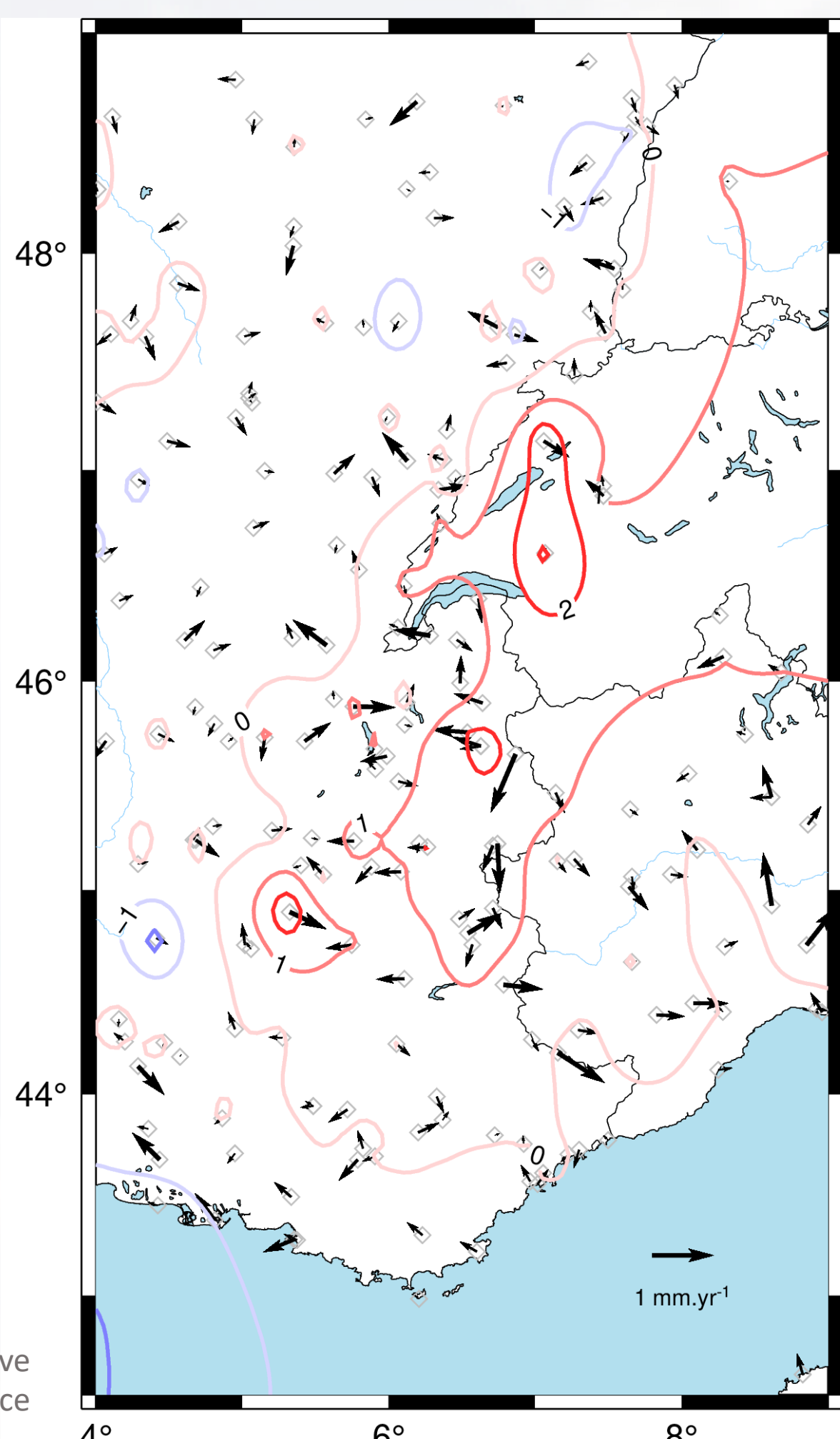


The identification of robust strain rate patterns in the Western Alps is made difficult by the low deformation rate in the region, hard to distinguish from the noise (Masson et al., 2019b; Walpersdorf et al., 2018). The precise characterization of present-day strain rate, and its spatial variability, is a crucial point to understand the origin of deformation. The main goal of this study is to identify a robust strain rate model by the re-evaluation of the GNSS horizontal velocities with recent data and the comparison of different datasets to identify common signals. We bring a comparison analysis on three velocity fields computed from three different networks.

