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

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Chapter 2
Improvements to DSM2-Qual: Part 2

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2 Improvements to DSM2-Qual: Part 2

2.1 Introduction

This chapter documents tests of Delta Simulation Model II (DSM2) Version 8.0.5 (release 8.0.6). The Bogacki-Shampine algorithm (Bogacki–Shampine method 2009) was implemented in the nutrient model to avoid negative value problems in the old solver. Also in Version 8.0.5, the user can set the minimum dispersion velocity (defined as `min_disperse_vel` in DSM2 input file) to avoid zero-dispersion problems at dead-end channels/closed gates.

2.2 Testing Scenarios and Result Analysis

The simulations used the historical run setup from July 1, 1996, to December 31, 2000.

2.2.1 Test 1: Compare With the Old Solver

In test 1, compare with the old non-conservative constituent solver, the minimum dispersion velocity was set to 0 to be consistent with the old model run. A restart file was used as the initial condition. The results are plotted and summarized in Appendix 2-A. Electrical conductivity (EC) results are identical and not plotted. The maximum monthly averaged difference of temperature is 0.06%. The maximum monthly averaged difference of dissolved oxygen (DO) is 1.3% at RSAC075. The differences are small enough to believe that both models are working properly in this historical run setup.

2.2.2 Test 2: Test Minimum Dispersion Velocity (0.01 ft/s)

In test 2, test minimum dispersion velocity, two historical runs were made with minimum dispersion velocities set to 0 and 0.01 feet per second. The results are plotted and summarized in Appendix 2-B.

Conservative Constituent (EC) Comparison

The maximum monthly averaged EC difference for Emmaton, Jersey Point, Rock Slough, Collinsville, and Clifton Court Forebay is less than 0.2%. This shows that a minimum dispersion velocity of 0.01 ft/s will not change the general results in main channels in Delta.

The minimum dispersion velocity helps mixing at dead-end channels or channels with gates; see plots for Delta Cross Channel in Appendix 2-B (Figure 2-1 and Figure 2-2).

The difference of EC in Montezuma Slough near the salinity control structure at SLMZU025 is larger as a percentage; maximum difference in this case is 5.6%.

A test with minimum dispersion velocity set to 0.1 ft/s showed bigger differences in the Delta (e.g., 0.7% at ROLD024, 0.6% at Clifton Court Forebay). Another test with minimum dispersion velocity set to 0.001 ft/s showed much smaller differences. The maximum difference becomes 1.5% at SLMZU025, but it may not give enough dispersion near dead ends.

Non-conservative Constituents

Comparisons are plotted at stations RSAC075, ROLD059, RSAN058, and Clifton Court. The instantaneous percent differences can be large at times (e.g., ammonia [NH3] at ROLD059, a maximum of 8%), but maximum monthly averaged differences of all constituents are less than 1.0% at all these locations. Maximum difference at Clifton Court is less than 0.2%.

In conclusion, the differences using 0.01 ft/s are not significant, minimum dispersion velocity can be used to improve mixing at dead-end channels/gates.

2.2.3 Test 3: Test Cold Start

In test 3, test cold start, all constituents' initial value was 20, `min_disperse_vel`= 0.01 ft/s). The results were compared with a run made with proper initial condition (using restart file) and are summarized in Appendix 2-C. The results are compared at stations RSAC075, ROLD059, RSAN058, and Clifton Court. At RSAC059 and RSAN058, the constituents converge within 1 year. It takes longer to converge at RSAC075. After 2 years, the difference for algae is still 5%; phosphate (PO4) is 10%. It takes 2 years at Clifton Court to converge. A proper initial condition should be used.

2.3 Conclusions

Version 8.0.5 tested as being successful:

- The new non-conservative constituent solver (Bogacki-Shampine method) is working properly.
- Minimum dispersion velocity can be used to avoid zero dispersion problems at dead-end channels and gates. Suggest using a very small value, such as 0.01 ft/s.
- A proper initial condition (using restart file) is recommended. Cold start can take more than 2 years to converge.

2.4 References

Bogacki–Shampine method. 2009 Aug 31. http://en.wikipedia.org/wiki/Bogacki%E2%80%93Shampine_method (accessed February 2011).

Appendix 2-A

Test 1: Compare with the old non-conservative constituent solver

The historical setup from July 1, 1996, to December 31, 2000, was run with the old solver for non-conservative constituents and Version 8.0.5 (new solver). In these runs, a restart file was used as the initial condition. The non-conservative constituent results were compared at stations RSAC075, ROLD059, RSAN058, and Clifton Court. The maximum monthly percent differences are summarized in Table 2-1. The maximum difference of any parameter and any location is DO: 1.3% at RSAC075. The differences are small and show that both solution methods are working correctly in this historical run setup.

