EPOS-GNSS - Processing GNSS data with gamit/globk

Rencontres RESIF

November 18th 2021

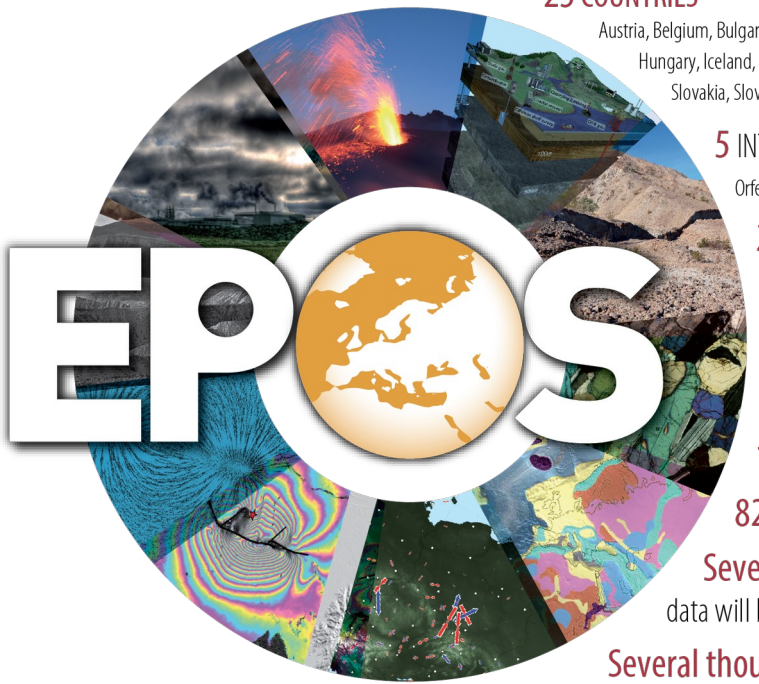
Gaël Janex, Anne Socquet, Andrea Walpersdorf

...and previously Aline Déprez, Alizia Tarayoun, Nathalie Cotte, Mary Grace Bato

EPOS

Goal : answering some of the most pressing societal questions concerning geo-hazards and those geodynamic phenomena relevant to the environment and human welfare.

The European Plate Observing System is a **multidisciplinary, distributed research infrastructure** that facilitates the **integrated use of data, data products, and facilities** from the solid Earth science community in Europe.



25 COUNTRIES

Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Grecee, Hungary, Iceland, Ireland, Italy, The Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom

5 INTERNATIONAL ORGANIZATIONS

Orfeus, EMSC, EUREF, INTERMAGNET, EuroGeoSurveys

256 NATIONAL RESEARCH INFRASTRUCTURES

4939 SEISMIC STATIONS

2272 GPS RECEIVERS

464 TB SEISMIC DATA

118 LABORATORIES

828 INSTRUMENTS

Several PetaBytes of solid Earth Science data will be available

Several thousands of **users** expected to access the infrastructure

EPOS ensures the **long-term access** to solid Earth science data and services.

EPOS-GNSS

EPOS-GNSS is one of the 9 EPOS Thematic Core Service (TCS)

The mission of the GNSS TCS is to **provide access to GNSS data, metadata, products, and software** in support of the Solid Earth Sciences.

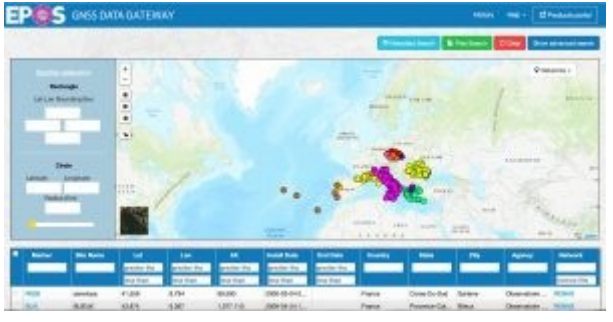
To achieve this goal, EPOS-GNSS:

- coordinates the archiving and distribution of relevant GNSS data, metadata and data products
- promotes best practice for GNSS station operation, data quality control and data management
- maintains and distributes open source software for GNSS data, metadata and product discoverability

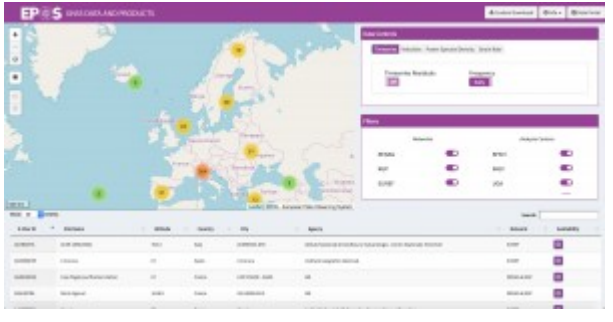
14 services (Data, Data Products, Software and Services)
3 community portals :

Metadata :
gnss-metadata.eu

Data :
gnssdata-epos.oca.eu



Products :
gnssproducts.epos.ubi.pt



GNSS processing within EPOS-GNSS

UGA / CNRS deliverables :

- Double-difference processing (GAMIT/GLOBK, Herring et al., 2015)
  - Time series for EPOS stations
    - Automatic d+2 and d+25 processing
  - Velocities derived from time series

GAMIT/GLOBK

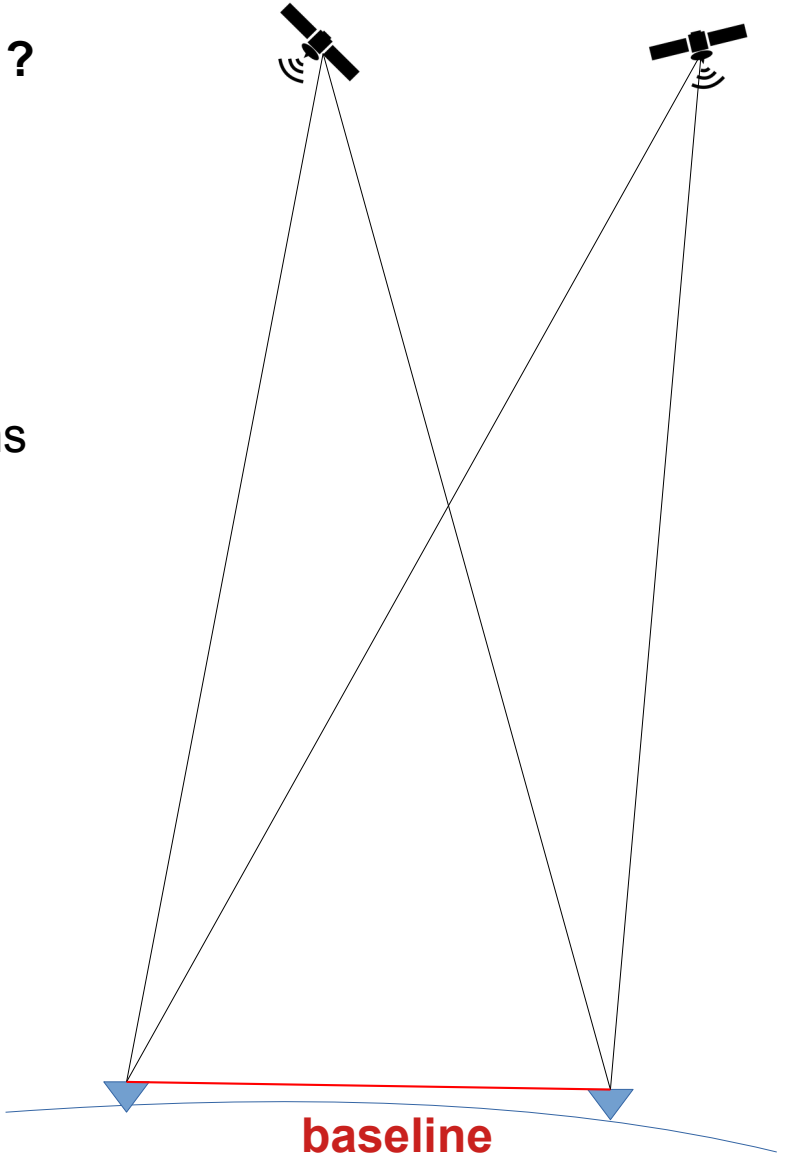
INGV deliverables :

