

## Automatic scaling of echo traces on ionogram for elucidation of a global current system

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Space weather occurs in a magnetosphere-ionosphere-atmosphere and solar-wind coupled system. In ionosphere, ionospheric current produces Ampere force and generates plasma motions. The motions of plasma and associated mechanical process excite electromotive force and resultant electric field. Curl of electric field causes magnetic field disturbances and evolution of ionospheric current. Therefore, it is very important to investigate an electromagnetism and dynamic process of ionospheric plasma for comprehensive understanding (i.e., causality and global aspects) of space weather phenomena.

Ionogram, observing data of ionosphere, gives important information of plasma behavior in the ionosphere such as ionospheric electron density and of which altitude variation. So ionogram is very useful for analyzing motion of plasma in variety of space weather phenomena. Ionospheric observations start 1920s, but the technique for automatic scaling of echo traces on ionogram hasn't been established yet because of the complexity of data and considerable variations.

For the above reasons, in this study, we develop a new algorithm for automatically scaling ionospheric echoes applying image analysis. Our method has five steps: 1. Data extraction in proportion to intensity of reflection. 2. Sampling echo traces density of data. 3. Removing scattered noise. 4. Acquisition of  $f_o$  (frequency of each layers) and  $h$  (height of each layers). Using this method, we successfully get echo traces,  $f_o$  (frequency of each layers) and  $h$  (height of each layers). It enables speedy and objective process for a large amount of ionogram data, and it helps to clarify a variety of space weather phenomena.

Applying above new technique, we try to understand how polar to equatorial (P-E) coupled channel is formed during substorm processes. As for the onset process of substorm, Imajo et al., (2015) suggest formation of global Cowling channel [Yoshikawa et al., 2012] from polar to middle and low latitude dayside ionosphere. On the other hand, detail of P-E coupled process during expansion phase to recovery phase of substorm and connection between dayside and nightside ionosphere have not been become clear.

In this talk, we will introduce our new technique of automatic scaling of echo traces on ionogram and will show preliminary results of combining analysis for substorm process by using ionospheric data (ionogram) and magnetospheric data (SuperMAG, MAGDAS).

Keywords: Ionogram, P-E combination