datasets

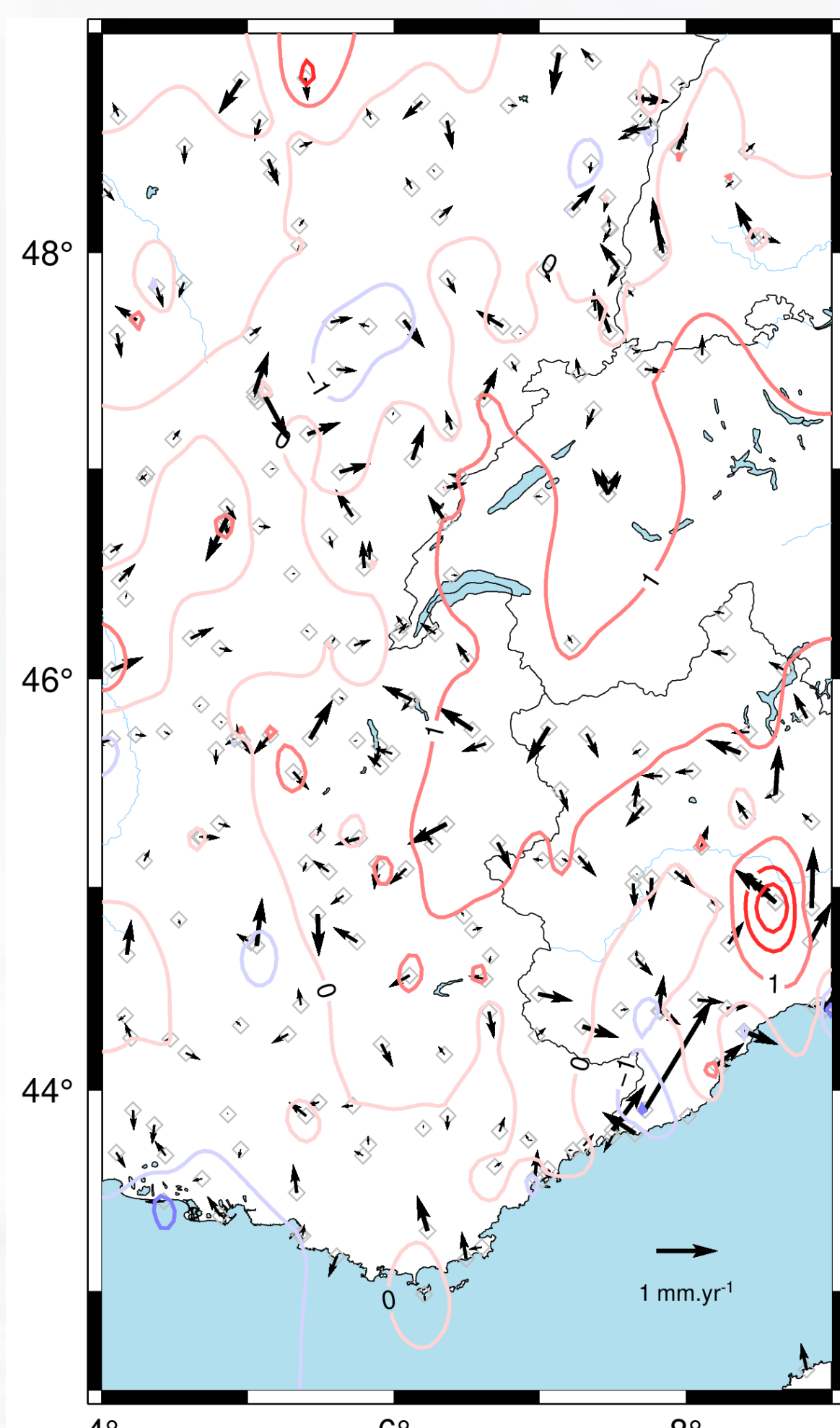
Géosciences Montpellier (GM)

