REPORT UAG-75

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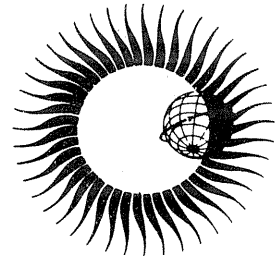
THE ALASKA IMS MERIDIAN CHAIN: MAGNETIC VARIATIONS FOR 9 MARCH-27 APRIL 1978



June 1980

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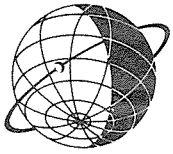
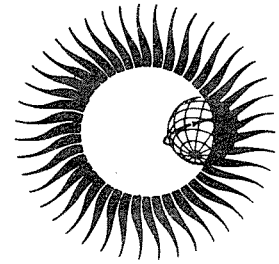


REPORT UAG-75

THE ALASKA IMS MERIDIAN CHAIN: MAGNETIC VARIATIONS FOR 9 MARCH-27 APRIL 1978

H.W. Kroehl and G.P. Kosinski
National Geophysical and Solar-Terrestrial Data Center
S.-I. Akasofu, G.J. Romick, C.E. Campbell and G.K. Corrick
Geophysical Institute, University of Alaska
C.E. Hornback and A.M. Gray
Space Environment Laboratory

June 1980



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THE ALASKA IMS MERIDIAN CHAIN: MAGNETIC VARIATIONS FOR 9 MARCH - 27 APRIL 1978

by

H.W. Kroehl[1], S.-I. Akasofu[2], G.J. Romick[2], G.P. Kosinski[1], C.E. Campbell[2], G.K. Corrick[2], C.E. Hornback[3] and A.M. Gray[3]

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The International Magnetospheric Study, IMS (Text is adapted from a National Academy of Sciences report on the IMS [1974]).

Recognizing the need for a more completely detailed understanding of the magnetosphere, the International Council of Scientific Unions through its Special (now Scientific) Committee on Solar-Terrestrial Physics launched the IMS, a carefully designed and highly coordinated program of spacecraft recordings together with ground-based, balloon, and rocket observing campaigns. The task of coordinating this multiplatform observing program fell upon the Satellite Situation Center and the IMS Central Information Exchange Office.

The general scientific goals of IMS attempt to define and understand the key physical processes associated with the energy, mass, and momentum transfer from the solar wind to the magnetosphere and atmosphere. These energy-transfer mechanisms involve diverse phenomena such as direct particle injection, magnetic energy storage, local particle acceleration, electromagnetic waves, traveling ionospheric disturbances, and Joule heating of the ionosphere. Ionospheric manifestations of magnetospheric energy release, called magnetospheric substorms, characteristically have large-scale spatial, temporal, and amplitude variability.

Geomagnetic observations provide the global basis for ground-based research during the IMS. They generate a unique and basic measure of the state of the magnetosphere for a number of reasons. Ground-based magnetometers record information about a variety of phenomena, ranging from the interaction of the solar wind with the magnetosphere to currents flowing in the upper atmosphere. The magnetometers operate as well in sunlight as in darkness and the recordings are unaffected by cloud cover, rain, or snow. Moreover, ground-based magnetometers require low telemetry rates, and their relative simplicity makes them well suited for unmanned operation.

Differing spatial and temporal patterns of magnetic variations at different latitudes indicate that the distribution of magnetometer stations can be nonuniform. Near the geomagnetic equator, several stations are required to determine the global diurnal variations that dominate this region and result from the equatorial electrojet. At midlatitude in the Northern Hemisphere, a longitudinal chain of magnetometers is vital to the definition of substorm effects in the ionosphere and magnetosphere. Through the auroral zone and polar cap, latitudinal chains of stations spaced 1° apart are necessary to define and discriminate spatial from temporal variations of the ionospheric currents and supplying field-aligned currents.

U.S. IMS Participation

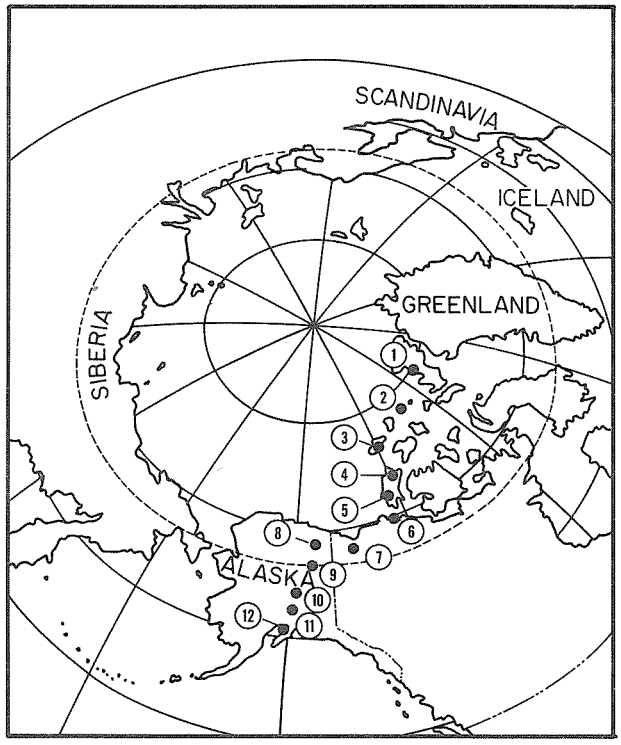
In support of the coordination aspects of the IMS, the United States established the Satellite Situation Center (SSC) and the IMS Central Information Exchange (IMSCIE) offices. The IMSCIE office, operated by NOAA/NGSDC and headed by J.H. Allen, publishes the monthly IMS Newsletter containing program plans, successful experiments and items of general interest. In addition to providing data and information for the IMS Newsletter, the SSC, operated by NASA/NSSDC and headed by Dr. James I. Vette, compiles and updates the Directory of Spacecraft and Experiment Scientific Contacts and computes and distributes the times of satellite conjunctions. The SSC has also conducted the Coordinated Data Analysis Workshops, a unique approach to the analysis of multidisciplinary data sets.

Of central interest to this report is the U.S.-supported geomagnetic observations program of installing magnetometers, radio transmitters (for communications with SMS/GOES satellites) and/or magnetic tape recorders at 28 sites to complement/upgrade existing networks and facilities. The three meridional chains of stations crossing the north polar region of the Western Hemisphere are identified in IMS Newsletter 77-1 [1977] as the Alaska Chain, 12 stations between N61 and N89 near E265 (corrected geomagnetic coordinates); the Alberta Chain, nine stations between N62 and N71 near E304; and the Fort Churchill Chain, nine stations between N62 and N80 near E327. The U.S. IMS effort supports 10 Alaska Chain stations, one Alberta Chain station and six Fort Churchill Chain stations. One zonal chain located in the auroral zone and identified as the East-West Chain consists of seven stations near N68 and lies between E354 and E261; the other, called the Midlatitude Chain, consists of eight stations near N19 and lies between E32 and E214 (from east to west). Here the U.S. IMS effort supports six

East-West stations and all eight Midlatitude stations. Funding for the U.S. IMS effort was provided by the National Science Foundation and NOAA.

The Alaskan Chain

The stations that at one time or another have been part of the Alaska Chain are identified in Figure 1. It should be noted that the quality of Isachsen data comes under question on 18 March 1978 and Talkeetna began operating in May 1978. The Geophysical Institute of the University of Alaska operates the IMS equipment at Eureka, Isachsen, Johnson Point, Sachs Harbor, Cape Parry, Inuvik, Arctic Village, Fort Yukon, and Talkeetna. The College magnetometer is operated by the U.S. Geological Survey as standard magnetic observatory. The Mould Bay magnetometer is operated by the Canadian Department of Energy, Mines and Resources as a standard magnetic observatory. The Anchorage magnetometer is part of the High-Latitude Monitoring Station operated by NOAA/Space Environment Laboratory (SEL). All instruments except the Anchorage one are triaxial fluxgate magnetometers.



	Station	Invariant Latitude
1	EUREKA	89.0°
2	ISACHSEN	85.2°
3	MOULD BAY	80.7°
4	JOHNSON POINT	77.6°
5	SACHS HARBOR	76.0°
6	CAPE PARRY	74.4°
7	INUVIK	71.0°
8	ARCTIC VILLAGE	68.6°
9	FORT YUKON	67.1°
10	COLLEGE	64.9°
11	TALKEETNA	62.9°
12	ANCHORAGE	60.8°

Fig. 1. The IMS Alaska Meridian Chain of geophysical observatories.

Because of the expeditious manner in which these data were obtained, the standard IMS routine for data handling was not followed. Each station's location, component data received and data transfer mechanism are identified in Table 1. Analog records of X, Y and Z variations recorded at Eureka, Isachsen (9-17 March 1978) and Mould Bay (9-23 March 1978) were digitized at 1-min intervals. One-min Mould Bay X, Y and Z variations for 24 March - 27 April 1978 were received on magnetic tape. Ten-second D, H and Z variations data from Johnson Point through Arctic Village were telemetered via SMS/GOES satellites to SEL in Boulder. After processing, 5-min averages were recorded on magnetic tape and forwarded by SEL. The 1-min values of D, H and Z variations from Fort Yukon, College, and Anchorage also were received from SEL but were transmitted to Boulder via the High-Latitude Monitoring Station.

Due to the different formats of the data (1-min point values, 1-min average values and 5-min average values of X, Y and Z or D, H and Z), initial efforts involved the development of a consistent data base. We chose to use 5-min average values of ΔX_m, ΔY_m and ΔZ_m, defined as variations in the invariant northward, eastward, and nadir directions, respectively, from a "quiet-day reference level." Average values were calculated, the 12 March 1978 average value was subtracted, and the resulting values were "rotated" appropriately for each station. These data comprise the plots shown on succeeding pages for the seven northernmost stations, namely Eureka through Inuvik.

Table 1. Alaska Chain Data for 9 March - 27 April 1978

	GEOGRAPHIC		GEOMAGNETIC		CORRECTED GEOMAGNETIC INVAR.						
	LAT.	E. LONG.	LAT.	E. LONG.	LAT.	E. LONG.	LAT.		SAMPLE	MEDIUM	COMMENTS
Eureka	80.0	274.3	86.7	236.5	89.1	258.4	89.0	X, Y, Z		Paper[1]	
Isachsen	78.8	256.0	83.4	251.3	85.2	262.0	85.2	X, Y, Z		Paper[1]	9-17 Mar.
Mould Bay	76.2	240.6	79.1	256.4	80.6	263.5	80.7	X, Y, Z		Paper[1]	9-23 Mar.
								X, Y, Z	1 min	Tape	24 Mar - 27 Apr.
Johnson Pt.	72.5	241.7	76.9	271.7	78.0	276.4	77.6	D, H, Z	5 min	Tape	SELDADS[2]
Sachs Harbor	72.0	234.7	75.2	266.2	76.1	270.3	76.0	D, H, Z	5 min	Tape	SELDADS[2]
Cape Parry	70.2	235.3	73.9	270.9	74.7	274.2	74.4	D, H, Z	5 min	Tape	SELDADS[2]
Inuvik	68.3	226.7	70.6	266.2	71.1	269.0	71.0	D, H, Z	5 min	Tape	SELDADS[2]
Arctic Village	68.1	214.4	68.1	255.3	68.5	258.9	68.6	D, H, Z	5 min	Tape	SELDADS[2]
Ft. Yukon	66.6	214.7	66.8	257.6	67.0	260.7	67.1	D, H, Z	1 min	Tape	HLMS[3]
College	64.7	211.9	64.8	257.1	64.9	260.3	64.9	D, H, Z	1 min	Tape	HLMS[3]
Anchorage	61.2	210.1	61.0	258.1	60.9	260.7	60.8	D, H, Z	1 min	Tape	HLMS[3]

[1]Hand digitized 1-min point values

[2]Space Environment Laboratory Data Acquisition and Display System

[3]High-Latitude Monitoring Station

Additional adjustments were required to the data from the four lowest latitude stations, because the "quiet-time reference level" was defined as the 6-h average value centered about 0000 UT (1244 magnetic local time). This value was then subtracted from each ΔX_m, ΔY_m and ΔZ_m, for that day. Supplemental adjustments were made to the data recorded on 27 March 1978 and on 4, 5, 11, 15, 20, 23 and 24 April 1978 due to large daytime variations. The resulting data are shown on succeeding pages for Arctic Village through Anchorage.

Data Availability

The World Data Center A for Solar-Terrestrial Physics archives the IMS data from the Alaska, Alberta, Fort Churchill, East-West, and Midlatitude Chains. The variations data on magnetic tape are 1-min average values in the recording coordinate system, either geographic X, Y and Z or local D, H and Z, with respect to an arbitrary reference level. Inquiries should be directed to Mr. William Paulishak, World Data Center A for Solar-Terrestrial Physics, NOAA, D63, Boulder, CO 80303 USA.

We would like to encourage the scientific community to use these unique data sets resulting from the IMS. It has been a major effort by many individuals and organizations to install and maintain the equipment and to process the data. Since the observing period is scheduled to the end of last year, it is now up to the scientific community to justify the outlay by using the data to better understand magnetospheric substorms and polar cap variations.

Daily Magnetic Variations Along Alaska Chain

The appendix contains stack plots of ΔX_m, ΔY_m and ΔZ_m, generated from 5-min average values and a daily polar plot of half-hourly vectors of horizontal variations recorded along the Alaska Meridian Chain for 9 March - 25 April 1978. The stations organized by decreasing invariant latitude (see Table 1) are Eureka (EUR), Isachsen (ISA), Mould Bay (MOB), Johnson Point (JOP), Sachs Harbor (SAH), Cape Parry (CAP), Inuvik (INU), Arctic Village (AAV), Fort Yukon (FYU), College (COL), and Anchorage (ANC). The "quiet-time reference level" is noted by a tick mark and a zero; the tick marks along the y axis are spaced 250 nT apart. Coordinates of the polar plot are invariant latitude and time. The solid triangle outside the plot notes the average invariant time of the chain at 2330 UT. The position of the chain in these coordinates for each UT hour is shown in Figure 4.

Average Magnetic Variations Along Alaska Chain

In Figures 2 and 3, we show polar plots of the average day magnetic variations and "equivalent" currents. The magnetic variations are a simple average of the half-hourly values from each day. These

vectors were then rotated 90° clockwide to approximate an equivalent ionospheric current system. Due to the large spatial and temporal variability of magnetospheric substorms, these plots should not be interpreted as a typical substorm equivalent current system (Kroehl and Richmond 1979 and Kamide 1979) but as the average magnetic variations recorded along the Alaska Chain for these days. From the equivalent current plot certain polar features are evident: namely, the eastward and westward auroral electroject, the Harang discontinuity (northward equivalent current), the polar cap diurnal variation, and a dayside current most probably associated with the polar cleft. The least disturbed day is 12 March 1978 and the most disturbed day is 27 March 1978. Other days of interest are 14 and 30 March 1978 and 18, 20 and 22 April 1978.

A computer-generated cine film has been made from the half-hourly polar plots and shows the temporal variations of the horizontal variation vectors for 9 March - 25 April 1978. The movie is on 16-mm film and runs for 7 min. Copies may be obtained for the cost of reproduction from H.W. Kroehl, NOAA/NGSDC, D64, Boulder, CO 80303 USA.

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KROEHL, H.W. and RICHMOND, A.D.	1979	"Magnetic Substorm Characteristics Described by Magnetic Potential Maps for 26-28 March 1976," in Dynamics of the Magnetosphere, S.-I. Akasofu (ed.), D. Reidel Pub. Co. New York, N.Y., pp. 269-286.
KAMIDE, Y. and MATSUSHITA, S.	1979	"Simulation Studies of Ionospheric Electric Fields and Currents in Relation to Field-Aligned Currents 2. Substorms," J. Geophys. Res., v. 84, no. A8, pp. 4099-4115.
NAS	1974	International Magnetospheric Study, Detailed Plan for a U.S. Ground-Based Research Program National Academy of Sciences, Washington, DC.
IMS Newsletter	1977	"North American Magnetometer Network," in IMS Newsletter 77-1, J.H. Allen, Ed. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colorado, USA 80303), pp. 5-7.

Acknowledgments

The scientific community is indebted to many individuals and organizations in these closing days of the IMS observing period. The geomagnetic program is a truly multiorganizational effort involving the University of Alaska; the University of California at Los Angeles; the State University of New York at Albany; the University of Alberta; the Department of Energy, Mines and Resources (Canada); the Geological Survey; the National Oceanographic and Atmospheric Administration and the National Science Foundation. The principal investigators for the 5 chains are Dr. S.-I. Akasofu, Dr. G.J. Romick, Dr. R.L. McPherron, Dr. Kim, Dr. G. Rostoker and Dr. J. Walker. Individuals responsible for the Alaska Chain include A.H. Shapley and J.H. Allen of NGSDC; B.S. Delana of the University of Alaska; D.J. Williams, R.N. Grubb, P.L. Orswell, J.D. Schroeder and J.C. Joselyn of SEL; and J.A. Bradley and R. Kuberry of USGS.

The Average Day Magnetic Variations

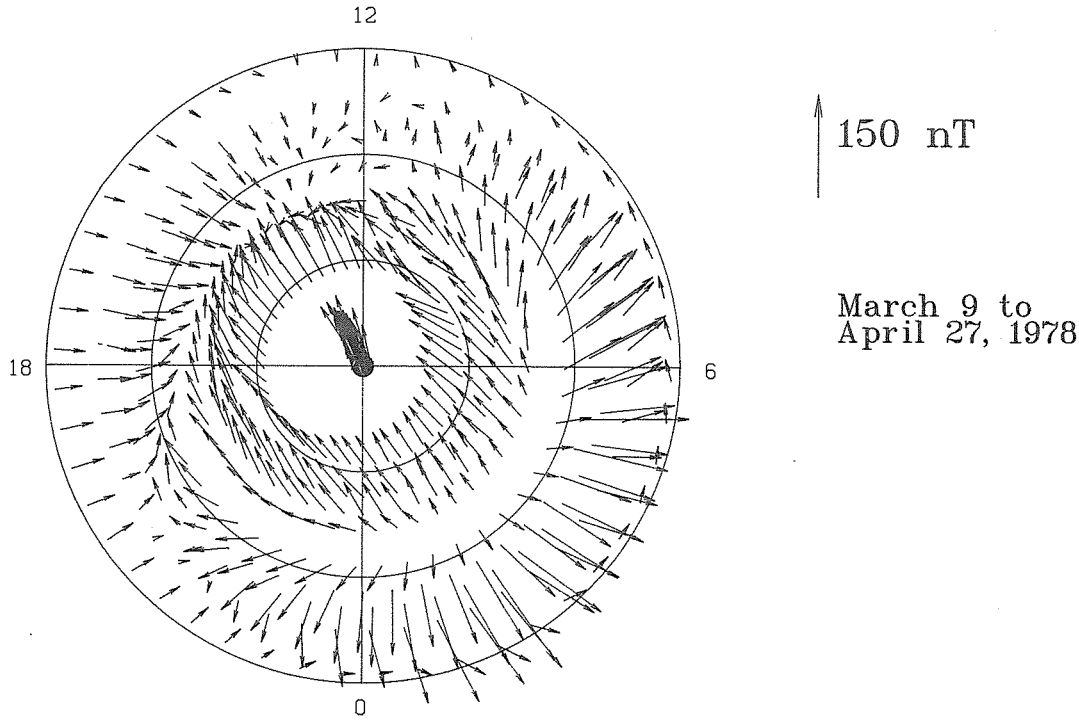


Fig. 2. Polar plot of the average day magnetic variations for 9 March to 27 April 1978. The variations shown represent simple averages of the half-hourly values from each day.

The Average Day Equivalent Currents

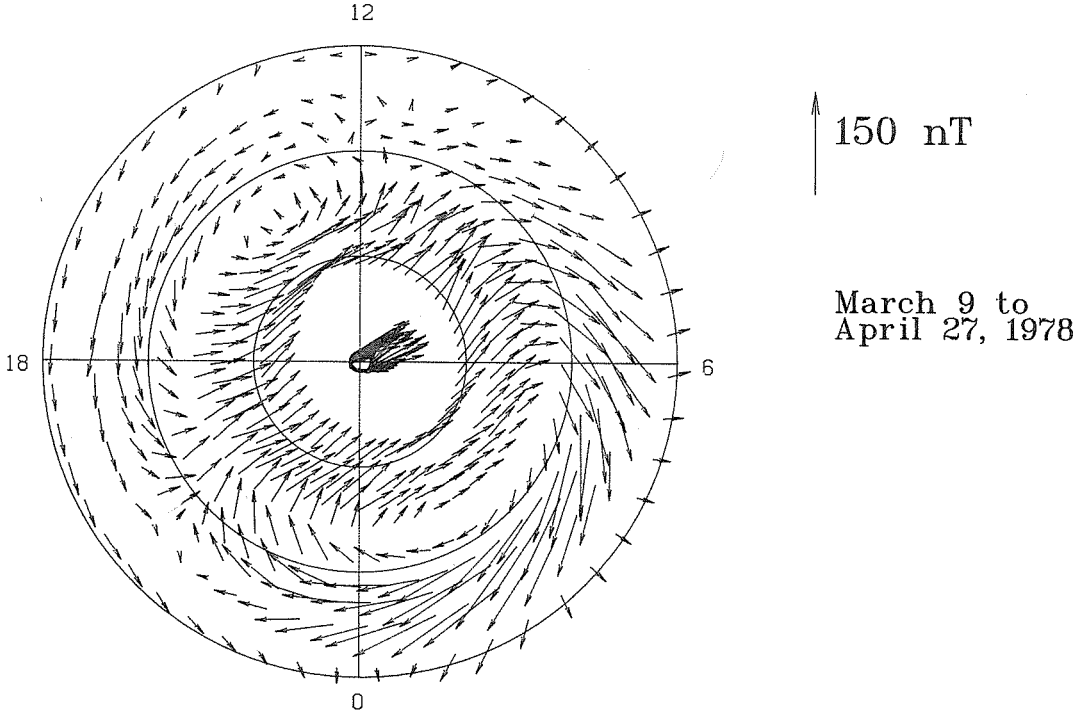


Fig. 3. Polar plot of the average day "equivalent" currents for 9 March to 27 April 1978. Diagram was generated by rotating the vectors of Figure 2 clockwise 90°.

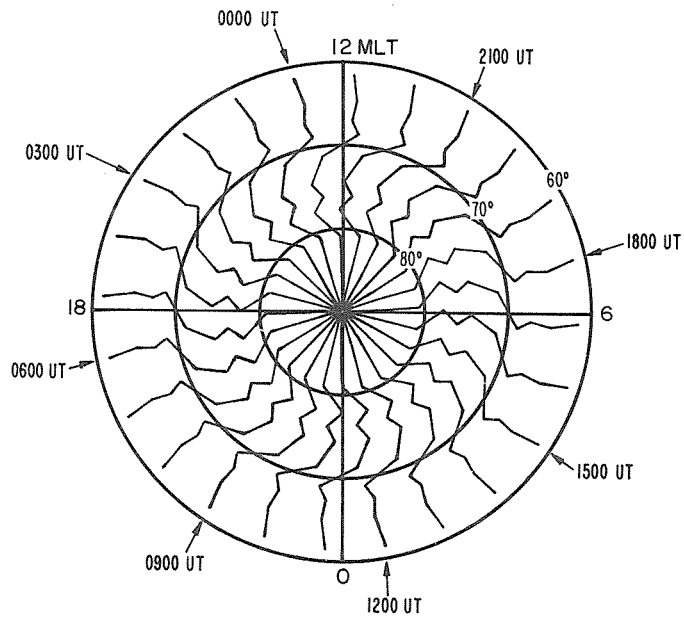
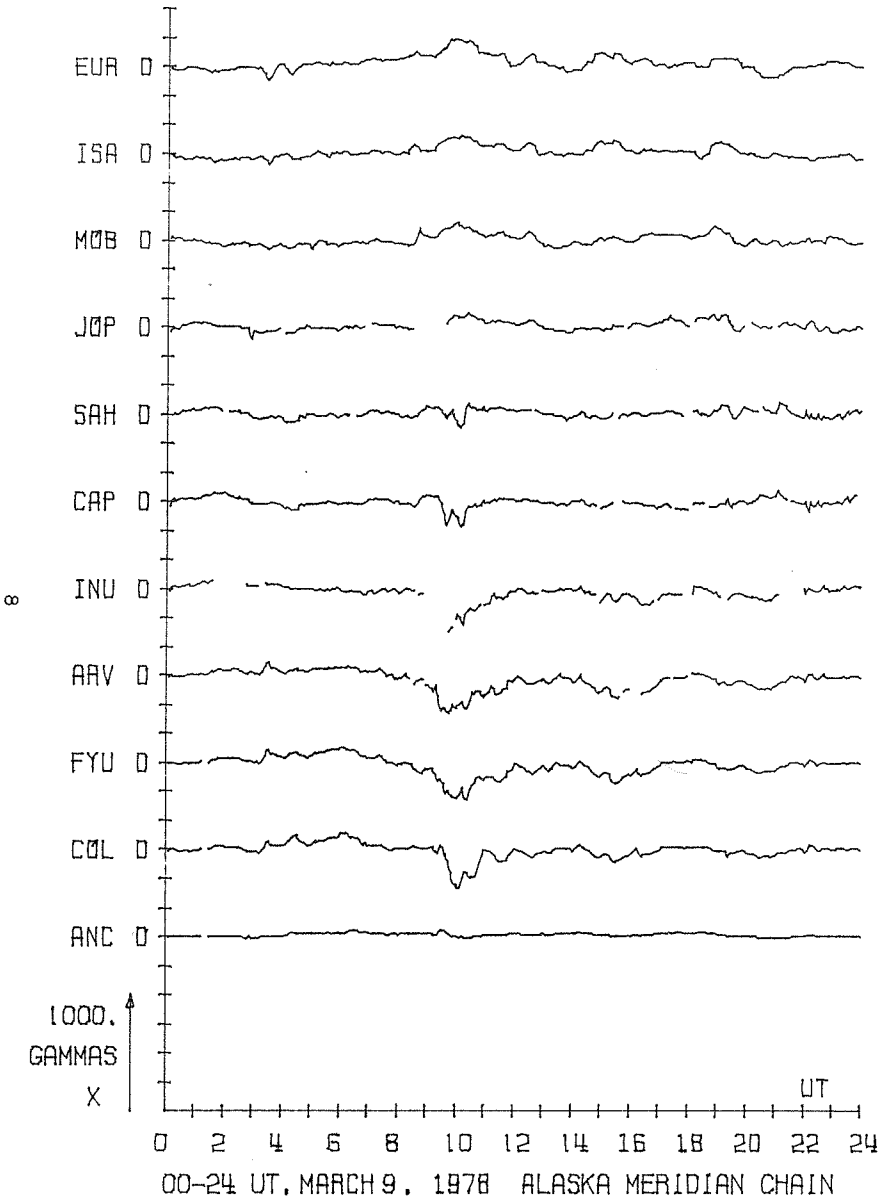


Fig. 4. Hourly location of Alaska Meridian Chain.

Following Pages:

APPENDIX

Daily Stack and Polar Plots of Alaska Chain Magnetic Variations (9 Mar - 27 Apr 1978)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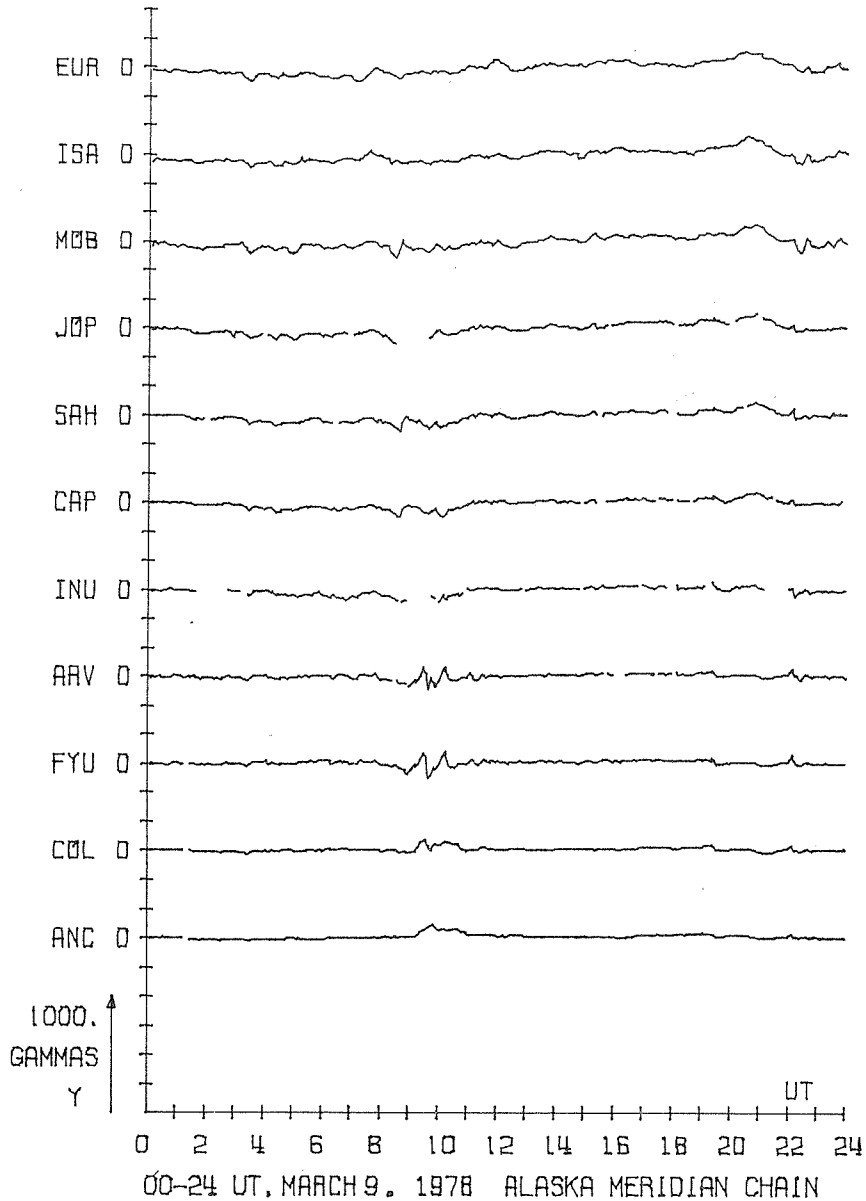
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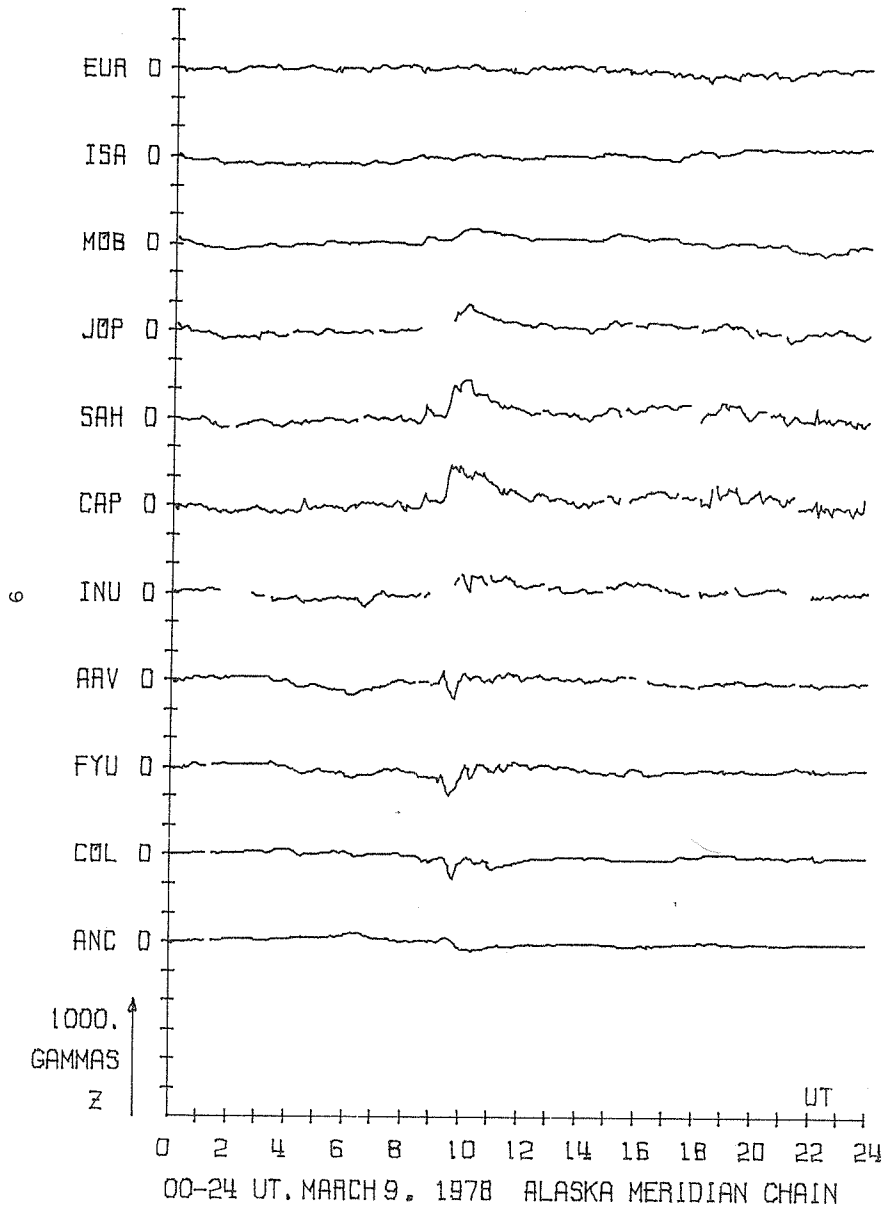

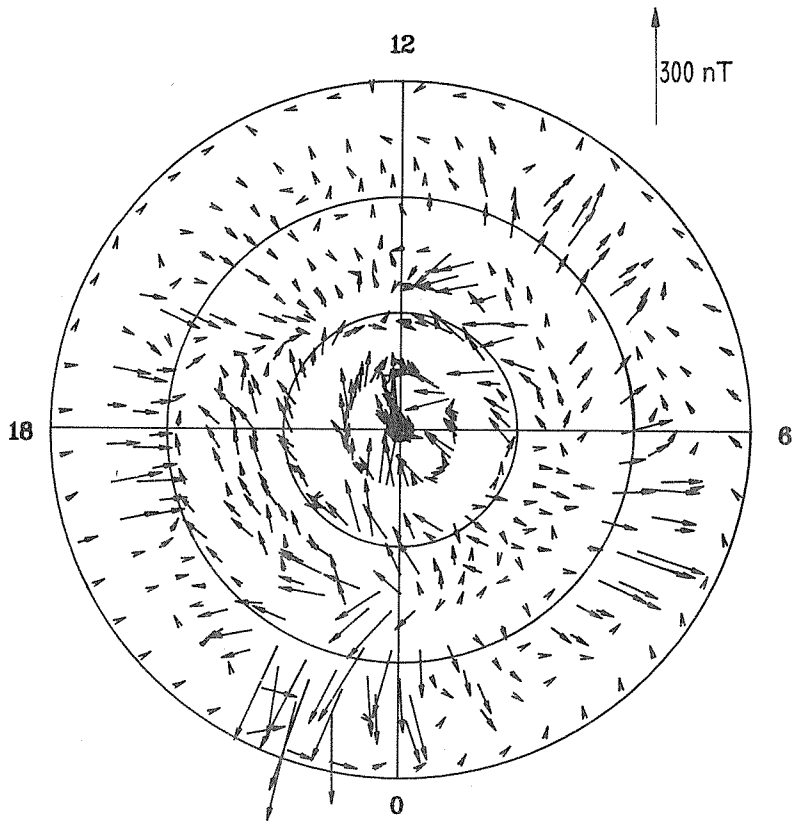

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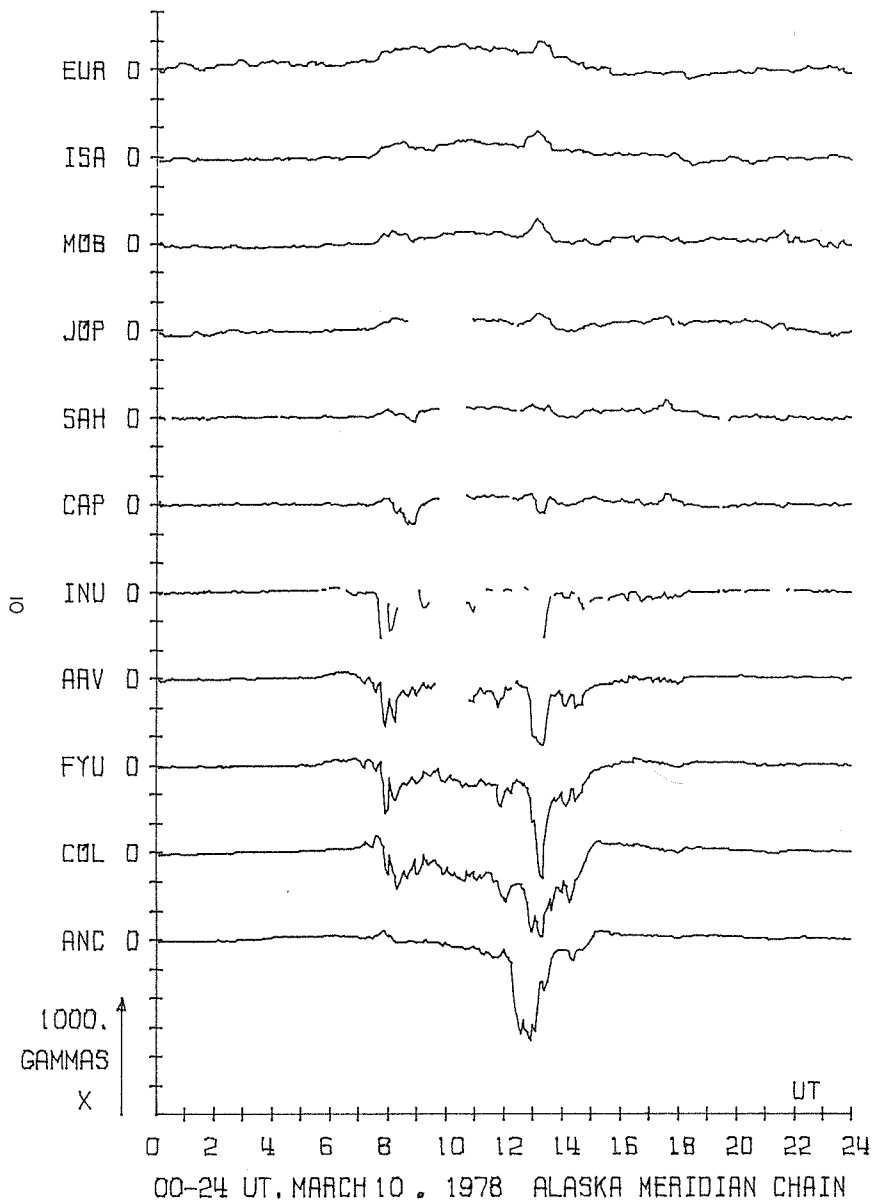
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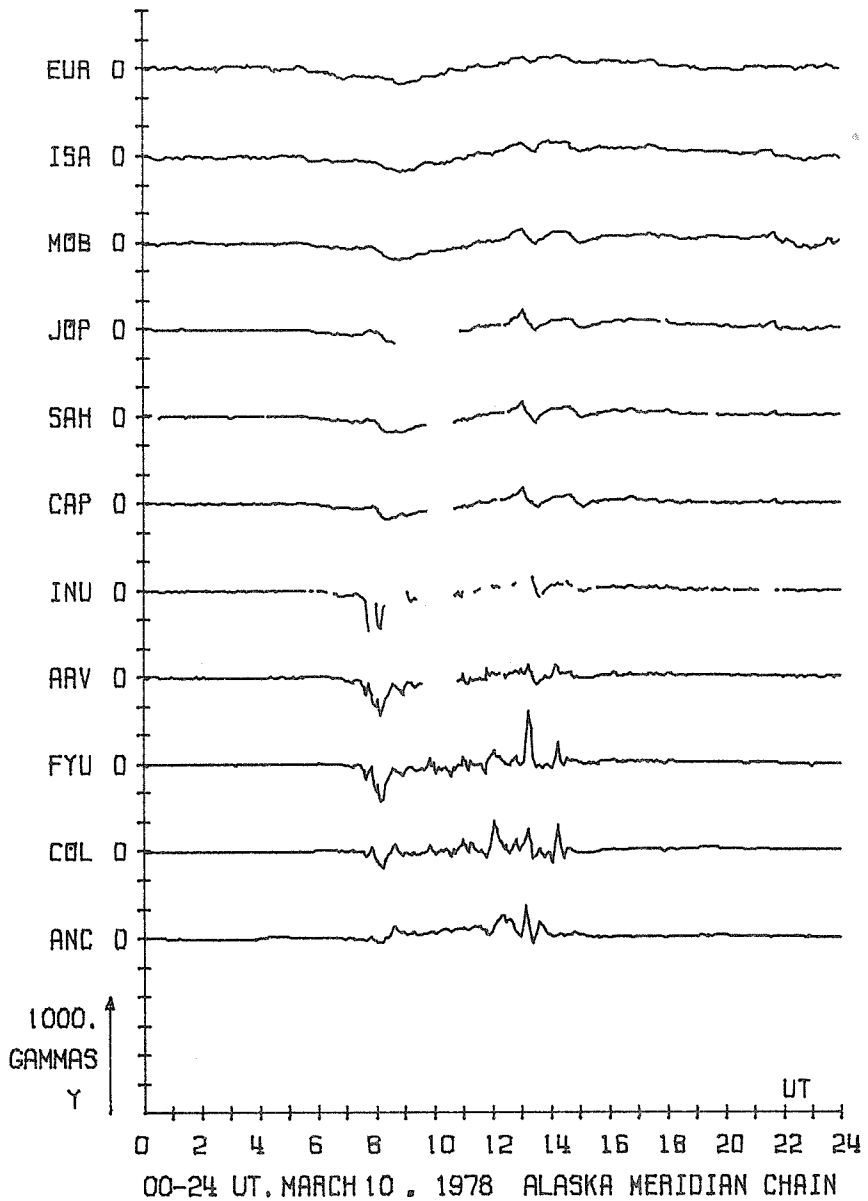
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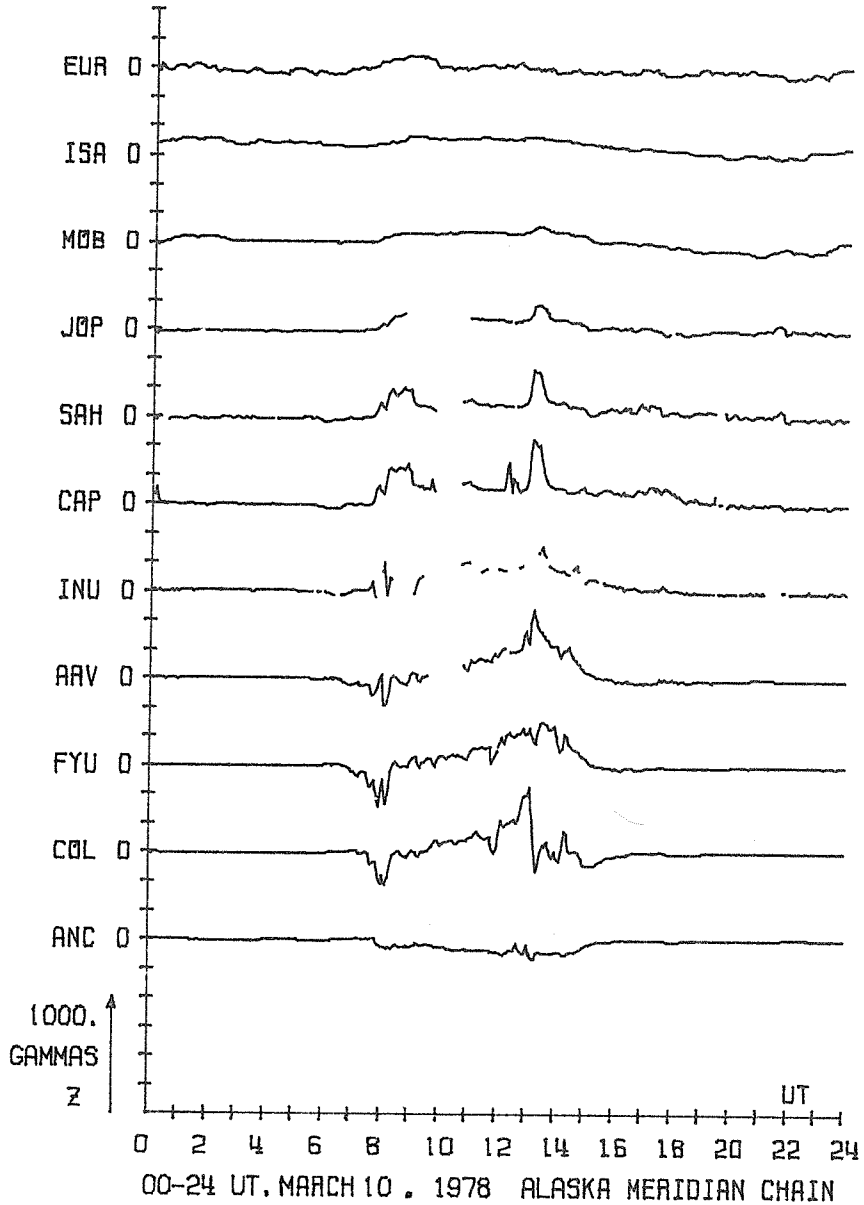

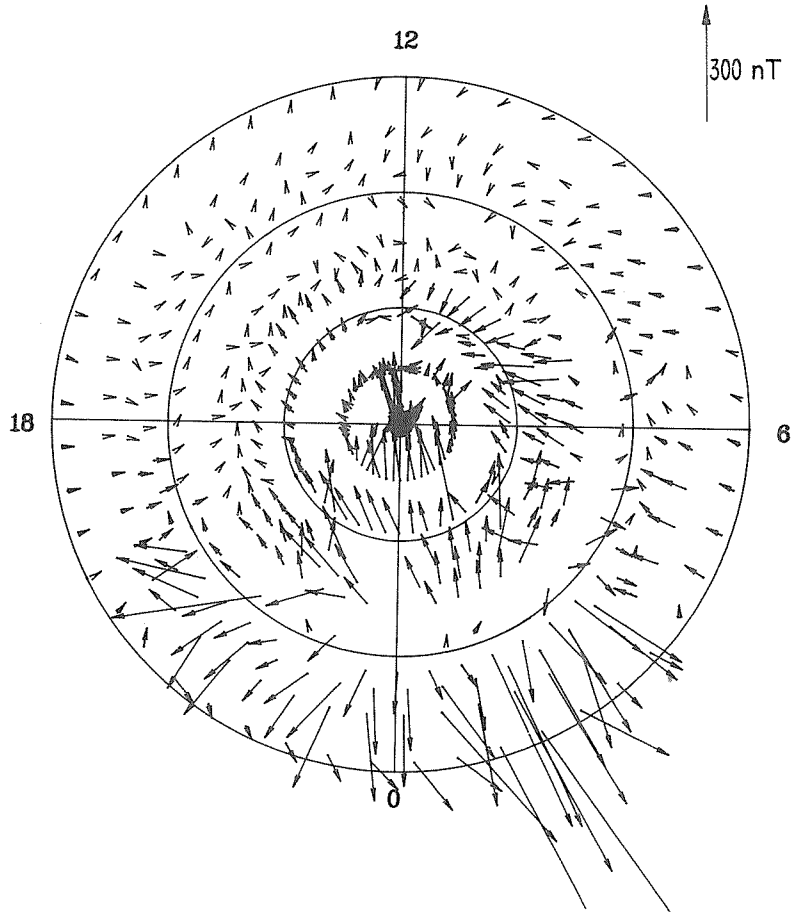

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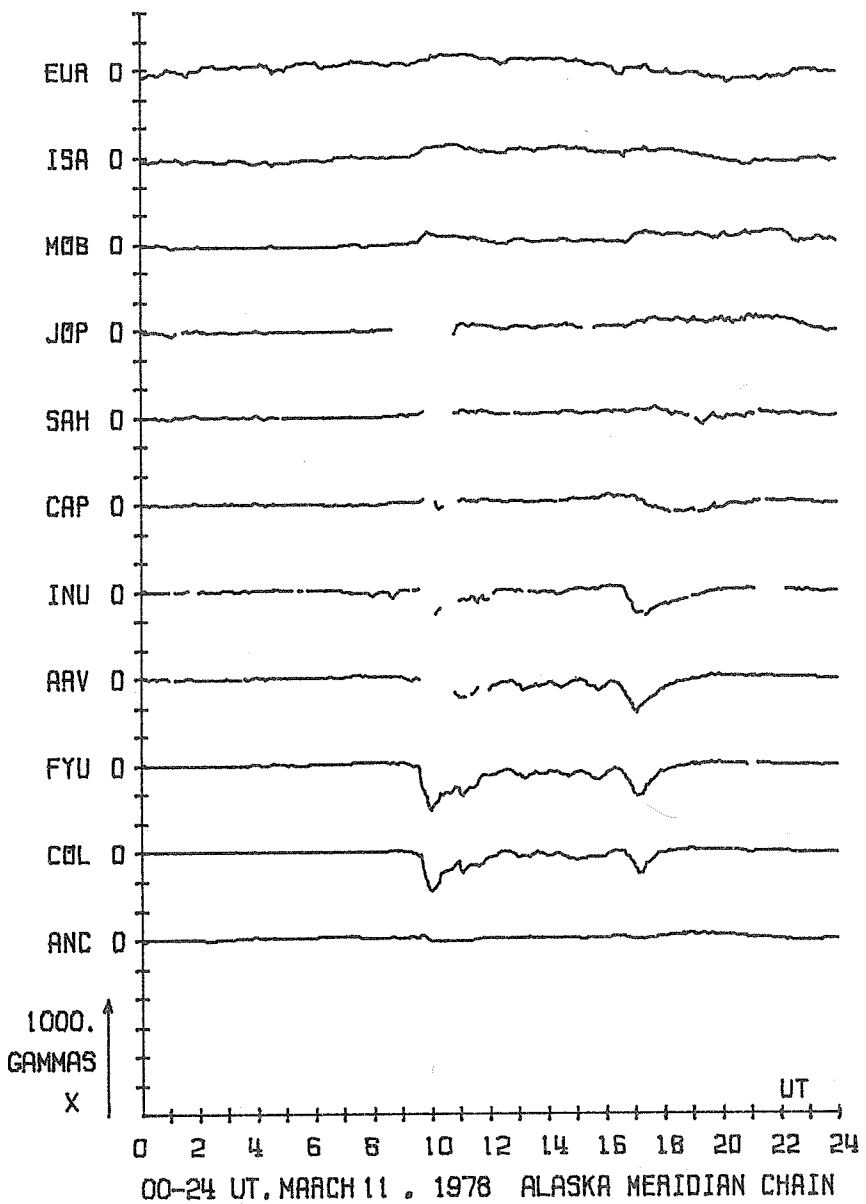
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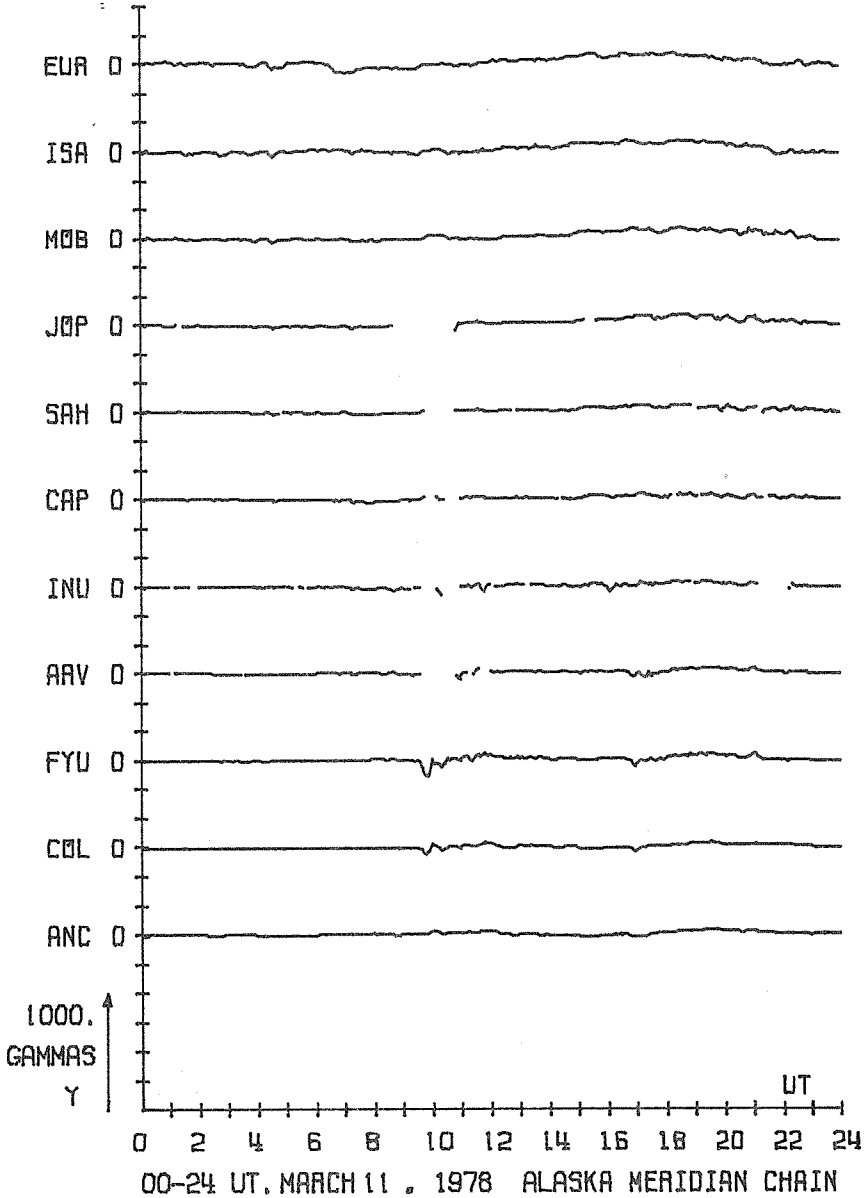
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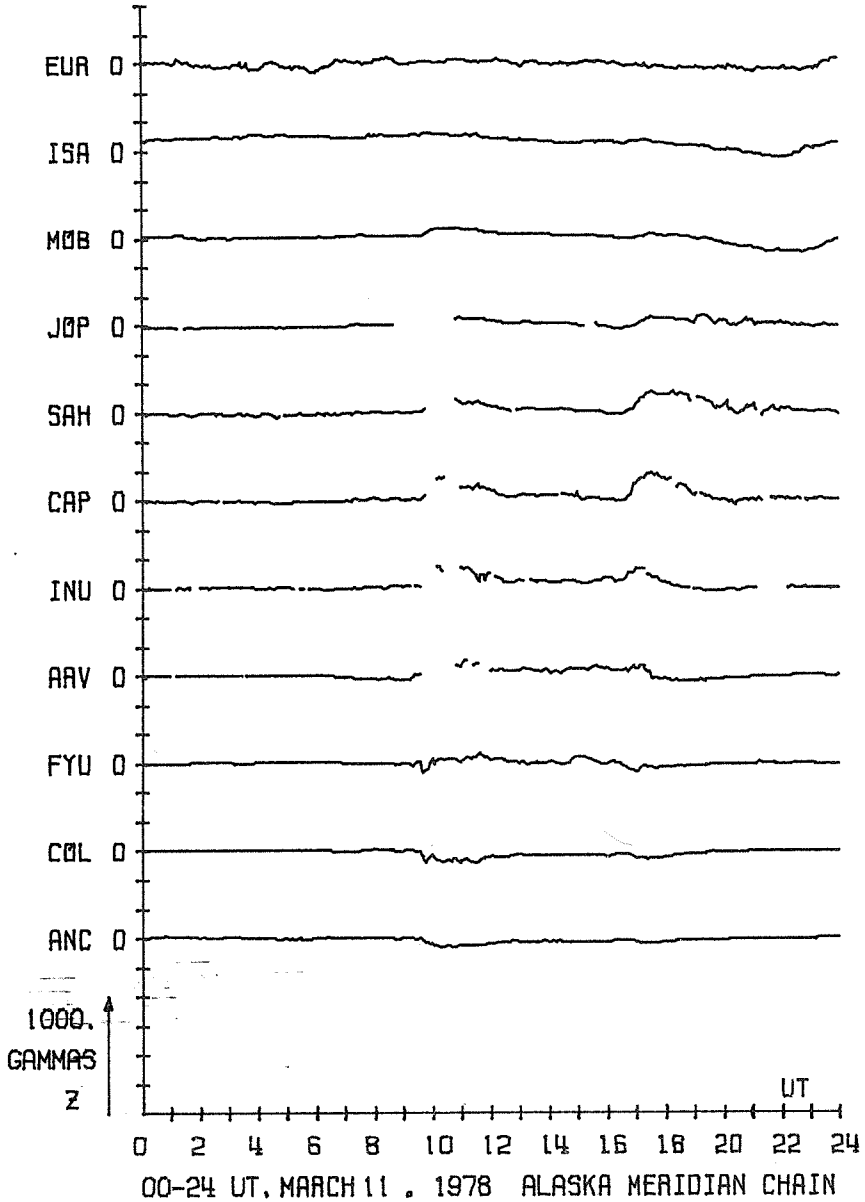

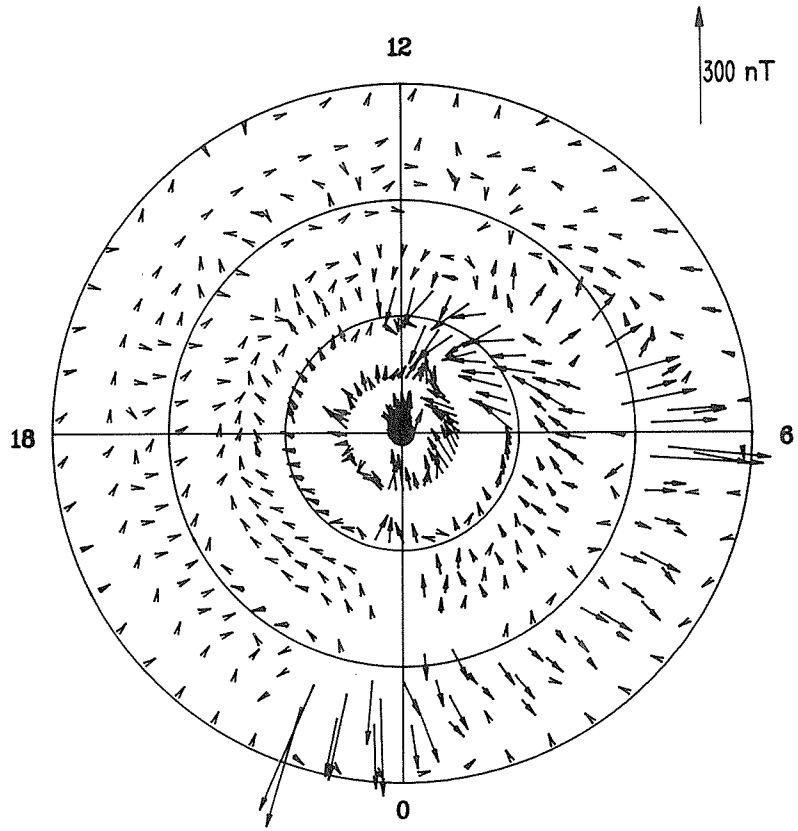

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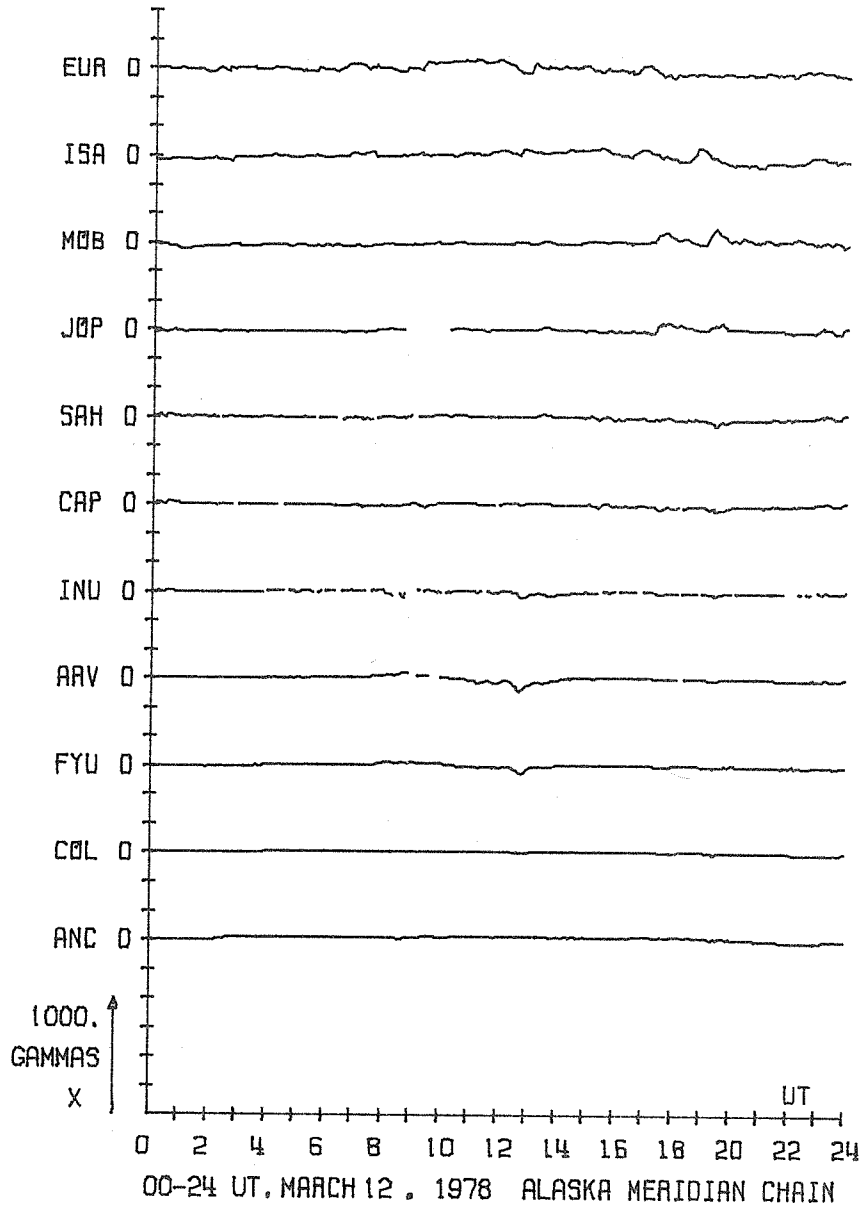
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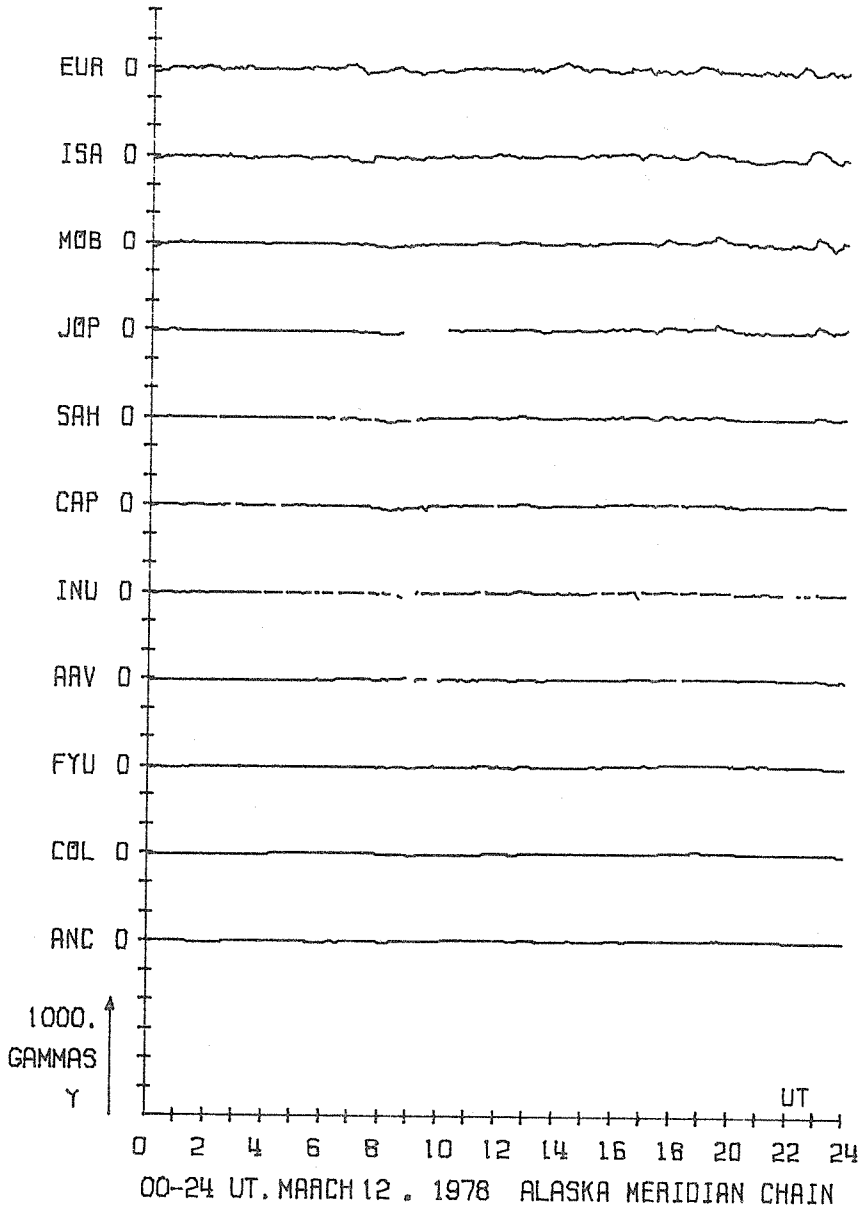
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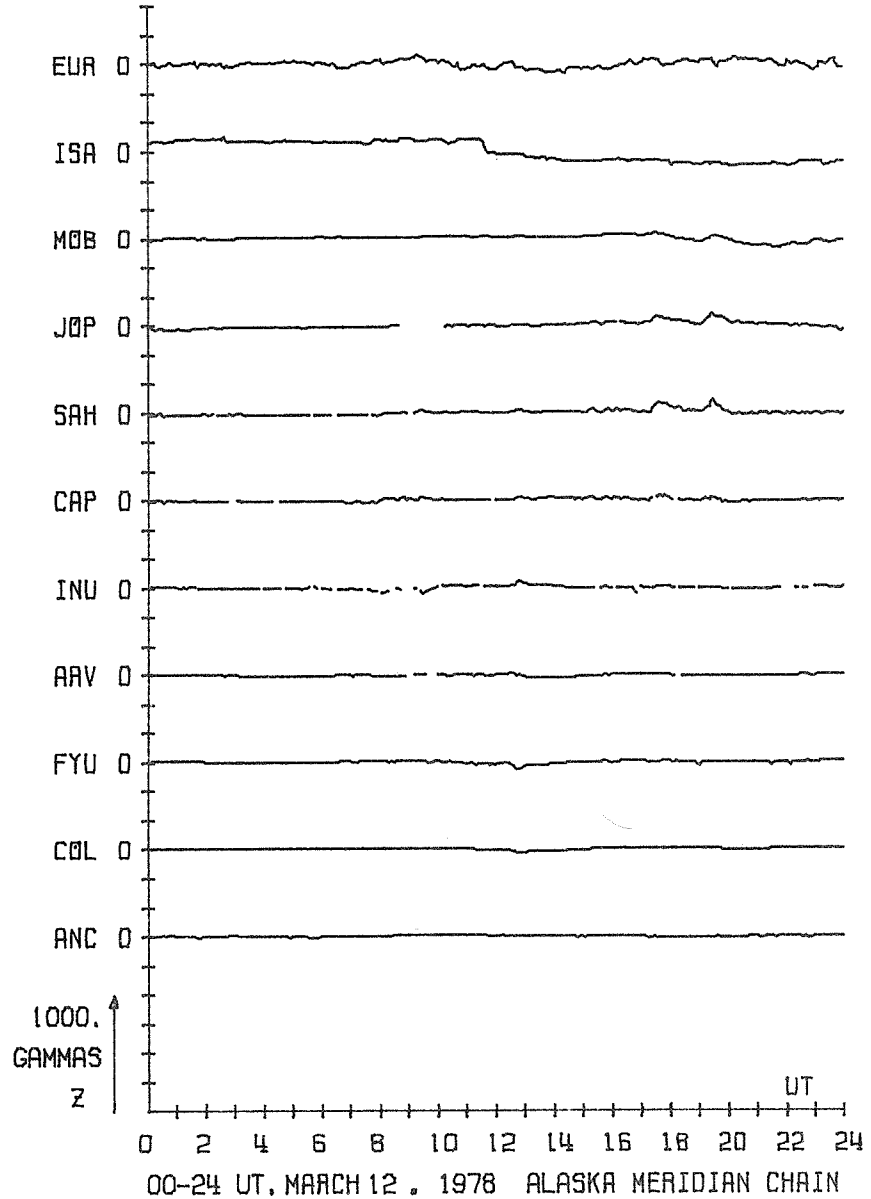

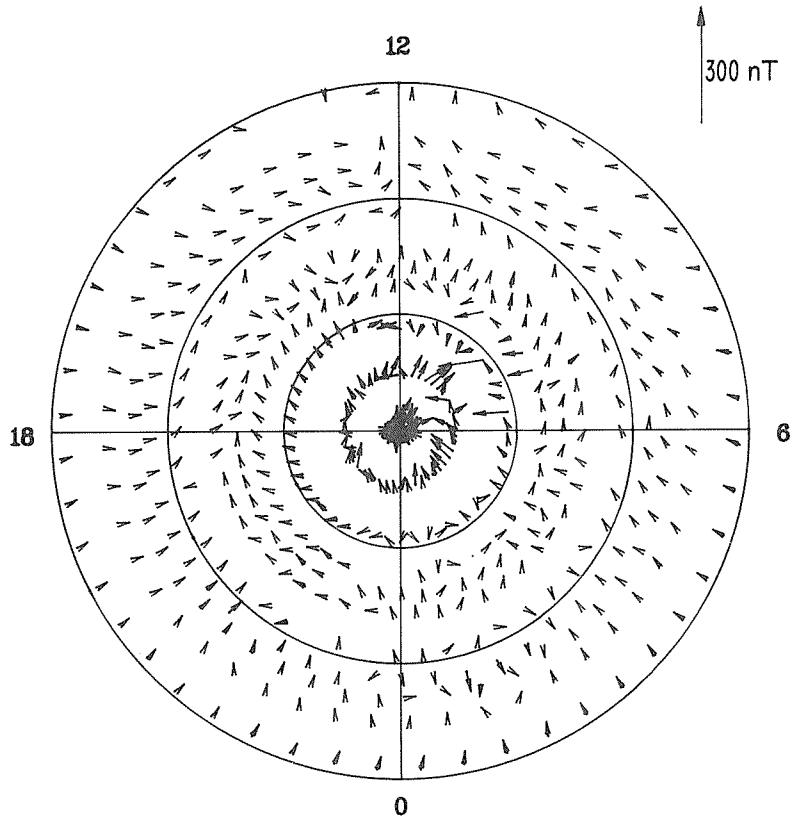

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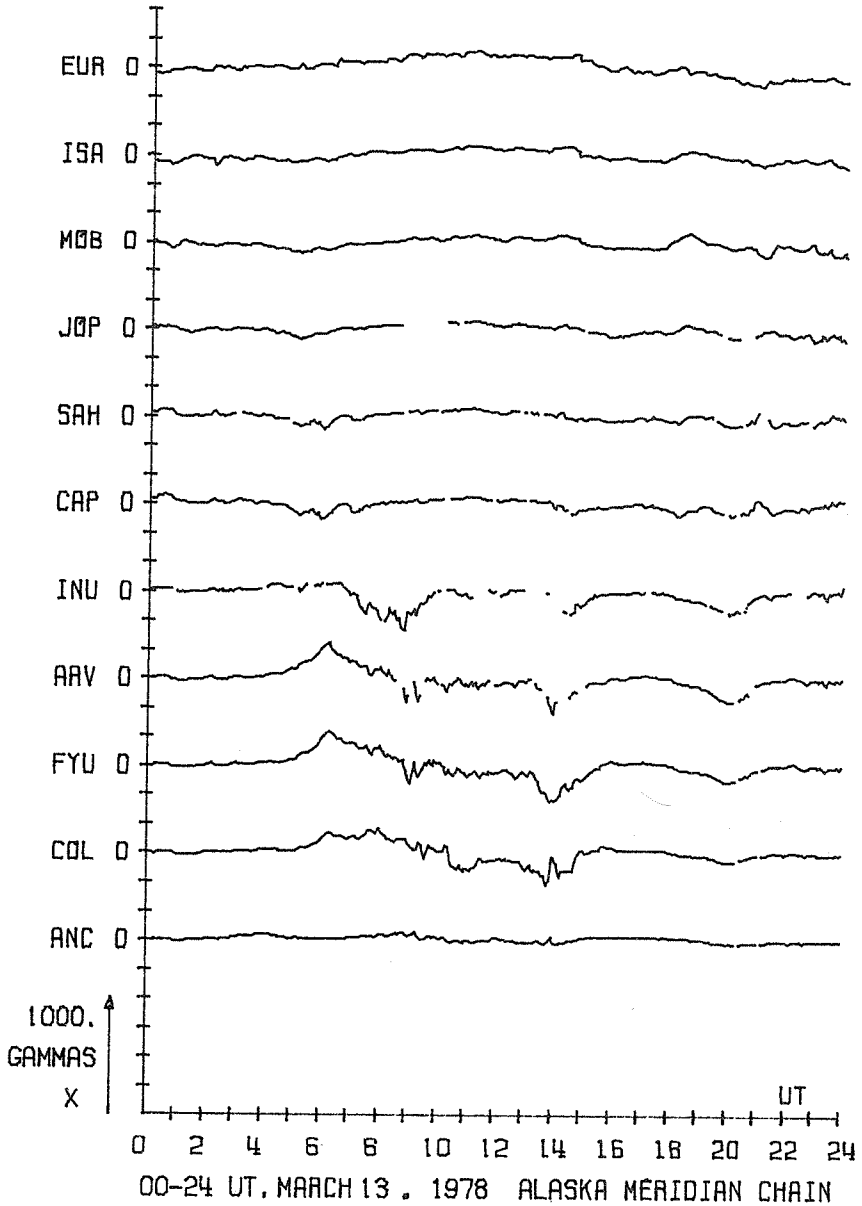
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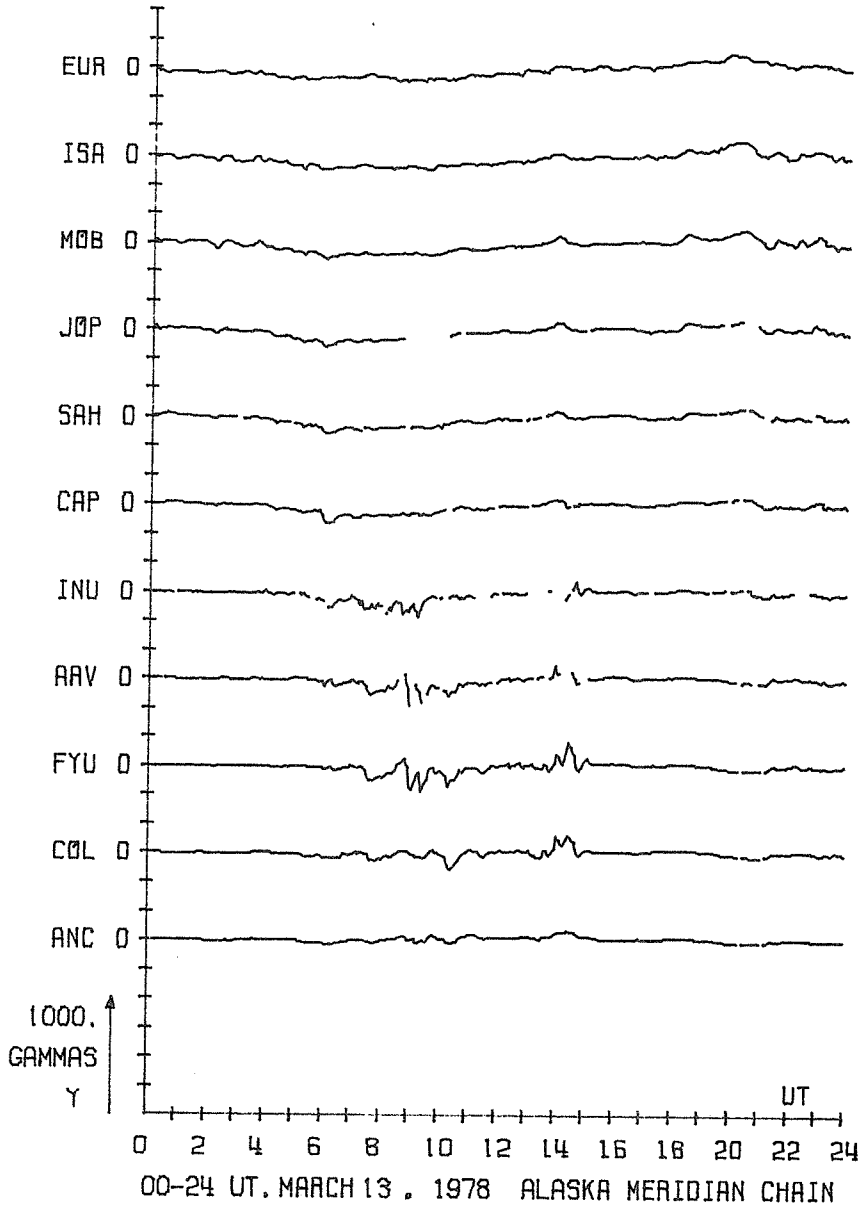
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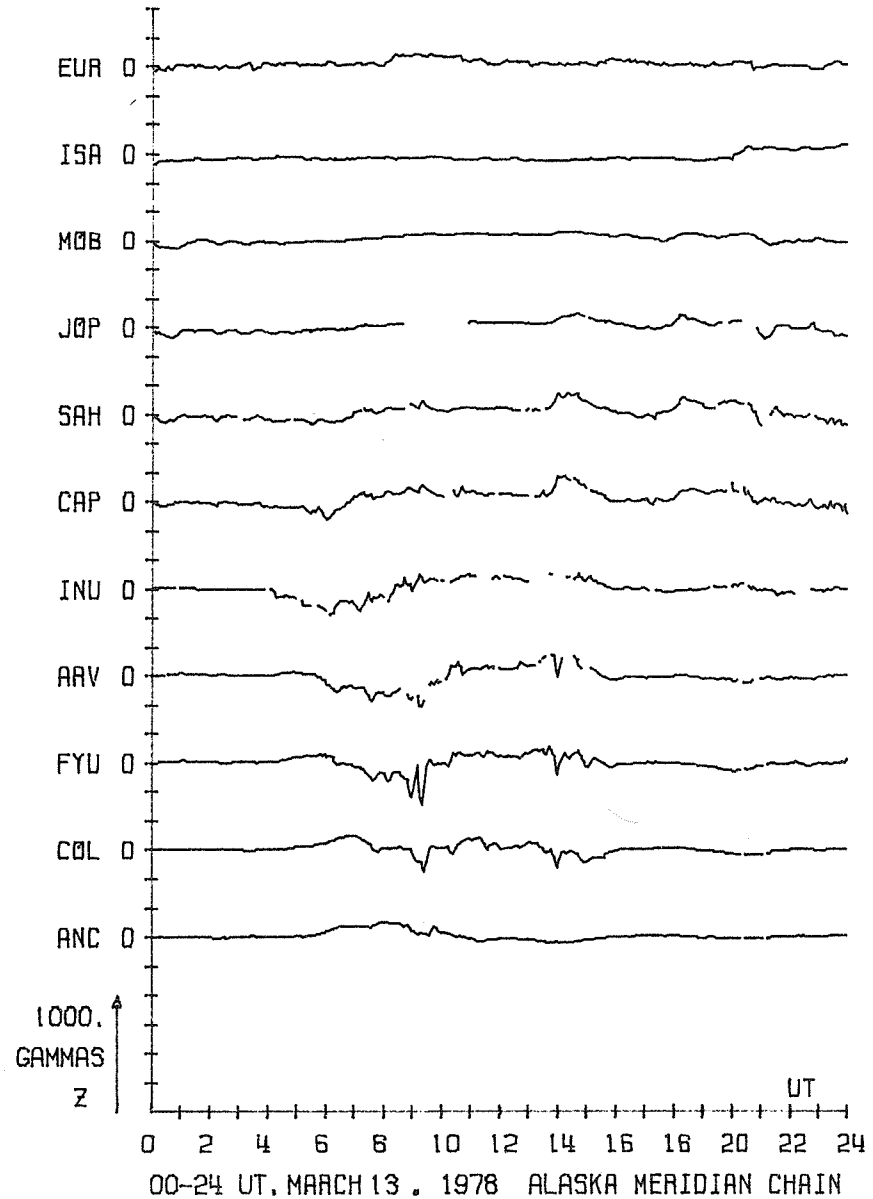

