Geomagnetic field observations in Antarctica at the geomagnetic observatories at Terra Nova Bay and DomeC

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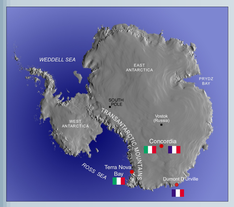
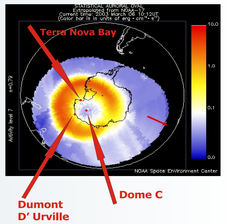
Introduction

During the 1986-87 austral summer a geomagnetic observatory was installed at the Italian Antarctic Base Mario Zucchelli Station (TNB, geographic coordinates:74.7S, 164.1E; corrected geomagnetic coordinates: 80.0S, 307.7E; magnetic local time MLT=UT-8). 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. More recently,after two short test surveys, from October 2004 a geomagnetic French-Italian observatory was installed on the Antarctic plateau (Dome C, DMC), very close to the geomagnetic pole (geographic coordinates: 75.1S, 123.4E; corrected geomagnetic coordinates:88.8S, 55.6E; magnetic local time MLT=UT-1). In this work we present some results obtained from TNB observations coming from almost twenty years of observations and also the preliminary results obtained from the analysis of the first year of data from DMC.

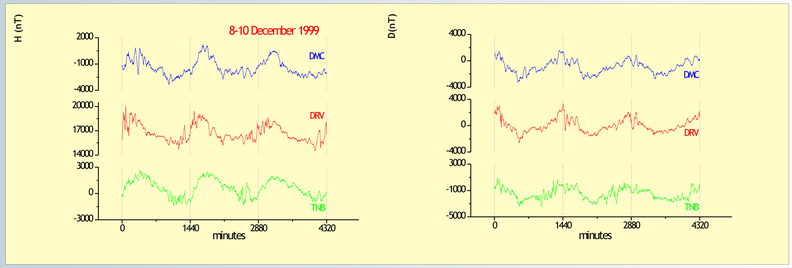


THE OBSERVATORIES

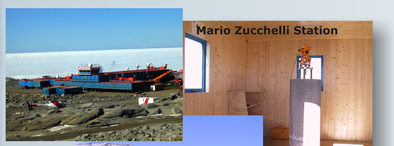
The figure at left shows the locations of Mario Zucchelli Station (BTN, Italy), Concordia station (DMC, France, Italy) and Dumont D'Urville (DRV, France) in the Antarctic continent and the auroral oval. During periods of moderate magnetic activity, BTN and DRV are inside the polar cap quite close to the auroral oval. Under particular geomagnetic conditions the stations are situated under the southern polar cusp. Instead DMC is always inside the polar cap.

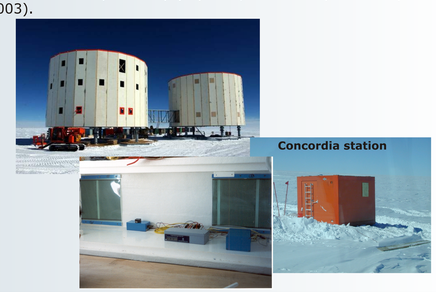


A comparison among the observatories



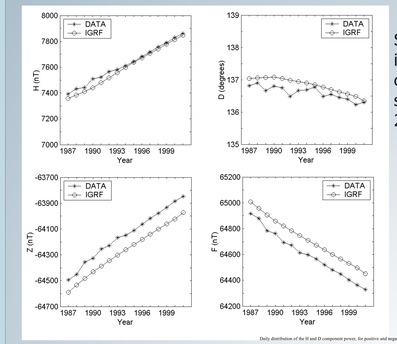
In these pictures, 1 minute plots for H and D from the three observatories (Terra Nova Bay-TNB, Dumont D'Urville-DRV and Dome C-DMC) are reported. An evident quite regular 24-hour variation is present at the three observatories for both components. Even if their location is different with respect to the auroral oval, some peculiar features are common to the three stations.
From the analysis of the whole data set available from the 1999/2000 campaign at Dome C (about a month of data) it was evident that amplitude of the daily variation varies from day to day and is closely related to the level of magnetospheric activity. A comparison with simultaneous data from TNB clearly showed that the solar wind speed control of the ULF geomagnetic field fluctuation power is very strict in the polar cap and less important close to the polar cusp (Lepidi S., Cafarella L., Francia P., Meloni A., Palangio P. and J.J. Schott, Annales Geophysicae, 21, 923, 2003).





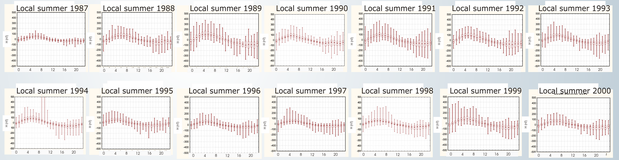
Mario Zucchelli Station

Variations in the Earth's magnetic field are continously measured by means of two three-axis fluxgate magnetometers along three orthogonal vector components oriented with respect to the local magnetic meridian; the horizontal magnetic field intensity H-component (south-north), the hortogonal-component (west-east, indicated as D in the following, used as an intensive element, expressed consequently in nT) and vertical intensity Z-component (positive increase inward). The intensity of the field F is measured by two indipendent overhouser magnetometers. Absolute measurements are performed only during austral summer.



