Western Region Technical Attachment
No. 94-32
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HAS THE RAINY DAY RATIO HAD ITS DAY?

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Prediction of rain is often a difficult task. In many current and future offices, decisions must be made concerning rain/no rain, precipitation amounts, and duration. This can become a very precarious job. One must decide which model is handling the situation the best, consider precipitation starting and ending times, the vertical depth of moisture, the moisture source, the freezing level, dynamics, topography, and the low-level wind direction.

The use of model gridded data (e.g., PCGRIDDS) will surely help in forecasting QPF, but experienced model assessment is necessary to determine its validity. Also, the WSR-88D and its precipitation algorithms, together with rain gage networks, will help provide ground truth and potentially a better first guess.

Most offices use two different methods of forecasting rain. One method uses a set of predetermined points or basins to forecast precipitation amounts in inches and tenths of an inch for specific periods, say 6 hour periods over 24 hours or longer. Another method used by WSFO SFO since the mid-1960s, has been the "Rain Day Ratio" concept. What is a Rainy Day Ratio and will it continue to be used under MAR? How will the QPF best be handled under MAR? These are questions that will be addressed later in this Technical Attachment.

A normal rainy day ratio (NRDR) is defined by:

$$\frac{\text{Normal rainfall in month}}{\text{Number of rain days} >= .10 \text{ inch of rain}} = \text{NRDR}$$

Currently, NWSFO San Francisco uses this concept to produce a QPF forecast for 17 circles of 30-mile radius for the next 24 hours in four 6 hour periods (see Fig. 1). First, a Rainy Day Ratio is chosen by looking at the models in combination with experience and observations. The forecaster can then run a program to translate these numbers into inches and tenths of an inch for specific points and basins (Tables 1 and 2). Note that these tables are only partial listings. If these point precipitation forecasts are not representative of the forecaster's expectations, the Rainy Day Ratio is adjusted until they look "reasonable."

When the forecaster has finalized the "proper" Rainy Day Ratio, the Rainy Day Ratio product, as well as the point and basin forecast products are externally distributed. At NWSO Sacramento, a short program checks, point by point, the QPF verses actual rain from a product produced by the California Nevada River Forecast Center (CNRFC) (Table 3). This

program can be run each hour and indicates the performance of the QPF in real time. If the precipitation has already exceeded the forecasted amount at numerous stations two hours into the forecast period, the QPF may be updated.

The rainy day ratio is essentially a type of algorithm, where one value is input resulting in corresponding precipitation amounts at various locations within and near the defined circle. Without understanding a Rainy Day Ratio, this method can be very misleading. Thus, validating the actual precipitation values from the Rainy Day Ratio is necessary. This is redundant and labor intensive.

More simply, if the forecaster feels that a reference station is going to get a certain amount of rain, a set of climatological algorithms or equations can be developed to give corresponding precipitation at various other stations, based on the forecast for that reference station. For example, if the forecaster felt that Honeydew, along the Northern California coast, was to receive about 3 inches of precipitation, then by using climatology and algorithms incorporated into a rather simple computer program, it can be shown that other stations in the area would receive about:

Miranda	1.80 inches
Ft. Seward	1.45 "
Bridgeville	2.00 "
Ruth Dam	1.70 "
Leggett	2.20 "

The amount of available moisture would be incorporated into the initial reference forecast, obtained from model output grids or experience. Forecast time periods could vary from 6 hours to 24 hours, and the output areas or basins could be selected by the forecaster. This method is more direct and much easier to understand since you are dealing with actual rain amounts.

