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Helicity of Magnetic Clouds and Their Associated Active Regions

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Abstract. Magnetic clouds are associated with many Coronal Mass Ejections. Many CMEs involve active regions. In this work we focus on the relationship between twelve magnetic clouds and their associated active regions. We use a cylindrically symmetric constant-α force-free model to derive field line twist, total current, and total magnetic flux from in situ observations of magnetic clouds. We compare these properties with those of the associated solar active regions, which we infer from solar vector magnetograms.

Our comparison of fluxes and currents reveals: (1) the total (unsigned) flux ratios Φ_{MC}/Φ_{AR} tend to be of order unity; (2) the total flux ratios tend to be orders of magnitude larger than the total (unsigned) current ratios I_{MC}/I_{AR}; and (3) there is a statistically significant proportionality between them. Our key findings in comparing total twists αL, where L is the axial dimension of the system, are: (1) the values of $(\alpha L)_{MC}$ are typically an order of magnitude greater than those of $(\alpha L)_{AR}$; and (2) there is no systematic sign or amplitude relationship between them. These findings compel us to believe that magnetic clouds associated with active region eruptions are formed by magnetic reconnection between these regions and their larger-scale surroundings, rather than pre-existing structures in the corona or chromosphere.