



Brewer Model

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Introduction

This work was carried out during the COST 1207 short term mission (STSM) in the [Agencia Regionale per la Protezione dell'Ambiente della Valle d'Aosta ARPA](#), at Aosta Valley Italy in April, 2014.

The intention of the STSM was to work on a Brewer model in order to simulate different situations and research in some effects that occurs in the instrument.

One of the topics to investigate was the parabolic shape of the sun scan, with the results we will be able to explain it.

Model Description I

The first step for the model is the calculation of the operative slits wavelengths and the full width at half maximum (FWHM) of the brewer . The operative wavelengths for a real Brewer (and its conversion to micrometer steps) are determined from a dispersion test.

With the operative wavelengths and the FWHM we build the slit function. (Kerr et al., 1985)

We use Cdisort as the radiative solver, which is part of Libradtran 1.7 (Bernhard et al., 2012), using Csolver in pseudospherical mode and 16 streams to solve the radiative transfer equation.

Now we need to create the input file for UVSPEC, we have to define:

- The atmospheric parameters.
- Ozone
- Extraterrestrial spectrum
- Wavelength range
- UVSPEC solver (Csolver)

Model Description II

In the case of the ozone cross-sections we used a Bass and Paur modified file with a resolution adapted to the model resolution of 0,005 nm and for 228.15 K, but also tested Molina & Molina, Bass and Paur (included in the libradtran 1.7 packet) and Daumont.

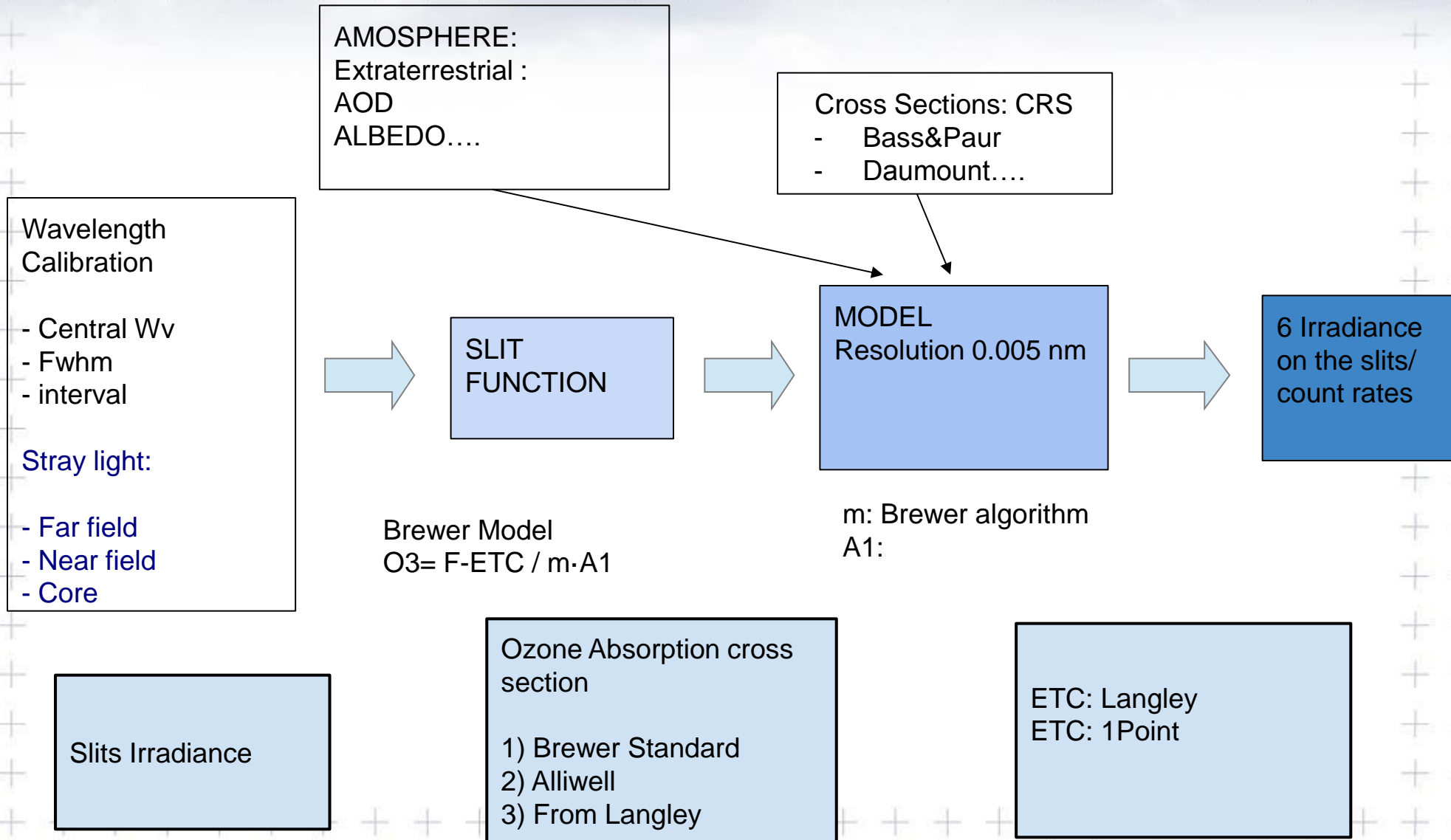
We use the brewer operative Rayleigh coefficients 0, 4870, 4620, 4410, 4220 and 4040. Also tested Volodya's proposal, no correction and Nicolet*.

