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STRATOSPHERIC MODELS AND MEASUREMENTS: A CRITICAL COMPARISON

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INTRODUCTION

The stated objectives of the HSRP/Atmospheric Effects of Stratospheric Aircraft (AESA) initiative are to support research in the atmospheric sciences that will improve our basic understanding of the circulation and chemistry of the stratosphere and lead to (interim) assessments of the impact of a projected fleet of HSCT's on the stratosphere. Three model comparison workshops have been conducted, so far, in support of this goal; they occurred in 1987 at Ft. Myers Beach, Florida, and in 1988 and 1991 at Virginia Beach, Virginia. These workshops have been focused on the differences between models used to calculate the atmospheric effects of the proposed aircraft emissions. It is now possible to test these models against atmospheric data, and that is the goal for 1991.

OBJECTIVES

The charge to the Models and Measurements (M&M) Subcommittee of AESA is to (1) establish a standard set of atmospheric measurements that can be used to test the reliability of atmospheric chemistry models; (2) develop a method for evaluating model/data comparisons; and (3) direct the first major international stratospheric model/data comparison. We are currently addressing objective (1).

Data sets. The first subcommittee meeting, held in March 1991, was devoted to a discussion of the available data sets. A wide range of data already exist for our purposes. These data include ozone column or total ozone; multiple years of ozone, H₂O, CH₄, N₂O, and NO₂ distributions; column estimates of HNO₃, NO₂, HCl, and HF; satellite distributions of nitric acid; ATMOS and balloon profiles of various species, radioisotope, and aerosol distributions; and a "climatology" of polar stratospheric cloud (PSC) occurrences. Certain balloon and aircraft campaigns have obtained simultaneous data on many species and radicals, such that one can determine correlations for long-lived trace species, as well as perform checks on fast photochemical processes.

Multiple years of temperature, wind, and geopotential height data are available, from which one can characterize the state of the stratosphere for different seasons and locations. One can derive certain dynamical quantities from these data and they, in turn, can be used to diagnose the net transport in both the atmosphere and in models. It is expected that the Upper Atmosphere Research Satellite (UARS) will provide even more extensive data distributions, but they may not be publicly archived until late 1993. More importantly, new aircraft measurement campaigns will be conducted at a range of latitudes and altitudes in the lower stratosphere from 1992 through 1994. Those data should become available fairly quickly.

Many of the data sets already reside in an Upper Atmosphere Data Pilot (UADP) computer system at the NASA Langley Research Center. This repository will be supplemented with other data sets during 1991 upon the recommendation and assistance of the M&M subcommittee members. Output from the models will be gridded in formats that are

compatible with the data and will also be stored in the UADP. Species distributions from the models will be compared with the data distributions, and the subcommittee members will then assess the accuracy of those comparisons at a week-long meeting in January 1992.

Modeling activity. The selection of a set of model intercomparisons is being determined at this May 1991 Williamsburg subcommittee meeting. So far, a preliminary group of model studies has already been suggested. For three-dimensional models, they include simulations of the "present-day" stratosphere and a passive tracer study, and simulations of the "present-day" atmosphere, passive tracer or residence time studies with Carbon-14 and/or aerosols, the partitioning of NO_y and Cl_y chemical families, and an estimate of the chemical budget for ozone for two-dimensional models. There continues to be a need for model/model comparisons in the areas of photolysis calculations, chemical partitioning, and derived transport fluxes. Details of how to conduct the proposed model experiments will become final by mid-summer 1991. Criteria will also be developed at that time for making judgments about the quality of the results of each of the several model experiments.

Two reports are envisioned from this year-long activity. First, the subcommittee will prepare a UADP data report and include examples of and a statement about the quality, coverage, and length of the data sets. The second report will contain the results of those comparisons. It is believed that the need for model/data intercomparisons will continue after January 1992, as new data sets become available and models improve. It is hoped that the present M&M activity will lead to greater insight into those areas of needed model improvement, yet provide increasing confidence in the models to be used for the HSRP/AESA assessments that will come in succeeding years.

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