

NATIONAL ANTARCTIC RESEARCH PROGRAM

Terra Nova Bay, Antarctica Geomagnetic Observatory

Magnetic Observation Results

2001-2002

2002-2003

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Introduction

This report deals with activities undertaken at the Geomagnetic Observatory during the austral summer 2001-2002.

Since the Observatory was located very close to the Base, where the growing human activity gave rise to an increased artificial electromagnetic noise, during this campaign, the Observatory has been moved to a new site, called OASI, about 1 km away from the old site.

In austral summer 2001-2002, geomagnetic absolute measurements have been performed at both sites, in order to evaluate possible spatial gradients between them. Conversely, the variometer measurements have been carried out only at the new site.

This report describes the activities performed from December 3 to 30, 2001 in the old Observatory and the activities performed from December 4 to 30, 2001 in the new Observatory.

The coordinates of the old Observatory are the following:

Geographic latitude:	74.6950°S
Geographic longitude:	164.1236°E
Corrected Geomagnetic latitude (IGRF00):	80.00°S
Corrected Geomagnetic longitude (IGRF00):	306.95°E
Magnetic local time midnight:	08:11 UT

The coordinates of the new Observatory at OASI are the following:

Geographic latitude:	74.6936°S
Geographic longitude:	164.0975°E
Corrected Geomagnetic latitude (IGRF00):	80.00°S
Corrected Geomagnetic longitude (IGRF00):	306.94°E
Magnetic local time midnight:	08:11 UT

For the present work H, D and Z INTERMAGNET formatted data from the fluxgate magnetometer have been used. The proton precession magnetometers used to record F total values were Overhauser type; for a description of instruments we refer to geomagnetism text books, for example Parkinson (1983) and Wienert (1970).

Since the total intensity F time variations, at polar latitudes, where values of inclination is almost 90°, are very close to the vertical component Z time variations, the plots of total intensity time variations are not shown. They can however be obtained from the well known equation:

$$F^2=H^2+Z^2$$

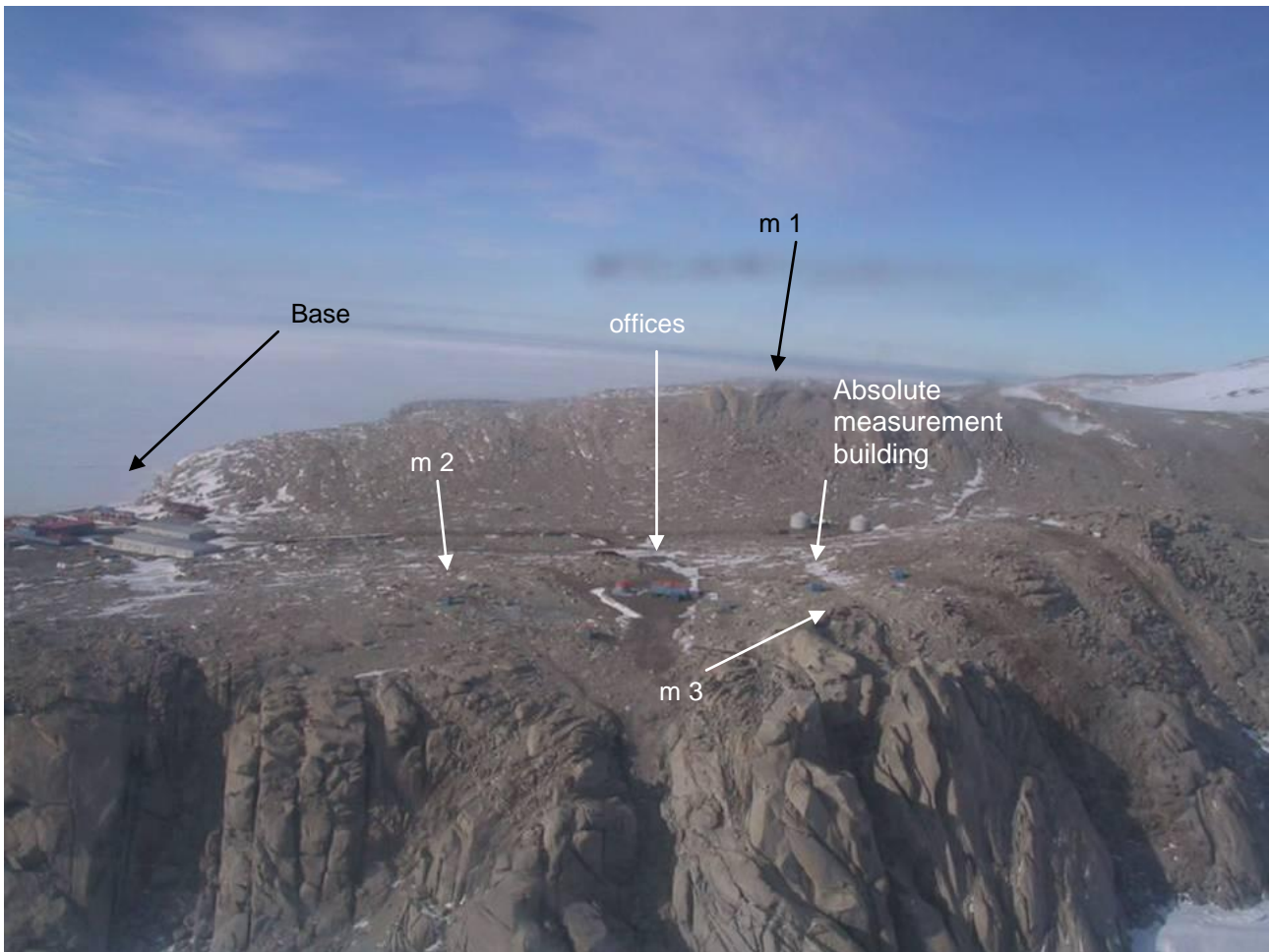
Absolute measurements

For the normal absolute measurements-taking at the Observatory, a standard fluxgate magnetometer theodolite for the determination of D, I angles has been used; please refer to previous reports for details.

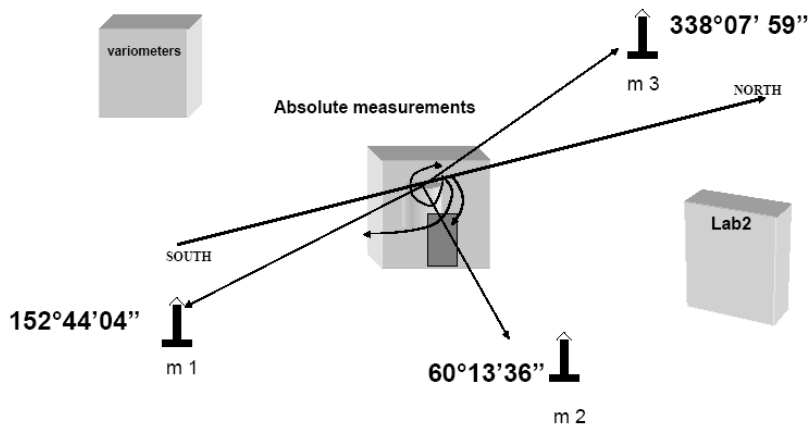
In the old site the peak of Cape Washington was used, as the preferred azimuth mark, for the computation of the Declination. The geographic coordinates of two geodetic points (Cape Washington and measuring location) were established in 1986/87 on the basis of GPS measurements; from these coordinates, an azimuth $A_z = 82^\circ 37.5'$ was found for the measuring point.

In the new site, three artificial azimuth marks, at different distances from the measuring location, were established. Also in this case, the coordinates of geodetic points (mark piers and measuring location) were established on the basis of GPS measurements. From these coordinates the azimuth values $m_1 152^\circ 44' 04''$, $m_2 60^\circ 13' 36''$ and $m_3 338^\circ 07' 59''$ were found.

In the following two figures the location of OASI buildings and of the azimuth marks is shown.



Picture showing the location of Terra Nova Bay Base, now Mario Zucchelli Station, OASI offices, absolute measurements hut, and the three new azimuth marks (m1, m2, m3).



Schematic draw of the buildings for absolute measurements, variometers and laboratories, and of the three azimuth marks (m1, m2, m3) with their azimuth values.

The proton magnetometer recordings, continuously undertaken during the execution of the DI measurements, have allowed the calculation of the absolute intensive elements. Tables 1 and 2 show absolute measurement values for each element at the new and the old site, respectively; the values of the intensive components H and Z (rounded off to the nT) were computed using the relations:

$$H = F \cdot \cos I$$

$$Z = F \cdot \sin I$$

H₀ and D₀ reference values computation

Since the fluxgate was magnetically oriented in the horizontal plane, as in the previous installations, it was necessary to compute H₀ and D₀ reference values, comparing absolute and relative measurements, at the same time. For the Z component, once the vertical levelling of the sensor was assured, it was assumed that the variations measured by fluxgate were actually the vertical component of the geomagnetic field variations.

In the description the mathematical procedure used for computation of H₀ and D₀, the following symbols are used:

H ₀ , D ₀	Reference values
H _{abs} , D _{abs}	Values of absolute measurements at time t
x,y	Instantaneous variations recorded by fluxgate system at time t

For each absolute measurement, the reference values were computed as:

$$H_0 = H_{abs} \cos(\varphi) - x$$

$$D_0 = D_{abs} - \varphi$$

where

$$\varphi = \arcsin (y/H_{\text{abs}})$$

In order to reduce this dispersion in the set, the Chauvenet criterion was used. The method, based on the hypothesis of a Gauss probability distribution for the data, consists in the elimination of measurements whose difference from the average is greater than a multiple of the standard deviation fixed by the sample dimension (in this case a value 2.49σ , corresponding to a sample of about 40 data elements, was used). This method, however, cannot be applied more than once, since an iterative procedure could exclude most of the values up to the complete elimination of the data (Worthing and Jeffner, 1943).

The average values of H_0 and D_0 are:

$H_0 = (7832 \pm 8) \text{ nT}$	New Obs.	$H_0 = (7836 \pm 8) \text{ nT}$	Old Obs.
$D_0 = (137.81 \pm 0.07) \text{ deg}$	New Obs.	$D_0 = (137.60 \pm 0.07) \text{ deg}$	Old Obs.

Daily base lines computation

After H_0 and D_0 reference values are found, the computation of the base lines in relation to absolute measurements and then the computation of the daily base lines for all days, can follow. The available data are the H, D and Z magnetic element variations recorded by fluxgate system (sampling rate 1 minute) and the absolute measurements recorded during December 2001.

The base lines computation was undertaken by two different procedures. In the case of Z, assuming that the fluxgate recordings show the variations of the vertical components, the base line (B_Z) was computed as the difference between the absolute measurements (Z_{abs}) and the fluxgate measurements (z). On the other hand, in the case of H and D, the magnetic orientation of the fluxgate system axes was taken into account. Using H_0 and D_0 reference values, the H and D base lines were computed for each absolute measurement as:

$$B_H = H_{\text{abs}} - [(H_0 + x)^2 + y^2]^{1/2}$$

$$B_D = D_{\text{abs}} - D_0 - \arctg[y/(x + H_0)]$$

Mean daily values of the base lines were obtained for those days in which more than one absolute measurement was available.

In order to have a daily base line for each magnetic element, a linear regression analysis using the least squares method has been undertaken; for H and D components the analysis was performed separately for the days before and after December 8, 2001. The results are shown in Fig. 1, where the experimental data, as well as the best fit lines are reported both for the old and the new site.

From the comparison between the measurements at the old and the new site we estimated that the gradient is:

$$\Delta H = -1.5 \text{ nT}$$

$$\Delta D = 13.0'$$

$$\Delta Z = 0.7 \text{ nT}$$

From now on, the measurements at the new site are reduced to the old site subtracting this gradient.

Using the daily base lines, one minute values for the three field elements H, D and Z were computed, only for the new site, as:

$$\begin{aligned}H &= [(H_0+x)^2 + y^2]^{1/2} + B_H \\D &= D_0 + \arctg[y/(x+ H_0)] + B_D \\Z &= z + B_Z\end{aligned}$$

In Tables 3, 4, 5 all the hourly and daily averages and the total mean values for the H, D and Z elements on the entire measuring period (from Dec 4, 2001 to Dec 30, 2001) are reported; the plots of the hourly means at OASI and at the old Observatory are shown in Fig. 2 and Fig 3. The plots of the one minute data follow in succession.

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Table captions

Table 1: Absolute measurement values 2001 at OASI

Table 2: Absolute measurement values 2001 at the Old Observatory

Table 3: Horizontal intensity hourly and daily means
(from Dec 4, 2001 to Dec 30, 2001)

Table 4: Declination hourly and daily means
(from Dec 4, 2001 to Dec 30, 2001)

Table 5: Vertical intensity hourly and daily means
(from Dec 4, 2001 to Dec 30, 2001)

Table 1**Terra Nova Bay, Geomagnetic Observatory****Absolute measurements 2001/2002 - OASI**

date julian day	D		(+)	I		(-)	(+)	(+)	(-)
	beg	end	D	beg	end	I	F	H	Z
	(LT)		(deg min)	(LT)		(deg min)	(nT)	(nT)	(nT)
338	18:28	18:33	135 49.9	18:38	18:44	82 55.4	64241	7914	63751
338	18:50	18:55	135 17.2	18:59	19:04	82 51.8	64259	7983	63761
339	18:24	18:29	136 07.7	18:32	18:39	82 44.9	64208	8106	63695
339	18:46	18:49	136 05.1	18:54	18:59	82 47.6	64221	8056	63713
340	18:41	18:45	136 17.9	18:49	18:54	82 53.6	64232	7946	63738
340	19:00	19:04	136 17.7	19:08	19:13	82 53.8	64262	7946	63769
341	19:20	19:23	135 46.1	19:27	19:31	82 55.5	64295	7920	63805
341	19:34	19:37	135 56.9	19:39	19:43	82 56.8	64309	7896	63822
342	18:46	18:50	136 02.5	18:56	19:00	82 55.2	64302	7926	63812
342	19:02	19:06	136 04.1	19:09	19:13	82 55.3	64324	7927	63833
344	18:55	18:58	136 25.3	19:02	19:07	82 53.0	64299	7965	63803
344	19:11	19:15	136 24.6	19:18	19:22	82 53.5	64302	7957	63808
345	19:09	19:12	136 48.6	19:16	19:21	82 53.6	64299	7955	63805
345	19:25	19:28	136 48.6	19:31	19:37	82 53.6	64313	7957	63819
346	18:46	18:50	137 04.5	18:53	18:58	82 51.1	64351	8008	63850
347	18:30	18:34	135 41.4	18:37	18:42	82 48.9	64249	8036	63745
347	18:47	18:50	135 38.4	18:47	18:50	82 48.5	64251	8044	63745
349	17:55	18:00	137 08.7	18:02	18:06	82 50.3	64258	8011	63757
349	18:14	18:17	136 56.3	18:20	18:26	82 52.3	64256	7973	63760
349	18:28	18:31	136 46.1	18:35	18:40	82 53.4	64252	7952	63758
351	17:18	17:22	136 47.2	17:26	17:31	82 53.4	64247	7952	63753
351	17:39	17:43	136 49.8	17:46	17:50	82 48.7	64261	8042	63756
352	18:02	18:06	136 48.9	18:09	18:14	82 53.5	64308	7957	63813
352	18:20	18:23	136 36.7	18:26	18:30	82 52.9	64297	7968	63802
353	18:05	18:09	136 47.0	18:12	18:16	82 52.4	64258	7973	63761
353	18:20	18:23	136 47.0	18:26	18:30	82 51.4	64256	7991	63757
354	17:56	17:59	137 08.5	18:02	18:06	82 53.0	64307	7968	63811
354	18:11	18:14	137 02.0	18:17	18:21	82 52.9	64318	7971	63823
355	17:10	17:13	137 05.5	17:16	17:20	82 52.4	64210	7965	63714
355	17:25	17:28	137 07.5	17:31	17:35	82 52.4	64241	7970	63745
356	18:02	18:05	137 20.5	18:08	18:12	82 50.2	64248	8011	63747
356	18:17	18:21	137 11.8	18:24	18:28	82 49.2	64261	8032	63757
358	16:48	16:52	135 24.6	16:56	16:59	82 53.0	64129	7946	63635
358	17:05	17:09	135 48.9	17:11	17:16	82 55.2	64154	7908	63664
360	18:00	18:03	136 19.2	18:06	18:11	82 55.1	64279	7925	63789
360	18:16	18:20	136 19.3	18:22	18:27	82 54.8	64273	7930	63782
361	17:22	17:25	136 20.1	17:28	17:33	82 55.5	64186	7906	63697
361	17:40	17:43	136 14.8	17:46	17:51	82 54.5	64221	7928	63730
362	19:12	19:15	135 33.3	19:18	19:21	82 52.7	64224	7963	63729
362	18:58	19:01	135 26.4	19:04	19:07	82 52.8	64234	7962	63738
363	17:10	17:13	135 34.0	17:16	17:20	82 55.4	64293	7922	63803
363	17:24	17:27	135 42.3	17:29	17:33	82 55.2	64294	7924	63803
364	18:06	18:09	137 44.1	18:11	18:15	82 49.9	64224	8014	63722

Table 2**Terra Nova Bay, Geomagnetic Observatory****Absolute measurements 2001/2002 – Old Observatory**

date	D		(+)	I		(-)	(+)	(+)	(-)
	beg	end	D	beg	end	I	F	H	Z
	(LT)		(deg min)	(LT)		(deg min)	(nT)	(nT)	(nT)
03.12.01	19 29	19 33	135 41.0	19 37	19 43	82 56	22		64262.8
03.12.01	18 52	18 56	135 23.3	19 01	19 08	82 52	37		64303.5
04.12.01	17 45	17 48	135 24.9	17 53	17 57	82 52	33		64187.2
04.12.01	17 26	17 31	135 29.1	17 35	17 40	82 49	04		64178.5
06.12.01	18 12	18 15	135 46.4	18 18	18 22	82 52	31		64213.6
06.12.01	18 00	18 03	135 46.0	18 05	18 10	82 52	22		64231.8
08.12.01	17 54	17 57	136 16.5	18 01	18 06	82 54	03		64254.8
08.12.01	18 08	18 11	136 16.8	18 14	18 18	82 52	57		64275.7
10.12.01	17 56	17 59	136 14.4	18 01	18 05	82 53	27		64285.3
10.12.01	18 07	18 11	136 10.6	18 14	18 18	82 53	40		64285.0
11.12.01	17 54	17 58	136 51.1	18 02	18 08	82 53	30		64247.2
11.12.01	18 14	18 17	136 50.7	18 20	18 24	82 53	39		64257.9
12.12.01	17 52	17 55	136 53.8	17 57	18 01	82 54	04		64304.6
12.12.01	17 39	17 42	137 1.4	17 45	17 48	82 54	16		64295.9
13.12.01	18 06	18 10	135 42.7	18 12	18 15	82 51	5		64235.6
13.12.01	17 52	17 55	135 57.5	17 58	18 01	82 48	21		64226.4
16.12.01	17 56	17 59	136 57.0	18 03	18 10	82 51	42		64388.0
17.12.01	18 42	18 45	136 51.1	18 47	18 51	82 49	22		64262.4
17.12.01	18 29	18 33	136 54.9	18 36	18 39	82 47	22		64253.7
18.12.01	19 19	19 22	136 30.6	19 23	19 26	82 51	15		64320.7
19.12.01	17 20	17 23	136 54.6	17 25	17 28	82 52	42		64228.9
19.12.01	17 33	17 36	136 39.2	17 39	17 42	82 53	1		64232.7
20.12.01	17 09	17 11	137 0.5	17 14	17 18	82 52	7		64272.9
20.12.01	17 23	17 26	137 2.5	17 28	17 32	82 52	30		64285.2
21.12.01	18 09	18 12	136 48.3	18 14	18 17	82 51	15		64274.8
21.12.01	18 19	18 22	136 40.1	18 24	18 27	82 51	07		64281.0
22.12.01	17 19	17 21	137 24.9	17 23	17 27	82 51	27		64264.4
22.12.01	17 04	17 08	137 24.9	17 11	17 14	82 52	15		64264.4
24.12.01	17 39	17 42	136 4.2	17 45	17 49	82 47	27		64226.8
24.12.01	17 51	17 54	135 44.9	17 56	18 00	82 45	33		64218.9
26.12.01	17 20	17 23	136 15.4	17 25	17 28	82 54	22		64246.6
26.12.01	17 32	17 34	136 16.7	17 36	17 40	82 54	55		64253.3
27.12.01	18 16	18 18	136 8.4	18 20	18 22	82 53	55		64249.4
27.12.01	18 27	18 29	136 1.0	18 31	18 35	82 54	55		64263.6
28.12.01	17 42	17 45	135 7.9	17 48	17 51	82 48	13		64221.9
28.12.01	17 57	17 59	134 53.7	18 01	18 04	82 49	03		64203.2
29.12.01	18 10	18 12	135 31.5	18 14	18 17	82 55	48		64301.0
29.12.01	18 20	18 22	135 27.3	18 23	18 26	82 56	27		64297.3
30.12.01	17 20	17 22	138 4.4	17 24	17 28	82 50	30		64175.2

Table 3**Terra Nova Bay Antarctica, Italian Geomagnetic Observatory***Hourly H values (nT) from Dec 4,2001 to Dec 30,2001*

UT	0	1	2	3	4	5	6	7	8	9	10	11	DAILY MEAN
	12	13	14	15	16	17	18	19	20	21	22	23	
julian day													
338	7974	7989	8046	8022	8006	7925	7949	7930	7927	7926	7918	7910	
	7889	7822	7828	7863	7868	7829	7880	7798	7839	7909	7878	7774	7904
339	7817	7960	8044	8065	8049	8087	7973	7979	7989	7938	7931	7893	
	7840	7804	7910	7870	7765	7820	7854	7845	7800	7811	7797	7805	7902
340	7914	7869	7894	7976	7969	7962	7971	7996	7947	7955	7944	7910	
	7889	7848	7832	7858	7840	7778	7833	7930	7751	7740	7950	7890	7893
341	7894	7876	7918	7990	7949	7913	7916	7922	7952	7917	7930	7902	
	7919	7886	7847	7809	7820	7815	7909	7874	7868	7839	7796	7810	7886
342	7917	7893	7869	7891	7918	7948	7926	7976	7968	7955	7942	7921	
	7904	7878	7842	7847	7870	7880	7896	7921	7906	9999	7841	7833	7902
343	7905	7879	7910	7922	7931	7985	7962	7934	7912	7901	7913	7911	
	7868	7871	7889	7870	7876	7876	7891	7872	7910	7791	7834	7867	7895
344	7893	7893	7915	7938	7960	7959	7965	7993	7982	7974	7926	7884	
	7895	7884	7844	7813	7847	7827	7767	7833	7792	7759	7808	7843	7883
345	7855	7866	7887	7927	7942	7949	7955	7941	7938	7930	7929	7912	
	7903	7886	7866	7811	7808	7743	7733	7759	7748	7808	7790	7758	7860
346	7795	7852	7883	7919	7943	7968	8028	8035	7999	8007	7957	7963	
	7906	7847	7839	7809	7792	7777	7788	7757	7747	7742	7734	7803	7870
347	7891	7960	8010	8029	8049	8046	8030	7991	7953	7902	7883	7865	
	7871	7869	7848	7857	7859	7845	7855	7888	7889	7820	7883	7865	7915
348	7889	7921	7955	7987	7970	7919	7936	7928	7912	7933	7932	7944	
	7939	7912	7874	7848	7837	7826	7812	7825	7791	7746	7920	7808	7890
349	7893	7922	7889	7975	8015	7986	7973	8010	7988	7942	7904	7881	
	7824	7792	7804	7820	7831	7868	7955	8089	7952	7817	7746	7835	7904
350	7824	7847	7855	7939	7993	8052	8049	8091	7952	7990	7928	7914	
	7886	7839	7807	7788	7728	7671	7659	7702	7774	7789	7777	7758	7859
351	7802	7842	7889	7901	7978	8061	8053	8110	8022	8046	8007	7987	
	7916	7896	7883	7839	7723	7697	7801	7933	7741	7882	7788	7839	7901
352	7819	7872	7942	7895	7939	7974	8008	7985	8015	7950	7950	7973	
	7941	7892	7860	7823	7783	7837	7826	7812	7780	7792	7808	7839	7888
353	7904	7897	7854	7945	7963	7998	8048	8032	7974	7988	7987	7953	
	7890	7830	7823	7831	7809	7788	7834	7822	7717	7791	7753	7809	7885
354	7834	7882	7885	7935	7973	7970	7967	7951	7970	7969	7953	7919	
	7882	7885	7871	7814	7845	7825	7764	7784	7757	7732	7723	7737	7868
355	7848	7861	7919	7960	7966	8002	8011	8026	7991	7993	7969	7966	
	7894	7811	7812	7807	7785	7736	7700	7650	7566	7650	7738	7796	7852
356	7844	7879	7916	7917	7985	8034	8037	8038	7989	7976	7937	7948	
	7933	7872	7843	7826	7852	7824	7785	7693	7726	7789	7849	7857	7889
357	7836	7858	7889	7941	7917	7982	8030	8018	7997	7979	7908	7893	
	7874	7861	7835	7842	7812	7784	7811	7853	7796	7834	7857	7837	7885
358	7863	7904	8003	8055	7985	8113	8063	8151	8146	8070	7975	7887	
	7868	7861	7825	7723	7764	7765	7749	7817	7793	7725	7754	7803	7903
359	7832	7933	8030	7946	7938	7968	8012	7989	7949	7893	7968	7909	
	7855	7852	7859	7858	7830	7842	7814	7890	7919	7787	7701	7730	7888
360	7847	7947	7942	7925	7936	7933	7915	7906	7893	7907	7927	7920	
	7902	7846	7860	7908	7882	7872	7855	7808	7791	7799	7913	7914	7889
361	7896	7992	7980	7909	7925	7943	8022	8016	7952	7964	7987	7963	
	7922	7922	7923	7890	7846	7834	7814	7827	7804	7911	7901	7914	7919
362	7937	7922	7942	7929	7991	8011	7971	7986	7934	7905	7885	7863	
	7855	7841	7849	7825	7826	7840	7842	7886	7828	7816	7799	7833	7888
363	7846	7868	7883	7903	7919	7916	7917	7932	7845	7798	7833	7832	
	7868	7866	7828	7846	7854	7834	7838	7976	7999	7928	7920	7860	7879
364	7718	7879	7826	7926	7996	8047	8057	8009	7895	7884	7947	7965	
	7911	7921	7903	7894	7913	7958	7994	7972	8031	7714	7647	7827	7910

TOTAL MEAN = 7889 nT

Table 4**Terra Nova Bay Antarctica, Italian Geomagnetic Observatory***Hourly D values from Dec 4,2001 to Dec 30,2001
(deg:first three digit, minutes: second two digits)*

UT	0	1	2	3	4	5	6	7	8	9	10	11	DAILY MEAN
	12	13	14	15	16	17	18	19	20	21	22	23	
julian day													
338	13545	13609	13534	13528	13534	13536	13540	13534	13542	13548	13530	13521	
	13527	13546	13545	13525	13537	13554	13518	13506	13520	13521	13459	13619	13535
339	13703	13647	13626	13606	13605	13554	13609	13531	13525	13510	13521	13529	
	13560	13607	13523	13527	13605	13544	13525	13511	13550	13642	13623	13553	13554
340	13605	13552	13638	13619	13553	13557	13554	13527	13547	13545	13514	13532	
	13525	13552	13601	13533	13532	13528	13533	13603	13522	13620	13511	13544	13546
341	13603	13607	13554	13553	13559	13551	13546	13528	13520	13525	13524	13529	
	13532	13530	13521	13518	13522	13548	13536	13506	13651	13627	13626	13614	13545
342	13608	13558	13626	13635	13618	13603	13544	13530	13521	13514	13526	13529	
	13531	13520	13513	13539	13543	13521	13537	13619	13631	99999	13613	13539	13548
343	13531	13560	13614	13620	13610	13554	13537	13531	13531	13537	13545	13549	
	13553	13602	13550	13546	13545	13546	13526	13500	13513	13514	13532	13559	13544
344	13602	13612	13625	13626	13617	13612	13608	13555	13546	13547	13548	13548	
	13553	13547	13558	13619	13611	13553	13623	13625	13641	13710	13711	13719	13615
345	13726	13701	13655	13657	13655	13647	13631	13617	13605	13550	13549	13544	
	13531	13533	13545	13611	13611	13636	13624	13557	13701	13708	13729	13720	13628
346	13719	13742	13659	13722	13707	13647	13647	13636	13617	13545	13445	13459	
	13520	13527	13518	13512	13516	13527	13533	13541	13555	13607	13618	13626	13606
347	13649	13708	13655	13626	13603	13530	13516	13513	13530	13538	13543	13554	
	13555	13559	13601	13601	13545	13548	13559	13611	13620	13605	13604	13620	13602
348	13608	13606	13607	13550	13549	13557	13557	13559	13557	13545	13549	13540	
	13519	13524	13516	13526	13535	13501	13509	13500	13504	13538	13611	13825	13546
349	13658	13651	13719	13729	13703	13636	13633	13619	13558	13544	13548	13550	
	13558	13611	13556	13556	13543	13511	13523	13530	13655	13803	13741	13747	13627
350	13743	13749	13753	13746	13736	13650	13624	13621	13605	13544	13601	13600	
	13559	13604	13621	13630	13657	13712	13725	13727	13749	13735	13720	13729	13656
351	13704	13710	13714	13730	13638	13649	13609	13542	13543	13536	13545	13531	
	13526	13524	13513	13447	13440	13520	13741	13648	13655	13732	13712	13726	13618
352	13728	13745	13739	13645	13654	13627	13625	13616	13607	13553	13517	13507	
	13507	13527	13540	13555	13616	13560	13611	13613	13630	13702	13726	13704	13622
353	13709	13718	13730	13659	13646	13633	13603	13556	13557	13545	13515	13559	
	13559	13604	13611	13600	13622	13547	13615	13601	13558	13656	13647	13705	13622
354	13705	13708	13644	13641	13700	13646	13645	13638	13630	13601	13536	13548	
	13602	13553	13552	13614	13621	13613	13633	13651	13644	13651	13638	13631	13629
355	13644	13635	13630	13640	13656	13637	13631	13608	13558	13548	13541	13510	
	13551	13558	13601	13525	13550	13524	13550	13623	13607	13638	13656	13624	13610
356	13652	13717	13729	13732	13720	13654	13633	13614	13612	13605	13529	13506	
	13525	13549	13601	13613	13603	13601	13612	13629	13709	13717	13645	13645	13628
357	13712	13703	13659	13655	13628	13633	13612	13557	13600	13603	13556	13538	
	13545	13551	13606	13605	13553	13622	13623	13613	13612	13617	13620	13644	13618
358	13751	13716	13526	13519	13555	13603	13511	13517	13524	13506	13526	13510	
	13518	13422	13445	13509	13435	13543	13602	13559	13638	13733	13725	13744	13552
359	13724	13752	13631	13622	13625	13611	13556	13552	13539	13537	13521	13515	
	13517	13530	13527	13523	13541	13535	13604	13501	13452	13450	13542	13628	13551
360	13624	13629	13557	13604	13609	13559	13558	13554	13557	13555	13550	13543	
	13540	13555	13554	13515	13518	13449	13514	13453	13453	13448	13510	13525	13539
361	13614	13602	13539	13559	13604	13556	13537	13527	13519	13521	13511	13506	
	13511	13507	13459	13502	13512	13448	13450	13457	13428	13416	13536	13434	13517
362	13438	13514	13509	13515	13507	13501	13515	13515	13520	13526	13539	13548	
	13549	13545	13540	13558	13600	13554	13610	13651	13802	13812	13759	13725	13557
363	13720	13637	13524	13516	13528	13531	13528	13617	13542	13546	13537	13534	
	13507	13508	13515	13457	13439	13516	13608	13605	13438	13615	13528	13540	13537
364	13714	13703	13813	13759	13754	13723	13701	13559	13516	13507	13507	13512	
	13522	13510	13517	13507	13450	13507	13527	13615	13328	13622	13549	13338	13553

TOTAL MEAN = 136° 2.4'

Table 5**Terra Nova Bay Antarctica, Italian Geomagnetic Observatory***Hourly Z values (nT) from Dec 4,2001 to Dec 30,2001 (values must be considered negative)*

UT	0	1	2	3	4	5	6	7	8	9	10	11	DAILY MEAN
	12	13	14	15	16	17	18	19	20	21	22	23	
julian day													
338	63499	63525	63558	63595	63661	63726	63772	63787	63802	63809	63802	63799	
	63808	63821	63834	63840	63788	63757	63816	63735	63622	63783	63648	63587	63724
339	63563	63543	63585	63645	63666	63696	63727	63774	63782	63790	63787	63805	
	63836	63850	63852	63804	63801	63803	63815	63780	63735	63841	63703	63596	63741
340	63609	63695	63751	63716	63756	63729	63786	63792	63784	63818	63828	63839	
	63870	63900	63895	63862	63796	63847	63754	63776	63770	63769	63765	63800	63788
341	63639	63750	63727	63709	63713	63759	63804	63810	63783	63788	63791	63799	
	63818	63829	63854	63854	63810	63748	63740	63786	63810	63891	63756	63631	63775
342	63620	63666	63687	63739	63732	63788	63824	63816	63799	63811	63815	63817	
	63815	63822	63855	63862	63844	63853	63787	63766	63830	99999	63858	63624	63784
343	63704	63736	63754	63765	63760	63781	63800	63803	63797	63798	63805	63824	
	63838	63852	63861	63844	63843	63830	63861	63803	63799	63708	63613	63679	63786
344	63692	63732	63754	63765	63789	63800	63811	63824	63830	63844	63855	63859	
	63877	63888	63899	63908	63860	63889	63855	63796	63778	63830	63815	63774	63822
345	63743	63670	63712	63733	63751	63772	63817	63844	63862	63861	63859	63862	
	63874	63858	63878	63938	63973	63986	63926	63860	63846	63818	63781	63758	63832
346	63728	63711	63738	63782	63805	63835	63844	63851	63864	63894	63911	63892	
	63867	63840	63823	63818	63825	63823	63805	63769	63747	63726	63642	63608	63798
347	63574	63586	63639	63685	63707	63741	63754	63763	63775	63796	63825	63839	
	63829	63853	63842	63833	63806	63783	63773	63792	63826	63832	63774	63781	63767
348	63779	63760	63756	63753	63756	63765	63797	63824	63837	63836	63833	63855	
	63882	63893	63904	63857	63830	63849	63807	63753	63670	63659	63725	63814	63800
349	63753	63700	63743	63778	63785	63769	63804	63860	63872	63894	63909	63928	
	63931	63936	63843	63880	63832	63694	63604	63661	63625	63736	63762	63758	63794
350	63753	63690	63699	63749	63814	63868	63916	63856	63913	63946	63949	63958	
	63964	64013	63979	63964	63953	63943	63889	63937	63784	63790	63799	63799	63872
351	63820	63784	63775	63762	63761	63757	63801	63850	63859	63875	63916	63944	
	63937	64063	64031	64011	64074	64088	63908	63701	63929	63913	63835	63838	63885
352	63747	63735	63745	63779	63775	63802	63816	63831	63848	63871	63888	63910	
	63934	63910	63894	63924	63931	63865	63843	63772	63806	63783	63789	63771	63832
353	63774	63723	63689	63703	63734	63770	63812	63813	63822	63840	63883	63904	
	63911	63896	63895	63932	63880	63903	63846	63814	63840	63816	63761	63804	63824
354	63846	63819	63792	63773	63787	63821	63844	63857	63866	63868	63873	63873	
	63910	63942	63922	63926	63890	63915	63871	63788	63753	63774	63761	63764	63843
355	63726	63676	63707	63707	63731	63777	63792	63800	63819	63839	63850	63871	
	63877	63874	63943	64001	63995	64002	63968	63935	63765	63730	63711	63718	63826
356	63810	63757	63755	63762	63760	63758	63785	63798	63813	63850	63870	63879	
	63872	63877	63885	63843	63861	63870	63857	63897	63889	63756	63746	63728	63820
357	63706	63751	63763	63769	63786	63798	63803	63805	63819	63843	63871	63864	
	63870	63881	63881	63876	63905	63897	63875	63828	63807	63789	63777	63739	63821
358	63733	63779	63716	63628	63690	63698	63734	63771	63790	63812	63814	63831	
	63812	63887	63894	63839	63855	63849	63822	63809	63850	63885	63853	63825	63799
359	63798	63772	63719	63728	63742	63751	63758	63778	63788	63793	63804	63814	
	63826	63835	63830	63812	63794	63757	63786	63754	63732	63637	63538	63544	63754
360	63549	63519	63637	63742	63763	63790	63808	63820	63815	63818	63829	63832	
	63831	63824	63836	63842	63819	63806	63764	63728	63653	63545	63597	63647	63742
361	63515	63558	63640	63701	63720	63762	63763	63780	63771	63777	63788	63802	
	63801	63802	63835	63848	63831	63817	63758	63697	63637	63659	63883	63736	63745
362	63777	63763	63720	63717	63716	63713	63738	63772	63769	63775	63814	63829	
	63817	63834	63835	63836	63816	63769	63700	63706	63729	63820	63830	63816	63775
363	63763	63782	63796	63807	63806	63806	63810	63833	63845	63844	63848	63829	
	63820	63840	63782	63764	63713	63633	63628	63637	63633	63790	63719	63498	63759
364	63543	63524	63529	63643	63676	63740	63781	63838	63863	63782	63813	63796	
	63789	63794	63847	63845	63838	63859	63825	63778	63687	63658	63558	63309	63721

TOTAL MEAN = 63794 nT

Figure Captions

Fig 1: Scatter plot and linear regression for daily H, D and Z¹ base lines both for OASI and the Old Observatory.

