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► **To cite this version:**

Aline Déprez, Anne Socquet, Nathalie Cotte, Andrea Walpersdorf, M.G. Bato. EPOS-GNSS: Prototype solution in double difference from CNRS-UGA analysis center. 18th General Assembly of WE-GENER: Understanding Earth deformation at plate boundaries, Sep 2016, Ponta Delgada, Azores, Portugal. , 2016. hal-01958414

HAL Id: hal-01958414

<https://hal.science/hal-01958414>

Submitted on 18 Dec 2018

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EPOS-GNSS: prototype solution in double difference from CNRS-UGA analysis center

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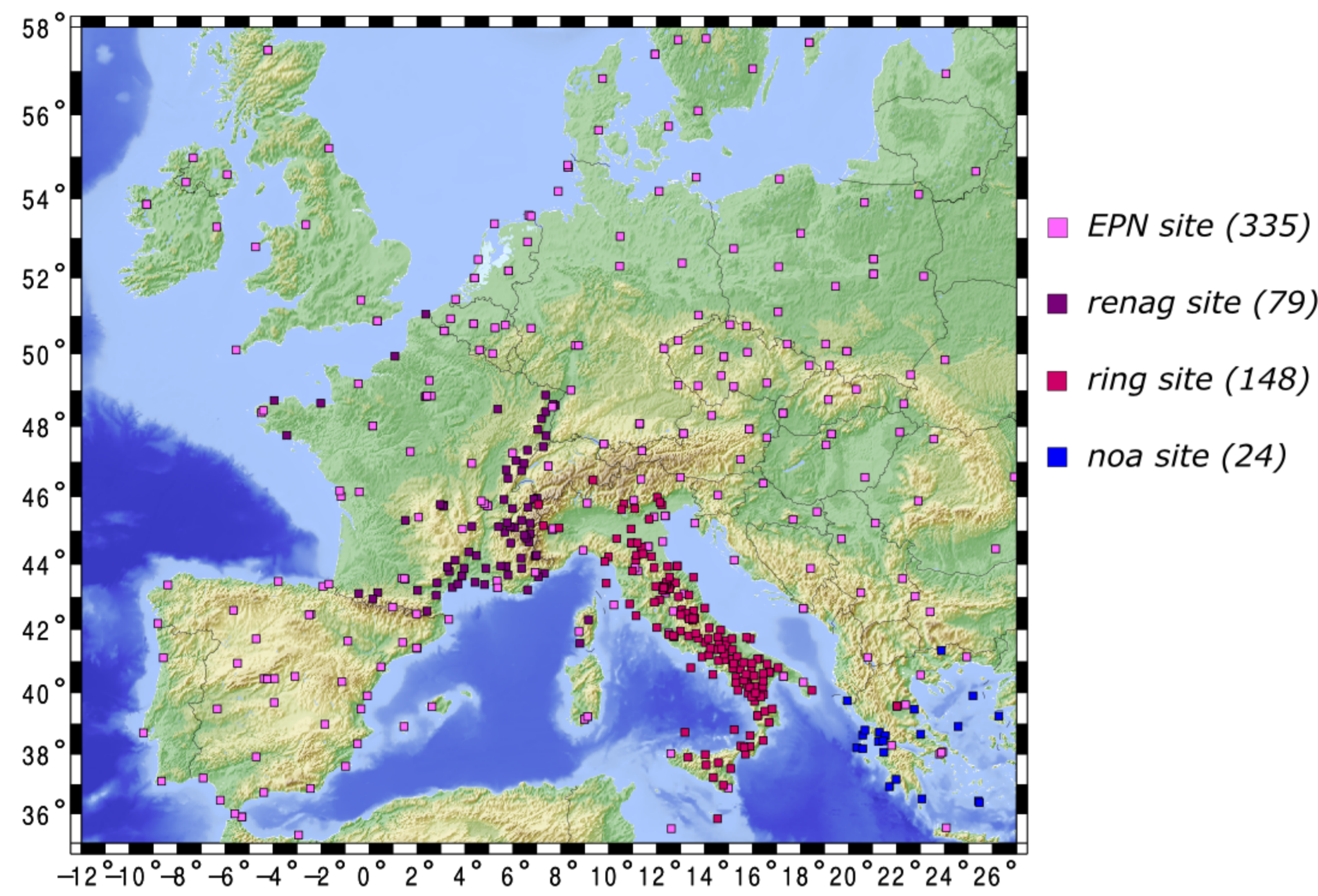
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1. Data bases

The prototype EPOS solution spans the **2005-2015 period** and includes about **600 European permanent stations**.

