Impact Factor 4.865   ISI indexed

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A new formulation of equivalent effective stratospheric chlorine (EESC)

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Abstract. Equivalent effective stratospheric chlorine (EESC) is a convenient parameter to quantify the effects of halogens (chlorine and bromine) on ozone depletion in the stratosphere. We show, discuss, and analyze a new formulation of EESC that now includes the effects of age-of-air dependent fractional release values and an age-of-air spectrum. This EESC can be more appropriately applied to various parts of the stratosphere because of this dependence on mean age-of-air. This new formulation provides quantitative estimates of EESC that can be directly related to inorganic chlorine and bromine throughout the stratosphere. In this paper, we first provide a detailed description of the EESC calculation. We then use this EESC formulation to estimate that human-produced ozone depleting substances will recover to 1980 levels in 2041 in the midlatitudes, and 2067 over Antarctica. These recovery dates are based upon the assumption that the international agreements for regulating ozone-depleting substances are adhered to. In addition to recovery dates, we also estimate the uncertainties and possible problems in the estimated times of recovery. The midlatitude recovery of 2041 has a 95% confidence uncertainty from 2028 to 2049, while the 2067 Antarctic recovery has a 95% confidence uncertainty from 2056 to 2078. The principal uncertainties are from the estimated mean age-of-air and fractional release values, and the assumption that these quantities are time independent. Using other model estimates of age decrease due to climate change, we estimate that midlatitude recovery may be significantly accelerated.

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