Terrestial field-aligned currents and mesocyclone phenomena - A tentative hypothesis.

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The conventional explanation of lightning relies on charge-polarisation dynamics specific to ice-particles and super-cooled water droplets in convective clouds. While such particle charge polarisations are potentially capable of creating an electrical field in a thermodynamic turbulent environment, there are apparent problems in such a hypothesis for mainstream theorists. The main problem is that the electric fields measured in storm clouds seem to be incapable of producing the lightning discharges that we see from thunderstorms. Other hypotheses have been suggested by numerous researchers over the years. These include the mechanisms of cosmic rays and runaway breakdown. These too, are fraught with technical problems. The Electric Universe researchers have also posited that ionospheric currents interact with the leaky capacitor action of the lower atmosphere and create a conductive pathway as the resistance is broken down by mesocyclonic convection. The problem with this theory is in explaining non-mesocylonic thunderstorms and the weakness of the global "fair-weather current". In light of these issues, I have suggested a hypothesis of terrestial electrical breakdown via the conventional charge-polarisation mechanism, but with the electric-field becoming shielded as part of a terrestial Birkeland Current that develops within the cloud itself. This field-aligned current explanation may also partially apply to tornado-genesis. A paper by Charles L. Chandler serves as a particularly note-worthy influence towards this hypothesis.

An overview of tornado-genesis

A 1999 study by **W. P. Winn et al** shows no remarkable evidence of electrical fields after two empirical measurements of electrical fields recorded under the base of tornadoes were conducted:-

A number of observers have reported lightning, diffuse luminosity, or other manifestations of electrical activity in tornadoes. To try to quantify these observations, eight instruments with sensors for electric field and other parameters were placed in front of a large tornado that passed by Allison, Texas, on June 8, 1995. The edge of the tornado vortex passed over two of the instruments and near other instruments. When the two instruments were in the low-pressure region near the edge of the vortex, they indicated electric field amplitudes less than about 3 kV/m, which is low compared with amplitudes of 10 kV/m or greater that are often present below thunderclouds. The thunderstorm produced frequent lightning, but there is no evidence from the measurements or from visual observations of lightning in the vortex. However, there was one interesting electrical effect associated with the tornado: the electric field at the two instruments in the vortex

relaxed to zero quickly after lightning flashes, whereas the electric field at nearby instruments outside the vortex did not relax quickly after the same lightning flashes. The most likely cause of the rapid relaxation is shielding of the electric field at the ground by charge induced on soil, leaves, grass, and other debris lofted by the strong winds.
http://www.agu.org/pubs/crossref/2000/2000JD900215.shtml

This 1955 study also found unremarkable results, albeit it did find that:-

"The electrical activity and magnitude of electric field changes in the vicinity of the tornado...are so complex and change so rapidly that the exact electrical behaviour within the clouds above is difficult to determine".

http://journals.ametsoc.org/doi/pdf/10.1175/1520-0469(1956)013%3C0269%3AEFIATG%3E2.0.CO%3B2

This may have possible implications for the complex alternating flow of differing charge within the double-layers of field-aligned currents as part of the storm circuit.

A paper by Charles L. Chandler titled "Observations on the Electromagnetic Nature of Tornadic Supercell Thunderstorms" features the following observations about the reliability of measuring charge and electric fields from tornadoes (that are spawned from thunderstorms):-

"Measuring electric charges from a distance is not possible, because charged double-layers build up, and there is no electric field outside of the double-layers. But moving electric charges generate magnetic fields, and these can be detected from a distance, because there is nothing to shield them. In fact, the magnetic field generated by a tornado was measured at 1.5 × 10−4 gauss from a distance of 9.6 km away using a magnetometer.110 There is currently no construct within the mainstream research community that assigns any significance to these data. Nevertheless, and with or without a construct that can explain it, if there is a strong causal relationship between the strength of the magnetic field and the incidence of tornadogenesis, we should be looking at these data along with the thermodynamic factors when assessing the tornadic risks."
http://charles-chandler.org/Geophysics/Tornadoes.php?text=full&images=onDemand&units=metric#id_7

Charles observes that a simple suction-vortex and latent-heat release mechanism cannot account for the concentration of the strongest wind speeds and lowest-pressure at the base of the tornado. The conventional account is thus, only partially complete. Charles proposes that a negatively charged inflow zone of the tornado circulates towards a positively-charged ground, this inflow absorbs heat via skin-friction with the ground and then releases the thermal potential energy in the tornadic funnel.

