

CHARGE OF THE EARTH

LCL Problem 3-7 The earth's electric charge

The electric field strength in the atmosphere near the surface of the earth is about 100 volts/meter and points downward. The potential increases with increasing height, up to about 300 kV = 300 000 volts. This field is maintained by thunderstorms, which deposit negative charge on the earth at the rate of about 10^3 amperes.

Calculate the electric charge carried by the earth.

$$E(R) = \frac{Q}{4\pi\epsilon_0 R^2} \approx 100 \text{ volt/meter}$$

$$R = \text{earth radius} \approx 4000 \text{ mi} \approx 6400 \text{ km} = 6.4 \times 10^6 \text{ m}$$

$$\frac{1}{4\pi\epsilon_0} = 9.0 \times 10^9 \text{ m/F}$$

$$Q = 4\pi\epsilon_0 R^2 E = \frac{(6.4 \times 10^6 \text{ m})^2 \times 10^2 \text{ volt/m}}{9.0 \times 10^9 \text{ m/F}}$$
$$\approx 4 \times 10^5 \text{ Coulomb}$$