Slide 1: Common Questions When Using ADCPs Under Ice

Welcome, this podcast was developed by the USGS Hydroacoustics Workgroup to summarize the questions we most often receive from the field as ADCPs are used more and more under ice with the midsection method. Please remember that the use of trade names does not imply endorsement by the USGS and is for descriptive purposes only.

Common Questions When Using ADCPs Under Ice

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(Photo Description): Hydrographer on an ice covered river with a PDA and rod-mounted TRDI StreamPro.

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Slide 2: Overview

In this podcast we will first cover common questions that apply to all measurements using an ADCP through ice, regardless of the equipment being used. Then, we will focus on questions specific to each manufacturer, both TRDI and SonTek.

[Photo Description]: A legendary specialist uses an ice auger to drill holes in preparation for an ice measurement with an ADCP.

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Slide 3: Do I need to do a temperature comparison?

A common misconception with ADCP ice measurements is that water temperature comparisons are not needed. In fact, we commonly see measurements where the ADCP was set on the bank when the holes were being drilled and the unit either got much cooler or warmer than the river temperature and these differences were never caught as no comparison was done before the measurement. So yes, ADCP and verification temperatures are required for ice measurements too.

Some offices have documented that ice-covered rivers are within a tenth of a degree or so of freezing and during ice measurements they use a verification temperature of 32 Fahrenheit or 0 Celsius based on this assumption. In this case, they note the ADCP temperature from the software as usual and a verification temperature of 32 Fahrenheit or 0 Celsius is entered as well. If there is open water upstream of the ice section this assumption might not hold true, and a thermistor might be needed for the verification temperature.

When using SWAMI, be sure these comparisons are noted in the channel Temperature/Salinity readings page under acoustic information, not in Environmental Measurements. In the Acoustic Information page, click the Temperature/Salinity button, which brings up the Temp/Salinity Readings page. Here, you can enter the time of the comparison, as well as the instrument and verification readings.

[Photo Descriptions): Left; Screen capture of the SWAMI Acoustic Information page. Right: Screen capture of the SWAMI Temp/Salinity Readings page.

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Slide 4: Do I need to process measurements on site?

Collecting ADCP data on a laptop or tablet is preferred for moving boat and ice measurements given the greater ability to view, analyze and process the data. Both the TRDI StreamPro and SonTek ADCPs have mobile options for data collection, a PDA for the StreamPro and a mobile device for the SonTek ADCPs with

Bluetooth. These mobile platforms may have more flexibility than a laptop or tablet in some deployment situations, but they do limit the user's ability to view and process measurements.

If ADCP ice measurements are collected on the PDA or a mobile device, load these measurements onto the PC versions of the software for processing before leaving the site to ensure there are no significant data quality issues. Measurements collected in the PC software should also be processed on site.

There may be situations where processing and finalizing the measurement on site isn't practical or there is some data issue that requires review by a more experienced user. While these situations certainly occur, hopefully they aren't frequent, and when collecting the data on a PC, the review is typically pretty quick.

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Slide 5: Is my ADCP going to work in the cold?

Many users have concerns about using their ADCPs in the cold, icy conditions we encounter when making ADCP measurements through ice. The major concern tends to be that winter conditions commonly require us to use the ADCPs in conditions that are outside of their published operating temperatures.

Both the SonTek and TRDI equipment report a minimum operating temperature of -5 Celsius, or 23 Fahrenheit. The minimum storage temperature for the TRDI equipment is -20 Celsius, or -4 Fahrenheit and for the SonTek equipment the minimum storage temperature is -10 Celsius or 14 Fahrenheit.

Given these specifications it’s important to avoid exposing the ADCP to very cold temperatures for extended periods as there have been cases where a user reports leaving the ADCP exposed to cold temperatures for an extended time and have been unable to communicate with the unit. Some offices use heat packs, hot water bottles or other methods to help keep the units warm in the these extreme conditions.

ADCPs in use by the USGS seem to work well in these winter conditions, even when temperatures are below the published operating temperatures. Most users experience a failure with Bluetooth communication in these cold temperatures before the unit itself would ever stop working. Using new or fully charged batteries is recommended in these conditions. If issues do occur in the field, do what you can to keep the unit warm and out of the elements.

[Photo Description]: A TRDI RiverRay ADCP with ice covering the transducer.

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Slide 6: How should I mount the ADCP?

If you are new to using ADCPs through ice a common question is how the unit should be mounted for deployment. At this point, there are no standard mounts in the USGS. Each office is designing and creating their own deployment options for their equipment. While you may decide to develop your own mount, or decide to copy a mount being used by another office, there are a few key points to keep in mind.

