Centro di Ricerche Sismologiche

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ISTITUTO NAZIONALE DI OCEANOGRAFIA E DI GEOFISICA SPERIMENTALE

PERFORMANCES OF TWO AUTOMATIC EARTHQUAKE LOCATION SYSTEMS IN THE NORTH-EASTERN ITALY

S. Gentili(1), P. L. Bragato (1), D. Pesaresi (1,2) and A. Snidarcig(1)
(1) Ist. Naz. di Oceanografia e di Geofisica Sperimentale (OGS), (2) Ist. Naz. Di Geofisica e Vulcanologia (INGV)

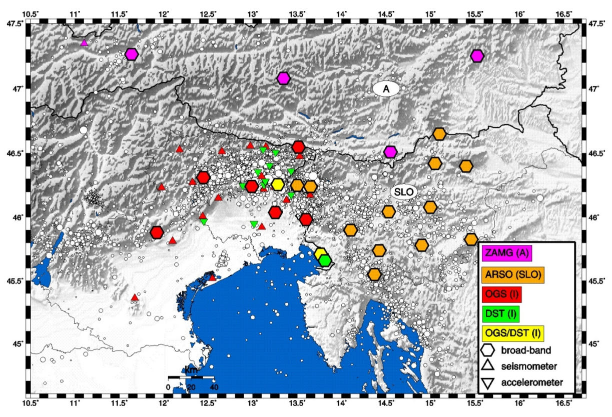


Fig. 1: Station currently acquired at CRS in the framework of the project "Trans-national seismological networks in the South-Eastern Alps"

Two automatic systems

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 (FAAS, Bragato and Govoni; 1999) which monitors the Friuli-Venezia Giulia region (NE Italy) and the surrounding area 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 near real-time data exchange, rapid location of earthquakes 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 performance are analyzed. Their procedures for earthquake detection, picking, 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 June 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:

event detection: STA/LTA triggering on remote stations + coincidence between at least 4 stations;

picking: P and S arrivals;

location: Hypo71 program;

magnitude: M_D using the same formulas as of Rebez and Renner (1991); M_L according to the formula by Bakun and Joyner (1984).

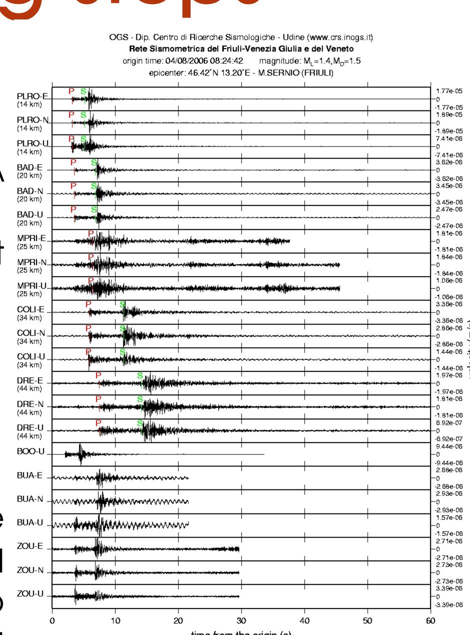
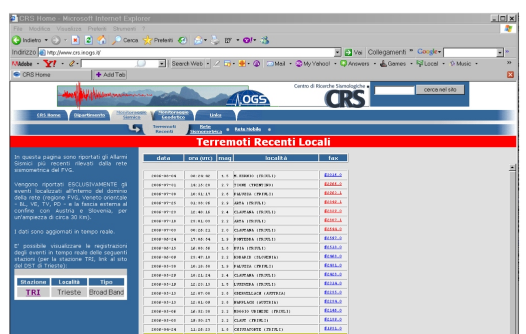


Fig. 2: FAAS picks



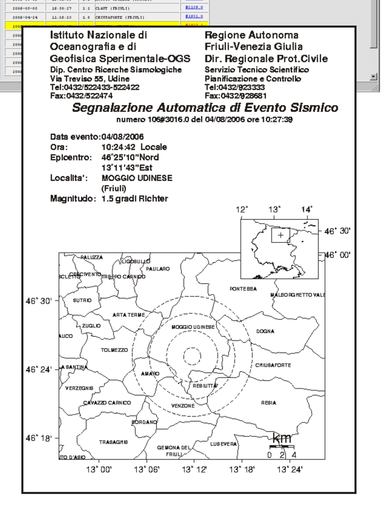


Fig.3: CRS web page reporting FAAS locations

Antelope:

event detection: STA/LTA detection + association based on location by grid search;

picking: only P arrivals are used;

location: grid search over 87X81 nodes for an extension of 7x6.4 degrees centered in 46.26, 13.28 (Fig.4) with dept steps at 0, 2, 4, 6, 8, 10, 12, 14, 16, 20 and 24 km, using the uniform velocity 1D model IASPEI91. The location procedure has been mainly set-up and tuned at DST, Trieste.

magnitude: M_L estimated using the program "orbampmag" developed by Nikolaus Horn at ZAMG, Vienna.

