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Geoscientific Instrumentation Methods and Data Systems Discussions

Interactive comment on "Single Point Positioning with Vertical Total Electron Content estimation based on single epoch data" *by* Artur Fischer et al.

Artur Fischer et al.

artur.fischer21@gmail.com

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Interactive response to the referee comment (Anonymous Referee #1) on "Single Point Positioning with Vertical Total Electron Content estimation based on single epoch data" by Artur Fischer, Sławomir Cellmer and Krzysztof Nowel. First of all, we appreciate your contribution to improving the manuscript. The remarks were implemented into the new version of the paper. The responses (R) to the questions (Q) and comments (C) are as follows: Q1. Page 1, Line 21 – "Single point positioning (SPP) allows of the indication of an autonomous position of a receiver using code data from the Global Positioning System (GPS)." Does the SPP positioning technique concerns only the GPS system or also other GNSS systems? R1. The SPP positioning technique concerns the GPS and other GNSS systems, e.g., GLONASS, GALILEO, or BeiDou. The idea

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was to use the real code data in the numerical experiment from the GPS because of the system's popularity, availability and declared precision comparing to other mentioned GNSS systems. C2. Equation (9). Not all values in the formula have been explained in the text of the article. R2. All symbols are explained in the new version of the manuscript. Q3. Equation (14). If V, X and L are vectors so why then they are written in capital letters? R3. This is our mistake. The symbols of vectors were corrected as the reviewer's suggestion. C4. Equation (16). The paper only presents the method of calculating the "mapcoeff" coefficients. Please provide information about determination of the rest of coefficients of matrix. R4. Information about the determination of the rest of the coefficients of matrix is included in the corrected version of the manuscript. C5. Equations (20, 21). Least squares solution is widely known in geosciences and I think it can be omitted from the article. R5. The formulas of LS solution have been removed in the new, improved version of the manuscript. C6. Equation (22). It must be underlined that this formula of the Euclidean distance between points in 3D space is the basic knowledge, so in my opinion there is no need to write this quantity as a new formula. R6. The terms from formula (22) are applied in formula (24). Therefore we decided to present them explicitly, in spite of the basic knowledge of the Euclidean distance formula. C7. Equation (24). The quantities in the denominator are not explained in the text. R7. The terms of equation (24) were briefly explained in the revised version of the research paper. Q8. Can the approach described in the paper be generalized by combining of the observations from different GNSS systems? If yes, then how would the computational procedure looks then? R8. Yes, the approach described in the paper can be generalized by combining the observations from different GNSS systems. First of all, the appropriate observational data from other GNSS systems have to be derived. Taking into account equations (8) and (10), the various variants of them should be considered because of different carrier frequencies of satellite signals from utilized GNSS systems as well as equation (13), related to "mapcoeff" calculation component. The equation (4) will remain unchanged. The mapping function as well, due to subsequent satellites zenith angles of different GNSS systems at the piercing point. Note,

that the value of VTEC0 would be still equal to 5 TECU. Undoubtedly, this quantity can be changed during another experiment containing more than one GNSS system. Taking into account equations (9) and (11), the existed set of GPS code equations should be supplemented by the new observation formulas using satellites of subsequent GNSS systems. The appropriate ingredients of mentioned formulations should be generated in relation to available satellites of GNSS systems, e.g. tropospheric or ionospheric correction components. Afterward, the matrix notation (14) will be updated by the magnification of matrices and vectors structure due to additional observations from following GNSS systems. Nevertheless, the combination of observations from different GNSS systems can be considered as an interesting idea of the next numerical experiment to verify the reliability of SPP with autonomous method of ionospheric delay estimation.

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