

# CUBA

## Introduction

The Institute of Meteorology of the Ministry of Science, Technology and Environment of Cuba is the institution responsible for the activities directed to the study of the behavior of the Ozone Layer and ultraviolet Solar Radiation.

## OBSERVATIONAL ACTIVITIES

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

The program of measurements of the total amount of ozone and ultraviolet solar radiation (UV-B) is in charge of the group of Solar Radiation and Atmospheric Ozone of the Center of Physics of the Atmosphere of the Institute of Meteorology and is carried out at the station of Havana (23° 10' N, 82° 21' W, 50 m) - site of the Institute of Meteorology of Cuba.

Measurements of total amount of atmospheric ozone started being carried out in a regular way in Cuba by mid 1981, using for these purposes filter ozonometers type M-83 and M-124 of Soviet origin. The program was carried through, with intervals without measurements during 1984 and from December 1992 until November 1998 being finally interrupted on July 2000, due to the lack of ozonometers in the required technical condition.

This monitoring program, from 1985 on, was framed as the investigation topic; "Study of the variations of the total amount of atmospheric ozone in the presence of tropical hurricanes", in the Cuban-Soviet collaboration program for the study of the tropical atmosphere and hurricanes, what allowed, in first place, to establish a regular regime of measurements of the ozone layer in our territory, and the development of investigations about the variability of the atmospheric ozone in the presence of tropical hurricanes for our region. The results of this investigations were materialized with the presentation of contributions to the International Symposia on Tropical Meteorology, that were held in Havana (April, 1987) and Obninsk (1991) and the publication of several papers (Gushchin et al, 1987), (Gushchin. G.P, Peláez. J.C et al, 1991).

In late 2003, after the incorporation of the Dobson Spectrophotometer #67, in the II Regional Dobson Intercomparison for WMO Regions III and IV held in Buenos Aires, Argentina (Nov-Dec 2003), Total Ozone monitoring resumed at Havana station (STN 311).

Regrettably, the monitoring program has been often interrupted by remodeling and constructive activities under way at the Institute of Meteorology, as the Dobson instrument could not be taken to another location. More in detail, measurements have been carried between the months of June to October 2006, June to October 2007,

March to October 2009 and April to October 2010. Currently regular measurements are under way since February 2011, after participating in the IV Regional Intercomparison, held at Buenos Aires in Nov-Dec 2010

We expect that, counting on greater support from meteorological authorities, the measurements program with Dobson #67 can be carried out without interruptions. All data obtained so far has been sent to WODC, and can be consulted on [http://es-ee.tor.ec.gc.ca/cgi-bin/total\\_ozone/](http://es-ee.tor.ec.gc.ca/cgi-bin/total_ozone/)

### **UV Measurements**

The program of surveillance of the ultraviolet radiation had its origin in a program of measurements that was carried out in the station of Havana (23° 10' N, 82° 21' W, 50 m) from 1984 to 1985 with the use of a filters instrument developed at the Main Meteorological Observatory in Postdam. Starting on March 2011, a program of measurements of the solar ultraviolet erythemal radiation has begun as part of the project "Study of the behavior of the Ozone Layer on Cuba" in collaboration with the Observatory of Solar Radiation of the Institute of Geophysics of the Autonomous University of Mexico and the National Meteorological Service of Argentina, the instrument used is a Biometer 501 #2853 manufactured by the firm Solar Light.

Together with the measurements of the total amount of ozone and ultraviolet solar radiation the Group of Solar Radiation and Atmospheric Ozone of the Center of Physics of the Atmosphere of the Institute of Meteorology of Cuba in the Havana Station is in charge of a research program for the solar ultraviolet radiation and other related magnitudes in the country.

### **Calibration activities**

Participation has taken place at the 2006 and 2010 intercomparisons. It was concluded at both events that measurements made in the periods previous to each one, didn't need to be re-evaluated, as the instrument's constants remained with no change. At the IV Intercomparison, between Nov and Dec 2010 the instrument was subjected to a deep revision where some mechanic and electric defects found were corrected.

We would like to highlight the support from Dr. Robert Evans from NOAA/ESRL/GMD, thanks to whom these Intercomparisons have turned so much useful for the good functioning of these instruments. We also thank Argentina's authorities and specialists from the Meteorological Service for their excellent hospitality, their welcome and assistance, that made the IV Regional Intercomparison of Dobson spectrophotometers and UV radiometers a successful event.

