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Comment on 'On the source region of traveling convection vortices' by A. G. Yahnin et al.

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Abstract. The source regions of traveling convection vortices (TCV) observed in the dayside magnetosphere outside the near noon sector have been mapped to magnetospheric locations within the outer radiation belt, but not to the Central Plasma Sheet (CPS) as claimed by *Yahnin and Moretta* [1996] and *Yahnin et al.* [1997]. Their suggested connection between TCV and the CPS is based on the unjustified application of terminology traditionally used for the auroral precipitation structure in the nightside magnetospheric sector [*Winningham et al.* 1975] to the late morning-noon sector. This is a case where an important finding on the location of TCV with respect to natural magnetospheric boundaries has been presented using misleading terminology, which leads to an incorrect physical interpretation of the result. Hence this Comment emphasizes the need for a critical reexamination and modification of the "traditional" terminology concerning the plasma domain structure in the magnetosphere.

Yahnin and Moretta [1996] and *Yahnin et al.* [1997; hereafter Y97] used low-altitude satellite particle measurements to determine the magnetospheric domain in which the travelling TCV-related currents originated. Spectrograms of low-energy particles ($E < 20$ keV) measured by the DMSP satellites were used to select the boundaries of plasma precipitation regions with various particle characteristics. These regions were then identified with magnetospheric plasma domains such as the CPS, BPS (boundary plasma sheet), LLBL (low latitude boundary layer), and so on. The coordinates of the precipitation-region boundaries were determined by means of the automated method of *Newell et al.* [1991] and *Newell and Meng* [1992]. On the basis of the traditional terminology for plasma precipitation regions used by *Newell et al.* [1991], Y97 concluded that the focii and trajectories of TCV lie inside the central plasma sheet near the CPS/BPS boundary.

Until recently, the most widely used descriptions of nightside auroral precipitation-region structures and corresponding terminology were those proposed by *Winningham et al.* [1975; hereafter W75] . According to W75, the area of auroral electron precipitation in the near-midnight sector is located poleward from the outer radiation belt, and is composed of diffuse and structured precipitations from the central and boundary plasma sheets (CPS and BPS), respectively. Under the categorization of auroral precipitations in the dayside sector proposed by *Newell and Meng* [1992], the diffuse and discrete precipitations equatorward of the LLBL are denoted "traditional CPS" and "traditional BPS", respectively, by analogy to the nightside notation.

Feldstein and Galperin [1985, hereafter FG85; 1993, hereafter FG93] and *Galperin and Feldstein* [1991, hereafter GF91; 1996, hereafter GF96] have shown that the terms BPS and CPS, as commonly used during the last 20 years, are not appropriate descriptions of auroral energetic-plasma precipitation in the night sector. In fact, CPS and BPS denote precipitations which have absolutely no relation to either the central plasma sheet or the boundary plasma sheet in the magnetotail. According to FG85 and GF96, the precipitation region can be divided into three parts with increasing geomagnetic latitude: equatorial diffuse precipitations, structured precipitations of accelerated particles (discrete auroral forms inside the auroral oval), and weak low-energy electron precipitation with VDIS-2 (velocity-dispersed ion structures of the second type) just poleward of the bright auroral oval. These three characteristic plasma structures are mapped along magnetic field-lines to the nightside magnetosphere as follows: to the Remnant Layer, a region of large-scale sunward convection within the outer radiation belt (RL); to the Central Plasma Sheet, a region mainly comprised of hot plasma on stretched field lines on both sides of the magnetotail current sheet; and to the Boundary Plasma Sheet at the boundaries of the tail lobes and the plasma sheet in the upper and lower parts of the tail, including the Plasma Sheet Boundary Layer (PSBL) and Low Energy Layers (LEL) [FG85; GF96]. Correspondingly, PSBL is characterized by the presence of VDIS-2, and the LEL salient feature is counterstreaming, very low-energy electron and ion beams.

