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COMPARISON OF RECALCULATED DOBSON AND TOMS TOTAL OZONE AT HRADEC KRALOVE, CZECHOSLOVAKIA, 1978-1990

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ABSTRACT

The re-evaluated Dobson total ozone data from Hradec Kralove, Czechoslovakia were compared with independent Total Ozone Mapping Spectrophotometer (TOMS) "version 6" data set. The comparison was performed by means of the parallel daily averages of ground-based and satellite total ozone pairs of the period November 1978 to December 1990. The comparison showed slight differences between both data series. Their average relative difference is 0.48%. The similar results have been reached for subsets of direct sun and zenith types of measurements as well. Their relative differences are 0.61% and 0.11% respectively. These facts indicate not only good mutual relation of both data sources but also reliability and accuracy of the zenith charts of the spectrophotometer No.74 used at Hradec Kralove. Preliminary assessment of seasonal MU-dependence of the differences between Dobson and TOMS data was made while using total ozones of winter and summer months representing values of $MU=2.70-5.20$ and $MU=1.12-1.30$ respectively. The results did not show systematic underestimation or overestimation of total ozone due to MU-dependence of the instrument at Hradec Kralove in both seasons.

1. INTRODUCTION

The total ozone data set created with the Dobson spectrophotometer No.74 at the Solar and Ozone Observatory (SOO) of the Czech Hydrometeorological Institute at Hradec Kralove, Czechoslovakia was homogenized using day-by-day method. The recalculations were performed on the calibration level represented by the World Primary Standard Spectrophotometer No.83 (WPSS). The recalculated data from the period 1962-1990 were published together with description of methodology of homogenization in 1991 [Vanicek,1991]. The experts from SOO decided to check the quality of these individually recalculated total ozone data by means of the independent satellite measurements performed with the Total Ozone Mapping Spectrophotometer (TOMS) in the similar way as it was done for preliminary re-evaluated total ozones in recent years [Bojkov,1988]. The TOMS data set was also used for assessment of seasonal MU-dependence of the instrument No.74 and reliability of its zenith charts. Accuracy of both direct sun and zenith measurements was checked in this way too.

2. SPECIFICATION OF THE DATA SETS

Daily averages of recalculated Dobson total ozone from Hradec Kralove of the period November 1978 to December 1990 published by SOO [Vanicek,1991] were taken as a data base for comparison. These data were compared with the TOMS total ozone data set "version 6" of the same period of time measured with this satellite system in the quadrant 2×5 deg. above the Observatory [Stolarski and McPeters,1991]. Both data series were arranged so that only the averages from days with parallel ground-

based and satellite measurements could be taken into consideration. The series containing 3505 doubled pairs of daily averages comparable with each other was created in this way and used for following processing. To show nearly steady distribution of occurrence of parallel measurements the Figure 1 presents number of the pairs in individual months and years. It is evident that there is no significant reduction of the number of the measurements in the period under consideration which could decrease reliability of the data series from the statistical point of view. Only the data from the months June 1979, August 1986 and August 1990 are missing due to participation of the spectrophotometer No.74 at the international comparisons at Potsdam 1979 and Arosa 1986 and 1990.

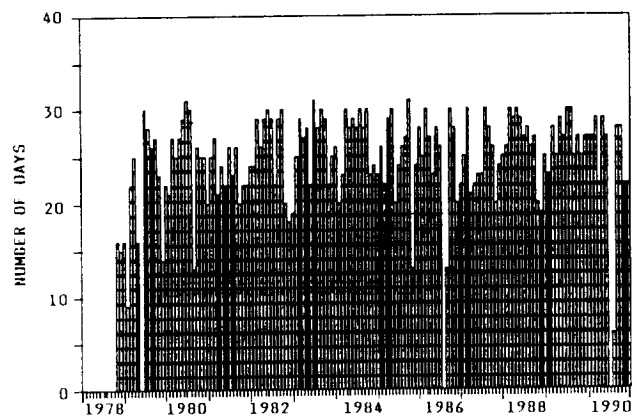


Fig.1. Number of days with parallel DOBSON and TOMS measurements in individual months of the period November 1978 to December 1990, Hradec Kralove.

3. COMPARISON OF MEASUREMENTS

In order to assess reliability of the Dobson data from Hradec Kralove and validity of the zenith charts the direct sun, zenith and all type of measurements were compared with the TOMS data separately. Comparison was performed by means of average relative differences of total ozones $100 \cdot (\text{DOBSON} - \text{TOMS}) / \text{DOBSON}$ calculated for all individual months of the period specified above. The results are shown in Figures 2,3,4 where the dotted lines express the averages and STDs typed over the curves.

It is obvious from the graphs that averages and STDs are not very different for all three groups of measurements. The averages do not exceed 0.62% and STDs are lower than 1.7% that is nearly equivalent to operational accuracy of the Dobson spectrophotometer. Moreover, the dif-

ferences between the ground-based-zenith and TOMS total ozones can be considered fully comparable with differences that have been got for direct sun measurements.

