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Aurora morphology in the dayside

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Abstract Day-side aurora phenomena are examined by using TV image data obtained at Ny-Ålesund in Svalbard, Godhavn in Greenland and Zhongshan Station, Antarctica. Results are summarized as follows. During the quiet period, in the pre- and post-noon sectors, (1) Weak arc (Sun-aligned arc), (2) Corona aurora and (3) Band aurora are observed in these stations. During disturbed period, Corona aurora and Band aurora are also observed in the pre- and post-noon sectors. However, bright discrete aurora, instead of weak arc (Sun-aligned arc), develops from the night side oval in the dawn and dusk sectors. Pre-noon corona and post-noon band aurora are observed in the lower latitude as compared with the location of those auroras during the quiet period.

Key words dayside aurora, Sun-aligned arc, corona aurora, band-aurora.

1 Introduction

Recently, many researchers examine dayside aurora phenomena by using ground and satellite aurora data (Sandholt *et al.* 1989; Elphinstone *et al.* 1993; Smith 1994; Meng 1994; Fasel *et al.* 1994; Ayukawa *et al.* 1996; and others). Elphinstone *et al.* (1993) examined day-side aurora morphology on the basis of Viking satellite data. They categorized dayside auroras into several kinds of types and summarized their characteristics. On the other hand, there are many reports about the dayside aurora phenomena obtained on the ground. However it is not sufficiently understood their characteristics and also is not clear their relationships to the satellite aurora data. This is a reason why there are not enough simultaneous aurora data obtained at multi point ground stations and thus it must be difficult to make clear global day-side aurora morphology.

In this paper, we examined the dayside aurora phenomena by using TV data obtained at Ny-Ålesund in Svalbard, Godhavn in Greenland and Zhongshan Station, Antarctica.

2 General characteristics of day-side aurora

The appearance region and its characteristics of dayside aurora depend on the magnetic local time and Interplanetary Magnetic Field (IMF). It means that aurora observation at multi point ground stations is essential to understand the characteristics of global dayside aurora. In this study, we mainly examined Ny-Ålesund aurora data and also compared with aurora data at Godhavn in Greenland and Zhongshan Station, Antarctica (these data are not shown in this paper). Typical quiet and moderate disturbed events are illustrated in Figures 1 and 2 for explaining the characteristics of dayside aurora.

One quiet event is illustrated in Figure 1, the geomagnetic activity is not so large ($Kp = 2_- - 2_+$) and Interplanetary Magnetic Field (IMF) is mainly the northward component during the period from 0500 UT to 1100 UT and it turns to the southward after 1100 UT. Greenland and Svalbard Stations are located in the dayside. Magnetic local time at Svalbard Station is different from universal time by 3 hours (MLT=UT+ 3 hours). Aurora images obtained at Ny-Ålesund, Svalbard from 0500 - 1400 UT on December 27,1994 are shown in Fig. 1. The top left image is aurora arc in the morning sector and is traditionally called Sun-aligned arc (Lassen and Danielsen 1978). This arc developed from the dayside region and frequently observed during the northward IMF condition. The aurora luminosity is usually less than a few kR. In the top right image, corona aurora with ray structure were seen near the zenith region. This corona is typically observed in the pre-noon sector and its luminosity is stronger than arc (about a few kR). Corona aurora develops from the day-side direction in the pre-noon sector and moves to the pole-ward from the equator. According to aurora data at Godhavn, corona aurora was also observed near the zenith during this period. From Zhongshan Station data, corona aurora was frequently observed till the post-noon sector and was not observed after ~1400 MLT.

The left bottom image illustrates band aurora appeared in the post-noon sector. This band developed from the evening sector. From statistical examinations of post-noon aurora obtained at Zhongshan Station, this band aurora does not continue to the night side aurora oval. It suggests that the source of this band is different from plasma-sheet. This band mainly appears in the magnetic local time from 1400 MLT to 1600 MLT and corresponds to the post-noon bright spot observed by Viking UV imager (Lui *et al.* 1989). The right bottom panel shows the aurora arc observed in the evening sector. This arc was similar to the weak arc (Sun-aligned arc) in the morning sector and developed from the dayside directions.

