Curriculum Dr Marcello De Lauretis

The research activity at the Department of Physical and Chemical Sciences of L'Aquila University concerns arguments of Geomagnetism and Space Physics, in particular the dynamics of the Earth's magnetosphere and its interaction with the solar wind. By using data from Antarctic stations, to which designing and practical realization he personally participated, he studied phenomena concerning the energy transfer from solar wind to the magnetosphere, that occur especially in the plasma sheets close to the magnetopause and geomagnetic tail, the magnetospheric regions connected to very high latitude stations.

- Project and implementation of advanced instrumentation and data acquisition systems for ULF geomagnetic field measurements. The relating data, starting from 1985, allowed the Group of Space Physics to produce a noticeable number of international scientific publications;
- Geomagnetic sounding at the underground "Gran Sasso Laboratories", in collaboration with AT & T Bell Laboratories;
- Design and implementation of the SEGMA network (South European GeoMagnetic Array) for monitoring dynamic magnetospheric processes, in collaboration with Austrian and Bulgarian institutions;
- Identification and interpretation of the solar cycle variation of the geomagnetic field line resonance frequency;
- Design and achievement of a gradient installation in central Italy for low latitude resonance studies, in collaboration with other European countries;
- Participation in studies concerning the test, by means of simultaneous ground and space measurements (CHAMP satellite), of the model of geomagnetic field line resonance;
- Project and implementation of ULF geomagnetic field measurement stations at the Italian bases in Antarctica; personal participation (during 2003) to the nineteenth Italian expedition in Antarctica;
- Investigations of possible ULF signatures on the 2009 L'Aquila earthquake;
- Studies of some aspects of ULF geomagnetic pulsations at low and high latitudes, by using data from ground stations and satellites.
- From the study of a long duration ULF event, identified by the data of Cluster and Geotail satellites, it was possible to simultaneously monitor the upstream neighboring regions to the sub-solar point and close to the flanks of the bow shock with results, in terms of local generation waves, dependent on the orientation of the interplanetary magnetic field. It was also possible to study the transmission of external waves through the magnetosphere, by the Polar satellite data, down to the ground;
- It has been investigated the role of the solar wind density in controlling the activity of ULF waves, showing that for extremely low densities the activities disappears, regardless of the favorable conditions of the cone angle and the solar wind speed, as the generation mechanism does not operate efficiently, and few ions are reflected by a bow shock extremely weak;
- He also investigated the transmission of usptream waves at polar latitudes through the lobes of the magnetic tail, statistically examining the correspondence between magnetospheric and ground waves, at our magnetic station of Dome C, in Antarctica, suggesting that the upstream waves dragged by the wind along the flanks of the magnetosphere and transmitted as compressive waves in the lobes, are partially converted into shear waves of Alfven and propagate, traveling along the open field lines, until the polar cap;
- From the study of a long duration event of upstream waves detected by the Cluster Satellite at the nose of the bow shock, it was found that the waves outside the shock are essentially Alfven waves propagating at a small angle with respect to interplanetary magnetic field;
- It has developed a method for the accurate identification of the upstream wave events, confirming that the angle between the normal to the bow shock and the interplanetary magnetic field is the key element for the wave generation. It is also found that the foreshock region in which we observe the waves is characterized by an effective size which decreases both with the increase of the solar wind speed and with the increase of the frequency of the waves;
- He studied the background noise near the L'Aquila Observatory Geomagnetic, in the frequency range 1-100 mHz, finding a pronounced diurnal variation of both the natural signal and the artificial one, identifying the problem of separating the two contributions, of very similar morphology. The main finding of this study is that, in our region, the main noise source is the D.C. current trains;
- By analyzing ionospheric (interpolated and non-interpolated) TEC variations before and after the Mw 6.3 Abruzzo earthquake (Italy, 2009), several regional changes were observed in the studied period. After analyzing non-interpolated TEC data of 5 GPS stations in Central Italy, a local disturbance of TEC, confined at heights below 160 km (i.e. in the lower ionosphere), was also found, possibly related to the forthcoming EQ main shock;
- Recently, we have studied the possible coupling between geomagnetic activity and atmospheric dynamics in the polar cap, comparing the magnetic data of our Antarctic stations with daily values of temperature and zonal wind ERA-Interim over Antarctica, at the declining phase solar cycle 23. We found a high and statistically significant correspondence of temperature fluctuations and zonal wind in the stratosphere and troposphere with the ULF geomagnetic power, particularly the periodicity of 27 days. A clear relationship was also found between the meteorological parameters and the potential difference in the polar cap. Changes in air conductivity, due to the precipitation of energetic electrons driven by the ULF waves can affect the atmospheric dynamics;