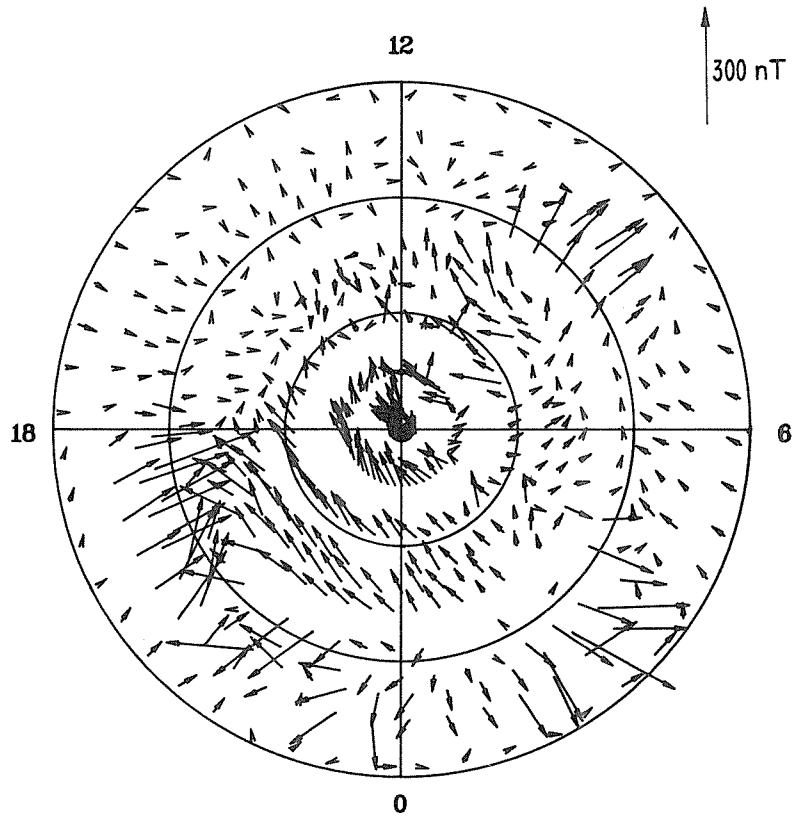

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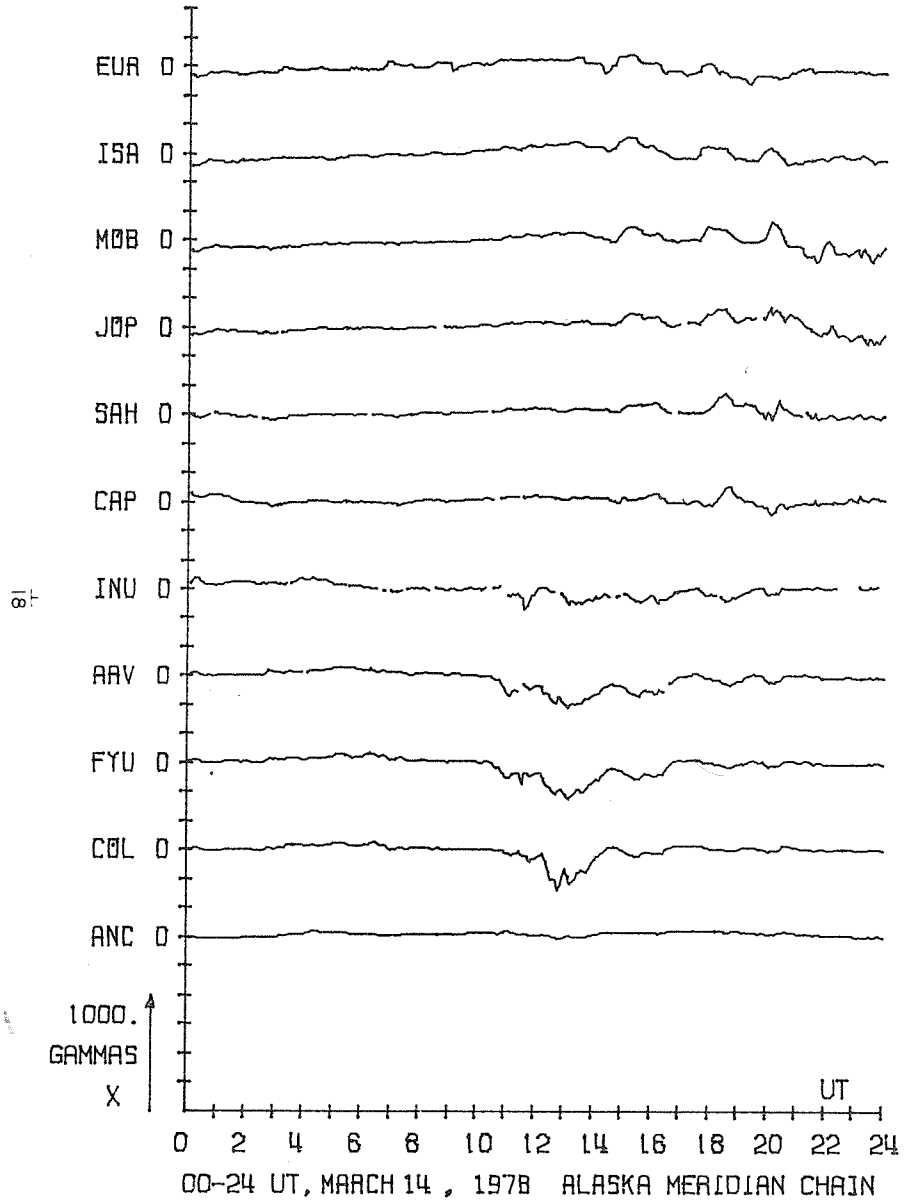
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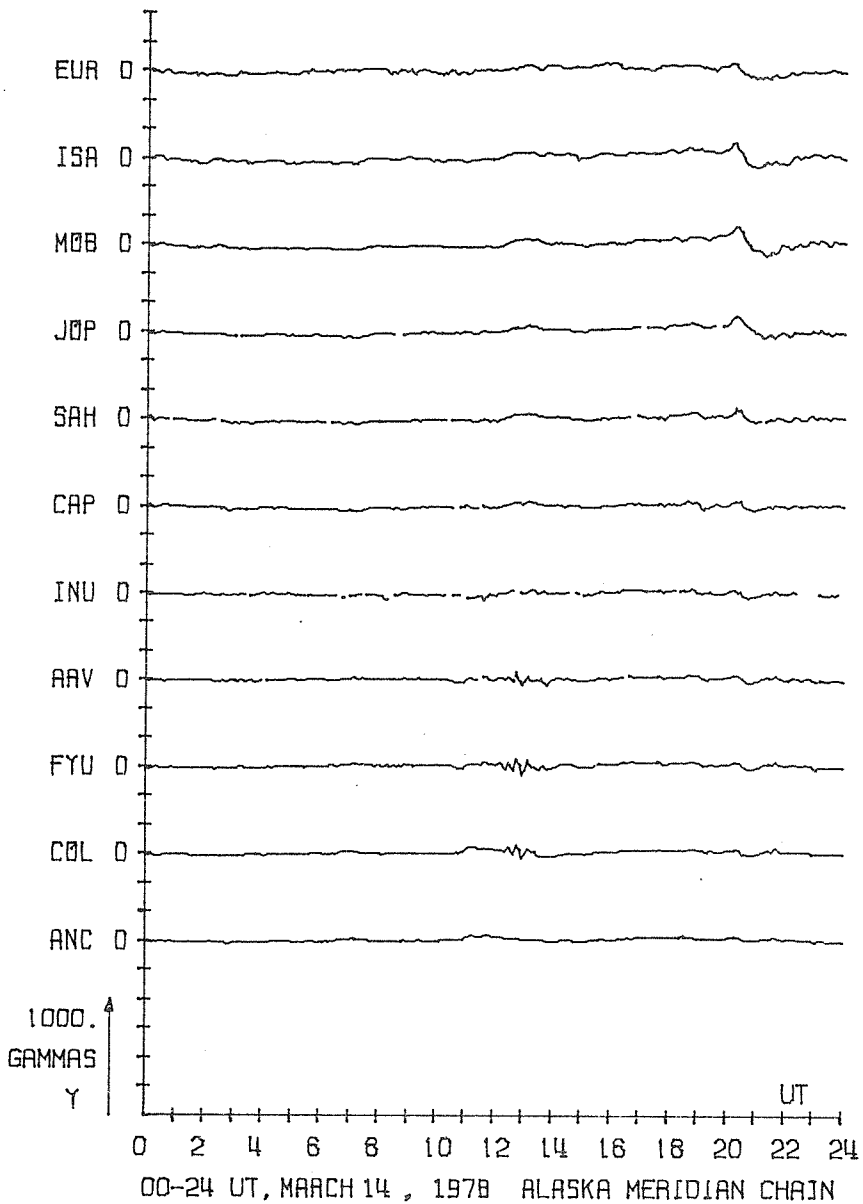
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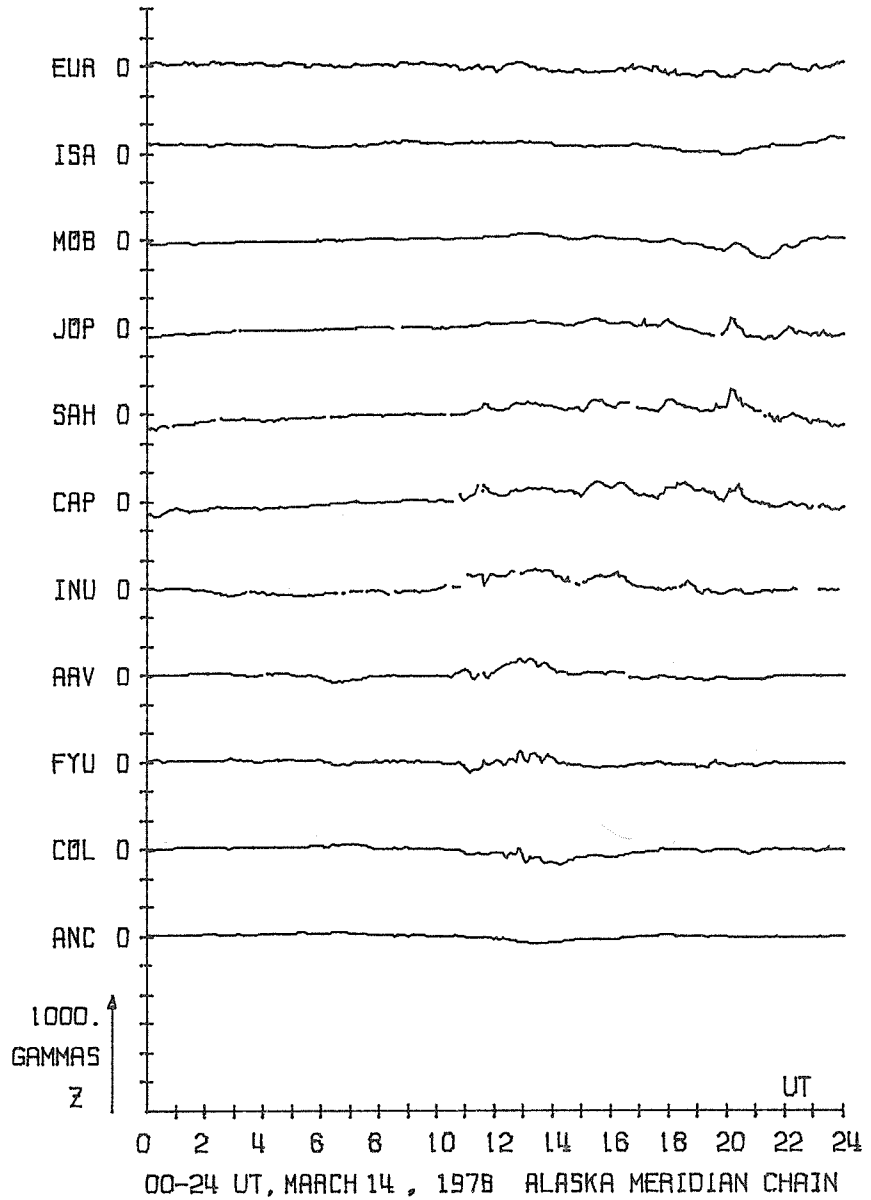

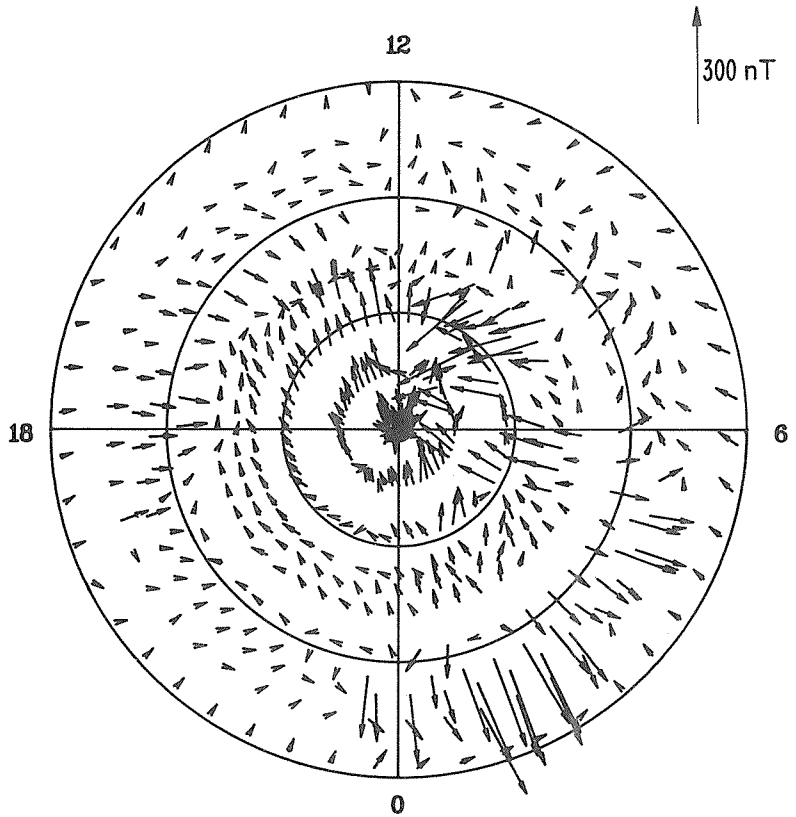

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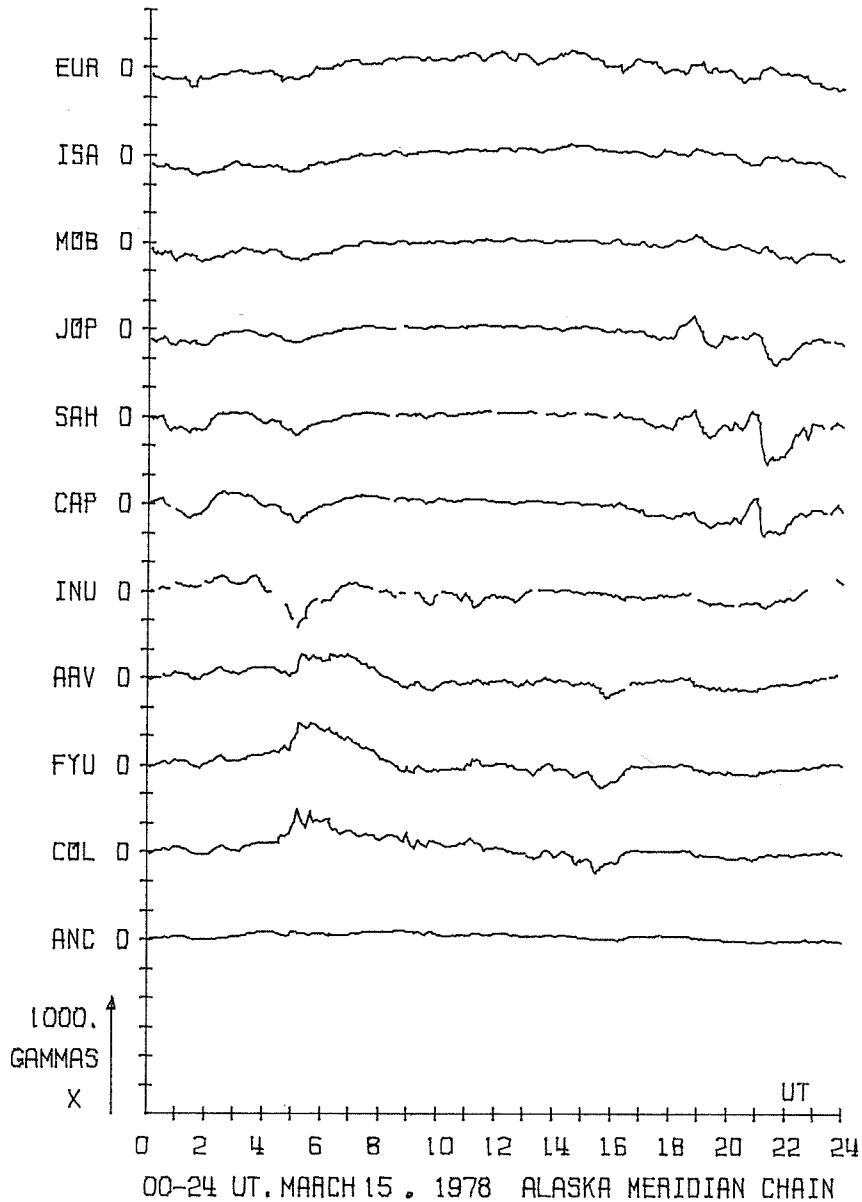
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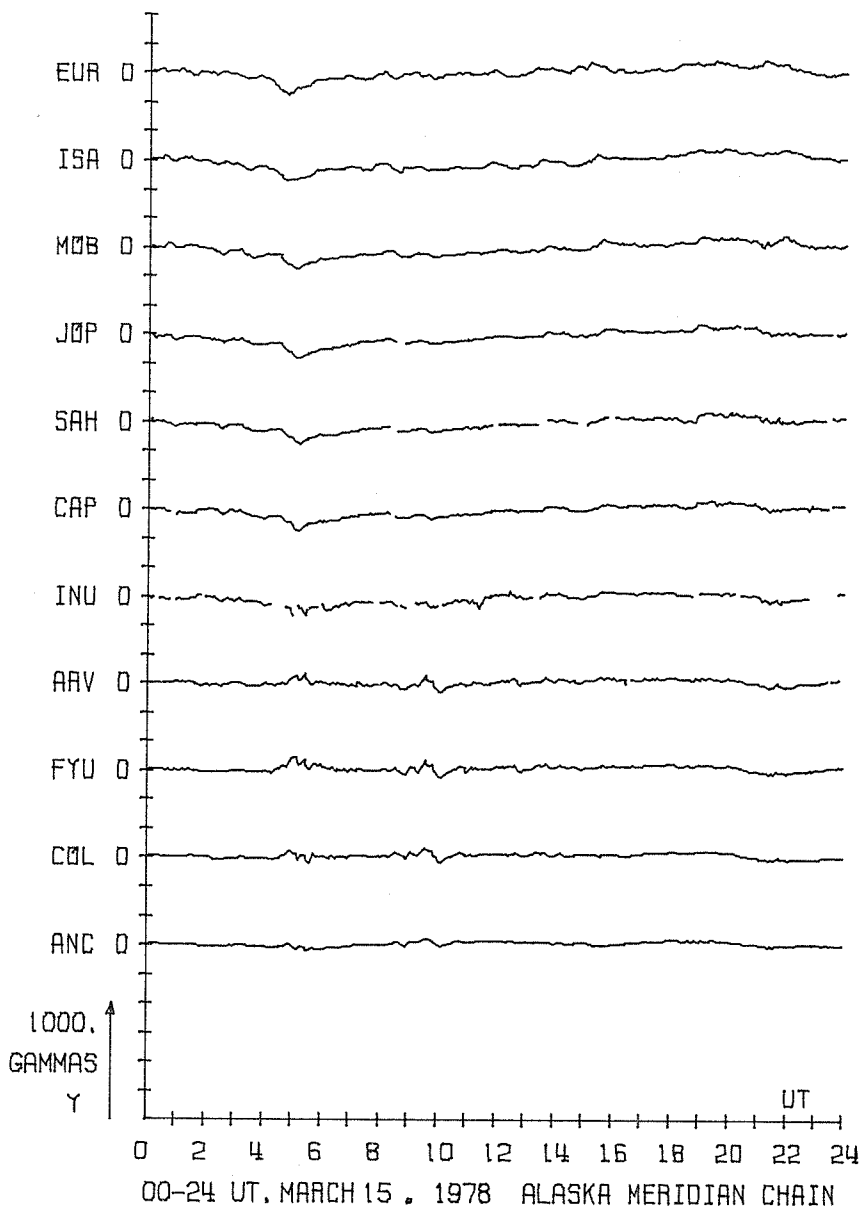
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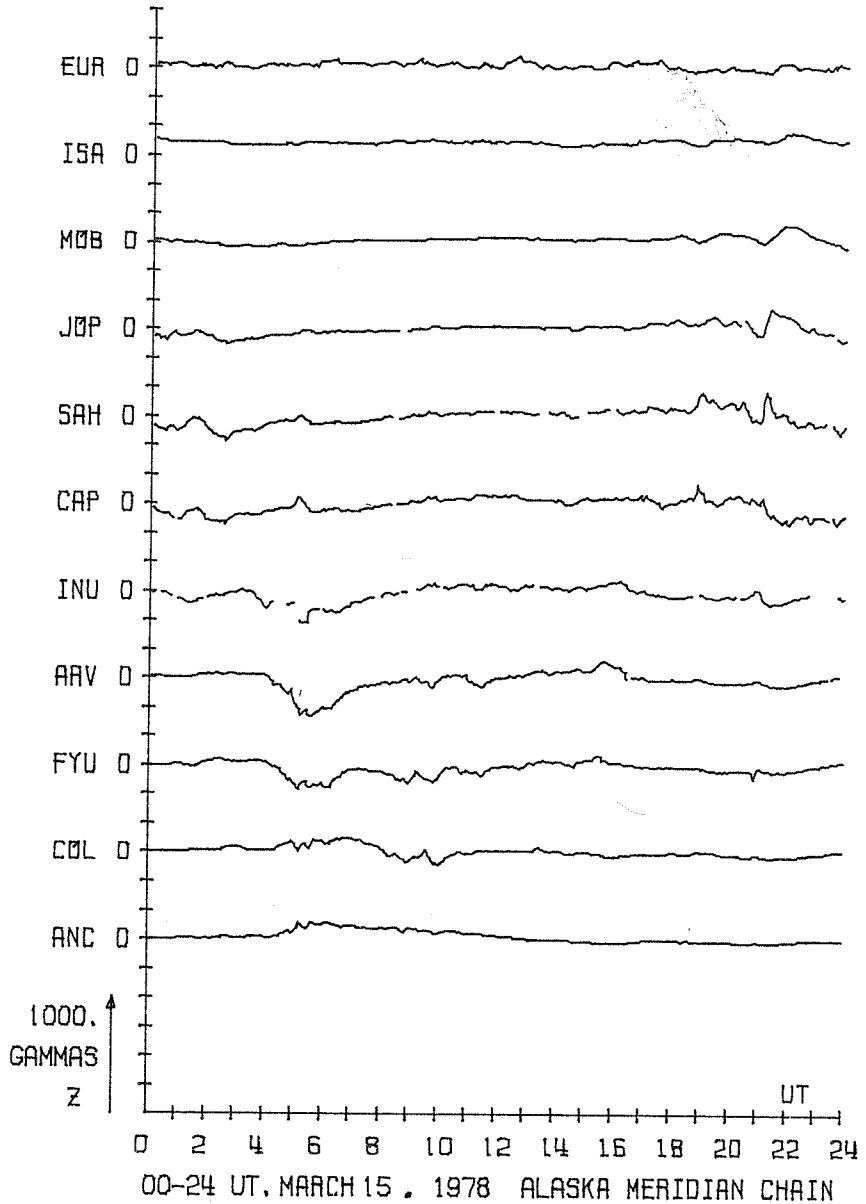

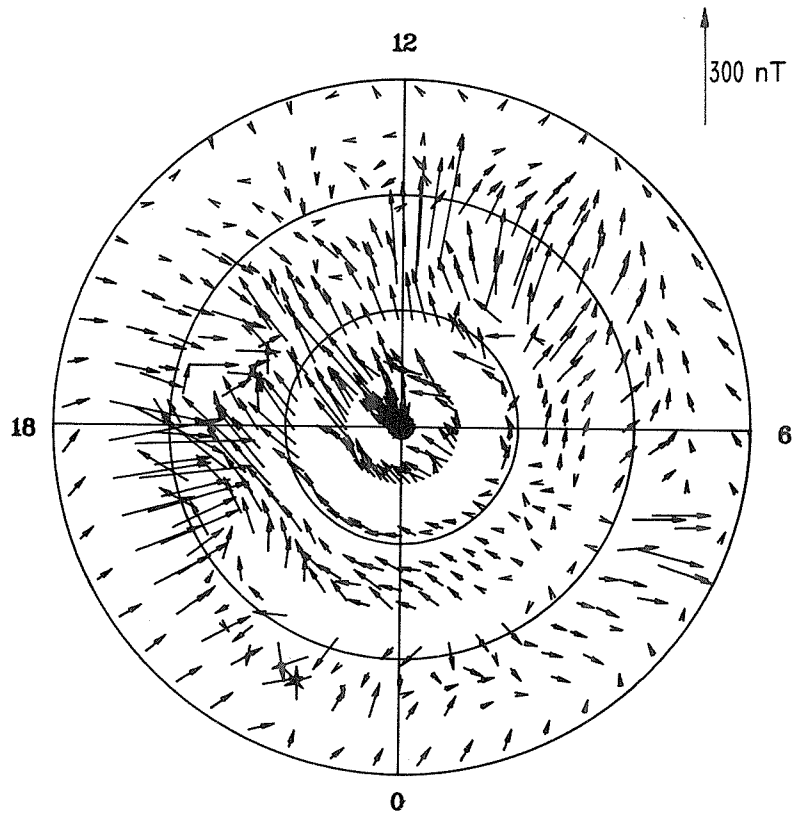

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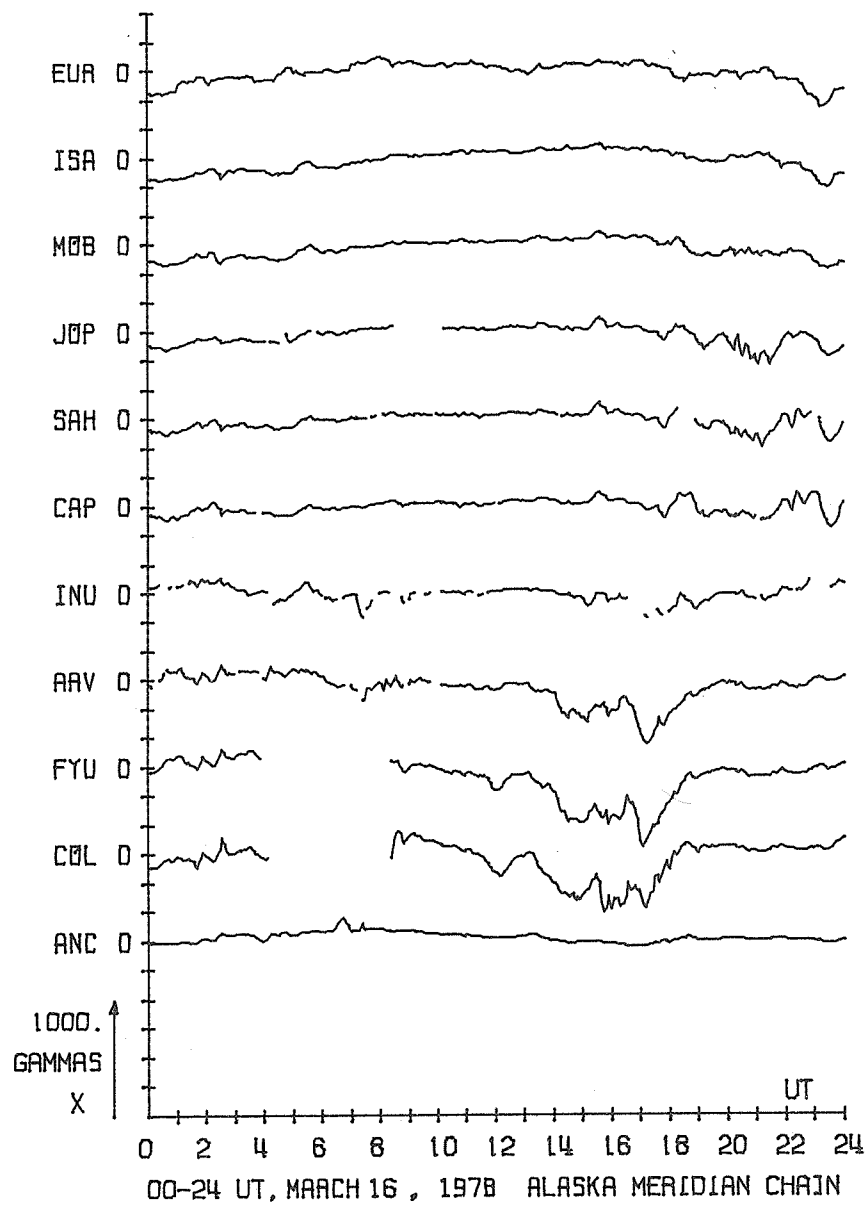
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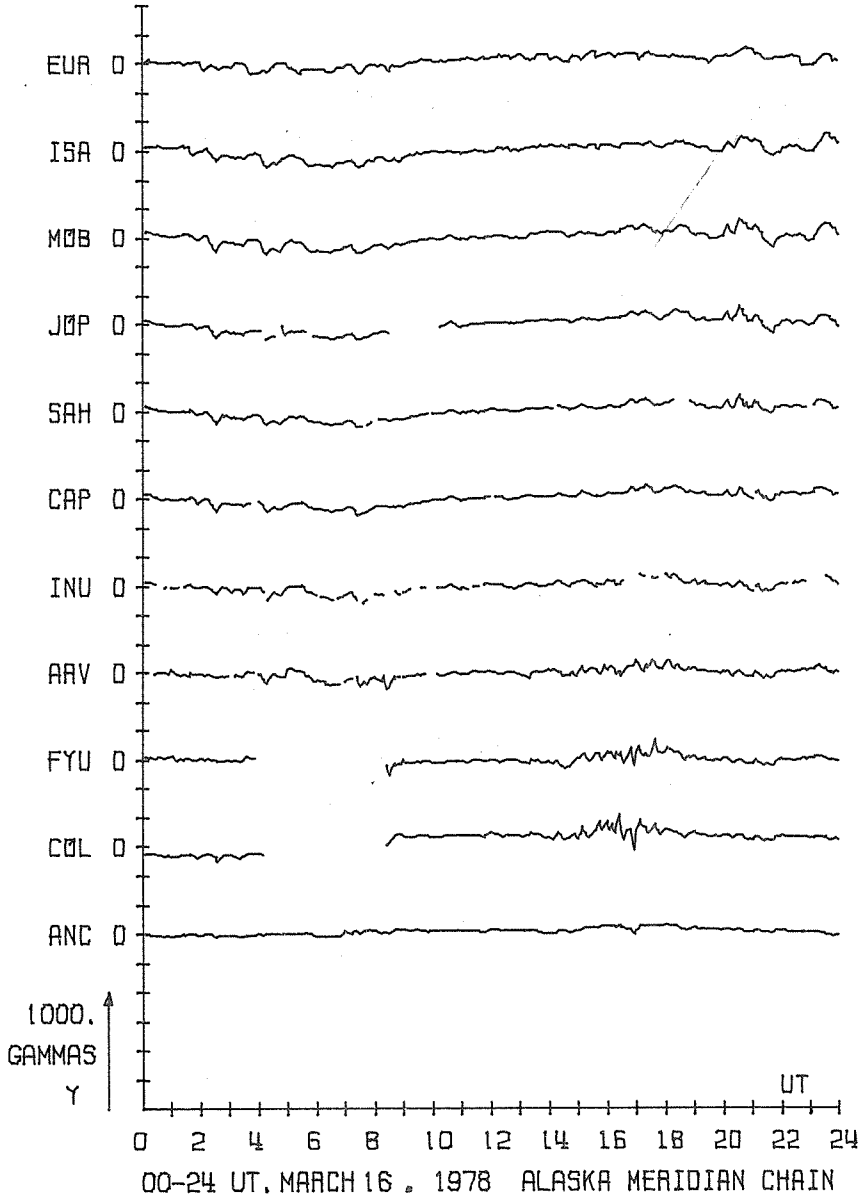
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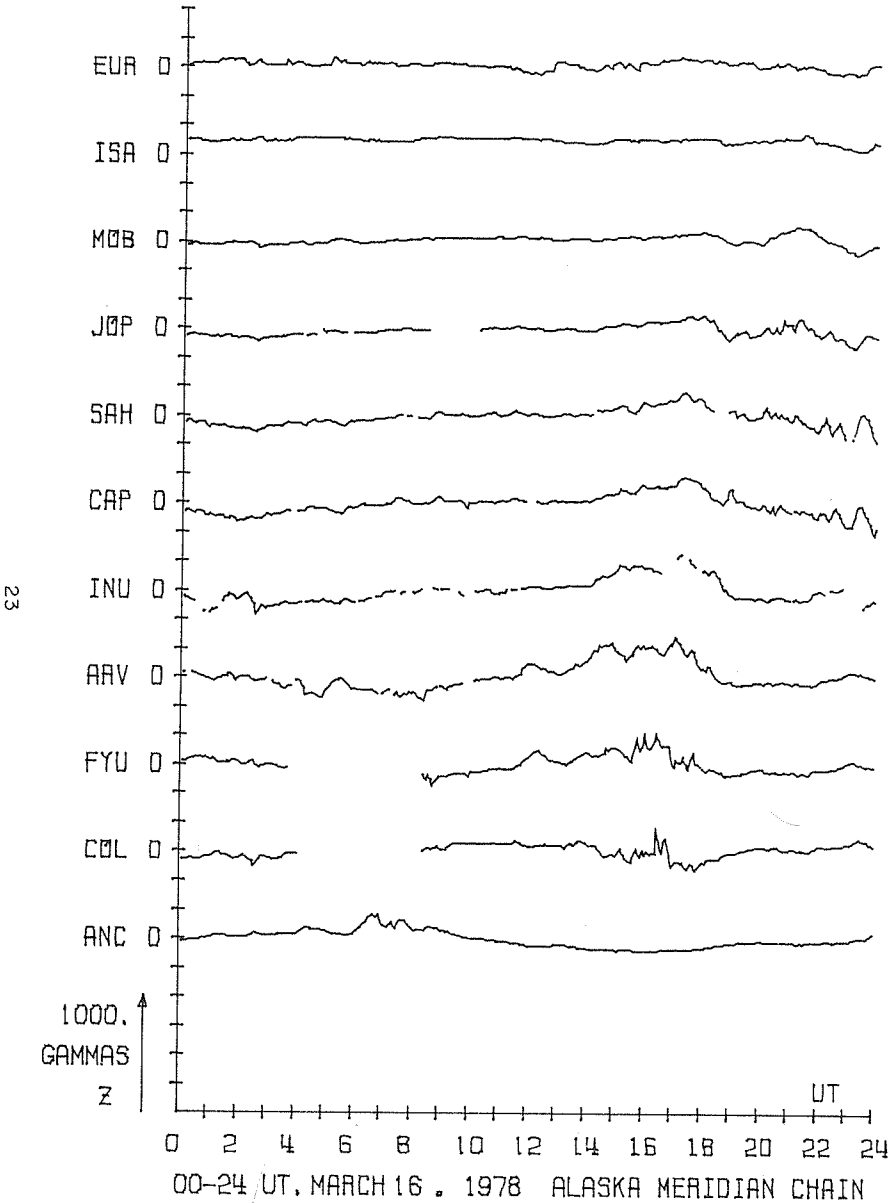

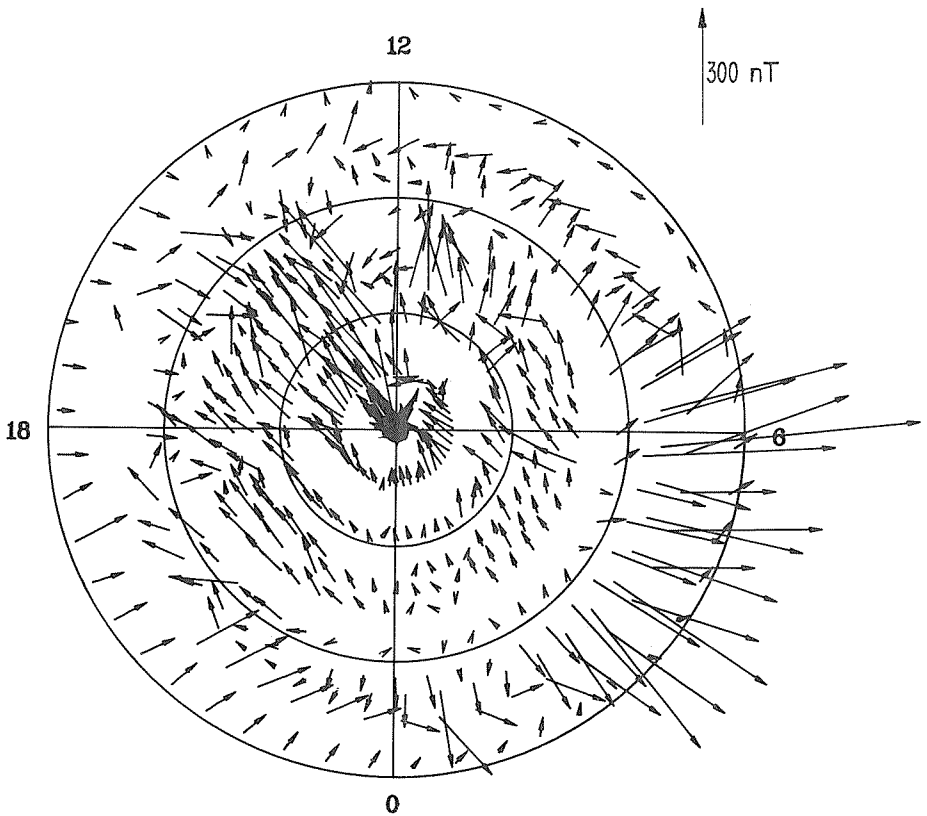

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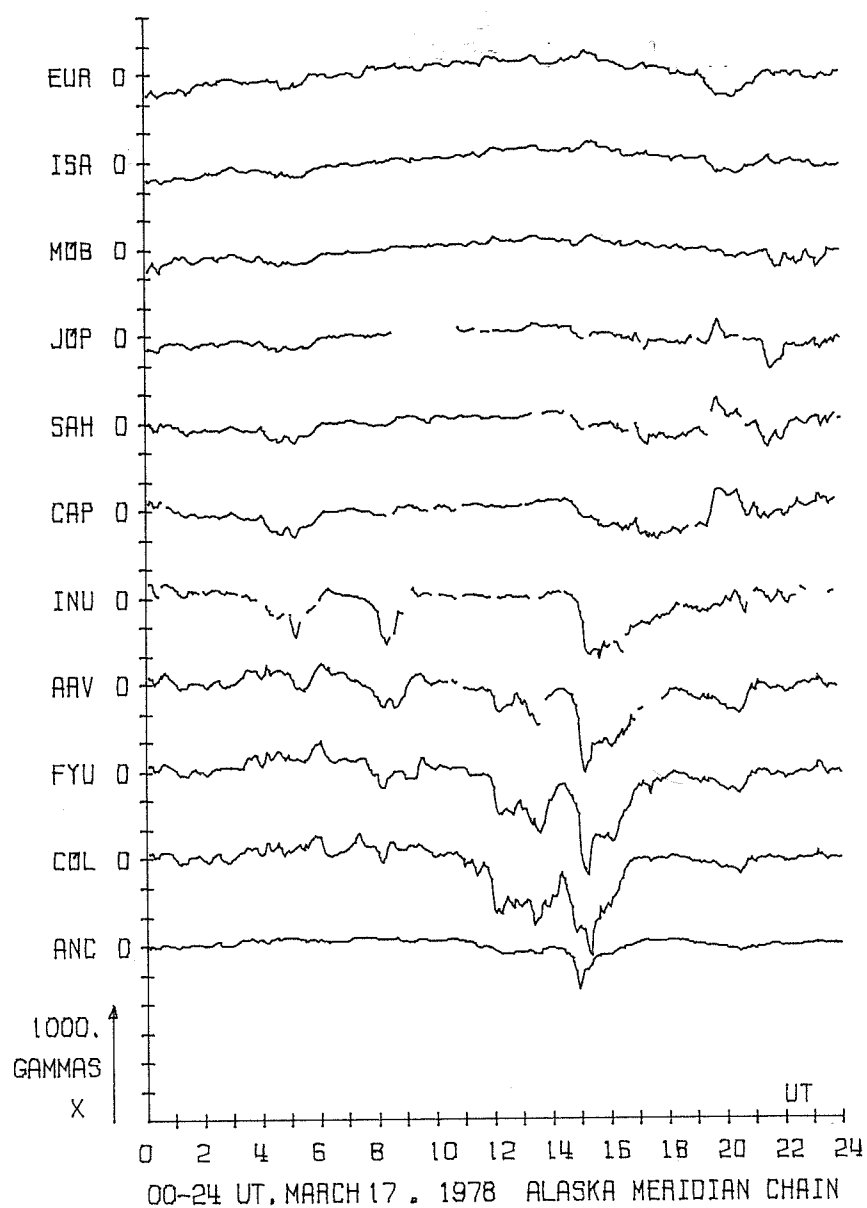
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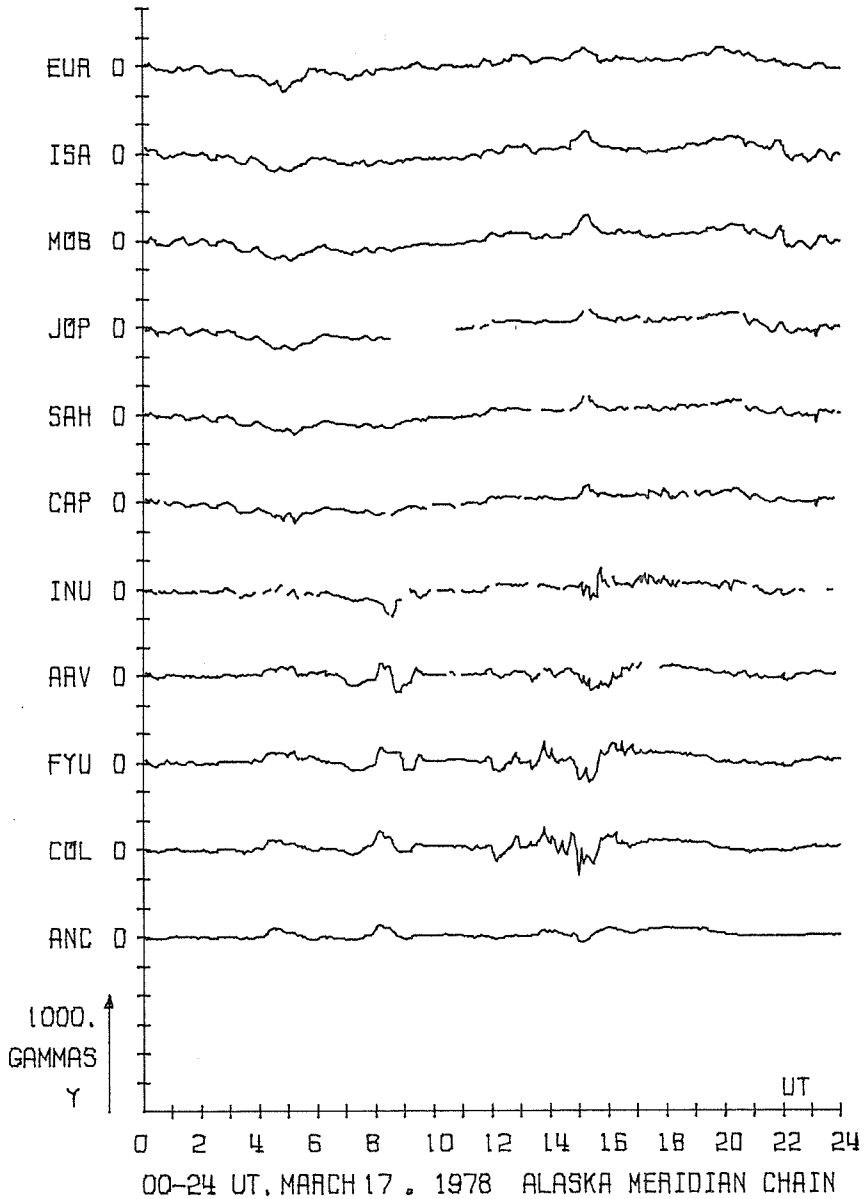
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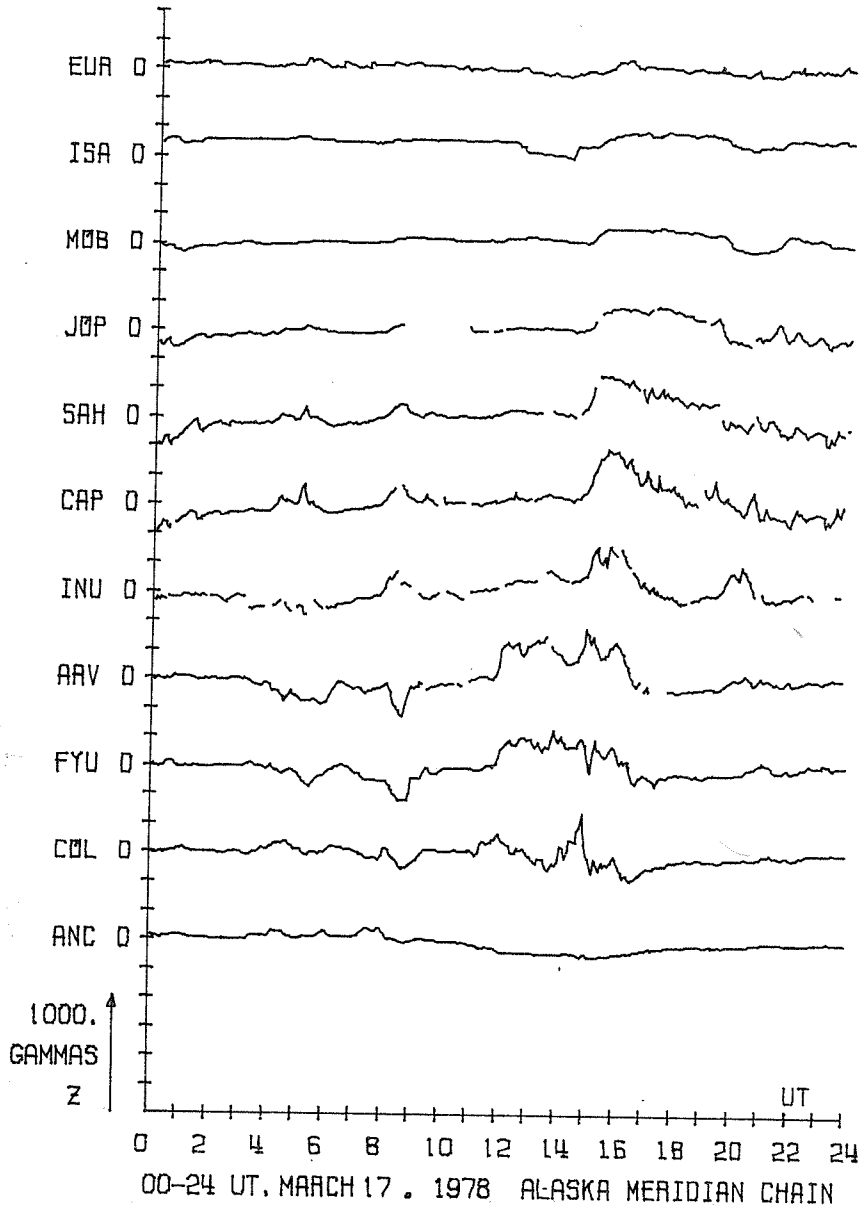

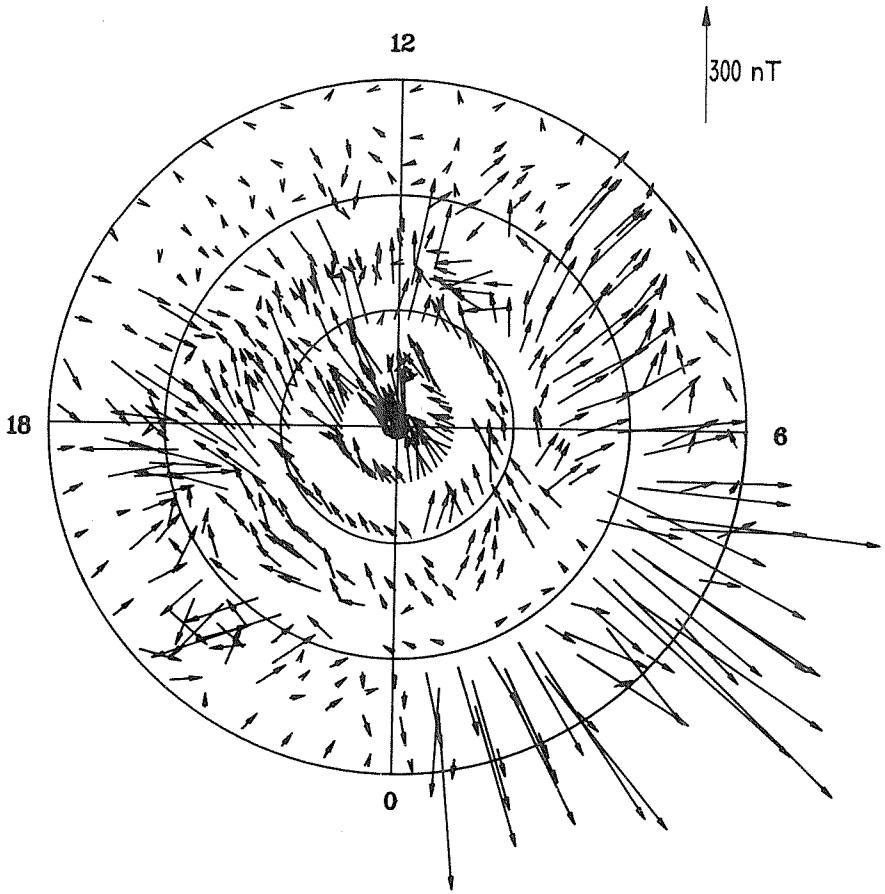

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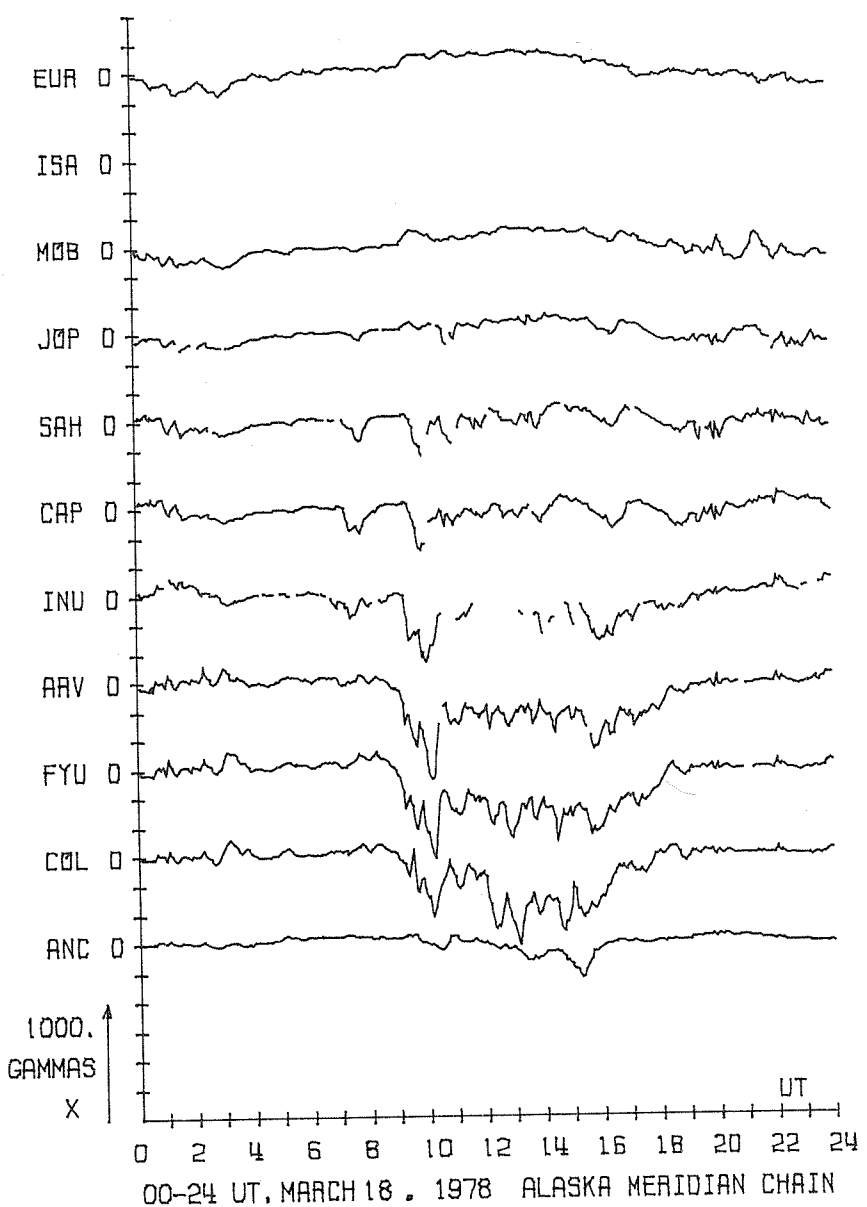
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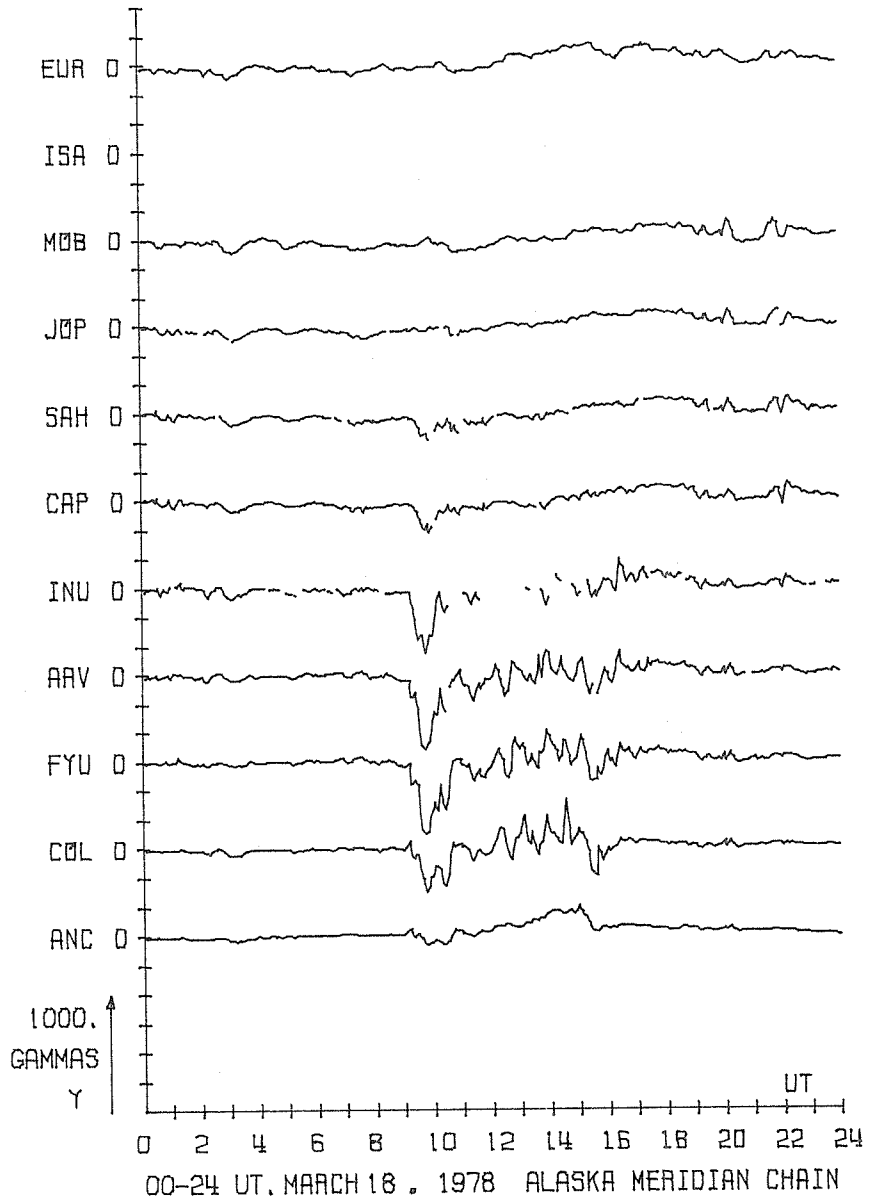
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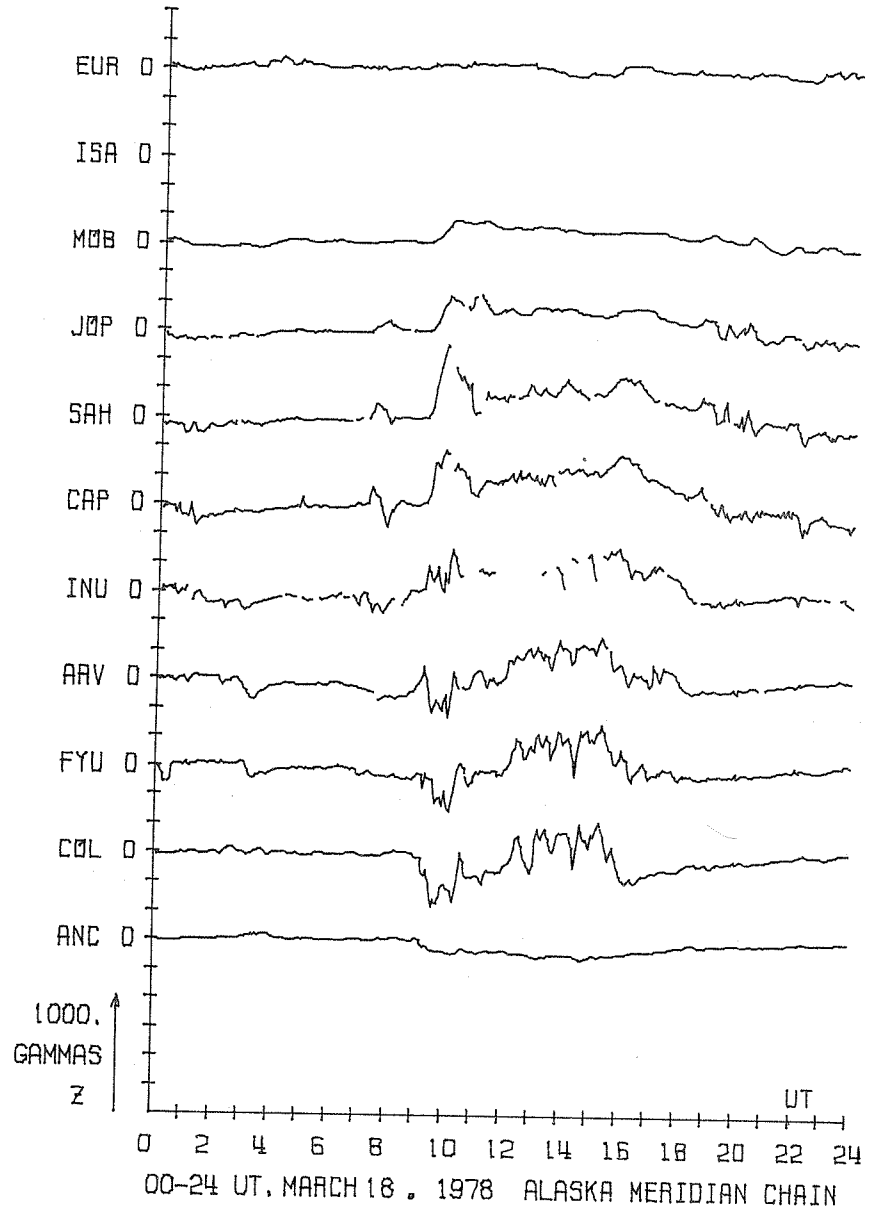

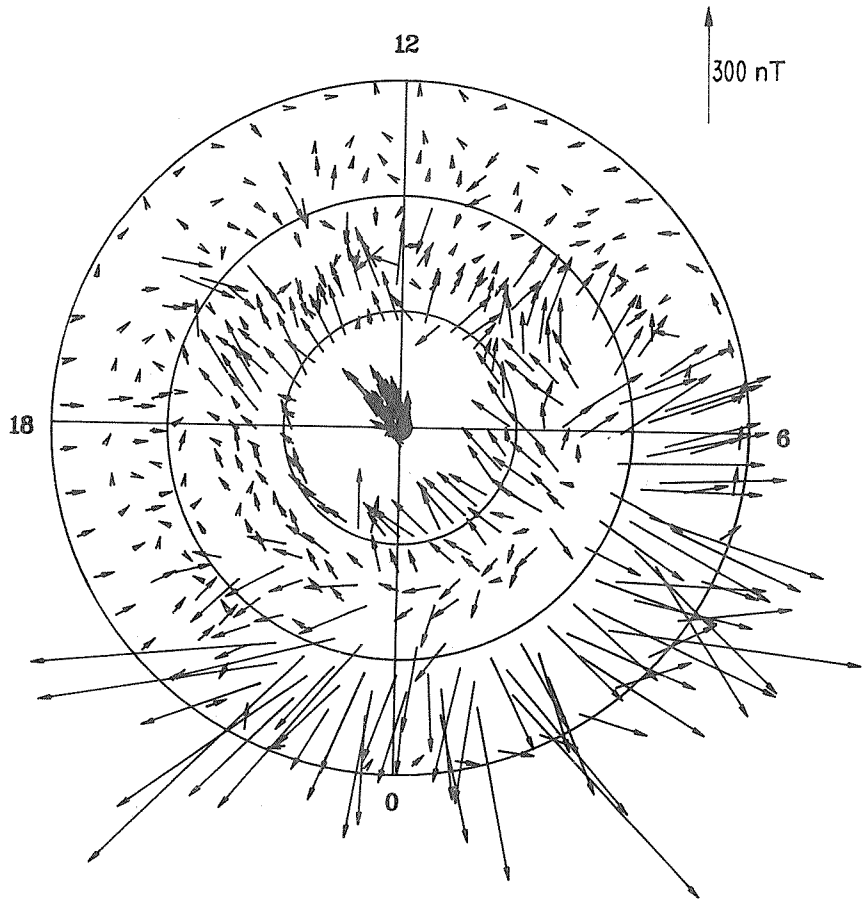

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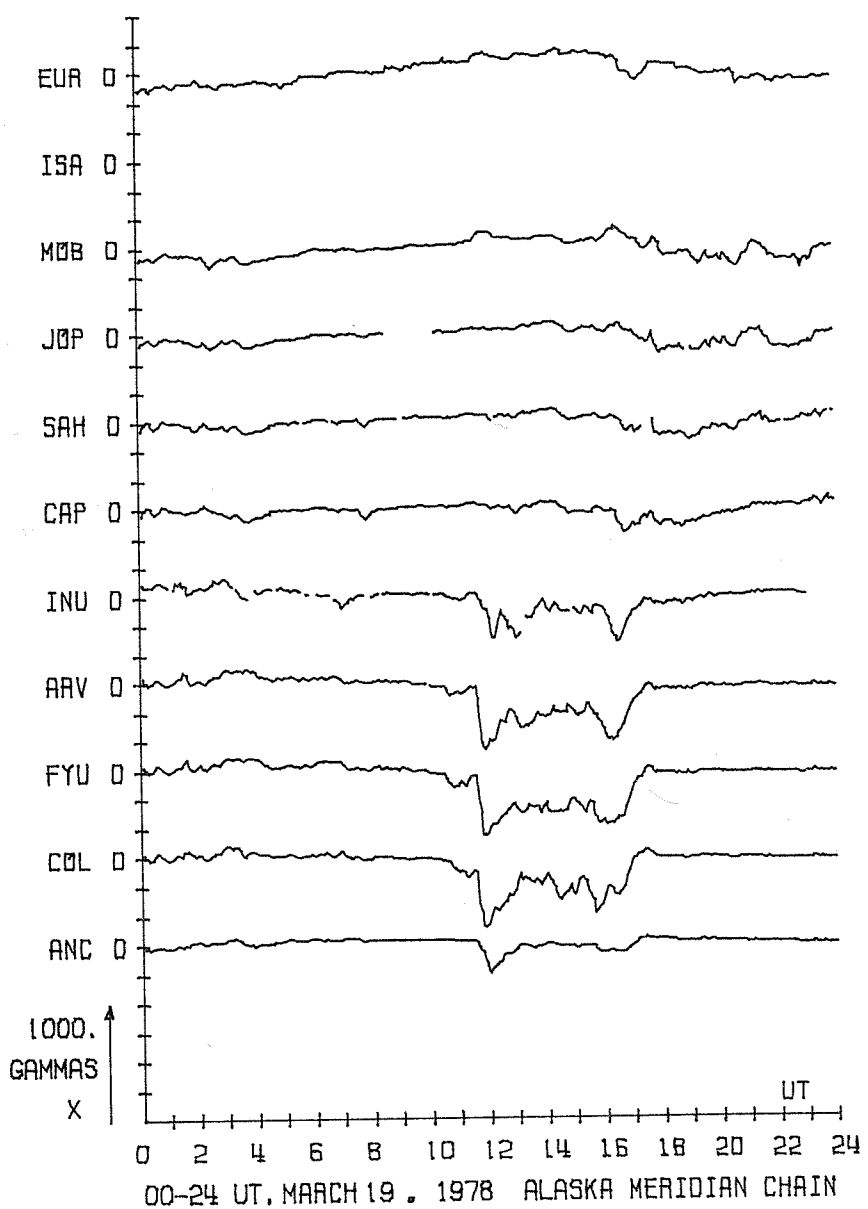
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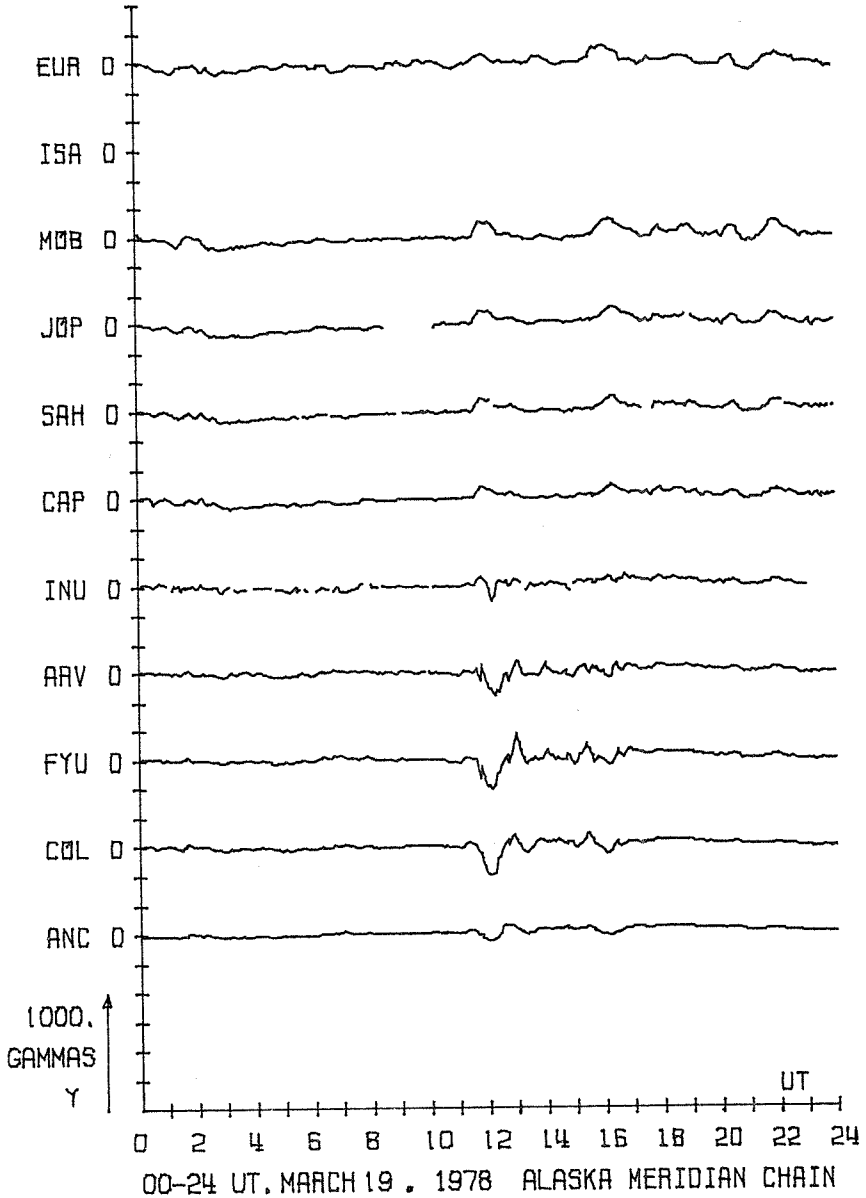
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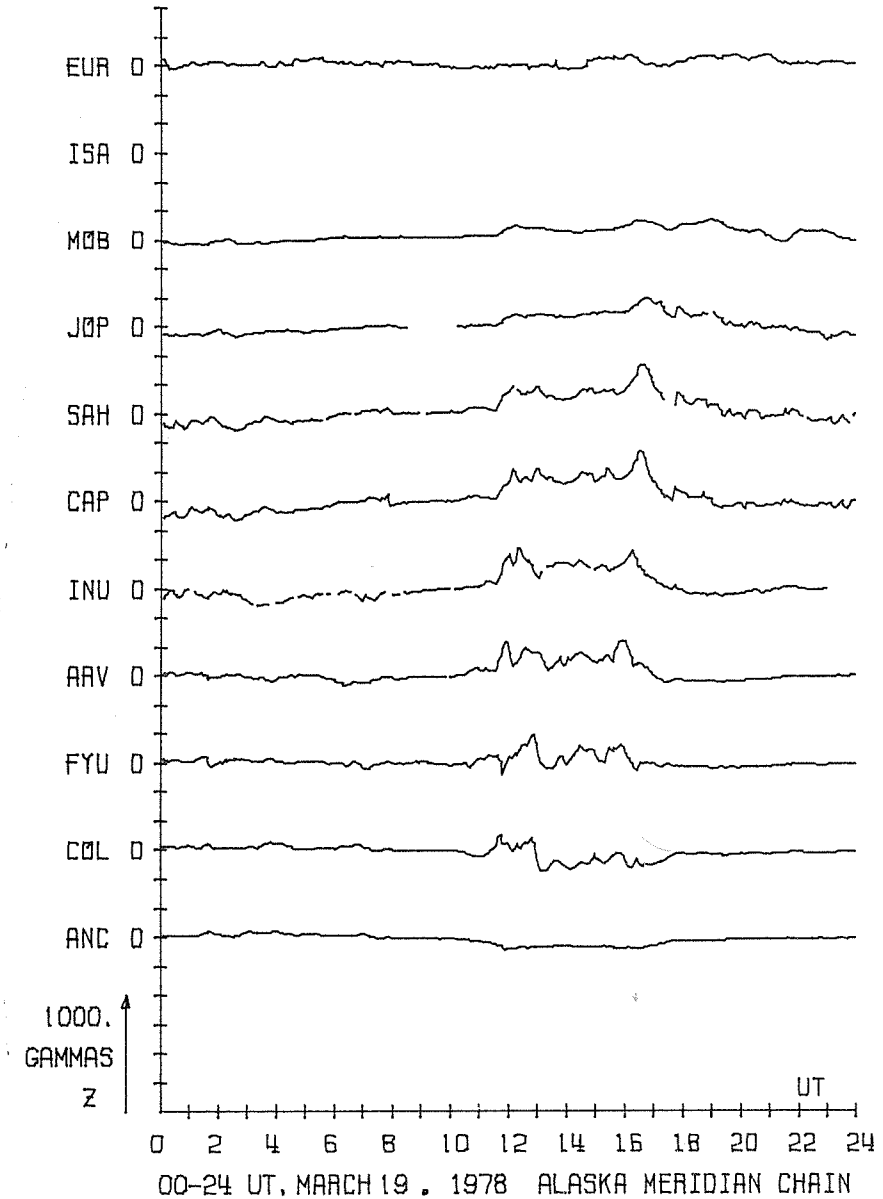

