

ODM Tools Python: Open Source Software for Managing Hydrologic and Water Quality Time Series Data

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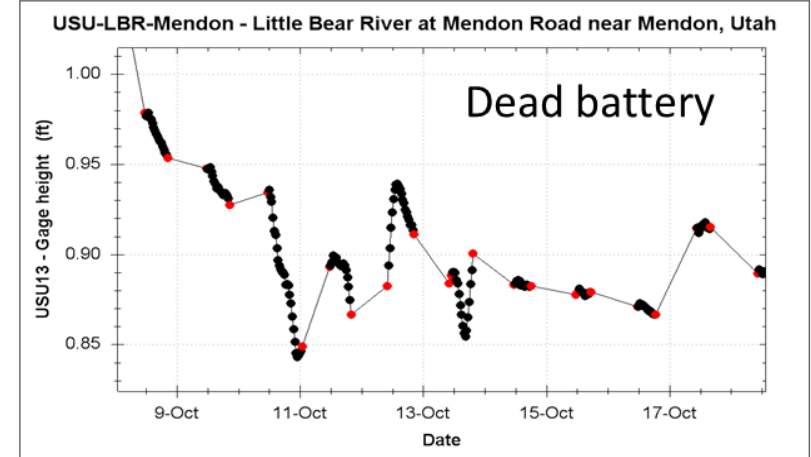
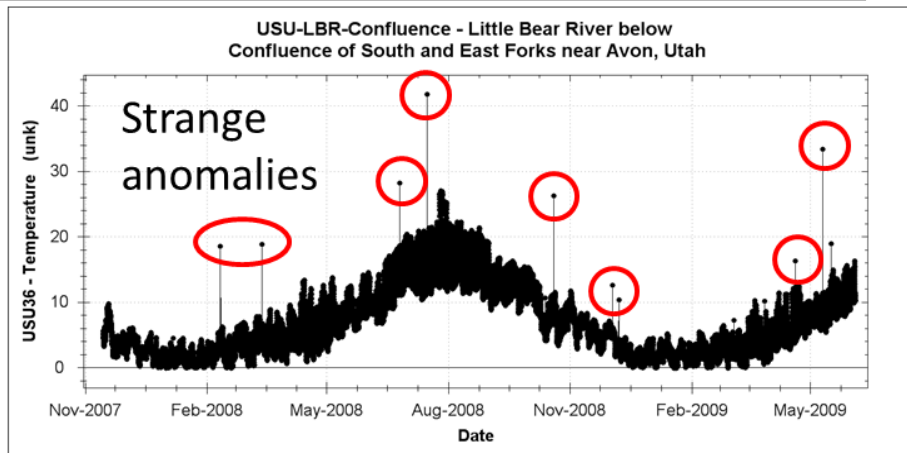
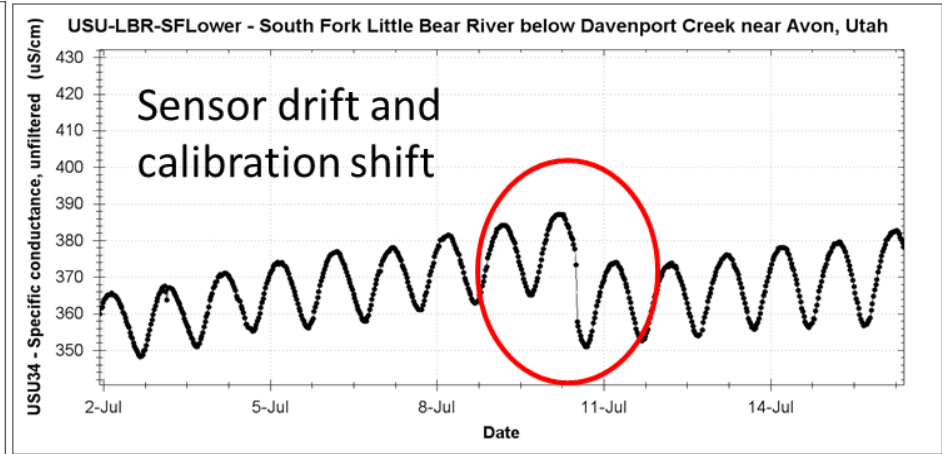
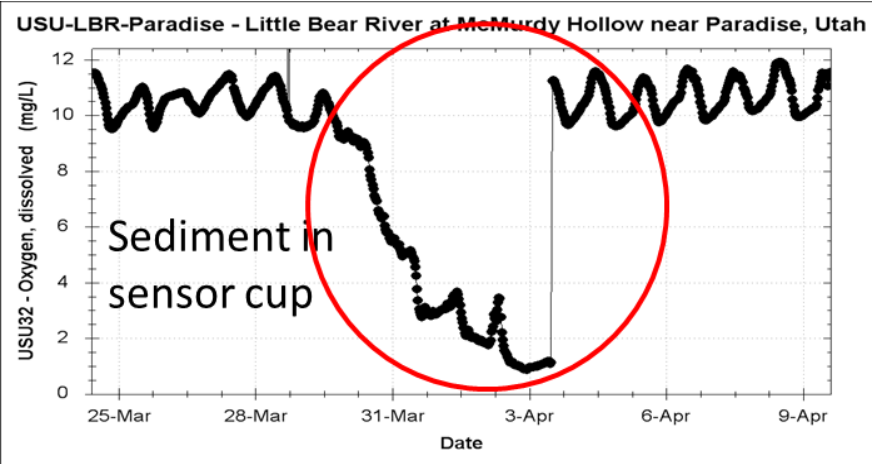
Amber Spackman-Jones



