ECGN - Development of the European Combined Geodetic Network in Austria

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Abstract

Austria takes part in the European Combined Geodetic Network - Project with three different stations: Graz, Trafelberg and Pfänder. One of them - Graz (= IGS) - is the oldest station and therefore it has got a very long time series for the position and the combination of GPS and laser instruments, whereas Trafelberg, a very new station, combines geodetic, gravimetric and seismic measurement devices. The presentation will concentrate on the present state of the three stations in Austria.

ECGN - Aims / topics:

- Investigation of the long time stability of the European Terrestrial Reference System ETRS89
- In-situ combination of geometric information (3-D coordinates measured by GPS with physical information (heights and other Earth gravity parameters) with an accuracy level of <±1 cm

The ECGN is an European network for the integration of time series of spatial/geometric observations (GNSS – GPS/ GLONASS and in the future GALILEO), gravity field related observations and parameters (gravity, tides, ocean tides), and supplementary information (meteorological parameters, surrounding information of the stations e.g. eccentricities and ground water level).

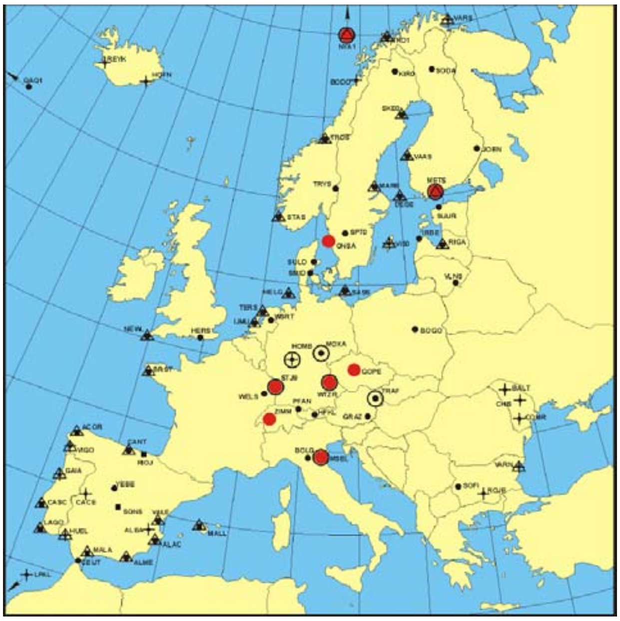

Fig. 1: Distribution of ECGN-stations in Europe (Ihde, 2005)

ECGN Stations in Austria

There are 3 different ECGN stations established in Austria. (Fig. 2)

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The main station is situated in Graz at the space laboratory on Lustbühel connected to the SLR station.

The second station is on the mount Pfänder near Bregenz in Vorarlberg. This station has been part of the Austrian Geodynamic Reference Network (AGREF) since 1992. The permanent GPS observations have been run since 1997.

The third station is situated near Vienna at the new geophysical observatory of the ZAMG, where seismic and gravimetric observation are disposed.

All stations are connected to the second order levelling network of Austria which is part of the UELN. Gravity values and consequently geopotential units and orthometric heights are available.

All three stations are part of the Austrian Positioning Service (APOS).

