

Hydroacoustics UPDATE:

Determining Magnetic Variation

David S. Mueller
Office of Surface Water
7/12/2005

INTRODUCTION

It is important that an accurate magnetic variation (also referred to as magnetic declination) be entered into the ADCP data collection software (WinRiver or RiverSurveyor¹) when collecting data with the navigation reference set to GPS. An inaccurate magnetic variation will cause a directional bias in the GPS-based discharges. This directional bias can be corrected by entering an appropriate magnetic variation in the ADCP post-processing software (WinRiver or RiverSurveyor). Setting the correct magnetic variation is encouraged in bottom-track based measurements but an incorrect setting will not affect the computed discharge; however, velocity directions are always affected by an incorrect magnetic variation, regardless of the navigation reference.

On-site techniques are the most accurate way of obtaining estimates of the local magnetic variation, when completed where good GPS positioning is available and no moving bed exists. Techniques for estimating local magnetic variation on-site are described in the help file for WinRiver. There are situations where on-site magnetic variation measurements are impractical or impossible. Often geomagnetic models are used to approximate the magnetic variation at a location. Magnetic variation models are available in commercial software, freeware, shareware, internet-based software, and GPS receiver firmware. This update addresses two freeware programs and the use of GPS receiver-based magnetic variations.

ADJUSTING MODEL ESTIMATES

If a magnetic model is used to get an *estimate* of the local magnetic variation at a site, the user must be aware that this is only an estimate from a model; the actual magnetic variation at the site may be different. This estimate can be adjusted during processing of the data to eliminate any residual directional bias in the GPS-based discharges. Typically the adjustment of model-estimated magnetic variations should not exceed +/- 0.5 degrees, but may on occasion approach +/- 1 degree. Adjustments larger than 1-degree must be investigated. The model estimate could be incorrect due to site conditions or the ADCP compass could be incorrect. Local magnetic anomalies are common in areas with geologic faults. These anomalies may not be accurately accounted for in geomagnetic models. In such cases, the on-site technique should be used. The need to adjust an

¹ The use of trade, product, or firm names in this paper is for descriptive purposes only and does not imply endorsement by the U.S. Government.

otherwise correct magnetic variation can be caused by an improper calibration of the compass in the ADCP or a change in the magnetic field around the instrument between the time of the calibration and the actual measurement (moved ferrous objects on the boat, moved closer to a steel bridge, etc.). If adjustments are made to the magnetic variation, a record of the magnetic variation should be recorded in the field folder for future reference. If the adjustment is larger than 1-degree a justification should be provided for the adjustment.

MAGNETIC VARIATION SOURCES

Geomagix

In USGS training classes we have distributed and recommended a model called Geomagix (<http://geomag.usgs.gov/models/index.html>). This model is offered by the USGS and has the option of using a wide variety of magnetic models. At present (July 2005), it is recommended that the IGRF 2005 model should be used. Currently (July 2005), the IGRF 2005 model is not included with the Geomagix download but can be downloaded from Interpex at: <http://www.interpex.com/geomagix/magfield.htm>. When the downloaded Geomagix file is run, it will extract into the current directory. Therefore, create an appropriate directory and move the Geomagix file to that directory before running it. The IGRF 2005 data must be downloaded from Interpex and unzipped in the same directory as Geomagix. The magnetic variation for a location is estimated by entering the longitude, latitude, and date and selecting the igrf-2005.cof file as the new model. Geomagix will report a variety of geomagnetic parameters of which the declination is the one of primary interest to the ADCP user (figure 1).

