Cosmic dust and the global electric circuit of the Earth

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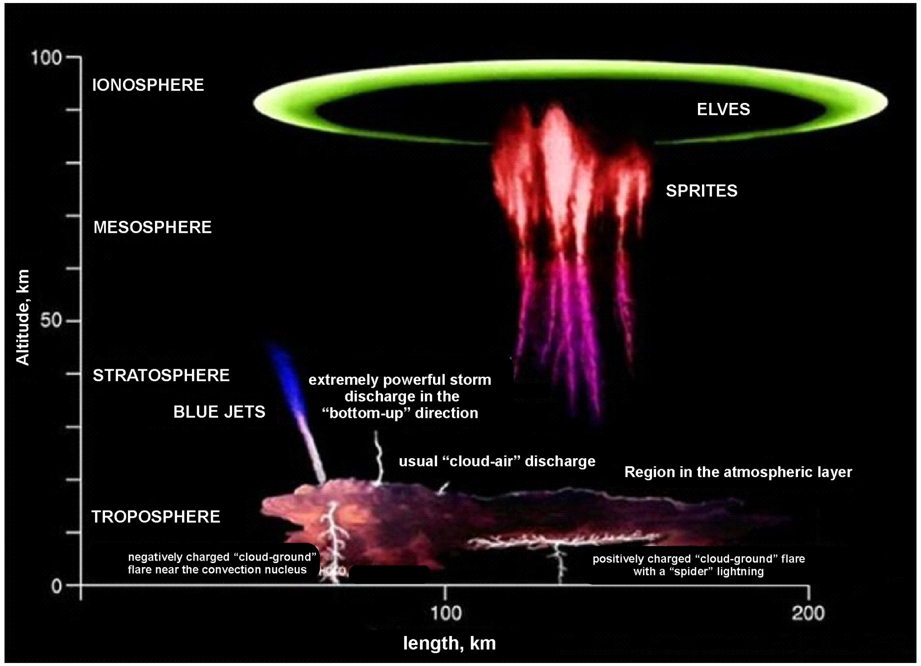
The problem of the global electric circuit of the Earth consists in combination of electric processes in the atmosphere, ionosphere, and space.

A key issue in formation of the global electric circuit of the Earth is determination of the conditions for emergence of a voltage (current) source, which maintains the difference of potentials between the ionosphere and the Earth’s surface with sufficient stability.

Main electric phenomena observed in the atmosphere of the Earth

1. Atmospheric electricity has been studied for almost two centuries. These studies have shown that the Earth's surface is charged negatively, and this charge creates the electric field E ⍰ 130-140 V/m. The average charge of the Earth is Q ⍰ $5 \cdot 10^5$ C.
2. In clear weather, the current of positive molecular ions (fair weather current) flows from the E-layer of the ionosphere. The density of this current is $j_+ \sim 3 \cdot 10^{-12} A/m^2$, and the total current to the Earth's surface ($S = 4 \cdot 10^{14}$ m^2) is about 1700 A.
3. The electric field decreases with a growing altitude, which is connected with the variation in the conductivity of the atmosphere (leaky capacitor). The main decrease of the voltage between the E-layer and the Earth's surface occurs in a narrow layer of about 3-5 km.
4. It has been found that the voltage of the intensity of the Earth's electric field changes synchronously at different points on the globe (unitary variation). The maximum of the electric field falls on 16-20 hours (universal time).
5. As a rule, rain, snow, hail, and lightning strokes carry the negative charge to the Earth.
6. The best pronounced and most noticeable phenomenon in the circuit of the electric processes running in the atmosphere is the electric breakdown between clouds and between a cloud and the Earth.

As a rule, the bottom of cumulus clouds is charged negatively, and the top, positively. A small number of positive charges is observed near the bottom edge of the clouds. The characteristic voltage of the electric field between the storm clouds and the Earth is 1-3 kV/cm, which is an order of magnitude below the air breakdown field at the atmospheric pressure. Recently, lightning discharges occurring above storm clouds have been discovered. These high-altitude discharges are called sprites. They follow in 100-200 μs after a conventional lightning discharge.



1. V.M. Muchnik. *Storm Physics* [in~Russian], 1974.
2. I.M. Imenitov and K.S. Shifrin, *State-of-the-art of studies of atmospheric electricity* [in Russian], Uspekhi Fiz. Nauk, **76**, 4, 593 (1962).
3. B.M. Smirnov, *Electric cycle in the Earth's atmosphere* [in Russian], Uspekhi Fiz. Nauk, **184**, No. 11, 1153 (2014).

Modern concept of the sources of atmospheric electricity

According to modern concepts, the “core” of the atmospheric electric machine is the storm cloud [1].

The dipole character of cloud charging stimulated development of various mechanisms of charge separation in the cloud and formation of the electric machine.

It is assumed that electric charges in the cloud are formed when water aerosols in different aggregate states collide.

Upward air streams lead to separation of charges. Specifically, positive (light) ions move upward, and negative ones move downward. Thus, the mechanical energy is transformed to the electric one.

The kinetic energy of light positive ions should satisfy the condition

$$\frac{M_+ V^2}{2} > Ze\varphi$$

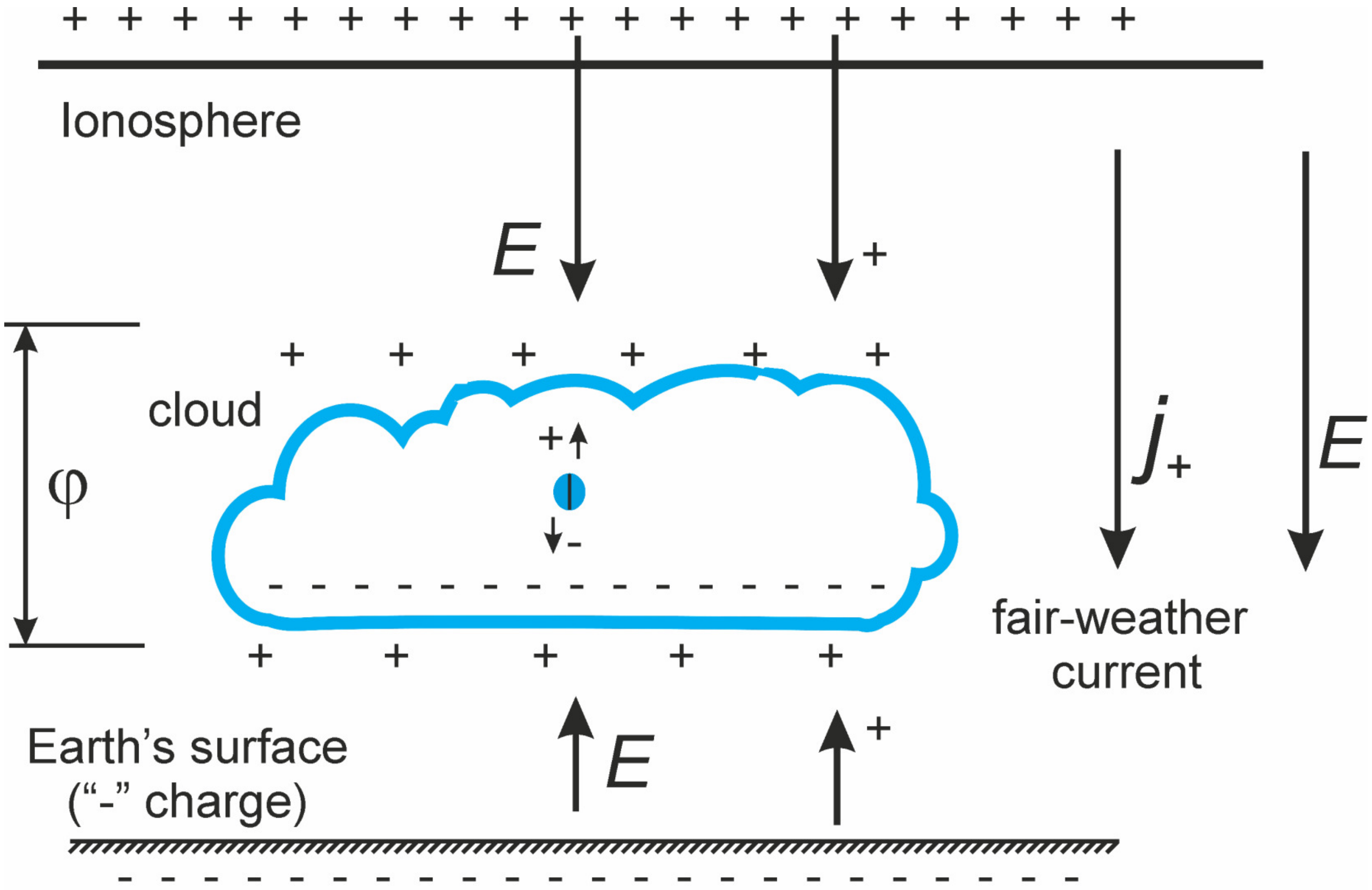
where M_+ is the mass of ions, V is the velocity of the air flow, Z is the charge of air ions, and $e\varphi$ is the potential of the “heavy component”.

