

**Summary of Comments on
Calibration Data Sets for
SFWMM v7.0**

DRAFT

Table of Contents

Minutes of SFWMM Data Workshop.....	3
Comments Offered by Participants during Data Workshop	7
Jed Redwine on Reference ET (Email Correspondence).....	11
Eric Carr Comments (Email Correspondence)	12
Jed Redwine on Topography (Email Correspondence)	13
Frank Marshall Comments (Email Correspondence)	15

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Minutes of SFWMM Data Workshop

IMC SFWMM v 7.0 Development Update
February 18, 2009

February 18, 2009

10:00 AM - 3:30 PM

Attendees:

Robert Fennema (ENP)
Jed Redwine (EPJV/RECOVER)
Gregg Reynolds (ENP)
Agnes McLean (ENP)
Andy Gottlieb (SFWMD/RECOVER)
Ronnie Best (USGS/UF)
Jim Vearil (USACE)
Jose Otero (SFWMD/IMC)
Walter Wilcox (SFWMD/IMC)
Ken Rutchey (SFWMD)
Daniel Kriesant (USACE/IMC)
Giles Rhoads (SFWMD Contractor)
Luis Cadavid (SFWMD)
Pierre Massena (USACE/IMC)
Paul Trimble (SFWMD)
Julio Fanjul (SFWMD)
Danielle Morancy (SFWMD)
Norapatt Ketprakong (SFWMD)
Donald DeAngelis (USGS)
Lizabeth Bologna (SFWMD)
Angela Montoya (SFWMD)
Bill Baker (MacVicar, Federico & Lamb, Inc.)
David Butler (SFWMD)
John Raymond (SFWMD)
Peter Kwiatkowski (SFWMD)
Zhongwei Li (SFWMD)
Victor Mullen (SFWMD)
Larry Stout (USACE/IMC)
Mohammad Masud Hassan (SFWMD Contractor)
Chandra Pathak (SFWMD)
Taiye Sangoyomi (SFWMD)
Quinlong (Gary) Wu (SFWMD)
Rama Rani (SFWMD)
Jana Newman (SFWMD)
Jenifer Barnes (SFWMD/IMC)
Michelle Irizarry-Ortiz (SFWMD)

Via phone:

Leonard Pearlstine (ENP)
Lori Miller (USFWS)
Stephanie Romanach (USGS)
Gary Goforth
Inez Lyons
Eric Carr (ATLSS, UT)
Daniel Lyons
Helen Viole
Amanda MacDonald (SFWMD)
Steve Hartley (USGS)

Introduction

https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_HESM/PORTLET_SFWMM/POR_TLET_SUBTAB_SFWMM_IMPLEMENT/TAB23998366/INTRODUCTION.PDF

Walter Wilcox introduces the topic of discussion today, and indicates that this will be an open forum discussion among colleagues. Today's discussion defines proposed changes to SFWMM, and final changes are expected in a 6 month timeframe. This is the first time the IMC has conducted this type of meeting prior to finalization of a SFWMM update.

Stage and Flow Time Series: presented by Pierre Massena (USACE/IMC) and Walter Wilcox (SFWMD/IMC)

https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_HESM/PORTLET_SFWMM/POR_TLET_SUBTAB_SFWMM_IMPLEMENT/TAB23998366/SFWMM_UPDATE_STAGE_FLOW.PDF

Changes in the number of flow and stage stations used for calibration of SFWMM v 7.0 have occurred. Compared with the SFWMM version 5.4, forty fewer gauge stations and 75 additional flow station are expected to be used. The new data used are mostly flow stations located in the Everglades Agricultural Area and southern Miami-Dade County. Several stage gauges in the Lower East Coast have been discontinued. Flow data has been gap-filled, and there are published guidelines for the gap-filling process (located at <http://www.sfwmd.gov/>). Pierre describes the QA/QC process for checking input data, and indicates that only 4% of the stage data records and 18% of the flow data records remain under investigation. Nearly all of the flow stations that describe canal inputs into NW Lake Okeechobee are under investigation. Modeling surrounding Lake Okeechobee has become increasingly sophisticated and the historical approach of using Modified Delta Storage continues, but the magnitude of this term has decreased due to the disaggregation of LO inflows into both observed and simulated time series. The Lake water budget is likely to change significantly in association with this update due to this changed approach. The change is necessary due to the increased complexity in planning activities expected in the basins north of Lake Okeechobee. It has become necessary to simulate patterns of delivery into the lake since the water storage and treatment facilities planned for the areas north of Lake Okeechobee will need to be optimized in the context of individual basin runoff patterns. Simulated time series are a prominent feature of the disaggregated approach to Lake Okeechobee, for use in baselines and calibration/verification data sets. The details of the creation of individual simulated time series are part of the documentation process associated with this update.

