BOLLETTINO DI GEOFISICA TEORICA ED APPLICATA
SUPPLEMENT TO:
VOL. XXXVI, N. 141-144 - MARCH-DECEMBER 1994

F. MARIANI

GEOMAGNETISM AND AERONOMY

Italian research activity (1991-1994) report to IAGA

INTRODUCTION

In the years 1991-94 activity on Geomagnetism and Aeronomy has been conducted along several lines of research, spanning from the deep geomagnetic field and the ionosphere to the magnetosphere and the interplanetary medium.

This report summarizes the activities of the following Institutions:

1. Dipartimento di Fisica, Università dell'Aquila;
2. Dipartimento di Fisica, Università La Sapienza, Roma;
3. Dipartimento di Fisica, Università Tor Vergata, Roma;
4. Dipartimento di Scienze della Terra, Università della Calabria, Arcavacata di Rende;
5. Istituto di Fisica della Atmosfera, CNR, Roma;
6. Istituto di Fisica dello Spazio Interplanetario, CNR Frascati;
7. Istituto Nazionale di Geofisica, Roma;
8. Istituto Ricerca Onde Elettromagnetiche, CNR, Firenze.

INTERPLANETARY MEDIUM AND PLANETARY MAGNETOSPHERES

Interplanetary medium and magnetospheric phenomena

Work on this subject was done along several lines on solar cycle variations, on MHD turbulence, on Earth's, on comets and on preparation of space experiments for incoming missions. Main active groups operate within universities (Roma la Sapienza, Roma Tor Vergata, L'Aquila, della Calabria) and Institutes of CNR (Istituto Fisica Spazio Interplanetario).

In situ measurements of solar wind and interplanetary magnetic field parameters have been investigated during a time interval covering more than two solar cycles, namely 20 and 21. A separate analysis for fast and slow wind has been made to understand long-term variations of the wind parameters. It has been found that fast wind, at 1 AU, carries a slightly larger momentum flux density and a slightly stronger magnetic field. No evidence was found for a positive correlation between velocity and field intensity as needed by some models to explain the wind acceleration. Support was found to approximately constant divergence of the field

Manuscript received December 27, 1994; accepted December 29, 1994.

Dipartimento di Fisica, Seconda Università, Roma, Italy.

lines associated with corotating high-velocity streams.

The studies on MHD turbulence have shown that the role of interplanetary sources, generating Alfvenic fluctuations to be added to those of solar origin, is less important than proposed in several models. Nevertheless, locally generated fluctuations are seen to play a relevant role in the turbulence evolution due to the nonlinear interactions that they are able to develop with the fluctuations of solar origin. Also solar wind convected structures are found to contribute significantly to changes in the Alfvenic character of the turbulence.

The nature and origin of the compressive component of the turbulence has been studied: in particular, a statistical analysis of the density fluctuations and of their relation to the turbulent Mach number has been performed. The nearly-incompressible approach does not appear extensively applicable in the solar wind, at least in the inner heliosphere. The evaluation of the polytropic index of solar wind fluctuations suggests that probably compressive turbulence is mainly generated by pressure imbalances between contiguous low-tubes, with cascade processes to smaller scales.

The analysis of velocity fluctuations of the solar wind has shown the existence of anomalous scaling exponents for the high-order structure functions. This study has also shown that the scaling exponents can be fitted by existing intermittency models and that these fluctuations have a clear multifractal structure. Moreover, evidence for the occurrence of Extended Self-Similarity in the solar wind fluctuations has been obtained.

Theoretical studies on MHD turbulence in the solar wind have been conducted. Numerical codes have been built which, by means of pseudo-spectral methods, allow to solve the MHD equations in a two-dimensional domain in both the incompressible and the compressible case. Nonlinear evolution of the tearing instability has been successfully studied.

Another line of research has been the plasma transport in a disordered magnetic field, with application to astrophysical and Solar System plasmas. A three-dimensional simulation of a stochastic magnetic field has been implemented. The results show that there are percolation and diffusion regimes, and that the diffusive threshold is lowered as the spectrum extension is increased. Also, anomalous diffusion regimes are found.

Solar oscillations

Studies on solar oscillations have been conducted in collaboration with the University of Roma II, the University of Firenze and the Arcetri Astrophysical Observatory. An experiment for the observation of solar oscillations through measurements of Doppler velocity on the surface of the Sun has been developed. Full disk images of the Sun in the Na and Fe lines are analyzed to investigate the correlation between the frequency of the oscillations and the atmospheric structure.

Meanwhile, a study of the acoustic waves propagation in the solar atmosphere has been carried out using observations made by the Fourier Transform Spectrometer at the Kitt Peak National Solar Observatory (USA, Arizona). An analysis of the oscillations of many photospheric lines profiles in four different data sets has evidenced a clear dependence on the height in the solar atmosphere of the ratio of the powers in the red wing and in the blue wing. This has allowed to test the properties of the 5-minutes waves propagation.

Presently many data sets of measurements made at the Solar Tower of the Arcetri Astrophysical Observatory during many years and using photospheric lines with different Lande' factor is in progress to understand whether the 5-minutes solar oscillations power evolves with the solar magnetic cycle.

Interaction with magnetospheres and comets

Collisionless shock waves have been studied by means of Monte Carlo simulations to reproduce the electron heating in the Earth's bow-shock. This research is going on with the detailed study of the waves that can be excited by the non-thermal features of the electron distribution functions.

Several series of bow shock crossing by IMP8 have been examined when IMP7 data were available to monitor external solar wind conditions. The motion of the shock has been studied

using shock velocities and shock normals obtained from least squares fits of the observed parameters to a reduced set of Rankine-Hugoniot relations.

Low frequency, large amplitude MHD waves have been observed in Saturn's foreshock. The wave frequency and polarization characteristics are consistent with generation by resonant interaction with backstreaming protons having twice the solar wind speed. Moreover in the subsolar magnetosheath large amplitude compressional waves are observed in a high-plasma regime. These features, together with the observed anticorrelation between field magnitude and ion density, suggest the identification with mirror mode waves.

Another research subject was the equilibrium structure of Jupiter's magnetosphere; a self-consistent model of the magnetic field is obtained by the numerical solution of a generalized Grad-Shafranov equation. The Voyager data are used as an input to determine the arbitrary functions which appear in the Grad-Shafranov equation. The formation of magnetic neutral lines, i.e., X-lines and O-lines, and the growth of a collisionless reconnection instability and of particle acceleration was considered. It was found that the formation of an X-line in the nightside magnetosphere can explain some observed features of Jupiter's UV emission.

In the environment of the Halley comet particles with energy larger than the pickup energy have been detected by Giotto, thus suggesting that other accelerating processes besides the pickup process operate. Several acceleration mechanisms could be effective in the mass loading region, and in order to detemine which process dominates, the shape of the distribution function of protons and water group ions has been systematically examined over a large distance. First order Fermi process (i.e. spatial diffusion between converging scattering centers) seems to be the dominant process, but the simultaneous presence of energy diffusion cannot be excluded.

Features of pickup ions of the water group have been investigated with data from the July 1992 Giotto encounter with the Grigg-Skjellerup comet.

