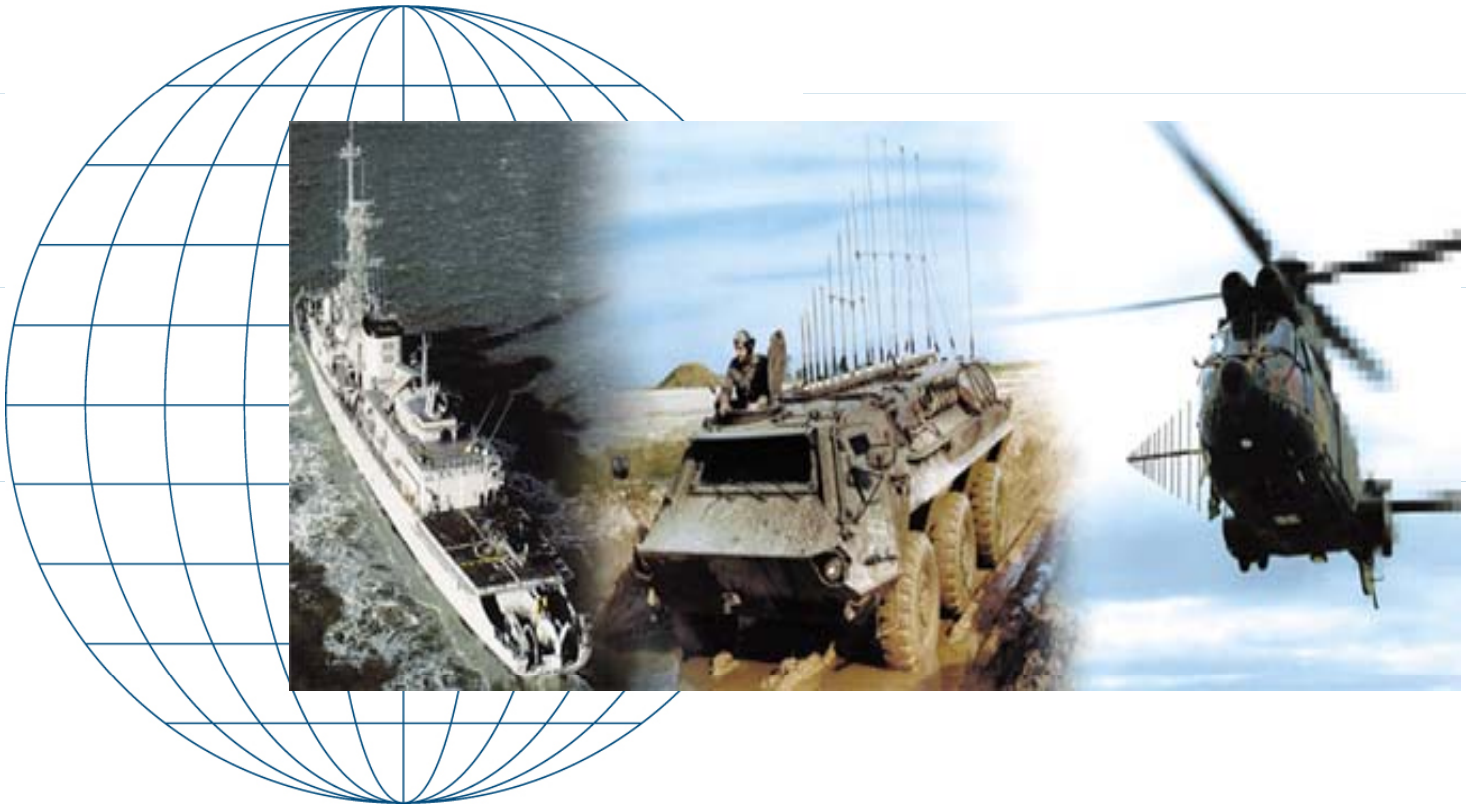
Aardvark Roost AOC

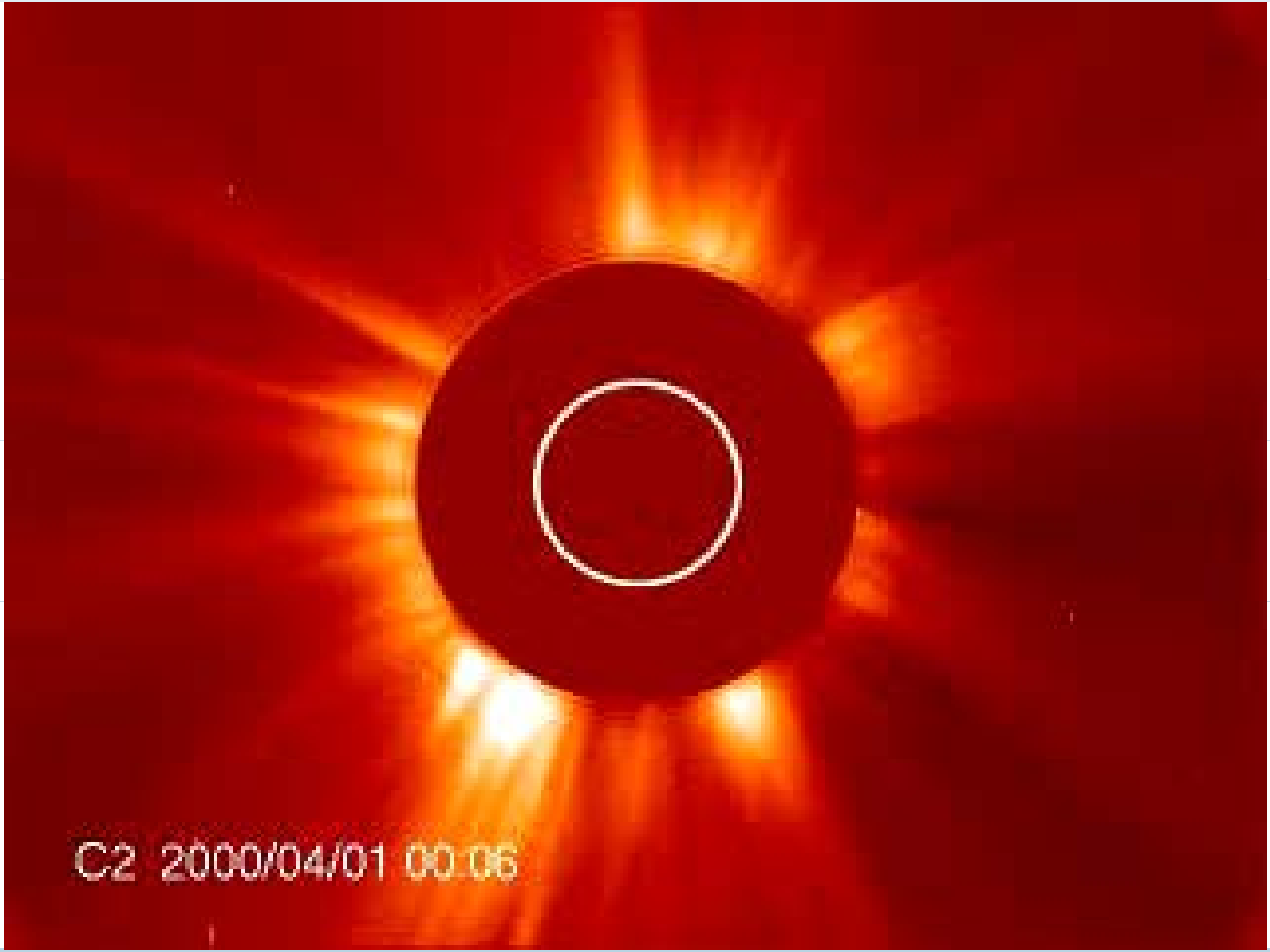
Space Weather in Southern Africa



Hannes Coetzee

What is Space Weather ?

