Hochschule Karlsruhe - Technik und Wirtschaft University of Applied Sciences

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Geodetic Infrastructures for the Albanian GNSS-Positioningservice ALBPOS

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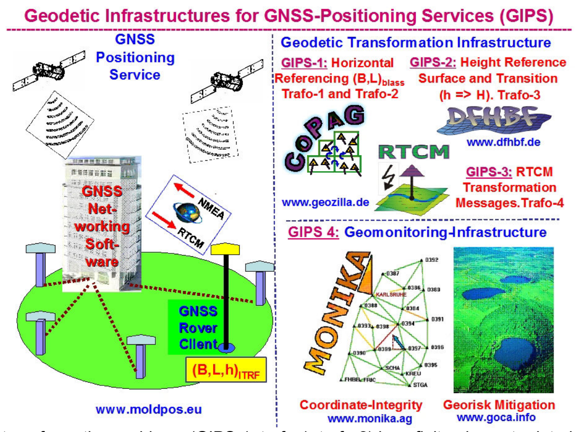
Introduction and Motivation

The worldwide ongoing process of the establishment of high precise DGNSS-positioning services and respective GNSS-reference station networks, which are related to the globally GNSS-consistent ITRF and ITRF-derivatives (e.g. ETRF89 or ETRF2000.2008.0 in Albania), implies the replacement of the georeferencing in the old independent classical national reference frames by ITRF-related ones. Accordingly the new age of GNSS-positioning services - as interdisciplinary tool with a broad and growing spectrum of precise satellite positioning, navigation, mobile GIS and mobile IT applications (www.navka.de) - requires the establishment and maintenance of a geodetic infrastructure for GNSS positioning services (GIPS). GIPS is divided into a transformation and a geomonitoring component (www.moldpos.eu). As concerns the transformation component, the old plan position data, which is related to a classical reference frame, has to be transformed to the ITRF-related horizontal georeferencing (B, L) provided by the GNSS-service. This forward transformation (GIPS-1, trafo-1, see figure right) concerns the establishment of modern GNSS-related databases for the infrastructure for spatial information in Europe (INSPIRE) and worldwide (cadastre, GIS, navigation, urban planning, construction, transportation, meteorology, land management, precise agriculture, etc.). It is necessary for a future direct horizontal positioning by GNSS services. The backward transformation (GIPS-1, trafo-2, see figure right) of the ITRF–related GNSS-position to an old classical datum is needed, because the classical non-ITRF reference frames will still be relevant for at least one decade or more.



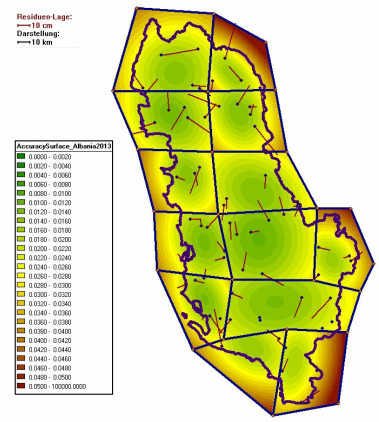
The presented concept and software CoPaG (www.geozilla.de) solves the above 3D-datum transformation problems (GIPS-1, trafo-1, trafo-2) by a finite element related mathematical modelling (FEM) and in a strict and general concept, including quality control. The computed high precise parameters are stored to transformation parameter data-bases. The ellipsoidal GNSS-heights always need a further processing, in order to transform h - by H=h-N - to the physical height H referring to the height reference surface (HRS) N.

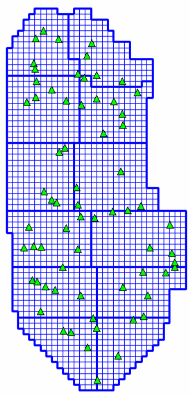
The software DFHBF (www.dfhbf.de) solves that height transformation problem (GIPS-2, trafo-3) and models again in a Finite Element (FEM) concept. Global geopotential models (GPM), existing HRS models, vertical deflections, terrestrial gravity g and identical points (h, H) can be used as observations for the computation of a HRS database by the DFHBF-software. The above databases can be used on GNSS-controllers and can be implemented reference transformations for setting up RTCM 3.x transformation messages for the GNSS rover-clients (www.rtcm.org, www.moldpos.eu, www.geozilla.de). The capacity of an absolute positioning by GNSS-positioning services requires, that possible changes of the coordinates of the GNSS reference stations in the amount of few millimetres are detected immediately. To solve that task, the GNSS-referencestation MONitoring by the KArlsruhe approach and software (MONIKA) has been developed (www.monika.ag, www.goca.info). The MONIKA approach and software can, besides the coordinate control of GNSS-positioning services, also be applied for a use of the permanent GNSS-stations as a geosensor-network for geodynamical questions and research, as well for a setting up temporary GNSS-arrays as a disaster monitoring and early warning GNSS service, e.g. for land-slides, flood and construction areas.