Table 2-1 Summary of maximum monthly percent difference

Maximum % difference	RSAC075	ROLD059	RSAN058	Clifton Court
TEMP	0.06	0.06	0.05	0.06
DO	1.30	0.16	0.28	0.11
ALGAE	0.60	0.40	0.30	0.60
BOD	0.70	0.20	0.18	*
NH3	0.25	0.17	0.11	*
NO2	0.20	0.14	0.08	*
NO3	0.25	0.17	0.15	*
ORGANIC_N	0.40	0.14	0.11	*
ORGANIC_P	0.40	0.20	0.13	*
PO4	0.15	0.32	0.25	*

*did not output

Appendix 2-B

Test 2: Test of minimum dispersion velocity

Historical runs from July 1, 1996, to December 31, 2000, were made with the minimum dispersion velocity (defined as `min_disperse_vel` in the input file) set to 0.00, 0.01, 0.1, and 0.001 ft/s.

Conservative Constituent (EC)

The maximum monthly averaged EC difference between the 0.00 and 0.01 runs for Emmaton, Jersey Point, Rock Slough, Collinsville, and Clifton Court Forebay was less than 0.2%. This shows the minimum dispersion velocity of 0.01 ft/s will not change the general results in main channels within the Delta. This result makes sense because main channels seldom have flow velocities near zero, and then only briefly during a tidal change.

The minimum dispersion velocity helps mixing at dead-end channels and channels with closed gates. For instance, the maximum instantaneous or monthly average difference of EC in the Delta Cross Channel during gate closures is greater than 100% (Figure 2-1 and Figure 2-2). In Montezuma Slough north of the salinity control structure (SLMZU025), a maximum instantaneous difference of 14.1% and maximum monthly average difference of 5.6% is noted (Figure 2-3 and Figure 2-4).

A test with minimum dispersion velocity set to 0.1 ft/s showed bigger differences in the Delta (e.g., 0.7% at ROLD024, 0.6% at Clifton Court Forebay) and in Montezuma Slough (Figure 2-5). Another test with minimum dispersion velocity set to 0.001 ft/s showed much smaller differences. The maximum difference in the latter case is 1.5% at SLMZU025 (Figure 2-6), but such a low value may not give enough dispersion near channel dead ends.

Non-conservative Constituents

Comparisons were done at stations RSAC075, ROLD059, RSAN058, and Clifton Court with 15 minute intervals. The instantaneous percent differences can be large at times (e.g., NH3 at ROLD059, maximum 8%, Figure 2-7), but maximum monthly averaged differences of all constituents were less than 1.0 % at all these locations (e.g., NH3 at ROLD059, Figure 2-8). Maximum differences at Clifton Court were less than 0.2%.

In conclusion, the differences are not significant and minimum dispersion velocity can be used to improve mixing at dead-end channels/gates.

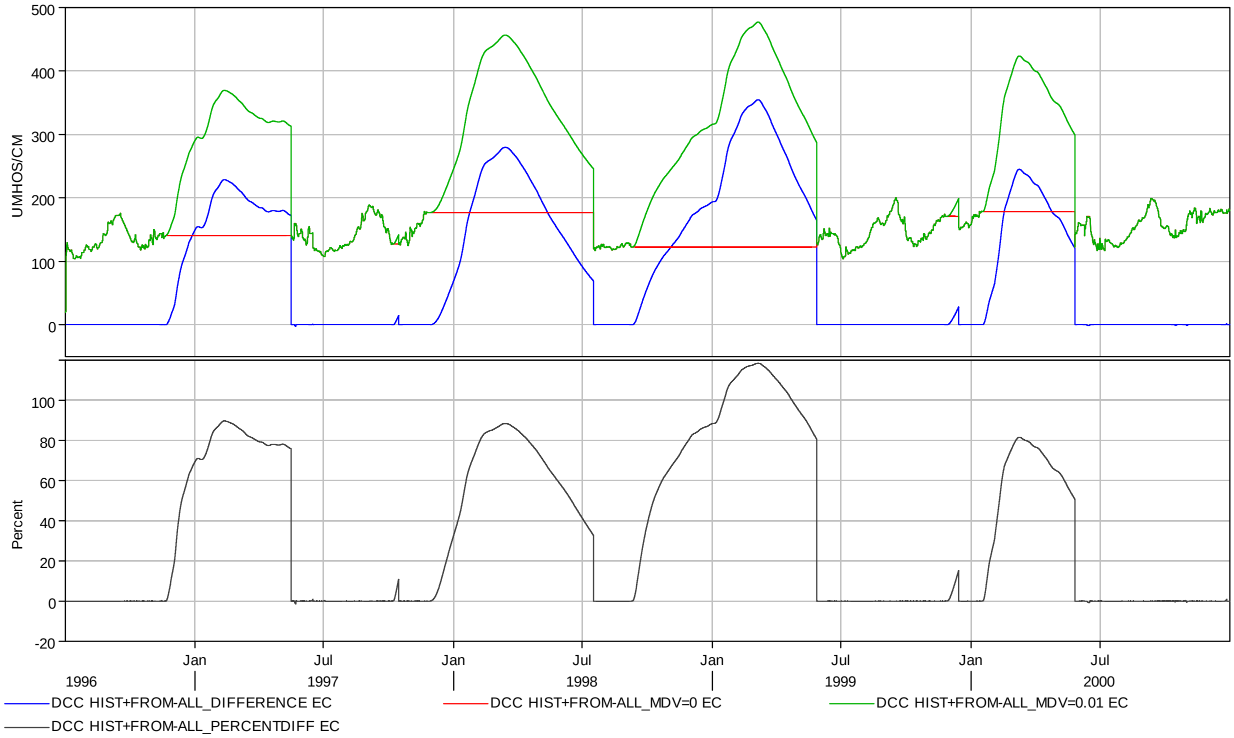

Figure 2-1 Delta Cross Channel (instantaneous, MDV=0 and 0.01)