The Violant Sun

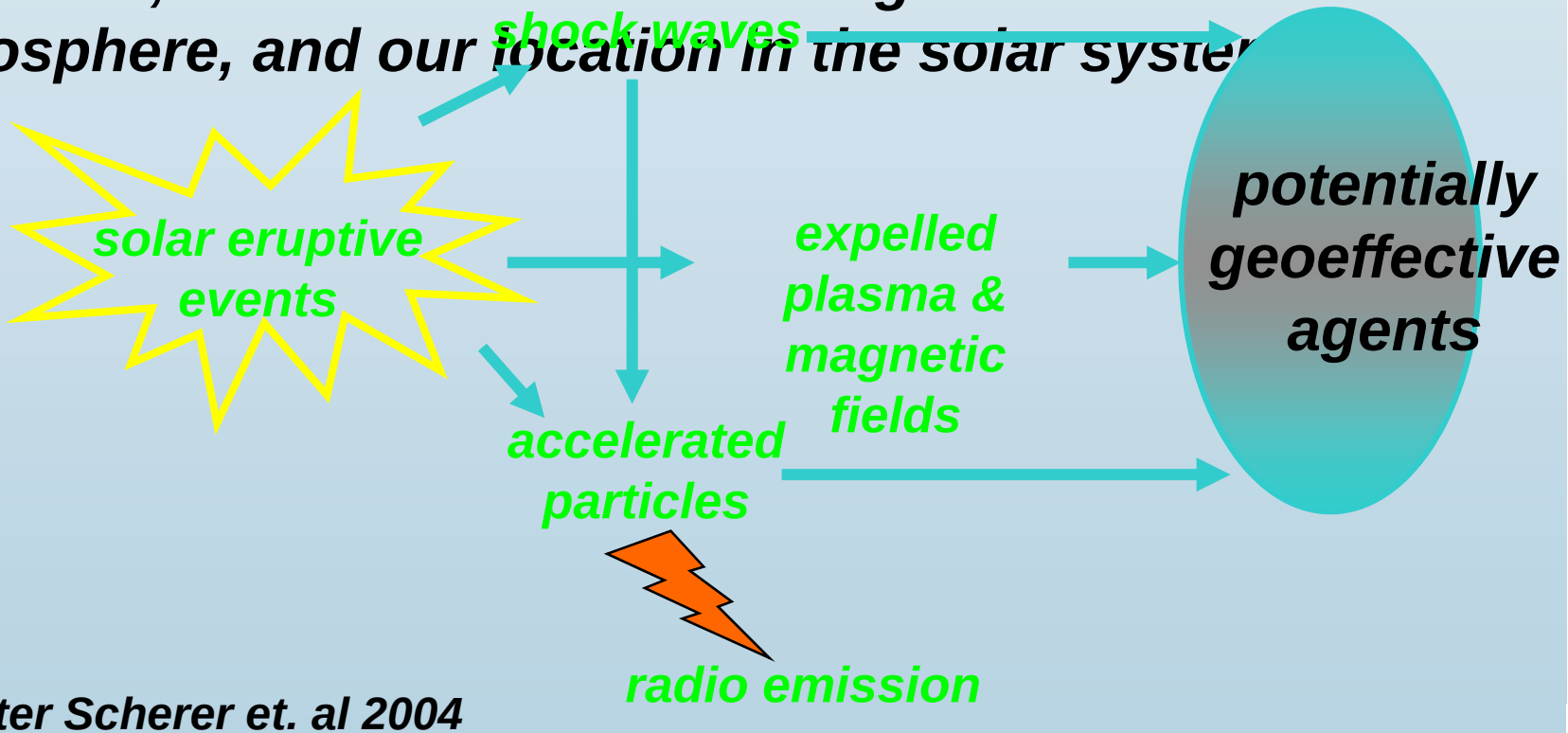


What is Space Weather?

Space weather describes the conditions in space that affect Earth and its technological systems.

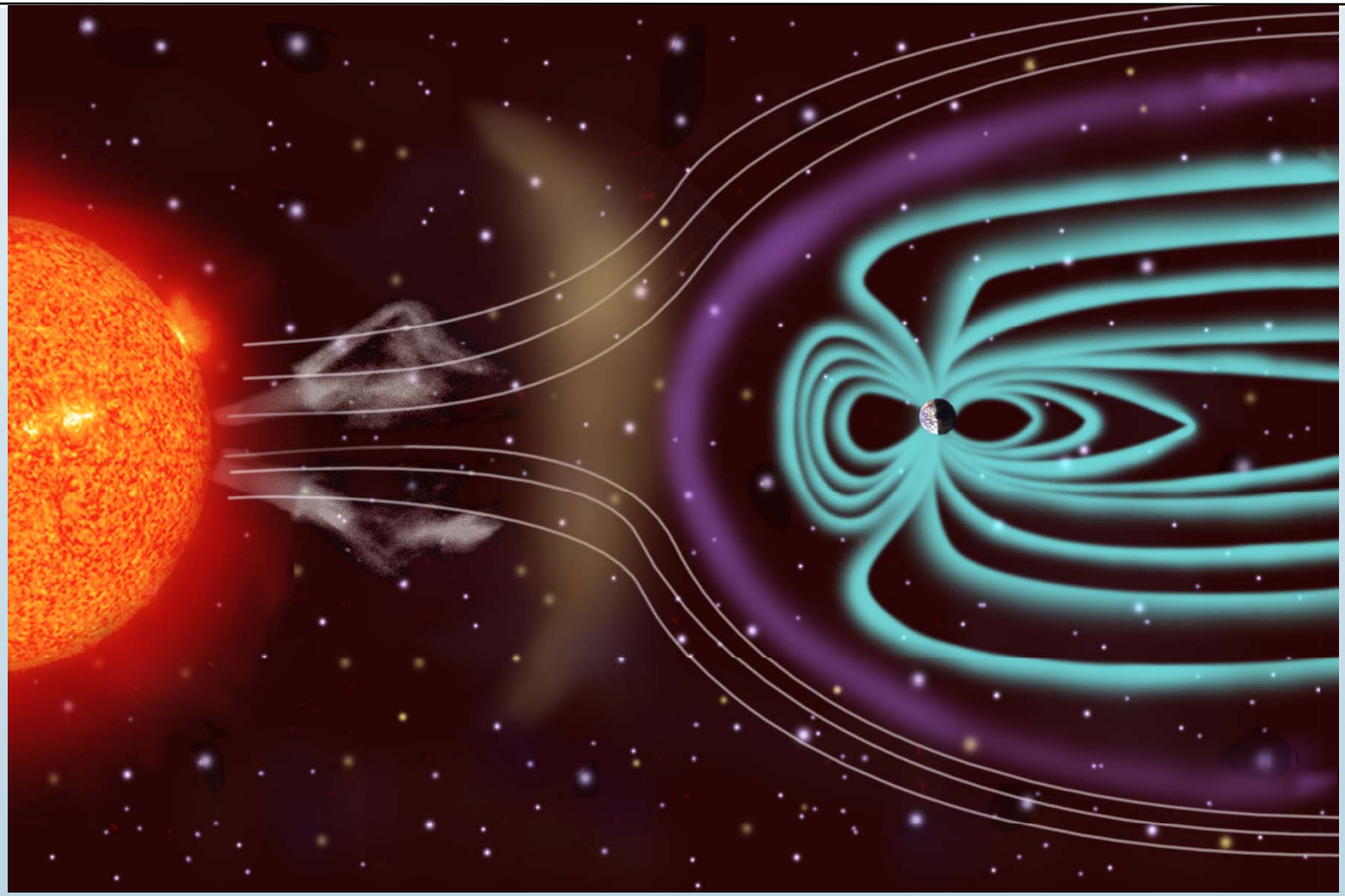
Space weather is a consequence of the behaviour of the sun, the nature of Earth's magnetic field and atmosphere, and our location in the solar system.

Solar eruptive events (solar flares, coronal Mass ejections (CMEs)) are the main drivers of space weather



