

Three atmospheric mysteries with a common solution

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The motivation of this little note was a popular article telling about an article of Earle Williams and colleagues proposing a model explaining so called D-region ledge below 80 km meaning that there are no free electrons in lower atmosphere (see <http://tinyurl.com/z87mjfs>). This model might explain also two other poorly understood phenomena.

1. Consider first D-region ledge. The incoming solar UV radiation generates free electrons, mostly by ionization of nitric oxide NO by kicking away the unpaired electron. This happens in the entire atmosphere. The electron density however goes to practically zero at lower heights and during night-time D-region disappears entirely. As a consequence, atmosphere is rather poor conductor of electricity. The idea of the article is that the dust generated as small meteors burn in the atmosphere into small dust particles, which then bind the free electrons generated by UV radiation and then gradually fall down to ground.
2. The stability of Earth's electric field is second mystery (see <http://tinyurl.com/j71xd5k>). Earth is negatively charged generating so called fair weather potential giving rise to electric field about 100-300 V/m at the surface of Earth and going to zero at heights about 1000 km. We do not understand the reason for why Earth is negatively charged. Even worse, a simple estimate using the value of electric field and estimate for ionic conductivity shows that it should take only a time of about 500 seconds for this negative charge to be lost by positive ionic currents from ionosphere (see <http://tinyurl.com/j71xd5k>)! How Earth can preserve its negative charge? What mechanism prevents these currents from flowing or compensates them with opposite currents? Thunderstorms and electric clouds have been proposed as mechanisms bringing negative charge to Earth. But this only shifts the problem to that of understanding how electric clouds and thunder are generated.

The model explaining D-region ledge could solve also this problem. There would be an ohmic positive ion current to earth and small ohmic electron current upwards in Earth's electric field. But besides this there would be downwards "gravitational" current of negatively charged dust particles compensating the ohmic current in equilibrium! Electrons could drift upwards to D-region from ground but could travel down as free travellers of dust particles! In purely plasma physics thinking one would neglect gravitation altogether since the ratio mg/qE of gravitational and electric forces would be about 10^{-12} for electron. For dust particles with low enough energy Q/m ratio one cannot neglect gravitation!

3. The origin of electric clouds and thunder storms is a third mystery. In the regions with thunder clouds at heights about 10 km the electric field can become about 10^3 V/m and lightnings are generated when the strengths becomes large than that required by di-electric breakdown in air. Between thunder clouds and Earth the electric field usually changes its sign. We do not really understand how the large negative charge of thunder cloud and positive charge at the surface of Earth below it are generated.

The model of D-region ledge suggests also a mechanism for the generation of thunder clouds. The electrically charged dust sticks cloud to like dust to water or ice so that the cloud becomes electrically charged. Since the dust does not reach ground and positive ionic current reaches it, the local electric field of Earth changes sign and eventually reaches the value needed for di-electric breakdown.

4. Lightnings are found to have a strange feature: the energies of electrons can be relativistic and gamma rays are observed. This does not fit with the standard view. For this I have proposed explanation in terms of dark electrons travelling along magnetic flux tubes without dissipation and thus accelerating to relativistic energies of about 10^5 eV. My first thought was that this model might throw light also to the above three mysteries but soon realized that standard physics is enough: the magnetic flux tubes containing dark ions and electrons represent a small effect. Dark matter in TGD sense is indeed at criticality and the criticality corresponds now to the dielectric breakdown.

To sum up, the model for D-region ledge proposed by Williams et al would explain also why the negative charge of Earth is stable and provide a mechanism for the generation of thunder clouds and lightnings.