IONOSPHERIC EFFECTS OF THE EXTREME SOLAR ACTIVITY OF FEBRUARY 1986

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During February 1986, near the minimum of the 11-year Solar sunspot cycle, after a long period of totally quiet solar activity (R_z = 0 on most days in January) a period of a suddenly enhanced solar activity occurred in the minimum between solar cycles 21 and 22. Two proton flares were observed during this period. A few other flares, various phenomena accompanying proton flares, an extremely severe geomagnetic storm and strong disturbances in the Earth's ionosphere were observed in this period of enhanced solar activity.

Two active regions appeared on the solar disc. Region NOAA 4711 occurred on the disc between 31 January - 11 February 1986. Several large flares appeared in this active region. The most important flares, two proton flares, were observed in this region 4 February, 0732 - 0835 UT imp. 3B and 6 February 0618 - 0732 UT, imp. 3B. Another large flare occurred in this region on 7 February 1014 - 1035 UT imp. 3B. The second active region NOAA 4713 occurred on the solar disc between 3 - 15 February. Its most important flare was observed on 4 February 1025 - 1128 UT.

The flares in both active regions were associated with enhancement of solar high energy proton flux which started on 4 February of 0900 UT. The enhancement of the solar proton flux on 6-9 February 1986 with maximum on 7 February 1730 UT and the end on 8 February is depicted in Fig. 1.

Associated with the flares, the magnetic storm with sudden commencement had its onset on 6 February 1312 UT and attained its maximum on 8 February (Kp = 9). Its development in Kp is also shown in Fig. 1.

The sudden enhancement in solar activity in February 1986 was accompanied by strong disturbances in the Earth's ionosphere, SIDs and ionospheric storm. The highest SID event, importance 3+, was observed on 4 February 0735 - 0945 UT. Two proton flares (4,6 February) were folowed by PCA events in the lower ionosphere.

The strong geomagnetic storm culminating on 8 February caused a strong ionospheric storm. The effects of this storm, as observed by the ionosonde at Pruhonice observatory (49°59'N; 14°33'E), are plotted in Fig. 2. Variations of the critical frequency of the F2 layer of the ionosphere from 7 to 11 February are shown in Fig. 2. The positive part of the storm effect began on 7 February forenoon and at about 1600 UT was followed by a sudden decrease of the critical frequency of the F2 layer (from 7.5 MHz to 2.3 MHz) while the virtual heights increased. The negative part of the storm characterized by spread echoes and low critical frequency lasted until 11 February. On 8 February from 1500 quite unusual effects were observed, unusually E layer h'= 155 km; foE = 2.25 MHz (higher virtual height and higher frequency than the normal E layer), which may be interpreted as a particle E layer, which appeared on the ionogram at 1500 UT (Fig. 3). This effect was followed by the appearance of a quite extraordinary layer (in 1615

UT) with virtual height of about 200 km (Fig. 4). This layer existed 1 hour and then droped down and became an Es layer type of a (auroral) which existed until 2200 UT.

These effects and type Es are quite unusual in our middle latitudes and were probably connected with strongly increased auroral activity.

The effect of the geomagnetic storm on the lower ionosphere consisted of two different types. The first type, observed at high latitudes, consisted in a large increase of electron density coincident with the geomagnetic storm. At midlatitudes we observed the post-storm effect (PSE), which consisted of the first phase (PSE I) coincident with the geomagnetic storm and the second phase, observed after the geomagnetic storm (PSE II). For the detection of post-storm effects, caused by the geomagnetic storm on February 1986 we used A3 absorption measurement given in table. 1.

TABLE 1

frequency	observ.	geomagn. lat. of refl.point
245 kHz	KUHLUNGSBORN	55°
1539 kHz	PANSKA VES	50°
164 kHz	SOFIA	45°
747 kHz	SOFIA	42°
1412 kHz	SOFIA	43°

The first phase (PSE I) of the post storm effect started on 6 February, the maximum of the geomagnetic storm was on 8 February (Ap = 202, ΣKp 62) and the end of the first phase had PSE on 10 February. PSE II started on 11 February. The results for night time absortpion data in given measuring paths (Fig. 4) indicated that the first phase of the PSE was well developed only for the northern most measuring path (p = 245 kHz, ø = 55°). The second phase of PSE II absorption enhancement on that path decreased very quickly (up to day +3 after PSE I end). This result indicates a direct effect in high latitudes rather than midlatitudes. On the other band, the results for 164 kHz and 747 kHz represent a typical midlatitude case with missing phase I and very well developed phase II. The case of 1539 kHz is very like the behaviour of the transitional type, normally observed in the subauroral zone, with the transition of the time of the commencement of the first phase with latitude. The effect on 1412 kHz is developed very weakly. The existence of the third phase PSE III after 15 February is not quite clear, either. This latitude boundary is in accord with the hypothesis on equatorward expansion of the auroral zone during geomagnetic storm in early February 1986.

