ResSIMLite vs. ResSIM Model Comparison

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The outflow calculations represented in the Envision model have been closely modeled after the representation in the USACE HEC-ResSIM model (hereafter "ResSIM"). The functions used to determine outflow within Envision are together termed here "ResSIMLite". The full HEC ResSIM model includes physical descriptions of reaches and flow routing details that were not represented in Envision, due to existing (and flexible) reach and routing representations.

1. ResSIM model run

The ResSIM model was obtained from the Portland Army Corps District in December of 2011. The model is in HEC-ResSIM version 3.1 (NOT 3.0, which is the downloadable version for the Army Corps website. The Willamette model will not run properly in Hec-ResSIM 3.0.). While version 3.0 is now compatible with windows 7, my experience has been that version 3.1 is not compatible. I run version 3.1 on Windows XP only.
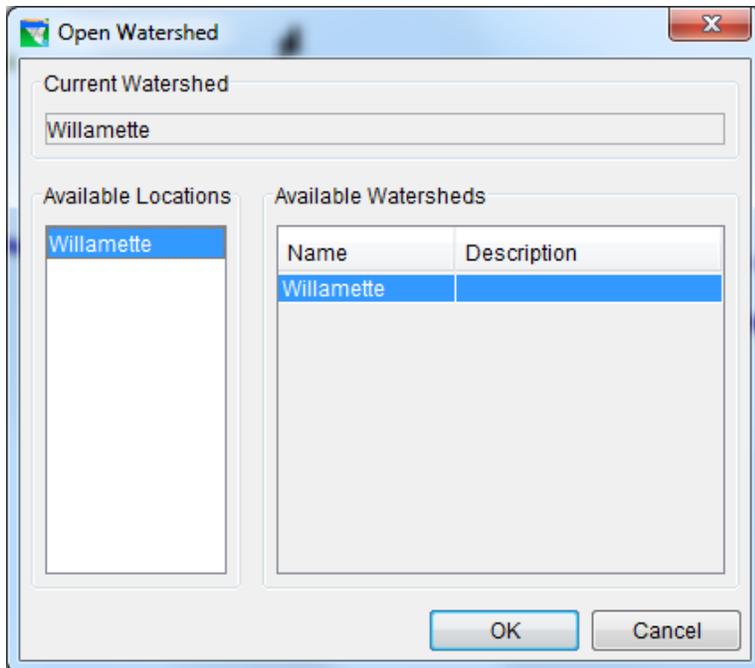
1.1 Running the model

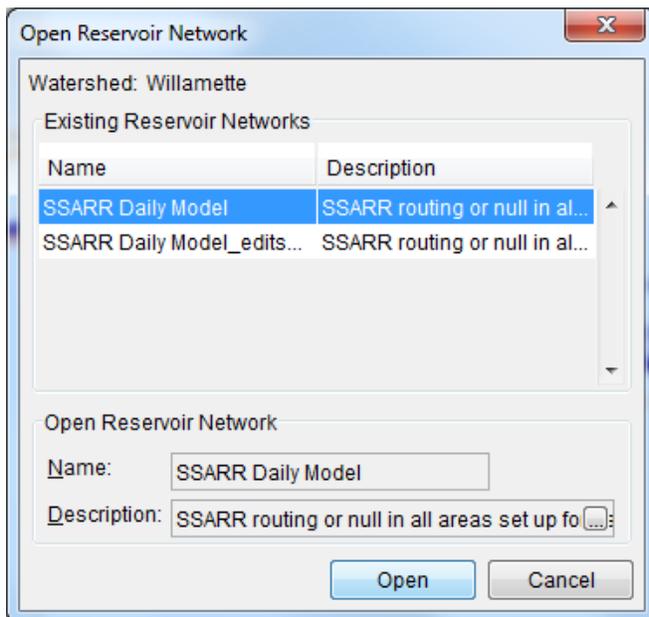The model files are located in the following directory:

R:\Projects\Willamette Dam operations\ResSIMModel

The files should be copied to a local directory on an XP machine for use.

To run the ResSIM model, first, the Willamette watershed must be opened.

Next, the reservoir network entitled SSARR Daily Model must be opened:

Finally, the simulation entitled "IRRM_Baseline_090111" must be opened. This simulates the time period from 1935 to 2008, incorporating elements of the 2008 Biological Opinion (those that reflect Portland District operations in 2010) as well as Interim Risk Reduction Measures associated with damaged spillway gates at several dams. More details the elements included in this model can be found in this document:

R:\Projects\Willamette Dam operations\Documents\From_USACE_Portland_District\ TOC Model documentation report for OMET.docx
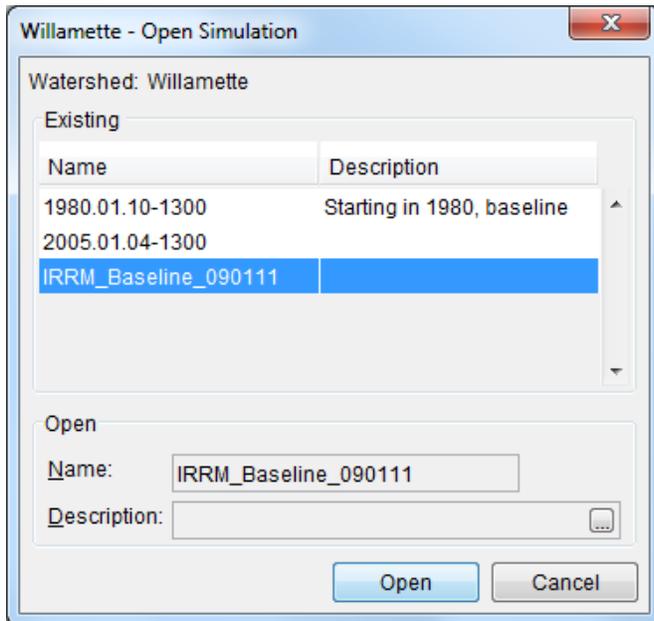

