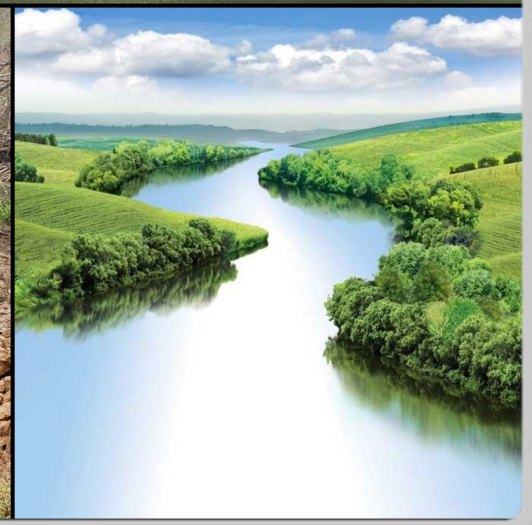
CE-QUAL-W2 MODEL UTILITIES



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CE-QUAL-W2 Workshop

July 18 – 20, 2023

US Army Corps of Engineers

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

Presentation Overview

We will cover the most important utilities included in the CE-QUAL-W2 v45 download:

- Version 4.5
  - Water balance
  - W2tools post-processor
  - Control File Version Converter
  - Excel Macro
- Previous versions
  - W2Control GUI
- Features under development
  - Control file parser
  - Python .xlsm to .csv converter

Water Balance Utility

- **Waterbalance.exe** is one of the most important W2 utilities:
  - Calculates ungauged flows by comparing the stages calculated by W2 at a flow control structure such as a dam or gate, with observed stages from a real-life gage.
    - Closely resembles the ungauged flow utility in HEC-RAS.

- From the Model Utilities user-manual:

  *The Water Balance Utility can be used for lakes and reservoirs in which water surface elevations are a function of inflows and controlled outflows from the system. The utility computes the flows necessary to match observed water surface elevations (typically taken at the dam) and outputs them to the **qwb.opt** file. This file is composed of a Julian date and an inflow (m3 sec-1).*

Water Balance Utility

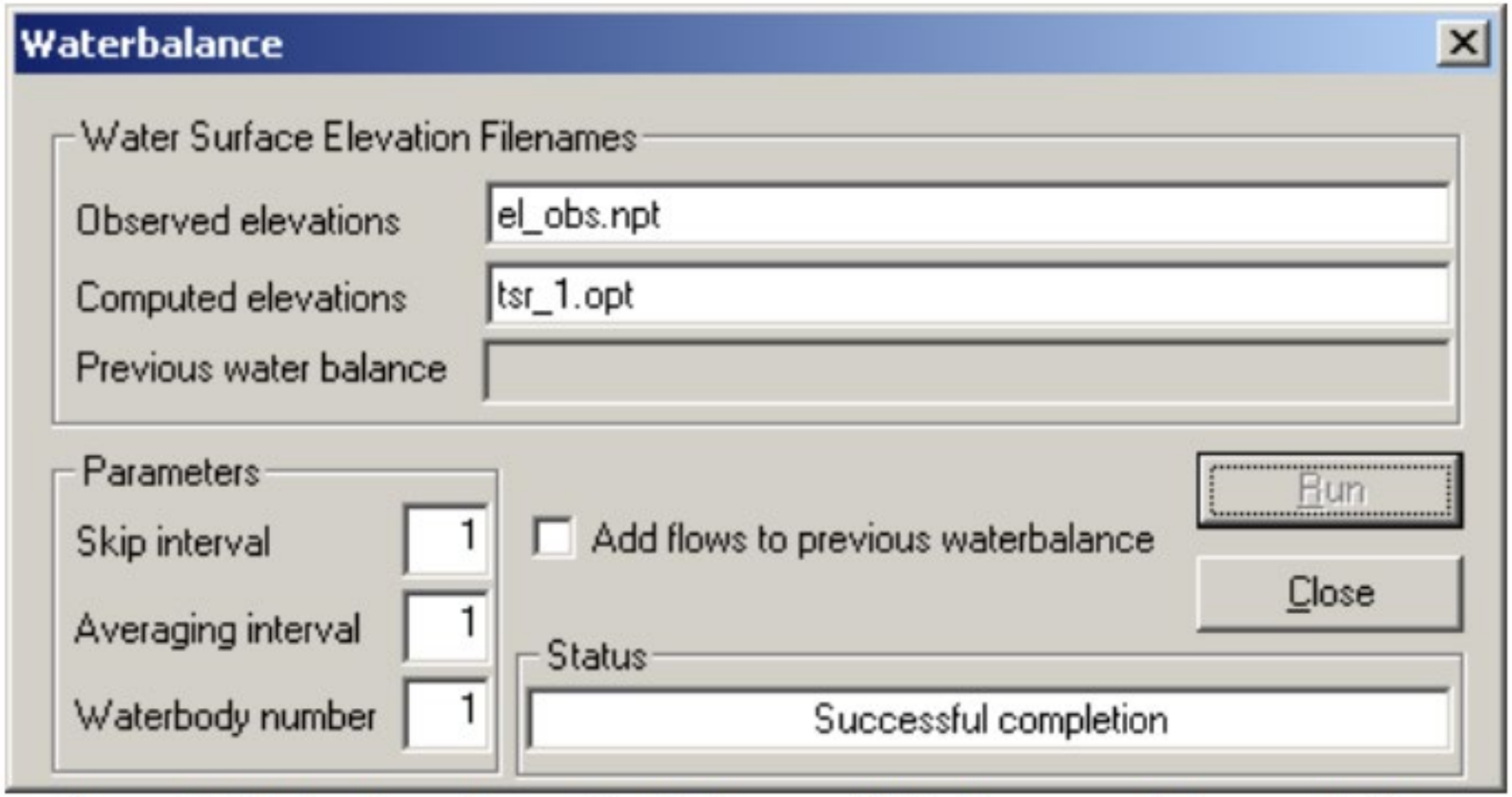


Figure 2. Dialog box for water balance utility if successful completion.

