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

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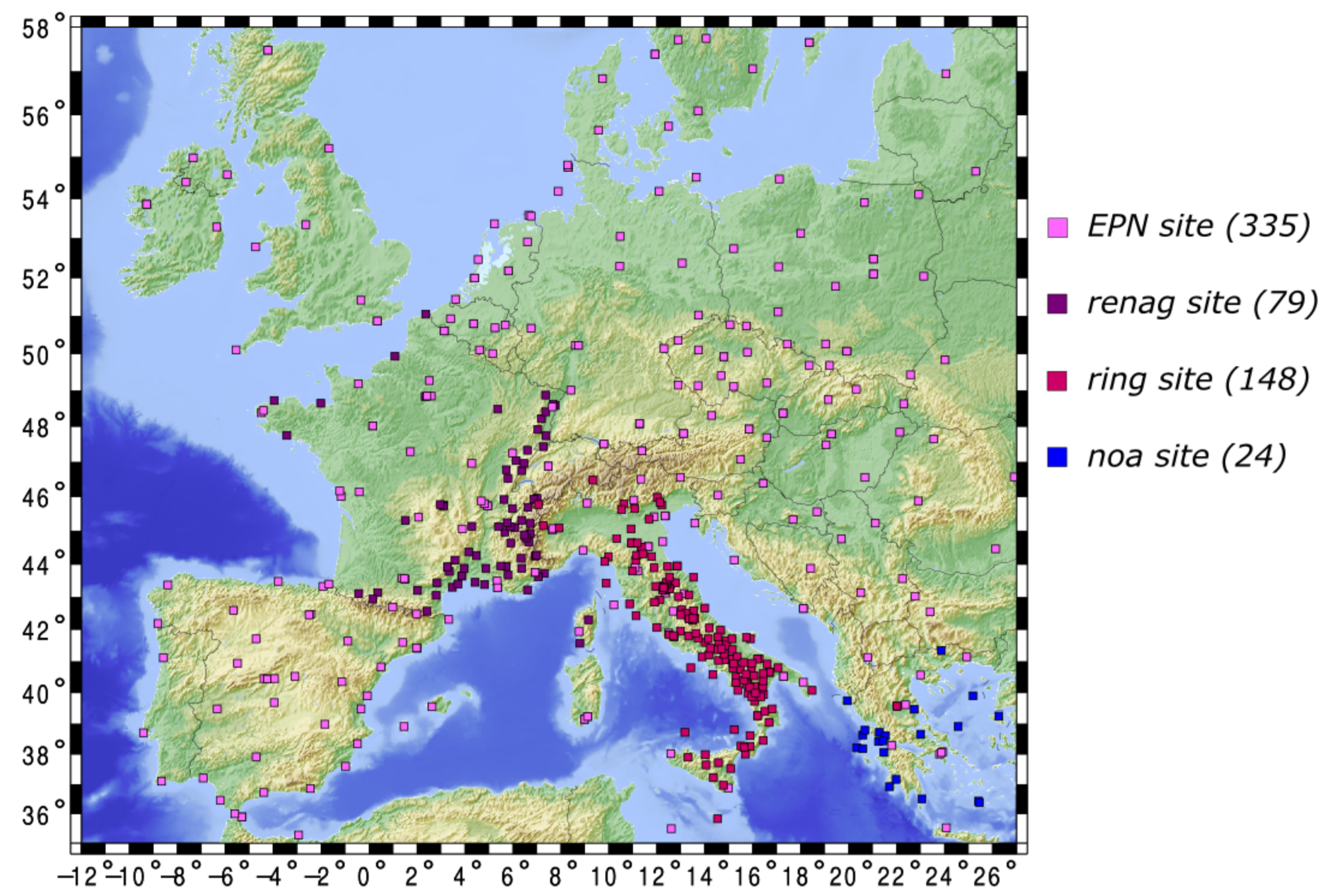
(1) ISTERre, CNRS-Université Grenoble Alpes, FRANCE
 (2) ISTERre, CNRS-Université Savoie Mont-Blanc, FRANCE



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:

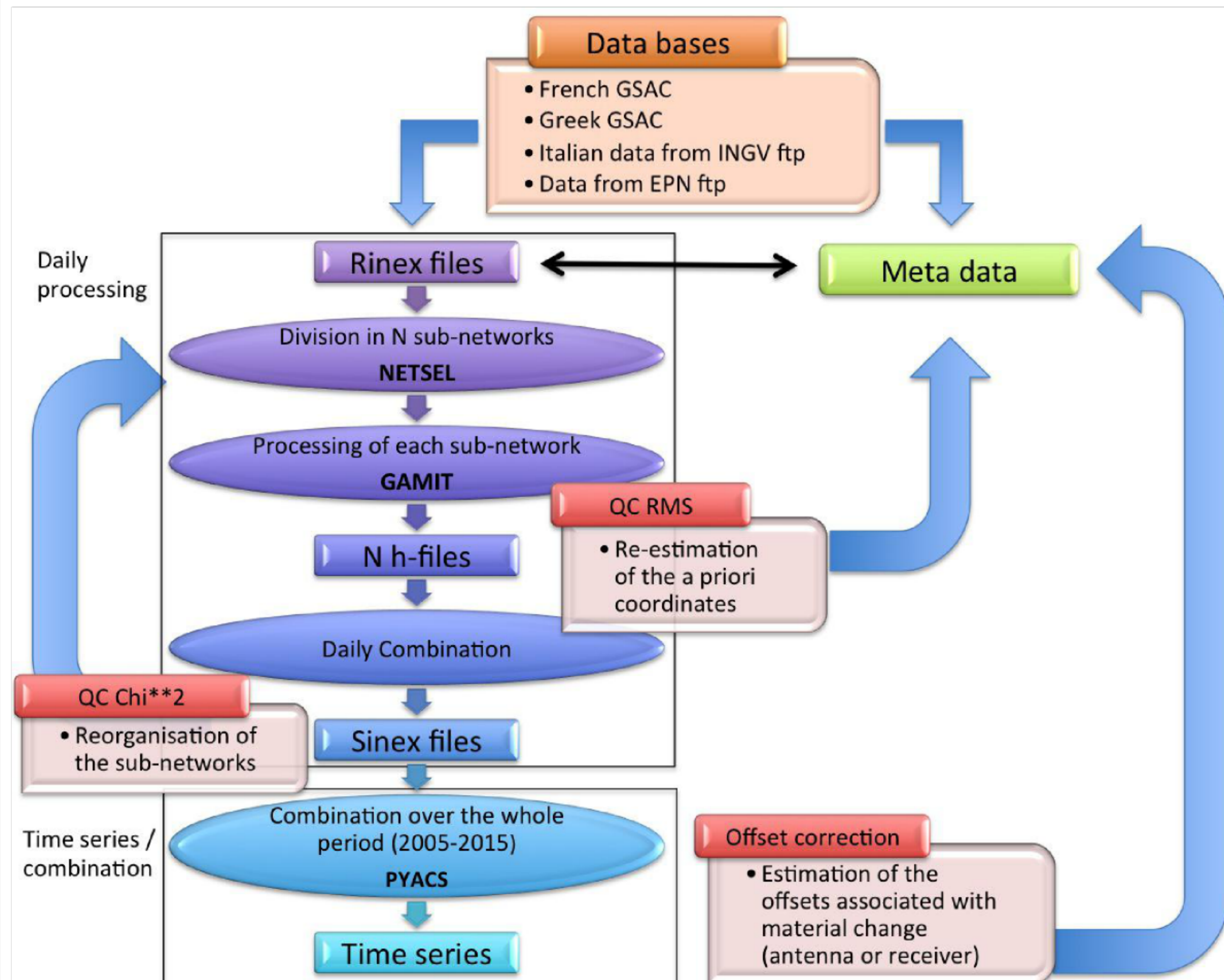
- **France** (CNRS-OCA): RENAG cGPS network
- **Greece**: NOA cGPS network
- **Italy** (INGV): RING cGPS network