- Computed by Christine Masson (Masson et al., 2019)
- 925 stations
- From 1998 to 2016 (mean duration of 7.9 years)
- Computed in a IGB08 reference frame*



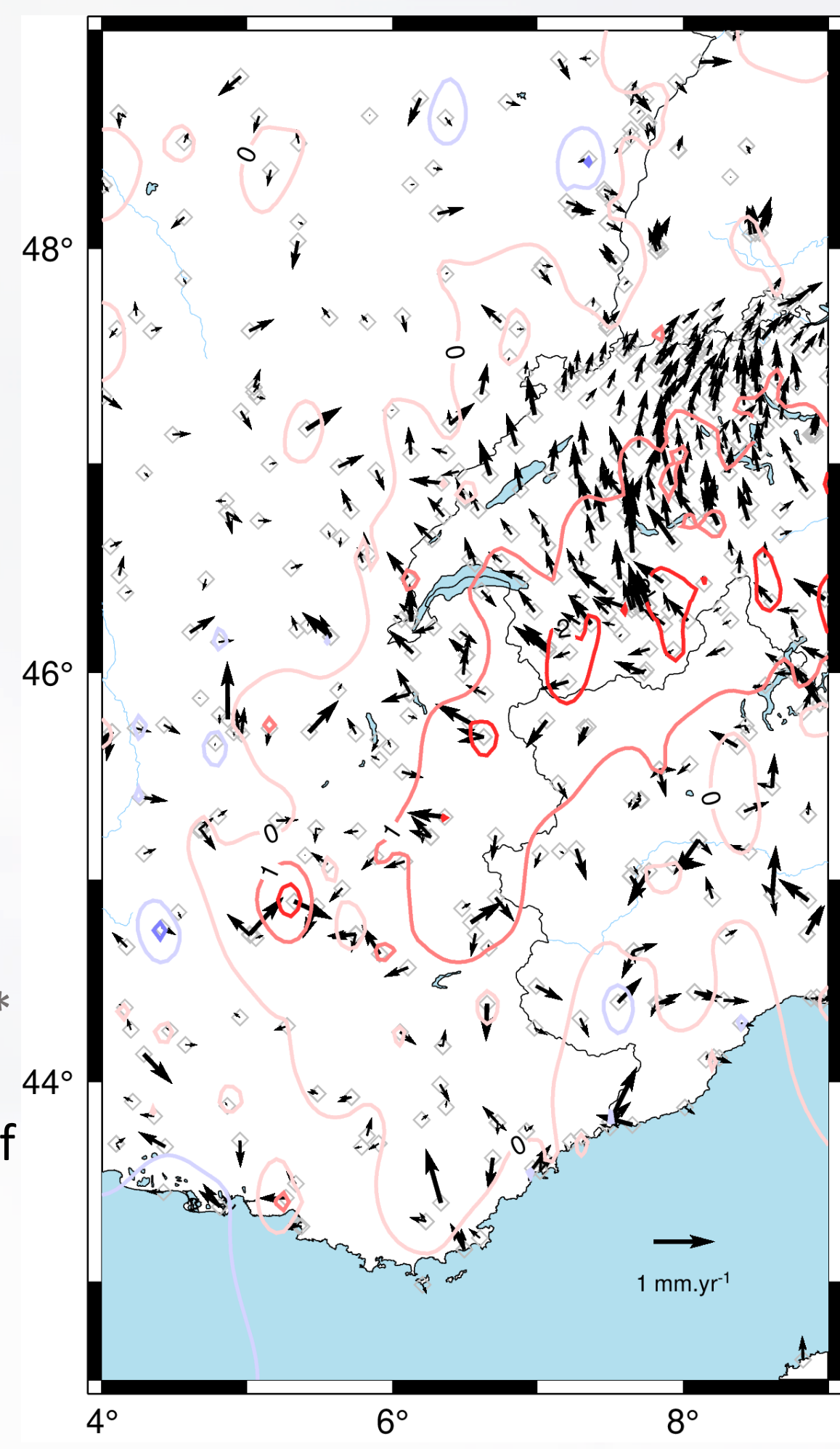
Nevada Geodetic Laboratory (NGL)

