

Optimización de la búsqueda de parámetros atmosféricos en modelos de transferencia radiativa

- Gamaliel López-Padilla • giovannilopez9808@gmail.com

Modelos de transferencia radiativa

The screenshot shows the NCAR UCAR Atmospheric Chemistry Observations & Modeling website. At the top, there's a banner for the Tropospheric Ultraviolet and Visible (TUV) Radiation Model. Below the banner, there's a search bar and a navigation menu with links to Home, Modeling, and TUV. The main content area features a section titled "TROPOSPHERIC ULTRAVIOLET AND VISIBLE (TUV) RADIATION MODEL". It contains several paragraphs of text about UV radiation, its effects on health and agriculture, and its vertical structure. There's also a section titled "CLIMATOLOGY OF ERYTHEMAL ULTRAVIOLET RADIATION, 1979-2000" with a monthly climatological distribution graph. At the bottom, there's a "DOWNLOADS AND TOOLS" section with a link to "TUV source code at NCAR Atmospheric Chemistry Observations & Modeling".

Figura 1: Tropospheric Ultraviolet and Visible (TUV) radiation model. [1]

The screenshot shows the NREL Grid Modernization website. At the top, there's a search bar and a navigation menu with links to Research, Publications, Data & Tools, Facilities, and Work with Us. The main content area features a section titled "SMARTS: Simple Model of the Atmospheric Radiative Transfer of Sunshine". It contains several paragraphs of text about the SMARTS model, its purpose, and its applications. There's also a section titled "Climatology of Erythemal Ultraviolet Radiation, 1979-2000" with a monthly climatological distribution graph. At the bottom, there's a "DOWNLOADS AND TOOLS" section with a link to "TUV source code at NCAR Atmospheric Chemistry Observations & Modeling".

Figura 2: Simple Model of the Atmospheric Radiative Transfer of Sunshine. [2]

¿Qué hacen estos modelos?

$$\frac{dE}{dAdt} = I_\nu(\hat{k}, \vec{r}, t) \vec{k} \cdot \vec{n} d\Omega d\nu \quad [3]$$

```
'AOD=0.041 '
2
25.750 0.476 0
1
'USSA'
1
0
1 0.2740
0
3
390
0
'S&F_URBAN'
5
0.041 2
18
1
51 37.0 180.0
285 2800 1 1366.1
2
285 2800 1
1
4
1
0 2.9 0
0
0
1
3
2015 1 11 8.2167 25.75 -100.255 -6
```

TUV inputs:

```
=====
inpfil =      CDMX    outfil =      cdmx   nstr =      -2
lat =        19.420   lon =       -99.145  tmzone =     -6.0
iyear =       2016    imonth =      1      iday =       9
zstart =      2.245   zstop =      80.000  nz =        81
wstart =     280.000  wstop =     400.000 nwint =     120
tstart =      10.000  tstop =      15.000  nt =        61
lzenit =       F      alsurf =     0.080   psurf =    -999.0
o3col =      228.380  so2col =     0.000   no2col =     0.100
taucl =       0.000   zbase =      4.000   ztop =      5.000
tauauer =     0.061   ssaaer =     0.800   alpha =     1.000
dirsun =      1.000   difdn =      1.000   difup =     0.000
zout =        2.245   zaIRD =    -9.990E+02 ztemp =    -999.000
lirrad =       T      laflux =      F      lmmech =     F
lrates =       T      isfix =       0      nms =        2
ljvals =       F      ijfix =       0      nmj =        0
iwfix =        0      itfix =       0      izfix =       0
=====
```

