

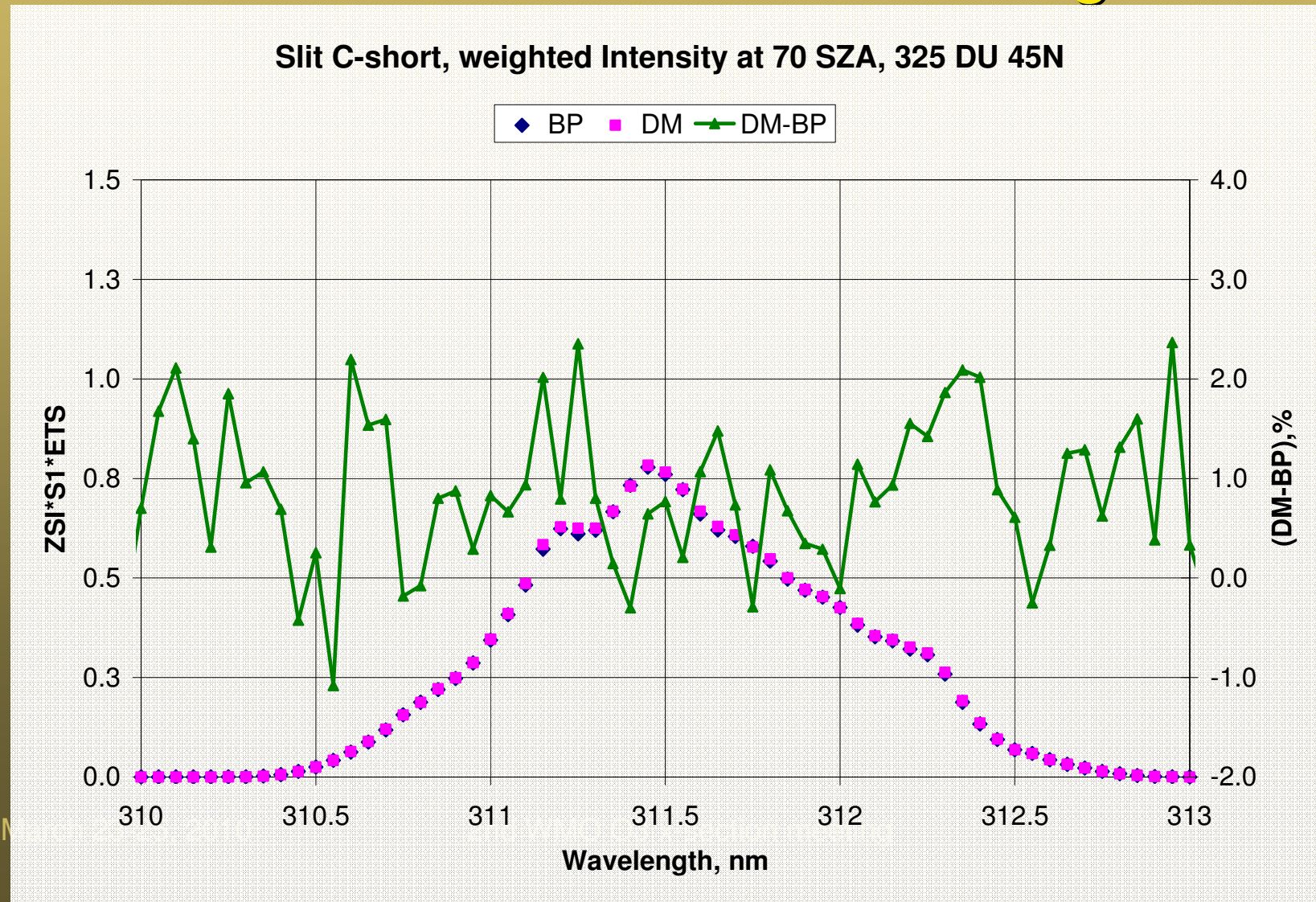
Sensitivity of Dobson and Brewer Umkehr ozone profile retrievals to the choice of the ozone cross- section.

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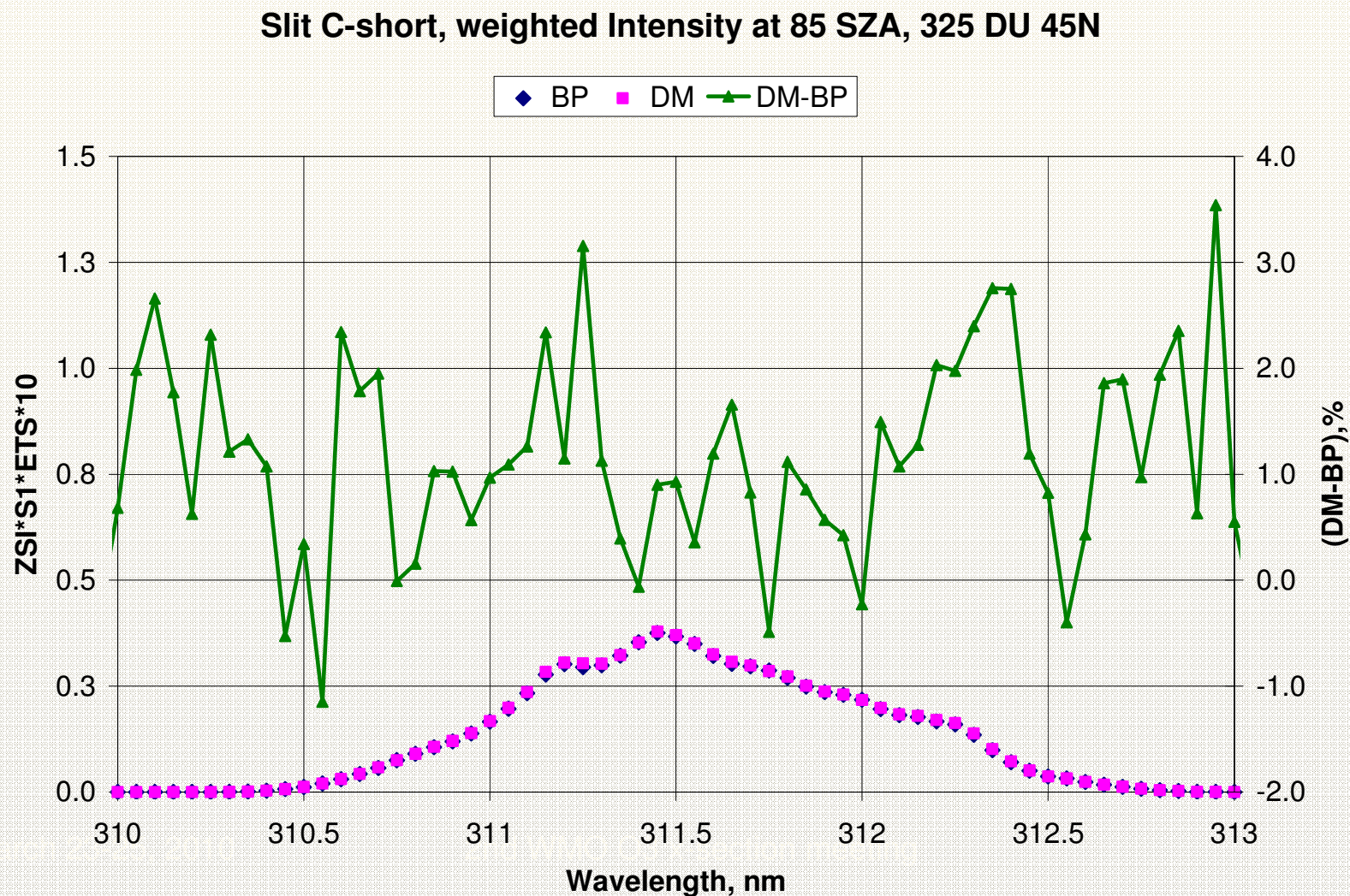
Umkehr ozone profile retrieval

- Single pair zenith sky measurement or N-value= $100 \cdot \log_{10}(I)$:
UMK04 – Dobson C-pair, O3BUmkehr – 310/326 nm for Brewer
- Optimal statistical retrieval is used for solution – iterative process
- SZA between 70 and 90 degrees
- RT forward model for SS N-values
 - spectrally resolved line-by-line calculations across both band-passes
 - O₃ absorption and Rayleigh scattering database
 - Ozone profile climatology
 - Band-pass functions (re-defined using Pandora measurements)
- Multiple scattering correction (total ozone and latitude profile dependent, profile adjustment based on MS Jacobian)
- Refraction in air correction
- Temperature correction (seasonal climatology)
- Out-of-band stray light correction
- Spectral shift in band-pass center registration

Slit and Solar Flux weighted intensity at 70 SZA, Dobson C-short, B&P and DMB x-sections similar at both short and long

