

Surrogate Analysis and Index Developer (SAID) Tool

Funded by the

Federal Interagency Sediment Project
and the USGS Midwest Region River
Sediment and Nutrient Initiative

Send questions, comments, and suggestions to

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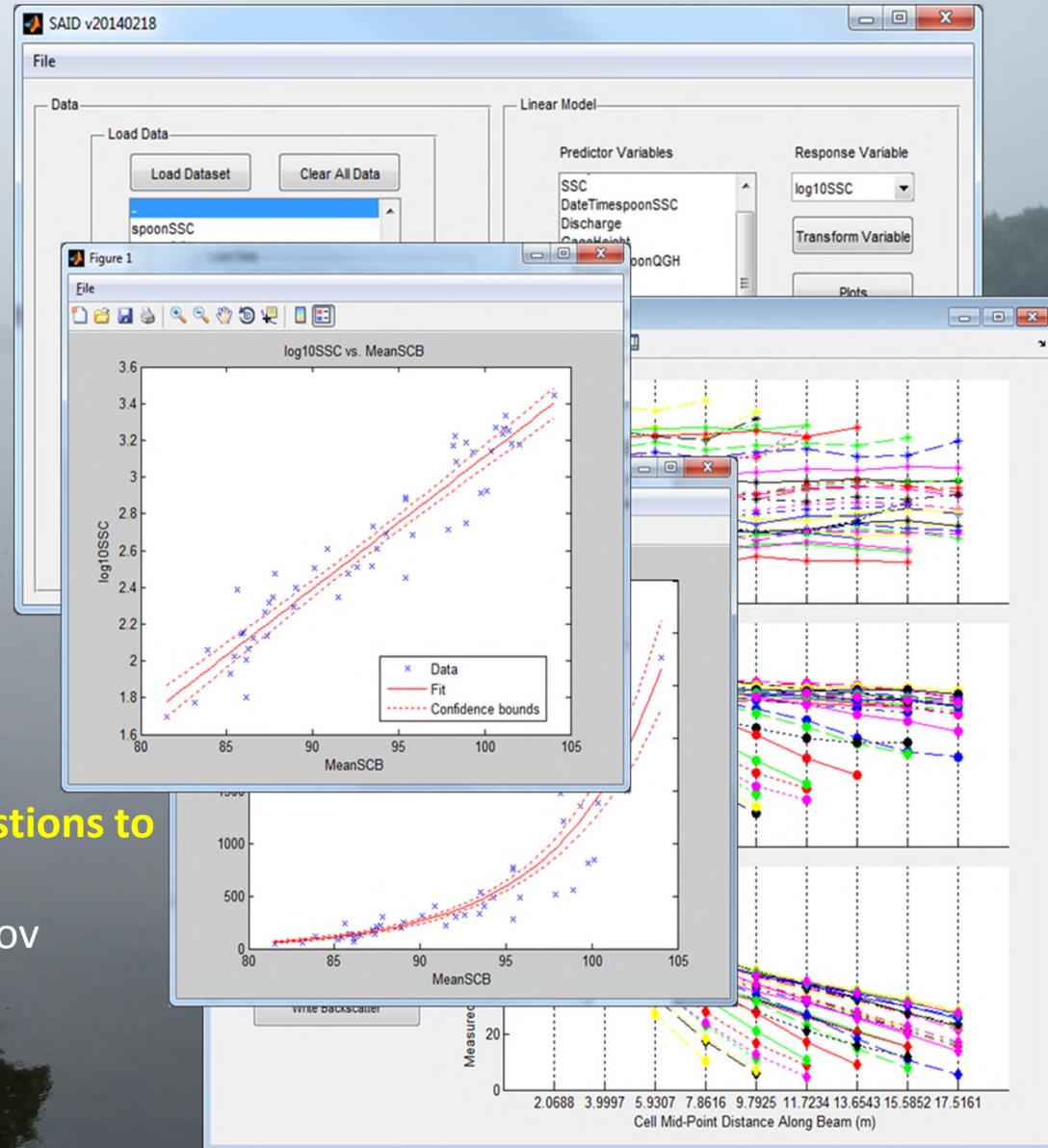
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678-924-6616 or landers@usgs.gov

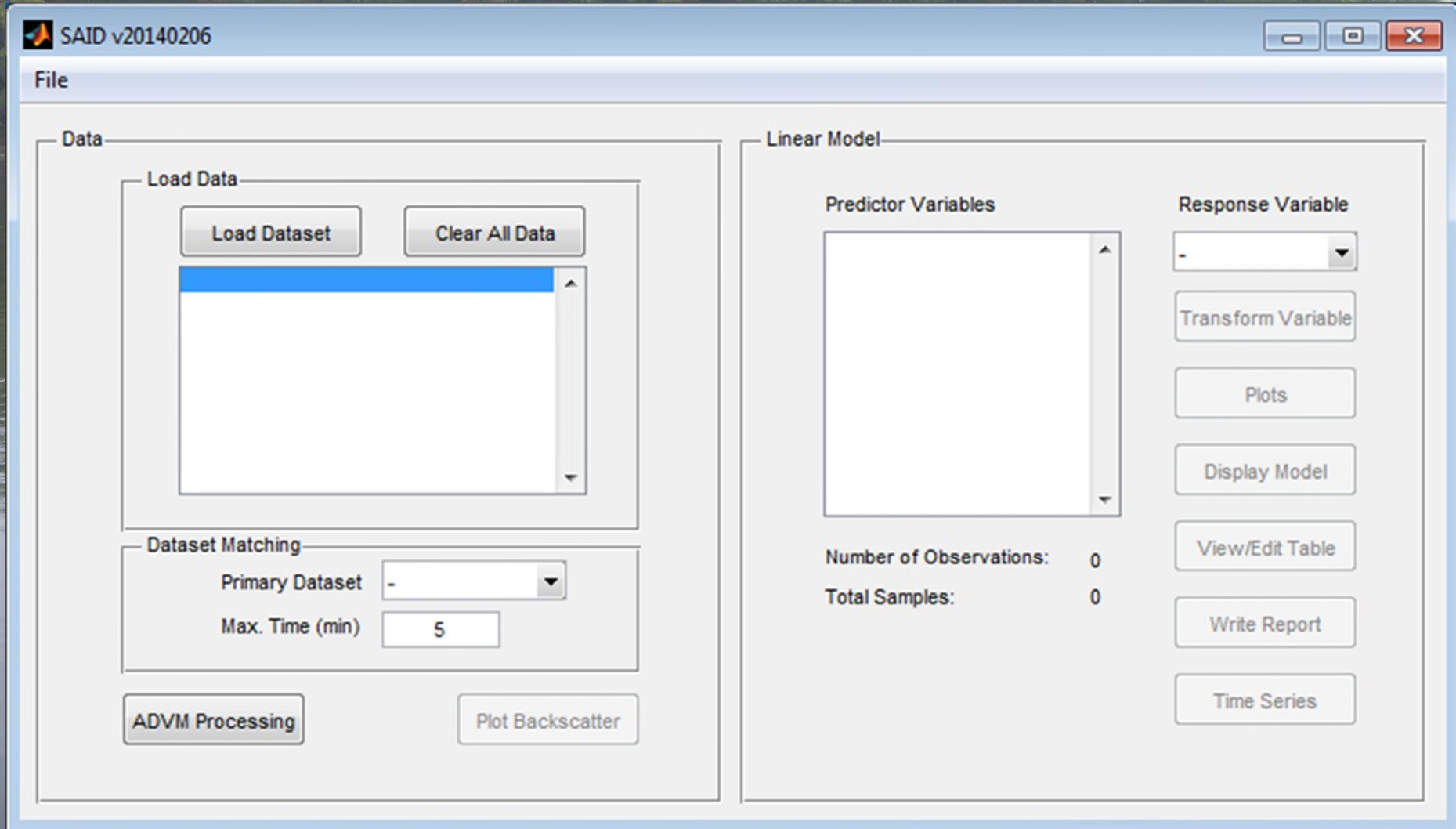


Features

- Assists in the creation of **regression models** that relate response and predictor (surrogate) variables
- **Processes acoustic parameters** to be used as predictor variables for suspended-**sediment concentrations (SSC)**.
- Supports **guidelines**
 - Multi-agency sediment acoustic methods work
 - USGS Techniques & Methods 3-C4 for turbidity and SSC

