

Cuba- National Report
10th WMO/UNEP Ozone Research Managers Meeting
Geneva, 28-30 March 2017

OBSERVATIONAL ACTIVITIES

Program of measurements of the total amount of atmospheric ozone and ultraviolet solar radiation (UV-B)

Total Ozone

- The measurements of total amount of ozone at Havana Ozone Station continue from February 2011 until August 2015 when Havana Ozone measurements are interrupted due to difficulties with the transportation of the instrument.
- . The Dobson No.67 was calibrated last time in the IV Regional Dobson Intercomparison in Buenos Aires, Argentina between Nov and Dec 2010 where the instrument was subjected to a deep revision.
- We have assisted and supported the colleagues at the Solar Radiation Observatory of the National Autonomous University of Mexico to restart total ozone measurements with Dobson spectrophotometer #98 after being repaired at NOAA/ESRL/GMD in charge of Robert Evans. Currently the instrument is operational and the station of Mexico City is reporting daily to http://exp-studies.tor.ec.gc.ca/e/ozone/Curr_allmap_g.htm

UV Measurements

- Due to problems with the radiometer (Biometer 501 No.2853 No.2853 manufactured by Solar Light) for UV solar radiation measurements and UV index determination at Havana station these measurements are interrupted since April 2012.
- In any case, partly compensating the lack of ground measurements, an analysis was made of the behavior of the UV index for Havana based on information from OMI (aura_omil2ovp_omuvb_vO3_havana.txt). The statistical analysis of these data were the subject of a bachelor degree thesis at Havana University, no significant trend was found for UV solar radiation for the period 2004-2013 at Havana station.

Stratospheric Aerosol

Grupo de Optica Atmosferica de Camagüey (GOAC) from INSMET, Cuba From 1989 to 1994: Stratospheric aerosols lidar measurements for the Mt. Pinatubo eruption. (*Antuña et al.*, 2002). Measurements interrupted because of the lack of spare parts and instrument aging. This year the Max Plank Institute for Meteorology offered the equipment and parts to refurbish the lidar, pending approval of Cuban authorities.

2008 to the present: Aerosol spectral optical properties with sun photometer in Camagüey in cooperation with the University of Valladolid, Spain. Measurements have been contributed also to AERONET (*Antuña et al.*, 2016).