- PPP (Precise Point Positioning) processing (GIPSY)
  - Time series for EPOS stations
  - Velocities derived from time series

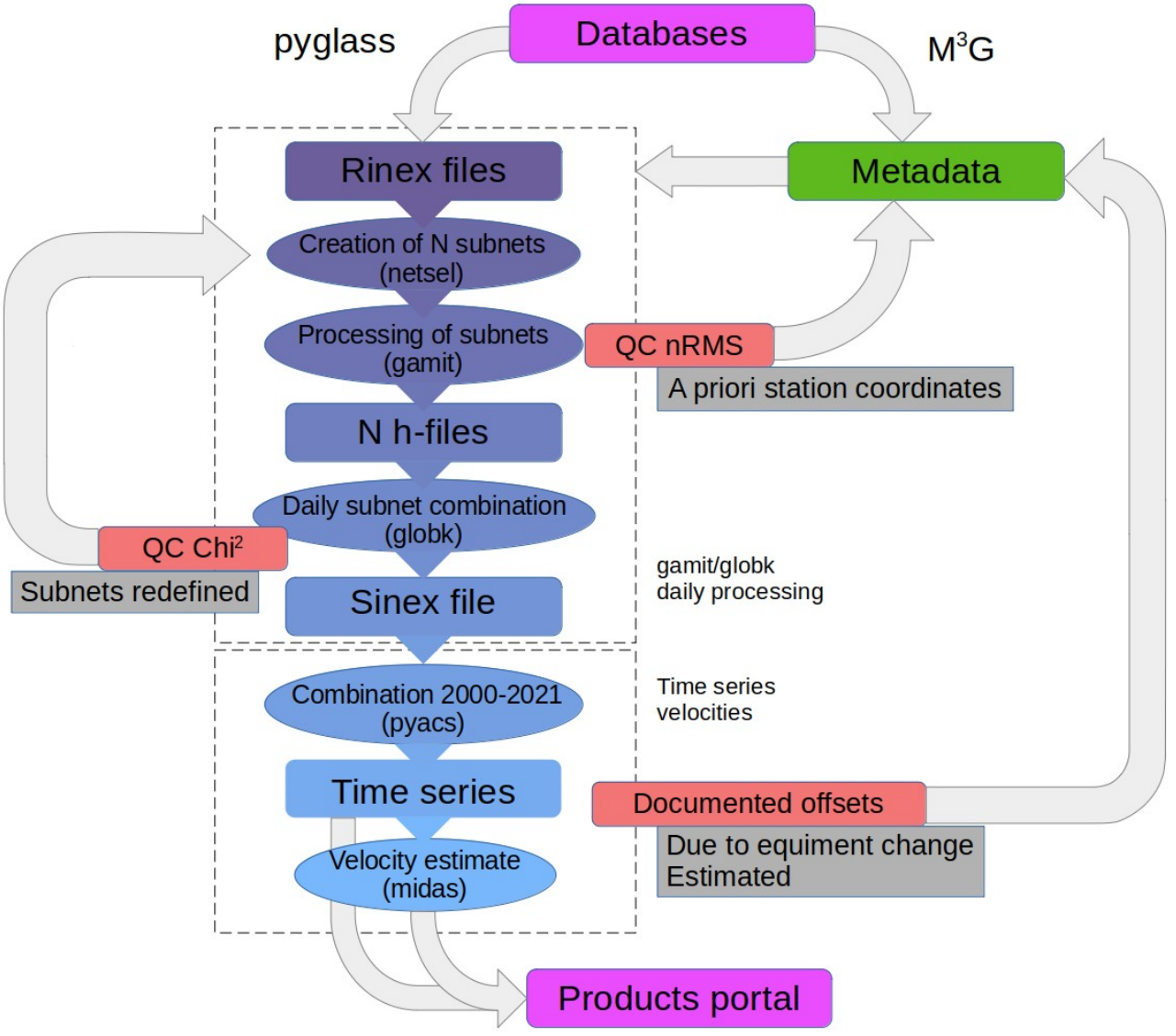
Why double-difference ?

- Takes out satellite and receiver clock errors from calculations
- Reduces the effect of orbit errors
- Reduces the effect of wave propagation unknowns in the atmosphere

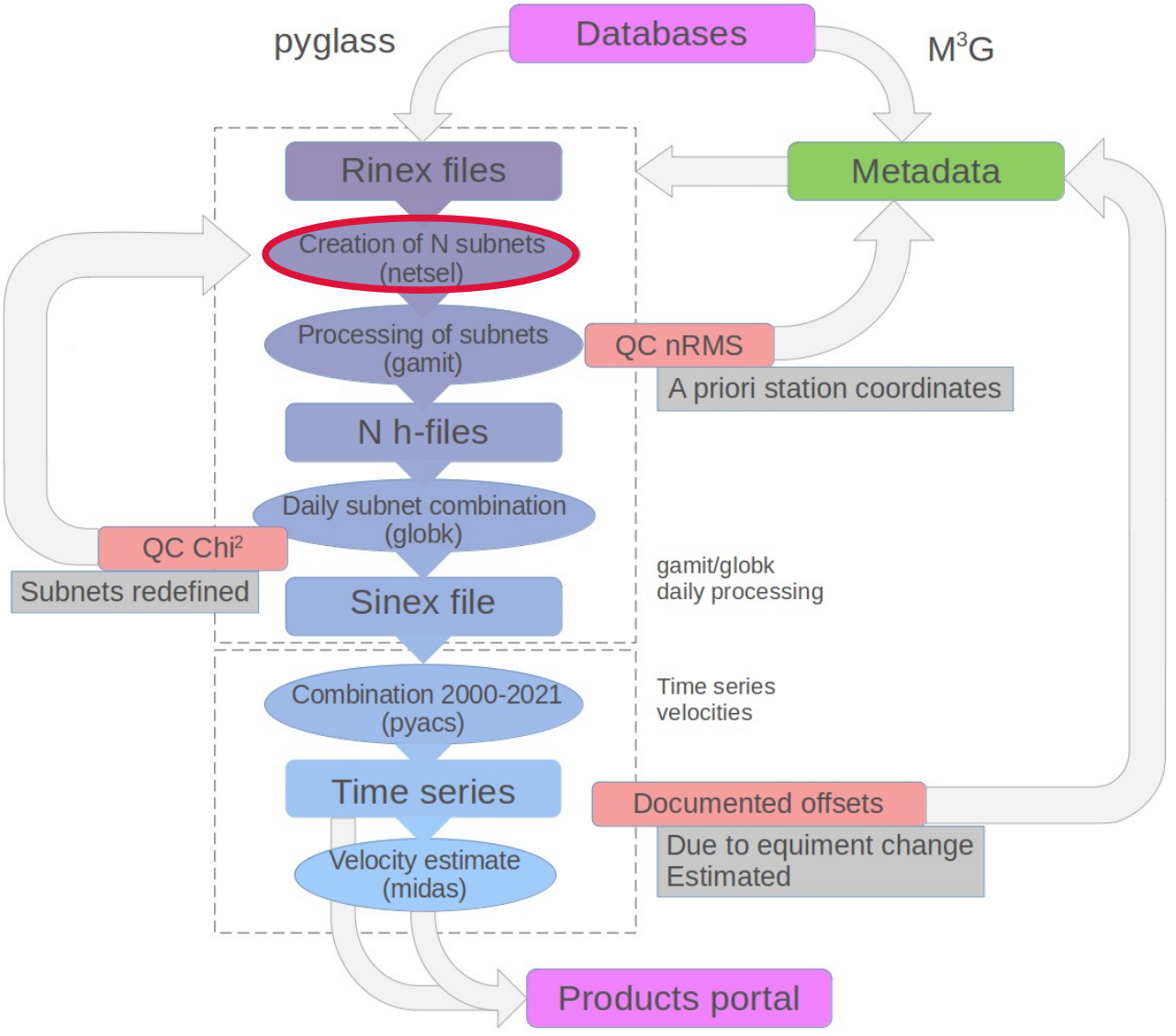
- Since we calculate **baselines** (distance between each receiver pair), computation costs rise geometrically with number of processed stations
  => The dataset is split into subnetworks
  => Need to combine subnetwork results together, and reference using IGS stations
- Need to reprocess whole data when new stations (with old data) are added