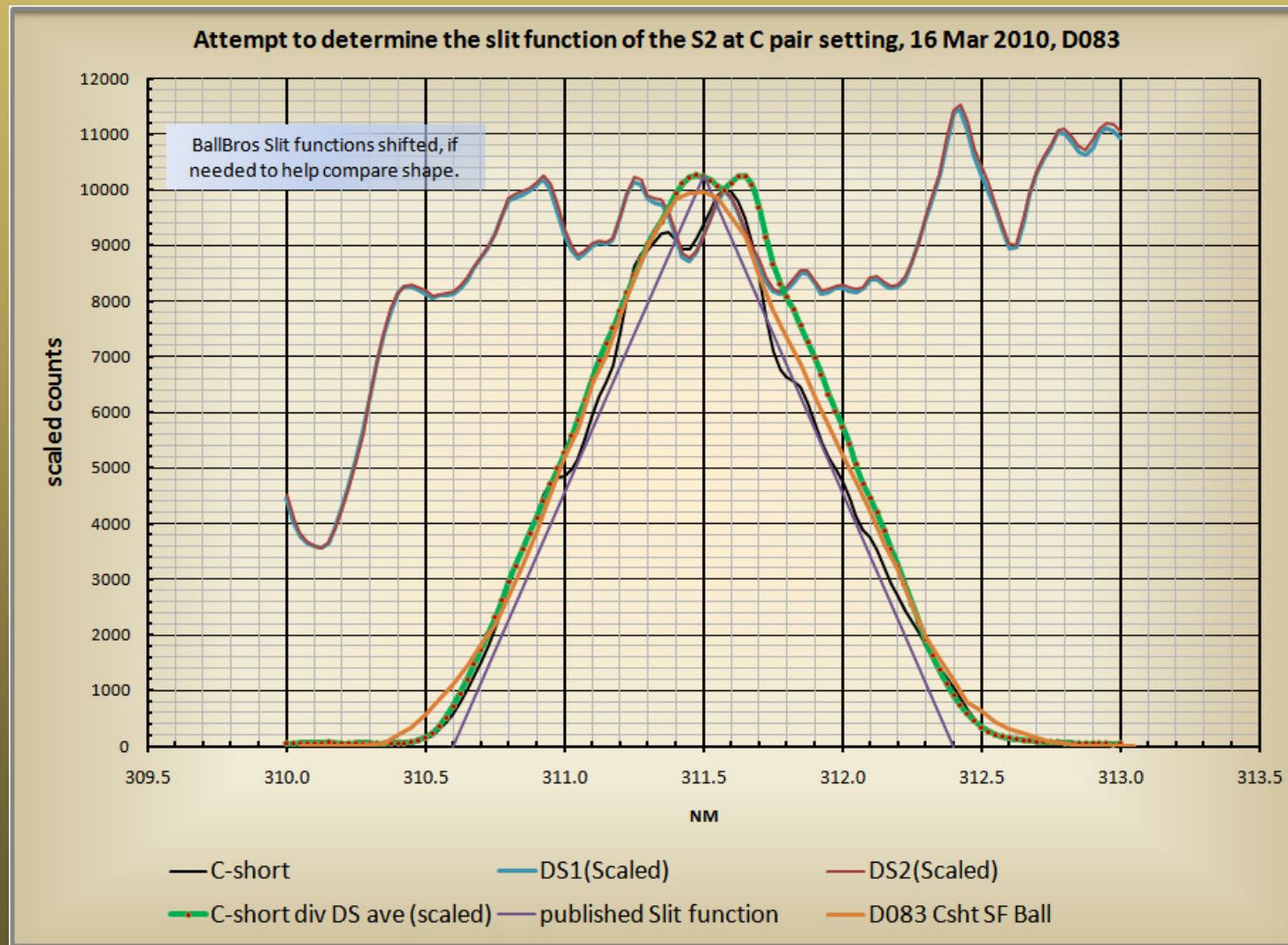


Slit and Solar Flux weighted intensity at 85 SZA, Dobson C-short B&P and DMB x-sections similar at both short and long



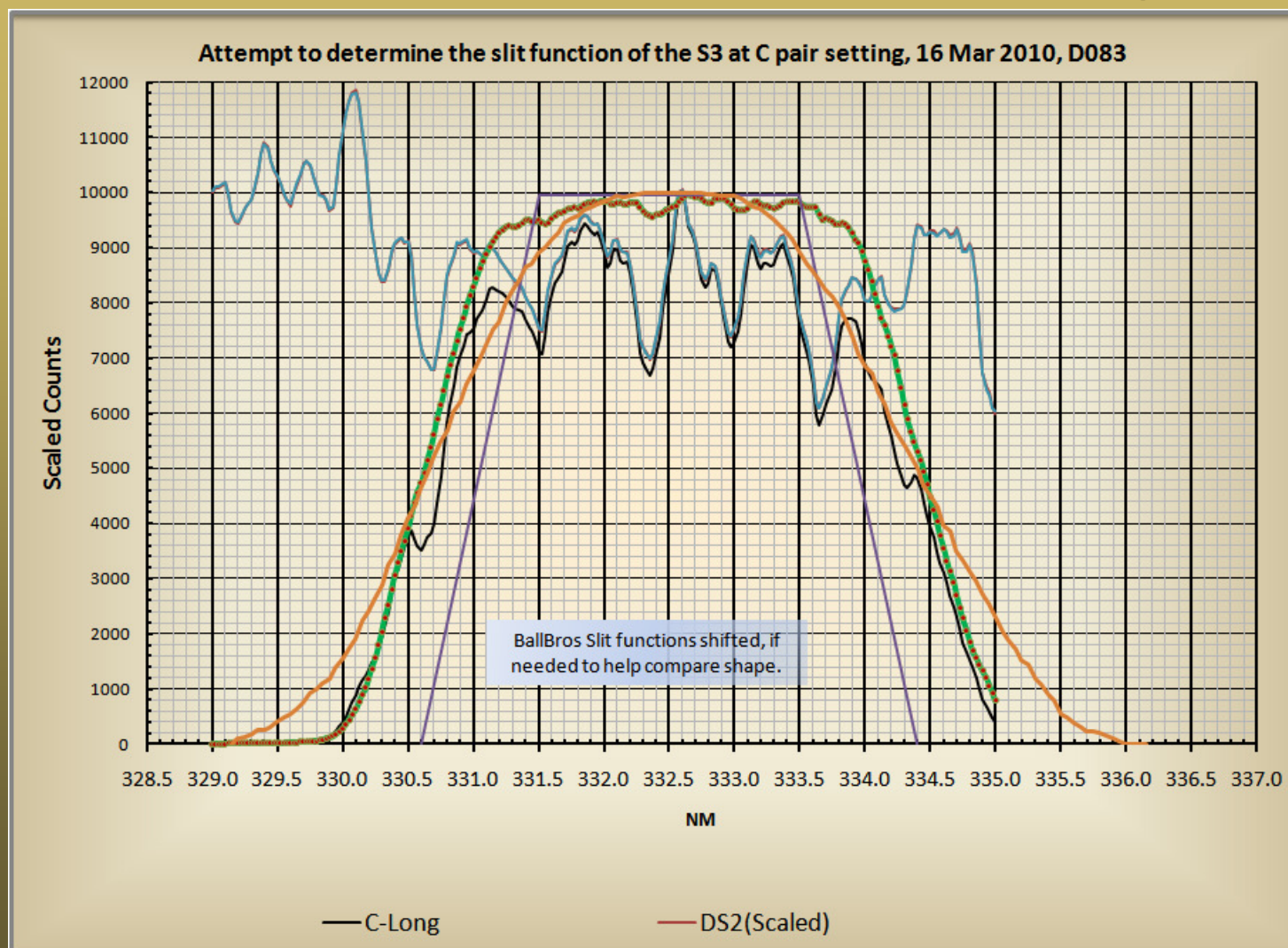
Slit functions, Dobson 083, March 17 2010

Pandora measurements, C-short



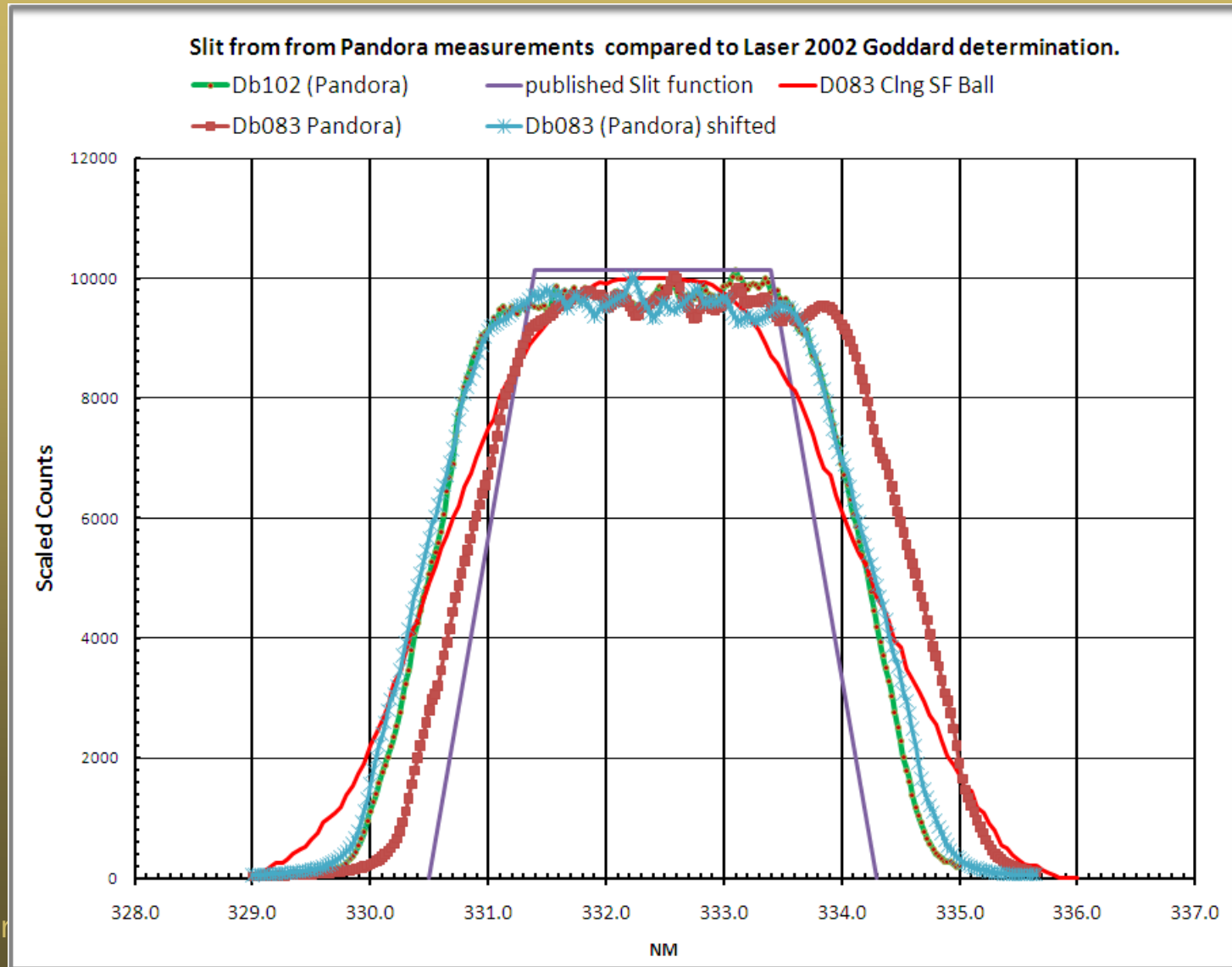
Slit functions, Dobson 083, March 17 2010

