

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

32nd Annual Progress Report  
June 2011

## **Chapter 9 DOC Validation with DSM2**

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## 9 DOC Validation with DSM2

### 9.1 Summary

Using the Delta Simulation Model II (DSM2), historical Delta dissolved organic carbon (DOC) was simulated over the period 1990 through 2010 and compared to available measured data. DOC fingerprints were generated at several locations to evaluate how contributions of various sources of DOC in the Delta vary by location.

### 9.2 Background

DWR's Delta Modeling Section is a participant in the Real Time Data Forecasting group (RTDF), a technical subcommittee of the Municipal Water Quality Investigations Program (MWQI). One of the key goals of RTDF is to develop the capability to produce short-term forecasts of Delta DOC. Aligned with this goal is the documentation of current DSM2 capability for reproducing historically observed DOC throughout the Delta. This task was identified as a deliverable in the 2009-2010 RTDF Work Plan (California Department of Water Resources, Municipal Water Quality Investigations Program 2009). A comparison of DSM2-simulated and measured DOC for the period of 1991 through 1997 was documented earlier (Pandey 2001). Since that analysis, 13 years of measured DOC data have been collected, including periods of continual monitoring in the Sacramento River at Hood, in the San Joaquin River at Vernalis, and at Banks Pumping Plant. In addition, simulated fingerprinting of sources of water quality constituents has become a helpful way of understanding model performance. This chapter summarizes the methods and results from an expanded DSM2 simulation of historical Delta DOC.

### 9.3 Study Methodology

Delta hydrodynamics for the period of 1990 through 2010 were simulated using the DSM2 hydrodynamic module (DSM2-HYDRO). The source for stage and flow data was the California Data Exchange Center (CDEC). The agriculture withdrawals and drainage flows were calculated by the Delta Island Consumptive Use Model (DICU), documented previously by DWR (1995). Several gates are installed and operated each year in the Delta. The simulation of these structures followed the documentation provided by the Interagency Ecological Program DSM2 Project Work Team is available at <http://www.water.ca.gov/dsm2pwt/data>.

After historical Delta hydrodynamics were simulated, Delta DOC was simulated by assuming that DOC in the Delta behaved as a conservative constituent. Boundary DOC for Delta inflows and for the downstream boundary at Martinez was developed by MWQI using available grab sample and continuously monitored data. Figure 9-1 presents the DOC values for the Delta inflows; the downstream boundary at Martinez was assumed to have a constant value of 2 mg/L.

DOC concentrations in agricultural drainage were based upon a study by Marvin Jung and Associates (2000), which assigned monthly DOC according to island location with respect to 3 Delta regions. These regions and the DOC values assumed in agricultural drainage are shown in Figure 9-2.

DSM2-simulated DOC is presented at every location that had observed DOC data. While grab samples were taken at a specific time on a given day, the grab sample results were plotted along with DSM2-simulated daily average DOC. One reason for this approach is that DSM2 water quality module (DSM2-QUAL) was calibrated to daily average electrical conductivity (EC); hourly variations in simulated EC or DOC are not typically shown. A second reason is that simulated DOC in the Delta tends to have a modest

tidal variation. Figure 9-3 shows the DSM2-simulated daily range for 15-minute DOC at Clifton Court Forebay, Old River at Bacon Island, and Jersey Point for 1991-1993. The daily range in simulated DOC varies by location, but is usually small compared to the daily average DOC. Over the 1991-2010 period, the daily range in simulated DOC at Clifton Court Forebay, Old River at Bacon Island, and Jersey Point DOC is 0.1 mg/L, 0.3 mg/L, and 0.2 mg/L, respectively.

The availability of measured DOC in the Delta from grab samples is extensive for the period 1990—1994 but much less for later periods. Continuous DOC is available at Banks Pumping Plant starting December 22, 2001; in the Sacramento River at Hood, starting February 22, 2003; and for the San Joaquin River at Vernalis, starting March 28, 2005. Figure 9-4 shows the locations where DSM2-simulated daily DOC is compared to measured DOC for the 1991-1994 period. Measured data are available at fewer locations for subsequent 4-year intervals.

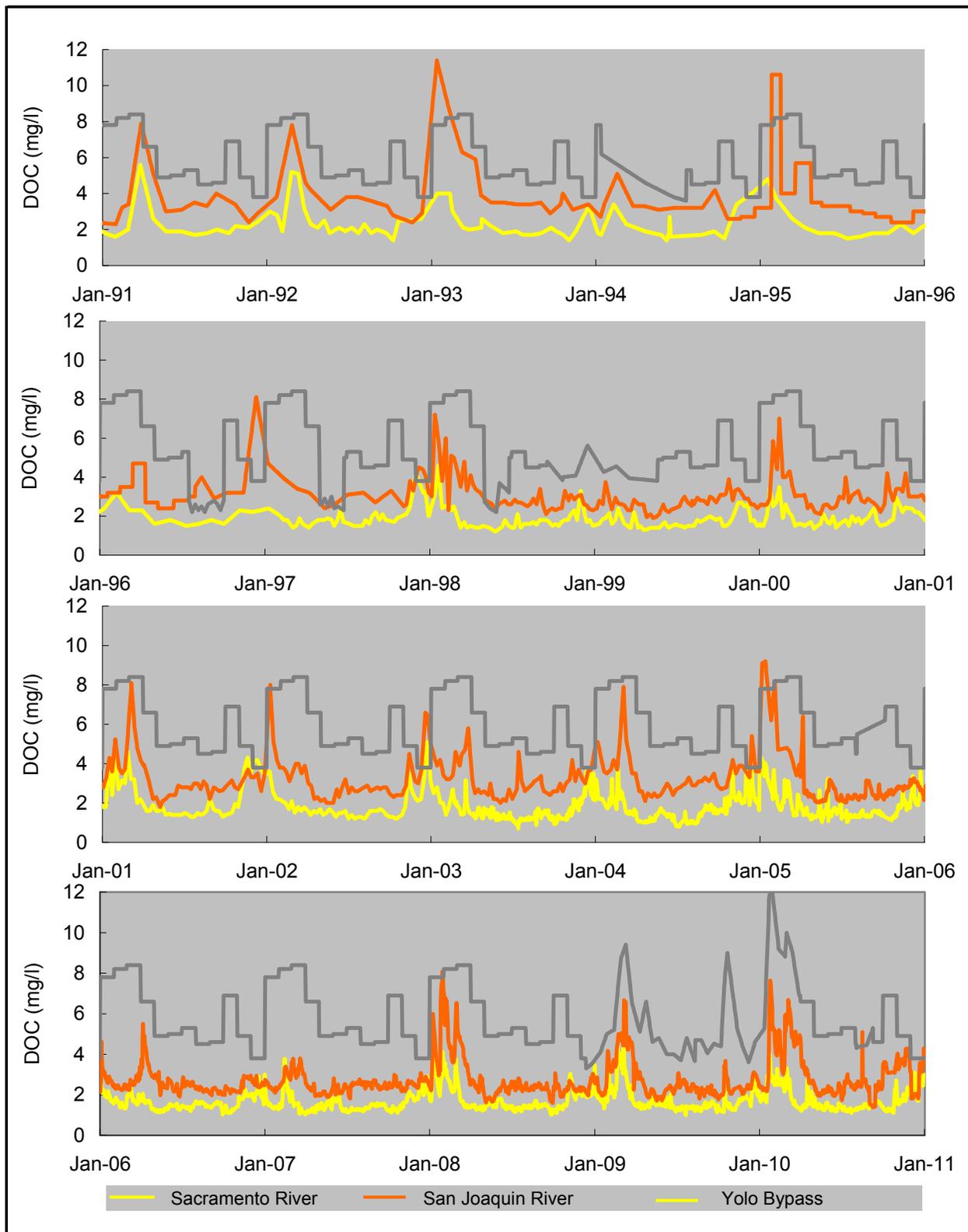


Figure 9-1 Assumed DOC for Delta inflows for simulation of historical conditions

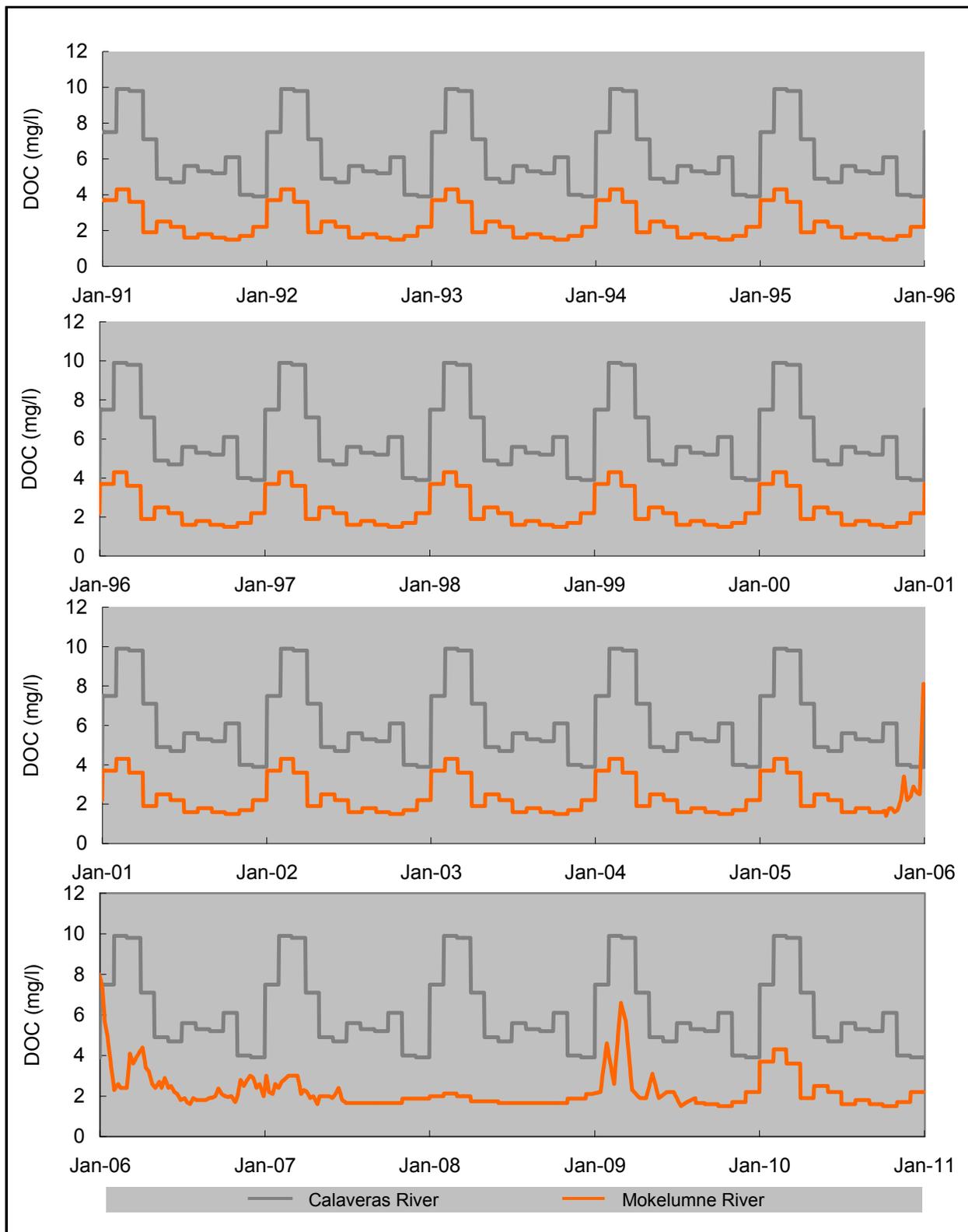


Figure 9-1 (cont.) Assumed DOC for Delta inflows for simulation of historical conditions

