SEGMA report 2011

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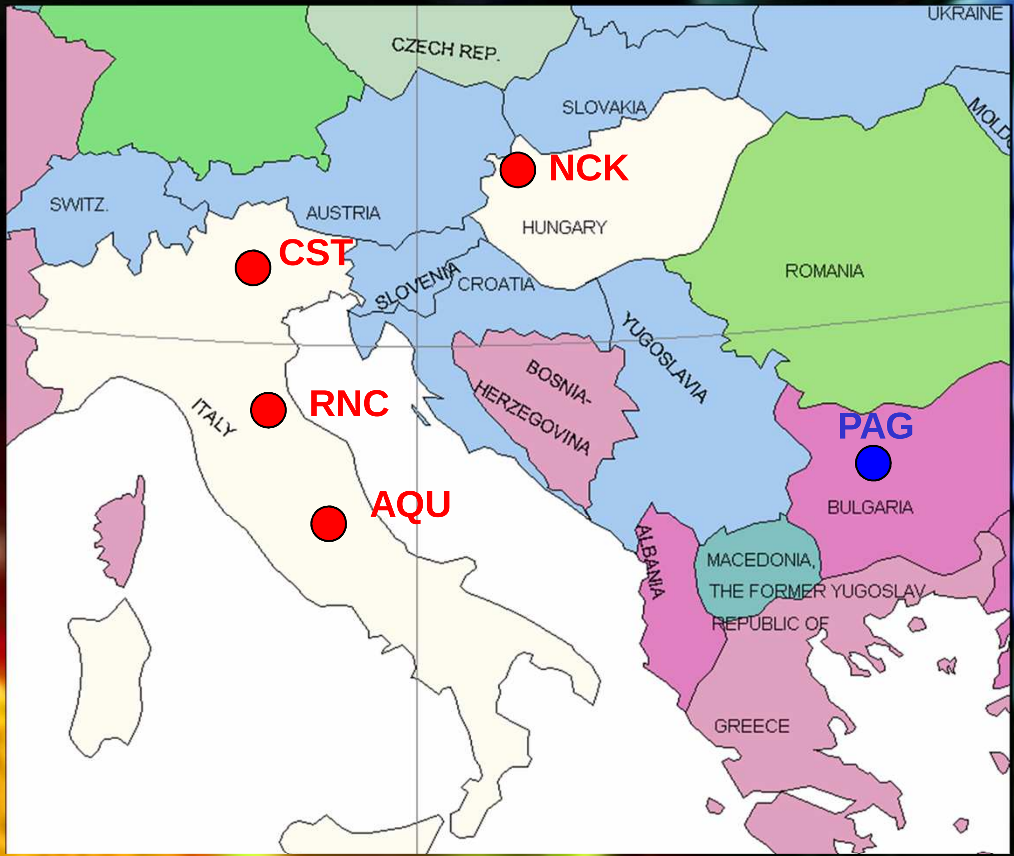
...MA Meeting

...Francisco, USA

...2011

SEGMA (South European GeoMagnetic Array) (1.56 < L < 1.88)

URL: http://sole-terra.aquila.infn.it/staz_segma.asp?lang=en



3 gradient installations

Stations	Latitud. separ.	L
NCK - CST	1.9°	1.83
CST - RNC	2.5°	1.71
RNC - AQU	1.9°	1.61

Cooperating institutions:

- *University of L'Aquila, Italy*
- *Space Research Institute (IWF), Graz, Austria*
- *Geodetic and Geophysical Research Institute, Sopron, Hungary*
- *Geophysical Institute, Sofia, Bulgaria*

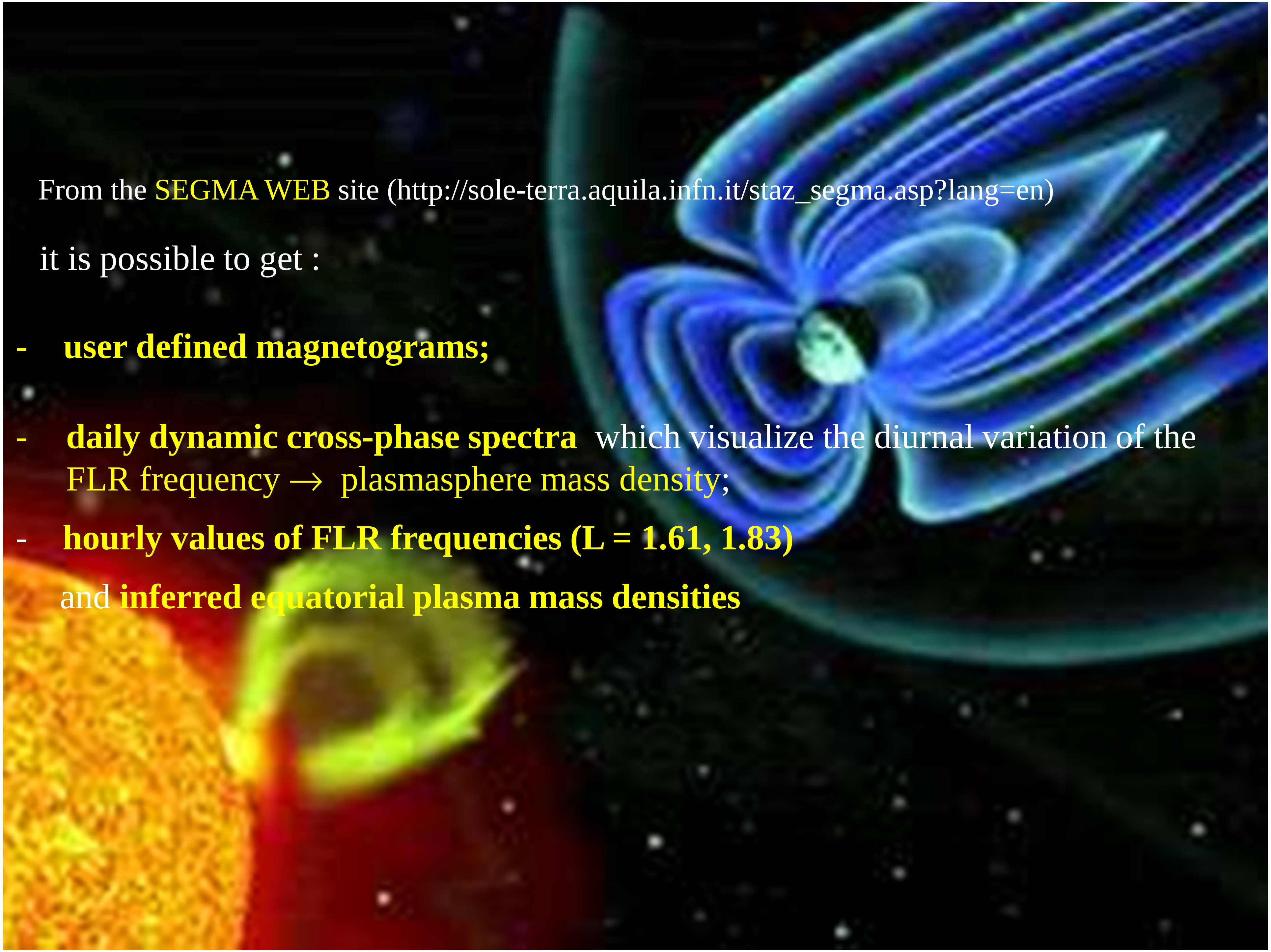
SEGMA array, coordinates of the recording stations

