Centro di Ricerche Sismologiche

Gruppo Nazionale di Geofisica della Terra Solida — Convegno 2006

ISTITUTO NAZIONALE DI OCEANOGRAFIA E DI GEOFISICA SPERIMENTALE

FAAS and Antelope: two automatic earthquake location systems in the northeastern Italy and surrounding areas

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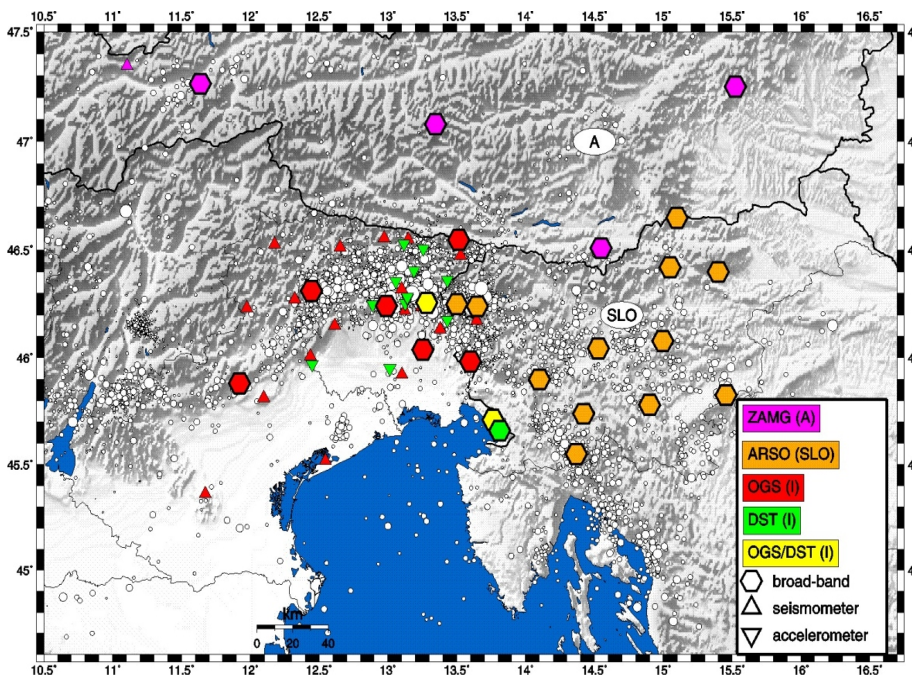


Fig. 1

Since 1996 at the Centro di Ricerche Sismologiche (CRS, http://www.crs.inogs.it) of the Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS) it is active the Friuli Automatic Alert System which monitors the Friuli-Venezia Giulia region (NE Italy) and surrounding areas based on 21 short period stations (red triangles in Fig.1, Priolo et al.; 2005).

Since 2002 the CRS is involved in the EU Interreg IIIA project "Trans-national seismological networks in the South-Eastern Alps" together to other four institutions monitoring the area (Bragato et al, 2003): DST of Trieste University and Civil Protection of Regione Autonoma Friuli-Venezia Giulia (Italy), ARSO (Slovenia), and ZAMG (Austria). The Antelope software suite has been chosen as the common basis for real-time data exchange, rapid earthquakes location and alerting. Each institution has an instance of the system running at its data center and acquires data in near real-time from its stations and those of the other partners (Fig.1).

In this poster, the FAAS and Antelope performances are analyzed. Their procedures for picking, earthquake detection, location and magnitude estimation are shortly described and the results compared with the manually revised data available in the NEI (North Eastern Italy) network bulletin (OGS database) from December 2005 to July 2006. We analyze the detection capabilities, quality of time arrival picks and locations and the differences among the various magnitudes (M_L and M_D). In particular, for pickings and locations we furnish an absolute estimation of the error in respect to the real, unknown values.

