EARTH'S MAGNETISM AT THE SOUTH POLE: A VIEW FROM INLAND AND COASTAL STATIONS AND FROM TEMPORARY INSTALLATIONS

ABSTRACT PS3 -A.56

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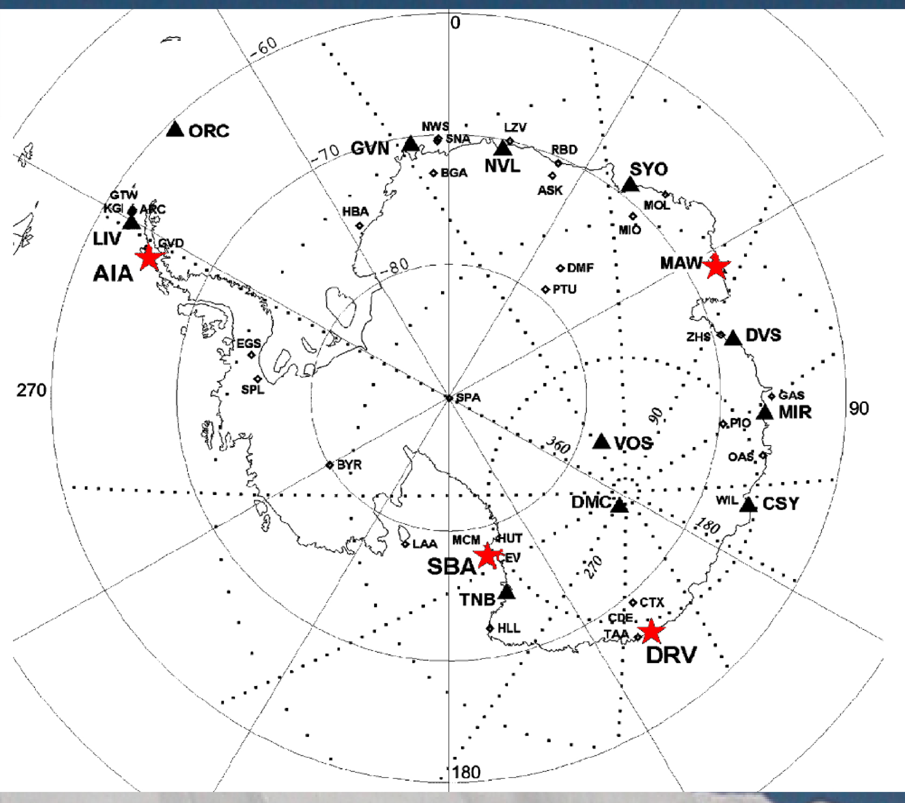
INTRODUCTION

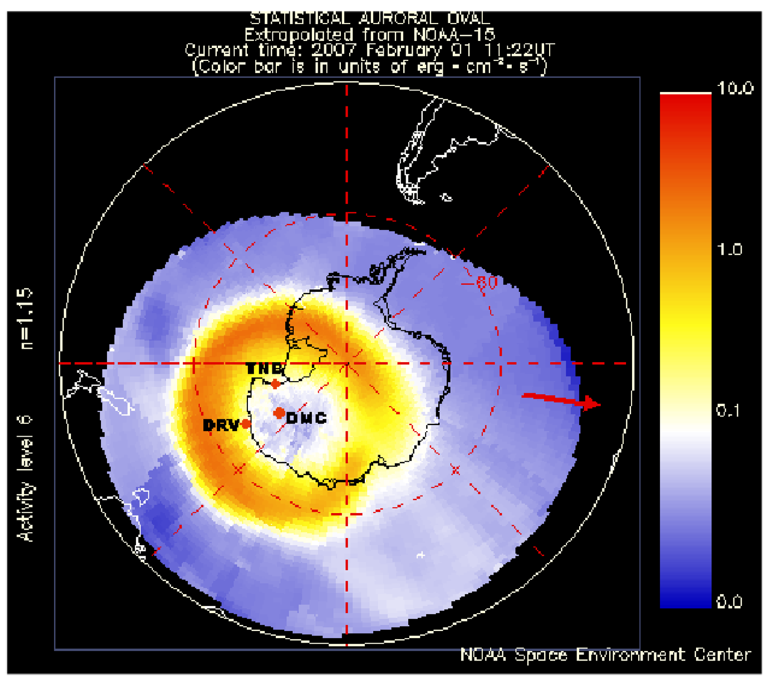
Contributions to the knowledge of the Earth's magnetism from polar regions is extremely important to understand the planetary phenomena which occur both below and above the Earth's surface. In those areas the Earth's magnetic field is stronger and the spatial and temporal changes are enhanced. At the same time polar regions are areas scarcely covered by observations for the adverse environmental conditions. We report the experience gained in several years of management and maintenance of permanent stations: MZS - Mario Zucchelli Station (formerly TNB), DRV - Dumont d'Urville (Victoria Land) and DMC, Concordia stations, Dome C) as well as temporary installations (TLD, Talos Dome) in Antarctica, showing how different acquisition systems, analysis and interpretation of data allow the scientific communities to contribute in originating important theories, models and results.

