(An Incomplete)
Introduction to Velocity Mapping using an ADCP

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Typical Use of ADCPs in the USGS

ADCP data are composed of detailed, three dimensional water velocity data….

however, we (USGS) typically only report a single value from our measurements (Discharge—Q). The data used to compute Q are archived and often never fully utilized.

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Beyond Discharge

Mapping velocity fields using ADCPs has gained popularity in recent years due (in part) to

- **Advancements in technology (GPS, improved instrument accuracy, etc.)**
- **The need for higher-order (2-D and 3-D) model calibration and validation data**
- **Exposure in the literature**
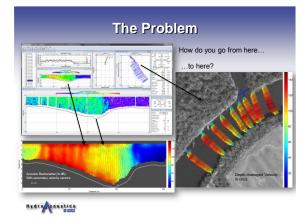- **Availability of data visualization software**

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Objectives of Post Processing Velocity Data

- **Read processed ADCP data**
- **Allow horizontal and vertical averaging**
- **Allow various layers to be extracted**
- **Combine with external positions**
- **Output data in format compatible with visualization software**
- **Visualize and output data for target audience**

• You
• Your collaborators
• Modelers
• General Public/Readers

The Problem

How do you go from here…
…to here?

Acoustic Backscatter (in dB)
With secondary velocity vectors

Depth-Averaged Velocity
in cm/s

Solution

Write your own software

- **e.g. FORTRAN, Excel, Matlab,…**
- **Batch file oriented when possible**
- **Developers have to support it (no funding for this)**
- **Can be modified and customized**
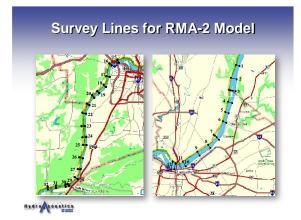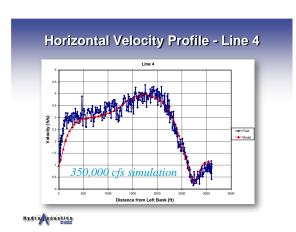- **Need to continuously validate results**

Better Solution

Get manufacturers, government agencies, or others to write standard, verified software that everyone can use.

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Reality

- Manufacturers haven't written such software
- David Mueller (USGS-OSW) has software based on FORTRAN and Matlab codes (AdMap)
- Jackson et al. have VMT (Matlab)
- University of Iowa has ADCPXP and VMS
- Randal Dinehart (WRD, CA) has Excel macros
- Marinna Martini (GD) has Matlab codes
- Others have written their own codes (e.g. Rennie, Wright, etc.)
- Difficulty—Many codes have not been applied to a large range of data sets and are often tailored to a specific data set

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Velocity Mapping
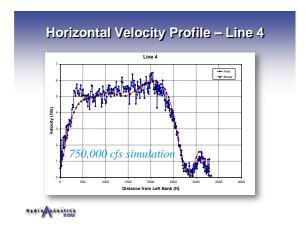
Example Applications

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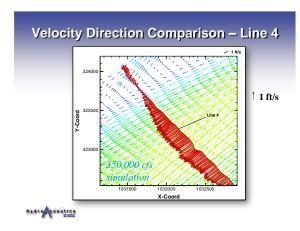
Model Calibration & Verification

- **Water-surface elevations are not sufficient to verify multidimensional hydrodynamic models**
- **Average velocities or general velocity distributions are valuable tools to good modelers**
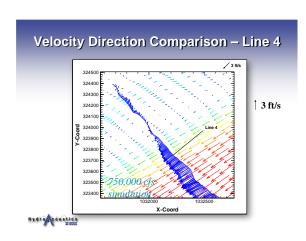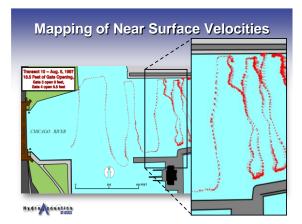- **Cost effective with the ADCP**

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Survey Lines for RMA-2 Model

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Horizontal Velocity Profile - Line 4

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Horizontal Velocity Profile – Line 4

