APPENDIX P

PREPARATION OF RAINFALL DATA

Preparation of the Regional Models' Rainfall Binary File (1914-2000)

The QA\QC of the regional models' rainfall binary file for the period 1914-1998 was carried out in four phases. There are 860 rainfall stations data for that period covering 11 counties (Broward, Highlands, Martin, Palm Beach, Collier, Glades, Monroe, Miami-Dade, Hendry, St. Lucie, and Lake Okeechobee). Near the end of this project, rainfall data for the period 1999-2000 at 964 stations covering the same counties were made available. The same principles used in the four phases to QA\QC rainfall in the period 1914-1998, were used in one phase to QA\QC rainfall in the period 1999-2000. The results of this work can be found in **"/net/peashooter/usr2/RAIN/rain"**

Phase I: QA\QC strategy for extreme daily rainfall. (sub-directory: "stage3")

Preliminary effort to prepare a provisional rainfall binary input file (henceforth called "1914-1998 binary input file"), daily rainfall values (accumulated over one day) greater than 16 inches were flagged as "missing". Even though these values were excluded in building such a provisional file, their quality was examined as part of this QA/QC effort and hence accepted or rejected in building the final binary file. Daily rainfall values less than 16 inches but higher than 5.5 inches in Miami-Dade, Broward, and Palm Beach counties, and 5 inches in the other counties of the District area were flagged as "questionable". The lower threshold values for "questionable" data represent approximately the 99.9 percentile in each respective county.

In this process, 1973 of "questionable" and "missing" (henceforth called "questionable") data points were recorded in a file and were considered for further QA/QC efforts. This process is briefly described here.

1) Extracting rainfall data from DSS files

For each day when at least one questionable data point is identified, daily rainfall data at all stations (860) were extracted from the DSS files. There were 844 of such days for which data sets were extracted and grouped by county in 11 files (***.final)** ; where "*" takes the name of any of the 11 counties).

2) Data searching

For each "questionable" data point, the nearest 6 neighbors (including that point) were identified. Each neighbor is identified in terms of rainfall value, radial distance "**dr**", an approximate direction indicator "**Quadrant #**", and **dbkey**. The approximate direction indicator depends on the relative position of the neighbor with respect to the point being checked as seen in Figure 1.

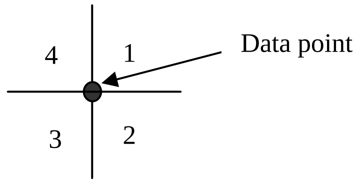

Figure 1. Neighbor location (by quadrant) with respect to the point being investigated.

The output file **"check1.out"** containing 1973 sets of results has been generated. A typical set in this file is presented below (bold fonts are not included in the file):

Dbkey	**X (ft.)**	**Y(ft.)**	**Year**	**Month**	**Day**	**value**
06177	762545	643219	1915	10	27	7.3

Neighbors

Rain (inches)	7.3	4.89	3.03	1.7	1.7	1.26
dr in (miles)	0	27.09	32.27	44.81	45.4	108.39
Quadrant #	4	3	1	3	3	2
Dbkey	06177	06249	06180	HB872	06211	06193

3) Data Quality Checking and classification:

The file **bad_xy_rating.bck** contains the 1973 data points with qualifiers "A", "A-", "B", "B-", "**C**", "F+", and "F". After excluding **5** points with negative values, the "check1.out" file was divided into 7 files representing the above seven qualifiers (Table 1). Data in each file are arranged by rainfall amount in descending order.

Qualifier	File name	Number of data points	At least one neighbor with	
			Absolute dr ≤	Absolute value difference %
A	**diff_20_dr_5.order**	635	5 miles	
A-	**diff_20_dr_10.order**	105	10	
B	**diff_40_dr_5.order**	238	5	
B-	**diff_40_dr_10.order**	125	10	
			Description	
F+	**above_12_rainfall.order**	79	Data with rain > 12 inch	
F	**below_1_neighbors.order**	126	Data with all neighbors < 1	
C	**diff_any_dr_any.order**	660	The remianing data points	

4) Procedures to accept or reject data, and to update rainfall binary file

Data were accepted or rejected based on the classification above and, if necessary, are examined manually using the information obtained above as follows:

1) Accept all data flagged with A, and A- qualifiers as good data.

2) Further examine all data flagged with B and B- qualifiers and decide whether to keep or eliminate (B flags indicate, in general, good quality data unless further examination proves otherwise).
3) Further examine all data flagged with F+ and F- qualifiers and decide whether to eliminate or to keep (F flags indicate, in general, poor quality data unless manual examination proves otherwise)
4) Scrutinize all data flagged with C qualifier and decide whether to keep or eliminate.
5) Perform data modifications in the DSS files containing the raw data and then rebuild the rainfall binary file.
6) Produce summaries using **grid_summary** and analyze results.
7) Examine monthly rainfall values using **xgridview**

<u>Phase II</u>: Examination of extreme daily rainfall data (sub-directory: "<u>stage3</u>")

Extreme daily data in the previous phase were grouped in 7 classes. The aim in this phase is to implement the procedures prescribed above to reduce the 7 classes into two classes: acceptance "A" or rejection "F". The procedures proposed were executed in two steps as presented below.

1) Examination of Each point.

In this phase, a given point was examined by looking at the 5 nearest neighbors. Determining factors for a rejection or acceptance of a point based on its neighbors are a combination of many measures. Examples of some measures are distance, and direction from a neighbor; difference in value, number of neighbors with high rainfall values, neighbors with flag "A" or "A-", the time of the year, frequency of flag "F" through out the period of record, and, if possible, well known tropical storm events. Some examples of rejecting or accepting a point are:

i) Direction: The reception of a storm event at the station being examined may be more similar to that of far stations than that of closer stations due to the storm direction and pattern. As seen below, rainfall at the stations being examined is more similar to rainfall at two stations in Quadrant "one" than rainfall at closer stations falling in quadrant 4. This situation promotes acceptance.

06122	**726776.00**	**934919.00**	**1995 10 17**	**10.80**	
rain	3.92	17.42	3.11	11.37	1.59
dr in mi	4.27	6.93	10.22	14.28	14.28
Quad. #	4	1	1	1	1
Dbkey	16603	15730	16673	16416	16618

ii) Number of neighbors with high rainfall values: The more the neighbors with "reasonably" high rainfall values, the higher the chance of acceptance versus the chance of rejection due to a large difference in values. Example:

05892	**787186.00**	**760605.00**	**1979 4 25**	**18.80**		
rain	18.80	12.86	14.09	14.40	13.20	12.50
dr in mi	0	3.69	4.07	5.09	5.13	5.70
Quad. #	--	2	2	3	4	3
Dbkey	06321	06306	05893	06254	05792	06322

iii) Hurricane Events: A Hurricane (or a large storm) event is identified when a high number of rainfall stations with high values is observed. Hurricane Mitch on 11/5/1998 is an example where 77 data points with high rainfall values were observed on that day. An example of one record is:

16675	**807538.00**	**799725.00**	**1998 11 5**	**12.90**		
rain	12.93	7.20	5.90	7.43	5.72	9.83
dr in mi	0.00	4.07	5.16	6.88	7.34	7.80
Quad. #	--	3	3	3	2	3
Dbkey	16675	06298	06306	06299	06276	16676

iv) Frequency of flag "F" or "F+" through out the period of record: Dbkeys mostly flagged with F or F+ indicate poor data quality and hence increase the chance of rejection in the examination of data with flags such as B, B-, or C.

2) Further examination of any "F" flag found among a group of "n or more" points with the same date.

In an effort to prevent the rejection of "good" quality data, daily snap shot visualization was conducted for every date with at least 2 data points flagged "F". In many cases, the "F" flag was replaced with "A" flag. Examples of these cases:

1. All 5 nearest neighbors are located, approximately, in one direction (e.g., quadrant 3; quadrants 3 and 4, etc.) with large rainfall difference while "slightly" farther points located in a different quadrant have smaller rainfall difference.
2. The longer the record on a particular date with the majority flagged "A", the more likely the flag "F" is changed to "A" (taking into consideration all factors that may prevent this change).
3. The longer the record on a particular date with similar records of high values the higher the chance of changing the "F" flag to "A" flag.

Statistics of rejected data

The file "qaqc2" is the output file with data points finally flagged as "A" or "F". There are 711 data points flagged "F" and they are grouped in the file "F_flags.final", and 1262 data points flagged "A" and grouped in the file "A_flags.final" (35% of the suspected data were deemed unacceptable in this phase).

DSS files update

File “qaqc2” was sorted into file “qaqc2.sorted”. Using file “qaqc2.sorted” along with DSS information extracted from file ”gr_thsn.in”, file “prepare_dss.out” was generated as a control file for updating the DSS files. Using the updated DSS files, the rainfall binary file was updated and an intermediate version was created.

<u>Phase III</u>: Examination of daily data corresponding to zero Monthly Rainfall (Sub-directory work1)

In this phase, efforts were made to identify and verify rainfall data for calendar months with zero rainfall. The objective was to reject or accept such data based on prescribed criteria. Part of this process was automated and part was performed manually. The following procedures were adopted.

1) Data extraction from DSS files

For each county, calendar month with zero rainfall data are extracted from the respective DSS file and stored in file zeros**.**”county name”. For a given year, **yr**, and month, **mo**, a typical line in this file is:

County.tag	**yr**	**mo**	**n**	**avg**	**value**
Broward	1968	12	20	0.07	0.00

Where:

n: is the number of stations containing data within that county on that date (**yr** and **mo**) excluding the point under investigation.

avg: is the county average of monthly rainfall on that month (**yr** and **mo**) based on the **n** points.

2) Automatic tentative flagging

The computed average “**avg**”, in most cases, was less than “1” in all counties giving more confidence in the quality of “zero” monthly rainfall. During the wet season months, the confidence in “zero” monthly rainfall is low particularly if ”**avg**” is high (5 inch is considered as a threshold). For each county, each point with “**avg** =< 1” is tentatively flagged “A” and each point with ”**mo** = Jun, Jul., Aug., or Sept and **avg >= 5**” is tentatively flagged “F”. The rest of the data points remain unflagged in this step. All data points (flagged and unflagged) are stored in file bad1.”county name”

Examples:

a line from zeros.broward:

broward. 1961 12 18 0.44 0.00

is re-written in bad1.broward as:

broward. 1961 12 18 0.44 0.00 A

a line from zeros.broward:
broward. 1975 6 23 8.01 0.00
is re-written in bad1.broward as:
broward. 1975 6 23 8.01 0.00 F

a line from zeros.broward:
broward. 1966 3 17 2.37 0.00
is re-written in bad1.broward as:
broward. 1966 3 17 2.37 0.00

3) Manual checking

All data points in file (bad1."county name") are checked manually. Although the majority of zero monthly rainfall data are tentatively accepted or rejected in the previous step, these data went through manual scrutinizing for any possible revision. Manual scrutinizing was also performed to all unflagged points where a flag "A" or "F" was subsequently assigned. A combination of one or more of the following factors were used for verification, and decision making (each example given for each factor is a result of several factors in addition to the factor being presented).

a) if the number of data points, **n**, is low, this gives less confidence in the computed **avg**, and hence less confidence in giving flag "F" when **avg** is high.

Example:
dade. 1936 11 3 2.41 0.00 A

b) Historical monthly average tables, (Appendix F, Ali and Abtew, 1999a) were consulted when the confidence in the computed **avg** was low (**n** value is very low). In this case, not only is a particular county average checked, but also the surrounding areas.

Example:
ok. 1944 10 1 7.60 0.00 F

October rainfall, 1944 is 6.70, 10.79, 9.75, and 7.51, and 7.60 for EAA, Lower Kissimmee, Martin/St. Lucie, Upper Kissimmee and Okeechobee areas respectively. This lends more confidence in giving flag "F" for this point.

c) the repetition of zero values on other tags on the same month gives more confidence that the data point is good, i.e., assiging flag "A".

Example:
dade. 1936 11 3 2.41 0.00 A
dade. 1936 11 3 2.41 0.00 A

d) Rainfall for the dry and transition months tends to be more heterogeneous (Ali et. al. 1999b) implying less confidence to give "F" when avg is high.

Example:

Dade	1978	11	40	1.96	0.00	A

e) A record of consecutive zero values at a given station gives more confidence in assigning flag "F" for all zero values regardless of the corresponding avg values.

Example:

Collier	1980	3	11	2.26	0.00	F
Collier	1980	4	15	3.26	0.00	F
Collier	1980	5	12	4.52	0.00	F
Collier	1980	6	14	2.44	0.00	F
Collier	1980	7	11	8.35	0.00	F
Collier	1980	8	14	10.21	0.00	F
Collier	1980	9	12	8.08	0.00	F
Collier	1980	10	14	1.08	0.00	F
Collier	1980	11	14	3.68	0.00	F
Collier	1980	12	14	0.87	0.00	F
Collier	1981	1	13	0.59	0.00	F
Collier	1981	2	13	2.83	0.00	F
Collier	1981	3	14	1.29	0.00	F
Collier	1981	4	9	0.30	0.00	F
Collier	1981	5	13	1.34	0.00	F
Collier	1981	6	14	7.82	0.00	F
Collier	1981	7	14	8.16	0.00	F
Collier	1981	8	13	13.94	0.00	F
Collier	1981	9	15	5.95	0.00	F

A subsequent DBHYDRO query shows that the beginning of the period of record for this dbkey is year 1980 with January and February records flagged M; and October 1981 through June 1982 flagged N indicating data acquisition irregularities.

f) if **avg** is significantly lower than normal (e.g., 2 to 3 inch in July), this gives more confidence that the data point is good, i.e., giving flag "A"

Example:

Broward	1961	7	19	2.89	0.00	A
Broward	1961	9	16	2.71	0.00	A

4) Further checking using DBHYDRO

This step was necessary to further check stations with zero rainfall for 3 or more consecutive months. This was achieved as follows:

1. Prepare one file that contains all monthly data with 3 or more consecutive months with zero rainfall.
2. For each record, use DBHYDRO to generate a file of daily rainfall corresponding to that record.
3. Visually examine the quality of the daily rainfall and, accept or reject accordingly.
4. In this effort, twenty nine dbkeys (Table 1) were found to be of poor quality and were dropped "entirely" from the input data used to build rainfall binary file.

