Using characteristics of solar granulation to predict solar flux emergence

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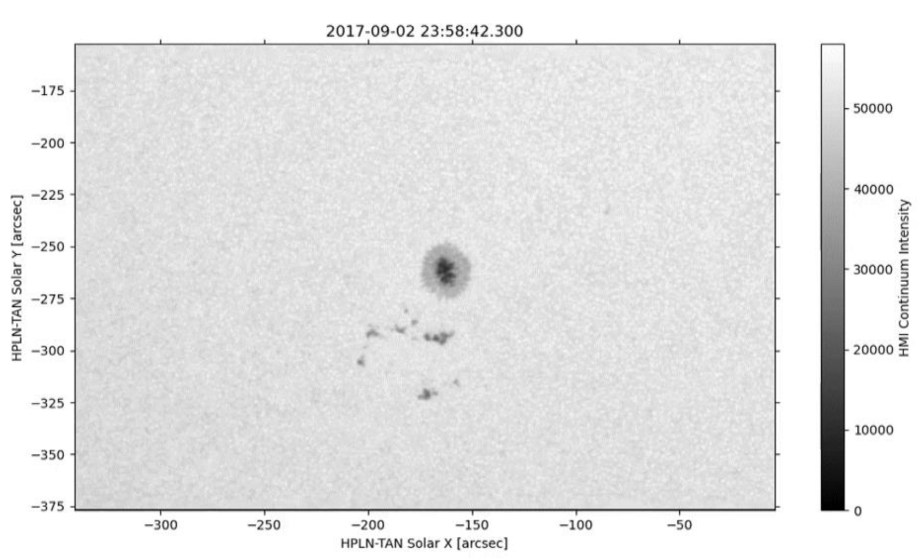
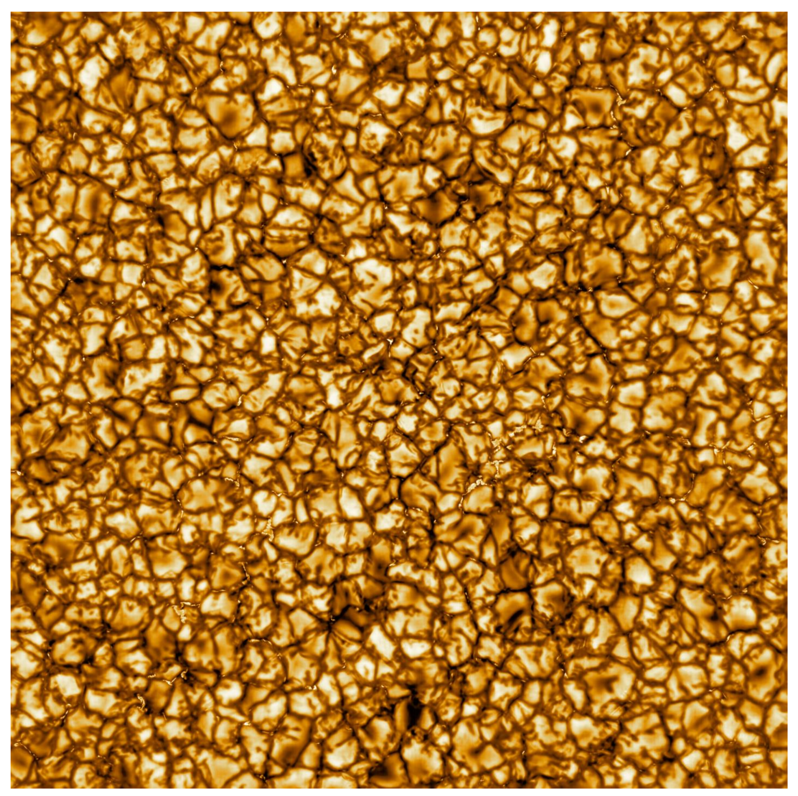
Abstract

Flux emergence dramatically alters the magnetic field configuration of the sun and drives solar activity. The ability to predict magnetic flux emergence from changes in solar granulation patterns would be an extremely useful observational tool. We applied a downhill tessellation algorithm to characterize the properties of the granules and trace changes in patterns over time. The specific properties we traced were area, eccentricity, and orientation. Using observational data from IBIS, we refined our granulation detection function and then applied it to a time series of simulation data from Muram. There were two notable shifts in these granulation patterns over time. Firstly, eccentricity patterns trended towards more elongated at the beginning of flux emergence and secondly, granule orientations became more aligned.

