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COMPARISON OF THE RESULTS OF AN IONOSPHERE MODEL WITH REAL TIME DIGISONDE 256 PROFILES AUTOMATICALLY DEDUCED BY COMPUTER(ARTIST)

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ABSTRACT

In the 70 to 250 km height range,the photochemical model developped by M. Dymek is compared with the experimental data obtained at the Dourbes Station where a Digisonde 256 is connected to a computer (ARTIST) processing the data,reducing the ionogram and computing the true height electron density profile. Comparisons between density profiles obtained from the model and from ARTIST are shown.

INTRODUCTION

Since the time when a digital ionospheric sounder was first realized the earlier dream of real time determination of electron density in the ionosphere became a hope. Now that this aim is reached, we have a fruitfull system to improve both knowledge and predictability of the ionosphere.

THE DOURBES STATION

The center for Geophysics at Dourbes applies digital sounding since 1969 with a Digisonde 128 and since 1980, with a Digisonde 256. Both instruments were built at the University of Lowell, Center for Atmospheric Research./1/ The Digisonde 256 determines not only the group travel time and the amplitudes of the echoes but also the phase, the wave polarisation (O or X), the Doppler offset from the transmitted frequency and the direction of the received echo (vertical or oblique). The last point involves switching of receiving antennas and delay lines. It is impossible for a person to deal with such an amount of information. This is the task of ARTIST (Automatic Real Time Ionogram Scaling with True height analysis)./2/ The ARTIST computer receives all information (at present with a frequency step of one tenth of Mhz) and also provides remote control and data transmission. The principal features of the system are described in /1/. The sounding results are fed to computer ARTIST which takes care of standard ionogram reduction and produces an electron density profile. A comparison of f_0F_2 determinations from ARTIST and by manual method shows good agreement,the difference being not greater than 0.1 Mhz in 72% of all cases. All profiles considered in this study were taken from that class.

THE PHOTOCHEMICAL MODEL

M.Dymek's calculations are based on :

1) photoionisation of the neutral atmosphere components using Chapman function (wave lenght spectrum divided in 49 slabs)

2) continuity equations for positive and negative ions with productions and losses (166 reactions,16 neutrals,24 positive and 14 negative ion species).

The reaction schemes can be seen from Figures 1 and 2. The model does not take account of vertical transport of ionisation by neutral winds and of diffusion. It should be noted that many rate constants are scarcely known.

Day by day changes of solar EUV-fluxes are not introduced but solar zenith angle control. This dependence is illustrated (in the 40° to 90° range) by Figure 3. (Like in all following figures the abscissa is electron density/ m^{-3}, ordinate height/ km). The E-layer is appearing with a critical density corresponding to f_0E but F_1 is not clearly seen. The F_2 critical density related to f_0F_2 lies beyond the limits of the drawing and is not well reproduced by the model. This is probably due to neglecting dynamic features.

COMPARISONS

The model is compared in the 70 to 250 km height range. From Jan. 20 to May 7, 1987 (with a break from Feb. 14 to March 18) 129 profiles were selected after the solar zenith angle /(upper right hand corner). Day number and Universal Time appear in the upper left hand corner. Solar zenith angles within 5° in a first comparison (Figure 4 a..d). The points are profile values computed from the individual ionograms. On the Figures 5 a..i those experimental points which are within 1° agreeing with the model value are noted as squares, the others as other symbols. Figure 5a is for sunrise/sunset on days at the end of March. Figures 5 b,c show a seasonal effect with zenith angles of 80 and 70°. One special feature on Figure 5d is for a condition where the actual F_{2} region was largely different from the model.

CONCLUSIONS

In spite of the weak quality of most of the chemical rate constants, the photochemical model works quite well in the range between 70 and 200 km. An improved model would be needed for the F_{2} region.