Table 1. Rainfall stations excluded entirely from the rainfall binary file.

County	Description		Dbkey
Broward	CA2A	2A-111_R	00443
Broward	-	2A-112_R	00447
Broward	-	3A-2_R	00547
Broward	-	3A-3_R	00557
Broward	-	3A-4_R	00552
Collier	COLL.E	BARRON_R	00808
Collier	-	TAMIAMI_R	00584
Collier	-	COCOH.WB_R	00843
Collier	-	FAKAHAT_R	00815
Collier	-	FAKA_R	00819
Collier	-	GOLD.W1_R	00838
Collier	-	GORDON_R	00834
Collier	-	HENDER_R	00829
Collier	-	-	00826
Dade	CA3A	3A-28_R	00623
Dade	-	NP-205_R	00793
Dade	-	-	00785
Dade	-	NP-202_R	00788
Dade	-	-	00773
Dade	-	NP-204_R	00763
Dade	-	-	00743
Dade	-	NP-207_R	00740
Highlands	MORGAN	H_R	00201
Monroe	COLL.E	ROBERTS_R	00804
Palm	C15	1-128_R	00362
Palm	CA1	1-141_R	00359
Palm	-	1-142_R	00365
Palm	-	LWD.L1_R	00336
Palm	SIMS	C1_R	00284

The above dbkeys only contained flags such as "M" or unusual rainfall records such as 0.00, 1.00, 2.00, 3.00, …etc. The output of the QAQC efforts can be found in 11 files **qaqc**."county name".

Statistics of rejected data

Out of 1797 monthly rainfall data points, there were 165 rejected sets of monthly data in this analysis. The majority of points were rejected between 1966 and 1998. Almost no rejection was assigned to a month belonging to a drought period as documented by MacVicar 1983, or by Trimble et. al. 1990. There is no particular month where rejection was assigned to all counties. Table 2 provides the number of rejections for each county.

Table 2. Zero monthly data, by county, excluded from the rainfall binary file.

Country	#. Rejections
Broward	19
Collier	62
Dade	16
Glades	3
Hendry	5
Highlands	10
Lee	1
Martin	1
Okeechobee	8
Palm Beach	40
Monroe	0

DSS update, binary file update, and visualization.

The DSS files were updated with the revised data presented above. The rainfall binary file and the associated statistical summary have then been updated. XGRIDVIEW application was used to view monthly rainfall, and other statistics from January 1914 through December 1998. Zero monthly rainfall appeared only on the dry season months. All, but small portion, of SFWMM domain was covered with zero rainfall in the following months: December 1932, January 1933, February 1933, February 1944, January 1949, January 1960, January 1961, April 1967, December 1968, and April 1970. Extended periods in which zero monthly rainfall is found over significant areas (that vary in location and size from a month to another) are: November 1948 to March 1949, November 1970 to April 1971, and December 1984 to February 1985. No zero rainfall was observed over the same spot for extended period.

<u>Phase IV</u>: Examination of Annual Rainfall below 30 inches and Monthly rainfall above 20 inches (sub-directory work1)

Visual examination of the binary file (using xgridview) showed annual rainfall below 30 inches in some areas. The evaluation of daily data values producing too low annual rainfall is difficult mainly due to the possibility of using more than one source (i.e. dbkey) of data to produce annual values. In other words, unless all the 365 daily data were from one station, it would be difficult to identify "bad" stations, or bad data based on an observed low annual rainfall in a grid "cell". For the cases where all, or the majority, of the daily data come from one source, one can identify and evaluate such sources (stations). The examination of such data was carried out in three steps: 1) Investigation of the corresponding DBHYDRO data, 2) Comparison with rainfall local statistics, and 3) visual inspection of annual snap shots extracted from the revised rainfall binary file.

In the first step, some algorithms were developed to extract daily rainfall data from DBHYDRO that correspond to all monthly DSS tags for all counties and for all years with annual sum < 30 inches (regardless of the number of missing months). The DBHYDRO extracted data can be found in '"county_name".D' files. Based on visual examination of daily rainfall in these files (364 cases), 22 years of daily data were found to be of poor quality (a combination of unrealistically low and missing values) and were consequently removed (Table 3.).

Table 3. Years excluded some stations from the rainfall binary file for

County	Dbkey	Date
Broward	05801	1980
Broward	13027	1992
Broward	05808	1965
Broward	05955	1974
Collier	06089	1990
Collier	06082	1981
Collier	06087	1980
Glades	06092	1985
Glades	05883	1981
Glades	05883	1982
Glades	05883	1983
Highlands	05741	1985
Highlands	05741	1986
Highlands	05741	1988
Okeechobee	05942	1967
Okeechobee	05942	1971
Okeechobee	05658	1985
Okeechobee	05740	1985
Palm beach	05924	1981
Palm beach	00336	1976
Palm beach	00336	1977
Palm beach	06227	1981

Similar efforts were made for monthly rainfall greater than 20 inches. Three hundred sixty two records of such data were extracted from DBHYDRO and stored in "all_mon.D" file. One month of rainfall was rejected where rainfall recorded 31.06 inches in January 1992 in an area of an average rainfall of 0.65. This record is tabulated below.

County	Date	Dbkey
Okeechobee	January, 1992	07507

The second step was to identify and verify annual rainfall based on its local rainfall statistics. An algorithm was developed to identify stations from monthly DSS files with annual rainfall below 30 inches and a maximum of 2 months of missing data, along with some relevant statistics for the respective county. A list of 98 records were extracted. A typical record contains the following information:

County	Dbkey	year	# Missing Months	# stations	Average Inches	St. Dev Inches	Value	adjusted. Value
okee	06049	1975	2	26	34.76	10.6	18.9	22.68

Where:

Missing Months: number of missing months in estimating "value"
stations: Number of stations used to calculate statistics for the given year and county.
Average: Annual average rainfall based on # stations -1 (the station of interest).
St. Dev: The associated standard deviation.
Value: Is the annual rainfall excluding the missing months.
Adjusted value is the annual rainfall after counting for the missing month using the following approximation: Adjusted value = value*12/(12 - # missing months).

The daily data set for a given year is rejected if the number of stations used to compute the statistics is more than 2 and the associated adjusted value is:

1) Below 20 inches,
2) Less than 1/2 of the average rainfall (for the given county and given year based on all locations except the one of interest) , **<u>or</u>**
3) Less than (AVG-2.5*STD) where STD is the standard deviation of annual rainfall within that county and that year.

If the number of stations is two or less, a proper discretion is used to reject or to keep. Illustration of this process as applied to the above record is presented below

< 20 ?	< 1/2 Avg ?	< Avg-2.5StD ?	# of Yes	Decision*
No	No	No	0	Keep

Table 4 below shows all 98 records along with the decision. Fifty three data sets were rejected.
The DSS files updated are in the /net/peashooter/usr2/RAIN/APR2000_UPDATE

The last step was to perform visual examination of annual snap shots of the rainfall binary file. As expected, areas of very low rainfall still exist. Associated stations were identified and further DBHYDRO queries were performed. Daily data at some of these stations were of poor quality indicated by an overwhelmingly large number of missing data for a given year. The following is a list of dbkeys where data sets were dropped for some years.

Dbkey	Year
H6055	1993
G6147	1993
5741	1989
16624	1991, 1992
12505	1992
12515	1992
05883	Entire POR
05890	Entire POR

POR= Period of Record

Table 4. Rainfall data with annual value below 30 inches based on a minimum of 10 months of data along with procedures to keep or reject data set for that year.

County	Dbkey	year	# Missing Months	# stations	Average Inches	St. Dev Inches	Value	Re-ass. Val	< 20 ?	< 1/2 Avg ?	< Avg-2.5StD ?	# of Yes	Decision*
okee	06073	1938	0	1	43.31	0	29.41	29.41	No	No	Yes	1	Keep
okee	06073	1972	2	18	37.54	7.37	17.65	21.18	No	No	No	0	Keep
okee	06236	1944	2	2	30.03	0.97	17.2	20.64	No	No	Yes	1	Keep
okee	05856	1974	2	21	45.4	5.46	22.55	27.06	No	No	Yes	1	**Reject**
okee	05875	1981	2	28	33.16	5.88	16.2	19.44	Yes	No	No	1	**Reject**
okee	05875	1992	2	12	47.55	6.05	22.02	26.42	No	No	Yes	1	**Reject**
okee	07499	1990	2	22	40.82	7.7	8.55	10.26	Yes	Yes	Yes	3	**Reject**
okee	06047	1975	2	26	34.76	10.59	18.7	22.44	No	No	No	0	Keep
okee	06049	1975	2	26	34.76	10.6	18.9	22.68	No	No	No	0	Keep
okee	06051	1975	2	26	34.75	10.61	19.02	22.82	No	No	No	0	Keep
okee	06052	1975	2	26	34.76	10.6	18.89	22.67	No	No	No	0	Keep
okee	06048	1975	2	26	34.73	10.64	19.47	23.36	No	No	No	0	Keep
okee	05740	1986	1	21	44.77	7.49	11.68	12.74	Yes	Yes	Yes	3	**Reject**
okee	05740	1988	2	14	40.12	5.06	6.87	8.24	Yes	Yes	Yes	3	**Reject**
high	06066	1968	1	9	47.34	6.3	29.9	32.62	No	No	No	0	Keep
high	06152	1961	2	6	39.98	1.74	22.97	27.56	No	No	Yes	1	**Reject**
high	06095	1985	0	11	38.62	8.95	13	13.00	Yes	Yes	Yes	3	**Reject**
brow	05954	1968	2	20	62.62	11.81	19.48	23.38	No	Yes	Yes	2	**Reject**
brow	05954	1976	1	18	51.12	6.64	20.56	22.43	No	Yes	Yes	2	**Reject**
brow	05954	1978	0	12	50.8	7.9	29.89	29.89	No	No	Yes	1	**Reject**
brow	05846	1984	0	13	54.89	11.58	26.89	26.89	No	Yes	No	1	**Reject**
brow	06178	1956	0	5	36.7	2.84	29.02	29.02	No	No	Yes	1	**Reject**
brow	06177	1944	2	1	46.9	0	30	36.00	No	No	Yes	1	Keep
hend	05819	1981	2	30	34.39	4.15	22.01	26.41	No	No	No	0	Keep
hend	05919	1981	1	30	34.57	3.4	16.6	18.11	Yes	No	Yes	2	**Reject**
hend	16671	1996	2	15	48.26	5.96	22.27	26.72	No	No	Yes	1	**Reject**
coll	06208	1962	2	6	55.18	4.62	24.38	29.26	No	No	Yes	1	**Reject**
coll	H1988	1985	1	16	52.4	14.33	24.38	26.60	No	No	No	0	Keep
coll	DU526	1997	0	20	48.29	7.26	27.41	27.41	No	No	Yes	1	**Reject**
coll	05986	1997	1	20	48.24	7.41	28.42	31.00	No	No	No	0	Keep

coll	06018	1990	0	13	44.83	7.94	23.8	23.80	No	No	Yes	1	**Reject**
mart	16582	1993	2	9	54.41	16.87	22.87	27.44	No	No	No	0	Keep
mart	06119	1981	2	12	35.36	7.85	15.19	18.23	Yes	No	No	1	**Reject**
mart	06239	1944	1	1	45.68	0	29.95	32.67	No	No	Yes	1	Keep
mart	06239	1961	0	10	40.16	3.57	28.38	28.38	No	No	Yes	1	**Reject**
monr	06163	1974	0	3	24.41	4.18	19.99	19.99	Yes	No	No	1	Keep
monr	06163	1998	2	2	49.68	3.95	24.71	29.65	No	No	Yes	1	Keep
monr	06245	1950	0	3	36.91	0.47	29.44	29.44	No	No	Yes	1	Keep
monr	06245	1974	0	3	24.41	4.18	19.99	19.99	Yes	No	No	1	Keep
monr	06162	1916	1	1	24.46	0	22.12	24.13	No	No	Yes	1	Keep
monr	06162	1918	0	1	42.55	0	29.87	29.87	No	No	Yes	1	Keep
monr	06162	1927	0	1	31.09	0	22.31	22.31	No	No	Yes	1	Keep
monr	06162	1933	1	1	55.77	0	28.46	31.05	No	No	Yes	1	Keep
monr	06162	1938	0	1	24.85	0	22.58	22.58	No	No	Yes	1	Keep
monr	06162	1962	0	7	34.84	3	23.06	23.06	No	No	Yes	1	**Reject**
monr	06246	1944	1	3	31.2	1.95	24.15	26.35	No	No	No	0	Keep
monr	06402	1921	1	2	36.01	.08	18.96	20.68	No	No	Yes	1	Keep
monr	06402	1923	0	2	29.09	5.94	18.8	18.80	Yes	No	No	1	**Reject**
monr	06402	1924	1	2	29.87	6.3	13.96	15.23	Yes	No	No	1	Keep
monr	06165	1989	2	5	35.85	7.56	19.69	23.63	No	No	No	0	Keep
lee.	05907	1981	1	11	40.73	9.69	18.61	20.30	No	Yes	No	1	**Reject**
lee.	15464	1994	1	7	54.19	6.95	13.95	15.22	Yes	Yes	Yes	3	**Reject**
lee.	15464	1996	0	5	43.74	7.59	22.27	22.27	No	No	Yes	1	**Reject**
lee.	06186	1945	1	2	55.9	4.69	24.18	26.38	No	Yes	Yes	2	**Reject**
lee.	06186	1950	0	3	38.98	4.83	22.6	22.60	No	No	Yes	1	**Reject**
lee.	06186	1951	2	3	60.75	8.37	27.25	32.70	No	No	Yes	1	**Reject**
palm	05924	1955	1	21	45.12	7.02	25.62	27.95	No	No	No	0	Keep
palm	05925	1956	2	32	39.85	5.12	21.2	25.44	No	No	Yes	1	**Reject**
palm	06328	1988	2	52	49.07	9.42	19.14	22.97	No	Yes	Yes	2	**Reject**
palm	05890	1970	2	68	54.37	6.79	17.34	20.81	No	Yes	Yes	2	**Reject**
palm	05890	1971	2	65	49.25	6.87	22.33	26.80	No	No	Yes	1	**Reject**
palm	05890	1972	1	61	50.68	12.76	18.5	20.18	No	Yes	No	1	**Reject**
palm	05891	1968	0	67	62.59	9.32	29.1	29.10	No	Yes	Yes	2	**Reject**
palm	05891	1971	2	65	49.33	6.53	17.34	20.81	No	Yes	Yes	2	**Reject**