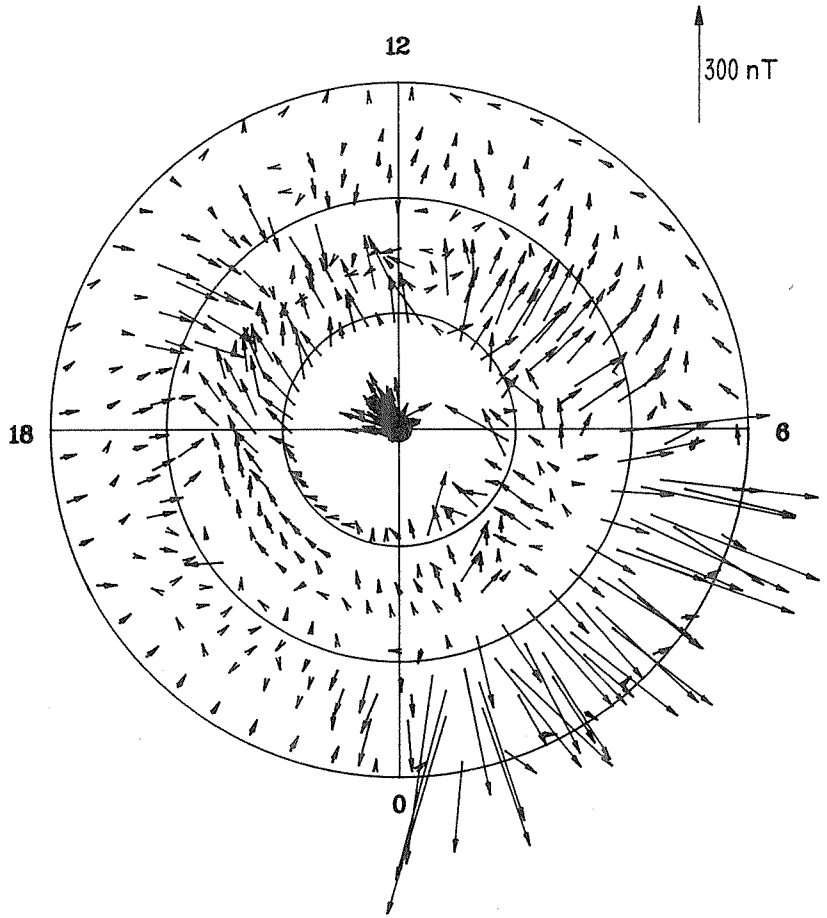

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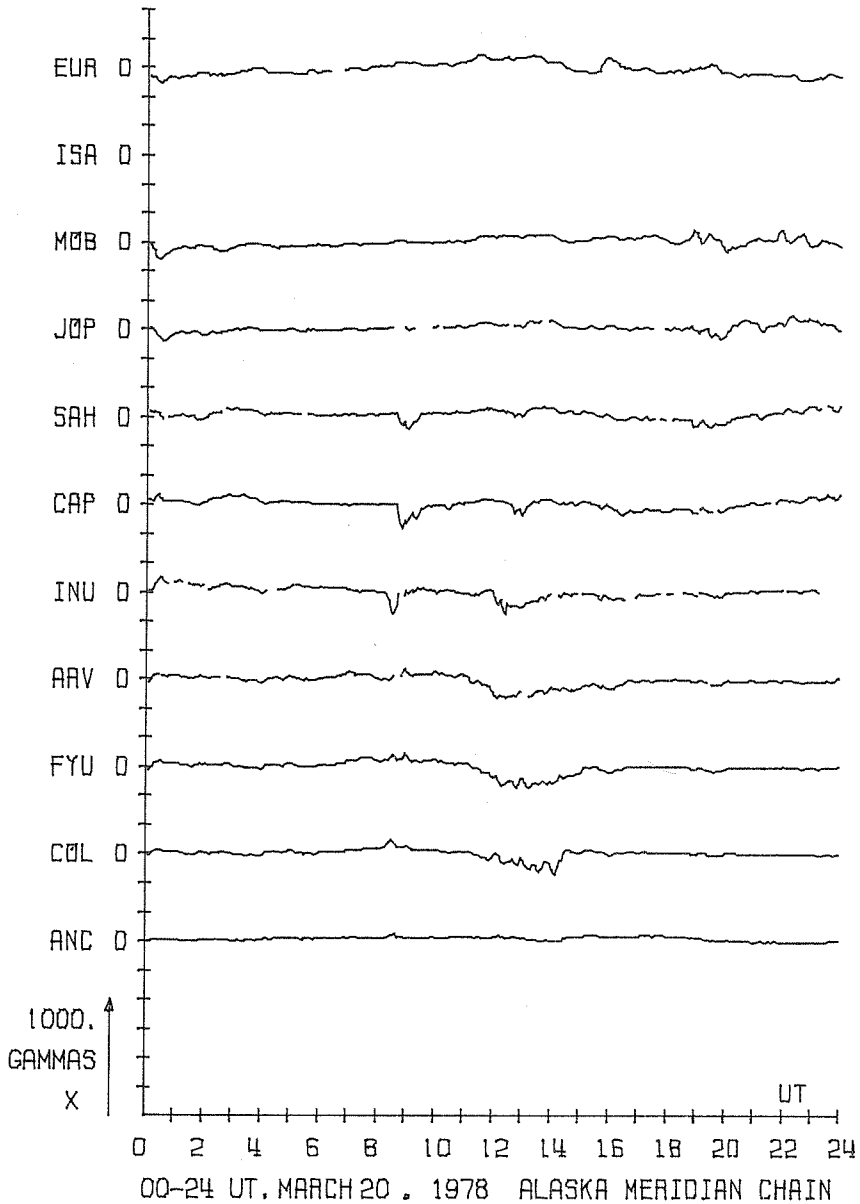
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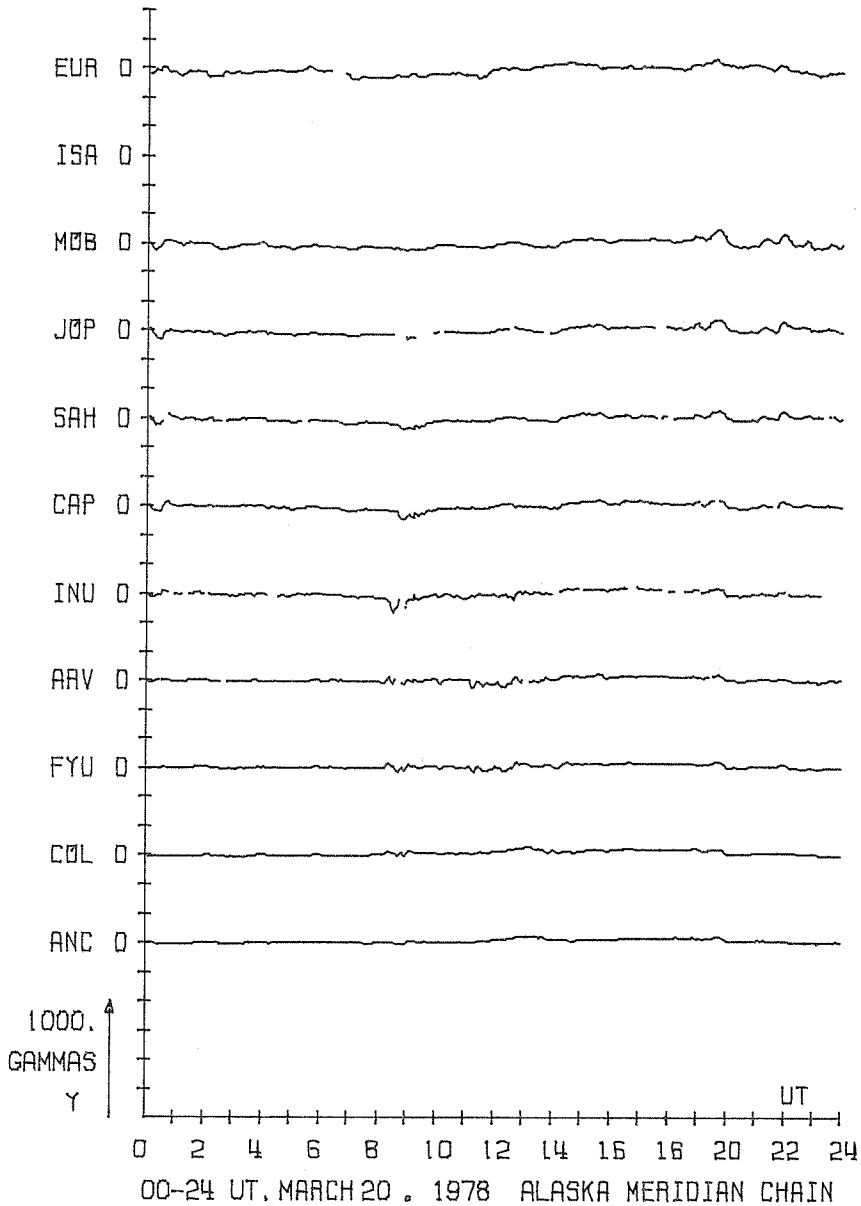
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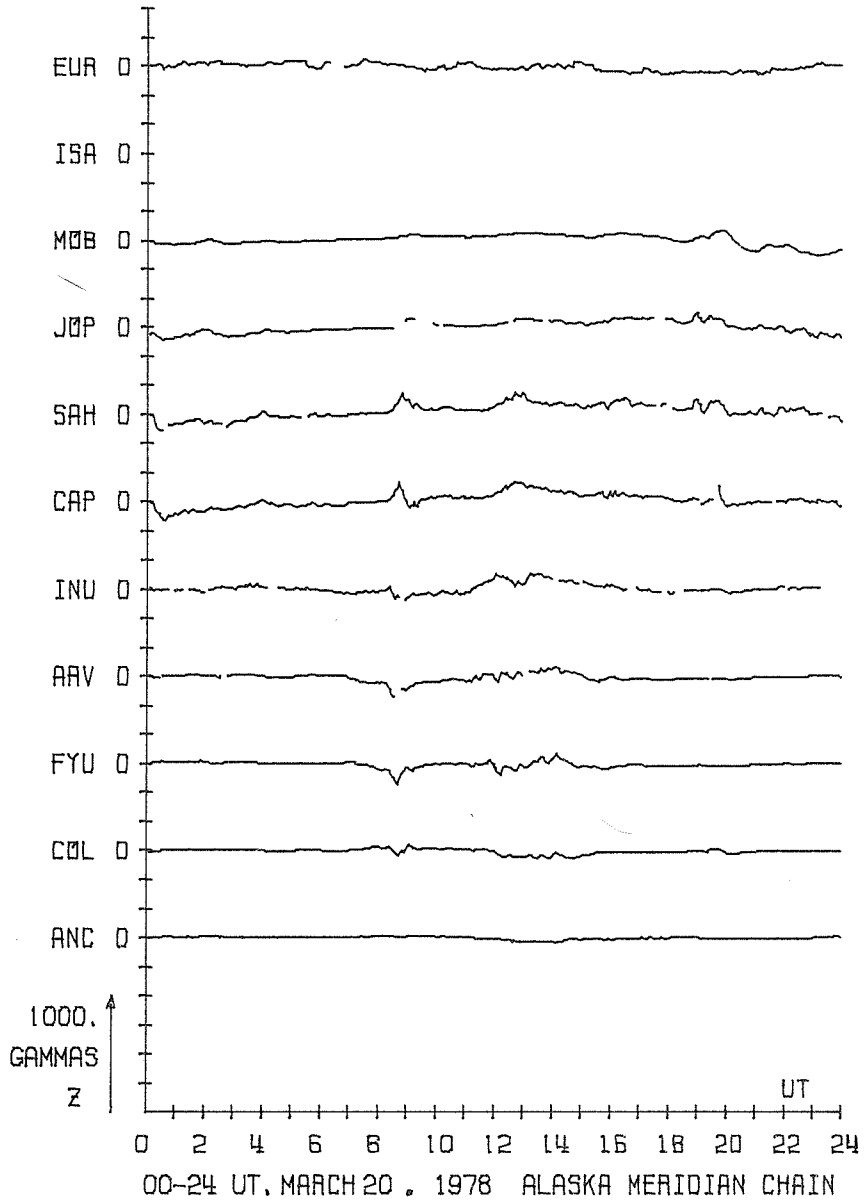

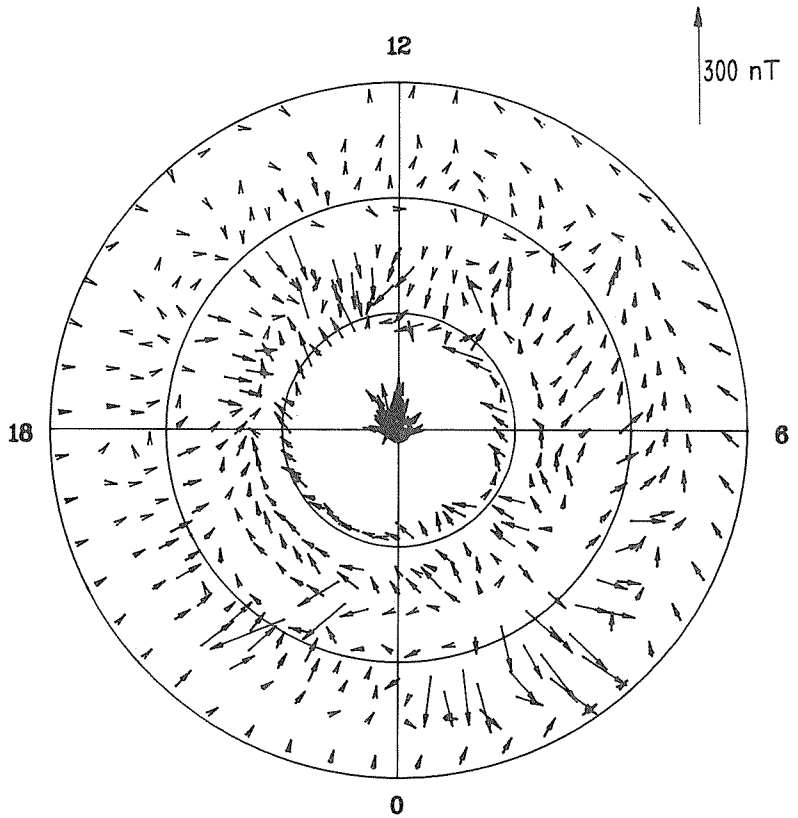

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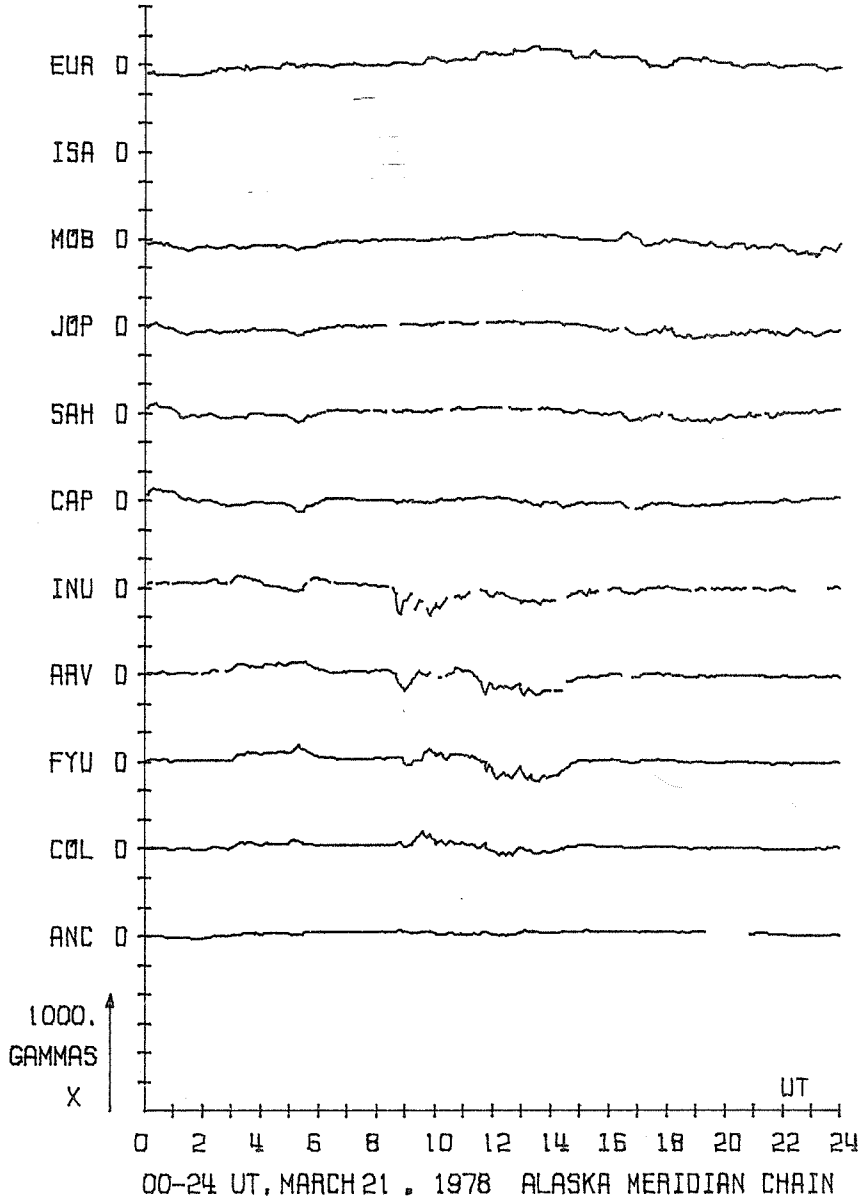
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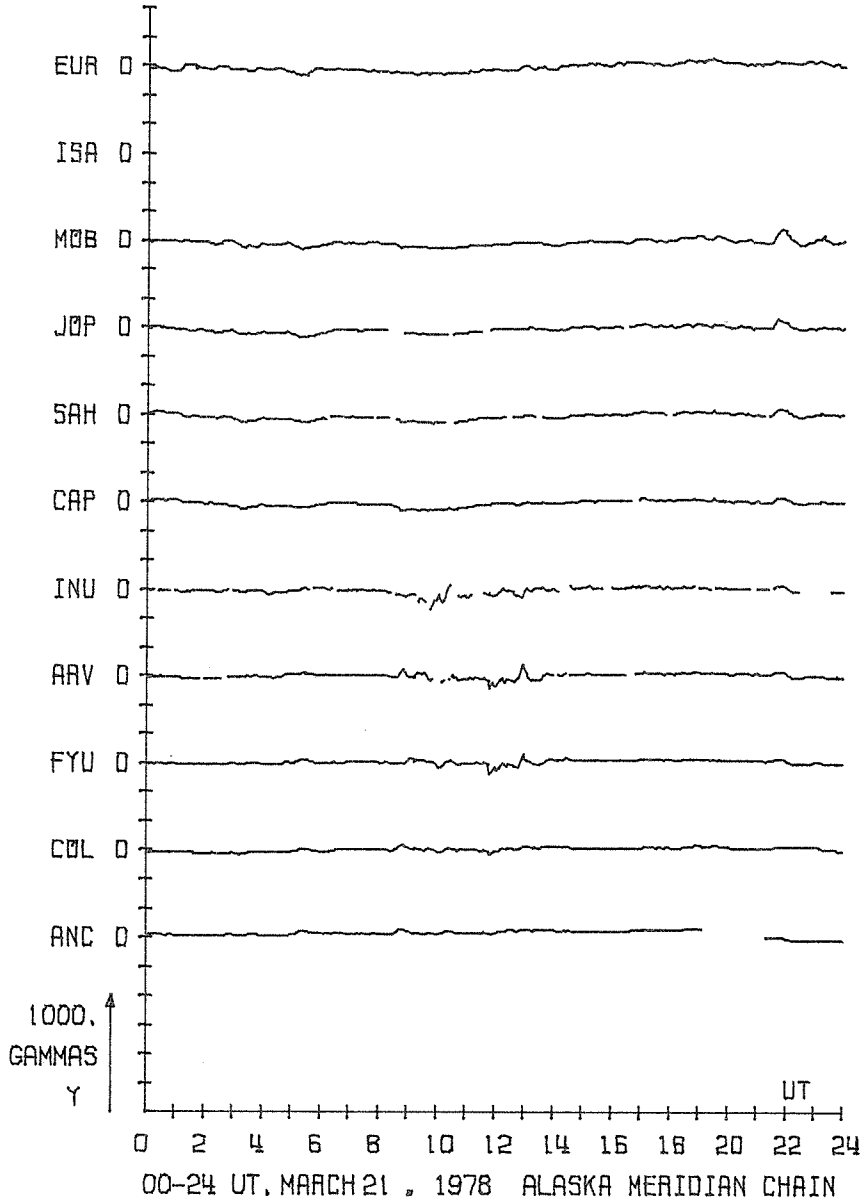
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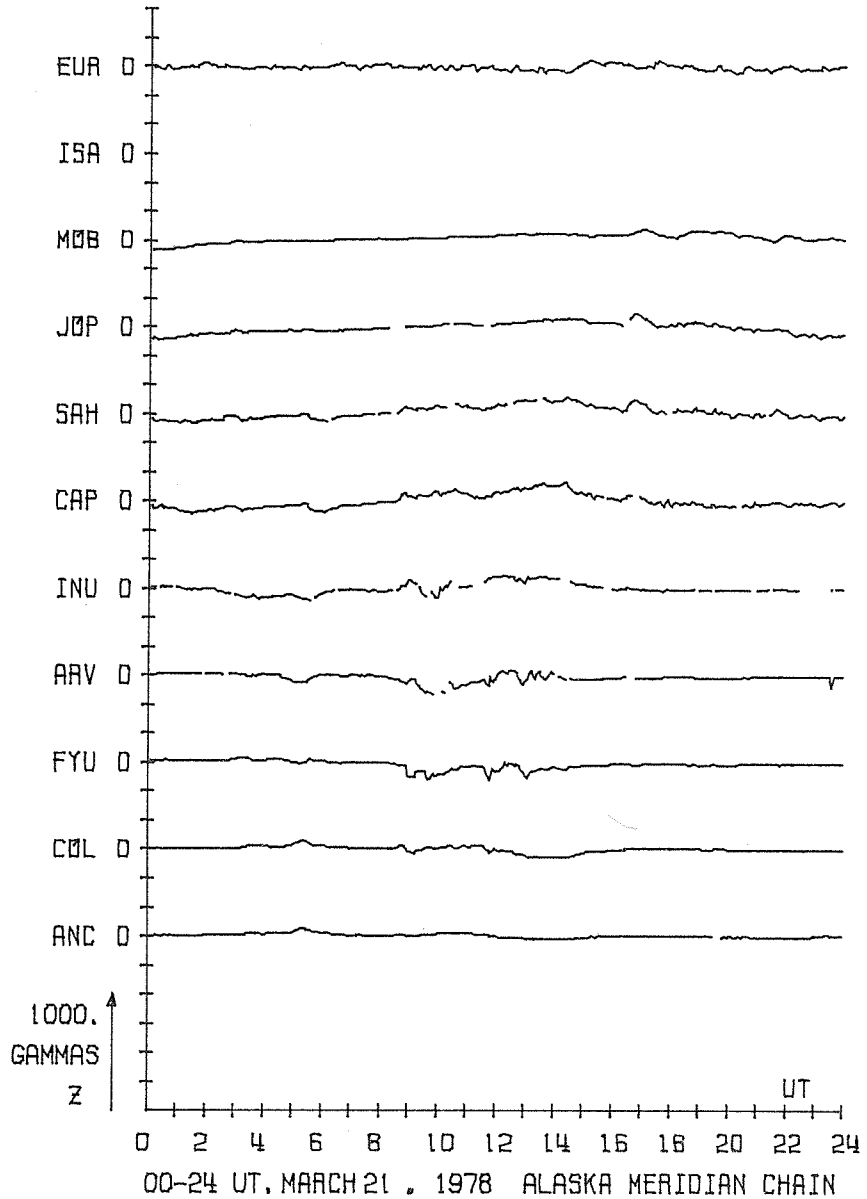

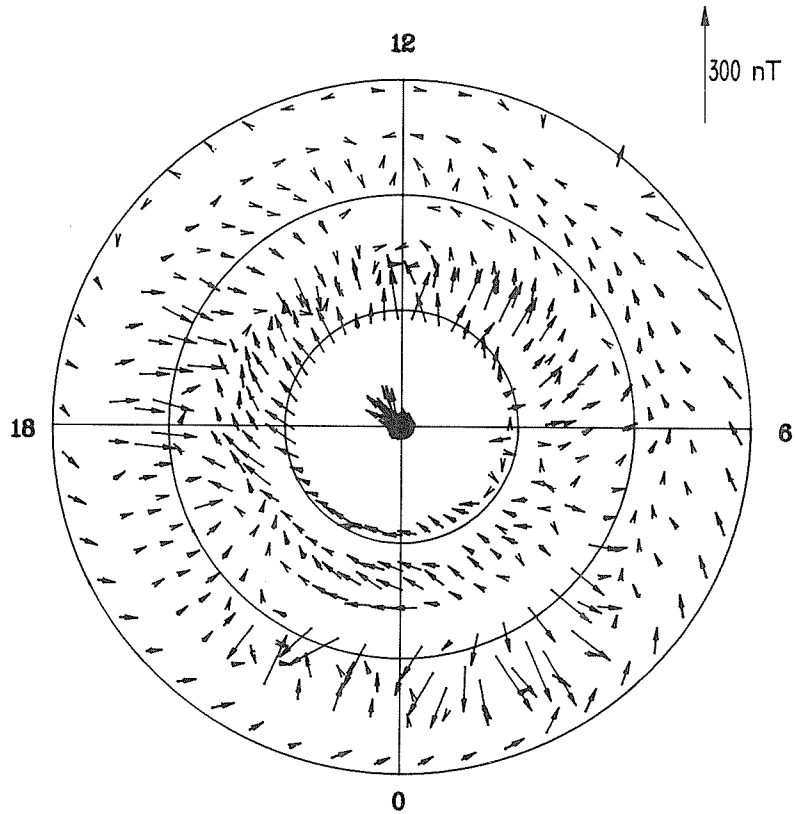

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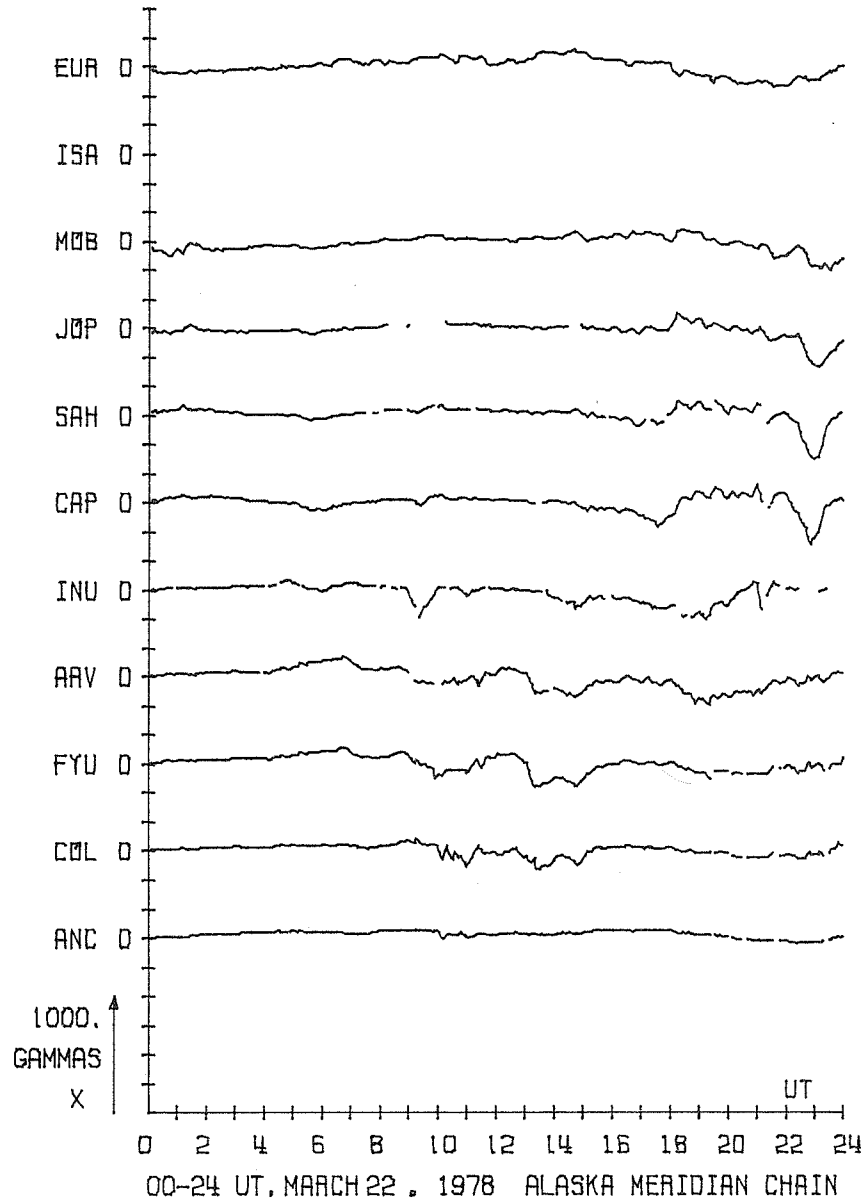
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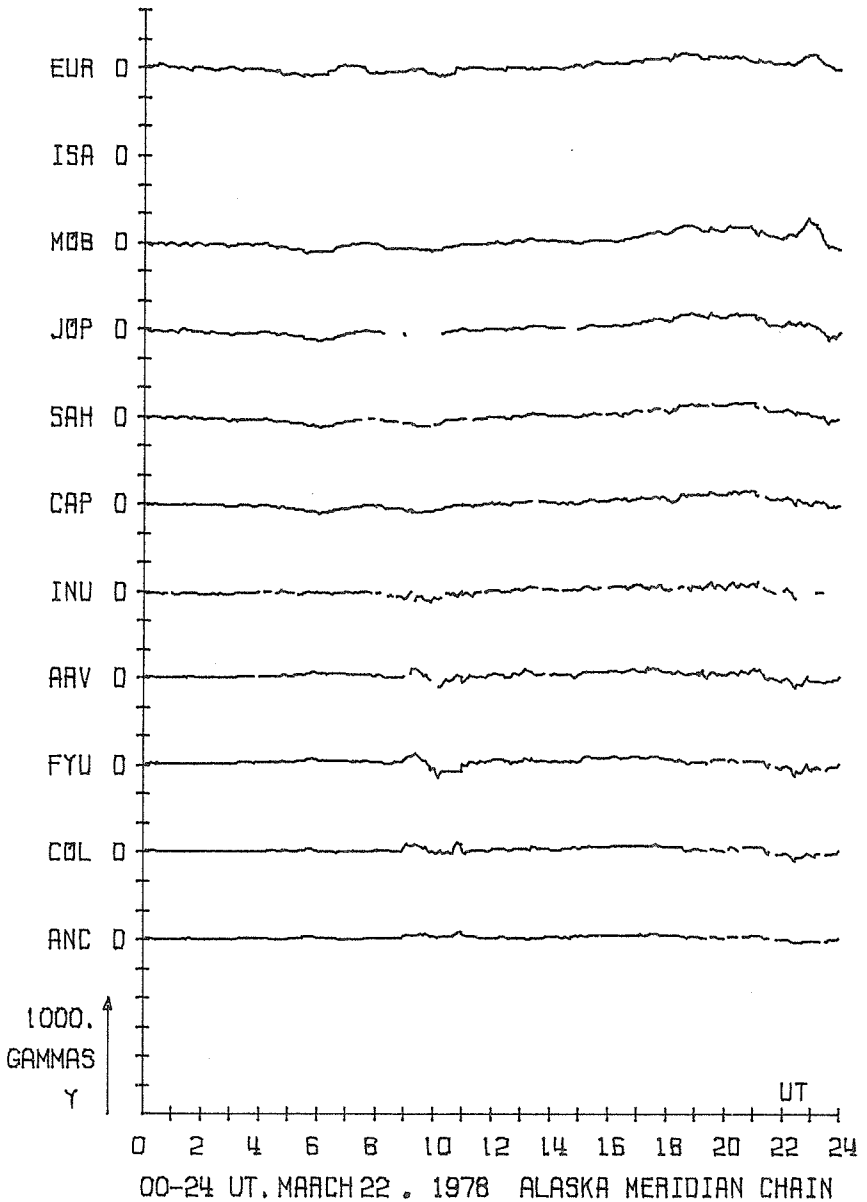
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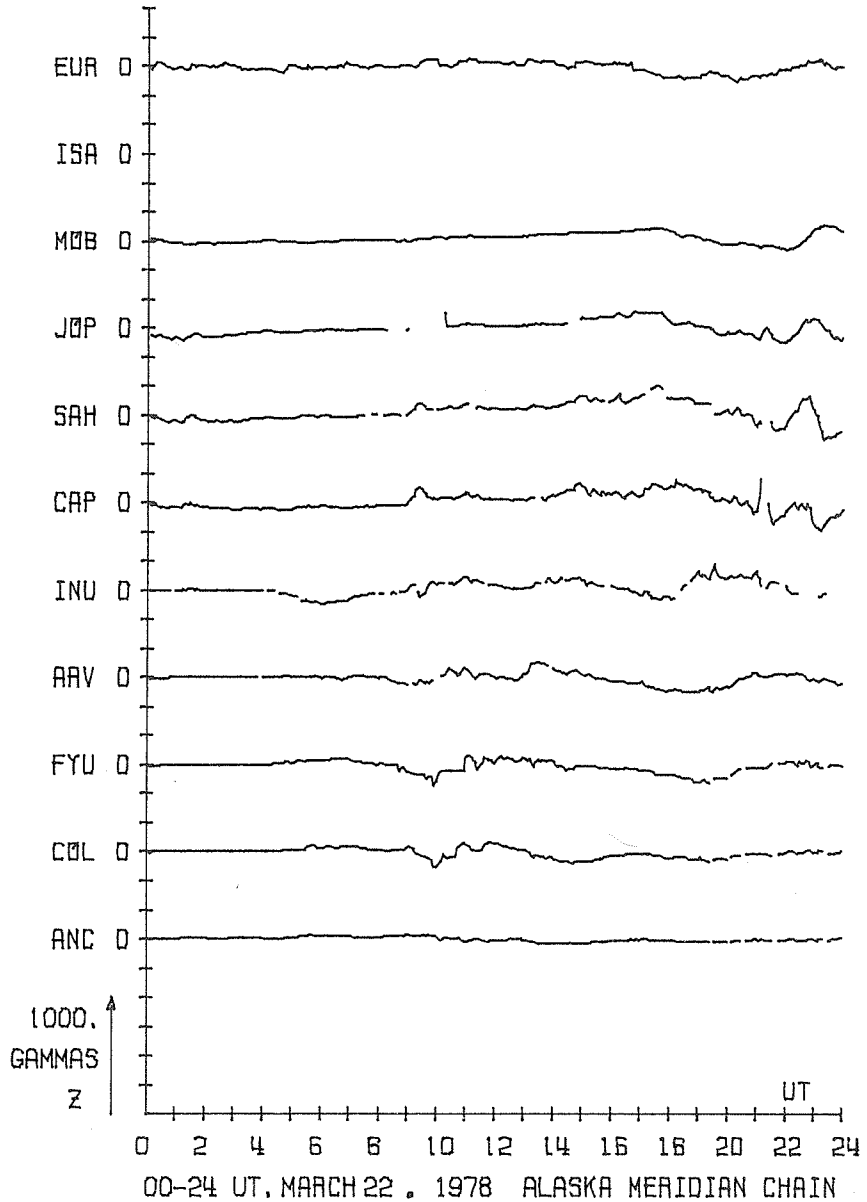
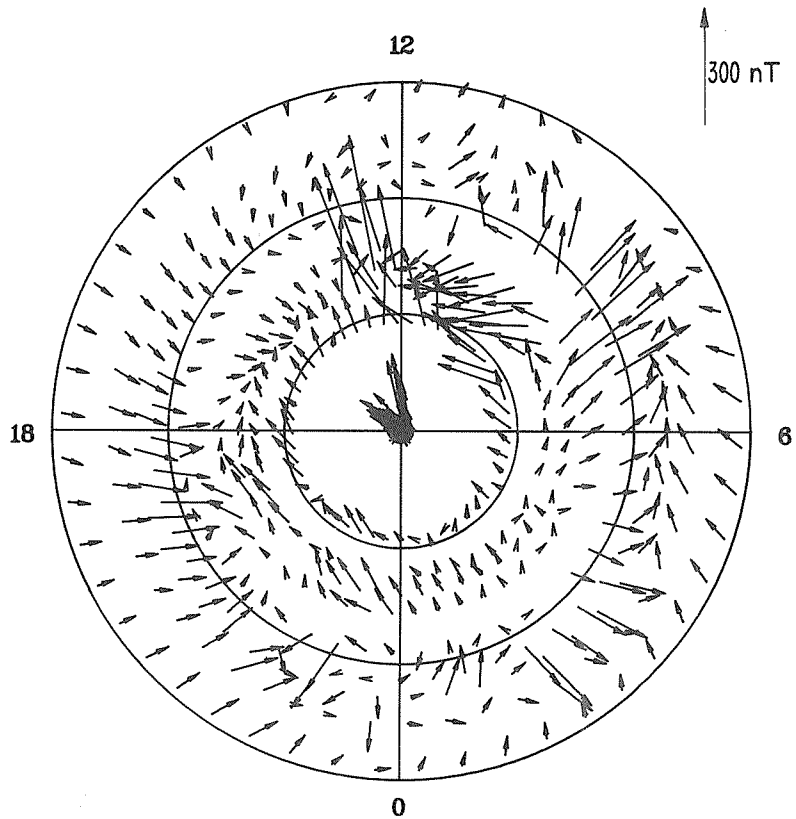
00-24 UT, MARCH 22 , 1978 ALASKA MERIDIAN CHAIN





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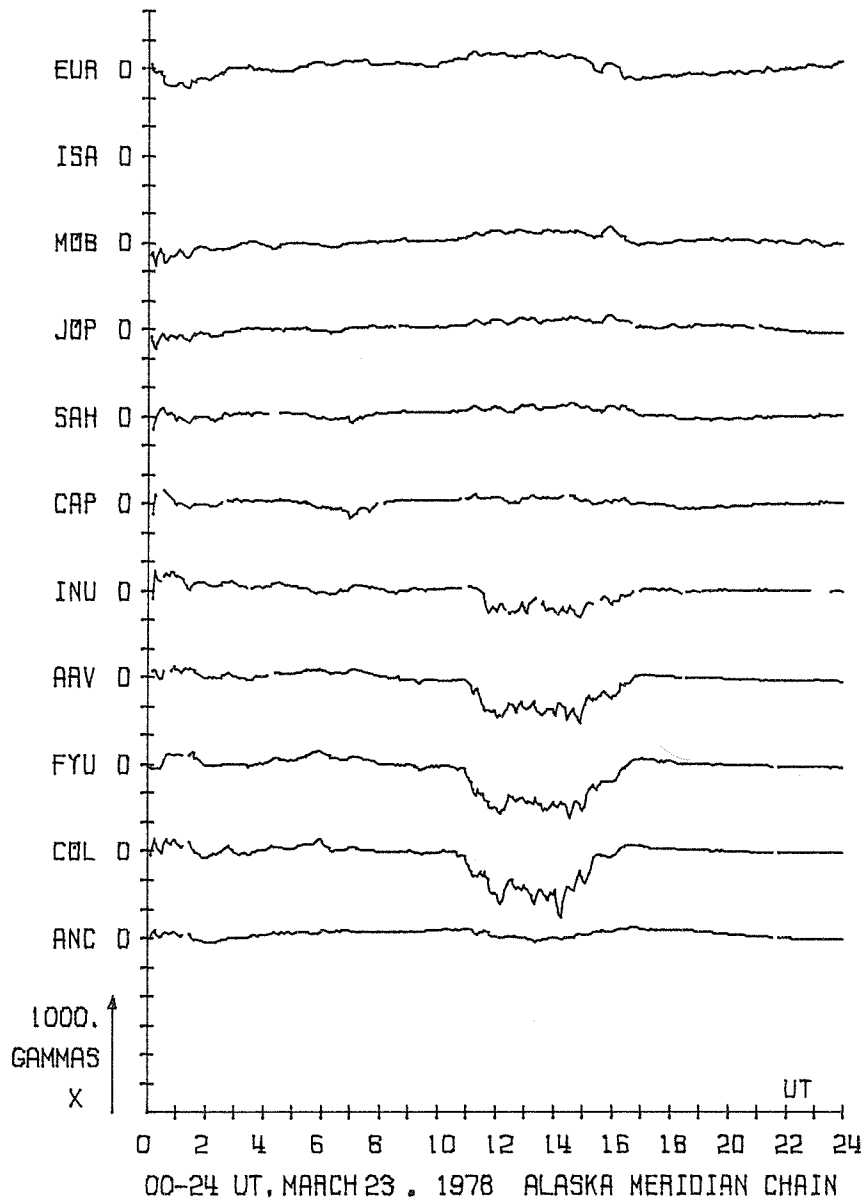
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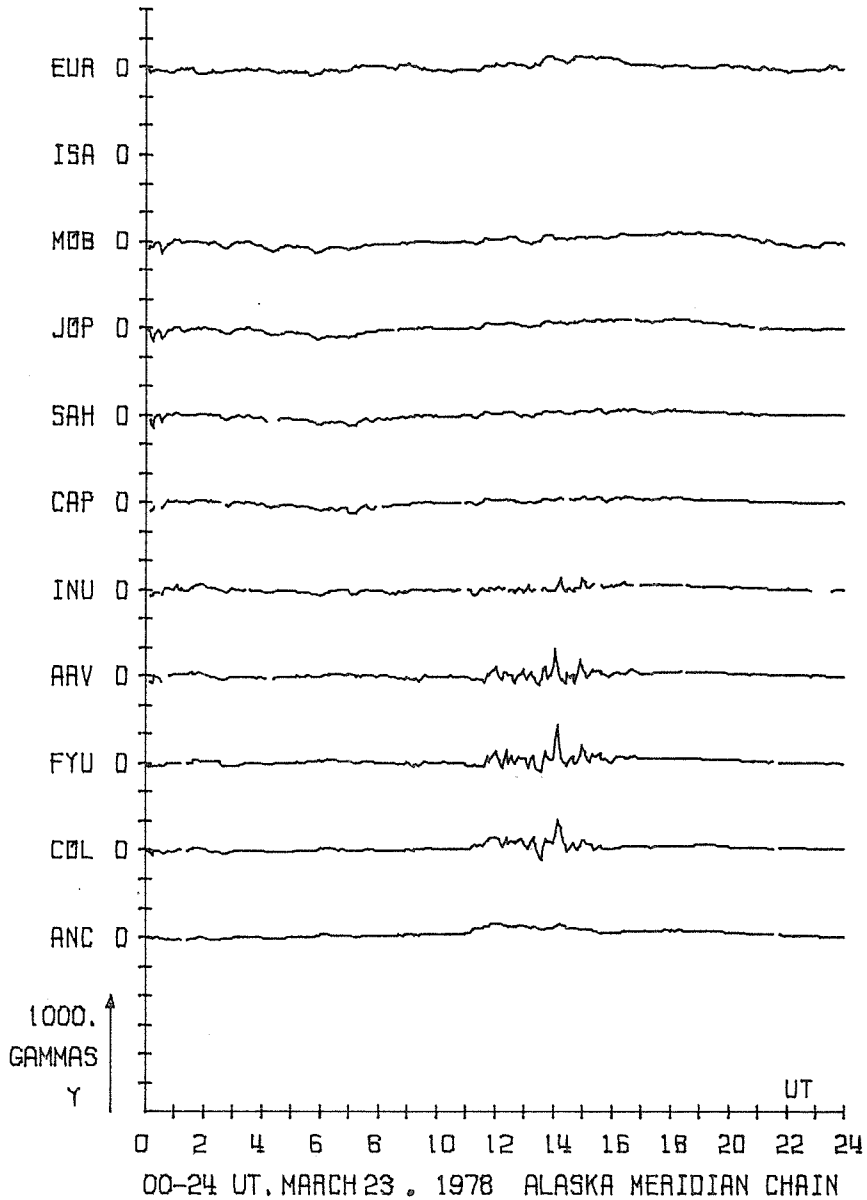
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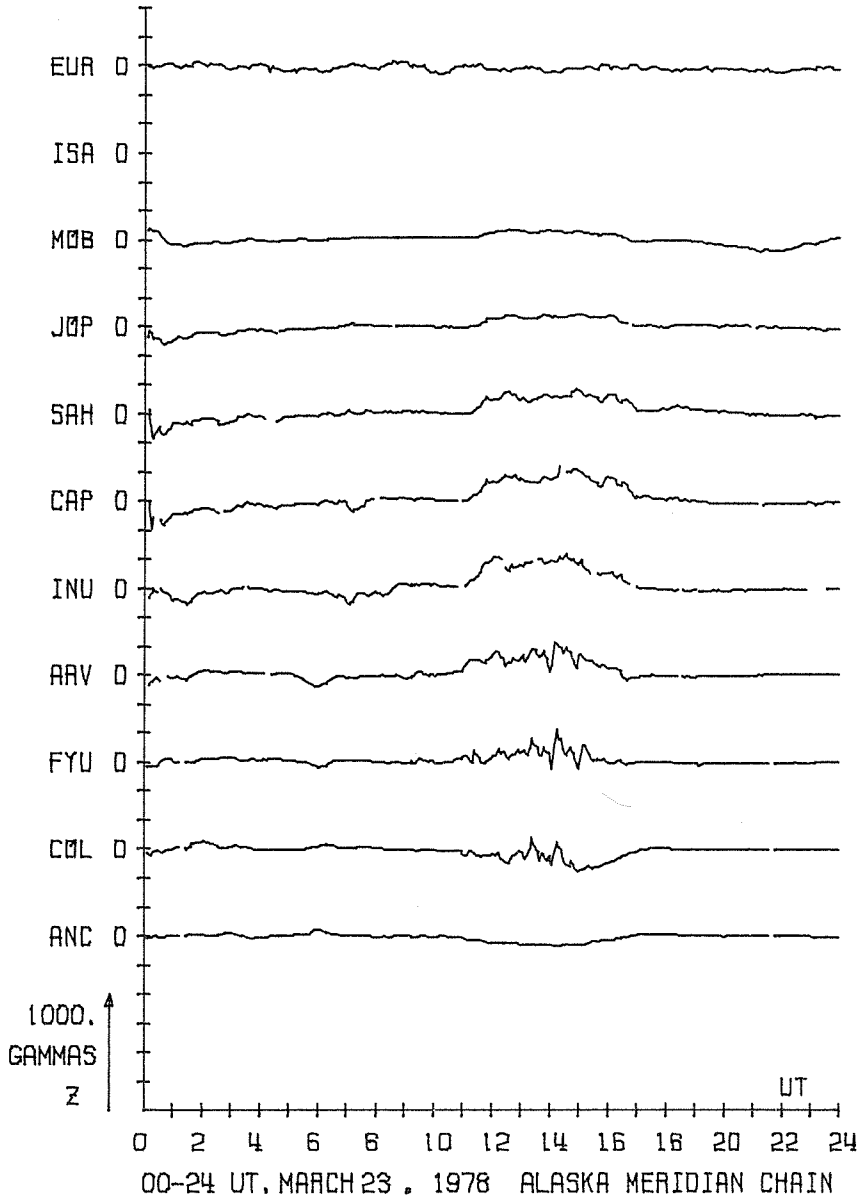

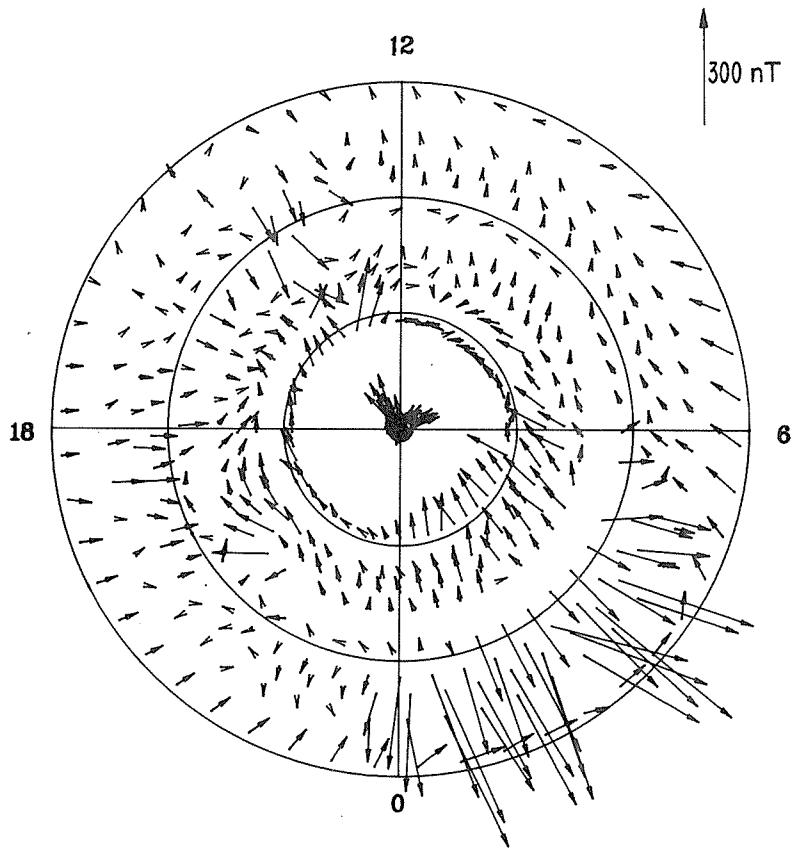

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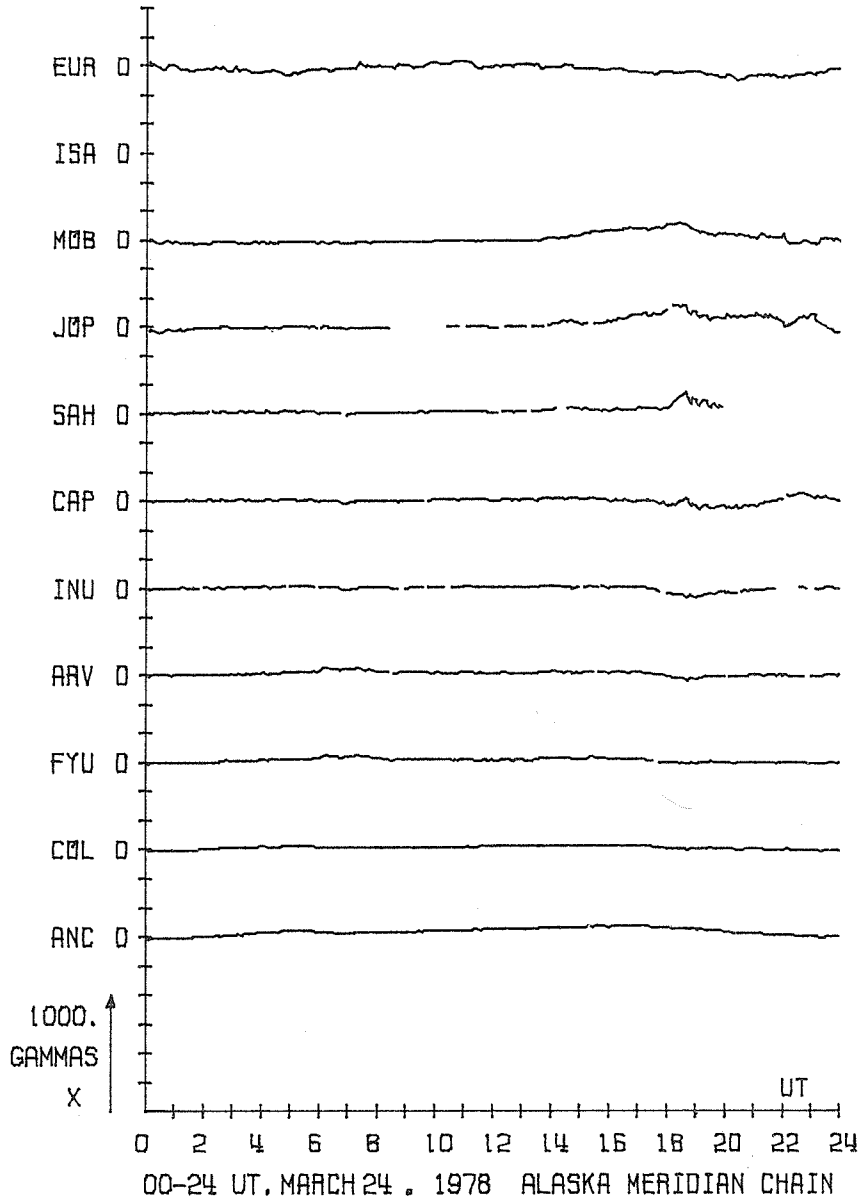
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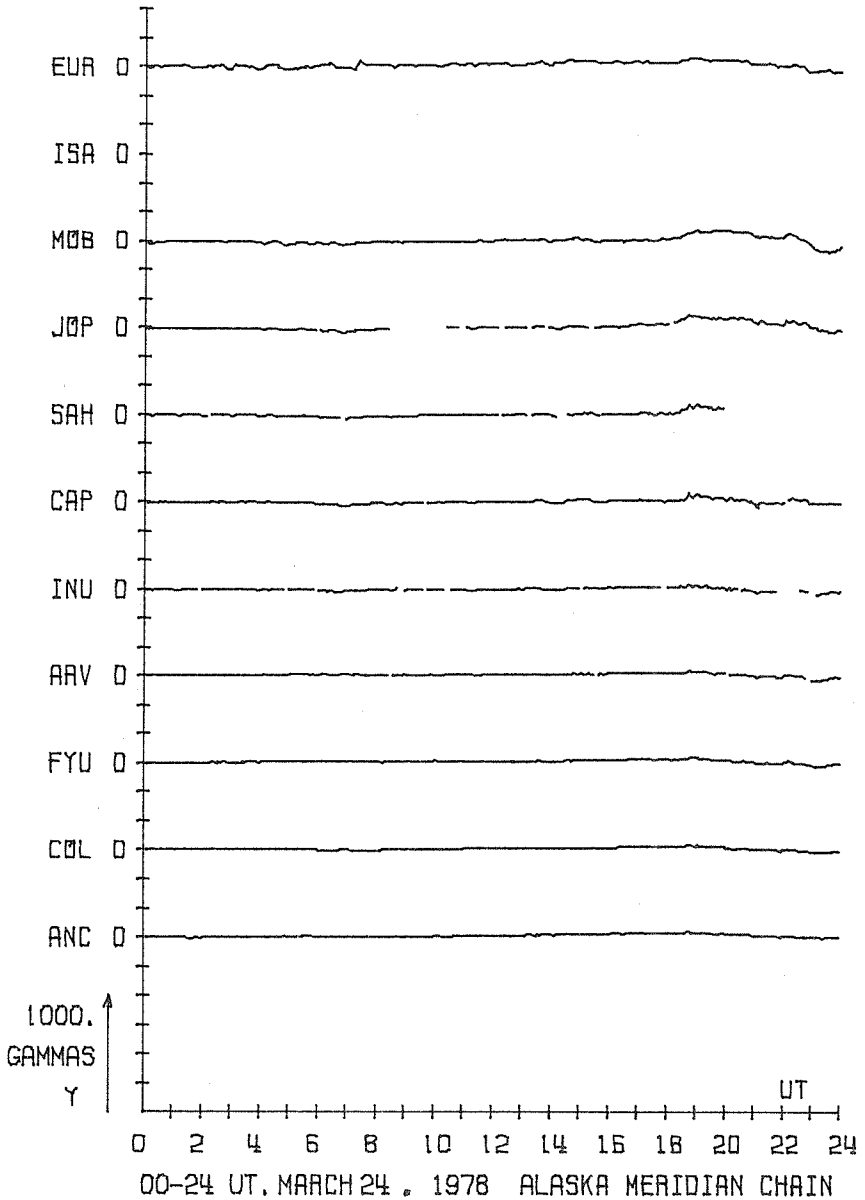
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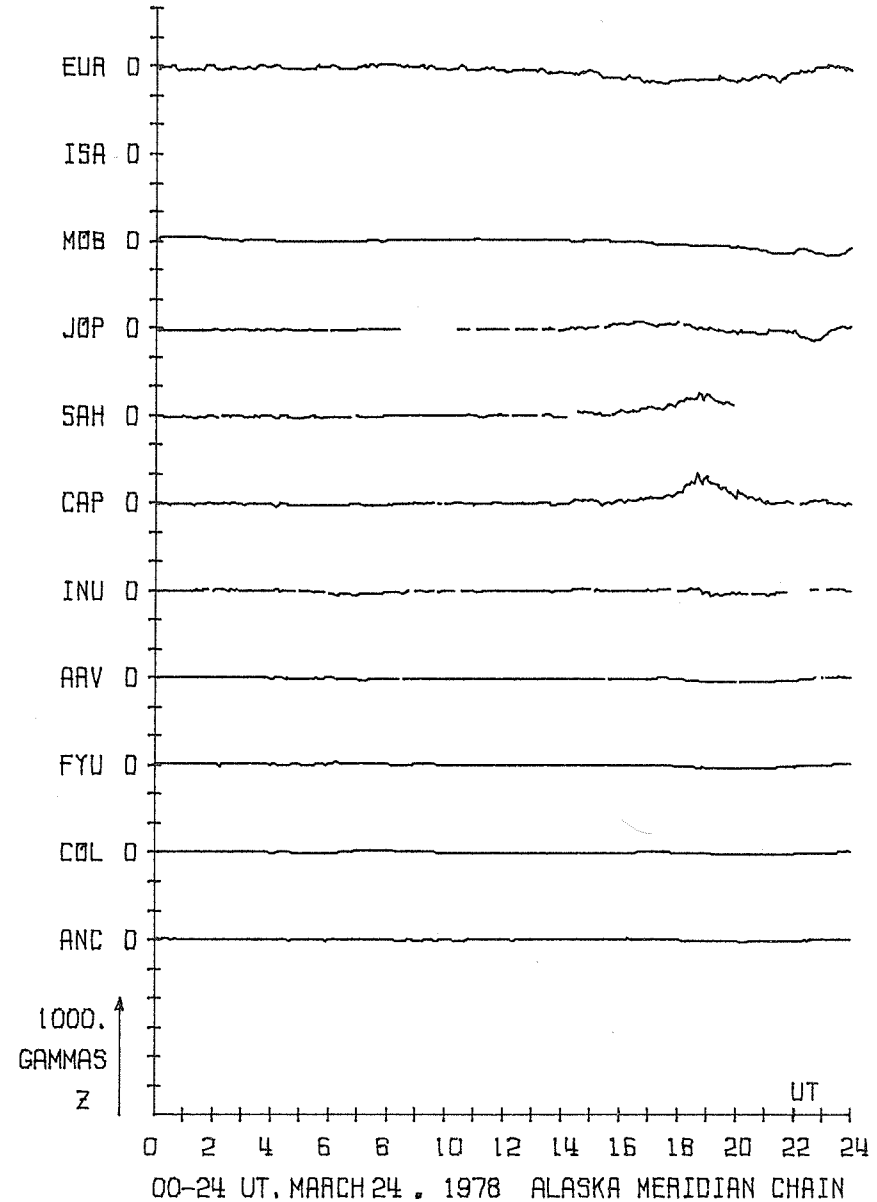

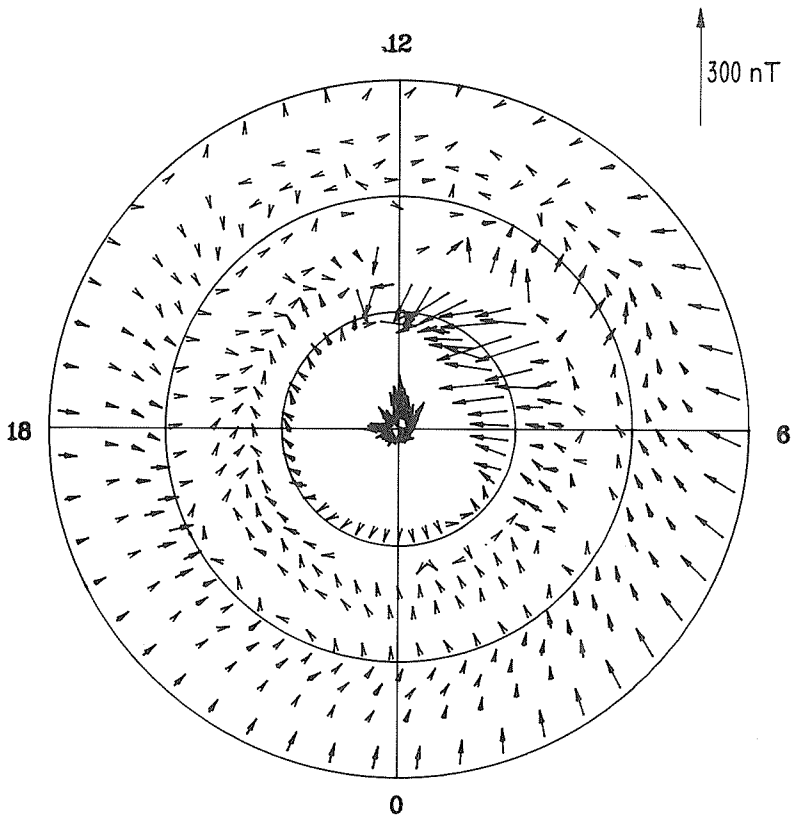

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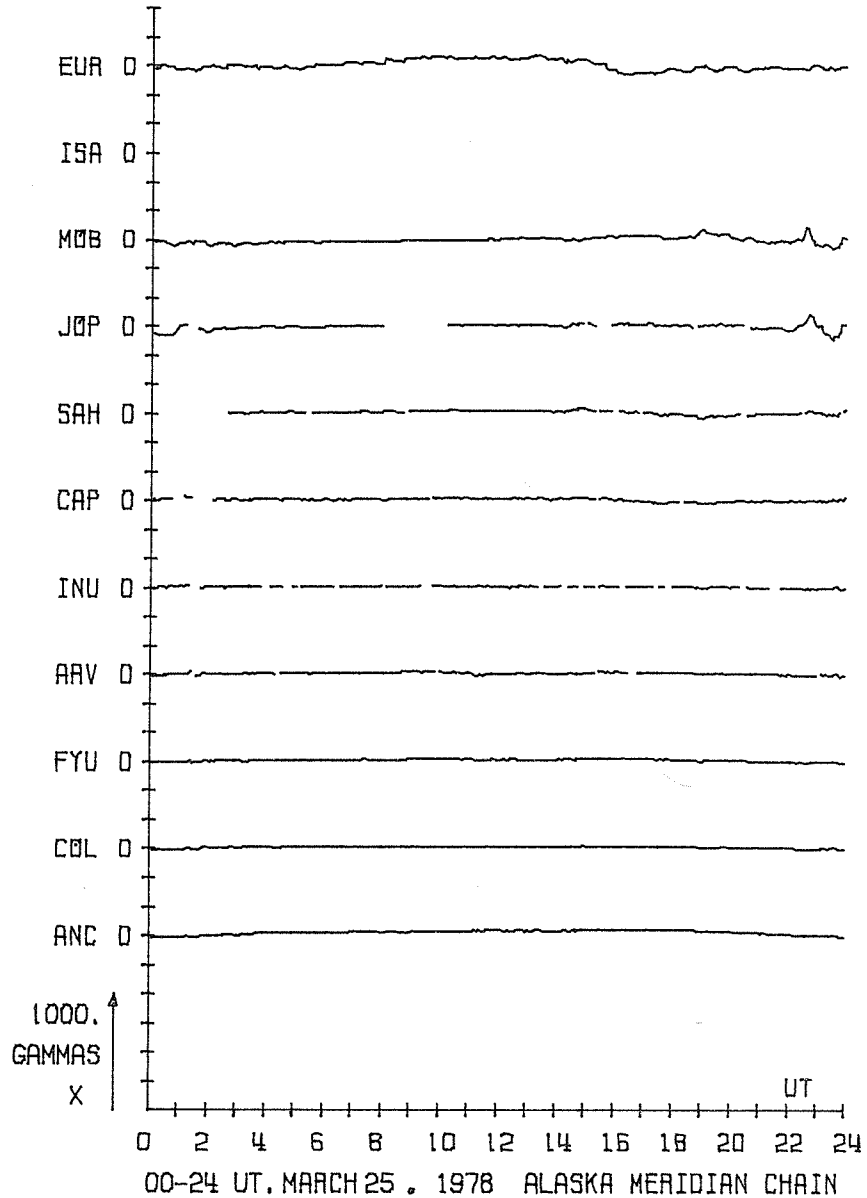
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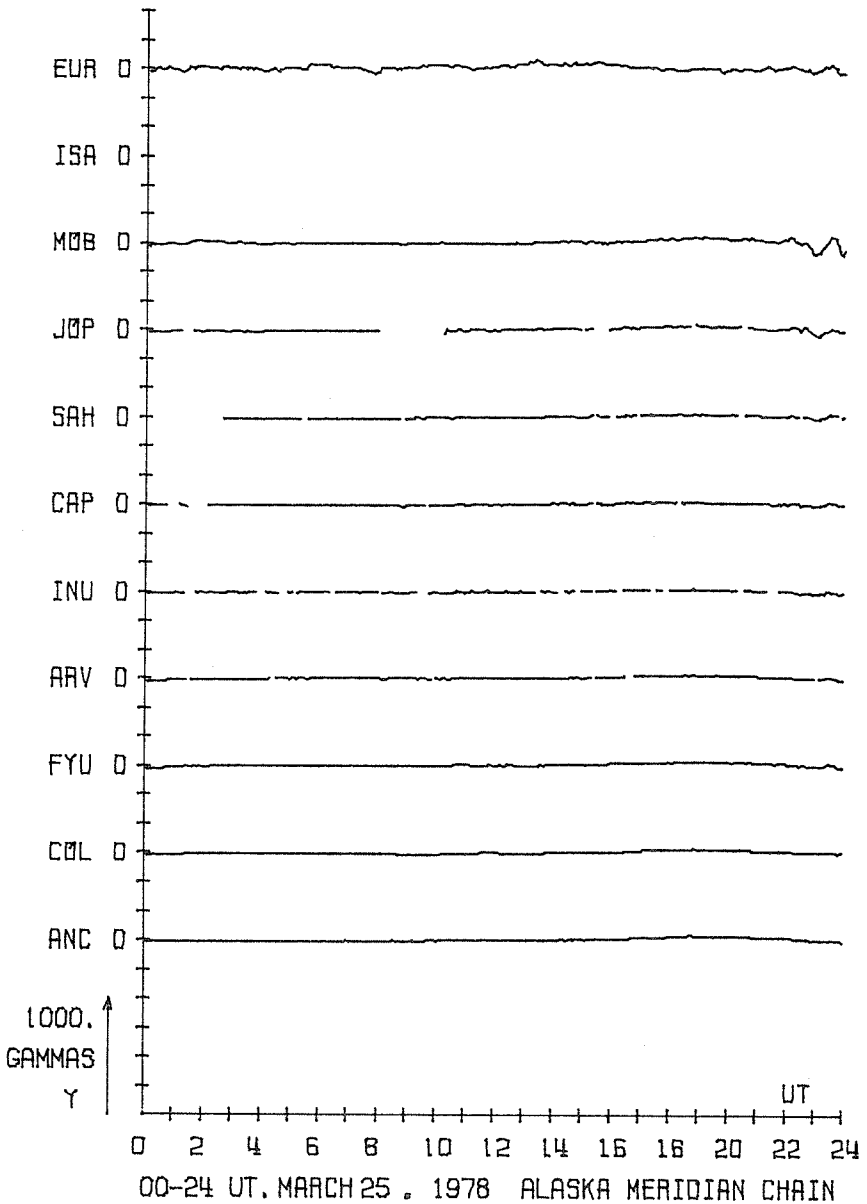
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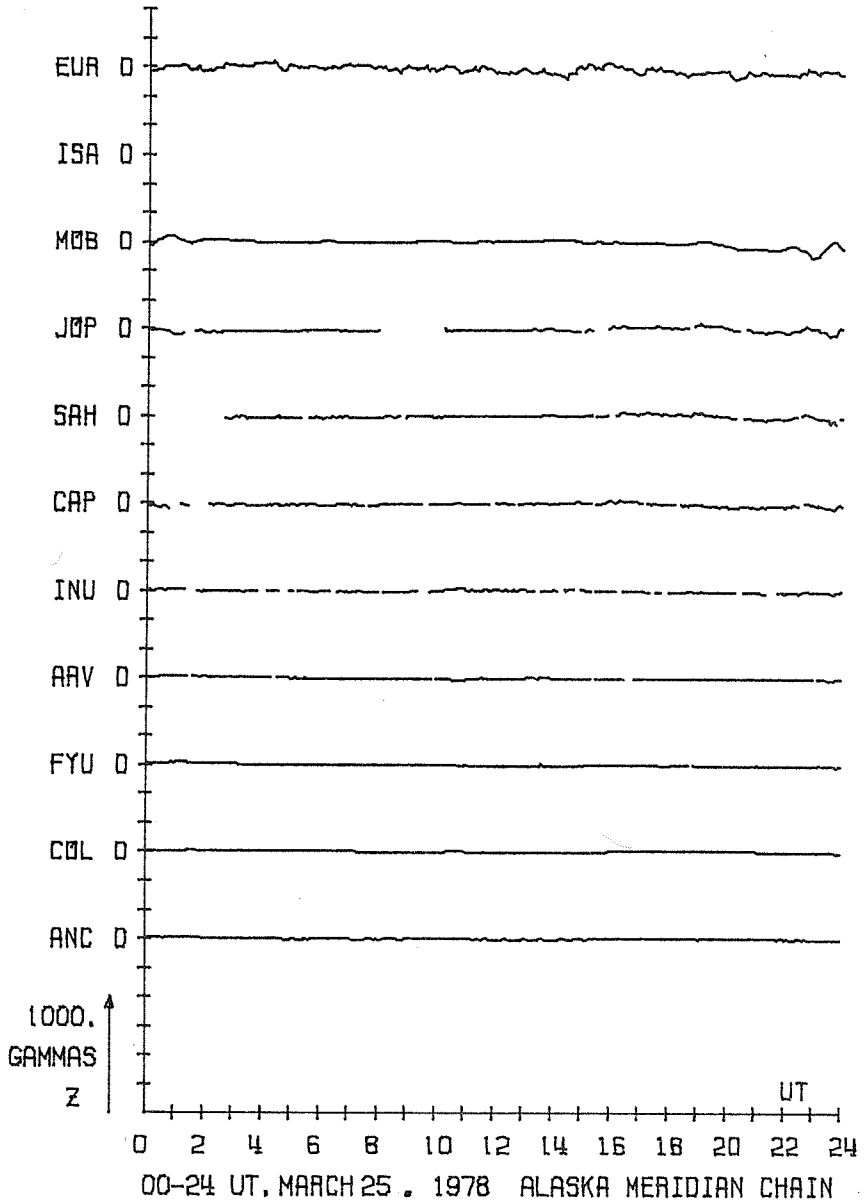

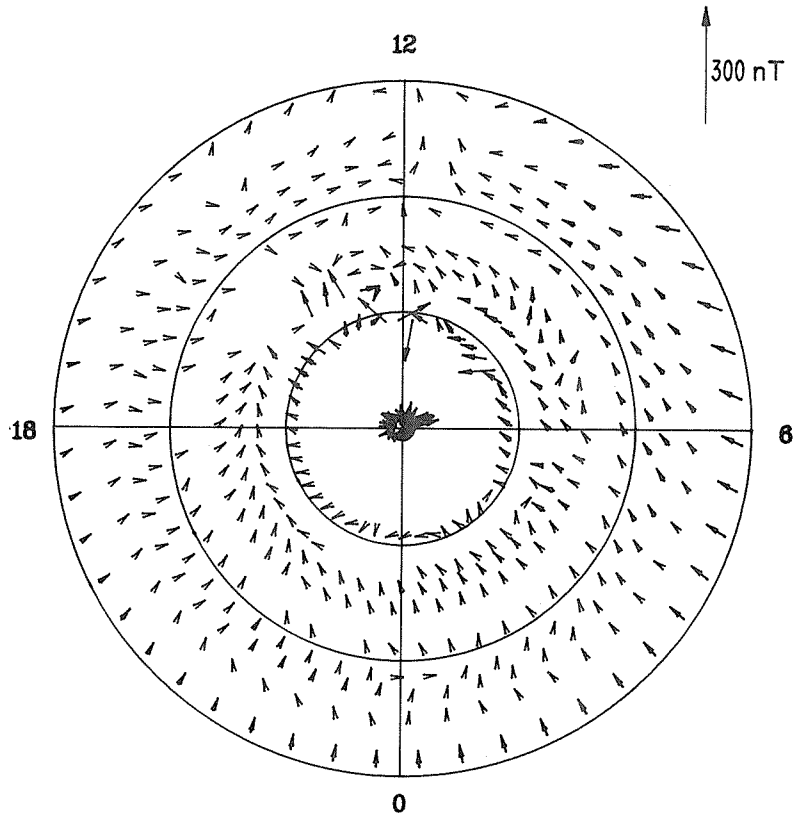

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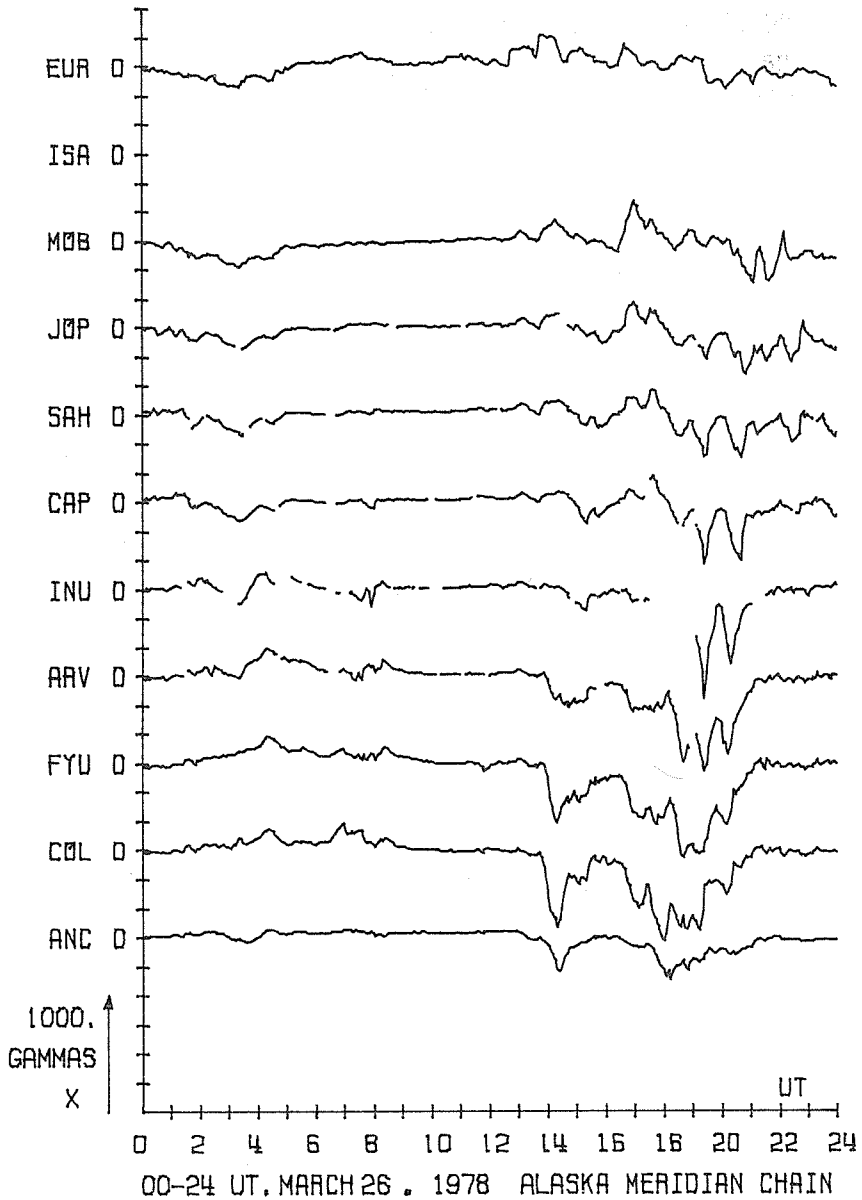
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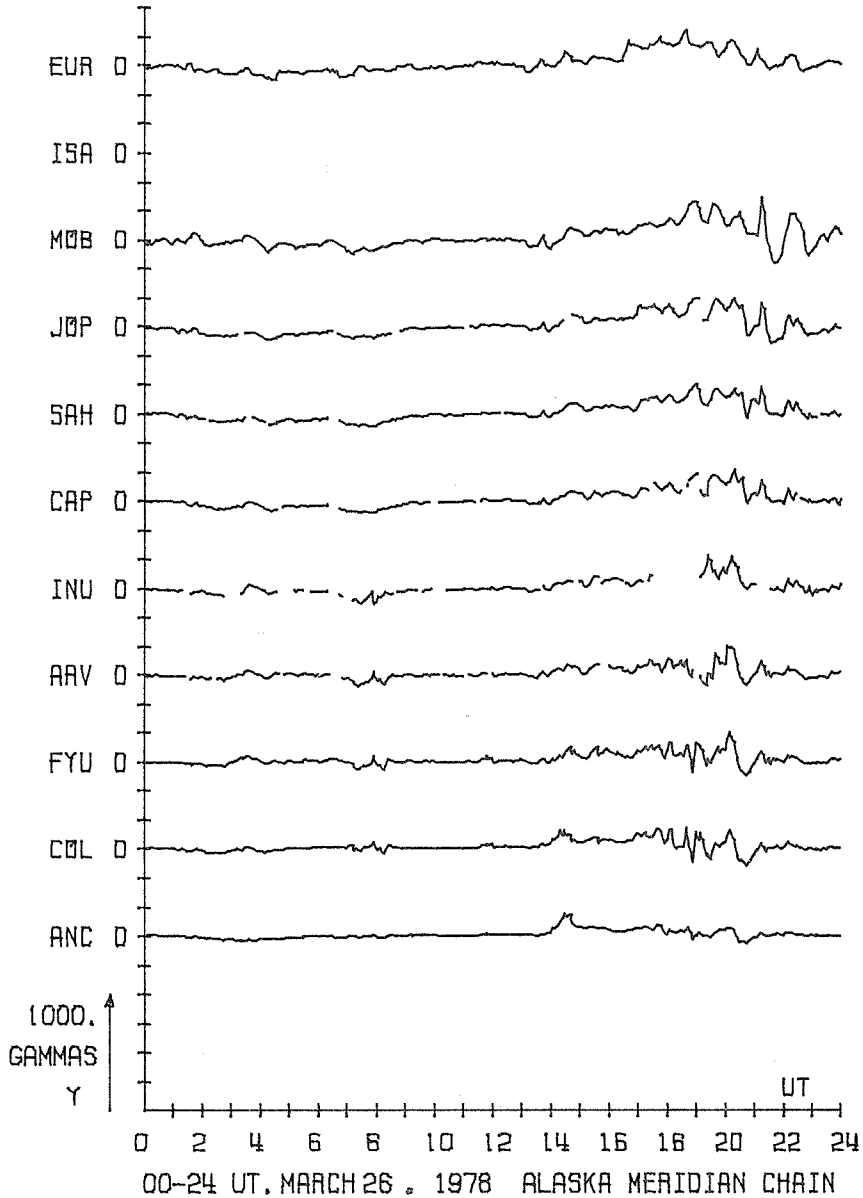
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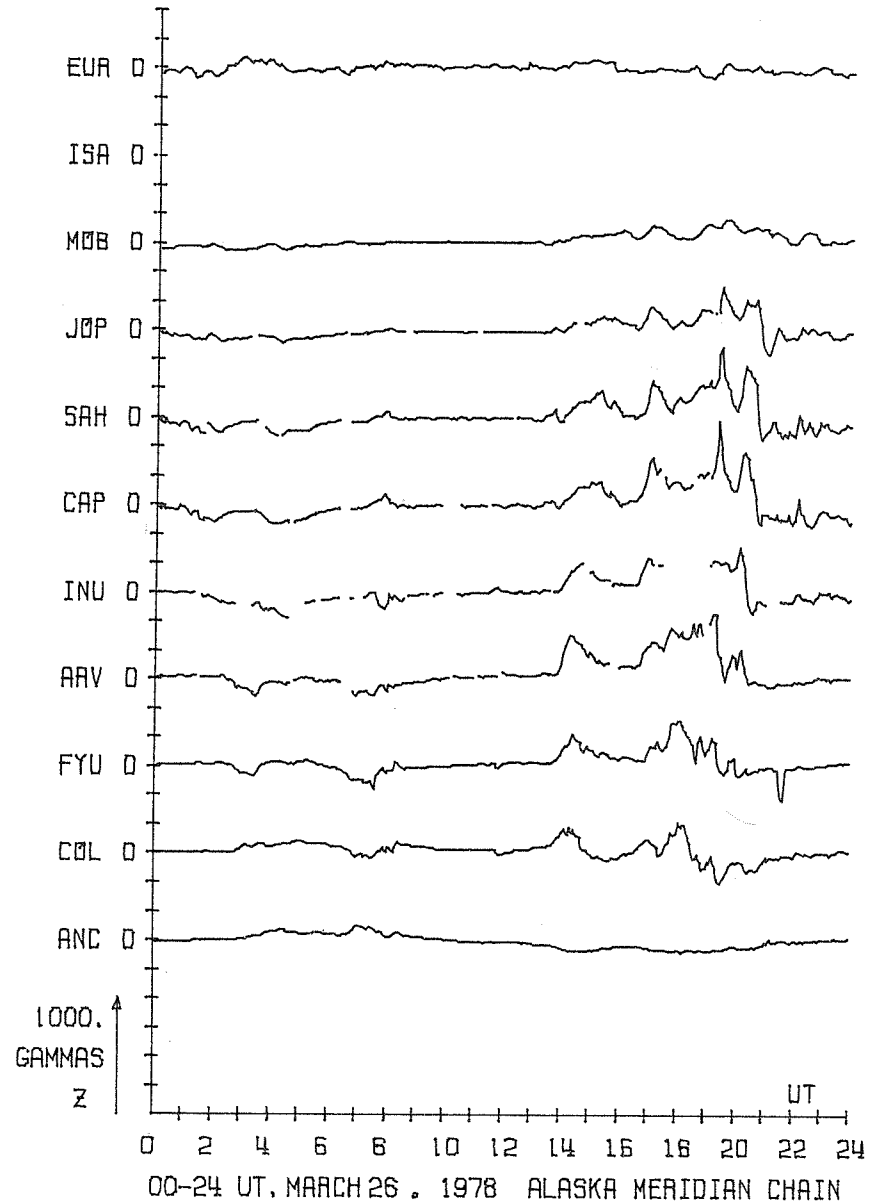