Processing steps. FAAS detects events by a STA/LTA trigger on remote stations. If there is a coincidence between at least 4 stations, the event is analyzed by picking P and S arrivals. The location is performed by Hypo71 program, while two magnitude values are supplied: the duration magnitude M_D by using the formula of Rebez and Renner (1991) and the local magnitude M_L according to the formula by Bakun and Joyner (1984).

Antelope detects events by STA/LTA algorithm and the association is based on location by grid search; only P arrivals are used. The location is performed by grid search over 87x81 nodes for an extension of 7x6.4 degrees (corresponding to cells of 8.9 km in longitude and 8.7 km in latitude) centered in Lat=46.26°, Lon=13.28° with depth steps at 0, 2, 4, 6, 8, 10, 12, 14, 16, 20 and 24 km, using the 1D uniform velocity model IASPEI91. The location procedure has been set-up and tuned mainly at DST in Trieste. The magnitude M_L is estimated using the program "orbampmag" developed by Nikolaus Horn at ZAMG in Vienna.

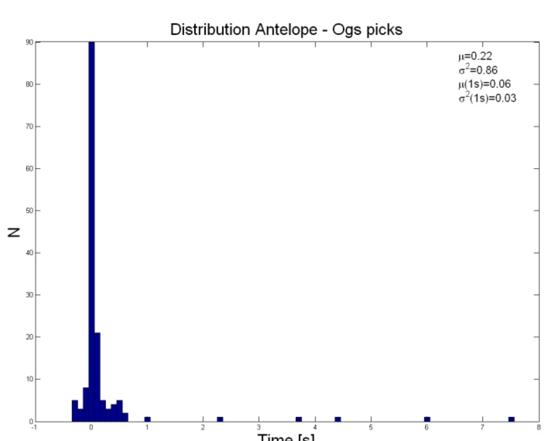


Fig 2

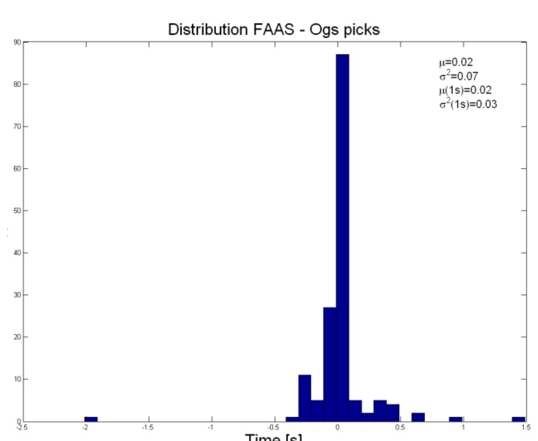


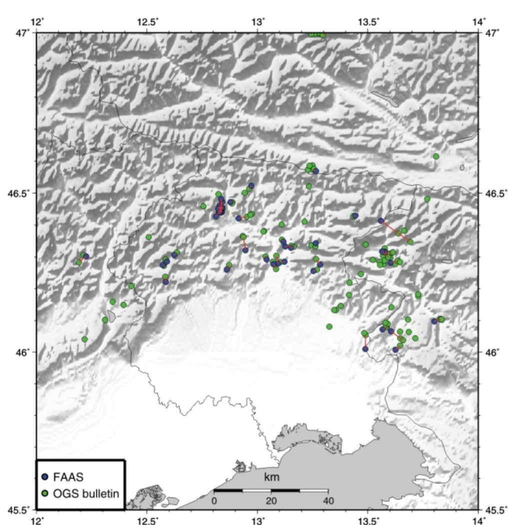
Fig 3

Picking: P waves picking times of FAAS and Antelope have been compared with those in the OGS database. From the Figures 2 and 3 it is possible to see that both FAAS and Antelope pick some hundredth of seconds after the OGS database. The mean and the variance have been calculated considering the entire data set and after eliminating the outliers (picks farther than 1s from the corresponding manual ones). Besides the variance relative to the manual picks, following Gentili and Bragato (2006) we have estimated the absolute variance of the three data sets (i.e. the variance of the difference between the real, unknown arrival times and the picked ones). In general, given two independent data sets A and B, it holds the relation var(A-B)=var(A)+var(B). Combining in a system the three equations derived for the available data sets, we have obtained:

$$\text{var(Antelope)}=0.018s^2,\quad \text{var(FAAS)}=0.016s^2,\quad \text{var(OGS)}=0,011s^2$$