Introduction



The granulation pattern is a prominent feature everywhere at the surface of the sun.



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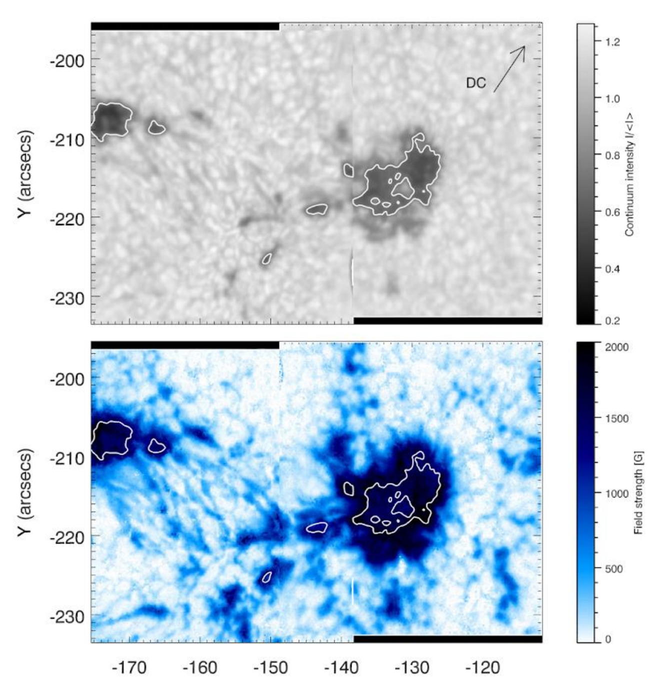
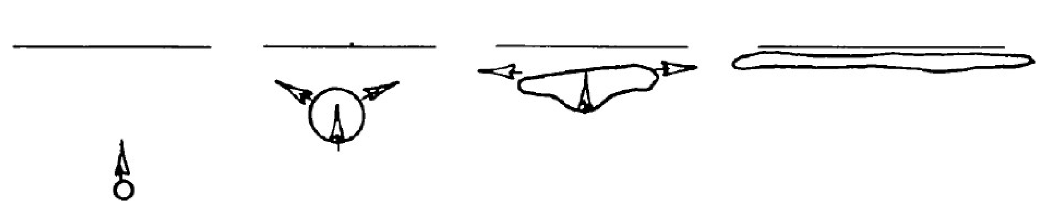


Large scale flux emergence disrupts the standard granulation pattern.

