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SEPARATION OF THE ATMOSPHERIC GEOMAGNETIC EFFECT OF AURORAL AND RING CURRENT ORIGIN ON THE BASIS OF THEIR DIURNAL COURSE II.

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SCOPE OF THE INVESTIGATION

The literature considers the geomagnetic effect of the equatorial neutral atmosphere a consequence of the auroral heating [1] only, in spite of the fact that some results indicate stronger response than it is expected. Our earlier results [2,3,4,5,6] demonstrated that there is an additional energy source for the equatorial thermosphere: namely the ring current. Based on the position of the humps in the LST (local solar time) function of the residuals — representing the different places of enhanced energy input — the storm time behaviour was analysed in [5] and now an attempt is made to investigate the ring current source by comparing the quiet time and the storm time behaviour.

MEASUREMENTS

Thermospheric density data (ϱ) were derived from the CACTUS microaccelerometer measurements [7]

Time interval: 1975-1977 (low solar activity)

Height interval: 400-600 km

Geomagnetic latitude: 0^{o} - 40^{o}

Model used: MSIS'86 = CIRA'86 upper atmospheric model

METHOD

MSIS'86 residuals

$$f = (\varrho^{CAC} - \varrho^{MSIS'86})/\varrho^{MSIS'86}$$

values have been analysed as a function of LST, scatter around zero would correspond to a perfect model.

Quiet time data: On the basis of the Dst curve 29 time intervals of ~100 days total length were selected where the Dst curve remained constant in the vicinity of the maximum value at least for several days. The data were grouped according to geomagnetic latitude and height intervals.

Storm time data: On the basis of the Dst curve those 21 quick geomagnetic disturbances were selected where the descending branch of the Dst curve (daily mean of hourly Dst values) was steep enough to reach the Dst minimum in less than two days.

The method of superposed epochs has been applied with Dst-minimum (hourly values of Dst) as key-time. Consecutive 24 hours intervals before and after key time were separated and the data were grouped according to geomagnetic latitude as well.

Running mean curves (two hours, 0,2 hours step) as well as instantaneous values have been plotted.

N is the number of instantaneous measurements used in the construction of a given curve.

RESULTS

The residuals of MSIS'86 model have been analysed on an independent observational material.

From Fig. 1 it is obvious that the MSIS'86 model generally overestimates the density in quiet times except in two LST intervals, namely at midnight at low geomagnetic latitudes and about LST=2^h at higher than 25^o geomagnetic latitude.

Fig. 2 proves that at quiet days the excess densities appear in every height interval.

As demonstrated in Fig. 3, the density excess is not an uniform function of LST, but several real, more or less separate humps are distinguishable:
the 0-2 LST hours double hump in quiet periods as well as the midnight (1), the early morning (2), the morning (3), the midday (4) and the evening (5) hump at storm time [5]. The pre-storm conditions are restored after 5-6 days.

As one can see in Fig. 4 and 5 the diurnal dependence of the variance of f-values is conspicuous:
three different kinds of behaviour can be distinguished — not mentioning the errors in the modelled effects.

1./ The most conspicuous features are the spikes in f-values, their intensity is almost the same during the storm and in quiet times. Furthermore, it looks like as they tend to appear more frequently in certain LST-s. The log f diagram indicates, however, that spikes of about the same intensity are present downward as well, showing that higher and lower density peaks occur with respect to the mean value. Such phenomenon can exist for example if density waves of large (several hundred percent) amplitude happen sporadically. The clarification of their characteristics requires further investigations.

2./ The uniform broadening of the curves at certain LST-phases exceeding the scatter of the measurements is

also conspicuous. The phenomenon is well visible on days No. -2., 4., 5. and 6., where the lower and upper cover curves run almost parallely.
This broadening could be caused by waves which exist continuously and everywhere. They contribute to the scatter of the residuals, an excess of 10-15 %, to make the more accurate modelling of the density almost impossible. The amplitude of this uniform wave activity is considerably smaller than that of the sporadic waves in point 1.

