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Some Recent Development in Integrating Empirical Statistical Models with Chemical-Transport Models for Predicting Stratospheric Ozone and Temperature

Abstract: In predicting atmospheric ozone and temperature, there have been two basic paralleling approaches in the literature. The first may be called a basic physical modeling approach, primarily based on modeling the complex atmospheric chemistry and dynamical transport phenomena involving a very large number of partial differential equations. The other may be called an empirical statistical approach that utilizes observed data on atmospheric variables collected from satellite and ground sources. Often these two approaches are informally compared for the improvement of both. For example, for given input conditions, ozone and temperature trends can be calculated from physical models, and these calculated results can then be checked with empirical data for confirmation and verification of hypothesized values. Conversely, unexpected empirical observations such as the ozone holecan stimulate much further development in physical models.

The purposes of this work are twofold. In the first, we introduce a hybrid statistical chemical-transport model for total column ozone prediction, based on the University of Illinois at Urbana-Champaign 2-D (UIUC 2-D) chemical-transport model of the global atmosphere. We propose a two-step general diagnostic procedure for latitudinal ozone from 60 degree South to 60 degree North to see if the model captures some important patterns in the data. Specifically, we first regress the observed measurements given by a cohesive dataset from the SBUV(/2) Satellite system on the model output on ozone. Second, we then regress the residuals from this regression on important and meaningful features of the data such as the annual cycle, solar flux and various oscillation indices. Systematic discrepancies of the model are then identified using an initial set of data (1979-1995) and statistically corrected afterward. The 1996-2003 validation sample confirms that the combined approach yields much better predictions than the direct UIUC 2-D outputs. In the second, we investigate the extent to which global predictions of atmospheric temperature based on general circulation models (GCM) can help predict climate changes in small local regions such as a city. It is well known that predictions from GCMs which are given in a global scale are of very limited use for local short term (day, month) temperature forecasts. On the other hand, GCM forecasts may be much more relevant in forecasting local climate changes over a five or ten year period, or over several decades. This can be of specific importance in assessing the

impacts of, for example, the increase in green houses gases from burning of fossil fuel. We shall report findings of using GCM calculations to improve the efficiency of long horizon forecasts of several local sites near Chicago including Aurora which has over 100 years of daily temperature readings.