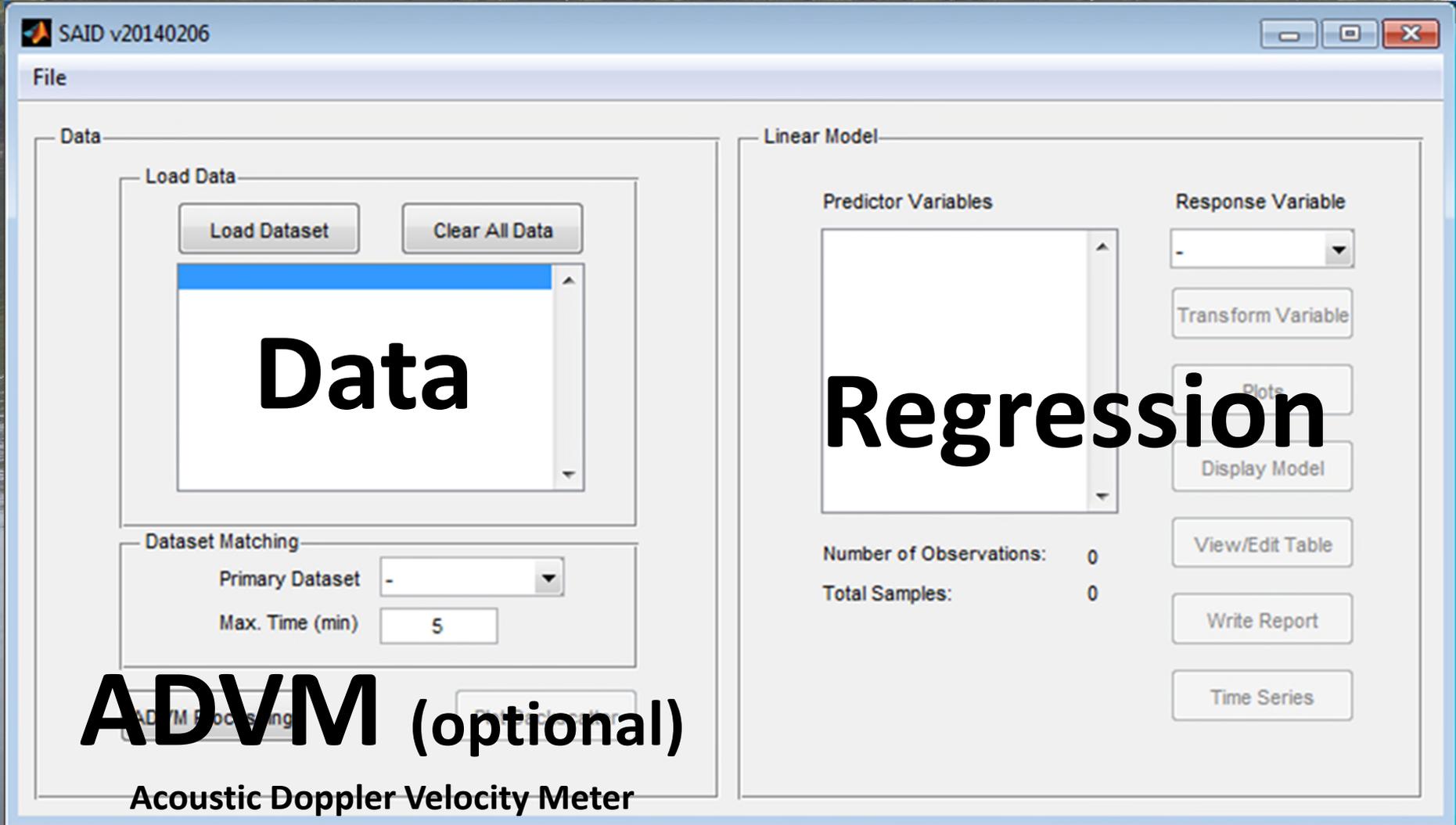
Graphical User Interface

Stand-alone utility

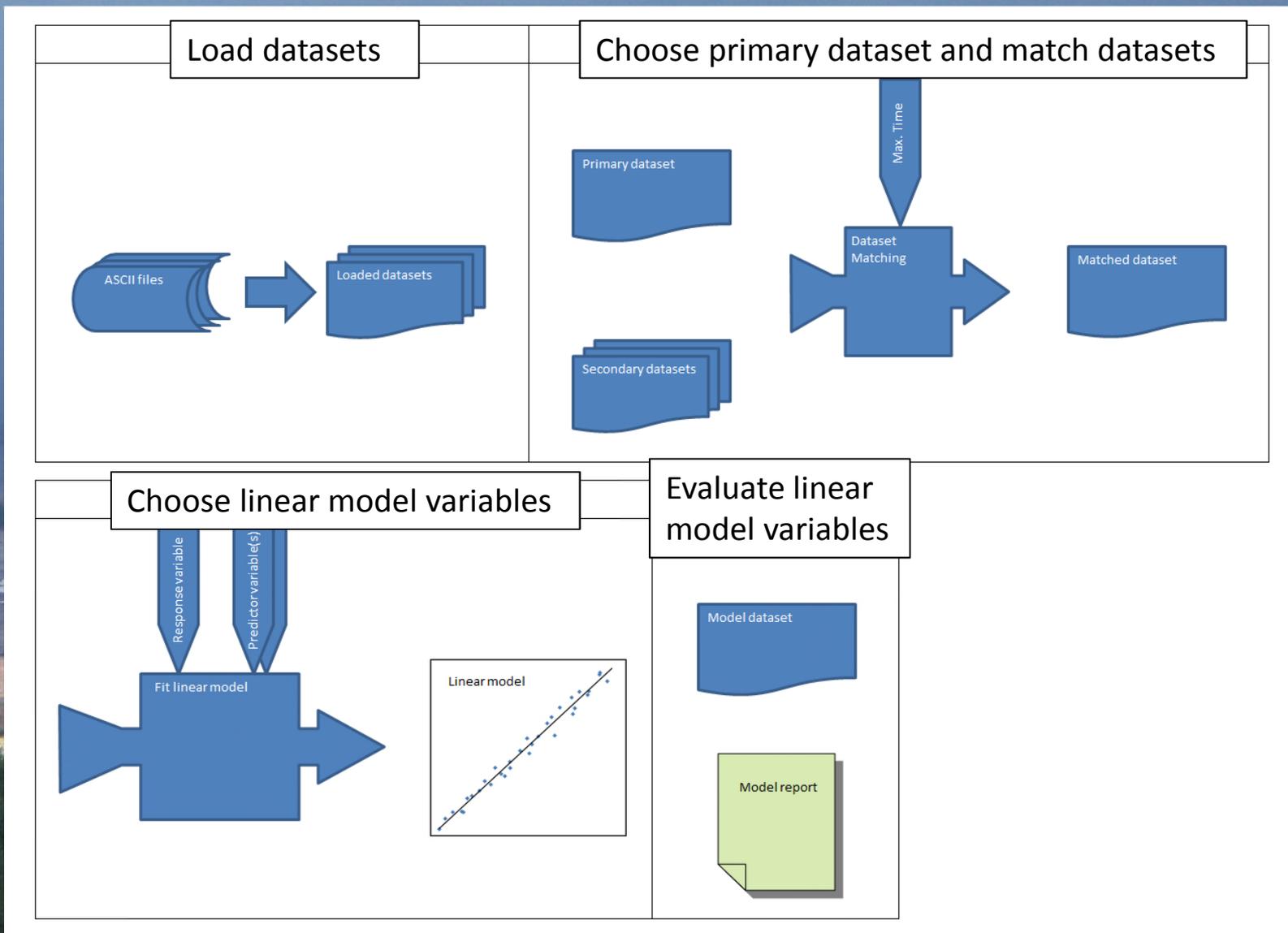


Graphical User Interface

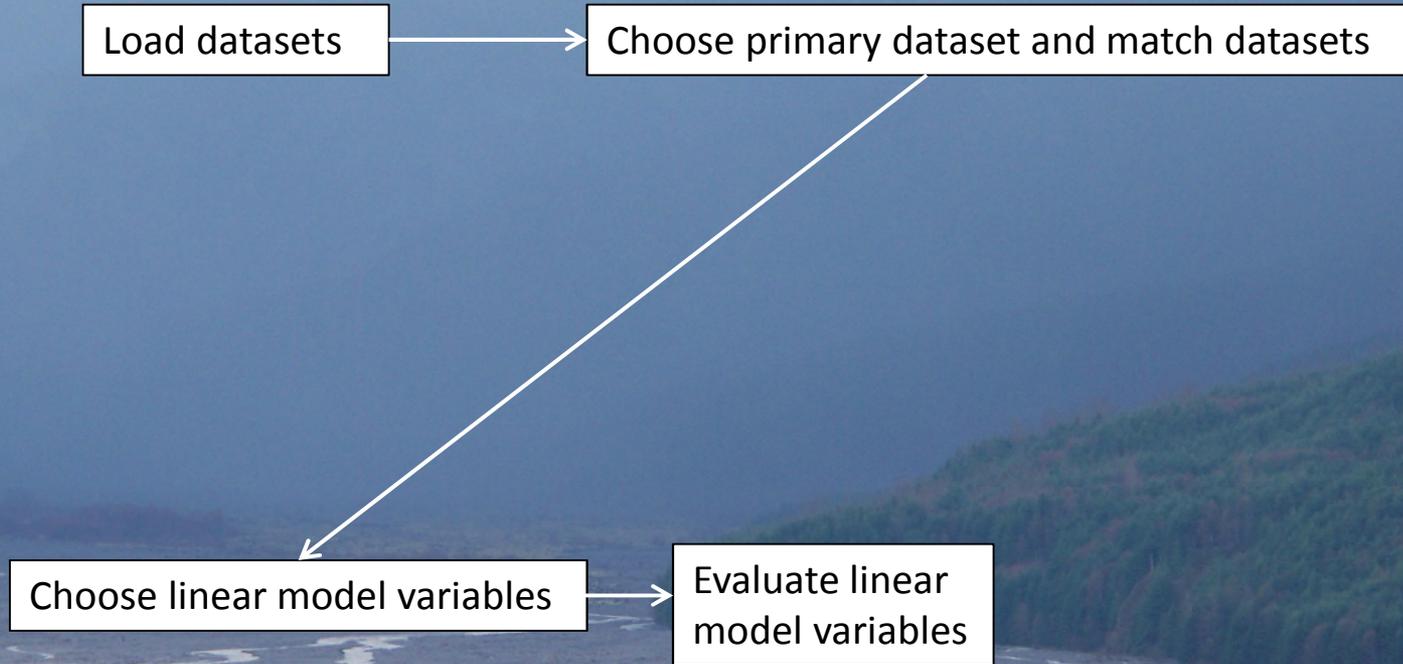
Stand-alone utility



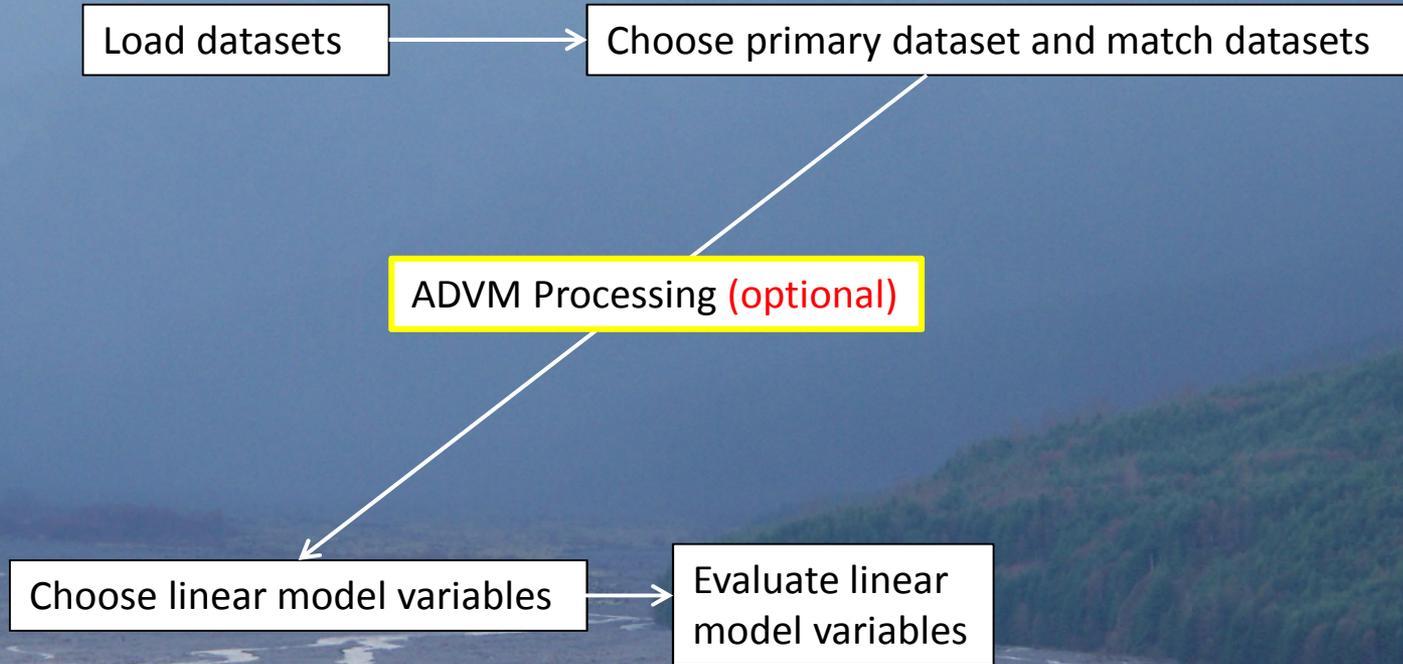
Workflow



Workflow



Workflow



Load Datasets

The screenshot shows the SAID v20140206 software interface. The window title is "SAID v20140206". The interface is divided into two main sections: "Data" and "Linear Model".

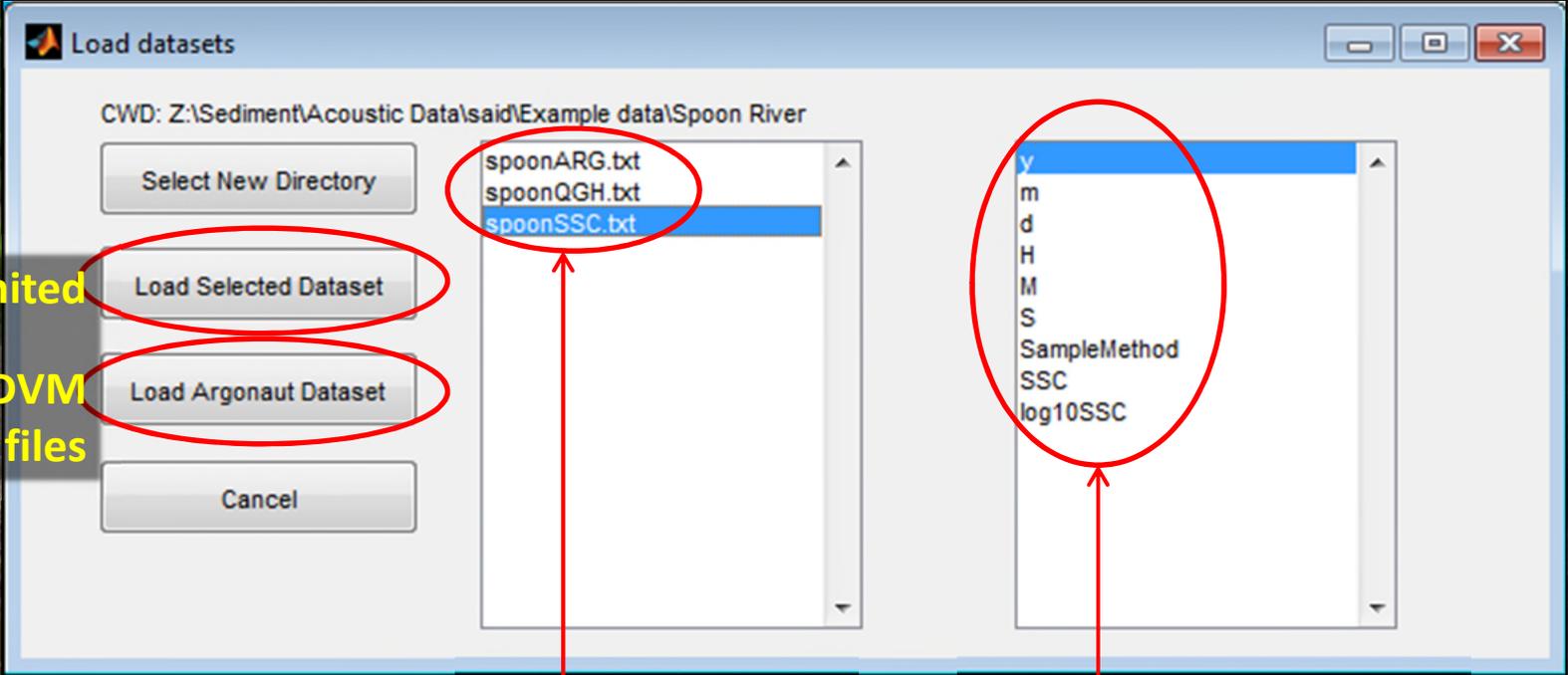
Data Section:

- Load Data:** Contains a "Load Dataset" button (circled in red) and a "Clear All Data" button. Below these is a list box with a blue header bar and a scroll bar.
- Dataset Matching:** Includes a "Primary Dataset" dropdown menu (currently set to "-") and a "Max. Time (min)" input field (set to "5").
- Buttons:** "ADVM Processing" and "Plot Backscatter".

Linear Model Section:

- Predictor Variables:** A large empty list box with a scroll bar.
- Response Variable:** A dropdown menu (currently set to "-") with buttons for "Transform Variable", "Plots", "Display Model", "View/Edit Table", "Write Report", and "Time Series".
- Statistics:** "Number of Observations: 0" and "Total Samples: 0".

Load Datasets



Tab-delimited
Argonaut ADVM
.ctl, .dat, .snr files

Files in Directory

Variable Names in File

Load Datasets

Date and Time Format

Header label	Data type
y	Year
m	Month
d	Day
H	Hour
M	Minute
S	Second

Table 1 – Date and time variables that are necessary in a tab delimited ASCII file

Similar to Sontek Argonaut Format

Load Datasets

Spreadsheet Examples of Converting Time Format

Don't let the time format be a hang-up

#	YEAR	MONTH	DAY	MINUTE	TURB	Excel date	Excel time	Excel date and time	D date format						
	12N	12N	12N	12N	12N	serial number	serial number	serial number	y	m	d	H	M	S	
5	2012	6	2	135	58.2	6/2/2012	2:15	6/2/2012 2:15	2012	6	2	2	15	0	
6	2012	6	2	150	59.0	6/2/2012	2:30	6/2/2012 2:30	2012	6	2	2	30	0	
7	2012	6	2	165	59.8	6/2/2012	2:45	6/2/2012 2:45	2012	6	2	2	45	0	
8	2012	6	2	180	60.6	6/2/2012	3:00	6/2/2012 3:00	2012	6	2	3	0	0	
9	2012	6	2	195	61.4	6/2/2012	3:15	6/2/2012 3:15	2012	6	2	3	15	0	
10	2012	6	2	210	62.5	6/2/2012	3:30	6/2/2012 3:30	2012	6	2	3	30	0	

USGS-ADAPS/RDB

USGS-WEB

Generic Date Time Separate

Load Datasets - NWISget

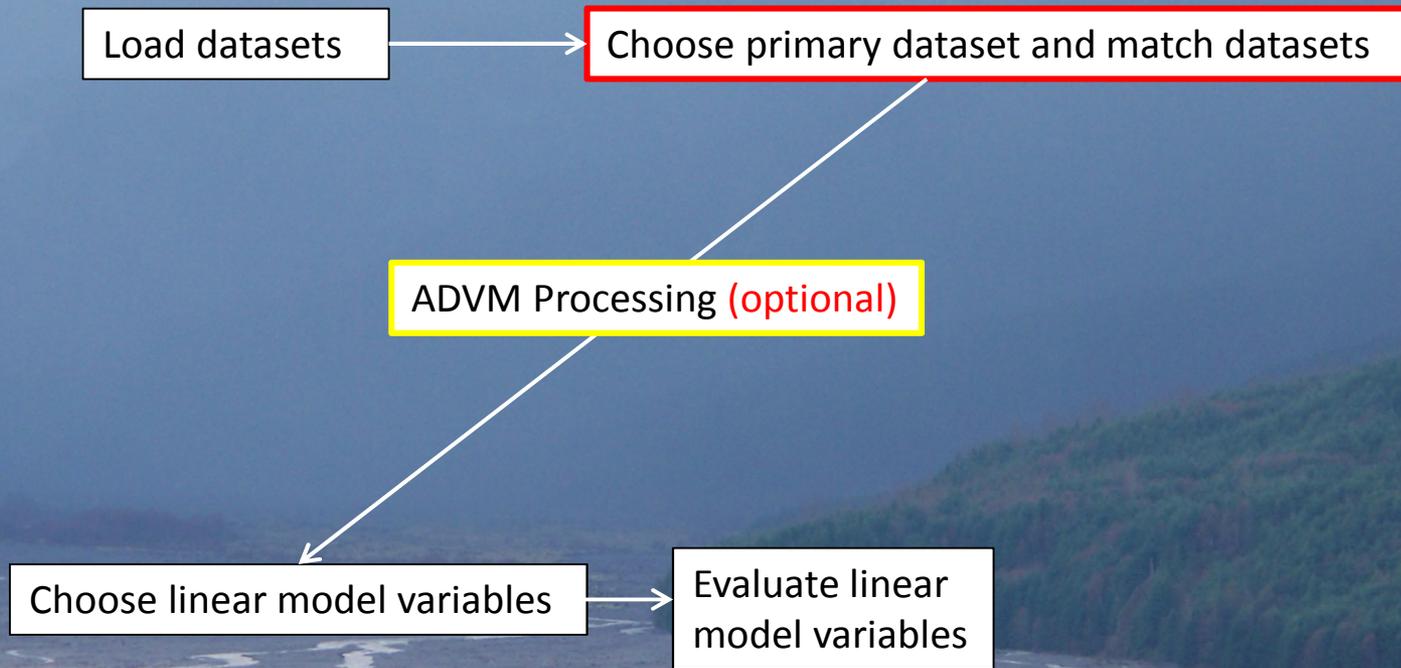
Pulls USGS data
and automatically
converts to
SAID format

The screenshot shows the NWISget application window with the following elements:

- Site number:
- Start date (yyyy-mm-dd):
- End date (yyyy-mm-dd):
- Site name:
- Load data from NWIS:
- Table with columns: Parameter, Export variable name
- Date export format: SAID NWS
- Write file:

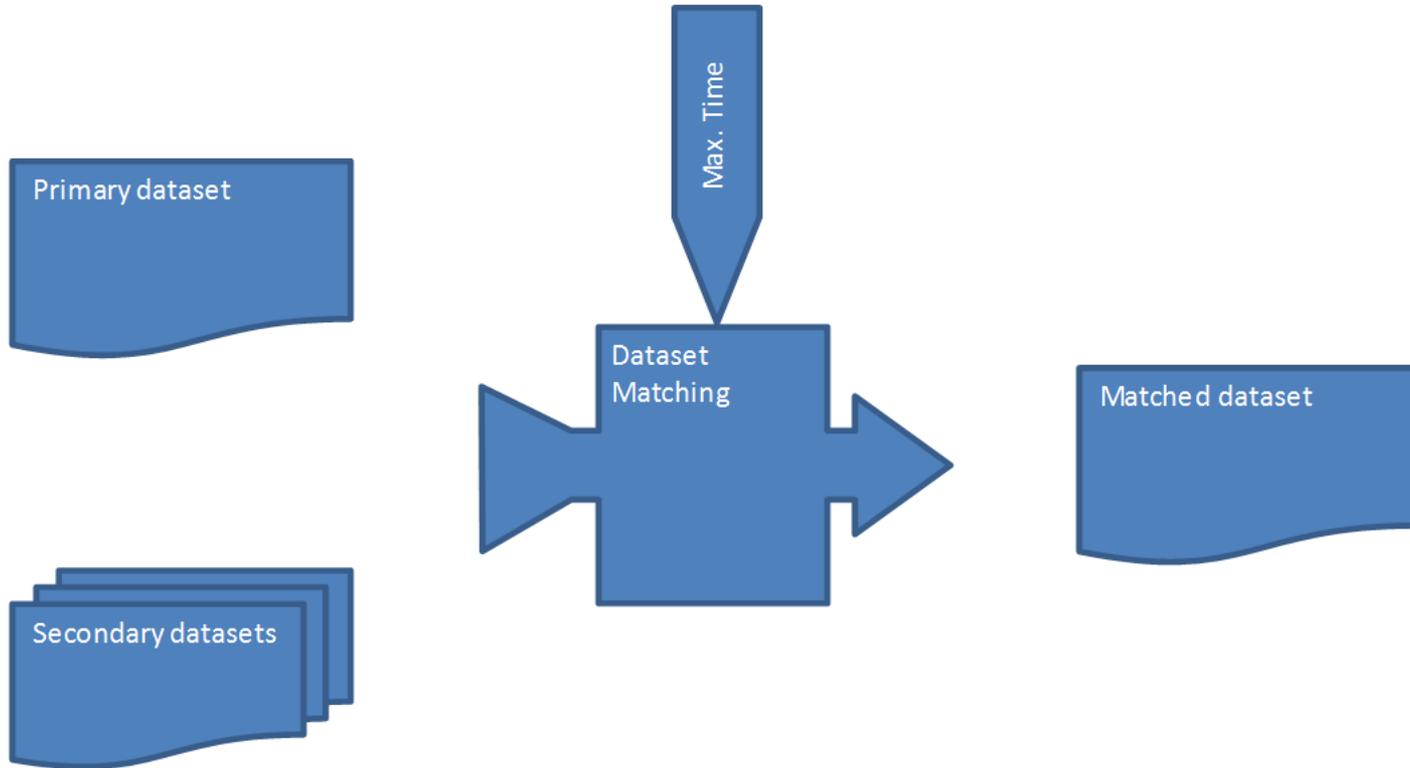
Exports file with date format for SAID

Workflow

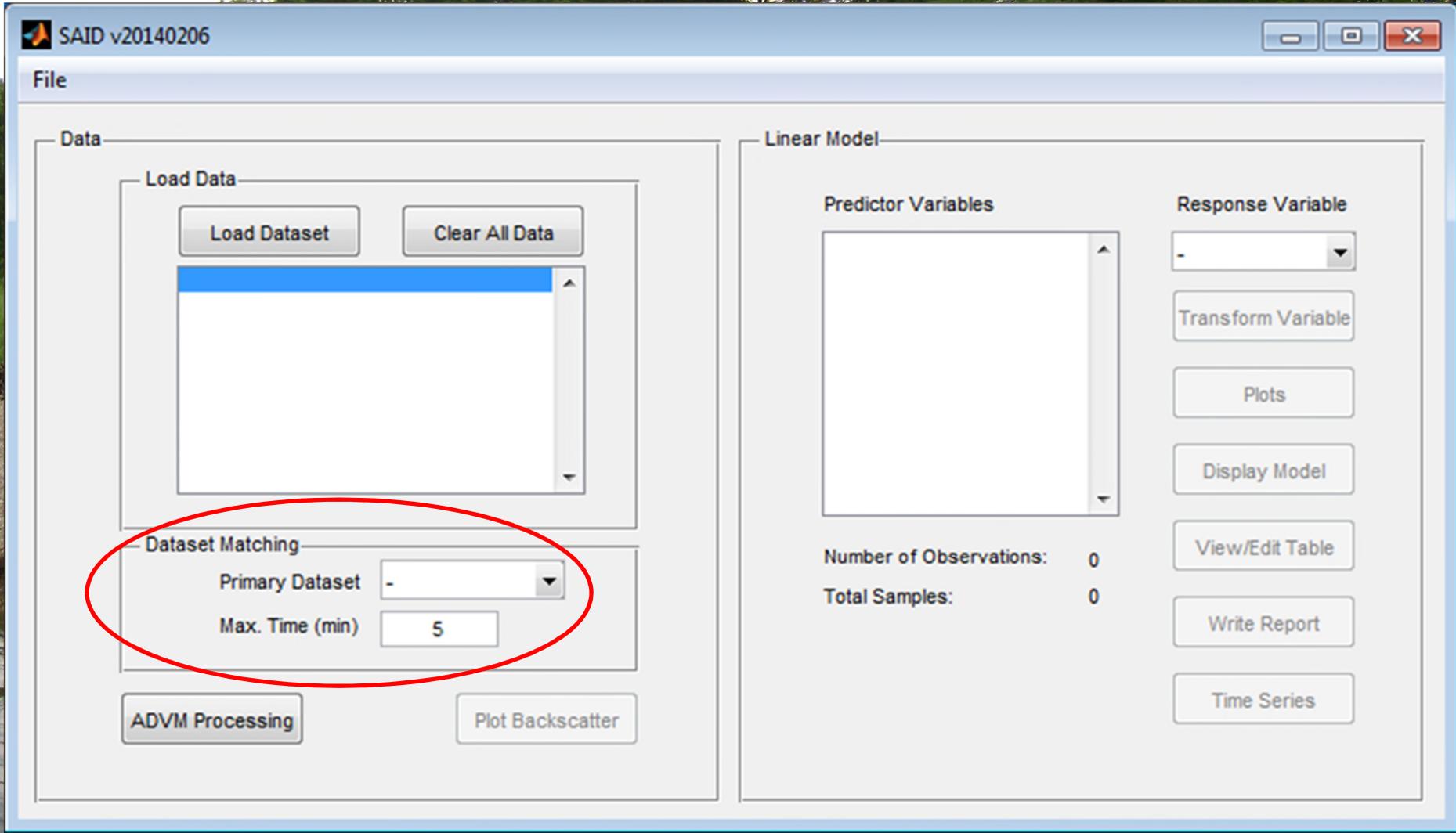


Workflow

Choose primary dataset and match datasets



Dataset Matching



Dataset Matching

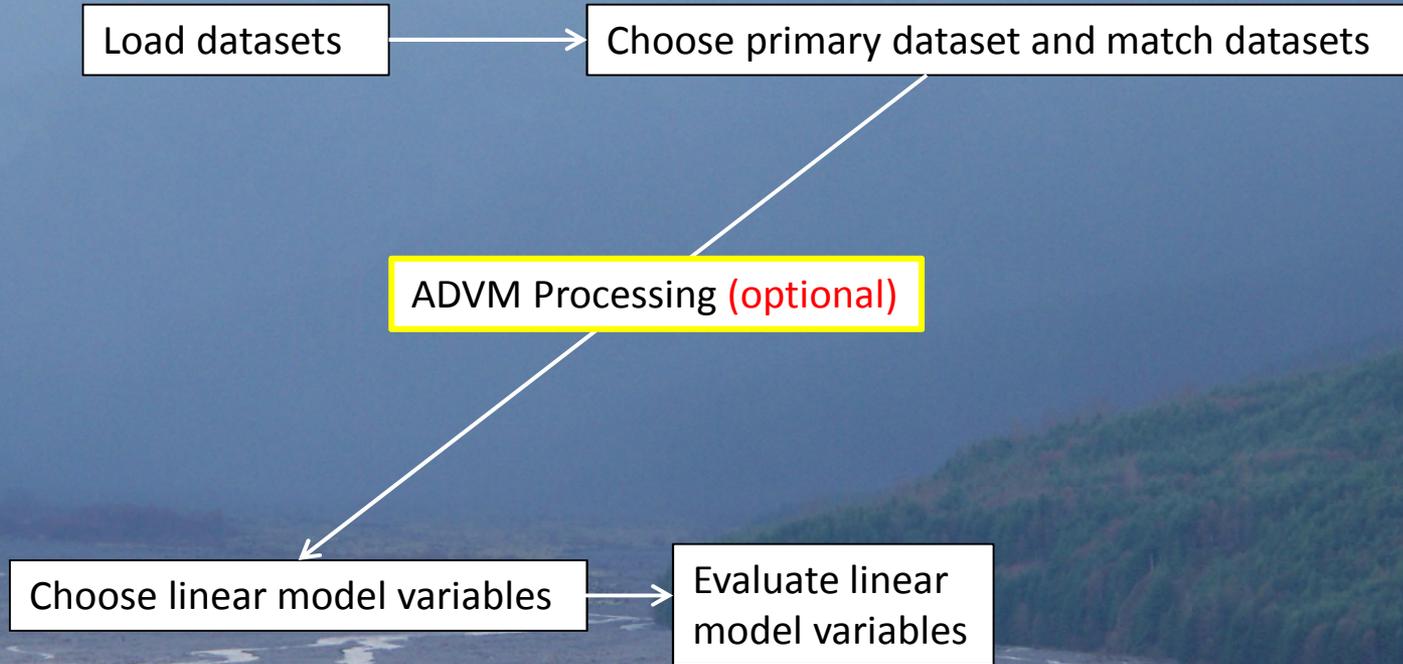
Dataset Matching

Primary Dataset

Max. Time (min)



Workflow



ADVM Processing

Method assumes:

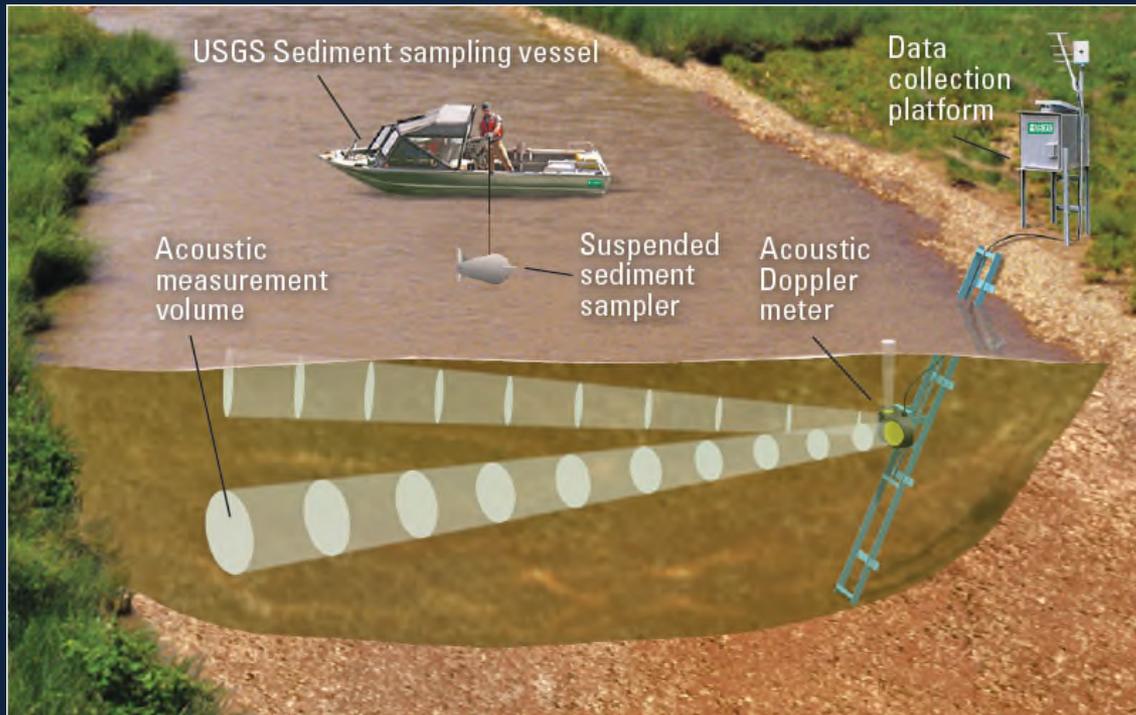
- Constant concentration along the beam path
- Fixed mount deployment
- Continuous time series



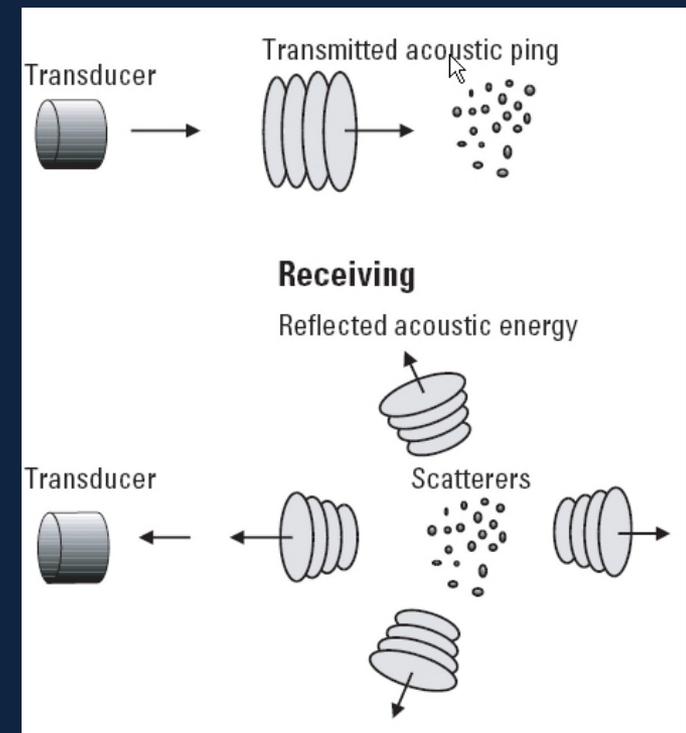
Early USGS work by Topping and Wright, 2006; Landers, 2012; Wood and Teasdale, 2013

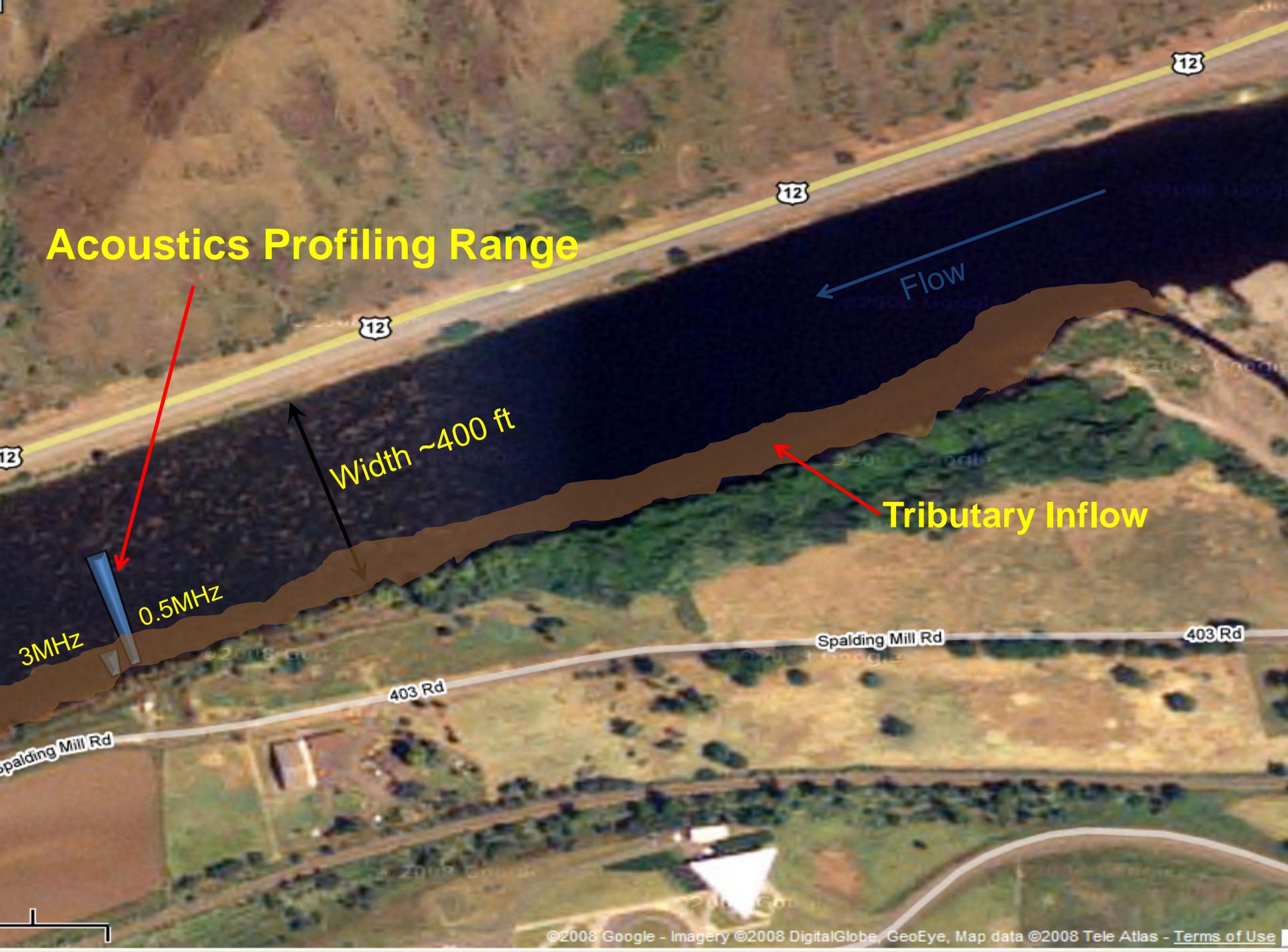
Continuous Sediment Acoustic Method

- Relies on the acoustic returns (backscatter) of particles in the water column as a surrogate for suspended-sediment concentration