Pandora measurements, C-long

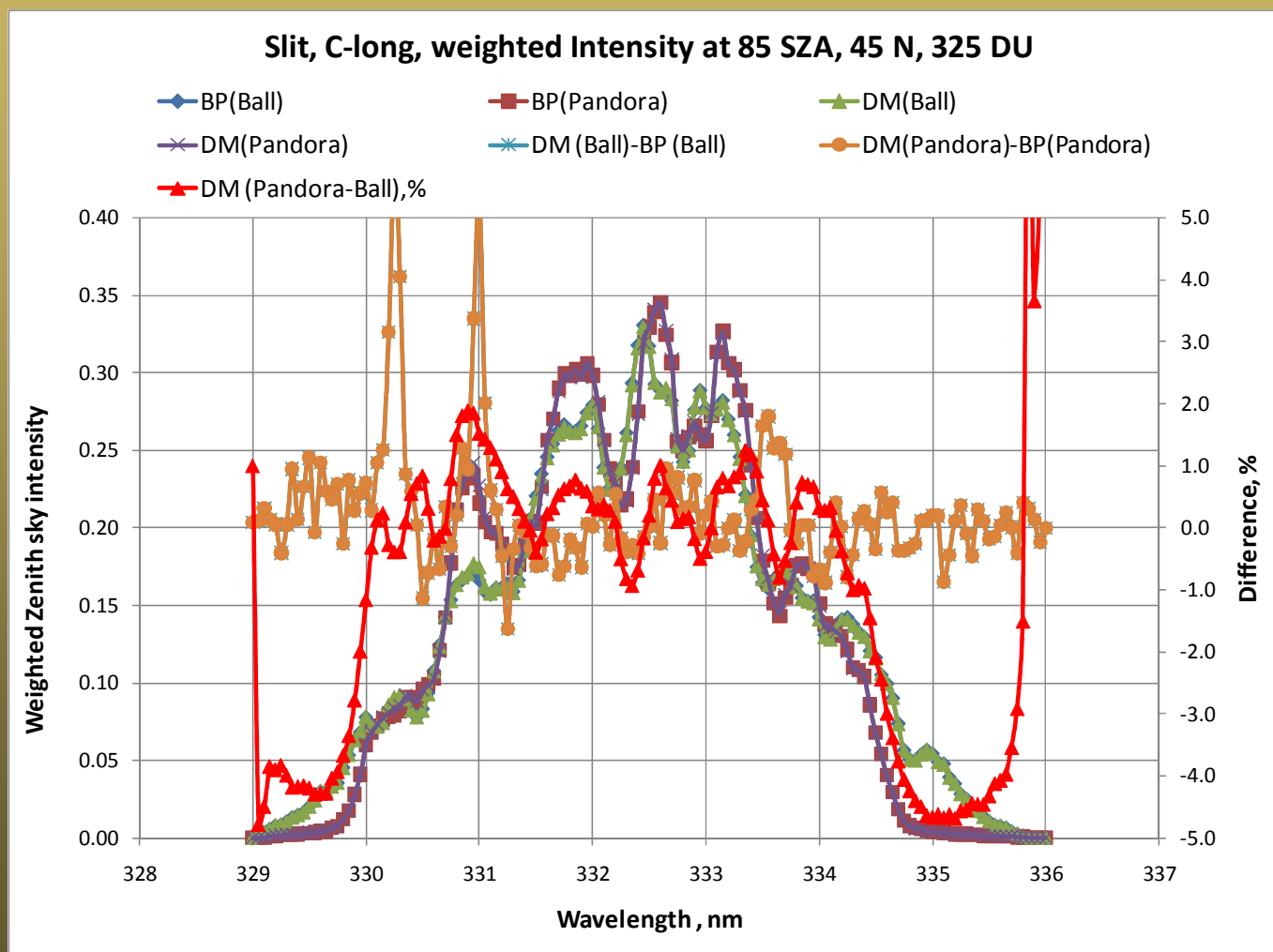


Slit functions, Dobson 102 and 083, March 2010

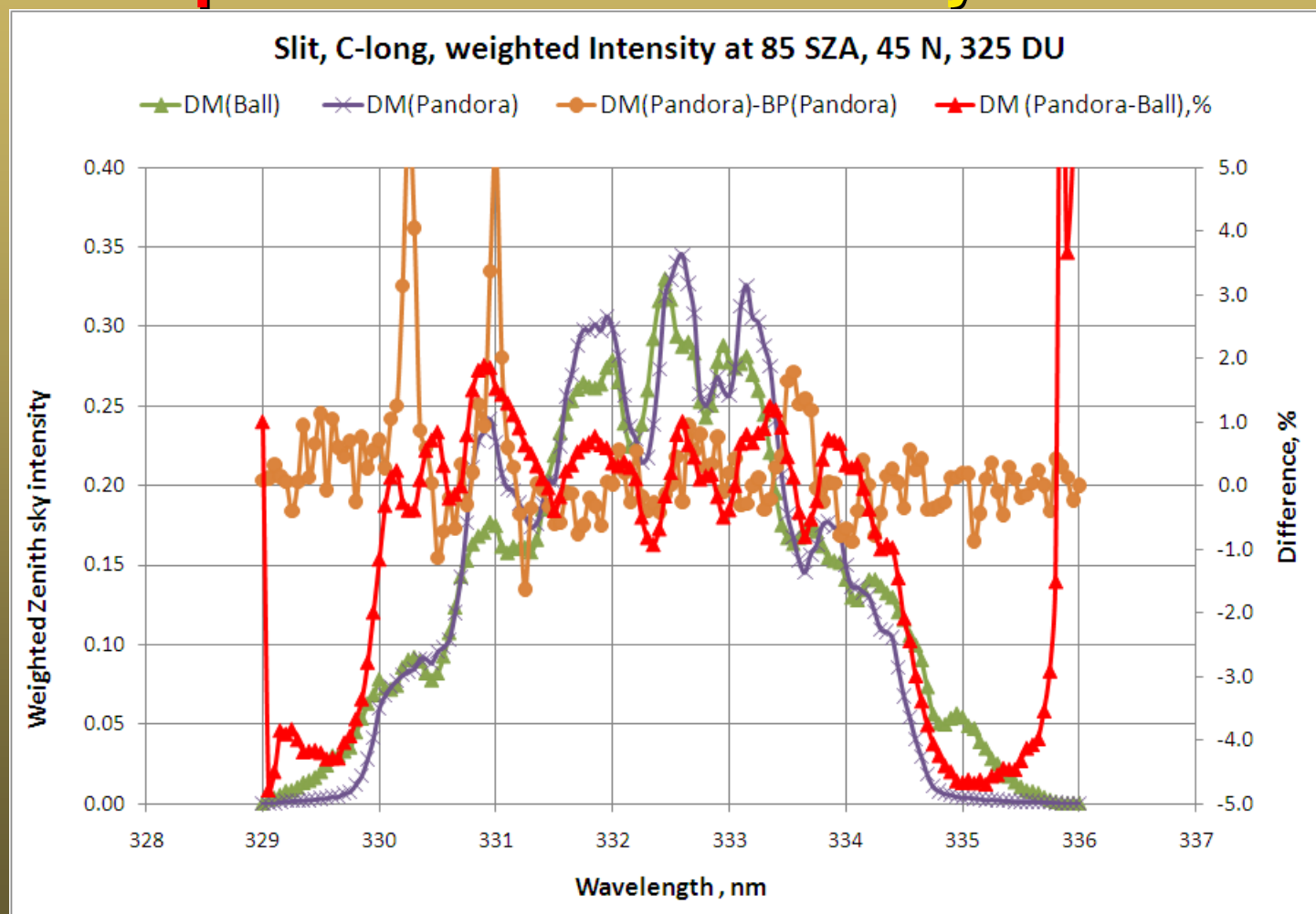
Pandora measurements, C-long, shape



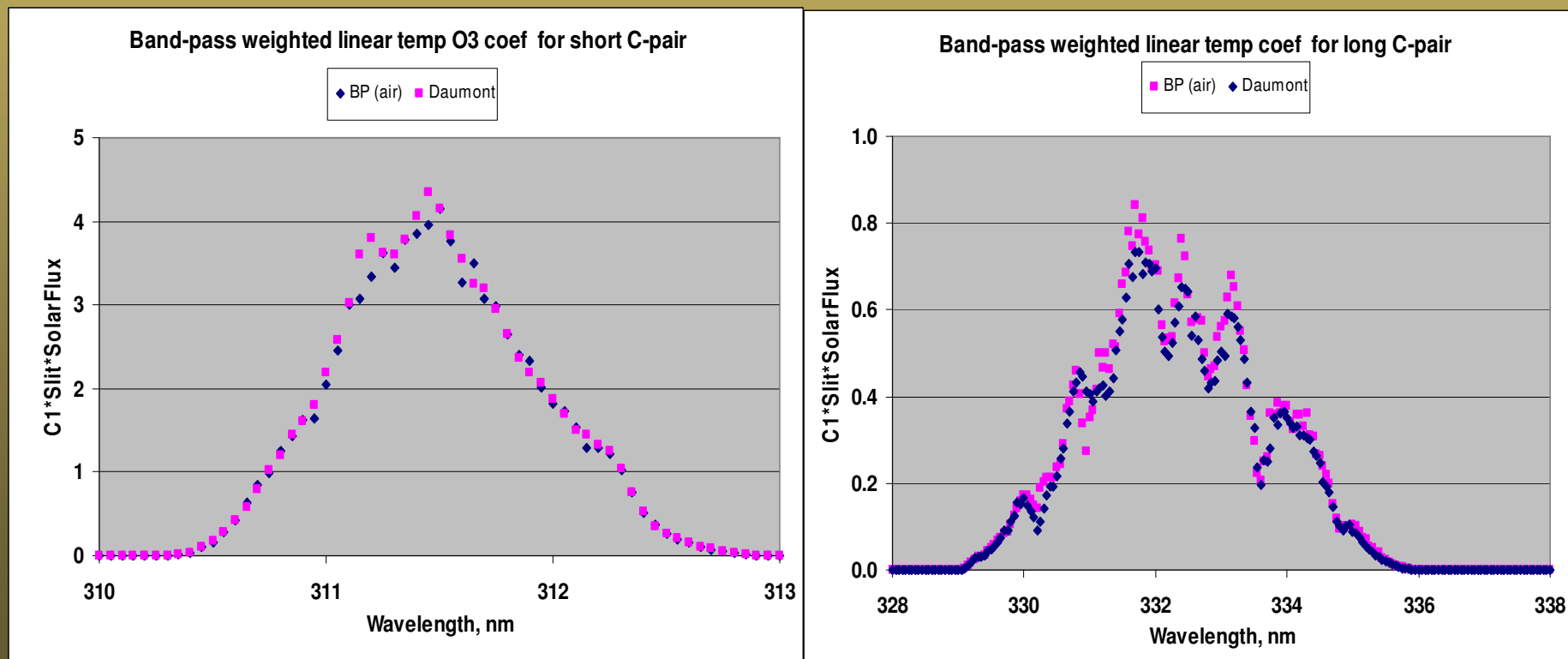
Slit and Solar Flux weighted intensity at 85 SZA, Dobson C-long, B&P and DMB x-sections similar, band-pass effect in zenith sky convolution



