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Measuring cloud sensitivity to aerosols at a global scale using isolated aerosol sources

Edward Gryspeerdt[1,2], Manuel Louro Coelho[1], Tristan Smith[3], Santiago Suarez De La Fuente[3], Rodrigo Quilelli Correa Rocha Ribeiro[4], and Maarten van Reeuwijk[4]

[1]Space and Atmospheric Physics Group, Imperial College London, London, UK (e.gryspeerdt@imperial.ac.uk)
[2]Grantham Institute - Climate Change and the Environment, Imperial College London, London, UK
[3]UCL Energy Institute, University College London, London, UK
[4]Department of Civil and Environmental Engineering, Imperial College London, London, UK

The sensitivity of clouds to anthropogenic aerosol perturbations remains one of the largest uncertainties in the human forcing of the climate system. A key difficulty is in isolating the impact of aerosols from large-scale covariability of aerosol and cloud properties. Natural experiments, where aerosol is produced independently of the cloud and meteorological properties, provide a pathway to address this issue. These aerosol sources often modify cloud properties, leaving linear cloud features known as shiptracks (when formed by a ship) or pollution tracks (more generally).

In this work, we use a database of point sources of aerosol over both land and ocean to identify clouds that are sensitive to aerosol and to measure their response. Using a neural network to identify when a point source is modifying the cloud, we are able to measure the sensitivity of individual clouds to aerosol at a global scale, looking at over 400 million cases.

We find the probability of track formation is strongly dependent on the background cloud and meteorological state, similar to previous regional studies. With our global database, we identify regions that are strongly susceptible to aerosol perturbations, even where aerosol sources are rare. We find that there are several regions that are highly susceptible to aerosol, but that have been previously overlooked due to a low frequency of pollution tracks.