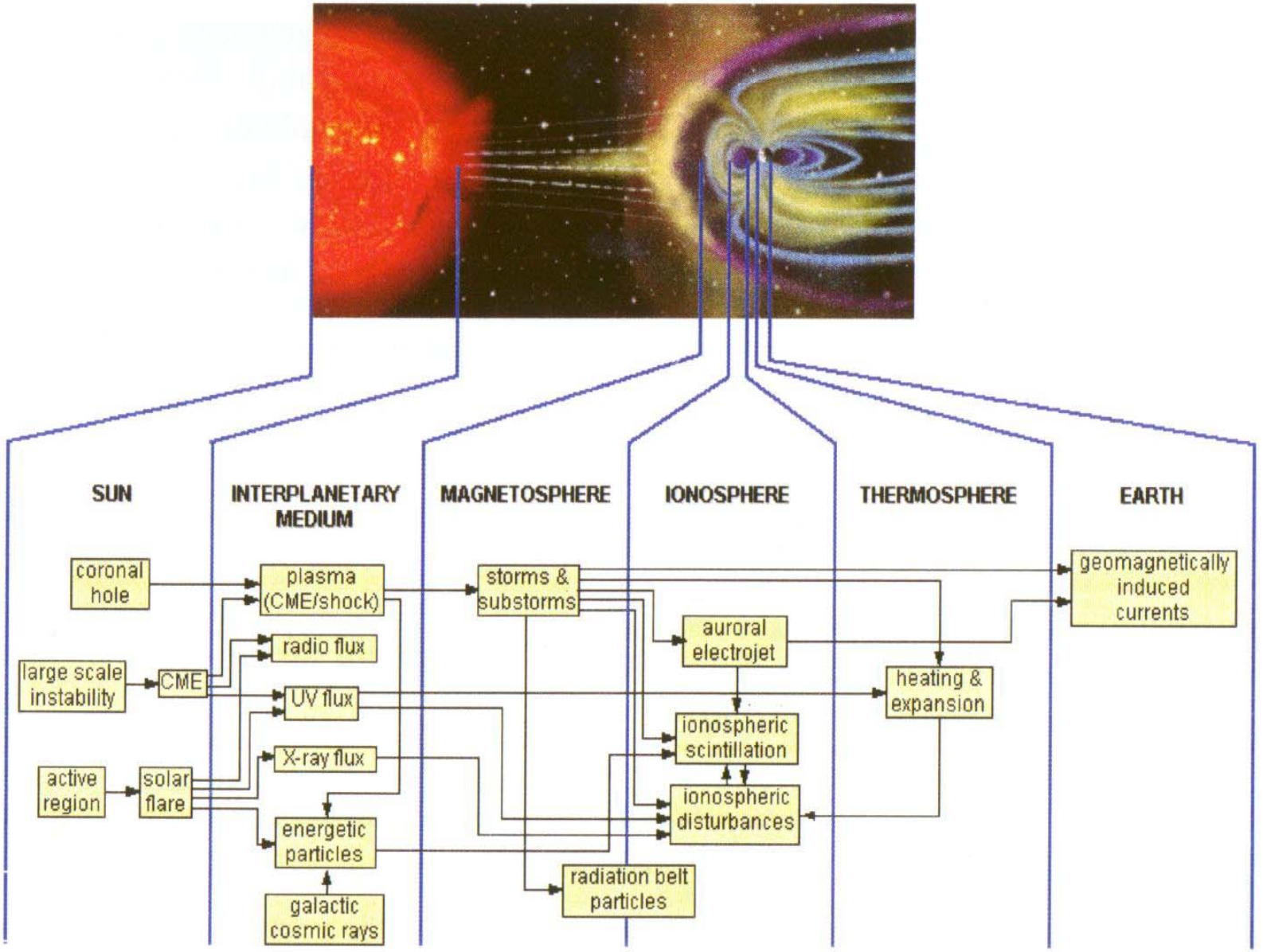
after Scherer et. al 2004

The Earth‘s Space Environment

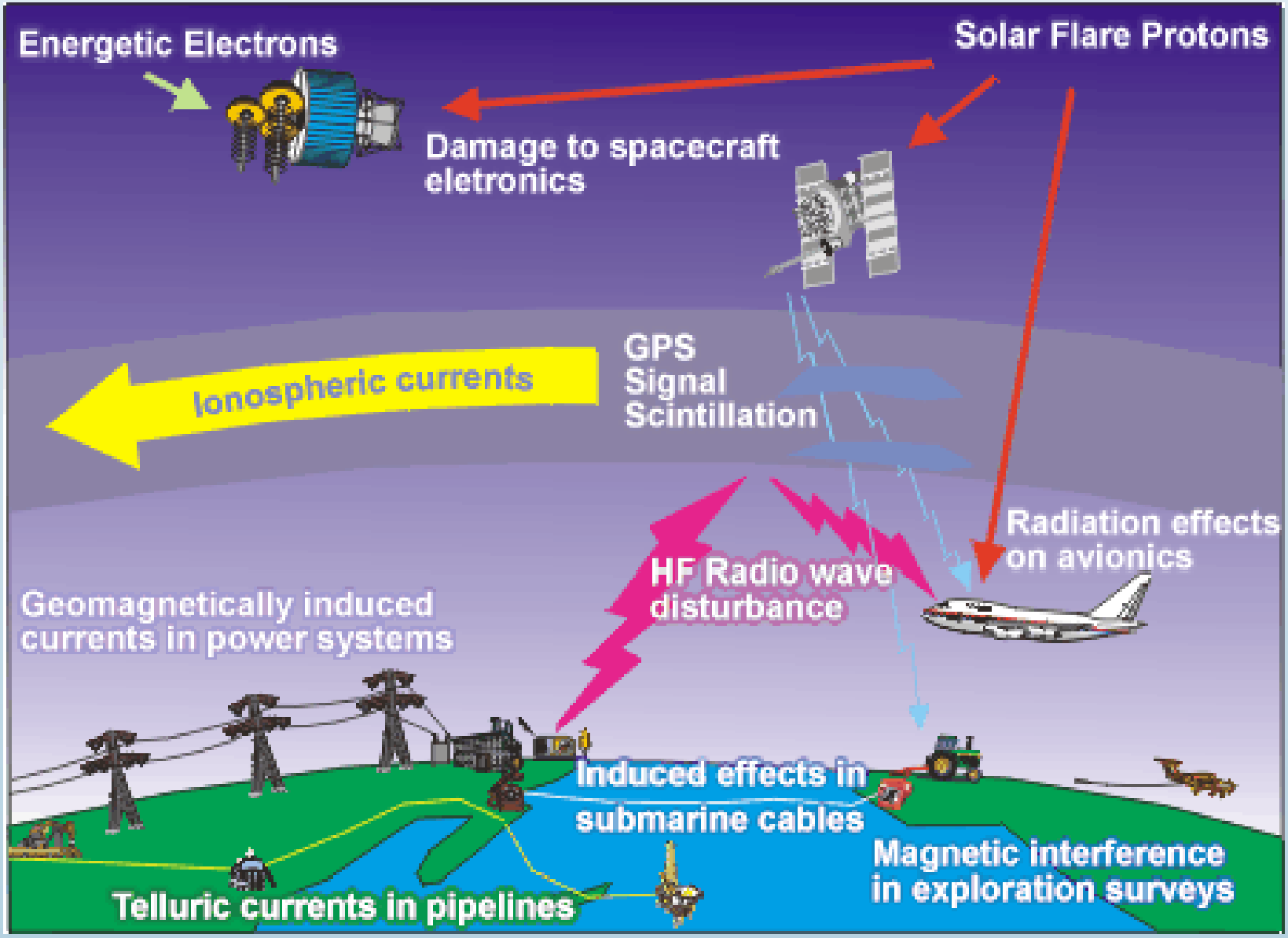


This schematic diagram shows the sun, solar wind, and Earth’s magnetosphere, the environment in which space weather is generated.