1.2 Storing and formatting ResSIM model output

Once the simulation has been run, the output used for comparison can be found in the Release Decisions report. This file is modified for the comparison by removing data from all leap years and sorting so that the numerical values of pool elevations, inflow and outflows are not interspersed with text.   Then, dates must be replaced with values for Envision time, which consists of the year*365 + day of current year. (For example, Jan 5th, 1980 is represented as 1980*365+5 =722705).

Values of current pool elevation, outflow and inflow are saved for comparison. Additionally, net inflows to each reservoir are saved in a separate file to be used replace modeled inflows within Envision for a better comparison.

Inflows from this simulation have been saved in a file entitled

C:\envision\StudyAreas\WW2100\Reservoirs\Inflows_from_ResSim\ ResSim_inflows_for_testing_cms.csv
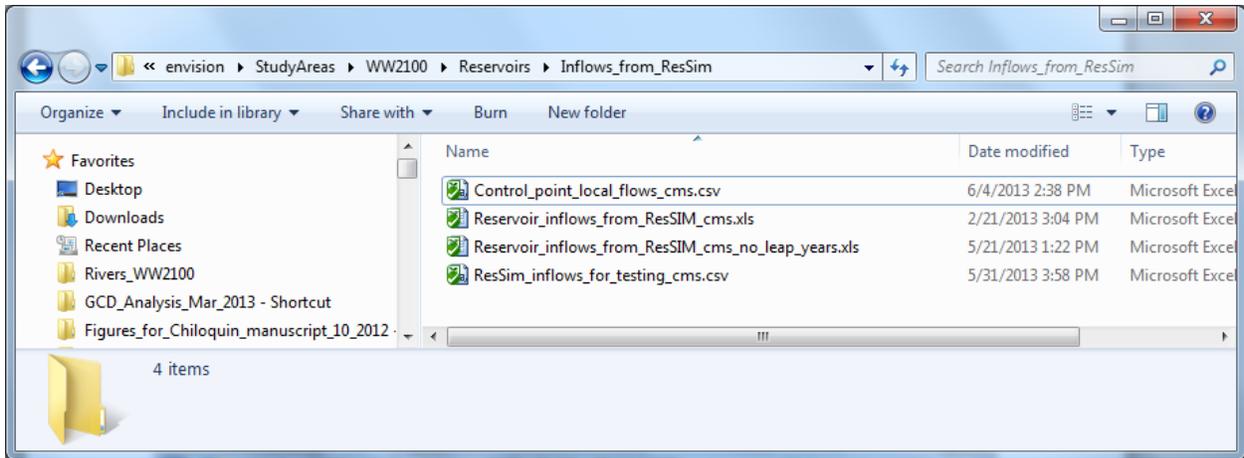
Code exists within Envision to read in these net reservoir inflows and use these values instead of modeled inflows for the purposes of model comparison. This code should not be active for Envision simulations, and is commented to clearly state that it is for model comparison only.

Outflows and pool elevations for comparison (individual file for each reservoir) are stored in this directory:

C:\envision\StudyAreas\WW2100\Reservoirs\Output_from_ResSim
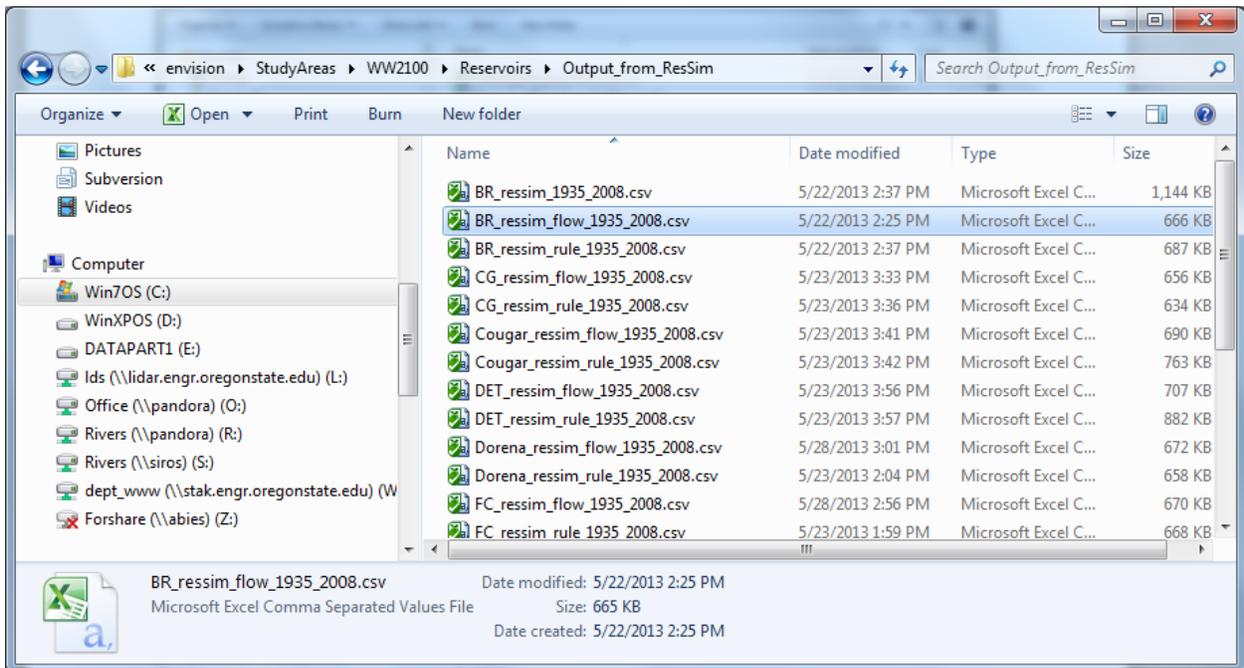
Floating point values (inflow, outflow, pool elevations) from both Envision and ResSIM simulations are stored in the files that end in " _flow_1935_2008.csv". Strings (active rules) are stored in files that end in " _rule_1935_2008.csv"

