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SOME MODELS FOR SKY COVER.(U)
AUG 78 P N SOMERVILLE, S WATKINS, R DALEY F19628-77-C-0080

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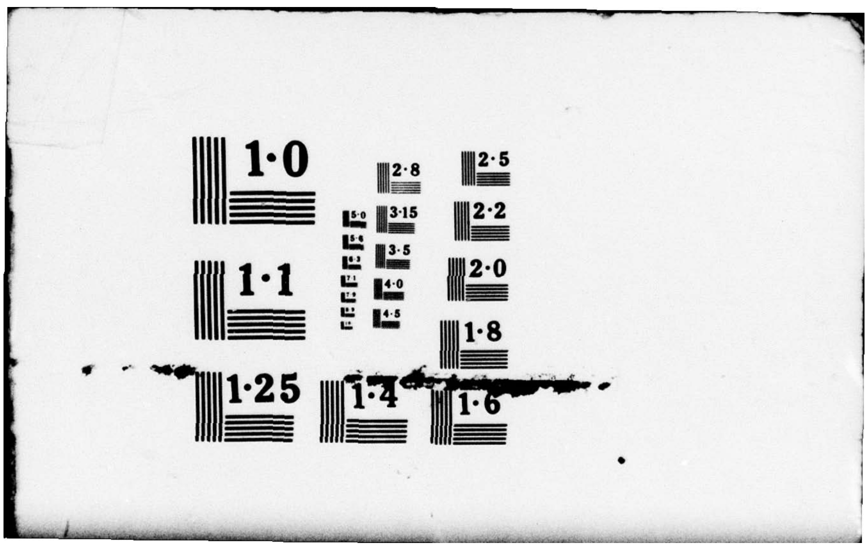
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SOME MODELS FOR SKY COVER

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Scientific Report No. 2

31 August 1978

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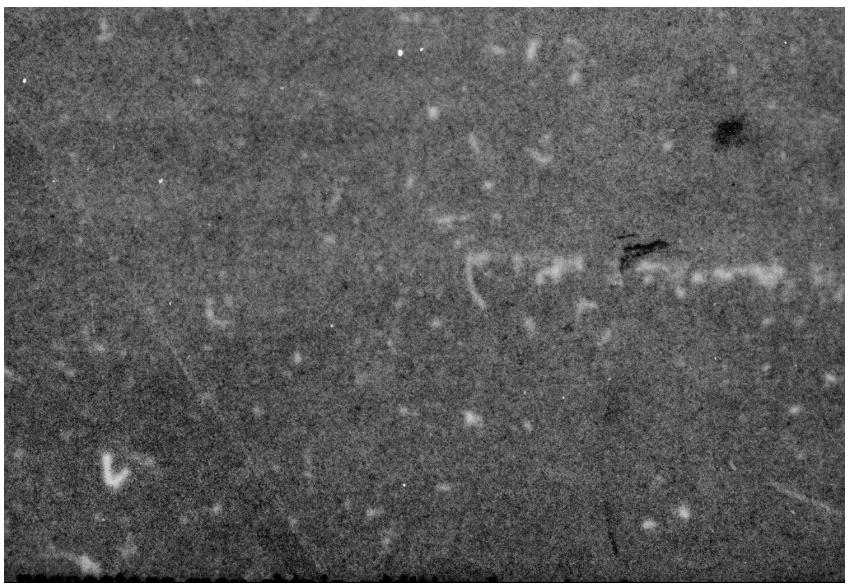

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: (18) (19) AFGL-TR-78-0219
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): (6) Some Models for Sky Cover.
5. TYPE OF REPORT & PERIOD COVERED: (9) Scientific Rep[redacted]t, No. 2, 31 May [redacted]77 - 31 Aug [redacted]78
6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): (10) Paul N. Somerville, Sharon Watkins and Richard Daley
8. CONTRACT OR GRANT NUMBER(s): (15) F19628-77-C-0080
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Florida Technological University, Department of Mathematics and Statistics, Post Office Box 25000, Orlando, Florida 32816 — 410982
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62101F, (16) 667009AD (17) 09
11. CONTROLLING OFFICE NAME AND ADDRESS: Air Force Geophysics Laboratory, Hanscom AFB, Ma. 01731, Contract Monitor: I. I. Gringorten, LYD
12. REPORT DATE: (11) 31 Augu[redacted]978
13. NUMBER OF PAGES: 26
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
15. SECURITY CLASS. (of this report): Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report): Approved for public release, distribution unlimited — (12) 26 p.
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
18. SUPPLEMENTARY NOTES
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
   - Cloud Cover
   - Sky Cover
   - Johnson Curve
   - Probability
   - Data Compaction
   - Model Building

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Models for predicting the climatological probability of a given amount of sky cover at a given time and for seven diverse locations are developed. The first models are for specific months and times of day (96 models, one for each month and three hour period of the day). The second models are general models and day of the year and hour of the day are model inputs.