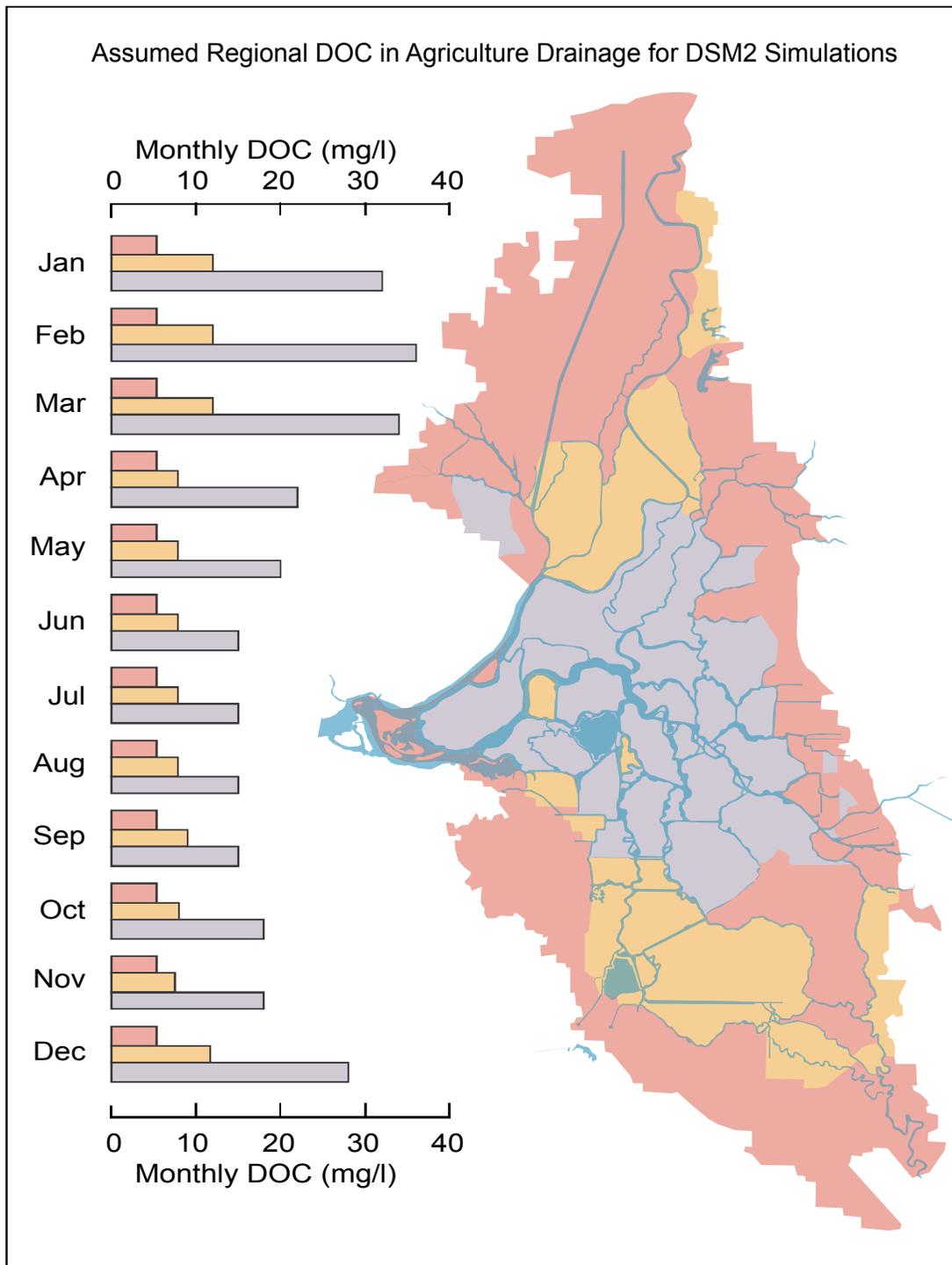


Figure 9-2 DOC assumed for agricultural drainage by Delta region

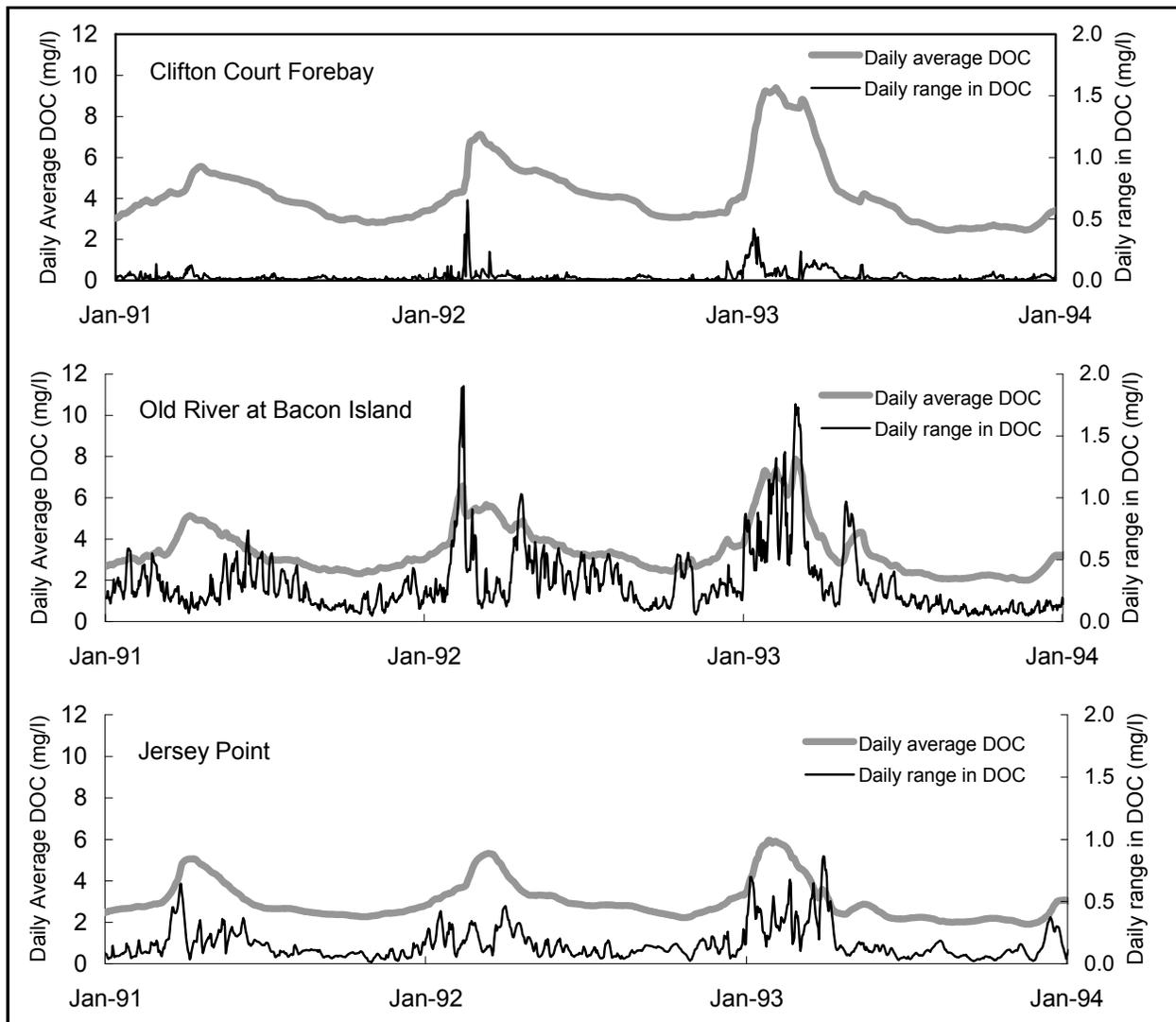
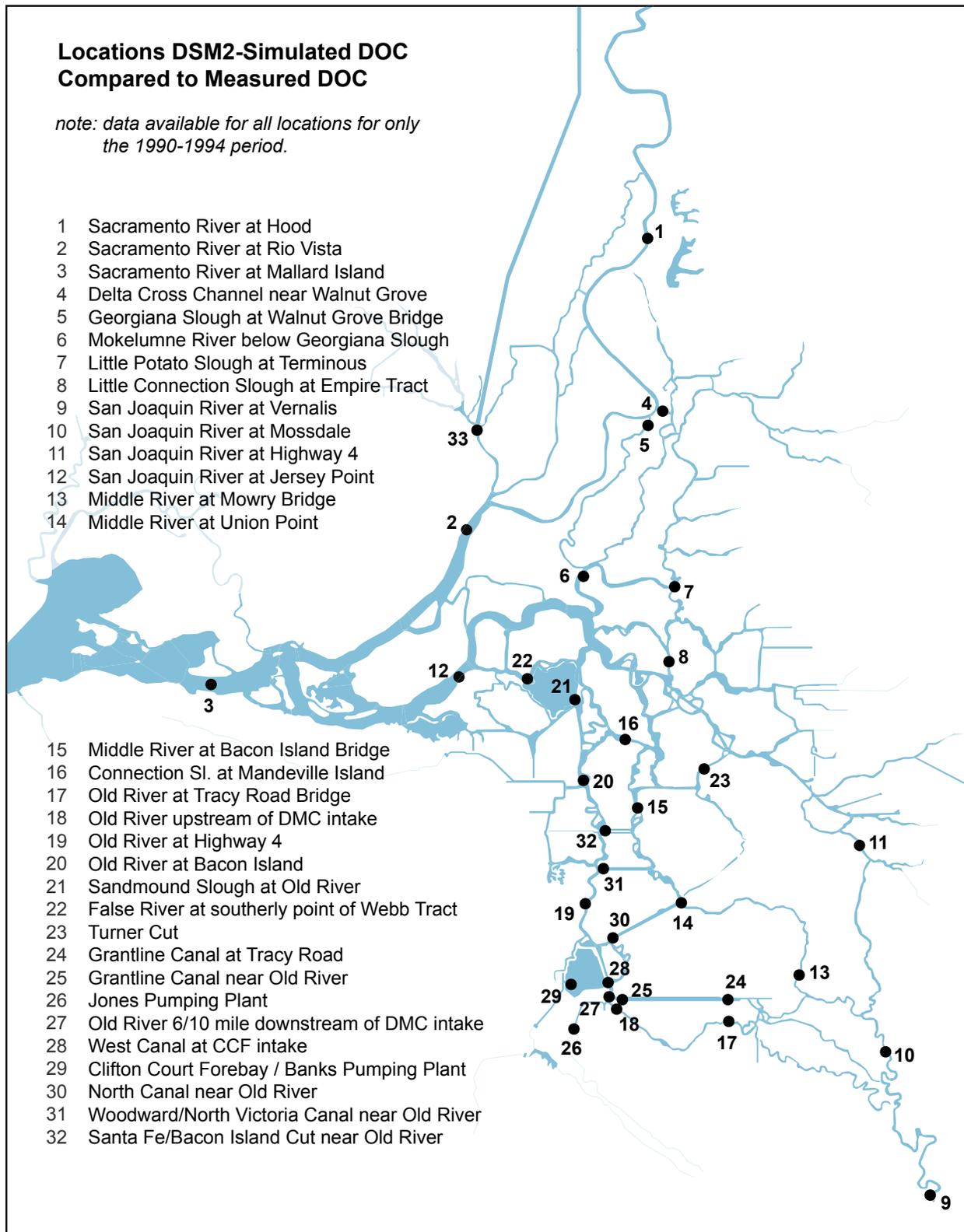


Figure 9-3 Example of daily range and daily average DOC in DSM2-simulated conditions



## 9.4 Study Results

Comparison of simulated and measured DOC is separated into 5 time periods to facilitate analysis considering the varying availability of measured data. These periods are June 1990-1994, 1995-1998, 1999-2002, 2003-2006, and 2007-2010, with results presented in Figure 9-5 through Figure 9-9<sup>1</sup>. These figures also show the DSM2 input boundary DOC at Sacramento River at Hood and San Joaquin River at Vernalis along with the grab sample or continuous DOC to show how the boundary time series was developed at these 2 locations.

