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SOME COMMON FEATURES OF AURORAL BREAKUPS FINE SPATIAL – TEMPORAL STRUCTURE

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Abstract
More than 60 breakups, including weak activations of pseudo-breakup type, moderate breakups and events of very strong auroral activity, were analyzed using a new method of TV data processing together with satellite auroral images and space magnetic field data. We studied fine subvisual details of spatial and temporal dynamics of active auroral forms and surrounding diffuse luminosity both in N-S and E-W directions of TV camera field of view. For all types of breakups a close interconnection of auroral activity was found across and along the oval.

Introduction
The problem where the main processes responsible for breakup are located (the near-Earth neutral line or inner edge of the plasma sheet) is very important for understanding aurora physics and has been discussing for many years [Elphinstone et al., 1996]. Perhaps, the first convincing facts and ideas about the key role of close interaction between the two regions (15-20 Re and 6-8 Re, correspondingly) for breakup development can be found in [Voronkov et al., 2004].

Observations
1. Weak pseudobreakup
Figure 1 (A) shows a sequence of Lovozero TV frames for 23.12.2000 (20.30-21.30 UT). One can see a weak quiet prebreakup arc in the zenith (20.30 – 21.13), accompanied by northern auroral activity. Data of Scandinavian magnetometer chain (D) reveal only small magnetic field variations at the moment of the breakup (about 21.20 UT). The major breakup occurred later, about 22.20 UT. IMAGE satellite pictures (B1) show an aurora development above the Kola Peninsula and weak traces of substorm recovery phase above Siberia (probably, pulsating aurora). Blown-up and contrast-enhanced fragments (B2) indicate a small auroral spot 200-250 km to the north of Lovozero prior to the pseudo-breakup (marked by the arrow). This spot intensified before the breakup (21.12.32), and faded after it. N-S (A1) and E-W (A2) TV keograms are shown in the bottom part of Figure 1. The false pulsations in the southern region of the N-S keogram are an artifact caused by changing the digits of the TV timer in the bottom of the frames in Figure 1 (A). The prebreakup auroral forms moving from the North at the speed of about 100 – 150 m/sec are well visible (A1). The keogram A2 shows E-W auroral form motions along the oval (300 – 500 m/sec). The keograms are high frequency filtered (FFT-based filtering) to reveal fine subvisual details of aurora structure.

2. Case of moderate breakup
Figure 2 presents the same as in Figure 1 but for more intense auroral activity. Magnetograms 2 (D) show breakup-type magnetic field variations. The breakup started at about 20.34 UT. Again, TV frames 2 (A) indicate auroral activity in the north. Satellite pictures 2 (B) and 2 (B1) show two spots of prebreakup aurora 500 km to the North from the main oval, probably related to NENL processes. Prior to breakup we can see the fading of the northern spot. Keograms 2 (A1) and 2 (A2) also demonstrate a very close interaction of events both across and along the oval. Note in 2 (A1) periodical (period about 5-7 minutes) wave-like auroral form motions from the southern prebreakup arc to the north (20.00-20.20 UT).

3. Strong auroral activity
Figure 3 illustrates an event of very strong auroral activity gradually expanding over the whole oval. In 3 (B) one can see active auroral forms 500 – 600 km to the north from the Kola Peninsula and well-pronounced omega-structures somewhere above Siberia. Unfortunately, IMAGE satellite altitude was too low in the time period of interest, so not the whole oval can be seen in the picture. The N-S keogram indicates prebreakup aurora motions in both N-S and S-N directions (22.00-22.50 UT). Continuous and intense auroral forms traveling in both E-W and W-E directions along the oval are presented in keogram 3 (D).

Conclusions
Observations of all types of breakups demonstrate a persistent and very strong interconnection between different regions of auroral oval both in longitudinal and latitudinal directions. The breakup is definitely a result of close interaction between more distant magnetosphere tail processes (15-20 Re) and events in the inner magnetosphere (6-8 Re). The motion of auroral forms along the oval gives evidence that the auroral breakup is not a purely local event. Rather, it is prepared by a complicated sequence of different processes occupying a large area of magnetosphere, like, for example, tornado or thunderstorm, which are a result of atmospheric circulation processes over a very large territory. We can suggest that the northern activity related, most probably, to the NENL is mostly controlled by solar wind magnetic field variations, while the near-Earth processes are related to the preceding auroral activity and activity in other regions of the oval.

