

The Earth's Ionosphere

Dr. Geoffrey Andima (Ph.D)
Busitema University
gandima.sci@busitema.ac.ug

Expectations

TEST

- What is the color of a blackbox?
- In which month is the October Revolution celebrated.
- How long did the 100 years war last?
- Where are chinese gooseberries from?
- What is the chief metal used in an olympic gold medal?
- Which country makes panama hats?

Outline

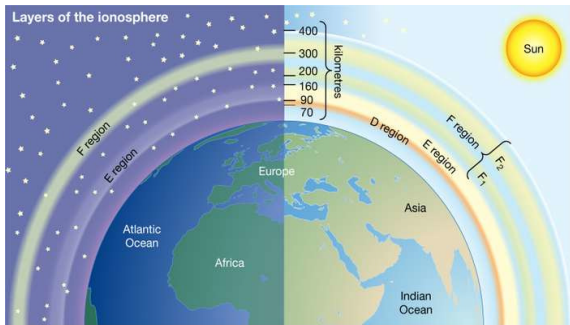
- Historical Perspective
- Formation
- Regions
- Ionospheric Phenomena

Historical Perspective

- Gauss in 1839 attributed daily variations in magnetic field to atmospheric electric currents.
- Lord Kelvin in 1860 speculated the existence of a conducting layer
- In 1901, Marconi send radio signals across the Atlantic ocean
- In 1902, Kennely and Heaviside suggested that the reflection of the radio waves are due to electric charges
- In 1903, Taylor and Fleming attributed the electrical charges to the solar UV.
- Watson-Watt in 1926 proposed the name "ionosphere".
- The works of Hulburt (1928) and Chapman (1931) marked the start of "modern theory".

The Ionosphere

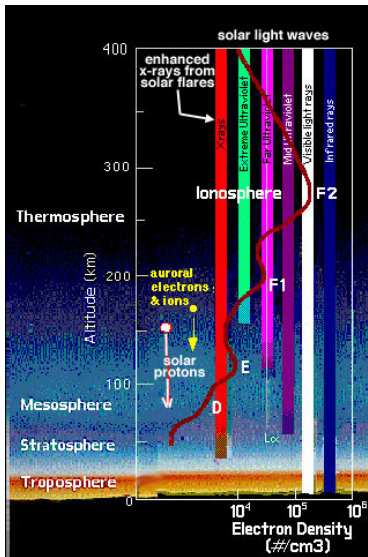
what is it?



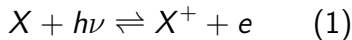
© 2012 Encyclopædia Britannica, Inc.

- Upper part of the earth's atmosphere with sufficient electrons as to affect the propagation of radio waves
- ~60 to 1,000 km

Formation



- Photoionization is the main ion source.



- By mass action,

$$[e] \propto \frac{[X][h\nu]}{[X^+]} \quad (2)$$

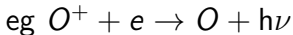
- absorption depends on the zenith angle
 $\Rightarrow e$ maximizes at a particular time of the day.

Loss of ions in the ionosphere

(i) Recombination

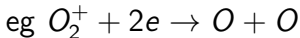
Occurs in three principal reactions

♣ Radiative- electron combines with an atomic positive ion



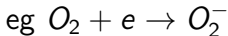
it is a slow process

♣ Dissociative-electron combines with a molecular ion



Main process of electron disappearance

♣ Attachment- electron attach to a neutral particle



Occurs mainly in the D region

ii) Diffusive transport

Structure

The ionosphere is well stratified

✓ **D** 60-90 km ($N_e \sim 10^2 - 10^4 \text{ cm}^{-3}$)

