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Pyroelectrical model for intracloud lightning

Nelson Falcón[1,] and Amilkar Quintero[2]*
[1]*Dpto. de Física. FACYT, Universidad de Carabobo. Apartado 129, Av. Bolívar Norte, Valencia 2001. Carabobo, Venezuela.*
[2]*Dept. Physics and Space Science, Florida Institute of Technology.*

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Abstract

We present a theoretical microphysical model of thundercloud electrification that incorporates the influence of an aerosol with electrical self-polarization (pyroelectric), like methane. We estimate the water and methane dipole contribution to the internal electric field and calculate the associated capacitance for the cloudy cell, using the telluric capacitor approach, with methane concentration lower than the air composition. We obtain that the water contribution to the internal electric field due to the electrical displacement vector generated by the atmospheric electric field of the Earth, is not enough to produce a typical discharge; the methane increases the electric field inside thunderclouds and facilitates the electrical charge generation and separation process. Applications in Titan Lightning activity and lightning of the Catatumbo River are suggested.

Key words: lightning: flashes, atmospheric electricity, methane.

Modelo piroeléctrico de descargas eléctricas intranubes

Resumen

Se presenta un modelo microfísico de la electrificación de nubes de tormenta que incorpora la influencia de aerosol de autopolarización eléctrica (piroeléctrico), como el metano. Estimamos la contribución de los dipolos de agua y metano al campo eléctrico interno y la capacidad asociada a la célula nublado, utilizando el método de condensador telúrico, con la concentración de metano menor que la composición del aire. Obtenemos que el aporte del agua al campo eléctrico interno por el vector de desplazamiento eléctrico generado por el campo eléctrico atmosférico de la Tierra, no es suficiente para producir una descarga típica. El metano aumenta el campo eléctrico en el interior de nubes de tormenta y facilita la generación de carga eléctrica y la separación del proceso. Aplicaciones en la actividad eléctrica atmosférica de Titán y al relámpago del río Catatumbo son discutidas.

Palabras clave: relámpago, descargas, electricidad atmosférica, metano.

1. Introduction

The last decade was marked by fascinating discoveries in the field of atmospheric electricity, at the same time many important problems about thundercloud remained to be solved, see Rakov and Uman and references therein (1). An important unsolved question is the very rapid increase of the electric field amplitude inside thunder-

* To whom mail should be addressed: nelsonfalconv@gmail.com

clouds, and the manner in which discharges are initiated inside the storms (2). That is due to the microphysical evolution of the charges, before the first lightning flash, does not find an explanation in the classical models of thundercloud electricity (3).

The classical picture about charge generation inside thunderclouds involved convection and particle charging. The convective mechanism describes the cloud electrification without any charge transfers during the particles collisions but only by convection which redistributes the charge attached previously by hydrometeors (4, 5). However the electric field is two orders of magnitude smaller than the minimal break down field, therefore this mechanism by itself is insufficient to generate the intracloud electric field required for lightings (6). The particle charging mechanisms, on the other hand, explains the cloud electrification by induction of polarization charges in particles, in any existing electric fields. The charged particles will be separated thereafter by convection and gravitation due to their different masses, during collision and rebounding between ice particles and other hydrometeors (1, 2). But this particle charging mechanisms is only valid for short ranges of cloud-temperature and result insufficient for the upper charge to look in thunderclouds (7, 8).

Since there has been no experiment to confirm conclusively the classical model of atmospheric electricity, thunderstorms as the sources of the global electric circuit; it remains a subject of debate (1); moreover the mechanism of terrestrial lightning generation is quite controversial (7, 8). Field measurements and numerical model show that electrification of particles in thunderstorms is accomplished on the order of ten minutes after the initial precipitation within the cloud, in conflict with the predictions in the particle charging mechanism (8, 2).

As Jayaratne (9) said: "The origin of thundercloud electrification has long been an unsolved problem in atmospheric physics. Despite a number of simulated laboratory experiment, together with the vast of field data collected over the past few decades, our knowledge of how these convective clouds masses get charged still remains sparse at the microphysical level". Also lightning flashes have been report in volcanic eruptions (10, 11), in Martian dust storms (12) and other anaerobic environment, as extra planetary lightning (Desch *et al.* (8), for compressible review).

Therefore the atmospheric electrical phenomena must involve the physical chemistry of aerosols (see Tokano et al. (6) and references therein). Hence we formulate to ourselves the following question: How do aerosols affect lightning production, including flash rate and charge separation mechanism in microphysical processes in thunderclouds?

