

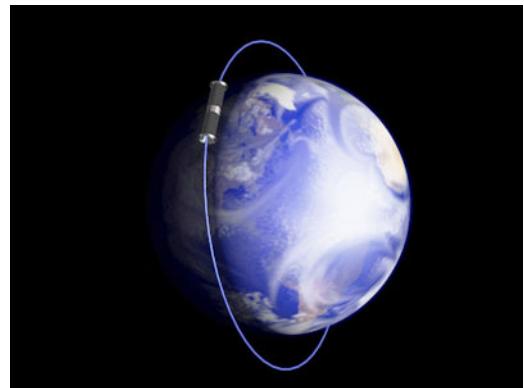
OSIRIS on Odin : Evaluation of the Ozone Cross Section

Ozone Theme Meeting
March 24, 2010

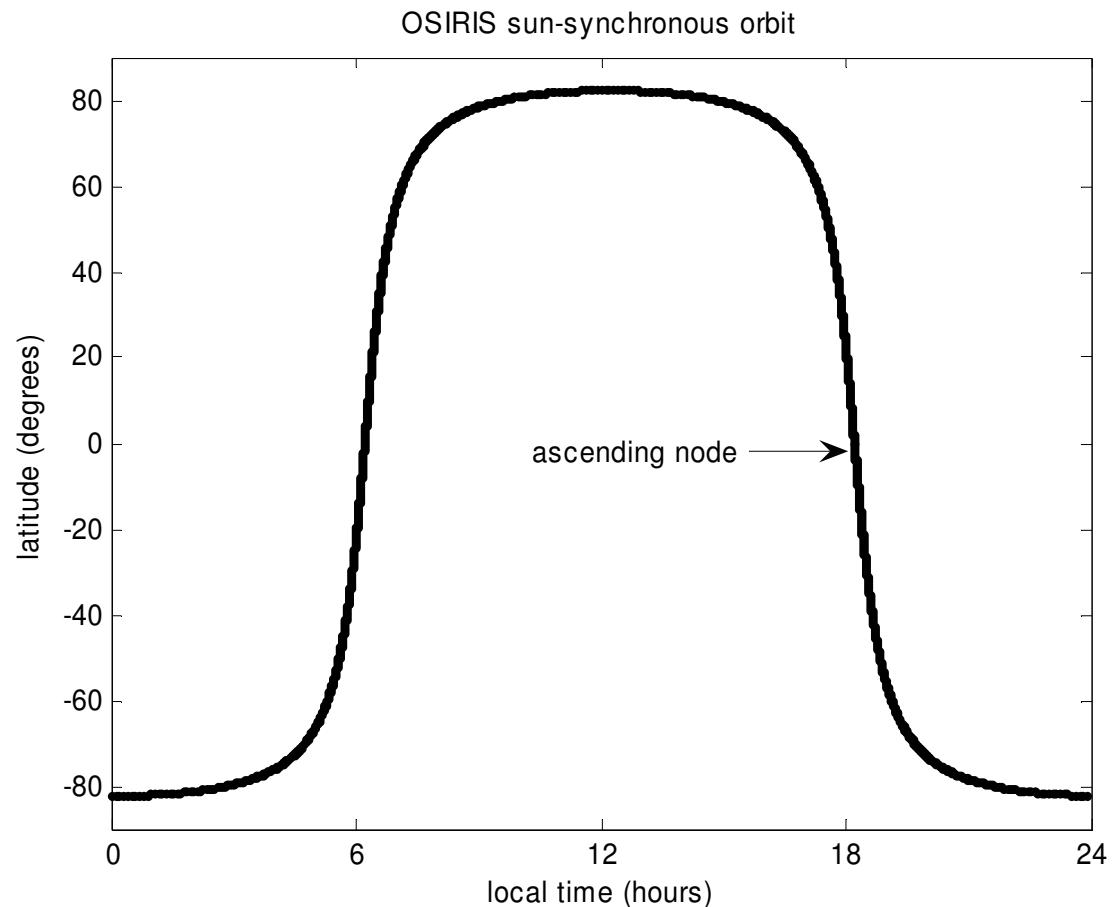
Geneva, Switzerland



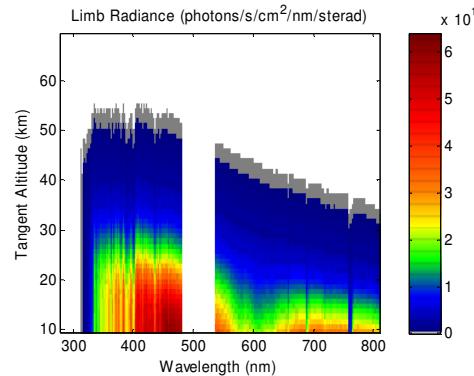
Odin - A Swedish led ESA Third Party Mission



- sun-synchronous
- near-terminator
- 98 degree inclination
- 1800h ascending node
- 0600h descending node
- 96 minute period
- 600 km altitude

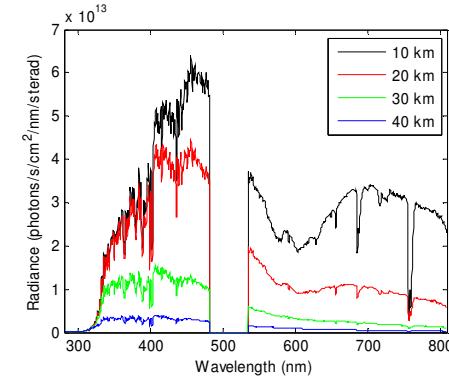


Optical Spectrograph and Infra-Red Imager System (OSIRIS)



1) Optical Spectrograph

- Single line of sight along satellite track
 - Narrow horizontal slit (1 arc minute)
- Grating spectrograph
 - 280-810 nm, 1 nm resolution
- Measures spectrum of scattered sunlight
 - Tangent altitudes 0 to 100 km
 - Odin moves to point OSIRIS



2) Infrared Imager

- Three channel filtered vertical imager
 - 1.26 and 1.27 micron Singlet Delta O₂
 - 1.53 micron OH Meinel

O₃ Dust
Forest Fires

Noctilucent Clouds

The Aurora

OH



NO
NO₂
BrO

Sodium

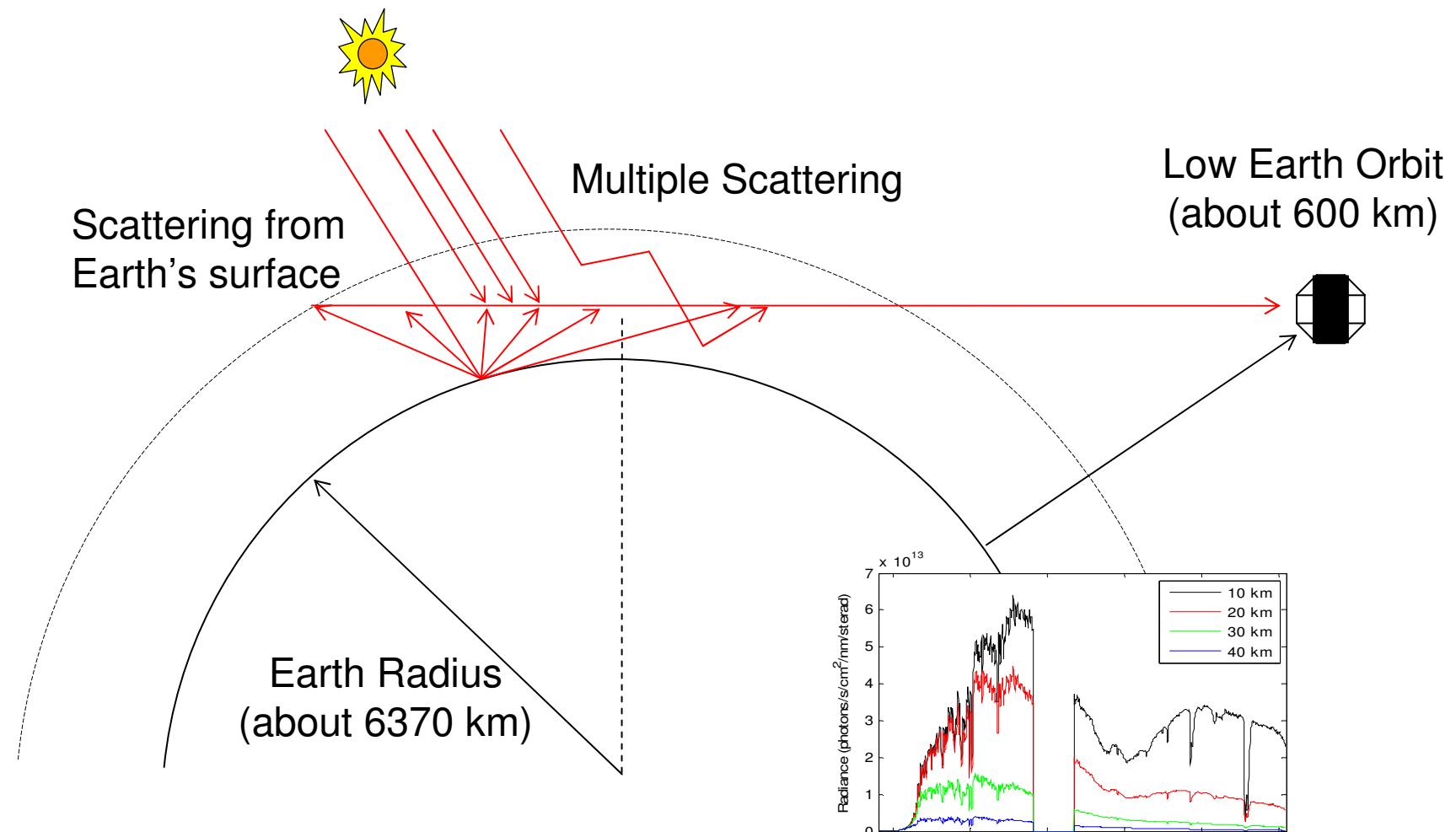
Sulphate Aerosol

Subvisual Cirrus



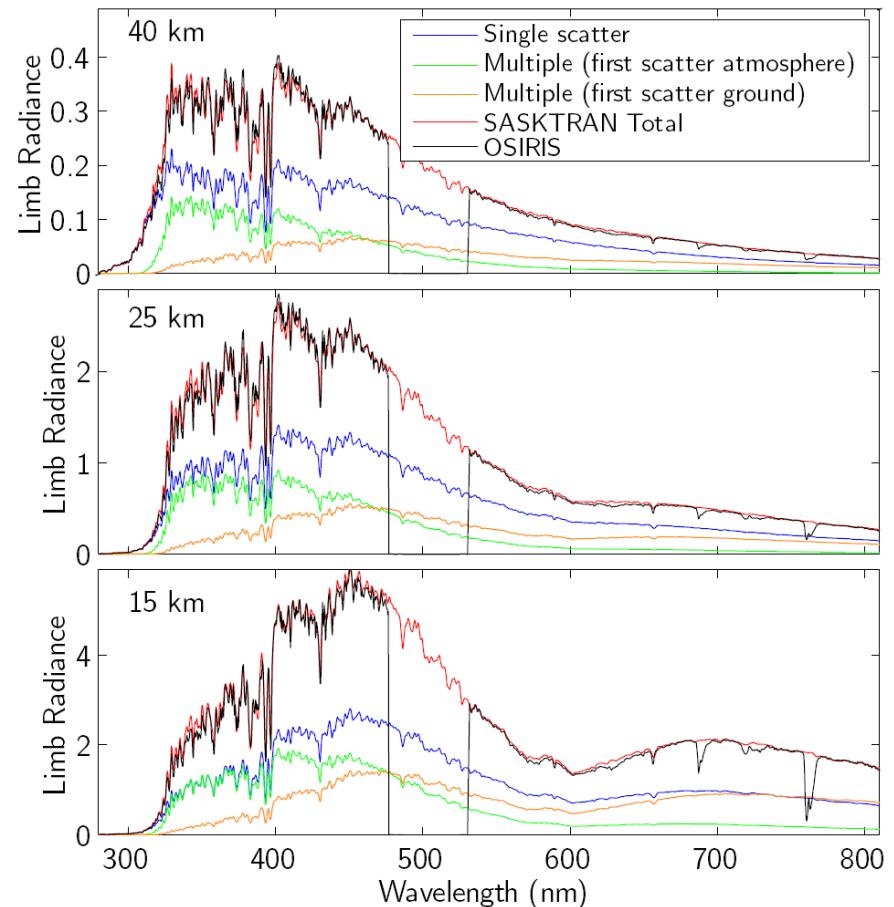
Limb Scattering

A measurement of the intensity of sunlight scattered from the atmosphere



SASKTRAN and OSIRIS Observations

- Retrieve effective scene albedo
- Retrieve stratospheric aerosol profile
- Retrieve the nitrogen dioxide profile
- Retrieve ozone profile
- Use the retrieved state profiles to model the measured spectra



