SAGE Perspective on Ozone Cross Sections

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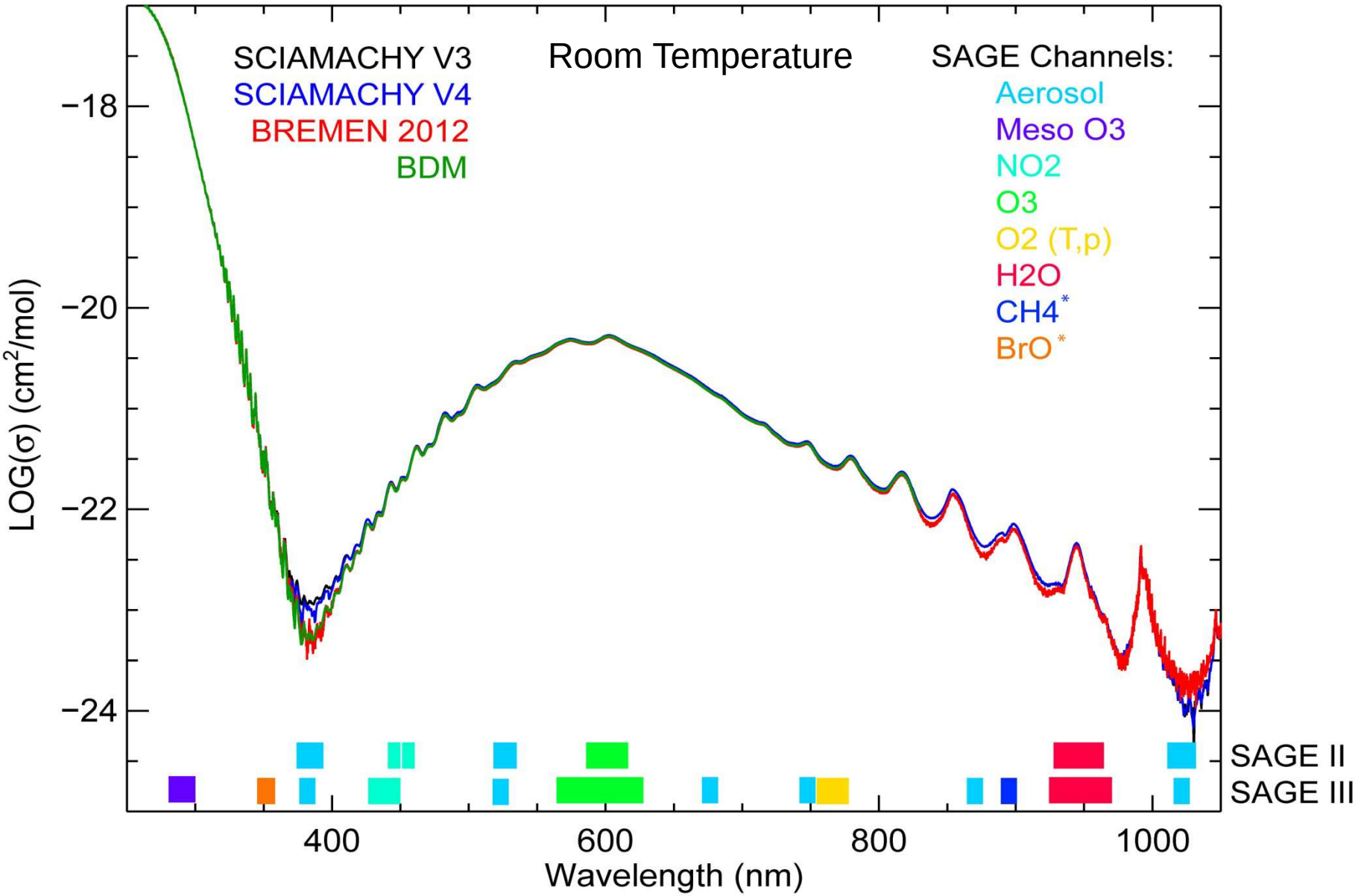
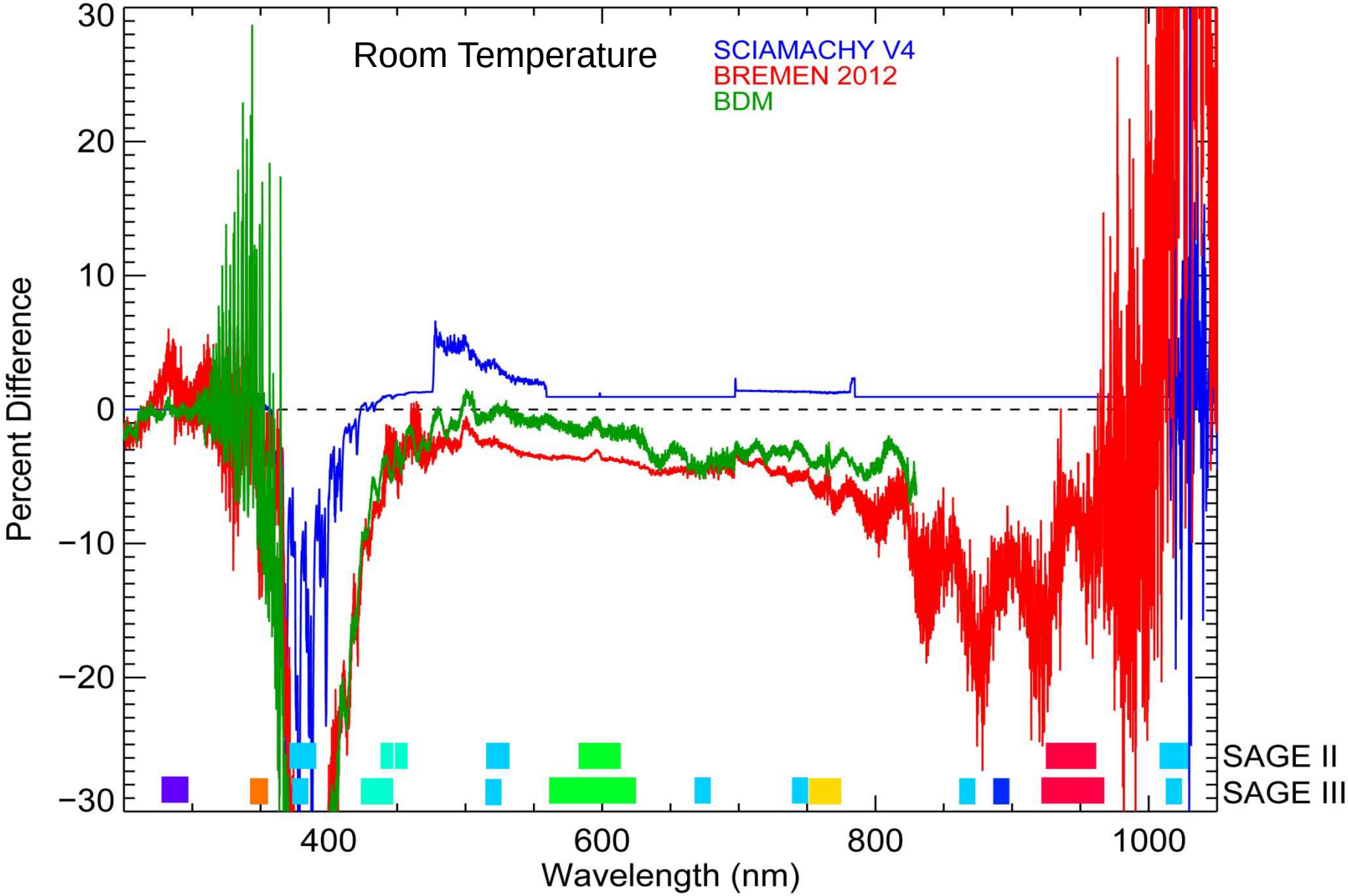
Ozone Cross Sections for SAGE Processing