Rainfall Dataset Development: presented by Alaa Ali (SFWMD/IMC)

https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_HESM/PORTLET_SFWMM/POR_TLET_SUBTAB_SFWMM_IMPLEMENT/TAB23998366/SFWMM_UPDATE_RAINFALL.PDF

Extreme data – 99% departure from typical, zero monthly sum. Contact Alaa if more information is desired on any of the slides presented. Cross-checking among data samplers is exhaustive. No gap-filling occurs in rainfall data set (in contrast to stage and flow data sets) due to the larger amount of uncertainty associated with rainfall patterns compared with stage/flow data sets.

Q: Are there plans to integrate NEXRAD data as quality check for this data set?

A: No. NEXRAD begins 1986-87. NEXRAD data are partially dependent on rain stations, NEXRAD is best for period when it exists, but hind-casting NEXRAD has yet to be developed, and for this reason it is not a viable alternative for supporting an extended period of record analysis.

Q: How are you applying the dataset when you are at the boundary of your system?

A: Boundaries are always associated with bias. It is unclear how cost-effective a thorough investigation of boundary-related bias would be for this dataset. And the subject of boundary related bias was not explored for this update.

Evapotranspiration: presented by Danielle Morancy (SFWMD/IMC) and Daniel Kriesant (USACE/IMC)

https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_HESM/PORTLET_SFWMM/POR_TLET_SUBTAB_SFWMM_IMPLEMENT/TAB23998366/SFWMM_UPDATE_ET.PDF

Michelle Irizarry-Ortiz (answer questions about ET information development)
NARR approach has been a real developmental opportunity for development of the ET measures. The updates to simulating evapotranspiration (ET) are based upon changing the reference crop for calculating potential ET and the use of the Penman-Monteith algorithm for calculating actual ET.

The ET update process is central to developing credible responses to past peer reviews and offer a forum for integrated feedback to future updates. ET estimation is an active area of development in other states due to its central importance for agricultural practices, and a comparison of the IMC approach with the approaches taken in other states is encouraged.

Topography: presented by Rachelle Grein

https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_HESM/PORTLET_SFWMM/POR_TLET_SUBTAB_SFWMM_IMPLEMENT/TAB23998366/SFWMM_UPDATE_TOPO.PDF

See presentation: Fewer unique data sources are used, and the current sources are considered higher quality than past data sources. The difference maps indicate large changes in elevation in Broward county and Big Cypress National forest, and these were linked to a single data set used for both of these areas in past updates.

Man-made features are masked.

The topic of converting to NADV 88 elevations was extensively discussed. This is a difficult issue since any conversion needs to be a coordinated between the modeling center and the operations division of the SFWMD. Kent Loftin is working on a report to describe how the process of conversion could occur; the report is being presented to IMC board next week. The paper should be available as final draft in the next two weeks. The conversion is likely to be a tremendous undertaking.

During calibration and verification there may be alterations to the elevation pattern in order tune the adequacy of the model. This is an area of particular interest to RECOVER staff, who request an intra-cell elevation variability estimate map for the natural areas be developed as part of the elevation update.

Land use: presented by Jenifer Barnes

https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_HESM/PORTLET_SFWMM/POR_TLET_SUBTAB_SFWMM_IMPLEMENT/TAB23998366/SFWMM_UPDATE_LAND_USE.PDF

Jenifer describes land use change updates.

Water Supply: presented by Luis Cadavid and Jenifer Barnes

https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_HESM/PORTLET_SFWMM/POR_TLET_SUBTAB_SFWMM_IMPLEMENT/TAB23998366/SFWMM_UPDATE_WATER_USE.PDF

Daily soil moisture accounting in EAA and urban areas....

In EAA and LOSA the SFWMM is calibrated in order to accurately gauge irrigation demand.

These demands are not necessarily met in simulations even though a precise representation of demand is desired.

In LEC and natural areas calibration is matched to stages.... (the primary objective is to ensure accuracy of surface/groundwater stages).

STA demands are included in simulations.