Motivation

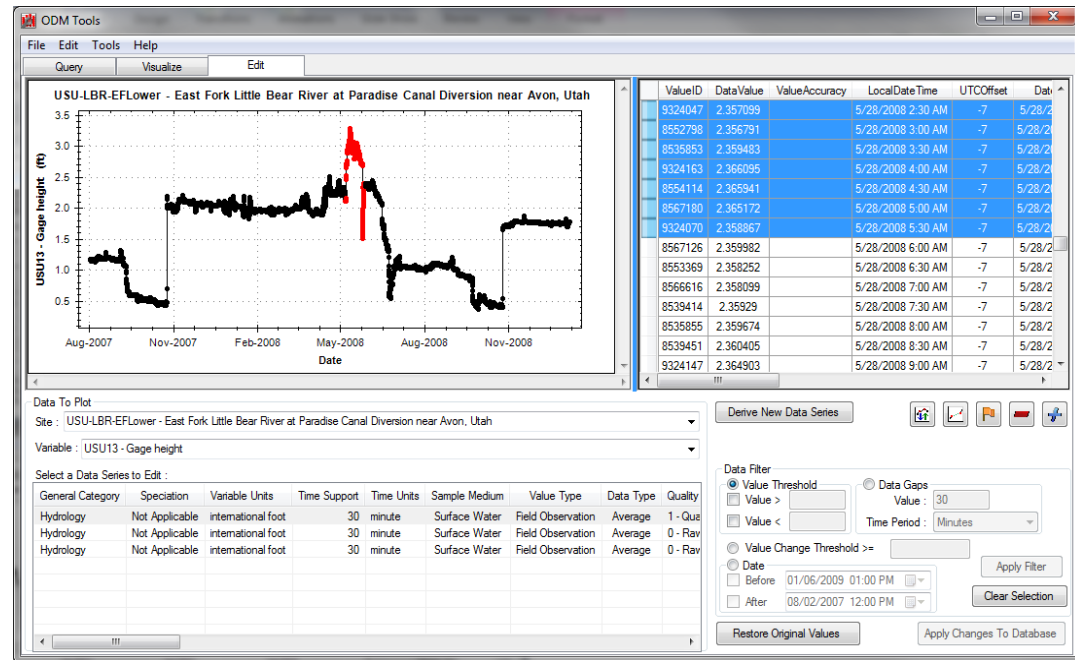


Motivation

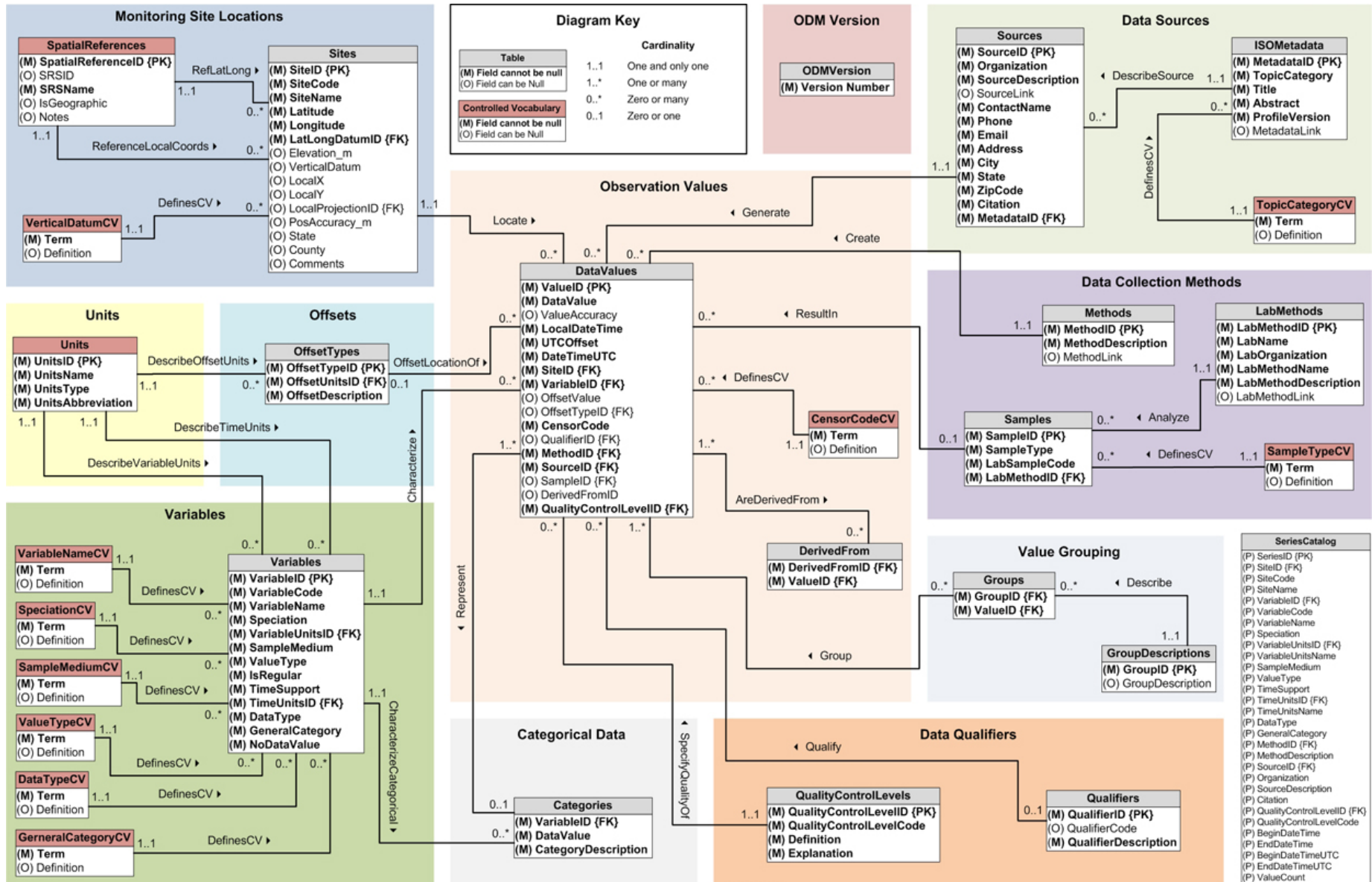


Some History

- ODM Tools originally developed as part of the CUAHSI Hydrologic Information System
- Developed in Microsoft Visual Studio .Net
- Limited to Windows Machines
- Only worked with Microsoft SQL Server databases
- Provided editing tools, but did not preserve the history of edits