Velocity Direction Comparison – Line 4

Velocity Direction Comparison – Line 4

General Flow Visualization

- **For navigation**
- **For sediment transport**
- **For contaminant transport**
- **For public safety**
- **For structure evaluation/location**
- **For biological/ecological studies**
- **For gage site evaluation**
- **For model development**
- **For understanding**

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Mapping of Near Surface Velocities

Transect 10 – Aug. 5, 1997
18.5 Feet of Gate Opening,
Gate 3 open 9 feet,
Gate 4 open 9.5 feet

CHICAGO RIVER
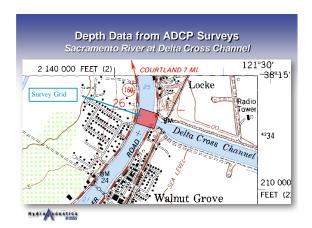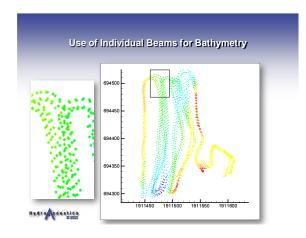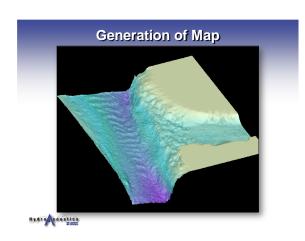
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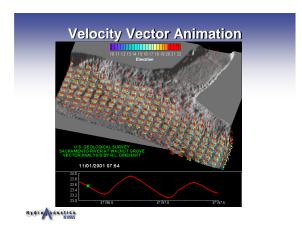

Hydrographic Survey from ADCP beam data and Animations of Velocity and Backscatter
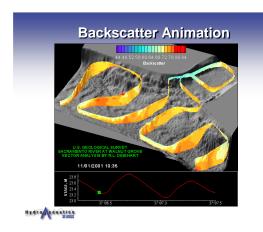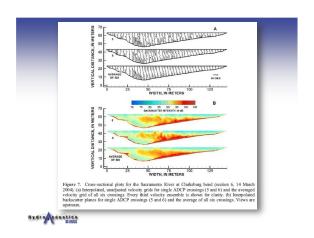
by Randal Dinehart
rldine@usgs.gov

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Depth Data from ADCP Surveys
Sacramento River at Delta Cross Channel

Use of Individual Beams for Bathymetry

Generation of Map

Figure 7. Cross-sectional plots for the Sacramento River at Clarksburg bend (section 6, 14 March 2004). (a) Interpolated, unadjusted velocity grids for single ADCP crossings (5 and 6) and the averaged velocity grid of all six crossings. Every third velocity ensemble is shown for clarity. (b) Interpolated backscatter planes for single ADCP crossings (5 and 6) and the average of all six crossings. Views are upstream.

Figure 9.   Cross-stream velocity vectors in averaged velocity grids at Clarksburg bend before and after reorientation to radial front (section 8, 14 March 2004). This example section was rotated 5°. Secondary circulation in each averaged velocity grid is represented by stream traces. Every third velocity ensemble is shown for clarity. Views are upstream.

Bed Velocity

Figure 2. Contours of bed elevation (A) and bed velocity (B). Solid lines represent topographic troughs. All data are interpolated at 5 m resolution from data collected with 20 m and 5 m transect spacing (as indicated). Elevation data are from single beam sonar and bed velocity is from four beam ADCP.

From Jamieson et al. 2009

ADCP Bathymetry

Get the most out of your data!

Single Beam Echo Sounder

ADCP– With Latency Correction (0.75 sec.)

ADCP-- No Latency Correction

ADCP bathymetry collected during a velocity survey
Data courtesy of E.C Jamieson, C.D Rennie, and R.B. Jacobson

ADCP Bathymetry

ADCP bathymetry
Bulu Pool, Lower Congo River, Africa

Don't Forget about Ancillary Data

ADCP Temperature

Acoustic Backscatter
(0 to 2 m above bottom)

The Tip of the Iceberg…

USB drives are provided to class participants

Each includes:
1. Lectures/exercises
2. Software (executable, source)
3. Data
4. Examples
5. References

Questions?

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