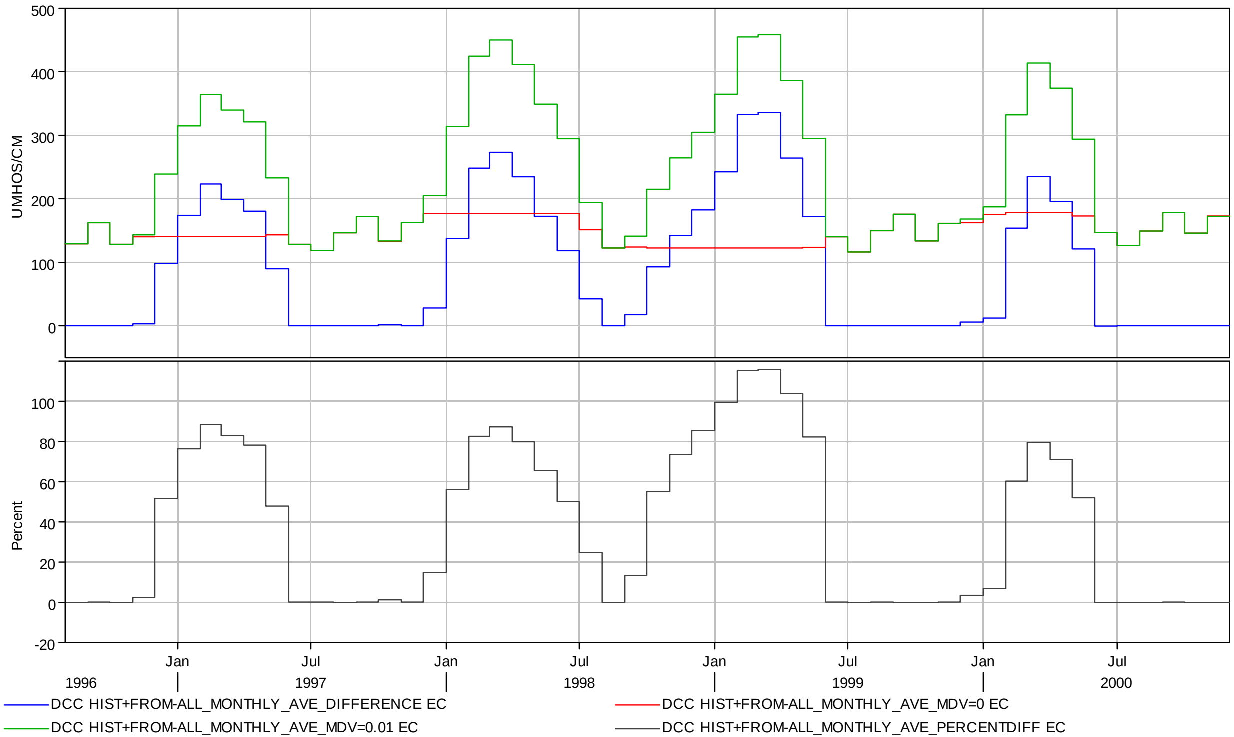

Figure 2-2 Delta Cross Channel (monthly average, MDV=0 and 0.01)

