RECENT MAGSAT RESULTS

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Meyer, et al., (1983) have improved their original global crustal model (Meyer, et al., 1984) and made a spherical harmonic analysis of the resulting magnetic field to n=50. Figure 1 shows the Z contours at 400 Km altitude from a field model composed of the first 15 degrees and order of their model and the terms n=16-29 from the Magsat model M051782 (Cain, et al., 1984). The main point to consider from such representations is that the lower order terms appear to contribute components comparable in magnitude to those of higher order. Thus one should allow in making tectonic interpretations of global maps of "anomalies" such as those published by Langel, et al., (1982), that there are likely continental scale (or smaller) features that have been removed along with the core field by the subtraction of the terms n=1 to 13 of the observed field. The view is also put forward by the paper by Hahn, et al., (1984). Planning for the analysis of data to be accrued by GRM should thus address this problem.

In the first determination of secular change from vector satellite data, Cain, et al., (1983) observed that the small quantity of observatory data available in 1981 for the Magsat analysis interval (September 1979 - June 1980) had little effect on the model M061581. Figure 2 is the secular variation from this model. Figure 3 is the same projection from the IGRF80 model (Peddie, 1983) which is very similar except for the north polar area. Cain, et al., (1983) concluded that the high rate of change in the northern regions was due to the increasing effect of the polar ionospheric currents as the Magsat orbit lowered and the current intensity increased as the seasons changed from northern winter to summer. Thus in order to obtain a model representative of the secular variation from the Earth's interior it would be necessary to model and eliminate the effects of these currents.

Pursuant to this elimination our group has collected and reduced, with the help of the World Data Center for Geomagnetism, the hourly values from some 60 magnetic observatories as depicted on Figure 4. The nighttime ($22\text{-}3^h$ local time), quiet (Kp,<2) values were then corrected for the Dst variation, the resultant points averaged for each day and a linear least squares fit made. This correction assumed that Dst represented the sum of the n=1 internal and external field at the magnetic equator and that the i/e ratio was 0.28. Likewise, the similar correction was made to the Magsat data as originally selected for the M061581 model (and also used for M051782). The corrected Magsat data were then combined with the new values of X, Y and Z for the 60 stations and an adjustment made to M051782 to degree and order 10 in both spatial and first time derivatives. In this instance, unlike in prior derivations, the observatory SV data were weighted ten times heavier than previously. These weights were originally taken as the standard errors of the linear fits (Schmitz and Cain, 1982). An attempt was made to increase the weights another factor of ten but the result was clearly suprious since many cells began to appear in the S.V. maps.

This new model, M070284, thus retains all M051782 terms from n=11 to 29, but improves somewhat on the secular terms (Fig. 5). The degradation of fit to the Magsat data was small, e.g., residuals of the Magsat scalar data increased from 12 to 15 nT. A comparison of this result is given in Figures 6, 7 and 8 for Bangui, Kakioka and Novosibirsk observatories comparing the IGRF80 with M070284. These plots are of the previously noted daily averages from each observatory (solid lines) along with the linear least-squares fit (dotted lines) and the model indicated (dashed lines). The adjustment required to plot the model values through the middle of each curve is given by the numbers to the right above each curve. This adjustment is mainly needed for the neglected very high order terms that result from local magnetic anomalies and, to a lesser extent, errors in the models. Generally, these adjustments agree with the observatory "biases" determined by Langel, et al., (1983). These plots illustrate that most of the M070284 computed secular variation matches the apparent SV for an observatory better than does IGRF80. However, it would appear that the high negative F remains for a part of the north polar area. Either there are not enough stations, the data are too noisy, or the observatories also reflect this high rate.

In lower latitudes the secular variation on Figure 5 generally agrees with that of the IGRF80 except where the latter does not follow the observatory trends. The increase of the secular variation degree and order to n=10 allowed more detail in the Asian region.

It is not obvious from the analysis to date whether the variations applied from the Dst corrected observatory data contain trends due to the external field. On a statistical basis one could determine the type of behavior that could be expected from quiet data from annual distortions of the magnetospheric topology (Campbell, 1984). Such average results may or may not apply to this specific year. Also, the Dst index used was determined only from four low latitude stations (Sugiura, private communication, 1984) and the levels subtracted in Figures 6-8 may contain some annual time. Figure 9 is a plot of the Dst values averaged for a whole UT data selecting only hours where Kp <2. It is surprising to find such large values even during such periods. The month-to-month changes in the H levels could be the result of the Dst correction applied. It is clear from such uncertainties that a definitive SV for the Magsat interval yet awaits a complete analysis of the external sources including their induced components.