- SAGE processing needs self-consistent ozone cross section dataset spanning broad spectral region from ~280 – 1030 nm
- Ozone profile products:
  - Stratospheric/tropospheric (cloud top-60 km): Chappuis band near 600 nm
  - Mesospheric (60-100 km): Hartley band near 290 nm (SAGE III only)
- Ozone is also an interfering species and must be accounted for as part of aerosol, H_2O, NO_2, and T/p retrieval process (Wulf bands)
- SAGE II v7 and SAGE III v4 use SCIAMACHY v3 (Bogumil et al.) cross section dataset for all spectral regions
  - Previous versions used Shettle and Anderson compilation (BP in UV)
  - Ozone decreased by ~1-2% relative to previous versions
  - Significant improvements in H_2O and aerosol products
- Two new reference cross section datasets evaluated here:
  - SCIAMACHY v4 (Chehade et al., 2013)
  - Bremen 2012 (Serdyuchenko et al., 2012)

Ozone Cross Sections over SAGE Spectral Regions



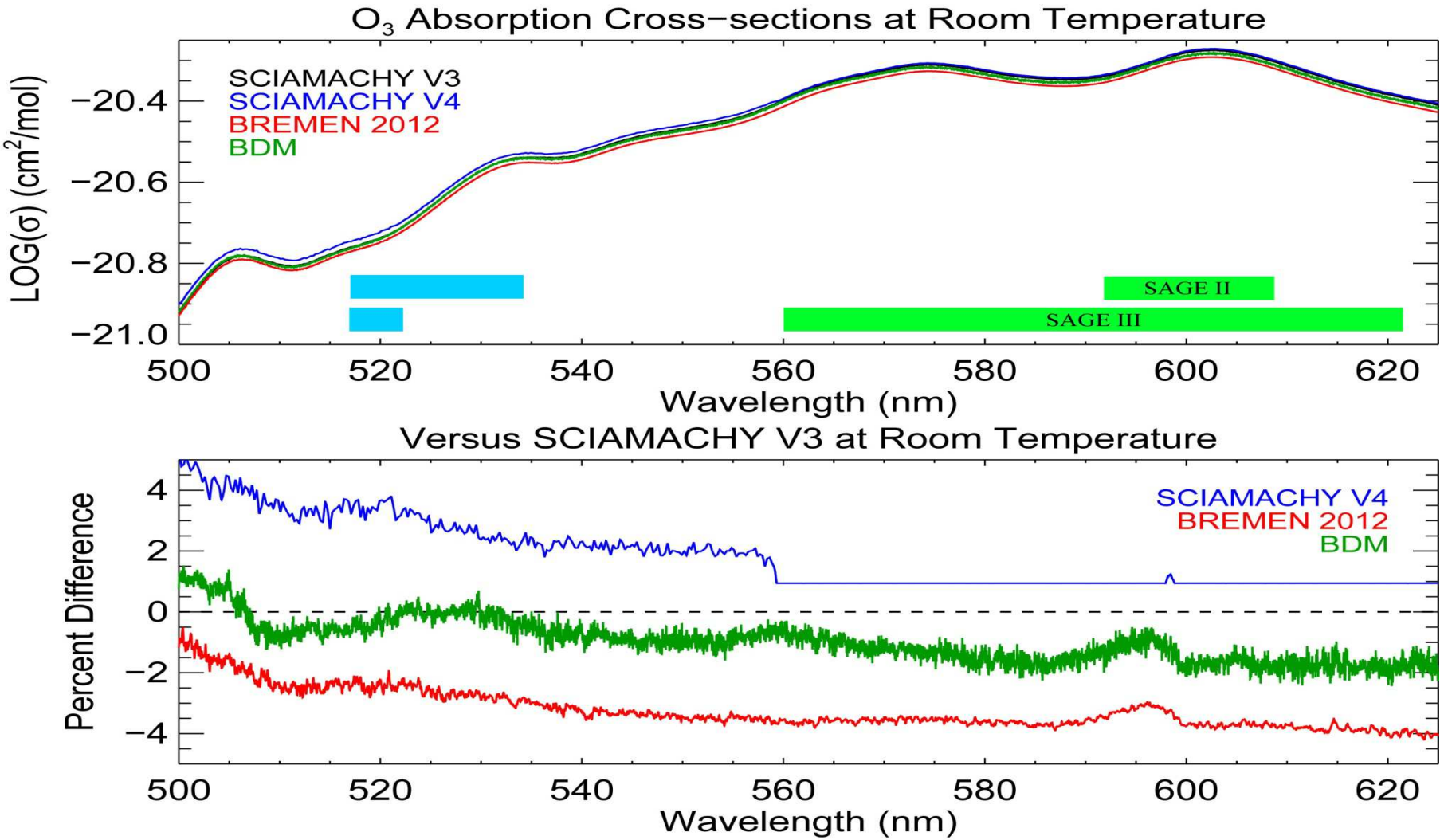
Cross Section Differences versus SCIAMACHY v3



