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Preliminary results on correlation in daily f_0F2 and $M(3000)F2$ variations

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Abstract
A statistical analysis of the hourly daily values of the factor $M(3000)F2$ and the $F2$-layer critical frequency f_0F2 is carried out first for each hour of the day through-out a given month of a given year at a given station (hour-to-hour variation) and then for each day of a given month and year at a given station (day-to-day variation). This analysis shows that these ionospheric characteristics are poorly correlated. It is concluded that the daily values of the first characteristic cannot be estimated from the second by using a simple linear equation.

Key words *radio propagation – ionosphere – aeronomy*

1. Introduction

The basic ionospheric data used in predictions are the E, F_1 and $F2$ layer ordinary-wave critical frequencies and the $M(3000)F2$ the maximum-usable-frequency factor for a distance of 3000 km. The $M(3000)F2$ variability has received relatively little attention. It has been assumed that what is valid for f_0F2 will also be valid for the other characteristics of the $F2$ layer (Bradley, 1993). On the other hand, ionospheric and geomagnetic phenomena can behave independently of each other or being rather unpredictable (Gulyaeva, 1992). Therefore, the study of the day-to-day variations of these characteristics is very important in order to define quiet ionosphere.

The time variability of the $F2$-layer characteristics is very complicated and cannot be represented analytically. In the preparation of $F2$-layer predictions, the first step is to construct maps from which it is possible to calculate the critical frequency f_0F2 for a given condition. Predictions of $M(3000)F2$ are produced in a similar manner. Therefore, it will be useful to establish the kind of relationship that might exist between the daily variations of the factor $M(3000)F2$ and the daily values of f_0F2. For this purpose a statistical analysis of the correlation of the daily values of the two characteristics for a given month at a given station for each hour of the day of the given month (hour-to-hour variation), and for each day of the month (day-to-day variation) has been carried out. This paper describes some preliminary results obtained from such statistical analysis at some mid-latitude European stations.

2. Data and analysis

In this work hourly daily values of the factor $M(3000)F2$, hereafter called simply M, and the corresponding values of f_0F2 are correlated using the simple linear regression relationship

$$M = a_0 + a_1 f_0F2 \tag{2.1}$$

Table I. Estimated values of the coefficients a_0 and a_1 in eq. (2.1) for each hour at a given month and year. Daily data from the station of Slough.

Hours	Values of a_0 (Slough, 1976)				Values of a_0 (Slough, 1979)			
	March	June	Oct.	Dec.	March	June	Oct.	Dec.
0.00	2.60	2.68	2.69	2.60	1.93	2.10	2.01	2.17
1.00	2.78	2.72	2.66	2.45	2.00	2.19	2.11	2.41
2.00	3.08	2.49	2.51	3.07	1.85	2.27	2.02	2.52
3.00	2.71	2.48	2.70	2.50	1.84	2.35	2.13	2.55
4.00	2.94	2.07	2.92	2.87	1.88	2.29	1.88	2.64
5.00	3.19	1.38	3.14	2.75	2.43	2.20	2.21	2.67
6.00	2.52	1.35	2.78	2.53	2.42	2.11	2.47	3.25
7.00	2.95	1.03	2.32	3.58	2.55	2.02	2.72	3.00
8.00	2.97	1.60	2.78	2.93	2.46	2.26	2.78	3.18
9.00	2.15	0.90	2.39	3.43	2.42	2.34	2.68	3.50
10.00	1.72	0.83	2.44	2.94	2.38	2.19	2.69	3.84
11.00	2.12	1.17	2.67	4.39	2.25	1.76	2.79	3.80
12.00	1.93	2.68	2.14	4.47	2.29	2.28	2.62	3.43
13.00	2.20	1.88	3.22	4.03	2.36	2.17	2.74	3.48
14.00	3.07	2.13	3.42	3.60	2.44	2.17	2.86	3.51
15.00	2.71	1.54	3.03	3.45	2.43	2.12	2.81	3.64
16.00	2.94	1.18	2.46	3.20	2.51	2.62	2.64	3.89
17.00	3.04	2.67	3.04	3.57	2.73	2.80	3.22	3.21
18.00	2.94	2.86	3.16	3.36	3.10	3.02	3.09	3.32
19.00	2.76	3.07	3.75	2.91	1.89	3.05	2.67	3.48
20.00	3.12	3.40	3.36	3.16	2.10	2.83	2.65	3.06
21.00	2.84	3.15	2.73	3.21	1.88	2.77	2.16	2.69
22.00	2.92	2.80	2.83	2.78	1.56	2.49	1.80	2.52
23.00	2.79	2.94	2.72	2.79	2.07	2.16	2.09	2.38

The data used are from the stations of Slough, Lannion, Poitiers and Rome, for the years of maximum solar activity 1979 and 1980, medium solar activity 1968 and 1969, low solar activity 1973 and minimum solar activity 1976 and 1986. At a given station and for a given year the daily data of M and f_0F2 for the four characteristic months March, June, October and December have been analysed.

To assess the best interrelationship between the factor M and the critical frequency f_0F2 two procedures are adopted with the criterion that the correlation coefficients be maximised and the coefficients a_0 and a_1 in eq. (2.1) be less variable. Indeed, if the factor M and the critical frequency f_0F2 are affected by the same solar activity, diurnal, seasonal, annual and latitudinal influences, the coefficients a_0 and a_1 should be virtually constant throughout the day and throughout the month and the year. Considering a linear dependence on solar activity (*e.g.* on R), then it can be written

$$M = b_0 + b_1 R \qquad (2.2)$$

$$f_0F2 = c_0 + c_1 R \qquad (2.3)$$

Table I. (*continued*) Estimated values of the coefficients a_0 and a_1 in eq. (2.1) for each hour at a given month and year. Daily data from the station of Slough.