Summary: Jose Otero

https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_HESM/PORTLET_SFWMM/POR_TLET_SUBTAB_SFWMM_IMPLEMENT/TAB23998366/SUMMARY.PDF

All information presented is available on the SFWMD portal, please send comments to Jenifer Barnes (jabarne@sfwmd.gov), those will be arranged and presented on the portal subsequent to this meeting. There is an existing list of comments from today's discussion.

Today marks the point where the calibration effort begins, it is expected to continue through May. Baselines will become available at the end of August, and documentation will be developed ongoing basis.

Baselines will be present on the PM viewer, companion Natural Systems Model will need to be produced, and will be developed independently. The portal will contain documentation of this effort.

https://my.sfwmd.gov/portal/page?_pageid=1314,2556275,1314_2554761:1314_23998367&_dad=portal&_schema=PORTAL

End of meeting at 3:30 on 2/18/2009

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Comments Offered by Participants during Data Workshop

Stage & Flow

#	Participant	Comment	Response
1	Ken Rutchey	What gap filling is being done?	Yes, must have complete data set
2	Jed Redwine	What is the process to develop simulated time series for LO inflow?	It's not simulated, it's historical as boundary conditions. Only some data prior to 1970s require linear regression.
3	Jim Vearil	How to deal with flows not monitored?	MDS
4	Chandra Pathak	What % of data is missing and how to deal with that	4% stage stations and 18% flow stations are under investigation, turned over to Data Management

Rainfall

#	Participant	Comment	Response
1	Ken Rutchey	How to address the variability of rainfall, with the relatively sparse gauge network	It is a known challenge, we do the best with the data available
2	Taiye Sangoyomi	Plans for use of NEXRAD?	No, started 1996-97. Can't mix gauge with NEXRAD. Hind-casting NEXRAD is yet to be looked at
3	John Raymond	How to apply estimation at the boundary?	Boundary of data implies bias. TIN-10 is intended to address most of this.

Reference ET

#	Participant	Comment	Response
1	John Raymond	What ET is shown in the maps?	They are both reference (potential v5.4 and reference 7.0). Actual computed within the model calculates ET that would look different.
2	Andy Gottlieb	Is there comparison to marsh areas	Yes, NARR uses all values available.
3	Taiye Sangoyomi	Were SFWMD stations used	Only for verification, it doesn't have corresponding radiation. Gauges are point data, NARR is a regional model. NARR will be contacted to make sure they have SFWMD stations.
4	Frank Marshall	This is only reference, not actual ET	
5	Jed Redwine	Have differences between measured ET versus calculated, identify factors that affect differences	Have looked at some daily data, cloud cover, etc. Looked OK. Looked at ENR and PBI, temp, relative hum, solar radiation, compared measurements vs. NARR, spatial pattern, found good correspondence. Peer review v5.5 had comments on ET north-south gradient. Use of NARR data set is a response to that review of SFWMM.
6	Quinlong Wu	How to improve solar radiation data	GOES only has 10 years. Collection and assembly of solar radiation is very significant effort. NARR has used satellite data to estimate solar radiation.
7			First step is reference ET Second and 3 rd step, in v5.4 was somewhat outside physical boundaries because of calibration. In v7.0, we'll use max and min to keep within physical range.
8	Hope Radin	Used for supplemental irrigation	It's the 3 rd step, account for soil water and other factors.
9	Quinlong Wu	Can the info on substrate condition be improved by using rainfall?	SFWMM calculates the available to the plant. At the regional scale, Kc, is strictly the relation between one crop and the other. The soil conditions are calculated in the model outside of Kc.
10	Jed Redwine	Feels refinement of ET and Kc is important because it addressed peer review comments	Kc now has more direct South Florida information in its development. Also used international data.
11	Frank Marshall	There is a major difference between St. John's and South Florida	Agree
12	Ronnie Best	As we move into the future, higher CO2 reduces ET rates	Looking into climate change trends, not a clear picture yet. CO2 better know.

