SAGE Perspective on Ozone Cross Sections

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Ozone Cross Sections for SAGE III Processing

- SAGE III processing requires ozone cross section dataset spanning broad spectral region from 280 – 1030 nm

- SAGE III has two main ozone profile products
  - Mesospheric (60-100 km): from UV near 290 nm
  - Stratospheric/tropospheric (cloud top-60 km): from Chappuis

- Ozone is also an interfering species and must be accounted for as part of H_2O, aerosol, and T/p retrieval process (O_3 Wulf bands)

- SAGE III version 4 uses Bogumil (SCIAMACHY) cross section dataset for all O_3
  - Previous versions used Shettle & Anderson compilation (BP in UV)
  - Improved H_2O and aerosol products
  - O_3 profiles change by only a few percent

Ozone Cross Sections over SAGE III Spectral Region


Ozone Abs. Cross-Section
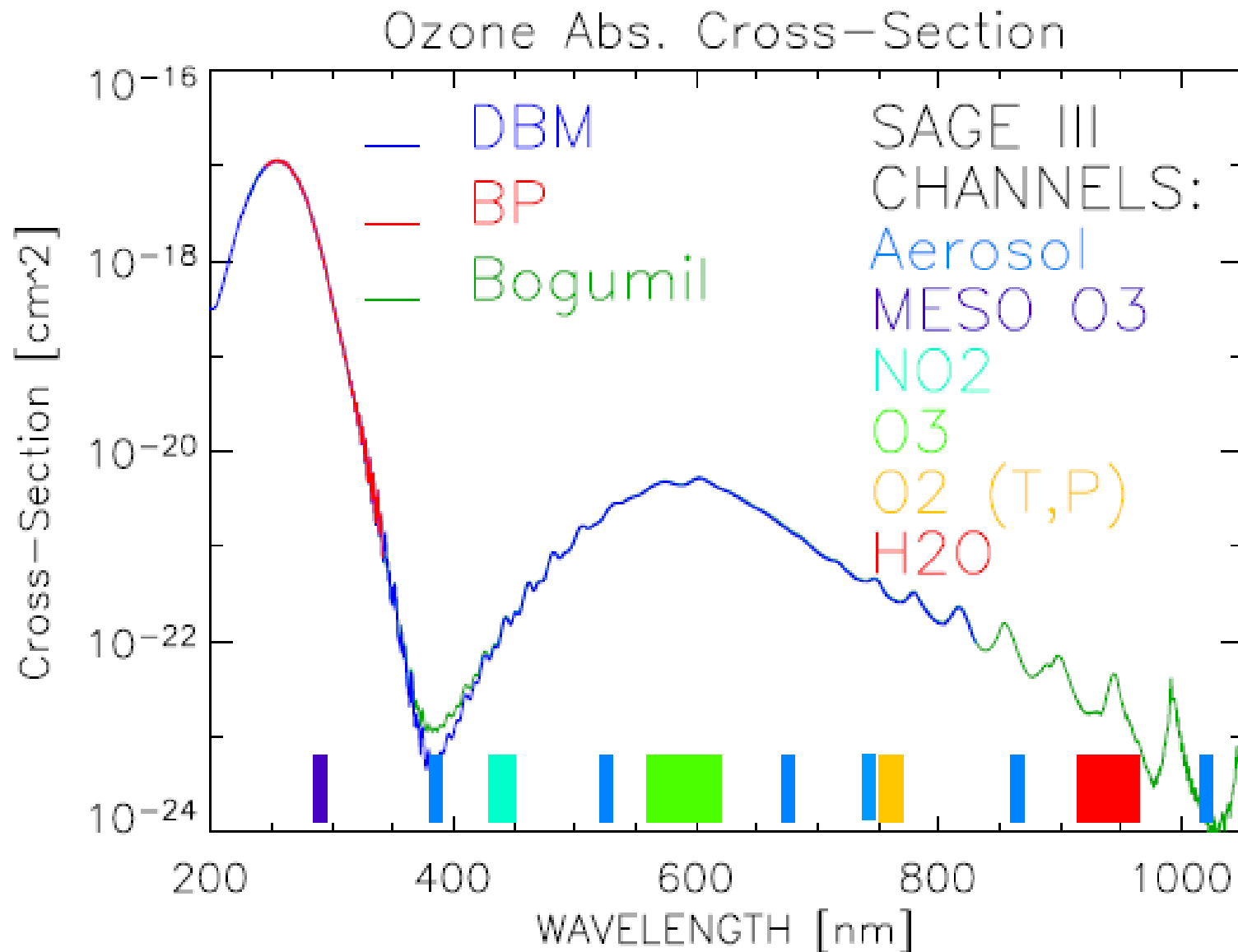
Impact of UV Cross Section Changes on SAGE III Mesospheric Ozone

