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The Importance of Meteo Factors in Greenhouse Gases Emissions

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Abstract: A changing climate influences atmospheric chemistry through not only temperature and precipitation changes, but changes in atmospheric transport processes, changes in the budget of species with biological sources (which respond to temperature and moisture changes), changes in vegetative cover, which would alter dry deposition rates, changes in the rate of export of pollutants from the urban regional environment to the global one. Changes in atmospheric chemical composition itself will lead to climate change.

Keywords: Greenhouse gases; Atmospheric pressure; Atmospheric humidity.

Introduction

Earth has a natural temperature control system. Certain atmospheric gases are critical to this system and are known as greenhouse gases. On average, about one third of the solar radiation that hits the earth is reflected back to space. The Earth's surface becomes warm and as a result emits

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infrared radiation. The greenhouse gases trap the infrared radiation, thus warming the atmosphere.[1] These greenhouse gases include those listed in the Kyoto Protocol: methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), sulphur hexafluoride (SF_6) and those listed under the Montreal Protocol and its Amendments: chlorofluorocarbons (CFCs), hydro chlorofluorocarbons (HCFCs), and halons, that together create a natural greenhouse effect.

All greenhouse gases except CO_2 and H_2O are removed from the atmosphere primarily by chemical processes within the atmosphere. Greenhouse gases containing one or more H atoms (e.g., CH_4, HFCs and HCFCs), as well as other pollutants, are removed primarily by the reaction with hydroxyl radicals (OH). This removal takes place in the troposphere, the lowermost part of the atmosphere, ranging from the surface up to 7 to 16 km depending on latitude and season and containing 80% of the atmospheric mass.

The greenhouse gases N_2O, PFCs, SF_6, CFCs and halons do not react with OH in the troposphere. These gases are destroyed in the stratosphere or above, by mainly solar ultraviolet radiation (UV) at short wavelengths (<240 nm), and are long-lived.[2, 3]

Clouds can both absorb and reflect solar radiation (thereby cooling the surface) and absorb and emit long wave radiation (thereby warming the surface). The competition between these effects depends on cloud height, thickness and radiative properties. The radiative properties and evolution of clouds depend on the distribution of atmospheric water vapor, water drops, ice particles, atmospheric aerosols and cloud thickness.

Thunderstorms, and their associated lightning, are a component of the physical climate system that provides a direct source of a key chemical species, NO_x. The magnitude and distribution of this lightning NO_x source controls the magnitude of the anthropogenic perturbations, e.g. that of aviation NO_x emissions on upper troposphere O_3.[4]

A major feedback accounting for the large warming predicted by climate models in response to an increase in CO_2 is the increase in atmospheric water vapor.

Changes in H_2O will impact troposphere O_3 concentrations. Because O_3 itself is a greenhouse gas, these changes will feedback to alter the climate.[5]

The primary source of troposphere OH consists in reactions that start with the photo dissociations of O_3 by solar UV.

$$O_3 + h\upsilon \rightarrow O(^1D) + O_2$$
$$O(^1D) + H_2O \rightarrow OH + OH$$

Global average relative humidity has been found to remain almost constant with warming in climate model experiments.[6] Changes in precipitation patterns and/or frequency and changes in vegetation patterns would complicate this picture. As a simple estimate, all else being equal, a 2K increase in temperature has been estimated to be associated with 10 to 30% increase in troposphere H_2O levels, implying a few percent increase in OH and other HO_x family members.[7]

This work aimed at the study of the dependence between the meteorological factors (air pressure, temperature, humidity) and the emission of greenhouse gasses. Analysis of variance (ANOVA) has been used in order to underline the influence of the season and weather on the medium values of the atmospherical humidity parameter.

Results and discussions

ANOVA analysis in the study of the simultaneous influence of the weather status and season on the atmospherically humidity.[8-10]

By ANOVA the influence of the variables: „season” and „weather” on average values of „atmospheric humidity” parameter has been investigated. There were considered two categories for the grouping factor variable as it follows:

- „Season”, with: „winter”, codified with „1” and „summer”, codified with „2”;
- „Weather”, with: „fog”, codified with „1” and „cloudless”, codified with „2”.

The average, standard deviation and the case number „N” for the two variables specified above for humidity values are presented in Table 1.

Table 1. The average, standard deviation and the case number „N”, for the atmospheric humidity values

Season code (Winter=1, summer=2)	Weather code (Fog=1, cloudless sky=2)	Mean	Std. Deviation	N
1	1	100.000	0.0000	24
	2	70.167	6.2183	24
	Total	85.083	15.6896	48
2	1	100.000	0.0000	24
	2	77.750	16.5903	24
	Total	88.875	16.1583	48
Total	1	100.000	0.0000	48
	2	73.958	12.9729	48
	Total	86.979	15.9558	96

The homogeneity Lorene test leads to the results shown in Table 2.