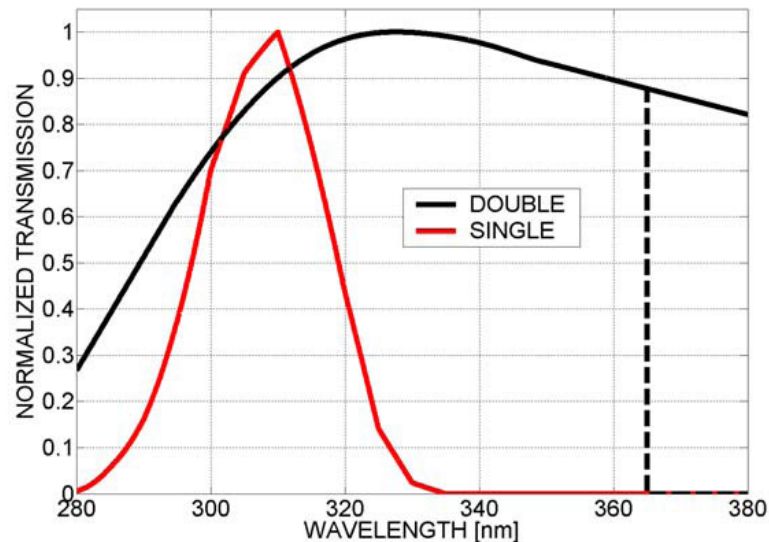
Slit and Solar Flux weighted intensity at 85 SZA, Dobson C-long, B&P and DMB x-sections similar, band-pass effect in zenith sky convolution



Temperature dependence at Dobson C-pair short and long wavelengths for B&P and DMB x-sections similar at short and some difference at long

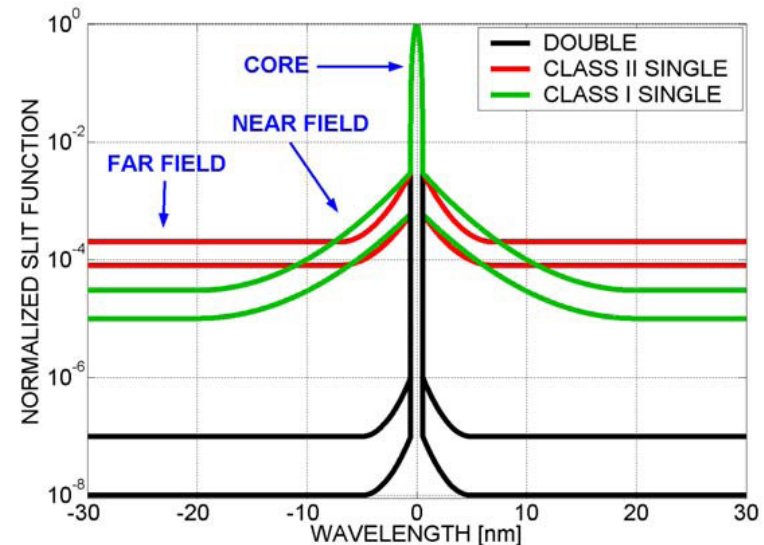


Depiction of stray light by A. Cede (NASA/Goddard)



Example of the spectral transmittance for the double (MKIII) and single (MKIV) Brewer

March 23-25, 2010

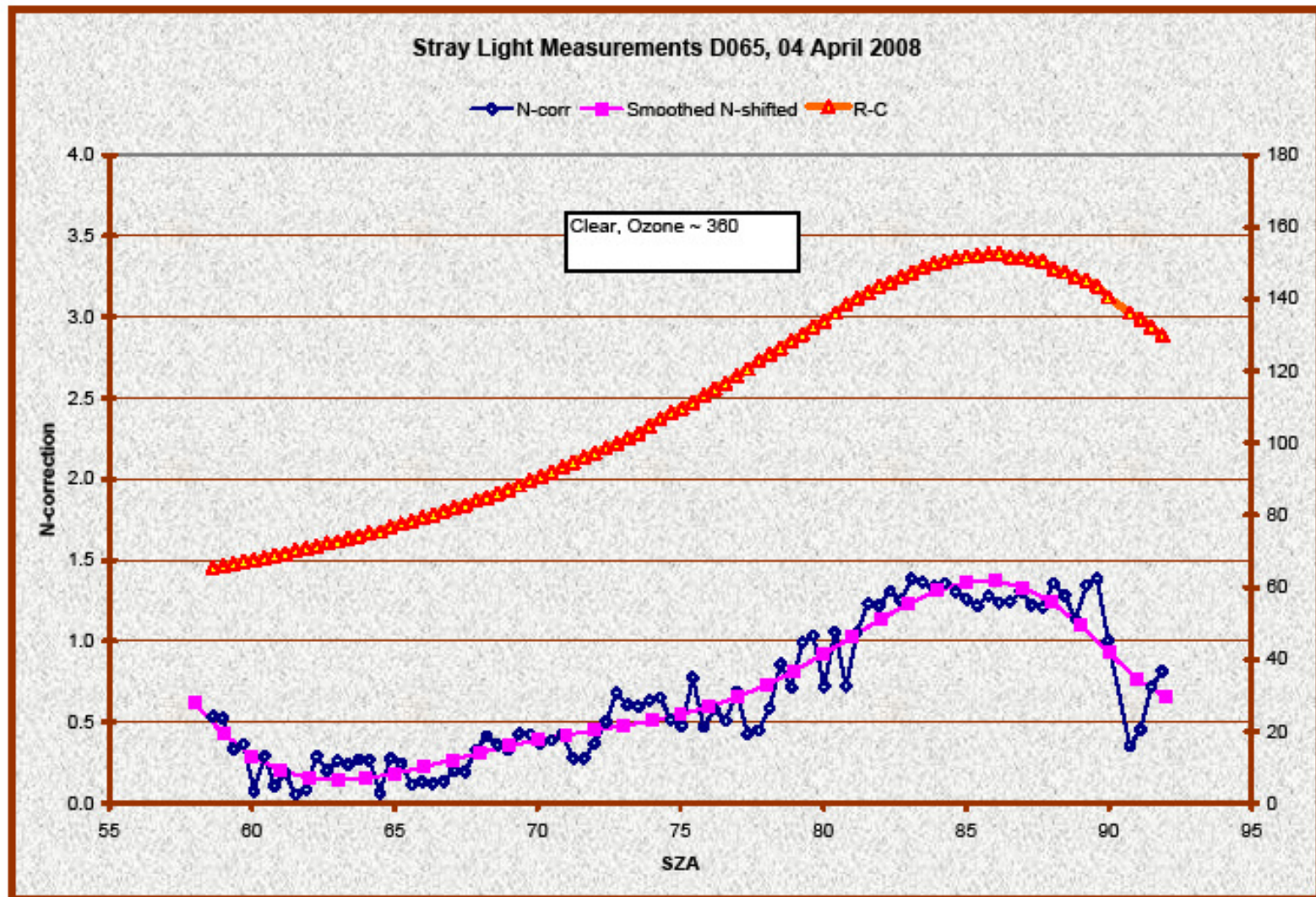


Examples of a Brewer slit functions for double and two single Brewers. The far, near fields and core are indicated, and the errors bars are provided