Water Balance Utility – How to adjust the model after running

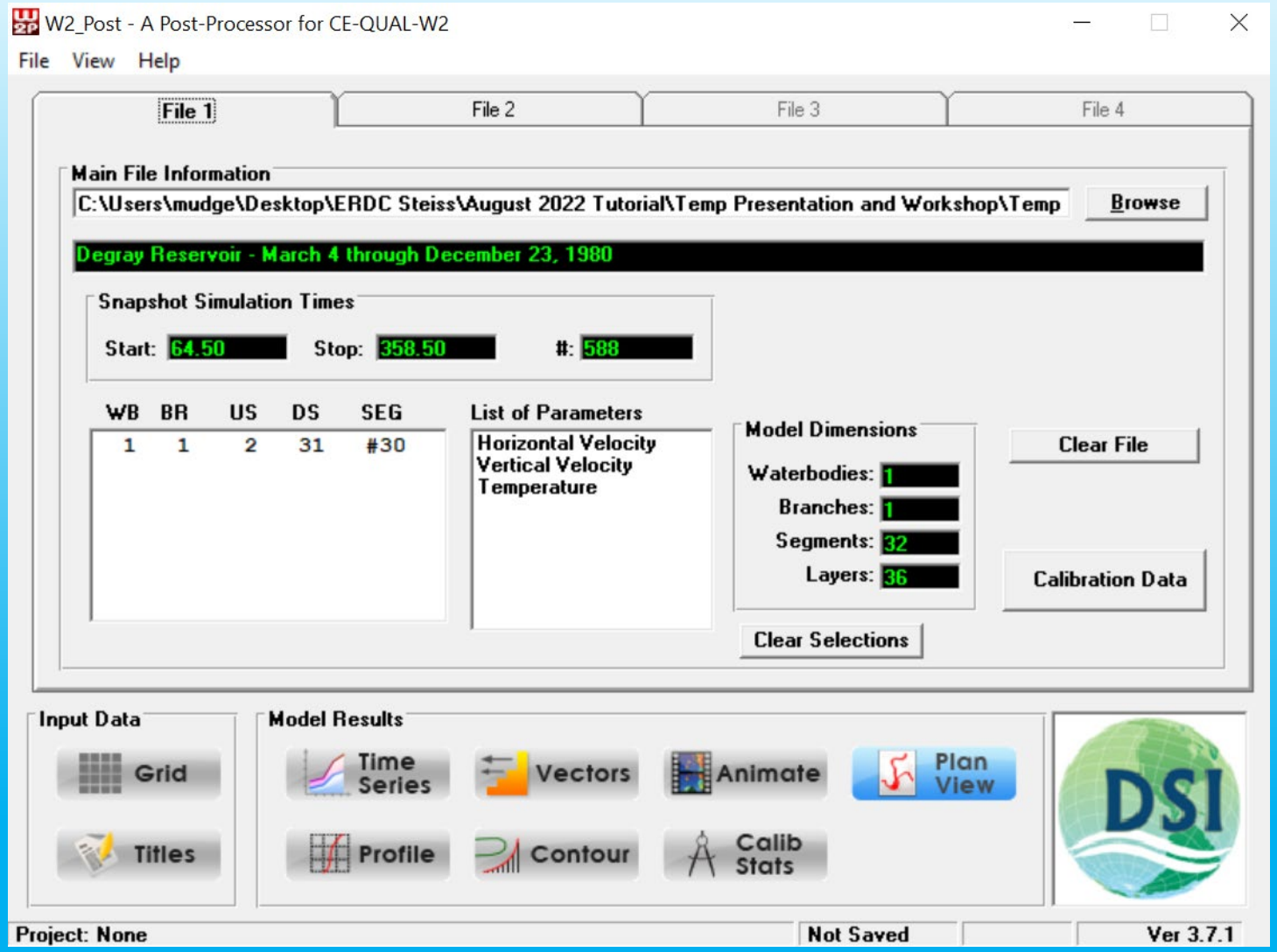
Iterative Process: We re-run the water balance utility with added inflows each time, producing an output file resembling the illustration below:

```
Computed flow to complete water balance
         1         1
      JDAY       QWB
    64.500      0.00
   358.700      0.00
```