2. Envision model run

2.1 Time frame:

Model comparisons presented within this document are from a model run encompassing the years 1994 to 2008. These years were chosen because of the current overlap of available climate data and output data from ResSIM. This period includes a large flood (1996) as well as a very dry year (2001).

2.2 Inflow matching:

Net inflows to reservoirs modeled by Envision are replaced by values from ResSIM. (This violates mass balances at the inflow points to the reservoirs, but serves the purpose of a creating a more reasonable comparison of the two models.

2.3 Input Files:

While the input files to run the Envision model are continually being updated based on various users' needs, the xml file (hbv.xml) used in the model comparison, as well as the text file with hydrologic model calibration parameters (hbvkellie.csv) can be found in the following folder:

R:\Projects\Willamette Dam operations\Envision_docs_model_comparison_06_05_2013

The model was run using a Status Quo scenario with no constraints. Below is an image of the Envision model screen immediately after the model run was completed.
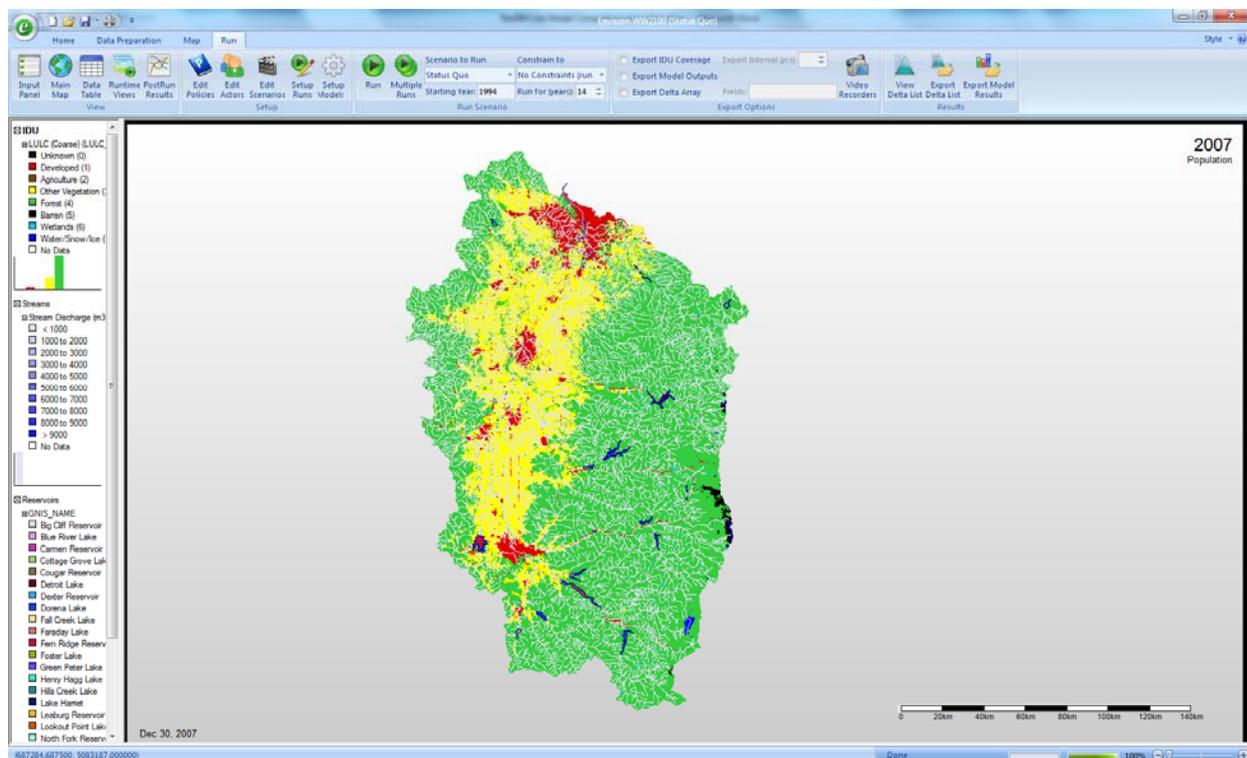
2.4 Output for comparison:

Output files are stored for comparison of ResSIM and Envision results. The names and locations of these files are described in the ResSIMLite information document. Each model run, all of the output files from the model are stored in the following location:

C:\envision\StudyAreas\WW2100\output

Within this folder, MatLab functions exist to import the reservoir information, plot ResSIM vs. Envision results for inflow (should be identical), outflow and pool elevation, and calculate statistics comparing the time series (NSE and RMSE). I have copied these functions to this folder as a backup:

R:\Projects\Willamette Dam operations\Envision_docs_model_comparison_06_05_2013\output

3. Comparison Results

Results presented below are current as of 06/05/2013. Further calibration and comparison would be useful to improve the representation of many of the reservoirs.

