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Status of the Dobson Total Ozone Data Set

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1. INTRODUCTION

During deliberations of the International Ozone Trends Panel (IOTP) it became obvious that satellite determinations of global ozone amounts by themselves could not provide the necessary confidence in the measured trends. During the time of the deliberations of the IOTP, Bojkov re-examined the records of several North American Dobson stations and Degorska re-examined the records of the Belsk station. They were able to improve the quality of the data sets, thus improving the precision of their total ozone data sets.

These improvements showed the greater potential of the world-wide Dobson total ozone data set in two primary areas.

Firstly, the improvements showed that the existing data set when evaluated will become more valuable for comparisons with satellite determinations of total ozone. Secondly, the Dobson data set covers a greater period of time than the satellite data sets thus offering the possibility of extending improved information on ozone trends further back in time.

An International Dobson Workshop was convened in September, 1991, under the auspices of the NOAA Climate and Global Change Program. It was part of the Information Management element of the C&GC Program. Further, it was considered as a "data archaeology" project under the above. Clearly if the existing Dobson data set can be improved by re-evaluating all data records, we will be able to uncover the "true" or "best" data and fulfill the role of archaeologists.

2. DISCUSSION

Participants at the Workshop were asked to specifically address the following questions: 1. Could the precision of the data from Dobson stations other than those mentioned above be improved in a similar fashion?
2. What procedures should be employed in the reanalysis of the existing data?
3. Which stations should be reanalyzed first?

The breakdown of the participants contributing to the discussion is approximately as follows:

- o Dobson station operators - 9
- o Dobson data analysts - 8
- o Inter-sensor analysts - 8

Interdisciplinary scientists in addition to these brought the total attendance to more than thirty participants.

It was the unanimous feeling of the Workshop participants that certain stations had already shown the ability to produce a highly precise data set.

Additional support for this conclusion will be amply supplied by several speakers at this Symposium as they discuss reevaluation of several specific data sets. Speakers at the Workshop discussed several ways to identify inconsistencies in the published data sets. These include:

(i) Examination of the station continuous record alone

(ii) Re-examination of the instruments calibration history

(iii) Comparison of the station record with those from nearby stations

(iv) Comparison of the station record with nearby 100 mb temperatures

(v) Comparison of the station record with satellite overpass measurements.

It is worth emphasizing that comparisons with external data sets such as noted in iii-v are useful in identifying possible inconsistencies in the data sets. They must not be used to correct or "tune" the data.

An extended discussion of these topics is given in Hudson and Planet (1992). Examples of some of these points are shown in Fig. 1-3. Figure 1 shows the time histories of the data from Potsdam and the fully revised data set from Belsk. While 600 km apart and having different ozone values over both stations, the time series should be similar. Shifts in the records are seen. Figure 2 shows the time series of the Potsdam ozone data along with the 100 mb temperature over Berlin. Again, similarities and differences are noted in the comparison.

Figure 3 shows the monthly averages of the differences between the Oslo Dobson data and TOMS total ozone measurements, again showing marked differences in the data sets.

It is with comparisons such as these and undoubtedly others that the Dobson data sets can be initially screened for quality.

3. DATA QUALITY

The stability of Dobson instruments were discussed in IOTP (1988). For a well-run system, the error in the resulting trend in ozone was estimated to be 1.2% per decade; for a poorly run instrument, up to 3.8% per decade.

The status of the individual station records were discussed by the Workshop participants. The stations were identified in four categories. The status and the number of stations in each category are:

1. Stations with completely revised records - 10;
2. Stations that are undergoing data record revaluation - 12;
3. Stations that are thought to have good records, but have not been completely revised - 10; and
4. Stations whose records need reevaluation - 40.

Clearly, much has yet to be done to bring the world-wide Dobson data set into a consistent and stable data set.

The need for a credible 35 year data set is critical for long-term trend studies as well as for supporting information for satellite data evaluation.

It should be noted that the data set maintained and published by the WODC contains provisional or upgraded data. Up to now, the WODC has precious few data sets that have been re-evaluated in the sense that we are talking about here. These are data from Belsk, Uccle, and for the stations maintained by Japan and the United Kingdom (for the ten years from 1979-1989). In addition the instrument at Bracknell has been relocated (Morrison, 1992). Guidelines for re-evaluation that were discussed by the Workshop participants are contained in Hudson and Planet (1992). Several documents are available that form the basis for understanding the Dobson instrument itself and its operation.