A radio spectroscopy investigation of the comet SL/9 impact with Jupiter on July 1994 has been done. By using a multichannel spectrometer (130,000 channels) assembled in a few months by the Institute For Radioastronomy (Bologna) and the Area di Ricerca (Frascati) and coupled with the 32 m dish of the Medicina Radiotelescope, it has been possible to detect the emission line of water at 1.35 cm as a consequence of the impacts of nuclei E,A and C on July 19,1994. Since water has never been detected at radio wavelengths in Jupiter's atmosphere, the detection relates to water of cometary origin released at high altitudes (above 1 microbar pressure). The extremely narrow bandwidth of the line (40 kHz) and its brightness cannot be explained by a classical approach of thermal or collisional broadening. The only mechanism which could explain the observations would be the masing one.

Moreover the masing mechanism seems to remain observable two or more months after impact. This would be the first evidence of a planetary maser caused by a catastrophic impact with a celestial body.

Earth's magnetosphere and ionosphere

The tethered satellite mission TSS-1 has been flown with the Space Shuttle in August 1992. The plasma characteristics and wave experiment RETE has been operated in the TSS-1 sheath and interesting charging events have been studied; even at the low voltages attained by the first flight it has been possible to analyse transitions of the RETE probes from the unperturbed plasma to the inner sheath region, since the Langmuir probe characteristics are distinctly different in the two regions. The sheath has been observed to be non-magnetized at the available low voltages and the current collected by the satellite appears to be enhanced by the satellite motion, which sweeps through the plasma.

Within the TSS-1 mission, the goal of the TEMAG experiment was the ambient magnetic field monitoring, in order to characterize the perturbations due to the locally generated electric currents. Because of the reduced lenght of the tether with respect to the nominal one, no significant changes of the geomagnetic field value have been observed.

Nevertheless the data show a significant perturbation due to a magnetic storm occurred during the mission.

Within the frame of the ESA Cluster Mission, development and manufacturing of the Cluster Ion Spectrometry (CIS) experiment is to be mentioned. CIS consists of two electrostatic analyzers of the top-hat type, which provide a 3D ion distribution during one spacecraft spin. One of the analyzers is followed by a time-of-flight detector which provides mass separation in the mass range between 1 and 32 amu. The experiment has a high sensitivity and a large energy and angle resolution together with a wide dynamic range, which allows to make measurements under a variety of conditions in the various regions of the magnetosphere.

Also, an electric field measurements experiment called OPERA for the Interball-Tail satellite has been designed built within an international cooperation (ESTEC and LPCE of Orleans).

The technique of reconstructing images of the inner magnetosphere through ENA (Energetic Neutral Atoms) detection has been investigated. These ENA transport indeed information on energy and flow direction of the magnetospheric energetic ions which originate them through charge-exchange mechanism, thus providing the chance of imaging the originating plasma distribution. For this purpose, an ENA detector has been designed for integration on an Argentinian satellite, named SAC-B, which will orbit at 550 km altitude and 38 degrees inclination.

Advanced technology for magnetic field measurements

In collaboration with the Agusta/OMI, a facility for generating highly uniform magnetic fields has been installed.

The system consists of a set of 4 square coils (with a side of about 3 meters) for each of the 3 components of the magnetic field. The steady component of the field is compensated by a biasing field generated by a DC current; the variable part of the field is dynamically compensated by a feedback loop consisting of an analog or a digital system. The response of the digital system is flat over the 0.00-1.00 Hz frequency range, i.e. the residual field is only 1/1000 of the ambient field variations.

This system provides a region of high uniformity that permits the calibration of high sensitivity instruments for measuring very low intensity magnetic fields, of the order of fractions of nT.

Geomagnetic pulsations

A facility for measuring geomagnetic micropulsations is active at L'Aquila since 1983. The activity in this research area has been mainly focused (in cooperation with the Center for Space Research of the Massachusetts Institute of Technology, the Goddard Space Flight Center of the NASA, the Institute of Atmospheric Research and Geomagnetism of Berlin, and the Institute of the Physics of the Earth of Moscow) on the study of the factors governing: a) the penetration in the magnetosphere of magnetohydrodinamic waves generated upstream of the Earth's bow shock, b) the transformation of such waves in magnetospheric field line resonances, which are observed on the ground as regular, quasi-monochromatic trains of geomagnetic pulsations.

Pi2 pulsations at low and mid-latitudes have been examined in the frame of reference of the substorm dynamics. Preliminary results of a statistical analysis of the geomagnetic pulsations measured at L'Aquila between 1985 and 1993 have evidenced a solar cycle dependence of the local field line resonance frequency which is in agreement with theoretical predictions.

An analysis of the geomagnetic field fluctuations measured at the L'Aquila Geomagnetic Observatory of the Istituto Nazionale di Geofisica has been carried out separately at solar maximum (1989-90) and at solar minimum (1985-86). Diurnal, seasonal and solar cycle variations have been evidenced.

In cooperation with the Solar-Terrestrial Environmental Lab. (Nagoya, Japan) and the Institute of the Earth Physics (Moscow, Russia), several events of geomagnetic pulsations, simultaneously observed at L'Aquila and at different Japanese and Russian stations after sudden storm commencements, have been analyzed for the identification of global oscillation modes of the magnetosphere.

A new method for the Earth's crust sounding has been proposed and applied to the frequency range of geomagnetic pulsations obtained during an experiment performed in 1987 at the Earth's surface (Campo Imperatore) and at a depth of 1500 m in the underground Gran Sasso Laboratory.

Antarctic studies

Antarctic activities have been carried out in the framework of the Italian Antarctic research program (PNRA). An intensive program to assemble all-sky cameras around a CCD has been started in cooperation with ENEA (the national institute for energy research). One of these has been installed in the Argentinian Antarctic base for operation in 1995. The data collected through this effort, together with the data acquired by other Italian equipment installed other institutions will be the Italian contribution to the AGONET program; AGONET is the NETwork of Antarctic Geospace Observatories formed by all the bases or automatic stations operated by all the countries which are present in Antarctica and want to join the project; SCAR (the Scientific Committee for Antarctic Research) sponsors the operation of a steering Committee and PNRA supports the operation of the Antarctic Data Center in Frascati.

A new study has been started, devoted to the analysis of a possible relationship between the trend of the Antarctic ozone density and the geomagnetic activity. For this goal data from TOMS experiment on board NIMBUS-7 satellite have been used and related to the geomagnetic index AE. The preliminary results seem to indicate that such relationship could be present, although this is frequently obscured by other more evident phenomena due to the dynamics of the atmosphere and to chemical agents.

Cosmic rays

The standard cosmic ray neutron detector running in Rome (rigidity threshold 6.2GV) since 1957 continued its activity. A new fully computerised system for recording every 5 minutes the cosmic ray neutron intensity, multiplicities 1 to 8 and atmospheric pressure. A special high efficiency neutron monitor was run in Campo Imperatore (2800 m a.s.l. near Rome) expecially developed for the detection of solar neutrons.

Although no neutron event was detected, the monitor was able to detect the giant proton event of September 1989.

Galactic cosmic ray modulation and interplanetary medium perturbations have been investigated during big decreases in cosmic ray intensity. It has been shown that magnetic clouds are very efficient trapping region for cosmic rays and that it is possible to do reasonable inferences on the large-scale structure of flare-related interplanetary perturbations, when interplanetary medium data are not completely present.

