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Using machine learning to unveil wave heating in 3D simulations

Solar atmospheric heating inferred from observations is known to be higher than the equilibrium rate of a static atmosphere, but it is unclear how the heating is supplied. Two leading theories are standing out as the most likely candidates to balance the high radiative losses of the solar atmosphere: heating by waves (AC heating), and magnetic reconnection (DC heating). Understanding AC heating in the chromosphere requires detailed modelling of pressure forces, magnetic field, and non-local radiative transfer (NLTE). We identify wave heating events in the 3D r-MDH simulation Bifrost and associate them with signatures in the chromospheric lines of Mg II, Ca II, and H I. With NLTE spectral synthesis of several hundred snapshots, we investigate the wave heating signatures in the simulated chromosphere. We use a novel approach involving machine learning to automatically detect wave heating signatures from our chromospheric analogues. The spectral signatures that reveal wave heating are used to calculate wave energy contributions to the chromospheric heating rate and energy transfer to higher layers.

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