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Position Paper on Ozone: ECC, Umkehr, SBUV Measurements and the NOAA Program

by

Alvin J. Miller

Given the very broad topic and the limitation on space, we will briefly discuss 3 seperate issues:

1. Comparison of SBUV ozone profiles with other measurement systems
2. The NOAA program of stratospheric ozone monitoring
3. The combined trend detection capability

1. Comparison of SBUV ozone profiles with other measurement systems

The basic comparisons of SBUV data with Umkehr and balloon ozonesondes have been presented by Bhartia et al (1984) and, more recently, have been updated to include the new Bass and Paur ozone absorption coefficients in the SBUV measurements. The new absorption coefficients have not yet been adopted for the Umkehr measurements. Preliminary results, summarized by Umkehr layer, are depicted in Figure 1, where the variations in time have been taken into consideration and the numbers reflect the difference at Nimbus launch. We see that an overall "S" shape appears in the comparisons with the tendency for near zero bias in layers 9 and 7 with a positive bias in layer 8, a negative bias in layers 6 and 5 of 5-10 %, although a large difference occurs between Umkehr and balloons in layer 6, a positive bias in layer 3 of 10-15 % and a return to zero bias in the lower layers. This pattern is consistent with the SBUV, LIMS and SAGE comparisons depicted in the NASA/WMO Assessment Document, Chapter 8, and the recent results of the balloon photometer intercomparisons.

2. NOAA Ozone Trend Evaluation Program

The trend evaluation program is comprised of the SBUV/2 instrument on-board the NOAA operational satellite series plus a validation program outlined in Table 1. As depicted in Table 1, the validation measurements were selected to complement each other as much as possible providing maximum information for the least cost. Two weaknesses appear, though, that should be addressed directly. First, the routine validation measurements extend only up to 1 mbar although the SBUV/2 profiles extend to about 0.4 mbar. Second below about 30 mbar the SBUV/2 retrievals are not independant of the total ozone retrievals such that in the lower stratosphere we are still very dependant on the limited ground-based data for trend detection.

3. Trend Detection Capability

The combined trend detection capability of the SBUV/2 validation program is summarized in Figure 2 which depicts the 95% confidence limits of decadal trend detection as a function of the standard deviation of instrument calibration. That is, over a decade, 5 satellite instruments will be launched with an error in their calibration, S. Within the computations presented, we have assumed that the SBUV/2 instrument is well characterized by the on-board Hg lamp. If this is not the case, different scenarios can be presented that are beyond the brief description presented here.

Within Figure 2, the solid line at 3% per decade represents the approximate level of decadal trend depicted by one-dimensional models for a 5 km layer at about Umkehr layer 8. Above this line, we see the values of trend detection for SBUV/2 validated by the Umkehr and balloonsonde measurements. It is stressed, however, that if the measurements are continued over a 15 year period, the values are decreased to about 2.3 and 1.9 % per decade, respectively. Looking at the SBUV/2, by itself, if the instrument satisfies it specifications (S = 0.93) we can detect a trend of about 2.8% per decade if we do nothing and this can be reduced to about 2.2% per decade if we include knowledge of when the instrument changes occurred and include this in the statistical analysis. Finally, if we include overlap between instruments such that we know the instrument- to - differences to the 0.5% level, the trend detection capability increases to 1.5 % per decade.

As stated, above, these results are for a well characterized system. If this is not true, ie if the Hg lamp fails and we can not determine the instrument drift internally, then we must utilize the NASA space shuttle SBUV (SSBUV) which brings the precision estimates to the 3% per decade level.

In summary, the combined program of SBUV/2 and its validation program should provide trend estimates in the middle stratosphere capable of detecting ozone changes at the level currently depicted by one-dimensional models.

References

Bhartia, P.K., K.F. Klenk, A.J. Fleig, C.G. Wellemeyer and D. Gordon, Intercomparison of Nimbus 7 solar backscattered ultraviolet ozone profiles with rocket, balloon and Umkehr profiles, J. Geoph. Res., 89, 5227-5238, 1984.