Fig 2: Hourly means of the H, D and Z¹ elements during the whole campaign at OASI.

Fig 3: Hourly means of the H, D and Z¹ elements during the whole campaign at the Old Observatory.

Fig. 4 – 32: Daily plots of the one minute values of the H, D and Z¹ elements.

¹ Z values must be considered negative

Terra Nova Bay Z_H and D base lines 2001/2002

OASI/2001/2002: B_Z (deg) = $0.27 * dd + 63860.93$
 OLD OBS.: 2001/2002: B_Z (deg) = $0.31 * dd + 63860.98$

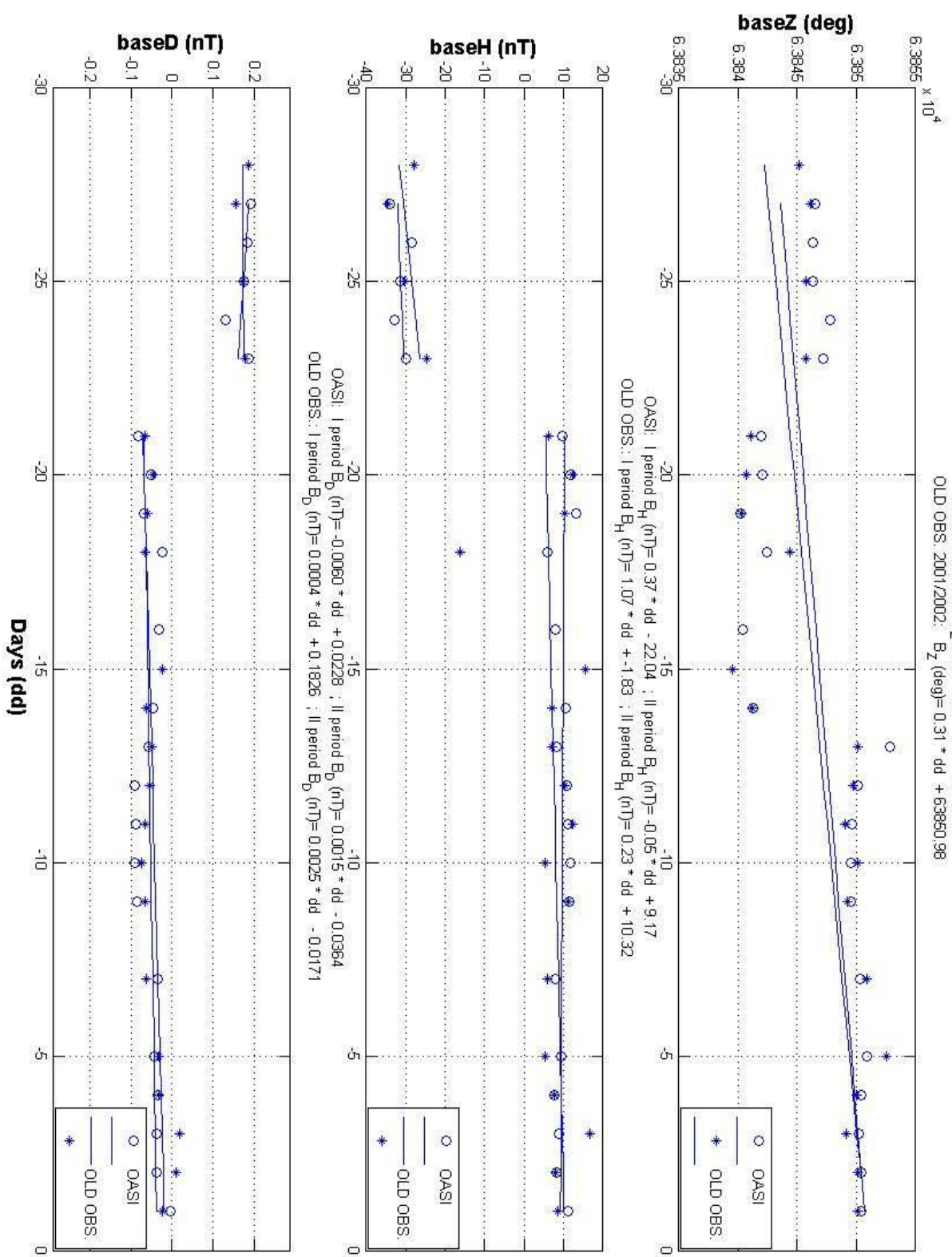


Fig.1

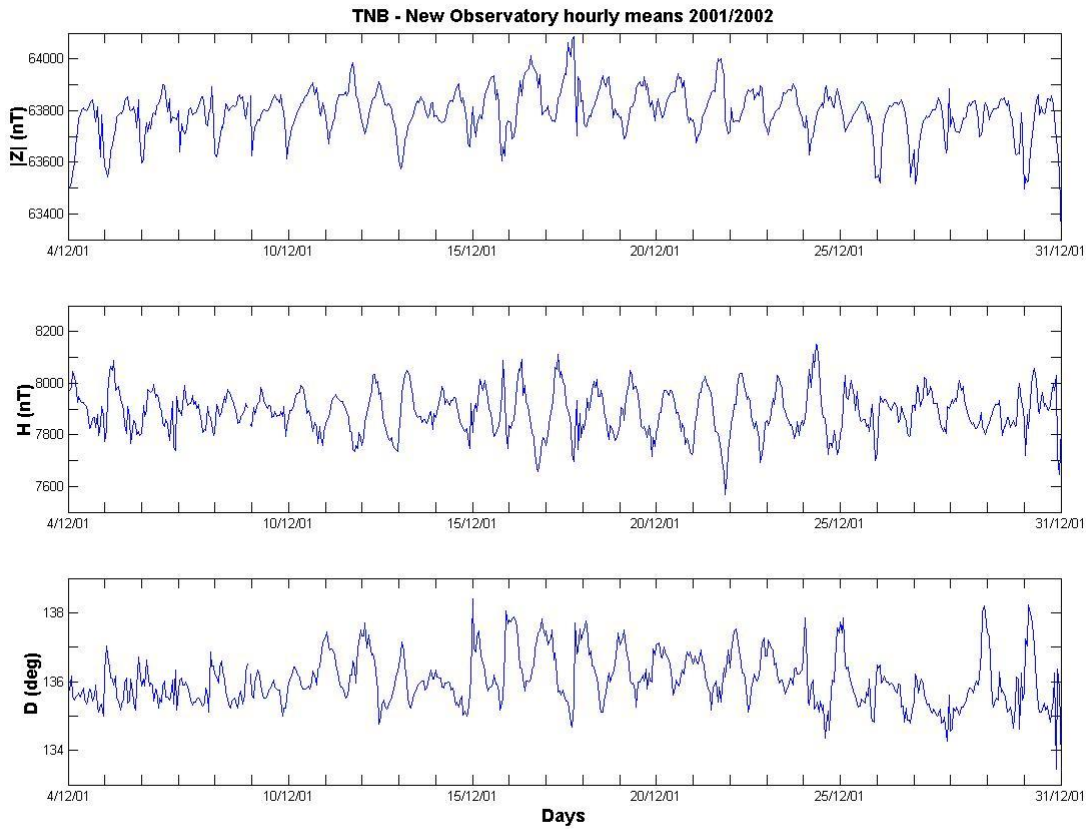


Fig.2

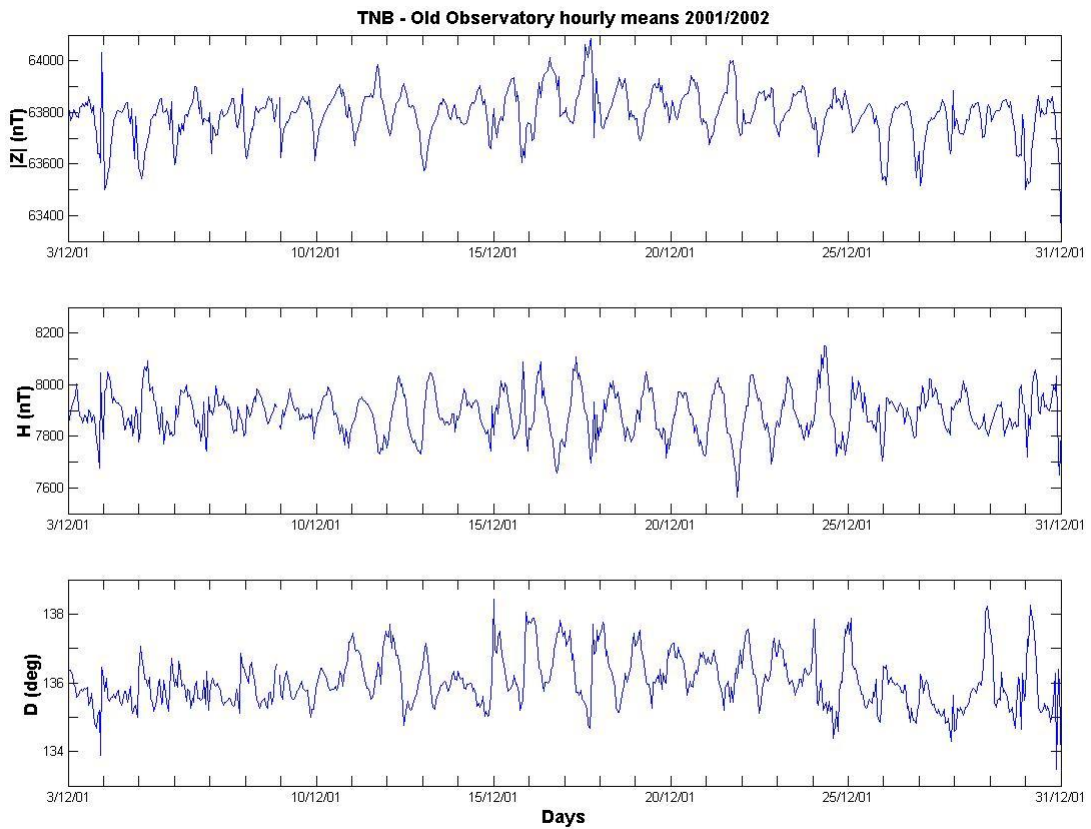
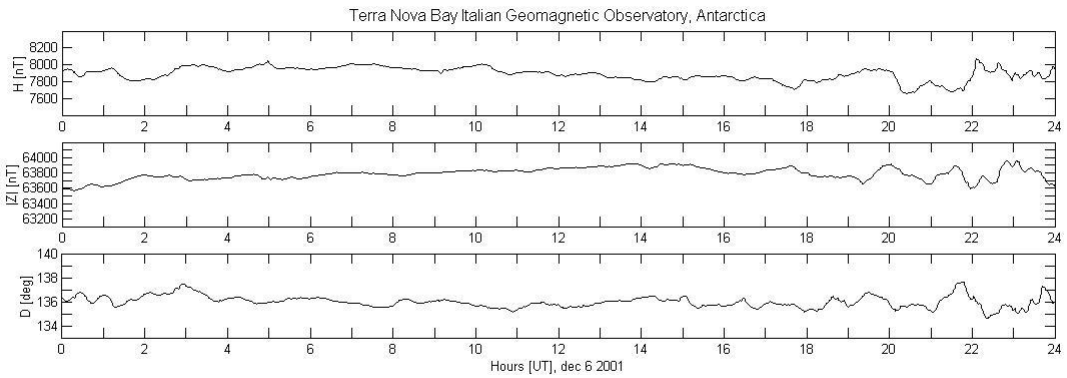
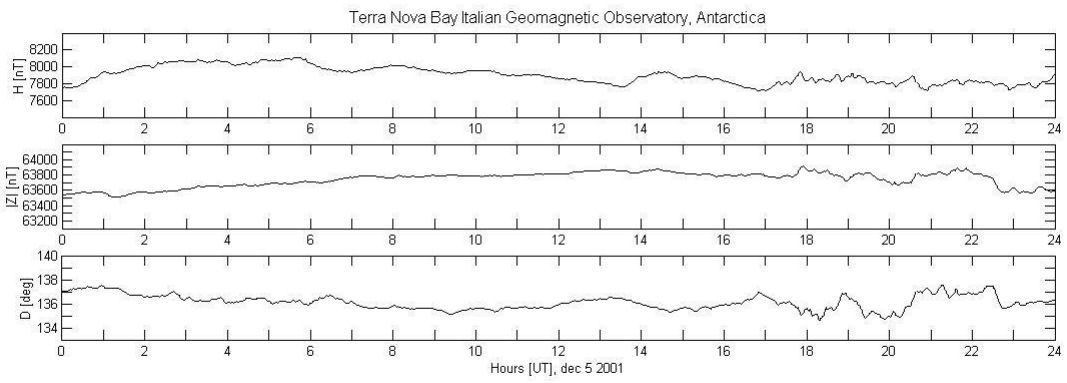
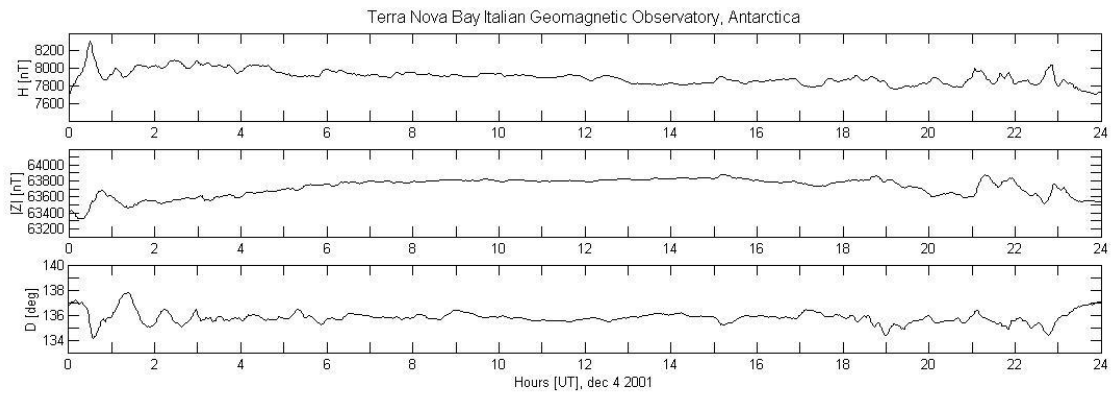
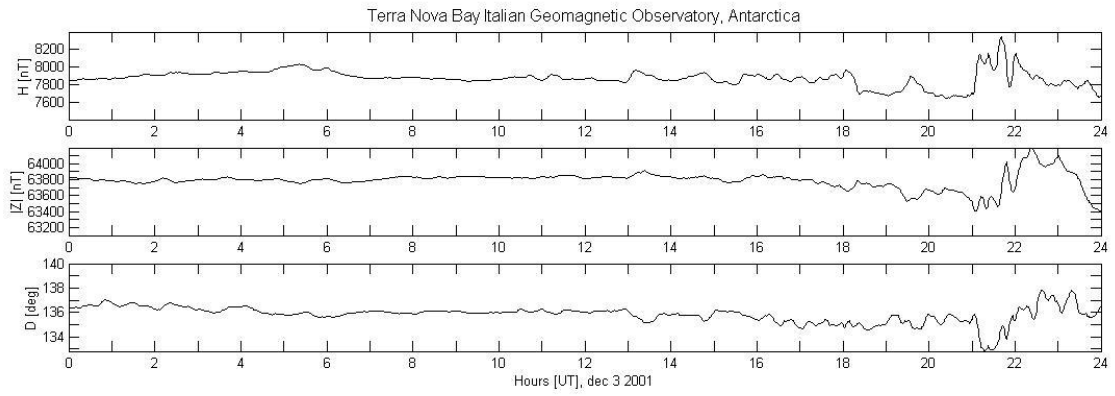
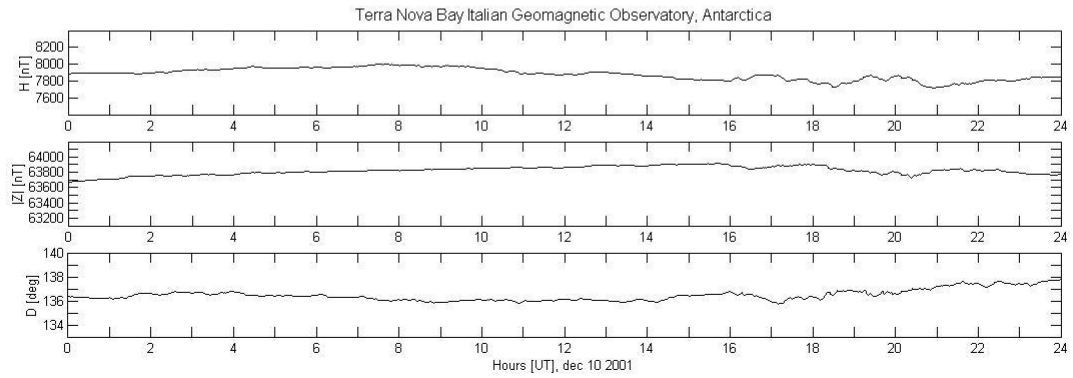
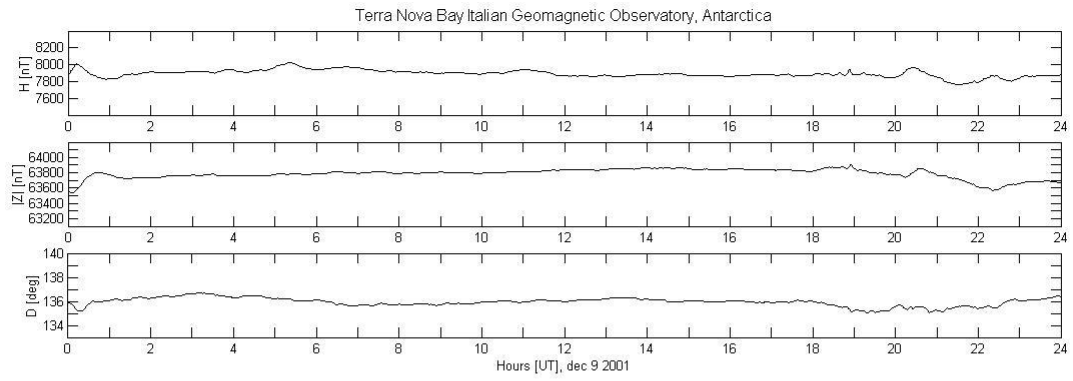
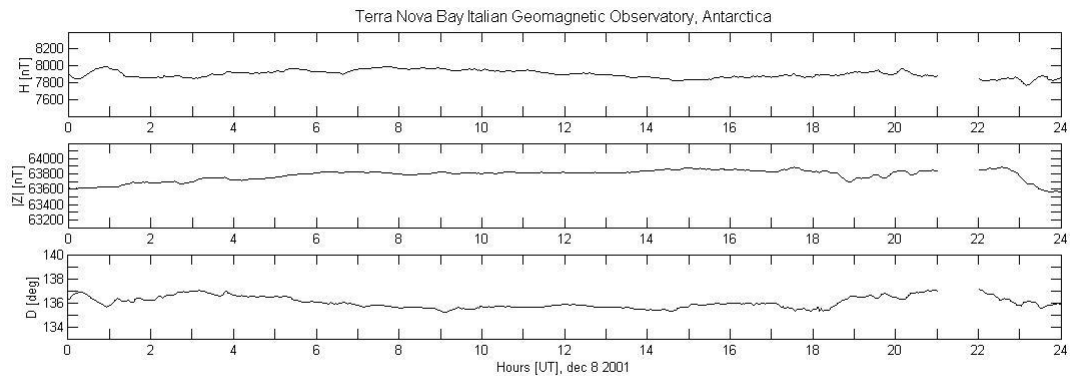
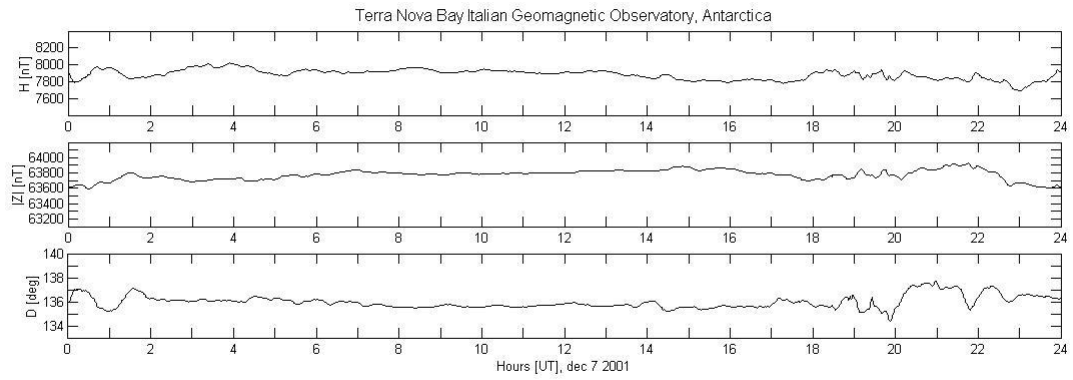
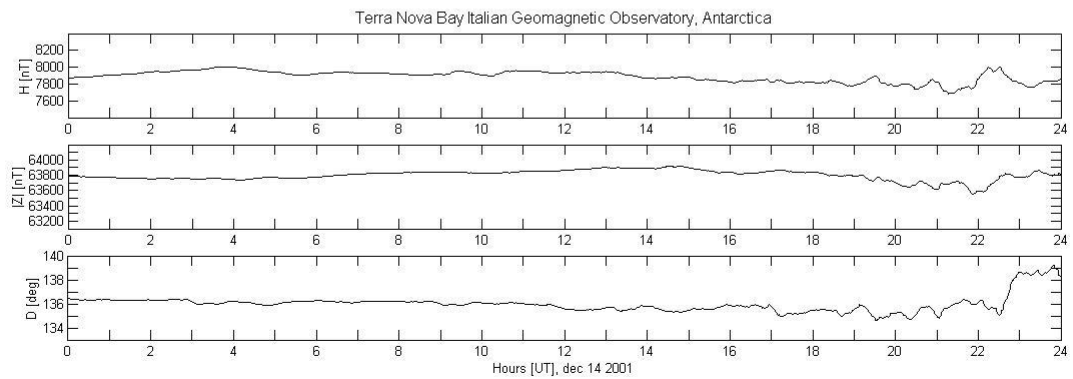
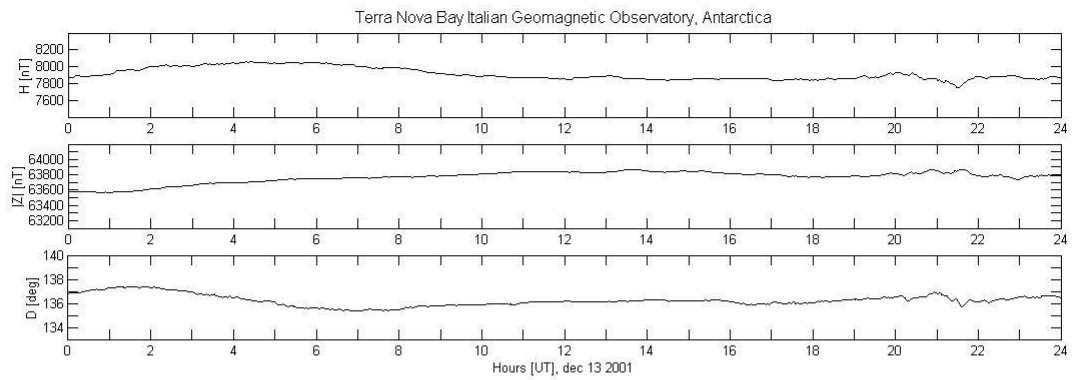
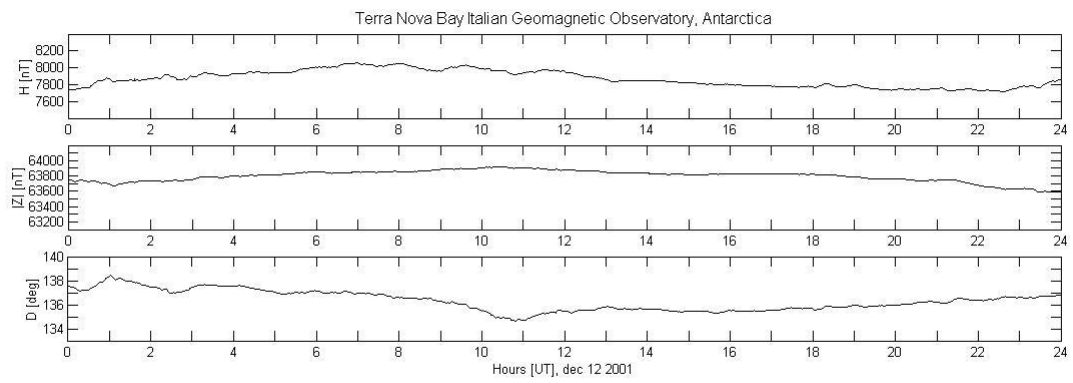
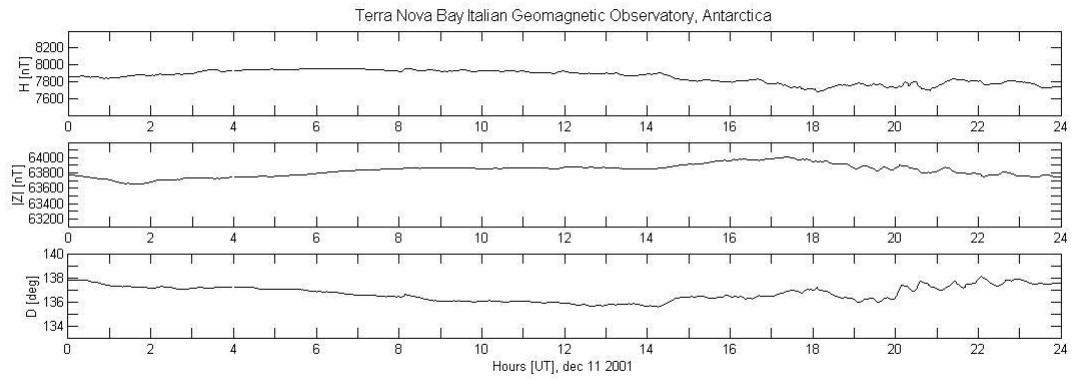


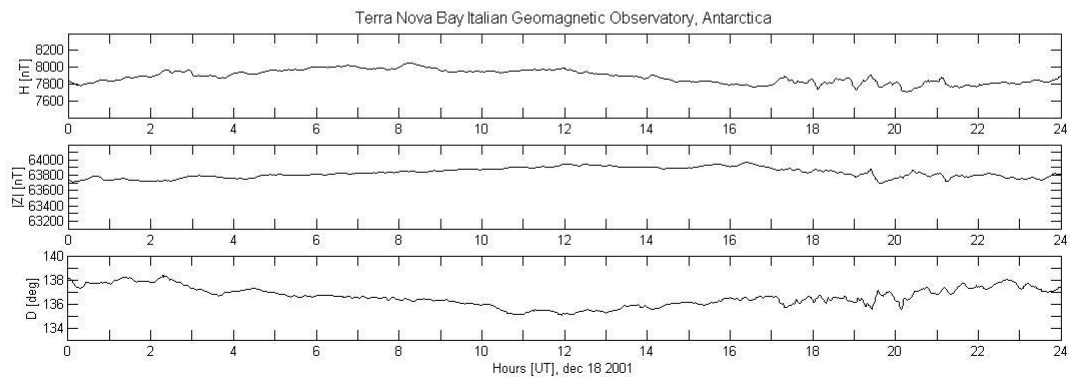
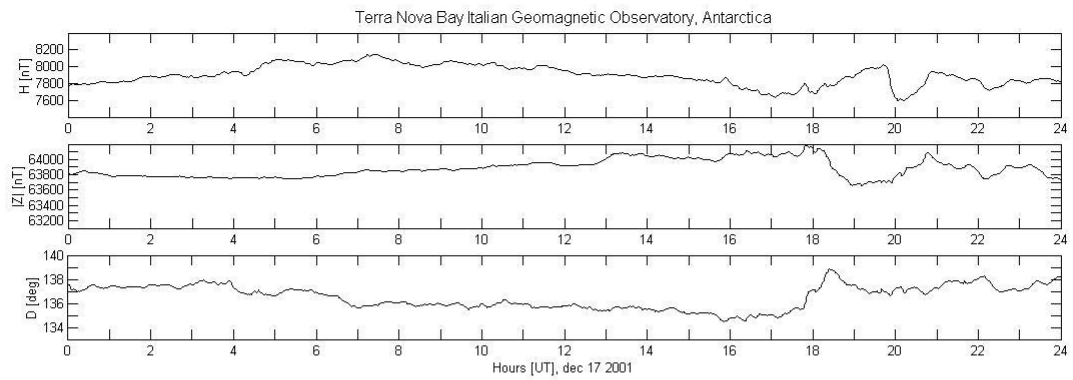
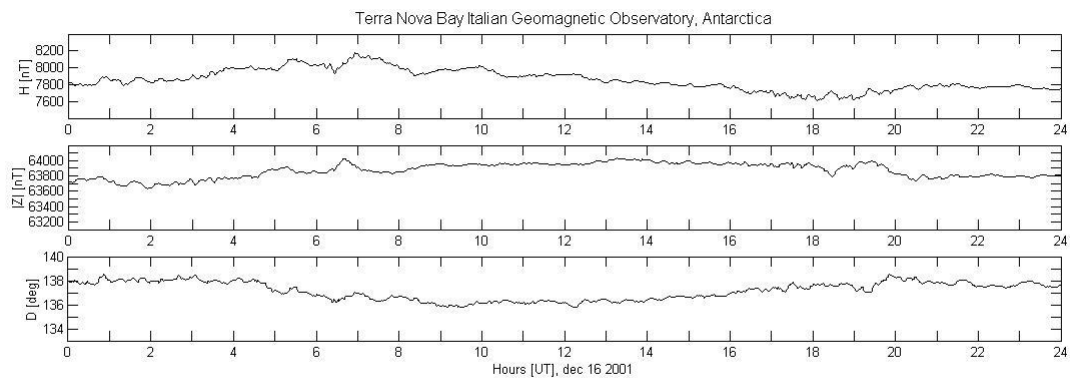
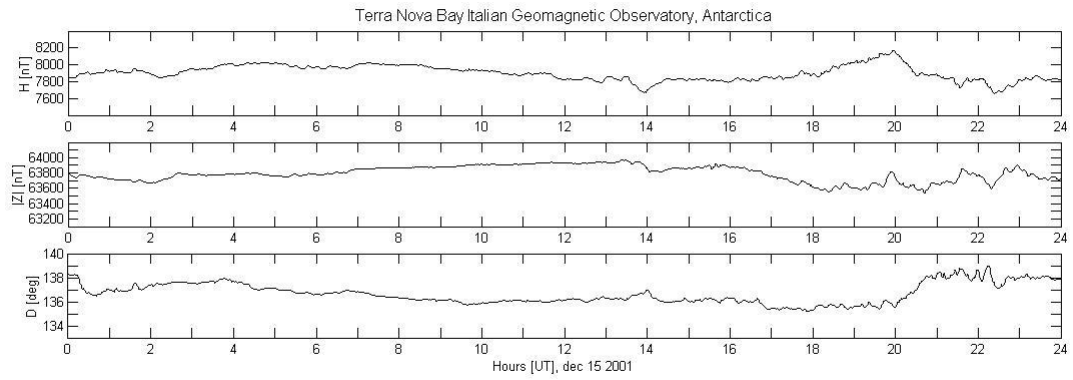
Fig.3