gamit/globk processing flow



gamit subnetwork processing

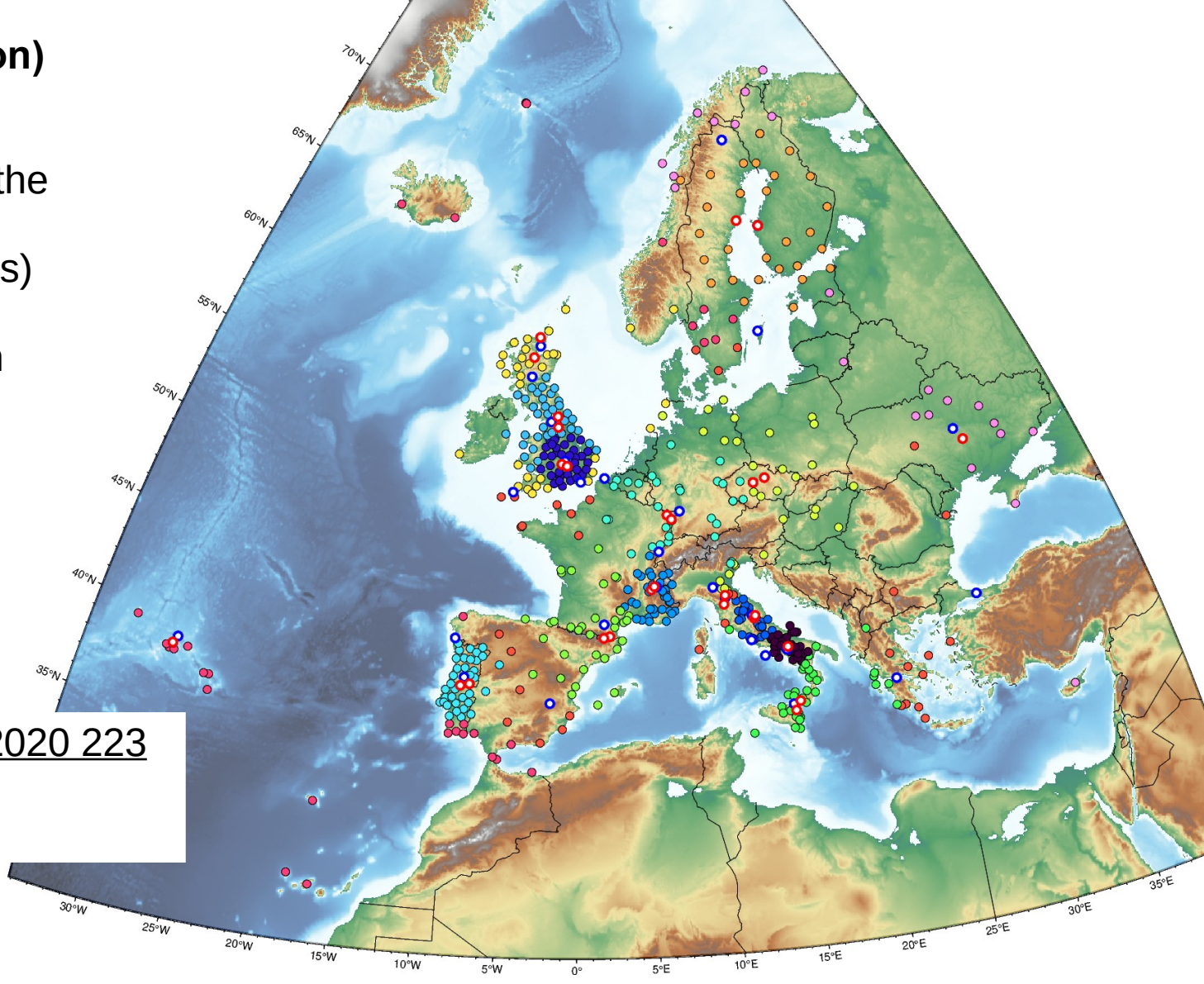


netsel (subnetwork creation)

For each day independently, the station network is split into subnetworks (up to 40 stations)

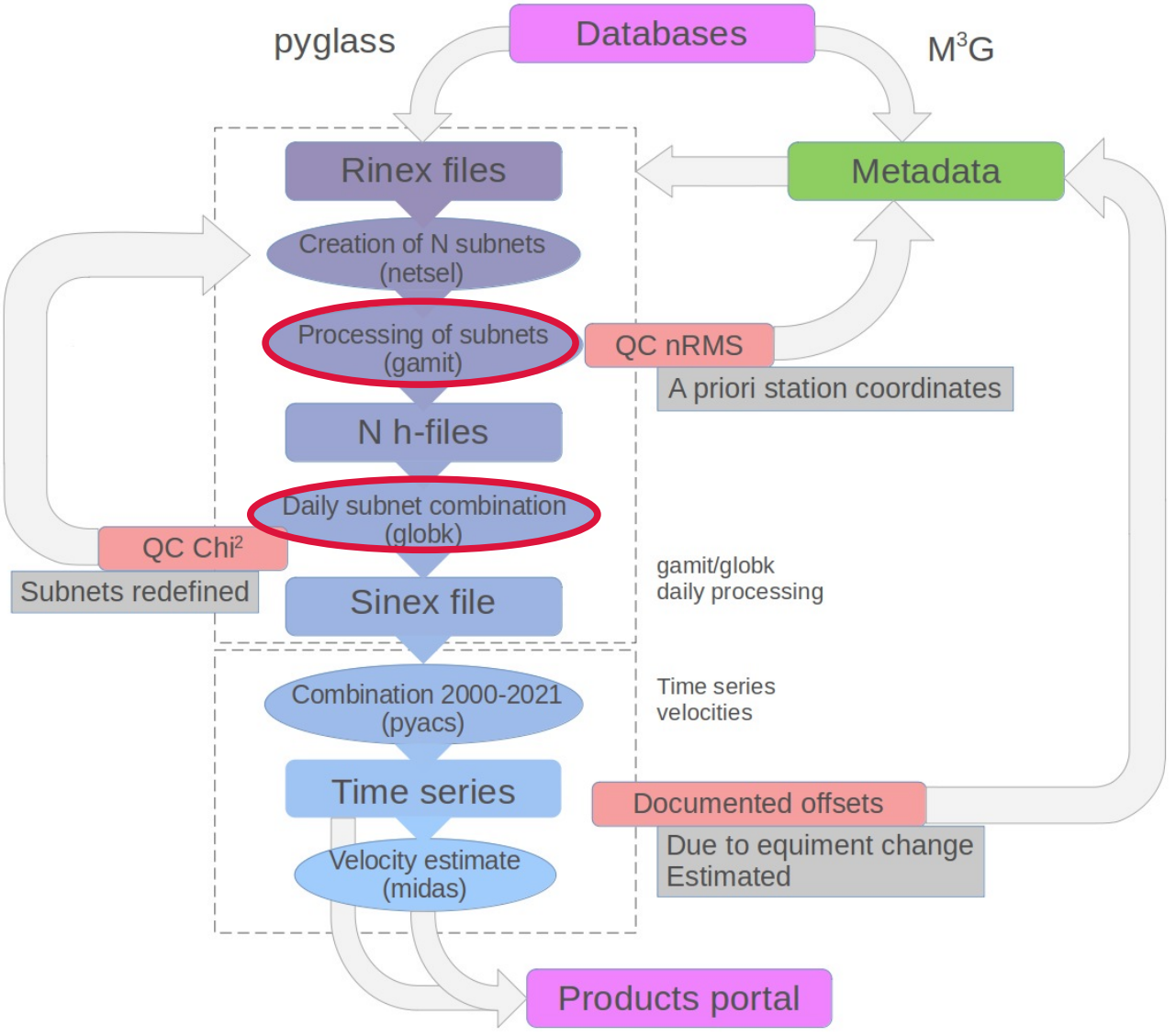
Overlapping stations between local networks

