

A comprehensive quantification of error location uncertainties for the French earthquake catalog

Andres Felipe Peña Castro[✉], Sophie Lambotte, Marc Grunberg, Pierre Arroucau, Jessie Mayor, Guillaume Daniel, and Jean Letort

MOTIVATION:

- Earthquake locations (specially depth) can have large uncertainties and it is necessary to understand how well constraint these locations are.

METHODS:

- 10 epicentral synthetic locations at each region in France and at $Z = 0, 2.5, 5, 10, 15$, and 20 km (**Figure 1**).
- [1D velocity models](#) are used to generate synthetic arrivals with [NonLinLoc](#)
- [Seismic network evolution](#) from 2010-2018
- Distance thresholds of 50 km and 100 km are used for regions with high and low density of stations, respectively

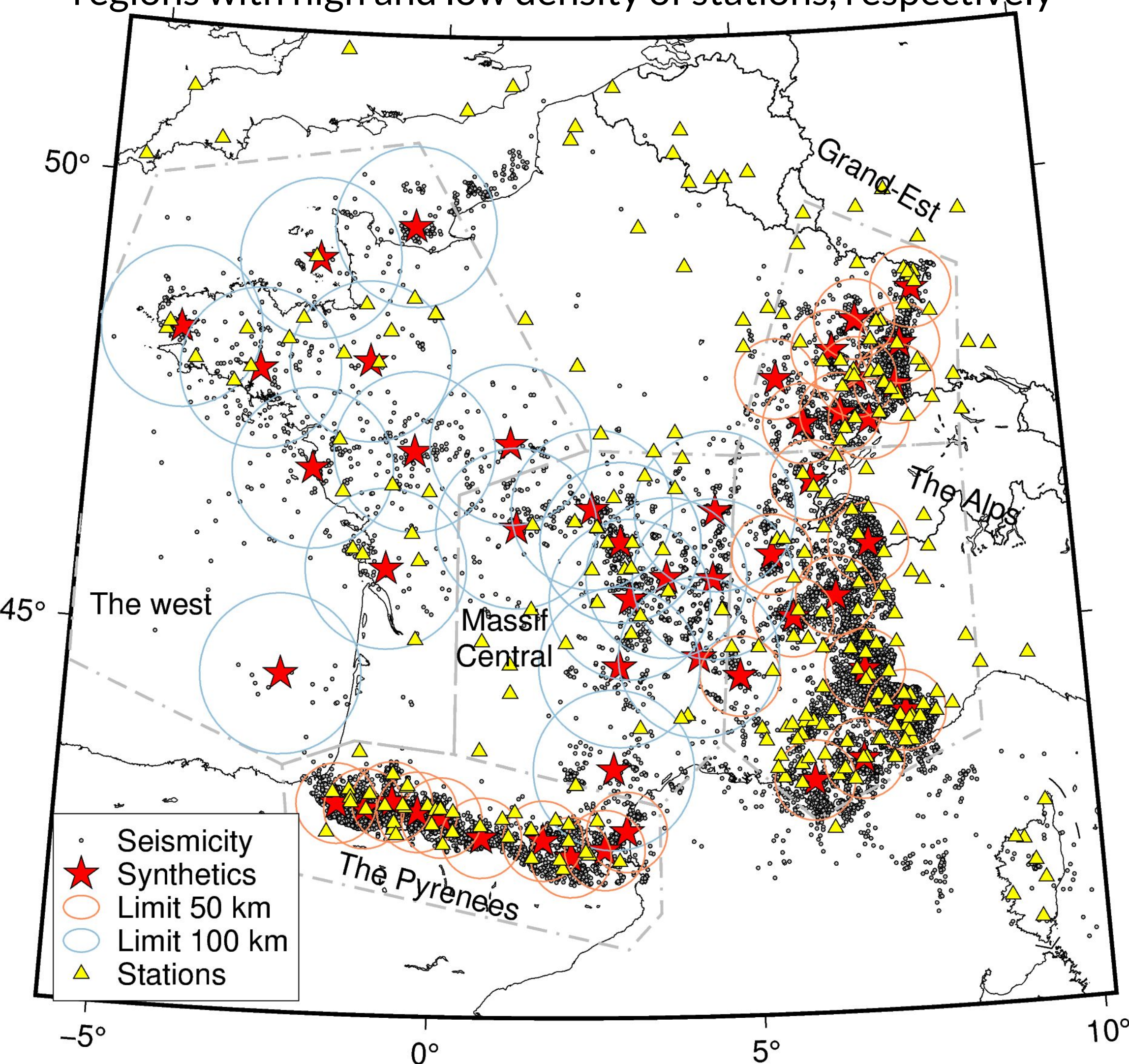


Figure 1. Seismicity overview (2010-2018) and synthetic locations in each region within France. Triangles represent seismic stations operational during 2014. Circles are distance thresholds of 50 km (orange) and 100 km (blue) from the synthetic events.

- We use [estimators](#) such as horizontal error (ERH), vertical error (ERZ), depth recovery, epicentral recovery, root-mean square (RMS), azimuthal gap, second azimuthal gap, closest station, and number of phases (NPHS).
- We [added noise](#) to the P- and S-wave arrivals with 100 different trials to mimic real pick conditions.

RESULTS and CONCLUSIONS:

- At each hypocentral location we report the mean or median (**Figure 2**) values obtained of all [estimators](#).