3./ On the first 24 hours of the disturbed periods in particular — but on several further days as well — a conspicuous increase of the variance in several LST intervals is visible. The humps marked by numbers in Fig. 3 on the running mean curves are due to this increase. In contrast to 1./ and 2./ here there is no corresponding excess variance in log f in negative values downward. Therefore this behaviour is attributed to an extra heating that according to our earlier results is originating from the ring current, and can be quite well modelled by the Dst as parameter [6]. In connection with this type of phenomenon the "beam-like character" of the extra heating was mentioned in [5].

4./ Farther from the stormtime days (days No. -2., 4., 5. and 6.) a noon and perhaps also an afternoon (18^h) hump is appearing, that should be investigated and modelled.

As demonstrated in Fig. 6, at quiet days the sharp midday spike of the variance has similar ranges in the Indian and in the Pacific sectors as well as in the European and in the American sectors respectively. It is higher in the Indian-Pacific than in the European-American sector. The midnight spike — on the contrary — is higher in the European-American sector.

The investigations are continued.

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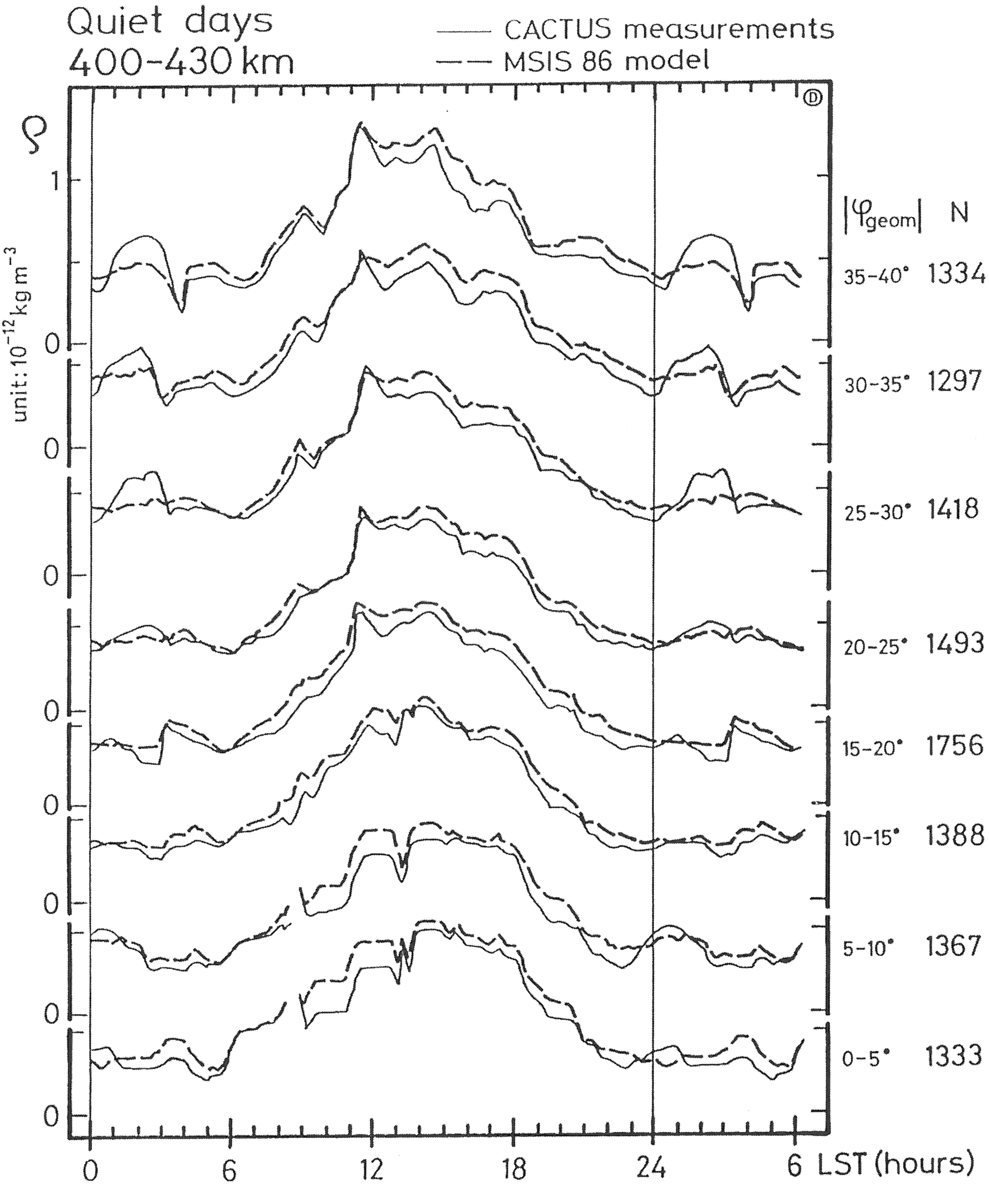

