EUREF 12: National Report of Austria

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1. Positioning

1.1 GGOS/GIAC

GGOS is the Global Geodetic Observing System of the IAG. GGOS integrates different geodetic techniques, different models and different approaches in order to ensure a long-term, precise monitoring of the geodetic observables.
The GIAC - GGOS Inter-Agency Planning Committee - is a forum that seeks to generate a unified voice to communicate with governments and intergovernmental organizations (GEO, UN bodies) in all matters of global and regional spatial reference frames and GGOS research and applications.

Member of the GIAC is any governmental organization that endorses the principles embodied in the *Frankfurt Declaration* and the *White Paper*, signed the agreement and contributes resources for the sustainable operation and modernization of GGOS.

The BEV has joined the CIAG by signing the *Frankfurt Declaration* and the *White Paper*, 2011. The BEV will contribute to GGOS with the IGS station Lustbühel/Graz.

1.2 Permanent Networks

Five networks of permanent GNSS stations are monitored in post-processing mode by the Federal Office of Metrology and Surveying and the Austrian Academy of Sciences. EUREF (sub-network of the EPN, 80 stations) and AMON (East Alpine Region, including APOS stations, 85 stations) are designed to realize the reference system ETRS89 whereas CERGOP (Central European Geodynamics, 80 stations) and MON (Plate Boundaries in the Eastern Mediterranean, 65 stations) focus on geokinematics. Due to maintenance problems the processing of ALBPOS network is presently suspended. However, a new network in Greece (Fig. 1) was established as a test bed for regional ionosphere models. The first four networks are processed on a weekly basis according to the EPN guidelines by the OLG group. In contrast to this, the recently implemented test bed in Greece was processed in a single run.

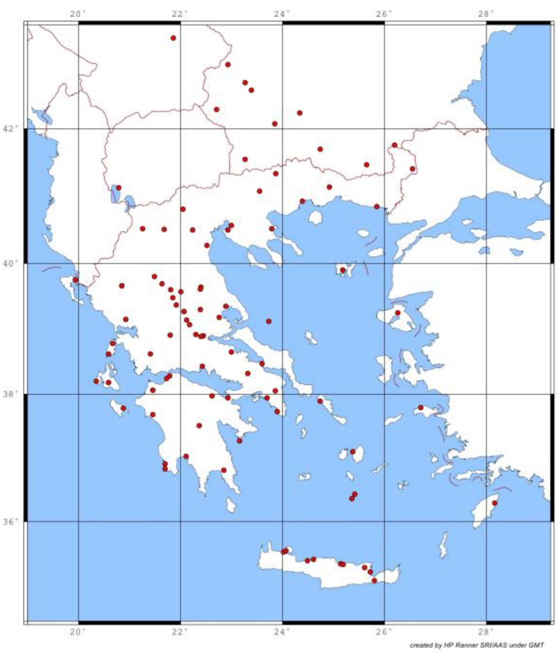

Fig. 1: Map of the Greek network as a test bed for ionosphere researches implemented in 2011

2. Ionosphere Research

Within the national project GIOMO (Next Generation near real-time Ionospheric Models) the effects of global and regional ionosphere models on the positioning with single frequency receivers was investigated. During the current low solar activity the influences are rather small, for a demanded precision of 1 m. However, considering the last two solar cycles, the choice of an adaptive model in near real-time will

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certainly lead to improvements especially during periods of high solar activity. This applies in particular to solar extreme events which cannot be forecasted. The models used by GPS and probably by GALILEO in future lead to deviations of several meters, especially in case of poor geometry. An example of the differences is given in Fig. 2. The investigations showed that a regional model, based on pseudo range measurements and derived in near real time, performs best considering robustness, best fit and availability.

