@sence_exercice_1

October 23, 2024

Mathis

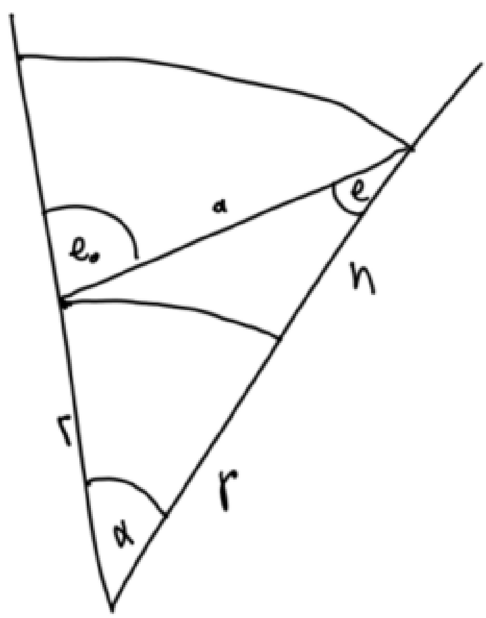
1 Atmospheric remote sensing Exercise 1

1.1 Task 0 Impact of airmass in various altitudes under different incident angels.

The airmass under a incident angle θ_0 is still $m = \frac{1}{cos(\theta)}$. To find θ we use the law of sines:

$\frac{r+h}{sin(180-\theta_0)} = \frac{r}{sin(\theta)}$

Plugging in the numbers given on the exercice sheet we get:

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Air mass at different elevations under different zenit angles:

Elevation (km)            1     5    20
Solar Zenith Angle (°)
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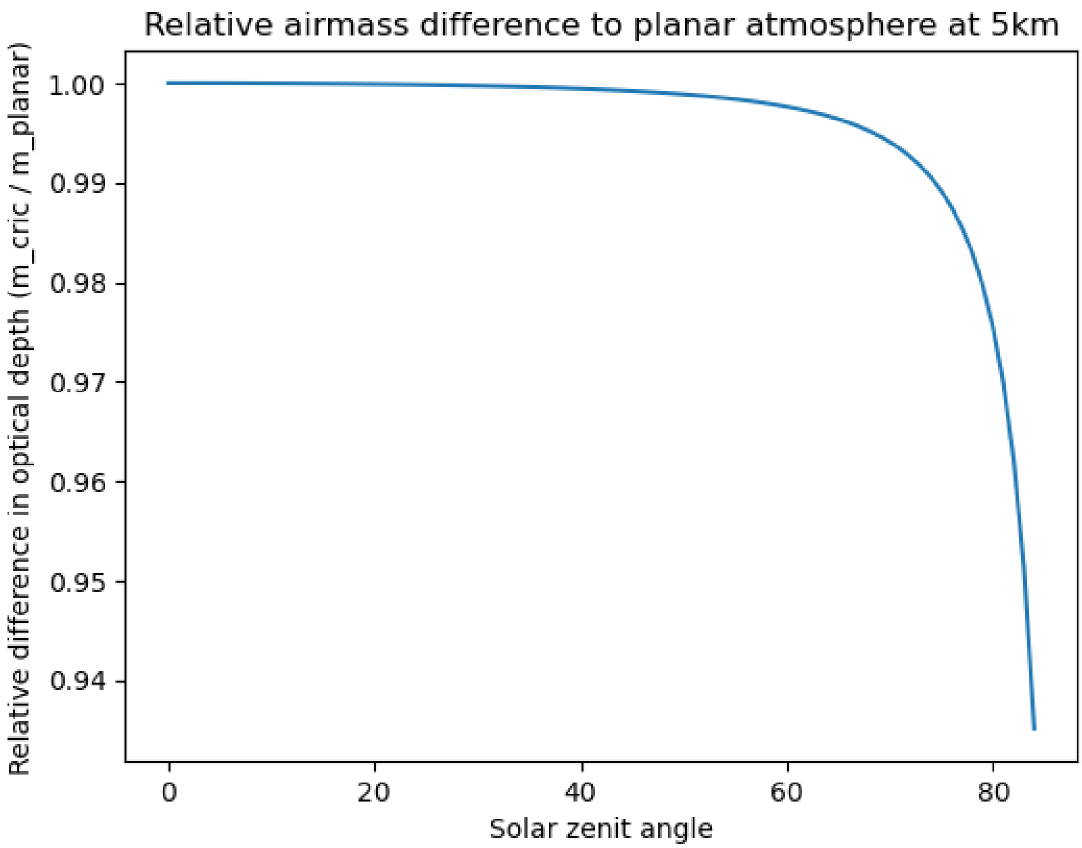
45	1.41	1.41	1.41
80	5.73	5.62	5.25
85	11.24	10.44	8.49