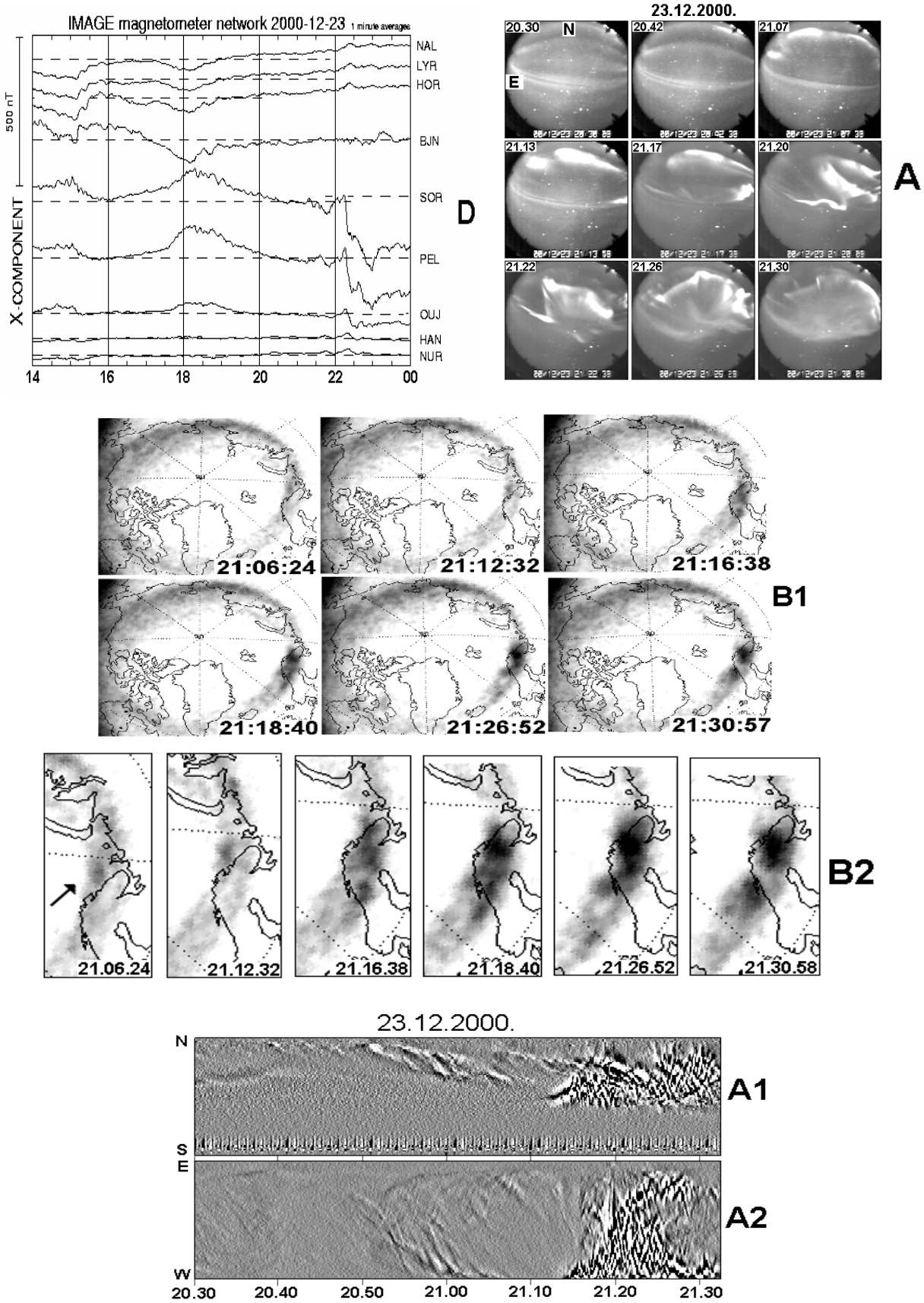

Fig.1 Weak auroral activity of pseudo-breakup type. Sequence of TV frames for Lovozero (A), ground magnetometers data (D), IMAGE satellite pictures (B1), with scaled and contrast-enhanced fragments (B2). N-S and E-W keograms for Lovozero TV data (A1 and A2, respectively).