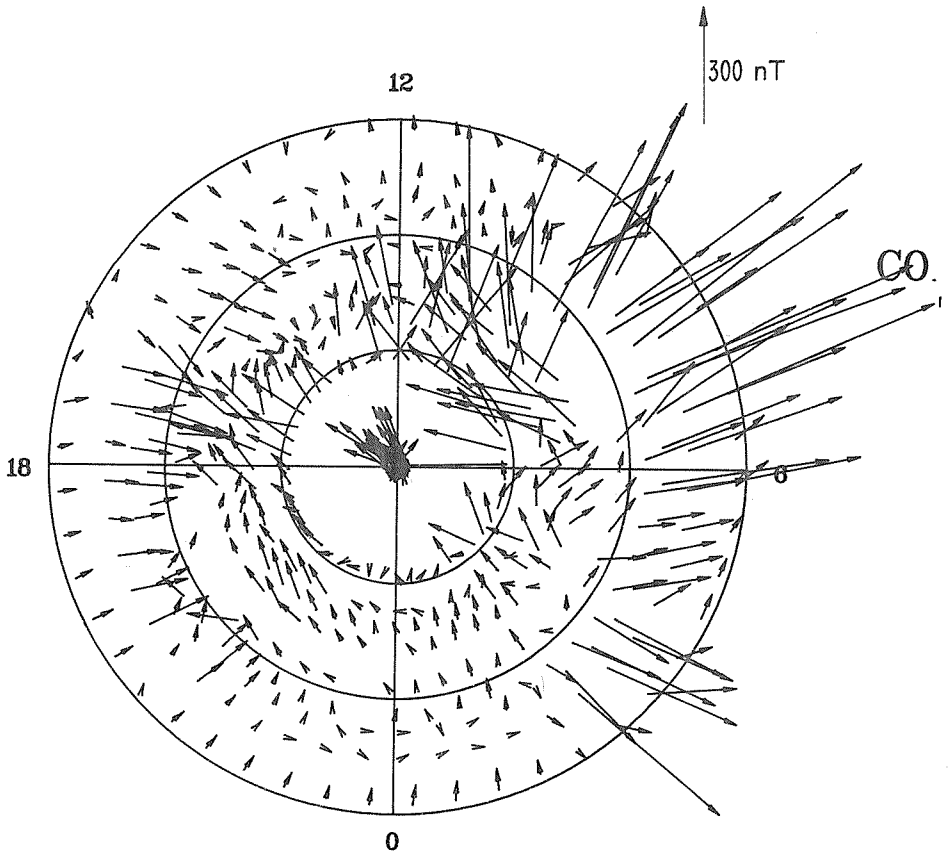

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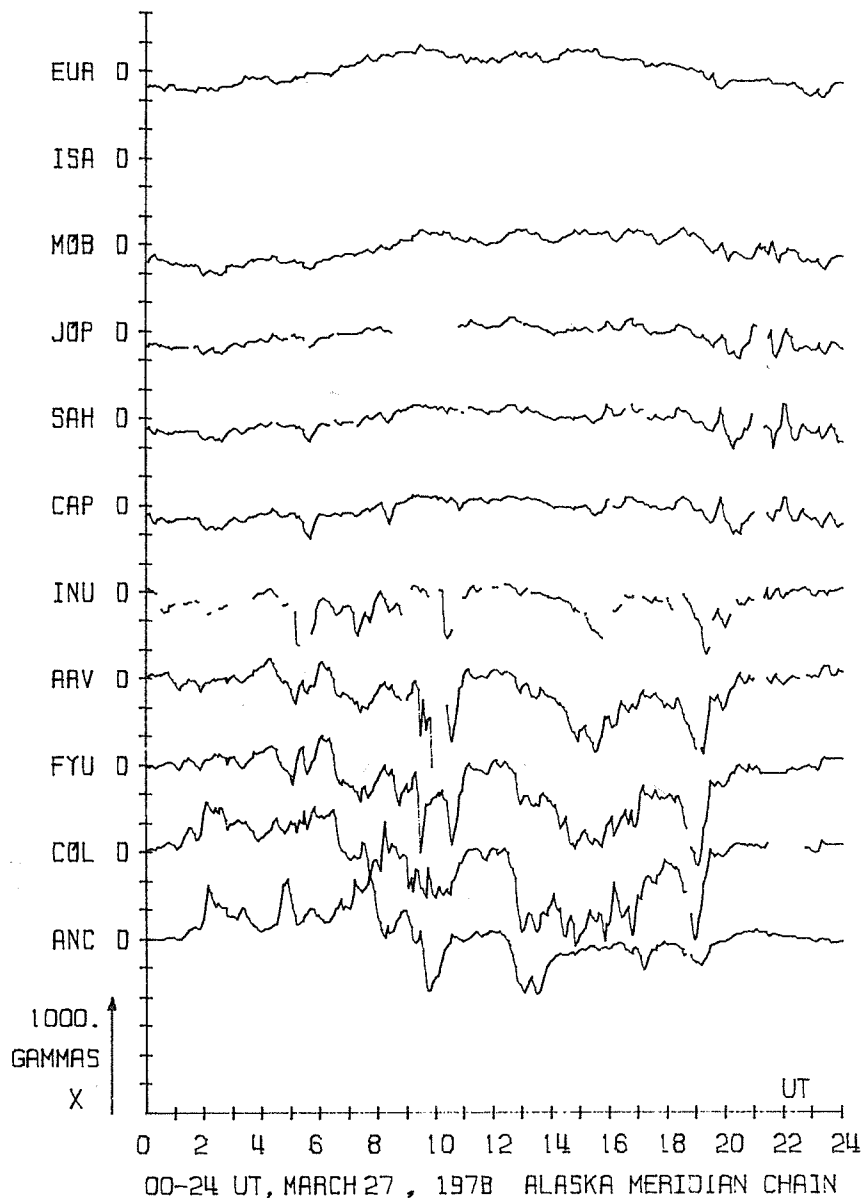
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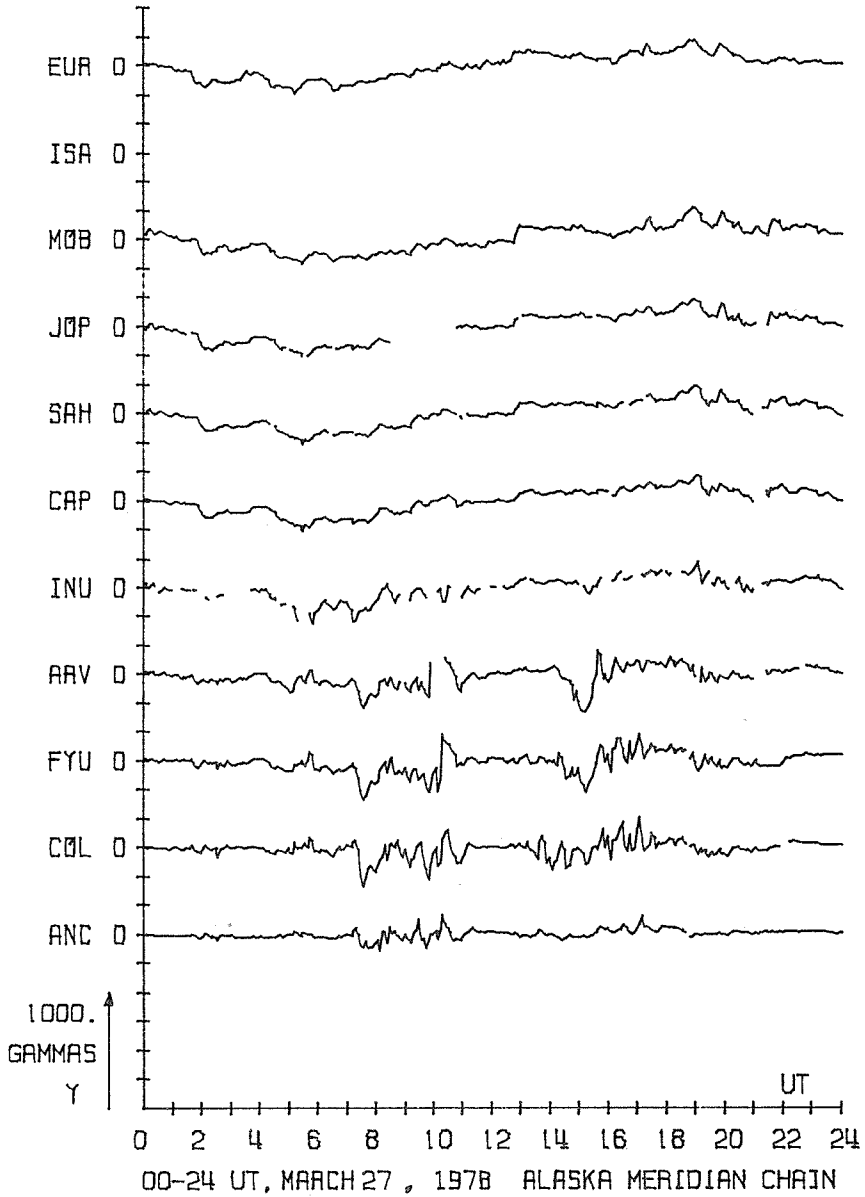
00-24 UT, MARCH 27 , 1978 ALASKA MERIDIAN CHAIN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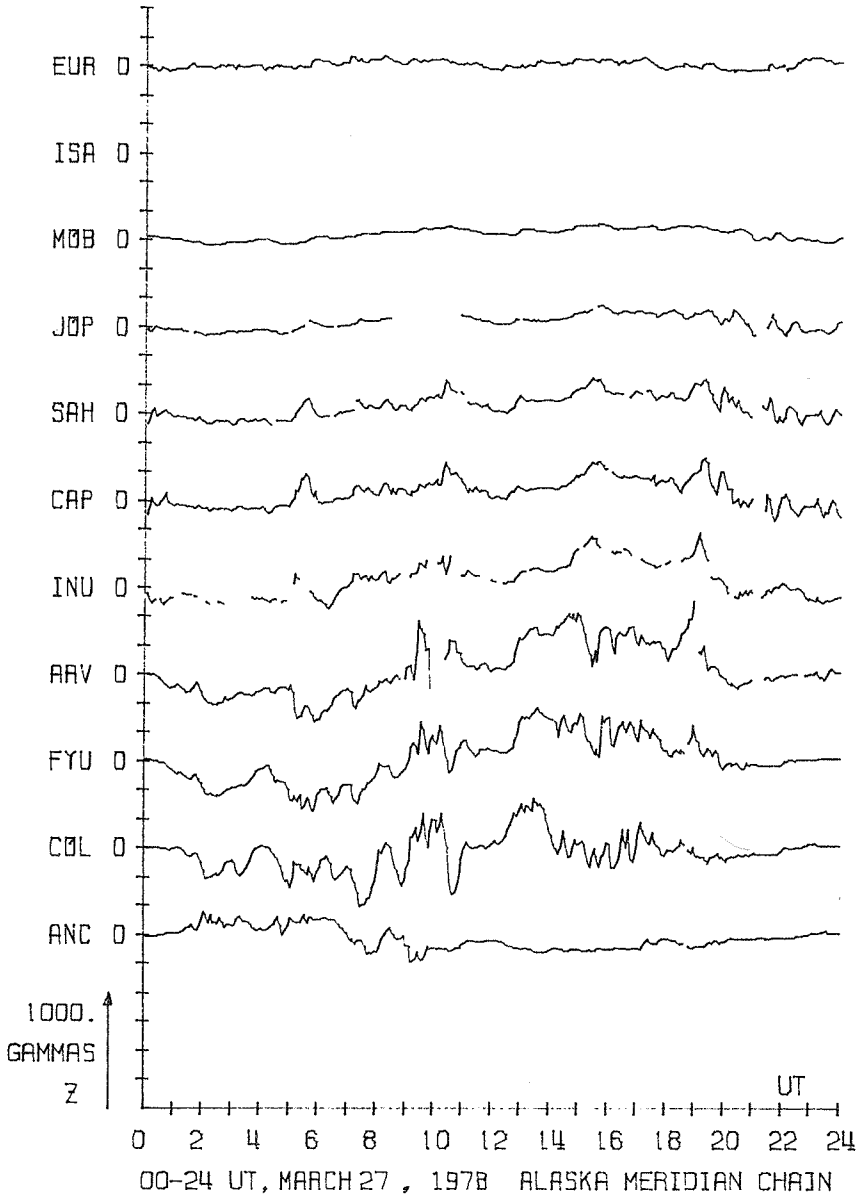

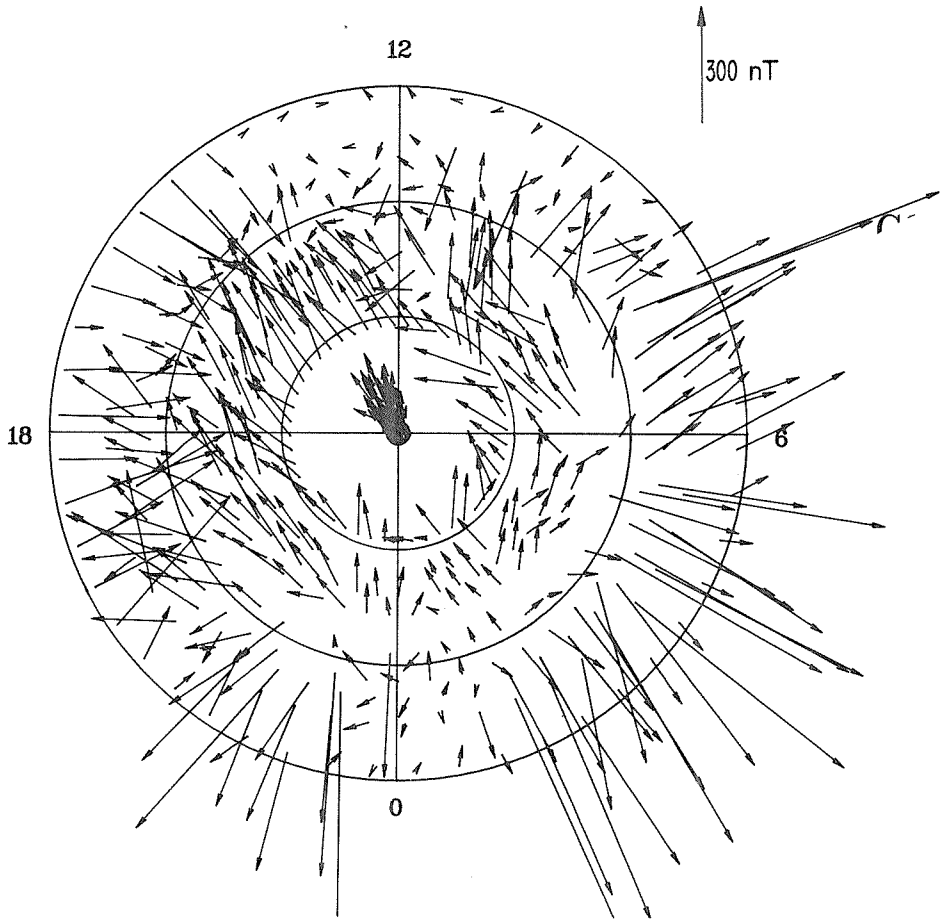

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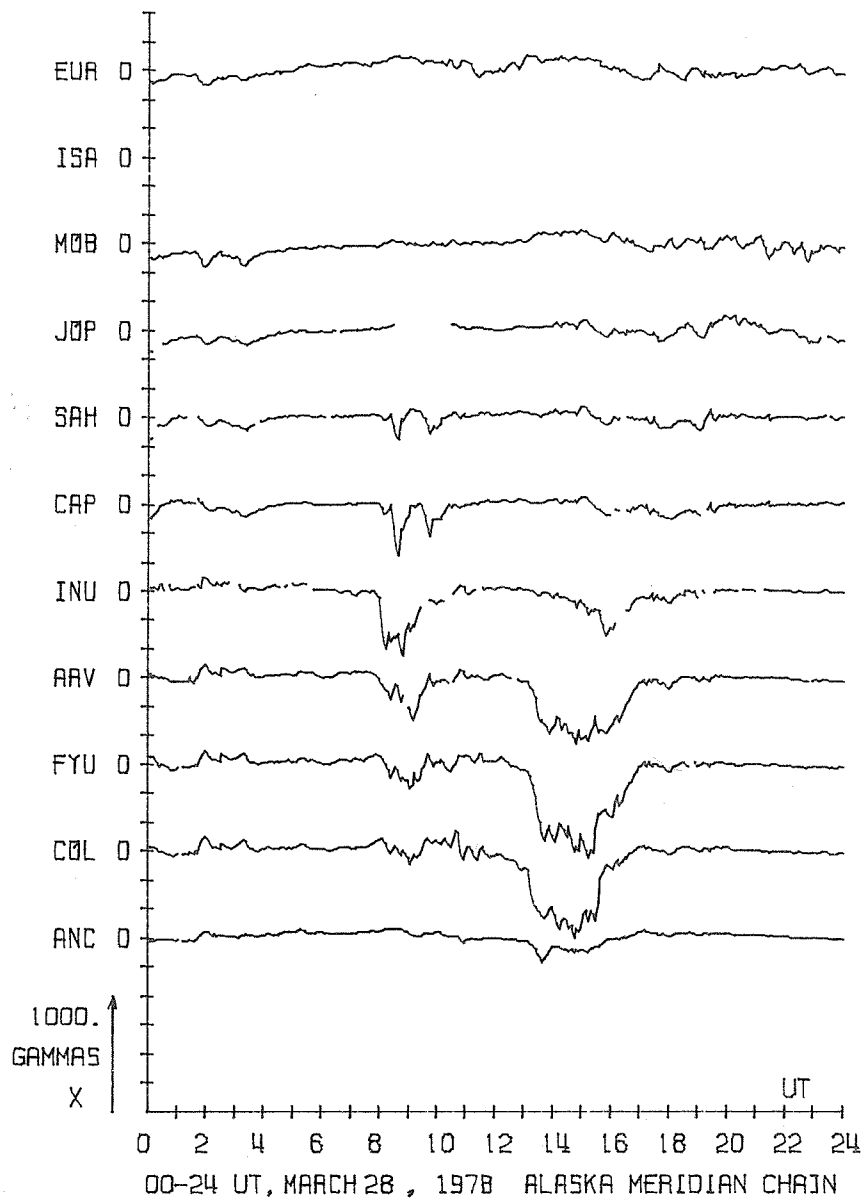
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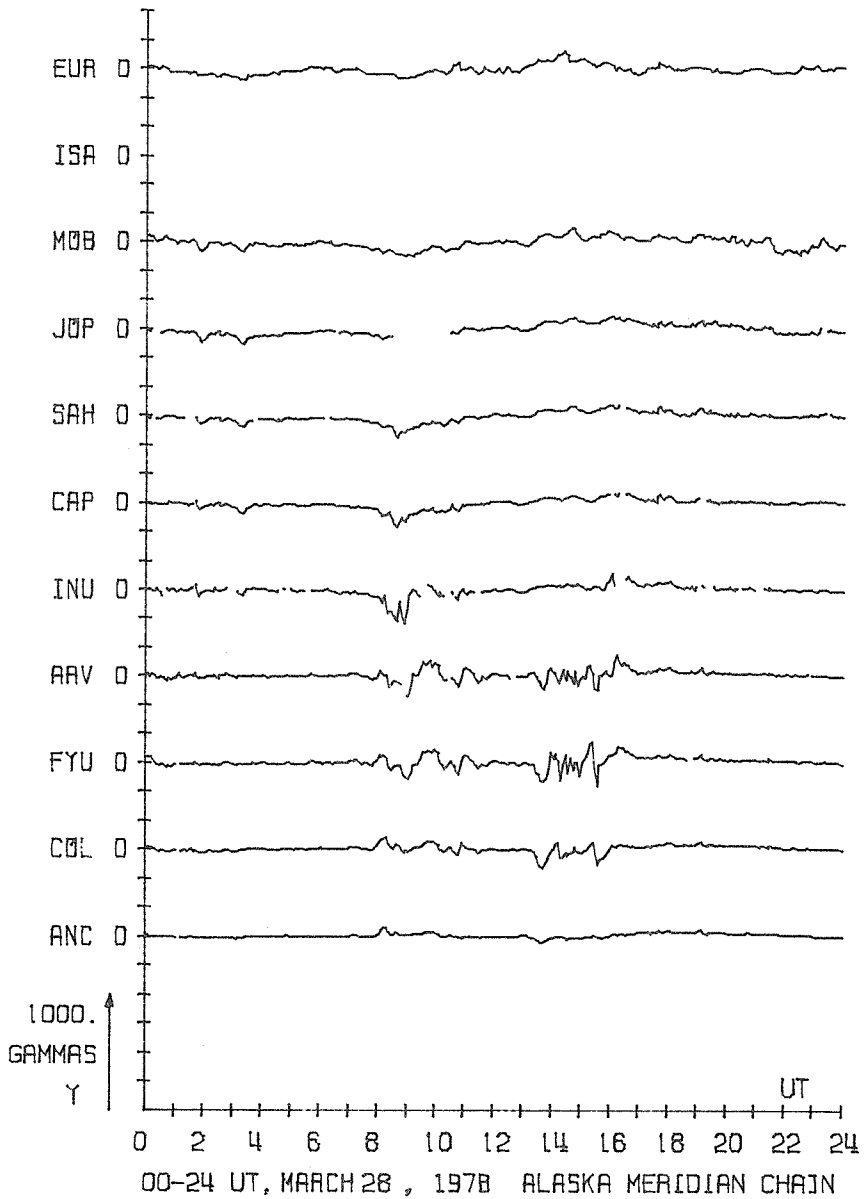
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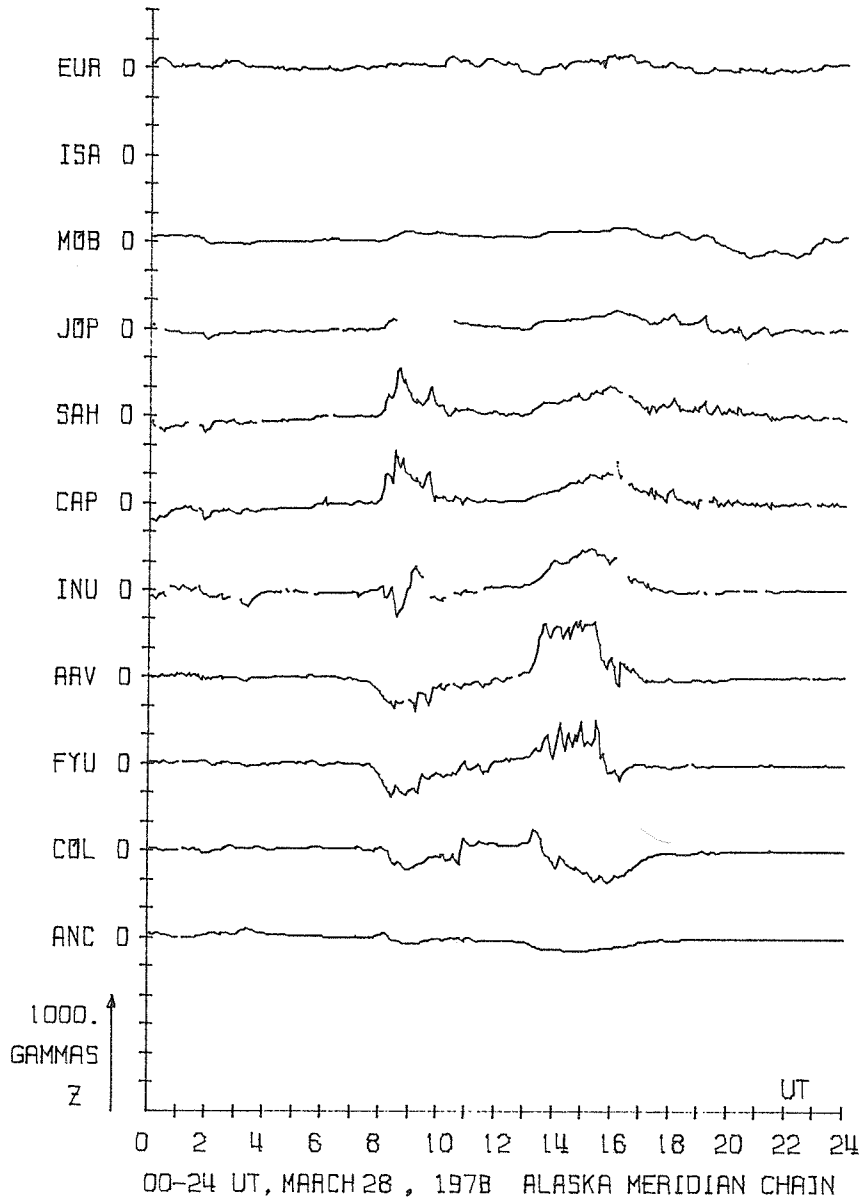

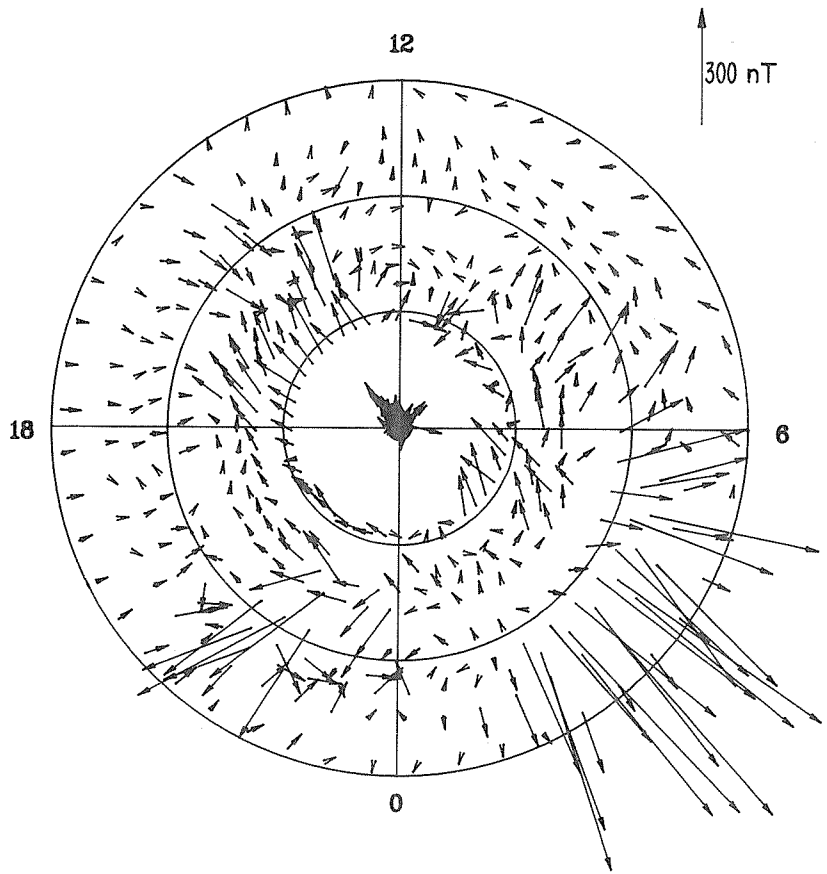

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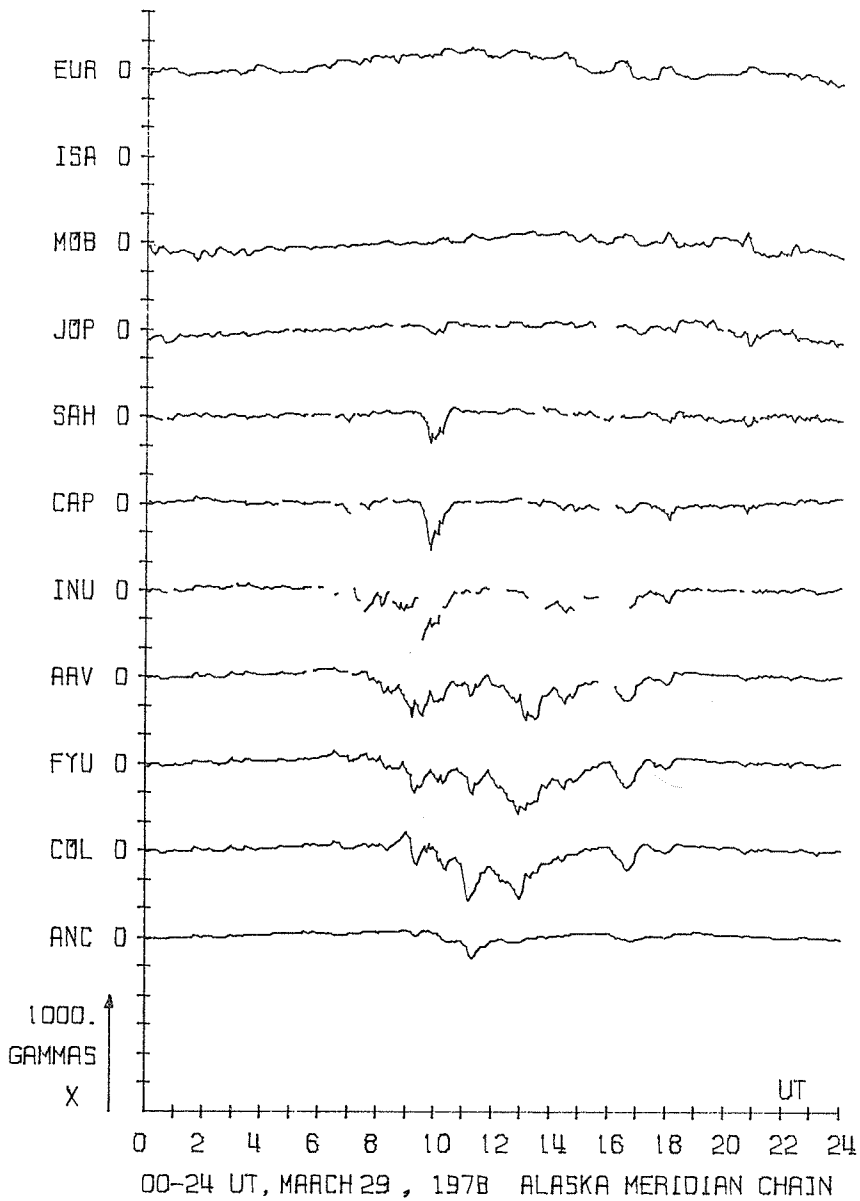
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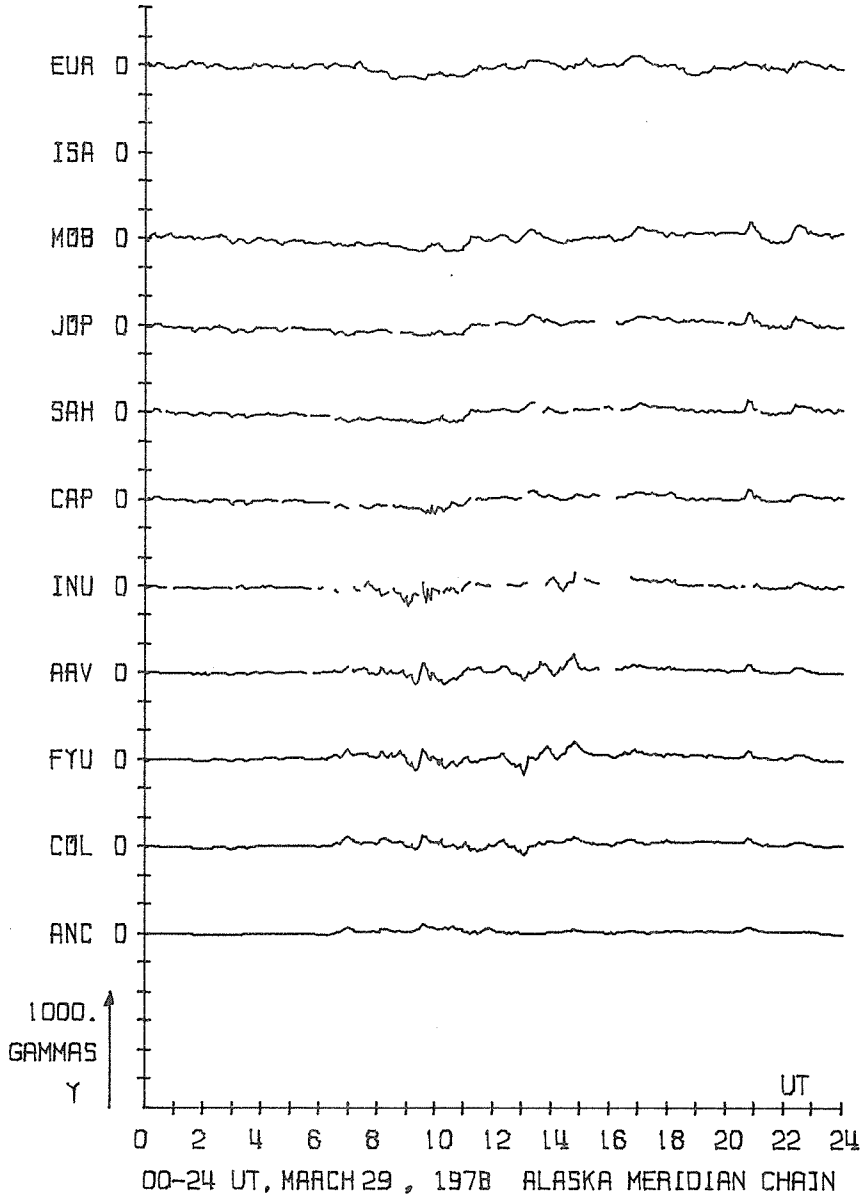
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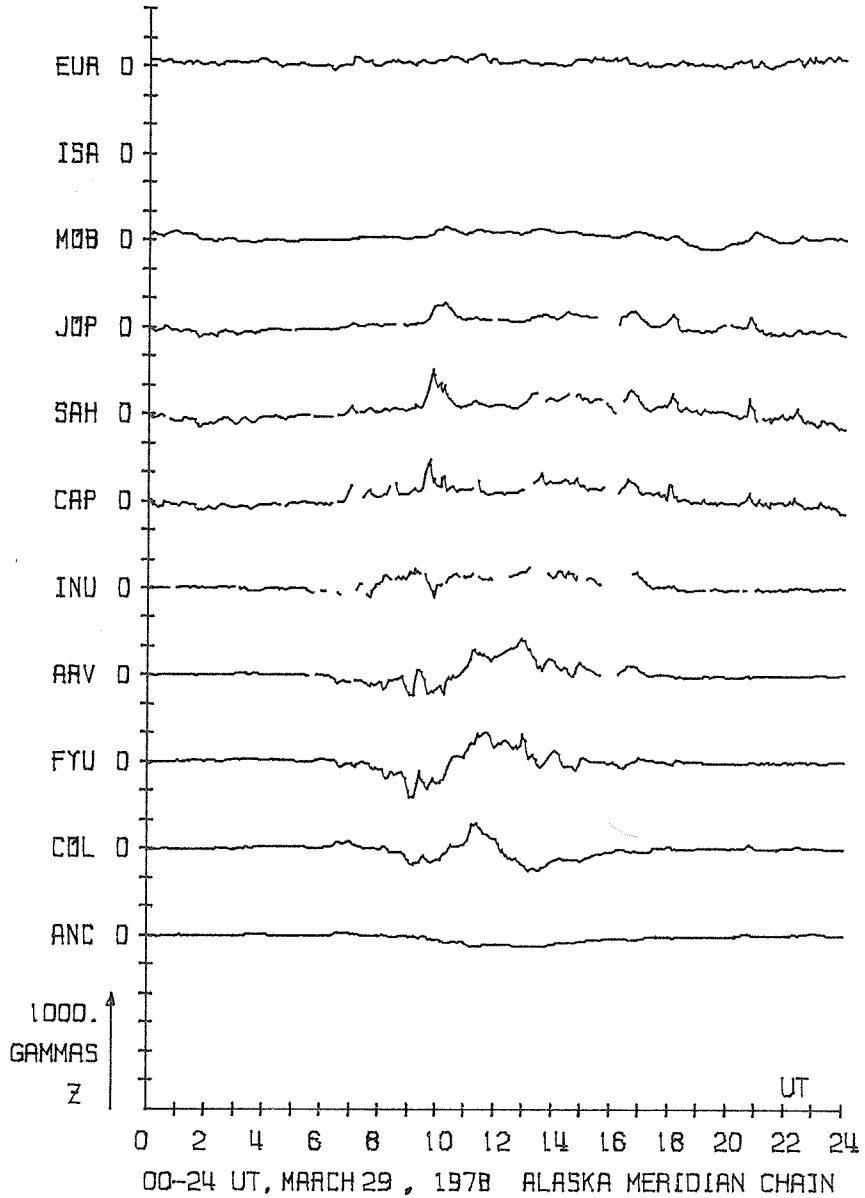

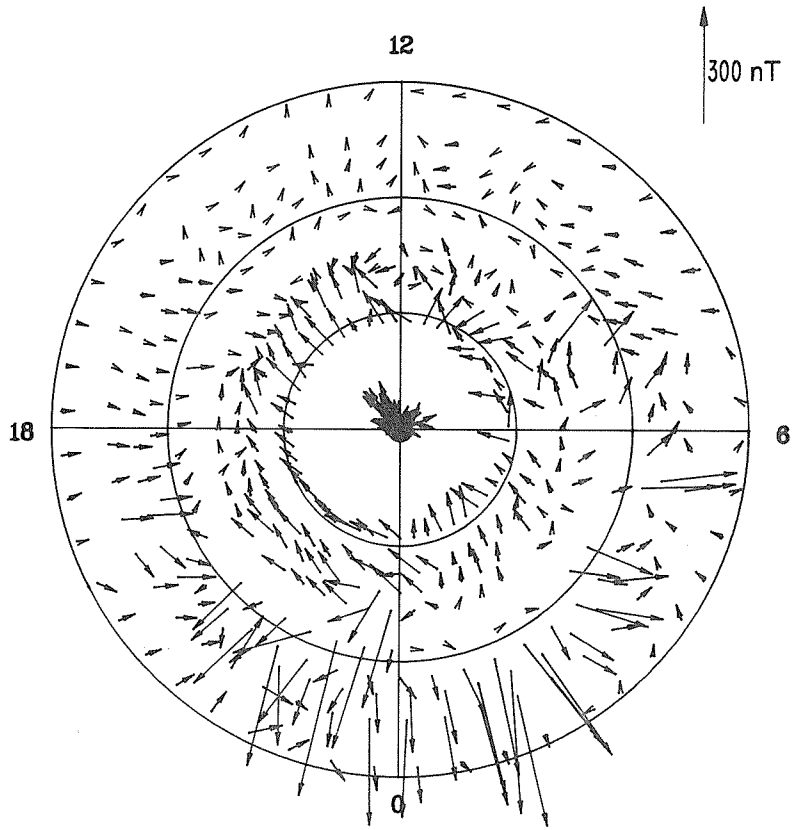

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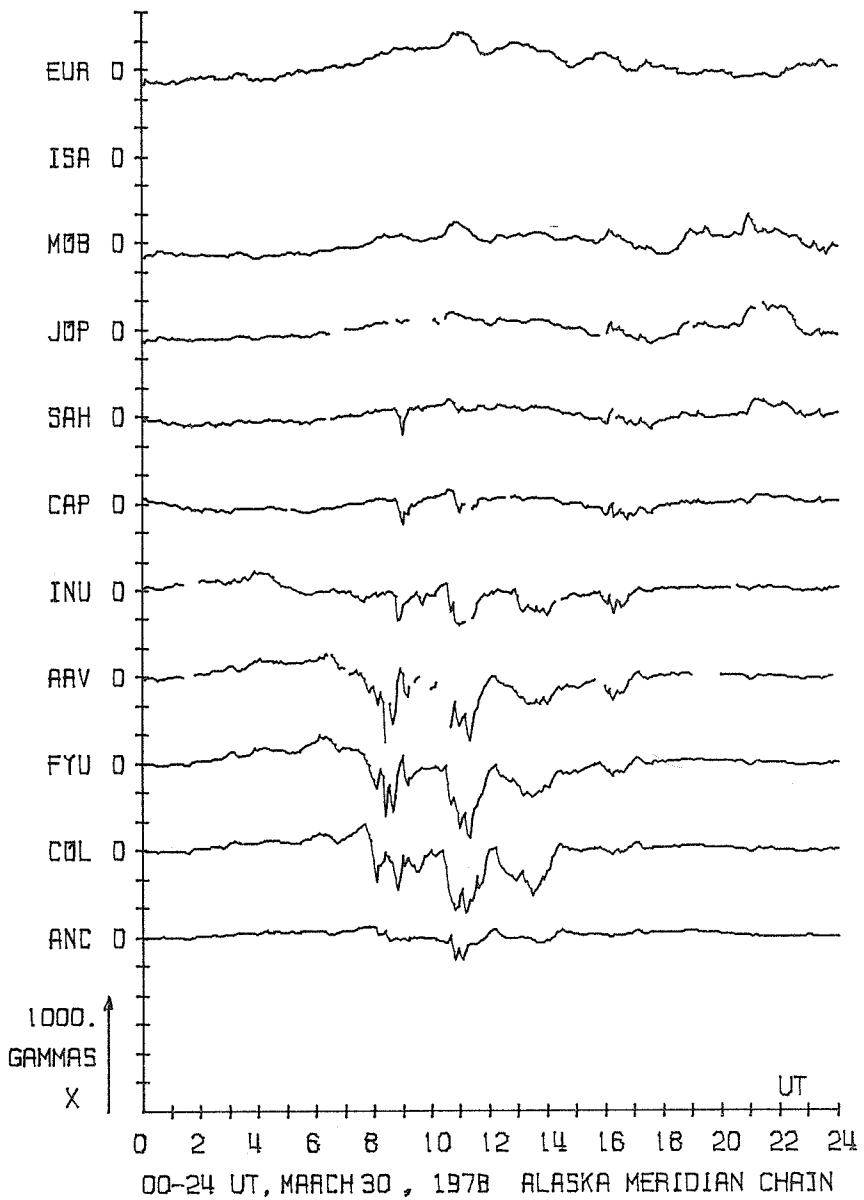
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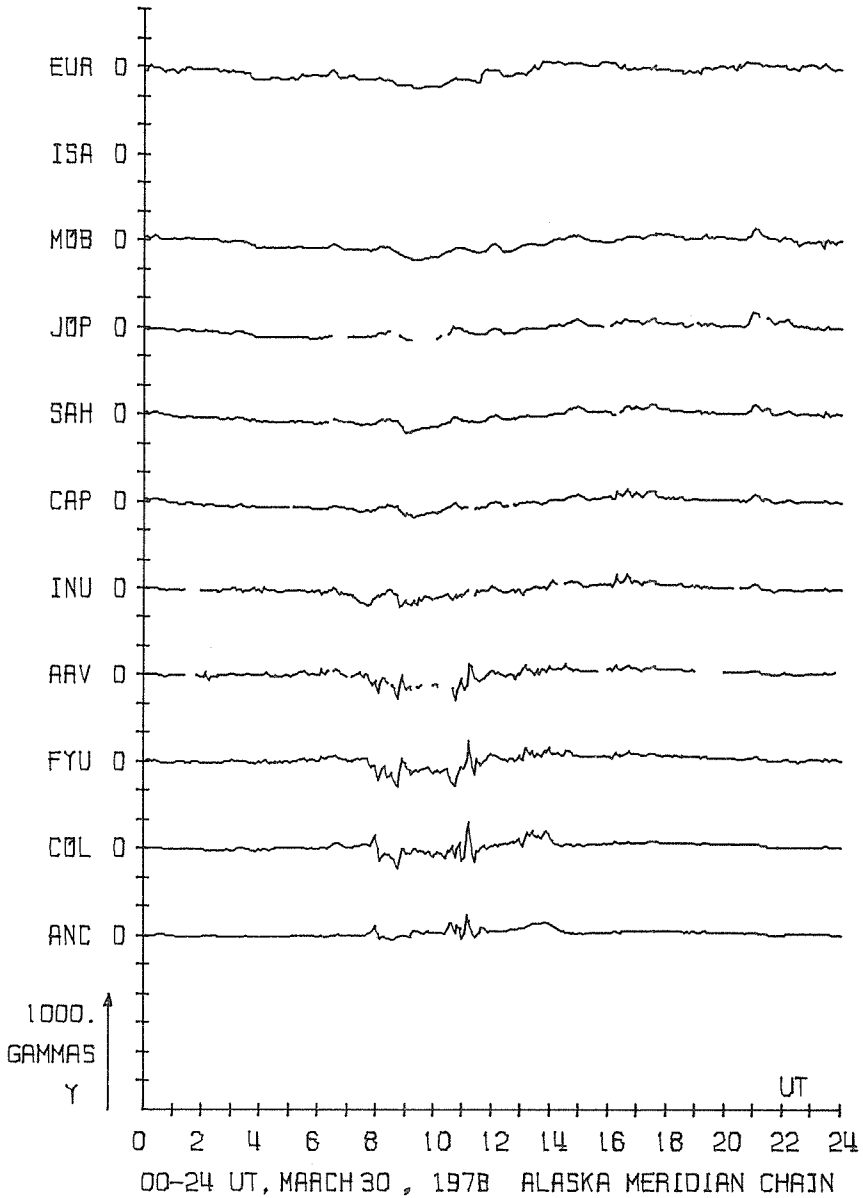
00-24 UT, MARCH 30 , 1978 ALASKA MERIDIAN CHAIN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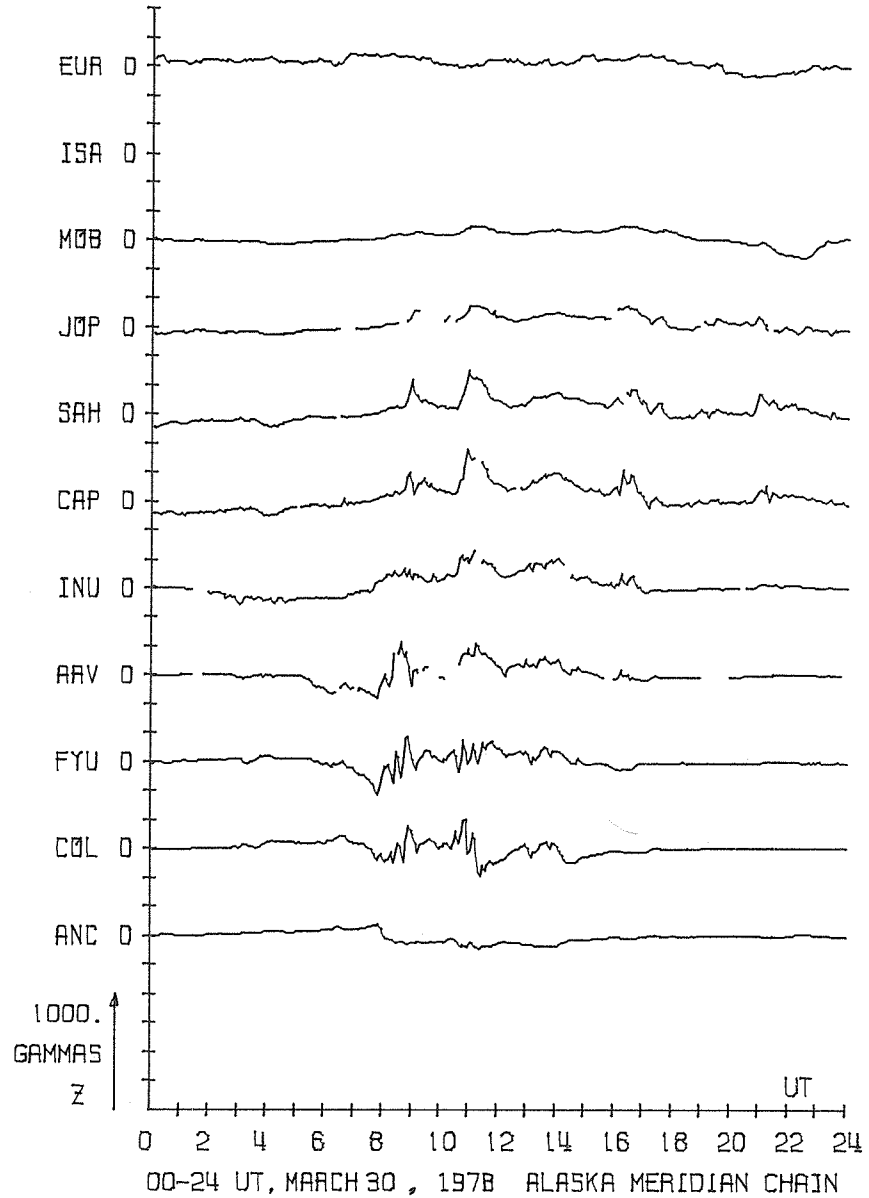

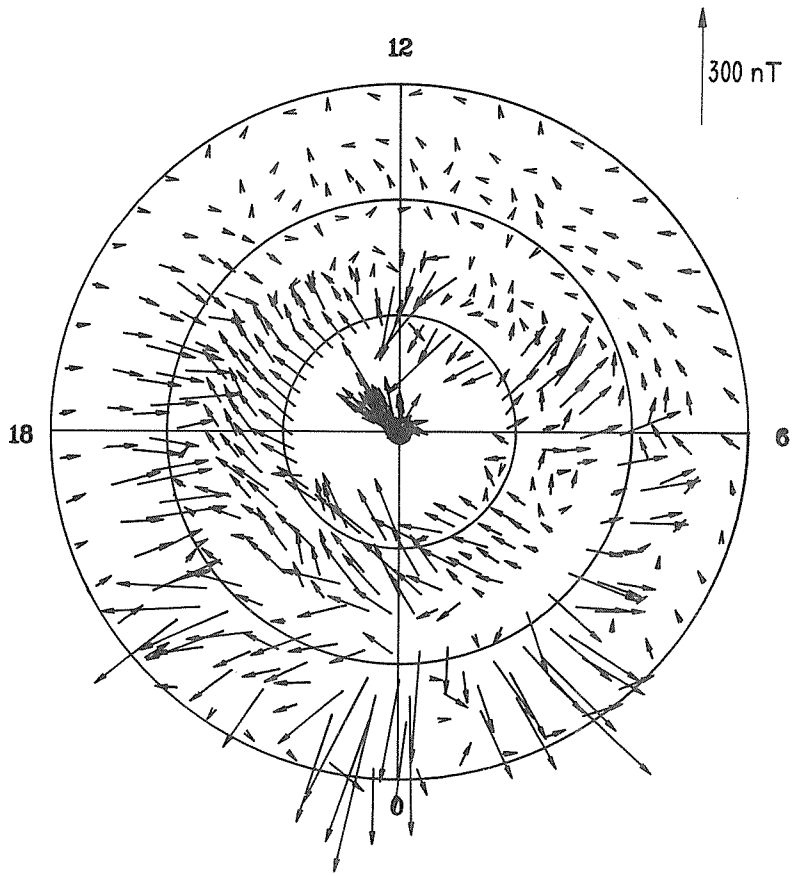

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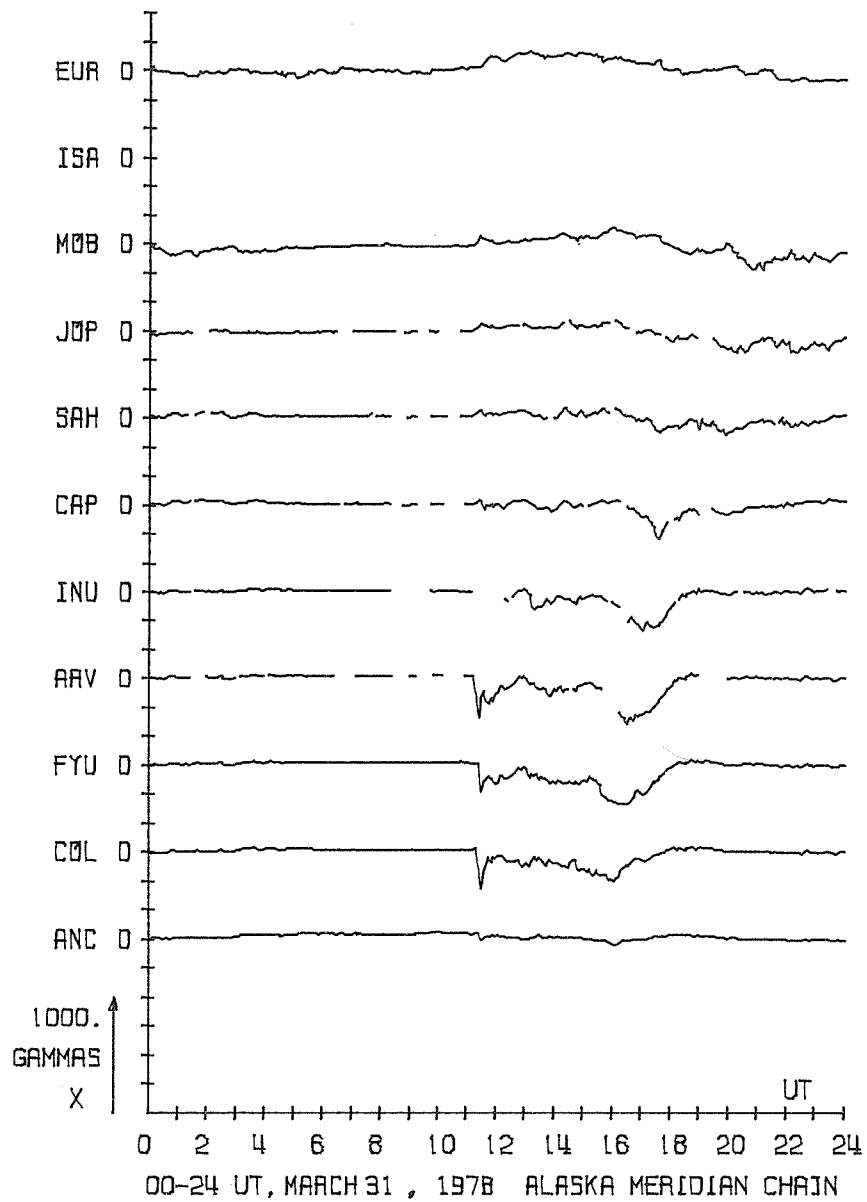
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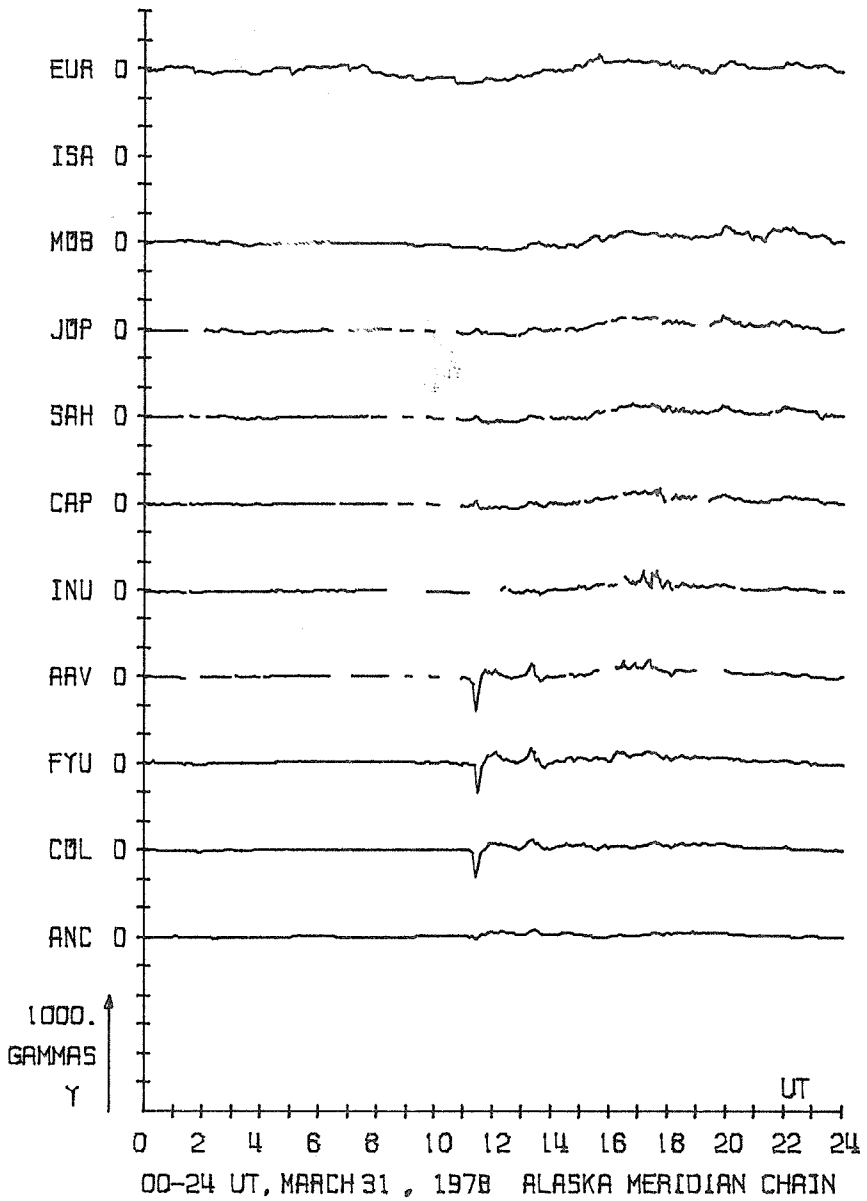
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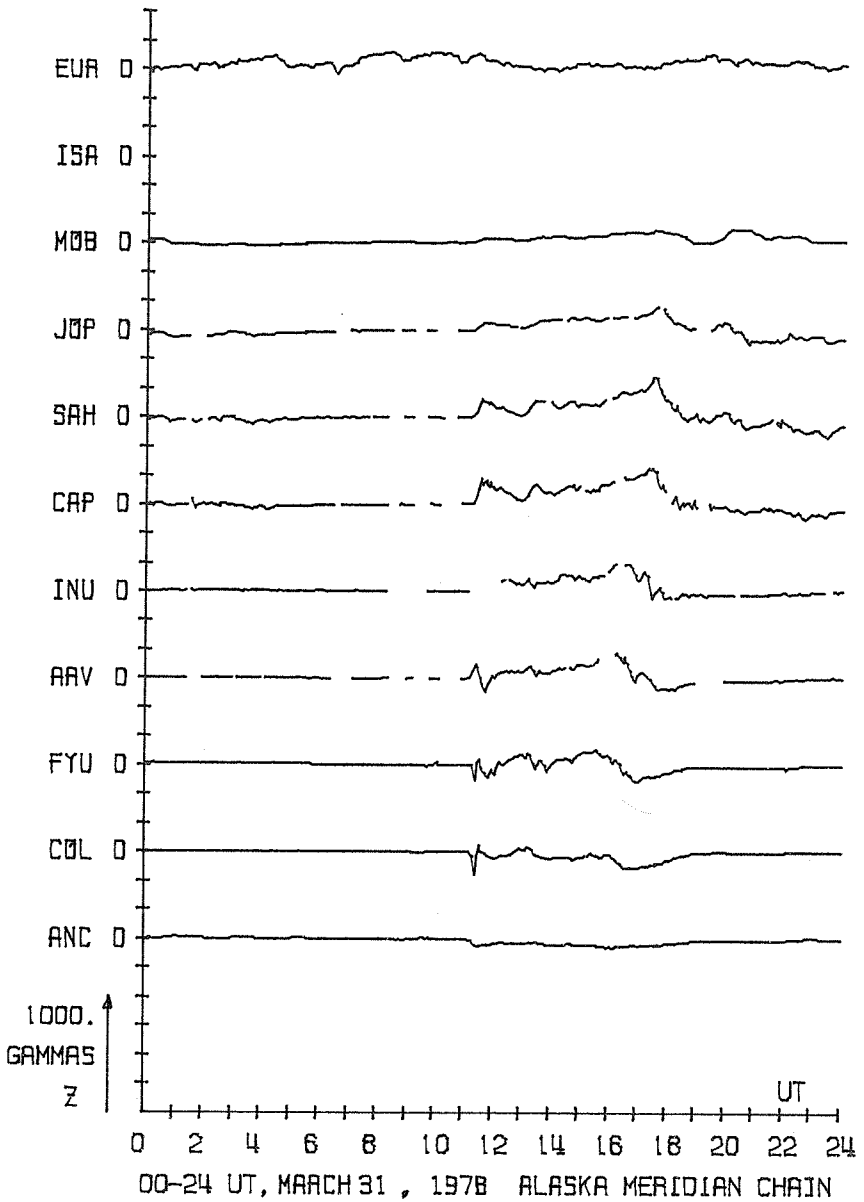

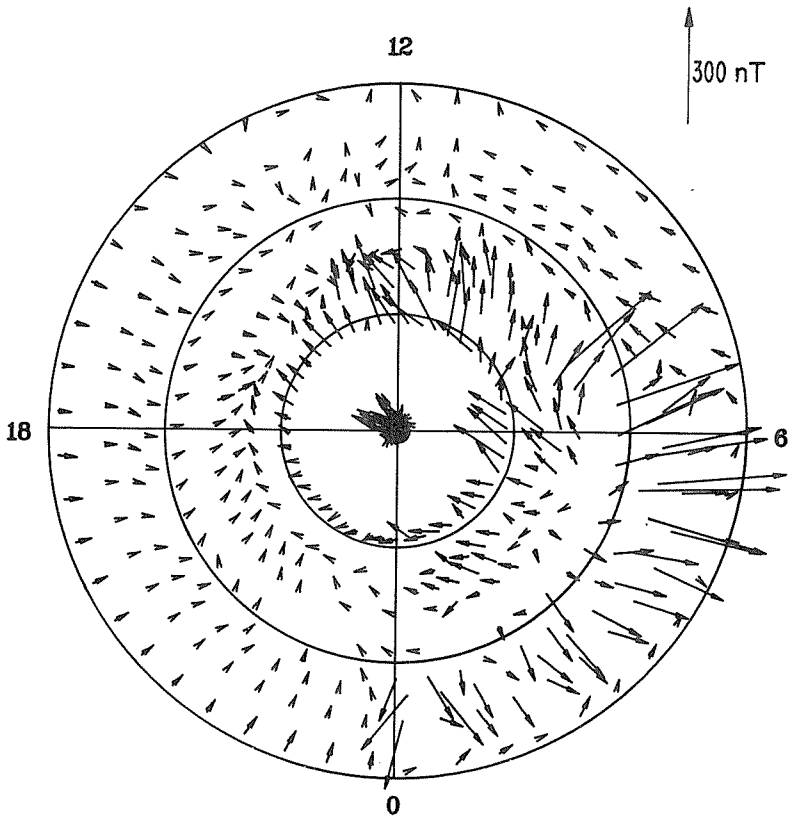

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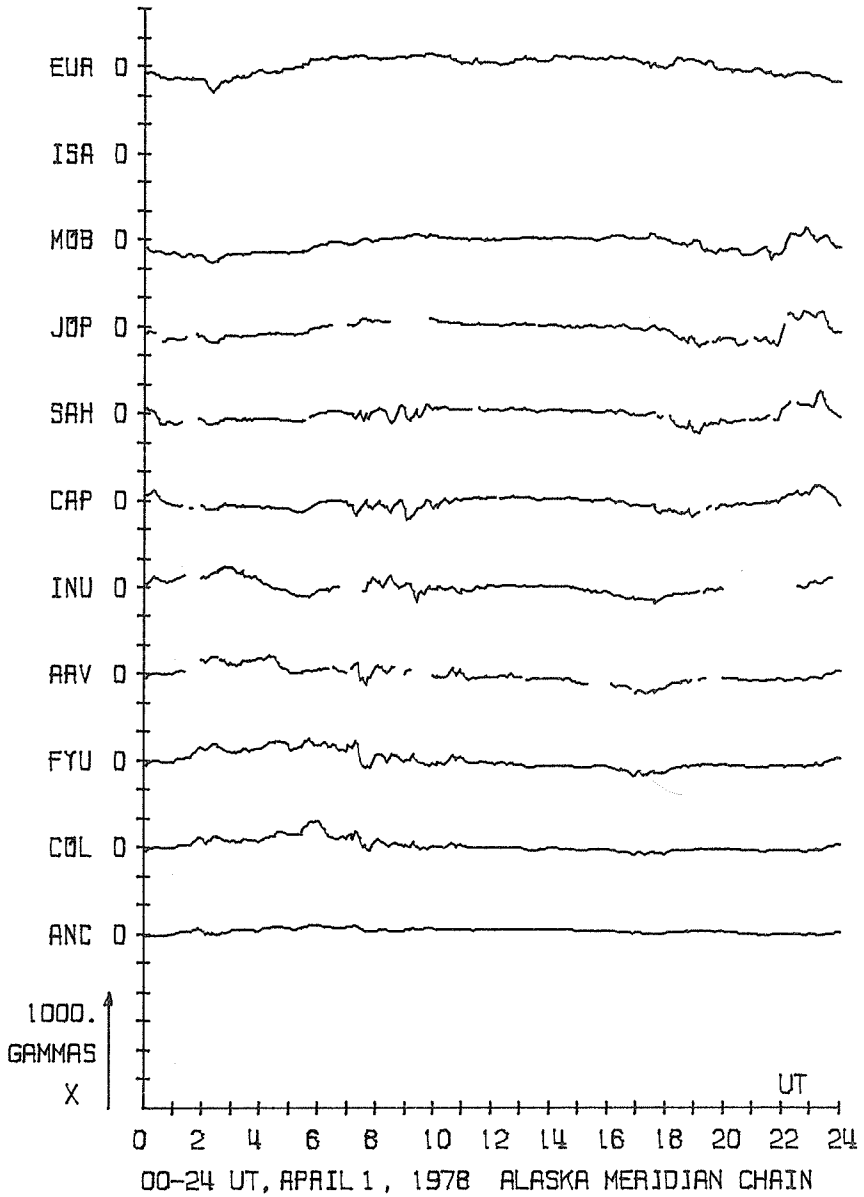
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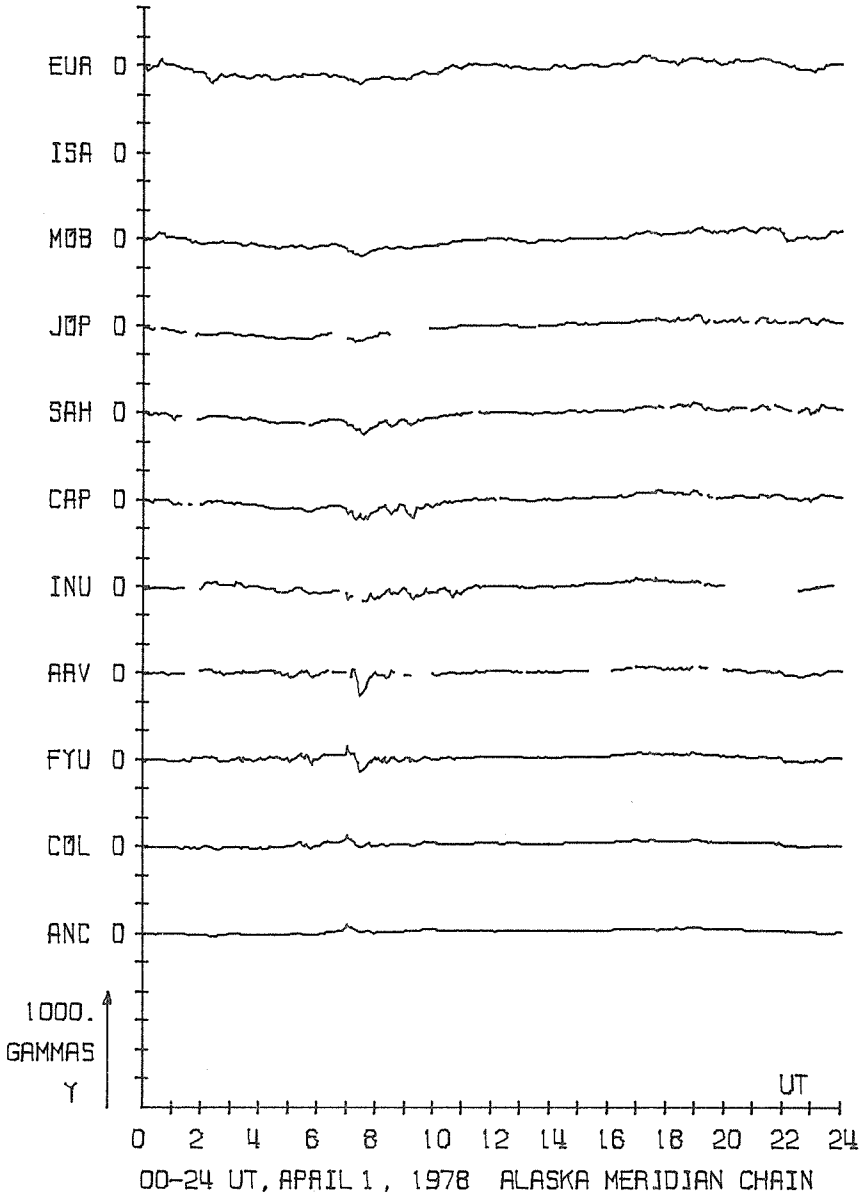
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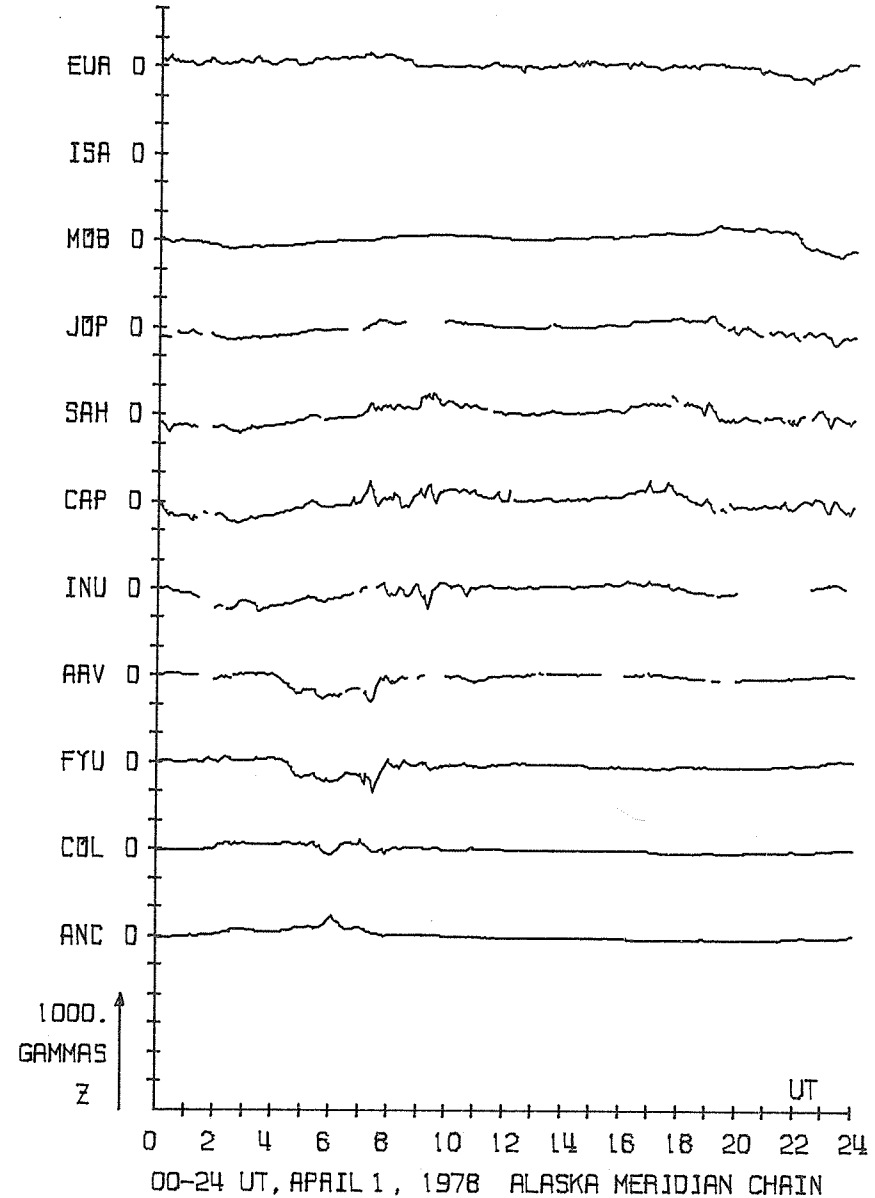