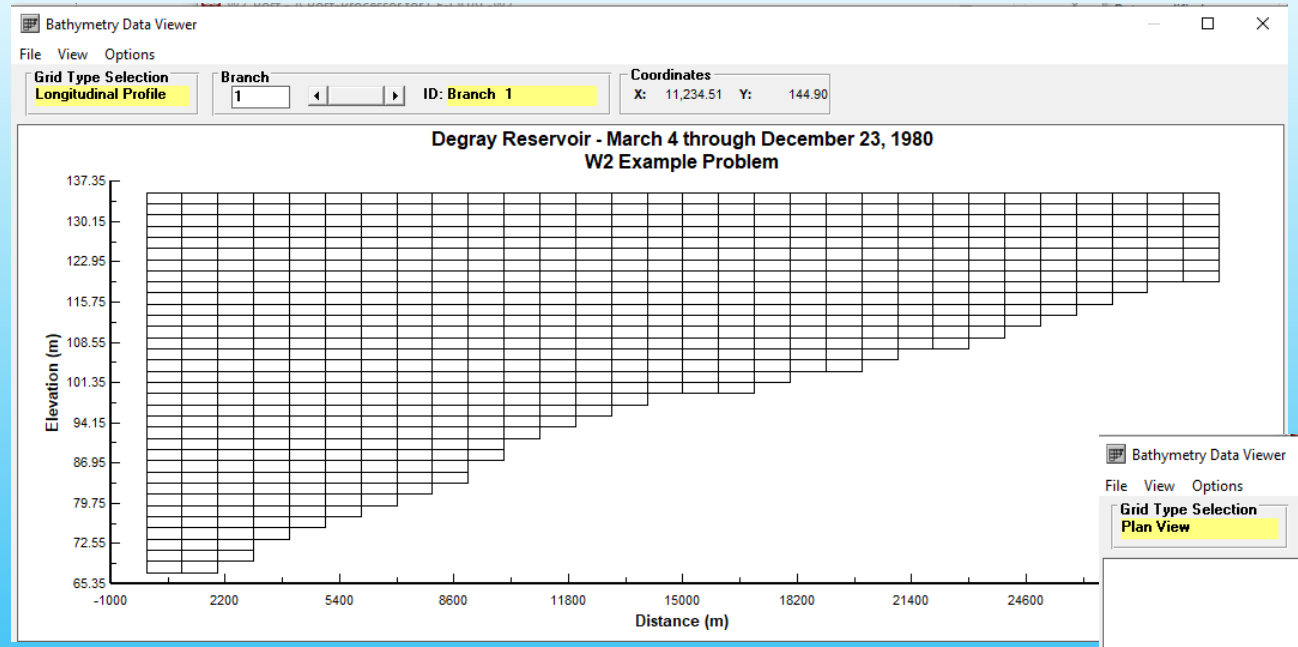
- Computed flows can be negative, indicating underestimated outflow or overestimated inflow.
- Inflows are typically added as distributed inflow, though not always the most accurate.
  - It is good to run sensitivity analysis on different simulations to add/subtract flows.
- Any additional flows need to have associated temperature and WQ concentrations.
- Subtracted flows will have temperature and WQ concentrations equal to cell from which flows are removed.

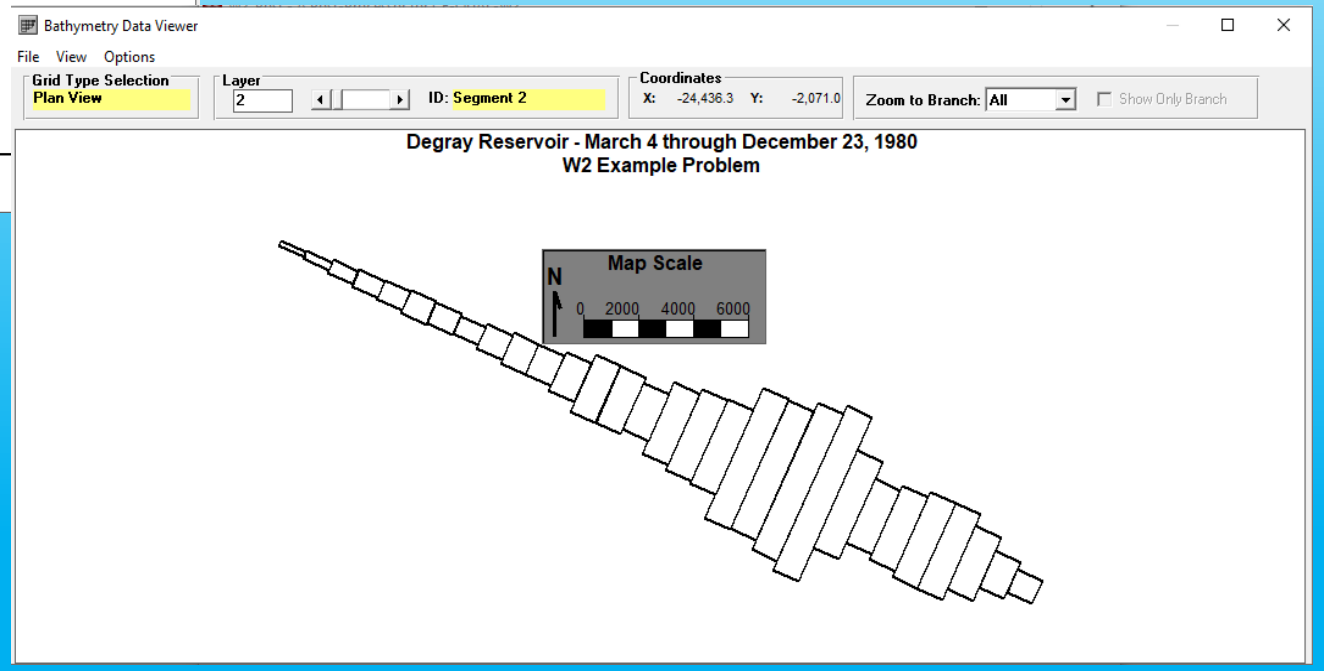
W2tools Post-Processor

- **W2_Post** is a CE-QUAL-W2 post-processing tool created by DSI which reads in a binary file.
- The name of the binary file is specified in the W2 control file.
- This binary file contains nearly all data generated during the model run.