palm	05891	1972	2	61	50.63	12.89	21.62	25.94	No	No	No	0	Keep
palm	05891	1973	0	60	48.67	11.76	18.9	18.90	Yes	Yes	Yes	3	**Reject**
palm	16695	1996	2	80	48.96	8.41	27.82	33.38	No	No	No	0	Keep
palm	06241	1943	0	14	42.51	6.64	25.03	25.03	No	No	Yes	1	**Reject**
palm	06270	1989	1	43	38.74	5.71	22.94	25.03	No	No	No	0	Keep
palm	06226	1976	1	49	47.85	8.11	25.96	28.32	No	No	No	0	Keep
palm	15862	1995	0	83	59.28	11.86	27.96	27.96	No	Yes	Yes	2	**Reject**
palm	15862	1996	1	80	49.05	8.16	21.12	23.04	No	Yes	Yes	2	**Reject**
palm	06242	1950	0	13	47.29	7.19	28.98	28.98	No	No	Yes	1	**Reject**
palm	06242	1985	2	56	50.52	8.94	26.89	32.27	No	No	No	0	Keep
palm	06324	1974	2	53	48.82	9.49	24.74	29.69	No	No	No	0	Keep
palm	06258	1949	2	14	53.58	9.78	25.38	30.46	No	No	No	0	Keep
palm	DJ194	1996	2	80	49.02	8.25	23.3	27.96	No	No	Yes	1	**Reject**
dade	05814	1979	2	38	54.08	10.8	21.76	26.11	No	Yes	Yes	2	**Reject**
dade	06408	1980	2	31	52.86	12.45	26.34	31.61	No	No	No	0	Keep
dade	05958	1972	0	36	58.26	8.46	28.48	28.48	No	Yes	Yes	2	**Reject**
dade	06249	1917	1	2	57.9	0	29.26	31.92	No	No	Yes	1	Keep
dade	05816	1979	2	38	53.98	11.07	25.25	30.30	No	No	No	0	Keep
dade	G6149	1993	2	32	49.89	10.15	20.58	24.70	No	Yes	No	1	**Reject**
dade	06247	1942	2	9	58.46	7.27	26.11	31.33	No	No	Yes	1	**Reject**
dade	05817	1970	1	27	43.44	6.31	22.59	24.64	No	No	Yes	1	**Reject**
dade	06172	1927	2	4	37.18	3.9	25.49	30.59	No	No	No	0	Keep
dade	06172	1948	2	11	64.28	13.85	27.36	32.83	No	No	No	0	Keep
dade	06316	1974	0	38	43.28	7.77	23.18	23.18	No	No	Yes	1	**Reject**
glad	06197	1931	0	2	35.46	0.65	29.37	29.37	No	No	Yes	1	Keep
glad	06198	1963	2	7	39.1	4.73	25.3	30.36	No	No	No	0	Keep
glad	06074	1976	1	10	40.23	8.7	15.98	17.43	Yes	Yes	Yes	3	**Reject**
glad	06124	1993	2	18	41.2	5.39	22.1	26.52	No	No	Yes	1	**Reject**
glad	06154	1948	1	3	50.02	3.91	28.72	31.33	No	No	Yes	1	Keep
glad	15786	1998	0	24	47.78	7.09	20.8	20.80	No	Yes	Yes	2	**Reject**
glad	05883	1978	0	10	46.96	10.94	22.01	22.01	No	Yes	No	1	**Reject**
glad	06077	1961	0	6	36.93	4.78	23.67	23.67	No	No	Yes	1	**Reject**
glad	06077	1971	1	11	45	7.02	24.71	26.96	No	No	Yes	1	**Reject**
glad	06077	1984	2	12	44.48	10.08	21.18	25.42	No	No	No	0	Keep

<u>Phase V</u>: QA\QC of rainfall data for 1999-2000

The methodologies applied to 1914-1998 data were applied to the recently extracted data set for the period 1999-2000. The results of this effort can be found in the subdirectory **"/net/peashooter/usr2/RAIN/result_99_00"** and are as follows:

A) 484 data points were identified as extreme values and needed further QA\QC that resulted in rejecting 254 data points. Results of this effort are found in the following files:

estimate2.out
diff_any_out
diff_40_dr_5.out
diff_40_dr_10.out
diff_20_dr_5.out
diff_20_dr_10.out
bad_xy_rating.out

B) Table 5 shows the QA\QC result of rainfall stations with annual rainfall below 30 (with maximum of 60 days missing data).
C) Dbkey <u>kd314</u> is dropped for unrealistically high values and dbkey <u>05875</u> is dropped for missing data throughout the period of record with zero data at the end and beginning of each month.

D) No greater than 20 inch monthly rainfall was rejected

E) Monthly rainfall less than 2 inches were inspected for the months of May through November 1999 (see file: "**monthly_low**" file). Table 6 shows monthly data rejected for June 1999.

Table 5. Rainfall data with annual value below 30 inches based on a minimum of 10 months of data along with procedures to keep or reject data set for that year.

County	dbkey	year	# Missing days	#stations	Average Inches	St. Dev Inches	Value	Adjusted value	< 20 ?	< 1/2 Avg ?	< Avg-2.5StD ?	# of Yes	Decision
brow	16642	2000	45	40	48.02	7.65	20.83	23.76	No	Yes	Yes	2	reject
coll	06089	2000	0	20	38.39	11.53	0	0.00	Yes	Yes	Yes	3	reject
coll	06082	2000	0	20	37.41	13.81	19.54	19.54	Yes	No	No	1	reject
coll	06090	1999	30	20	54.61	11.37	0	0.00	Yes	Yes	Yes	3	reject
coll	06090	2000	0	20	38.39	11.53	0	0.00	Yes	Yes	Yes	3	reject
lee.	15464	1999	0	8	52.09	7.86	16.64	16.64	Yes	Yes	Yes	3	reject
palm	12524	2000	0	101	41.63	8.26	18.9	18.90	Yes	Yes	Yes	3	reject
palm	16695	2000	3	101	41.63	8.25	18.62	18.77	Yes	Yes	Yes	3	reject
glad	15495	2000	0	32	27.47	6.47	11.34	11.34	Yes	Yes	No	2	reject
glad	12515	2000	0	32	27.34	6.76	15.62	15.62	Yes	No	No	1	reject
glad	16694	2000	3	32	27.34	6.76	15.62	15.75	Yes	No	No	1	reject

Table 6. Rainfall data for June/1999 that are excluded from the rainfall binary file.

Station	Year	Month	# stations	# Missing days	Average	Value
collier.T15	1999	6	22	28	10.67	0
collier.T20	1999	6	22	0	10.67	0
collier.T50	1999	6	21	26	11.18	0.07
dade.T40	1999	6	80	0	10.74	1.48
dade.T44	1999	6	81	0	10.62	0
martin.T37	1999	6	13	0	9.74	0.23
martin.T35	1999	6	13	27	9.74	0.19
okeechobee.T32	1999	6	39	28	12.69	0
palm.T164	1999	6	102	23	13.05	0

Comparison between rainfall binary file versions V1.2, V1.3, & V1.4 (Statistical Comparison)

A new version, V1.3, of rainfall binary file was created to reflect the changes made as a result of the QA\QC efforts. In V1.3, rainfall is estimated at the center of the SFWMM grid cell centroid using approximated Theissen method. Another version, V1.4, was created where rainfall is estimated using Triangular Irregular Network, TIN. In this version, TIN estimates are obtained at the centroids of 10x10 sub cells within the SFWMM cell and averaged over that cell. In this section, rainfall statistics of the new versions V1.4, and V1.3 and the old version V1.2 were compared. The purpose of this comparison is 1) to evaluate the effect of the QA\QC on the rainfall binary file in the period 65-95, 2) to evaluate the changes of the binary file as a result of changing the estimation method, and 3) to compare rainfall statistics of period 96-00 to that of period 65-95. Statistical measures used for the comparison are monthly rainfall difference between the two versions, annual rainfall, and maximum monthly rainfall, monthly average and standard deviation of monthly rainfall. The comparison is presented for the entire model grid as well as for local areas such as Lake Okeechobee (LOK), Everglades Agricultural Area (EAA), and the Everglades National Park (ENP).

Statistics representing the entire model domain are depicted in Figures 1 through 6. The difference of monthly rainfall between versions V1.3 and V1.2, reflecting the QA\QC effect, and that between V1.4 and V1.3, reflecting the estimation method effect, are depicted in two different formats (Figures 1a, 1b, and 2a, and 2c). Figures 1a and 1b present these differences over the years while Figures 2a and 2b present the differences month by month. Notice from Figure 1a, that the majority of monthly rainfall difference ranges within ± 0.2 inches, with the average[1] (the solid line) close to zero and the difference magnitude is higher between 1983 and 1995. Figure 1b shows that all, but two, of V1.4-V1.3 values are within 0.2 inches. Figures 2a and 2b shows that large differences occur mainly in the wet months (May through October).

The annual rainfall for the three versions, as depicted in Figure 3, are almost identical in most of the years with below one inch difference in 1977, 1983, 1985, 1992, and 1993. Figure 4 depicts maximum monthly rainfall for each month. For the period 65-95, V1.3 monthly rainfall maxima decrease in February by 4 inches and change slightly in May, August, September, and December. V1.4 maxima are lower in general. For the period 96-00 (V1.3 and V1.4), monthly rainfall maxima are significantly lower for all months than those within the 65-95 period.

Figure 5 and 6 show the average and the standard deviation of monthly rainfall averaged over the model domain and over the years. These statistics for the period 65-95 are almost identical for the three versions and for the period 96-00 are almost identical for the two versions V1.3 and V1.4. However, there is a significant difference between the two periods. This does not provide enough evidence for possible change in the weather pattern because the 96-00 period is too short to show weather persistence. On

[1] An average for a given year represents the average of the monthly difference for that year.

the other hand, there is a high degree of similarities between version 1.2 and version 1.3 statistics within the period 65-95 reflecting minimal impacts of the QA\QC on the global characteristics of rainfall data. Also, same of level of similarity between V1.3 and V1.4 show that the change in estimation method does not have a considerable impact on the global characteristics of rainfall data.

The global statistics presented in Figures 1 through 6 show slight differences for 65-95 period. V1.3-V1.2 differences are expected to be more significant in the areas where QA\QC efforts resulted in significant changes of the data. V1.4-V1.3 differences may be more significant where the TIN is dense. Of interest is to present the statistics of the three versions for three important areas: LOK, EAA, and ENP basins.

Figures 7 through 12 depict the same statistics for Lake Okeechobee, LOK. For V1.3-V1.2, the majority of monthly rainfall difference ranges within $\pm$ 0.5 inches, a wider range than that of the global case. Figure 7a shows that the difference of the average, represented by the solid line, has positive peaks (as high as 0.6 inches) in 1967, 1971, 1977, and 1992. Figure 8a. shows that the difference is higher for March, June, August, and September. This is consistent with the fact that many of the rainfall data representing 'too' low annual values were removed from the LOK area. Figures 7b and 8b show much less variation reflecting less impact on rainfall due to the change in the estimation method on the global statistical characteristics.

Figure 9 depicts LOK annual rainfall for the two versions and the annual rainfall calculated by Ali and Abtew (1999). Annual rainfall for version 1.3 exceeded that of version 1.2 in many years due to the removal of many too low annual rainfall data. Annual rainfall for V1.4 is between V1.3 and V1.2 rainfall values. This is due to the "averaging" nature of the TIN estimator. Estimated annual rainfall by Ali and Abtew (1999) is almost consistently higher, with similar pattern, compared to rainfall of V1.2, V1.3, and V1.4. The systematic difference may be attributed to difference in data sources and/or methods of rainfall estimation rather than a data quality problem.

Monthly rainfall maxima are identical for version 1.3 and version 1.2 except in November where monthly rainfall maximum is reduced by about 3 inches (Figure 10). Rainfall maxima are consistently lower for V1.3 period 96-00. V1.4 maxima for the two periods are consistently lower due to the "averaging" nature of the TIN estimator. Figures 11 show high degree of similarities across the versions for the same period with distinct difference between the two periods. Figure 12 shows standard deviation similarities for the three versions with the exception of March, June and August where V1.2 standard deviation is lower.

Figures 13 through 18 depict similar statistics for the Everglades Agricultural Area, EAA. Notice from Figure 13a that the majority of monthly rainfall difference ranges within $\pm$ 0.1, a smaller range than the global case. Figures 13a and 14a exhibit a small range of variation of the difference reflecting high confidence in data quality. Figures 13b and 14b exhibit similar variation indicating no big impact on rainfall estimation due to the change in the estimation method.

Figure 15 depicts EAA annual rainfall for the three versions and the annual rainfall calculated by Ali and Abtew (1999). Annual rainfall for all versions are almost identical. Estimated annual rainfall by Ali and Abtew (1999) shows high matching which reinforces the high quality of EAA data.

Figure 16 shows that monthly rainfall maxima for 65-95 period decreased for version 1.3 in the months of February, September, and October reflecting the removal of extreme rainfall values. Version V1.4 has the same pattern of V1.3 with lower values. Monthly maxima are lower for the period 96-00 showing consistency with similar observations in different areas. Figures 17 and 18 show that monthly average and standard deviation are essentially the same for the three versions. Such statistics are different for the period 96-00.

Figures 19 through 24 depict similar statistics for the ENP, ENP. Notice from Figure 19a that the majority of monthly rainfall difference ranges within ± 0.5, a similar range to the global case. Figure 19a shows less variation indicating less impact due to the change in estimation method. Figure 20a shows high difference in May through November. Figure 20b shows similar trend but lower values. Figure 21 depicts ENP annual rainfall for the three versions. Annual rainfall for version 1.3 and version 1.2 are similar until 1991. Some differences are observed between 1991 and 1995. V1.4 annual values are similar to V1.3 with minor differences in some years. Figure 22 shows that rainfall maxima increased for version 1.3 in the months of April, November, and December while they decreased for the month of August. The increase of rainfall Maxima is attributed to the use of new data as a result of rejecting closer data. V1.4 maxima are consistently lower. Figures 23 and 24 show that monthly average and standard deviation within the same period are almost identical for the three versions. Such statistics are different for the period 96-00.

