Chapter 4: Data Addendum

4.1 Overview of updates

In the Initial Draft of their Review Report (and in deliberations during public Teleconference Meetings), the ELM Peer Review Panel made a variety of recommendations to improve the model (October 2006). Among these were requests that we evaluate some alternative methods of developing input data for 1) habitat-specific parameters and 2) atmospheric phosphorus (P) deposition. While both are important topics that will likely be further evaluated for future model refinements, we initially responded by implementing a variety of new data methods, and compared the resulting model (v2.6a, an "alpha" release) performance with that of ELM v2.5 (July 2006 release, v2.5.2).

The Panel recommended that we further aggregate the number of habitat types that were considered in the regional, greater Everglades application. For this aggregation, we collapsed a number of habitat sub-types into their primary habitat classes, reducing the total number of habitats from 28 to 10. As indicated in the ELM v2.5 documentation, there were numerous habitat types in the model for which we had few data, and parameterization of those habitats was generally based on replicating the parameter values from similar habitats. This was reflected in the output of an ELM v2.6a scenario with a reduced number of habitats: it was difficult to discern meaningful differences in the hydrologic or surface water quality performance of the model, compared to ELM v2.5. To simplify the documentation, we anticipate that we will use a similarly- reduced set of habitat types in applications of ELM v2.6. While a larger number of habitats is not necessary for successful application of ELM for water quality evaluations, an improved ecological synthesis of those habitats remains a research goal. In the future, we hope to maintain a parallel database of parameters for the larger number of habitats, summarizing ongoing research on processes in those ecosystems, which are of interest in hydrologic and nutrient (ecosystem) restoration in this region.

Another Review Panel recommendation was to evaluate alternative methods for input of atmospheric P deposition to the model. For this, our goal was to report on the relative model performance using alternatives to the rainfall-based method of ELM v2.5. The simplest alternative applied a spatially and temporally constant deposition rate, with results that were essentially equivalent to the rainfall-based deposition method of ELM v2.5. Another method applied a temporally constant, spatially varying P deposition rate that was generally half that of the rate used in v2.5. Use of this method led to a slight increase (approximately 1 ug l^{-1}) in the under-predictions of the model. The atmospheric P deposition rates that were used in ELM v2.5 will likely be modified in future applications, employing the method of a temporally constant rate that varies to some extent across the spatial domain of the Everglades. The primary importance of these P deposition rates involves the determination of the background P loading and accumulation of the Everglades, against which other loading sources are compared to determine their potential ecological significance.

4.3 Initial condition maps

4.3.4 Vegetation

4.3.4.1 Habitat type

[existing ELM v2.5 Documentation Report text]...

4.3.4.1 Updates to Habitat type

The ELM Peer Review Panel requested that we evaluate the model performance under a simplified scheme of a reduced number of initial habitat types. The ELM v2.5 Documentation Report (Fitz and Trimble 2006) indicated that, specifically for the current "water quality" oriented Performance Measures, initialization of the model under a significantly reduced number of habitat types would produce the same or similar results as the 28 habitats used in ELM v2.5. This was based upon the existing level of parameter complexity, wherein the model does not have unique parameters for each of the individual habitat-specific parameters across all habitat types. We showed that the actual complexity of the habitat-specific parameter matrix was reflective of a relatively small number of sensitive parameters for a smaller number of the principal Everglades ecosystem types (or eco-regions). Habitats for which there were relatively few data were simply parameterized with replicate values from similar habitats. The "under-utilized" (or under-parameterized) habitat types in ELM v2.5 database represented a goal for data synthesis: beyond specific model applications for scenario comparisons, we hope to summarize process-based parameters for these habitats, which are generally representative of most of the habitat types that are of interest in hydrologic and nutrient (ecosystem) restoration in this regional system.

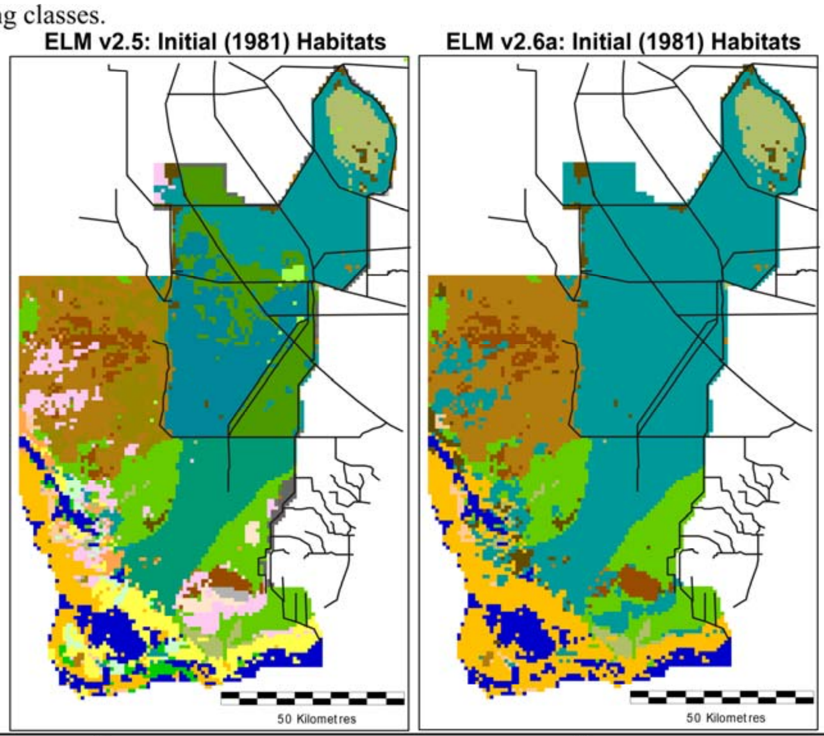
Nevertheless, we recognize that the apparent parameter complexity associated with 28 habitat types is unnecessary for successful application of ELM, and this can "distract" users from the focus on the smaller subset of principal habitats on which most of the current ELM dynamics are based. Following the recommendation of the Peer Review Panel, we developed an aggregated map of initial habitat types.

The v2.5 habitat definitions had been primarily organized among the four broadly defined categories of: graminoid marsh, forest, savannah, and scrub, with the intent to broadly categorize among some of the functional components of ecosystems (e.g., nutrient uptake, plant growth and turnover, resistance to overland flow, evapotranspiration feedbacks, etc). The *primary* classes in the original classified vegetation maps (from varying sources, see Chapter 4) exceeded 70 in number, which we (had previously) aggregated into the modeling superset of 28 habitat types that were of potential interest in modeling ecosystem interactions and landscape succession – in the future.

In developing the further habitat aggregations that were recommended by the Review Panel, we collapsed savannah- and scrub- based habitats into their respective primary forest type. Within the general category of marshes, we aggregated a number of habitats that encompassed different (sub-grid scale) heterogeneities of densities of sawgrass (*Cladium*), and included similar graminoids into the newly generic sawgrass class. Because of their spatial distribution and importance to differentiating ecosystems in the Everglades, we maintained "wet prairies" and "dry (marl) prairies" as a distinct classes.

The uncommon (in the available data at this scale) exotic/invasive habitat and the "Human influence" habitat were assigned to the dominant habitat that was in close spatial proximity.   The resulting map of initial (1981) habitat types is shown in Figure 4A.1, including the crosswalk of habitat identification numbers between the original and aggregated maps. Four of the 10 habitats encompassed 85% of the model domain, compared to 12 of 28 habitats representing the same proportion of the domain in ELM v2.5.

Figure 4A.1. Habitat types used to initialize ELM v2.5, and the aggregated habitats IDs used in the v2.6a habitat scenario. For this aggregation, IDs 16,27,28,29 were assigned to dominant neighboring classes.



	ID	Area (km2)	Habitat type	ID	Area (km2)	Habitat type
Open Water	1	540	Open Water	1	540	Open Water
Marshes	2	1318	Sawgrass Plain	2	4992	Sawgrass (2,3,4,5,7,9,10)
	3	1119	Sawgrass RS Pristine			
	4	983	Sawgrass Slough (deep)			
	5	927	Sawgrass RS Degraded			
	6	1029	Sawgrass Marl Prairie	6	1191	Dry (marl) prairie (6,14)
	7	509	Gramminoid Mix			
	8	363	Wet Prairie	8	363	Wet Prairie
	9	4	Slough with Gramminoids			
	10	33	Slough with Non-gramminoids			
	11	0	Cattail (high density)			
	12	0	Cattail (med density)			
	13	0	Cattail (low density)	13	0	Cattail (11,12,13)
	14	85	Muhly Grass			
	15	58	Salt Marsh	15	59	Salt Marsh
Forest	16	21	Mixed Hardwood Forest			
	17	895	Cypress Swamp Forest	17	1499	Cypress swamp (17,21)
	18	479	Mangrove Forest	18	1186	Mangrove swamp (18,19,25,26)
	19	94	Buttonwood Forest			
Savannah	20	298	Pineland Savannah	20	325	Upland forest
	21	605	Cypress Savanna			
Scrub	22	107	Brush	22	239	Mixed forest (16,22,23)
	23	105	Hardwood Scrub			
	25	499	Mangrove Scrub			
	26	107	Buttonwood Scrub			
Invasive/ Disturbed	27	35	Brazilian Pepper			
	28	14	Melaleuca			
	29	167	Human Influence			

4.4 Static attributes

4.4.2 Model parameters

4.4.2.2 Habitat-specific parameters

[existing ELM v2.5 Documentation Report text]...

