M1/M2 internship at ICM-CSIC (Barcelona) / LGL-TPE (LYON)

Computing strain rates from diverse geodetic data set using the B-Strain transdimensional inversion tool

Background :

GNSS observations can be used to measure the velocity of the earth's surface at a given geographical point. If these measurements are made on a network of stations, they can be spatially interpolated and a continuous velocity field reconstructed. This velocity field can then be differentiated to reconstruct a map of the rate of deformation in a given region. These deformation maps contain a wealth of information (expansion/compression rates, shear, etc.) and are useful for understanding the tectonic processes at play in the region processes at play in the region, identify the most active structures and estimate the seismic hazard. However, the spatial distribution of GNSS stations is often irregular, leaving some areas undersampled, and standard techniques for calculating strain rates suffer from artifacts due to the uncertainties associated with interpolating velocities on a regular grid. At the LGL-TPE, we have developed an adaptive interpolation and differentiation method based on a transdimensional Bayesian approach, notably developed by Thomas Bodin for imaging the inner Earth. The B-Strain method has been successfully used in California [Pagani et a. 2021], in the Balkans [Métois et al., in prep], using GPS data sets assumed to be uniform.

Nevertheless, it is not uncommon to want to combine different datasets from different GNSS calculations, or from other geodetic techniques, in the same deformation rate calculation. For example, InSAR time series can now be used to extract interseismic velocities over vast regions with high spatial resolution (a few tens of meters for Sentinel 1A data). The B-Strain tool needs to be adapted to integrate different datasets in the same inversion.

Objectives :

The internship project aims to implement in the B-Strain tool the possibility of inverting several datasets simultaneously. This involves increasing the number of hyperparameters, as well as considering strategies for decimating InSAR data. The new version of B-Strain will be applied in mainland France and the Balkan area.

Tools :

The trainee should have a solid background in geosciences or computer science. He or she should be familiar with the B-Strain tools, mainly written in Fortran and available online at https://forge.univ-lyon1.fr/marianne.metois/bayesianstrainrate, as well as with the Bayesian transdimensional inversion method for theoretical aspects. The trainee will be required to work on cluster environments under UniX.

Scientific team and supervision :

The internship will take place at the Laboratoire de Géologie de Lyon (LGL-TPE) or the Institut de Ciències del Mar (Barcelona), under the supervision of Thomas Bodin (ICM), Marianne Métois (LGLTPE, Lyon) and Cécile Lasserre (LGLTPE, Lyon). The student will collaborate with Aimine Méridi, a thesis student on Balkan tectonics.

Practical information:

Internship gratification provided by a CNES or INSU PNTS AAP project (GIPI project).

To apply :
Please send a CV, a covering letter and possibly the names of referees we could contact : tbodin@icm.csic.es , cecile.lasserre@univ-lyon1.fr, marianne.metois@univ-lyon1.fr

References:

Pagani, C., Bodin, T., Métois, M., & Lasserre, C. (2021). Bayesian estimation of surface strain rates from global navigation satellite system measurements: Application to the southwestern United States. *Journal of Geophysical Research: Solid Earth*, *126*(6), e2021JB021905. Lien

Bodin, T., Sambridge, M., Rawlinson, N., & Arroucau, P. (2012). Transdimensional tomography with unknown data noise. Geophysical Journal International, 189(3), 1536–1556. https://doi.org/10.1111/j.1365-246x.2012.05414.x

https://forge.univ-lyon1.fr/marianne.metois/bayesianstrainrate

https://bstrain.readthedocs.io/en/latest/

https://bstrainplotter.univ-lyon1.fr/