Need multi-cell acoustic data





Acoustics Profiling Range

Flow

Width ~400 ft

Tributary Inflow

3MHz

0.5MHz

Spalding Mill Rd

403 Rd

403 Rd

Spalding Mill Rd

Acoustic Data Corrections

$$WCB = MB + 20\log_{10}(\psi r) + 2r(\alpha_w)$$

$$SCB = WCB + 2r\alpha_s$$

$$SCB = MB + 20\log_{10}(\psi r) + 2r(\alpha_w) + 2r(\alpha_s)$$

Near Field
Correction

Measured
Backscatter

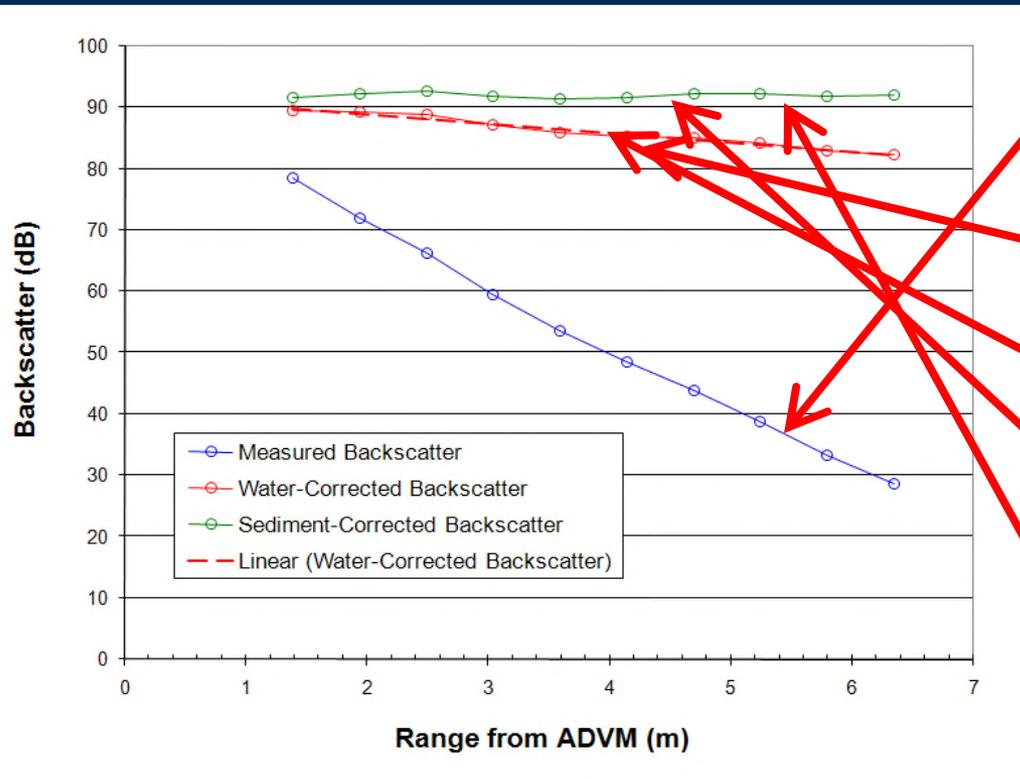
Beam
Spreading

Water
Absorption

Sediment
Attenuation

2-Way Transmission Losses

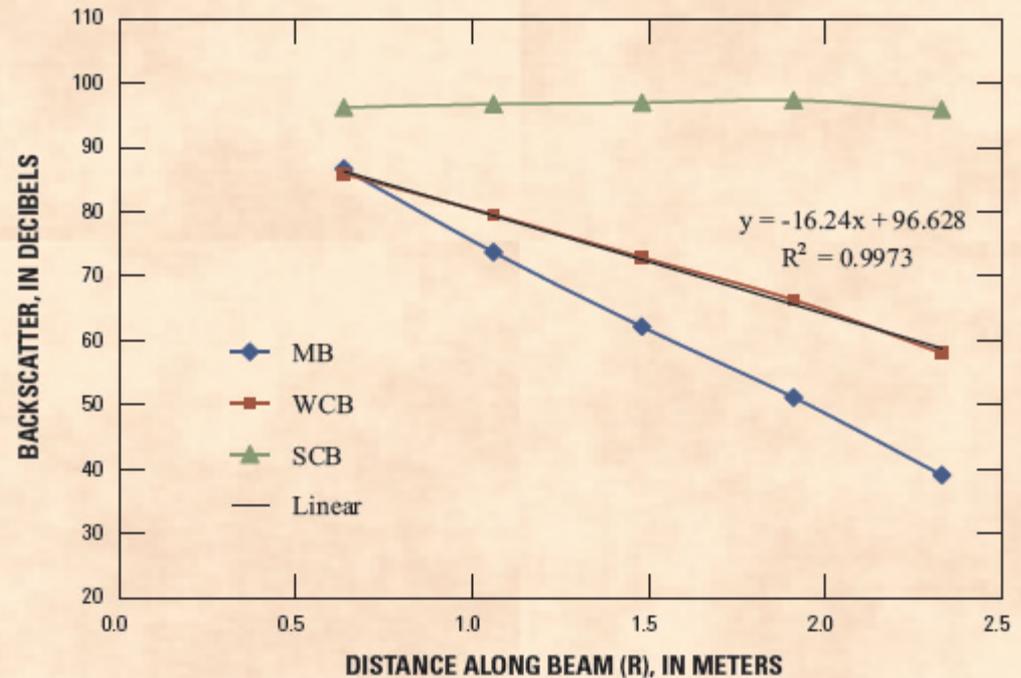
Acoustic Data Processing



1. Collect raw backscatter in multiple cells
2. Calculate “near field”
3. Correct for spreading and absorption by water
4. Calculate attenuation of signal
5. Correct for absorption by sediment
6. Calculate average backscatter
7. Relate to sample data



Worksheet for Each Value



Ancillary Data and Preliminary Calculations

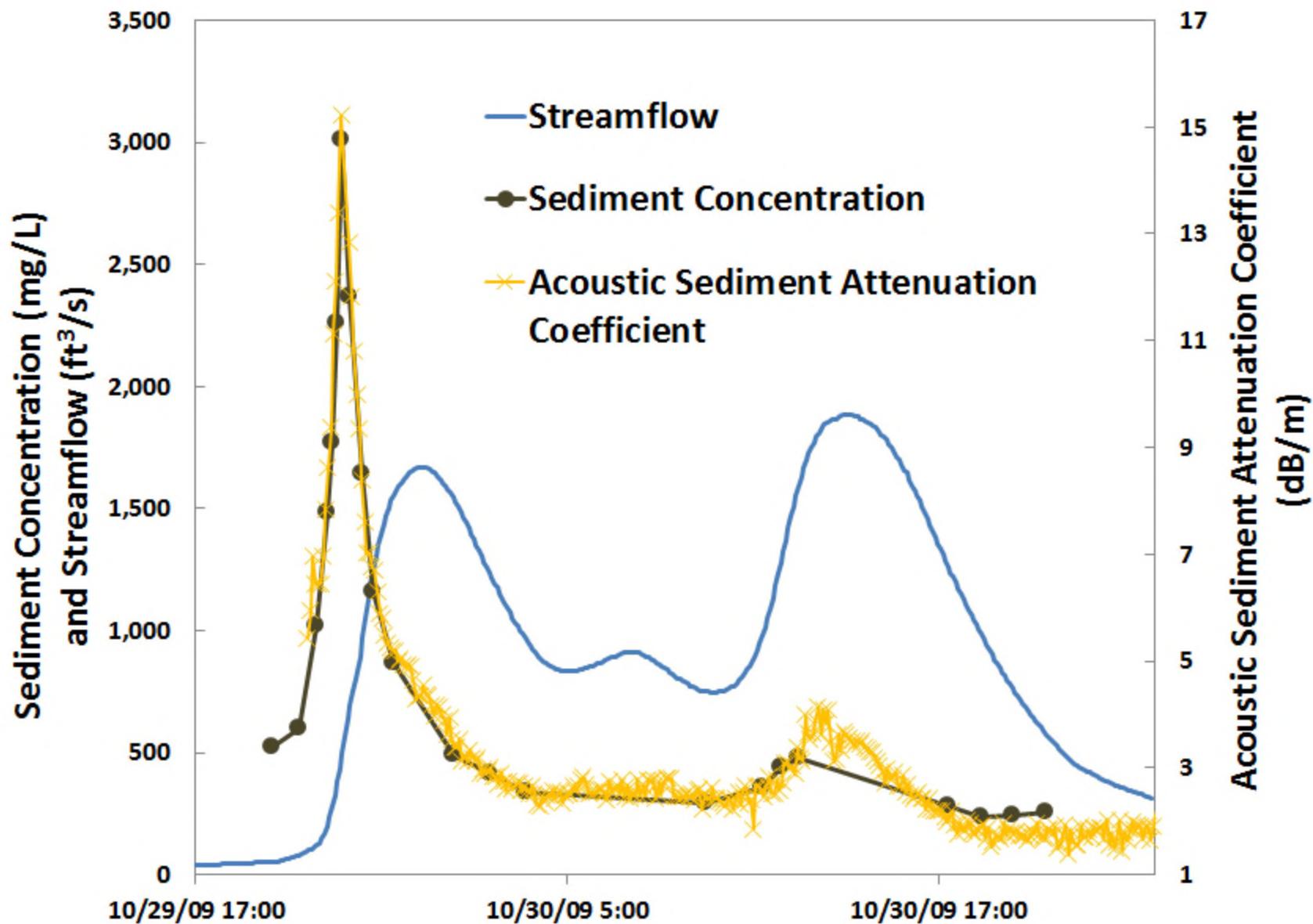
Intensity scale factor	0.43	dB/count
Water temperature	13.0	deg C
Frequency	3,000	kHz
Fluid absorption	2.49	dB/m - from Schulkin and Marsh, 1962

Sediment Attenuation and Average Backscatter Calculations

Sediment Attenuation Coefficient	8.12	dB/m - computed from RB profile
Average Backscatter	96.6	dB - computed from BS profile

Cell	Distance along beam, R (m)	Raw backscatter (counts)	Measured Backscatter, MB (dB)	Water-Corrected Backscatter, WCB (dB)	Sediment-Corrected Backscatter, SCB (dB)
1	0.64	201.5	86.65	85.9	96.2
2	1.06	171.5	73.75	79.5	96.7
3	1.48	144.5	62.14	72.9	96.9
4	1.91	119.0	51.17	66.3	97.3
5	2.33	91.0	39.13	58.1	95.9

Sediment Concentration and Attenuation Coefficient Kickapoo Creek, Bloomington, Illinois



ADVM Configuration and Processing

ADVM processing options

Configuration

Frequency (kHz)

Effective Transducer Diameter (m)

Beam Orientation

Slant Angle (deg)

Number of Beams

Blanking Distance (m)

Cell Size (m)

Number of Cells

Save

Cancel

Processing

Beam

Moving Average Span (# of observations)

Backscatter Values

Intensity Scale Factor

Minimum Cell Mid-Point Distance (m)

Maximum Cell Mid-Point Distance (m)

Minimum Number of Cells

Minimum Vbeam (m)

Near Field Correction

Remove Cells Farther than Minimum WCB

ADVM Configuration



Configuration

Frequency (kHz)

1500

Effective Transducer Diameter (m)

0.03

Beam Orientation

Horizontal

Slant Angle (deg)

25

Number of Beams

Blanking Distance (m)

1

Cell Size (m)

1.75

Number of Cells

10

Save

Cancel

ADVM Processing



Processing

Beam

Avg

Moving Average Span (# of observations)

1

Backscatter Values

Amp

Intensity Scale Factor

0.43

Minimum Cell Mid-Point Distance (m)

3

Maximum Cell Mid-Point Distance (m)

Inf

Minimum Number of Cells

1

Minimum Vbeam (m)