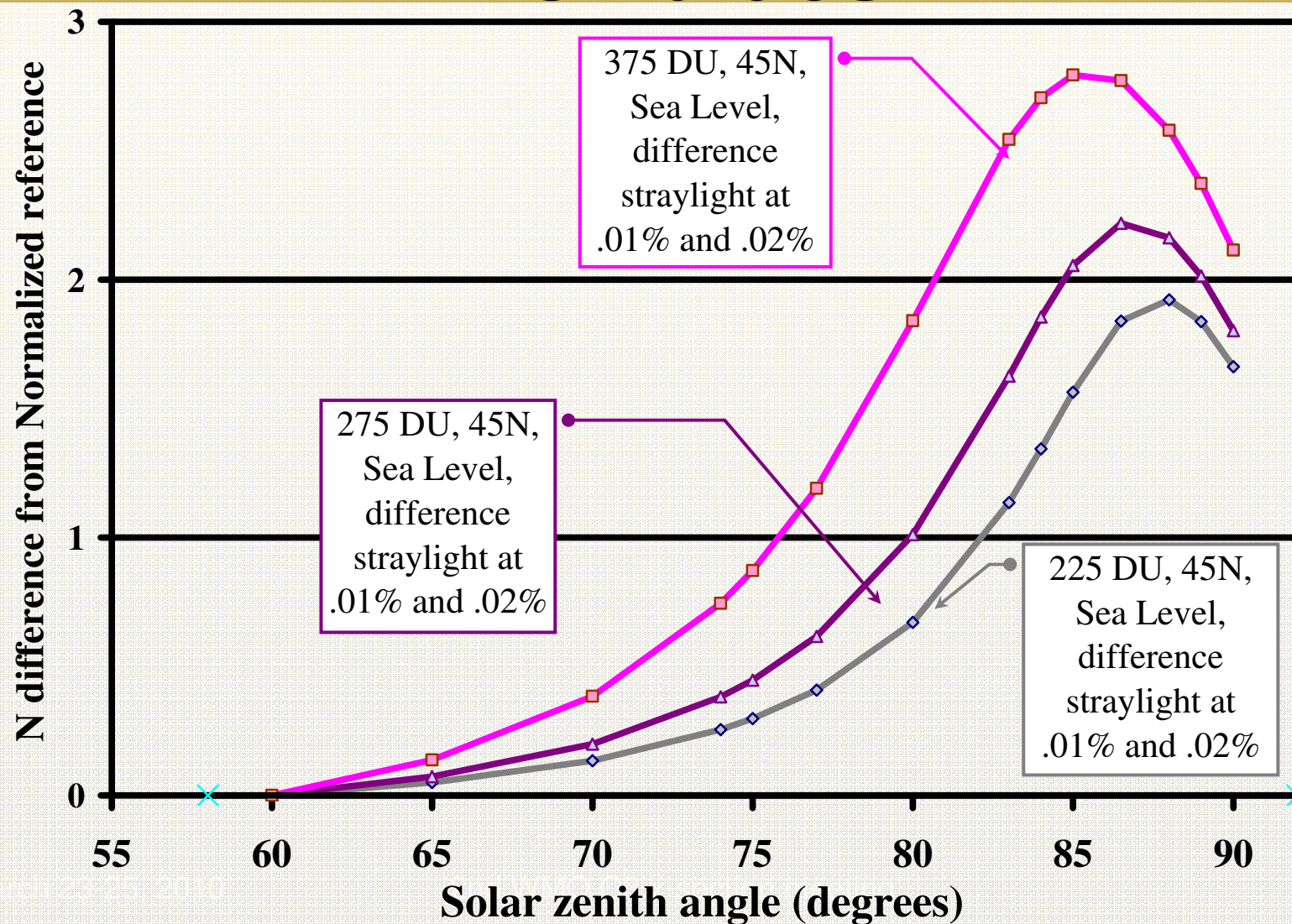
2nd WMO O3 x-section meeting

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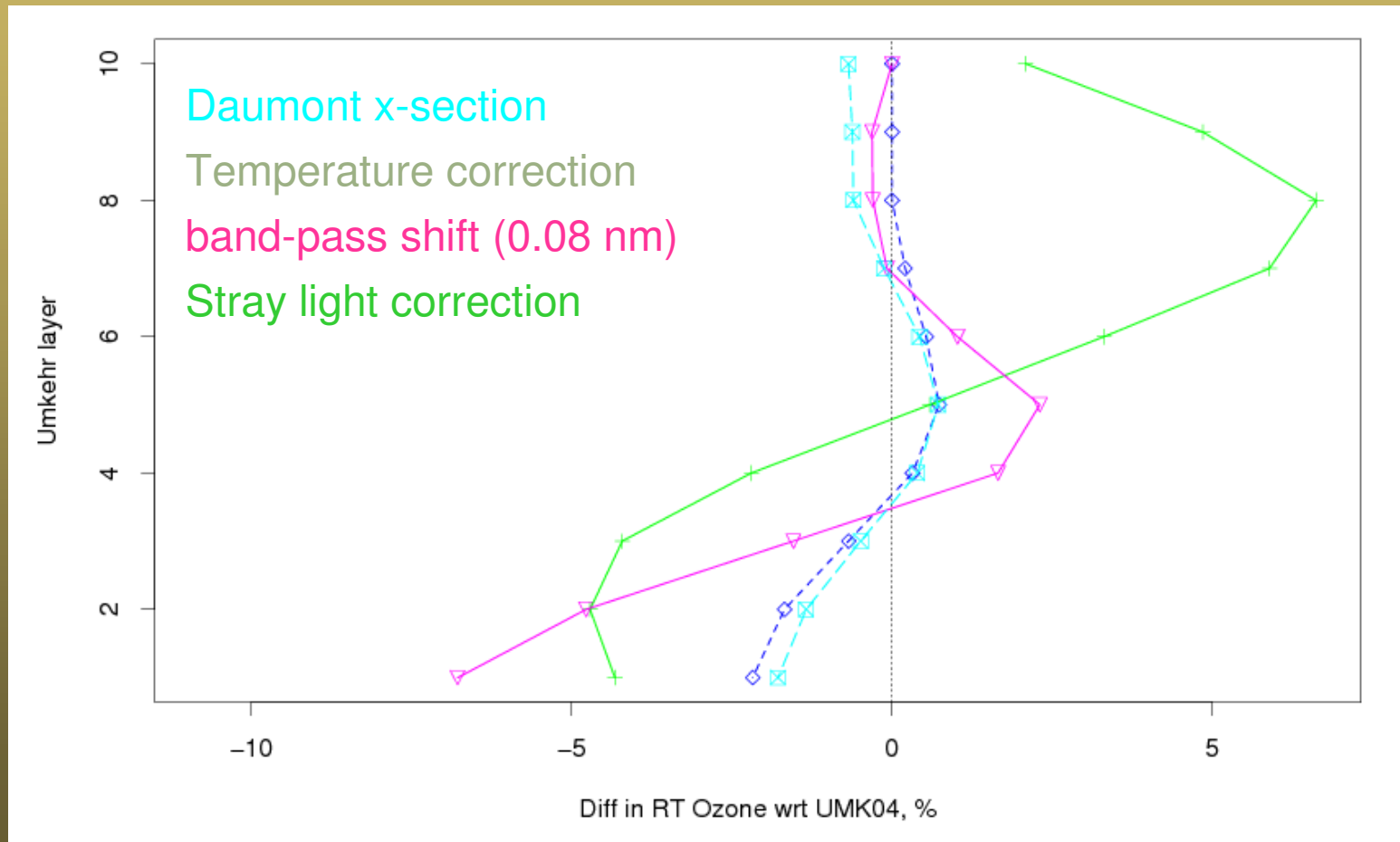
Stray light measurements in Boulder ~ 1 N-value change



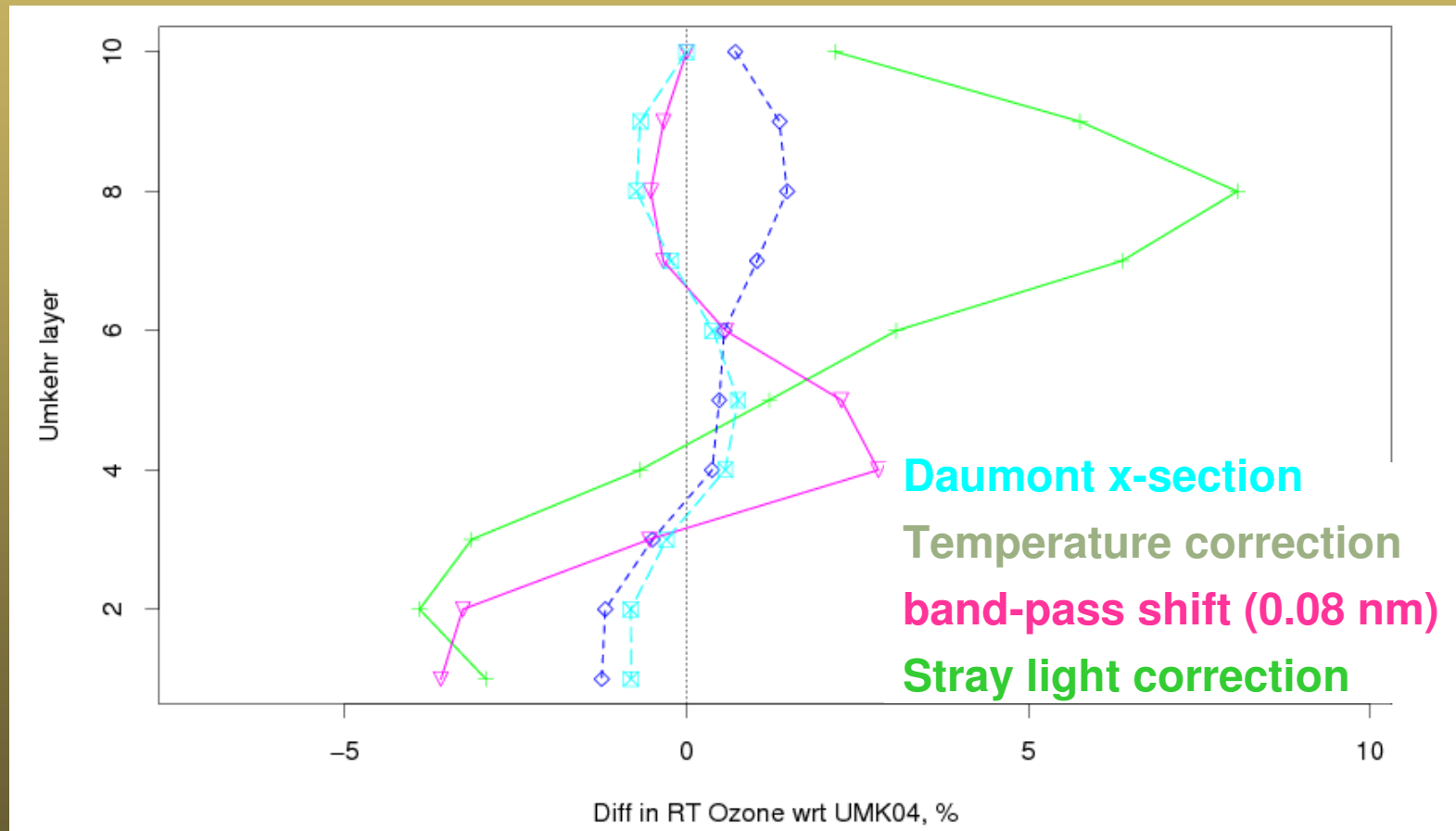
Stray light estimates for different TO values