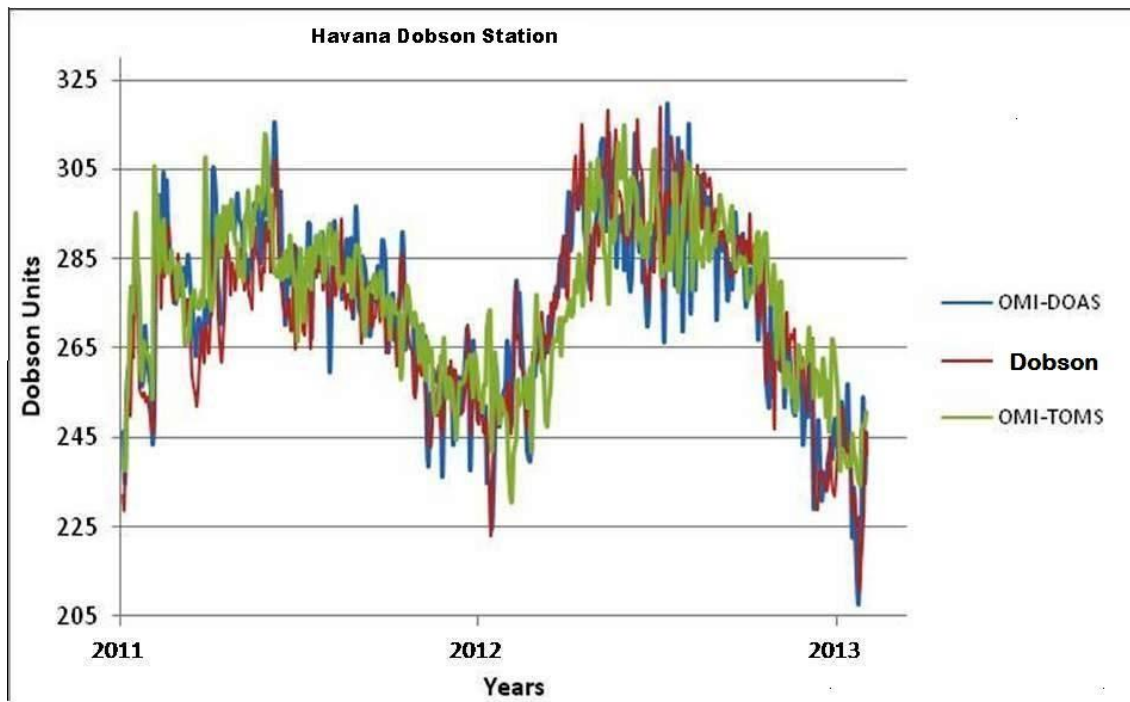
RESULTS FROM OBSERVATIONS AND ANALYSIS

The study of ground measurements at Havana station and those from the OMI instrument over the same location, and at Camaguey station, located Eastward on the National Territory show, in agreement with former reports, the following results.

The total ozone distribution over the National Territory is well defined by an annual cycle with maxima in the summer months and minima in the winter months. The amplitude of this cycle is of about 40 Dobson Units and its mean value is 275 Dobson Units

Regarding the spatial distribution over the National Territory, the total ozone content shows a small latitudinal gradient of about 2 DU between the Eastern and the Western regions in the winter season. In the summer this gradient turns bigger reaching 10 DU in May. The small values in latitude are explained by the disposition of our territory, which practically spans over a single latitude (rigorously just a range no larger than 3.5 degrees). As previously pointed out, the most relevant feature is the wide annual cycle of the TOC.

In addition to the annual cycle, TOC also shows two other seasonal cycles. It is known the variation of ozone following the quasi-biannual oscillation of stratospheric wind, with its greater value precisely over the Equatorial region. At our territory's location, this signal is less visible, but still existent (Bojkov and Fioletov, 1996).



Cuban scientist on lidar measurements from GOAC participated in the WMO panel in charge designing GAW Aerosols Lidar Observation Network (GALION):

J. Bösenberg, R. Hoff, A. Ansmann, D. Müller, J. C. Antuña, D. Whiteman, . Sugimoto, A. Apituley, M. Hardesty, J. Welton, E. Eloranta, Y. Arshinov, S. Kinne, V. Freudenthaler, (2008), Plan for the implementation of the GAW Aerosol Lidar Observation Network GALION. GAW Report No. 178, WMO TD No. 1443, 45 pag.

DISSEMINATION OF RESULTS

Data reporting

All data obtained so far has been sent to WODC, an can be consulted on http://esee.tor.ec.gc.ca/cgi-bin/total_ozone/ until august 2015 when Havana Ozone measurements are interrupted due to difficulties with the transportation of the instrument

Relevant scientific papers

GOAC members promoted and facilitated the series of Workshops on Lidar Measurements in Latin America from 2001 to the present and the foundation of the Latin American Lidar Network (LALINET). LALINET is one of the regional lidar networks associated to GALION:

J. C. Antuña-Marrero, E. Landulfo, **R. Estevan, B.Barja**, A. Robock, E. Wolfram, P. Ristori, B. Clemesha, F. Zaratti, R. Forno, E. Armandillo, A. E. Bastidas, A. M. de FrutosBaraja, D. N. Whiteman, E. Quel, H. M. J. Barbosa, F. Lopes, E. Montilla-Rosero, J. L. Guerrero-Rascado, 2016, LALINET: The first Latin American-born regional atmospheric observational network. Bull. Amer. Meteor. Soc., <http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-15-00228.1>

Antuña, J. C., A. Robock, G. L. Stenchikov, L. W. Thomason, and J. E. Barnes, (2002): Lidar validation of SAGE II aerosol measurements after the 1991 Mount Pinatubo eruption. *J. Geophys. Res.*, 107(D14), 4194, doi:10.1029/2001JD001441

PROJECTS, COLLABORATION, TWINNING AND CAPACITY BUILDING

- Currently we do not have collaboration any project with foreign institution.

Recommendations 10- ORM

- It would be helpful for technicians who perform measurements and processing of measurements with the Dobson spectrophotometer to be able to attend courses similar to those held at the Hradec Kralove Observatory (Czech Republic) in the same way as holding Dobson Data Quality Workshop which took place in Hradec Kralove in 2011.
- The Dobson Intercomparisons have been greatly extended and now are hardly ever performed every six years, at least for the III and IV WMO's Regions. We consider that the Intercomparisons of the Dobson instruments should be realized at least every four years.

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