SuperDARN レーダーによる高時間分解能二次元電離圏電場観測

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A new SuperDARN high temporal two-dimensional resolution ionospheric electric field observation

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The mechanisms responsible for the creation of pulsating aurora remain controversial. Furthermore whether the ionosphere plays an important role is also unknown. It has recently been revealed that the electric field collocated with pulsating aurora shows periodic variations closely synchronised with an occurrence of the aurora by analysing electric field data along a single SuperDARN beam and simultaneous optical auroral data with an all-sky TV camera [Hosokawa et al., JGR, 2008, 2010]. Hosokawa et al., 2009 also discovered a bipolar signature in electric field data when transient break-up aurora passed over a SuperDARN single beam and inferred the transient 2-D electric field structure and its temporal evolution. To investigate the physical mechanism of such transient aurora and the associated electric field modulation, it is essential to know the structure and temporal variation of the two-dimensional electric field surrounding the aurora. However, as it takes at least 1 second to measure one-dimensional electric field data (along a single beam) with the conventional SuperDARN technique, it has been difficult to obtain two-dimensional electric field data with a temporal resolution that is high enough to resolve such variations. We have developed a new SuperDARN observational technique to overcome this problem and successfully obtained two-dimensional high temporal resolution SuperDARN electric field data and optical pulsating aurora simultaneously for the first time during the Iceland-Syowa geomagnetically conjugate auroral observation campaign period in September, 2009 [Yukimatu et al., 2010] and also in a more improved mode in September, 2010. The new technique and initial results will be described and discussed in detail and further application of this new technique will be shown.

脈動オーロラの数秒程度の周期の明滅と同期して、オーロラ近傍の電離圏電場が変動していることが、SuperDARN レーダーの特定ビームの一次元高時間分解能電場観測によって明らかにされてきた[Hosokawa et al., JGR, 2008, 2010]。脈動オーロラの明滅機構は多くのモデルが提唱されてきたが未解明のままであり、新たに見出された、同期する電場変動が脈動オーロラのどの様な物理機構と関わるのかも不詳のままである。一方ブレイクアップオーロラが通過する折その近傍で bipolar な電場変動が捉えられた[Hosokawa et al., 2009]。これらを真に理解する為には、オーロラ近傍の二次元電場構造とその時間発展を高い時間分解能で詳細に把握する必要がある。従来の観測手法では、レーダー1 ビームの観測に数秒、最速でも 1 秒程度の積分時間を要し、数秒程度で変動するオーロラに同期する電場の二次元構造を捉えることは困難であった。我々は、SuperDARN レーダーで、十分な S/N 比が得られ、ある条件を満たせば、1 秒程度の高い時間分解能で、二次元電場を観測できる観測手法を提案・開発した[Yukimatu et al., 2010]。この観測手法と、昨 2009 年 9 月及び本 2010 年 9 月に実施されたアイスランドにおける初期実験の解析結果を詳述し、高時間分解能オーロラ同時光学観測との比較解析の初期結果を詳述すると共に、この新しい観測手法の応用についても議論する。

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