First, ensure the mount properly attaches to the ADCP. For example, the SonTek RiverSurveyor ADCPs have four holes on the top of the ADCP to mount the GPS bracket. These were only intended to hold the GPS, and the manufacturer does not recommend using these as the only mounting location. Instead, the M9 or S5 bracket should wrap around the ADCP in addition to using the holes on the top. For the RiverRay and Rio Grande, there are mounting posts on the top of the units that are acceptable to use as they are used to mount these ADCPs to a trimaran.

Another consideration is the material being used for the mount. In the TRDI RiverRay and Rio Grande, and SonTek M9 and S5, there is a compass in the ADCP and the deployment mounts should be free of ferrous materials.

For those using the StreamPro with a one meter transducer cable, you may find that a transducer cable extension would be useful and these are available for purchase from the HIF. Another option you might consider is a 90 degree adapter for attaching the communication cable for both the TRDI and SonTek ADCPs. The pin orientation for the connector on the SonTek ADCPs varies from unit to unit so each ADCP requires a custom adapter to ensure the adapter is vertical when installed. If you are interested in these connectors for either SonTek or TRDI ADCPs, please contact the HaWG.

[Photo Description]:Left top; TRDI StreamPro ADCP mounted on stand (courtesy USG5 WY). Left bottom; TRDI StreamPro transducer extension cable (courtesy USGS HIF). Center; TRDI Rio Grande mounted on aluminum pipe with angle indicator. Right; SonTek RiverSurveyor M9 and SS with ice mounting rod (courtesy Environment Canada).

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Slide 7: How should I mount the ADCP?

Another important consideration is ensuring your mount has a way to align the ADCP with the cross section. Using the software to correct for angles is something we will discuss later, but aligning the ADCP to your cross section is necessary for angle correction, and in many cases, the ADCP cannot be seen through the ice.

When mounting your ADCP, ensure the ADCP can't rotate on the mount, and that the mount won’t rotate where it attaches to the rod. Then, an angle indicator is very useful as it allows you to align the unit to the cross section without having to see it. The use of a mechanical fastener or instant-weld type product will ensure the ADCP mount will not rotate on the rod.

This setup has a flat spot on the rod so the angle indicator can be moved up and down on the rod and still maintains alignment with the ADCP itself.

If you are looking for advice or more details on how to create a new ice mount or modify an existing mount, please contact the Hydroacoustic Work Group or visit the USGS Hydroacoustic forum. We will discuss these, and other, options for obtaining advice in an upcoming slide.

[Photo Description]: Upper left; TRDI RiverRay mounted on a rod with angle indicator. Lower left; TRDI RiverRay with ice rod mount. Center; Angle indicator on an aluminum ice rod. Right; TRDI StreamPro mounted on an ice rod with angle indicator.

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Slide 8: Should I account for Angles?

Another common question when using ADCPs under ice is whether or not it’s worth correcting for angles as we never accounted for angles with conventional meters under ice. The ability to correct for angles is one of the main advantages of using ADCPs under ice. Many offices are noticing that while we assumed angles were minimal when using conventional meters, there were likely angles under the ice we were not accounting for.

This site was measured recently in Maine. The tagline was strung and the holes were drilled nearly perfectly perpendicular to the channel banks. Upstream of the section there was no sign of boulders, islands or anything else that would disturb the flow and while there was a bend in the river a ways upstream, the reach was relatively straight.

During data collection, however, it was clear that the right half of the channel actually had some pretty large angles. The discharge differences when using angle correction versus no angle correction was only a couple percent in this case, but in some cases the differences can be quite large. Also, the differences with and without angles may be small, but they are a bias, and it's good practice to eliminate biases when we can.

Given the fact that ADCPs have the ability to account for angles, and that ice conditions introduce a lot of unknowns when it comes to angles, the recommendation is to account for angles with ADCPs under ice, when possible. The specifics of doing this will be discussed later in this talk.

Even if you are not accounting for angles, it is important to understand how the software handles angles as incorrect settings could lead to significant errors in your final discharge.

[Photo Description]: First; An ice measurement cross section drilled perpendicular to the river banks. Second; An upstream view of the ice measurement cross section. Third; A screen capture of a contour plot from the TRDI Section by Section Pro showing angles measured by the ADCP.

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Slide 9: Should I enter ice information?

Both the Section by Section Pro and RiverSurveyor Stationary Live software packages give the user an option to enter information on ice conditions during the measurement. Many users wonder why they should enter this information as it's not used for computation of discharge.