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3. M. Dymek, Artificial Satellites - Space Physics 18, #2, 27 (1983)

4 M. Dymek, Photochemical model of ion composition and electron density in the terrestrial ionosphere between 70 and 300 km, Publications Serie A # 180, Institut Royal Meteorologique, Bruxelles, in press (1987)

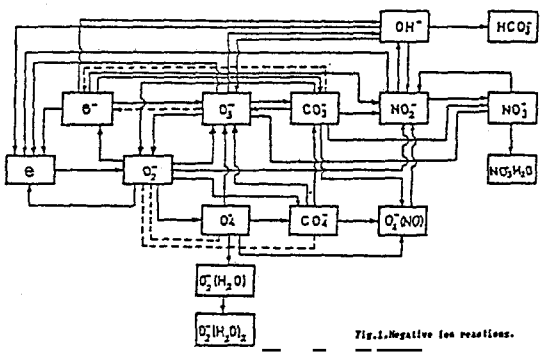


Fig.1.Negative ion reactions.

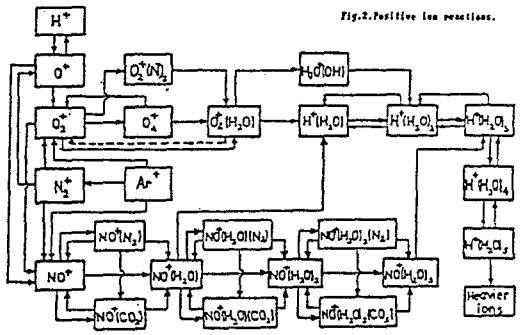


Fig.2.Positive ion reactions.

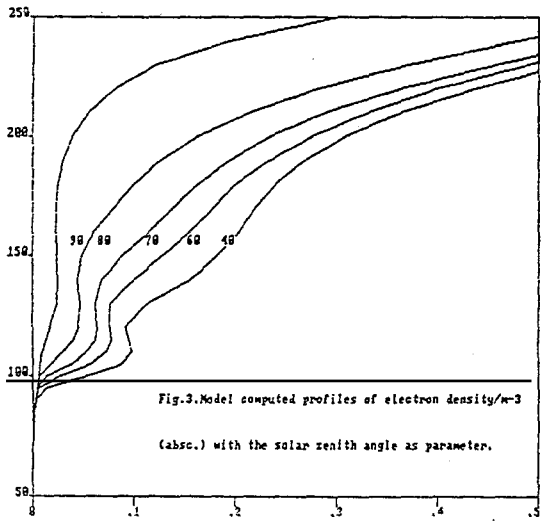


Fig.3.Model computed profiles of electron density/m-3 (absc.) with the solar zenith angle as parameter.