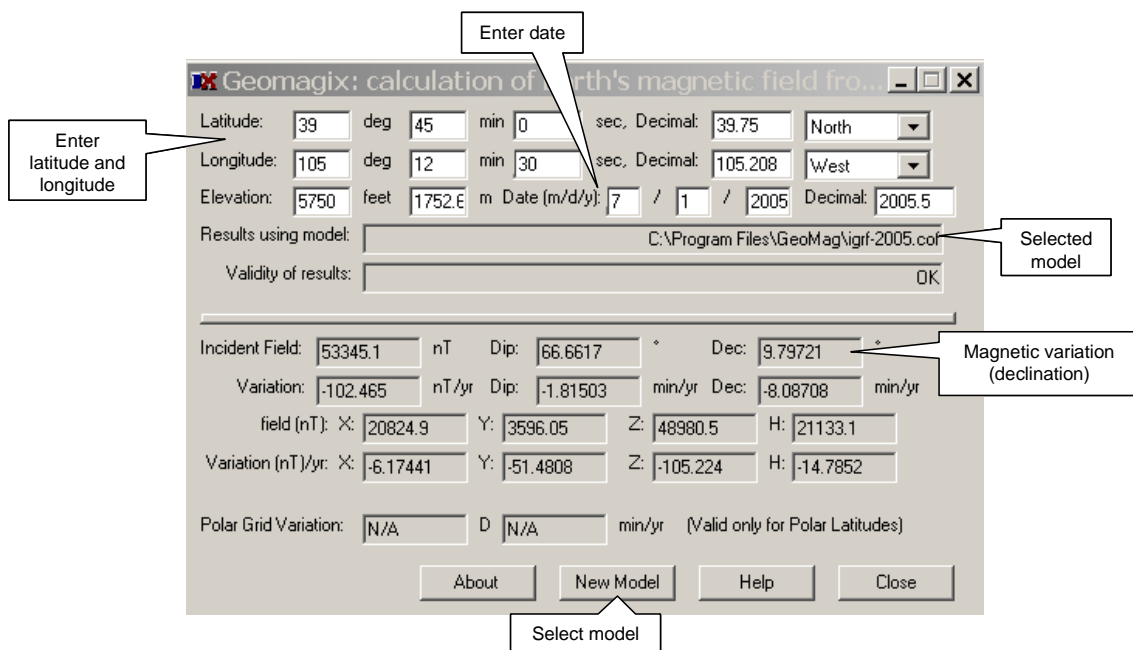


Figure 1. Screen capture of Geomagix with annotation.

Geomag

Kevin Johnson (IL WSC) recently identified another geomagnetic model (Geomag), which has a simpler user interface and a Windows installation routine. GeoMag is a Windows-based program for calculating the magnetic variation anywhere on the earth, from 1900 to 2005 (Figure 2). The user enters longitude, latitude (or UTM northing/easting/zone), and the date; and Geomag will compute the magnetic declination. In addition to computing the magnetic declination, it also converts latitude and longitude to UTM coordinates and vice versa. Geomag can be downloaded from <http://www.resurgentsoftware.com/GeoMag.html>. Geomag is installed by simply double-clicking on the downloaded file and following the prompts. When prompted for your company and serial number, any series of numbers or characters can be entered, but at least one character must be entered in each field for it to install.

