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Using laboratory and field observations to constrain an optical parameterization for cirrus

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A single habit optical parameterization for cirrus is constrained by observed microphysical relationships derived from in-situ data. The chosen particle for this parameterization is a hollow column with a stepped internal structure, as observed in laboratory cloud chamber studies. This particle was chosen as it exhibits lower asymmetry parameters than solid columns of equal aspect ratio, a quantity which is typically over –predicted when assuming pristine particles. To represent the full size range of cirrus ice crystals, the aspect ratio was varied as a function of maximum dimension in order to fit within observed mass-dimensional and area ratio-dimensional relationships. By applying these microphysical constraints, we create an optical parameterization that is physically consistent with the microphysical scheme within a configuration of the Met Office Unified Atmosphere model.

Optical properties are computed using T-Matrix, Ray Tracing and Ray Tracing with Diffraction on Facets (RTDF) for 56 wavelengths in the short-wave, and the bulk properties are found for 28 Particle Size Distributions (PSDs) as used in the microphysical scheme. The bulk properties are then parameterized as simple functions of wavelength and Ice Water Content (IWC), and therefore the optical properties are directly coupled to the GCM prognostic variable IWC. These are implemented into the GA6 configuration of the Met Office Unified Model in conjunction with the Edwards 2007 long-wave parameterization. The annual 20 year top of atmosphere (TOA) short-wave fluxes are computed, along with the temperature and humidity structure of the atmosphere. The ability of a single habit radiative parameterization to accurately predict cirrus optical properties, whilst also preserving observed microphysical relationships, is discussed.