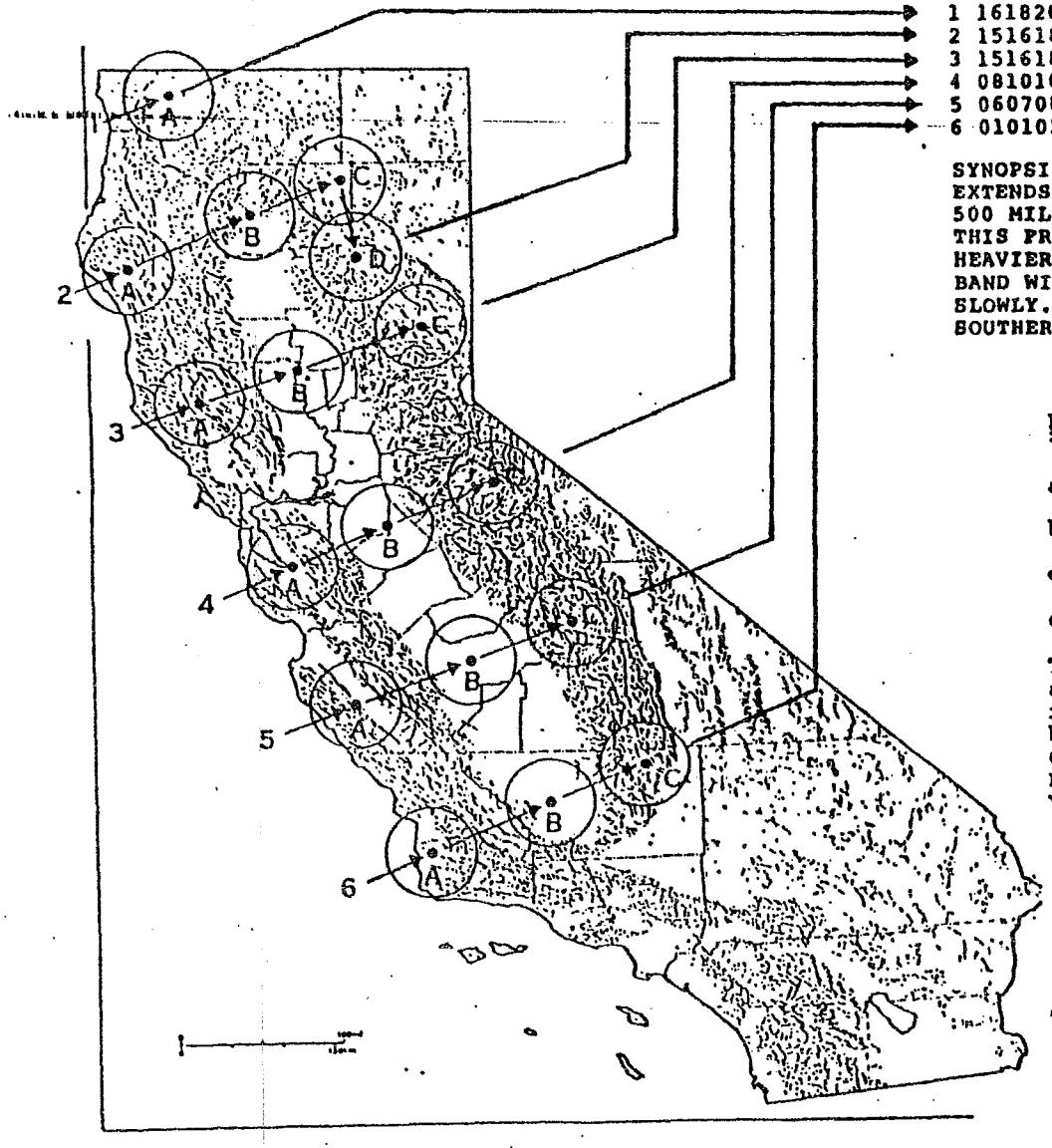
It is hoped that QPF verification and forecasting will continue to improve with technology, including NEXRAD algorithms, more dense rain gage networks, PCGRIDDS, AWIPS, and other systems that allow the running of locally or nationally developed QPF models on a local scale. As these technologies improve the quality of QPF point forecasts, the need for empirical, less accurate methods should diminish. Concepts like the Rainy Day Ratio, which are often misconstrued will seldom be needed once the modernized office is fully operational.

SAMPLE QPRF MESSAGE (AFOS ID SFOQPSSFO)

NNNNZCZC SFOQPSSFO
TTAA00 KSFO 171134
NWS SAN FRANCISCO QPRF 3 AM PST MON FEB 17 1986
RAINY DAY RATIOS FOR 4 SIX HOURLY PERIODS BEGINNING 4 AM PST MON

1 16182020
2 15161820 10101215 12151520 12151520
3 15161820 08091012 12151520
4 08101012 06081011 12121515
5 06070810 00020506 08101010
6 01010203 00010203 06070810

SYNOPSIS...BROAD FRONTAL ZONE WITH CONSIDERABLE SUBTROPICAL AIR EXTENDS FROM NORTHERN AND CENTRAL CALIFORNIA WESTWARD FOR ABOUT 500 MILES THEN SOUTHWESTWARD TO BEYOND THE HAWAIIAN ISLANDS. THIS FRONTAL BAND IS FORECAST TO MOVE SLOWLY EASTWARD WITH THE HEAVIER PRECIPITATION MOVING SOUTHEAST OVER THE DISTRICT. THIS BAND WILL HAVE COPIOUS AMOUNTS OF RAIN AND MOVE THROUGH VERY SLOWLY. SNOW LEVELS 5000 NEAR THE OREGON BORDER TO 8000 FEET SOUTHERN SIERRA. NULL



