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Effects of spatial resolution on Stokes profiles

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Introduction

Both numerical simulations and experimental observations of the solar atmosphere are limited by finite resolution. However the real physics of the sun are under no such limit. Thus sub-resolution processes may be expected to affect the spectra we observe beyond what can be captured by a numerical simulation of the same nominal resolution. Here, we attempt to quantify and qualify the effects of such sub-resolution processes on observed Stokes profiles, and the physical parameters of the solar atmosphere inferred from those profiles.

Method

- Run the same Bifrost [1] simulation at different resolutions (6 km, 12 km, 23 km)
- Synthesize Stokes profiles for Fe 617.3 nm and Ca 854.2 nm, using Rh1.5D [2]
- Spatially degrade and downsample these profiles
- Use center-of-gravity [3] and weak-field-approximation [4] to infer line-of-sight magnetic field strengths and velocities from the degraded spectra.

Conclusions

- Differences between simulations persist even after spatial degradation.
- Mainly small-scale fine-structure - the larger picture doesn't change much.
- Higher resolution gives more concentrated "hotspots" of more extreme velocities/field strengths.
- These extreme values also become more extreme with higher resolution.
- Same tendency displayed in both photosphere and chromosphere.

References

[1] Gudiksen, B. V., Carlsson, M., Hansteen, V. H., et al. 2011, A&A, 531, A154

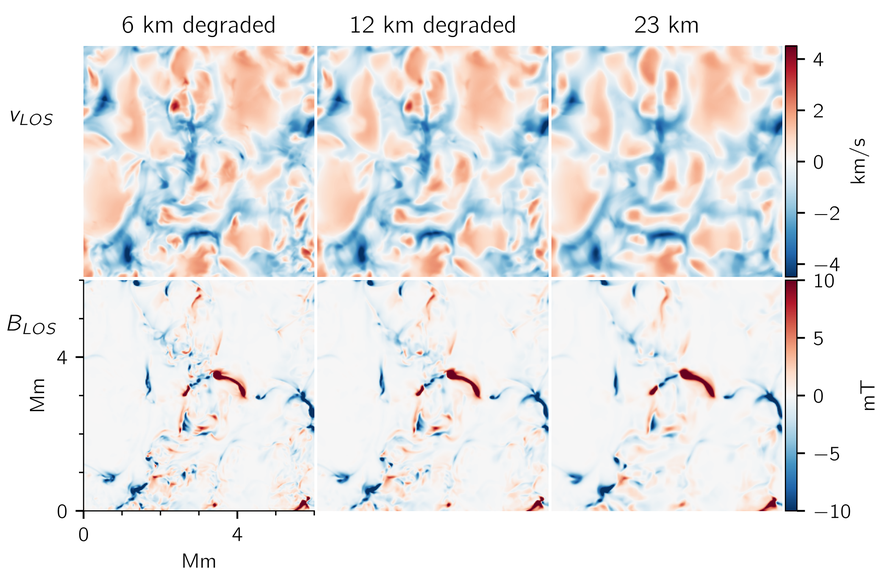
[2] Pereira, T. M. D. & Uitenbroek, H. 2015, A&A, 574, A3

