IAGA Activities in Italy (2007-2008)

IAGA activities in Italy are currently developed by several universities as well as by mayor Scientific Institutions such as Istituto Nazionale di Geofisica e Vulcanologia (INGV), Istituto Nazionale di Astrofisica (INAF) and Consiglio Nazionale delle Ricerche (CNR).

The present document, organized on the basis of IAGA Divisions and Interdisciplinary Commissions, summarizes the principal achievements, the participation to international programs and the most relevant programs in which the Italian Scientific community is involved.

IAGA Community in Italy is organized according to the following scheme:

Italian Delegate: Prof. U. Villante, University of L'Aquila
Vice Delegate: Dr. L. Vigliotti, CNR – Istituto di Scienze Marine (ISMAR), Bologna

Division I: "Internal Magnetic Field" (Coordinator dr. L. Vigliotti – CNR - ISMAR, Bologna)
Division II: "Aeronomic Phenomena" (Coordinator dr. B. Zolesi – INGV - Sez. Roma 2)
Division III: "Magnetospheric Phenomena" (Coordinator dr. G. Consolini – INAF/IFSI , Roma)
Division IV: "Solar Wind and Interplanetary Magnetic Field" (Coordinator dr. R. Bruno – INAF/IFSI, Roma)
Division V: "Geomagnetic Observatories, Surveys, And Analyses" (Coordinator dr. A. Meloni – INGV, Roma)
Interdivisional Commission: "History" (Coordinator dr. A. De Santis – INGV, Roma)

DIVISION I:
"Internal Magnetic Field" (Coord.: L. Vigliotti)

A) Research groups:

The principal Italian groups involved in research activities related with IAGA Division I "Internal Magnetic Field" are:

1. Istituto Nazionale di Geofisica e Vulcanologia, Roma;
2. Department of Physics of the University of Bari;
3. Department of Physics of the University of Camerino;
4. Department of Physics of the University of Genova;
5. Department of Physics of the University of Milano;
6. Department of Physics of the University of Parma
7. Department of Physics of the University of RomaTre;
8. Department of Physics of the University of Torino;
9. Department of Physics of the University of Urbino;
10. Department of Physics of the University of Siena;
11. CNR/ISMAR, Bologna;
12. Istituto di Fisica dello Spazio Interplanetario-INAF, Roma.

B) Scientific Report

During the years 2007-2008 the research carried out in the framework of the IAGA-Division-I (Internal Magnetic Field) concerned several issues within different geophysical and Earth sciences disciplines. Interdisciplinary studies concerning the registration of the Earth magnetic field by rocks and sediments can be grouped into four main subjects:

- Geodynamic reconstructions.
- Magnetic polarity and secular variation record of the magnetic field.
- Magnetic properties of rocks and sediments for environmental, climatic and volcanic reconstructions.
- Magnetic properties of minerals, rocks, atmospheric particulate and ice cores.

The research on geodynamic reconstructions focused on different areas of the Italian peninsula, the Mediterranean region as well as South America and the Iran Plateau. New constraints into the Neogene-Quaternary evolution of the Adria plate have been obtained by paleomagnetic evidence from the Piedmont Tertiary basin, the Calabrian arc and the Apennine.

In the framework of the ESF funded program Euromargins, the project WESTMED (Imaging the WESTern MEDiterranean margins: a key target to understand the interaction between deep and shallow processes) investigated the Tertiary evolution of the western Mediterranean and in particular the Alborán Sea, the Betic Chain and the Gibraltar Arc.

Extraeuropean investigations focused on several regions in South America such as the Ande, the Puna plateau in Northern Argentina and the Tierra del Fuego.

The tectonic evolution of the Northern and Central Iran was investigated in the framework of a multidisciplinary international consortium (MEBE, Middle East Basin Evolution) with the aim to search for the remnants of the Paleothethys.

Magnetostratigraphic studies were carried out on several time intervals: Triassic, Cretaceous, Miocene, Upper Pliocene and Pleistocene. The studied sections belong to sedimentary sequences from the Alps, the Apennines and Bethic Chain, as well as from marine cores collected in the Mediterranean Sea, in the Svalbard islands and the peri-Antartic basins. The latter allow the development of a precise chronology of the climatic history in the Antactic continent. Two COFIN Projects focused to a detailed dating of the events related to the Messinian Salinity Crisis (Origin, chronology and distribution of salty deposits in the basin of the central Mediterranean (Sicily, Calabrian and Tuscany): large scale implications for the Messinian salinity crisis) and for the definition of the Burdigalian and Langhian stratotypes (Searching for the Global Stratotype Sections and Points (GSSPs) for the Burdigalian and Langhian stages and paleoceanographic implications).

The variations of the Earth magnetic field during the whole Brunhes Chron were reconstructed from a core collected in the Wilkes Basin (Antarctica).

High resolution datings of sedimentary sequences of Holocene age were obtained by using the secular variations of the Earth magnetic field recorded by several cores collected in the Adriatic Sea, Sardinia Channel, Sicily as well as boreholes in southern Apennine and even in trenches escavated at Piano delle Pecore and at Boca do Rio in Algarve (Portugal). Research concerning the secular variations of the magnetic field were also developed as consulting activity for Archeological departments and local agency.

Paleomagnetic analysis were also applied to volcanological risk assessment. Several works concentrated on projects funded by the Civil Protection trought the INGV on selected areas interested by these risks such as Vulcano, Stromboli, Panarea, Vesuvius. The studies concern the reconstructions of the emplacement mechanisms and flux directions of pyroclastic deposits as well as the emplacement temperatures and the estimations of physical parameters of historical eruptions. Studied areas include volcanoes even outside the Italian region: Vesuvio, Vulcano, Stromboli, Teide (Canary Island), El Chichón (Mexico), Cerro Galan (Argentina).

The environmental magnetism approach was applied on different sedimentary sequences from the Italian peninsula, Iberia as well as Antactica. The latter was investigated in the framework of the international project ANDRILL (ANtarctic geological DRILLing), aimed at reconstructing the climatic history of the Antarctic continent during the Cenozoic.

In the framework of the European project Promess-1 a detailed study has been carried out on the sediments retrieved from two complementary boreholes (PRAD1-2 e PRAD2-4) drilled in Central Adriatic spanning the last four glacial-interglacial cycles. The results show the strong relationships between magnetic parameters and anoxic intervals related to the insolation (sapropel layers).

Rock-Magnetic measurements were also performed on ice cores belonging to the EPICA Project in Antarctica and from cores drilled in Greenland. New techniques based on the superparamagnetic properties were developed to identify microparticles of meteoritic origin.

Magnetic properties of atmospheric dust, collected in urban areas and particularly in the city of Rome, were used for an estimation of the anthropogenic contribution in atmospheric pollution of highly populated areas.

Magnetic properties of soils and sediments coupled with other geophysical investigations in the area of the claimed meteoritic crater of the Sirente lake (Abruzzo) demonstrated that a different hypothesis is responsible for the observed structure.

The magnetic properties of iron sulphurs such as Greigite and Pyrrothite were summarized by the publication of a review concerning also the magnetic characteristics of non-ordinary condritic meteorites and acondrites.

In 2008 the paleomagnetic laboratory of INGV Rome was seated as a member of the steering committee of an international conference on rock magnetism (Understanding the Earth's Magnetic Field, Magnetic Materials, and the Origin of Magnetism: Assessing the State of Art and Celebrating the Career of Subir Banerjee. Cargese, Corsica June 2-7).

Research Projects

ANDRILL (ANtarctic geological DRILLing) is a multinational collaboration comprised of more than 200 scientists, students, and educators from five nations (Germany, Italy, New Zealand, the United Kingdom and the United States) to recover stratigraphic records from the Antarctic margin using Cape Roberts Project (CRP) technology.

WESTMED "Imaging the western Mediterranean margins: a key target to understand the interaction between deep and shallow processes". (EUROMARGIN, ESF):

PROMESS-1 PROfiles across MEditerranean Sedimentary Systems (EC Project), V European frame program.

PRIN (MIUR) Origin, chronology and distribution of salty deposits in the basin of the central Mediterranean (Sicily, Calabrian and Tuscany): large scale implications for the Messinian salinity crisis.