Estimations show that in the case of reasonable air flows, molecular ions cannot take part in such a process of formation of the electric battery.

In [2], attention is drawn to the fact that convective upward flows lead mainly to mixing of heteronymous aerosols. Moreover, the energy of electrostatic (Coulomb) interaction of the aerosols residing in the cloud in different aggregate states exceeds the thermal energy of the aerosols significantly. Therefore, their charge in air decreases.

Inadequacy of considering the cloud as an electric source in the question about the Earth’s global electricity is evident.

[1] E.A. Mareev and V.Yu. Trakhtengerts, *Mysteries of atmospheric electricity* [in~Russian], Priroda, No. 3 (2007).
[2] B.M. Smirnov, *Electric cycle in the Earth’s atmosphere* [in Russian], Uspekhi Fiz. Nauk, **184**, No. 11, 1153 (2014).



Charge separation as a result of convective flows should satisfy the following conditions:

$$\frac{M_+ V_+^2}{2} > e\varphi \qquad M_- g < F_{st} = 6\pi\eta R V_{conv}$$

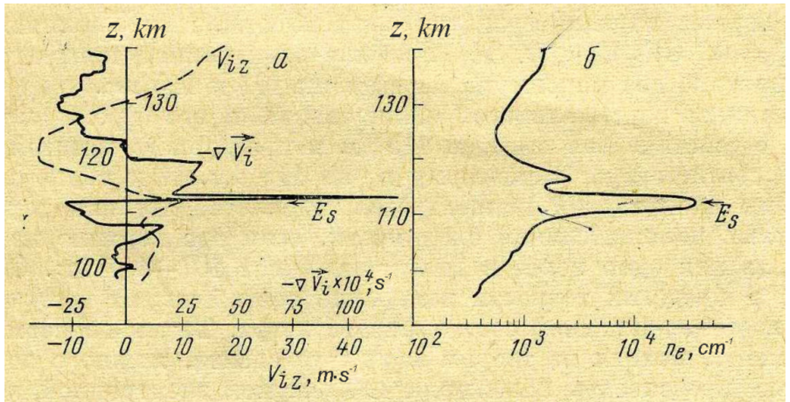
Anomalous E-layer in the Earth's ionosphere

Ionosphere is the plasma shell of the Earth. The E-layer exists in it at altitudes of 100-120 km, which is characterized by anomalous distribution of plasma density.

Estimations show that intensities of the short-wave radiation of the Sun is insufficient to explain anomalous distribution of the plasma density in the E-layer (especially by night) [1, 2]. It is necessary to involve various corpuscular flows (horizontal motions with velocities of up to 10^2 m/s).

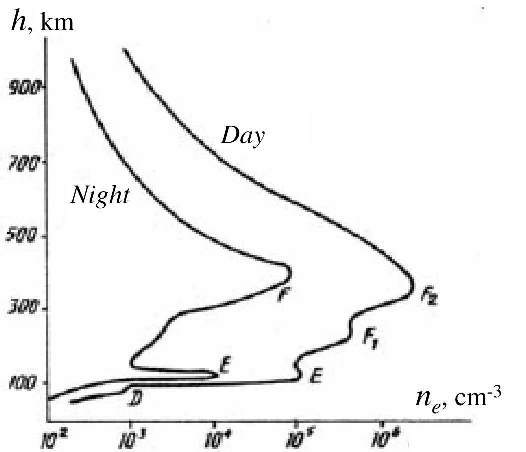
In the E-layer region, plasma ions turn to be non-magnetized due to collisions with the neutral gas of the atmosphere ($\nu_{im} > \omega_{hi}$).

It was noted in [3] that in the period of strong meteor showers, an increase in the electron density in the E-layer region is observed.



Altitude distribution of the wind [4]

Altitude distribution of the electron density [4]



Typical vertical distribution of the electron density in the ionosphere for the daytime and nighttime conditions [3].

1. A.D. Danilov, *Popular Aeronomy* [in Russian], Gidrometeoizdat (1989).
2. K.I. Kringauz, *Temperature of neutral and charged particles in the ionosphere and magnetosphere* [in Russian], Usp. Fiz. Nauk, **92**, No. 2.
3. Ya.A. Alpert, *Propagation of Electromagnetic Waves in the Ionosphere* [in Russian], Nauka, Moscow (1972).
4. A.A. Andreev, L.A. Katayev, G.P. Komrakov, et al., *Vertical wind profiles and formation of the E-layer in midlatitudes* [in Russian], Geomagn. Aèron., **XIII**, No. 6, 1042 (1973).

Anomalous acceleration of ions in the magnetosphere and ionosphere of the Earth

1. It was found that distribution and composition of particles in the solar wind and the magnetospheric plasma are fundamentally different.
2. As the particles penetrate the magnetosphere, they accelerate and redistribute over energies, and the composition of the hot plasma is enriched with the ions of the ionospheric origin [1].
3. It was found in [2] that at $L < 5$, a maximum at $E > 100$ keV is formed in the proton spectrum. It shifts towards higher energies, as L decreases, and is observed both near the geomagnetic equator, and at midlatitudes.
4. By using the *Polar* satellite [3], strong electric fields were detected, which were perpendicular to the magnetic field and reached 100 mV/m.

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[1] A.S. Kovtyukh, *External Plasma Shells of the Magnetosphere*, in: Prof. M.I. Panasyuk, ed., *Model of Space, Vol. 1* [in Russian], “Universitet” Publ. House (2007), p. 456-481.

[2] N.A. Vlasova, B.N. Knyazev, A.S. Kovtyukh, et al., *Protons with E > 30 keV in the radiation belts of the Earth in magnetically quiet time near the geomagnetic equator and at low altitudes,* Space Res., **22**, No., 1, 53-66 (1984).

[3] A. Keiling, J.R. Wygant, C. Cattell, M. Johnson, M. Temerin, F.S. Mozer, C.A. Kletzing, J.S cudder, and C.T.Russell, *Properties of large electric fields in the plasma sheet at 4-7 RE measured with Polar*, J. Geophys. Res., 106, 5779-5798 (2001).

Cosmic dust

1. The Earth is surrounded with a dense dust envelope.
2. Space dust is conventionally understood as particles of solid matter having dimensions from several micrometer fractions to several micrometers.
3. According to different data [1, 3, 4], from 10 to 400 thousand tons of matter and more precipitate daily on the Earth's surface.
4. Existence of dust around the Earth is confirmed by studies of zodiacal light [3], which is a result of scattering of solar radiation by interplanetary dust "floating" above the Earth's surface [3].
5. In their composition, interstellar particles have hard-melting cores consisting of silicates, graphite, carbide, silicon, iron, etc. [2].
6. Dust and large meteors (1 mm in diameter and larger) descend to altitudes below 100 km in the rarefied atmosphere of the Earth. At such altitudes, large meteors burn up and cause the well-known phenomenon of meteor showers, and small ones continues moving towards the Earth's surface. .

1. A.P. Boyarkina, N.K. Vasilyev, et al. *On estimation of the cosmogenic inflow of heavy metals to the Earth's surface*, in: Space Matter and the Earth [in Russian], Nauka, Novosibirsk (1986), p. 203.
2. J. Matis, *The size distribution of interstellar grain*, Astr. J., 217, 425 (1977).
3. R.D. Call. *Particles in Atmosphere and Space*, New York (1966).
4. F.H. Ludlam, *Luminous night clouds* [in Russian], Usp. Fiz. Nauk, **LXV**, 3, 407-440 (1958).

Cosmic dust

Reserves of metals (hydroxides of magnesium and iron) found in the middle of the Pacific Ocean have high contents of nickel, cobalt, copper, and minor admixtures of platinum, iridium, zinc, lead, molybdenum, silver, gold, and phosphorus.
The estimate reserves are 380 billion tons.
Calculations showed that the metal reserves grow by approximately 1 mm in a thousand years. This coincides with the well-known fact of fast accumulation of bog ore in lakes.
In Russia, iron ore has long been mined for on lake bottoms.
Basing on the data about metal accumulation, in 1983 the amount of cosmic dust precipitating on the Earth was estimated as 2.4 billion tons per year or $6 \cdot 10^6$ tons per day.