For the simulations we used the brewer #185.

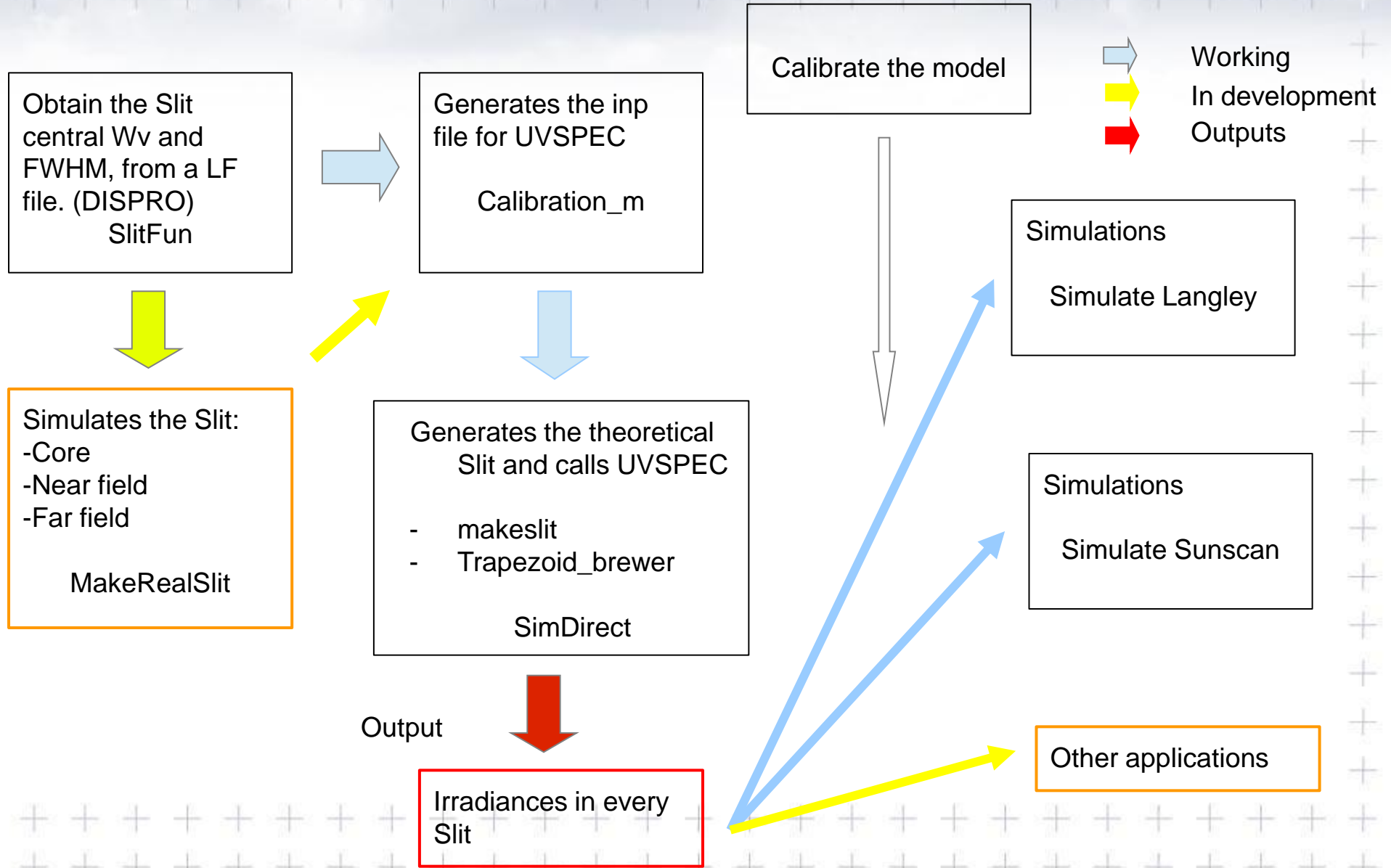
Slit	1	2	3	4	5	6
Op. WVL (A)	3031.9	3063.0	3100.5	3134.7	3168.0	3199.9
FWHM (A)	11.19	11.10	10.99	11.07	11.01	10.82

*Nicolet, M. (1984), On the molecular scattering in the terrestrial atmosphere: An empirical formula for its calculation in the hemisphere, *Planet. Space Sci.*, **32**, 1467–1468