1 large tying network



Example for day 2020 223
572 stations
16 networks

gamit subnetwork processing

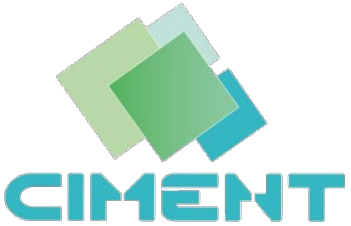


Large number of small compute jobs :

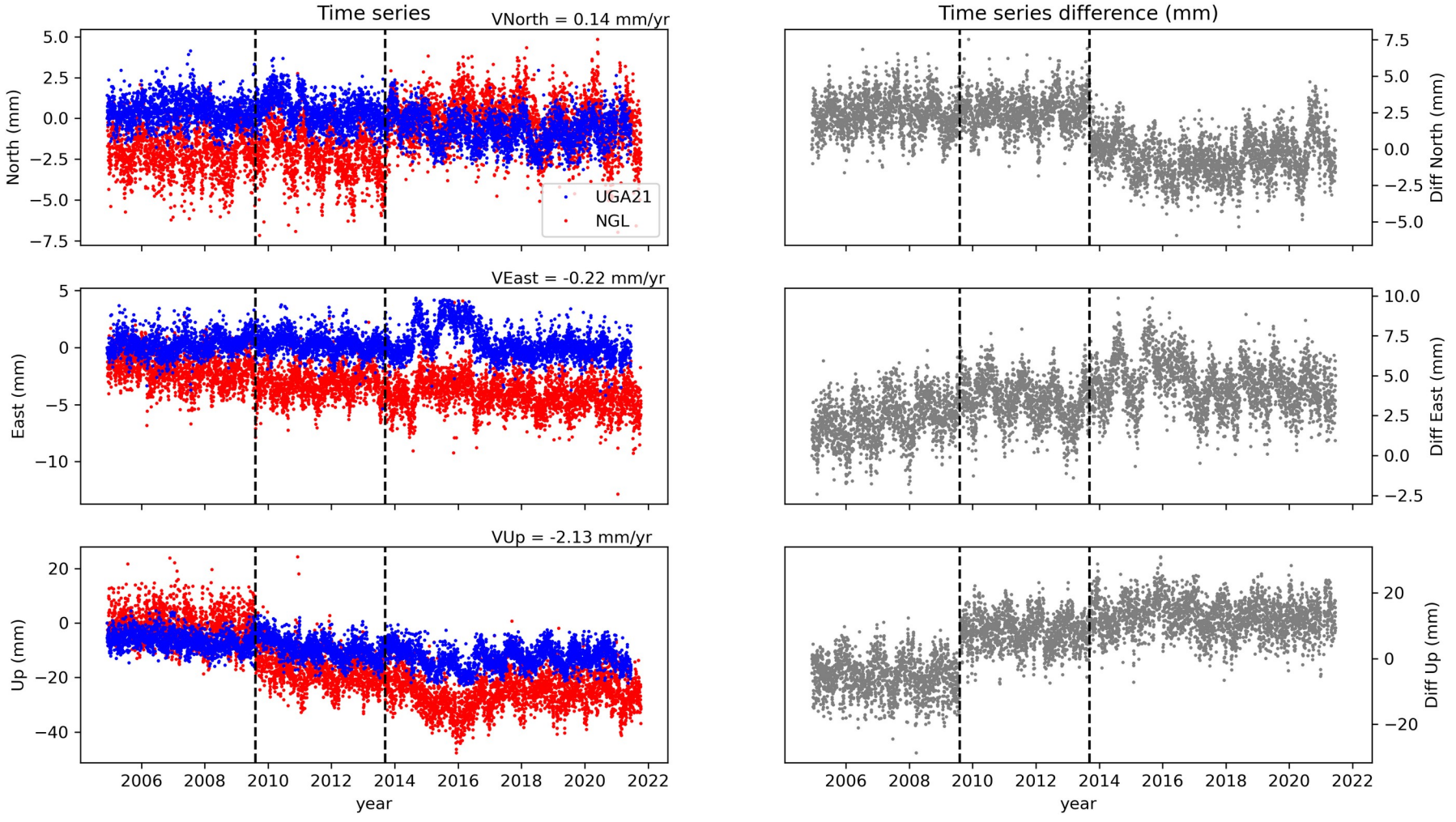
Period	gamit subnetwork processing (~ 30 min runtime)	globk daily combinations (~ 1 min runtime)
1 day	1 per subnet : 16-18 currently	1
1 year	~ 6000	365
2000-2021	~ 80000	~ 8000

Use of the UGA mutualized high-performance computing platform (ciment)

- Cigri compute grid job submission (best effort mode)
- Input data and results go through iRODS distributed data storage
- Technical IT support provided by the Gricad team.

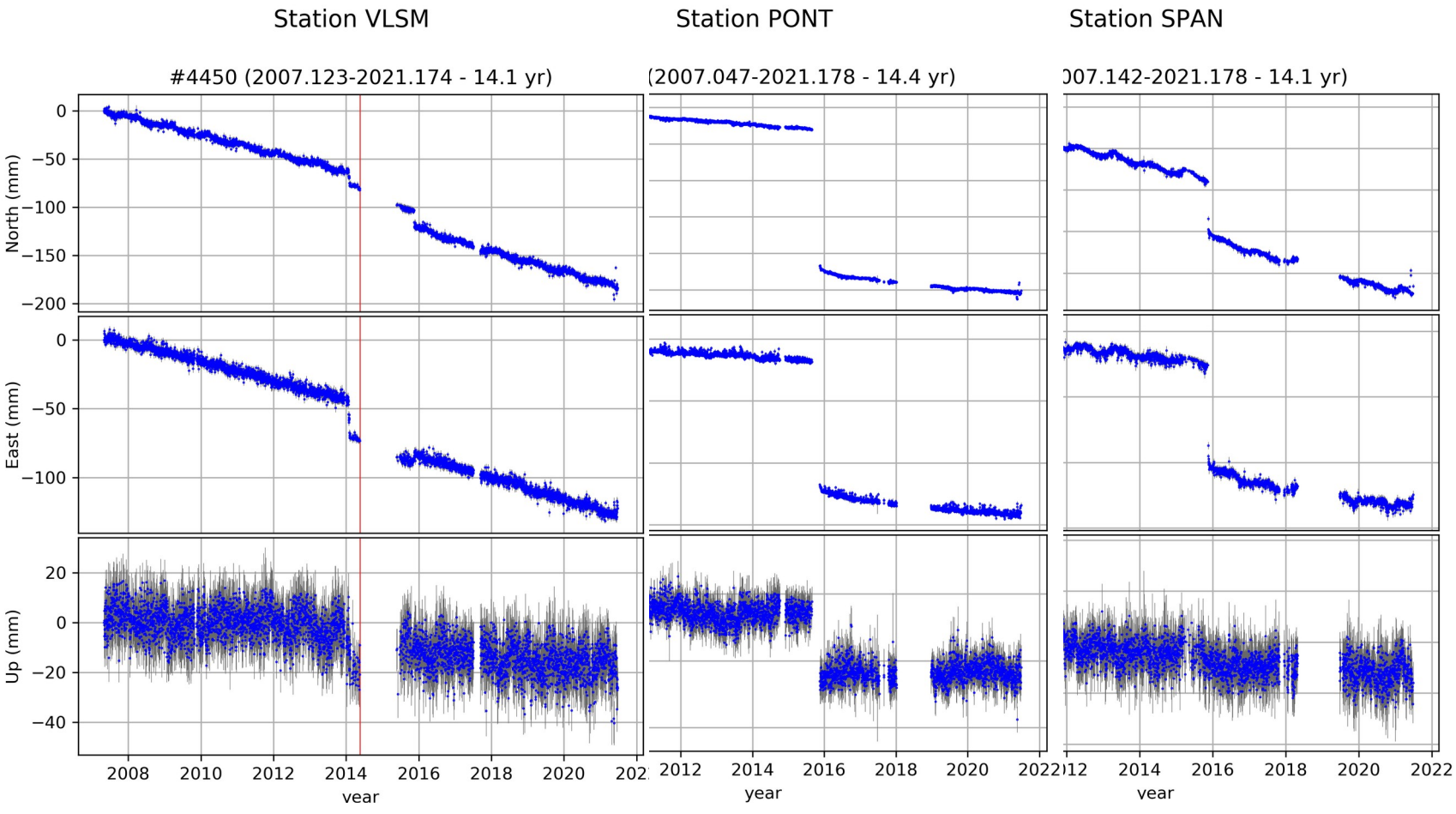


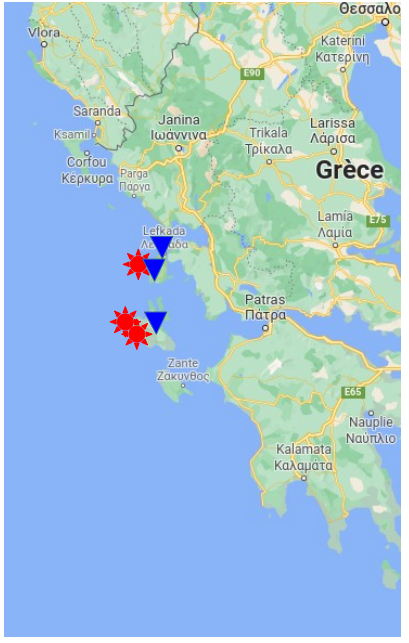
Example time series : ENTZ, gamit processing compared to NGL PPP processing