Hours	Values of 10 a_1 (Slough, 1976)				Values of 10 a_1 (Slough, 1979)			
	March	June	Oct.	Dec.	March	June	Oct.	Dec.
0.00	1.11	0.88	0.73	1.23	0.90	0.71	0.90	1.02
1.00	0.51	0.79	0.92	1.74	0.81	0.61	0.73	0.44
2.00	−0.49	1.45	1.42	−0.17	1.10	0.54	0.90	0.10
3.00	0.83	1.59	0.82	1.84	1.18	0.46	0.73	0.23
4.00	0.24	2.78	0.61	0.87	1.18	0.65	1.44	0.27
5.00	−0.51	4.03	0.30	2.04	0.35	0.84	0.99	0.35
6.00	2.39	3.50	1.74	3.34	0.71	0.96	0.56	−1.41
7.00	1.15	4.17	2.69	−1.67	0.59	1.07	0.41	−0.62
8.00	1.02	2.88	1.41	1.46	0.57	0.76	0.29	−0.13
9.00	2.42	4.01	1.68	0.30	0.50	0.53	0.29	−0.24
10.00	2.94	4.19	1.60	1.11	0.47	0.73	0.23	−0.50
11.00	2.11	3.58	1.20	−1.42	0.50	1.25	0.10	−0.48
12.00	2.44	0.58	2.06	−1.51	0.43	0.62	0.20	−0.22
13.00	1.98	2.14	0.41	−0.86	0.36	0.72	0.10	−0.29
14.00	0.35	1.77	0.02	−0.06	0.29	0.73	0.00	−0.30
15.00	1.03	2.86	0.66	0.20	0.30	0.83	0.06	−0.41
16.00	0.74	3.54	1.61	0.65	0.30	0.23	0.21	−0.63
17.00	0.62	0.66	0.65	−0.47	0.16	0.04	−0.24	−0.11
18.00	0.64	0.47	0.16	−0.19	−0.21	−0.20	−0.16	−0.28
19.00	0.83	0.05	−1.03	0.95	1.00	−0.19	0.27	−0.68
20.00	0.06	−0.40	−0.11	−0.01	0.87	0.09	0.27	−0.29
21.00	0.58	−0.02	1.38	−0.59	1.08	0.01	0.86	0.12
22.00	0.37	0.55	0.66	0.90	1.46	0.22	1.31	0.36
23.00	0.53	0.27	0.75	0.73	0.75	0.63	0.79	0.53

and substituting for R in eq. (2.2), it becomes

$$M = b_0 - c_0\frac{b_1}{c_1} + \frac{b_1}{c_1} f_0F2 = a_0 + a_1 f_0F2 \tag{2.4}$$

with $a_0 = b_0 - c_0\dfrac{b_1}{c_1} \qquad a_1 = \dfrac{b_1}{c_1}$

Two procedures are followed to study the relationship between the hourly daily values of M and f_0F2:

1) the linear regression eq. (2.1) is fitted by the method of least squares to the M values of each hour of the day throughout the given month of a given year at a given station and the corresponding values of the critical frequency f_0F2 (hour-to-hour variation);

2) the same linear regression is fitted by the method of least squares to the M hourly daily values of each day of a given month and year at a given station, and the corresponding f_0F2 daily values (day-to-day variation).

Table II. Correlation coefficients when the linear regression eq. (2.1) is fitted to the daily values of $M(3000)F2$ and f_0F2 of a given hour of all days of a given month and year.

Hours	Corr. coeff. (Slough, 1976)				Corr. coeff. (Slough, 1979)			
	March	June	Oct.	Dec.	March	June	Oct.	Dec.
0.00	0.54	0.60	0.34	0.56	0.42	0.40	0.44	0.55
1.00	0.48	0.36	0.50	0.45	0.46	0.37	0.47	0.25
2.00	−0.28	0.60	0.64	−0.08	0.78	0.44	0.50	0.06
3.00	0.40	0.64	0.38	0.47	0.69	0.35	0.35	0.13
4.00	0.12	0.63	0.31	0.24	0.59	0.47	0.50	0.11
5.00	−0.14	0.65	0.09	0.47	0.21	0.59	0.28	0.09
6.00	0.89	0.67	0.30	0.54	0.38	0.62	0.25	−0.31
7.00	0.46	0.76	0.62	−0.24	0.41	0.57	0.25	−0.22
8.00	0.36	0.66	0.49	0.26	0.54	0.55	0.50	−0.13
9.00	0.51	0.72	0.62	0.12	0.65	0.36	0.68	−0.34
10.00	0.64	0.64	0.66	0.28	0.71	0.43	0.57	−0.75
11.00	0.61	0.58	0.58	−0.39	0.74	0.65	0.39	−0.64
12.00	0.60	0.17	0.75	−0.70	0.65	0.32	0.50	−0.31
13.00	0.53	0.55	0.27	−0.46	0.53	0.44	0.19	−0.40
14.00	0.12	0.36	0.02	−0.04	0.47	0.37	0.01	−0.52
15.00	0.39	0.70	0.40	0.06	0.53	0.55	0.14	−0.57
16.00	0.45	0.79	0.62	0.22	0.47	0.17	0.47	−0.71
17.00	0.30	0.20	0.29	−0.21	0.24	0.02	−0.40	−0.26
18.00	0.41	0.28	0.09	−0.07	−0.41	−0.20	−0.24	−0.33
19.00	0.39	0.03	−0.55	0.32	0.65	−0.17	0.25	−0.49
20.00	0.06	−0.22	−0.07	0.00	0.48	0.10	0.26	−0.14
21.00	0.34	−0.01	0.43	−0.18	0.55	0.01	0.51	0.08
22.00	0.23	0.37	0.27	0.24	0.62	0.12	0.65	0.23
23.00	0.31	0.22	0.34	0.37	0.35	0.38	0.35	0.34

3. Results and discussion

Examples of the statistical analysis according to the procedure referring to the hour-to-hour variation are reported in table I, where only some results from the data of the station of Slough are listed. Table II shows the corresponding correlation coefficients. In figs. 1 and 2 are illustrated the trends of the coefficients a_0 and a_1, respectively in various months and years, for the station of Slough, Lannion and Poitiers. Figure 3 illustrates the distribution of the corresponding correlation coefficients versus time of day. It can be easily seen from fig. 3 that the correlation is poor and contradictory. This fact leads to the conclusion that no linear correlation between M and f_0F2 can be established having a significative value for prediction purposes. On the other hand, figs. 1 and 2 show that the coefficients a_0 and a_1 have the same trend of variation