The main consideration is when the ADCP is simply clipped onto the ice at a fixed depth, or lowered below the slush that same depth, any variations in the ice or slush thickness will be reflected as changes in the river bottom depth in the contour plot.

In this contour plot, where no ice measurement information was entered, there appears to be a large boulder or change in depth mid channel. When the ice information is entered, you notice that there is a natural drop in depth in that area, but the large bump in bottom depth was actually slush at the surface and the water was flowing right at the bottom of the channel. In this case, the final discharge is no different, but the bottom contour plot reflects the actual channel conditions and might make more sense to someone who wasn't there when the measurement was made.

So while ice conditions are not required for discharge computations, they can make the contour plots more useful by reflecting actual channel conditions, especially when slush is present. Also, some cooperators may find the contour plots with ice, slush and velocity conditions useful for forecasting potential for ice jams and flooding.

[Photo Description]: First; Screen capture of ice information entry page for SonTek RiverSurveyor Stationary Live software. Second top and bottom; Screen capture of the contour plot from the TRDI Section by Section Pro software.

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Slide 10: How do I handle slush?

For many of us, unfortunately, slush is common during measurements in winter conditions. One concern with new users is how ADCPs are used to determine the slush/water interface. With a conventional meter, we would simply lower the meter into the hole until we started getting clicks and with an ADCP the procedure is similar. A common approach when using ADCPs is to start the unit pinging and lower the unit into the hole until valid data is obtained. The assumption is that as the ADCP enters the moving water the slush is cleared from the face and it reports valid velocity readings. Once you find this slush/water interface ensure you adjust the ADCP depth or the software settings to reflect the correct transducer depth.

You may find the SNR or intensity profile plots to be useful as well as you can typically see very high SNR values or intensity readings near the surface in these profile plots if slush is present, as this screen capture from a SonTek measurement shows.

In some cases, you can actually feel the bottom of the slush with the ADCP mount or a slush basket, which is a great way to confirm the depth you obtained with the ADCP while pinging.

[Photo Description]: Left; Screen capture of the TRDI Section by Section Pro software. Right; Screen capture of the SonTek RiverSurveyor Stationary Live software with the ADCP in slush conditions (courtesy Water Survey of Canada).

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Slide 11: Can I import SxS Qms into SWAMI?

Given the prominent use of SWAMI across the USGS, many users ask whether or not SWAMI will import midsection ADCP data from SxS Pro and RiverSurveyor Stationary Live. SWAMI will import the XML summary file from SxS Pro and the .dis file from RiverSurveyor Stationary Live. If you are using SWAMI for field notes, we recommend you import acoustic data to better populate the database and eliminate possible errors when manually entering information.

Do not import the mmt file from SxS Pro as there are differences between that mmt and the mmt file created by WinRiver II Again, SWAMI can import the xml summary from SxS Pro created using the File > XML Summary File > Export menu selection.

The dis file is created in RiverSurveyor Stationary Live by selecting the export discharge summary button in the toolbar.

As a reminder, these ice measurements with ADCPs have a Qm method of midsection, a deployment method of ice and a velocity method of ADCP. The suspension method for many users is round rod as the ADCP is mounted on a round rod or pipe.

(Photo Description]:First; Screen capture of a Windows dialog showing the available import file options in SWAMI. Second; Screen capture of the SWAMI channel information page.

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Slide 12: SonTek - How do I account for angles?

Now, let's move onto some questions and considerations specific to the SonTek RiverSurveyor Stationary Live software, starting with how users can account for angles. As we mentioned earlier, accounting for angles is worthwhile if you have the ADCP and deployment setup that allows you to do so.

In RSSL there are two options for angle adjustment. The first option is to use the internal compass to account for flow angles, which is referred to as ENU. If you plan on using this option, we recommend that you first calibrate the ADCP’s compass using the compass calibration routine in the software. Once the calibration is complete, select change system settings on the start page. There, you will be able to select get tagline azimuth, which will open a new dialog.

As you can see in the get tagline azimuth dialog you first orient the ADCP with the connector facing downstream, perpendicular to the tagline. This can be done by simply setting the ADCP on the ice and holding it in place. This reading is very important to the measurement, so be sure the unit is oriented correctly and that you can hold it steady for the 10 or 20 seconds recommended by the software. Once you have started the process and are finished collecting this heading data, simply press stop.

[Photo Description]: First; Start page in the RiverSurveyor Stationary Live Software. Second left; System Settings dialog from the RiverSurveyor Stationary Live Software. Second right; Get Tagline Azimuth dialog from the RiverSurveyor Stationary Live Software.

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Slide 13: SonTek - How do I account for angles?