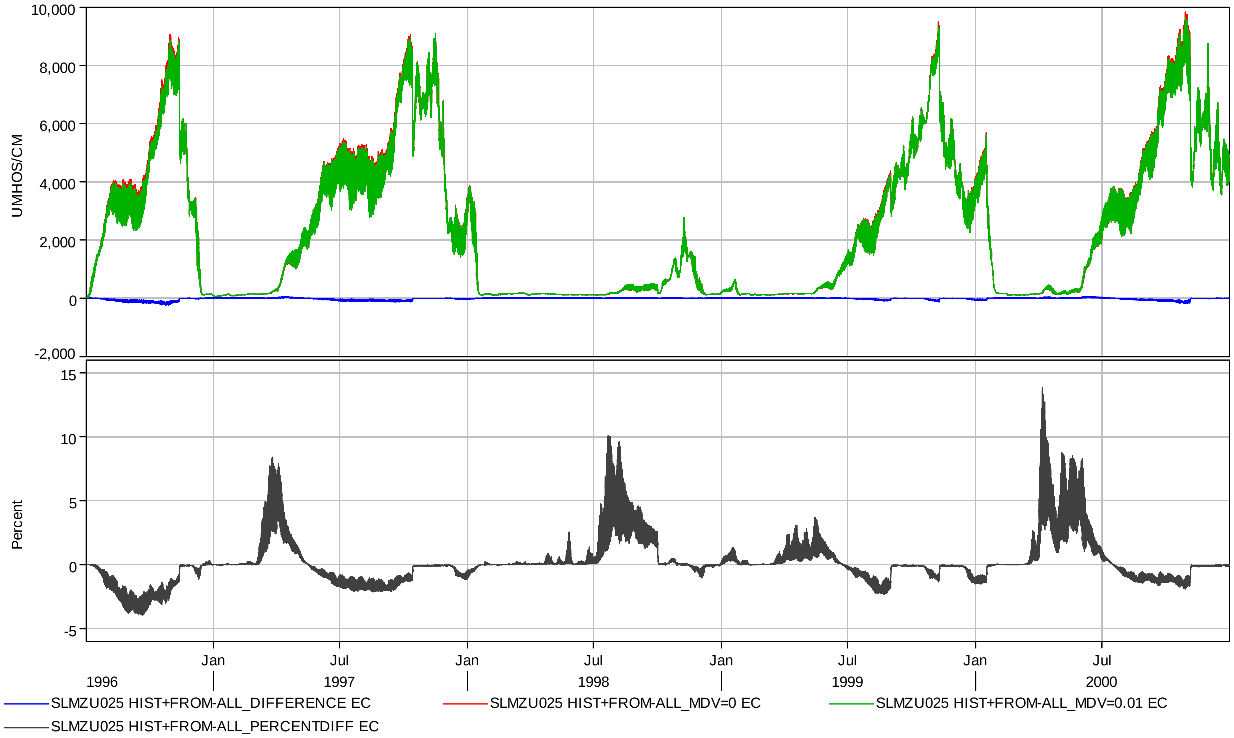

Figure 2-3 Montezuma Slough (instantaneous, MDV=0 and 0.01)

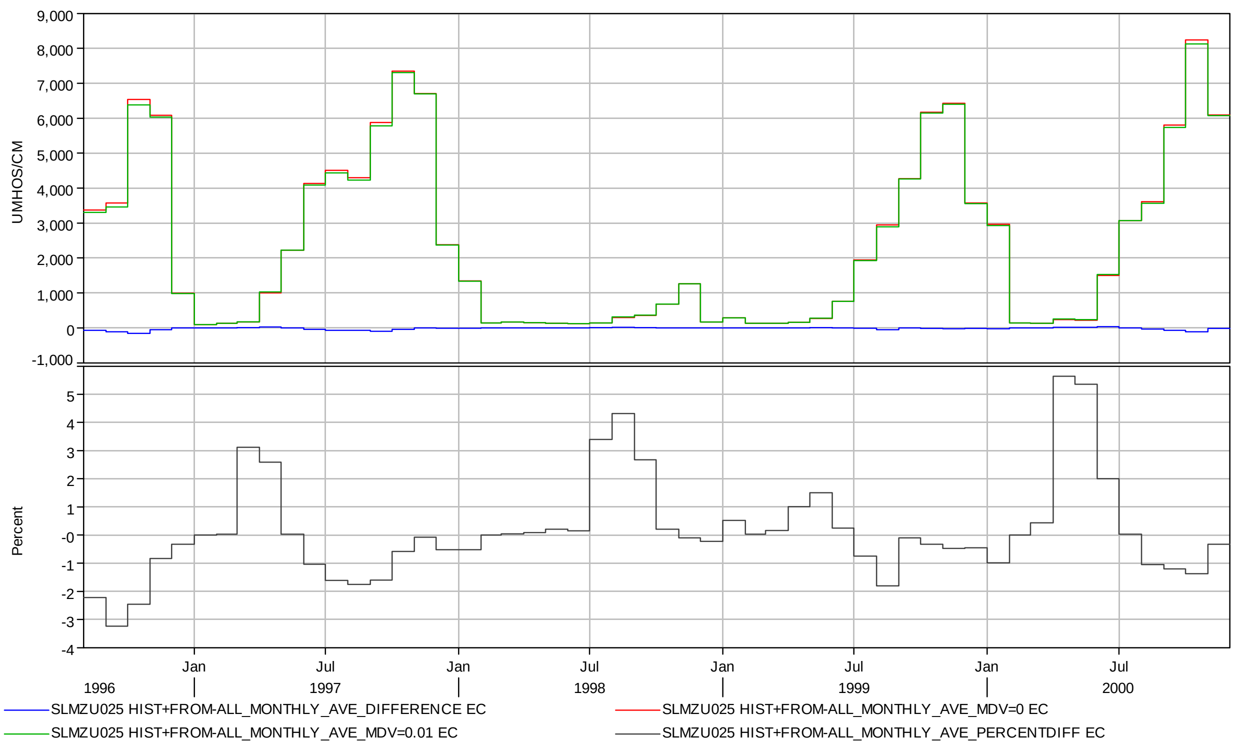

Figure 2-4 Montezuma Slough (monthly average, MDV=0 and 0.01)

