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Dynamics of coronal mass ejections

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Abstract. We discuss the dynamics of coronal mass ejections (CMEs), mainly focusing on magnetohydrodynamic (MHD) processes. Observations show that CMEs are one of the most dynamic phenomena in the solar atmosphere, producing a huge amount of kinetic energy up to about 10^{32} erg. The key physical processes producing a CME are: emergence of magnetic field from the solar interior to the solar atmosphere (flux emergence), and formation and destabilization of a magnetic structure with free energy on the Sun. CMEs are highly dynamic phenomena, whereas evolution toward the onset of a CME is quasi-static, so some stabilizing effect should work during this quasi-static phase. A CME starts with the destabilization of a quasi-staic magnetic structure, expelling a large amount of magnetic flux stored in the structure from the Sun. How to destabilize a magnetic structure globally is the central subject of CME dynamics, and various models have been proposed to explain the destabilizing mechanism for a CME. MHD simulations have proven to be a powerful tool, because they can reproduce the time-dependent, nonlinear process producing a CME. This talk is aimed at reviewing key features of those proposed models, and also demonstrating a view of CME dynamics based on the evolution of emerging field lines on the Sun.