COFIN (MIUR) Searching for the Global Stratotype Sections and Points (GSSPs) for the Burdigalian and Langhian stages and paleoceanographic implications.

NEAREST Integrated observations from NEAR shore sourcES of Tsunamis: towards an early warning system, VI European Frame program.
Bilateral program Italy-Spain, MIUR - Ministerio de Educación y Ciencia
Programma Nazionale Ricerca in Antartide (PNRA) e German Antarctic North Victoria Land Expedition (GANOVEX)

MEBE Middle East Basin Evolution

Other projects have been developed in cooperation with:
Bari University
Centre des Faibles Radioactivités di Gif-sur-Yvette, CNRS-CEA, France
Department of the Civil Protection/INGV
FIRB Air Plane, Multidisciplinary Research Platform on earthquakes and volcanoes
Instituto Geografico Nacional di Madrid
Universidad Nacional Autonoma de Mexico
Australian Research Council (The eruption, emplacement and characteristics of extremely large volume pyroclastic flow deposits (Ignimbrites)

C) Future Projects and Programs.

In the years 2009-2010 most of the studies will continue to complete the research described in the scientific activity. In the framework of the international drilling project ANDRILL it will be published the outstanding results obtained during the two drilling seasons. The Paleomagnetic Laboratory of the INGV is involved in this project as one of the principal investigators (referent structure) together the University of California at Davis (USA) and the University of Otago (New Zealand). The continuation of the drilling is still under revision after the identification of new possible sites (Coulman High, MacKay Valley and Offshore New Harbor).

Results that should be also published include the paleomagnetic data from the DSDP 268 (Knox Coast Wilkes Land) and 269 (south-eastern margin of the Indian abyssal plain), always in Antarctica and the results from PRAD1-2 (Project Promess-1) in the Adriatic Sea. The former studies belong to projects (SEDCLIM e ANISPAL) funded by the Istituto Andaluz de Ciencias de la Terra (Granada, Spain).

Several researches should be completed especially concerning the geodynamics of the Mediterranean region and the Alpine chains. Final results are expected to define the evolution of the calabrian block during the last 5 Ma and the paleogeographic reconstruction of different areas of the Iranian mountains (Project MEBE, Middle East Basin Evolution). The research on the development of arcuated chains will continue in different areas of South America (Colombia, Bolivia, Patagonia) including also new investigations in the Caraibic plate.

Magnetostratigraphic investigations will continue on several sections belonging to different regions of the mediterranen region. The research includes:

- The lower Miocene interval (Burdigalian-Langhian) that outcrops at Conero, Sicily and Malta
- The Paleogene found in the Venetian Alps, in the Iberian peninsula and in Bulgaria;
- Mesozoic intervals exposed in sections of the Umbro-Marche Apennine

Furthermore the research will include integrated magnetostratigraphy on several marine cores of Holocenic and Pleistocenic age retrived in the Mediterranean region and in polar areas (Antarctic margins and Svalbard Island).

Studies concerning the secular variation of the earth magnetic field in Italy show a significant increase in the last few years and it is possible that a reference curve (master curve) for the central mediterranean region will be available in the next few years.

Paleomagnetic studies of volcanic products from Stromboli and Pantelleria will continue in order to constrain the timing the the volcanic events and to estimate the possible risk related to these volcanoes. Additional work about the emplacement temperatures of pyroclastic deposits from campanian area are expected together new magnetic data from the Campanian Ignimbrite.

Further research will be developed about the magnetic properties of ultrafine atmospheric dust in order to improve the application of the magnetic parameters to the analysis of the air pollution and to characterize the atmospheric particulate.

In 2010 the CNR will be involved in the study of the Lake Van (East Turkey) within the Paleovan project, a scientific drilling funded by the ICDP.

DIVISION II:
"Aeronomic Phenomena" (Coord.: B. Zolesi)

A) Research groups:

The principal Italian groups involved in research activities related with IAGA Division II "Aeronomic Phenomena" are:

1. Istituto Nazionale di Geofisica e Vulcanologia , Roma
2. Consiglio Nazionale delle Ricerche, Firenze
3. International Centre for Theoretical Physics, Trieste

1) **Istituto Nazionale di Geofisica e Vulcanologia, Roma**

Theoretical studies and systematic observations of the terrestrial ionosphere have been performed since 1936, year of foundation of the former Istituto Nazionale di Geofisica by Guglielmo Marconi. Presently, ionospheric vertical soundings are performed in two ionospheric observatories in Italy, Rome (41.8° N, 12.5° E) and Gibilmanna (37.9° N, 14.0° E), and one in the italian antarctic base M. Zucchelli. Considerable cooperation has been activated with the Argentinian colleagues to install and operate the Italian ionospheric station AIS in Tucuman (26.9° S, 294.6° E), Argentina. Regular ionospheric oblique soundings have been performed starting in November 2003 over radio link Inskip, UK (53.50°N; 2.5°W) , Rome, Italy (41.8°N; 12.5°E) and over the radio link Inskip, UK (53.50°N; 2.5°W) and Chania, Crete, Greece (35.70 N, 24.00 E) since April 2005.

In the last years, due to the growing interest in real time ionospheric mapping and short term previsions, the need for immediate availability of good scaled data became more and more important. For this reason, together with the ionosonde, the INGV developed a computer program, called Autoscala, for the automatic scaling of critical frequency fo*F*2 and MUF(3000)*F*2 from ionograms. The main characteristic of Autoscala is that it is based on image recognition technique, and it can run without using information on polarization. Thanks to these characteristics, Autoscala can be applied to any kind of ionosonde.
Autoscala was extended with the addition of a routine for the automatic scaling of the sporadic-*E* layer and a routine for the *F* layer . The Autoscala software has been also expanded including a routine for the real time computation of the electron density profile, which is essential for ionospheric monitoring and space weather applications. This routine has a structure designed to limit time calculation and it works adjusting the parameters of a model according to the recorded ionogram trace. To date Autoscala is applied on the ionograms recorded by the AIS-INGV installed at Rome (41.8° N, 12.5° E), Gibilmanna (37.9° N, 14.0° E), in Italy, and Tucumán (26.9° S, 294.6° E), in Argentina, and on the ionograms recorded by the VISRC2 ionosonde installed at Warsaw (52.2° N, 21.1° E), in Poland, and by the AIS-Parus ionosonde installed at Moscow (55.5° N, 37.3° E), in Russia.

A network of GPS high rate sampling measurements, taken at 50 Hz, to investigate and the ionospheric irregularities causing scintillation, a scattering effect on the trans-ionospheric signals transmitted by GNSS satellites, has been installed in Arctic region (Svalbard Islands) and Antarctic. The experimental observations can provide information on the temporal and spatial evolution of irregularities of scale size ranging from hundreds of meters to few kilometers, typically embedded into bigger regions, commonly called patches. The understanding of the patchy ionosphere can be achieved with 3D plus time tomography reconstruction and through a proper modeling. INGV works on the original development of scintillation models; on the climatology of scintillations through the statistical analysis of the measurements acquired almost continuously during the last 6 years over both the poles; collaborate to the development of the ionospheric imaging over high latitude regions. INGV is also working on another important issue for the understanding of the long-term variation of the ionosphere: the investigation of upper atmosphere secular trends, eventually connected to anthropogenic effects (greenhouse effect) and/or natural causes (next excursion or inversion of the geomagnetic field).

Solar events have been studied using the characteristics of CMEs measured with SoHO/LASCO coronagraphs and the temporal evolution of solar energetic protons in different energy ranges measured by GOES 11 spacecraft. The analysis of these effects demonstrates that they are observed on the Earth's surface not only as ionospheric absorption of radio waves and as intense geomagnetic activity, but also as significant variations of cosmic ray modulation, even at high energies.

A critical analysis of recent publications devoted to the NmF2 pre-storm enhancements is performed. There are no convincing arguments that the observed cases of NmF2 enhancements at middle and sub-auroral latitudes bear a relation to the following magnetic storms. In all cases considered the NmF2 pre-storm enhancements were due to previous geomagnetic storms, moderate auroral activity or they presented the class of positive quiet time events (Q-disturbances). Recent studies conclude that there is no such an effect as the pre-storm NmF2 enhancement as a phenomenon inalienably related to the following magnetic storm.