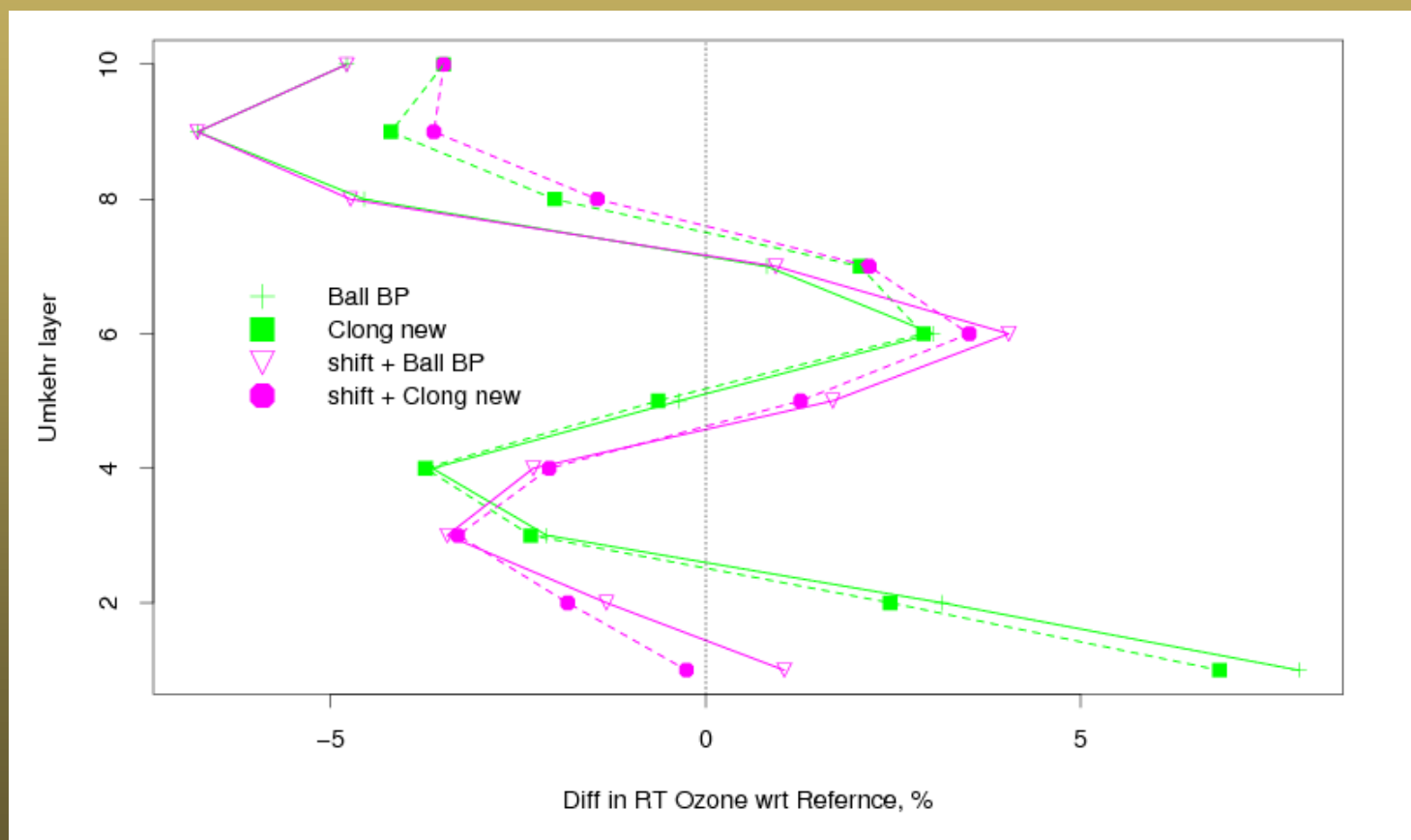
Boulder, Fall (09/20/007), TO 271 DU, D061, relative to UMK04 with B&P x-sec



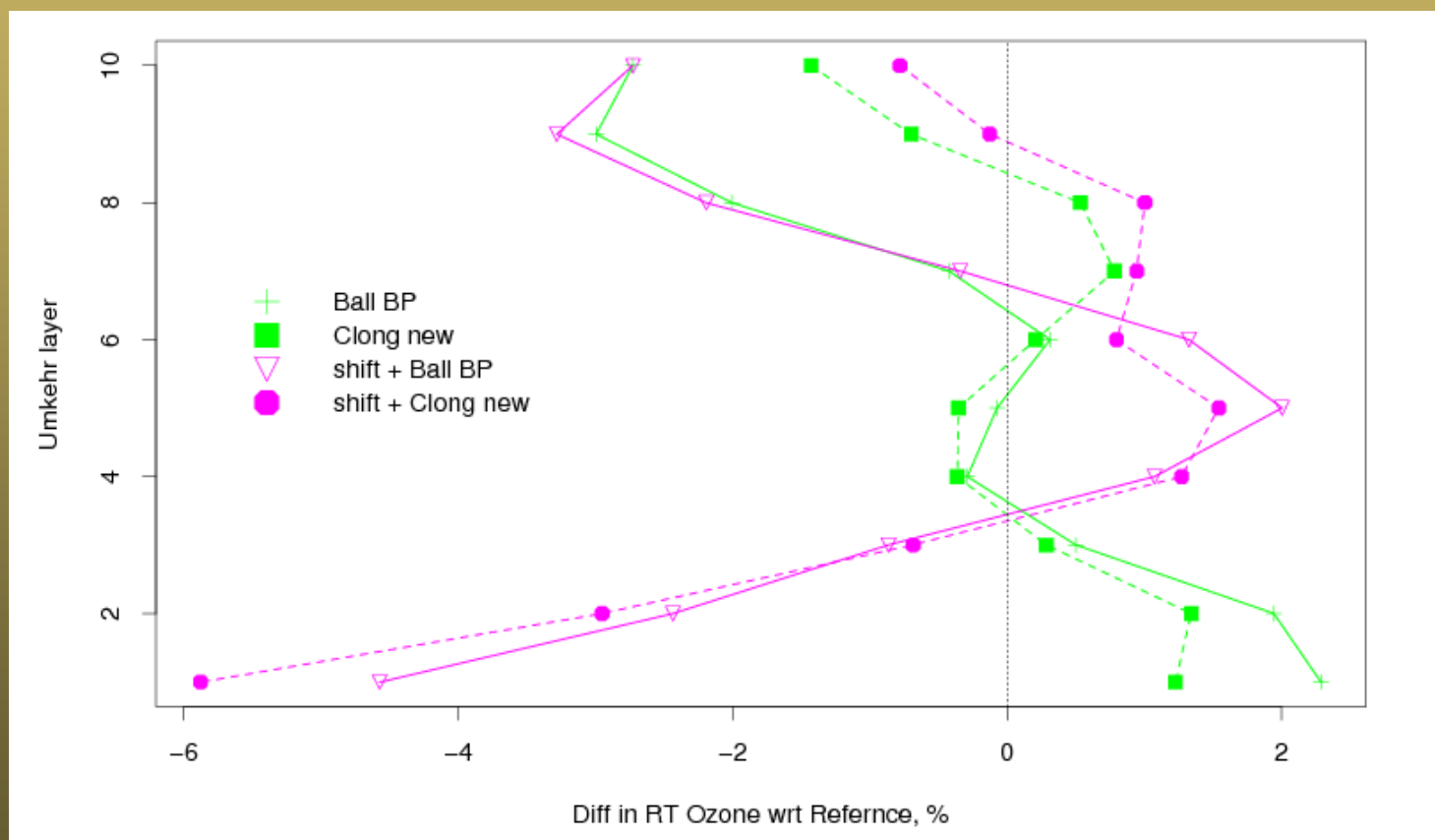
Boulder, **Spring** (04/07/2009), TO 330 DU, D061, relative to UMK04 with B&P x-sec



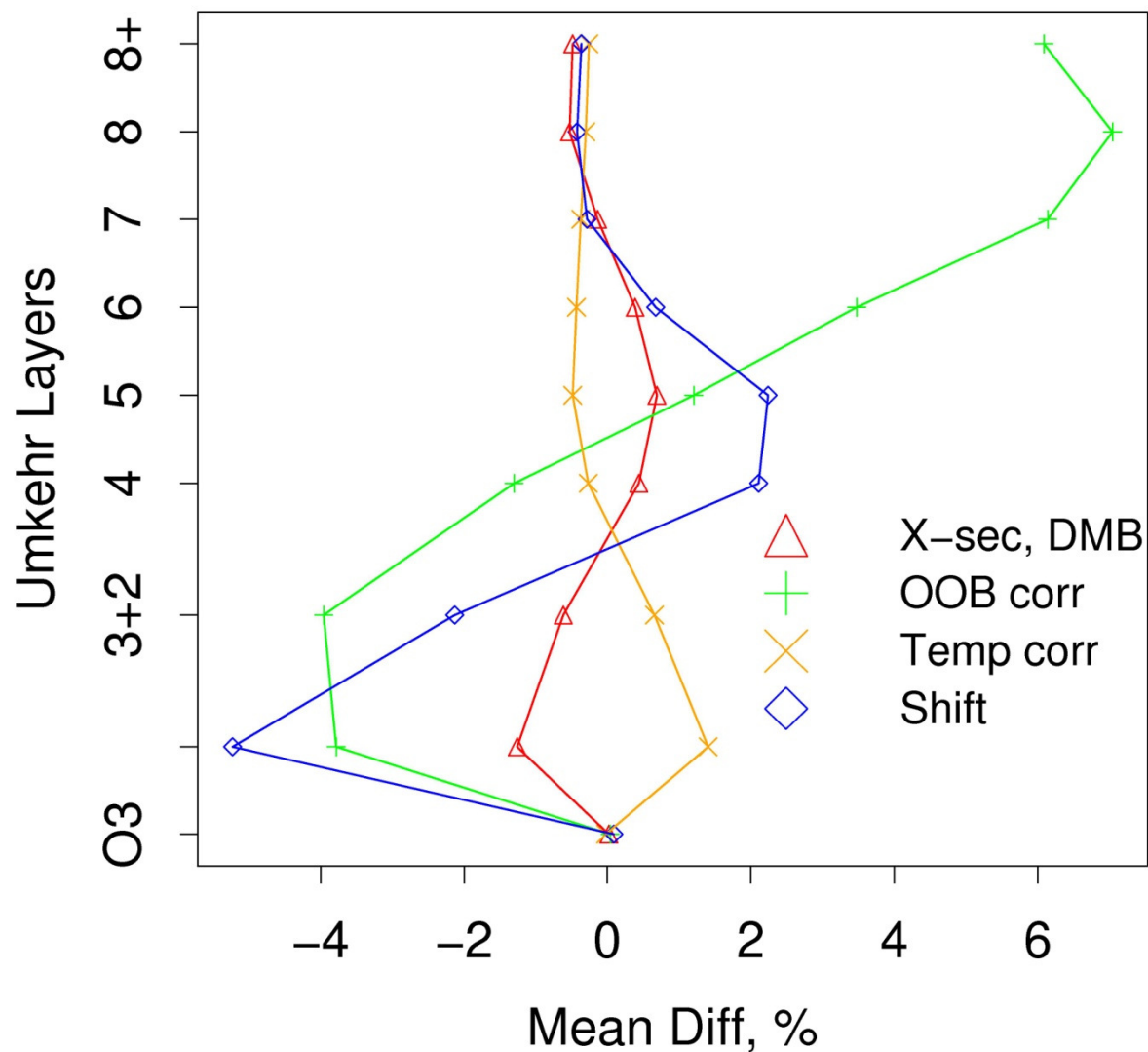
**Boulder, Fall (09/20/007), TO 271 DU,
D061 (BLD), new slit C-long (dashed line),
reference profile (sonde+MLS)**