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

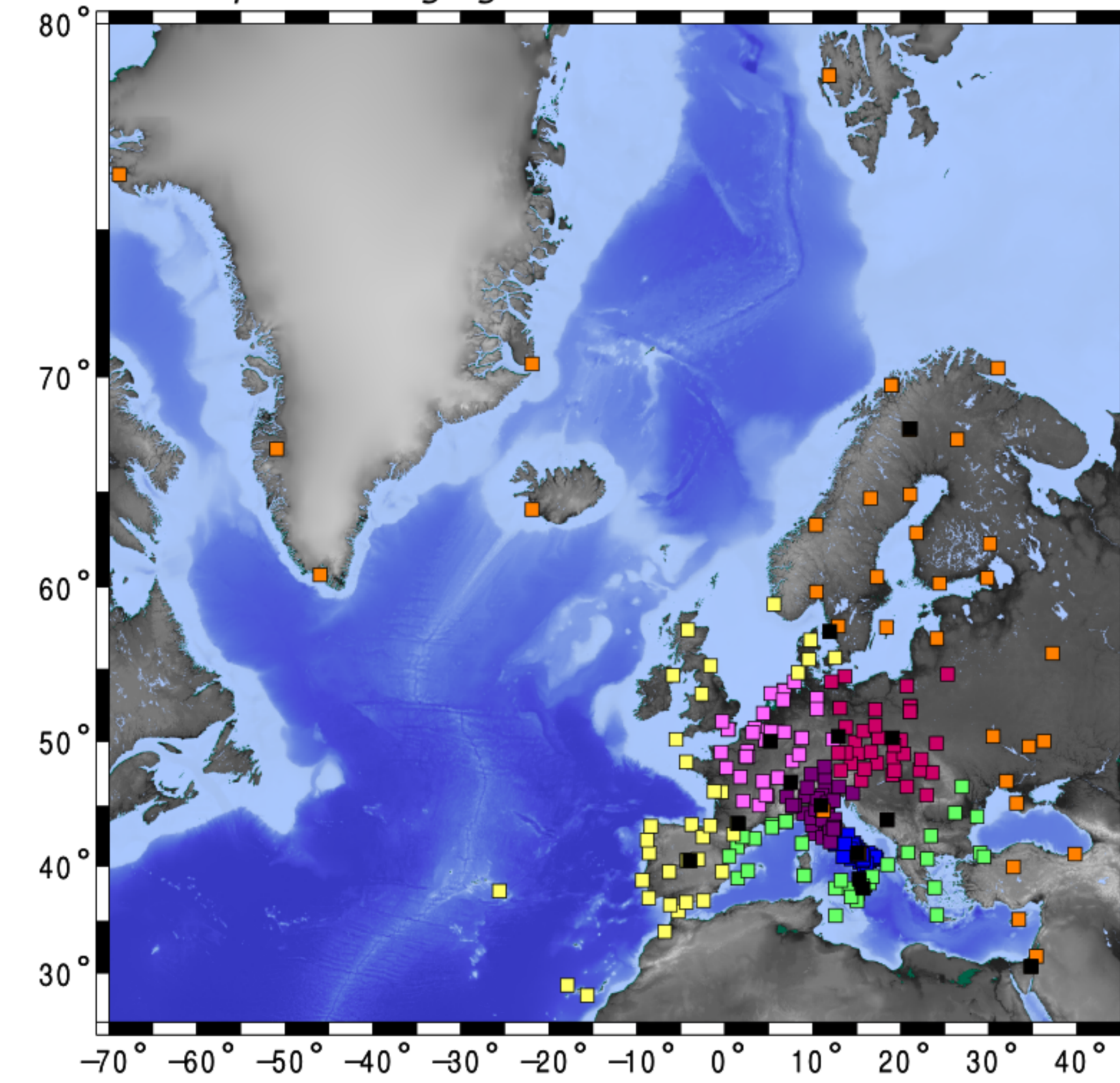


3. Daily processing

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**.