4.4.2.3 Updates to Habitat-specific parameters

As described above, we aggregated the habitats (i.e., ecosystem types) that were considered for assessment of the resulting model performance in a new ELM scenario. The reduced number of habitats was associated with a reduced number of records in the "HabParms.xls" database of parameters that were (potentially) unique to each habitat (i.e., habitat-specific parameters). For simplicity in this evaluation, we made no numerical adjustments – such as averaging – to the parameter fields associated with each aggregated habitat's database record. We merely used an existing habitat record that was deemed representative of the targeted ecosystem type. While any formal habitat-aggregation for future model applications could involve more comprehensive parameter adjustments, this simple step maintained the primary parameter records from ELM v2.5, facilitating rapid assessment of the model performance that was associated with the reduced, primary set of habitat types.

Despite reducing the habitat complexity by 64% in the ELM v2.6a scenario (relative to that of ELM v2.5), measures of actual parameter complexity decreased by only 28 - 33% (Table 4A.1). Considering only the thirteen habitat-specific parameters that were identified to have potentially significant effects on model results (Uncertainty Chapter 7), there were 64 and 43 unique parameter values that were used in the v2.5 application and v2.6a scenario, respectively. In ELM v2.5, habitats for which there were relatively few data had been simply parameterized with replicate values from similar habitats: aggregating the database into primary habitat types simplified the parameter set, but not to a very large extent.

Table 4A.1. Comparison of parameter complexity relative to the number of habitats considered, and to the actual parameter distributions that existed in the ELM v2.5 database. While any parameter may potentially take on 10 (28) values for 10 (28) habitats, the number of values that are "actually-unique" for each habitat may be less.

Attribute	**v2.5.2**	**v2.6a scenario**	**Percent reduction**
Number of parameters	40	40	0%
Number of habitats	28	10	64%
Number of potentially-unique parameter values	1120	400	64%
Number of actually-unique pararmeter values	138	100	28%
Number of actually-unique pararmeter values of 13 "important" parameters	64	43	33%

4.4.2.3 Scenario evaluation & conclusions

For the scenario of a reduced number of habitats, we evaluated two fundamental performance characteristics of the model. Any differences in the model performance in predicting stage and predicting surface water P concentration can be attributable to the differences in the parameter sets of ELM v2.5 and the ELM v2.6a scenario.

Stage predictions were generally very similar among the two scenarios, with the two simulations having the same median value of the Nash Sutcliffe Efficiency statistic for all monitoring locations (Table 4A.2). Predictions at 8 monitoring sites had values of this statistic that decreased by more than 0.05, while 4 sites showed an increase of more than 0.05 in the statistic.

Predictions of surface water phosphorus (P) concentration were also similar between the ELM v2.5 performance assessment and that of the ELM v2.6a scenario. The between-scenario difference in the median Bias for all monitoring sites was effectively zero (Table 4A.3). Predictive Bias was improved by >1 ug l^{-1} for two monitoring sites, but generally the differences between scenarios were minor.

These results reinforced the statement (Chapter 4, July 2006) that the ELM v2.5 included more habitat types (28) than were necessary for the intended applications of assessing water quality performance in most of the Everglades. In order to simplify the parameter documentation, and reduce the apparent complexity of the model, it appears to be beneficial to aggregate the habitat distributions that are considered in ELM v2.6 applications. As part of this incremental update to the model, we will further evaluate the distributions of parameter values in the simplified parameter database. In parallel, a more comprehensive database of parameters for ca. 28 habitats will be maintained, striving towards the modeling goal of synthesizing the recent advances in knowledge of ecosystem processes in some of the key habitats of the greater Everglades region.

Table 4A.2. Statistical evaluation of simulated vs. observed stage for the scenario of 10 habitats in the model domain, 1981 – 2000. Units of Bias (***observed minus simulated***) and RMSE are meters. Comparison is made between the values of the NS Efficiency in the results from this scenario and in the results from ELM v2.5 (Model Performance Chapter 6, July 2006).

		Stage 1981-2000 (v2.6a, 10 habitats)					v2.5.2	v2.5.2-v2.6a
Site	Basin	N	Bias (m)	RMSE (m)	R2	NS Eff.	NS Eff.	NS Eff Diff
_1-7	WCA1	7046	0.06	0.15	0.72	0.27	0.27	-0.01
1-8T	WCA1	6869	-0.04	0.15	0.77	0.58	0.55	-0.03
_1-9	WCA1	6879	-0.02	0.13	0.74	0.50	0.46	-0.04
WCA2F1	WCA2A	2259	0.12	0.18	0.82	0.57	0.57	0.01
WCA2F4	WCA2A	1941	0.08	0.15	0.77	0.64	0.64	0.00
WCA2E4	WCA2A	2260	0.10	0.18	0.77	0.55	0.56	0.00
2A-17_B	WCA2A	7305	0.06	0.16	0.75	0.65	0.65	0.00
2A-300_B	WCA2A	7278	0.07	0.20	0.69	0.63	0.64	0.01
WCA2U1	WCA2A	2150	0.14	0.26	0.68	0.32	0.37	0.05
3A-NW_B	WCA3A	7035	-0.02	0.14	0.73	0.72	0.72	0.00
3A-10_B	WCA3A	6445	-0.03	0.13	0.75	0.61	0.58	-0.03
3A-NE_B	WCA3A	6813	0.03	0.21	0.70	0.69	0.69	0.00
3A-11_B	WCA3A	6487	0.23	0.26	0.85	-0.58	-0.56	
3A-3_G	WCA3A	7305	-0.01	0.15	0.86	0.86	0.86	0.00
3A-2_G	WCA3A	7145	0.05	0.12	0.87	0.84	0.83	0.00
3A-12_B	WCA3A	6738	-0.02	0.16	0.65	0.58	0.56	-0.02
3A-9_B	WCA3A	6969	0.15	0.19	0.86	0.58	0.59	0.01
L28-2	WCA3A	4007	0.19	0.21	0.85	0.07	0.06	-0.01
3A-S_B	WCA3A	6871	0.12	0.16	0.86	0.61	0.61	0.00
3A-4_G	WCA3A	7305	0.13	0.18	0.85	0.66	0.68	0.02
3A-28_G	WCA3A	7295	-0.01	0.13	0.82	0.82	0.82	0.00
_3-99	WCA2B	3338	0.24	0.32	0.54	0.00	0.04	0.04
2B-Y	WCA2B	5515	0.00	0.32	0.76	0.74	0.73	0.00
_3-76	WCA3B	3390	-0.14	0.21	0.61	-1.02	-1.27	
_3-71	WCA3B	3454	-0.01	0.11	0.62	0.52	0.50	-0.02
_3-34	WCA3B	1633	-0.09	0.13	0.81	0.58	0.48	-0.10
SHARK.1_H	WCA3B	6684	-0.03	0.11	0.83	0.80	0.78	-0.02
3B-SE_B	WCA3B	6029	-0.14	0.22	0.84	0.56	0.50	-0.06
HOLEY1	Holey L.	4041	-0.15	0.20	0.64	0.19	0.11	-0.08
HOLEY_G	Holey L.	5599	-0.01	0.21	0.50	-0.35	-0.49	
HOLEY2	Holey L.	4046	-0.11	0.20	0.57	0.34	0.30	-0.04
ROTT.S	Roten. T.	5208	0.12	0.17	0.60	0.23	0.24	0.01
BCNPA13	BCNP	1923	-0.17	0.26	0.38	-0.12	-0.16	
L28.GAP	BCNP	6393	-0.11	0.20	0.46	0.16	0.31	0.15
3A-SW_B	BCNP/3A	6641	0.09	0.13	0.86	0.69	0.68	-0.02
BCNPA5	BCNP	3636	-0.15	0.23	0.36	-0.21	0.02	0.23
BCNPA4	BCNP	3601	0.03	0.19	0.54	0.41	0.38	-0.03
TAMI.40M	BCNP	7305	-0.04	0.23	0.62	0.44	0.66	0.22
BCNPA11	BCNP	3549	0.14	0.27	0.32	0.00	-0.01	

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Table 4A.2. Continued.

