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Observational study of the solar wind expanding from the Sun beyond the Earth and to the interstellar medium

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All planets in our solar system are engulfed by a supersonic plasma flow from the Sun, called the solar wind, and make ceaseless interaction with the flow. In the case of the Earth which has a magnetic field, the magnetosphere is formed in its neighborhood, and the Earth's atmosphere does not directly interacts with the solar wind. Even for such a protected environment with the magnetic barrier, violent fluctuations of the solar wind cause significant influences on the near-Earth space environment and upper atmosphere. Since these influences sometimes endanger the space system and the social infrastructure including telecommunications, efforts to improve our understanding of physical processes in the Sun-Earth system are extensively made to enable reliable predictions (research for space weather forecast). In particular, precise understanding of the solar wind is crucial for achieving the space weather forecast. Effects by the solar activity is observed not only in the Earth's upper atmosphere but also in the near-surface environment, and some mechanisms which assume the solar wind plays a role to connect between them are proposed. The solar wind expanding beyond the Earth orbit encounters the interstellar medium, and causes intense interactions there. The region formed through this interaction, called the heliosphere, has a dimension as large as 100 AU. Recently, spacecraft (Voyager-1,2) reached the boundary of the heliosphere, and are providing in situ data in the unexplored region of the interstellar space. This boundary region of the heliosphere located far away is not disconnected with the Earth's environment. Namely, the large-scale structure of the heliosphere strongly influences the propagation of galactic cosmic rays coming to the Earth. Here, it should be noted that a drastic change of the solar wind is in progress being accompanied with the marked decline in the solar activity, and as the result the heliosphere is expected to shrink globally. Thus, one can clarify the hidden process in the Sun-Earth coupling by investigating the relation between the current solar activity and change of the Earth's environment. The solar wind observations using interplanetary scintillation (IPS) have been conducted over a long period at the Solar-Terrestrial Environment Laboratory of Nagoya University. Large-aperture UHF-band radio telescopes located at three observatories in Japan are used for the IPS observations, and obtained data enable accurate determination of global distribution of the solar wind. Number of collaboration studies with domestic and oversea researchers have been made using our IPS data, which are quite unique in the world space community. Three-dimensional properties of the heliosphere evolving drastically with the solar activity, propagation dynamics of disturbances associated with eruptive events, and enigmatic mechanism for the solar wind acceleration investigated through our collaboration researches. We intend to elucidate the solar wind variation caused by the peculiar solar activity and its influence to the Earth's environment from further IPS observations.

Keywords: solar wind, interplanetary scintillation, solar cycle, heliosphere, space weather