Network of the European permanent stations used for the prototype EPOS solution



The RINEX data and metadata were downloaded from archive centres (GSAC nodes) maintained in:

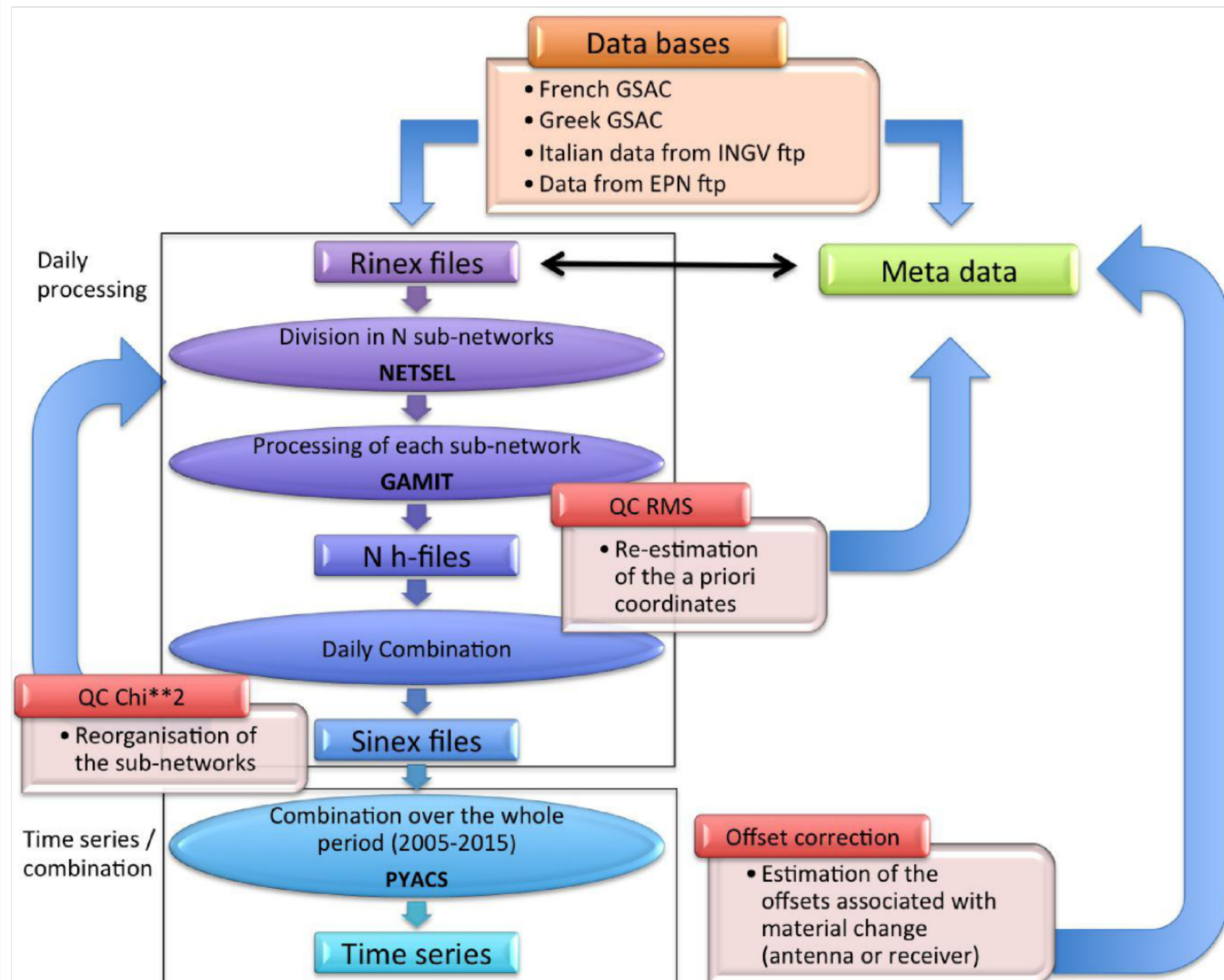
- **France** (CNRS-OCA): RENAG cGPS network
- **Greece**: NOA cGPS network
- **Italy** (INGV): RING cGPS network

Data from the European Permanent Network (EPN), downloaded from the EPN server, were also included.