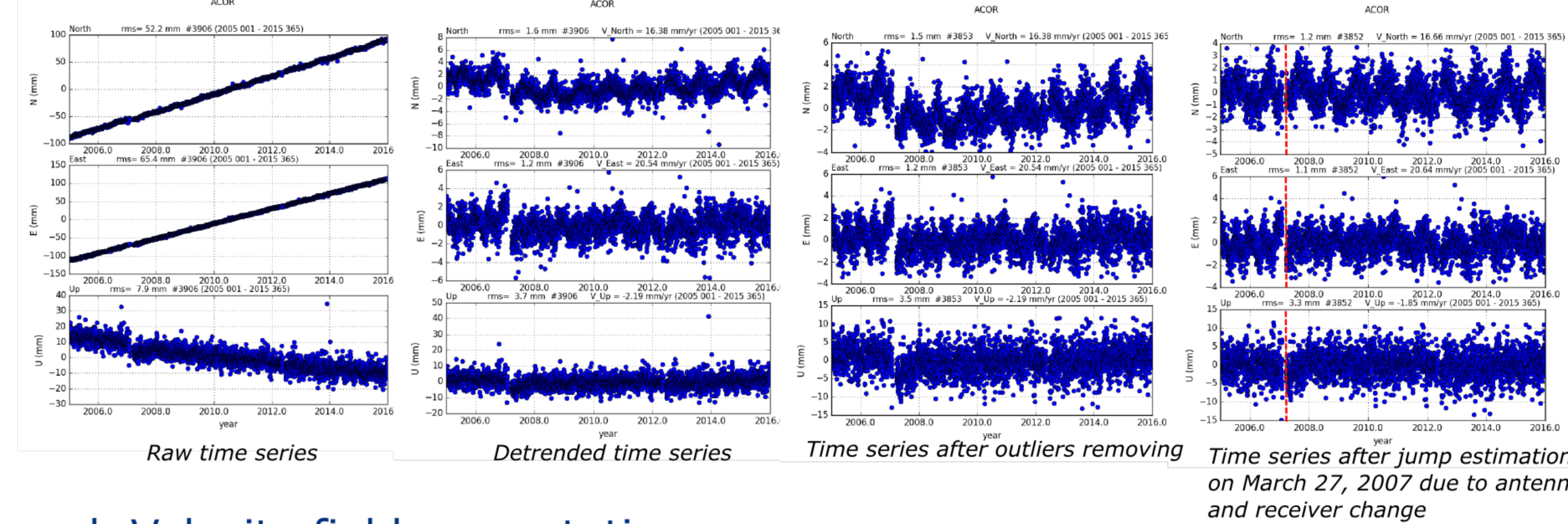
4. Quality check

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

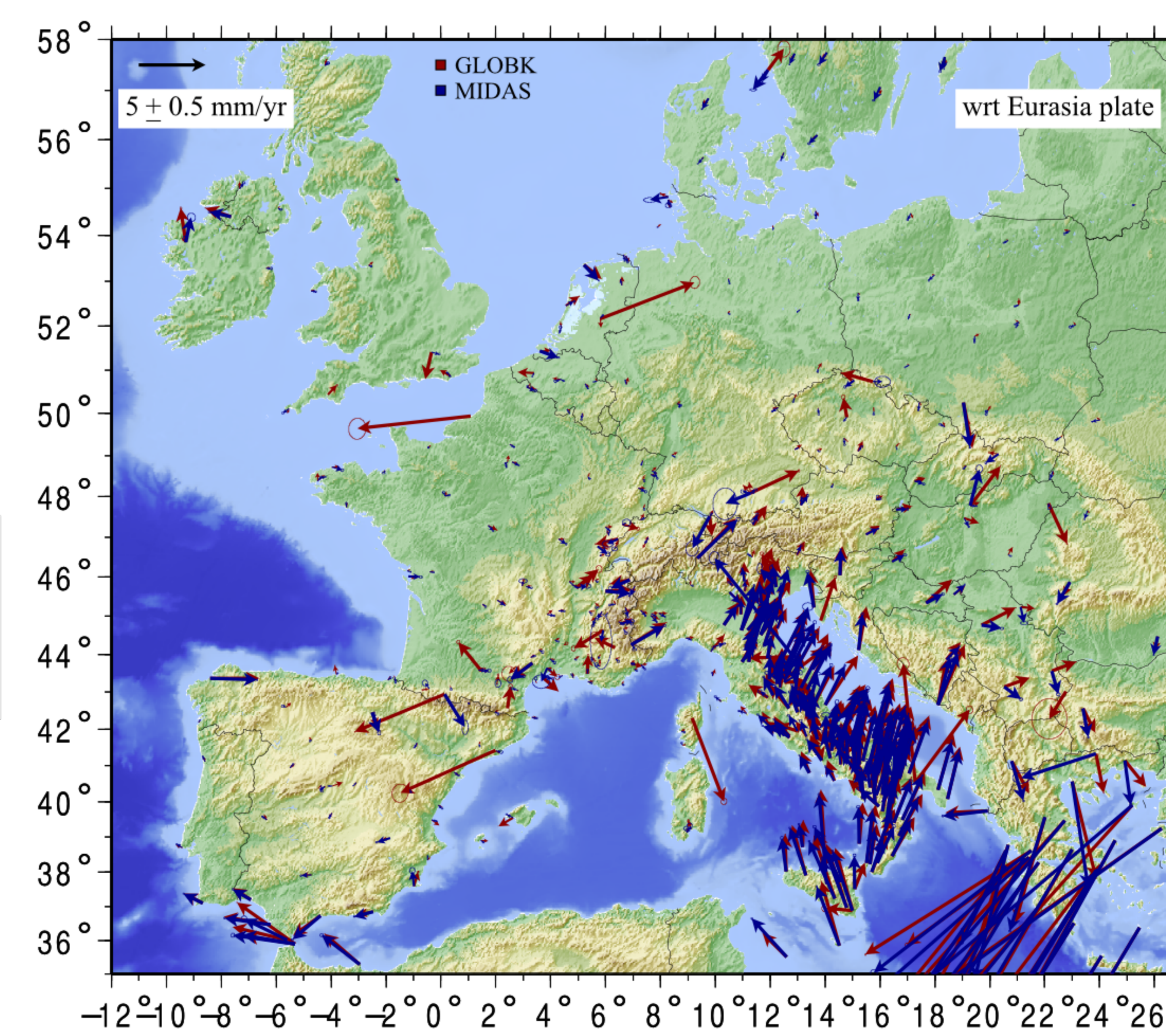
a. Time series combination

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



