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Atmospheric temperature and density stratification for magneto-hydrodynamic models and spectro-polarimetric inversions

Numerical models of the solar atmosphere are an important tool in solar physics. Both, models and spectro-polarimetric inversion techniques require stratifications for the plasma temperature and density. For the case of explicit numerical schemes with high-order derivatives we require an isotropic diffusion equation for numerical stability. Otherwise, wiggles and inaccuracies can occur at steep temperature gradients in the solar transition region. We test a wide parameter range of the isotropic heat conduction to obtain realistic temperature gradients and feasible models. Our goal is to construct an atmospheric stratification that can serve as an initial condition for multi-dimensional models, as well as a more realistic reference atmosphere for inversions. To compensate for energy losses in the corona, we implement an artificial heating function that mimics the expected heat input from the field-line braiding mechanism. We find that our heating function maintains and stabilizes the obtained coronal temperature stratification. Unexpectedly, we find that higher grid resolutions may need larger diffusivity, contrary to the common understanding that high-resolution models are automatically more realistic and would need less diffusivity. The reason is that smaller grid spacing may represent steeper temperature gradients in the transition region, which has larger potential for numerical problems. We conclude that isotropic heat conduction is is required for explicit schemes with high-order numerical derivative. The Spitzer-type heat conduction alone would not be sufficient to maintain numeric stability.

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