Reply to referee comments

On heating of solar wind protons by the parametric decay of large amplitude Alfvén waves

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H. Comişel, Y. Nariyuki, Y. Narita, and U. Motschmann

We thank reviewer for evaluating our paper.

Reviewer:
The last minor remark is that the following text belongs rather to Discussion than to the description of the model: "The used spatial resolution for the field ... Thus we conclude that the numerical heating does not play a significant role compared to the physical heating."

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Reply:
We follow the reviewer's remark.

Changes in the manuscript:
The mentioned text is moved from section 2 to section 4.
Page:10, Line:11 to Page:11, Line:2
"The used spatial resolution for the field quantities (magnetic field, electric field, and velocity moments) is close to the ion inertial length and the proton gyroradius ($\rho_i \sim 0.1 d_i$) or smaller spatial gradients cannot be resolved. The magnetic field within a numerical cell is overall homogeneous with the linear interpolations at the particle position between mesh points or due to the wave magnetic field. Thus, the perpendicular projection of the proton motion is nearly a circle and this circular gyration is resolved by about 100 time steps. Gradients become important over about 10 gyroradii and not just over one gyration. We are warned that numerical heating could have some contribution in our simulations. Among various candidate mechanisms causing numerical heating one may specify: the numerical noise given by the statistical representation of the distribution functions, the rounding error or cutoff error when evaluating the differential operator, the absorption of the numerically-arising electric (possibly the electrostatic field) by the ions, and the random scattering due to the numerically fluctuating magnetic field (here the magnetic diffusion may be applicable). The numerical free energy occurring in the system can be converted in wave energy. This wave energy can be absorbed by particles and heating of the plasma. The heating effects described above can be compensated by using a suitable resistivity parameter, a smoothing procedure for the magnetic field, and numerical tests including various parameters. We have tested simulation runs with or without using pump wave by varying the number of particles per cell, time steps δt, and grid sizes to find out sufficient energy accuracy (within 5% for 500 elapsed ion-gyroperiods). Thus we conclude that the numerical heating does not play a significant role compared to the physical heating."