Control point representation issues: The comparison of the two models is not perfect, because while the reservoir inflows are identical, the uncontrolled flows that reach downstream control points are not. I experimented with adjusting control point flows using the input data from ResSIM, but this is difficult because of flow routing differences between the two models. ResSIM adds flow at each control point that represents "cumulative local flows" that have come in since the last control point. The total discharge is the sum of cumulative local flows and flow that has been routed from upstream reservoirs. I have calculated Nash-Sutcliffe efficiency (NSE) values for the output time series at several downstream control points from this simulation, in order to provide some quantification of the difference in measured vs. modeled outflows at control point. My expectation is that as the representation of discharge at control points improves, the fit as compared to the ResSIM model will also improve. NSE calculations exclude the first year of each model run, so therefore cover 13 years (1995 – 2008).

Control Point	NSE (Observed vs. Modeled)
Willamette at Salem	0.82
Willamette at Albany	0.72
Willamette at Harrisburg	0.79
McKenzie near Vida	0.14
S. Santiam at Waterloo	0.85
Santiam at Jefferson	0.88
Coast Fork Willamette at Goshen	0.85

All of the figures in Sections 3.1 – 3.11 show two time series, ResSIM model output (in black) and Envision model output (in blue). NSE and RMSE values for the pool elevation time series are included in the figure caption, as well as the RMSE and NSE for the outflow time series. Outflow time series are

difficult to interpret visually and therefore are not included in this document. While ResSIMLite replicates the ResSIM pool elevation time series fairly well (NSE > 0.8 in most cases), room for improvement exists especially with regard to winter flows and late summer drawdown.
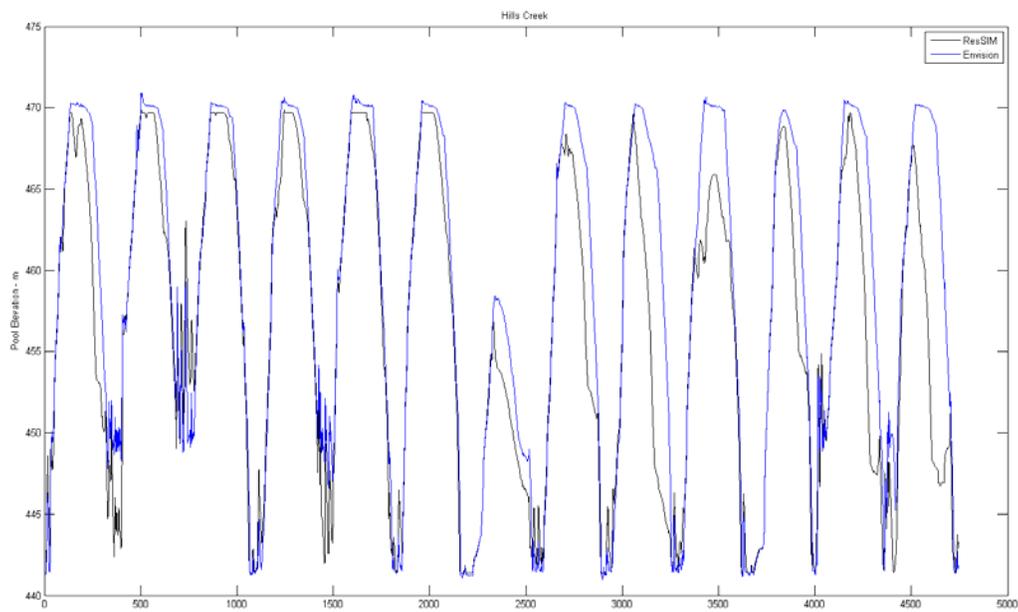
3.1 Hills Creek Reservoir