Table 2. The homogeneity variance test using atmospheric humidity values

F	df1	df2	Sig.
63.526	3	92	0.000

Tests the null hypothesis that the error variance of the dependent variable is equal between groups.
a. Design: Intercept+Season+Weather condition Season

Analysis of variance applied in the study of season's influence on atmospheric humidity

The results of the homogeneity test are presented in Table 3.

Table 3. The homogeneity test of variances, with humidity values as basis, for unifactorial ANOVA (season's influence)

Atmospheric. Humidity in % readings/day			
Levene Statistic	df1	df2	Sig.
0.298	1	94	0.587

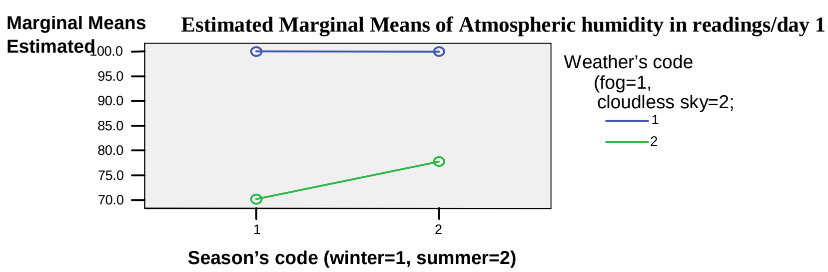


Figure 1. The average of the four conditions of influence exponents, of which two depend on season, and the other 2 depend on weather, on the humidity values.

Analysis of variance applied in the study of simultaneous influence of weather and season over atmospheric pressure

Table 4. The average, standard deviation and the case number „N”, for atmospheric pressure (mm Hg)

Cod season (Winter=1, summer=2)	Cod weather conditions (Fog=1, clear=2)	Mean	Std. Deviation	N
1	1	611.346	0.9371	24
	2	614.117	0.3199	24
	Total	612.731	1.5621	48
2	1	613.900	0.3695	24
	2	615.600	0.4644	24
	Total	614.750	0.9541	48
Total	1	612.623	1.4705	48
	2	614.858	0.8470	48
	Total	613.741	1.6392	96

The homogeneity Leyene test of variances leads to the results presented in Table 5.

Table 5. The homogeneity test of variances

F	df1	df2	Sig.
19.495	3	92	0.000

Tests the null hypothesis that the error variance of the dependent variable is equal between groups.

a. Design: Intercept+season+wether condition+season * Weather conditions

Analysis of variance unifactorial (ANOVA) applied in the study of season’s influence over atmospheric pressure

The homogeneity test leads to the results in Table 6.

Table 6. The homogeneity test of variances with atmospheric pressure values as basis, for unifactorial ANOVA (season’s influence)

Levene Statistic	df1	df2	Sig.
21.098	1	94	0.000

Unifactorial ANOVA applied in the study of weather's influence over atmospheric pressure (mm Hg)

The homogeneity test leads to the results in Table 7.

Table 7. The homogeneity test of variances, with atmospheric pressure values as basis, for unifactorial ANOVA (weather's influence)

Levene Statistic	df1	df2	Sig.
20.954	1	94	0.000

The average of the 4 conditions of influence exponents, of which two depend of season, and the other two depend on weather, on the atmospheric pressure values are presented in Figure 2.

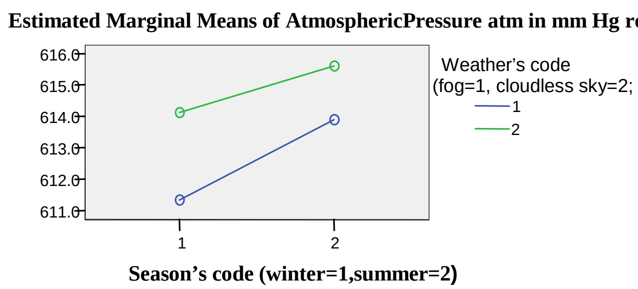


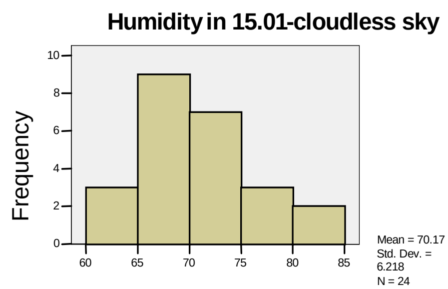
Figure 2. The average of the four conditions of influence exponents, from which two depend of season, and the other two depend of weather, on the atmospheric pressure values.

Experimental

1. General statistic data concerning air humidity and atmospheric pressure were registered in 2006 in Ceahlau Toaca Meteorological Station, at 1898 m altitude. Data were processed using Windows SPSS soft.

