Geophysical Research Abstracts
Vol. 18, EGU2016-18055, 2016
EGU General Assembly 2016

Two-fluid modeling of magnetosonic wave propagation in the partially ionized solar chromosphere

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We perform 2D two-fluid simulations to study the effects of ion-neutral interactions on the propagation of magnetosonic waves in the partially ionized solar chromosphere, where the number density of neutrals significantly exceeds the number density of protons at low heights. Thus modeling the neutral-ion interactions and studying the effect of neutrals on the ambient plasma properties becomes important for better understanding the observed emission lines and the propagation of disturbances from the photosphere to the transition region and the corona. The role of charged particles (electrons and ions) is combined within resistive MHD approach with Coulomb collisions and anisotropic heat flux determined by Braginskii's transport coefficients. The electromagnetic fields are evolved according to the full Maxwell equations, allowing for propagation of higher frequency waves neglected by the standard MHD approximation. Separate mass, momentum and energy conservation equations are considered for the neutrals and the interaction between the different fluids is determined by the chemical reactions, such as impact ionization, radiative recombination and charge exchange, provided as additional source terms. To initialize the system we consider an ideal gas equation of state with equal initial temperatures for the electrons, ions and the neutrals and different density profiles. The initial temperature and density profiles are height-dependent and follow VAL C atmospheric model for the solar chromosphere. We have searched for a chemical and collisional equilibrium between the ions and the neutrals to minimize any unphysical outflows and artificial heating induced by initial pressure imbalances. Including different magnetic field profiles brings new source of plasma heating through Ohmic dissipation. The excitation and propagation of the magnetosonic waves depends on the type of the external velocity driver. As the waves propagate through the gravitationally stratified media shock fronts are form, where additional plasma heating is observed.