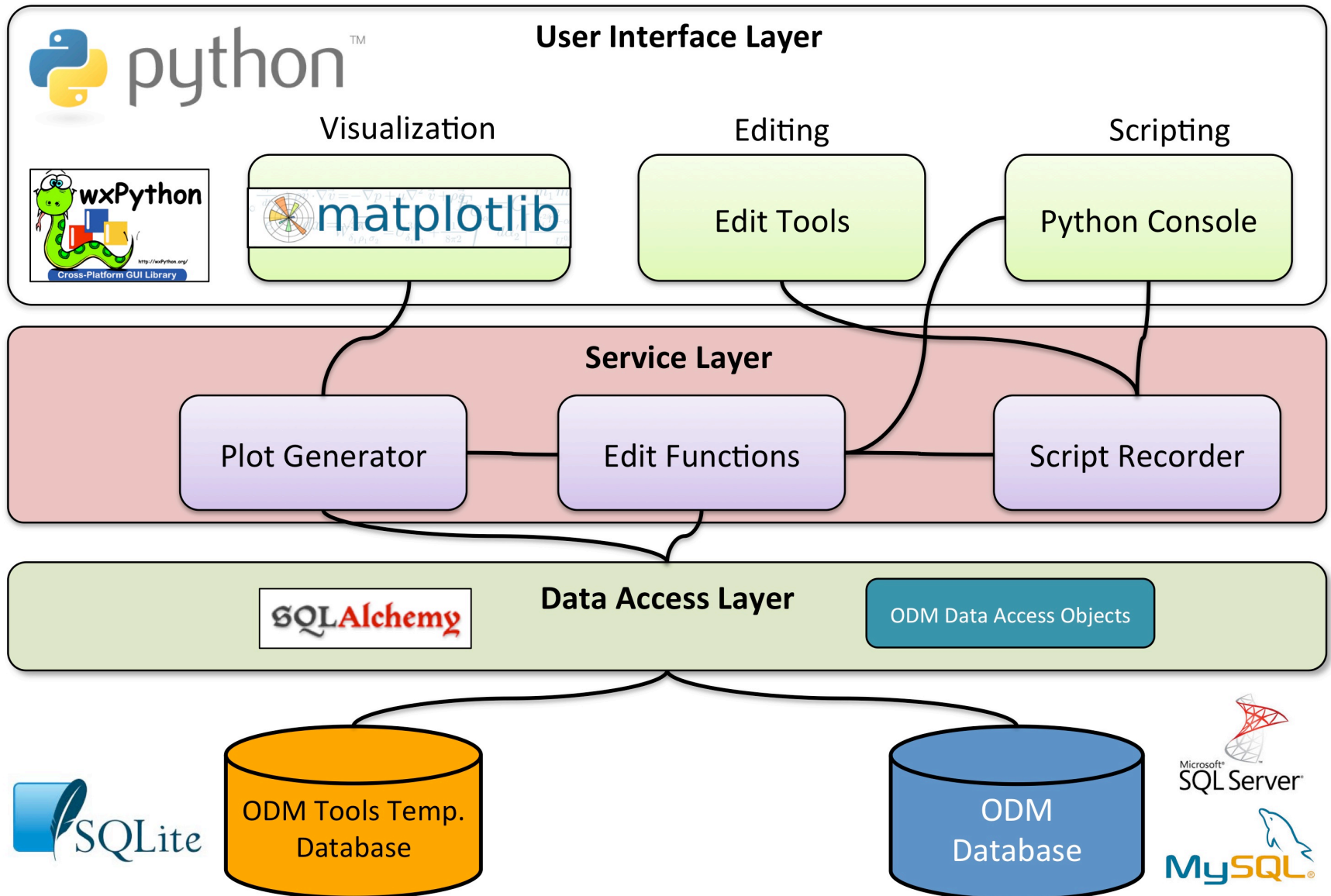
Observations Data Model



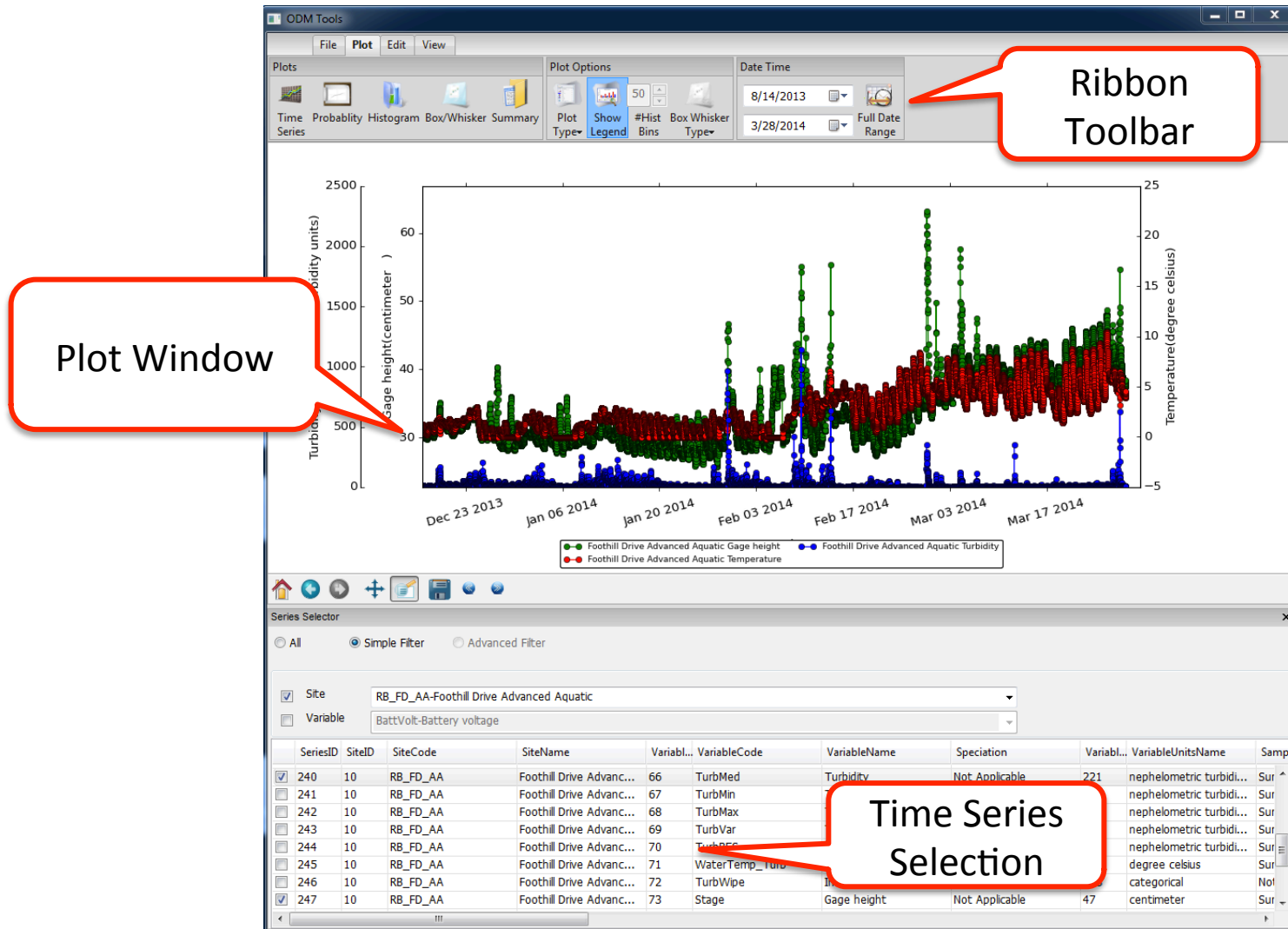
ODM Tools Python: Design Goals

- Multi-platform support (Windows, Linux, Mac)
- Multi-database support (Microsoft SQL Server and MySQL)
- Implement a scripting interface to save the provenance of data edits in QC process
- Modernize the Graphical User Interface (GUI)

Architecture



Graphical User Interface



Dockable Windows

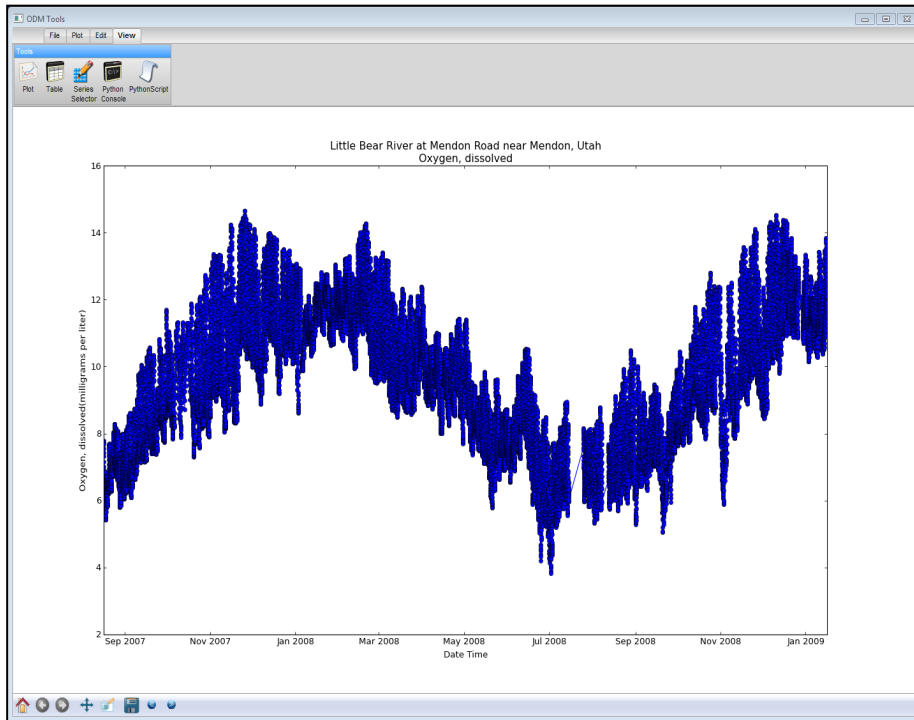


Table View

ValueID	DataValue	Val...	LocalDateTime	UT...	DateTimeUTC	Sit...	Va...	Of...	O
8607706	4.00045970149		2008-07-02 07:30:00	-7.0	2008-07-02 14:30:00	1	32		
8615287	4.25681459701		2008-07-01 07:30:00	-7.0	2008-07-01 14:30:00	1	32		
8616334	4.23571177612		2008-07-02 05:30:00	-7.0	2008-07-02 12:30:00	1	32		
8619129	4.33288192537		2008-07-02 01:30:00	-7.0	2008-07-02 08:30:00	1	32		
8619782	4.4006091194		2008-07-02 03:00:00	-7.0	2008-07-02 10:00:00	1	32		
8619818	4.4100449403		2008-07-01 05:00:00	-7.0	2008-07-01 12:00:00	1	32		
8620012	4.36762985075		2008-07-02 03:30:00	-7.0	2008-07-02 10:30:00	1	32		
8620220	3.83081343284		2008-07-02 08:00:00	-7.0	2008-07-02 15:00:00	1	32		
8622377	3.89308523881		2008-07-02 06:30:00	-7.0	2008-07-02 13:30:00	1	32		
8622441	4.49635820896		2008-07-01 04:30:00	-7.0	2008-07-01 11:30:00	1	32		
8625349	4.58550746269		2008-07-02 00:30:00	-7.0	2008-07-02 07:30:00	1	32		
8625395	4.59515373134		2008-07-02 00:00:00	-7.0	2008-07-02 07:00:00	1	32		
8625705	4.2038311791		2008-06-25 06:30:00	-7.0	2008-06-25 13:30:00	1	32		
8626475	4.62864941791		2008-07-03 04:30:00	-7.0	2008-07-03 11:30:00	1	32		
8627214	4.66996268657		2008-07-03 04:00:00	-7.0	2008-07-03 11:00:00	1	32		
8627341	4.66188076119		2008-07-03 02:00:00	-7.0	2008-07-03 09:00:00	1	32		
8628198	4.28373167164		2008-07-01 05:30:00	-7.0	2008-07-01 12:30:00	1	32		
8630093	4.78889435821		2008-07-02 10:00:00	-7.0	2008-07-02 17:00:00	1	32		
8630222	4.37667031343		2008-07-02 04:30:00	-7.0	2008-07-02 11:30:00	1	32		
8634141	4.93983449254		2008-06-30 07:30:00	-7.0	2008-06-30 14:30:00	1	32		
8634276	4.48706534328		2008-06-25 05:00:00	-7.0	2008-06-25 12:00:00	1	32		

