Properties of the near-Sun solar wind turbulence from radio occultation experiments with NOZOMI spacecraft

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Coronal radio sounding experiments, carried out during the solar conjunction of the spacecraft NOZOMI (December, 2000 – January, 2001), provided information on the solar wind plasma acceleration region (heliocentric distances from 12.8 to 36.9 solar radii). The high time resolution measurements (averaging time were 0.05 s for frequency and 0.006 s for intensity) gave new results on the solar wind fine structure down to and including the turbulence inner scale. Special emphasis is placed on a new approach of obtaining the irregularities anisotropy ratio based upon the comparison of the convective velocities deduced from the combined analysis of the intensity and frequency simultaneous measurements and the intensity spectra Fresnel ripples.

According to the spacecraft NOZOMI coronal sounding experiment data the X-band signal scintillation index increased with the approach to the sun of the radio path following the power-law function with the power index near 1.52. The frequency fluctuation intensity also became stronger in a power-law way when the radial heliocentric distance decreased but with the power index in the vicinity of 1.85. This magnitude is in a good agreement with the results of other radio occultation experiments. The frequency data were used to get information on the turbulence regime of the large-scale irregularities while the intensity data presented the evidence on the small-scale irregularity structure. It is shown that the large-scale irregularity part of the turbulence is described by higher magnitudes of the spectral index if to compare with the small-scale irregularity interval. The turbulence inner scale changed from 9 km to 37 km in the range of heliocentric radial distances from 12.8 to36.9 solar radii. Thus the radial dependence deviated from linear in the acceleration region. The solar wind small-scale irregularities were elongated along the radial direction with the axial ratio changing from 1.8 to 2.8.