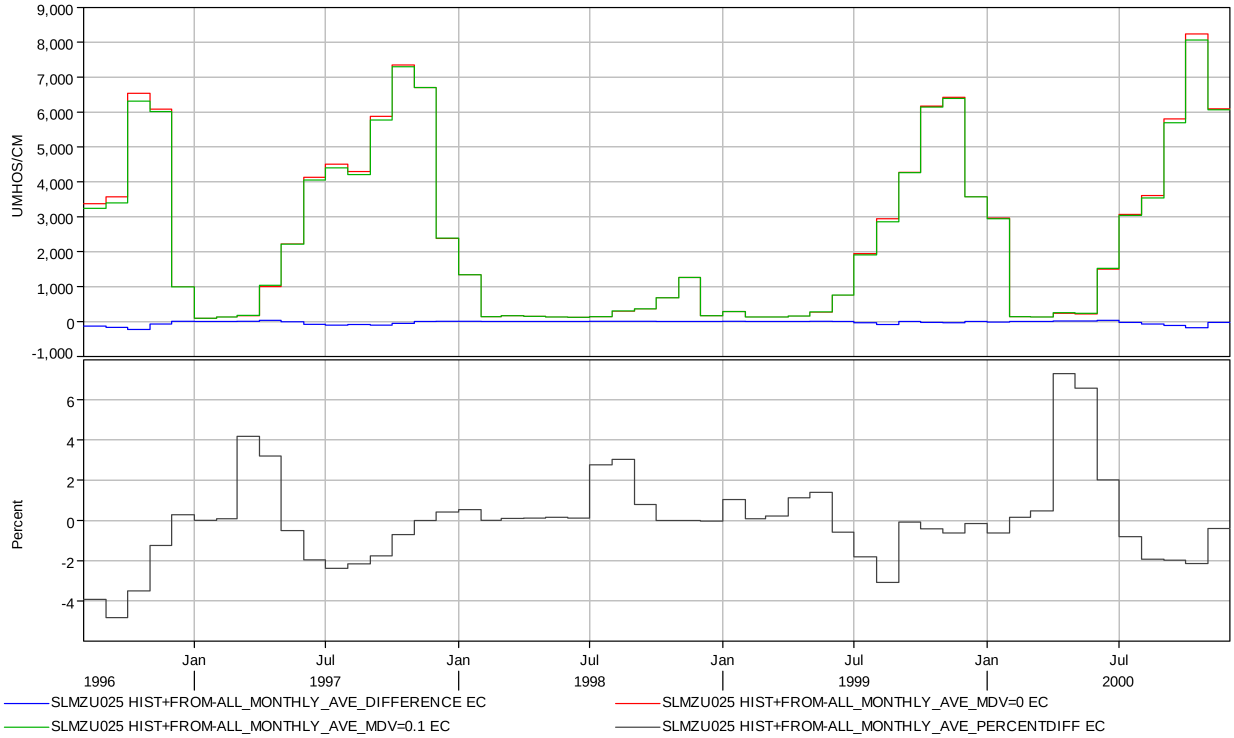

Figure 2-5 Montezuma Slough (monthly average, MDV=0 and 0.1)

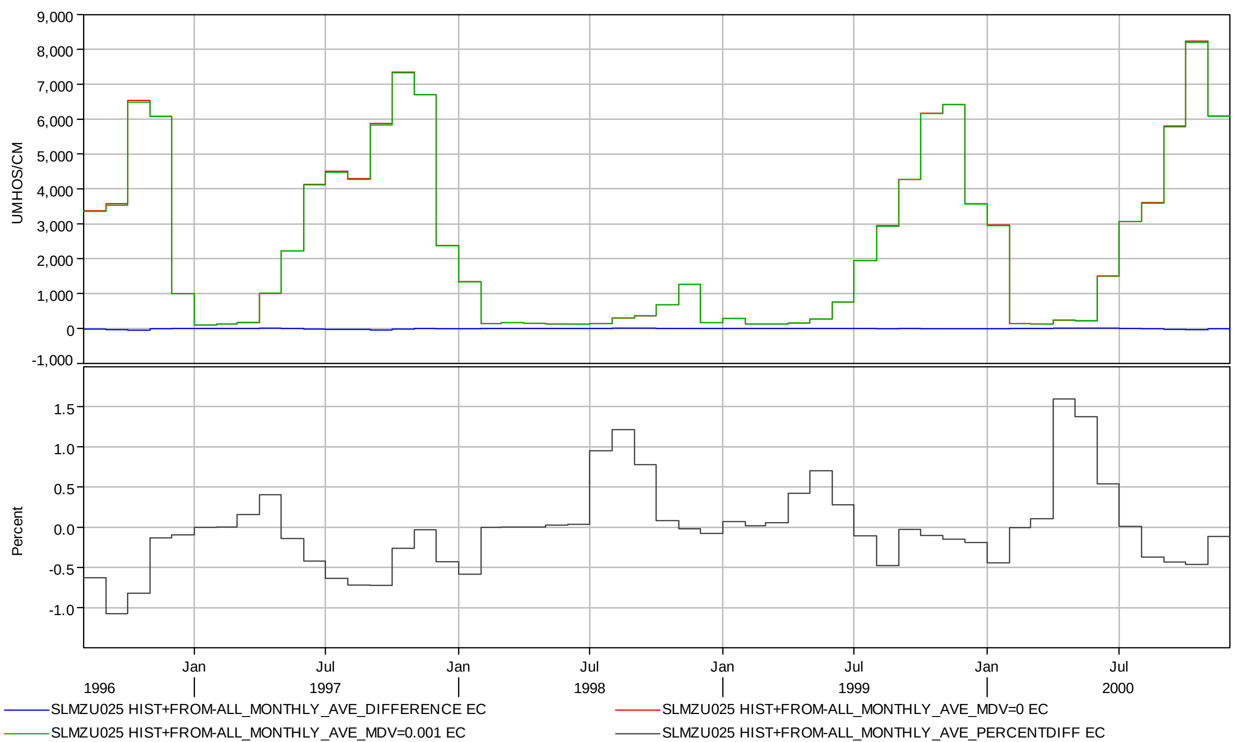

Figure 2-6 Montezuma Slough (monthly average, MDV=0 and 0.001)