Estimates of amounts of error to be expected when using the model are given.

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ACKNOWLEDGEMENT

The authors would like to express their appreciation to Jeff Einerson and Sherrill Falls who participated in the project.

A special expression of appreciation is necessary for Mrs. Ann Henry for her painstaking efforts in typing and proofreading the manuscript.

1. Introduction

Sky cover records are available for many stations by month and by time of day. To obtain the climatic probability of a sky cover condition at a specific location and for a given day and hour of the day, it is presently possible to retrieve these records and to obtain an empirical estimate. This is a rather slow, cumbersome and costly process. It is the purpose of this report to document some efforts to compact some of this data by the use of analytical models and a limited number of parameters so as to make possible rapid recall and reuse.

In this report, we develop models for seven weather stations. The data used to develop the models was extracted from the "Revised Uniform Summary of Weather Observations" (RUSSWO's) prepared by the Data Processing Branch of the Air Weather Service. For each station 96 separate models were first developed, one for each three hour period of the day for each of the twelve months. These were then condensed into single models.

2. Development of the 96 Individual Models

The basic model used for cloud cover has been the Johnson S_B family of distributions. Using these, the empirical distribution is transformed to a standard normal variate (equivalent normal deviate). An advantage of such a transformation is that estimates of the percentiles of the fitted distribution can be obtained using a table of areas under a standard normal distribution.

The S_B family is given by

$$Z = \gamma + \eta \, \ell n \, [x/(1-x)]$$

where γ and η are constants determined by the data. The value of x is the proportion of the sky that is covered (end point of the interval). The variable Z is of course the standardized normal variable (equivalent normal deviate). The probability of sky cover less than or equal to x_0 is given the area under the standardized normal curve below the value z_0. That is

$$P(X \le x_0) = P(Z \le z_0).$$

The data in the RUSSWO's for a given station is by month and by three hour period of the day. Thus 96 different models were first developed, one for each time of day for each month of the year. There are 11 categories of observed sky cover designated 0.,.1,.2,...,1.0. The interior boundaries between the eleven categories of sky cover were taken to be .05,.15,...,.95.

For a given month and time of day, the values of γ and η were obtained by simple linear regression. The values of Z corresponding to the tabulated proportion of sky cover less than an interior boundary value for x is regressed against that x. The 96 sets of values of γ and η for each station, obtained in this manner are tabulated in Section 5. Also given is the RMS (root mean square error) and a table giving the frequencies of different magnitudes of errors. The RMS is defined as

$$RMS = \sqrt{\text{sum of squared deviations/number of observations}}\ .$$

By deviation, we mean the difference between the observed cumulative frequency and the cumulative frequency obtained from our model.

It should be noted that we chose to use the Johnson distribution because of its ease in use and the many shapes which it can assume. Another model considered as a possible model for sky cover was the beta distribution. The incomplete beta function is a two-parameter model with the following distribution function:

$$P(X \le x_0) = \int_0^{x_0} t^{a-1} \, (1-t)^{b-1} \, dt/B(a,b).$$

To test the applicability of the beta model, the method of moments was used to calculate the 96 sets of beta parameters for the Patrick Air Force Base data. The curves of cloud cover for Patrick were usually U-shaped with the estimates for a ranging from .214 to 1.281, and the estimates for b ranging from .299 to .863. The only readily available computer routine designed to evaluate the incomplete beta distribution with parameters of this size was the ISML subroutine MDBETA, available in Fortran IV. The programming was involved since our initial beta work was in SAS. The 96 sets of two parameters were used to compute the 960 expected values of the cumulative distribution function (one for each value of x corresponding to an interior boundary). For the Johnson curves, the RMS for the Johnson curves was .0249. For the beta curves the RMS was .0223.