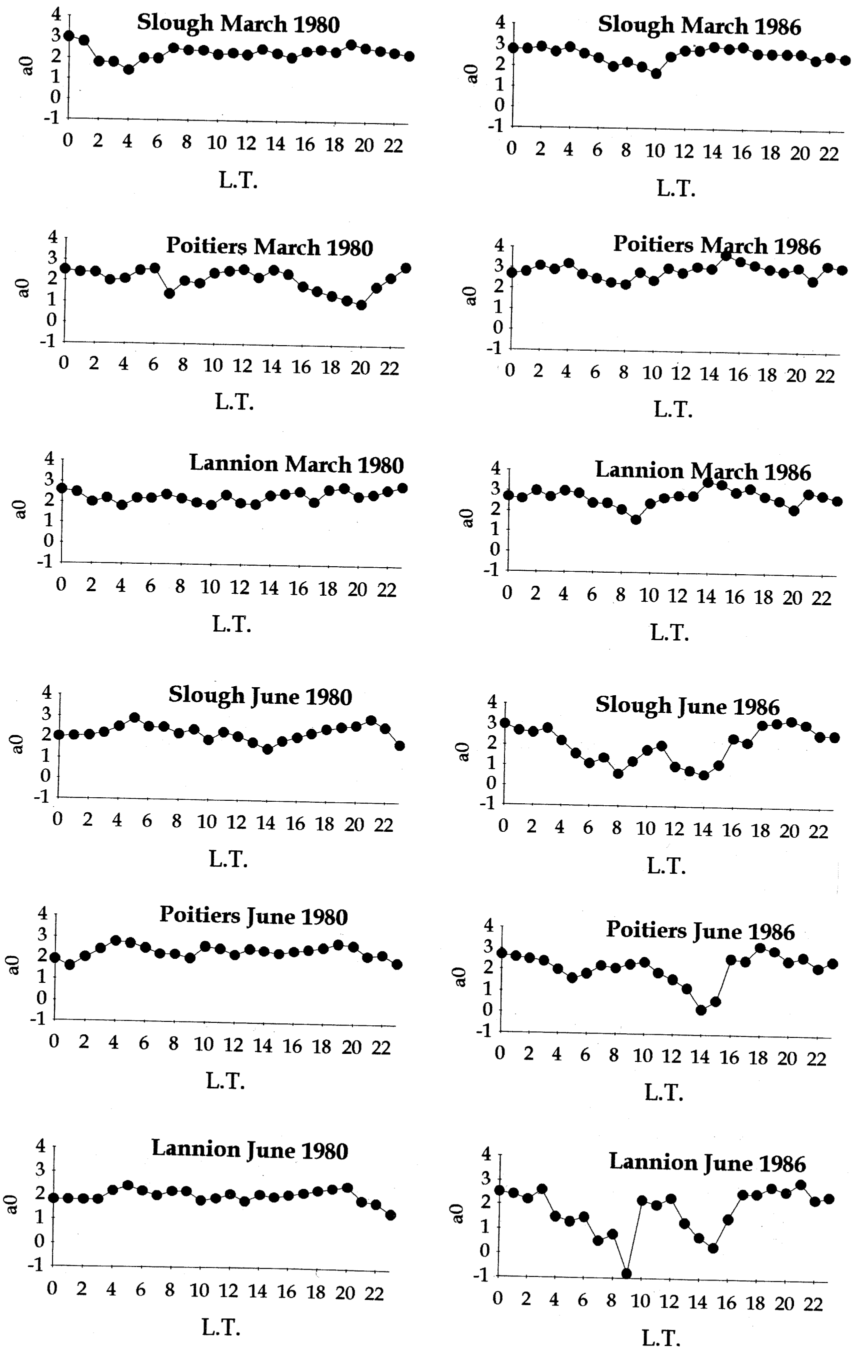

Fig. 1. Showing hour-to-hour variations of the coefficient a_0 in eq. (2.1) for March and for June for a year of minimum solar activity (1986) and a year of maximum solar activity (1980) and selected locations.

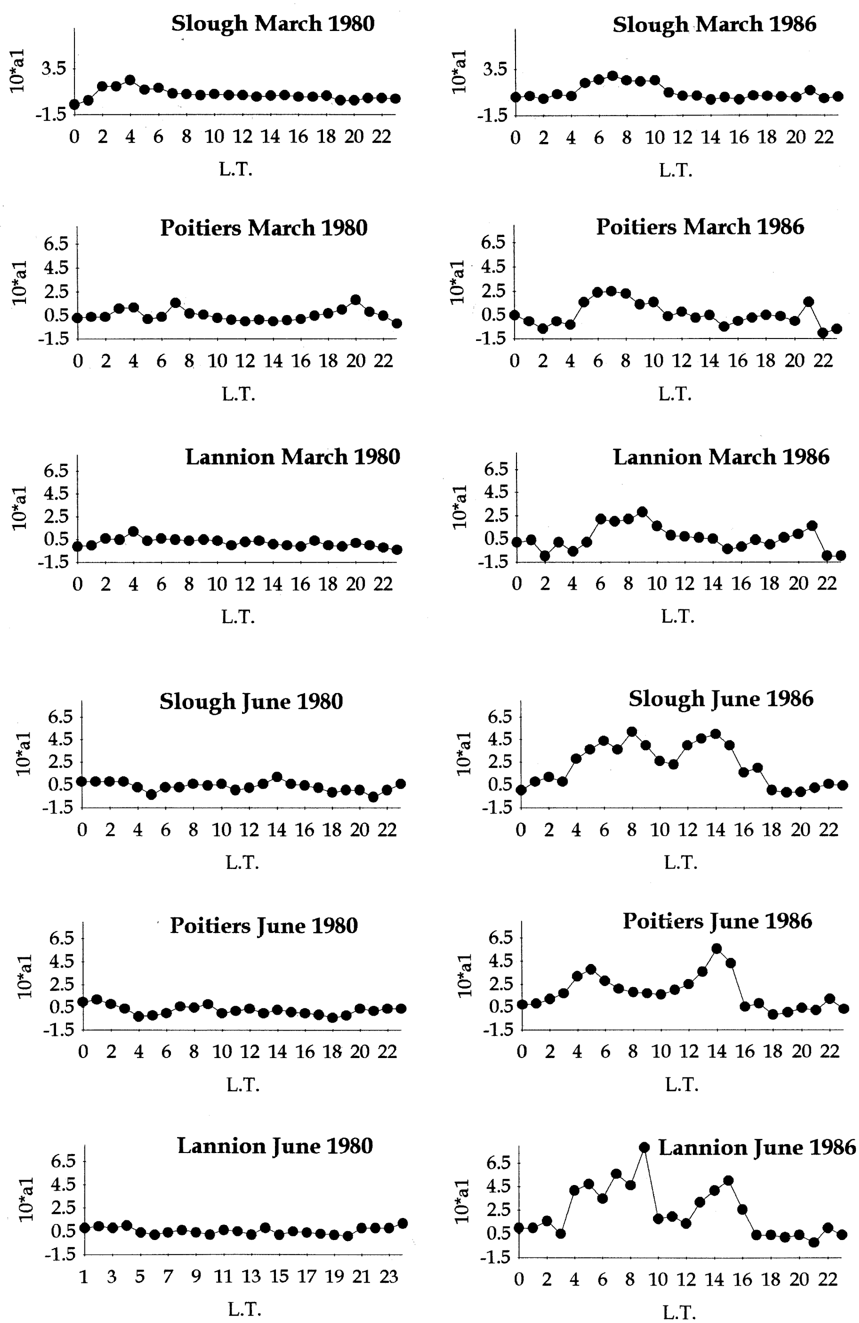

Fig. 2. Showing hour-to-hour variations of the coefficient a_1 in eq. (2.1) for March and for June for a year of minimum solar activity (1986) and a year of maximum solar activity (1980) and selected locations.