-Inf

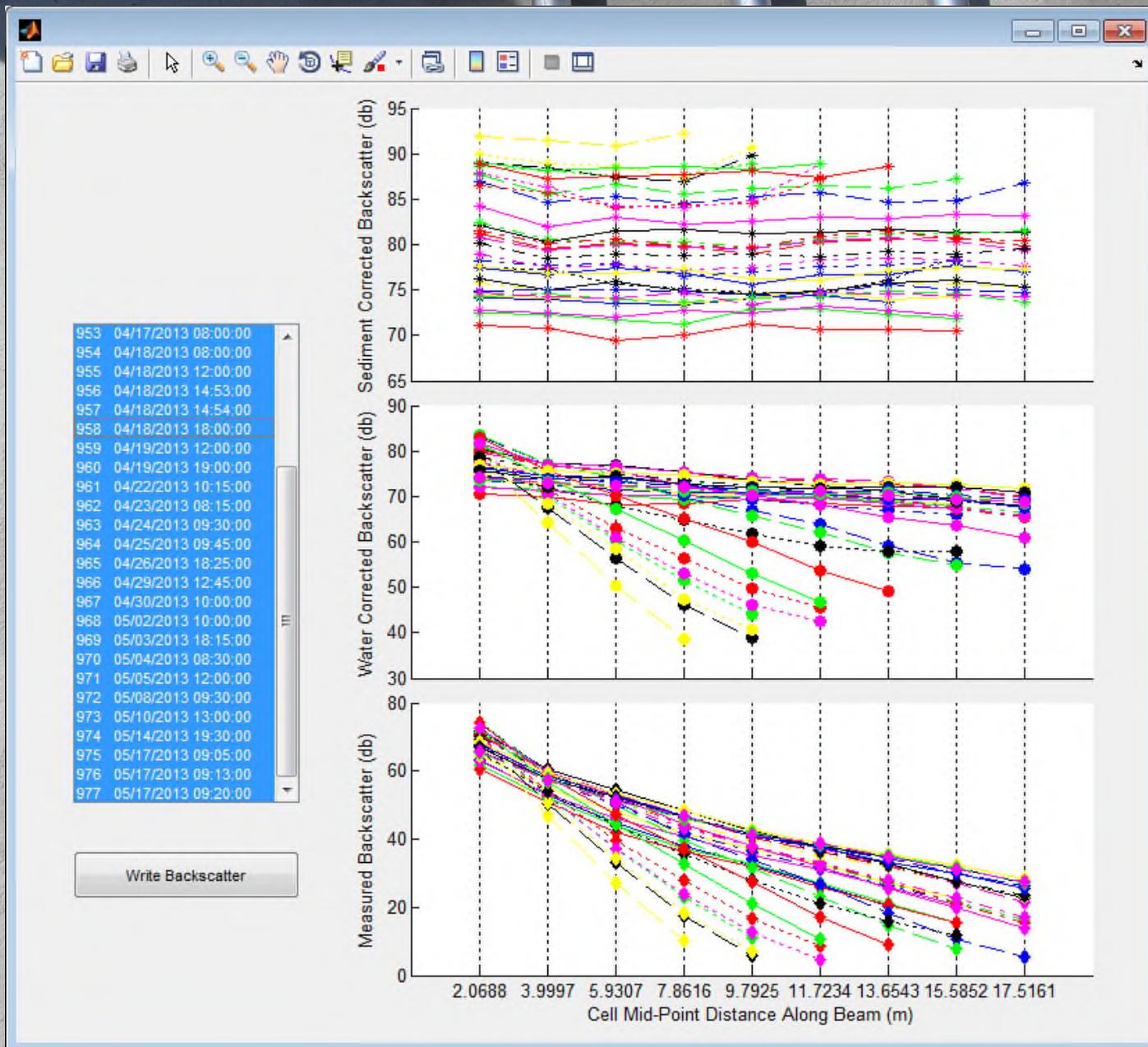
Near Field Correction



Water Corrected Backscatter (WCB) Profile Adjustment

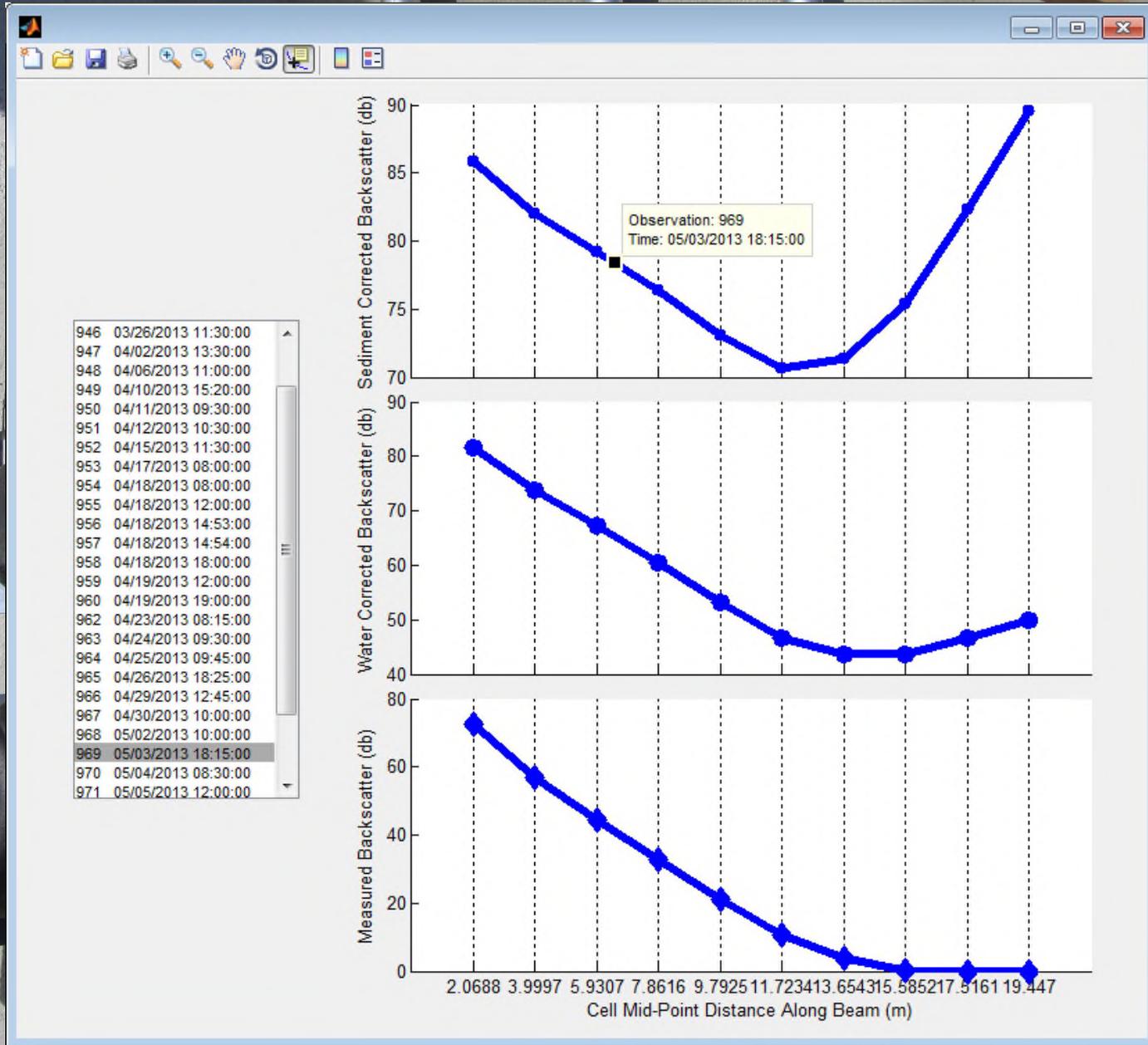


ADVM Backscatter Plots



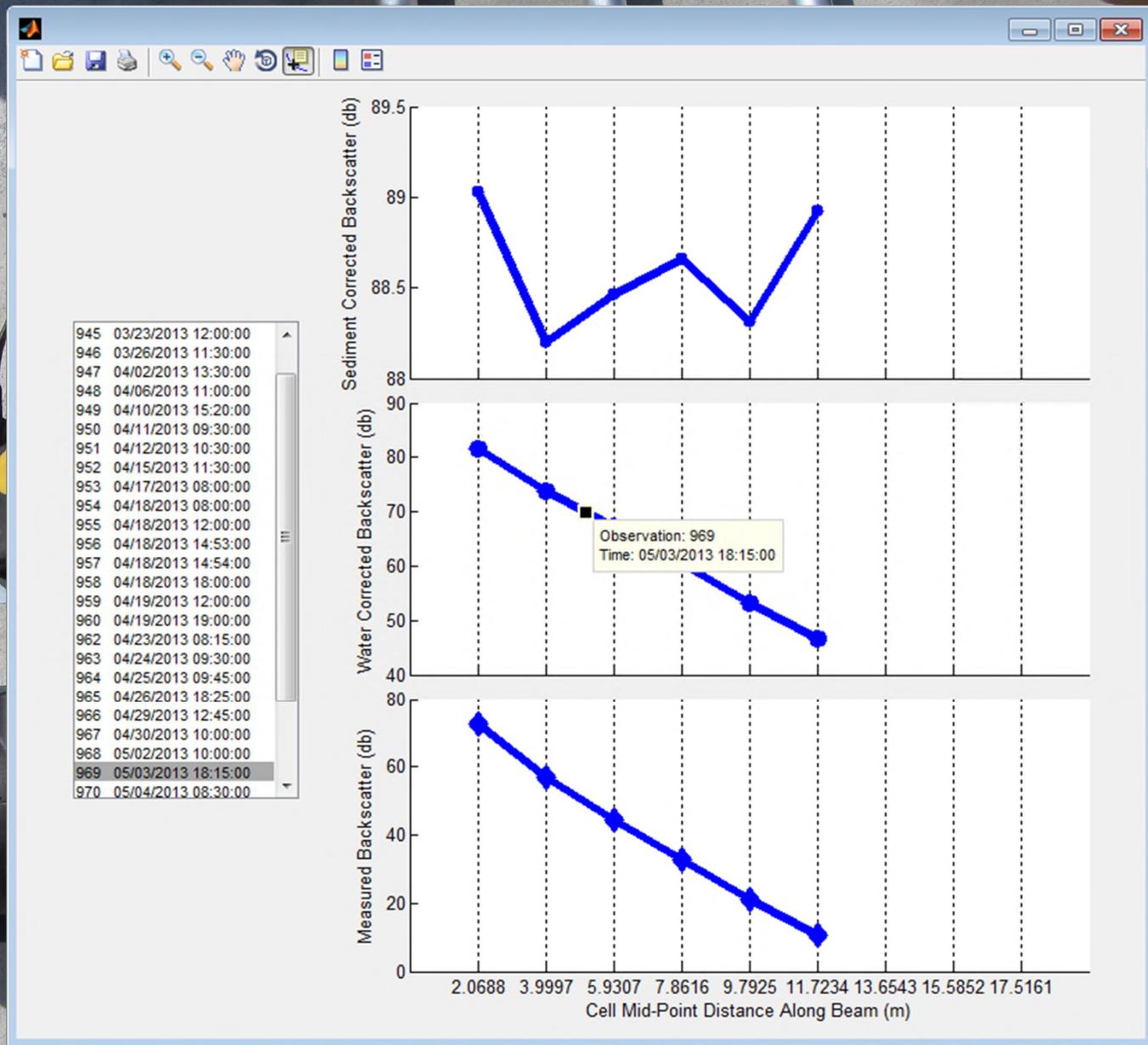
ADVM Backscatter Plot

WCB Profile
Adjustment
Needed

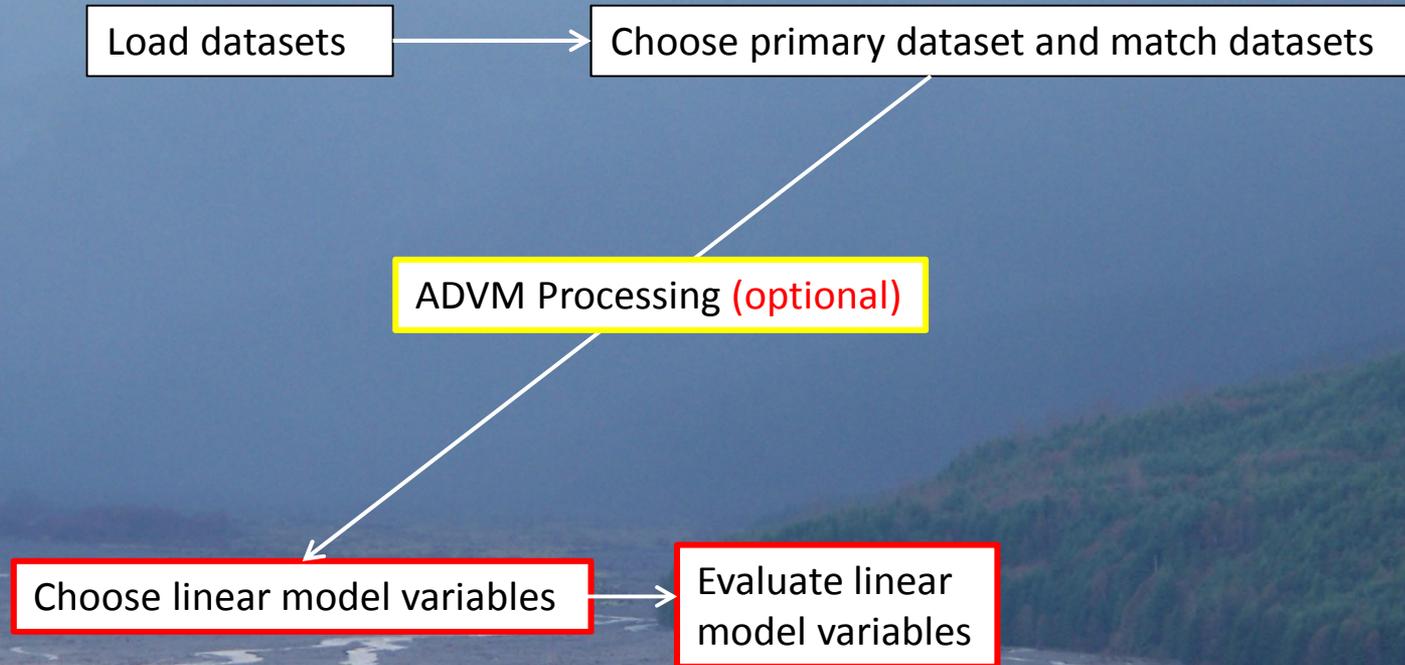


ADVM Backscatter Plots

WCB Profile
Adjustment
Applied



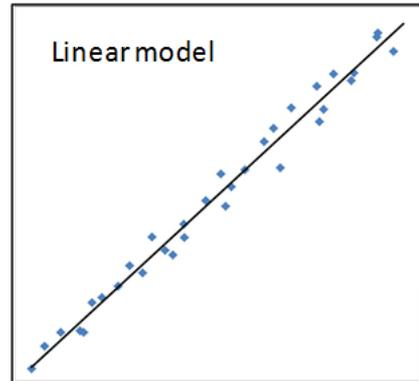
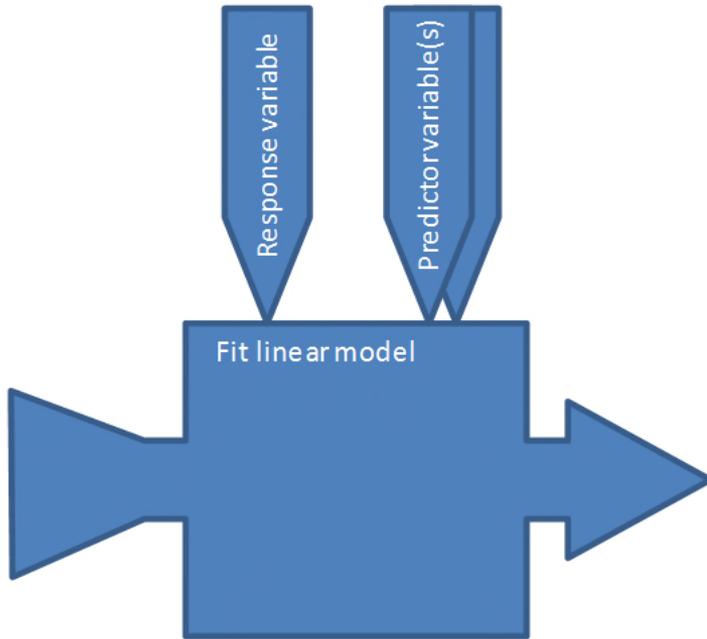
Workflow



Workflow

Choose linear model variables

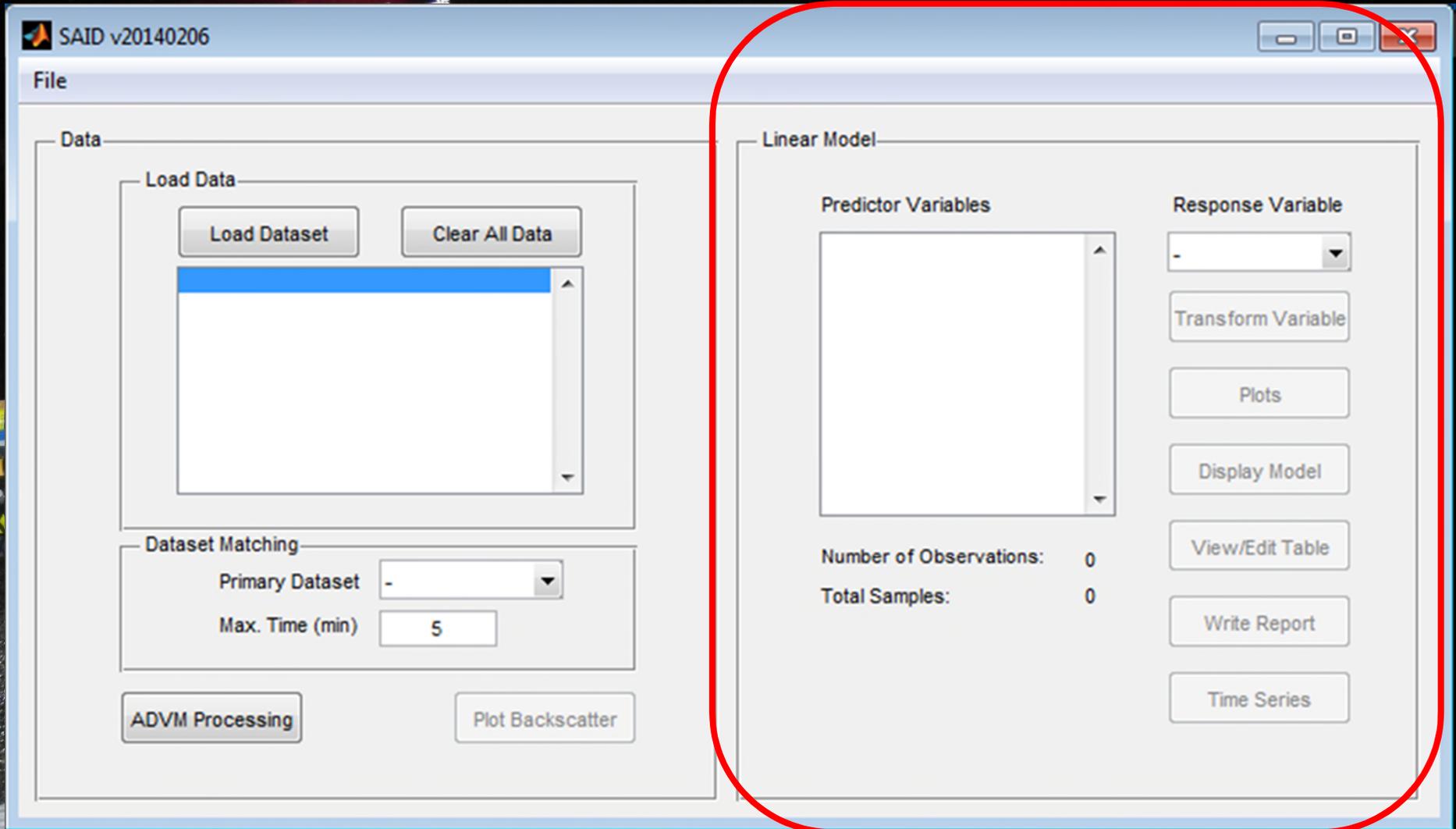
Evaluate linear model



Model dataset

Model report

Linear Regression Model



Linear Regression Model



Linear Model

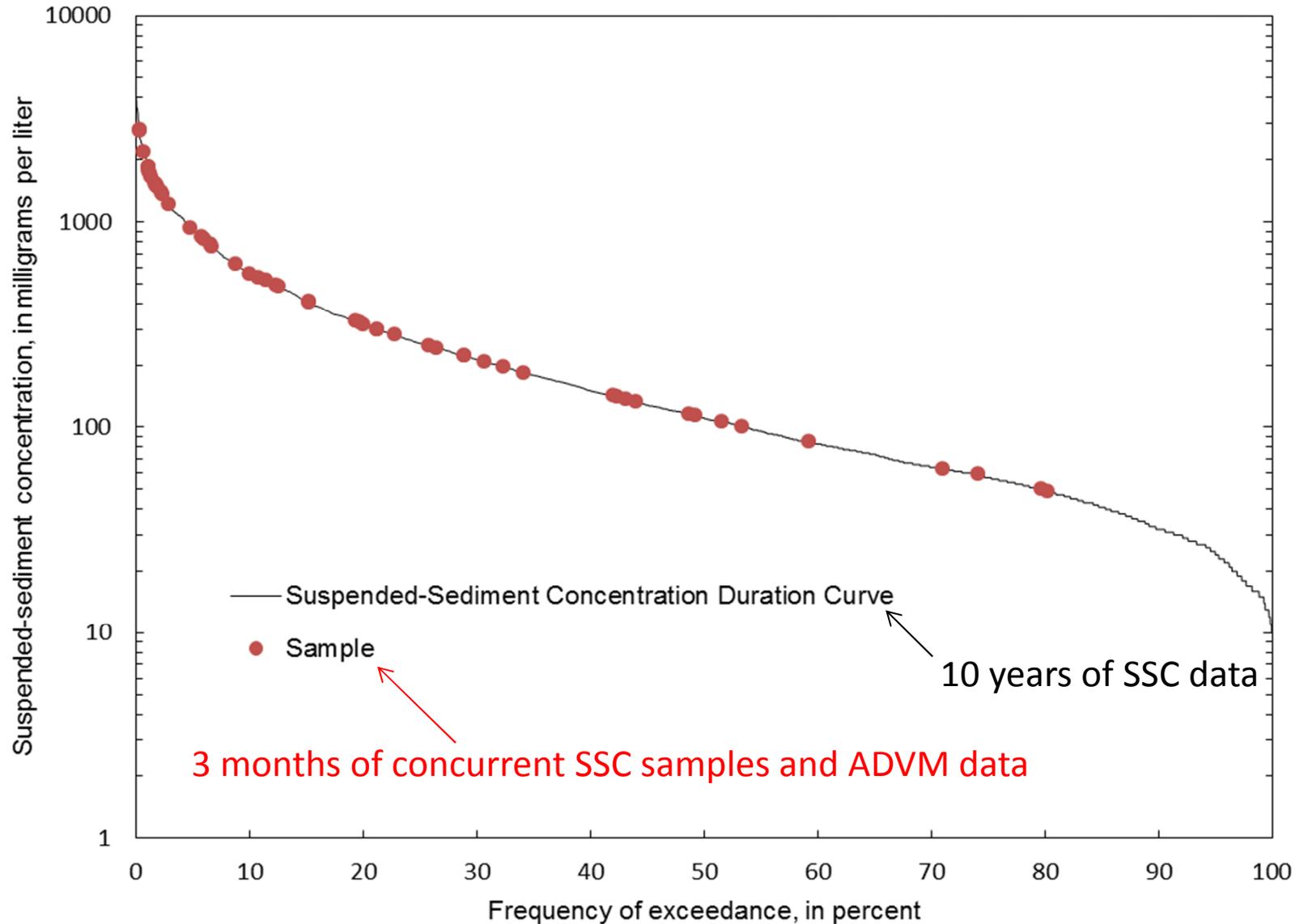
Predictor Variables	Response Variable
DateTimespoonSSC	log10SSC
DateTimeArgonaut	
Discharge	Transform Variable
GageHeight	
DateTimespoonQGH	Plots
log10SSC	
log10Discharge	Display Model
ADVMTemp	
Vbeam	View/Edit Table
alphaS	
MeanSCB	Write Report

