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Unsupervised classification of ozone profiles from UKESM1

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The distribution of ozone in the atmosphere is relevant for air pollution and radiative forcing. This distribution features complex spatial and temporal variability, set by balances between chemical production, loss processes, and advection. At present, the way in which ozone comparison regions are defined relies on somewhat arbitrarily drawn boundaries. In an effort to develop a more general, data-derived method for defining coherent regimes of ozone structure, we apply an unsupervised classification technique called Gaussian Mixture Modelling (GMM). We apply GMM to the output from the UKESM1 coupled climate model, including the historical run and two of the future climate projections. GMM identifies different ozone profile classes without using any latitude or longitude information, thereby highlighting coherent ozone structure regimes. We determine each of the model data set contains 9 groups of unique vertical classes. The classes depend on latitude, even though GMM was not given any latitude information. Polar and subpolar classes show low tropopause and low tropospheric ozone, and the tropical classes have high tropopause. Northern hemisphere high latitude classes have higher stratospheric ozone than southern hemisphere high latitude classes. We analyze how the spatial extent of the classes changes under different scenarios by comparing classes in SSP126 and SSP585 with a historical simulation. This work suggests that GMM may be a useful method for identifying coherent ozone regimes for comparing different model results and observational data.