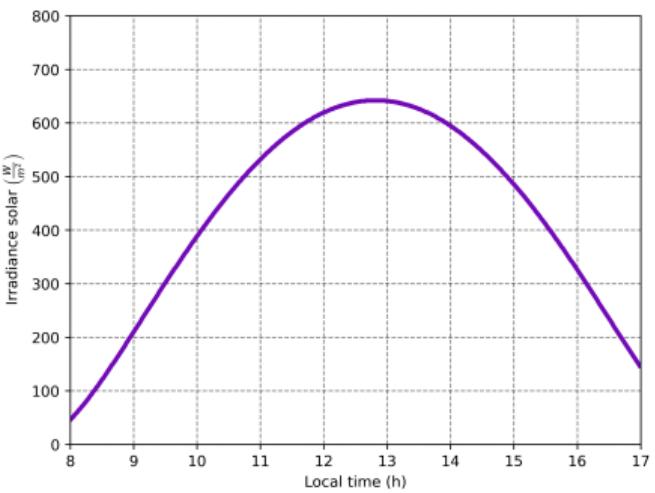
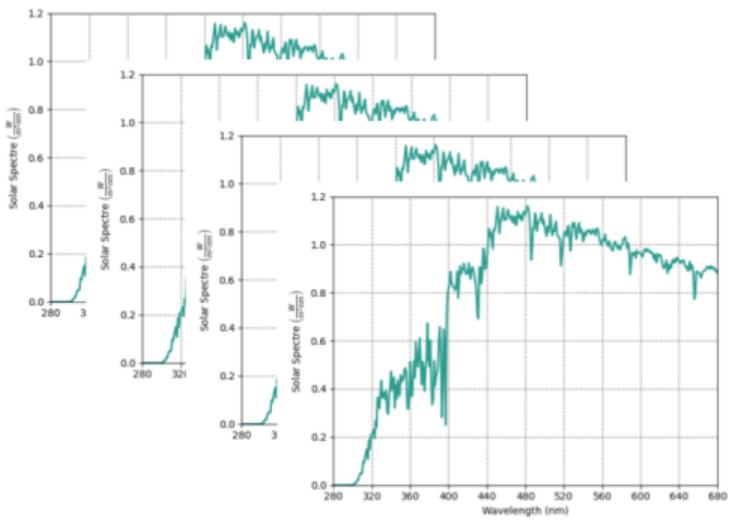
Figura 4: Archivo de inputs del modelo TUV