With this azimuth logged the idea is that you can simply put the ADCP in the water at any orientation and the software will compute the flow angle for you automatically. Some users have reported erroneous angles when using this method due to issues with the compass, either from the compass itself, or interference from steel toe boots, cell phones, laptops, power lines and other sources.

Given the potential for compass errors and the erroneous flow angles the errors produce, we also recommended holding the unit with the connector facing downstream and perpendicular to the flow for every station so that the XYZ method can be used, if needed. This method works similar to the FlowTracker; we hold the ADCP at a fixed relationship to the tagline and it measures the angle for us. You can switch between XYZ

and ENU on a station by station basis, so if you see angles due to compass errors you could simply switch to XYZ for that station or the entire measurement.

To clarify, we recommend holding the ADCP with connector downstream and perpendicular to the tagline even if you intend on using the compass and ENU. There have been several measurements where compass errors or interference lead to erroneous angles and XYZ wasn't an option as the unit wasn’t oriented correctly.

(Photo Description]: First; Get Tagline Azimuth dialog from the RiverSurveyor Stationary Live Software. Second; Station dialog from the RiverSurveyor Stationary Live Software.

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Slide 14: SonTek - Can I enter a manual station?

Another common question with the RSSL software is whether a user can enter a manual station. This is useful when the water is too shallow for the ADCP to measure and the user wants to estimate the depth and velocity, or if there is slush present from the bottom of the ice to the bottom of the river.

The ability to enter a manual station is referred to as an island edge. If you need to input a manual station, first ensure the correct water surface type is selected. Here, we have ice selected. If you wanted to change this setting, you need to uncheck island edge, change the setting, and re-select island edge. With ice selected you will see options to enter a manual depth, a velocity correction based on the last measured or next measured velocity and information on ice conditions.

If ice and slush is selected for the water surface type you have the same options, though water surface to bottom of slush ice is now available. If there is slush to bottom you would enter the manual depth as the real river depth and the slush information would match this depth. In this case, the velocity correction would be zero as there would be no velocity.

For users who don’t want to enter the ice or slush information, but still have slush to bottom, you can use the ice water surface type, enter a manual depth of zero and a velocity correction of zero.

(Photo Description): First; Island Start Edge dialog with ice water surface type selected in RiverSurveyor Stationary Live software. Second; Island Start Edge dialog with ice and slush water surface type selected in RiverSurveyor Stationary Live software.

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Slide 15: SonTek - What version should I be using?

Another common question is what version of RiverSurveyor Stationary Live is current. As of February 2014 the current version is 3.70 released in September 2013.

Version 1.00 of RSSL did not support ice measurements, a feature that was added in version 2.SO. Other updates were made in versions 2.60 and 3.70 to improve the exported ASCII file, add a new connection dialog and add support for the new PCM boxes.

If you are using a previous version, please update as soon as possible to take advantage of the latest features.

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Slide 16: TRDI - How do I account for angles?

In SxS Pro there is one option for automatically accounting for angles. This velocity method is called the y-velocity method and can be selected in the wizard when setting up the measurement or in the processing settings during playback.

When using the y-velocity method you are required to orient beam 3 perpendicular to the cross section and pointing downstream. The use of an angle indicator on the rod is recommended when using this method as it can be difficult to see the ADCP under the ice and it is even more difficult to hold the rod consistently for the

entire 40 second duration without some indicator to know if the ADCP has rotated. Be aware that the orientation of beam 3 and the connector on top of the Rio Grande and RiverRay are different, so before using the connector as a guide, you have to determine how beam 3 is oriented to the connector ahead of time.

Be sure to monitor the reported angles in SxS Pro when using this method and re-collect any stations that appear to have erroneous angles.

[Photo Description]:Top left; Screen capture of the Processing setup section of the measurement wizard in the SxS Pro software. Bottom left; Hydrographer holding a StreamPro ADCP on a rod with angle indicator. Top right; Angle indicator an aluminum ice rod. Bottom right; Screen capture of the Processing section of the Processing dialog in the SxS Pro software.

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Slide 17: TRDI - Can I enter a manual station?

In the SxS Pro software manual verticals are entered by selecting Manual Vertical from the Acquire menu or pressing F8. The Manual Vertical dialog allows you to enter a manual depth, a velocity and ice information. In slush to bottom conditions you would enter the actual channel depth, a velocity of zero and the ice and slush conditions. If you had slush to bottom, but didn't want to enter ice conditions you can enter a manual depth of zero and a velocity of zero without the ice or slush information.

As you can see, the dialog also displays the previous vertical's velocity, which can be used to help estimate the velocity for your manual station. This dialog does not use a correction factor, you simply enter the velocity you wish to use. Once the information is entered, you will see the manual vertical on the contour plot. This example shows a slush to bottom hole where the actual channel depth was entered, a velocity of zero was entered and ice conditions were entered.