The role of the effective solar R12eff as a filter mechanism to correct the results given by Simplified Ionospheric Regional Model (SIRM) under the real-time conditions was examined. It was demonstrated that there is a large variability in time and space even in the restricted European area. To overcome the consequences of such R12eff dispersion in regional mapping and modelling, a hybrid hR12eff has been introduced and applied to improve the performance of SIRMUP.

Different models on ionospheric forecasting have been recently developed and improved as the foF2 forecasting local model, ap(τ) model, based on foF2 hourly values and on a modified planetary geomagnetic index ap and the forecasting empirical local model over Rome (IFELMOR) able to predict the state of the critical frequency of the F2 layer during geomagnetic storms and disturbed ionospheric conditions.

Moreover the performances of now casting models (SIRMUP&LKW e ISWIRM&LKW) to predict the maximum usable frequency (MUF) for a given radio link have been tested using measurements from oblique radio soundings performed over the radio link Inskip-Rome.

Ray tracing technique based of TOF (Time of Flight) and DOA (Direction of Arrival), have been tested by using measurements collected over the radio link between Uppsala – Bruntingthorpe .

2) **Consiglio Nazionale delle Ricerche, Firenze**

Objective of CNR team activity is the study of the variability of the ionosphere and of its interactions both with the near-Earth space (Space Weather) and with the inner parts of the Earth's environment (atmosphere and lithosphere). This work is two-folded: on the one hand the long lasting experience in experimental work and data analysis gives us the skill to work on our time series of data as well as to analysis the available worldwide data, mainly derived from GNSS. On the other hand theoretical effort has been put into understanding the dynamics of small scale irregularities producing radio scintillation, and the role of complexity in the Sun-Earth interaction.

3) International Centre for Theoretical Physics, Trieste

The research activity of this group is oriented to the ionospheric modeling and data ingestion and assimilation to be applied to an original model for the electron density profile. Schools, courses and training activity is the aim of ICTP and of this group. In detail a new version of the 3D and time dependent NeQuick model of ionospheric electron density has been developed. The model is used to simulate ionospheric effects on GNSS operations and it has been adopted as the ionospheric corrections model for the European GALILEO satellite navigation system. The improved topside of the new version of NeQuick has been adopted as the default option for the IRI model of electron density. Research activities related to the IRI model and to the low latitudes ionosphere has been carried out in collaboration with groups of Argentina, Nigeria and Cote d'Ivoire. The investigation about the detection technique and the behavior of ionospheric low latitude bubbles in collaboration with a group of the Universidad Complutense of Madrid, Spain, has continued. Research efforts are now devoted mostly to 3D and time specification of the electron density in the ionosphere using experimental data ingestion. In addition, a new research topic has been initiated using radio occultation techniques to determine the electron density distribution in the ionosphere.

B) **Main scientific themes: Ionospheric Physics and Radio propagation**

Ionospheric measurements and ionospheric monitoring is an important task of the italian ionospheric teams since 1936. Ionospheric vertical and oblique soundings have been performed as routine activity or as special campaigns in Italy, in the mediterranean area and in the polar regions. Applied studies to the ionogram autoscaling have been improved for real time management of the ionospheric results. Moreover the irregularities, causing scintillation, a scattering effect on the trans-ionospheric signals transmitted by GNSS satellites, are recently monitored by a network of GPS receivers in the polar regions. Then all the Italian ionospheric teams are active in theoretical studies on the morphology of the ionosphere , its variability and its interactions both with the near-Earth space and with the inner parts of the Earth's environment, the temporal and spatial evolution of irregularities, the long-term variation of the ionosphere; also active on ionospheric modeling and mapping introducing a new hybrid solar index activity hR12eff and developing a local model for foF2 forecasting based on a modified planetary geomagnetic index ap. Finally tests on now casting models as well ray tracing technique and data ingestion and assimilation methods have been performed in the last 3 years.

C) Projects

EURIPOS: European Research Network of Ionospheric and Plasmaspheric Observation Systems, EURIPOS project aims to provide a wider and more efficient access to and use of the ground based ionospheric sounders and the Global Navigation Satellite Systems (GNSS) receivers existing in different European countries and to coordinate and optimize their operation and evolution and their interaction with their users. Proposal to be submitted to FP7.

DIAS: European Digital Upper Atmosphere Server, A European service for the specification and the prediction of the state of the ionosphere, funded by the *eContent* programme of the European Commission .

GIFINT (Geomagnetic Indices Forecasting and Ionospheric Nowcasting Tools), Pilot project of Space weather promoted and financed by European Space Agency ESA.

Mediterranean Ionospheric regional Tomography: an international project aiming to determine in real time the ionization over the Mediterranean area.

Rosa: a joint Italian-Indian project lead by ASI (Italian Space Agency) devoted to the production of the software for managing an occultation receiver space-born on the Oceansat-2 satellite and analysing its data.

COST Action 296: MIERS: Mitigation of Ionospheric Effects on Radio Systems, a four years European-international action devoted to study the mitigation of the ionospheric effects on radio systems.

COST Action ES0803: **Developing space weather products and services in Europe;** a four years European-international action devoted to study and spread results of Space Weather research.

ICESTAR/IHY (Interhemispheric Conjugacy in Geospace Phenomena and their Heliospheric Drivers), funded by SCAR, *Experimental investigation to relate the presence of polar cap ionospheric features to HF signalling characteristics,* endorsed by ARCFAC V (European Centre for Arctic Environmental Research).

Ionospheric scintillation monitoring and forecasting in Northern Europe, endorsed by Royal Society (UK).

A proposal "Original and Novel Solutions to Counter GNSS Ionospheric Scintillation Effects" is in preparation to be submitted to Royal Society (UK) with the aim to tackle GNSS ionospheric scintillations by forecasting and mitigating their effects.

A proposal has been submitted to FP7-GALILEO-2008.4.3.1 *CIGALA (Concept for Ionospheric-Scintillation Mitigation for Professional GNSS in Latin America)* with the scope to develop mitigation

algorithms to be implemented in the next generation of GNSS receivers with particular attention for GALILEO system.

A proposal “Dynamics of the near-Earth plasma during the Solar Maximum” has been submitted to FIRB-PROGRAMMA "FUTURO IN RICERCA", issued by the Italian Ministry of Education, University and Research, to investigate the ionospheric irregularity at middle-low latitude under the next foreseen Solar maximum conditions.

Division III:
“Magnetospheric Phenomena” (Coord.: G. Consolini)

A) Research Groups

The Italian scientists/groups involved in research activities related with the IAGA Div. III themes “Magnetospheric Phenomena” are from some Universities and research institutions (INAF, INGV), in detail:

Department of Physics of the University of L’Aquila,
Department of Physics of the University of Calabria,
Department of Physics of the University of Roma “Tor Vergata”,
Department of Physics of the Third University of Roma,
Istituto di Fisica dello Spazio Interplanetario-Roma of the Istituto Nazionale di Astrofisica, Roma,
Osservatorio Astrofisica di Arcetri of the Istituto Nazionale di Astrofisica, Arcetri (Firenze)
Istituto Nazionale di Geofisica e Vulcanologia.

B) Scientific Report

The study of magnetospheric phenomena in Italy is principally focused on the investigation of the interaction between the interplanetary solar wind and the planetary magnetospheres (mainly the Earth’s magnetosphere), of the Earth’s magnetospheric dynamics, of the processes responsible for the plasma transport in the magnetospheric regions, and of the Earth’s magnetosphere-ionosphere coupling. Among the different physical processes occurring in the magnetospheric environments a special attention is put 1) on the investigation of the microphysics and of the macroscopic effects of the magnetic reconnection processes, 2) on the study of the role that turbulence and nonlinear phenomena plays in plasma transport both across the boundary magnetospheric regions and in the central plasma sheet, 3) on the overall magnetosphere-ionosphere large scale plasma convection, on the observation of auroral displays in polar regions, 4) on the characterization of the overall magnetospheric dynamics (via the observation of ULF waves in the magnetosphere and the study of geomagnetic indices) during magnetospheric substorms and storms in response to solar wind changes.

