

10TH MEETING OF OZONE RESEARCH MANAGERS OF THE PARTIES TO THE  
VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER.  
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**NATIONAL REPORT - BRAZIL**

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## THE BRAZILIAN NETWORK OF OZONE AND UV RADIATION MEASUREMENTS

The human activities have disturbed the natural balance of atmosphere composition (WMO, 2014). This fact has produced global scale issues like ozone layer depletion and climate change around the world. The scientific researches are very important to follow the changes of the environment and expand the knowledge. But the most important is to stop the liberation of ODS (Ozone Depletion Substances) and the GHG (Green House Gases), through activities that are sustainable and not harmful to the environment. Brazil acceded to the Montreal Protocol through Decree No. 99,280 on June 6th, 1990, becoming a Party. The ODS were banned in 2010, but the GHG emissions continue happening, in urban areas and mainly in the Amazon rainforest. That is the biggest environmental crime that our politicians are committing against the Earth. The international commissions should urgently interfere in order to change this scenario. There is no emissions inventory of ODS in Brazil, but yes for GHG in the main cities.

### 1- OBSERVATIONAL ACTIVITIES

#### 1.1 Column measurements of ozone and other gases/variables relevant to ozone loss:

Ozone research in Brazil is 42 years old. The first Dobson Spectrophotometer was installed in the city of Cachoeira Paulista – SP in 1974 and the second one in Natal - RN in 1978. Since then was established the first site for ozone monitoring in the tropics to provide continuous data for national and international researches. Also in Natal was installed in 1994 a spectrophotometer Brewer and in 2009 a GUV radiometer to study the ozone layer, ultraviolet radiation and photosynthetically active radiation. In 2006, was created the LAVAT - Laboratory of Tropical Environmental Variables, where the ozone activities are conducted. From then on, a meteorological station (2006) and a solarimetric station (2007) were installed in INPE-Natal-RN. Besides that there are Brewer spectrophotometers in Cuiabá, Santa Maria and La Paz (Bolívia). The Brazilian Antarctic Station Comte. Ferraz has not been operating since 2012 due to a fire. The GHG measurements are made in Farol de Mãe Luiza, Natal since 11/25/2015.

**Table 1 – INPE's network spectrophotometers Dobson and Brewer.**

SITE	LAT. (SOUTH )	LONG. (WEST )	DOBSON NUMBER	BREWER R NUMBE R	PERIOD and TYPE
NATAL BRAZIL	5.84°	35.21°	093 since 1978 - today	110 073	1994-1996 MARK IV 1996 - today MARK IV
CUIABÁ BRAZIL	15.3°	56.1°	-	056 081	1991-1997 MARK II 2002-today MARK IV
LA PAZ, BOLÍVIA	16.54°	68.06°	-	110	1996-2004 MARK IV
CACHOEIRA PAULISTA BRAZIL	22,68°	45,00°	114 since 1976 - today	124	1997- today MARK IV
SAO JOSE DOS CAMPOS BRAZIL	23,2°	45,86°	-	056	2000 - 2006 MARK II
SANTA MARIA BRAZIL	29,26°	53,48°	-	081 056 167	1992-1998 MARKIV 2000-2002 MARK II 2003 - today Mark III

## 1.2 Profile measurements of ozone and other gases/variables relevant to ozone loss:

The ozonesondes began to be launched in 1995 at INPE / CRN. In 2001, with the construction of the laboratory in Barra de Maxaranguape / RN, the launches were relocated to there due to the urban growth of Natal and the need to obtain samples of unpolluted air. In September 2013, the balloons were launched again at INPE / CRN. The profile ozone concentrations measured by the ECC sounding technique on balloons is made by the participation in the SHADOZ Project (The Southern Hemisphere Additional Ozonesonde Network - <http://croc.gsfc.nasa.gov/shadoz>).

## 1.3 UV measurements:

The UV is monitored by INPE in São José dos Campos, Cachoeira Paulista, Cuiabá, Santa Maria, Natal, Angicos, Caicó and Currais Novos. The UV measurements in Rio Grande do Norte are made by Davis meteorological stations located in the followed sites: Natal (since 01/25/2016), Angicos (since 02/14/2015), Caicó (since 02/06/2014) and Currais Novos (12/09/2016).

