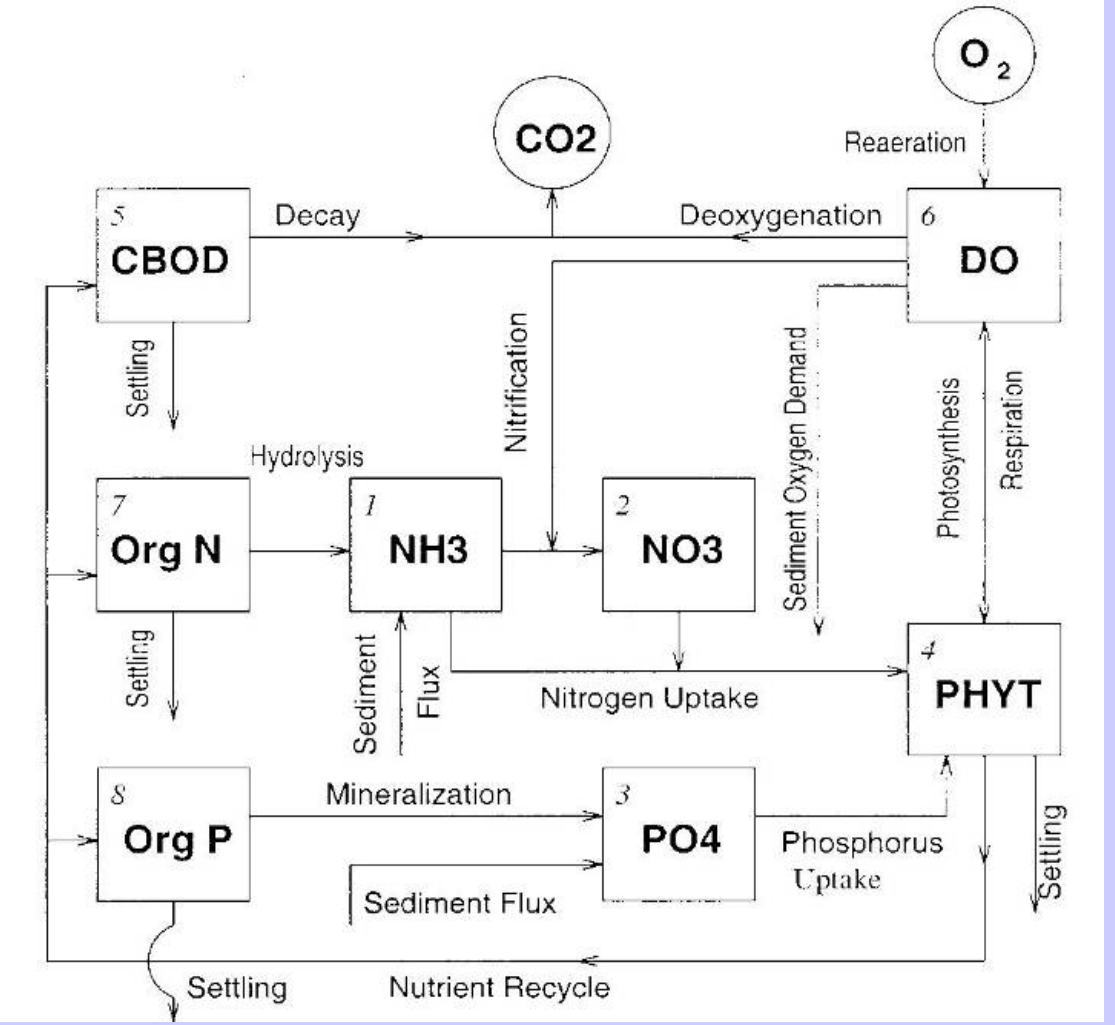
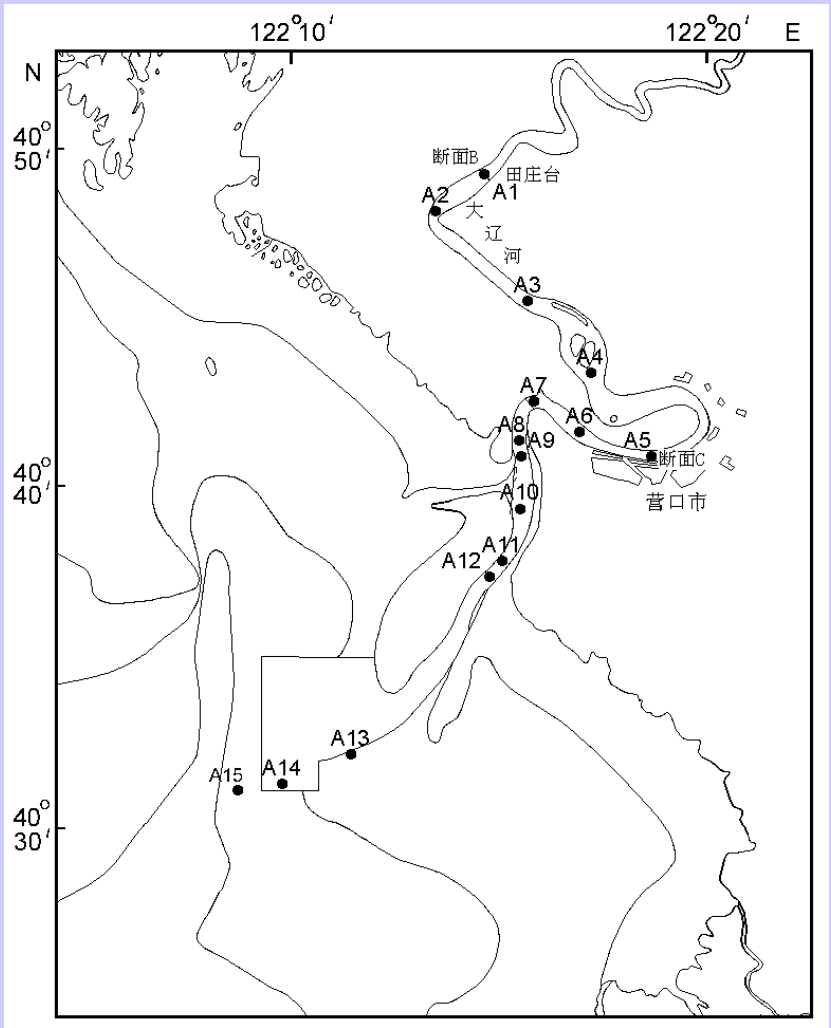
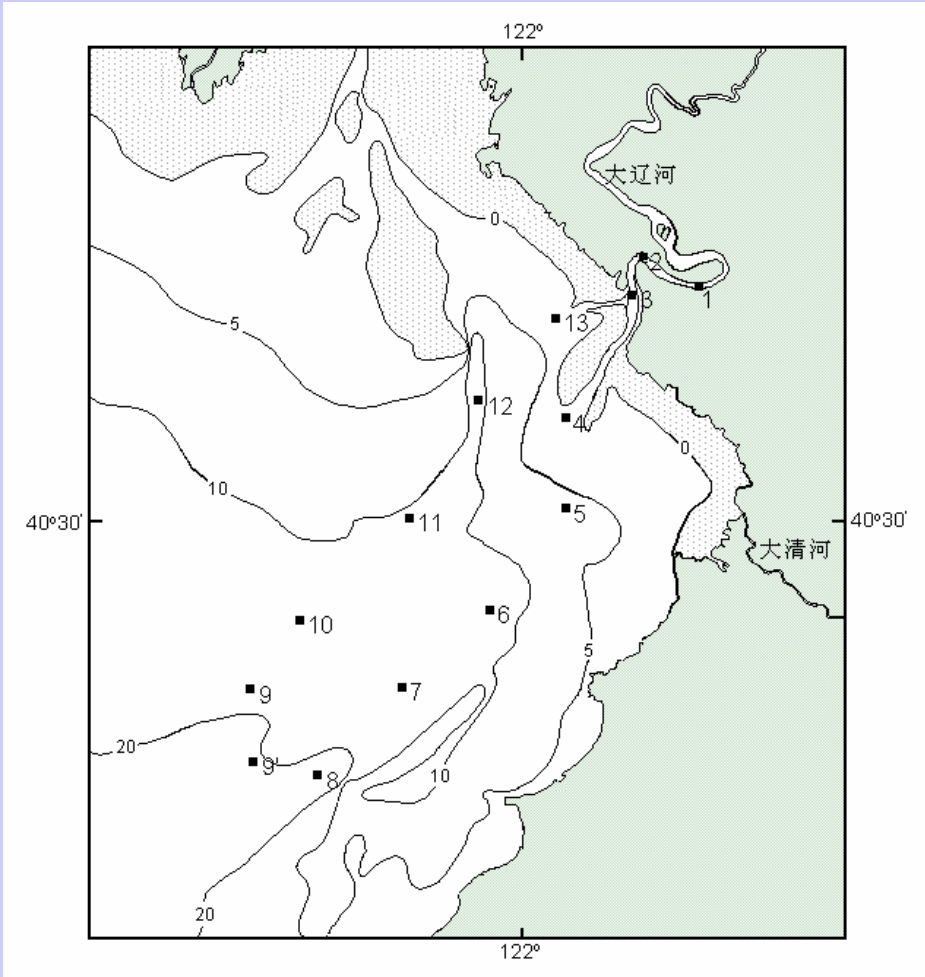
LECTURE 9 – FATE AND TRANSPORT MODELING USING WASP/EUTRO (Case Studies)

