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Effects of spatial resolution on Stokes profiles

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Both numerical simulations and observations of the solar atmosphere are limited in how small spatial variations they can resolve. The smallest processes in simulations are limited by the numerical grid employed, but the sun is under no such constraints. Therefore, observations and simulations at the same nominal resolution are not directly comparable, since sub-resolution effects not present in the simulations may still influence the observed Stokes profiles. A natural question, then, is when inferring quantities such as velocities or magnetic fields, how much is lost by not including the sub-resolution effects in the modelling? This will affect both the selection of numerical grids for simulations (to compare with observations), and the use of inversions to infer properties from observations, which often assume 1D atmospheres at the scale of each pixel. In the present work we study the effects of spatial resolution on Stokes profiles. We make use of 3D rMHD Bifrost simulations run with spatial resolutions of 6, 12, and 23 km, all starting from the same initial state. From these we compute synthetic spectra using the RH1.5D code for photospheric and chromospheric lines, which we degrade and downsample to the pixel scale of the lowest-resolution simulation (23 km). We then compare the inferred physical quantities (in particular magnetic field and line-of-sight velocities) for varying amounts of sub-pixel resolution. We find that important differences persist despite the downsampling and degradation to a lower resolution, and quantify the variation in the inferred physical quantities caused by the imprint of sub-resolution effects.

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