Estimating Uncertainty in a 41-year Merged Ozone Dataset from SBUV instruments

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Abstract

The SBUV Merged Ozone Dataset (MOD) provides the longest available Earth Science Data Record (ESDR) for global total ozone and ozone profiles, spanning a 41-year period from 1970 to 2011 (except a 5-year gap in the 1970s). Data from all SBUV instruments were processed using the Version 8.6 algorithm. Although modifications in instrument design were made in the evolution from the BUV instrument to the modern SBUV2 model, the basic principles of the measurement technique and retrieval algorithm remain the same. Smoothing consistency to this record compared to those based on measurements using different instrument types. We present the results of our validation efforts and corresponding uncertainty estimates, and provide recommendations for data users about data utility and limitations in best to apply the SBUV MOD data to various scientific analyses.

1. Constructing the SBUV Merged Data Set

Data for the SBUV MOD are selected based on the results of a detailed analysis of instrumental uncertainties [Dudas et al., 2012] and performances against independent standard and ground-based profile observations [Kramarova et al., 2012]. We select SBUV data for the MOD using the following rules:

- SBUV/2 data are not included due to missing instrumental issues [Dudas et al., 2012].
- Only measurements made between 6am to 4pm Equatorial Crossing Time are included in the MOD. With one exception in 1994-1995, when NOAA 11 data were included to avoid a gap in the data.
- When data from more than one SBUV instrument are available we simply average them.
- Profile MOD data are filtered for aerosol contamination after the entry of El Chichon and Mt Pinatubo.

We recommend using MOD in specific layers (see table 1) to avoid errors related with finite SBUV vertical resolution.

![BUV Instrument Orbit Drift History](image)

**2. Instrument-to-instrument offsets**

![Figure 2: Vertical profiles of mean differences for pairs of overlapping SBUV instruments. Horizontal bars show corresponding standard deviations.](image)

3. Stability of SBUV MOD

![Figure 3: Time series of the ozone anomalies (difference from the mean climatology) derived from all SBUV instruments and MOD for 50S–50N in the 0-4 hPa layer](image)

4. Smoothing error for monthly zonal mean profiles

![Figure 5: Time series of the monthly smoothing error for MOD in the tropics (0-5N) for (a) total ozone, (b) 4-2 hPa layer, and (c) combined layer 0-10S-10N](image)

5. SBUV MOD versus independent measurements

![Figure 6: Time series of differences for MOD relative to SAGE and Aura MLS for the latitude band 90N-90S](image)

6. Conclusions

![Figure 7: Vertical profiles of (a) mean biases and (b) drifts for MOD relative to SAGE and Aura MLS for the latitude band 90S-90N](image)

References

1. Bhartia, P. K., McPeters, R. D., Plew, E. L., Taylor, S. R., Kramarova, N. A., Bhartia, B. H., and Nelson, S. S.: Total ozone from the Nimbus-7 SBUV instrument, and the SBUV series of instruments on board NOAA satellites 9, 11, 15, 17, and 19. The orbital properties of each satellite vary in a general, determination taken within the Sun to 4pm DCT range is not noisy. Solid lines indicate time periods for each instrument that were included in MOD.

![Figure 1: Equatorial Crossing Times of the SBUV instrument as a function of time. The SBUV MOD set includes measurements obtained from the Nimbus-7 SBUV instrument, and the SBUV series of instruments on board NOAA satellites 9, 11, 15, 17, and 19. The orbital properties of each satellite vary in a general, determination taken within the Sun to 4pm DCT range is not noisy. Solid lines indicate time periods for each instrument that were included in MOD.](image)

![Figure 4: Ozone loss rates through from 1994 (from the TOES) derived from 1000 realizations of the Monte-Carlo model (Stolarski et al., 2007) and 2006 for latitudes band 50S-50N. The green line shows the seasonal trend derived from the MOD SBUV, and the error bars show 95% confidence interval. The red line shows the mean loss rate from 1000 realizations, and error bars show 2- sigma variations.](image)

We constructed the Merged Ozone Dataset based on measurements obtained from the series of SBUV instruments. Consistency among SBUV instruments were achieved through various model validations and no additional adjustments were applied. The SBUV MOD is the longest record of global ozone profile, spanning more than 40 years. This dataset is essential for studies of the ozone climatic cycle and its impact on climate and weather. The SBUV MOD data are available to researchers and other institutions through the NASA SOC (http://www.soc.stanford.edu).