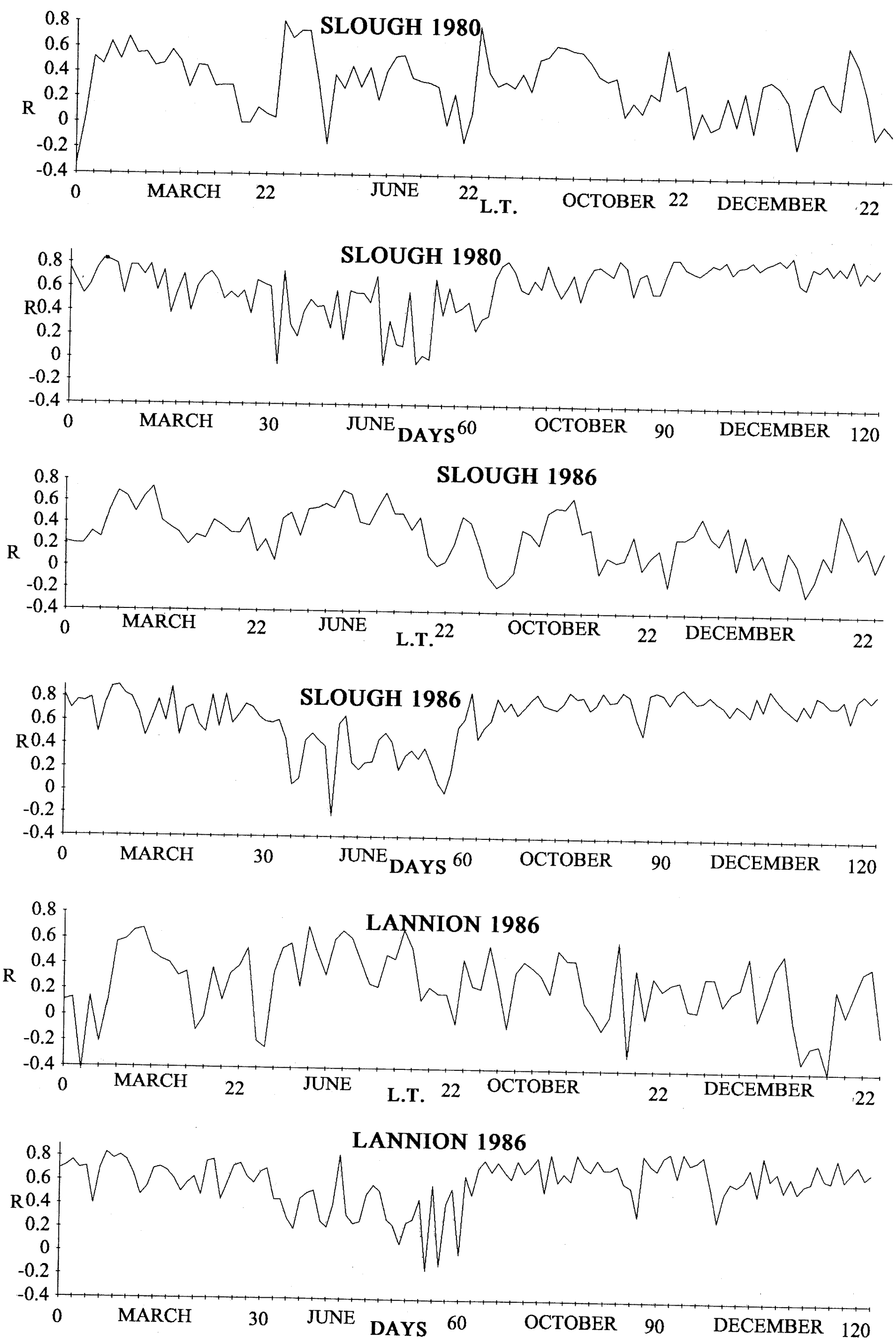

Fig. 3. Distribution of the correlation coefficients from the regression analysis of hourly daily data for selected locations, months and years.

Table III. Standard error of estimate.

Hours	Standard error (Slough, 1976)				Standard error (Slough, 1979)			
	March	June	Oct.	Dec.	March	June	Oct.	Dec.
0.00	0.11	0.08	0.09	0.07	0.15	0.10	0.12	0.12
1.00	0.06	0.11	0.07	0.09	0.13	0.11	0.09	0.12
2.00	0.12	0.07	0.07	0.07	0.08	0.10	0.11	0.12
3.00	0.10	0.09	0.08	0.16	0.12	0.10	0.13	0.12
4.00	0.13	0.14	0.10	0.18	0.16	0.11	0.17	0.16
5.00	0.22	0.22	0.16	0.17	0.14	0.11	0.21	0.20
6.00	0.08	0.20	0.24	0.21	0.16	0.13	0.13	0.21
7.00	0.14	0.23	0.14	0.17	0.16	0.15	0.15	0.18
8.00	0.17	0.17	0.18	0.15	0.14	0.11	0.09	0.12
9.00	0.28	0.20	0.18	0.13	0.12	0.13	0.07	0.13
10.00	0.23	0.23	0.19	0.18	0.10	0.14	0.07	0.08
11.00	0.17	0.24	0.15	0.19	0.10	0.14	0.05	0.11
12.00	0.21	0.17	0.14	0.12	0.10	0.16	0.07	0.12
13.00	0.21	0.19	0.10	0.12	0.11	0.12	0.09	0.11
14.00	0.19	0.13	0.08	0.11	0.10	0.16	0.07	0.08
15.00	0.17	0.10	0.11	0.15	0.09	0.08	0.07	0.08
16.00	0.10	0.11	0.14	0.16	0.12	0.09	0.06	0.09
17.00	0.13	0.16	0.13	0.14	0.11	0.12	0.07	0.08
18.00	0.12	0.09	0.11	0.14	0.07	0.07	0.08	0.12
19.00	0.17	0.10	0.11	0.15	0.10	0.09	0.12	0.14
20.00	0.10	0.11	0.12	0.20	0.19	0.08	0.09	0.20
21.00	0.13	0.11	0.13	0.14	0.14	0.11	0.14	0.14
22.00	0.10	0.12	0.10	0.12	0.17	0.13	0.13	0.14
23.00	0.10	0.09	0.09	0.09	0.16	0.11	0.15	0.12

and virtually the same values for a given month and year at different stations, but they show a high variability form hour-to-hour during low solar activity and summer time. Therefore, an estimation of the daily values of the factor M from those of f_0F2 following this procedure hardly can be obtained. To assess the reliability of this statement, it is worthwhile to calculate the standard errors. It is found that these errors are lying between 0.1 and 0.2. As an example the standard errors of estimate for Slough and for the years 1979 and 1976 are reported in table III.

The results obtained when the second procedure is adopted, *i.e.* when the day-to-day variation of the hourly daily values of M and f_0F2 for a given month and year at a given station are considered using the linear regression of eq. (2.1), do not differ substantially from those obtained by using the first procedure. In table IV some coeffi-

Table IV. Estimated values of the coefficients a_0 and a_1 in eq. (2.1) for each day of a given month. Daily data from Rome.