In particular, among the cited stations, Concordia represents a good example of scientific cooperation between two different countries, Italy and France. Since 2005 Concordia station remains open all year round providing facilities for a growing number of scientific researches. The station is located 1200 km from Mario Zucchelli Station (Italy), 560 km from Vostok (Russia), 1100 km from Dumont D'Urville (France) and Casey (Australia). The permanent magnetic observatory at Dome C is located above more than 3000 m of ice, and this makes the observations unaffected by crustal field contributions and coast effects. It also lays always inside the Southern Polar Cup, close to the South Geomagnetic pole. While MZS, DDU and TLD are approximately at the same geomagnetic latitude (~ 80° S) with about 2 hours total displacement in magnetic local time (MLT; see table). The availability of simultaneous measurements from all these stations allows to make interesting comparisons among the signal propagation in the azimuthal direction and studies on the open field from a high latitude site (~89° S). This is the permanent condition fullfilled by one of the two geomagnetic observatories located (together with Vostok station, VOS) in the southern polar cap, very close to the geomagnetic pole.



Location of the magnetic observatories in Antarctica. Large full triangles: open; red stars: INTERMAGNET observatories; small open squares: closed. Dotted lines: geomagnetic coordinates according to the 2005 IGRF model.

Station	Geogr. Coord.	Corr. Geom. Coord. (IGRF 2003)	MLT Noon (UT)
MZS/TNB	74.7S 164.1E	80.0S 307.7E	20:11
DRV	66.7S 140.0E	80.4S 235.7E	00:55
DMC	75.1S 123.4E	88.8S 55.7E	12:55
SBA	77.8S 166.8E	80.0S 326.5E	19:01
TLD	72.8S 159.0E	80.4S 292.4E	21:06



The location of the observatory, with a statistical pattern of the auroral power flux based on data from the Total Energy Detector on board the NOAA-15 satellite over Antarctica. The position of DMC DRV and TNB stations and the magnetic local noon (red arrow) are reported.

DMC is always inside the polar cap

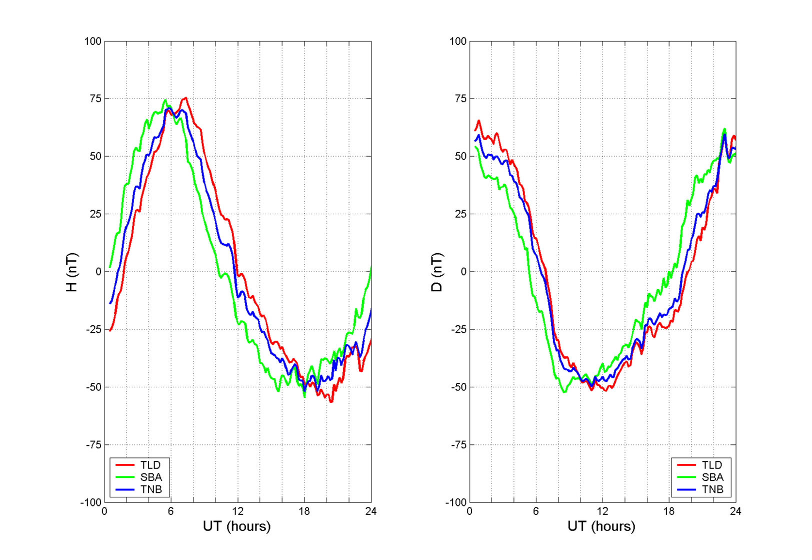
TALOS DOME, temporary installation: mean temperature -40° C