[Photo Description]: Upper left; Screen capture of the acquire menu options from the SxS Pro software. Lower left; Screen capture of a manual vertical in the SxS Pro contour plot. Right; Screen capture of the manual vertical dialog from SxS Pro software.

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Slide 18: TRDI - What can I do about that one bin?

Several users have shared data sets and noted one bin, usually near the bottom of the profile, that shows a velocity that doesn't seem to be realistic. These bins are usually based on just one or two ensembles that had a velocity at that depth and SxS Pro gives you an option to screen depth cells based on the number of ensembles they are computed from.

As a default, this setting will allow a depth cell to be used in a station even if that depth cell was only measured in one ensemble. If you see these outlying bins with high or low erroneous velocities, try changing this good ensembles in cell setting to screen the erroneous bin.

Usually increasing the good ensemble in cell setting to 4 or 5 will remove these erroneous bins. If this setting doesn't remove them, the water track screening thresholds can usually be changed to remove them.

(Photo Description): Left: Screen capture of data from a contour plot in the SxS Pro software. Right: Screen capture of the Processing dialog in the SxS Pro software.

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Slide 19: TRDI - Any other important settings?

There are a couple other settings in the SxS Pro software that are worth being aware of. First, when using a StreamPro ADCP, be sure to uncheck the use compass option in the measurement wizard. To use the compass with the StreamPro the head and transducer must be aligned, which is not the case when the transducer is mounted on a rod and the head sitting on the ice or in a backpack. If this box is checked, you will

get invalid data if the head is in a backpack due to large pitch and roll and your velocity direction information and heading information will not be useful.

It's also important to point out that if you are correcting for angles, you can have the y-velocity method selected during data collection, so you can identify large angles while you are collecting and determine if you are holding the rod correctly. This can be set in the measurement wizard before data collection begins.

In the processing dialog you will notice a setting for reference, with ADCP and bottom as the options. The default setting for SxS Pro midsection measurements is ADCP, which assumes the ADCP isn't moving and references the velocity to the ADCP itself. If bottom is selected the program will remove the bottom track velocity from instrument movement, which can cause large errors in moving bed conditions.

[Photo Description]: Upper left; Screen capture of the ADCP setup from the SxS Pro measurement wizard. Lower left; Screen capture of the Processing setup from the SxS Pro measurement wizard. Right; Screen capture of the Processing dialog from the SxS Pro software.

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Slide 20: TRDI What version should I be using?

Another common question is what version of SxS Pro is current. As of February 2014 the current version is 1.10 released in September 2013.

Listed here are some of the major improvements in version 1.10. These include support for the RiverRay vertical beam, new correlation and error velocity plots, ice information on manual verticals, large icons that can be enabled for tablet use, WT error thresholds that are specific to each station and several other RiverRay specific improvements. If you are using a previous version, please update as soon as possible to take advantage of the latest features.

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Slide 21: Could you summarize all of this?

Now, let's highlight some of the main points we covered in this talk. First, don't forget that temperature verification is required for ice measurements. Also, measurements should routinely be processed on site, though exceptions may be necessary.

Winter conditions can be tough on us and our equipment, and we need to be aware that these conditions may cause some problems. We also need to be ready to address those problems as they arise.

Another important consideration is to ensure you have the proper mount and rod setup for your ADCP, especially if you plan on adjusting for angles. We recommend accounting for angles whenever your equipment and software options allow.

Manual stations can be created in both manufacturer software packages and these can be useful to account for slush or an occasional station where the water is too shallow to measure with the ADCP.

Lastly, please ask questions. It's common to hear from users who have been dealing with hardware and software issues for quite some time, issues that could have been easily remedied had they sought out help.

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Where do I go for help?

While it seems several offices are using ADCPs through ice, it also seems that communication between these offices is relatively minimal. It also seems that some offices who are new to the technique are not sure where to go with questions.

If you have questions on the equipment, software, deployment options or methods when using ADCPs under ice there are two main options. The first is to email the USGS Hydroacoustic Work Group. The email address

to reach the group is shown here. Another option is to post a topic on the OSW Hydroacoustic forum, which has a specific area for posts relating to measuring under ice.

In addition to these resources, an often under-utilized resource is the manual or help section of both SxS Pro and RiverSurveyor Stationary Live.

For those users who are more experienced, consider sharing what's worked and what hasn’t worked on the forum so the information is there for those just starting out.

We thank you for taking the time to watch this informational video....keep warm out there.