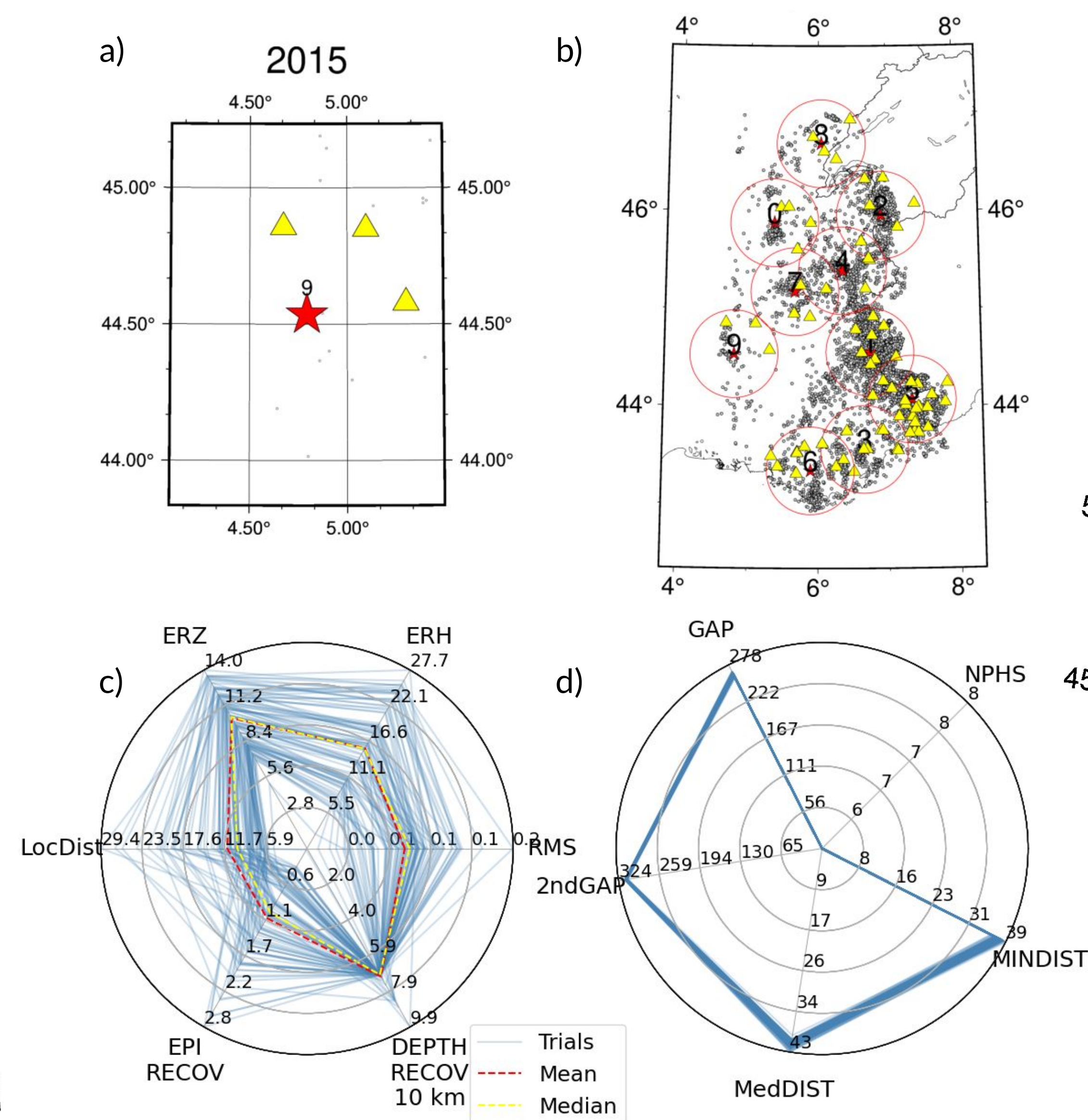


Figure 2. a) Map of event 9 located in the Alps and nearby seismic stations in 2015 b) Overview of synthetic and stations for the Alps. c) and d) show the radar plots of all estimators with the different trials (blue), the mean (red) and median (yellow). The synthetic depth of this event is 10 km.

- We observe a general reduction of most (mean or median) estimators (except the [RMS](#)) that follows the improvement of the seismic network through time (**Figures 3 and 4**)