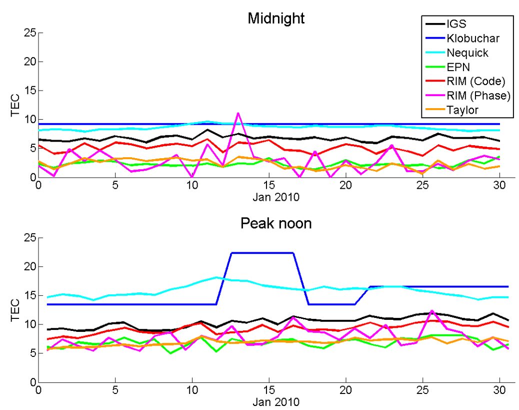

Fig. 2: Comparison of different ionosphere models in January 2010

3. Height - Grid

The increasing use of global navigation satellite systems (GNSS) for surveying tasks leads to observations and consequently to positions in a global coordinate frame. Nevertheless coordinates in the local Austrian coordinate frame MGI are often still very important. When high accuracy is demanded, one countrywide set of 7 parameters for a spatial similarity transformation between the global and the local Austrian coordinate frame is insufficient. To meet the accuracy demands for large area data acquisition like Airborne Laser Scanning (ALS) you have to subdivide the whole area into sections with individual transformation parameters. This inevitably leads to discontinuities at the transformation boundaries. These discontinuities can be avoided by using a grid-based transformation method. For the planar transformation from ETRS89 to the Austrian coordinate frame MGI for the whole area of Austria, the GIS-Grid was introduced by the BEV in 2010 [1], [2]. To permit a grid-based transformation for the height component, too, the BEV developed the Height-Grid in cooperation with the Institute of Photogrammetry and Remote Sensing of the Vienna University of Technology.

The determination of the Austrian Height-Grid is based on the whole set of data of the levelling and gravity measurements maintained by the BEV (Federal Office of Metrology and Surveying).

