

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

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Modelos de transferencia radiativa

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Modeling

TROPOSPHERIC ULTRAVIOLET AND VISIBLE (TUV) RADIATION MODEL

Tropospheric ultraviolet (UV) radiation is the driving force for all tropospheric photochemical processes. Photons in the UV wavelength have the potential to break usually fairly stable molecules into very reactive fragments (photolysis) and thus initiate reaction chains otherwise unlikely or even impossible. UV radiation is also harmful to living organisms and detrimental to human health. High doses of UV radiation are considered the major contributing factor for the development of skin cancer or cataracts. UV radiation can weaken the human immune system and can affect crop yields and phytoplankton activity (to only name a few effects).

Some questions of interest might be: What factors influence the amount of UV radiation available? What is the vertical structure of the radiative field? What sort of feedbacks (e.g., increased/decreased photolysis rates) can be expected from perturbations that - directly or indirectly - affect UV radiation? What are some of the health-related effects that can be expected from changes in atmospheric composition?

CLIMATOLOGY OF ERYTHEMAL ULTRAVIOLET RADIATION, 1979-2000

The monthly climatological distribution for the period 1979-2000 of daily total erythemal (skin-reddening) ultraviolet radiation at Earth's surface, calculated with the TUV model using satellite-based (Nimbus-7, Meteor-3 and Earth Probe) TOMS (Total Ozone Mapping Spectrometer) observations of atmospheric ozone. The effects of clouds and scattering aerosols are accounted for using TOMS reflectivity at 380 nm.

DOWNLOADS AND TOOLS

- [TUV source code](#) at NCAR Atmospheric Chemistry Observations & Modeling

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

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SMARTS: Simple Model of the Atmospheric Radiative Transfer of Sunshine

OptGrid
Modeling Tools
Solar Integration Data Sets
Wind Integration Data Sets
Solar Resource Data & Tools

SMARTS: Simple Model of the Atmospheric Radiative Transfer of Sunshine

The Simple Model of the Atmospheric Radiative Transfer of Sunshine, or SMARTS, predicts clear-sky spectral irradiances.

Earth's atmosphere is a continuously changing filter that modifies the sunlight that travels through it. SMARTS computes how changes in the atmosphere affect the distribution of solar power or photon energy for each wavelength of light.

SMARTS is a versatile, complex model that requires significant experience and knowledge of basic physics and meteorology, climatology, or atmospheric sciences. It is therefore used primarily by researchers and engineers. Solar energy researchers use SMARTS to test the performance of spectroradiometers, develop reference spectra, establish uniform testing conditions for materials research, optimize daylighting techniques, and verify broadband radiation models. Researchers also use SMARTS in the fields of architecture, atmospheric science, photobiology,

