Hydroacoustics UPDATE:

Sontek M9 Discharge Bias in Low Backscatter Environments

John Mazurek

2/25/2021

The Hydroacoustics Work Group (HaWG) would like to call your attention to some potential issues the Sontek M9 Acoustic Doppler Current Profiler (ADCP) in low backscatter environments. Measurements affected by this issue may display an apparent secondary reflection of the channel bottom on both the Velocity and SNR contour plots. Sontek and others have documented a resultant low bias in the water velocity and discharge data in measurements acquired under low backscatter conditions. In general, this phenomenon tends to occur in low backscatter water with significant water depth (>18 ft.) and low water velocities.

Measurements collected in environments where the potential for this issue is high should be carefully evaluated for signs of a reflected bottom profile in the velocity and SNR contour plots. If the discharge measured using a M9 is unexpectedly less than the expected discharge during low backscatter conditions, users should: (1) Collect a comparison measurement with another instrument (2) Submit your M9 measurement and comparison to the USGS Hydracoustics Work Group (HaWG), (3) Collect future measurements in similar environmental conditions at that site using either a TRDI instrument OR using an M9 loaded with a Sontek-supplied configuration file (M9_mr (6000).ini) available from the Hydroacoustics Work group (HaWG). More information can be found in the 2017 Sontek Technical Report RiverSurveyor Operation Low Backscatter.

Background

During comparison measurements performed in 2015-2016 in Sweden, Norway, and Canada, the calculated discharges from Sontek M9s showed a negative bias in low SNR environments downstream of hydroelectric operations. Sontek M9 discharges were compared to discharges from TRDI RioGrande ADCPs along with calculated ouputs from the hydroelectric station and computations from a tracer dilution measurement. Sontek was notified of these measurements in August 2016 and began to investigate the cause of the bias.

Sontek identified the issue as being caused by the return signal from a previous ping reflecting up and down within the water column and incorporating into the following ping. In this scenario, the signal from the previous ping reflects off the riverbed, then is received by the transducer, but some of the signal also reflects back off of the water surface, then reflects again off of particles in the water column before being received by the transducer. In low backscatter conditions, the signal strength associated with these double reflected pings is near enough to the signal strength of the initial reflection off of the particles in the water column that they are incorporated into the return signal measured by the M9 transducers. The effect of this

phenomenon is that water velocities inferred from the measured velocities of the particles in the water column are biased low. In some instances, this can be visualized as a 'double reflection' where a region of low velocity and/or SNR in the respective contour plot(s) displays a shape that appears to mirror the shape of the riverbed.

Measurements Collected in low Backscatter Environments with the Sontek M9

Sontek M9 measurements should be screened for a secondary reflection of the river bottom in the velocity and SNR data if the water is clear with low backscatter one or more of the environmental conditions at the site meet the following criteria:

1. The water is deep (more than ~18 ft.)
2. The water velocities are low
3. The water temperature is cold

If such conditions exist during the collection of a discharge measurement using a Sontek M9, the user should collect a comparison discharge measurement with another type of ADCP. If measurements acquired in low backscatter environments are identified to potentially contain the 'double reflected ping' phenomenon, users are encouraged to submit their measurements to the HaWG (at the email alias listed below). Once this issue has been identified to occur at a site, future measurements acquired under similar environmental conditions should be conducted using another type of ADCP. Alternatively, future measurements may be conducted using a Sontek M9, granted that the configuration file described in the next paragraph is loaded prior to data collection.

Sontek has provided a limited solution to the double reflected ping issue as described in detail in the Sontek Technical Report. A configuration file, "M9_mr (6000).ini", which will increase the lag between pings to 6 times the default rate must be applied to the M9 ***prior to*** collecting measurement data. This configuration cannot be retroactively applied to the data. Collecting data with this configuration applied will allow the initial ping to dissipate before sending a subsequent ping. A separate configuration file, "M9_mr (1000).ini is provided to reset the M9 back to default ping rate.

Cautions when Changing Configuration

Users applying this configuration change to 6 times the default lag time between pings must use caution to ensure to take extra precautions to eliminate any additional uncertainty or error is added to the measurement. This configuration change should only be applied for measurements where there is high potential for this phenomenon to exist and M9 ADCPs should not be universally loaded with this configuration file. When collecting a measurement with the M9_mr (6000).ini configuration file loaded, extreme care must be taken to ensure slow and smooth ADCP boat operation while maintaining a low boat speed. After collecting Sontek M9 measurements with the '600.ini' configuration, the ADCP should be immediately loaded with the default ping rate configuration file (M9_mr (1000).ini). This is to avoid the inadvertent

collection of data with the modified configuration during measurements with environmental conditions where the configuration change is not warranted.

Please contact the HaWG with any measurement data where you feel the issue may be present or to request copies of the configuration files. The HaWG can be contacted at the email alias: gs-w_hawg_all@usgs.gov