Number of Observations: 32

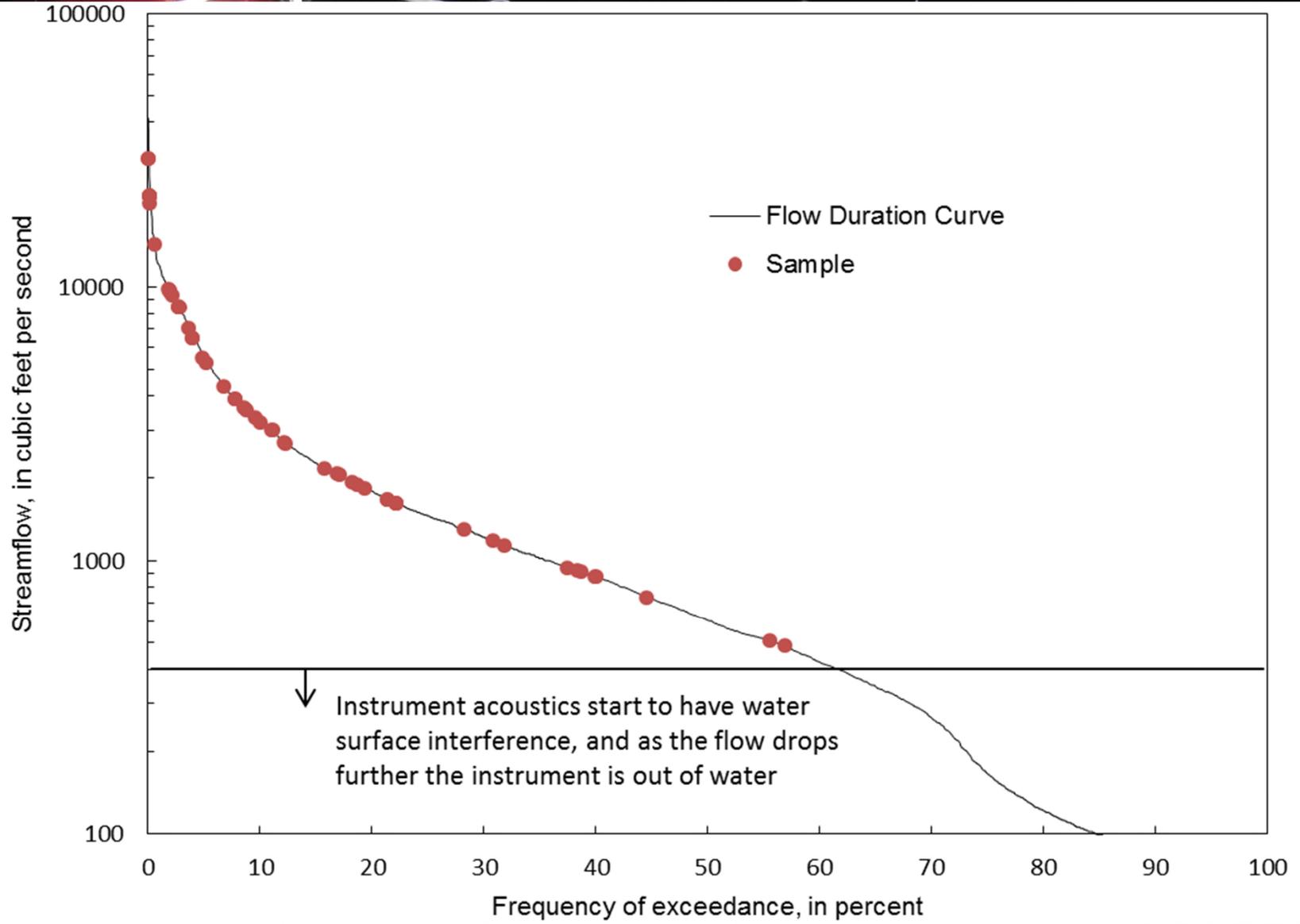
Total Samples: 1000

Time Series

Linear Regression Model



Linear Regression Model



Linear Regression Model



	Observation	DateTimespoonSSC	log10SSC	alphaS	MeanSCB	Leverage	Cook's Di...	Dffits
<input type="checkbox"/>	944	03/20/2013 14:30:00	2.2648	0.1778	73.9821	0.0788	0.0097	0.1690
<input type="checkbox"/>	945	03/23/2013 12:00:00	2.3856	0.1337	72.2537	0.1240	0.3071	1.0709
<input type="checkbox"/>	946	03/26/2013 11:30:00	2.0569	0.0953	70.4880	0.1908	0.0355	0.3233
<input type="checkbox"/>	947	04/02/2013 13:30:00	2.0253	0.1679	72.7195	0.1123	0.0290	-0.2934
<input type="checkbox"/>	948	04/06/2013 11:00:00	2.0645	0.1714	74.0404	0.0772	0.0343	-0.3222
<input type="checkbox"/>	949	04/10/2013 15:20:00	2.5159	0.4021	81.5799	0.0967	0.0601	-0.4299
<input type="checkbox"/>	950	04/11/2013 09:30:00	3.0828	0.8733	84.4967	0.1052	0.0596	0.4269
<input type="checkbox"/>	951	04/12/2013 10:30:00	3.1335	0.9743	85.5511	0.1262	0.0465	0.3734
<input type="checkbox"/>	952	04/15/2013 11:30:00	2.5105	0.3056	80.4132	0.0820	0.0108	-0.1783
<input type="checkbox"/>	953	04/17/2013 08:00:00	2.4757	0.2952	80.2825	0.0805	0.0194	-0.2397
<input type="checkbox"/>	954	04/18/2013 08:00:00	3.4425	2.9241	87.7971	0.29477	0.2523	-0.8828
<input type="checkbox"/>	955	04/18/2013 12:00:00	3.3365	2.2283	84.8483	0.1579	0.0266	0.2795
<input type="checkbox"/>	956	04/18/2013 14:53:00	3.3075	2.0726	86.1517	0.1123	1.8478e-04	0.0231
<input type="checkbox"/>	957	04/18/2013 14:54:00	3.2227	2.0726	86.1517	0.1123	0.0182	-0.2315
<input type="checkbox"/>	958	04/18/2013 18:00:00	3.2201	1.5909	83.4550	0.0640	0.0505	0.3982
<input type="checkbox"/>	959	04/18/2013 19:00:00	3.1000	1.0000	80.0000	0.0000	0.0000	0.0000

Remove Observation Restore All Observations

Linear Regression Model

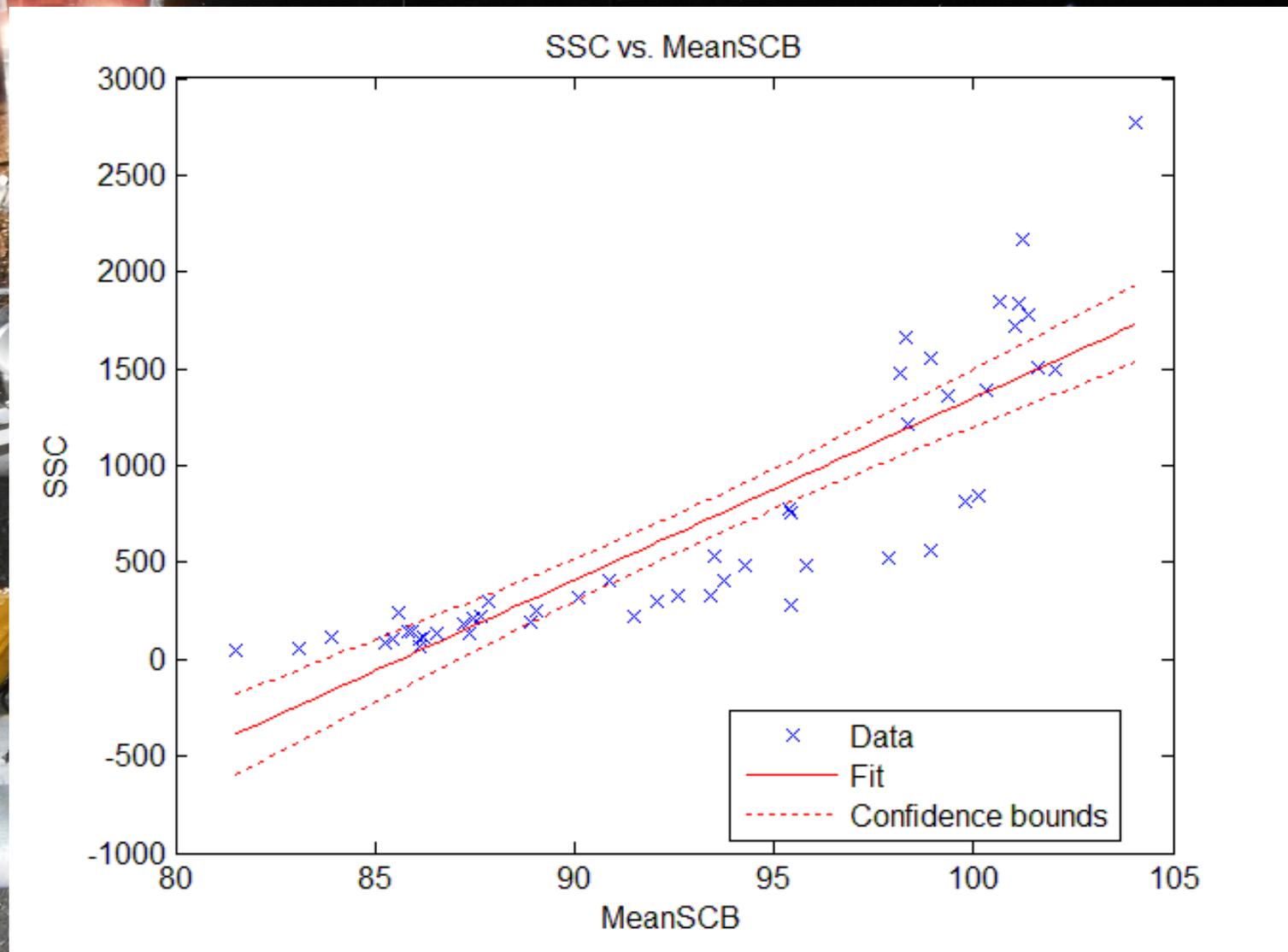
Plots

Scatter

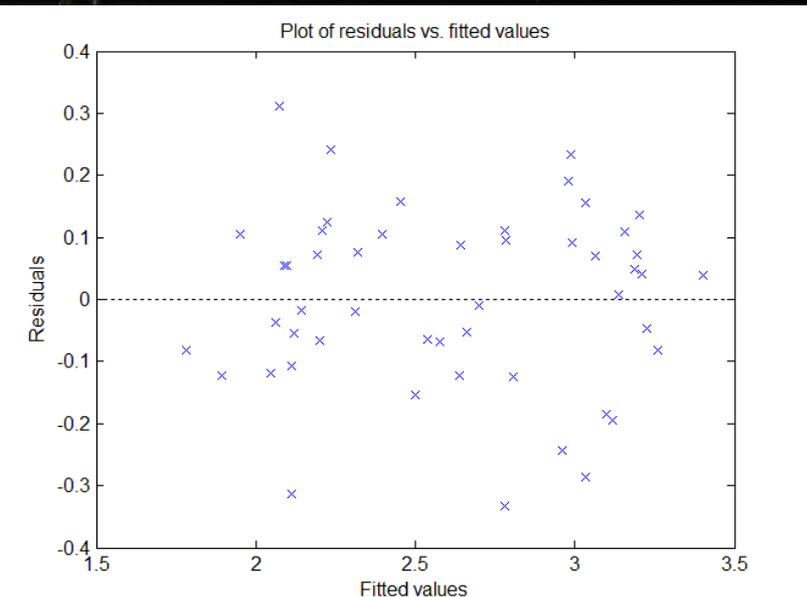
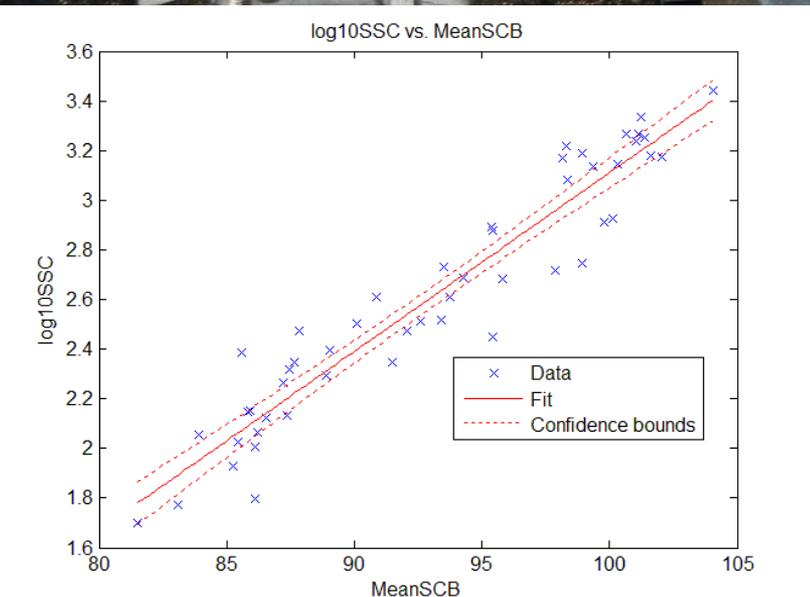
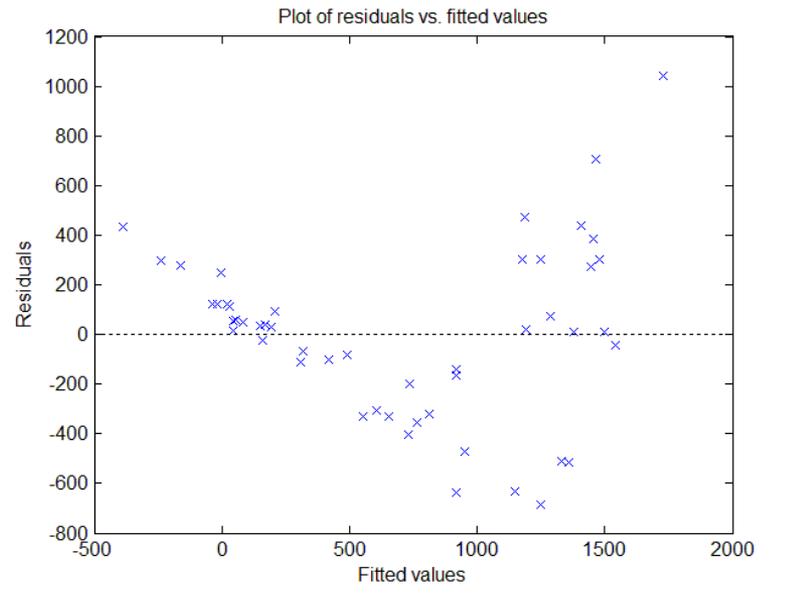
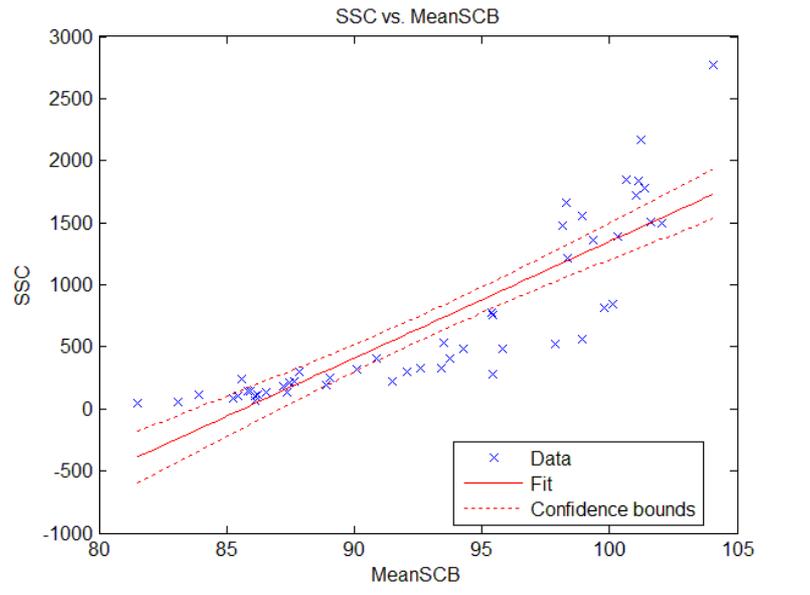
- Model
- Pred Vs. Obs