- Computed by Juliette Grosset for this study from the NGL position time series (Blewitt, 2018)
- 1123 stations
- From 1998 to 2021 (mean duration of 10 years)
- NGL data computed using JPL product in a IGS14 reference frame*



Swisstopo (ST)

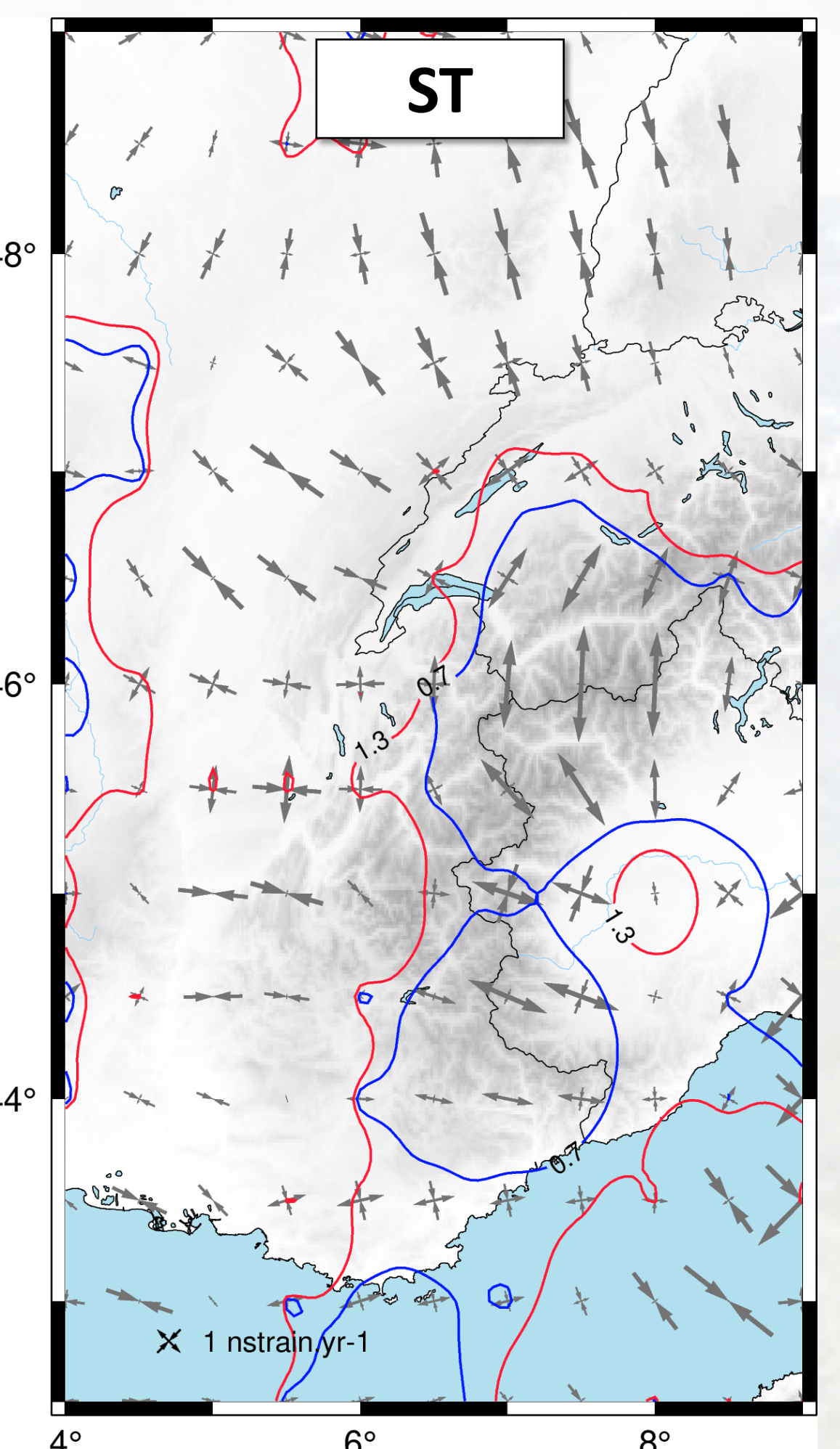
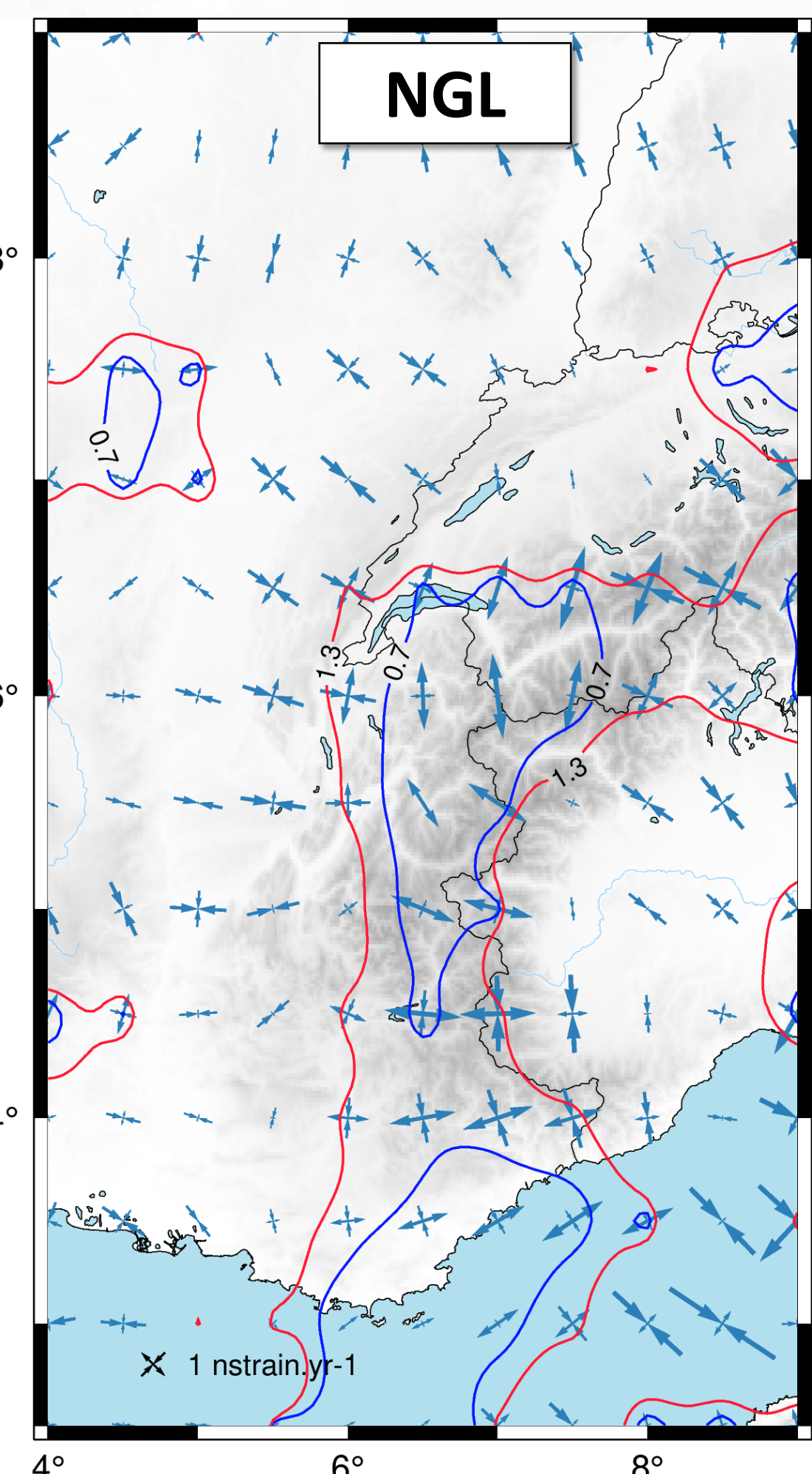
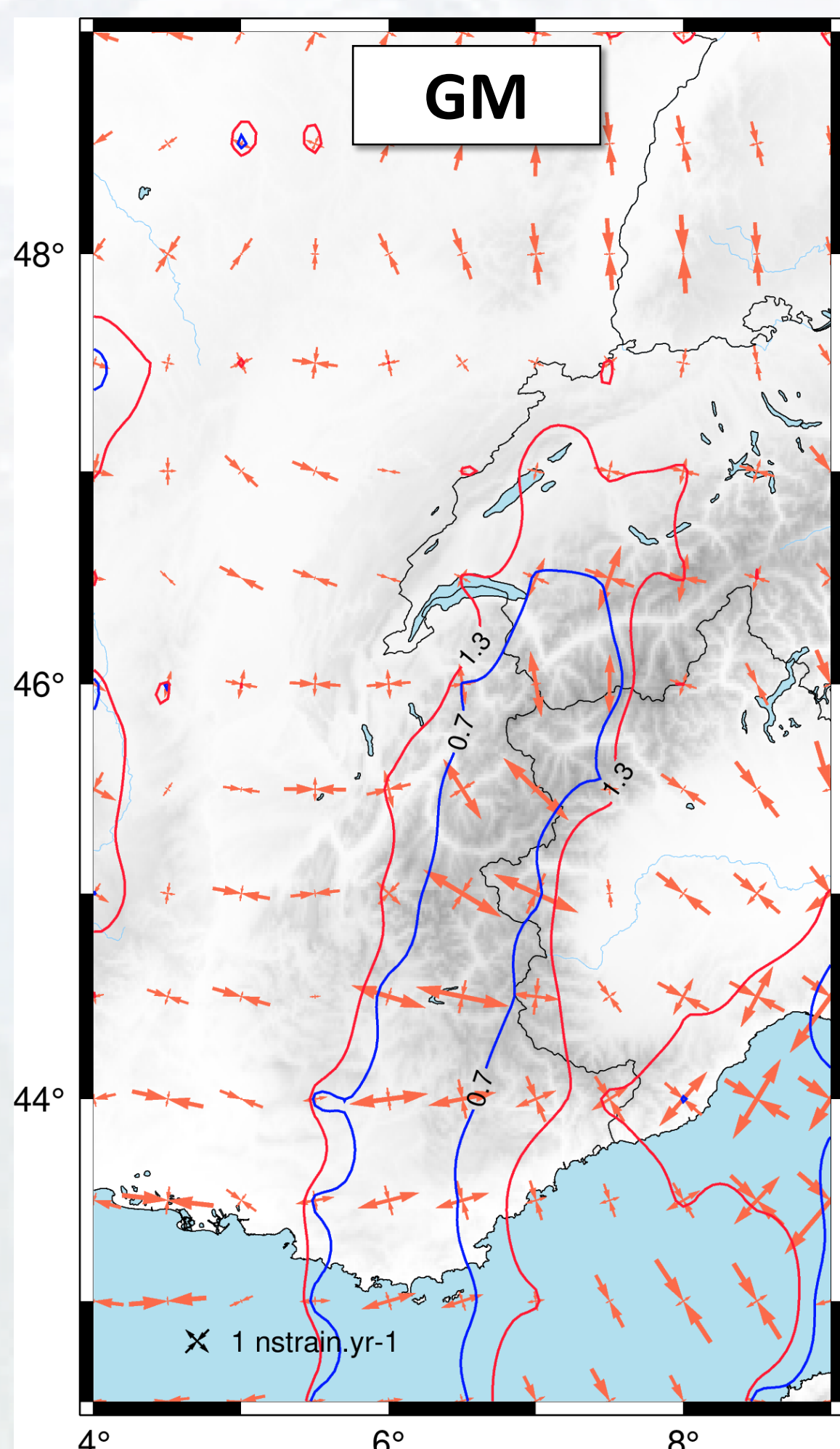
- Computed and communicated by Elmar Brockmann
- 4817 stations
- Compilation from 33 available velocities fields*
- Allows a good coverage of Switzerland