Fig. 1 Running mean density (ρ) curves — plotted for quiet times — as a function of local solar time (LST) and of geomagnetic latitude (φ_{geom}).

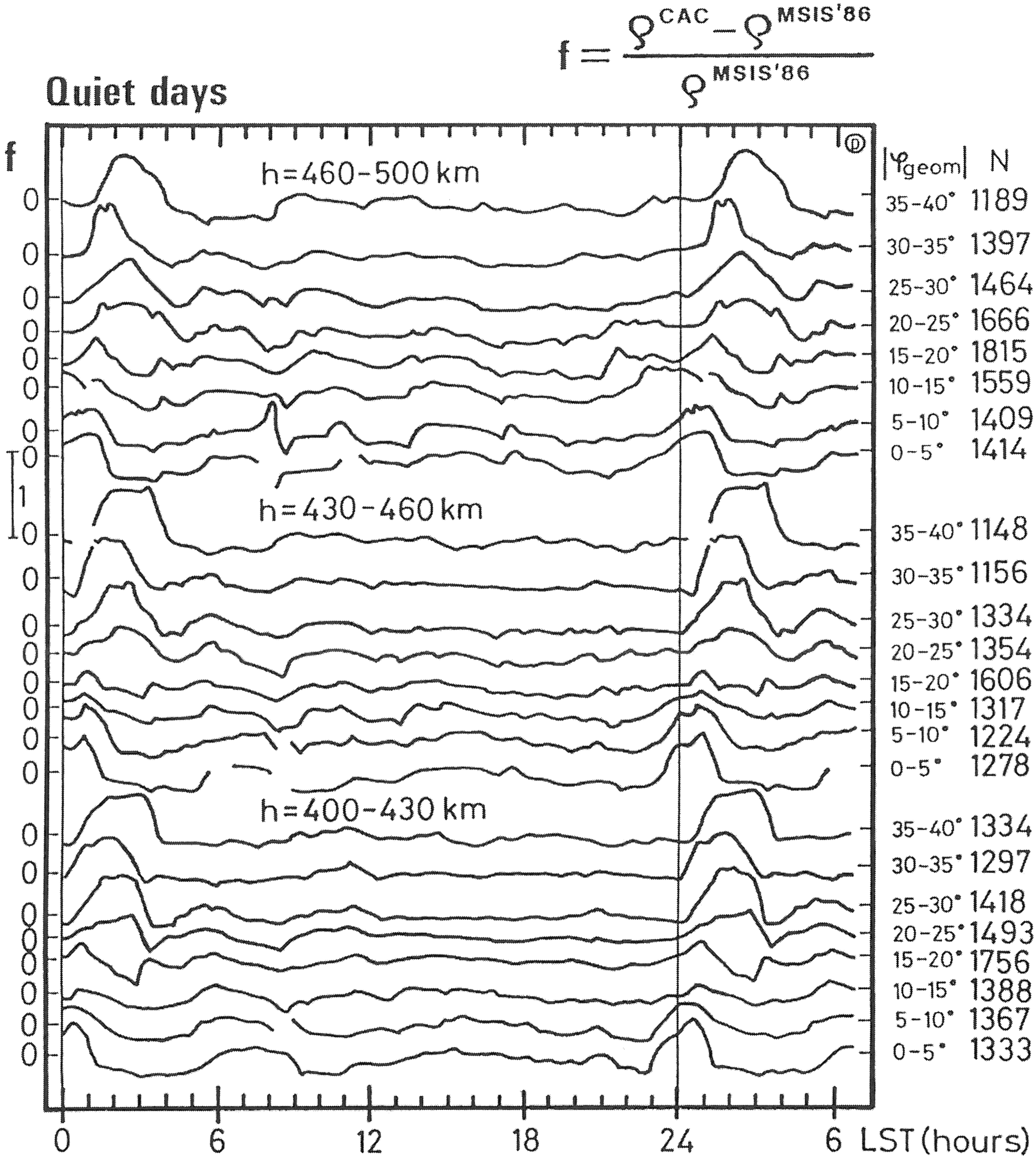

Fig. 2 Running mean curves of density excess (f) as function of LST for different heights and geomagnetic latitude intervals for quiet times.