The DSM2 simulation of historical Delta DOC conditions reproduces measured DOC well. The timing and magnitude of yearly peak DOC in the winter was successfully reproduced by DSM2 throughout the Delta during the July 1990 through 1994 period. The continued good performance in subsequent years at the locations measured DOC was available (Banks Pumping Plant, Jones Pumping Plant, Old River at Bacon Island, Old River at Highway 4) indicates that the simulated DOC Delta wide was likely accurate as well.

In contrast to a DSM2 simulation of Delta EC, successful simulation of Delta DOC is not as sensitive to accurate modeling of sea water intrusion because the major sources of DOC in the Delta are the Sacramento and San Joaquin Rivers and in-Delta island discharges. Fingerprints of DOC can be generated to explain relative sources of DOC at any location in the Delta at a specific time. This practice is routinely performed in monthly updates of DSM2 simulations of historical conditions for the Real Time Data Forecasting group (RTDF). Past results can be accessed at MWQI's RTDF website at [http://www.water.ca.gov/waterquality/drinkingwater/rtdf\\_rprt.cfm](http://www.water.ca.gov/waterquality/drinkingwater/rtdf_rprt.cfm)

In Figure 9-10, DOC fingerprint results are shown for 1991 through 1994 at 6 locations: Clifton Court Forebay, Jones Pumping Plant, Middle River at Union Point, Old River at Tracy Road, Old River at Bacon Island, and San Joaquin River at Jersey Point (see Figure 9-4 for these locations).

The DOC fingerprints show significant contribution to yearly winter peak DOC periods in the south Delta by the San Joaquin River inflow and drainage from Delta islands. Considering how well the simulated DOC tracked the measured DOC in the south Delta, Figure 9-10 indicates that the simulated island drainage is adequate for generating meaningful results. Figure 9-10 also shows that summertime island drainage is a significant contributor to DOC in Old River at Tracy Road. Moving downstream to Old River at Bacon Island and at San Joaquin River at Jersey Point, Figure 9-10 as expected shows in-Delta drainage contributing less to the overall DOC. At Old River at Bacon Island and Jersey Point, both the Sacramento River inflow and the San Joaquin River inflow are important for producing the annual peak DOC values.

## 9.5 Conclusions

The simulation of historical Delta DOC conditions with DSM2 provides meaningful results. Significant errors at times observed in DSM2 simulation of historical Delta EC conditions do not translate into significant DOC errors. The annual pattern of rising DOC in the winter time is reproduced in the DSM2 simulation. The DOC simulation indicates that the significant sources of DOC for the yearly peak period depend upon the location in the Delta: Delta island drainage and San Joaquin River inflow in the south Delta; and Sacramento River and San Joaquin River inflow in the central and west Delta.

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<sup>1</sup> Figures 9-5 through 9-10 are placed in the final pages of this chapter.

## 9.6 References

California Department of Water Resources, Division of Planning. "Estimation of Delta Island Diversions and Return Flows." Division Report, State of California, Department of Water Resources, Sacramento, CA., 1995.

California Department of Water Resources, Municipal Water Quality Investigations Program. *Municipal Water Quality Investigations Program 2009-2010 Workplan*. 2009.

<http://www.water.ca.gov/waterquality/drinkingwater/workplans.cfm> (accessed March 2011).

Jung, Marvin. "Revision of Representative Delta Island Return Flow Quality for DSM2 and DICU Model Runs." Prepared under DWR contract by Marvin Jung and Associates, Inc., CALFED Ad-Hoc Workgroup to Simulate Historical Water Quality Conditions in the Delta, 2000.

Pandey, G. "Chapter 3: Simulation of Historical DOC and UVA Conditions in the Delta." *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. 22nd Annual Progress Report from the California Department of Water Resources to the State Water Resources Control Board*, 2001.

