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The annual cycle of hydrogen peroxide: an indicator of chemical instability?

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Abstract. A box model has been used to study the annual cycle in hydrogen peroxide concentrations with the objective of determining whether the observed difference in summer and winter values reflects instability in the underlying photochemistry. The model is run in both steady-state and time-dependent modes. The steady-state calculations show that, for some range of NO_x background levels, two stable solutions to the continuity equations exist for a period of days in spring and fall. The corresponding time-dependent model indicates that, for sufficiently high background NO_x concentrations, the spring and fall changes in H_2O_2 concentration may be interpreted as a forced transition between the two underlying stable regimes. The spring transition is more rapid than that in fall, an asymmetry that becomes more marked as background NO_x increases. This asymmetry is related to the different time scales involved in chemical production and loss of H_2O_2. Observations of the spring increase in H_2O_2 concentration may therefore provide a better measure of the change in the underlying chemical regime than does the fall decrease. The model results developed in this paper will be compared with two sets of observations that cover annual variations of peroxide concentrations under different background pollution conditions.

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