**Boulder, Fall (09/20/007), TO 271 DU,
D116, new slit at C-long (dashed line),
reference profile (sonde+MLS)**



Boulder, Dobson 061, 1979-2008, relative changes in layers



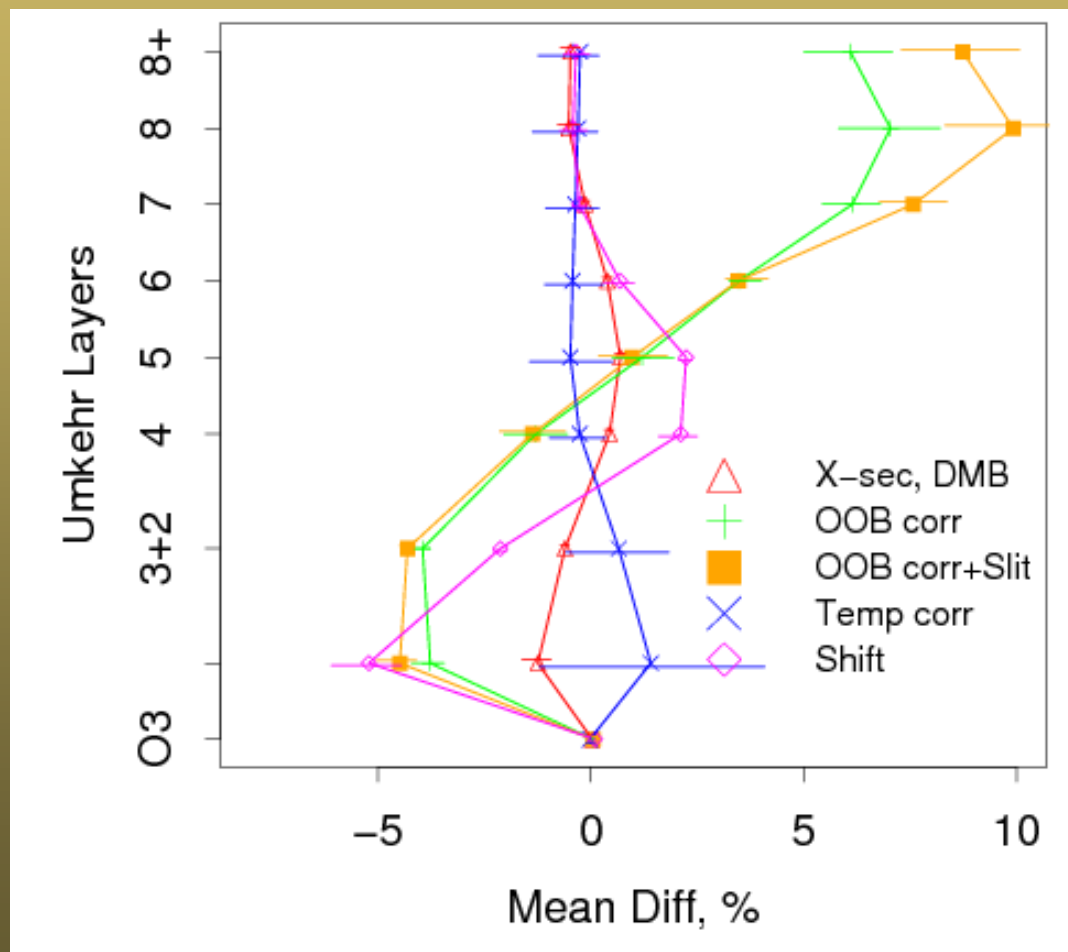
X-section (DMB-BP)

Band-pass spectral shift

Stray light correction

Temperature climatology correction

Boulder, Dobson 061, 1979-2008, relative changes in layers



X-section (DMB-BP)

Stray light correction

**Stray light and C-long
band-pass change**

**Temperature
correction
(climatology)**

**Band-pass spectral
shift (-0.08 nm)**

Conclusions for Dobson Umkehrs

- Effect of X-section data set change – very small
- Effect of band-pass (BP): shift (0.1nm) error is small (wide BP), but the appropriate BP shape increases Umkehr retrieved ozone in upper stratosphere
- Effect of temperature corrections (climatology based) is small
- Stray light effect in Dobson Umkehr measurements (10^{-5}) is significant for retrieval error, but needs to be further evaluated for individual instruments
- Errors in Dobson Umkehr ozone profile retrievals related to the uncertainties in instrumental parameters are larger than due to X-section choice

Dobson vs. Brewer

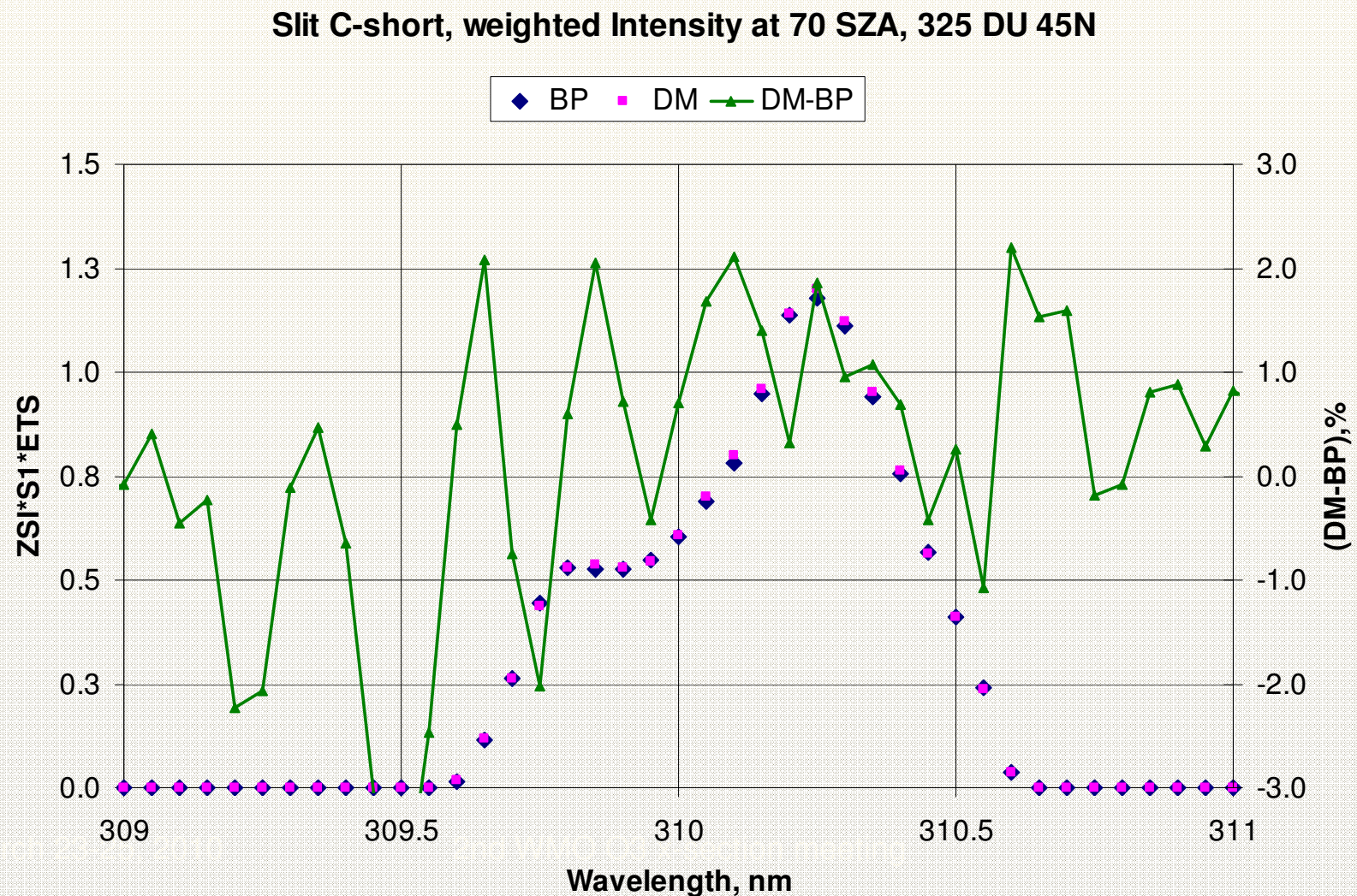
	Dobson	Brewer
Spectral channels (nm)	311.4/332.5	310.1/326.5
Spectral band-pass	Wide. Short channel: triangular 1.5 FWHM Long channel: trapezoid, about 3.8 nm at the base and 2 nm at the top	Narrow. Both channels have similar triangle shape, ~0.6 nm FWHM
Other filters	Cobalt filter (cuts off light above ~360 nm)	Double: Grating, PMT set zero below 250 nm and above 800 nm Single: UG-11 and NiSO ₄ filters – zero below 280 and above 330 nm
Stray light (far field)	~2*10 ⁻⁵ , 0.005 %	Single, class II: ~10 ⁻⁴ for Mark IV at NEUBrew Double, Mark III: ~10 ⁻⁷ for Double B171

