Determination of the Broadband Aerosol Optical Depth Baseline and comparison with sunphotometer data.

F. GARCÍA, R. ESTEVAN, J. C. ANTUÑA, J. ROSAS,
I. Y. PLATERO, J. C. ANTUÑA Jr. , N. DÍAZ
Grupo de Óptica Atmosférica de Camagüey
CMPC – INSMET, Camagüey, Cuba.

Abstract:

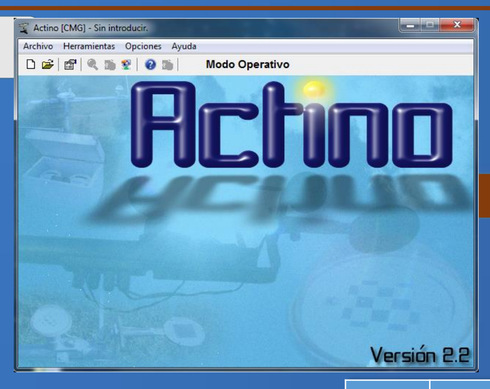
The Broadband Aerosol Optical Depth (BAOD) was calculated for Camagüey Actinometric Station (EAC) using the methodology described by Gueymard (1998). The main data source was the Solar Radiation Database of EAC (for 1981-2013 period). The BAOD calculation was performed for observations with total cloud coverage equal or less than one tenth of sky (Clear Sky, HCD) and for actinometric observations with *Squared Sun* solar disk. To determine the BAOD Baseline the periods of *El Chichón* and *Pinatubo* volcanic eruptions were eliminated. The average value of BAOD for the entire period and for aerosol background conditions is 0.115 (± 0.075) with a decreasing trend of -1.20 x 10^{-6} day^{-1}. The results were compared with spectral AOD values obtained from a sunphotometer near to the station. The highest correlation values were obtained for the wavelengths of 500 and 675 nm, with an R^2 = 0.45 for both cases.

A

Actino 2.2 program (B) and Camagüey Actinometric Station (C). The observations are manually enhanced and then are introduced to the software. The observer selects the solar disk with which he made the observation and reports the amount of sky covered by clouds. For the calculation of BAOD, observations with total cloud coverage equal or less than one tenth of sky (Clear Sky, HCD) and actinometric observations with Squared Sun solar disk (SC) were used (HCD+SC).

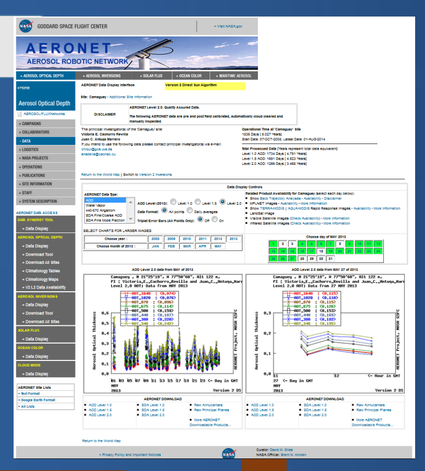
Squared Sun Disk: ⊙²
In the solar disk and in a 5° area around it there is no trace of clouds, fog, haze, smoke, or dust.

B



C

D



E

CIMEL CE-318 sunphotometer (D) and webpage of Camaguey Site in AERONET (E). The sunphotometer is installed near the EAC and it has been operational since 2008. Mean values of Precipitable Water Vapor (WV) were obtained from AERONET.

Month	WV (cm)
JAN	2.76
FEB	2.71
MAR	2.58
APR	3.14
MAY	3.43
JUN	4.29
JUL	4.11
AUG	4.31
SEP	4.43
OCT	4.20
NOV	3.20
DEC	2.81

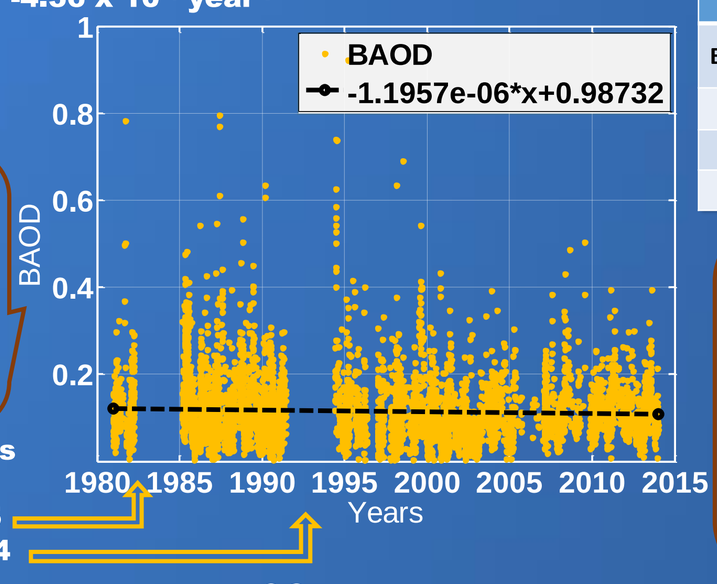
Instantaneous values of WV were also used to compare BAOD and spectral AOD. Table shows monthly mean values used.