Day	Values of a_0 (Rome, 1980)				Values of a_0 (Rome, 1986)			
	March	June	October	December	March	June	October	December
1	2.6728	2.1546	2.7547	2.2159	2.6588	2.806	2.7915	2.9357
2	2.9521	1.8922	2.8740	2.5772	2.9190	2.755	3.1278	2.8240
3	2.7985	2.6613	2.6947	2.4930	2.6184	2.907	2.7119	2.9043
4	2.7799	2.8380	2.5294	2.5579	2.9866	2.803	2.6651	3.0792
5	2.5416	2.8289	2.0901	2.6323	2.7807	2.703	2.7534	3.0865
6	2.5840	2.4992	2.2531	2.6256	2.8262	2.871	2.9000	3.1018
7	2.6429	2.0977	2.2255	2.5451	2.7110	2.933	2.8900	3.0086
8	2.4904	1.9326	2.5389	2.3981	2.7313	2.565	2.7039	2.9760
9	2.7257	2.2643	2.4129	2.7912	3.0021	2.729	2.7266	3.0449
10	2.7052	2.2429	2.4211	2.4091	2.8475	2.699	2.5974	2.7867
11	2.6348	2.3375	2.2128	2.5600	2.9304	2.748	2.7891	2.9636
12	2.7613	1.4429	2.3850	2.3234	2.8538	2.585	2.7963	2.9960
13	2.6370	2.3932	2.3759	2.4969	2.6757	2.874	2.7250	2.7523
14	2.6791	2.0132	2.6899	2.7204	2.5377	2.282	2.7210	3.1573
15	2.8637	2.1300	2.4023	2.4246	2.9674	2.378	2.8395	2.9512
16	2.9921	2.6164	2.5410	2.3300	2.8495	2.884	2.5335	2.7828
17	2.8857	2.2341	2.7726	2.5113	2.8467	2.731	2.8499	2.9725
18	2.7133	2.4989	2.4513	2.3361	2.8548	2.479	2.8542	2.8241
19	2.9469	2.7916	2.3624	2.6004	2.7137	2.310	2.9408	2.9533
20	2.6791	2.7526	2.4203	2.5051	2.9772	2.542	2.6963	2.9847
21	2.1386	2.7656	2.4001	2.4309	2.8655	2.773	2.8033	2.6783
22	2.4206	2.9924	2.4654	2.5994	2.6216	2.761	2.7820	2.9580
23	2.5208	2.8110	2.3181	2.7842	2.5983	2.685	2.6399	2.8793
24	2.7820	2.6590	2.6219	2.8590	2.7887	3.128	2.8577	3.0130
25	2.6396	2.3230	2.5835	2.7413	2.7322	3.140	2.8708	2.9140
26	2.4315	2.1192	2.4771	2.6635	2.7130	2.818	2.8398	2.9373
27	2.4437	2.1133	2.8520	2.7694	2.8396	2.945	2.8704	3.2805
28	2.6317	2.4044	2.9243	2.6352	2.8190	3.237	3.0092	3.4288
29	2.5884	2.7242	2.8554	2.5811	2.7939	2.678	2.8172	3.5865
30	2.3191	2.5256	2.6950	2.5349	2.8022	2.853	2.8071	3.4296
31	2.3825		2.2523	2.5260	3.6244		2.7121	3.4199

cients obtained using data from Rome for the years 1980 and 1986 are reported. The corresponding correlation coefficients are listed in table V; whereas in fig. 3 the linear correlation coefficients using data from Slough and Lannion are shown. Figures 4 and 5 illustrate the trends of the coefficients a_0 and a_1, respectively in different months and years, for the stations of Slough, Lannion and Poitiers. It can be seen from these figures that the coefficients a_0 and a_1 could be considered practically constant. However, it seems that the coefficient a_1 has a solar activity dependence with higher values at

Table IV. (*continued*) Estimated values of the coefficients a_0 and a_1 in eq. (2.1) for each day of a given month. Daily data from Rome.

Day	Values of a_1 (Rome, 1980)				Values of a_1 (Rome, 1986)			
	March	June	October	December	March	June	October	December
1	0.0148	0.0472	0.0095	0.0630	0.1455	0.0445	0.1154	0.0930
2	−0.0098	0.0889	−0.0013	0.0295	0.0803	0.0470	0.0340	0.1417
3	0.0023	−0.0026	0.0146	0.0322	0.1422	0.0352	0.1265	0.1119
4	0.0007	−0.0177	0.0162	0.0317	0.0731	0.0486	0.1410	0.0629
5	0.0182	−0.0209	0.0580	0.0282	0.1073	0.0854	0.1035	0.1021
6	0.0153	0.0121	0.0503	0.0411	0.0693	0.0528	0.0905	0.0779
7	0.0148	0.0622	0.0536	0.0470	0.0956	0.0207	0.1029	0.1187
8	0.0267	0.0868	0.0270	0.0632	0.1136	0.0981	0.1364	0.1225
9	0.0059	0.0476	0.0325	0.0194	0.0700	0.0567	0.1258	0.0902
10	0.0096	0.0354	0.0291	0.0495	0.0941	0.0628	0.1546	0.1296
11	0.0182	0.0183	0.0385	0.0424	0.0748	0.0837	0.1156	0.1081
12	0.0060	0.1454	0.0292	0.0447	0.0915	0.1253	0.1249	0.1073
13	0.0162	0.0299	0.0356	0.0445	0.0959	0.0659	0.1094	0.1560
14	0.0148	0.0750	0.0135	0.0221	0.1378	0.1407	0.1034	0.0567
15	0.0032	0.0581	0.0294	0.0487	0.0704	0.1273	0.0986	0.1081
16	−0.0132	−0.0022	0.0278	0.0555	0.0957	0.0510	0.1592	0.1571
17	−0.0049	0.0419	0.0025	0.0394	0.0945	0.0753	0.0967	0.1295
18	0.0114	0.0067	0.0195	0.0505	0.0959	0.1066	0.0979	0.1476
19	−0.0175	−0.0260	0.0328	0.0122	0.1283	0.1629	0.0772	0.1310
20	0.0066	−0.0225	0.0360	0.0219	0.0874	0.1184	0.1187	0.1138
21	0.0511	−0.0193	0.0357	0.0421	0.0852	0.0633	0.0995	0.1870
22	0.0245	−0.0417	0.0294	0.0336	0.1219	0.0675	0.1076	0.1176
23	0.0229	−0.0247	0.0440	0.0230	0.1336	0.0823	0.1305	0.1312
24	−0.0032	−0.0119	0.0314	0.0242	0.1046	−0.0067	0.1120	0.0825
25	0.0043	0.0264	0.0240	0.0287	0.0929	−0.0048	0.1043	0.1292
26	0.0148	0.0505	0.0297	0.0333	0.1036	0.0729	0.0893	0.1280
27	0.0181	0.0472	0.0131	0.0215	0.0818	0.0174	0.0715	0.0312
28	0.0012	0.0254	0.0061	0.0388	0.0886	−0.0324	0.0715	−0.0009
29	0.0040	−0.0048	0.0117	0.0298	0.0941	0.0592	0.0730	−0.0000
30	0.0230	0.0145	0.0175	0.0296	0.0885	0.0655	0.0874	−0.0001
31	0.0164		0.0460	0.0364	−0.0484		0.1137	0.0006

low solar activity (fig. 5). From fig. 3 and table V it can be seen that there exists a better correlation between M and f_0F2 when the day-to-day variation is examined but yet poor. To compare further the two procedures the standard errors are calculated.