Series Selector

☒ All ☐ Simple Filter ☐ Advanced Filter

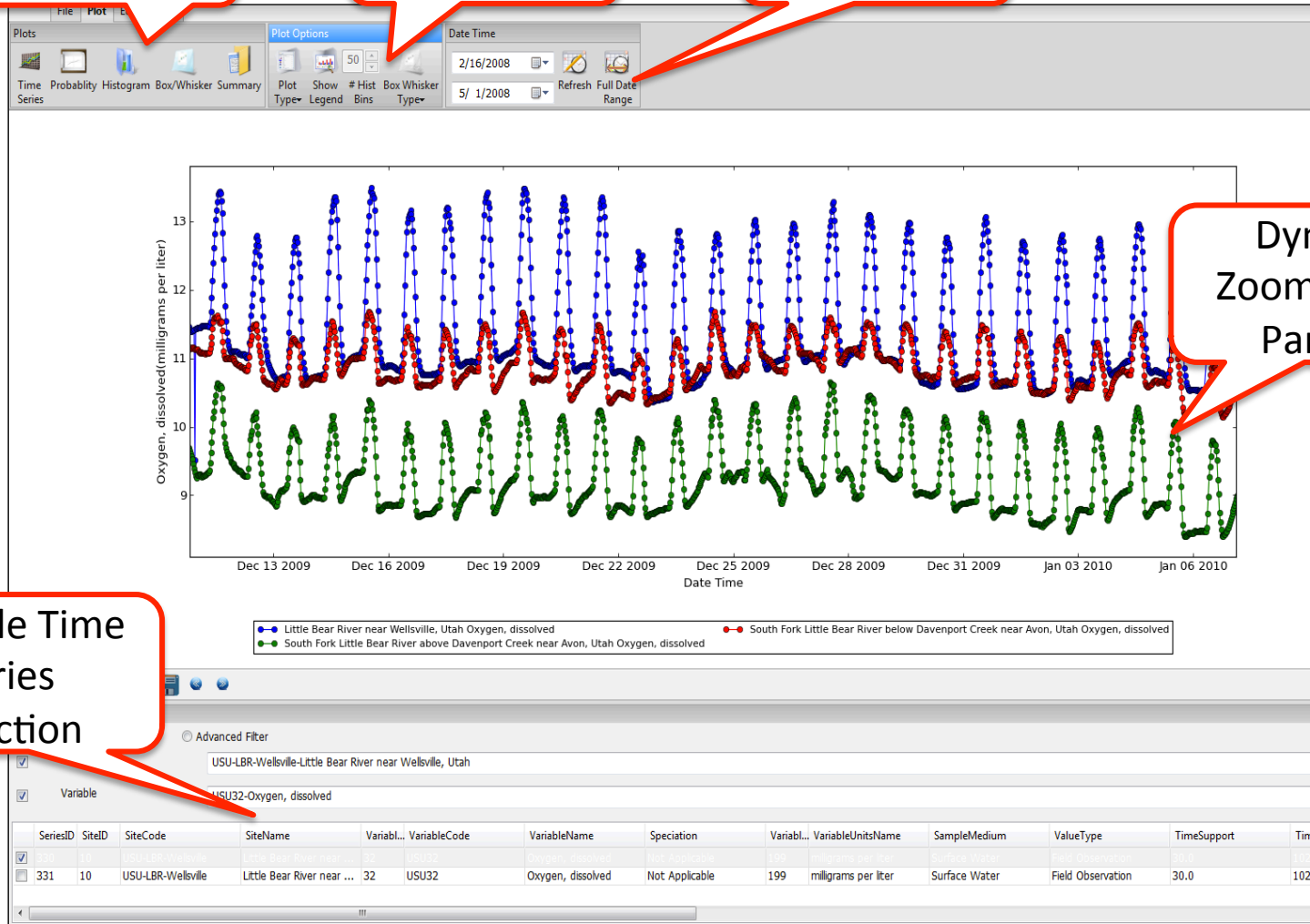
	SeriesID	SiteID	SiteCode	SiteName	Variabl...	VariableCode	VariableName	Speciation	Varia
☐	12	1	USU-LBR-Mendon	Little Bear River at Me...	13	USU13	Gage height	Not Applicable	48
☐	13	1	USU-LBR-Mendon	Little Bear River at Me...	13	USU13	Gage height	Not Applicable	48
☐	14	1	USU-LBR-Mendon	Little Bear River at Me...	13	USU13	Gage height	Not Applicable	48
☒	15	1	USU-LBR-Mendon	Little Bear River at Me...	32	USU32	Oxygen, dissolved	Not Applicable	19
☐	16	1	USU-LBR-Mendon	Little Bear River at Me...	32	USU32	Oxygen, dissolved	Not Applicable	19
☐	17	1	USU-LBR-Mendon	Little Bear River at Me...	33	USU33	Oxygen, dissolved per...	Not Applicable	1
☐	18	1	USU-LBR-Mendon	Little Bear River at Me...	34	USU34	Specific conductance	Not Applicable	19

Data Visualization

Multiple
Plot Types

Plot Display
Options

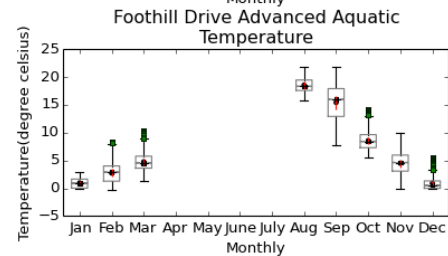
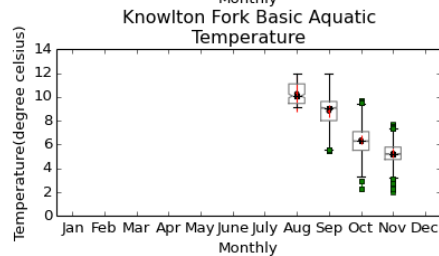
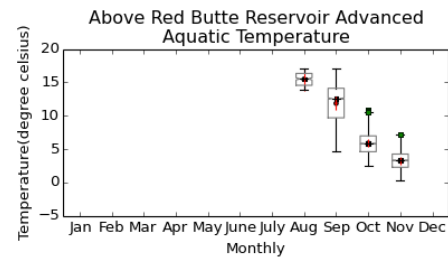
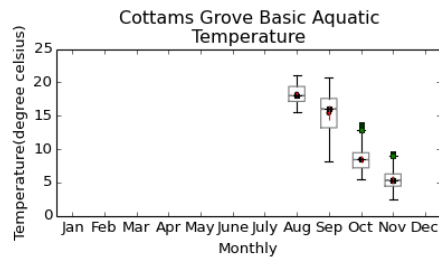
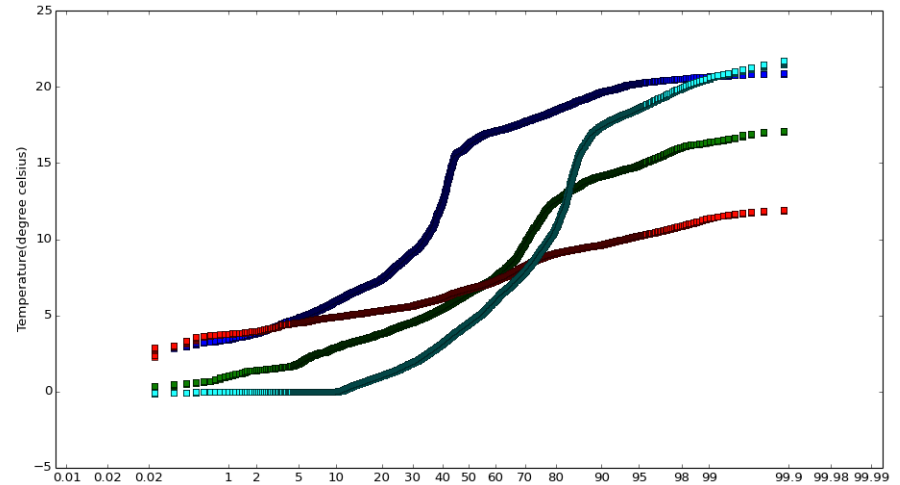
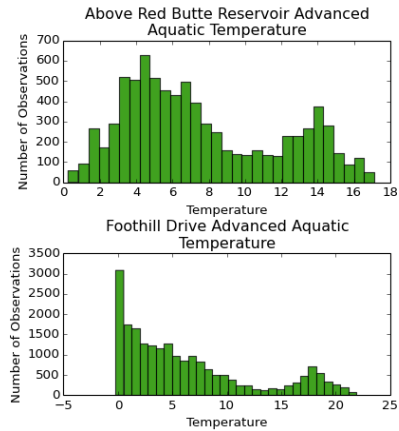
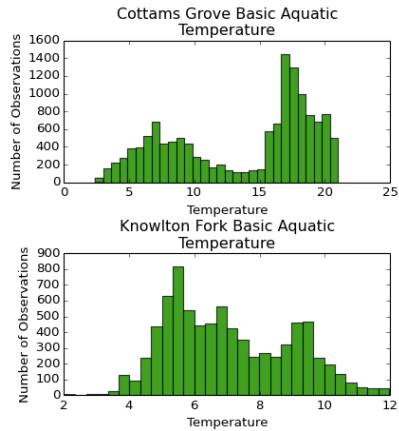
Date Range
Restrictions