Event detection: the capability of detecting earthquakes depending on their magnitude has been analyzed (maps in the Figures 4-6 and histograms in the Figures 7-18). For the two systems we have considered the area monitored by FAAS (coordinates: LON=[12-14],LAT=[45.5-47]). For Antelope we have also considered the larger trans-national area of interest for the INTERREG project (coordinates: LON=[12.1-15.7], LAT=[44.5-47.3]). It emerges that for the smaller area, the maximum magnitude of not detected earthquakes is 2.7 for FAAS and 2.9 for Antelope. For the larger area, the maximum magnitude of the events lost by Antelope is 3.3.

Fig 4



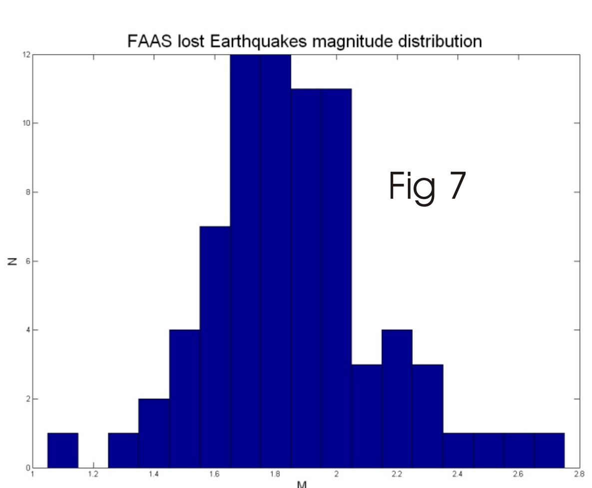


Fig 7

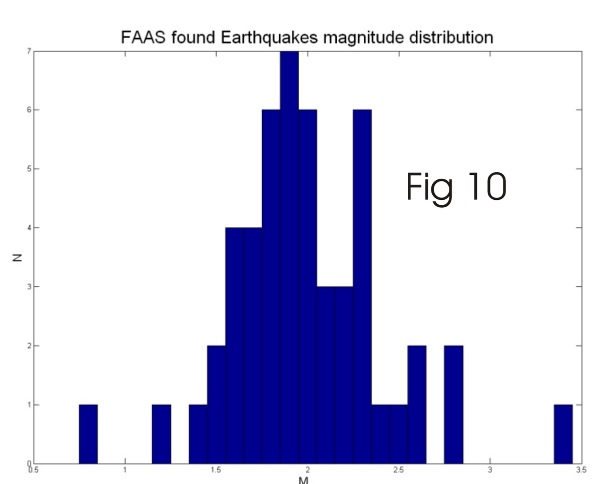


Fig 10

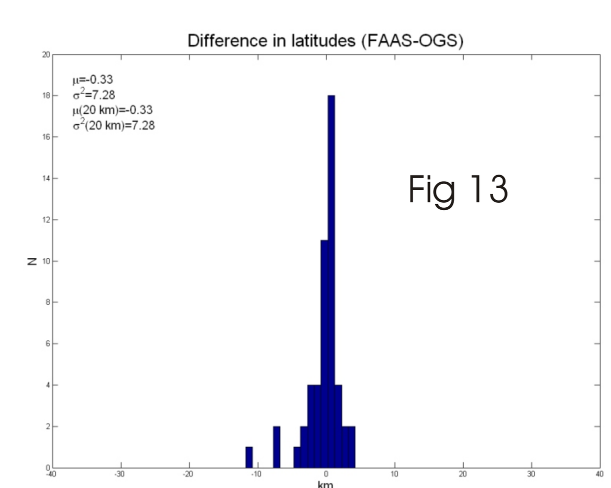


Fig 13

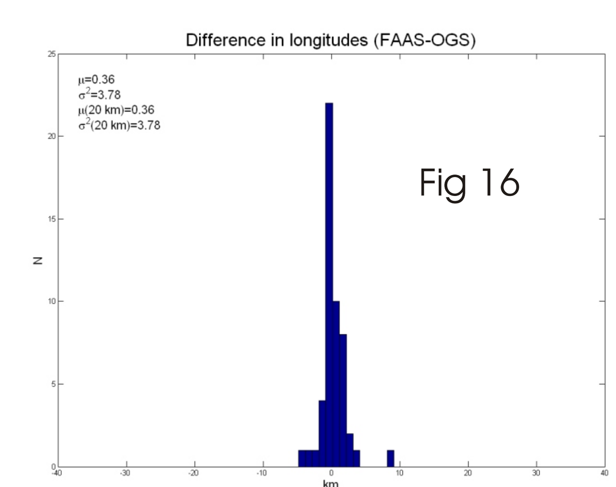
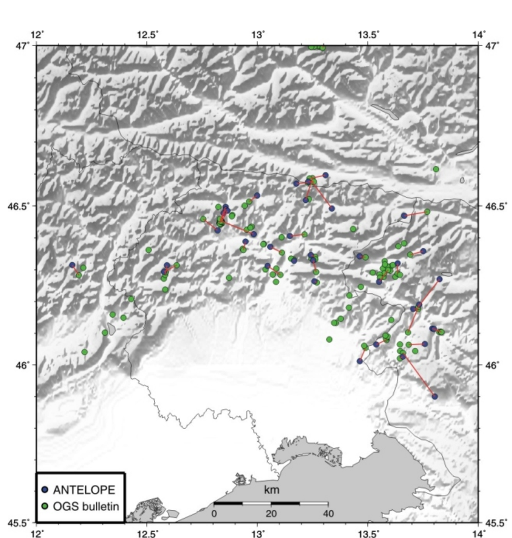


