The Western Alps covered by a high precision GPS Network

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1 Tectonic setting

Global plate motion models predict a N-S mean convergence rate of 6 mm/yr between the African and Eurasian plates around the Western Mediterranean region (fig. 1a). Most of this deformation is probably accomodated in the active mountain belts showing important seismicity and topography : Pyrenees, Alps, Apennines, Maghrebids. In these structures, the deformation is complex as attested by compressive directions far from the overall direction of convergence or even by active extension (Southern Apennines or Eastern Pyrenees). A regional GPS network embedded in an interplate fiducial network is the best way to measure crustal deformation within mountain belts and place them in the tectonic framework of global plate motions. As a first step towards mapping the distribution of the African-Eurasian motions within the Mediterranean region, we have installed and measured in September 1993 a high precision GPS network in the Western Alps, the most deformed, the largest and the highest range in the Alpine collision zone. Expecting a local convergence rate of 2-6 mm/yr between stable Europe and Apulia, we plan to remeasure the network every five years. The estimated velocities will reveal the convergence and how it is distributed inside the range. In the event of a large earthquake, the network will also be useful to constrain the dislocation at depth.

2 Network description and data processing

The benchmarks cover the internal and external range of the Alps with a typical spacing of 50 km (fig. 1b). This spacing increases in the peripheral zones to reach "stable zones" on the Eurasian plate and the Corso-Sarde microplate. 58 sites have been measured in France, Swiss and Italy between 4 and 7 nights using 37 dual-frequency receivers. Three sites had continuous tracking during entire 15-day campaign. All the GPS data analysis described here is conducted with the GAMIT/GLOBK software (King and Bock 1994, Herring 1993). To establish a robust reference frame, a subset of 50 sites is combined with data from eight permanent stations of the International GPS Service (IGS) in Europe. Both station positions and satellite orbital parameters are estimated in our solution. Each daily session is first processed independently. This enables us to "clean" the data, to detect and repair cycle slips, or unweight bad data contaminated with heavy multipath, for example. For 86 percents of baselines shorter than 550 km, the horizontal repeatability is better than 10 mm (mean values of 4 and 6 mm for North and East components respectively). A first way to improve this solution would be to combine the independent daily solutions to compute more precise multi-day orbital arcs. A second improvement will result from merging with the GLOBK Kalman filter the variance/covariance matrix of our solution and of IGS solutions provided by worldwide GPS network. Future analysis will combine the daily solutions of the alpine network of 58 sites and the IGS network to estimate the coordinates of 66 stations, as well as more precise multi-day orbital arcs, in a single global solution, with positions referred to September 1993.

3 Data archive and distribution

All data relative to the ALPES-93 campaign have been assembled at Ecole Normale Supérieure (ENS) in Paris, France. They are accessible by Internet and a specific request directed to the authors (vigny@geophy.ens.fr). The archive includes raw data, rinex data files, log sheets and station descriptions, and precise orbits from all IGS centers for the corresponding period (1993 days 248-260, GPS week 712-714). Cleaned and compressed RINEX data files free of cycle slips, station positions ($\approx$ 1 cm), and variance / covariance solutions will also be included. To preserve these data for at least 20 years, we plan to publish a compact disk (CDROM) that will be available to the geodetic community on request.

(*) The GPS Alps Working Group includes French geophysical and geological laboratories of Chambéry, Grenoble, Montpellier, Nice, Paris and Toulouse, the French geodetic institute IGN, and also Swiss and Italian partners at ETH Zurich and ING Roma. We thank the French organisations CNRS, EDF and CNES for material and financial support.

