

## Plasma velocity enhancements in the near-Earth tail lobe for substorm development

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The transition to lobe field line reconnection from plasma sheet reconnection at the NENL was studied using Geotail plasma and magnetic field data. We identified lobe observation intervals occurring between  $X = -10$  and  $-35$  Re for which low-latitude ground station Kakioka has Pi 2 onset in the nightside local time. Most of these lobe substorm events have velocity enhancements toward the neutral sheet. The velocity vectors often have significant dawn-dusk components immediately after the enhancement, and become aligned more or less with a north-south direction in a few minutes. Focusing on this direction change, we discuss the dawn-dusk expansion of the reconnection region and its significance for substorm development.

Reconnection starts at the NENL in the plasma sheet a few minutes prior to a ground substorm onset signature, and proceeds to the lobe field lines. How the transition to the lobe is associated with substorm onset and development was studied using Geotail data. We first identified lobe intervals by examining 12-s averages of magnetic field and plasma data obtained earthward of  $X = -50$  Re for November 1994 through February 1997. The lobe observation frequency has clear dawn-dusk asymmetry particularly in the region of  $X = -15$  to  $-30$  Re in such a manner that the frequencies are higher in the dusk than in the dawn. Considering that the Geotail orbits are mostly near the equatorial plane, this asymmetry can be interpreted as the plasma sheet thinning associated with the NENL formation. We then selected lobe observation intervals occurring between  $X = -10$  and  $-35$  Re for which low-latitude ground station Kakioka has Pi 2 onset in the nightside LT (defined here as 1900 &#8211; 0400 LT). Most of events have total field decrease near substorm onset, and can be categorized into 2 types. The first type represents that the field is tilting southward when the total field starts to decrease and that the plasma velocity is enhanced toward the neutral sheet around the  $B_z$  minimum. This corresponds to a traveling compression region when rapid field increase occurs before the field decreases. The second type shows that  $B_z$  is tilting northward at the start of the field decrease and that the velocity is enhanced toward the neutral sheet similarly. This type occurs earthward of  $X = -20$  Re, which is clearly in contrast with the first type occurring tailward of  $X = -20$  Re. This occurrence tendency is consistent with the NENL operating around  $X = -20$  Re. In most cases, the velocity enhancements occur between one minute before and after substorm onset. In a few minutes after the enhancement the velocity reaches the magnitude of 0.02 &#8211; 0.1 of the lobe Alfvén speed. The velocity vectors often have significant dawn-dusk components immediately after the enhancement, and then becomes aligned more or less with a north-south direction. With the spatial distribution of the lobe occurrence frequencies and the temporal variations of the velocity enhancement vectors, we present the dawn-dusk expansion of the reconnection region, and discuss its significance for substorm development.