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Intercomparison Between Aeros Electron Temperature Model and Mean Temperature Profiles of Different Incoherent Scatter Radar Stations*

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Abstract. The *F*-region temperature model based on AEROS-A measurements is compared with mean height profiles of incoherent scatter radar observations at middle and low latitudes and at the magnetic equator. The mean values of the ground station are in good agreement with the model temperature confirming that the generated model is representative for the electron temperature within the natural spread produced by geophysical events.

Key words: Ionosphere – *F*-region – Electron temperature model – Aeros-A measurements – Electron temperature height profiles – Incoherent scatter observations.

Introduction

In the last decade a large amount of electron temperature data became available observed mainly by satellites and ground-based Incoherent Scatter Radar (ISR) Stations. The satellite measurements can determine the world-wide temperature distribution in the *F*-region. The satellites cover large areas within relatively short time periods. They are considered an effective tool to obtain global temperature patterns. Along a satellite orbit many parameters change simultaneously and, therefore, it becomes uncertain quite often whether particular observations are modified more by geographic, temporal or time variations-mentioning only a few of possible sources. Therefore, significant global temperature patterns based on satellite data can only be obtained by a very large amount of data on statistical basis and even then the separation of different influences is not always unequivocal. In particular, height profiles constructed from a large number of in situ observations can be strongly affected by temporal changes when the data are collected during a long time period. The ground-based radar stations are better able to determine temperature profiles at a fixed location

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in a short time. They produce the most reliable height profiles and are an ideal test of the satellite observations.

The AEROS temperature model (Spenner and Plugge, 1979) based on more than 10,000 measurements describes the global distribution in the height interval 300 to 700 km for the first 7 months of 1973. A crucial test of the model can be obtained by comparing height profiles of the model with those of different ISR stations.

As the number of passes near active ISR stations is rather scarce, it seems reasonable to check the model with mean profiles of the available ground observations for equatorial, low and middle latitudes.

Even when particular in situ measurements were in good agreement with the ISR ground observations (Spenner and Rawer, 1978), it has to be demonstrated that the modeling functions represent the mean temperature pattern. The aim of this paper is to check the AEROS temperature model by available ground observations and to compare results of the model with other observations. A large amount of such different results is summarized by Schunk and Nagy, 1978.

ISR-Data Base

Measurements of the three ISR stations, Millstone Hill/USA, Arecibo/Puerto Rico and Jicamarca/Peru have been used for our comparison. They are considered as representative for middle, low and equatorial latitudes.

Usually the stations have measured periods of 1–3 days each month and measuring times 10–30 min per profile. The processed data are collected on magnetic tapes for up to 4 years. The tapes used for our comparison are summarized in Table 1, giving the periods of measurements, the 12 months running mean of the Zurich Sunspot Number R_{12} and the location of the ISR-station. Our mean profiles have been obtained by averaging over the indicated periods (Table 1). For comparison with the AEROS model we used only ISR-measurements within the local time ranges 14–16 LT and 2–4 LT. Even though a seasonal

Table 1. Location and time of the used data

Tape name	Station	Location		time	R_{12}	Number of used profiles
		geog.	geom.			
N35	Arecibo Puerto Rico	18N 293E	30N 2E	12/71–12/72	58– 73	50
W287	Jicamarca Peru	12S 283E	1N 352E	11/66– 4/69	75–110	700
MH7	Millstone Hill USA	43N 289E	54N 357E	2/72–10/75	25– 71	100
			AEROS-A	12/72– 8/73	40– 50	

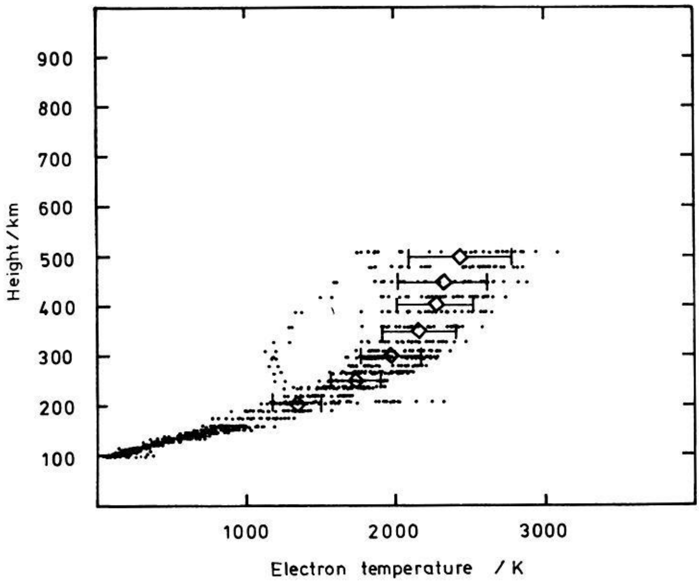

Fig. 1. Millstone Hill ISR-data for winter midday from 1972 to 1973 and median value with mean absolute deviation

variation of the electron temperature is not reproduced by the AEROS-data we restrict ourselves to ISR-data for the first three months of every year, in analogy to the first three months of 1973 which had been used for the AEROS model. As is seen in the last column of Table 1 even with these restrictions excluding annual and diurnal meaning effects there remain enough profiles to given representative mean profiles for the indicated solar activity ranges. An example of our averaging is seen in Fig. 1 showing the increasing variability of the *F*-region electron temperature with increasing height. The observed variability with height is believed to be real and not mainly due to errors in the measurements. This assumption is supported by the small variance during nighttime and the regularity of most of the individual profiles.