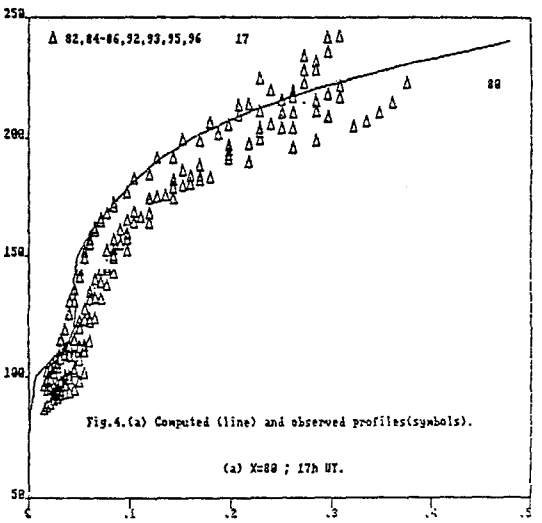
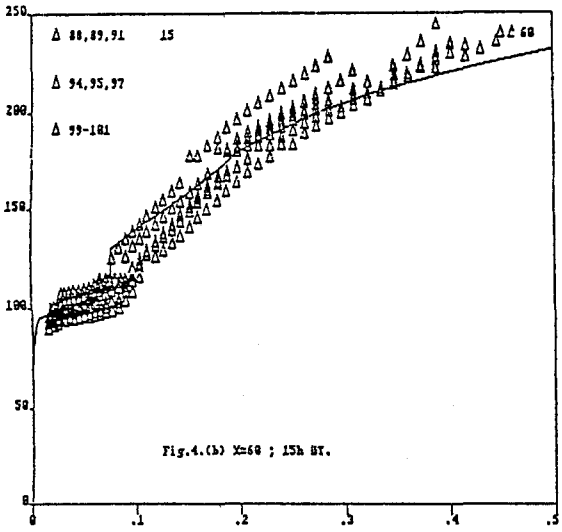
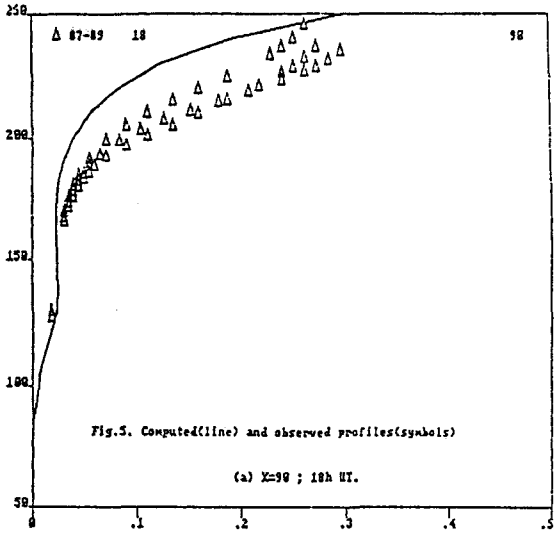
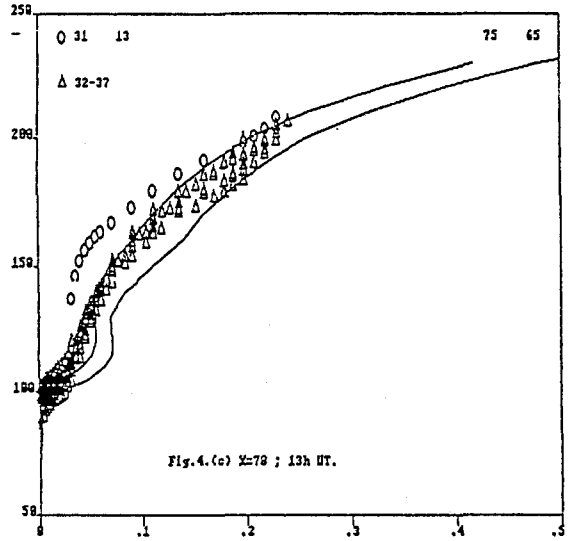


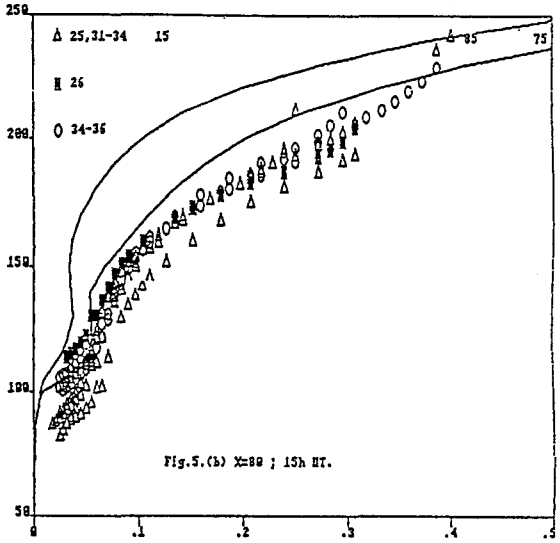
Fig.4.(a) Computed (line) and observed profiles(symbols).

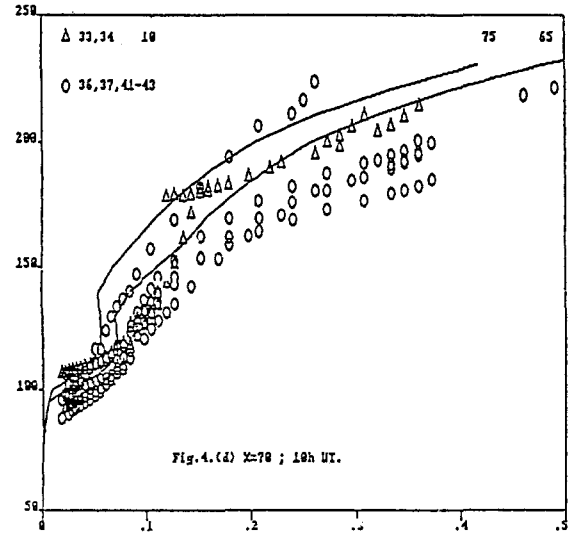
(a) X=80 ; 17h UT.