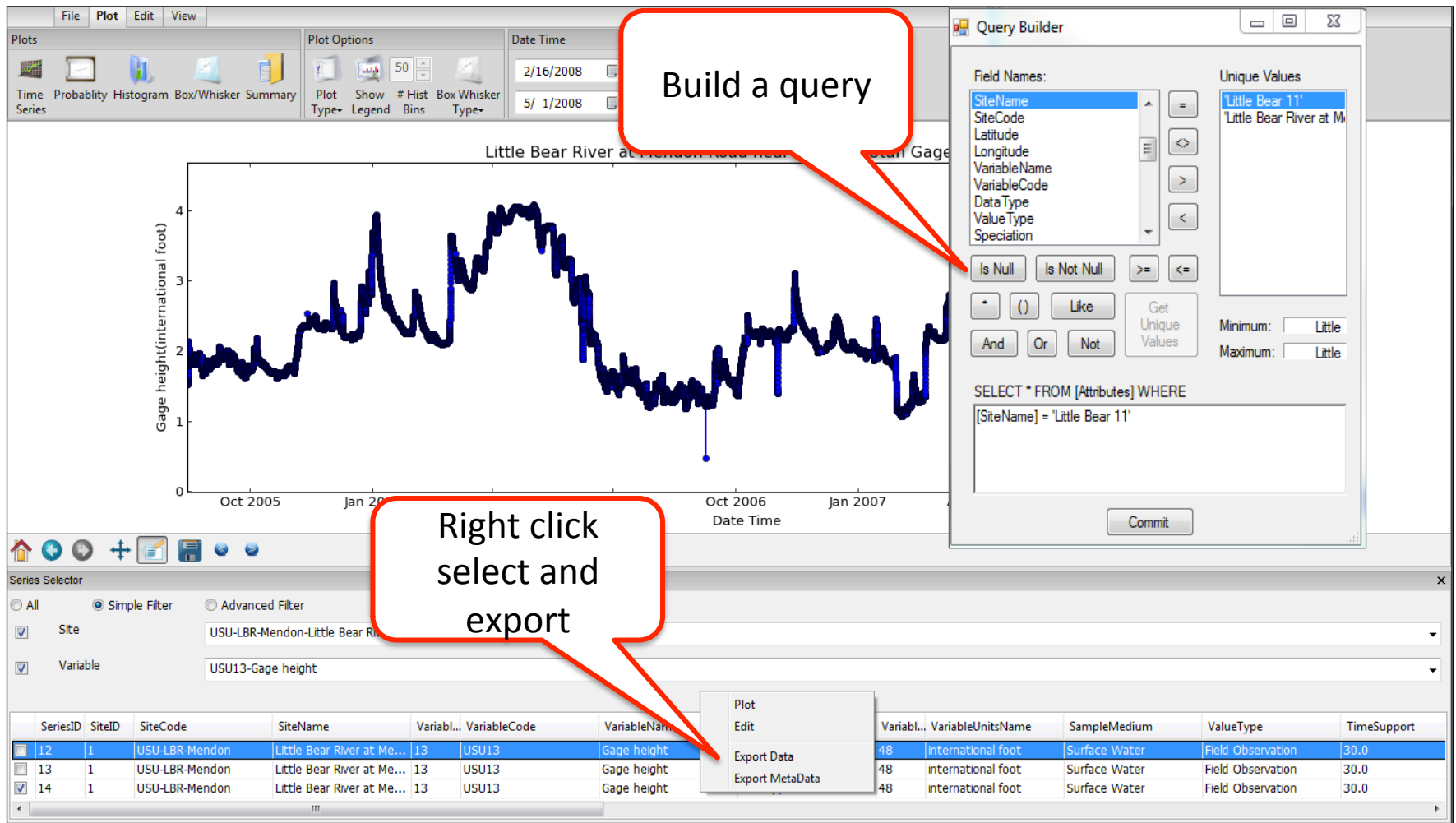
Multiple Time
Series
Selection

Dynamic
Zooming and
Panning

Data Visualization: Plot Types



Query and Export



Data Editing for Quality Control

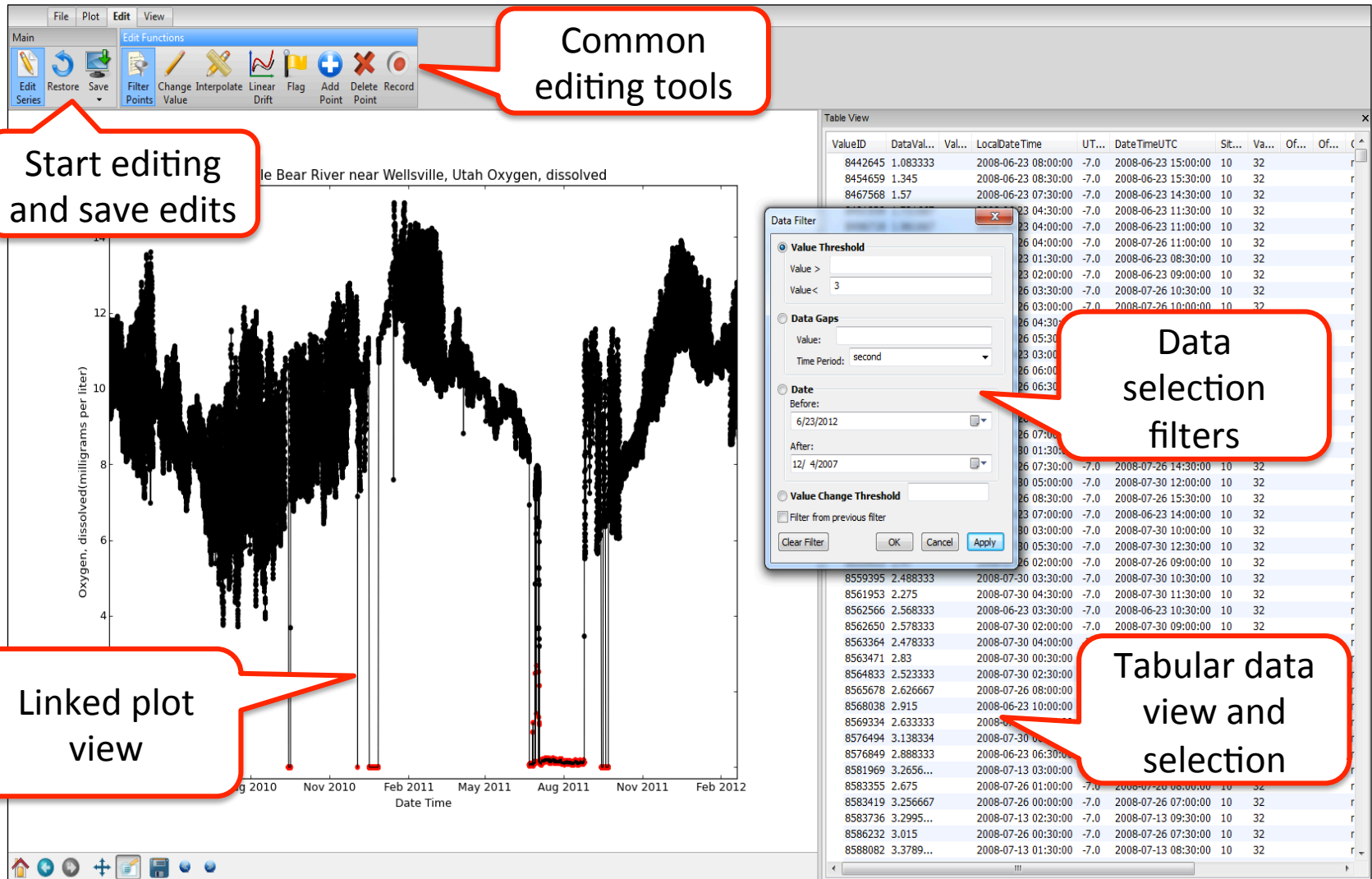
Common editing tools

Start editing and save edits

Linked plot view

Data selection filters

Tabular data view and selection



Data Editing for Quality Control

The screenshot displays the ODM Tools application interface. The main window shows a plot titled "Little Bear River at Paradise, Utah Gage height" with the y-axis labeled "Gage height(international foot)" ranging from 4 to 10 and the x-axis labeled "Date Time" from Dec 22 2007 to Apr 12 2008. The plot shows a baseline of gage height around 5 feet, a sharp rise to approximately 9 feet in early March 2008, and a subsequent drop and fluctuation. A red line highlights the peak of the rise. Below the plot is a "Series Selector" table.