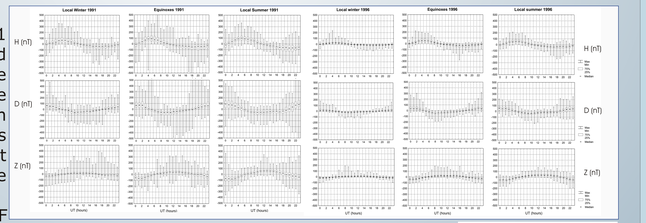
Secular variation plots at Mario Zucchelli Station in the time interval 1987-2001. Each value is compared with the corresponding value from the IRGF model. F plot shows a significant intensity decrease of about 600 nT from 1987 to 2001 (at a mean rate of about -43nT yr^{-1}).

Mean daily variations of the geomagnetic H component in the hourly mean values during local summer from 1987 to 2000 as box-plot statistics organised as a function of universal time (UT). It is evident a clear solar cycle modulation in the amplitude of the daily variation.

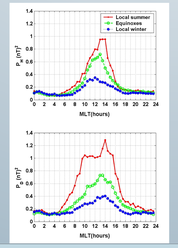


Lloyd seasons:
summer (Nov, Dec, Jan, Feb)
Equinoxes (Mar, Apr, Sep, Oct)
winter (May, Jun, Jul, Aug)

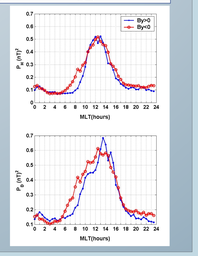
Mean daily variation in 1991 and 1996 (at maximum and minimum of the solar cycle respectively) for the three Lloyd seasons. The season and solar cycle dependence is evident on the amplitude but not on the pattern of the diurnal variation.



Daily distribution of the ULF pulsation power (H and D component), for the three Lloyd seasons.
It is evident a maximum around local geomagnetic noon, whose amplitude progressively increases from winter to summer, consistently with the polar cusp moving in summer to higher latitudes, and then approaching TNB.



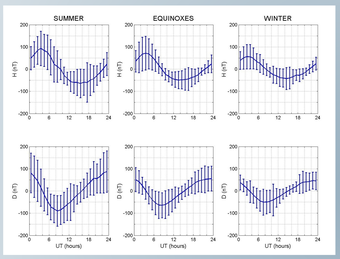
Daily distribution of the H and D component power, for positive and negative interplanetary magnetic field By conditions.
For both components the morning power level is higher for negative By conditions, consistently with an east-west displacement of the cusp.



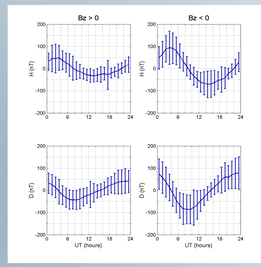
Concordia Station

In 1994 France and Italy started a program for opening a permanent scientific station on the high East Antarctic craton, at Dome C (DMC, latitude 75° 06' S, longitude 123° 23' E, about 950 km away from the coast). Domes are regions of high elevation on the Antarctic plateau (Dome C is at 3280 m). As a result of a joint French Italian agreement 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 during 2005 winter expedition. The station is intended to provide support to a growing number of scientific researches. The new station, called Concordia, is located 1200 km from Mario Zucchelli Station (Italy), 560 km from Vostok (Russia), 1100 km from Dumont D'Urville (France) and Casey (Australia).

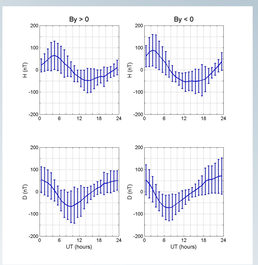
A geomagnetic observatory works at Concordia station. Its operations started regularly at the end of 2004. Also in this case variations in the Earth's magnetic field are continously monitored by a three-axis fluxgate magnetometer along three orthogonal vector components oriented with respect to the local magnetic meridian. The intensity of the field is measured by two indipendent overhouser magnetometers. Absolute measurements are performed during the whole year.



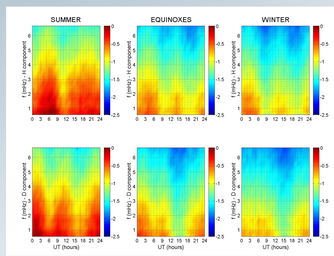
Mean daily variations of the geomagnetic H and D components during 2005, seaarately for the three Lloyd seasons. The seasonal dependence is evident on the amplitude but not on the pattern of the diurnal variation.



Mean daily variation during 2005, separately for positive and negative values of the interplanetary magnetic field Bz component. The amplitude of the variation is larger for Bz>0, when the high latitude current systems are more intense.



Mean daily variation, separately for positive and negative values of the interplanetary magnetic field By component. For By<0 the pattern of the diurnal variation is shifted earlier of about 2 hours with respect to By>0.



Dynamic average power spectra, for the three Lloyd seasons. The power level progressively decreases from summer to winter.