Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh

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Chapter 7
DSM2-PTM Standard Test Suite Design and Automation

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7.1 Introduction

The DSM2-PTM Module is undergoing development for new features and bug fixes (Zhou & Nam, 2013). It is essential to have module testing standardized and automated for the changes to the code and input data.

This chapter describes the PTM standard test suite design, including several DSM2 test grids, their respective key configuration variables, and design purpose. Scenario runs and plot generation can be batch processed for every version of DSM2-PTM. This batch automation is implemented by Python scripts.

7.2 Standard Test Design Methodology

7.2.1 Scripts Automation

The proposed PTM standard test suite is designed to be placed under the DSM2 folder, e.g., `D:\delta\dsm2_v8\`. It includes python scripts (*.py), DSM2 grid scenarios ("Simple_grid," "Delta_grid," and "Convg_test" folders), output ("plot" and "plot_compare" folders), shown in Table 7-1.

Python scripts are used for automation control (green-boxed files in Figure 7-1), with the help of Vtools.[1] The functions include:

- Running HYDRO and PTM in each scenario
- Making DSS files of result timeseries, which need to be compared (between different output locations, or between different versions)
- Generating plots for particle flux

Table 7-1 Python batch process scripts and their functions

Scripts	Functions
runPTMsuite.py	Control all of the test scenarios running for each DSM2-PTM (or HYDRO) executable version
comparePTMsuite.py	Make output comparisons among multiple DSM2-PTM (or HYDRO) executable versions
batchSimple.py batchDelta.py batchConvg.py	Provide special functions for Simple Grids Test, Delta Historical Test, Convergence Test
batchGeneric.py functions.py envvar.py	Provide generic functions and variables
out_bpart.py (usually under each scenario folder)	Provide plots with the respective output locations and time windows for its resident scenario

[1] Vtools is a Python library authored by the Bay-Delta Office that offers access to data stored in HECDSS format and that simplifies analysis of time series data using the Python numerical package NumPy (NumPy). It is similar in function to Vscript (Sandhu, 1999) and HECDSS-Vue (HEC-DSSVue).