Our data set is stored on a distributed data-management system called **IRODS**, maintained in the University Grenoble Alpes (UGA), France. It consists in about **1 850 000 rinex files** of about **3kb**, being an amount of data of about **750G**.

Data were processed in double difference with **GAMIT/GLOBK** software.

2. Processing chart

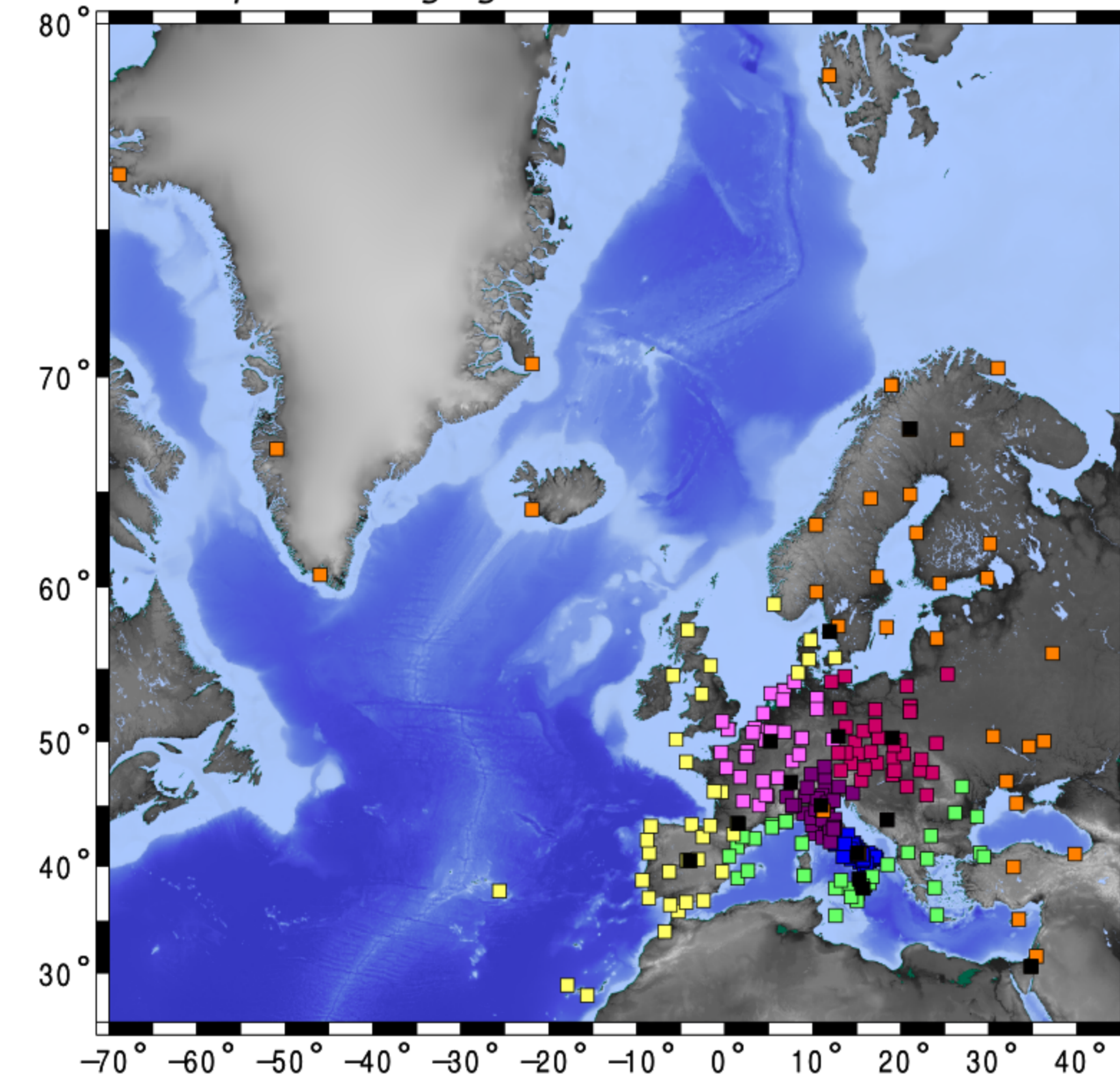


3. Daily processing

a. Division in N sub-networks

For each day independently, the network is first split into **sub-networks** (between 8 and 14 subnetworks) using **NETSEL** tool included in the GAMIT/GLOBK package. The sub-networks consist in about **40 stations**, with **2 overlapping** stations.