Residual

- Raw Vs. Fitted
- Probability
- Stan. Ser. Corr.
- Vs. Time



Linear Regression Model



Linear Regression Model

Linear regression model:

$\log_{10}SSC = -4.09 + 0.072\text{MeanSCB}$

Estimated Coefficients:

	Estimate	SE	tStat	pValue	Lower90%	Upper90%
(Intercept)	-4.0927	0.30312	-13.502	5.786e-18	-4.60112	-3.58431
MeanSCB	0.072036	0.0032488	22.174	7.1985e-27	0.0665876	0.0774854

Number of observations: 50, Error degrees of freedom: 48

Root Mean Squared Error: 0.144

R-squared: 0.911, Adjusted R-Squared 0.909

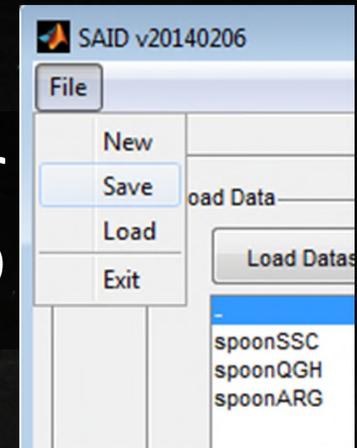
F-statistic vs. constant model: 492, p-value = 7.2e-27

Non-parametric smearing bias correction factor: 1.0523

Probability plot correlation coefficient: 0.99036

High leverage: 0.12
High influence (Cook's D): 2.1923
High influence (DFFITs): 0.4

Save model state for later
use and editing in SAID



Linear Regression Model (.csv output)

-Attempts to meet new policies being written for regression models

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Frequency (kHz):			1500													
2	Effective Diameter (m):			0.03													
3	Beam Orientation:			Horizontal													
4	Slant Angle (deg):			25													
5	Nbeams:																
6	Blanking Distance (m):			1													
7	Cell Size (m):			1.75													
8	Number of Cells:			10													
9	Beam Number:			2													
10	Moving Average Span:			1													
11	Backscatter Values:			Amp													
12	Intensity Scale Factor:			0.43													
13	RMin (m):			^-Inf													
14	RMax (m):			Inf													
15	Min Cells:			1													
16	Min Vbeam (m):			^-Inf													
17	Near Field Correction:			1													
18	Remove Minimum WCB:			1													
19																	
20	Dataset File Locations																
21	-----																
22	Z:\Sediment\Acoustic Data\Spoon River at Seville 05570000\vsaid example\spoon\$SC.txt																
23	Z:\Sediment\Acoustic Data\Spoon River at Seville 05570000\vsaid example\spoon\$DGH.txt																
24	Z:\Sediment\Acoustic Data\Spoon River at Seville 05570000\vsaid example\spoon\$ARG.txt																
25																	
26	Linear regression model:																
27	log10SSC = -4.03 + 0.072MeanSCB																
28																	
29	Estimated Model Coefficients																
30				Estimate	SE		tStat		pValue								
31	(Intercept)			-4.0327		0.30312		-13.502	5.79E-18								
32	MeanSCB			0.072036		0.0032466		22.174	7.20E-21								
33																	
34	Number of observations			50													
35	Error degrees of freedom			48													
36	Root Mean Squared Error (Standard Error of Reg			0.14415													
37	R-squared			0.911													
38	Adjusted R-Squared			0.909													
39	F-statistic vs. constant model			492													
40	p-value			7.20E-21													
41	Non-parametric smearing bias correction factor			1.0523													
42	Probability plot correlation coefficient			0.39036													
43	High leverage			0.12													
44	Extreme outlier (Standardized residual)			3 (absolute value)													
45	High influence (Cook's D)			2.1923													
46	High influence (DFFITS)			0.4													
47																	
48	Variance-covariance matrix																
49				(Intercept)	MeanSCB												
50	(Intercept)			0.091884		-0.00036255											
51	MeanSCB			-0.000363		1.06E-05											
52																	
53	Predictor variable summary statistics																
54				MeanSCB													
55	Minimum			81.5325													
56	1st Quartile			87.2422													
57	Median			93.466													
58	Mean			93.0933													
59	3rd Quartile			98.3502													
60	Maximum			104.0639													
61																	
62	Response variable summary statistics																
63				log10SSC	SSC												
64	Minimum			1.639		50											
65	1st Quartile			2.2648		184											
66	Median			2.5622		367											
67	Mean			2.6134		700.04											
68	3rd Quartile			3.1335		1360											
69	Maximum			3.4425		2770											
70																	
71	Observations																
72	Observation Number	Missing	Excluded	SSC	DateTimeSpoonSSC	DateTimeSpoonARG	log10SSC	alphaS	MeanSCB	Fittedlog10SSC	RawResiduals	NormalQuantile	EstimatedSSC	Standardize dResiduals	Leverage	CooksD	Dffits
73	1	0	0	299	2/7/2013 13:00	2/7/2013 12:56	2.47567	0.329104	87.8315	2.23436	0.241316	1.85396	180.504	1.70329	0.034063	0.0511534	0.326527
74	2	0	0	281	2/10/2013 12:00	2/10/2013 11:56	2.44811	1.13258	95.4164	2.78075	-0.33204	-2.25866	635.152	-2.33003	0.022741	0.0631677	-0.37347
75	3	0	0	756	2/13/2013 10:30	2/13/2013 10:26	2.87852	1.05533	95.4367	2.78221	0.0963125	0.610044	637.295	0.675873	0.022789	0.0053265	0.102622

Acoustic Information
(if used)

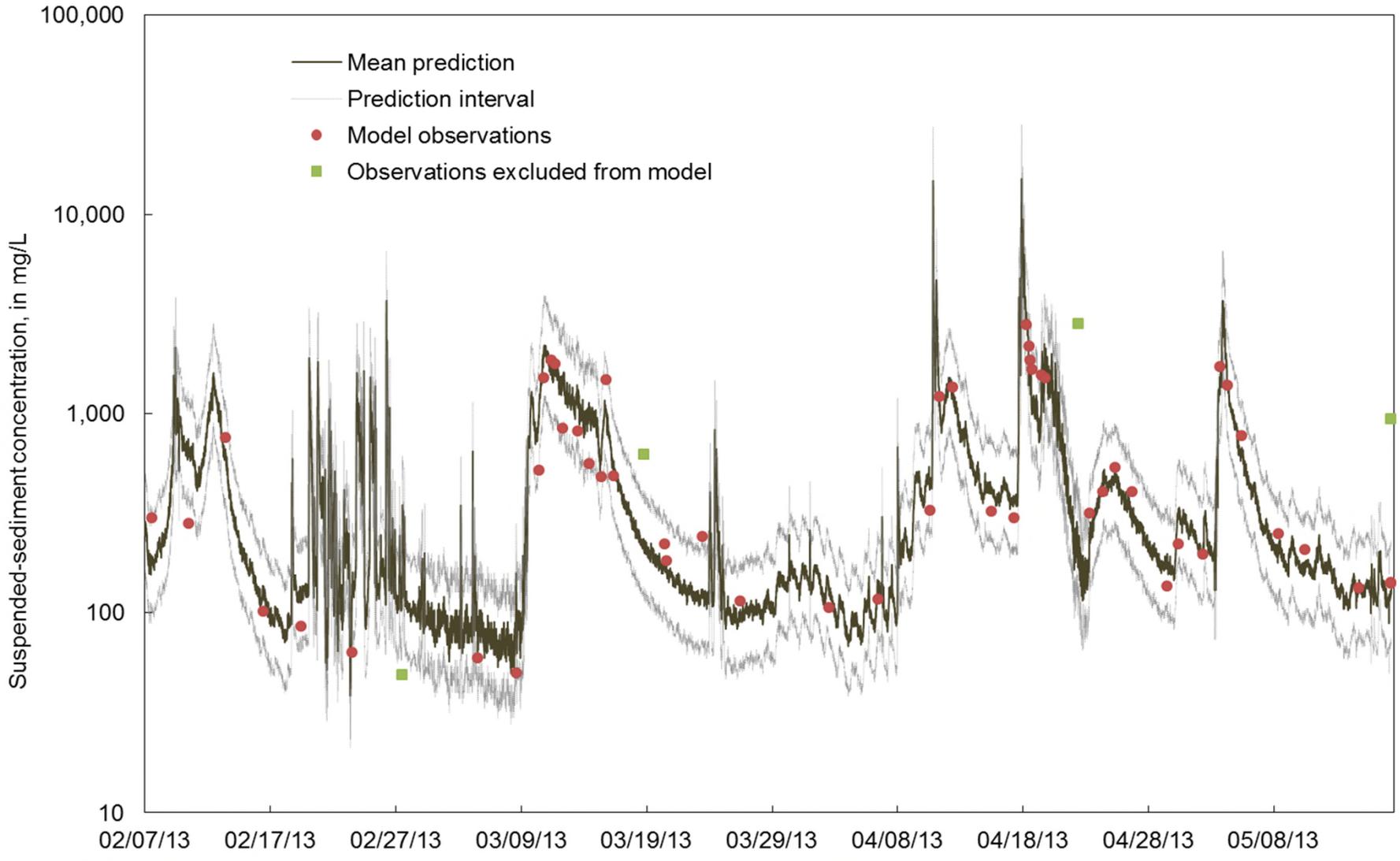
File Information

Regression
Diagnostics

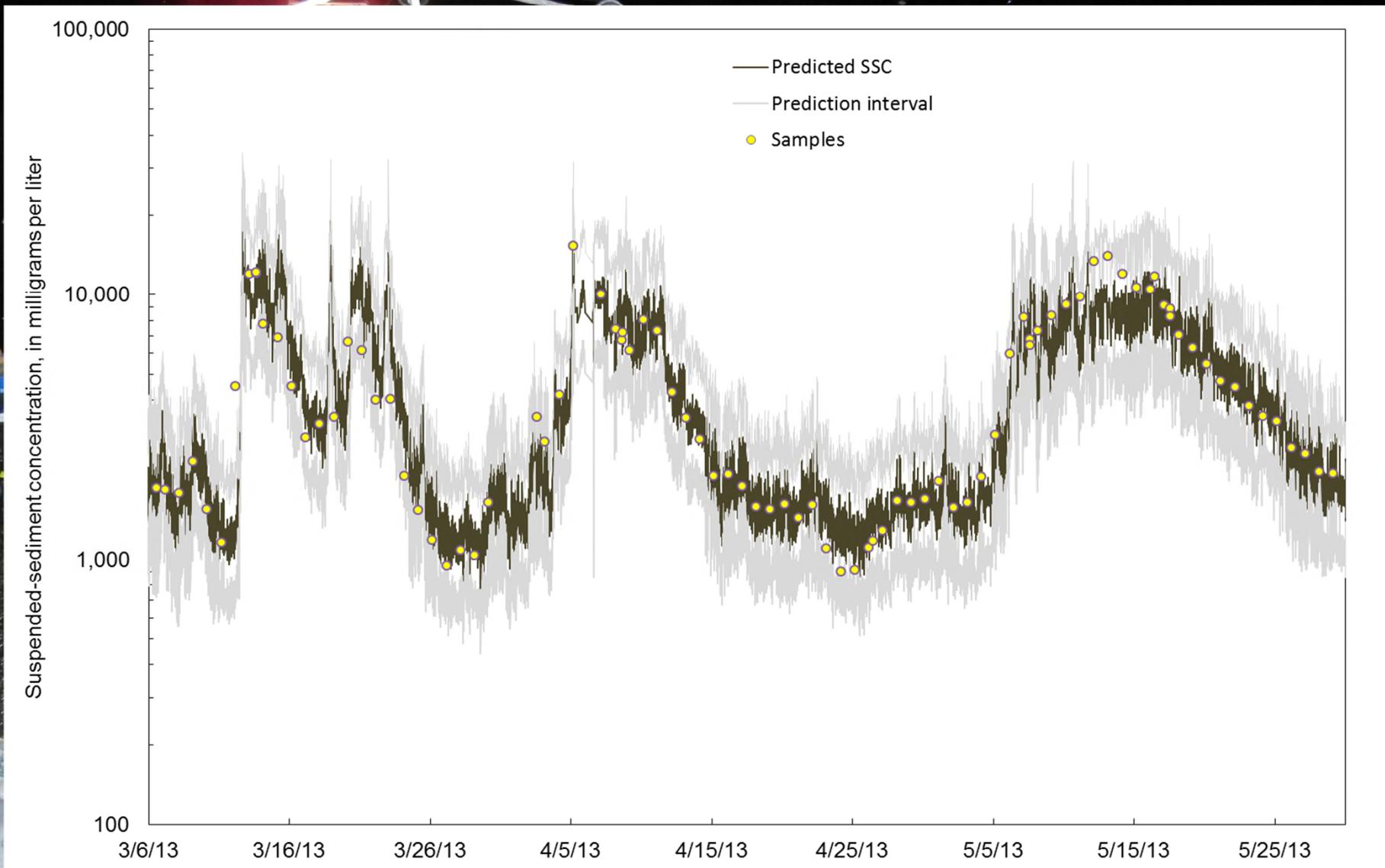
Data Summary

Data Results

Spoon River, Illinois – Sediment Acoustic Time Series



Elwha River, Washington – Sediment Acoustic Time Series



Illinois River at Florence, Illinois Spring 2013

Linear Model

Predictor Variables

- YSITurb
- DateTimeFlorenceSSC201206
- GageHeight
- Discharge
- DateTimeFlorenceQGH
- TurbidityFBRU
- TurbidityFNU
- log10TurbidityFBRU
- DateTimeFlorenceTurbidity
- ADVMTemp
- Vbeam
- alphaS
- MeanSCB