A.F. Grachev, *On the nature of cosmic dust in sediment rocks*, Fiz. Zemli, 11, 3-13 (2011).

Growth mechanism of dust particles

Ejection of plasma from the surface of stars (solar wind), as well as supernova bursts lead to formation of ionized gas in space.

Plasma spread is accompanied by recombination of electrons and ions and formation of neutral atoms, which can form clusters and dust particles due to gravitational attraction.

A dust particle surrounded by electrons and ions is charged negatively, which leads to surface recombination of ions and continuous precipitation of matter to the surface of the particle.

During plasma recombination on the particle surface, all laws of conservation of momentum and energy are fulfilled, by contrast to the case of recombination of electrons and ions in free space.

In the case of surface recombination, the excessive energy goes into heating of the dust particle and electromagnetic radiation.

In space plasma, various chemical elements precipitate to the dust particle. They can form stable electric coupling, i.e., new stable couples can form in the absence of strong external gravity.

This is how meteors come into being and grow.

Charging of material bodies in plasma

This process is an important section of physics of ionized gases. To describe charging of bodies in plasma qualitatively, researchers generally use the models borrowed from the theory of electric probes.

Due to its greater mobility, the flow of electrons surpasses the flow of ions to the surface of a body in plasma, and the body is charged negatively.

An increase in the negative charge leads to repulsion of electrons and attraction of ions. With allowance for the electron velocity distribution function, the stationary potential Φ of the body (floating potential) is determined on the basis of equality of the flows of electrons and ions, J_e and J_i, respectively.

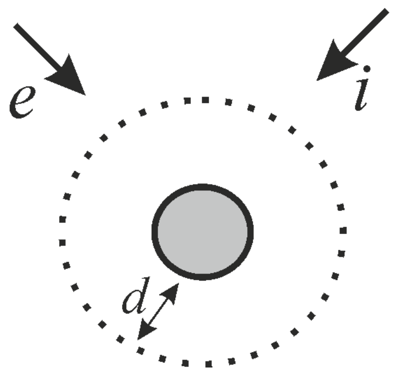
Near the surface of the body, a layer having the thickness *d*, which is proportional to the Debye radius, is formed. For a body, which has the radius *a* and the Maxwellian distribution function, we have:

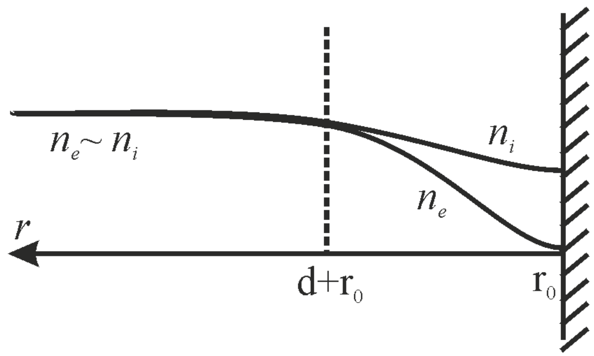
$$J_e = qN_e \pi a^2 \left(\frac{kT}{2\pi m_e} \right)^{\frac{1}{2}} \ell^{-\frac{q\Phi}{kT}}$$

$$J_i = qN_i \pi a^2 \left(\frac{kT}{2\pi m_i} \right)^{\frac{1}{2}} \left[1 - \frac{q\Phi}{kT} \right]$$

Cross section of the charged body

$$\sigma = \pi a^2 \left(1 - 2\frac{q\Phi}{mV^2} \right)$$





Charging of material bodies in plasma

Staying in plasma, dust particles can grow due to surface recombination of ions, which leads to continuous precipitation of material to the surface of dust particles [1].

Under surface recombination of ions and electrons, the excessive energy is transmitted to the dust particle, which determines its heating and promotes forming of strong chemical bonds. Thus, one can explain the origin of dust particles and large meteors in space from the ionized plasma component in space.

In the stationary state, $J_e = J_i$, which allows one to determine the floating potential. As a rule it is negative and equal to

$$\Phi \approx -\alpha \frac{T_e}{e}$$

where the coefficient α is of the order of magnitude of several units [1, 2].

For distances from $r < r_d$ from the body surface, the formula for the potential has the form similar to the formula for the Debye shielding:

$$\Phi = \frac{Ze}{r} \exp\left(-r / r_a\right)$$

[1] V.E. Fortov, F.G. Khrapov, et al., *Dust plasma* [in Russian], Usp. Fiz. Nauk, **174,** 5, 495 (2004).
[2] A.Piel. *Plasma Physics*, Springer-Verlag (2010).

Charging of material bodies in plasma

However, due to openness of the system, which ensures the flow of ions to the body surface at distances exceeding the Debye radius, the potential is not shielded exponentially, but has the power asymptotics.

Absorption of electrons and ions on the body (particle) in plasma affects shielding of this field. Due to this reason, the shielded field of the particle differs from the Debye field.

Thus, as a rule, any body or dust particle located in plasma will be charged negatively, until it reaches a potential, at which the currents of ions and electrons will be identical.

If one considers a dust particle as a small sphere having the radius *r*, which is less than the Debye radius, then its capacity *C* will be determined by the formula

$$C = 4\pi\varepsilon_0 r$$ where $\varepsilon_0 = 8.9 \cdot 10^{-12}$ f/m

The charge of the dust particle is

$$q = C\Phi = 4\pi\varepsilon_0 r\Phi$$

Average mass and size of dust particles reaching the Earth's surface

Let us estimate the charge and mass of cosmic dust particles within the framework of the model of charging of the Earth by cosmic dust, basing on the experimental data.

For estimation, the following average parameters will be chosen.

1.Assume that dust particles consist of graphite (carbon). The density of graphite is $\rho = 2.3\cdot10^3$ kg/m^3, $\boldsymbol{m_p=4\pi\rho r^3/3}$, where r is the radius of the dust particle.

2.We use the average value of the dust flow $\Pi = 2\cdot10^8$ kg/day ≈ $2\cdot10^3$ kg/s.

3.The charge of the dust particle is determined by the particle radius and the thermal energy of electrons in space

$$q_p=4\pi\varepsilon_0 r\Phi$$

$\Phi \sim 5$ V. This estimate is found from the velocity of the solar wind, $V\sim10^6$ m/s.

4.The negative current carried by dust particles is equal to the fair-weather current

$$J_- = J_+ = 1700 \text{ A}$$

Compare two equations for the dust flow and the current carried by the dust to the Earth:

$$\left.\begin{aligned} m_p N_p V_p S_3 &= \Pi \\ q_p N_p V_p S_3 &= J_+ \end{aligned}\right\} \Rightarrow \frac{m_p}{q_p} = \frac{\Pi}{J_+} \qquad \frac{4\pi\rho r^3}{4\pi\varepsilon_0 r\Phi} = \frac{\Pi}{J_+} \Rightarrow r = \sqrt{\frac{\Pi\varepsilon_0\Phi}{J_+\rho}}$$

$$m_p = 2\cdot10^{-16}\,kg$$
$$q_p = 1.5\cdot10^{-16}\,C$$
$$r = 0.4\cdot10^{-6}\,m$$

where N_p and V_p are the density and velocity of the dust particle motion, and S_3 is the area of the Earth's surface.

Average mass and size of dust particles reaching the Earth's surface

Let us estimate the gravity of such dust particles and compare it with the electric force in the fair weather field.

$$m_p g = 2 \cdot 10^{-15}\ \text{N}, \qquad E \sim 140\ \text{V/m}, \qquad q_p E = 2 \cdot 10^{-14}\ \text{N}$$

In fair weather, dust particles having weights of $2 \cdot 10^{-16}$ kg and less, stop at an altitude of more than 3-5 km, where the electric field starts decreasing, and act at centers of water vapor condensation. At an altitude of 4-6 km, the electric field decreases to 5-10 V/m.

In the case of minor supersaturation in the atmosphere, condensation activity at negatively charged particles (cores) is several orders of magnitude higher than that at the positive ones. The condensation occurs mainly at negatively charged particles [1].