Example of division in 8 sub-networks for the day 100 in 2006. The tie sub-network, in black, consists in a set of station couples belonging to the 7 others sub-networks



It allowed us to define parameters of the jobs (GAMIT processing) to launch on a distributed system.

b. All sub-network processing

For each day and for each sub-network the GAMIT processing is **conducted independently** on the **high performance computing platform** CIMENT hosted at UGA. Theoretically, for the EPOS prototype solution, 56 400 jobs have to be launched. These jobs, launched in **best-effort** on 3 different clusters, present an identical format with a walltime of 2h. The mean duration of these jobs is **25 min**. At the end of this step, a GAMIT **h-file** is available for each couple day/sub-network.

c. Daily combination

An other set of about 4000 (in theory) very short jobs has to be launch to **combine the h-files** of the different sub-networks and obtain a daily solution for the whole network. These jobs last a **few minutes**.

The **daily solution** is obtained at that time in the form of a **SINEX file**. The whole SINEX file set consists in an amount of about **400G**.

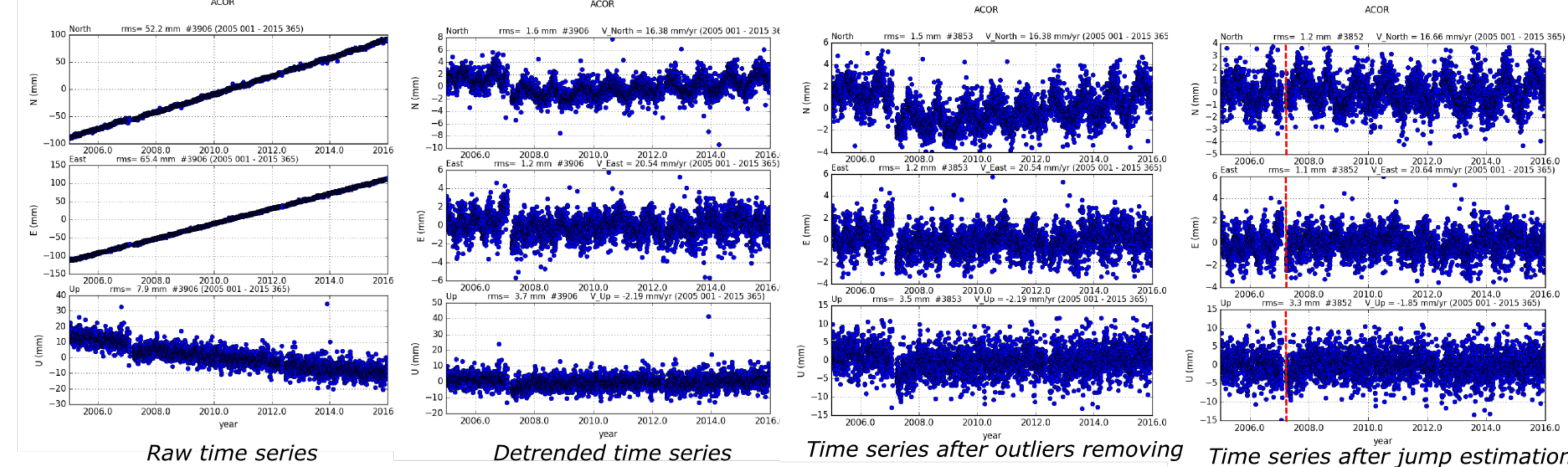
4. Quality check

Along our processing chain, we included **two quality checks**. After the GAMIT processing of the sub-networks, we checked the **RMS value**. The unexpected high RMS values were due to no accurate enough **a priori coordinates** for some sites. We re-estimated them and re-launched the processing of the sub-network. After the daily combination a few SINEX files were associated with high **CHI**2 value**. A **sub-networks reorganisation** allowed us to optimize the consistency within the daily sub-network set.