Mario Zucchelli station: summer mean temperature -5° C – winter mean temperature -30° C

Dumont d'Urville station: summer mean temperature -5° C; winter mean temperature -30° C

Concordia station: mean temperature -50° C

SOME RECENT RESULTS

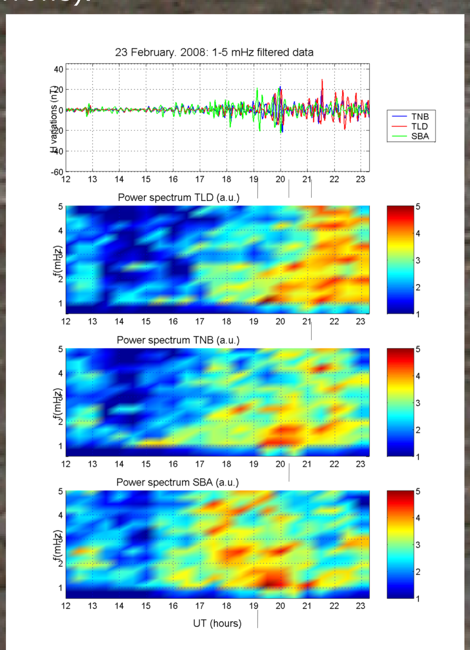


During the 2007-2008 Antarctic campaign, a LPM . magnetometer was installed at TLD. The system, with rechargeable batteries powered by a solar panel and a wind generator, has minimal power requirements. The TLD dataset consists of 1-min averages, from 1-sec original sampling rate, of the three geomagnetic field components H, D and Z recorded from 18 January to 14 March, 2008.

Above: daily distribution of the average 10-min values of the two horizontal geomagnetic field components at SBA (Scott base), TNB and TLD. Each point represents the variation at a fixed 10-min interval, averaged over the whole 57-days analyzed time period. It is evident that the diurnal variation is very similar at the three stations, but there is a clear time shift between the stations, corresponding to the difference in MLT (see Table 1): SBA is leading ~1 hr with respect to TNB and ~2 hrs with respect to TLD.

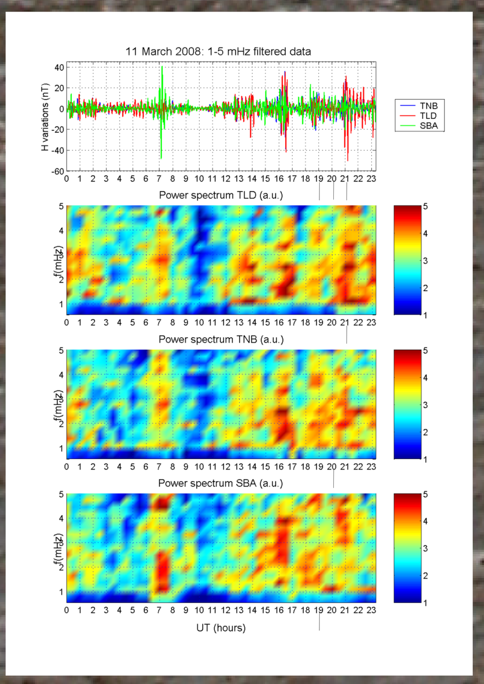
The event occurring on *23 February, 2008*: the wave activity arises from ~ 17 UT. As evident both from the filtered data and the power spectra, the signal amplitude in the first hours (17-19 UT) is greater at SBA; around 20 UT it is greater at TNB and from 21 UT at TLD. This feature indicates an increasing amplitude approaching local geomagnetic noon (indicated by the arrows).