Impact of UV Cross Section Changes on SAGE III Mesospheric Ozone

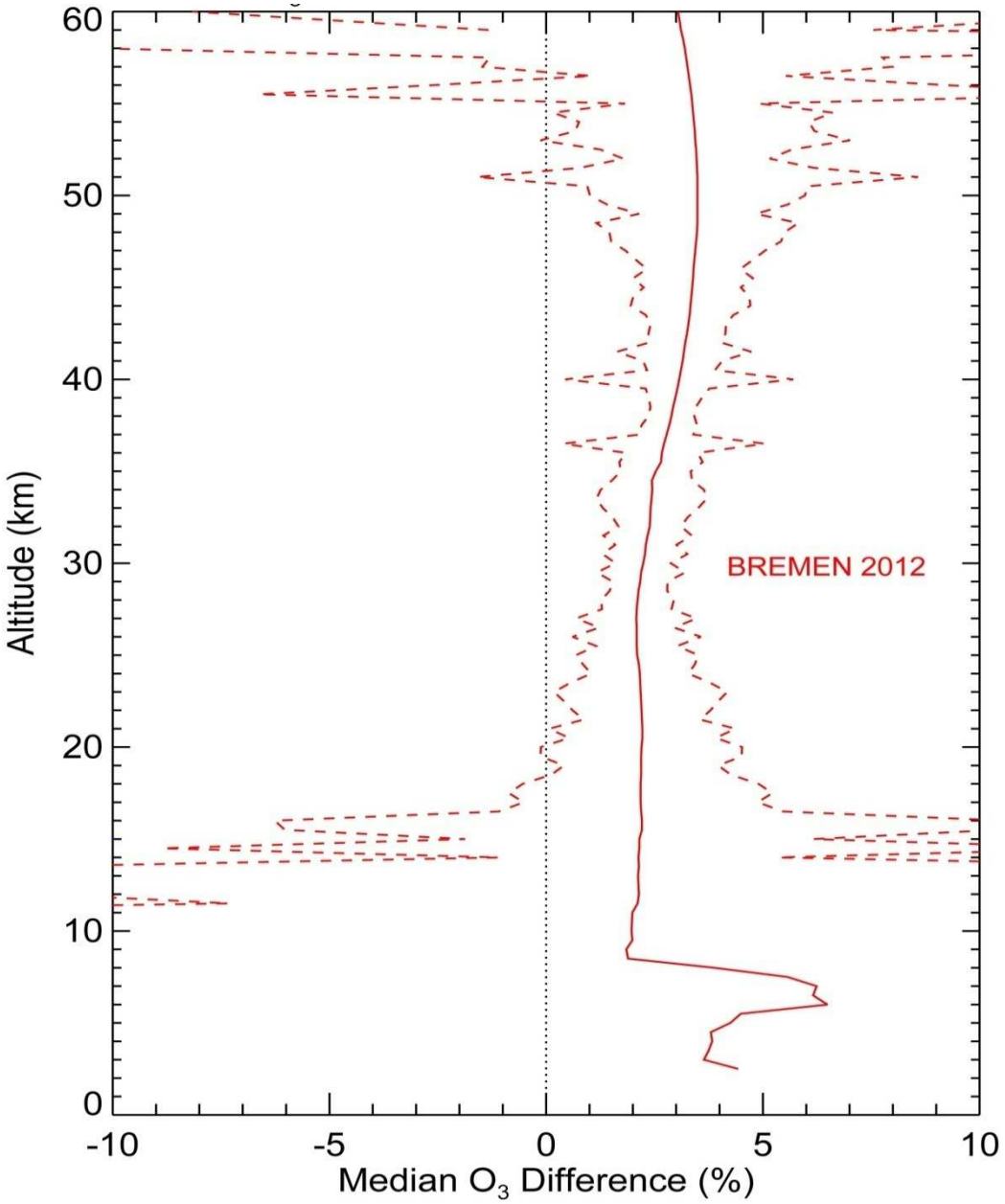
- Retrieval based on measurements from three channels near Hartley band: 284, 290, and 296 nm
- BP, BDM, and SCIAMACHY v3 differences at these wavelengths within ±2% with similar temperature dependence
  - Leads to ±2% differences in retrieved mesospheric ozone values
  - SAGE III mesospheric ozone product has not been validated to sufficient accuracy levels to comment on quality of various cross section datasets
- Impact of Bremen 2012 cross sections on mesospheric O_3 has not yet been evaluated
  - Mesospheric O_3 is low priority product for SAGE III Meteor 3M
  - UV channels on SAGE III/ISS instrument will have limited lifetime due to expected contamination issues

Impact of Cross Sections on Primary SAGE Ozone Product (Chappuis)



