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LATITUDINAL DEPENDENCE OF THE ENERGY INPUT INTO THE MESOSPHERE BY HIGH-ENERGY ELECTRONS

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Night-time ionospheric absorption measurements (A2, A3) give the possibility to study the precipitation of high-energy electrons into the mesosphere during and after magnetospheric storms. The uniform Finnish riometer network together with A3-measurements from Kuhlungsborn and Collm (GDR) have been used to investigate the night-time absorption as a function of latitude (L = 6.5 - 2.5) and storm-time for seven storms (WAGNER et al., 1982 a). The common trends visible in all these events can be summarized in a schematic average picture (see Figure), showing the distribution of increased ionospheric absorption as a function of latitude (L-value) and storm-time. During the main phase of the storm enhanced precipitation of high-energy electrons has been found for all L-shells ($2.5 < L < 6.0$). During the recovery phase the precipitation in auroral latitudes can be relatively low, but in medium latitudes an electon precipitation belt starts to develop. The position of the poleward boundary of this precipitation belt is found to be a function of storm-time. It reaches $L \approx 4.5$ at the end of the recovery phase. The ionospheric absorption increase is only a rough indicator for the flux of precipitating electrons, because it is only a height-integrated and energy-integrated information. Either in-situ measurements onboard of low-altitude satellites or pitch-angle distribution measurements made in the equatorial plane may be used to gain more detailed information about the energy input into the region below 100 km by precipitating electrons. Measurements of the pitch-angle distribution of electrons for four energy channels (35 - 70, 75-120, 120-240, 240-560 keV) made onboard of Explorer-45 for $2 < L < 5.2$ in the equatorial plane have been used to study the variations of the electron population for two storms in August 1972 (WAGNER et al., 1982 b). During the main phase of the storm the slot region is filled up totally and the electron fluxes increase by one order of magnitude for the 35-70 keV electrons and by three orders of magnitude for the 240-560 keV electrons. Some energy is at once released to the ionosphere by precipitation, but a great amount of this energy is stored in the electron radiation belt. During the recovery phase the input of new high-energy electrons into the radiation belt decreases and the stored energy is transferred to the ionosphere by precipitation. The number of high-energy electrons inside a magnetic tube of 1 cm^2 area at 100 km altitude, the so-called flux tube content, has been determined in dependence on L, energy channel, and stormtime. During the recovery phase the flux tube content decreases exponentially in a rather steady way. The time constant of this decrease is determined by the lifetime of the electrons against pitch-angle diffusion processes and by the time constant of the electron input due to radial diffusion. The lifetime against pitch-angle diffusion and the flux tube content just after the main phase control the precipitation into the ionosphere.

The energy input rates for the recovery phase of the magnetospheric storm August 9 (15.15 UT) through August 14 (10.00 UT), 1972 have been estimated for L = 3 and L = 4 in dependence on energy. The total energy input by high-energy electrons ($35 < E_e < 560$ keV) for that part of the recovery phase has been found

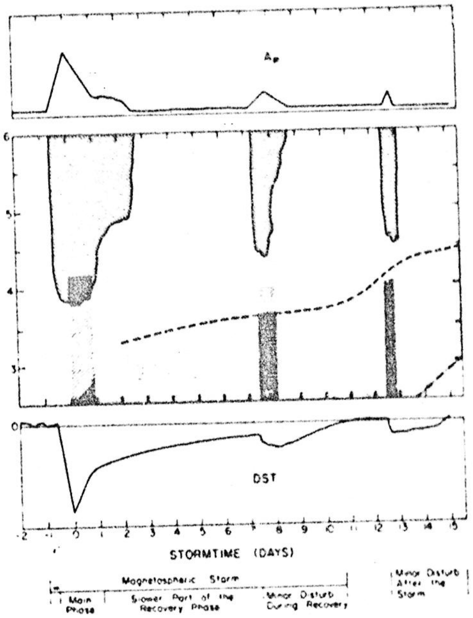

Figure 1.

to be more than 100 erg/cm^2 at L = 3. Electrons with high energies (but lower fluxes) transfer more energy into the ionosphere than electrons with $35 \le E_e \le 120$ keV. At the beginning of the recovery phase the energy input from electrons with $120 < E_e < 560$ keV is higher by a factor 2-3. During the recovery phase the energy input by electrons with $35 \le E_e < 70$ keV decreases from 2×10^{-4} to 7×10^{-6} erg/cm^{2}s, and that by electrons from the highest energy channel decreases from 7×10^{-4} to 6×10^{-5} erg/cm^{2}s. The higher the energy of the precipitating electrons, the lower the stopping height (see, e.g., REES 1963). For the energies mentioned above the energy input maximum occurs between 95 km (~ 40 keV) and about 75 km (~ 500 keV). As has been shown above the energy is transferred only to a narrow belt ($2 < L < 4$ to 4.5) in midlatitudes. For the part of the recovery phase (August 9-14, 1972), which has been used to estimate energy rates, the total energy released in this belt has been estimated to be $3 \cdot 10^{19}$ erg. During the whole recovery phase of that storm about $5 \cdot 10^{19}$ have been transferred to this belt by high-energy electrons.

In comparison with other storm processes such as ring current injections (some 10^{23} erg), auroral particle precipitation or Joule heating (some 10^{22} erg) the energy input by high-energy electrons which had been stored in the radiation belt is small. But the special properties of this energy input are interesting: (a) The energy is directly deposited below 90 km altitude. (b) Energy is transferred into the lower ionosphere for many days up to some weeks after storms. (c) The energy input occurs only in a midlatitudinal belt ($2 < L < 4$ to 4.5).

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