The table shows the number of cases for each selection criterion for calculating the BAOD. The selection criterion used is the broadest of the three related with almost twice the observations that the HCD.

Camagüey Actinometric Station (EAC) is located at 21.42° N, 77.87° W, 118 m ASL. The station is part of the Solar Radiation Diagnostic Service for Cuba (A). On the map the rest of the stations that are part of the service.

Criteria	Observations	%
HCD	3317	3.32
SC	5460	5.46
HCD + SC	**6497**	**6.50**

Trends:
-1.20 x 10^{-6} day^{-1}
-4.36 x 10^{-4} $year^{-1}$

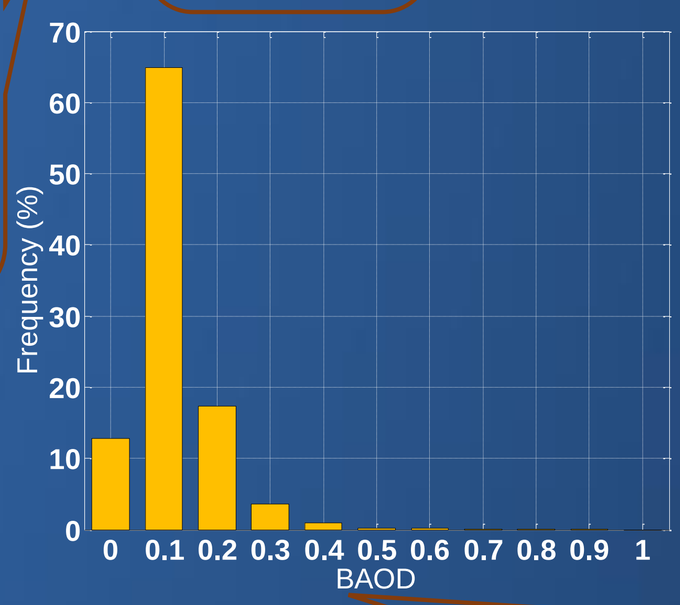


BAOD series for the entire period, calculated for observations that meet the criterion HCD + SC. Gaps in the figure correspond to periods of volcanic eruptions and periods with missing data. The trend found is significant at 99.9%

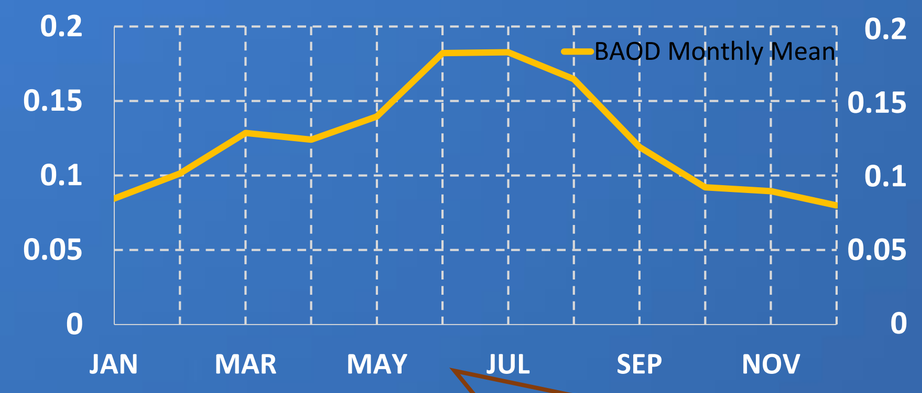
Gaps representing volcanic eruptions periods:
El Chichón 4/APR/1982 to 4/MAR/1985
Pinatubo 15/JUN/1991 to 15/MAY/1994

	Max.	Min.	Mean	Std. Dev.
BAOD	**9.22 x 10^{-1}**	**0.25 x 10^{-2}**	**1.15 x 10^{-1}**	**7.47 x 10^{-2}**
δ_c	1.18 x 10^{-1}	4.25 x 10^{-2}	9.97 x 10^{-1}	1.31 x 10^{-2}
δ_{nt}	9.75 x 10^{-4}	6.09 x 10^{-4}	9.55 x 10^{-4}	3.62 x 10^{-5}
δ_w	1.84 x 10^{-1}	2.69 x 10^{-2}	1.17 x 10^{-1}	3.15 x 10^{-2}