		Stage 1981-2000 (v2.6a, 10 habitats)					v2.5.2	v2.5.2-v2.6a
Site	Basin	N	Bias (m)	RMSE (m)	R2	NS Eff.	NS Eff.	NS Eff Diff
G-618_B	ENP	7124	-0.04	0.14	0.71	0.66	0.66	0.00
L29	ENP	7305	0.01	0.13	0.67	0.65	0.67	0.02
LOOP1_H	ENP	5938	0.11	0.17	0.63	0.27	0.32	0.05
LOOP2_H	ENP	5972	0.16	0.23	0.68	0.26	0.24	-0.03
NESRS3_B	ENP	5579	0.03	0.15	0.67	0.64	0.65	0.01
NESRS2	ENP	6228	-0.01	0.09	0.75	0.75	0.74	-0.01
NP-201	ENP	5723	0.17	0.20	0.82	0.44	0.50	0.06
BCNPA10	ENP	3637	-0.10	0.17	0.53	0.19	0.24	0.05
NESRS1	ENP	6536	-0.01	0.09	0.74	0.73	0.72	0.00
NP-205	ENP	7149	0.05	0.14	0.80	0.77	0.78	0.01
L67EX.W	ENP	6319	0.06	0.19	0.74	0.55	0.59	0.04
L67EX.E_B	ENP	6187	-0.01	0.11	0.74	0.70	0.70	0.00
G-620_B	ENP	6264	0.02	0.11	0.79	0.78	0.79	0.01
NP-202	ENP	7069	0.10	0.16	0.75	0.56	0.61	0.06
NESRS4_B	ENP	4854	-0.01	0.10	0.70	0.63	0.63	0.00
G-596_B	ENP	7282	-0.10	0.22	0.58	0.23	0.16	-0.07
NESRS5_B	ENP	4953	0.00	0.08	0.76	0.69	0.70	0.01
G-3273	ENP	6137	-0.16	0.24	0.73	0.48	0.44	-0.04
L67E.S	ENP	3631	0.10	0.19	0.57	0.38	0.34	-0.04
NP-203	ENP	7049	0.06	0.13	0.74	0.65	0.68	0.03
G-1502	ENP	7305	-0.11	0.21	0.72	0.62	0.61	-0.01
NP-P33	ENP	7147	0.03	0.13	0.62	0.60	0.57	-0.03
NP-P34	ENP	6971	0.04	0.17	0.82	0.62	0.64	0.02
NP-RG1	ENP	1570	-0.07	0.13	0.85	0.69	0.67	-0.02
NP-206	ENP	6641	-0.07	0.20	0.75	0.70	0.69	-0.01
NP-RG2	ENP	1502	-0.09	0.16	0.84	0.61	0.63	0.03
NP-P36	ENP	6952	0.08	0.13	0.71	0.54	0.55	0.01
RUTZKE_G	ENP	2369	-0.06	0.20	0.80	0.21	0.21	0.00
NP-P35	ENP	6851	-0.14	0.20	0.80	-0.16	-0.11	
NP-P62	ENP	6851	-0.04	0.14	0.78	0.75	0.79	0.04
NP-P44	ENP	6440	-0.20	0.30	0.80	0.51	0.51	0.00
NP-TSB	ENP	7299	-0.17	0.23	0.81	0.54	0.56	0.01
NP-P72	ENP	7186	-0.22	0.30	0.75	0.41	0.47	0.06
NP-P38	ENP	6896	-0.10	0.14	0.87	0.43	0.44	0.01
SWEVER3	ENP	5330	0.19	0.25	0.68	-2.36	-2.47	
SWEVER4	ENP	5582	0.02	0.18	0.75	-0.51	-0.58	
NP-P67	ENP	7107	0.03	0.10	0.79	0.74	0.72	-0.03
NP-P46	ENP	6680	-0.03	0.13	0.72	0.41	0.42	0.01
SWEVER2B	ENP	5488	0.14	0.17	0.58	-0.39	-0.33	
NP-207	ENP	6755	0.05	0.09	0.86	0.73	0.71	-0.02
NP-EPS	ENP	5240	-0.02	0.06	0.69	0.64	0.67	0.03
NP-EP12R	ENP	2828	-0.07	0.09	0.76	0.22	0.22	-0.01
NP-EP9R	ENP	2608	-0.12	0.14	0.76	-0.12	-0.09	
	Median:	6356	-0.01	0.17	0.74	0.56	0.56	0.00
							Count Diffs > 0.05 (v2.6a "worse"):	8.00
							Count Diffs < -0.05 (v2.6a "better"):	4.00

Table 4A.3. Statistical evaluation of simulated vs. observed surface water phosphorus concentration for the scenario of 10 habitats in the model domain, 1981 – 2000. Units of Bias (observed minus simulated) and RMSE are ug l^{-1} (ppb). Comparison is made between the absolute values of Bias in the results from this scenario and in the results from ELM v2.5 (Model Performance Chapter 6, July 2006).

			Distance to	1981-2000 (v2.6a, 10 Habitats)					v2.5.2	v2.5.2 - v2.6a
Site	Basin	Site type	Source (km)	N	ObsMean	RelBias	Bias	RMSE	Bias	Diff ABS_Bias
LOX4	WCA1	Marsh	0.5	12	10	-0.90	-9.1	11	-9.4	0.2
LOX3	WCA1	Marsh	4.0	11	11	0.40	4.4	7	4.6	0.2
LOX5	WCA1	Marsh	7.5	13	10	0.30	2.8	5	3.1	0.3
LOX9	WCA1	Marsh	6.0	13	9	0.43	4.1	5	4.2	0.1
LOX10	WCA1	Marsh	2.0	12	10	0.52	5.3	6	5.3	0.1
LOX8	WCA1	Marsh	7.9	14	9	0.28	2.4	4	2.7	0.3
LOX7	WCA1	Marsh	3.4	14	8	0.31	2.6	3	2.7	0.1
LOX6	WCA1	Marsh	1.0	14	8	-0.43	-3.4	5	-3.4	0.0
LOX11	WCA1	Marsh	6.0	14	9	0.45	4.2	5	4.3	0.1
LOX12	WCA1	Marsh	2.0	14	8	0.32	2.4	3	2.4	0.0
LOX13	WCA1	Marsh	5.2	14	9	0.44	3.8	5	3.9	0.1
LOX14	WCA1	Marsh	0.5	14	8	-1.21	-9.8	11	-9.8	0.0
LOX15	WCA1	Marsh	0.5	14	8	-1.89	-14.6	16	-14.4	-0.2
LOX16	WCA1	Marsh	1.0	14	9	-0.71	-6.0	7	-6.0	-0.1
CA33	WCA3A	Marsh	3.0	14	13	-0.45	-5.7	8	-5.8	0.1
CA35	WCA3A	Marsh	2.0	14	12	-1.77	-21.1	23	-20.7	-0.4
CA32	WCA3A	Marsh	2.6	14	8	0.13	1.1	2	1.1	0.0
CA36	WCA3A	Marsh	1.0	14	30	-0.15	-4.6	11	-3.8	-0.8
CA38	WCA3A	Marsh	5.2	14	9	-0.18	-1.6	4	-1.2	-0.3
CA34	WCA3A	Marsh	3.0	14	10	0.19	2.0	4	2.2	0.2
CA311	WCA3A	Marsh	6.5	14	6	-0.71	-4.1	5	-3.8	-0.3
CA315	WCA3A	Marsh	10.6	14	6	-0.15	-0.9	2	-0.7	-0.2
NE1	ENP	Marsh	8.0	29	10	0.42	4.3	7	4.4	0.1
P33	ENP	Marsh	16.0	30	8	-0.05	-0.4	3	-0.3	-0.1
P34	ENP	Marsh	20.1	26	6	-0.94	-5.8	6	-5.6	-0.2
P36	ENP	Marsh	26.0	30	17	0.63	10.5	24	10.8	0.3
P35	ENP	Marsh	33.2	29	13	0.57	7.7	16	7.7	0.0
TSB	ENP	Marsh	2.1	30	8	-0.51	-3.9	6	-4.0	0.1
P37	ENP	Marsh	17.3	28	6	-0.65	-3.8	5	-3.9	0.0
EP	ENP	Marsh	4.0	27	6	-0.24	-1.5	4	-1.4	-0.1

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Table 4A.3. Continued.