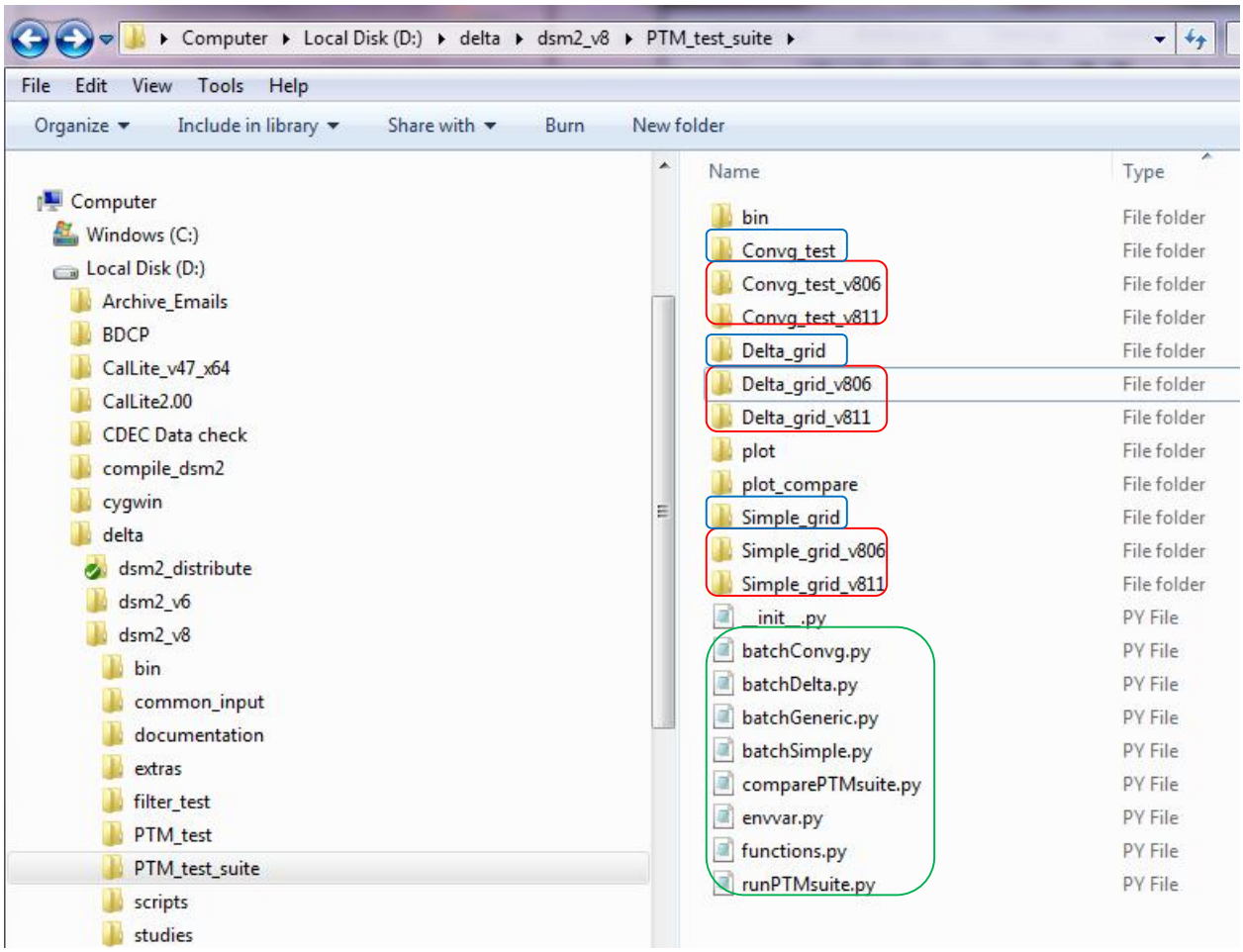

Figure 7-1 Example file organization of PTM standard test suite

7.2.2 Files Organization

Three major categories of test grids are created in this study:

- Simple Grid Test: test particle movement in several simplified grids, which represent different waterbodies or hydro conditions
- Delta Historical Test: test particle movement in the Sacramento-San Joaquin Delta, under historical configuration of various hydrological conditions
- Convergence Test: vary PTM calculation time step to examine the result convergence

Standard scenarios are provided for the above 3 categories (blue-boxed folders in Figure 7-1). They serve as the running base for every new test version change; every test version uses a special version name as its index. This version name (e.g., v806, v811) is determined by the user, when the DSM2 binary, Delta grid, or timeseries is changed. It is input in runPTMsuite.py, and then used to generate the duplicate result output folders (red-boxed folders in Figure 7-1).

Under either of above 3 categories, each scenario folder represents one unique HYDRO condition (different grid or time period) (red-boxed folders in Figure 7-2). Each HYDRO scenario can have multiple PTM particle insertions scenarios. Test results are included in the respective folder “output;” plots are

included in the respective "output_plot" folder. The results are then copied to folder "plot" in the upper directory for users' convenience.

