Radio and Space Plasma Physics Group

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The influence of magnetospheric substorms on high-latitude ionospheric convection

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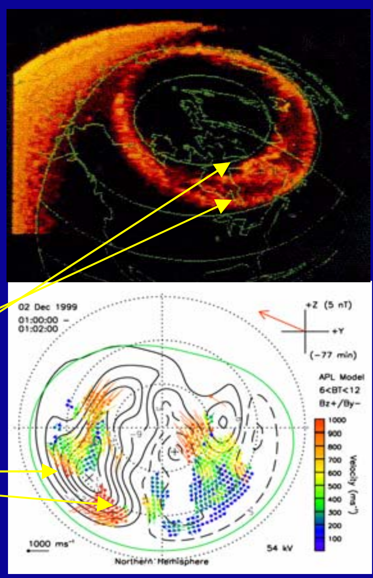
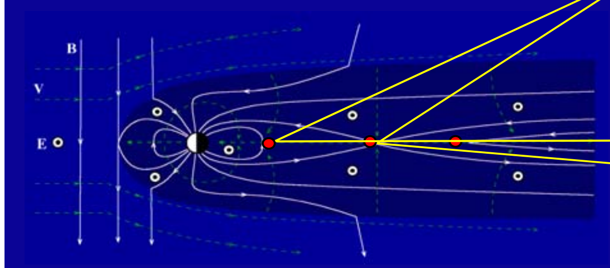
Why do we want to know?

Substorms are a global process

THEMIS will make unprecedented in-situ observations but these will still be local point measurements

The high-latitude ionosphere can tell us about the dynamics of the entire magnetosphere





Introduction

A number of statistical studies have attempted to determine the ionospheric convection response to substorms (e.g. Provan et al., 2004; Bristow and Jensen, 2007)

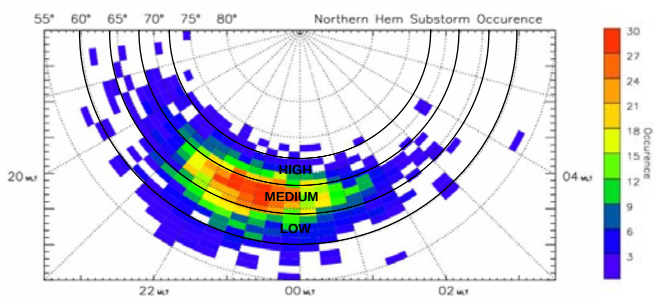
These studies have involved a limited number of substorms such that all events had to be artificially combined into a single substorm coordinate system

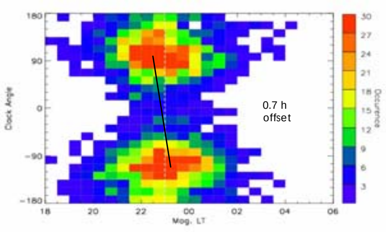
Here we analyse SuperDARN radar data from 1979 northern hemisphere isolated substorms that were identified in IMAGE FUV satellite data (Frey et al., 2004; Wild and Grocott, 2008)

The substorms have then been grouped according to onset latitude using similar criteria to Milan et al. (2008) in their discussion of average substorm auroral evolution

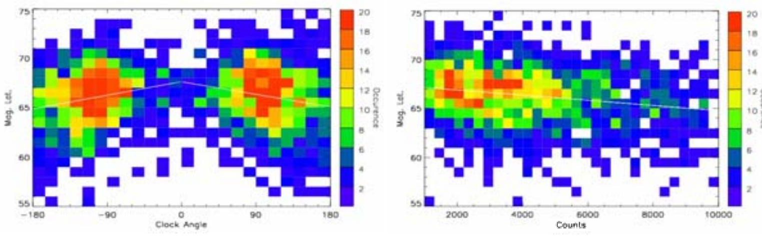
The local and global influence of substorms on the average SuperDARN convection patterns has then been studied