In what follows a resume of the main contribution of the Italian groups to the above themes is reported. These reported results are documented in the publication list.

a) In the framework of the studies related to the interaction of solar wind with magnetized planetary bodies the principal activity is devoted to the detection of energetic neutral atoms with a special emphasis to the future ESA-JAXA Bepi-Colombo mission to Mercury.

b) The studies on magnetic reconnection mainly focused on the investigation of the features of this phenomenon at the Earth’s magnetopause by means of the observations of the ESA Cluster II and ESA/CSNA Double Star space missions. In particular a relevant result was a statistical study on the occurrence of reconnection at low-latitude magnetopause for different conditions of the solar wind and interplanetary magnetic field, supporting the validity of the “component model”. Moreover, a fractal version

of the Sweet-Parker magnetic reconnection model, able to overcome the limited reconnection rate, has been proposed to include the effects of turbulence and complexity.

c) The investigation of the role of turbulence and nonlinear processes in magnetospheric phenomena has mainly focused on the transport of ions across the Earth's magnetopause in presence of magnetic turbulence, on the comparative study of magnetic turbulence in the various regions of the Earth's magnetosphere, on the interaction of large scale zonal flows and drift-Alfven turbulence in the ionosphere, on the modeling of strong magnetic turbulence in terms of nonlinear vortices, on the numerical study of particle acceleration in the Earth's magnetotail, both by means of electromagnetic fluctuations and by means of the cross tail electric field, and on the scaling of the Kolmogorov-Sinai entropy in the presence of magnetic turbulence in the percolation regime. These studies have shown that magnetic turbulence has a strong influence on both plasma and energetic particles in the magnetospheric environment, and that turbulence can also be an efficient particle accelerator in the geomagnetic tail.

d) The study of the overall magnetospheric dynamics has been carried out by different approaches, dealing with the investigation of the magnetospheric response to solar wind changes by means of geomagnetic indices and with the observations of ULF waves in the magnetosphere. The analysis of the overall magnetospheric dynamics in response to solar wind changes and features by means of geomagnetic indices evidenced that magnetospheric activity is analogous to that of a nonequilibrium system near a stationary state, that the impulsive character of the magnetospheric high-latitude substorms can be treated in the more general framework of extreme event statistics, and that solar wind Alfvénic turbulence can be geo-effective.
The study of SI (Sudden Impulses) in the magnetosphere allowed to discriminate between the role of the magnetospheric and ionospheric current systems. A worldwide study of the SFE (Solar Flare Effect) preceding the October 29, 2003 Halloween Superstorm evidenced that the different phases of a SFE (and associated currents) depend on the flux of the X and UV solar radiation.
Furthermore, extension of the previous study of the Pc5 pulsations of the geomagnetic field at discrete frequencies in the solar wind, magnetosphere and on the ground has been performed using also data from two meridional magnetometers arrays, in Europe and in North America. The principal results of these studies have been to show that such fluctuations, observed in the interplanetary space, can be amplified in the magnetosphere by cavity and field line resonance processes. A theoretical study demonstrated the possible existence of surface wave global modes of the outer magnetosphere at discrete frequencies as low as 1-4 mHz with characteristics similar to those of field line resonances. An analysis of SEGMA measurements during the campaign May 31-June 14, 2007 (IHY/CIP 57) revealed a close correspondence between solar wind pressure fluctuations and ULF activity. In the framework of a co-operation with the Key Laboratory for Space Weather/CSSAR, Beijing (China) has been carried out an analysis of the characteristics of Pi2 geomagnetic pulsations excited by "bursty bulk flows" (BBF) in the plasma sheet of the geomagnetic tail. From a statistical study of the polarization of low and mid frequency pulsations at Terra Nova Bay it has been proposed a model for interpreting the diurnal and latitudinal pattern of the field line resonance region at high latitudes. The identification of the pulsation sources in the polar cap at different latitudes has been conducted through a comparison between measurements at Terra Nova Bay (80°S) and Dome C (89°S). ULF field line resonance frequencies (fR) of three different magnetic shells (L = 1.61, 1.71, 1.83) have been monitored during a 4-year period (2001–2004) using a cross-phase analysis of magnetic measurements recorded at SEGMA. This study reveals that the variations of the daily averages of fR, follow the variations of the daily values of the 10.7-cm solar radio flux F10.7 with an estimated time delay of 1–2 days. This result implies that changes of the ionization rate in the ionosphere, due to changes of the solar radiation, influence the whole distribution of the plasma density along the plasmaspheric field lines.
Always dealing with the overall magnetospheric dynamics, in the framework of the project GIFINT (Geomagnetic Indices Forecasting and Ionospheric Nowcasting Tools) firstly funded by ESA and successively by the Italian Space Agency some tools based on the Artificial Neural Networks were developed to forecast the Dst and AE geomagnetic indices with 1 hour ahead using only interplanetary magnetic field data at L1 (ACE Solar wind data). The service is currently available at http://gifint.ifsi-roma.inaf.it.

e) Dealing with the investigation of the magnetospheric/ionospheric coupling the effects of the solar wind pressure pulses on the high-latitude ionosphere has been investigated by the SuperDARN backscatter echoes. The Italian community is indeed involved in the SuperDARN Network by a French-Italian co-operation (LPCE-CNRS and IFSI-Roma/INAF) to run the radar of the Kerguelen island (Southern

hemisphere) and to install two radars in the French-Italian Dome C Antarctica Station. Other relevant results concerned the evidence of simultaneous reconnection at the North and South magnetotail lobes for northward IMF, the signatures, at the high latitude regions, of particular configuration of magnetopause reconnection when the IMF is mostly along the dawn dusk direction, the dynamics of the Auroral Oval in response of different kinds of solar wind perturbations, the study of ionospheric effects of Kelvin-Helmoltz instability at the magnetopause and statistical comparison between SuperDARN echo occurrence and GPS scintillation.

On the experimental side, geomagnetic measurements have been routinely conducted at SEGMA (South European GeoMagnetic Array, in cooperation with the Space Research Institute of Graz, Austria; http://sole-terra.aquila.infn.it/staz_segma.asp) and in Antarctica (Mario Zucchelli Station at Terra Nova Bay). Always related to Antarctica, some experimental work has been done to improve the instrumentation devoted to the auroral observations at "Mazio Zucchelli" Station (Terra Nova Bay). Furthermore, activities connected to the participation in some experiments of the next ESA-JAXA Bepi Colombo mission to Mercury have been done.

The above scientific themes fall in the objectives of several international and national programs (SuperDARN Network, SEGMA, COST Action 724, Cost ES0803, IHY, INTAS, ESS-ASI) and of several past and future international space missions (Cluster, Double Star, Bepi Colombo, Europa-Juppiter System Mission, Cross-Scale) in which the Italian community is involved.
The activity of the Italian groups is mainly funded by specific programs of the Italian Space Agency (ASI), of the Italian National Program for Antarctica Research (PNRA), of the European Space Agency (ESA), of the International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union (INTAS), and in the framework of the European Co-operation in the field of Scientific and Technical Research (COST Actions).

Apart from the above research activities, the Italian community has been also involved in some educational and outreach activities such as those related with the International School of Space Science, directed by U. Villante [("Magnetospheric Dynamics", 9-15 April 2007, directed by P. Francia (Univ. of L'Aquila) and E. Amata (INAF-IFSI); "Turbulence and Waves in Space Plasmas" (9-14 September 2007), directed by M. Vellante (Univ. of L'Aquila), R. Bruno (INAF-IFSI), V. Carbone (Univ. of Calabria) and R. L. Lysak (Univ. of Minnesota) and the International Heliophysical Year exhibition ("In the Fire of the Sun", 10-29 April 2008, Castello Cinquecentesco, L'Aquila).

C) Future Projects and Programs.

