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Axisymmetric Flow Properties for Magnetic Elements of Differing Strength

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Aspects of the structure and dynamics of the flows in the Sun's surface shear layer remain uncertain and yet are critically important for understanding the observed magnetic behavior. In our previous studies of the axisymmetric transport of magnetic elements we found systematic changes in both the differential rotation and the meridional flow over the course of Solar Cycle 23. Here we examine how those flows depend upon the strength (and presumably anchoring depth) of the magnetic elements. Line of sight magnetograms obtained by the HMI instrument aboard SDO over the course of Carrington Rotation 2097 were mapped to heliographic coordinates and averaged over 12 minutes to remove the 5-min oscillations. Data masks were constructed based on the field strength of each mapped pixel to isolate magnetic elements of differing field strength. We used Local Correlation Tracking of the unmasked data (separated in time by 1- to 8-hours) to determine the longitudinal and latitudinal motions of the magnetic elements. We then calculated average flow velocities as functions of latitude and longitude from the central meridian for ~600 image pairs over the 27-day rotation. Variations with longitude indicate and characterize systematic errors in the flow measurements associated with changes in the signal from disk center to limb. Removing these systematic errors reveals changes in the axisymmetric flow properties that reflect changes in flow properties with depth in the surface shear layer.