A plausible mechanism for the charge generations and separation process inter clouds could be the electrical self-polarization or pyroelectricity of some atmospheric aerosols; the pyroelectrics materials have the property of polarized spontaneity due to the intrinsic symmetry of the molecules that constitute it, this implies that the electrical displacement vector is not null, even without the presence of external electric fields (13).

In this work we incorporate the influence of the pyroelectrics materials, which could serve to explain the increase of the electric field inside the thunderclouds and the formation of the electrical charges (14). The methane (CH_4) is the sixth atmospheric component, equivalent to $2\ 10^{-6}$ of the total fraction of the atmosphere (15) and its pyroelectricity has associate it as co-causal agent of the most eminent lightning flashes in Venezuela, the Lightning over the Catatumbo river, see Falcon *et al.* (14, 16-18); and its watery derivatives, the methane hydrides, seem to play an important role in the oceanic climatology (19). Besides this element has been considered to be a basic element for the generation of lightning in Titan (6, 20) and the methane cloud have been associated with lightning in Jupiter too (21). It is necessary to emphasize that the methane, it is the first element of the atmospheric composition with pyroelectric properties.

Our objective is to evaluate the role of the methane in thunderclouds charge process; to do this, we present a theoretical microphysical model. We begin, describing *grosso modo* the principal characteristics of the lower atmosphere, and shaping the convective clouds as unitary cells, following the approximations of the numerical models (22, 23), and supposing it at hydrodynamic equilibrium (24), in section 2. Next (section 3), we estimated the contribution of water and methane dipoles to the electrical displacement vector of a cloudy cell. We study the charge process, modeling the cloudy cell as a *parallel plate* capacitor or telluric capacitor (25), in section 4. Finally the conclusions are shown in section 5.

The present model for thundercloud electrification could be a simplified model, but we want to show that methane pyroelectric properties are important to understand the microphysical mechanism in the charge process of thunderclouds; the role of the electrical displacement vector is usually ignored, and this could be a serious emission, because there is a lot of terrestrial and extraterrestrial evidence that can prove it importance.

2. The basic assumptions about the lower troposphere

We consider an only and isolated cumuliform type cloud, constituted by several cloudy cells, which altitudes are between 1.6 Km and 14 Km (2). The volume of each cell is of the order of 5 10^{10} m^3, approximation accord with the numerical models of clouds formation (22, 23), supposing it at hydrodynamic equilibrium (24). Also the cloudy cell geometry is considered to be a cubic region of side 3.6 Km, where the cell locates to an altitude h (the low part of the cell) and $h+d$ (the top part of the cell) of the surface. The cloudy cell is in a region of the atmosphere sufficiently low, where it is possible to approximate the temperature gradient by a linear model, and the atmospheric pressure exercised by the column of dry air decreases with the altitude (22, 25).

In the atmosphere without clouds, below to 60 Km of altitude, there is an electrical vertical field which intensity for average latitudes, is given by (26):

$$\vec{E}(z) = -[93.8e^{-4.527z} + 44.4e^{-0.375z} + 11.8e^{-0.121z}]\hat{z} \text{ KV/Km} \quad [1]$$

Obviously the z-axis is orthogonal to the Earth surface in each point, and with z in kilometers.

The electrical potential difference in the cloudy cell, between the top and low part, without any others particles that are not air, change monotonously with the altitude, as the variation of the electric field.

The figure 1 summarizes the characteristic values of the magnitudes of temperature, pressure, electric field and electrical potential difference for the firsts 15 Km of altitude.

Notice that the cell will discharge when the potential difference is of the order of the dielectric break down potential of the air: 1000 KV for humid air and 3000 KV for dry air, at surface level (27, 28). In absence of steam condensation and aerosols, the cell does not reach the dielectric break down potential of the air, as it is in the observed phenomenology for in lightning flashes.

Even if the cloudy cell could be considered to be, a parallel plate capacitor or telluric capacitor (25), there must be considerate that the value of the dielectric constant k changes in function temperature. We obtain experimental measurement data of the dependence of water dielectric constant

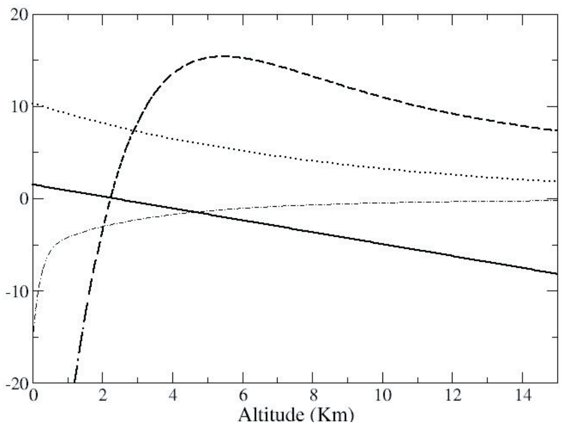

Figure 1. Characteristics of the lower troposphere. The solid line represents the linear temperature approach of the troposphere, in united of 10 Celsius; the dotted line is the atmospheric pressure in 10 KPa; the dashed line is the atmospheric electric field in 10 KV/KM; and the dashed-dotted line is the electrical potential difference of a cloudy cell, in KV.