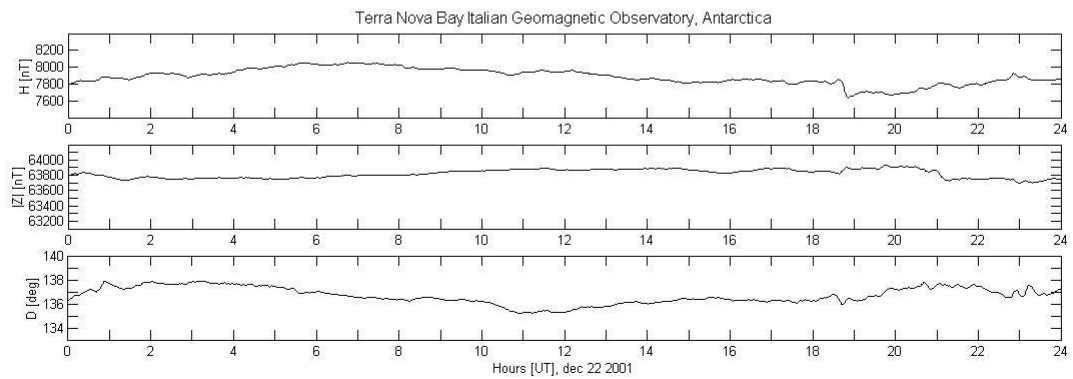
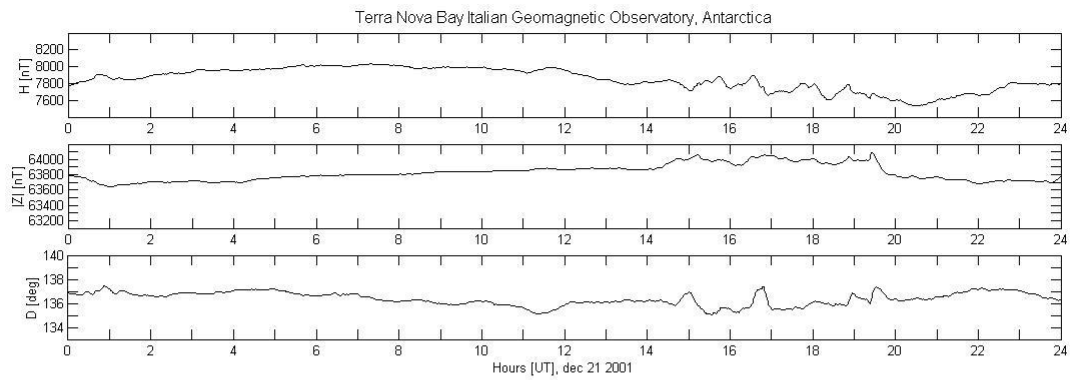
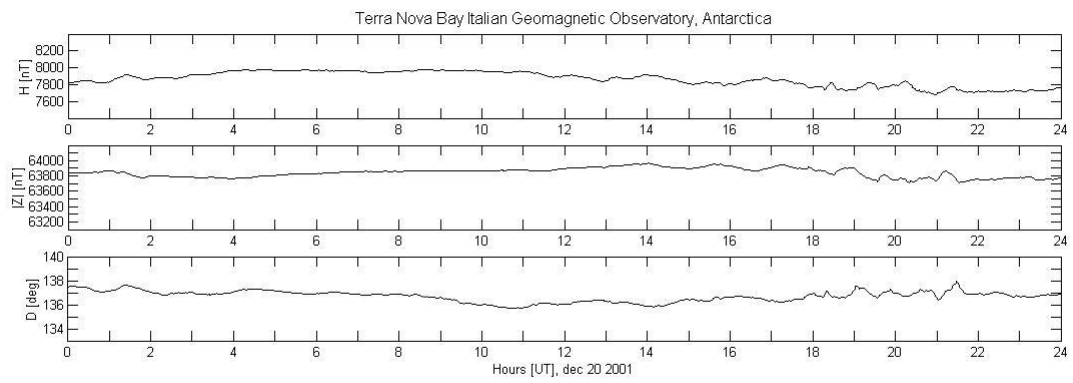
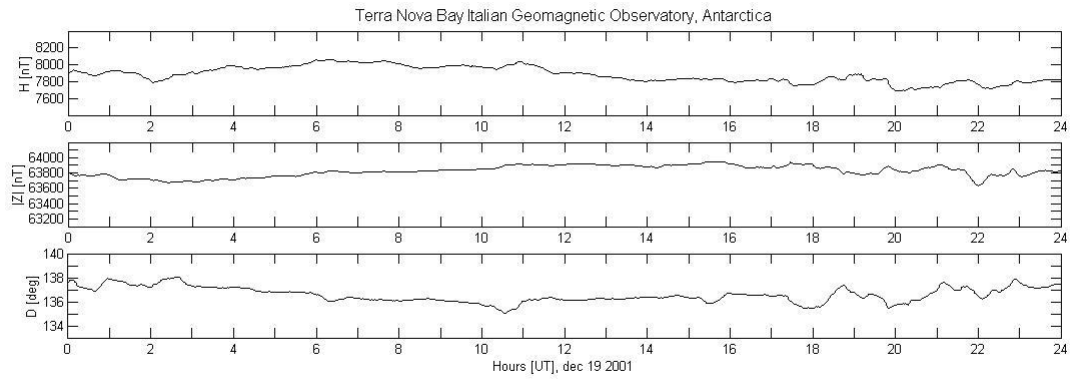
Fig.4-32

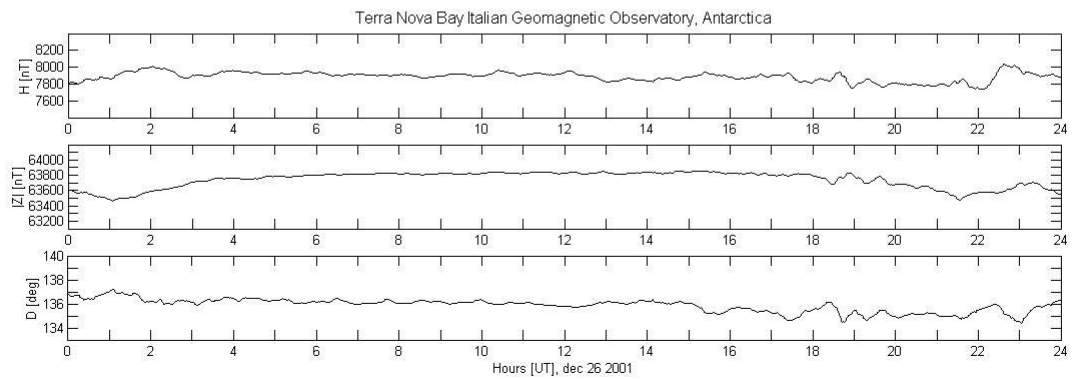
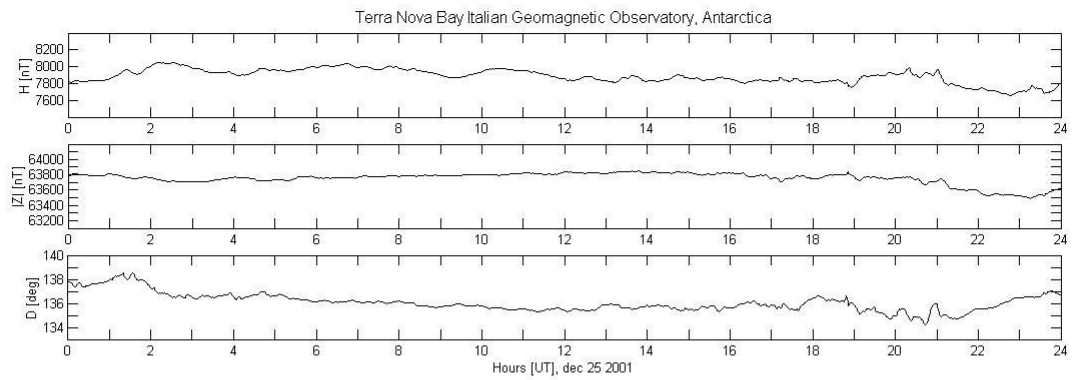
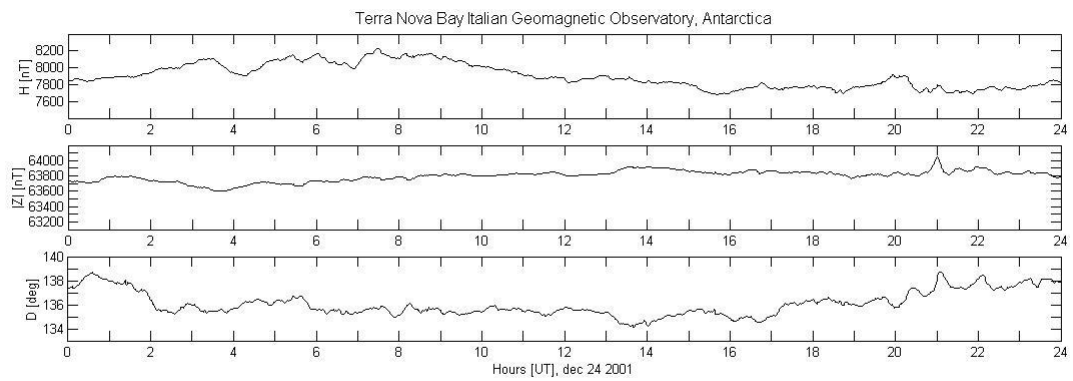
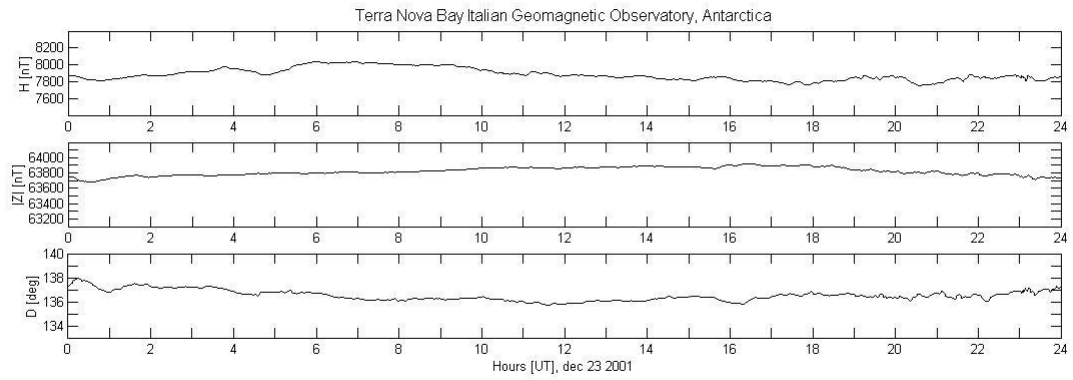


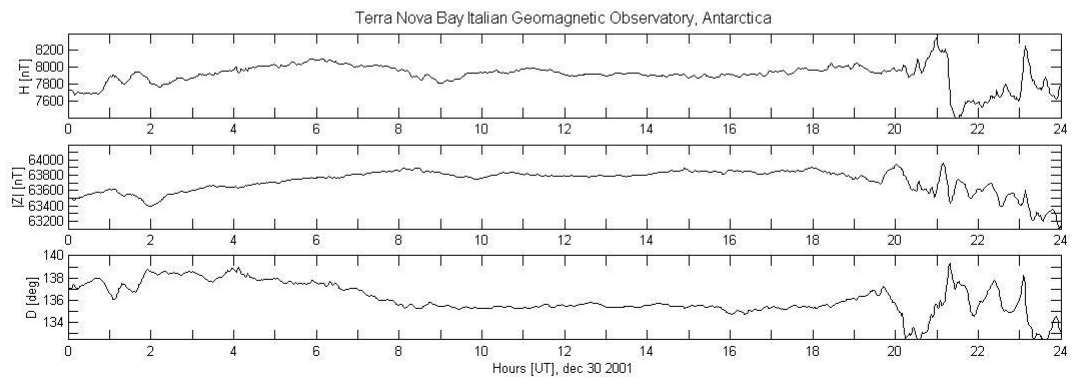
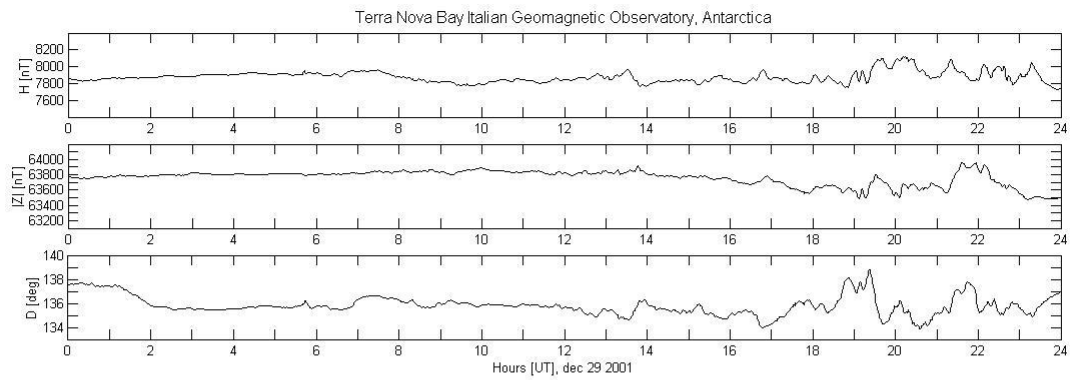
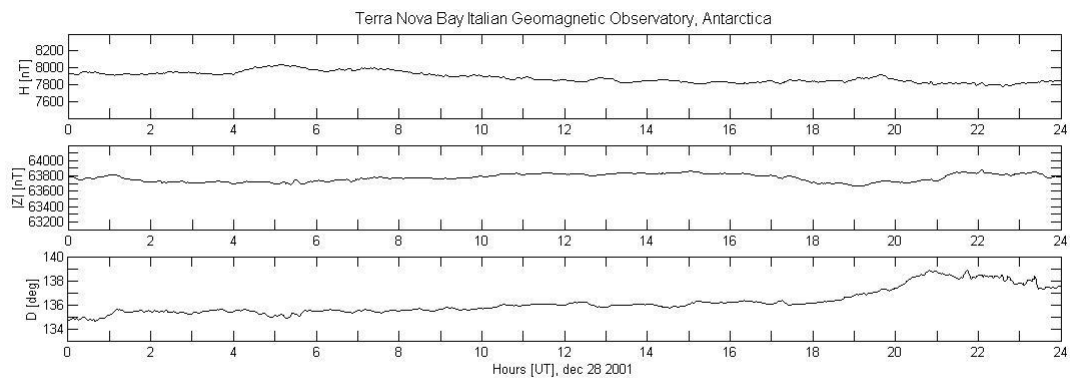
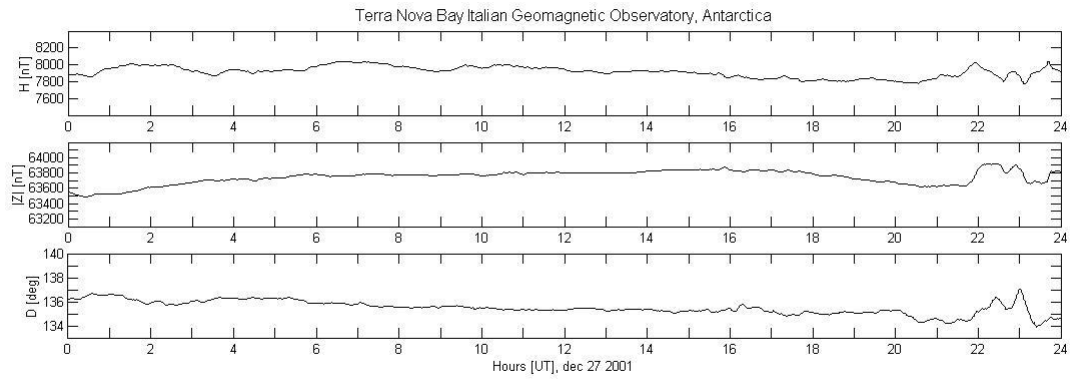




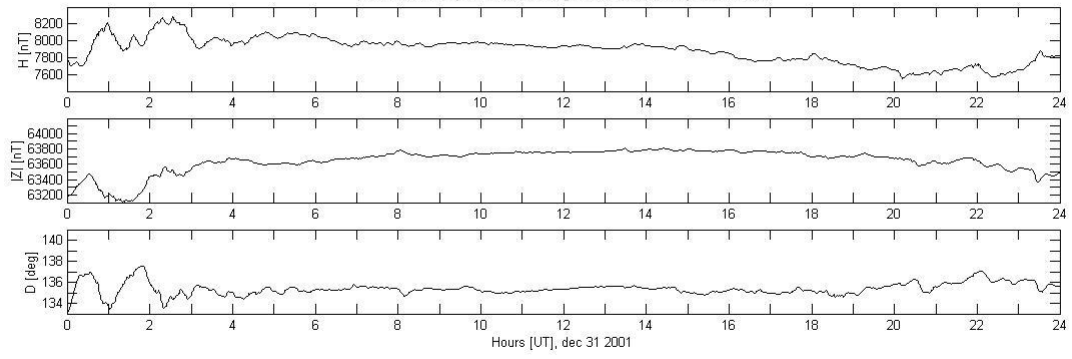








Terra Nova Bay Italian Geomagnetic Observatory, Antarctica



NATIONAL ANTARCTIC RESEARCH PROGRAM

**Terra Nova Bay, Antarctica
Geomagnetic Observatory**

**Magnetic Observation Results
2002-2003**

2007

Geomagnetic Observation Results 2002-2003

Terra Nova Bay - Antarctica

Introduction

This report deals with activities undertaken at the Antarctic Italian Geomagnetic Observatory during the austral summer 2002-2003.

The coordinates of the Observatory at OASI are the following:

Geographic latitude:	74.6936°S
Geographic longitude:	164.0975°E
Corrected Geomagnetic latitude (IGRF00):	80.00°S
Corrected Geomagnetic longitude (IGRF00):	306.94°E
Magnetic local time midnight:	08:11 UT

This report describes the activities performed from November 21, 2002 to February 17, 2003.

For the present work H, D and Z INTERMAGNET formatted data from the fluxgate magnetometer have been used.

The proton precession magnetometers used to record F total values were Overhauser type; for a description of instruments we refer to geomagnetism text books, for example Parkinson (1983) and Wienert (1970).

Since the total intensity F time variations, at polar latitudes, where values of inclination is almost 90°, are very close to the vertical component Z time variations, the plots of total intensity time variations are not shown. They can however be obtained from the well known equation:

$$F^2=H^2+Z^2$$

Absolute measurements

For the normal absolute measurements-taking at the Observatory, a standard fluxgate magnetometer theodolite for the determination of D, I angles has been used.

At OASI three different azimuth marks are available, for the computation of the Declination (please refer to the 2001/2002 report for details). The coordinates of geodetic points (mark piers and measuring location) were established on the basis of GPS measurements. From these coordinates the azimuth values 152° 44' 04'', 60° 13' 36'' and 338° 07' 59'' were found.

The proton magnetometer recordings, continuously undertaken during the execution of the DI measurements, have allowed the calculation of the absolute intensive elements.

Table 1 shows absolute measurement values for each element; the values of the intensive components H and Z (rounded off to the nT) were computed using the relations:

$$H = F \cdot \cos I$$

$$Z = F \cdot \sin I$$

H₀ and D₀ reference values computation

Since the fluxgate was magnetically oriented in the horizontal plane, as in the previous installations, it was necessary to compute H₀ and D₀ reference values, comparing absolute and relative measurements, at the same time. For the Z component, once the vertical levelling of the sensor was assured, it was assumed that the variations measured by fluxgate were actually the vertical component of the geomagnetic field variations.

In the description the mathematical procedure used for computation of H₀ and D₀, the following symbols are used:

H ₀ , D ₀	Reference values
H _{abs} , D _{abs}	Values of absolute measurements at time t
x,y	Instantaneous variations recorded by fluxgate system at time t

For each absolute measurement, the reference values were computed as:

$$H_0 = H_{abs} \cos(\varphi) - x$$

$$D_0 = D_{abs} - \varphi$$

where

$$\varphi = \arcsin (y/H_{abs})$$

In order to reduce this dispersion in the set, the Chauvenet criterion was used. The method, based on the hypothesis of a Gauss probability distribution for the data, consists in the elimination of measurements whose difference from the average is greater than a multiple of the standard deviation fixed by the sample dimension (in this case a value 2.87 σ , corresponding to a sample of about 120 data elements, was used). This method, however, cannot be applied more than once, since an iterative procedure could exclude most of the values up to the complete elimination of the data (Worthing and Jeffner, 1943).

The average values of H₀ and D₀ are:

$$H_0 = (7875 \pm 8) \text{ nT}$$

$$D_0 = (137.87 \pm 0.07) \text{ deg}$$

These values are considerably different from those reported in the previous yearbooks because a different instrument was used for the measurements of the instantaneous variations (please refer to the Introduction for more details).

Daily base lines computation

After H₀ and D₀ reference values are found, the computation of the base lines in relation to absolute measurements and then the computation of the daily base lines for all days, can follow. The available data are the H, D and Z magnetic element variations recorded by fluxgate system

(sampling rate 1 minute) and the absolute measurements recorded from Nov 21, 2002, to Feb 17, 2003.

The base lines computation was undertaken by two different procedures. In the case of Z, assuming that the fluxgate recordings show the variations of the vertical components, the base line (B_Z) was computed as the difference between the absolute measurements (Z_{abs}) and the fluxgate measurements (z). On the other hand, in the case of H and D, the magnetic orientation of the fluxgate system axes was taken into account. Using H_0 and D_0 reference values, the H and D base lines were computed for each absolute measurement as:

$$B_H = H_{abs} - [(H_0+x)^2 + y^2]^{1/2}$$
$$B_D = D_{abs} - D_0 - \arctg[y/(x+H_0)]$$

Mean daily values of the base lines were obtained for those days in which more than one absolute measurement was available.

In order to have a daily base line for each magnetic element, a linear regression analysis using the least squares method has been undertaken. The results are shown in Fig. 1, where the experimental data, as well as the best fit lines are reported.

Using the daily base lines, one minute values for the three field elements H, D and Z were computed as:

$$H = [(H_0+x)^2 + y^2]^{1/2} + B_H$$
$$D = D_0 + \arctg[y/(x+H_0)] + B_D$$
$$Z = z + B_Z$$

Following the Observatory move in 2001/2002 to the new site at OASI, the measurements are reduced to the old site subtracting the following gradient:

$$\Delta H = -1.5 \text{ nT}$$
$$\Delta D = 13.0'$$
$$\Delta Z = 0.7 \text{ nT}$$

In Tables 2, 3, 4 all the hourly and daily averages and the total mean values for the H, D and Z elements on the entire measuring period (from Nov 21, 2002 to Feb 17, 2003) are reported; the relative plots are shown in Fig. 2. The plots of the one minute data follow in succession.

Geomagnetic field trend (1987-2003)

The availability of a long series of data since 1987 allows to evaluate the geomagnetic field trend. For each Antarctic campaign we computed the average value of H,D,Z and F over the time period in which the absolute measurements were performed. In Fig.70 we show these values together with the corresponding IGRF values obtained from the web site: <http://www.geomag.bgs.ac.uk>.

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Table captions

Table 1: Absolute measurement values 2002/2003

Table 2: Horizontal intensity hourly and daily means
(from Nov 21, 2002 to Feb 17,2003)

Table 3: Declination hourly and daily means
(from Nov 21, 2002 to Feb 17,2003)

Table 4: Vertical intensity hourly and daily means
(from Nov 21, 2002 to Feb 17,2003)

Table 1**Terra Nova Bay, Geomagnetic Observatory****Absolute measurements 2002/2003**

date julian day	D		(+)	I		(-)	(+)	(+)	(-)
	beg	end	D	beg	end	I	F	H	Z
	(UT)		(deg min)	(UT)	(deg min)	(deg min)	(nT)	(nT)	(nT)
325	05:35	5:41	138 11.2	5:42	5:48	82 42.9	64314	8156	63795
325	05:52	5:55	137 15.2	5:56	6:00	82 45.1	64335	8117	63821
326	06:24	6:28	136 25.0	6:29	6:34	82 51.8	64299	7988	63800
326	06:36	6:39	136 39.6	6:41	6:46	82 52.1	64305	7984	63808
327	05:23	5:28	136 20.0	5:30	5:34	82 47.9	64275	8058	63768
327	05:43	5:46	136 25.0	5:47	5:51	82 45.3	64291	8108	63777
328	05:57	6:02	136 59.5	6:04	6:12	82 48.6	64290	8046	63785
328	06:16	6:20	136 53.6	6:21	6:27	82 48.5	64295	8048	63789
330	05:12	5:15	136 39.4	5:17	5:21	82 48.7	64227	8036	63722
330	05:25	5:28	136 36.1	5:30	5:35	82 49.2	64218	8026	63714
332	05:59	6:04	135 40.8	6:06	6:10	82 42.5	64345	8166	63824
332	06:13	6:17	135 41.1	6:18	6:23	82 45.7	64322	8104	63810
333	06:10	6:14	136 07.2	6:16	6:21	82 48.4	64267	8047	63762
333	06:24	6:27	136 03.3	6:29	6:34	82 49.0	64271	8038	63767
334	06:30	6:35	136 18.5	6:37	6:43	82 50.0	64269	8018	63767
334	06:46	6:50	136 18.7	6:51	6:57	82 50.1	64273	8016	63771
335	06:23	6:28	136 38.6	6:29	6:34	82 50.3	64260	8012	63759
335	06:36	6:39	136 31.5	6:41	6:45	82 49.8	64282	8024	63779
336	06:32	6:36	135 52.2	6:38	6:42	82 49.2	64259	8031	63755
336	06:45	6:50	136 01.8	6:51	6:56	82 48.0	64276	8056	63770
339	04:34	4:38	136 28.4	4:47	4:53	82 47.1	64234	8067	63725
339	05:02	5:05	136 04.5	5:08	5:13	82 47.2	64232	8065	63723
340	06:54	6:57	135 27.6	7:00	7:04	82 52.9	64317	7971	63821
340	07:09	7:12	136 14.8	7:16	7:18	82 52.0	64324	7988	63826
341	06:14	6:18	135 05.4	6:21	6:25	82 49.7	64285	8025	63782
341	06:37	6:41	135 03.5	6:45	6:48	82 50.3	64256	8010	63755
343	05:32	5:36	136 09.7	5:38	5:42	82 51.8	64280	7986	63782
344	05:37	5:40	136 14.7	5:43	5:47	82 52.0	64241	7976	63744
344	05:50	5:52	136 21.5	5:54	5:58	82 53.0	64243	7959	63748
345	05:11	5:15	135 55.0	5:18	5:21	82 50.0	64177	8007	63676
345	05:25	5:27	135 45.0	5:32	5:35	82 49.9	64170	8007	63668
345	05:41	5:45	135 51.3	5:47	5:50	82 50.6	64176	7995	63676
346	04:40	4:43	135 42.4	4:45	4:49	82 48.4	64172	8035	63667
346	04:55	4:57	135 33.8	5:00	5:03	82 48.3	64185	8039	63680
348	05:24	5:27	135 27.9	5:30	5:33	82 49.4	64161	8015	63658
348	05:37	5:39	135 30.8	5:42	5:45	82 48.5	64172	8034	63667
350	05:34	5:36	135 49.6	5:39	5:42	82 46.6	64196	8072	63686
350	05:48	5:50	135 48.0	5:53	5:56	82 48.6	64204	8036	63699
351	06:17	6:20	135 33.4	6:24	6:28	82 53.2	64214	7952	63720
351	06:31	6:34	135 40.0	6:36	6:38	82 52.7	64223	7962	63727
352	04:09	4:11	136 09.8	4:14	4:16	82 53.6	64172	7939	63679
352	04:20	4:24	135 57.6	4:26	4:29	82 54.8	64224	7924	63733
353	06:00	6:02	135 18.5	6:05	6:08	82 46.8	64332	8086	63821
353	06:13	6:16	135 27.3	6:18	6:21	82 50.5	64311	8015	63809
354	05:37	5:39	136 49.9	5:41	5:44	82 49.0	64241	8032	63737
354	05:47	5:51	136 27.8	5:54	5:56	82 50.3	64249	8009	63748
355	06:47	6:50	135 51.8	6:52	6:54	82 48.8	64272	8041	63767
355	06:58	7:01	135 56.1	7:03	7:06	82 50.0	64258	8017	63756
357	06:26	6:30	137 28.2	6:32	6:35	82 40.6	64313	8198	63788

357	06:43	6:46	137	13.0	6:49	6:52	82	39.4	64347	8225	63819
358	05:36	5:39	135	57.0	5:41	5:44	82	50.6	64252	8004	63752
358	05:50	5:52	136	07.2	5:55	5:57	82	51.5	64241	7987	63742
360	06:10	6:13	136	44.7	6:15	6:18	82	48.9	64258	8038	63754
360	06:21	6:24	136	40.1	6:26	6:29	82	48.6	64257	8043	63752
362	06:49	6:52	136	07.1	6:55	6:58	82	49.5	64291	8031	63787
362	07:00	7:03	136	13.9	7:05	7:08	82	48.8	64289	8042	63784
363	04:10	4:13	136	34.4	4:16	4:18	82	52.5	64214	7964	63719
363	04:21	4:24	136	33.9	4:25	4:28	82	45.3	64215	8098	63702
364	06:04	6:06	136	37.0	6:09	6:11	82	51.4	64299	7997	63800
364	06:14	6:16	136	29.9	6:18	6:21	82	52.4	64285	7976	63788
365	04:51	4:54	136	42.9	4:55	4:58	82	52.4	64260	7972	63763
365	05:01	5:03	136	38.6	5:06	5:09	82	53.4	64259	7953	63765
2	06:33	6:35	136	23.7	6:37	6:41	82	51.7	64259	7985	63761
2	06:45	6:47	136	13.2	6:50	6:53	82	51.3	64249	7992	63750
4	04:46	4:49	136	07.3	4:51	4:54	82	49.5	64164	8014	63662
4	04:59	5:02	136	28.2	5:06	5:09	82	53.7	64154	7935	63661
5	06:21	6:24	135	55.4	6:26	6:29	82	50.2	64230	8009	63729
5	06:31	6:34	135	40.2	6:36	6:39	82	49.8	64237	8017	63735
6	06:18	6:22	136	06.1	6:24	6:27	82	53.1	64255	7958	63760
6	06:30	6:34	136	04.5	6:36	6:39	82	53.4	64262	7955	63767
9	04:22	4:25	135	51.8	4:27	4:30	82	49.3	64172	8018	63669
10	05:37	5:41	135	30.2	5:43	5:47	82	45.4	64141	8087	63629
10	05:49	5:53	135	30.0	5:56	6:00	82	46.1	64158	8076	63648
12	10:58	11:06	135	34.4	11:10	11:19	82	54.0	64247	7942	63754
12	11:20	11:23	135	40.2	11:25	11:28	82	53.8	64265	7947	63772
16	05:33	5:38	135	44.8	5:42	5:49	82	51.8	64210	7978	63712
16	05:54	5:59	135	46.8	6:01	6:07	82	51.1	64227	7992	63727
17	04:41	4:45	136	01.8	4:48	4:54	82	47.7	64162	8047	63656
17	04:58	5:03	136	07.1	5:06	5:10	82	47.9	64162	8044	63656
18	05:16	5:20	137	01.4	5:23	5:26	82	50.6	64244	8003	63744
18	05:32	5:36	137	04.8	5:39	5:44	82	50.8	64261	8002	63761
20	05:19	5:23	136	44.3	5:26	5:31	82	50.8	64313	8009	63812
21	04:46	4:50	136	23.7	4:53	4:57	82	48.0	64230	8051	63723
21	05:06	5:09	136	12.3	5:12	5:18	82	47.3	64227	8064	63718
22	05:46	5:50	136	34.1	5:53	5:57	82	47.5	64304	8069	63795
22	06:02	6:06	136	18.3	6:09	6:14	82	47.1	64325	8078	63816
23	05:56	6:00	136	06.4	6:03	6:08	82	53.5	64243	7951	63749
23	06:12	6:17	136	16.3	6:20	6:24	82	53.3	64275	7957	63780
24	06:05	6:10	136	03.2	6:12	6:17	82	50.5	64249	8006	63748
27	05:15	5:18	135	42.5	5:20	5:25	82	51.2	64260	7994	63761
27	05:28	5:31	135	30.7	5:34	5:38	82	50.7	64250	8003	63750
29	06:15	6:19	136	19.4	6:22	6:27	82	51.6	64255	7986	63757
29	06:32	6:36	136	09.7	6:38	6:42	82	52.2	64258	7976	63761
30	05:15	5:18	135	46.7	5:20	5:25	82	44.9	64213	8105	63700
30	05:28	5:31	135	34.4	5:34	5:38	82	44.5	64216	8114	63701
32	06:04	6:07	135	45.3	6:10	6:13	82	50.5	64168	7996	63668
32	06:16	6:20	135	58.1	6:23	6:27	82	50.3	64192	8003	63691
34	05:43	5:46	135	58.3	5:48	5:53	82	47.9	64233	8053	63726
35	05:19	5:24	136	50.9	5:27	5:31	82	44.2	64139	8109	63625
35	05:37	5:40	136	00.0	5:42	5:46	82	47.6	64188	8052	63681
36	06:09	6:12	135	45.8	6:15	6:18	82	48.9	64220	8032	63715
37	05:42	5:45	136	39.8	5:48	5:51	82	50.0	64247	8014	63745
37	05:53	5:57	136	36.2	5:59	6:03	82	48.7	64266	8041	63761
41	05:35	5:38	136	33.8	5:40	5:43	82	46.8	64218	8071	63709
41	05:46	5:50	136	29.0	5:52	5:55	82	46.5	64239	8080	63729
42	05:25	5:28	136	46.9	5:31	5:35	82	48.0	64202	8048	63696
42	05:39	5:42	136	48.1	5:45	5:48	82	47.2	64230	8065	63722
45	05:54	5:58	136	38.9	6:01	6:04	82	51.7	64207	7978	63710
45	06:08	6:11	136	30.5	6:14	6:17	82	52.6	64218	7963	63722
46	05:31	5:34	136	49.9	5:36	5:39	82	48.8	64289	8043	63784
46	05:42	5:46	136	18.8	5:48	5:52	82	50.0	64291	8020	63788
48	06:15	6:18	136	24.7	6:21	6:24	82	49.1	64271	8034	63767
48	06:26	6:29	136	27.2	6:32	6:35	82	50.3	64259	8011	63758