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
=====
```

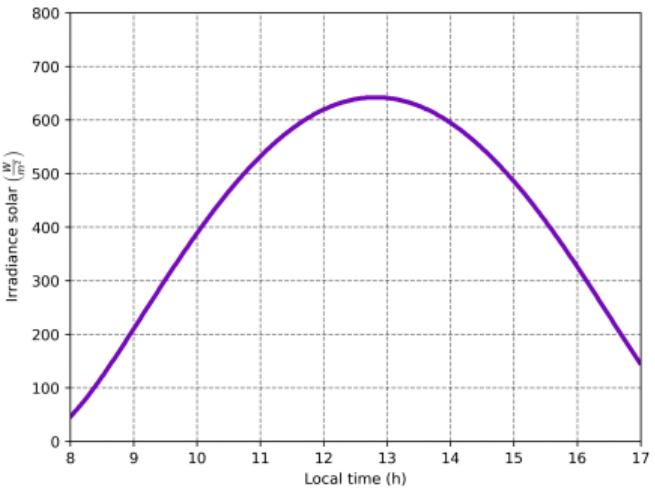
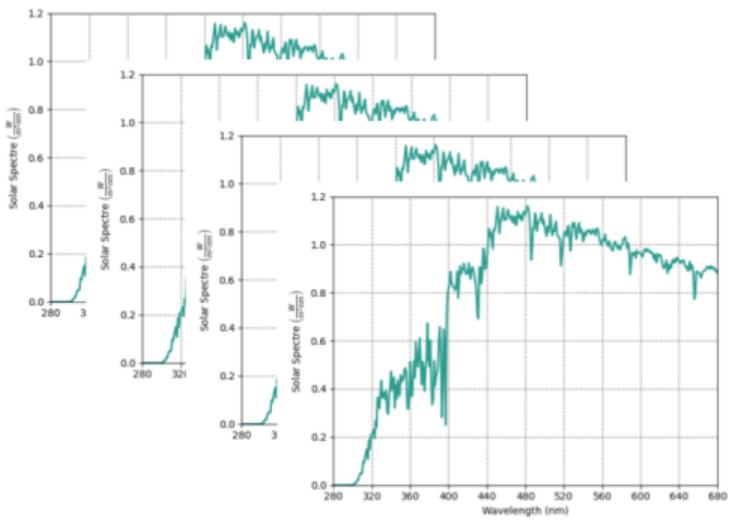
Figura 4: Archivo de inputs del modelo TUV

Figura 3: Archivo de inputs del modelo SMARTS

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

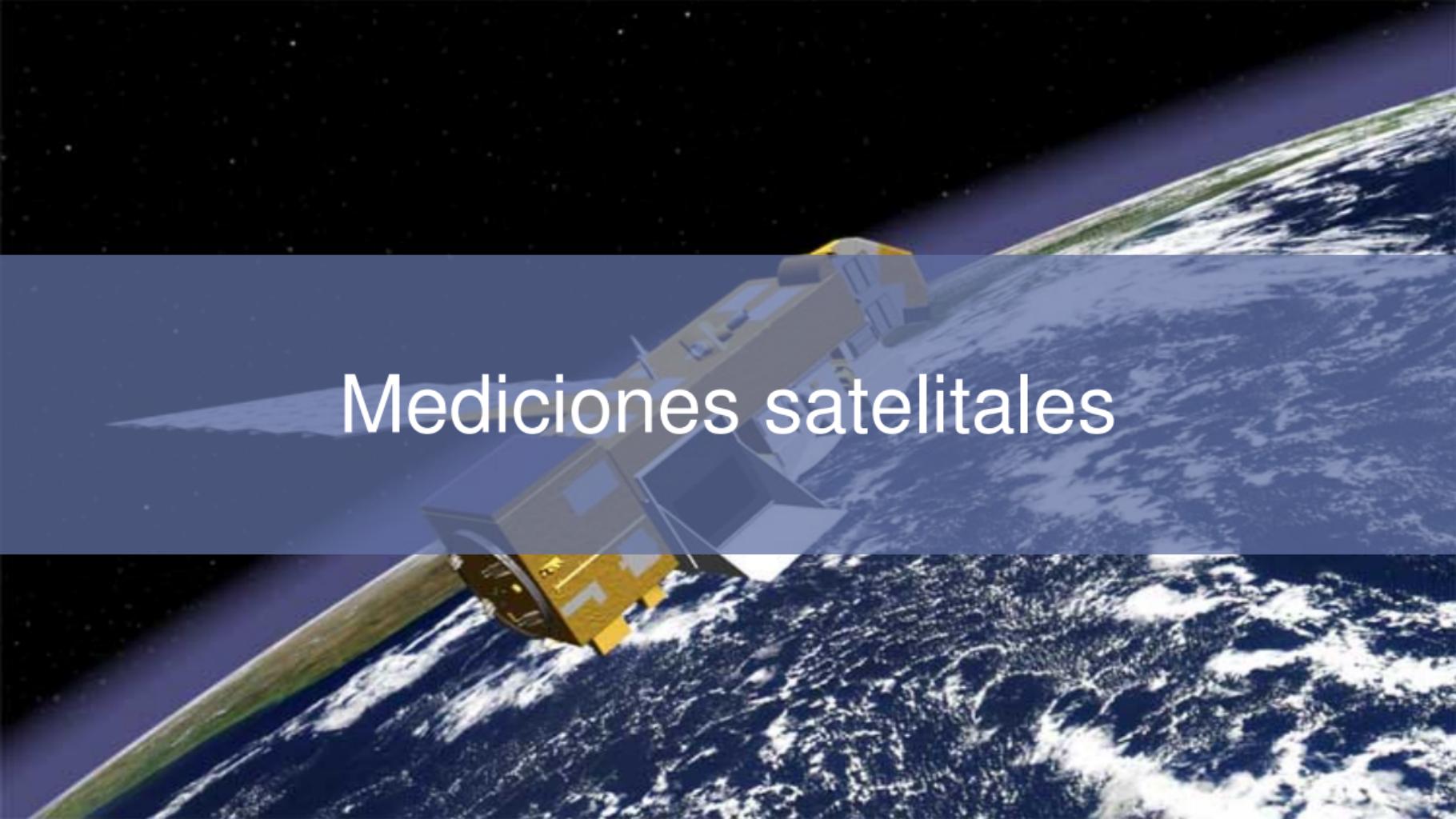
```
# Calculo de la irradiancia solar a partir de los resultados del
# modelo SMARTS
size = np.size(irradiance)
integral = irradiance[0]
for i in range(1, size):