In summary, it would appear that the use of a mix of observatory and GRM data even over less than a year intervals would allow an accurate determination of global secular variation. However, a more comprehensive analysis of the external currents would be required than is presented herein.

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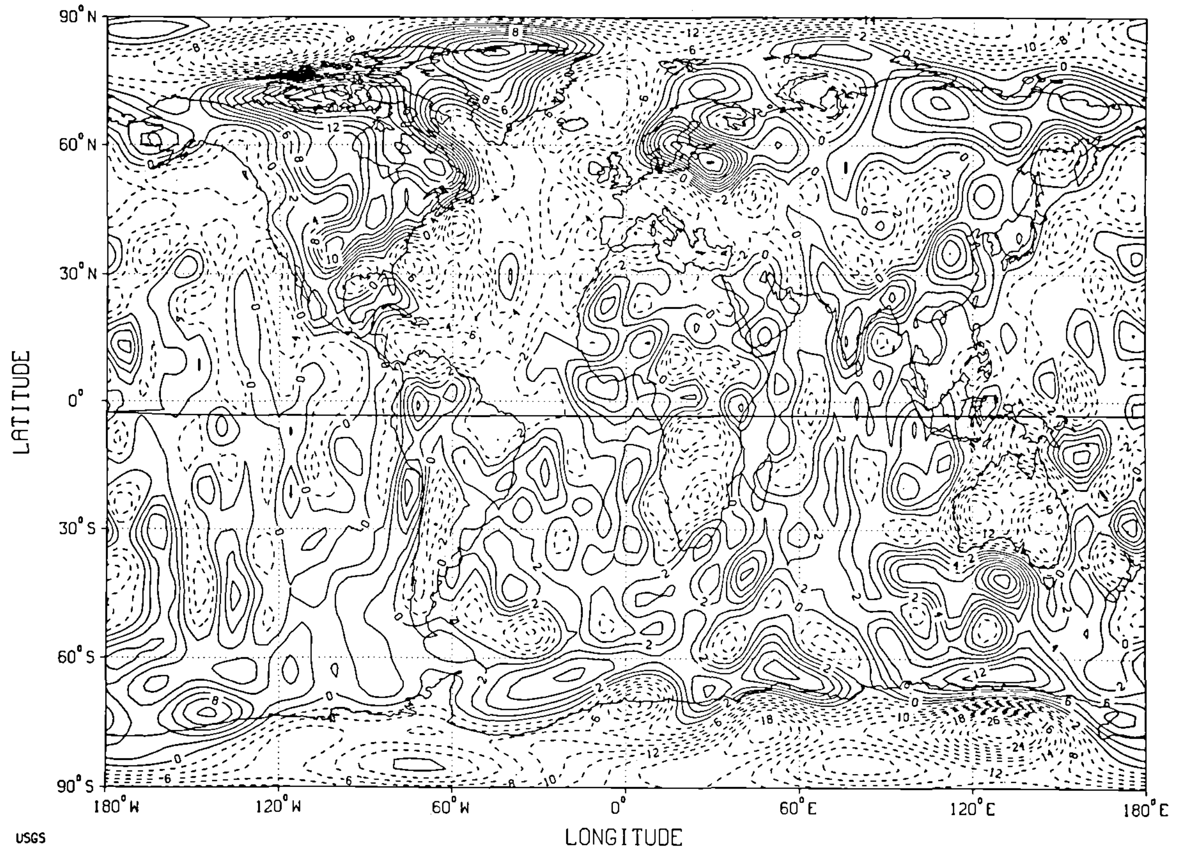


Figure 1. Vertical field derived from composite crustal model by Meyer, et al., (1984) for n=1-15, plus terms n=16-29 from model by Cain, et al., (1983). Contours in nanoTesla at 400 Km altitude.

