

# ECUADOR

## 1. OBSERVATIONAL ACTIVITIES

### 1.3 UV measurements

Since 2013, The Meteorology and Hydrology National Institute (INAMHI) starts measuring UV radiation on nine weather automatic stations located around Ecuador country.

**Table 1: Weather stations with UV sensors and date period of measuring**

Weather Stations	Geographic location				Sensor/ equipment		Measuring	
	zone	Latitude (°)	Longitude(°)	Altitude (masl)	Brand	Model	Start	Last records
Cuenca	highland	-2.8972444	-79.0058611	2587	Kipp&Zonen	UV-S-AE-T	oct-13	dic-15
Izobamba (Quito DM)	highland	-0.3660889	-78.5550611	3085	Kipp&Zonen	UV-S-AE-T	oct-12	dic-16
					Kipp&Zonen	Brewer MKIII Nro. 218	ene-14	mar-16
Loja	highland	-4.0197222	-79.2011111	2160	Kipp&Zonen	UV-S-AE-T	jun-13	dic-16
Pedernales	coastland	0.0638056	-80.0502222	25	Kipp&Zonen	UV-S-AE-T	abr-13	dic-16
Pichilingue	highland	-1.0743056	-79.4929167	2	Kipp&Zonen	UV-S-AE-T	jun-13	dic-16
Puyo	jungle	-1.5075000	-77.9438889	960	Kipp&Zonen	UV-S-AE-T	jun-13	dic-16
Riobamba	highland	-1.6547222	-78.6811111	2850	Kipp&Zonen	UV-S-AE-T	abr-15	dic-16
San Gabriel	highland	0.5998333	-77.8219167	2846	Kipp&Zonen	UV-S-AE-T	jun-15	dic-16
Santa Elena	coastland	-2.2336056	-80.8751000	38	Kipp&Zonen	UV-S-AE-T	jun-13	dic-16

The UV data has been recorded every minute, and Brewer MKIII every 5 minutes. The data series are available since start date shows on the table 1. All this weather stations include also other meteorological parameters measurements.

### 1.4 Calibration activities

Previous to install UV-S-AE-T sensors in each weather station, they were tested by contrasting among all UV sensors during their acquisition process. After that, each sensor was verified annually in field by contrasting with other US-S-AE-T sensor selected as reference previously. Since September 2015, these sensors do not have maintenance.

The BREWER BR218 spectrophotometer has only one calibration until now. It was performed in November 2013, during its acquisition procedure, by field contrast with other BREWER BR158 (Kipp & Zonen's won). This equipment shows troubles with orientation calibration because it was built to work at median latitudes locations and, it cannot work with an equatorial geographic location satisfactorily. It is necessary a full reinstallation of this spectrophotometer in order to reorient it to the north or south each

equinox and, the software got several jams during this procedure also. Nowadays, this equipment is out of order as consequence to electrical storm occurred in April 2016.

## 2. RESULTS FROM OBSERVATIONS AND ANALYSIS

The main outputs from UV data set note that Ecuador country has actual very higher values of Ultraviolet Index (UVI). The Table 2 and 3 show a maximum UVI value in each month during 2014 and 2015.

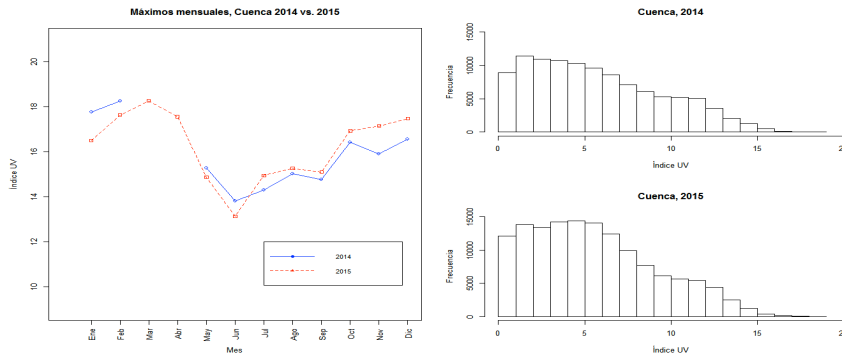
**Table 2: Maximum UVI values observed at six weather stations, at year 2014**