A special analysis of simultaneous plasma measurements by geosynchronous satellites and by low-altitude satellites above auroral regions was performed by *Hones et al.* [1996]. Their result was: "our analysis of the full data set refutes the view that the auroral oval of discrete forms maps to the plasma sheet boundary layer and that the equatorward diffuse aurora is the main portion of the plasma sheet. The analysis supports, instead, the opinion of *Feldstein and Galperin* [1985] that the auroral oval is the mapping of the plasma sheet's full thickness and the diffuse aurora maps into the outer radiation belt". Thus, as demonstrated by the *in situ* measurements of high-altitude satellites, diffuse plasma precipitations equatorwards of the auroral oval are mapped to the region of the outer radiation belt but not to the central plasma sheet. The discovery of the LEL structure at the outer edge of the plasma sheet [*Parks et al.* 1992] also supports the correctness of the mapping scheme by FG85 for the plasma sheet periphery [*Feldstein and Galperin* 1994]. Further improvement of this scheme and algorithms developed for automatic iden-

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tification of plasma structure boundaries on the basis of low-altitude DMSP spectrograms are presented by *Newell et al.* [1996].

Newell et al. [1991] extended the identification of CPS/BPS by W75 to the dayside sector. Since then, some researchers have continued to use the erroneous terminology of "traditional CPS" and "traditional BPS" mapping to the central plasma sheet and boundary plasma sheet, respectively. Below I demonstrate that the use of this "traditional" notation can lead to incorrect conclusions about the magnetospheric sources of geophysical phenomena observed from Earth, using the work of *Yahnin and Moretto* [1996] and *Yahnin et al.* [1997] as examples.

For 5 events detected by ground-based observations, Y97 found that the TCV focii were located in the "traditional CPS" region, so they concluded that the TCV sources were really placed in the central plasma sheet. For two cases (June 28, 1986 and December 17, 1990), I was able to calculate the magnetospheric magnetic field from observations using the empirical model of *Tsyganenko* [1995, hereafter T95] and the conceptual, paraboloid model of *Alexeev et al.* [1996, hereafter A96]. The parameters which serve as an input for the T95 model are the solar wind pressure (P), the IMF components (By and Bz), Dst indices, and the geomagnetic dipole orientation (angle Ψ). The A96 model requires two additional parameters — the geocentric distance to the inner boundary of the magnetotail current sheet, and the magnetic flux from the polar cap — which were determined from DMSP plasma observations.

Figure 1 presents the results of mapping the TCV focus location to the magnetosphere for the June 28 event ($\Phi' = 75°$, MLT = 1000 h), using the predictions of the T95 model (Figure 1a) and the A96 model (Figure 1b). The projection of the field-line with the TCV focus at its footpoint in the northern hemisphere is depicted in the meridional (Z, $\sqrt{X^2 + Y^2}$) and equatorial (X, Y) planes. Figure 1b also shows the modeled magnetopause location in the corresponding planes. The field-line threading the TCV location in both models does not bend far to the magnetospheric night side and does not map to the central plasma sheet, which is located in the night side of the magnetosphere according to any standard textbook. Instead, the magnetic field-line threading the TCV focus is located within the outer radiation belt at a distance $\sim 1Re$ from the magnetopause at apex of the field line.

Mapping the TCV focus to the magnetosphere for the December 17 event gives similar results. Additional confirmation of the TCV location in the outer radiation belt is its position inside the poleward boundary of the region of trapped energetic ($E > 30$ keV) electrons according to NOAA-10 satellite observations (Y97). This boundary coincides with the auroral oval equatorial boundary and, hence, with the boundary between the "traditional CPS and BPS". Note that *Yahnin et al.* [1995] carried out similar mapping of the TCV foci to the magnetosphere using of the *Tsyganenko* [1989] magnetic field model, whereas the present paper relies on the up-to-date T95 and A96 magnetic-field models.

