Recommended Procedure for the Adjustment of Individual GPS Baseline Solutions

Session processing of GPS data is preferable to baseline processing and should be used whenever possible. Session processing accounts for all mathematical correlations between baselines in a session. It also allows for easier ambiguity resolution, estimation of tropospheric scale parameters and involves less data processing than baseline processing (if the latter is done properly). The problem with baseline processing is that the individual baselines are mathematically correlated with other baselines derived from the same observing session (some receiver data is reused in different baselines). The correlations can be accounted for only by including all possible baselines together in a session or network adjustment, including the linearly dependent baselines (also referred to as "trivial" baselines).

Recognizing that session processing software is not widely available, a procedure has been developed to account for the mathematical correlations when using baseline processing. The following summarizes the recommended steps required to adjust individual GPS baseline solutions. This is a general procedure which accommodates observing sessions with different numbers of receivers. A more efficient procedure can be developed when the same number of receivers is used in all sessions.

1. Single Baseline Solutions

1.1 Process all possible individual single baseline solutions, including all linearly dependent ones (also called "trivial" baselines).

1.2 Scale the covariance matrix for each individual baseline solution by its estimated variance factor. Note: some GPS processing software may do this automatically. Note also that this will not maintain equivalency with session processing which uses the same variance factor for all baselines in the session. The intention here is to try to model any increased noise level in longer baselines through the use of the different variance factors.

2. Session Adjustments

2.1 Combine all possible individual baseline solutions from step 1 into separate minimally constrained adjustments for each session; i.e., adjust each session separately. Note that step 2 is not really necessary if all sessions use the same number of receivers. One can instead combine all baselines together in the final network adjustment without scaling the baseline covariance matrices by n/2 (as long as the final covariance matrix is scaled by the final estimated variance factor).

2.2 Scale the covariance matrix for the adjusted session coordinates by the estimated variance factor from the session adjustment in step 2.1. Note that this can be done automatically by most adjustment software.

2.3 Additionally scale the estimated covariance matrix for the adjusted session coordinates by n/2, where n is the number of receivers used in the session. This will correct the covariance matrix for the artificial increase in redundancy due to the repeated use of each receiver's data in different

baselines. For an explanation of this see Craymer and Beck ["Session versus Baseline GPS Processing", Proc. of ION GPS-92, 5th International Technical Meeting of the Satellite Division of the Institute of Navigation, Albuquerque, NM, September 16-18, 1992]. Note that this scale factor must be applied after scaling by the estimated variance factor in step 2.2. Note also that the n/2 scale factor is not needed if the same number of receivers are used in all sessions.

2.4 Check for outliers in the baseline residuals and identify any receivers which may be responsible for them. Only data from a receiver may be reject, not individual baselines, unless all baselines in a session associated with the receiver are omitted (i.e., all data from the receiver is omitted). Omitting partial data from a receiver would necessitate recomputing the baselines derived from that receiver (i.e., repeating step 1).

3. Network Adjustment

3.1 Combine all session adjustment solutions from step 2 into a final minimally constrained network adjustment. Make sure that the n/2 scale factor from step 2.3 is incorporated into each session adjustment's covariance matrix. Note the n/2 scale factor is not needed if the number of receivers is the same in all sessions.

3.2 Scale the resulting covariance matrices of the adjusted network coordinates and the residuals by the estimated variance factor. Note that this can be done automatically by most adjustment software.

3.3 Check for outliers in the session residuals and identify any points which may be outliers. Only data from a receiver may be reject, not individual baselines (see step 2.4).

For questions or more information, please contact:

Michael R. Craymer
Geodetic Survey Division
Geomatics Canada
Natural Resources Canada
615 Booth Street, Ottawa K1A 0E9

Tel. (613) 947-1829
Fax. (613) 992-6628
Email: craymer@nrcan.gc.ca
http://www.geod.nrcan.gc.ca/~craymer/

M. Craymer

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