Table 2**Terra Nova Bay Antarctica, Italian Geomagnetic Observatory***Hourly H values (nT) from Nov 21,2002 to Feb 17,2003*

UT	0	1	2	3	4	5	6	7	8	9	10	11	DAILY MEAN
	12	13	14	15	16	17	18	19	20	21	22	23	
julian day													
325	8079	7831	7932	8009	8063	8157	8143	8156	8116	8071	7989	7894	
	7884	7850	7842	7778	7774	7742	7702	7671	7642	7732	7785	7792	7901
326	7859	7900	7978	8043	8024	8029	7998	7994	8049	7987	8005	7912	
	7943	7896	7851	7840	7816	7796	7787	7905	7859	7749	7673	7733	7901
327	7755	7853	7905	8102	8147	8084	8070	8038	7978	7960	7954	7912	
	7889	7886	7872	7854	7802	7784	7776	7762	7790	7761	7888	7806	7901
328	7913	7925	7956	7968	7999	8037	8043	8023	7968	7979	7979	7945	
	7942	7884	7866	7852	7817	7776	7756	7782	7739	7753	7813	7800	7896
329	7826	7865	7904	7912	7958	8057	8067	8074	8068	8031	7939	7966	
	7897	7850	7879	7828	7811	7870	7852	7798	7817	7714	7786	7857	7901
330	7834	7896	7894	7977	7988	8028	8011	8000	7982	7949	7958	7962	
	7941	7903	7878	7855	7847	7801	7767	7683	7787	7757	7462	7659	7867
331	7737	7776	7932	7908	8164	8153	8086	8089	8077	8083	8049	7967	
	7906	7859	7857	7834	7911	7937	7940	7917	7780	7810	7884	7861	7938
332	7927	7963	8004	8034	8010	8046	8084	7980	7960	7938	7934	7895	
	7918	7891	7864	7847	7765	7796	7730	7694	7701	7785	7817	7894	7895
333	7912	7889	7953	7949	7999	8037	8047	8035	8044	7941	7941	7925	
	7882	7918	7870	7858	7879	7786	7751	7745	7892	7834	7800	7776	7903
334	7786	7902	7954	8000	8072	8064	8028	8053	8037	7983	7954	7907	
	7901	7896	7841	7843	7834	7805	7774	7716	7759	7745	7736	7791	7891
335	7858	7885	7997	8011	8072	8018	8030	7999	7970	7962	7968	7916	
	7901	7912	7856	7840	7822	7796	7838	7864	7735	7744	7768	7756	7896
336	7812	7921	7960	7976	8071	8062	8054	8048	7995	7941	7932	7899	
	7903	7877	7866	7865	7835	7783	7829	7763	7767	7828	7860	7861	7904
337	7901	7936	7932	8015	8108	8051	7998	7979	7934	7952	7949	7955	
	7932	7904	7842	7855	7860	7835	7803	7777	7764	7886	7882	7925	7916
338	7894	7913	7939	7998	7985	7983	7997	8038	8005	8001	7976	7909	
	7922	7892	7864	7848	7848	7779	7758	7812	7863	7783	7873	7817	7904
339	7862	7893	7943	7994	8064	8049	8025	8028	8003	7968	7899	7875	
	7900	7907	7882	7898	7836	7802	7816	7929	7851	7829	7824	7819	7912
340	7864	7922	7979	7958	7981	7963	7968	7999	7992	7959	7924	7964	
	9999	9999	9999	9999	9999	9999	9999	9999	7940	7953	7802	7701	7929
341	7824	7765	7911	7986	7988	8035	8017	8061	7971	7931	7917	7906	
	7885	7865	7881	7856	7875	7903	7833	7877	7775	7819	7895	7958	7906
342	7929	7964	7963	8010	8080	8001	8025	7942	7933	7888	7881	7941	
	7922	7919	7893	7812	7839	7825	7778	7886	7901	7873	7861	7873	7914
343	7859	7853	7925	7955	7977	7976	7978	7944	7929	7927	7924	7932	
	7914	7910	7929	7906	7914	7894	7888	7935	7875	7874	7899	7927	7919
344	7957	7990	7982	7946	8019	7984	7973	8016	7968	7956	7937	7947	
	7941	7920	7923	7911	7883	7882	7915	7888	7848	7904	7889	7914	7937
345	7926	7940	7963	8007	7996	8003	7998	7977	7985	7961	7960	7948	
	7943	7932	7929	7924	7905	7890	7882	7934	7912	7965	7966	7937	7949
346	7949	7979	7978	7963	8021	7996	7929	7950	7961	7965	7973	7923	
	7920	7877	7928	7911	7896	7923	7911	7982	7957	7905	7886	7923	7942
347	7947	7988	8003	8015	8041	8034	7999	7948	7942	7940	7915	7912	
	7916	7919	7922	7924	7915	7942	7923	7953	7900	7880	7941	7963	7949
348	7956	8016	8056	8070	8086	8017	8036	7950	7911	7978	7970	7939	
	7921	7872	7919	7894	7838	7758	7782	7852	7812	7883	7786	7896	7925
349	7950	8034	8064	8118	8104	8103	8077	8015	7908	7955	7951	7910	
	7940	7896	7912	7914	7906	7940	7940	7940	7967	7938	7886	7905	7970
350	8003	7941	7924	7962	8022	8040	8014	7977	8013	7995	7956	7931	
	7919	7920	7890	7912	7911	7895	7933	7995	8005	7876	7907	7901	7952
351	7879	7937	7948	7946	7973	7999	7969	7949	7981	7956	7936	7929	
	7951	7921	7929	7937	7951	7965	7942	7977	7986	8025	7877	7837	7946
352	7893	7903	7933	7924	7942	7963	7947	7937	7922	7917	7907	7906	

	7888	7872	7906	7917	7874	7894	7940	8013	8065	7864	7863	7843	7918
353	7834	7895	7947	7967	7966	8025	8006	7965	8088	7953	7944	7906	
	7876	7899	7910	7917	7845	7743	7689	7677	7783	7878	7822	7849	7891
354	7833	7881	7943	7977	8115	8073	8007	7981	7974	7962	7917	7892	
	7930	7905	7863	7841	7839	7830	7670	7715	7701	7640	7633	7631	7865
355	7762	7863	8015	8128	8165	8069	8035	7994	7963	7945	7925	7924	
	7933	7920	7895	7856	7849	7880	7895	7930	7920	7896	7912	7928	7942
356	7941	7989	8030	8046	8029	8027	8045	8028	7996	7958	7928	7915	
	7900	7819	7873	7851	7836	7819	7896	7637	8057	8005	7942	7879	7935
357	7797	7873	7960	7979	8006	8051	8170	8187	8122	8097	8019	7953	
	7895	7812	7803	7864	7793	7697	7702	7756	7661	7847	7718	7708	7895
358	7761	7898	7936	7970	7971	8003	8047	8019	8016	7960	7970	7939	
	7907	7900	7838	7761	7789	7776	7868	7765	7645	7714	7858	7898	7884
359	7897	7915	7915	7900	7940	7992	7998	8020	8026	7999	7942	7905	
	7903	7880	7866	7850	7803	7818	7757	7715	7710	7799	7826	7892	7886
360	7904	7913	7922	7951	7998	8003	8031	7988	8018	8005	8015	8009	
	7970	7940	7891	7879	7848	7816	7867	7834	7990	7811	7655	7750	7917
361	7772	7947	7967	8089	8168	8159	8085	8034	8058	7976	7989	7940	
	7929	7823	7889	7821	7806	7809	7789	7702	7727	7762	7770	7775	7908
362	7834	7882	7951	8083	8035	8011	8024	8047	8090	8061	7989	7900	
	7902	7897	7868	7864	7834	7812	7786	7835	7837	7793	7751	7819	7913
363	7893	7942	8001	7954	7967	7996	7987	8029	8043	7979	7953	7921	
	7922	7892	7856	7853	7829	7759	7747	7795	7784	7800	7816	7845	7898
364	7875	7916	7928	7945	7964	7986	7992	8001	7997	7981	7943	7940	
	7895	7900	7893	7869	7852	7832	7769	7730	7737	7782	7893	7892	7896
365	7940	7882	7909	7936	7961	7947	8024	7978	7973	7967	7967	7955	
	7924	7878	7885	7893	7885	7899	7888	7863	7905	7891	7894	7899	7923
1	7911	7913	7923	7930	7917	7946	7986	8023	7983	8019	7992	7954	
	7949	7901	7876	7880	7884	7871	7853	7837	7718	7775	7800	7857	7904
2	7907	7931	7970	8011	7978	7979	7981	7991	7973	8002	7973	7928	
	7894	7903	7894	7871	7850	7773	7822	7867	7848	7838	7774	7779	7906
3	7847	7923	7964	7963	7971	7987	7988	7993	7982	7986	7931	7939	
	7934	7889	7883	7870	7675	7710	7809	7818	7869	7742	7803	7895	7890
4	8022	7917	8070	8044	8062	7985	7997	7982	8002	7940	7918	7925	
	7899	7894	7889	7854	7868	7911	7874	7824	7862	7905	7893	7908	7935
5	7979	7945	7990	8003	8007	9999	8003	7983	7995	7968	7954	7954	
	7946	7922	7910	7863	7896	7799	7845	7919	7949	7851	7914	7898	7934
6	7932	7976	7973	7973	7993	7968	7963	7964	7948	7930	7918	7925	
	7928	7903	7895	7866	7927	7923	7925	7909	7883	7822	7837	7851	7922
7	7910	7963	7971	7978	8008	8055	8041	8037	8006	7966	7952	7966	
	7942	7920	7911	7903	7865	7846	7853	7864	7829	7862	7856	7938	7935
8	7873	7913	7968	7964	7983	8003	8022	8007	8008	7958	7925	7913	
	7907	7918	7889	7897	7926	7928	7918	7901	7865	7901	7880	7899	7932
9	7904	7949	7986	7984	8016	8022	8009	7966	7964	7955	7945	7913	
	7906	7928	7915	7911	7917	7911	7878	7891	7920	7974	7886	7950	7942
10	7904	7985	8048	7932	7970	8065	8066	8005	7962	8017	7933	7956	
	7965	7870	7913	7885	7888	7854	7798	7794	7795	7843	7733	7866	7919
11	7892	8015	8059	8059	8017	8031	8015	7982	7935	7974	7984	7959	
	7928	7946	7934	7904	7924	7916	7862	7883	7955	7777	7813	7900	7944
12	7876	8035	8080	8071	8087	8086	8101	8075	8009	7960	7967	7955	
	7963	7916	7917	7886	7880	7831	7840	7920	7951	8032	7951	7812	7967
13	7783	7961	7983	8010	8097	8051	8041	8008	7977	8019	7991	7988	
	7950	7909	7903	7923	7934	7929	7944	7967	7975	7979	7926	7837	7962
14	7833	7999	8086	8114	8104	8102	8063	8048	8009	7960	7921	7922	
	7881	7843	7871	7916	7924	7950	7972	7958	7942	7948	7946	7973	7970
15	7953	7987	8004	8050	8065	8066	8039	7947	7961	7988	7973	7936	
	7924	7921	7890	7887	7856	7909	7941	7927	7927	7837	7891	7976	7952
16	7924	8034	8016	7985	7985	7989	7997	7968	7978	7983	7974	7953	
	7926	7903	7906	7894	7892	7919	7892	7848	7872	7802	7796	7868	7929
17	7853	7954	7981	8024	8033	8031	7961	8013	7998	7987	7984	7964	
	7938	7893	7879	7823	7809	7679	7656	7753	7837	7842	7850	7843	7899
18	7873	7901	7907	7892	7935	7995	8004	7999	7994	7985	7954	7931	
	7964	7865	7848	7850	7832	7804	7738	7780	7754	7766	7770	7865	7883
19	7877	7861	7928	7929	7943	8004	8049	8030	8047	8054	7970	7947	
	7875	7862	7873	7814	7809	7804	7818	7787	7795	7825	7851	7850	7900
20	7848	7845	8005	8078	7965	7979	7959	8011	7976	7927	7930	7930	
	7918	7906	7857	7837	7782	7704	7664	7674	7644	7730	7745	7793	7863
21	7854	7817	7893	7973	8035	8077	8075	8082	8024	7980	7998	7917	
	7884	7887	7866	7835	7850	7818	7885	7836	8001	7820	7730	7721	7911
22	7795	7877	7945	7968	8016	8062	8045	8038	8030	7972	7986	7953	

	7928	7884	7875	7877	7852	7808	7801	7719	7724	7823	7732	7683	7891
23	7687	7857	7960	8036	7986	7998	7978	7981	7969	7957	7932	7949	
	7899	7915	7864	7869	7830	7852	7821	7805	7755	7732	7796	7857	7887
24	7893	7885	7940	7973	7977	7985	7996	8011	8006	7973	8005	7926	
	7892	7881	7907	7833	7811	7768	7781	7826	7758	7623	7690	7980	7888
25	7914	7904	7950	8022	8018	8201	8168	8120	8072	8049	7994	7976	
	7879	7836	7837	7851	7850	7819	7834	7888	7737	7859	7815	7809	7933
26	7851	7808	7900	7933	7982	8000	8018	8043	8025	8002	7985	7931	
	7894	7899	7846	7827	7795	7753	7705	7757	7681	7714	7755	7828	7872
27	7871	7928	7993	7928	7945	8013	7996	7955	7892	7906	7914	7905	
	7912	7902	7895	7889	7870	7855	7864	7877	7883	7857	7846	7822	7905
28	7844	7868	8024	8004	8010	9999	9999	9999	9999	9999	9999	9999	
	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	7932
29	7906	7932	7923	7943	7960	7993	7982	7956	7940	7959	7947	7914	
	7930	7852	7851	7845	7830	7832	7799	7795	7735	7765	7753	7780	7880
30	7852	8021	8058	8133	8136	8108	8136	8075	7989	8013	7972	7876	
	7909	7849	7822	7863	7776	7732	7778	7928	8014	7945	7928	7934	7952
31	7949	8010	8093	7977	8108	8144	8079	8065	8036	8057	7979	7925	
	7907	7906	7840	7800	7825	7869	7855	7885	7884	7892	7883	7888	7952
32	7960	8048	8054	8037	8040	8029	8016	7995	7977	7988	7960	7939	
	7924	7884	7861	7876	7856	7880	7953	7875	7595	7676	7704	7744	7911
33	7886	7985	8122	8118	8147	8174	8148	8073	8074	7995	7982	7925	
	7861	7816	7790	7758	7688	7776	7742	7591	9999	7725	7719	7753	7906
34	7827	7810	7895	8003	8083	8065	8071	8013	8017	8034	7995	7899	
	7925	7865	7847	7872	7865	7833	7856	7857	7850	7883	7918	7863	7923
35	8012	7999	8054	8067	8073	8109	8065	8126	8176	8058	7943	7923	
	7888	7893	7868	7866	7902	7901	7799	7864	7792	7717	7797	7850	7948
36	7891	7945	8001	8058	8079	8054	8034	8029	7980	7957	7941	7932	
	7863	7922	7863	7835	7845	7872	7903	7896	7884	7914	7883	7907	7937
37	7941	7907	7940	7967	7981	8012	8052	8084	7995	7983	7916	7954	
	7888	7907	7858	7834	7857	7817	7761	7786	7827	7802	7848	7827	7906
38	7902	7933	7921	8028	7983	7977	7974	8003	8020	8029	8008	7928	
	7905	7908	7898	7869	7868	7845	7870	7779	7778	7851	7894	7865	7918
39	7986	7914	7968	8018	8030	7999	7990	8021	8063	7965	7954	7942	
	7911	7910	7815	7895	7910	7905	7852	7850	7854	7901	7914	7802	7932
40	7912	7879	7984	7983	9999	9999	9999	9999	9999	9999	9999	9999	
	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	7900
41	7926	7972	8054	8018	8044	8078	8100	8043	8036	8000	7920	7907	
	7916	7896	7874	7878	7892	7878	7861	7841	7899	7921	7870	7833	7944
42	7893	7985	8016	8039	8070	8069	8074	8053	8004	7963	7909	7907	
	7912	7884	7899	7894	7873	7858	7886	7925	7946	7910	7916	7920	7950
43	7906	7928	7967	8003	7995	8007	8045	8033	7960	7976	7950	7915	
	7868	7896	7914	7884	7810	7825	7853	7823	7889	7805	7807	7816	7911
44	7817	7862	7887	7930	7961	7979	7964	7965	7956	7945	7945	7915	
	7899	7892	7882	7892	7889	7887	7861	7885	7891	7794	7783	7787	7895
45	7834	7851	7921	7973	8012	7994	7955	7955	7969	7977	7942	7948	
	7883	7900	7874	7833	7844	7814	7805	7846	7790	7929	7817	7753	7892
46	7801	7823	7915	7999	7984	8045	7982	7985	7980	8029	7982	7918	
	7901	7880	7856	7844	7794	7805	7790	7868	7882	7824	7799	7888	7899
47	7880	7908	7924	7958	7979	7996	8015	8008	8036	7964	7959	7903	
	7882	7857	7859	7866	7860	7839	7836	7769	7932	7910	7915	7850	7913
48	7860	7900	7913	7933	8005	8013	8003	7994	7964	7965	7950	7934	
	7920	7853	7890	7853	7834	7847	7815	7825	7849	7873	7795	7793	7899

TOTAL MEAN = 7916 nT

Table 3**Terra Nova Bay Antarctica, Italian Geomagnetic Observatory***Hourly D values from Nov 21,2002 to Feb 20,2003
(deg:first three digit, minutes: second two digits)*

UT	0	1	2	3	4	5	6	7	8	9	10	11	DAILY MEAN	
	12	13	14	15	16	17	18	19	20	21	22	23		
julian day														
325	13442	13719	13839	13832	13747	13740	13648	13519	13448	13456	13457	13506		
	13510	13546	13540	13518	13611	13550	13721	13651	13744	13740	13730	13726	13627	
326	13748	13630	13735	13653	13629	13611	13605	13554	13511	13521	13459	13456		
	13503	13524	13521	13518	13546	13600	13606	13608	13550	13611	13712	13722	13604	
327	13711	13733	13709	13703	13632	13557	13535	13514	13451	13456	13510	13524		
	13529	13542	13527	13533	13548	13610	13618	13653	13630	13655	13621	13714	13607	
328	13639	13639	13719	13646	13637	13656	13631	13610	13534	13537	13536	13519		
	13524	13513	13532	13532	13548	13549	13537	13530	13623	13719	13711	13714	13611	
329	13705	13631	13656	13659	13651	13611	13613	13544	13531	13522	13505	13507		
	13527	13521	13504	13527	13523	13522	13632	13635	13702	13634	13643	13652	13605	
330	13712	13712	13701	13652	13625	13617	13611	13603	13556	13537	13522	13527		
	13526	13539	13538	13529	13544	13618	13635	13718	13733	13739	13755	13823	13628	
331	13842	13826	13801	13733	13732	13710	13639	13548	13521	13515	13521	13517		
	13528	13538	13547	13609	13527	13453	13501	13444	13513	13551	13553	13607	13608	
332	13625	13557	13702	13712	13646	13614	13527	13530	13530	13524	13526	13532		
	13536	13531	13521	13549	13607	13614	13643	13617	13609	13706	13712	13627	13607	
333	13656	13732	13701	13637	13616	13549	13532	13431	13516	13523	13530	13537		
	13537	13524	13537	13533	13528	13523	13548	13612	13637	13656	13702	13700	13601	
334	13702	13704	13626	13650	13644	13619	13606	13530	13509	13538	13544	13536		
	13530	13537	13549	13556	13603	13611	13622	13642	13709	13658	13652	13636	13615	
335	13705	13713	13752	13648	13653	13646	13616	13552	13517	13519	13538	13513		
	13514	13520	13534	13533	13550	13537	13623	13640	13704	13653	13705	13654	13616	
336	13651	13638	13631	13649	13630	13617	13555	13543	13526	13537	13540	13530		
	13539	13548	13606	13549	13540	13543	13535	13707	13702	13626	13556	13700	13608	
337	13738	13719	13635	13705	13635	13549	13550	13556	13560	13543	13527	13535		
	13534	13536	13548	13540	13547	13617	13632	13618	13624	13624	13630	13558	13611	
338	13659	13657	13622	13552	13545	13537	13548	13528	13520	13522	13542	13545		
	13530	13527	13539	13535	13545	13539	13614	13602	13503	13634	13621	13709	13555	
339	13658	13705	13717	13723	13621	13538	13557	13547	13546	13543	13543	13545		
	13602	13554	13557	13548	13605	13559	13641	13617	13644	13648	13649	13652	13618	
340	13643	13644	13703	13642	13639	13613	13617	13556	13549	13549	13553	13550		
	99999	99999	99999	99999	99999	99999	99999	99999	99999	13430	13443	13603	13715	13608
341	13646	13710	13632	13645	13551	13524	13455	13455	13520	13439	13507	13512		
	13513	13539	13523	13525	13520	13514	13511	13518	13539	13617	13610	13551	13538	
342	13524	13511	13558	13626	13613	13613	13541	13546	13542	13549	13541	13531		
	13532	13536	13533	13518	13514	13523	13510	13505	13602	13650	13524	13547	13541	
343	13650	13650	13632	13617	13611	13601	13550	13541	13552	13537	13540	13543		
	13547	13542	13531	13531	13520	13523	13527	13533	13552	13551	13454	13512	13548	
344	13535	13541	13604	13612	13550	13602	13605	13539	13541	13529	13528	13525		
	13529	13532	13521	13522	13517	13518	13518	13500	13529	13543	13603	13514	13536	
345	13508	13541	13549	13549	13538	13539	13530	13536	13530	13529	13529	13529		
	13530	13530	13529	13527	13533	13539	13547	13505	13519	13417	13418	13504	13524	
346	13514	13512	13523	13527	13532	13529	13556	13548	13520	13526	13523	13525		
	13524	13552	13534	13518	13542	13519	13455	13459	13550	13550	13454	13519	13526	
347	13541	13542	13541	13542	13522	13526	13516	13521	13523	13528	13533	13540		
	13540	13533	13522	13517	13523	13515	13515	13507	13551	13411	13347	13425	13518	
348	13521	13532	13600	13522	13514	13517	13508	13509	13535	13507	13511	13457		
	13456	13539	13516	13510	13524	13456	13514	13442	13446	13437	13611	13654	13519	
349	13638	13642	13606	13521	13505	13500	13447	13437	13441	13530	13522	13530		
	13530	13520	13516	13519	13500	13505	13444	13429	13426	13537	13613	13446	13518	
350	13423	13505	13555	13558	13544	13539	13524	13515	13523	13537	13537	13532		
	13543	13523	13534	13524	13511	13545	13539	13460	13507	13503	13438	13518	13523	
351	13614	13556	13558	13605	13521	13517	13524	13526	13527	13516	13518	13525		

	13526	13526	13527	13513	13510	13452	13443	13426	13355	13457	13632	13636	13525
352	13601	13640	13652	13627	13550	13538	13544	13536	13532	13539	13542	13546	
	13552	13554	13537	13515	13527	13517	13516	13519	13508	13747	13758	13754	13600
353	13737	13614	13633	13751	13718	13620	13549	13540	13523	13532	13524	13511	
	13557	13550	13517	13530	13518	13526	13539	13641	13730	13713	13750	13656	13615
354	13734	13635	13720	13726	13659	13631	13558	13549	13547	13547	13544	13532	
	13532	13530	13519	13537	13601	13534	13602	13514	13707	13757	13720	13730	13619
355	13747	13757	13806	13740	13706	13608	13546	13545	13537	13536	13533	13532	
	13524	13527	13524	13533	13518	13518	13458	13436	13438	13458	13528	13543	13553
356	13546	13544	13524	13517	13516	13531	13527	13509	13504	13517	13542	13554	
	13553	13557	13542	13533	13513	13519	13609	13724	13444	13316	13448	13613	13529
357	13748	13755	13833	13753	13711	13706	13703	13626	13558	13523	13507	13514	
	13514	13534	13614	13544	13610	13606	13558	13720	13654	13702	13755	13743	13639
358	13702	13719	13702	13640	13606	13549	13603	13550	13537	13511	13532	13508	
	13517	13520	13513	13453	13533	13555	13553	13557	13624	13643	13659	13544	13558
359	13624	13734	13707	13632	13623	13637	13636	13605	13615	13607	13556	13545	
	13539	13511	13525	13559	13549	13647	13556	13556	13651	13731	13706	13638	13620
360	13658	13658	13619	13652	13646	13635	13629	13623	13612	13541	13505	13503	
	13525	13530	13517	13520	13532	13613	13638	13717	13719	13815	13637	13729	13621
361	13809	13728	13702	13731	13649	13647	13615	13549	13535	13511	13511	13449	
	13502	13527	13524	13532	13539	13622	13641	13617	13713	13719	13741	13740	13622
362	13712	13727	13722	13710	13636	13619	13604	13541	13525	13546	13531	13510	
	13515	13537	13538	13549	13544	13533	13639	13705	13722	13733	13733	13728	13623
363	13745	13751	13727	13622	13628	13642	13607	13555	13541	13551	13531	13530	
	13519	13531	13549	13552	13547	13549	13637	13639	13656	13707	13657	13722	13622
364	13715	13721	13740	13651	13643	13634	13629	13620	13532	13528	13554	13544	
	13533	13536	13538	13554	13527	13616	13647	13606	13712	13642	13639	13618	13620
365	13634	13714	13643	13656	13645	13630	13621	13608	13549	13554	13541	13526	
	13540	13551	13557	13550	13554	13548	13557	13604	13547	13546	13618	13631	13609
1	13624	13651	13659	13653	13655	13649	13641	13632	13611	13546	13551	13549	
	13535	13537	13550	13602	13558	13560	13602	13558	13650	13650	13708	13718	13622
2	13700	13646	13707	13634	13613	13600	13613	13612	13554	13534	13535	13542	
	13555	13554	13551	13554	13608	13614	13623	13614	13644	13722	13736	13757	13623
3	13653	13537	13517	13530	13527	13518	13514	13510	13533	13519	13528	13513	
	13515	13511	13512	13506	13508	13503	13504	13511	13437	13533	13530	13621	13523
4	13608	13625	13655	13607	13609	13614	13553	13549	13547	13534	13542	13535	
	13532	13519	13526	13548	13531	13514	13519	13559	13513	13520	13518	13521	13544
5	13522	13541	13546	13551	13602	99999	13533	13511	13525	13530	13534	13528	
	13525	13528	13524	13524	13510	13611	13604	13527	13535	13438	13504	13554	13532
6	13546	13556	13547	13560	13550	13600	13550	13541	13534	13534	13532	13533	
	13539	13542	13546	13558	13525	13516	13507	13519	13528	13550	13515	13546	13539
7	13559	13612	13605	13605	13558	13549	13545	13531	13520	13509	13501	13522	
	13525	13525	13523	13511	13517	13517	13512	13456	13528	13503	13532	13522	13530
8	13602	13556	13619	13618	13622	13616	13540	13526	13519	13530	13540	13547	
	13544	13534	13543	13544	13527	13518	13503	13459	13530	13520	13529	13517	13539
9	13542	13540	13533	13541	13541	13524	13510	13517	13532	13538	13536	13538	
	13542	13539	13535	13534	13526	13505	13518	13454	13424	13407	13438	13439	13519
10	13615	13508	13541	13546	13534	13523	13514	13457	13506	13509	13512	13530	
	13502	13455	13510	13510	13519	13515	13506	13518	13531	13534	13615	13620	13525
11	13641	13635	13640	13649	13603	13526	13519	13513	13520	13528	13524	13522	
	13522	13520	13519	13509	13506	13444	13435	13433	13425	13501	13353	13413	13520
12	13546	13556	13552	13546	13552	13553	13605	13535	13506	13511	13515	13527	
	13515	13525	13525	13538	13533	13530	13500	13437	13419	13417	13502	13441	13521
13	13544	13636	13504	13527	13536	13521	13508	13501	13508	13522	13514	13522	
	13527	13529	13530	13518	13506	13506	13457	13446	13424	13401	13344	13505	13510
14	13542	13627	13646	13611	13546	13529	13533	13549	13609	13600	13554	13550	
	13604	13604	13548	13527	13508	13521	13513	13452	13436	13404	13405	13418	13532
15	13436	13616	13612	13540	13535	13528	13518	13506	13519	13523	13501	13537	
	13537	13532	13532	13528	13525	13539	13532	13457	13536	13544	13538	13517	13529
16	13606	13550	13544	13542	13543	13535	13527	13530	13545	13545	13542	13528	
	13525	13536	13541	13544	13554	13529	13521	13528	13525	13553	13607	13543	13540
17	13611	13552	13602	13553	13553	13544	13550	13543	13521	13515	13526	13509	
	13529	13538	13540	13615	13625	13657	13721	13658	13652	13719	13726	13707	13609
18	13708	13704	13717	13618	13618	13648	13631	13625	13611	13555	13537	13532	
	13458	13459	13604	13552	13557	13644	13647	13639	13741	13721	13802	13808	13631
19	13734	13707	13646	13623	13644	13643	13639	13627	13619	13523	13535	13544	
	13540	13541	13515	13513	13517	13615	13641	13656	13655	13705	13659	13700	13621
20	13719	13725	13740	13643	13656	13623	13607	13612	13607	13602	13559	13540	
	13548	13548	13556	13557	13622	13648	13705	13720	13722	13735	13706	13706	13637
21	13725	13714	13643	13640	13625	13549	13626	13622	13542	13524	13523	13514	

	13530	13556	13602	13604	13614	13611	13546	13619	13547	13643	13711	13729	13615
22	13730	13739	13741	13727	13706	13633	13614	13622	13557	13535	13527	13537	
	13535	13541	13556	13554	13546	13556	13634	13716	13750	13750	13723	13740	13636
23	13715	13819	13810	13703	13624	13607	13553	13610	13602	13551	13541	13542	
	13537	13535	13539	13539	13549	13609	13600	13640	13705	13727	13701	13702	13626
24	13727	13809	13707	13621	13556	13544	13546	13545	13554	13539	13518	13525	
	13533	13554	13542	13542	13529	13539	13626	13629	13637	13717	13714	13628	13613
25	13703	13733	13722	13716	13646	13643	13645	13627	13526	13436	13538	13530	
	13522	13512	13518	13558	13617	13607	13644	13647	13738	13732	13702	13706	13625
26	13645	13653	13717	13656	13714	13654	13645	13622	13557	13524	13530	13532	
	13525	13539	13558	13601	13615	13654	13722	13712	13730	13731	13717	13749	13636
27	13745	13654	13529	13441	13458	13522	13530	13522	13521	13535	13549	13551	
	13553	13557	13559	13558	13553	13544	13557	13547	13553	13606	13608	13633	13551
28	13716	13715	13635	13619	13623	99999	99999	99999	99999	99999	99999	99999	
	99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	13645
29	13645	13614	13626	13610	13608	13603	13558	13543	13547	13548	13547	13522	
	13512	13501	13536	13545	13546	13606	13608	13549	13618	13610	13644	13714	13560
30	13737	13732	13801	13623	13548	13531	13543	13518	13514	13503	13513	13443	
	13441	13449	13532	13519	13532	13522	13605	13708	13614	13636	13528	13520	13551
31	13619	13626	13602	13643	13633	13555	13533	13506	13506	13508	13508	13443	
	13527	13526	13533	13516	13526	13530	13509	13516	13513	13450	13436	13458	13528
32	13612	13605	13547	13608	13549	13541	13540	13531	13530	13528	13527	13539	
	13539	13536	13531	13521	13512	13516	13521	13414	13555	13624	13706	13711	13544
33	13743	13802	13748	13615	13613	13550	13529	13502	13516	13452	13451	13454	
	13510	13514	13516	13527	13515	13544	13603	13543	99999	13643	13718	13732	13559
34	13813	13746	13730	13659	13621	13546	13525	13502	13510	13460	13515	13544	
	13540	13526	13520	13537	13543	13534	13552	13512	13606	13531	13534	13607	13555
35	13542	13639	13612	13624	13549	13609	13538	13521	13511	13508	13512	13526	
	13529	13542	13541	13535	13534	13519	13549	13509	13553	13615	13604	13632	13545
36	13651	13724	13608	13612	13543	13531	13533	13537	13527	13530	13546	13526	
	13521	13525	13523	13528	13540	13542	13512	13523	13552	13545	13538	13606	13545
37	13538	13647	13608	13628	13618	13618	13619	13560	13553	13539	13543	13523	
	13516	13522	13529	13525	13531	13527	13523	13547	13528	13705	13648	13632	13555
38	13646	13716	13624	13552	13552	13607	13614	13536	13529	13522	13525	13529	
	13526	13522	13527	13526	13541	13528	13520	13542	13539	13701	13620	13552	13551
39	13552	13625	13638	13611	13556	13616	13601	13535	13537	13533	13533	13539	
	13543	13532	13519	13541	13539	13534	13548	13552	13616	13606	13553	13657	13554
40	13635	13654	13716	13633	99999	99999	99999	99999	99999	99999	99999	99999	
	99999	99999	99999	99999	99999	99999	99999	99999	99999	13551	13607	13606	13625
41	13634	13650	13652	13555	13628	13613	13608	13532	13519	13517	13510	13526	
	13529	13535	13541	13542	13538	13549	13532	13528	13520	13456	13526	13645	13548
42	13649	13659	13723	13626	13625	13628	13601	13526	13519	13530	13528	13536	
	13531	13530	13532	13530	13531	13531	13611	13619	13608	13555	13554	13610	13559
43	13610	13610	13550	13558	13609	13609	13549	13527	13527	13535	13540	13536	
	13544	13552	13541	13523	13550	13555	13603	13611	13616	13628	13622	13621	13555
44	13653	13651	13651	13651	13647	13639	13636	13623	13608	13555	13555	13548	
	13548	13549	13555	13558	13560	13559	13603	13608	13619	13619	13645	13652	13619
45	13708	13718	13658	13633	13658	13646	13609	13601	13602	13557	13546	13534	
	13539	13532	13541	13545	13603	13552	13644	13633	13660	13711	13717	13658	13624
46	13712	13604	13654	13712	13640	13625	13604	13546	13550	13523	13526	13519	
	13533	13532	13535	13530	13544	13602	13624	13634	13607	13711	13719	13647	13611
47	13722	13626	13613	13639	13612	13625	13618	13555	13540	13538	13525	13534	
	13534	13515	13534	13605	13601	13611	13620	13643	13636	13521	13560	13647	13606
48	13618	13627	13650	13620	13638	13633	13614	13609	13551	13542	13523	13529	
	13541	13556	13539	13608	13555	13608	13632	13629	13702	13649	13716	13732	13617

