Hinode-3: 3rd Hinode Science Meeting
Hitotsubashi Memorial Hall, Tokyo
1–4 December, 2009

Flux transport dynamo with strong surface diffusivity

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Abstract. The flux-transport dynamo model for the solar sunspot cycle is revised and is demonstrated by using the axisymmetric kinematic simulations. The flux-transport dynamo has succeeded to explain the general cyclic behaviors of the sunspots especially in the gradual shift of the sunspot toward the equator and the poleward migration of the surface magnetic field. It has been known, however, that previous models failed to avoid the strong polar surface field and the strong toroidal field at the base in the high latitude, both of which are not consistent with observations. With an additional intense diffusivity profile near the surface two problematic features can be avoided. The surface poloidal field generated by the α effect is transported down to the base of the convection zone not by the meridional flow but by the surface diffusion mainly in the mid-latitude. This prevents the concentration of the polar surface field and the amplification of the toroidal field at the high latitude. The condition to obtain the proper magnetic field strength near the pole is $\eta_{\rm surf}/u_0 > 2 \times 10^9$ cm, where $\eta_{\rm surf}$ and u_0 are the surface diffusivity and the meridional flow speed, respectively. We also do some parameter studies to ensure the importance of the surface strong diffusivity. In addition the dependence of the cycle period on free parameters, the speed of meridional flow and the surface diffusivity, is investigated. We found that the dependence of the cycle period on the speed of the meridional flow changes by using the different penetration depth of the meridional flow through the tachocline.