<b>2014</b>	Cuenca	Izobamba	Loja	Pedernales	Pichilingue	Puyo	Santa Elena
January	17.77	17.18	-	-	-		-
February	18.26	16.83	-	-	-		-
March	-	17.05	-	-	-		-
April	-	17.09	-	-	12.88	15.08	14.8
May	15.28	15.65	15.52	-	11.72	13.8	14.48
June	13.81	13.96	13.24	-	10.88	13.08	12.04
July	14.32	14.61	14	-	10.04	12.72	11.16
August	15.03	15.04	14.68	11.71	10.6	12.52	12.16
September	14.78	15.94	16.08	12.44	12	12.76	11.84
October	16.41	17.2	17.32	11.69	12.48	12.48	14.64
November	15.9	17.12	-	10.35	11.12	11.12	-
December	16.56	17.09	-	10.06	11.48	13.6	-

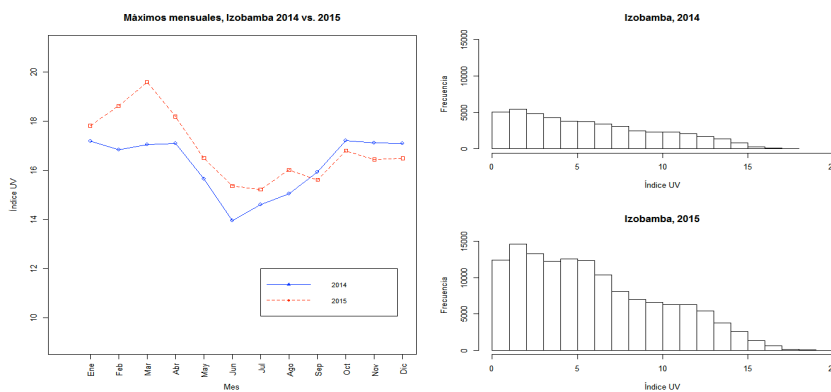
**Table 3: Maximum UVI values observed at nine weather stations, at year 2015**

<b>2015</b>	Cuenca	Izobamba	Loja	Pedernales	Pichilingue	Puyo	Riobamba	San Gabriel	Santa Elena
January	16.5	17.81	-	-	12.64	13.76	-	-	-
February	17.63	18.61	-	-	14.12	15.52	-	-	15.96
March	18.26	19.58	-	-	14.4	15.32	-	-	17.16
April	17.56	18.18	-	13.49	13.96	15.84	19.34	-	16.12
May	14.87	16.49	-	12.15	11.4	13.72	16.64	-	14.04
June	13.14	15.36	-	10.6	10.16	12.08	14.96	13.67	12.08
July	14.95	15.22	12.98	11.24	10.04	12.4	15.51	14.1	11.96
August	15.27	16.02	13.68	10.98	11.32	13.36	15.53	15.28	13.04
September	15.1	15.62	14.52	10.66	10.76	13.08	16.3	14.6	13
October	16.93	16.79	17.09	12.28	11.68	13.56	18.56	15.76	15.24
November	17.14	16.44	16.55	10.41	10.68	13.84	16.32	14.88	12.71
December	17.47	16.48	15.74	11.54	11.62	14.86	16.45	15.08	14.2

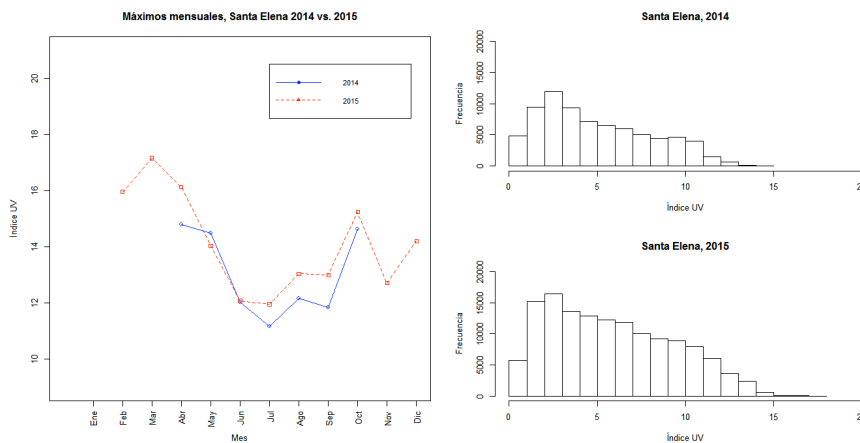
**Figure 1. Cuenca weather station, maximum UV Index measurements by month and distribution of all available measurements in 2014 and 2015.**



