United States Department of the Interior
U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

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Memorandum

OFFICE OF SURFACE WATER TECHNICAL MEMORANDUM 2017.12

SUBJECT: Methods for Quantifying Streamflow Measurement Uncertainty for Measurements Stored in the National Water Information System

Scientific information, including water-data provided by the U.S. Geological Survey (USGS), is subject to growing scrutiny by user communities, cooperating agencies, Congressional oversight committees, and the general public. In this environment, quantifying the uncertainty of our streamflow measurements has become increasingly important.

This memorandum establishes the Interpolated Variance Estimator (IVE) method (Cohn and others, 2014) for mid-section measurements, including those made with an acoustic Doppler Current profiler (ADCP), and the QRev method (Mueller, 2016) for moving-boat ADCP measurements, as the sources for quantifying measurement uncertainty for measurements stored in the National Water Information System (NWIS). WMA plans to modify NWIS to store these quantitative estimates of the measurement uncertainty and the method used to compute the uncertainty. Field computing software will also be modified so that this uncertainty information is automatically computed, if needed, and stored. Consequently, the additional computation, collection and storage of uncertainty information should not impact data collection and processing procedures for streamflow measurements collected by USGS hydrographers.

Hydrographer qualitative ratings of excellent/good/fair/poor should continue to be assigned to each measurement and will also be retained. For measurement procedures where an automated quantitative estimate of uncertainty is not available, only the qualitative rating will be assigned to the measurement.

Estimating Uncertainty of USGS Streamflow Measurements

Measurement uncertainty has long been a topic of concern and its computation an important goal for the USGS. OSW Technical Memo 1989.03 transmitted Pelletier (1988), a paper providing an excellent summary of considerations in estimating current-meter discharge measurement uncertainty. OSW Technical Memo 1993.14 introduced MEASERR (Sauer and Meyer, 1992), a USGS method for estimating uncertainty in velocity-area measurements. MEASERR and the ISO 748 method are conceptually similar - empirical or laboratory estimates of various component uncertainties are applied to each discharge measurement. IVE and Qrev reference some laboratory information as well, but they are based primarily on direct, at-site measures of field conditions. Additional information on the IVE and Qrev uncertainty estimation methods is below.

IVE

The interpolated variance estimator (IVE) is recommended for quantification of uncertainty in mid-section velocity-area measurements, whatever the instrumentation. It is automatically computed by FlowTracker (labeled as the "Statistical" method) and will soon be added to SVMobileAQ. The method starts with the equation for measurement uncertainty suggested by ISO 748 (2007) but rather than using laboratory or empirical results to estimate uncertainty in the depth and velocity, it instead relies on information contained in the many verticals collected during the measurement. For width uncertainty and for systematic uncertainties caused by meter fabrication errors, values suggested by ISO 748 are employed. IVE does not address consistent field user biases such as persistent meter tilt or flow angularity. Internal OSW testing has shown that, given standard USGS practices, the IVE method provides more sensitivity to measurement conditions than the standard ISO method. Recent comparisons of IVE with other methods for computing measurement uncertainty (Despax and others, 2016) indicate that IVE provides a more realistic estimate relative to other methods tested. Note that IVE will only be applied when 10 or more verticals are used.

QRev

Computing the uncertainty of an ADCP moving-boat discharge measurement is a complex task and to date (2017) there is not an uncertainty model that has been generally accepted for application to actual field measurements. The current method used in QRev is a combination of Type A and Type B estimates of uncertainty (Joint Committee for Guides in Metrology, 2008). Qrev uncertainty estimates account for many aspects of an ADCP moving boat measurement pertaining to the variability of cross-section depth and velocity measured by the ADCP, profile and edge extrapolations, lost or invalid ensembles, the presence of a moving bed, and systematic biases related to the boat and instrument configuration and operation. All estimates are at the 95 percent uncertainty level and expressed as:

- Random error: discharge coefficient of variation times a coverage factor.
- Invalid Data: 20% of the percent discharge for invalid cells and ensembles.
- Edge Discharge: 30% of the total percent discharge in the edges.
- Extrapolation: Average percent difference of the best four alternative extrapolation methods.

- Moving-Bed: 0% if GPS is the reference; 1% if valid test indicates no moving bed; 1.5% if a moving-bed is present; and 3% if the moving-bed test is invalid or not completed.
- Systematic: 3%

QRev allows the user to override the automatic uncertainty values by entering a user-supplied uncertainty estimate for any of the above sources of uncertainty. Research is ongoing to develop a more robust approach to uncertainty (Mueller, 2016).

//signed//

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Distribution: GS-W All

References

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