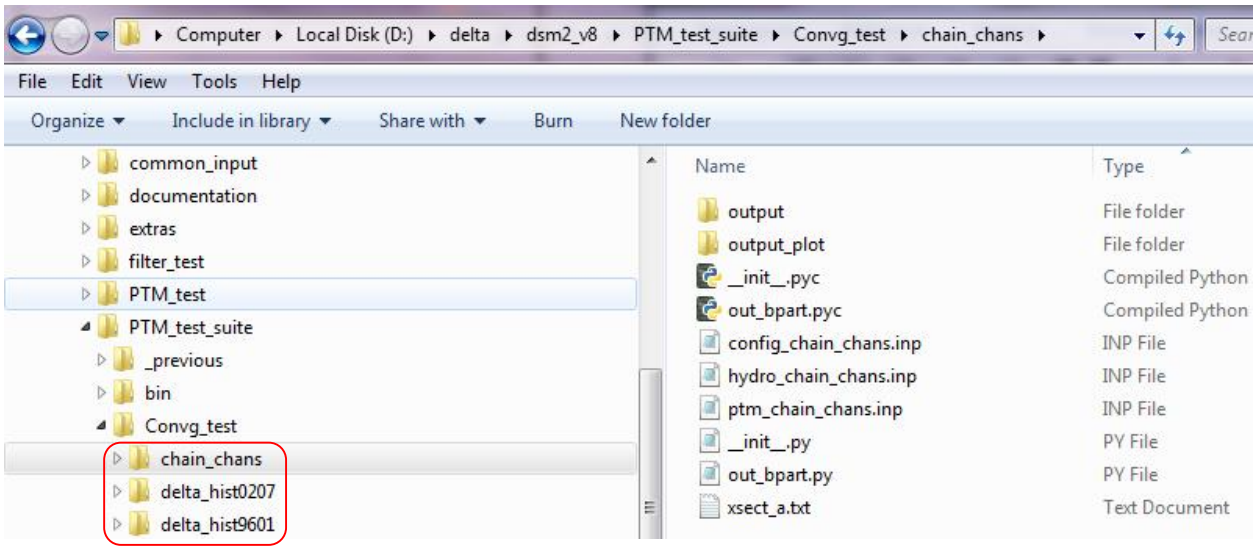

Figure 7-2 DSM2 configuration files sample in one simulation scenario

To compare results from different test versions, users can run comparePTMsuite.py, specifying the version names in the script. The "plot_compare" folder is used to store DSS and plots of comparison results.

7.3 Test Grid Designs

7.3.1 Simple Grids Test

This set of simple grids tests particle movement in several simplified grids (comprised of limited or single type waterbodies), which represent different waterbodies or hydro conditions.

Usually all channel lengths are 15,000 ft. All the channels share the same trapezoidal cross-section (Table 7-2). 200cfs flow release at upstream; 0 ft. stage at downstream. Output locations are depicted by the diamond symbols in Figure 7-3. All grids follow a similar design. Details are in the configuration files.

Table 7-2 Channel cross section for test grid

Distance ft.	Elevation ft.	Area ft.^2	Width ft.	Wet Perimeter ft.
0.5	20	2640	160	160
	0	960	80	80
	-24	0	40	40

CHAIN CHANNELS, STEADY FLOW

Purpose: Test particle movement in channels, with uniform and steady hydraulic conditions.

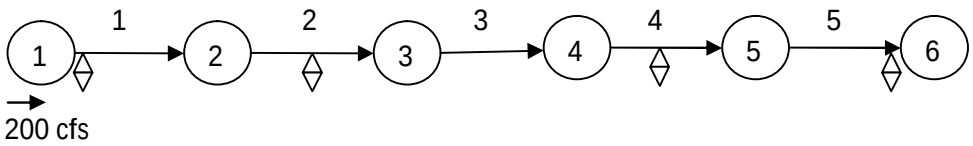

Figure 7-3 DSM2 grid for chain channels, steady flow

CHAIN CHANNELS, TIDAL STAGE AT THEIR DOWNSTREAM END

Purpose: Test particle movement in channels, with uniform spatial environment but time-varying hydraulic conditions.

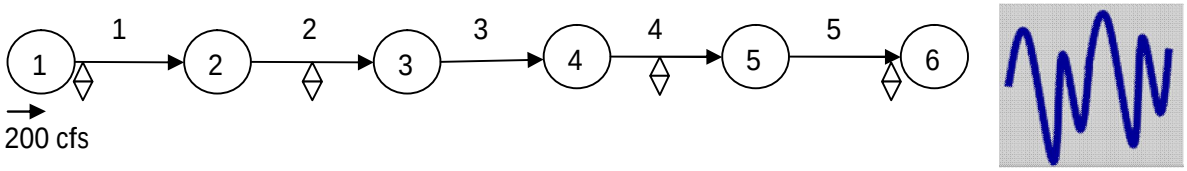

Figure 7-4 DSM2 grid for chain channels, tidal stage at their downstream end

TWO BRANCHED CHANNELS, STEADY FLOW

Purpose: Test particle splitting at junction, with uniform and steady conditions.

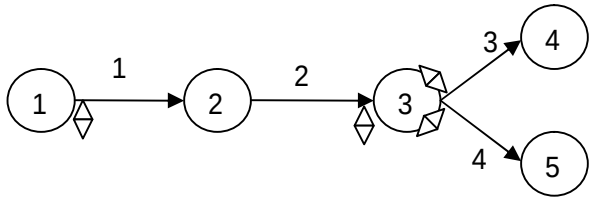

Figure 7-5 DSM2 grid for two branched channels, steady flow

TWO BRANCHED CHANNELS, TIDAL STAGES AT THEIR DOWNSTREAM ENDS (TWO TIDES ARE THE SAME)

Purpose: Test particle splitting at junction, with uniform spatial environment but time-varying conditions.

