Numerical simulation of Alfvén wave in the low-latitude ionosphere

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The Alfvén wave is a kind of ULF electromagnetic waves which propagates through the magnetized cold plasmas. Such waves are composed of the shear mode which propagates along the background magnetic field lines and the compressional mode which is perpendicular to those lines. The existence of the ionospheric Alfvén resonator (IAR) is due to the reflection of the Alfvén waves at the top and bottom of the ionosphere where the Alfvén velocity varies sharply. The IAR has inherent effect to the propagation of ULF waves through the ionosphere and the ground observations of the geomagnetic pulsations.

It has been known that the IAR is existence at the high latitude areas from the observations of the electromagnetic noise on the Earth's surface and by satellites. And the results show that the coupling of the shear mode and the compressional mode is important to the geomagnetic pulsations. However, few researches are processed to the low latitude IAR. The difference of the electronic density and the conductivities between different areas results in the fact that the factors of the IAR and the geomagnetic pulsations are not the same between the high latitude and the low latitude. Thus, researches of the IAR at low latitude are significative to realize the generation mechanism of the IAR and the propagation mechanism of Alfvén waves through the low latitude ionosphere.

This work is based on the two-fluid dynamics equations describing plasma flow in a cold magnetized medium, especially taking it into account that the background magnetic field is slantwise to the ionosphere is taken ioto account. J describing the shear mode and Bz describing the compressional mode are calculated in both vertical and parallel component by simulating the whole process. Those results can be used to analysis the characteristics of Alfvén waves propagating at low latitude. Then the disturbed magnetic fields through atmosphere to the ground also are calculated, to show some possible relations between them and the geomagnetic pulsations.

The conclusions are as follows,

(1) The results show that at the bottom end of ionosphere where the conductivities are of the most gradients, J, the field-aligned current, is reflected distinctly with opposite sign. Thus, it is concluded that IAR also exists at low latitude areas, and the generating mechanism and the generating altitude are matched with the forecast;

(2) When Alfvén waves reach the bottom end of IAR, the Bz component is created. It shows that, the coupling of shear and compressional mode occurs when the waves are reflected in IAR, and generates compressional Alfvén waves that propagate across background magnetic field lines;

(3) The results of simulating the disturbed magnetic fields on the ground show that, the source of those fields is the Bz component of Alfvén waves. Thus, it can be deduced thatčň theoretically, the geomagnetic pulsations observed on the ground are related close to the compressional Alfvén mode generated by the coupling of space plasma waves.