Station	Geograph. Coord.	CGM Coord.	*L*	Start of operation	Magnetometer type
Nagycenk (NCK)	47.63 N 16.73 E	42.79 N 91.41 E	1.89	1999	fluxgate
Castello Tesino (CST)	46.05 N 11.65 E	40.84 N 86.63 E	1.78	2000	fluxgate
Ranchio (RNC)	43.97 N 12.08 E	38.28 N 86.58 E	1.65	2001	fluxgate
L'Aquila (AQU)	42.38 N 13.32 E	36.33 N 87.37 E	1.57	1985	fluxgate, induction
Panagyurishte (PAG)	42.51 N 24.18 E	37.02 N 97.24 E	1.60	2003	induction

Main features of the fluxgate instrument and data acquisition

- 0.01 nT resolution
- Max. data rate 64 vectors/sec
- Standard final sampling rate: 1Hz
- Absolute time via GPS receiver

Check operations and data recovery made frequently at AQU, NCK and PAG. Once every 1-2 months at CST and RNC.



From the SEGMA WEB site (http://sole-terra.aquila.infn.it/staz_segma.asp?lang=en)

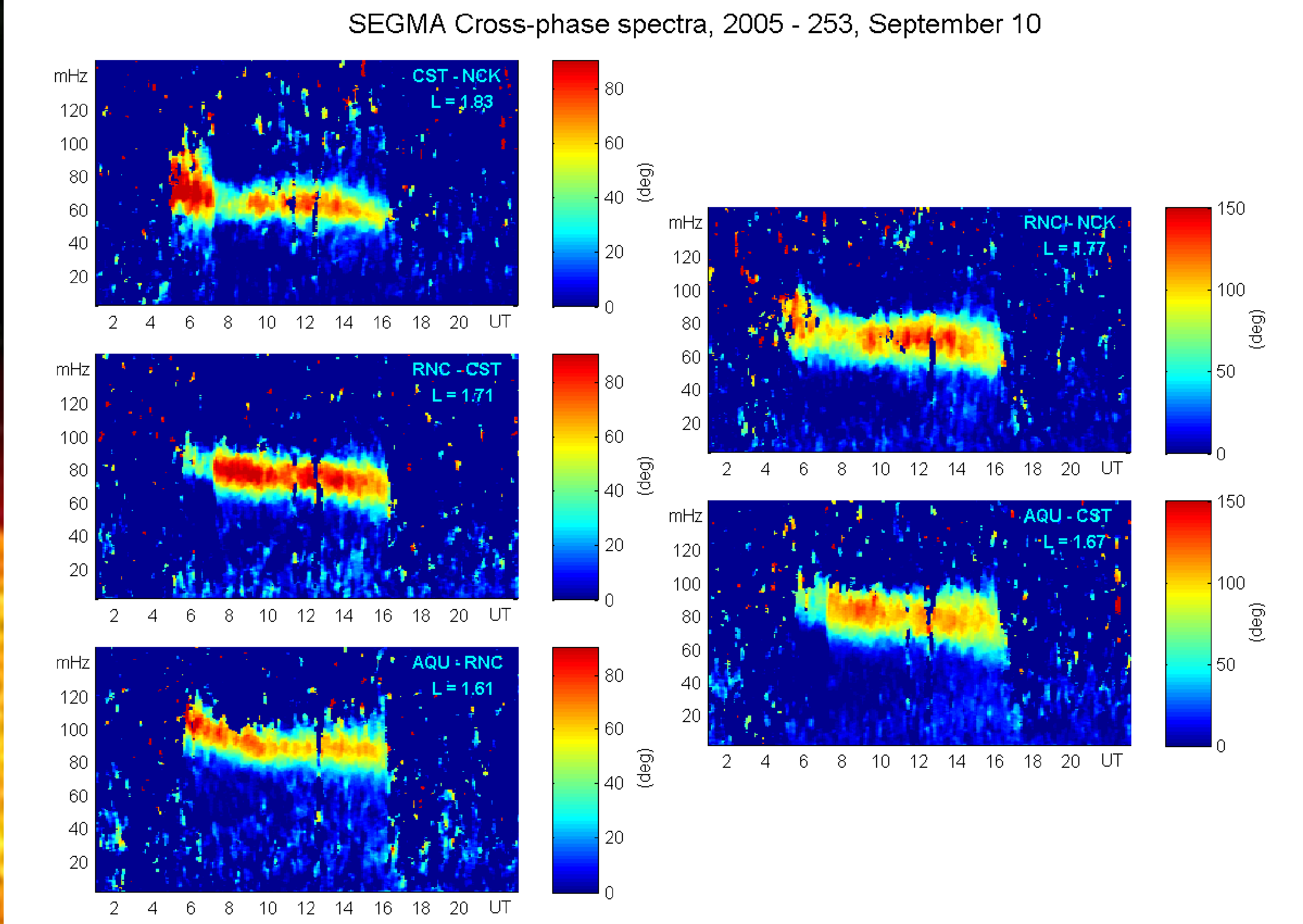
it is possible to get :