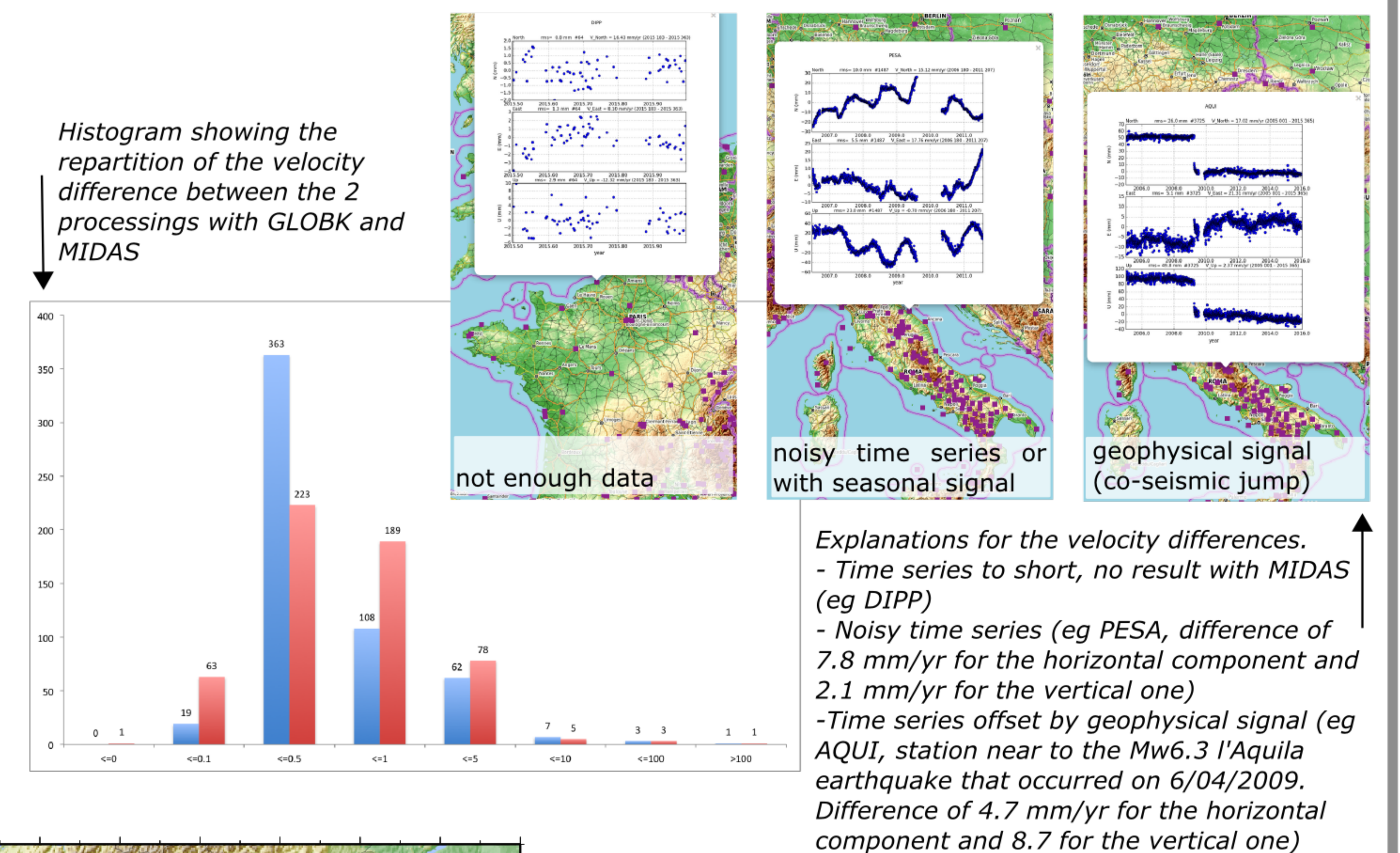
b. Velocity field computation

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

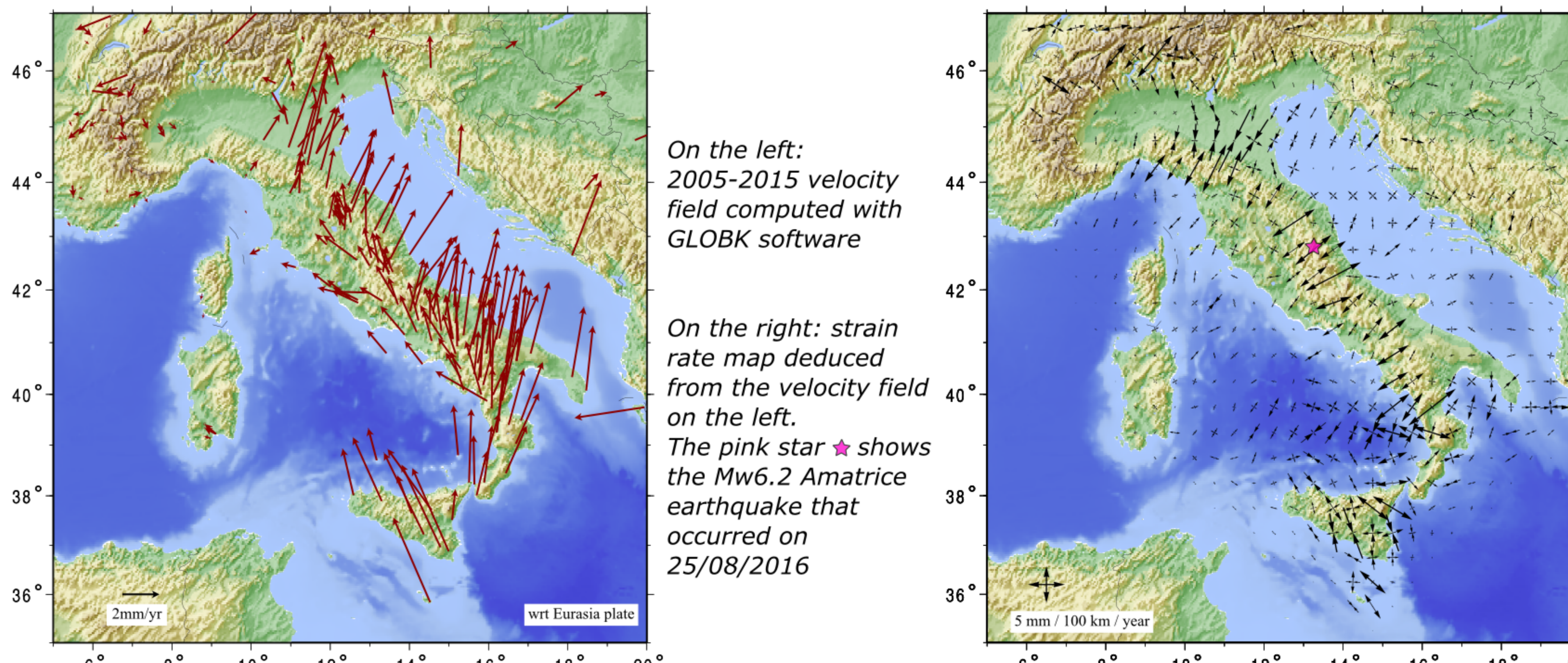


We computed the 2005-2015 **velocity field** by using GLOBK software. Such a combination on 11 years with about 600 stations is very **time consuming** (more than 100h). This no splittable step is exposed to computer instability that is why we are looking for a faster method.

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.