5. Products

a. Time series combination

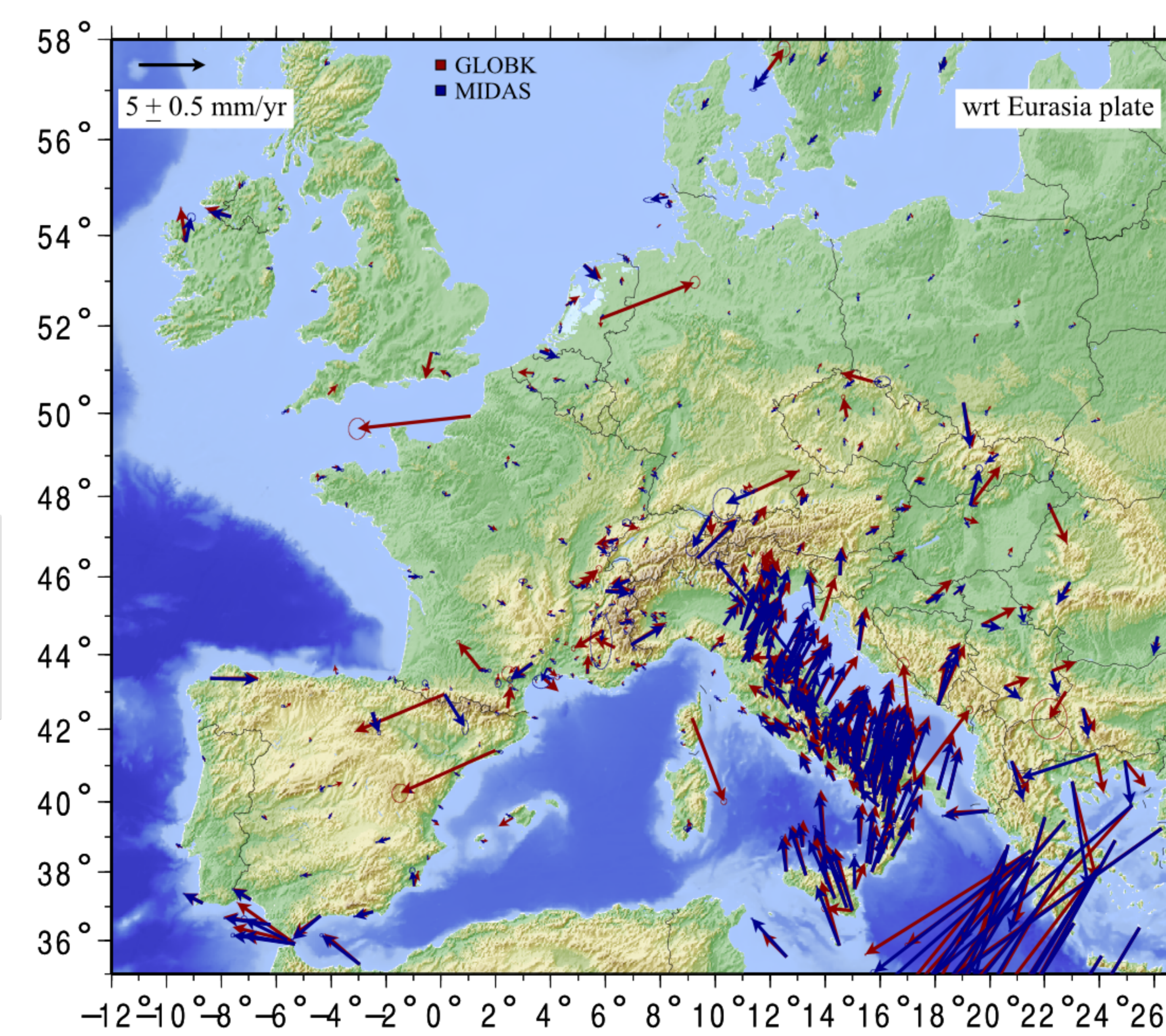
Example of time series processing for the station A Coruna (ACOR) in Spain



The **PYACS** software was used to **compute the time series**. PYACS consists in a set of tools, written in python language and dedicated to the analysis of geodetic data. It was developed in Observatoire de la Côte d'Azur in Nice (France) by J.M. Nocquet. This package allowed us to **visualize the position time series** for each station, to **detrend it**, to **remove potential outliers** and to **estimate and correct** for the **jumps** associated with **material changes** (antenna or receiver).