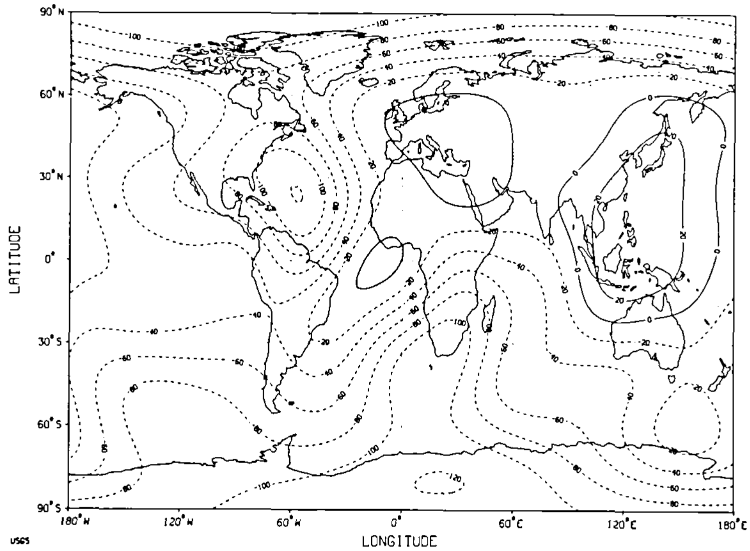


Figure 2. 1980 secular variation in total field from the model M051782 (Cain, et al., 1983).

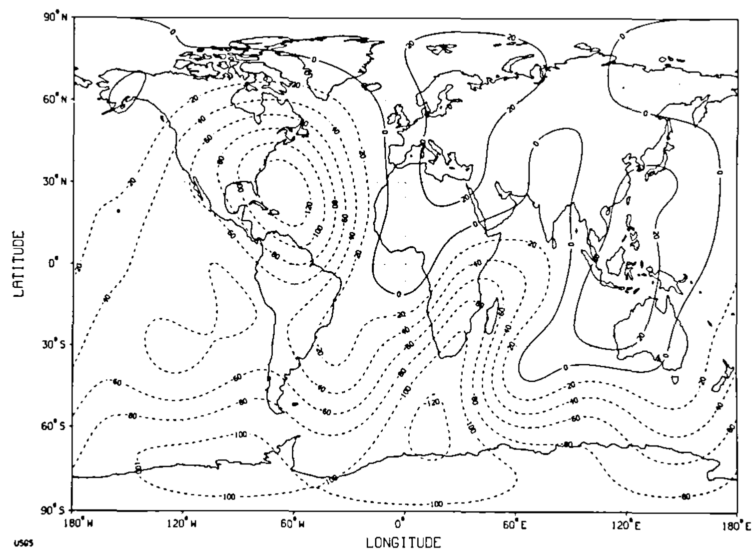


Figure 3. 1980 secular variation in total field from the 1980 IGRF.

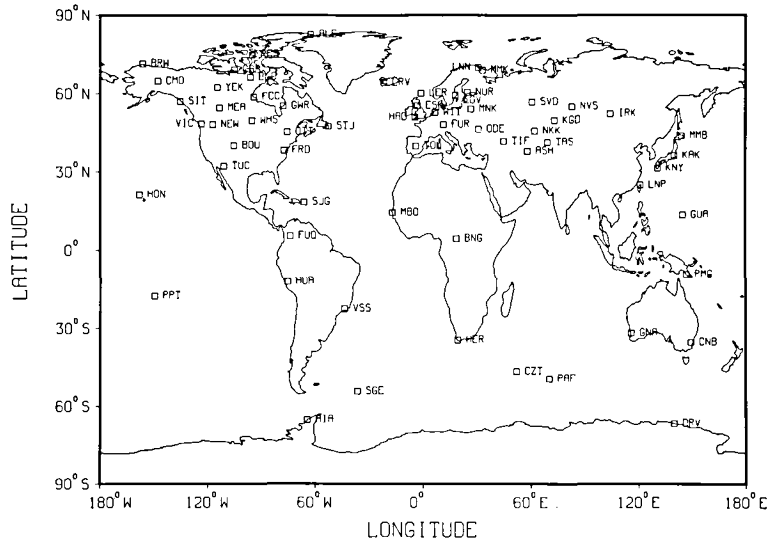


Figure 4. Magnetic observatories providing hourly values during the Magsat analysis interval, September 1979 - June 1980.

