Study of thermospheric wind variations at substorm onsets using a Fabry-Perot interferometer at Tromsoe, Norway

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We studied the thermospheric wind variations at the onsets of isolated substorms by using a Fabry-Perot interferometer (FPI) at Tromsoe, Norway. The wind variations were measured from the Doppler shift of both red line (630.0 nm, altitudes: 200-300 km) and green line (557.7 nm, altitudes: 90-100 km) emissions with a time resolution of ~13 min. The wind data were obtained for 7 years from 2009 to 2015. We first identified the onset times of local isolated substorms by using ground-based magnetometer data of Tromsoe and Bear Island stations, and then checked the wind variations before and after these onset times. Totally, we obtained 8 events from red line data and 10 events from green line data located at different local times. By checking the all-sky images at Tromsoe, we found that most wind observations were made at the equatorward of substorm onset arcs at the onset times. For half of the events, the observation location kept at the south of the auroral arcs from -30 min to +90 min of the event times. Then, we calculated the differences of wind velocities at the onset time and at 30-min (1-hour) after the onset time using winds averaged over ±15 min (±30 min) of the epoch time. For red line events, except for few notable decreases at dawnside, eastward wind tends to increase from the onset time to both 30-min and 1-hour after the onset time at all nightside local times. This result is opposite to the tendency expected from thermospheric tidal wind variations, and suggest a particular eastward drive of thermospheric wind during substorms. With some exceptions, northward wind tends to decrease at local times before 2 LT and increase after that, which is consistent with the expectation from thermospheric tides. For green line events, eastward components have a tendency of increase at all local times with some notable decreases at duskside. Northward components show some increases at pre-midnight sector, and significant decreases at duskside, post-midnight sector and dawnside. All the observed wind changes after the substorm onsets were less than 76 m/s for red line events, and 51 m/s for green line events. These wind changes are much smaller than the typical plasma convection speed, indicating that the plasma motion caused by thermospheric wind through ion-neutral collision is a minor effect as the driver of high-latitude plasma convection and as the triggering of substorm onset. Since the movement of onset arcs could inevitably affect the local wind field, we will consider this factor when discussing the wind variations in the presentation.

Keywords: Thermospheric wind, Substorm, Fabry-Perot interferometer