DFLBF/CoPaG-DB Computation

The CoPaG concept is dealing with the precise and continuous transformation of plan positions (N,E)class to the ITRF datum (N,E)ITRF. From the theoretical point of view a respective transformation can not renounce completely on height information. The so-called CoPaG (Continuously Patched Georeferencing, see www.geozilla.de) concept however, has the advantage that the point height information is needed only on a poor accuracy level in the target system. If precise height information is available in both systems, it can be introduced as a third ob-servation equation in system. Further basic considerations and a respective problem solution for the plan datum transition are due to the occurrence and the mathematical treatment of 'weak-forms'. These are long-waved deflections of the shape of classical networks, reaching a range of several meters in the nation-wide scale. This requires the partition of the total network area into a set of different "patches" in a FEM similar to DFHBF (right). The intro-duction of continuity conditions along the patch borders analogue to the DFHBF implies restrictions between the transformation parameters d of neighbouring patches.

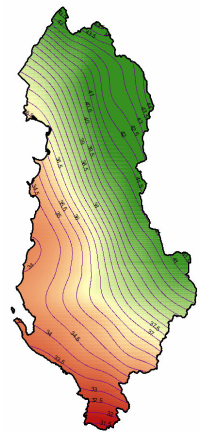
Because of its mathematical strictness and general validity the CoPaG concept has a broad and far-reaching application profile in the context with the big amount of similar datum transition problems occurring world-wide in the upcoming GNSS-age. xx shows the patch-layout for the computation of the <(1-3) cm CoPaG database Albania (see accuracy surface).





DFHBF-DB Computation

The computation of the precise Albanian height reference surface (HSR), namely the Albanianc Geoid, was done with the DFHRS software, vers. 4. Here the DFHRS DB contain a continuous FEM representaion NFEM of the HRS to transform by H=h-NFEM(**p**|B,L) ellipsoidal GNSS heights h into physical heights H. The HRS, a geoid or a quasigeoid, can be modelled in a first method, in an arbitrary large area as a con-ti-nuous surface by the parameters **p** of bivariate polynomials over a FEM mesh grid. Geometric observations, e.g. existing geoid grids N, vertical deflections (ξ,η) and identical points (B,L,h|H) can directly be related to NFEM(**p**|B,L). N or (ξ,η) grid or GPM-related information may be par-ted into different “patches” with individual datum-parameters **d** in order to reduce the effect of existing medium- and long-waved systematic errors.



In the DFHBF-software, vers. Gravity values g and the information of global geopotential models GPM are parametrized in regional Spherical Cap Harmonics representations (Cnm’, Snm’) t.
The computation of a Geoid for Albania led to a closed surface with an accuracy of (1-3) cm. As further observation components the geopotential model EGM2008 and the non-fitted EGG97 QGeoid have been used and compared. The re-spective final result of a (1-3) cm Albanian DFHBF database is ready for use in GNSS heighting. It can used for the determination of physical normal heights H, both on GNSS-controllers, and or for a setting up RTCM transformation messages by GNSS-services.

Albanian Reference Frames used for CoPaG-/DFLBF-/DFHBF-DB Computation

The state of Albania is situated between latitude 39°38'- 42°39' North and longitude 19°16'-42°04' East und extends over an area of 28.748 km2 (land 27,398 km^2, water 1,350 km^2).The terrain is mostly mountainous (highest point 2753 m) and hills with small plains along coast. Albania is affected from natural hazards such as destructive earthquakes, tsunamis and draughts. The new ITRF-related datum frame for the Albanian GNSS-positioning service ALBPOS is the ETRF89 consistent European ETRF2000.2008.0. The classical national horizontal geodetic network ALB86 is referring to Krassowski ellipsoid and UTM projection. Based on 109 identical points from both systems the (1-3) cm CoPaG- and DFLBF databases were computed with the CoPaG-Software using those identical points (see left part below). The vertical datum of Albania is referring to MSL Adriatic Sea and is related to orthometric heights and the geoid as height reference surface (HRS). The (1-3) cm DFHRS database was computed with the DFHBF-Software with respect to the ETRF2000.2008.0 georeferencing using the 109 identical points (B, L, h; H) and EGM2008 observations. So Albania is ready for putting the Albanian GNSS-positioning service into operation.

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