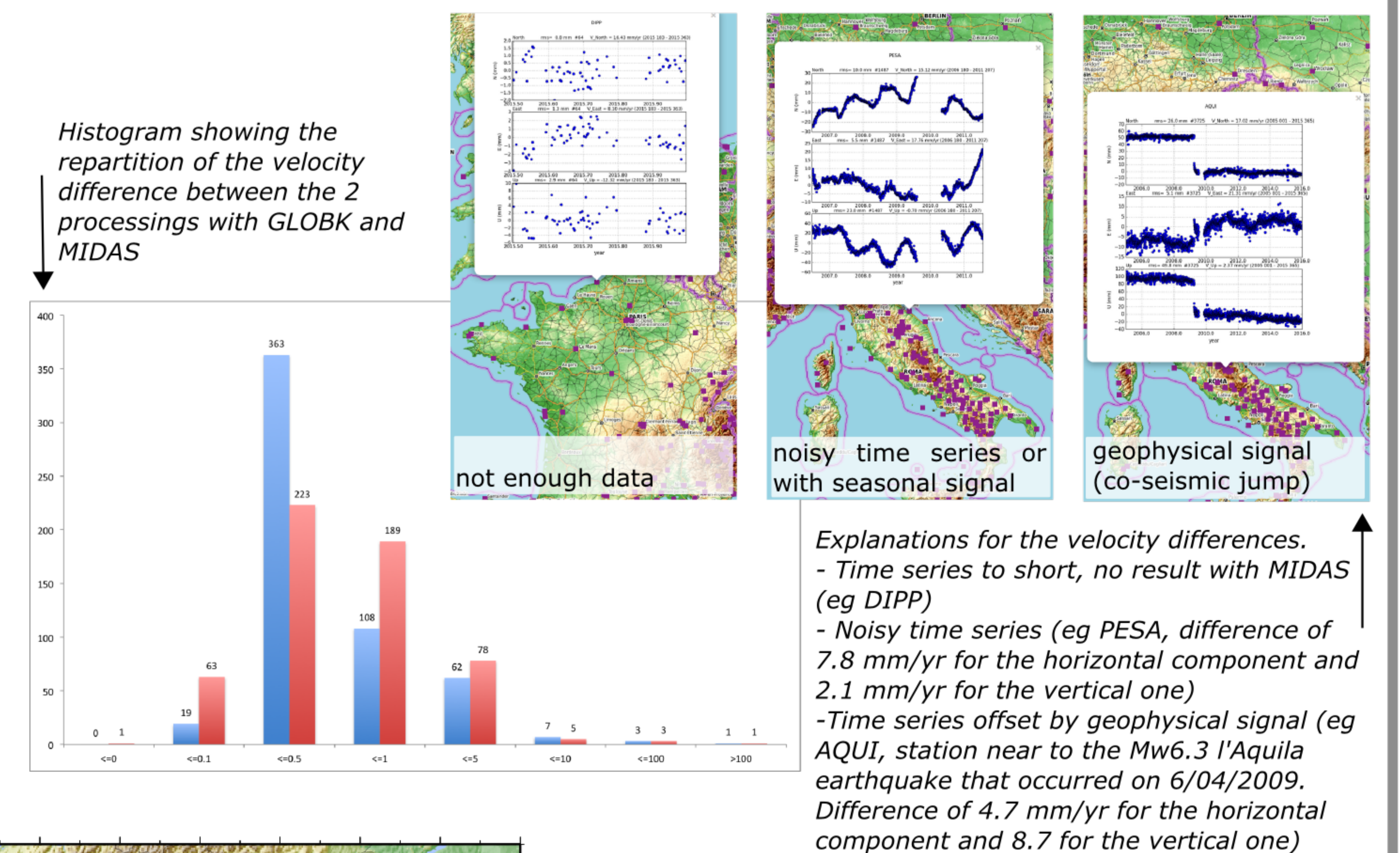
b. Velocity field computation

Comparison of 2005-2015 velocity field obtained with either GLOBK or MIDAS softwares