1.1. Distribution of humidity values in six days established as „reference".

1.1.1. Synthetic data concerning air humidity.



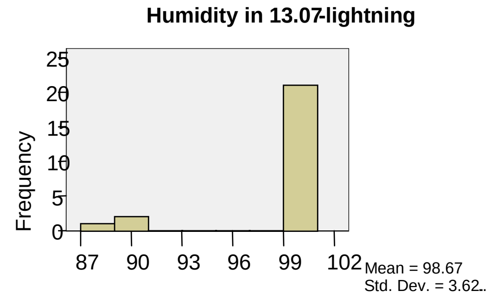


Figure 3. Histogram for humidity variation in 15.01.06 cloudless sky.

Figure 4. Histogram for humidity variation in 13.07.06 thunderstorms.

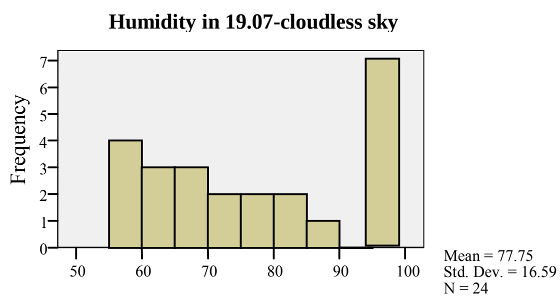


Figure 5. Histogram for humidity variation for 19.07.06 cloudless sky.

1.2. Distribution of atmospheric pressure values in 6 days established as „reference".

1.2.1. Synthetic data concerning atmospheric pressure.

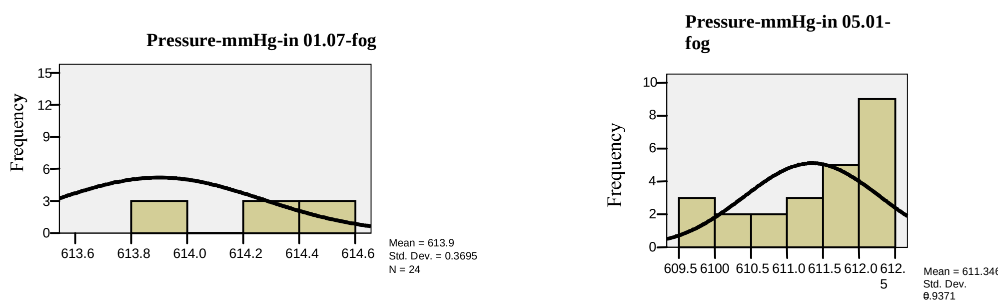


Figure 6. Histogram for pressure variation in foggy days

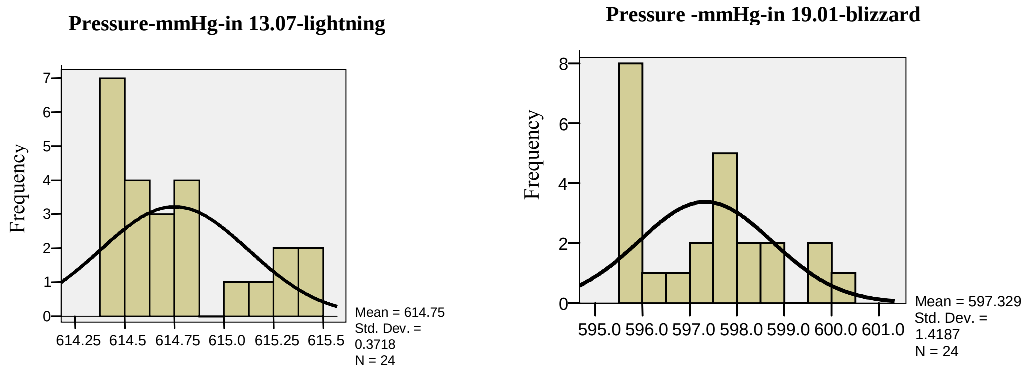


Figure 7. Histogram for atmospheric pressure variation for 13.07.06 (electric discharge) and for 19.01.06 (blizzard)