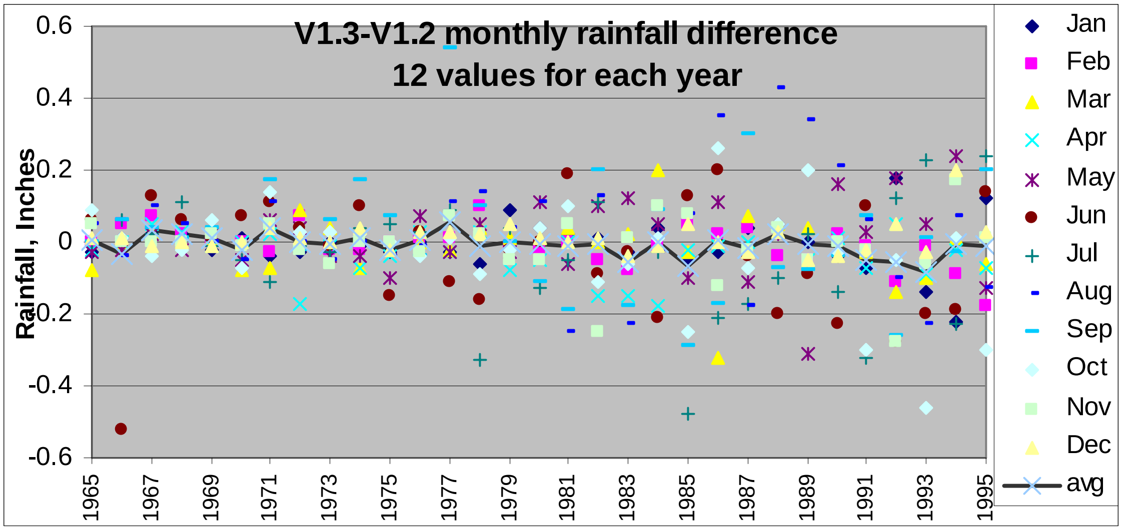

Figure 1a. Difference between V1.3 and V1.2 monthly average rainfall for the period 1965-1995 (12 values/year)

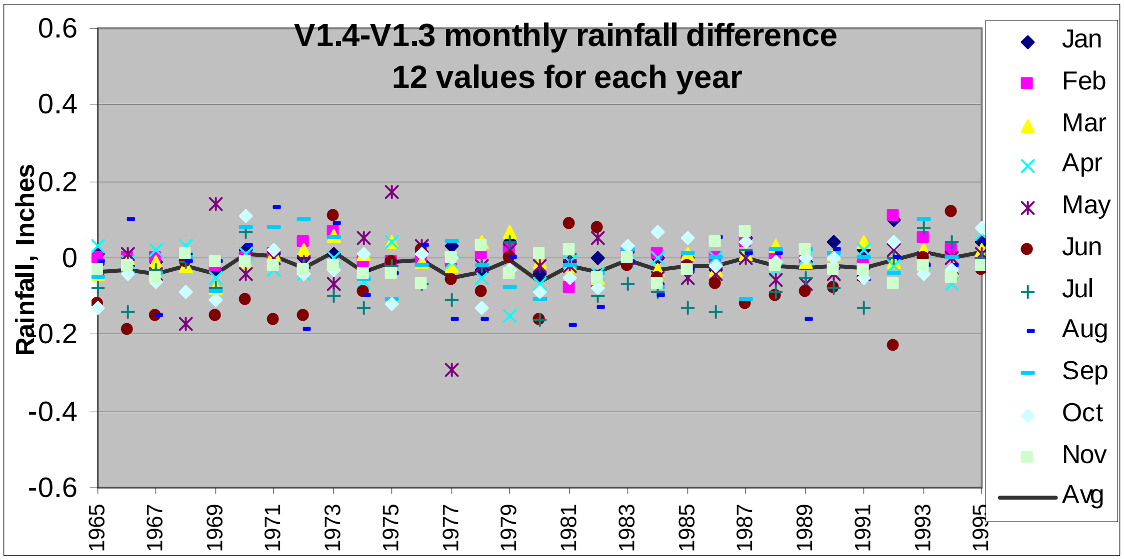

Figure 1b. Difference between V1.4 and V1.3 monthly average rainfall for the period 1965-1995 (12 values/year)

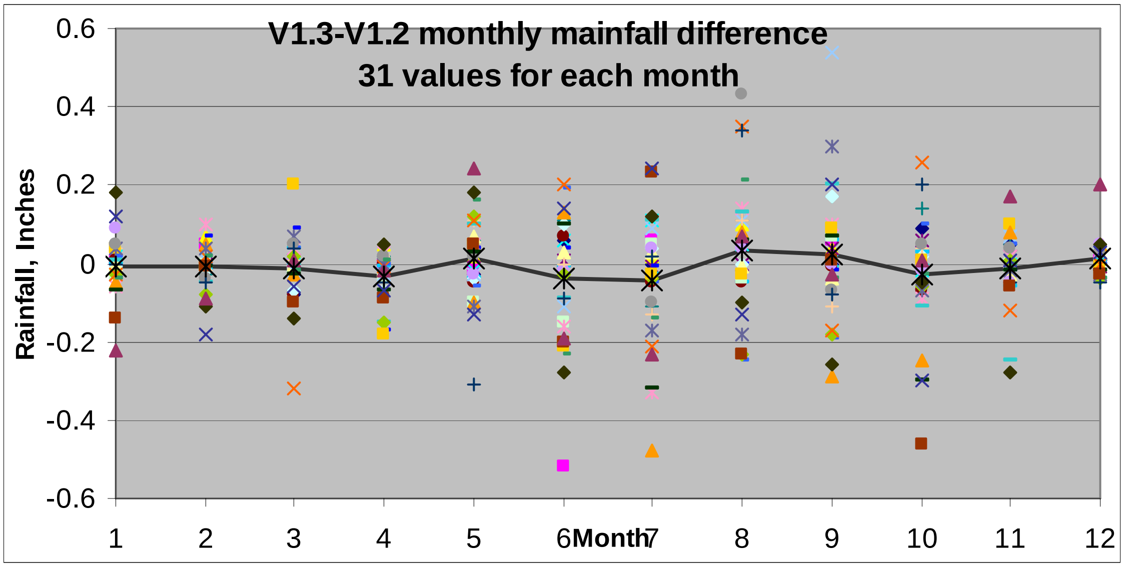

Figure 2a. Difference between V1.3 and V1.2 monthly average rainfall for each month (period 1965-1995)

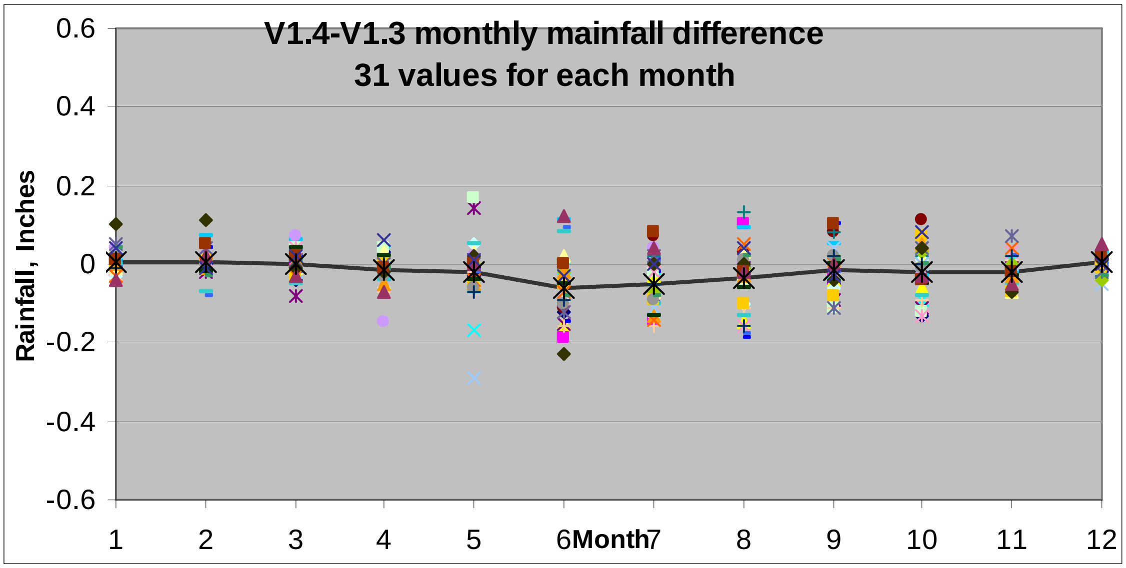

Figure 2b. Difference between V1.4 and V1.3 monthly average rainfall for each month (period 1965-1995)

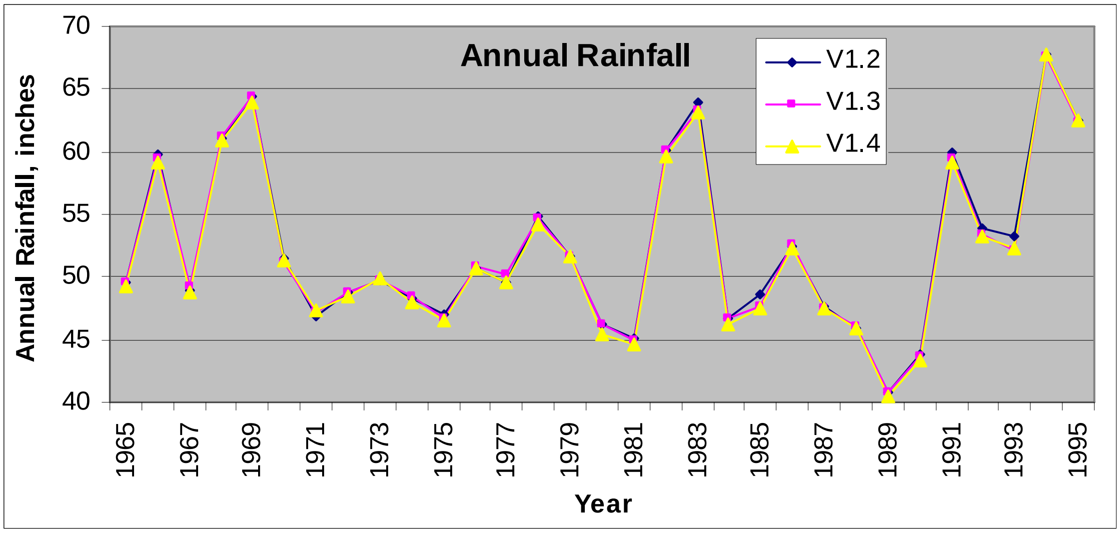

Figure 3. Annual rainfall for V1.2, V1.3, and V1.4 Rainfall Binary Files for the period 1965-1995

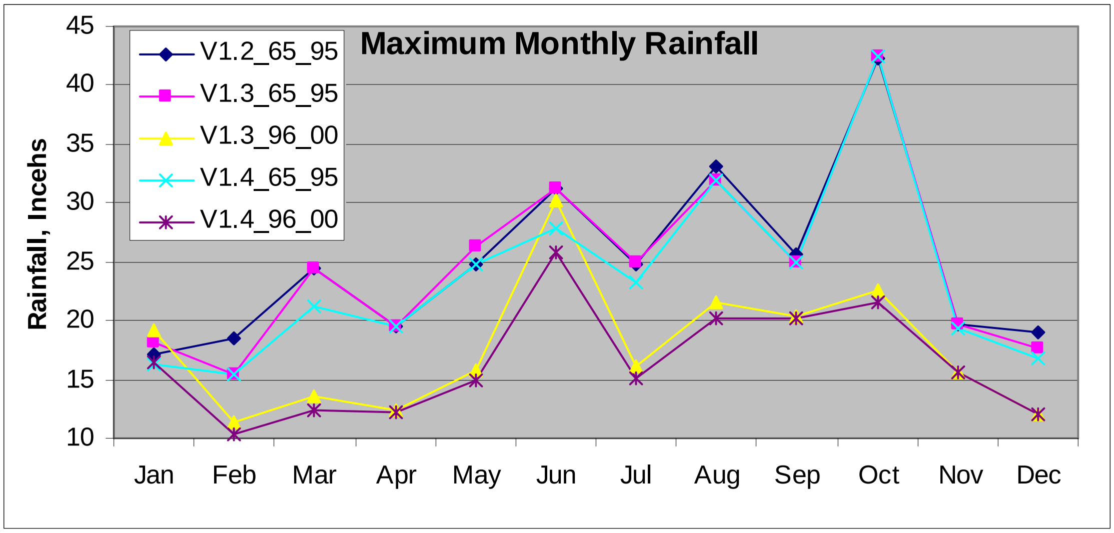

Figure 4. Maximum monthly rainfall for the entire model domain.

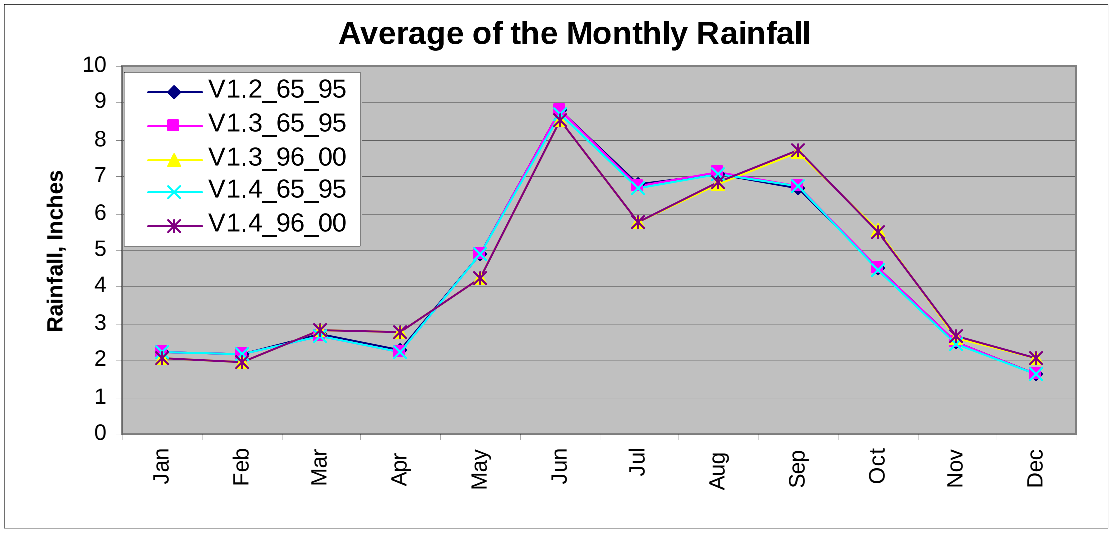

Figure 5. Average of Monthly rainfall averages for the entire model domain.