TOTAL MEAN = 135° 58' nT

Table 4**Terra Nova Bay Antarctica, Italian Geomagnetic Observatory***Hourly Z values (nT) from Nov 21,2002 to Feb 17,2003 (values must be considered negative)*

UT	0	1	2	3	4	5	6	7	8	9	10	11	DAILY MEAN	
	12	13	14	15	16	17	18	19	20	21	22	23		
julian day														
325	63683	63888	63798	63790	63820	63811	63814	63838	63857	63857	63867	63870		
	63879	63850	63888	63897	63966	63919	64032	63926	63929	63864	63803	63780	63859	
326	63776	63782	63778	63779	63793	63825	63811	63821	63852	63837	63854	63858		
	63926	63909	63886	63890	63845	63866	63897	63801	63823	63708	63741	63789	63827	
327	63764	63747	63768	63802	63780	63769	63775	63788	63800	63795	63809	63823		
	63843	63843	63858	63857	63875	63960	63943	63801	63793	63828	63801	63784	63817	
328	63797	63750	63727	63743	63757	63783	63791	63805	63823	63850	63854	63894		
	63908	63921	63929	63944	63919	63972	63851	63775	63841	63857	63844	63776	63838	
329	63770	63759	63719	63751	63766	63810	63794	63801	63823	63830	63836	63861		
	63847	63847	63851	63828	63845	63825	63821	63855	63801	63767	63799	63828	63810	
330	63733	63754	63710	63700	63719	63720	63741	63775	63805	63826	63843	63846		
	63863	63879	63877	63875	63882	63885	63888	63861	63705	63751	63801	63842	63803	
331	63727	63689	63689	63748	63819	63753	63768	63820	63862	63888	63903	63898		
	63887	63859	63888	63878	63804	63760	63710	63720	63642	63627	63588	63698	63776	
332	63678	63664	63696	63700	63717	63764	63809	63796	63790	63791	63809	63816		
	63832	63860	63879	63915	63991	63961	63926	63887	63814	63804	63722	63760	63807	
333	63760	63680	63691	63702	63730	63753	63775	63810	63822	63816	63833	63824		
	63808	63820	63818	63773	63767	63879	63846	63824	63880	63791	63717	63699	63784	
334	63674	63668	63664	63682	63738	63778	63770	63813	63833	63831	63835	63834		
	63838	63877	63900	63961	63938	63932	63875	63928	63878	63829	63755	63802	63818	
335	63759	63702	63663	63667	63704	63731	63766	63797	63824	63838	63833	63841		
	63874	63910	63872	63879	63862	63852	63766	63776	63821	63830	63774	63740	63795	
336	63736	63742	63756	63741	63778	63766	63766	63787	63792	63812	63841	63847		
	63853	63870	63847	63866	63869	63887	63826	63904	63868	63683	63614	63748	63800	
337	63685	63676	63708	63739	63760	63768	63770	63793	63796	63827	63854	63894		
	63895	63891	63865	63916	63889	63826	63850	63823	63825	63851	63816	63739	63811	
338	63677	63717	63771	63768	63752	63759	63769	63797	63806	63825	63830	63834		
	63851	63851	63848	63872	63873	63897	63915	63787	63759	63799	63860	63756	63807	
339	63763	63715	63730	63699	63709	63722	63733	63752	63778	63793	63820	63819		
	63817	63828	63822	63815	63880	63893	63887	63765	63750	63751	63748	63699	63779	
340	63738	63724	63702	63724	63759	63779	63796	63820	63820	63823	63836	63849		
	99999	99999	99999	99999	99999	99999	99999	99999	99999	63630	63548	63508	63607	63729
341	63629	63679	63749	63714	63746	63752	63764	63744	63719	63766	63741	63741		
	63758	63761	63747	63703	63695	63725	63704	63606	63621	63581	63624	63663	63705	
342	63766	63723	63676	63728	63704	63722	63730	63770	63786	63796	63792	63809		
	63810	63810	63842	63859	63884	63820	63764	63722	63754	63803	63629	63463	63757	
343	63564	63677	63675	63721	63743	63768	63781	63771	63779	63781	63788	63799		
	63807	63805	63793	63792	63782	63785	63782	63784	63754	63716	63650	63664	63748	
344	63562	63589	63614	63682	63717	63731	63764	63768	63766	63768	63768	63791		
	63801	63807	63804	63770	63761	63790	63824	63776	63743	63723	63784	63660	63740	
345	63694	63700	63691	63690	63705	63677	63715	63742	63763	63760	63749	63775		
	63804	63809	63795	63791	63785	63769	63736	63818	63757	63742	63723	63680	63744	
346	63667	63651	63609	63682	63683	63686	63728	63772	63758	63734	63747	63762		
	63798	63803	63812	63785	63788	63801	63786	63766	63824	63824	63694	63543	63738	
347	63557	63589	63606	63608	63625	63668	63699	63718	63735	63733	63724	63752		
	63774	63796	63790	63774	63750	63762	63774	63789	63762	63646	63557	63502	63695	
348	63407	63455	63500	63557	63569	63652	63677	63687	63728	63706	63720	63740		
	63754	63749	63752	63763	63735	63724	63721	63554	63514	63393	63394	63388	63618	
349	63400	63496	63508	63493	63585	63627	63675	63687	63669	63683	63718	63754		
	63801	63781	63793	63772	63743	63740	63796	63726	63703	63865	63765	63589	63682	
350	63438	63648	63636	63650	63666	63678	63710	63727	63737	63777	63791	63791		
	63808	63764	63749	63775	63769	63681	63745	63846	63882	63790	63584	63773	63726	
351	63653	63614	63684	63684	63714	63711	63722	63725	63742	63750	63743	63740		
	63757	63775	63799	63785	63774	63797	63785	63780	63722	63830	63857	63771	63746	

352	63760	63691	63642	63685	63731	63768	63764	63773	63766	63775	63775	63778	
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TOTAL MEAN = 63761 nT

Figure Captions

Fig 1: Scatter plot and linear regression for daily H, D and Z^2 base lines.

Fig 2: Hourly means of the H, D and Z^1 elements during the whole campaign.

Fig. 3 – 91: Daily plots of the one minute values of the H, D and Z^1 elements.

Fig. 92: Geomagnetic field trend since 1987.

² Z values must be considered negative

TNB Z, H and D base lines 2002/2003

$$B_z \text{ (nT)} = 0.04 * \text{dd} + 63951.13$$

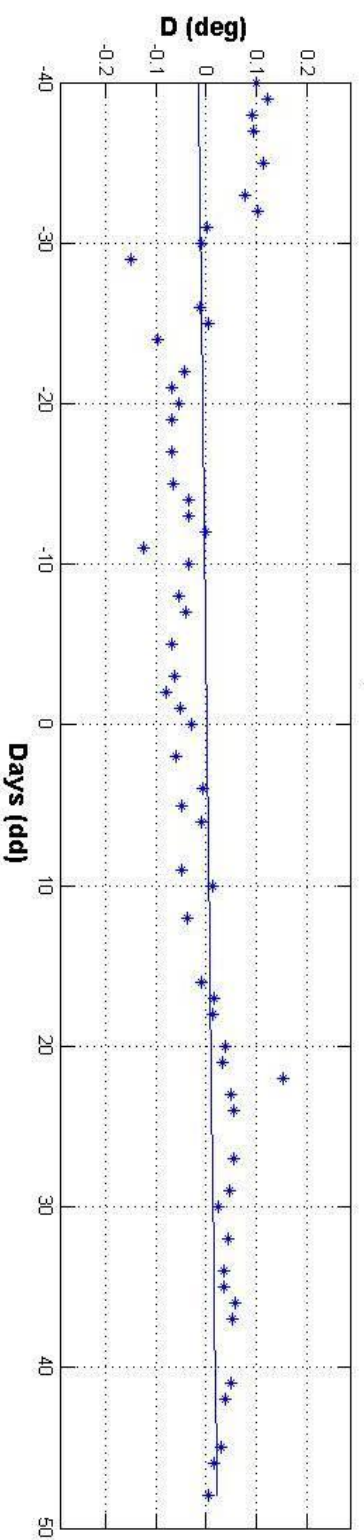
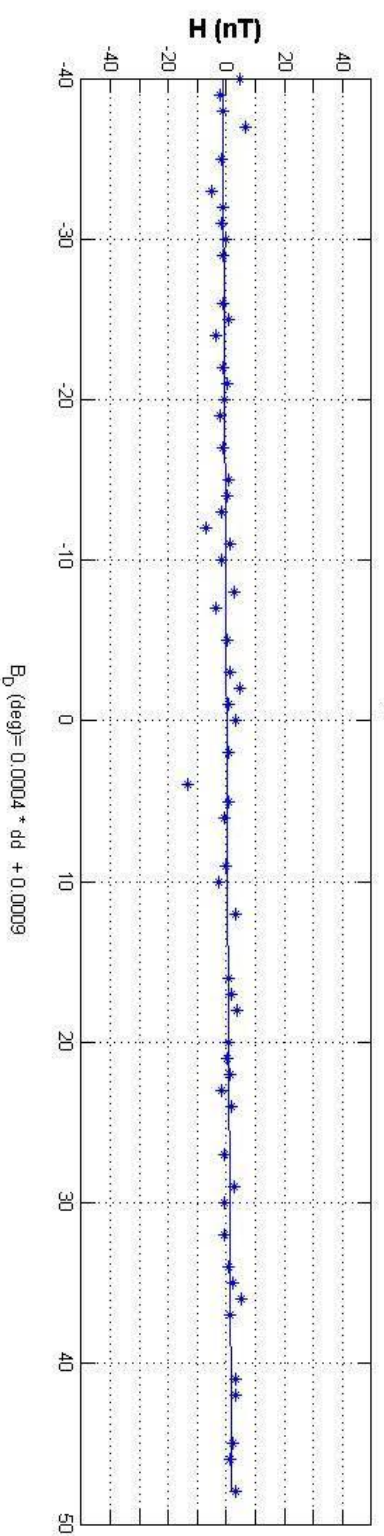
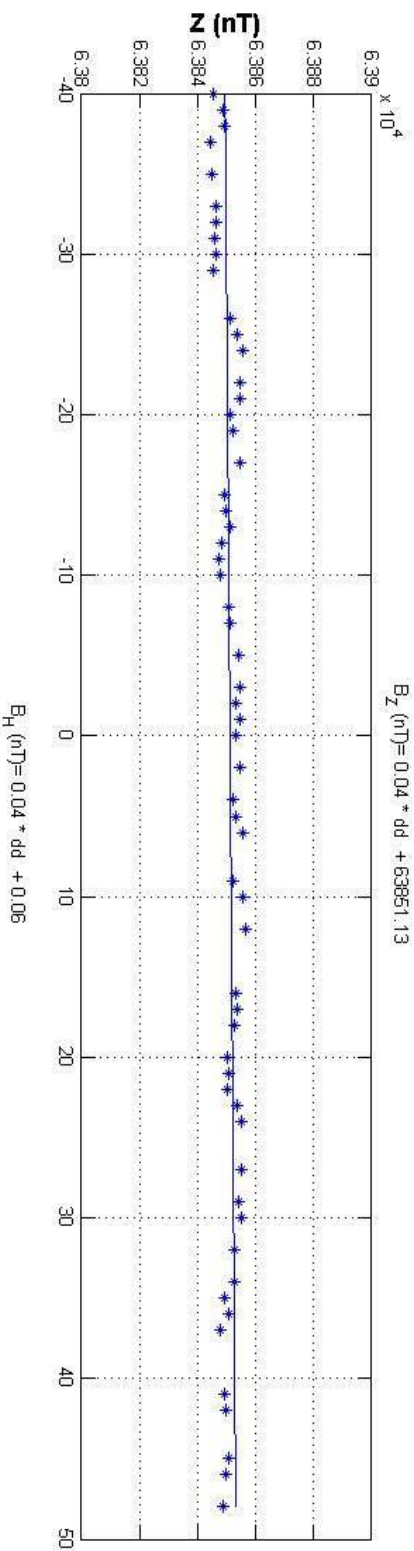


Fig.1

TNB hourly means 2002/2003

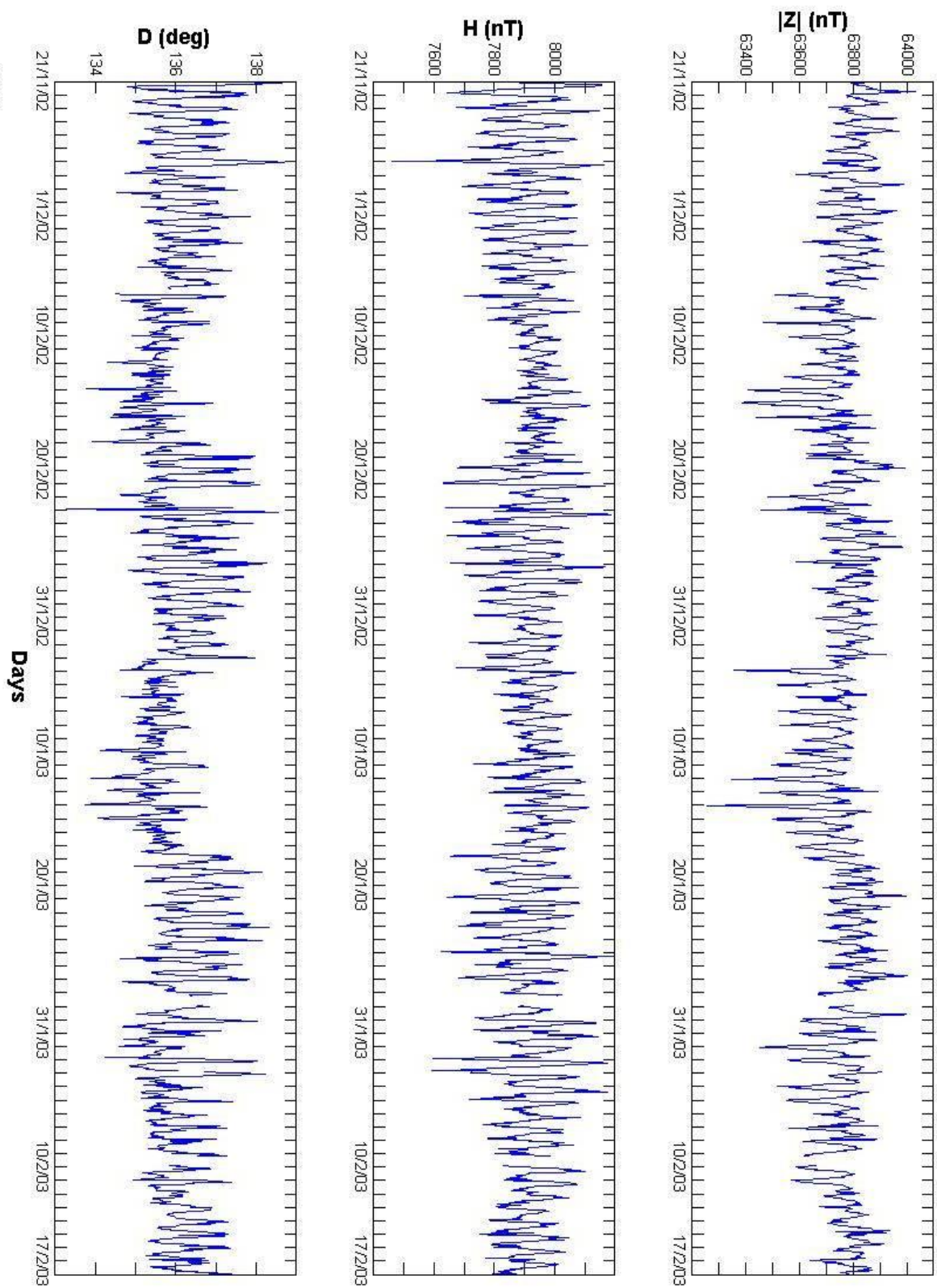
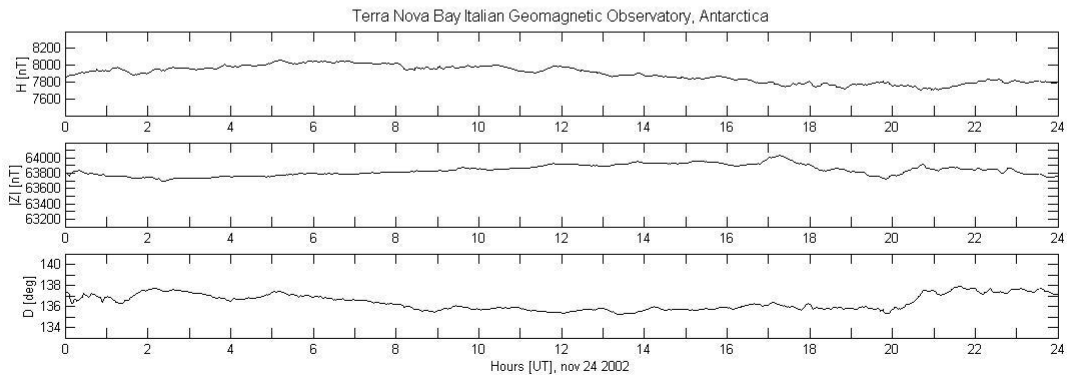
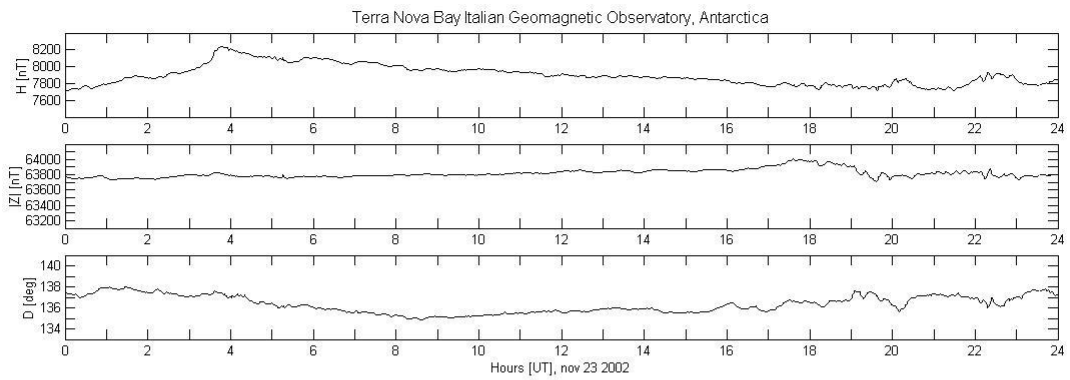
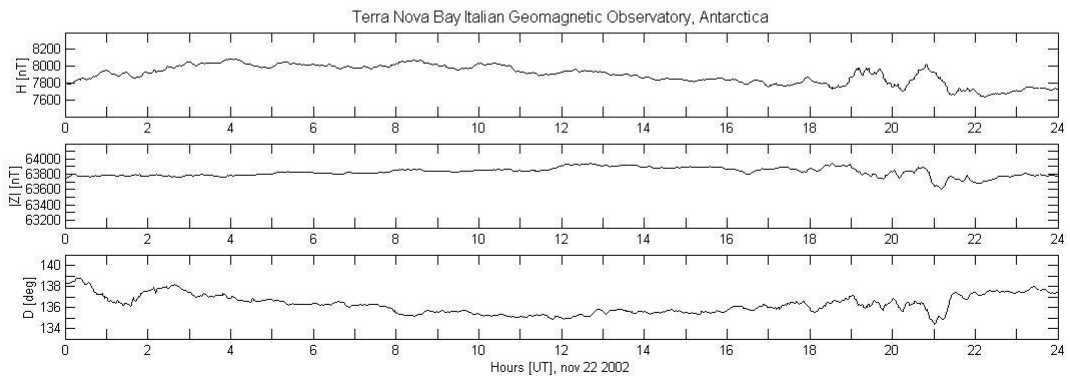
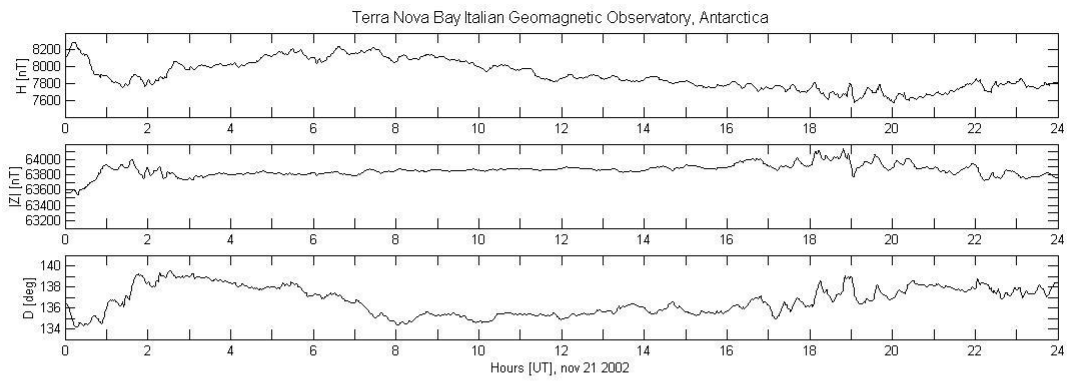
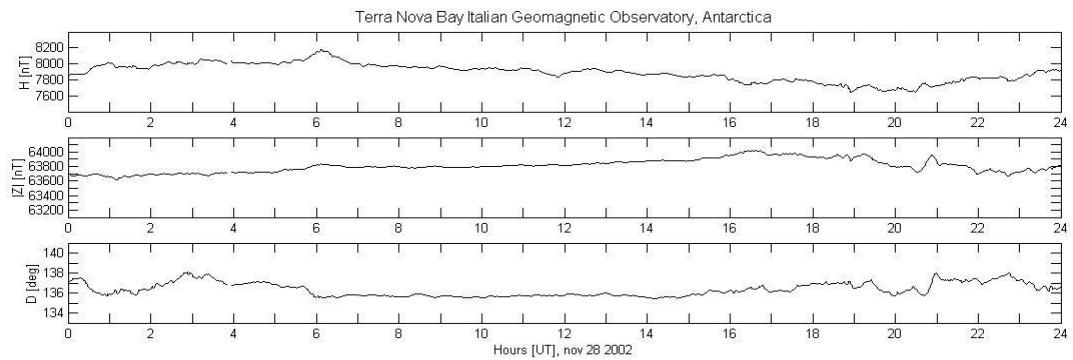
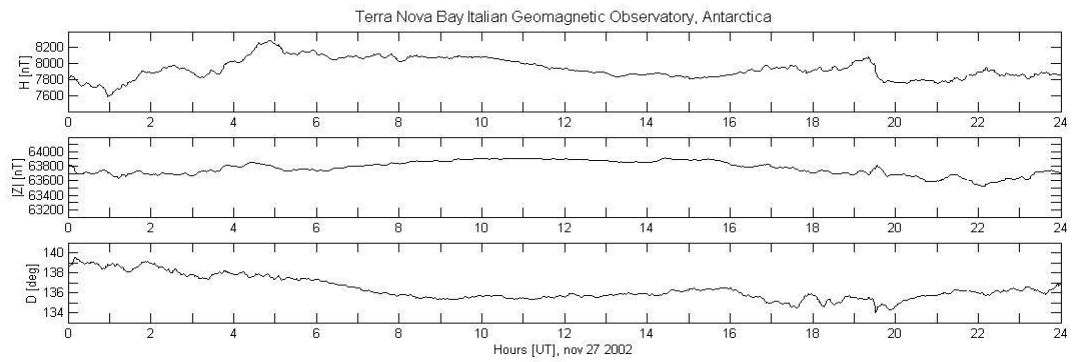
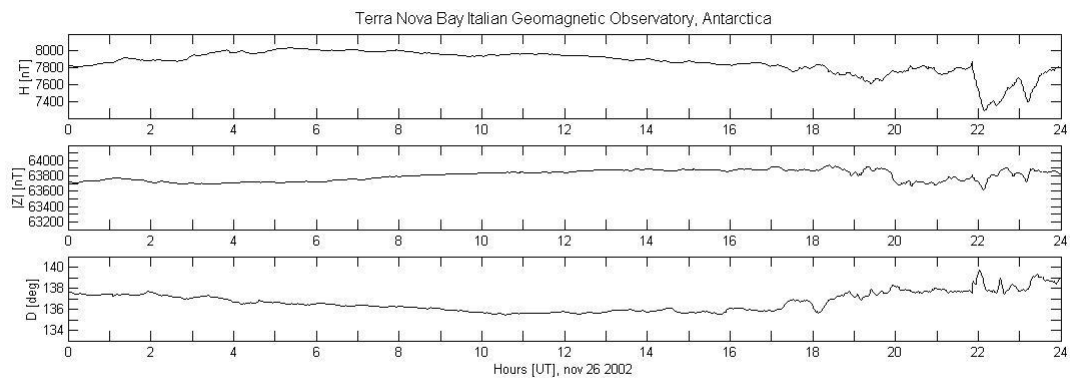
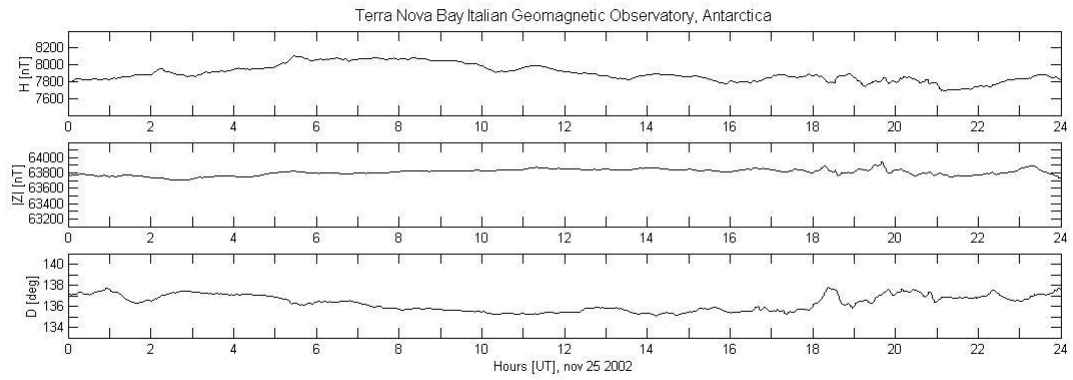
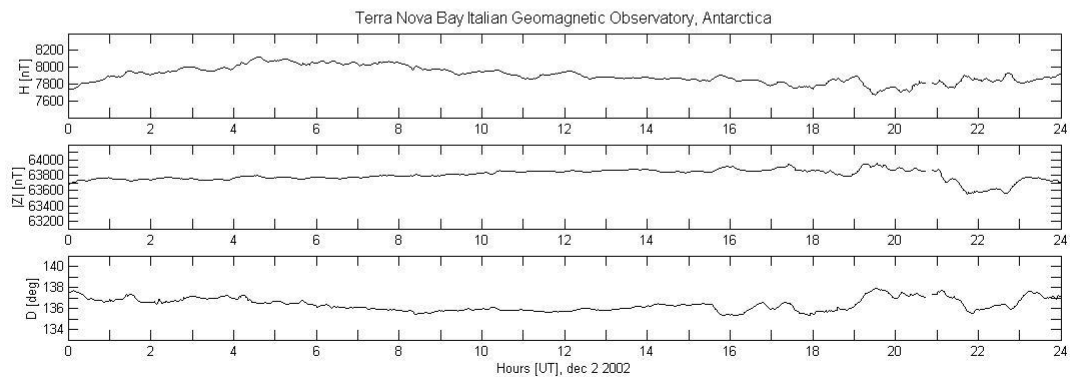
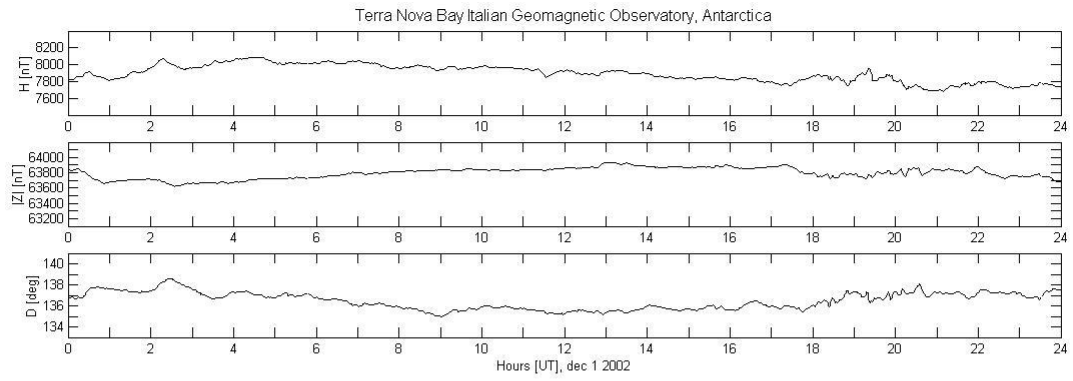
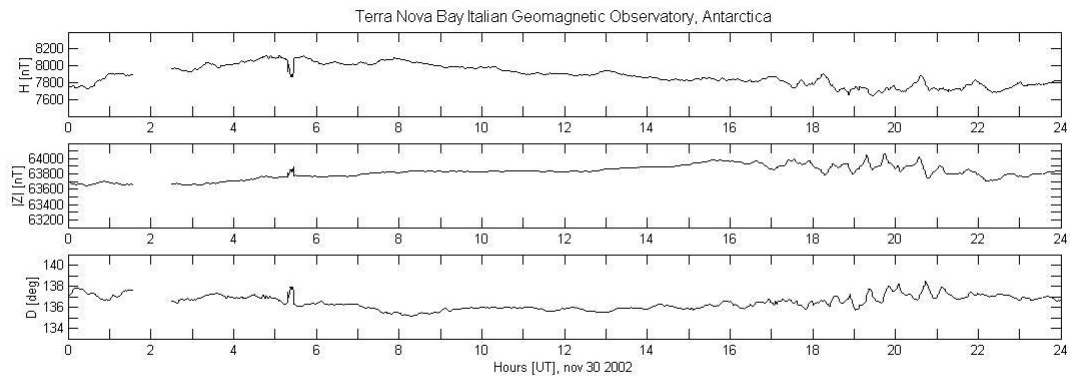
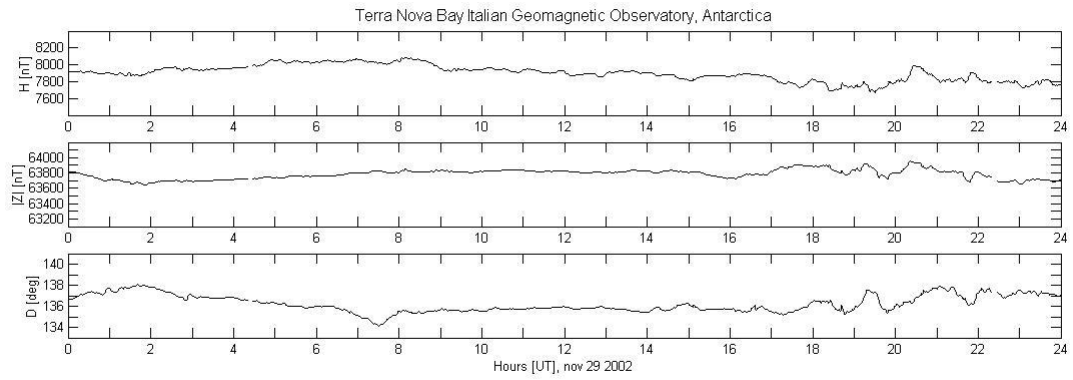
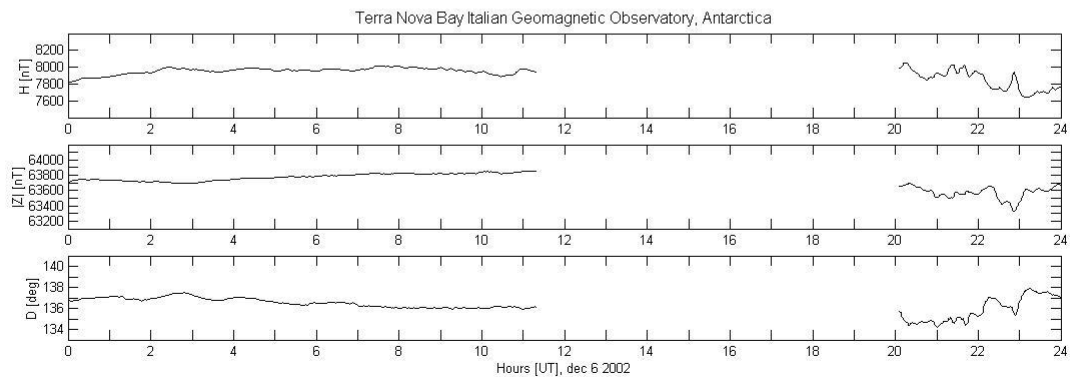
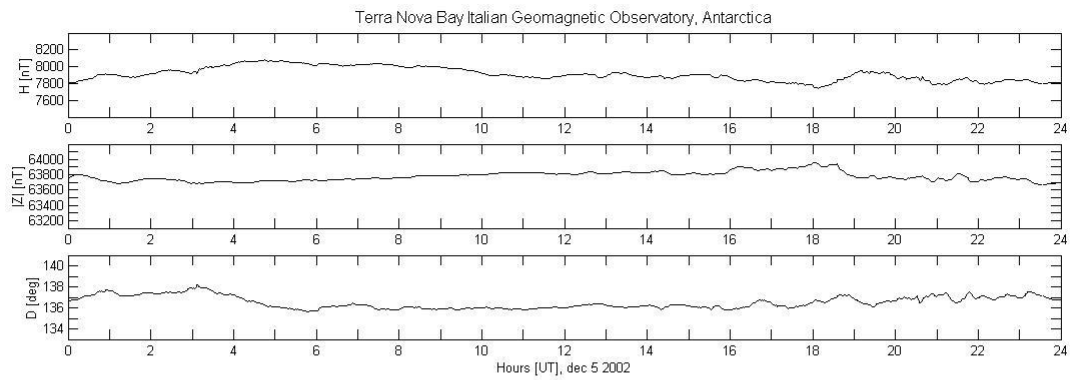
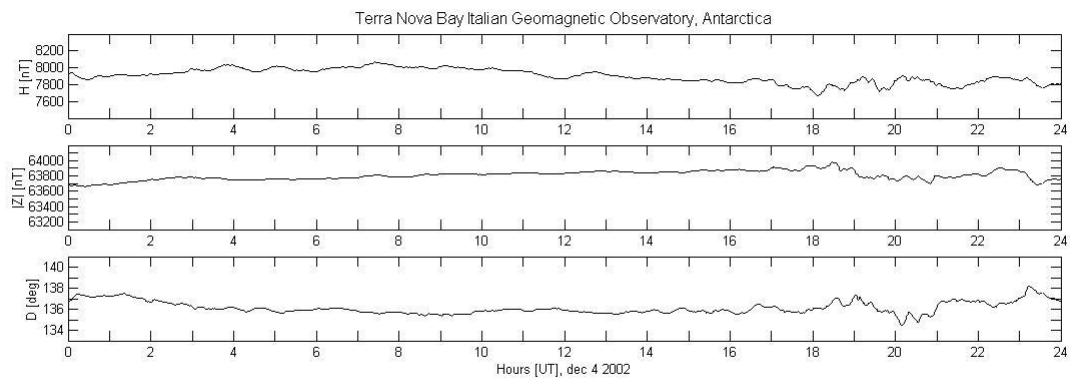
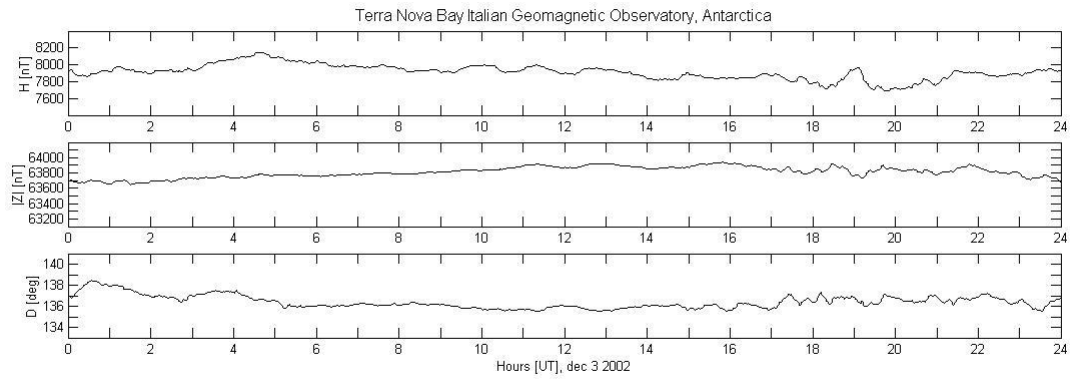