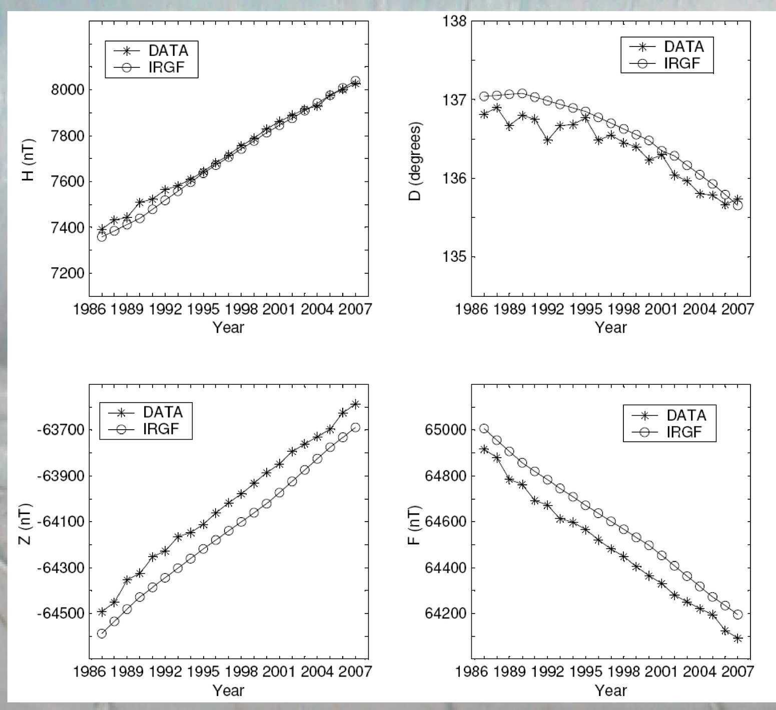
The event occurring on *11 March*, 2008: there is a sustained wave activity in the dayside MLT sector, from ~13 UT, simultaneously at the three stations. Moreover. there is a burst of activity around 7 UT, with a definitely greater amplitude and lower, broader frequency, at SBA, i.e. the station that at 07:03 UT is at MLT midnight .The arrows indicate MLT noon at the three stations.



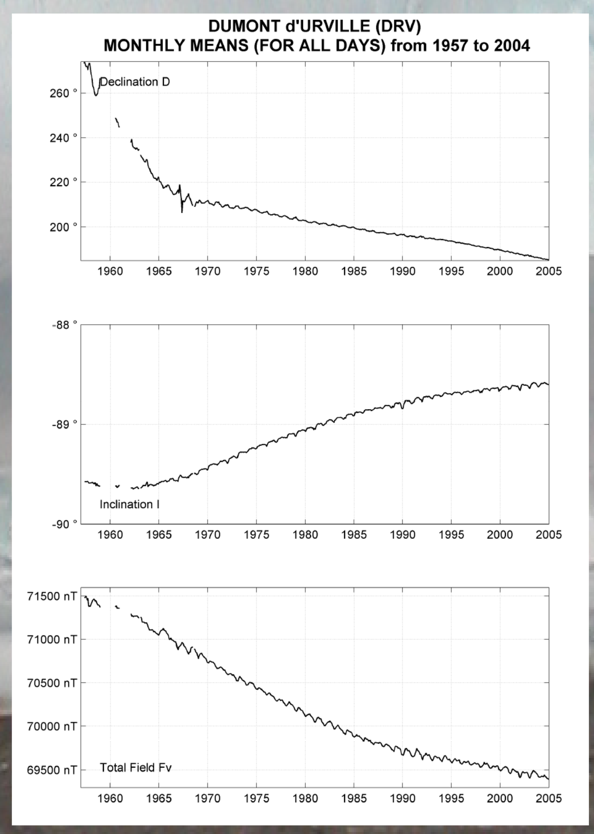
Top panel: variations of the geomagnetic field H component at the three stations, filtered in the 1-5 mHz frequency range.

Three bottom panels: dynamic power spectra at the three stations.