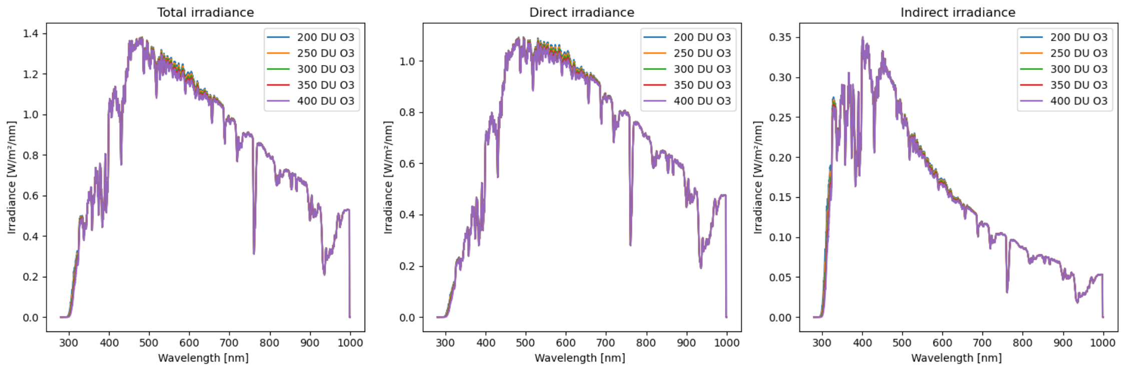
From the Beer-Lambert law $I = I_o \exp(-\tau m)$ we find $\tau = \frac{\ln \frac{I_0}{I}}{m}$. The relative deviation only dependent on the airmass.



1.2 Task 1 Sensitivity to total column ozone

For this experiment we use the uvspec solver of libradtrans to simulate a atmosphere with different ozon amounts. All experiments were conducted with a solar zenit angel of 40°, 10mm of water, and a albedo of 0.2.

The spectral ranges that are affected the most are between 280 nm and 350 nm and between 500 nm and 700 nm.



In both cases the indirect irradiance is the main contributor to the reduced irradiance. For the wavelength range between 280 nm and 380 nm we find that an increse of Ozon higher then 300 du does not lead to lower irradiance. This result does not align with what we expect and contradicts the findings of the erythemal analysis. One explenation is that the value differences get to small and rounding errors are to large to distinguish anymore.

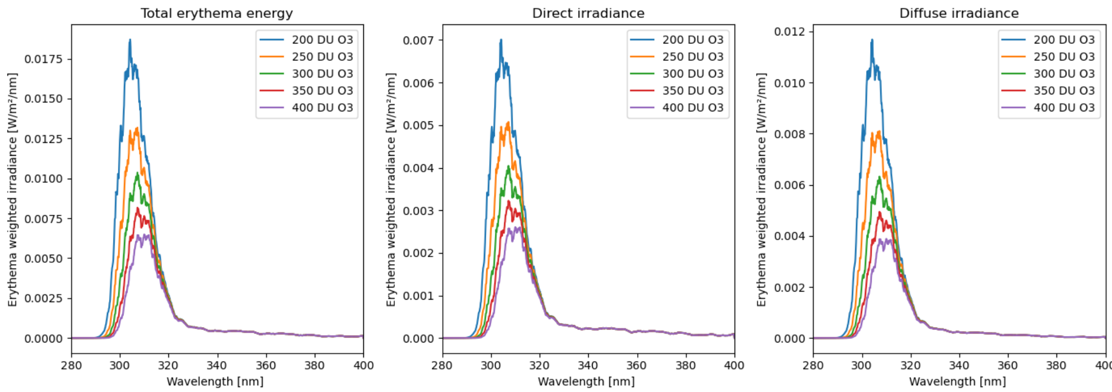
Table of integrated irradiance differences between 280nm and 380 nm

