SOLAR CONVECTION AND MAGNETO-CONVECTION

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1. Discussion

We explore the general properties of convection in a solar surface layer. Our three-dimensional simulations use a tabulated equation of state that includes excitation and ionization of hydrogen and other abundant atoms, and the formation of H_2 molecules. The radiative energy exchange is determined by solving the radiative transfer equation. This is particularly important in the upper cooling layer, where the observed granulation pattern is created. Our hydrodynamic runs simulate a region $6 \times 6 \times 3$ Mm, extending vertically from the temperature minimum at 0.5 Mm above the visible surface, down to 2.5 Mm below it. We have run a new simulation at twice the resolution (25 km horizontally, and 15 - 35 km vertically) of a previous run. The bulk properties of the convection are very similar in both runs. The general picture is one in which most of the gas is found in slowly rising, expanding upflows. The gas that does reach the surface moves horizontally, cools, and descends back into the stratified atmosphere, being compressed into narrow, rapidly descending filaments. This general topology of the convection is described in detail by Stein and Nordlund (1989). The high resolution run reveals more small granules, and has more small scale structure in the granulation pattern and in the downdrafts. Figure 1

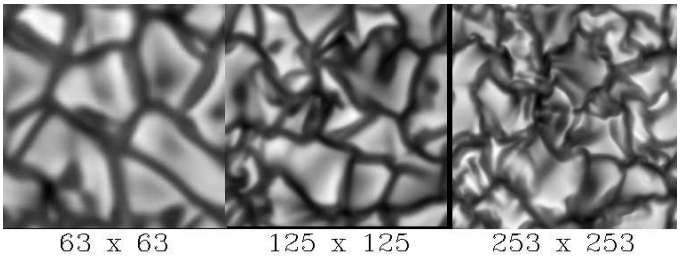

Figure 1. The progressive change in the surface emergent intensity (granulation) pattern as we go from horizontal grids of 63×63 to 125×125 to 253×253.

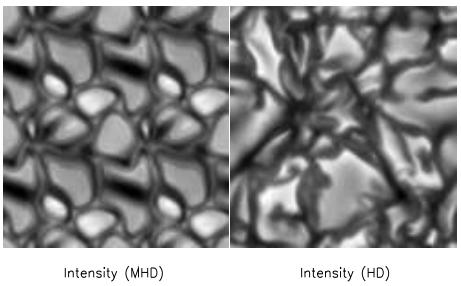

Figure 2. A comparison of the granulation patterns for hydrodynamic and magnetohydrodynamic convection. The runs are made at identical horizontal resolution (50 km).

compares the granulation pattern in three different runs, with horizontal grids of 63×63, 125×125, and 253×253 (new run), respectively.

Figure 2 shows the granulation pattern from a preliminary magnetoconvection run (see also Nordlund and Stein 1990; Stein et al. 1992). An initially uniform vertical magnetic field of 500 G was imposed on a snapshot of hydrodynamic convection. The computed region is $3 \times 3 \times 1.5$ Mm. We plot a 6×6 Mm region of the granulation pattern, assuming periodicity in the horizontal directions, to facilitiate comparison with the hydrodynamic run. It is seen that the granule sizes tend to be smaller in the presence of the imposed magnetic field.

References

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