			Distance to	1981-2000 (v2.6a, 10 Habitats)					v2.5.2	v2.5.2 - v2.6a
Site	Basin	Site type	Source (km)	N	ObsMean	RelBias	Bias	RMSE	Bias	Diff ABS_Bias
X1	WCA1	Mar. Trans.	0.5	10	40	0.58	23.2	33	22.9	-0.3
X2	WCA1	Mar. Trans.	1.0	10	16	0.23	3.7	7	3.5	-0.2
X3	WCA1	Mar. Trans.	1.0	10	11	-0.38	-4.3	10	-4.6	0.3
X4	WCA1	Mar. Trans.	3.0	9	10	0.44	4.5	5	4.5	0.0
Y4	WCA1	Mar. Trans.	1.2	10	12	0.32	4.0	13	3.8	-0.2
Z1	WCA1	Mar. Trans.	0.5	10	42	0.08	3.5	14	3.0	-0.4
Z2	WCA1	Mar. Trans.	0.5	9	14	-1.33	-19.0	23	-19.3	0.3
Z3	WCA1	Mar. Trans.	0.5	10	10	-1.72	-16.7	19	-16.8	0.1
Z4	WCA1	Mar. Trans.	1.2	10	9	0.34	3.2	6	3.2	0.0
E1	WCA2A	Mar. Trans.	1.0	13	65	0.24	15.3	30	15.3	0.0
E2	WCA2A	Mar. Trans.	2.0	12	58	0.32	18.9	29	19.0	0.1
E3	WCA2A	Mar. Trans.	3.0	12	39	0.28	10.8	21	10.9	0.1
E4	WCA2A	Mar. Trans.	5.6	13	15	-0.29	-4.4	7	-4.3	-0.1
E5	WCA2A	Mar. Trans.	8.4	13	9	-0.77	-6.5	8	-6.5	-0.1
F1	WCA2A	Mar. Trans.	0.5	14	120	0.27	31.8	72	32.5	0.7
F2	WCA2A	Mar. Trans.	2.1	13	67	0.49	32.7	47	32.7	0.0
F3	WCA2A	Mar. Trans.	4.3	13	29	0.30	8.8	13	8.8	0.0
F4	WCA2A	Mar. Trans.	5.2	13	19	-0.02	-0.3	5	-0.2	-0.1
F5	WCA2A	Mar. Trans.	6.5	13	11	-0.51	-5.5	7	-5.6	0.0
U1	WCA2A	Mar. Trans.	12.3	13	11	-0.01	-0.1	8	0.0	0.0
U2	WCA2A	Mar. Trans.	11.1	13	14	0.41	5.6	29	5.6	0.1
U3	WCA2A	Mar. Trans.	8.8	14	9	-0.46	-4.0	7	-3.9	-0.1
L7	WCA1	Canal	0.0	8	118	0.03	4.1	54	4.2	0.1
L40-1	WCA1	Canal	0.0	20	62	-0.17	-10.3	34	-10.1	-0.2
L40-2	WCA1	Canal	0.0	20	84	0.16	13.1	30	13.2	0.2
S10A	WCA1	Canal	0.0	25	54	-0.79	-42.8	60	-42.6	-0.2
S10C	WCA1	Canal	0.0	26	81	-0.21	-16.8	41	-16.6	-0.2
S10D	WCA1	Canal	0.0	39	99	0.11	11.0	38	11.1	0.2
S10E	WCA1	Canal	0.0	23	88	0.17	15.1	40	15.4	0.2
X0	WCA1	Can. Trans.	0.0	8	53	-0.27	-14.4	26	-14.1	-0.3
Z0	WCA1	Can. Trans.	0.0	8	60	-0.10	-6.3	19	-6.0	-0.3
E0	WCA1	Can. Trans.	0.0	13	86	0.18	15.6	35	16.9	1.3
F0	WCA2A	Can. Trans.	0.0	12	93	0.22	20.4	34	21.6	1.2
S144	WCA2A	Canal	0.0	29	19	-0.57	-10.8	19	-10.6	-0.2
S145	WCA2A	Canal	0.0	35	16	-0.79	-13.0	19	-12.7	-0.3
S146	WCA2A	Canal	0.0	29	16	-0.79	-12.9	20	-12.7	-0.2
S11A	WCA2A	Canal	0.0	33	27	-0.49	-13.0	26	-12.9	-0.1
S11B	WCA2A	Canal	0.0	32	44	0.12	5.4	23	5.5	0.1
S11C	WCA2A	Canal	0.0	39	55	0.42	23.2	32	23.3	0.1
C123SR84	WCA2A	Canal	0.0	26	46	0.47	21.5	27	21.8	0.3
S151	WCA3A	Canal	0.0	40	27	0.27	7.4	19	7.9	0.5
S12A	WCA3A	Canal	0.0	39	16	0.31	5.0	20	5.4	0.4
S12B	WCA3A	Canal	0.0	39	14	0.16	2.2	14	2.7	0.4
S12C	WCA3A	Canal	0.0	40	14	0.06	0.8	7	1.2	0.4
S12D	WCA3A	Canal	0.0	40	14	0.11	1.5	6	2.0	0.4
S333	WCA3A	Canal	0.0	39	15	0.20	3.0	8	3.4	0.4
COOPERTN	WCA3A	Canal	0.0	20	11	0.33	3.8	5	4.1	0.2
S31	WCA3B	Canal	0.0	26	21	0.34	7.0	17	7.9	0.9
			Median All:	14	14	0.11	2.2	11	2.4	0.2
			Median Canal:	28	45	0.12	3.4	24	3.8	0.3
			Median Marsh:	14	10	0.11	1.5	7	1.7	0.1
							Count Diffs > 1.0 (v2.6a "better"):			2.00
							Count Diffs < -1.0 (v2.6a "worse"):			0.00

4.5 Boundary conditions

4.5.3 Nutrient/constituent inflows

4.5.3.1 Atmospheric nutrient deposition

[existing ELM v2.5 Documentation Report text]...

4.5.3.2 Updates to atmospheric nutrient deposition

The ELM Peer Review Panel requested (October 2006) that we evaluate other methods of calculating atmospheric deposition of phosphorus (P) for boundary condition input to the model. The current rainfall-based method was not considered to be an optimal approach.

The ELM versions 2.1 through 2.5 applied a constant rainfall P concentration (in the GlobalParms data file, "GP_TP_IN_RAIN" = 0.02 mg P l^{-1}) to the spatial time series of rainfall inputs, resulting in a long-term (20-yr) mean deposition rate that varied spatially within the relatively narrow range of 25 - 27 mg P m^{-2} yr^{-1}. After development of ELM v2.1, in 2003 we evaluated a variety of data sources to further refine our estimates of atmospheric deposition of P, evaluating the spatial distribution of deposition within the greater Everglades. This refinement was principally based on data from Ahn and James (2001) and Walker (1999). Separation of P deposition into distinct wet and dry contributions did not appear promising in this (2003) data evaluation, but may be evaluated again in the near future (2007). The following provides an overview of the updated method that will likely be used to estimate atmospheric P deposition for future versions of ELM (i.e., v2.6 or higher).

Locations of the available atmospheric deposition monitoring sites are shown in Figure 4A.2. The distances of these (within-ELM-domain) monitoring sites from the nearest model boundary were calculated (Table 4A.4). Except for site "ENPRC", the distances for peripheral sites outside the boundary of natural areas were set to a value of 1 m. Although ENPRC is inside the domain boundary, it is also located near the headquarters facilities of Everglades National Park, and subjected to some degree of local anthropogenic input. This site was excluded from calculations for peripheral sites or interior sites.

Local anthropogenic sources affect the total amount of atmospheric phosphorus. It was hypothesized that remote or interior locations of the Everglades receive less input from atmospheric deposition than locations at the boundary. This hypothesis was generally supported by data reported at 11 sites in and around the Everglades (Ahn and James 2001) (Walker 1999). To estimate the relationship between the P deposition rate in the interior of the Everglades and the distance to the boundary of natural area, two statistical models were developed to fit the data.

In one method, the spatially distributed P deposition rates were derived from all 11 sites (Figure 4A.3), using the regressed relationship:

$$\text{P deposition (mg m}^{-2}\text{ yr}^{-1}) = 39.91 - 2.98 \cdot \text{LOG}\left(\text{Distance to boundary (m)}\right)$$

P deposition rates were calculated on a distance interval of 30 m within the ELM domain, and then were integrated into the 1000 m grid cells. Cells with values lower than 10 mg P

m^{-2} yr^{-1} were set to 10 mg P m^{-2} yr^{-1}. The resulting deposition rates ranged from 10 to 23.8, with a mean of 11.8 mg P m^{-2} yr^{-1}.

The second method represented an upper bound of atmospheric P deposition. In this approach, an equation fitted data from 4 sites that defined the upper boundary of the data cloud (Figure 4A.4):

$$\text{P deposition (mg m}^{-2}\text{ yr}^{-1}) = 36.67 \cdot e^{\frac{-0.603 \cdot (\text{Distance to boundary (m)})}{1000}} + 12.51$$

P deposition rates were calculated on a distance interval of 30 m within the ELM domain, and then were integrated into 1000 m grid cells. The resulting deposition rates ranged from 12.5 to 43.4, with a mean of 14.4 mg P m^{-2} yr^{-1}. The results of this method were tentatively selected for model application, with the input map depicted in Figure 4A.5.

Table 4A.4. Summary of atmospheric P deposition data that are most relevant (proximate) to the spatial domain of the ELM.