*Vertical velocities (represented with lines) have been corrected from their different reference frame to be compared

Strain rates

- Extension and strike-slip strain rates in the inner Alps, and shortening rates in the foreland.
- A N-S extension rate area is present on the three maps on the France-Switzerland-Italy border, from about 1.7 to 2.3×10^{-9} yr $^{-1}$
- The extension rate is associated in the French Alps with strike-slip (GM, NGL)
- Very low deformation rates in northern Switzerland.



$Extension < 0.7 < Strike - slip < 1.3 < Shortening$

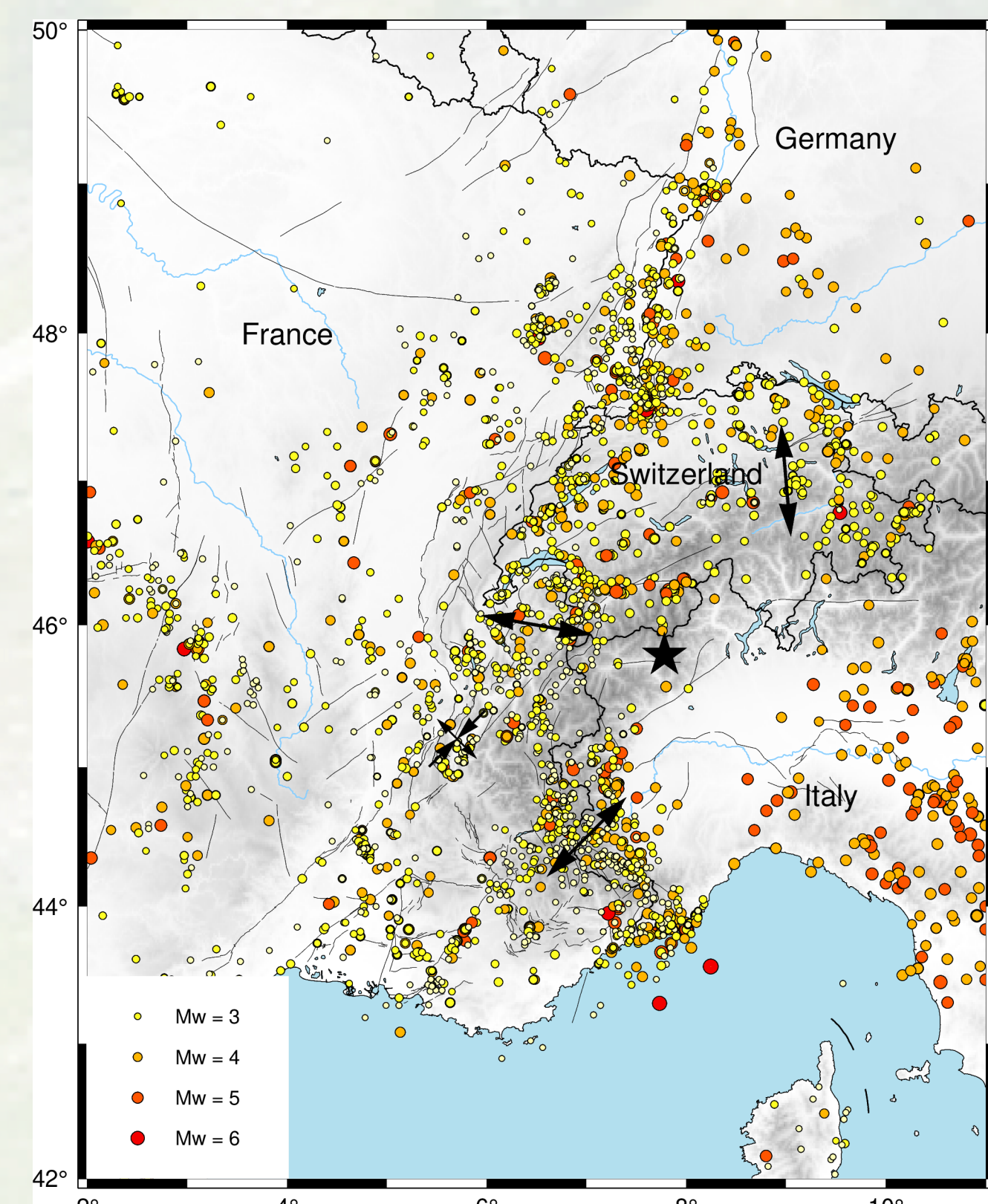
Synthesis

First-order synthetic strain rate map interpreted from the comparison of the 3 GNSS datasets. Demarcated area and arrows amplitude are extracted from the 3 strain rate map.

What are the processes of deformation in the Western Alps ?

- Uplift and extension rates are first-order consistent with isostatic adjustment processes, such as GIA (Mey et al., 2016, Grosset et al., submitted) or erosion (Vernant et al., 2013).
- French Alps extension rate/strike-slip could be influenced by Adria/Eurasia rotation (D'Agostino et al., 2008)
- None of these processes explained completely the shortening in the foreland.

Geodetical strain rate vs. Seismic strain ?



Reference

Blewitt, G. (2018). Harnessing the GPS Data Explosion for Interdisciplinary Science. <https://eos.org/science-updates/harnessing-the-gps-data-explosion-for-interdisciplinary-science>.
