The strength and structure of magnetic diffusivity is rather poorly understood in the solar convection zone. We studied the influence of various diffusivity profiles on the evolution of poloidal and toroidal magnetic fields in a kinematic flux transport dynamo model for the Sun. We mathematically constructed various candidate profiles of diffusivity vs. radius, using constraints from mixing length theory and turbulence, and comparing observed solar poloidal field evolution with results from modeling. We then studied the effect of each diffusivity profile on the cyclic evolution of magnetic fields in the Sun, by solving the mean-field dynamo equations. We investigated how resultant field amplitudes, cycles, and structures evolving inside the convection zone are influenced by different diffusivity profiles. Our simulations suggest which diffusivity profiles may be more relevant for magnetic flux evolution in the Sun.

We found that the solar dynamo generally depends less on the "shape" of reasonable magnetic diffusivity profiles than on the "locations" of diffusivity gradients. In particular, without a gradient appropriately oriented near the tachocline, insufficient toroidal field may be carried up by the meridional circulation to sustain normal dynamo cycles.

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