Location	Site	Date	P Deposition (mg m^{-2} yr^{-1})	Sources	Distance to boundary (m)	Mean P Deposition (mg m^{-2} yr^{-1})
Peripheral	BG1&2	92-96	40.73	Ahn & James 2001	1	40.0
	ENR	92-96	49.17	Ahn & James 2001	1	
	L6	92-96	33.98	Ahn & James 2001	1	
	S140	92-96	35.66	Ahn & James 2001	1	
	S310	92-96	41.43	Ahn & James 2001	1	
	S7	92-96	39.06	Ahn & James 2001	1	
Interior	L-1	93-98	15.70	Walker 1999	768	14.7
	West	93-98	22.30	Walker 1999	2185	
	I-9	93-98	10.40	Walker 1999	6266	
	I-7	93-98	13.70	Walker 1999	10399	
	L67A	92-96	11.42	Ahn & James 2001	17485	
Other	ENPRC	92-96	32.70	Ahn & James 2001	-	

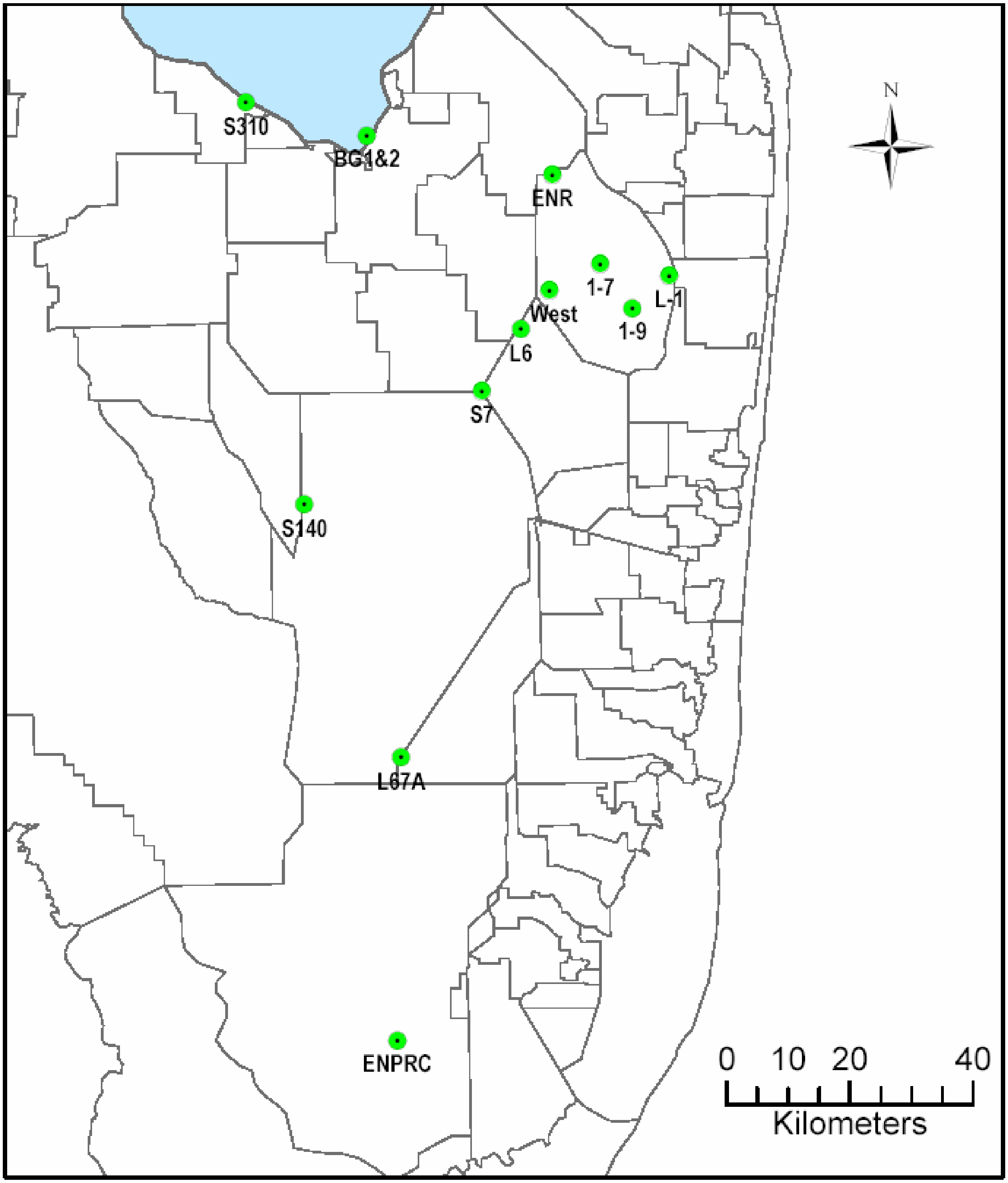

Figure 4A.2. Locations of atmospheric deposition monitoring sites operated by the SFWMD and USFWS.

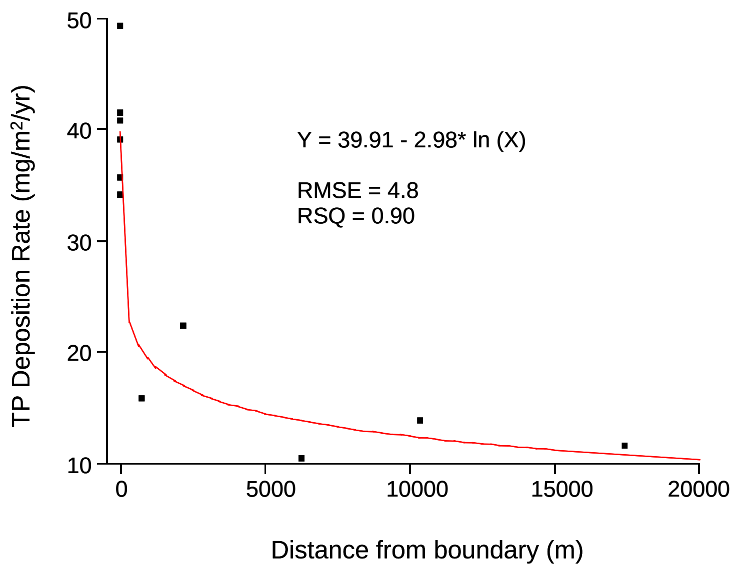

Figure 4A.3. Regression analysis of atmospheric P deposition vs. distance from the ELM domain boundary, for all monitoring sites.

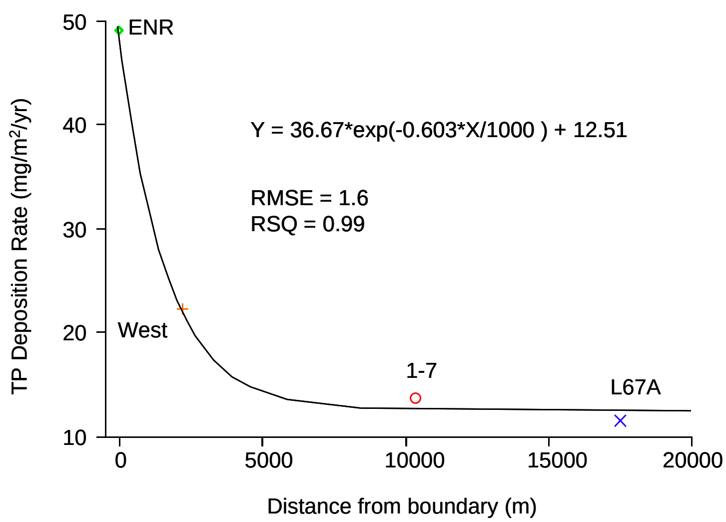

Figure 4A.4. Regression analysis of atmospheric P deposition vs. distance from the ELM domain boundary, for selected sites that define the upper boundary of data cloud (ENR, West, I-7 and L67A).