Table 1. NOAA SATELLITE OZONE VALIDATION PROGRAM

- ~16 PRIMARY DOBSON STATIONS - TRIENNIAL CALIBRATION AGAINST BOULDER STANDARD INSTRUMENT
- OTHER DOBSON AND M-83 SITES WITH OVERSIGHT VIA SATELLITE CONSISTENCY, WMO, U.S. AND AES CALIBRATION PROGRAMS
- ~16 PRIMARY UMKEHR SITES - INCLUDES 7 AUTOMATED INSTRUMENTS
- OTHER UMKEHR SITES AS AVAILABLE
- AEROSOL IMPACT EVALUATION BY GMCC
- BALLOONSONDE MEASUREMENTS MONITORED BY GMCC AT 3 SITES ON A ONCE-PER-WEEK SCHEDULE
- OTHER BALLOONSONDES AS AVAILABLE
- SSBUV
- OTHER SOURCES AS AVAILABLE:
  OZONE ROCKETSONDES
  SOLAR OBSERVATIONS

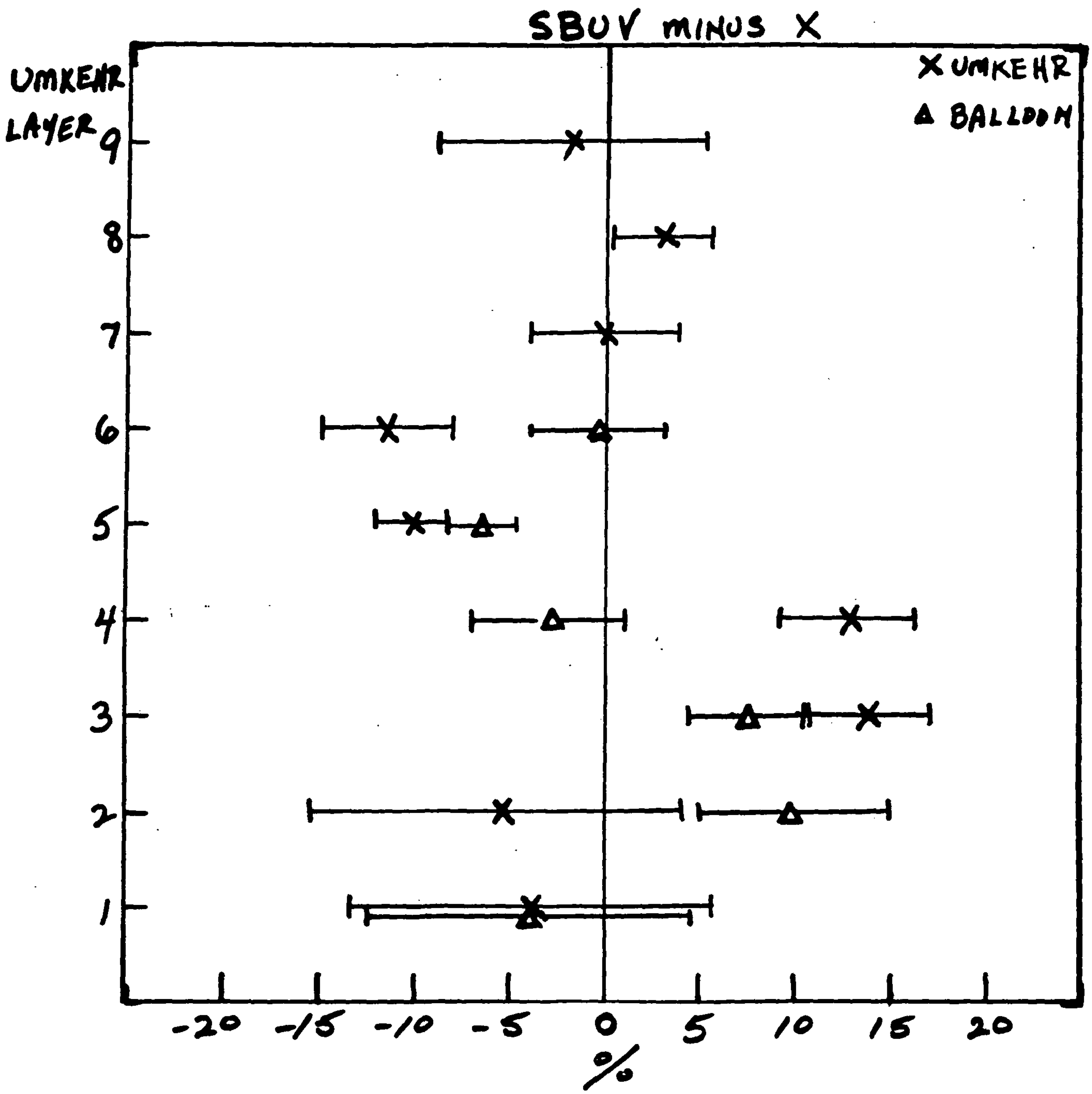
SBUV MINUS X
UMKEHR LAYER
X UMKEHR
Δ BALLOON
9
8
7
6
5
4
3
2
1
-20 -15 -10 -5 0 5 10 15 20
%