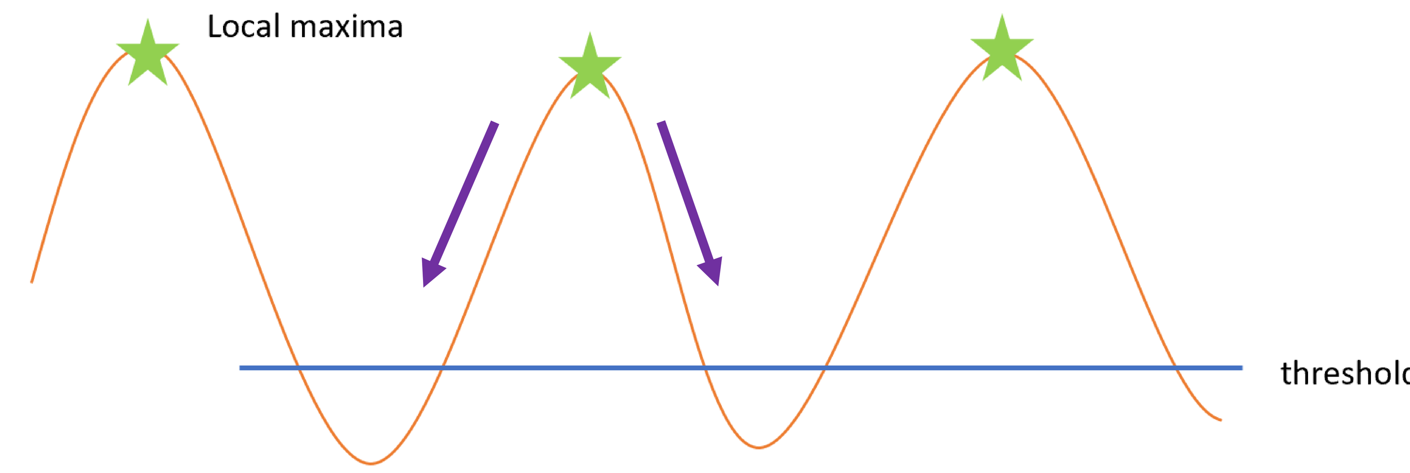


Cross-section of tubes of magnetic fields rising to surface of sun.

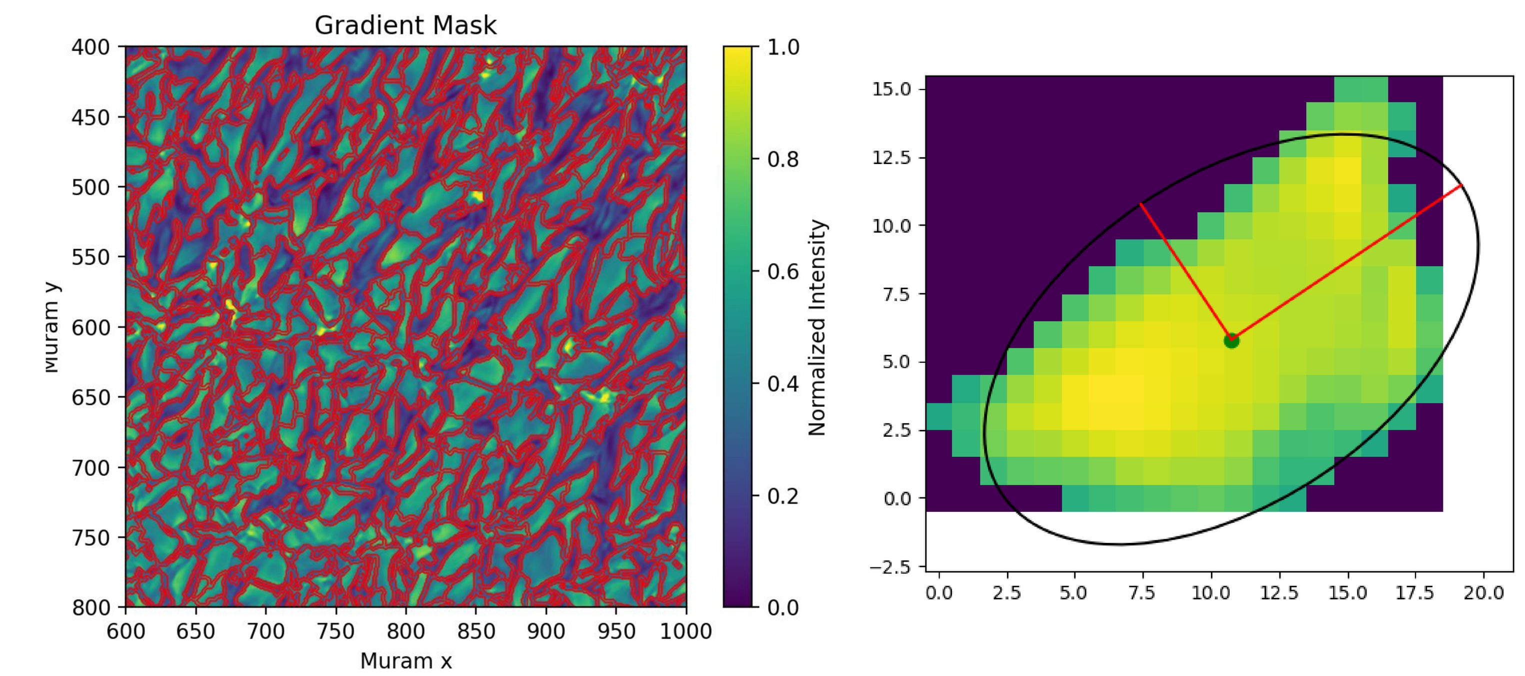
Our Goals:

a) Characterize the properties of each granule in various datasets (observations and simulations)
b) Look for changes in the granulation properties over time
c) See if this could be used as an early-detection system for flux emergence

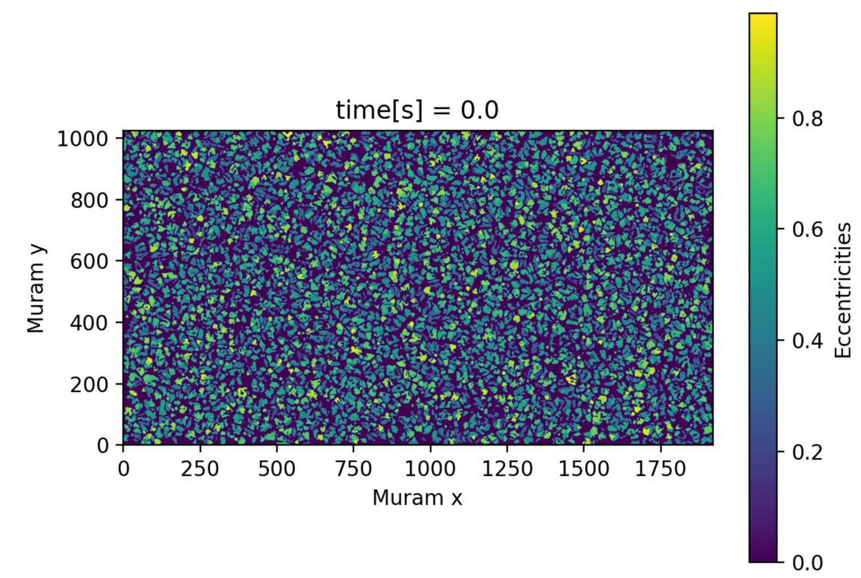
Methods & Results

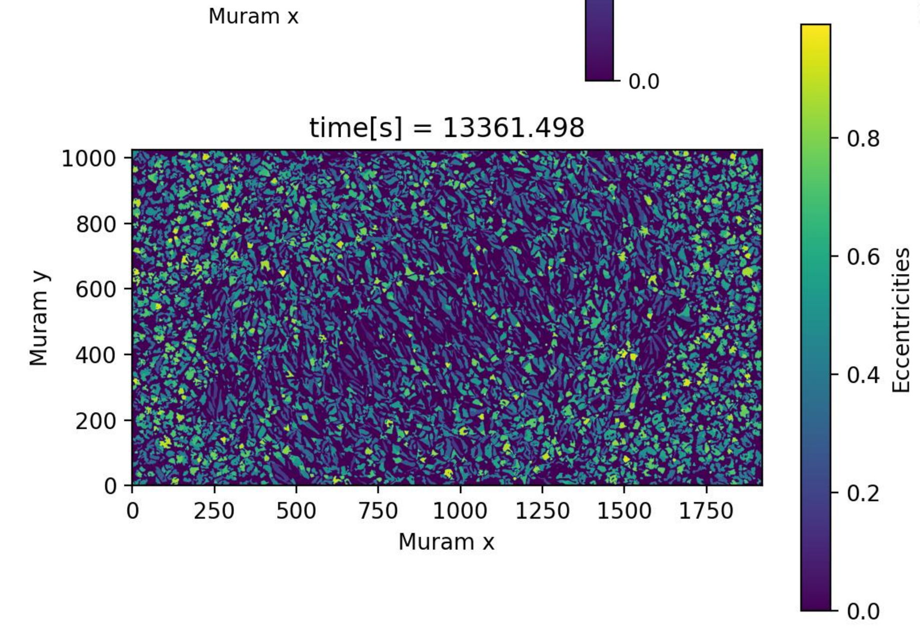


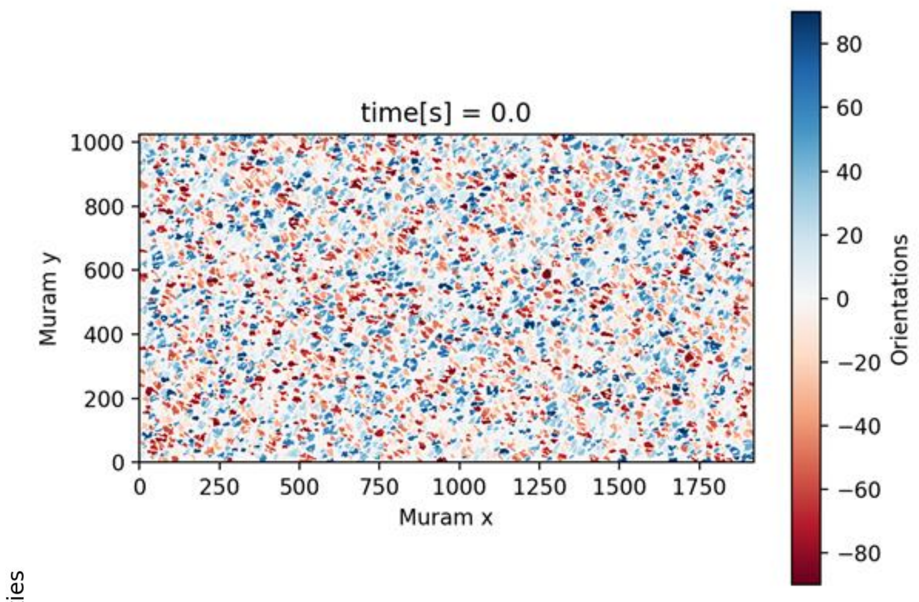
