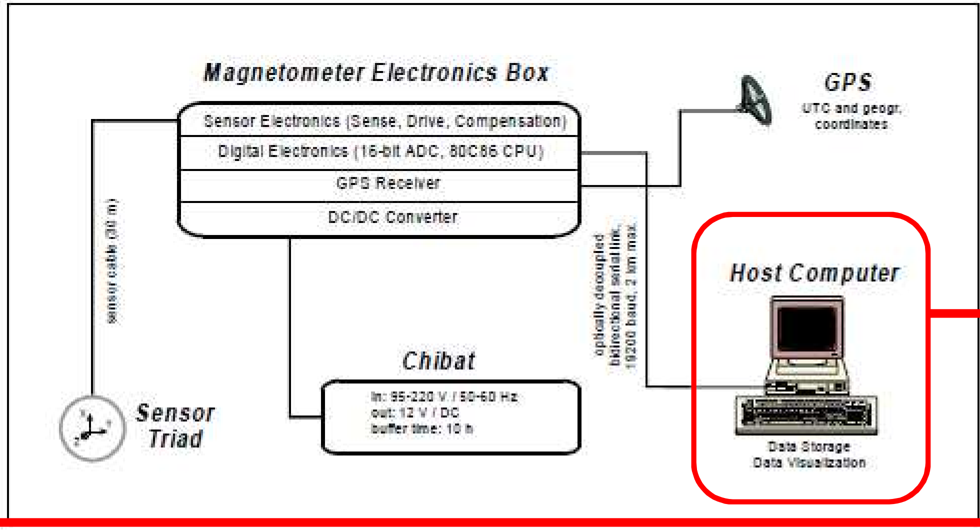
WP2 - Report of UNIVAQ activities (1st year)

- Upgrading SEGMA instrumentation
- FLRINV: inversion algorithm to convert FLR frequencies into estimates of the equatorial plasma mass density

upgrade of data recording of CHIMAG instrument



- porting of the original software from C language under DOS to MATLAB under Linux (Ubuntu 64 bit)
- rewriting of interrupt management into event-driven management
- rewriting the Graphical User Interface for housekeeping values and data by means of XML files and a web interface

Remote control of the system

Insertion of a section to communicate with the system, tested with:

- A Local Area Network and ADSL line (easy)
- A USB GSM/GPRS Modem (some problems with the connection and IP addressing stability)
- Satellite Internet connection (still to be done)

The system now is operating with a GSM modem and:

- Can send data once a day
- Can be reached through a SSH connection
- Can be reached through a web interface

Remote management of power supply

We are using a programmable remote control based on the exchange of SMS in order to:

- Reset the host PC
- Switch on and off the power supply of both datalogger and host PC
- Monitor power failures

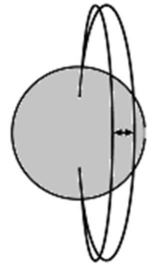
To do

- Real-time filtration and data resampling to 1 Hz
- 15 min data transmission
- Design and realize a new acquisition system for L’Aquila station

Inference of the plasma mass density from field line eigenfrequencies

Standard procedure for low and middle latitudes:

Assumption: Observed FLR frequencies (f_R) correspond to the axisymmetric **toroidal** mode eigenfrequencies in a **dipole** field.



Toroidal Mode

Governing equation:

$$d^2E/dz^2 + \lambda\,(1- z^2)^6\,\rho(z)/\rho_o\,E = 0$$

E : wave electric field
z = cos (θ), **θ**: colatitude
ρ : mass density along the field line
ρ_o: equatorial mass density

Eigenvalues λ are found imposing:

1) the boundary condition: **E = 0** at the altitude (100-200 km) where the wave is reflected

