SBUV version 8.6 retrieval algorithm: error analysis and validation technique.

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SBUV version 8.6 algorithm was used to reprocess data from the Back Scattered Ultra Violet (BUV), the Solar Back Scattered Ultra Violet (SBUV) and a number of SBUV/2 instruments, which span a 41-year period from 1970 to 2011 (except a 5-year gap in the 1970s)[see Bhartia et al., 2012]. In the new version Daumont et al. [1992] ozone cross section were used, and new ozone [McPeters et al., 2007] and cloud climatologies [Joiner and Bhartia, 1995] were implemented. The algorithm uses the Optimum Estimation technique [Rodgers, 2000] to retrieve ozone profiles as ozone layer (partial column, DU) on 21 pressure layers. The corresponding total ozone values are calculated by summing ozone columns at individual layers. The algorithm is optimized to accurately retrieve monthly zonal mean (mzm) profiles rather than an individual profile, since it uses monthly zonal mean ozone climatology as the A Priori. Thus, the SBUV version 8.6 ozone dataset is better suited for long-term trend analysis and monitoring ozone changes rather than for studying short-term ozone variability.

Here we discuss some characteristics of the SBUV algorithm and sources of error in the SBUV profile and total ozone retrievals. For the first time the Averaging Kernels, smoothing errors and weighting functions (or Jacobians) are included in the SBUV metadata. The Averaging Kernels (AK) represent the sensitivity of the retrieved profile to the true state and contain valuable information about the retrieval algorithm, such as Vertical Resolution, Degrees of Freedom for Signals (DFS) and Retrieval Efficiency [Rodgers, 2000]. Analysis of AK for mzm ozone profiles shows that the total number of DFS for ozone profiles varies from 4.4 to 5.5 out of 6-9 wavelengths used for retrieval. The number of wavelengths in turn depends on solar zenith angles. Between 25 and 0.5 hPa, where SBUV vertical resolution is the highest, DFS for individual layers are about 0.5.

We found that the main source of error in the SBUV ozone profile retrievals is a smoothing error. The smoothing error represents the part of profile variability that the observing system cannot measure. Between 10 and 1 hPa the smoothing errors for the SBUV mzm retrievals are of the order of 1%, but start to increase above and below this layer. The largest smoothing errors, as large as 15-20%, were detected in the troposphere.

The smoothing effect should be taken into account when two profile measurements with different vertical resolution are compared. The SBUV averaging kernels, provided with the ozone profiles in version 8.6, help to eliminate the smoothing effect when comparing the SBUV profiles with high vertical resolution measurements, and make it convenient to use the SBUV ozone profiles for data assimilation and model validation purposes. The smoothing error can also be minimized by combining some layers of data, and we discuss recommendations for this approach as well. We show some results of intensive validation of the SBUV ozone profiles against satellite (UARS and AURA MLS, SAGE and MIPAS) and ground based (microwave spectrometers, lidars, Umkehr instruments and balloon-borne ozonosondes) profile measurements using two techniques described above to account for difference in vertical resolution.

References:

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