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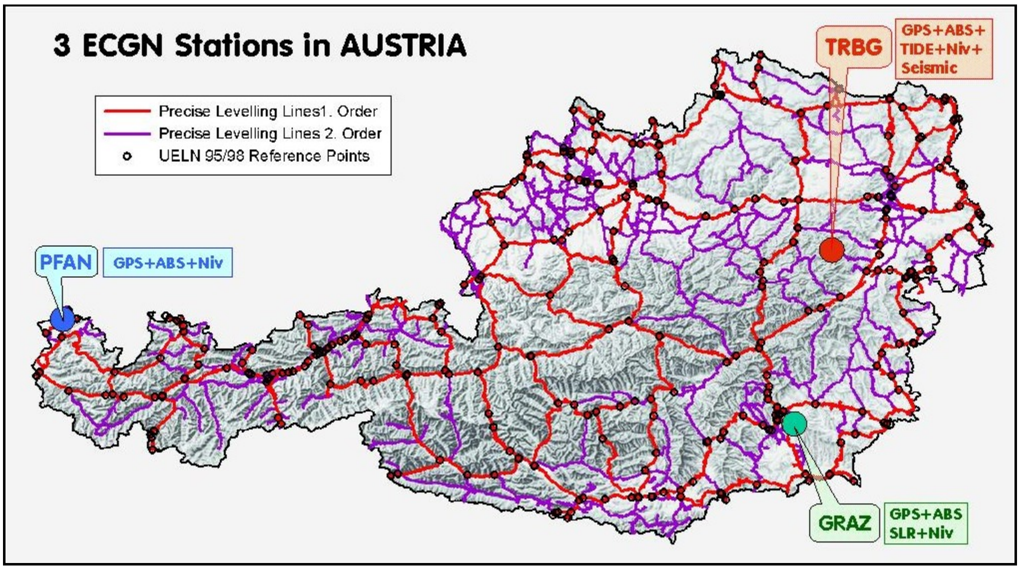

Fig. 2: The ECGN stations in connection with the levelling network in Austria

Station GRAZ

The station GRAZ is situated at the observatory of the Institute of Space Research of the Austrian Academy of Sciences (IWF-OeAW). (Fig. 3)

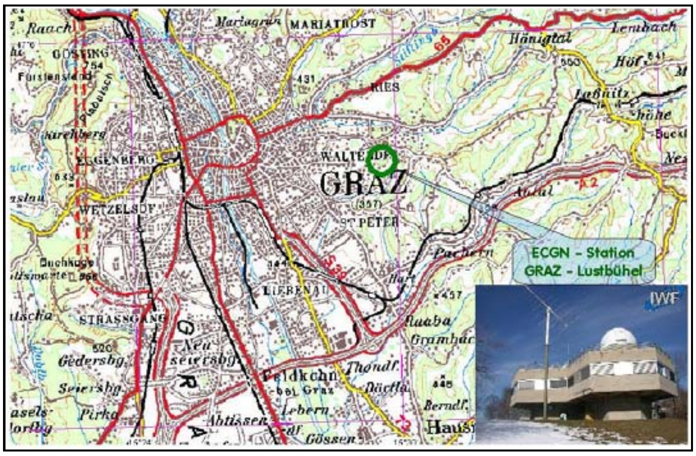

Fig. 3: ECGN station GRAZ

On the roof of the observatory of GRAZ-Lustbühel there are several GPS antennas that have been operating since 1992. In 1993 the levelled benchmark below the antenna „GRAZ“ was connected to the precise levelling network and in combination with the 2004 measured gravity value the orthometric height was obtained. In the background the astrodome of the satellite laser can be seen. (Fig. 4).