## RESULTS FROM OBSERVATIONS AND ANALYSIS

With regard to the series of observations, an analysis of measured data has been made jointly with data from TOMS and OMI instruments on board of satellites Nimbus7, Earth Probe and Aura, both, the Over Pass and satellite cover for our territory and near by region. <http://toms.gsfc.nasa.gov/overpass/city.html>, <http://toms.gsfc.nasa.gov/ozone/ozoneozone.html>

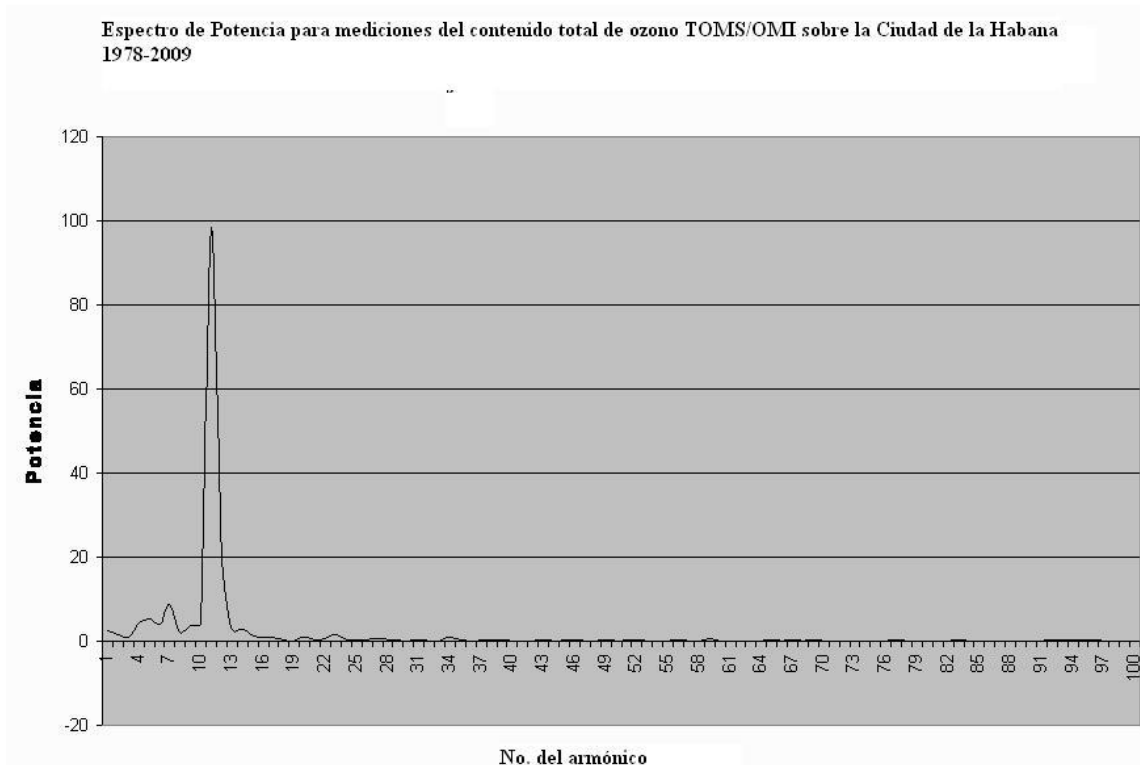
### Results

- 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).

With the purpose of detailing periodicities along this series, the Fourier transform was applied so the power of different harmonics could be displayed.

Figure 1 shows this power spectrum of TOMS/OMI measurements, where a considerable maximum is observed harmonic # 11, which has a period of 372 days, the next harmonic also shows a high value, and corresponds to a period of 341 days. As it is logical to assume, these maxima correspond to the relevant annual cycle of TOC) which lays closest to harmonic 11

Total ozone variation associated to the quasi-biannual oscillation can also be seen in the smaller maximum between harmonics 6 and 7 which corresponds to a period between 585 and 682 days, which is close, but doesn't reach the 2 years.



### Main lines of research

The main lines of investigation embraced in the project “Study of the behavior of the Ozone Layer in Cuba” are directed to the investigation of possible variations of the total amount of ozone in the presence of tropical hurricanes for our region. Equally it is objective of the project to characterize the behavior of the total content of ozone in our region.