DECODE FIRST LINE: 1 16182020
a b c d

a = 1st 6-Hour Period = 1.6 times a normal rainy day amount

b = 2nd 6-Hour Period = 1.6 times a normal rainy day amount

c = 3rd 6-Hour Period = 2.0 times a normal rainy day amount

d = 4th 6-Hour Period = 2.0 times a normal rainy day amount

To obtain forecast precipitation for a point, multiply the applicable QPRF value by the rainy day normal for the point of interest for the appropriate month in Table 1. If the point lies between two or more 30-mile radius circles, interpolate between applicable QPRF values. Use Table 2 to obtain forecast precipitation for a basin, and Table 3 to obtain a range of values to be expected over the 30-mile radius circle.

Fig. 1

RAINY DAY NORMALS
Stations Arranged Alphabetically

	Oct.	Nov.	D-J-F	Mar.	Apr.
Alderpoint	.67	.79	.82	.69	.60
Alder Springs	.54	.64	.63	.51	.46
Alpha Site	.88	1.11	1.17	1.00	.87
Alturas RS	.17	.19	.19	.15	.14
Angwin PUC	.80	.95	1.00	.80	.75
Antioch Mills	.22	.28	.30	.25	.23
Atlas Road	.65	.80	.85	.75	.65
Atwell	.80	1.04	1.08	.97	.84
Bakersfield	.15	.22	.24	.21	.18
Balch PH	.66	.88	.96	.84	.72
Battle Creek (USBR)	.59	.68	.71	.58	.51
Battle Creek (ADR)	.40	.46	.48	.48	.35
Beale AFB	.48	.60	.62	.53	.47
Bear Trap Meadow	.75	.98	1.06	.93	.80
Big Sur	.82	1.15	1.26	1.14	.94
Bishop	.14	.19	.20	.18	.16
Blue Canyon	.96	1.16	1.22	1.03	.91
Boulder Cr Locatelli	1.05	1.40	1.52	1.32	1.14
Brandy Creek	.94	1.14	1.19	.96	.87
Bridgeville	.85	1.00	1.10	.90	.80
Brookings	.90	1.10	1.10	.90	.85
Brooks Farnham Rch	.29	.36	.39	.33	.29
Brush Creek RS	1.05	1.25	1.31	1.10	.98
Bucks Lake	1.05	1.24	1.31	1.08	.96
Burney	.45	.51	.49	.43	.38
Calaveras Big Trees	1.12	1.42	1.52	1.32	1.15
Camptonville	.88	1.05	1.10	.93	.82
Canby	.19	.21	.21	.17	.16
Canby 11 SW	.31	.35	.35	.28	.26
Castle Crags	.95	1.15	1.20	.97	.88
Cecilville Sawyer	.54	.73	.63	.51	.46
Cedarville	.10	.11	.11	.09	.08
Challenge RS	.95	1.19	1.25	1.05	.93
Chico Experiment Sta	.43	.51	.54	.45	.40
Clarksburg	.31	.39	.42	.36	.32
Clear Creek	.51	.57	.60	.48	.43
Clearlake Park	.43	.53	.56	.47	.42
Cloverdale 3 SSE	.66	.83	.88	.75	.65
Coalinga	.16	.23	.25	.22	.18
Coffee Creek RS	.81	.92	.95	.77	.69
Coleman Fish Hatchery	.40	.45	.48	.48	.35
Cottonwood	.52	.61	.63	.53	.47
Covelo RS	.56	.61	.65	.54	.47
Cow Creek	.59	.68	.71	.58	.51
Crescent City (AP)	.85	.95	.95	.75	.70
Crescent City 7 ENE	1.02	1.14	1.13	.90	.80
DeSabla	.93	1.11	1.16	.98	.87
Dos Rios	.70	.84	.88	.74	.65