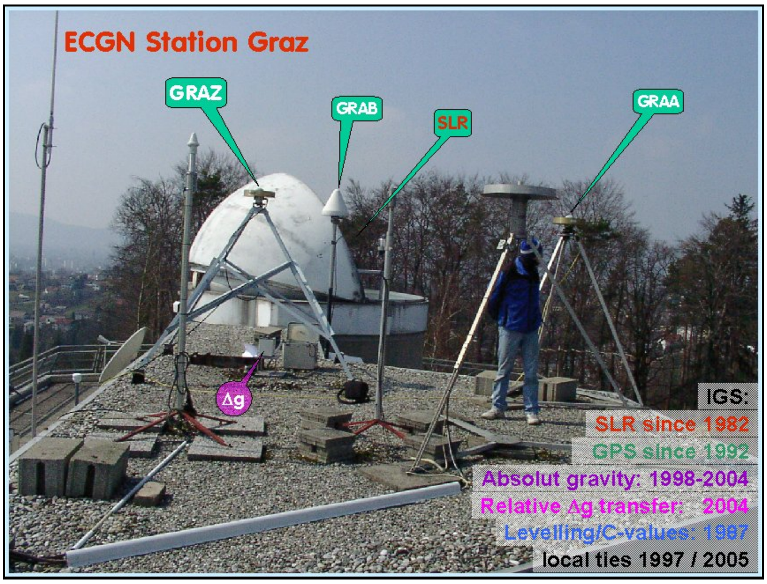

Fig. 4: Antennas at the ECGN station GRAZ

"GRAZ" is also a station of the International GPS Service.

The SLR has been operating very successfully since 1982. Since October 2003 a new 2 kHz satellite laser ranging system has been operating. Now the SLR station measures three times more returns from Lageos-1 than all other SLR stations. The results of lower satellites are much better than before, too.

A lot of local ties exist around the observatory, because this location has been used for astro-geodetic observations from the very beginning.

The absolute gravity station at the ground floor was established in 1998 during the UNIGRACE campaign (Fig. 5).

The local gravimetric ties around the building have been 1st order points of the ÖSGN (Österreichisches Schweregrundnetz = Austrian Gravity Base Network) since 1980.

Fig. 5: JILAg-6 absolute gravity observation in GRAZ

Station PFAN

The ECGN station PFAN is located on the ridge of mount Pfänder at 1042 m, 646m above the Bodensee (Lake Constance). (Fig. 6)

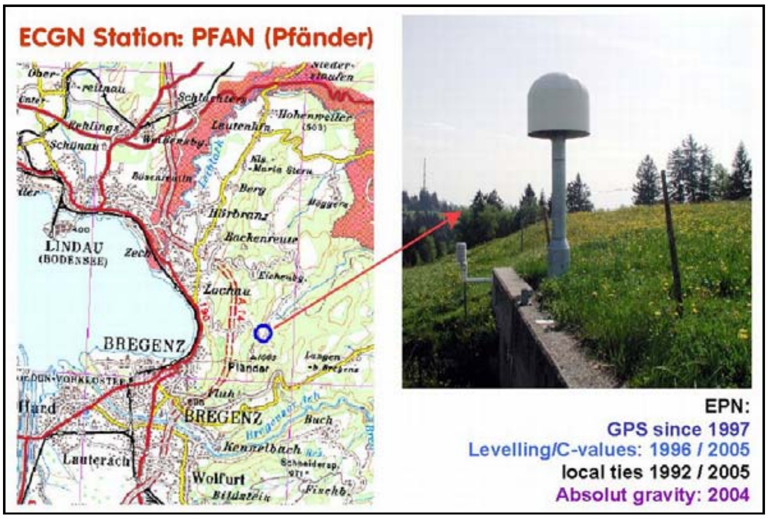

Fig. 6: ECGN station PFAN

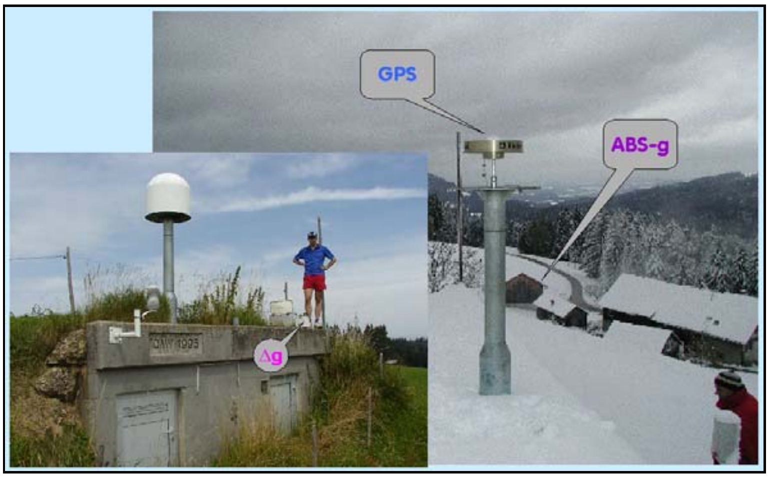

Fig. 7: Image of the permanent station PFAN and the surroundings.