## 1.4 Calibration activities:

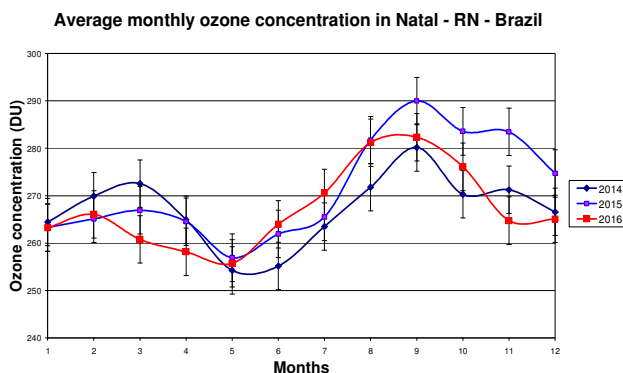
Five Brewer spectrophotometers were calibrated by International Ozone Services Inc. (IOS) in 2004, 2007 and 2009. INPE participated in the international calibration in 1994, in Spain, where the Natal Dobson (093) was shipped with our expert. In 1997, the expert Bob Evans, from NOAA, checked the Natal Dobson, on a visit to Natal, but did no adjustments in the instrument. Buenos Aires WMO Intercomparison was made in 2001, 2003, 2006 and 2010 with the participation of our two Dobson instruments. Three GUV was calibrated in 2001, in São José dos Campos, Brazil, using standard instrument of Biospherical Instruments Inc. The GUV 9285 is operating in Natal, the GUV 9255, in Cachoeira Paulista and the GUV 9285, in Brazilian Antarctic Station. Nowadays, only one GUV is operational in São José dos Campos.

## 2- RESULTS FROM OBSERVATIONS AND ANALYSIS

### 2.1 Dobson spectrophotometers

Ground based ozone total column has been measured continuously at low latitude sites, using Dobson spectrophotometer at Natal (6° S, 35° W) and Cachoeira Paulista (23° S, 38° W). The ozone data from 2014 to 2016 for the two Dobson spectrophotometers are presented in the Figure 1.

In Natal, the total ozone column varies between 255 and 290 DU and shows seasonal variability, with two maximum in the equinox. In Cachoeira Paulista the total ozone Concentrations varies from 250 and 295 DU with one maximum in spring.



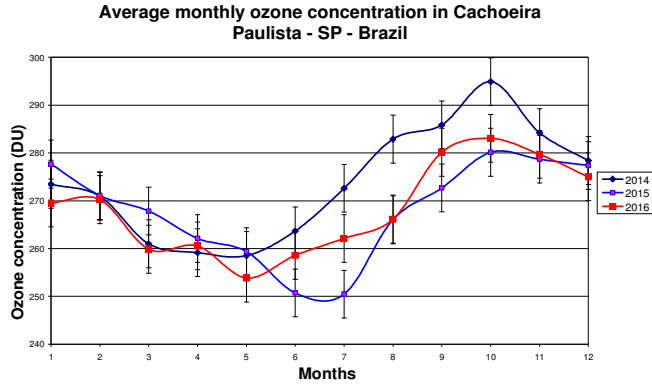


Figure 1: Average monthly ozone concentration in Natal and Cachoeira Paulista, Brazil.

## 2.2 Brewer spectrophotometer

The Brewers operating in Brazil need calibration.

## 2.3 Ozonesonde

From 1978 to 2002, weekly ozonesondes were launched in Natal, Rio Grande do Norte, Brazil and, from 2002 to 2015, in Maxaranguape, a city near Natal. In 07/23/2015 the laboratory in Maxaranguape was closed and the launches returned to Natal. The last launching was in 11/08/2016. The new ozonesondes are expected to arrive in one or two months in Natal.

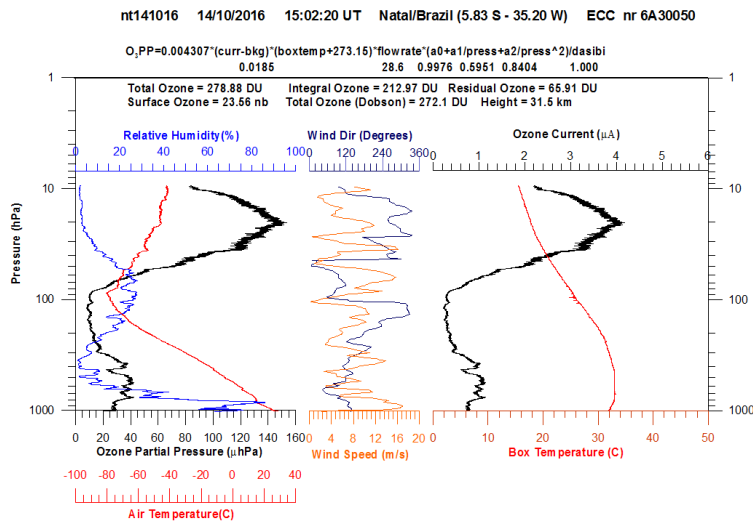


Figure 2: The ozone concentration profile measured in Natal with the ozonesonde, for 10/14/2016.

## 2.4 GHG monitoring

The CO<sub>2</sub> concentration in Natal shows a good agreement with the global average increasing.