Figura 3: Archivo de inputs del modelo SMARTS

$$I(t) = \int_{\lambda_0}^{\lambda_i} E(\lambda, t) d\lambda \quad (1)$$

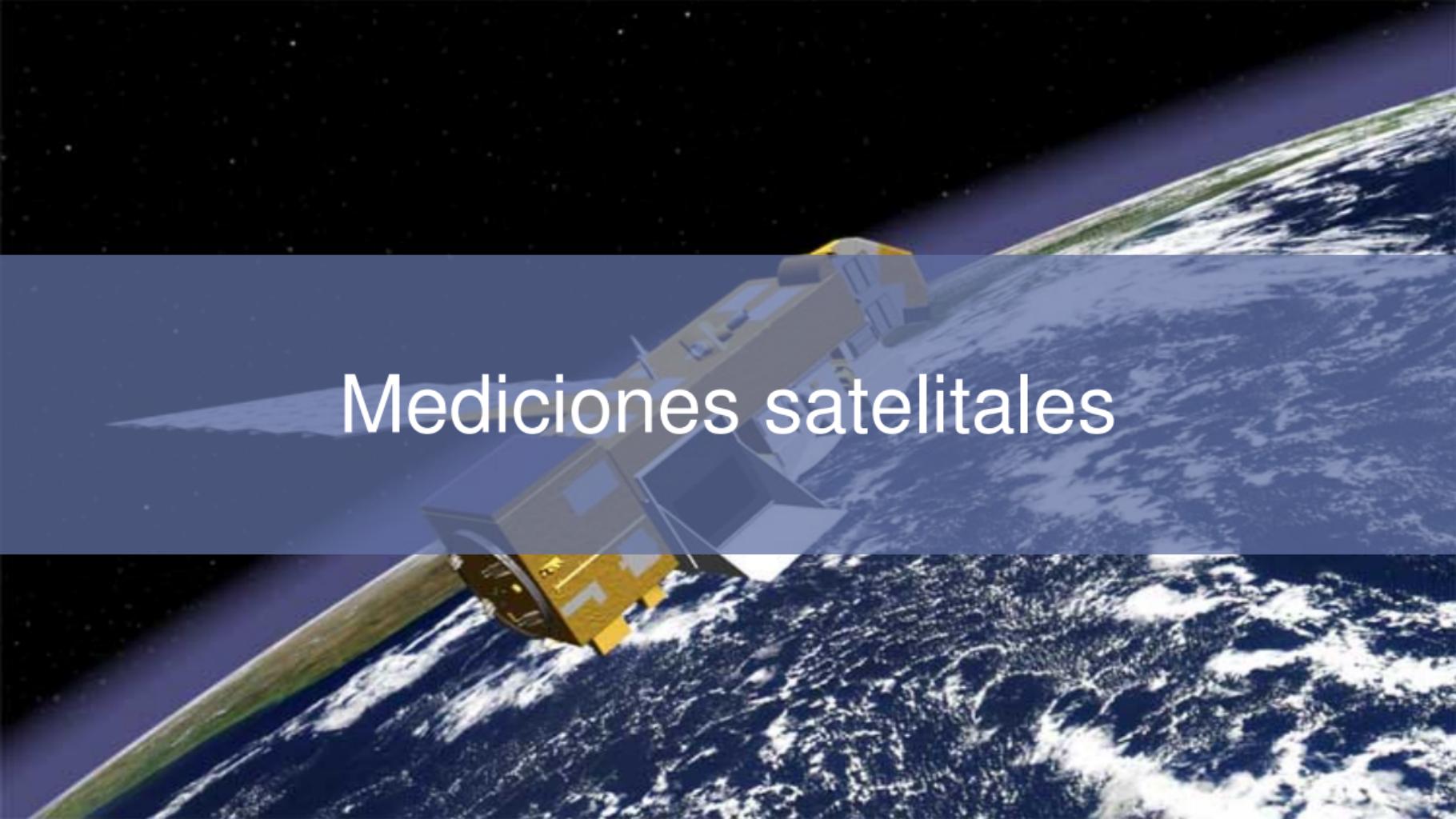
```
# Calculo de la irradiancia solar a partir de los resultados del
# modelo SMARTS
size = np.size(irradiance)
integral = irradiance[0]
for i in range(1, size):
    integral += irradiance[i]*(wavelength[i]-wavelength[i-1])
```

Figura 5: Implementación de la ecuación 1.



A central illustration of a man with glasses and a suit, looking slightly to the side. He is surrounded by various icons related to data collection and analysis, such as a microphone, an envelope, a pencil, gears, a magnifying glass, a bar chart, a line graph, a pie chart, and a smartphone. The background is a light blue.

Recolección de datos

A photograph of a satellite in orbit around Earth. The satellite is positioned in the center-left of the frame, angled towards the bottom left. It has a gold-colored rectangular body with various equipment and solar panels attached. The background shows the dark void of space with a few distant stars. In the upper right, the planet Earth is visible, showing its blue oceans and green continents. A thin white horizontal bar serves as a text overlay.

Mediciones satelitales

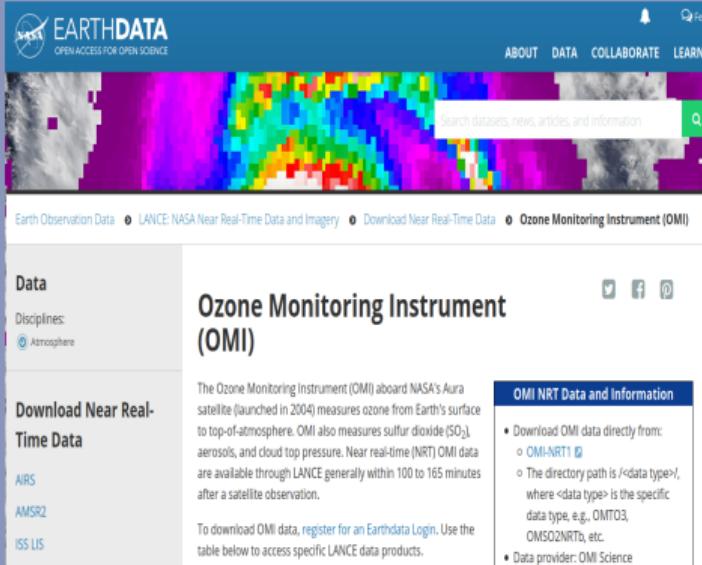


Figura 6: Página web del proyecto OMI. [4]