Thus, the beta curves gave a better fit than the Johnson curves. The relatively small increase in "goodness of fit" is discounted by the more difficult programming involved, and, more important, the fact that no good approximations to the beta distribution function exist for small values of the parameters. For the Johnson curves, standard normal tables are readily available and easy to use. Many pocket calculators can directly evaluate the normal distribution function. Except for the data for Patrick Air Force base, the beta curves were abandoned in favor of the Johnson model.

3. Development of the Overall Models

In the previous section we outlined the development of individual models for each month for each time of day. In this section we develop a single overall model for each station which is valid for all times of day and all days of the year.

Each of the 96 pairs of estimates of γ and η are valid for a specific time of day and month of a year. We shall attempt to regress each of γ and η on functions of time of day and month (day) of the year. If we can do this, then, given day of the year and hour of the day, we can calculate estimates for γ and η , which can be used to calculate

$$Z = \gamma + \eta \, \ell n \, [x/(1-x)] \ .$$

For such regression purposes, we let H be the hour of the day and let it correspond to the midpoint of the three hour period. In a similar fashion, we chose to make D the day of the year. Labelling the days of the year from 1 to 365, we assign values to D corresponding to the months of the year as follows:

Months Over Which Data has been Amassed	D
Jan.	15
Feb.	45
Mar.	74
Apr.	105
May	135
Jun.	166
Jul.	196
Aug.	227
Sep.	258
Oct.	288
Nov.	319
Dec.	349

As a first step in the selection of terms for the comprehensive model, values of γ for each three hour period were plotted against month (D) of the year. A separate linear regression was run of γ against D for each three hour period and the residuals examined both individually for each three hour period, and collectively. The residuals indicated a cyclic effect and overlaying of the plots of the residuals facilitated estimation of an appropriate phase shift (gamma day phase shift) for a sine term to supplement the linear regression.

In an analogous manner estimates for gamma hour phase shift, eta day phase shift and eta hour phase shift were obtained for additional model terms.

In addition to using the above terms, two additional types of terms were used. First, sin terms with periods of one half and one quarter of the model terms described above were used. Second, certain "cross product" terms were added to the model.

The postulated model before terms were removed by stepwise regression included the following terms (non-cross product). (GD, GH, ED, EH refer to gamma-day, gamma-hour, eta-day and eta-hour phase shifts respectively.)

$$GD365 = \sin \frac{2\pi(D-GD)}{365}$$

$$GD182 = \sin \frac{4\pi(D-GD)}{365}$$

$$GD91 = \sin \frac{8\pi(D-GD)}{365}$$

$$GH24 = \sin \frac{2\pi(H-GH)}{24}$$

$$GH12 = \sin \frac{4\pi(H-GH)}{24}$$

$$GH6 = \sin \frac{8\pi(H-GH)}{24}$$

$$ED365 = \sin \frac{2\pi(D-ED)}{365}$$

$$ED182 = \sin \frac{4\pi(D-ED)}{365}$$

$$ED91 = \sin \frac{8\pi(D-ED)}{365}$$

$$EH24 = \sin \frac{2\pi(H-EH)}{24}$$

$$EH12 = \sin \frac{4\pi(H-EH)}{24}$$

$$EH6 = \sin \frac{8\pi(H-EH)}{24}$$

The cross product terms crossed terms beginning with G with each other, and terms beginning with E with each other. (Of course, all the eta terms-terms beginning with E were multiplied by ℓn (x/(1-x) in the stepwise regression model.)

A stepwise procedure was used to determine which sine terms should be included in the overall formula. For the largest models developed, the significance level for entry of a sine term was 0.50 and for staying in the model was 0.05. The large model was trimmed by omitting terms which contributed least, and only the reduced models appear in Section 5.

4. Use of the Models

Suppose one wishes to find the probability of less than 85% sky cover at Bedford on November 10, 1982 at 6 A.M. Using Model I, one would proceed as follows.

For Bedford in November at 6 A.M., $\gamma = -.339$, $\eta = .217$.

We have $Z = \gamma + \eta \, \ell n \, [x/(1-x)]$

$$= -.339 + .217 \, \ell n \, (.85/.15)$$

$$= .037$$

Prob $[Z \le .037] = .51$.

Using Model I, we have the probability of less than 85% sky cover on November 10, at 6 A.M. as 0.51.