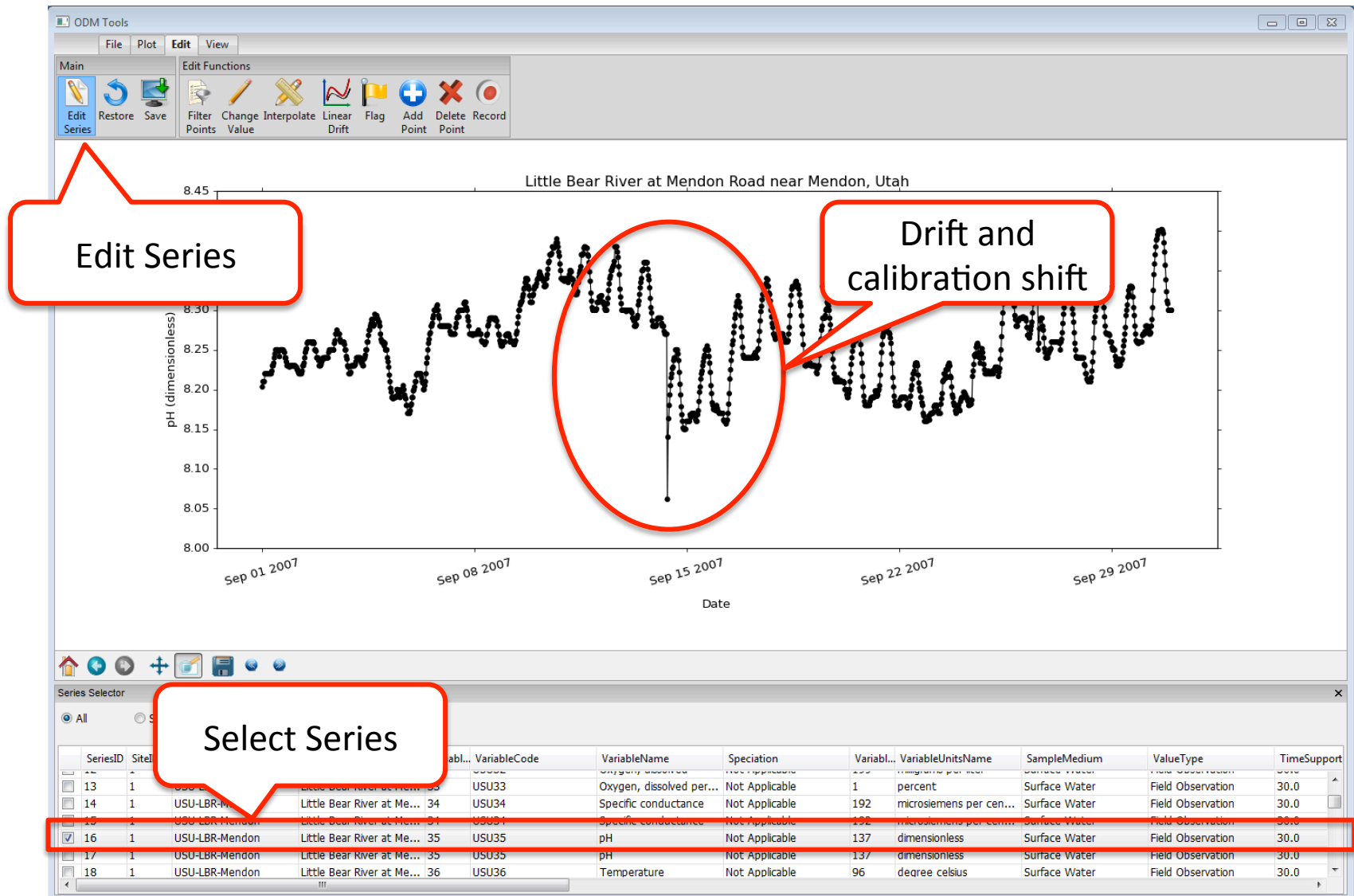
SeriesID	SiteID	SiteCode	SiteName	VariableCode	VariableName	Speciation	VariableUnitsName	SampleM
165	11	USU-LBR-Confluence	Little Bear River below...	USU36	Temperature	Not Applicable	96 degree celsius	Surfa
166	11	USU-LBR-Confluence	Little Bear River below...	USU39	Phosphorus, total as P	P	199 milligrams per liter	Surfa
167	11	USU-LBR-Confluence	Little Bear River below...	USU40	Phosphorus, total as ...	P	199 milligrams per liter	Surfa
168	11	USU-LBR-Confluence	Little Bear River below...	USU41	Solids, total Suspended	Not Applicable	199 milligrams per liter	Surfa
169	12	10105900	Little Bear River at Pa...	USU42	Gage height	Not Applicable	48 international foot	Surfa
170	12	10105900	Little Bear River at Pa...	USU43	Discharge	Not Applicable	35 cubic feet per second	Surfa
171	12	10105900	Little Bear River at Pa...	USU42	Gage height	Not Applicable	48 international foot	Surfa

Two callout boxes highlight specific features:

- Python Code Console:** A window showing a Python script that imports `EditService` from `odmservices.edit_service`, creates an `EditService` object for series ID 171, sets a connection string, filters values greater than 8, and retrieves active points.
- Python Script Editor:** A window showing the same Python script as the console, with buttons for "Execute", "Execute Selection", and "Execute Line".

How does it work?

Step 1: Select a Time Series for Editing



Step 2: Select Data to Edit

The screenshot displays the ODM Tools application interface. The main window shows a plot titled "Little Bear River at Mendon Road near Mendon, Utah" with pH (dimensionless) on the y-axis (ranging from 8.00 to 8.45) and time on the x-axis (from Sep 01 2007 to Sep 22 2007). The plot shows two data series: a red line with dots representing pH data from Sep 01 to Sep 15, and a black line with dots representing pH data from Sep 15 to Sep 22. A red circle highlights the "Filter" button in the "Edit Functions" toolbar. A red arrow points from this circle to the "Data Filter" dialog box, which is open on the right side of the screen.

The "Data Filter" dialog box has the following options:

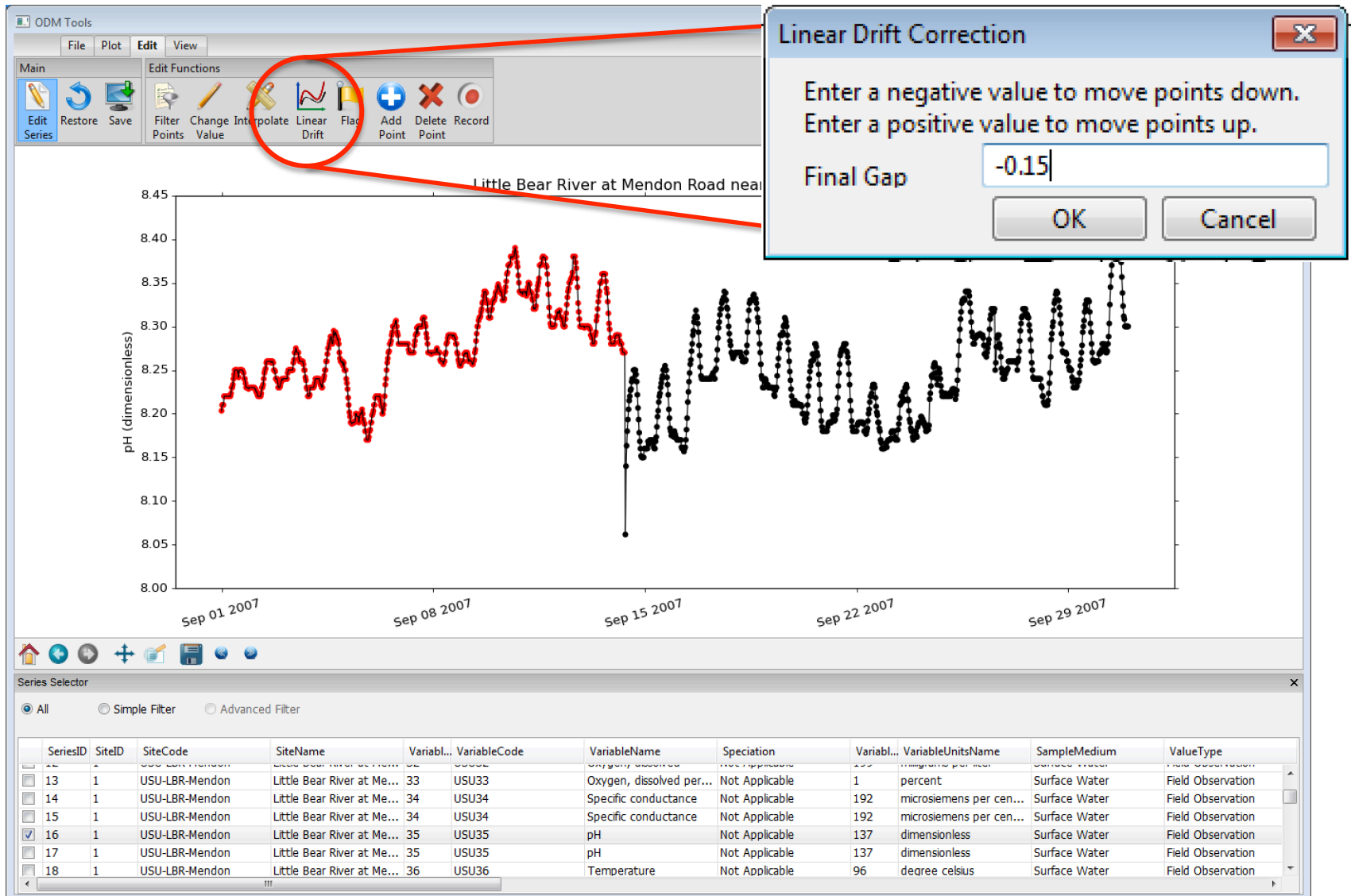
- ☒ **Value Threshold**
 - Value >
 - Value <
- ☐ **Data Gaps**
 - Value:
 - Time Period:
- ☐ **Date**
 - Before:
 - After:
- ☐ **Value Change Threshold**
- ☐ Filter from previous filter

Buttons at the bottom: Clear Filter, OK, Cancel, Apply.