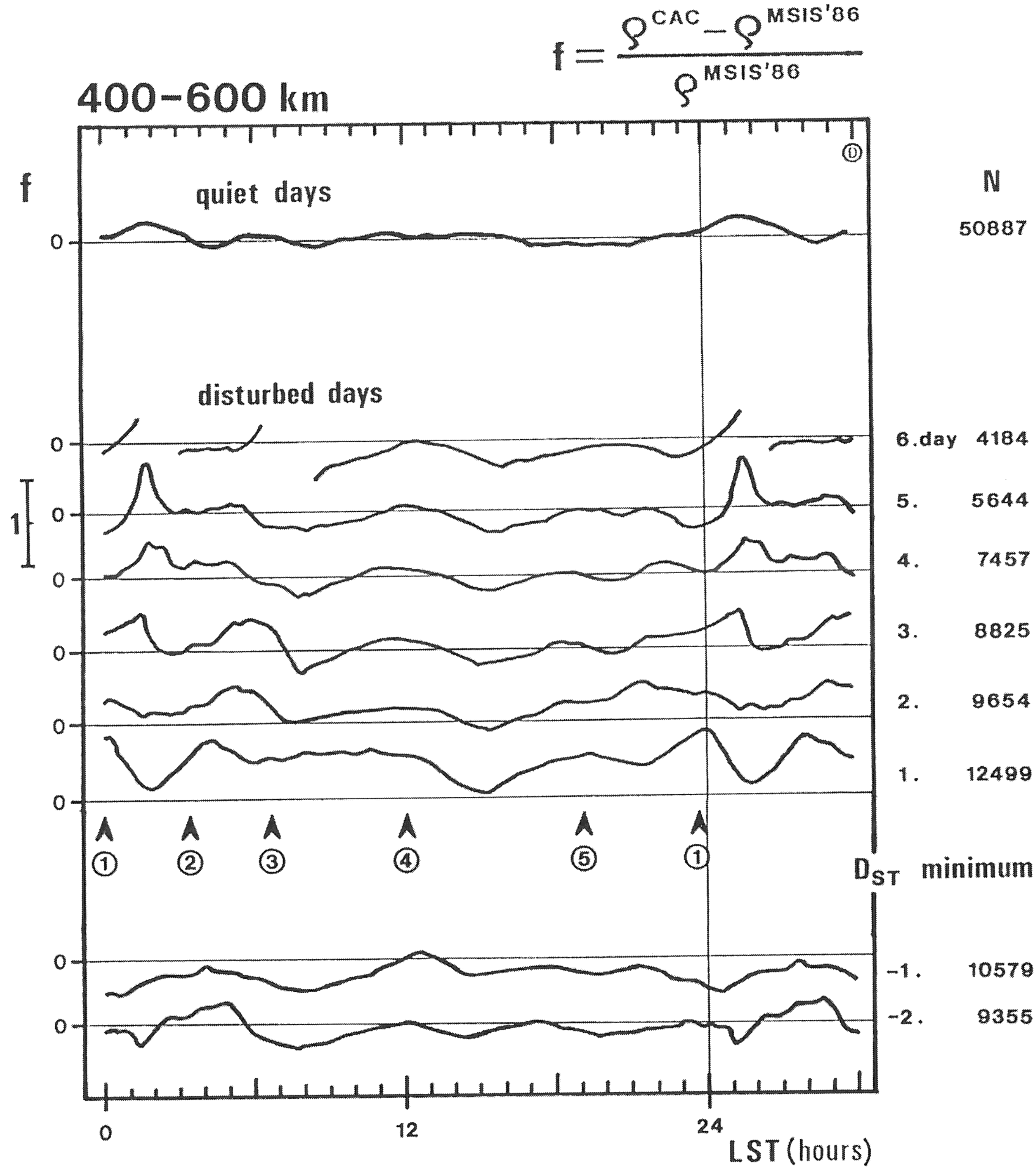

Fig. 3 Running mean curves of density excess, without any grouping, for quiet times (upper curve) and for consecutive 24 hours before and after Dst minima of geomagnetic disturbances.