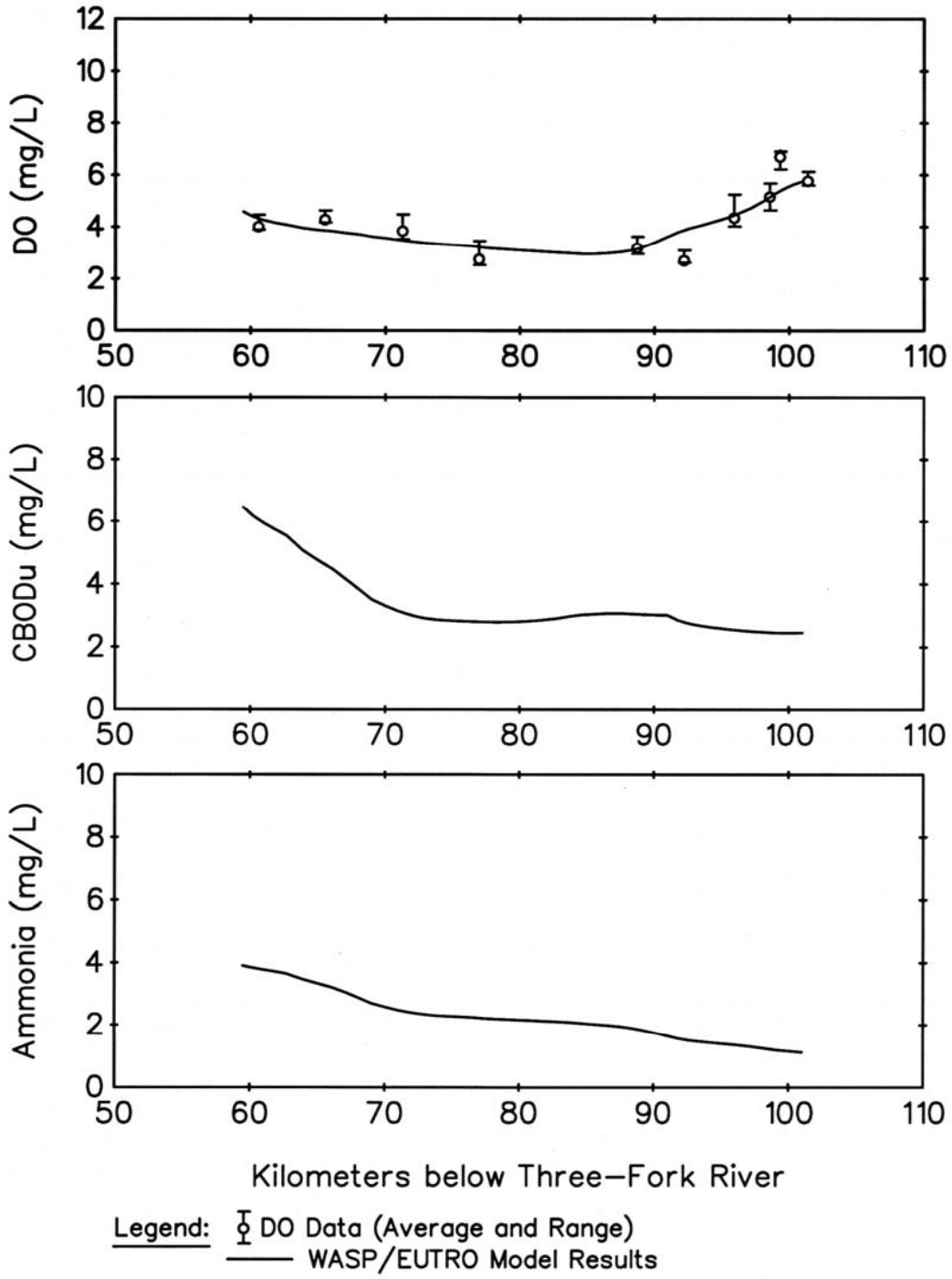


The Liaohe River in China

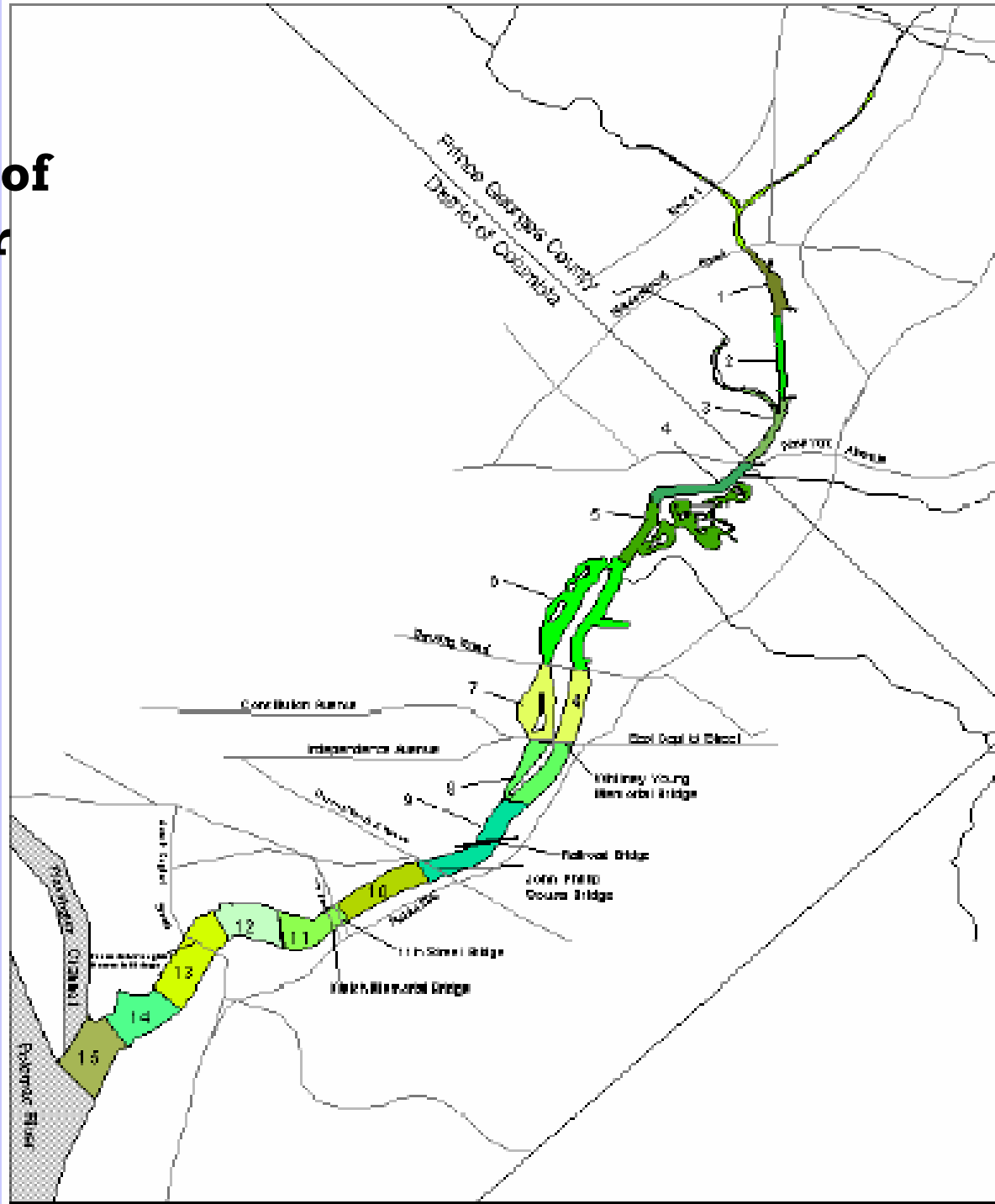




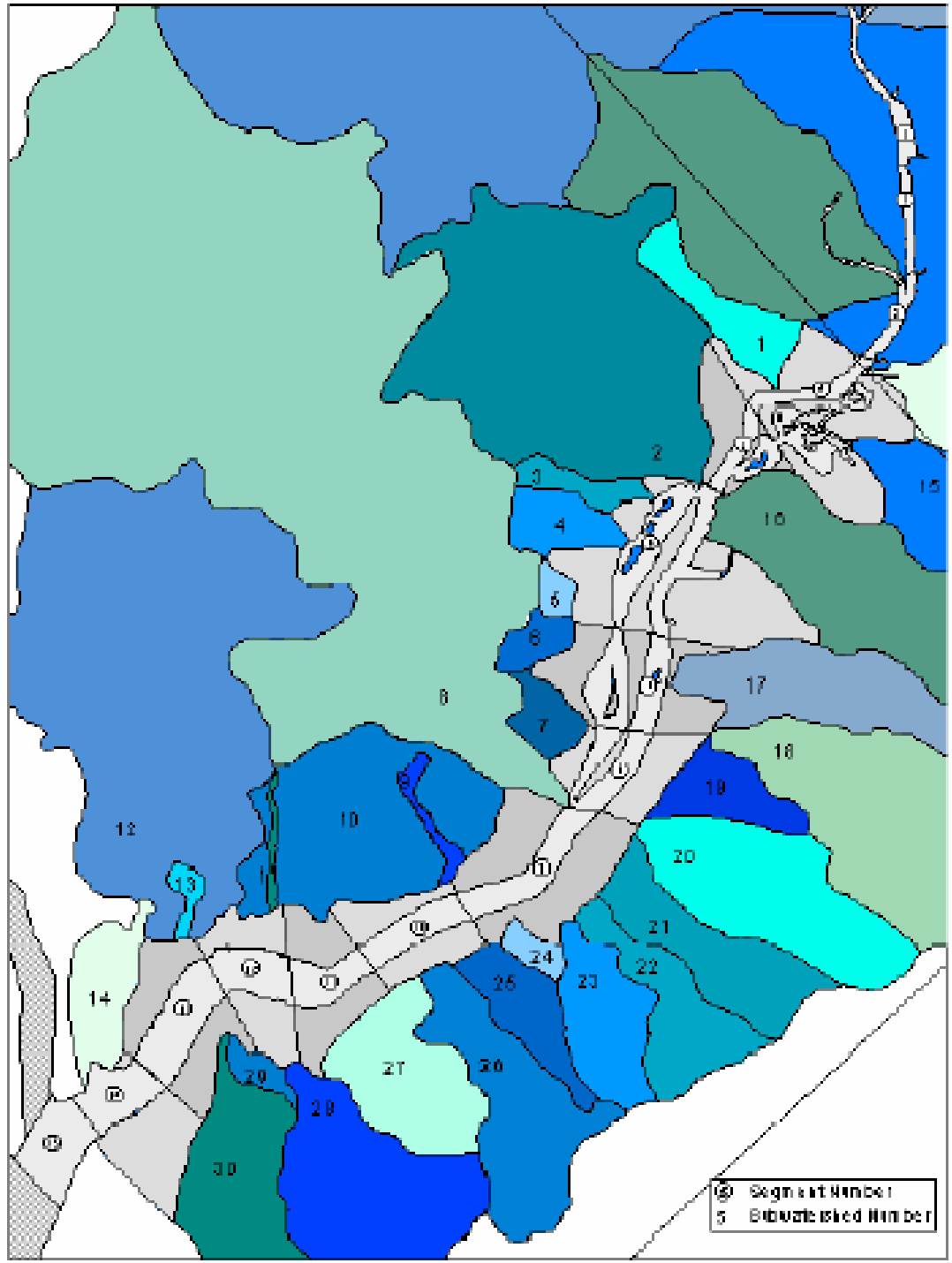
BOD/DO Modeling of Liaohe River Using WASP/EUTRO