The main programs of the next two years are devoted to the continuation of the previous research activity based on the analysis of data collected by the space missions (Cluster, Double Star) and ground based geomagnetic observatories, on theoretical and modelling developments. Particular attention will be devoted to the following aspects:
a) the importance of the reconnection between the magnetopause field and the interplanetary magnetic field;
b) the effects of non-Gaussian transport, turbulence and nonlinear phenomena in local as well as global magnetospheric dynamics;
c) particle transport in the inner magnetosphere and ring current formation;
d) the discrimination of the influence of the magnetospheric and ionospheric current systems in the manifestation of sudden impulses of the magnetospheric and ground field;
e) for major solar/interplanetary events, the analysis of the direct consequences of the solar flares, focusing attention on the relationships among features of the geomagnetic variations (onset, amplitude and duration), those of the EUV and x-ray radiation flux and the onset/intensification of ionospheric currents;
f) the generation and propagation mechanisms of ULF waves (1 mHz-1 Hz) in the magnetosphere
g) the remote sensing of the plasma mass density in the plasmasphere through determination of the resonance frequency of geomagnetic field lines

On the side of experimental activities the following activities will be developed
1. extension of SEGMA (South European GeoMagnetic Array) with a new geomagnetic station at higher latitudes (L > 2) in order to obtain a closer connection to European subauroral arrays;

2. upgrading of the ground-based instrumentation in Antarctica. Installation of two SuperDARN radars at Dome C;
3. continuation in the participation to the activities related with some experiments (SERENA, MEA-MMO, SIXS-MPO) of the next ESA-JAXA Bepi Colombo mission to Mercury;
4. participation to the future magnetospheric missions in the framework of the ESA-Cosmic Vision program (Europa-Juppiter System Mission, Cross-Scale).

Division IV:
"Solar Wind and Interplanetary Magnetic Field" (Coord.: R. Bruno)

A) Research Groups

Main goals of this division is to study the solar wind in its various aspects, from its generation low in the corona throughout its expansion into the heliosphere in order to gain a global view of the governing processes.
In Italy there are several groups working on this subject, sometimes in a synergistic way. Part of these groups belong to Universities, others are represented by Observatories and Institutes belonging to the National Institute for Astrophysics (INAF), others belong to National Institute for Geophysics and Vulcanolgy (INGV).
These groups are located, from north to south, at:

INAF - Osservatorio Astronomico di Torino,
INAF - Osservatorio Astrofisico di Arcetri, Firenze
Dip. di Astronomia e Scienza dello Spazio, Università di Firenze,
Dip. di Fisica, Università di Roma Tor Vergata, Roma
Dip. di Fisica, Università di L'Aquila,
INGV - Istituto Nazionale di Geofisica e Vulcanologia, Roma
INAF - Istituto Fisica Spazio Interplanetario, Roma
INAF - Osservatorio Astronomico di Roma,
Dip. di Fisica, Università della Calabria, Rende
Dip. di Fisica e Astronomia, Università di Catania,
INAF - Osservatorio Astrofisico di Catania.

B) Scientific Report

The main research themes are:

- On solar chromosphere dynamics as relevant to account for the origin of the fast solar wind;
- On active region formation and evolution which is at the basis of the emergence of flux tubes in the solar atmosphere and their interaction with the surrounding environment;
- On flares and eruptive prominences to understand the physical processes occurring immediately before and during flares;
- On triggers of Coronal Mass Ejections with particular emphasis on the role of magnetic helicity transport and accumulation in CME initiation;
- On Coronal Mass Ejection and their relation to local magnetic topology at the source regions with a special interest on the properties of the Current Sheets, that, according to many models, are predicted to form between the flare loops and the CME bubble;
- On the energy cascade along the turbulence spectrum and the heating rate in the solar wind;
- On the origin of coherent and magnetically dominated structures advected by the wind and their role in wind turbulence;
- On anomalous scaling of fluctuations and the related problem of Intermittency;
- On solar cycle modulation of solar wind fluctuations and heliolatitudinal dependence;

- On the search for links between coronal plasma density features observed by remote sensing and in-situ observation by s/c;
- On the effects of solar wind turbulence on geomagnetic activity;
- On IMF influence on ionospheric scintillations at mid-high latitudes.

The activity for the next two years will mainly follow the lines reported above with particular emphasis on the following topics:

- chromosphere dynamics observations at the main solar telescopes, in particular at the DST/NSO telescope with IBIS
- multi-wavelength observational campaigns in order to study the details of the emergence of magnetic flux tubes in the solar atmosphere
- multi-wavelength – multi-instrument study of flares and erupting prominences
- modelling approach to the study of the initiation mechanisms in CMEs and validation by STEREO mission data analysis
- use of different techniques to study magnetic helicity transport in corona
- study of the ionospheric irregularity at middle-low latitude under the next Solar maximum conditions
- use of radio science to highlight the connections between CSs revealed by radio techniques and CSs detected in UV data in connection with CME's events
- solar wind plasma heating rate by turbulence including compressive effects;
- identification and characterization of advected flux-tubes using magnetic helicity studies based on new numerical techniques;
- study of the high frequency termination of turbulence spectrum, beyond the ion-cyclotron frequency

In addition, some of the above groups are also involved in national/international experimental programmes. Their activity within the next two year will focus on:

- IBIS and EST projects: analysis and restoring of solar images, EST Heat Stop design, EST-MCAO design and simulation, EST Broad Band Imager design, EST Data Acquisition and Control study;
- The design and development of an Italian Solar Satellite (ADAHELI) for photosphere/chromosphere studies (if the project will be funded by Italian Space Agency for phase B study).
- Development of new electrostatic deflectors for space use through numerical studies and, if adequately funded, realization of new prototypes for possible use on Solar Orbiter and Cross-Scale missions;
- Development of numerical studies on compressive algorithms and moments calculation
- Activity (if funded) related to space plasma experiments at the IFSI-Large Plasma Chamber (e.g. turbulence generation/damping and characterization).

Funds
All the above activities have been totally or partially funded by:
European Commission within the FP7, FP6 framework, PRIN-INAF, Italian Space Agency (ASI), European Centre for Arctic Environmental Research, Royal Society (UK)

1. Dipartimento di Fisica, Università di Roma Tor Vergata

Scientific report
The evolution of solar surface activity controls the outer structure of the Sun's atmosphere (from the chromosphere to the corona), and the large-scale structure of the heliosphere, i.e. the huge volume of plasma containing our solar system, the solar wind, and the entire solar magnetic field. Recent observation-based simulations pointed out the relevance of chromospheric and coronal magnetic loop footpoints motion, controlled by plasma convection in the photosphere, to account for the origin of the fast solar wind. The loop footpoints movement, under the influence of photospheric flows, permits the transfer of kinetic energy to magnetic energy which is firstly stored in the loops of different sizes, and subsequently released via reconnection process with existing open fields.

The interplay between solar convective motions and solar magnetic structures is one of the critical outstanding issues of solar chromosphere dynamics and represents the basic topic of our research.

Main research projects in 2009/2011.
The 2009-2011 research projects are primarily devoted to chromosphere dynamics observations at the main solar telescopes, in particular at the DST/NSO telescope with IBIS.
Over the next three years, the Rome Tor Vergata Solar and Space Physics Team (link http://www.fisica.uniroma2.it/solare) will have several important responsibilities on the IBIS and EST projects: analysis and restoring of solar images, EST Heat Stop design, EST-MCAO design and simulation.
The design and development of an Italian Solar Satellite (ADAHELI) for photosphere/chromosphere studies will be the main focus if the project will be funded by ASI (Italian Space Agency).

Funding Agencies
During the 2007/2008 two-years period our research was pursued in the framework of international collaboration (THEMIS French-Italian telescope CNR-funded , USA-Italy "Two dimensional Spectro-polarimetry" project with IBIS at the DST/NSO telescope MAE-funded, The European Association for Solar Telescopes EAST, European Solar Telescope Project EU-FP7-funded).

2. Dipartimento di Fisica e Astronomia - Sezione Astrofisica, Università di Catania
INAF - Osservatorio Astronomico di Roma,
INAF - Osservatorio Astrofisico di Catania.

Scientific report
The common denominator of the many activity phenomena observed in the solar atmosphere is undoubtedly the magnetic field, which emerges from the convection zone and evolves by several stages assuming a configuration more and more complex. When the topology of the magnetic field forming an active region (AR) becomes too intricate, the configuration becomes unstable and an energy release occurs in the solar atmosphere, often giving rise to ejections of plasma from the solar corona. In this framework, the scientific goals of this group regard the study of the physical processes responsible for the formation and evolution of active regions, by means of a comparison between data obtained during observational campaigns involving instruments operating in several spectral ranges and the most recent models, and a study of the physical processes taking place in the various regions of the solar atmosphere during flares, erupting prominences and CMEs.