With regard to the characterization of regime of ultraviolet solar radiation and in the specific case of the ultraviolet solar radiation of erythemal effect, it is necessary to point out that due to the location of the Havana station (urban type), the program of measurements is directed to the study of the behavior of this component of the radiation flux only for the City of Havana. A no less important objective of the project is the forecast of the index of UV radiation in several locations of the country that require of this type of information for its socioeconomic importance.

## DISSEMINATION OF RESULTS

### Data reporting

Monthly resumes of the TOC measurements made at Havana station (STN 311) up to March 2011 have been sent to WOUDC, and can be consulted at <http://es-ee.tor.ec.gc.ca/cgi-bin/totalozone/>

### Information to the public

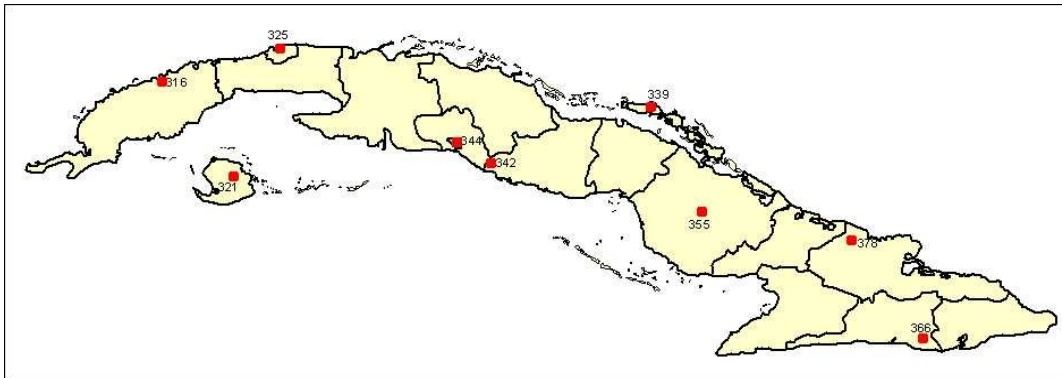
We have plans to start in this year an UV forecast for the whole National Territory

### Relevant scientific papers

There are two papers under way

## FUTURE PLANS

Following one of the recommendations included in the issue related to Surface Networks at the 7<sup>th</sup> ORM where the priority of establishing new stations for the monitoring of UV radiation on tropical regions, this year (2011) we expect to establish the UV stations network based on UVA and UVB solar radiation instruments. The stations are located at the same places of the already installed automatic meteorological stations, which measure, in addition, the global component of solar irradiance. It's important to state that most of the instruments that we are using use termopiles as sensor devices, therefore in the topic related to needs, we request some international collaboration to allow us replacing these instruments by others of higher quality and known performance (Broad band radiometers specifically).



## NEEDS AND RECOMMENDATIONS

- It's important to state that skin cancer is the fastest growing cancer type in Cuba, so health authorities pay great attention to all factors that might influence the behavior of this pathology, amongst them, the levels of UV radiation. In addition, the greatest number of medical consults given to visiting tourists is related to skin injuries due to extensive exposition to solar radiation. An increased knowledge of UV solar radiation levels would improve not only the general health of our population, but also that of visiting foreigners, mostly from Europe and Canada.
- We wish to highlight that for the tropical region where we stand, UV levels are high. On the other hand **“SPARC Report on the Evaluation of Chemistry Climate Model”**, (Final Review Meeting in Toledo, Spain, November 9-11, 2009). **Models consistently predict a partial recovery of tropical ozone followed by a decrease in the second half of the 21th century, such that the tropical column ozone is predicted not even to return to 1980s values within this century; the long-term decrease is mainly found in the lower stratosphere.** It is important that calibration of UV monitoring instruments be made with a periodicity of at least two years, and that in the same manner in which Dobson spectrophotometers are thoroughly analyzed, UV radiometers are fully investigated. In other words, not only a comparison with some reference instrument, but an analysis of the spectral response and other characteristics of the instruments. According to all of this, we consider that it is necessary the onset of a Regional Reference and Calibration Laboratory of UV instrument for WMO Regions III and IV.
- It's also important that through the Vienna Convention Trust Fund for Research and Systematic Observations, the UNEP's Compliance Assistance Programme (CAP) or other funding sources, the participation of personnel from our region to the excellent training course that specialists from SOO Hradec Kralove at the Czech Republic offer be enabled.
- We would like to propose also that developing countries could count on international funds that allow them to participate at workshops and Symposia.