- An analysis in Antarctica focused on time scales of several days, that characterizes the evolution of the solar wind streams, allowed us to observe that, during the local winter, the Pc5 and Pc1-2 power is correlated with the fluctuations of temperature, delayed by a few days, and the presence of common signals at the periodicity related to the solar rotation period that characterize the speed of the solar wind and the geomagnetic activity;
- A comparative study conducted in Antarctica, by using ground ULF geomagnetic field measurements and simultaneous data from the Super Dual Auroral Radar Network radar, evidenced resonant signals in the ionosphere that find correspondence in frequency/time both with the geomagnetic signals observed at ground around local noon and with oscillations of the solar wind dynamic pressure detected just upstream of the morning flank of the bow shock. The signals at Terra Nova Bay can be interpreted in terms of signatures of field line resonances occurring at lower latitudes, driven by solar wind oscillations transmitted into the magnetosphere;
- A new method, by means of the empirical mode decomposition (EMD) technique, has been developed to identify the mean field aligned (MFA) reference frames for magnetohydrodynamic waves in magnetized plasma. The method shows some undesired features of the classical moving average (MAVG) approach under particular conditions, such as spectral alteration in the rotated components, and the efficiency of the proposed alternative method, based on the EMD.
- A statistical study of Pc1–2 waves at southern polar latitudes in correspondence to the declining phase of solar cycle 23 and the onset of the solar cycle 24, allows us to analyze the solar cycle, seasonal and magnetic local time dependence and then to investigate the possible generation processes related to the solar wind–magnetosphere interaction. Polarized waves show an almost linear polarization, suggesting a wave propagation along a meridional ionospheric waveguide, from the injection region up to the latitude of the Mario Zucchelli Antarctic station. The origin of the waves appears to be due to substorm/storm related instabilities and, in the dayside, to solar wind compressions of the magnetopause. Based on these results, we propose a simple model to estimate Pc1–2 power variations depending on geomagnetic activity and solar wind density;
- We investigated the possible relationship between the ULF geomagnetic activity (Pc1-2) in Antarctica and the variations of some atmospheric parameters (tropospheric temperature, specific humidity, and cloud cover) obtained from reanalysis data set. The atmospheric parameters significantly change following the increase of geomagnetic activity within 2 days. These changes are evident in particular when the interplanetary magnetic field component is oriented southward and its y-component duskward. We suggested that both the precipitation of electrons induced by Pc1-2 activity and the intensification of the polar cap potential difference, modulating the microphysical processes in the clouds, could affect the atmosphere conditions;
- We also examined the coast effect in Antarctica, by using the geomagnetic field measurements at two coastal stations and, as a reference, at an inland temporary station. Spectral analysis in the Pc5 frequency range revealed large differences between coastal and inland stations, such as higher spectral power levels in the vertical component and higher coherence between horizontal and vertical components at coastal stations. Using the interstation method, we found that remote reference induction arrows were directed almost perpendicularly with respect to their respective coastlines, while the single station analysis shows that at the reference station the amplitude of the induction arrows is much smaller than at coastal ones, indicating that coast effect at a few hundred kilometers from the coastline is relatively small. The coast effect on polarization parameters evidenced that the azimuthal angle of polarized signals at one of the coastal stations is largely different with respect to the inland station, while the polarization ratio and ellipticity attain comparable values.

Publications.
Dr. De Lauretis is author of 53 articles on international journals with referees, 16 conference proceedings to National and International Congresses, 29 poster and 50 oral contributions to National and International Congresses and 6 internal memoranda.

Collaboration:
Istituto Nazionale di Geofisica e Vulcanologia (dr. P. Palangio); Istituto di Fisica dello Spazio Interplanetario (IFSI/INAF, dr. R. Cerulli-Irelli); Institute of the Physics of the Earth (Moscow, Russia, dr. V.A. Pilipenko); Space Research Institute, Austrian Academy of Sciences (Graz, Austria, dr. W. Magnes); Geophysical Institute of the Bulgarian Academy of Sciences (dr. P. Nenovski).

He has participated in projects funded by MIUR (biennial projects PRIN 1998, 2000, 2002, 2004, 2012), ENEA (PNRA: 1999-2001, 2002-2003, 2004-2006, 2007-2009, 2010-2011, 2013-2014), ASI ed ESA.
He is referee of international journals.

He participated in the organization of the second “Convegno Nazionale di Fisica Cosmica” (L’Aquila, 29/5 – 2/6 1984) and “Osservazioni elettromagnetiche e gravimetriche relative al sisma del 6 Aprile 2009 a L’Aquila” (L’Aquila, 26-28 April 2010).