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Inner heliospheric evolution of interplanetary magnetic clouds

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Interplanetary magnetic cloud parameters change while these structures propagate into the heliosphere. By fitting the data to a force–free field model (*Lundquist*, 1950; *Burlaga*, 1988), we obtain results which are statistically analyzed in reference to the change with heliospheric distance, r_h. We work with ensemble averages, binning the results in radial intervals of width 0.1 AU for the range $0.3 \leq r_h \leq 1$ AU. Doing this, we find that the average central axial field strength varies with r_h as $\langle B_0 \rangle = 22 \cdot r_h^{-1.38}$ (B_0[nT], r_h[AU]), and the average diameter varies linearly as $\langle D \rangle \approx 0.18 \cdot r_h$ (D[AU]). The orientation of the axis of the underlying magnetic flux tube is generally found to lie along the east-west direction and in the ecliptic plane.

For this study we employ primarily events observed by Helios 1 and 2 and Wind, which are extended by observations from spacecraft operating during the Helios mission (e.g. Voyager 1 and 2, Pioneer 10 and 11, and others). This gives us the possibility to monitor the evolution of magnetic cloud parameters for a given event as a function of r_h directly by line–up observations. (Several events were found). From these line-ups, we find further that the decrease of $\langle B_0 \rangle$ with r_h is different according as $r_h < 1$ AU and $r_h > 1$ AU. We offer an interpretation of this finding.