13	Ken Rutchey	Why not use the water budget approach?	ET is adjusted in calibration, but still physically based and using better control of the ranges. Must have robust parameters for future scenario estimation.
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Topography

#	Participant	Comment	Response
1	Agnes McLean	Explain man-made features masked-out	Remove roads, levees, buildings, landfill mounds. Small areas.
2	Jed Redwine	Variability of elevation within 2x2 cell, generate map Would like a map cells that have most variability	Might take some time to show variability cell-by-cell. Will consider, but only to EPA (HAED data)
3	Pete Kwiatkowski	Masking out, shouldn't it be included?	Model locates levees, STAs, not necessarily as elevations
4	Jim Vearil	Go to NAVD 88	Major effort
5	Frank Marshall	Place "NGVD 29" in elevation maps	Point taken
6	Ronnie Best	We have to convert to 88, when? It is a federal mandate. It is understood that it is a major effort.	
7	Agnes McLean	What is "model value", blue cells	Cells that receive structure flows, are not sending water anywhere
8	Walter Wilcox	Fewer sources, more consistency, big improvement over 5.4	
9	Pete Kwiatkowski	Ground truth major changes from 5.4 to 7.0	Differences are primarily due to major differences among data sources. Not sure we will do ground truthing. Big cypress and LEC SA1 and SA2 data was 5-ft contour, it was legacy data. Biggest change is much more confidence in v7.0 data source.
10	Walter Wilcox		
11	Ronnie Best	Does data set stay constant? UT asks that it not change.	This baseline map stays the same, time slices may affect man-made features. Scenario changes are assumed to change some man-made features. Tope is not changed except for calibration efforts.
12	Agnes McLean	No more ponding in northern WCA 3A, lower in eastern Big Cypress, potentially lesser seepage across LEC protection levee in southern Miami-Dade	
13	Jed Redwine	Documentation very important, RECOVER needs to reference the documentation.	

Land Use

#	Participant	Comment	Response
1	Agnes McLean	Any thoughts to change land use for 2050	Will use all the county comp plan info into 2050 and recalculate land use.

Water Use

#	Participant	Comment	Response
1	Jed Redwine	Water use for STA-1W?	Need to cut that cell out
2	Pete Kwiatkowski	Units in maps?	Fraction (1 minus value) of each cell for that type
3	Quinlong Wu	Water use simulated or input?	Some supplemental irrigation are simulated, LOSA is pre-processed. In the LEC, we assume that the ET recharge accounts for that. In the EAA and LOSA-AFSIRS, calibrate to demand. Deliveries from WCAs to LEC based on minimum stages for canals. Demands subject to water shortage criteria. Off-line versus simulated, off-line does not have the feedback that simulated has. Demands are basin-by-basin, not field-by-field.
4	Pete Kwiatkowski	STA demands?	Included in simulation, minimum depth for STAs. In calibration, first time will play a role. STAs not in calibration before. Stages of STA not calibrated.

Jed Redwine on Reference ET (Email Correspondence)

Dear All,

The discussion below is offered as a contribution to the ET discussion presented by Daniel Kriesant at the SFWMM v7.0 update. Paul Trimble was sent a copy of this letter yesterday. ET modeling paper: http://tenaya.ucsd.edu/~dettinge/hidalgo_eto.pdf

This article is useful because it seeks to attribute the causes of potential ET to specific combinations of environmental variables. This type of multivariate approach to analyzing daily potential ET could be very useful for our discussion about the SFWMM, and the ensuing discussions on climate change relationships to CERP.

The paper gets exactly to what I had hoped to encourage with my question on Wednesday, namely can we develop an information based story to explain differences in evapotranspiration across the region. If we can reconstruct the story about our historical observations, we have the opportunity to be more specific about why we predict the future pattern to be similar to or different from the historical pattern. The strength of this approach is that we use information to develop a narrative, which we can then explicitly test in a hierarchical fashion by ranking the parameters of interest with respect to how important it is for us to reduce the associated uncertainty.

I hope you find this article an interesting model for how to conduct an ET analysis for south Florida. I recognize that the parameters of interest may be different, but the process of comparing daily ET to a combination of explanatory factors, and depicting the difference between different "modalities" of ET (like seasonal patterns, geographic patterns) is an exemplary approach to the topic, which if we took this approach, the IMC/RECOVER relationship would benefit greatly.

one passage of interest is found on page 7:

"It is unfortunate that ET could not be further validated as there are almost no data available in California from other methods such as lysimeter, Bowen ratio, or eddy covariance."

The Greater Everglades Assessment module has a landscape-monitoring design that could be useful for monitoring and making spatially explicit inferences about patterns in potential ET. The EDEN network also has expressed a desire to add ET measures to the stage gauges deployed throughout the ecosystem. I noticed Frank Marshall's expressed interest in estimating ET in the estuaries.