We used open-source image processing routines from the Python Scikit-image library: a maxima finder, a watershed tesselator, and a property-extractor

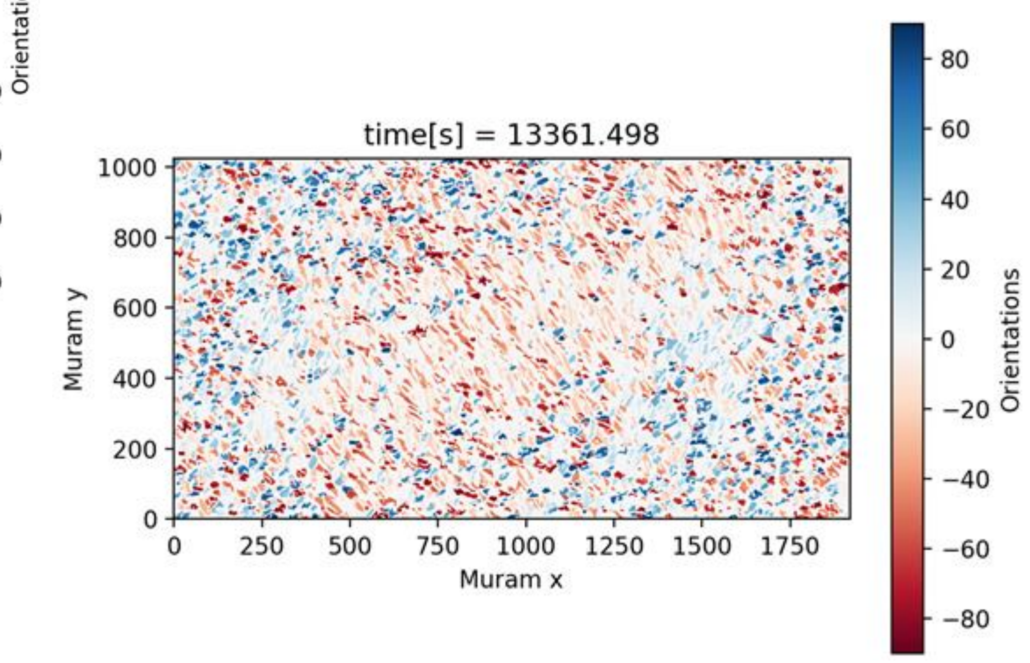


We applied these routines to data from IBIS (not shown) and a time series from a Muram simulation of flux emergence (Cheung+ 2010) that we focus on here.