See, for example Dobson (1957), Komhyr (1980) and Basher (1982). In addition to these guidelines, there unquestionably are other procedures that Dobson scientists have used and are not included in this discussion. It would be useful if a fourth report could be added to the library of Dobson references. This would be a "handbook" for reevaluating Dobson data records. In fact, this is precisely the agenda for the second Workshop held in June 1992, just before the main Symposium.

4. CONCLUSION AND RECOMMENDATIONS

It was the unanimous feeling of the Workshop participants that certain Dobson stations have already shown the ability to re-evaluate their data and produce higher-quality data sets. The major question is, what other stations should be reanalyzed and by what procedures?

The highest priority is the reanalysis of all stations with suitable calibration information. The procedures used to analyze retrospectively the existing data records should of course be applied to new data so that we can establish a long term data set based on common procedures and thus maintain the continuity of the Dobson ozone record.

On a scientific priority basis, knowledge of the stability of high latitude data is probably the most important in that significant decreasing ozone trends have been noted in those regions. Further, the high latitude data are acquired at large zenith angles which introduce retrieval uncertainties in the measurements themselves. Next would be Southern Hemisphere data. Outside of the Antarctic, few of the southern stations have been subjected to detailed re-evaluation. Next would be tropical stations. The fact that ozone changes in the tropics appear to be small at present require the best possible data set to accurately determine future trends in this region.

Finally, the northern stations require more analysis. Longitudinal variations in ozone have been observed and detailed analysis of the northern station data are needed for comparisons of data from the many stations in this latitude region.

A plan established from the Workshop can be described us follows:

1. Identify the priority stations
2. Advise the organizations responsible for the station operations of the need for re-evaluation of all Dobson data sets
3. Provide assistance to those stations that have not reanalyzed their data.

This has led to the decision to conduct a second Workshop at which those scientists who have developed specific procedures to discuss the details for the benefit of those stations not yet covered.

4. Archive, in one place, all the results of each reanalysis, including

especially all calibration data.

5. SUMMARY

The establishment a long-term credible Dobson total ozone data base is critical to characterizing the trends of global ozone amount. This is an international problem and must be addressed in that vein. Much has been done by and through the WMO and some national station operations. A high level of cooperation must be maintained to reach the goal.

6. REFERENCES

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Morrison, L., 1992: personal communication.

BELSK & POTSDAM

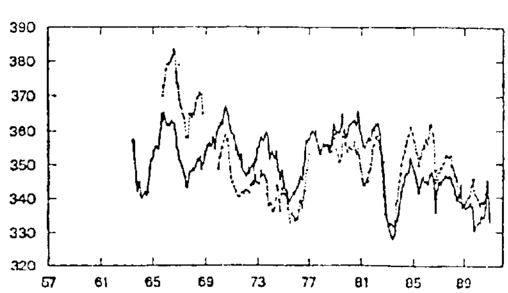

Fig. 1 The completely revised Belsk total ozone record (solid line) is plotted with the published Potsdam total ozone record (doted line). Both series are shown as 12 month running means. The stations are about 600 km apart.

Potsdam

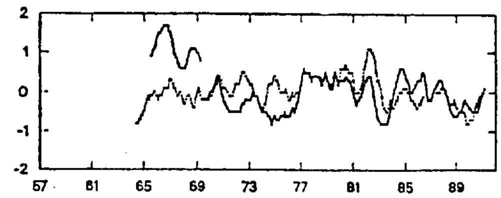

Fig. 2 The published Potsdam total ozone record (solid line) is plotted with the 100 mb temperature from Berlin (dotted line). Both series are shown as the normalized deviations from the long term monthly means and are smoothed.

Oslo

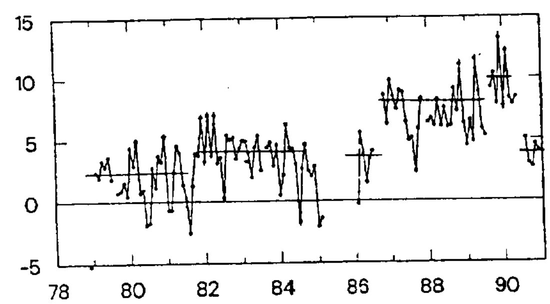

Fig. 3 The monthly mean difference between the total zone above Oslo measured by the TOMS satellite instrument and the ground based Dobson instrument. The y-axis shows the absolute difference (Dobson minus TOMS) multiplied by 100 and divided by the Dobson reading.