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Upgrade of the multi-station IPS system and solar wind observations at the cycle 24 maximum

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Since interplanetary scintillation (IPS) serves as a useful method to determine global distribution of the solar wind, IPS observations have been regularly conducted over more than 30 years using the multi-station system of the Solar-Terrestrial Environment Laboratory (STEL) of Nagoya University. Such long-term data collection is made possible by continuous maintenance and improvement of the system. The STEL has four antennas dedicated for IPS observations at Toyokawa, Fuji, Kiso, and Sugadaira. The system at Toyokawa was upgraded to a new antenna (called the Solar Wind Imaging Facility Telescope, SWIFT, Tokumaru et al., 2011) in 2008. After that, the observation control and data acquisition systems at Fuji and Kiso were upgraded in 2010 to enable 3-station IPS observations using Toyokawa, Fuji and Kiso antennas. However, the low-noise phased-array receivers of Fuji and Kiso antennas, which are a vital part to archive high sensitivity, remained unchanged, and some other parts such as reflectors, gears, motors, became superannuated. In order to improve these problems, we have performed extensive work for upgrading Fuji, Kiso and Sugadaira antennas since 2013.

The items for this upgrade are as follows; (1) installation of low-noise amplifiers using HEMTs (FE327-V5) and the phased-array control system, (2) development of the phase/gain calibration system using the loop method and the receiver temperature measurement system using a noise source for Fuji and Kiso antennas, (3) fabrication of reflector and replacement of gears and motors (for Kiso). The work at Fuji almost completed by the end of 2013, and that at Kiso will be made in this spring.

Owing to the upgrade project, IPS observations for 2013 was made for the period between April and August. Obtained IPS data clearly show that the fast wind reappears over the northern pole. This is not the case for the southern pole, and the slow wind is found to be dominant in the southern hemisphere. The disappearance and reappearance of the fast wind over the northern pole preceding that over the southern pole have been observed in solar maxima of two previous cycles, so that this is regarded as a common feature of the solar dynamo activity. While our IPS data for this cycle show good correlation between fast wind areas and polar fields, they reveal that the slope for this cycle differs from the ones for past cycle. This fact suggests that higher-order magnetic moments for this cycle may have more contribution for formation of fast winds than past cycles. The solar wind structure is expected to significantly change with declining solar activity toward the next minimum, and we intend to finish work for the upgrade project as soon as possible in order to miss observing this change.

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