Active region formation and evolution: In order to establish, during the first phase of formation of an AR, if this will have a complete evolution (with an average lifetime of ~1-2 months), or if it will diffuse after a short time (1-7 days), we analysed data acquired during some observational campaigns performed at the THEMIS and DST telescopes, in coordination with space instruments (SOHO, TRACE, HINODE). The results obtained show that the first manifestation of the emergence of an active region takes place in the outer solar atmosphere and subsequently in the more internal layers. This result is particularly significant because such a phenomenology is expected in the last generation numerical models concerning the emergence of flux tubes in the solar atmosphere and their interaction with the surrounding environment. Also, important results were obtained from the comparison of a short-lived active region with a recurrent one. Moreover, numerical simulations predict that magnetic flux emerging into the solar atmosphere interact and reconnect with the pre-existing chromospheric and coronal field. This suggests that flux emergence is a relevant source of energy for the chromosphere. The efficiency of the interaction and the consequent heating seem to depend on the geometry of the two flux systems.

Flares and eruptive prominences: We performed the analysis of data acquired from ground-based solar telescopes in the visible range (INAF-OACt, IPM/THEMIS and IBIS/DST) and from satellites TRACE (EUV), RHESSI (X-rays), MDI/SOHO. Such studies provided new elements to the understanding of the physical processes occurring immediately before and during flares. In particular: 1) the presence of significant plasma motions in a short-lived filament, correlated to events of cancellation of magnetic flux: b) the presence of multiple processes of reconnection during some very energetic flares; c) X-ray emission providing a confirmation to the thick target model; d) evolution of the magnetic configuration and trend of the Ly-alpha emission in active regions characterized by flare occurrence.

Modelling the initiation of Coronal Mass Ejections: We investigated by means of numerical simulations both emergence of magnetic flux and shearing motions along the magnetic inversion line as possible driver mechanisms for CMEs. The pre-eruptive region consisted of three arcades with alternating magnetic flux polarity, favourable for the breakout mechanism to work. The equations for ideal magnetohydrodynamics (MHD) were advanced in time by using a finite volume approach and were solved in spherical geometry. By applying time-dependent boundary conditions at the inner boundary, the central arcade of the multi-flux system expands, leading to the eventual eruption of the top of the helmet streamer. With our simulation setup, both driving mechanisms resulted in a slow CME. The overall evolution of the system was, independently of the driving mechanism, the same: the actual CME is the detached helmet streamer. However, the evolution of the central arcade is different in the two cases. The central arcade eventually becomes a flux rope in the shearing case whereas it does not become a flux rope in the flux emergence case.

Role of magnetic helicity transport and accumulation in CME initiation: Accumulation of magnetic helicity above a threshold might result in a non-equilibrium configuration of the magnetic topology and eventually in the expulsion of the excess of helicity during CMEs. We used line of sight MDI magnetograms to calculate the accumulated amount of magnetic helicity in corona before some events, taking into account different kind of CMEs. In particular, we calculated the magnetic flux trend and the accumulated amount of magnetic helicity in corona for 20 halo CMEs observed during the period July 2002 - June 2003. The results indicate that the magnetic helicity accumulation does not have a unique trend in all the events analyzed: in some events it shows a sudden change that is temporally correlated with the CME occurrence, while in the majority of the events analyzed, it shows a time behaviour characterized by a monotonous trend.

Main research projects in 2009/2011.
In the next two years we will focus our attention on the following items:

EST Design Study: in the next years the Catania team will be involved in the Design Phase of the Broad-Band Imager and Detectors, as well as in the Data Acquisition and Control Package for the EST project.
Active region formation, evolution and decay: we will perform multi-wavelength observational campaigns in order to study the details of the emergence of magnetic flux tubes in the solar atmosphere, how they interact with pre-existing field lines and how they decay. In this respect, particular emphasis will be given to the detection and study of small magnetic elements, known as Moving Magnetic Features, that are generally observed during the decay phase of sunspots, in order to clarify their role in the magnetic field diffusion process.
Flares and erupting prominences: we will continue the multi-wavelength – multi-instrument study of these very energetic phenomena, focusing our attention on the reconnection process and on the possibility to confirm the thick target model. To this aim, a comparison between the increase in emissivity in some spectral lines and some models will be carried out.
Coronal Mass Ejections: We will continue the modelling approach to the study of the initiation mechanisms in CMEs and we will analyze data obtained by the STEREO mission during the ascending phase of the next maximum of the solar cycle, in order to compare the results obtained by the simulations with observational data.
Magnetic helicity transport: We will compare the different techniques used so far to determine the horizontal velocity fields (necessary step to determine the magnetic helicity transport) in order to single out the most accurate method; we will also use STEREO data in order to reach a more detailed knowledge of the helicity content in source regions.

Funding Agencies
These researches are carried out in collaboration with several national and international institutes, like for instance the Italian institutes financed by INAF (PRIN-INAF- Scientific exploitation of the Interferometric BIdimensional Spectrometer (IBIS). Magnetic structuring of the lower solar atmosphere), by ASI (Esplorazione del Sistema Solare) and the nodes of the SOLAIRE Network, financed by the European Commission (EC) in the framework of FP6, as well as the institutes involved in the Design Phase of the European Solar Telescope (EST), financed by the EC in the framework of FP7.

3. Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy

Scientific report

IMF influence on ionospheric scintillations at mid-high latitudes.
Observations from a network of specially equipped GPS scintillation receivers in Northern Europe has been used to investigate the dynamics of ionospheric plasma in the northern hemisphere. During disturbed conditions the total electron content (TEC) and scintillation data, combined with ionospheric tomography, reveal strong enhancements and steep gradients in TEC under a prevailing negative Bz component of the interplanetary magnetic field (IMF). Amplitude and phase scintillation maxima are often co-located with the TEC gradients at the edge of plasma patches, revealing the presence of small-scale irregularities. In particular the well known 30 October 2003 event reveals two phases of plasma dynamics: the former reflects the expected convection pattern for IMF Bz southward and the latter possibly indicates a sort of TEC plasma stagnation signature of the more complex convection patterns during several positive/negative excursions of IMF Bz. Following these findings a climatology of scintillation has been developed. A larger amount of data has been selected focusing on equinoctial season. Preliminary results indicate the preferred sectors of auroral oval boundaries and cusp/cleft region as zones with higher percentage of scintillations occurrence.

Main research projects in 2009/2011.
A proposal "Dynamics of the near-Earth plasma during the Solar Maximum" has been submitted to FIRB-PROGRAMMA "FUTURO IN RICERCA", issued by the Italian Ministry of Education, University and Research, to investigate the ionospheric irregularity at middle-low latitude under the next foreseen Solar maximum conditions

Funding Agencies
The conducted studies are included and partially supported by the following projects:
Experimental investigation to relate the presence of polar cap ionospheric features to HF signalling characteristics, endorsed by ARCFAC V (European Centre for Arctic Environmental Research)
Ionospheric scintillation monitoring and forecasting in Northern Europe, endorsed by Royal Society (UK).

4. INAF - Osservatorio Astrofisico di Arcetri,
Dip. di Astronomia e Scienza dello Spazio, Universita' di Firenze,
INAF-Torino Astronomical Observatory.

Scientific report
Coronal Mass Ejections.
Over the past years, scientists at the Arcetri Astrophysical Observatory and the University of Firenze, have worked on the interpretation of remote observations of Coronal Mass Ejections, on the basis of data acquired by space missions (mostly by SOHO). These analyses focused on inferring the physical conditions of the different parts of CMEs (front, core), with a special interest on deriving the properties of the Current Sheets, that, according to many models, are predicted to form between the flare loops and the CME bubble. Evidence of CSs has indeed been found in many events (see, e.g., Bemporad et al., ApJ 638, 1110, 2006; Bemporad et al., ApJ 655, 576, 2007; Bemporad et al. Annales Geophys 26, 3017, 2008; Poletto et al., Annales Geophys 26, 3067, 2008; Vrsnak, Poletto, Vujic et al., arXiv0902.3705, 2009) and the studies helped defining the CS behavior in time and at different heliocentric distances. Also, the nature of macroscopic coronal CSs, vs microscopic CSs, has been discussed by Bemporad, ApJ 689, 572, 2008. Of particular interest for its connection with magnetotail properties is the most recent paper of this series (Schettino, Poletto, Romoli, ApJL 67, 72, 2009), where evidence of a filamentary structure of the coronal CS, analogous to the filamentary nature of CS observed in the magnetotail, is discussed, pointing to a further analogy between magnetospheric and coronal physics.

