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Choosing a 'best' global aerosol model: Can observations constrain parametric uncertainty?

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Anthropogenic aerosol has been shown to contribute to climate change via direct radiative forcing and cloud-aerosol interactions. While the role of aerosol as a climate agent is likely to diminish as CO_2 emissions increase, recent studies suggest that uncertainty in modelled aerosol is likely to dominate uncertainty in future forcing projections. Uncertainty in modelled aerosol derives from uncertainty in the representation of emissions and aerosol processes (parametric uncertainty) as well as structural error. Here we utilise Latin hyper-cube sampling methods to produce an ensemble model (composed of 280 runs) of a global model of aerosol processes (GLOMAP) spanning 31 parametric ranges. Using an unprecedented number of observations made available by the GASSP project we have evaluated our ensemble model against a multi-variable (CCN, BC mass, PM2.5) data-set to determine if 'an ideal' aerosol model exists. Ignoring structural errors, optimization of a global model against multiple data-sets to within a factor of 2 is possible, with multiple model runs identified. However, (even regionally) the parametric range of our 'best' model runs is very wide with the same model skill arising from multiple parameter settings. Our results suggest that 'traditional' in-situ measurements are insufficient to constrain parametric uncertainty. Thus, to constrain aerosol in climate models, future evaluations must include process based observations.