A project was developed (International Cosmic Ray Service) to combine satellite and spaceprobes cosmic ray, magnetic and plasma data with ground-based cosmic ray data (exchanged in real time), for obtaining continuous information on the electromagnetic and radiation situation in the interplanetary space and Earth's magnetosphere.

Also, some investigation was made on the possible effect of strong geomagnetic storms on the biosystem, particularly on some human diseases.

Continuous monitoring of cosmic ray particles in the last solar cycle has shown a long series of intense ground-level enhancements associated with solar cosmic-ray events, suggesting an intensification in the capability of the solar atmosphere to generate relativistic particles. Typical phenomena in the equatorial- and middle-heliolatitudinal belts appear to be the source of discrepaciencies over successive sunspot cycles. Moreover, a different relationship between the geomagnetic activity level and sunspot numbers has been found when ascending and descending phases of sunspot cycles are considered separately.

BIBLIOGRAPHY

Amata E., Formisano V., Torrente P. and Giovi R.; 1991: *The plasma parameters during the inbound and outbound legs of the Giotto trajectory.* AGU Geophysical Monograph 61, 131.

Antalova A., Jakimiec M. and Storini M.; 1994: *Solar activity leading to the galactic cosmic ray modulation in 1988 and 1989 years.* Proc. 8th Int. Symp. on Solar Terrestrial Physics, Sendai, June 5-10, Part-I, 53(1)-53(4), 1994.

Bavassano B.; 1992: *Solar Probe: a rendezvous with the Sun.* N. Cim., **15C**, 501.

Bavassano B.; 1994: *Recent observations of MHD fluctuations in the solar wind.* Ann. Geophys., **12**, 97.

Bavassano B. and Bruno R.; 1991: *Solar wind fluctuations at large scale: a comparison between low and high solar activity conditions.* J. Geophys. Res., **96**, 1737.

Bavassano B. and Bruno R.; 1992: *On the role of interplanetary sources in the evolution of low-frequency Alfvenic turbulence in the solar wind.* J. Geophys. Res., **97**, 19129.

Bavassano B., Iucci N., Lepping R. P., Signorini C., Smith E. J. and Villoresi G.; 1994: *Galactic cosmic ray modulation and interplanetary medium perturbations due to a long-living active region during October 1989.* J. Geophys.Res., **99**, 4227.

Bavassano B., Storini M., Felici A., Parisi M. and Sykora J.; 1994: *A search of interplanetary effects associated with solar corona.* In: Baker D. N., Papitashvili V. O. and Teague M. J. (eds), Proc. 1992 STEP Symp., 5th COSPAR Colloquium, pp. 285-288.

Bavassano Cattaneo M.B. and Formisano V.; 1994: *Particle acceleration at comets.* Physica Scripta, **T50**, 98.

Bavassano Cattaneo M. B.; 1991: *Acceleration of pickup ions in the vicinity of comet Halley.* In Cometary Plasma Processes, AGU Geophysical Monograph 61, 311.

Bavassano Cattaneo M. B. et al.; 1991: *Upstream waves in Saturn's foreshock.* Geophys. Res. Lett., **18**, 797.

Belcher J. W. et al.; 1991: *Mercury Orbiter: Report of the Science Working Team.* NASA Tech. Memorandum 4255, 1, Feb. 1991

Bellucci G., Formisano V. and Amata E.; 1992: *Magnetohydrodinamic Instabilities at Comet Halley: Giotto Observations.* N. Cim., **15C**, 665.

Berrilli F. et al.; 1992a: *A Study of the Solar Atmosphere with High- Resolution Spectroscopic Images: Acquisition System.* N. Cim., **15C**, 519.

Berrilli F. et al.; 1992b: *The Solar CCD Imaging System at Tor Vergata University.* Atti del XXVI Congresso Nazionale della Società Astronomica Italiana.

Berrilli F. et al.; 1993: *First measurements of solar oscillations with the THEMIS panoramic monochromator.* Mem. S.A.It., **64**, 781.

Bertello L. et al.; 1992: *New Observations of 5-minutes Oscillations in the Opposite Flanks of Solar Fraunhofer Lines. I. The Effect of Varying the Spectral and Temporal Resolution.* Ap. J., **401**, 768.

Bonifazi C. et al.; 1993: *Tethered Satellite System (TSS): Preliminary results on the active experiment CORE equipment.* N. Cim., **16C**, 515.

Bruno R. and Bavassano B.; 1991: *Origin of low cross-helicity regions in the inner solar wind.* J. Geophys. Res., **96**, 7841.

Bruno R. and Bavassano B.; 1992: *Evolution of the Alfvenic correlation in the solar wind.* N. Cim., **15C**, 599.

Bruno R. and Bavassano B.; 1993: *Cross-helicity depletions in the inner heliosphere and magnetic field and velocity fluctuation decoupling.* Planet. Space Sci., **41**, 677.

Bruno R., Villante U. and Stecca A.; 1994: *Solar wind parameters through two solar activity cycles.* Ann. Geophys., **12**, 105.

Carbone V.; 1993a: *Cascade model for intermittency in fully developed magneto- hydrodynamic turbulence.* Phys. Rev. Lett., **71**, 1546.

Carbone V.; 1993: *The inertial-range spectrum of fully developed magnetohydrodynamic turbulence.* Ann. Geophys., **11**, 866.

Carbone V.; 1994: *Scaling exponents of the velocity structure functions in the interplanetary medium.* Ann. Geophys., **12**, 585.

Carbone V.; 1994: *Scale-similarity of the velocity structure functions in fully developed magnetohydrodynamic turbulence.* Physical Review E, **50**, R671.

Carbone V.; 1994: *Time intermittency in a shell model for fully developed hydromagnetic turbulence.* Europhys. Lett., **27**, 581.

Carbone V., Malara F. and Veltri P. 1992: *Anisotropic MHD fluctuations in the Solar Wind.* N. Cim., **15C**, 621.

Carbone V. and Veltri P.; 1992: *Relaxation Processes in Magnetohydrodynamics: a Triad Interaction Model.* Astron. Astrophys., **259**, 359.

Cavallini F. et al.; 1992: *High-resolution Spectroscopic Imaging of the Sun with a Universal Birefringent Filter and a Fabry-Perot Interferometer.* N. Cim., **15C**, 509.

Coates A.J. et al.; 1993: *Pick up water group ions at Comet Grigg-Skjellerup.* Geophys. Res. Lett., **20**, 483.

Cordaro E.G. and Storini M.; 1992: *Cosmic Ray Measurements in Antartica during the international solar terrestrical energy program.* N. Cim., **15C**, 539-545.

Cordaro E. G. and Storini M.; 1992: *The response of Los Cerrillos detectors to the 1989/90 GLE events.* Geofisica Internacional, **31**, 65.

Cordaro E.G., Johnson E.R. and Storini M.; 1992: *A neutron monitor on King George Island.* Geofisica Internacional, **31**, 79.

Cordaro E.G. and Storini M.; 1994: *Neutron Monitor Data for Solar-Terrestrial Physics: The Human Environment.* Proc. 8th Int. Symp. on Solar Terrestrial Physics (dedicated to STEP, Sendai), Part-I, 250(1)-250(4).

Cosmovici C.B. and Stalio; 1992: *EUV-FUV spectroscopy of TSS Optical Phenomena.* N. Cim., **15C**, 703.