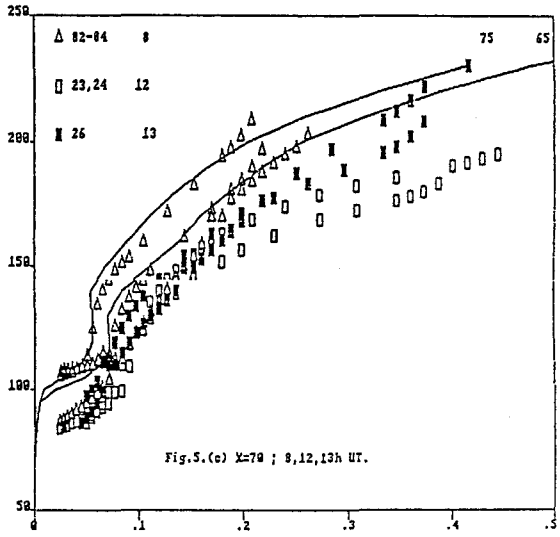

Δ 88,89,91 15
Δ 94,95,97
Δ 99-101
Fig.4.(b) X=60 ; 15h UT.


Δ 87-89 18
Fig.3. Computed(line) and observed profiles(symbols)
(a) X=90 ; 18h UT.


O 31 13
Δ 32-37
Fig.4.(c) X=70 ; 13h UT.


Δ 25,31-34 15
H 26
O 34-36
Fig.5.(b) X=80 ; 15h UT.


Δ 33,34 10
O 36,37,41-43
Fig.4.(d) X=70 ; 10h UT.


Δ 82-84 8
□ 23,24 12
H 26 13
Fig.5.(c) X=70 ; 8,12,13h UT.

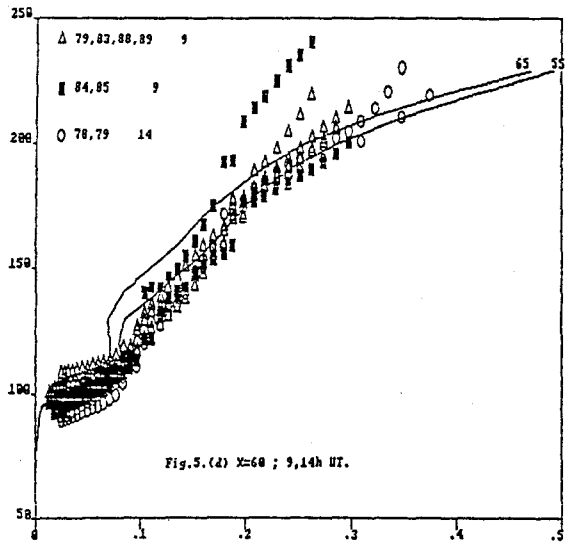


Fig.5.(d) X=60 ; 9,14h UT.

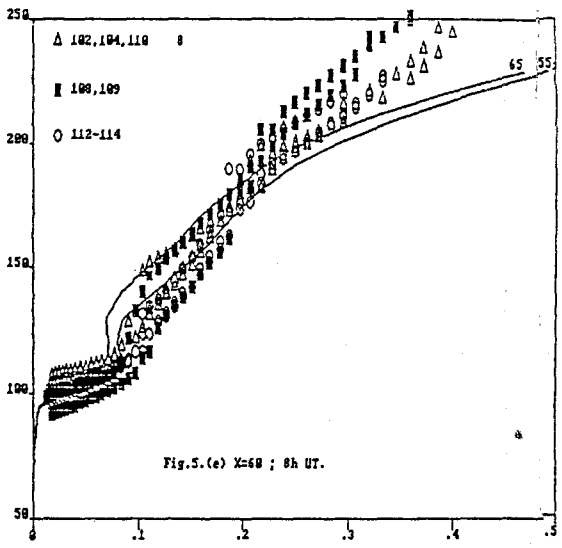


Fig.5.(e) X=60 ; 8h UT.