    integral += irradiance[i]*(wavelength[i]-wavelength[i-1])
```

Figura 5: Implementación de la ecuación 1.



A central illustration of a man with glasses and a suit, looking slightly to the side with a thoughtful expression. He is surrounded by various data analysis and business icons, including a microphone, a pencil, gears, a magnifying glass, a bar chart, a pie chart, and a smartphone. The background is a light blue gradient.

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

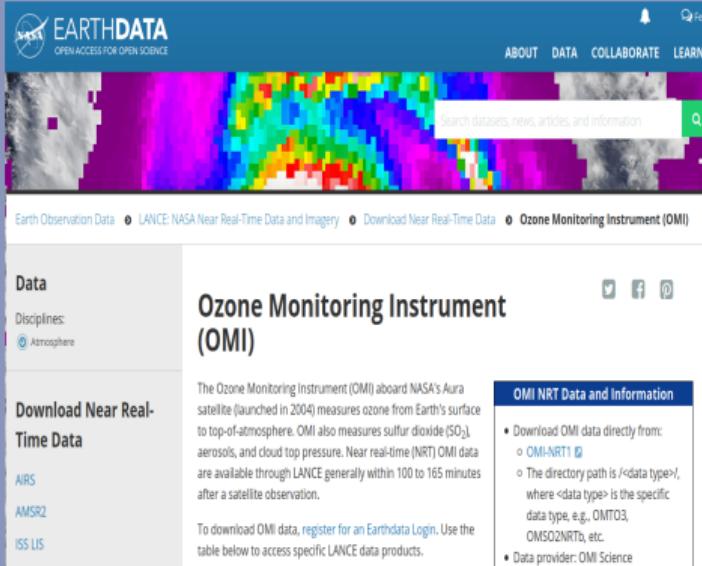


Figura 6: Página web del proyecto OMI. [4]

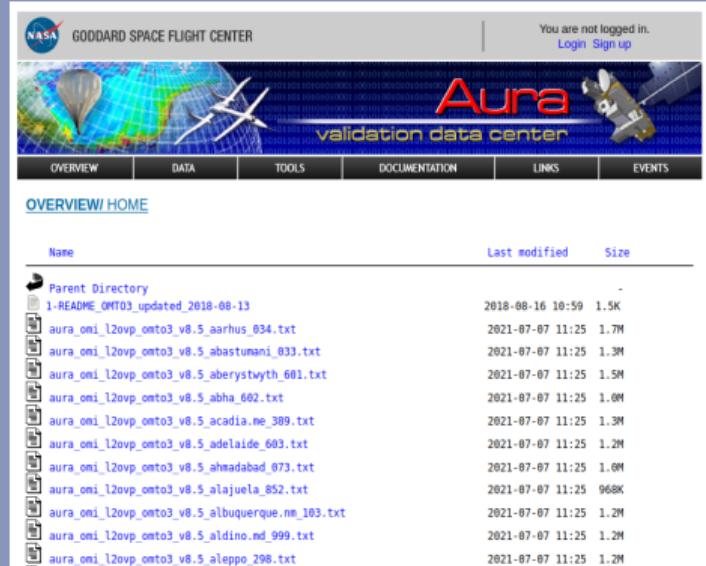


Figura 7: Página web de los datos OMI. [5]

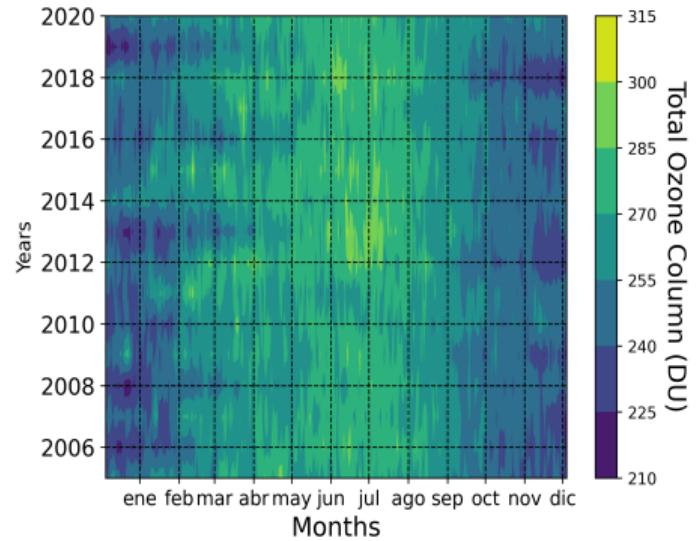


Figura 8: Datos de columnas de Ozono en CDMX.

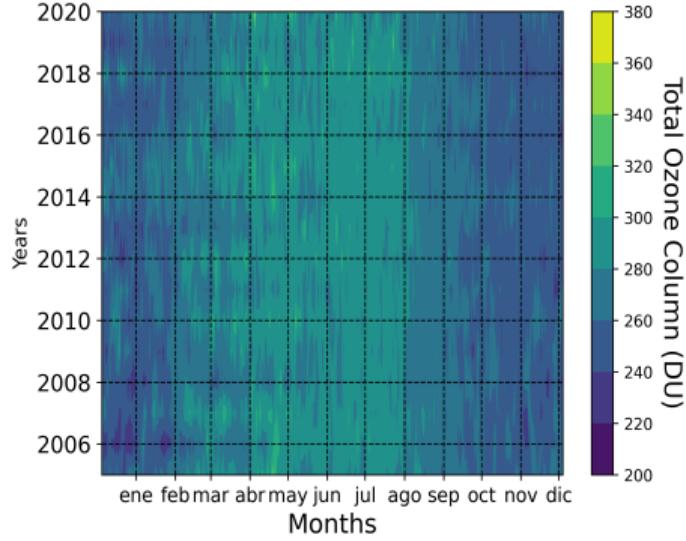


Figura 9: Datos de columnas de Ozono en Monterrey.



Mediciones in situ



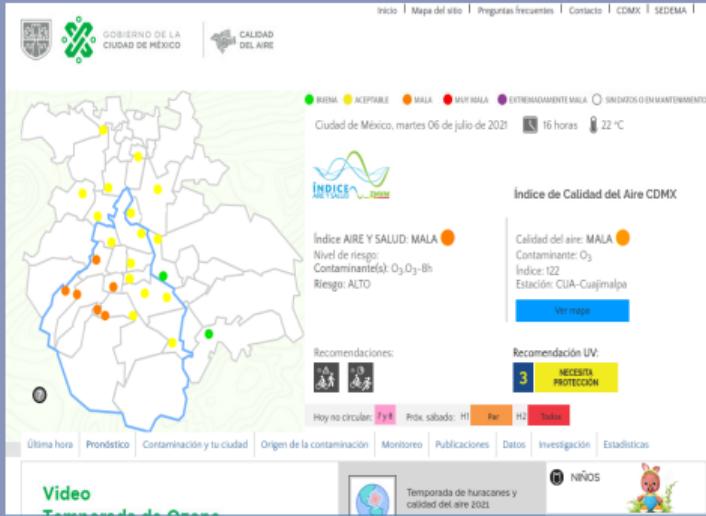


Figura 10: Página web de la SEDEMA. [6]



