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Ambiguity resolution in precise point positioning: what method should we use for Geosciences?

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Precise point positioning (PPP) is a valuable and preferable tool for geophysical studies using GPS. In recent years, integer ambiguity resolution for a single GPS receiver has been developed in order to improve the positioning quality of PPP. PPP ambiguity resolution can be implemented by applying improved satellite products for which the fractional-cycle biases (FCBs) have been separated from the integer ambiguities of a network solution. One method to achieve these products is to estimate the FCBs by averaging the fractional parts of the float ambiguity estimates, and the other is to estimate the integer-recovery clocks by fixing the undifferenced ambiguities to integers in advance. Of particular interest is how these two methods differ in practice and the ensuing impacts on geophysical studies like monitoring plate motions.

In this study, the daily positioning qualities of both methods are therefore compared with one year of GPS data from a global network of about 350 stations. The mean biases between all daily position estimates derived from these two methods are only 0.2, 0.1 and 0.0 mm, whereas the standard deviations of all position differences are only 1.3, 0.8 and 2.0 mm for the East, North and Up components, respectively. The differences of the position repeatabilities are below 0.2 mm on average for all three components. The RMS of the position estimates minus those from the International GNSS Service weekly solutions for the first method differs by below 0.1 mm on average for each component from that for the second method. Hence, considering the recognized millimeter-level precision of current GPS-derived daily positions, these statistics overall demonstrate the good agreement between the ambiguity-fixed position estimates derived from these two methods.

However, it is found that the different strategies of separating the FCBs from integer ambiguities in these two methods lead to a pattern of geographical distribution for their positioning discrepancies. Specifically, for the East component, the station-specific RMS statistics of the position differences are well below 1.5 mm in Europe and North America with relatively-dense networks, whereas usually over 2.0 mm in oceanic areas and Africa with very sparse networks. In terms of the East position repeatability and the East RMS statistics against the IGS weekly solutions, the first method performs slightly better over dense networks, whereas the second method performs a little better over sparse networks. Overall, the second method slightly outperforms the first method for the East component.

In conclusion, we note that the first method is compatible with current official clock-generation methods, whereas the second method is not, but can potentially lead to slightly better positioning quality, which is meaningful to some geophysical studies.