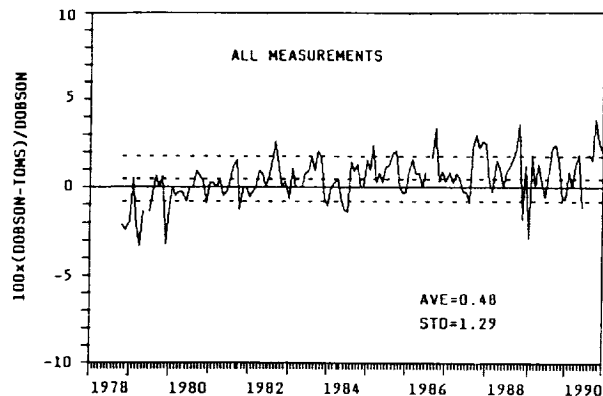


Fig. 2. Relative differences between Dobson and TOMS daily averages of total ozone in individual months (full line), AVE and STD (dashed lines) - all measurements.

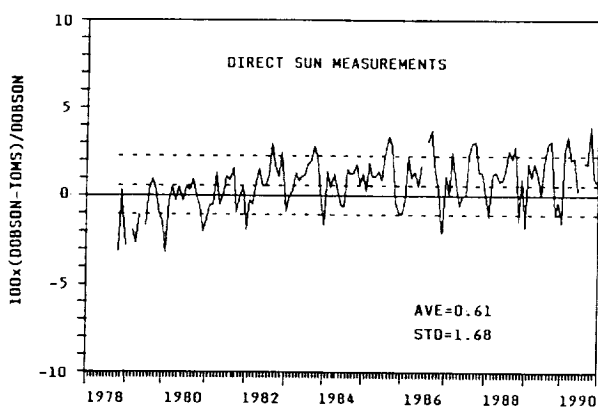


Fig. 3. Relative differences between DOBSON and TOMS daily averages of total ozone in individual months (full line), AVE and STD (dashed lines), Hradec Kralove - direct sun measurements.

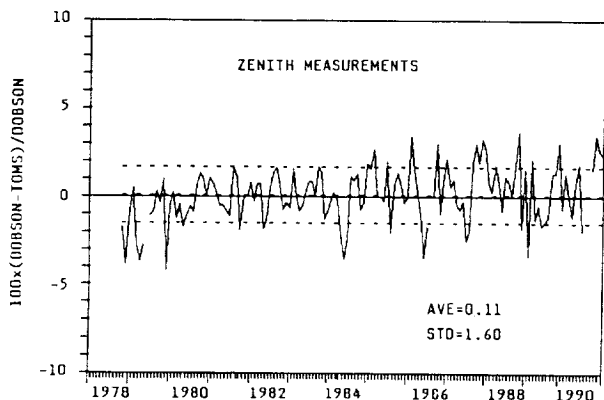


Fig. 4. Relative differences between DOBSON and TOMS daily averages of total ozone in individual months (full line), AVE and STD (dashed lines), Hradec Kralove - zenith measurements.

Zenith measurements of total ozone have been performed since 1967 at Hradec Kralove. The percentage of this type of measurements was about 40% in the period 1978-1990. The original zenith charts of the instrument No.74 (Chart AD, Chart CD, Chart C' and Chart for Cloud Corrections) [Komhyr,1980], approximated by polynomial regressions, are used in computer program for calculation of total ozone. In the final step of processing the zenith total ozones are corrected towards direct sun ground quartz plate AD standard values by means of the factors established from parallel direct sun and zenith measurements [Vanicek,1991]. Therefore it seems that the way of use of the zenith charts implemented at the Observatory does not require any change at present time.

4. MU-DEPENDENCE OF THE SPECTROPHOTO-METER NO.74

Side-by-side comparison of the spectrophotometer No.74 with the WPSS No.83 at Arosa, Switzerland in 1986 and 1990 gave the differences of total ozone for different values of MU. These deviations were generally lower than 0.4% and they show fairly low MU-dependence of the instrument No.74 for MU=1.15-4.00.

In order to assess MU-dependence in routine operation of the instrument the parallel satellite TOMS data mentioned above were used as a reference. The mean differences of total ozone in percents $100 \times (\text{DOBSON} - \text{TOMS}) / \text{DOBSON}$ in individual years were calculated for the seasons November, December, January - NDJ and May, June, July - MJJ. In these seasons the MU reaches maximum and minimum values MU=2.70-5.20 and MU=1.12-1.30 respectively at the latitude of Hradec Kralove. The results presented in Figure 5 show that the mean relative differences of total ozones are mostly lower than $\pm 1.5\%$ for both seasons. It is evident from the graphs that both in winter (NDJ) and in summer (MJJ) neither essential overestimation nor underestimation of ground-based total ozone appear. This conclusion confirms the fact that MU-dependence of the spectrophotometer No.74 has not affected significantly quality of routine ground-based measurements and therefore reliability of the total ozone data base at Hradec Kralové at least since 1978.

