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Where on Earth can we observe pristine aerosol?

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To understand how sensitive the climate is to greenhouse gas and aerosol emissions it is important to define the baseline from which the aerosol forcings are calculated [Carslaw et al., 2013]; but if no regions in the world are anthropogenically unaltered, where on Earth can we observe and learn about the behaviour of pristine environments? This question is relevant to both future modelling and long-term observational studies in climate science. Identification of such regions is also important if we are to fully understand climate response to natural aerosol changes [Spracklen and Rap, 2013].

Here we use a combination of model simulations and statistical emulation of the Global Model of Aerosol Processes (GLOMAP) to identify regions which are most pristine in today's atmosphere. The simulations are used to identify present day (PD) regions which have daily mean cloud condensation nuclei (CCN) concentration similar to pre-industrial (PI) levels. The emulation of an ensemble of perturbed parameter runs [Lee et al., 2013] for the PI and PD allows a full Monte Carlo variance-based sensitivity analysis of CCN to 28 different parameters, covering both natural and anthropogenic emissions and their processes, which affect the uncertainty in CCN concentrations. We use this information to assess which regions exhibit little change in the sensitivity the 28 parameters between the PI and PD. Potentially pristine environments are defined based on where both the CCN number concentration and its sensitivity to the 28 parameters have remained constant through the industrial period.

Our results indicate that the low to mid-latitude maritime southern hemisphere is the most pristine region in the PD atmosphere, especially during the austral summer. Other pristine regions include Alaska and Yukon, the Melanesian islands and the Antarctic Peninsula. Simulated anthropogenic influence on CCN has high seasonality in the southern hemisphere but low seasonality in the northern hemisphere. Finally, we highlight which regions of high cloud albedo radiative forcing have the highest number of pristine days. It is in these pre-industrial-like regions that measurements to help improve baseline calculations could be established.

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