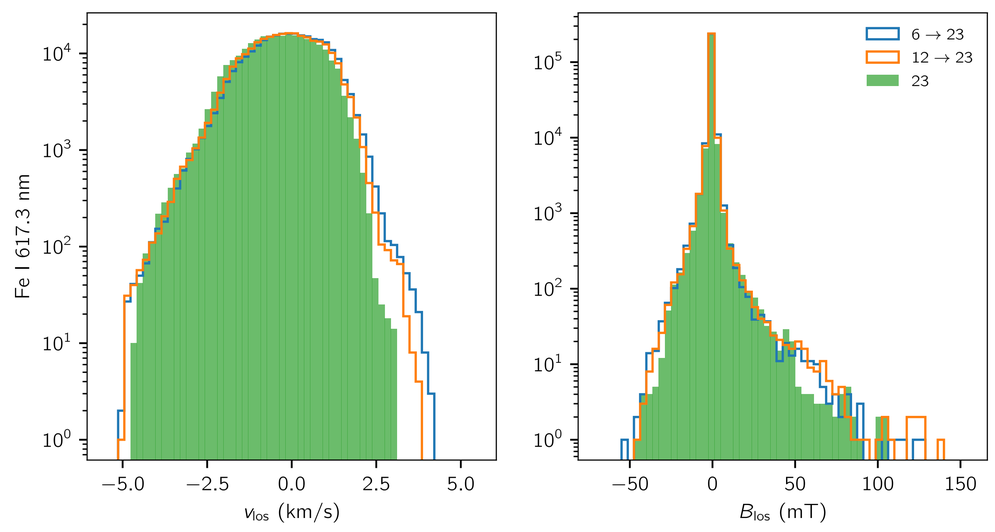
[3] Uitenbroek, H. 2003, ApJ, 592, 1225

[4] Centeno, R. 2018, ApJ, 866, 89

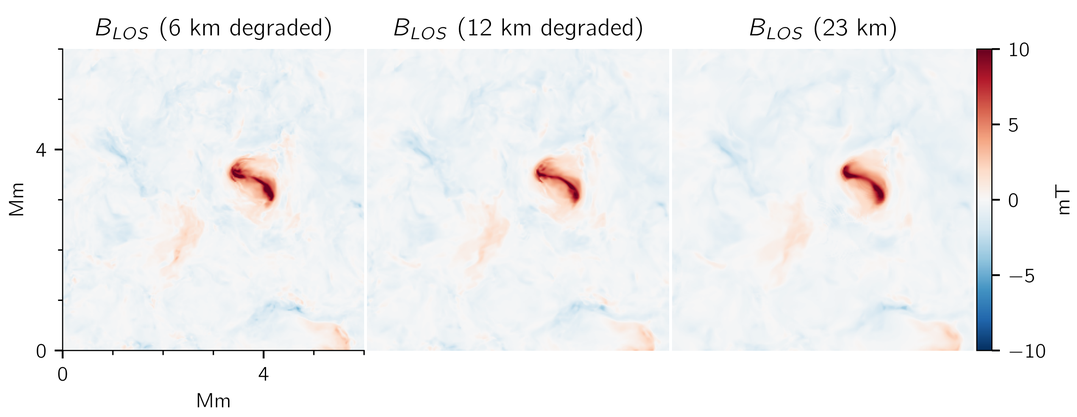
Results

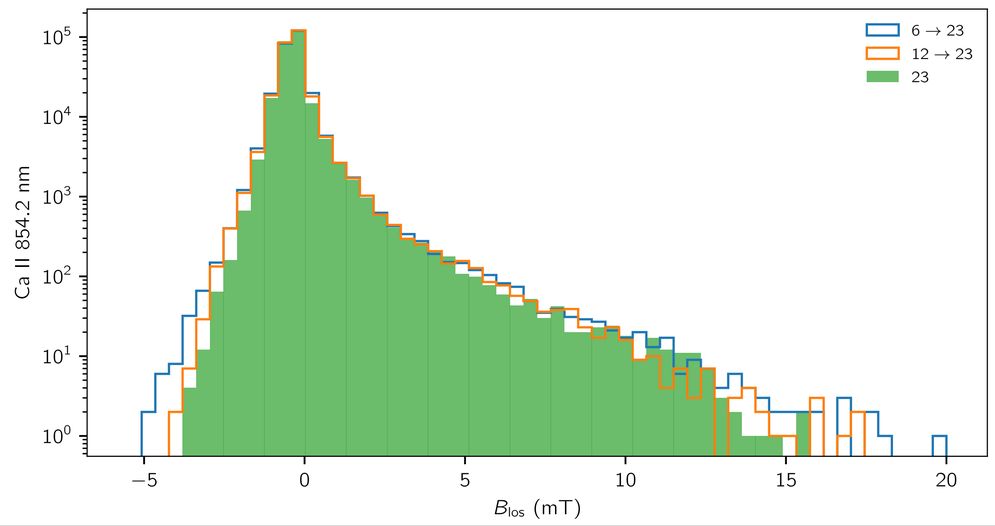
Inferred line-of-sight velocities and magnetic fields for the photospheric Fe I 617.3 nm (*):





Inferred line-of-sight magnetic fields for the chromospheric core of Ca II 854.2 nm (*):





(*): The colormaps on the left are zoomed in on a quarter of the simulations' full extent for ease of visual comparison; the distribution histograms, conversely, cover the whole field of view for the simulations.

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