- Retrieval based on measurements from three channels: 284, 290, and 296 nm

- BP, DBM, and Bogumil differences at these wavelengths within +/- 2% with similar temperature dependence
  - Leads to +/- 2% differences in retrieved mesospheric ozone values
  - Mesospheric ozone product has not been validated to sufficient accuracy levels to comment on quality of various cross section datasets

- BP to DBM switch has <u>no effect</u> upon SAGE I & II O_3 products
 - Rely totally upon Chappuis measurements

Ozone Wulf Band Cross Section Assessment

- Accurate knowledge of O_3 Wulf band cross sections critical to success of SAGE III H_2O, aerosol, and T/p retrievals
- Atmospheric spectra from Gas and Aerosol Measurement Sensor (GAMS) used to evaluate cross sections
- Two reference cross section data sets evaluated:
  - Shettle and Anderson Compilation
  - Bogumil (SCIAMACHY)
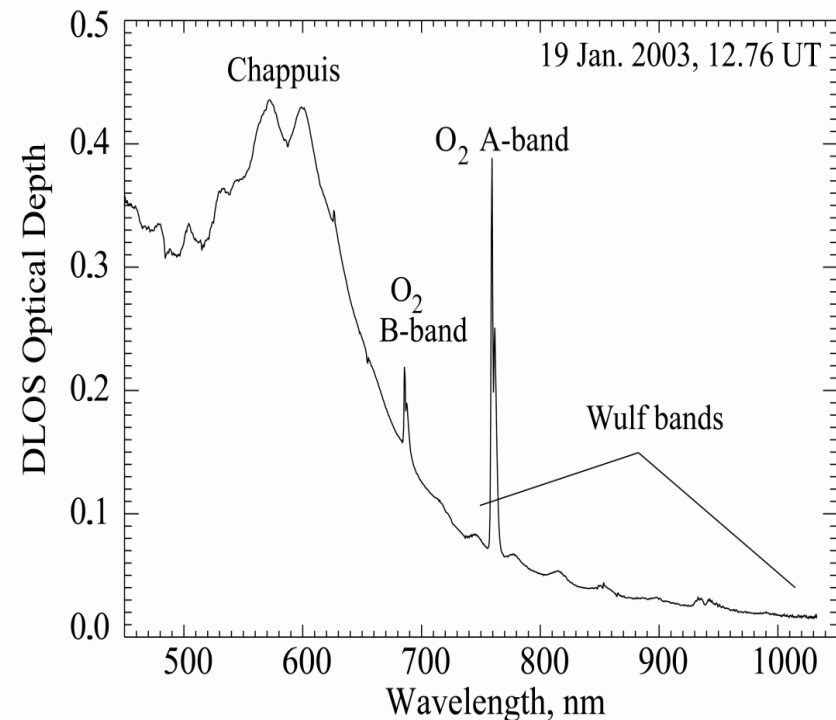
Pitts et al., Ozone observations by the Gas and Aerosol Measurement Sensor during SOLVE II, *Atmos. Chem. Phys., 6,* 2695, 2006.
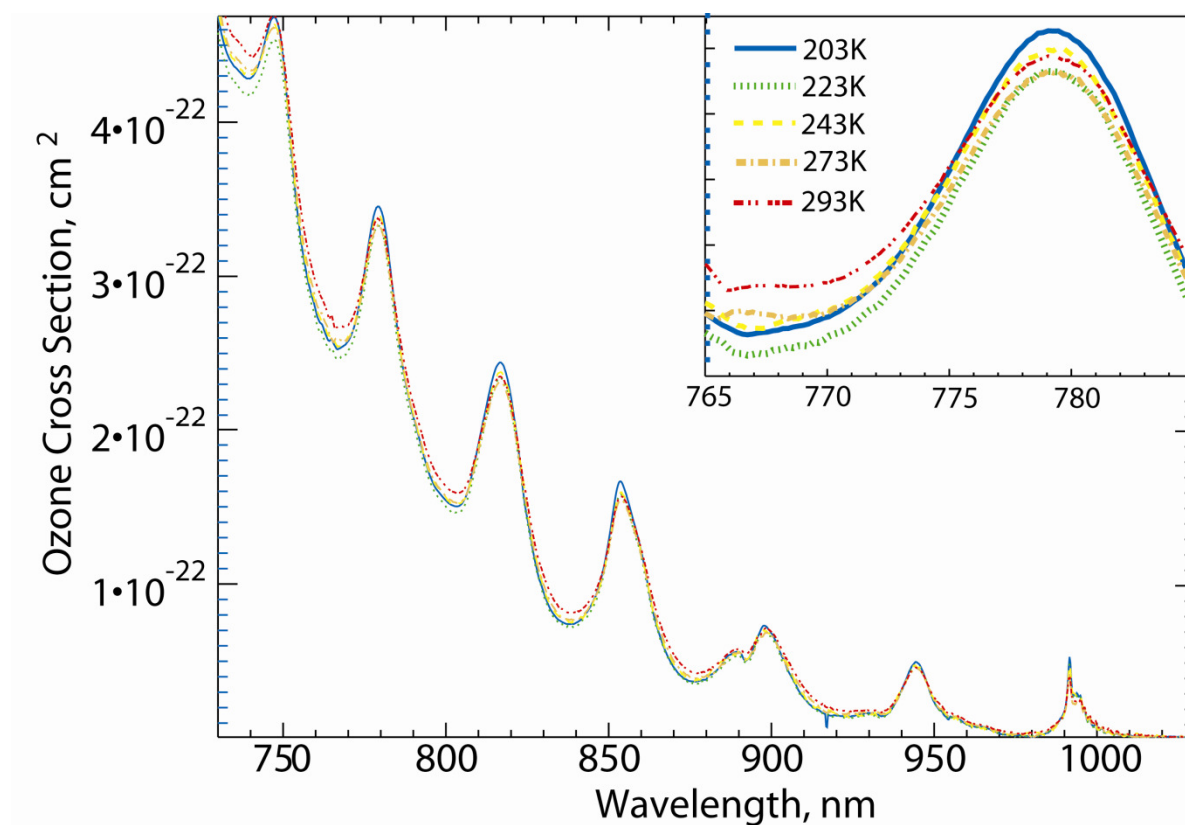
Shettle and Anderson Compilation[*]
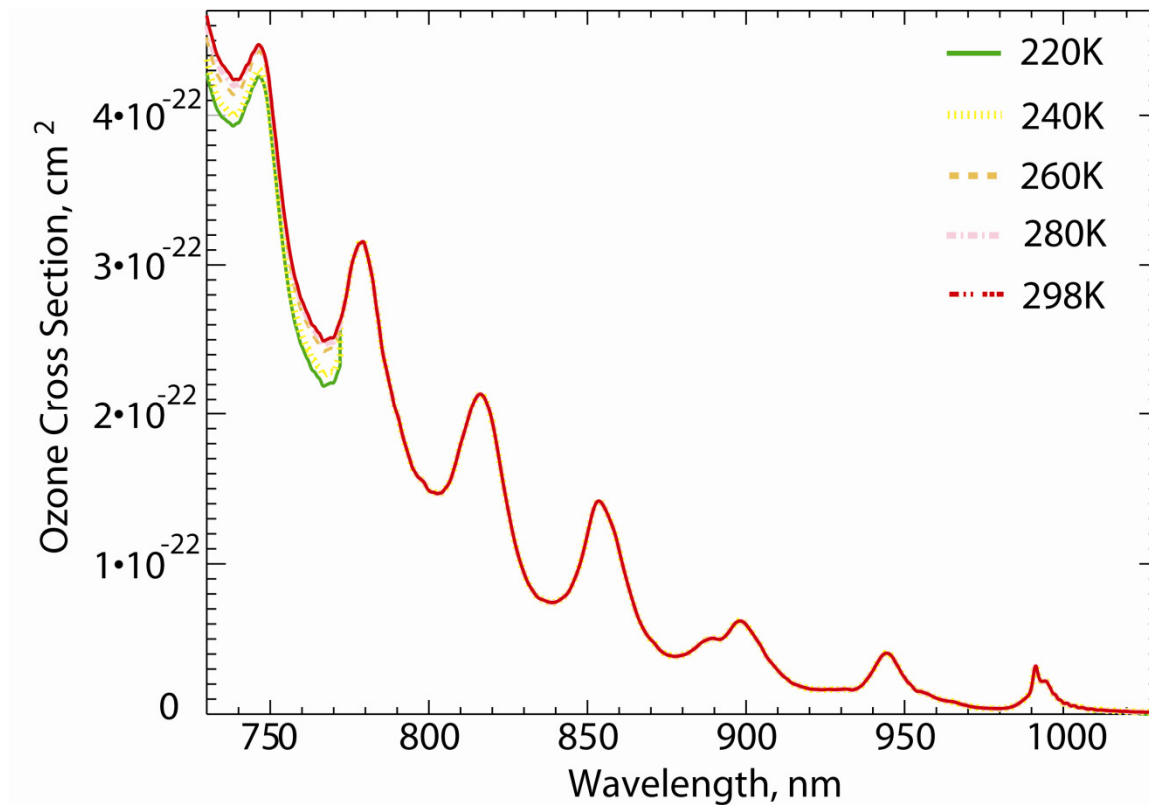
- Developed by merging four different sets of lab measurements
- Temperature dependence limited to $\lambda < 762$ nm (Burkholder and Talukdar, 1994)