Brewer model



Brewer model

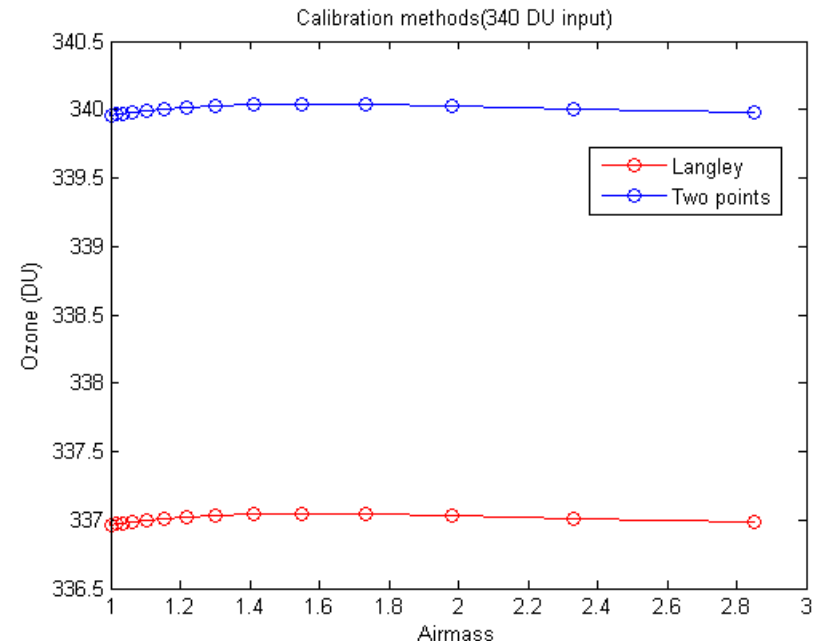


Simulations

Calibrations

The difference of approximately 3 DU is mainly due to:

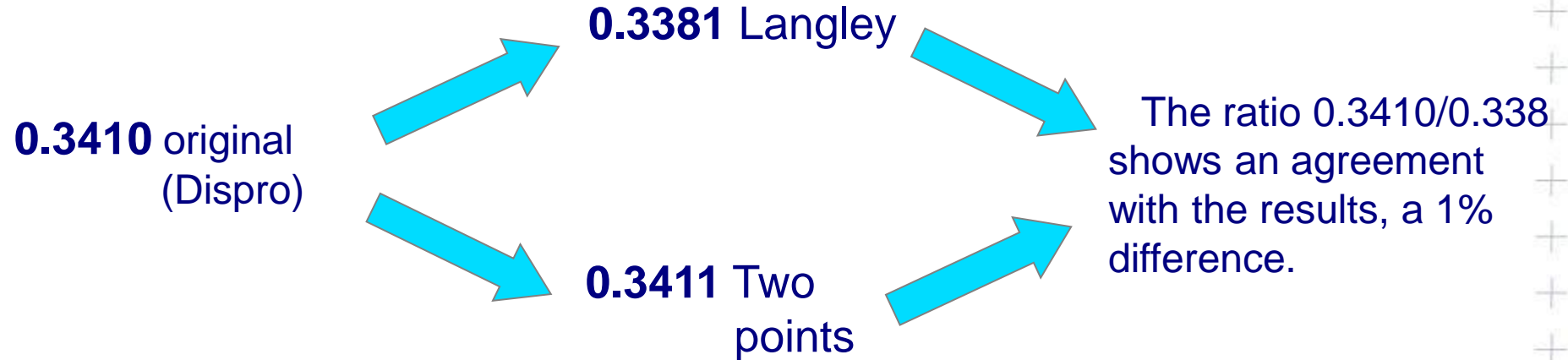
- Bad Rayleigh coefficients ?,
- Use of standard weightings.?
- The calculation of the differential ozone absorption coefficient ?.



The calculation of the ozone absorption coefficient from langley of the model results give a value 1% lower than the standard method calculation and explains almost all difference.

Simulations

Calibrations. Langley vs. two points.