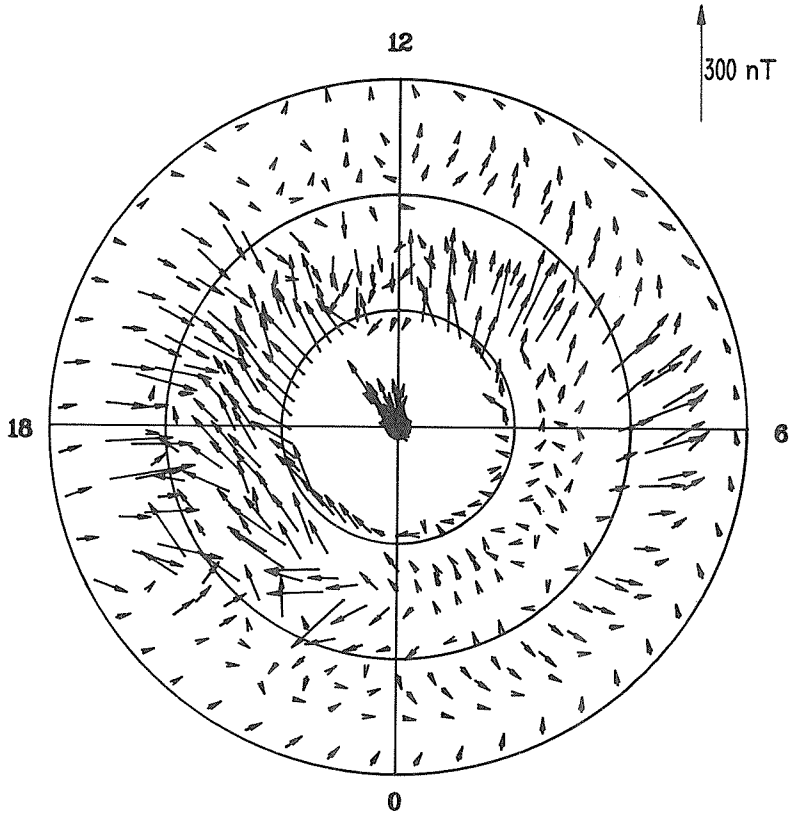

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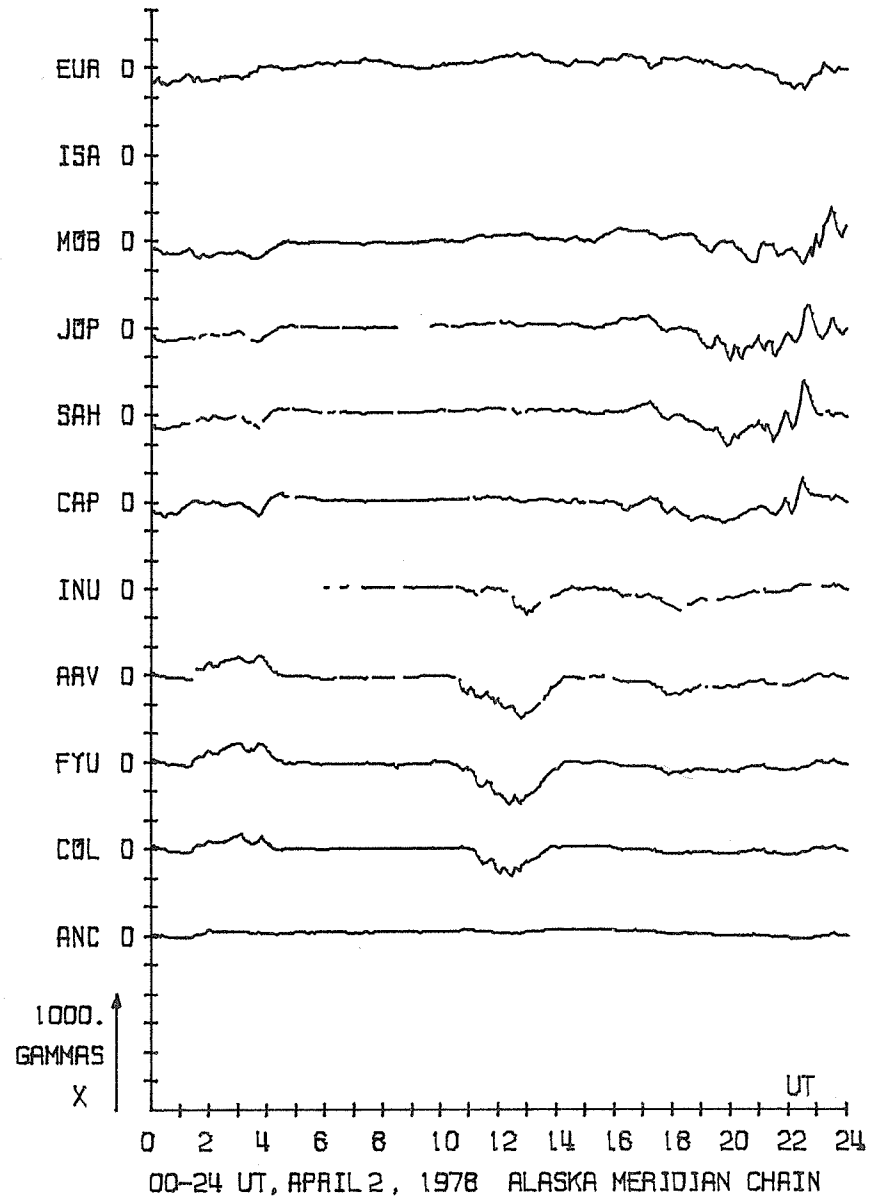
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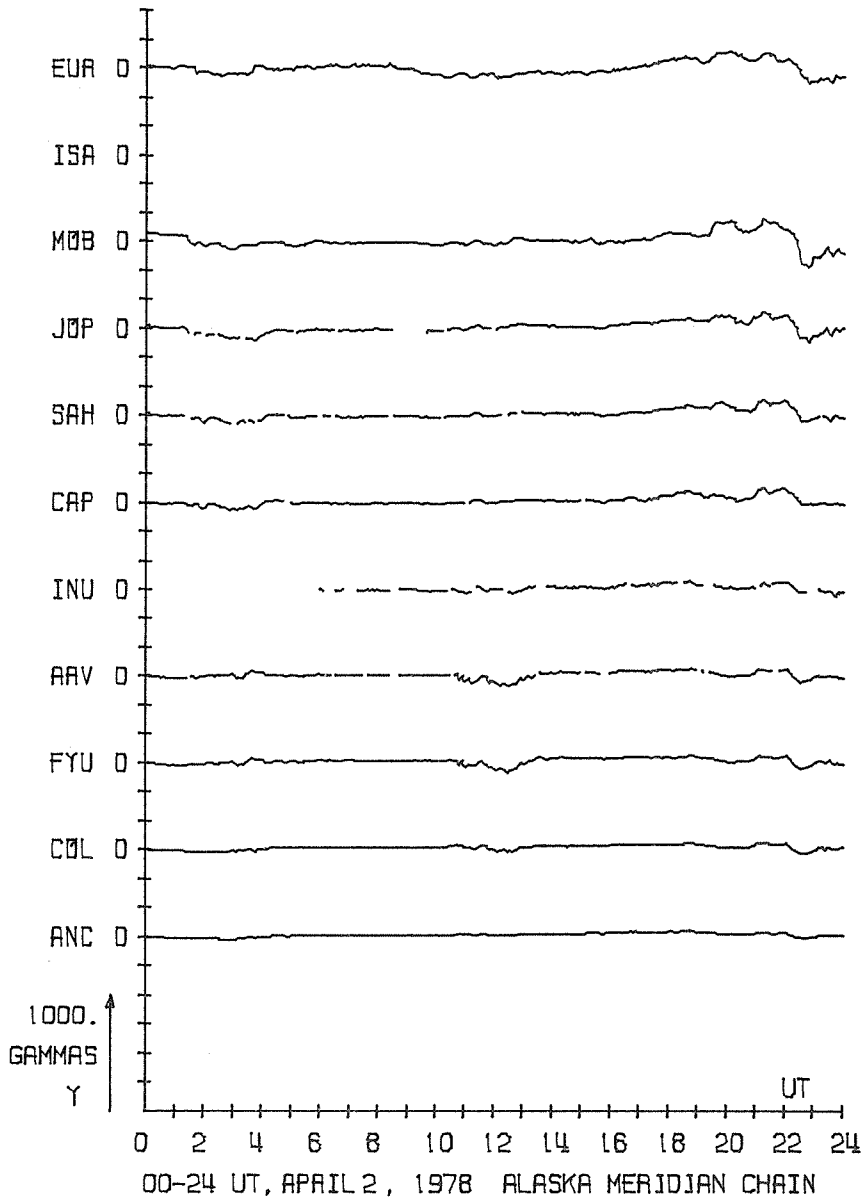
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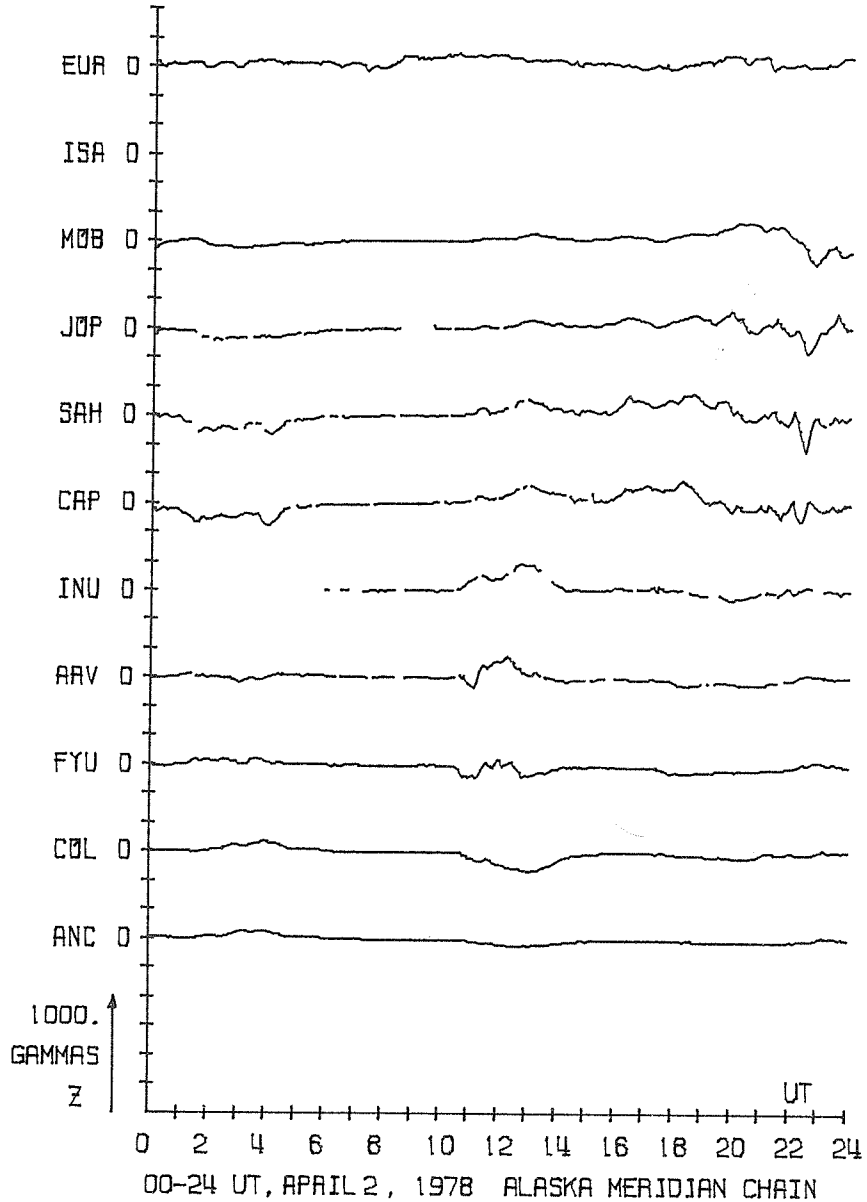

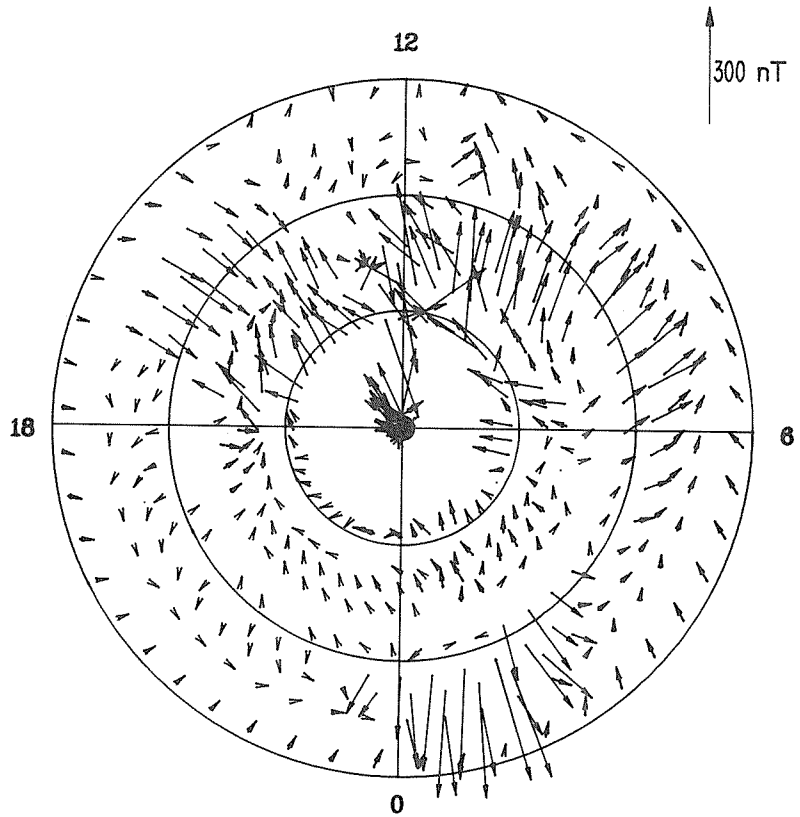

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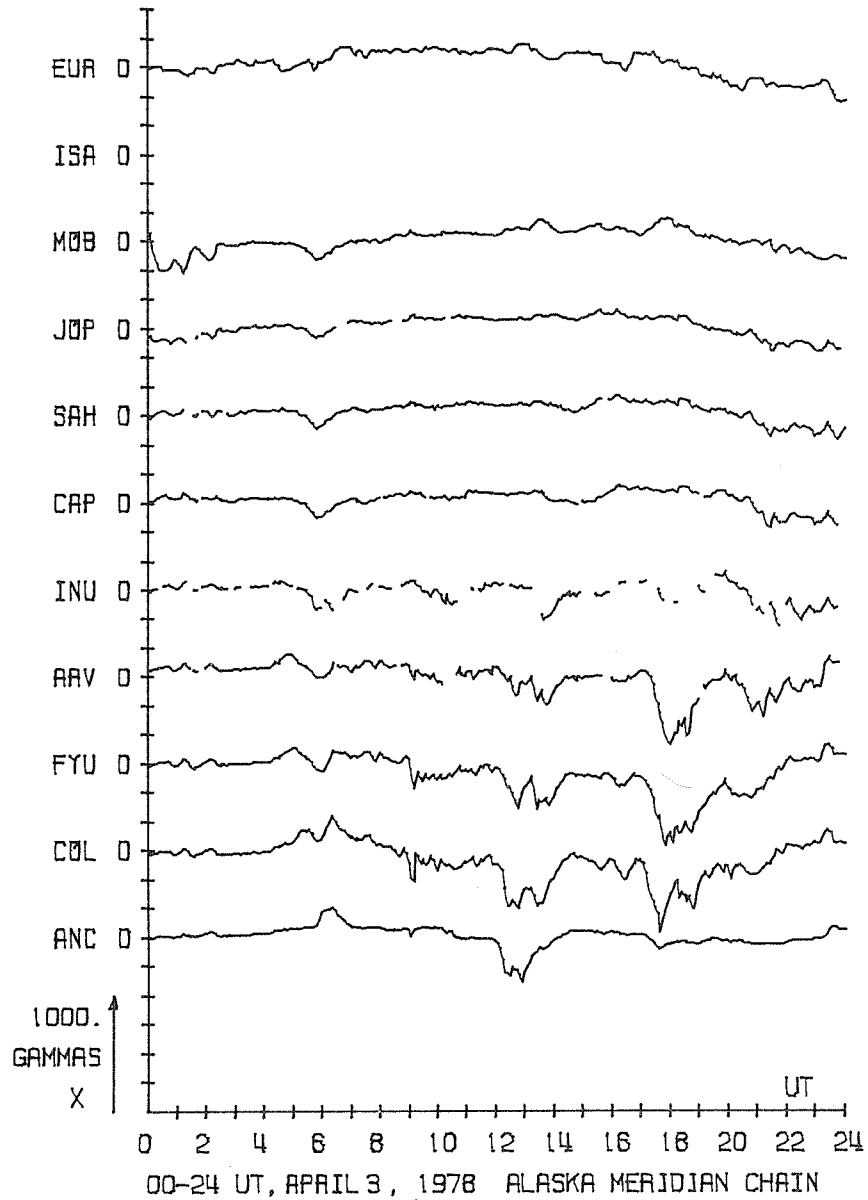
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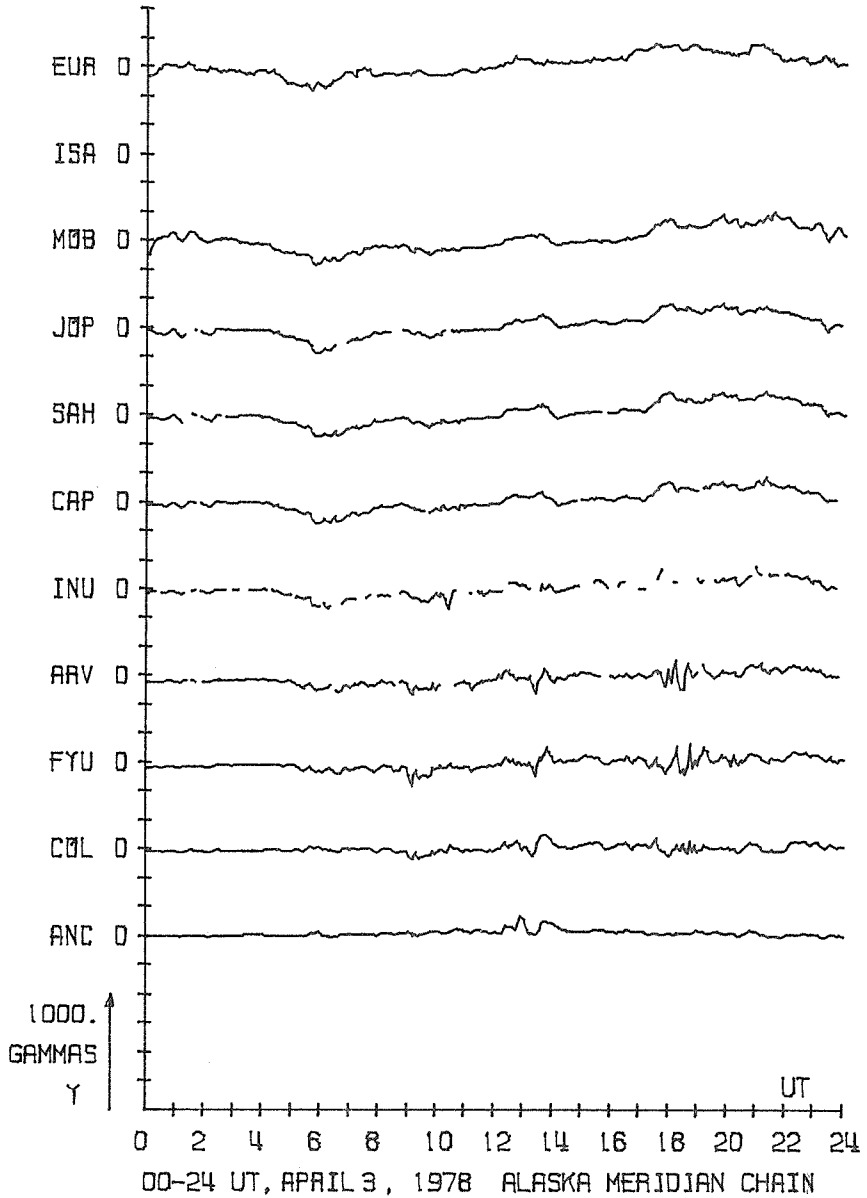
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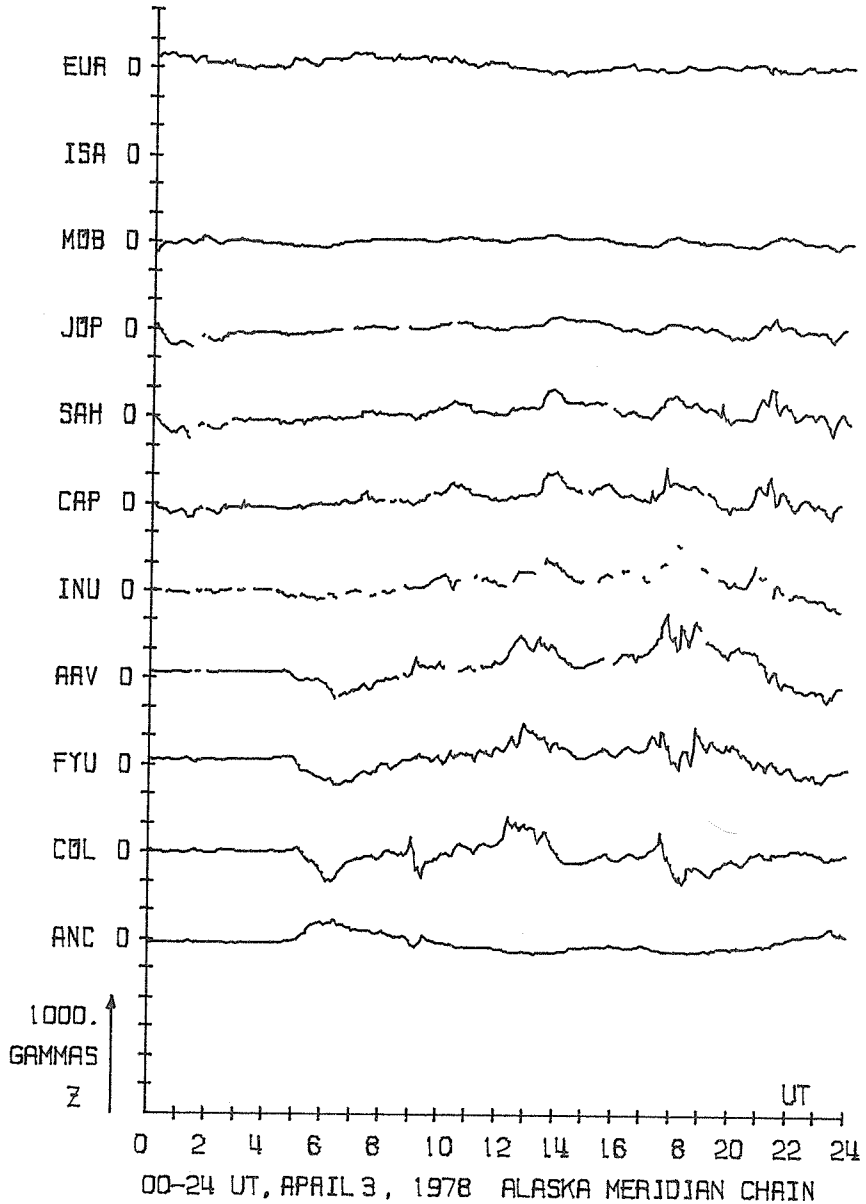

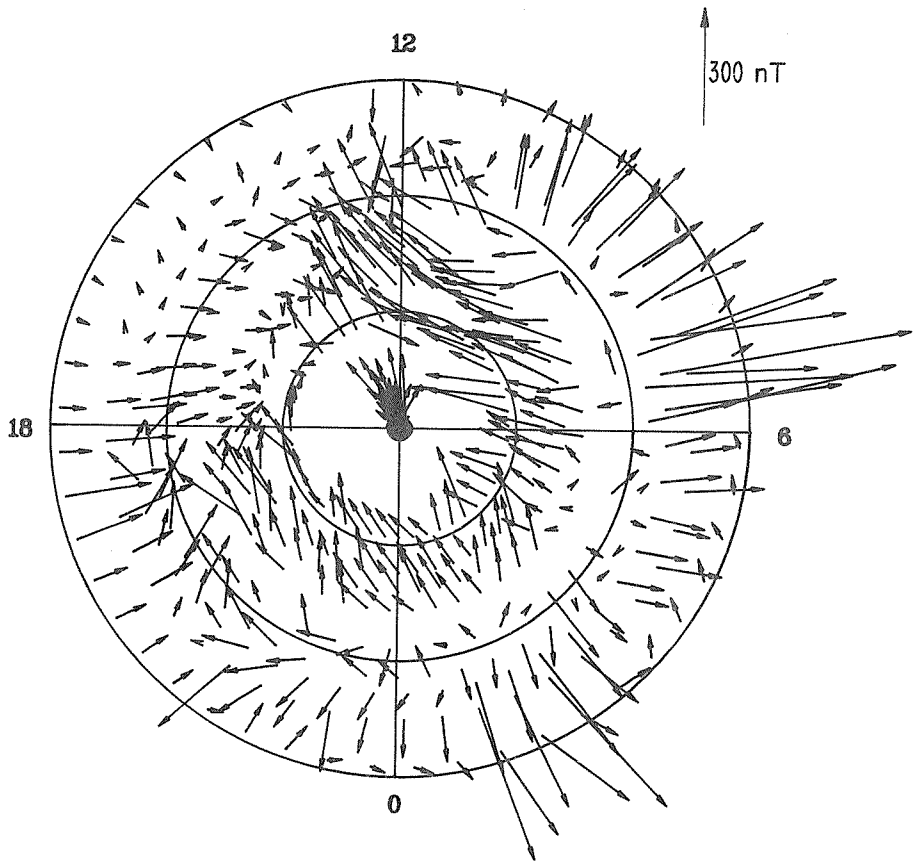

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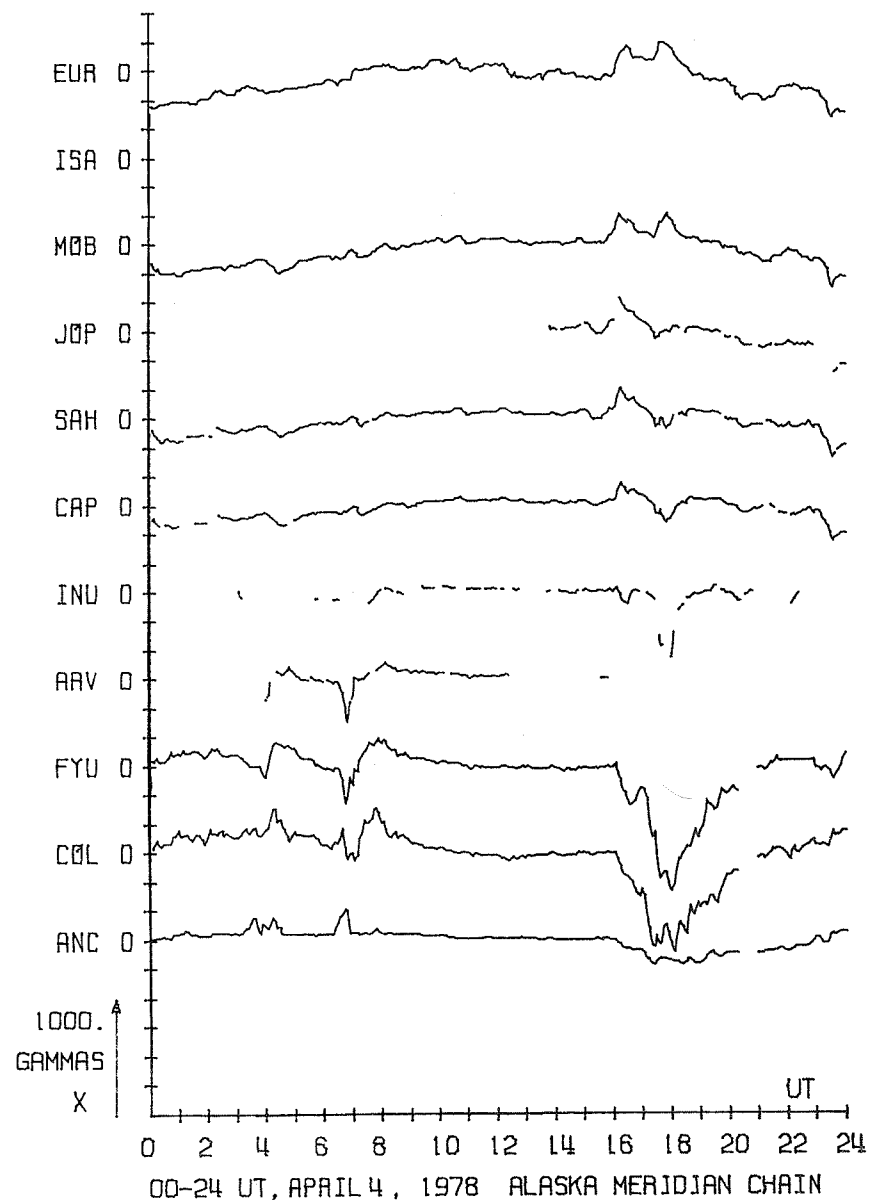
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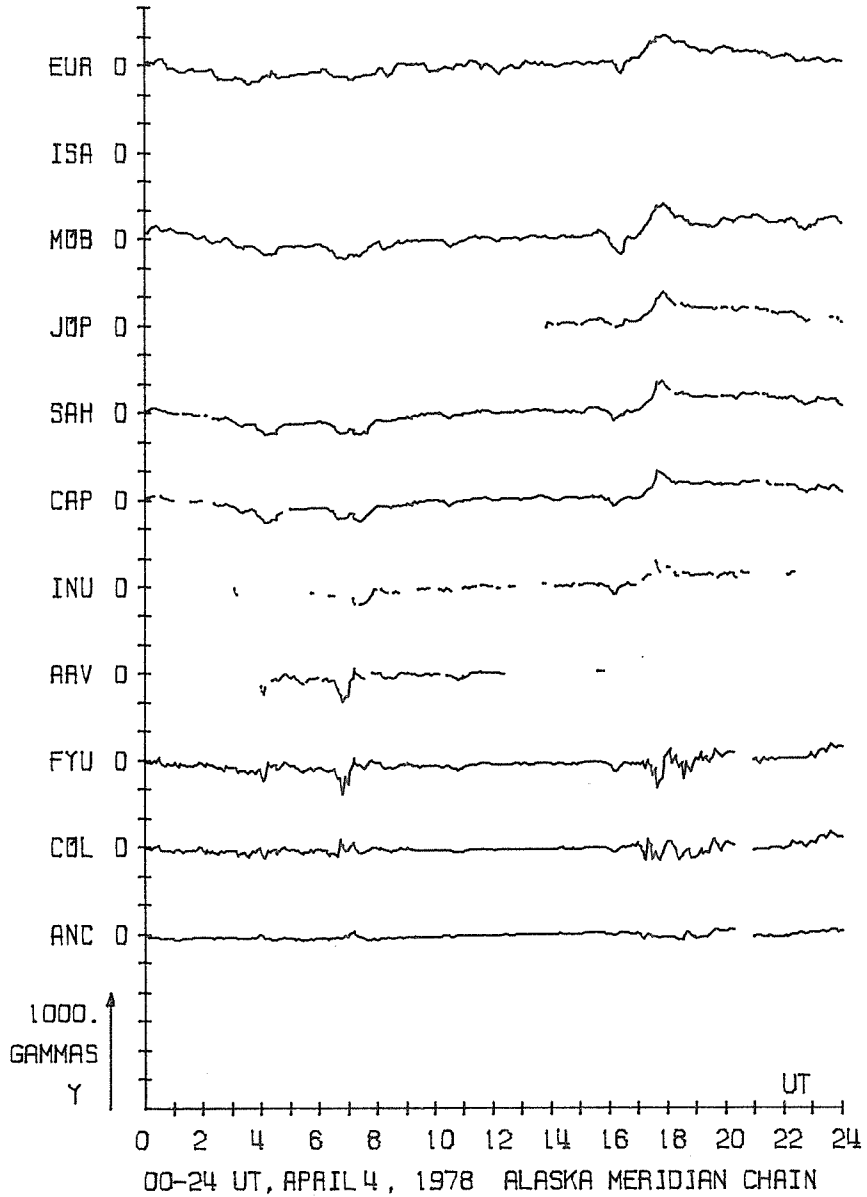
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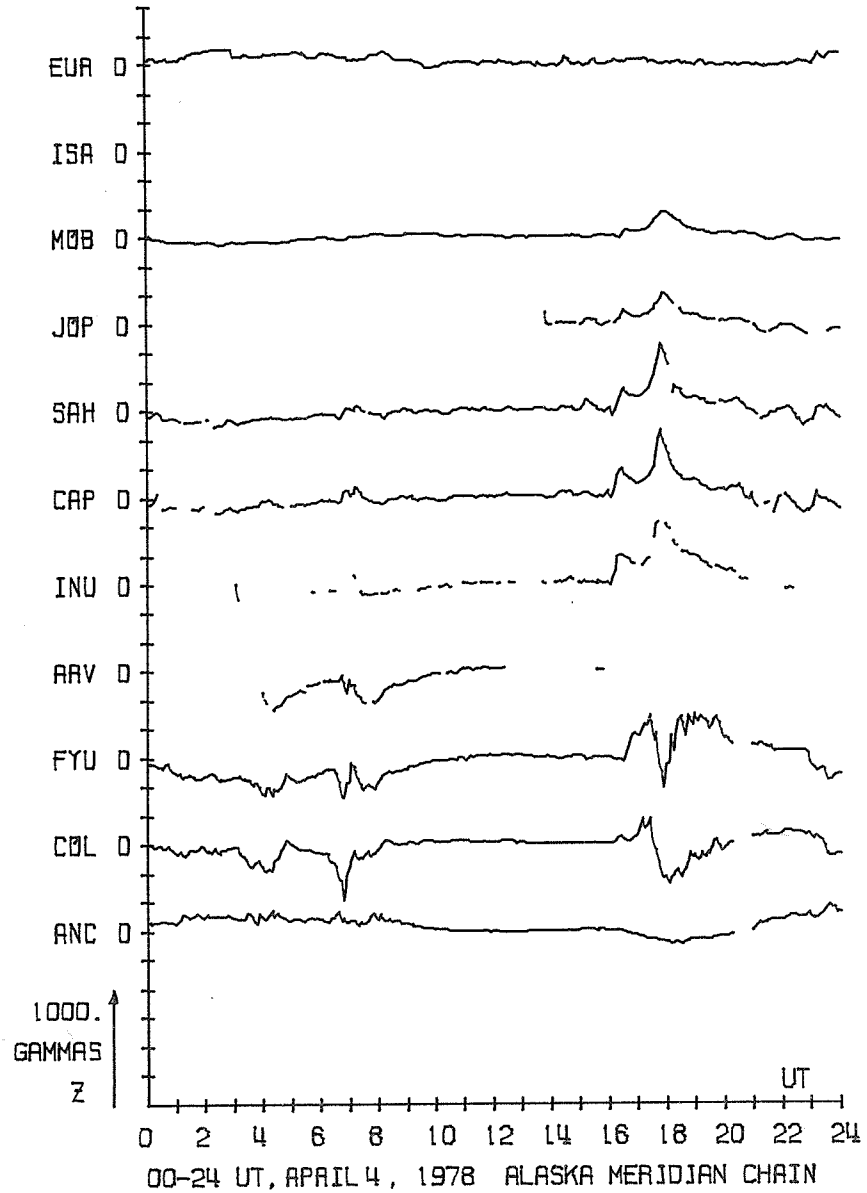

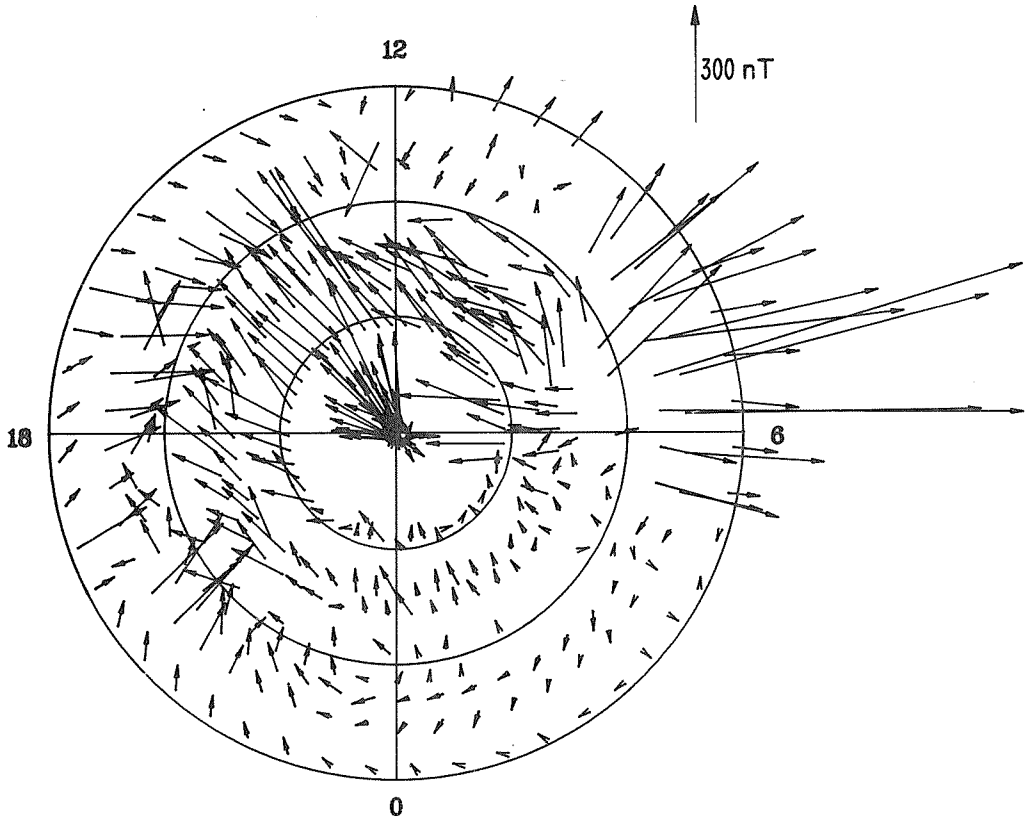

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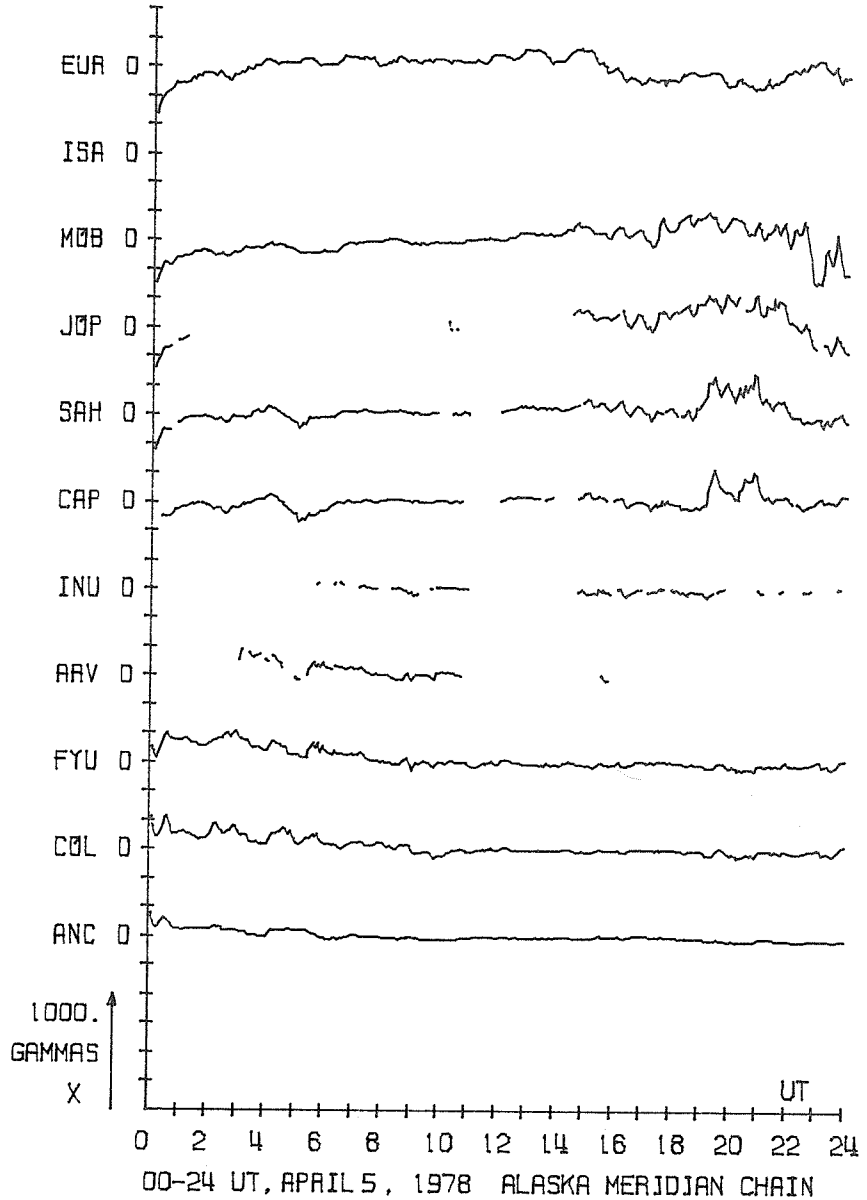
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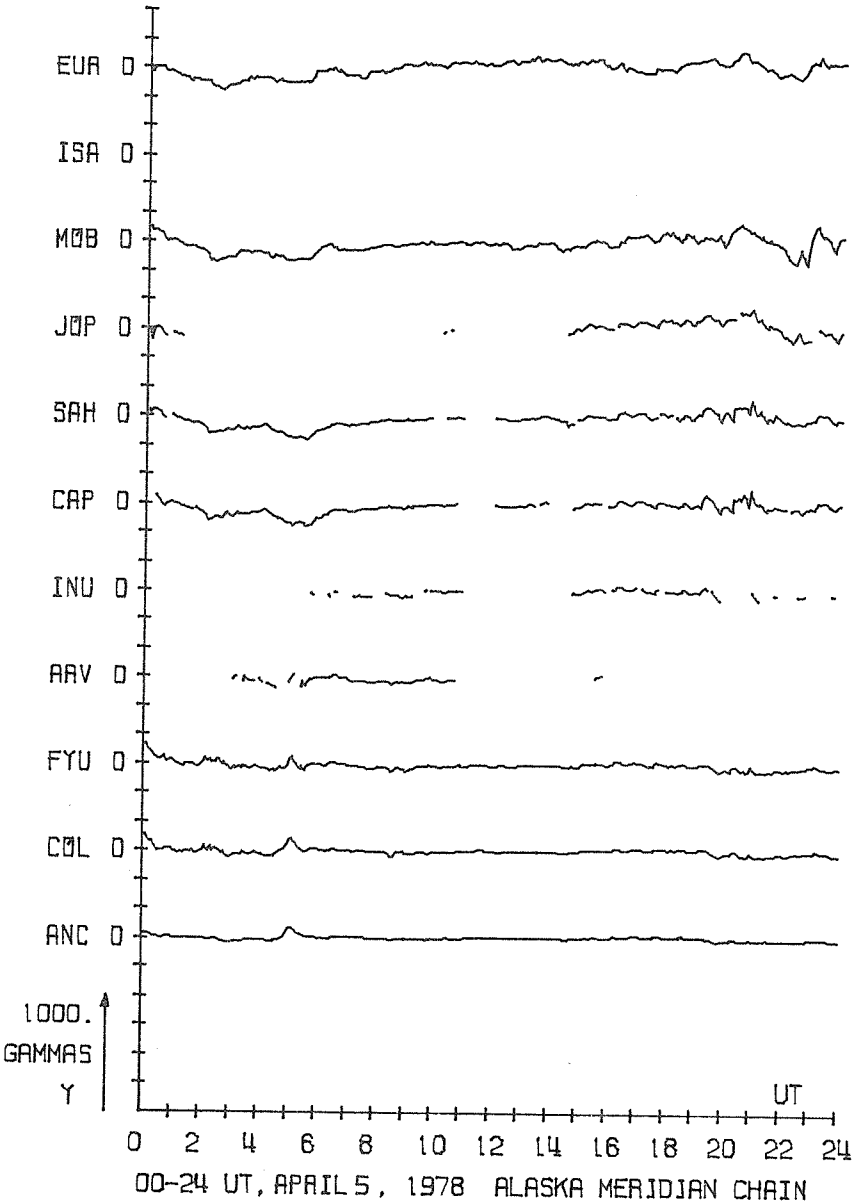
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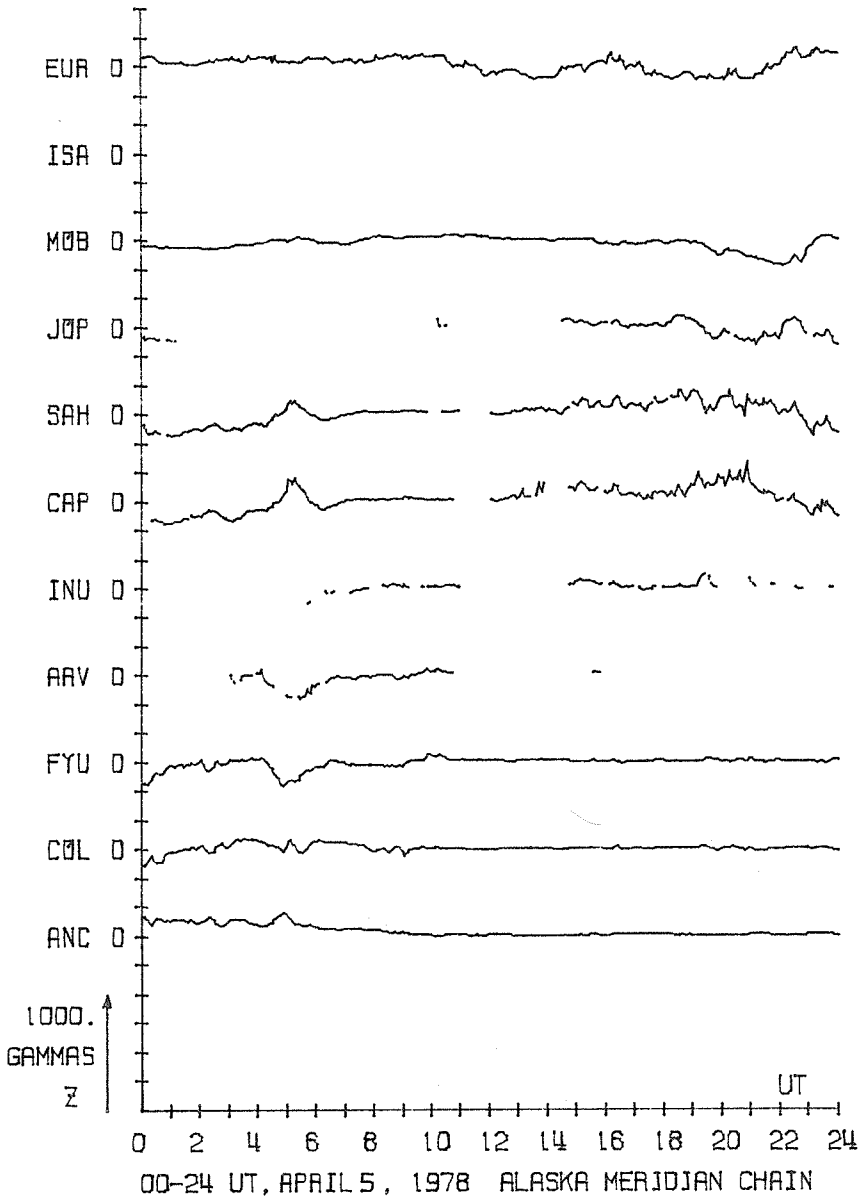

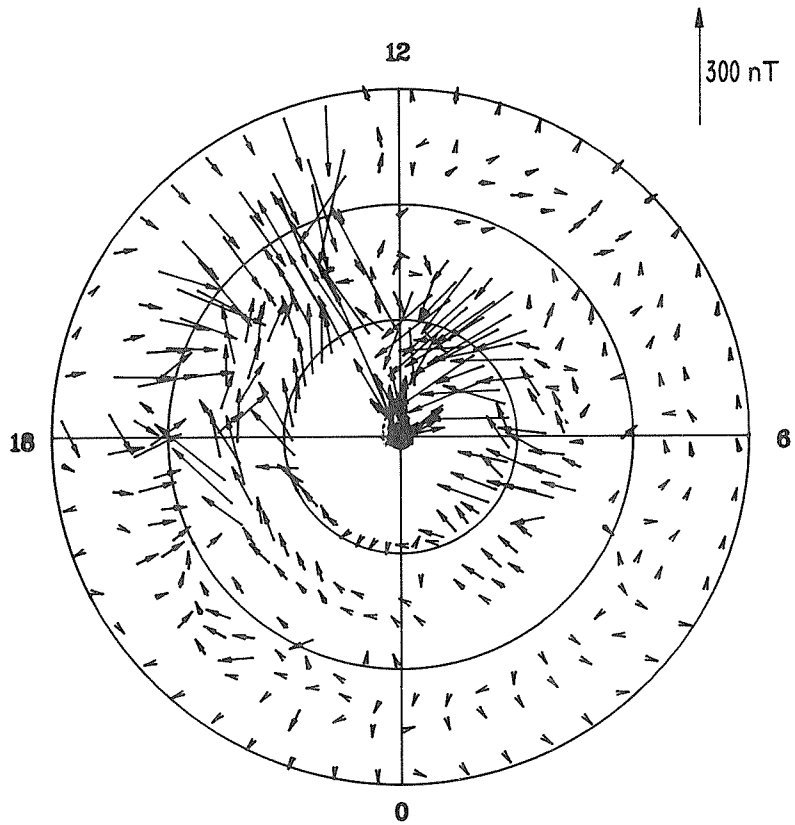

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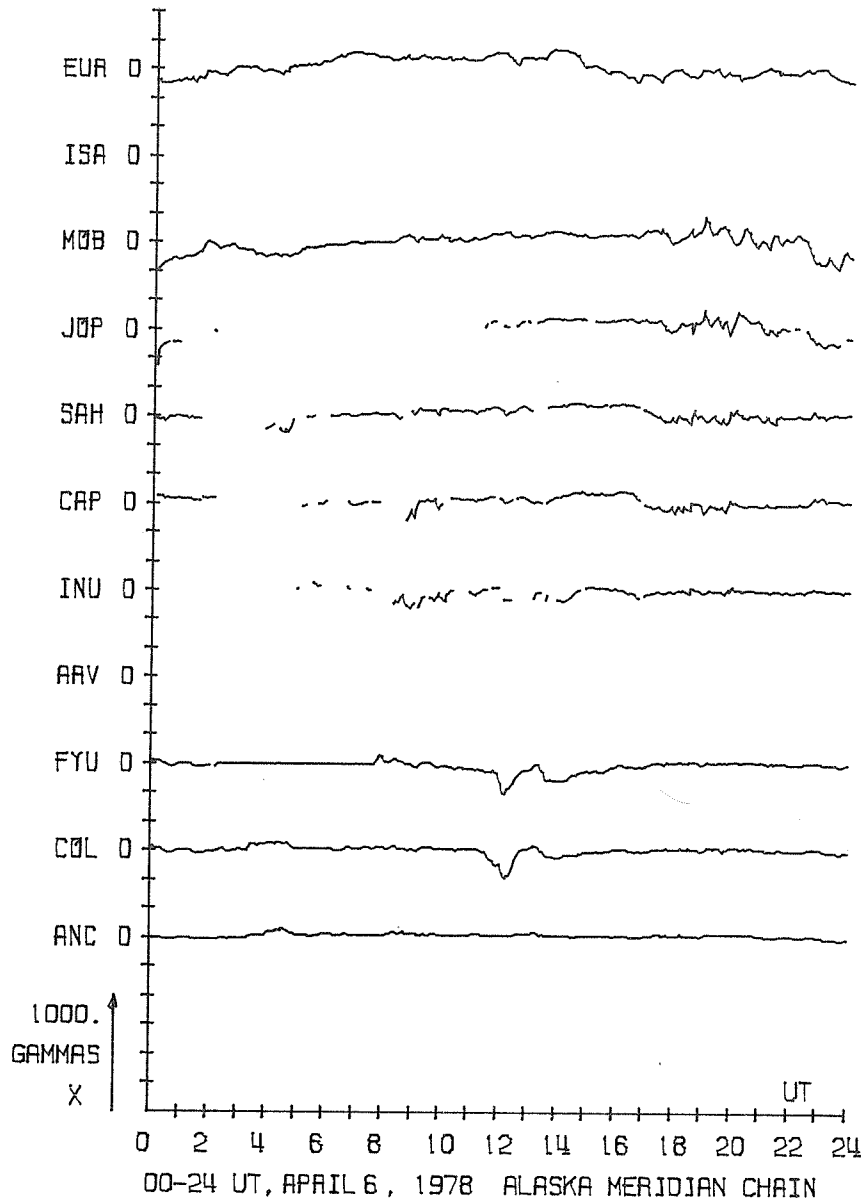
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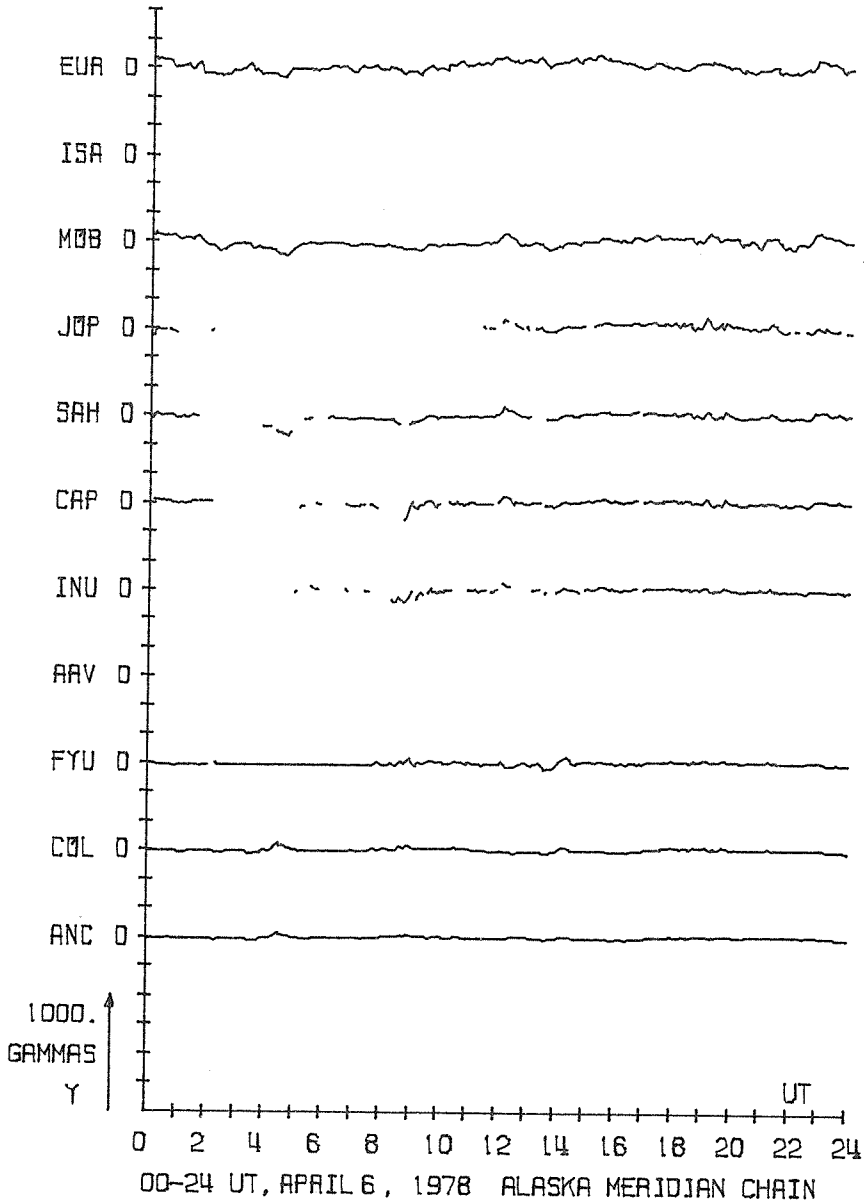
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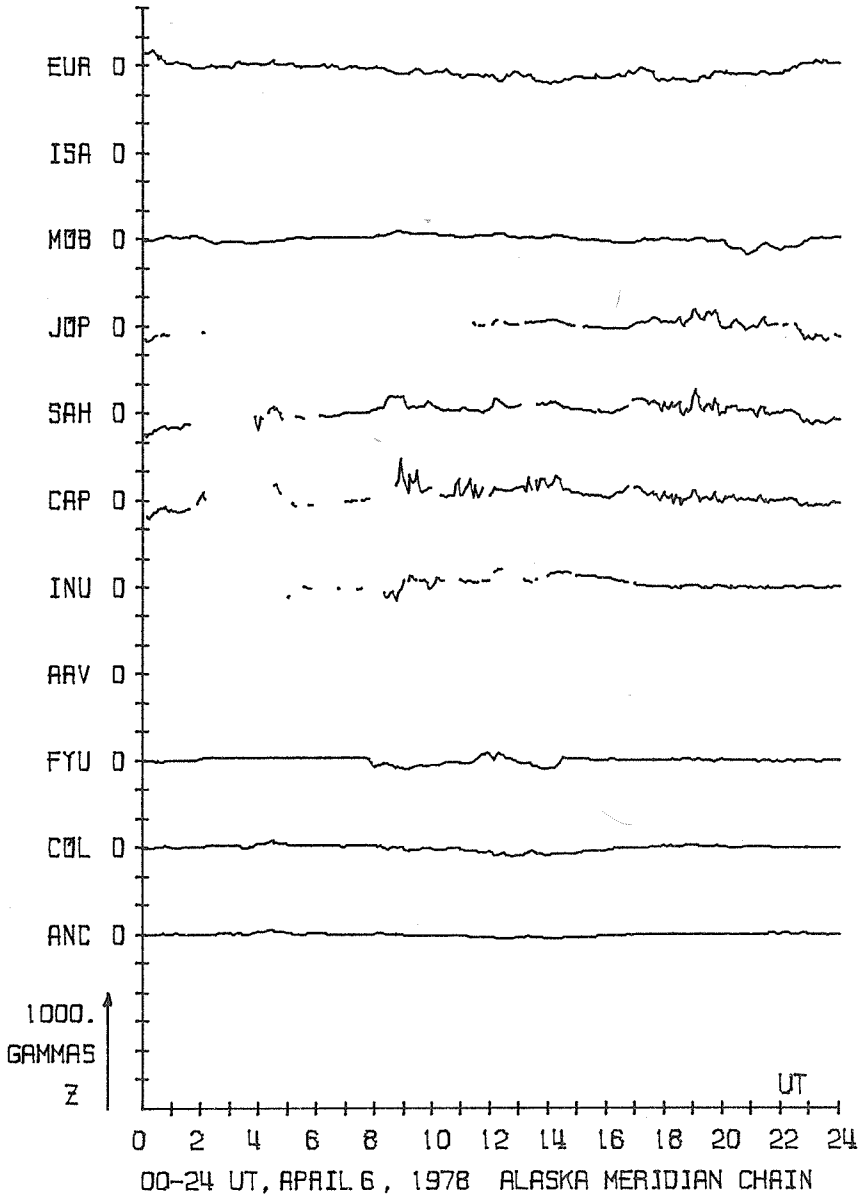

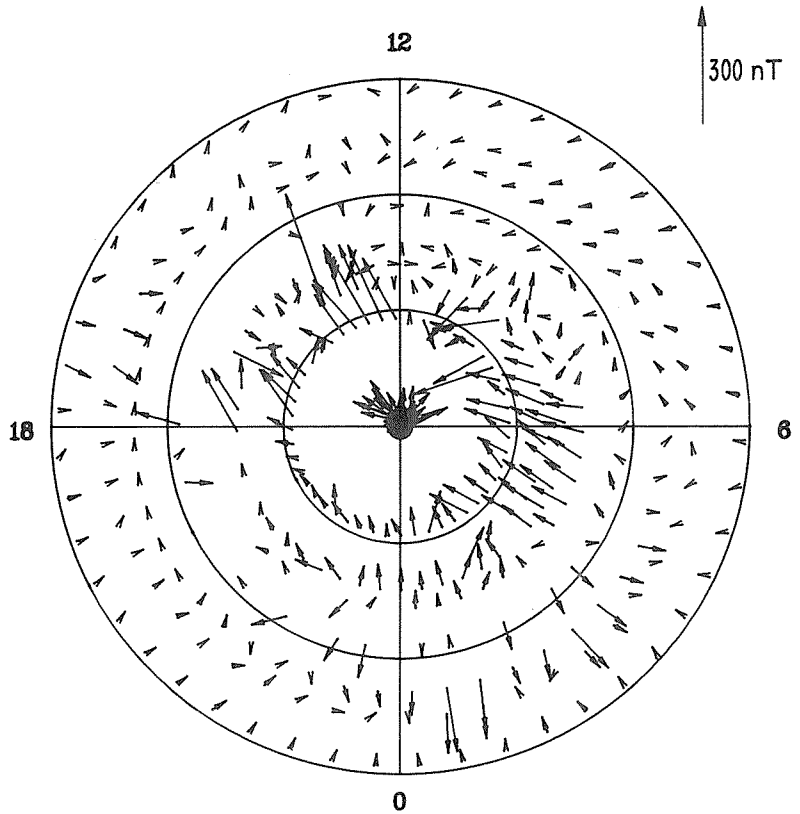

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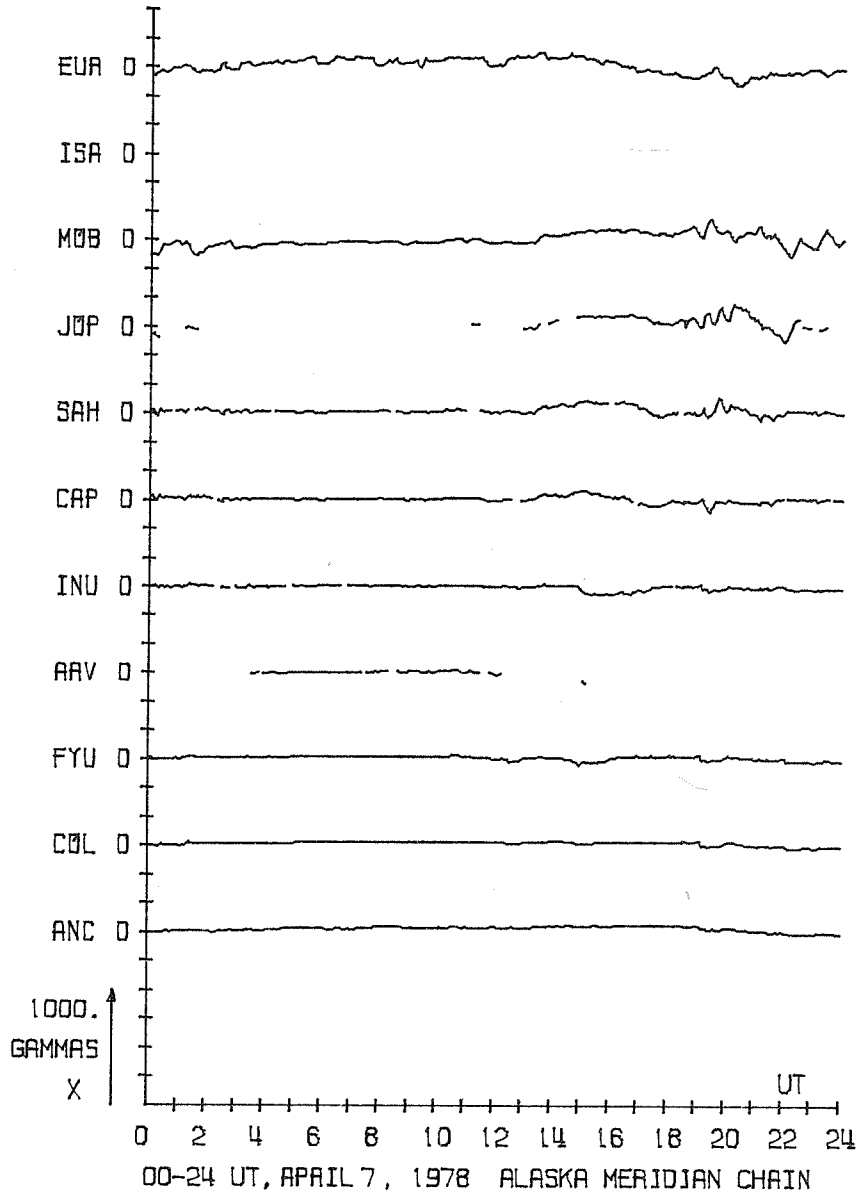
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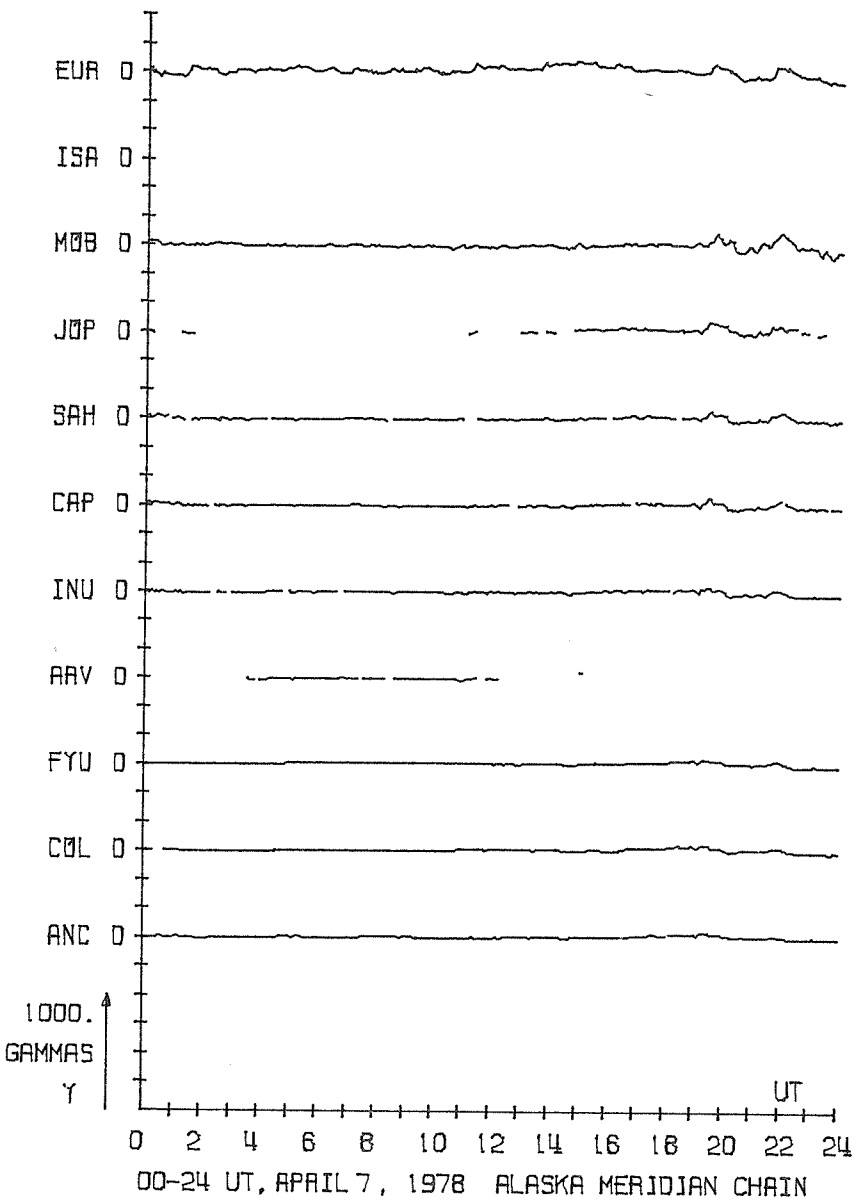
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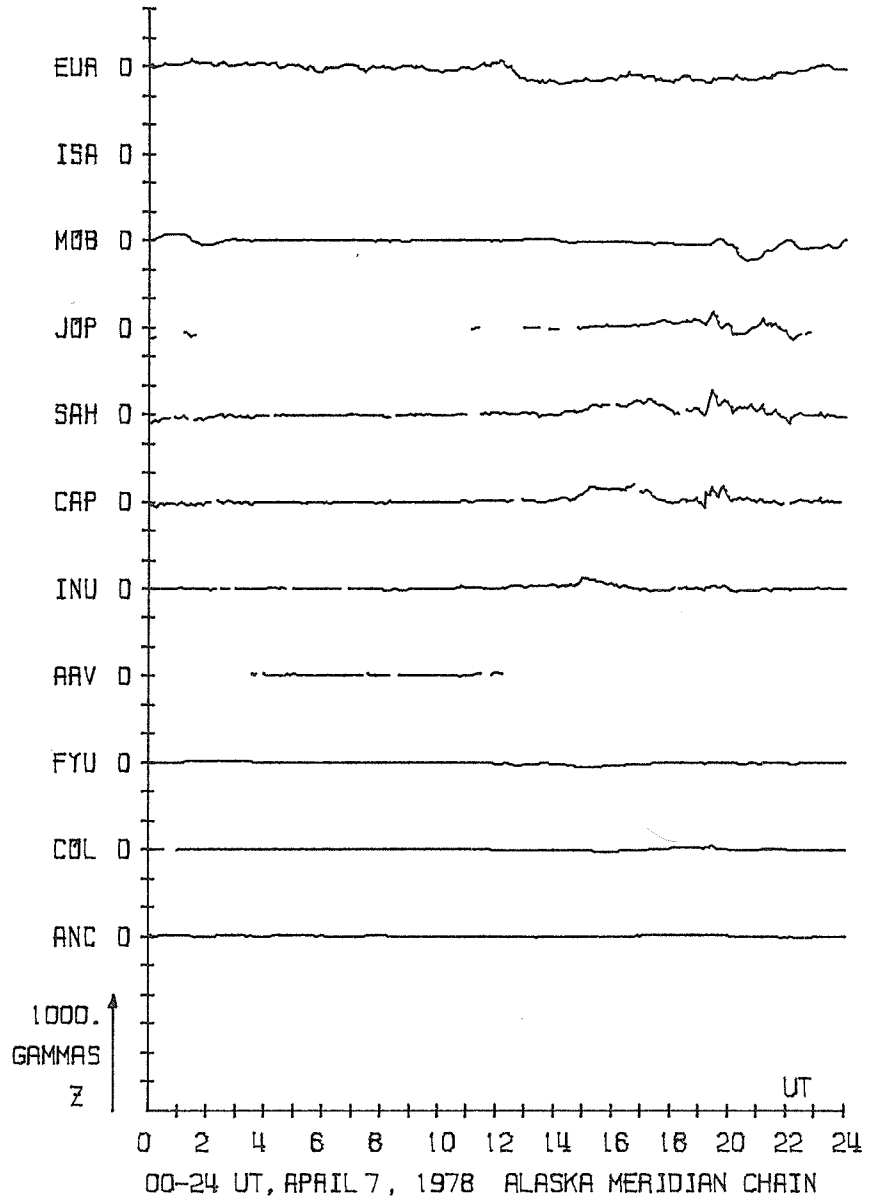

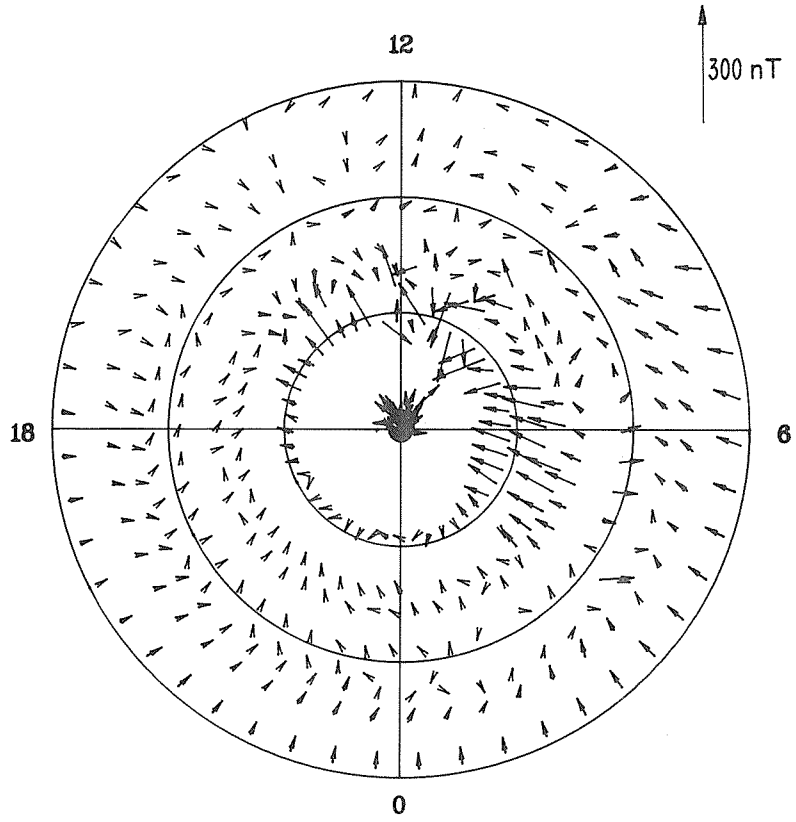

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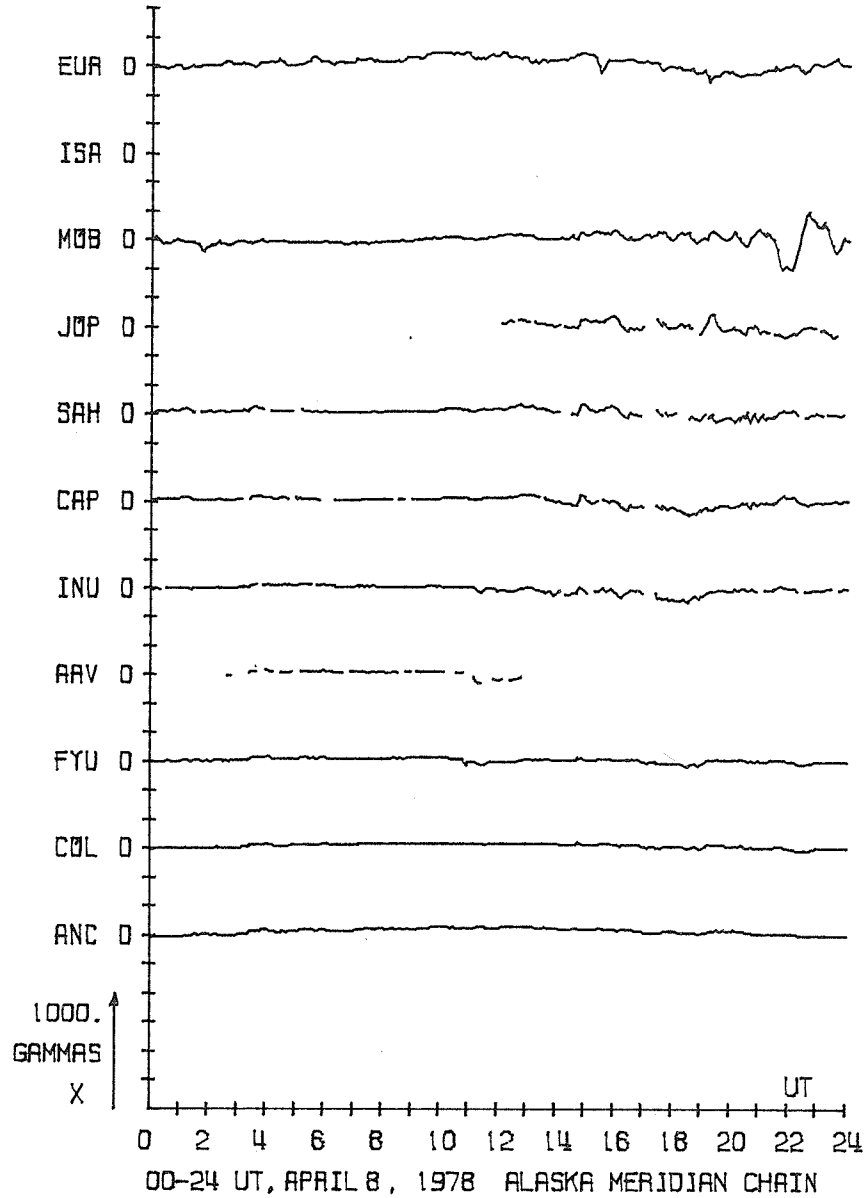
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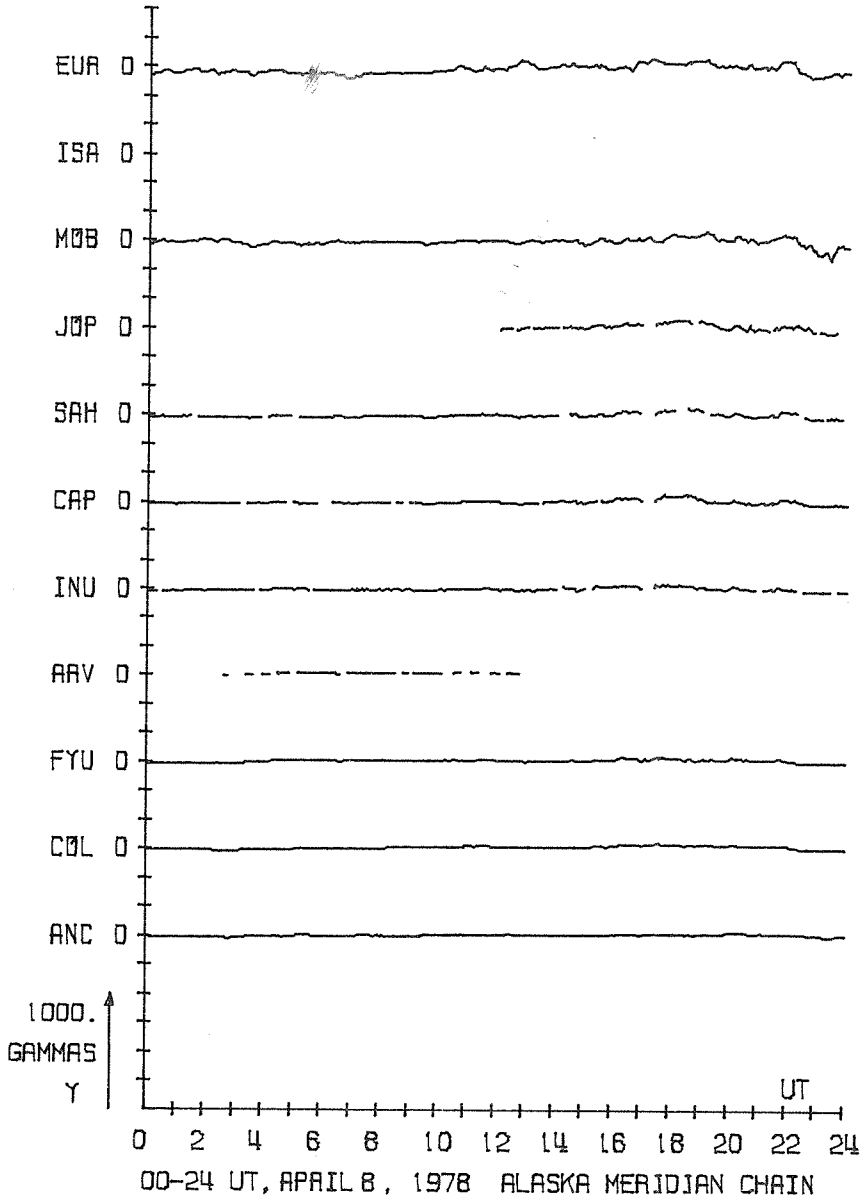
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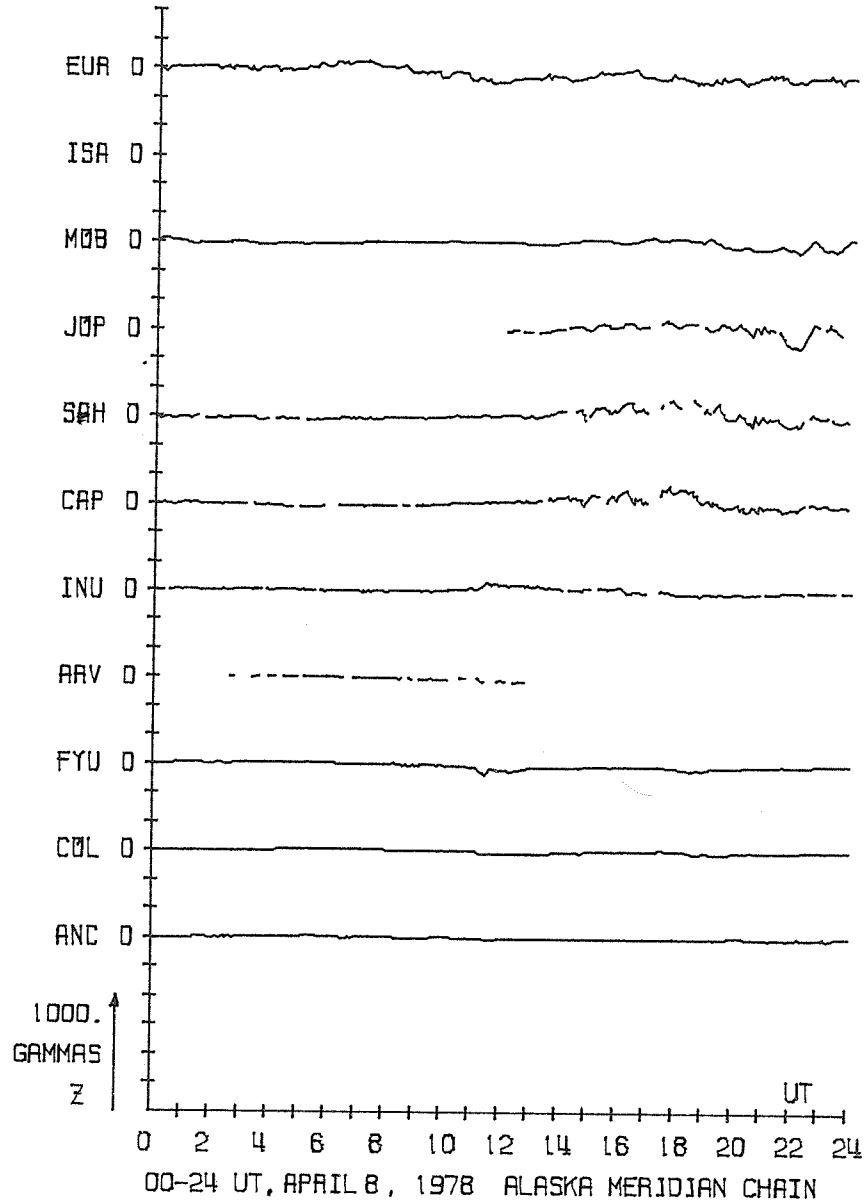