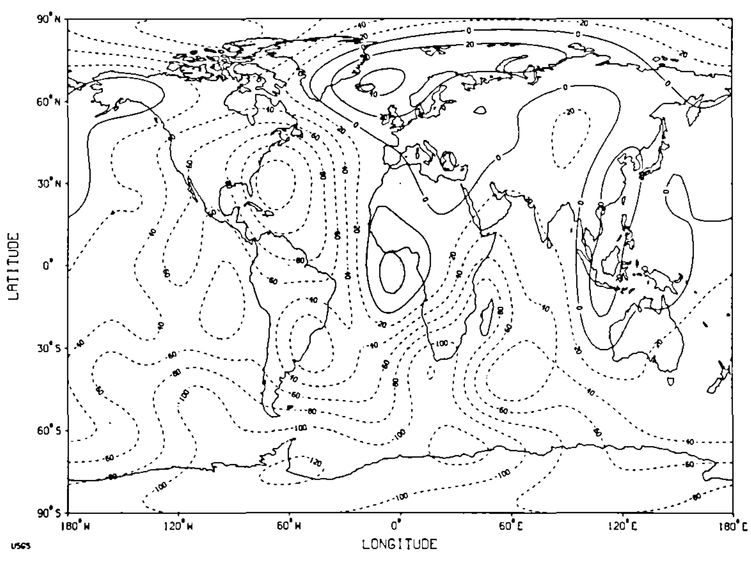
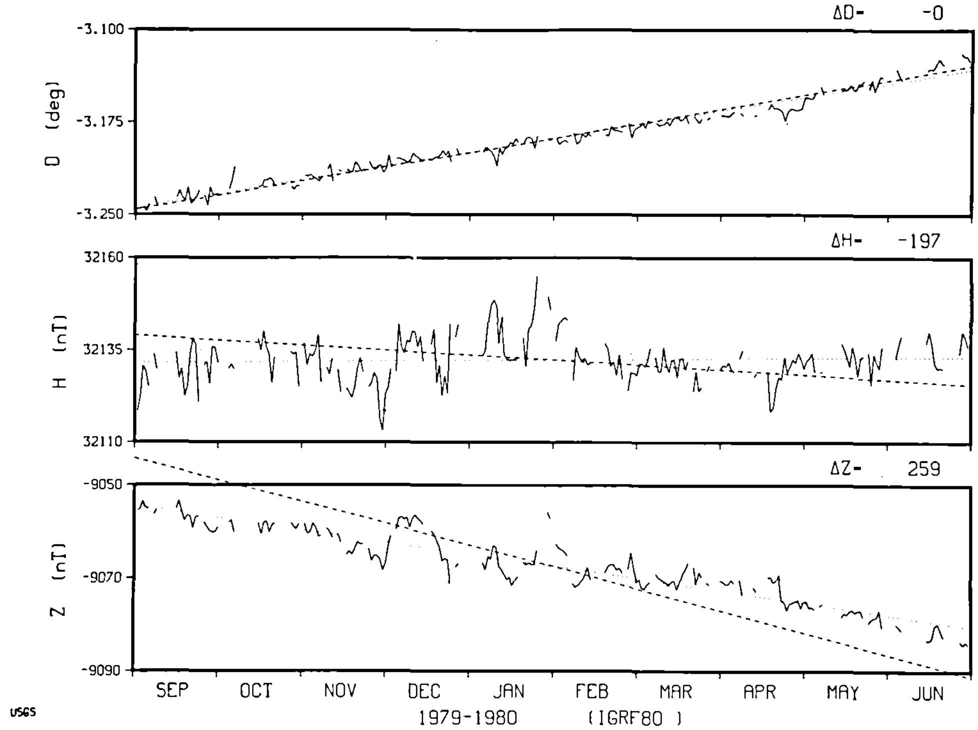