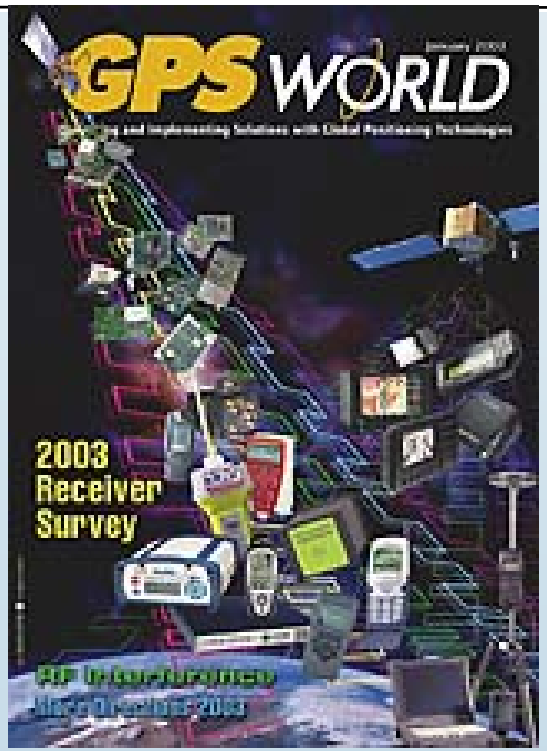
Sun-Earth Space Environment

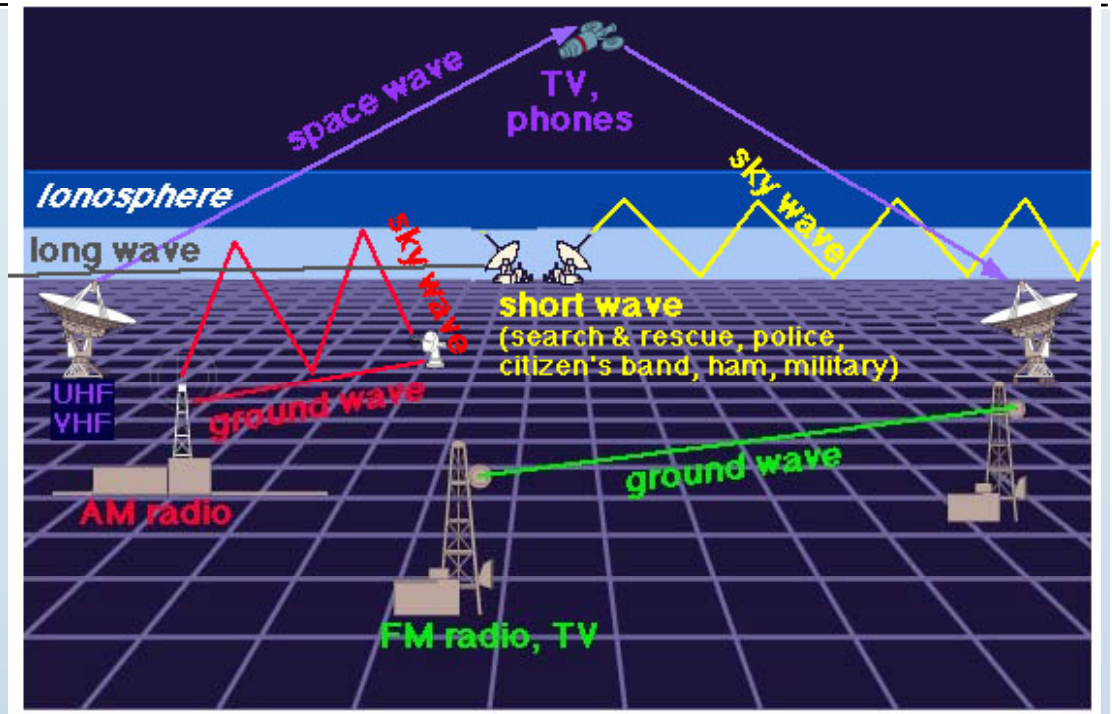


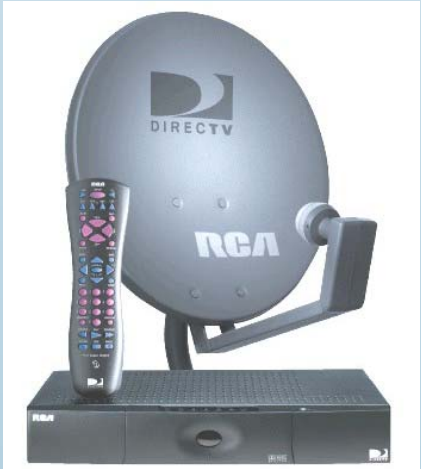
Space Weather Effects

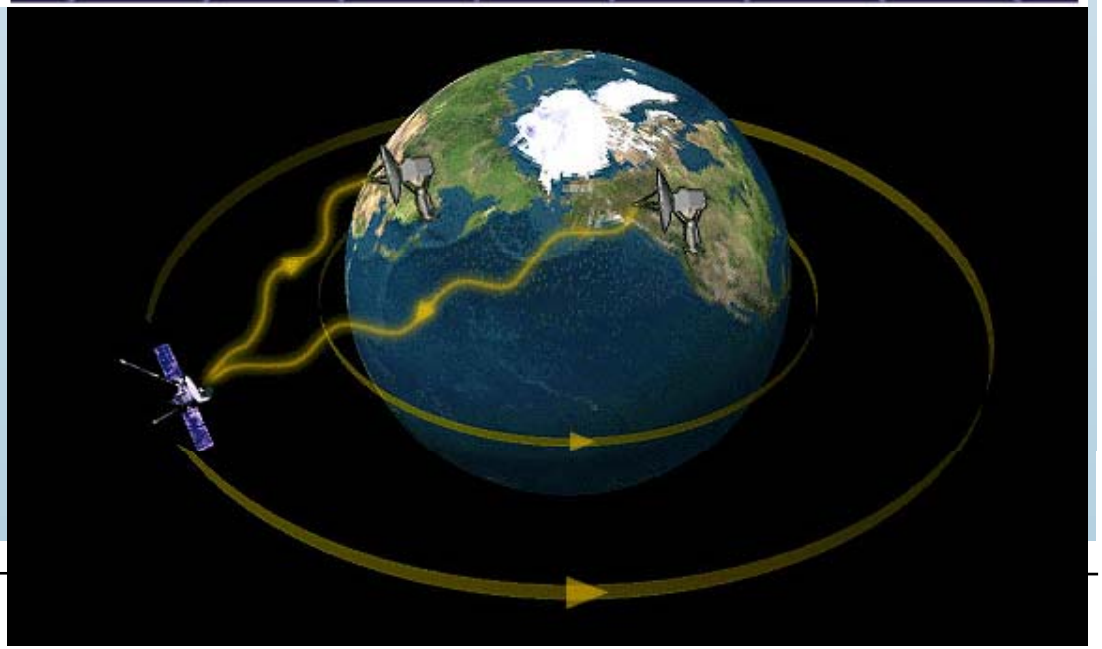


Communication and Navigation







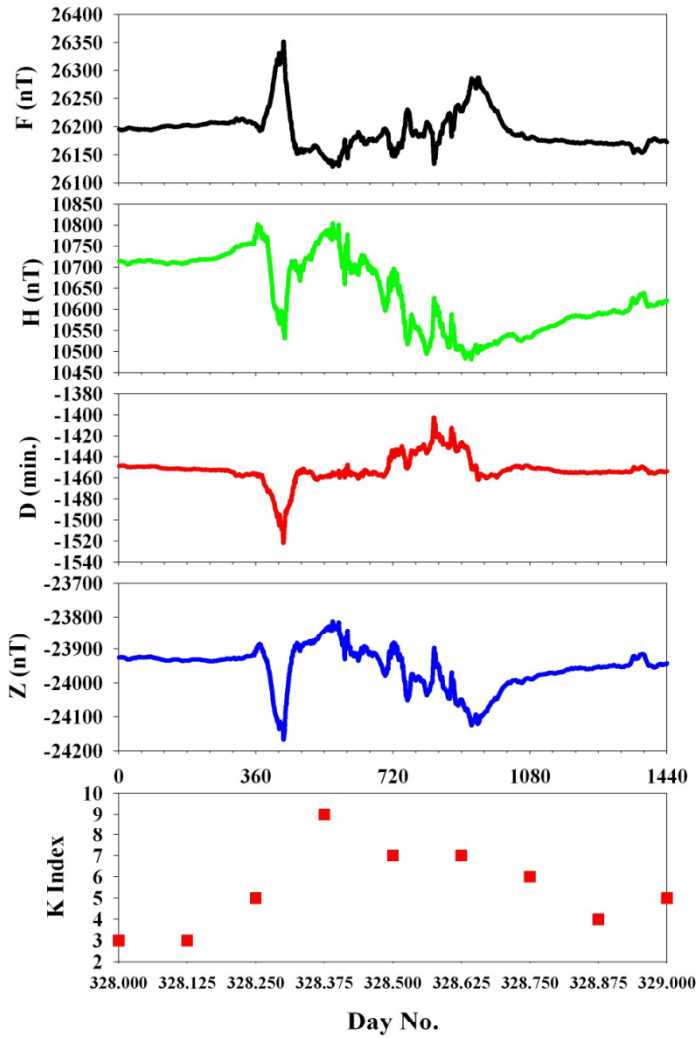


Solar Event

From SUN to Hermanus Magnetic Observatory 22 Nov 2001 – 24 Nov 2001

- *22 Nov 2001 : SOHO observation of CME on Sun*
- *24 Nov 2001 : Major Magnetic Storm on Earth*
- *Observations by Hermanus Magnetic Observatory*

Coronal Mass Ejection (CME)



0600 – 0800 UT :