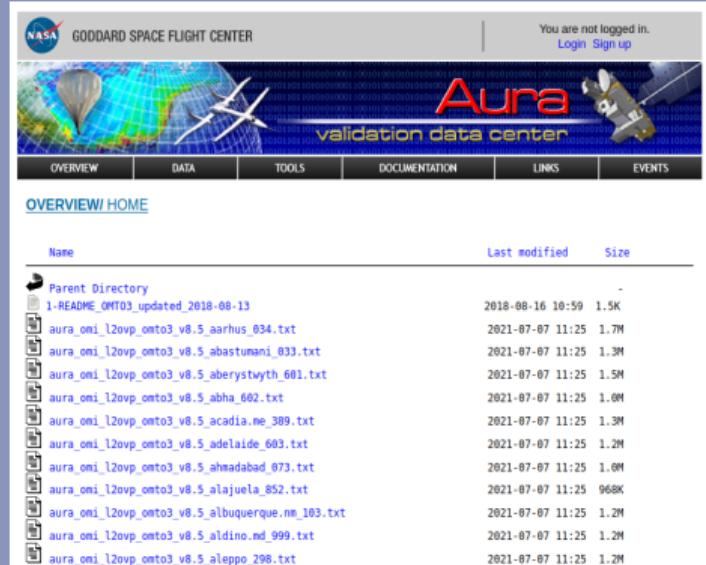


Figura 7: Página web de los datos OMI. [5]

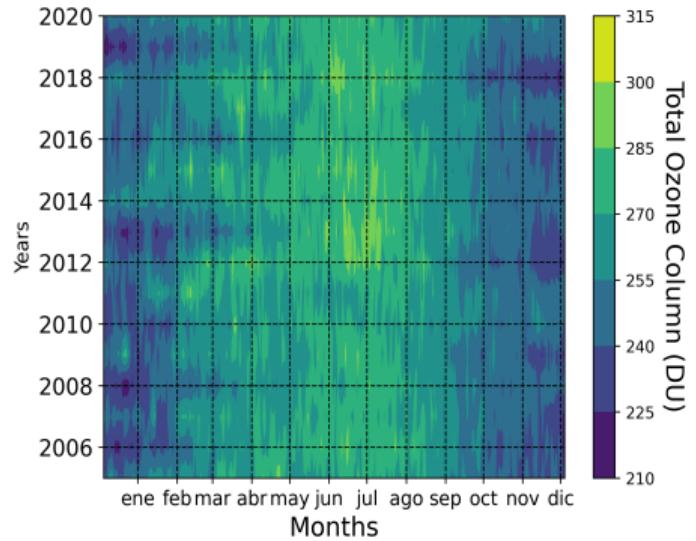


Figura 8: Datos de columnas de Ozono en CDMX.

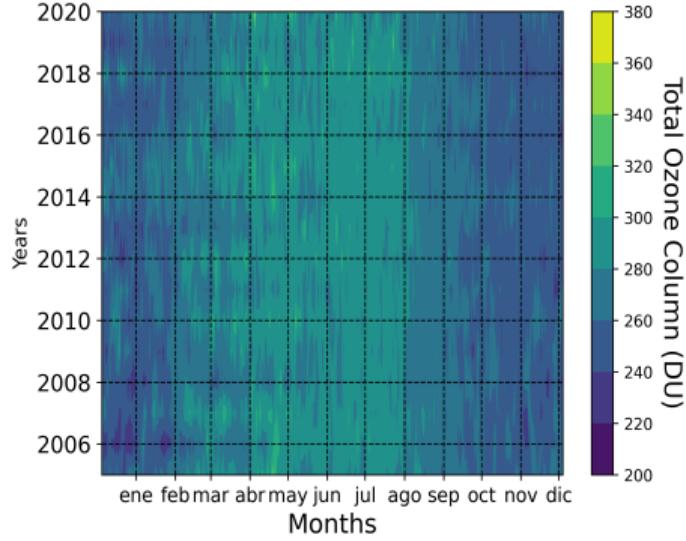


Figura 9: Datos de columnas de Ozono en Monterrey.