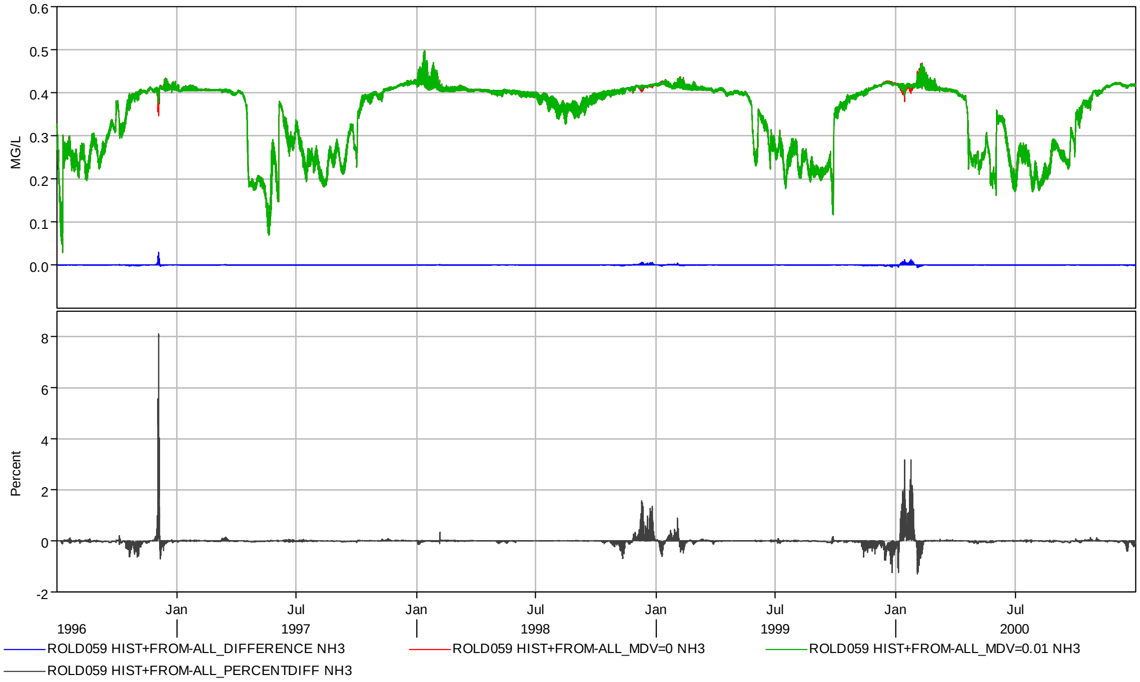

Figure 2-7 Old River at Tracy Road (instantaneous, ammonia)