Response Variable

TurbidityFNU

Transform Variable

View/Edit Table

Display Model

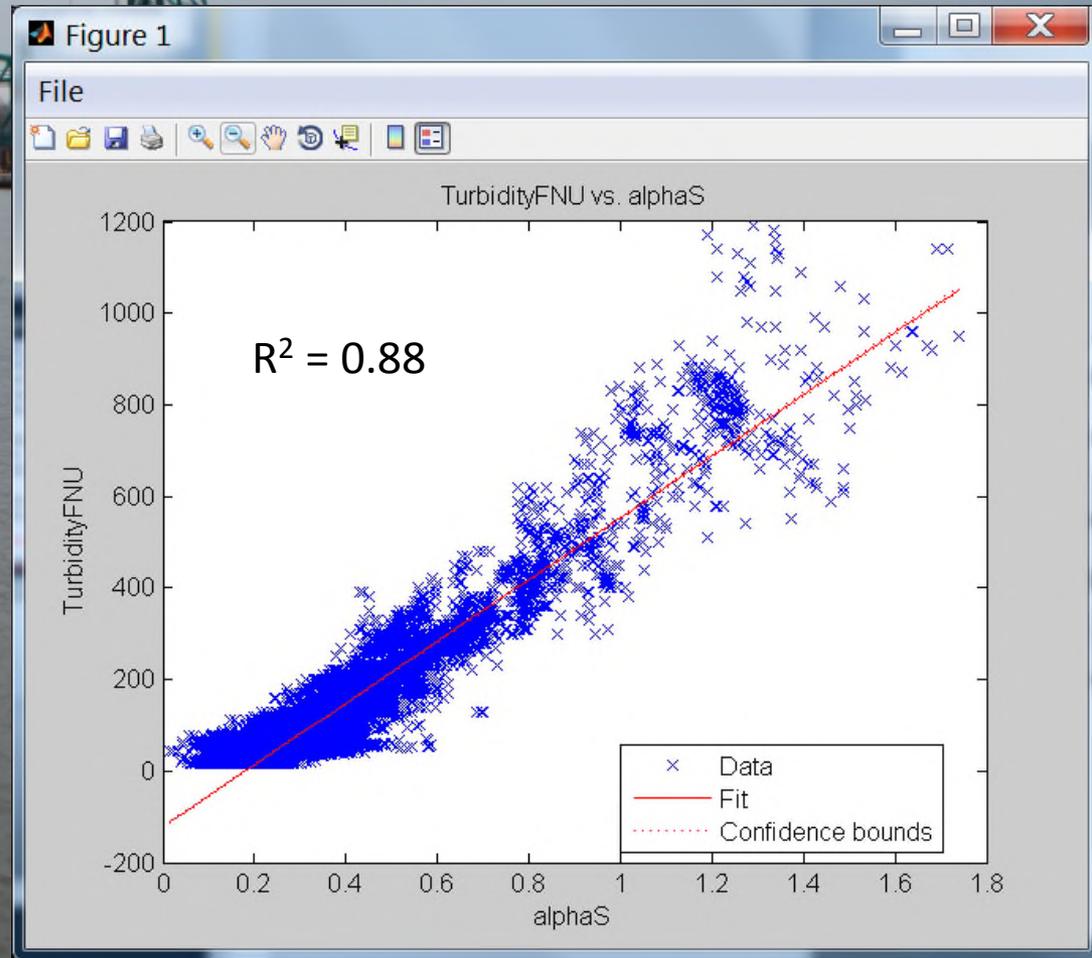
Write Report

Plots

Time Series

Number of Observations: 12549

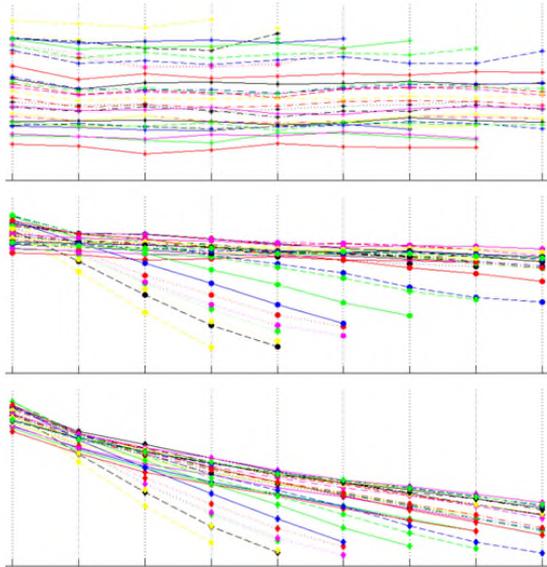
Total Samples: 43116



SAID Resources

Surrogate Analysis and Index Developer
(SAID) Tool

User Manual



Manual Version

20140416

Software Version

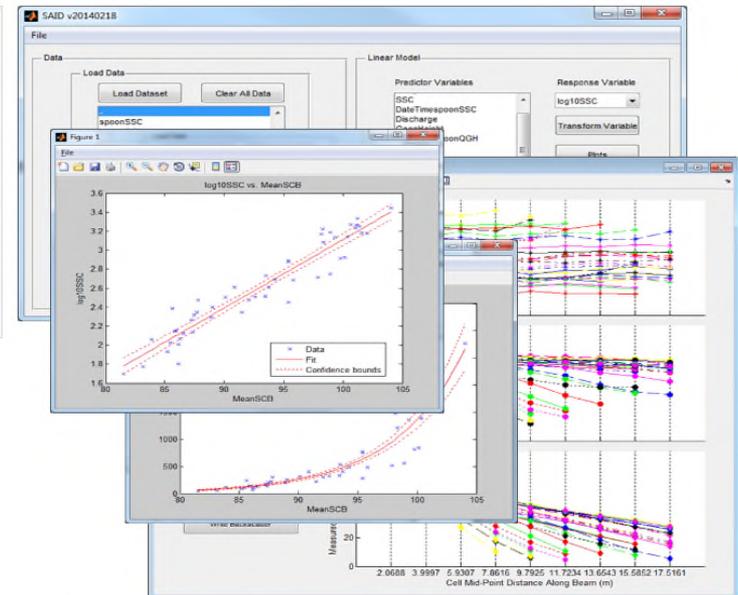
20140416



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The Surrogate Analysis and Index Developer (SAID) Tool

- SAID Menu
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- Features
- Documentation
- Downloads
- Known Issues
- Bug Reports or Suggestions
- User Group
- Collaborators
- SALT Home



Website

The Surrogate Analysis and Index Developer (SAID) tool is a stand-alone tool to assist in the creation of ordinary least squares (OLS) regression models by providing visual and quantitative diagnostics to the user. The tool also processes acoustic parameters to be used as predictor variables using a constant spatial suspended sediment concentration method. The method utilizes acoustic backscatter data from fixed-mount stationary acoustic Doppler velocity meters (ADVM).

Within the program, you can:

<http://water.usgs.gov/osw/SALT/SAID/>

Real-Time Sediment Acoustics

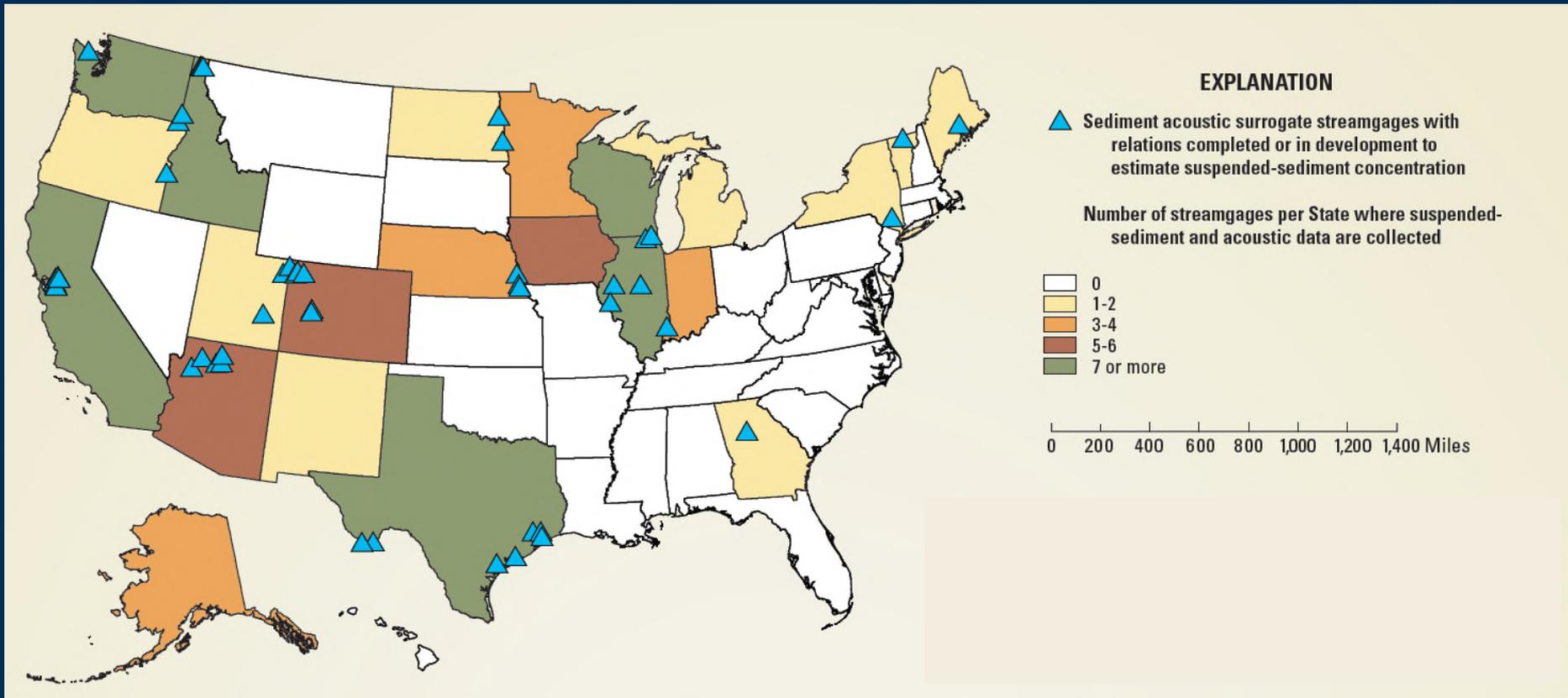
An aerial photograph showing a river delta where a river meets a larger body of water. The river channel is filled with a thick, light-colored sediment plume that spreads out into the larger body of water. The surrounding land is a mix of green fields, brownish soil, and some buildings. The sky is a clear blue.

- Early warning for municipal water supply and hydropower facilities
- Track sediment loads after wildfire, construction activities, levee failures, etc.
- Monitor river response to remediation activities and changing land uses

Molly Wood, Gary Wall, Steven Brady, Mark Landers

Real-Time Sediment

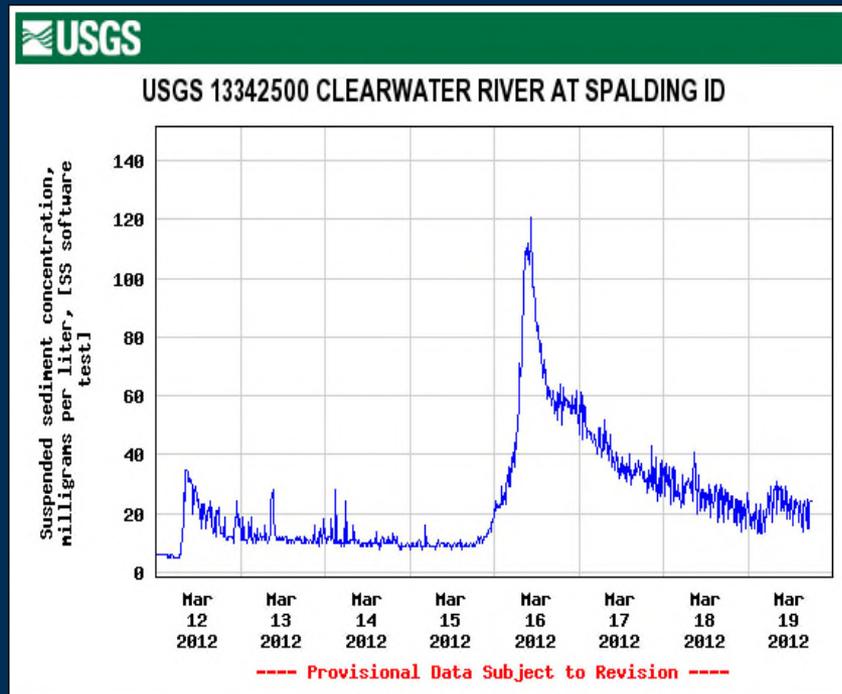
Imagine a national real-time acoustic sediment network.....



Over 70 sites in 22 States with continuous acoustics and concurrent suspended sediment measurements as of 2012

Real-Time Sediment

- SALT is working on two options for real-time computation of sediment using acoustics:
 - RASSDAT (Gary Wall, USGS NY WSC)
 - NRTWQ (Steve Brady, USGS KS WSC)



RASSDAT

Displays results on USGS NWIS-Web
Python and VBA script, Windows GUI

RASSDAT 1.0

Station List

13342500

New

Load

Edit/Review

Delete

Period to Process

Start

Friday, April 25, 2014

End

Friday, April 25, 2014

Station Setup

Station ID: 13342500

Station Name: Clearwater River at Spalding, Idaho

File Name: 13342500

Model

Model Form: $Y=B0+B1X1+B2X2$

Explanatory Variables

	X1	X2	na
SCB	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SAC	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
DD 0	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
DD 0	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Coefficients and Statistics

B0: -2.431

B1: 0.0557

B2: 0

BCF: 1.04

Import SAID Data

Acoustic Data Descriptors (DDs)

Cell	Value
Cell1	38
Cell2	39
Cell3	40
Cell4	41
Cell5	42
Cell6	0
Cell7	0
Cell8	0
Cell9	0
Cell10	0

Site Parameters

Slant Distance (m)

Cell	Value
Cell1	1.379
Cell2	1.931
Cell3	2.482
Cell4	3.034
Cell5	3.586
Cell6	0
Cell7	0
Cell8	0
Cell9	0
Cell10	0

Temperature

DD#: 49

degrees C

Response Variable Transformation

Log10

none

Accept

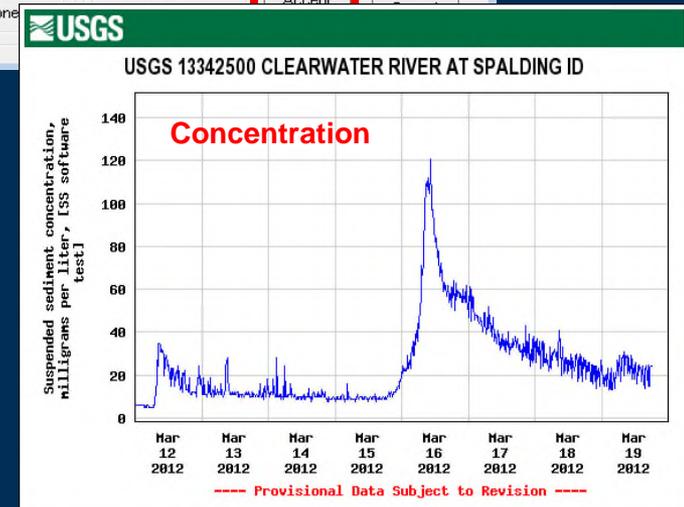
```
idws..tion_1917d81b976a99d7_675f65ed2490beaf - Python NWISpython.py
WARNING TO USERS OF THIS SYSTEM

This computer system, including all related equipment, networks, and network
devices (including Internet access), is provided by the Department of the
Interior (DOI) in accordance with the agency policy for official use and
limited personal use.

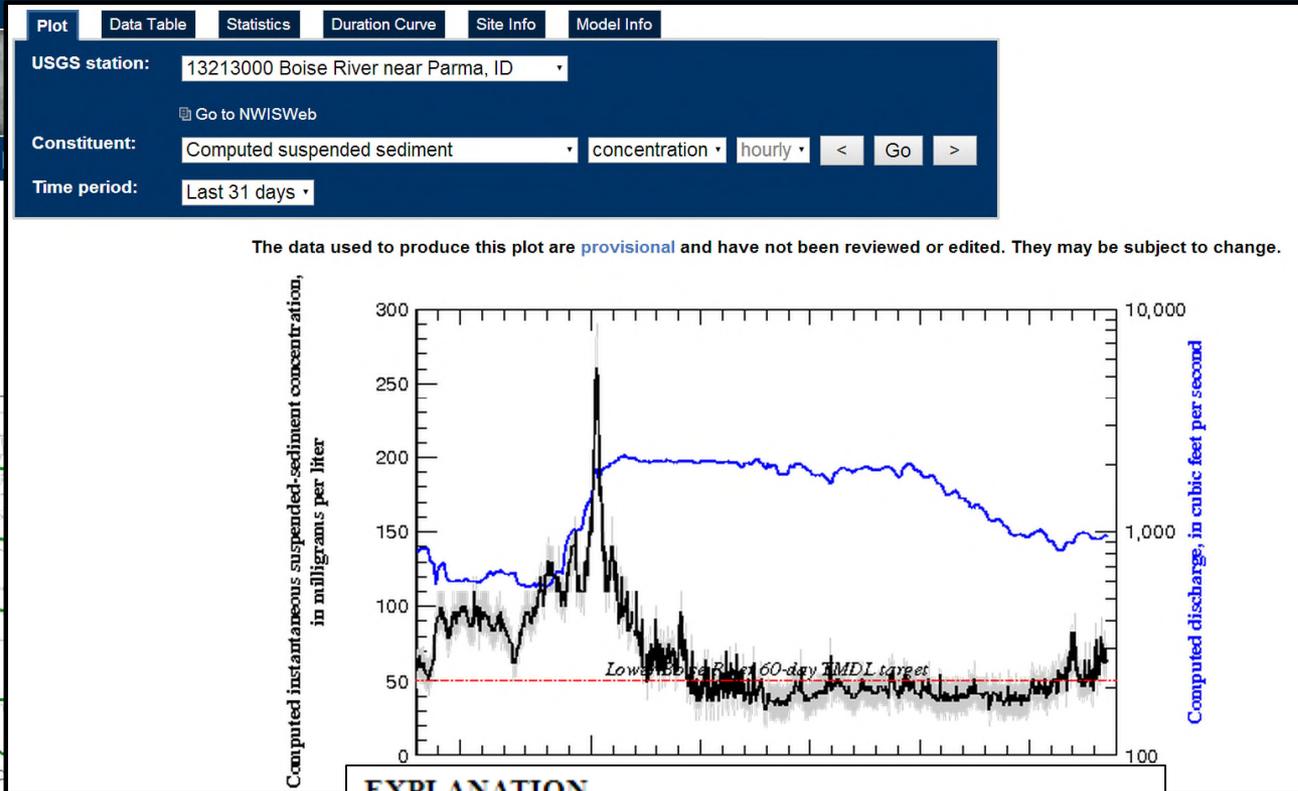
All agency computer systems may be monitored for all lawful purposes,
including but not limited to, ensuring that use is authorized, for management
of the system, to facilitate protection against unauthorized access, and to
verify security procedures, survivability and operational security. Any
information on this computer system may be examined, recorded, copied and
used for authorized purposes at any time. All information, including personal
information, placed or sent over this system may be monitored, and users of
this system are reminded that such monitoring does occur. Therefore, there
should be no expectation of privacy with respect to use of this system.

By logging into this agency computer system, you acknowledge and consent to
the monitoring of this system. Evidence of your use, authorized or
unauthorized, collected during monitoring may be used for civil, criminal,
administrative, or other adverse action. Unauthorized or illegal use may
subject you to prosecution.

sun2didbse% sending files....
```



NRTWQ: <http://nrtwq.cr.usgs.gov/nrtwq/>



EXPLANATION

- Discharge
- Measured or computed water-quality constituent
- 90-percent prediction interval for computed value
- Value obtained from discrete sampling and analysis
- Load calculated using laboratory analysis and discharge
- ⋯ Water-quality criteria

QUALITY

water, water treatment, regular
these measurements can be us

Will Either Show:

ona, California, Colorado
ns and loads for sediment,
and all historical hourly in-s

s of streamflow, water temper
obtained from the USGS Na



US Geological Survey



- State has water-quality time-series and surrogate
- ▼ Continuous Water-Quality Gage
- ▼ Discontinued Continuous Water-Quality Gage



Sediment Acoustics

Sediment Acoustics Menu

Sediment Acoustics Home

Continuous Time-Series Methods

Discrete Measurement Methods

Documents and References

Training

Mailing Lists and Forums

Demonstration Sites

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mswood@usgs.gov