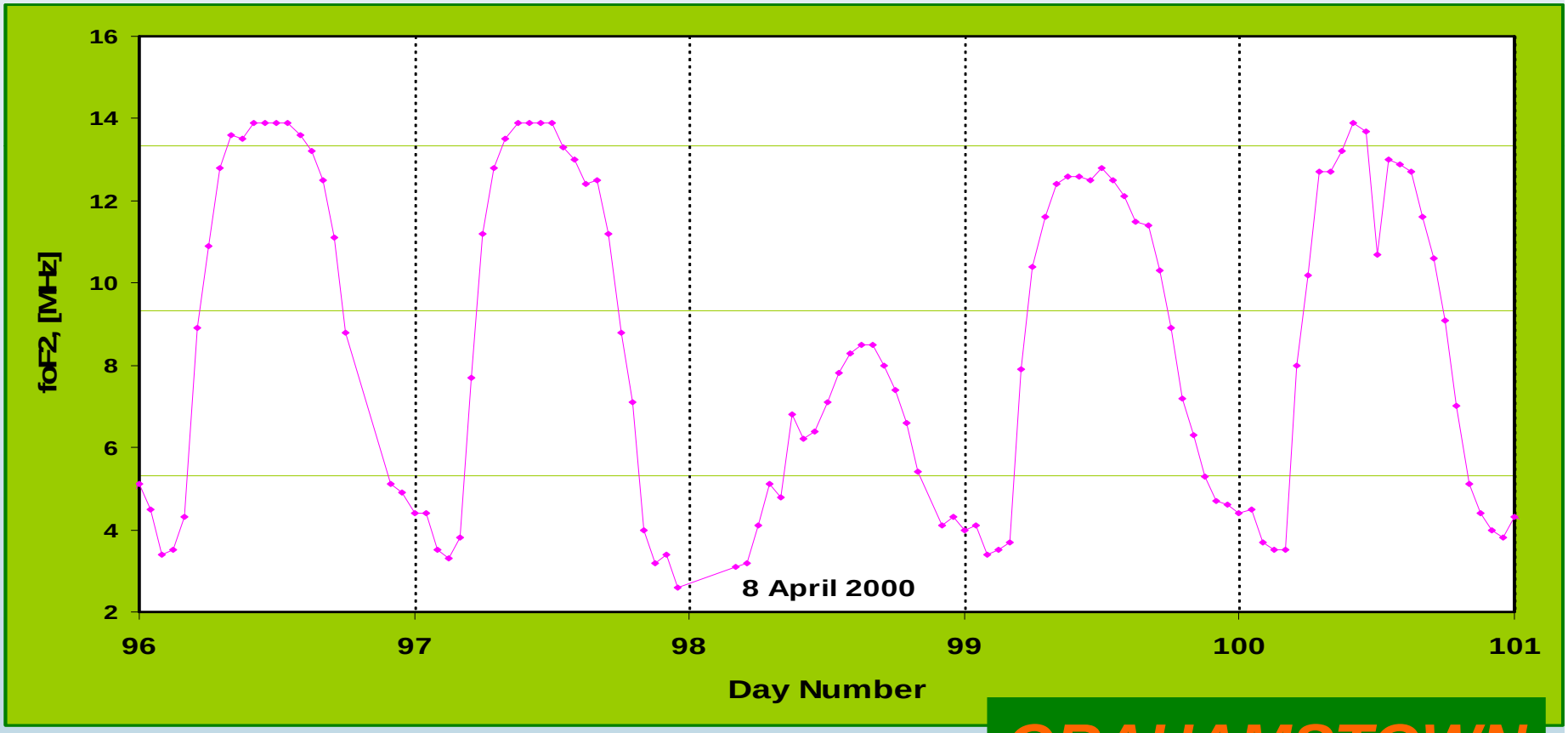
$\Delta F = 143\ nT$

$\Delta H = -270\ nT$

$\Delta D = -70\ min.$

$\Delta Z = -231\ nT$

CME effect on HF Radio Comms



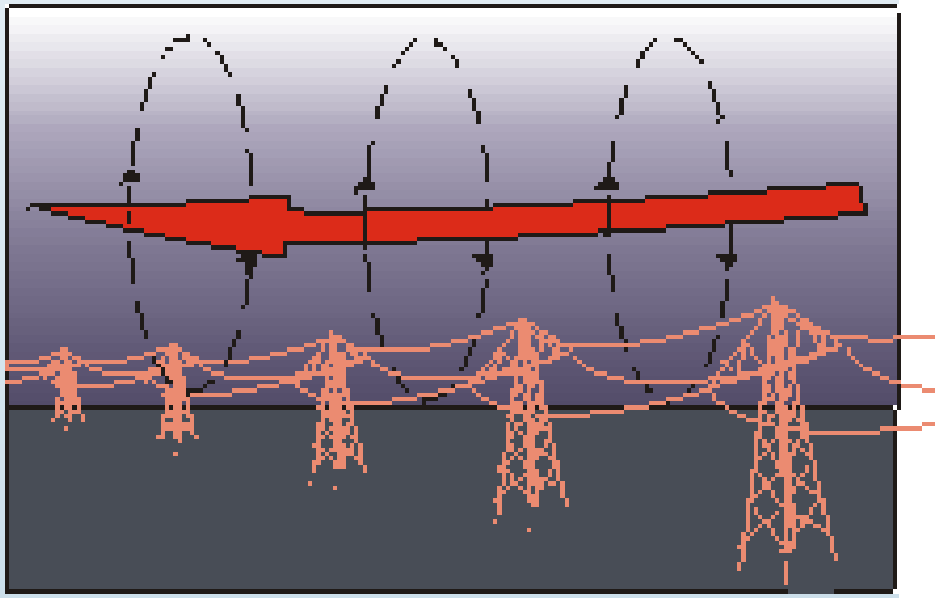
GRAHAMSTOWN

foF2

[MHz]

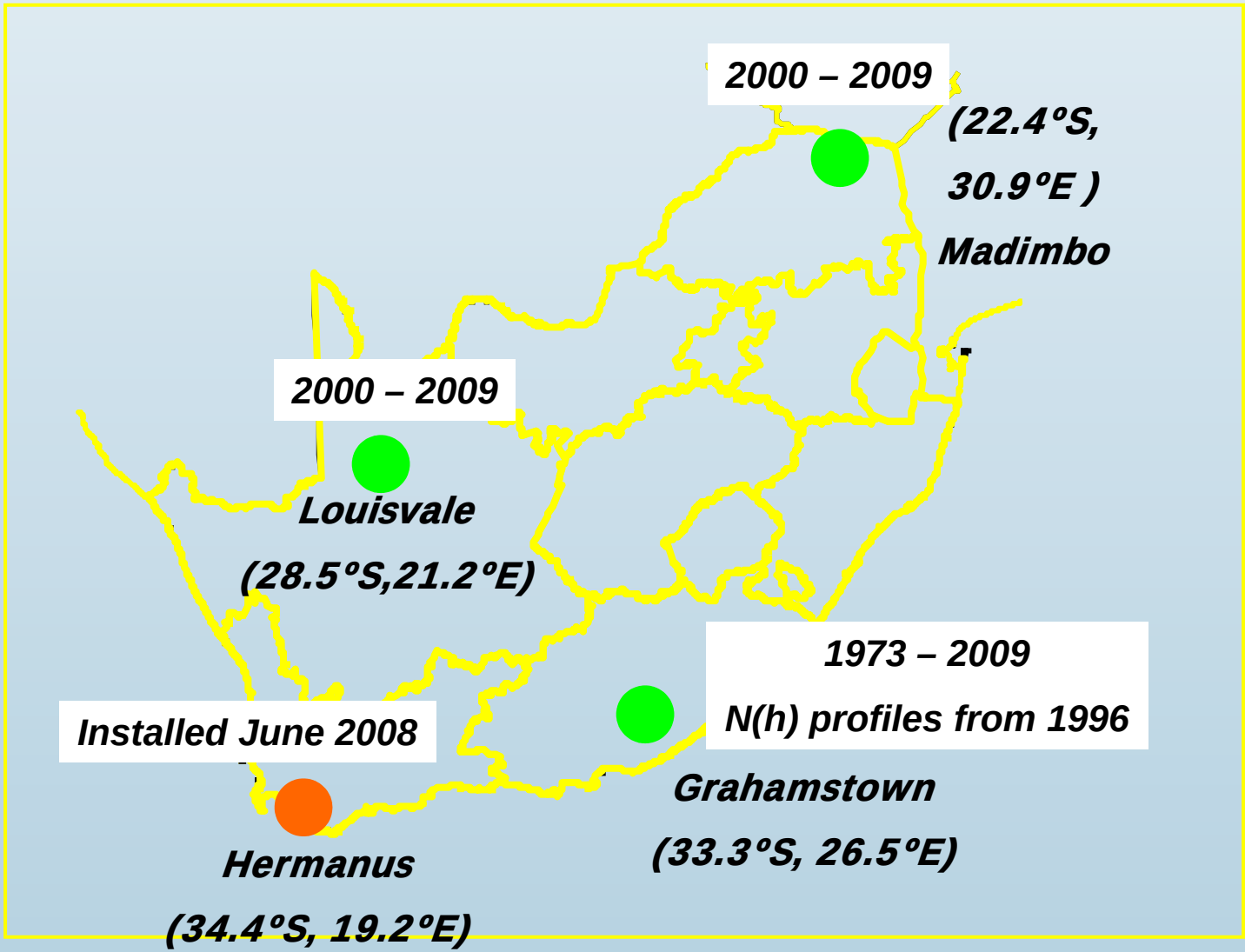
Geomagnetically Induced Currents

- GIC occur at the end of the space weather chain.
- GICs are driven by electric fields produced by variations in the Earth's magnetic field that occur during geomagnetic storms.
- GICs flowing in power transformers produce extra magnetic flux which cause transformer failures.
- Intense GIC levels can cause collapse of power systems.