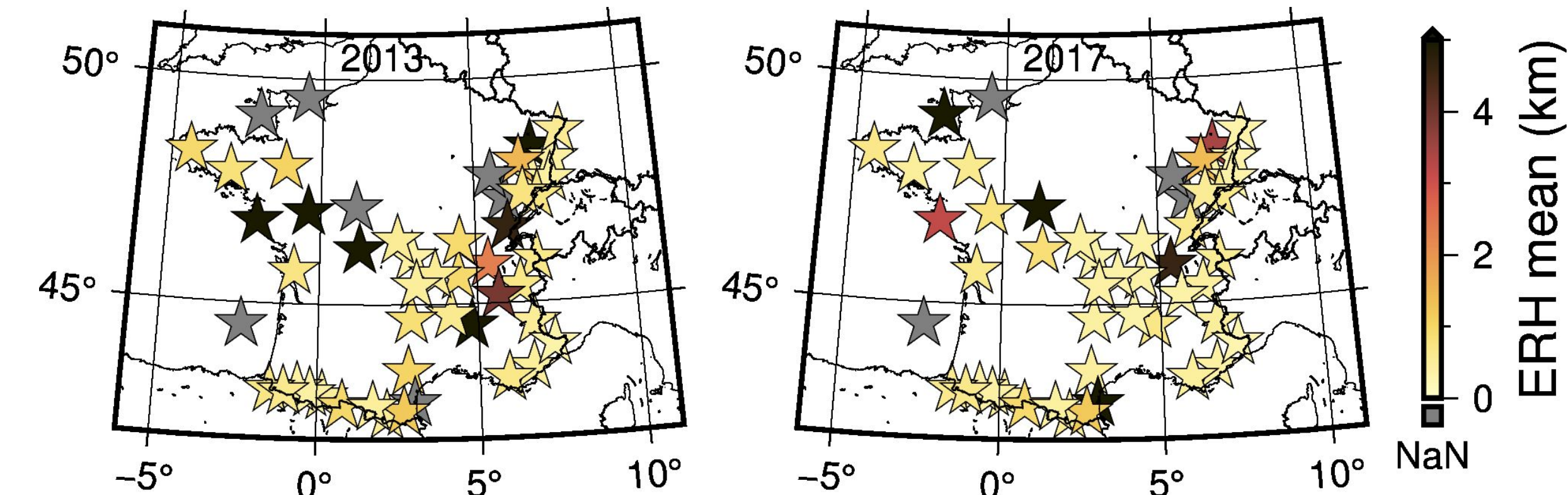


Figure 3. Mean horizontal error for synthetic events at a depth of 5 km using the seismic stations in 2013 (left) and 2017 (right).

- The Pyrenees, the Alps, and the Grand-Est have lower horizontal (**Figure 3**) and vertical errors (**Figure 4**) in comparison with The West and Massif Central although the distance threshold of event-stations is higher for the latters.