Thanks again to Jenifer and Jose for getting us together to focus on this update. The 2x2 is our primary planning tool, and is important to all of us who work on CERP.

Sincerely,

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Eric Carr Comments (Email Correspondence)

From: Eric Carr [<mailto:carr@nimbios.org>]
Sent: Friday, February 20, 2009 5:03 PM
To: Barnes, Jenifer; G. Ronnie Best; Laura Brandt; Don DeAngelis
Cc: Eric Carr; Lou Gross; Jane Chomsky
Subject: Questions/Comment : SFWMM 7.0 Workshop : ATLSS

Dear Jenifer Barnes

We appreciated the presentation and update with regard to the status of 7.0. Below are several questions that came to mind as we examined the information provided.

Thank You,

Eric Carr

carr@nimbios.org

SFWMD 7.0 Data presentation Response / Questions.

1) NAD and NGVD. The NAD and NGVD conversion debate raises many issues.

NOTE: In order to use the HAED elevation data, the District must convert them from NAD to NGVD. In the past, we were not able to obtain the converted HAED data set or documentation about the conversion methodology used by the District.

CONCERN: If users of SFWMD products use an alternate method of converting HAED data to NAD, subsequent elevation differences could make interpretation of biological model results more difficult.

REQUESTS: Could the SFWMD document the NGVD/NAD conversion methodology used in their 7.0 topography creation? Could the SFWMD provide or suggest a compatible conversion tool that performs the same conversion? Could the SFWMD provide the converted HAED dataset used?

2) Calibration Verification. I understand that the time period covered in hydrology simulations will be extended in V7.0 to 1965-2005, adding 5 years to the 1965-2000 period covered in V5.5. Will the same V5.5 calibration and verification periods be maintained for V7.0? How will the added years (2001-2005) be categorized? We wish to understand this because ATLSS has typically concatenated these period files for use with the ATLSS High Res Hydro creation.

3) Soil Storage Coefficients (STC). Will changes to soil storage coefficients be made with the associated land-use changes incorporated in SFWMM 7.0? This was not mentioned during the presentations. The land-use map seems to change for each calibration period, incorporating land-use updates that occurred over time. Will there be a corresponding change in STC values for each calibration period? Will subsequent scenario runs incorporate varying STC within the simulation period or use one static map for all simulated years? What land-use / STC will be used for scenarios?

4) Status of Indicator Regions. Due to changes in land use and other map layers, are there plans to change Indicator Regions?

Jed Redwine on Topography (Email Correspondence)

<<Doug_Donelson_High_Resolution_Hydrology_1_8_22_08.doc>> Attached is the High Resolution Hydrology MSR. A significant theme in the document is the analysis of the HAED data and its relationship with the SFWMM v5.4. Pg 8 contains a histogram of the distribution of elevation range in the cells, and the range is likely to be a good response variable for depicting elevation ranges across the grid. Figure 5 on pg 11 may also be a useful map for your purposes. If the elevation ranges could be published along with documentation of the topography, it would be a very useful reference to RECOVER evaluations, as we are attempting to describe the anticipated ecological effects predicted by SFWMM simulations.

Thanks again for hosting the meeting on Wednesday. It was a very useful and meaningful activity for all of the CERP partners.

Sincerely,
Jed Redwine

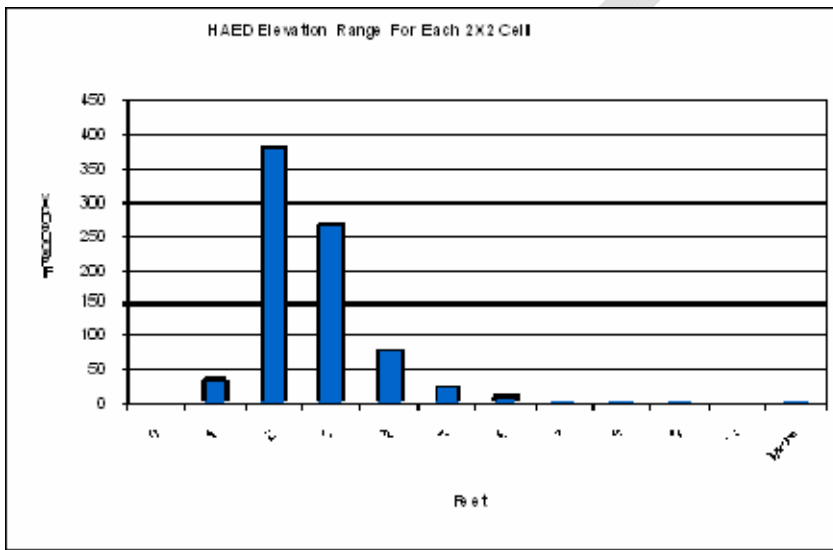


Figure 1 Elevation Ranges Of HAED Data. This is a frequency distribution of the range of the HAED elevations within each of the 2X2 cells that contain HAED data.