D'Agostino, N., Avallone, A., Cheloni, D., D'Anastasio, E., Mantenuto, S., and Selvaggi, G. (2008). Active tectonics of the Adriatic region from GPS and earthquake slip vectors. *Journal of Geophysical Research: Solid Earth*, 113(B12).
Delacou, B., Sue, C., Champagnac, J.-D., and Burkhard, M. (2004). Present-day geodynamics in the bend of the western and central Alps as constrained by earthquake analysis. *Geophysical Journal International*, 158(2):753–774.
Masson, C., Mazzotti, S., Vernant, P., and Doerflinger, E. (2019b). Extracting small deformation beyond individual station precision from dense Global Navigation Satellite System (GNSS) networks in France and western Europe. *Solid Earth*, 10(6):1905–1920.

Mathey, M., Sue, C., Pagani, C., Baize, S., Walpersdorf, A., Bodin, T., Husson, L., Hannouz, E., and Potin, B. (2021). Present-day geodynamics of the Western Alps: New insights from earthquake mechanisms. *Solid Earth*, 12(7):1661–1681.
Mey, J., Scherler, D., Wickert, A. D., Egholm, D. L., Tesauro, M., Schildgen, T. F., and Strecker, M. R. (2016). Glacial isostatic uplift of the European Alps. *Nature Communications*, 7(1):1–10.
Vernant, P., Hivert, F., Chéry, J., Steer, P., Cattin, R., and Rigo, A. (2013). Erosion-induced isostatic rebound triggers extension in low convergent mountain ranges. *Geology*, 41(4):467–470.
Walpersdorf, A., Pinget, L., Vernant, P., Sue, C., and Deprez, A. (2018). Does Long-Term GPS in the Western Alps Finally Confirm Earthquake Mechanisms? *Tectonics*, 37(10):3721–3737.

