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High resolution in-line analyses of precipitation at two UK ground locations, and possible relevance to convective cooling at cloud level.

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Wet deposition of many molecular pollutants can be simulated 'sufficiently well' by a simple meteorological model, including the poorly soluble ozone (Tost et al, 2007, 2754). Carbon dioxide (CO_2) has a Henry constant similar to that of ozone, but perhaps because its boundary layer presence is three orders of magnitude greater than ozone it has been widely assumed to be immune to significant cleansing by scavenging and deposition. In 2009 this 'elephant' was approached (cautiously!) at the first of two UK locations using high time-resolution analyses of delivered rainwater, and some initial observations seem relevant to the 'organised convection' theme of the present session.
Six variables are measured every second, averaged every 60 seconds, including: conductivity; acidity ([H3O+] = 10ˆ-pH) and; stripped CO_2 (by NDIRS). Convective precipitation typically delivers significantly more CO_2 than predicted from Henry's Law, is supersaturated on arrival and shows a characteristic 'spiky' profile against time.
In assessing the above, this paper revisits eighty years of measurements of the Henry's Law equilibrium for the CO_2/water system at partial pressures less than 1 atmosphere, and (more recently) low-pressure solubility at temperatures down to 4°C (Carroll, Slupski and Mather, 1991, 1203; Faraday Discuss. 2013, 167, 462-3). The observed solute load and supersaturation would become plausible if the reported upturn in solubility between 20°C and 4°C continued into the super-cooled zone. In a cloud, super-cooling will arise under convection when condensing droplets are chilled by adiabatic expansion of the carrier air. Droplets will increase in molar volume by up to 2.5% at -34°C (the temperature of spontaneous ice nucleation, Hare and Sorensen, 1987), offering a physical framework for the observed characteristics, and the possibility that 'spikiness' reflects the degree of organisation of convection.