Example time series in ITRF14, eurasia fixed (Altamimi 2017)

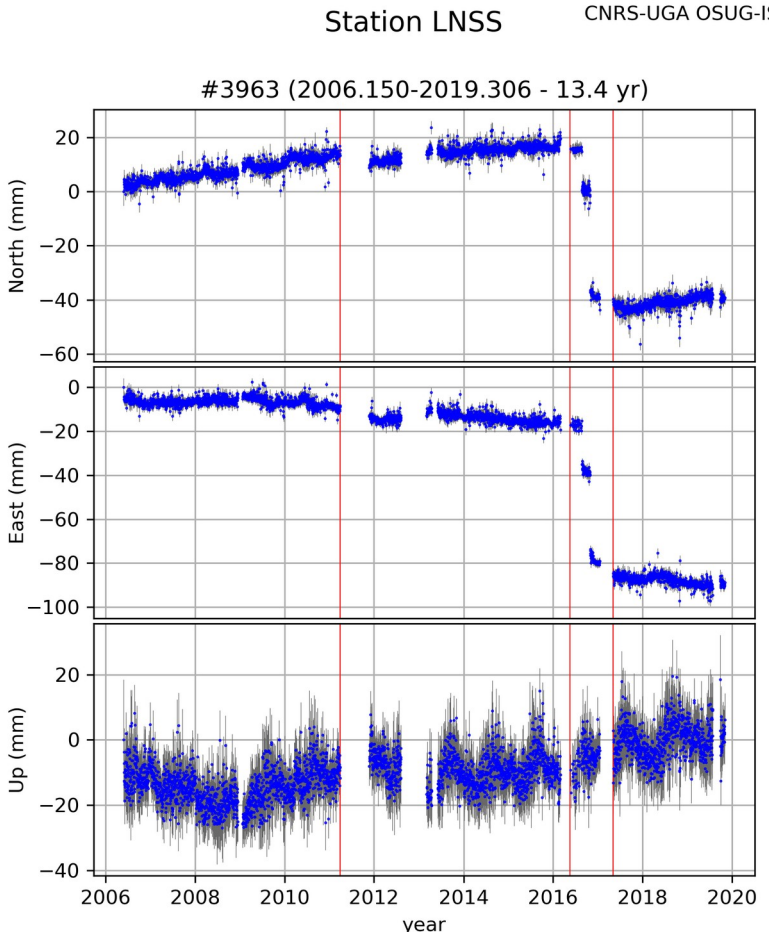
Example time series with post-seismic (2014-2015, western Greece)

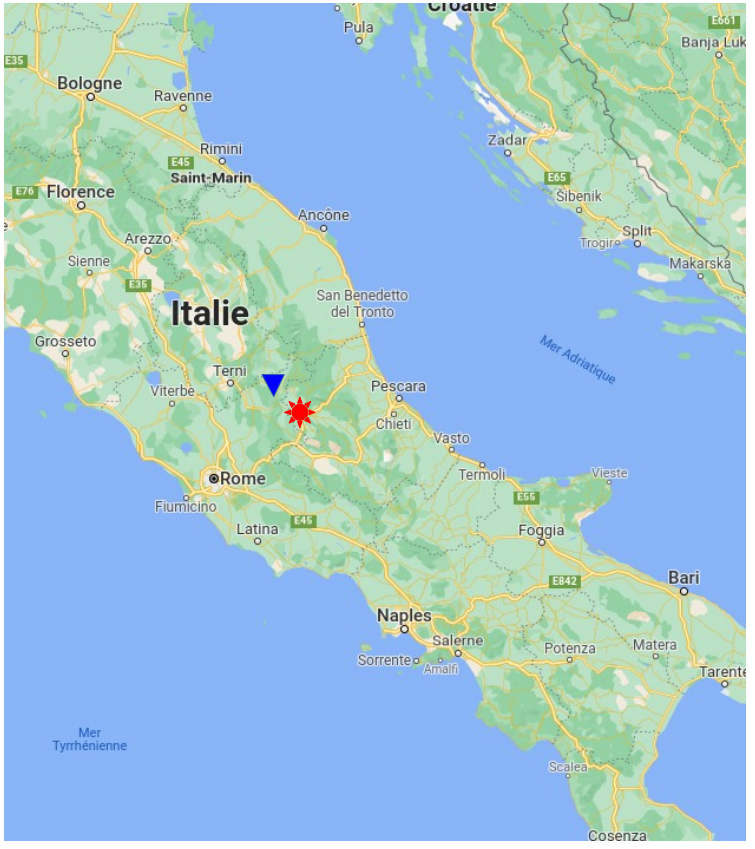




Example time series in ITRF14, eurasia fixed (Altamimi 2017)

Example time series with post-seismic (L'Aquila, 2016, Italy)





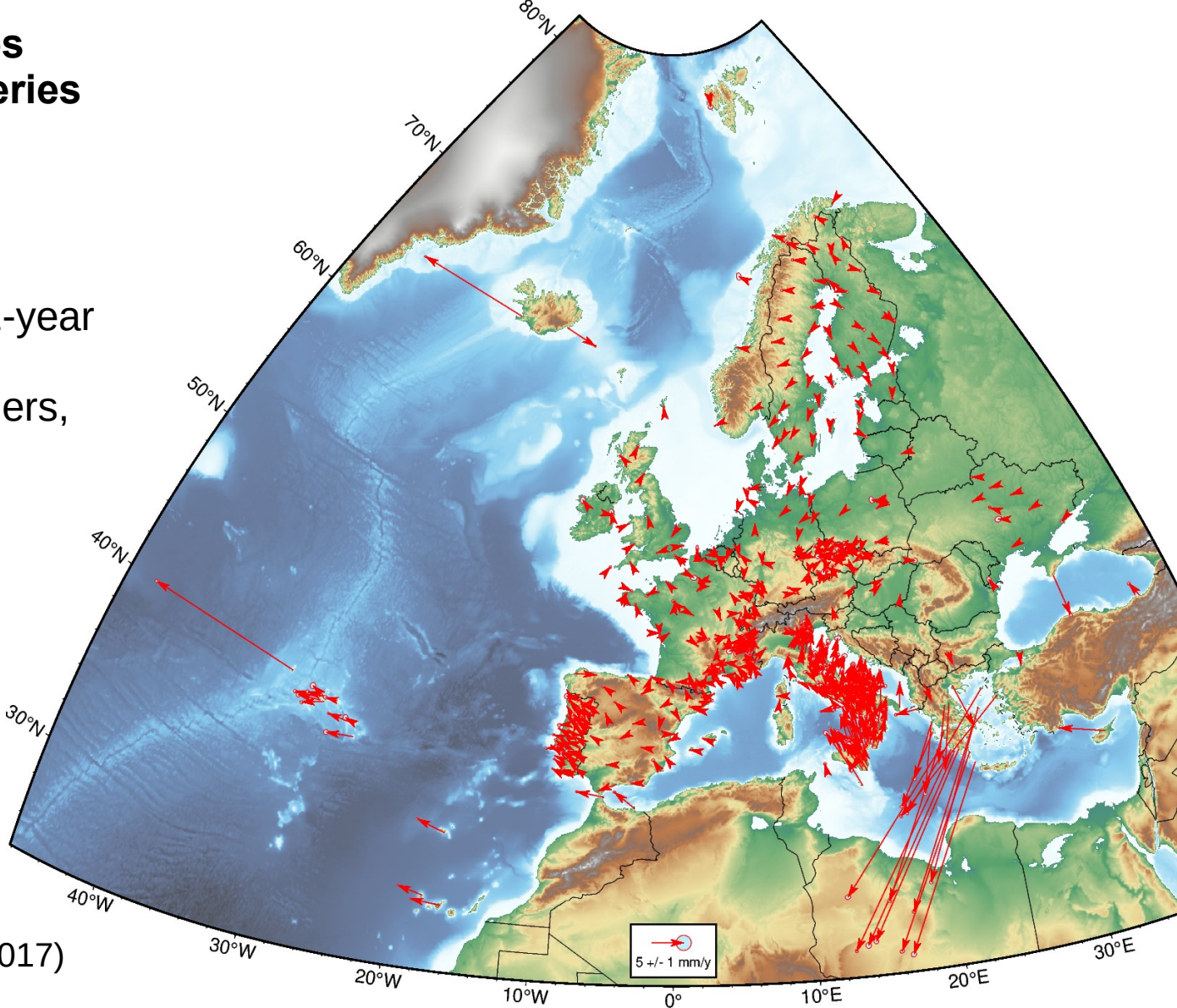
Example time series in ITRF14, eurasia fixed (Altamimi 2017)