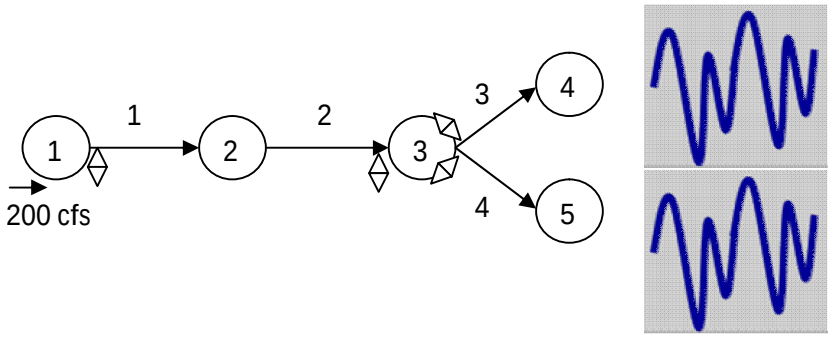

Figure 7-6 DSM2 grid for two branched channels, tidal stages (same frequency) at their downstream ends

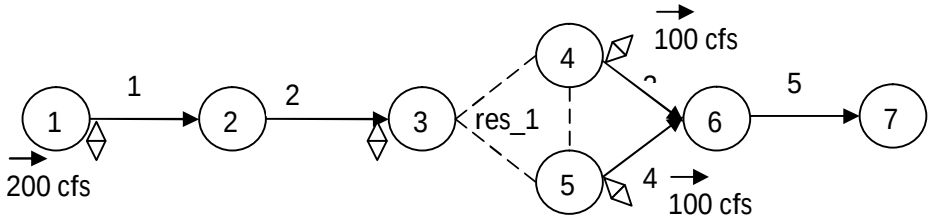

Figure 7-7 DSM2 grid for chain channels with reservoir, steady flow

CHAIN CHANNELS WITH DIVERSIONS, STEADY FLOW

Purpose: Test particle's movement at diversions (diversion at channel node, diversion at reservoir node, diversion directly at reservoir), with uniform and steady conditions.

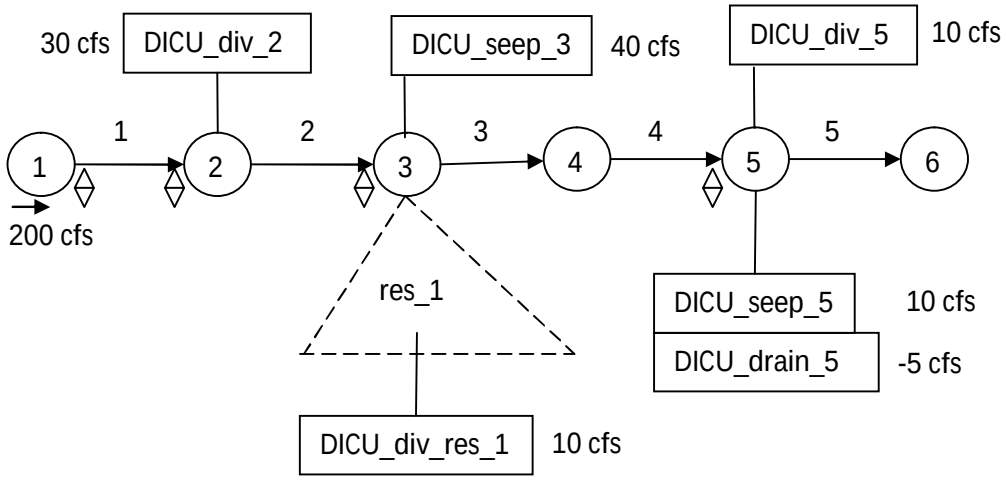

Figure 7-8 DSM2 grid for chain channels with diversions, steady flow

Purpose: Test particle movement at transfer (node->node, reservoir->reservoir, node->reservoir, reservoir->node), with uniform and steady conditions.

