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(6) IONOSPHERIC TOTAL ELECTRON CONTENT MEASUREMENTS FROM TURKEY DURING THE SOLAR ECLIPSE OF 29 APRIL 1976

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Total ionospheric electron content (TEC) has been determined from the measurements of the Faraday rotation of a plane polarized wave that have been returned from the geostationary satellite ATS 6 transmitting at a frequency of 140 MHz. The results of the computations have been presented in the form of diurnal curves in order to investigate the effect of the solar eclipse of 29 April 1976 on the TEC over Ankara longitudes.

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IONOSPHERIC TOTAL ELECTRON CONTENT MEASUREMENTS FROM TURKEY* DURING THE SOLAR ECLIPSE OF 29 APRIL 1976

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ABSTRACT

Total ionospheric electron content (TEC) has been determined from the measurements of the Faraday rotation of a plane polarized wave that have been returned from the geostationary satellite ATS 6 transmitting at a frequency of 140 MHz. The results of the computations have been presented in the form of diurnal curves in order to investigate the effect of the solar eclipse of 29 April 1976 on the TEC over Ankara longitudes.

1. INTRODUCTION

A station was set up in Ankara at the Electrical Engineering Department of the Middle East Technical University (METU) to observe variations of the total electron content (TEC) between December 1975 and June 1976. The METU station was equipped with a Switched polarimeter consisting of a linear cross yagi antenna, a receiver and a pen recorder recording the Faraday polarization twist of VHF radio waves which are transmitted at the 140 MHz from the geostationary satellite ATS-6 (Davies et al. 1972) located at approximately 35°E longitude over the equator. The location of the sub-ionospheric point is 36.4°N, 33.2°E. The polarization angle was measured at 15 minute intervals, and continuous data were received for almost all days except during late December and partly in January due to chart seconder failure. There were also some off signal periods due to the interruptions of the signal from the satellite.

The data have been reduced at the Physics Department of the METU employing the method described by Klobuchar (1975)*. After being encoded and punched the data are being sorted into hourly group. In order to remove the '$n\pi$' ambiguity the critical frequencies (f_0F_2) of the nearest ionosonde stations to the subionospheric point have been obtained from the WDC-C1.

* Presented at the NATO Advanced Study Inst. on Dynamical an Chemical Coupling of Neutral and Ionized Atmosphere 11-22 April 1977, Norway.

The effect of the solar eclipse of 29 April 1976 on the METU TEC data is described in this paper.

2. RESULTS

The diurnal variations in the ionospheric TEC are shown in figure 1 for three days in April 1976 prior to the solar eclipse. In these curves the effect of increasing magnetic activity is also seen. As Kp-the daily sum of the three hour planetary magnetic activity index-increased enhancements did occur in the TEC. Maximum TEC enhancements are observed around noon hours.

In order to investigate the changes observed during the eclipse a non-eclipse or a 'control' curve is constructed by taking the arithmetic mean of TEC data of the 27th and 28th of April 1976. The Kp was 18 during the control days where as it was 23 on the eclipse day. Figure 2 shows the diurnal variations in the TEC data obtained on the eclipse day. The control curve is also drawn in the same figure, for comparison purposes. The TEC values were greater than those of the control curve during the morning period. The solar abscuration was clearly felt in the TEC as the data obtained on the eclipse day exhibited a very marked decrease. After 15 00 hours the TEC values again became greater than those of the control curve and this behavior continued until 22 00 hours. In order to investigate the effects of the eclipse on f_oF_2 data, the diurnal variations of the f_oF_2 measured on a magnetically quiet day (26 April 1976) and on eclipse day (29 April 1976) are plotted on a transparent sheet. As can be seen a very similar behavior is observed in the f_oF_2 data. On the eclipse day the f_oF_2 values started to decrease 18 minutes earlier than the first contact point and they continued to decrease till 50 minutes past the maximum obscuration. Whereas, the corresponding time intervals were 33 minutes and 5 minutes respectively in the eclipsed TEC data. Figure 3a shows the difference in TEC between the eclipse and control day values. In figure 3b the time rates of change of both the TEC and the control curve are illustrated. The TEC on the eclipse day started to decrease at 10 45 hours, well before the first contact time (11 18 hours). The TEC values continued to decrease till 5 minutes past the maximum solar obscuration which took place at