Operational Data Products

There are three operational data products produced at the Odin OSIRIS Data Centre in Saskatoon:

- 1)Ozone – cloud tops up to 55 km
- 2)Nitrogen Dioxide – cloud tops up to 40 km
- 3)Stratospheric Sulphate Aerosols – tropopause up to 30 km

There are other regularly retrieved data products including:

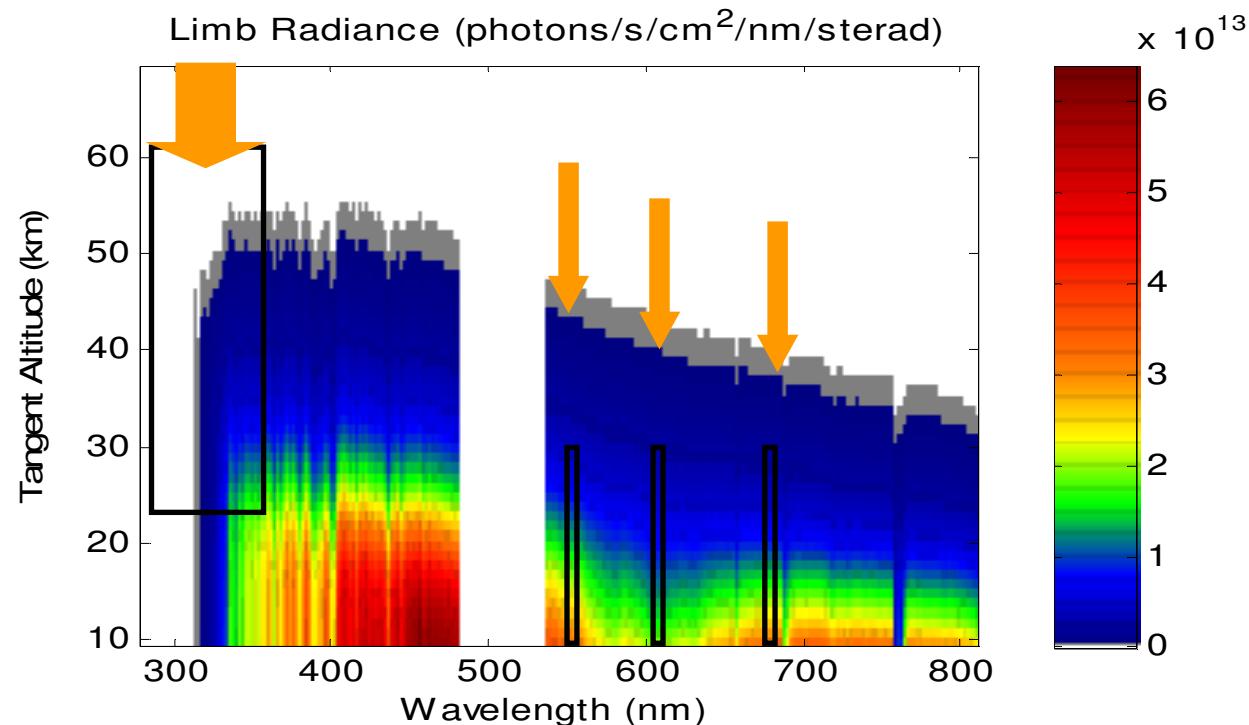
- 1)Bromine Oxide – 20 to 32 km

There are a number of research grade data products:

sodium, ground state hydroxyl, mesospheric ozone, mesospheric temperature, water vapour, atomic oxygen, atomic hydrogen, nitric oxide, ...



Ozone



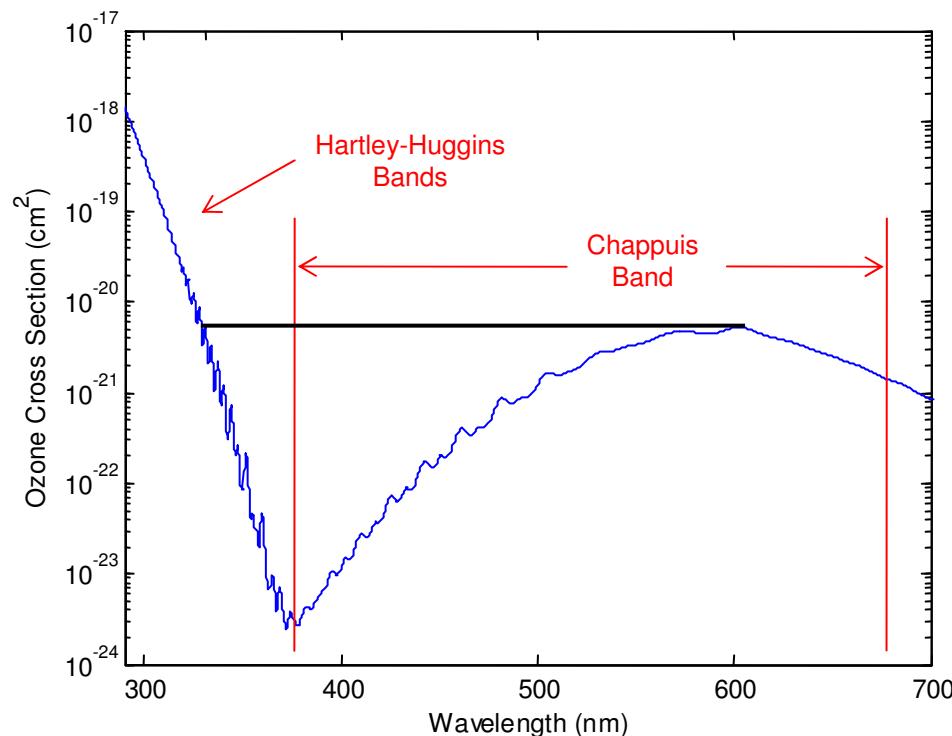
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Ozone: Limb Scatter Signature

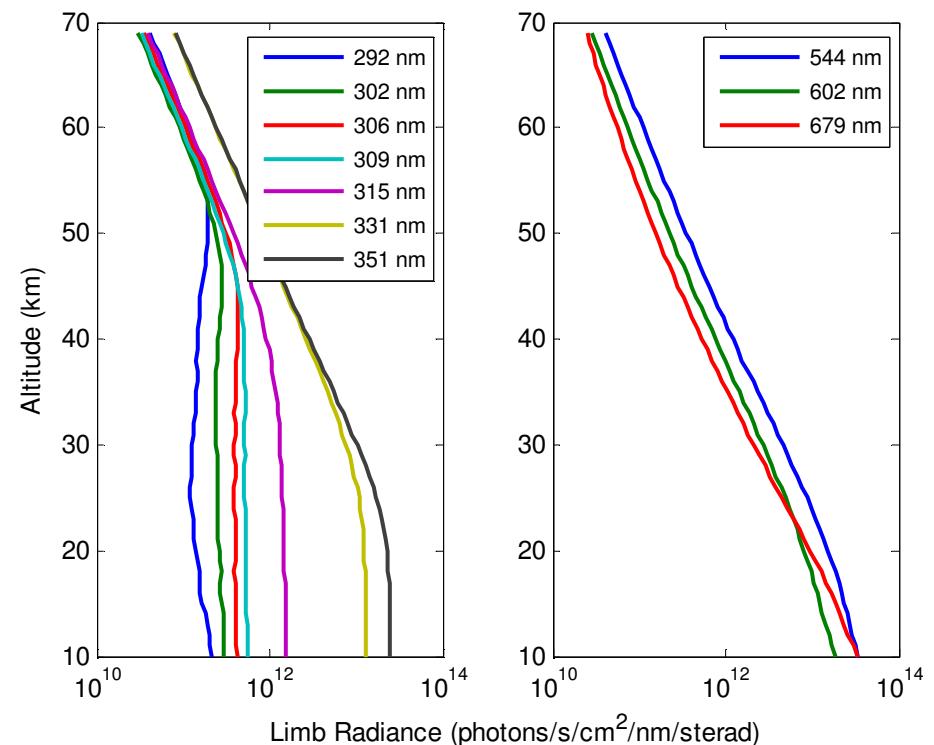
Ozone Retrieval at Optical Wavelengths

- UV wavelengths (Hartley-Huggins bands)
- Visible wavelengths (Chappuis bands)

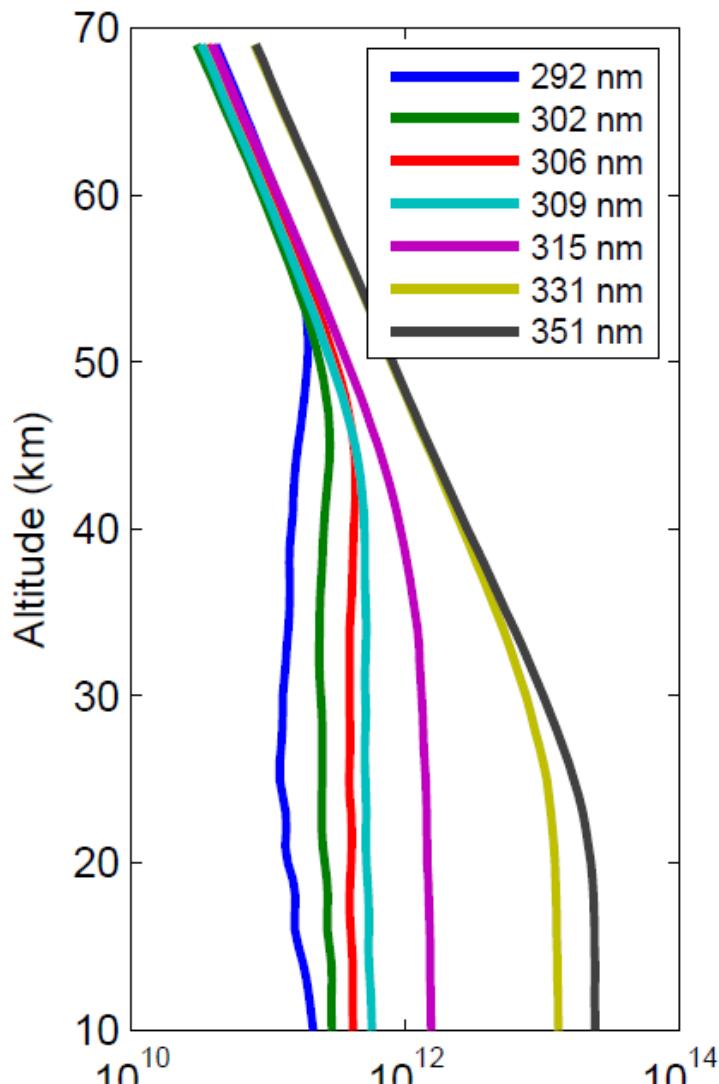


Limb Signature of Ozone

- Minimum altitude probed by a line of sight identified by a “knee” in the radiance profile (optically thick)