with the temperature (see original data in "Clipper Controls C. A." (29)), and we adapt it to obtain the variation in function of the altitude:

$$k = k_2 z^2 + k_1 z + k_0 \qquad [2]$$

with k_0=82.8515, k_1=2.23490 Km^{-1} and k_2=0.020830 Km^{-2}.

The figure 2 show that the dielectric constant is proportional to the altitude, therefore the cloud increases its capacitance as the water ascends in the atmosphere to an altitude z of the cloudy cell.

3. Results: electric displacement and dipoles in aerosols

To study the electrical behavior of the cloud, we consider every cloudy cell as a collection of water dipoles for the most part, and methane dipoles in a smaller fraction.

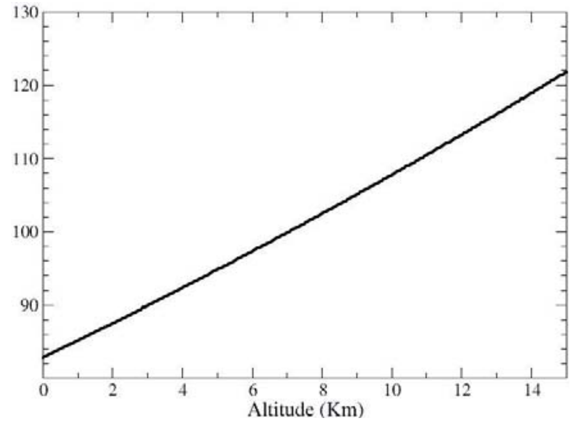

Figure 2. Variation of the dielectric constant of the water depending on the altitude due to the thermal gradient of the lower troposphere.

For the water molecule, the electrical dipolar moment is: 6.2 10^{-30} $C\,m$ (15). The distribution of the electrical dipoles of the water molecules follow, in thermal equilibrium, a Maxwell distribution, for which the electrical displacement average D contemplates all the possible orientations of the dipolar moment respect to the atmospheric electrical exterior field, in consequence if n denote the value spreads on the total number of molecules and p is the dipolar moment at the temperature T (14), then:

$$\langle \vec{D} \rangle = \frac{\int \varepsilon \vec{E} \exp\left(-\dfrac{\vec{p}\cdot\vec{E}}{k_B T}\right) dn}{\int \exp\left(-\dfrac{\vec{p}\cdot\vec{E}}{k_B T}\right) dn} \qquad [3]$$

with k_B the Boltzmann constant, E is the Terrestrial electric field, T the effective temperature of the molecule inside the cloud and ε_0 is the vacuum permittivity constant. The probability to found a molecule with the dipolar momentum vector in an angle α with the external electric field is equal to the area differential:

$$dA = 2\pi r^2 \sin\alpha\, d\alpha \qquad [4]$$

The differential fraction of the molecules number in the differential area section is:

$$dn = \frac{dA}{4\pi r^2} = \frac{1}{2} d(\cos\alpha) \quad [5]$$

with the equations [3] and [5] we obtain:

$$\langle \vec{D} \rangle = \frac{\int_{-1}^{1} \varepsilon \vec{E} \cos\alpha \exp\left(-\frac{\vec{p}\cdot\vec{E}}{k_B T}\right) d(\cos\alpha)}{\int_{-1}^{1} \exp\left(-\frac{\vec{p}\cdot\vec{E}}{k_B T}\right) d(\cos\alpha)} \quad [6]$$

This result is valid for the molecules placed in the cloudy cell at a constant altitude *z* and with effective temperature *T* of the place; since the cell is immersed in a vertical pressure gradient, we must estimate the average value for the whole cloudy cell from the altitude *h* to the top level *h+d*; with *d* the typical thickness of the cell:

$$\langle D \rangle_{H_2O} = \frac{\varepsilon_0}{d} \int_{h}^{h+d} k_{H_2O}(z) E(z) dz \quad [7]$$

It is easy to see that, the behavior of the watery cell, after certain altitude level, the conductivity of the cell does not correspond to the water, but to the ice or snow, by virtue of the thermo barotropic atmospheric gradient, for this, the internal electrical field of the cloudy cell at a altitude of 8-10 Km is lower than 0.5 MV/Km.

