Effects of the Observed Meridional Flow Variations since 1996 on the Sun's Polar Fields

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The cause of the low and extended minimum in solar activity between Sunspot Cycles 23 and 24 was the small size of Sunspot Cycle 24 itself – small cycles start late and leave behind low minima. Cycle 24 is small because the polar fields produced during Cycle 23 were substantially weaker than those produced during the previous cycles and those (weak) polar fields are the seeds for the activity of the following cycle. The polar fields are produced by the latitudinal transport of magnetic flux that emerged in low-latitude active regions. The polar fields thus depend upon the details of both the flux emergence and the flux transport. We have measured the flux transport flows (differential rotation, meridional flow, and supergranules) since 1996 and find systematic and substantial variation in the meridional flow alone.

Here we present experiments using a Surface Flux Transport Model in which magnetic field data from SOHO/MDI and SDO/HMI are assimilated into the model only at latitudes between 45-degrees north and south of the equator (this assures that the details of the active region flux emergence are well represented). This flux is then transported in both longitude and latitude by the observed flows. In one experiment the meridional flow is given by the time averaged (and north-south symmetric) meridional flow profile. In the second experiment the time-varying and north-south asymmetric meridional flow is used. Differences between the observed polar fields and those produced in these two experiments allow us to ascertain the effects of these meridional flow variations on the Sun's polar fields.