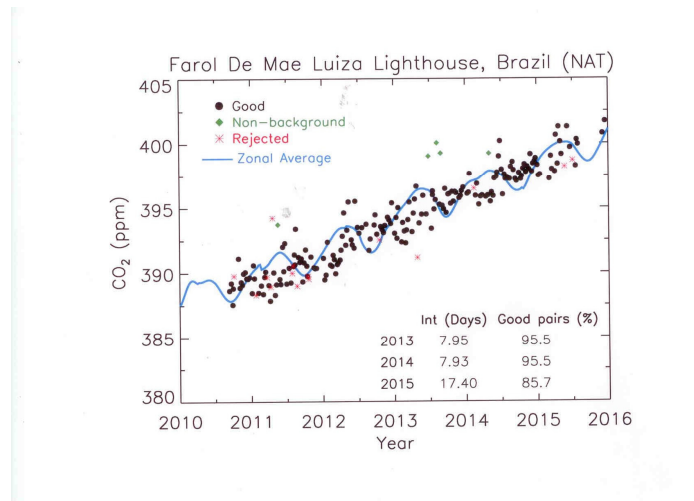


Figure 3: The CO<sub>2</sub> concentration measured in Natal from 2010 to 2016 (NOAA, 2016).

## 2.5 UV monitoring

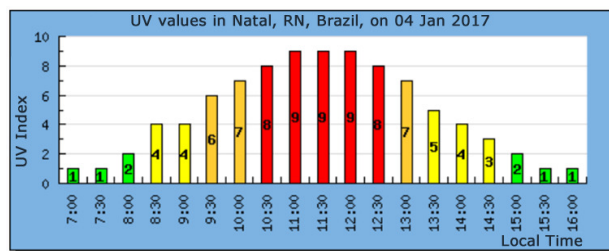
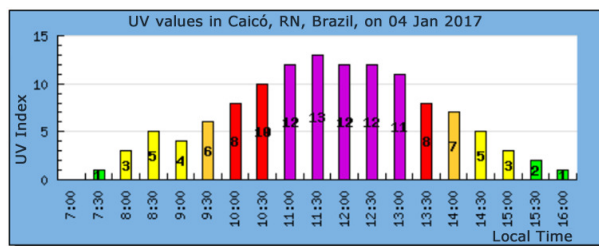
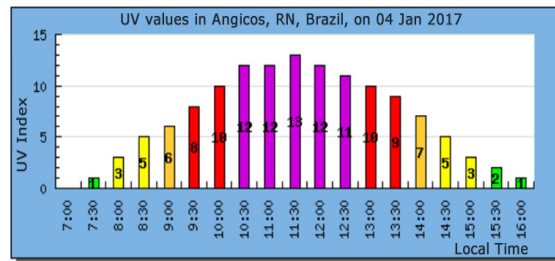
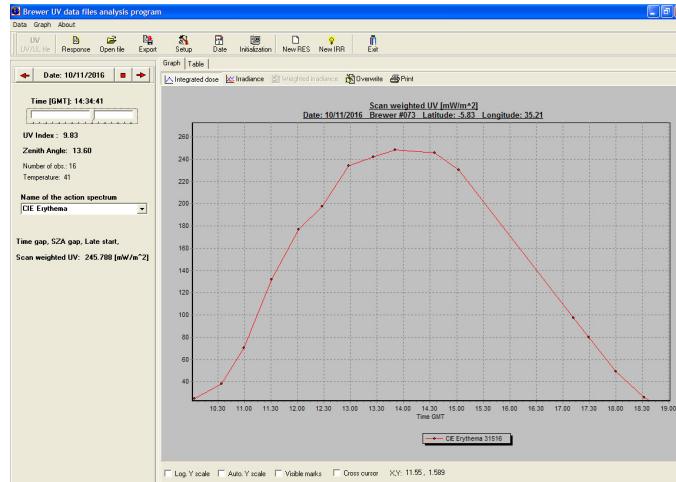


Figure 4: The UV index for Angicos, Caicó and Natal for 01/04/2017.