Model Segmentation of Tidal Anacostia River



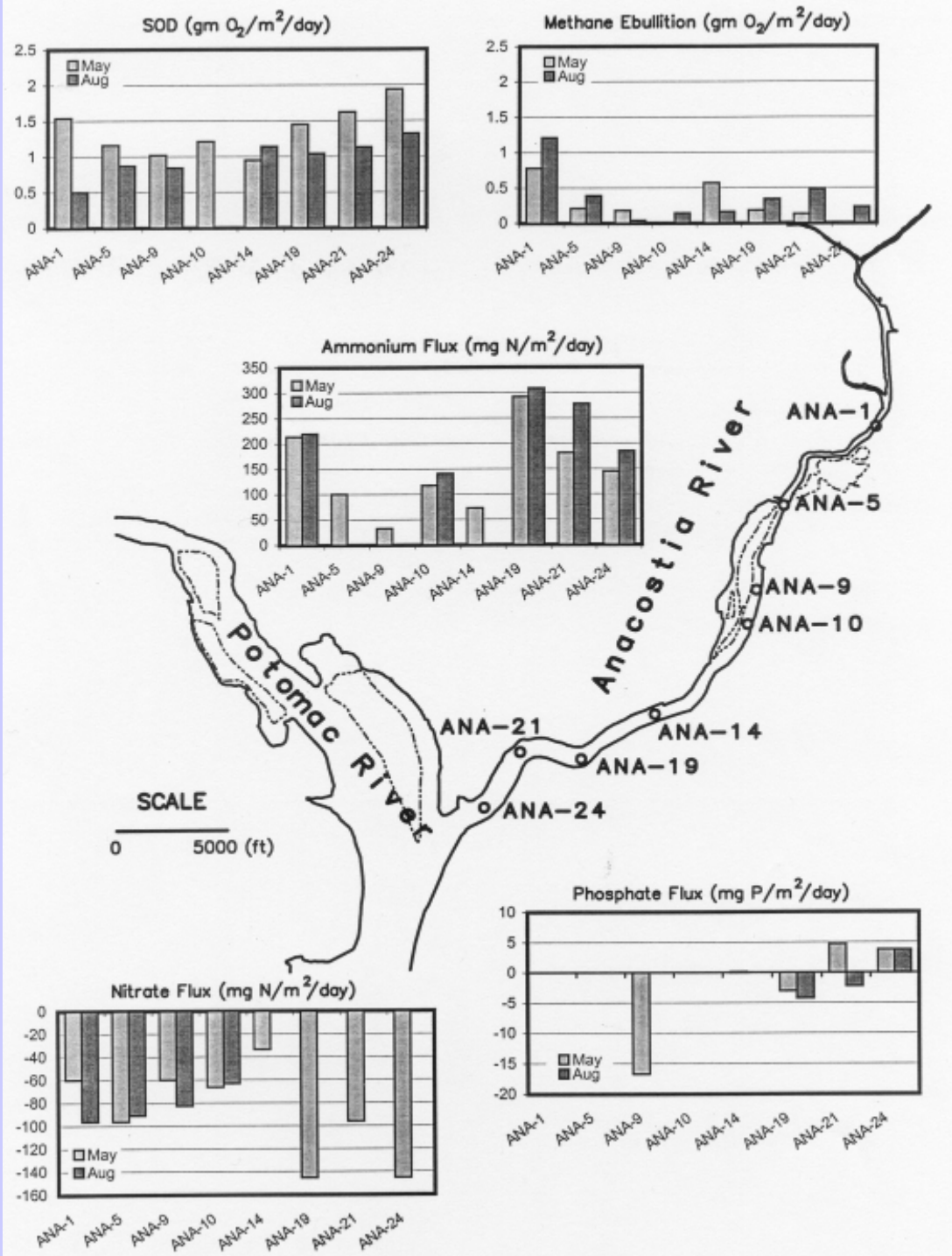
Anacostia Basin Subwaters



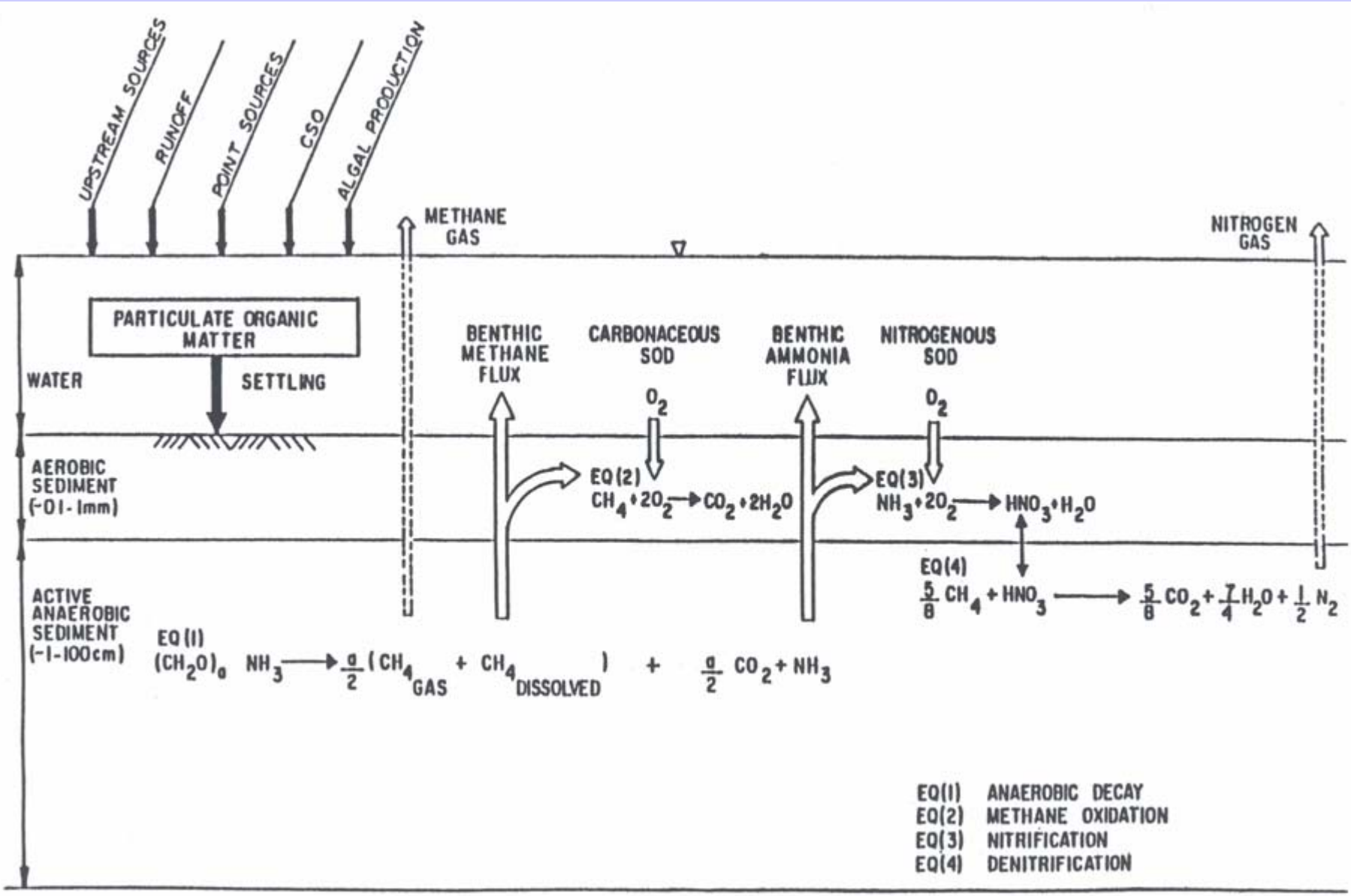
Anacostia River, Washington, DC

Sediment Oxygen Demand and

Nutrient Flux Rates Data

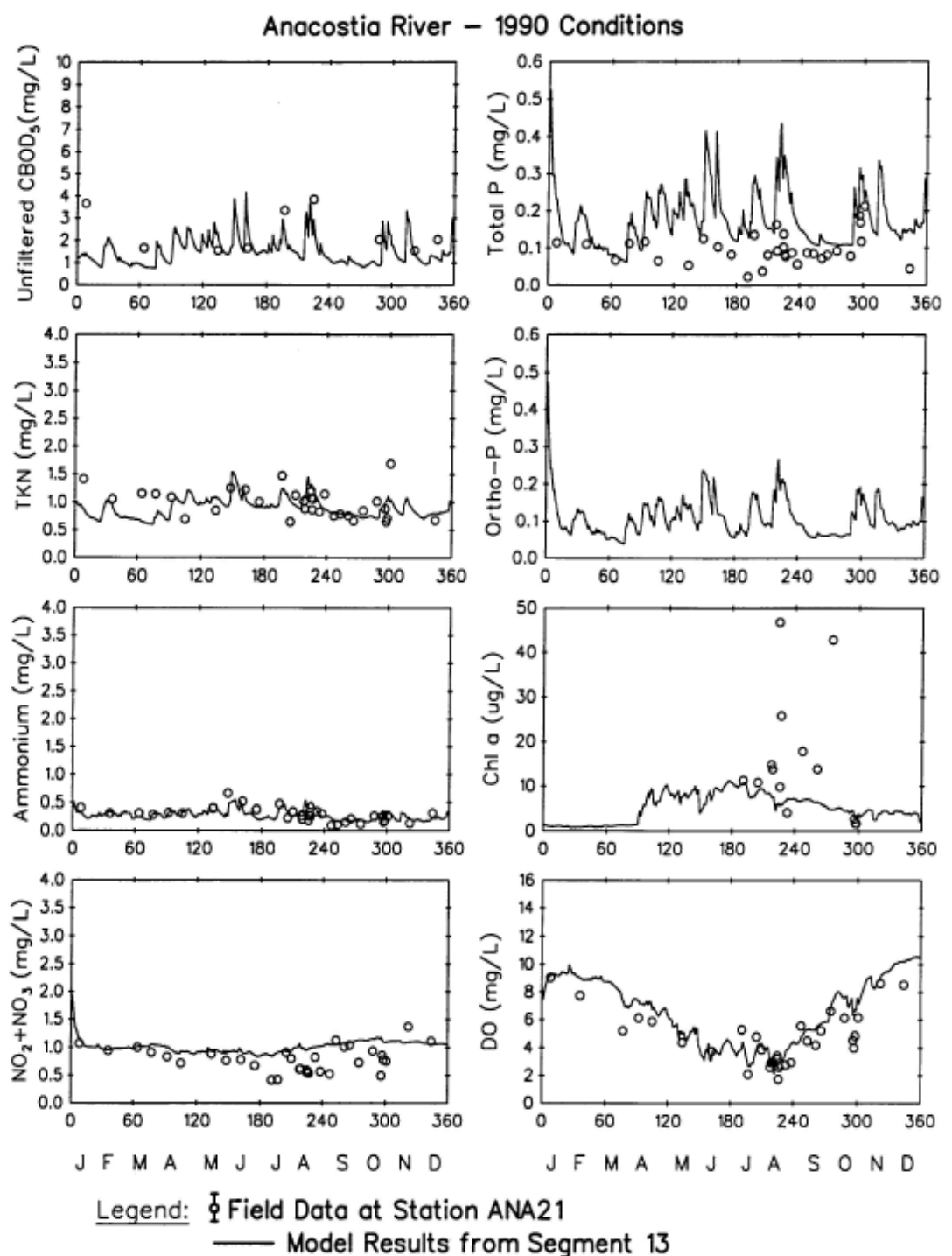


Sediment Diagenesis Kinetics for SOD and Ammonia Flux Calculations

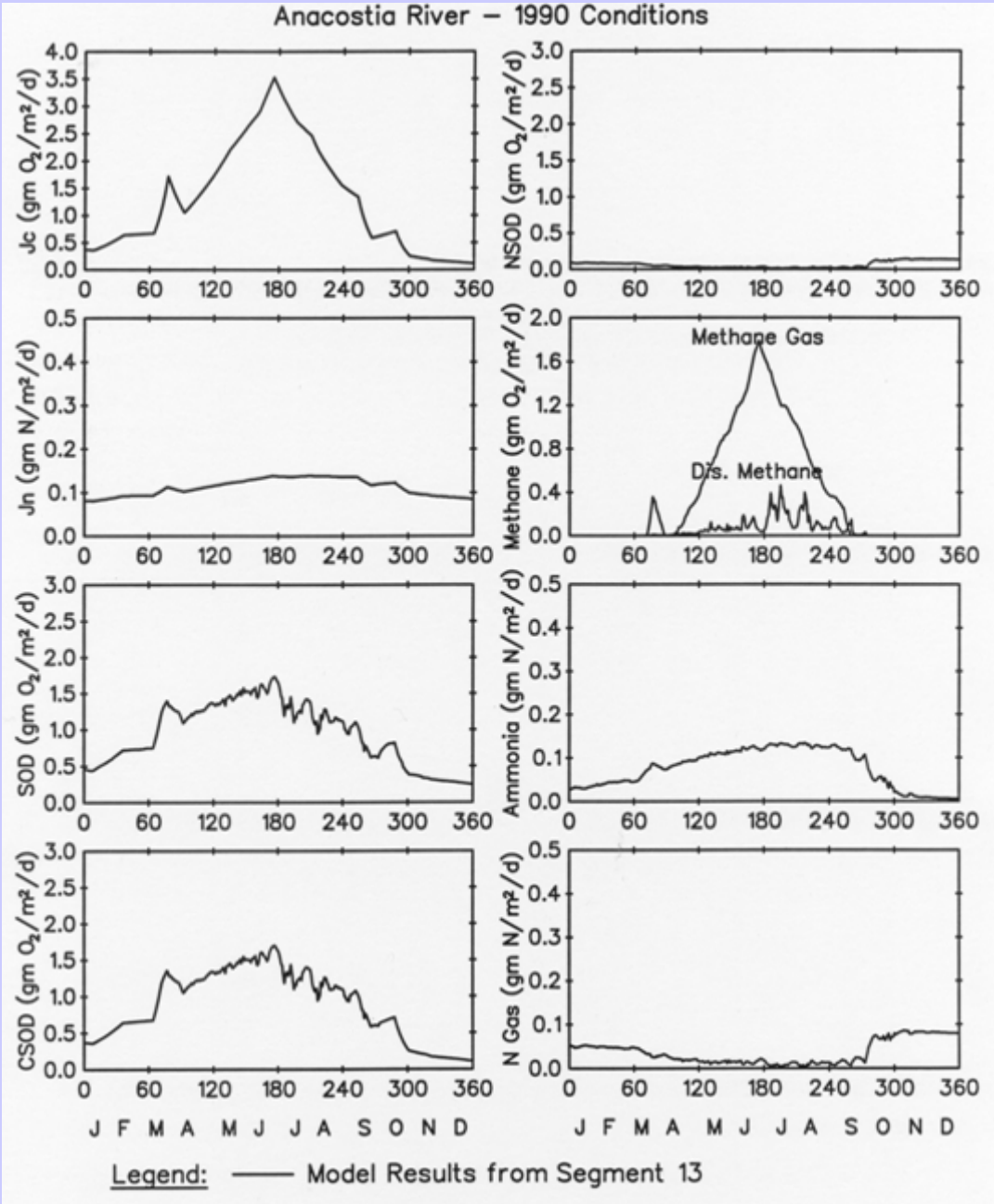


Source: HydroQual, 1992.

