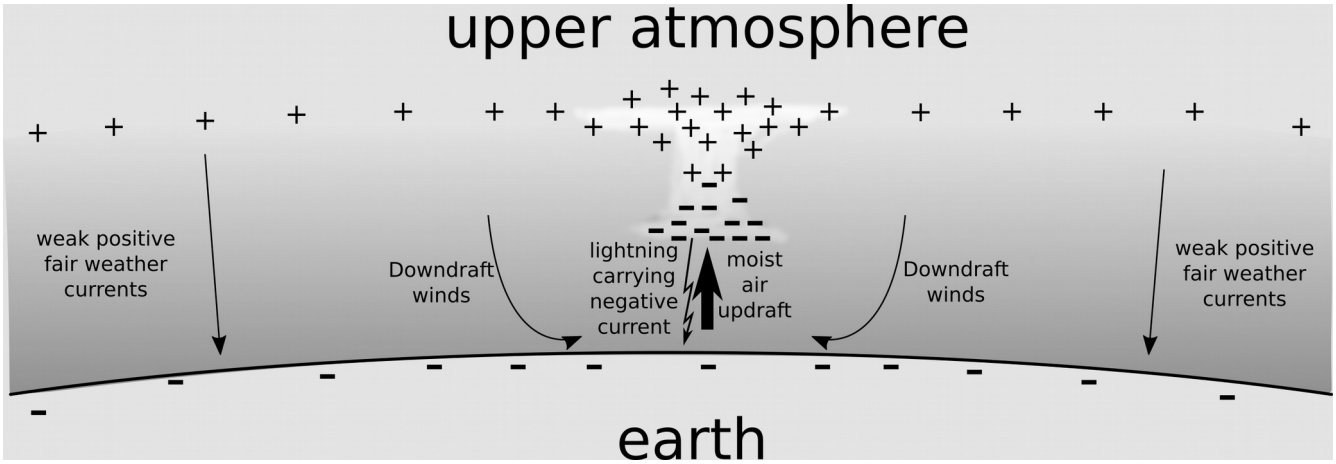
Soaring Birds, Thunderstorms, and Atmospheric Electricity

Soaring eagles, hawks, vultures, and manned gliders locate an region of updraft, circle without adding their own power, and gain elevation. The updrafts are the inevitable result of the sun heating the land and the air directly above it. Hot air rises because it is less dense, but somewhere air from above must come down to replace the rising hot air. As a result over an expanse of land there are areas of rising air and adjacent areas of descending air. A bird and glider pilot can feel when they have entered a region of rising air and circle within it to gain altitude.

Thunderclouds are the extreme result of hot air rising; their anvil-shaped top showing the altitude where the ambient temperature is sufficiently low that the air can rise no higher. Inside the updraft of a thunder cloud, "somehow" water droplets and/or ice crystals get separated into smaller and larger pieces such that the smaller pieces have a positive charge. The smaller pieces get caught in the updraft and carried to the top of the thundercloud making it positive while the heavier pieces fall to the lower part making it more negative.

Although the earth is negatively charged, it is not as strongly negative as the lower part of a thundercloud. As a result sparks in the form of lightning jump from the bottom of the clouds to the ground carrying negative charge to the earth ("negative lightning"). Some lightning also travels between parts of the clouds and even occasionally from the top of the clouds to the earth ("positive lightning"). Lightning can even happen during snow storms.

The positive charges at the top of the thunderclouds spread out through the upper atmosphere and become the positive side of a giant spherical shell capacitor where the earth surface is the negative side. Thus, an average electric field of 100 V/m directed downward is in the atmosphere even in locations of clear weather far from the thunderstorms that produced the charging. Below a thunderstorm before lightning strikes, an upward electric field of thousands of V/m is present; if your hair stands on end, jump in a car or crouch down on one foot and hope.



As shown in the above drawing, there are two circulating currents, one of air and the other of electricity. As the updraft of moist air under the thunderstorm removes air from the surface of the earth, that air is replaced by downward flow of dryer, cool air from well-above the earth surface. Also, the charge difference within the thunder cloud causes positive charges to spread out through the earth and negative charges to flow via lightning to the surfaced of the earth. That downward flow of negative charges is an upward flow of electric current. Meanwhile, far from the thunderstorm, the positive charges in the upper atmosphere cause a barely-detectable downward flow of electric positive to the earth surface. Thus, there is a circulation of positive electric current upward through the storm and downward far from the storm.