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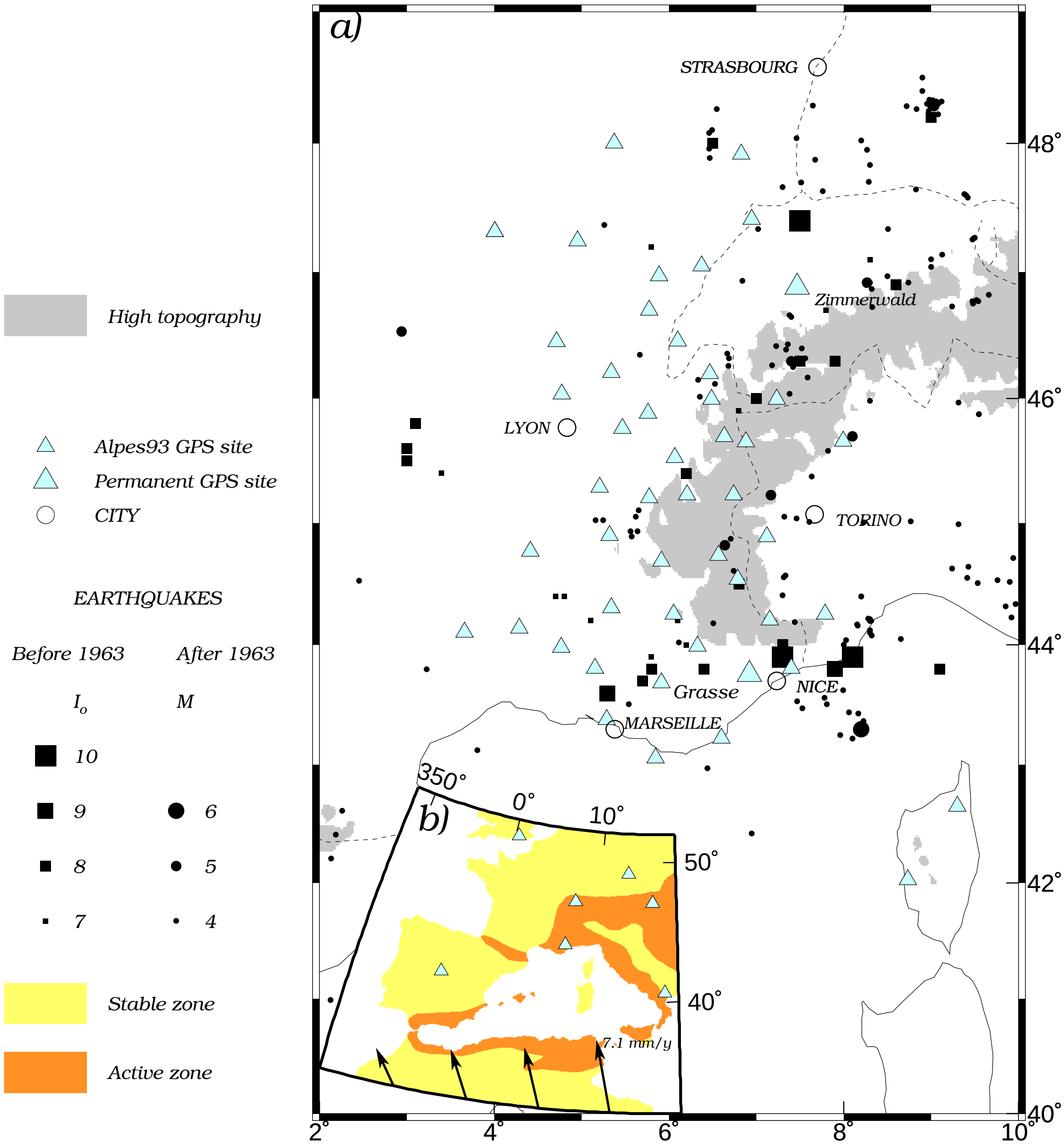
figure : a) The ALPES93 GPS network accross the Western Alps with historical and instrumental seismicity (EUR); b) Tectonic framework of the Western Mediterranean region (Armijo et al., 1986). Black arrows indicate the motion of the African plate relative to the Eurasian plate from the NUVEL1 model (Demets et al. 1990).



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