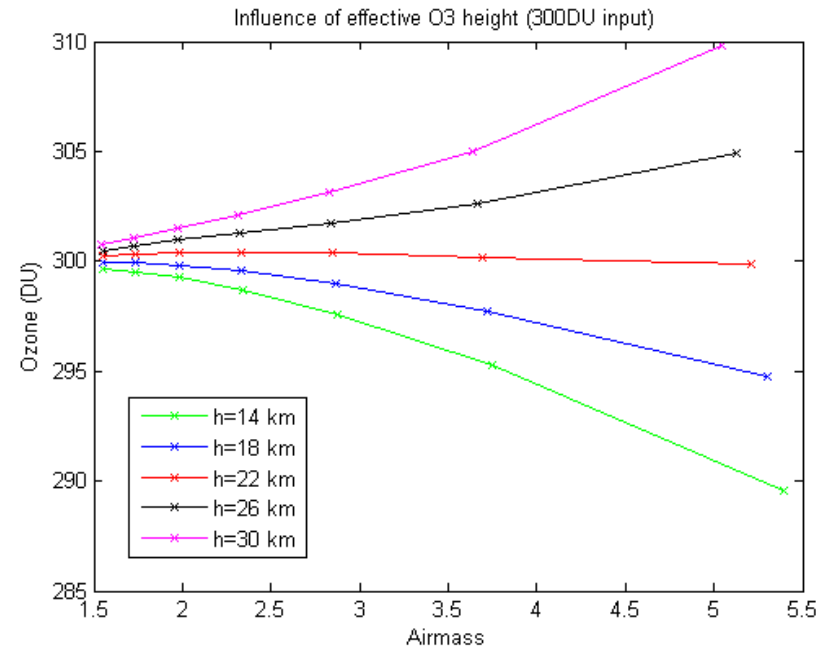


Simulations Model sensitivity

Simulating different effective O₃ heights at different air masses yields on a dispersion on the retrieval increasing with increasing air mass.

The highest heights simulated for the highest air masses deviates a +3% in the ozone calculation

The lowest heights simulated for the highest air masses deviates a -3% in the ozone calculation



All the simulations were made with the two points calibration

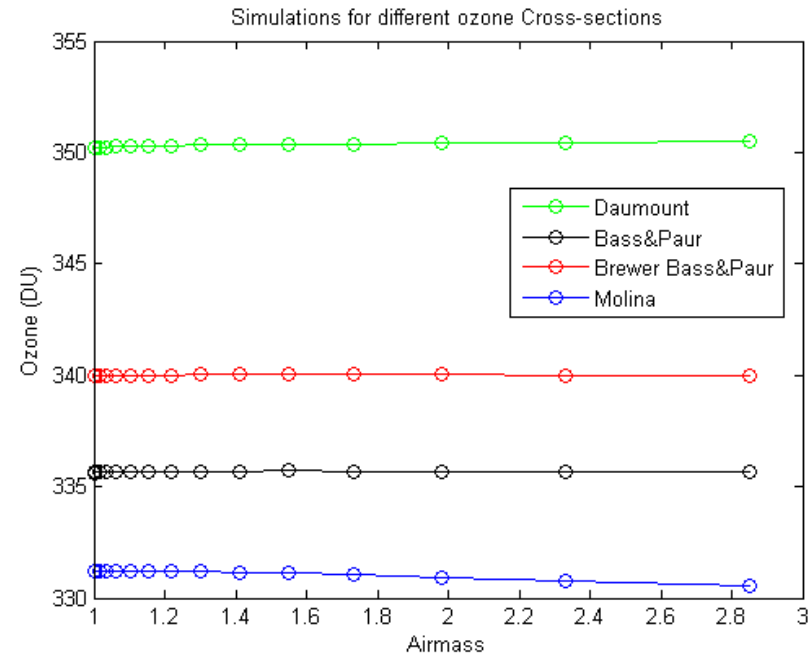
Simulations Model sensitivity

Simulating for different ozone Cross-sections for different air masses shows a perfect agreement for the **Bass&Paur** used on Brewer calibration*.

There is near a 3% overestimation when using **Daumont**, constant with the air mass

There is near a 1% underestimation when using **Bass&Paur (UVSPEC)**, constant with the air mass

There is near a 3% underestimation when using **Molina**, constant with the air mass



All the simulations were made with the two points calibration

*Redondas, A., Evans, R., Stuebi, R., Köhler, U., and Weber, M., Evaluation of the use of five laboratory-determined ozone absorption cross sections in Brewer and Dobson retrieval algorithms. Atmos. Chem. Phys., 14, 1635-1648, 2014.

Simulations Model sensitivity

Rayleigh

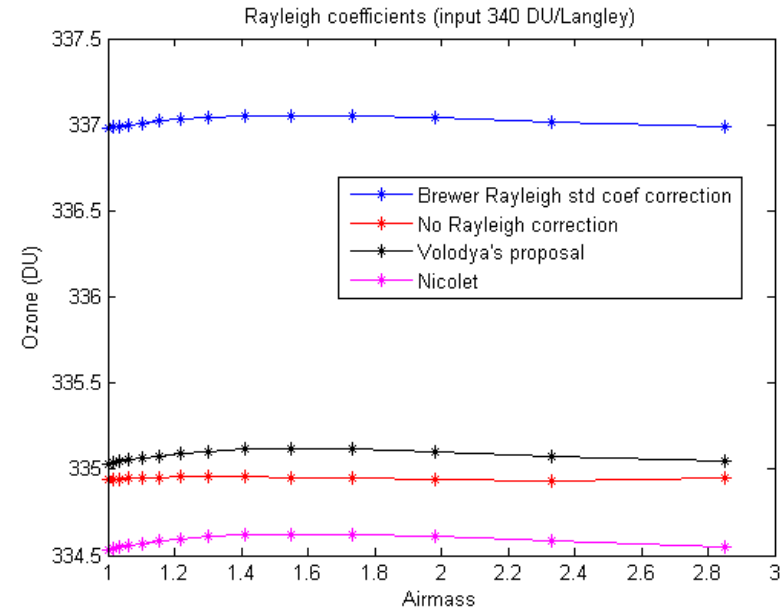
Using the Brewer Rayleigh standard coefficients correction gives the best results, near to 0.9% error in ozone calculation.

