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When will the global ozone layer recover? A semi-empirical approach

P E Huck (1), G E Bodeker (2), S Kremser (2), M Rex (3), M L Santee (4), M Meinshausen (5), and A J McDonald (6)

(1) Bodeker Scientific, Christchurch, New Zealand (petra@bodekerscientific.com), (2) Bodeker Scientific, Alexandra, New Zealand, (3) Alfred-Wegener Institut, Potsdam, Germany, (4) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, USA , (5) Potsdam Institute for Climate Impact Research, Potsdam, Germany, (6) Department of Physics and Astronomy, University of Canterbury, Christchurch, New Zealand

Semi-empirical models to relate the conversion of total Antarctic stratospheric chlorine (Cl_y) to activated Antarctic stratospheric chlorine (defined by daytime chlorine monoxide (ClO)), and the quantity of activated chlorine to the rate of ozone destruction were developed. These two models provide a proof-of-concept for a new fast and inexpensive way to describe the inter- and intra-annual evolution of stratospheric ozone. 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. Based on these results, SWIFT – a Semi-empirical, Weighted Iterative Fit Technique – was developed to capture more detail in the chemical processes of Arctic and Antarctic ozone depletion. SWIFT solves differential equations that describe the vortex average evolution of quantities driving chlorine activation and deactivation and ozone depletion. This set of equations provides a new and fast interactive stratospheric chemistry scheme. Chemistry-climate models, which are state-of-the-art models currently used to make projections of the global ozone layer, are extremely computationally demanding and cannot provide ensembles of simulations that span the full range of uncertainty required for international policy. Implementation of our stratospheric chemistry scheme into a simple climate model builds a fast emulator of these highly complex models using semi-empirical equations describing key stratospheric processes related to ozone destruction which are trained on observations.