Horizontal velocities produced from time series using MIDAS

- MIDAS : Blewitt et al., 2016
- Input data : time series
- Velocity is the most frequent 1-year position shift (sliding window)
- Robust : low sensitivity to outliers, steps, seasonal component.
- Fast (a few minutes for this data set)

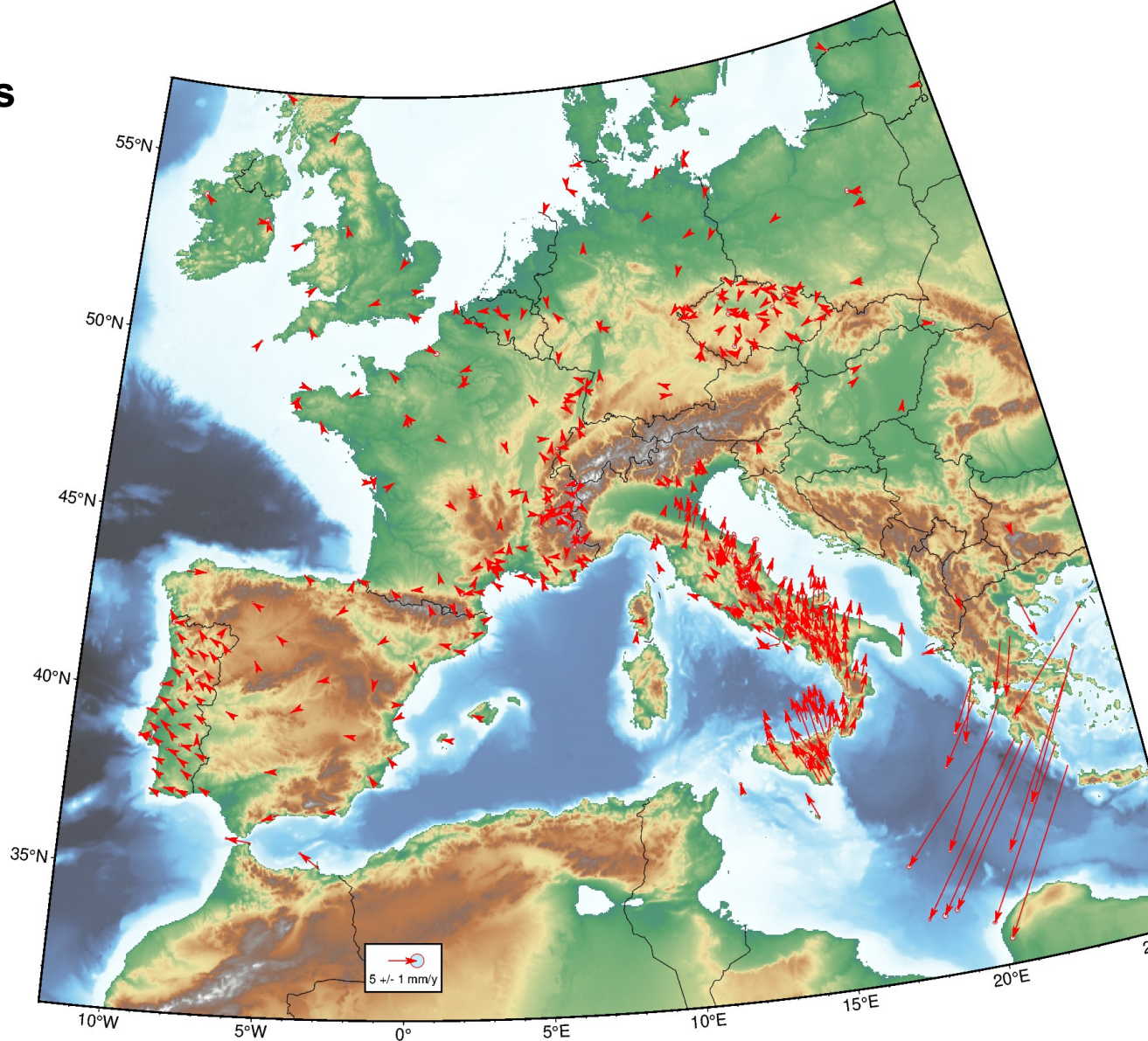
615 velocities calculated :
  - 576 showed here
  - 39 not showed (high errors)

Reference : Eurasia fixed (Altamimi 2017)