Ozone: Limb Scatter Signature



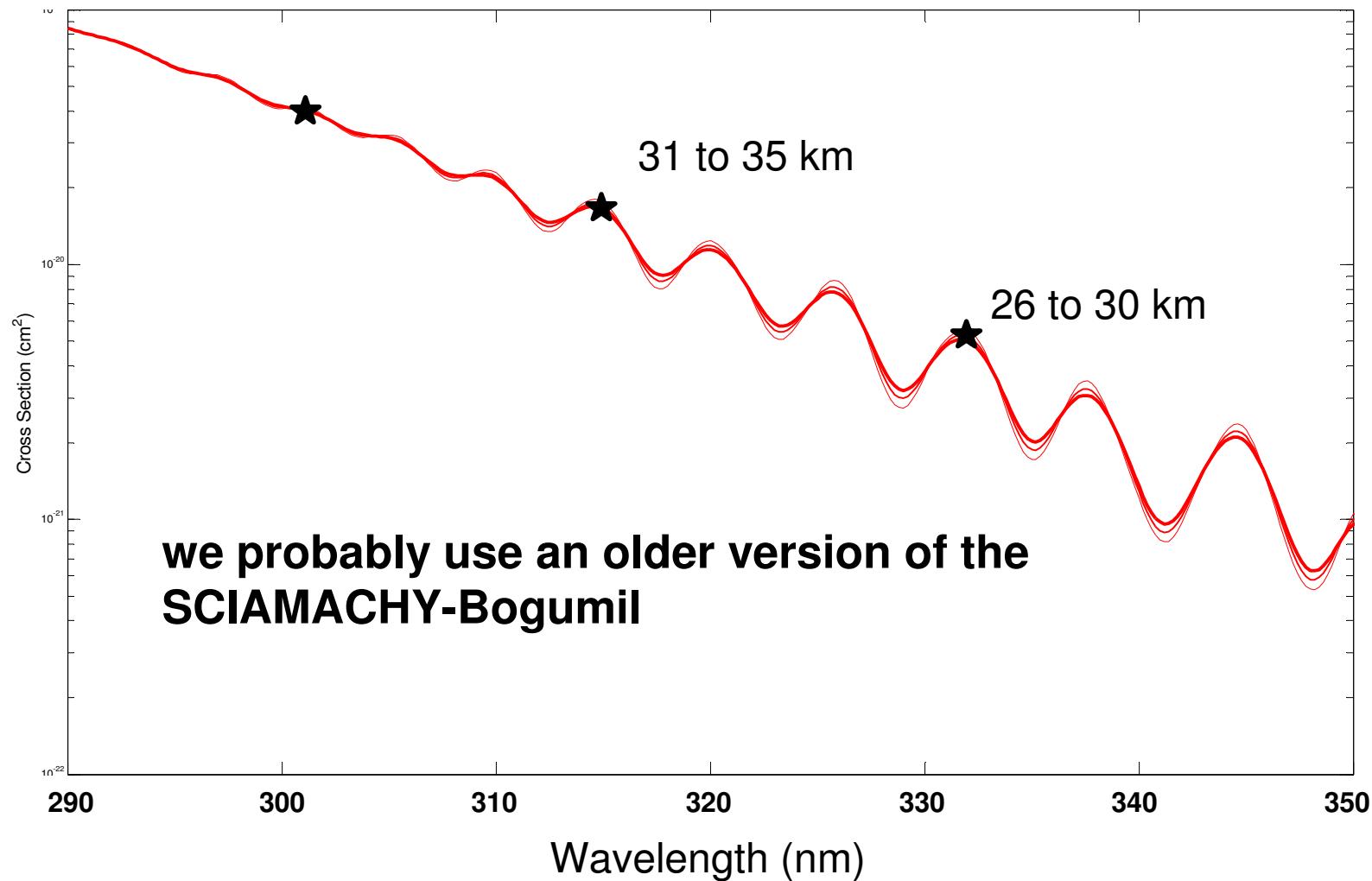
OSIRIS retrievals use the radiance in the altitude range between the knee and below the exponential decay.

$$\ln\left(\frac{\tilde{I}_{ref}}{\tilde{I}_{abs}}\right)$$



Odin-OSIRIS Ozone Retrieval Vectors

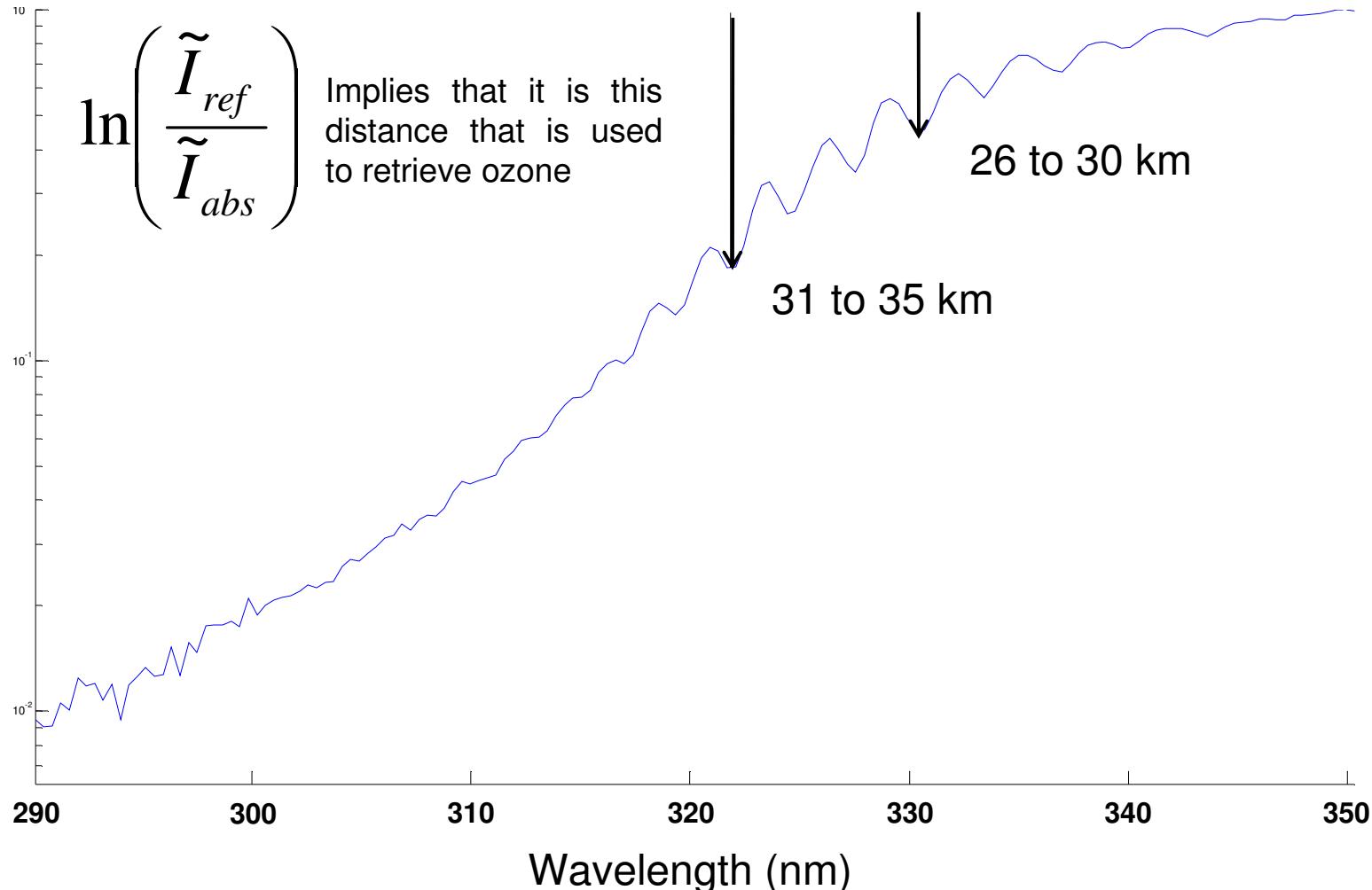
SB Convolved With Three Different Width Gaussians – Old Retrieval



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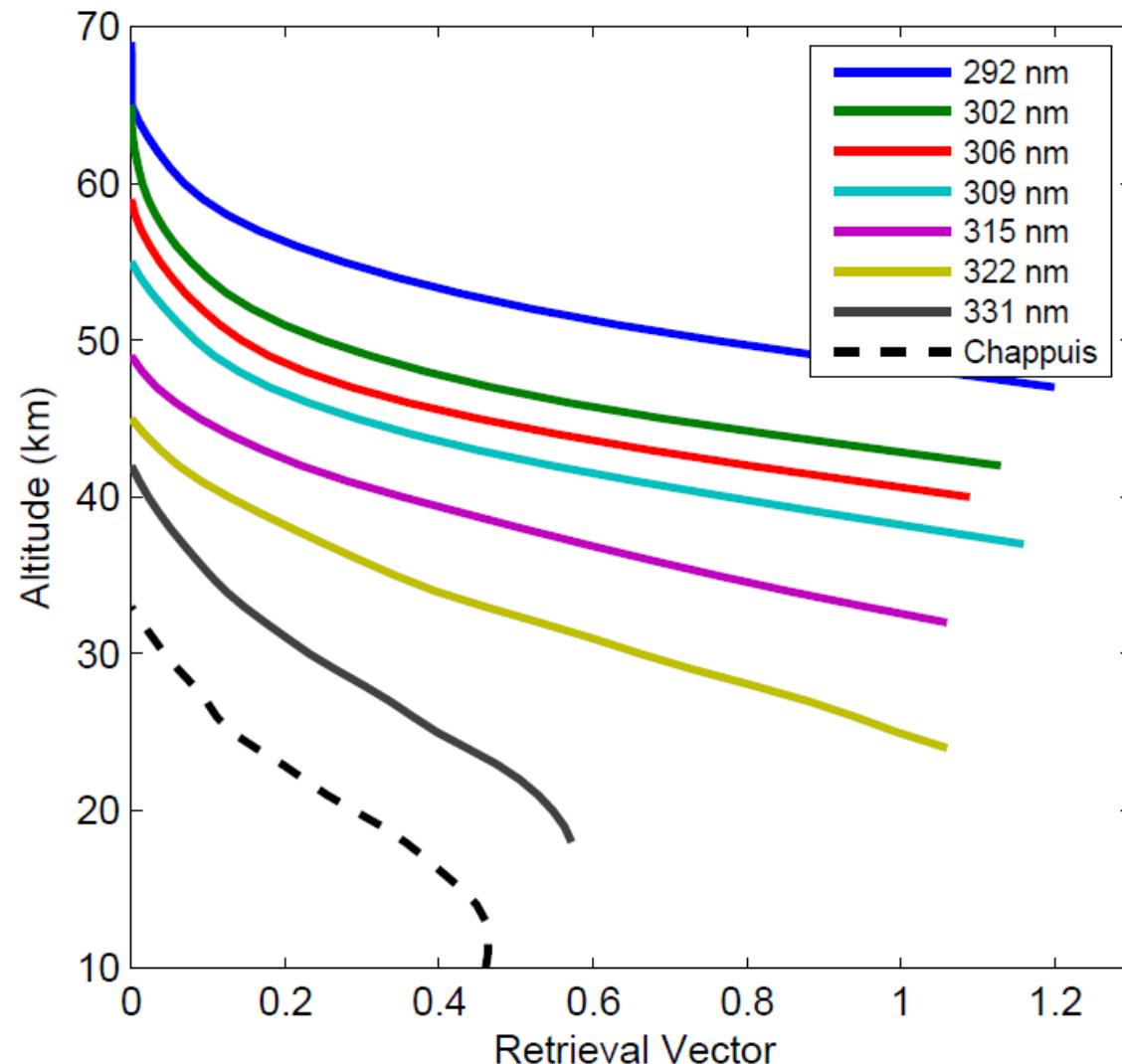
Normalized OSIRIS Spectrum at 30 km Tangent Altitude