REFERENCES

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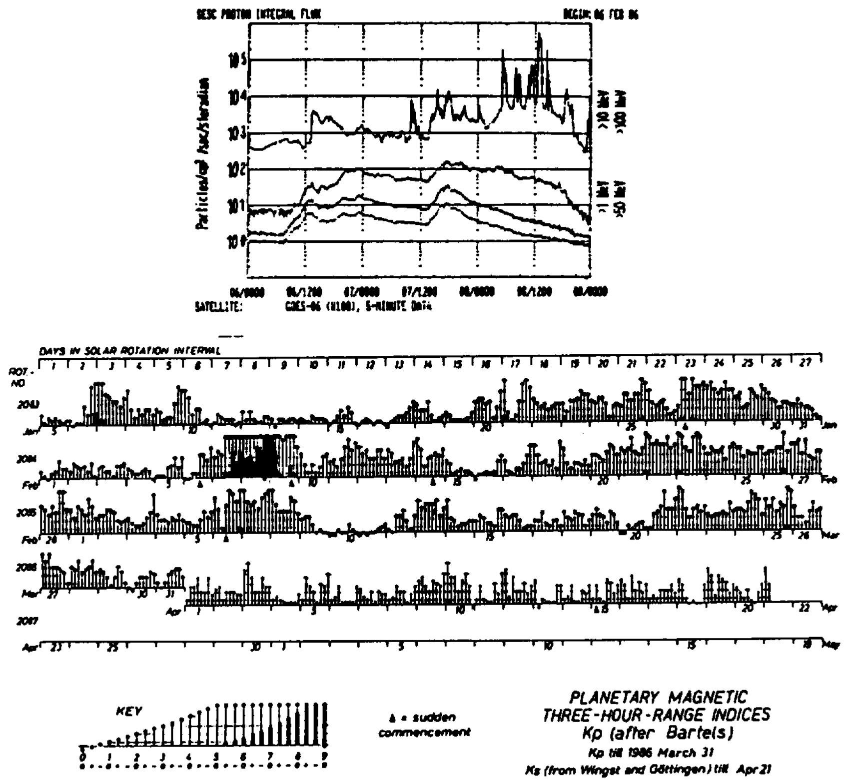

Fig. 1: The enhancement of the high energy proton flux as observed on 6-9 February 1986 Below: Planetary magnetic three-hour range indices Kp.

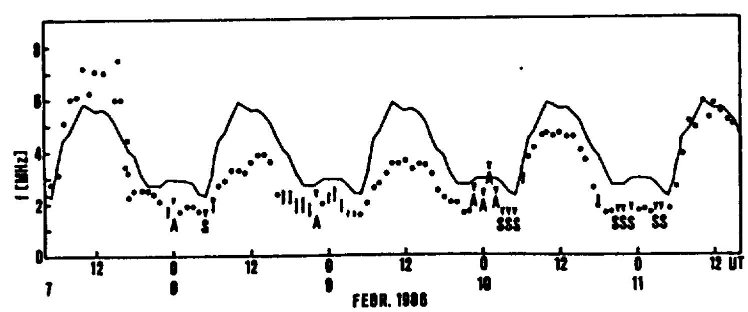

Fig. 2: Critical frequencies of F2 layer, Pruhonice. full line - median of foF2 in FEBRUARY, v - foF2 less than given value; A - blanketing Es layer; S - interference.