13 10 hours. The maximum change in TEC was approximately -9×10^{16} el/m^2 with respect to the control curve. Recovery took place at a rapid rate near the fourth contact and within 25 minutes following the fourth contact the TEC reached the control curve values. The increase in TEC continued until 18 15 hours. Following this the TEC started to decrease reaching the control curve values at 20000 hours.

3. DISCUSSION

On the eclipse day, unfortunately, the magnetic activity index Kp was increased to 4 around 15 00 hours indicating the existence of a moderate magnetic substorm. Therefore, it is very difficult to distinguish the effects of the eclipse phenomenon on the TEC data from the effects of high magnetic activity. Summarizing, the unusual features observed in the TEC on the eclipse day are: (1) the decrease in TEC well before the first contact; (2) the unexpected increase in the TEC well after the fourth contact. The time differences due to the altitude variations can not along explain the early decrease seen in the TEC data. If the diurnal variation of the TEC on the eclipse day is considered as the representative of the data at the subionospheric level, i.e.420 km., the parallel behavior of the f_0F_2 data indicates that downward diffusion alone may not be responsible for the observed changes in the TEC data. The well known difficulty in interpreting the effects of an eclipse on the topside ionosphere is once more noted in this work.

ACKNOWLEDGEMENTS. The polarimeter was supplied through the grant AFOSR 75-2800. All the f_0F_2 data used for this study were obtained from the WDC-C1 and the authors express their thanks to Mr.R.W.Smith. The authors also wish to thank to Dr.Oranç and Mr.G.Gerçeker who provided the Faraday signal data, and to Dr.J.A.Klobuchar for his valuable technical assistance.

FIGURE CAPTIONS

Figure 1. The diurnal variations in TEC obtained at the METU station.

Figure 2. The diurnal variations in TEC obtained during the solar eclipse of 29 April 1976. The trasparency gives the diurnal variations of the f_oF_2 that correspond to a magnetically quiet day and to the solar eclipse day.

Figure 3. The diurnal variations of TEC and the time rate of changes of the TEC obtained both on the control days and on the solar eclipse day.