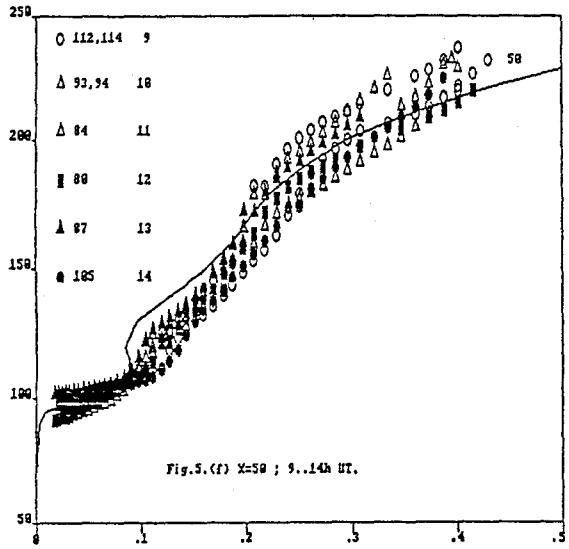
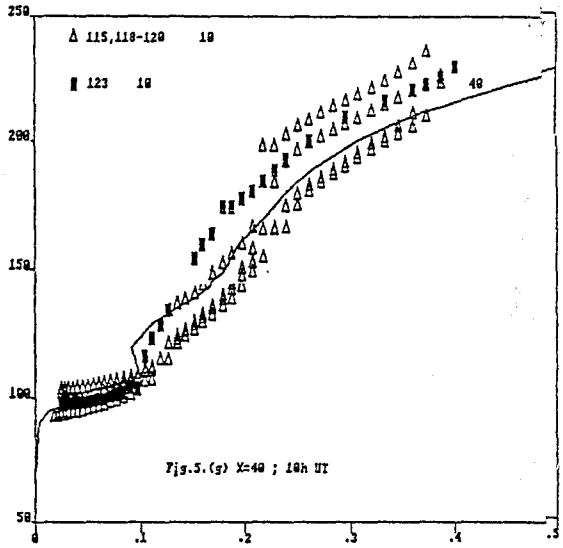


Fig.5.(f) X=50 ; 9..14h UT.



Fjg.5.(g) X=40 ; 10h UT

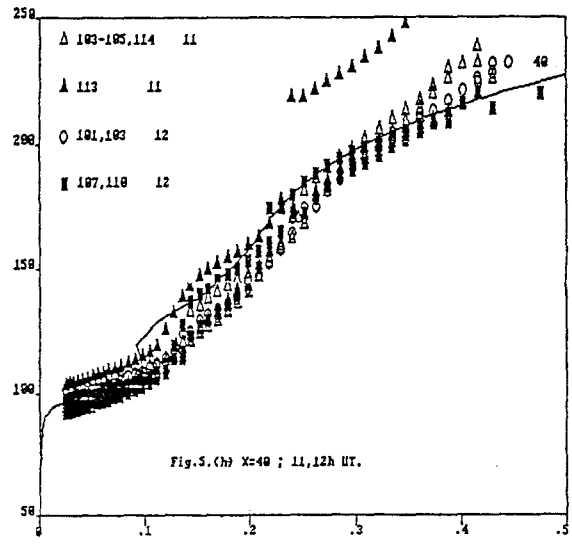


Fig.5.(h) X=40 ; 11,12h UT.

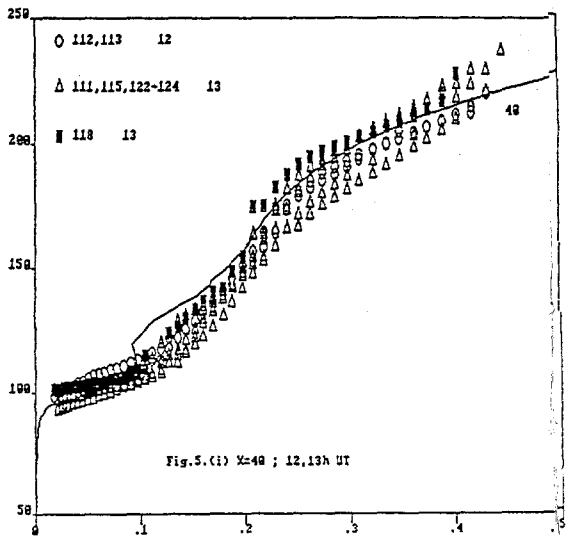


Fig.5.(i) X=40 ; 12,13h UT