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Realistic numerical simulations of formation of magnetic structures

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Abstract. One of most intriguing processes on the Sun is formation and dynamics of sunspots and active regions, where magneto-convective conditions are very different from quiet Sun regions. High-resolution observations from Hinode and numerical simulations shed light into these processes. In our 3D radiative MHD simulations we take into account real-gas equation of state, ionization and excitation of all abundant species, turbulent and magnetic effects. We present recent results of numerical simulations of top layers of the convective zone and the photosphere in the presence of magnetic field. We discuss the process of formation of filamentary structures and high-speed flows in the strong inclined field, reproducing many features of the Evershed effect, and compare the results with the observational data from Hinode. In addition, we demonstrate a new process of spontaneous formation of magnetic structures characterized by strong concentrations of magnetic field and long lifetime (much longer than the time scale of convection). We will discuss the conditions and properties of convection when formation of the magnetic structures is possible. We also investigate the oscillation power spectra, the distribution of acoustic power and other properties of the magnetic structures, and compare with the observed phenomena, like the effect of acoustic halos in active regions.