HAO Colloquium Series
(Refreshments served)

Speaker: Lisa Upton, Vanderbilt University
Time: 1:30–2:30 pm
Date: Wednesday, May 7, 2014
Location: CG1 – 1210 South Auditorium (also webcast at http://www.fin.ucar.edu/it/mms/cg-live.htm)

Title: How Meridional Flow Variations May Save Us from the Next Maunder Minimum

Abstract:
Solar Cycle 24 is proving to be the weakest solar cycle in over a hundred years and some have speculated that we may be on the verge of entering the next Grand Minimum, i.e., a period spanning decades with little to no solar activity (e.g., the Maunder Minimum).

We have characterized the differential rotation (DR) and meridional flow (MF) and their variations since 1996 using a cross-correlation technique on. The MF is faster at solar cycle minimum and slower at maximum. Furthermore, the MF speeds that preceded the Solar Cycle 23/24 minimum were ~20% faster than the MF speeds that preceded the prior minimum. This faster MF has been suggested to have caused weaker polar field strengths and thus the subsequent extended solar minimum and an unusually weak cycle 24.

We have simulated surface magnetic flux transport with a model that advects the magnetic flux emerging in sunspots using the near-surface flows. These flows include the axisymmetric DR and MF and the non-axisymmetric cellular convective flows (supergranules), all of which vary in time as indicated by direct observations. Daily sunspot area data are used as sources of new magnetic flux. At each time step, magnetic maps of the entire Sun are created. We have tested this model and found that the evolution of the polar fields can be reliably reproduced many years in advance.

The model was used to determine the impact of observed MF variations on the sunspot cycle. One simulation included a MF that is constant, a second included a MF that has the observed variations in time, and a third included a MF in which the observed variations were exaggerated. These simulations show that the variations in the MF over cycle 23 produce polar fields that are ~20% stronger (rather than weaker). This suggests that the cause of the weak polar fields at the end of Cycle 23 should be attributed to the emergence of fewer active region sources, rather that the variation in the meridional flow. However, the variations in the MF prevented the polar fields from becoming weaker than they otherwise might have been. This indicates that the variations in the MF may provide a feedback mechanism for regulating the solar cycle and possibly preventing or recovering from a Grand Minimum.