Using Model II, D = 314, H = 6

We have GD = 81, GH = 5.6, ED = 110, EH = 6.4.

$$\gamma = -.336 + .00074(314) - .003(6) - .054 \sin \frac{2\pi(314-81)}{365} - .069 \sin \frac{4\pi(314-81)}{365}$$

$$-.203 \sin \frac{2\pi(6-5.6)}{24} - .062 \sin \frac{2\pi(314-81)}{365} \times \sin \frac{8\pi(314-81)}{365}$$

$$+ .078 \sin \frac{4\pi(314-81)}{365} \times \sin \frac{8\pi(314-81)}{365}$$

$$= -.336 + .232 - .018 - .004 - .010 = .000 + .003$$

$$= -.133.$$

$$\eta = .196 - .00005(314) + .002(6) + .067 \sin \frac{2\pi(314-110)}{365} + .066 \sin \frac{2\pi(6-6.4)}{24}$$

$$= .196 - .016 + .012 + .004 + .000$$

$$= .196.$$

We have $Z = -.133 + .196 \, \ell n \, (.85/.15)$

$$= .207$$

Prob $(Z \le .207) = .58$

Using Model II gives a probability of .58.

5. Tables for the Models

For each station, Model I gives the values of γ and η in the formula

$$Z = \gamma + \eta \, \ell n \, [x/(1-x)]$$

Model II gives the expressions for γ and η to be used in the above formula.

The following notation is used

GD365 is $\sin \frac{2\pi(D-GD)}{365}$

GD182 is $\sin \frac{4\pi(D-GD)}{365}$

GD91 is $\sin \frac{8\pi(D-GD)}{365}$

GH24 is $\sin \frac{2\pi(H-GH)}{24}$

GH6 is $\sin \frac{8\pi(H-GH)}{24}$

ED365 is $\sin \frac{2\pi(D-ED)}{365}$

ED182 is $\sin \frac{4\pi(D-ED)}{365}$

ED91 is $\sin \frac{8\pi(D-ED)}{365}$

D, H are input day and hour respectively. (Note $0 < D \leq 365$ and $0 < H \leq 24$.)

GD, GH, ED, EH are "phase shifts" whose values for a particular station are tabulated.

It should be noted that under "Error Information" the stated probabilities, strictly speaking are not probabilities, but relative frequency with which the "residual" for the fit exceeds the stated error.

Station 14601 Bangor, Maine

Model I (Johnson) γ and η Parameters

HOUR PERIOD

		0-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23
Jan.	γ =	-.179	-.201	-.381	-.432	-.476	-.422	-.235	-.191
	η =	.116	.116	.176	.190	.196	.194	.147	.130
Feb.		-.099	-.169	-.303	-.361	-.422	-.416	-.179	-.047
		.112	.108	.160	.178	.194	.207	.175	.133
Mar.		-.138	-.191	-.421	-.461	-.473	-.409	-.226	-.137
		.119	.139	.196	.224	.210	.195	.172	.134
Apr.		-.273	-.381	-.540	-.632	-.715	-.624	-.453	-.257
		.126	.157	.184	.230	.264	.249	.220	.153
May		-.165	-.391	-.516	-.630	-.716	-.726	-.510	-.187
		.151	.220	.222	.271	.307	.309	.284	.169
Jun.		-.140	-.454	-.533	-.647	-.813	-.693	-.584	-.213
		.177	.252	.252	.335	.404	.378	.340	.239
Jul.		-.095	-.364	-.422	-.525	-.722	-.603	-.452	-.121
		.175	.260	.256	.351	.485	.436	.359	.245
Aug.		-.017	-.187	-.366	-.393	-.577	-.453	-.268	.009
		.131	.185	.227	.330	.419	.391	.315	.192
Sep.		.085	-.042	-.287	-.354	-.410	-.315	-.080	.111
		.135	.172	.220	.296	.321	.313	.244	.153
Oct.		-.028	-.086	-.353	-.378	-.382	-.349	-.113	-.047
		.128	.147	.210	.237	.262	.249	.188	.126
Nov.		-.376	-.358	-.569	-.687	-.669	-.567	-.344	-.268
		.135	.133	.198	.227	.239	.228	.160	.128
Dec.		-.171	-.187	-.359	-.480	-.480	-.375	-.137	-.136
		.108	.121	.201	.215	.232	.215	.155	.124

Error Information

X	Prob(Abs.Error ≥ X)
.01	.530
.02	.211
.03	.084
.04	.035
.05	.016
.06	.004
.07	.001
.08	.001
.09	.000

RMS Error = 0.0175

Station 14601 Bangor, Maine (CONT.)

