@article{Labe2021,
abstract = {It remains difficult to disentangle the relative influences of aerosols and greenhouse gases on regional surface temperature trends in the context of global climate change. To address this issue, we use a new collection of initial-condition large ensembles from the Community Earth System Model version 1 that are prescribed with different combinations of industrial aerosol and greenhouse gas forcing. To compare the climate response to these external forcings, we adopt an artificial neural network (ANN) architecture from previous work that predicts the year by training on maps of near-surface temperature. We then utilize layer-wise relevance propagation (LRP) to visualize the regional temperature signals that are important for the ANN's prediction in each climate model experiment. To mask noise when extracting only the most robust climate patterns from LRP, we introduce a simple uncertainty metric that can be adopted to other explainable artificial intelligence (AI) problems. We find that the North Atlantic, Southern Ocean, and Southeast Asia are key regions of importance for the neural network to make its prediction, especially prior to the early-21st century. Notably, we also find that the ANN predictions based on maps of observations correlate higher to the actual year after training on the large ensemble experiment with industrial aerosols held fixed to 1920 levels. This work illustrates the sensitivity of regional temperature signals to changes in aerosol forcing in historical simulations. By using explainable AI methods, we have the opportunity to improve our understanding of (non)linear combinations of anthropogenic forcings in state-of-the-art global climate models.},
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