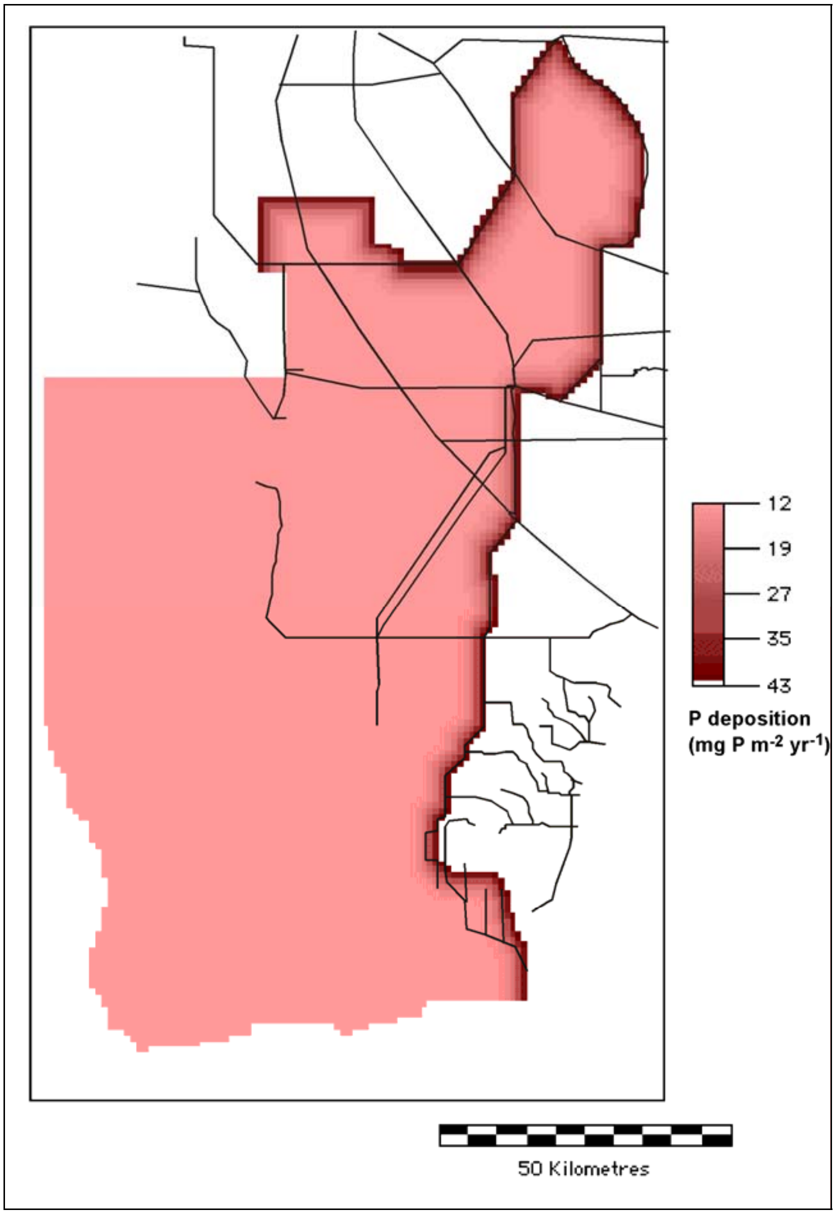

Figure 4A.5. The spatial distribution of atmospheric P deposition rates, using the second method described in the text. These data were input to the ELM v2.6a as one of the scenarios for evaluating the effects of different deposition rates on some model Performance Measures.

4.5.3.3 Atmospheric nutrient deposition – scenario evaluations

Source code changes: The ELM v2.5 (v2.5.2, July 2006 release) algorithms and data were minimally modified for this alpha release of ELM v2.6. The only data modification was made for estimates of atmospheric deposition of P, as described above. The only source code change that affected the output of the regional ELM application[1] was in the source file "UnitMod.c" This involved the addition of an input map, and code within the "cell_dyn9" module for vertical solutions of P associated with water. For this change, daily additions of phosphorus from atmospheric sources was made to be conditional on the value of the existing "GP_TP_IN_RAIN" global parameter of P concentration in rain: if (the temporally and spatially constant) GP_TP_IN_RAIN >0.0, atmospheric inputs of P mass were solely derived from the rainfall P concentration and the (spatially-varying) daily rainfall volume; a null (0.0) concentration parameter resulted in atmospheric inputs of P mass that were solely derived from the (temporally constant) spatial map of P deposition (e.g., Figure 4A.5).

Scenarios and results: We made two scenarios to compare to the previous results of the ELM v2.5. For the first v2.6a scenario, we input a map that had a spatially constant (domain-wide) P deposition rate of 26 mg P m^{-2} yr^{-1}, which was effectively the same spatial distribution of P inputs as found in ELM v2.5, but which was constant in time instead of varying with rainfall events. The *results between this method (v2.6a) and the rainfall-based method (v2.5) were difficult to distinguish in statistical analysis of the surface water P concentration Performance Measure*. Table 4A.5 shows the difference in the model performance Bias statistic between the two scenarios: the between-scenario difference in median Bias at all monitoring sites was < 1 ug l^{-1}; two sites had (absolute values of) differences greater than 1 ug l^{-1}, with a 1.7 ug l^{-1} maximum difference at any site.

For the second v2.6a scenario, we used the spatially distributed map of atmospheric P deposition shown in Figure 4A.5. Eighty five percent of the model domain in this scenario had an atmospheric P deposition rate that was less than approximately half that of the long-term rate used in ELM v2.5 (i.e., 12-13 vs. ~25-27 mg P m^{-2} yr^{-1}). Table 4A.6 shows the difference in the model performance Bias statistic between the two scenarios: the between-scenario difference in median Bias at all monitoring sites was -1.0 ug l^{-1}, which represented a slight tendency towards further model under-prediction compared to observed data. The maximum absolute value of the difference in Bias between the scenarios was almost 4 ug l^{-1}, in which the predictions of the v2.6a scenario were statistically improved relative to the v2.5 performance. Overall, however, model performance of v2.6a scenario was not quite as good as the ELM v2.5 application, with 28 sites having the absolute magnitude of the bias increased by at least 1 ug l^{-1} (towards under-prediction).

[1] See Model Perturbation Experiments Chapter 11 for source code changes that were intended for subregional model experiments (ELM v2.6a), primarily involving boundary conditions of overland and groundwater flows. These code changes were made such that they did not affect the (current implementation of the) regional application.

Table 4A.5. Statistical evaluation of simulated vs. observed surface water phosphorus concentration for the scenario of spatially and temporally constant atmospheric P deposition (26 mg P m^{-2} yr^{-1}), 1981 – 2000. Units of Bias (***observed minus simulated***) and RMSE are ug l^{-1} (ppb). Comparison is made between the absolute values of Bias in the results from this scenario and in the results from ELM v2.5 (Model Performance Chapter 6, July 2006).

			Distance to	**1981-2000 (v2.6a, constant P deposition)**					v2.5.2	v2.5.2 - v2.6a
Site	Basin	Site type	Source (km)	N	ObsMean	RelBias	Bias	RMSE	Bias	Diff ABS_Bias
LOX4	WCA1	Marsh	0.5	12	10	-0.89	-9.0	11	-9.4	0.4
LOX3	WCA1	Marsh	4.0	11	11	0.47	5.1	7	4.6	-0.5
LOX5	WCA1	Marsh	7.5	13	10	0.40	3.8	4	3.1	-0.8
LOX9	WCA1	Marsh	6.0	13	9	0.53	5.0	6	4.2	-0.9
LOX10	WCA1	Marsh	2.0	12	10	0.59	5.9	6	5.3	-0.6
LOX8	WCA1	Marsh	7.9	14	9	0.36	3.1	4	2.7	-0.4
LOX7	WCA1	Marsh	3.4	14	8	0.40	3.4	4	2.7	-0.7
LOX6	WCA1	Marsh	1.0	14	8	-0.41	-3.2	4	-3.4	0.2
LOX11	WCA1	Marsh	6.0	14	9	0.51	4.8	5	4.3	-0.5
LOX12	WCA1	Marsh	2.0	14	8	0.36	2.8	3	2.4	-0.3
LOX13	WCA1	Marsh	5.2	14	9	0.53	4.5	5	3.9	-0.6
LOX14	WCA1	Marsh	0.5	14	8	-1.21	-9.8	11	-9.8	0.1
LOX15	WCA1	Marsh	0.5	14	8	-1.87	-14.4	16	-14.4	0.0
LOX16	WCA1	Marsh	1.0	14	9	-0.66	-5.7	7	-6.0	0.3
CA33	WCA3A	Marsh	3.0	14	13	-0.50	-6.3	8	-5.8	-0.5
CA35	WCA3A	Marsh	2.0	14	12	-1.72	-20.5	22	-20.7	0.2
CA32	WCA3A	Marsh	2.6	14	8	0.27	2.2	3	1.1	-1.1
CA36	WCA3A	Marsh	1.0	14	30	-0.12	-3.7	9	-3.8	0.1
CA38	WCA3A	Marsh	5.2	14	9	-0.03	-0.3	3	-1.2	1.0
CA34	WCA3A	Marsh	3.0	14	10	0.33	3.4	5	2.2	-1.2
CA311	WCA3A	Marsh	6.5	14	6	-0.36	-2.1	4	-3.8	1.7
CA315	WCA3A	Marsh	10.6	14	6	0.15	0.9	2	-0.7	-0.3
NE1	ENP	Marsh	8.0	29	10	0.44	4.6	7	4.4	-0.2
P33	ENP	Marsh	16.0	30	8	-0.04	-0.3	3	-0.3	-0.1
P34	ENP	Marsh	20.1	26	6	-0.85	-5.3	6	-5.6	0.3
P36	ENP	Marsh	26.0	30	17	0.61	10.2	24	10.8	0.5
P35	ENP	Marsh	33.2	29	13	0.60	8.1	15	7.7	-0.4
TSB	ENP	Marsh	2.1	30	8	-0.51	-3.9	5	-4.0	0.2
P37	ENP	Marsh	17.3	28	6	-0.56	-3.3	5	-3.9	0.6
EP	ENP	Marsh	4.0	27	6	-0.25	-1.6	3	-1.4	-0.2

Table continued next page.