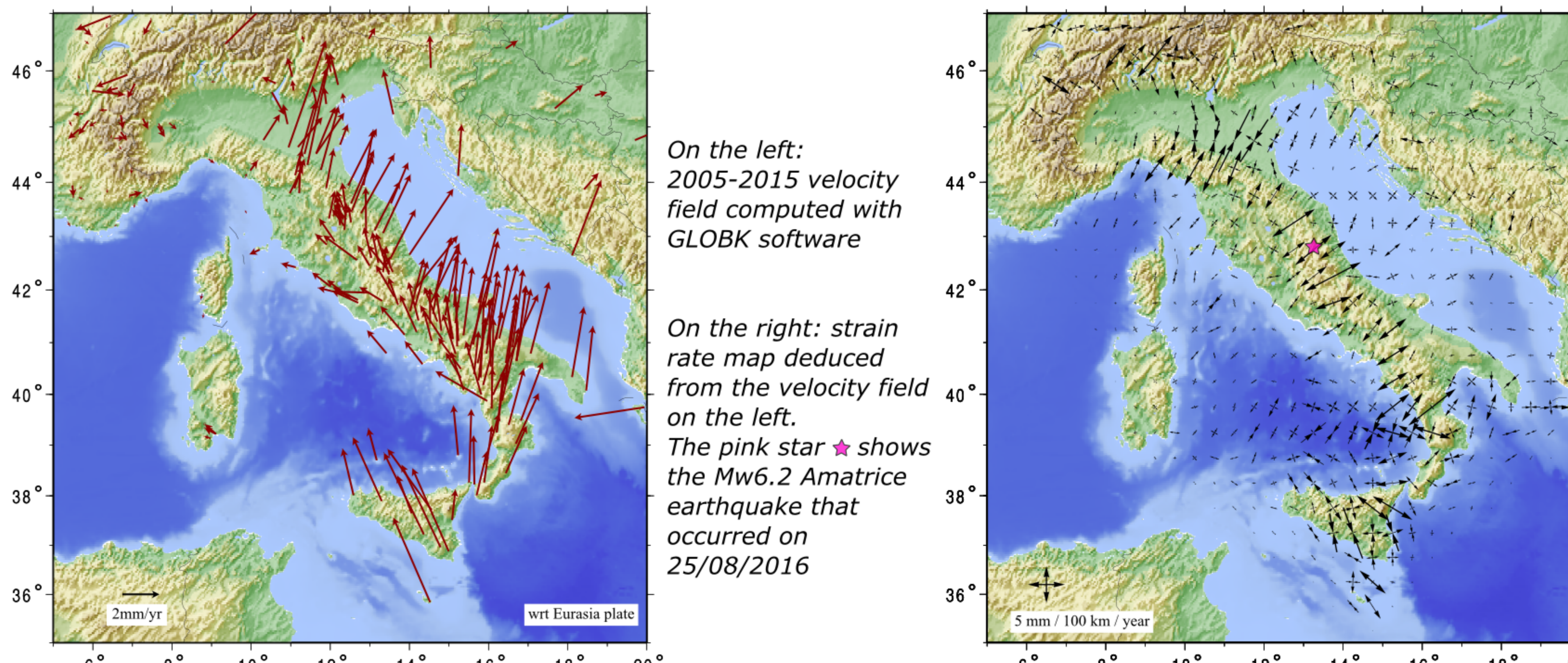


We computed the 2005-2015 **velocity field** by using GLOBK software. Such a combination on 11 years with about 600 stations is very **time consuming** (more than 100h). This no splittable step is exposed to computer instability that is why we are **looking for a faster method**.

MIDAS software, developed by G. Blewitt in Nevada Geodetic Laboratory (USA), seems to be a good alternative, that we are actually testing. We compared the 2 velocity fields and highlighted significant differences for some site.



c. Strain rate computation



After a selection of reliable sites in Italy and surrounding areas, we made some tests for the **strain rate computation**, using a set of tools developed by Y. Ziegler in Ecole et Observatoire des Sciences de la Terre, Strasbourg (France).

References:
 Blewitt, G., C. Kreemer, W.C. Hammond, J. Gazeaux, 2016, MIDAS robust trend estimator for accurate GPS station velocities without step detection, accepted for publication in the Journal of Geophysical Research, doi: 10.1002/2015JB012552
 Masson, F., Lehujeur, M., Ziegler, Y., and Doubre, C. (2014). Strain rate tensor in Iran from a new GPS velocity field. Geophys. J. Int., 197(1) :10-21.