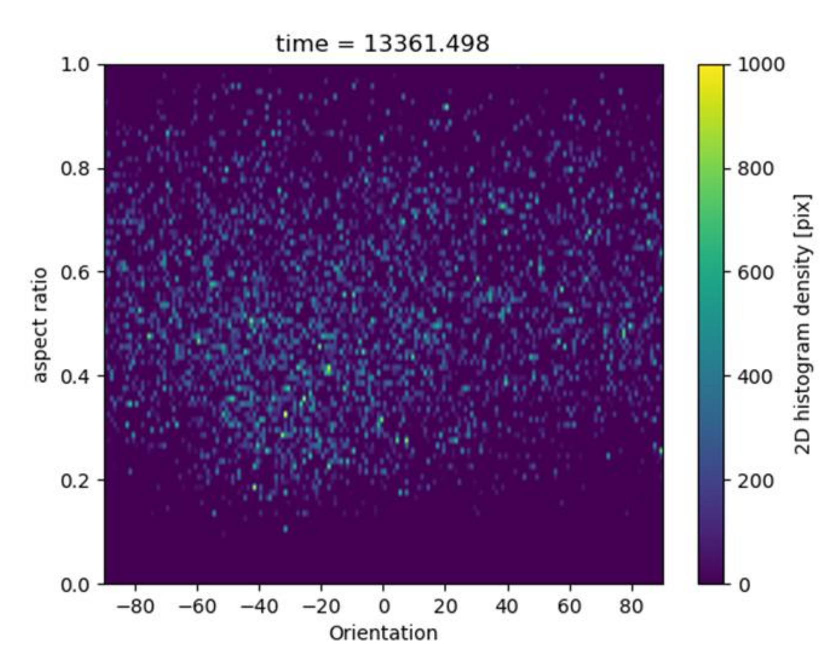




Conclusions and Future Work

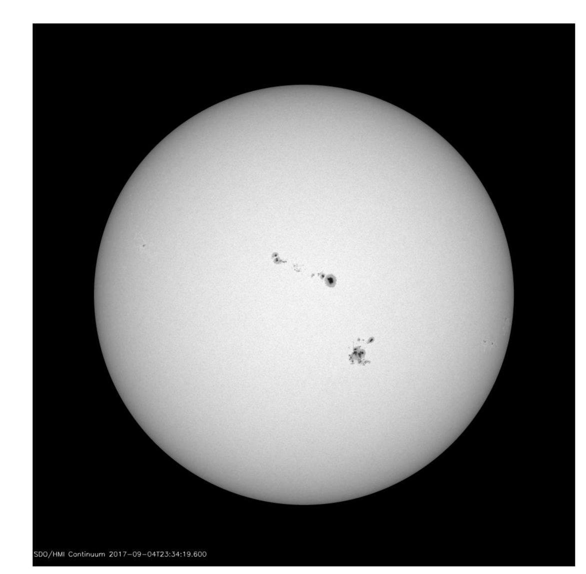
Conclusions:

- We were able to apply to both real data and simulated data
- Found changes in the granulation pattern in time in granule aspect ratio and orientation
- Found *correlated* changes in the aspect ratio and orientation



Future work :

- Explore how low of spatial resolution we can apply this to (progressively degrade the muram data down to HMI resolution)
- Apply to time-series of real data (higher-resolution Hinode data and lower resolution HMI data)
- See when the first signs of distorted granules appear relative to other signals (velocities, detectable magnetic fields)



References

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- Cheung & Isobe 2014
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Acknowledgements

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