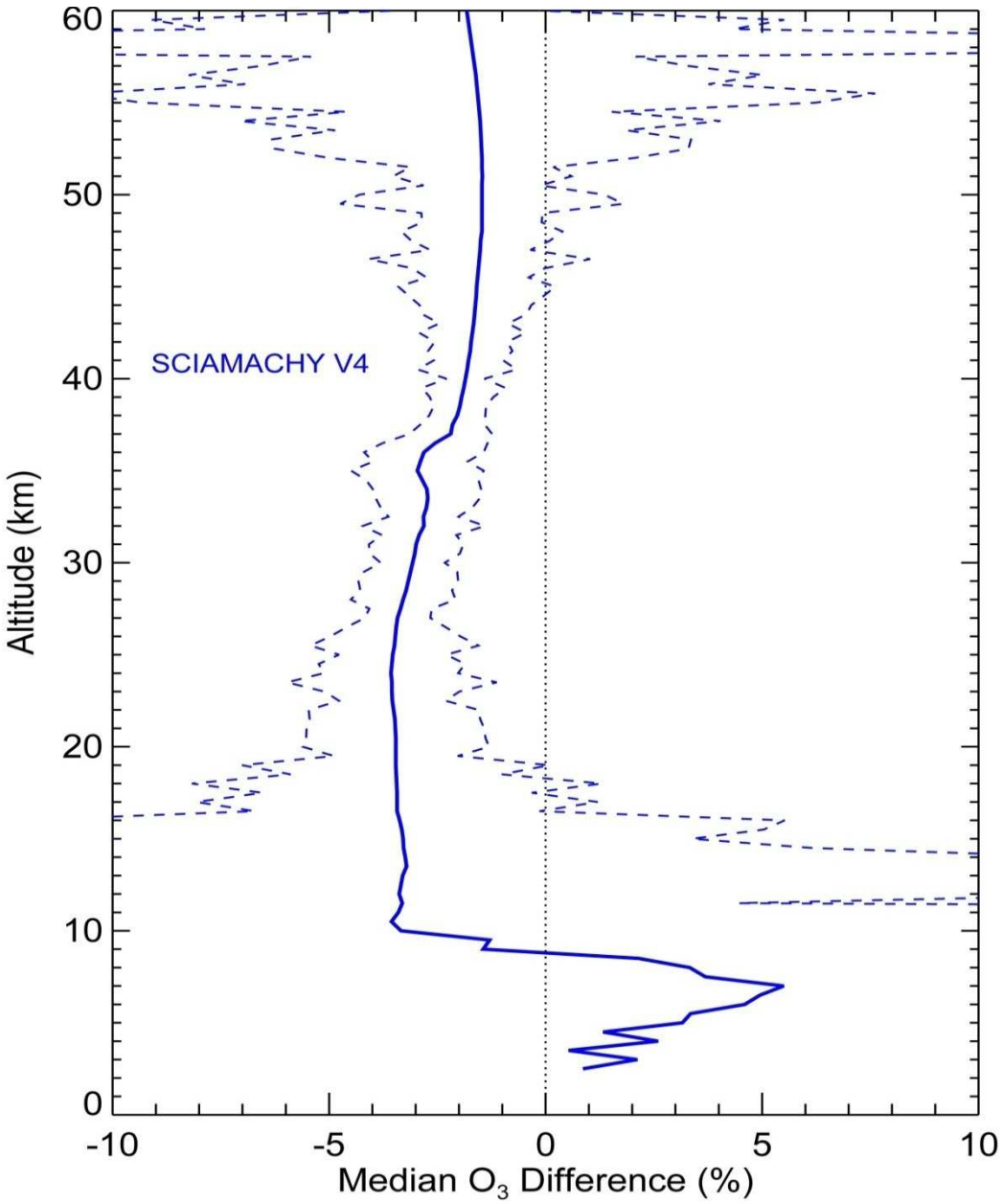
- Retrieved O_3 optical depth dependent on 600/525 differential cross section
- Subsequent number density dependent on magnitude of 600 nm cross sections