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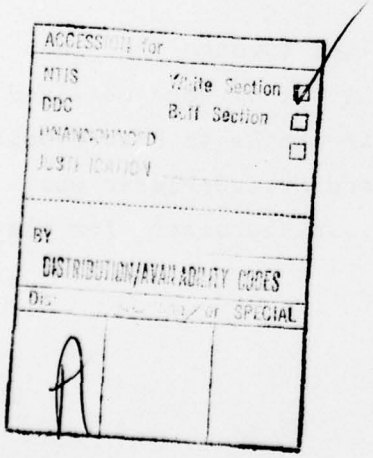
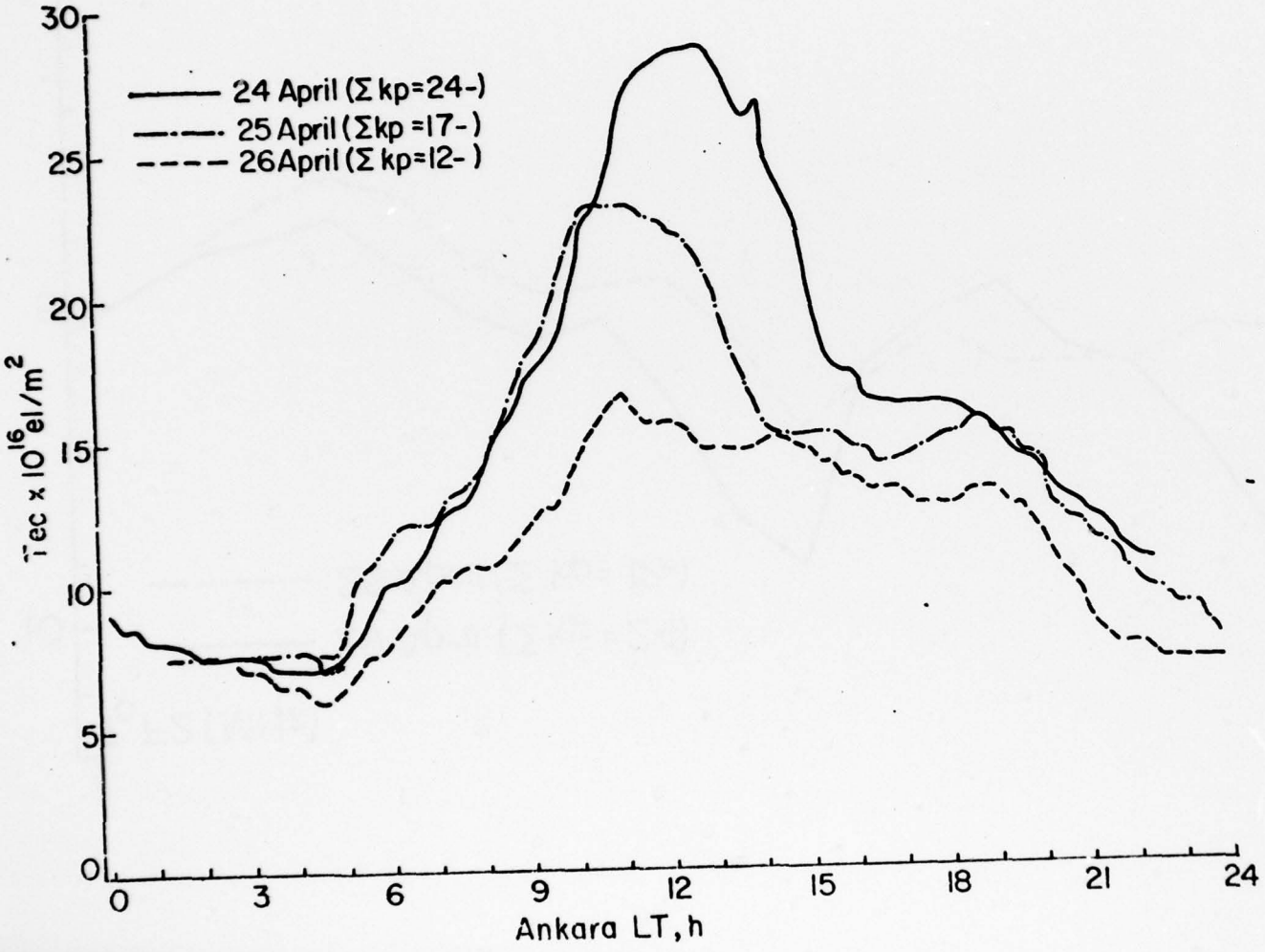
Davies, K., Fritz, R.B., and Grubb, R.N., 1972, J.Environ.Sci. 4, 31.

* Klobuchar, J.A., 1975, Private communication.