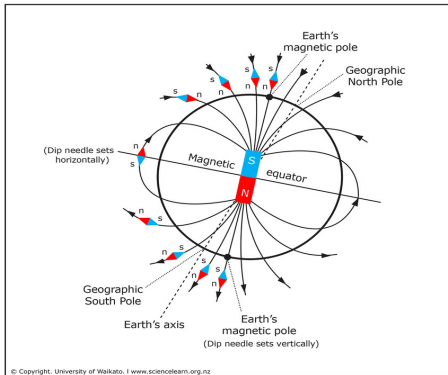
✓ **E** 105-160 km ($N_e \sim 10^5 \text{ cm}^{-3}$)

✓ **F1** 160-180 km ($N_e \sim 10^5 - 10^6 \text{ cm}^{-3}$)

✓ **F2** Peaks at about 300 km ($N_e \sim 10^6 \text{ cm}^{-3}$)

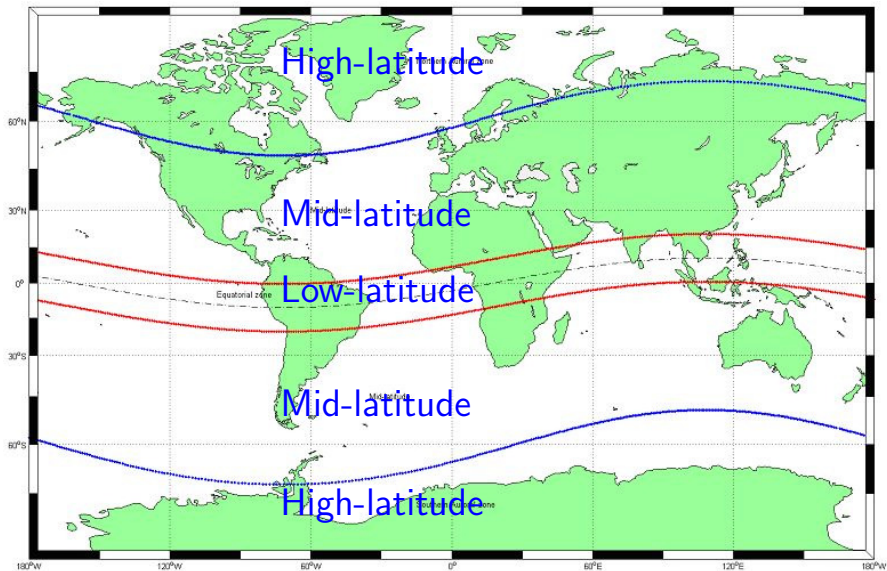
- **D & F1** disappear at night
- **E & F2** persist through out the night but with reduced intensity

Regions of the Ionosphere



- The ionosphere is a magneto-ionic medium.
- The interaction of the magnetic and electric fields are dependent on the orientation fields

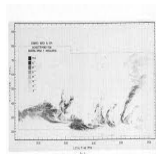
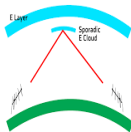
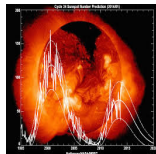
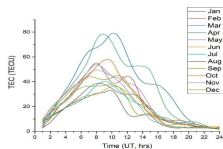
geomagnetic regions of the ionosphere



should we care?

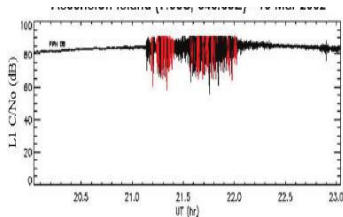
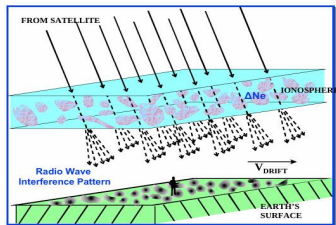
Highly variable

- Regular variations
 - diurnal
 - monthly
 - 11 year
- Irregular variations
 - Sporadic Es
 - Spread F
 - Plasma bubbles



Research applications

- **Group delay:** Proportional to the total electron content. This can change the apparent position by tens of metres.
- **Scintillation:** caused by small-scale irregularities in electron density. These can cause temporary loss of the signals.



- **GICs:** currents induced as a result of a geomagnetic storm. May result in transformer overload.

THANK YOU