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FINAL REPORT
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DATA VALIDATION FOR EARTH PROBE-TOTAL OZONE MAPPING SPECTROMETER

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GOALS:

The goal of this project is to provide scientific analyses to aid in validation of data sets used in the detection of long term global trends of total ozone. Total ozone data from the Earth Probe-Total Ozone Mapping Spectromoeter instrument will be compared for validation purposes with features in previous TOMS data. Atmospheric dynamics concepts will be used in the interpretation of the analyses.

RESULTS:

Excellent results were made on the topics covered by this grant and have been summarized in the publications listed below:

PUBLICATIONS SPONSORED BY GRANT NAG 5-1519:

1. Stanford, J. L., J. R. Ziemke, R. D. McPeters(1), A. J. Krueger(1), and P. K. Bhartia(1), 1996: Spectral Analyses, Climatology and Inter-annual Variability of Nimbus-7 TOMS Version 6 Total Column Ozone. *Bull. Am. Meteor. Soc.*, 77, 353-357.

   (1) NASA Goddard Space Flight Center, Greenbelt, MD

Abstract:

An ozone climatology using space-time spectral analyses is now available as NASA Reference Publication RP-1360. This note gives a brief description of RP-1360 and examples of its graphics. The address for copies of the publication is given, along with the Internet route for obtaining tabulated data via ftp.

2. Stanford, J. L. and J. R. Ziemke(1), 1996: A Practical Method for Predicting Midlatitude Total Column Ozone from Operational Forecast Temperature Fields. *J. Geophys. Res.*, 101, 28,769-28,774.

(1) National Research Council Fellow, NASA Goddard Space Flight Center, Code 916, Greenbelt, MD 20770 USA

Abstract:

Accurate forecasts of total column ozone (OMEGA) are important because, among other reasons, forecasts of clear-air biologically-important solar ultraviolet (UVB) reaching the earth's surface are exponentially sensitive to OMEGA. We present a simple method for predicting OMEGA using forecast lower stratospheric temperatures and a precalculated look-up table based on ozone climatology from several years of satellite observations. Compared with observations, the simple method gives one-day forecast OMEGA errors of 1-2% (2-3%) in Northern (Southern) Hemisphere summers, comparable with current multivariate UVB forecast models being used by national weather services in several countries. The advantage of the prediction method described here is its simplicity: a convenient look-up table based upon ozone climatology is used, without the need for recalculation in each forecast. The method may prove useful for surface UVB forecasts, especially in the biologically important summer seasons of both hemispheres.

3. Ziemke, J. R. (1) and J. L. Stanford, 1997: Correlation of Total Ozone with Dynamical Variables. ATMOSPHERIC OZONE, Proc. XVIII Quadrennial Ozone Symposium, L'Aquila, Italy, 12-21 September 1996, Ed. R. D. Bojkov and G. Visconti, *World Meteor. Org.*, Geneva 1998, Vol. 1, pp. 97-100.

(1) NASA Goddard Space Flight Center, Greenbelt, MD

Abstract:

Recently Stanford and Ziemke developed a model for predicting total column ozone (Omega) from lower stratospheric temperatures and a pre-calculated look-up table based on several years of satellite ozone observations. The present paper extends that work by examining correlations between Omega and a number of other dynamical variables. Omega prediction models based on multiple dynamical variables are not found to reduce prediction errors over the single-variable model. This is attributed to observational and computational noise. Further results from the temperature-dependent Omega prediction model reveal that it captures medium scale Omega features well in summer midlatitudes of both hemispheres and that, depending on the accuracy of predicted temperatures from operational forecasts, Omega predictions may be made a number of days in advance. Because solar ultraviolet reaching the earth's surface is exponentially dependent on Omega, these results may be useful for UV predictions a number of days in advance in the biologically important summer seasons.

4. Ziemke(1), J. R., J. R. Herman(1), J. L. Stanford and P. K. Bhartia(1), 1998: Total ozone/UV-B monitoring and forecasting: Impact of clouds and the horizontal resolution of satellite retrievals. *J. Geophys. Rev.*, 103, 3865-3871.