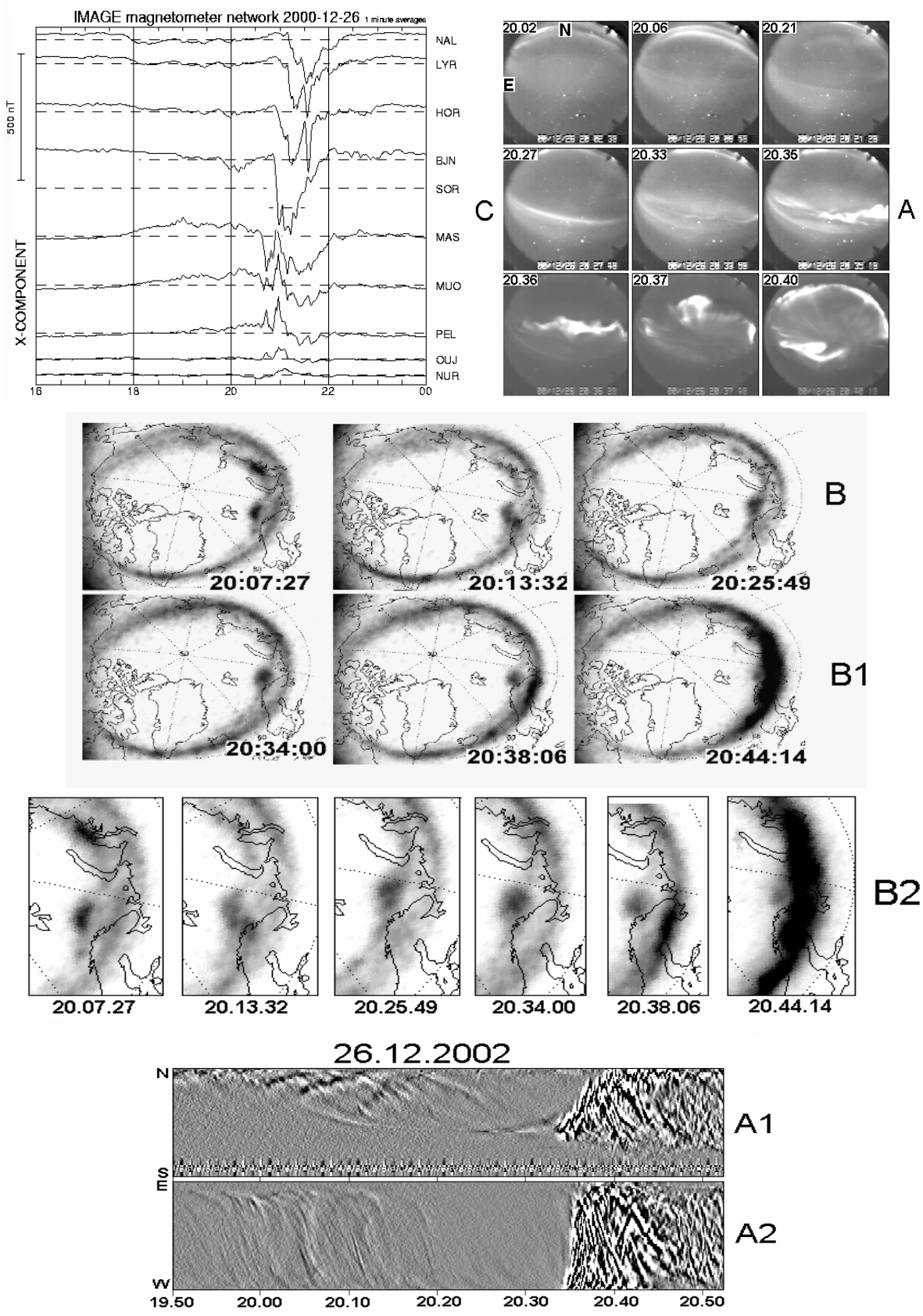

Fig. 2. The same as in Figure 1 but for a moderate breakup event.