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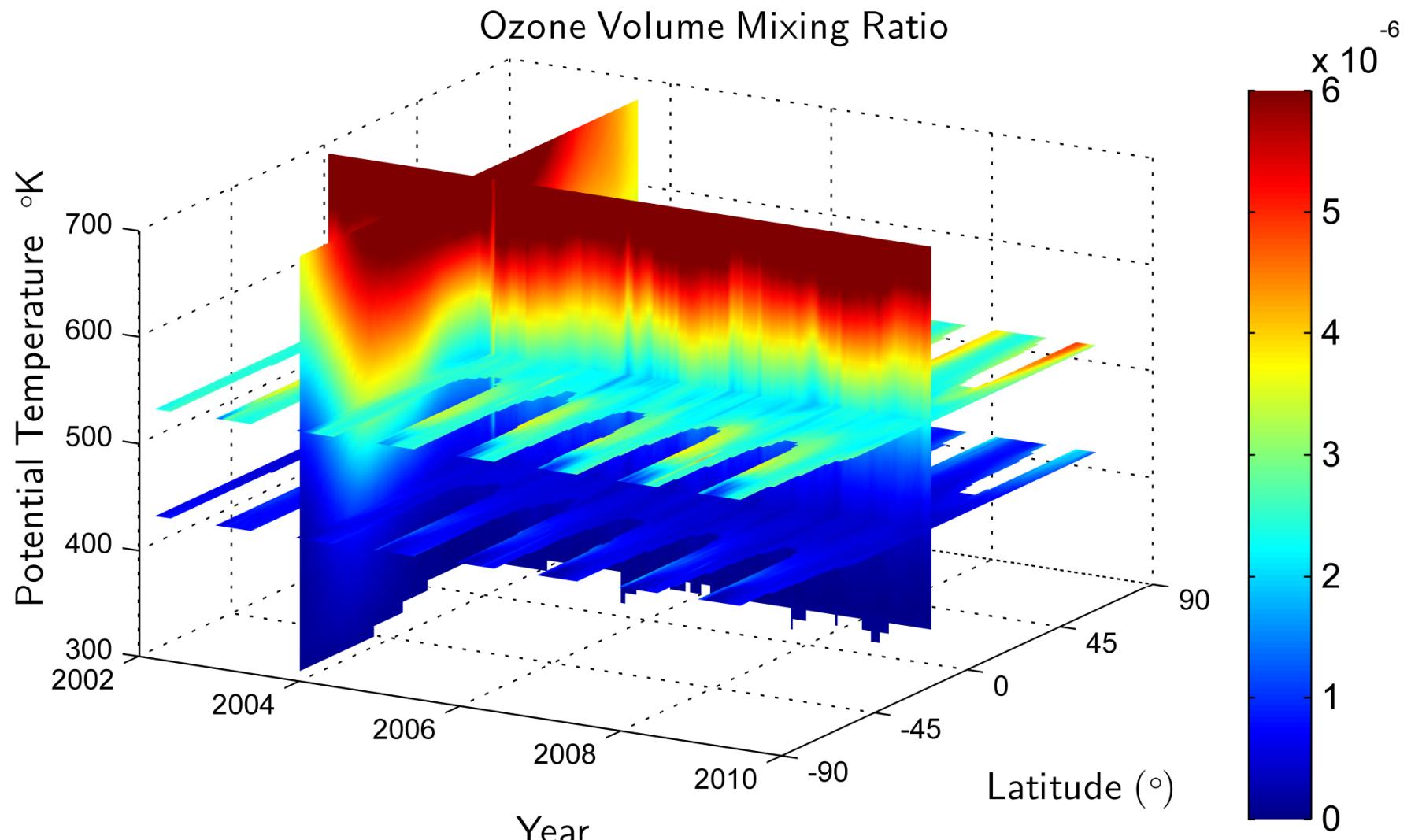
Odin-OSIRIS Ozone Retrieval Vectors



$$\ln\left(\frac{\tilde{I}_{ref}}{\tilde{I}_{abs}}\right)$$



OSIRIS Ozone Data Set

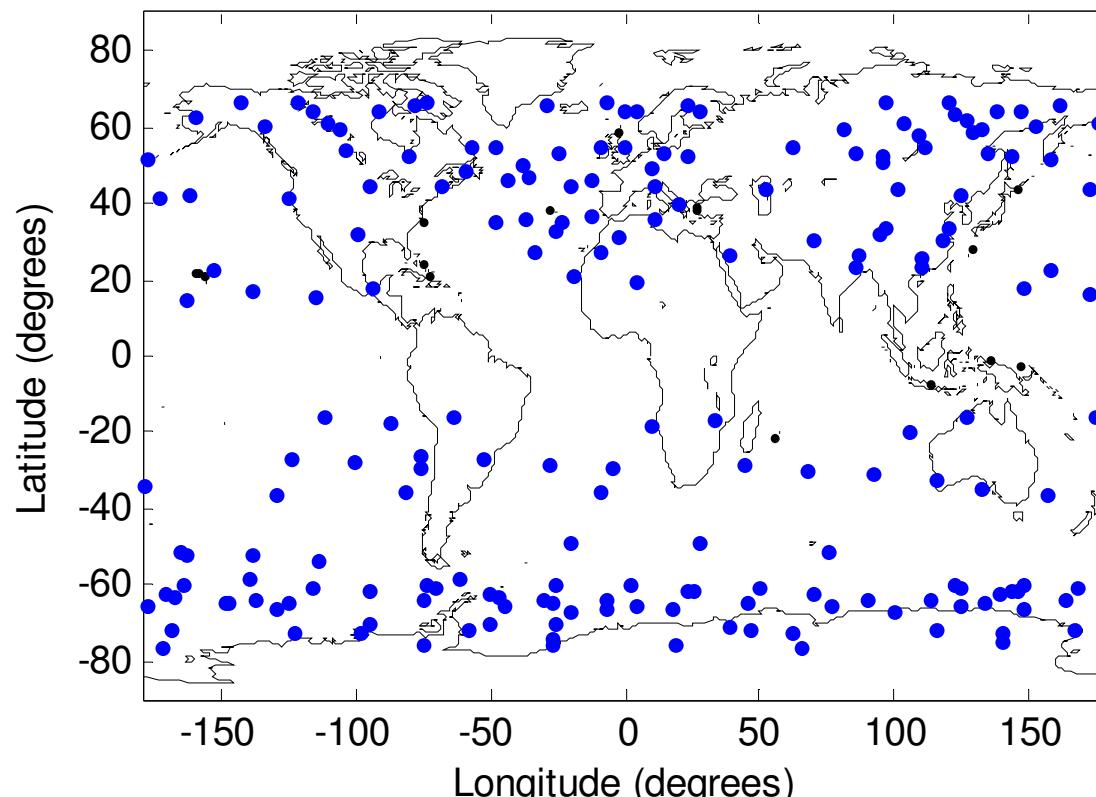


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Ozone: Odin-OSIRIS Comparison

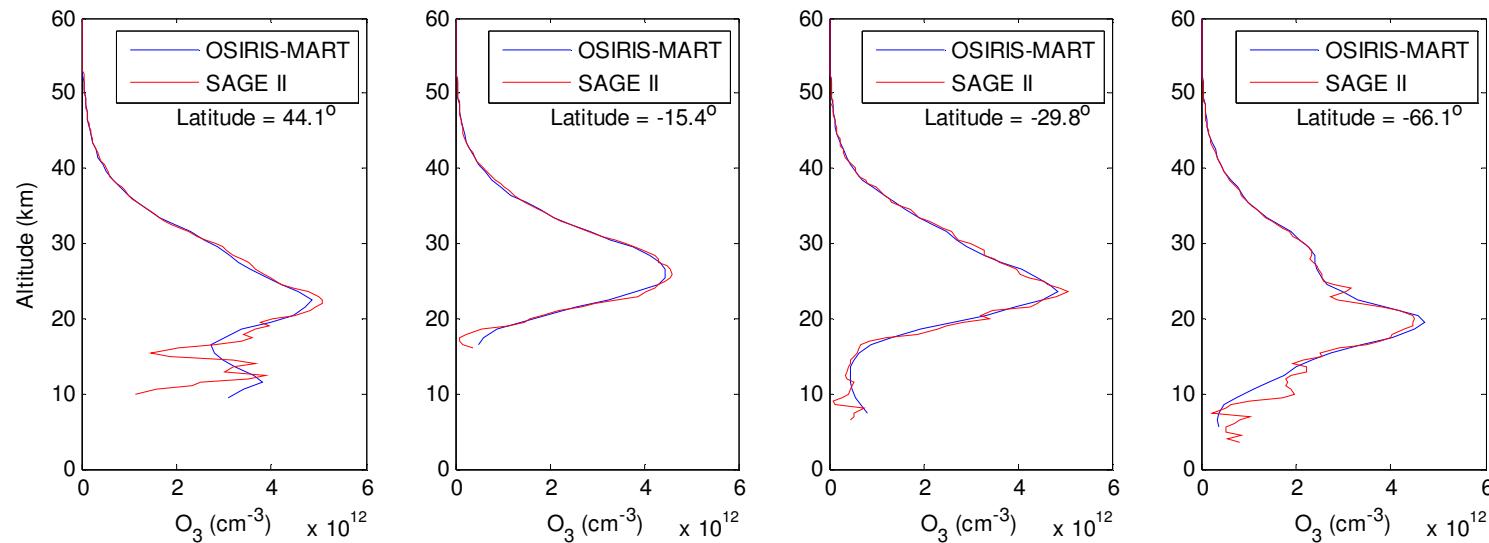
- SAGE II Ozone is the “Gold Standard” 1984-2005 (Langley Team)
- Four years of overlap with OSIRIS mission
- Coincidence criteria: 200 km, 2 hours
 - 196 measurement events