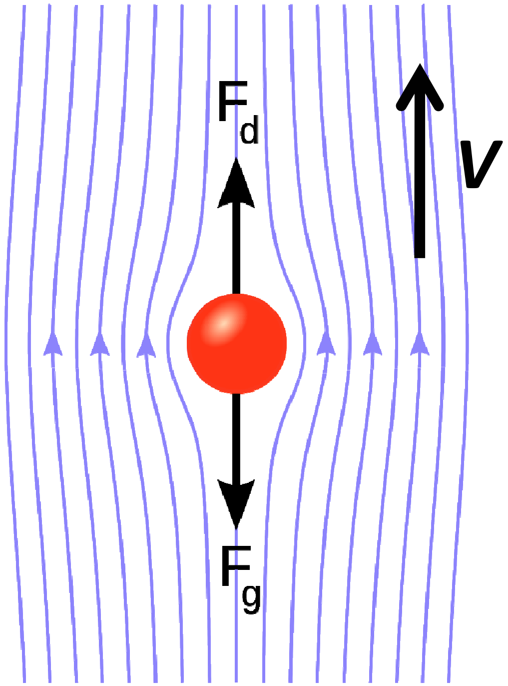
Negatively charged water drops concentrate near the bottom of the cloud. From the E-layer of the ionosphere, positive light ions precipitate to the cloud top. Thus, the dipole character of cloud charging is formed.

Increased condensation of water at negative cores leads to formation of large charged air ions, which are transferred to the Earth in the form of rain, snow, and lightning discharges.

[1] A.I. Rusanov, *On thermodynamics of nucleation at charged centers* [in Russian], Dokl. Akad. Nauk, **238**, 4, 831 (1978).

Ionic wind

Ionic wind is a phenomenon, where a gas motion is produced by means of an electric field.



Consider a spherical liquid drop having the radius R in a vertical gas flow having the velocity V. The particle is affected by the gravity force F_a and viscous-friction force F_d.

$$F_d = 6\pi R \eta V \qquad F_g = mg = \frac{4}{3}\pi R^3 \rho g$$

Here, η is the fluid viscosity, m is the mass drop, and ρ is the water density.

The equilibrium condition is $F_g = F_d$. From here, it is possible to find the gas velocity, at which the drop will be at rest.

$$6\pi R \eta V = \frac{4}{3}\pi R^3 \rho g \Rightarrow \boxed{V = \frac{2}{9}\frac{\rho g R^2}{\eta}}$$

$$R = 10^{-5} m,\ \eta = 1{,}72 \cdot 10^{-5} kg/(m \cdot s),\ \rho = 10^3 kg/m^3 \Rightarrow \boxed{V = 1.3\text{cm/s}}$$

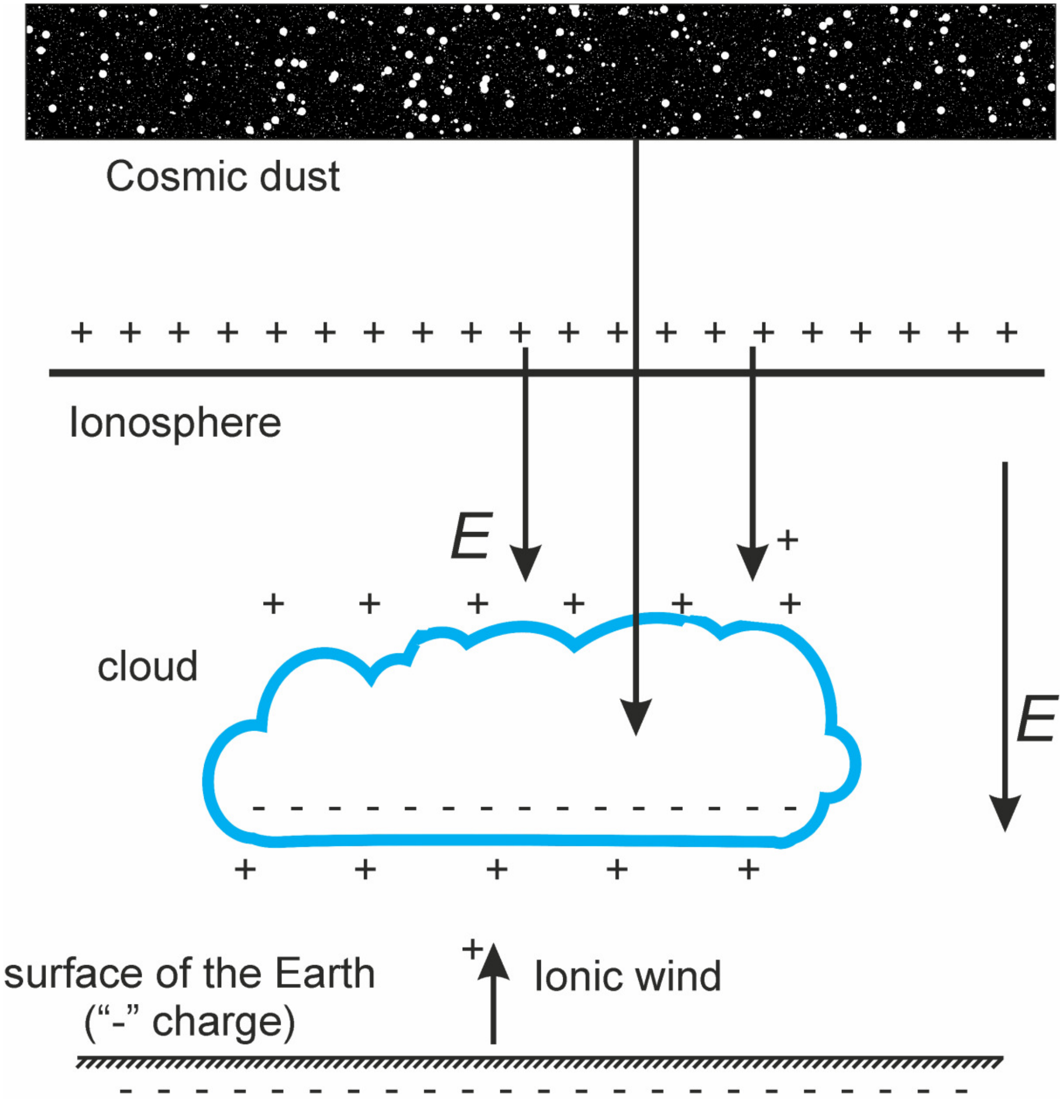
Table. Mobility of negative and positive ions in nitrogen at room temperature, normalized to the normal molecule density N = 2.69 x 10^{19} cm^{-3}

Ion	NO_2^-	NO_3^-	CO_3^-	$NO_2^- \cdot H_2O$	$NO_3^- \cdot H_2O$	$CO_3^- \cdot H_2O$	N_2^+	CO_2^+	N_2H^+	N_3^+	N_2O^+	N_4^+	$H^+ \cdot H_2O$	$H^+ \cdot (H_2O)_2$	$H^+ \cdot (H_2O)_3$
K, $cm^2 V^{-1} s^{-1}$	2,5	2,3	2,4	2,4	2,2	2,1	1,9	2,2	2,1	2,3	2,3	2,3	2,8	2,3	2,1

Formation of storm clouds

1. Upward flows of humid air condense of negatively charged dust particles, leading to formation of a cloud.
2. Origination of a storm cloud occurs at the cost of arrival of dust particles and condensation of water vapor. As the electric field between the cloud and the Earth increases, an ionic wind (motion of neutral gas) arises, which holds large drops in the cloud.
3. Light positive ions move from the E-layer to the top of the cloud, since efficiency of moist condensation on them is significantly lower, than that at negative ions. Thus, the dipole character of the cloud is created.
4. In the electric field between the cloud and the Earth, positive ions can drift towards the bottom part of the cloud, which has the negative charge.
5. In a storm cloud, the electric field reaches values of about 3 kV/cm, which is an order of magnitude of the field for the breakdown in air. Upward air flows contain dust particles of the terrestrial origin, which initiate formation of a lightning discharge between the cloud and the Earth.
6. Positively charged ions can counterbalance the electric field, the ionic wind stops, and raining or snowing will start.
7. As a rule, a lightning discharge is followed by rain. However, there are situations, where lightning charges occur during a rain. It means that a cloud was not discharged completely after the first lightning stroke, but the velocity of the ionic wind decreased.
8. Lightning discharges occur only, when a cloud contains water drops. If the cloud consists of charged icicles, there will be no lightning. That is why no lightning occurs on the North and South Poles, nor in midlatitudes in wintertime.