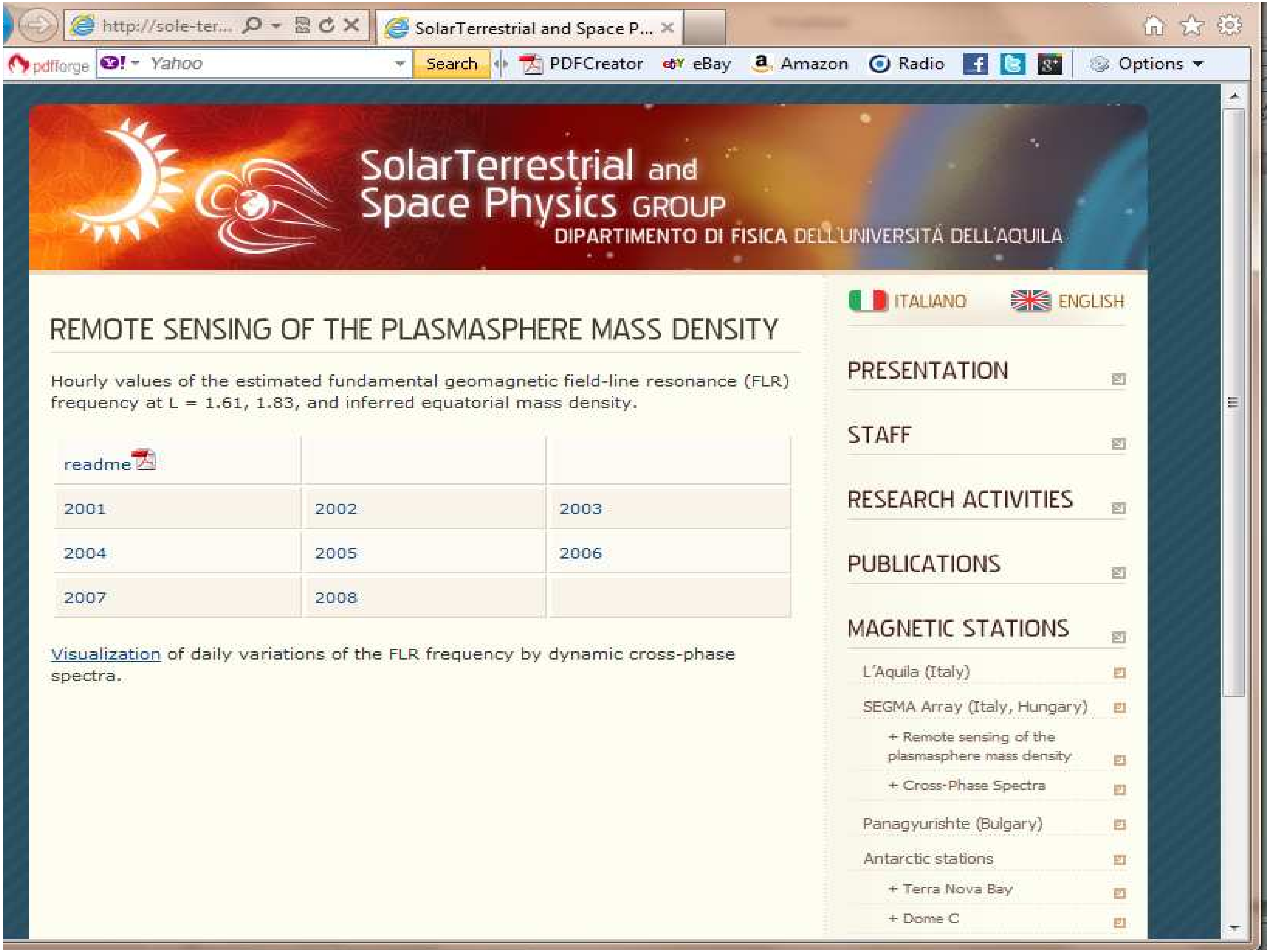
- **user defined magnetograms;**

- **daily dynamic cross-phase spectra** which visualize the diurnal variation of the FLR frequency $\rightarrow$ plasmasphere mass density;

- **hourly values of FLR frequencies (L = 1.61, 1.83)** and **inferred equatorial plasma mass densities**

An example of daily dynamic cross-phase spectra from the SEGMA WEB site





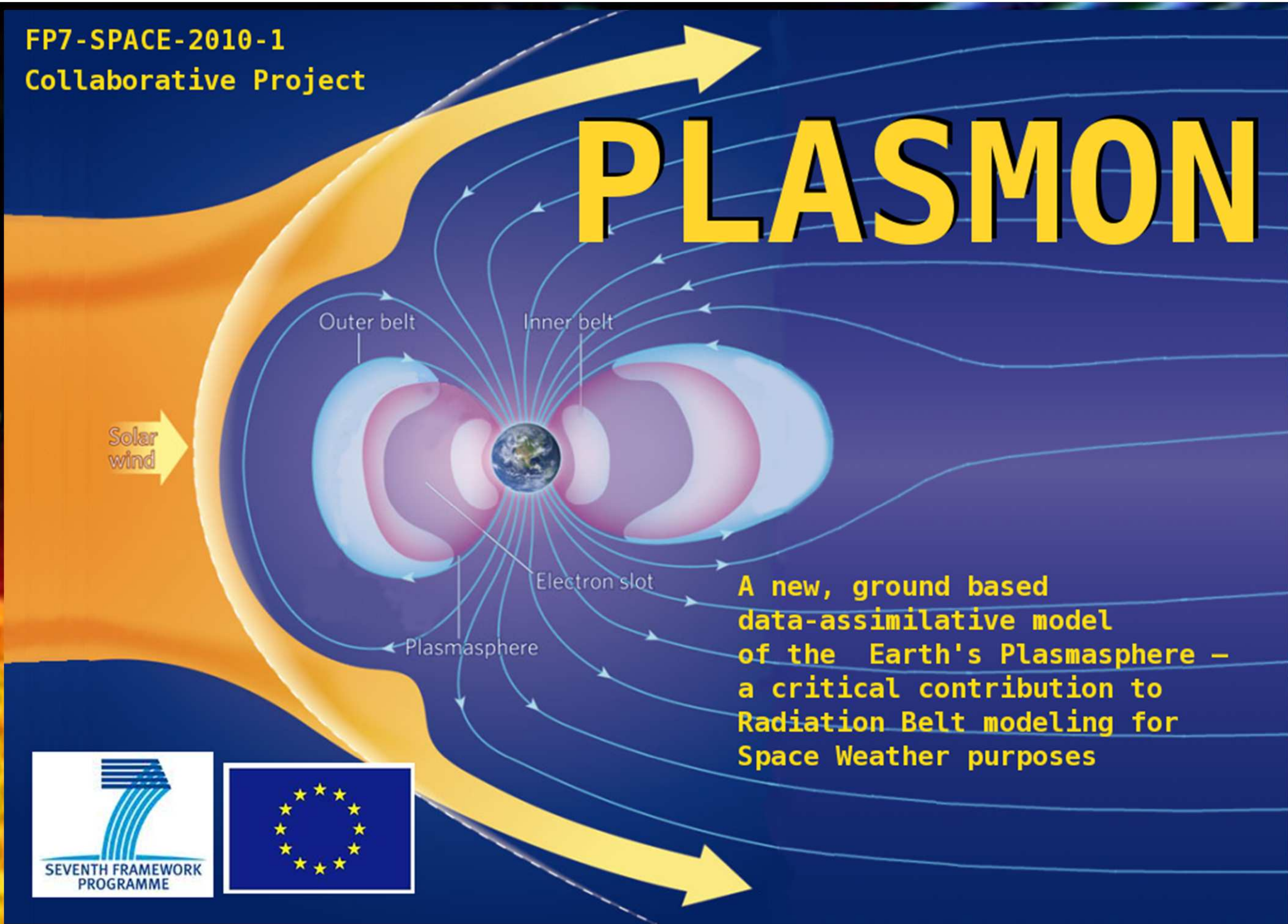
REMOTE SENSING OF THE PLASMASPHERE MASS DENSITY

Hourly values of the estimated fundamental geomagnetic field-line resonance (FLR) frequency at L = 1.61, 1.83, and inferred equatorial mass density.