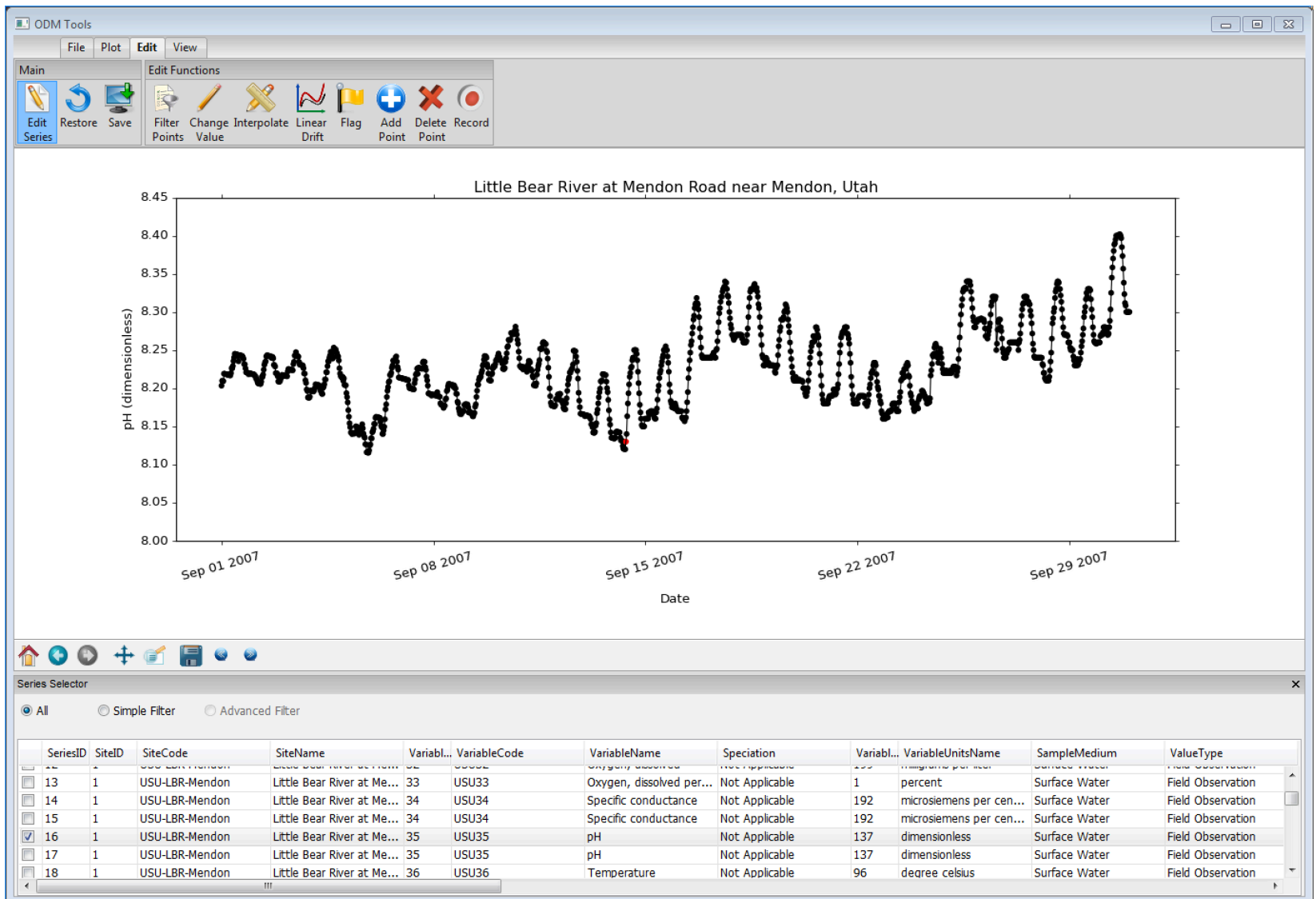
At the bottom of the ODM Tools window is a "Series Selector" table with the following data:

SeriesID	SiteID	SiteCode	SiteName	VariableCode	VariableName	Speciation	VariableCode	VariableName	Speciation	VariableCode	VariableName	Speciation
13	1	USU-LBR-Mendon	Little Bear River at Me...	33	USU33	Oxygen, dissolved per...	Not Applicable	1	percent	Surface Water	Field Observation	
14	1	USU-LBR-Mendon	Little Bear River at Me...	34	USU34	Specific conductance	Not Applicable	192	microsiemens per cen...	Surface Water	Field Observation	
15	1	USU-LBR-Mendon	Little Bear River at Me...	34	USU34	Specific conductance	Not Applicable	192	microsiemens per cen...	Surface Water	Field Observation	
16	1	USU-LBR-Mendon	Little Bear River at Me...	35	USU35	pH	Not Applicable	137	dimensionless	Surface Water	Field Observation	
17	1	USU-LBR-Mendon	Little Bear River at Me...	35	USU35	pH	Not Applicable	137	dimensionless	Surface Water	Field Observation	
18	1	USU-LBR-Mendon	Little Bear River at Me...	36	USU36	Temperature	Not Applicable	96	degree celsius	Surface Water	Field Observation	