Bremen 2012 Cross Sections versus SAGE II v7



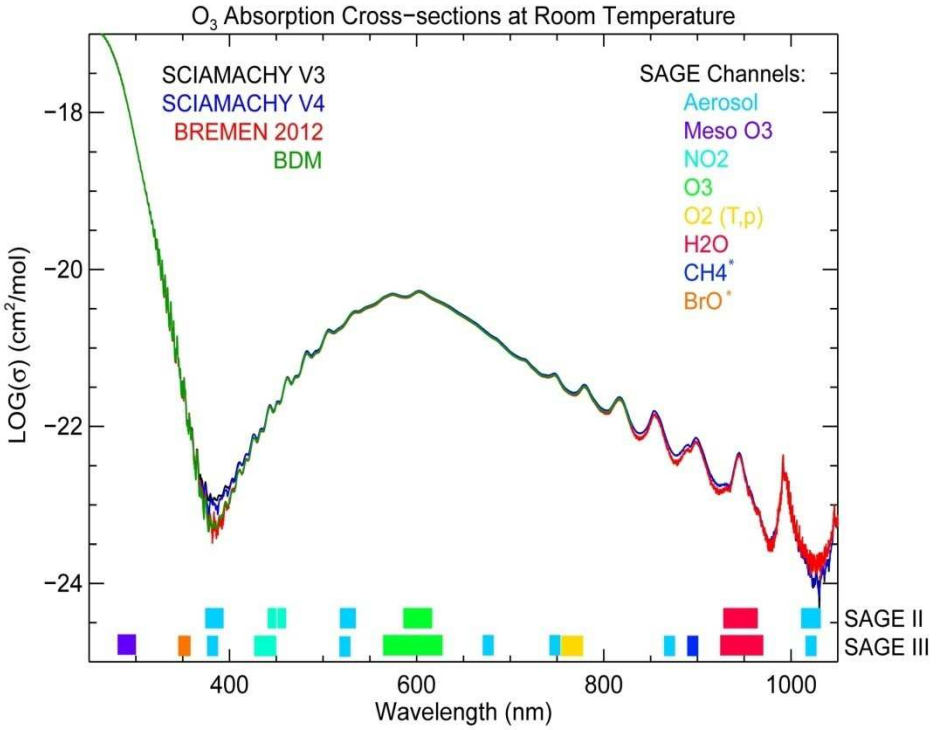
- 600/525 differential cross section decreases
- 600 nm cross section decreases ~4%
- Ozone number densities ~2-3% larger than SAGE II v7
- Expect similar changes to SAGE III ozone

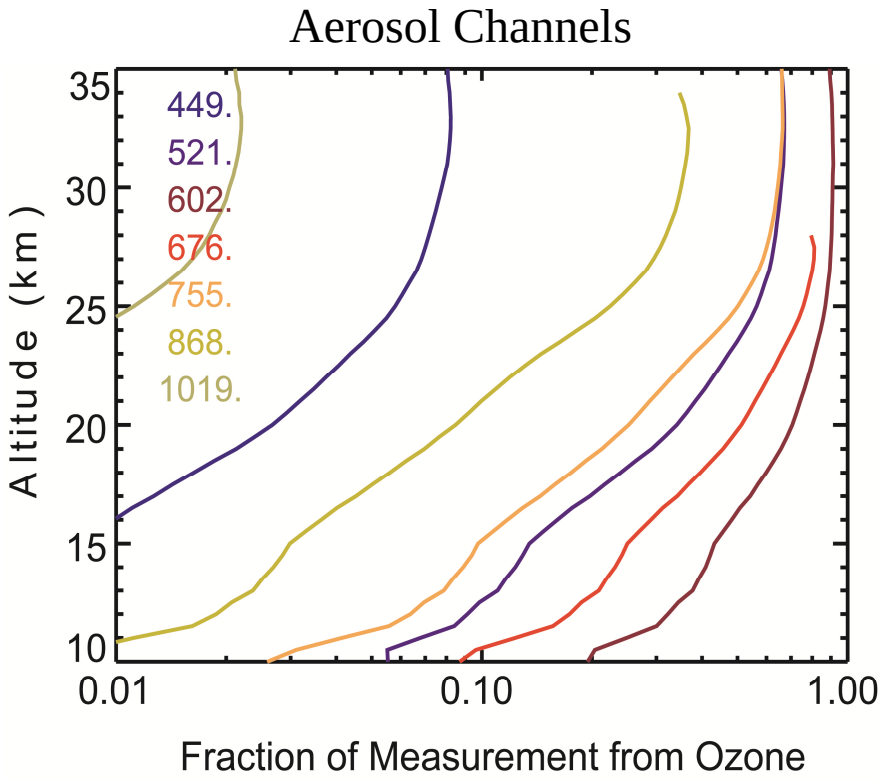
SCIAMACHY v4 Cross Sections versus SAGE II v7



- 600/525 differential cross section decreases
- 600 nm cross section increases ~2%
- Ozone number densities ~2-4% smaller than SAGE II v7
- Expect similar changes in SAGE III ozone