De Petris M. et al.; 1991: *Interplanetary perturbation- induced effects on polar ozone level.* Ann. Geophys., **9**, 381-386.

De Petris M. et al.; 1993: *Solar-induced effects on the high-latitude atmospheric O3-content.* In Trends in Geophys. Res., **2**, 459.

Di Lellis A. et al.; 1992: *Experimental activity and numerical simulations for the plasma experiment of the ESA CLUSTER project.* N. Cim., **15C**, 657.

Di Lellis et al.; 1993: *The hot ion analyzer instrument for the ESA Cluster Mission.* N. Cim., **16C**, 743.

Dobrowolny M. and Melchioni E.; 1993: *Electrodynamic Aspects of the First Tethered Satellite Mission.* J. Geophys. Res., **98**.

Dobrowolny M., Melchioni E. and Candidi M.; 1993: *An overview of plasma science in the first Tethered Satellite Project (TSS-1).* N. Cim., **16C**, 4951.

Dobrowolny M. and Stone N.; 1994: *A technical overview of TSS-1: The first Tethered Satellite Mission.* N. Cim., **17C**, 1.

Dobrowolny et al.; 1994: *The RETE experiment for the TSS-1 mission.* N. Cim., **17C**, 101.

Dorman L.I., Iucci N. and Villoresi G.; 1993a: *Possible monitoring of space dangerous processes by cosmic rays.* Proceed. 23rd Int. Conf. Calgary, Canada, 3, 695.

Dorman L.I, Iucci N. and Villoresi G.; 1993b: *Space dangerous phenomena and their possible prediction by cosmic rays.* Proceed. 23rd Int. Conf. Calgary, Canada, 3, 699.

Dorman L.I., Iucci N. and Villoresi G.; 1993c: *The use of cosmic rays for continuous monitoring and prediction of some dangerous phenomena for the Earth's civilisation.* Astrophysics and Space Science, **208**, 55.

Formisano V. et al.; 1991: *Jets Physics in Comet P/Halley.* N. Cim., **14**, 319.

Giallongo E. et al.; 1994: *The Gunn-Peterson effect in the spectrum of the z = 4.7 QSO 1202-0725: the intergalactic medium at very high redshifts.* Astrophys. J. Lett., **425**, L1-L4.

Glassmeier K. G. et al.; 1991: *GIOTTO's Mission to Planet Earth.* Geophys. Res. Lett., **18**, 1663.

Katz L. et al.; 1994: *Observations of Ionospheric Heating in the TSS-1 Subsatellite Presheath.* J. Geophys., Res. **99**, 8961.

Kleimenova N.G. et al.; 1993: *Geomagnetic pulsations Pc2-3 at the low and middle latitudes.* Geomagn. and Aeronomy, **31**, 101.

Klein L. et al.; 1993: *Scaling of density fluctuations with Mach number and density-temperature anticorrelations in the inner heliosphere.* J. Geophys. Res., **98**, 7837.

Klein L. et al.; 1993: *Anisotropy and minimum variance of magnetohydrodynamic fluctuations in the inner heliosphere.* J. Geophys. Res., **98**, 17461.

Lepping R.P. et al.; 1994: *The WIND Magnetic Field Investigation.* Spa. Sci. Rev.

Malara F. and Elaoufir J.; 1991: *Oblique propagation of non-linear Hydromagnetic waves: one and two dimensional behavior.* J. Geophys. Res., **96**, 7641.

Malara F., Veltri P. and Carbone V.; 1991: *Magnetic Neutral Points Stretching and Coalescence in Tearing-Generated MHD Structures.* Phys. Fluids, B3, 1801.

Malara F. and Elaoufir J.; 1992: *Nonlinear Oblique Propagation of Magnetohydrodynamic Waves in the Solar Wind.* N. Cim., **15C**, 631.

Malara F., Veltri P. and Carbone V.; 1992: *Competition among Nonlinear Effects in Tearing Mode Saturation.* Phys. Fluids, B4, 3070.

Malara F. et al.; 1992: *Incompressible Disturbances in Nonuniform Media: Small Scales Formation.* Ap. J., **396**, 297.

Mariani F.; 1993: *Tethered satellites in the geophysical environment.* N. Cim., **16C**, 549-566.

Massetti S. and Storini M.; 1993: *On the Homestake neutrino data.* Solar Phys., **148**, 173.

Mastrantonio G. et al.; 1994: *The Interplanetary Magnetic Field: Case Study.* N. Cim., **17C**, 313.

Melchioni E. and Dobrowolny M.; 1992: *Interaction of a plasma source with an ambient plasma.* N. Cim., **15C**, 675.

Melchioni E. and Dobrowolny M.; 1993: *Early results from the RETE Experiment in the TSS-1 Mission.* N. Cim., **16C**, 539.

Mussino et al.; 1994: *Long-term variations in the geomagnetic activity level. Part II) Ascending phases of sunspot cycle.* Ann. Geophys., **12**, 1065.

Neubauer F.M. et al.; 1993: *First Results from the Giotto Magnetometer Experiment during the P/Grigg-Skjellerup Encounter.* Astron. Astrophys., **268**, L15-18.

Oberhardt M.R. et al.; 1993: *Positive Spacecraft Charging as Measured by the Shuttle Potential and Return Electron Experiment.* IEEE Trans. Nuc. Scie., **40**, 1532.

Orlando M. et al.; 1993: *Semiannual variation of the geomagnetic activity and solar wind parameters.* Geophys. Res. Lett., **20**, 2271.

Orsini S. et al.; 1992: *Proposal of an Italian experiment for the mission SAC-B. ISENA: Imaging Particle Spectrometer for Energetic Neutral Atoms.* In: Chakrabarti S. (ed) Instrumentation for Magnetospheric Imagery, SPIE Proceedings, 1744, 91.

Orsini S. et al.; 1994: *Model calculation of energetic neutral atom precipitation atow altitudes.* J. Geophys. Res., **99**, 13489.

Savaglio S., D'Odorico S. and Moller P.; 1994: *The metal systems in Q0000-2619 at high resolution.* Astron. Astrophys., **281**, 331.

Signorini C. and Conforto A.M.; 1992: *On the biological effects of cosmic rays: Epidemiological studies.* N. Cim., **15C**, 565.

Storini M.; 1990 and 1991: *Galactic cosmic-ray modulation and solar-terrestrial relationships.* N. Cim., **13C**, 103, 1990 and N. Cim., **14C**, 211 (errata).

Storini M. and Felici A.; 1994: *Solar wind in the near-earth interplanetary space: 1964-1987 revisited.* N. Cim., **17C**, 697.

Storini M., Iucci N. and Pase S.; 1992: *North south anisotropy during the quasi-stationary modulation of galactic cosmic rays.* N. Cim., **15C**, 527.

Storini M. et al.; 1993 and 1994: *Long-term corona features associated with Schwabe-cycle phases.* Proc. IAU Colloquium n. 144. In Solar Coronal Structures, V. Rusin, P. Heinzel and J.-C. Vial (eds.), VEDA Publ. Co., Bratislava (Slovakia), 143-146. And Solar corona irradiance variability affecting solar wind and cosmic rays, Proc. 8th Int. Symp. on Solar Terrestrial Physics, Sendai, June 5-10, Part-I, 20(1)-20(4).