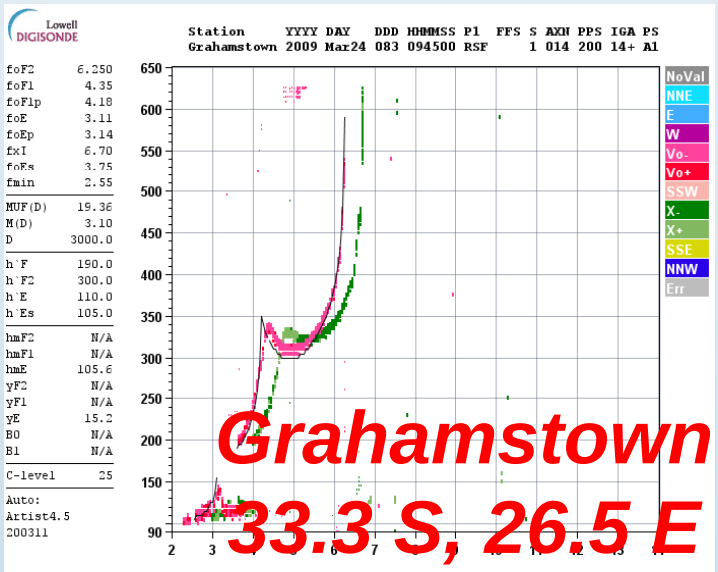


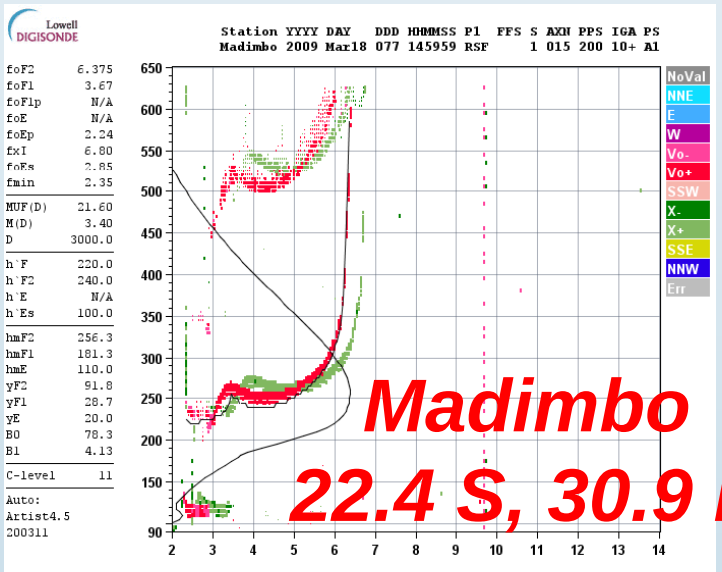
Characterizing the Ionosphere

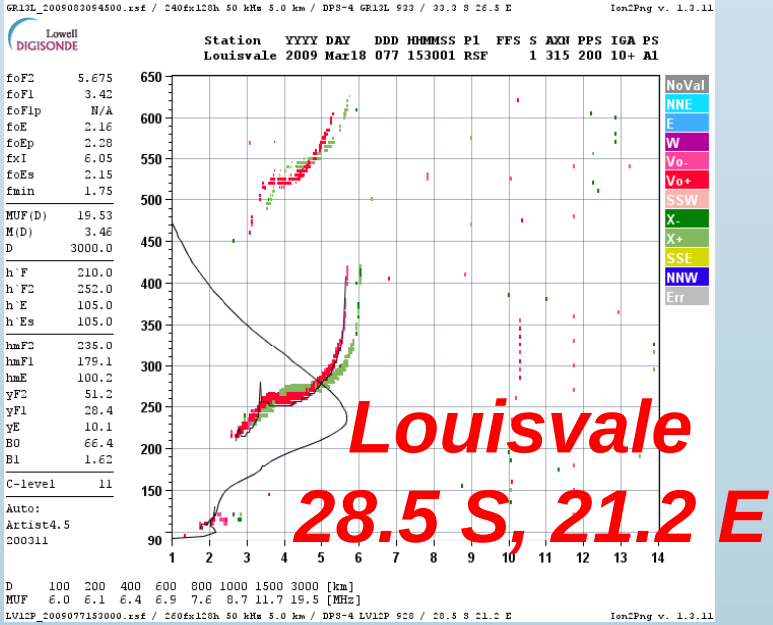
South African Ionosonde Network

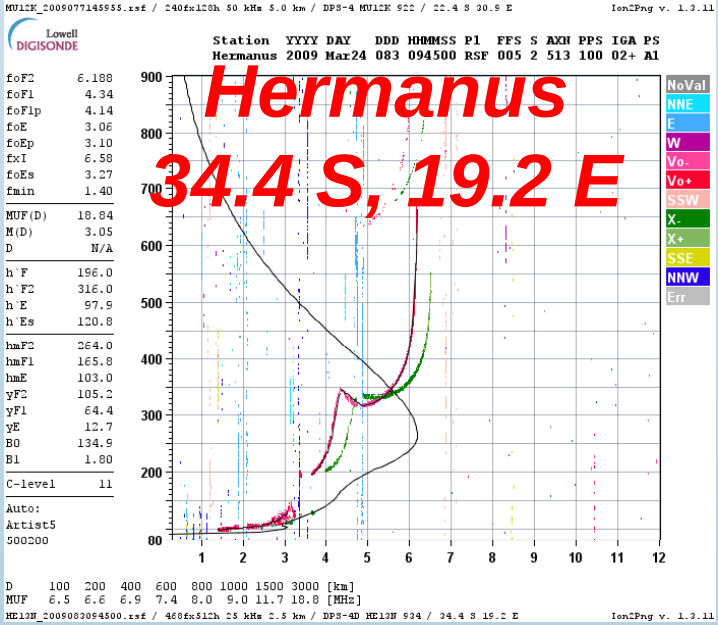


Real Time Ionospheric Information





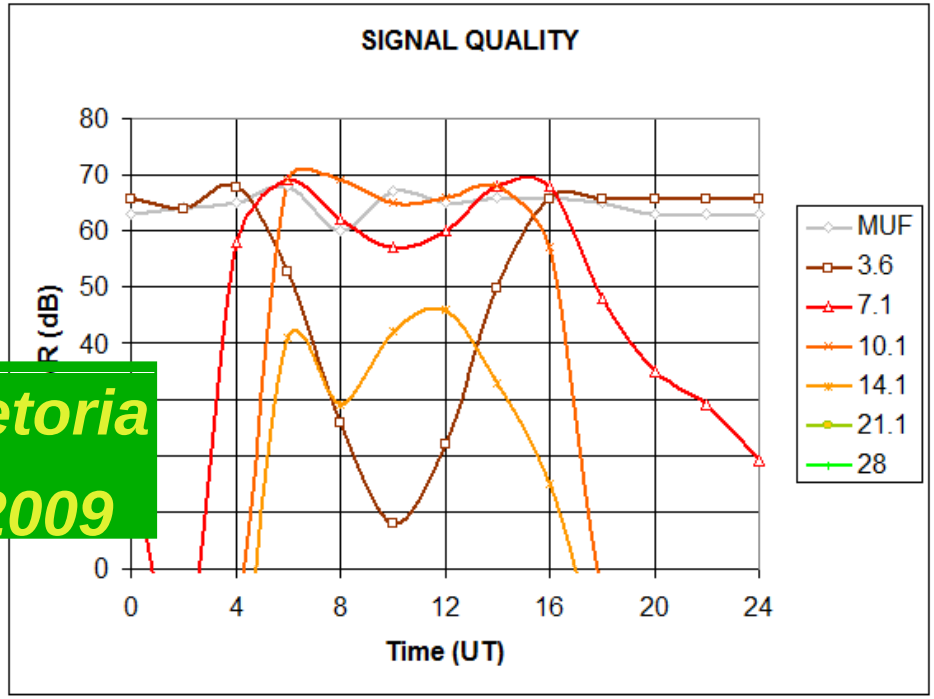


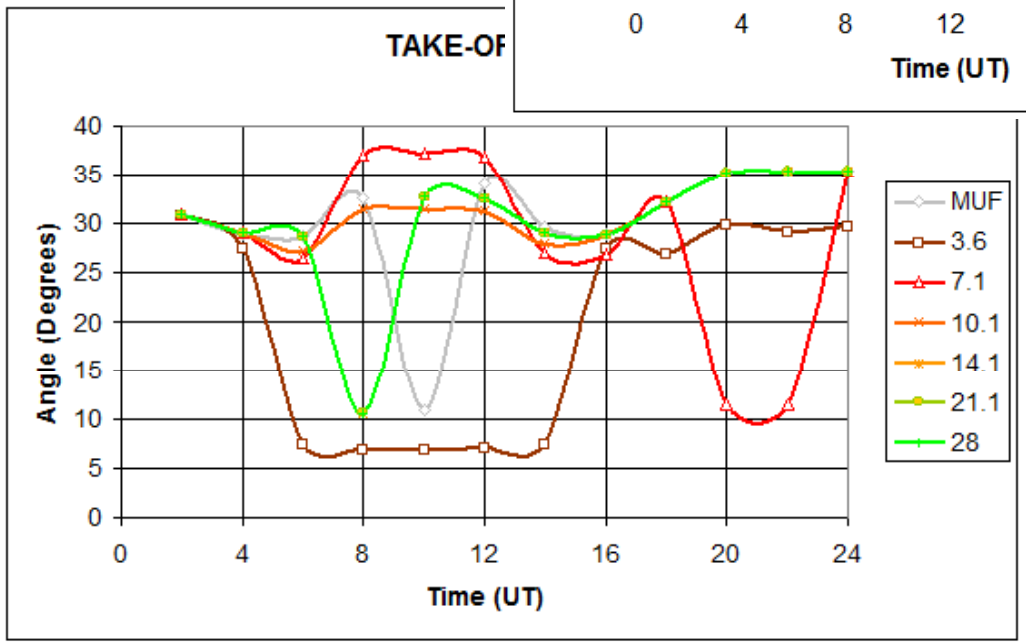


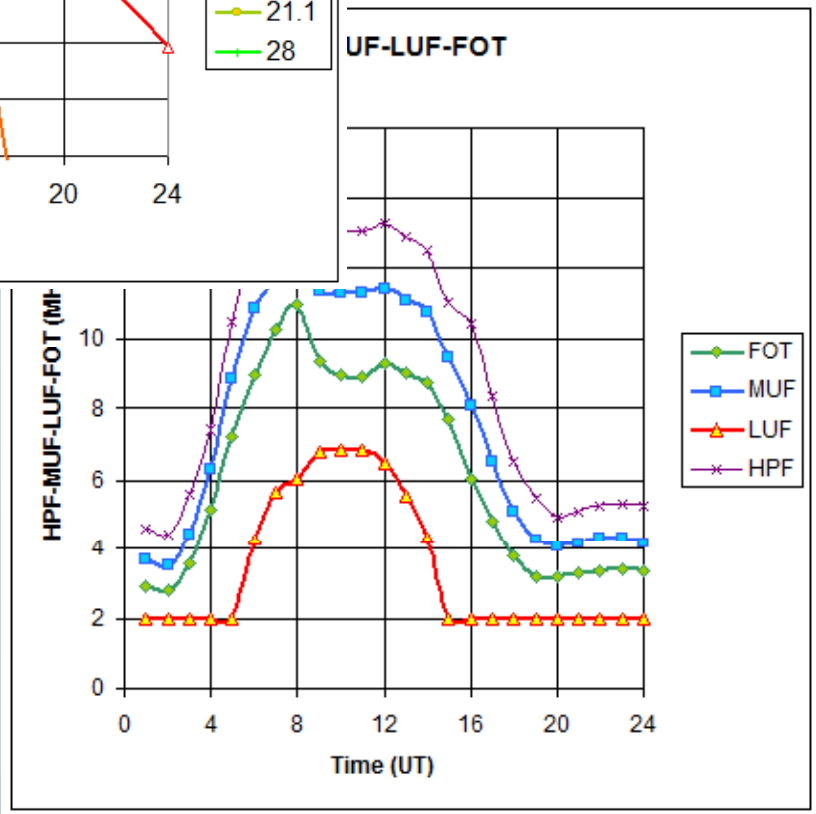
Frequency Predictions

Cape Town – Pretoria

25 – 31 March 2009