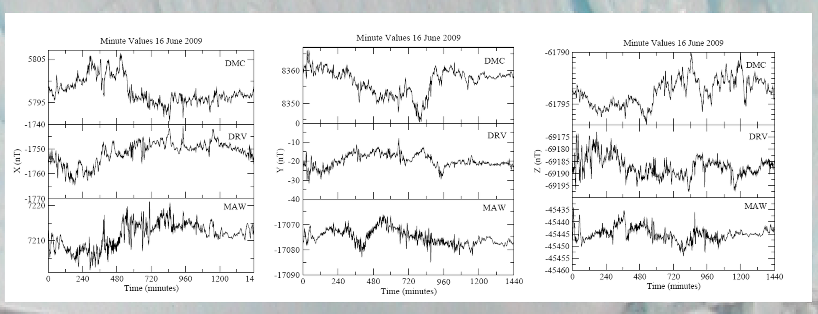




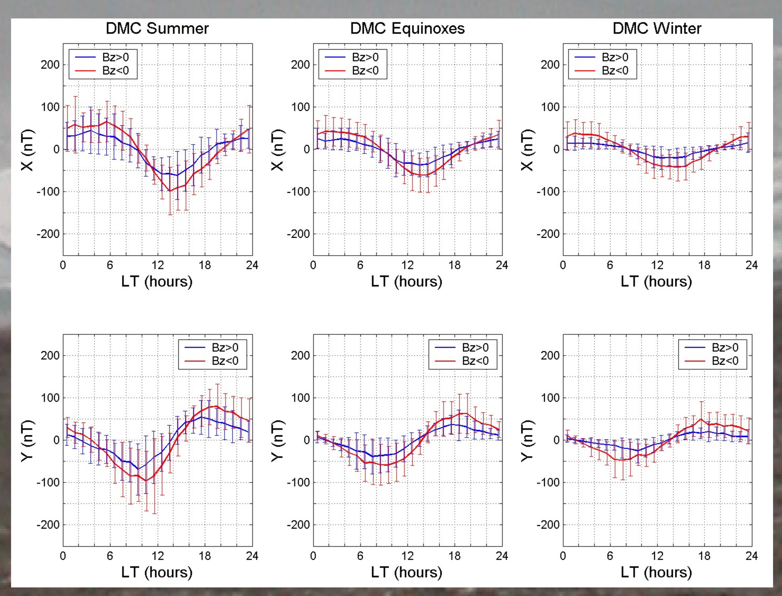
Geomagnetic field trend (1987-2007) at MARIO ZUCCHELLI STATION
The availability of a long series of data since 1987 allows to evaluate the geomagnetic field trend together with the corresponding IGRF values obtained from the web site: http://www.geomag.bgs.ac.uk.



Geomagnetic field trend (1957-2004) at Dumont d'Urville
A long series of data since 1957 allows to evaluate the geomagnetic field trend for the scalar F together with Inclination and Declination. The total field has gone down of about 2000nT in the last 50 years.



Minute values comparison between three observatories in Antarctica (Intermagnet preliminary data for DRV and MAW)



Daily distribution of the average hourly values and their standard deviation for the X and Y components for the years 2005 and 2006, considering separately the three Lloyd seasons, both for positive and negative conditions of Bz of the IMF. It is clear that the amplitude of the daily variation, which decreases from summer to winter, strongly depends on IMF conditions, being larger when Bz<0 (expanded polar cap region). Moreover the amplitude reduction from summer to winter is larger for Bz >0, indicating that in this case the contribution of ionospheric currents (strongly dependent on photo-ionization from the Sun) could be important, while for Bz <0 the key role is played by field aligned currents, with a moderate seasonal variation.

WHY GEOMAGNETIC OBSERVATORIES AT POLAR AREAS ARE PARTICULARLY IMPORTANT...

Geomagnetic observatories around the world are important for monitoring changes both of the solid Earth (geodynamo and crustal magnetism) and the external phenomena related to the Sun-Earth interaction. In polar areas geomagnetic observations are even particularly necessary since there the field is stronger (dipole almost parallel to the rotation axis) and strongly variable. The global distribution of geomagnetic observatories is still unbalanced in favor of the northern hemisphere and leaves the southern poorly covered. But polar areas have to be strenghthened by a wilder presence of new observatories, going beyond the limits to operatre in very harsh environmental conditions .

In the inland Antarctica, Concordia represents the only permanent geomagnetic observatory (with the exception of Vostok, Russia) which can provide reliable geomagnetic data (hopefully soon delivered via INTERMAGNET website, a databank of quasi-real time dataset from most of geomagnetic obs). Concordia dataset are practically unaffected by crustal contamination and the station lays all year round INSIDE the polar cap (very important for ionospheric-magnetospheric and space weather studies).

The recently introduced standard of 1-second recording at ground stations represents an important reference frame for the coming satellite missions and for solar-terrestrial environmental studies.
Modern dataset will allow a better constrain of any future global and local models for the wider coverage of the geomagnetic observations. Dataset from Concordia. finally, are an excellent base for the computation of the recently introduced POLAR MAGNETIC INDICES PMn (North Pole) and PMs (South Pole).