Storini M. et al.; 1994: *Interplanetary Perturbation-Induced Effects on the Atmospheric Ozone: A Case Study for the Northern Hemisphere.* Proc. 8th Int. Symp. on Solar Terrestrial Physics, Sendai, Part-I, 227(1)-227(4).

Sykora J. et al.; 1994: *Long-term variations in the solar corona: A study of latitudinal asymmetries.* In: D.N. Baker, V.O. Papitashvili and M.J. Teague (eds), Proc. 1992 STEP Symp., 5th COSPAR Colloquium, pp. 289-292.

Vannaroni G., Giovi R. and De Venuto F.; 1992: *Laboratory Simulation of the interaction between a Tethered Satellite System and the Ionosphere*, N. Cim., **15C**.

Vannaroni G. et al.; 1992: *Characterization of the interaction between a hollow cathode source and an ambient plasma.* J. Applied Physics, **71**, 4709.

Vellante M. et al.; 1993: *Simultaneous geomagnetic pulsation observations at two latitudes: resonant mode characteristics.* Ann. Geophys., **11**, 734.

Vellante M. and Villante U.; 1991: *Relationship between field line resonance at low geomagnetic latitudes and solar wind structures.* Geophys. Res. Lett., **18**, 1501.

Vellante M. and Villante U.; 1992: *Solar wind controlled pulsations at low latitudes.* N. Cim., **15C**, 575.

Veltri P.; 1994: *Low Frequency Turbulence and Energy Dissipation in the Solar Wind.* Spa. Sci. Rev., **68**, 63.

Veltri P., Mangeney A. and Scudder J.D.; 1992: *Reversible Electron Heating versus Wave-Particle Interactions in Quasi-Perpendicular Shocks.* N. Cim., **15C**, 607.

Veltri P. and Zimbardo G.; 1993: *Electron whistler interaction at the Earth's bow shock: II. Electron pitch angle diffusion.* J. Geophys. Res., **98**, 13335.

Veltri P. and Zimbardo G.; 1994: *Electron whistler interaction at the Earth's bow shock: I. Whistler instability.* J. Geophys. Res., **98**, 13325.

Villante U., Cariglia U. and Bavassano B.; 1992: *New remarks on the magnetic-field regime in the distant geomagnetic tail: Pioneer 8.* N. Cim., **15C**, 587.

Villante U. et al.; 1992a: *Pc3 activity at low geomagnetic latitudes: a comparison with solar wind observations.* Planet. Space Sci., **40**, 1399.

Villante U. et al.; 1992b: *Pi2 pulsations at separated sites: a comparison between mid and low latitude observations.* Ann. Geophys., **10**, 472.

Villoresi G. et al.; 1994: *The influence of geomagnetic storms and man-made magnetic field disturbances on the incidence of myocardial infarction in St. Petersburg (Russia),* Physica Medica, **10**, 107.

Villoresi G. et al.; 1994: *The effect of interplanetary geophysical disturbances on the incidences of clinically important pathologies (Moscow 1979-1981).* Physica Medica, **10**, 79.

Zimbardo G.; 1991: *Collisionless Reconnection in Jupiter's Magnetotail.* Geophys. Res. Lett., **18**, 741-744.

Zimbardo G.; 1992: *Chaotic Collisionless Reconnection in Jupiter's Nightside Magnetosphere.* N. Cim., **15C**, 645.

Zimbardo G.; 1993: *Observable implications of tearing mode instability in Jupiter's nightside magnetosphere.* Plan. Spa. Sci., **41**, 357.

Zimbardo G.; 1993: *Planetary Bow Shocks and Magnetospheres.* In: Menon J. (ed) Trends in Geophysical Research, Council of Scientific Research Integration , Trivandrum, India, 2, 269-287.

GEOMAGNETISM AND IONOSPHERIC PHYSICS

Research in these fields is mainly done at the Istituto Nazionale di Geofisica (ING) and at CNR/Istituto Ricerca Onde Elettromagnetiche (IROE).

Geomagnetic models

Geomagnetic survey data together with areomagnetic and satellite data when present, were analyzed in order to get the best field representation in Italy and other regions in order to match some of the fundamental points: the core field, the crustal contribution, the navigation aids and the real Earth's surface field.

Magnetic field time variations of internal origin

Very long time data series were used to investigate the secular variation. An analysis of almost five centuries of information has given, for the first time, a complete picture of the Italian, and part of the Mediterranean area, behaviour of the secular variation.

Magnetic field time variations of external origin

Magnetic storms, substorms, and pulsations were investigated by means of mid latitude and polar geomagnetic observations in order to contribute to the knowledge of the energy transfer processes, from the solar wind to the magnetosphere and the magnetosphere-ionosphere interaction.

Electromagnetic induction in the Earth

Magnetotelluric and geomagnetic depth sounding analysis have been used to study crustal and upper mantle conductivities, covering some of the Italian regions in order to understand the electromagnetic structure of the lithosphere and also to investigate on possible electromagnetic earthquake precursors.

Nonlinear analysis of the geomagnetic field

Fractal characterization of the external magnetic field during magnetic storms at L'Aquila and Terra Nova (Antarctica) was used to give an objective measurement of the dynamical state of the magnetosphere, this specific aspect being particularly evident at high latitudes. Also the irregular, apparently unpredictable, behaviour of the secular variation was investigated with chaotic dynamic models.

Magnetic anisotropy

Studies of magnetic anisotropies have been made to define the magnetic fabric of a rock, which is representative of the complessive petrofabric. This research concentrated on the study of weak deformations of Neogene clayey units in different structural settings of the Italian peninsula.

Paleomagnetism

Investigations on the fossil remanent magnetism residing in rocks have been made to identify vertical axis rotation and latitude translation of litospheric blocks, to get information on detailed stratigraphy of rock sequences and investigation of the past characters of the Earth's magnetic field. Research in this field concentrated on the Neogene geodynamics of the Italian peninsula and on the magnetostratigraphic study of significant Neogene sequences.

Magnetic mineralogy

Studies have been made of the natural magnetic minerals and their modes of occurrence (abundance, size, sources, variability) in rocks. Research in this field concentrated on the magnetic behaviour of iron sulphides (and paleomagnetic implications) and on the magnetic mineralogy variations in sedimentary sequences.

Geomagnetic research in Antarctics

In the frame of the Italian national research program for Antarctica a certain number of geomagnetic projects started and some of them have reached significant and interesting results. A geomagnetic Observatory installed in 1987 has been regularly working ever since. Some themes are part of wide research programs and some are strictly related to Antarctica. Among these the geodynamical evolution of Ross sea area, that is studied by means of a detailed program of aeromagnetic surveys and the study of the spatial distribution of time variations in polar areas.

Observatories and magnetic surveys

The modernization of Italian Observatory operations, as well as the improvement of their quality were among the major efforts that we faced in the last years.

The main presently working Italian geomagnetic observatory of L'Aquila is located near the village of Preturo about ten kilometres north-west from L'Aquila city. Here continuous recording of geomagnetic elements H and Z (horizontal and vertical components), D declination and F total field are made since the IGY. As now a set of Ruska variographs with normal sensitivity and with time scale of 20 cm/h is used; a digital recording system made out of an automatically recording proton vector magnetometer has been systematically used also; a third independent automatic set with digital output from a fluxgate three element set and a proton precession magnetometer (derived from an AMOS MKIII with a new data acquisition system) has been systematically used to check and integrate the other recording systems.

