Resolution of the 180 degree ambiguity for non-potential magnetic field topologies

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A well known problem in solar astronomy is that solutions for the transverse magnetic field direction are ambiguous with respect to a 180 degree reversal in the field direction. Numerous effort have been put into solving the 180 degree ambiguity problem. Because the methods of the removal of the 180 degree ambiguity are usually used directly to observational data, there have not been a decisive view of which method is the more reasonable. Our approach is to test three methods for the removal of the 180 degree ambiguity with three MHD models. These methods are 1) Reference-field method; 2) Method of magnetic pressure gradient; and 3) Magnetic field divergence-free method. The three MHD equilibrium models to which these methods are applied are: 1) an analytical solution of a non-linear force-free magnetic field equilibrium; 2) a simulation of an emerging twisted flux tube; 3) a pre-eruptive twisted magnetic flux rope equilibrium reached by relaxation. Success of the methods depends on the magnetic topologies, especially in cases of non-potential magnetic configurations. Our most important conclusion is that the magnetic divergence-free method is the most successful one with all three types of MHD configurations. This method requires a second level of vertical magnetic field. Therefore, multi-layer magnetic field measurements are highly desirable for any serious attempt to solve the 180 degree ambiguity problem.