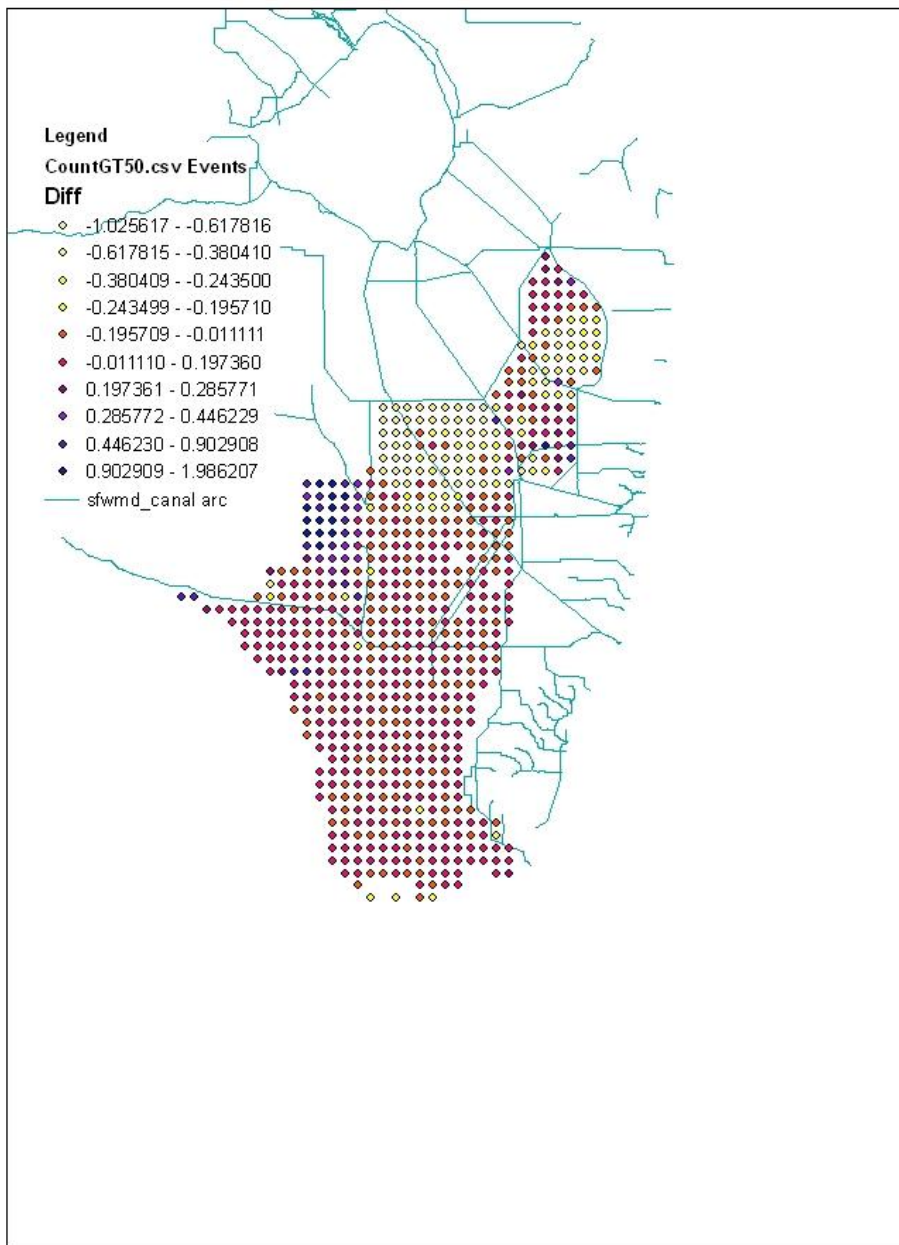


Figure 2 HAED Adjustments. This shows the amount the HAED elevations were adjusted to match the SFWMM elevations. To include good information where available, while avoiding adding a bias to the water stage, the HAED points in each SFWMM cell were adjusted by the difference between the SFWMM elevation and the mean value of the HAED points in that cell. This overlays the HAED variability on the SFWMM elevation. 91% of the SFWMM cells had their HAED points adjusted by 0.4 feet or less.