Horizontal velocities produced from time series using MIDAS

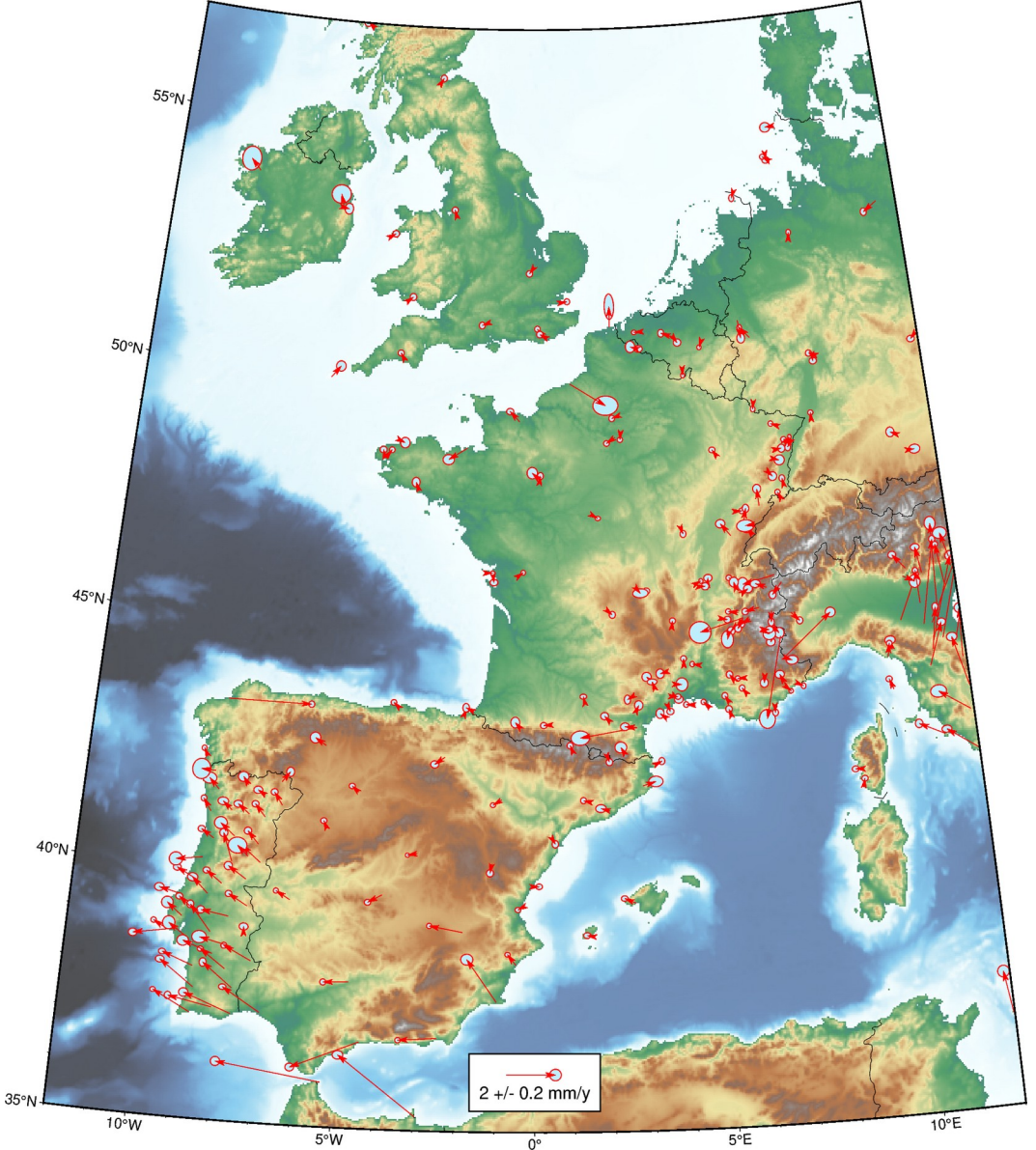
Focus on central Europe



Reference : Eurasia fixed (Altamimi 2017)

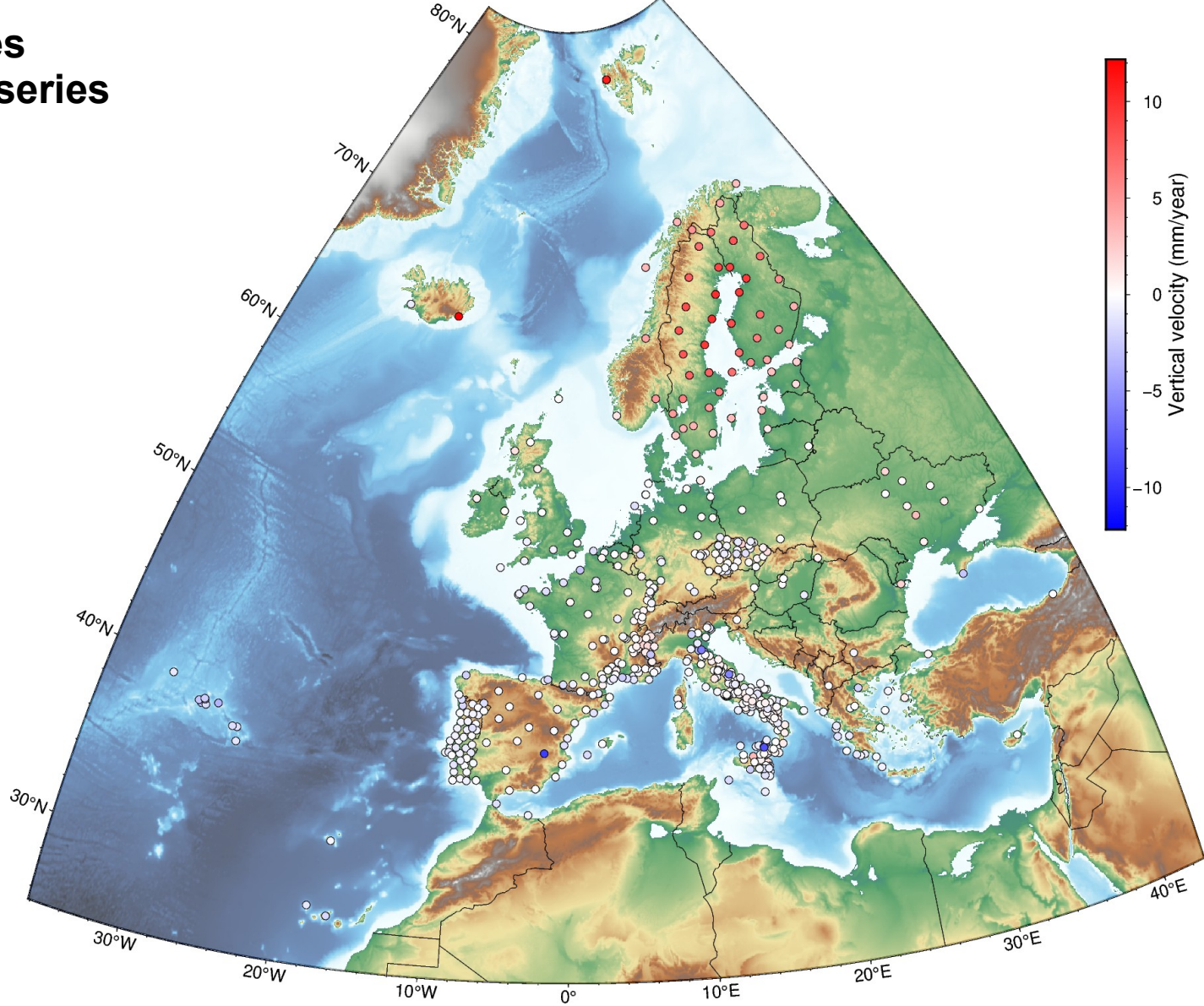
Horizontal velocities produced from time series using MIDAS

Focus on « stable » western Europe
Velocity and errors scaled up for plot

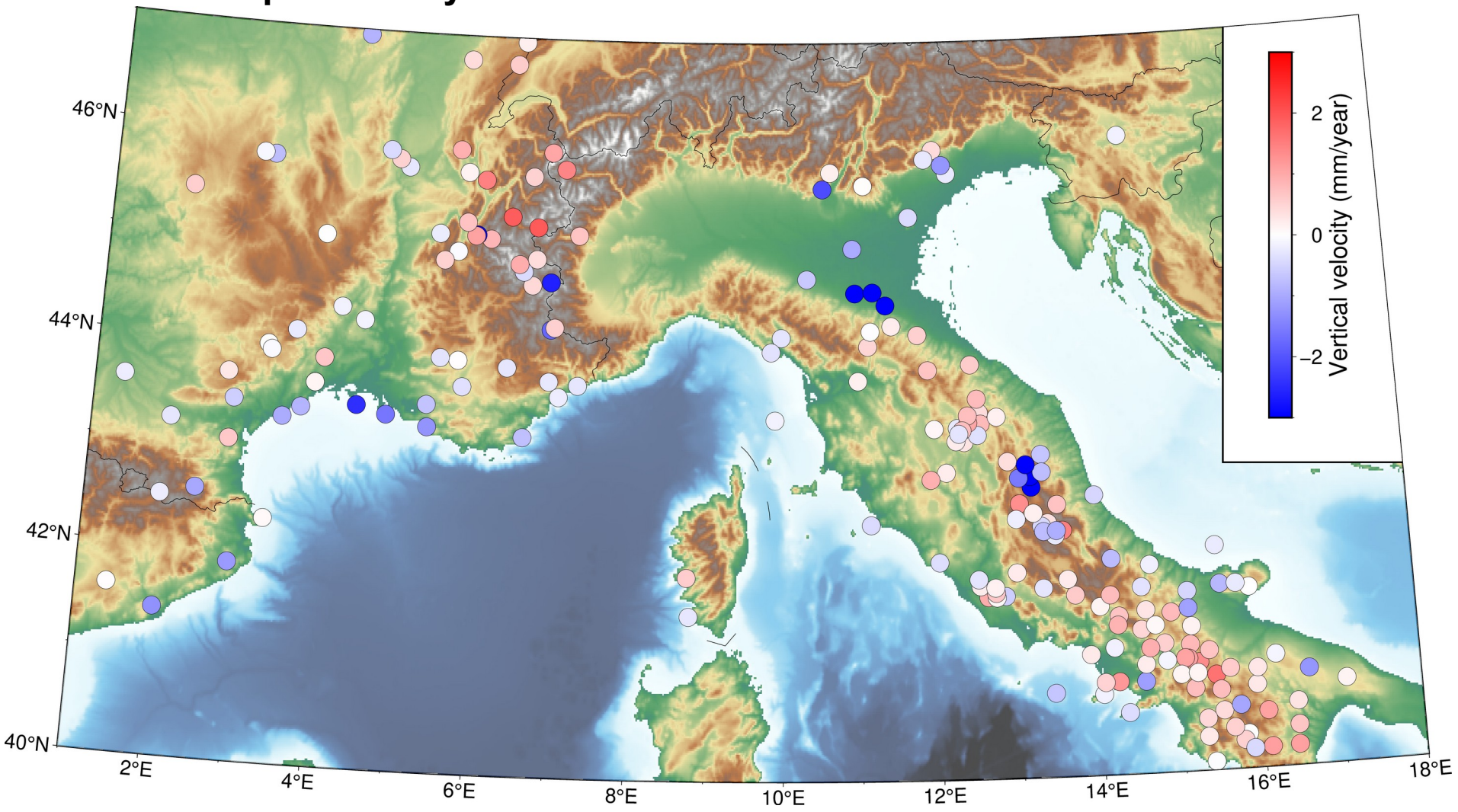


Reference : Eurasia fixed (Altamimi 2017)