Fig 16

Fig 5



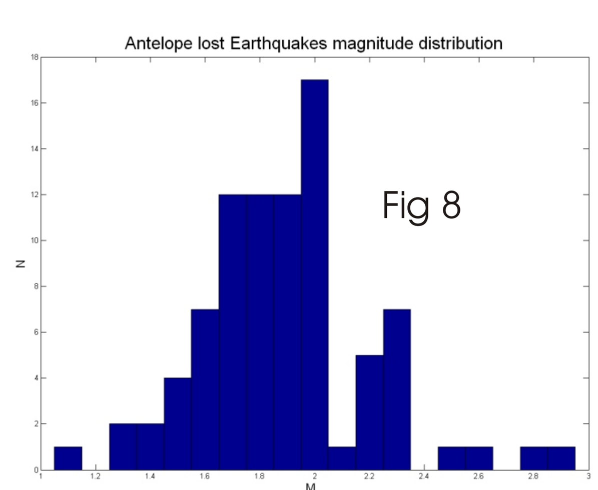


Fig 8

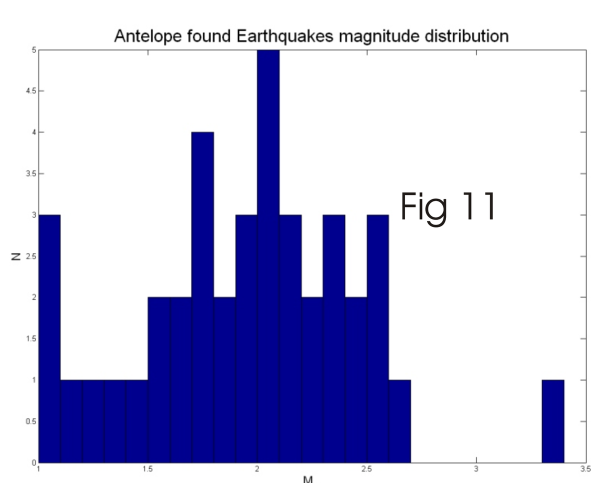


Fig 11

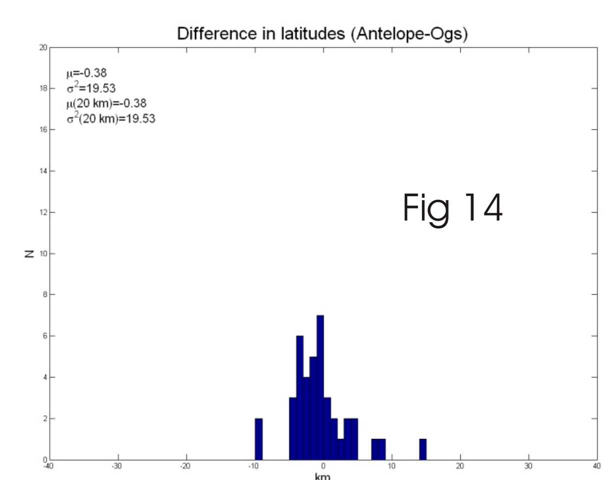


Fig 14

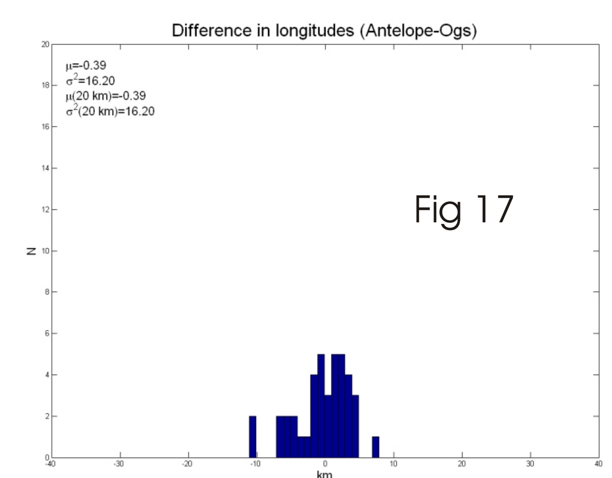
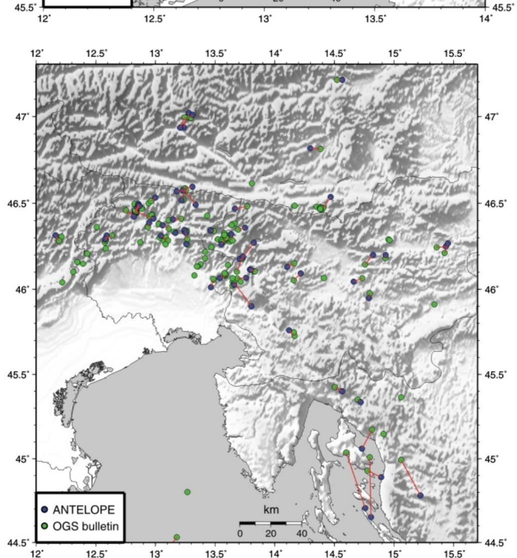