Model II (Comprehensive Johnson)

$$\gamma = -.405 + .00036D - .001H - .063\ GD365 - .102\ GD182 - .224\ GH24 + .091\ GD182 * GD91$$

$$\eta = .217 - .00006D + .001H + .074\ ED365 + .074\ EH24$$

GD = 83, GH = 5.7, ED = 113, EH = 6.8 .

Error Information

X	Prob(Abs. Error ≥ X)
.01	.803
.02	.615
.03	.442
.04	.284
.05	.180
.06	.114
.07	.058
.08	.021
.09	.014

RMS Error = .037 .

Station 14702 Bedford, Mass.

Model I (Johnson) γ and η Parameters

HOUR PERIOD

		0-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23
Jan.	γ =	-.134	-.169	-.353	-.401	-.430	-.365	-.178	-.116
	η =	.097	.113	.163	.180	.204	.204	.147	.125
Feb.		-.052	-.105	-.283	-.358	-.386	-.327	-.087	-.043
		.093	.097	.180	.188	.207	.220	.172	.130
Mar.		-.107	-.104	-.292	-.343	-.429	-.422	-.255	-.149
		.115	.130	.180	.198	.215	.227	.196	.144
Apr.		-.185	-.268	-.404	-.510	-.565	-.556	-.358	-.203
		.128	.155	.186	.232	.255	.268	.227	.151
May		-.152	-.336	-.439	-.479	-.591	-.567	-.435	-.194
		.155	.194	.217	.253	.304	.313	.265	.189
Jun.		-.038	-.239	-.318	-.401	-.606	-.562	-.395	-.097
		.169	.238	.221	.287	.380	.384	.317	.227
Jul.		.059	-.180	-.317	-.390	-.629	-.505	-.324	.004
		.190	.231	.248	.324	.434	.416	.347	.256
Aug.		.083	-.080	-.261	-.290	-.529	-.346	-.137	.060
		.164	.198	.231	.299	.406	.374	.312	.201
Sep.		.110	.043	-.163	-.189	-.243	-.160	-.029	.103
		.130	.150	.186	.238	.299	.284	.222	.157
Oct.		.179	.156	-.155	-.173	-.167	-.084	.093	.130
		.127	.139	.206	.227	.244	.231	.191	.146
Nov.		-.088	-.072	-.339	-.438	-.463	-.384	-.174	-.083
		.112	.130	.217	.234	.255	.232	.168	.135
Dec.		-.043	-.067	-.232	-.340	-.380	-.249	-.077	-.035
		.111	.113	.176	.196	.237	.206	.134	.123

Error Information

X	Prob(Abs. Error ≥ X)
.01	.582
.02	.243
.03	.084
.04	.024
.05	.008
.06	.002
.07	.000
.08	.000
.09	.000

RMS Error = .0176

Station 14702 Bedford, Mass. (CONT.)

Model II (Comprehensive Johnson)

$$\gamma = -.336 + .00074D - .003H - .054\ GD365 - .069\ GD182 - .203\ GH24 - .062\ GD365 * GD91 + .078\ GD182 * GD91$$

$$\eta = .196 - .00005D + .002H + .067\ ED365 + .066\ EH24$$

GD = 81, GH = 5.6, ED = 110, EH = 6.4 .

Error Information

X	Prob(Abs. Error ≥ X)
.01	.780
.02	.578
.03	.396
.04	.273
.05	.166
.06	.090
.07	.053
.08	.029
.09	.016