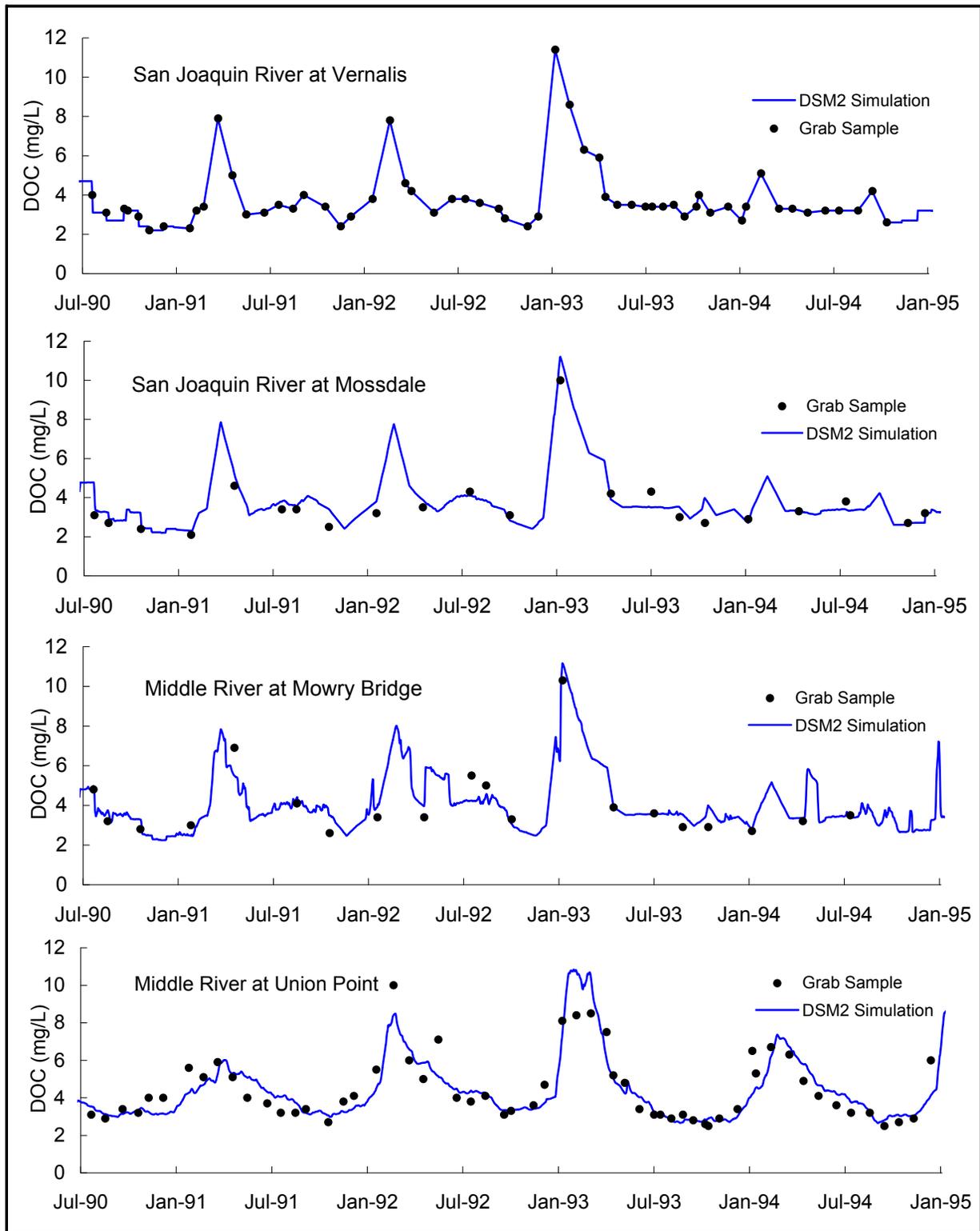


Figure 9-5 DSM2-simulated daily DOC and measured DOC, July 1990–1994

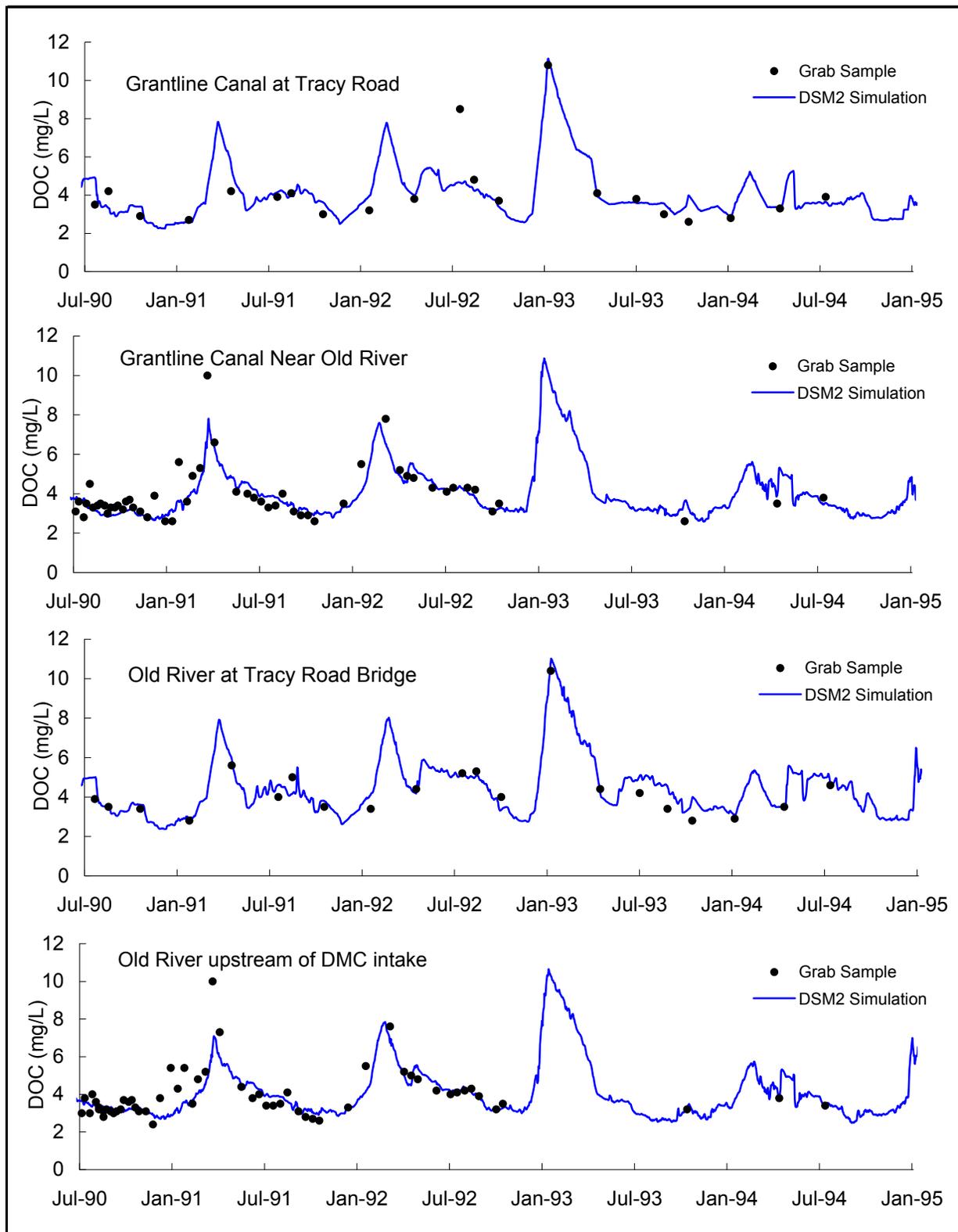


Figure 9-5 (cont.) DSM2-simulated daily DOC and measured DOC, July 1990–1994

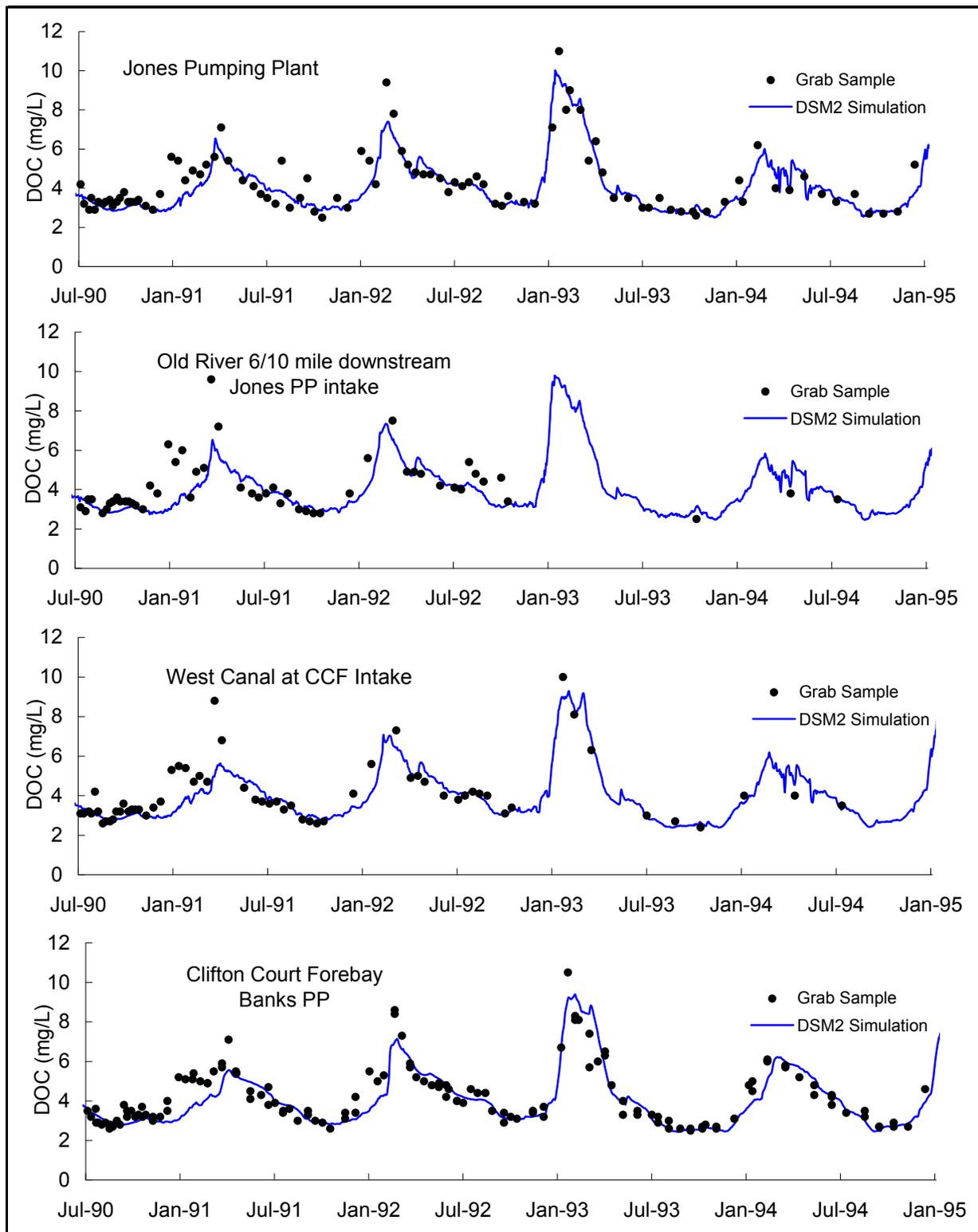


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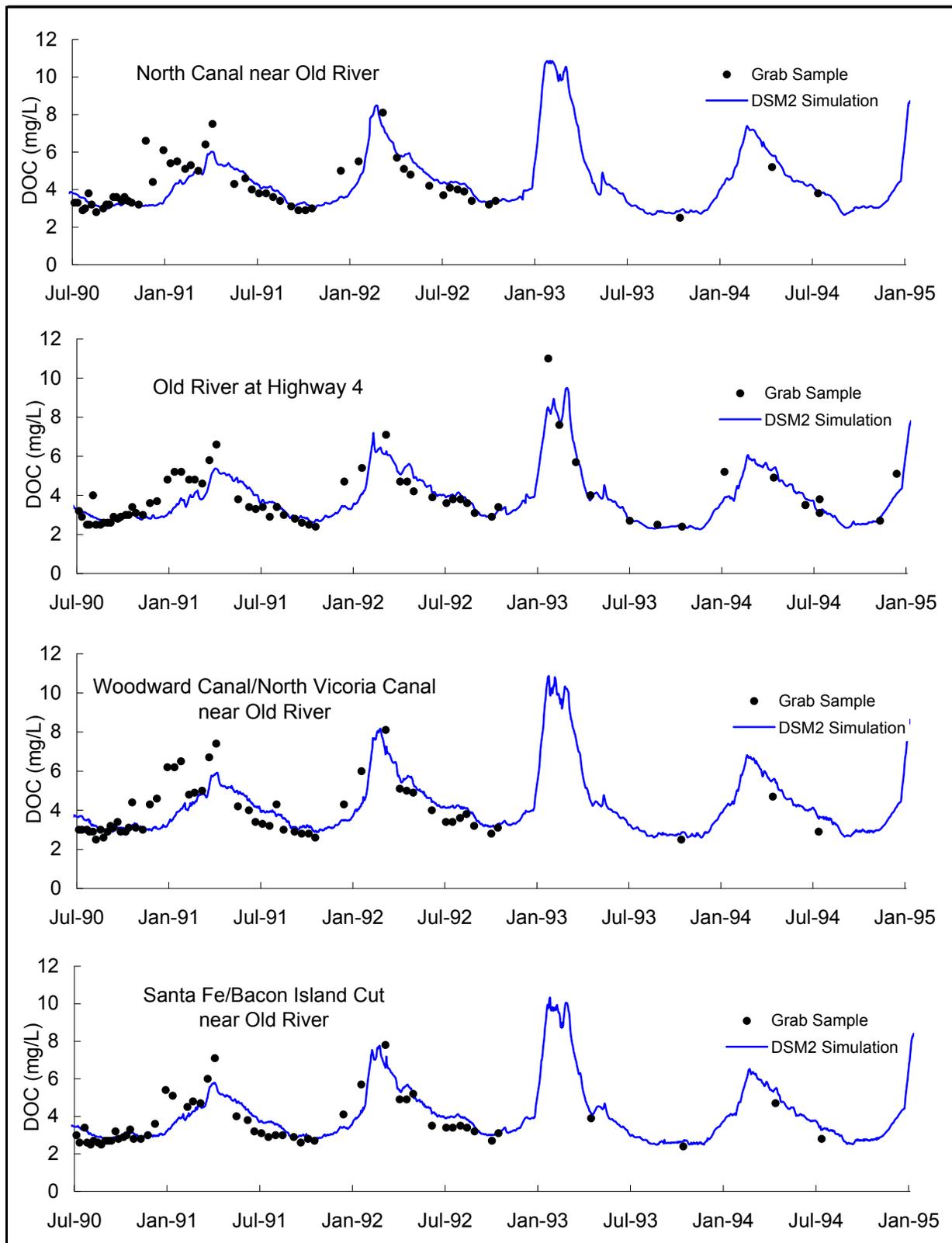


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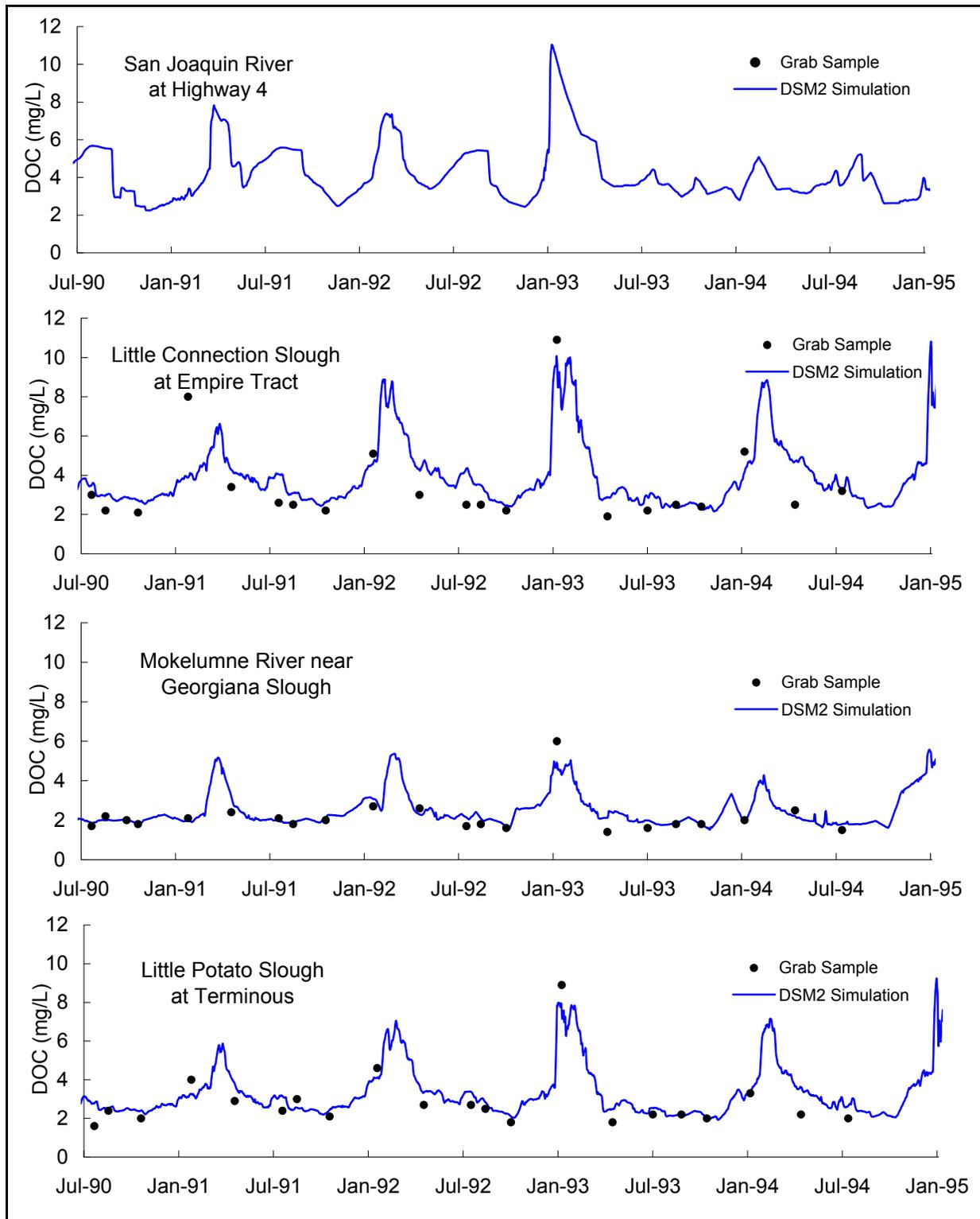