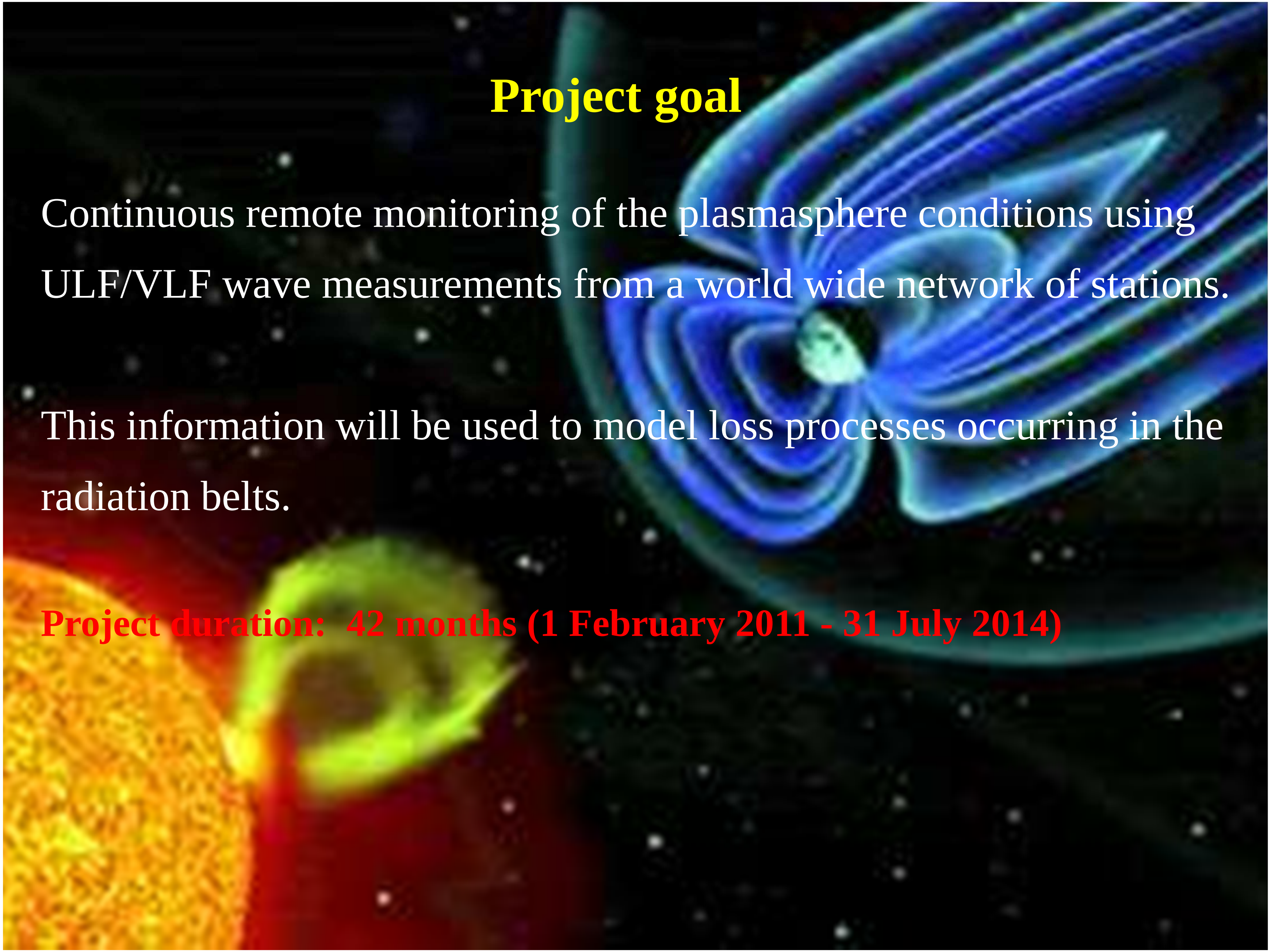
readme		
2001	2002	2003
2004	2005	2006
2007	2008	

Visualization of daily variations of the FLR frequency by dynamic cross-phase spectra.

PRESENTATION
STAFF
RESEARCH ACTIVITIES
PUBLICATIONS
MAGNETIC STATIONS
L'Aquila (Italy)
SEGMA Array (Italy, Hungary)
+ Remote sensing of the plasmasphere mass density
+ Cross-Phase Spectra
Panagyurishte (Bulgary)
Antarctic stations
+ Terra Nova Bay
+ Dome C



Theme: Security of space assets from space weather events


Project goal
Continuous remote monitoring of the plasmasphere conditions using ULF/VLF wave measurements from a world wide network of stations.
This information will be used to model loss processes occurring in the radiation belts.
Project duration: 42 months (1 February 2011 - 31 July 2014)