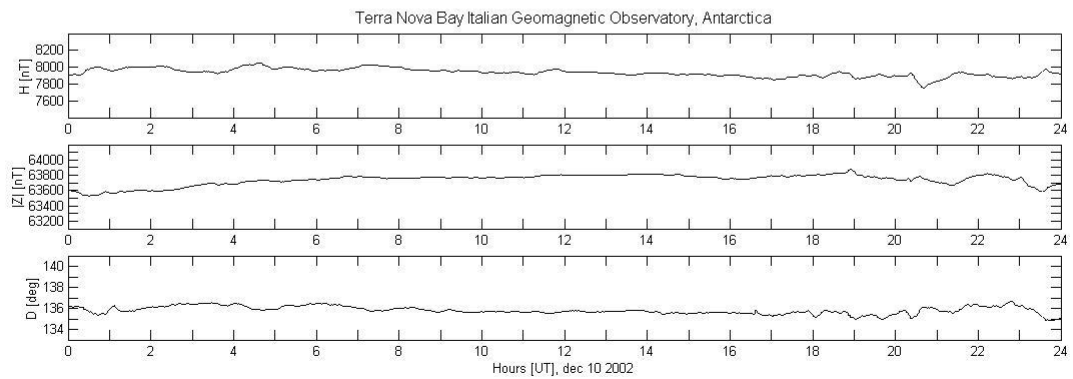
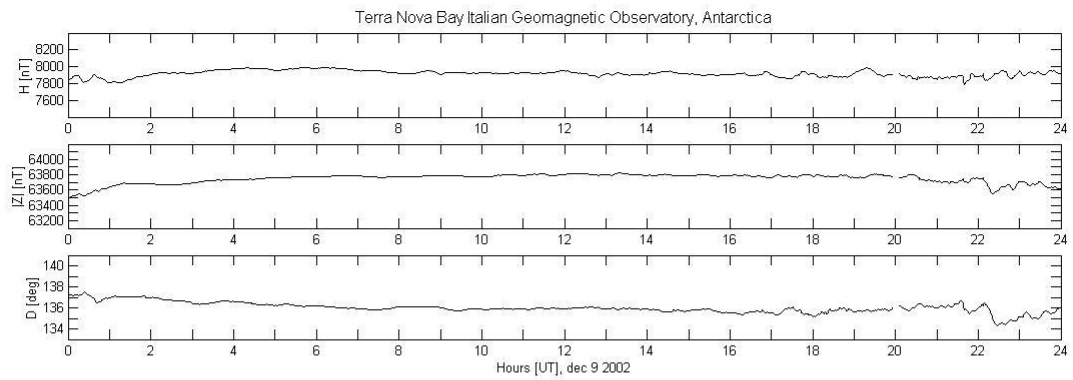
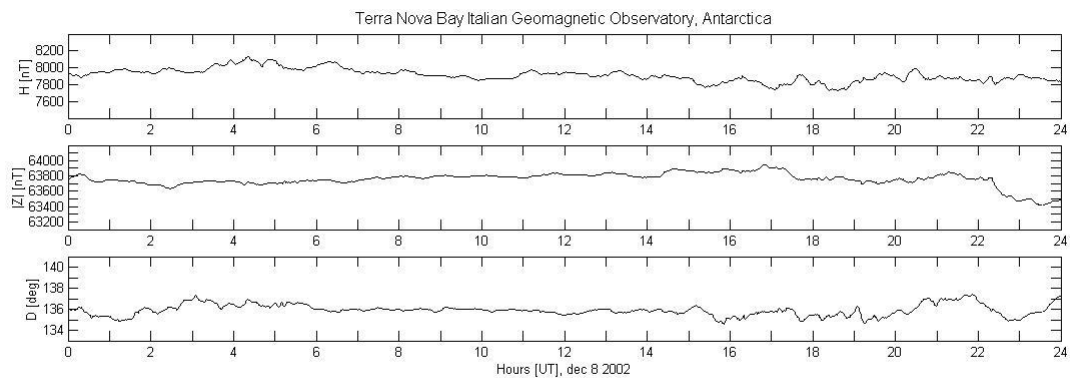
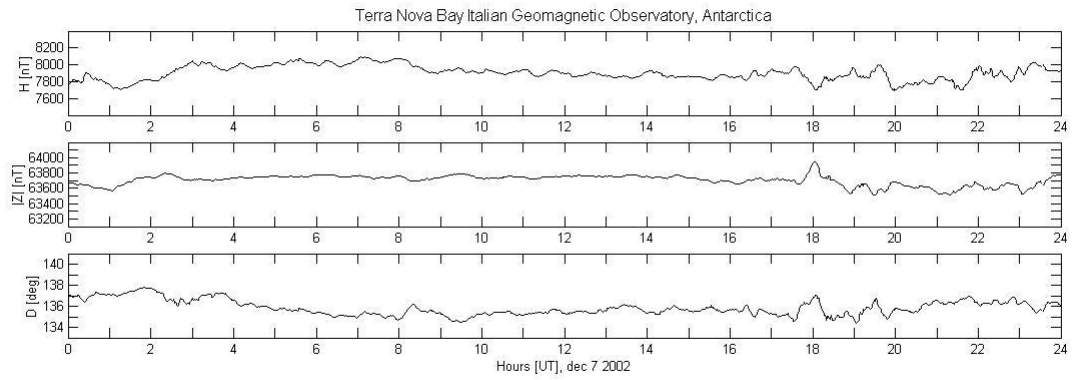
Fig 2

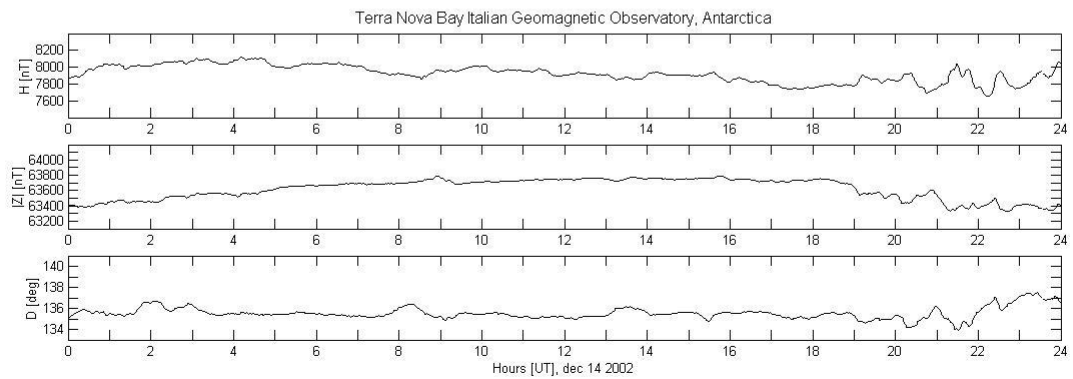
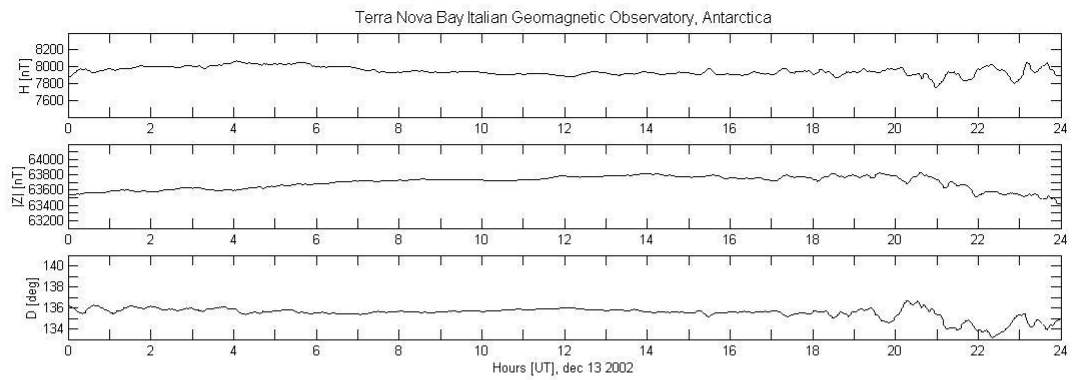
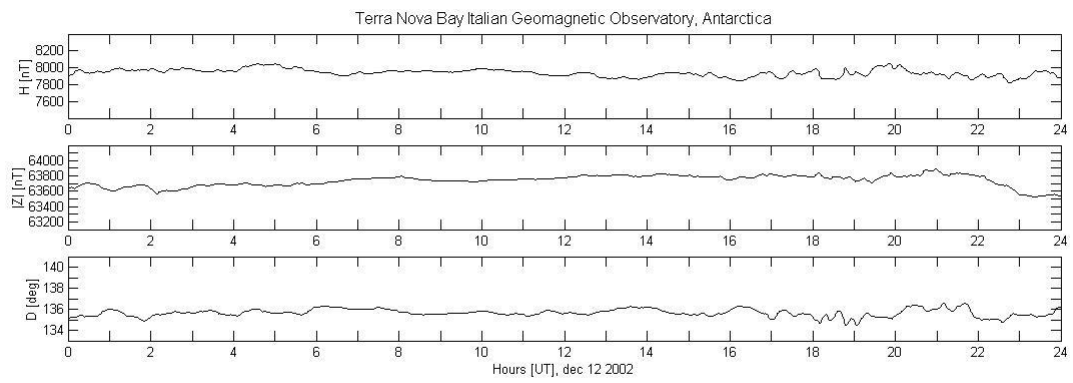
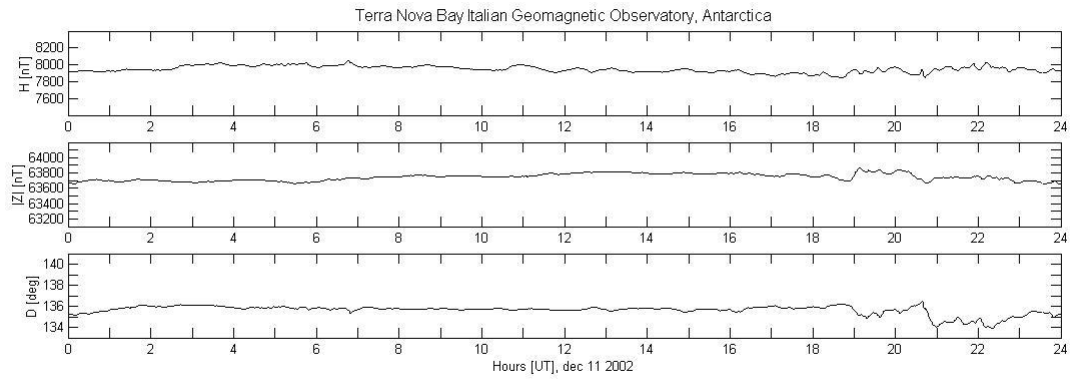


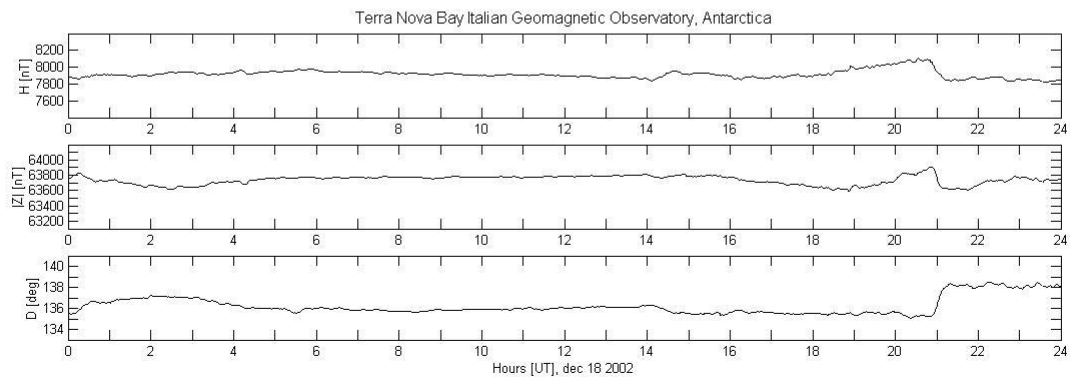
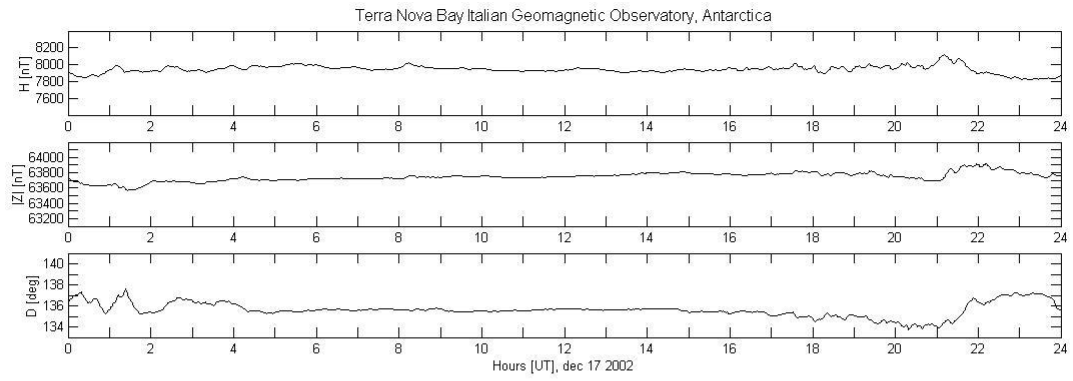
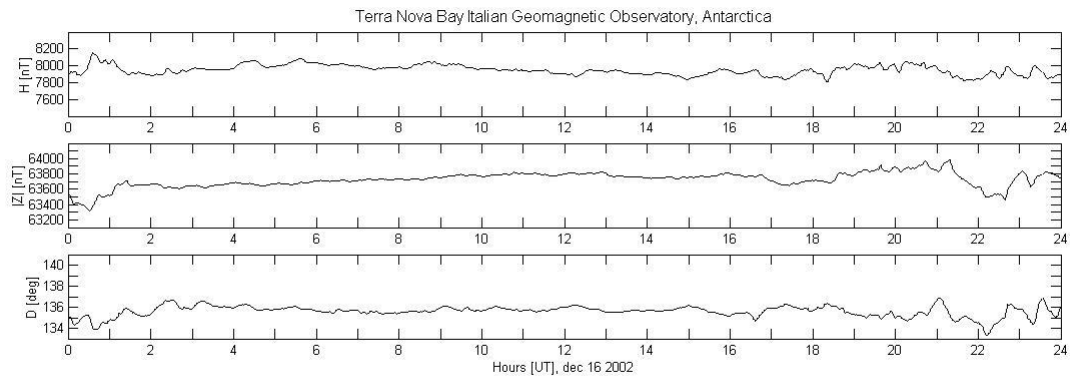
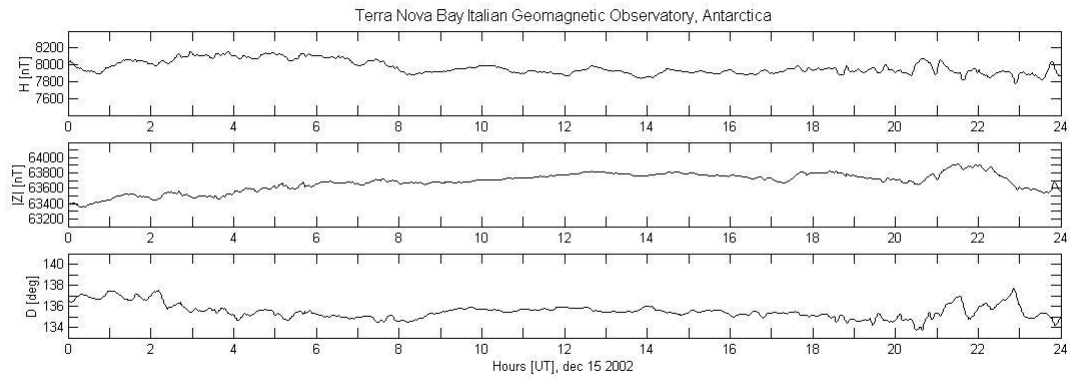


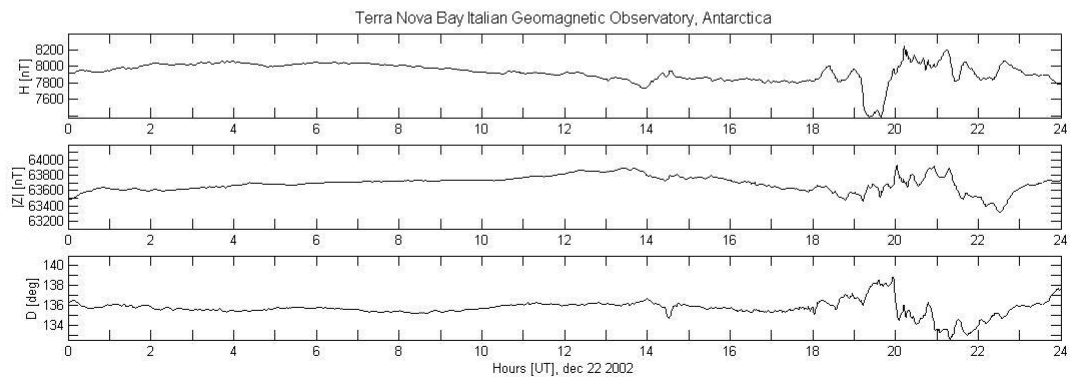
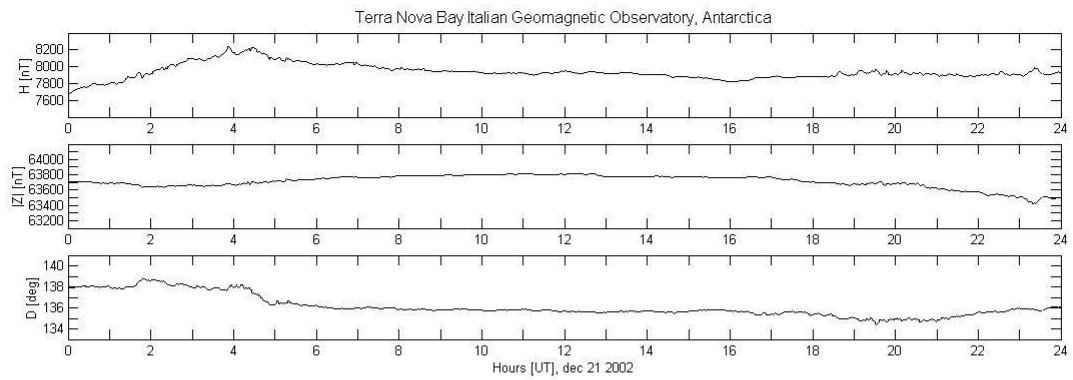
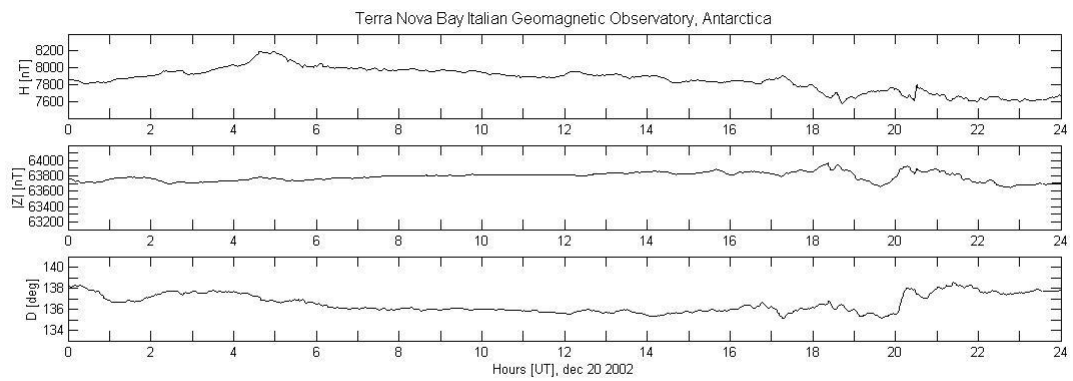
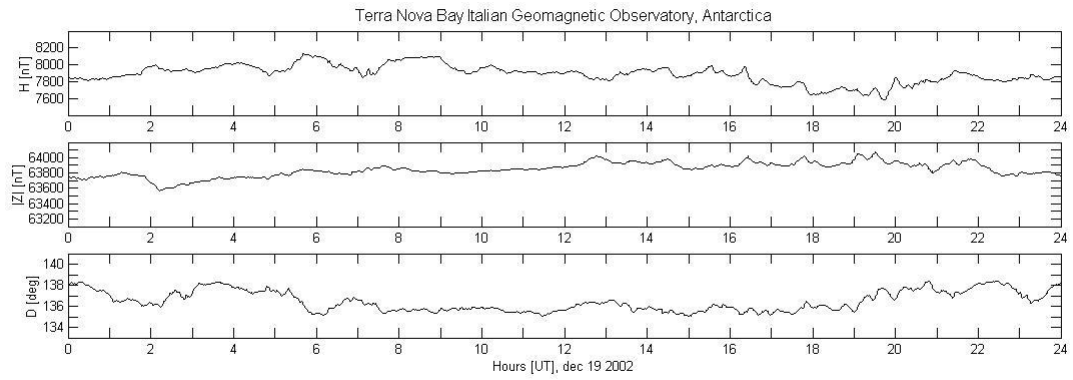


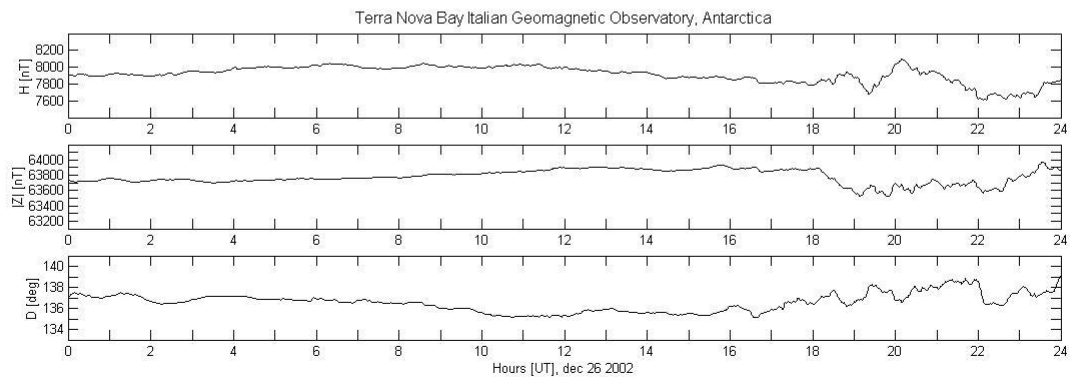
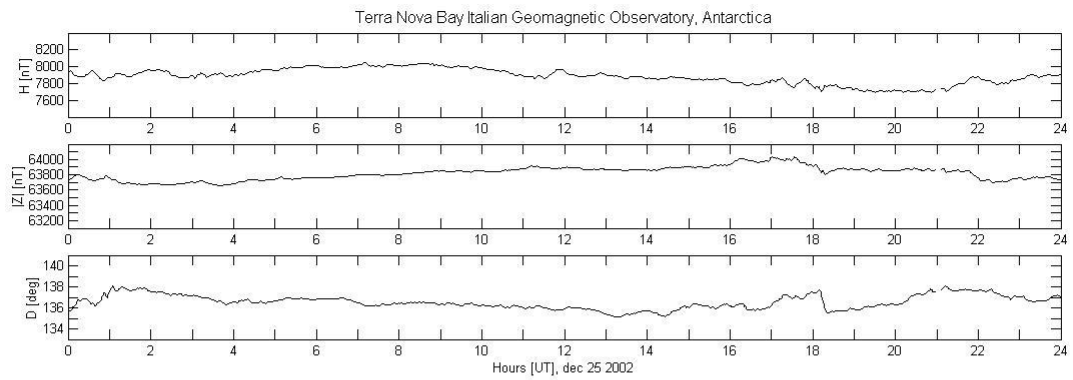
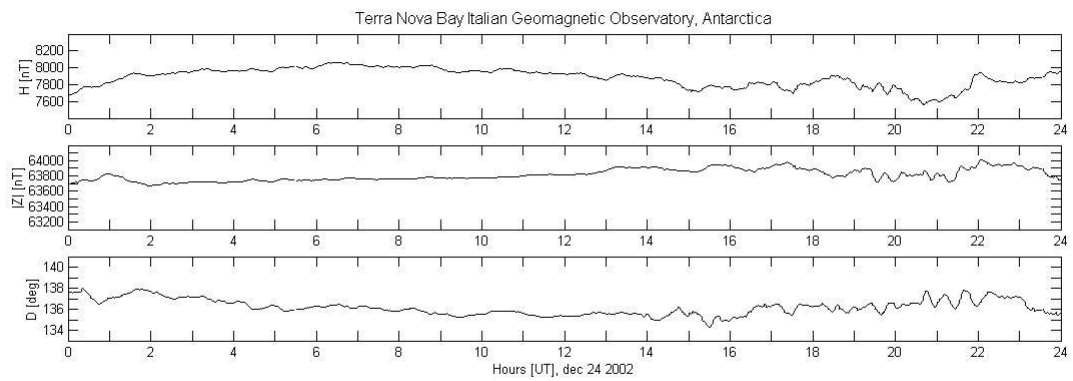
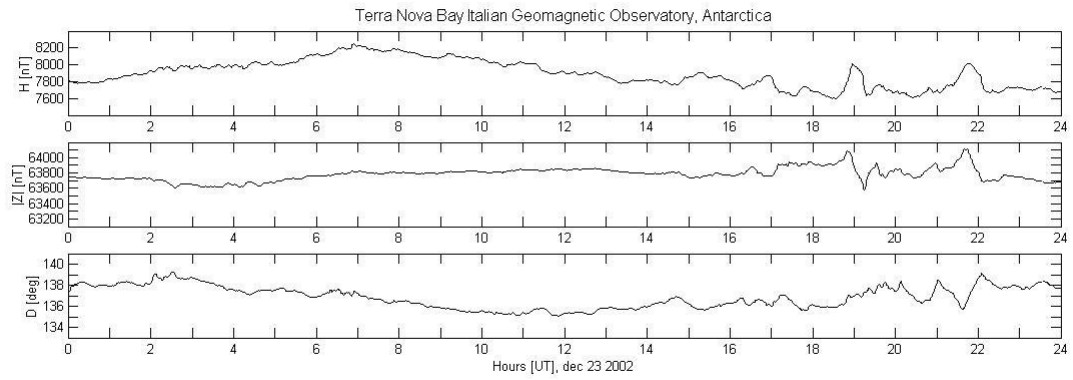


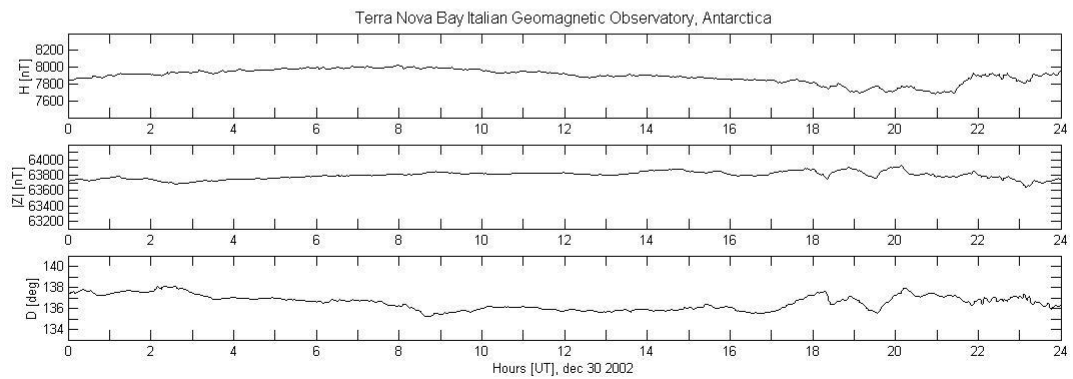
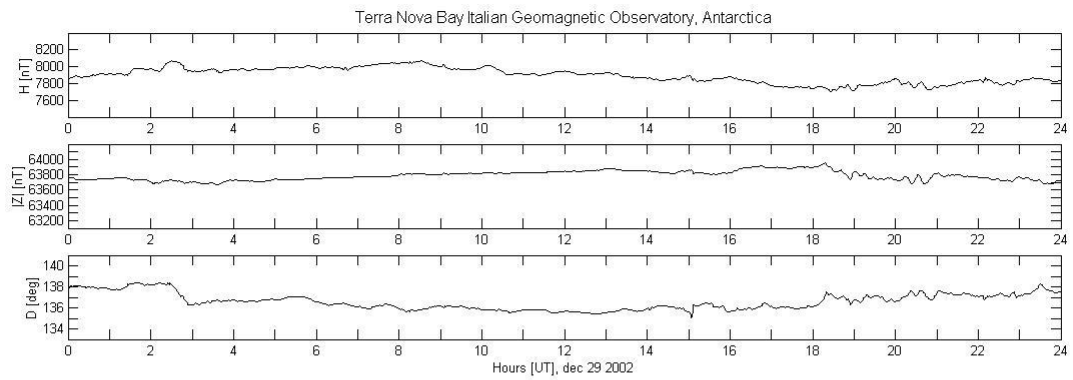
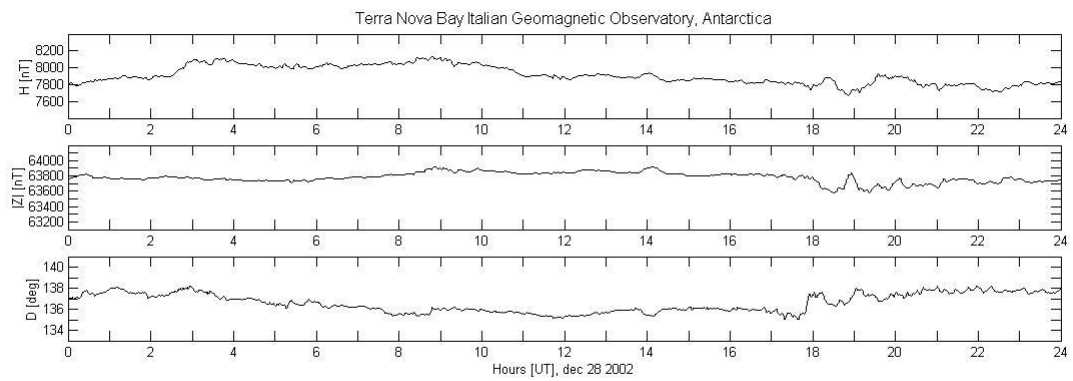
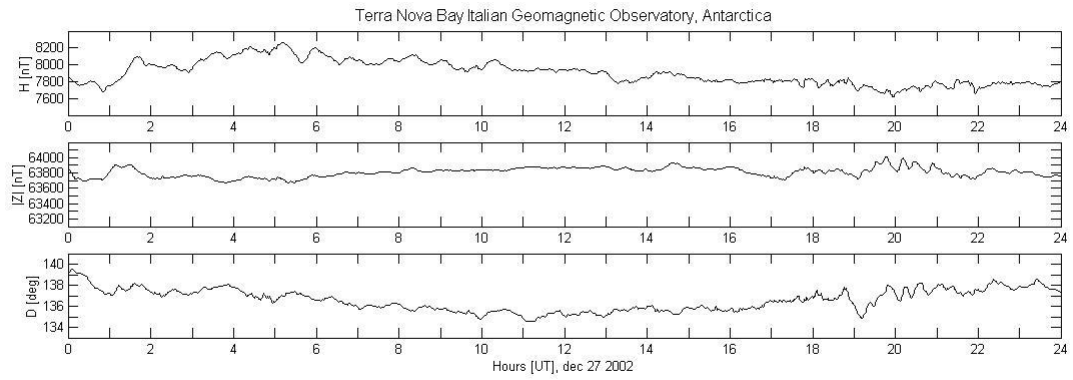