The absolute gravity observations are done at the garage of a farmer near by, about 30 m below the GPS-antenna. The gravity transfer to the GPS station is done by relative gravimeters. The GPS receiver (and the complete electronically equipment) is placed in the small chamber below the antenna. (Fig. 7). The absolute gravity observations are done in the very stable founded implement shed of the farmer. (Fig. 8)

Fig. 8: Absolute gravity measurements at PFAN

Station TRFB

The Conrad-Observatory (COBS) of the "ZAMG“ (Zentralanstalt für Meteorologie und Geodynamik) built on Trafelberg (TRFB) is situated about 50 km SW of Vienna in the calcareous part of the foothills of the Eastern Alps at 1044m. The remoteness of the location and the undisturbed surroundings of the underground observatory guarantee an extreme low background noise and allow special investigations and long term research projects to be conducted - tasks, which will gain importance in the near future (Fig. 9).

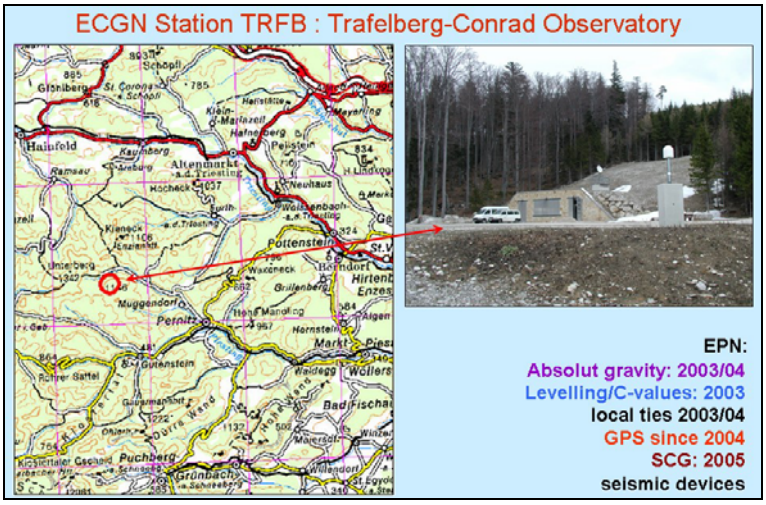

Fig. 9: ECGN station TRFB at the geophysical underground observatory

The observatory is used not only for seismic observations but also for gravimetric and in future for magnetic investigations in a separate building.

The first part was opened in May 2002 and contains a 145m long tunnel with several instrument pillars for seismometers, a room with 4 vertical boreholes (50 and 100m), a gravity laboratory, an office room and the necessary adjoining rooms.

The GPS pillar was built in 2004 in front of the west-side of the building.

A special room – the Gravity Lab – was constructed for gravimetric investigations. There a big concrete socked weighing about 80 tons was built directly on the rock. Its foundation of 8 x 2 meters allows to measure gravity with at least 3 big instruments like superconducting tidal gravimeters and free fall absolute gravimeters (see the image-picture). (Fig. 10)

Fig. 10: Image of superconducting and absolute gravimeters

Fig. 11: Absolute gravimetry inside the Gravity Laboratory

In 2003 first absolute gravity measurements were carried out. The foundation of the place is very stable and the surroundings indeed are very quiet. Therefore a mean drop sigma of 70nm/s² (7 µGal) could be achieved (Fig. 11).

Very important is the determination of the local vertical gravity gradient at the certain point res. the gravity differences between the various reference points.