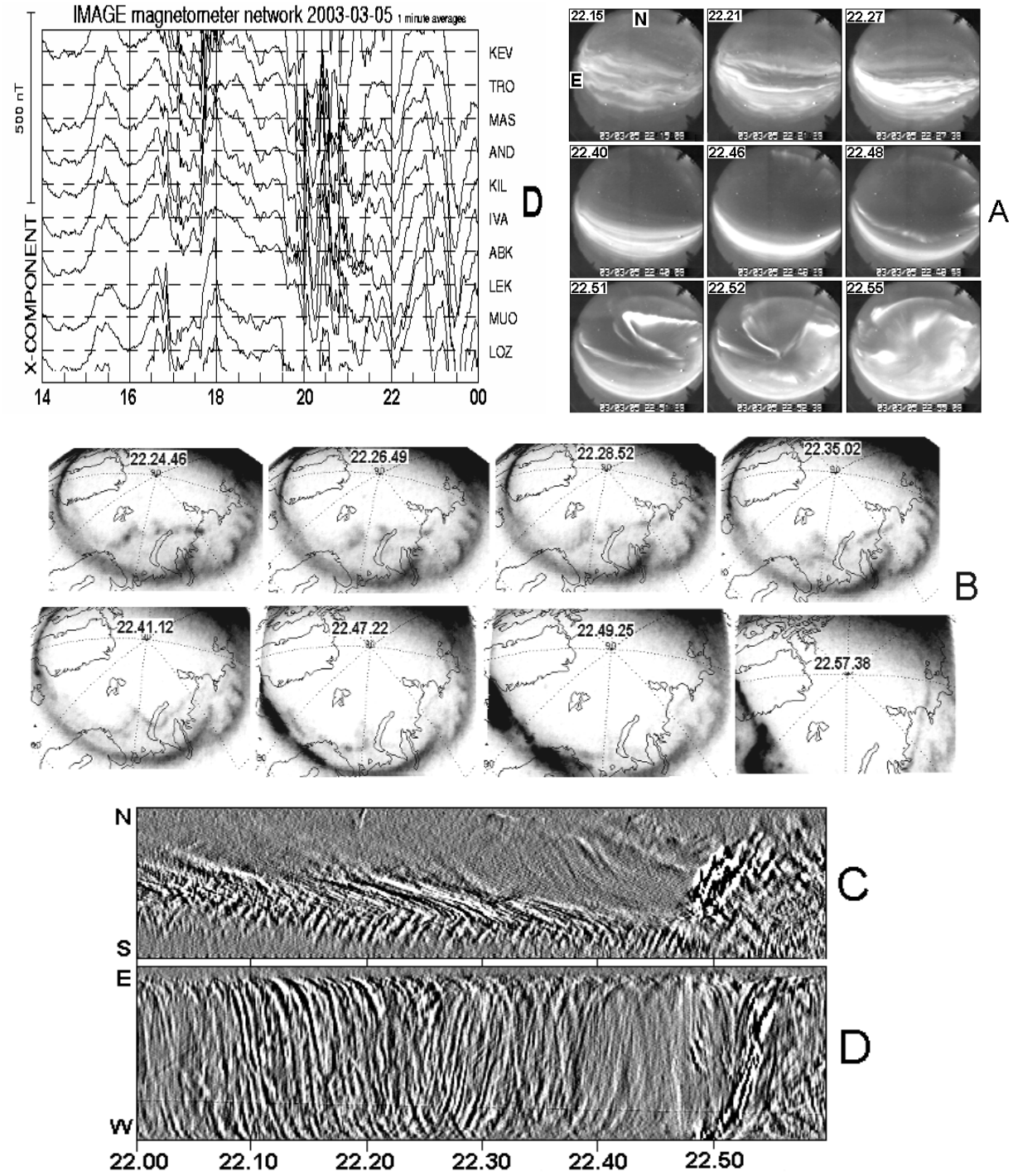

Fig.3. Very strong auroral activity spreading along the whole oval.

References

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