Formation of storm clouds



Lightning enhancement over major oceanic shipping lanes

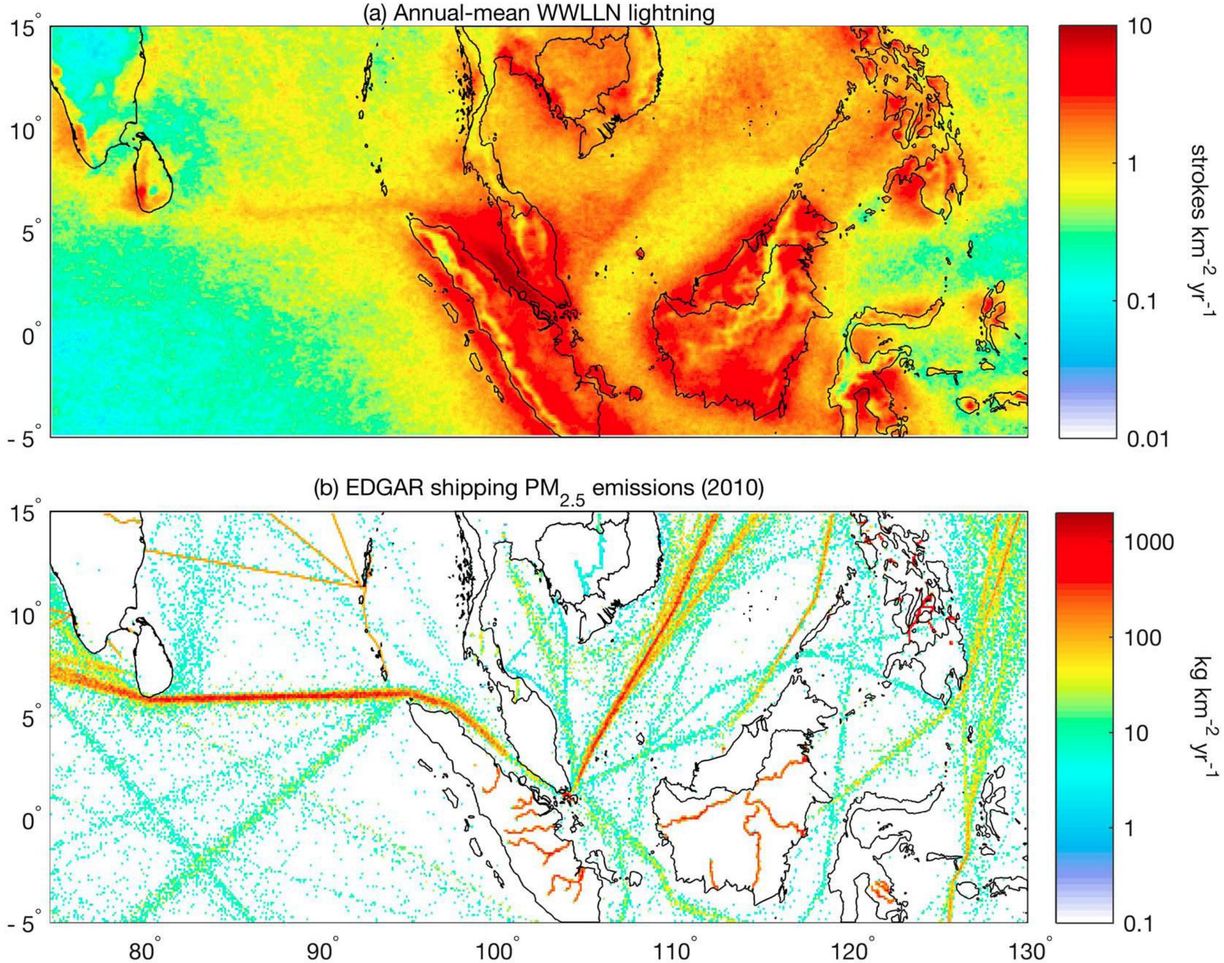
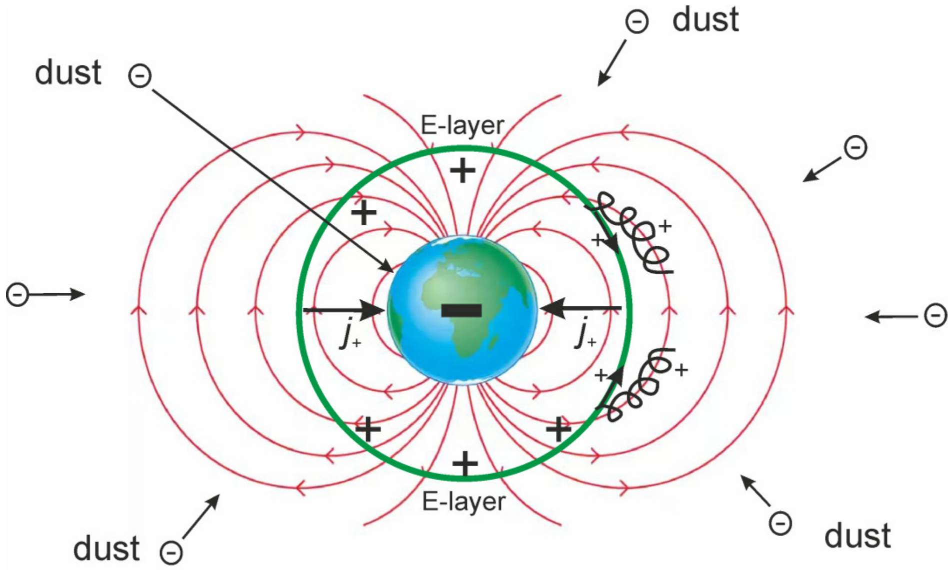


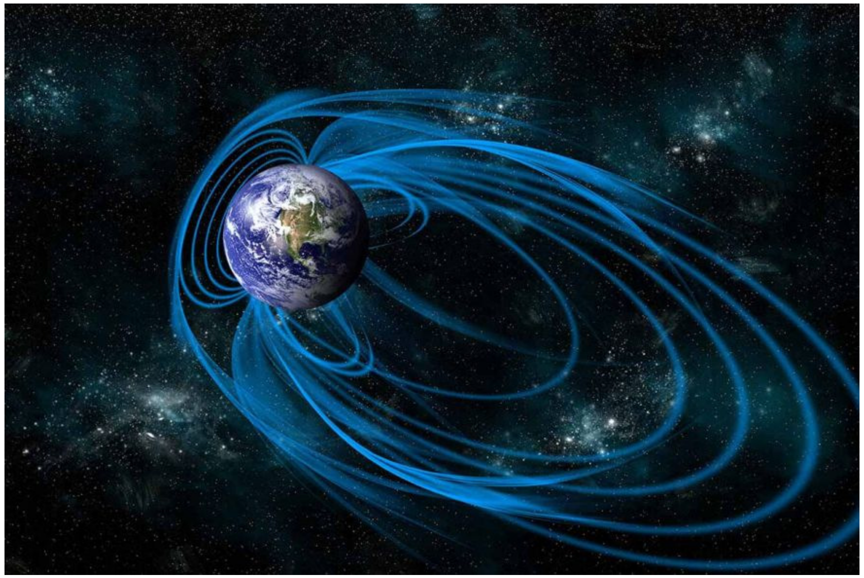
Figure 1. (a) Observed annual-mean WWLLN lightning density for 2005–2016 in the eastern Indian Ocean and the South China Sea. (b) PM2.5 shipping emissions estimates from EDGAR database for 2010, both at 0.1° resolution.

Joel A. Thornton, Katrina S. Virts, Robert H. Holzworth, Todd P. Mitchell. Lightning enhancement over major oceanic shipping lanes // Geophysical Research Letters. 10.1002/2017GL074982. P.9102-9111

Global electric circuit of the Earth

1. The Earth can be represented as a mote in the Universe, which is surrounded with charged particles: electrons, ions, and cosmic dust.
2. Physical processes running around a dust particle in plasma and near the planet Earth are different. This is due to the fact that the Earth has a magnetic field and a dense atmosphere, which screen off direct arrival of light ionized particles to the surface of the planet.
3. Cosmic dust particles with dimensions of several micrometers penetrate through the magnetic field easily due to the force of gravity and precipitate slowly in dense atmospheric layers, reaching the Earth's surface.
4. As a rule, cosmic dust bears the negative charge and charges the Earth to Q = -5·10^5 C.