Modelling the Ionosphere

IRI – International Reference Ionosphere

-- global model

-- updated annually

-- covers all upper atmosphere parameters

National SA Model

-- South African Ionospheric model

-- Bottomside ionosphere

-- neural network based

Global foF2, hmF2 and M3000F2 Models

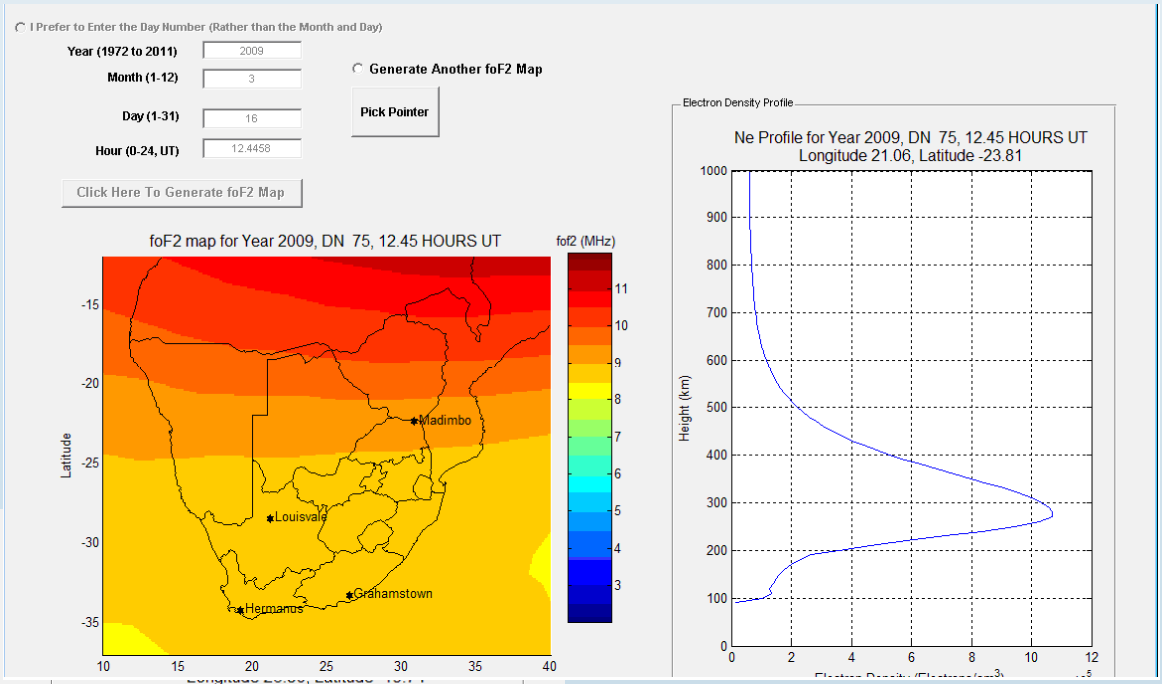
-- neural network based

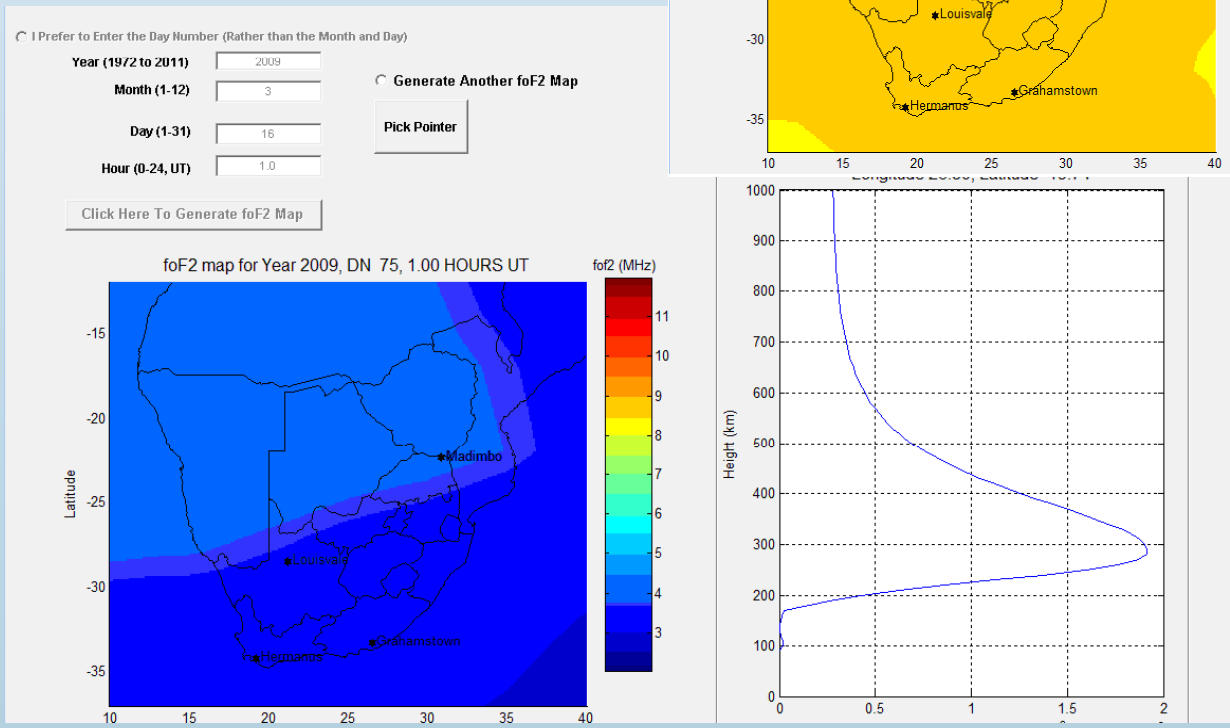
-- initially trained with data from 50 worldwide stations