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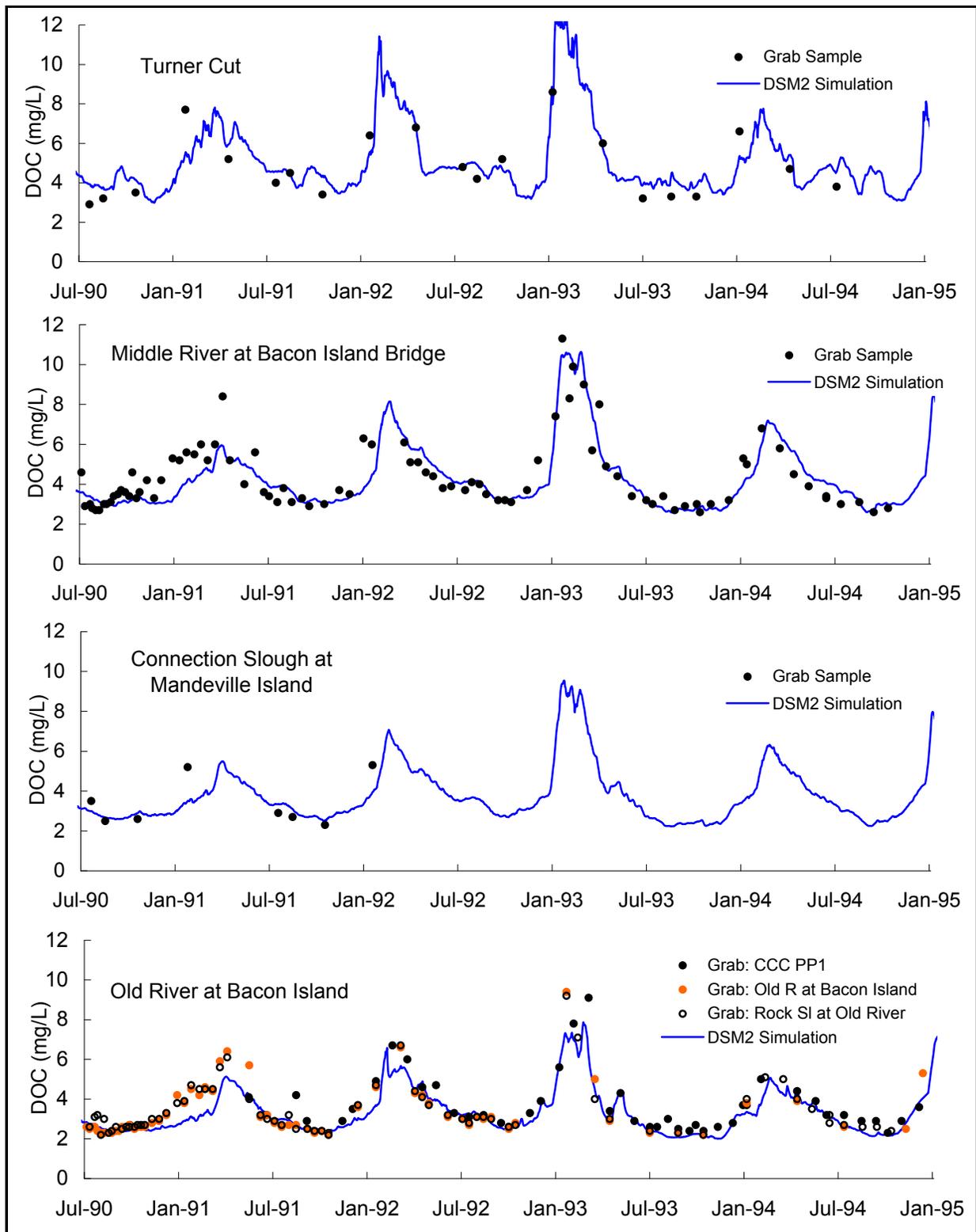