Main research projects in 2009/2011.
These studies will be continued over the next years: in particular, at present we are involved in a collaboration with radio scientists to highlight the connections between CSs revealed by radio techniques and CSs detected in UV data and in a collaboration with ACE scientists to check the in situ properties of a series of CMEs, each followed by a CSs, observed in the corona.

Funding Agencies
Funds for these works come from the Italian Space Agency (BASI).

5. INAF-Istituto di Fisica dello Spazio Interplanetario,
Dipartimento di Fisica, Università della Calabria,

Dipartimento di Fisica, Università di L'Aquila,
INAF-Torino Astronomical Observatory.

Scientific report

Data analysis and models

Fluctuations in the solar wind extend over several frequency decades, from the Sun's rotation period up to the ion-cyclotron period and beyond into the kinetic regime. Being the solar wind a collisionless medium, fluctuations assume a key-role in all the processes involving wind acceleration and plasma heating which still represent fundamental problems largely unsolved. The spectrum of these fluctuations is a typical turbulence spectrum which undergoes a clear radial evolution as the wind expands into the interplanetary medium. Within the magnetohydrodynamic framework, this evolution has been ascribed to the presence of non-linear interactions mainly between Alfvénic fluctuations propagating in opposite directions along the background mean magnetic field. In reality, Alfvénic fluctuations are not the only component of solar wind turbulence. The situation looks much more complicated involving the presence of other minor components like compressive fluctuations and a sort of background magnetic and plasma structure which is advected by the wind. As a consequence, problems related to the anisotropy of these fluctuations, their inhomogeneity, the existence of mechanisms of local generation of coherent structures and consequent coupling with stochastic fluctuations represent a sort of Pandora's box for those who are interested in solar wind turbulence. In the past few years, our studies have been focusing on some of these aspects related to solar wind fluctuations. The main activity has been addressed to the study of the following topics:

1) The energy cascade along the turbulence spectrum and the heating rate in the solar wind;
2) The study and the origin of coherent and magnetically dominated structures advected by the wind
3) Anomalous scaling of fluctuations and the related problem of Intermittency
4) Solar cycle modulation of solar wind fluctuations
5) Search for links between coronal plasma density features observed by remote sensing and in-situ observation by s/c
6) Effects of solar wind turbulence on geomagnetic activity

Laboratory activity

1) From the experimental point of view the IFSI group is actively involved, as one of the 4 Lead-Institutes, in laboratory studies on electrostatic analysers within the framework of his participation to the international consortium recently selected by ESA to realize the plasma suite experiment SWA onboard the future ESA mission Solar Orbiter.
2) IFSI is also involved, as one of the Lead-Institutes, in an international consortium for the Cross-Scale Mission in the framework of ESA-Cosmic Vision Programme
3) Moreover, the same group is working to the refurbishment of the Large Plasma Chamber located at IFSI able to reproduce the ionospheric environment experienced by a satellite orbiting at an altitude of about 300 km.

Main research projects in 2009/2011.

In the next future the activity of this group, related to *data analysis/models*, will keep focusing on problems related to:

1) solar wind plasma heating rate by turbulence including compressive effects;
2) identification and characterization of flux-tubes in solar wind and computer simulations using magnetic helicity studies based on wavelets analysis;
3) turbulence in high latitude solar wind as observed by Ulysses and solar cycle modulation;
4) the high frequency termination of turbulence spectrum, beyond the ion-cyclotron frequency, and possible relation to a new kind of inertial region rather than dissipation region, a sort of magnetosonic cascade.

As far as *laboratory activity* concerns:

1) the IFSI group will keep developing new features of electrostatic deflectors for space use through numerical studies and, if adequately funded, will realize new prototypes in the framework of its partecipation to international consortia for Solar Orbiter and Cross-Scale missions;
2) the IFSI group will perform numerical studies on compressive algorithms
3) at the same time, if funded, the IFSI group will concentrate on space plasma experiments in the Large Plasma Chamber (e.g. turbulence generation/damping and characterization).

Funding Agencies
Almost the totality of the funds used for the above activities come from the Italian Space Agency.

DIVISION V:
"Geomagnetic Observatories, Surveys, And Analyses" (Coord.: A. Meloni)

A) GEOMAGNETIC OBSERVATORIES

Observatory	IAGA code	Latitude	Longitude	Elev (a s.l.)
L'Aquila	AQU	42°23'N	13°19'E	682
Castello Tesino	CTS	46°03'N	11°39'E	1175
Lampedusa	LMP	35°31'N	12°32'E	35
Mario Zucchelli	TNB	74°42'S	164°6'E	30
Concordia (*)	DMC	75°06'S	123°21'E	3200

Magnetic Observatories operated by INGV, Italy.
(*) in cooperation with France, IPEV

1. L'AQUILA GEOMAGNETIC OBSERVATORY

The Observatory started its activity in 1958 and published regular yearbooks from 1960. Last published 2007. It's located near Preturo, ten kilometres north-west from the city and includes the following buildings: a) absolute measurements, b) variometers, c) proton precession vector magnetometer, d) laboratory, e) general services.

Declination and Inclination measurements are carried out by means of an optical theodolite equipped with a fluxgate magnetometer. The horizontal and vertical components are determined associating the I value to the total field measurement made by a proton precession magnetometer. A proton precession magnetometer for the measurement of F and a fluxgate magnetometer for the measurement of the H, D and Z component variations are used for time variations; both instruments have a 0.1 nT resolution; the original sampling rate is 1 Hz, then the data are filtered with a Gauss filter and recorded at 1 min.

Two additional variometric systems are also working: two tri-axial fluxgate magnetometers, one with toroidal and the other with linear sensors, for the measurement of the H, D and Z variations. These systems are generally not used for the yearbook compilation but their data are used to check and, if necessary, integrate the measurements.

L'Aquila is an INTERMAGNET Observatory and only for this observatory in Italy K magnetic activity indices SSC, SFE and SI notifications are made.

2. CASTELLO TESINO GEOMAGNETIC OBSERVATORY

The Geomagnetic Observatory of Castello Tesino is located about fifty-five kilometers Est from Trento (Northern Italy). The Observatory has been working almost continuously since 1964 and is considered the main Northern Italy magnetic Observatory. It works as an automatic Observatory and consists of three buildings, completely amagnetic, the first includes a laboratory for small repairs, the second for the absolute measurement equipments, the last one with the automatic digital system.

Declination and Inclination measurements are carried out by means of an optical theodolite equipped with a fluxgate magnetometer. The horizontal and vertical components are determined associating the I value to the total field measurement made by a proton precession magnetometer. A proton precession magnetometer for the measurement of F and a fluxgate magnetometer for the measurement of the H, D and Z component variations are used for time variations; both instruments

have a 0.1 nT resolution; the original sampling rate is 1 Hz, then the data are filtered with a Gauss filter and recorded at 1 min. Last published yearbook is 1995; at this time a detailed work to reconstruct absolute variations for following years is underway.

3. TERRA NOVA BAY (MARIO ZUCCHELLI STATION)

During the 1986-87 austral summer a geomagnetic observatory was installed at the Italian Antarctic Mario Zucchelli Station. In the first years the measurements of the geomagnetic field were carried out only during summer expeditions. Since 1991 the recording was implemented with an automatic acquisition system operating through the year.

Declination and Inclination measurements are carried out by means of an optical theodolite equipped with a fluxgate magnetometer. The horizontal and vertical components are determined associating the I value to the total field measurement made by a proton precession magnetometer.

A proton precession magnetometer for the measurement of F and a fluxgate magnetometer for the measurement of the H, D and Z component variations are used for time variations; both instruments have a 0.1 nT resolution; the original sampling rate is 1 Hz, then the data are filtered with a Gauss filter and recorded at 1 min.