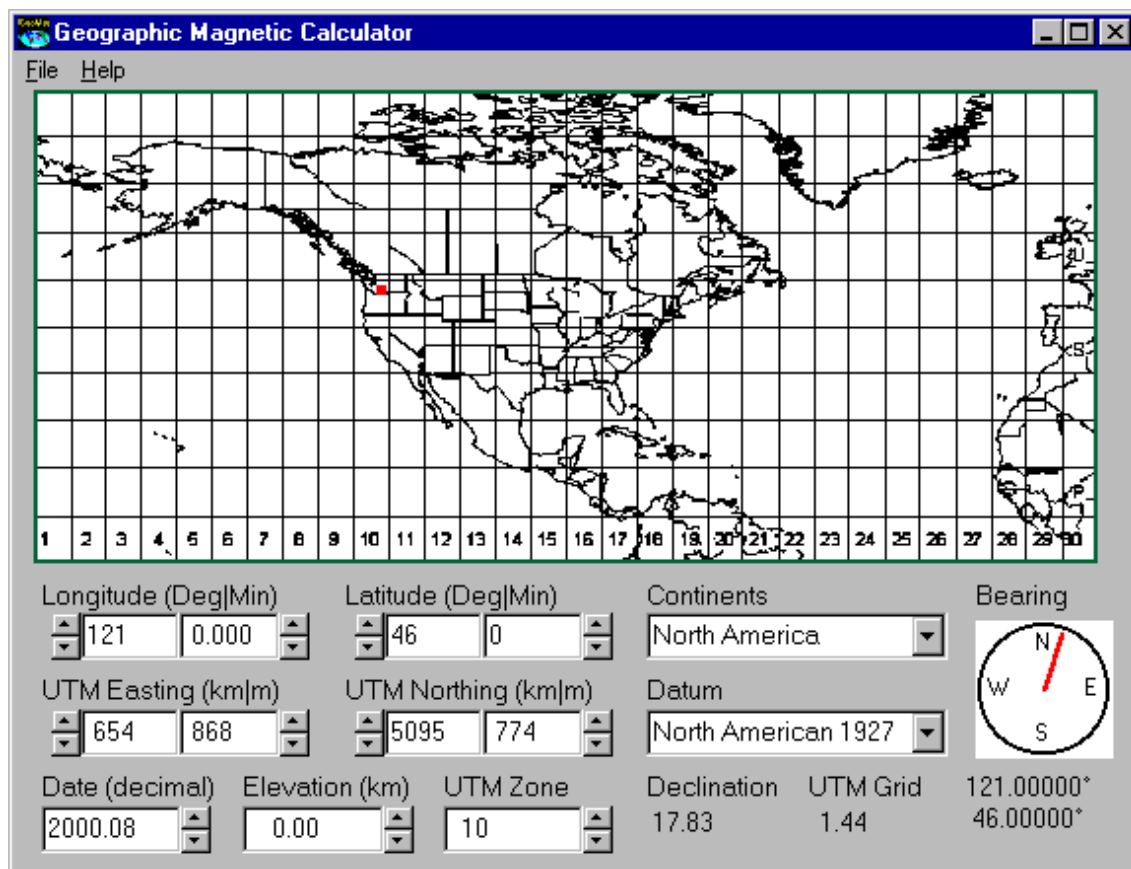
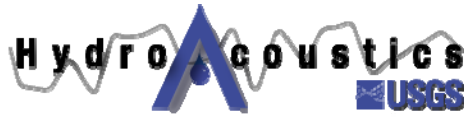


Figure 2. Screen capture of Geomag.



GPS Receivers

Most Global Positioning System (GPS) receivers will output a National Marine Electronics Association (NMEA) data type called "RMC". The magnetic variation is one of the data fields provided by the RMC data type. The magnetic variation reported in the RMC data type is not derived from GPS satellites but is determined from a lookup table stored in the GPS receiver firmware. This lookup table is based on geomagnetic models similar to those mentioned above. Therefore, the magnetic variation from a GPS receiver should be treated no differently than a magnetic variation obtained from any other geomagnetic model. However, if there is no means to update the lookup table every 3-5 years, the magnetic variation will lose accuracy over time. For a more detailed discussion by manufacturer experts on the source of magnetic variation in GPS receiver see: <http://www.eomonline.com/Common/Archives/Aug96/gps.htm>

SUMMARY

This Hydroacoustic Update includes information regarding the determination of the local magnetic variation (declination) at a site for use in ADCP data collection and processing. Properly conducted on-site magnetic variation tests are the most accurate method for determining the magnetic variation at a site, if there is sufficient space to perform the test, good GPS positions are available, and no moving bed is present. The magnetic variation can also be estimated from geomagnetic models. Three common sources of local magnetic variation estimates based on geomagnetic models are the two freeware programs Geomagix and Geomag, and the RMC NMEA data type available as output from most GPS-receivers. Estimates of the local magnetic variation from geomagnetic models may be adjusted, but if the adjustment is greater than +/- 1 degree, the cause of the adjustment must be investigated and documented. If you have any questions, please contact David Mueller (dmueller@usgs.gov or 502-493-1935) or email the USGS Hydroacoustics Work Group, hawg@simon.er.usgs.gov.