Substorm Statistics





Substorm onset MLT is only weakly correlated to IMF clock angle



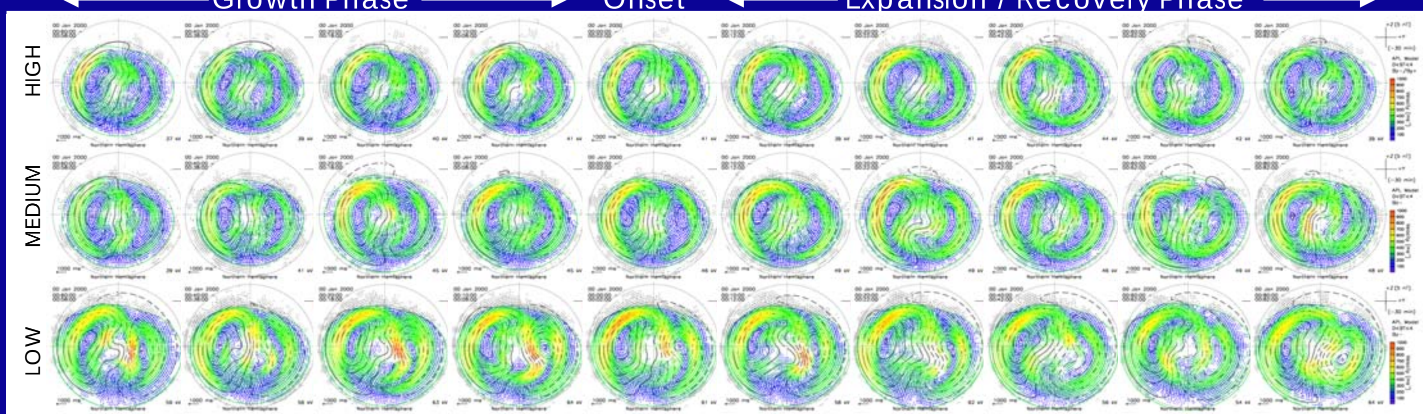
Substorm onset latitude is correlated to both IMF clock angle and substorm intensity

SuperDARN Average Substorm Convection Maps

Growth Phase → Onset ← Expansion / Recovery Phase →

Large-scale convection becomes enhanced during the growth phase (due to dayside reconnection)

Lower-latitude substorms are associated with more intense pre-existing convection



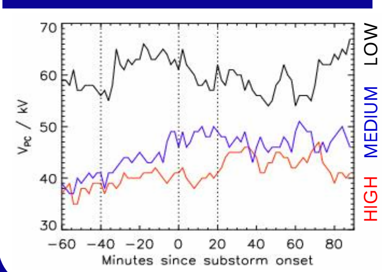
After ~80 minutes the flows related to high latitude substorms are subsiding whereas those associated with low latitude ones remain intense

The Harang discontinuity is most evident for mid-latitude substorms

The suppression of flow at substorm onset is most evident for low-latitude events

By ~20 minutes into the expansion phase all latitude bins show an enhancement to the nightside convection

Global Response

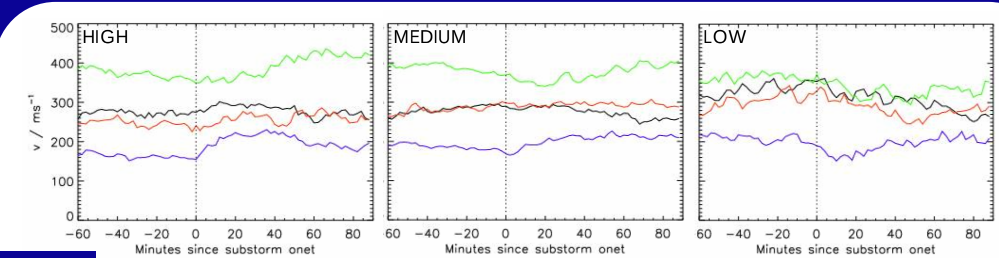


Low-latitude: strongest overall convection but most severe post-onset drop

Mid-latitude: modest convection enhancement during the expansion phase

High-latitude: show a marked convection enhancement which begins ~20 minutes post-onset

Local Response



- The fastest flows are in the dusk convection cell
- The nightside flows are in general the slowest
- There is a definite enhancement in the nightside flows for high latitude onset events
- The enhancement is less for medium latitude onset events with a decrease evident for low-latitude onset events

Conclusions

Low-latitude substorms: are generally of larger intensity and are associated with intervals of stronger convection, BUT more noticeably suppress the flow immediately after onset

Mid-latitude substorms: have a more significant effect globally than high-latitude substorms but do not produce a very large enhancement in the flows locally

High-latitude substorms: are slower at producing a large-scale convection response but produce the most noticeable enhancement to the flow in the locally disturbed region

Refs

Bristow and Jensen, A superposed epoch study of convection during substorms, J. Geophys. Res., 112, 2007.
Frey et al., Substorm onset observations by IMAGE-FUV, J. Geophys. Res., 109, 2004.
Milan et al., A superposed epoch analysis of auroral evolution during substorms, ICS-9, 2008.
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