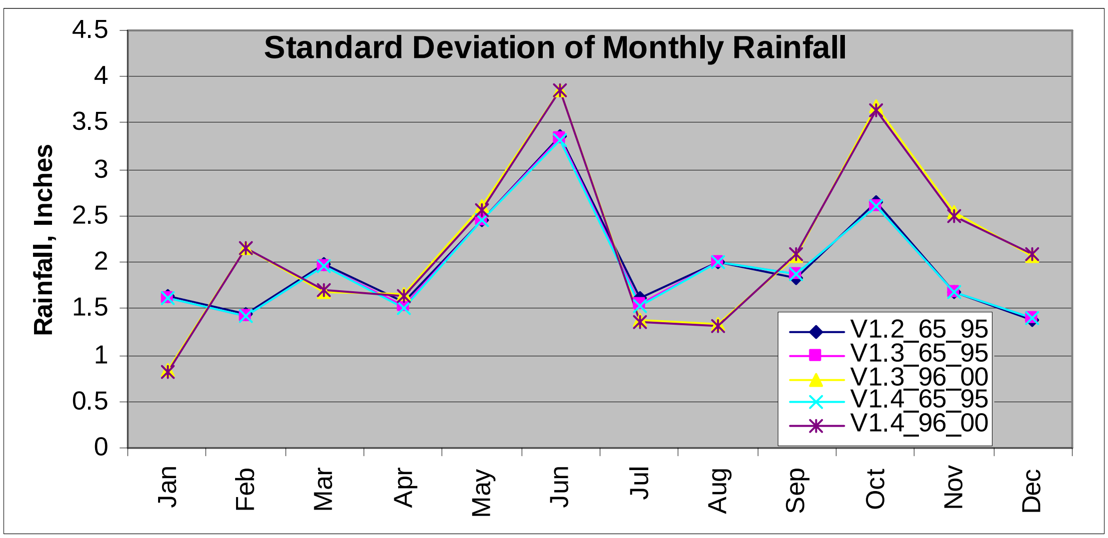

Figure 6. Standard Deviation of Monthly rainfall for the entire model domain.

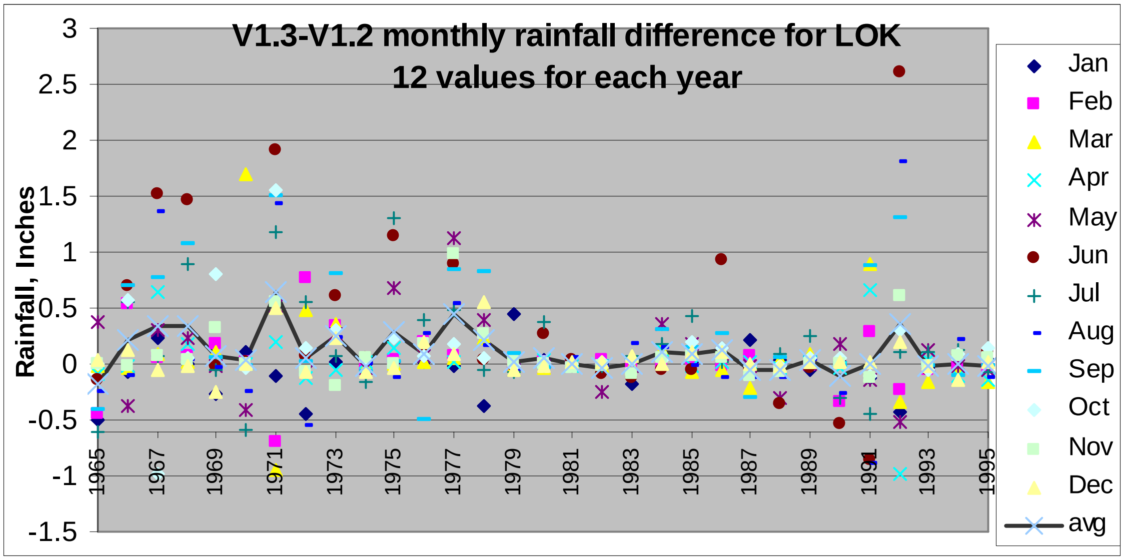

Figure 7a. Difference between V1.3 and V1.2 monthly average rainfall for LOK area and the period 1965-1995 (12 values/year)

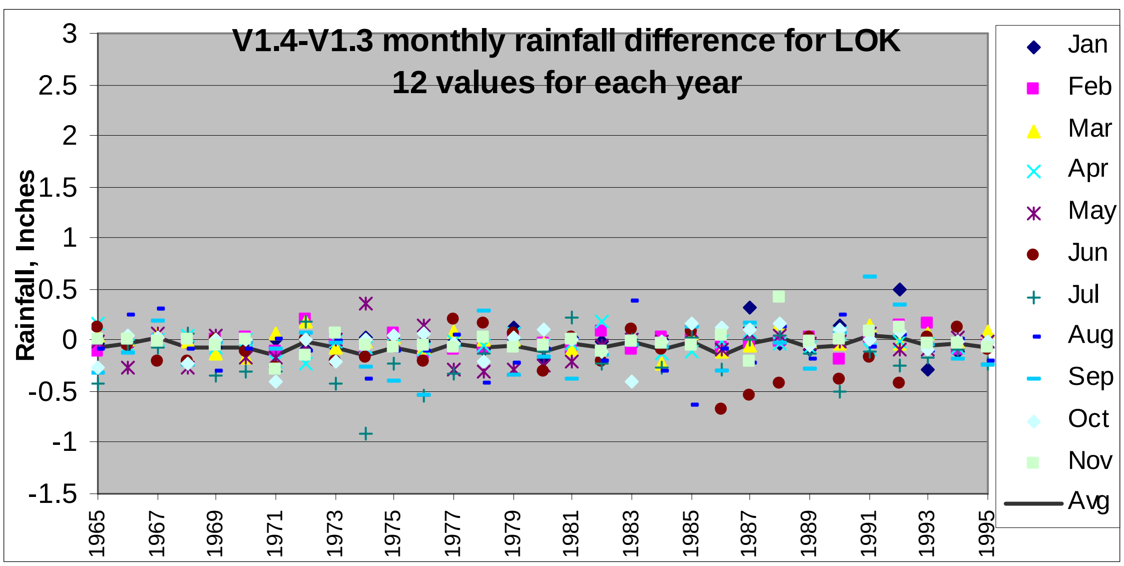

Figure 7b. Difference between V1.4 and V1.3 monthly average rainfall for LOK area and the period 1965-1995 (12 values/year).

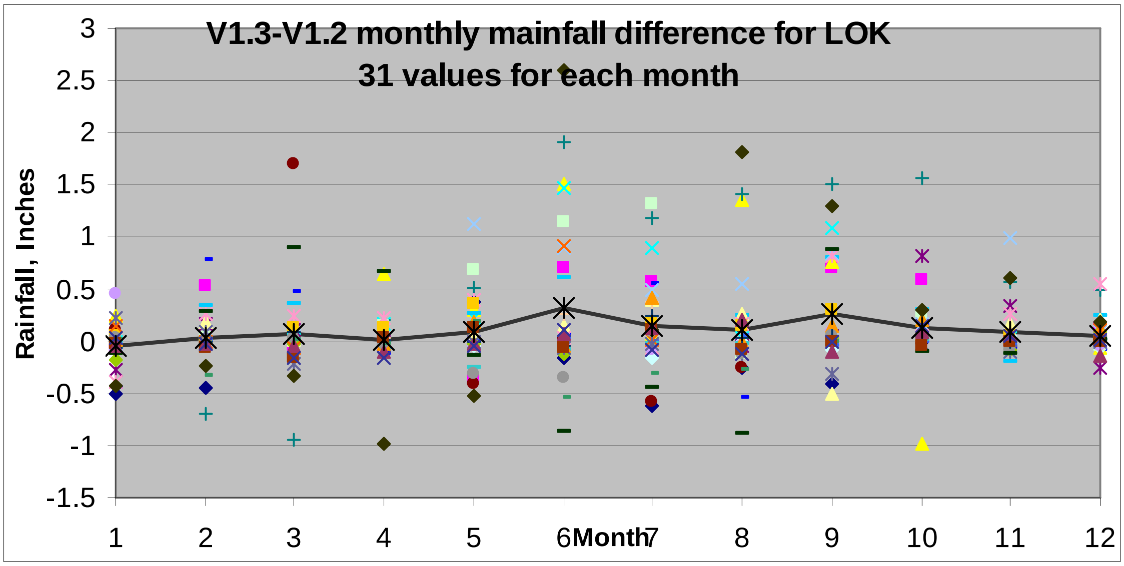

Figure 8a. Difference between V1.3 and V1.2 monthly average rainfall for LOK area and each month (period 1965-1995)

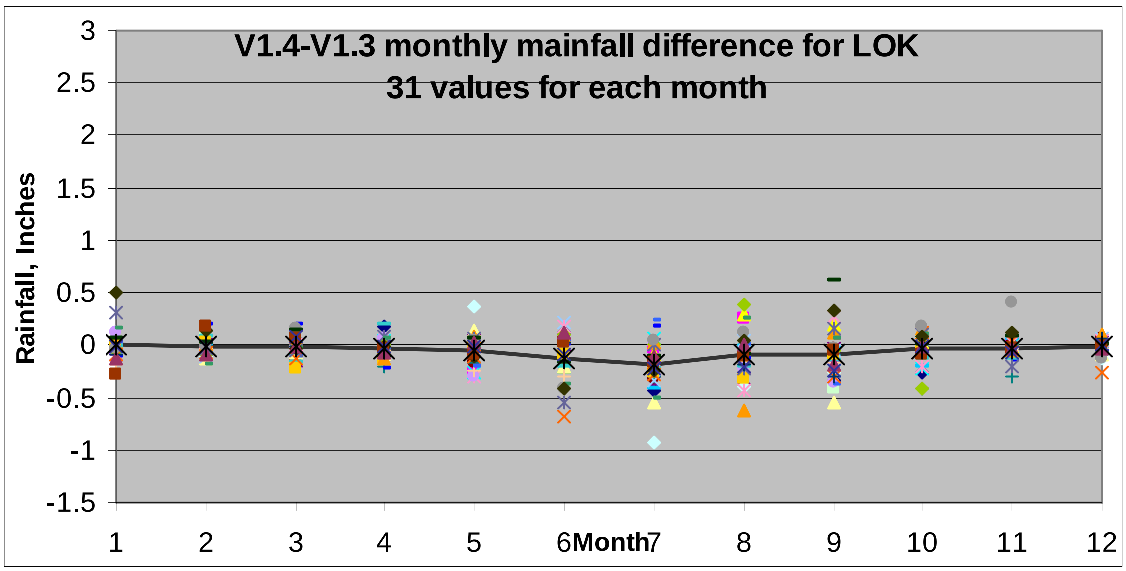

Figure 8b. Difference between V1.4 and V1.3 monthly average rainfall for LOK area and each month (period 1965-1995)

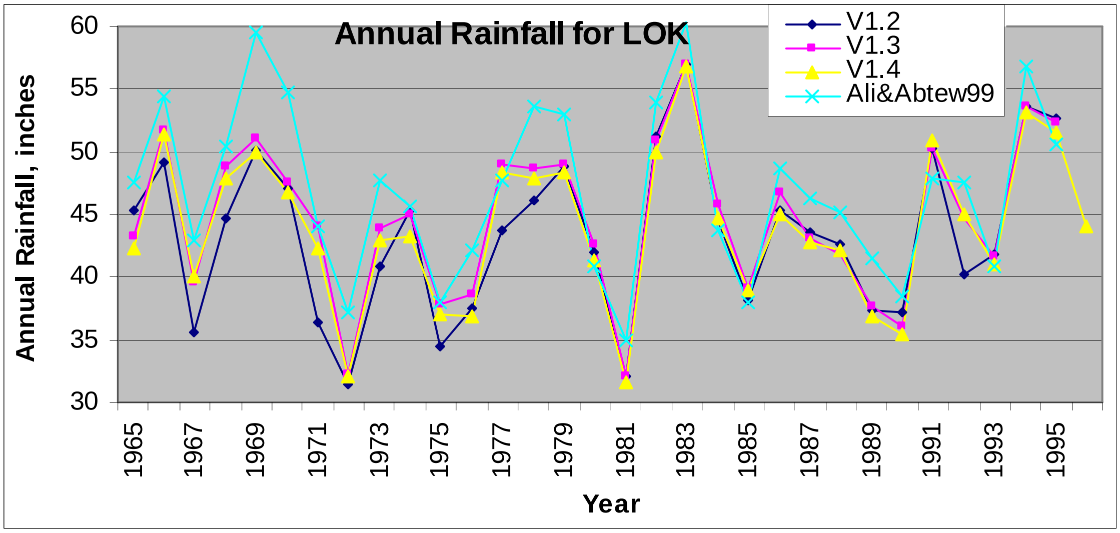

Figure 9. Annual rainfall for V1.2, and V1.3 Rainfall Binary File for LOK area and the period 1965-1995

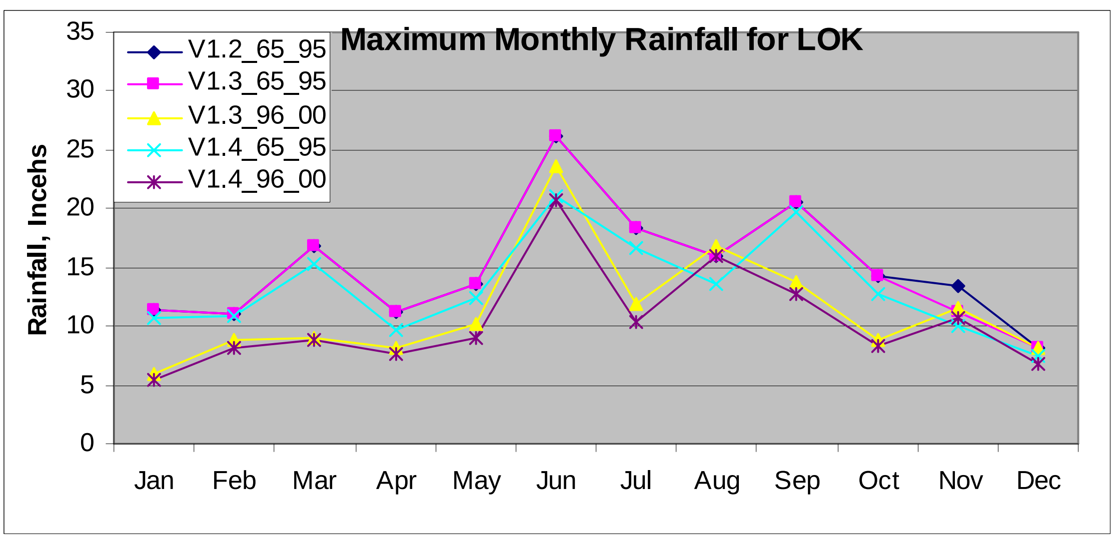

Figure 10. Maximum monthly rainfall for LOK area.

