

INCREASED AIR POLLUTION IN VENEZUELA DURING THE LAST DECADE (1991-2000) OF THE TWENTIETH CENTURY

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ABSTRACT

The main purpose of surface meteorological stations (both conventional and automatic) is for weather issues, however some particular measurements and phenomena observations undertaken by the stations' observers are valuable for studies on air quality and environmental matters. This is the case of some meteorological variables such as horizontal air visibility, solar radiation (irradiance on a surface), sunshine, cloudiness, potential water (pan) evaporation, and maximum and minimum temperature, all meteorological parameters commonly (daily) recorded in the weather stations around the world; all of them strongly influenced by changes of the lower atmosphere components around the stations, i.e. smog, aerosols, gases, and other pollutants and compounds floating in the air. These meteorological variables were all used for this research on air quality. Data from the Venezuelan Air Force-Meteorological Service (VAF-MS) were used to assess and search for trends in time series data of such atmospheric parameters during the decade 1991-2000, as influenced (and previously reported by the author) due to increasing air pollution in Venezuela. The findings were then contrasted and matched with the last reference normalized (WMO) climatological 30-year period 1961-1990. All time series data were first tested for

homogeneity, adjusted their inhomogeneities as possible, before calculating the common statistics such as means, deviations, test of significance and so on. The results point out significant decreased values of air horizontal visibility, solar radiation, sunshine and potential water (pan) evaporation, and increased values of cloudiness and minimum temperature for the selected decade 1991-2000, if compared with the reference period 1961-1990. Therefore, from this research and previous ones undertaken by the author in the area (Venezuela), there is no doubt that it is the expected result of an increased air pollution in the lower atmosphere of that South American country.

INTRODUCTION

The author has evaluated and undertaken studies on climate change in Venezuela (as well as in Colombia, Ecuador and Bolivia). He has pointed out that several climatic anomalies detected in climatological time series of stations located in those countries, mostly during the last 25 years of the XX Century, are the results of an increasing air pollution and environmental degradation, which in turn is the major cause of such a climate change on this South American area, as well as in the rest of the world. All this has been determined from researches and evaluations on anomalous tendencies detected in the following meteorological variables commonly recorded in the weather stations: horizontal air visibility, solar radiation, sunshine, cloudiness, potential water (pan) evaporation, and maximum and minimum temperature, which have shown important and significant climatic anomalies during the selected decade 1991-2000, the last 10-year period of the Century and the millenium of great significance for the earth life.

BACKGROUND

Several articles have reported on the climate change due to anthropogenic activities by increased air pollution and environmental damage. Most of these studies have been undertaken for developed countries; few of them in the Third World or for developing countries. Nevertheless, the author has been researching on this vital topic and presented his findings in scientific congresses or published them in journals (Quintana-Gomez 2002, 2001, 1999a, 1999b, 1998).

By the 11th World Clean Air and Environment Congress of Durban, South Africa, 1998, the author presented his first evidences on climate change induced by increased air pollution in Venezuela, as evaluated from significant anomalies detected in some time series of an important amount of records of the VAF-MS stations during the last 25 years of the last century. At that Congress, the author presented his results on losses of potential water (pan) evaporation strength and reduction of the horizontal air visibility, as a result of increasing air pollution in the country.

The Dr. R. M. Lobato (IUAPPA, ABEPPOLAR) encouraged the author to continue to work in this area on clean air and environmental issues, so that the author continued to search for some other anomalous meteorological data of another climatic parametres such as solar radiation, cloudiness and sunshine which are strongly influenced by the air pollution; the findings were then presented at the 12th World Clean Air and Environmental Congress of Seul, Korea, 2001. At that event, the author analyzed anomalies detected in time series data of solar radiation (irradiance), sunshine and cloudiness of some selected meteorological stations in Venezuela. The recentmost research on this topic was presented by the author at the Gobal Conference and International Seminar on Urban Air Quality held in Sao Paulo, Brazil in 2002, in

where studies on urban meteorological stations and their climatic anomalies detected in the time series (due to increasing air pollution) were the target and objective of that presentation.