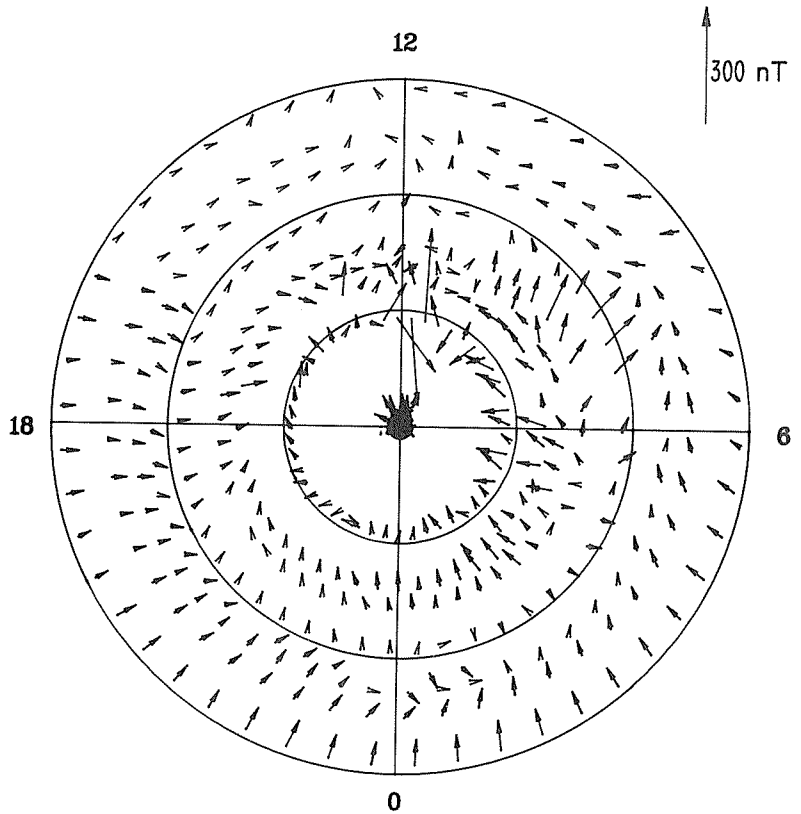

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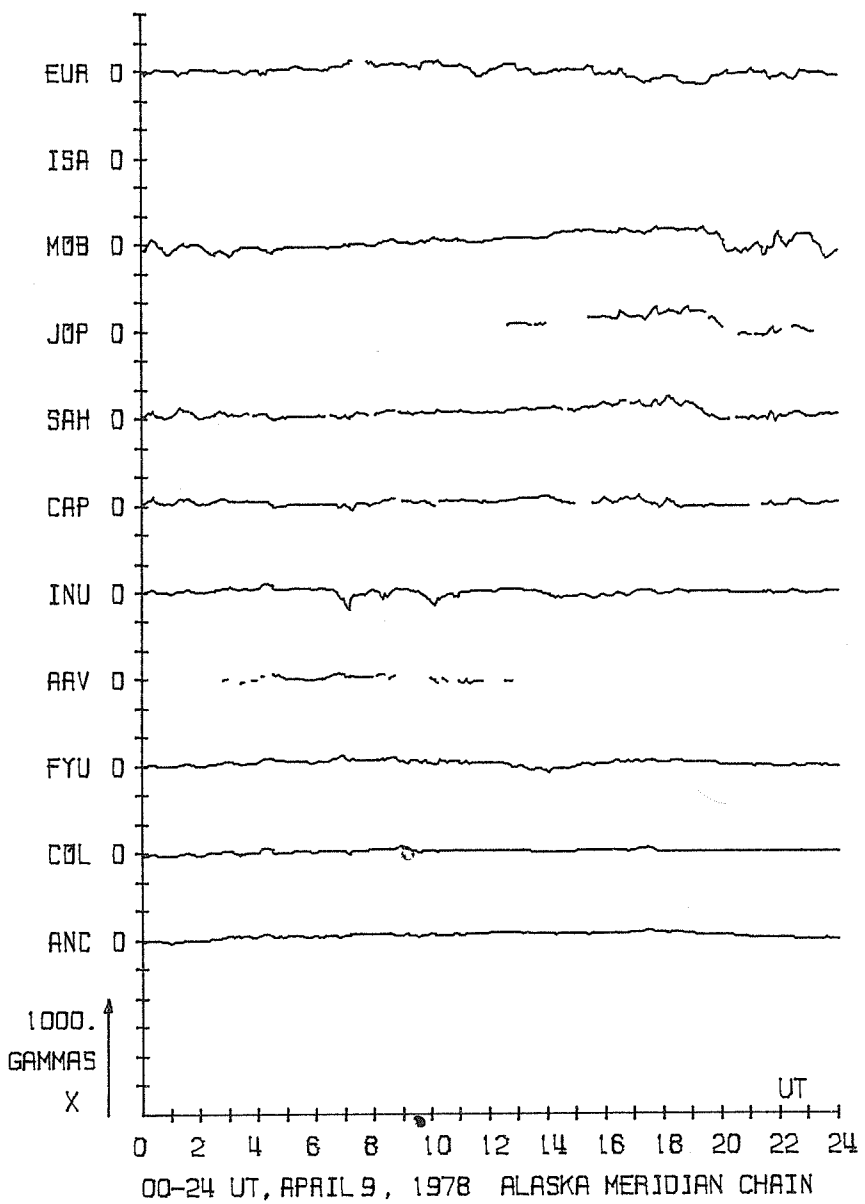
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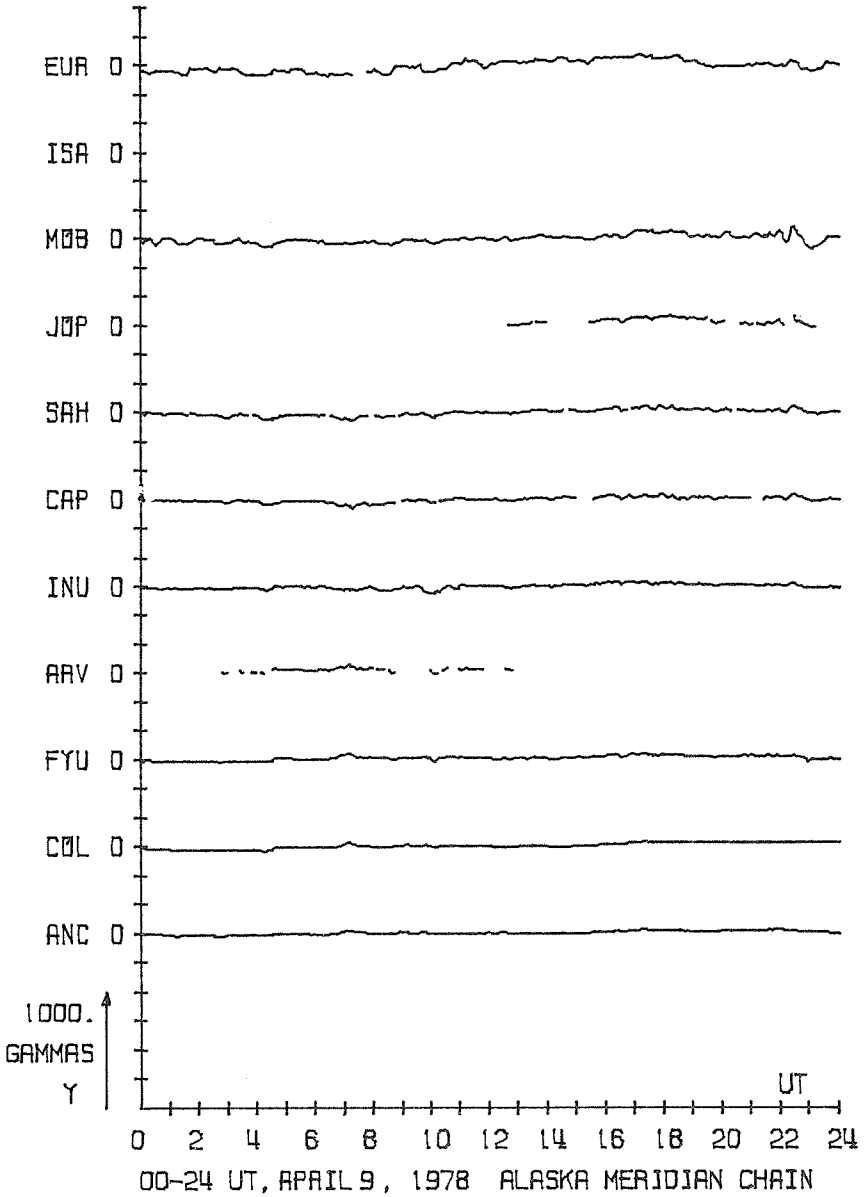
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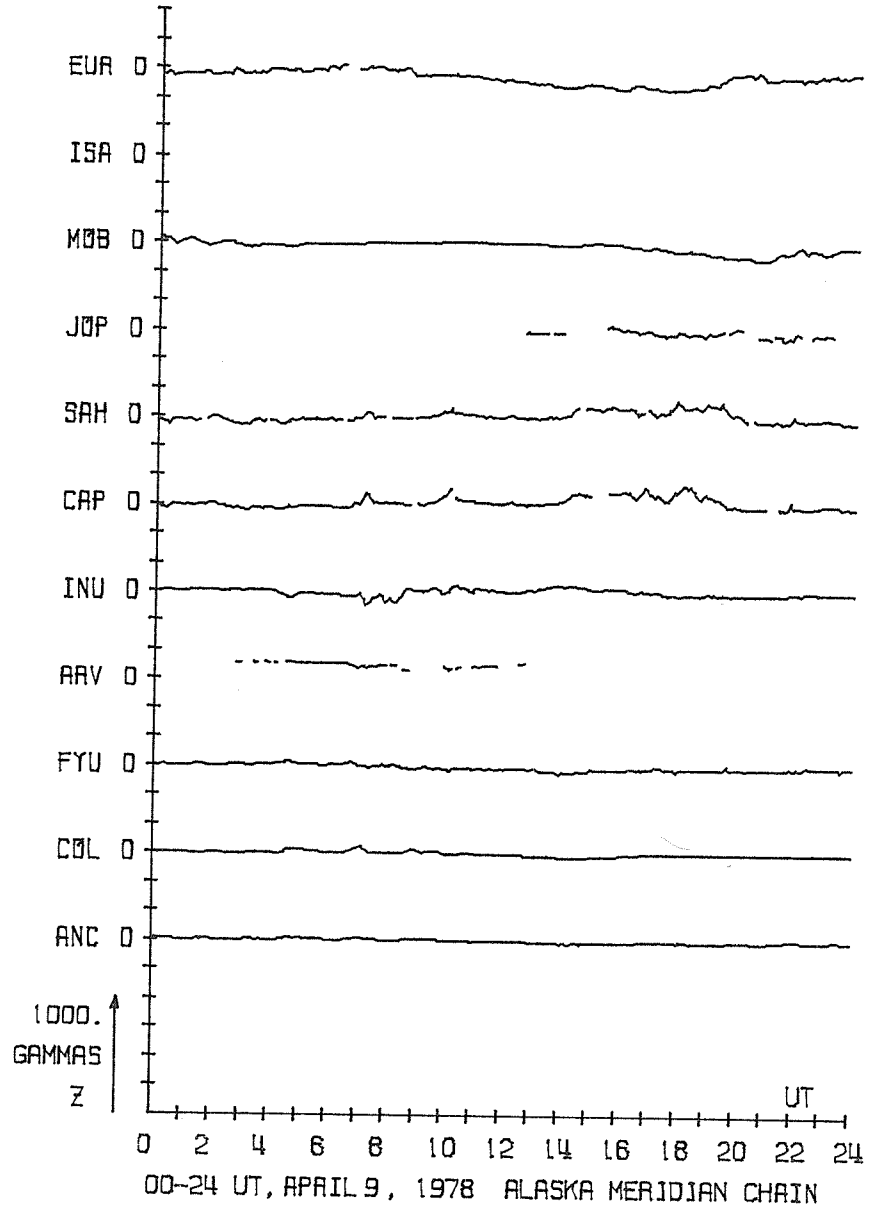

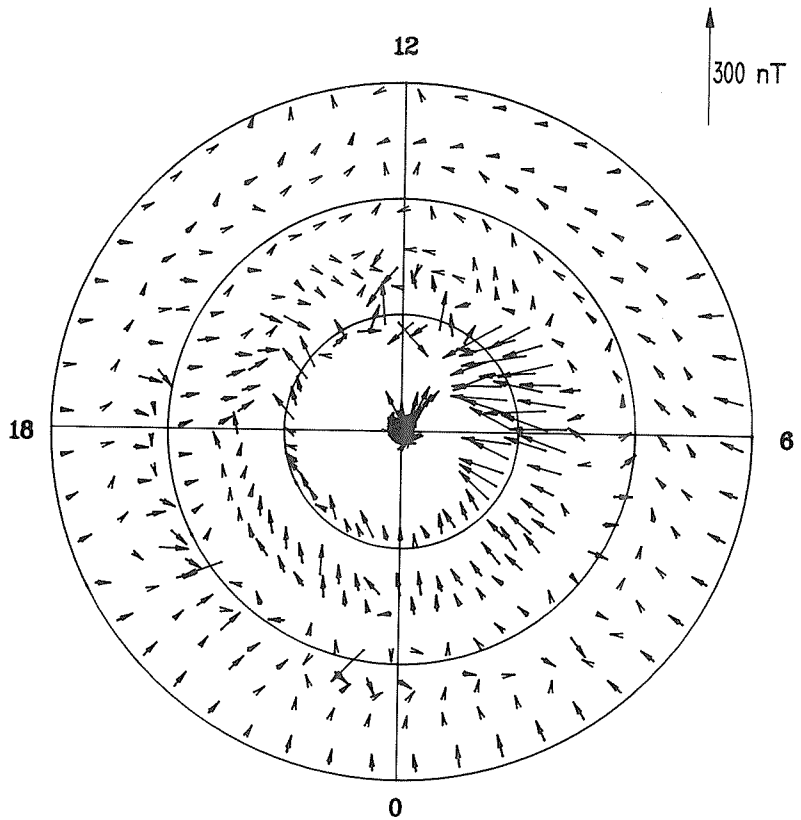

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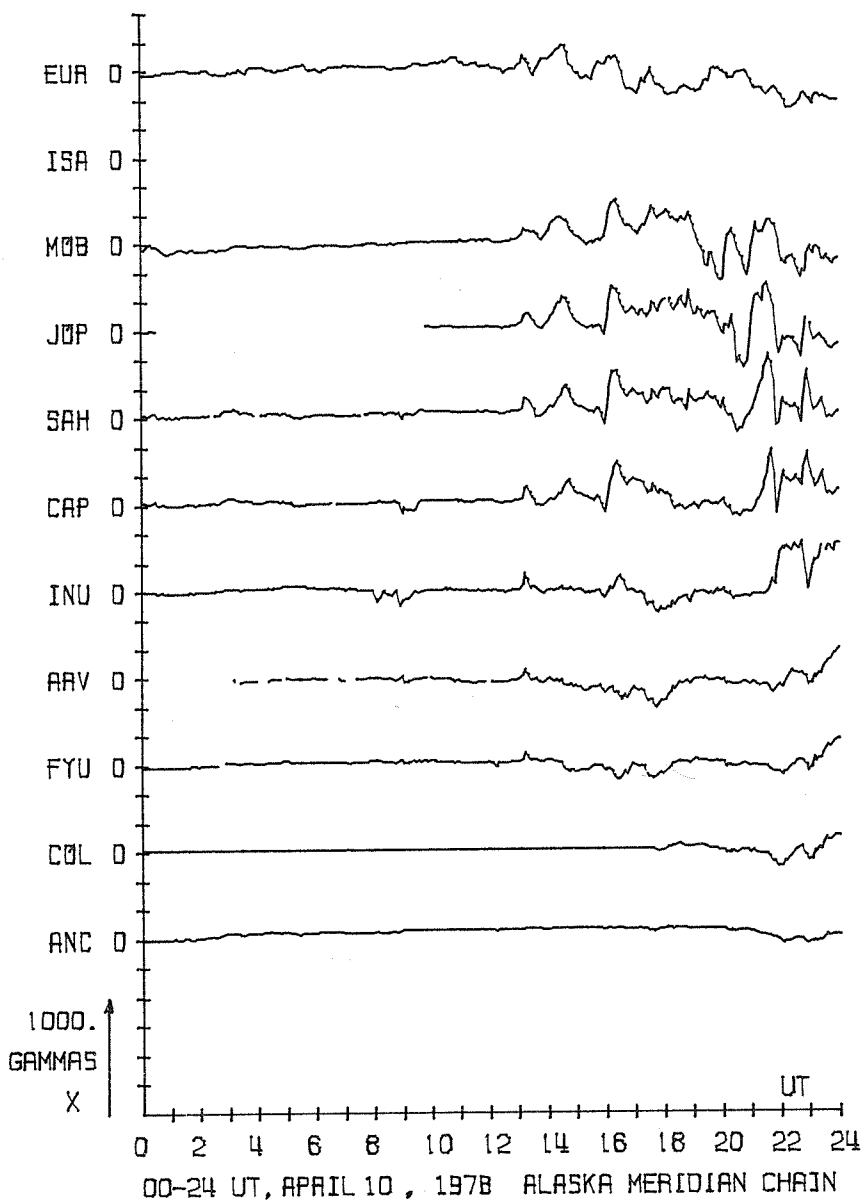
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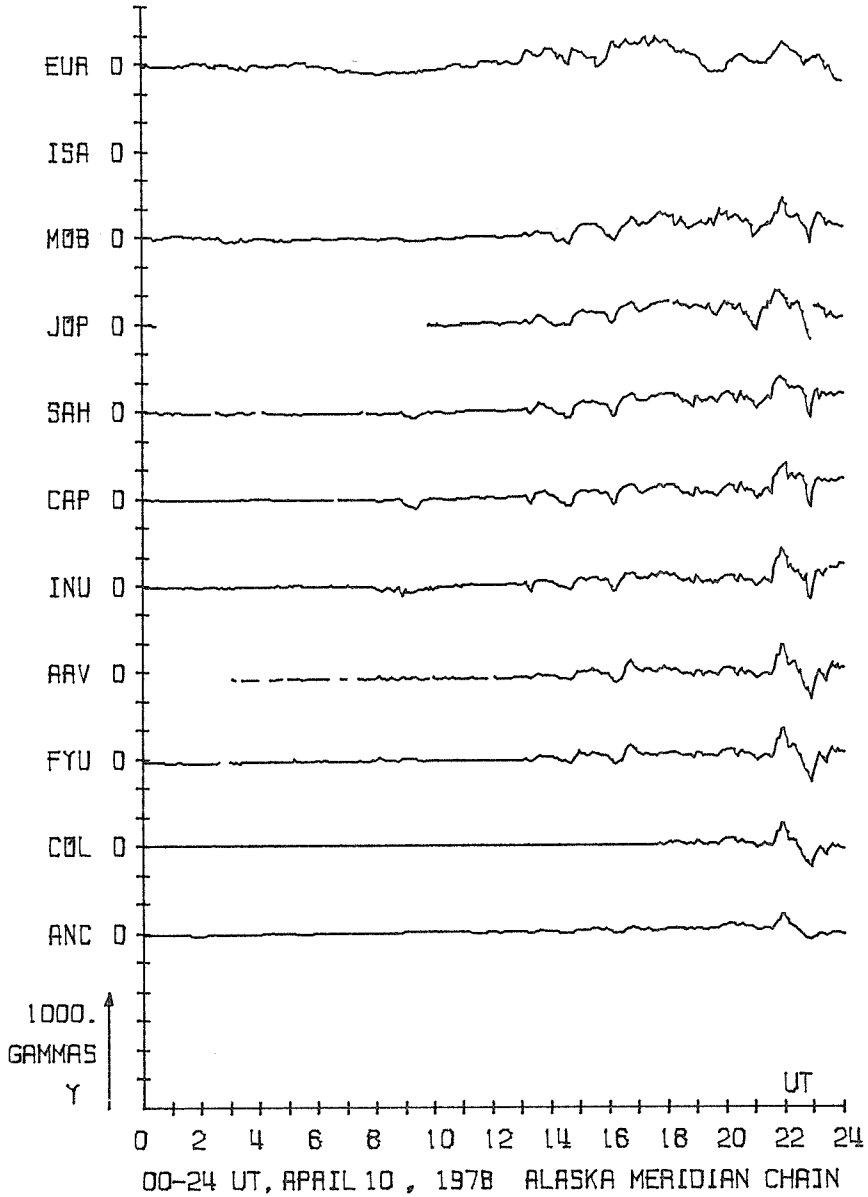
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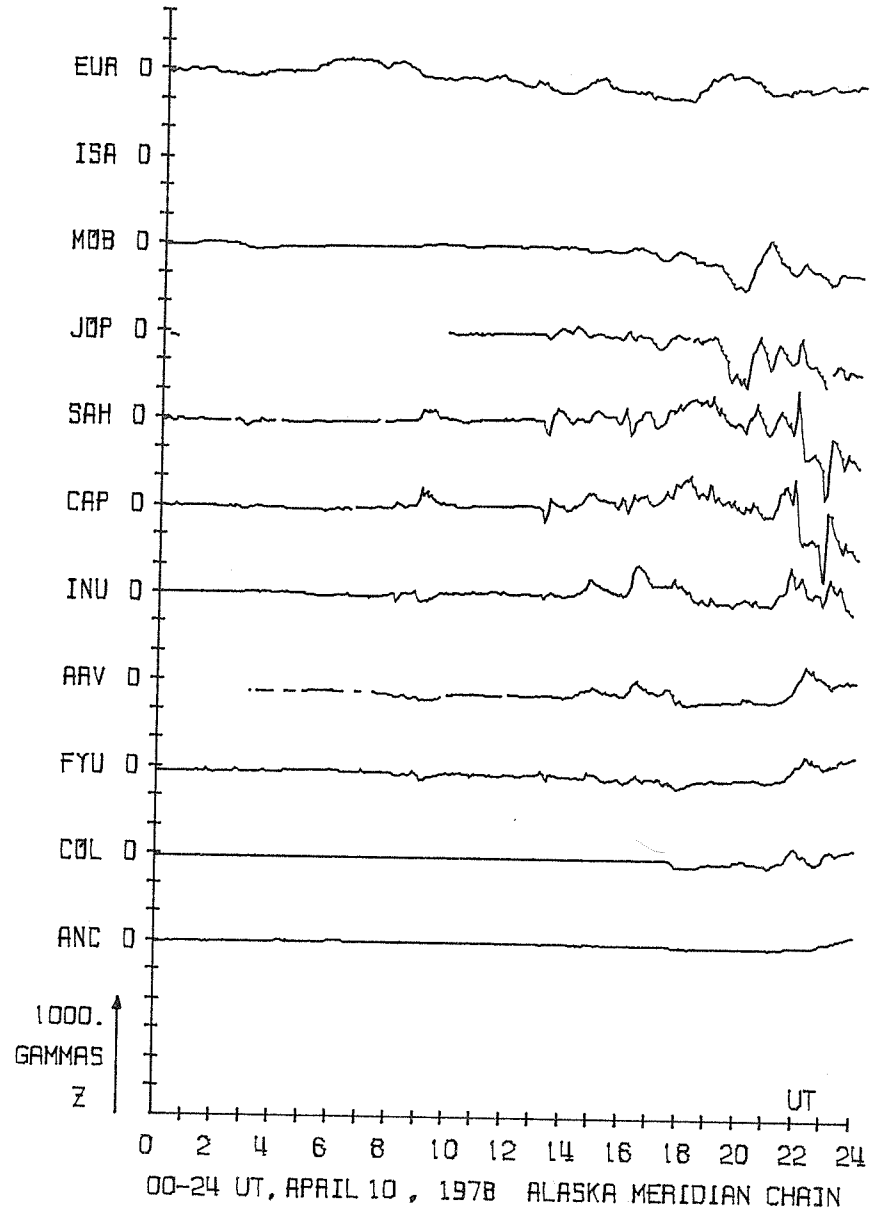

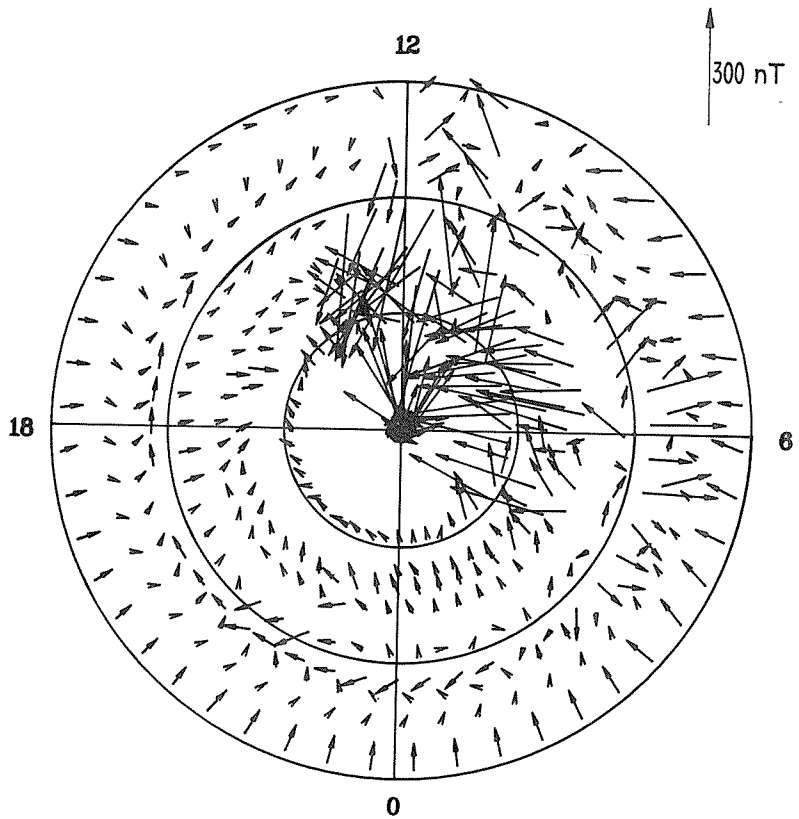

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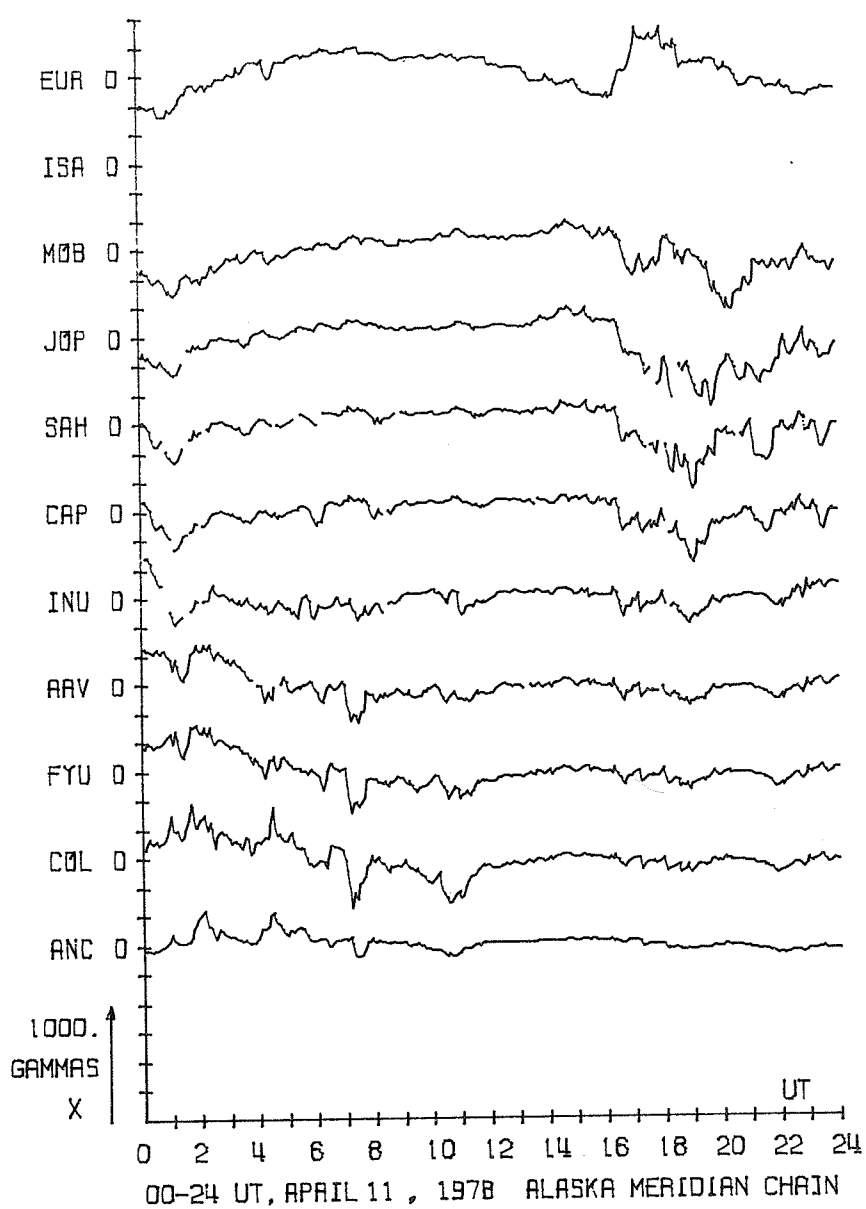
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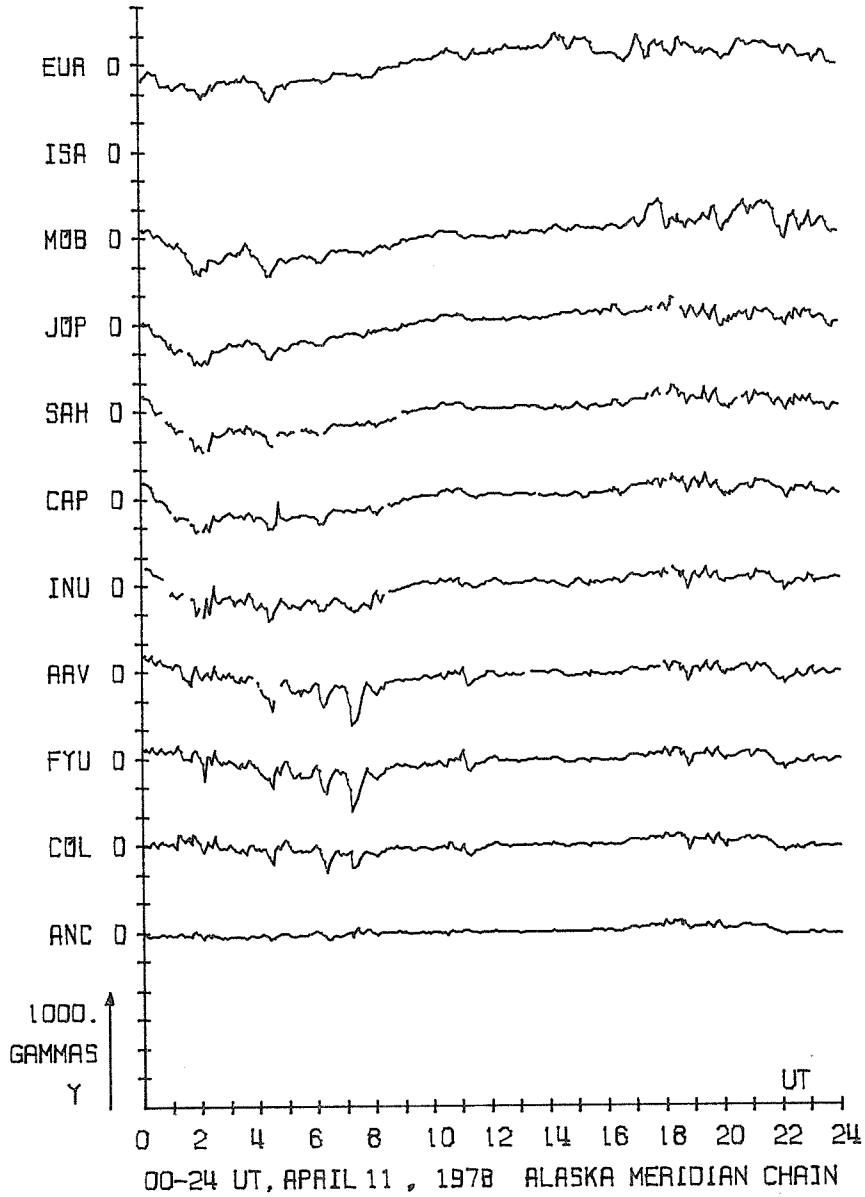
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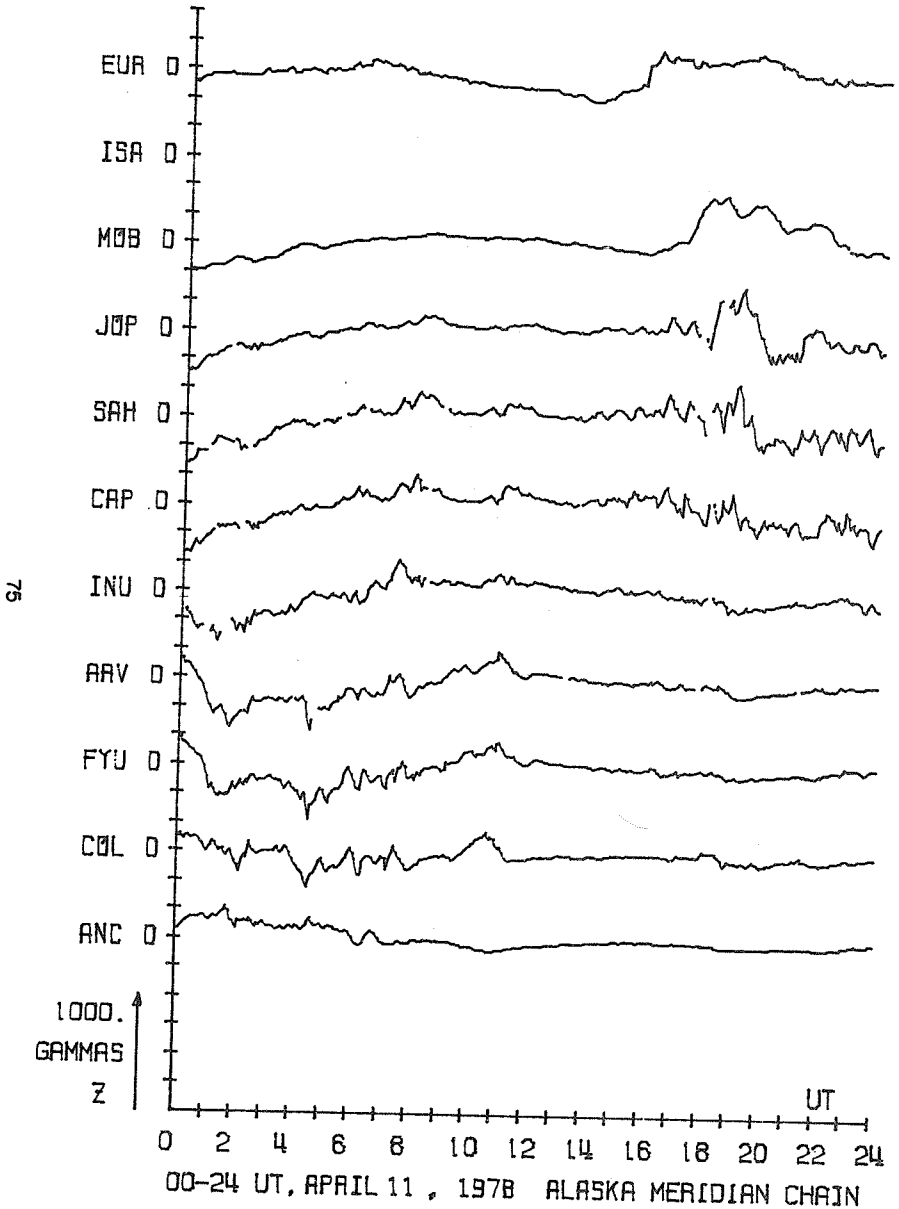

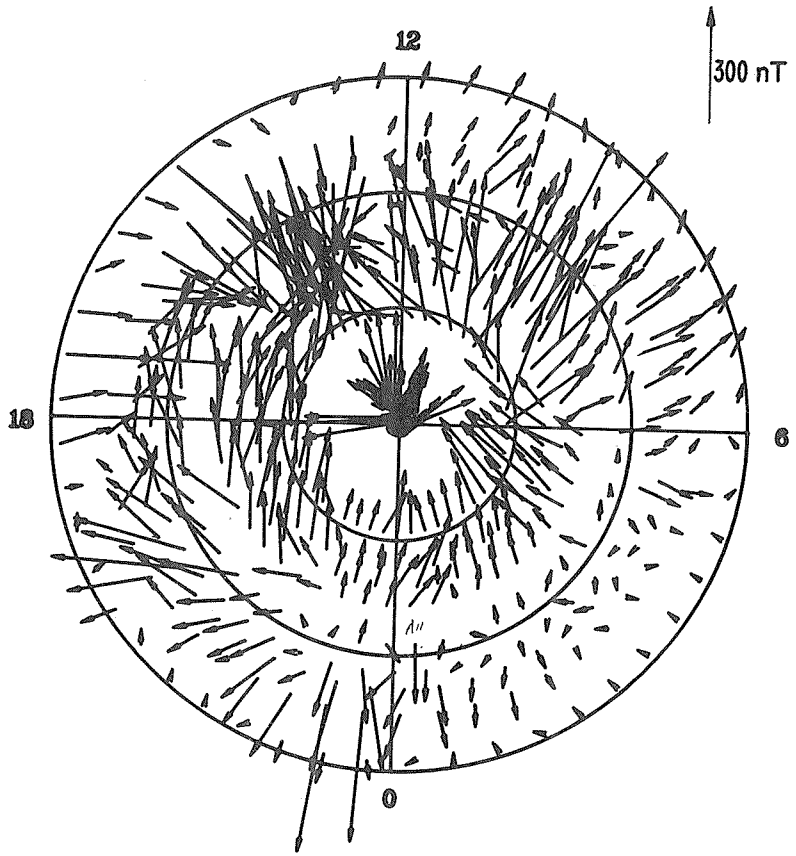

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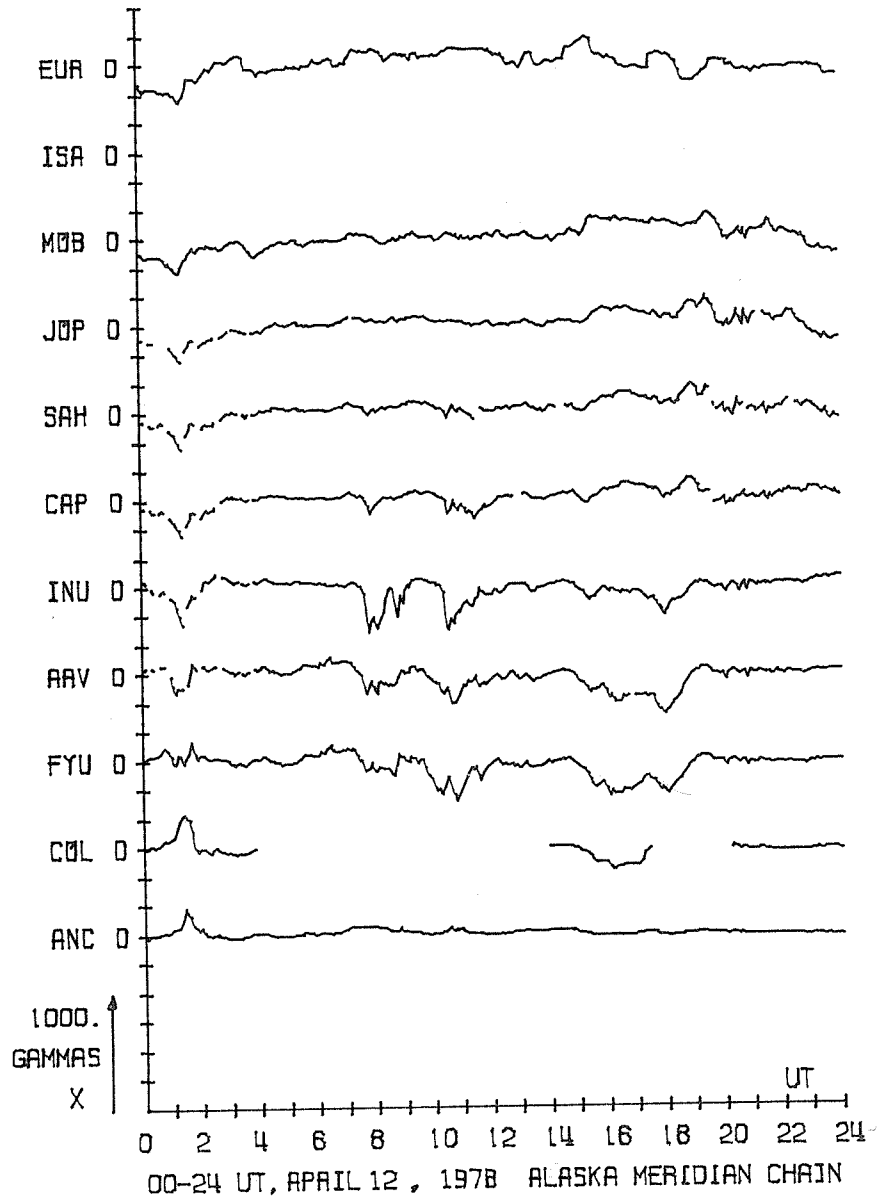
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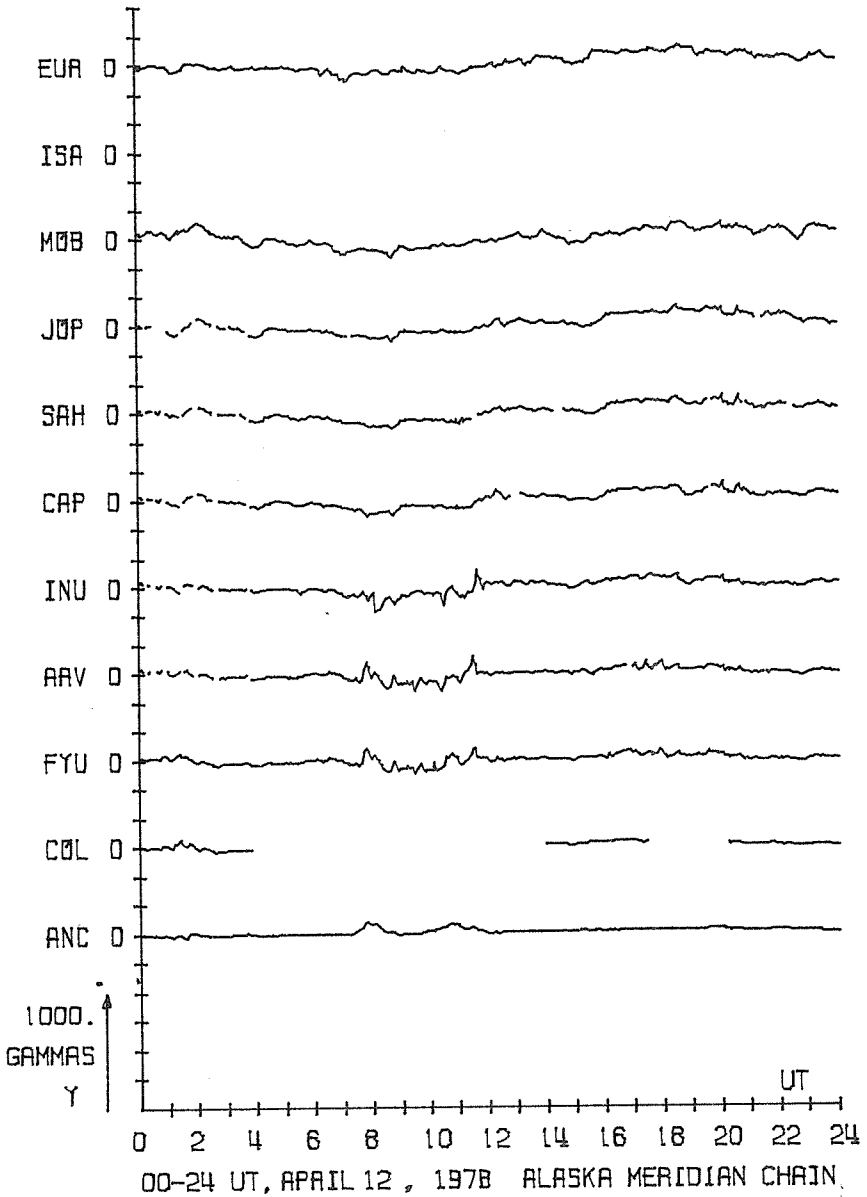
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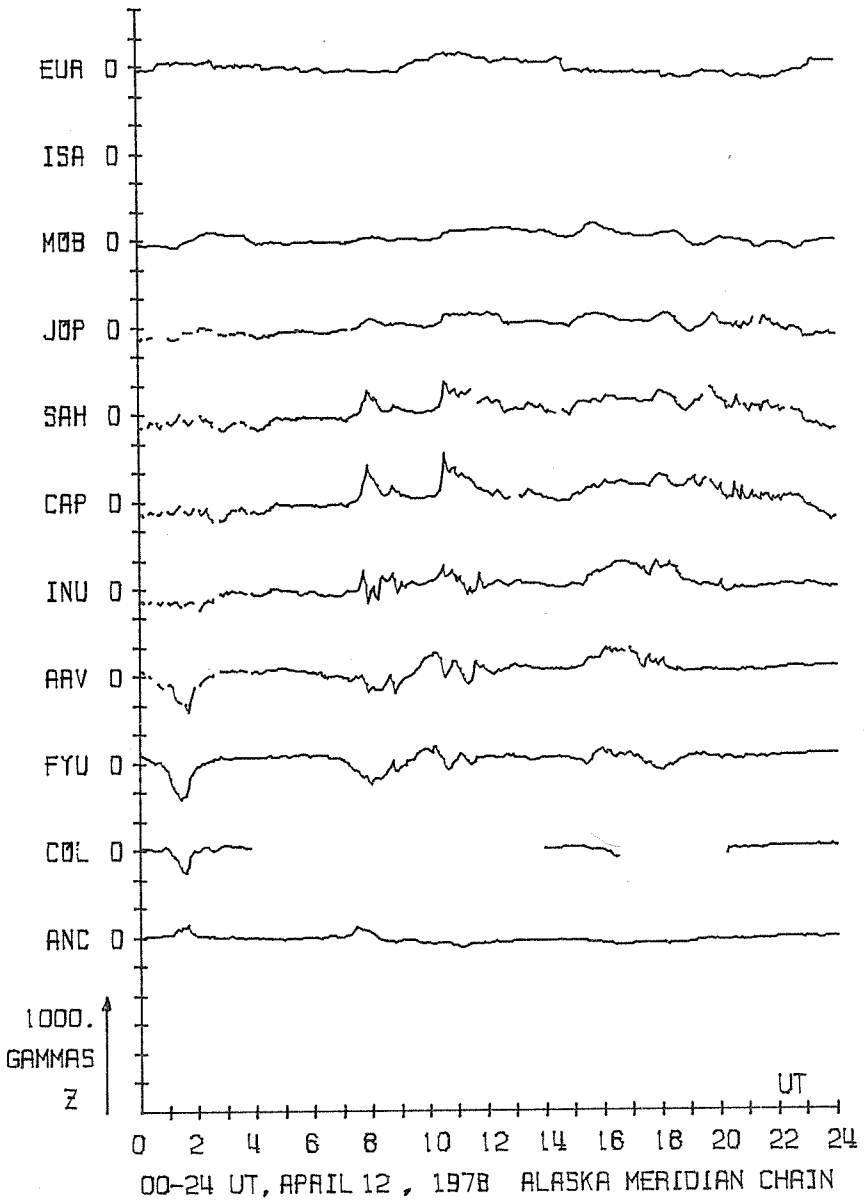

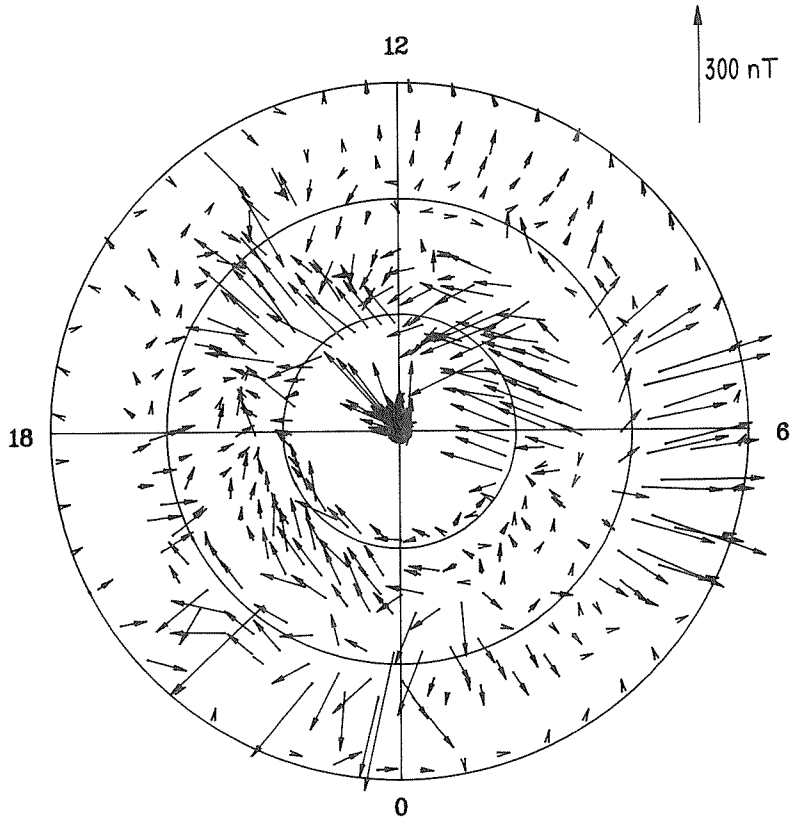

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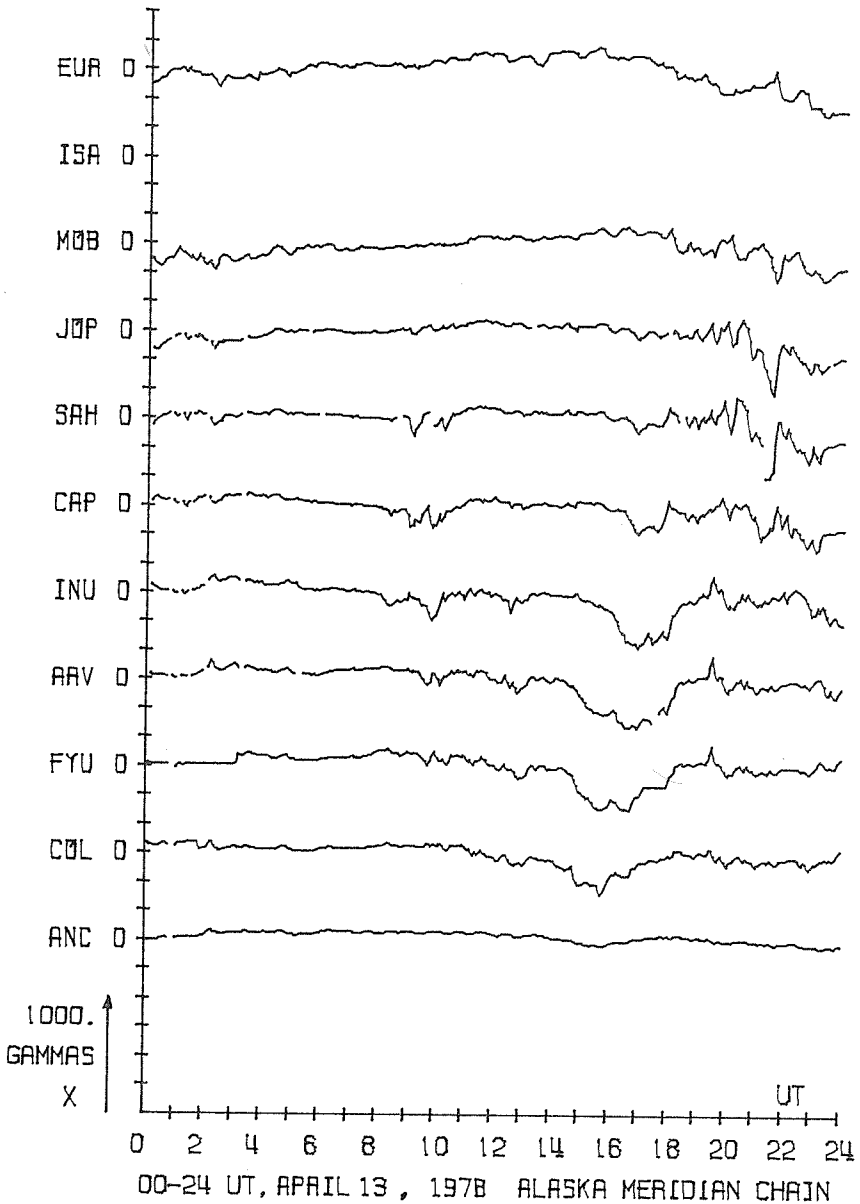
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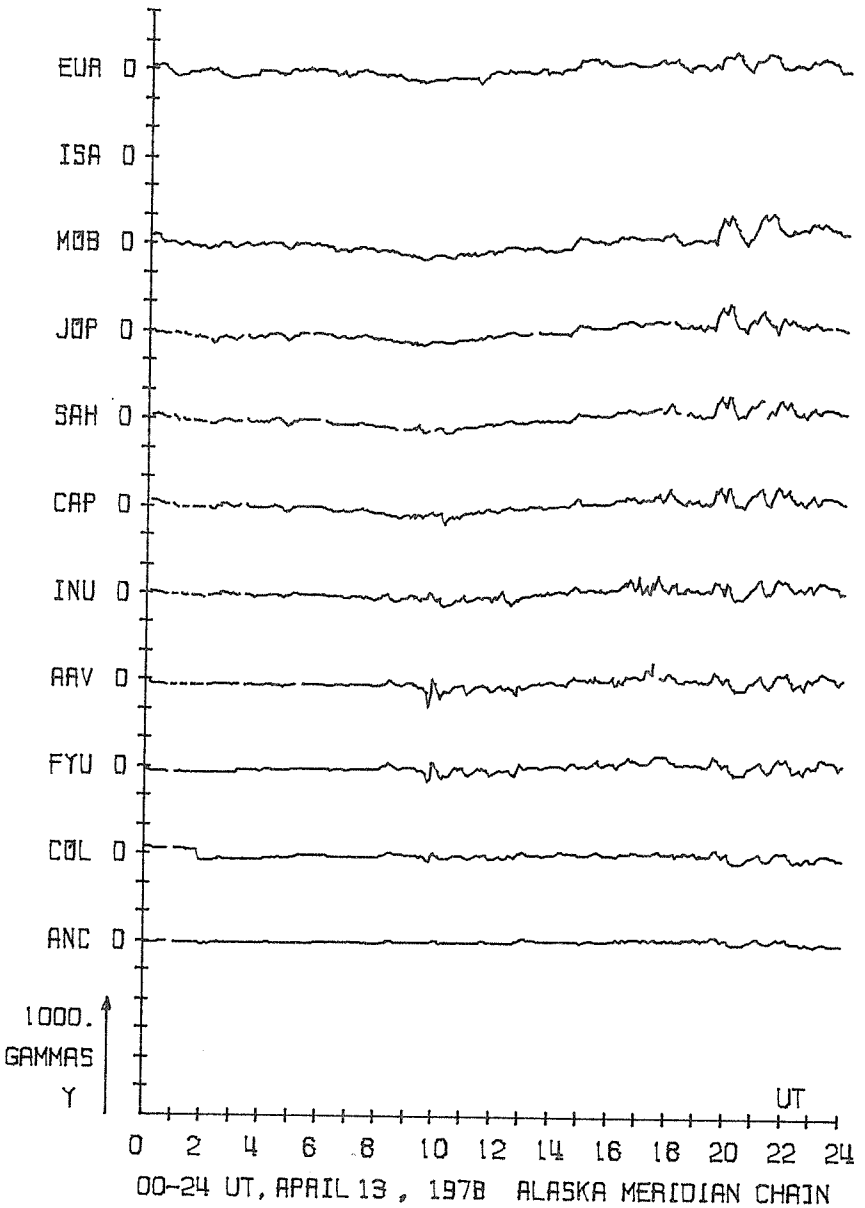
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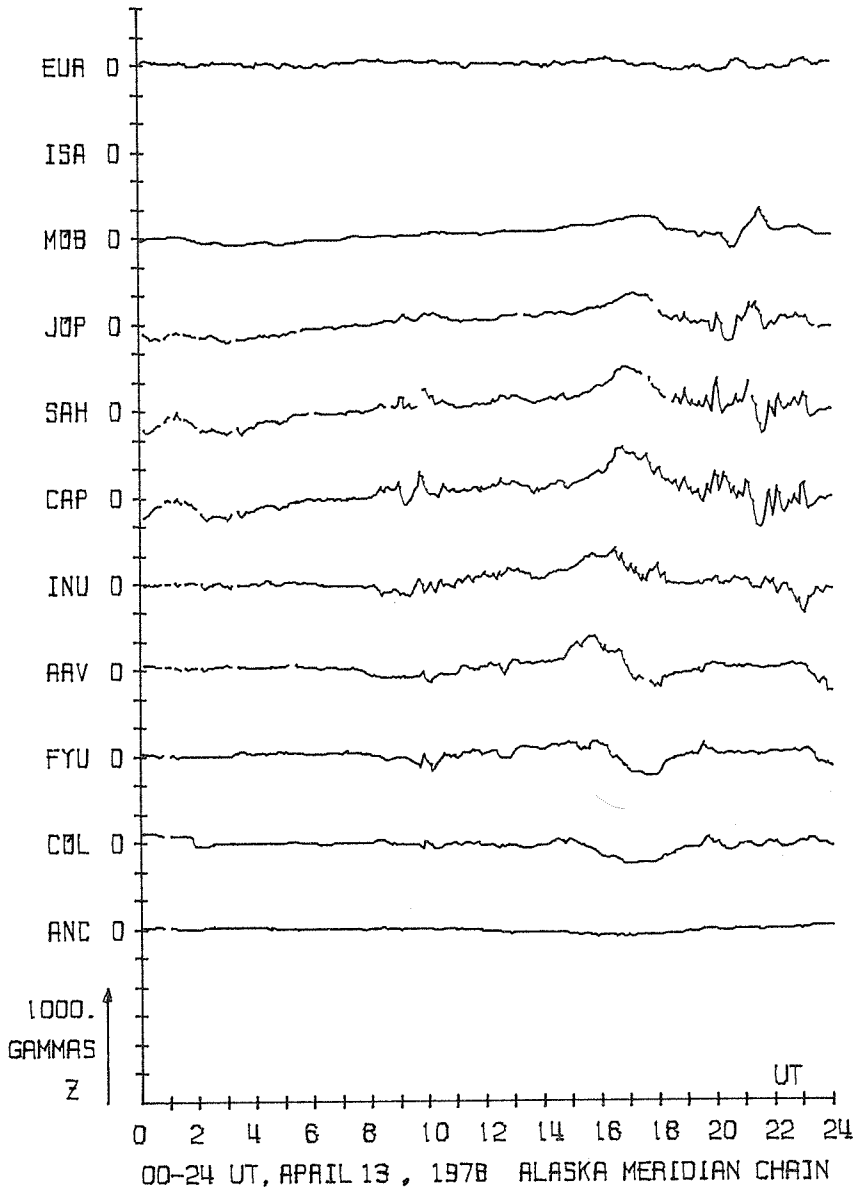

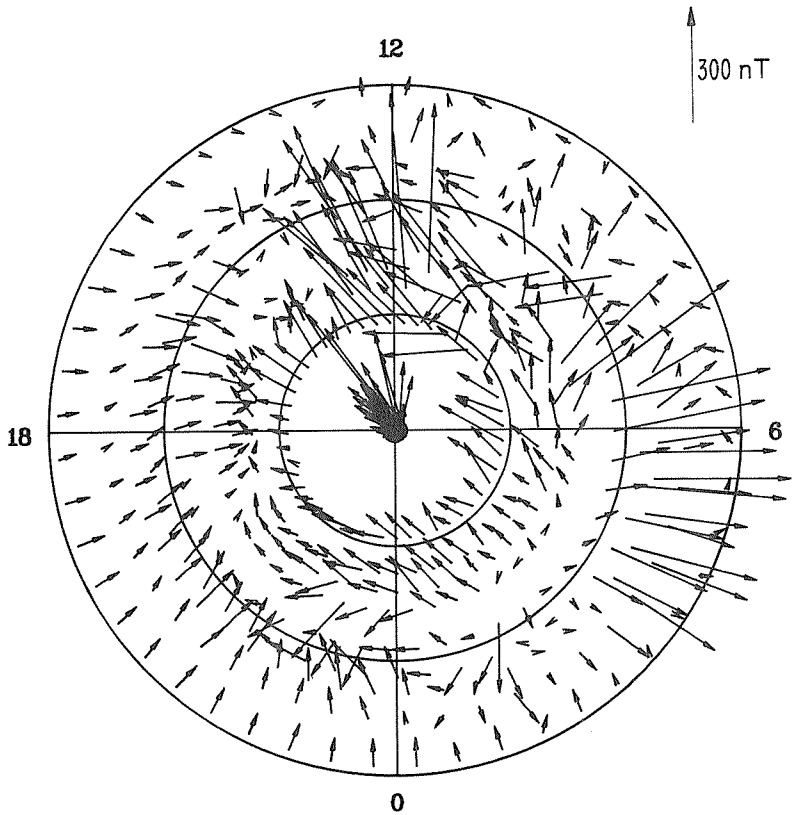

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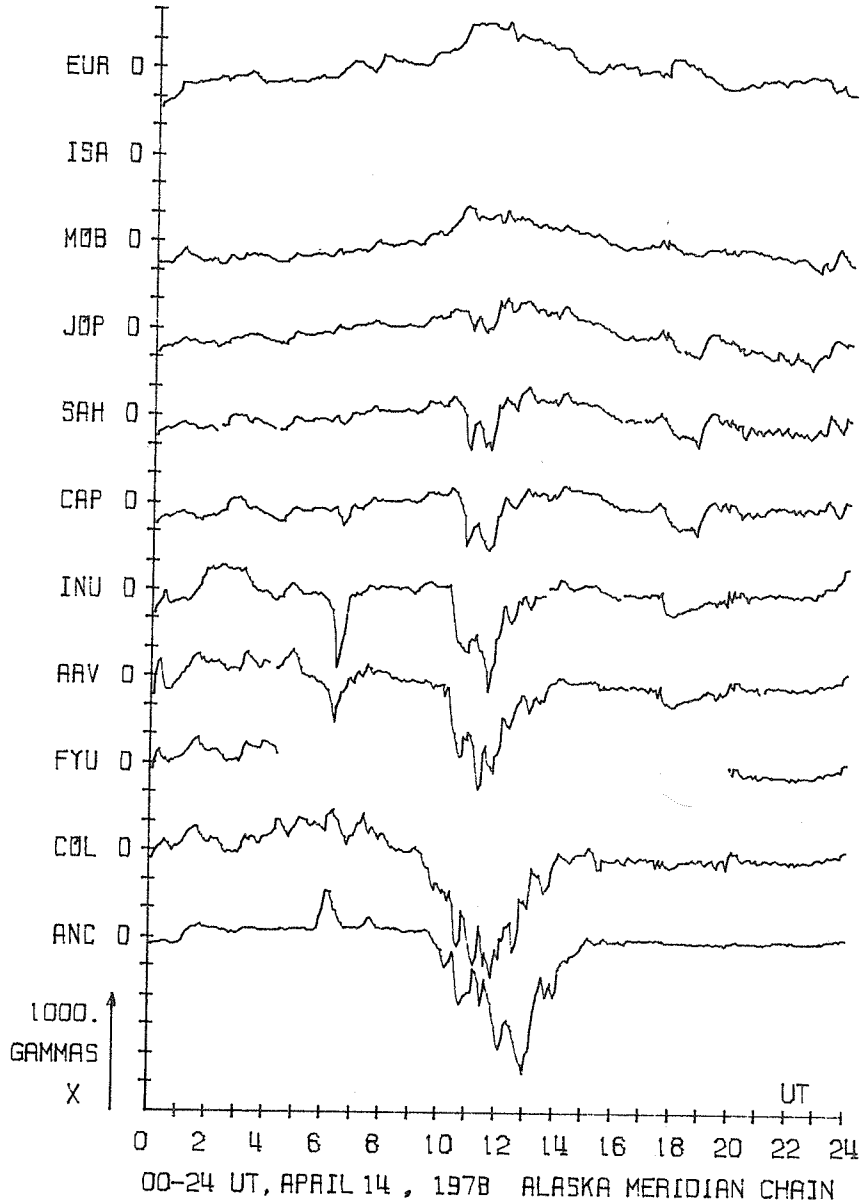
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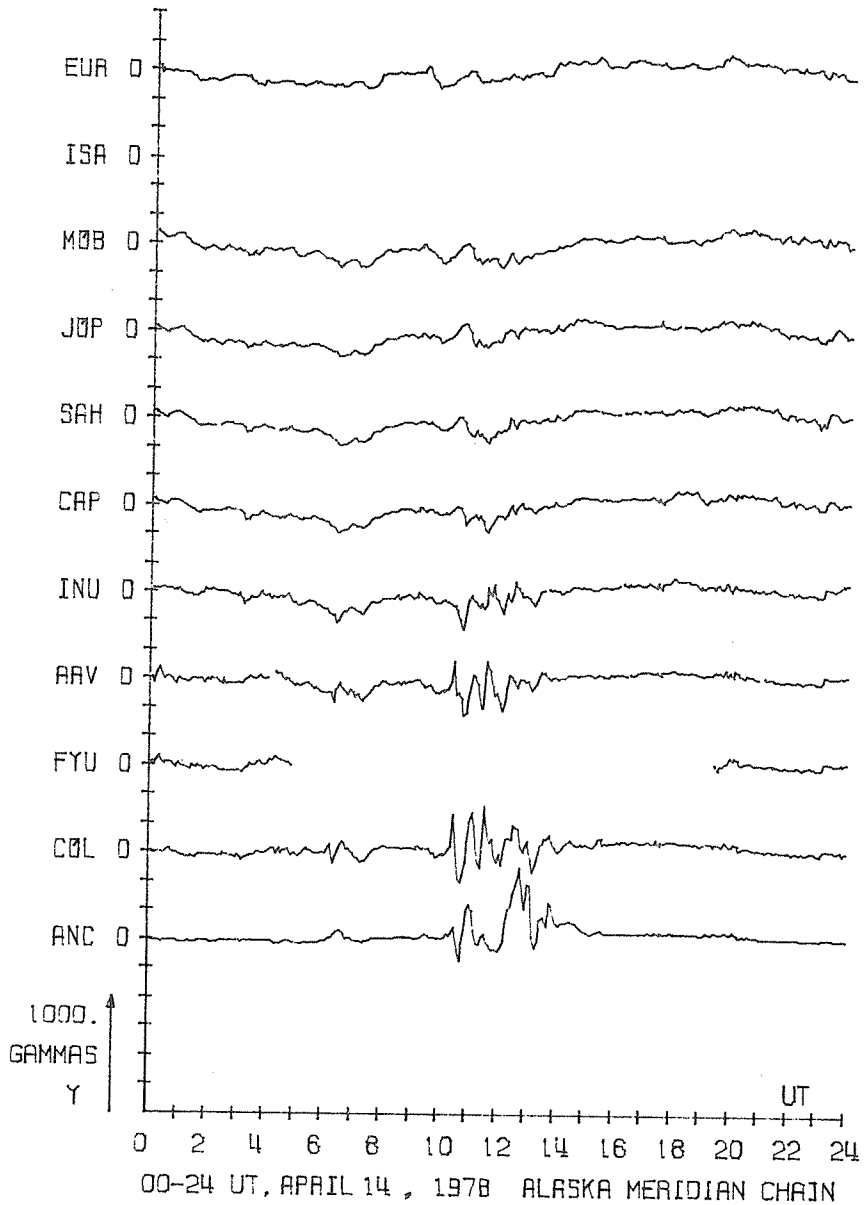
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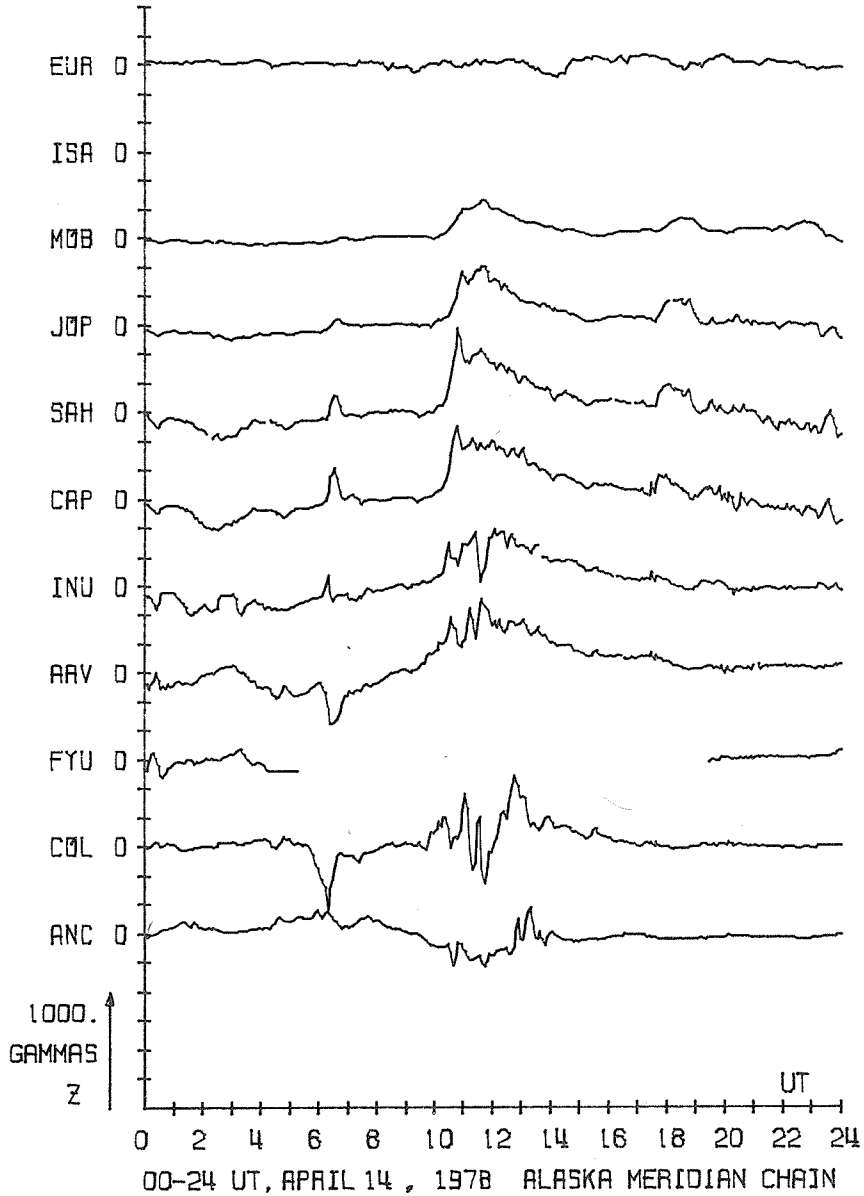