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25 April (Σkp =17-)
26April (Σ kp=12-)
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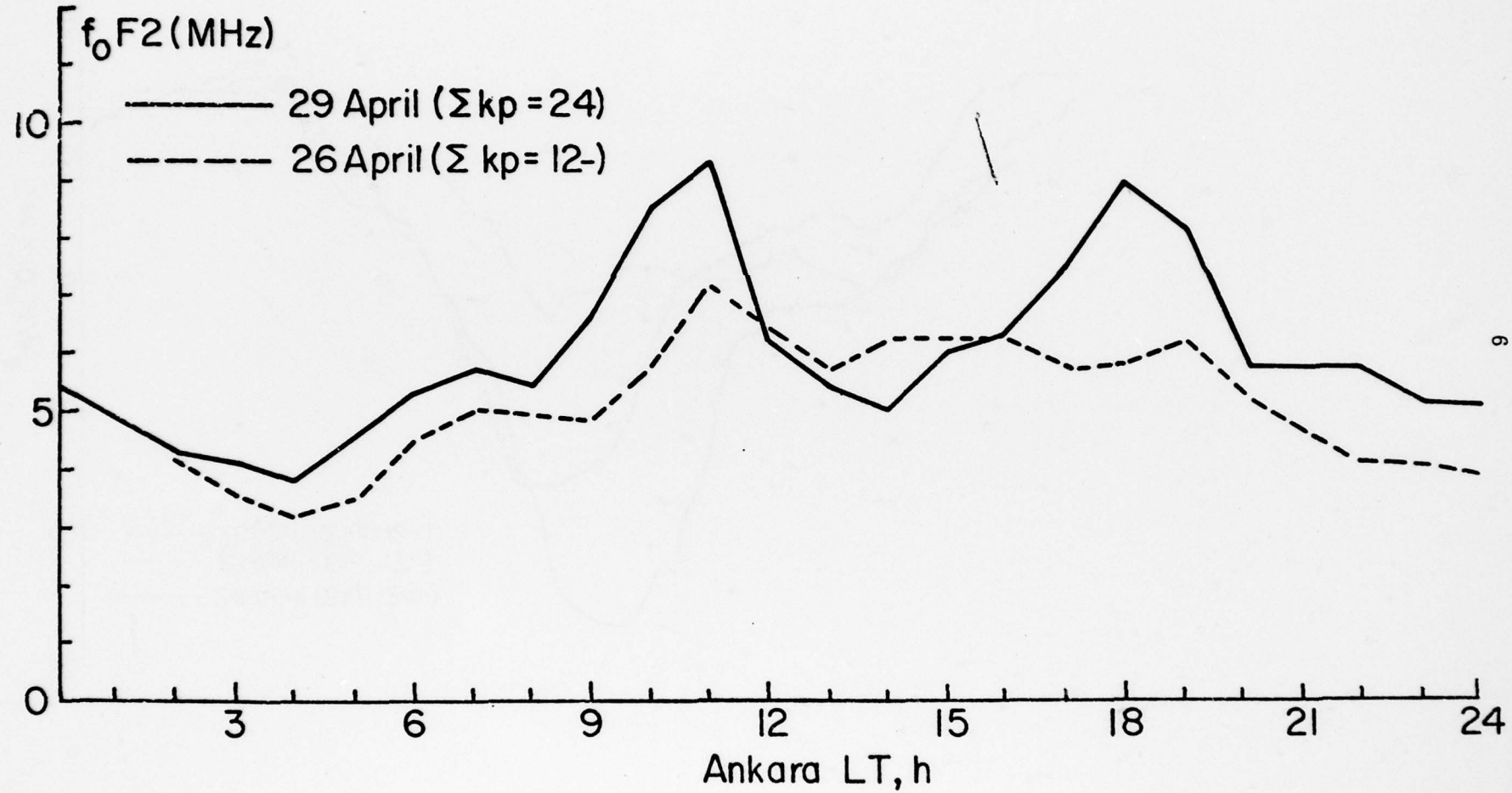