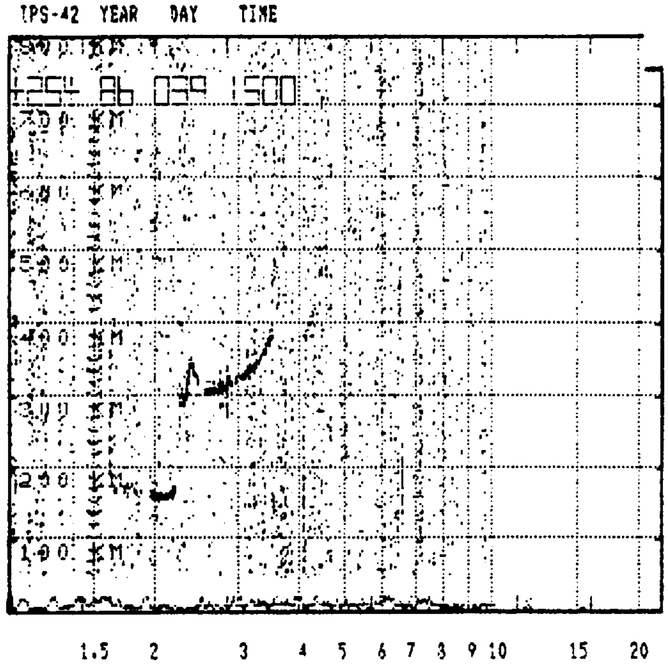

Fig. 3: Ionogram with particle E layer; Pruhonice; 08.2.1986 - 1500 UT

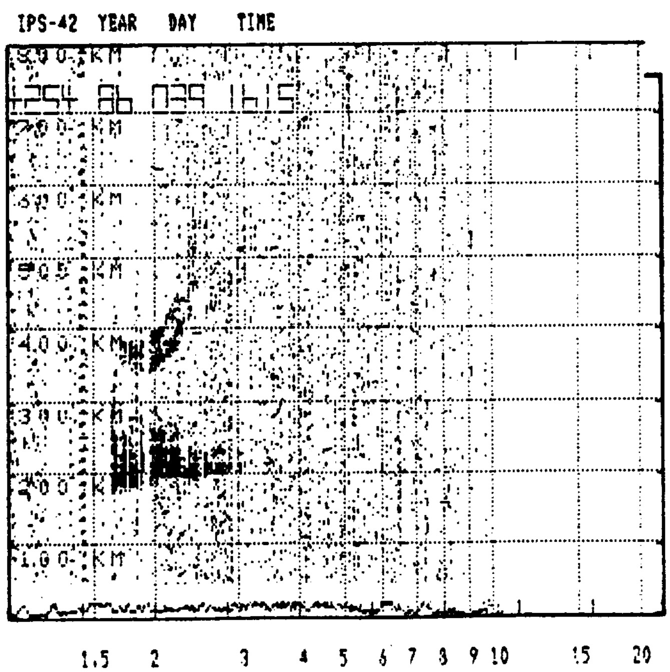

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Fig. 4: Ionogram with extraordinary layer. Pruhonice, 8.2.1986 - 1615 UT.

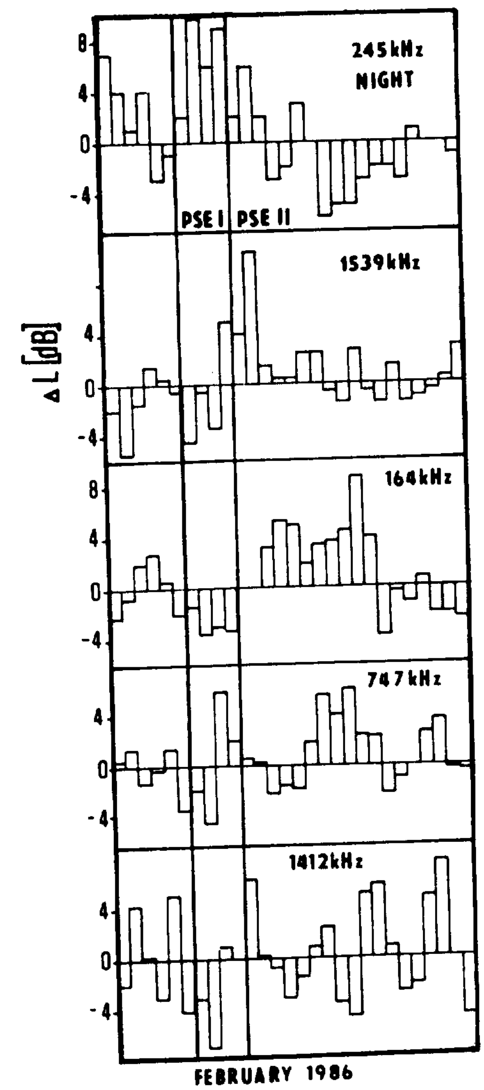

Fig. 5: The effect of the geomagnetic storm of February 1986 in the lower ionosphere. Δ L - changes in ionospheric A3 absorption on several measuring paths.

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