In table VI the standard errors of estimate for Rome and for the years 1980 and 1986 are listed.

A comparison of these values with those reported in table III for Slough and the years 1976 and 1979, shows that they are of

Table V. Correlation coefficients when the linear regression eq. (2.1) is fitted to the hourly daily values of $M(3000)F2$ and f_0F2 of a given day for a given month and year.

Day	Correlation coefficients (Rome, 1980)				Correlation coefficients (Rome, 1986)			
	March	June	October	December	March	June	October	December
1	0.3300	0.3050	0.1264	0.7629	0.7656	0.3693	0.7969	0.5921
2	−0.2760	0.5768	−0.0140	0.6765	0.5103	0.2459	0.2061	0.8016
3	0.0589	−0.0256	0.2260	0.6796	0.6633	0.2032	0.6506	0.7014
4	0.0168	−0.1476	0.2838	0.5631	0.4633	0.3344	0.7836	0.3528
5	0.4761	−0.1979	0.6596	0.5811	0.5802	0.3367	0.7997	0.6544
6	0.3520	0.1339	0.7347	0.6242	0.4701	0.4915	0.7151	0.4190
7	0.2802	0.4819	0.7049	0.7679	0.5553	0.1293	0.5926	0.5857
8	0.5331	0.3406	0.4913	0.7401	0.6439	0.5117	0.7383	0.5954
9	0.1689	0.3573	0.5459	0.2626	0.6336	0.3594	0.8245	0.4965
10	0.2296	0.3479	0.5437	0.7165	0.6669	0.3598	0.8799	0.6981
11	0.3268	0.1265	0.5698	0.5284	0.5872	0.3162	0.8093	0.6020
12	0.1211	0.5966	0.6014	0.6887	0.6343	0.5284	0.7296	0.5008
13	0.4407	0.2429	0.6749	0.6536	0.7233	0.4121	0.5930	0.6701
14	0.2940	0.5881	0.3219	0.3722	0.6202	0.6485	0.5947	0.3954
15	0.0683	0.5309	0.5196	0.7770	0.4984	0.4196	0.5803	0.6752
16	−0.2545	−0.0242	0.5736	0.7984	0.5600	0.3281	0.8175	0.8514
17	−0.0880	0.2192	0.0712	0.6238	0.5120	0.4336	0.5222	0.5564
18	0.2313	0.1090	0.4552	0.7090	0.5550	0.5950	0.7390	0.6631
19	−0.3943	−0.2229	0.6281	0.2013	0.5609	0.7098	0.6617	0.5994
20	0.1001	−0.2525	0.7219	0.1686	0.5840	0.4261	0.7043	0.5178
21	0.6850	−0.2541	0.7487	0.7995	0.5290	0.4212	0.6932	0.6388
22	0.3899	−0.2728	0.5844	0.5902	0.6487	0.4049	0.8377	0.5836
23	0.4286	−0.1978	0.8164	0.4522	0.7742	0.3065	0.7845	0.6724
24	−0.0805	−0.1598	0.5522	0.4774	0.6953	−0.0451	0.7622	0.4939
25	0.0949	0.2162	0.4526	0.5136	0.4683	−0.0375	0.6357	0.7384
26	0.2787	0.2982	0.5982	0.5503	0.5223	0.3629	0.5874	0.6999
27	0.3812	0.3395	0.3429	0.5850	0.5314	0.0914	0.5328	0.2282
28	0.0270	0.1944	0.1847	0.5761	0.5405	−0.1812	0.6773	−0.2497
29	0.0846	−0.0370	0.3020	0.4758	0.6370	0.1740	0.4584	−0.0013
30	0.5557	0.0983	0.5071	0.5254	0.5017	0.2977	0.6679	−0.0500
31	0.3968		0.7919	0.6443	−0.1016		0.6746	0.3552

the same order and therefore we may conclude that the two procedures do not give different results.

All these results suggest that the correlation between the daily values of M and f_0F2 is rather poor, although the correlation between the monthly median values of the factor M and f_0F2 is significantly higher (Kouris, to be published). Finally, if a comparison is made between daily observed M values and estimated using eq. (2.1), it can be seen that the matching is very loose (fig. 6), and that because of the poor correlation between M and f_0F2.