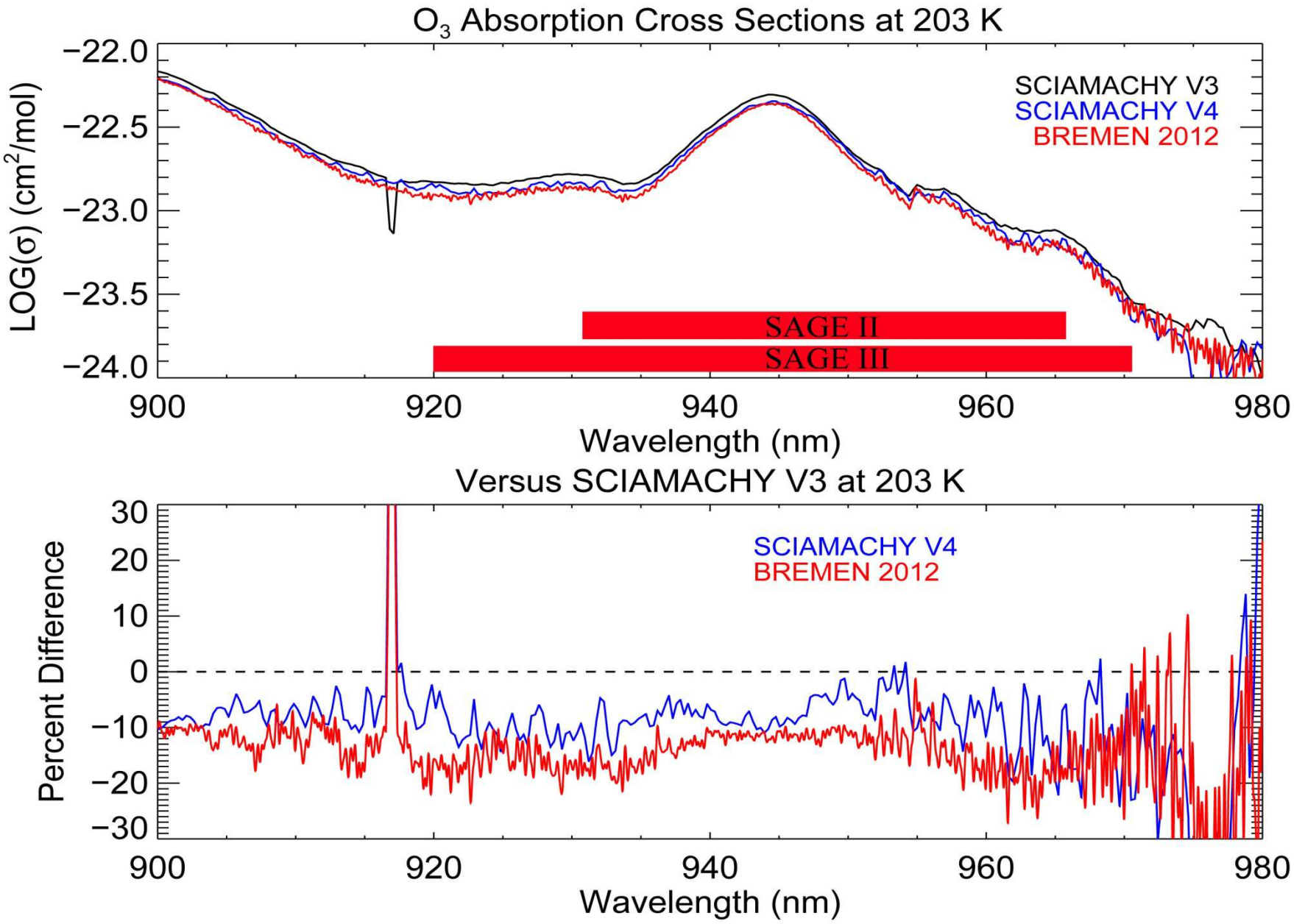
Ozone is Interfering Species in Aerosol and Gas Species Channels