Using another proposals gives worse results:

Volodya's proposal 1.4%

No correction 1.5%

Nicolet* 1.6%



Original [0 4870 4620 4410 4220 4040]

Volodya [5329 5099 4837 4612 4411 4224]

Nicolet [5050 4832 4584 4372 4178 4002]

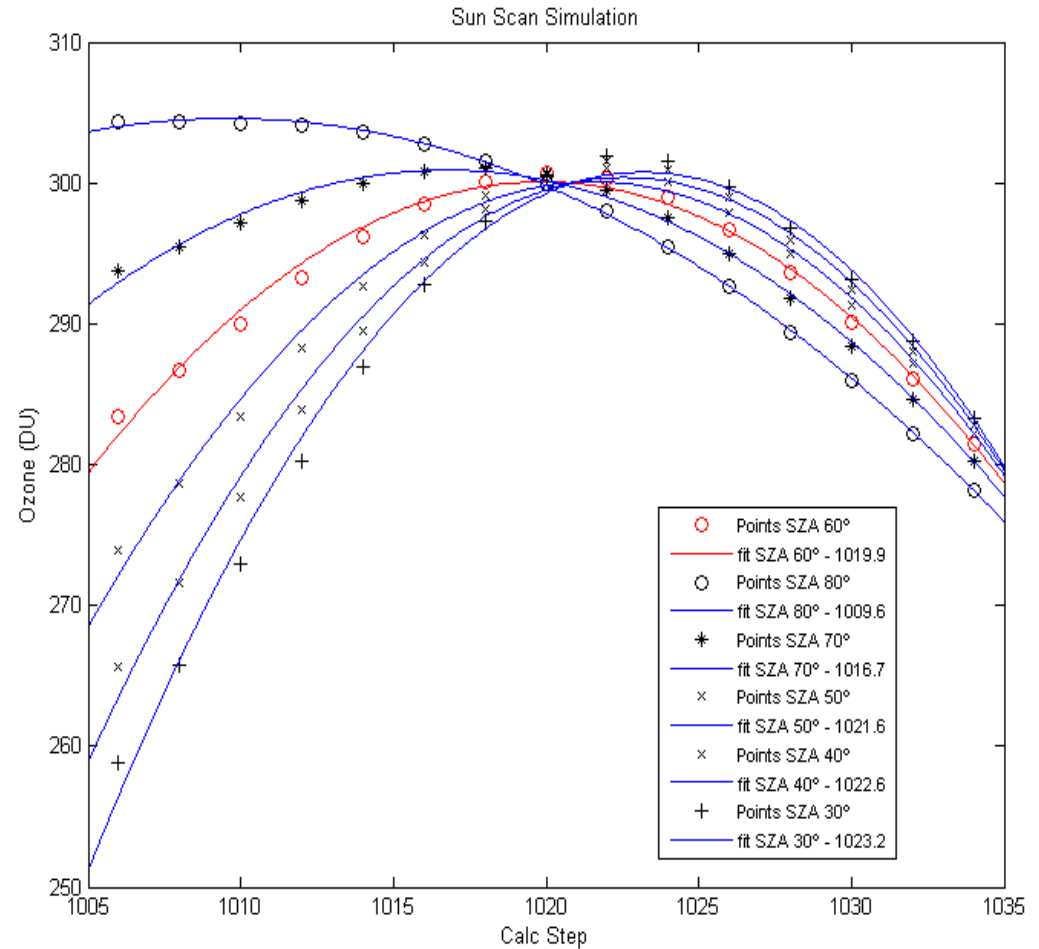
*Nicolet, M. (1984), On the molecular scattering in the terrestrial atmosphere: An empirical formula for its calculation in the hemisphere, *Planet. Space Sci.*, **32**, 1467–1468

Results

Sun Scan simulation

We have simulated several Sun scans for different solar zenith angles (SZA) for brewer 185 whose operative step is 1020 and the Zero is 1733, we moved 12 steps backward and forward from each slit center every 2 steps (MKIII Brewer operator manual appendices).

In red we have the best approach to the operative Calc step, which is for 60° SZA.

