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Reconstructing solar magnetic fields from historical observations: Testing the surface flux transport model

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We aim to use the surface flux transport model to simulate the long-term evolution of the photospheric magnetic field from historical observations. In this work we study the accuracy of the model and its sensitivity to uncertainties in its main parameters and the input data.

We test the model by running simulations with different values of meridional circulation and supergranular diffusion parameters, and study how the flux distribution inside active regions and the initial magnetic field affect the simulation. We compare the results to assess how sensitive the simulation is to uncertainties in meridional circulation speed, supergranular diffusion and input data. We also compare the simulated magnetic field with observations.

We find that there is generally good agreement between simulations and observations. While the model is not capable of replicating fine details of the magnetic field, the long-term evolution of the polar field is very similar in simulations and observations. Simulations typically yield a smoother evolution of polar fields than observations, that often include artificial variations due to observational limitations. We also find that the simulated field is fairly insensitive to uncertainties in model parameters or the input data. Due to the decay term included in the model the effects of the uncertainties are rather minor or temporary, lasting typically one solar cycle.