Table 1

RAINY DAY AVERAGES FOR RIVER BASINS

	Oct.	Nov.	D-J-F	Mar.	Apr.
Smith	1.25	1.30	1.40	.95	.85
Total Klamath above Klamath Glen	.70	.80	.80	.65	.60
Klamath Local	1.00	1.10	1.15	.90	.80
Klamath above Orleans	.70	.80	.80	.60	.55
Trinity-Hoopa to Lewiston	.60	.70	.75	.60	.55
Trinity above Lewiston	.70	.80	.85	.70	.65
Redwood	1.00	1.10	1.15	.80	.75
Mad	.90	1.00	1.05	.80	.75
Eel above Scotia	.90	1.00	1.05	.75	.65
SF Eel above Miranda	1.00	1.20	1.25	.95	.85
Eel above Ft Seward	.75	.85	.90	.70	.60
Van Duzen	.90	1.10	1.15	.85	.80
Russian above Hopland	.70	.85	.90	.75	.65
Russian above Healdsburg	.75	.90	.95	.85	.75
Russian above Guerneville	.80	.95	1.00	.90	.80
Napa above St Helena	.80	.95	1.00	.85	.75
Napa above Napa	.75	.90	.95	.80	.70
San Francisco Bay Streams	.40	.55	.60	.40	.35
Pit above Pit #5	.30	.35	.35	.20	.20
Sacramento above Shasta	.95	1.10	1.15	.95	.85
Keswick-Bend Bridge	.60	.70	.75	.65	.60
Bend Bridge-Ord Ferry	.40	.50	.50	.45	.40
Stony above Black Butte	.55	.65	.70	.50	.45
Cache above Rumsey	.75	.85	.90	.70	.65
Feather above Oroville	1.05	1.20	1.25	1.05	.90
NF Yuba above Bullards Bar	1.05	1.20	1.30	1.05	.95
Yuba above Englebright	1.00	1.15	1.25	1.00	.90
Bear above Camp Far West	1.00	1.15	1.20	1.00	.90
Yuba Local	.50	.60	.60	.55	.50
American above Folsom	1.00	1.20	1.30	1.10	.95
Cosumnes above Michigan Bar	.65	.85	.90	.85	.75
Mokelumne above Pardee	1.00	1.15	1.25	1.05	.95
Calaveras above New Hogan	.70	.85	.90	.75	.65
Stanislaus above New Melones	.95	1.15	1.25	1.05	.90
Tuolumne above New Don Pedro	.80	1.00	1.10	.95	.80
Merced above New Exchequer	.80	1.00	1.10	.95	.80
Chowchilla above Raymond	.70	.80	.85	.75	.65
Fresno above Daulton	.70	.80	.85	.75	.65
San Joaquin above Friant	.80	1.00	1.10	.95	.80
Kings above Pine Flat	.70	.90	1.00	.85	.75
Kaweah above Terminus	.75	.95	1.05	.90	.75

Table 2

NNNN>##<A
<ZCZC SFOMIS7
ETTAA00 KSAC 081738

Program run for 17 Z Data

STATION NAME	FCST RAIN	ACTUAL RAIN	+ / - OFF BY
ELK VALLEY	0.50	0.00	-.50
DR. FINE BRIDGE	0.60	0.28	-.32
GASQUET	0.60	0.20	-.40
ORLEANS	0.40	0.00	-.40
HOOPA	0.40	0.10	-.30
OKANE	0.60	0.10	-.50
BRIDGEVILLE	0.60	0.10	-.50
RUTH DAM	0.50	0.00	-.50
HONEYDEW	0.90	0.20	-.70
MIRANDA	0.50	0.10	-.40
FT. SEWARD	0.40	0.10	-.30
LEGGETT	0.60	0.20	-.40
COVELO	0.30	0.00	-.30
WHISPERING PINES	0.40	0.12	-.28
YORKVILLE	0.50	0.00	-.50
VENADO	0.50	0.00	-.50
ELK VALLEY	0.60	0.00	-.60
ANGWIN	0.40	0.00	-.40
ATLAS ROAD	0.30	0.00	-.30
CHITTENDEN	0.00	0.00	0.00
COFFEE CREEK/RDGE	0.40	0.00	-.40
SHASTA DAM	0.40	0.00	-.40
SHINGLETOWN	0.30	0.12	-.18
DESABLA	0.40	0.00	-.40
BUCKS LAKE	0.50	0.00	-.50
BRUSH CREEK	0.30	0.00	-.30
OROVILLE	0.30	0.00	-.30
STRAWBERRY	0.30	0.00	-.30
SIERRAVILLE	0.10	0.00	-.10
CAMPTONVILLE	0.20	0.00	-.20
PINE GROVE	0.00	0.00	0.00
CALAVERAS	0.00	0.00	0.00