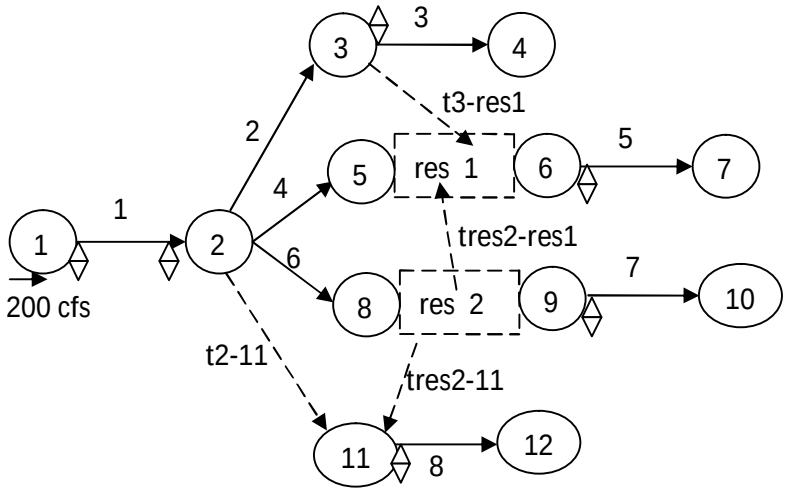

Figure 7-9 DSM2 grid for multiple branched channels with different types of transfers

7.3.2 Delta Grid Test

This tests particle movement in the Sacramento-San Joaquin Delta under historical hydrological conditions.

The Delta is a complex river and bay system under tidal influence and the most important implementation of the DSM2 module. Since its grid system is usually unchanged, emphasis has been put on different hydrological conditions (with specified running periods) and particle release locations.

In order to represent the diversity of hydrological conditions, different Water Years (WY) are selected for the tests, e.g., WY 1996 for Wet Year, and WY 2002 for Dry Year. Then seasons are selected, e.g., Jan-

Feb for flooding season, Jul-Aug for dry season, and Apr-May for fish migration season (usually with complex facility operations) as shown in Table 7-3.

Table 7-3 Simulation periods for the Delta grid test in PTM unit test suite

Year	Water Year Type	Month	DCC	HORB[1]
1996	Wet	Jan-Feb	Closed	Closed
		Apr-May	Closed	Closed-Open-Closed
		Jul-Aug	Open	Closed
2002	Dry	Jan-Feb	Closed	Closed
		Apr-May	Open-Closed-Open	Closed-Open-Closed
		Jul-Aug	Open	Closed

[1]Head of Old River Barrier

Different locations are selected for particle insertion (Table 7-4) and particle flux output (Table 7-5), in order to investigate various areas of interest in the Delta.

Table 7-4 Particle insertion locations for the Delta grid test in PTM unit test suite

Location	DSM2 Node
Sacramento River, Freeport	335
San Joaquin River, Mossdale	6
Calaveras River	21
Mokelumne & Cosumnes Rivers	257
Sacramento River, Rio Vista	351

Table 7-5 Simulation periods for the Delta grid test in PTM unit test suite

Location	Explanation
SWP export	Particles out to State Water Project
CVP export	Particles out to Central Valley Project
Martinez boundary	Particles out to the ocean
DICU diversion	Particles out of agricultural diversions
Whole Delta	Particles which stay in Delta

7.3.3 Convergence test

This set of tests varies the PTM calculation sub-time-step to examine the result convergence. Investigated time-steps: 1 minute, 3 minutes, 5 minutes, 15 minutes, 30 minutes, and 1 hour (HYDRO calculation time-step is 15 minutes; PTM output time step is 15 minutes).

CHAIN CHANNELS, STEADY FLOW (SAME CONFIGURATION IN 7.3.1)

Purpose: Test PTM simulation time-step convergence in a connected channels chain, with uniform and steady environment.

DELTA GRID 1996 JAN-FEB (SAME CONFIGURATION IN 7.3.2)

Purpose: Test PTM simulation time-step convergence in Sacramento - San Joaquin Delta, during flooding season of Wet Water Year.

DELTA GRID 2002 JUL-AUG (SAME CONFIGURATION IN 7.3.2)

Purpose: Test PTM simulation time-step convergence in Sacramento - San Joaquin Delta, during dry season of Dry Water Year.

7.3.4 Other Potential Tests under development

Convergence test with both HYDRO and PTM time steps varied.

Particle insertion duration varied as 0 day (all are inserted immediately), 1 day, 30 day, etc.

7.4 Conclusions

The newly developed test suite provides a comprehensive package covering various simulation conditions for DSM2-PTM. It enables module developers to investigate changes to their programming more efficiently and consistently, by batch-running, automated plot generation, comparison among different module versions, etc. Other test conditions could be incorporated into this suite framework in the future.

7.5 Acknowledgements

Xiaochun Wang helped in report revisions and quality checks.

7.6 Bibliography

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