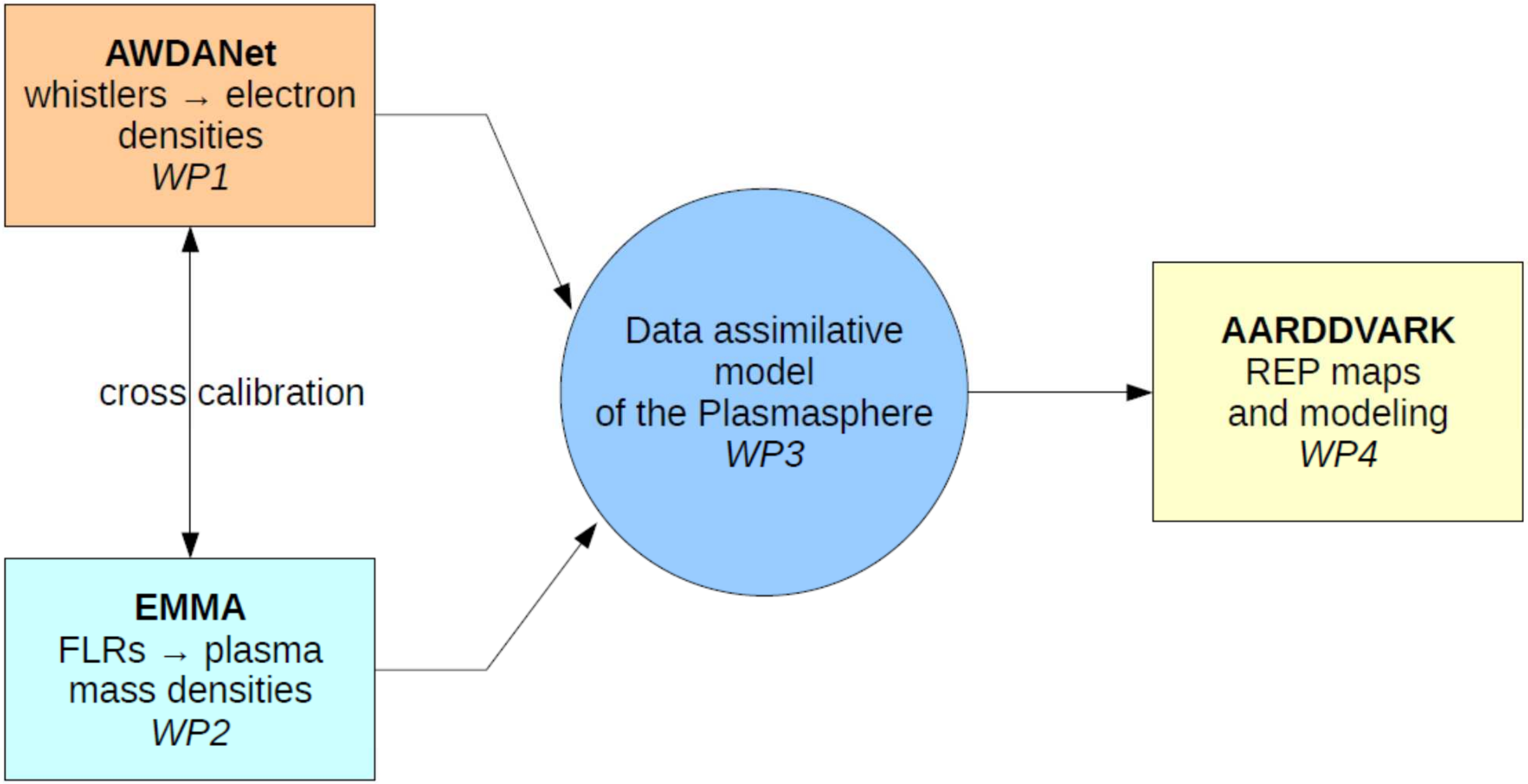
Participating Institutions

Short name	Institution	Country
1 ELTE	Eötvös Loránd University (Coordinator)	Hungary
2 NERC-BAS	British Antarctic Survey	UK
3 ELGI	Eötvös Loránd Geophysical Institute	Hungary
4 UNIVAQ	University of L'Aquila	Italy
5 UOULU	Sodankyla Geophysical Observatory	Finland
6 UO	University of Otago	New Zealand
7 HMO	Hermanus Magnetic Observatory	South Africa
8 NMT	New Mexico Inst. of Mining and Technology	USA
9 IGPAS	Inst. of Geophysics, Polish Acad. of Scien.	Poland
10 UW	University of Washington	USA
11 LANL	Los Alamos National Laboratory	USA

Work packages

	Title	Lead participant
WP1	Automatic retrieval of equatorial electron densities and density profiles by Automatic Whistler Detector and Analyzer Network (AWDANet)	**Eotvos University**
WP2	Retrieval of equatorial plasma mass densities by magnetometer array (EMMA) and cross-calibration of whistler and FLR method	**L'Aquila University**
WP3	Data assimilative modeling of the Earth's plasmasphere	**New Mexico Inst.**
WP4	Modeling REP losses in radiation belts based on AARDDVARK network	**BAS**
WP5	Dissemination and exploitation of the results	**Otago University**

PLASMON structure



Map of operating / planned EMMA stations (1.6 < L < 6.7)

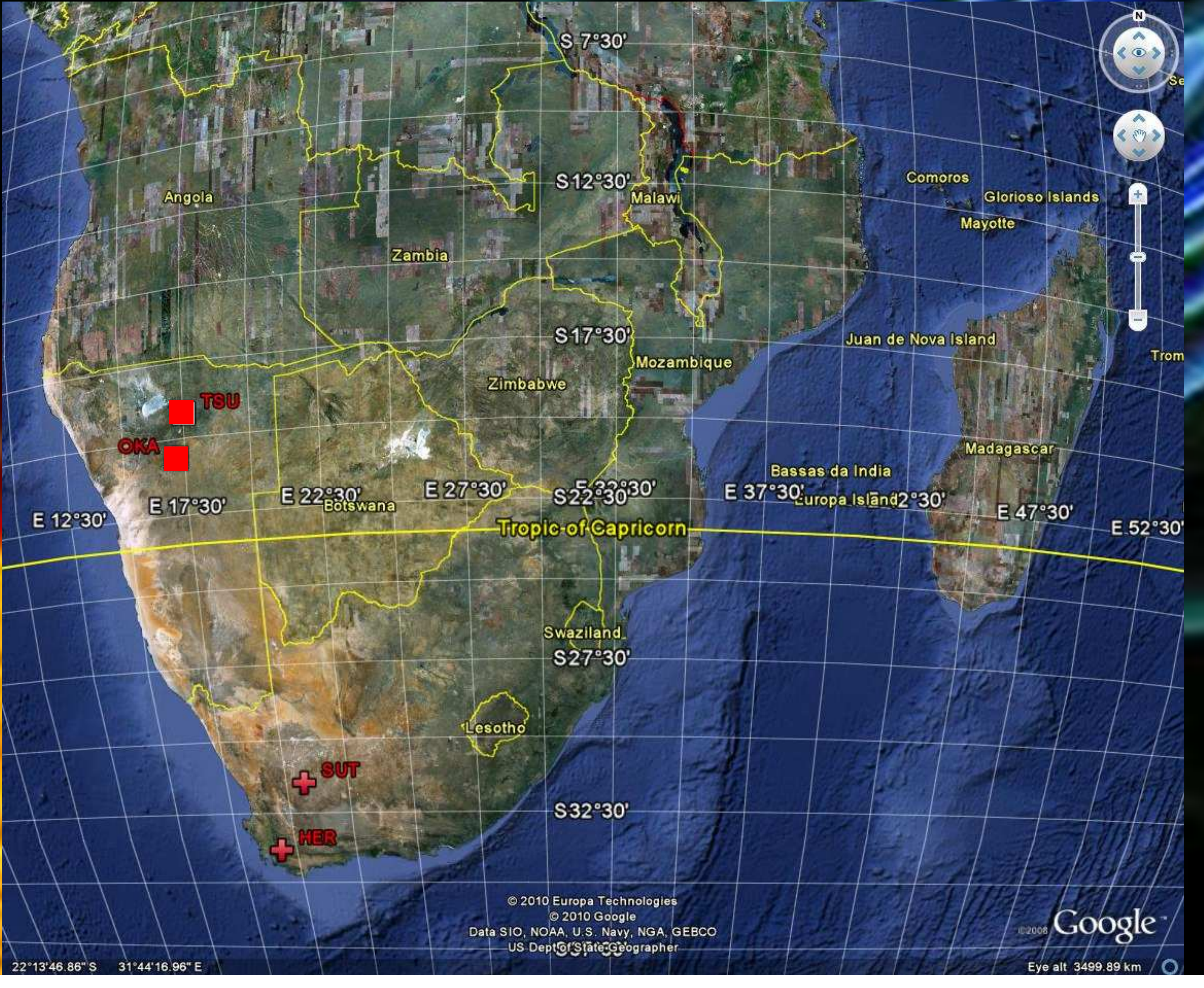
Δ SEGMA

+ MM100

□ IMAGE

■ planned new stations

Map of operating (+) / planned (■) South Africa stations



WP2 objectives

1. Unify and extend SEGMA, MM100 and IMAGE networks into EMMA (+ S.Africa stations) to have better latitudinal coverage (3 new stations by month 12, other 4 new stations by month 24): ELGI, IGPAS, HMO

