Scale-free statistics of spatiotemporal auroral emissions observed by groundbased observations

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The applicability of the self-organized criticality (SOC) paradigm to turbulent plasma sheet dynamics in the tail of Earth's magnetosphere has been intensively discussed in recent years. By now one the most important observational proofs of SOC state of the magnetotail have been scale-free (power-law) statistical distributions of nighttime auroral emission regions as depicted by the Ultraviolet Imager (UVI) onboard POLAR spacecraft [Uritsky et al., 2002; 2003]. In that study, individual active auroral regions have been analyzed using spatiotemporal detection technique and statistical methods accepted for quantifying critical behavior of SOC models. Here we report the results of a similar approach applied to ionospheric emissions as observed by groundbased observations (scanning photometers and all-sky TV) of Polar Geophysical Institute on Barentsburg during 2000-2002 winter seasons. The scanning photometer provides north-south scans with sampling time of 60 s, except for selected observation periods when this time was 30 s. For smaller temporal scales we use all-sky TV data calibrated by simultaneous scanning photometer data. We study the statistics of individual auroral emission regions observed in the 427.8 nm and 557.7 nm spectral lines. The probability distributions of the emission events over the lifetime, maximum length, integrated length, maximum power, integrated energy output are shown to follow power law relations over wide ranges of scales. The power-law distribution exponents are consistent with the exponents reported previously [Uritsky et al., 2002] and approximately obey scaling relations predicted for avalanching systems at criticality. The results obtained support the hypothesis of SOC in the magnetosphere and allow to extend the range of scale-free auroral dynamics associated with SOC mechanism by at least one order of magnitude toward smaller spatial and temporal scales.