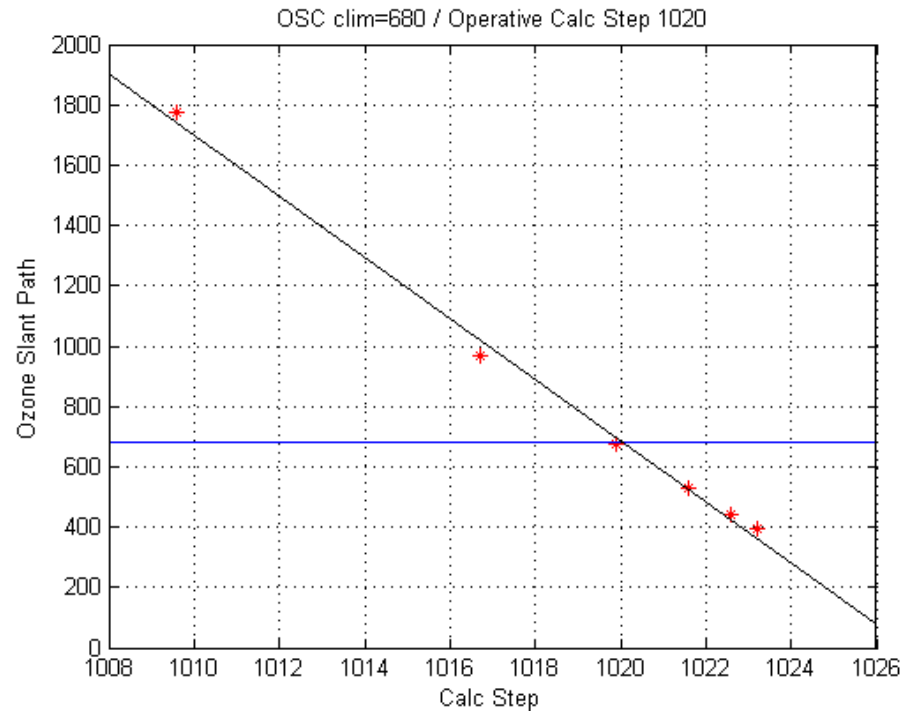


Results

Cal-Step determination

And more clear....

Using the Sun scan simulations we can confirm the calc step value.



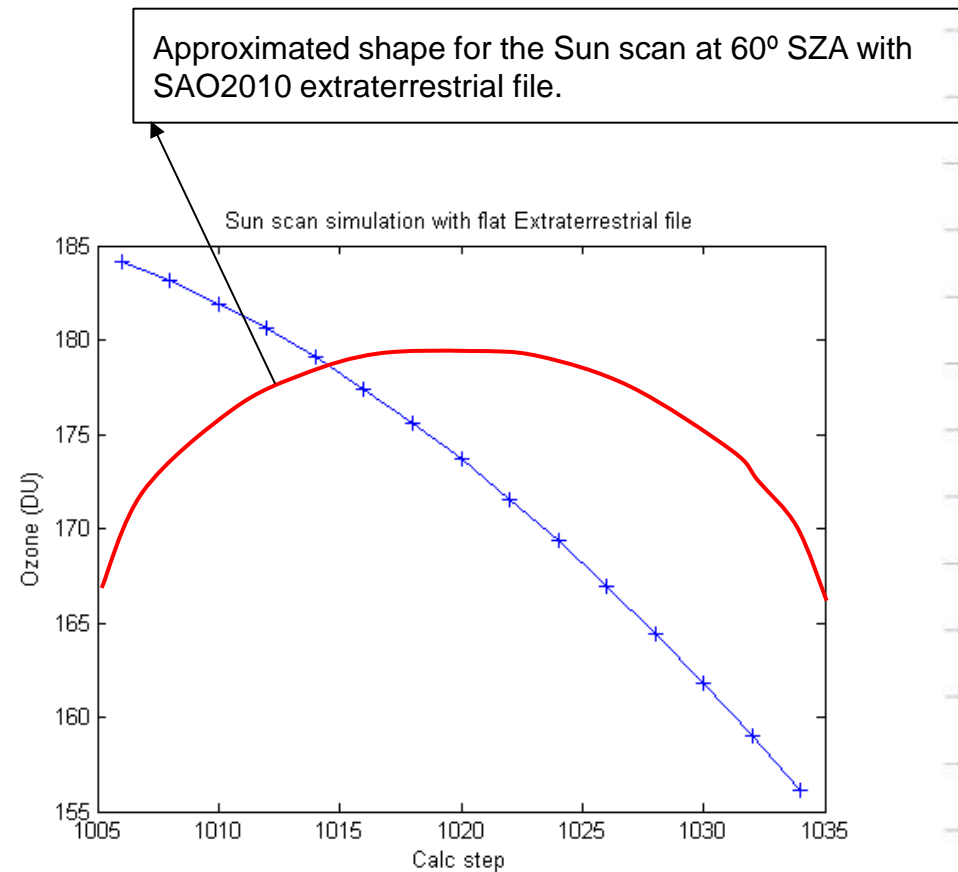
Results Sun Scan simulation using flat extraterrestrial file.