Mediciones in situ



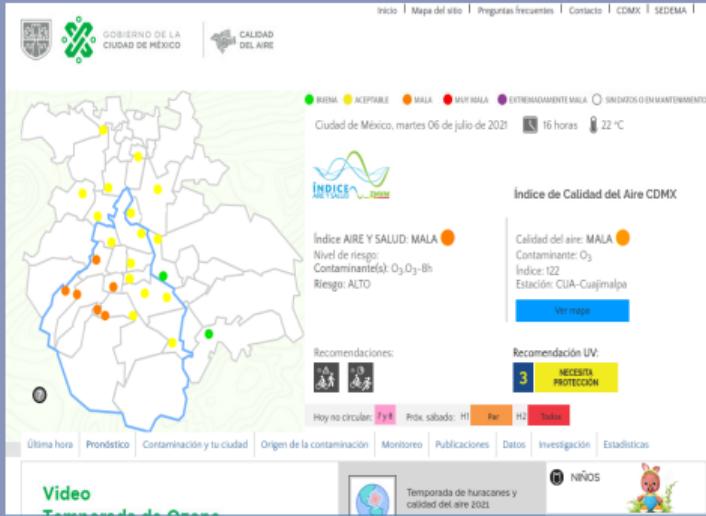


Figura 10: Página web de la SEDEMA. [6]



Figura 11: Página web del SIMA. [7]

UVB → [280nm, 320nm]

UVA → [320nm, 400nm]

UVB+UVA → [280nm, 400nm]

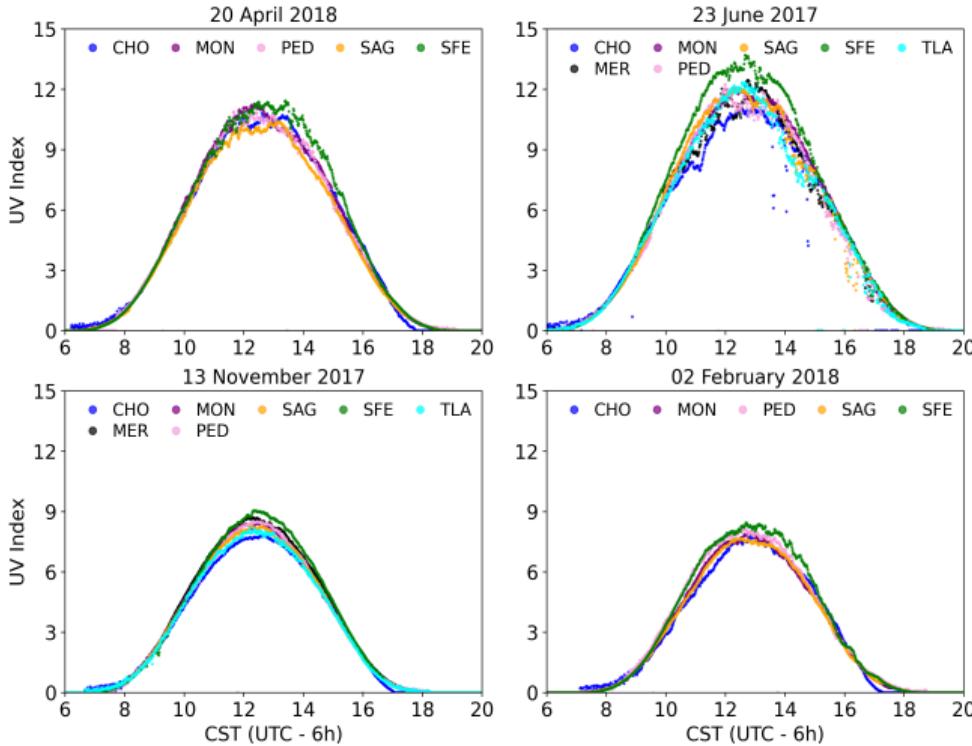


Figura 12: Mediciones de indice UV en las diferentes estaciones de monitoreo de la SEDEMA. [6]

