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Interactive comment on "The asymmetric geospace as displayed during the geomagnetic storm on August 17, 2001" *by* Nikolai Østgaard et al.

Anonymous Referee #1

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This paper presents a highly interesting study of the dynamical behaviour of the magnetosphere based on asymmetric observations of auroral and convection features in the ionosphere. The combination of a large IMF By component and a large tilt angle due to the season sets up a highly asymmetric system that can be studied in both polar ionospheres in order to probe variations in the internal structure of the magnetosphere. The paper clearly showcases the power of simultaneous auroral image observations in both hemispheres, which can be used to address big questions of magnetospheric physics not possible from in-situ magnetospheric measurements alone. The video produced for the supplementary information provides an excellent way of viewing the event as a whole and of how all the different data sources fit together. Visual information like

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this is incredibly useful for helping to understand the strengths and limitations of a data set.

Major Comments:

(1) I have a few questions regarding the determination and portrayal of ionospheric convection in the paper that the authors need to clarify: (i) Does the determination of the convection using the SECs method use any 'in-fill' data (such as a convection climatology e.g., Weimer, Ruohoniemi and Greenwald, Cousins and Shepherd) to cover regions where there are little or no real data? If not, how reliable do you think the convection solutions are in these regions? (ii) The flow vectors shown from the DMSP SSIES instrument appear to be 2-D vectors. Although the cross-track ion velocities measured by the ion drift meter on DMSP SSIES are very reliable data, I had thought that there were issues with the along-track velocity estimates. Is this not the case? (iii) In Figure 11, the convection map in 11C is 'now drawn by hand'. Why? Is it not possible to reproduce the map presented in 11A? (iv) In Figure 11D, the convection map is 'drawn by hand, guided by the few available SuperDARN vectors. . .'. Is it not possible to use a climatological model to better estimate the global convection here (which SuperDARN or other datasets can provide)?

(2) I also have a query about the scaling between SI13 and VIS. The IMAGE spacecraft is clearly close to apogee for both time intervals considered in the paper (the scaling interval and the two-hemisphere interval). What is the orbit of POLAR at this time? My concern is that at the time of the scaling, POLAR is close to perigee, whereas during the time of the two-hemisphere observations it is closer to apogee. This would mean that the spatial size of the measurement cells in the ionosphere are different for the observations made by VIS in the two hemispheres (this is implied by the video, as the overall field of view of VIS is much smaller in the northern hemisphere when the spacecraft is closer to perigee). Does this difference in VIS cell size in the two hemispheres affect the number of counts that are typically measured within a cell? And does this therefore affect the measured intensity? If so then this might cast some

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doubt over the scaling – it may not be as simple as implied in the paper.

Minor Comments:

(1) The authors should consider referencing the work of Grocott et al. in the paper introduction (and elsewhere in the paper if appropriate). For example, Grocott et al. (2010), Superposed epoch analysis of the ionospheric convection evolution during substorms: IMF By dependence, JGR, 115, A00106, doi:10.1029/2010JA015728 (and also see papers referenced within). This paper shows the IMF By-dependent dawn-dusk asymmetry in convection being reduced at substorm onset.

(2) Page 4, Section 2 – At no point is it stated what co-ordinate system is being used for the plotting of the polar data. As IMAGE data are typically in APEX co-ordinates, and SuperDARN and DMSP measurements are often in AACGM co-ordinates, it should be made clear what co-ordinate system has been used in the polar plots.

(3) Page 4, Section 2 – Although there are instrumental references for the IMAGE, POLAR and OMNI data, there are no instrumental references for SuperDARN, SuperMAG, DMSP and CHAMP. This should be rectified.

(4) Page 14, Figure 7 – The blue symbols in panel A are very hard to see on the coloured background. You might want to consider an alternative way of displaying these symbols.

(5) Page 17, Lines 7-10 and Figure 10 – The text implies that the measurements of DeltaMLT combine observations from the poleward edge of the oval with those nearer to the equatorward edge. However, the modelling work presented earlier has already shown that the offsets in these two regions will be different. If the measurements were all from the poleward edge then this would reinforce the suggestion that the changes are substorm related.

(6) Page 19, Figure 11 and Page 20, Figure 12 – How are the reconnection regions (red lines) identified? The equipotential contours in figure 11A suggest that there is flow

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across the OCB across most of the nightside (if the dawn convection cell is included).

(7) Page 21, Lines 4-5 and Page 22, Figure 14 – Considering the text 'The equatorward convection just outside the auroral oval near noon is probably an artefact of the inversion, since the solution there is relatively unconstrained by observations compared to the surrounding regions'. This may be true. However, the observed convection variation around noon may also be the signature of split reconnection X-lines. If one considers the preferential anti-parallel reconnection regions on the magnetopause during IMF By-dominated conditions, the reconnection regions are split into two separate regions, one at high latitude in the northern hemisphere, and one at high latitude in the southern hemisphere. This can lead to an ionospheric convection signature that is characterised by two poleward flow regions either side of noon (mapping to the two reconnection regions) with a reduced flow region, and possibly no flow across the OCB, very close to noon. (See Chisham et al. (2002), Ionospheric signatures of split reconnection X-lines during conditions of IMF Bz<0 and |By|∼|Bz|: Evidence for the antiparallel merging hypothesis, JGR, 107(A10), 1323, doi:10.1029/2001JA009124).

(8) Page 25, Line 1 – 'Mapped into the plasma sheet they cover huge regions'. The use of the word 'huge' is very vague. It should be possible to put some approximate value to this.

Other Comments and Typos:

(1) Page 3, Line 12 – 'do' should be 'does'.

(2) Page 3, Line 24 – 'is' should be 'are'.

(3) Page 4, Line 20 – 'is' should be 'are'.

(4) Page 5, Line 26 – It would read better if '. . .more energetic electrons drifting towards dawn scattered into the loss cone. . .' was written '. . .more energetic electrons drifting towards dawn where they are scattered into the loss cone. . .'.

(5) Page 7, Line 4 – 'weigh' should be 'weight'.

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(6) Page 15, Line 9 – ‘Figure 7B and 7B’ should be ‘Figures 7B and 7C’.

(7) Page 15, Section 4.5 title – This should possibly be retitled ‘Why latitudinally wider aurora in the southern dawn?’ to distinguish it from being wider in MLT.

(8) Page 18, Line 3 – ‘have’ should be ‘has’.

(9) Page 18, Line 9 – ‘. . .for the period we observe large asymmetry’ should be ‘. . .for the period when we observe large asymmetry’.

(10) Page 20, Line 3 – remove one of the ‘the’s.

(11) Page 20, Line 3 – ‘hemisphere’ should be ‘hemispheres’.

(12) Page 23, Line 12 – remove ‘being’.

(13) Page 23, Line 14 – ‘encounters’ should be ‘encounter’.

(14) Page 23, Line 19 – ‘leads’ should be ‘lead’.

(15) Page 25, Line 20 – ‘summerize’ should be ‘summerized’.

(16) Page 25, Line 28 – ‘in’ should be ‘at’.

(17) Page 27, Line 5 – The SuperDARN acknowledgement should include ‘Italy’ in the list of countries.

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