The Re-analysis of Ozone Profile Data from a 41-year series of SBUV Instruments.

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Main Objectives

- The SBUV data set is the only homogeneous satellite ozone record with global coverage that spans more than 40-year time period.
- All SBUV data were recently reprocessed using an updated (Version 8.6) algorithm (Bhartia et al., 2012) that uses Daumont et al. (1992) ozone cross sections, and new ozone (McPeters and Lobow, 2012) and cloud (Joiner and Bhartia, 1995) climatologies.
- Consistency across instruments is achieved by Version 8.6 through radiance-level calibration adjustments based on precise comparison of radiance measurements during overlap periods (DeLand et al., 2012). The characteristics of the SBUV retrieval algorithm, retrieval errors are accurately analyzed and estimated; the Averaging Kernels, A Priori and Smoothing Errors are reported with the ozone retrievals making it convenient to use SBUV ozone profiles in data assimilation processes.
- The simultaneous existence of two or more SBUV instruments that measure ozone at different local times might improve the temporal resolution of the assimilated ozone fields.
- The monthly mean SBUV ozone profiles are available for download at http://cpcwww.nsstc.uah.edu/DATA/SBUV/SBUV-4.

SBUV Averaging Kernels

Averaging Kernels (AK) represent the sensitivity of the retrieved profile to the true profile: where \( \hat{X} \) - retrieved profile, and \( X \) - true state. A column of the AK at a given layer shows the response of the retrieval to a delta function perturbation of ozone amount in that layer; a row of the AK at a given layer indicates the sensitivity of the retrieved ozone at that layer to changes in ozone at all layers.

Error analysis

Smoothing error shows the difference between the retrieved profile and the true profile by smoothing the retrieval algorithm.

We estimate smoothing error by using the following expression (Rodgers, 2000)

\[
\text{Smoothing Error} = A + \text{Smooth} \cdot \hat{X}
\]

Where \( A \) is a unit matrix, \( \hat{X} \) is the averaging kernel matrix, which represents sensitivity of the retrieval to the true profile (figures 1a and 1c), \( \text{Smooth} \) is the convolution of the ensemble of the true states about the mean state, calculated as

\[
\text{Smooth} = \text{conv} \{ \text{True} \} - \text{conv} \{ \text{Mean} \}
\]

Averaging Kernels (AK) is the smoothing kernel matrix, \( A \), that is independent of the true profile and is used to smooth the retrieved ozone profile. The smoothing effect should be taken into account when comparing SBUV ozone profiles with high vertical resolution measurements. It might be done by convolving highly resolved profiles with the Averaging Kernels (for integrating Kernels) or by merging together several layers with low DFS.

Validation

The SBUV ozone profiles have been intensively validated against multiple satellite and ground-based profile measurements. In the stratosphere between 25 and 1 hPa the mean biases and standard deviations are within 5% for monthly mean ozone profiles. Though the SBUV algorithm has a coarser vertical resolution in the lower stratosphere and troposphere, we found that the integrated ozone column between the surface and 2.5 hPa measured by SBUV agrees within 5% with the corresponding value obtained by ensemble of sondes measurements. The validation of SBUV total ozone retrievals versus ground based Dobson/Brewer observations demonstrated an excellent agreement.

References