Figure 9-5 (cont.) DSM2-simulated daily DOC and measured DOC, July 1990–1994

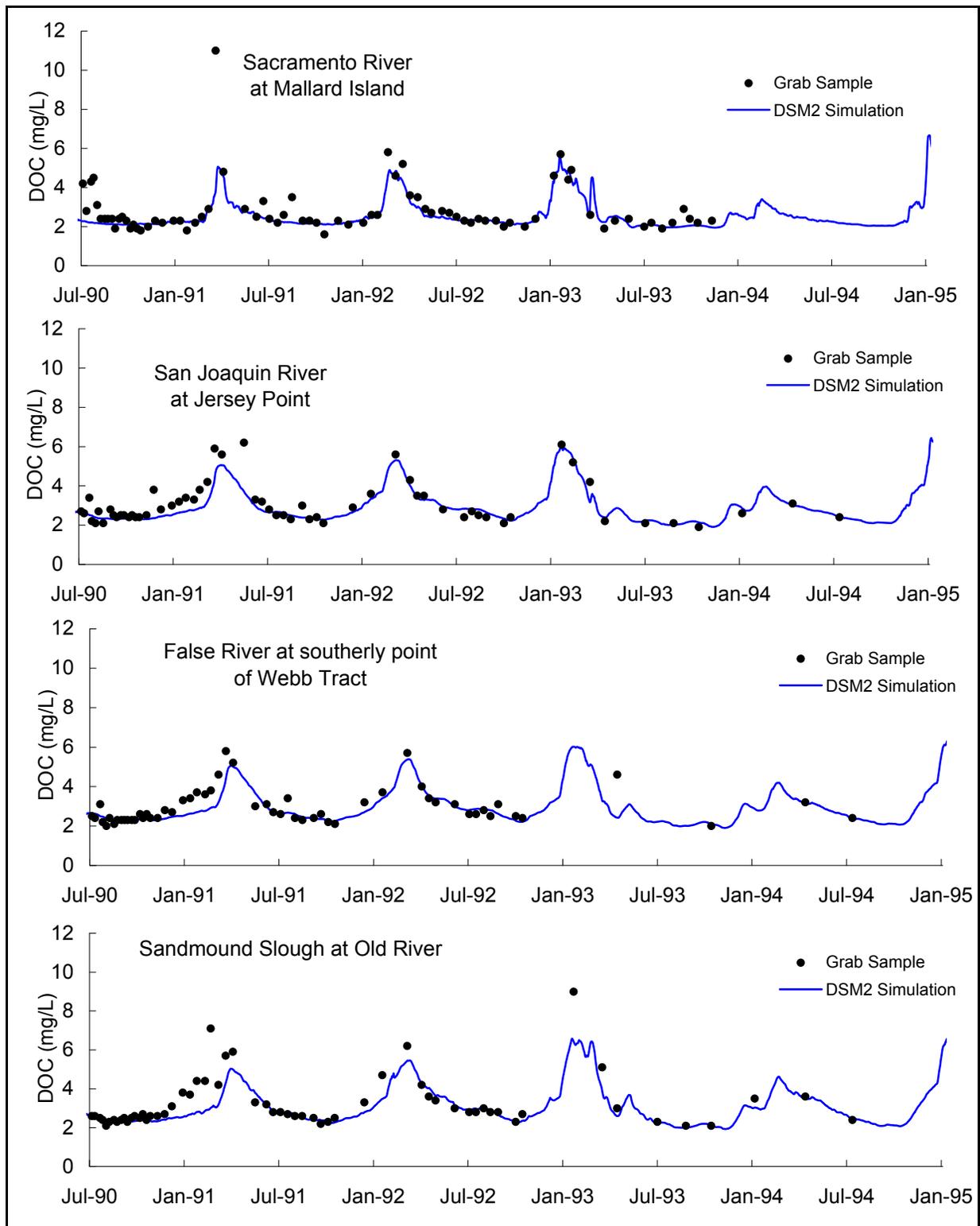


Figure 9-5 (cont.) DSM2-simulated daily DOC and measured DOC, July 1990–1994

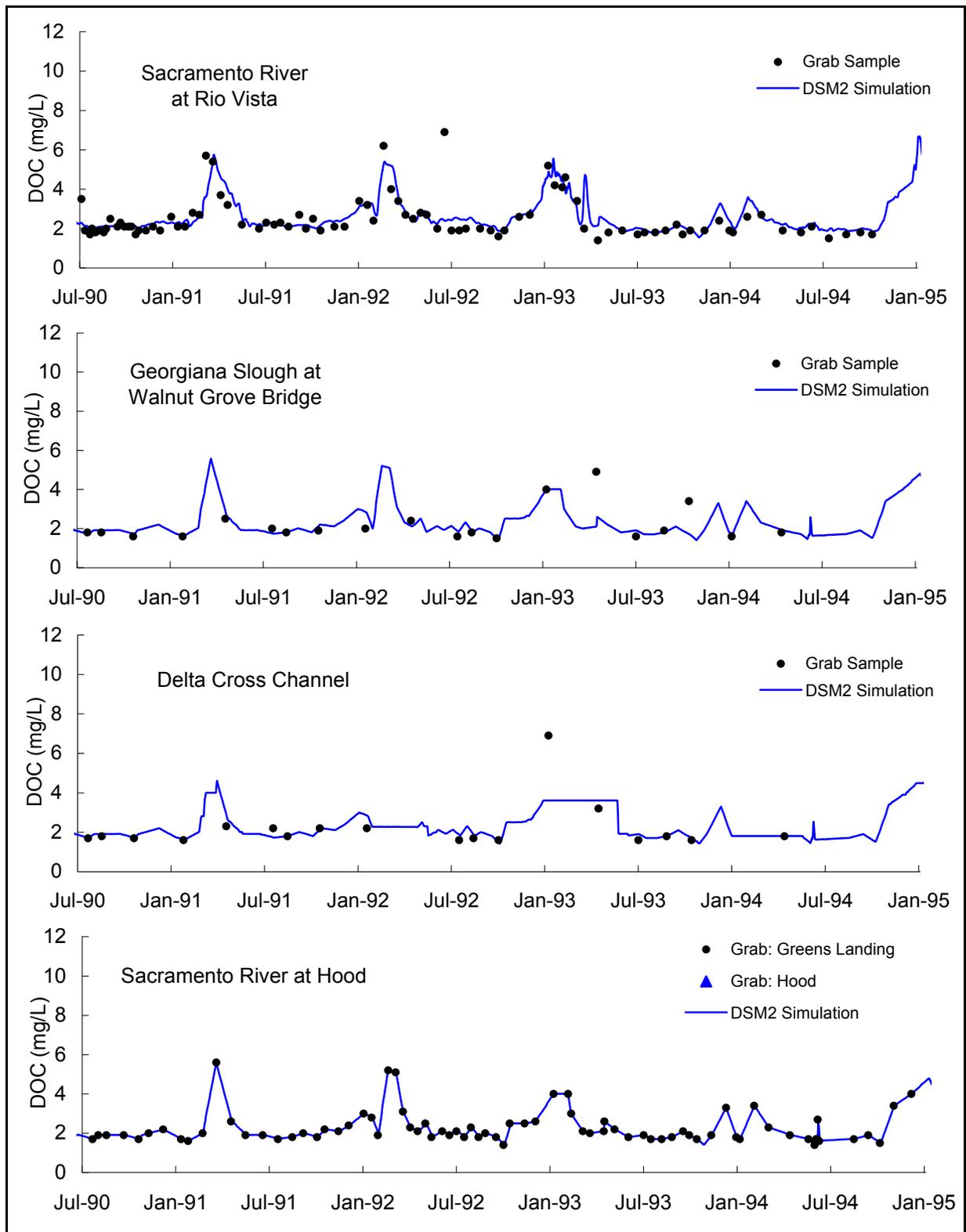


Figure 9-5 (cont.) DSM2-simulated daily DOC and measured DOC, July 1990–1994

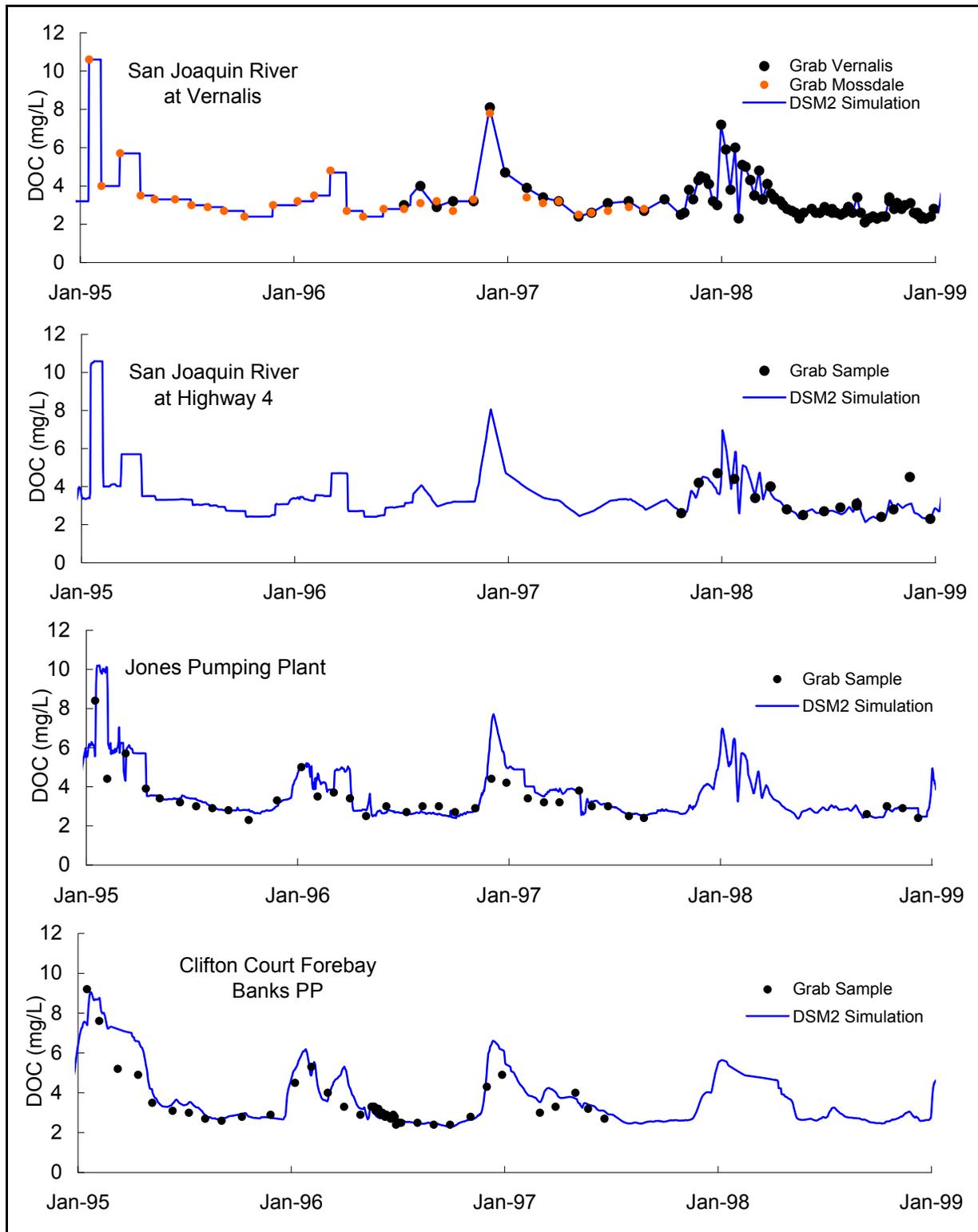


Figure 9-6 DSM2-simulated daily DOC and measured DOC, 1995–1998

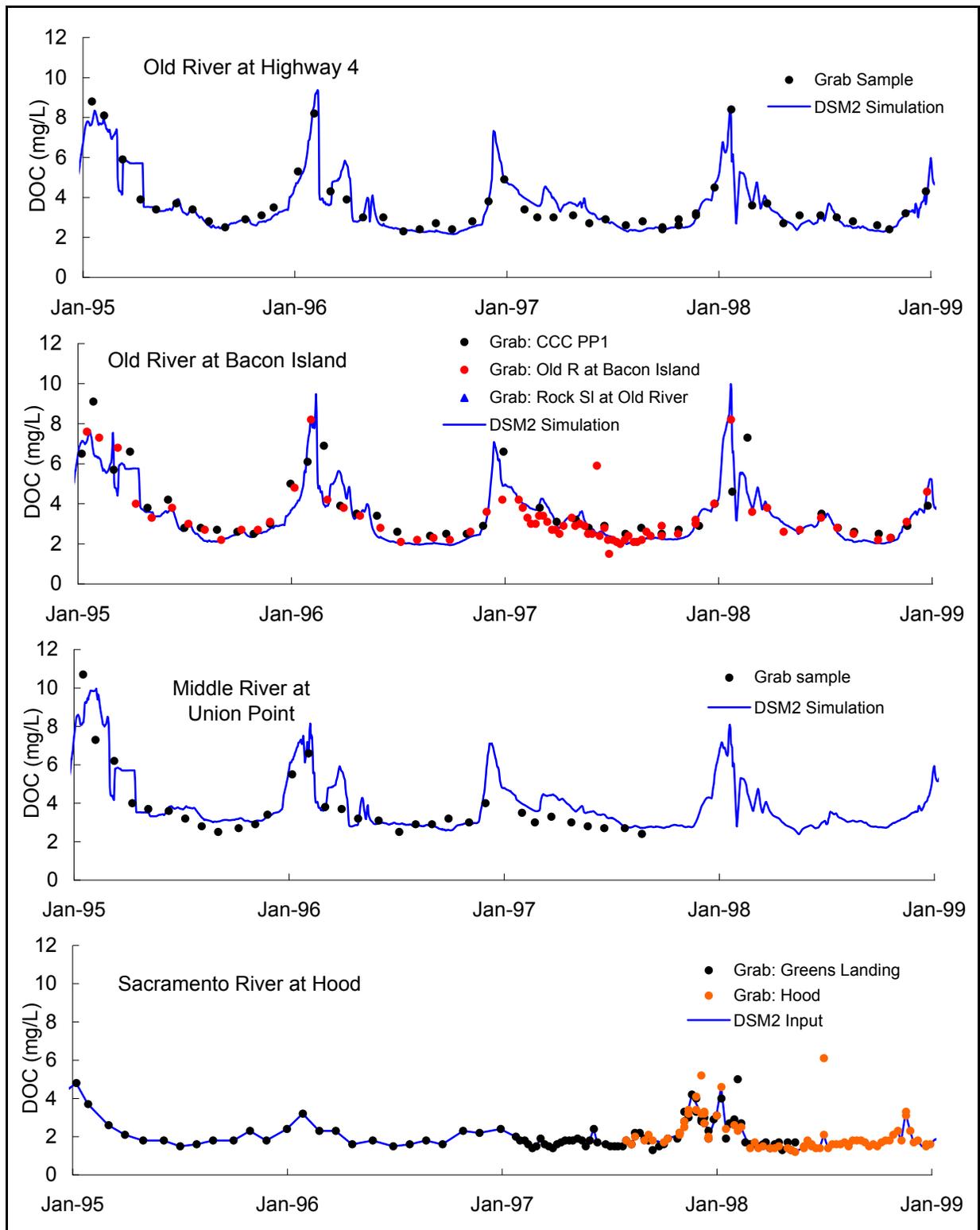