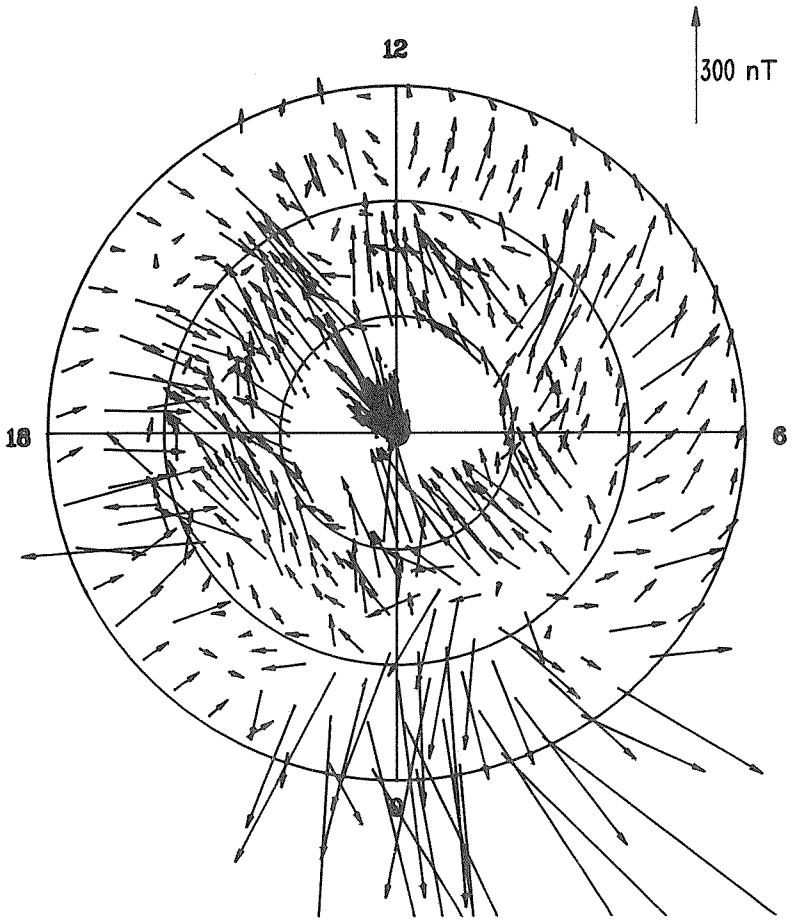

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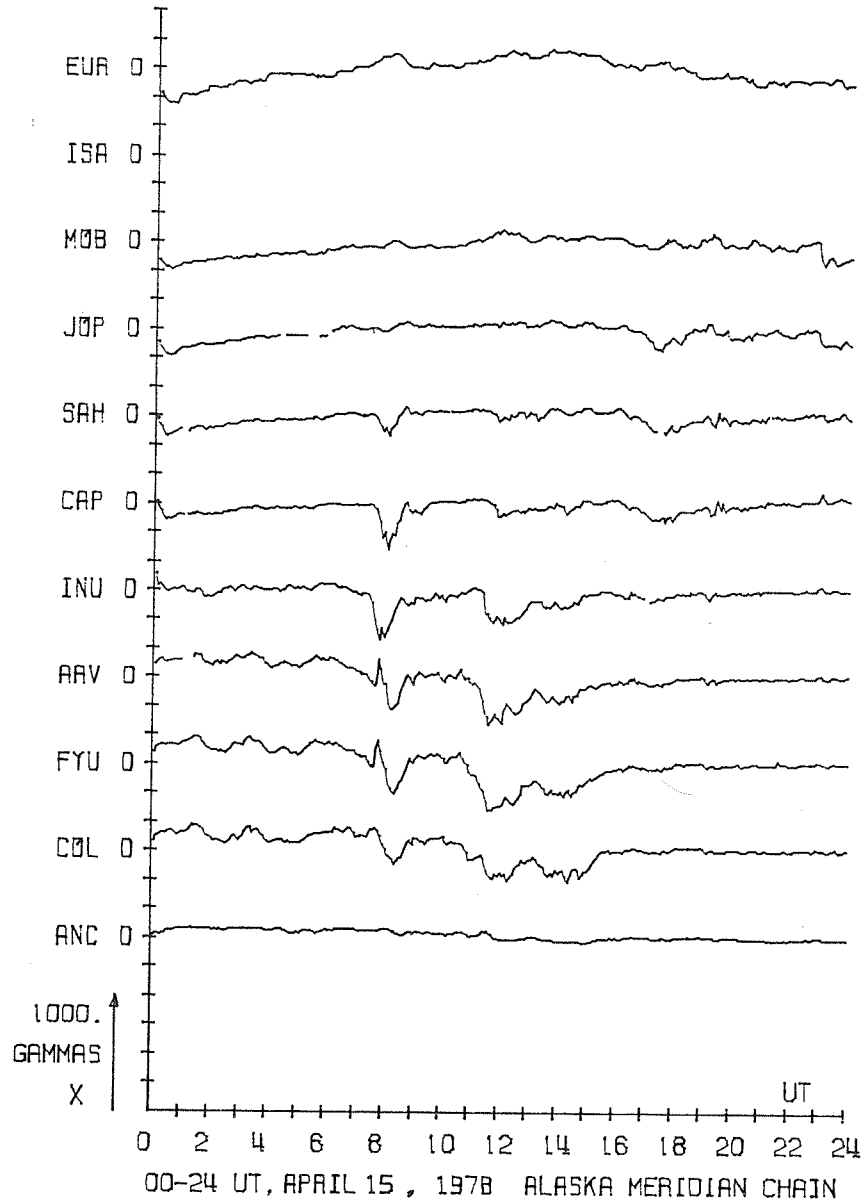

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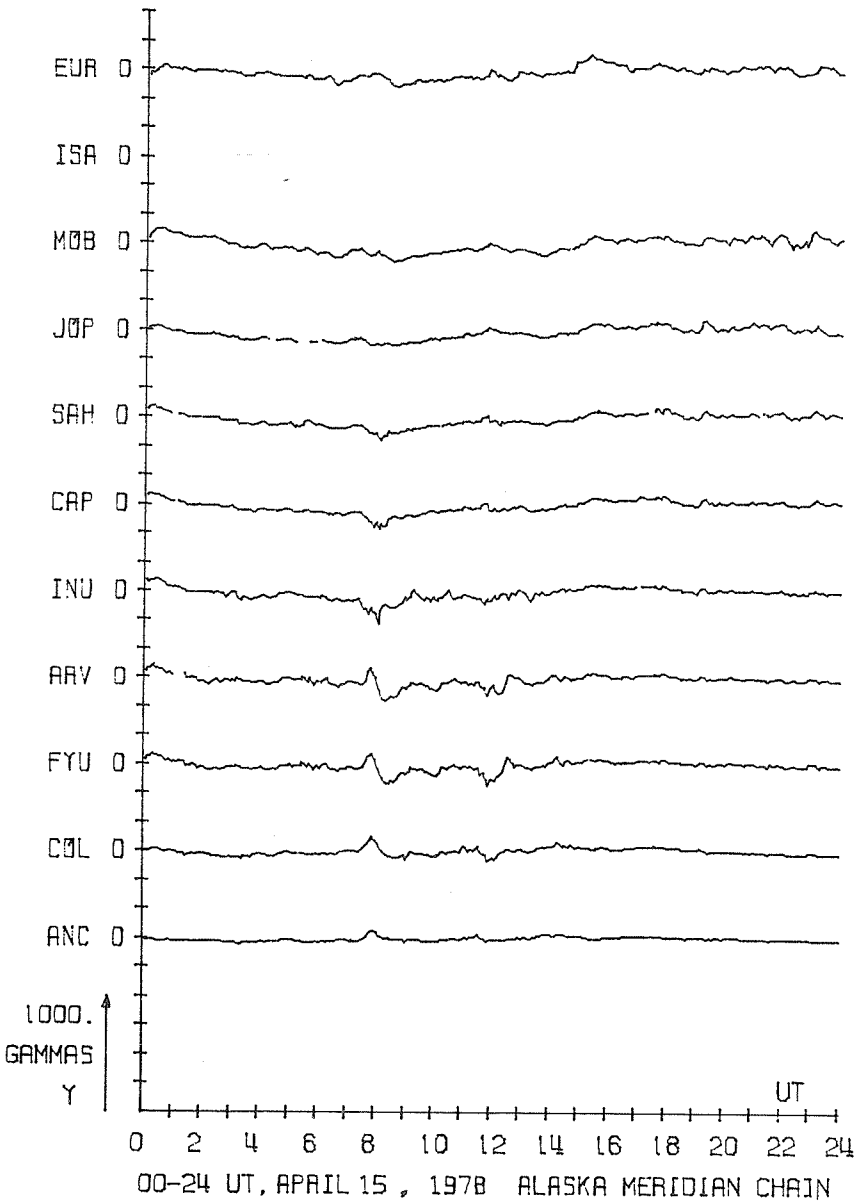

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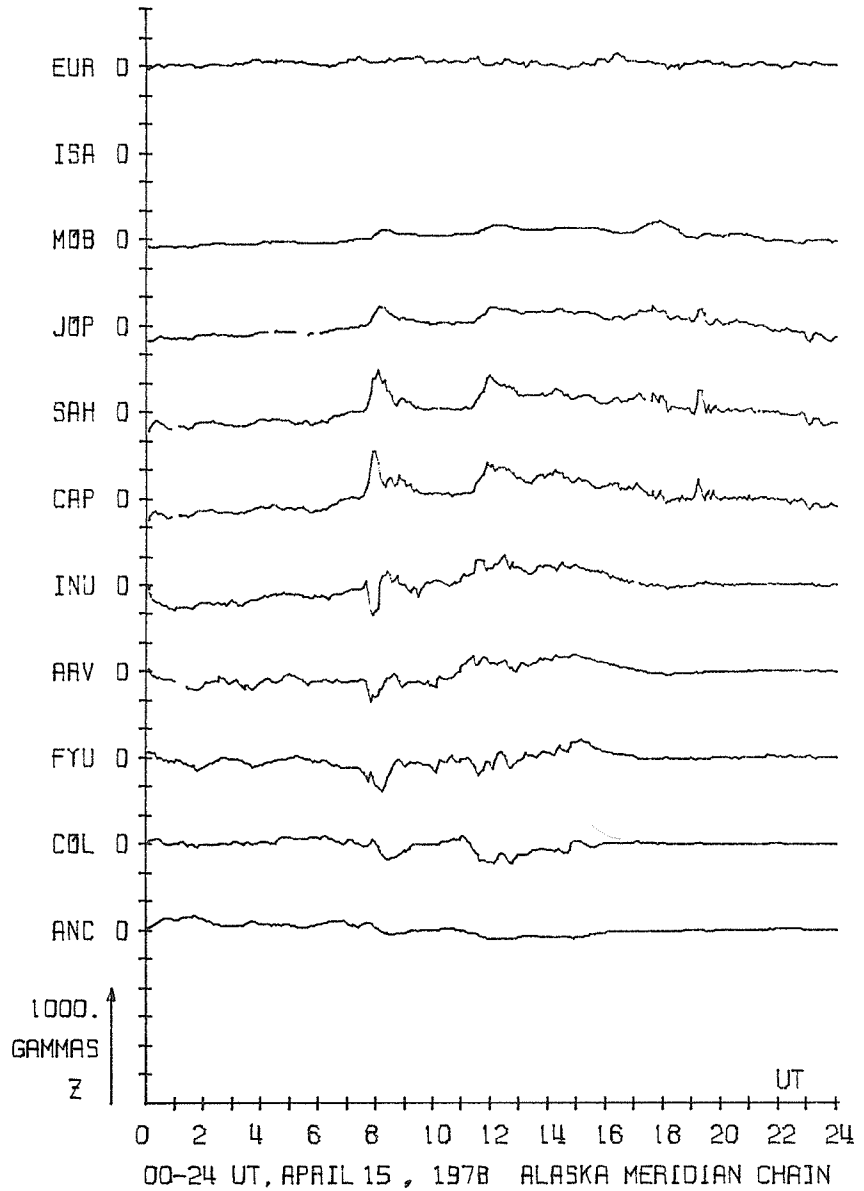

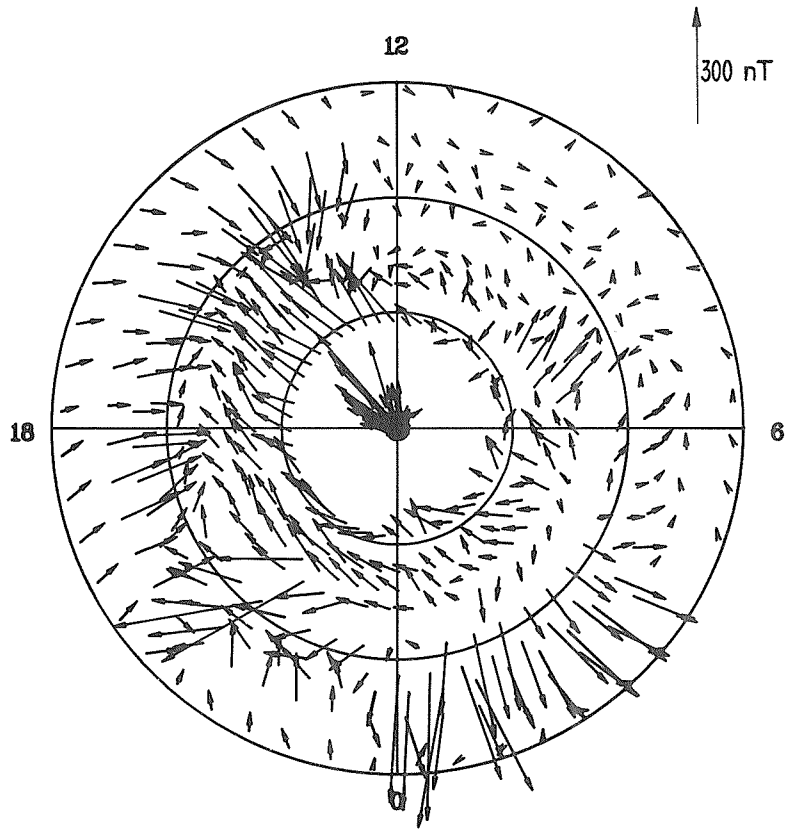

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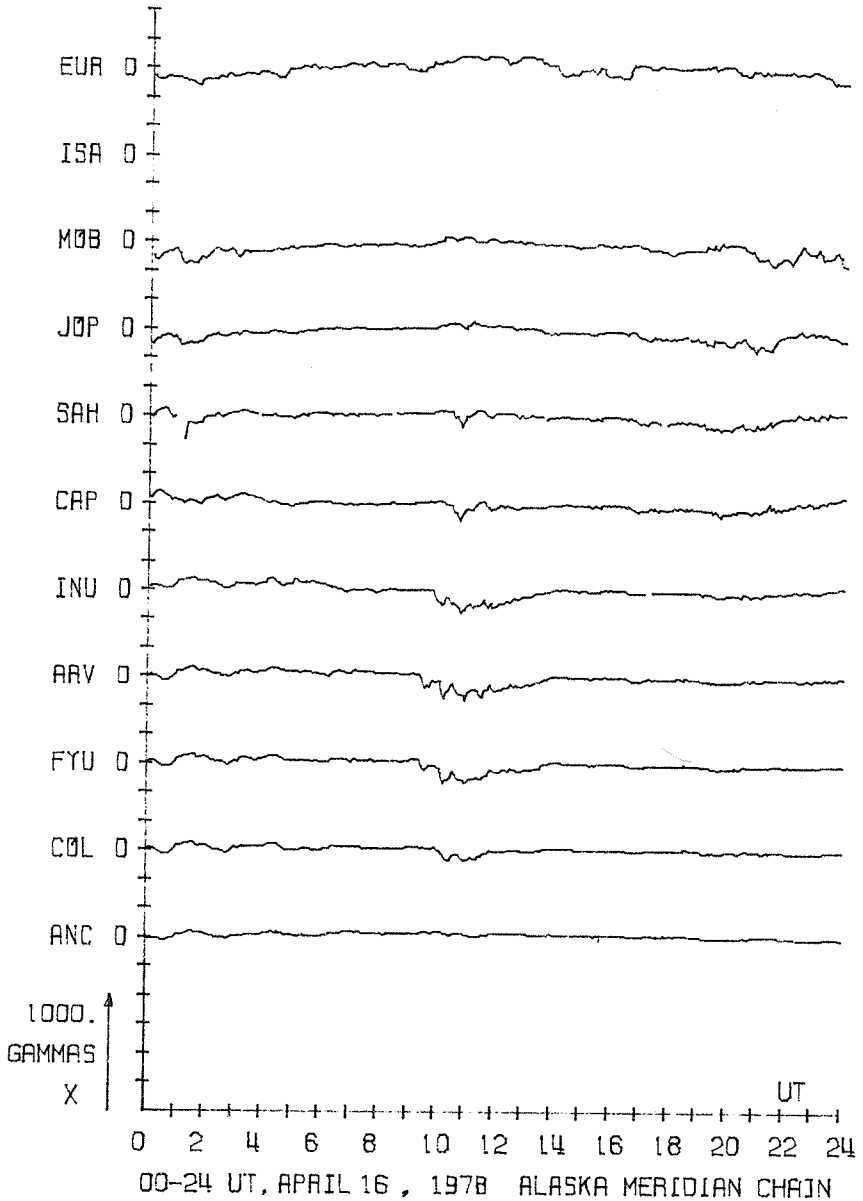
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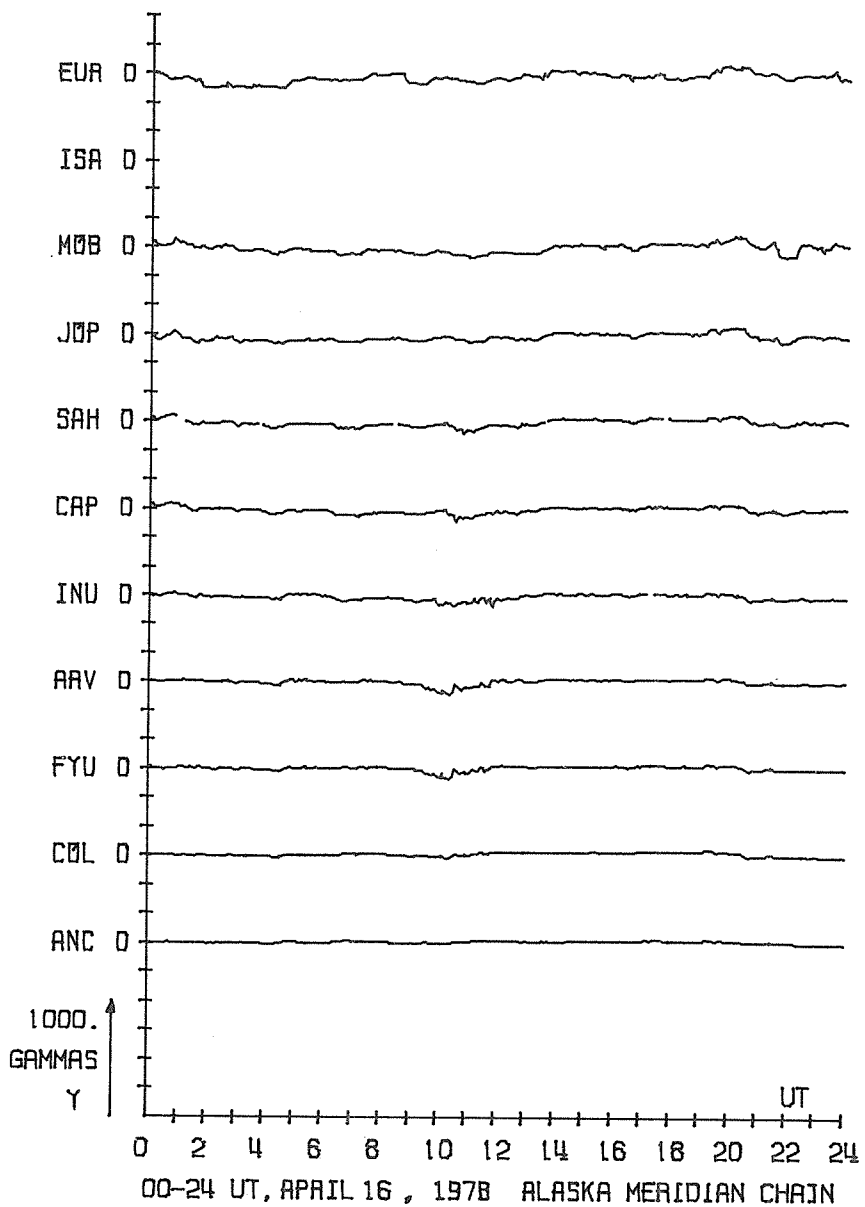
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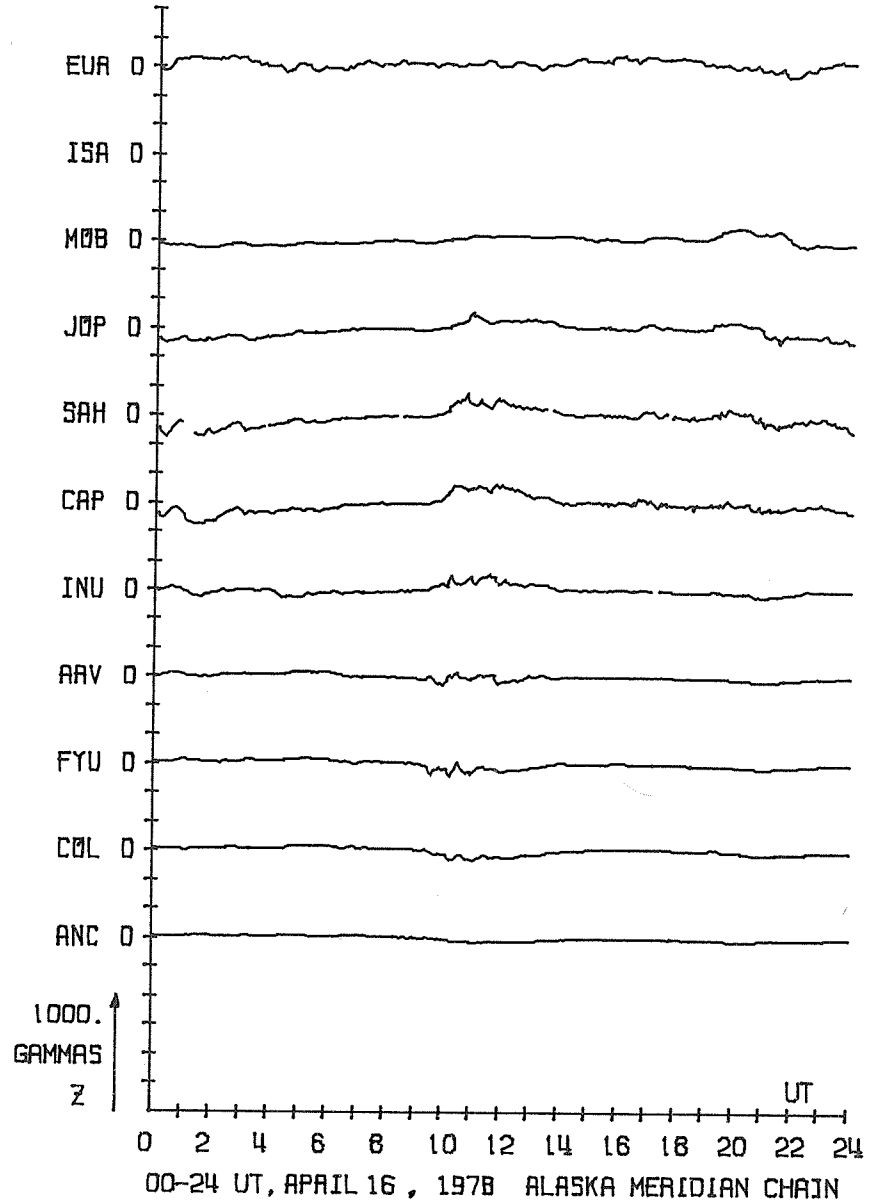

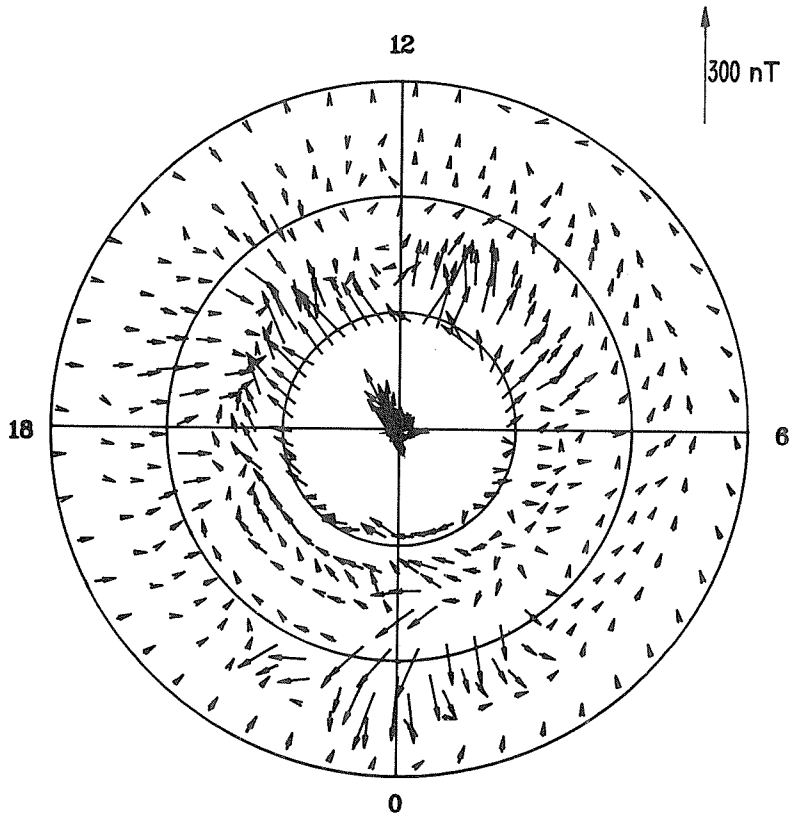

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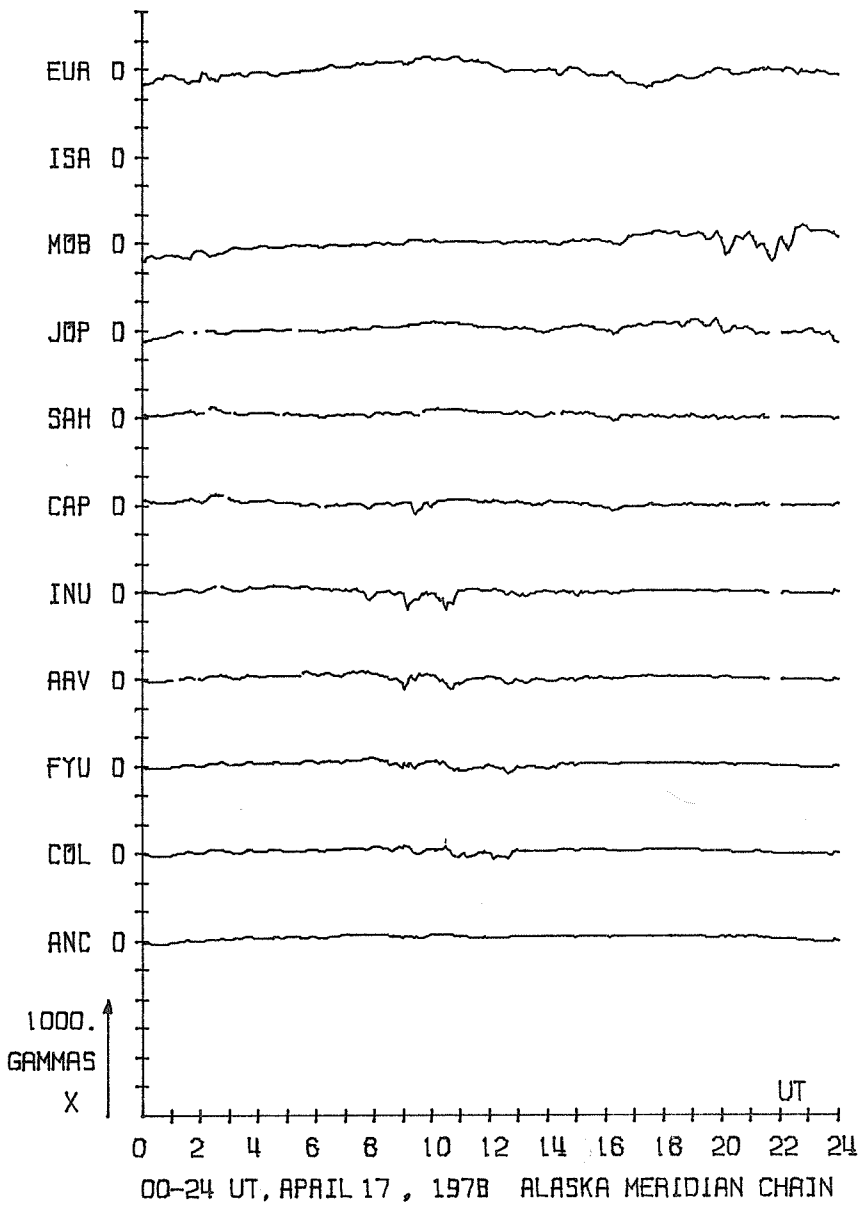
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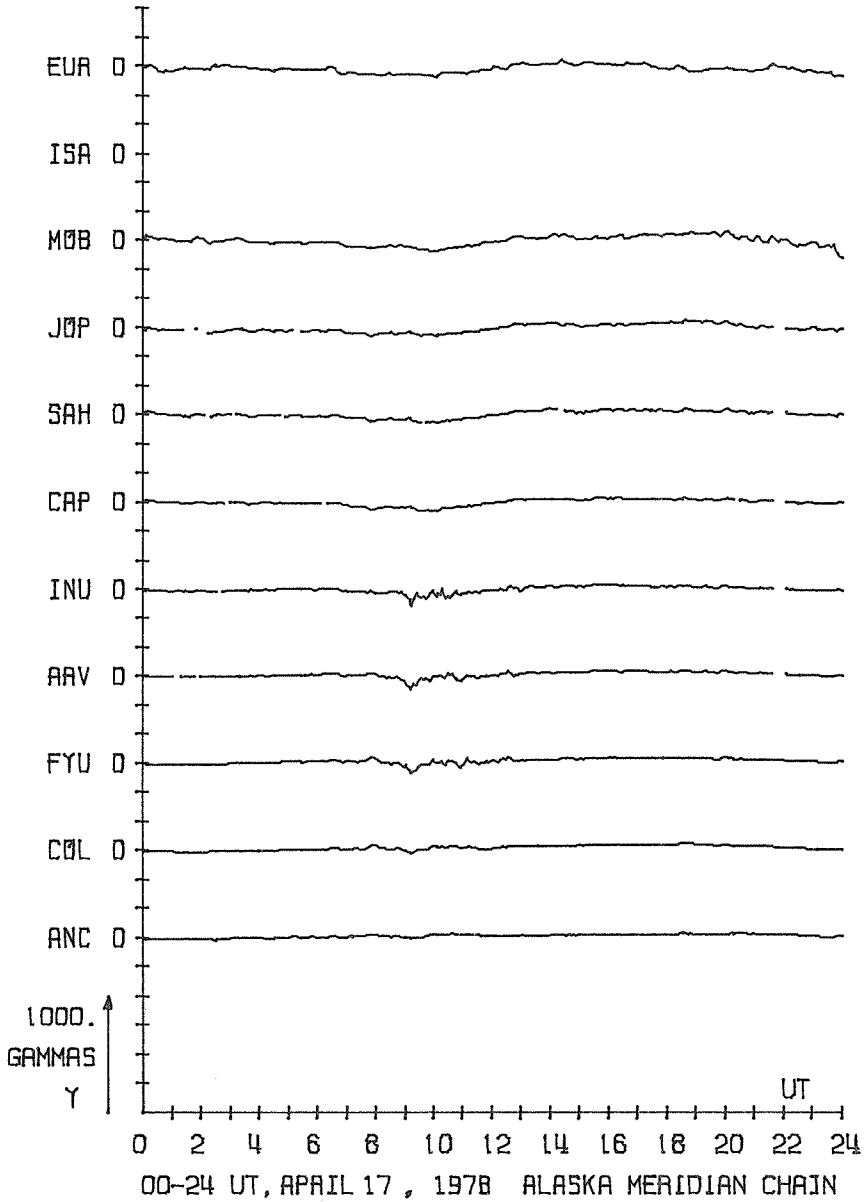
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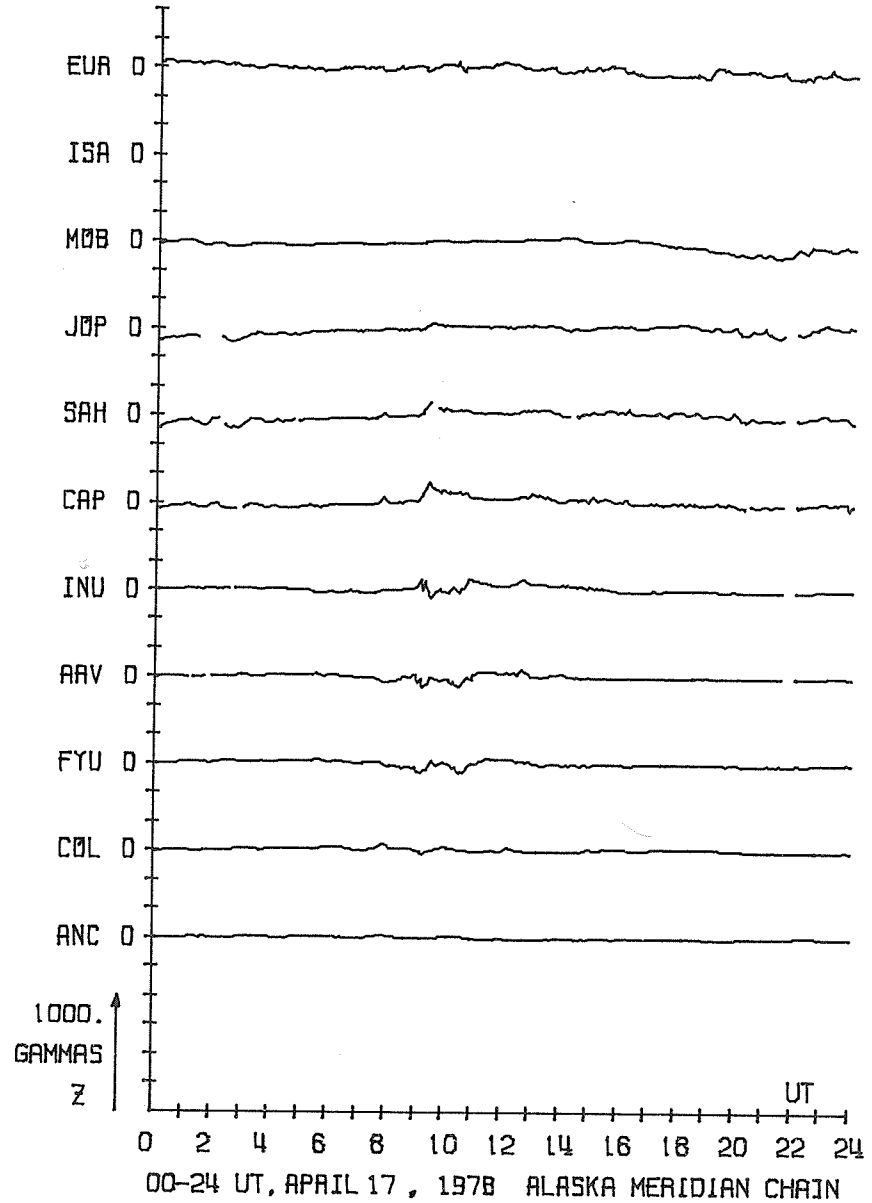

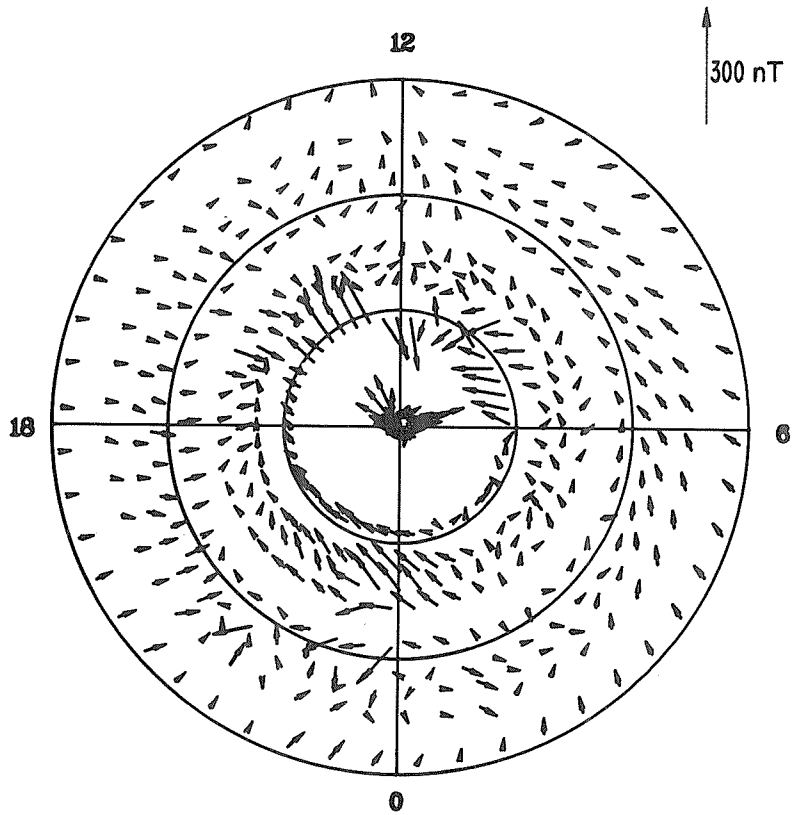

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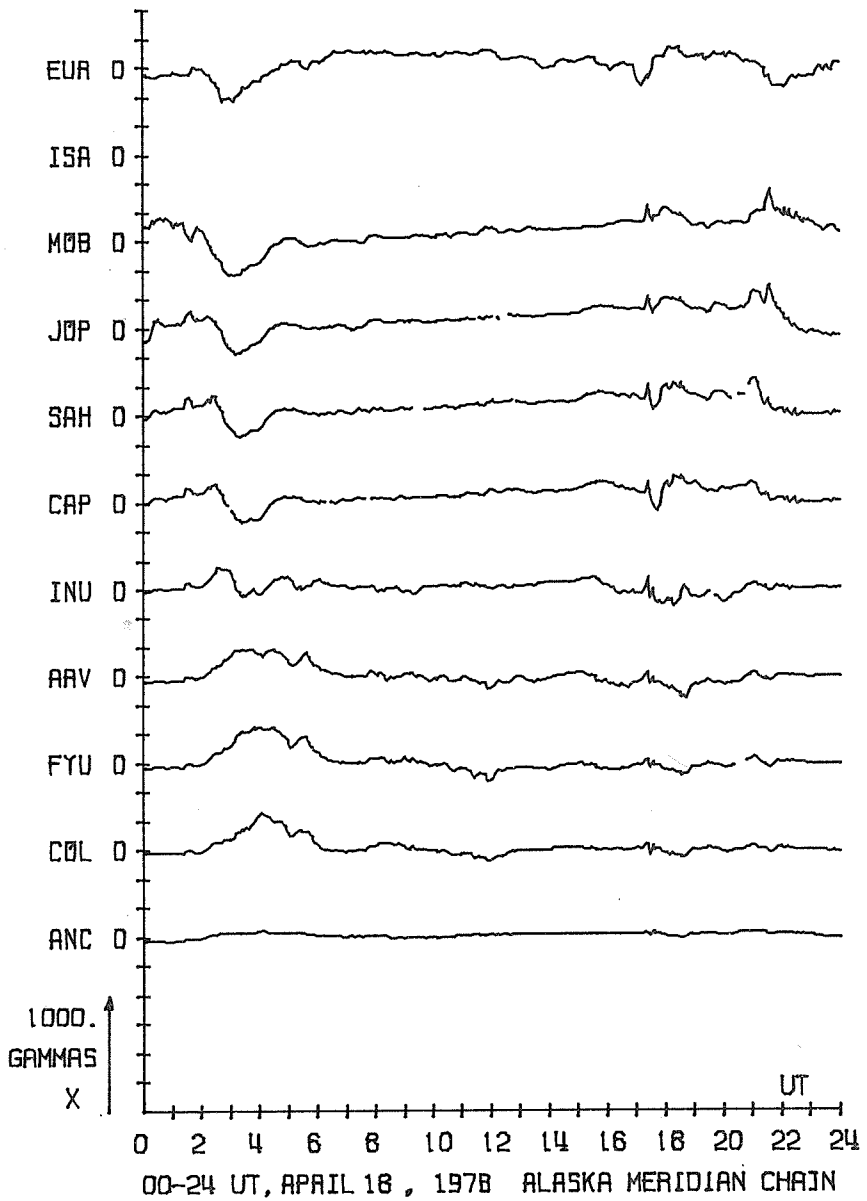

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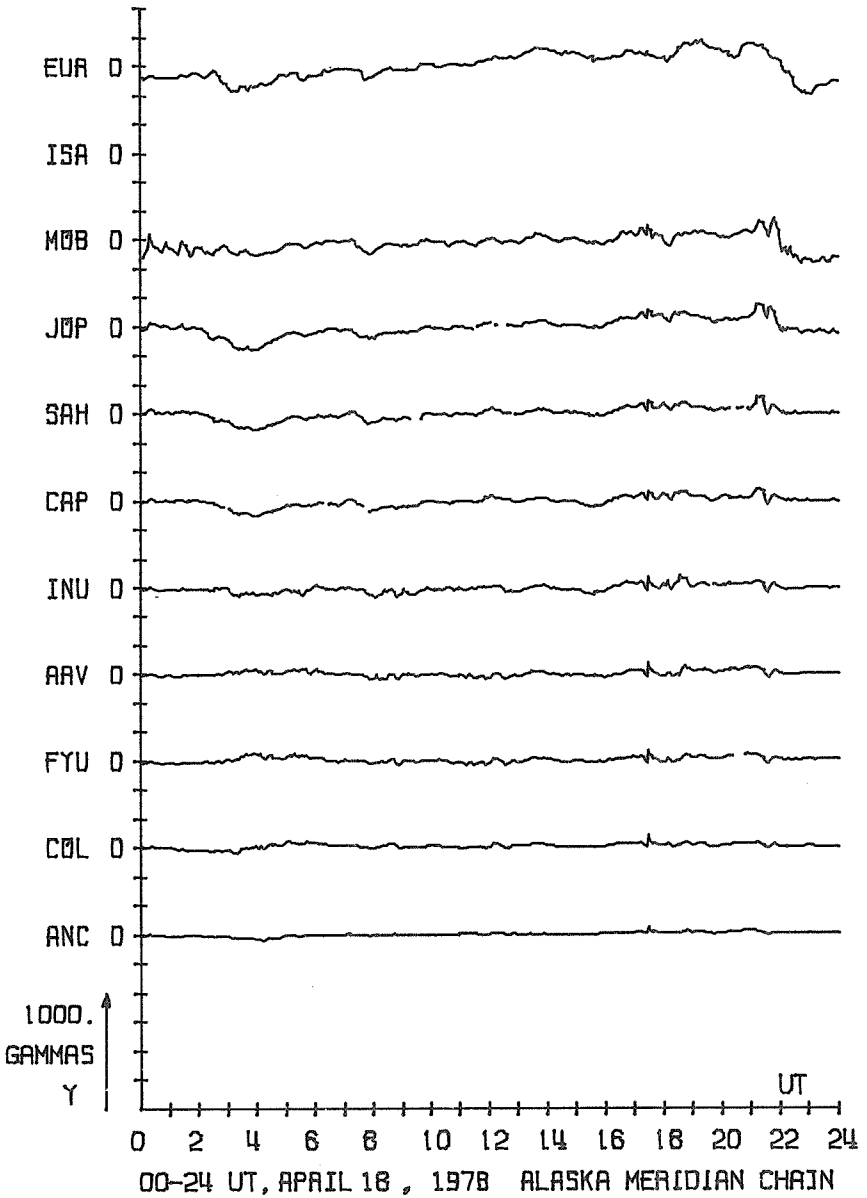

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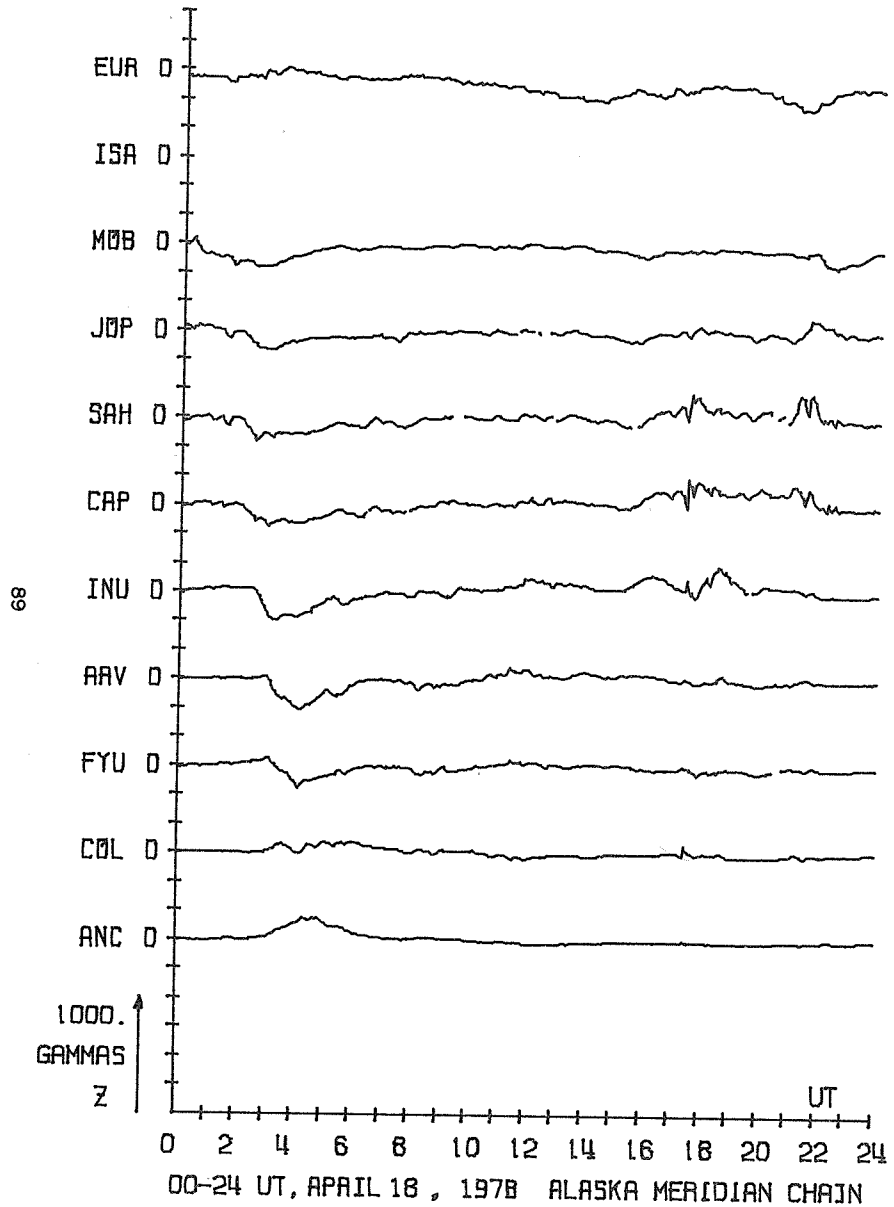

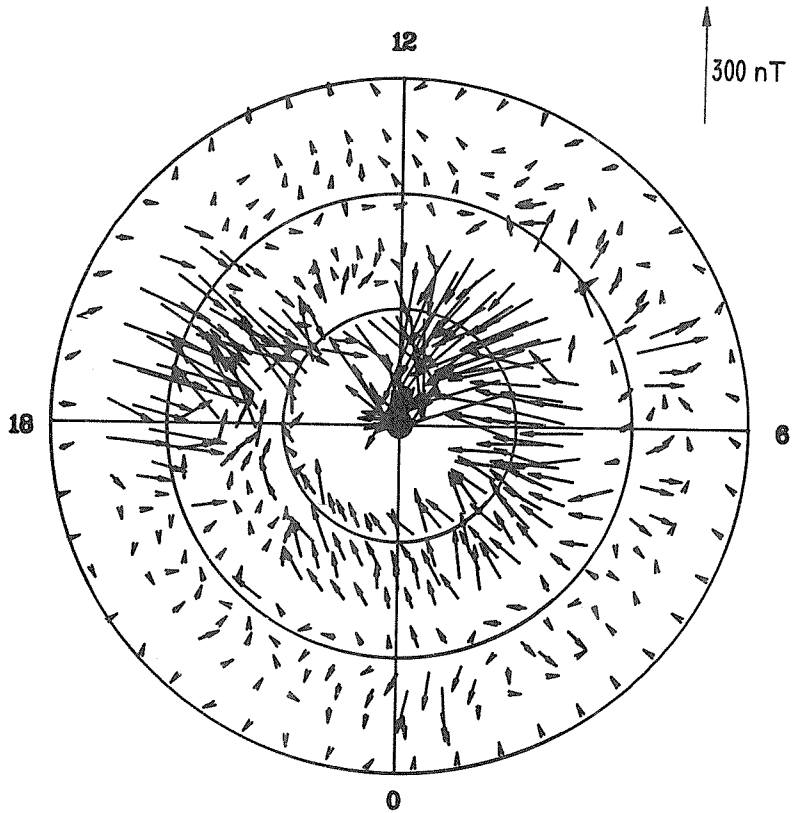

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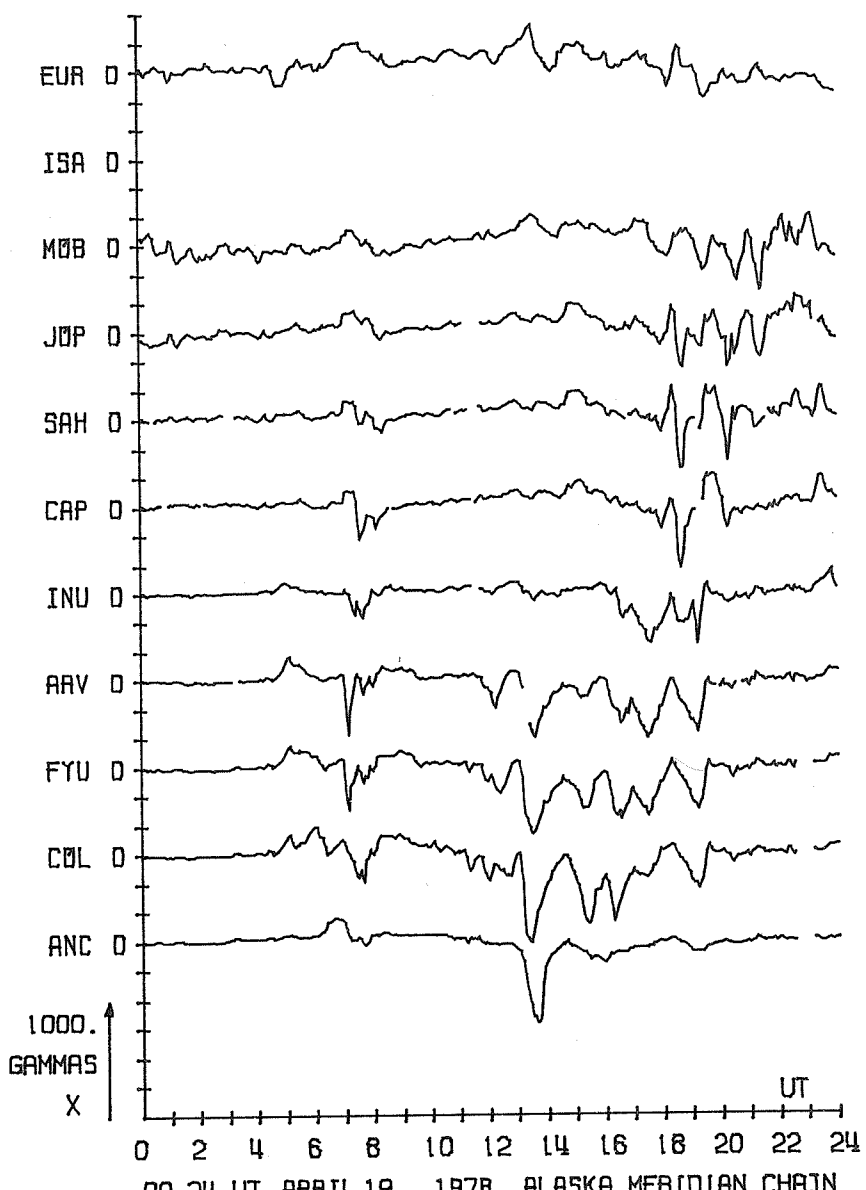
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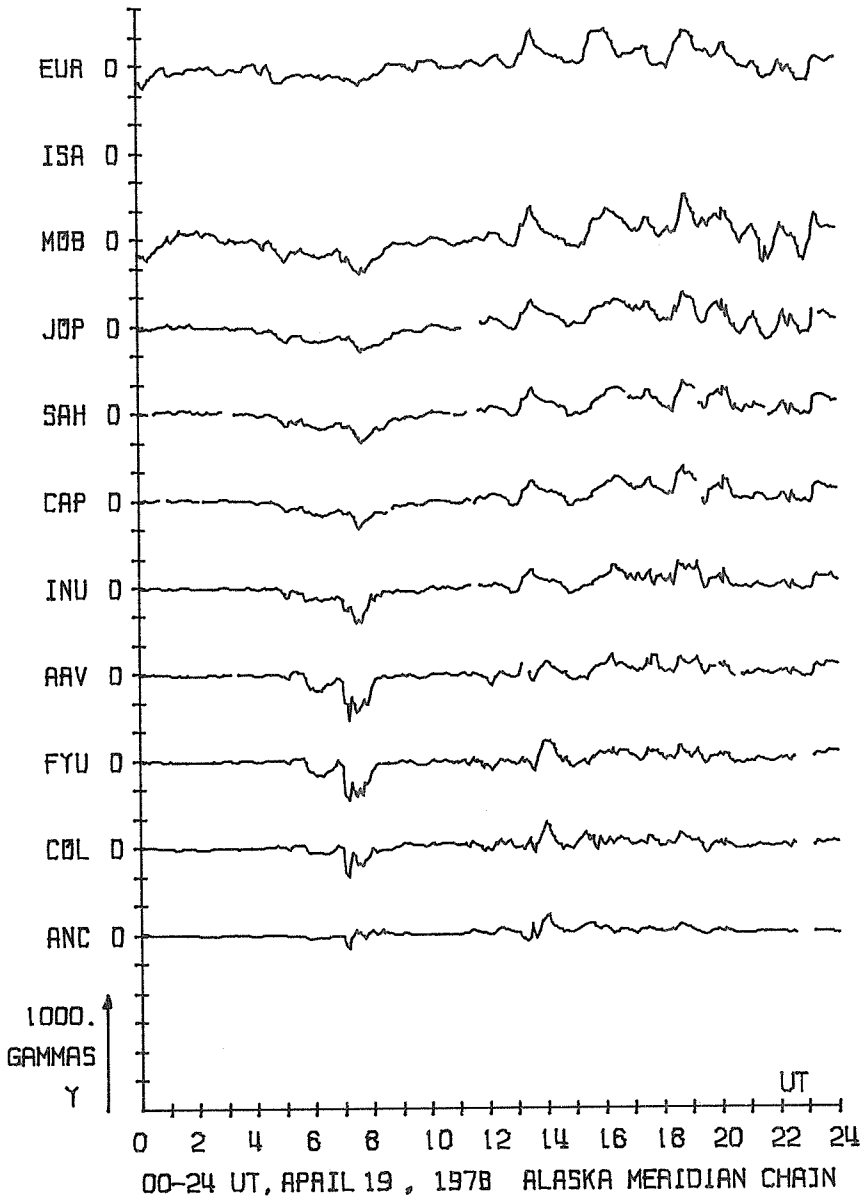
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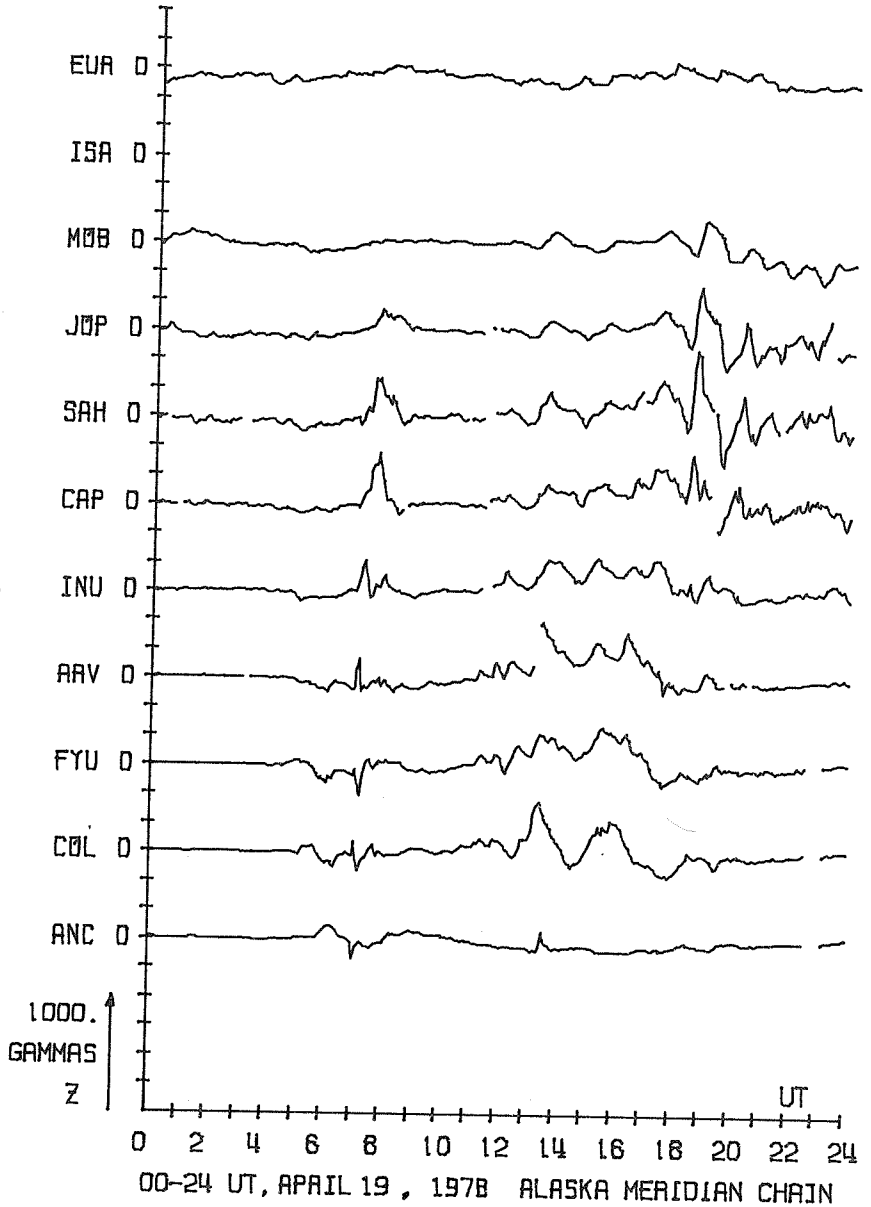

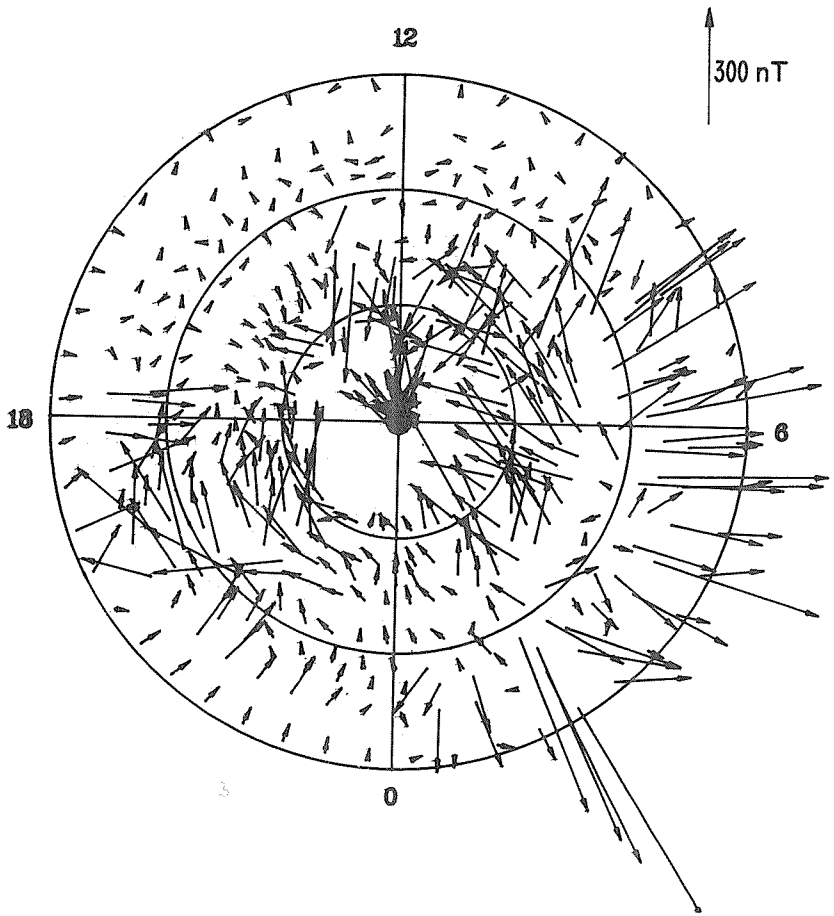

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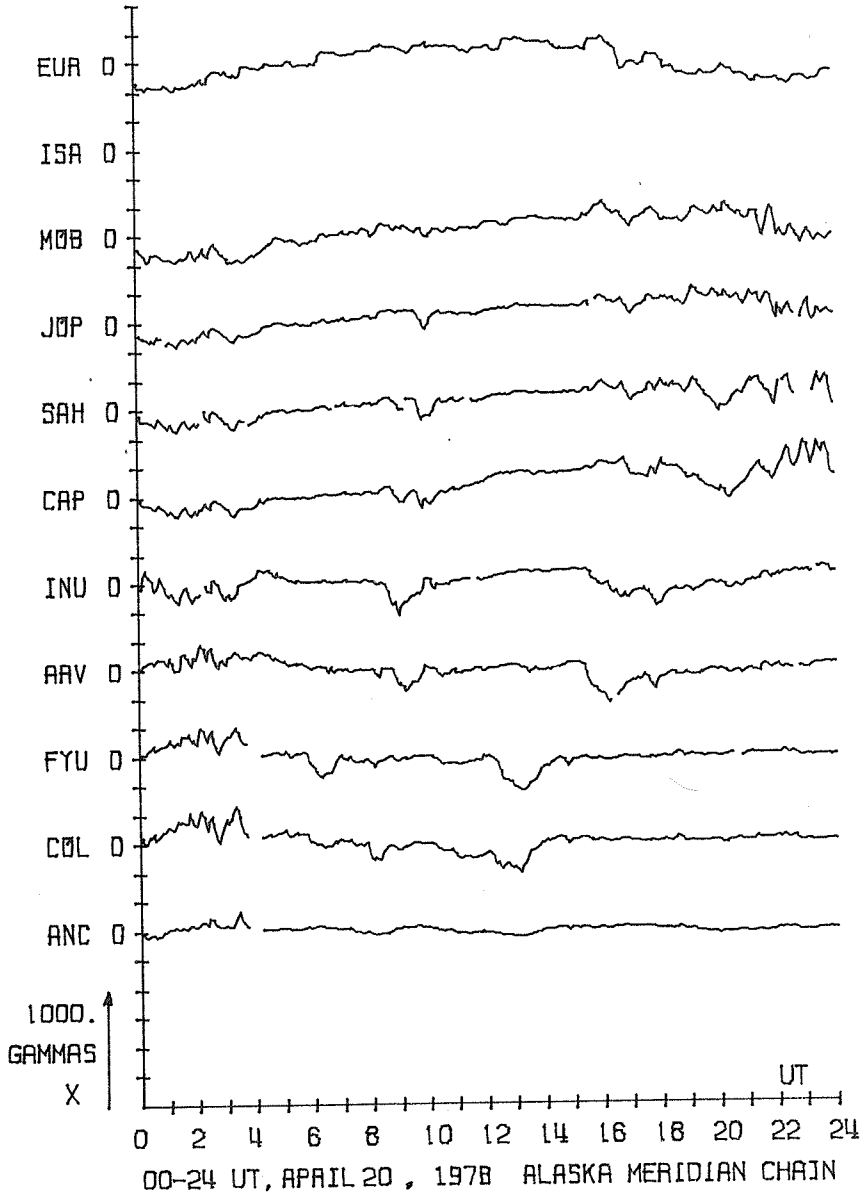
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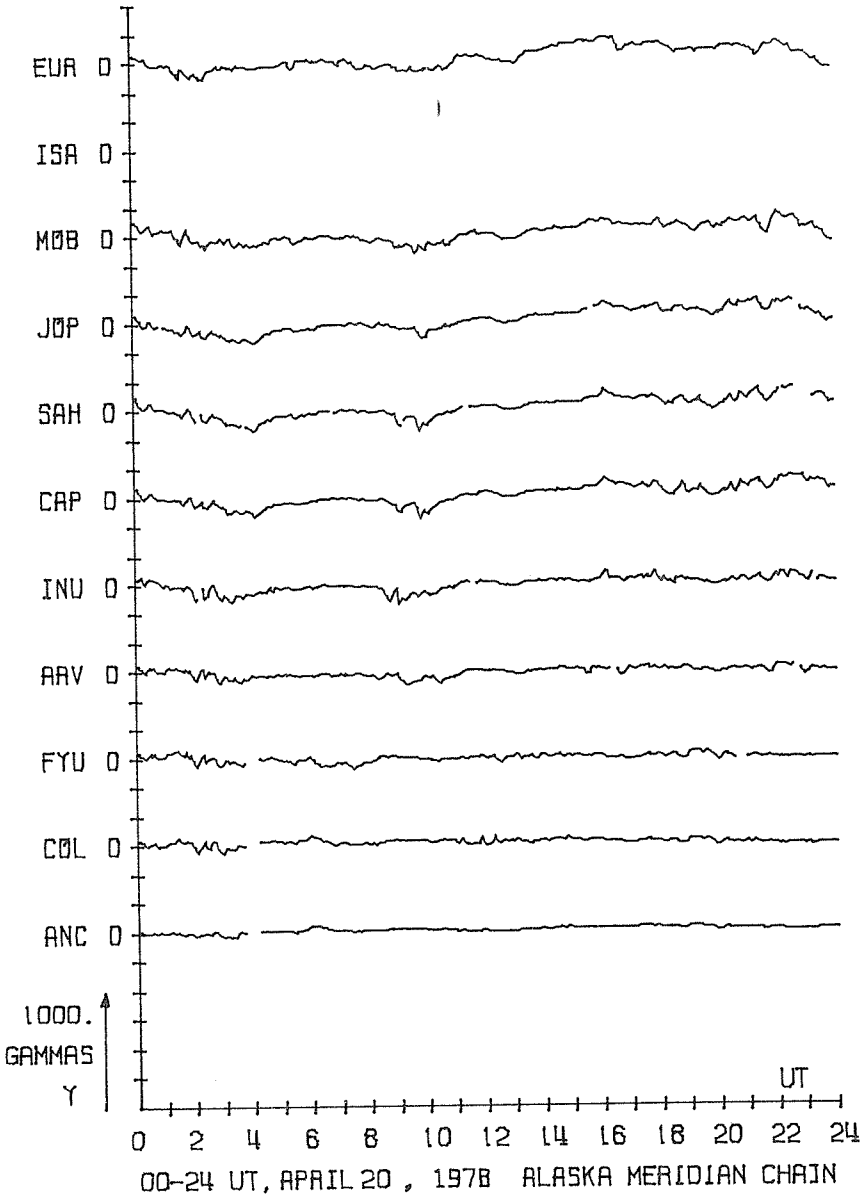
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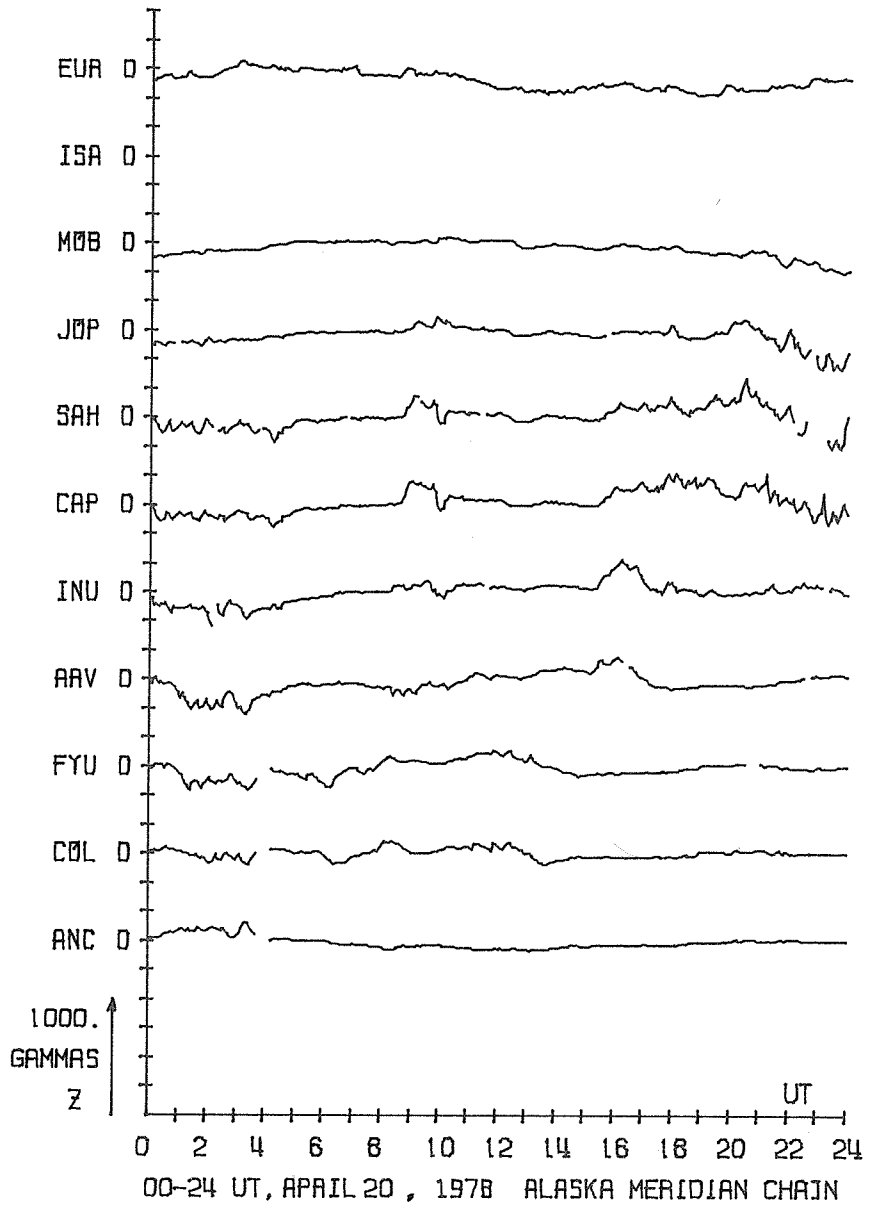

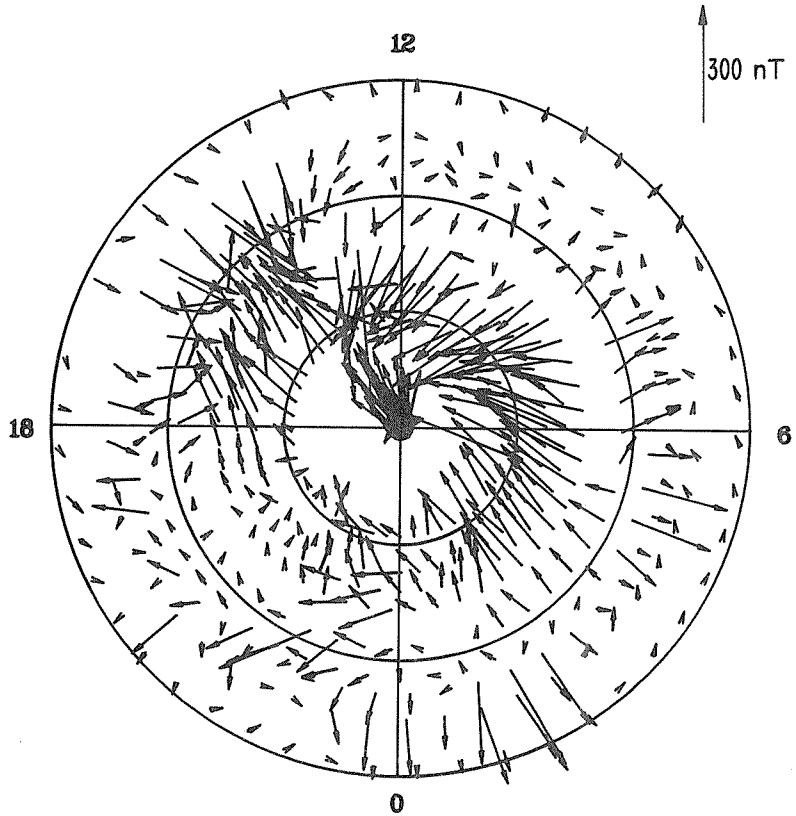

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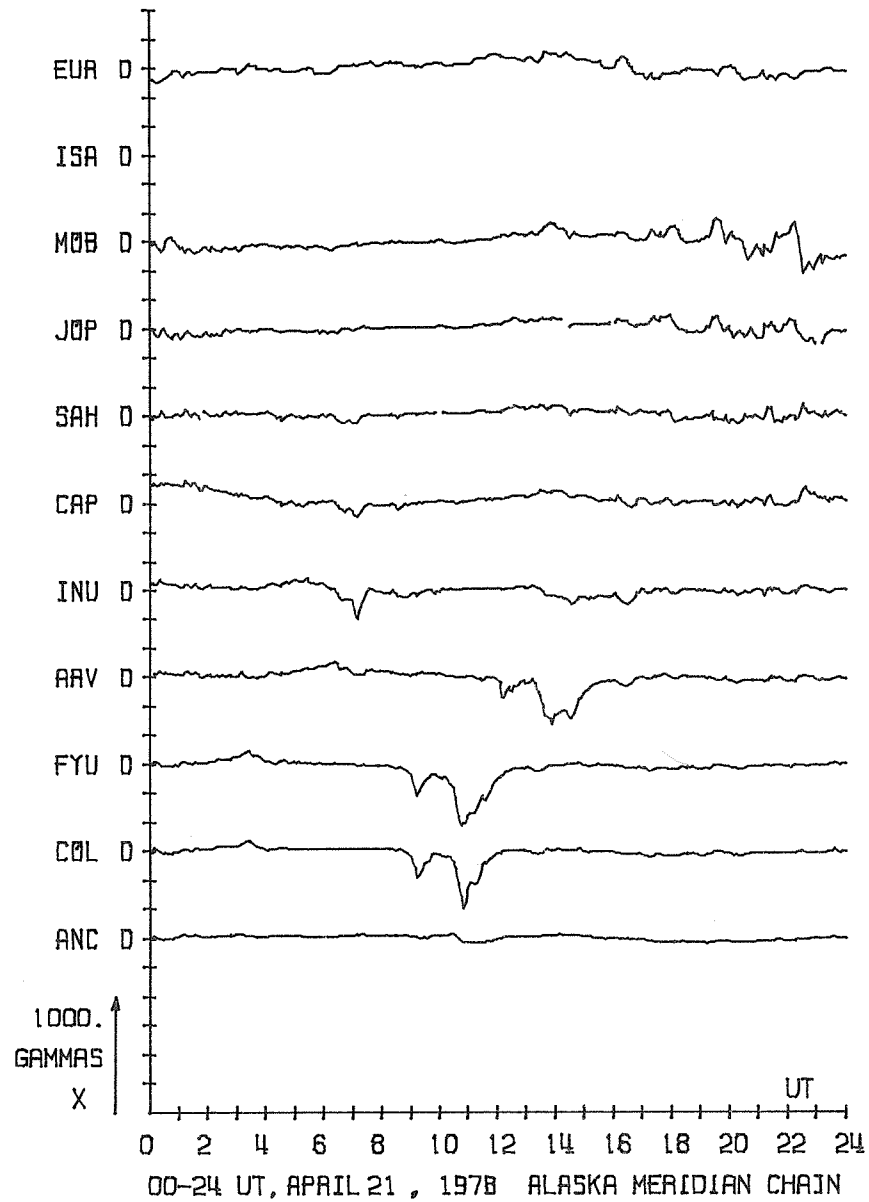
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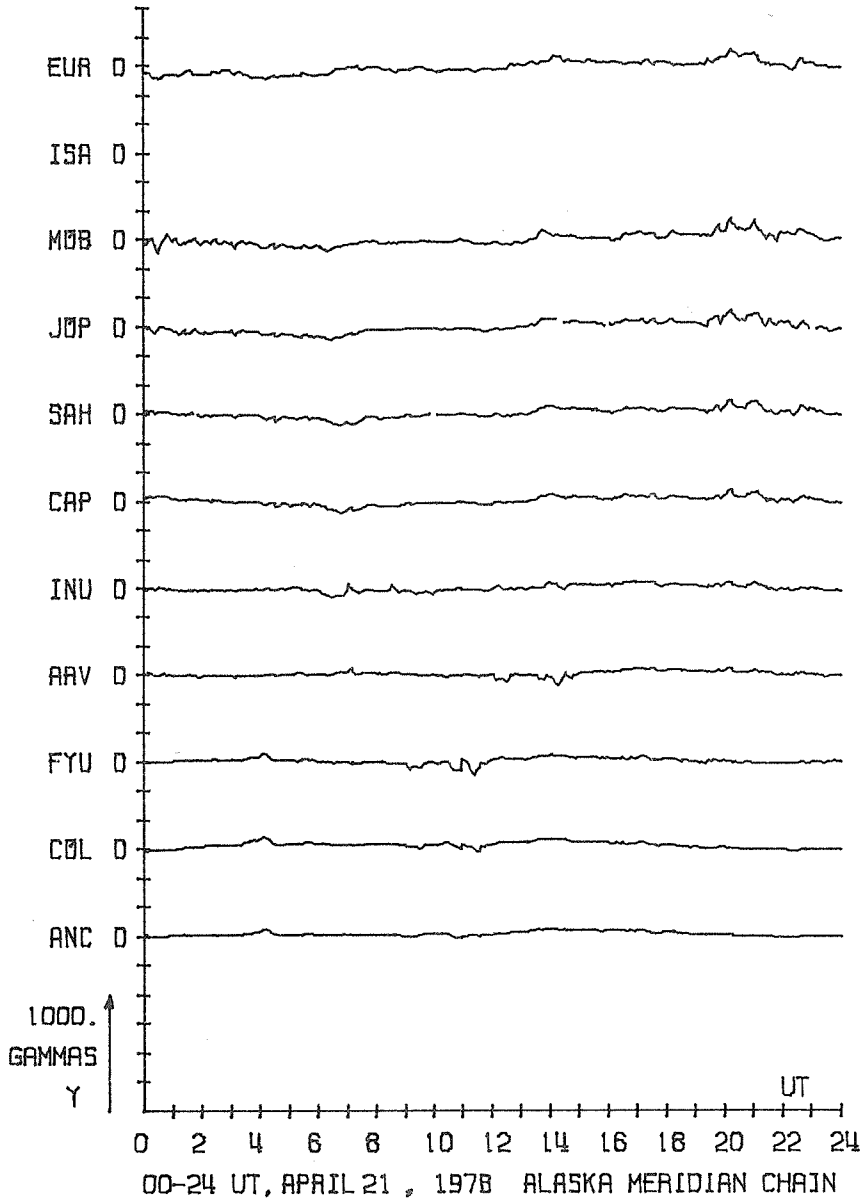
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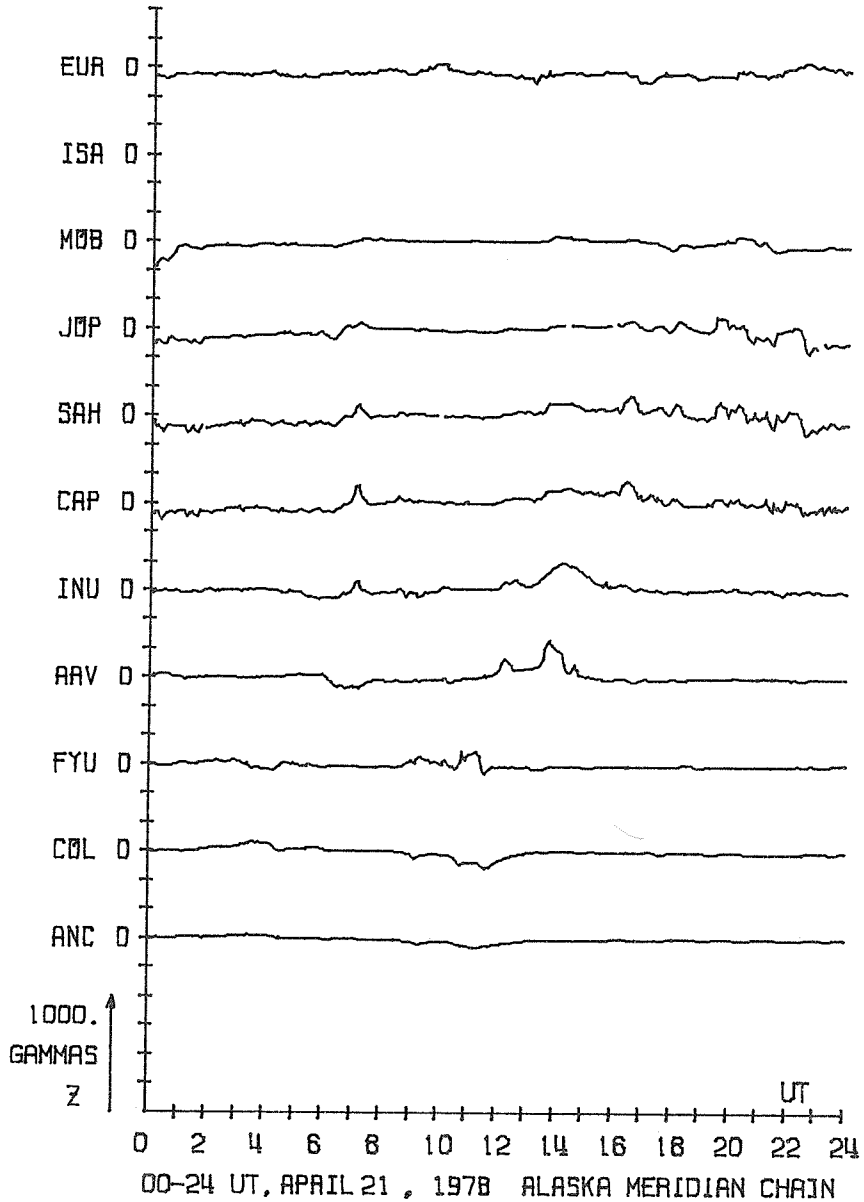