Vertical velocities produced from time series using MIDAS



Vertical velocities
Alps and Italy

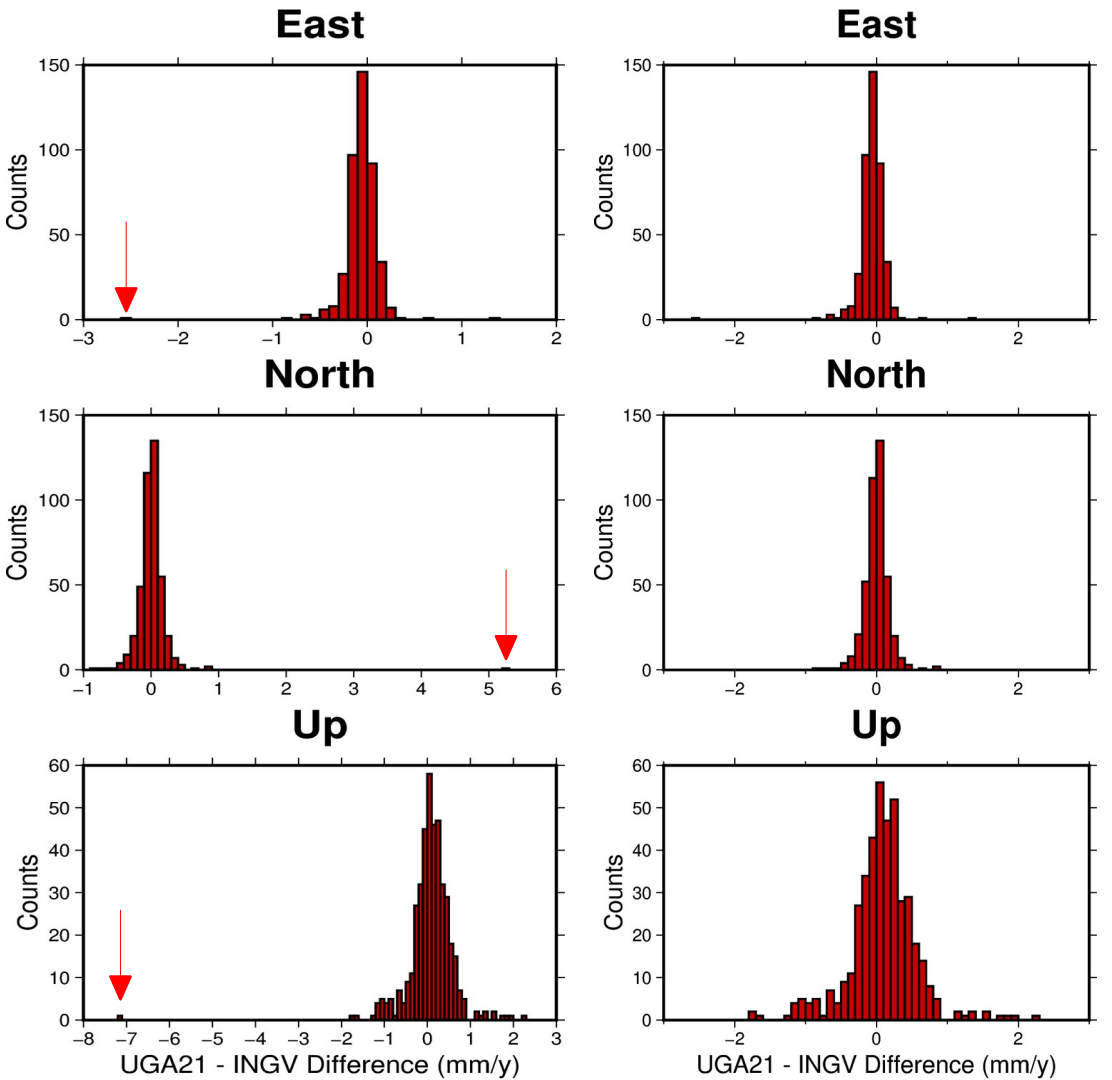


Comparison of velocities : our DD solution vs INGV PPP solution

INGV produces a PPP solution (Gipsy)
Velocities are also estimated with Midas

Very good match for most of the 427 stations compared :

- 2 stations with horizontal diff > 1mm/yr
- 2 stations with vertical diff > 2mm/yr



Ongoing / future work

- Valorization through RESIF-RENAG web site, and integration in RENAG combined solution

Séries Temporelles Opérationnelles GNSS RENAG

Solution opérationnelle pour les stations du réseau RENAG (solution automatique non validée scientifiquement).

Le traitement en bref: Le calcul commence en 2000. Le traitement en double différence est effectué avec le logiciel GAMIT (Herring et al., 2010), la mise en référence (ITRF08) et le post-traitement automatique avec le logiciel PYACS (J.-M. Nocquet, Geoazur).

Visualisations: 1/ Raw (sans post-traitement), 2/ Detrended (tendance soustraite), 3/ Offsets removed (offsets dûs aux changements de matériels et tendance soustraits).

Traitement automatique **opérationnel** par le centre de donnée RENAG de Geoazur

Visualisation dynamique

Sites: Select up to 4

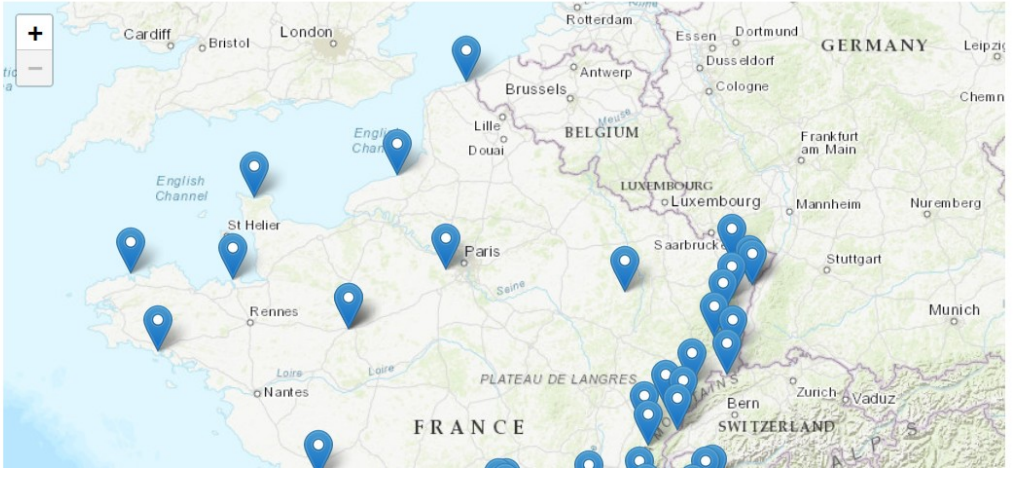
Type de série: Raw

Submit

Visualisation statique

Type de série: Detrended

Submit



Ongoing / future work

- Valorization through RESIF-RENAG web site, and integration in RENAG combined solution

- Automate the times series analysis for offset calculations, using trajectory models tools developped at ISTerre in recent years.