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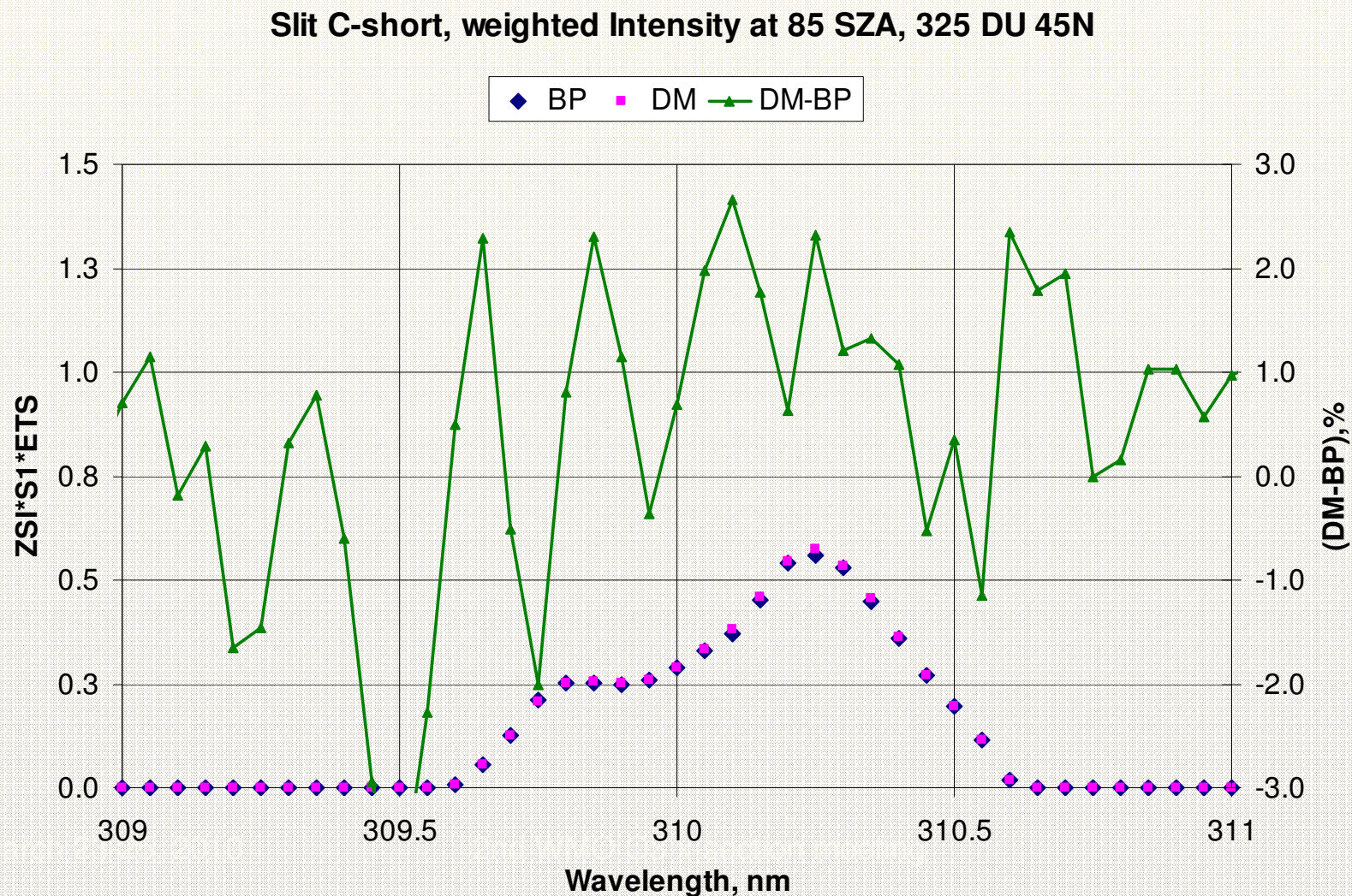
2nd WMO O3 x-section meeting

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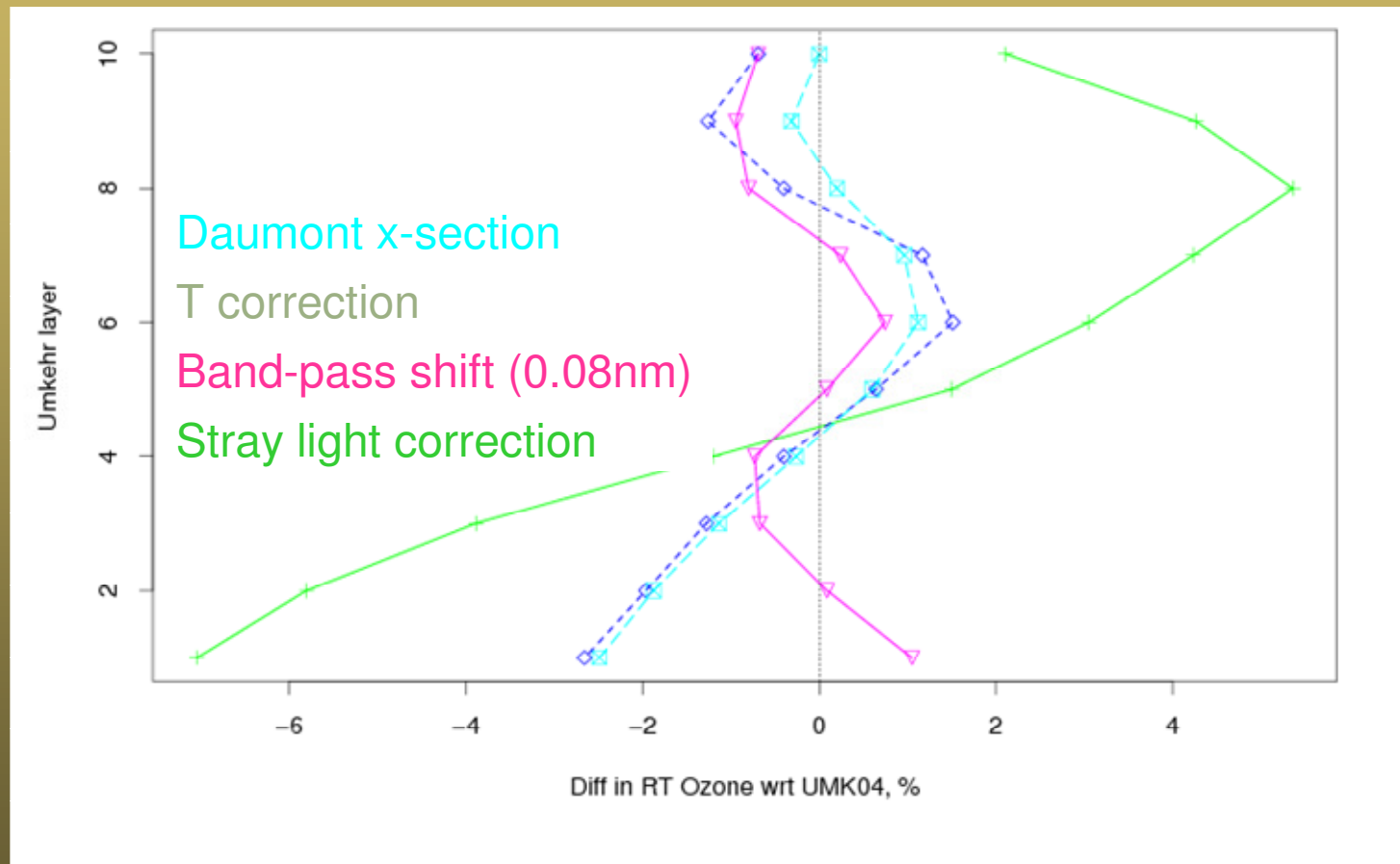
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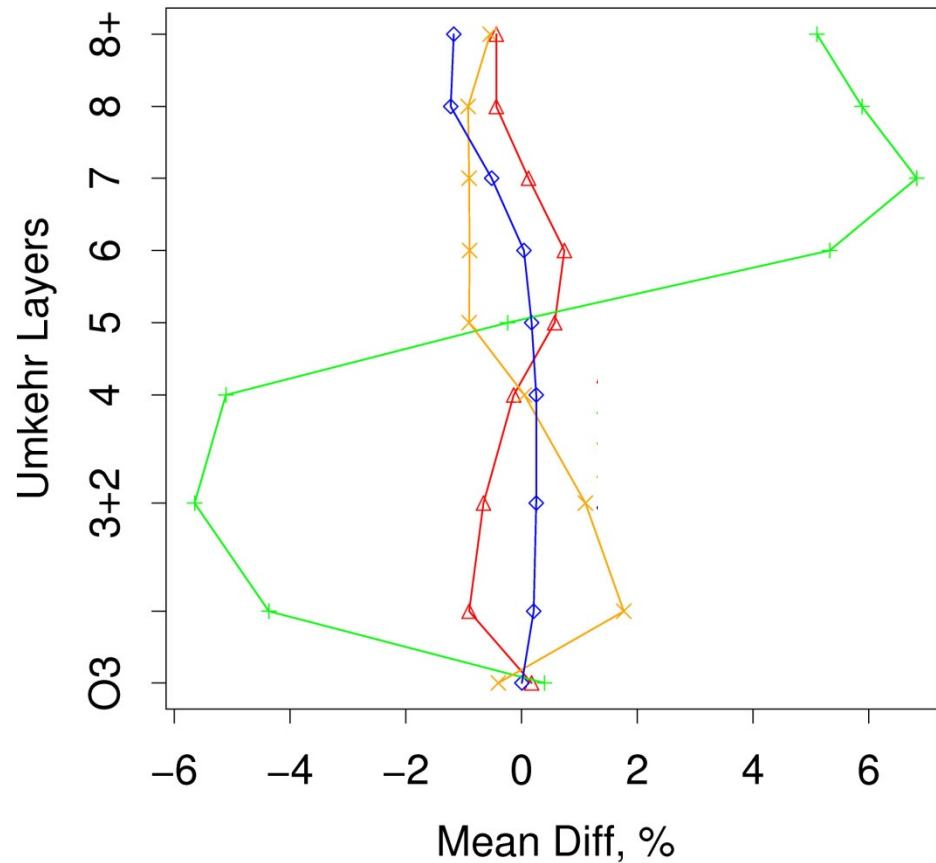
Slit and Solar Flux weighted intensity at 85 SZA, Brewer C-short, B&P and DMB x-sections similar at both short and long



Effects on Brewer Umkehr RT Boulder, 09/20/07



MLO, Brewer 009 (Environment Canada), 1998-2005, relative changes in layers



X-section (DMB-BP)

Band-pass spectral shift

Stray light correction

Temperature climatology
correction

Conclusion for Brewer Umkehrs

- Effect of X-section change – small
- Effect of band-pass shift is small
- Effect of temperature corrections (climatology based) is small
- Stray light effect in single Brewers (1×10^{-4} level for Mark IV) is significant for ozone profile retrieval, but needs to be further evaluated
- Errors in Brewer Umkehr ozone profile retrievals related to the uncertainties in instrumental parameters are larger than errors due to X-section choice
- X-section sensitivity in Brewer Umkehr retrievals is similar to Dobson Umkehr retrievals (although Brewers have more narrow band-pass)

Further work

- Out-of-band contribution into Umkehr measurement (due to non-zero transmission in the far field of the slit band) needs to be evaluated for both Dobsons (2×10^{-5} ?) and single Brewers (1×10^{-4} ?)
- Band-pass centers (shift from nominal), wavelength separation, and BP widths need to be carefully evaluated for all instruments – implication to ozone profile retrieval
- NiSO_4 - UG11 filter transmission in single Brewers needs to be measured and utilized in Umkehr profile retrievals
- As we develop the Brewer Umkehr profile retrieval software for satellite validation activities – proper ozone x-sections would be of great importance.
- Total ozone from zenith sky measurements is of interest for satellite validation at low sun conditions (increase in stray light in direct sun measurements).