Frank Marshall Comments (Email Correspondence)

Comments on Calibration / Verification of SFWMM Version 7 Prepared by William K. Nuttle and Frank Marshall

As background on these comments, the authors are users of the SFWMM (or 2X2 model) directly for evaluation and analysis of a variety of hydrologic situations and indirectly as input to other models. Any changes to the version and calibration of the 2x2 model may affect several of our applications, including FATHOM in Florida Bay, box models in Biscayne Bay, and multivariate linear regression salinity models for Florida Bay and the southwest Gulf coast. The 2x2 model is, and will remain for the foreseeable future, the primary source of information on Everglades stage and freshwater flows to the coast related to present and future planned SFWMD operations and policies. For this calibration / verification activity we respectfully offer the following comments so that the next version of the 2x2 model provides the most accurate representation possible of South Florida hydrologic conditions.

For Everglades hydrology (stage and flow), the calibration and verification activities should be expanded to include the grid cells that represent the areas where stage or flow data are being used for modeling, typically where an important monitoring station is also located. The multivariate linear regression (MLR) salinity models for Florida Bay and the southwest Gulf coast estuaries that use Everglades stage in conjunction with wind and sea level data to predict salinity in the estuaries rely on stage data from several “significant” stations, as follows:

1. Craighead Pond (CP)
2. P33
3. P35
4. EVER7
5. EVER6
6. E146
7. NP206
8. G3273
9. P37
10. NP62
11. TSH
12. NP67

Some of these same stations are also important because they are used for other regression models related to the paleosalinity evaluations that are currently underway.

The MLR salinity models are utilized for the evaluation of CERP alternatives using performance measure data generated by the Interagency Modeling Center (IMC). When 2X2 model stage data are used as input to the MLR salinity models, a data adjustment step is employed by IMC to remove model-induced bias. At stations like P33 (where

calibration/verification was done for Version 5) the adjustment needed was insignificant. However at stations like CP (relatively removed from a calibration/verification cell) the removal of model bias is an important step. If the Version 7 were to be calibrated and verified at the stations above the bias-removal step may no longer be needed. However, we understand that there may be computational difficulties calibrating the model at stations near the edge of the grid, such as CP, EVER 7, EVER6 and perhaps others.

For Florida Bay modeling and analysis, benefit can be gained by including the measured USGS creek flows in the calibration/verification exercise if at all possible. At the least, the verification exercise should compare monthly total surface and groundwater discharge across the Taylor Slough transect with measured creek flows.

For Biscayne Bay, the calibration/verification exercise should make use of diagnostic flows and/or level data as close to the coast as possible. Documentation of the new/revised model should clearly describe the boundary conditions imposed on groundwater discharge into Biscayne Bay. At issue is whether the boundary condition used takes into account the intrusion of salt water into the surficial aquifer in south Miami-Dade County. The presence of salt water in the aquifer may represent a significant barrier to fresh groundwater discharge at the coastal limit of the 2x2 grid. Further, the dynamic nature of the interface between fresh and saline groundwater (i.e. seasonal movement of the interface) likely results in dynamic changes in the volume of freshwater contained in the surficial aquifer, driving exchange between canals and groundwater that are independent of variation in canal stage and surficial water levels.

Similar concerns about the representation of groundwater discharge apply to Florida Bay, but groundwater is not deemed to be as important as component of the freshwater budget there as in Biscayne Bay.

Further, for both regions if it is possible, it would be helpful to the estuary models if the rainfall and evaporation fields were extended out over the estuarine and coastal waters receiving inflow from the SFWMD system. It is important that the rainfall and evaporation rates used to evaluate effects of SFWMD operations on these coastal water bodies is consistent with the rainfall and evaporation input data used to drive 2x2 model simulations.

Lastly, the use of any hydraulic elements in the model that do not represent actual water management facilities should be documented clearly. It is our understanding that canals may have been used in some applications of the model that are hydraulic artifacts. This may not still be the case. We understand that the use of these elements is not unusual in hydrologic modeling but use of such features should be documented.