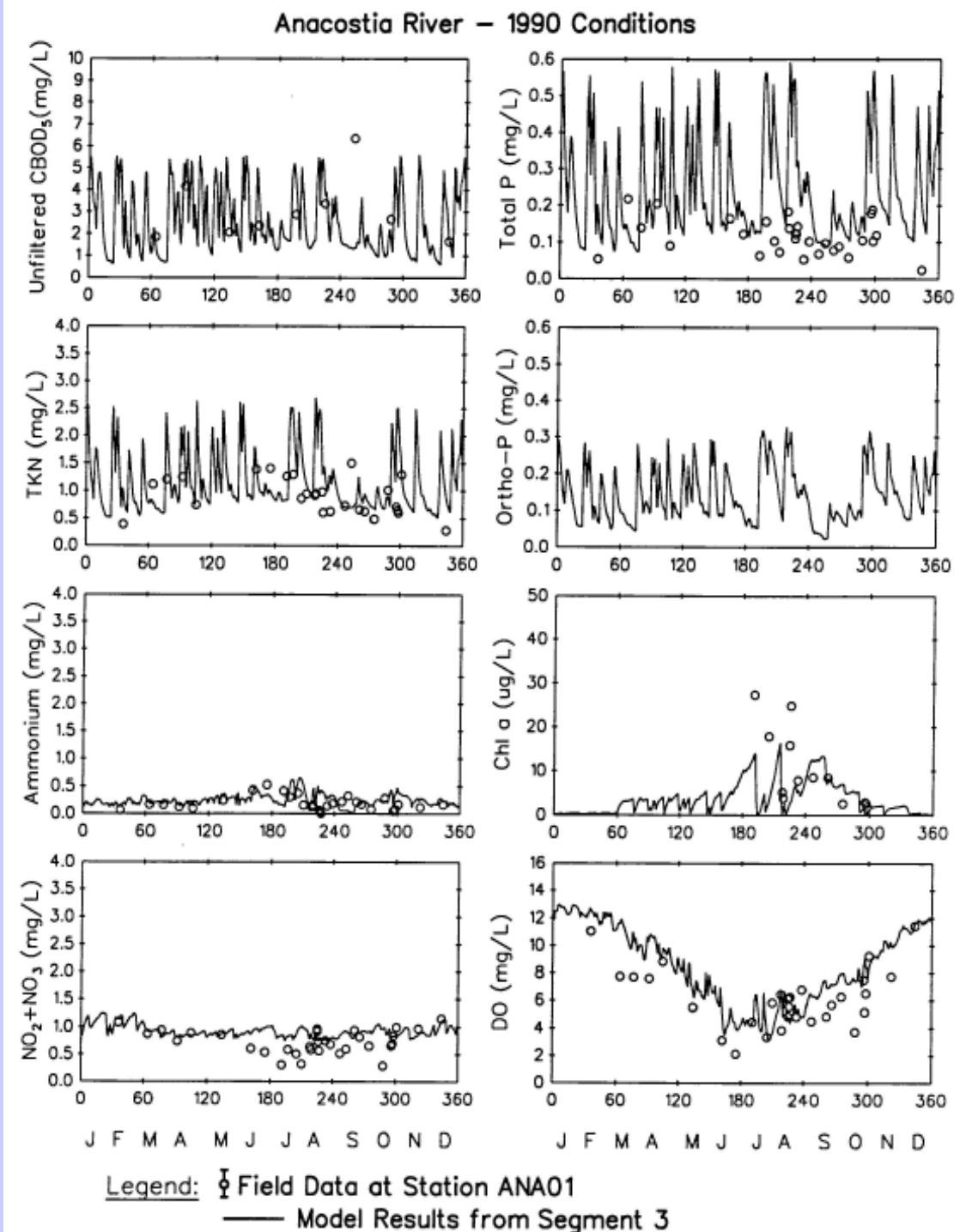
Model Calibration Results



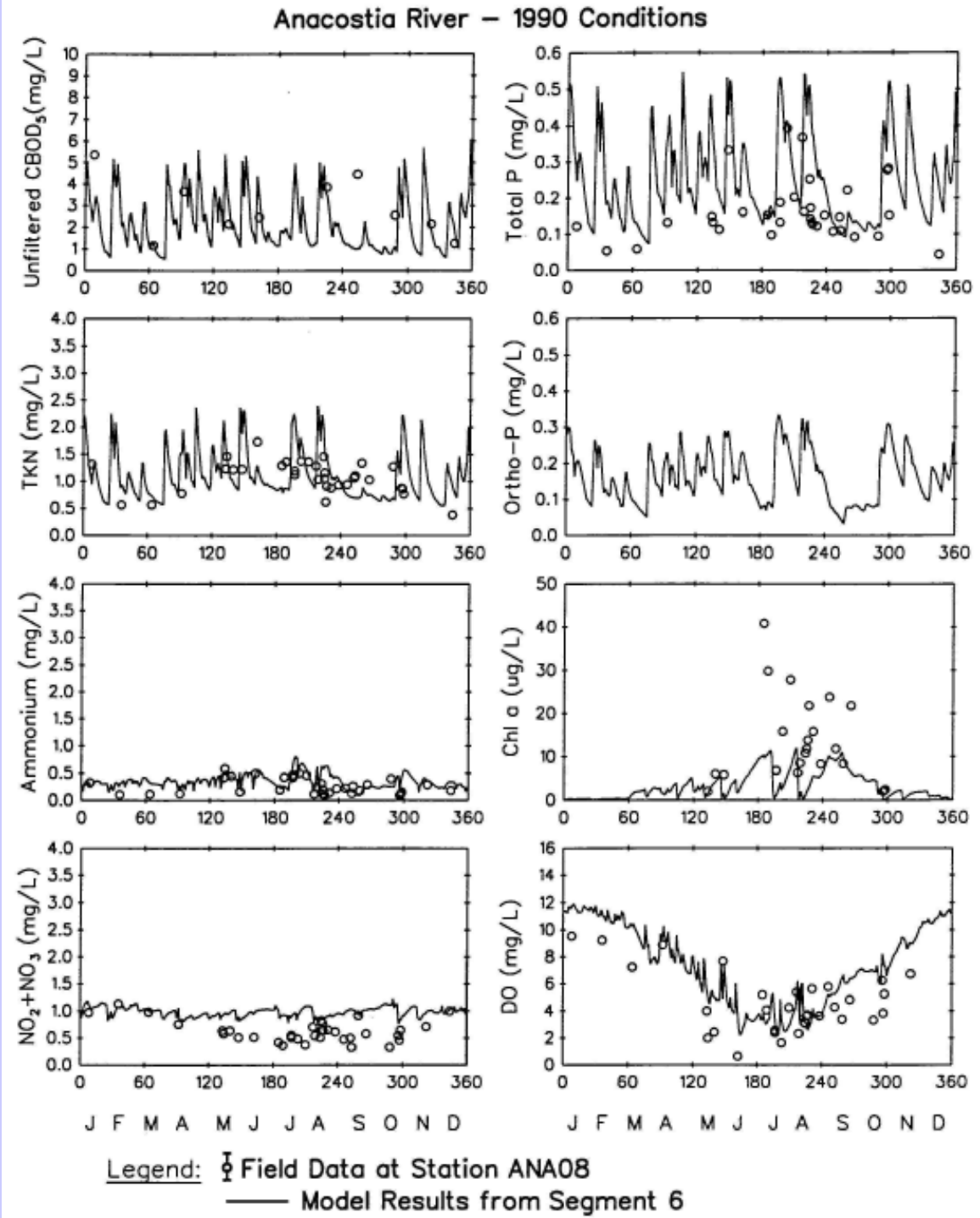
Results of SOD and Nutrient Fluxes from an Enhanced WASP/EUTRO5 Kinetics



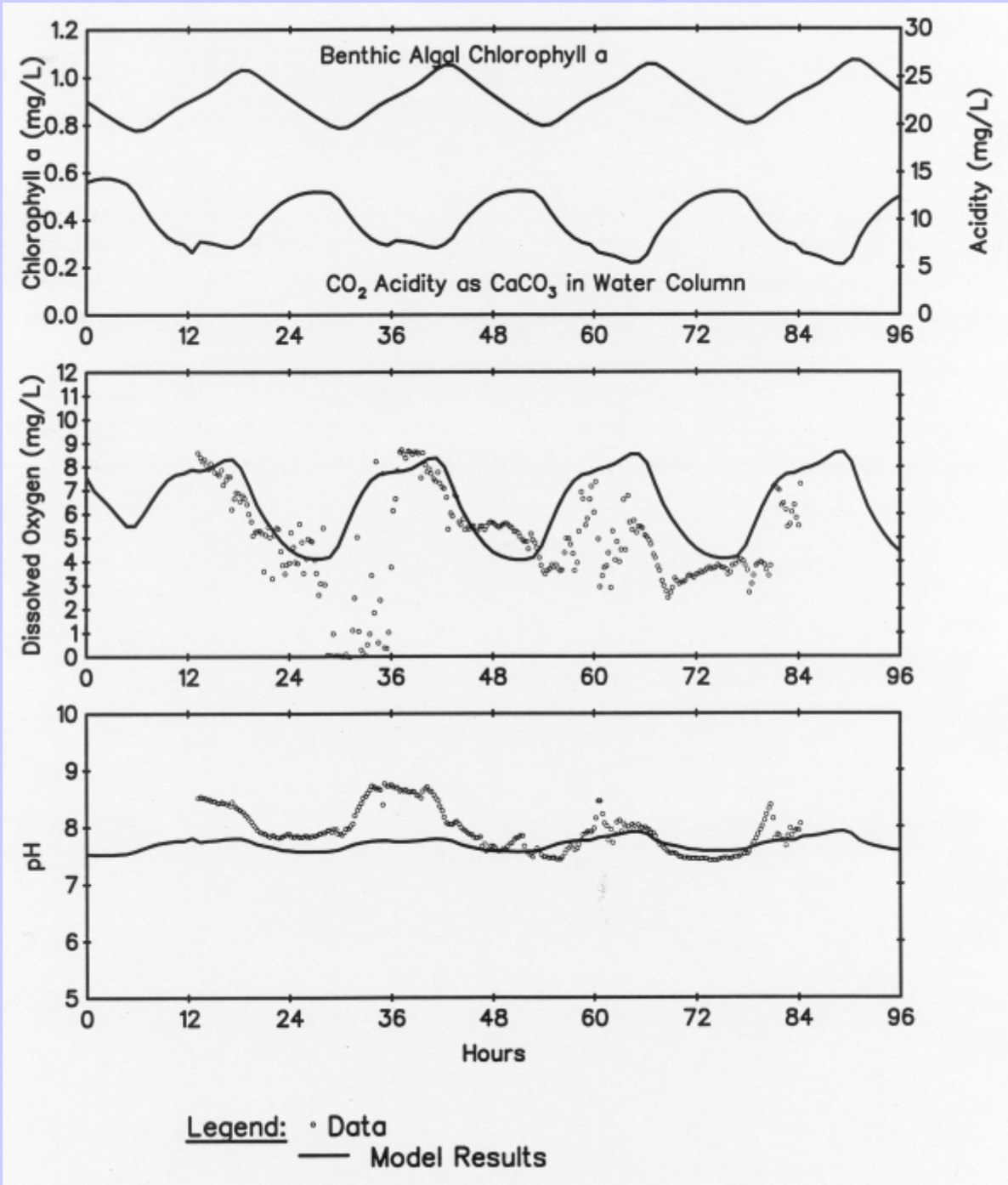
Model Calibration Results



Model Calibration Results



Santa Fe River Diurnal DO and pH Modeling

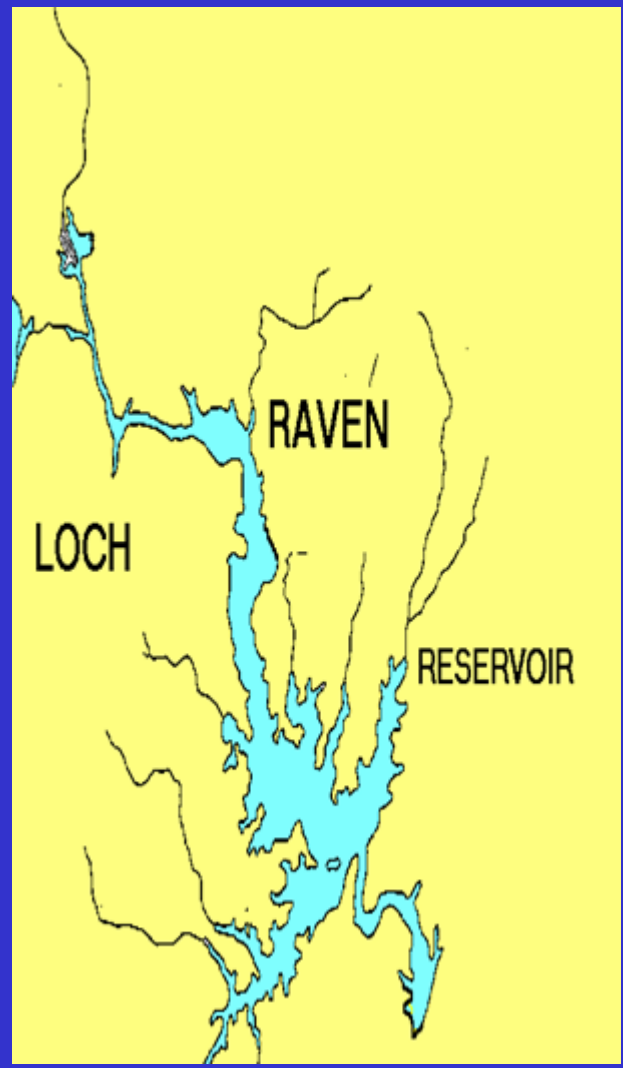


Background

- Located close to the City of Baltimore
- Important drinking water source
- Threats from eutrophication (DO)
- TMDL requirements

Geometry:

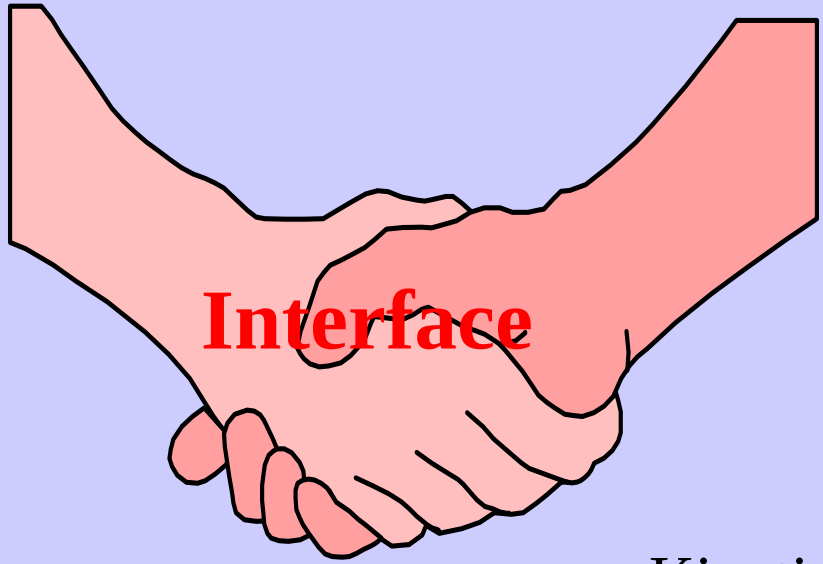
Length: 11 km
Width: 410 m in average
Depth range: 21m maximum



Longitudinal-Vertical 2-D Configuration

Modeling Framework

CE-QUAL-W2
Hydrodynamic
Model



WASP/EUTRO5
Water Quality
Simulation Model

Solving for flow
velocity

Kinetics calculations with
incorporated flow
information

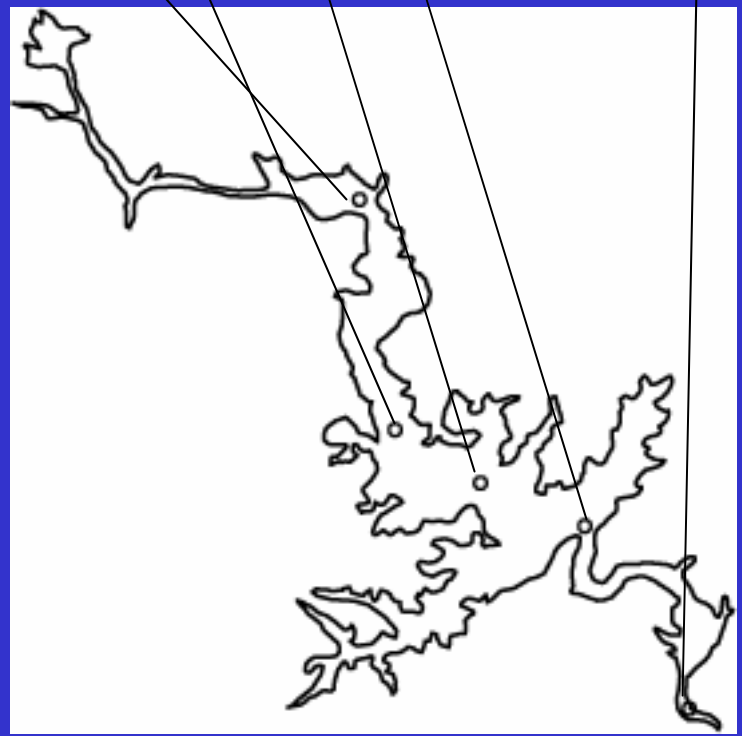
Hydrodynamics Segmentation:

Longitudinal 17 segments, variable grid lengths, one meter thick

1	5	11	21	33	45	59	73	89	105	121	139	159	179	199	218	238
2	6	12	22	34	46	60	74	90	106	122	140	160	180	200	219	239
3	7	13	23	35	47	61	75	91	107	123	141	161	181	201	220	240
4	8	14	24	36	48	62	76	92	108	124	142	162	182	202	221	241
	9	15	25	37	49	63	77	93	109	125	143	163	183	203	222	242
	10	16	26	38	50	64	78	94	110	126	144	164	184	204	223	243
		17	27	39	51	65	79	95	111	127	145	165	185	205	224	244
		18	28	40	52	66	80	96	112	128	146	166	186	206	225	245
		19	29	41	53	67	81	97	113	129	147	167	187	207	226	246
		20	30	42	54	68	82	98	114	130	148	168	188	208	227	247
			31	43	55	69	83	99	115	131	149	169	189	209	228	248
			32	44	56	70	84	100	116	132	150	170	190	210	229	249
					57	71	85	101	117	133	151	171	191	211	230	250
					58	72	86	102	118	134	152	172	192	212	231	251
							87	103	119	135	153	173	193	213	232	252
							88	104	120	136	154	174	194	214	233	253
										137	155	175	195	215	234	254
										138	156	176	196	216	235	255
											157	177	197	217	236	256
											158	178	198	218	237	257

WASP Grid:

1	2	4	8	13	18	24	30	37	44	51	59	68	77	86	95	104
	3	5	9	14	19	25	31	38	45	52	60	69	78	87	96	105
		6	10	15	20	26	32	39	46	53	61	70	79	88	97	106
		7	11	16	21	27	33	40	47	54	62	71	80	89	98	107
			12	17	22	28	34	41	48	55	63	72	81	90	99	108
					23	29	35	42	49	56	64	73	82	91	100	109
							36	43	50	57	65	74	83	92	101	110
										58	66	75	84	93	102	111
											67	76	85	94	103	112



Indirect mapping

First layer: 4 meters

Other layers: 2 meters

Considerations:

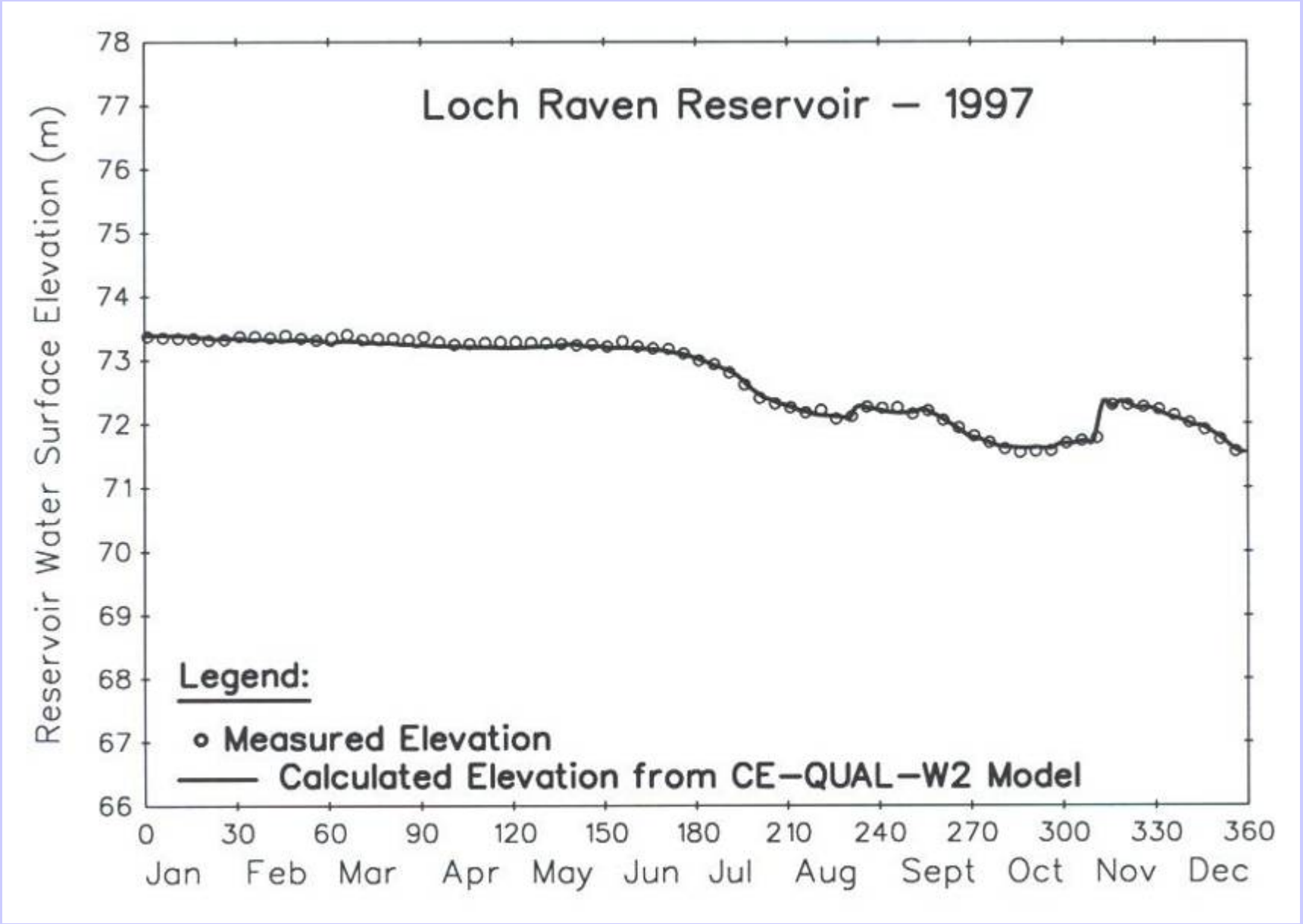
Spatial scale difference

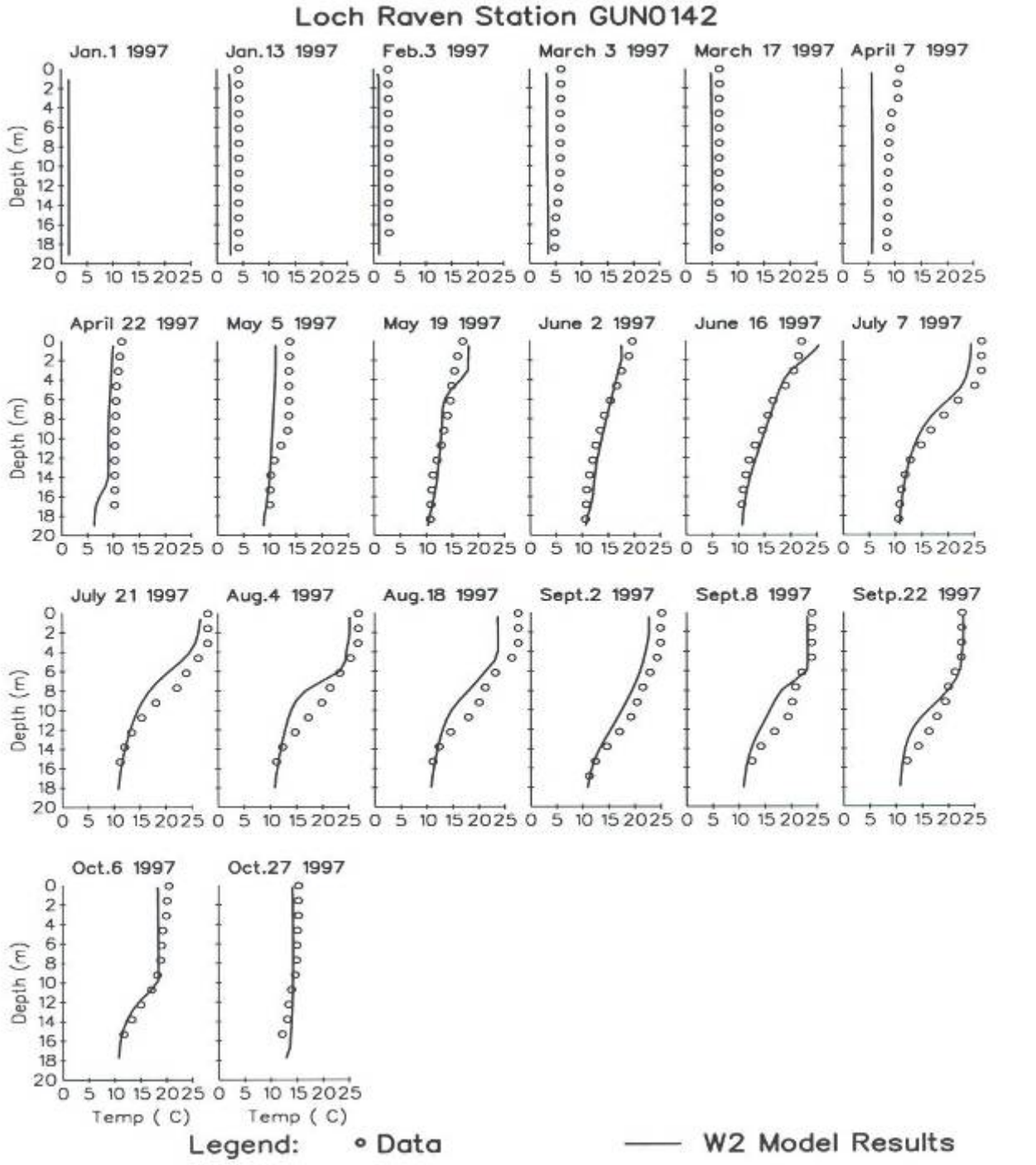
Layer subtraction

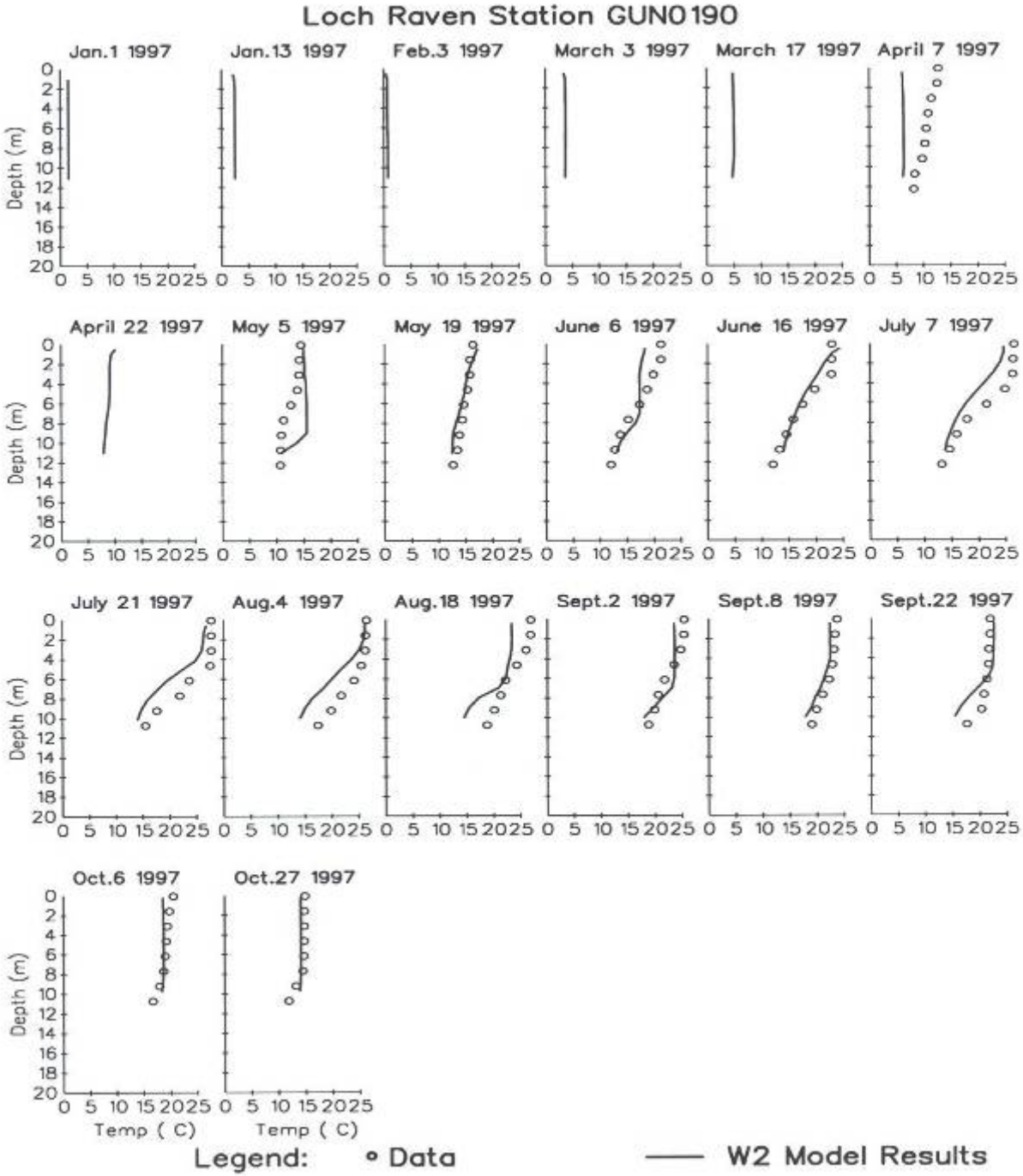
Numerical stability

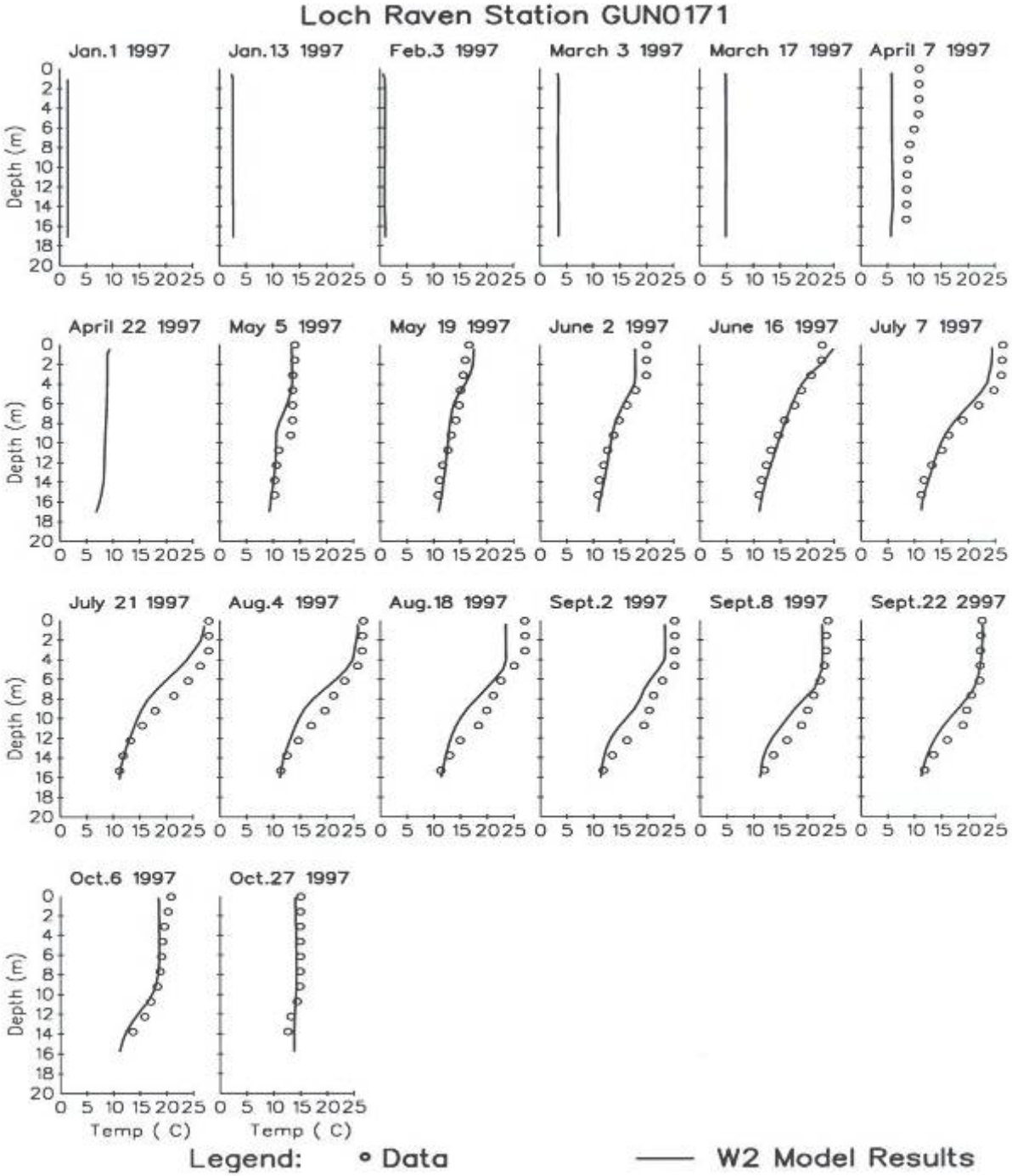
Extra diffusions by averaging

Model Calculated Water Surface Elevations vs. Data for Loch Raven Reservoir in 1997

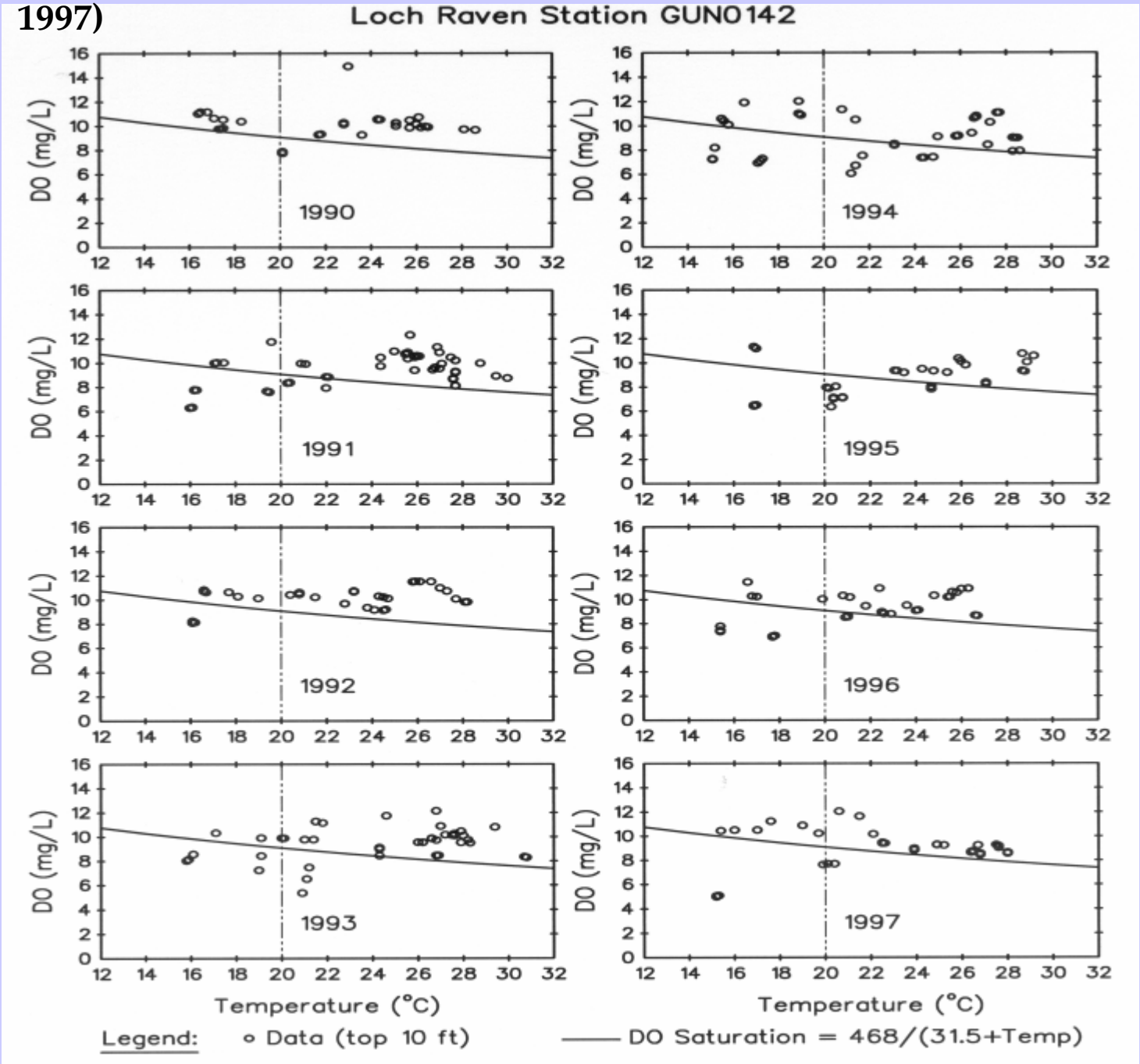



Loch Raven Station GUN0142
Jan.1 1997
Jan.13 1997
Feb.3 1997
March 3 1997
March 17 1997
April 7 1997
April 22 1997
May 5 1997
May 19 1997
June 2 1997
June 16 1997
July 7 1997
July 21 1997
Aug.4 1997
Aug.18 1997
Sept.2 1997
Sept.8 1997
Setp.22 1997
Oct.6 1997
Oct.27 1997
Depth (m)
0 2 4 6 8 10 12 14 16 18 20
0 5 10 15 20 25
Temp (C)
Legend: ∘ Data
—— W2 Model Results