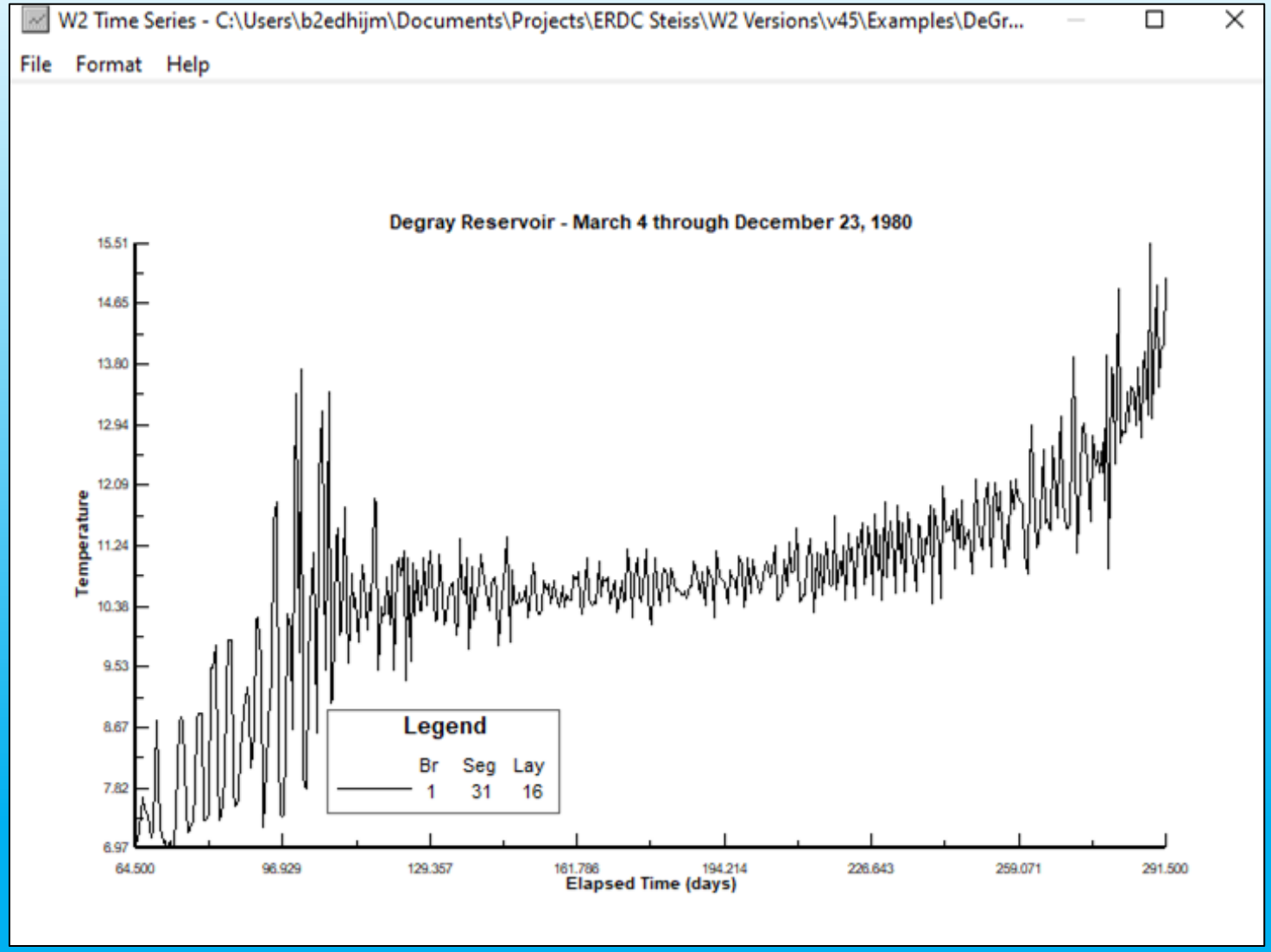


Bathymetry Viewer

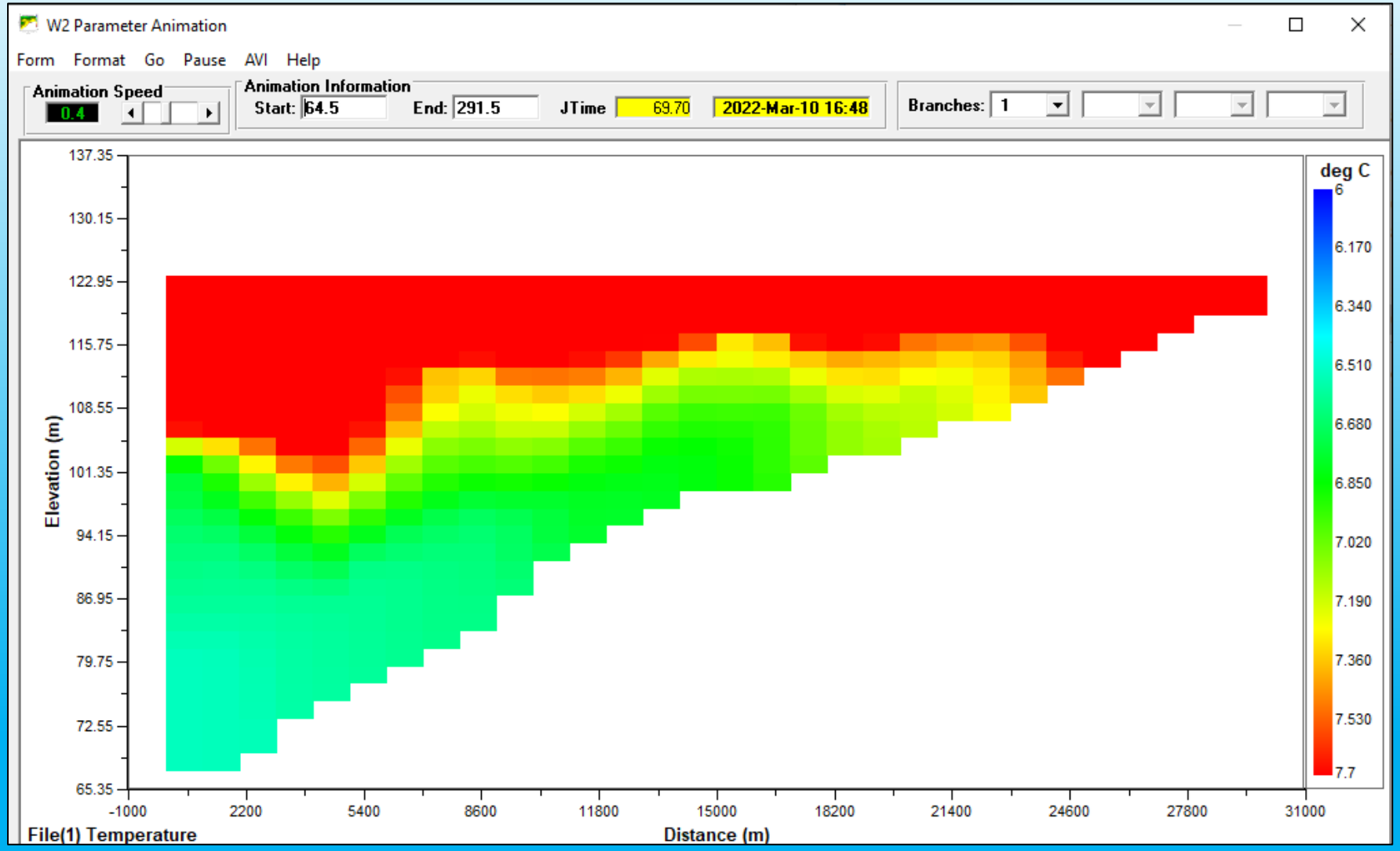




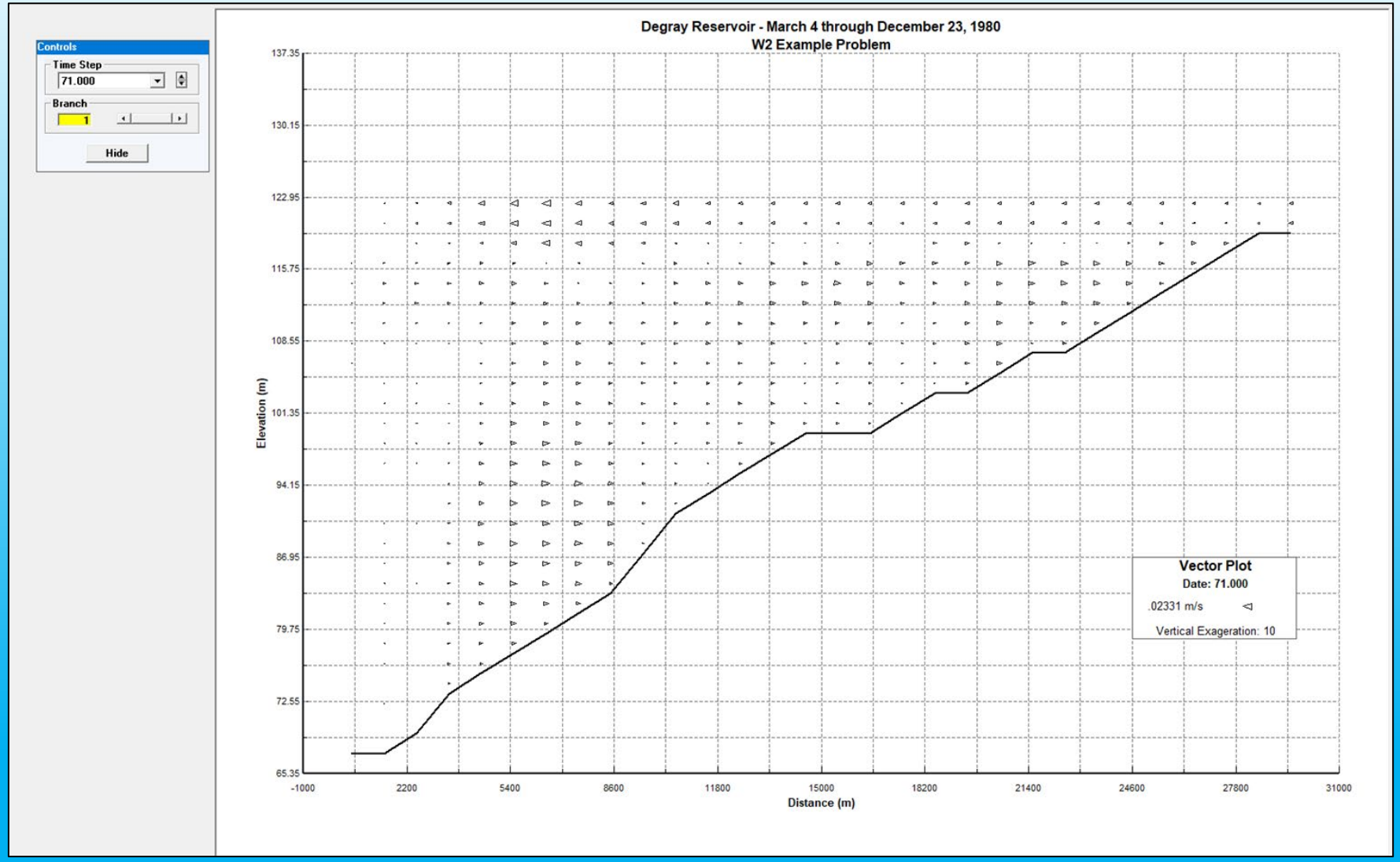
Temperature Time Series – Example View



Contour Plotting and Animations



Vector Field Plotting



Output Visualization Future Work

- Visualizing Python-based output using built-in plotting tools.