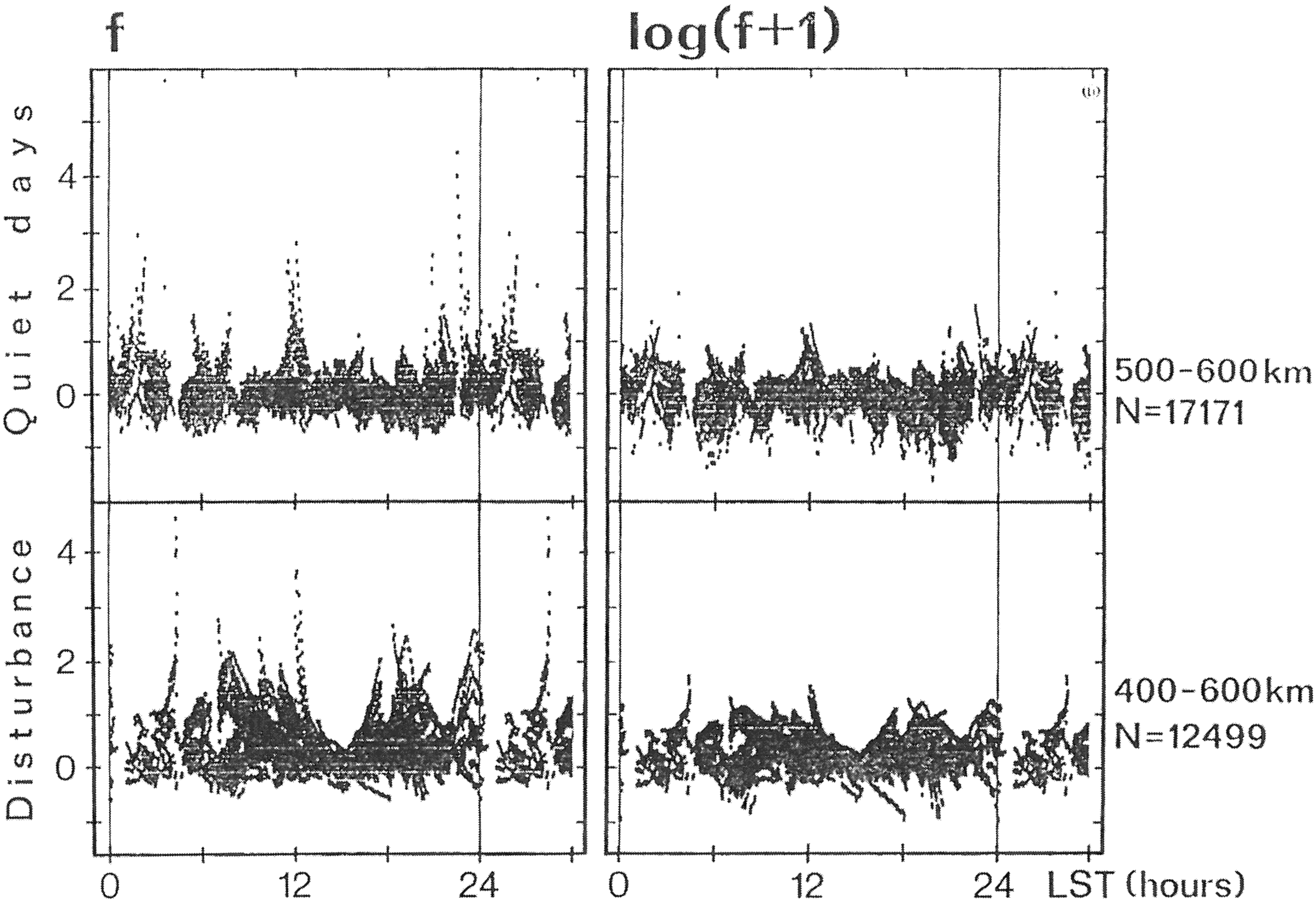

Fig. 4 Instantaneous residual values of two curves in Fig. 3 are plotted, namely the quiet days curve and the first 24 hours curve of the disturbed periods: f values (left panel) and log f values (right panel).