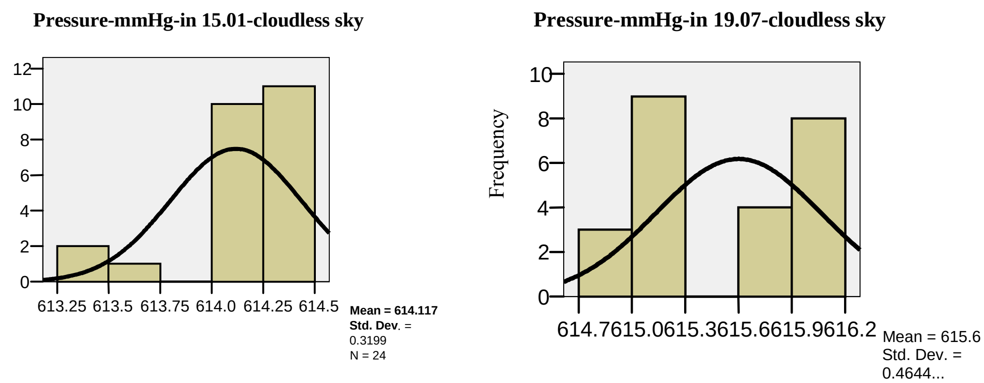


Figure 8. Histogram for atmospheric pressure variation for cloudless days

Conclusions

Conclusions regarding the form and normality of distribution for humidity and atmospheric pressure data at the level of the entire year, on illustrative samples.

1. The distribution for atmospheric humidity values, except the cases where these are constant on sample, is similar to the Gauss-Laplace distribution (Figure 6).

2. The distribution for atmospheric pressure values was found to be similar to Gauss-Laplace distribution.

3. The normality of distribution for atmospheric humidity values, except the cases where these are constant on the sample, was investigated for the arching and kurtosis values. The samples „humidity in 15.01 cloudless " and „humidity in 19.07 cloudless sky" present value rates close to normality regarding the arching parameter, and the sample „humidity in 15.01 cloudless sky" presents value rates close to normality regarding the kurtosis parameter.

4. For the normality of distribution for atmospheric pressure values, the arching and kurtosis values were investigated. The samples „atmospheric pressure in 19.01 (blizzard)„ and "atmospheric pressure in 19.07 (cloudless sky)" present value rates close to normality regarding the arching, and the sample "atmospheric pressure in 13.07 (blizzard)" presents value rates close to normality regarding the kurtosis parameter.

Conclusions for analysis of variance ANOVA testing of humidity and atmospheric pressure at the level of the entire calendar year, on illustrative samples.

1. Atmospheric humidity values for the two seasons are statistical different, ignoring the weather.

2. ANOVA testing is irrelevant in the case of bifactorial influence (simultaneous factors „season" and „weather") on the atmospheric pressure values.

3. ANOVA testing is irrelevant in the case of unifactorial influence (only „season" factor) on the atmospheric pressure values for the entire year.

4. ANOVA testing is irrelevant in the case of unifactorial influence

(only „weather" factor) on the atmospheric pressure values for the entire year.

Conclusions regarding the correlation analysis for the humidity and atmospheric pressure at the level of the entire calendar year, on illustrative samples.

I. Correlations for atmospheric humidity data:

I.1. Atmospheric humidity values are weakly correlated, tested by both Pearson and Spearman tests. This could be explained by the presence of constant values (100%) for the samples.

I.2. The 100% value of humidity appears frequently (54 of 96 analyzed samples for the variance analysis), irrespective of the season.

II. Correlations for atmospheric pressure data:

II.1. Atmospheric pressure values are much better correlated, as tested by Pearson correlation test, than the humidity ones:

- „atmospheric pressure in 15.01 (cloudless sky)" with „atmospheric pressure in 05.01 (fog)" with correlation coefficient of 0.852, significant correlation;

- „atmospheric pressure in 15.01 (cloudless sky)" with „atmospheric pressure in 19.07 (cloudless sky)" with correlation coefficient of 0.855, significant inverse correlation;

-„atmospheric pressure in 05.01 (fog)" with „atmospheric pressure in 19.07 (cloudless sky)" with correlation coefficient of 0.855, significant inverse correlation;

- „atmospheric pressure in 19.01 (blizzard)" with „atmospheric pressure in 19.07 (cloudless sky)" with correlation coefficient of 0.852, the best direct correlation calculated;

II.2. Atmospheric pressure values are much better correlated, as tested by Spearman correlation test, than the humidity ones:

-„atmospheric pressure in 05.01 (fog)” with „atmospheric pressure-mmHg in 01.07 (fog)” with correlation coefficient of 0.866, significant inverse correlation;

-„atmospheric pressure in 15.01 (cloudless sky)” with „atmospheric pressure in 19.01 (blizzard)” with correlation coefficient of 0.938, significant inverse correlation;

-„atmospheric pressure in 15.01 (cloudless sky)” with „atmospheric pressure in 19.07 (cloudless sky)” with correlation coefficient of 0.963, the best inverse correlation calculated;

-„atmospheric pressure in 19.01 (blizzard)” with „atmospheric pressure in 19.07 (cloudless sky)” with correlation coefficient of 0.928, the best direct correlation calculated.

II.3. For the atmospheric pressure, there are very good analogy between Pearson and Spearman coefficients of correlation, so it can be concluded that the atmospheric pressure values are normally distributed in the investigated samples.

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