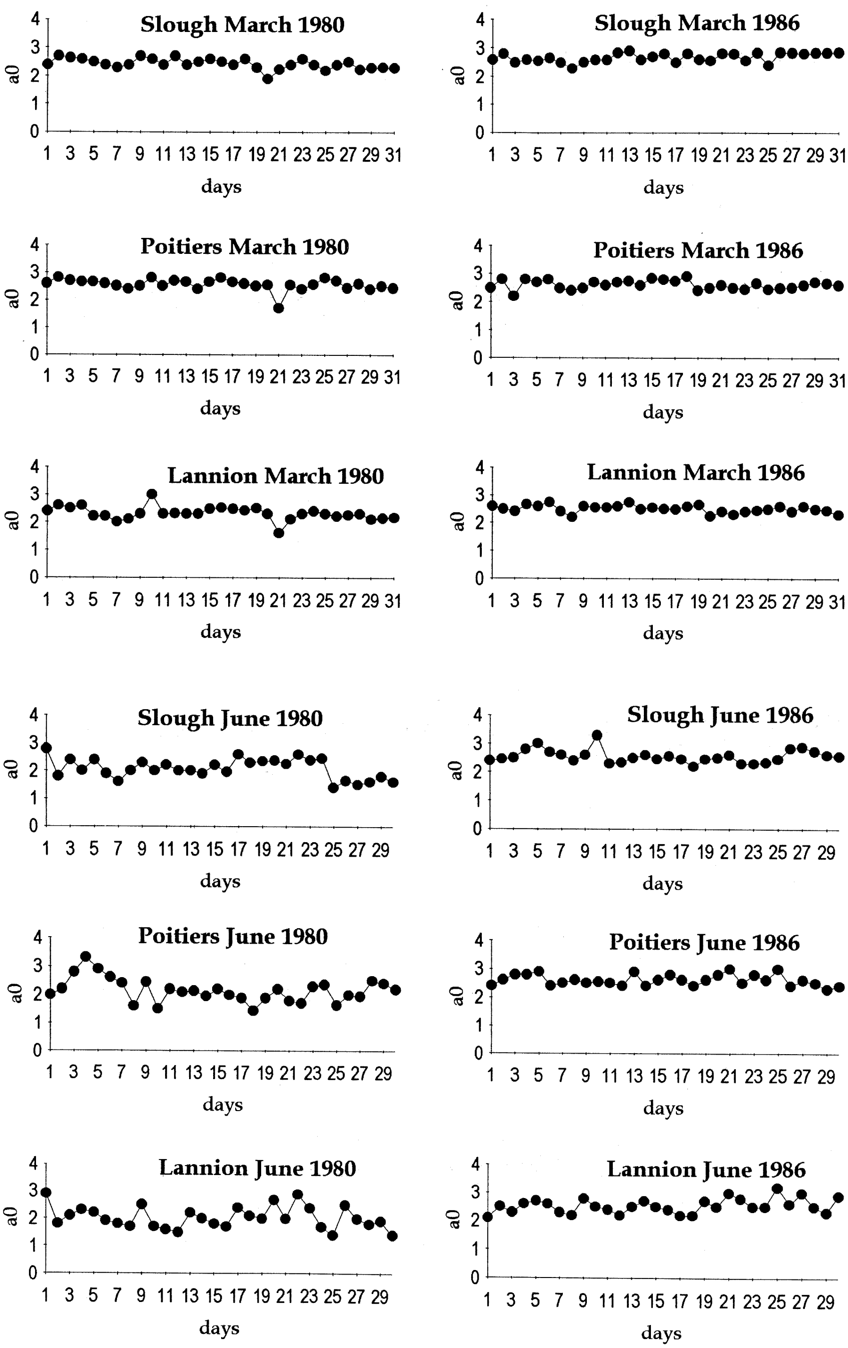

Fig. 4. Day-to-day variation of the coefficient a_0 in eq. (2.1) for March and for June for a year of minimum solar activity (1986) and a year of maximum solar activity (1980), and selected locations.

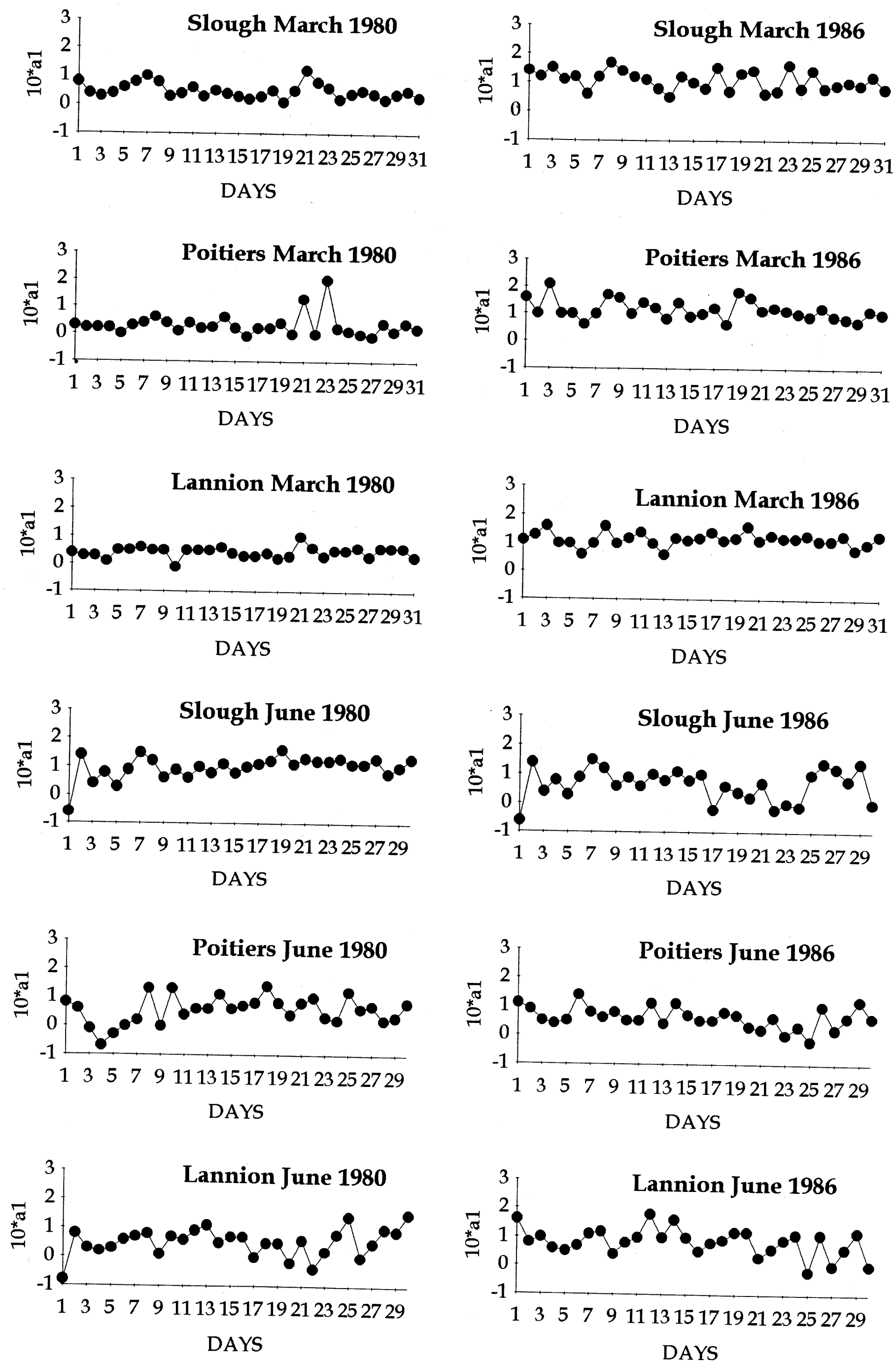

Fig. 5. Day-to-day variation of the coefficient a_1 in eq. (2.1) for March and for June for a year of minimum solar activity (1986) and a year of maximum solar activity (1980), and selected locations.