2. Develop an automatic **FLR identification** method [month 24]: UNIVAQ, ELGI, IGPAS

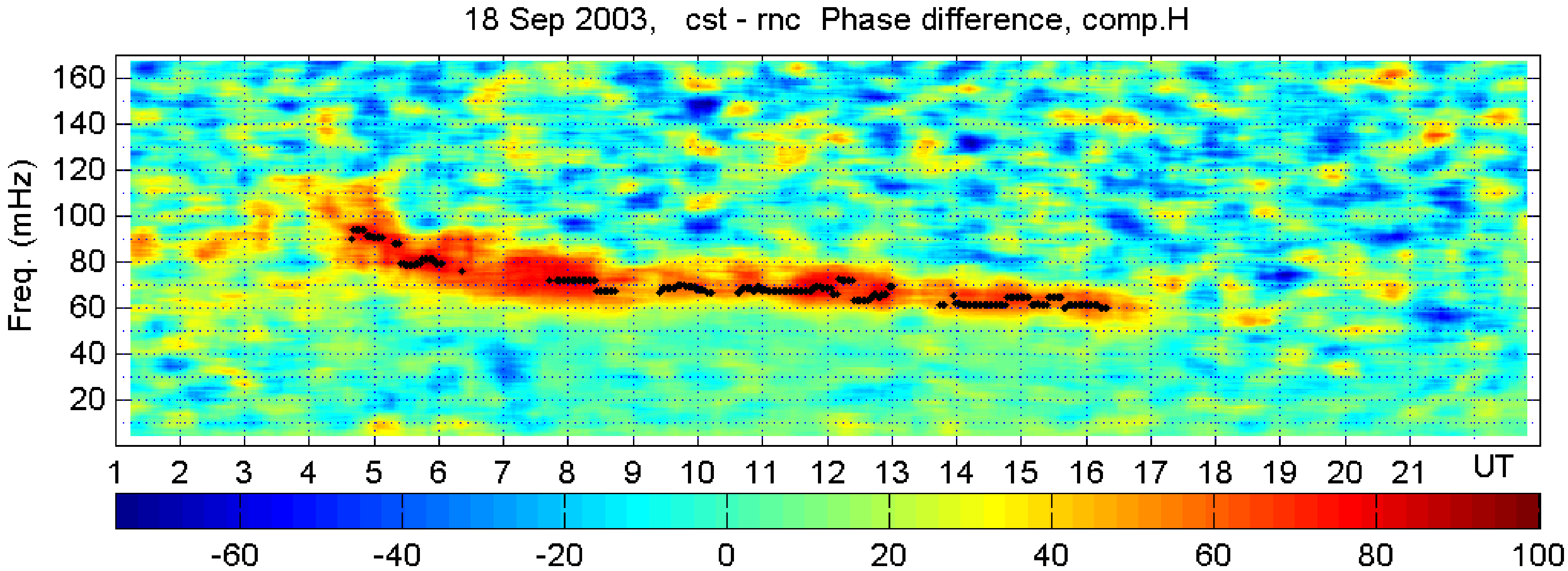
3. Develop an automatic **FLR inversion** method [month 24]: UNIVAQ, ELGI, IGPAS, (NMT)

4. Develop all EMMA stations to work in quasi-real-time mode of operation [month 42]: ELGI, IGPAS, HMO, UNIVAQ, FMI

5. Evaluate relative abundances of heavy ions in the plasma composition from simultaneous determinations of mass density (FLR method) and electron density (whistler metod) [month 42]: ELGI, UNIVAQ, ELTE, (LANL, NERC-BAS, NMT, UO, HMO, UOULU)

Automated selection of FLR frequencies (objective 2)

UNIVAQ, ELGI, IGPAS   delivery date: month 24



- Current algorithms (from *Berube et al. 2003*) used by UNIVAQ and ELGI: to be improved, and fully automatized.
- ~1 mHz frequency resolution, ~ 20 min time resolution.
- Specific version for each station pair (because of different latitude, interstation separation, ground conductivity, noise level, etc.).
- All versions running on a central server where data must arrive in quasi-real time.

Automatic FLR inversion (objective 3)

UNIVAQ, ELGI, IGPAS, (NMT)   delivery date: month 24

The inversion algorithm has to convert FLR frequencies into estimates of the equatorial plasma mass density (1.6 < L < 6.7).

Need to consider geomagnetic field geometry (*Tsyganenko, Singer et al., 1981*)
more realistic than dipole geometry; important at high latitudes,
and even at middle latitudes during severe geomagnetic storms.

Realistic plasma distribution models for low latitudes (power law not very good).

All magnetometer stations working in quasi-real-time (objective 4)

ELGI, IGPAS, HMO, UNIVAQ, FMI   delivery date: month 42

Upgrading the DAQ hardware and software to provide real-time accessibility of the data.

Data from each station transferred every 15 min to the central server, where they will be processed to get FLR frequencies and plasma mass densities.

Cross-calibration method for whistlers and FLRs (objective 5)