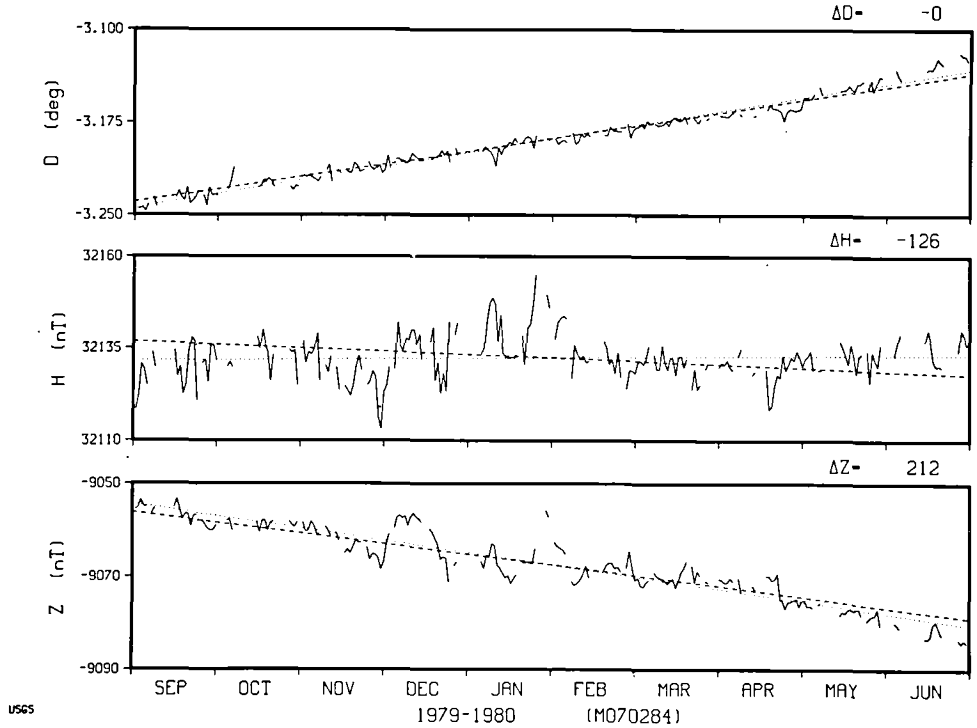
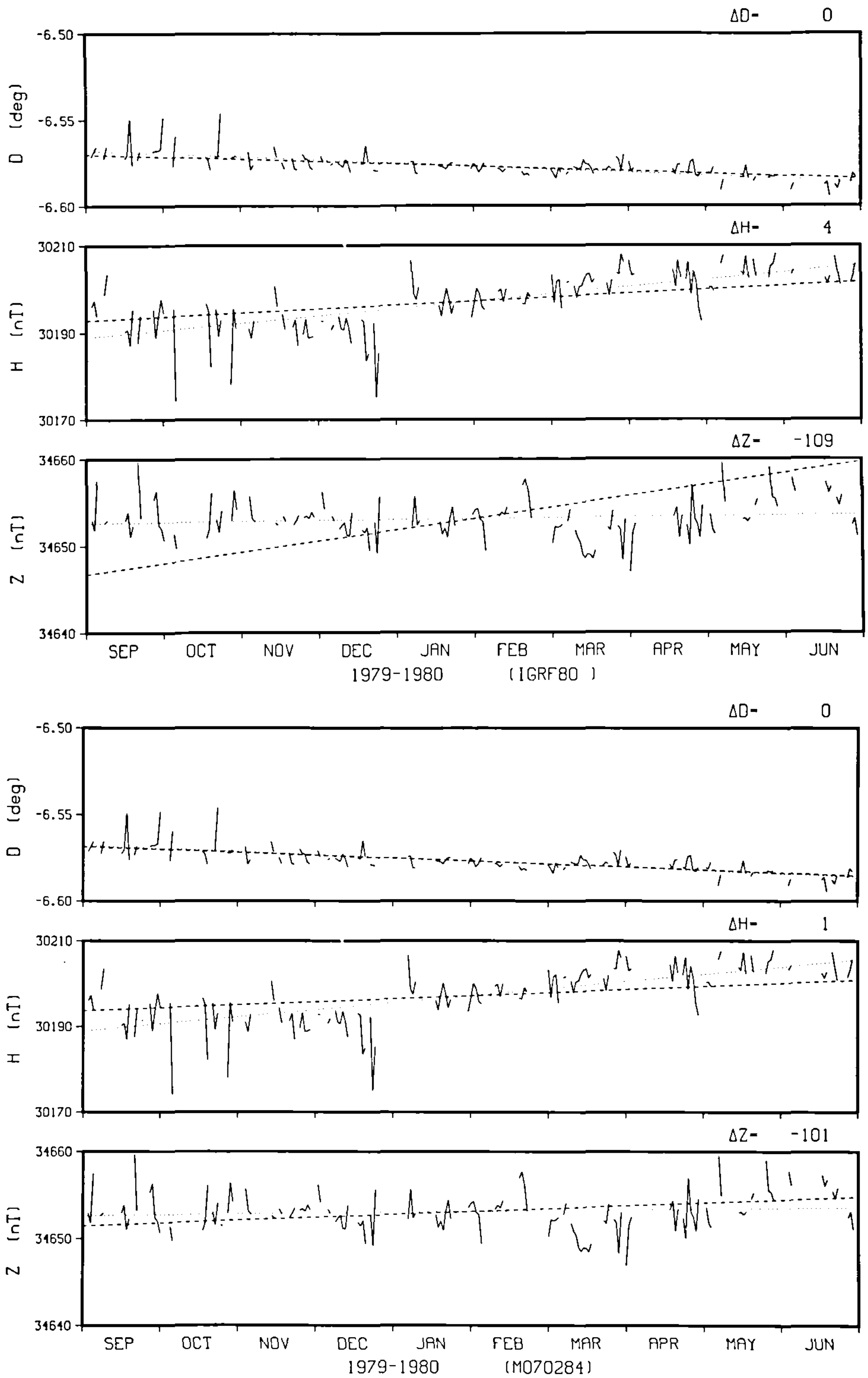