DATA AND PROCEDURE OF ANALYSIS

The network of surface weather stations of the VAF-MS was used in this research. This network possesses the longest and most continuous data in the entire country. Unfortunately, there is not a good coverage of such a network of stations over the region; huge areas of southern parts (Amazonia) have not any stations. There are 36 weather stations belonging to the VAF-MS, but not all the 36 stations could be used in this research, as some of these stations were founded and established not long ago, some of them have records of less than 20 years, which is not recommended for analysis like this one. So 26 stations that have data of more than 30 years were preselected. These 26 stations are located roughly between 60 and 74 degree W Lat. and 4 and 12 degree N Lat. with altitudes between the sea level up to 1500m/s.l. As expected, most of the stations are located and serve mainly the principal airports and enclave areas of the country. The selected period under this study was the last decade, 1991-2000, of the Twentieth Century; it was compared with the reference 1961-2000 period. The meteorological variables analyzed were monthly and yearly (as derived from daily observations) data of horizontal air visibility, solar radiation, sunshine, cloudiness, potential water (pan) evaporation, and maximum and minimum temperature. Before starting the process of analyzing the information and searching for anomalous values and trends, all the time series data were first tested for homogeneity of the records. The tests of homogeneity are found in the references (Quintana-Gomez, 2002, 2001, 2000, 1999a, 1999b, 1998). After applying the homogeneity tests, the

station Caracas-La Carlota (the one which serves Caracas, the Venezuela's capital) had to be discarded for possessing irretrievable inhomogeneities and missing information. Then, common statistics methods and tests were applied to determine significant differences, deviations (anomalies) and tendencies of the records for the selected period 1991-2000 in all the stations. Averages and means as well as deviations (from mean values of the reference period 1961-1990) for the entire country as a whole were calculated, after the right process of standardization of the data, which is necessary for making possible comparisons among stations located at different geographical sites and altitudes, was made. Finally, graphical trends of each selected parametre for the period 1991-2000 were drawn and analyzed.

RESULTS

The standardization process of deviations values for each individual station proved to be very useful , specially for solar radiation, potential water (pan) evaporation and maximum and minimum temperature, as these meteorological parametres are strongly influenced and dependent on altitude of the station location. In same context, the horizontal air visibility which is directly a finction of the degree of air turbidness, and hence strongly dependent of how near (far) the station is of an urban or industrialized area, the standardization was a very valuable tool.

The most remarkable feature of the solar radiation variable during the selected decade 1991-2000 is a noticeable downward tendency during this 10-year period. A reduction of values of this variable. A similar pattern is also observed with the series of sunshine, i.e. the same downward trend is observed, which is expected due to the close link between both variables. Also, another similar tendency, i.e. the downward trend is noticed with the

potential water (pan) evaporation. With regard the horizontal air visibility, it has to mention that the same similar drawn or pattern is also observed in this variable: the downward trend during the period, the reduction of values for this decade, if compared with the reference 19961-2000 period. On the other hand, different situation is observed with the series of cloudiness, as this parametre seems to be increased during 1991-2000, i.e. an upward tendency is observed being it the remarkable feature of this variable; something similar is noticed with patterns of the minimum temperature, that is another upward trend as the most remarkable feature as well. Finally, the maximum temperature pattern seems not to present a significant variation during the decade 1991-2000; it is observed neither an upward nor a downward tendency during the decade.

DISCUSSION OF RESULTS AND REMARKS

It is evident that the selected decade 1991-2000 presents climatological anomalies if compared and contrasted with the reference 1961-1990 period, at least and after analyzing the chosen meteorological variables of this study.

A question arises, what factor(s) or cause(s) could have been producing these climatic alterations and anomalies (climate change) in the area? The answer is not so simple; maybe one should not discard that the chosen data is not so reliable as expected. The author realizes that several and unknown sources of anthropogenic inhomogeneities could have feasibly been introduced in the different steps of collecting the data, i.e. during the process of observation, with the right operation of the instruments, their calibration, the process of data transcription/transmission, when averaging and other calculations, with the homogenization and standardization of values and so on. However, it is firmly believed, for

trusty informations and personal comprobations, that the major cause or the principal reason of these anomalies (climate change) observed during the decade 1991-2000, is due to an increasing air pollution and environmental degradation observed everywhere in the country, which is also present in most of the South American area, as well as in many other region of the world.

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