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SBUV PMC Version 3 [V3] Data Files – Notes

The PMC detection algorithm used to process data for the *DeLand et al.* [2007] paper was designated Version 3, based on specific changes discussed in Section 2 of that paper. Since completion of data analysis for that paper, some additional improvements have been made and implemented in the PMC processing system. We want to make all potential data users aware of these changes and their impact relative to previous versions of SBUV PMC data.

1. Instrument Calibration. The calibration designation mentioned in the file *scan_contents_v3.txt* means that SSAI personnel typically update the calibration of each operational SBUV/2 instrument every year and generate a new long-term characterization. This characterization can be slightly different (typically ~1% or less for individual channel radiance values) from previous calibration versions for the early portion of the data record, which could have a small effect on PMC residual albedo values. In the past, new PMC seasons have been processed without going back and updating the processing of previous data. NOAA-16, NOAA-17, and NOAA-18 data have now been fully reprocessed with a single self-consistent calibration.

2. NOAA-17 In-Band Scattered Light (IBSL). In 2004, SSAI staff discovered that NOAA-17 SBUV/2 radiance data showed an anomaly at high solar zenith angle (SZA) values in the Southern Hemisphere. As the spacecraft passed SZA = 78°, radiance values increased sharply and remained elevated during remainder of sunlit portion of orbit. The magnitude of this increase is wavelength-dependent, ranging from ~20% at 252 nm to a few percent at 292 nm and negligible at longer wavelengths. The 4^{th} order background fit used in SBUV PMC algorithm was able to follow this variation reasonably well, but the elevated albedo values do lead to higher PMC residual albedo values. Tests suggest that the offset is not quite 1:1 for larger errors, *i.e.* a 5% radiance change led to approximately a 5% PMC albedo change, but a 20% radiance change only produced a 10-15% PMC albedo change.

The current NOAA-17 SBUV/2 data (indicated by *'s3d'* as a calibration designation) use an empirical correction algorithm in the original ozone data processing to remove this IBSL effect. Examination of Southern Hemisphere seasonal averages with the correction in place show an increase in PMC detections at high SZA, a slight decrease in PMC albedo averaged over 5 degree latitude bands, and a very small change for hemispheric average albedo.

Current NOAA-18 SBUV/2 data are also affected by the IBSL error at high SZA values in the Northern Hemisphere. The corresponding latitude range is approximately 65-80°N, but only for the descending portion of orbit where SZA values greater than 78° occur. A NOAA-18 correction algorithm is in development, and revised PMC data will be produced when this algorithm is available.

3. Solar Zenith Angle Interpolation. I discovered an error in the interpolation step that takes the single solar zenith angle value reported for each scan and creates SZA values for each sample. The impact is very small for SBUV/2 instruments (< 0.1°), but is larger for Nimbus-7 SBUV (up to 0.8° at 255 nm) because that instrument sampled the 12 standard wavelengths in a different sequence. I ran some test cases and found ±1% changes in the average PMC albedo over the hemisphere for Nimbus-7 (e.g. $9.22 \times 10^{-6} \rightarrow 9.32 \times 10^{-6}$). SBUV/2 albedo changes using the corrected interpolation method are a factor of 10 smaller. The corrected SZA interpolation method is used for all current PMC data.

4. Latitude Range. I modified the data extraction code that creates useful PMC season subsets (latitude restricted, date restricted) to work from the new Level 2 data sets produced by NASA's V8 profile ozone algorithm. This also gave me the opportunity to extend the measurement coverage down to 40° latitude for comparison with some of the recent ground-based observations (such as Logan, Utah). I have run some single day tests comparing the PMC detection algorithm results using minimum latitude = 50° (previous version) and minimum latitude = 40°. There's no obvious difference in the behavior of the 4th order background fit. The PMC results at higher latitudes (where the statistics are meaningful) show albedo changes of ±1% or less. The current standard PMC processing uses `min_lat` = 40°, but the additional data don't add much value to hemispheric average calculations.

5. Local Time Variation. No adjustment has been made to the 252 nm albedo values reported in these data files for local time variations. The formulas provided in *DeLand et al.* [2007] can be applied to create adjusted albedo values if so desired, using information contained in these files.

I do plan to reprocess all of the previous SBUV data sets (Nimbus-7, NOAA-9, NOAA-11, NOAA-14) in the same way as the most recent data sets, but that requires first finding the time to re-extract the baseline data sets and then repeating all of the PMC detection runs. I would also like to figure out how to make all of the data sets available to colleagues without asking everyone to click and download 150 separate PMC season data sets. Suggestions are welcome.

