Modeling of solar mesogranulation

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Introduction

We investigate a possibility of mesogranulation being a surface self-arrangement phenomenon of the granular field. We consider one- and two-dimensional cell models simulating granulation; two different rules for cell interaction are employed to determine differences between a pressure-induced cell-competition and a random-walk system.

One spatial dimension

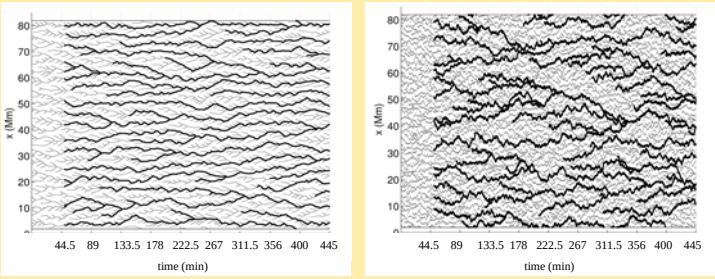
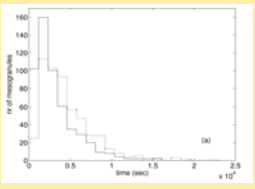
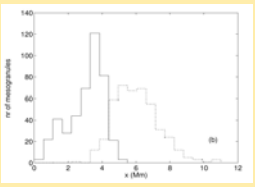


Fig. 1 Left: cell-competition model, right: random walk model. Intergranular lanes older than 50 min. are marked as thick. The time span of the domain is 445 min.



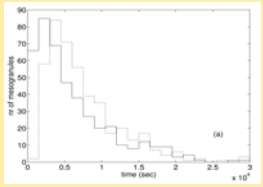
mean lifetime = 101.7 min



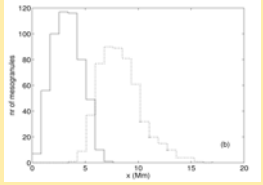
mean size = 4.27 Mm

Fig. 2

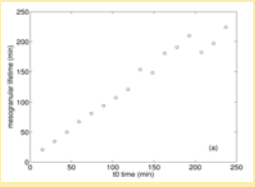
Mesogranule statistics for 1 hour of the mesogranular evolution time:
(a) lifetime distribution
(b) size distribution.
Solid line – dissolvers
dashed line – fragmenters.
Left panel:
cell-competition model
right panel:
random walk model.



mean lifetime = 55 min



mean size = 5.44 Mm



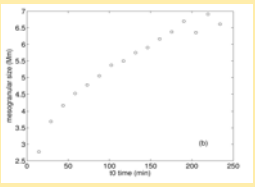
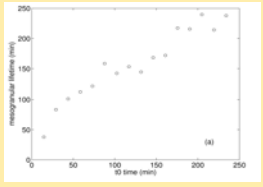
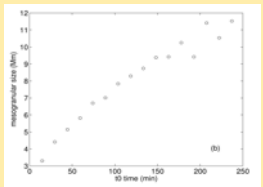


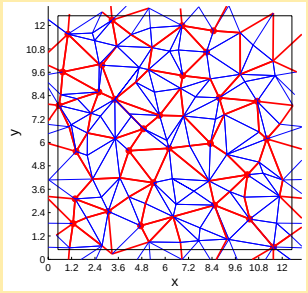
Fig. 3

Dependence of the (a) mesogranule lifetime and (b) mesogranule size on the mesogranular evolution time.
Left panel: cell-competition model, right panel: random walk model.





Two spatial dimensions



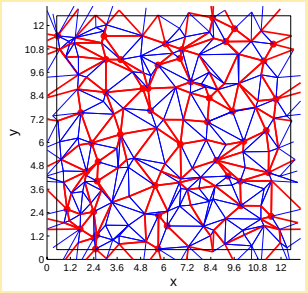
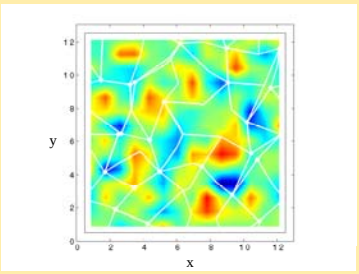


Fig. 4 Examples of the domain snapshots; features older than 1 hour are marked in red as mesogranular. Left: cell competition model, right: random walk model.



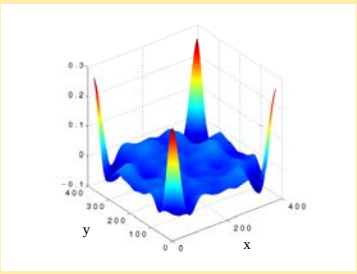


Fig. 5 Left: the velocity divergence field with the corresponding mesofeatures overplotted in white for the cell-competition model. Right: the cross-correlation function between the velocity divergence field and mesofeatures in the left image.

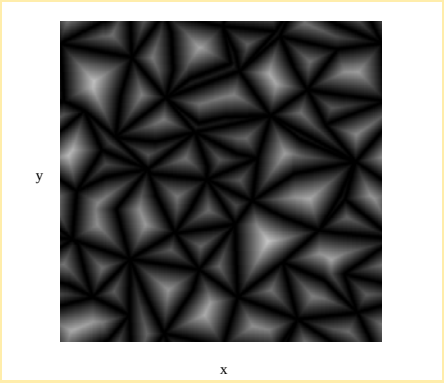


Fig. 6
Mesogranulation intensity image, cell-competition model. Such intensity time series will be used to extract mesogranulation lifetime and size statistics, and their dependence on the mesogranular evolution time.

Conclusions

We find mesogranulation in all models using a method corresponding to the cork method used in observations and MHD simulations. This indicates that mesogranulation can be a surface self-arrangement phenomenon of the granulation field, without any connection to deeper convection levels. In the case of the one-dimensional model we find that mesogranulation has no characteristic size- and timescale (Fig. 3), regardless of the cell interaction rules. Similar analysis for the two-dimensional models will follow.