#load atmospheric transmittance from file created in Modtran in wavenumbers

# the transmittance is specified in the wavenumber domain with

# 5 cm-1 intervals, but we want to work in wavelength with 2.5 cm-1

waven **=** numpy**.**arange**(**2000.0**,** 3300.0**,** 2.5**).**reshape**(-**1**,** 1**)**

wavel**=** ryutils**.**convertSpectralDomain**(**waven**,** type**=**'nw'**)**

#remove comment lines, and scale path radiance from W/cm2.sr.cm-1 to W/m2.sr.cm-1

tauA **=** ryfiles**.**loadColumnTextFile**(**'data/path1kmflamesensor.txt'**,**

**[**1**],**abscissaOut**=**waven**,** comment**=**'%'**)**

lpathwn **=** ryfiles**.**loadColumnTextFile**(**'data/pathspaceflamesensor.txt'**,**

**[**9**],**abscissaOut**=**waven**,** ordinateScale**=**1.0e4**,** comment**=**'%'**)**

#convert path radiance spectral density from 1/cm^-1 to 1/um, at the sample

#wavenumber points

**(**dum**,** lpathwl**)** **=** ryutils**.**convertSpectralDensity**(**waven**,** lpathwn**,** type**=**'nw'**)**

#load the detector file in wavelengths, and interpolate on required values

detR **=** ryfiles**.**loadColumnTextFile**(**'data/detectorflamesensor.txt'**,**

**[**1**],**abscissaOut**=**wavel**,** comment**=**'%'**)**

#construct the flame emissivity from parameters

emis **=** ryutils**.**sfilter**(**wavel**,**center**=**4.33**,** width**=**0.45**,** exponent**=**6**,** taupass**=**0.8**,**

taustop**=**0.1 **)**

#construct the sensor filter from parameters

sfilter **=** ryutils**.**sfilter**(**wavel**,**center**=**4.3**,** width**=**0.8**,** exponent**=**12**,**

taupass**=**0.9**,** taustop**=**0.0001**)**

#plot the data

plot1**=** ryplot**.**Plotter**(**1**,** 2**,** 2**,**'Flame sensor'**,**figsize**=(**12**,**8**))**

#it seems that all attempts to plot in same subplot space must use same #ptitle.

plot1**.**plot**(**1**,** wavel**,** detR**,** "Spectral"**,**"Wavelength [$\mu$m]"**,** "Relative magnitude"**,**

plotCol**=[**'b'**],** label**=[**'Detector'**])**

plot1**.**plot**(**1**,** wavel**,** emis**,** "Spectral"**,**"Wavelength [$\mu$m]"**,** "Relative magnitude"**,**

plotCol**=[**'g'**],** label**=[**'Emissivity'**])**

plot1**.**plot**(**1**,** wavel**,** sfilter**,** "Spectral"**,**"Wavelength [$\mu$m]"**,** "Relative magnitude"**,**

plotCol**=[**'r'**],** label**=[**'filter'**])**

plot1**.**plot**(**1**,** wavel**,** tauA**,** "Spectral"**,**"Wavelength [$\mu$m]"**,** "Relative magnitude"**,**

plotCol**=[**'c'**],** label**=[**'Atmosphere transmittance'**],** maxNX**=**10**,** maxNY**=**10**)**

#check path radiance against Planck's Law for atmo temperature

LbbTropical **=** ryplanck**.**planck**(**wavel**,** 273**+**27**,** type**=**'el'**).**reshape**(-**1**,** 1**)/**numpy**.**pi

plot1**.**plot**(**2**,** wavel**,** LbbTropical**,** "Radiance"**,**"Wavelength [$\mu$m]"**,**

"Radiance [W/(m$^2$.sr.$\mu$m)]"**,** plotCol**=[**'r'**],** label**=[**'300 K Planck Law'**])**

plot1**.**plot**(**2**,** wavel**,** lpathwl**,** "Radiance"**,**"Wavelength [$\mu$m]"**,**