Figure 9-6 (cont.) DSM2-simulated daily DOC and measured DOC, 1995–1998

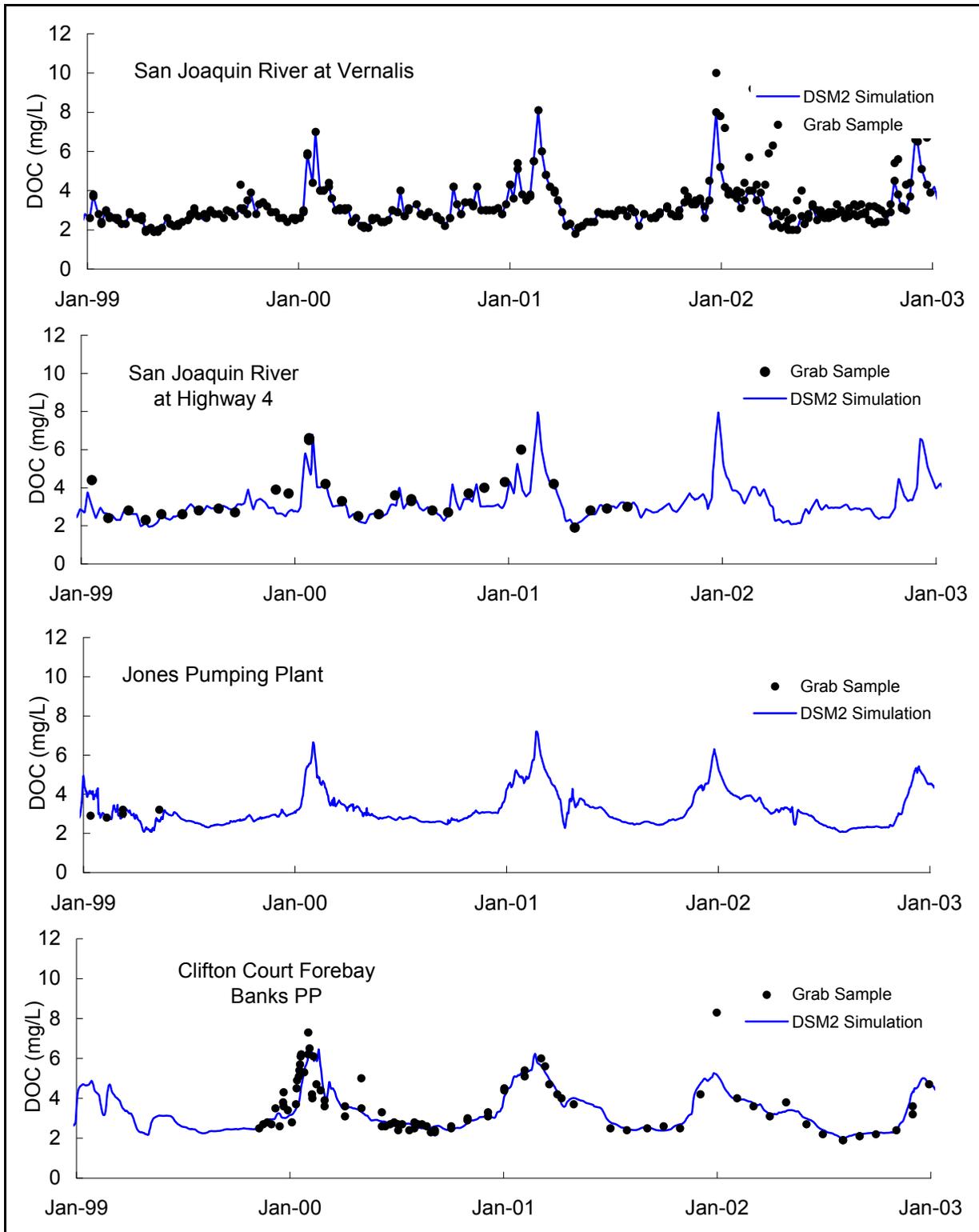


Figure 9-7 DSM2-simulated daily DOC and measured DOC, 1999–2002

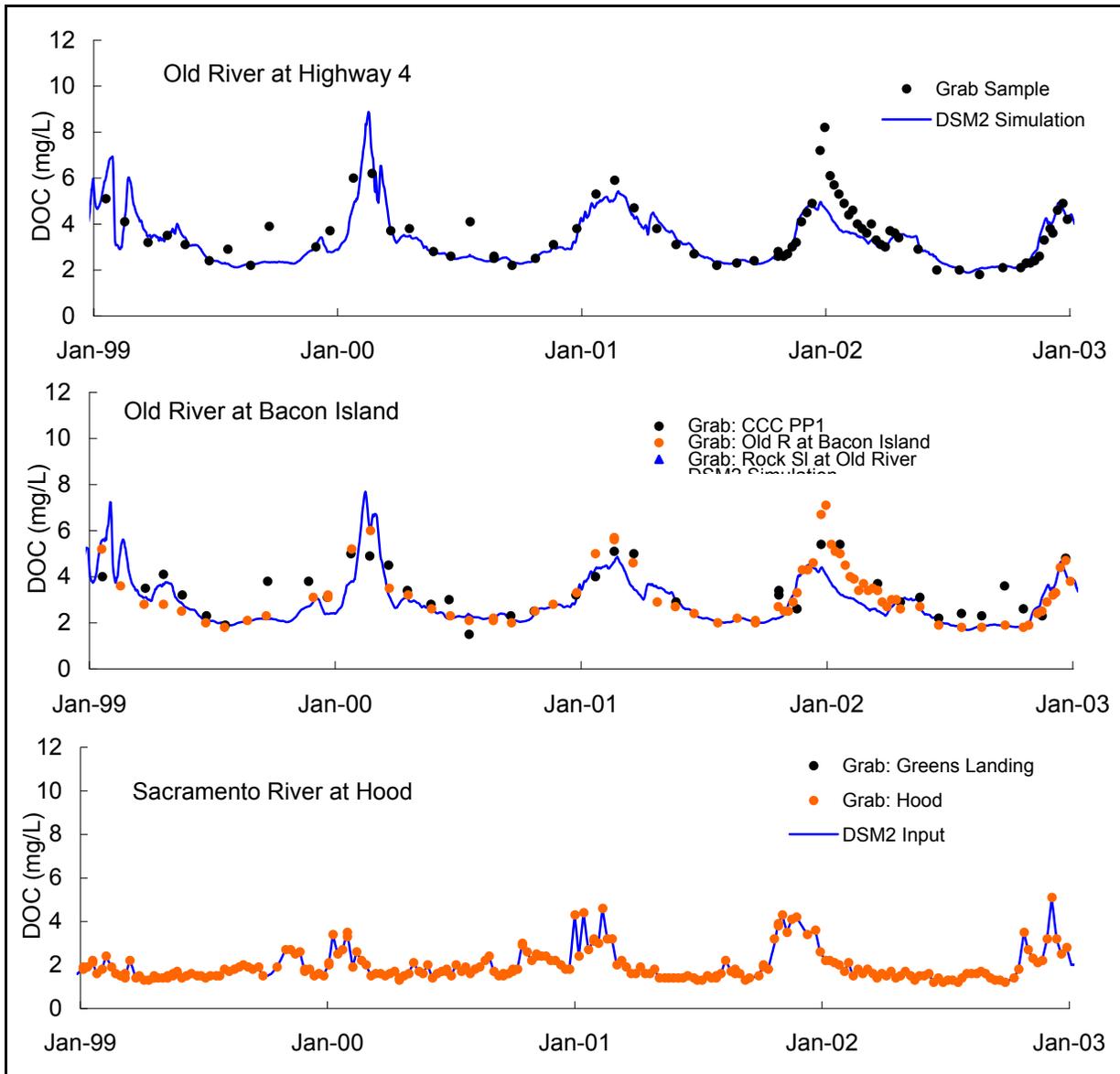


Figure 9-7 (cont.) DSM2-simulated daily DOC and measured DOC, 1999–2002

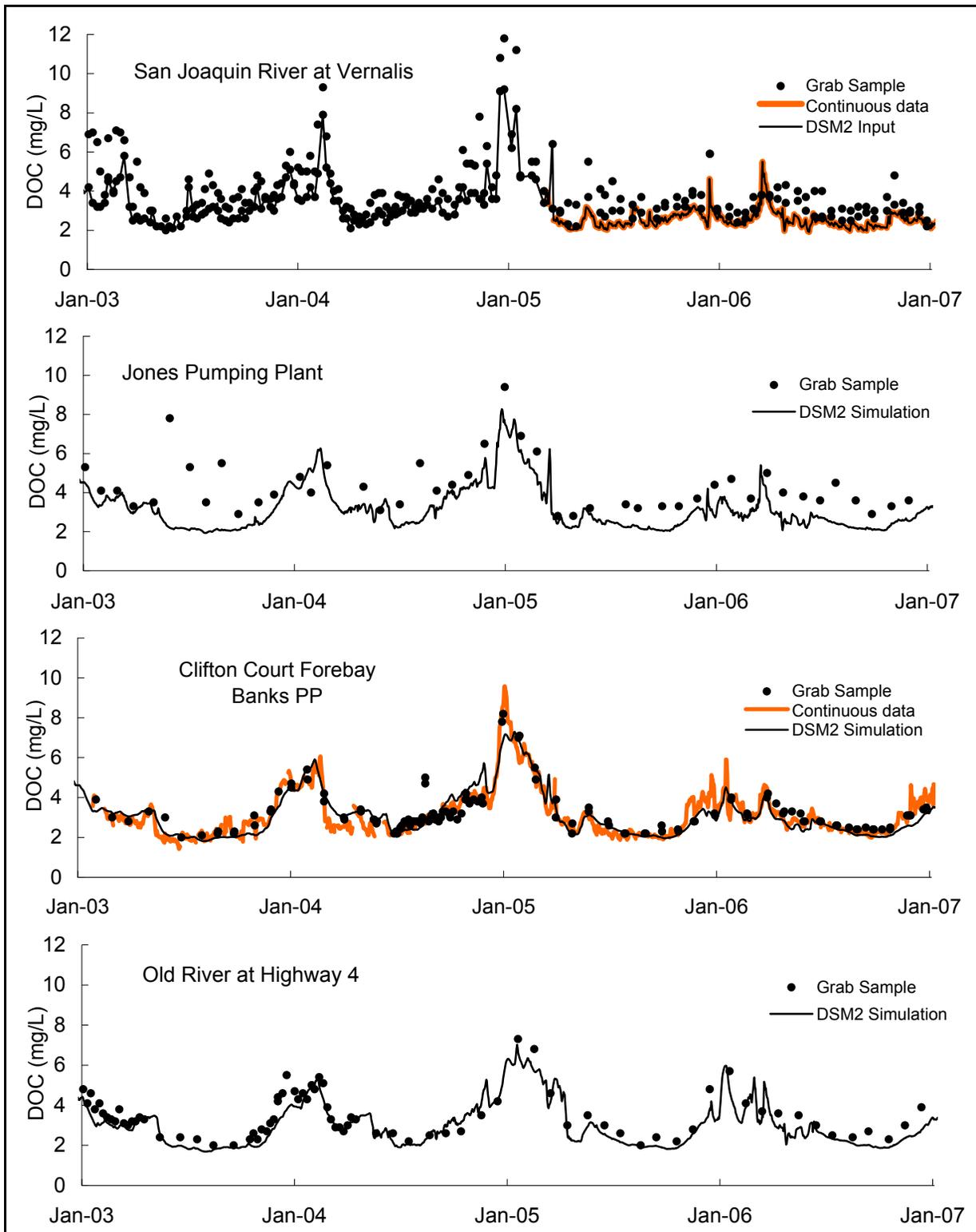


Figure 9-8 DSM2-simulated daily DOC and measured DOC, 2003–2006

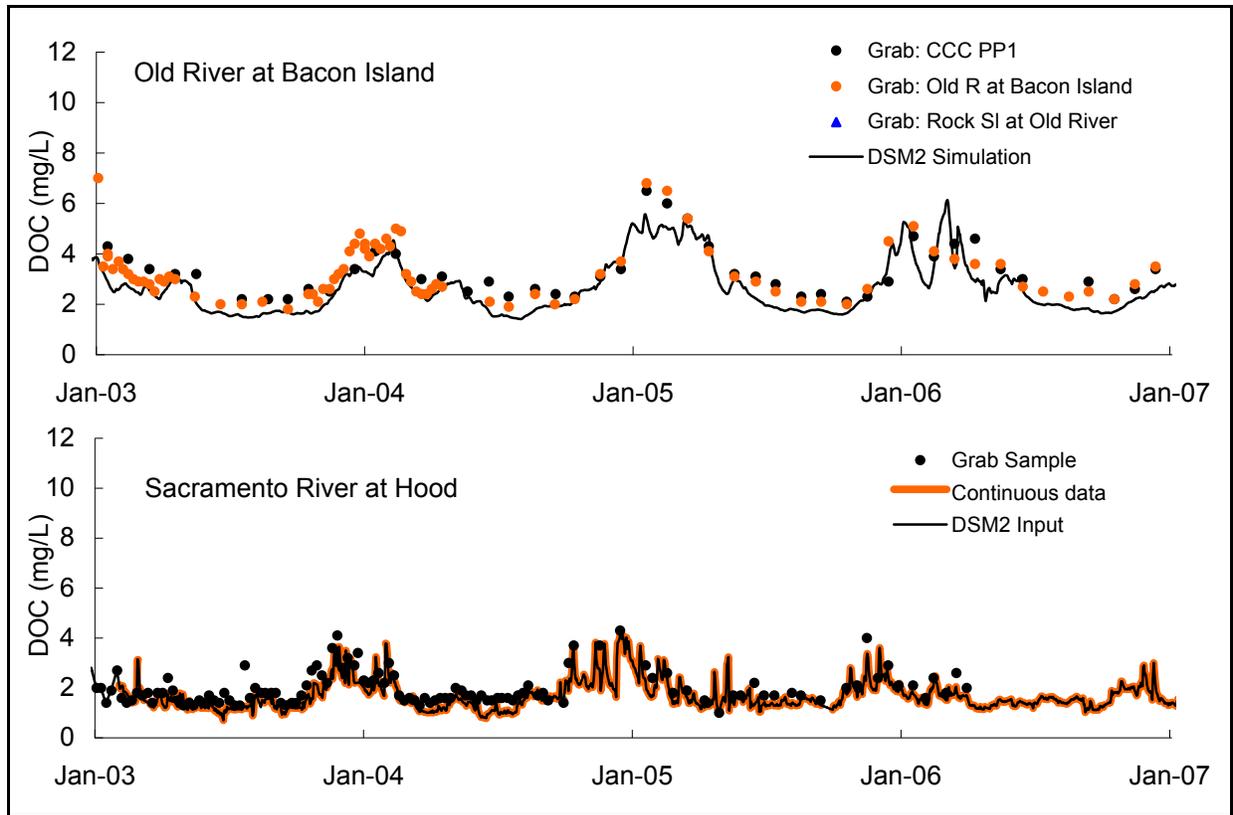


Figure 9-8 (cont.) DSM2-simulated daily DOC and measured DOC, 2003–2006

