Geophysical Research Abstracts, Vol. 9, 04890, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04890

MHD Simulation of Magnetic Field Evolution in Preflare State above the Active Region AR 0365

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The resent X-ray observations show, that primordial energy release during the solar flare takes place in the solar corona above an active region. It can be explained by energy accumulation in the magnetic field of current sheet, which is created in the vicinity of singular line in the corona by focusing of disturbances, arriving from the photosphere. After the quasistationary evolution the current sheet transfers into unstable state, and explosive energy release occurs, which causes the flare and/or CME. For the MHD simulation of flare energy accumulation in corona above the real active region all conditions must be taken from observational data. The initial magnetic field must be set several days before the flare, when currents in corona are practically absent, and the magnetic field in the corona is calculated as potential one using observed field distribution on the photosphere. To obtain the potential field using photospheric line-of-sight field distributions obtained by SOHO MDI, the method of numerical Laplace equation solving with inclined derivative as the boundary condition is developed. For MHD simulation it is necessary to set evolution of two magnetic field components parallel to the photosphere, but now such data are not available for active region AR 0365. The calculated potential field is used for setting such boundary condition in each moment of time. This method of boundary condition setting is valid, if the magnetic field on the photosphere is defined mainly by currents under the photosphere, but not by the currents in the corona. Such direct setting of initial-boundary problem permits to take into account the magnetic field between the spots. Such a way, we have possibility to obtain more properly all main field singularities in corona, than for magnetic field approximation by dipoles or magnetic charges used in previous works. The MHD simulation for real active region meets difficulties due to numerical instabilities, which appear mainly not in the places of the current sheet creation, but

near the boundary of computational domain. To stabilize such instabilities a number of numerical methods are developed and programming realized in the PERESVET code. The finite-difference scheme for MHD equations is absolutely implicit, and it is conservative relative to the magnetic flux. In the regions near the boundary it is additionally used the artificial viscosity and some other special methods are applied. The calculations show, that the used methods permit to obtain a stable solution near the nonphotospheric boundary, if the size of a photospheric boundary of the computational domain is at least several times more, than the size of active region. The previous calculations for the active region AR 0356 show appearance of an instability near the nonphotospheric boundary for the size of the photospheric boundary of the computational domain equal to 1.2×10^{10} cm. The MHD calculation for the size of the photospheric boundary equal to 4×10^{10} cm shows absence of instabilities near the nonphoptospheric boundary. For the size of 4×10^{10} cm the potential field posses all main singularities of AR 0365 field. The calculations of potential field are performed for regions with sizes 1.2×10^{10} cm, 1.5×10^{10} cm, 2×10^{10} cm, 4×10^{10} cm and 6×10^{10} cm. The instability appeared near the photospheric boundary does not propagate inside the computational domain, which permit to perform MHD simulations in corona during the several days. The MHD calculations during three days (from 20:48 24 May 2003 to 20:48 27 May 2003) show several current sheets creation in corona in the vicinities of singular lines. The results of simulations permit to find the positions of emission sources, caused by explosive energy release in the created current sheets and compare it with observations of emissions in different diapasons (radio, optical, X-rays) for all flares 26 and 27 May 2003. The performed simulation shows the possibility of further modernization of numerical methods to accelerate the calculations. It is necessary for setting more realistic rate of changing of observed photospheric magnetic field and for improving of solar flare and CME prognosis basing on MHD simulations in the real active region.