RMS Error = .036

Station 26435 Nenana, Alaska

Model I (Johnson) γ and η Parameters

HOUR PERIOD

		0-2	3-5	6-8	9-11	12-14	15-17	18-20	20-23
Jan.	γ =	.019	-.028	-.099	-.234	-.236	-.209	-.062	-.000
	η =	.096	.094	.131	.155	.155	.149	.127	.105
Feb.		-.020	-.078	-.255	-.325	-.306	-.292	-.118	.011
		.114	.122	.148	.170	.172	.168	.150	.128
Mar.		.152	.021	-.183	-.111	-.119	-.208	-.101	.121
		.142	.143	.168	.170	.182	.183	.181	.142
Apr.		-.098	-.381	-.475	-.375	-.345	-.444	-.417	-.141
		.187	.204	.204	.214	.225	.224	.228	.224
May		-.253	-.351	-.371	-.398	-.516	-.590	-.523	-.334
		.239	.250	.220	.244	.289	.305	.311	.263
Jun.		-.580	-.577	-.545	-.605	-.761	-.826	-.783	-.639
		.302	.273	.264	.327	.417	.428	.387	.350
Jul.		-.635	-.758	-.709	-.692	-.793	-.858	-.733	-.676
		.267	.270	.249	.273	.352	.381	.332	.296
Aug.		-.649	-.805	-.876	-.835	-.874	-.920	-.851	-.657
		.235	.254	.249	.281	.362	.379	.326	.257
Sep.		-.412	-.565	-.799	-.750	-.789	-.787	-.708	-.475
		.165	.193	.233	.244	.261	.258	.230	.179
Oct.		-.481	-.483	-.791	-.851	-.827	-.764	-.523	-.461
		.149	.151	.211	.208	.218	.208	.182	.165
Nov.		-.156	-.174	-.380	-.531	-.542	-.507	-.327	-.236
		.135	.131	.178	.208	.202	.165	.141	.143
Dec.		-.127	-.129	-.170	-.384	-.434	-.370	-.234	-.148
		.138	.132	.139	.198	.200	.172	.162	.147

Error Information

X	Prob(Abs. Error ≥ X)
.01	.581
.02	.253
.03	.076
.04	.031
.05	.016
.06	.005
.07	.001
.08	.001
.09	.001

RMS Error = 0.0181

Station 26435 Nenana, Alaska (CONT.)

Model II (Comprehensive Johnson)

$$\gamma = -.320 - .00035D = .005H - .319\ GD365 - .132\ GH24$$

$$\eta = .191 + .002H + .091\ ED365 + .026\ EH24$$

GD = 120, GH = 5.3, ED = 100, EH = 5.7

Error Information

X	Prob(Abs. Error ≥ X)
.01	.809
.02	.623
.03	.473
.04	.323
.05	.212
.06	.127
.07	.069
.08	.030
.09	.018

RMS Error = .040

Station 12867, Patrick AFB

Model I (Johnson) γ and η Parameters

Hour Period

		0-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23
Jan.	γ =	.260	.219	-.061	-.151	-.196	-.166	.028	.278
	η =	.202	.189	.249	.283	.325	.330	.298	.233
Feb.		.313	.241	-.043	-.123	-.130	-.135	.004	.286
		.215	.214	.268	.279	.323	.310	.276	.225
Mar.		.259	.239	-.125	-.166	-.194	-.215	-.043	.255
		.196	.210	.279	.302	.328	.319	.296	.222
Apr.		.440	.396	-.046	-.010	-.027	-.080	-.002	.329
		.260	.278	.321	.347	.364	.335	.323	.258
May		.495	.497	.031	-.003	-.053	-.147	-.197	.205
		.278	.318	.354	.402	.414	.369	.336	.298
Jun.		.321	.301	-.165	-.279	-.385	-.492	-.581	-.066
		.349	.388	.414	.493	.495	.405	.389	.348
Jul.		.441	.500	-.153	-.412	-.574	-.609	-.586	.047
		.351	.399	.461	.570	.586	.524	.429	.362
Aug.		.356	.519	-.126	-.347	-.515	-.650	-.581	-.001
		.360	.382	.521	.617	.623	.512	.416	.363
Sep.		.159	.226	-.327	-.452	-.556	-.622	-.573	-.080
		.351	.367	.485	.534	.537	.465	.421	.355
Oct.		.270	.262	-.097	-.148	-.256	-.271	-.158	.113
		.272	.274	.346	.360	.394	.355	.317	.290
Nov.		.413	.391	.070	.043	-.039	-.079	.106	.343
		.243	.241	.297	.328	.372	.360	.295	.247
Dec.		.399	.338	.081	.003	-.043	-.080	.134	.329
		.227	.213	.256	.245	.318	.329	.261	.226

Error Information

X	Prob(Abs. Error ≥ X)
.01	.711
.02	.419
.03	.179
.04	.086
.05	.046
.06	.029
.07	.017
.08	.009
.09	.003

RMS Error = .0249

Station 12867, Patrick AFB (CONT.)

Model II (Comprehensive Johnson)

$$\gamma = -.018 - .138\ GD365 + .091\ GD182 - .332\ GH24$$
$$-.141\ GD365 * GH24$$

$$\eta = .344 + .106\ ED365 + .073\ EH24$$

GD = 105, GH = 8.0, ED = 118, EH = 6.0 .

