Perturbations by under the atmosphere phenomena: space weather and problems of volcanic ionospheric disturbances studies

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We suppose that the most influential factor in space weather is various phenomena caused by solar activity. However, perturbations by the earth itself or events near the solid earth sometimes play a role as one of the extras on the stage. We examine ionospheric disturbances excited by volcanic eruptions. It is often observed that such signals originated from such huge near-surface events (e.g., earthquakes, tsunamis, severe weather, artificial explosions, rocket launches), in particular after the GNSS era starts. For understanding the whole upper atmosphere, it is also important to investigate them, not only drastic weather changes driven by the sun. In this presentation, we will show you our results about ionospheric disturbances excited by volcanic eruptions and expectations to space weather from our point of view.

We are studying for several years the propagation of the infrasound and the GNSS-TEC perturbation excited by the Kuchinoerabujima eruption on May 29 in 2015. Volcanic ionospheric disturbances are rarely reported comparing with that occurred by earthquakes or tsunamis, though some volcanic eruptions make huge atmospheric perturbations. Because the disturbances produced by significant eruptions has relatively smaller strength than coseismic signals, and space weather phenomena, they can easily hide the volcanic signals. However, in the Kuchinoerabujima case, we succeeded in finding a clear ˜0.1 TECU N-shaped signal, and we also obtained the infrasonic signal detected with broadband seismometers and barometers. The travel time indicates that the infrasound and TEC perturbation have the same origin. We are trying to extract explosion magnitude from both of the observations, obtain the reliability of GNSS-TEC information, and finally, consider to discuss the directivity of the explosion. We are now examining the propagation and amplitudes using ray-tracing calculation with several model parameters. The modeling is still difficult because even on a quiet day, the wind field and the electron density profile strongly influence the wave condition.

GNSS-TEC observation has the potential for estimating some information on solid earth events. Some research projects already succeeded in inverting massive earthquake or tsunami events properties from TEC data. Besides, now we are convinced volcanic ionosphere disturbances also have partially but surly important information. We encountered the uncertainty of the results. However, one of the factors that make the discussion difficult is that the background properties are unknown, and it would be improved with the progress of space weather research. Also, many researchers suggest observation results and mechanisms of ionospheric disturbances recently before earthquakes occur and actively discussed the signals are fake or not. We expect if people knew space weather more precisely, they could draw more information also about near-surface phenomena from ionosphere observation and obtain a more accurate description of the whole earth system.