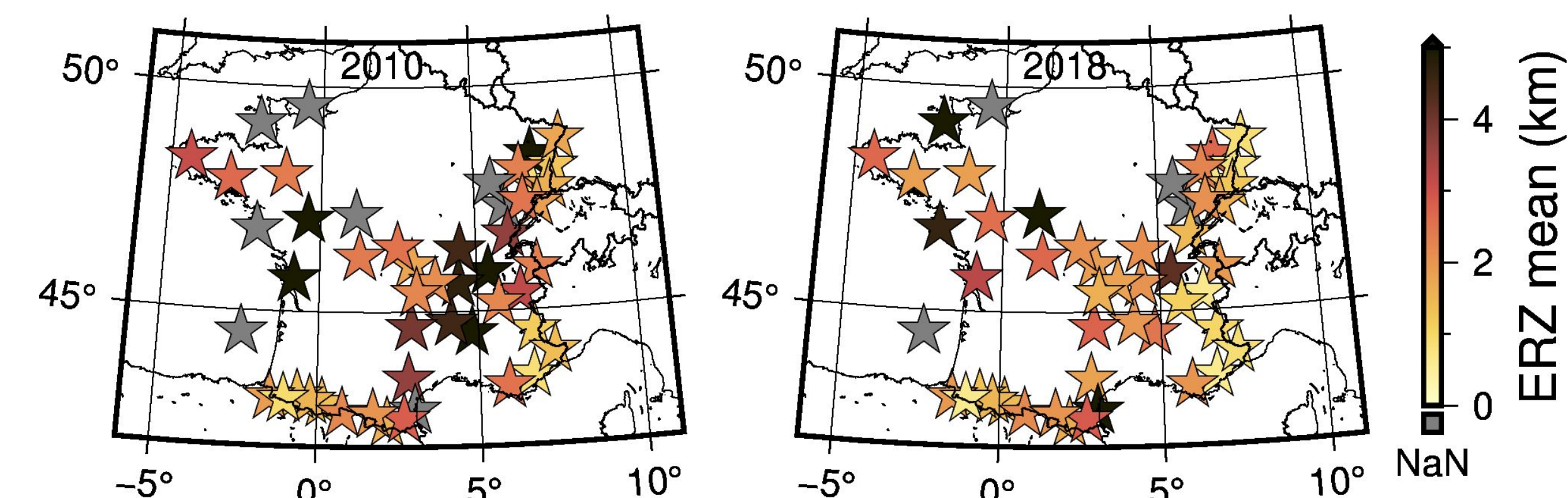


Figure 4. Mean vertical error for synthetic events at a depth of 5 km using the seismic stations in 2010 (left) and 2018 (right).

FUTURE STEPS:

- Compare solutions and estimators when 3D velocity models are included.
- Denser number of synthetic locations.
- Variations with other distance thresholds.