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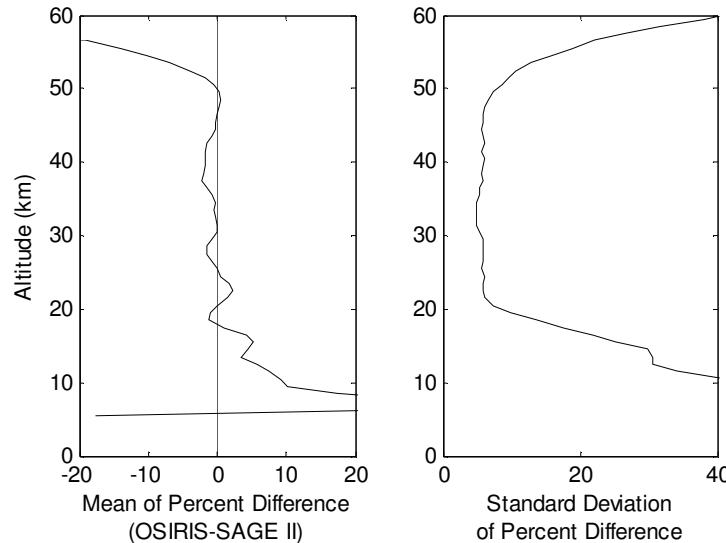
Ozone: Odin-OSIRIS Comparison



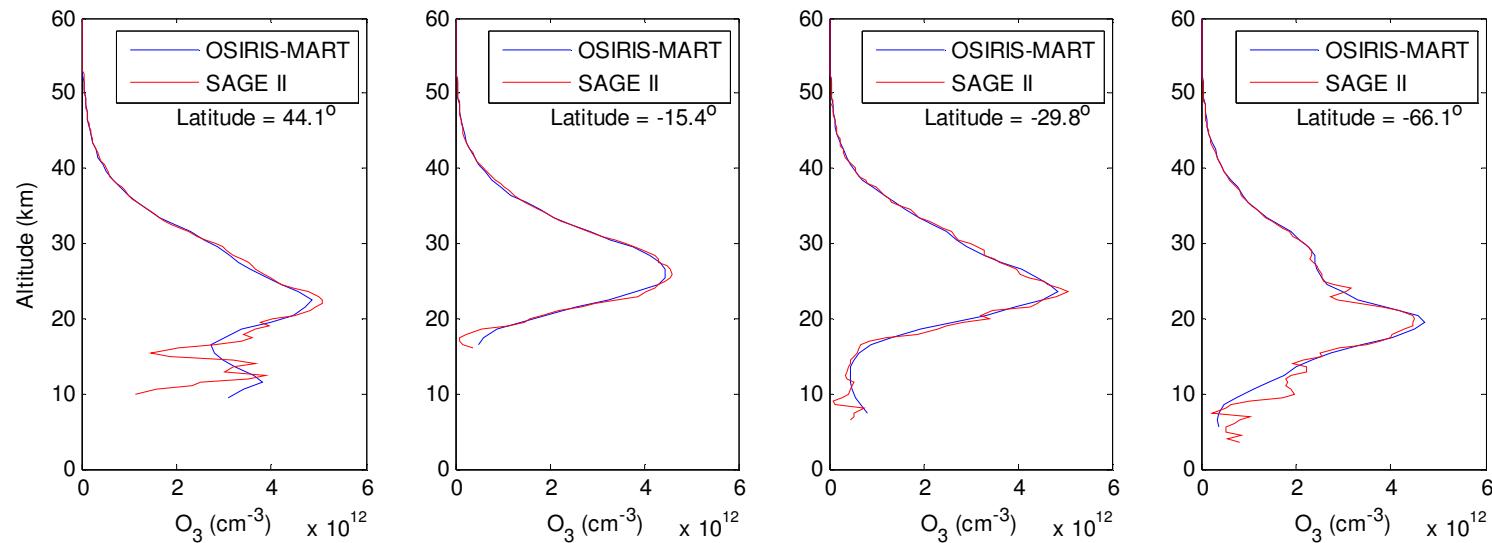
Individual profiles show main vertical structure is well captured, even at lowest altitudes

Statistics on the entire 196 profile set

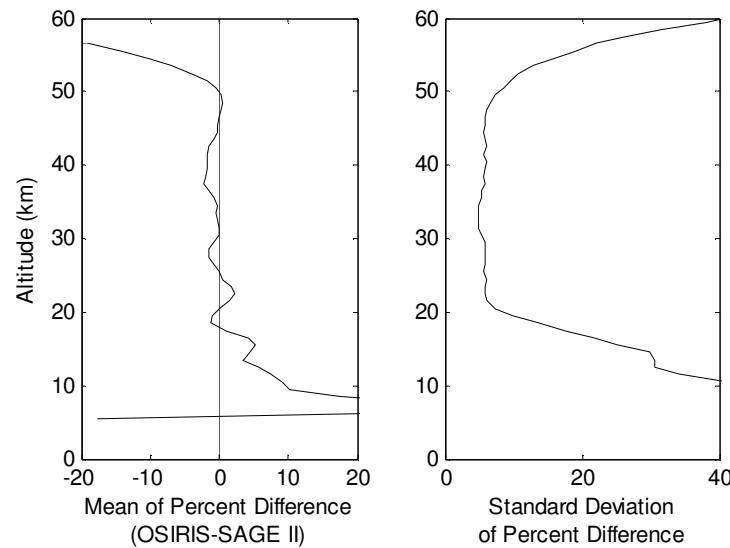
- Mean bias of <2% from 18-50 km
- Standard dev ~5% from 20-50 km



Ozone: Odin-OSIRIS Comparison

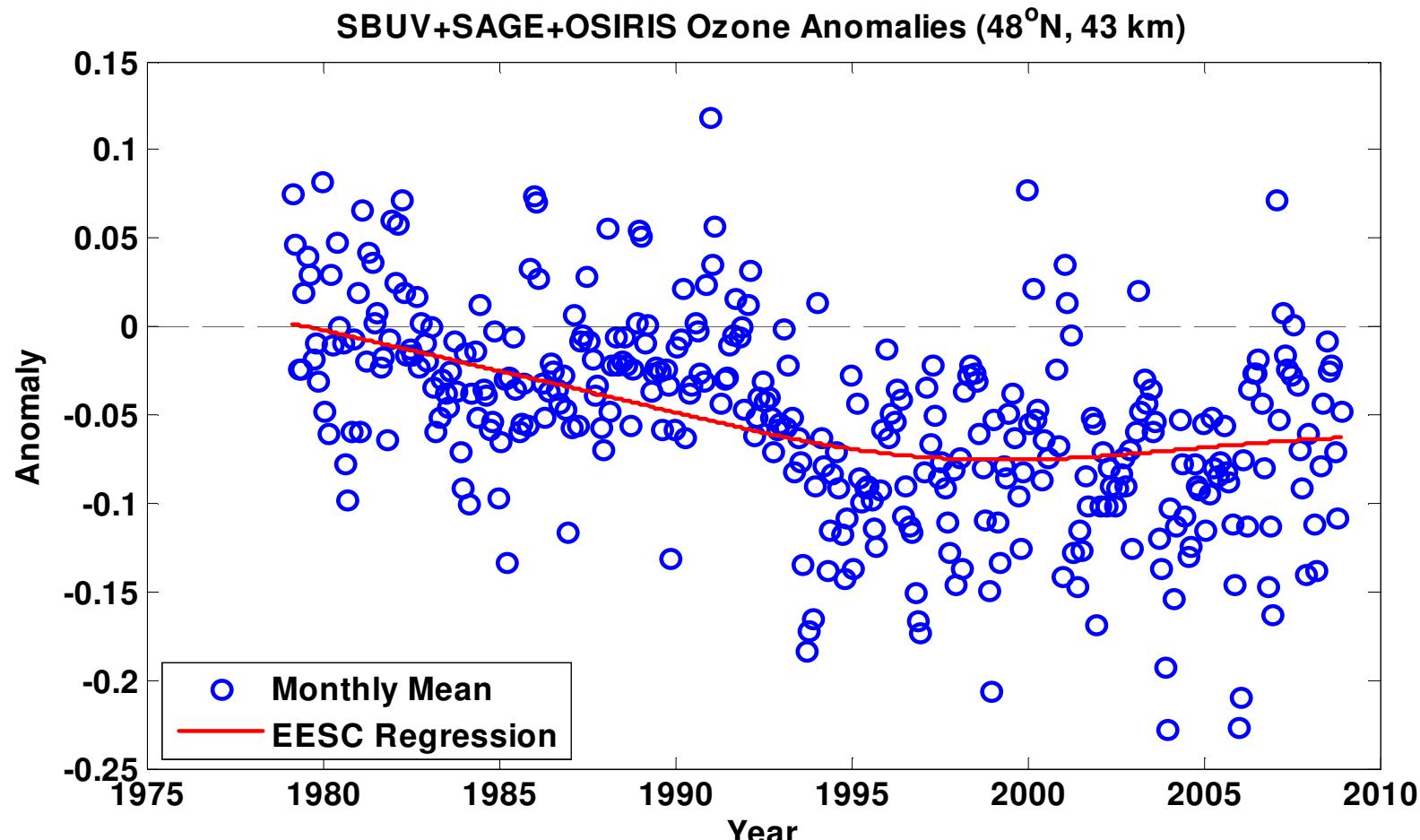


We are currently investigating a number of things that impact the solution on the order of a percent or two. These include: tangent altitude registration, polarization, curved rays, cross sections, improved aerosol retrieval, improved handling of clouds, two-dimensional radiative transfer modelling, temperature dependant slit width, etc.



Odin-OSIRIS Ozone Trend Analysis Done at Environment Canada

- Environment Canada scientists led by Chris McLinden are using the OSIRIS ozone data product (2001-2009) to extend the SAGE and SBUV time series