One of the objectives of the STSM was to determine the origin of the sun scan curved shape

The SC shape comes from ET (mainly, with high frequency oscillations) and X-secs (slow trend)

To suppress the Fraunhofer structure of the ET we generated an extraterrestrial flat file.

Simulating a SC with this file shows only the effect of the X-secs that is broad enough to make SC appear linear

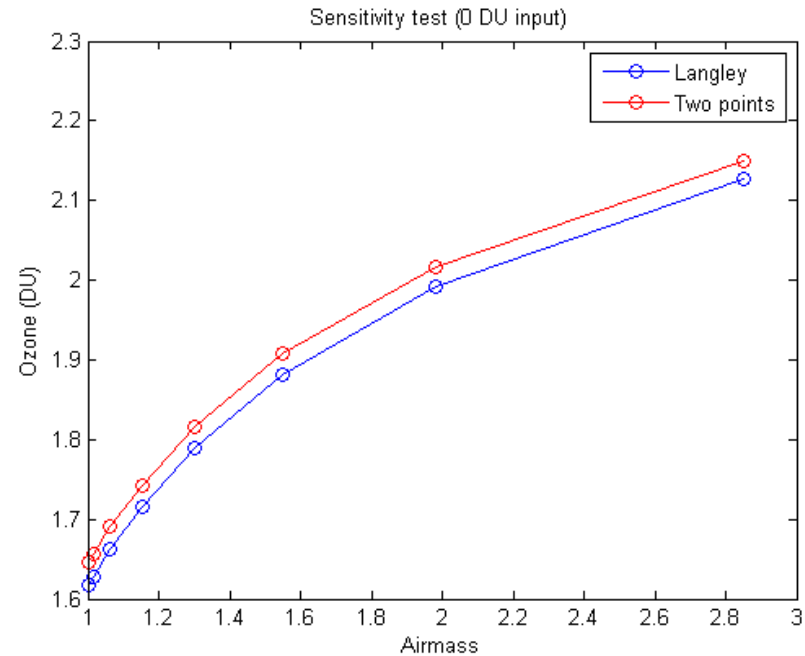


Results

Ozone offset

Running the model using 0 DU as input show a non zero output, (1.61-2.12DU) increasing with the airmass.

There is a 1.2 % difference, which is constant for all the air masses, using two points calibration or langley calibration



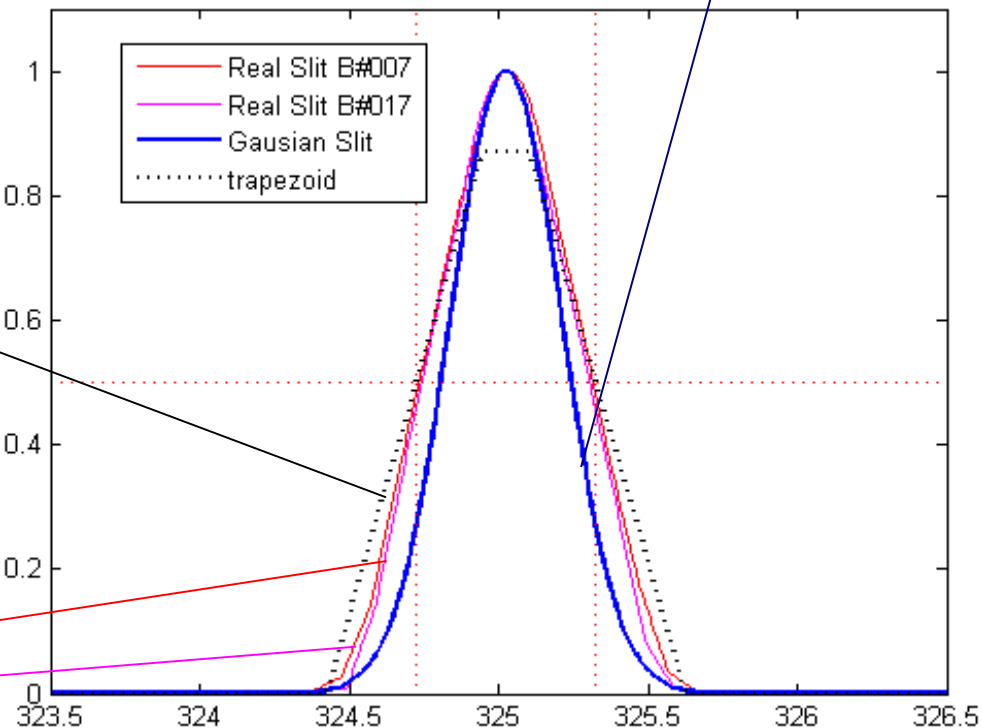
In progress Real Slit simulation

What we have now...

