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Relations among solar wind speed, coronal magnetic field, and the photospheric magnetic field: Long-term variations

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We have calculated the three dimensional structure of the coronal magnetic field by using the potential field model (RF-model) devised by Hakamada with synoptic maps of the photospheric magnetic field observed at the NSO, Kitt Peak, for the following 13 Carrington rotations; CR 1830, CR 1844, CR 1855, CR 1870, CR 1887, CR 1898, CR 1901, CR 1909, CR 1925, CR 1939, CR 1950, CR 1964 and CR 1976, during almost one solar cycle (about 11 years) from the maximum phase of 22 solar activity cycle through the maximum phase of 23 cycle. We drew thirteen synoptic maps of the common logarithm of the absolute value of the radial component of the coronal magnetic field on the source surface, Log10|Br_sou|and thirteen synoptic maps of the common logarithm of the absolute value of the radial component of the photospheric magnetic field, Log10|Br_pho|, projected on the source surface from the photosphere along the field lines in the corona, as well as, thirteen synoptic maps of the solar wind speed, V, on the source surface estimated by the computer-assisted tomography method with the data of interplanetary scintillation observations by STE Lab. We thus obtained three parameters, V, Log10|Br_sou|, and Log10|Br_pho|on the same thirteen synoptic maps that can be compared directly with each other. In the previous paper, we obtained a good multi-correlation coefficient assuming the following multi-regression equation; V = A + B*Log10|Br_sou|+ C*Log10|Br_pho|. In this paper, we examine the same multi-correlation and multi-regression analysis for individual rotation. We classify the data into two groups by the value of magnetic data according to the results of the previous analysis;

(I) group 1: Log10|Br_sou|is between -1.5 and 0.0, and Log10|Br_pho|is between -1.0 and 1.5,
(II) group 2: the outside of group 1.

We found the following results;
(1) The multi-correlation coefficient of group 1 is high (about 0.7 - 0.8) in the minimum phase and low (0.3 - 0.4) in the maximum phase. The multi-correlation coefficient of group 2 is always low (0.1 - 0.3) during the whole cycle.
(2) The A of group 1 is large (about 1000 km/s) during whole cycle, but, tends to decrease to 600 - 800 km/s around the maximum phase. The A of group 2 is small (about 400 km/s) during whole cycle.
(3) The B of group 1 is always positive and large (300 - 400) in the maximum and small (55 - 150) in the minimum. The C of group 1 is negative and large (-50 - -120) in the maximum and almost 0 in the minimum.
(4) Both the B and the C of group 2 are extremely small, almost 0, during the whole cycle.
These results suggest that the solar wind consists of two groups; the first one is the solar wind accelerated to 450 - 750 km/s by a mechanism related to Log10|Br_sou|in the corona. The second one is the background solar wind that is almost independent of Log10|Br_sou|and Log10|Br_pho|and always has a speed of 450 km/s. The acceleration mechanism is seen clearly for the group 1 in the minimum phase and does not work well in the maximum phase, showing that the acceleration mechanism depends on the three-dimensional structure of the coronal magnetic field. The acceleration rate is high in the steady open field regions in the corona that appears in the minimum phase.