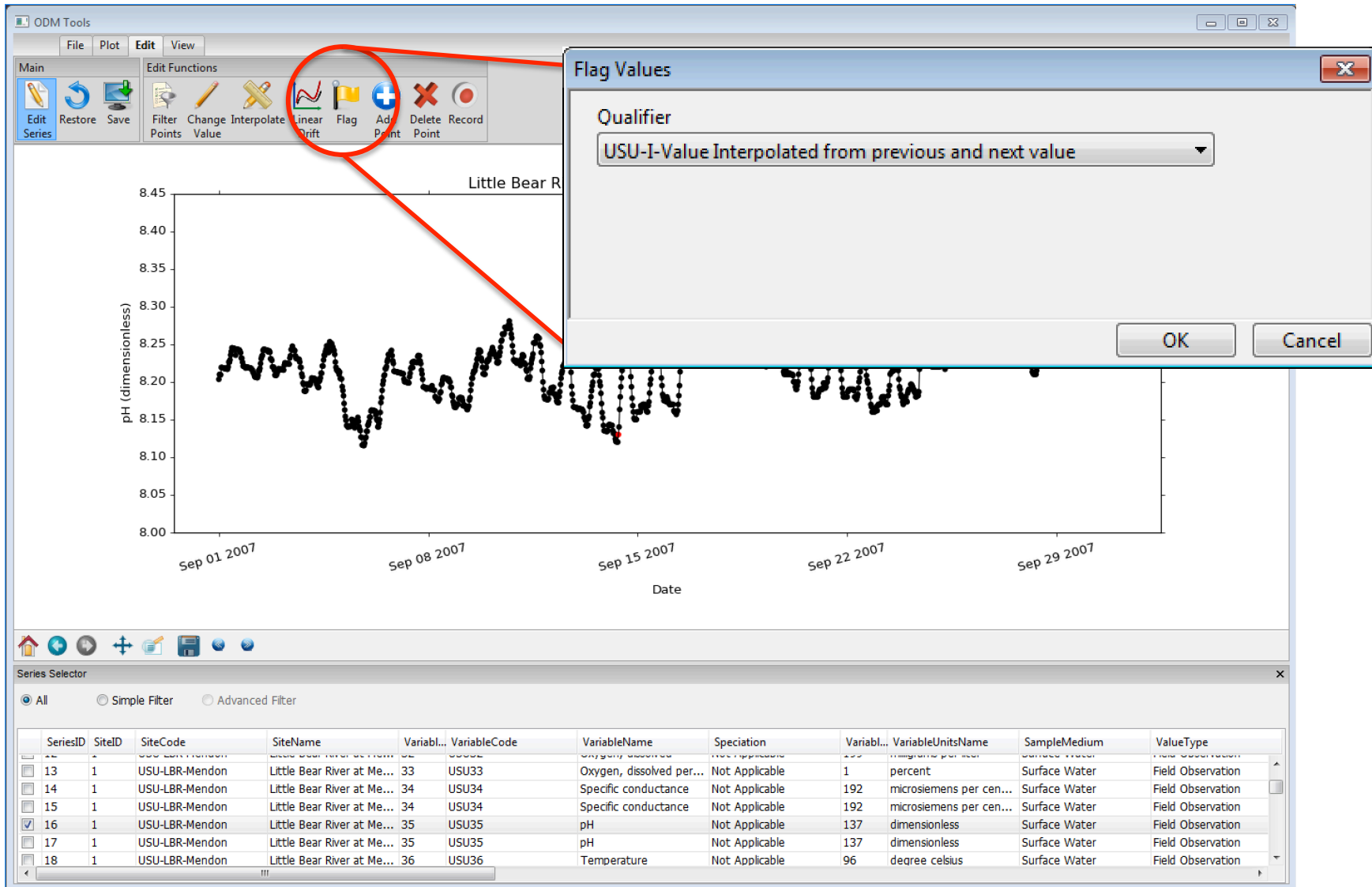
Step 3: Linear Drift Correction



Step 4: Interpolate



Step 5: Flag



Step 6: Save Modified Data Series

Save...

How would you like to save this data series?

☐ Save as new data series

☒ Save as modified data series

Save...

☒ Automatically generate a new method

☐ Select an existing Method

Description

Water temperature measured in the river

Turbidity measured in the river

Water level measured in the river

Battery voltage measured in the river

Air temperature measured in the river

Relative humidity measured in the river

Precipitation measured in the river

☐ Create a new Method

Method Description

Save...

☒ Select an existing Method

Code	Definition
-9999	Unknown
0	Raw data
1	Quality control
2	Derived data
3	Intermediate data
4	Known data

☐ Create Quality Control Method

Code:

Definition:

Explanation:

Save...

☒ Use Current Variable

☐ Select an existing Variable

Code	Name
USU3	Battery voltage
USU4	Turbidity
USU5	Turbidity
USU6	Turbidity
USU7	Turbidity
USU8	Turbidity

☐ Create New Variable

Save...

Summary

Site

Code: USU-LBR-Mendon

Name: Little Bear River at Mendon Road near Mendon, Utah

Variable

Code: USU35

Name: pH

Units: dimensionless

Sample Medium: Surface Water

Value Type: Field Observation

Time Support: 30.0

Time Units: minute

Data Type: Average

General Category: Water Quality

Method

Description: Values derived from ODM Tools Python

Source

Organization: Utah State University Utah Water Research Laboratory

Description: Continuous water quality monitoring by Utah State University

Citation: Continuous water quality monitoring by Jeff Horsburgh, David Ste...

< Back

Finish

Cancel

Recording Edits

The screenshot displays the ODM Tools interface. The main window shows a plot titled "Little Bear River at Mendon Road near Mendon, Utah" with pH (dimensionless) on the y-axis (ranging from 8.00 to 8.45) and Date on the x-axis (ranging from Aug 30 2007 to Sep 27 2007). The plot shows a fluctuating line with data points. A red circle highlights the "Record" button in the "Edit Functions" toolbar.

Below the plot is the "Series Selector" window, which lists various data series. The series "USU-LBR-Mendon" is selected, and the variable "pH" is highlighted in the "VariableCode" column.

On the right side, a window titled "Editing a new file" shows a Python code editor with the following code:

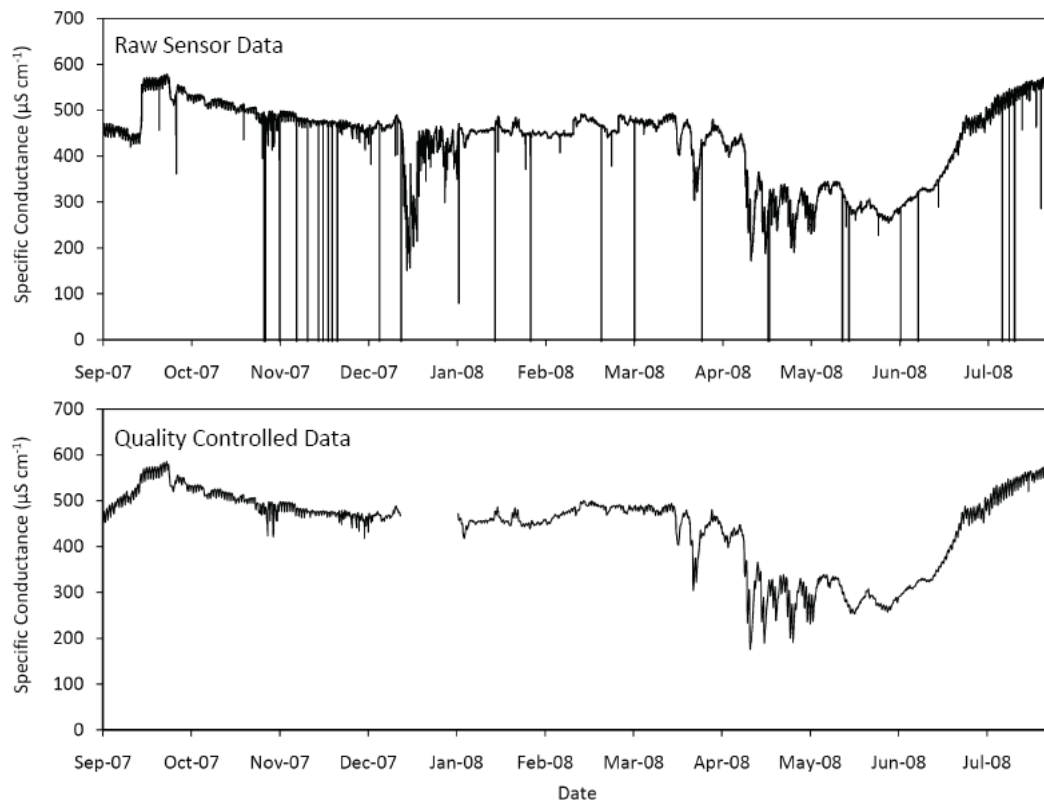
```
1 from odmservices import EditService
2 from odmservices import SeriesService
3 edit_service = EditService(series_id=16, connection_string='mssql+pyodbc://sa:nlcd34GI:
4 series_service = SeriesService(connection_string='mssql+pyodbc://sa:nlcd34GI:
5 ## To run commands from the python console uncomment and run the following c
6 #edit_service = Tools
7 edit_service.select_points([datetime.datetime(2007, 9, 1, 0, 0), datetime.da
8 edit_service.drift_correction(-0.15)
9 edit_service.select_points([datetime.datetime(2007, 9, 14, 8, 30)])
10 edit_service.interpolate()
11
```

A red callout bubble points to the code editor with the text: "Automatically generated Python code with each editing step".

SeriesID	SiteID	SiteCode	SiteName	Variabl...	VariableCode	VariableName	Speciation
14	1	USU-LBR-Mendon	Little Bear River at Me...	34	USU34	Specific conductance	Not Applicable
15	1	USU-LBR-Mendon	Little Bear River at Me...	34	USU34	Specific conductance	Not Applicable
16	1	USU-LBR-Mendon	Little Bear River at Me...	35	USU35	pH	Not Applicable
17	1	USU-LBR-Mendon	Little Bear River at Me...	35	USU35	pH	Not Applicable
18	1	USU-LBR-Mendon	Little Bear River at Me...	36	USU36	Temperature	Not Applicable
19	1	USU-LBR-Mendon	Little Bear River at Me...	36	USU36	Temperature	Not Applicable
20	1	USU-LBR-Mendon	Little Bear River at Me...	37	USU37	Turbidity	Not Applicable
21	1	USU-LBR-Mendon	Little Bear River at Me...	39	USU39	Phosphorus, total	P

Ultimate Objective

- Transform raw sensor data to quality controlled data in a repeatable way



Summary

- ODM Tools Python is a cross platform (Windows, Mac) software for sensor data management
- Visualization capabilities are helpful in screening new data as they arrive
- ODM Tools provides GUI-based and scripting of data quality control edits

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Any opinions, findings, and conclusions or recommendations expressed in this material are those of the
author(s) and do not necessarily reflect the views of the National Science Foundation.



Questions?

OPEN SOURCE CODE REPOSITORY:

ODM Tools Python is available in GitHub

<https://github.com/UCHIC/ODMToolsPython>