Therefore, the usage of "traditional CPS/BPS" terminology when identifying the structural boundaries of plasma precipitation at low latitudes led Yahnin et al. to incorrectly identify the TCV source positions. TCV sources are indeed located well within the magnetosphere, as shown by Y97, but in the outer radiation belt rather than the central plasma sheet. Hence, the field-aligned currents related to the TCV originate not in the plasma sheet, as Y97 stated, but in the outer radiation belt. This incorrect treatment could be evaded if the papers under consideration critically reassess the traditional CPS/BPS identification, as done by *Newell et al.* [1996], FG85, FG93 and GF91.

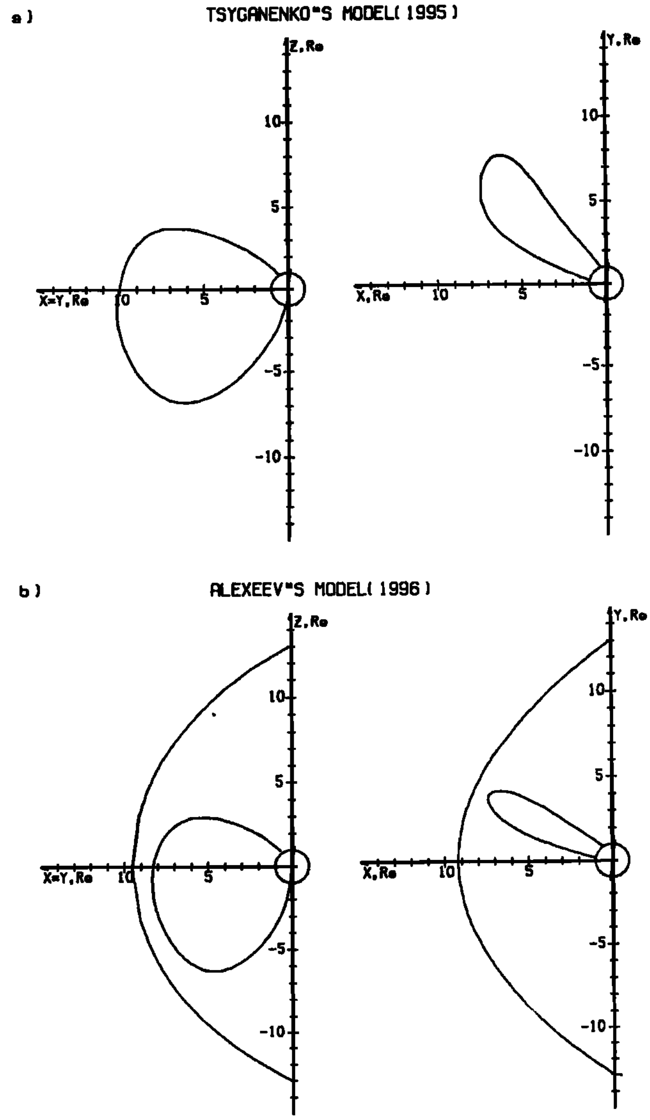

Figure 1. TCV focus mapping to the magnetosphere on June 28, 1986 using (a) *Tsyganenko* [1995] and (b) *Alexeev et al.* [1996] paraboloid external magnetic-field models. The magnetic field-line in the meridional plane is presented at left, and its projection to the equatorial plane is shown at right. For the paraboloid model (b), the modeled location of the magnetopause in the corresponding planes is included as well.

The misunderstanding of magnetospheric TCV sources discussed above testifies once more to the desirability of a terminology revision and the fulfillment of the following recommendation of IAGA Working Group IIF/III4

("Extension of the Auroral Oval and Polar Cap into the Magnetosphere") at the IAGA Assembly in Boulder, July 1995: "The community should decouple nomenclature of ionospheric populations from magnetospheric populations, creating a set of operational definitions which are model independent". Efforts to apply this IAGA WG recommendation have been used by *Newell et al.* [1996] and *Feldstein and Galperin* [1996].

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