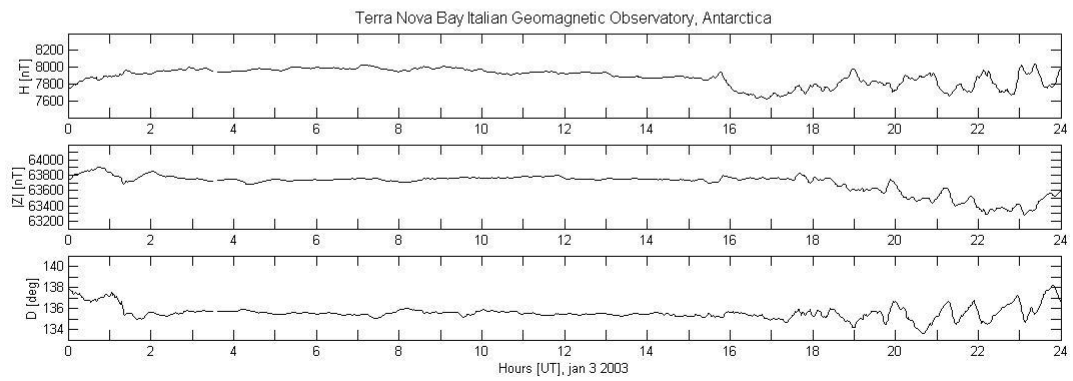
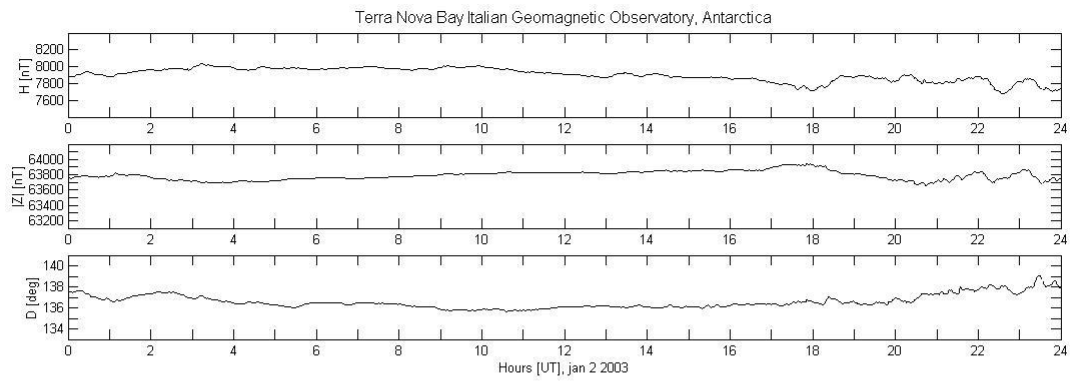
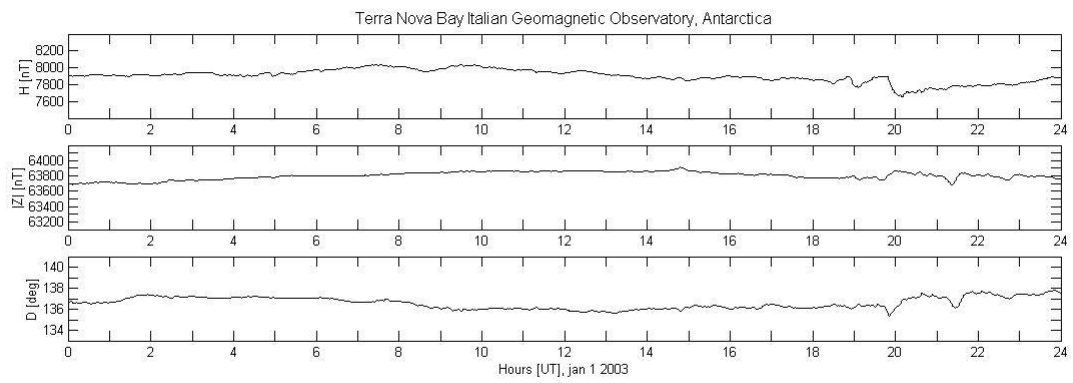
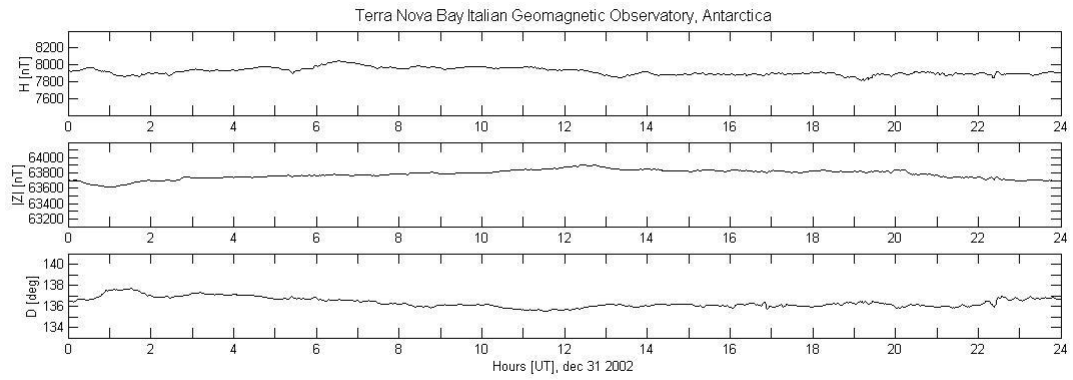


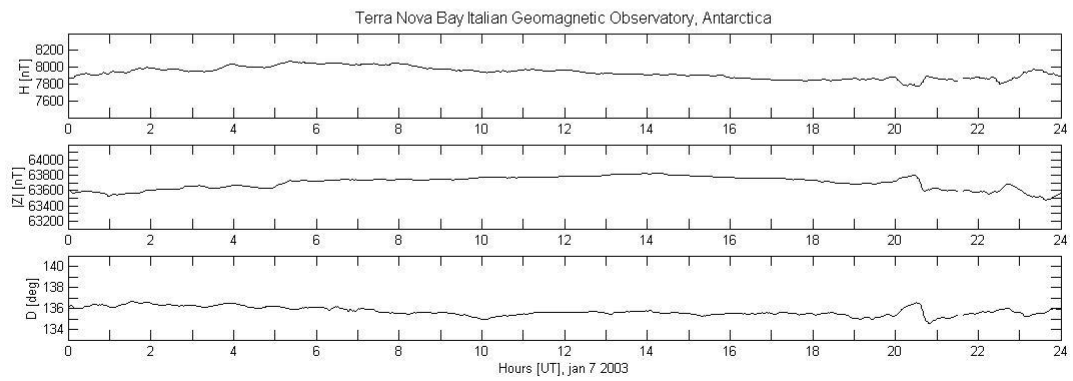
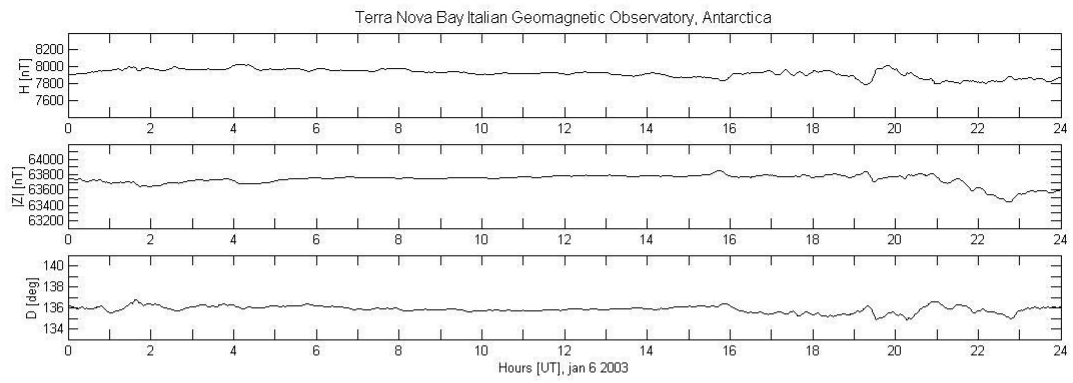
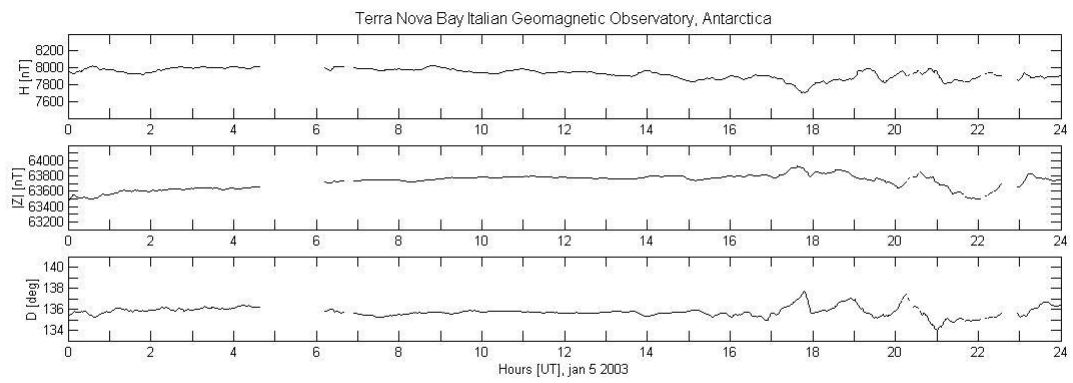
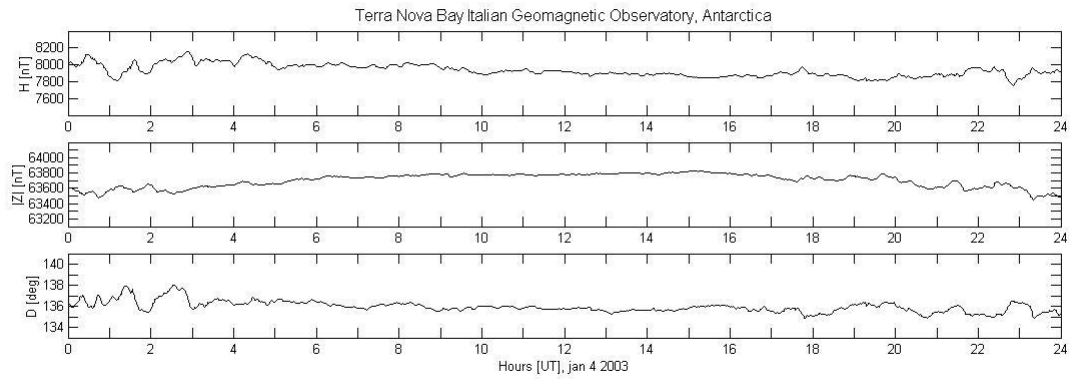


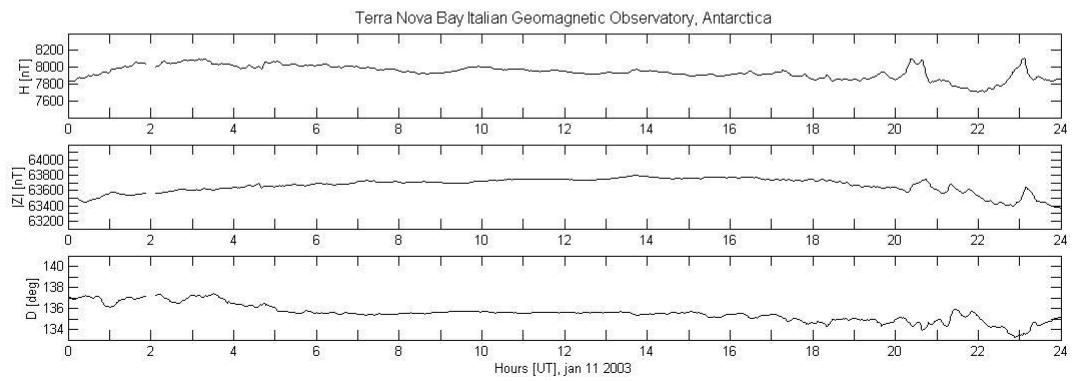
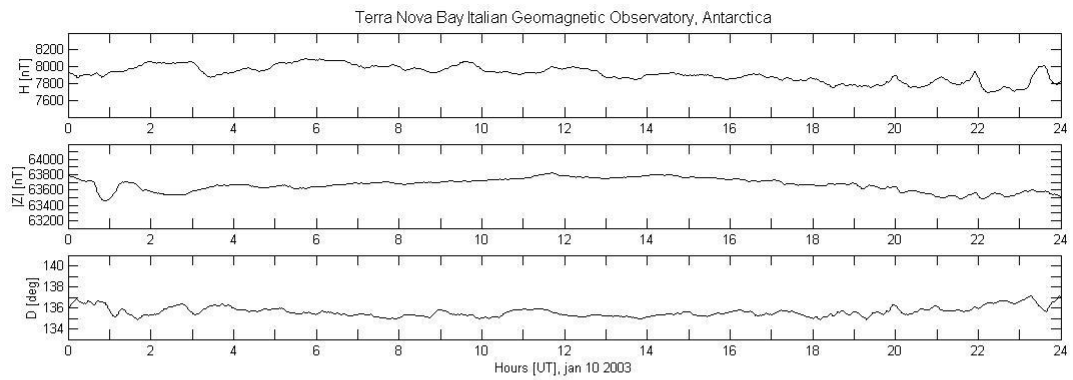
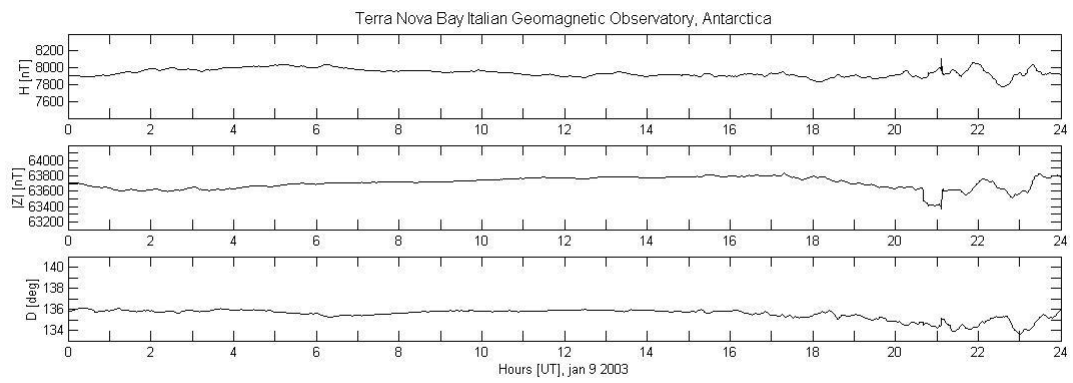
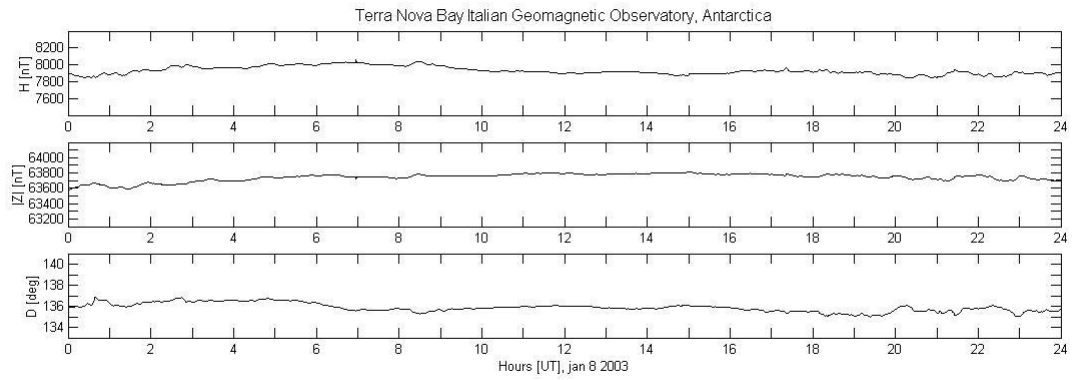


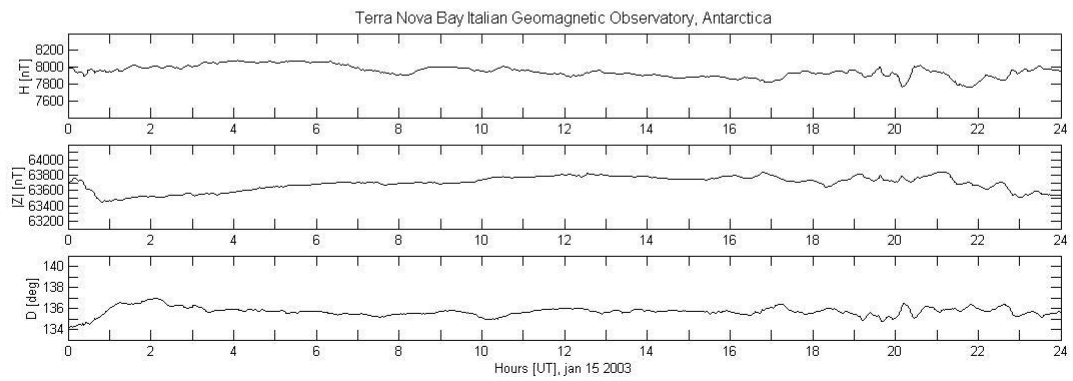
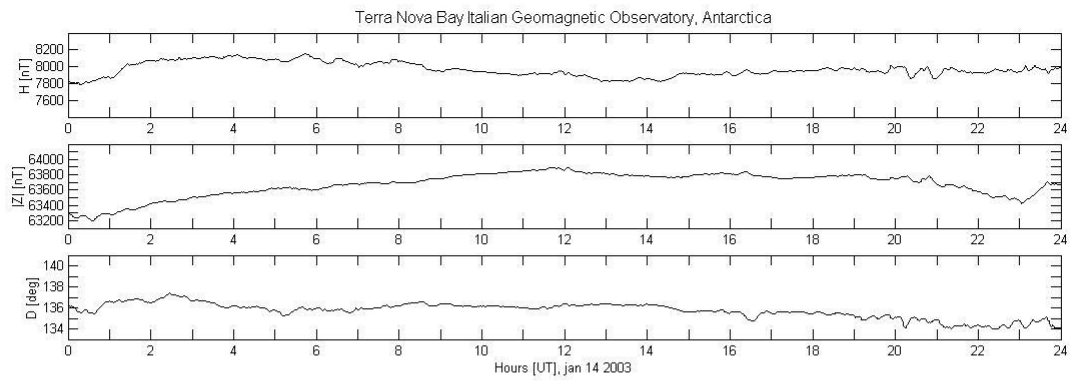
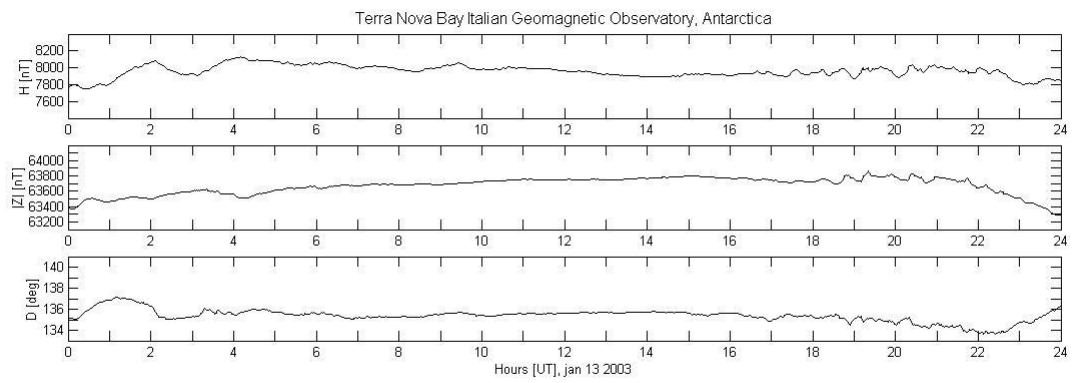
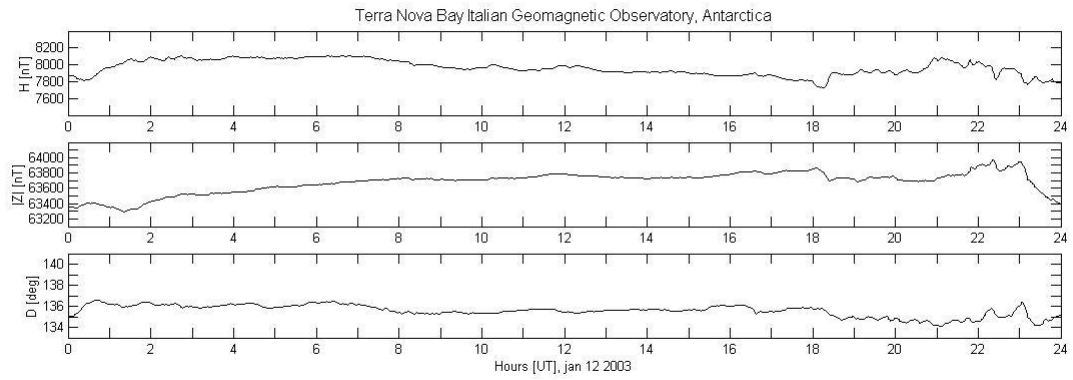


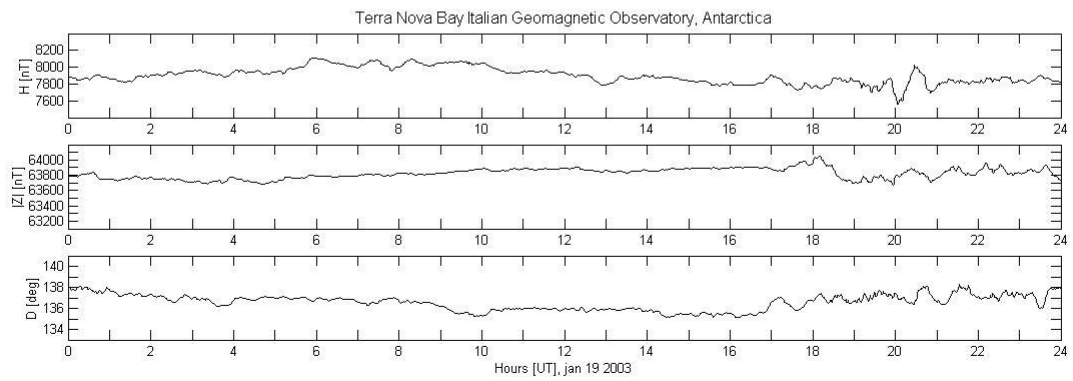
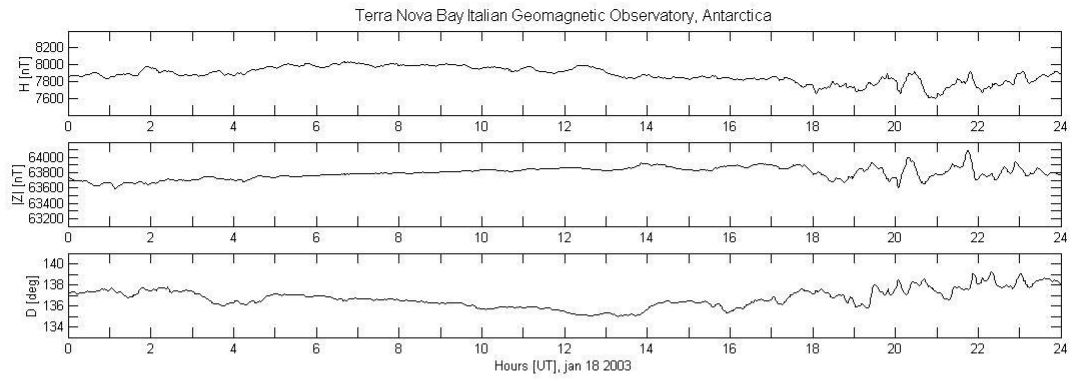
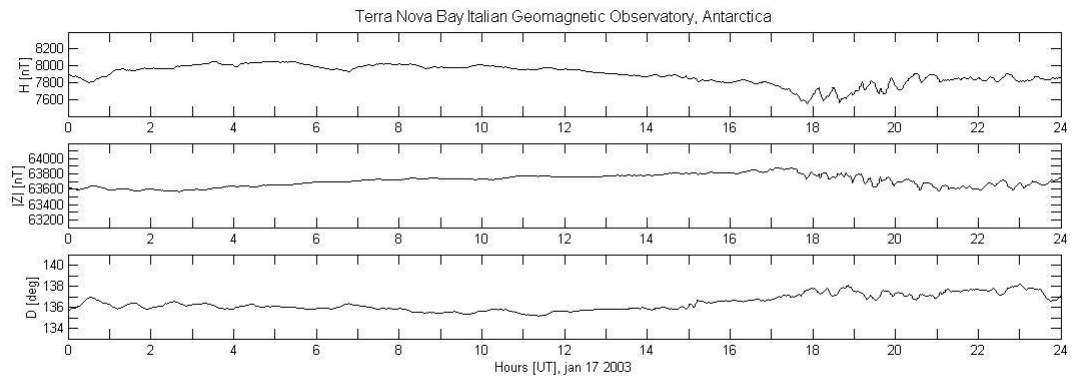
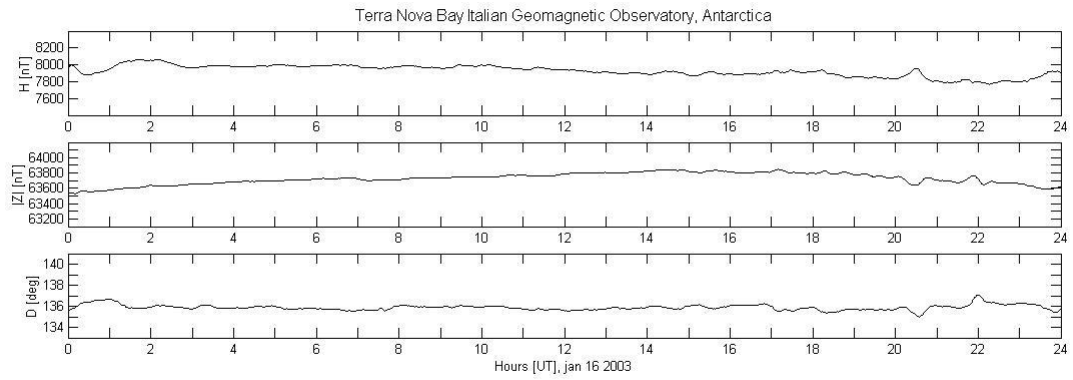


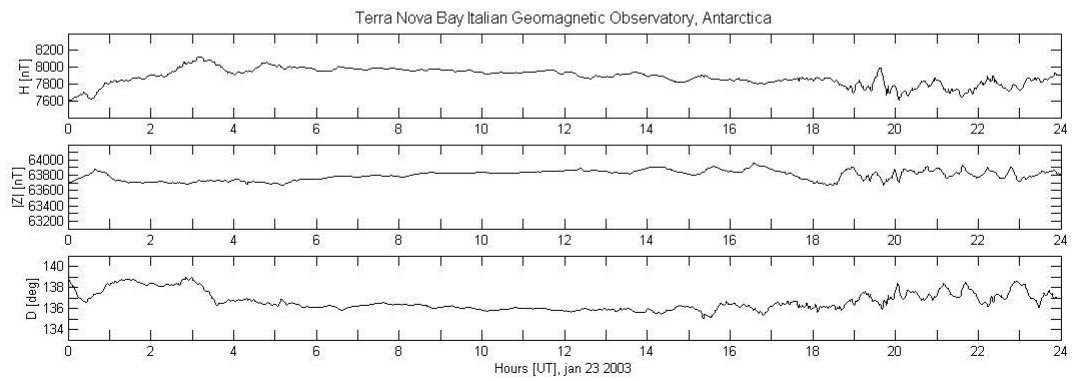
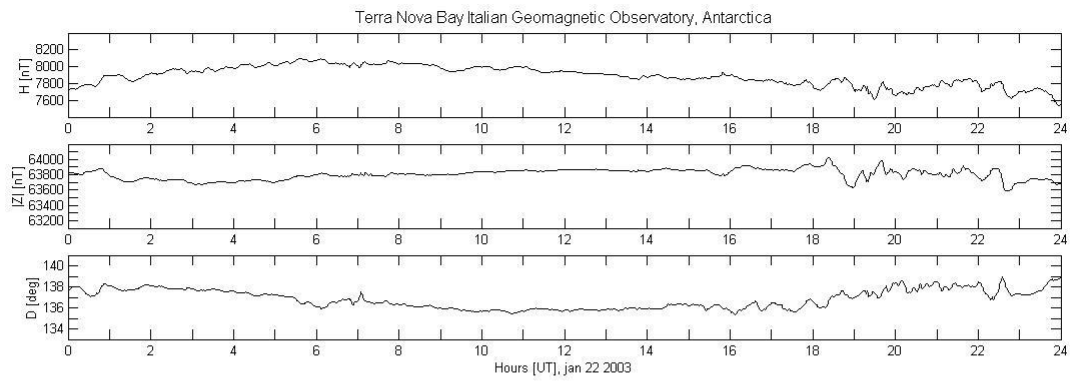
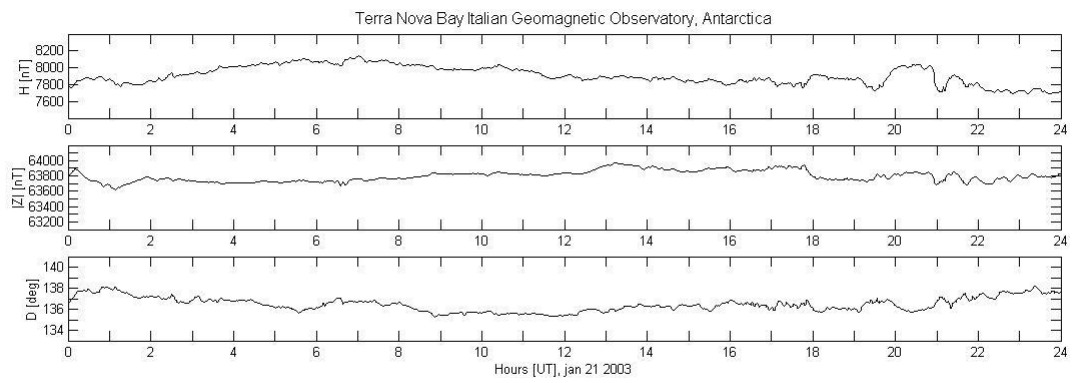
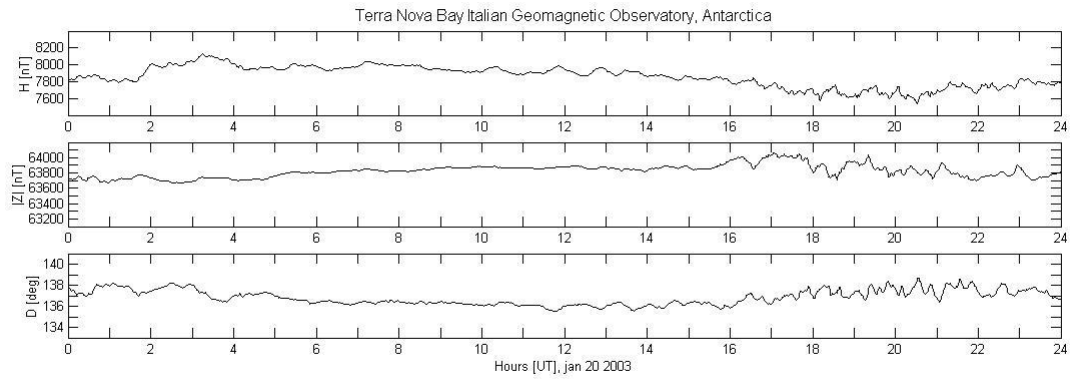