(1) NASA Goddard Space Flight Center, Greenbelt, MD

Abstract

This study compares the horizontal resolution of solar backscatter ultraviolet 2 (SBUV2) total ozone (Omega) fields with those from the new NASA earth probe (EP) and advanced earth observing satellite (ADEOS) total ozone mapping spectrometer (TOMS) side-scanning photometers. The latter instruments provide high resolution, easily resolving the medium-scale waves (4-7 wavelengths around the earth at a fixed latitude) that dominate day to day midlatitude Omega fluctuations. In contrast, SBUV2 instruments do not, since these devices measure only at nadir (straight downwards), yielding approximately 14 measurements daily at a given latitude. This has consequences not only for global monitoring of Omega and ultraviolet-B (UV-B, 290-320 nm), but also for short timescale Omega and UV-B predictions in summer because timescales of a few days are coupled to medium horizontal scales (several thousand km) by baroclinic waves that typically force the observed Omega variations. We use a simple Omega prediction model to test the use of Omega fields from TOMS and SBUV instruments and show that the higher zonal resolution from side-scanning TOMS instruments results in sizeable reductions in Omega prediction errors, whereas predictions using SBUV2 Omega are no better than persistence (where tomorrow's Omega is taken to be today's) in the biologically important summer months. Daily variabilities (equivalent to errors in 24-hour persistence forecasting of Omega) in high-resolution TOMS midlatitude ozone during summer are shown to sometimes exceed 50 Dobson units, producing daily changes of 20% or greater in computed ground-level clear-sky UV-index. This study demonstrates that even these large daily changes in measured or predicted clear-sky UV are usually smaller than daily UV changes associated with transient clouds. While surface UV-B variability is dominated by local cloudiness variations, Omega forecasts can enhance UV-B prediction in relatively cloud-free regions such as the USA's desert southwest and in stagnant high pressure regimes that can persist for 1-2 weeks in summer. Furthermore, as weather forecast models increase in accuracy of forecasted cloudiness, accurate predictions will allow more accurate UV-B forecasts for cloud-free regions, the locations where they are most needed. Results from the present paper show, however, that TOMS-like side-scanning Omega measurements are required for ozone prediction and monitoring, rather than SBUV-type nadir observations.

5. NASA TECHNICAL REPORT:

Olsen, M. A., J. L. Stanford, R. D. McPeters(1), and J. R. Ziemke(1), 1997: Comparison of Nimbus 7 TOMS version 6 and 7 ozone fields by space-time spectral analysis, NASA REFERENCE PUBLICATION No. 1409, 32 pages.

(1) NASA Goddard Space Flight Center, Greenbelt, MD 20771

Abstract:

Total column ozone fields from Nimbus-7 total ozone mapping spectrometer (TOMS) version 7 (V7) data are analyzed by space-time spectral analysis and compared with previous analyses of version 6 (V6) data. One purpose of this note is to briefly comment on some differences between these two data sets. A second purpose is to help prospective TOMS users avoid several pitfalls inherent in analyzing TOMS data. Among the differences noted are improvements in the treatments of the known wave 1 low latitude feature and of large solar zenith angle effects at high latitudes. A variety of low amplitude, traveling features are noted, some of which are atmospheric in origin and some of which may be related to the satellite orbital characteristics or retrieval methods. Interpretations of these in terms of atmospheric dynamics should thus be made with care. Overall, the sensitive tests provided by space-time decomposition suggest that TOMS version 7 constitute an improved global data set valuable for investigations of total ozone.

Copies of NASA RP-1409 (Olsen et al., 1997) may be obtained from: NASA Center for Aerospace Information 800 Elkridge Landing Road Linthicum Heights, Maryland 21090--2934 Telephone: (301) 621--0390

Copies of reprints of these papers have been sent or will be when available, to the NASA Scientific and Technical Information Facility.

INVENTIONS/PATENTS: None were made under the research sponsored by this grant.

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Further information on our research is available at
http://www.public.iastate.edu/~atmos/homepage.html

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