[*]Shettle, E.P. and S.M. Anderson, in *Proceedings of the 17th Annual Conference of Atmos. Transmission Models*, 1995.
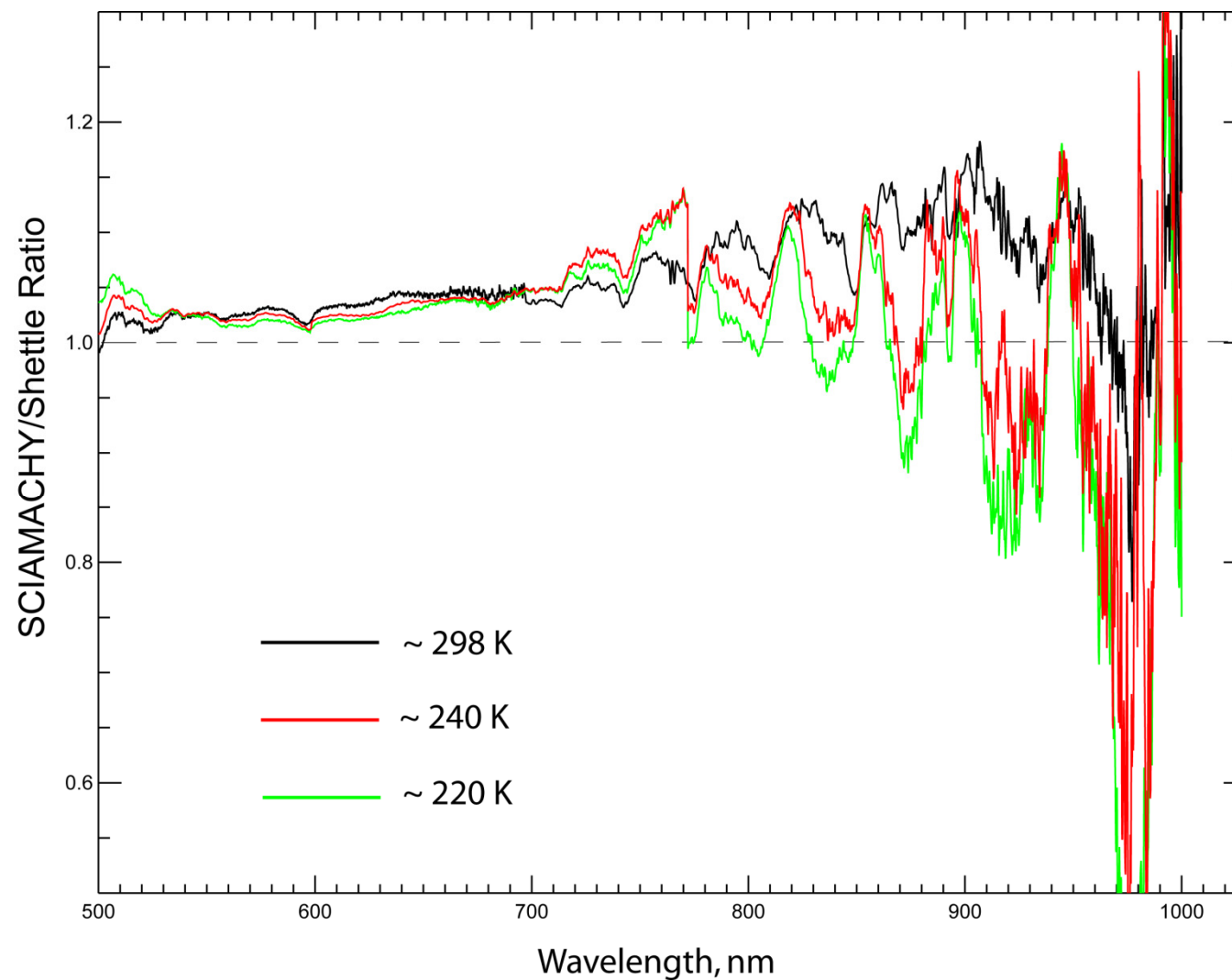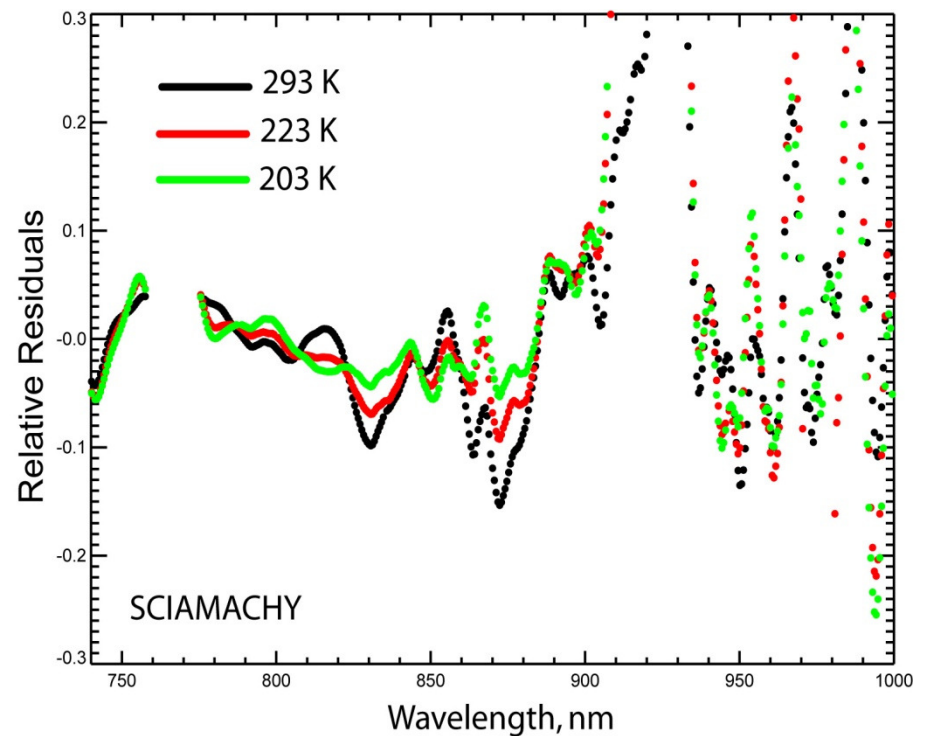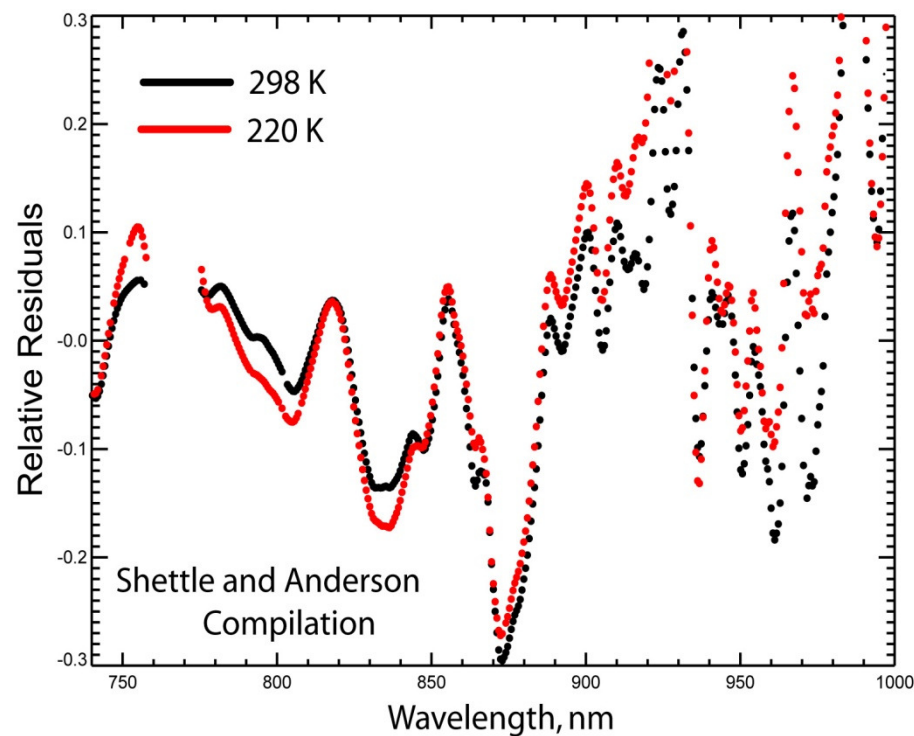
Bogumil Ozone Cross Sections*