As a regular procedure also in the last few years absolute measurements were made about three times a week in order to compute base line values for all recording systems; these mesurements are carried out by means of magnetic theodolites (magnet suspension and fluxgate) and vector proton precession magnetometer. A monthly K-indices and rapid variation bullettin, a four months 02 UT hour absolute instantaneous element values, for a reciprocal check among the European geomagnetic observatory network, and finally the complete traditional Yearbook containing all hourly mean values are published.

The second Italian magnetic observatory located in Northern Italy near the city of Trento is Castello Tesino where a completely automatic system made out of a proton precession magnetometer (similar to the L'Aquila one) is working. Also for Castello Tesino Observatory a Yearbook is published.

In Sicily a photographic paper variograph, traditionally working in Gibilmanna, close to Palermo city, has been regularly active during the last few years. This observatory being severely affected by artificial noise, is mainly effective for the purpose of daily variation check during magnetic survey operations in southern Italy.

Repeat station magnetic measurements are made specifically to determine the absolute value of the geomagnetic field in a certain location and its secular variation. The updating of the national geomagnetic network is done in cooperation with the Istituto Geografico Militare Italiano (IGMI). Between 1989 and 1992 the two Institutes measured the declination (D), inclination (I) and the total intensity (F) of the Earth's Magnetic Field at 116 repeat stations distributed over the Italian territory. The network is similar to that used for the 1985.0 survey but includes now also new stations taken on the Pontine Islands, the Egadi Islands, and the Island of Lampedusa. All data from field measurements were reduced to 1990.0.

High precision measurements made in the seventies on a second order network of more than 2500 data points allowed the complete magnetic mapping of Italy; the results of the latest repeat station network were used also to update all those measurements. The new maps reporting the field updated at 1990.0 have been drawn with automatic graphic contouring programs.

Field operations for the 1995.0 updating of all national repeat station network started in 1993 and are running through in order to completed by 1995.

BIBLIOGRAPHY

Balia E. et al.; 1991: *A magnetovariational study in Sardinia.* Phys. Earth Plan. Inter., **66**, 92.

Bianchi C. et al.; 1992a: *Magnetic and ionospheric effects of the strong Magnetospheric storm of March 13th, 1989 over Italy.* N. Cim., **15C**, 45.

Bianchi C. et al.; 1992b: *Regional latitudinal magnetic and ionospheric effects of the March 13, 1989 storm over Italy.* Can. J. Phy., **70**, 566.

Bozzo E. and Meloni A.; 1992: *Geomagnetic anomaly maps of Central Victoria Land (East Antarctica) from ground measurements.* Tectonophysics, **212**, 99.

Bozzo E., Colla A. and Meloni A.; 1992: *Ground magnetics in north Victoria Land (East Antarctica).* In: Yoshida Y. (ed) Recent progress in Antarctic Earth Science, 563.

Bozzo E. et al.; 1994: *Technical procedures for aeromagnetic surveys in Antarctica during the Italian expeditions (1988-1992).* Ann. Geofis., **37**, suppl. 5.

Cafarella L., De Santis A. and Meloni A.; 1992: *Secular variation in Italy from historical geomagnetic field measurements.* Phys. Earth Plan. Inter., **73**, 206.

Cerv V. et al.; 1993: *Electrical conductivity investigation of the Corso-Sardinian microplate area.* Phys. Earth Plan. Inter., **80**, 169.

Chiappini M. and De Santis A.; 1991: *Adjustment of Jacobs' formulation to the case of Mercury.* N. Cim., **14C**, 197.

Chiappini M. and De Santis A.; 1994: *Magnetic investigations for studying planetary interiors.* Ann. Geofis., **37**, 3.

Chiappini M. et al.; 1992: *The analysis of geomagnetic and ionospheric data: Fractal vs. superimposed epoch approach: logical implications and practical effectiveness.* IV Workshop Italian Res. on Antarctic Atmosphere, Porano, **35**, 505.

Chiappini M. et al.; 1993: *Geomagnetic and ionospheric time series analysis.* In: Hruska J. et al. (eds) Proceed. Solar Terrestr. Prediction Workshop, **3**, 81.

De Franceschi G., De Santis A. and Pau S.; 1992: *Ionospheric mapping by regional spherical harmonic analysis: new developments.* PRIME Workshop, Barcellona.

De Franceschi G., De Santis A. and Pau S.; 1993: *Ionospheric mapping by regional spherical harmonic analysis: new developments.* Adv. Space Res., **14**, 62.

De Santis A.; 1991: *Translated Origin Spherical Cap Harmonic Analysis (TOSCA).* Geophys. J. Intern., **106**, 253.

De Santis A.; 1992: *Conventional Spherical Harmonic Analysis for regional modelling of the geomagnetic field.* Geophys. Res. Lett., **19**, 1065.

De Santis A. and Chiappini M.; 1992: *Automatic K determination by means of fractal and harmonic analysis.* Ann. Geophys., **10**, 597.

De Santis A. and Chiappini M.; 1994a: *Chaos and fractal behaviour of the geomagnetic field over polar caps: some preliminary results.* In: Porano M., Colacino, Giovanelli G., Stefanutti L. (eds), Italian Research of Antarctic Atmosphere, 45.

De Santis A. and Chiappini M.; 1994b: *Fractal and Chaotic analysis of the geomagnetic field.* Ann. Geofisica, **37**, suppl. 5.

De Santis A. et al.; 1991: *Regional Mapping of the critical frequency of the F2 layer by Spherical Cap Harmonic Expansion.* Ann. Geophysicae, **9**, 401.

De Santis A. et al.; 1992: *Regional Modelling and Mapping of the ionospheric parameters by Spherical Cap Harmonic Expansion.* Adv. Space Res., **12**, 279.

De Santis A. et al.; 1994: *Regional spherical modelling of 2D functions: the case of the critical frequency of the F2 ionospheric layer.* Computers and Geosciences, **20**, 849.

Faccenna C. et al.; 1994: *Evolution of a transfer-related basin: the Ardea basin (Latium, Central Italy).* Basin Research, **6**, 35.

Florindo F., Sagnotti L. and Scalera G.; 1994: *Using the ASCII Version of the Global Paleomagnetic Database.* EOS, **75**, 236.

Mele G., Meloni A. and Palangio P.; 1994: *A tectonomagnetic Effect Detected in Central Italy.* Ann. Geofisica, **37**, 17.

Meloni A., Cafarella L. and De Santis A.; 1992: *Historical measurements of the geomagnetic field in Italy: a short report.* In: Schroder W. (ed), Exploring the Earth: progress in geophysics since the 17th century, 189.

Meloni A. and Palangio P.; 1991: *Low noise D-I magnetometer for absolute measurements in polar regions.* HHI-Report, **22**, 147.

Meloni A., Palangio P. and Fraser-Smith A.C.; 1992: *Some characteristics of the ELF/VLF radio noise measured near l'Aquila.* IEEE Transactions on Antennas and Propagation, **40**, 233.

Meloni A. et al.; 1992: *The geophysical Observatory at Terra Nova Bay.* In: Yoshida Y. (ed) Recent progress in Antarctic Earth Science, 585.