Table 3

DATA FILES: RR4SAC 161217 - WRKSTP 161210 - RR4SAC 171217 - WRKSTP 171229

LOCATION	WEIGHTING FACTORS CIRCLE	WEIGHT	RDA	RATIOS 06Z	12Z	18Z	00Z	RAINFALL 06Z	12Z	18Z	00Z
ORLEANS	1 1 2	504505	0.75	0	0	0	0	0.00	0.00	0.00	0.00
HOOPA	1 1 2	502525	0.78	0	0	0	0	0.00	0.00	0.00	0.00
DR. FINE B	1 1 1	303040	0.95	0	0	0	0	0.00	0.00	0.00	0.00
ORICK PPT	1 1 2	504505	0.97	-	-	-	-				
ELK VALLEY	1 1 1	303040	1.25	0	0	0	0	0.00	0.00	0.00	0.00
GASQUET	1 1 1	303040	1.35	0	0	0	0	0.00	0.00	0.00	0.00
Circle number 1A averages			1.01	0	0	0	0	0.00	0.00	0.00	0.00
Forecast Ratios from QPRF				00	03	08	10				
EUREKA	2 2 1	403030	0.48	15	0	-	-	0.70	0.00	T	T
FT. SEWARD	2 2 2	403030	0.80	0	0	0	0	0.00	0.00	0.00	0.00
RUTH DAM	2 2 2	403030	0.95	0	0	0	0	0.00	0.00	0.00	0.00
MIRANDA	2 2 2	303040	0.99	0	0	0	0	0.00	0.00	0.00	0.00
BRIDGEVILL	2 2 2	403030	1.10	0	0	0	1	0.00	0.00	0.00	0.10
OKANE	1 2 2	403030	1.20	0	0	0	0	0.00	0.00	0.00	0.00
LEGGETT	2 2 2	403030	1.20	0	0	0	1	0.00	0.00	0.00	0.10
HONEYDEW	2 2 2	403030	1.66	0	0	0	2	0.00	0.00	0.00	0.30
Circle number 2A averages			1.05	2	0	0	1	0.09	0.00	0.00	0.07
Forecast Ratios from QPRF				00	01	08	15				
RED BLUFF	3 3 7	504010	0.38	0	-	0	0	0.00	M	0.00	0.00
REDDING FI	3 3 3	403030	0.68	0	0	0	0	0.00	0.00	0.00	0.00
COFFEE RID	3 3 3	303040	0.95	-	-	-	-				
SHASTA DAM	3 3 3	403030	0.96	0	0	0	0	0.00	0.00	0.00	0.00
Circle number 2B averages			0.74	0	0	0	0	0.00	0.00	0.00	0.00
Forecast Ratios from QPRF				00	00	05	15				
ALTURAS	4 4 4	403030	0.19	0	-	0	0	0.00	M	0.00	0.00
BURNEY	4 4 4	403030	0.49	-	-	-	-				
Circle number 2C averages			0.34	0	-	0	0	0.00	—	0.00	0.00
Forecast Ratios from QPRF				00	00	04	12				
SUSANVILLE	5 5 8	403030	0.29	-	-	-	0	M	M	M	0.00
MANZANITA	5 5 4	504010	0.90	-	-	-	-				
MINERAL	5 5 5	303040	1.06	-	-	-	-				
DESABLA	5 5 7	504010	1.16	0	0	0	0	0.00	0.00	0.04	0.00
BUCKS LAKE	5 5 5	403030	1.31	0	0	-	-	0.04	0.00	M	M
Circle number 2D averages			0.94	0	0	0	0	0.02	0.00	0.04	0.00
Forecast Ratios from QPRF				00	00	04	15				
UKIAH	6 6 6	403030	0.80	-	-	0	1	M	M	0.00	0.10
ATLAS ROAD	6 6 9	403525	0.85	0	0	0	0	0.00	0.00	0.00	0.00
WILLITS	6 6 6	403030	0.91	0	0	0	0	0.00	0.00	0.00	0.04
ANGWIN	6 6 9	404020	1.00	0	0	0	0	0.00	0.00	0.00	0.00
YORKVILLE	6 6 6	403030	1.00	0	0	0	3	0.00	0.00	0.00	0.30
ST. HELENA	6 6 9	404020	1.10	0	0	-	-	0.00	0.00	M	M
WHISPERING	6 6 6	403030	1.20	0	0	0	0	0.00	0.00	0.00	0.00
VENADO	6 6 6	403030	1.20	0	0	1	1	0.00	0.00	0.12	0.08
Circle number 3A averages			1.01	0	0	0	1	0.00	0.00	0.02	0.07
Forecast Ratios from QPRF				00	00	08	15				
SACRAMENTO	7 710	252550	0.46	0	-	0	0	0.00	M	0.00	0.00
CHICO	7 7 7	403030	0.54	-	-	-	-				
OROVILLE	7 7 8	504505	0.61	0	0	0	0	0.00	0.00	0.00	0.00
[illegible]	7 7 7	[illegible]	0.63	-	-	-	-				

Table 4