Primera aproximación a la solución:
Búsqueda de los parámetros por
diferenciales

$$RD = \left(\frac{Model - measurement}{measurement} \right) * 100$$

```
while 9 <= RD <= 11:  
    execute_model(parameters)  
    model_result = read_model_results()  
    RD = obtain_RD(model_result,  
                    measurement)  
    if not(9 <= RD <= 11):  
        aod = aod+delta_aod
```

Segunda aproximación a la
solución:

Búsqueda de los parámetros por
medio del algoritmo de búsqueda
binaria

```
while 9 <= RD <= 11:  
    execute_model(parameters)  
    model_result = read_model_results()  
    RD = obtain_RD(model_result,  
                    measurement)  
    if not(9 <= RD <= 11):  
        aod = aod_binary_search(RD,  
                                aod)
```

```
def aod_binary_search(self, aod, RD):
    """
    Función que calcula el AOD que se introducirá en el modelo SMARTS
    este emplea una búsqueda binaria para que sea más eficiente
    """
    if self.RD_search(RD):
        self.aod_i = aod
    elif RD > self.parameters["RD límite"]+self.parameters["RD delta"]:
        self.aod_i = aod
    else:
        self.aod_lim = aod
    aod = self.obtain_aod(self.aod_lim,
                          self.aod_i)
    return aod

def obtain_aod(self, aod_i, aod_f):
    return round((aod_i+aod_f)/2, 3)

def RD_search(self, RD):
    lim_i = self.parameters["RD límite"]-self.parameters["RD delta"]
    lim_f = self.parameters["RD límite"]+self.parameters["RD delta"]
    return lim_i < RD < lim_f
```

Calculando el dia 2015-01-11

AOD_i	AOD	AOD_f	RD
0.01	0.505	1	7.812
0.01	0.258	0.505	17.906
0.258	0.382	0.505	12.764
0.382	0.444	0.505	10.369

Calculando el dia 2015-01-12

AOD_i	AOD	AOD_f	RD
0.01	0.505	1	17.57
0.505	0.752	1	7.194
0.505	0.629	0.752	12.38
0.629	0.691	0.752	9.793

Calculando el dia 2015-01-17

AOD_i	AOD	AOD_f	RD
0.01	0.505	1	16.497
0.505	0.752	1	6.262
0.505	0.629	0.752	11.286
0.629	0.691	0.752	8.764
0.629	0.66	0.691	10.028

Calculando el dia 2015-01-11

AOD_i	AOD	AOD_f	RD
0.01	0.505	1	-1.067
0.01	0.258	0.505	13.109
0.258	0.382	0.505	5.749
0.258	0.32	0.382	9.35

Calculando el dia 2015-01-12

AOD_i	AOD	AOD_f	RD
0.01	0.505	1	7.938
0.01	0.258	0.505	23.347
0.258	0.382	0.505	15.525
0.382	0.444	0.505	11.646
0.444	0.475	0.505	9.806