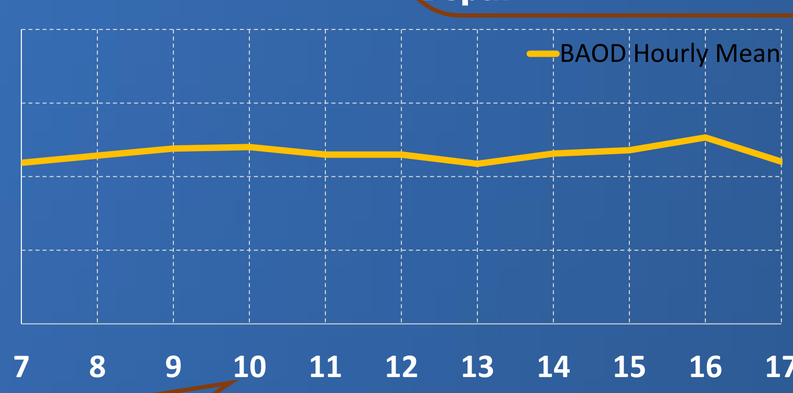
Main statistics for BAOD and the rest of the components of the Gueymard methodology.
δ_c: Clean Dry Atmosphere Optical Depth
δ_{nt}: Nitrogen Dioxide Optical Depth
δ_w: Water Vapor Optical Depth



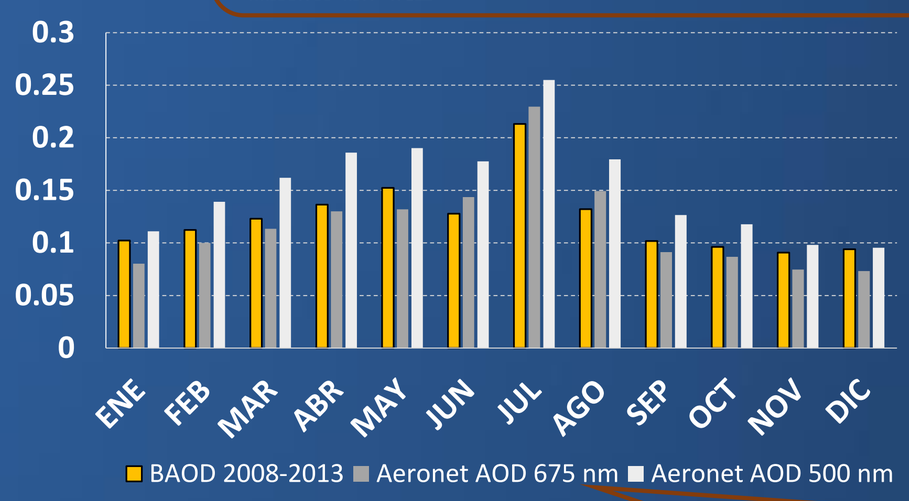
The largest number of cases were focused on 0.1 with more than 60% of the sample. The cumulative frequency from 0 to 0.1 is 77.6% and becomes almost 95% when the values are taken as 0.2



The annual course shows the maximum grouped in the summer months, June, July and August.
This is consistent with the effect on those months of Saharan dust events in the Caribbean region reported by several authors.
Max: July (0.183) Min: December (0.079)



The diurnal course of BAOD doesn't show large variations. Between 07 and 10 LT slight growth trend is observed and then decreases to find the minimum value at 13 LT with 0.109.
Max: 16 LT (0.126) Min: 13 LT (0.109)



The months of January, November and December show lower percentage differences between the mean values of BAOD and AOD at 500 nm. In the remaining months these differences are smaller for the AOD at 675 nm.

Conclusions

- **A new and broader criterion for selecting observations to calculate the BAOD was applied.**
- **The BAOD Baseline at EAC was determined for the entire period, with an average value of 0.115 (± 0.075), a maximum of 0.922 and a minimum of 0.25 x 10^{-2}.**
- **The trend for the whole period was negative, with a value of -1.20 x 10^{-6} day^{-1} (-4.36 x 10^{-4} $year^{-1}$) and a statistically significant at 99.9%.**
- **The annual course of BAOD showed an average growth in the summer months, consistent with reported by other authors.**
- **The comparison made with the spectral AOD measurements derived from sunphotometer showed better results for 500 and 675 nm wavelengths.**

Acknowledgements

Authors want to thank to Victoria Cachorro Revilla and Juan C. Antuña Marrero for theirs effort in establishing and maintaining Camagüey site.
We thank GOA-UVA team by support and logistic.