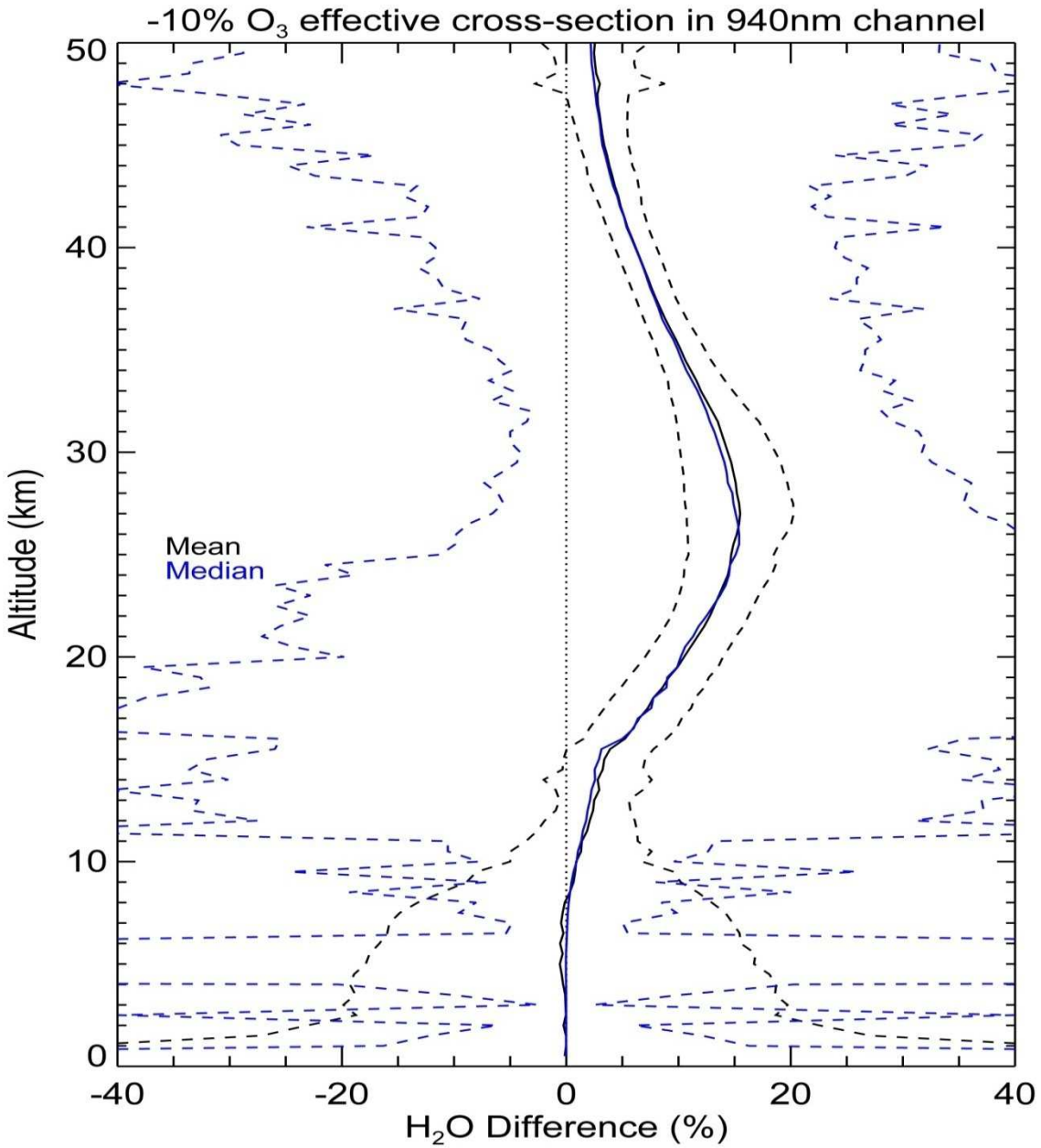


- Accurate knowledge of O_3 cross sections critical to success of aerosol, H_2O, NO_2, and T/p retrievals
- O_3 can be significant component in aerosol channels
- O_3 signal comparable to H_2O in 940 nm band (stratosphere)

Wulf Band Cross Sections near 940-nm H_2O Feature



Impact of Ozone Cross Sections on SAGE H_2O Products



- SAGE II H_2O directly impacted by changes in ozone cross sections
- SAGE III H_2O more dependent on getting the shape correct

Summary

- SAGE II/III processing needs self-consistent ozone cross section dataset covering ~280-1030 nm spectral range
- SCIAMACHY v3 (Bogumil) cross sections adopted for SAGE II v7 and SAGE III v4 processing
- Switch to Bremen 2012 cross sections would result in ~3% increase in primary O_3 profile product (Chappuis)
  - Potentially significant impact on H_2O (SAGE II change >10%)
  - Small impact on aerosol and NO_2
- BP or BDM cross sections not optimal since they don't cover complete spectral range
- SCIAMACHY v3/v4 differences are a concern
- Additional laboratory measurements needed to reduce uncertainty in visible and NIR cross sections (especially Wulf bands)