Figure 5. 1980 secular variation in total field from the model M070284.

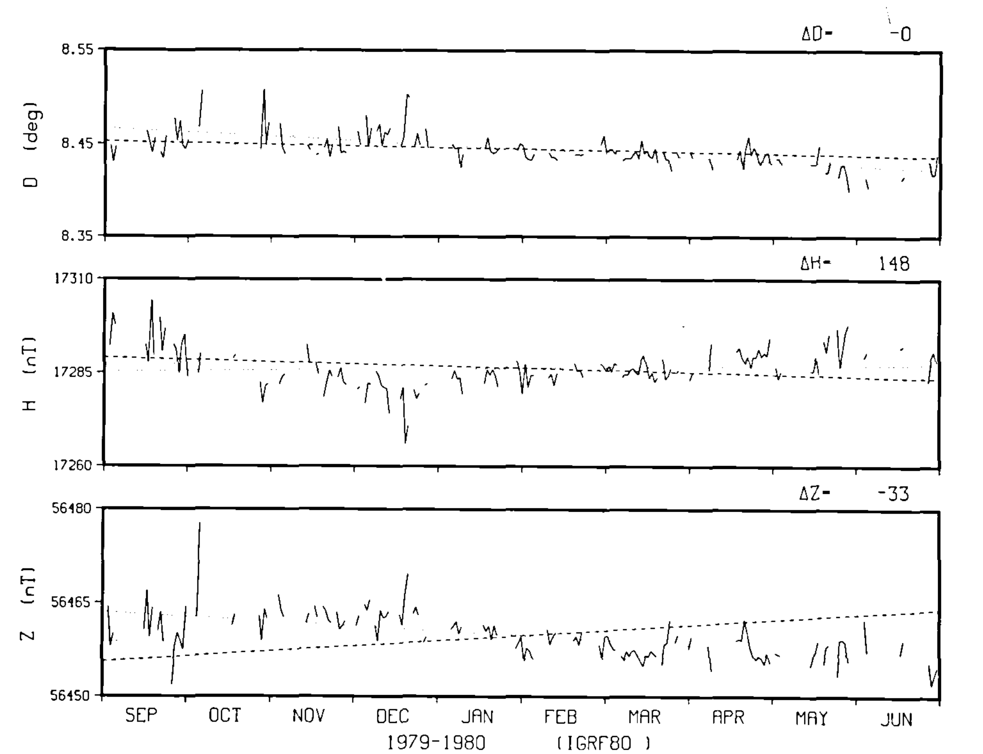


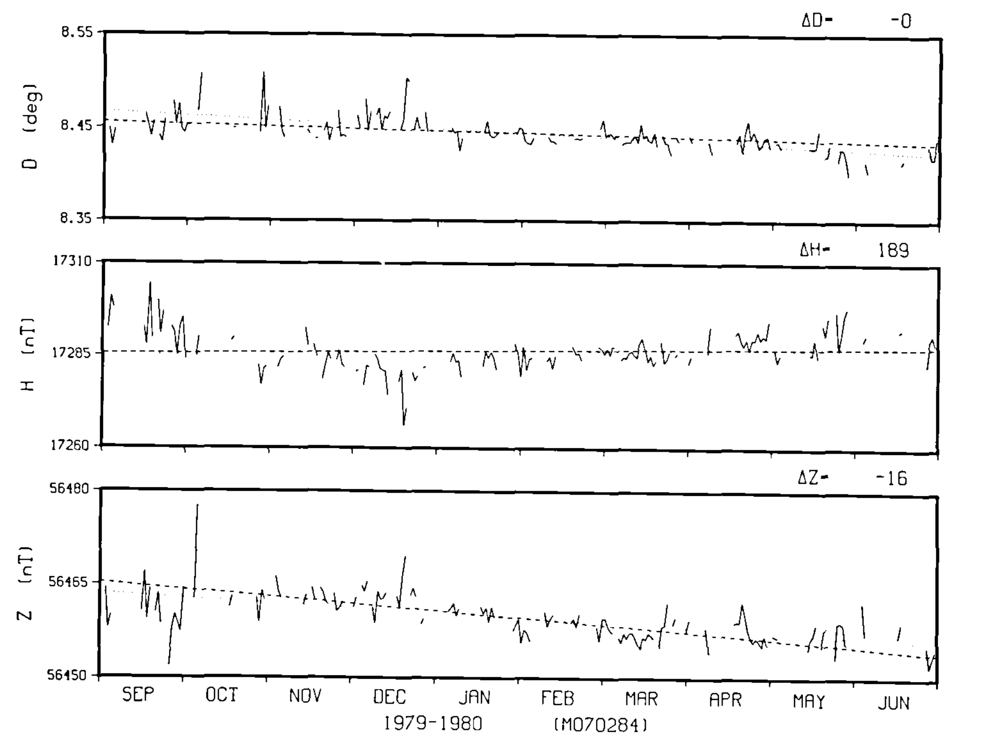


Figures 6a-6b. Bangui quiet, nighttime, daily means (solid lines) best fit (dotted lines), and model value (dashed lines) adjusted by values over each plot. $\Lambda = 5^{\circ}$.



Figures 7a-7b. Kakioka quiet, nighttime, daily means (solid lines), best fit (dotted