Meloni A. et al.; 1994: *The 1990.0 magnetic repeat station survey and repeat normal reference fields for Italy.* Ann. Geofis. **37**, 949.

Sagnotti L.; 1992: *Paleomagnetic evidence for a Pleistocene counterclockwise rotation of the Sant'Arcangelo basin, southern Italy.* Geophys. Res. Lett., **19**, 135.

Sagnotti L. and Meloni A.; 1993: *Pleistocene rotations and strain in southern Italy: the example of the Sant'Arcangelo basin.* Ann. Geofisica, **36**, 83.

Sagnotti L. and Speranza F.; 1993: *Magnetic fabric analysis of the Plio-Pleistocene clayey units of the Sant'Arcangelo basin, southern Italy.* Phys. Earth Plan. Inter., **77**, 165.

Sagnotti L. et al.; 1994a: *Paleomagnetic Evidence for No Tectonic Rotation of the Central Italy Tyrrhenian Margin Since Upper Pliocene.* Geophys. Res. Lett., **21**, 481.

Sagnotti L. et al.; 1994b: *Magnetic fabric and structural setting of Plio-Pleistocene clayey units in an extensional regime: the Tyrrhenian margin of Central Italy.* J. Struct. Geol., **16**, 1243.

Scalera G., Favali P. and Florindo P.; 1993: *Use of the paleomagnetic databases for geodynamical studies: some examples from the Mediterranean region.* In: Boschi E. et al. (eds) Recent Evolution and Seismicity of the Mediterranean Region, Kluwer Academic Publishers, the Netherlands, 403.

Torta J.M. et al.; 1992: *New representation of geomagnetic SV over restricted regions by means of SCHA: application to the case of Spain.* Phys. Earth Plan. Inter., **74**, 209.

Torta J.M., Garcia A. and De Santis A.; 1993: *A geomagnetic reference field for Spain at 1990.* J. Geom. Geoelectr., **45**, 573.

Winkler A. and Sagnotti L.; 1994: *Anisotropy of anhysteretic remanence and magnetic susceptibility of marly clays from Central Italy.* Ann. Geofisica, **37**, 1027.

PHYSICS OF THE IONOSPHERE AND RADIOPROPAGATION

Most of the activities in this field have been performed by the ING and the IROE.

Ionospheric observatories and Ionospheric Survey

Contributions to the ionospheric planetary synoptic using data of the standard vertical sounding, taken at ING observatories, in Italy and in Antarctica have been regularly produced. Special campaigns of oblique radio soundings in Europe and in the world have been performed in order to validate the ionospheric prediction models used by Ionospheric Survey.

Atmospheric and ionospheric research using radio tecniques

Measurements of Total Electron Content in the Ionosphere are obtained using satellite signals in the UHF range. Two receivers are installed in the observatories of l'Aquila and Gibilmanna and are included in an international cooperation to evaluate the TEC parameter along the geographical meridien. VLF signals coming from " omega " stations are then received in Rome and in Florence to investigate the lower layer of the ionosphere and the dynamics of its absorption.

Ionospheric modelling

PRIME (Prediction Retrospective Ionospheric modelling over Europe) is a four years project that joined the efforts of the most part of the groups that in Europe are involved in the studies of ionospheric radio and propagation. An important contribution has been given by ING in the activities of PRIME, besides with data campains of measuraments, especially in the models of long term and instantaneous mapping, in the vertical electron density profile models and in the forecasting and ionospheric variability.

Solar terrestrial interactions

In the frame of the National Project of Antarctic Research, two solid state riometers at 30 and 38.2 MHz respectively, have been installed at Terra Nova Bay (74 42 S, 164 06 E) during the Italian Antarctic Expeditions 1993/1994 and 1994/1995, to provide studies on the ionospheric absorption in the lower part of the ionosphere by measuring the cosmic noise coming from the outer space. This kind of measurements will integrate the vertical ionospheric sounding and the geomagnetic data coming from the ionospheric and geomagnetic observatories already operating at Terra Nova Bay, with the objective of investigating the state of the ionosphere-magnetosphere coupling.

New radio receivers for ionospheric research

A new approach in design has been developped at IROE in the past years. This approach, the software receiver approach, is based on the real time signal processing of signals by means

of microprocessors programmed to accomplish most of the operations traditinally carried out by analog electronics. Systems to carry out the following measurements have been built.

a) Phase and amplitude of VLF signals. Two prototypes, specialized for OMEGA signals, are operated in Firenze and Roma by IROE and ING. Main objective of this measurement campaign is a comparative study of the lower edge of the ionosphere over the Central Italy.

b) Polarization angle of VHF signals. This polarimeters provide measurement of Faraday Rotation affecting signals from beacon geostationary satellites, enabling to evaluate Total Electron Content (TEC).

c) Differential Doppler affecting the two channels of Navy Navigation Satellite System (NNSS). This system enables the evaluation of TEC along the meridian track of NNSS polar satellites. Two stations, operated in two observatories of Istituto Nazionale di Geofisica (ING), namely in Gibilmanna and L'Aquila, lengthen an European chain making possible the study of TEC variability versus geographical latitude.

Data observed by other Agencies have been used too: availability of global GPS data through computer network (International GPS Service for Geodynamics, IGS, established by International Association of Geodesy) has stimulated to investigate the possibility to extract TEC information from differential Pseudorange and Phase delays.

Studies on total electron content (TEC)

The large data base (1975-1991) of TEC has enabled a statistical study of the Slab Thickness of the ionosphere. It turned out that this parameter, relating TEC to the maximum electron density provided by ionosonde through the critical frequency of the F2 layer (foF2) provides an easier modelling of the ionosphere versus geographical position, time and solar activity.

The simultaneity of IROE TEC observations during the calibration campaign of the ERS-1 altimeter, has contributed to evaluate the ionospheric error affecting its height measurements.

In the frame of the Project COST 238 (PRIME), IROE has been involved in two main tasks: the calibration of electron density profiles using TEC data to improve their top side and the test and validation of maps of ionosonde and TEC parameters.

The comparative study of TEC observed at IROE and American stations has improved a deeper understanding of the origin of ionospheric storms triggered by magnetic storms.

Investigations are carried out in the frame of Geodesy and Geodynamics programs of Italian Space Agency (ASI) in order to improve a better understanding of the techniques needed to improve the correction of ionospheric errors affecting phase and group delays.

BIBLIOGRAPHY

Banzon V.; 1992: *An analysis of 510 year data series of the dryness/wetness index for 120 regions of China.* In: Schroder W. et al. (eds), Solar-Terrestrial Variability and Global Change, Bremen-Roennebeck, pp. 223-238.

Banzon V., De Franceschi G. and Gregori G.P.; 1992: *The mathematical handling and analysis of non-homogeneous and incomplete multivariate historical data series.* In: Frenzel B. et al. (eds), European Climate Reconstructed From Documentary Data: Methods and Results, Gustav Fischer Verlag, Stuttgart, Jena, New York, pp. 137-150.

Bianchi C., Ciraolo L. and Scotto C.; 1994: *Low ionospheric observations by means of the software receiver for OMEGA signal.* Ann. Geofisica, **37**, 93.