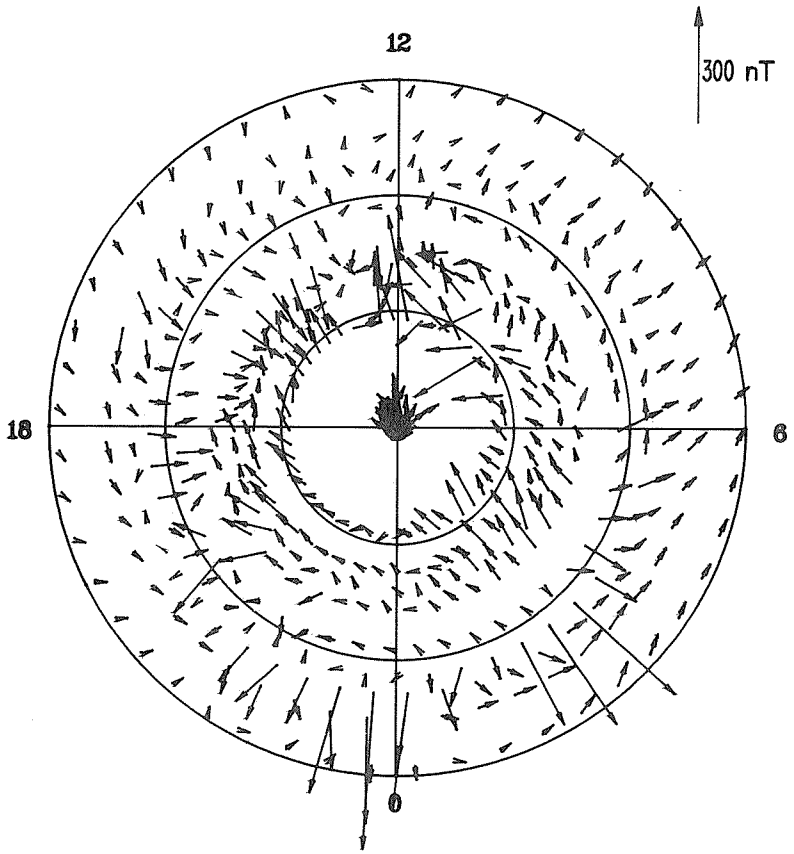

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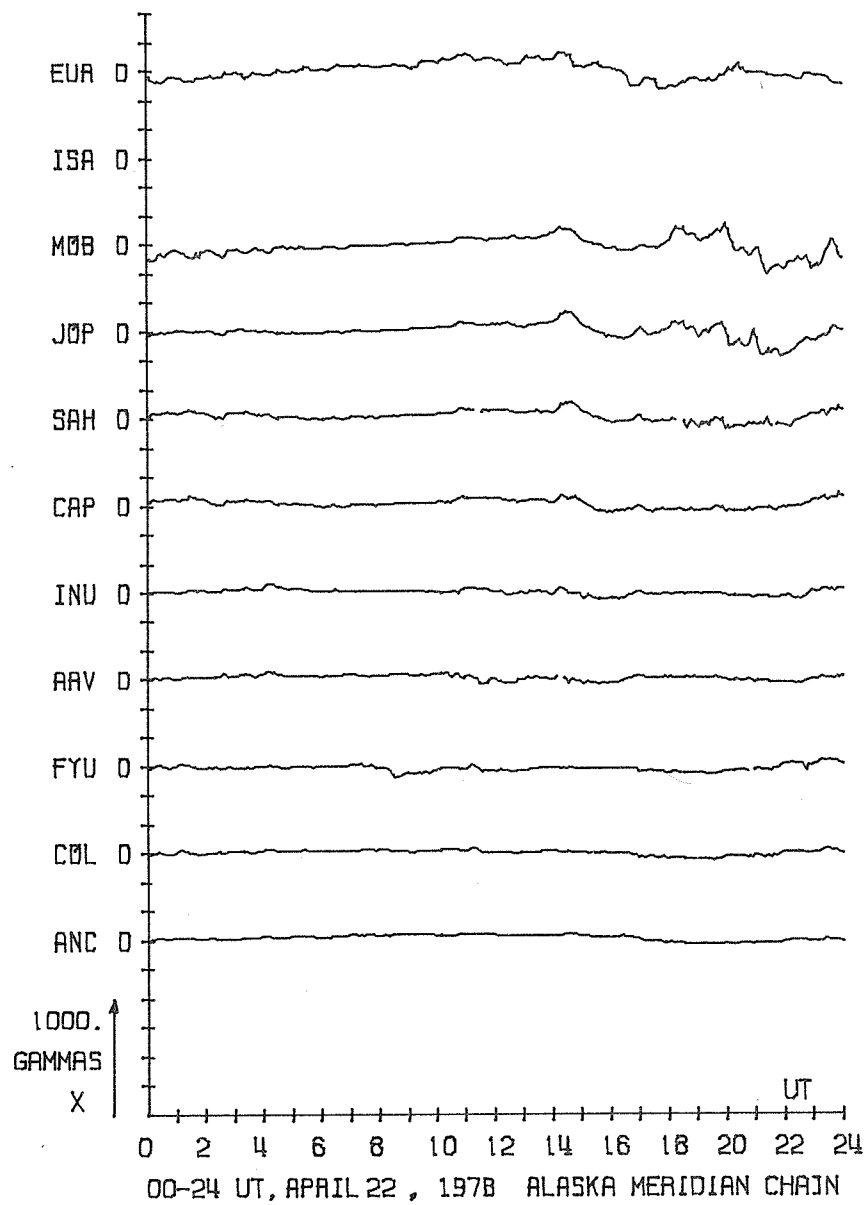
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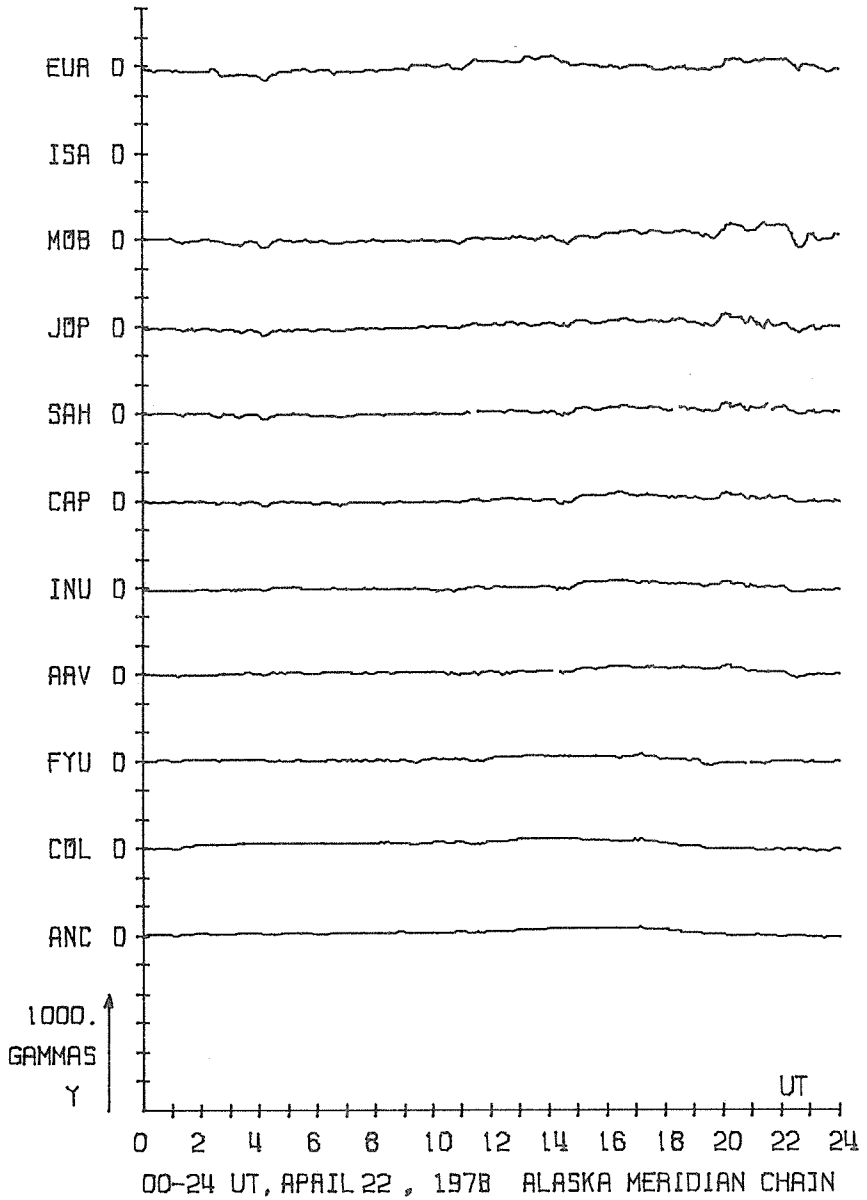
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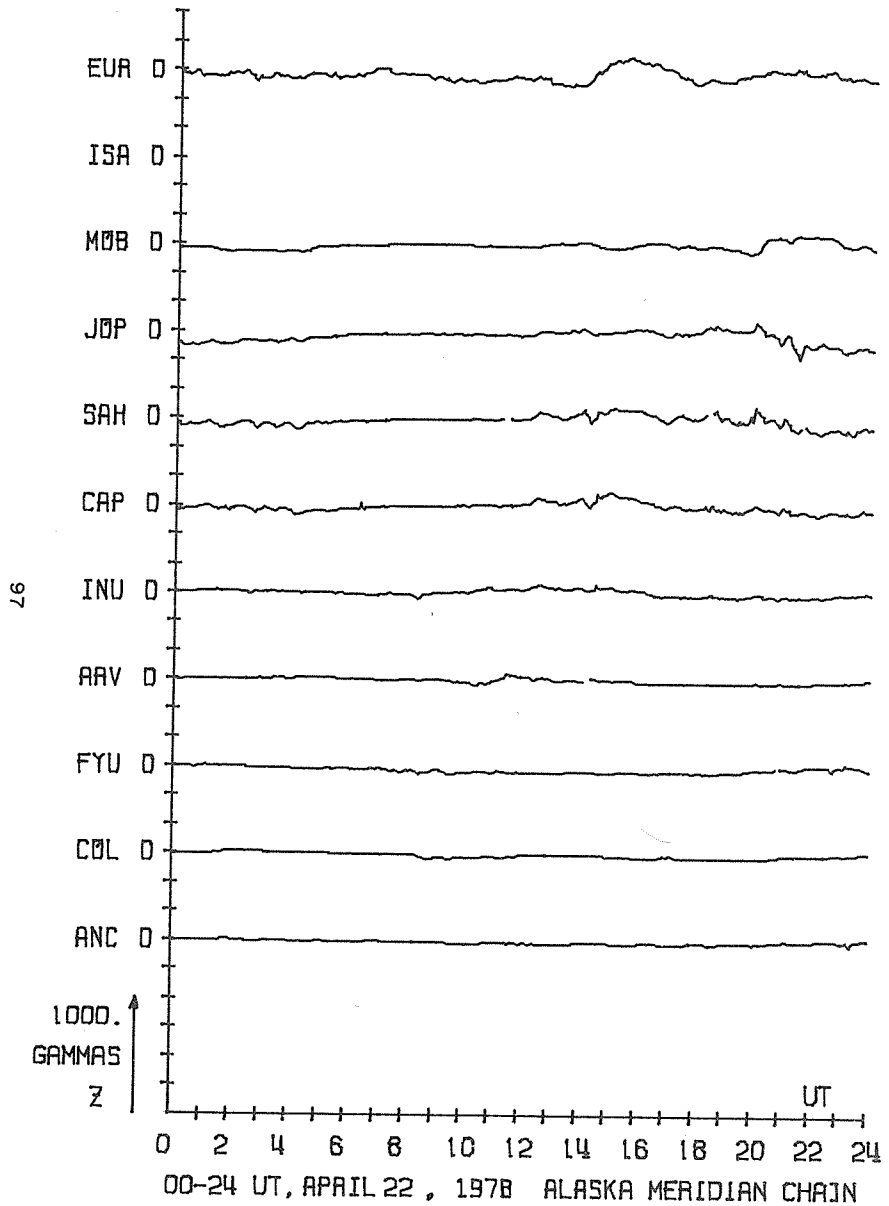

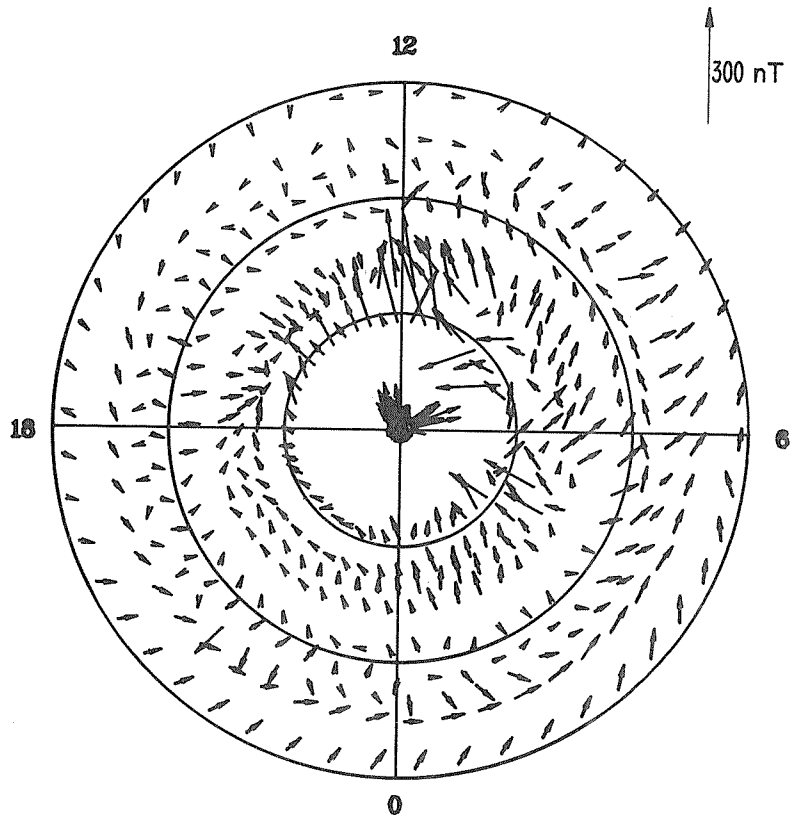

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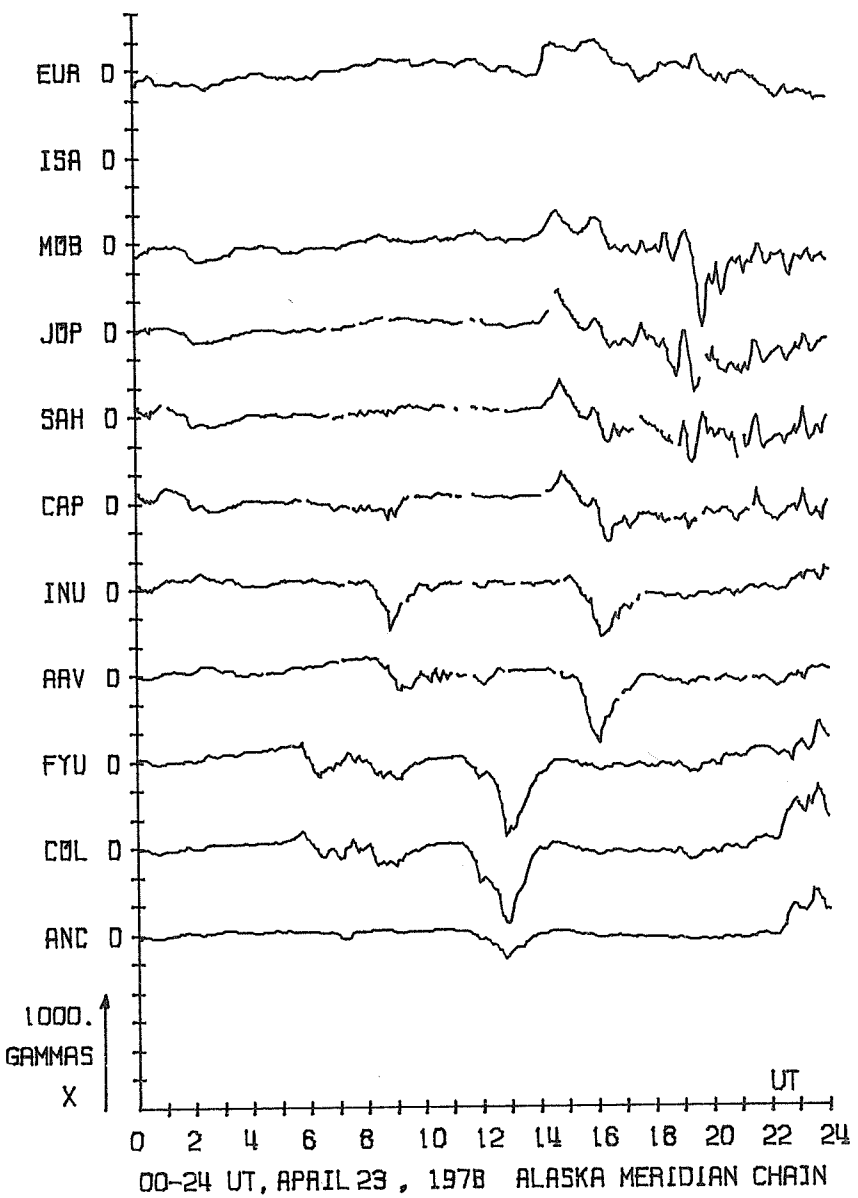
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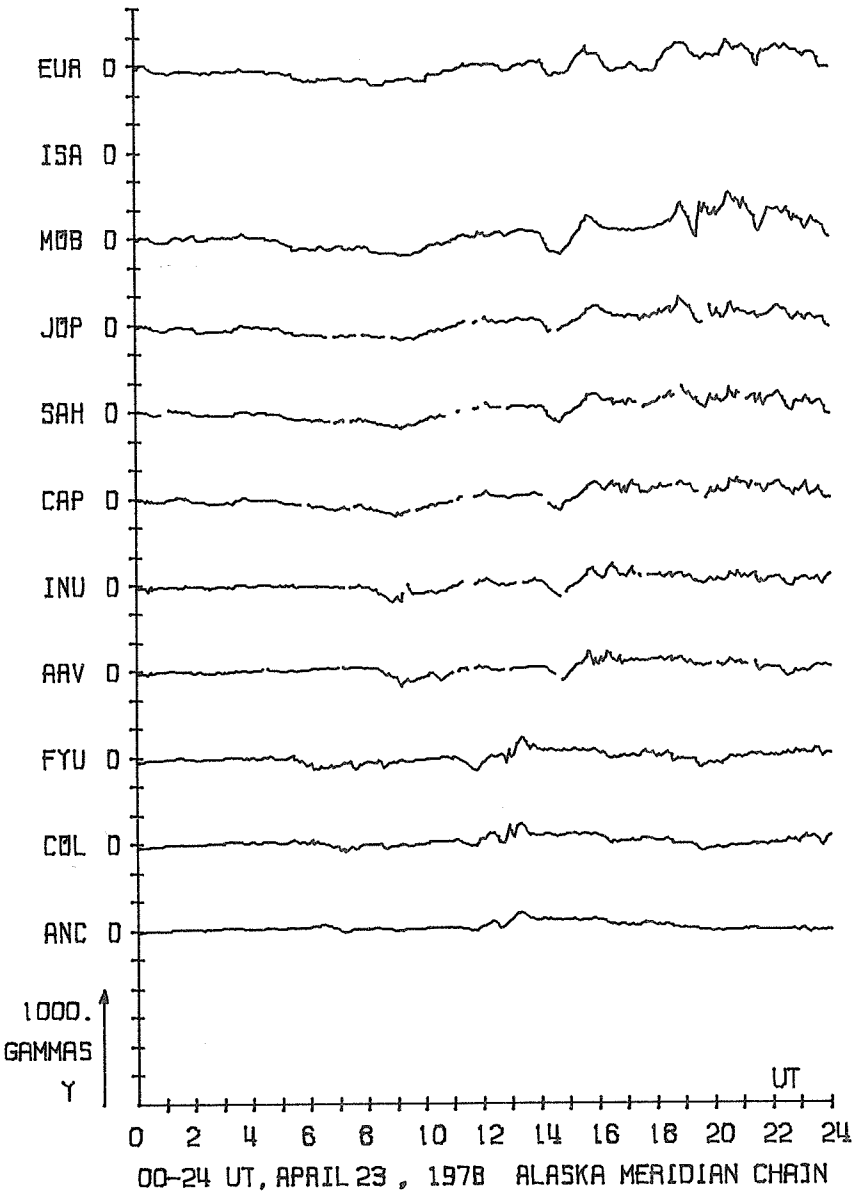
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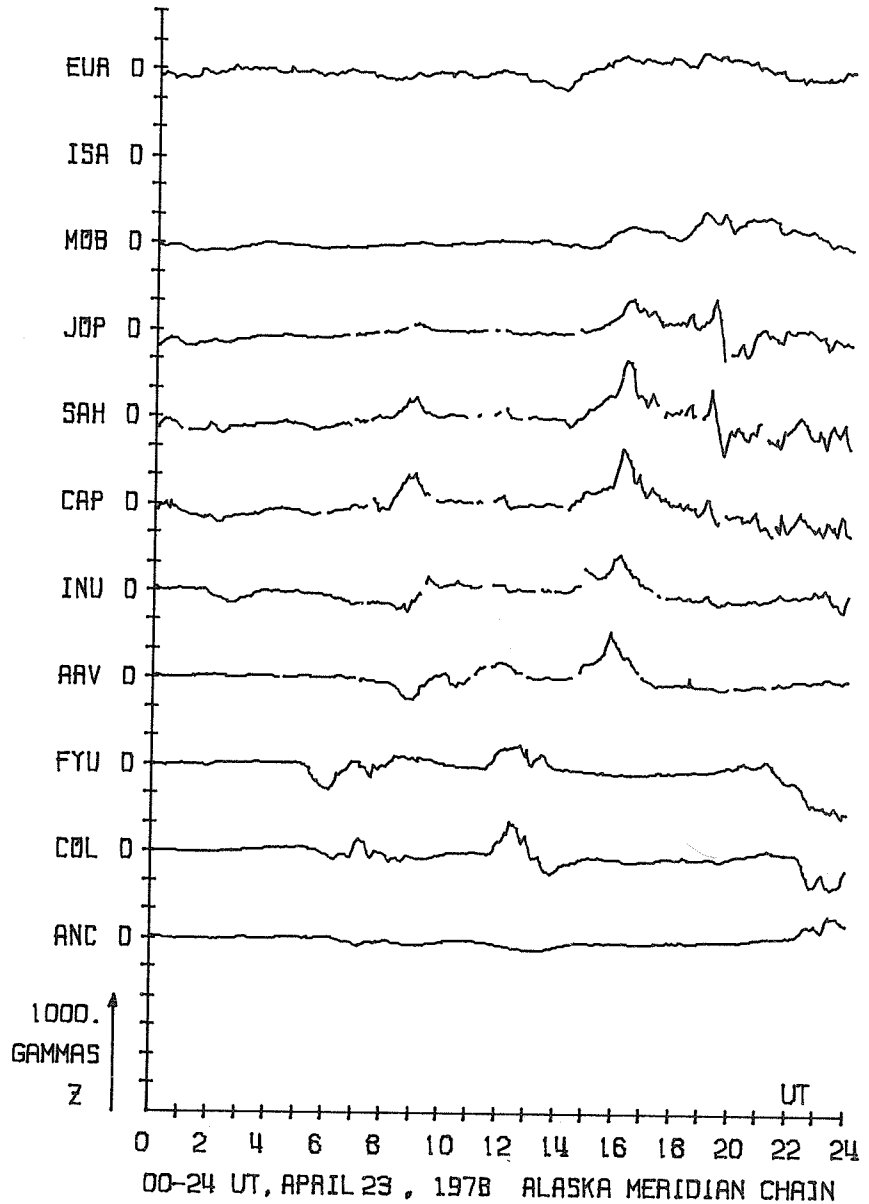

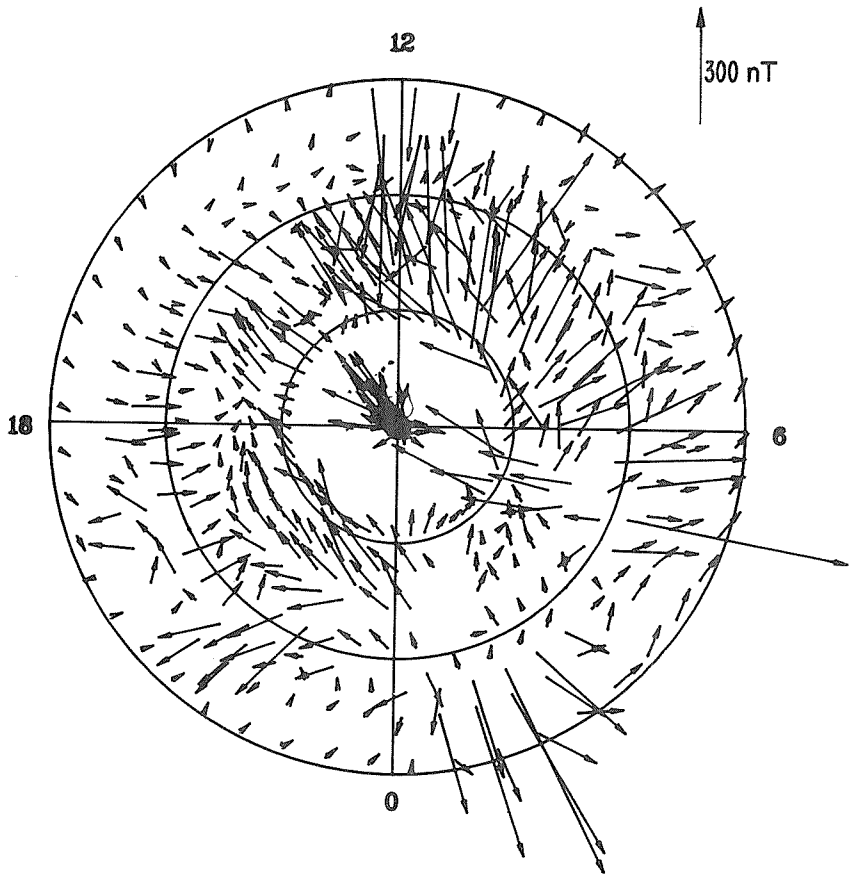

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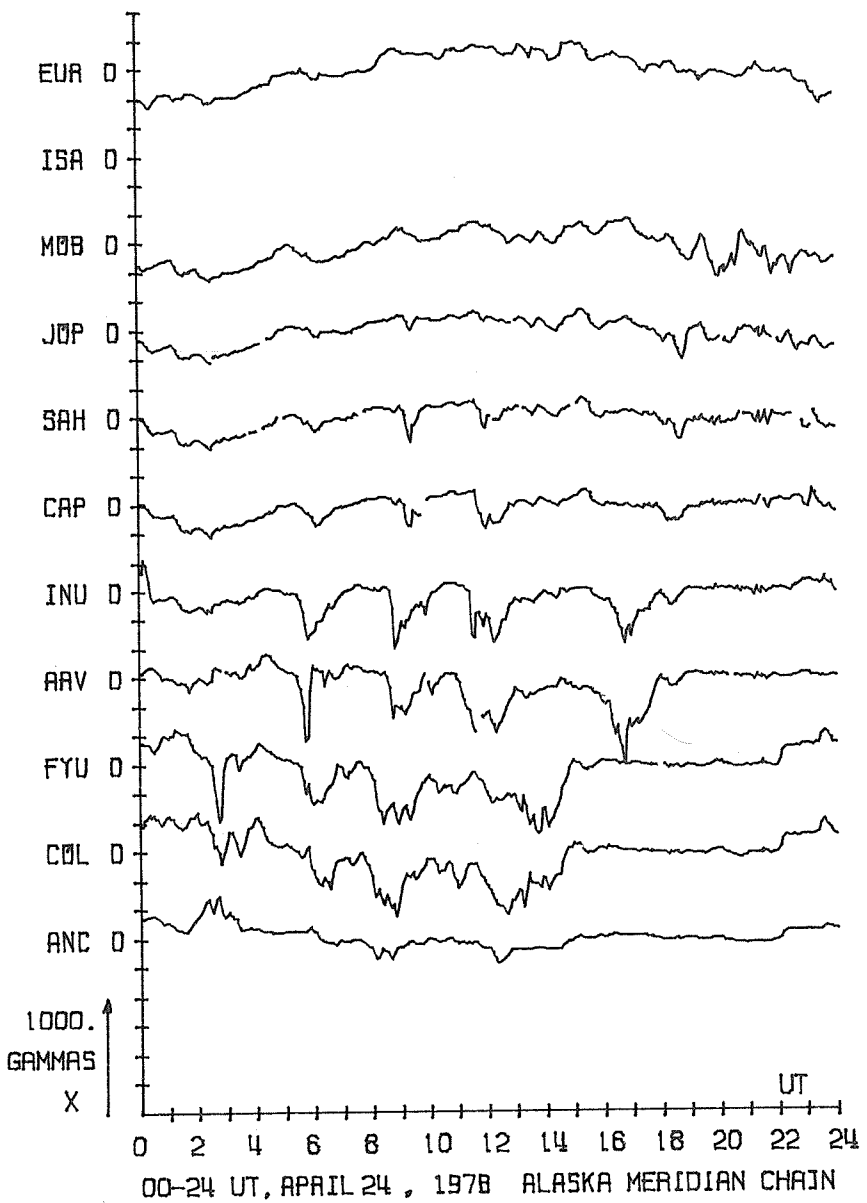
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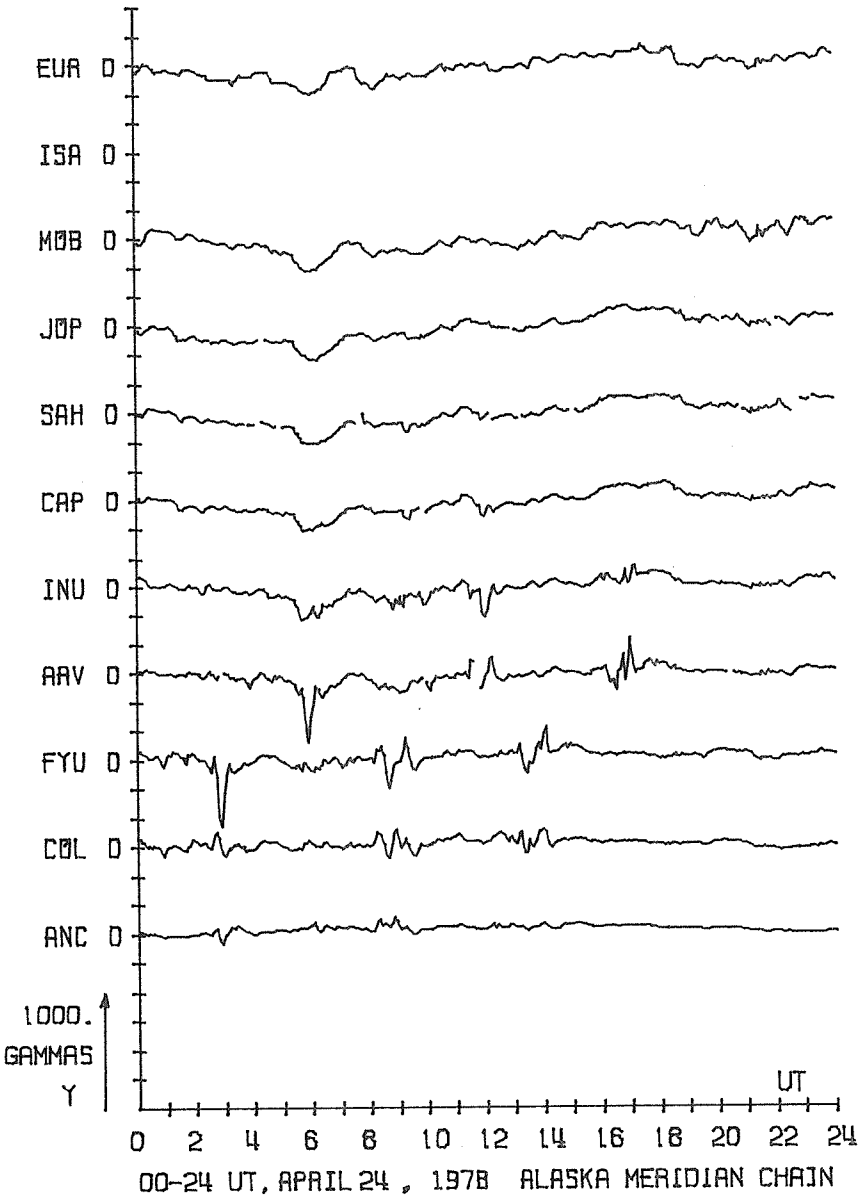
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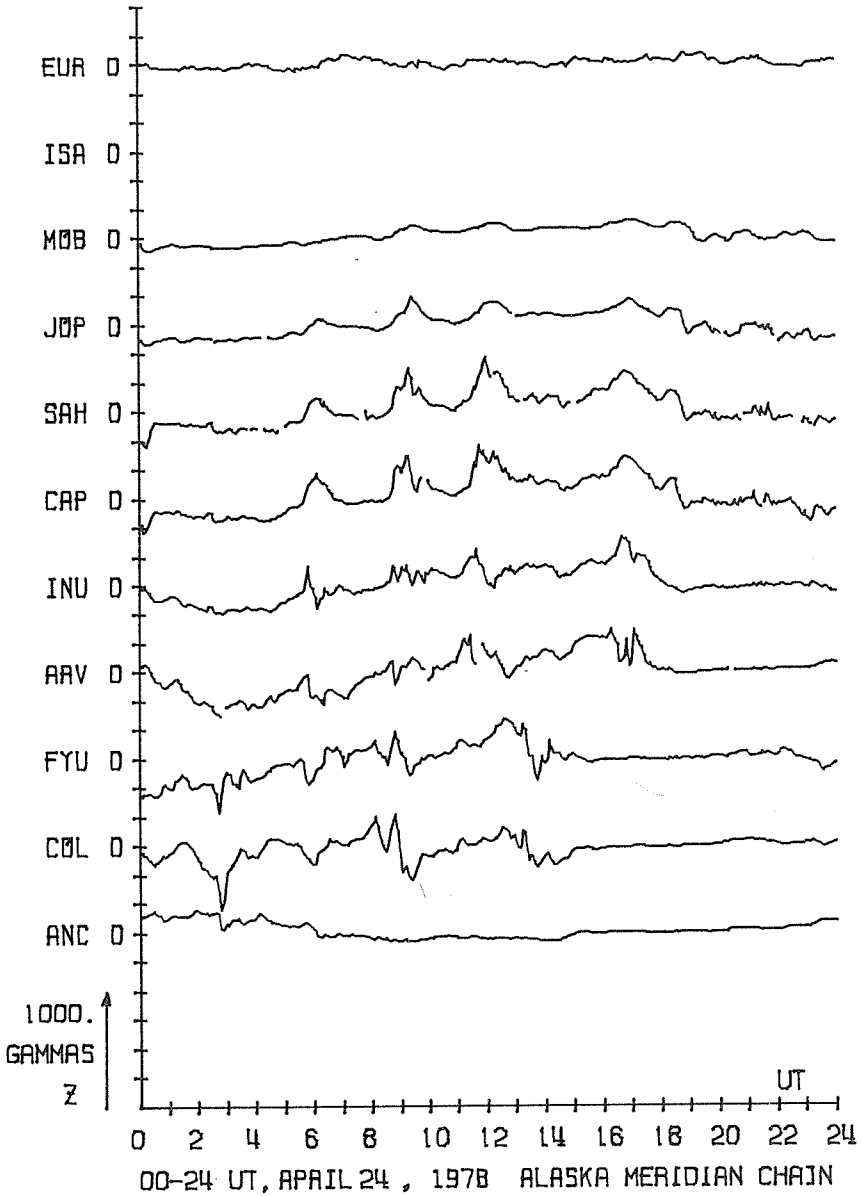

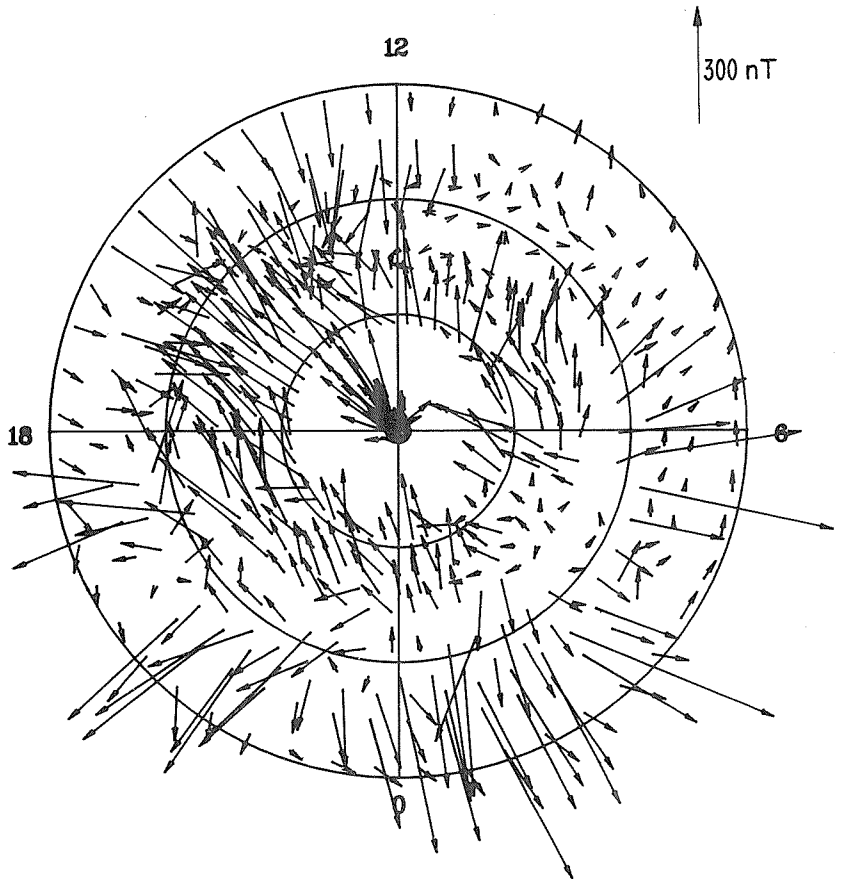

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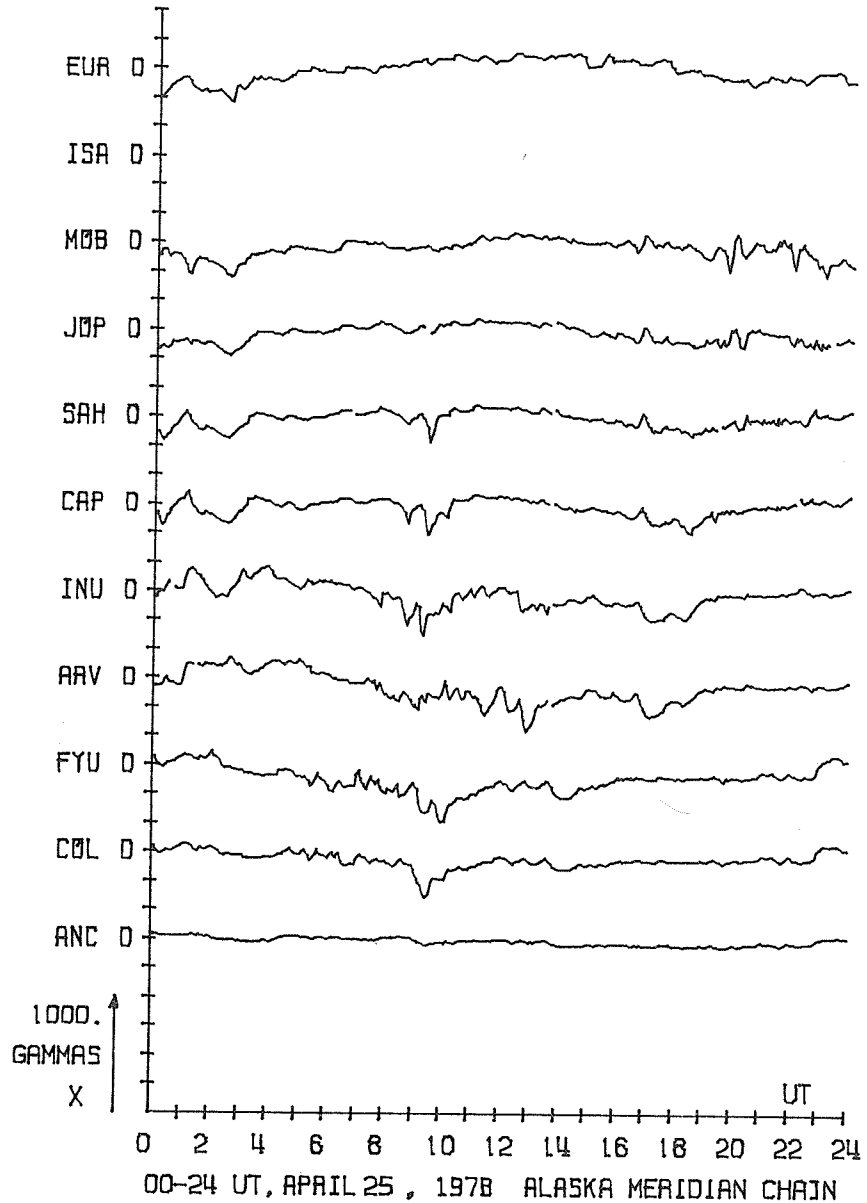
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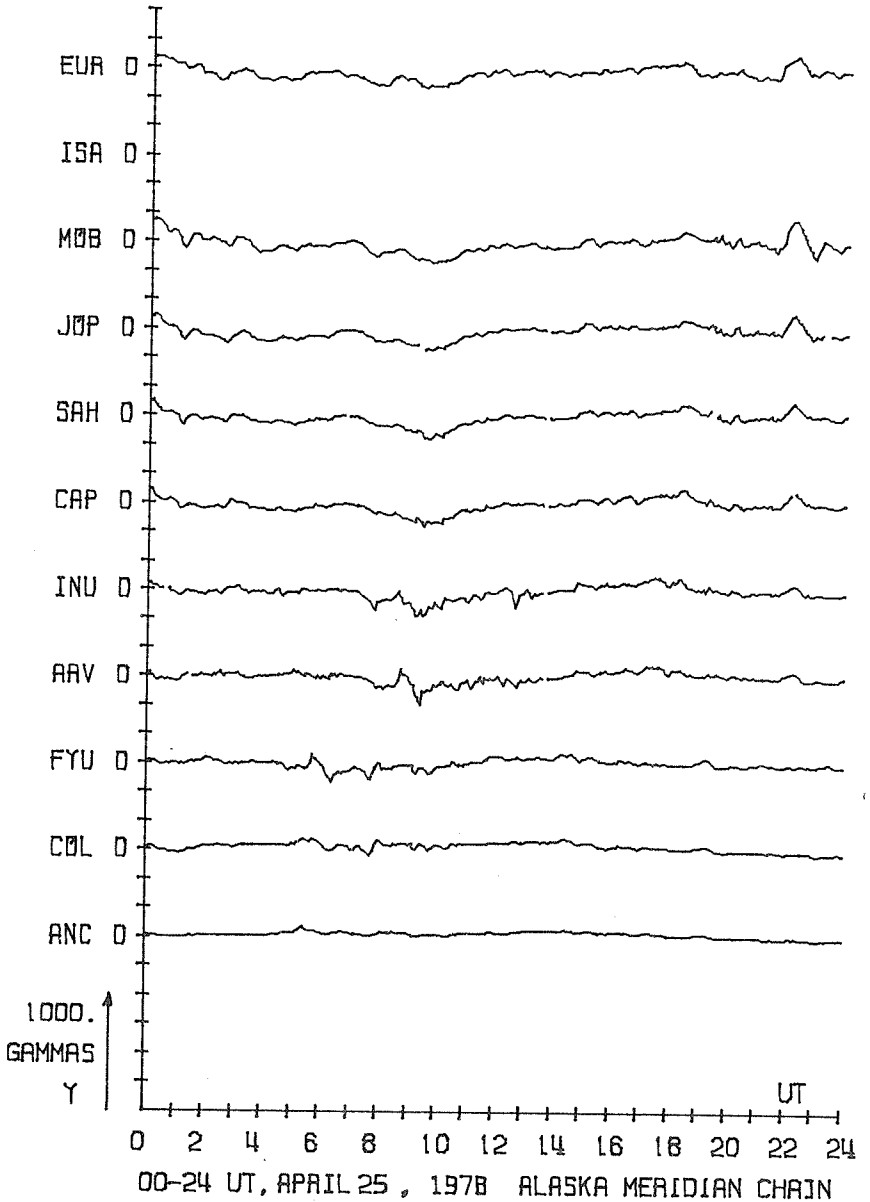
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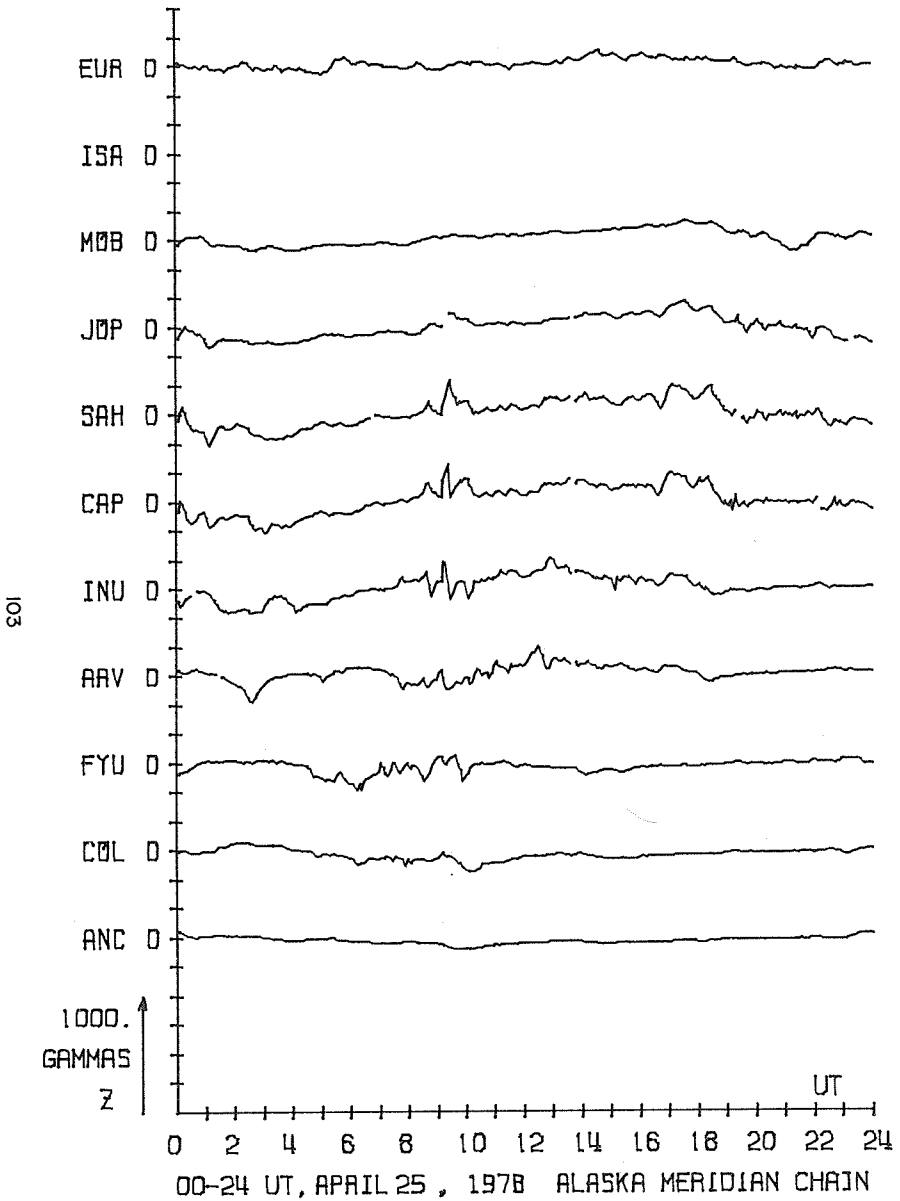

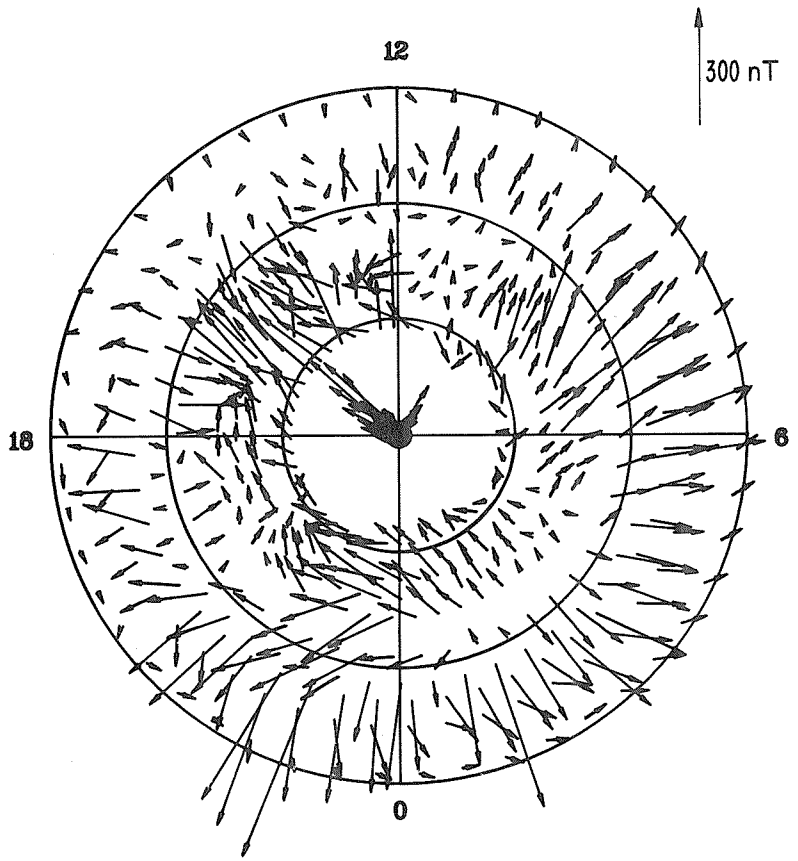

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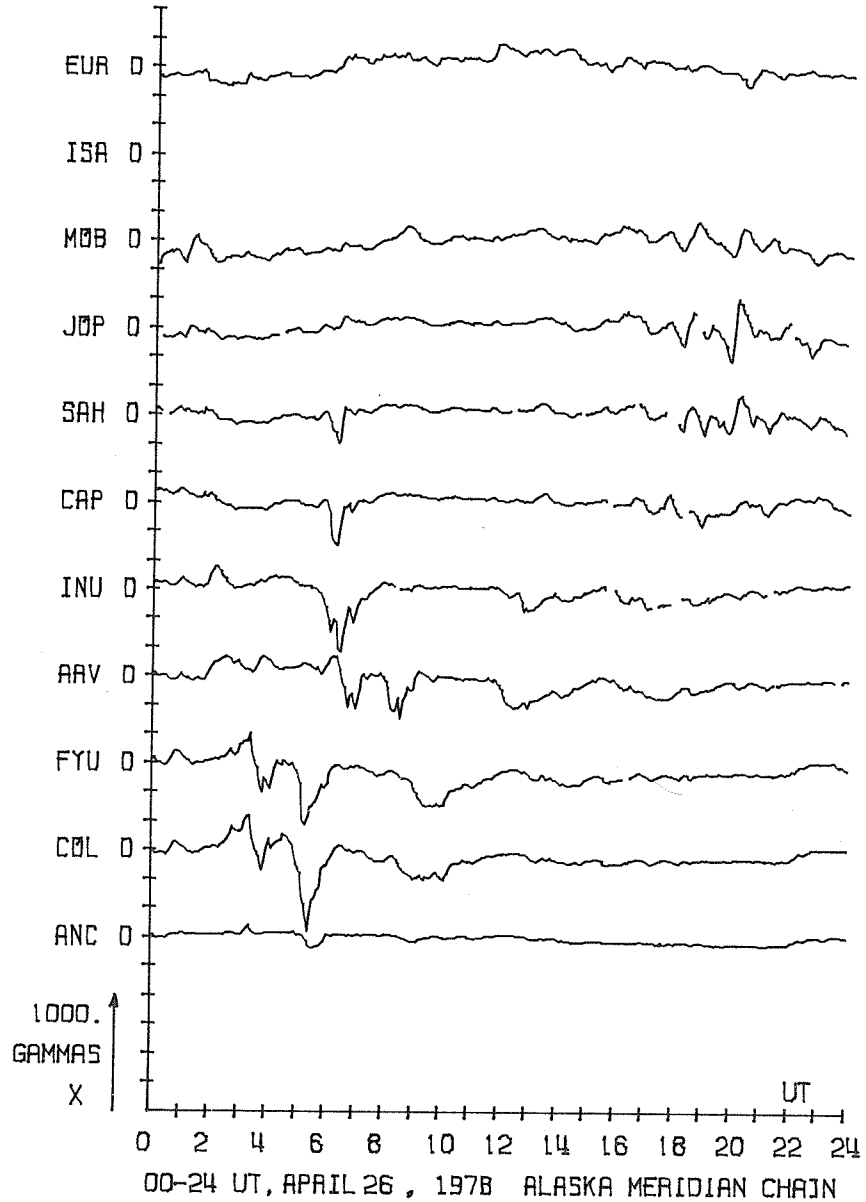
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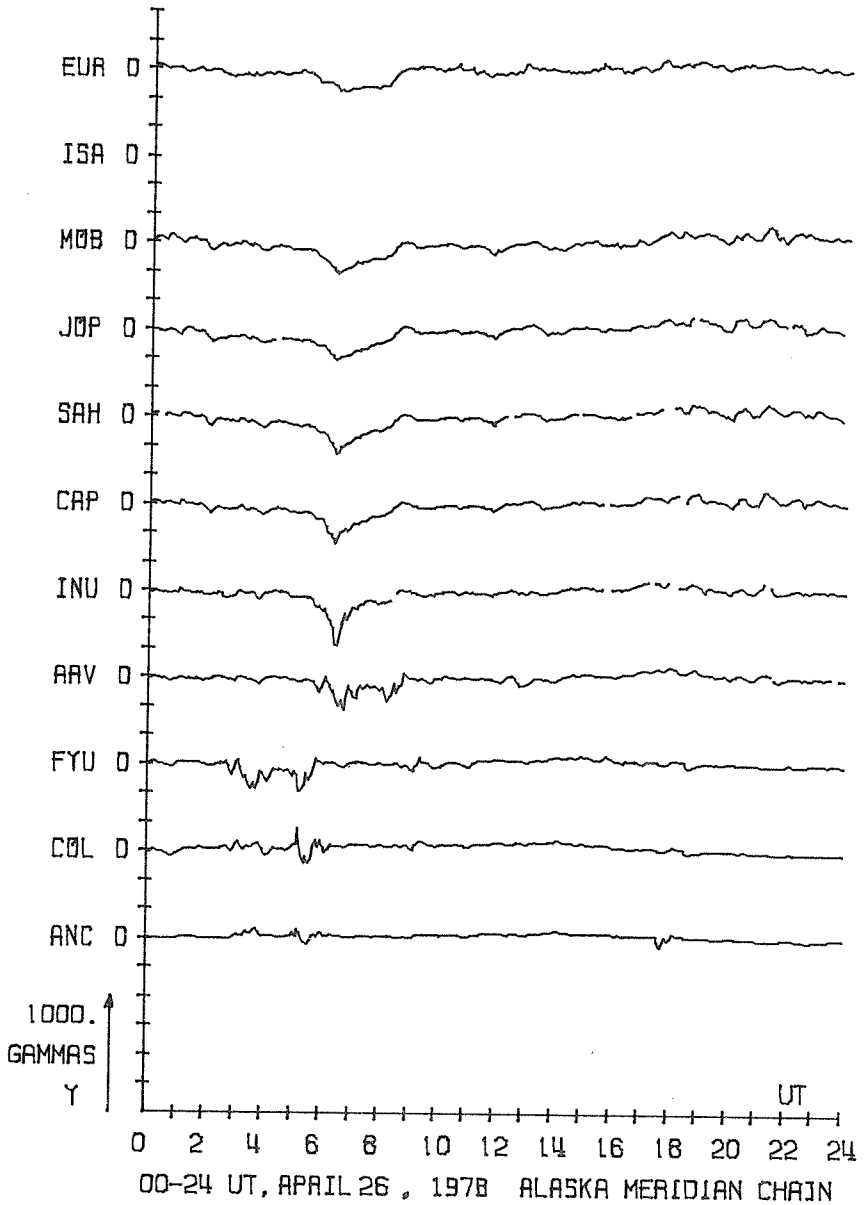
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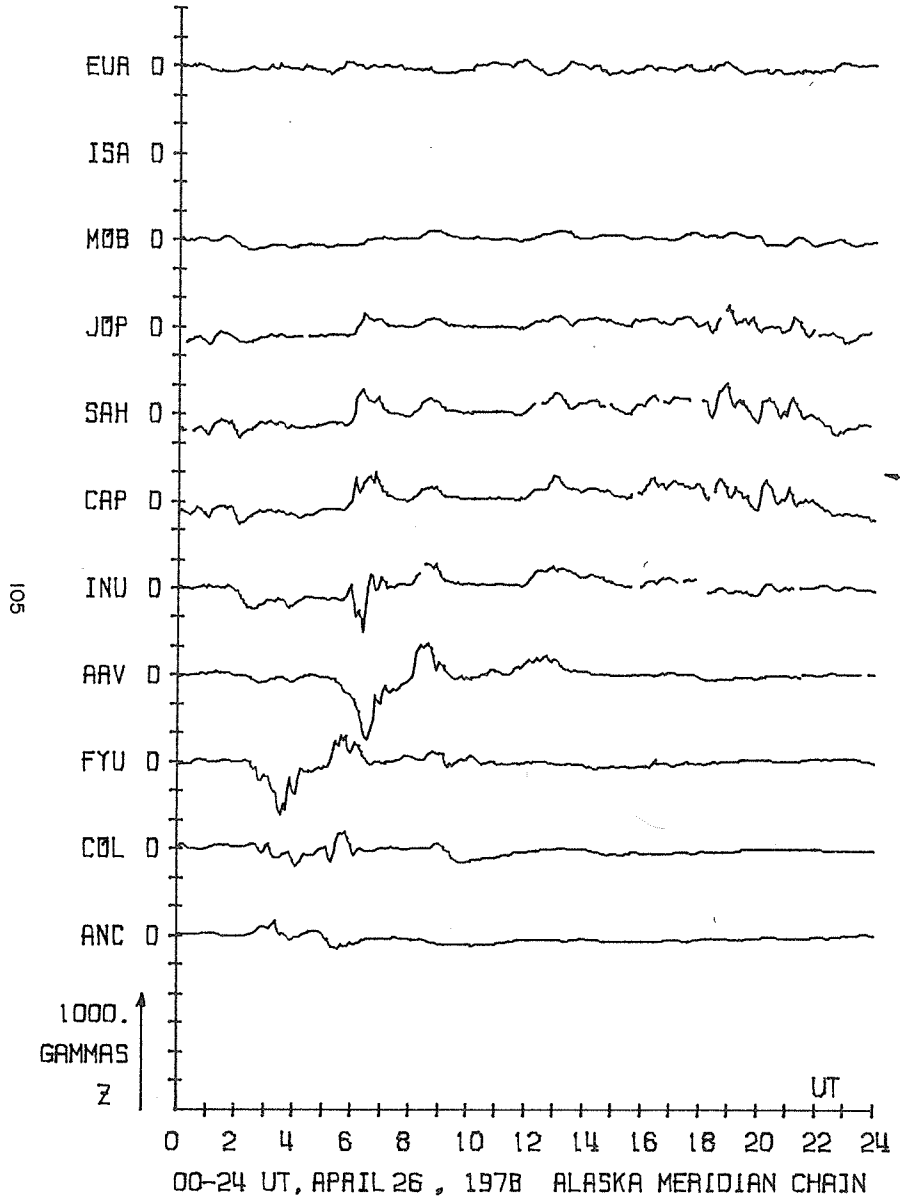

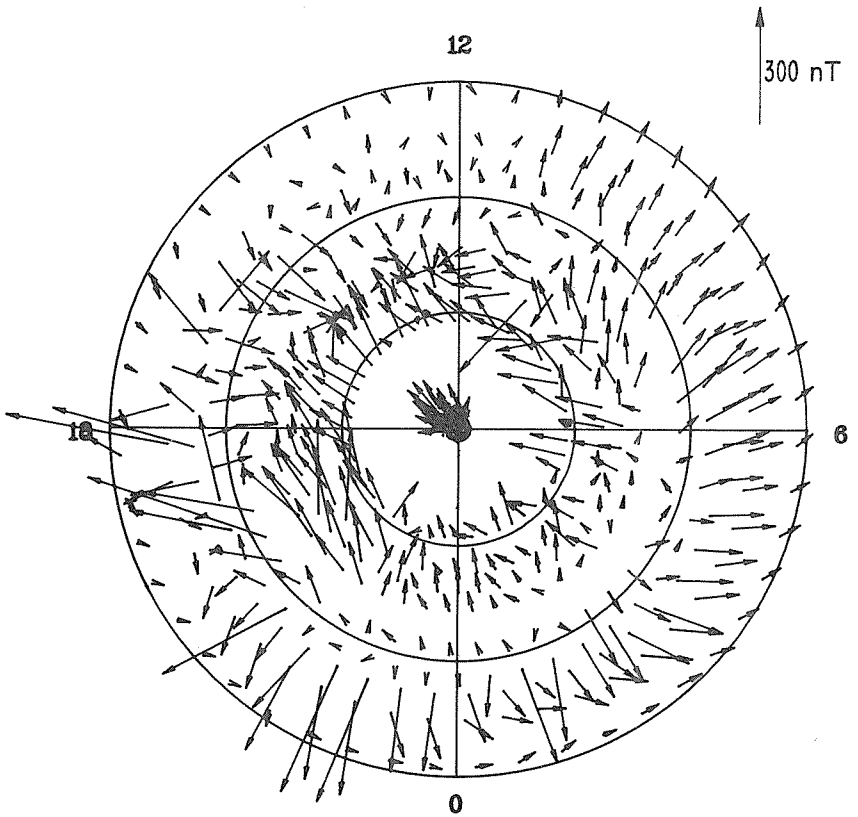

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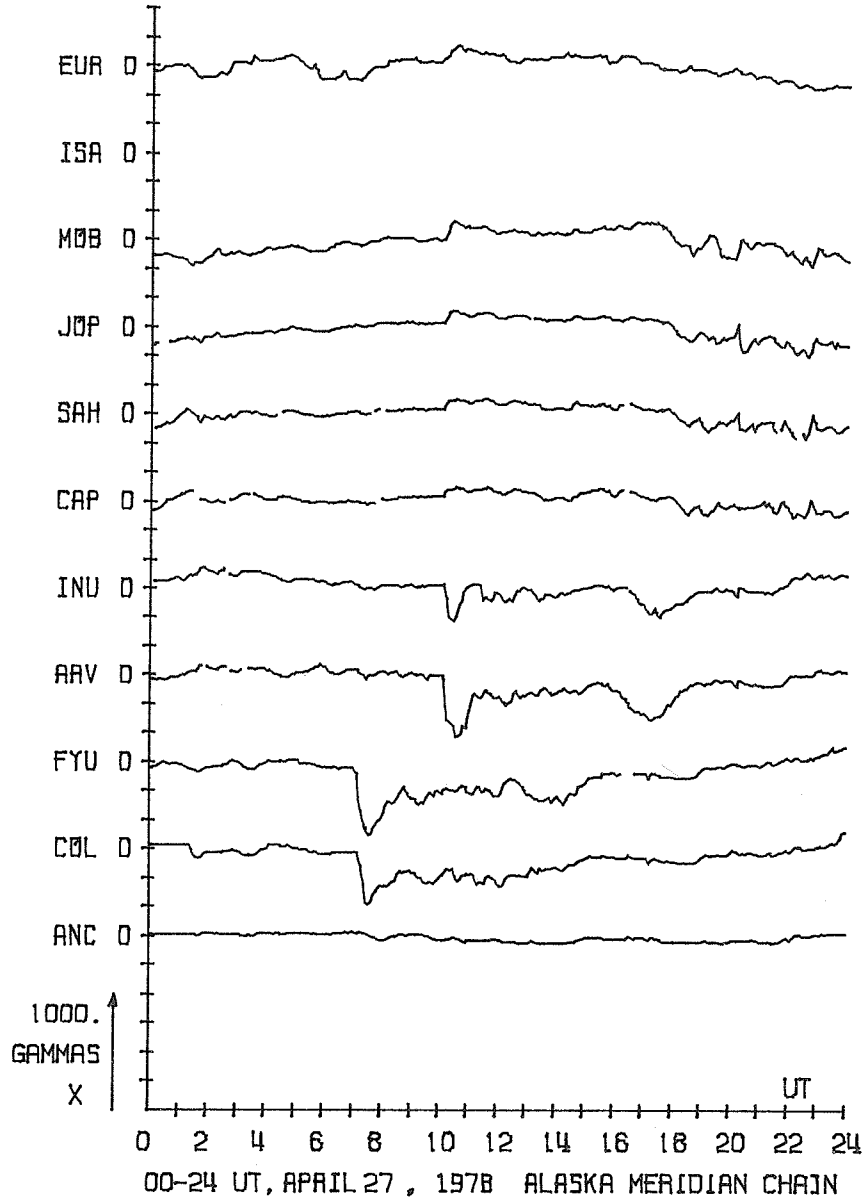
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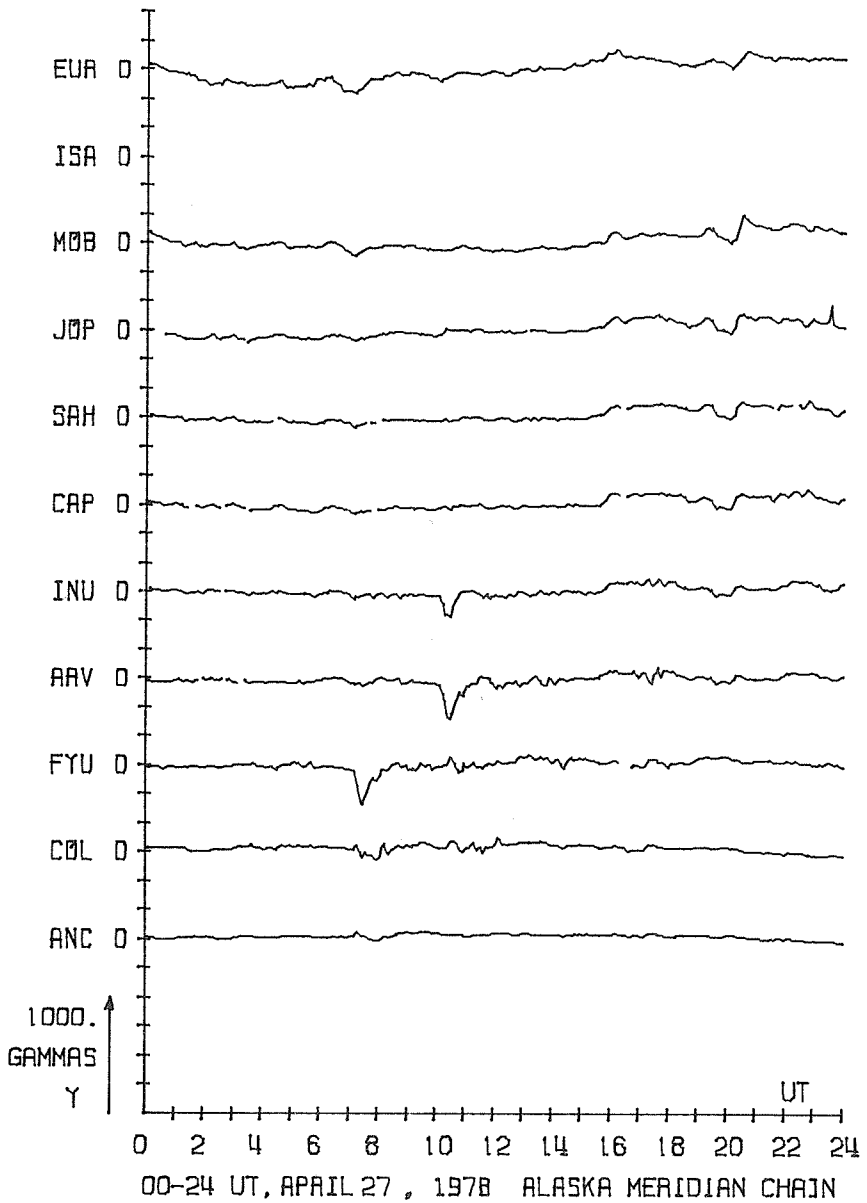
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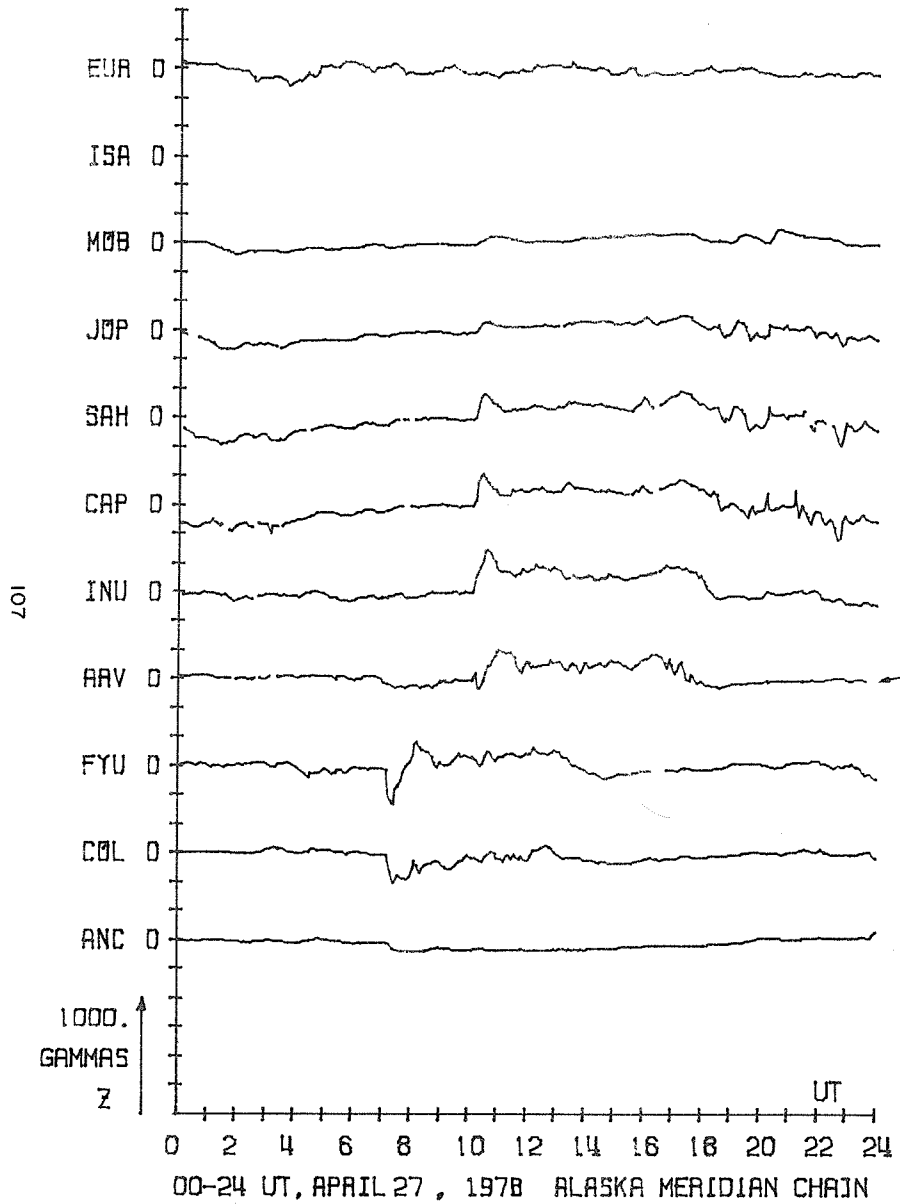

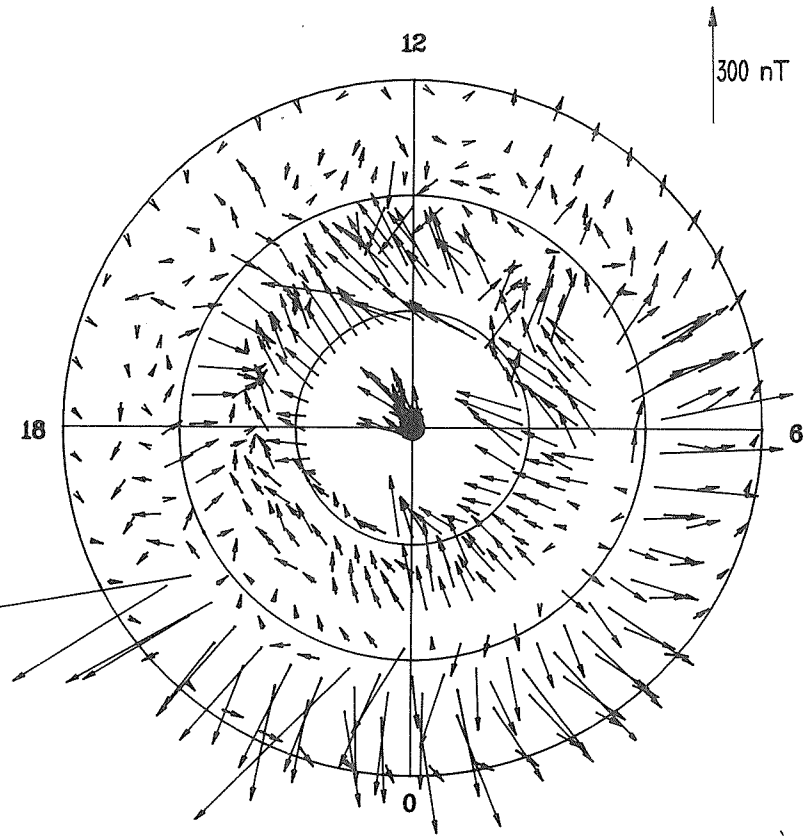

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