Moderate disturbed event is illustrated in Figure 2, the geomagnetic activity was $Kp = 3_+$ and IMF Bz component was fluctuating between negative and positive values during the interval from 0500 UT to 1600 UT, December 25,1994. The top left image shows bright discrete aurora in the morning sector. The aurora luminosity is usually stronger than a few kR and propagates from the night side oval. From aurora data at Godhavn, similar discrete aurora was observed in the morning sector during this period. In the top right image, corona aurora is seen near the zenith region. This corona event is frequently observed in the pre-noon sector and is also observed in the post-noon sector (~1400 MLT) during the disturbed period. In this time, very active corona aurora was also seen

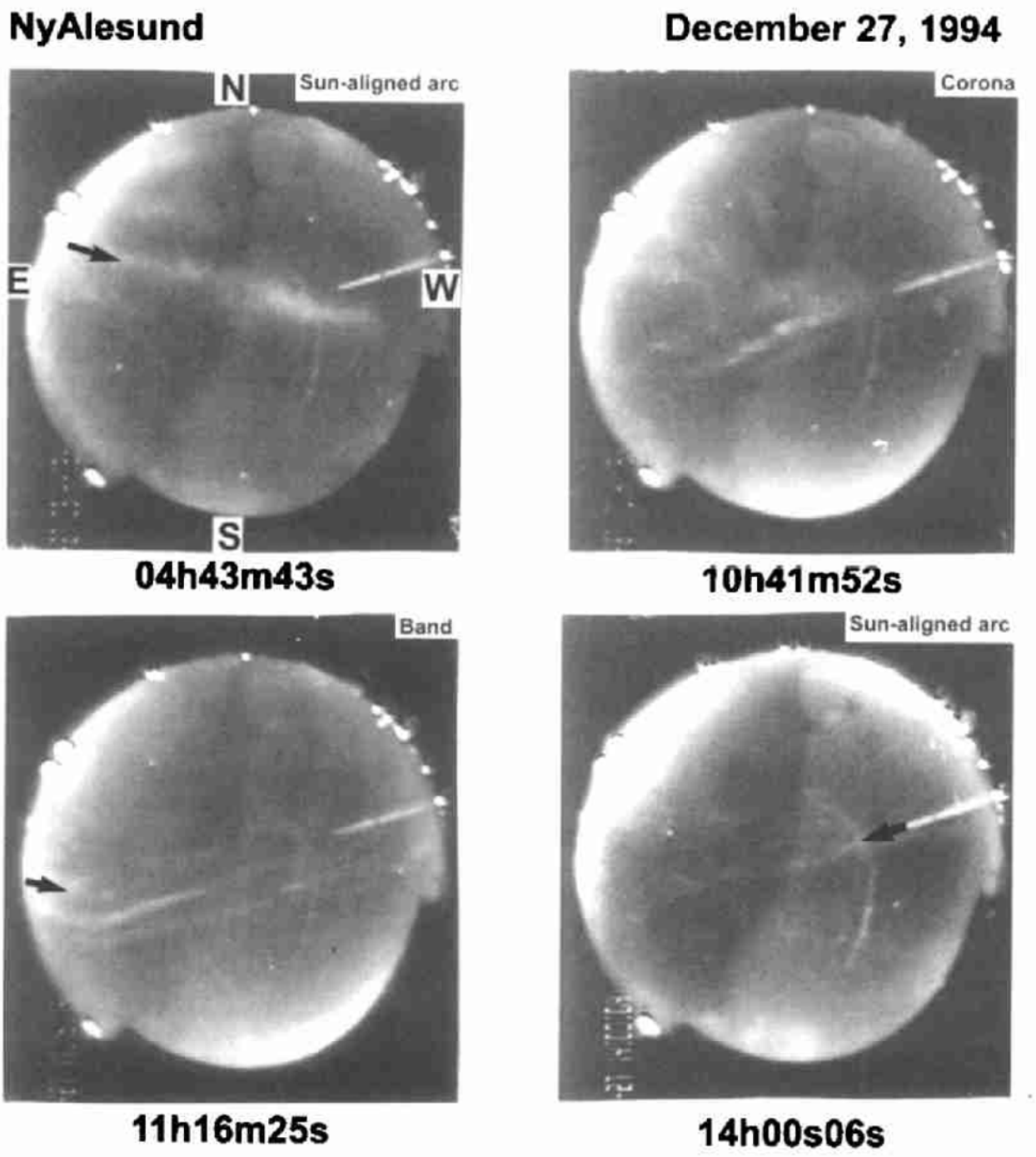

Fig. 1. Typical aurora images during quiet period at Ny-Alesund, Svalbard. Top left and right images are weak arc (Sun-aligned arc) and corona aurora respectively. Bottom left and right images are band and weak arc (Sun-aligned arc) respectively in the post-noon sector.

at Godhavn from 0800 UT to 1100 UT. The luminosity of corona during the disturbed period was stronger than that during the quiet period.

The left bottom panel illustrates the post-noon band aurora observed at the southward region (equatorward side). This band looks like developing from the night side aurora oval. The source of this band seems to be night side plasma-sheet. Right bottom panel shows the westward traveling surge developed from the evening sector. This surge appeared in associated with the substorm phenomena.