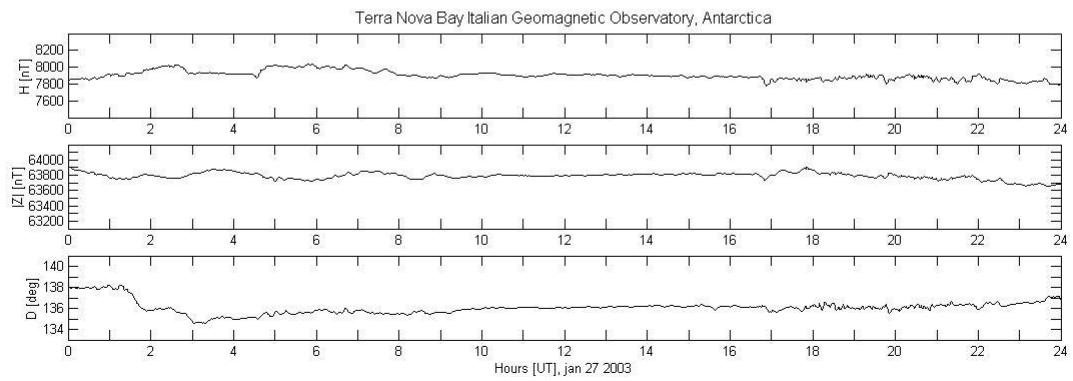
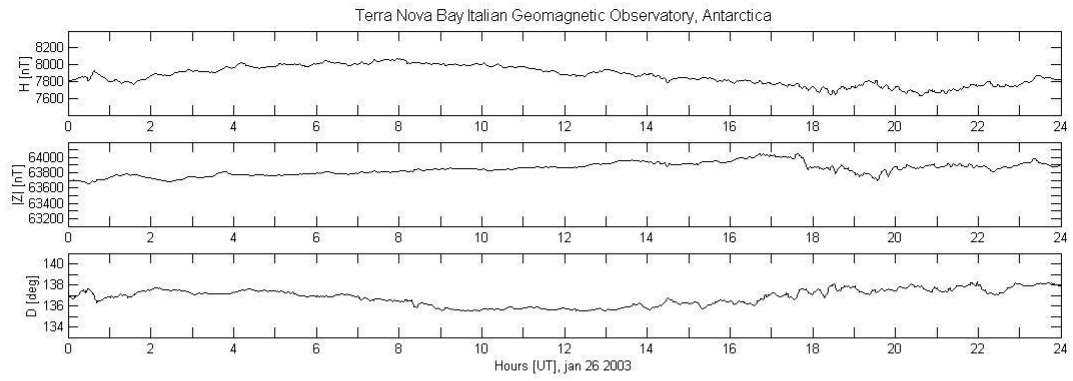
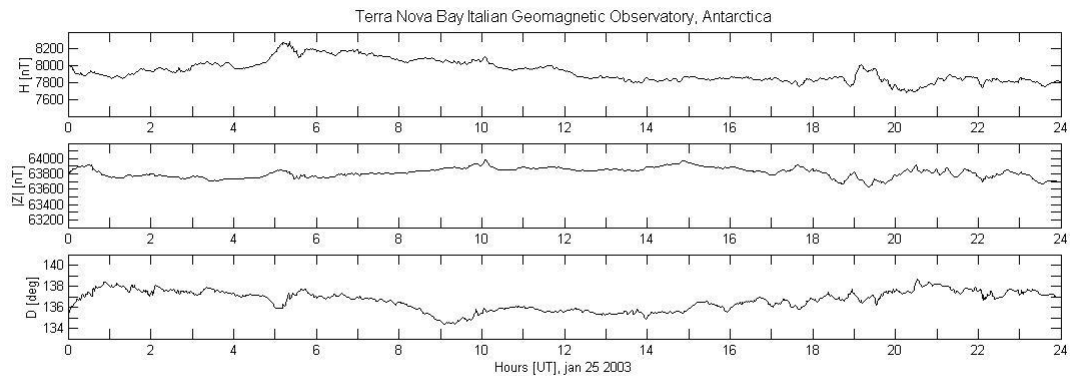
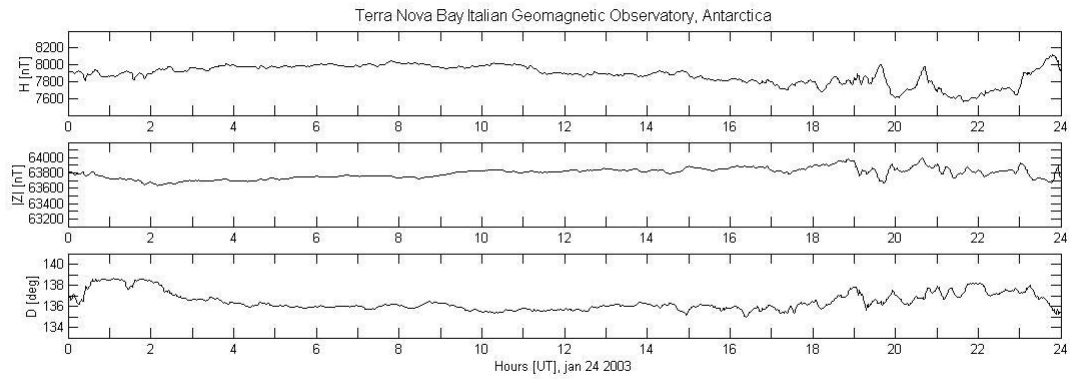


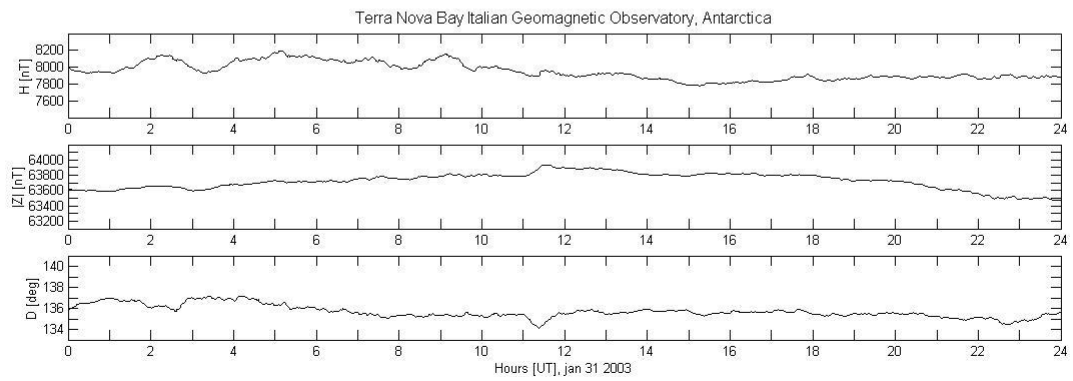
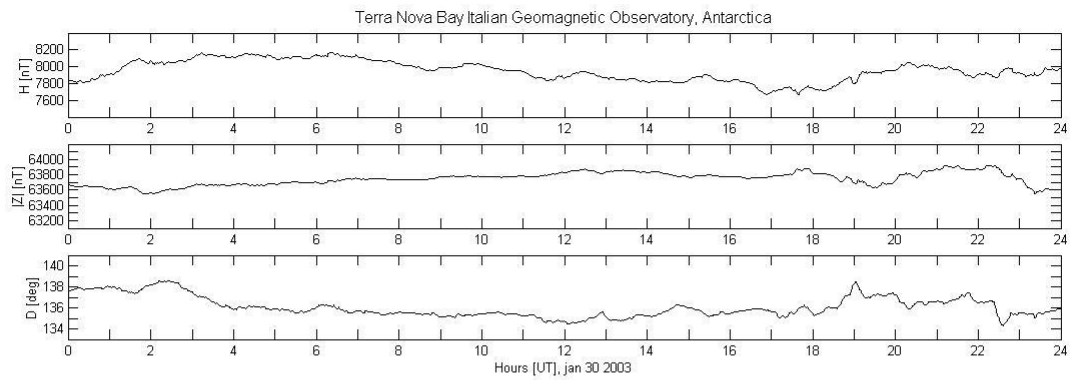
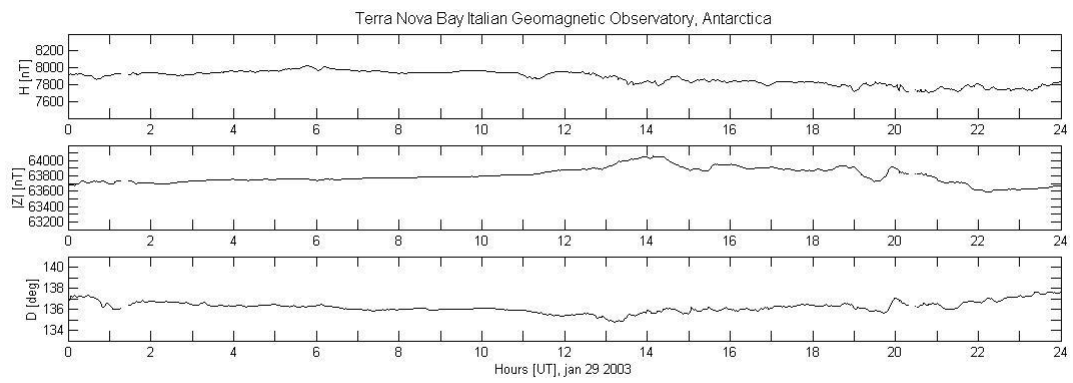
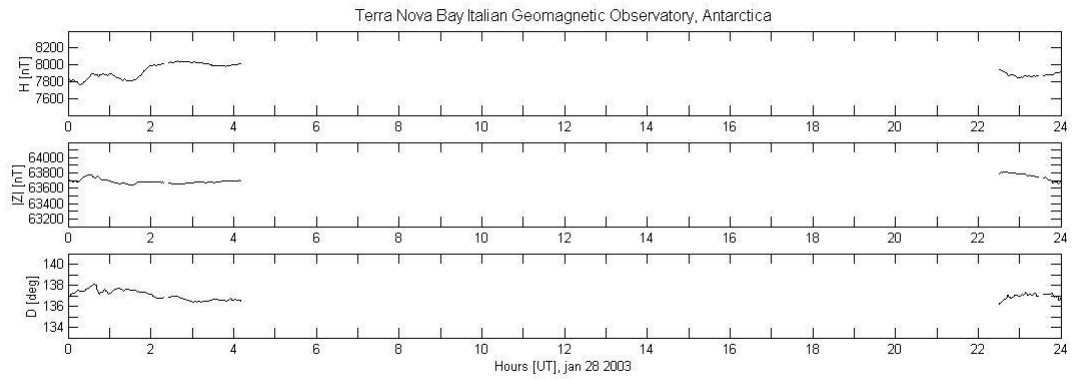


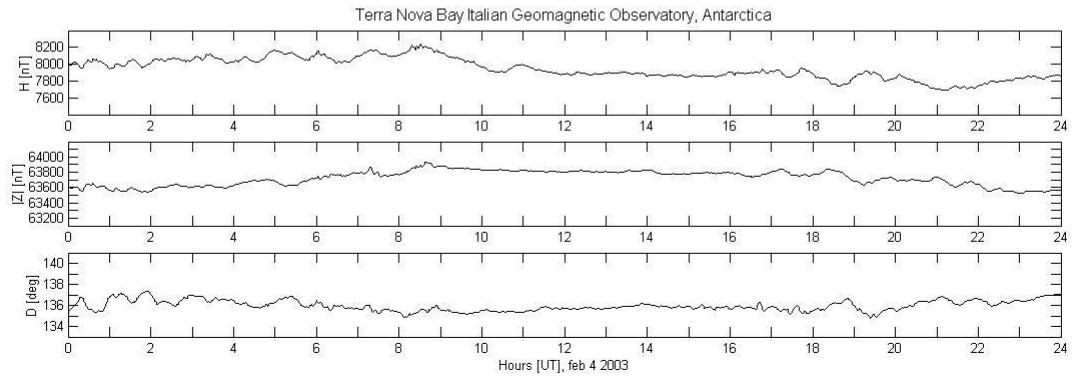
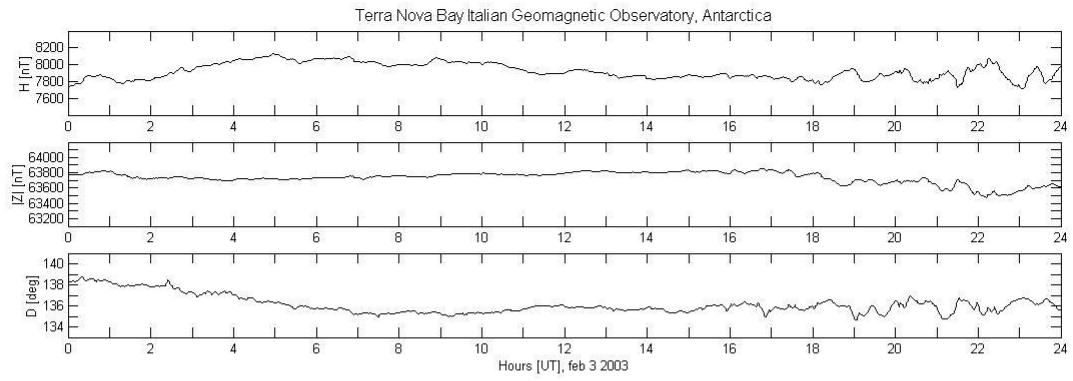
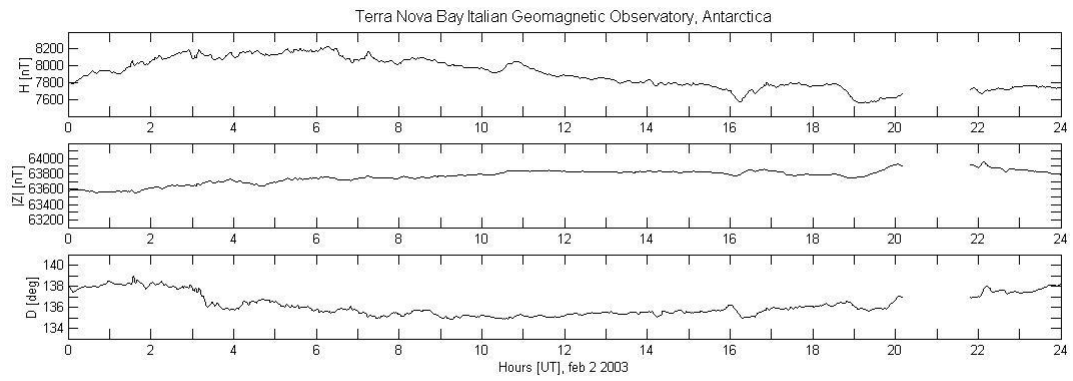
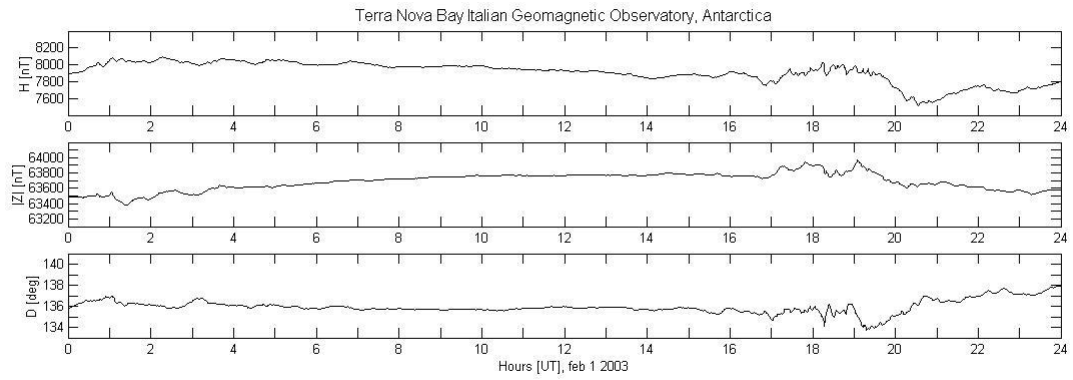


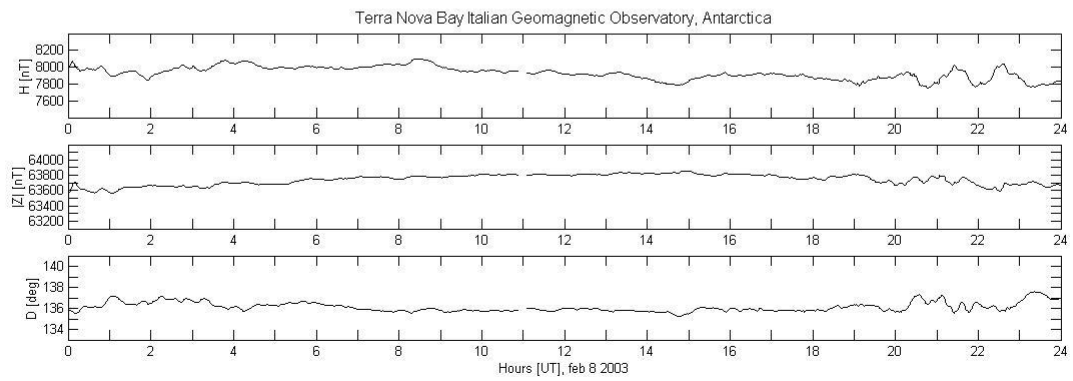
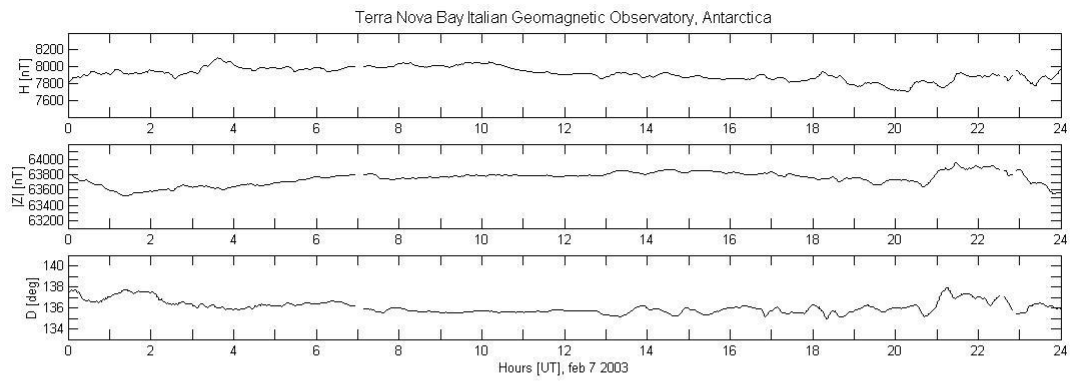
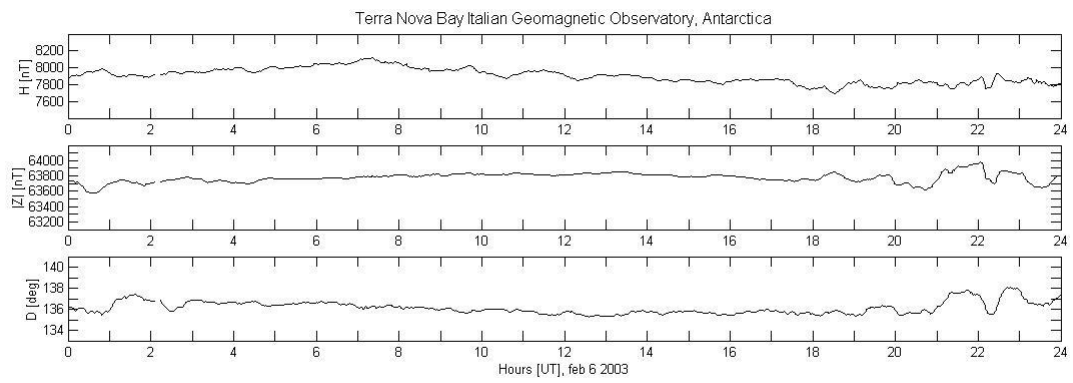
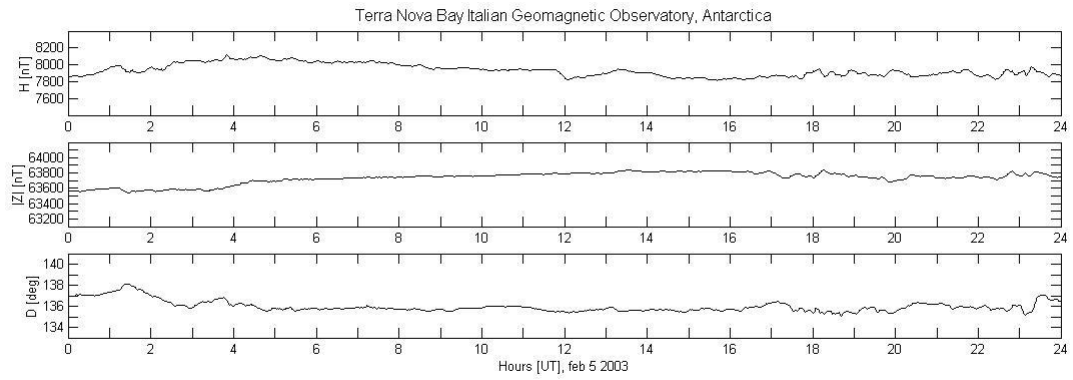


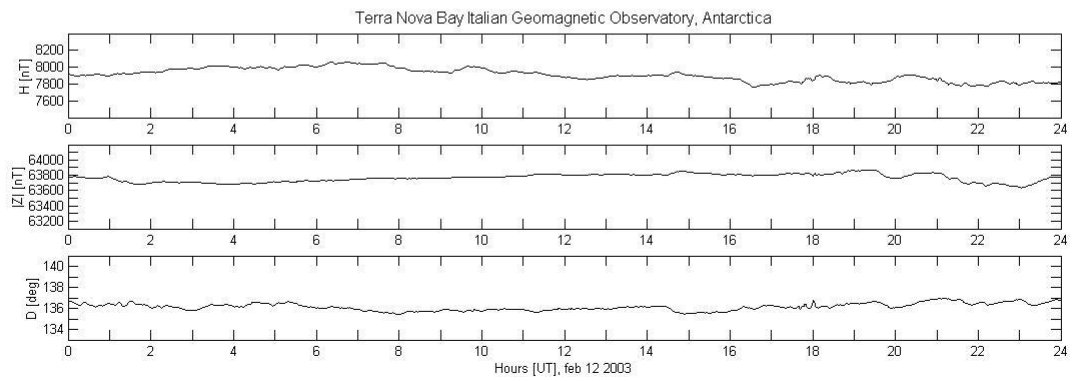
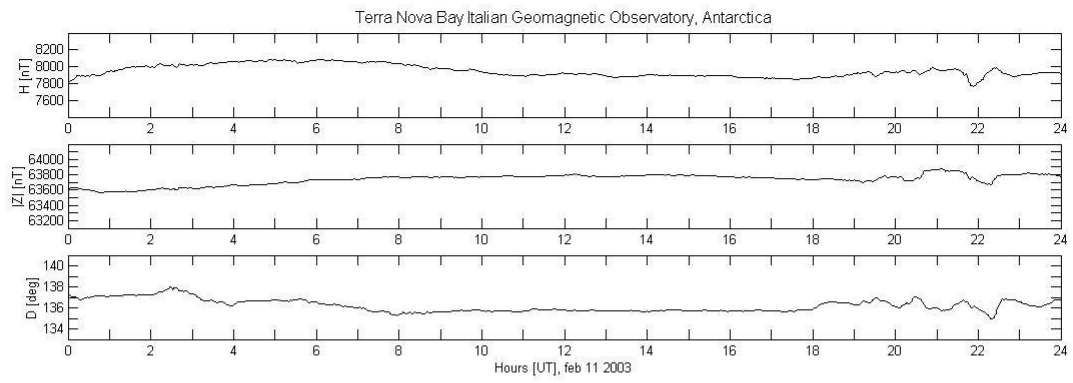
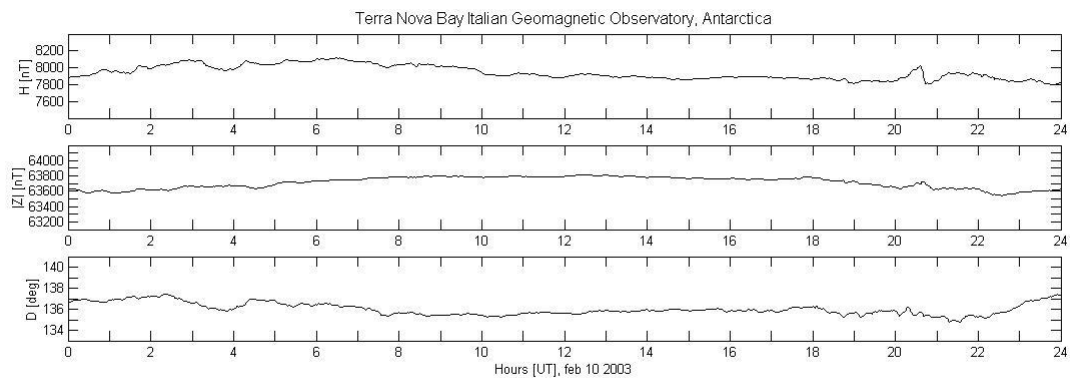
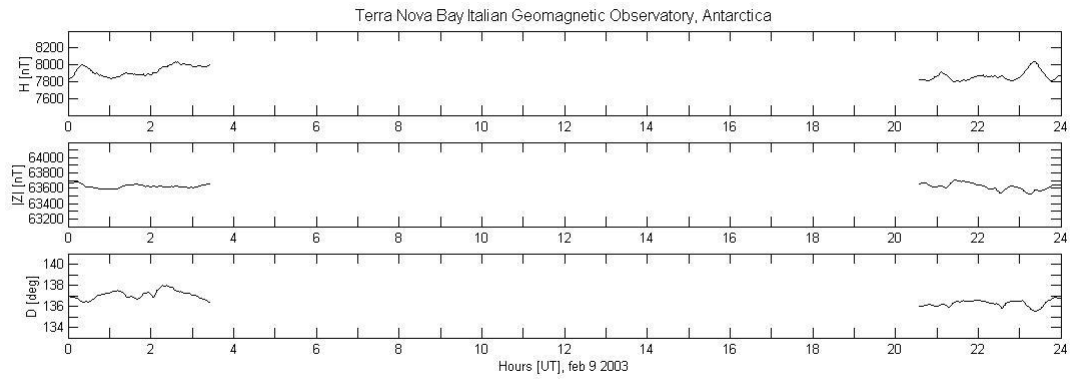


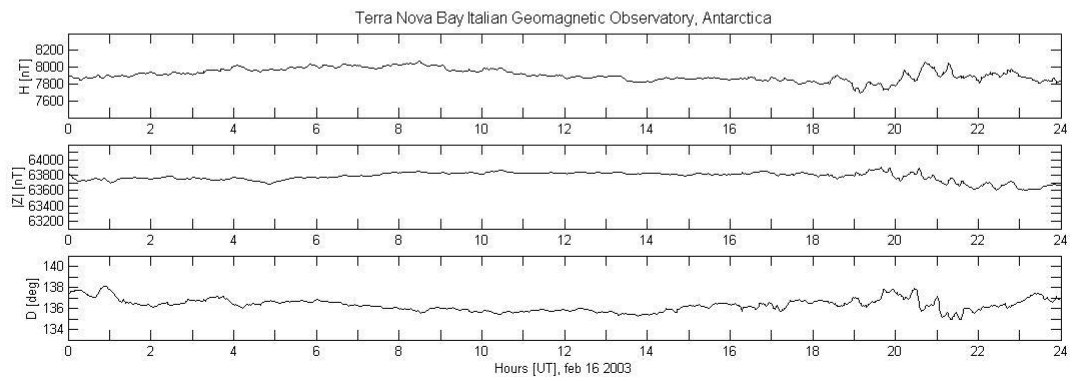
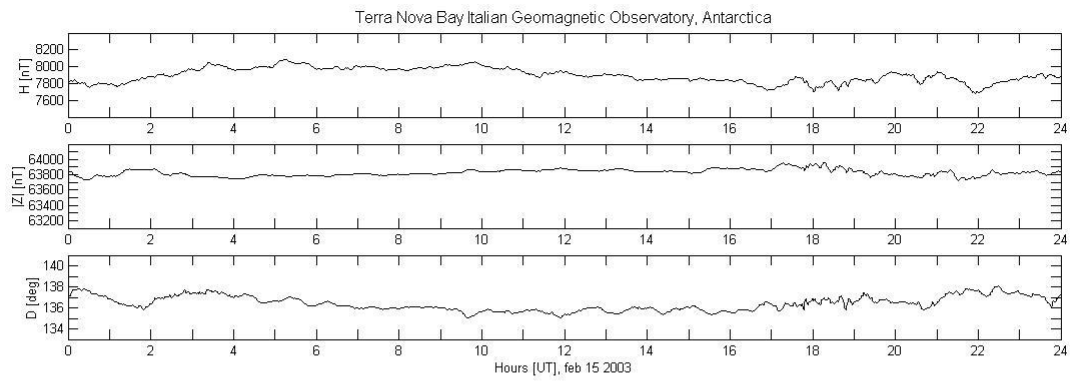
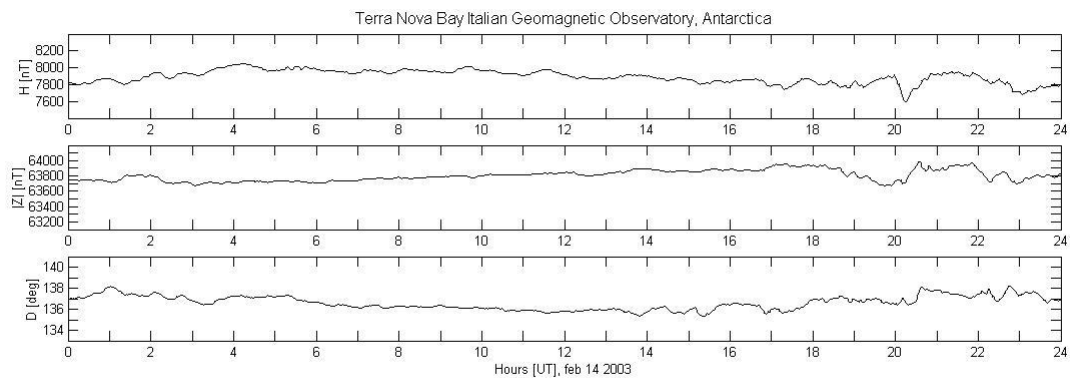
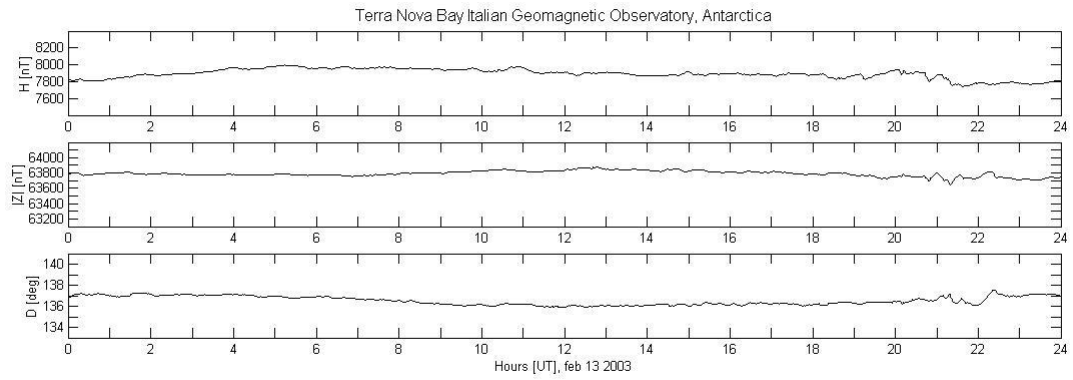




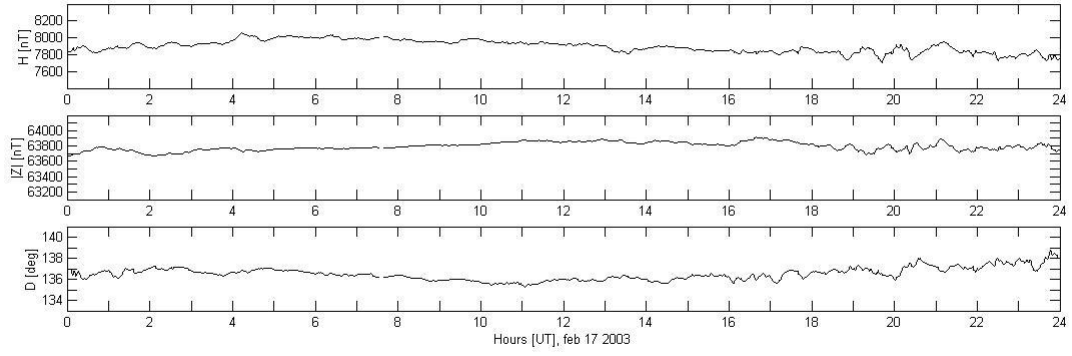








Terra Nova Bay Italian Geomagnetic Observatory, Antarctica



TNB Geomagnetic Observatory

Mean values

Campaign	H(nT)	D(deg min)		Z(nT)	F(nT)
1986/1987	7391	136	49	64494	64916
1987/1988	7432	136	54	64452	64879
1988/1989	7444	136	40	64355	64784
1989/1990	7509	136	48	64325	64762
1990/1991	7522	136	45	64254	64693
1991/1992	7564	136	29	64228	64672
1992/1993	7582	136	40	64166	64612
1993/1994	7610	136	41	64148	64598
1994/1995	7643	136	46	64112	64566
1995/1996	7682	136	29	64062	64521
1996/1997	7716	136	33	64018	64481
1997/1998	7756	136	27	63979	64447
1998/1999	7789	136	24	63932	64405
1999/2000	7829	136	14	63886	64364
2000/2001	7861	136	18	63848	64330
2001/2002	7889	136	02	63794	64280
2002/2003	7916	135	58	63761	64251