Figure 1 - Hills Creek Reservoir Pool Elevation (m). NSE = 0.74. RMSE pool elevation = 4.83. RMSE outflow = 22.62. Simulation of years 1995 to 2008.
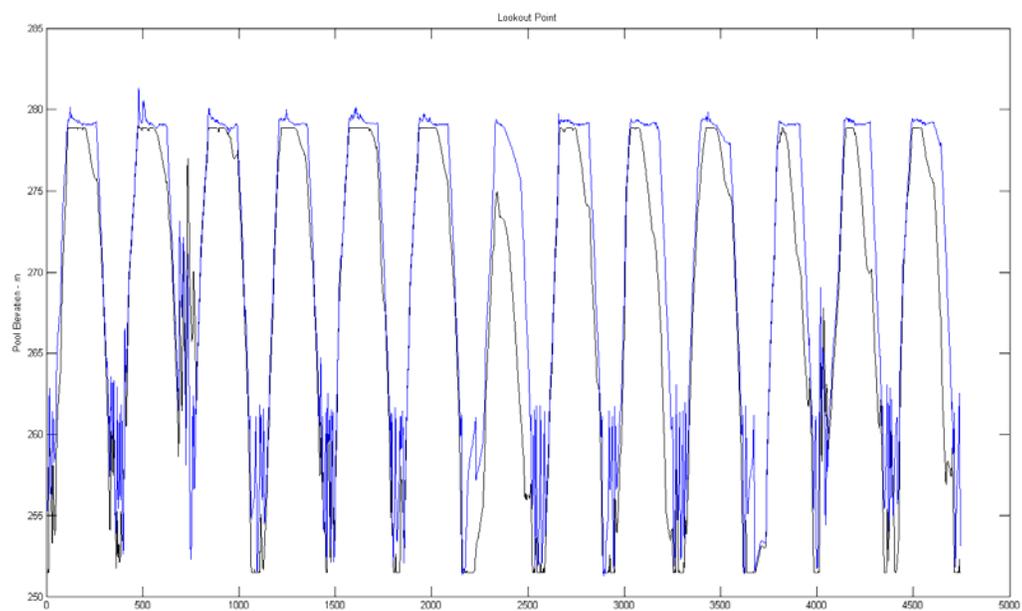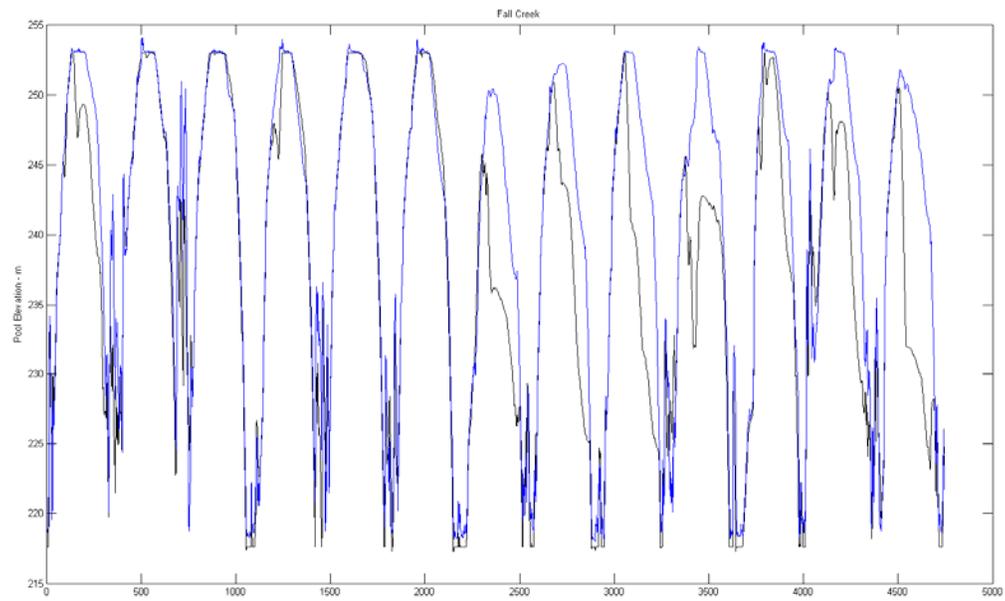
3.2 Lookout Point Reservoir

Figure 2 - Lookout Point Reservoir Pool Elevation (m).   NSE - 0.823. RMSE pool elevation - 4.15. RMSE outflow - 59.23.