We must study the mesoscopics aerosols, which act to intermediate scales in the convective clouds; limiting ourselves to those that for its ethereal chemistry composition, present a dipolar moment electrically auto induced and which relative abundance is a significant fraction of the air. All of this leaves us basically with the methane, which has a lattice constant of $2a$=1.095 Å and an angle of α_m=109.5° that correspond to the orbital *s-p* (H-C-H) in tetrahedral symmetry (30), of the symmetry group T_d in Schofield's notation. For this symmetry we obtain that its dipolar moment is 4.04 10^{-29} *C m*, that is bigger than the dipolar moment of water.

The tetrahedral configuration multiplies the dipolar moment in a factor of four; of this we infer that the induced microscopic field in the cells of methane increases the local field regard to the induced microscopic field in a watery cell. It must be considered that the crystalline configuration of the methane belongs to the C_4 symmetry group. These molecules and its microcrystal are pyroelectrics, which polarize spontaneously when have been formed crystals lacking of symmetry centers (it excludes certainly the NaCl that is a cubic system). In effect the crystals formation of pyroelectrics type in the cloud might create spontaneous dipolar fields, so as that the aerosols crystallize under some types of symmetry C_1 triclinic, C_S or C_2 monoclinic, C_{2v} rhombic, C_4 or C_{4v} tetragonal, C_3 and C_{3v} rhombohedra or C_6 and C_{6v} hexagonal; the electrical displacement vector is (13):

$$\vec{D} = \vec{D}_0 + \vec{P} + \varepsilon_o \vec{E} \quad [8]$$

with *P* is the polarization and *E* is the external electric field that in this case is the terrestrial electric field. Notice that still in absence of an exterior electrical field; there will be a not null electrical displacement that would favor the charges separation and even might originate the avalanche needed in lightning generation models.

In the entire range of atmospheric conditions that prevail in the troposphere, where thunderstorms exist, methane is found mostly in its gaseous phase, however methane and others aerosols are over frozen and they could be founded crystallized; beside the ice-water contains several methane molecules (19). Methane is almost insoluble in water and it could be think that it cannot play a significant role in any charge separation process while it is in the gas phase, but pyroelectricity appears also in gaseous phase because it is a molecular phenomenon not a solid phase phenomena (13). In normal conditions the methane is only in gaseous phase at the atmosphere but if there is no difference between the solid or gaseous phase when we are talking about the pyroelectrical properties of it. Notice also, the ice-methane appears in other planetary atmosphere, for example in Titan, Saturn and Neptune (see Desch *et al.* (8) and references therein).

In clouds, almost all the solid nuclei are either nucleated to form water droplets or washed out by precipitation process, but this model is independent of a kinematics description (24), so the charge process occur before the precipitation; there is a very good evidence in Maracaibo Venezuela, where lightning flashes would be occur without precipitation (16, 18, 31).

To estimate the intrinsic electrical displacement D_0 in the cloudy cell of methane, we will suppose a cloudy cell of diluted (ideal) gas, in absence of external fields. By the Gauss Law it is obtained that intrinsic electrical displacement is equivalent to the superficial charge density (σ); this can be interpreted as, if in every point of the cell, the field is produced by the most near molecule of methane; despising the contributions of others molecules in conformity with the approximation of ideal gas, it is valid to suppose that $x \sim a$. Using the same approximation $x \sim a$ for the electric field intensity E, in the z-axis, for the methane. The electric field is given by a simple equation of electrostatic:

$$E_{dipole} = \frac{1}{4\pi\varepsilon_0}\frac{|\vec{p}|}{r^3} = -\frac{4}{4\pi\varepsilon_0}\frac{q2a \cdot \cos\alpha}{(x^2+a^2)^{3/4}} \approx \frac{e\cos\alpha}{\sqrt{2}\varepsilon_0 \pi a^2} \quad [9]$$

where e the electrons charge and p is the electrical dipolar momentum.

We assume that the local field is produced only by the nearest molecule of methane because it is only the interaction between first neighbours in a first approach, a full interaction with all the molecules require a more extensive calculus and of course it will be a better approach to nature.