Additional systems are also working for the measurement of the H, D and Z variations. These systems are generally not used for the yearbook compilation but their data are used to check and, if necessary, integrate the measurements.

4. CONCORDIA

In 1994 France and Italy started a program for opening a permanent scientific station on the high East Antarctic plateau at Dome C at 3280 m asl. The national Antarctic Programs (IPEV and PNRA respectively) started logistic, technical and scientific activities at Dome C that were initiated with the realization of a summer camp. The permanent Base opened in 2005

The observatory is constituted by two shelters, a) variometer shelter and b) absolute measurements shelter, at a distance of about 300 m from the old field camp. Operations started regularly at the end of 2004. Variations of the Earth's magnetic field are monitored by a three-axis fluxgate magnetometer along three orthogonal vector components oriented with respect to the local magnetic meridian. The intensity of the field is measured by an overhauser magnetometer. Absolute measurements are performed during the whole year.

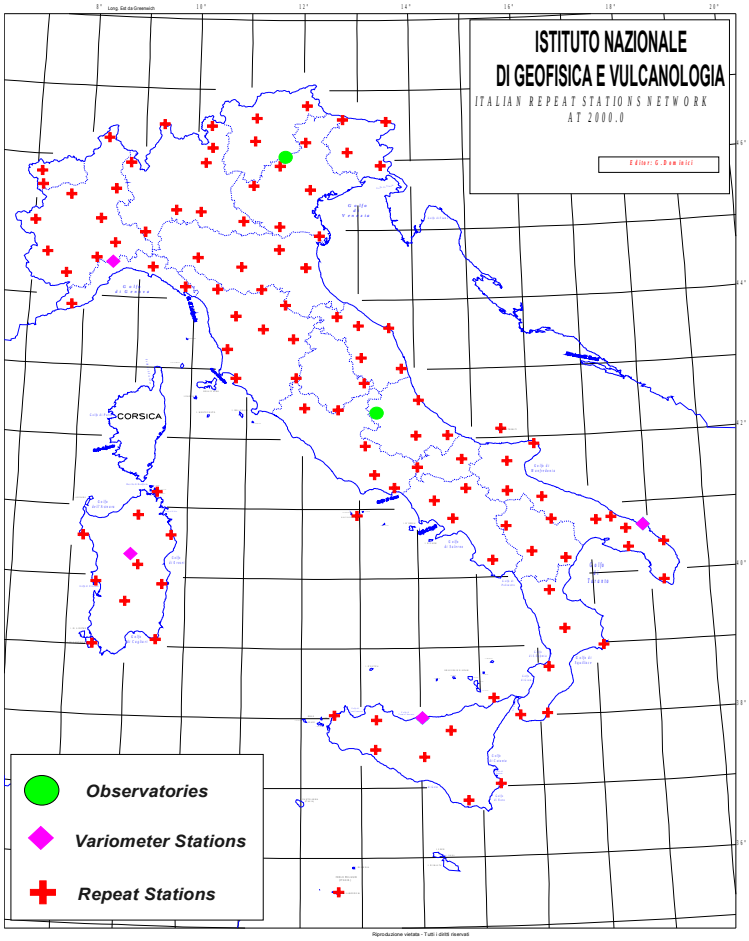
The flux-gate variometer, a suspended DMI magnetometer, and an Overhauser magnetometer operate for the acquisition of the geomagnetic field intensity and components time variations. The instrument sensors are located in a cave under the shelter in order to keep the sensors at a constant temperature (about -40°C). In the absolute shelter D, I, F absolute measurements are carried out according to standard observatory practice.

B) MAGNETC SURVEYS

In order to harmonize the observatories for a better spatial knowledge of the geomagnetic field and its secular variation over Italy a national magnetic network. The Italian repeat station network, consists of 116 points. INGV has the task to make measurements and data elaboration. The measurements are generally carried out by means of Declination/Inclination theodolites and total intensity magnetometers, a gyroscope theodolite is used to check and establish new azimuth marks when necessary. The information on the more rapid time variations, both for the diurnal variation and for possible irregular perturbations, is taken at the two observatories L'Aquila, in central Italy, and Castello Tesino, in northeast Italy. Moreover, for selected areas, other temporary magnetic time recording stations, favourably displaced for having nearly a total coverage of the Italian territory, are installed during the survey. All magnetic repeat stations are represented in figure 1 together with the Observatories and temporary stations.

The most recent full survey was competed at 2005 (114 repeat stations, mean distance 55 km), the most recent partial survey at 2007.5 on 37 repeat stations with an average spacing around 85-90 km was recently completed . For all full surveys we publish regularly D, I and F magnetic element values and 1/2000,000 cartography for F, H, Z and D. All maps are published together with a CD rom and interactive program to display maps and magnetic field values across all Italy. In September 2009 we

plan to start the geomagnetic measurements for the 2010 survey; all the measurements will be made in one year. Together with Albanian colleagues we will also make the repeat survey for Albania.



C) OTHER ACTIVITIES RELEVANT TO DIVISION V

GEOSTAR: In the view of improving the number of observing systems that would guarantee a complete coverage for a full global analysis of the geomagnetic field there is a strong need of marine, in particular seafloor, measurements (we remember that around 2/3 of the Earth's surface is in fact covered by seas. At INGV the contribution in this direction is the continuing development of an automatic system called Geostar, that includes in one geophysical station seismic sensors and other devices. The station characteristics for the magnetic part are a) fluxgate magnetometer (built at INGV): resolution: 1.0 nT power, consumption: 2W accuracy: 5-10nT, sampling: 6 values/min, b) Scalar Magnetometer (GEM System): resolution: 0.1nT, consumption: 1W, accuracy: 1nT, sampling: 1value/min.

ARM: (Antarctic Reference Model) Magnetic modeling provides scientific communities with updated information on magnetic field elements as the output of computer programs. ARM is is the first 3D model for the geomagnetic field over Antarctic regions. It allows the computation of the main field and its secular variation over these regions from 1960 to 2005. It is base on the Spherical Cap Harmonic Analysis.

Crustal magnetic field investigations. The study of tectonics can take important advantages by the use of magnetic field surveys that allow the determination of the crustal field contribution. We report here some recent contributions in this field. High spatial resolution aeromagnetic surveys were undertaken, especially at INGV, by the use of helicopter born magnetometry and data interpretation in volcanic magnetized areas. We report the most recent activities undertaken. At the Eolie islands archipelago, in the Tyrrhenian, surveys and studies were made on Salina island and Volcano island. Other measurements and studies were made on El Hierro (Canary isalnds) in cooperation with Spanish colleagues.

A group at the Università of Camerino has undertaken analysis and interpretation of marine and in particular devoted to the realization of kinematic models fore the Mediterranean and the Atlantic.

"Interdisciplinary Commission on History" (Coord.: A. De Santis)

A) Institutions involved in the activities
The Istituto Nazionale di Geofisica e Vulcanologia (INGV) in its sections and laboratories of Rome, Naples, Catania, Grottaminarda, Arezzo, Rocca di Papa, Stromboli and Vulcano, which possess museal areas specifically dedicated to Education and Outreach.
Other institutions, such as the Italian Universities and National Council of Research (CNR) were involved too.

B) Scientific report
INGV hosted periodic visits for schools of different levels (from Primary to Secondary), and for general public, for a total of more than 50,000 people visiting in the two-year period 2007-2008.
INGV also participated and contributed to many national and international conferences and manifestations; for instance: "Festival della Scienza" ("Show of Science") XVII and XVIII editions in Genoa, together with corresponding "open days" in several INGV sites, "Il fuoco del Sole " ("The fire of Sun") in L'Aquila, and many other in the frame of the National Scientific and Technological Culture Week.
Completed in 2007 the project EDURISK (INGV and Italian Civil Protection Department), that involved more than 500 teachers and around 8000 students from 9 Italian regions. This project was started in 2008 again with a new phase.
Many Italian Institutions (e.g. INGV, CNR, INAF) contrituted to the "European Night's researcher" on 26/9/2008.

c) Financial Support
Institutional funds together with the Italian Civil Protection Departement support.

SCIENTIFIC PUBLICATIONS

DIVISION I:
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IAGA DIVISION II:
"Aeronomic Phenomena"

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