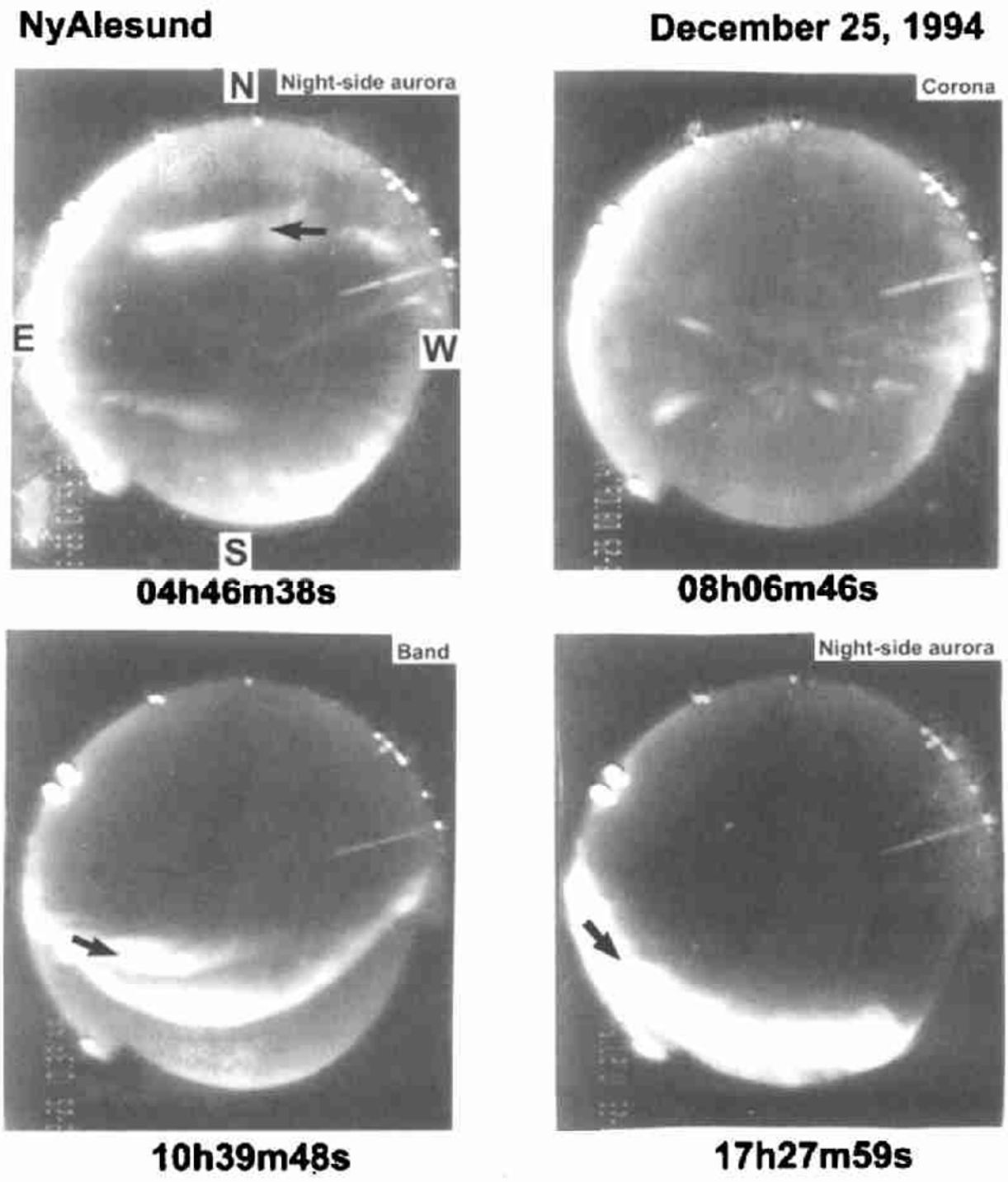

Fig. 2. Typical aurora images during moderate disturbed period at Ny-Ålesund, Svalbard. Top left and right images are bright discrete aurora and corona aurora respectively in the pre-noon sector. Bottom left and right images are band and westward traveling surge in the post-noon sector.

3 Summary and discussion

From the examinations of dayside aurora, several different kind of dayside auroras are recognized during quiet and disturbed conditions. Examination results are schematically summarized in Figure 3. During quiet period, Weak arc (Sun-aligned

arc), Corona aurora and Band aurora are seen near the pre- and post-noon sectors. Weak arc appears near the dawn and the dusk sectors. This arc develops from the day-side region and its luminosity is usually less than 1 kR. Corona aurora is mainly observed in the pre-noon sector and occasionally seen till the post-noon sector (~ 1400 MLT). Corona aurora shows the ray-structure and its luminosity is higher than a few kR. Corona develops from the dayside and moves to the pole-ward direction from the equator. Band aurora is observed in the post noon sector (1200 - 1600 MLT). This aurora shows the homogeneous structure and its luminosity is higher than a few kR. Band aurora develops from the evening sector, however it does not continue to aurora oval in the night side region. It suggests that the particle source of band aurora is different from the plasma-sheet. Although we did not show the typical example of "plasma mantle arc" in this paper, this arc is sometimes observed near the noon sector. Plasma mantle arc is very faint less than a few kR and with line structure.

During disturbed period, corona and band aurora appear in the pre- and post-noon sectors, respectively. The appearance regions of corona and band aurora are seen in lower latitudes as compared with the location of auroras during the quiet period. In the dawn