Table 4A.5. Continued.

Site	Basin	Site type	Distance to Source (km)	N	ObsMean	RelBias	Bias	RMSE	v2.5.2 Bias	v2.5.2 - v2.6a Diff ABS_Bias
				1981-2000 (v2.6a, constant P deposition)						
X1	WCA1	Mar. Trans.	0.5	10	40	0.58	22.9	33	22.9	0.0
X2	WCA1	Mar. Trans.	1.0	10	16	0.21	3.4	7	3.5	0.1
X3	WCA1	Mar. Trans.	1.0	10	11	-0.40	-4.6	10	-4.6	0.0
X4	WCA1	Mar. Trans.	3.0	9	10	0.46	4.7	5	4.5	-0.1
Y4	WCA1	Mar. Trans.	1.2	10	12	0.31	3.8	13	3.8	0.0
Z1	WCA1	Mar. Trans.	0.5	10	42	0.07	2.9	14	3.0	0.1
Z2	WCA1	Mar. Trans.	0.5	9	14	-1.35	-19.4	23	-19.3	-0.1
Z3	WCA1	Mar. Trans.	0.5	10	10	-1.74	-16.9	20	-16.8	-0.1
Z4	WCA1	Mar. Trans.	1.2	10	9	0.34	3.2	6	3.2	-0.1
E1	WCA2A	Mar. Trans.	1.0	13	65	0.24	15.6	31	15.3	-0.3
E2	WCA2A	Mar. Trans.	2.0	12	58	0.33	19.4	29	19.0	-0.5
E3	WCA2A	Mar. Trans.	3.0	12	39	0.29	11.4	21	10.9	-0.4
E4	WCA2A	Mar. Trans.	5.6	13	15	-0.27	-4.1	7	-4.3	0.2
E5	WCA2A	Mar. Trans.	8.4	13	9	-0.73	-6.2	8	-6.5	0.2
F1	WCA2A	Mar. Trans.	0.5	14	120	0.27	32.6	72	32.5	-0.2
F2	WCA2A	Mar. Trans.	2.1	13	67	0.49	33.0	47	32.7	-0.2
F3	WCA2A	Mar. Trans.	4.3	13	29	0.31	8.9	13	8.8	-0.1
F4	WCA2A	Mar. Trans.	5.2	13	19	0.02	0.3	5	-0.2	-0.1
F5	WCA2A	Mar. Trans.	6.5	13	11	-0.51	-5.5	8	-5.6	0.0
U1	WCA2A	Mar. Trans.	12.3	13	11	0.05	0.5	7	0.0	-0.5
U2	WCA2A	Mar. Trans.	11.1	13	14	0.42	5.8	29	5.6	-0.1
U3	WCA2A	Mar. Trans.	8.8	14	9	-0.40	-3.5	8	-3.9	0.5
L7	WCA1	Canal	0.0	8	118	0.03	3.9	53	4.2	0.4
L40-1	WCA1	Canal	0.0	20	62	-0.17	-10.3	34	-10.1	-0.2
L40-2	WCA1	Canal	0.0	20	84	0.15	13.0	30	13.2	0.2
S10A	WCA1	Canal	0.0	25	54	-0.79	-42.5	60	-42.6	0.1
S10C	WCA1	Canal	0.0	26	81	-0.20	-16.4	41	-16.6	0.1
S10D	WCA1	Canal	0.0	39	99	0.11	11.0	38	11.1	0.1
S10E	WCA1	Canal	0.0	23	88	0.17	15.3	40	15.4	0.1
X0	WCA1	Can. Trans.	0.0	8	53	-0.27	-14.3	26	-14.1	-0.1
Z0	WCA1	Can. Trans.	0.0	8	60	-0.10	-6.1	19	-6.0	-0.1
E0	WCA1	Can. Trans.	0.0	13	86	0.20	16.9	36	16.9	0.0
F0	WCA2A	Can. Trans.	0.0	12	93	0.23	21.6	35	21.6	0.1
S144	WCA2A	Canal	0.0	29	19	-0.56	-10.6	19	-10.6	0.1
S145	WCA2A	Canal	0.0	35	16	-0.77	-12.8	18	-12.7	0.0
S146	WCA2A	Canal	0.0	29	16	-0.77	-12.6	20	-12.7	0.1
S11A	WCA2A	Canal	0.0	33	27	-0.47	-12.6	25	-12.9	0.3
S11B	WCA2A	Canal	0.0	32	44	0.13	5.7	23	5.5	-0.2
S11C	WCA2A	Canal	0.0	39	55	0.43	23.3	32	23.3	0.0
C123SR84	WCA2A	Canal	0.0	26	46	0.48	21.9	27	21.8	-0.1
S151	WCA3A	Canal	0.0	40	27	0.29	7.8	19	7.9	0.1
S12A	WCA3A	Canal	0.0	39	16	0.34	5.6	20	5.4	-0.1
S12B	WCA3A	Canal	0.0	39	14	0.20	2.8	14	2.7	-0.1
S12C	WCA3A	Canal	0.0	40	14	0.10	1.4	7	1.2	-0.2
S12D	WCA3A	Canal	0.0	40	14	0.14	2.1	6	2.0	-0.1
S333	WCA3A	Canal	0.0	39	15	0.23	3.5	8	3.4	-0.1
COOPERTN	WCA3A	Canal	0.0	20	11	0.36	4.1	5	4.1	-0.1
S31	WCA3B	Canal	0.0	26	21	0.38	7.9	17	7.9	0.0
			Median All:	14	14	0.14	2.8	11	2.4	-0.4
			Median Canal:	28	45	0.14	3.7	24	3.8	0.1
			Median Marsh:	14	10	0.18	2.5	7	1.7	-0.8
							Count Diffs > 1.0 (v2.6a "better"):			1.00
							Count Diffs < -1.0 (v2.6a "worse"):			2.00

Table 4A.6. Statistical evaluation of simulated vs. observed surface water phosphorus concentration for the scenario of spatially-varying, and temporally constant, atmospheric P deposition (Figure 4A.5), 1981 – 2000. Units of Bias (***observed minus simulated***) and RMSE are ug l^{-1} (ppb). Comparison is made between the absolute values of Bias in the results from this scenario and in the results from ELM v2.5 (Model Performance Chapter 6, July 2006).

			Distance to	**1981-2000 (v2.6a, spatial vary P deposition)**					v2.5.2	v2.5.2 - v2.6a
Site	Basin	Site type	Source (km)	N	ObsMean	RelBias	Bias	RMSE	Bias	Diff ABS_Bias
LOX4	WCA1	Marsh	0.5	12	10	-0.86	-8.8	11	-9.4	0.6
LOX3	WCA1	Marsh	4.0	11	11	0.61	6.7	8	4.6	-2.0
LOX5	WCA1	Marsh	7.5	13	10	0.56	5.3	6	3.1	-2.3
LOX9	WCA1	Marsh	6.0	13	9	0.64	6.0	7	4.2	-1.8
LOX10	WCA1	Marsh	2.0	12	10	0.63	6.3	7	5.3	-1.0
LOX8	WCA1	Marsh	7.9	14	9	0.53	4.6	5	2.7	-2.0
LOX7	WCA1	Marsh	3.4	14	8	0.52	4.3	5	2.7	-1.6
LOX6	WCA1	Marsh	1.0	14	8	-0.41	-3.2	4	-3.4	0.1
LOX11	WCA1	Marsh	6.0	14	9	0.59	5.5	6	4.3	-1.2
LOX12	WCA1	Marsh	2.0	14	8	0.45	3.4	4	2.4	-1.0
LOX13	WCA1	Marsh	5.2	14	9	0.60	5.2	6	3.9	-1.3
LOX14	WCA1	Marsh	0.5	14	8	-1.21	-9.8	11	-9.8	0.1
LOX15	WCA1	Marsh	0.5	14	8	-1.76	-13.5	15	-14.4	0.9
LOX16	WCA1	Marsh	1.0	14	9	-0.61	-5.2	7	-6.0	0.8
CA33	WCA3A	Marsh	3.0	14	13	-0.37	-4.6	7	-5.8	1.2
CA35	WCA3A	Marsh	2.0	14	12	-1.66	-19.8	22	-20.7	0.9
CA32	WCA3A	Marsh	2.6	14	8	0.42	3.4	4	1.1	-2.3
CA36	WCA3A	Marsh	1.0	14	30	-0.08	-2.4	9	-3.8	1.4
CA38	WCA3A	Marsh	5.2	14	9	0.14	1.2	3	-1.2	0.0
CA34	WCA3A	Marsh	3.0	14	10	0.47	4.9	6	2.2	-2.6
CA311	WCA3A	Marsh	6.5	14	6	0.04	0.2	2	-3.8	3.6
CA315	WCA3A	Marsh	10.6	14	6	0.31	1.9	2	-0.7	-1.2
NE1	ENP	Marsh	8.0	29	10	0.60	6.2	8	4.4	-1.7
P33	ENP	Marsh	16.0	30	8	0.26	2.0	3	-0.3	-1.7
P34	ENP	Marsh	20.1	26	6	-0.35	-2.2	3	-5.6	3.5
P36	ENP	Marsh	26.0	30	17	0.77	13.0	25	10.8	-2.2
P35	ENP	Marsh	33.2	29	13	0.73	9.9	17	7.7	-2.2
TSB	ENP	Marsh	2.1	30	8	-0.28	-2.1	4	-4.0	1.9
P37	ENP	Marsh	17.3	28	6	0.03	0.2	3	-3.9	3.7
EP	ENP	Marsh	4.0	27	6	0.15	0.9	3	-1.4	0.5

Table continued next page.