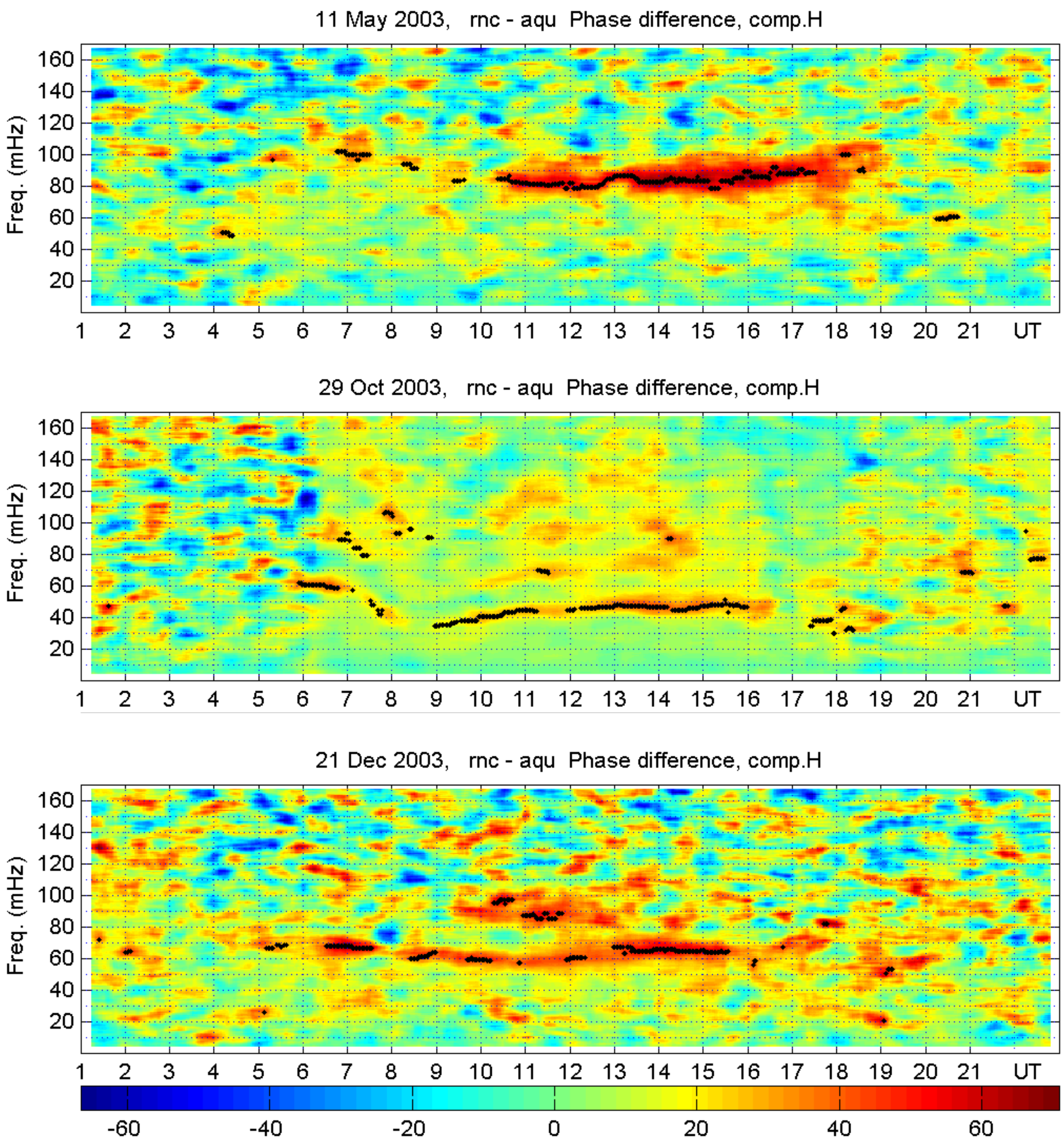
ELGI, UNIVAQ, ELTE, (LANL, NERC-BAS, NMT, UO, HMO, UOULU)   delivery date: month 42

When simultaneously available, plasma mass densities from FLRs and electron densities from whistlers will be cross-correlated (for separate magnetospheric activity conditions), both for validating the two methods, and for obtaining evaluations on the relative abundances of heavy ions.

In addition, comparisons with in-situ satellite measurements (e.g., MPA data from LANL) will be extremely useful for a direct validation.

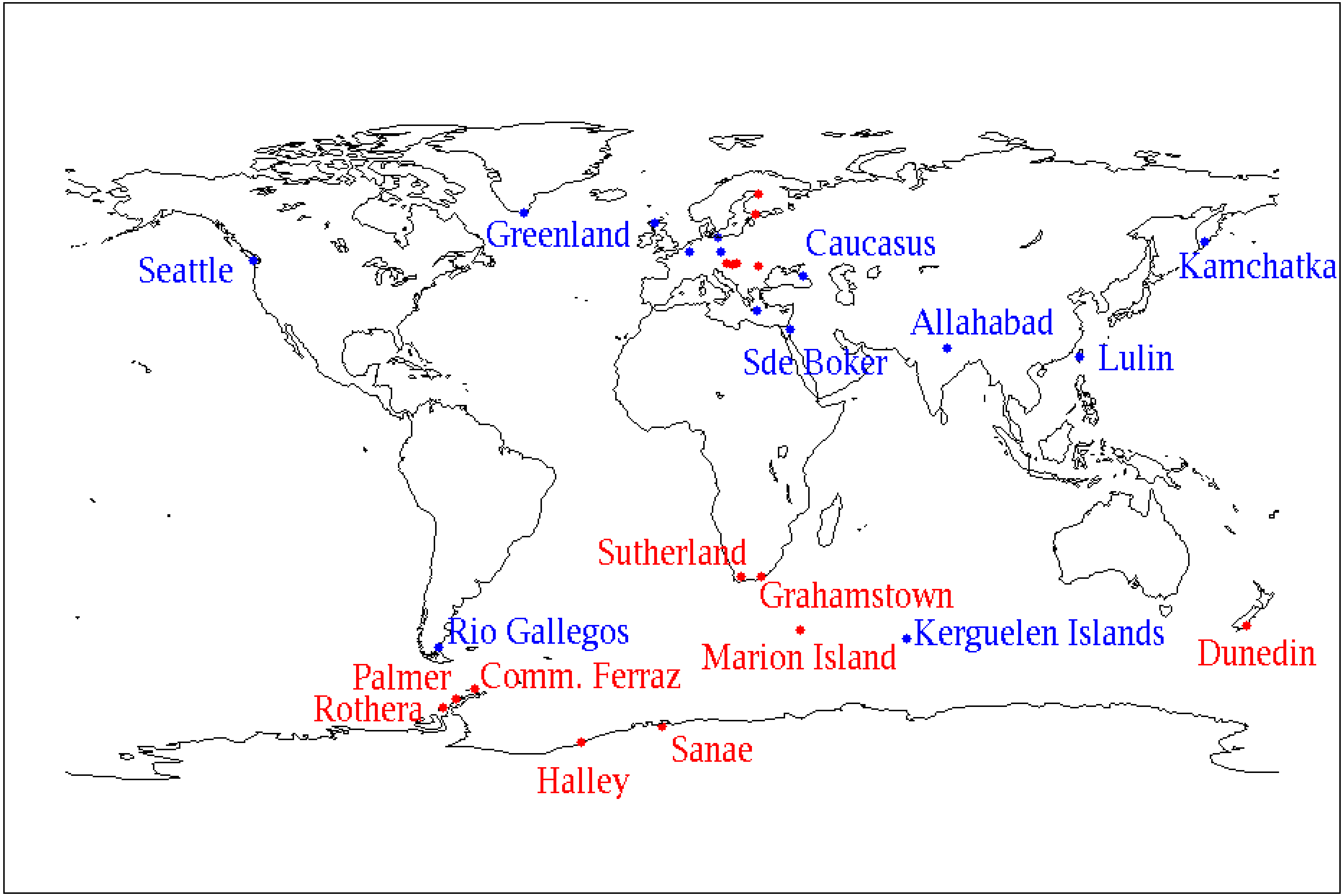
At the end, a procedure has to be developed for weighting the data from the two methods.


