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Dynamic structure of convective motion depending on the height with line profile originating at solar photosphere

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On the solar surface, there are bright cellular patterns which are called granules, separated by narrow dark regions named intergranular lanes. These spatial patterns result from surface convection. The surface convection induces the magnetic field dynamics and it is considered as an energy source of corona heating problem. Therefore, it is important to understand a convective motion in revealing the mechanism of corona heating problem. However, the smallness of its spatial structure prohibits us from resolving granular patterns in the observation. Furthermore, though the vertical structure is important in convection mechanism, it is difficult to observe it because there are few methods for a direct observation of solar interior. In this study, we investigate the height dependence of the vertical velocity and its spatial correlation with granular pattern based on the analysis of spectrum obtained by Solar Optical Telescope (SOT) on board the Hinode satellite. SOT/Spectropolarimeter (SP) obtains the spectrum including the Fe I 630.13/630.25nm lines, which corresponds the solar photosphere. The high spatial resolution of SP enables us to obtain spectra in granule and intergranular lanes separately. In addition, the seeing free condition in space observation enables the long time observation with high resolution, in this study, which is difficult for ground base observation. Consequently, we can remove the 5-min oscillation, which affects the radiative intensity and Doppler velocity, and then reduce errors of the analysis.

In this study, we focus on line profile of Stokes I originating in quiet region. Vertical velocity of convection is obtained from the Doppler shift of the line profile. We also analyze the wavelength structure of the line profile. Because of the dependence of absorption coefficient on wavelength, the intensity at different wavelength position reflects the structure at different height. The intensity at the line center reflects the structure in the higher layer, while the intensity at the line wings reflects the structure in the lower layer. We found that the difference of convective velocity between upper and lower level are typically 300 m s-1. At some locations, it exceeds 1km s-1. Taking into account that the speed of sound is approximately 7km s-1, it means that there are remarkable acceleration or deceleration around the solar surface. Further, there is a tendency between convective motion and acceleration, that granular region has upward motion with deceleration and intergranular region has downward motion with acceleration. In the presentation, we will discuss about the description of typical convective structure on the solar surface and what happens where has the different structure.

Keywords: sun, convection, spectrum, phtosphere