His Abstract ends with the following summarisation:-

"This means that the unexplained power expended by the tornado on the ground answers its own question, as the frictional heat so generated is the only energy that could cause a robust updraft so close to the ground, while the charge neutralization is the critical conversion. The energy budget of the entire tornado can then be reconciled as the sum of frictional heating at the ground, latent and ohmic heating inside the vortex, and the low pressure aloft. An extensive review of the available data is made, without finding reason to abandon this model. The implications are then considered."

Thus electromagnetic forces combine with thermodynamic forces in his model. This notion has some plausability, as considerable magnetic fields have been detected near tornadoes:-

A study published in Science magazine in 22nd September 1967 by Marx Brook found:-

"Measurements of the magnetic field and earth current in the vicinity of a tornado show large steplike deflections coincident with the touching down of the funnel. Calculations with a simple current model indicate that a minimum current of several hundred amperes must be postulated to account for the observed deflection in magnetic field. The existence of a steady current of 225 amperes for a period of about 10 minutes provides joule heat at the rate of approximately 10^{10} joules per second, and involves a total charge transfer of 135,000 coulombs. The calculations imply that a tornado is electrically equivalent to several hundred isolated thunderstorm cells active simultaneously."
http://www.sciencemag.org/content/157/3795/1434.abstract

The issue of dust devils is interesting as there have been electric fields observed inside of them. EU theorist Wal Thornhill summarises it in article on Holoscience.com:-

"It's now official that dust devils on Earth exhibit strong electric fields, in excess of 4,000 volts per meter" - Wal Thornhill
http://www.holoscience.com/wp/electric-dust-devils/

The electric fields of dust devils may actually be a bit problematic if one sees them as essentially the same sort of dynamic that a tornado is.

Regarding dust-devils the electric field and associated magnetic field might be a result of tribo-electric effects as a result of a scenario where synoptic conditions are conducive, and that dust particles in dry conditions act as important components of charge polarity. We have to provide proof otherwise. Regardless, electric field measurements inside these vortices can indeed be problematic given the fact that the same electric fields apparently present in dust-devils are NOT so present in tornadoes (which are much stronger). Fields of less than 3kv per meter were measured in the tornadoes (bare in mind the general electric field environment under the storm cloud), but the fields in the dust devils were in excess of 4kv.

As Charles Chandler noted in his paper, it could be a result of the way the double-layers interact in tornadoes that shield the electric field. Dust devils, if they are presumed by EU theorists to be similar vortex structures- would also have double-layers and should, in theory, exhibit the same unremarkable voltage and electric field characteristics of tornadoes. But they do not. Why? Is there a fundamental difference in the capability of double-layers to shield out the electric field depending on the strength of the voltage (i.e. the REAL voltage) across the vertical length of the filament? Or could there simply be a possibility that dust-devils are simply not the same phenomena as tornadoes?

The question of thunderstorm genesis

Charles L. Chandler is critical of Electric Universe theories that could give rise to the electrical environment that produces thunderstorms. In the paper above, he writes:-

"Electric Universe — Ionosphere-Surface Current
This theory states that the Earth is negatively charged, and that the atmosphere is a leaky capacitor, where there is a fair-weather current all of the time flowing from the Earth toward outer space, but that unique conditions can reduce the resistance within this capacitor, resulting in an enhanced current.237,238 One such condition would be the reduced pressure within a mesocyclone, which would increase the conductivity of the column of air from 1 km to over 12 km above the surface. This is only a fraction of the distance to the ionosphere, but it traverses the densest part of the atmosphere, and this is the source of 2/3 of the resistance between the surface and the ionosphere. Hence the mesocyclone could be opening up a conduit through which a current could flow.