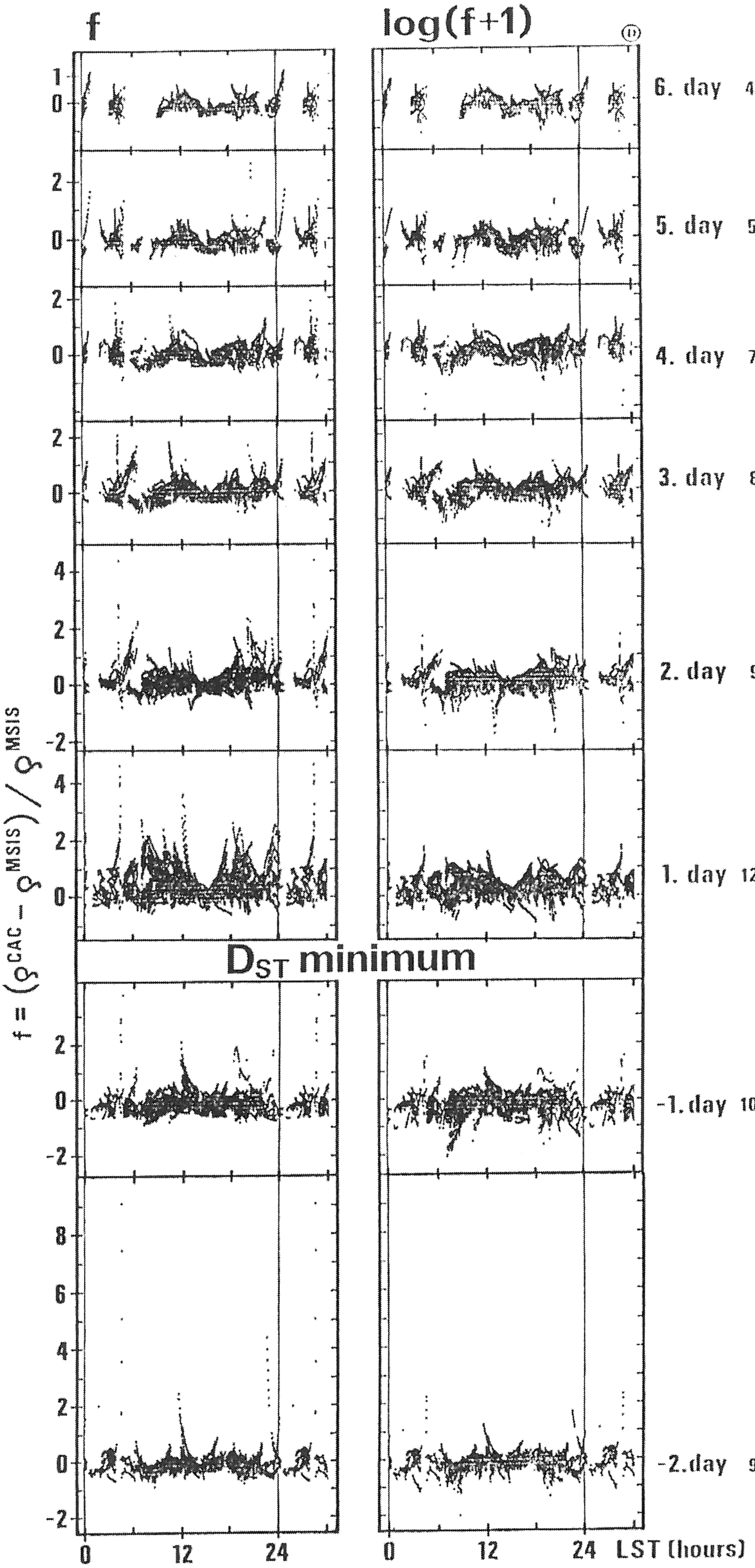

Fig. 5 The same as in Fig. 4 but for eight consecutive 24 hours of disturbed periods.