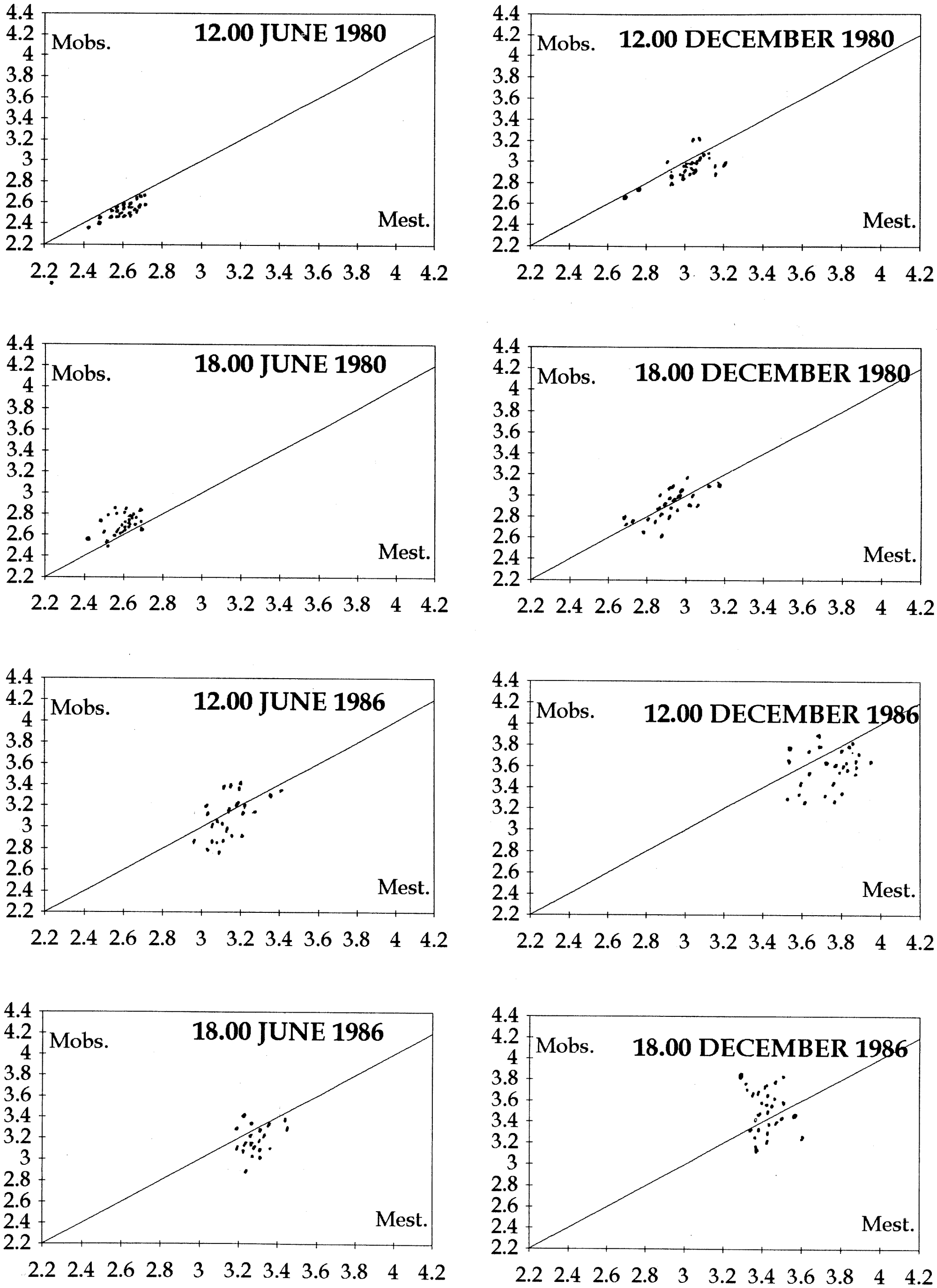

Fig. 6. Observed daily $M(3000)F2$ values versus estimated daily values.

Table VI. Standard error of estimate.

Day	Standard error (Rome, 1980)				Standard error (Rome, 1986)			
	March	June	October	December	March	June	October	December
1	0.1277	0.1369	0.1780	0.2193	0.1787	0.1638	0.1325	0.2320
2	0.0953	0.1377	0.2132	0.1218	0.2097	0.2080	0.1890	0.1853
3	0.1136	0.1184	0.1613	0.1357	0.2069	0.2036	0.1867	0.1765
4	0.1277	0.0925	0.1622	0.1805	0.2407	0.1639	0.1387	0.2945
5	0.1021	0.0974	0.1896	0.1599	0.2461	0.2838	0.1209	0.2206
6	0.1174	0.0919	0.1380	0.1906	0.2447	0.1872	0.1447	0.2558
7	0.1406	0.1100	0.1435	0.1315	0.1748	0.1715	0.1856	0.2105
8	0.1303	0.1519	0.1412	0.1946	0.1964	0.1897	0.1537	0.2501
9	0.1027	0.1270	0.1507	0.2386	0.1378	0.1776	0.1293	0.2094
10	0.1149	0.1366	0.1508	0.1602	0.1702	0.1317	0.1077	0.2308
11	0.1347	0.1077	0.1857	0.2258	0.1793	0.2252	0.1224	0.2293
12	0.1255	0.1267	0.1266	0.1725	0.1893	0.1936	0.1818	0.2257
13	0.0945	0.1278	0.1152	0.1903	0.1435	0.2015	0.2524	0.2226
14	0.1330	0.1039	0.1231	0.2096	0.2351	0.1650	0.2460	0.2736
15	0.1242	0.0774	0.1618	0.1558	0.1869	0.3038	0.2053	0.1949
16	0.1368	0.0857	0.1357	0.1604	0.1910	0.1912	0.1559	0.1505
17	0.1470	0.0959	0.1295	0.1631	0.2037	0.1571	0.2522	0.2820
18	0.1232	0.0683	0.1376	0.1768	0.1991	0.1378	0.1718	0.2357
19	0.1056	0.0802	0.1178	0.2220	0.2174	0.1283	0.1825	0.2506
20	0.1460	0.0555	0.1249	0.2069	0.1794	0.1987	0.2080	0.2681
21	0.1172	0.0738	0.1142	0.1328	0.1986	0.1689	0.1890	0.2417
22	0.1721	0.1068	0.1536	0.1900	0.1858	0.1800	0.1291	0.2098
23	0.1361	0.0813	0.1162	0.1763	0.1554	0.1705	0.1871	0.2131
24	0.1149	0.0750	0.1796	0.1775	0.1520	0.2027	0.1695	0.2149
25	0.1210	0.1066	0.1872	0.1783	0.1998	0.1285	0.2183	0.1789
26	0.1615	0.1060	0.1684	0.2035	0.1873	0.1750	0.2383	0.1965
27	0.1329	0.1206	0.1440	0.1146	0.2139	0.2159	0.2393	0.1998
28	0.1216	0.1024	0.1193	0.2120	0.2200	0.1857	0.1445	0.2393
29	0.1110	0.0840	0.1342	0.2068	0.1801	0.2622	0.2977	0.6028
30	0.0863	0.1459	0.1087	0.1932	0.2446	0.1556	0.2156	0.3612
31	0.1005		0.1303	0.1755	0.6728		0.2574	0.4158

4. Conclusions

The statistical analysis of the variation of the daily values of the factor M with the corresponding values of f_0F2 shows that they are poorly correlated and therefore a relationship between them hardly can be established. This means a different behaviour in the diurnal variations of the two ionospheric characteristics, and therefore in MUF and the height of the maximum electron density.

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