line) and model value (dashed lines) adjusted by values over each plot. $\Lambda = 26^{\circ}$.





Figures 8a-8b. Novosibirsk quiet, nighttime, daily means (solid lines), best fit (dotted lines), and model value (dashed lines) adjusted by values over each plot. $\Lambda = 44^{\circ}$.

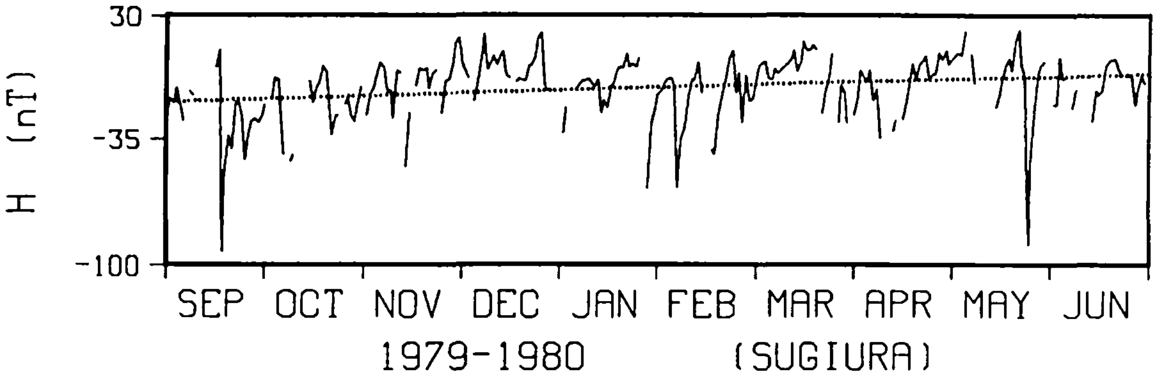


Figure 9. Average value of Dst for U.T. intervals for which K_p<2 using the data from M. Sugiura.