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Semi-empirical models for chlorine activation and ozone depletion in the Antarctic stratosphere: Proof of concept

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Two semi-empirical models were developed, one to relate the conversion of total Antarctic stratospheric chlorine (Cly) to activated Antarctic stratospheric chlorine (defined by daytime chlorine monoxide (ClO)), and a second to relate the rate of ozone destruction to ClO. The two resultant first order differential equations provide a fast and inexpensive way to describe the inter- and intra-annual evolution of daytime ClO and total column ozone in the Antarctic spring. The equations are based on physical relationships and capture key sensitivities in the Antarctic stratosphere that determine the interaction between changes in chemical composition, changes in climate, and Antarctic ozone depletion. To keep the models as parsimonious as possible, only the essential processes required to describe the activation and deactivation of bulk quantities averaged over the vortex area, and for the duration of the Antarctic vortex period, are considered. The empirical coefficients are derived by fitting the equations to observations of daytime ClO and ozone mass deficit (OMD). These two semi-empirical models are able to explain much of the intra- and inter-annual variability observed in daily ClO and OMD time series.