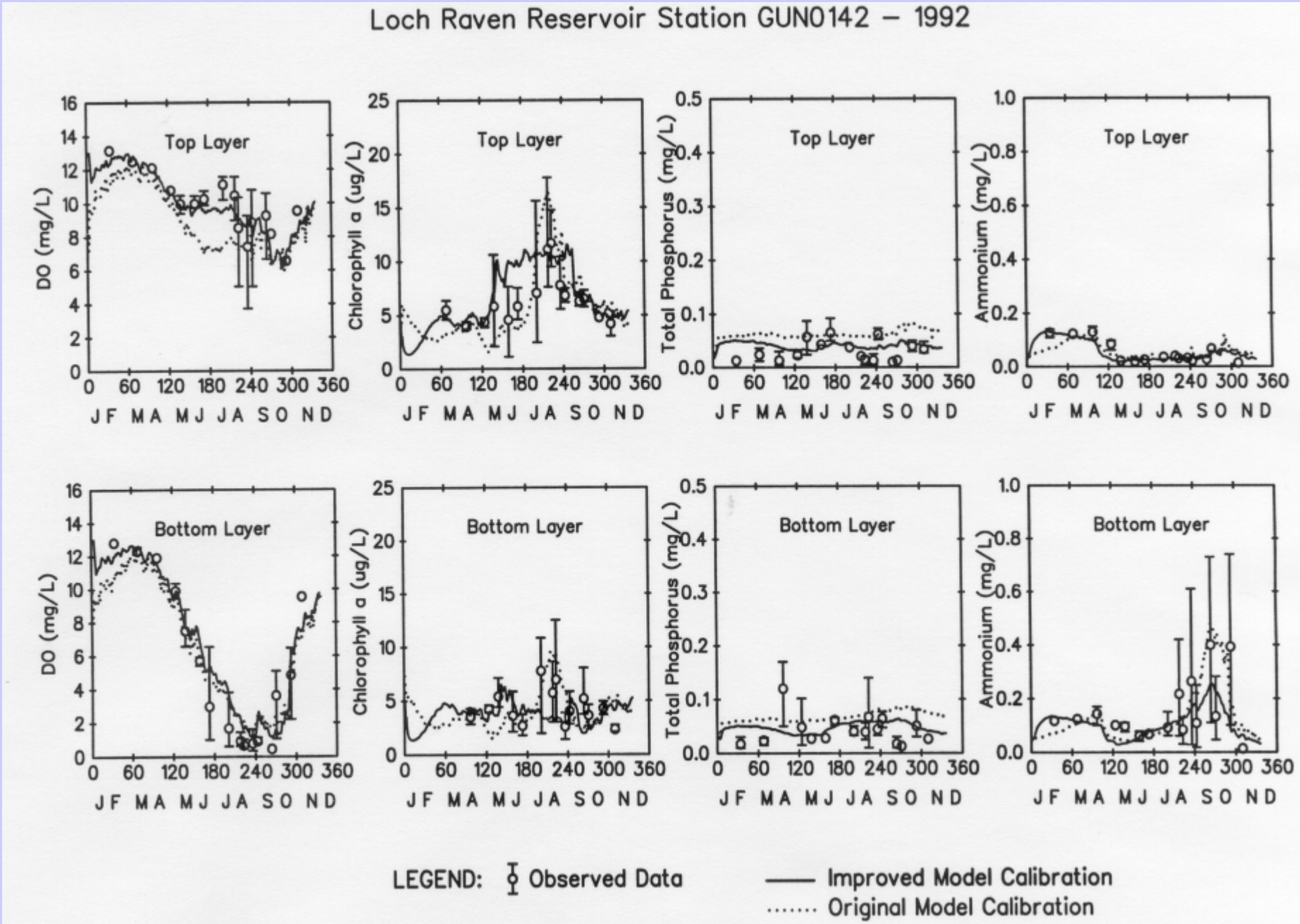

Loch Raven Station GUN0190
Jan.1 1997
Jan.13 1997
Feb.3 1997
March 3 1997
March 17 1997
April 7 1997
April 22 1997
May 5 1997
May 19 1997
June 6 1997
June 16 1997
July 7 1997
July 21 1997
Aug.4 1997
Aug.18 1997
Sept.2 1997
Sept.8 1997
Sept.22 1997
Oct.6 1997
Oct.27 1997
Depth (m)
0 2 4 6 8 10 12 14 16 18 20
0 5 10 15 20 25
Temp (C)
Legend: ∘ Data
—— W2 Model Results


Loch Raven Station GUN0171
Jan.1 1997
Jan.13 1997
Feb.3 1997
March 3 1997
March 17 1997
April 7 1997
April 22 1997
May 5 1997
May 19 1997
June 2 1997
June 16 1997
July 7 1997
July 21 1997
Aug.4 1997
Aug.18 1997
Sept.2 1997
Sept.8 1997
Sept.22 2997
Oct.6 1997
Oct.27 1997
Depth (m)
0 2 4 6 8 10 12 14 16 18 20
0 5 10 15 20 25
Temp (C)
Legend: ° Data
—— W2 Model Results

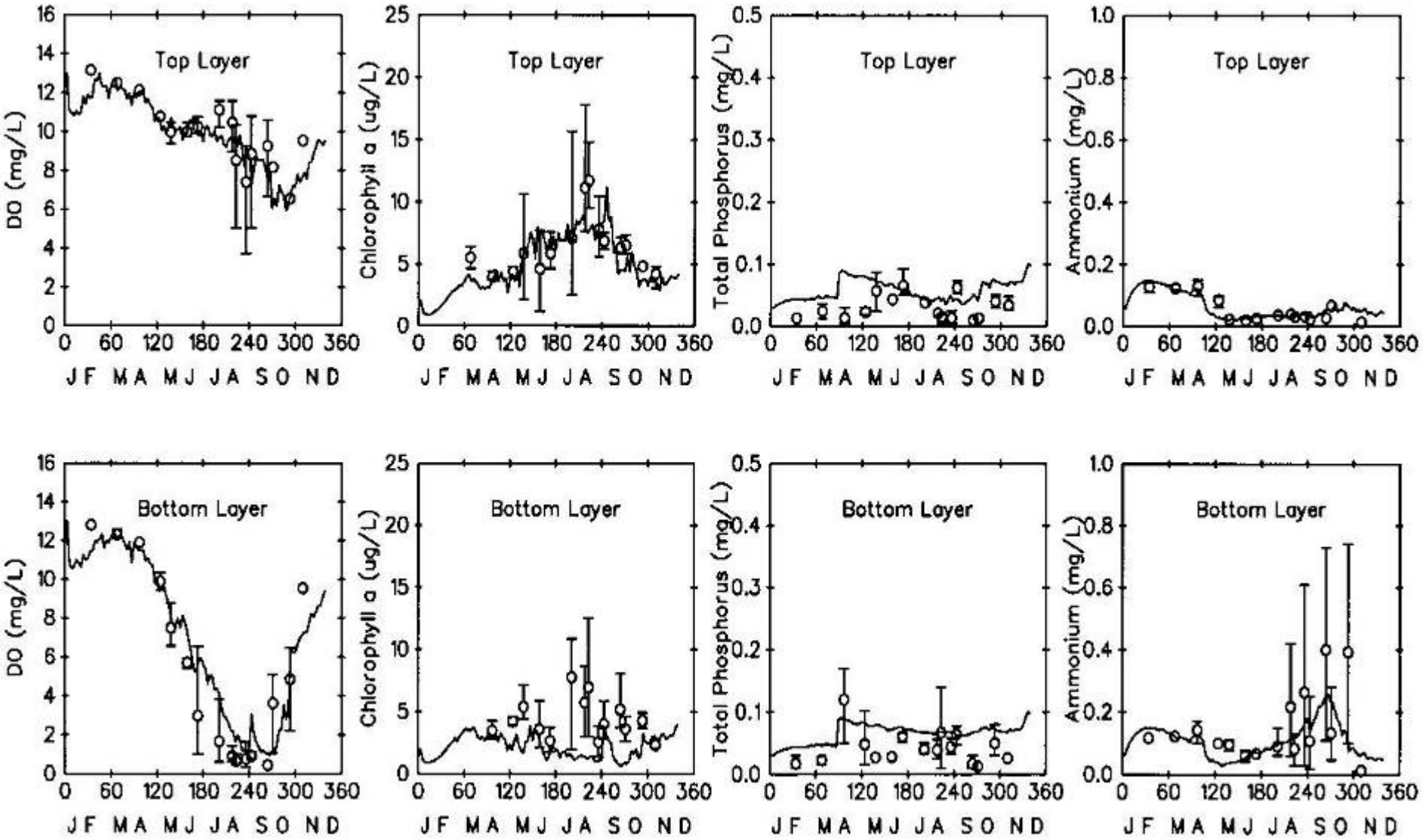
DO vs. Temp in Loch Raven Station GUN0142 near Dam (1990-1997)



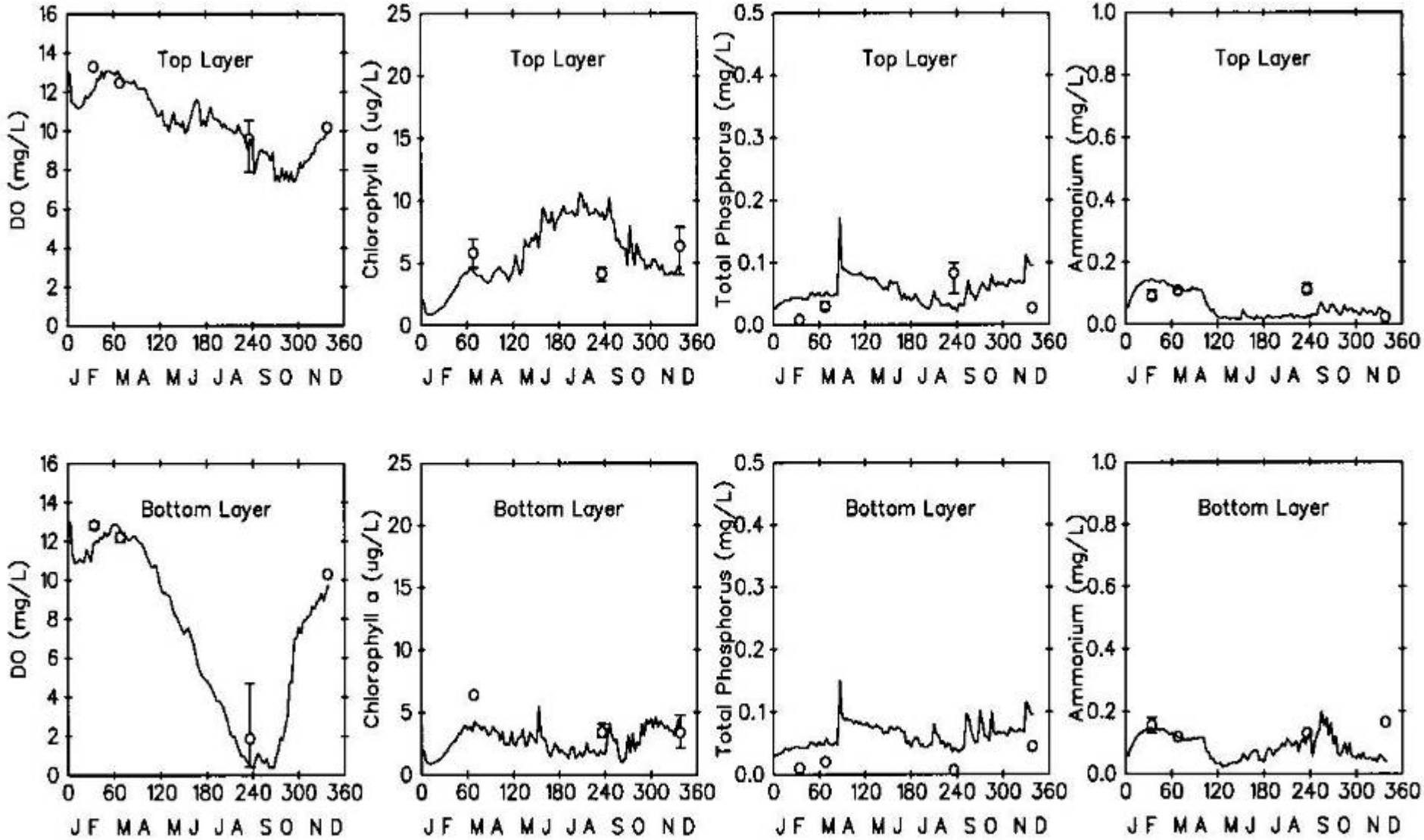
Model Results (Original and Improved) vs. 1992 Data