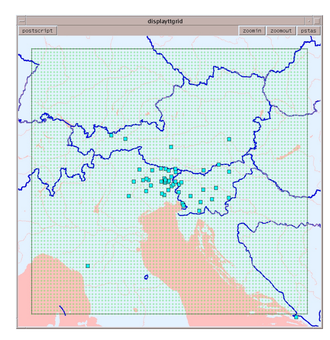


Fig.4: Antelope location grid

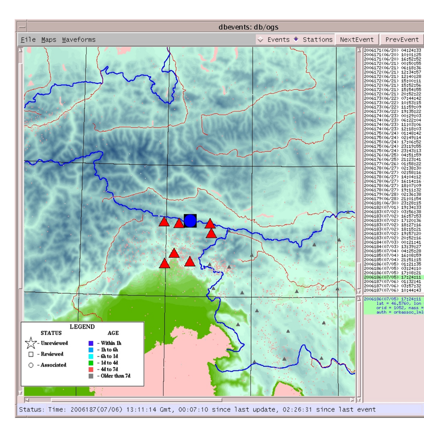


Fig.5: example of location by Antelope

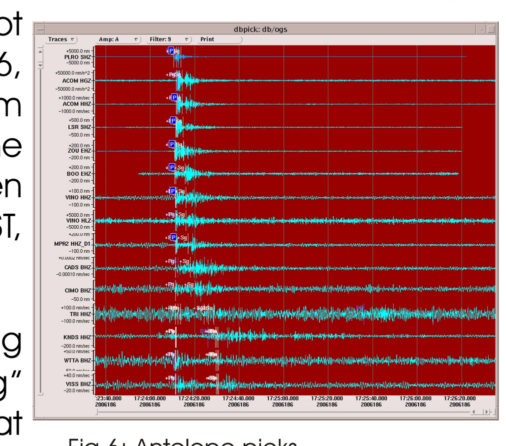


Fig 6: Antelope picks

Comparison

event detection: the capability of detecting earthquakes depending on their magnitude has been analyzed (maps in the Figures 9-11 and histograms in the Figures 12-17). For the two systems we have considered the area monitored by FAAS (coordinates box: LON=[12 14],LAT=[45.5 47]). For Antelope we have also considered the larger transfrontalier area of interest for the INTERREG project (coordinates box: LON=[12.1 15.7], LAT=[44.5 47.3]). It emerges that for the smaller box, the maximum magnitude of not detected earthquakes is 2.7 for FAAS and 2.9 for Antelope. For the larger box, the maximum magnitude of the events lost by Antelope is 3.3.

picking: P waves picking times of FAAS and Antelope have been compared with those in the OGS database. From the Figures 7 and 8 it is possible to see that both FAAS and Antelope pick some hundredth of seconds after the OGS. 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). Other to 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:

var(Antelope)=0.014s, var(FAAS)=0.014s, var(OGS)=0,009s

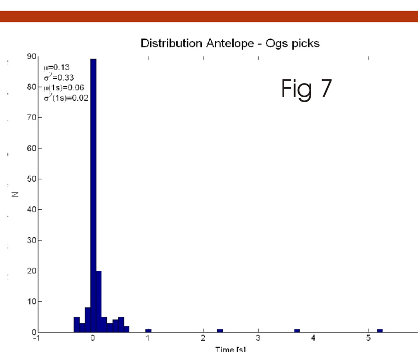


Fig 7

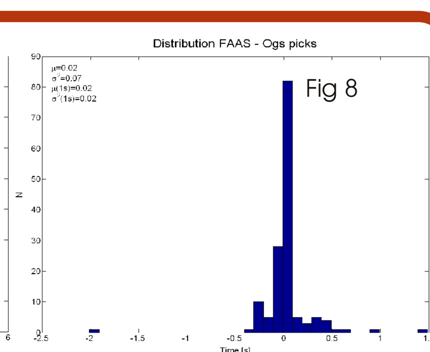
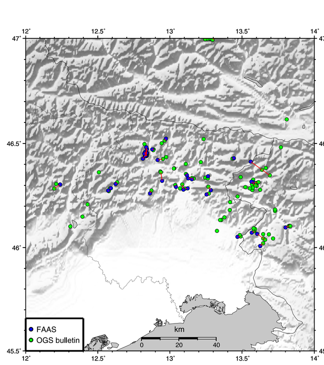