- Using YAML configuration files, essentially streamlining the organization of output files and making them easy for humans to read
- Making output compatible with USACE security settings

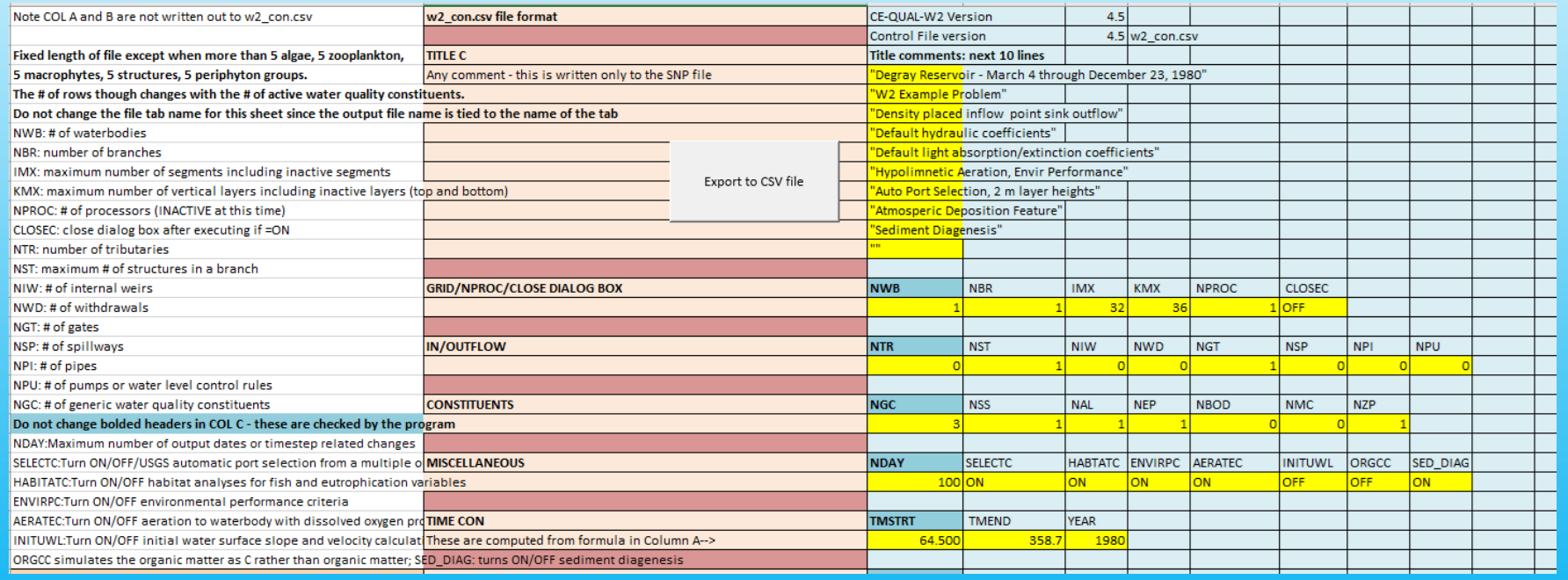
A case-study of these tools will be presented following this lecture.

Control File Converter, from v3.7– 4.2 to v4.5

- Feature allows conversion of legacy models to version 4.5.
- Different model versions produce slightly different outputs.
- Additional details will be offered in tomorrow’s workshop.

Excel Macro - .xlsm to .csv

This visual basic macro in Excel allows us trim the heavily annotated **.xslm** file to an input file readable by the model:



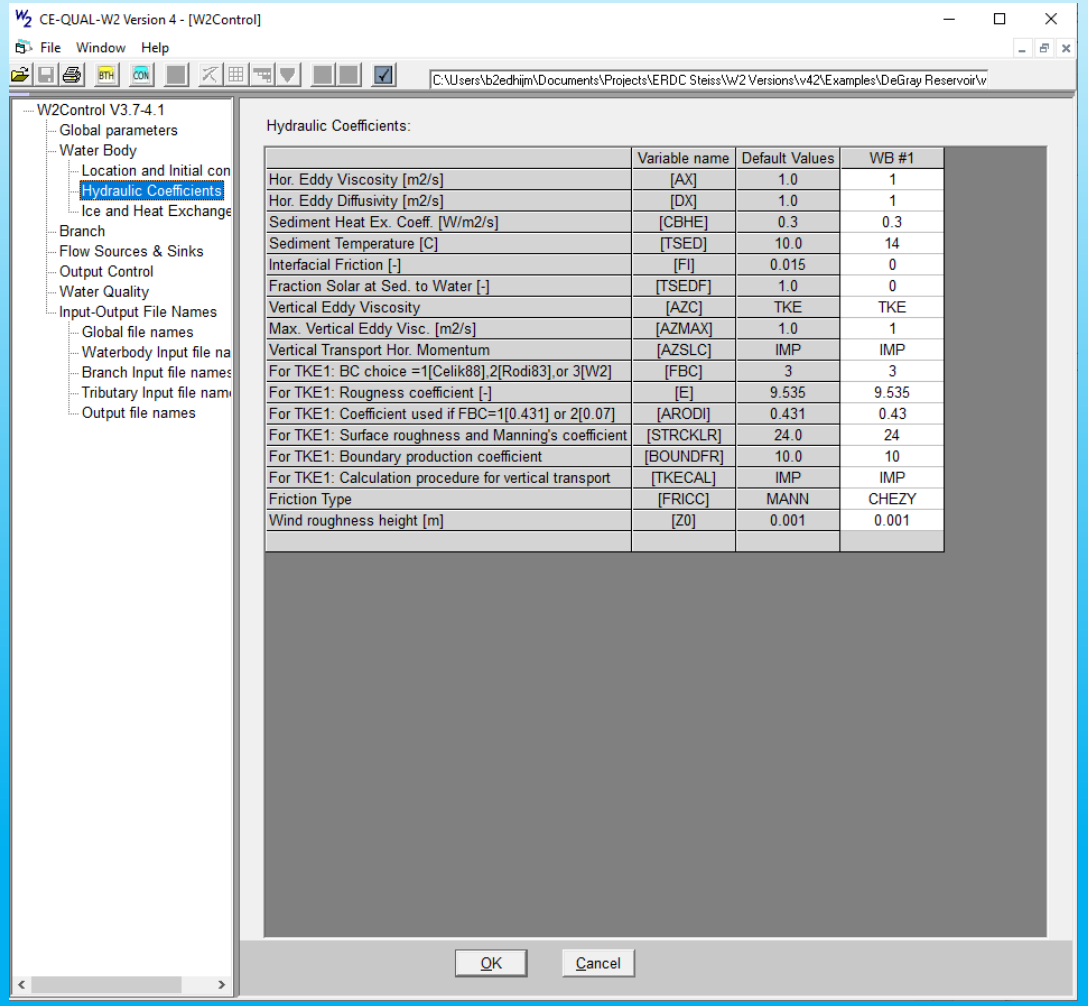
Note COL A and B are not written out to w2_con.csv	**w2_con.csv file format**	CE-QUAL-W2 Version		4.5							
		Control File version		4.5	w2_con.csv						
Fixed length of file except when more than 5 algae, 5 zooplankton,	**TITLE C**	**Title comments: next 10 lines**									
5 macrophytes, 5 structures, 5 periphyton groups.	Any comment - this is written only to the SNP file	"Degray Reservoir - March 4 through December 23, 1980"									
The # of rows though changes with the # of active water quality constituents.		"W2 Example Problem"									
Do not change the file tab name for this sheet since the output file name is tied to the name of the tab		"Density placed inflow point sink outflow"									
NWB: # of waterbodies		"Default hydraulic coefficients"									
NBR: number of branches		"Default light absorption/extinction coefficients"									
IMX: maximum number of segments including inactive segments		"Hypolimnetic Aeration, Envir Performance"									
KMX: maximum number of vertical layers including inactive layers (top and bottom)		"Auto Port Selection, 2 m layer heights"									
NPROC: # of processors (INACTIVE at this time)		"Atmosperic Deposition Feature"									
CLOSEC: close dialog box after executing if =ON		"Sediment Diagenesis"									
NTR: number of tributaries		""									
NST: maximum # of structures in a branch											
NIW: # of internal weirs	**GRID/NPROC/CLOSE DIALOG BOX**	**NWB**	NBR	IMX	KMX	NPROC	CLOSEC				
NWD: # of withdrawals		1	1	32	36	1	OFF				
NGT: # of gates											
NSP: # of spillways	**IN/OUTFLOW**	**NTR**	NST	NIW	NWD	NGT	NSP	NPI	NPU		
NPI: # of pipes		0	1	0	0	1	0	0	0		
NPU: # of pumps or water level control rules											
NGC: # of generic water quality constituents	**CONSTITUENTS**	**NGC**	NSS	NAL	NEP	NBOD	NMC	NZP			
Do not change bolded headers in COL C - these are checked by the program		3	1	1	1	0	0	1			
NDAY:Maximum number of output dates or timestep related changes											
SELECTC:Turn ON/OFF/USGS automatic port selection from a multiple o	**MISCELLANEOUS**	**NDAY**	SELECTC	HABTATC	ENVIRPC	AERATEC	INITUWL	ORGCC	SED_DIAG		
HABITATC:Turn ON/OFF habitat analyses for fish and eutrophication variables		100	ON	ON	ON	ON	OFF	OFF	ON		
ENVIRPC:Turn ON/OFF environmental performance criteria											
AERATEC:Turn ON/OFF aeration to waterbody with dissolved oxygen pr	**TIME CON**	**TMSTRT**	TMEND	YEAR							
INITUWL:Turn ON/OFF initial water surface slope and velocity calculat	These are computed from formula in Column A-->	64.500	358.7	1980							
ORGCC simulates the organic matter as C rather than organic matter; SED_DIAG: turns ON/OFF sediment diagenesis											

Export to CSV file

- The separation between the user-interface and .csv file enables the user to create and save many different model set-ups, but only one input file.
- Additionally, a python script based on the ‘pandas’ module can serve this function, as macros are blocked by security settings on some USACE computers.