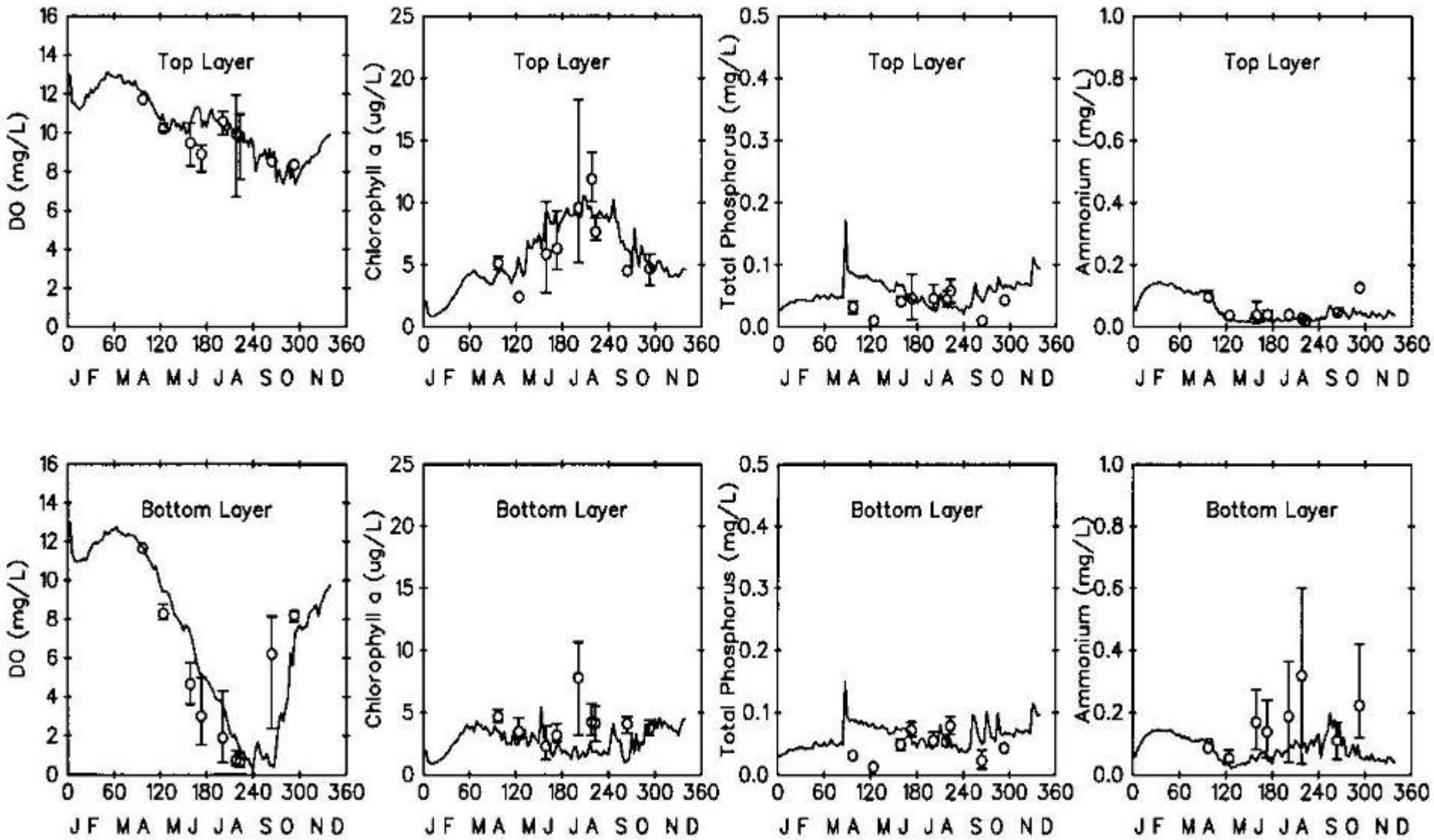
Loch Raven Reservoir Station GUN0142 – 1992



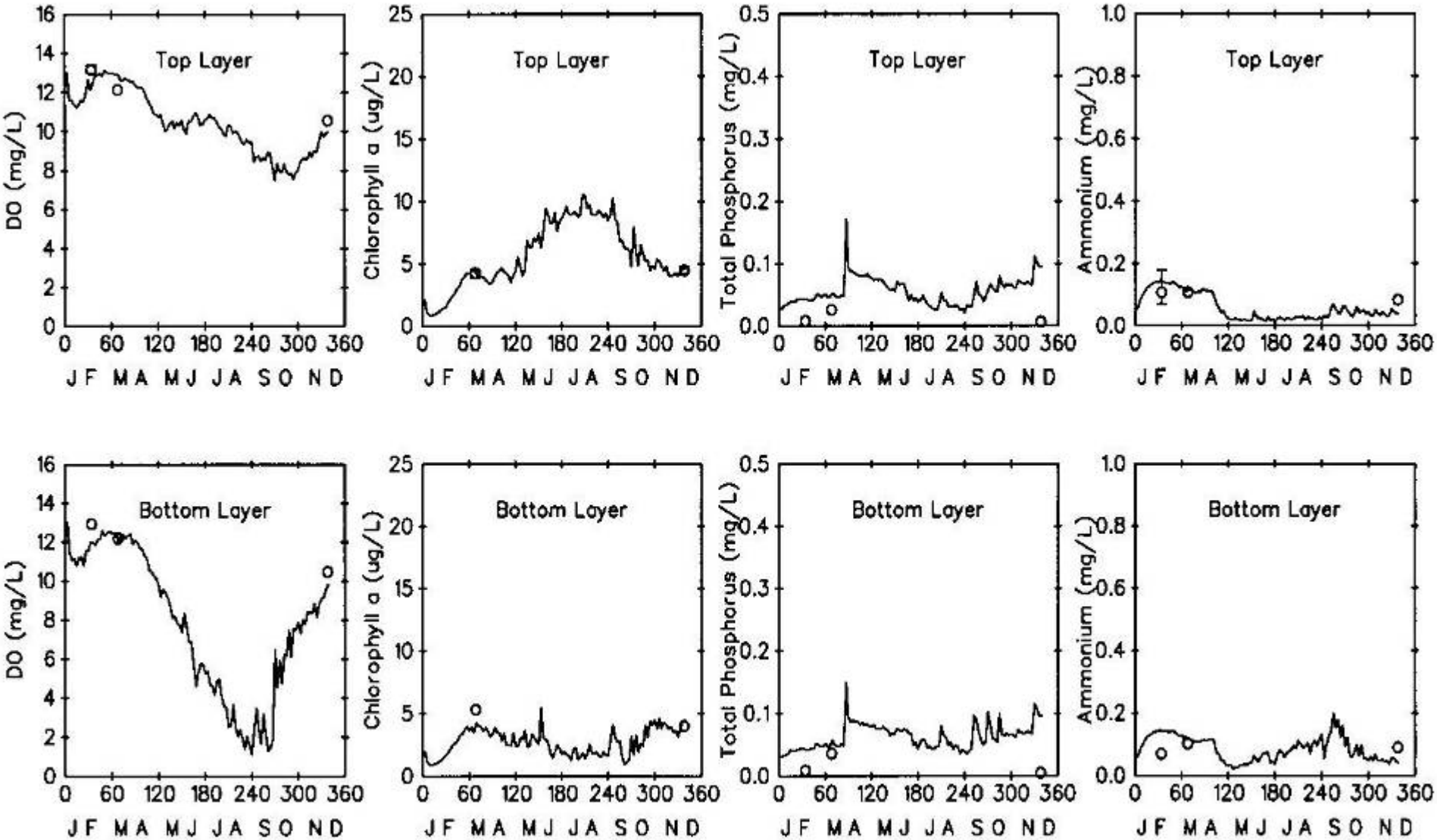
Loch Raven Reservoir Station GUN0156 – 1992



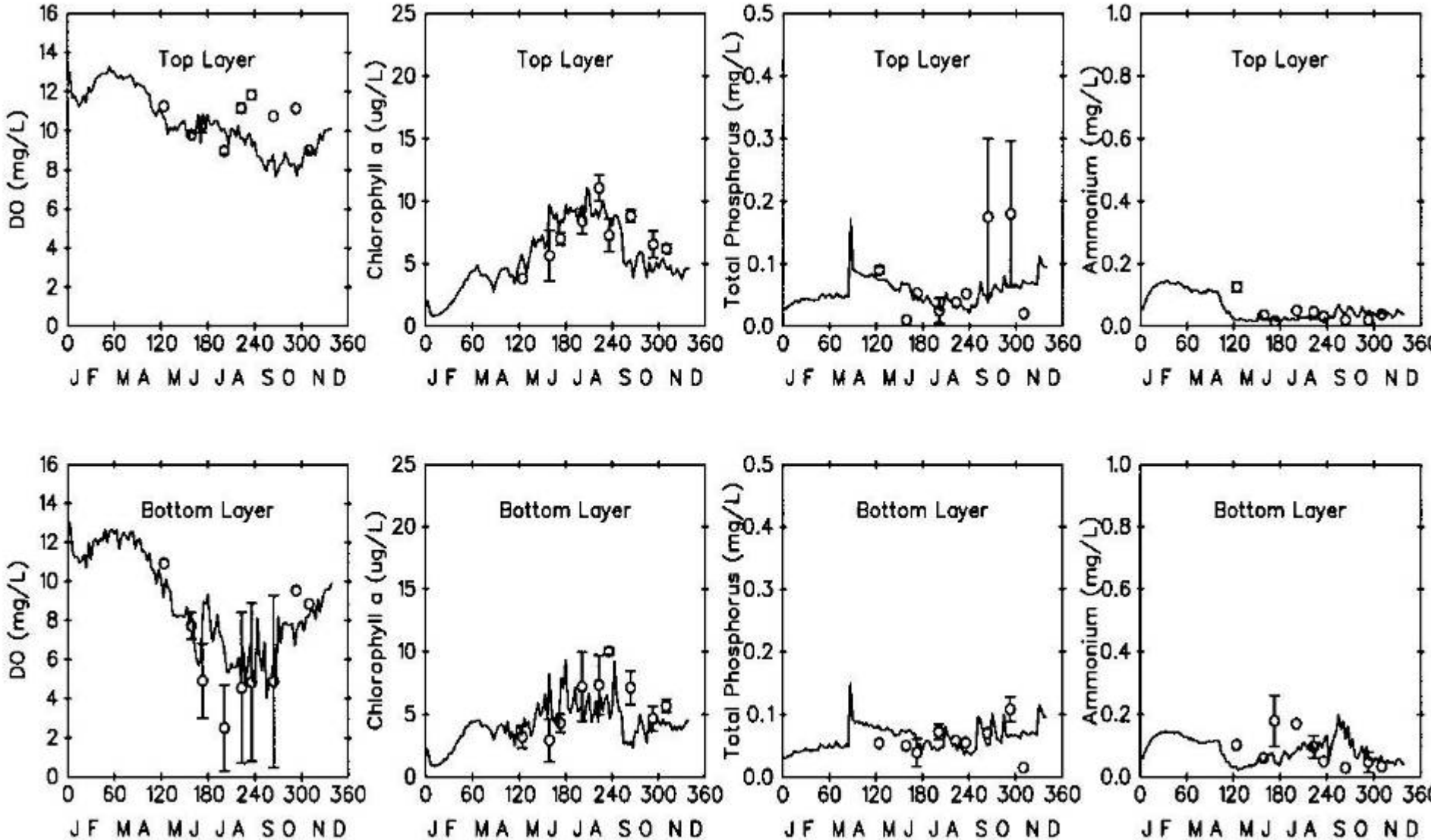
Loch Raven Reservoir Station GUN0171 – 1992



Loch Raven Reservoir Station GUN0174 – 1992



Loch Raven Reservoir Station GUN0190 – 1992



Quantitative Assessment of Water Quality Model Results

Year	$CBOD_5$		Ammonia		DO	
	Mean absolute errors (mg/L)	RMS errors (mg/L)	Mean absolute errors (mg/L)	RMS errors (mg/L)	Mean absolute errors (mg/L)	RMS errors (mg/L)
October 27-28, 2005	13.61	16.69	4.62	5.79	—	—
November 3-4, 2005	17.19	25.91	5.18	6.83	0.42	0.51

—: DO no field data

Santa Fe River Diurnal pH and DO Modeling for TMDL