Fig 8

Fig 9


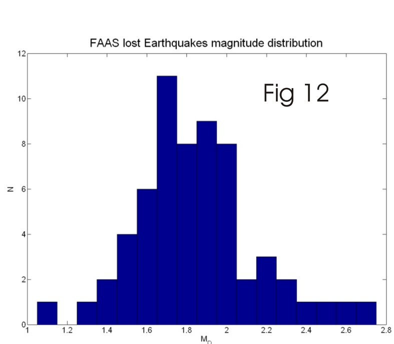


Fig 12

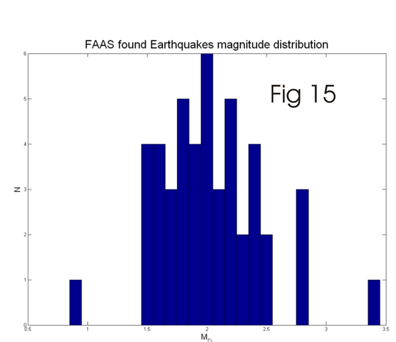


Fig 15

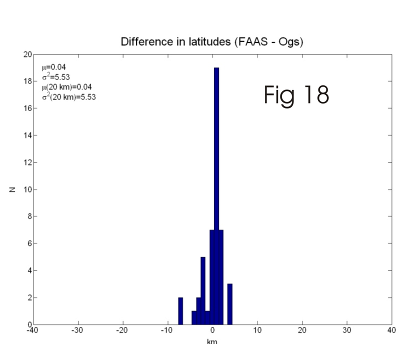


Fig 18

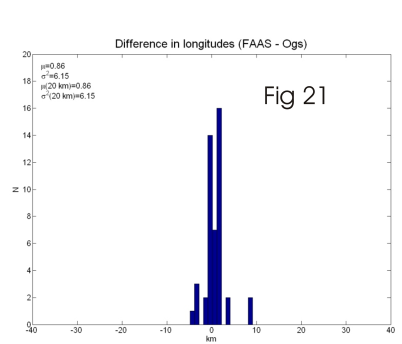
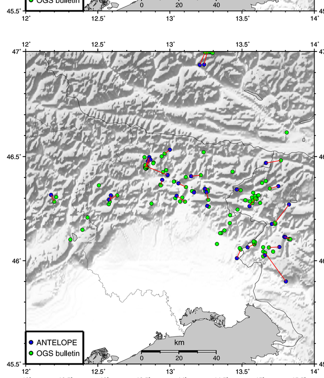


Fig 21

Fig 10


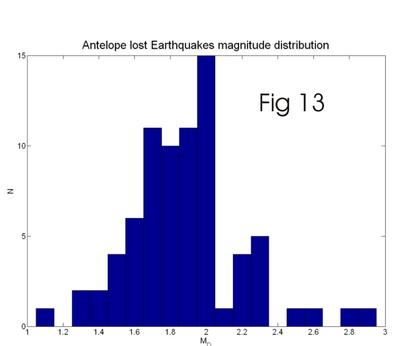


Fig 13

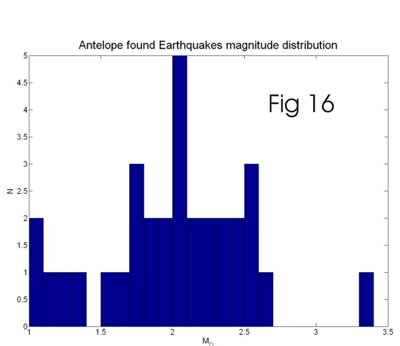


Fig 16

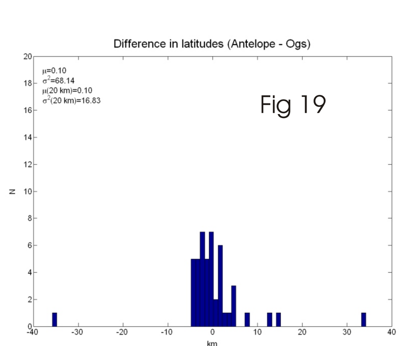


Fig 19

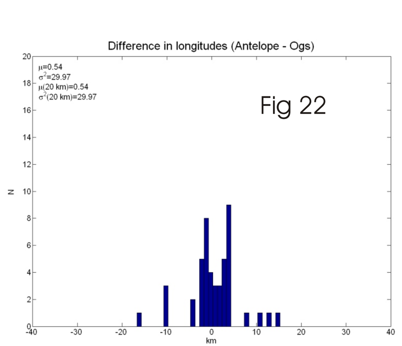
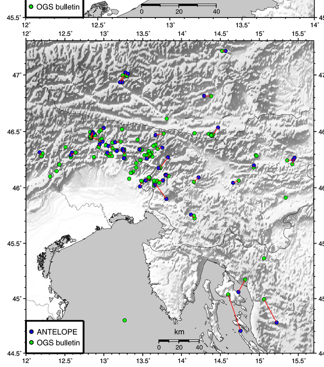


