Near-tail region as a major reservoir of substorm energy

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In order to understand the energetics of substorms, it is an important and basic question where and when the energy is stored and released in the magnetotail. However, the comprehensive knowledge of the substorm magnitude dependence of substorm features (the occurrence area, the pattern of the energy storage and release, etc.) is still lacking. The purpose of this paper is to investigate in a model-independent manner the energy storage and release process of substorms as a function of both the position and the substorm magnitude. We have performed the superposed epoch analysis of the total pressure for each group. One of the results is that both the amount and the increasing rate of the energy in (-15<X<-6Re, -8<Y<8Re) strongly depend on the substorm intensity.

In order to understand the energetics of substorms, it is an important and basic question where and when the energy is stored and released in the magnetotail. There are two popular scenarios to answer the question. One is the near-Earth neutral line (NENL) model and the other is the current disruption model. So many studies have been made based on each model. However, the comprehensive knowledge of the substorm magnitude dependence of substorm features (the occurrence area, the pattern of the energy storage and release, etc.) is still lacking. The purpose of this paper is to investigate in a model-independent manner the energy storage and release process of substorms as a function of both the position and the substorm magnitude.

To carry out a statistical study, we identify substorm onsets on condition that the Pi2 is simultaneously observed at three mid- to low-latitude ground stations along the 210MM or in South American region, when they are located near the midnight sector. In order to enable a clear recognition of the energy storage and release process, we choose substorm onsets with no other onsets in the preceding 30-min interval. As an index of the substorm magnitude, we use the amplitude of the positive bay observed at mid and low latitudes; because the positive bay is the remote effect of the substorm wedge current system at the auroral latitudes, local perturbations of the current density in the wedge current system are smoothed out and thus the amplitude of the positive bay is regarded as a good indicator of the total magnitude of the wedge current. As an index of the energy storage and release in the magnetotail, we use the total pressure obtained by GEOTAIL. From over four years' worth of data we have identified about 250 substorms. We have classified the events by their magnitudes and occurrence areas and performed the superposed epoch analysis of the total pressure for each group. One of the results is that both the amount and the increasing rate of the energy in (-15<X<-6Re, -8<Y<8Re) strongly depend on the substorm intensity. We have also found a difference of offsets in total pressure profiles between large and small substorm groups. Thus we have examined solar wind dynamic pressure before the onsets. As a result, the solar wind dynamic pressure was larger for the large substorm group. We correct the offset by using the solar wind data for each event and discuss about the energy transfer processes.