3.3 – Fall Creek Reservoir

Figure 3 -Fall Creek Reservoir Pool Elevation (m). NSE = 0.72.   RMSE pool elevation = 5.90. RMSE outflow = 16.45. Simulation of years 1995 to 2008.
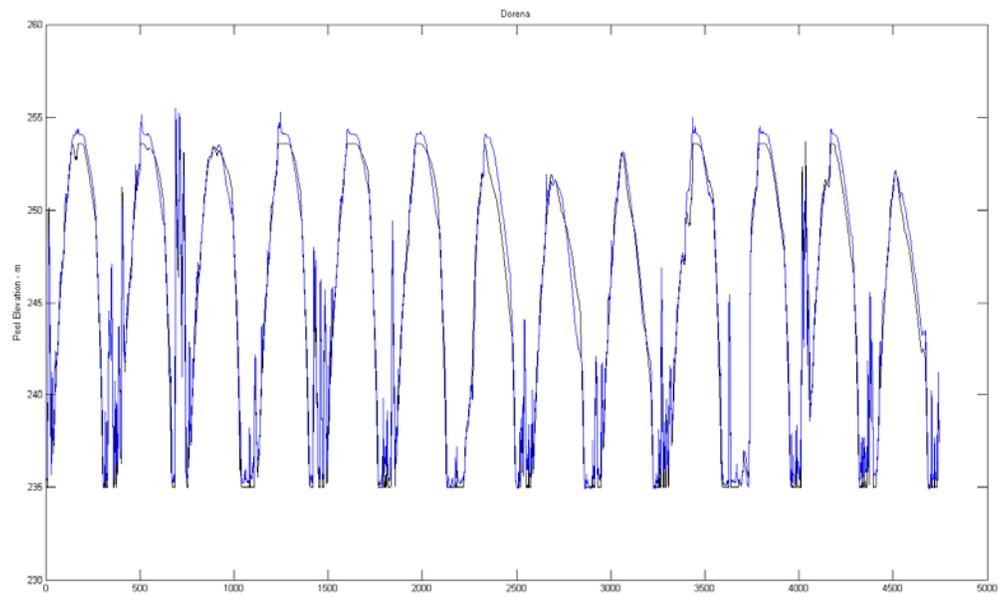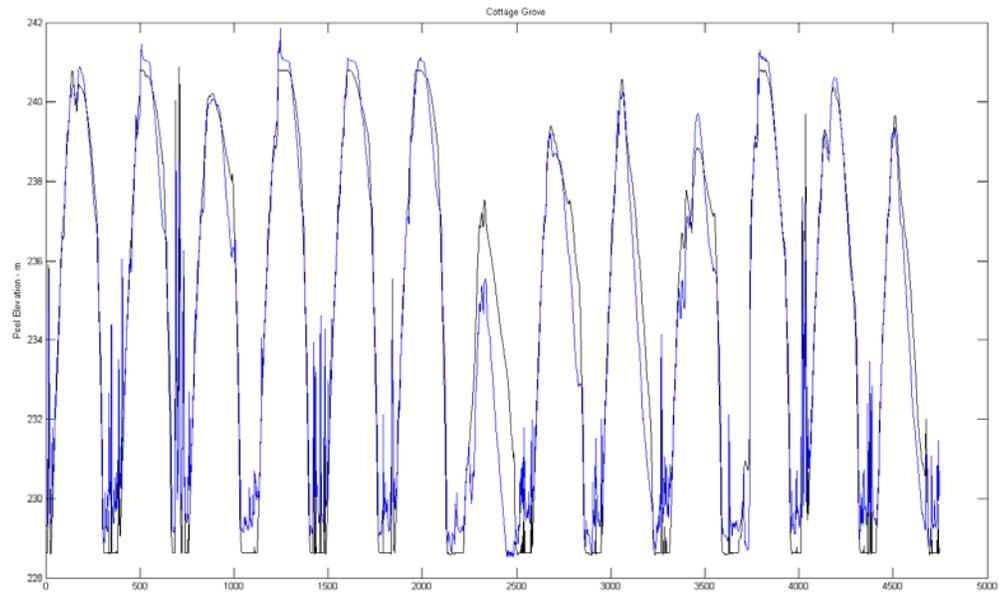
3.4 – Dorena Reservoir

Figure 4 - Dorena Reservoir Pool Elevation (m). NSE = 0.98. RMSE pool elevation = 0.88. RMSE outflow = 10.28. Simulation of years 1995 to 2008.

3.5 – Cottage Grove Reservoir

Figure 5 – Cottage Grove Reservoir Pool Elevation (m). NSE = 0.93.   RMSE pool elevation = 1.14. RMSE outflow = 7.60. Simulation of years 1995 to 2008.
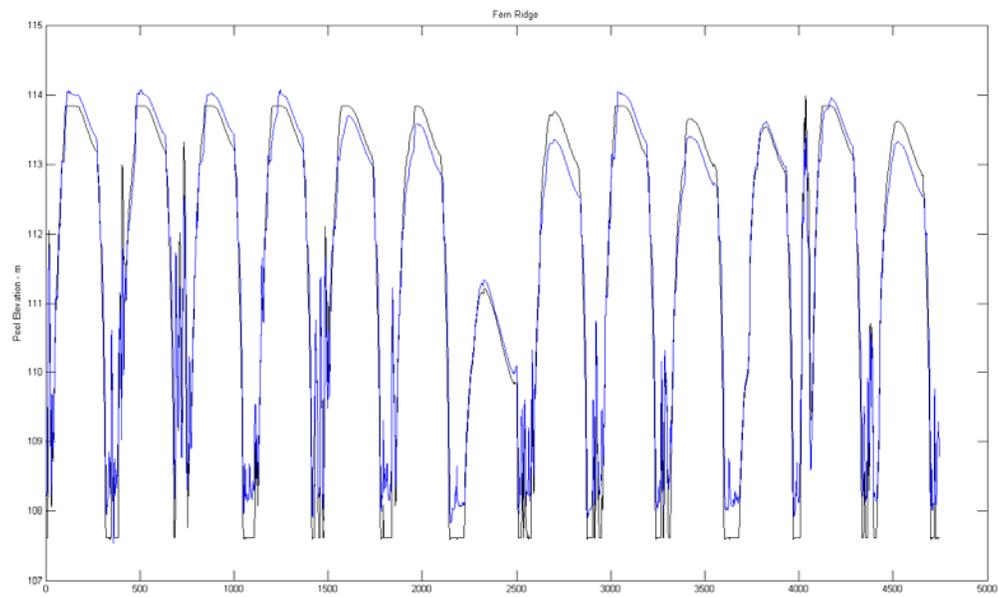
3.6 – Fern Ridge Reservoir