RMS Error = .054

Station 41008 Saigon, Vietnam

Model I (Johnson) γ and η Parameters

HOUR PERIOD

		0-2	3-5	6-8	9-11	12-14	15-17	18-20	20-23
Jan.	γ =	.109	.096	- .238	.061	- .356	- .496	- .259	.015
	η	.621	.656	.712	.634	.736	.753	.682	.598
Feb.		.367	.290	- .126	.104	- .286	- .328	.108	.405
		.693	.729	.807	.754	.850	.836	.847	.774
Mar.		.222	.113	- .259	- .042	- .365	- .200	.024	.190
		.783	.800	.770	.693	.850	.872	.782	.788
Apr.		- .580	- .584	- .699	- .728	- .869	- .522	- .459	- .513
		1.106	1.139	1.096	1.071	.975	.852	.784	1.079
May		-1.324	-1.167	-1.243	-1.224	-2.346	-1.622	-1.664	-1.512
		.956	1.027	1.010	.843	1.328	.976	.879	.925
Jun.		-1.339	- .912	-1.188	-1.720	-2.226	-2.562	-1.991	-1.579
		.955	.797	.988	1.224	1.263	1.220	.897	.937
Jul.		-1.393	-1.235	-1.419	-1.975	-2.212	-2.255	-2.585	-1.551
		.951	.993	.989	1.262	1.235	1.170	1.149	.898
Aug.		-1.571	-1.378	-2.032	-2.124	-2.596	-2.690	-2.462	-1.809
		.939	.974	1.213	1.262	1.277	1.193	1.082	.928
Sep.		-1.317	-1.452	-1.623	-1.691	-2.368	-2.437	-1.918	-1.582
		.706	1.035	1.018	1.032	1.224	1.158	.888	.856
Oct.		-1.397	-1.325	-1.682	-1.333	-2.076	-2.255	-2.155	-2.021
		1.002	1.081	1.172	1.069	1.275	1.203	1.158	1.201
Nov.		- .797	- .574	- .716	- .586	-1.522	-1.401	-1.353	-1.164
		.896	.821	.715	.680	1.115	1.010	.999	1.062
Dec.		- .307	- .177	- .528	- .407	- .852	- .930	- .744	- .397
		.677	.727	.696	.801	.810	.816	.732	.686

Error Information

X	Prob(Abs. Error ≥ X)
.01	.644
.02	.548
.03	.458
.04	.383
.05	.325
.06	.270
.07	.218
.08	.180
.09	.147

RMS Error = .0595

Station 41008 Saigon, Vietnam (CONT.)

Model II (Comprehensive Johnson)

$$\gamma = -.532 - .0025D - .008H - .878\ GD365 - .327\ GH24$$

$$\eta = .914 + .003H + .185\ ED365$$

GD = 108, GH = 8, ED = 125, EH = 0 .

Error Information

X	Prob (Abs. Error ≥ X)
.01	.694
.02	.590
.03	.527
.04	.466
.05	.415
.06	.368
.07	.327
.08	.297
.09	.259

RMS Error = .092

Station 45715 Shemya, Alaska

Model I (Johnson) γ and η Parameters

HOUR PERIOD

		0-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23
Jan.	γ =	-.996	-1.059	-1.099	-1.437	-1.434	-1.615	-1.296	-1.066
	η =	.373	.361	.398	.525	.537	.750	.513	.397
Feb.		-1.009	-1.070	-1.194	-1.417	-1.430	-1.561	-1.378	-1.170
		.371	.362	.429	.554	.553	.574	.475	.470
Mar.		-1.048	-1.132	-1.390	-1.452	-1.467	-1.451	-1.617	-1.083
		.374	.396	.524	.532	.523	.523	.734	.385
Apr.		-1.229	-1.428	-1.549	-1.549	-1.559	-1.506	-1.438	-1.306
		.296	.379	.441	.442	.447	.435	.402	.365
May		-1.588	-1.676	-1.770	-1.667	-1.540	-1.482	-1.530	-1.591
		.299	.298	.343	.342	.337	.330	.351	.335
Jun.		-1.932	-2.058	-2.043	-1.966	-1.722	-1.735	-1.715	-1.914
		.203	.249	.302	.331	.303	.313	.238	.219
Jul.		-1.923	-2.003	-2.077	-1.925	-1.806	-1.784	-1.816	-1.870
		.214	.195	.225	.248	.251	.206	.229	.190
Aug.		-1.510	-1.632	-1.722	-1.636	-1.528	-1.579	-1.563	-1.506
		.163	.188	.240	.244	.271	.270	.249	.217
Sep.		-.952	-1.004	-1.121	-1.089	-1.070	-1.043	-1.087	-.967
		.225	.247	.312	.327	.337	.328	.348	.271
Oct.		-.840	-.857	-1.026	-1.129	-1.170	-1.220	-1.126	-.918
		.326	.335	.408	.437	.473	.486	.440	.383
Nov.		-.874	-1.004	-1.048	-1.296	-1.368	-1.329	-1.074	-.975
		.387	.421	.421	.519	.520	.562	.467	.428
		-.910	-.920	-.986	-1.334	-1.330	-1.344	-1.115	-1.053
		.388	.358	.380	.536	.495	.505	.475	.389