"Radiance [W/(m$^2$.sr.$\mu$m)]"**,** plotCol**=[**'b'**],**

label**=[**'Tropical path radiance'**])**

# define sensor scalar parameters

opticsArea**=**7.8e-3 # optical aperture area **[**m2**]**

opticsFOV**=**1.0e-4 # sensor field of view **[**sr**]**

transZ**=**1.0e4 # amplifier transimpedance gain **[**V**/**A**]**

responsivity**=**2.5 # detector peak responsivity **=**A**/**W**]**

# define the flame properties

flameTemperature **=** 1000**+**273.16 # temperature in **[**K**]**

flameArea **=** 1 # in **[**m2**]**

distance **=** 1000 # **[**m**]**

fill **=** **(**flameArea **/**distance**\*\***2**)** **/** opticsFOV # how much of FOV is filled

fill **=** 1 **if** fill **>** 1 **else** fill # limit target solid angle to sensor FOV

# first do for flame

# get spectral radiance in W/m^2.sr.cm-1

radianceFlame **=** ryplanck**.**planck**(**waven**,** flameTemperature**,** type**=**'en'**)\**

**.**reshape**(-**1**,** 1**)/**numpy**.**pi

inbandirradianceFlame **=** radianceFlame **\*** detR **\*** tauA **\*** emis **\*** sfilter **\*\**

fill **\*** opticsFOV

totalirradianceFlame **=** numpy**.**trapz**(**inbandirradianceFlame**.**reshape**(-**1**,** 1**),**

waven**,** axis**=**0**)[**0**]**

signalFlame **=** totalirradianceFlame **\***transZ**\***responsivity **\***opticsArea

print**(**'Optics : area={0} m^2 FOV={1} [sr]'**.**format**(**opticsArea**,** opticsFOV **))**

print**(**'Amplifier: gain={0} [V/A]'**.**format**(**transZ**))**

print**(**'Detector : peak responsivity={0} [A/W]'**.**format**(**responsivity**))**

print**(**'Flame : temperature={0} [K] area={1} [m^2] distance={2} [m] fill={3} [-]'**.\**

format**(**flameTemperature**,** flameArea**,** distance**,** fill**))**

print**(**'Flame : irradiance={0:9.2e} [W/m^2] signal={1:7.4f} [V]'**.\**

format**(**totalirradianceFlame**,** signalFlame**))**

# now do path

inbandirradiancePath **=** lpathwn **\*** detR **\*** sfilter **\*** opticsFOV

totalirradiancePath **=** numpy**.**trapz**(**inbandirradiancePath**.**reshape**(-**1**,** 1**),**waven**,** axis**=**0**)[**0**]**

signalPath **=** totalirradiancePath **\*** transZ**\***responsivity **\***opticsArea

print**(**'Path : irradiance={0:9.2e} [W/m^2] signal={1:7.4f} [V]'**.\**

format**(**totalirradiancePath**,** signalPath**))**

**(**dum**,** iFlamewl**)** **=** ryutils**.**convertSpectralDensity**(**waven**,** inbandirradianceFlame**,** type**=**'nw'**)**

**(**dum**,** iPathwl**)** **=** ryutils**.**convertSpectralDensity**(**waven**,** inbandirradiancePath**,** type**=**'nw'**)**

plot1**.**plot**(**3**,** wavel**,** iFlamewl**,** "Irradiance"**,**"Wavelength [$\mu$m]"**,**

"Iradiance [W/(m$^2$.$\mu$m)]"**,**plotCol**=[**'r'**],** label**=[**'Flame'**])**

plot1**.**plot**(**3**,** wavel**,** iPathwl**,** "Irradiance"**,**"Wavelength [$\mu$m]"**,**

"Iradiance [W/(m$^2$.$\mu$m)]"**,**plotCol**=[**'b'**],** label**=[**'Path'**])**

plot1**.**plot**(**4**,** waven**,** inbandirradianceFlame**,** "Irradiance"**,**"Wavenumber [cm$^{-1}$]"**,**

"Irradiance [W/(m$^2$.cm$^{-1}$)]"**,**plotCol**=[**'r'**],** label**=[**'Flame'**])**

plot1**.**plot**(**4**,** waven**,** inbandirradiancePath**,** "Irradiance"**,**"Wavenumber [cm$^{-1}$]"**,**

"Irradiance [W/(m$^2$.cm$^{-1}$)]"**,**plotCol**=[**'b'**],** label**=[**'Path'**],** maxNX**=**10**,** maxNY**=**10**)**

plot1**.**saveFig**(**'flamesensor01.eps'**)**