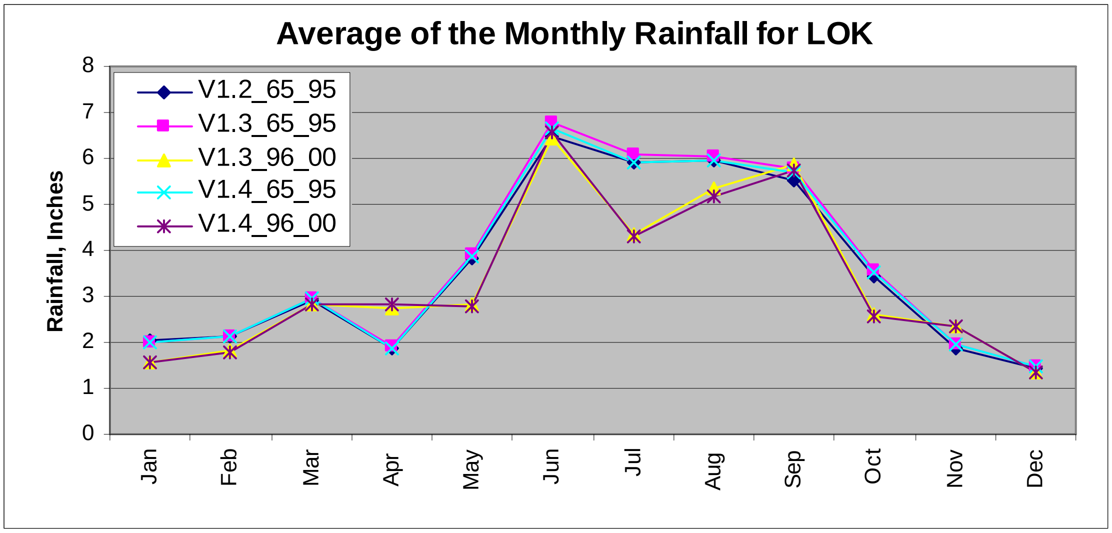

Figure 11. Average of Monthly rainfall for LOK area.

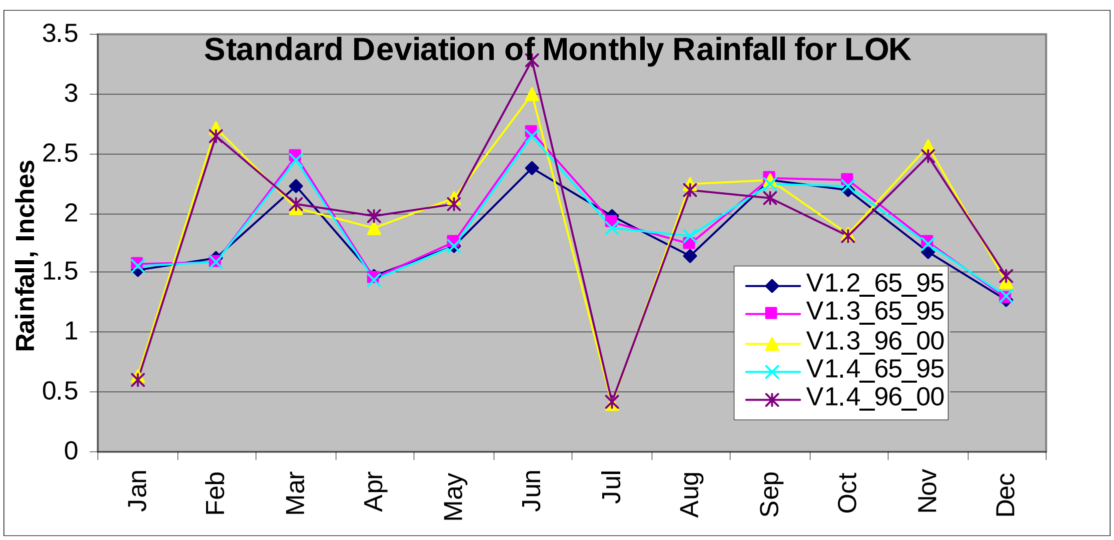

Figure 12. Standard Deviation of Monthly rainfall for LOK

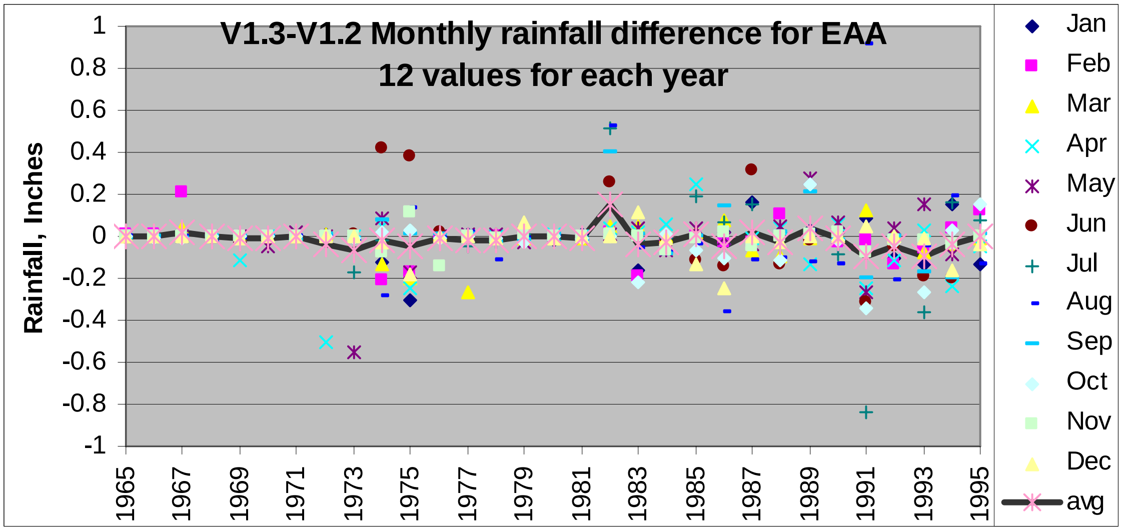

Figure 13a. Difference between V1.3 and V1.2 monthly average rainfall for EAA area and the period 1965-1995 (12 values/year)

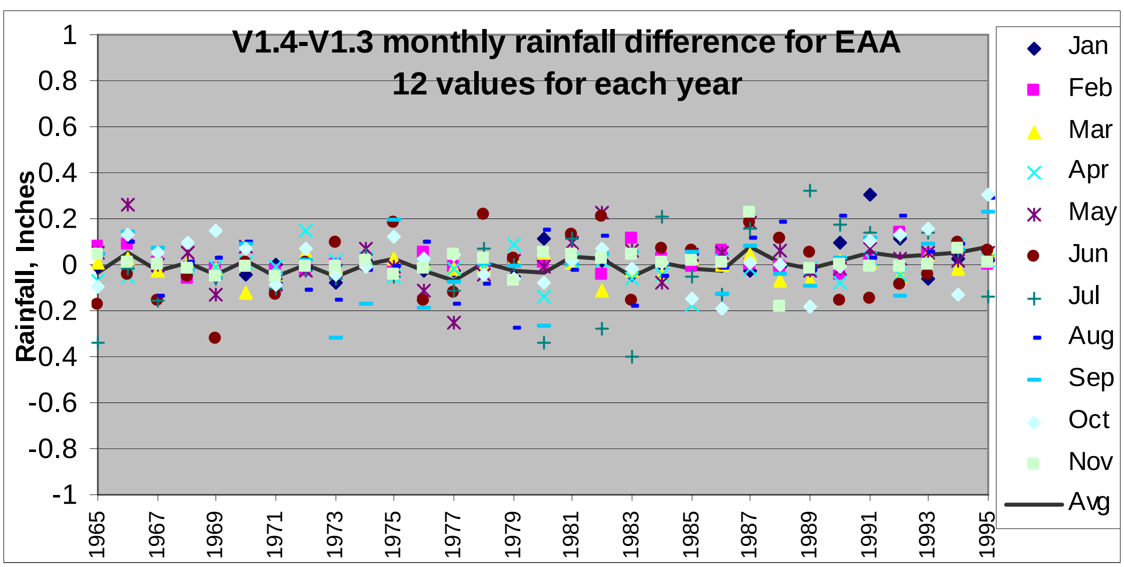

Figure 13b. Difference between V1.4 and V1.3 monthly average rainfall for EAA area and the period 1965-1995 (12 values/year)

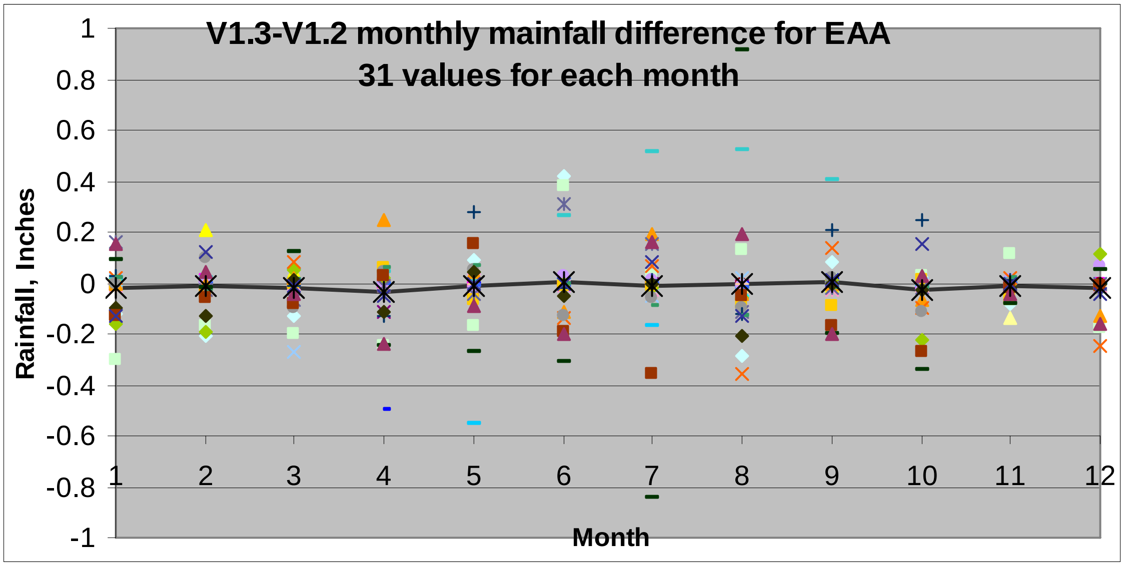

Figure 14a. Difference between V1.3 and V1.2 monthly average rainfall for EAA area and each month (period 1965-1995)

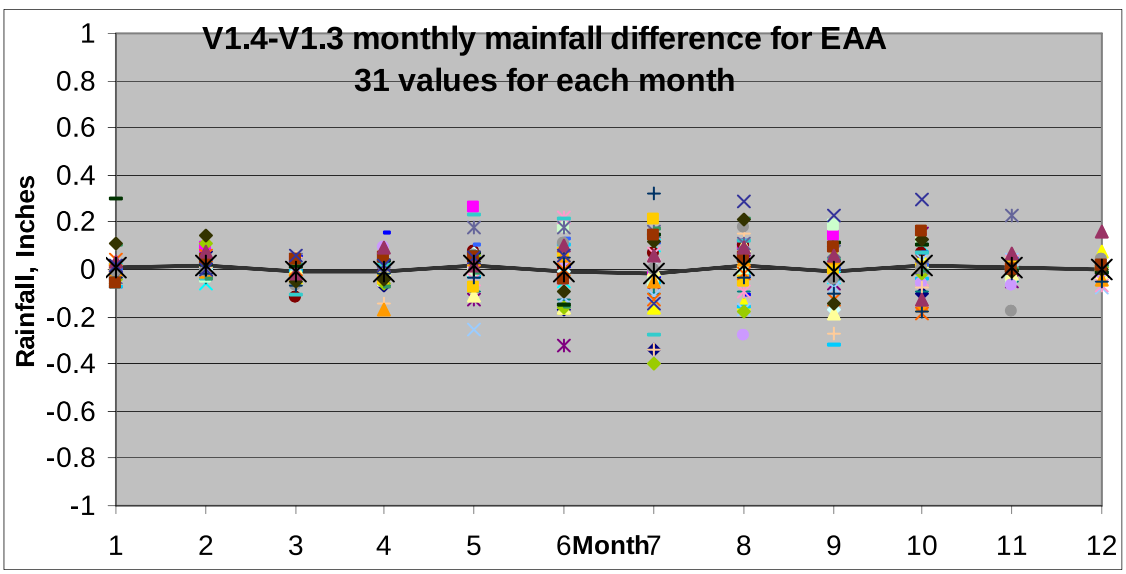

Figure 14b. Difference between V1.3 and V1.2 monthly average rainfall for EAA area and each month (period 1965-1995)