Results

The ISR-standard-profiles together with the mean absolute deviations for the three locations and for day and night are given in Figs. 2 and 4. The mean spread of time middle latitude data (Fig. 2) for daytime increases with height and gets as large as 15%. In equatorial latitudes (Fig. 4) the highest data scatter is observed in the height range 200–300 km which is the region of the local temperature maximum. The Arecibo data scatter (Fig. 3) behaves somewhere in between. For all three locations the mean deviation does not exceed 15%.

The described feature shows that the smaller the difference between neutral and electron temperature, and the better the heat contact of the electron gas to the neutrals is, the smaller is the electron temperature scatter. The same

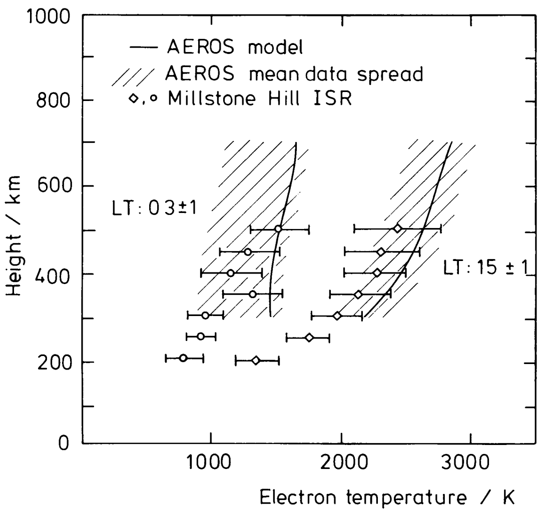

Fig. 2. Comparison between Millstone Hill data and AEROS model

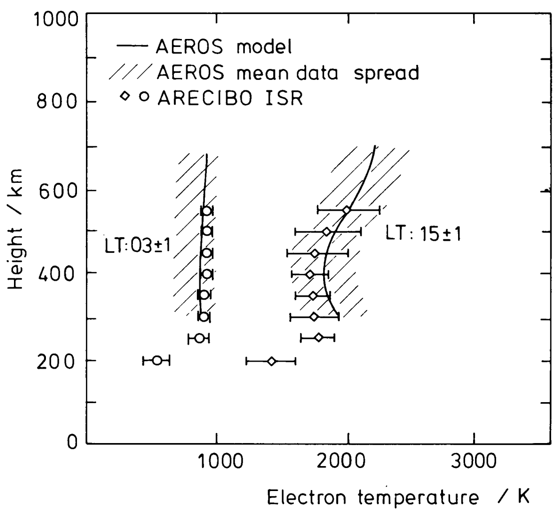

Fig. 3. Comparison between Arecibo data and AEROS model

holds for nighttime, where only the Millstone Hill data show large mean deviations increasing with height.

The solid lines in Figs. 2–4 represent the AEROS-model profiles for day and night in the height range 300–700 km covered by the satellite AEROS-A. The hatched areas indicate the mean deviation of the AEROS-data, as had been described in the foregoing article. For all three stations the model values lie within the expected failure zone. For Millstone Hill there is a general tendency of the model to exceed the ISR mean profile by about 10%. The same feature has been reported by Benson et al. (1977). Their extensive comparison between Millstone Hill measurements and satellite data of AE-C show a general excess of 11% in electron temperature, while the ion temperature agreed well and the discrepancy for other stations was less than 3%.

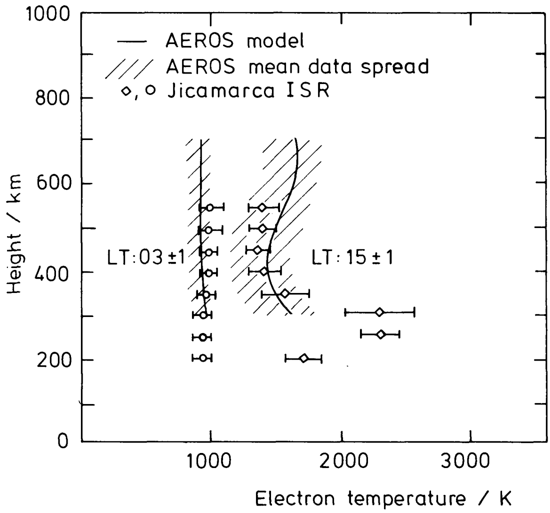

Fig. 4. Comparison between Jicamarca data and AEROS model

In analogy to this, we find good agreement of the AEROS model with the other stations, Arecibo and Jicamarca. Even though the solar activity range is not the same as that covered by the AEROS-A data used for the model, namely $R_{12}=40$–50. As was reviewed by Schunk and Nagy (1978) the electron temperature in the high electron density region 200–400 km seems to become higher with decreasing solar activity. So the few percent higher model temperature at 1500 LT may represent even better the actual temperature profile during the AEROS mission than the ISR data obtained at a higher solar activity (Table 1). The result of the comparisons shown here confirms that the AEROS model temperatures are quite representative within the natural spread generated by different geophysical conditions.

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