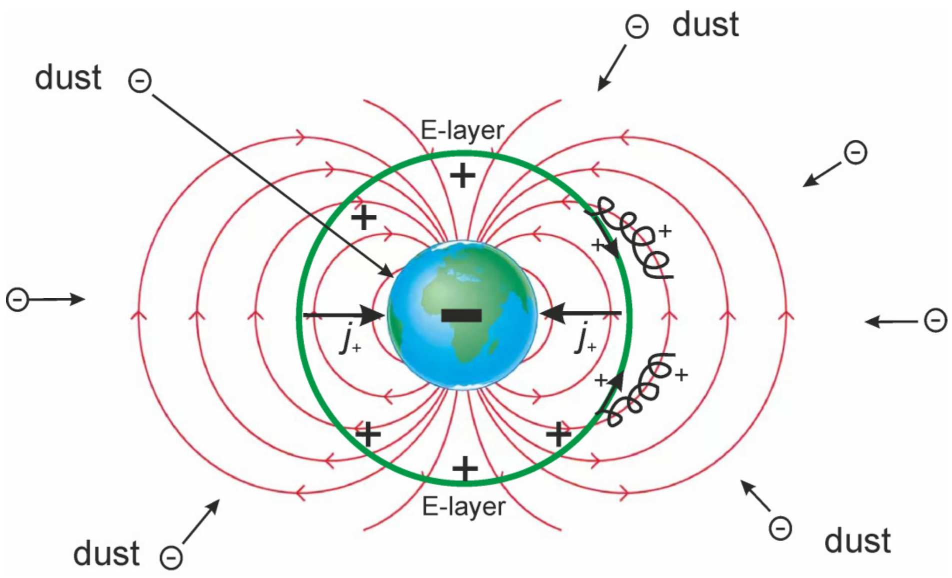


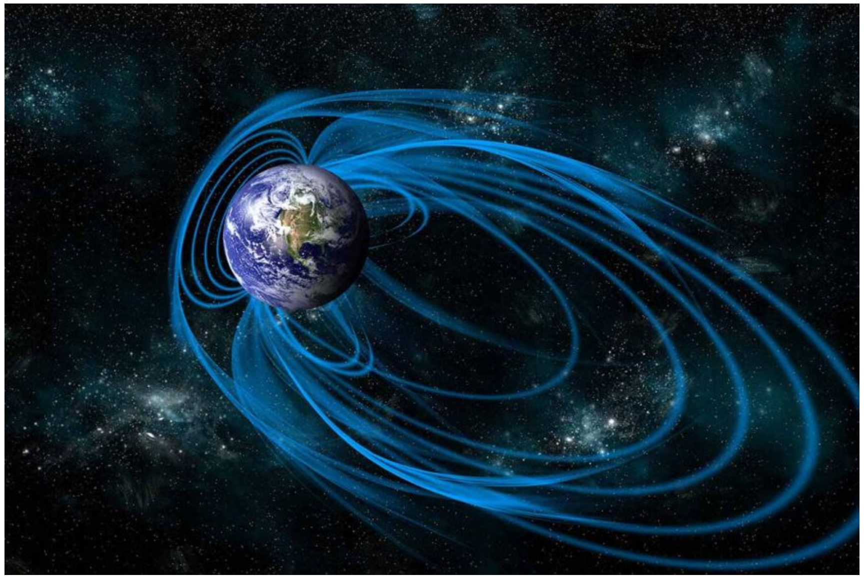


Global electric circuit of the Earth

5. To compensate for the negative charge from the ambient space plasma, acceleration of positively charged ions occurs, which can penetrate into the atmosphere only along the magnetic field in northern latitudes. In the dense layers of the troposphere, at altitudes of 100-120 km, where the frequency of ion collisions with the neutral gas exceeds the cyclotron frequency, ions start moving under the electric field of the Earth and in fair weather, creates the current to the Earth, J_+~1700 A.
6. The stationary state is achieved, when the current of positive ions is equal to the current of negatively charged dust. The "negative" dust is transferred to the Earth in the form of rain, snow, and lightning.
7. Using the fair-weather current and the dust flow to the Earth's surface, one can estimate the average dimensions, mass, and charge of the graphite particle:

   $r = 4{\cdot}10^{-7}$m, $m = 10^{-16}$ kg, $q = 2 \cdot 10^{-16}$ C.





Influence of cosmic dust on weather conditions

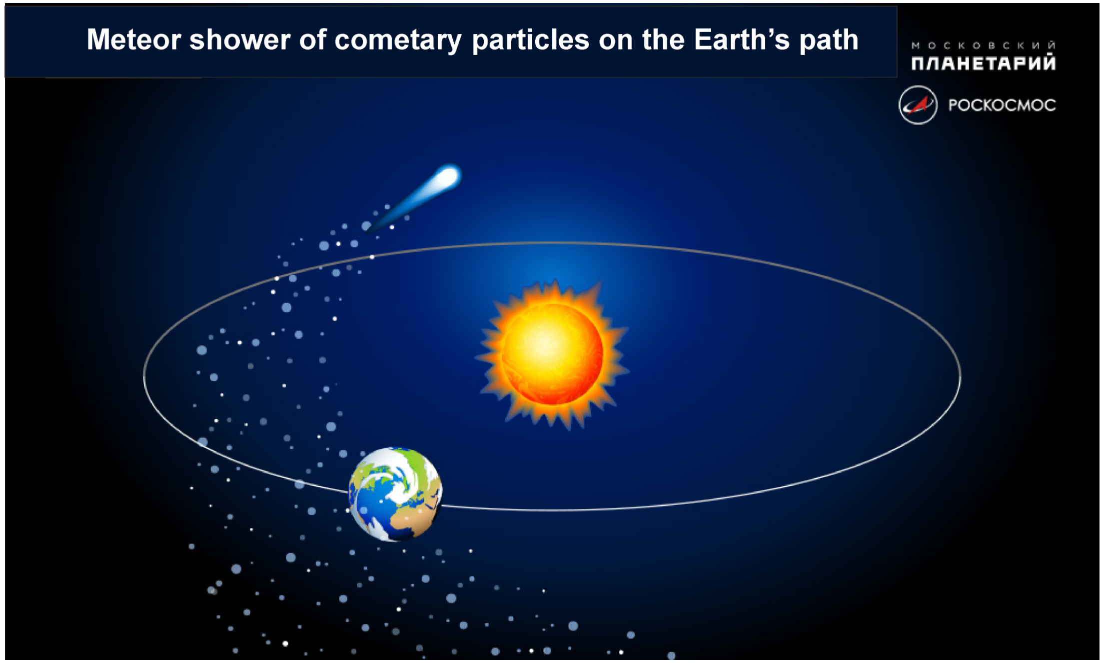
The following Russian weatherlore is well known:

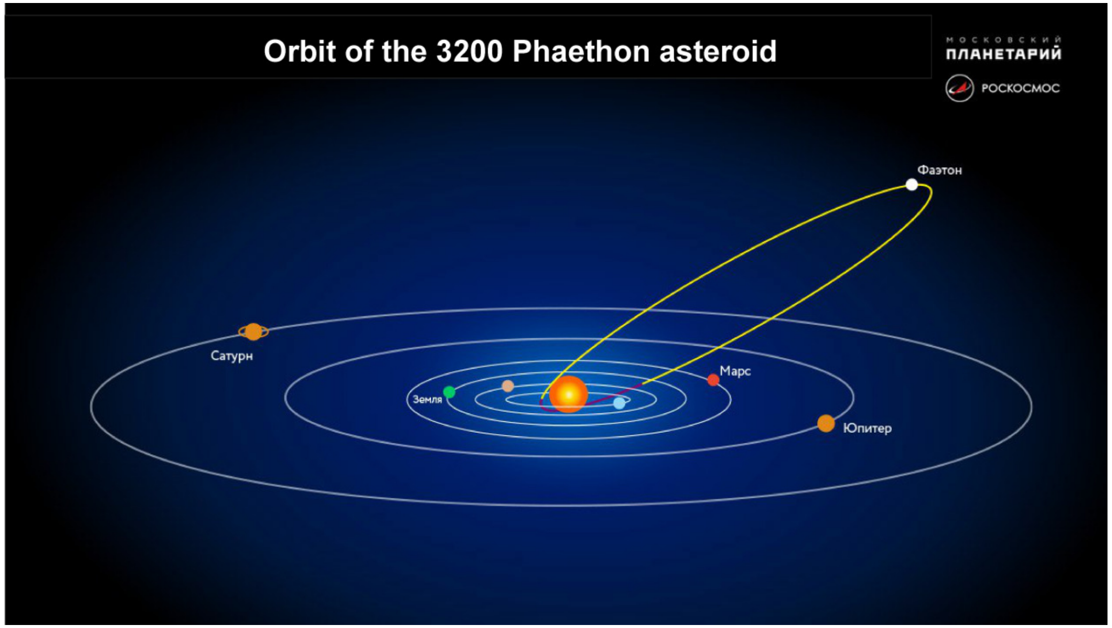
1.“Wives’ summer” (called “Indian summer” in US and Canada) comes in the middle of September.

