Geophysical Research Abstracts
Vol. 14, EGU2012-3084-1, 2012
EGU General Assembly 2012

The evolution of OPUS: A set of web-based GPS processing tools offered by the National Geodetic Survey

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The Online Positioning User Service (OPUS) is a suite of web-based GPS processing tools that were initially developed by the National Geodetic Survey approximately eleven years ago. The first version, known as OPUS static (OPUS-S), processes L1 and L2 carrier-phase data in native receiver and RINEX formats. Datasets submitted to OPUS-S must be between two and 48 hours in duration and pass several quality control steps before being passed onto the positioning algorithm. OPUS-S was designed to select five nearby CORS to form baselines that are processed independently. The best three solutions are averaged to produce a final set of coordinates. The current version of OPUS-S has been optimized to accept and process GPS data from any location in the continental United States, Alaska, Hawaii and the Caribbean.

OPUS Networks (OPUS-Net), one of the most recently developed versions and currently in beta testing, has many of the same processing characteristics and dataset requirements as OPUS-S but with one significant difference. OPUS-Net selects up to 10 IGS reference sites and three regional CORS to perform a simultaneous least squares adjustment with the user-submitted data. The CORS stations are primarily used to better estimate the troposphere while the position of the unknown station and the three CORS reference stations are determined from the more precisely known and monitored IGS reference stations. Additional enhancements to OPUS-Net are the implementation of absolute antenna patterns and ocean tides (FES2004), using reference station coordinates in IGS08 reference frame, as well as using improved phase ambiguity integer fixing and troposphere modeling (GPT and GMF *a priori* models).

OPUS Projects, the final version of OPUS to be reviewed in this paper, is a complete web-based, GPS data processing and analysis environment. The main idea behind OPUS Projects is that one or more managers can define numerous, independent GPS projects. Each newly defined project is assigned a unique ID which is shared amongst field personel assigned to the project. A typical GPS project may include simultaneous occupations that span one or more days, often referred to as a session, as well as having numerous sessions which can occur for projects that span several days, weeks or months. After individual GPS data files have been collected in the field, they are submitted to OPUS-S (OPUS-Net in the future) with the project-specific ID. OPUS-S is used as a pre-processor at this stage, to determine if the results for each data file surpass a set of pre-defined tolerances and is acceptable for further analysis. After all the data files for a project have been successfully submitted to OPUS-S, an OPUS Projects manager can begin to process each of the sessions in a least squares adjustment. Multiple session adjustments are combined using GPSCOM, a Helmert blocking normal equation processor, to estimate a single set of coordinates for each station in the project.

To evaluate the accuracy and performance of OPUS, approximately 861 data files collected at 227 stations in central Texas, during the summer of 2011, were submitted to each version of OPUS (OPUS-S, OPUS-Net and OPUS Projects). An initial analysis using IGS08 coordinates from OPUS-S solutions show that the mean RMS double difference phase residuals to be approximately 3.9 mm. The network approach from OPUS-Net shows very low scatter and indicates homogeneous solution quality even when data quality from some reference stations were poor. At the time this abstract was written and submitted, the OPUS Projects session processing and combination using Helmert blocks was incomplete, but a quick review of the completed sessions showed excellent agreement between coordinates derived for individual stations using OPUS-Net and OPUS Projects. The final set of analyses will compare coordinates derived using individual baselines as well as from the network and Helmert blocking approaches.