**Figure 2. Izobamba weather station, maximum UV Index measurements by month and distribution of all available measurements in 2014 and 2015.**

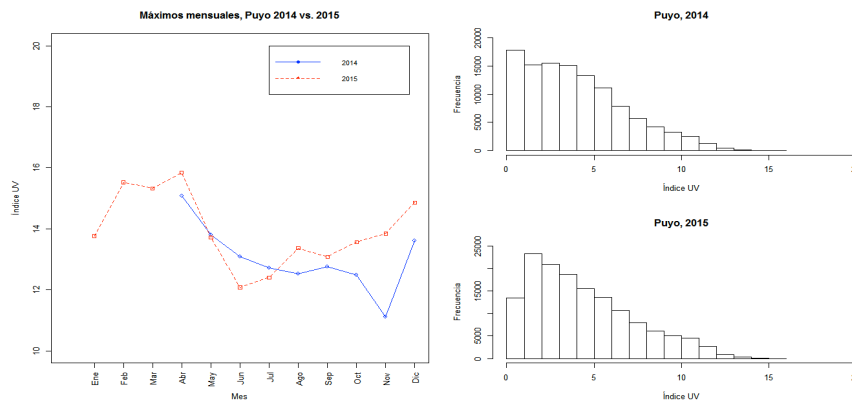


**Figure 3. Santa Elena weather station, maximum UV Index measurements by month and distribution of all available measurements in 2014 and 2015.**



Figures 1, 2, 3 and 4 show UVI values from selected weather stations as representative places to highland, coastal and jungle cities. In Cuenca (highland) weather station (Figure 1), its maximum UVI values follow similar patterns in 2014 and 2015. In 2014, the highest UVI value recorded was 18.256 (11<sup>th</sup> February) which was similar to the maximum obtained in 2015 (18.261; 11<sup>th</sup> March). In addition, its frequency distribution graphics of the measurements obtained in both years show slightly higher frequency of UVI measurements of 4-5 in 2015. In Izobamba (Quito DM) weather station (Figure 2); other highland city, the highest UVI value measured in 2014 was 17.2 (22<sup>nd</sup> of October) while the highest UVI value in 2015 was 19.6 (7<sup>th</sup> of March).

**Figure 4. Puyo weather station, maximum UV Index measurements by month and distribution of all available measurements in 2014 and 2015.**



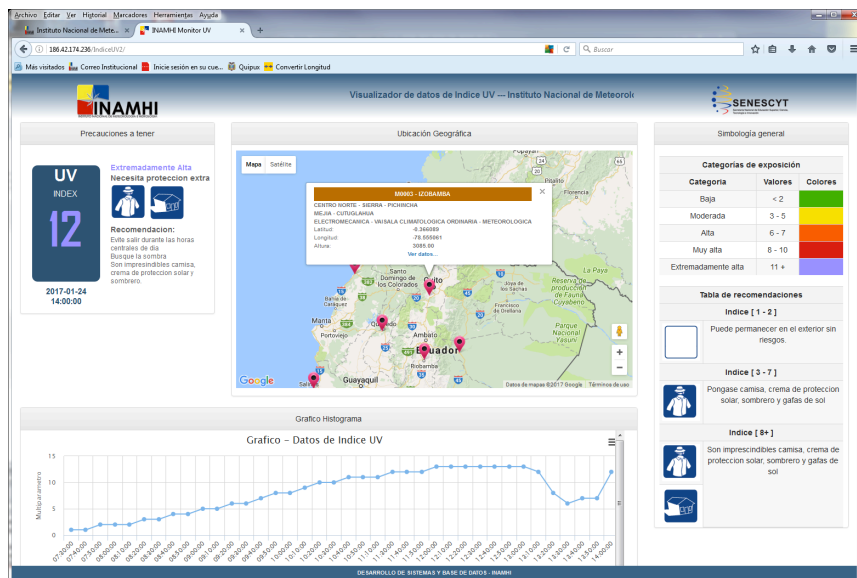
In Santa Elena weather station (Figure 3), a coastland one, the highest UVI value measured in 2014 was 14.80(27<sup>nd</sup> of April) while the highest UVI value in 2015 was 17.6 (20<sup>th</sup> of March). In Puyo weather station (Figure 4), placed at near a jungle city, the highest UVI value measured in 2014 was 15.08(16<sup>nd</sup> of April) while the highest UVI value in 2015 was 15.84 (21<sup>th</sup> of April).