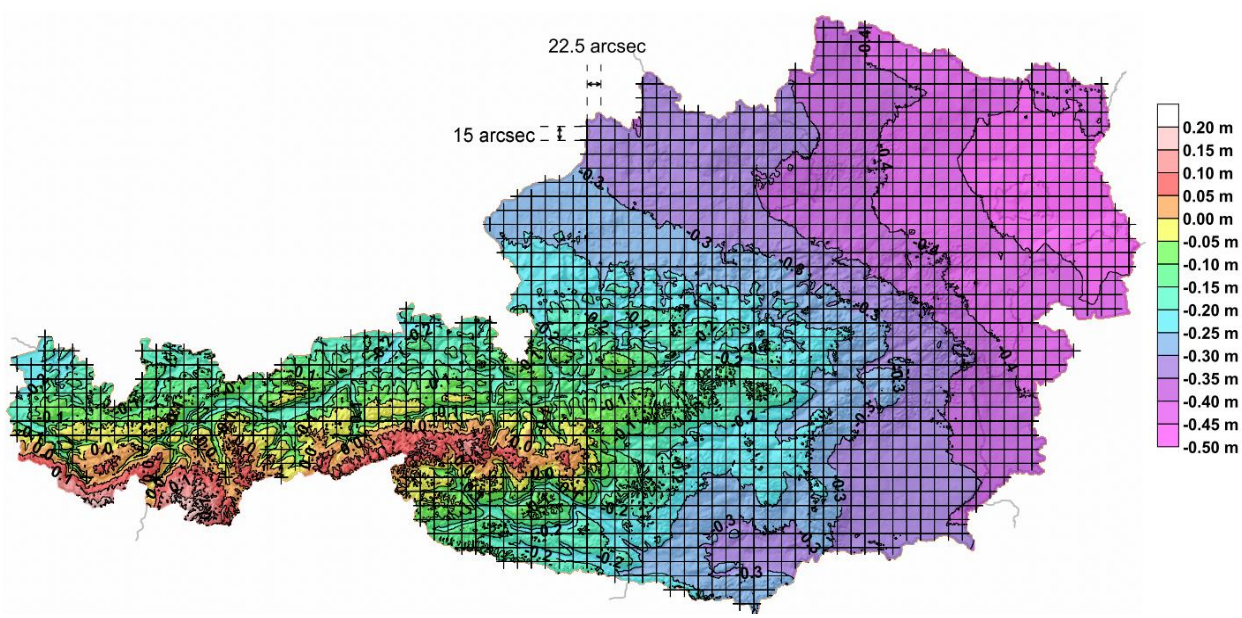

Fig. 3: Surface of the Austrian Height-Grid

It permits the transformation from ETRS89 orthometric heights (gauge Amsterdam) to MGI conventional heights (gauge Adria) with an accuracy of better than 5 cm. The spacing of the grid points is 22.5" longitude and 15" latitude (500 m x 500 m), see Fig.3. The value of each grid point represents the difference between orthometric heights H_{ORTH} and conventional height H_{CONV} (height in use). It can be calculated directly for all levelling points which are situated along the levelling lines of Austria. Though, because of the large gaps between the levelling lines and the regionally varying height correlation of the difference $H_{ORTH} – H_{CONV}$, the difference cannot be modelled for the whole area of Austria directly without significant loss of accuracy. Thus the Height-Grid was developed by splitting this difference into two terms by introducing normal heights H_{NORM}.

$$H_{ORTH} – H_{CONV} = (H_{NORM} – H_{CONV}) + (H_{ORTH} – H_{NORM})$$

For each of these two terms an own sub-model was interpolated. The first term is the difference between the normal height and the conventional height. This value can be calculated for every levelling point. Both, the normal height and the conventional height are based on theoretical gravity, so there is no relevant height correlation for this term. Thus this difference can be used directly for the interpolation of the first sub-model. The second term is the difference between the orthometric height and the normal height. This term can also be expressed, slightly simplified, as

$$H_{ORTH} – H_{NORM} = H_{CONV} (\gamma^*-g^*)/g^*$$

γ^* is the average normal gravity and g^* is the average gravity along the perpendicular between the Geoid and the earths surface. This term was calculated for 52,964 points with existing gravity measurements. These points are distributed all over Austria with an average point distance of about three kilometres. Though, because of the height correlation of the term and the rough alpine topography of Austria, the points are still not dense enough. So the data were densified by using the interpolated Bouguer gravity of 50,800 control points, 47,200 levelling points and 358,000 grid points of the 500 m x 500 m elevation model. Finally the Height-Grid was calculated by calculating the sum of the two sub-models [3], [4].

An additional product is a list of correction values for comparisons between the transformation results based on the Height-Grid and the conventional heights in Austria, listed in the point descriptions of the Austrian control points (triangulation points). These correction values are available for all triangulation points with valid ETRS89 coordinates. They can be used to compare a measurement which is attached to the conventional heights of the triangulation points with a measurement that was transformed with the Height-Grid.

4. APOS - Austrian Positioning Service

For APOS the year 2011 was marked first by embedding the GLONASS signals into its commercial services (“APOS Real Time”, “APOS Postprocessing”) and secondly by the realisation of a new concept for the APOS production system in general, concerning the migration of e.g. data and customer management into new databases and servers.

4.1 APOS - Production System

The APOS reference station network uses raw data from about 70 stations operated by national and international associate partners (see Fig. 4). To compensate for the dismantling of station HFLK (Hafelekar) in summer 2011 the new station INBK (Innsbruck) was erected and equipped in co-operation with the Leopold-Franzens- University of Innsbruck – LFUI. The station went online in summer 2011 and was integrated as a reference station for postprocessing purposes at the moment. It serves as an additional APOS RTK monitoring station as well. INBK is situated at a distance of approximately 10 km from the APOS station PATK (Patscherkofel) but at a much lower altitude, i.e. an altitude difference of 1,634 m. This might be the reason for significant offsets (approximately up to 8 cm) shown by the RTK monitoring in the height component at INBK so far, depending whether PATK is part of the RTK network processing or not. To evaluate possible troposphere modelling problems in the processing software for this special situation further performance measurements must be carried out this year. Afterwards a decision will be taken about the final setting.

The central software migration from Trimble GPSnet to Trimble VRS³net along with the upgrade to GNSS was finished in May 2011 and went successfully into service.