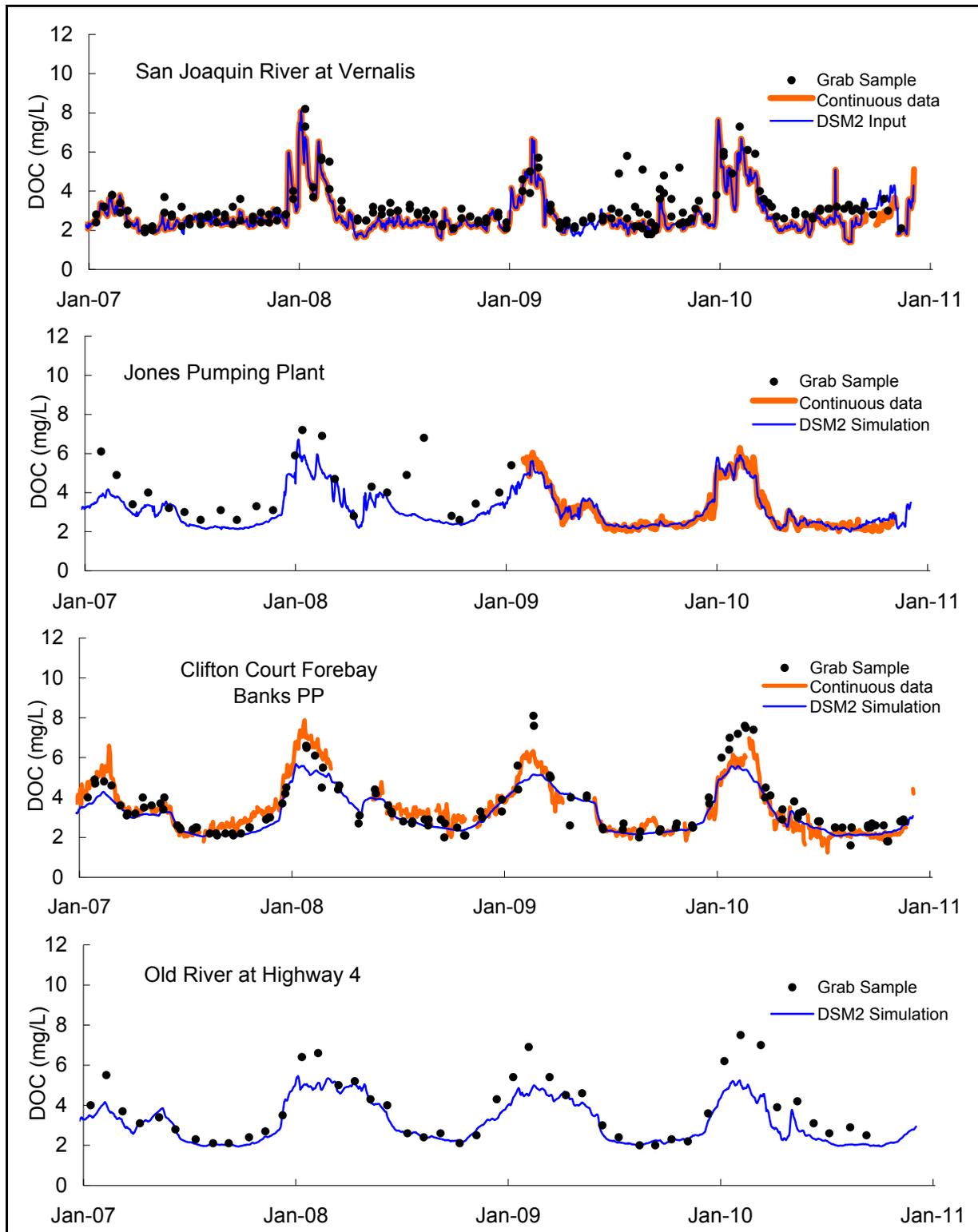


Figure 9-9 DSM2-simulated daily DOC and measured DOC, 2007–2010

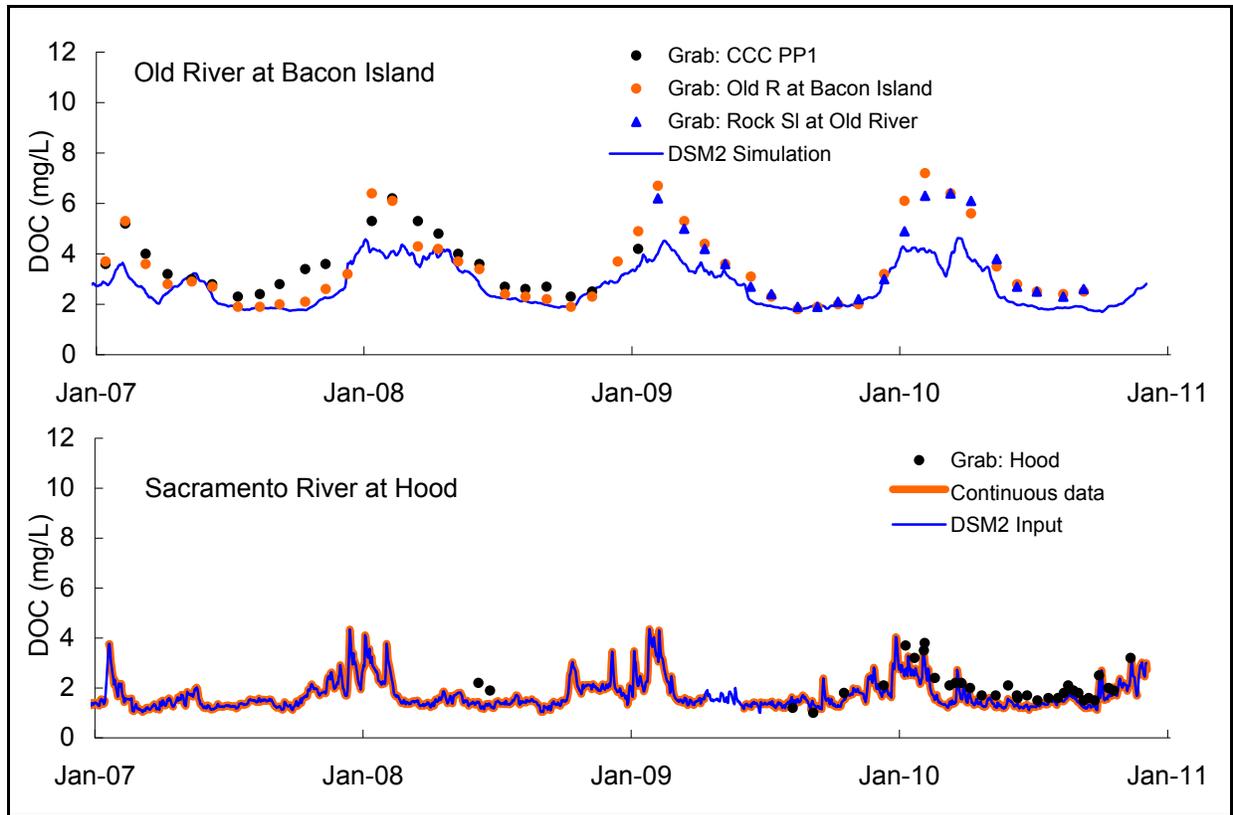


Figure 9-9 (cont.) DSM2-simulated daily DOC and measured DOC, 2007–2010

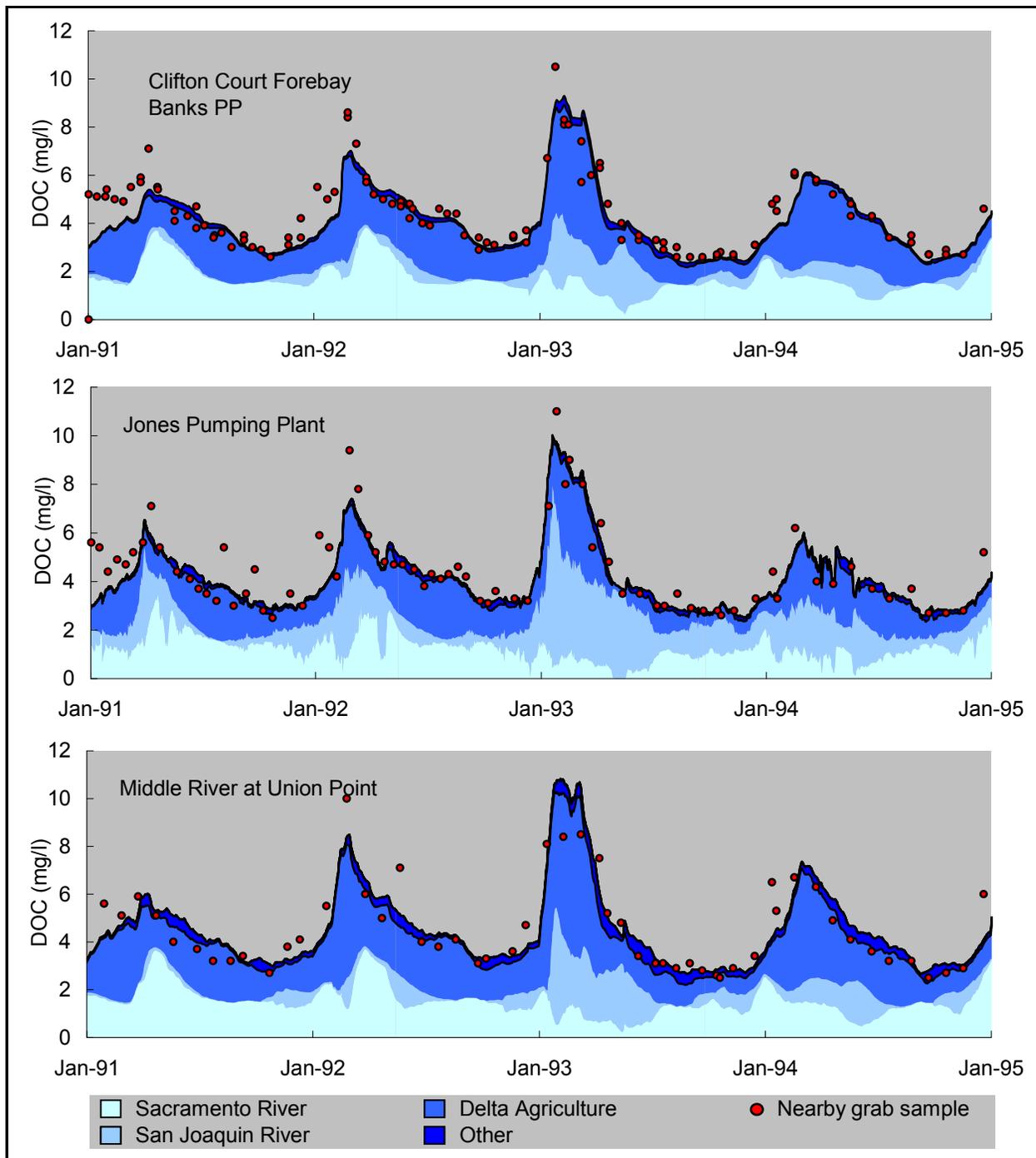


Figure 9-10 DSM2-simulated daily DOC fingerprint and measured DOC, 1991–1994

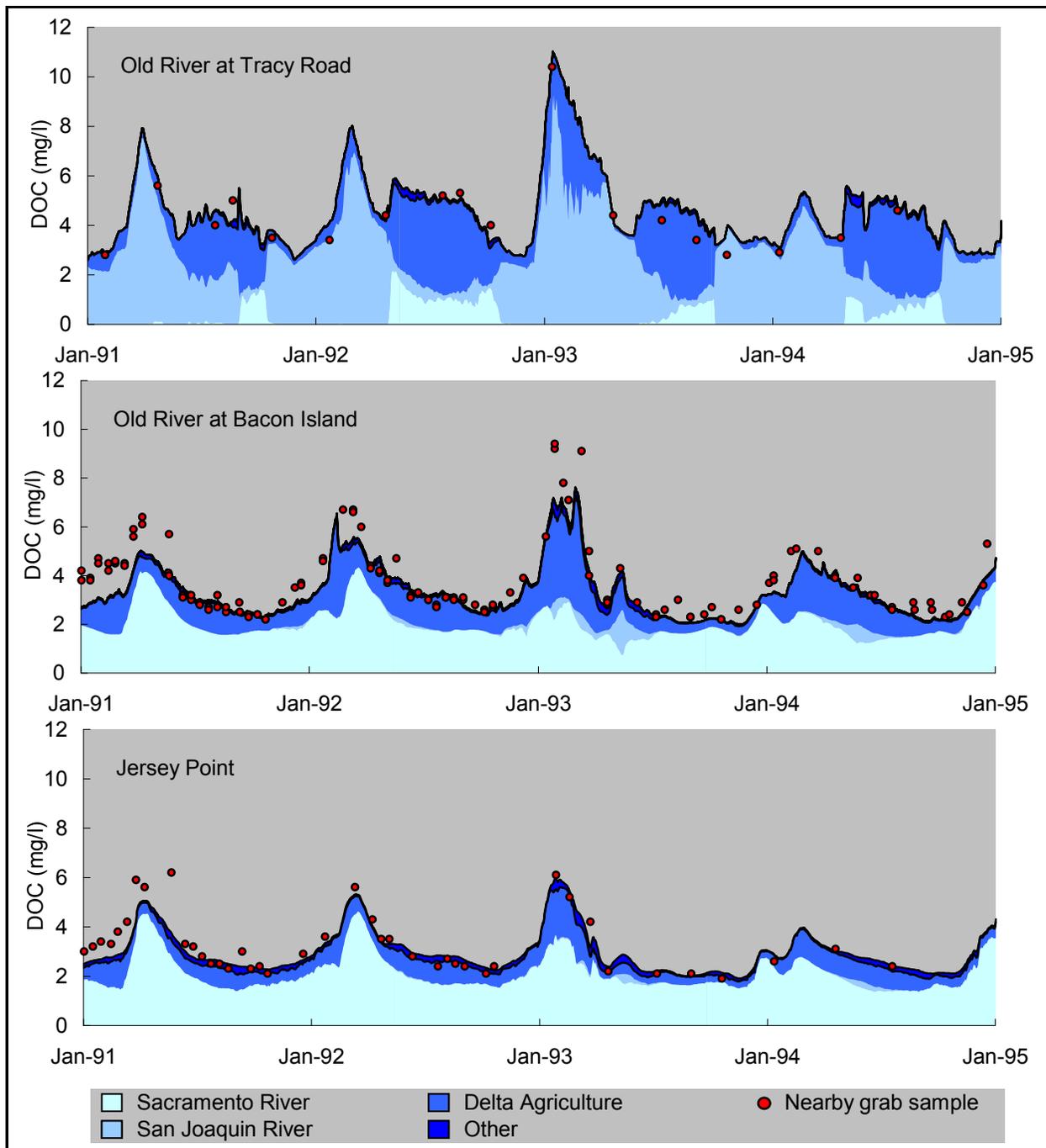


Figure 9-10 (cont.) DSM2-simulated daily DOC fingerprint and measured DOC, 1991–1994