GOES-7 Predictions of IUE's Radiation

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The Particle Flux Monitor (commonly called the FPM) had been a valuable instrument for the 13 years that it worked, giving observers information which would affect any exposure they chose to take with one of the spectrographs. Since the failure of the FPM in 1991, we have had no *real-time* knowledge of the level of radiation IUE is experiencing. In the monitor's absence, we have found a way to inform observers in advance of their US2 shifts (when radiation is at its highest) of what radiation level to expect by using information from the Geostationary Operational Environmental Satellite (GOES-7).

Throughout IUE's mission, observatory staff have made efforts to inform the guest observers of how much radiation to expect. Often, the best indication of today's level is that which was seen yesterday. But now there are days when we do not have this luxury; perhaps an observer has taken exposures which are too short to give a reliable measurement of the background radiation level. Also, there are days when the level either rises or falls drastically compared to the day before.

New studies of the patterns seen in the GOES-7 electron fluence have allowed us to make better predictions throughout the course of the year. We use the peak GOES-7 value to predict the maximum FPM for the US2 shift. But while the GOES-7 reaches its peak at about 17 UT every day, IUE's eccentric orbit causes a shift of two hours per month for the time of maximum radiation. So in certain months, the useful GOES-7 information arrives *after* IUE experiences its peak. This time lag is a problem from about April through September each year. The following table shows examples of GOES-7 radiation predictions on the given days compared to IUE values. The values for the IUE FPM are calculated from background levels of exposures taken during the shift.

Table 1

Comparing GOES-7 Predictions with Actual IUE Data

Date (1993)	June 20	June 21	June 22	June 23	June 24	June 25	June 26	June 27
GOES-7	1.1	1.2	1.1	1.0	1.1	1.8	2.0	1.8
IUE FPM	0.8	1.4	1.8	0.5	1.4	1.8	1.5	2.1
Date (1993)	Oct. 12	Oct. 13	Oct. 14	Oct. 16	Oct. 17	Oct. 18	Oct. 19	Oct. 20
GOES-7	2.6	2.3	2.3	2.5	2.1	1.9	1.5	1.2
IUE FPM	2.3	2.4	2.5	2.5	2.2	1.8	1.6	1.1

By convention, the FPM is given in volts, which was the output from the instrument.

The fogging rate of the cameras is given by

$$DNs/hour = constant \times 10^{FPM},$$

where FPM is in volts, and the constant depends on the camera and the dispersion. For high dispersion, the values are: 1.0 for the SWP and 1.3 for the LWP.

We have been using the GOES-7 data as a predictive tool for two years. This year (1993), we calculated new algorithms relating pre-peak data from the GOES-7 to infer the GOES-7 daily maximum. This maximum value is then used to make the FPM prediction. If this method is to be helpful, then predictions must fall within 0.5 volts of the actual FPM. We have met that goal, with a minimum of exceptions. From Table 1, we see an inaccurate prediction for June 22 and possibly one for June 26. Keep in mind that the "actual" FPM values given in the table may not indicate the true FPM peak for that day; it merely indicates the peak which was seen in the exposures that were taken. With this new method of prediction-making in place, the GOES-7 data has become even more valuable to us.

The following table gives a sampling of the radiation history of IUE. The statistics quoted for 1993 are through September 30 only.

Table 2

Peak Radiation Level FPM (Volts)	Percentage of Days Affected 1982	1983	1984	1991	1992	1993
FPM < 1.0V	8.8	1.4	2.7	31.0	26.3	13.6
1.0 < FPM ≤ 1.7	22.7	19.7	26.0	40.1	44.1	30.0
1.7 < FPM ≤ 2.0	26.6	15.9	12.3	14.3	13.7	20.1
2.0 < FPM ≤ 2.4	19.7	26.3	19.9	11.5	8.8	26.4
2.4 < FPM ≤ 2.8	18.9	26.6	22.4	1.6	4.4	9.5
2.8 < FPM ≤ 3.0	1.6	6.8	6.6	0.3	2.5	0.7
FPM > 3.0	1.9	3.2	10.1	1.1	0.3	0.0

The 1991-1993 values in Table 2 are derived from the GOES-IUE relation. These percentages are presented in order to give a "ballpark" idea of the radiation IUE has received. As we get closer to a minimum in solar activity, we expect to witness higher radiation than we've seen recently.