Additional Notes (updated from Version 2 CD)

6. Terminator Crossings. *DeLand et al.* [2003] discusses the effect of satellite orbit drift on the SBUV PMC data analysis (Section 2.1.3). The NOAA-9 NH 1990 and SH 1990-1991 seasons are not provided for this reason. The NOAA-11 SBUV/2 instrument was shut down during its near-terminator period, so no data are available for the following seasons: NH 1995, SH 1995-1996, NH 1996, SH 1996-1997. For the NOAA-14 SBUV/2 instrument, inspection suggests that only limited periods be used for the following seasons:

SH 2001-2002: valid = 2001/355 - 2002/041
NH 2002: valid = 2002/142 - 2002/205
SH 2002-2003: valid = 2002/325 - 2003/015

7. Incomplete Seasons. There are some data gaps in PMC seasons due to problems with specific SBUV and SBUV/2 instruments. This list identifies all known gaps of 5 or more days. While many of these seasons were excluded for the albedo trend analysis presented in *DeLand et* *al.* [2007], the presence of a gap does not necessarily mean that the PMC data have quality problems.

Nimbus-7 SBUV

NH 1979: no data July 3-7 (days 184-188)
NH 1990: data end June 21 (day 172)

NOAA-9 SBUV/2

NH 1993: data end July 30 (day 212)
SH 1994-1995: no data February 13-23, 1995 (days 44-54)
NH 1995: data end August 1 (day 214)
NH 1996: no data May 22 - June 17 (days 143-169)
NH 1997: limited coverage [4 orbits = 90 scans/day] after July 14 (day 195)
SH 1997-1998: limited coverage; data end February 19, 1998 (day 50)

NOAA-11 SBUV/2

SH 1988-1989: data begin December 2, 1988 (day 336)
NH 1997: data begin July 15 (day 196)

NOAA-14 SBUV/2

NH 1995: no data August 11-24 (days 223-236)
NH 1998: no data June 20-30 (days 171-181)
SH 2005-2006: 2006 data not yet available
NH 2006: 2006 data not yet available

NOAA-17 SBUV/2

NH 2002: data begin July 11 (day 192)

NOAA-18 SBUV/2

NH 2005: data begin June 5 (day 156)

8. NOAA-16 SBUV/2 Noise. The NOAA-16 SBUV/2 instrument developed a significant electronic noise problem in October 2003 that directly affects the signals at 252 and 273 nm, leading to many anomalously high radiance values in those channels. We do not have a method for specifically flagging these bad measurements at this time. The NOAA-16 SH 2003-2004 and NH 2004 PMC results are therefore not recommended for general use. The electronic noise problem decreased significantly beginning in Fall 2004, and further episodes have been much less severe. We believe that the NOAA-16 PMC data from the SH 2004-2005 season onward are of good quality.

9. Solar Proton Events. Large solar proton events (SPEs) can decrease upper stratospheric ozone abundances by ~40% for 1-2 days following the event (*e.g. Jackman et al.* [2001]). The ozone reduction leads to a wavelength-dependent increase in backscattered UV radiance that mimics the spectral signature expected from a PMC. The radiance increase of the SPE effect can be 2-4 times greater than a typical PMC radiance change. Thus, an SPE can produce an incorrect increase in both the number and brightness of PMCs observed by an SBUV-type instrument. We have identified such dates using the list of SPEs maintained at the National Geophysical Data Center (NGDC). We recommend that all measurements be omitted for these dates.

Date of Event	*Satellite(s) Affected*
1982 day 194 (Jul 12)	Nimbus-7
1989 day 225 (Aug 13)	Nimbus-7; NOAA-9; NOAA-11
1989 day 335 (Dec 1)	Nimbus-7; NOAA-9; NOAA-11
1991 day 162 (Jun 11)	NOAA-9; NOAA-11
1991 day 166 (Jun 15)	NOAA-9; NOAA-11
2000 day 196 (Jul 14)	NOAA-11; NOAA-14
2000 day 197 (Jul 15)	NOAA-11; NOAA-14
2001 day 328 (Nov 24)	NOAA-16
2005 day 17 (Jan 17)	NOAA-14; NOAA-16; NOAA-17

10. Nimbus-7 SBUV Non-Sync Noise. As discussed in *DeLand et al.* [2007], the Nimbus-7 SBUV instrument developed a problem with chopper wheel synchronization in February 1987, leading to increased noise in the observed albedo values and an apparent large increase in the number of faint PMCs detected. Data at low latitudes are clearly affected by this problem. At higher latitudes, seasonal average frequency and albedo values are not obviously different from previous years, but the noise fluctuations are certainly present. Because we do not have a method to quantify the possible changes caused by these "non-sync" data, Nimbus-7 SBUV PMC data for 1987-1990 cannot be trusted for long-term trend analysis.

References

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