Figure 6 – Fern Ridge Reservoir Pool Elevation (m). NSE = 0.96.   RMSE pool elevation = 0.42. RMSE outflow = 11.06. Simulation of years 1995 to 2008.
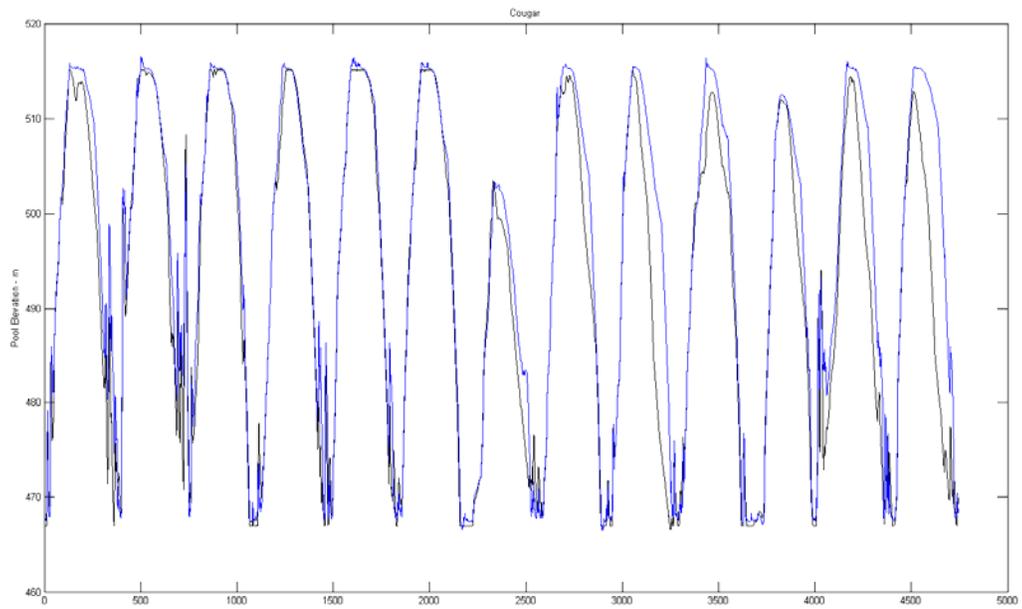
3.7 – Cougar Reservoir

Figure 7 - Cougar Reservoir Pool Elevation (m). NSE = 0.88.   RMSE pool elevation = 5.78. RMSE outflow = 16.97. Simulation of years 1995 to 2008.

3.8 – Blue River Reservoir

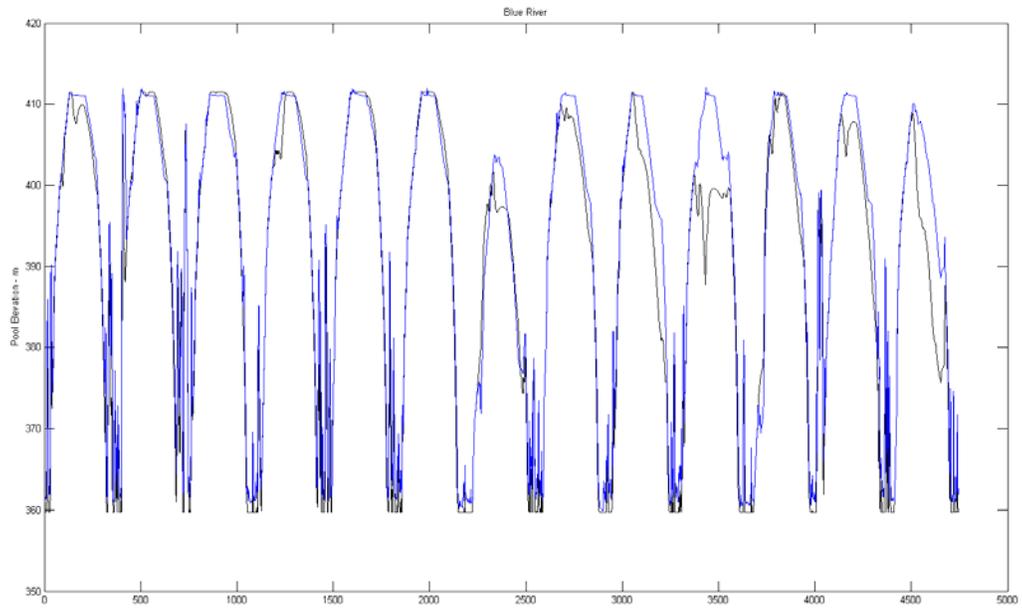**Figure 8 – Blue River Reservoir Pool Elevation (m). NSE = 0.94.   RMSE pool elevation = 4.53. RMSE outflow = 13.25. Simulation of years 1995 to 2008.**
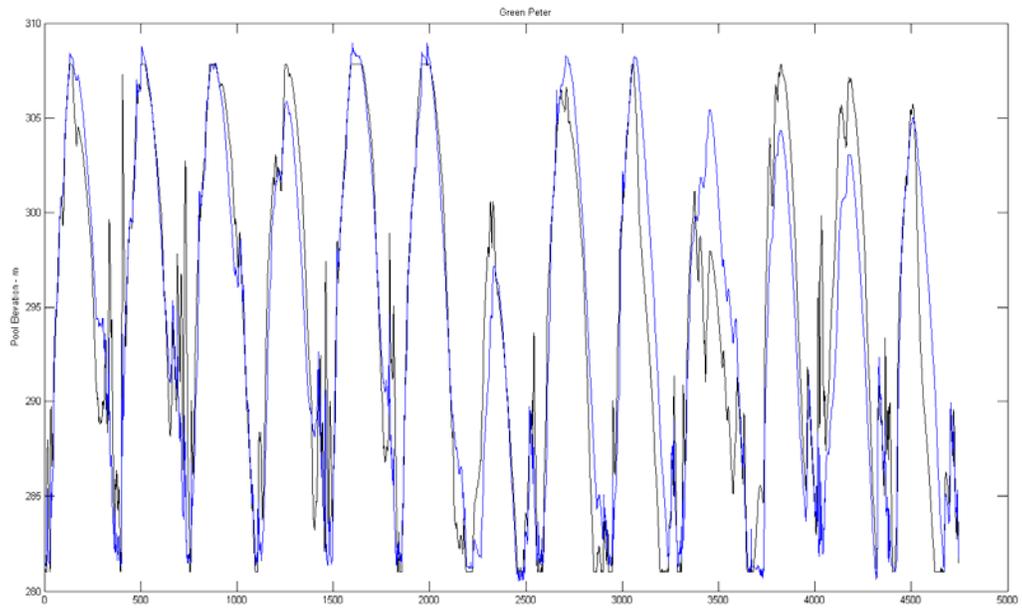
3.9 – Green Peter Reservoir