Ozone content [du]	Total Irradiance difference [w/m²]	Direct	Indirect
200	0.0	0.0	0.0
250	-7.48e-05	-2.83e-05	-4.66e-05
300	-7.95e-05	-3.01e-05	-4.95e-05
350	-7.95e-05	-3.01e-05	-4.95e-05
400	-7.95e-05	-3.01e-05	-4.95e-05

Table of integrated irradiance differences between 500 nm and 700 nm

Ozone content [du]	Total Irradiance difference [w/m²]	Direct	Indirect
200	0.0	0.0	0.0
250	-4.07	-1.48	-2.59
300	-7.47	-2.73	-4.74
350	-10.3	-3.81	-6.53
400	-12.8	-4.74	-8.06

1.3 For the next subtask we analyse the erythemal impact of uv radiation.



We can integrate these curves and find the average irradiance difference per additional percent ozon in the atmosphere.

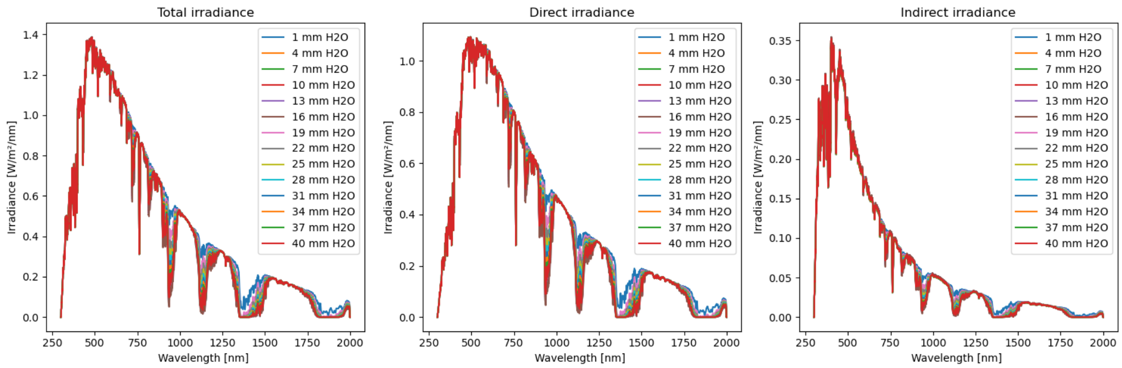
	Ozone content [du]	Average irradiance increase %
0	225.00	3.17
1	275.00	2.45
2	325.00	1.96
3	375.00	1.61

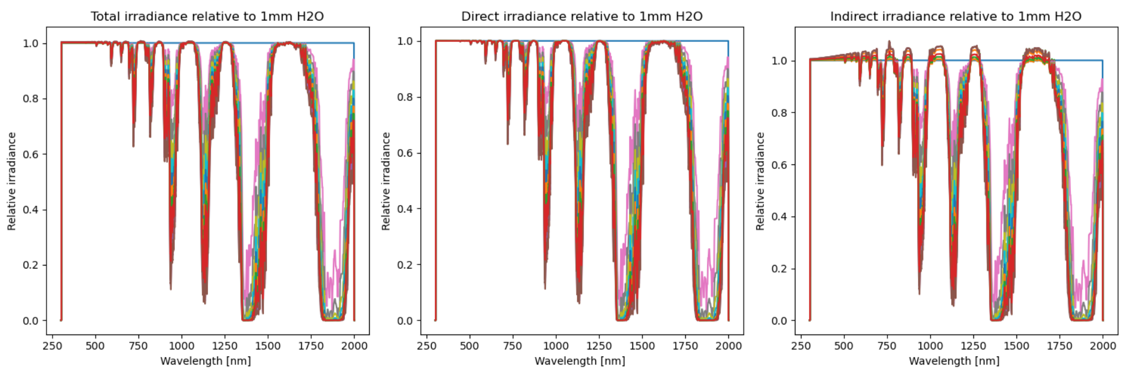
These findings lead to a uv index shown in the table below:

	UV index
Ozone content[du]	
200	11
250	9
300	7
350	6
400	5

1.4 Task 3 Sensitivity to precipitable water vapour

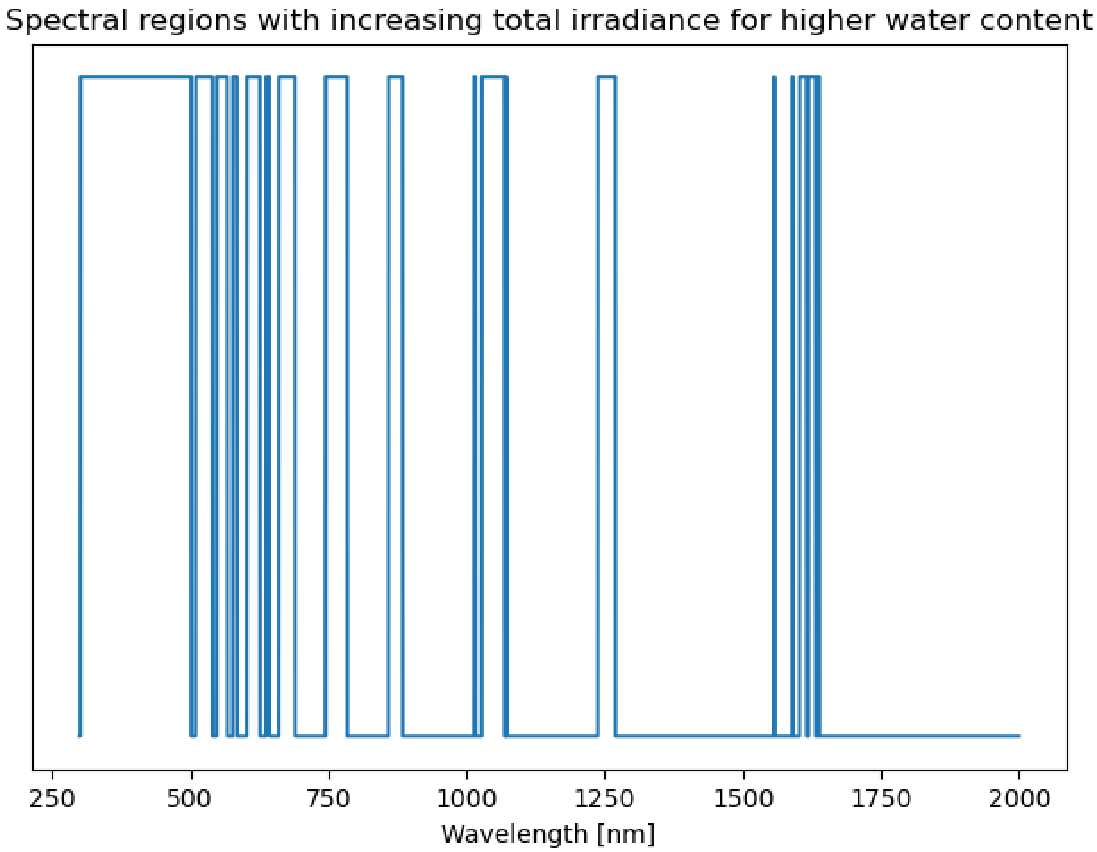
As in the last task we use the uvspec solver of libradtrans to solve for different atmospheres. In this experiment we vary the water content between 1mm and 40mm of precitable water vapor. For the solar zenit angle we use 40°, for the ozon content we use 200 du, and a surface albedo of 0.2.





We find several strong absorbtion bands from 550 nm until the end of our analysed range of 2000 nm. At 1400 nm and 1800 nm we see wide absorbtion bands at which already relatively small changes can fully absorb and lead to barely any incomming radiation. To retrive the percipitable water content we best use the absorbtion band at 900 nm or the one at 1100 nm, as they do not get desaturated and show a strong signal. Of the two the absorbtion band around 900 nm seems more usefull, as it yealds a stronger signal and has less overlap with absorbtion bands from other trance gases like methan.

An interresting finding is that the indirrect irradiance increases with an increasing Water content. This effect is so strong that the total irradiance increases in certain regions. This is an interresting effect, as it needs additional emission. This can be either a numerical error of uvspec of some of the absorbed light gets reemitted ad a different wavelength and thereby increases irradiance in certain wavelength regions.


Spectral regions with increasing total irradiance for higher water content
250
500
750
1000
1250
1500
1750
2000
Wavelength [nm]