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# GPS positioning performance from algorithm advances in the network version of OPUS

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The National Geodetic Survey, NOAA has been operating a web-based GPS positioning service, known as the Online Positioning User Service (OPUS), for approximately ten years. During that time, several versions have evolved to reflect a few of the most commonly used GPS positioning techniques such as static and rapid static positioning. Our first and most popular prototype is known as OPUS-S and was developed to process static L1 and L2 carrier-phase data in native receiver and RINEX formats. The processing algorithms of OPUS-S are primarily optimized to accept datasets from two to 48 hours in duration that have been observed from any location in the continental United States, Alaska, Hawaii and the Caribbean. For significantly shorter datasets, for example those observed between 15 minutes and two hours, we recommend users process their datasets with the rapid static (OPUS-RS) version. OPUS-RS works best in the United States where CORS coverage is extensive, a requirement for interpolating the ionosphere and troposphere in one of the pre-processing stages.

Since both versions of OPUS are used extensively by the surveying, engineering and GIS/LIS communities, our goal of this investigation was to retain most of the GPS dataset observing requirements while incorporating some of the most advanced models and algorithms to extend the positioning capabilites and improve overall accuracy in the new network version known as OPUS-Net. Some of the improvements were to replace the three independent solutions algorithm in OPUS-S with a network approach where three nearby CORS and the 10 closest IGS reference stations are used in a simultaneous least squares solution. The CORS stations are primarily used to better estimate the troposphere while the position of the unknown station is determined primarily from the more precisely known and monitored IGS reference stations. Additional improvements are due to implementing absolute antenna patterns and ocean tides (FES2004), using reference station coordinates in the IGS05 reference frame as well as adding phase ambiguity integer fixing, relative troposphere modeling (GPT and GMF *a priori* models) and satellite and reference station *a priori* weighting.

Since the initial evaluation of OPUS-Net in 2010 (Geophysical Research Abstracts, Vol. 12, EGU2010-0), a much more thorough investigation has been performed and will be presented. GPS reference station data from 94 CORS and IGS stations, most in the United States with a few around the globe, were used as rovers. Data were collected from the rovers every fourth day in 2009 and then parsed into four separate datasets ranging from one to four hours in duration. In all, approximately 24717 datasets were submitted to OPUS-Net for processing. Initial analysis show the mean RMS double difference phase residuals to be 12 $\pm$ 3 mm. The low scatter from the network approach indicates homogeneous solution quality even when data quality from some reference stations were poor. The mean NEU offsets from the accepted positions of the rovers for the 6160 one hour datasets were 0 $\pm$ 54 mm, 6 $\pm$ 52 mm and -4 $\pm$ 45 mm respectively. The magnitudes of the NEU offsets for the four hour solutions were very similar except that the standard deviations improved (decreased) to approximately 21 mm, 18 mm and 24 mm for each of the three components. Even though solutions were computed from data taken throughout the year, the results show that there is excellent agreement with the mean coordinates for the rovers and the mean IGS weekly combined SINEX solutions.