Since, as the Gaussian approximation for the cell is independent, in the classic description, of the volume of the cell, we have that in the limit case of a monomolecular cell, both expressions of electric fields must coincide ($E_{dipole}\sigma/\varepsilon_0$), follows that:

$$D_0 = \sigma \approx \frac{e\cos\alpha}{\sqrt{2}\pi a^2} \approx 6.93\left[\frac{\mathrm{C}}{\mathrm{m}^2}\right] \quad [10]$$

If the cell is uniform, its charge density remains constant, treating a monomolecular cell or treating of a macroscopic cell, the cloudy cell composition is a fraction ($0 \le f \le 1$) of methane, in this case the intensity of the autoinduced field, in virtue of the realized approximations, finally we obtain for the molecule of methane:

$$E_0 \cong f\frac{6.93}{\varepsilon_0}\left[\frac{\mathrm{C}}{\mathrm{m}^2}\right] = 7.8310^{11} f\left[\frac{\mathrm{V}}{\mathrm{m}}\right] \quad [11]$$

For a cloudy cell of water and methane, the electrical displacement due to the methane is equal to the intrinsic pyroelectric displacement plus the induced by the electrical atmospheric field; this second term can be evaluated in an analogous form to the watery cell. The dielectric constant of the methane is 1.67 (15), valid approximation in the range of temperature and pressure of the low troposphere. The dielectric constant of methane is the main cause that many researches label it as a poor candidate for electrical charging (32-34), but the methane influence in lightning generation is not for its dielectric properties. Few years ago, Tokano *et al.* (6) label it as the main cause of Titan's lightning, but they did not mention the cause. We are proposing that it is for the pyroelectrical properties that methane is the principal element in lightning generation (34, 20), this because the intrinsic electric displacement vector do not depend of the dielectric constant.

For methane cloudy cell the average value will be:

$$\langle D \rangle_{CH_4} \approx 6.93 f \left[\frac{\mathrm{C}}{\mathrm{m}^2}\right] + 1.67 \frac{\varepsilon_0}{d} \int_h^{h+d} E\,dz \qquad [12]$$

Now, we are considering only two elements in the cloudy cell, water and methane; there is had that the polarization term becomes:

$$P = \varepsilon_0 (\chi_{H_2O} + \chi_{CH_4}) \vec{E} \qquad [13]$$

Rewriting the equation (8) of the electric displacement vector, in terms of the dielectrics constants we obtain:

$$\vec{D} = \vec{D}_0 + \varepsilon_0 (k_{H_2O} + k_{CH_4} - 1) \vec{E} \qquad [14]$$

For a cloudy cell the average value is:

$$\langle \mathrm{D} \rangle \approx 6.93 f \left[\frac{\mathrm{C}}{\mathrm{m}^2}\right] + \frac{\varepsilon_0}{d} \int_h^{h+d} k_{H_2O} E dz + k_{CH_4} \frac{\varepsilon_0}{d} \int_h^{h+d} E dz - \frac{\varepsilon_0}{d} \int_h^{h+d} E dz \qquad [15]$$

Notice that, the water molecules do not contribute to the intrinsic electrical displacement (D_0). The constant value f, that represents the concentration of methane in a cloudy cell consisted mainly of water, is very small to consider it in the factors of polarization that contribute to the total electrical displacement of the cloudy cell, however it is of vital importance for the factor of intrinsic electrical displacement.

Obviously convective clouds are not composed only of diluted ideal mixture of water and methane, certainly the main component of clouds is water and in nature clouds have a lot of solid and liquid particles and the phase transitions occurring within that volume, however we are considering that only these two elements, water and methane, are the principal elements in the electric charge process of clouds.

The figure 3 shows the results obtained for the electrical displacement module divided by the vacuum permittivity: for water, for a methane fraction and for a cloudy cell of water plus a methane fraction. The concentration of methane in clouds is very small so we use a very small concentration that can generate the necessary charge to produce a discharge, we use a concentration thousand times minor to the methane atmospheric average composition, inside the cloudy cell (f = 2 10^{-9}); where the electrical displacement vector of the cloud is affected by the values that the water and the methane possesses at the altitude where finds the base of the cloudy cell.

Observe (in figure 3) that even for a cloudy cell which composition of methane should be thousand times minor that the atmospheric average composition, it will be had a pyroelectric field in the order of 1.5 MV/Km, which value is in the order of the electrical displacement of the water.

For any methane concentration bigger than the used one, the electrical displacement of methane is very superior to the electrical displacement of the water, which increases notably the interior electric field of the cell. If the methane concentration in the cloud is null, there will exist a value of electrical displacement, which is not the sufficiently big to produce a discharge.

This results obtained for the internal electric field of the cloudy cell are in agree with observations in lightning (28), and with numerical simulations for extraterrestrial atmospheres (6).