2.The so-called “Christmas Frost” usually lasts from January 7 to January 9.

3.On January 19, the “Frost of the Baptism of the Christ” starts.

Visible paths of most meteors are located at altitudes between 50 and 100 km.
Allowing for the Knudsen parameter and the Stokes force of viscous friction, one can find that the average velocity of a micrometer dust particle at altitudes up to 3-5 km is
$V \sim 5 \cdot 10^{-2}$-10^{-1} m/s.
From here, we find the time of particle participation, $\tau = L/V \approx$ 14-20 days.


Meteor shower of cometary particles on the Earth’s path
МОСКОВСКИЙ
ПЛАНЕТАРИЙ
РОСКОСМОС


Orbit of the 3200 Phaethon asteroid
МОСКОВСКИЙ
ПЛАНЕТАРИЙ
РОСКОСМОС
Фаэтон
Сатурн
Марс
Земля
Юпитер

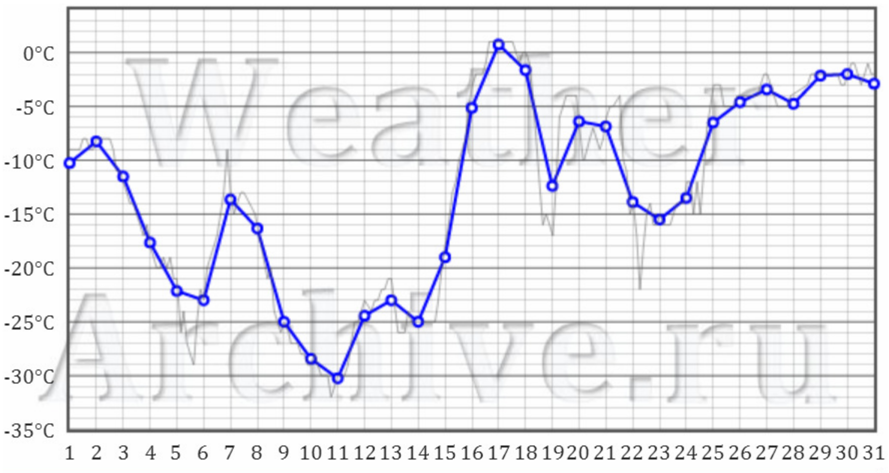
Meteor showers, dates of events

Shower name	Maximum	Activity period	Intensity at the maximim	Radiant coordinates			Notes
				Ascension		Declination, degrees	
				Hours	Minutes		
Quadrantids	Jan. 4	Jan. 1-6	70	15	28	+ 50	Метеоры синего цвета со шлейфами Blue meteors with
Eta Aquariids	May 5	Apr. 24 - May 20	40	22	**20**	-1	Long-time maximum, several radiants
Alpha Scorpiids	Apr. 28	Apr. 20 - May 19	20	16	32	-24	Several radiants, long-time activity from May till July
Alpha Capricornids	Jul. 28	Jul.15 - Aug. 20	20	22 22	36 04	-17 +02	Double radiant; later maximum on August 7
Perseids	Aug. 12	Jul. 23 - Aug. 20	75	3	4	+ 58	Prolific shower; bright meteors with tails
Orionids	Oct. 21	Oct. 16-26	20	6	24	+ 15	Diffuse tails; connected with Halley's comet
Geminids	Dec. 13	Dec. 7-15	60	7	28	+ 32	Many bolides

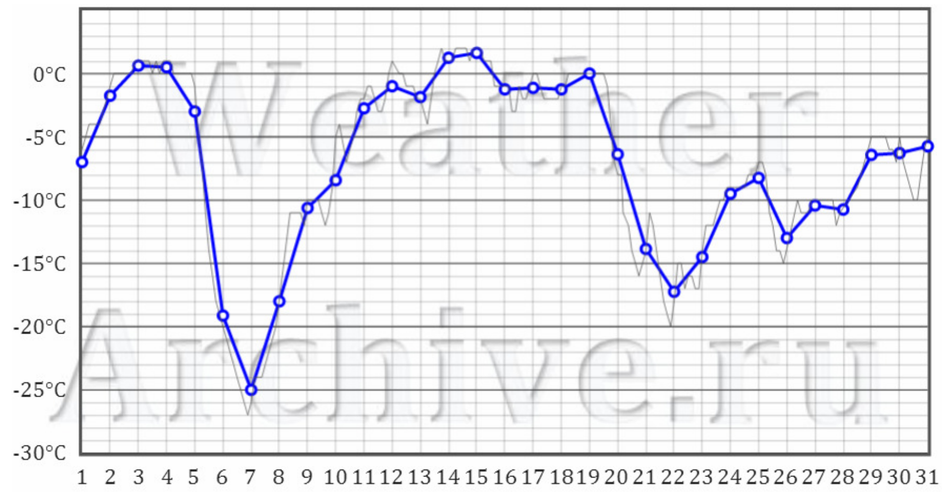
The dates of meteor showers are approximate, since they vary each year slightly.