- Produced for SCIAMACHY satellite mission using pre-flight model spectrometer
- Self-consistent measurements covering 230 to 1075 nm
- Temperature dependence measured over entire spectral range

*Bogumil et al., *J. Photochem. Photobiol. A.: Chem., 157,* 167-184, 2003.

Bogumil /Shettle and Anderson Cross Section Differences

Relative Residuals from Fits to GAMS Spectra

Mean residuals from three SOLVE II flights

Wulf Band Assessment Conclusions

- Quality of fits using Bogumil cross sections at stratospheric temperatures are significantly better than Shettle and Anderson compilation

- Bogumil cross sections recommended for SAGE III operational processing (Version 4)
    - Small (~2-3%) changes to Version 4 ozone products
    - Version 4 water vapor showed marked improvement over earlier versions

- Sufficiently large residuals remain in fits to warrant additional laboratory measurements

Summary

- SAGE III processing requires ozone cross section dataset covering ~280 – 1030 nm spectral range

- Bogumil cross sections adopted for SAGE III processing (Version 4)
  - Ozone profile products changed by only a few percent
  - Water vapor product showed marked improvements over previous versions
  - Aerosol products improved

- Switch to DBM in UV would result in ~2% change in retrieved mesospheric ozone values

- BP to DBM switch has no effect upon SAGE I & II ozone products

- Additional laboratory measurements would be desirable to verify temperature dependence (300 K to 190 K) over 280-1030 nm spectral region