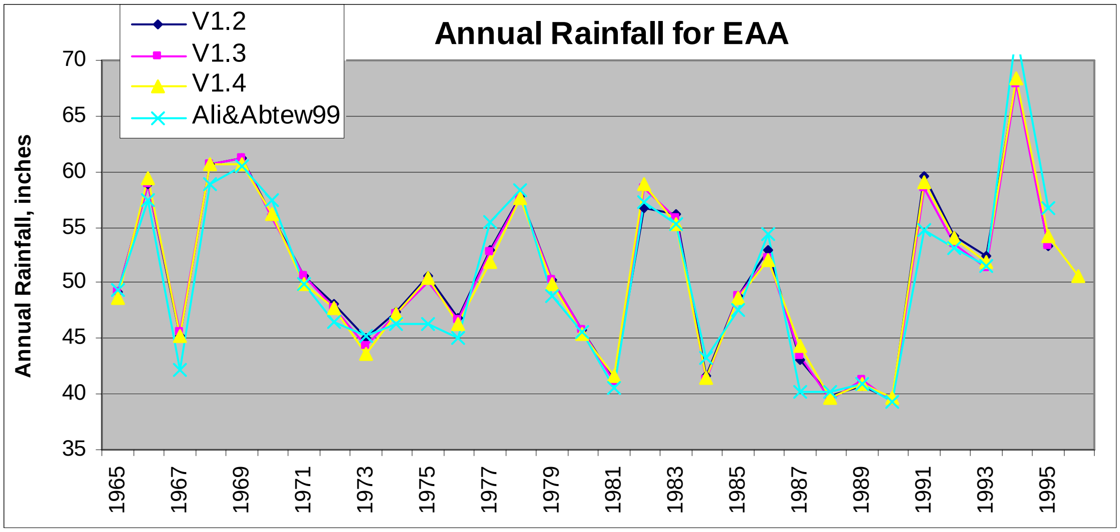

Figure 15. Annual rainfall for V1.2, and V1.3 Rainfall Binary File for EAA area and the period 1965-1995

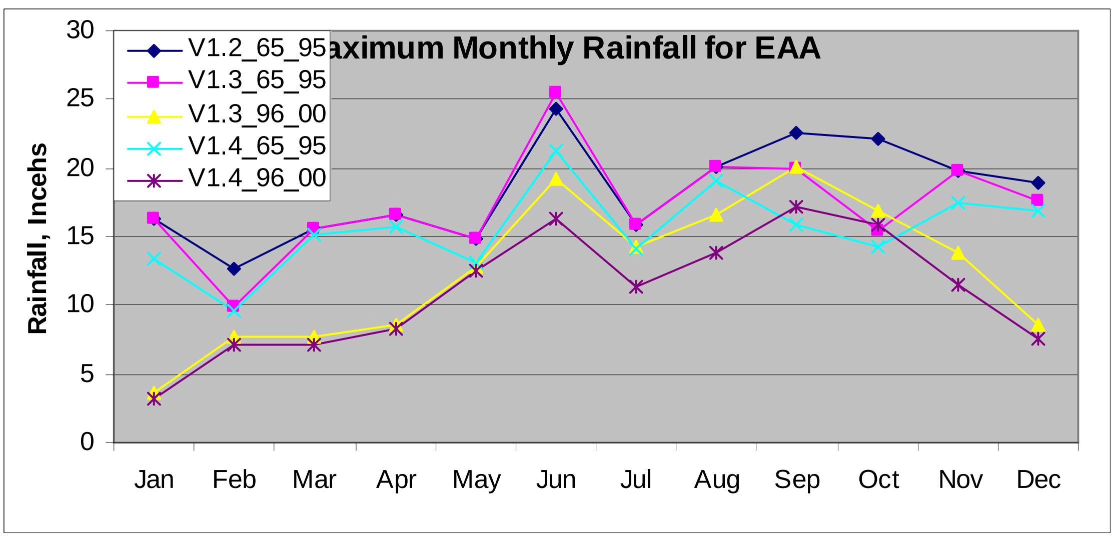

Figure 16. Maximum monthly rainfall EAA area.

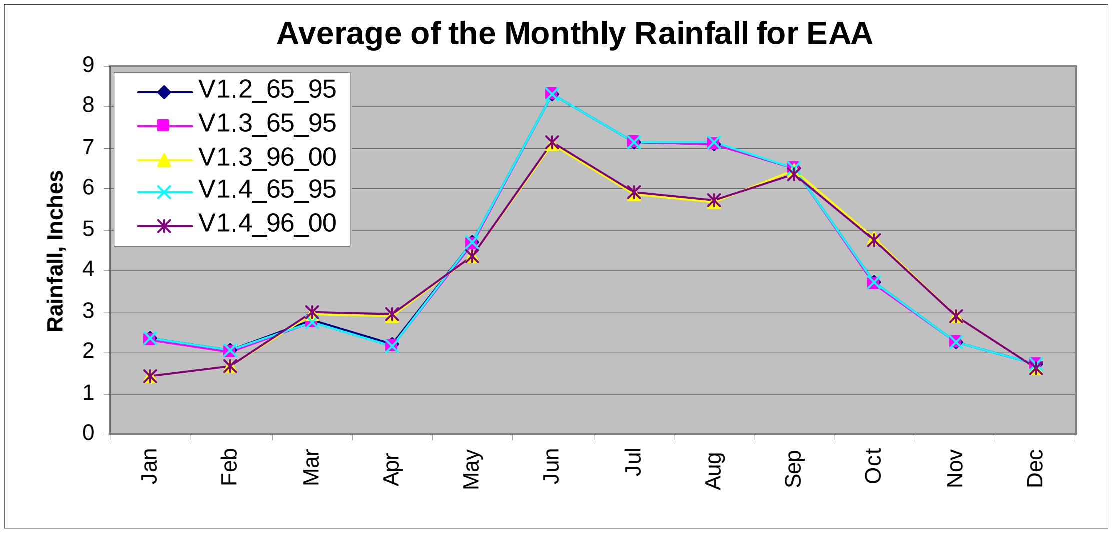

Figure 17. Average of Monthly rainfall EAA area.

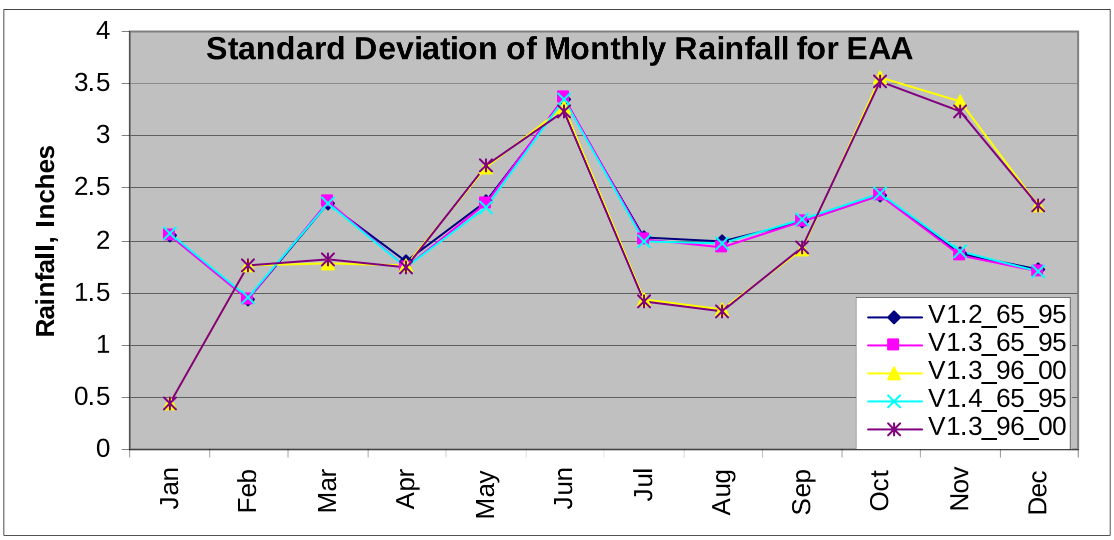

Figure 18. Standard Deviation of Monthly rainfall EAA area.

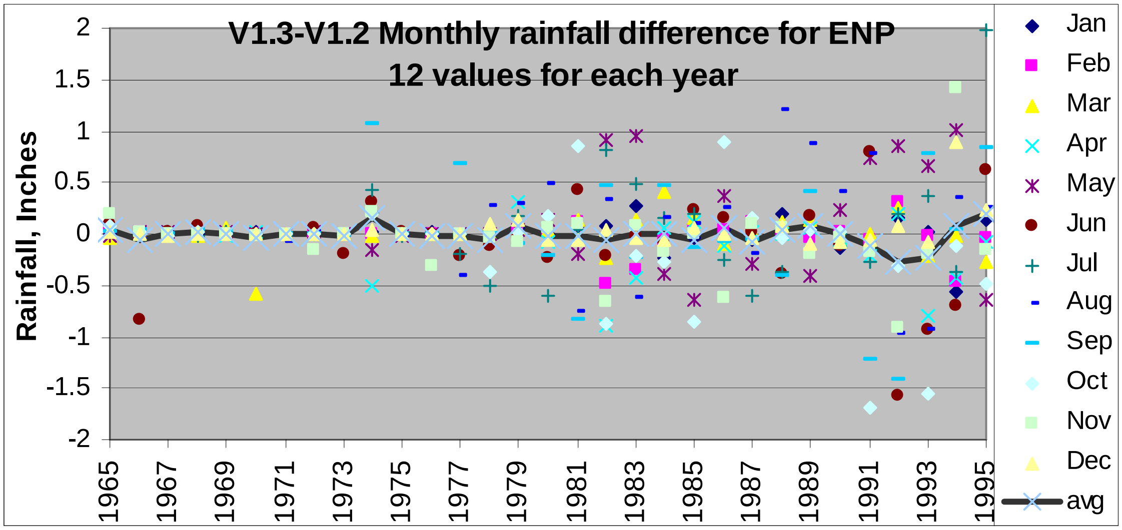

Figure 19a. Difference between V1.3 and V1.2 monthly average rainfall for ENP area and the period 1965-1995 (12 values/year).

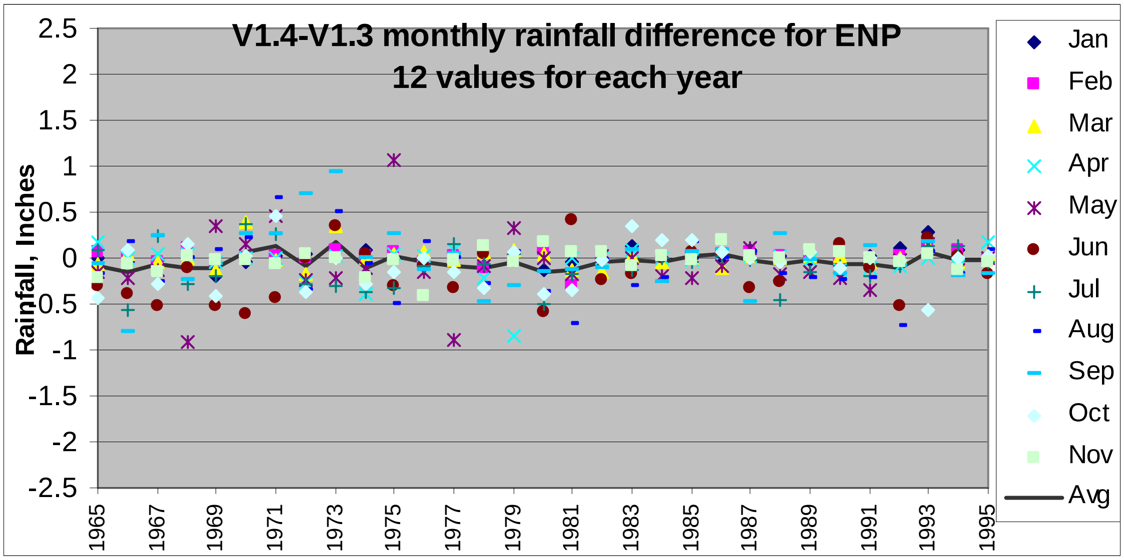

Figure 19b. Difference between V1.4 and V1.3 monthly average rainfall for ENP area and the period 1965-1995 (12 values/year).