4. Discussion: charge process

In the approximation of the cloudy cell like a telluric capacitor, following the typical atmospheric assumption (25); we must consider the capacity associated with cell, the potential difference inside the cell and the charge acquired just before the discharge.

The capacitance of the cloudy cell is:

$$C = \varepsilon_0 A \left[\int_{h}^{h+d} \frac{dz}{k(z)} \right] \qquad [16]$$

The equation (16) expires with the basic assumptions of a parallel plate capacitor, because when we took a differential of the thickness, there is guaranteed that the area of the plates is very superior to the distance of separation, and the dielectric constant does not vary with the altitude in this differential. This approximation can be observed as a set of capacitors in series, with different materials. Due to the fact that the composition of the cloud is principally of water, and to that the dielectric constant of the water is bigger than the methane constant, for the calculation of the capacitance we despise any contribution of the methane.

We take a cloudy cell with an area of 12.96 Km^2; the values of the electrical capacity were increasing slightly with its altitude monotonously like the figure 4 indicates, acquiring its maximum value at the altitude such that the temperature of the cell is close to the freezing point.

We shown values of the capacitance for different thicknesses, however, for effects of our posterior calculations we will use the thickness of 3.6 Km. With the electrical displacement vector, we calculated the potential difference between the low limit and the top limit of the cloudy cell. The figure 5 shows the potential difference generated inside the cloudy cell.

It is very important to compare the order of magnitude of the potential difference produced by the electrical displacement (see figure 5), with the produced by the atmospheric electric field (see figure 1), which the potential produced by the electrical displacement is superior in an order of 10^3. In the figure 5 we add the potential difference

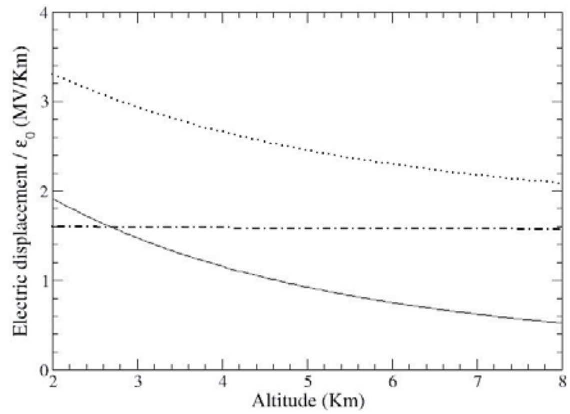

Figure 3. Contributions of water and methane in the electrical displacement of the cloudy cell. The dotted line represents water plus a fraction of methane; the solid line is a water cloudy cell only, and dashed-dotted line is a methane fraction only.

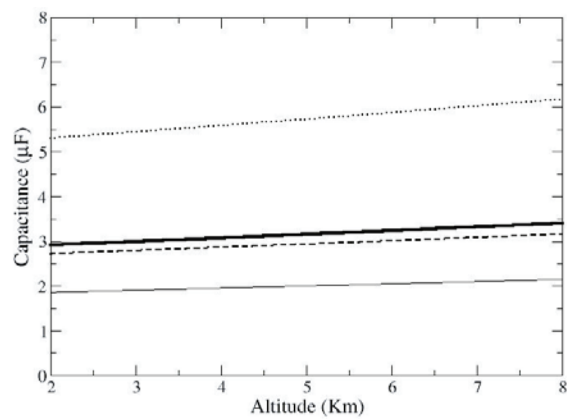

Figure 4. Electrical capacitance of the watery cell depending of the altitude; using different thickness up to down, 2.0 Km, 3.6 Km, 4.0 Km and 6.0 Km respectively.

produced by the electrical atmospheric field and the produced for the electrical displacement of the elements that compose the cloud, being this the total potential difference inside the cloudy cell; however due to the great difference of the orders of magnitude

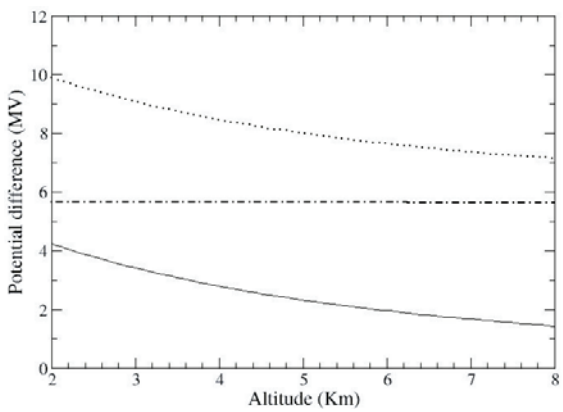

Figure 5. Variation of the internal electrical potential difference of a cloudy cell: water plus a fraction of methane (dotted line), only a methane fraction (dashed-dotted line), and only water (solid line).