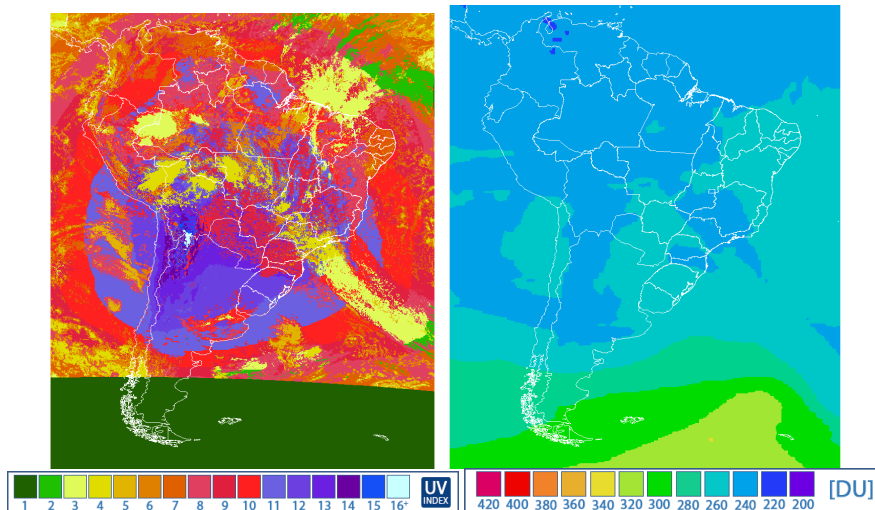
The figure 5 shows the diurnal UV variation measured in Natal by Brewer spectrophotometer.



**Figure 5: Diurnal UV variation measured in Natal with the Brewer, for 10/11/2016.**

### 3- THEORY, MODELLING AND OTHER OZONE RELATED RESEARCH

The forecast of Ozone Layer Concentration and UV radiation can be obtained from INPE/CPTEC site (<http://satellite.cptec.inpe.br/uv>), which used satellite data NOAA 16, sensor SBUV/2.



**Figure 6. Example of UV index and Ozone forecast by INPE/CPTEC for 01/19/2017.**

### 4- DISSEMINATION OF RESULTS

#### 4.1 Data reporting

The Brewer data have been submitted to WOUDC since 2004 and Dobson data since 1978.

#### 4.2 Information to the public

The Ozone e UV monitoring and forecasts are in web sites: [www.crn2.inpe.br/lavat](http://www.crn2.inpe.br/lavat) and <http://satellite.cptec.inpe.br/uv>.

#### 4.3 Relevant scientific papers

Jaime Rodrigues Coariti, Solar Ultraviolet Radiation and human health in the cities of La Paz - Bolivia and Natal – Brazil. PhD thesis at Universidade Federal do Rio Grande do Norte and CRN/INPE, Natal, 2017.

Lucas Vaz Peres, Hassan Bencherif, Nkanyiso Mbatha, André Passaglia Schuch, Abdoulwahab Mohamed Tohir, Nelson Bègue, Thierry Portafaix, Vagner Anabor, Damaris Kirsch Pinheiro, Neusa Maria Paes Leme, José Valentin Bageston and Nelson Jorge Schuch. *Ann. Geophys.*, 35, 25–37, 2017.

Paes Leme, Neusa M., Silva, Francisco R., Penha, Tércio L.B., Rodrigues, Nilson L., Silva, Edmilson L, Rae, Cristina T. S., Aleixo, Tiago, Total ozone trends in the tropics 1974-2013, IGAC 2014.

#### **5- PROJECTS, COLLABORATIONS, TWINNING AND CAPACITY BUILDING**

INPE / NOAA project with air sample collection in order to measure gases: CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>, CO, N<sub>2</sub>O and SF<sub>6</sub> ( May / 2010 in Maxaranguape - RN and November / 2015 in the Lighthouse of Mãe Luiza - Natal- RN).

INPE/NASA Southern Hemisphere Additional Ozonesondes Project (SHADOZ), PI Anne M. Thompson.

#### **6- IMPLEMENTATION OF THE RECOMMENDATIONS OF THE 9TH ORM**

The observations of ozone and climate variables were maintained. The scientific expertise are expanded by PhD thesis and master degree students. The linkage between climate changes and ozone depletion is part of the main researches in Brazil.

#### **7- FUTURE PLANS**

The current monitoring networks should be maintained operational. However, there is no special plan or project for building new capacities to conduct ozone or UV radiation. Projects focusing on climate change may include instruments installation and research related to ozone and UV.

#### **8- NEEDS AND RECOMMENDATIONS**

It is very important the support for the annual calibrations and maintenance of the Brewer. The last calibration of the Brazilian Brewers was in 2009. All instruments need calibrations as soon as possible. Financial support for trips techniques and participation in Ozone and UV Meetings, Congresses and Symposium are also needed.

#### **9- REFERENCES**

*NOAA Earth System Research Laboratory, Global Monitoring Division, Issue 9: October 2016.*

*Thompson, A. M., et al. (2012), Southern Hemisphere Additional Ozonesondes (SHADOZ) ozone climatology (2005–2009): Tropospheric and tropical tropopause layer (TTL) profiles with comparisons to OMI-based ozone products, J. Geophys. Res., 117, D23301, doi:10.1029/2011JD01691.*

*WMO (World Meteorological Organization), Assessment for Decision-Makers: Scientific Assessment of Ozone Depletion: 2014, 88 pp., Global Ozone Research and Monitoring Project—Report No. 56, Geneva, Switzerland, 2014.*