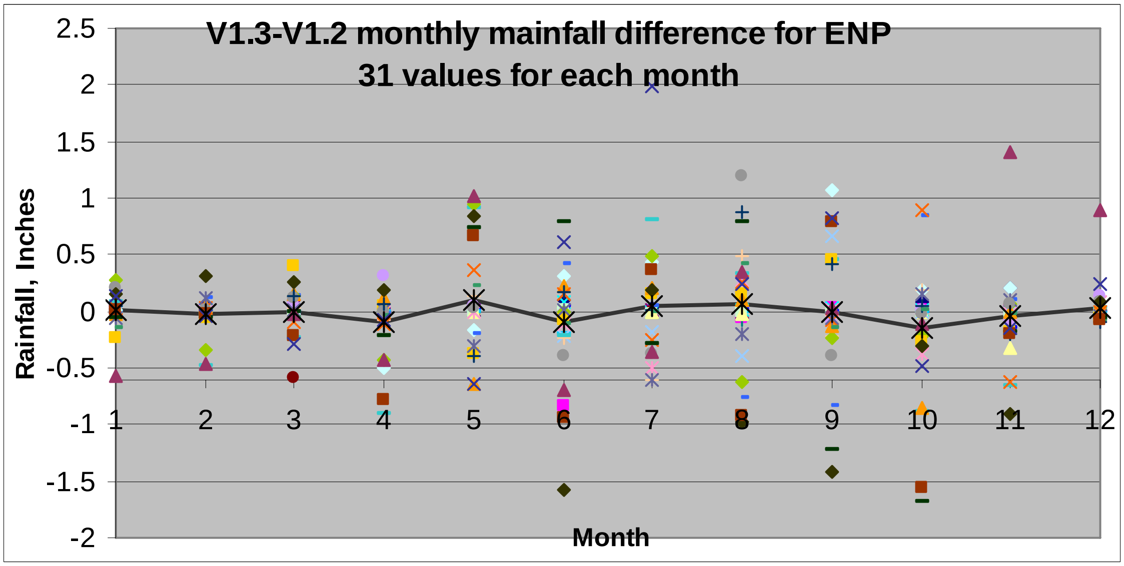

Figure 20a. Difference between V1.3 and V1.2 monthly average rainfall for ENP area and each month (period 1965-1995)

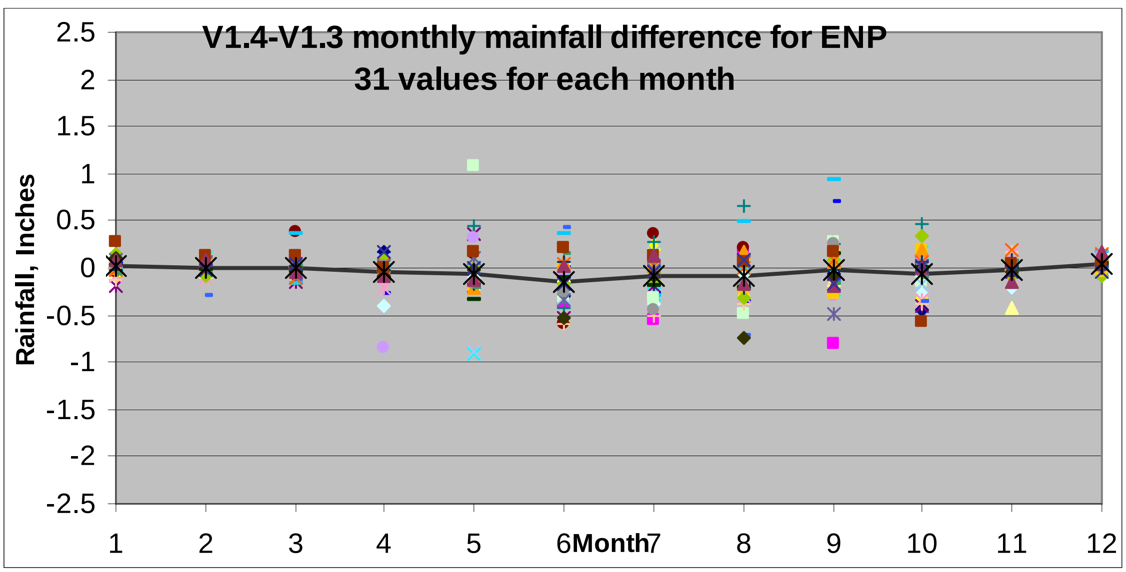

Figure 20b. Difference between V1.4 and V1.3 monthly average rainfall for ENP area and each month (period 1965-1995)

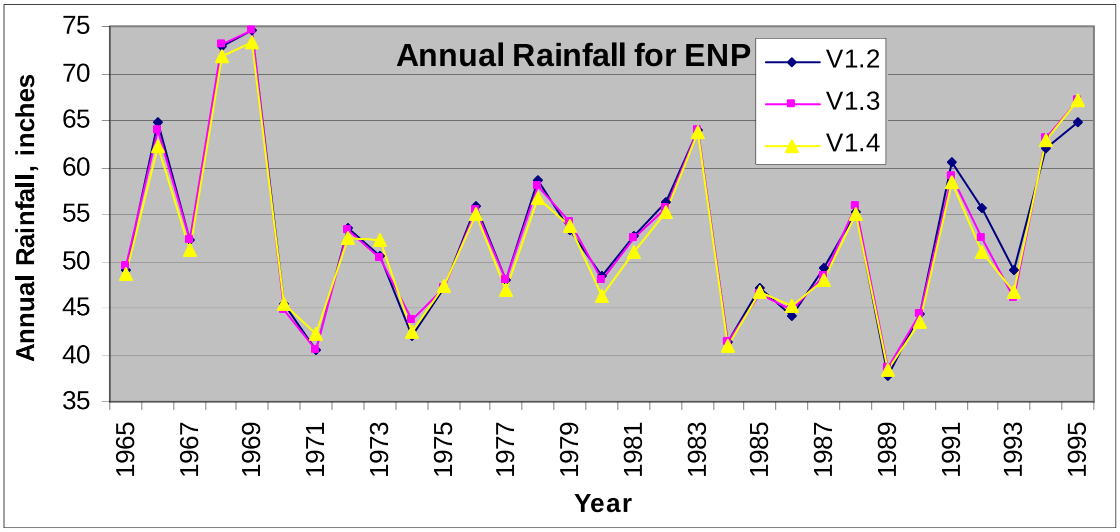

Figure 21. Annual rainfall for V1.2, and V1.3 Rainfall Binary File for ENP area and the period 1965-1995

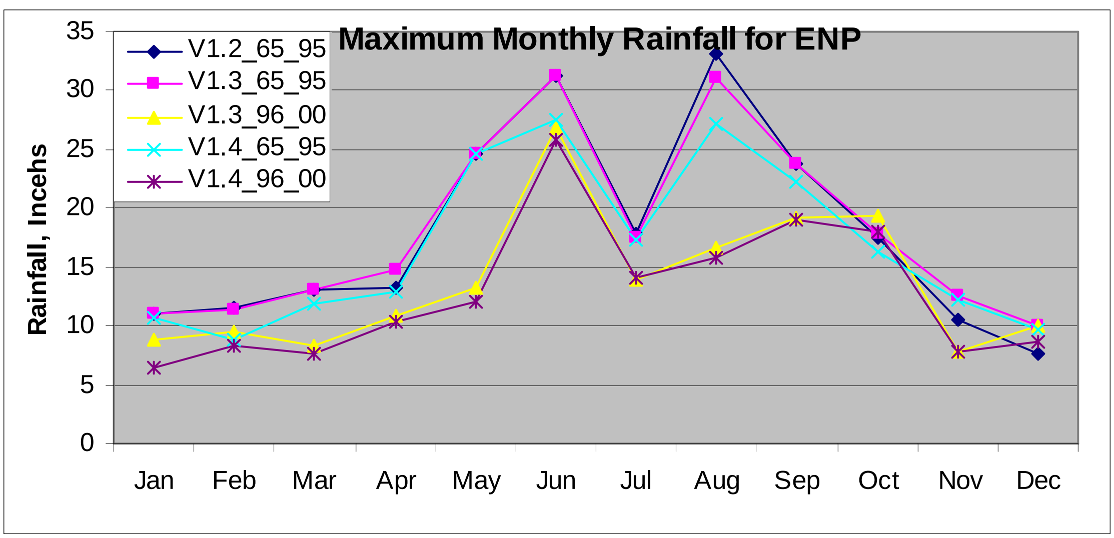

Figure 22. Maximum monthly rainfall for ENP area.

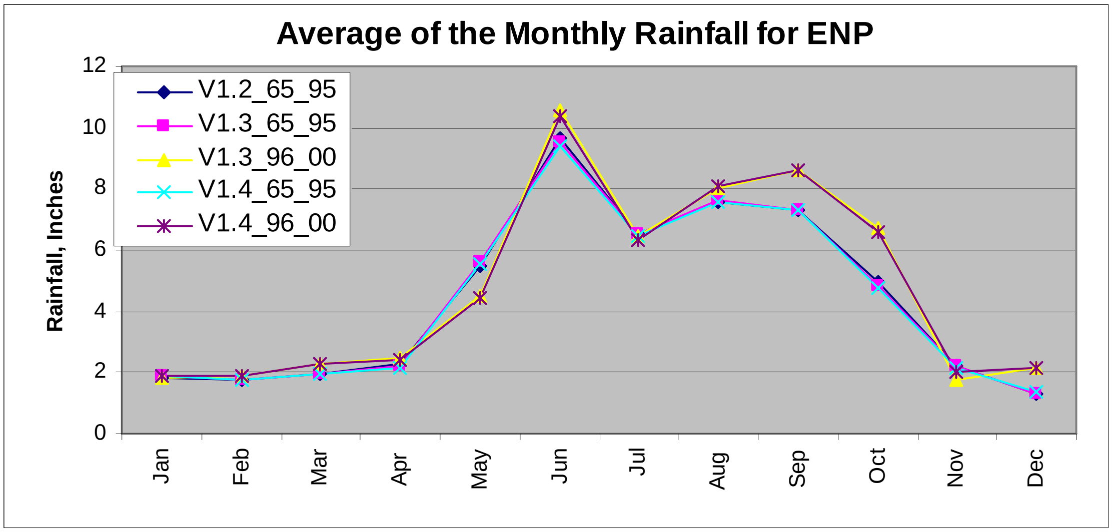

Figure 23. Average of Monthly rainfall for ENP area.

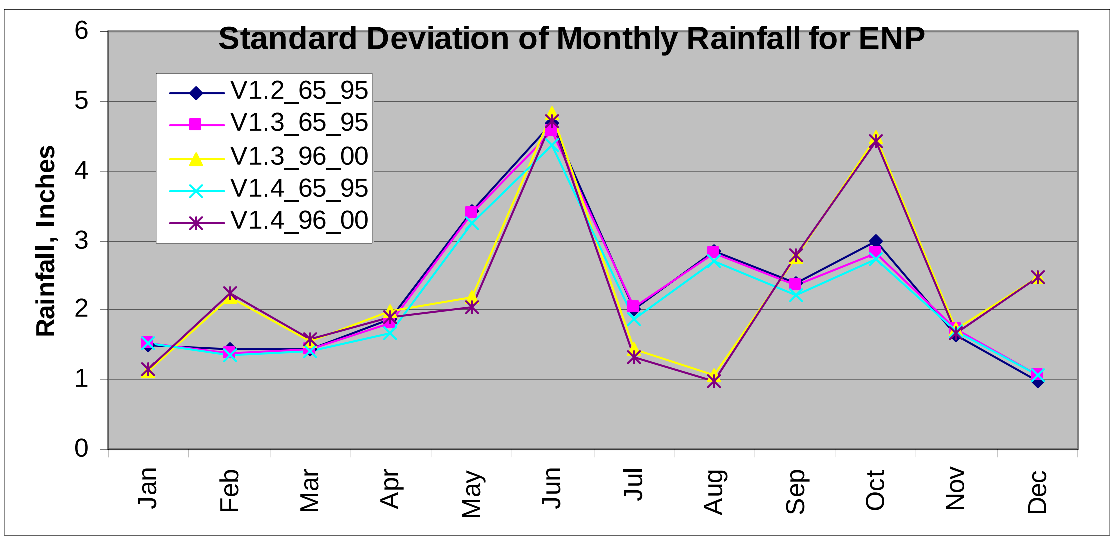

Figure 24. Standard Deviation of Monthly rainfall for ENP area.

Comparison between rainfall binary file versions V1.2, V1.3, & V1.4 (Hydrologic Performance Measures)

Three SFWMM simulations were made using the New rainfall binary file versions 1.3, 1.4-TIN1, and 1.4-TIN10. The three rainfall binary files were built based on the updated rainfall data. The first file was based on the existing method (selecting the nearest neighbor as an approximation to Theissen polygon method), and was referred to as N1. The second and the third files were based on the Triangular Irregular Network method (TIN). In the second file (referred to as TIN1), rainfall for a given SFWMM cell is represented by TIN estimation at the centroid of that cell. In the third file (referred to as TIN10), rainfall for a given SFWMM cell is represented by the average of the TIN estimates at the centroids of 10X10 sub cells within the SFWMM cells. The purpose of TIN10 is to assure more continuity and better rainfall representation within the model domain. The threee simulations, along with the original 95BSRR, were combined in a Performance Measures, PM, graphic set. The main purpose of this exercise was to investigate the impact of QA\QC and the change in rainfall estimation method on the model performance.

Based on the PM graphs, the results, in general, exhibit slight variations. No specific location or specific performance measure can be characterized by a unique pattern of variations. In other words, no systematic difference or trend was observed due to QA\QC. In many cases, the TIN simulations show closer results to the Base than N1 simulation suggesting that the effect due to estimation method change partially offsets the effect due to QA\QC. The changes, though slight, are so numerous. Few of these changes are reported for each performance measure category as follows:

<u>Budget</u>: For all basins, observed changes range between -4% and 4% approximately with the majority very close to 0. All, but WCA2B, basins show slight reduction in some budget components (mainly rainfall and structure flows) from the 95BSRR to N1, and from N1 to TIN1 and TIN10. WCA2B shows slight increase from N1 to TIN1 and TIN10 for rainfall and a corresponding reduction in structure flow.

<u>Lake Okeechobee</u>: Stage duration curve is slightly lower for N1 but it is back higher for TIN1 and TIN10. Number of events for LOK stage above 17 ft. decreases from Base to N1 to TIN1 to TIN10.

<u>Water Supply</u>: Water Supply Deliveries from LOK to Service Areas do not significantly change from the Base to N1. On the other hand these deliveries to service Areas 1 and 2 increase by 20% and 15% respectively from N1 simulation to TIN1 and TIN10 simulations. Mean Annual EAA Supplemental irrigation demand decreases by 10%.

<u>Canals</u>: In general, changes are minor. C-100A at S-123 and C-11 at S-13A stage duration curve reflects an increase for TIN stages compared to Base and N1.

<u>Indicator Region</u>: Hydrographs are, in general, very similar except cases where rainfall data have changed as a result of QA\QC (e.g., hydrographs and stage duration curve for

indicator region 33, Upper Mullet Slough). Indicator region 30 (Corbett WMA) shows an increased number of weeks of low water depth (< 0 ft) and a decreased number of weeks of high water depth (>0). Indicator region 31 (Mullet Slough) shows a decreased number of weeks of low water depth (< 0 ft) and an increased number of weeks of high water depth (>0).

<u>Minimum Flow and Level</u>: Percentage of time marsh stage stays below minimum level criteria for more than a given number days increased in some locations and decreased in some other locations. For example, this percentage decreased for gage CA1-7, (Cell R48 C31), and gage Rocky_Gld_G-596, (Cell R18 C26) and increased for gage 3A-NE (Cell R40 C23), and gage NP-34 (Cell R17 C13).

<u>Hydroperiods</u> The effect of the change in estimation method seems to offset the effect of the QA\QC on the Mean NSM hydroperiod. Examples are the mean NSM hydroperiod for the ENP, North Big Cypress National Preserve, Central Shark River Slough, and many others. There are some cases, however, where this phenomenon does not exist such as in WCA-1, WCA-2A, and WCA-3A graphs.

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