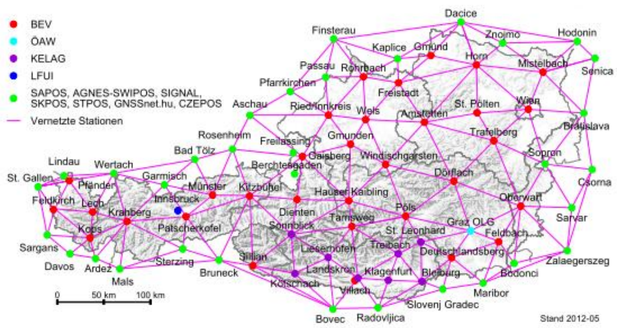

Fig. 4: APOS - reference station network (status 2012 - 05)

4.2 APOS Production System - Commercial Aspects

Up to now about 500 external customers, respectively more than 1,300 accounts of "APOS Real Time" in all kinds of working fields are registered. By April 2012 5,000 online hours had been reached and the number is still increasing.

4.3 M-GEX Project Participation

As scheduled for 2012 the BEV/APOS participates in the IGS project M-GEX at the Austrian IGS reference station GRAZ. The main mission is to track the signals of GPS/GLONASS/GALILEO and to collect resp. forward observations in RINEX3 – format to the project partners.

5. Gravi metry

Austria took part in the European Comparisons of Absolute Gravimeters ECAG2011 in Walferdange, Luxemburg from Oct. 30th – Nov. 3rd. All in all 22 instruments were compared. Austria's FG5-242 and 5 other instruments took part in the key comparison EURAMET.M.G-K1 (see Fig. 5). The results will be published soon.

On February 14th - 15th, 2012 a discussion meeting on Absolute Gravimetry (Joint meeting of JWG 2.1 "Techniques and Metrology in Absolute Gravimetry" and JWG 2.2 "Absolute Gravimetry and Absolute Gravity Reference System") was held at the BEV in Vienna. 33 experts took part.

Topics were amongst others influences on the g value due to self attraction of the instruments, diffraction effect, reference height, final report of ICAG2009, future ICAG's and ECAG's and possible sites, realization of a International Gravity Reference System.

Fig. 5: ECAG in Walferdange / Luxemburg

Final decisions how to correct and handle the cognitions will be taken at the CCM-WGG meeting in June 2012 in Istanbul. An excursion to the ECGN station TRFB at the Conrad Observatory of the ZAMG[1] on Trafelberg was organised on the third day. There we visited a stable, quiet gravimetric laboratory with a superconducting tidal gravimeter installed. This laboratory is qualified for RICAG (Regional International Comparison of Absolute Gravimeters).

A repeated absolute Gravimetry campaign could be realized in northern Italy - region South Tyrol / Alto Adige (see Fig. 6). In 2001 there were measured 6 stations with the absolute gravimeter JILAg-6. In 2011 four stations were re-measured with the new FG5-242. One station was destroyed (Schlanders) and one station was not longer useable (Brenner old). Therefore two new stations were established (Eyrs and Brenner new). At the other 4 stations there were noticed gravity differences of up to -40 µGals due to construction of buildings and underground garages near by. Also a systematic difference between JILAg and FG5 instruments of about 8 µGal could be part of these differences.

6. Precise Levelling

Due to financial shortage only 88 km of precise levelling could be realized in 2011. The levelling line to the Conrad Observatory on Trafelberg was repeated which include the ECGN station

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TRFB. The comparison with the first epoch 2003 shows an insignificant height change of ~ -2 mm for a distance of 18 km length and an elevation difference of ~ 630 m. Uncertainties of the temperature coefficients of the used rods in 2003 and 2011 together with the uncertainty due to the levelling - length causes a complete uncertainty of ~ ± 3 mm.

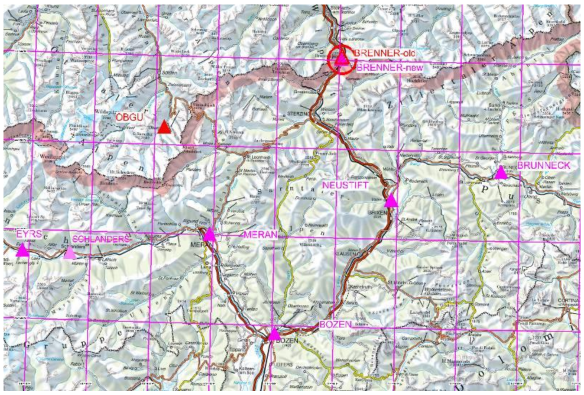

Fig. 6: Absolute Gravity observations 2011 in northern Italy

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