Fig 22

Fig 11


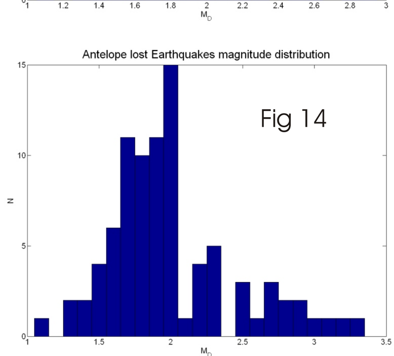


Fig 14

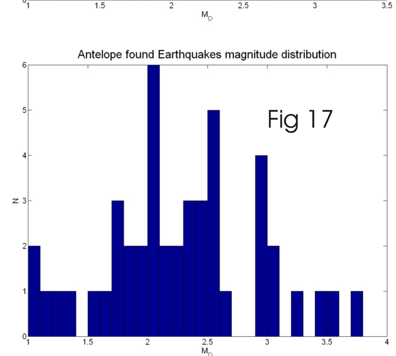


Fig 17

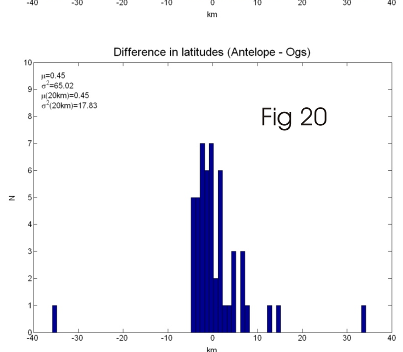


Fig 20

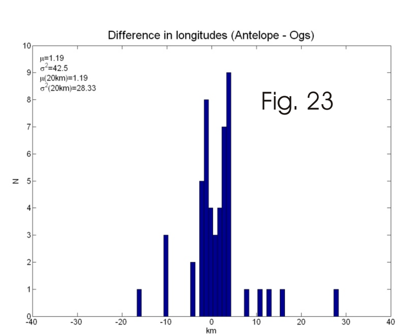


Fig. 23

location: regarding the accuracy in location, the systematic error of both FAAS and Antelope relative to the OGS bulletin (μ in figures 18-23) is of the order or smaller than 1 km, while the variance is much higher for Antelope than for FAAS. 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)=31km, var_{LAT}(Antelope)=15km

var_{LONG}(FAAS)=8km, var_{LAT}(FAAS)=4km

var_{LONG}(OGS)=0km, var_{LAT}(OGS)=2km

FAAS performs better than Antelope. Such result is probably related to the use of S picks by FAAS.

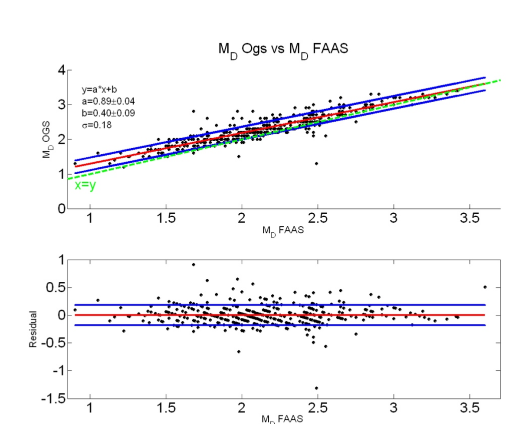
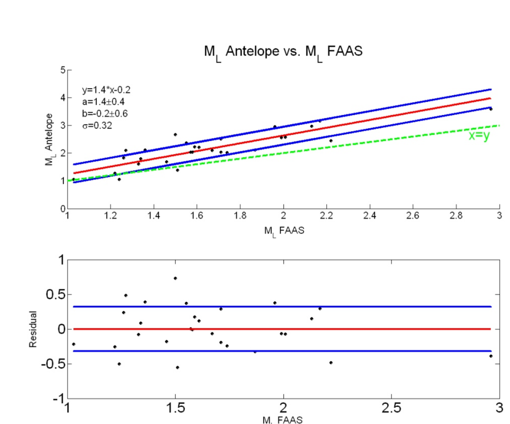
Fig 24


Fig 25


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 24 shows how FAAS underestimates M_D by about 0.2, which is within the standard deviation of the calibration of M_D (about 0.3). Both Antelope and FAAS compute M_L (Figure 25): the latter tends to underestimate M_L and such result is mainly related to the use of a different attenuation law.

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