The following page shows a plot from a period in 1991 when the FPM was still functioning. Up to now, we have only demonstrated how we use the GOES-7 data as an aid in predicting radiation during US2. But from this plot and others like it, we have detected several clues of when to expect high radiation during our low-radiation shifts, US1 and Vilspa:

- On a given day, if the minimum value for electrons is greater than about 1000 (units are electrons/sec/cm^2/steradian), then radiation can be expected to rise anywhere from 0.5 to 2.0 volts during US1 and possibly Vilspa shifts.
- The disappearance of the daily rise-and-fall pattern signals higher radiation.
- The return of the diurnal pattern for electrons indicates a corresponding return of the normal radiation exposure for IUE.

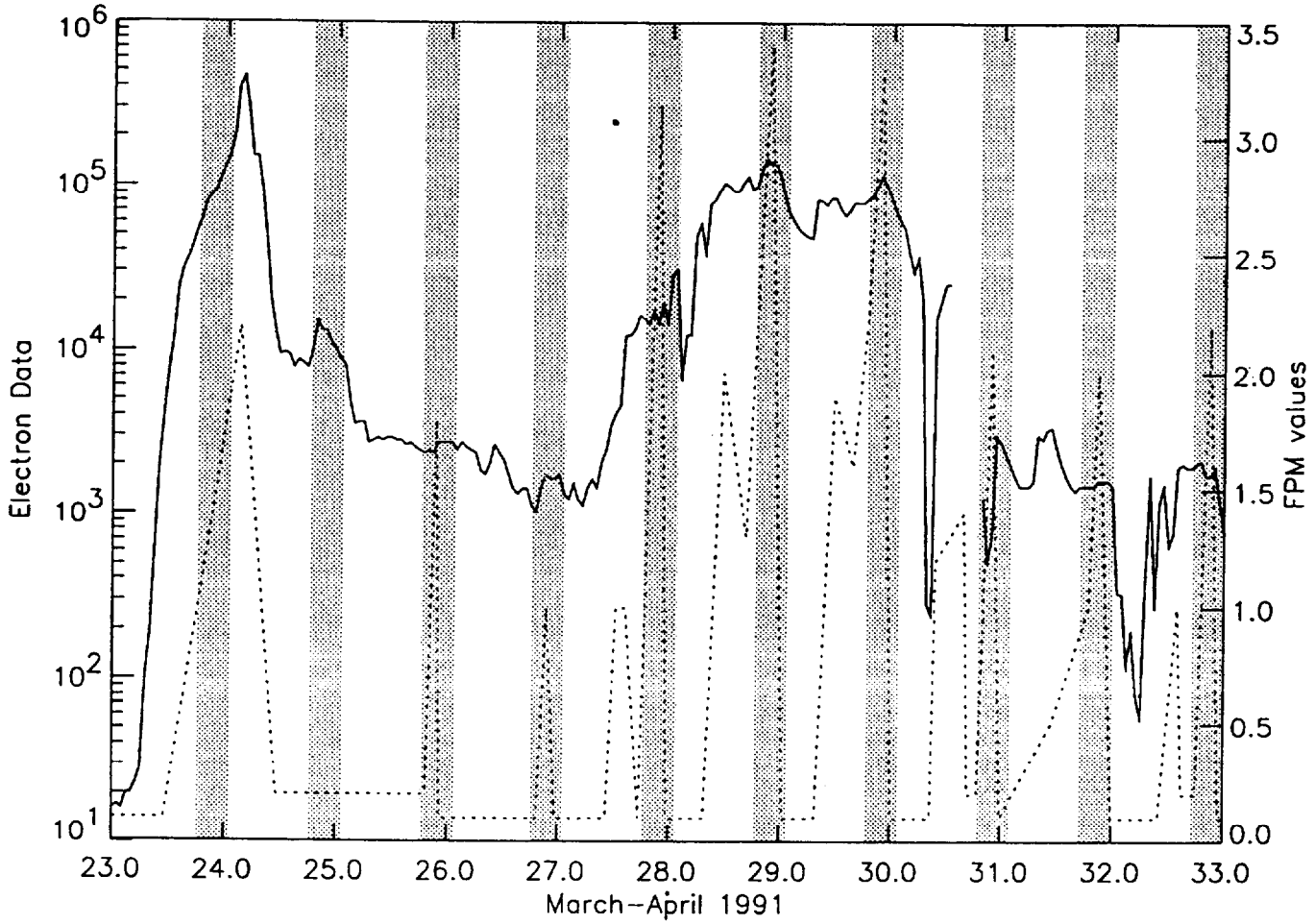

Figure 1: Data from the GOES-7 (solid) and IUE (dotted). US2 shift is shaded. The solar event of March 23-24, 1991 affected our radiation levels for several days. Initially suppressed, the FPM rose significantly on the 27th and the days that followed.