Relationship of SAR arc dynamics to substorms and storms

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It is known that midlatitude red arcs (SAR arcs) are related to magnetic storms, which are determined by a variation in the Dst geomagnetic index. According to the mechanism of SAR arc generation proposed by Cole [1965, 1970], these arcs appear during the main phase of a magnetic storm in the development process of auroral disturbance. The Cole generalization agreed well with the results of SAR arc observations available at that time. Subsequently, after the theoretical work of Cornwell et al. [1971], it was established that SAR arcs are formed at the storm recovery phase. At present, the concept dominates that SAR arcs are associated with the recovery phase of a magnetic storm [Kozyra et al., 1997]. However, satellite investigations performed in 1980-1990 sometimes indicated that energetic particles of the ring current penetrate into the outer plasmasphere during the main phase of a magnetic storm and/or during individual substorms [Kozyra et al., 1993, 1997]. The results of the synchronous measurements from the DE 1 and DE 2 satellites at plasmaspheric and ionospheric altitudes clearly showed that a SAR arc can be observed at the latitudes of the projection of the cold plasma density radial gradient inside the plasmasphere [Horwitz et al., 1986; Brace et al., 1988]. It was shown in [Ievenko, 1993, 1995, 1999] that a SAR arc appears and/or becomes brighter during the substorm expansion phase. A SAR arc formation is beginning in the equatorial boundary region of the diffuse aurora (DA). At the recovery phase of intense substorms at SAR arc latitudes, luminosity pulsations are usually observed in the 427.8 nm N_2^+ emission due to pulsating precipitations of energetic particles from the outer plasmasphere [Ievenko, 1995]. In the case of a prolonged substorm activity, a SAR arc separates from DA and moves equatorward [Ievenko, 1999]. Ievenko and Alexeyev [2004] statistically showed the significant relation of emission 630,0 nm [OI] intensity in SAR arcs to the geomagnetic indices ASYM, AL and K_p at current values of Dst to –135 nT. The Dst–statistical significant dependence of SAR arc intensity begins at Dst $<$ -50 nT. It is, probably, indicates to the considerable contribution of the asymmetric ring current to the generation of SAR arc during the substorms expansion phase.

Here we present new results of subauroral phenomenon studies based on spectrophotometric observations at the Yakutsk meridian (CGMC: 53-61° N, 200° E). The relation of DA dynamics in the 557,7 nm emission to the substorm growth phase during magnetospheric convection intensification after the turn of IMF B_z to the south is shown

by the examples of some events. The formation of SAR arcs during the substorm expansion phase at the beginning of moderate storms with a sudden onset is analysed in detail. Using photometric observations of 427,8 nm N_2^+ emission intensity variations at SAR arc latitudes shows the main peculiarities of development for pulsing precipitations of asymmetric ring current energetic particles in the outer plasmasphere. The latitudinal distribution of observation rate of SAR arcs at the Yakutsk meridian is analysed. It is assumed that the interval of latitudes where SAR arcs are observed during weak and moderate storms is a statistical map of the region of L shells of the outer plasmasphere, into which the developing ring current penetrates during substorms at Kp = 3-6.