Thank you for your attention
Acknowledgments
The research leading to these results has received funding from the European Union Seventh Framework Programme [FP7/2007-2013] under grant agreement n°263218

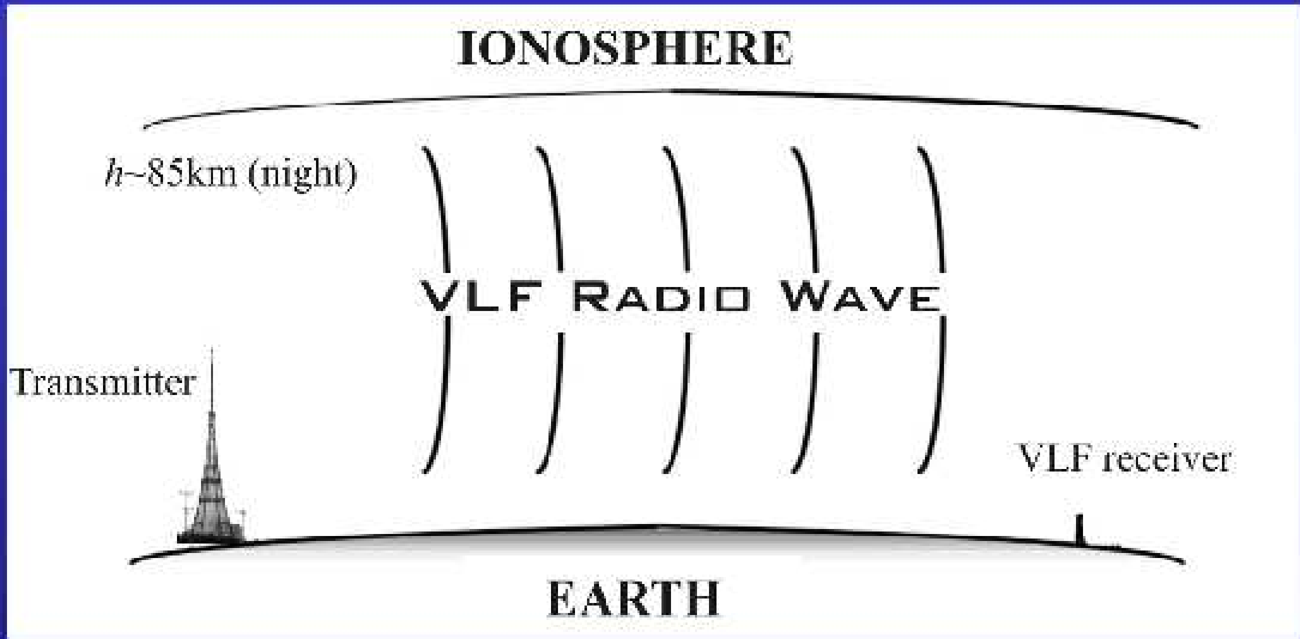


11 May 2003,   rnc - aqu Phase difference, comp.H
29 Oct 2003,   rnc - aqu Phase difference, comp.H
21 Dec 2003,   rnc - aqu Phase difference, comp.H
Freq. (mHz)
20 40 60 80 100 120 140 160
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 UT
-60 -40 -20 0 20 40 60

Network of whistler detectors



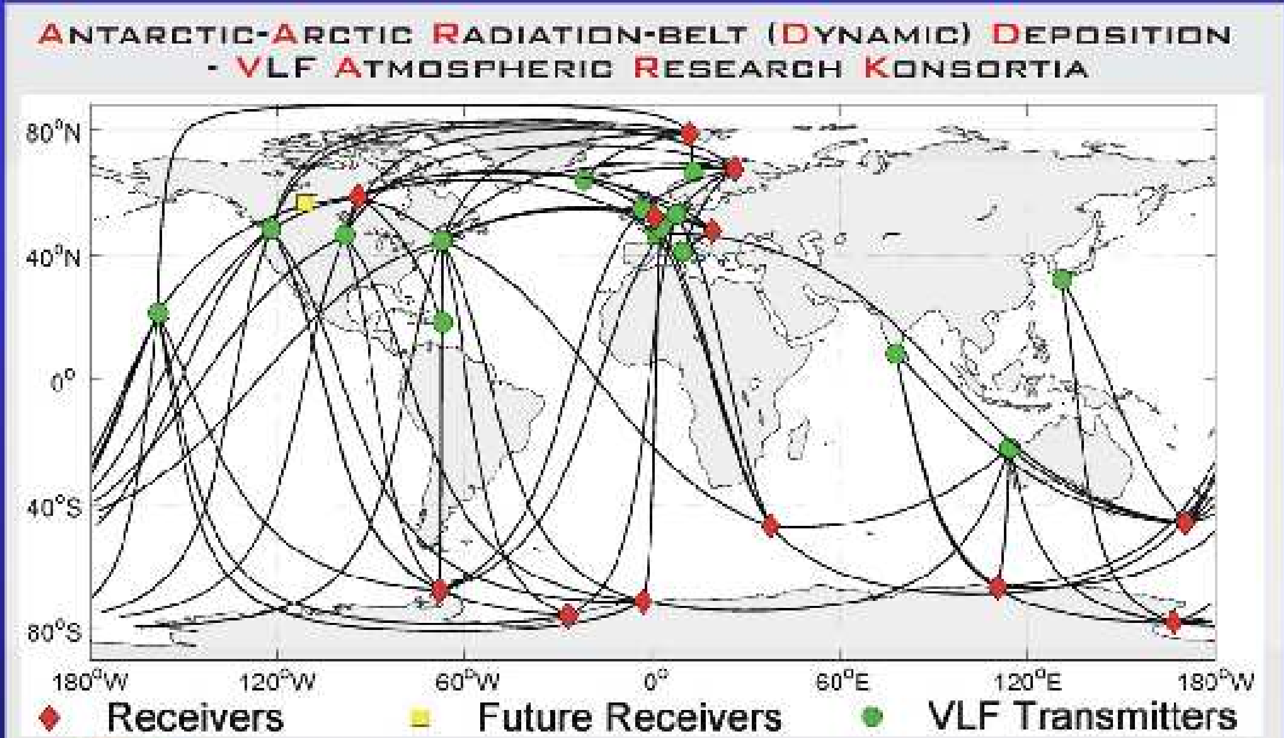
Subionospheric Radio Wave Propagation



Radio transmissions at Very Low Frequencies (VLF) largely trapped between the conducting ground (or sea) and the lower part of the ionosphere (70-90 km) , forming the Earth-ionosphere waveguide.

Changes in the ionosphere causes changes in the received signal. There is very low attenuation in this frequency range, such that transmissions can propagate for many 1000km's - long range sensing of the upper atmosphere!

Our AARDDVARK



UNIVERSITY of OULU

Antarctica New Zealand

UNIVERSITY OF KWAZULU-NATAL

UNIVERSITY of OTAGO NEW ZEALAND

An aarmory of AARDDVARKs. This map shows our existing network of sub-ionospheric energetic precipitation monitors.

MORE INFORMATION: www.physics.otago.ac.nz\space\AARDDVARK_homepage.htm