Error Information

X	Prob(Abs. Error ≥ X)
.01	.474
.02	.320
.03	.205
.04	.112
.05	.075
.06	.058
.07	.052
.08	.048
.09	.036

RMS Error = 0.0335

Station 45715 Shemya, Alaska (CONT.)

Model II (Comprehensive Johnson)

$$\gamma = -1.672 + .0017D - .002H - .327\ GD365 - .174\ GD182 - .115\ GH24 + .138\ GD365 * GH24 + .124\ GD182 * GD91$$

$$\eta = .344 + .003H - .131\ ED365 + .056\ EH24 - .028\ ED365 * EH24 + .030\ ED182 * ED91$$

GD = 108, GH = 6, ED = 108, EH = 6 .

Error Information

X	Prob(Abs. Error ≥ X)
.01	.608
.02	.405
.03	.292
.04	.208
.05	.149
.06	.100
.07	.077
.08	.064
.09	.058

RMS Error = .042

Station 33123 Tripoli, Libya

Model I (Johnson) γ and η Parameters

HOUR PERIOD

		0-2	3-5	6-8	9-11	12-14	15-17	18-20	20-23
Jan.	γ =	.369	.311	.051	-.054	-.057	-.085	.122	.287
	η =	.279	.257	.329	.331	.329	.344	.317	.308
Feb.		.479	.423	.122	.083	.061	.077	.258	.489
		.279	.274	.345	.319	.328	.332	.319	.301
Mar.		.462	.393	.028	.061	.082	.068	.191	.434
		.276	.306	.353	.347	.350	.334	.317	.287
Apr.		.500	.376	.061	.112	.142	.110	.234	.462
		.269	.308	.321	.302	.294	.274	.298	.280
May		.670	.514	.244	.321	.356	.315	.345	.619
		.253	.298	.286	.277	.277	.277	.293	.279
Jun.		.945	.712	.550	.680	.762	.738	.719	.954
		.223	.288	.292	.269	.266	.254	.284	.248
Jul.		1.441	1.151	1.119	1.542	1.805	1.641	1.519	1.608
		.262	.281	.364	.435	.452	.335	.336	.314
Aug.		1.734	1.419	1.316	1.578	1.816	1.700	1.683	1.908
		.317	.339	.385	.454	.433	.338	.346	.373
Sep.		1.197	1.084	.761	.764	.805	.788	.888	1.097
		.289	.332	.391	.390	.352	.344	.336	.314
Oct.		.718	.620	.247	.237	.201	.174	.442	.673
		.301	.317	.395	.405	.383	.366	.338	.313
Nov.		.478	.419	.015	-.016	-.004	-.003	.288	.437
		.313	.339	.394	.364	.394	.382	.349	.323
Dec.		.302	.315	-.026	-.083	-.122	-.134	.112	.280
		.288	.283	.361	.333	.346	.356	.328	.305

Error Information

X	Prob(Abs. Error ≥ X)
.01	.601
.02	.342
.03	.128
.04	.027
.05	.007
.06	.000
.07	.000
.08	.000
.09	.000

RMS Error = .0196

Station 33123 Tripoli, Libya (CONT.)

Model II (Comprehensive Johnson)

$$\gamma = .973 - .0021D - .003H + .761\,GD365 + .156\,GD182$$
$$-.183\,GH24 + .337\,GD365 * GD182$$

$$\eta = .286 + .00016D + .001H$$

GD = 147, GH = 5, ED = 192, EH = 5 .

Error Information

X	Prob(Abs. Error ≥ X)
.01	.842
.02	.702
.03	.556
.04	.438
.05	.323
.06	.244
.07	.185
.08	.149
.09	.112

RMS Error = .054