Calculando el dia 2015-01-17

AOD_i	AOD	AOD_f	RD
0.01	0.505	1	6.977
0.01	0.258	0.505	21.899
0.258	0.382	0.505	14.338
0.382	0.444	0.505	10.58

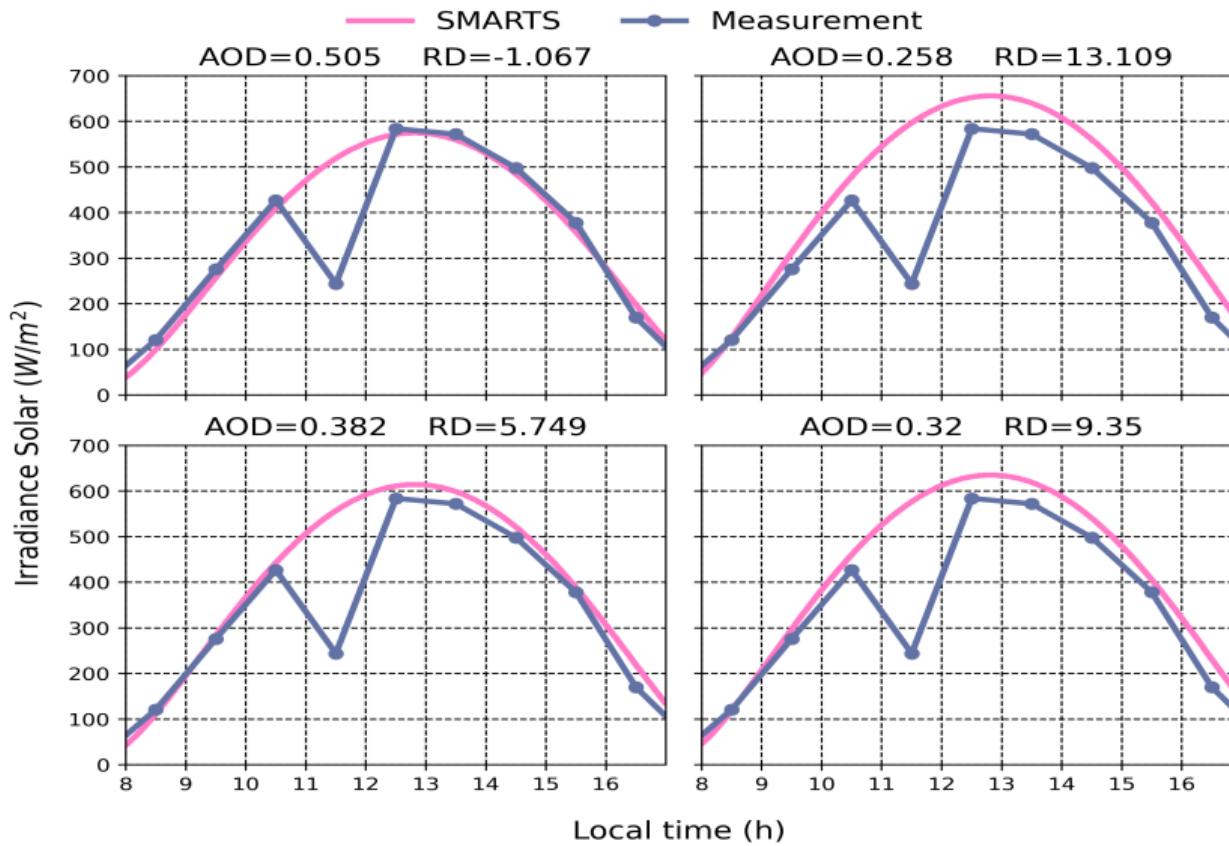


Figura 13: Resultados del Modelo SMARTS haciendo uso de la búsqueda binaria.



THANK YOU

- [1] NCAR, “Atmospheric chemistry observations & modeling.”
<https://www2.acom.ucar.edu/modeling/tropospheric-ultraviolet-and-visible-tuv-radiation-model>, 7 2021.
- [2] NREL, “Smarts: Simple model of the atmospheric radiative transfer of sunshine.”
<https://www.nrel.gov/grid/solar-resource/smarts.html>, 7 2021.
- [3] A. Carramiñana, *Transferencia radiativa*, ch. 2, pp. 1–24.
INAOE, 8 2020.
<https://www.inaoep.mx/~alberto/cursos/radiacion/cap2.pdf>.
- [4] EarthData, “Ozone Monitoring Instrument (OMI).”
<https://earthdata.nasa.gov/earth-observation-data/near-real-time/download-nrt-data/omi-nrt>.
- [5] Goddard Space Flight Center, “Aura Validation Data Center.” <https://avdc.gsfc.nasa.gov/pub/data/satellite/Aura/OMI/V03/L2OVP/OMTO3/>.
- [6] SEDEMA, “Sistema de Monitoreo Atmosférico,Ciudad de México.” <http://wwwaire.cdmx.gob.mx/default.php?opc=%27aKBhnMI=%27&opcion=bQ==>.
- [7] SIMA, “Sistema integral de monitoreo ambiental.” <http://aire.nl.gob.mx/>.