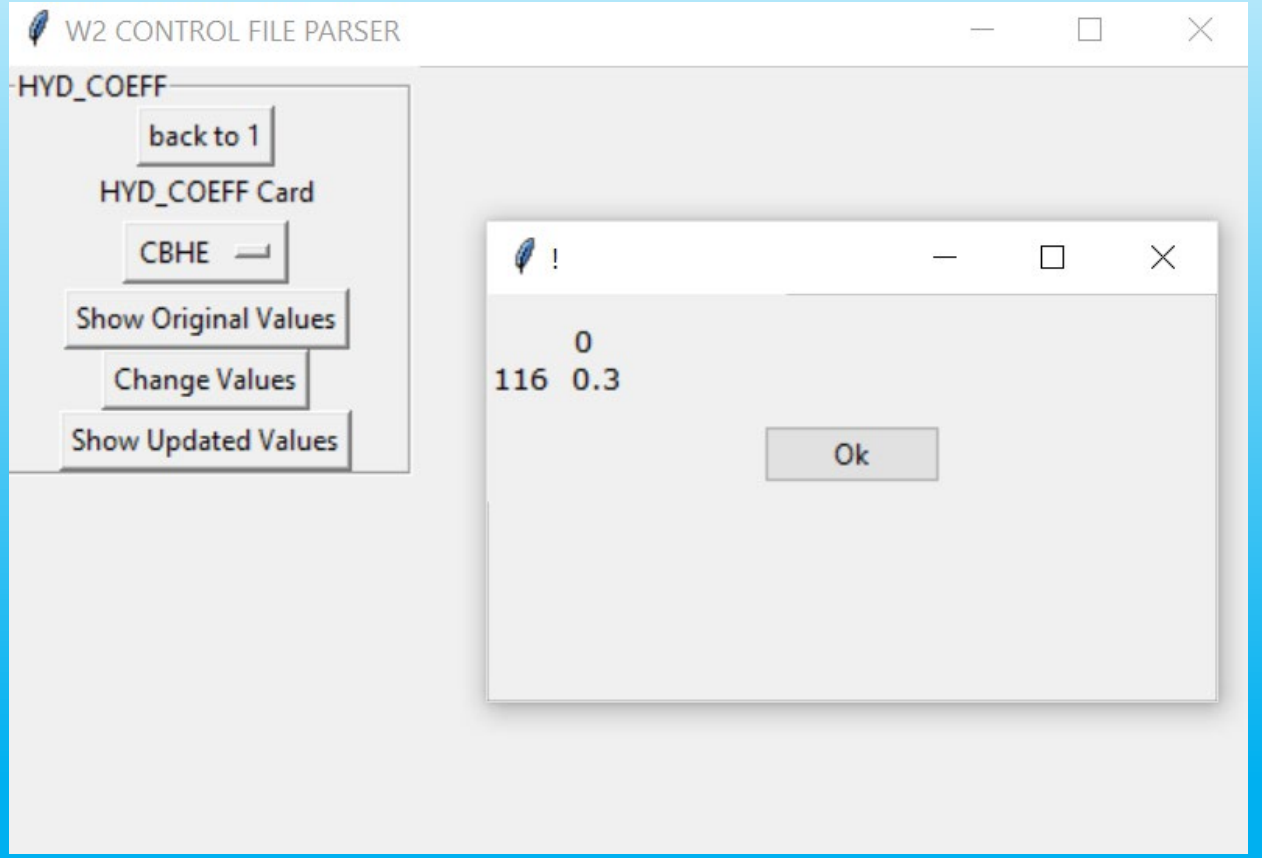
W2Control GUI

The interface prior to the **.xlsm** file absorbs the **.npt** file:



	Variable name	Default Values	WB #1
Hor. Eddy Viscosity [m2/s]	[AX]	1.0	1
Hor. Eddy Diffusivity [m2/s]	[DX]	1.0	1
Sediment Heat Ex. Coeff. [W/m2/s]	[CBHE]	0.3	0.3
Sediment Temperature [C]	[TSED]	10.0	14
Interfacial Friction [-]	[FI]	0.015	0
Fraction Solar at Sed. to Water [-]	[TSEDF]	1.0	0
Vertical Eddy Viscosity	[AZC]	TKE	TKE
Max. Vertical Eddy Visc. [m2/s]	[AZMAX]	1.0	1
Vertical Transport Hor. Momentum	[AZSLC]	IMP	IMP
For TKE1: BC choice =1[Celik88],2[Rodi83],or 3[W2]	[FBC]	3	3
For TKE1: Rougness coefficient [-]	[E]	9.535	9.535
For TKE1: Coefficient used if FBC=1[0.431] or 2[0.07]	[ARODI]	0.431	0.43
For TKE1: Surface roughness and Manning's coefficient	[STRCKLR]	24.0	24
For TKE1: Boundary production coefficient	[BOUNDFR]	10.0	10
For TKE1: Calculation procedure for vertical transport	[TKECAL]	IMP	IMP
Friction Type	[FRICC]	MANN	CHEZY
Wind roughness height [m]	[Z0]	0.001	0.001

A Python tool under development will move the control file **.csv** in a similar way to the W2Control GUI:s:



Questions?