#### 4. DISSEMINATION OF RESULTS

##### 4.2 Information to the public

Nowadays, eight weather stations are continuously measuring UVI, their data is available in quasi-real time at the INAMHI webpage (1).

**Figure 6. Actual webpage screen of online data from UV weather station network**



##### 4.3 Relevant scientific papers

Harari Arjona R<sup>1</sup>, Piñeiros J<sup>2</sup>, Ayabaca M<sup>2</sup>, Harari Freire F<sup>3</sup>, Climate change and agricultural workers' health in Ecuador: occupational exposure to UV radiation and hot environments, Ann Ist Super Sanita. 2016 Jul-Sep;52(3):368-373. doi: 10.4415/ANN\_16\_03\_08. (2)

María Carzola PhD, Ozone structure over the equatorial Andes from balloon-borne observations and zonal connection with two tropical sea level sites, Universidad San Francisco de Quito, Instituto de Investigaciones Atmosféricas, Colegio de Ciencias e Ingenierías Quito Ecuador, SprigenrLink, Journal of Atmospheric Chemistry, Volume 73/2016, Sprigenr Netherlads. (3)

## **5. PROJECTS, COLLABORATION, TWINNING AND CAPACITY BUILDING**

INAMHI and the Research National Secretariat (SENESCYT) are working together in order to develop a Physics-Chemical Atmospheric laboratory, which is located at YACHAY city, at 80 kms north from Quito DM. In this case, Ecuador need advising support to develop his new research program.

In 2014, The San Francisco de Quito University has developed at Research Atmospheric Institute, and Maria del Carmen Cazorla, Phd, is the current head. (4).

## **6. IMPLEMENTATION OF THE RECOMMENDATIONS OF THE 9<sup>th</sup> OZONE RESEARCH MANAGERS MEETING**

The deployment of Ultraviolet National network is the main contribution from Ecuador to Montreal protocol, in addition to compliance follow on reduction of SAO substances. Of course, the current economical restriction of Ecuador, has affected INAMHI budget, but, there is enough hope this situation will be overcome in short time.

## **7. FUTURE PLANS**

INAMHI has a duty to maintain the de UV monitory national network permanently and plans to increase the number of weather automatic stations with a new UV sensors. In addition, INAMHI are working to deploy a new reference surface automatic solar station in order to be including into the Baseline Surface Radiation Network (BSRN).

## **8. NEEDS AND RECOMMENDATIONS**

Ecuador needs an urgent advice to develop its Physic - Chemical National Laboratory, in order to prepare list equipment requirements and specifications, preparation of new researcher on these areas and to create a long time research partnership with other partner laboratories.

In the same way, INAMHI also needs an urgent advice about minimal equipment acquisition for its metrology laboratory about solar radiation and air quality, in order to guarantee the quality control of these parameter measurements.

INAMHI will need international financial assistance to maintain the operation of its national UV radiation-observing network, especially to calibrate the BREWER spectrophotometer (#218) and UV sensors, and; hardware and software upgrades for its spectrophotometer.

## **References**

- (1) [www.serviciometeorologico.gob.ec](http://www.serviciometeorologico.gob.ec).
- (2) <http://www.annali-iss.eu/issue/view/28>
- (3) <http://link.springer.com/article/10.1007%2Fs10874-016-9348-2>,
- (4) [http://www.usfq.edu.ec/programas\\_academicos/colegios/politecnico/institutos/iia/Paginas/default.aspx](http://www.usfq.edu.ec/programas_academicos/colegios/politecnico/institutos/iia/Paginas/default.aspx)