Fig 17

Fig 6



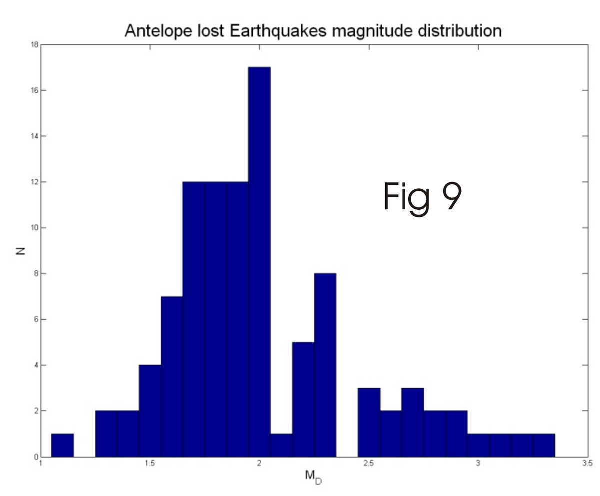


Fig 9

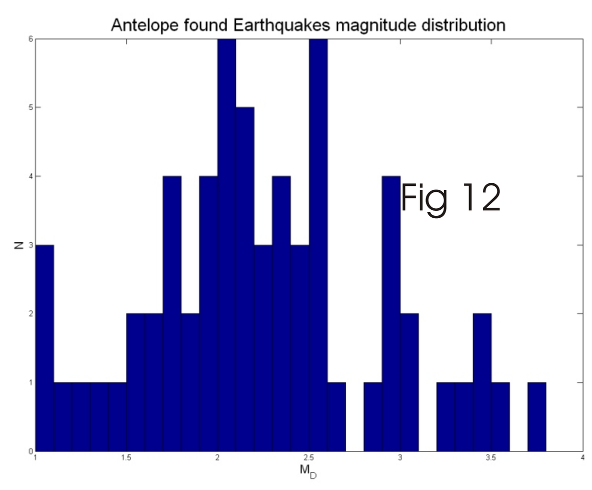


Fig 12

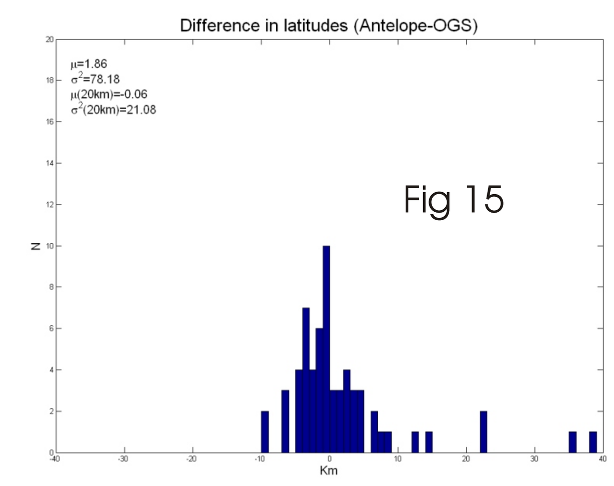


Fig 15

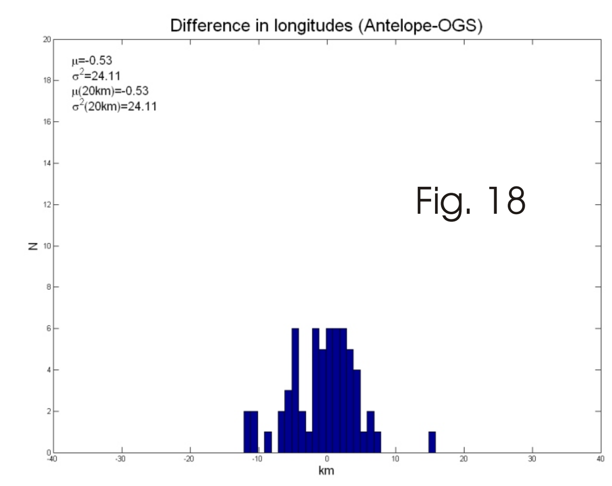


Fig. 18

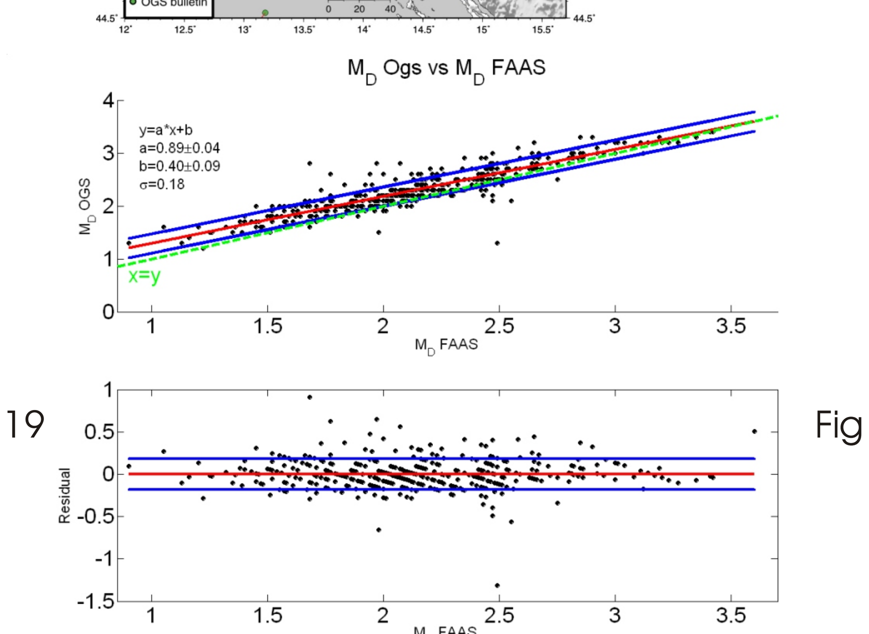


Fig 19

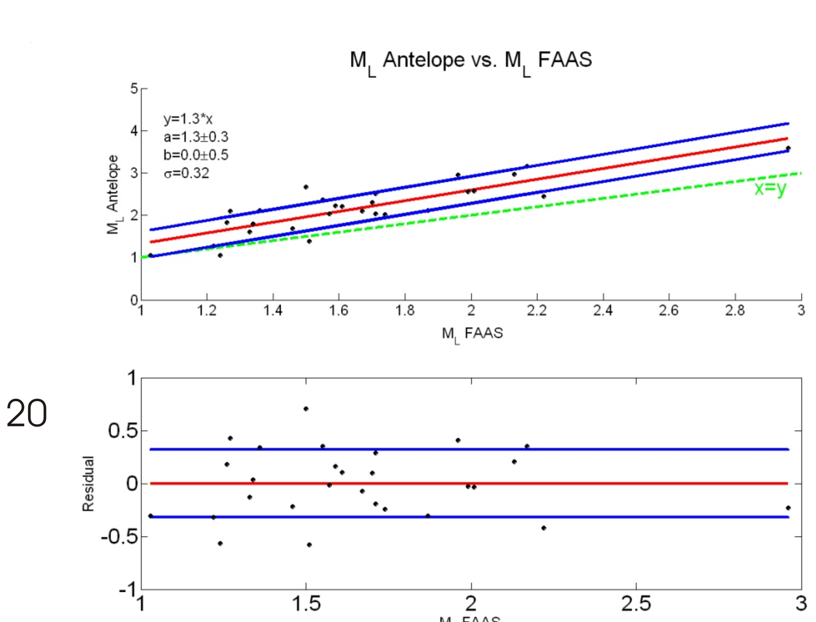


Fig 20

Location: regarding the accuracy in location, the systematic error of both FAAS and Antelope relative to the OGS bulletin (μ in figures 13-18) is of the order or smaller than 1 km. Using the same method described above for the picks and considering the small area monitored by FAAS, we have estimated the absolute variance of the locations in the three data sets referred to the real, unknown epicenters: var_{LONG}(Antelope)=30km^2, var_{LAT}(Antelope)=16 km^2, var_{LONG}(FAAS)=7 km^2, var_{LAT}(FAAS)=4 km^2, var_{LONG}(OGS)=0 km^2, var_{LAT}(OGS)=2 km^2.

The variance is much higher for Antelope due to the low grid resolution.

Magnitude: In order to understand if the M_D and M_L of the three system are coherent, we plot the comparison among the magnitude of the different databases. The OGS bulletin reports M_D, which is also computed by FAAS. Figures 19 shows how FAAS underestimates M_D by about 0.2 (Gentili et al. 2006), which is within the standard calibration deviation (about 0.3). Both Antelope and FAAS compute M_L (Figure 20): the latter tends to underestimate M_L and such result is mainly related to the use of a different attenuation law.

References

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