The problem with this theory is that is does not explain vortexes that descend from non-mesocyclonic thunderstorms. It also does not take into account the fact that the global current is extremely weak. The "fair weather field" is something like .1 kV/m, which is vanishingly small compared to the fields in a thunderstorm. So it is far more likely that storm-generated fields are the only forces that could possibly be influential. It also labors under the same criticisms directed at the joule heating theory — the airflows in a discharge vortex are fundamentally different from those in a tornadic vortex."

The TRAPPA Group summarised its views on the current knowledge garnered from fields of atmosphere-ionosphere science:-

"Lightning couples energy directly to the mesosphere and lower ionosphere through quasi-electrostatic (QE) and electromagnetic pulsed (EMP) fields. **The fields heat the partly ionised atmosphere and cause additional ionisation, thereby changing the atmospheric conductivity**. Electromagnetic waves from lightning discharges may also have an indirect effect on the lower ionosphere via reflection effects or interactions with radiation belt electrons that can be precipitated from the magnetosphere into the upper atmosphere. Perturbations to the ionosphere are observed as perturbations to the amplitude and/or phase of signals from Very Low Frequency (VLF) transmitters used for submarine communications. Quantitative estimates of ionisation and heating by TLEs are still lacking but can in principle be

modelled. They hold the promise of new insights into the properties and microphysics of the mesosphere."

"The sprite discharge is driven by the quasi-electrostatic (QE) field in the mesosphere following a positive cloud-to-ground (+CG) flash in a thundercloud below"
http://www.trappa.es/content/thunderstorm-effects-atmosphere-ionosphere-system-tea

Note that these findings with regard to atmosphere-ionospheric interactions via thunderstorms seem to present possible explanations as to how tropospheric lightning can induce discharges in the upper atmosphere.

Interestingly, Charles Chandler does assume that the electric field potential in terrestial particles alone - are enough to generate thunderstorms, lightning and their associated tornadoes.

To verify this, the reliable measurement of the ACTUAL electric fields inside tornadoes should occur (i.e. those that may not be subject to double-layer shielding). If not, the time-varying magnetic fields generated by cumulonimbus clouds and tornadoes need considerably further study. There is evidence mentioned in his paper of a historic neglect in terms of the usage of magnetometers in tornado research.

Mainstream scientists in interviews with the media, have repeatedly admitted that conventional measurements of electric fields are insufficient to account for lightning discharges from thunderstorms:-

Lightning researcher Joseph Dwyer was interviewed by NPR on the 4th of June 2010. He made the following admission:-

"Dr. DWYER: Well, all the questions about lightning that we don't know. They're all very basic ones, like how does it get started, how does it move? For example, it's a real mystery how lightning gets started up inside the thunderstorms. **There never seems to be enough charge up there and big-enough electric field to actually make a spark.**"
http://www.npr.org/templates/story/story.php?storyId=127477667

Another report, this one from LiveScience in 2008:-

"Nobody understands how lightning makes X-rays," says Martin Uman, a professor of electrical and computer engineering at the University of Florida. "Despite reaching temperatures five times hotter than the surface of the sun, the temperature of lightning is still thousands of times too cold to account for the X-rays observed."
http://www.livescience.com/2712-lightning-remains-huge-mystery.html

National Geographic in 2007:-

"The electric fields in thunderstorms appear to be too weak to form lightning, so scientists have been puzzled by how the bolts form. Cosmic rays have also been suggested as a trigger for the flashes".