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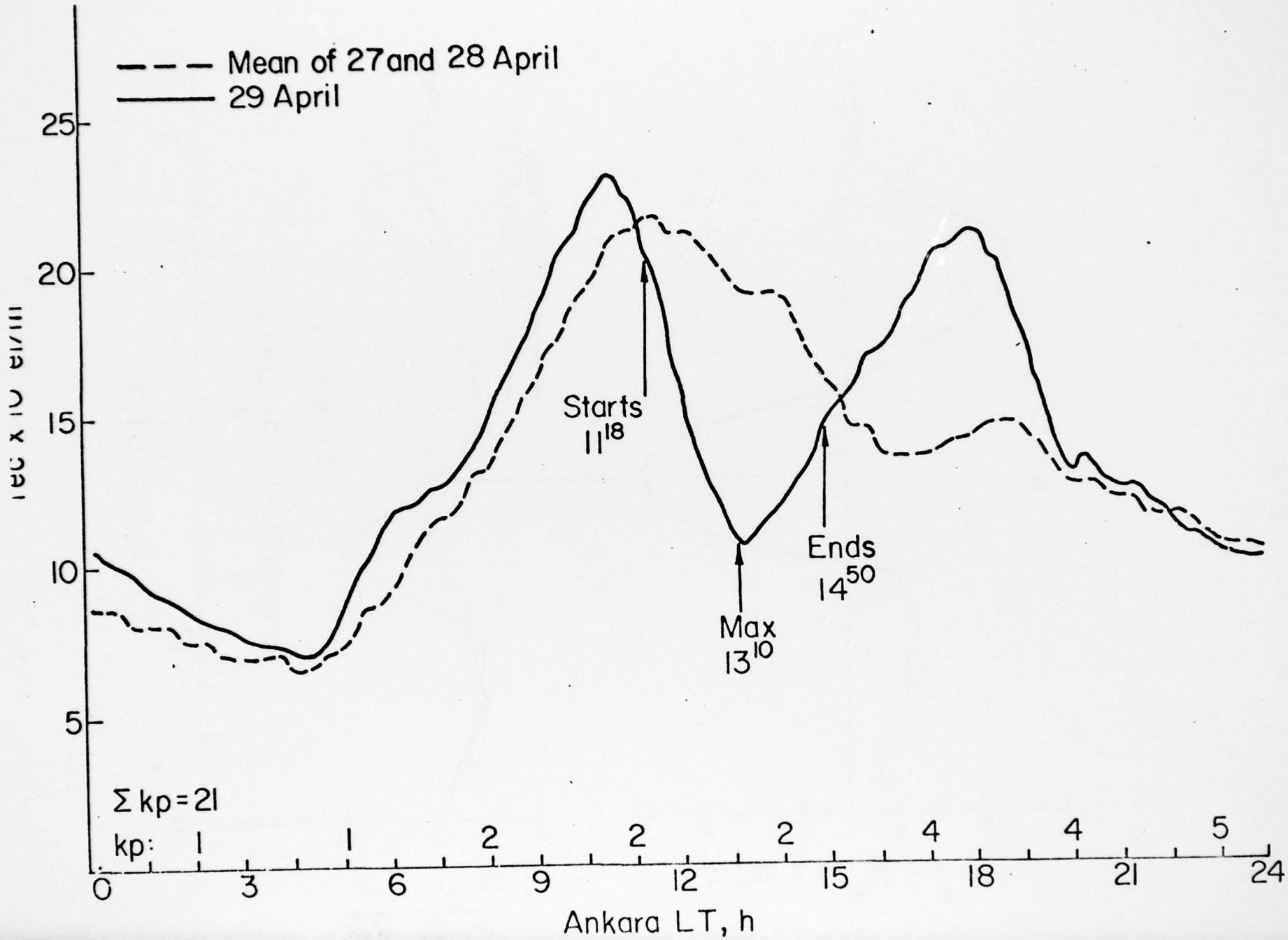
Mean of 27and 28 April
29 April
25
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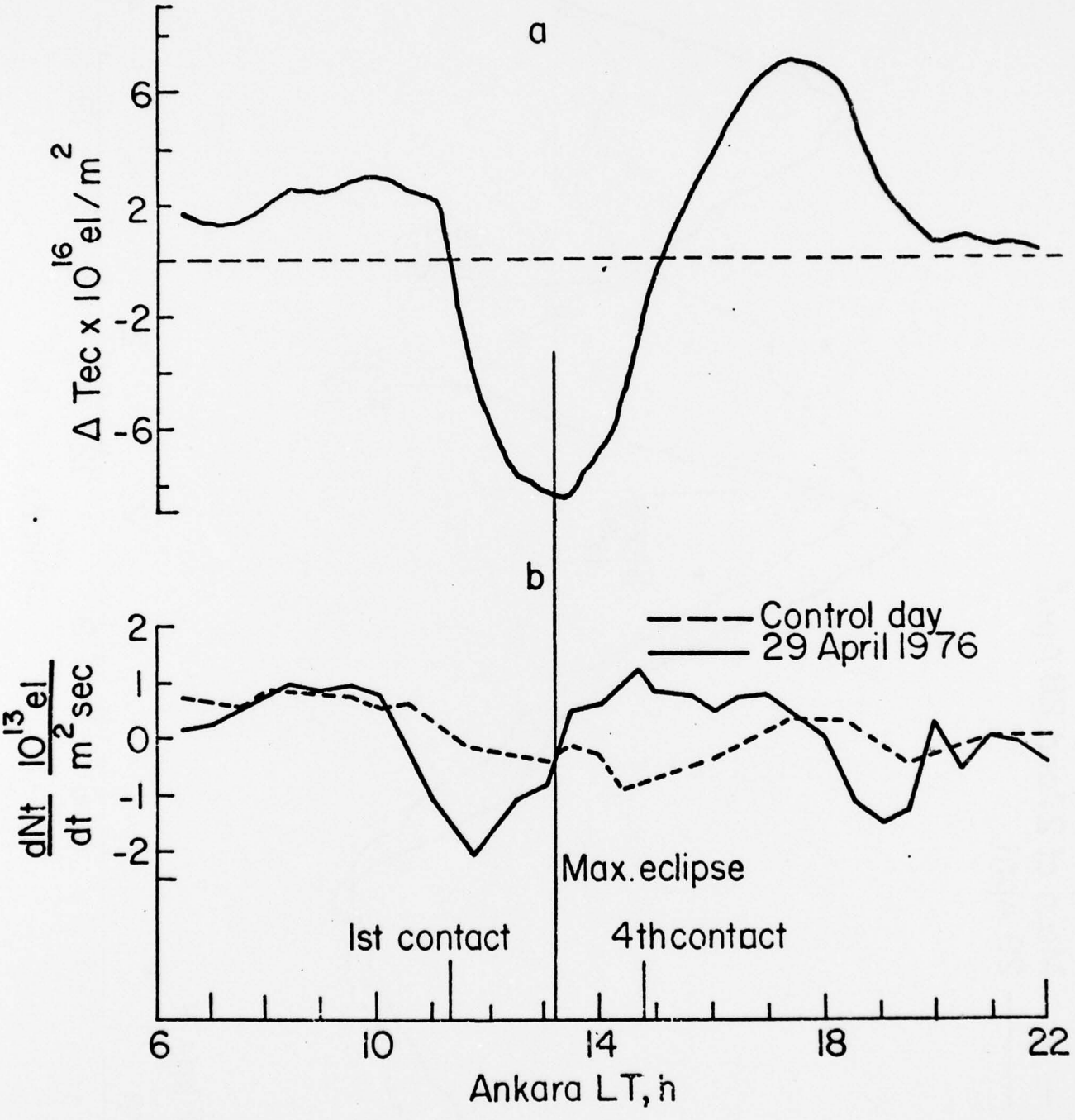
a
6
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-2
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Δ Tec x 10^16 el/m^2
b
Control day
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dNt/dt 10^13 el/m^2 sec
Max. eclipse
1st contact
4th contact
6
10
14
18
22
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