Figure 9 – Green Peter Reservoir Pool Elevation (m). NSE = 0.81.   RMSE pool elevation = 3.75. RMSE outflow = 58.23. Simulation of years 1995 to 2008.
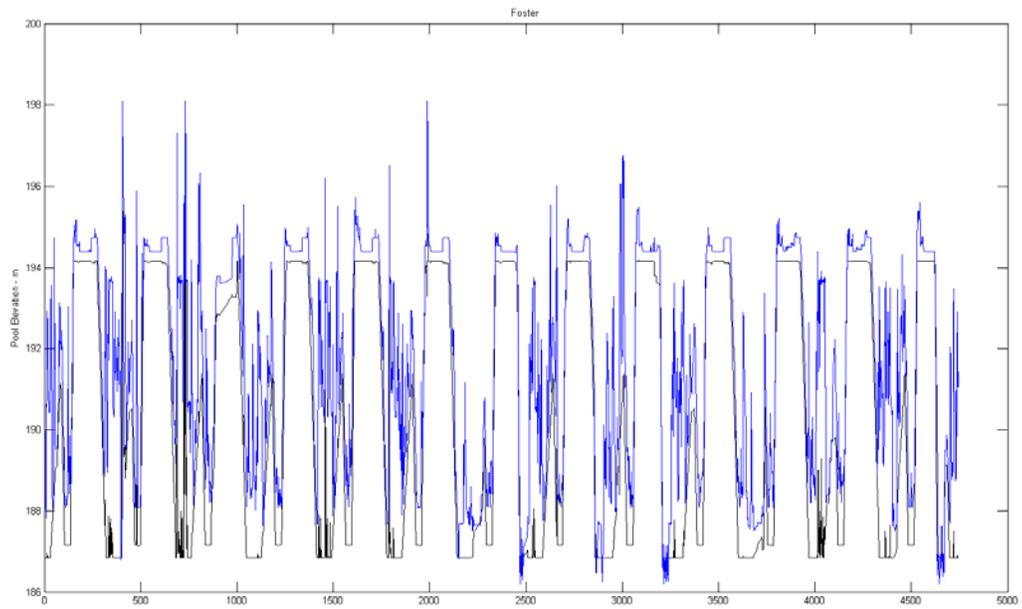
3.10 – Foster Reservoir

Figure 10 - Foster Reservoir Pool Elevation (m). NSE = 0.48.   RMSE pool elevation = 2.23. RMSE outflow = 26.57. Simulation of years 1995 to 2008.
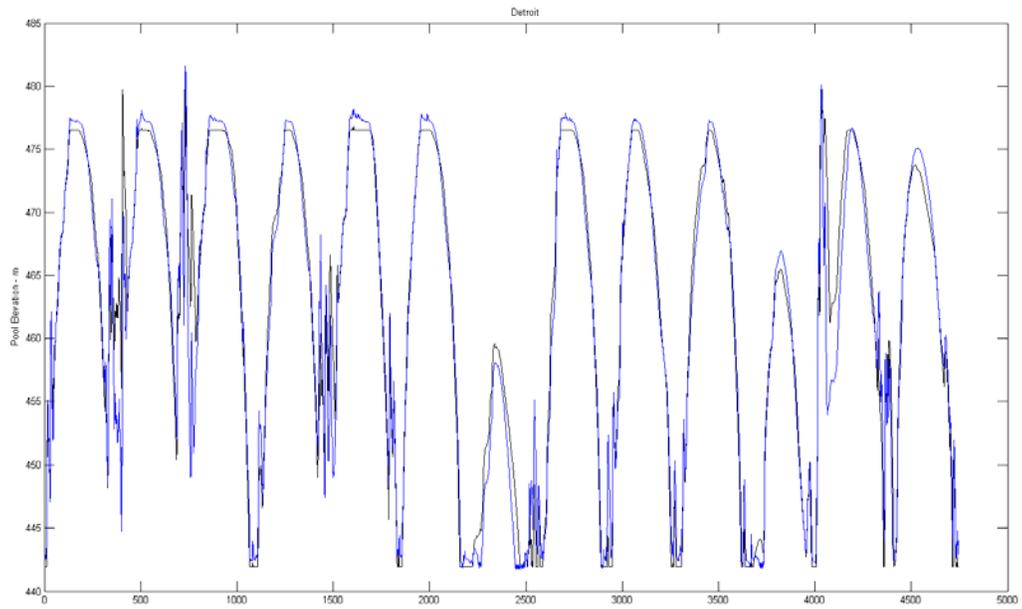
3.11 – Detroit Reservoir

Figure 11 - Detroit Reservoir Pool Elevation (m). NSE = 0.95. RMSE pool elevation = 3.75. RMSE outflow = 58.23. Simulation of years 1995 to 2008.