Modelling the non-additivity of forcings using a convolutional neural network

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Abstract

The changes of the global mean surface temperature (GMST) are studied during the historical period from1900 to 2015. These changes are mainly resulting from the influence of the external forcings, with the emission of greenhouse gases and aerosols. In detection and attribution studies it is often assumed that the influence of external forcings is additive, it implies that the influence of the forcings can be deduced from the sum of theinfluence of each forcings when taken separately. Here, we study the additivity in a multi-model ensemble, using the single forcing simulation from DAMIP (Detection and Attribution Model Intercomparison Project). We show that at the end of the historical period, the influence of the forcings is non-additive. We studied this non-additivity with a convolutional neural network to simulate the combined effects of the external forcings. The network is trained to reproduce the GMST of the historicals simulations from the GSMT of single-forcing simulations. When the neural network is trained using only a single model, it succeeds to reconstitute the historical simulations. However the analyses of sensitivity using occlusions or gradients methods, show that the forcings are misrepresented. Conversely, lower performances are obtained when using all the models, but the analyses of sensitivity are then more consistent. We suggest that similar networks could be used in future studies to attribute the climate changes.

Keywords: climate models, non, additivity, neural networks

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