Call for Collaboration in WMO Project for the Assessment of the Performance of Flow Measurement Instruments and Techniques

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Introduction

Advances in computing and electronics have resulted in a new generation of hydrometric instruments. Hydroacoustic instruments, perhaps the best example of the new generation of instruments, are having a dramatic effect on how flow measurements are made. Commission for Hydrology (CHy) of the World Meteorological Organization (WMO) identified the need "to develop a proposal and to implement a project to assess the performance of flow measurement instruments and techniques" (WMO 2004, p. 30) in response to the dramatic changes in hydrometric instrumentation and the need to compute associated discharge measurement uncertainties. The resulting proposal and implementation plan, developed by a small group of experts (WMO 2007), addresses a wide range of instrumentation that can be used to measure discharge. Because hydroacoustic instruments are becoming an essential tool for flow measurement, it is important that these instruments be among the first instruments addressed by this project. This paper provides the substance of the proposal and is intended to encourage hydroacoustic experts to participate in the endeavor.

Background

Hydroacoustic instrumentation in many applications offers more detailed and better quality data at a lower cost while being easier and safer to use than older models of current meters. Acoustic velocity technologies can report vector components of water velocity that can improve measurement accuracy and are essential to accurate discharge measurements in situations of bidirectional flow. Acoustic Doppler velocimeters (ADVs) have made it possible to more affordably and easily measure actual flow vectors in field environments. Because of the advantages that hydroacoustic instruments offer, many governmental agencies are increasing use of the instrumentation.

Existing WMO guidance and standards for hydrometry include the *Guide to Hydrological Practices, WMO-No.168*, Chapters 10, 11, 12, and 13 (WMO 1994), and the *Manual on Stream Gauging, WMO-No. 519* (WMO 1980). These documents are intended to provide general guidance and specific information respectively, on stream gauging practices. They are not intended to provide detailed results of testing of flow measurement technology and measurement techniques. Both of these documents were substantially written before the development of hydroacoustic instrumentation. The methodology used by ADCP instrumentation, Doppler shift, does not duplicate the methodology used by the older current meters. Additionally, an ADV, unlike previous instrumentation, measures velocity vectors. Increasing and more complex demands on water supplies are requiring that the uncertainty of flow measurements be quantified by using standardized methods similar to those adopted by the International Organization for Standardization (1983, 1993), American Institute of Aeronautics and Astronautics (1995), the U.S. National Institute of Standards and Testing (Taylor and Kuyant 1994), and the United Kingdom Accreditation Service (1997).

A new edition of the WMO *Guide to Hydrological Practices* is currently in the final stages of preparation and should be published in 2007. However, the use of hydroacoustic instruments is continuing to evolve in response to new improvements in the instrumentation. More recent and broader information on the appropriate use of hydroacoustic instrumentation and methodologies and their uncertainties is needed to advance the current state of practice.

Objectives and Approach

The main objective of the WMO project is to help make information and standardized test results on hydrometric instrumentation and measurement methodologies generally available to National Hydrological Services (NHSs) by providing a public web site as a forum for the exchange of instrumentation and measurement methodology test results and information. A secondary objective of this project is to encourage and solicit the testing of the new hydrometric instrumentation and methodologies. The objectives encompass a broad range of instrumentation, but it is recognized that hydroacoustic instrumentation is of major importance.

Six outputs, articulated in the report of the Meeting of Experts (WMO 2007), are expected from the project:

1. A summary of field discharge measurement instrumentation and techniques, where "techniques" includes methodologies and procedures for field measurements.
2. Collection of international and national standards and guidelines regarding field discharge measurement instrumentation and techniques.
3. A framework for the assessment of uncertainty in discharge measurement and guidelines for its implementation, including
   - Standardized approaches to uncertainty analysis;
   - Uncertainty analysis implementation examples;
   - Guidance in the form of decision-aid tools; and
   - Uncertainty analysis outcomes/inferences (recommendations for optimization of instrument configuration, operation and algorithms).
4. Guidelines for conducting and reporting results of instrument calibration and performance tests on instruments and techniques.
5. Collection of test reports on the performance of instruments and techniques, including
   - Manufacturer specifications;
   - Multiple instrument comparisons;
   - Reports of tests performed under laboratory conditions;
   - Reports by NHSs;
   - Contact details of institutions where testing is conducted; and
   - Other relevant information.
6. A Web site designed to disseminate all the preceding for promoting the exchange of information and fostering the use of common standards in testing and presentation of results.

WMO CHy is seeking additional participation of experts from national laboratory testing facilities, national hydrological services organizations, international organizations and associations, manufacturers, industry and academia that would be willing to contribute to this international initiative. Several papers in this special issue on hydroacoustics are examples of the information and contributions that are needed to make this project successful:

- "Comparison of Fixed- and Moving-Vessel Flow Measurements with an aDp in a Large River" by R. Szupiany, M. Amsler, J. L. Best, and D. R. Parsons;
- "Framework for Estimating Uncertainty of ADCP Measurements from a Moving Boat by Standardized Uncertainty Analysis" by J. González-Castro and M. Muste;
- "Validation of Streamflow Measurements Made with Acoustic Doppler Current Profilers" by Kevin Oberg and David S. Mueller;
- "Application of Acoustic Doppler Velocimeters for Streamflow Measurements" by Michael Rehmel;
- "Errors in Acoustic Doppler Profiler Velocity Measurements Caused by Flow Disturbance" by David S. Mueller, Jorge D. Abad, Carlos M. Garcia, Jeffery W. Gartner, Marcelo H. Garcia, and Kevin A. Oberg; and
- "Evaluation of Mean Velocity and Turbulence Measurements with ADCPs" by Elizabeth A. Nystrom, Chris R. Rehmann, and Kevin A. Oberg.

The complete proposal and implementation plan can be accessed at http://www.wmo.int/pages/prog/hwrp/Flow/index.html.

Summary

Estimating uncertainty and developing standards associated with newer hydrometric instruments and measurement techniques such as hydroacoustic instrumentation are quite challenging. Enhancing our understanding of uncertainty inherent in hydroacoustic measurements and making its estimation available to practitioners and water monitoring organizations would be a significant contribution to the state of the practice and would result in significant benefits to society. WMO CHy is seeking the participation of experts from national laboratory testing facilities, hydrological services organizations, international organizations and associations, manufacturers, industry and academia that would be willing to contribute to this international initiative.

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