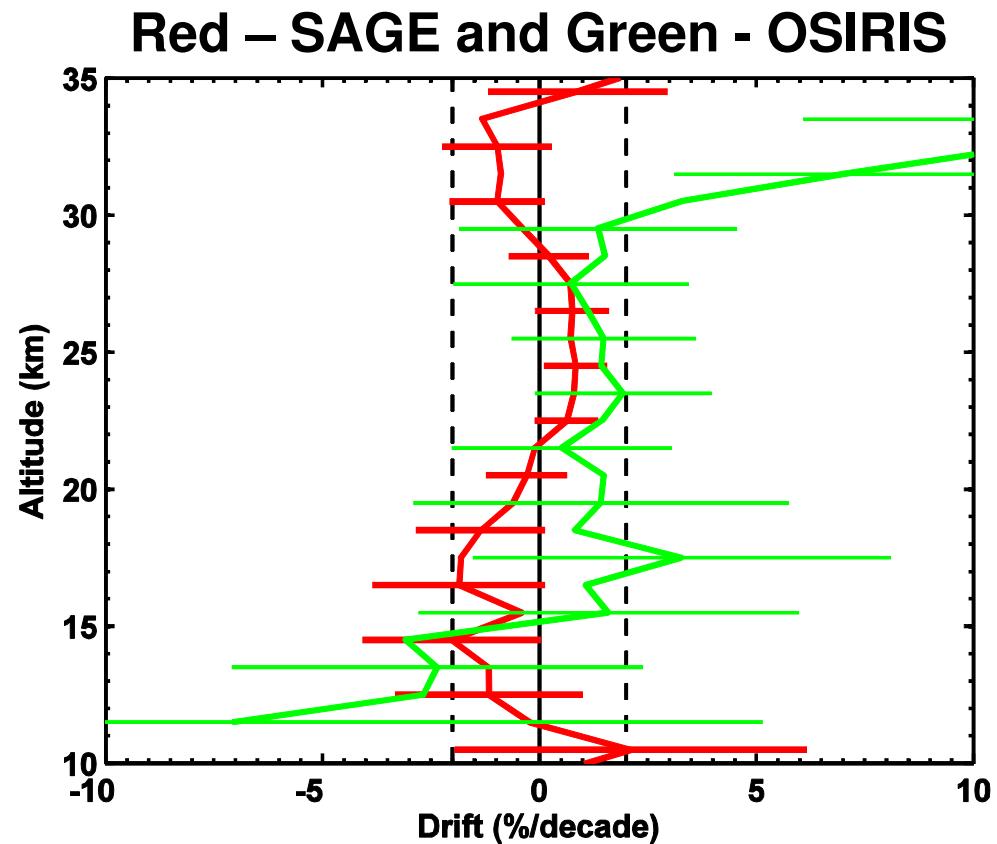
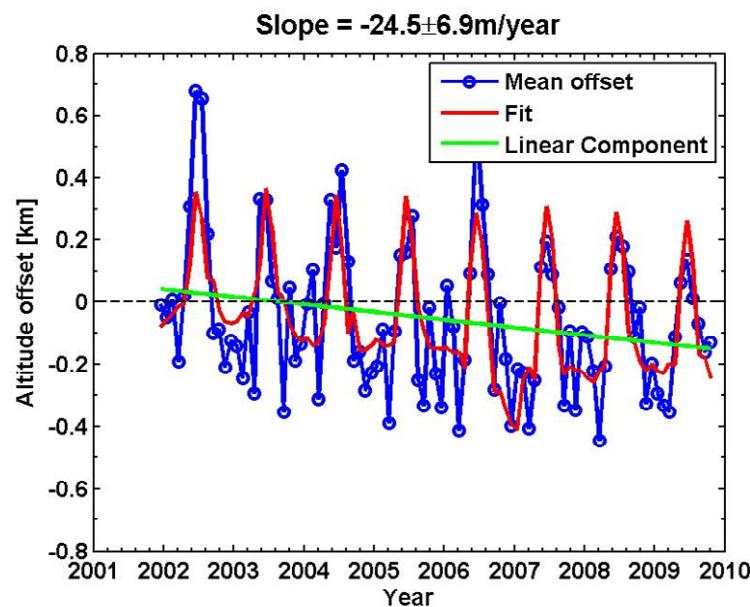


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Odin-OSIRIS Ozone Stability

- The precision and stability of the OSIRIS data plays a key role in extending the data record from 2005 to the present.



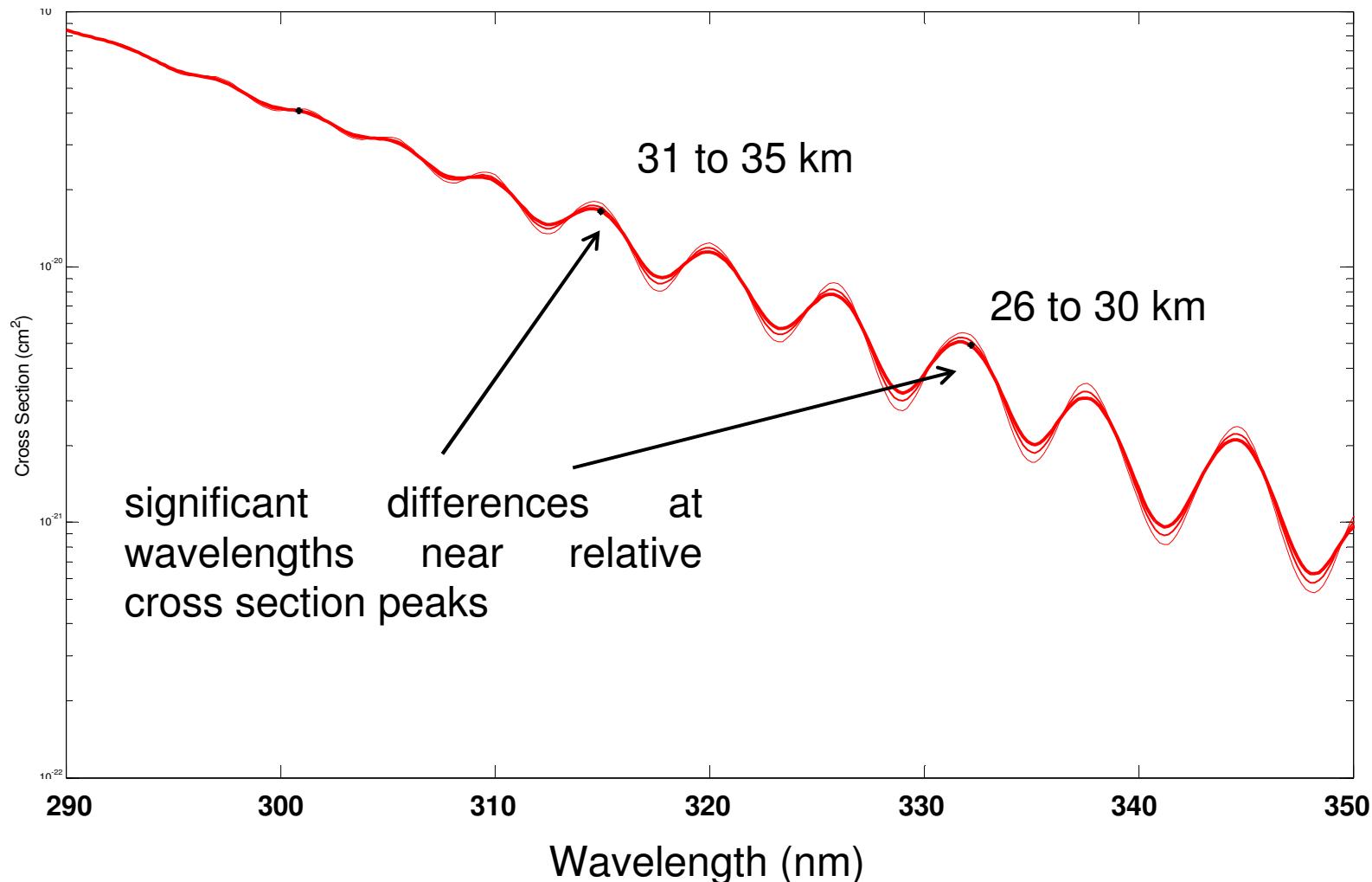
Work Done For This Meeting

- Modified wavelengths used for the retrieval
- Verified these were relatively insensitive to the assumed slit width by looking at an ensemble of retrievals
- Use the same ensemble of retrievals to estimate the impact of changing from SCIAMACHY-Bogumil to Bass-Paur to Daumont-Brion-Malicet



Odin-OSIRIS Ozone Cross Section Analysis

DBM Convolved With Three Different Width Gaussians – Old Retrieval

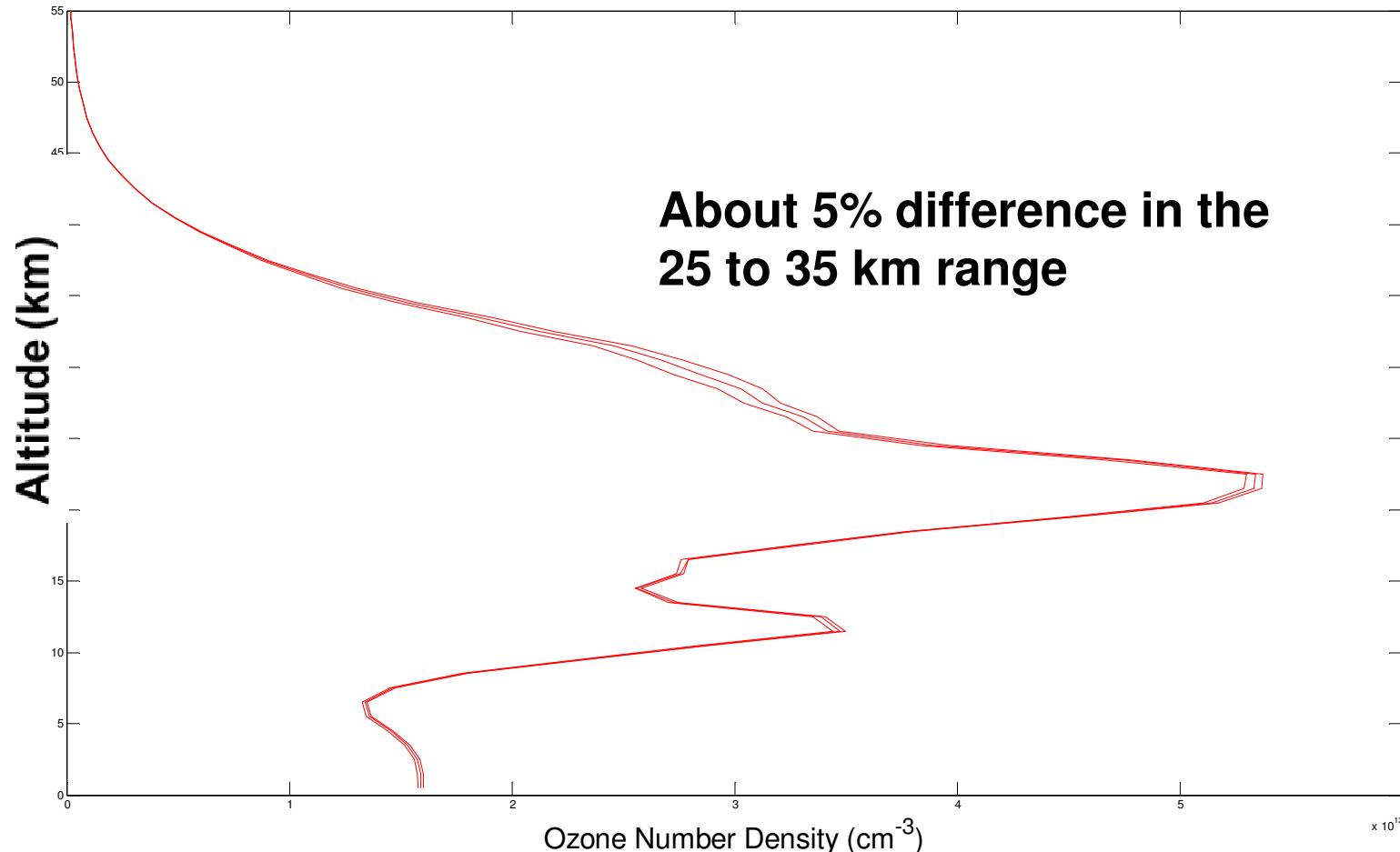


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Odin-OSIRIS Ozone Cross Section Analysis

Ozone Retrieved With DBM Cross Section at Three Resolutions (Old Wavelengths)