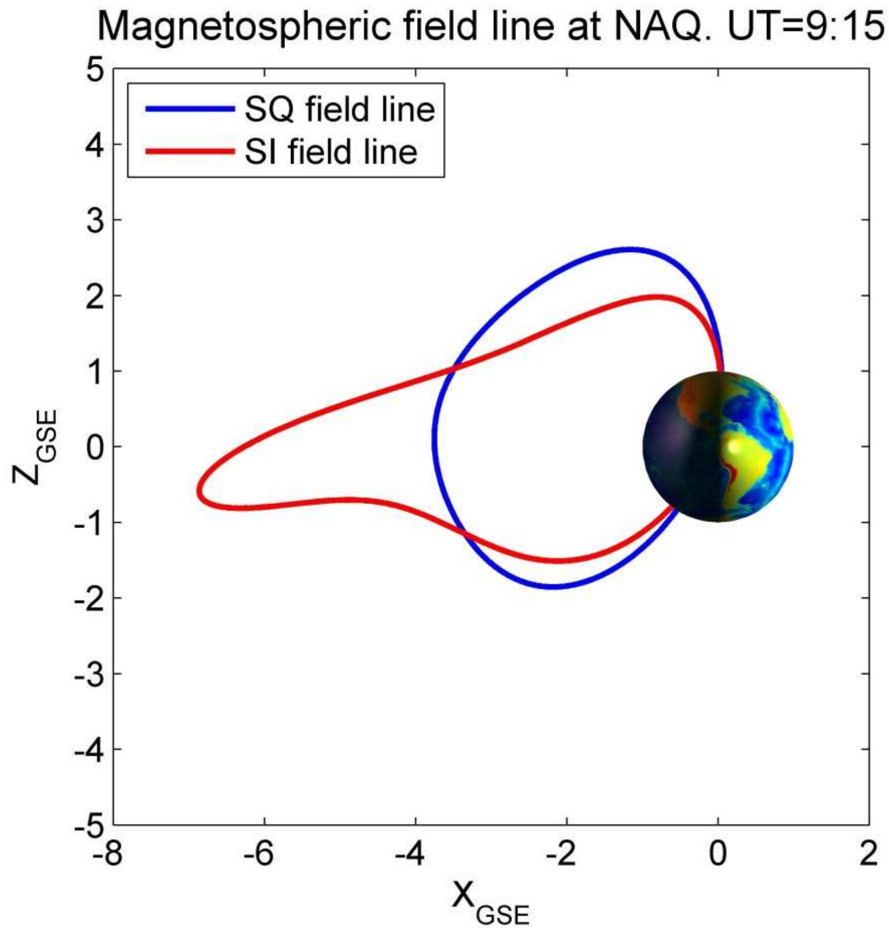
2) A given functional form for the mass density along the field line.

Common assumption: $\rho(r)/\rho_o = (r / r_o)^{-m}$

For any given **L- shell** and **m** value, the inferred **equatorial** mass density is:

$$\rho_o = \frac{k\,\lambda(L,m)}{L^8\,{f_R}^2}$$

At high latitudes, and even at middle latitudes during particular conditions, need to consider geomagnetic field geometry more realistic than dipole geometry (i.e. *Tsyganenko* models).



Dipole field

$$\frac{d^2\varepsilon}{dz^2} + L^2 R_E^2 \,(1+3z^2)\, \frac{\omega^2}{V_A^2}\,\varepsilon \;=\; 0$$

ε : wave electric field

z = cos (θ), **θ :** colatitude

R_E : Earth radii

Arbitrary field geometry (Singer et al., 1981)

$$\frac{d^2\xi'}{ds^2} + \frac{d\left[\ln\left(h_\alpha^2 B\right)\right]}{ds}\frac{d\xi'}{ds} + \frac{\omega^2}{V_A^2}\,\xi' = 0$$

s distance along the field line

B (s) magnetic field

ξ' (s) = ξ (s) / h_α (s)

ξ (s) field line displacement

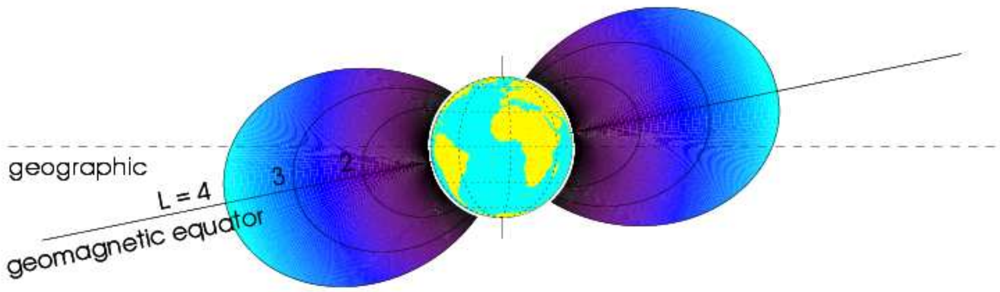
h_α (s) distance to an adjacent field line

For near real time monitoring, necessary to use real time (provisional) solar wind & Dst data for tracing Tsyganenko field lines.

Density inference for low L-shells

Ionosphere-Plasmasphere Model (M. Förster, GFZ, Potsdam)

Physical-numerical model to describe the thermal plasma behaviour in corotating flux tubes conjoining the ionosphere and the plasmasphere. Constituents: O^+, H^+, He^+, O_2^+, N_2^+, NO^+



Configuration: tilted geomagnetic dipole from 120 km altitude along the field lines to 120 km altitude at the conjugated site.

Input parameters:

- MSIS neutral gas model
- neutral wind model HWM93
- F10.7, Kp indices

It solves the following fully time-dependent, nonlinear, coupled second order partial differential equations:

- ✓ continuity equations together with the
- ✓ momentum equations for all species,
- ✓ electron and ion energy equations,
- ✓ kinetic equation for the suprathermal electrons.

The dependence of the inferred equatorial density on the field-aligned density distribution becomes important at L<= 2.

It would be helpful to consider more updated models (i.e. FLIP) to further investigate the effect of changing solar/magnetospheric conditions on the inferred plasma density.