Figura 11: Página web del SIMA. [7]

UVB → [280nm, 320nm]

UVA → [320nm, 400nm]

UVB+UVA → [280nm, 400nm]

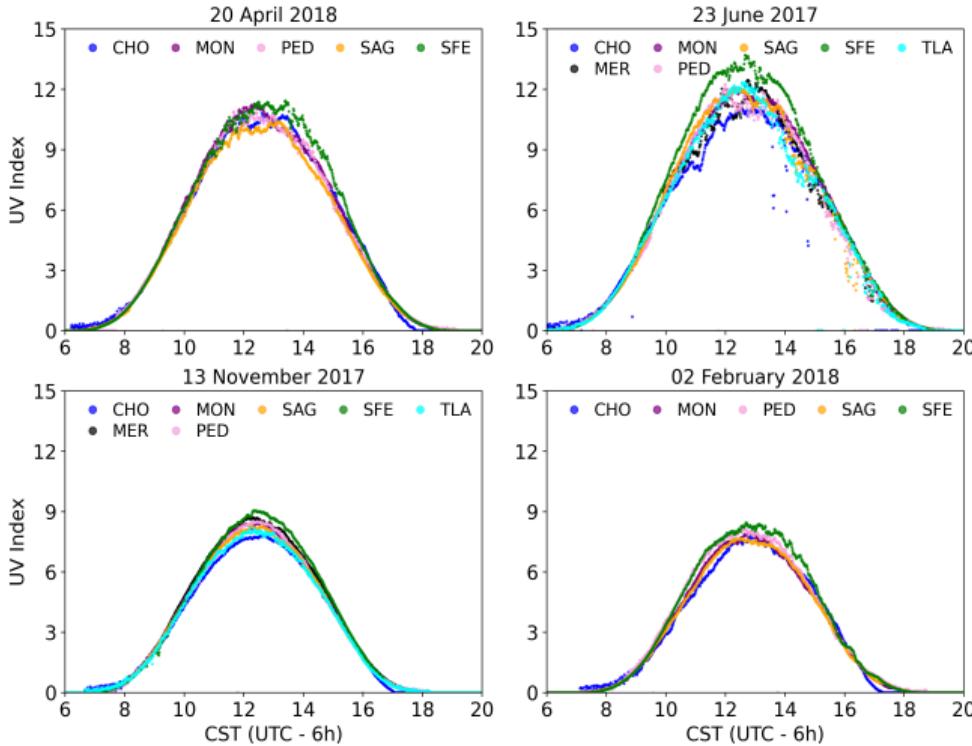


Figura 12: Mediciones de indice UV en las diferentes estaciones de monitoreo de la SEDEMA. [6]

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

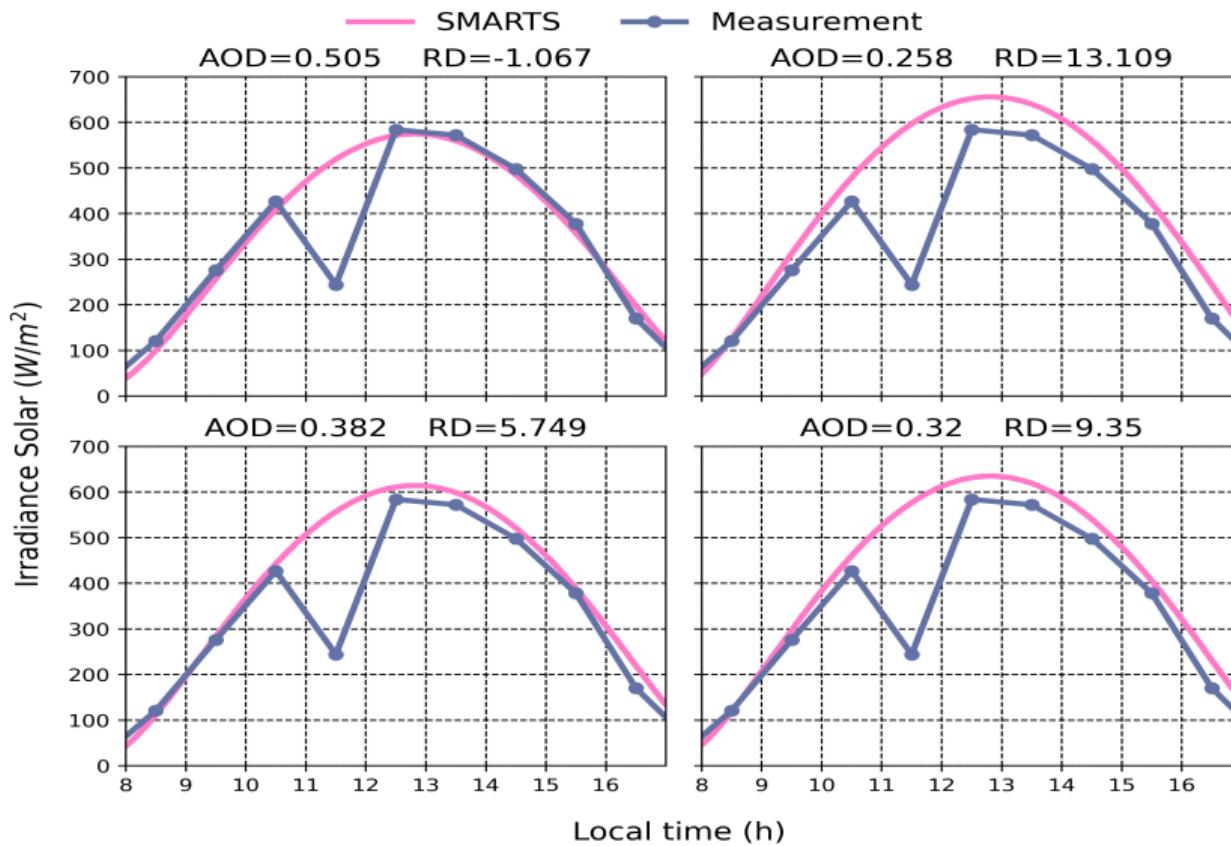


Figura 13: Resultados del Modelo SMARTS haciendo uso de la búsqueda binaria.



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/>.