Average daily temperature in January, 2015

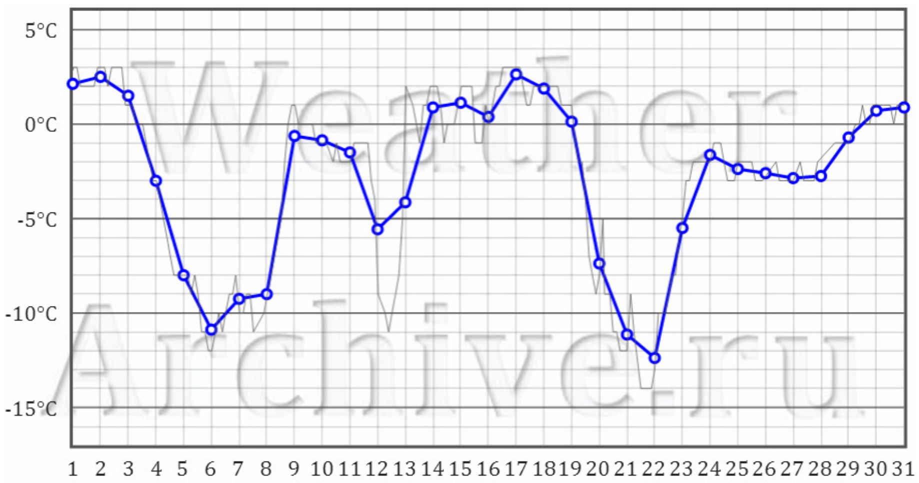
Arkhangelsk



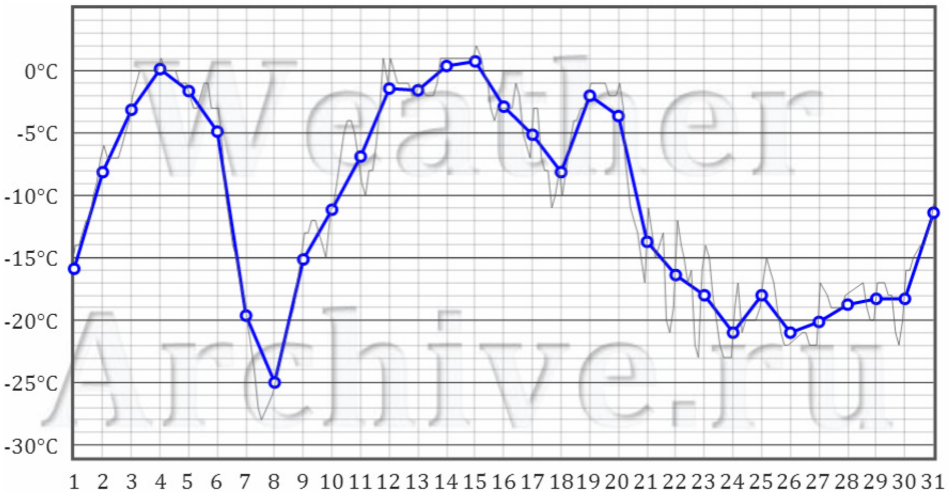
Nizhny Novgorod



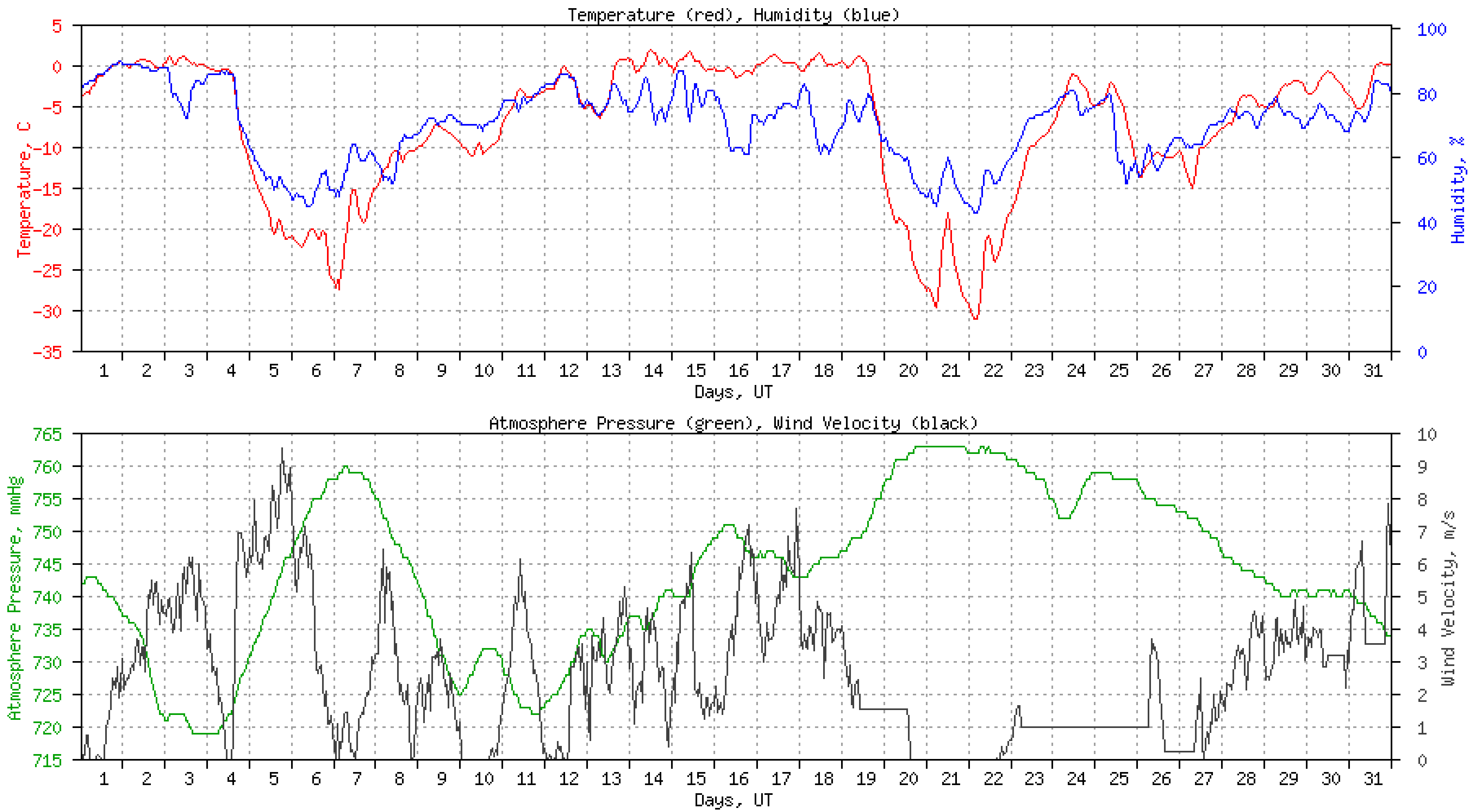
St. Petersburg



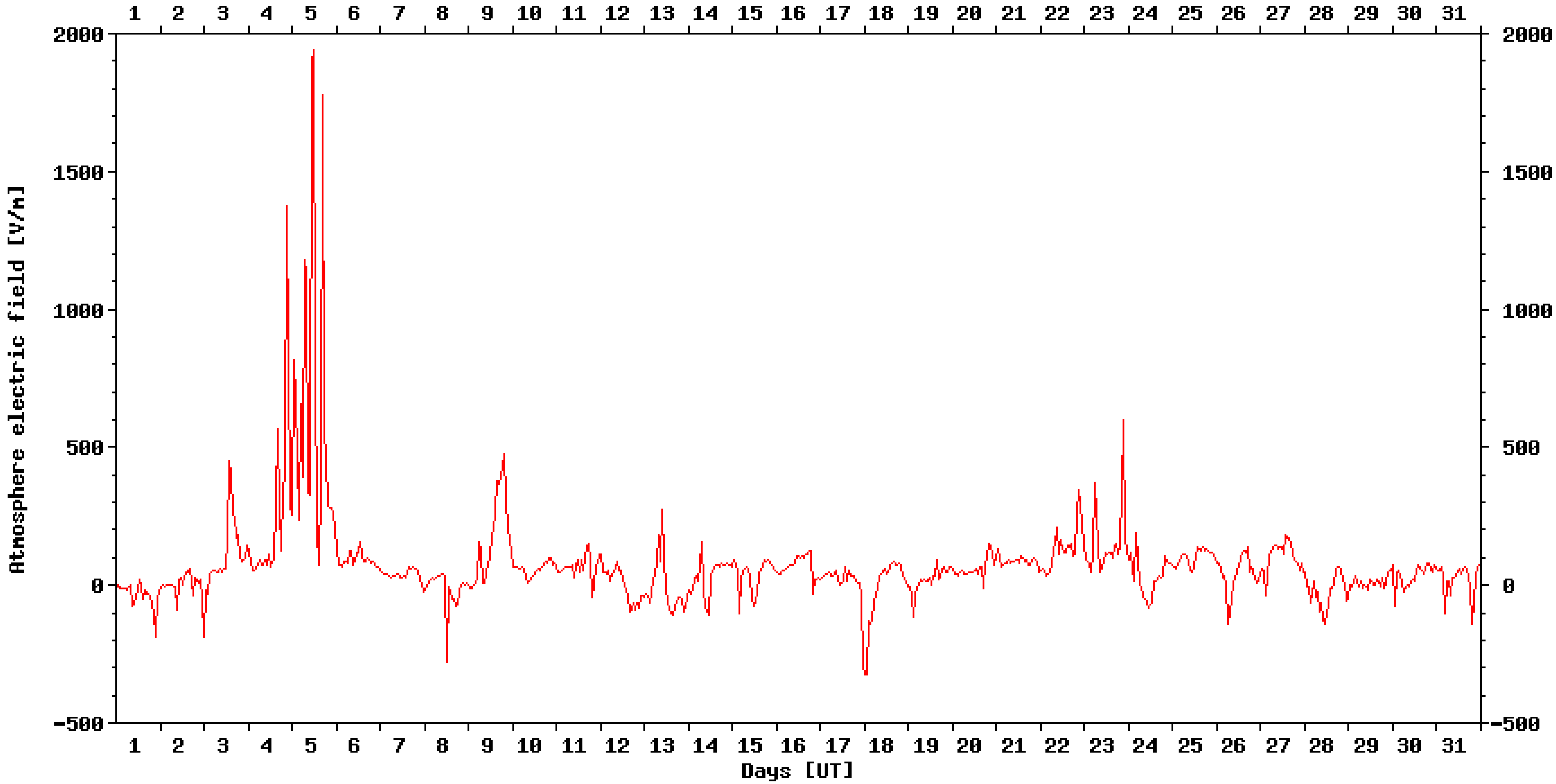
Samara



Archive data, January 2015. Borok



Archive data, January 2015. Borok



Meteor shower in May, 2017

"NASA reports that in the coming week, it is expecting a previously unknown meteor shower over the Earth. It is said in the agency, that some Earth-based observers will be able to observe up to 200 "falling stars" hourly, which ranks this unknown shower among some of annual meteor showers."

A meteor shower can be seen at the end of May.
supercoolpics.com

NASA says that the previously unknown meteor shower has beed dubbed "Camelopardalids", and its peak is expected on May 24, whereas the Earth will enter the potential meteor zone on May 23-25. The previously unknown meteor shower is the tail of the 209P/LINEAR comet, which traveled exactly along the trajectory of the Earth's rotation about 200 years ago. Note that in May, astronomy lovers can now enjoy two meteor showers, specifically, Eta Aquariids, which are known full well and are the tail of the comet flying over the Earth on May 6, and the new showers, which arose on May 24-25.