Chiappini M. et al.; 1992: *The analysis of geomagnetic and ionospheric data.* In: Colacino M. et al. (eds), Italian Research on Antartic Atmosphere, **35**, 505.

Chiappini M., De Franceschi G. and De Santis A.; 1993: *Geomagnetic and ionospheric time series analysis.* In: Hruska J. et al. (eds), Solar Terrestrial Predictions, NOAA Environmental Research Laboratories, Boulder, Colorado, USA, **3**, 81.

Ciraolo L. and Spalla P.; 1992: *Status of Art in TEC evaluation at IROE.* Proceed. Int. Beacon Satellite Symposium, Boston 1992.

Ciraolo L. and Spalla P.; 1993: *A versatile prototype to observe Differential Doppler from NNSS satellites.* Proceed. of the GPS/Ionosphere Workshop, Neustrelitz, Sept 29-30, 1993.

Ciraolo L., Spalla P. and Capannini E.; 1994: *Development of NNSS Differential Doppler Observations at IROE.* Int. Beacon Satellite Symposium, Aberystwith U.K., 11-15 July 1994.

Ciraolo L., Spalla P. and Beni P.; 1994: *An analysis of consistency of TEC evaluated using Pseudo-Range GPS observations.* Int. Beacon Satellite Symp., Aberystwith U.K., 11-15 July 1994.

De Franceschi G. and De Santis A.; 1993: *ASHA for daily F0f2 mapping.* Working Book PRIME Workshop, Leitinger, Part. II, 289.

De Franceschi G. and De Santis A.; 1994: *PASHA: regional long-term predictions of ionospheric parameters by ASHA.* Working Book PRIME Workshop, Leitinger, Part. I, 51 and Ann. Geofisica, **37**, 209.

De Franceschi G., De Santis A. and Pau S.; 1994: *Ionospheric mapping by regional spherical harmonic analysis: new developments.* Adv. Space Res., **14**, 61.

De Franceschi G. et al.; 1991: *"Calorimetric" vs. "istantaneous" phenomena: a proposal for ionospheric research in Antartica.* In: Colacino M. et al. (eds) Italian Research on Antartic Atmosphere, **34**, 385.

De Franceschi G. et al.; 1992: *The planetary pattern of the ionosphere: 15 coefficients to synthesize the bottom of the F layer.* Ann. Geophysicae, **10**, 407.

De Franceschi G. et al; 1993: *A 10 year analysis on the planetary scale of the virtual height of the F layer.* J. Atmosph. Terr. Phys. **55**, 1553.

De Santis A. et al.; 1991: *Regional mapping of the critical frequency of the F2 layer by spherical cap harmonic expansion.* Ann. Geophysicae, **9**, 401.

De Santis A., De Franceschi G. and Kerridge D.J.; 1994: *Regional spherical modelling of 2-D functions: the case of the critical frequency of the F2 ionospheric layer.* Computers and Geosciences, **20**, 849.

De Santis A. et al.; 1992: *Regional modelling and mapping of the ionospheric characteristic parameters by spherical cap harmonic expansion.* Adv. Space Res., **12**, 279.

Di Giovanni G. and Radicella S.; 1994: *An analytical model of the electron-density profile in the ionosphere.* Adv. Spa. Res., **10**, 27.

Dominici P. et al.; 1994: *On the dawn time ionospheric structure observed during the HRIS campaigns.* Ann. Geofisica, **37**, 71.

Francis C.R. et al.; 1992: *The calibration of the ERS-1 Radar Altimeter.* ESA Report ER-RP-ESA-RA-0257.

Gregori G.P. et al.; 1992: *Geomagnetic activity vs. volcanic cycles and their forecasting. Applications to Etna and Vesuvius.* In: Schroder W. et al. (eds), Solar-Terrestrial Variability and Global Change, Bremen-Roennebeck, 188.

Gregori G.P. et al.; 1994: *Floods, climatic anomalies, and explosive vulcanism: a four decade-cycle?* In: Schroder W. et al. (eds), Geophysics: Past Achievements and Future Challenges, Bremen-Roennebeck, 109.

Kecic Z. et al.; 1994: *Further tests of the IRI and DGR model ionospheres. Proceed. of PRIME.* Ann. Geofisica, **37**, 221.

Kouris S.S., Dominici P. and Zolesi B.; 1993: *Behaviour of f0F2 over european mid-latitudes.* Adv. Space Res., **13**, 117.

Kouris S.S., Barbatsi T. and Zolesi B.; 1994: *Correlations in daily variations from the median of foF2, M(3000)F2 and h'F.* Ann. Geofisica, **37**, 221.

Kouris S.S. et al.; 1994: *Preliminary results on correlation in daily foF2 and M(3000)F2 variations,* Ann. Geofisica, **37**, 231.

Putz E. et al.; 1992: *Experiences from the Joint Valuation of European TEC data.* Proceed. Int. Beacon Symposium, Boston 1992.

Putz E. et al.; 1992: *Untersuchung zur Interpretation von Swerewellen-Signaturen in der Kombination von Elektronen Inhaltsdaten aus verschidenen Quellen.* Kleinbeobachter Berichte, 1992.

Radicella S. et al.; 1991: *Improvements and use of the R-DG model of electron density.* Proceed. III PRIME Workshop, Roma 21-25 Gennaio 1991.

Radicella S. et al.; 1992: *Preliminary Validation Tests of TEC Models.* Cost 238 (Prime)/URSI Joint Workshop on Data Validation of Ionospheric Models and Maps (VIM), Roquetes, Spain 4-6 May, 1992.

Scotto C., Bianchi C. and Zolesi B.; 1994: *The effect of solar terminator on the F2 layer.* IEE workshop 392 HF Radio System and Tecniques University of York, UK, July 1994.

Sizun H., Spalla P. and Dick M.I.; 1994: *Eindhoven pre-meeting map testing results.* Cost 238 (PRIME) Meeting, Eindhoven, May 1994.

Xiaoqing Pi et al.; 1994: *Longitudinal effects of the ionospheric Responses to Substorms at Middle and Lower Latitudes: A Case Study.* Ann. Geophysicae, March 1994.

Zhang M.L., Radicella S. and Spalla P.; 1991: *The use of simultaneous observations of TEC and ground vertical ionospheric sounding to improve the modeling of the ionosphere.* Proceed. IRI Workshop, Athens, Nov 1991.

Zolesi B. and Cander Lj.R.; 1991: *Review of Progress in Ionospheric Mapping.* N. Cim., **14C**, 155.

Zolesi B., Cander Lj.R. and de Franceschi G.; 1991: *Mapping of some ionospheric characteristics over a restricted area using SIRM, ICAP91 Antennas and Propagation.* IEE Conference Pubblication No. 333, 512.

Zolesi B., Cander LJ. R. and De Franceschi G.; 1993: *Simplified ionospheric regional model (SIRM) for Telecommunication Applications.* Radio Science, **28**, 603.

Zolesi B. et al.; 1993: *Preliminary result on oblique sounding experiment between Xinxiang (China) and Rome (Italy).* Proceed. Int. Symp. on Radio Propagation (ISRP'93), Bejing, China, 423.

Zolesi B., Cander Lj. and De Franceschi G.; 1994: *A simple algorithm for regional mid latitude ionospheric modelling.* Adv. Spa. Res., **14**, 57.