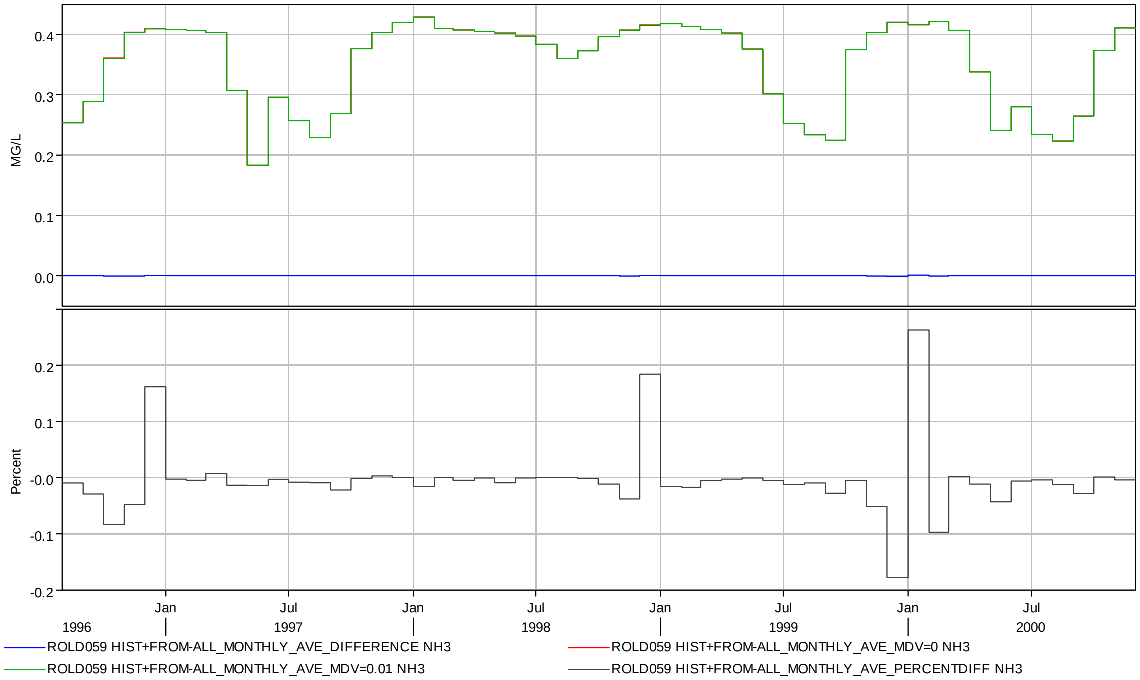

Figure 2-8 Old River at Tracy Road (monthly average, ammonia)

Appendix 2-C

Test 3: Cold Start

In test 3, a cold-start run (all constituents with initial value of 20) was made, starting with the date October 1, 1996, and continuing for several simulated years. The results were compared with a run made with proper initial condition using a restart file. The non-conservative constituent results were compared at stations RSAC075, ROLD059, RSAN058, and Clifton Court. At RSAC059 and RSAN058, all constituents converge within 1 year. It takes longer to converge at RSAC075. After a little more than 2 years (October–December 1998), the difference for algae was still 5% (Figure 2-9) and for PO4, 10% (Figure 2-10). It takes up to 2 years at Clifton Court to converge (Figure 2-11).