5. CONCLUSIONS

Comparison of the homogenized total ozone data from Hradec Kralove with the independent satellite TOMS data set confirmed that the Dobson spectrophotometer No.74 does not show essential MU-dependence in the range of MU from 1.15 to 4.20 which is the typical one for its operation in Central Europe. Moreover, the comparison showed that quality of

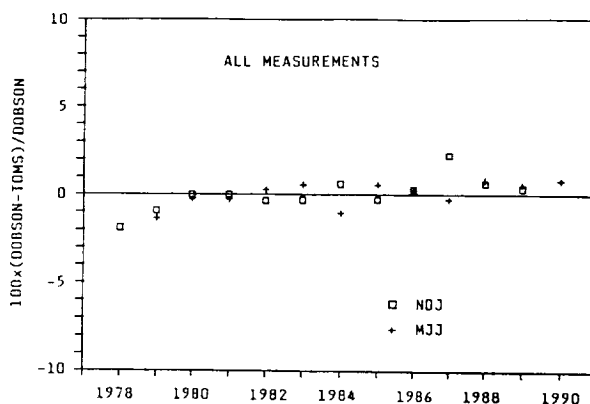


Fig. 5. Relative differences between DOBSON and TOMS averages of total ozone in the months NDJ and MJJ, Hradec Kralove - all measurements.

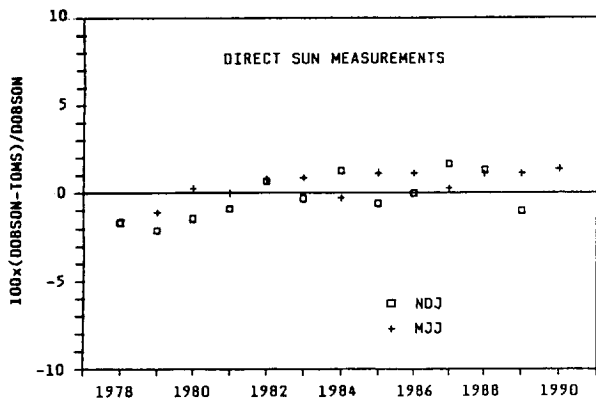


Fig. 6. Relative differences between DOBSON and TOMS averages of total ozone in the months NDJ and MJJ, Hradec Kralove - direct sun measurements.

zenith measurements is fully comparable with quality of direct sun ones. Therefore, the validity of the approximated zenith charts can be supposed to be acceptable for the next observations. These facts confirm reliability of the total ozone data base from Hradec Kralove as a whole and show the way how the satellite data can be used for checking and improving the quality of the data sets at individual stations of the Global Ozone Observing System.

ACKNOWLEDGMENTS

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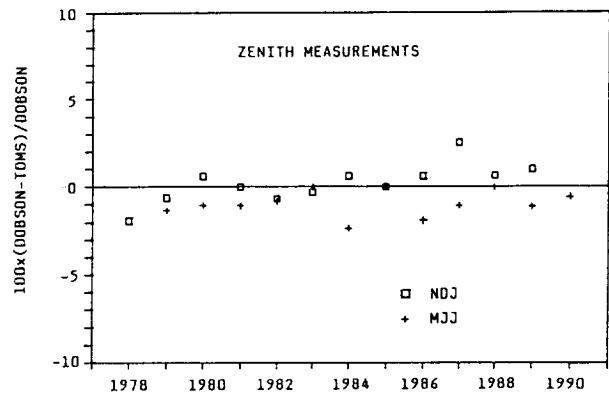


Fig. 7. Relative differences between DOBSON and TOMS averages of total ozone in the months NDJ and MJJ, Hradec Kralove - zenith measurements.

REFERENCES

- Bojkov, R.D., 1988: Ozone Trends Panel - Report, WMO Ozone Project Report No.18.
- Komhyr, W.D., 1980: Operations handbook - Ozone Observations with a Dobson Spectrophotometer, Global Ozone Res. and Monit. Proj. Rep. 6, 122pp., World Meteorolog. Org., Geneva.
- Komhyr, W.D., R.D. Grass, R.D. Evans and R.K. Leonard, 1989: Results of international Dobson spectrophotometer and Brewer spectrophotometer calibrations, Arosa, Switzerland, 1986. Proc. of the Quadrennial Ozone Symp., Gottingen, FRG, 1988, 776-779.
- Komhyr, W.D., Evans R., 1990: International Comparison of Dobson Spectrophotometers, Arosa, Switzerland, 1990 - the preliminary results.
- McPeters, R., Stolarski, R., 1991: Private communication.
- Vanicek, K., 1991: The Recalculated Total Ozone Data, Hradec Kralove, 1962-1990, Publications of Czech Hydrometeorological Institute.