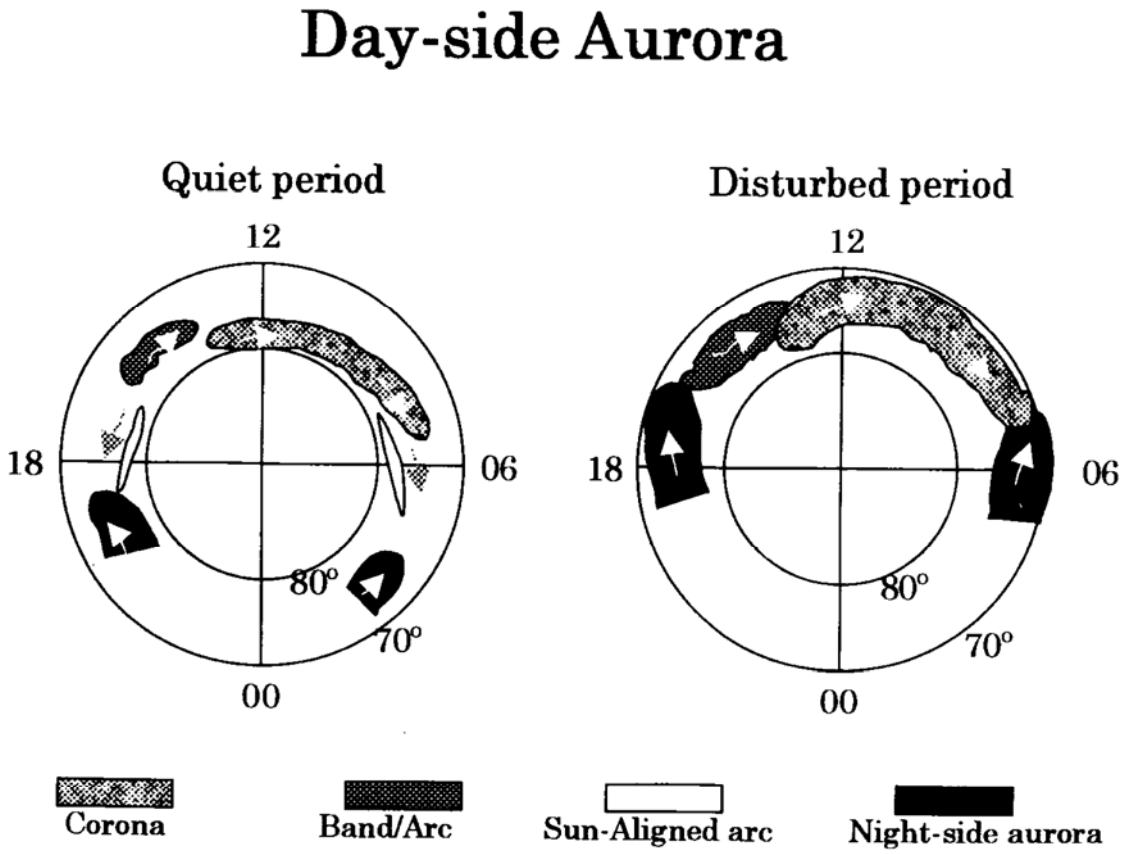

Fig. 3. Left panel illustrates day-side aurora during quiet period. (1) Weak arc (Sun-aligned arc) is seen in the dawn and the dusk sector; (2) Corona aurora is seen from the morning to the noon sector; (3) Band aurora is seen in the post-noon sectors. Right panel illustrates day-side aurora during moderate disturbed period. (1) Bright discrete aurora appears in the dawn and dusk sectors instead of weak arc (Sun-aligned arc); (2) Corona is seen in the prenoon sector; (3) Band aurora appear in the post-noon sectors. The appearance regions of corona and band aurora are in lower latitudes as compared with the location of auroras during the quiet period.

and the dusk sectors, bright discrete aurora develops from the night side region instead of weak arc (Sun-aligned arc). These bright auroras belong to the night side aurora oval.

From the comparison between these day-side auroras and simultaneous particle precipitation data obtained by DMSP satellite, we considered that weak arc (Sun-aligned arc) is originated in the low latitude boundary layer particles and corona aurora seems to relate to the plasma sheet or low latitude boundary layer. Source of plasma mantle arc must be plasma mantle and bright band looks like corresponding to low latitude boundary layer.

The relationships between IMF fluctuations and time developing of dayside aurora are not examined here in detail but it seems important to make further understanding of the physical processes between solar wind particles and dayside magnetosphere.

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