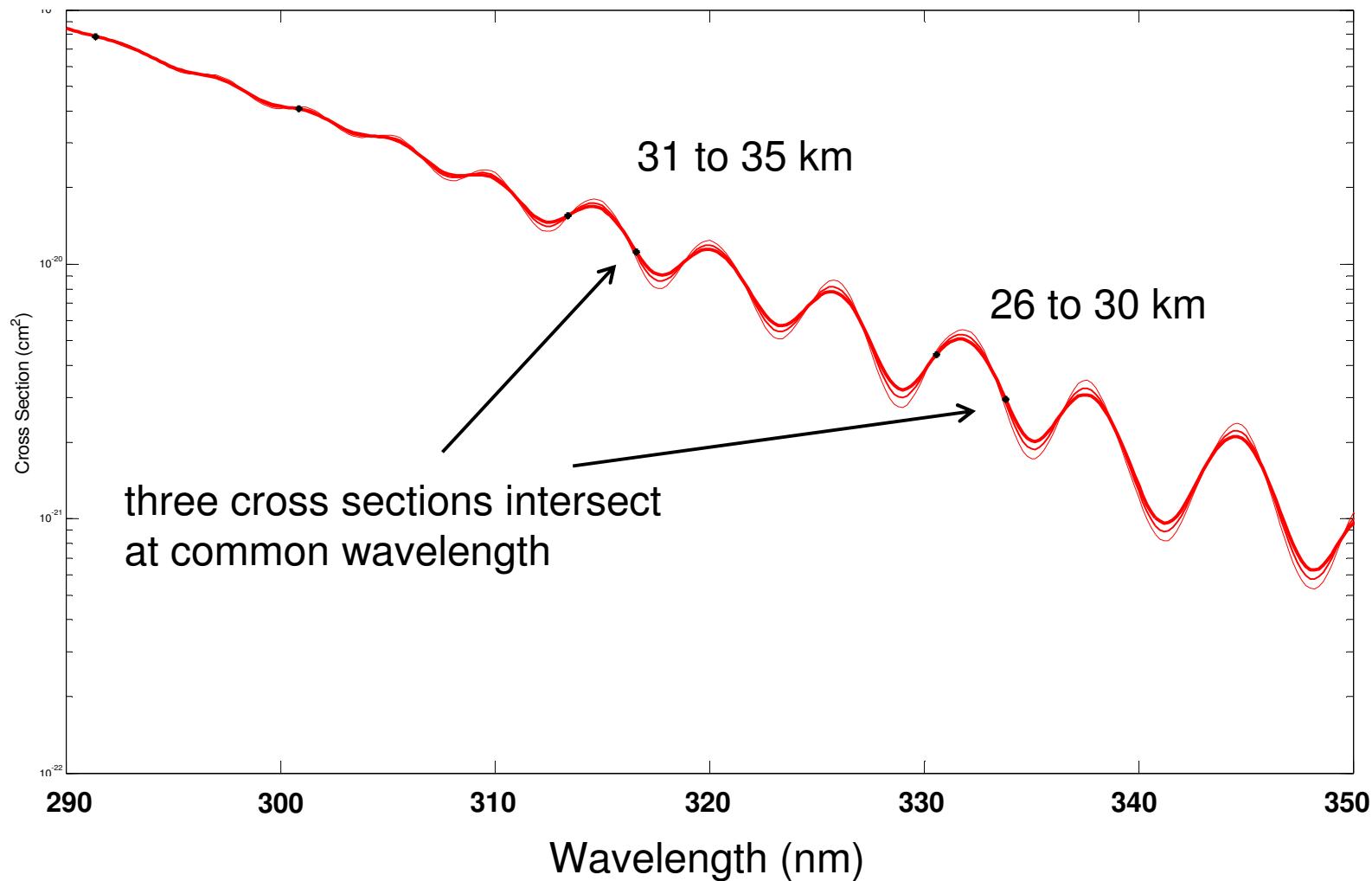


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Odin-OSIRIS Ozone Cross Section Analysis

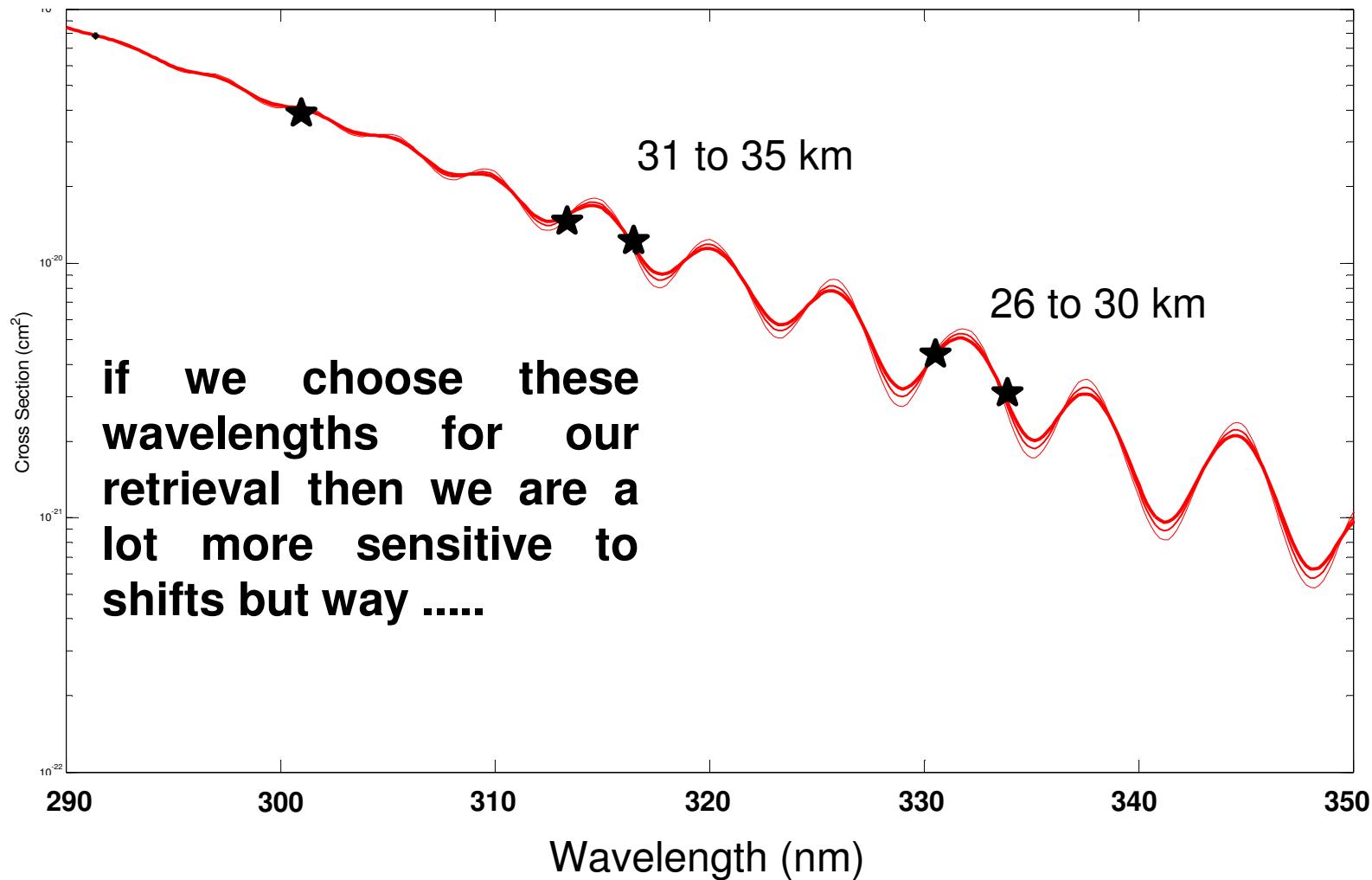
DBM Convolved With Three Different Width Gaussians – New Retrieval



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DBM Convolved With Three Different Width Gaussians – New Retrieval

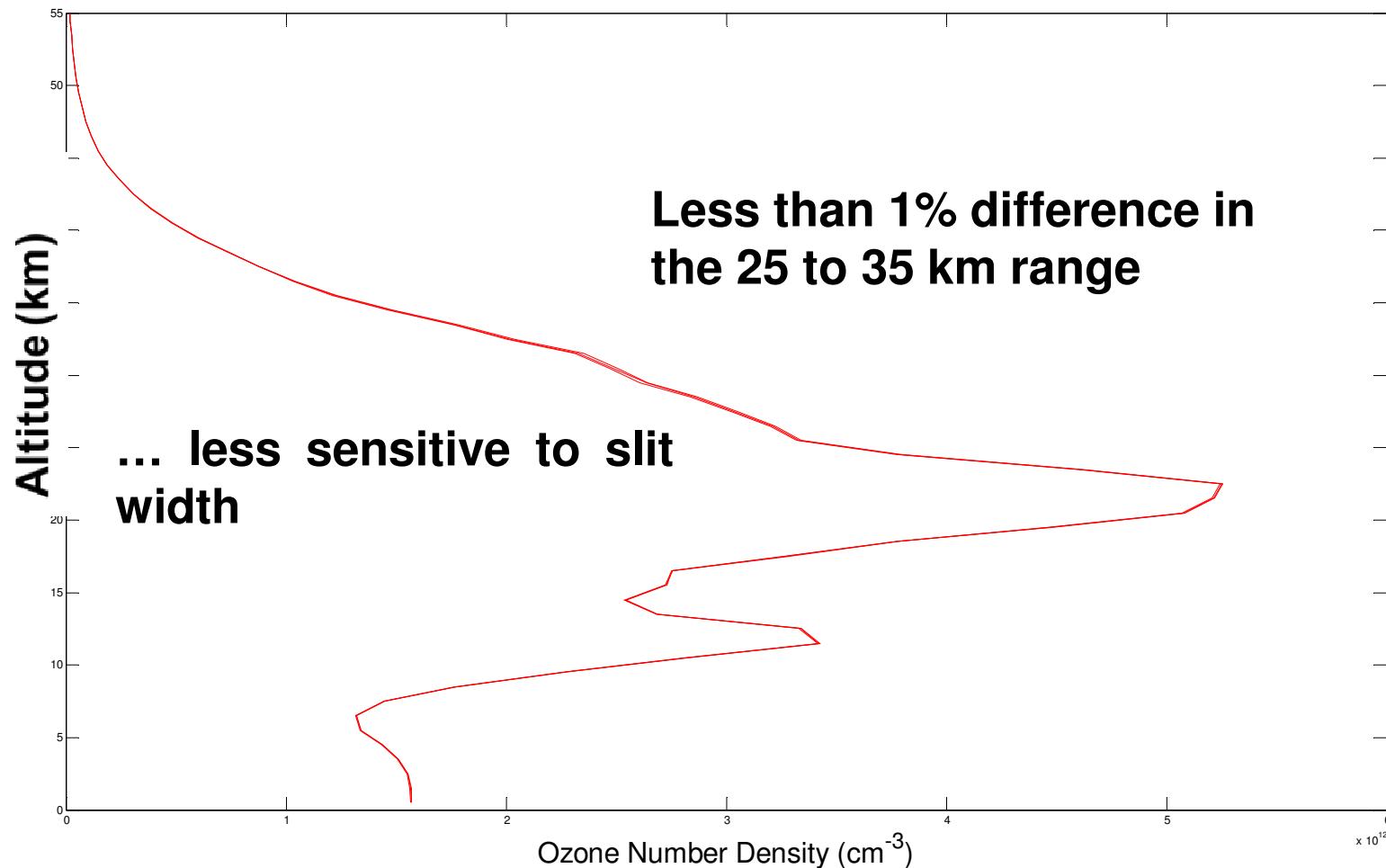


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Odin-OSIRIS Ozone Cross Section Analysis