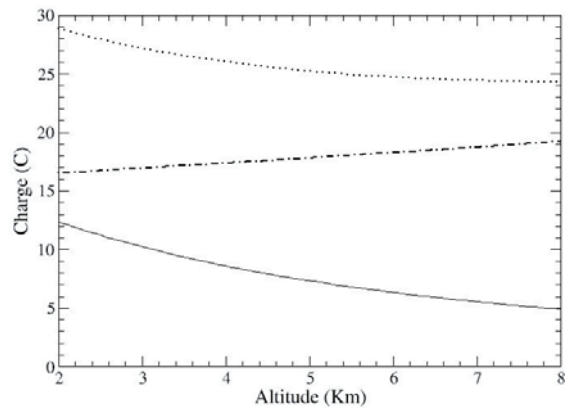

Figure 6. Maximum charge accumulated by the cloudy cell depending on the altitude of different components; water plus a fraction of methane (dotted line), only a methane fraction (dashed-dotted line), and only water (solid line).

the predominate factor is the electrical displacement.

The maximum acquired charge by the watery cell is limited by the break down dielectric voltage of the humid air ($\Delta V \approx 1$ MV) necessary in order that the electrical activity appears (26). The figure 6 shows the charge that we obtain.

The results obtained for the charge of a cloudy cell considering the presence of methane seem to be in the range of the recent observations in lightning (1) (27, 28, 35). If only the influence of the water is considered, the values of charge are insufficient to produce a discharge or lightning flash; even more, if is only considered the geometry of the cell and the influence of the electrical atmospheric field, the results we obtained for the charge of a cloudy cell are of the order of 20 microamperes, which certainly is a negligible quantity, when we speak about the charge of a body of very big size as a cloudy cell. Now, we can summarize the quantitative model presented phenomenologically for the case of lightning Catatumbo River (Venezuela) in figure 7, Original photography by Alan Highton (36), autorized publication, from "Congo Mirador" site (sourth Maracaibo Lake, Venezuela) in November 9, 2008 at 22:19 Hours (HLV), camara Nikon D60.

5. Conclusions

When we use the parallel plate capacitor model (capacitor telluric), then the water dielectric constant increases with the altitude, due to the monotonous decrease of the temperature. This proper factor of the water molecules is proportional to the capacitance what seems to indicate that the cloudy cell is charging as the water go up.

In agreement of the numerical models, the break down potential of a cloudy cell (28), only of water, it is not sufficient for a discharge. With this study of aerosols in the atmosphere, it is possible to identify the elements that help to increase the electrical values of the displacement vector of a cloudy cell. The methane due to its configuration of tetrahedral crystalline symmetry possesses pyroelectrics properties, which can polarize even without the presence of an external electric field. Increased the relative concen-