Table 4A.6. Continued.

Site	Basin	Site type	Distance to Source (km)	N	ObsMean	RelBias	Bias	RMSE	v2.5.2 Bias	v2.5.2 - v2.6a Diff ABS_Bias
				1981-2000 (v2.6a, constant P deposition)						
X1	WCA1	Mar. Trans.	0.5	10	40	0.55	22.0	33	22.9	0.9
X2	WCA1	Mar. Trans.	1.0	10	16	0.21	3.3	7	3.5	0.2
X3	WCA1	Mar. Trans.	1.0	10	11	-0.37	-4.2	10	-4.6	0.4
X4	WCA1	Mar. Trans.	3.0	9	10	0.53	5.4	6	4.5	-0.9
Y4	WCA1	Mar. Trans.	1.2	10	12	0.38	4.7	13	3.8	-0.9
Z1	WCA1	Mar. Trans.	0.5	10	42	0.07	3.1	14	3.0	0.0
Z2	WCA1	Mar. Trans.	0.5	9	14	-1.33	-19.1	23	-19.3	0.2
Z3	WCA1	Mar. Trans.	0.5	10	10	-1.69	-16.4	19	-16.8	0.4
Z4	WCA1	Mar. Trans.	1.2	10	9	0.45	4.3	7	3.2	-1.1
E1	WCA2A	Mar. Trans.	1.0	13	65	0.26	16.9	31	15.3	-1.5
E2	WCA2A	Mar. Trans.	2.0	12	58	0.35	20.6	30	19.0	-1.7
E3	WCA2A	Mar. Trans.	3.0	12	39	0.32	12.5	22	10.9	-1.6
E4	WCA2A	Mar. Trans.	5.6	13	15	-0.14	-2.1	6	-4.3	2.2
E5	WCA2A	Mar. Trans.	8.4	13	9	-0.50	-4.3	6	-6.5	2.2
F1	WCA2A	Mar. Trans.	0.5	14	120	0.28	33.7	73	32.5	-1.2
F2	WCA2A	Mar. Trans.	2.1	13	67	0.52	34.8	48	32.7	-2.1
F3	WCA2A	Mar. Trans.	4.3	13	29	0.39	11.3	15	8.8	-2.4
F4	WCA2A	Mar. Trans.	5.2	13	19	0.13	2.5	6	-0.2	-2.3
F5	WCA2A	Mar. Trans.	6.5	13	11	-0.24	-2.6	5	-5.6	3.0
U1	WCA2A	Mar. Trans.	12.3	13	11	0.22	2.4	7	0.0	-2.4
U2	WCA2A	Mar. Trans.	11.1	13	14	0.58	7.9	29	5.6	-2.3
U3	WCA2A	Mar. Trans.	8.8	14	9	-0.13	-1.1	8	-3.9	2.8
L7	WCA1	Canal	0.0	8	118	0.03	3.6	53	4.2	0.6
L40-1	WCA1	Canal	0.0	20	62	-0.17	-10.6	34	-10.1	-0.5
L40-2	WCA1	Canal	0.0	20	84	0.15	12.7	30	13.2	0.5
S10A	WCA1	Canal	0.0	25	54	-0.79	-42.4	60	-42.6	0.2
S10C	WCA1	Canal	0.0	26	81	-0.20	-16.3	41	-16.6	0.3
S10D	WCA1	Canal	0.0	39	99	0.11	11.2	38	11.1	-0.1
S10E	WCA1	Canal	0.0	23	88	0.17	15.4	40	15.4	0.0
X0	WCA1	Can. Trans.	0.0	8	53	-0.26	-14.1	26	-14.1	0.0
Z0	WCA1	Can. Trans.	0.0	8	60	-0.10	-6.0	19	-6.0	0.0
E0	WCA1	Can. Trans.	0.0	13	86	0.21	17.9	36	16.9	-1.0
F0	WCA2A	Can. Trans.	0.0	12	93	0.24	22.5	35	21.6	-0.9
S144	WCA2A	Canal	0.0	29	19	-0.51	-9.7	18	-10.6	0.9
S145	WCA2A	Canal	0.0	35	16	-0.72	-11.8	18	-12.7	0.9
S146	WCA2A	Canal	0.0	29	16	-0.72	-11.7	19	-12.7	1.0
S11A	WCA2A	Canal	0.0	33	27	-0.45	-11.9	25	-12.9	1.0
S11B	WCA2A	Canal	0.0	32	44	0.15	6.5	23	5.5	-0.9
S11C	WCA2A	Canal	0.0	39	55	0.44	24.1	33	23.3	-0.8
C123SR84	WCA2A	Canal	0.0	26	46	0.50	23.0	28	21.8	-1.2
S151	WCA3A	Canal	0.0	40	27	0.31	8.5	19	7.9	-0.6
S12A	WCA3A	Canal	0.0	39	16	0.39	6.4	20	5.4	-1.0
S12B	WCA3A	Canal	0.0	39	14	0.27	3.6	14	2.7	-1.0
S12C	WCA3A	Canal	0.0	40	14	0.16	2.3	7	1.2	-1.0
S12D	WCA3A	Canal	0.0	40	14	0.20	2.9	7	2.0	-1.0
S333	WCA3A	Canal	0.0	39	15	0.29	4.4	8	3.4	-0.9
COOPERTN	WCA3A	Canal	0.0	20	11	0.42	4.8	5	4.1	-0.7
S31	WCA3B	Canal	0.0	26	21	0.42	8.7	17	7.9	-0.8
			Median All:	14	14	0.20	3.4	11	2.4	-1.0
			Median Canal:	28	45	0.16	4.0	24	3.8	-0.3
			Median Marsh:	14	10	0.26	3.2	7	1.7	-1.5
									Count Diffs > 1.0 (v2.6a "better"):	11.00
									Count Diffs < -1.0 (v2.6a "worse"):	28.00

4.5.3.4 Atmospheric nutrient deposition – conclusions

The original, rainfall-based method of determining atmospheric P deposition appeared adequate for the intended applications of ELM. However, for some objectives it may be (at least conceptually) beneficial to apply a deposition rate that is not entirely linked to the temporal heterogeneity of rainfall. For our immediate goal during the ongoing Peer Review project, we did not attempt to determine the optimal refinement of this input method. Our goal was to report on the relative model performance characteristics under some alternative methods to the rainfall-based method of ELM v2.5.

The simplest method applied a spatially and temporally constant deposition rate, with results that were generally equivalent to the rainfall-based deposition method of ELM v2.5. In a further refinement, the spatially distributed (and temporally constant) P deposition rate (Figure 4A.5) loaded the oligotrophic interior regions of the Everglades with approximately half of the P load that was input to the ELM v2.5 application. The statistical evaluation of model predictions of surface water P concentrations showed that the model tended to slightly increase the magnitude of under-prediction using this P deposition method, generally within interior, oligotrophic locations of the Everglades. Overall, the median Bias of the ELM using this temporally constant, spatially distributed atmospheric P deposition was a slight (2.4 ug l^{-1}) under-prediction for the 78 monitoring sites in the greater Everglades region.

P deposition rates used to drive other models associated with the Everglades have been significantly greater than those used in ELM v2.5 and these v2.6 scenarios. The Everglades Water Quality Model (Raghunathan et al. 2001) applied a loading rate of approximately 47 mg P m^{-2} yr^{-1} to the model domain, and the DMSTA (Walker and Kadlec 2003) applied a constant dry deposition rate of 20 mg P m^{-2} yr^{-1}, plus rainfall P loads that were based on a rainfall concentration of 10 ug l^{-1}. For subsequent refinement of ELM, we anticipate further scrutiny of available data on P deposition rates within the Everglades interior, and will determine whether model parameters should be adjusted to compensate for this subtle change in model predictive bias. The primary importance of these P deposition rates involves the determination of the background P loading and accumulation of the Everglades, against which other loading sources are compared to determine their potential ecological significance (see Model Application Chapter 8).

4.6 Literature cited

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