http://news.nationalgeographic.com/news/2007/10/071011-lightning-rays_2.html

These weak electric fields reminds the author of this paper of the weak electric fields measured inside the tornadoes. Yet, strong perturbations in the Earth's surface magnetic field were detected adjacent to the tornadoes. Perhaps this offers a clue as to the cause of the electro-dynamic environment of the thunder-storm itself. Perhaps there are Birkeland Currents (field-aligned currents) that merge into larger and denser currents extending downward from the ionosphere at specific intervals and generating vorticity within the atmosphere. Like the tornado, and as Charles Chandler observed in his paper - the double-layers (which are present as polarised charge sheaths in Birkeland Currents) could be shielding the actual electric fields and voltages from detection.

Still - the question remains, ARE terrestial charge-particle interactions suffice as the initiator of the electrical breakdown? Or do we need a cosmic circuit as the source of the breakdown?

The following Duke University report reveals some interesting findings about upper-atmospheric lightning:-

"Previous research, some of it by Steven Cummer, a Duke assistant professor of electrical and computer engineering, has linked sprite development to the extra-powerful thunderstorms observed in places like the Midwestern United States.

Earlier work also ties each sprite to an unusually strong cloud-to-ground lightning bolt, followed by a second discharge at heights of 25-50 miles."
http://ftp.ee.duke.edu/news/?id=211

Now, this begs the question about the anode and cathode dynamics with respect to any leaky capacitor function of the Earth in an ionospheric circuit. Which direction do electrons and positive ions flow respectively? Do we have uni-directional flow? Flows from high to low potential or vice versa or both? Clearly, one could assume a complex circuit in the vicinity of such systems if they are relying on an Electric Universe theory of thunder-storms and their associated tornadic manifestations.

Here, cosmic rays and runaway breakdown are proposed as possible mechanisms:-

http://www.scientificamerican.com/article.cfm?id=experts-do-cosmic-rays-cause-lightning

But again, run into technical problems with regard to the plausability of the mechanism.

It seems we still lack compelling data as to the likely cause of terrestial lightning and tornadogenesis. This paper discusses some of the problems with regard to the genesis of thunderstorms and offers some interesting summaries of various studies and potential ways forward:-
http://www.physics.nmt.edu/~rsonnenf/phys535/pubs/2006_Williams_Problems_in_lightning_physics.pdf

Interestingly, the paper suggests that the native environment in the cloud can create runaway electrons. In other words, lightning may not need runaway electrons (via cosmic rays) to be generated:-

"A far greater number of observations support an alternative idea that a special phase and polarity of lightning is needed to accelerate electrons into runaway, with subsequent production of high-energy photons. In other words, the evidence supports the idea that lightning is causing the runaways, rather than the runaways are initiating lightning."

My own hypothesis, as a science journalist and researcher - is that lightning could still feasibly be terrestially generated by charge separation mechanisms as part of the behaviour of ice particles and super-cooled water droplets in a thermodynamic turbulent environment. A voltage gradient may develop, and - like we have seen in the Floating-Water-Bridge experiments by Dr Elmar Fuchs - rotating vortices of bi-directional charge could well develop. These could produce double-layers on the annulus of the filaments that shield the actual electric fields from measurement. The field-aligned currents could also explain how such high radiation can be generated from the runaway electrons - via synchrotron radiation generated via helical Birkeland Currents. Synchrotron radiation originates from a helicoidal or circular path of electron movement aligned to the fields in Birkeland Current filaments - and the centripetal acceleration can produce EM radiation across the entire spectrum.

The helicoidal twist morphology of lightning might possibly be a sign of field-aligned currents within the filament:-

http://www.flickr.com/photos/stormhighway/5938746412/

The general rotation of the storm itself could be a result of the azimuthal component of atmospheric field-aligned currents in the vertical.

Perhaps the way forward would be to focus on the changing nature of the magnetic field both before and during the development of thunderstorms and the generation of tornadoes, particularly as this will be crucial for locating the terrestrial or extra-terrestial origin of lightning formation.