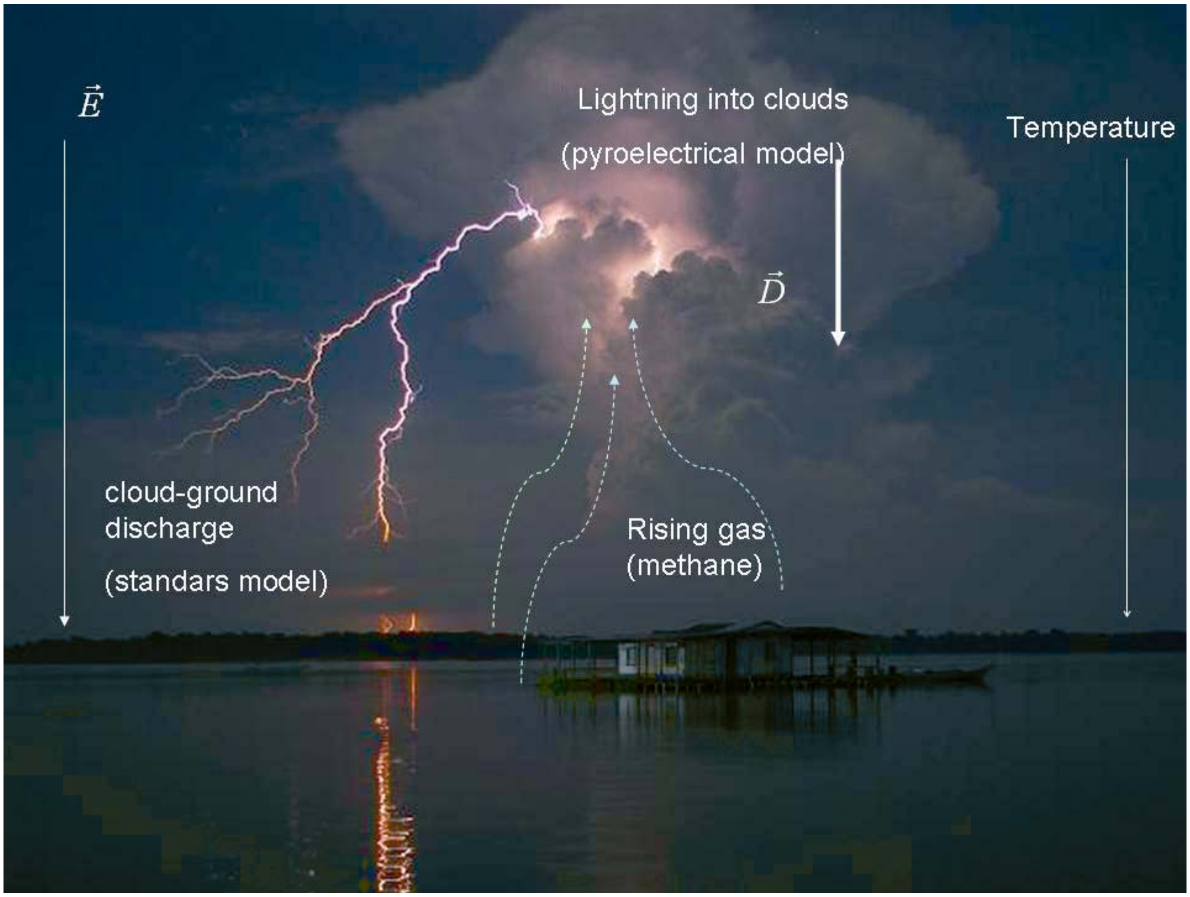

Figure 7. Phenomenological picture of the clouds loading mechanism in the in the lightning Catatumbo River, which the pyroelectric gas accumulation increases the electric displacement vector. Original photography by Alan Highton (37).

tration of methane or probably of others pyroelectric aerosols in the cloudy cell, the electrical activity meets increased, as in the hypothetical case of a cloudy cell of water and methane (or even of methane hydrates).

The lightning flashes phenomenology and especially of the electrical discharges cloud to cloud and cloud to ground show that these manifestations are frequent in low latitudes (lower than 60° of latitude), in the night hours and in cumulonimbus clouds type (1). The usual explanation of this phenomenology is attributed to the presence of convective flows, typical of the intertropical regions favored by the diurnal warming and by the thermal gradients between cloud and ground in the stormy zones with abundant convective movements (24). Notice that the convective model does not explain for itself the electrical activity but rather the rainfall. To explain the lightning flashes, it is needed to add a series of very debatable models which could cause the charges separation in thunderclouds (8).

Also, the accumulation methane is major in low latitudes (19), it continues being major in the night hours when the methane is not photodissociated and is major in cumulonimbus clouds where the opaqueness filters the solar radiation that avoids its photodissociation and allows its relative accumulation in the interior of the same ones.

Notice that (see figure 3), they do not need big relative concentrations in the interior of the cloudy cells; it is enough with scarcely a relative concentration thousand times minor than the air, without photodissociation, to generate the lightning flashes.

The observed phenomenology seems to agree with our model, existing extraterrestrial evidence, principally in the atmosphere of the satellite of Saturn: Titan, where the atmospheric concentration of methane is very superior to the Earth (37), and the electrical activity in this celestial body is also superior to that of our planet (38); besides many other bodies of the solar system, with presence of methane in their atmospheres, in which is not demonstrated the presence of electrical activity but it presumes strongly its existence (8, 21).

We are inclined to think that the presence of aerosols and/or pyroelectrics particles are co-helper to the electrical activity observed in no hydroscopic environments such as the volcanic eruptions and the sandstorms, where the lightning flashes demonstrate without the presence of rainfall (39). Note, in figure 7, that it is proposing a mechanism to explain the increase in the electric displacement vector, internal to the clouds, where discharges originate, according to which there is no net transport of matter (molecules ionized gas or methane) but the relative accumulation of gas in the cloud increases the value of field strength, making a major difference of potential within the cloud cells (see figure 5), where the discharge occurs. Not required to explain the observed discharge, propose fast convective air flows, for the capacitance has increased due to methane, which, by analogy act as "dielectric". The downloads are due to the propagation of induced charges in a Townsend type mechanism (40).

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