Gaussian fit, doesn't take into account what happens in the near field

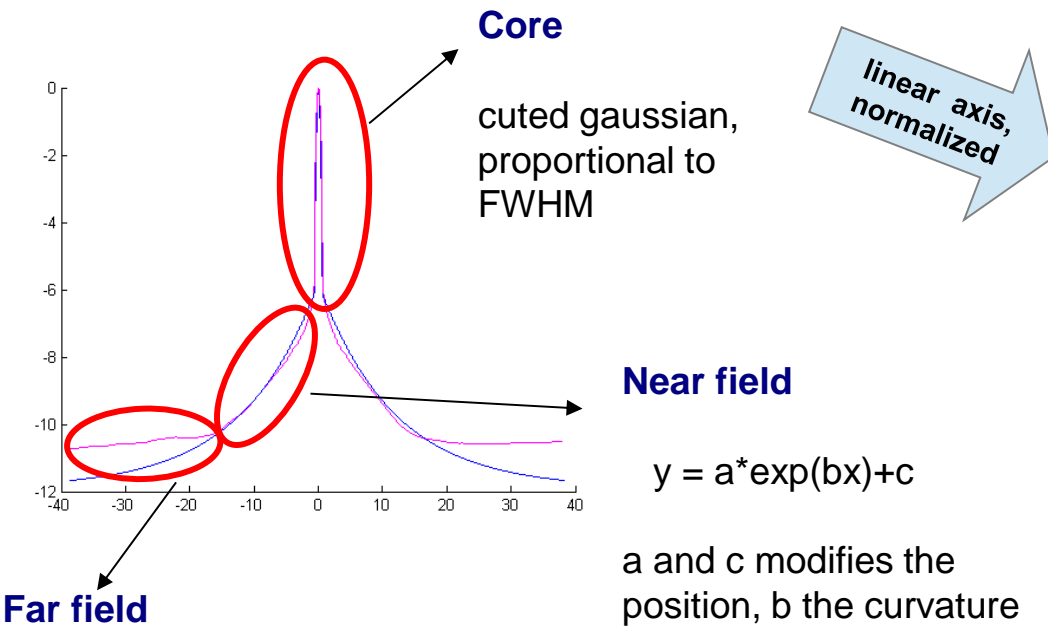
Trapezoid (Gröbner, 2001), also tested Makeslit (Henri): Same results !!

Real slit measurements:
-difficult to measure
-need a Laser



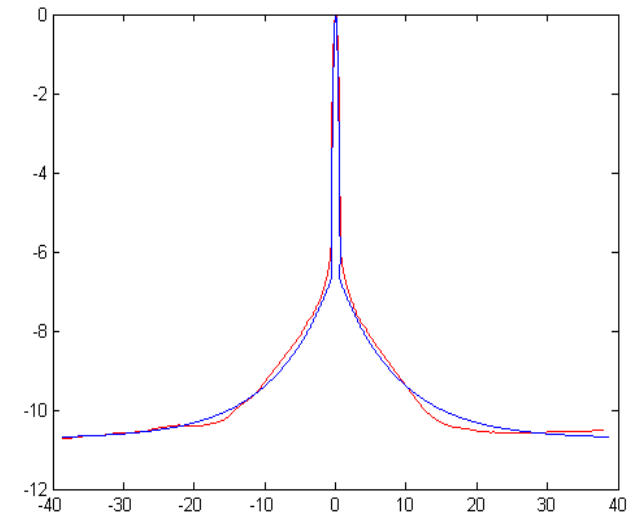
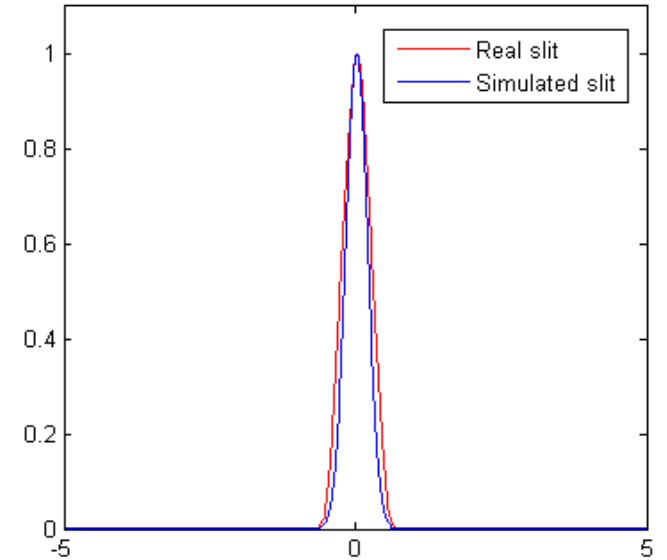
In progress

Real Slit simulation with Volodya's set



$y = mx + b$

Then adjusted with the Near field



Logarithmic axis

Thanks for your attention, and special thanks to Dr. Henri Diemoz, Alberto Redondas and Volodya Savastiouk.



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