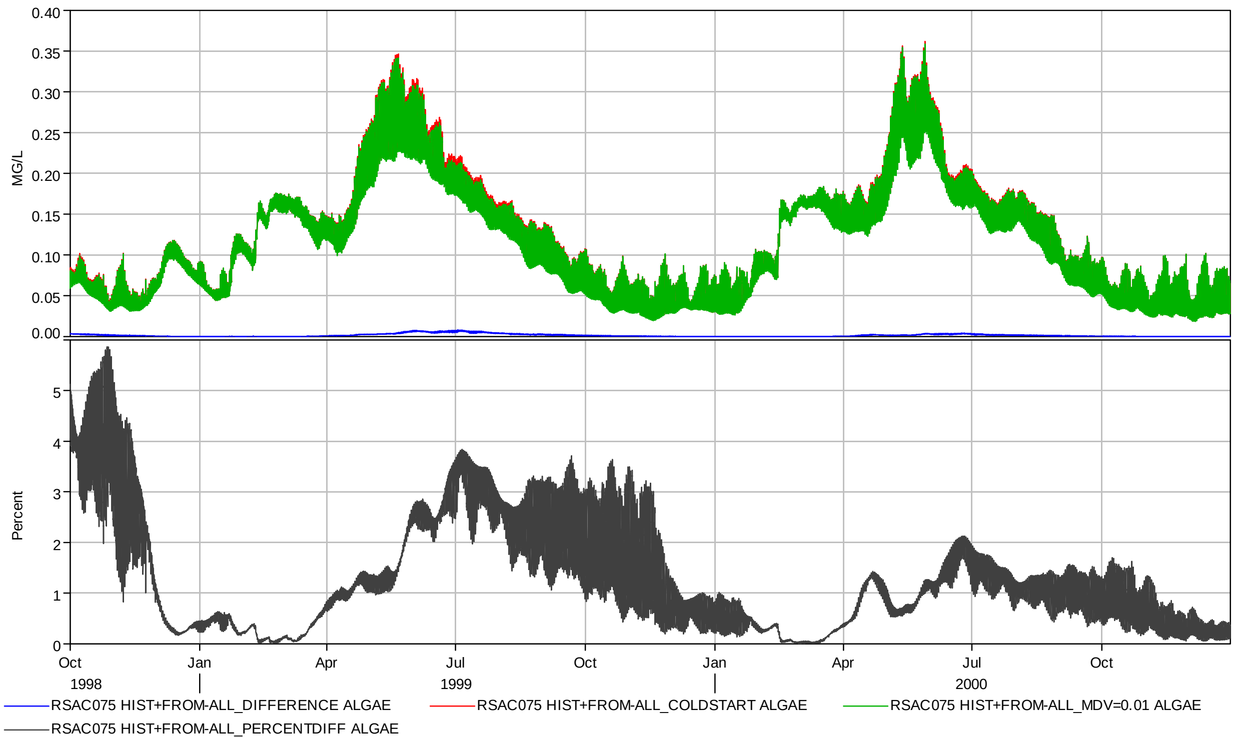

Figure 2-9 Mallard Island cold vs. warm start, algae

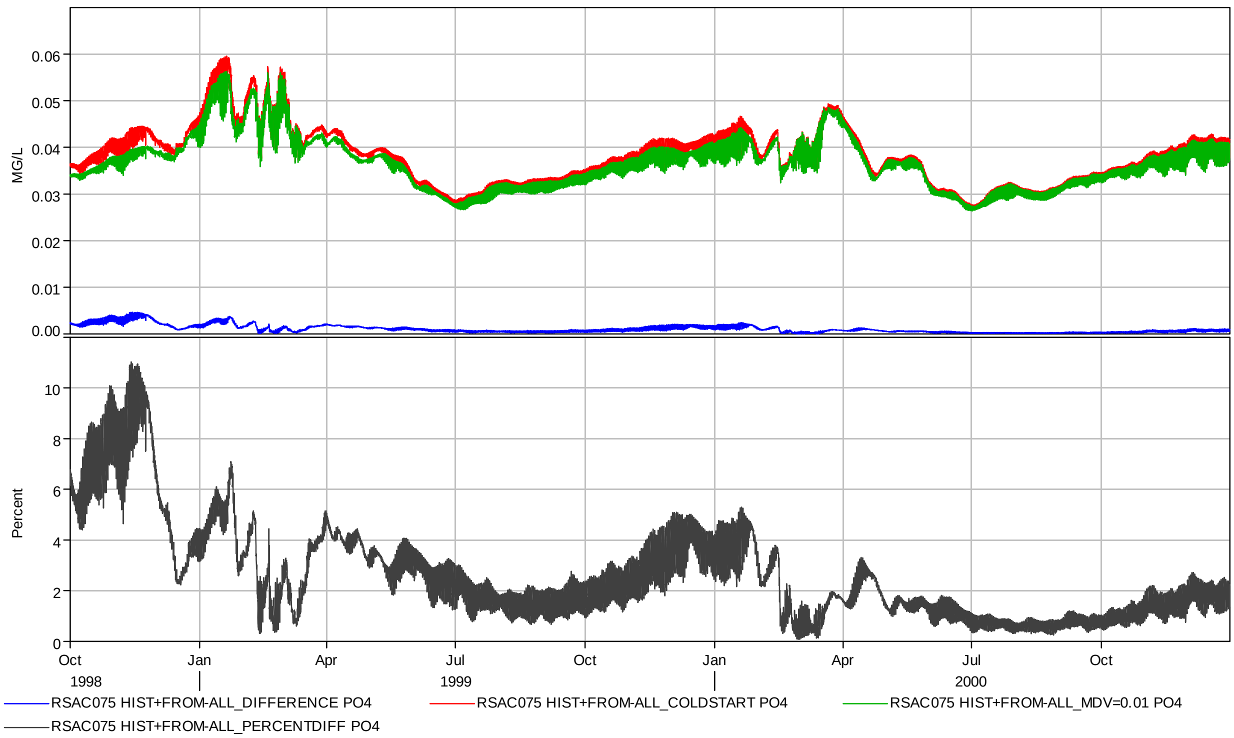

Figure 2-10 Mallard Island cold vs. warm start, phosphate

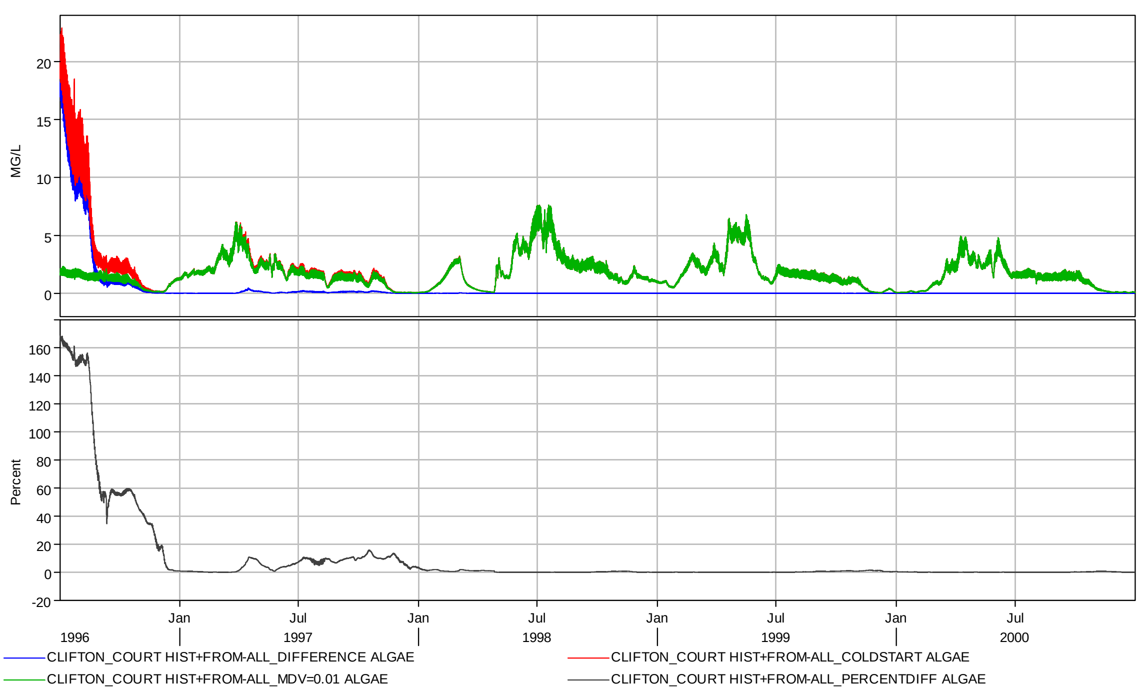

Figure 2-11 Clifton Court cold vs. warm start, algae