# Simulating Cyclic Evolution of Coronal Magnetic Fields using a Potential Field Source Surface Model Coupled with a Dynamo Model

A. Suresh[1,2,3], M. Dikpati[1], J. Burkepile[1], and G. de Toma[1]
[1]HAO/NCAR [2]Yale University [3]LASP REU

The structure of the Sun's corona varies with solar cycle, from a near spherical symmetry at solar maximum to an axial dipole at solar minimum. Why does this pattern occur? It is widely accepted that large-scale coronal structure is governed by magnetic fields, which are most likely generated by the dynamo action in the solar interior. In order to understand the variation in coronal structure, we couple a potential field source surface model with a cyclic dynamo model. In this coupled model, the magnetic field inside the convection zone is governed by the dynamo equation and above the photosphere these dynamo-generated fields are extended from the photosphere to the corona by using a potential field source surface model. Under the assumption of axisymmetry, the large-scale poloidal fields can be written in terms of the curl of a vector potential. Since from the photosphere and above the magnetic diffusivity is essentially infinite, the evolution of the vector potential is given by Laplace's Equation, the solution of which is obtained in the form of a first order Associated Legendre Polynomial.
By taking linear combinations of these polynomial terms, we find solutions that match more complex coronal structures. Choosing images of the global corona from the Mauna Loa Solar Observatory at each Carrington rotation over half a cycle (1986-1991), we compute the coefficients of the Associated Legendre Polynomials up to degree eight and compare with observation. We reproduce some previous results that at minimum the dipole term dominates, but that this term fades with the progress of the cycle and higher order multipole terms begin to dominate. We find that the amplitudes of these terms are not exactly the same in the two limbs, indicating that there is some phi dependence. Furthermore, by comparing the solar minimum corona during the past three minima (1986, 1996, and 2008), we find that, while both the 1986 and 1996 minima were dipolar, the minimum in 2008 was unusual, as there was departure from a dipole. In order to investigate the physical cause of this departure from dipole, we implement north-south asymmetry in the surface source of the magnetic fields in our model, and find that such n/s asymmetry in solar cycle could be one of the reasons for this departure.