The superconducting tidal gravimeter GWR will be transferred from the present station Vienna to the Conrad Observatory soon. In Vienna a permanent run over the last 10 years could be achieved.

Side by side simultaneous absolute observations are necessary to check the instrument factor and the drift of the SCG. (Fig. 12)

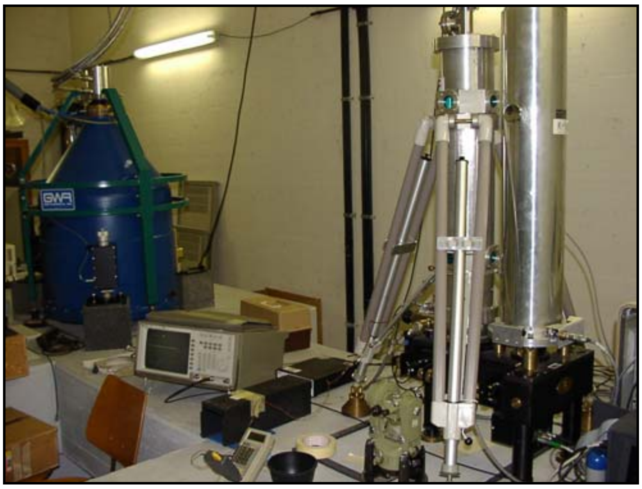

Fig. 12: The SCG tidal gravimeter and the JILAg-6 absolute meter side by side

One part of the Conrad Observatory consists of a tunnel of 145m length for seismic investigations and seismometer comparisons. There are several independent instrumental pillars. The tunnel is orientated exactly West to East. All pillars contain benchmarks of the precise levelling network to check the long-term stability. (Fig. 13)

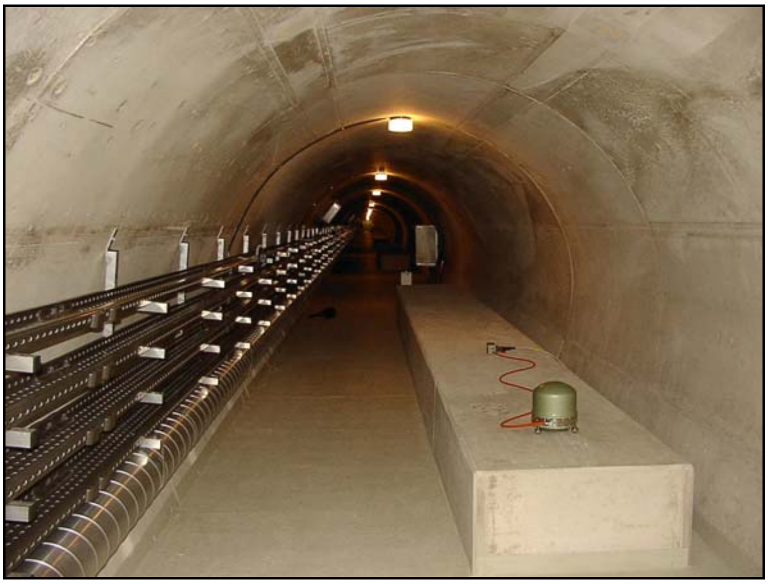

Fig. 13: Tunnel for seismic observations at COBS

A lot of local ties in and around the observatory allow to check the stability of the station over a long period of time.

Influences and future aspects

As yet no meteorological automatic equipments are implemented.

To detect correlations between different observation signals, it would be of interest to measure precipitation, temperature, air pressure, humidity, etc.

Also the influence of changing groundwater levels on the gravity values may not be neglected. Therefore groundwater gauges should be installed nearby.

Further studies of atmospheric parameters due to zenith path delays are in progress, particularly of the integrated water vapour of the troposphere.

The correlation of large pressure areas and GPS height monitoring in correlation to gravity changes could give interesting insights in the crust elastics.

The repetition of absolute & relative gravity measurements and the checking of the local ties will be done periodically.

References:

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