-- developed as PhD project in South Africa

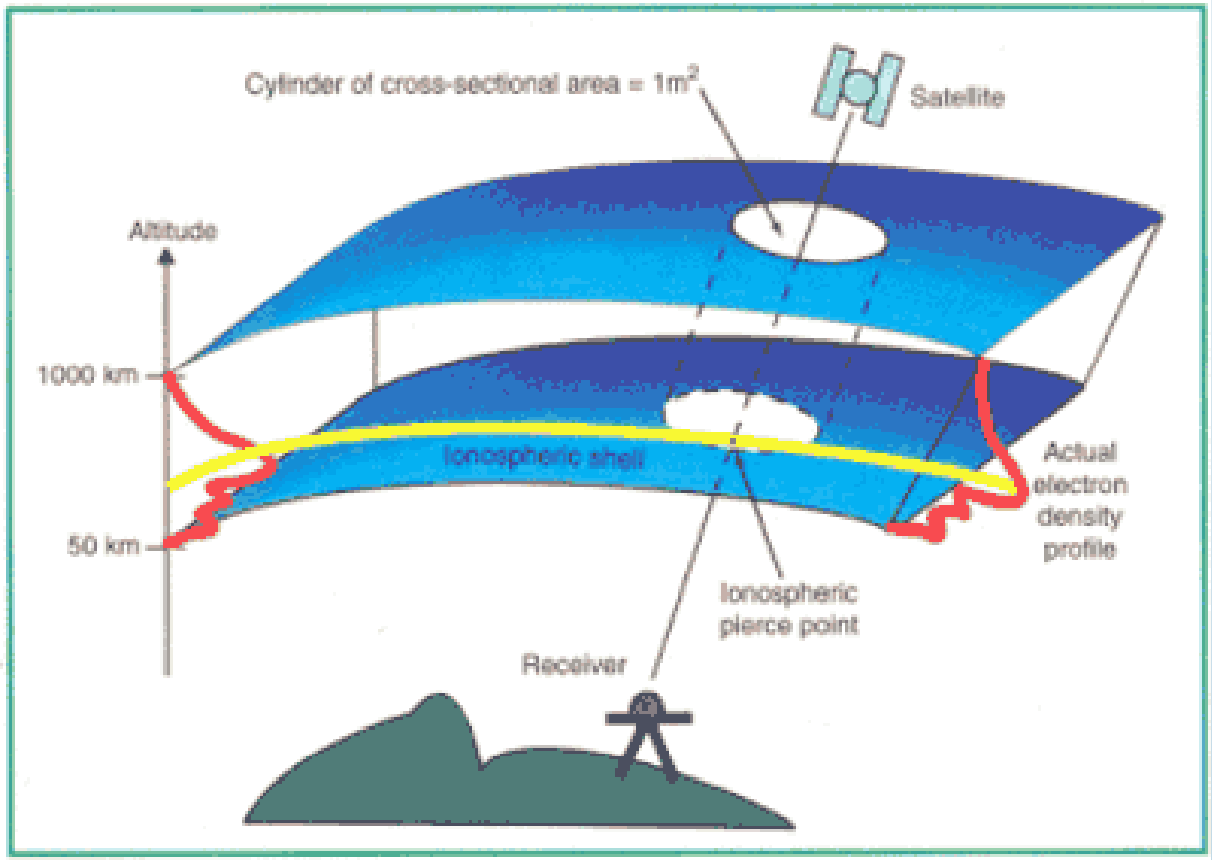
-- current version includes 135 global stations

Real-Time Ionospheric Map





Total Electron Content (GPS)

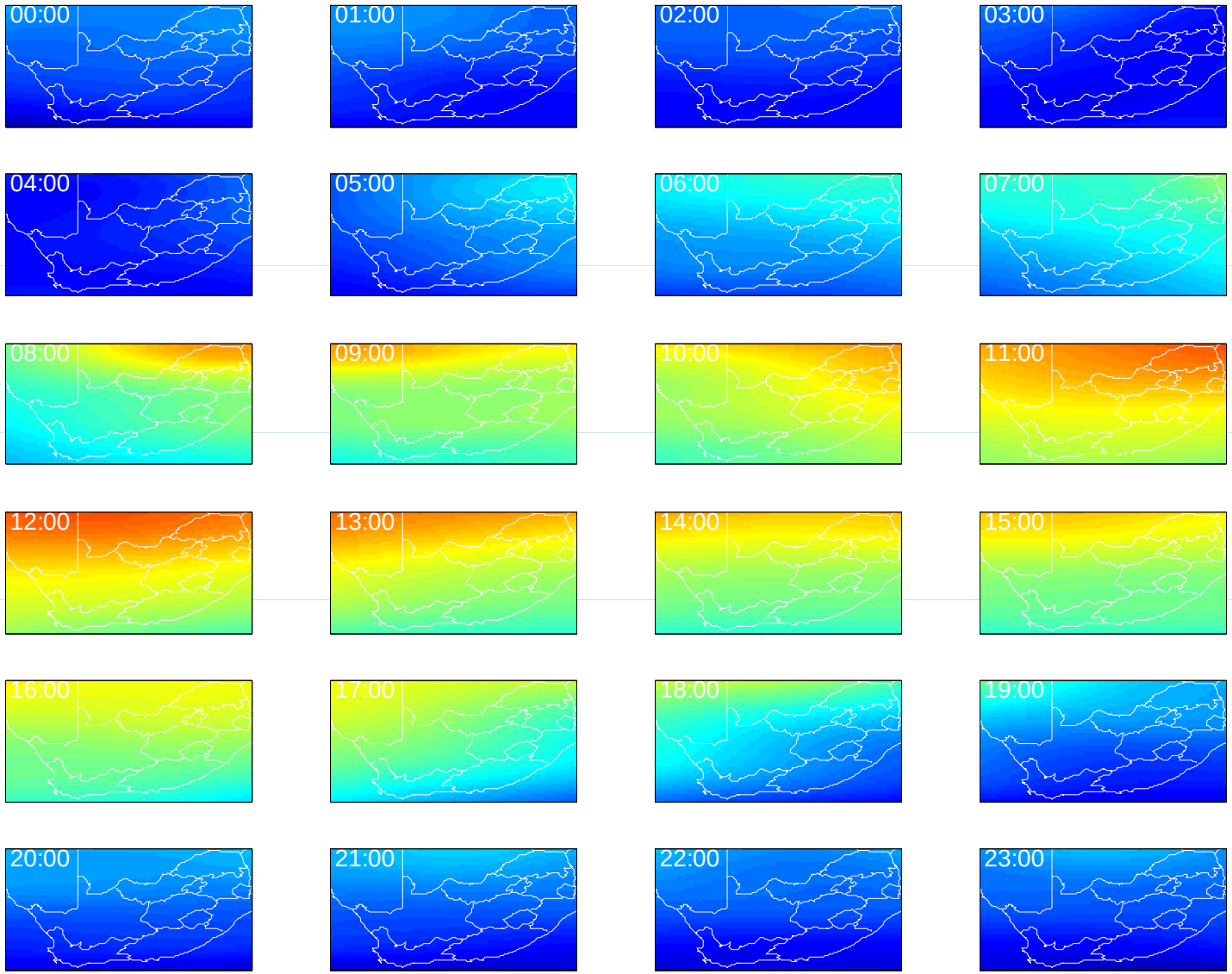


integral of electron density N along cylindrical column centred on ray path s, between receiver R and satellite S through the ionosphere. TEC corresponds to total number of free electrons- included in cylindrical column with sectional area 1m^2.

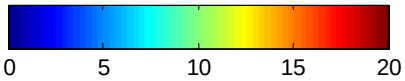
1 TEC Unit = 10^{16} electrons per square meter

Total electron Content (TEC)

Hourly GNSS-derived Ionospheric Total electron Content maps over Southern Africa for 3 March 2009



Hermanus Magnetic Observatory
South Africa
http://spaceweather.hmo.ac.za



TEC Units ($x10^{16}$ $e^{-}.m^{-2}$)

Space Weather Instruments at SANEA-IV

- *HF radar*
- *Aurora cameras*
- *Riometers*
- *Magnetometers*
- *Neutron Monitors*
- *VLF-receiver*
- *GPS receiver for geodecy*
- *Seismometer*
- *Meteorology*

Summary

- *Technology and Communications are growing at a rapid rate*
- *Space Weather is going to have a serious impact, especially during high solar activity*
- *Northern hemisphere models and predictions not always valid for southern hemisphere*
- *There is a very definite need to continue researching Southern African Space Weather*
- *www.spaceweather.co.za*
- *http://spaceweather.hmo.ac.za*
- *http://ionosond.ru.ac.za*

Summary

Thank You