Figure 4

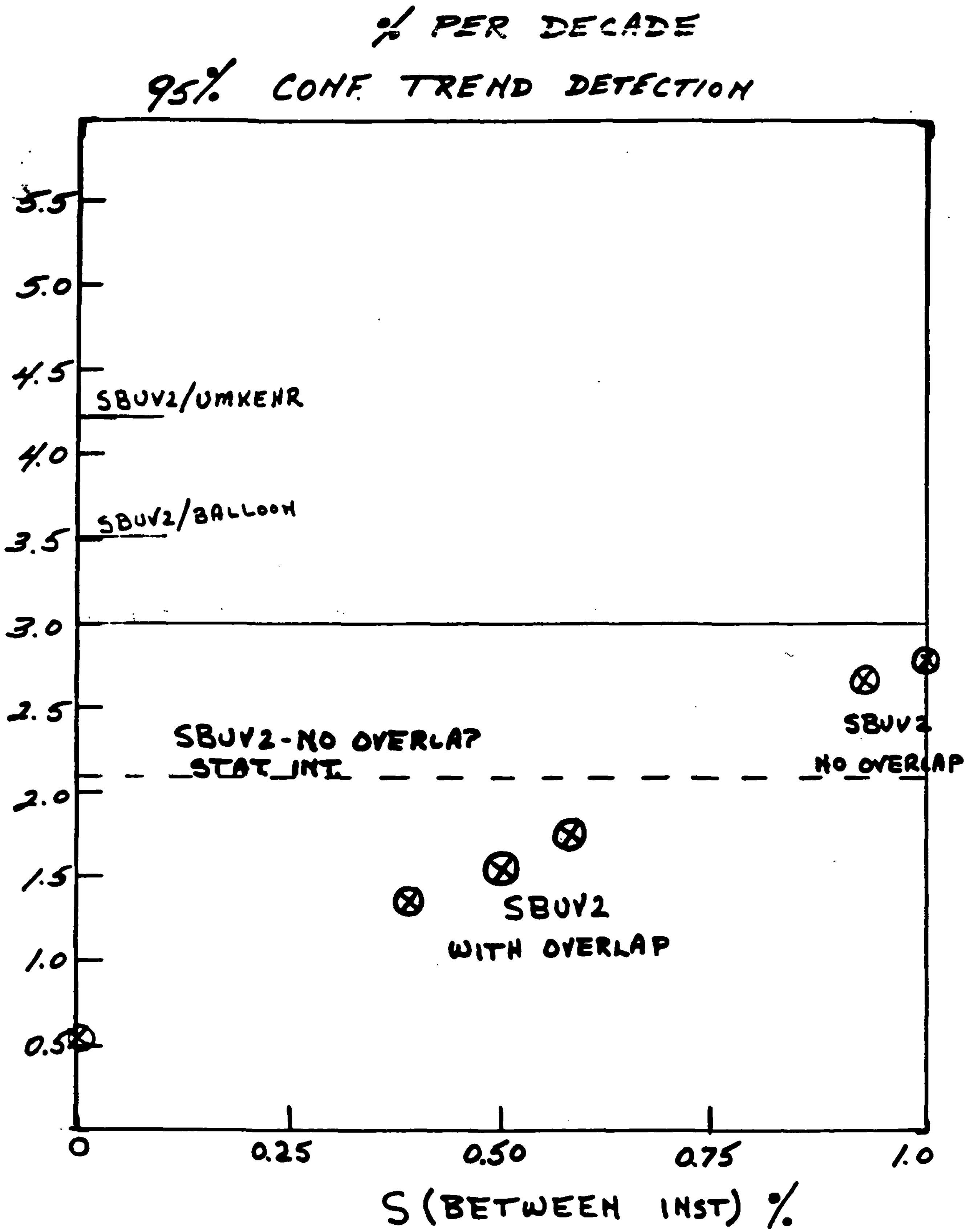
% PER DECADE
95% CONF. TREND DETECTION
5.5
5.0
4.5
SBUV2/UMKEHR
4.0
SBUV2/BALLOON
3.5
3.0
2.5
SBUV2-NO OVERLAP
STAT. INT.
SBUV2
NO OVERLAP
2.0
1.5
SBUV2
WITH OVERLAP
1.0
0.5
0
0.25
0.50
0.75
1.0
S (BETWEEN INST) %

Figure 2