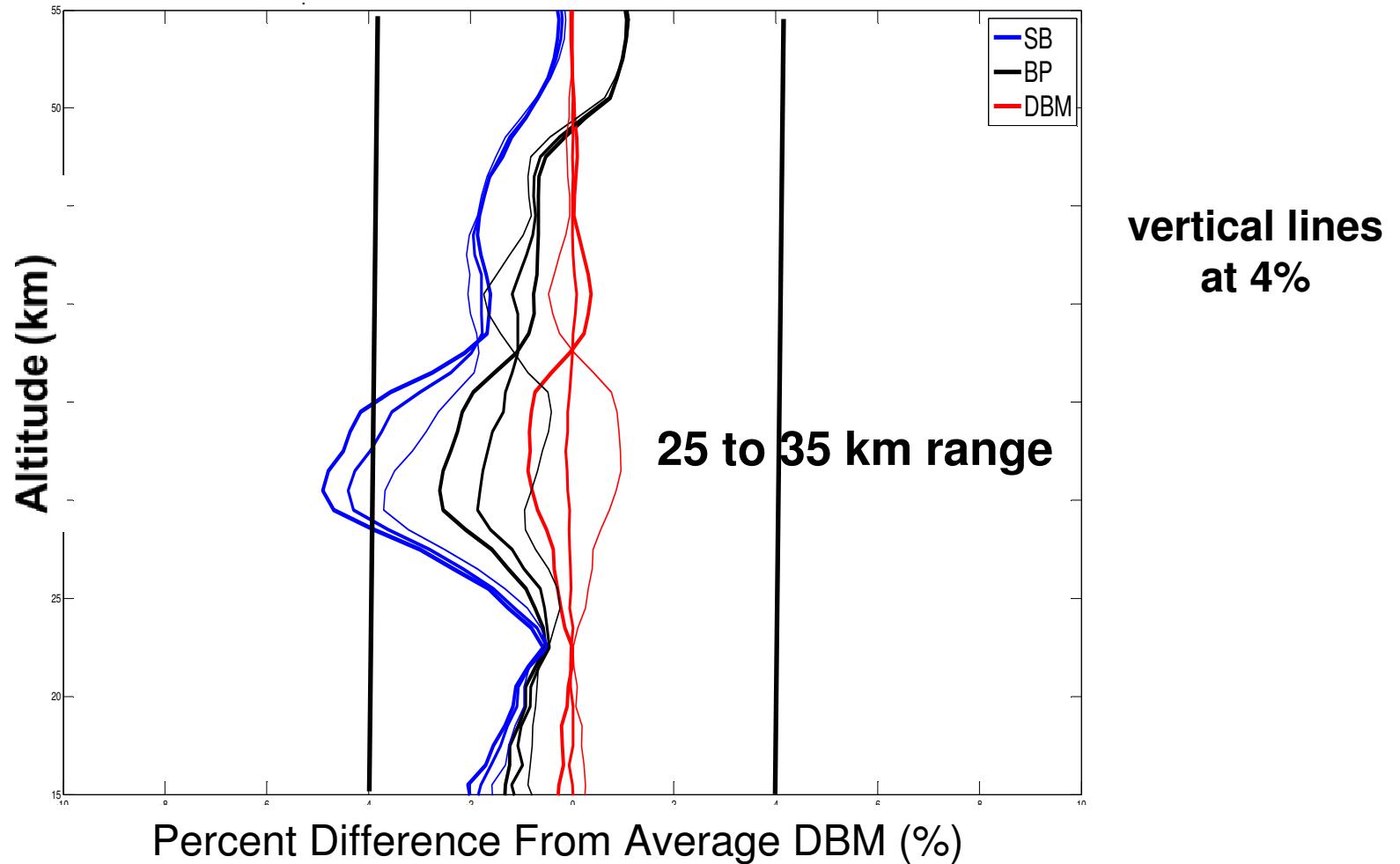
Ozone Retrieved With DBM Cross Section at Three Resolutions (New Wavelengths)



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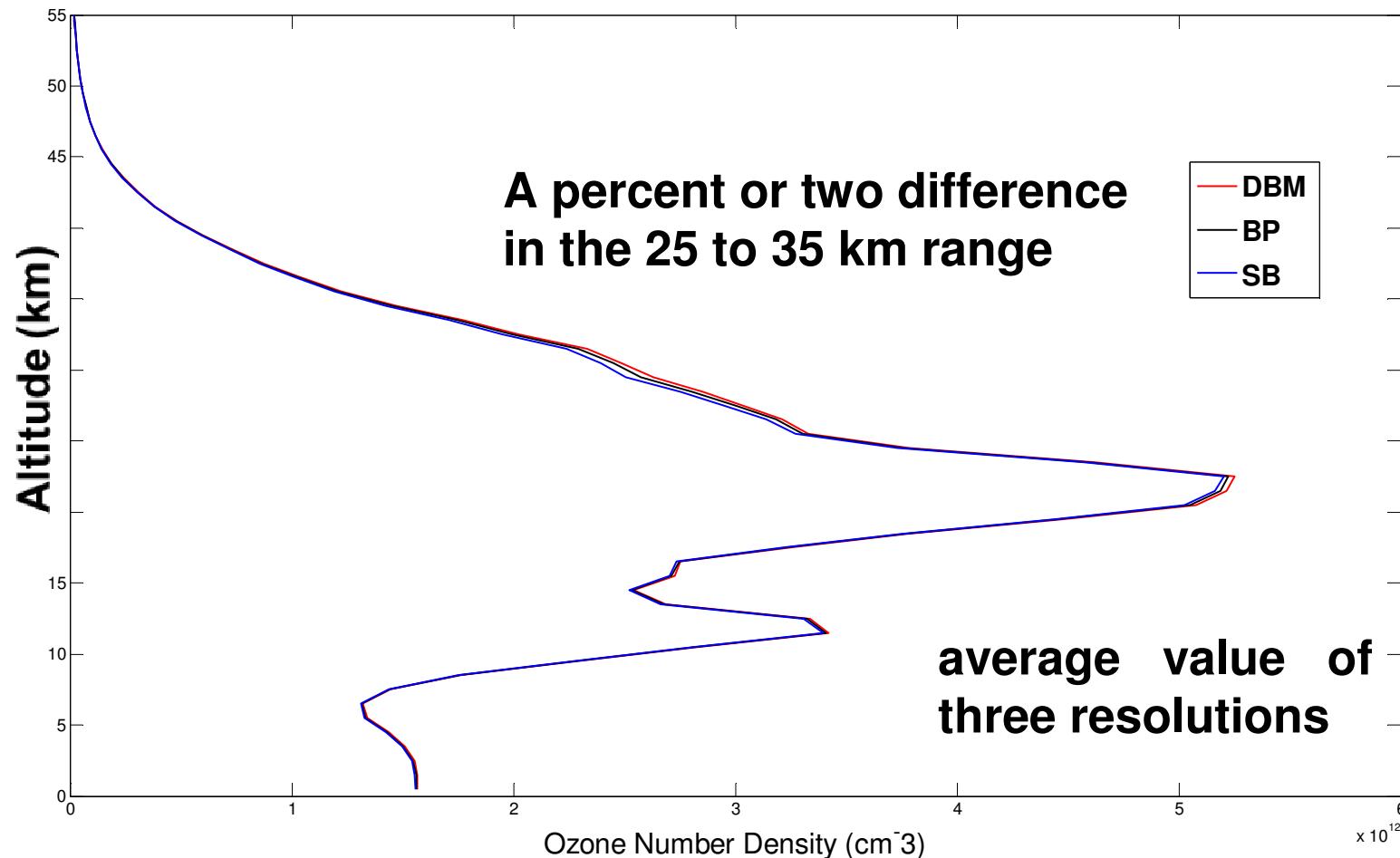
Comparison of Multiple DBM, SB and BP Retrievals



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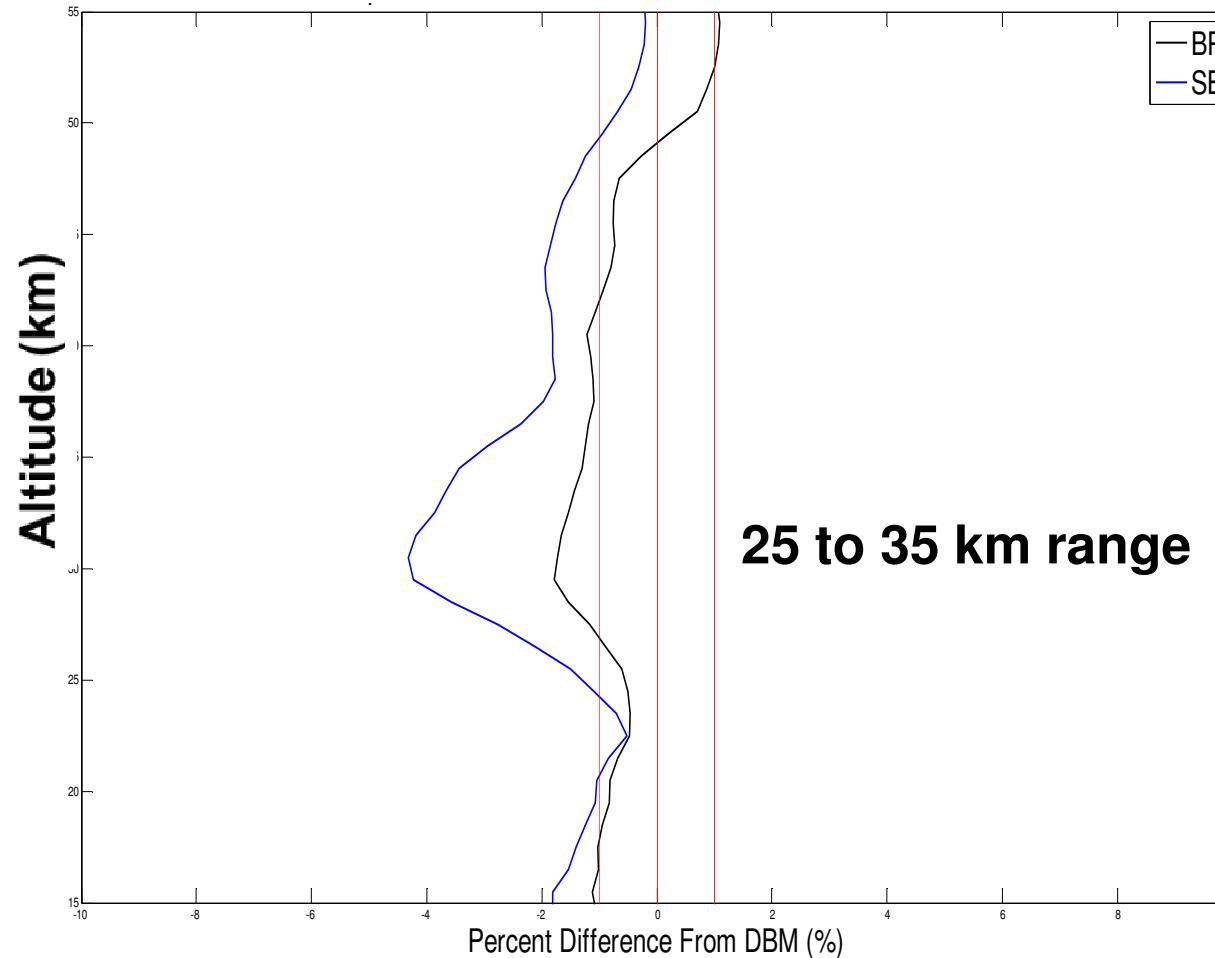
Ozone Retrieved With Three Different Cross Sections (New Wavelengths)



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Comparison of Average of DBM, SB and BP Retrievals



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- This work is far from complete
- It looks as if a change to the Daumont-Brion-Malicet cross sections would have at most a 4% impact on the altitude range from 25 to 35 km, with only 1.5% maximum difference with BP.
- This needs to be verified with a much larger ensemble of retrievals
- It also needs to be characterized over a range of latitudes, seasons and solar scattering geometries
- Reprocessing only takes a couple of months so we can react quickly to any decision made by this group