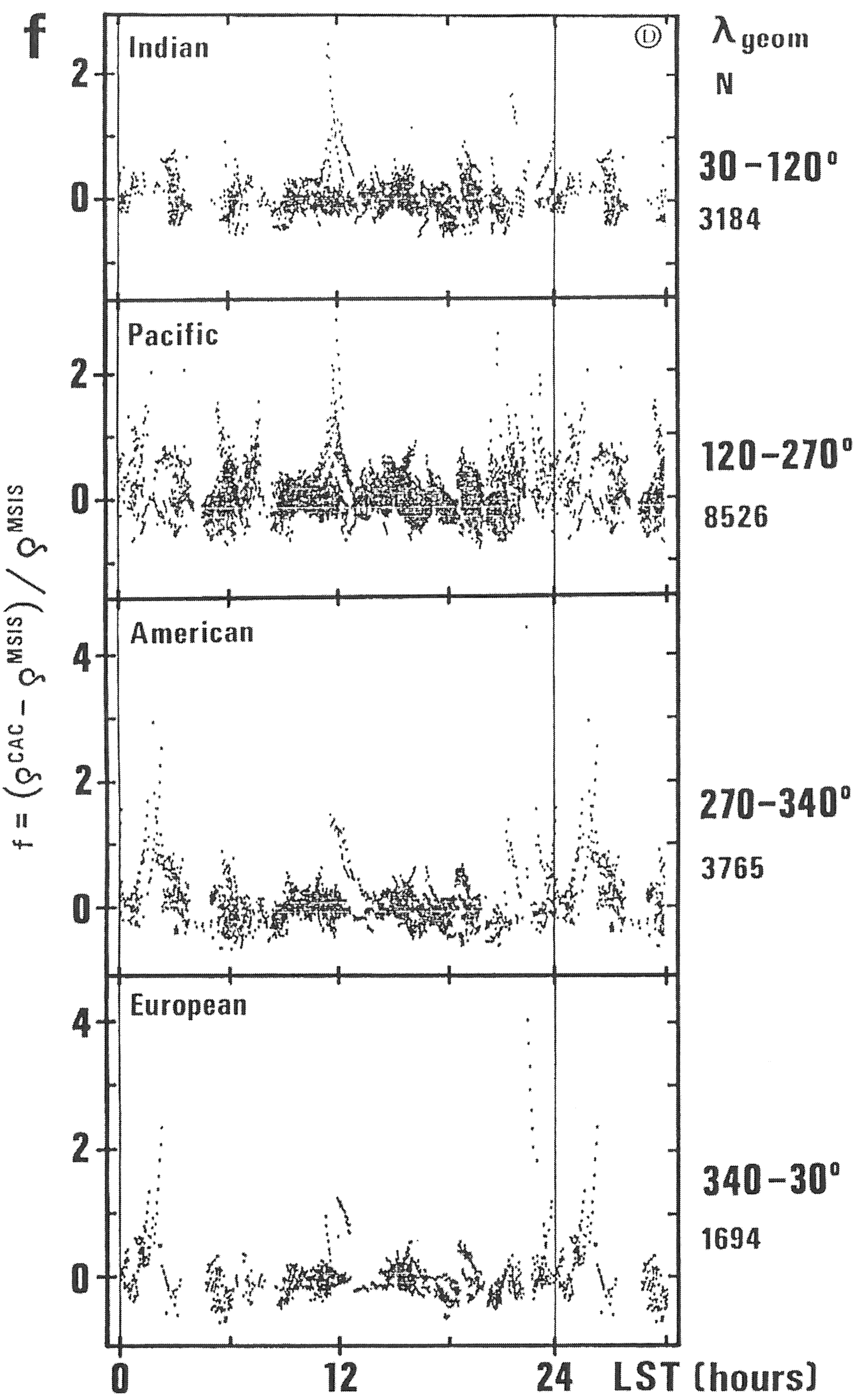

Fig. 6 The same as in Fig. 4 for quiet days but separated according to geomagnetic longitude.