NASA TECHNICAL MEMORANDUM NASA TM-75649

METHOD FOR THE "RAPID" TEMPERATURE CORRECTION OF A TRANSMISSION IN AN INHOMOGENEOUS ATMOSPHERE

V.A. Varnava, A.B. Karasev, V.V. Sapunov
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(NASA-TM-75649) METHOD FOR THE RAPID TEMPERATURE CORRECTION OF A TRANSMISSION IN AN INHOMOGENEOUS ATMOSPHERE (National Aeronautics and Space Administration) 8 p HC A02/MF A01 CSCL 04A G3/46

N79-29730

Unclas
34080

Translation of "Metodika 'bystroy' korrektsii po temperature propuskaniya neodnorodnoy atmosfery," USSR Academy of Sciences, Moscow, Report, 1979, pp. 1-6

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 JULY 1979

This is Number XVIII of a list of works performed in the USSR in accordance with a program of joint Soviet-American research in improving methods of temperature sounding by satellites. It is Appendix III to the Protocol of the Third Conference of the Soviet-American Working Group on Space Meteorology, held in Moscow, 10-22 November, 1976.

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V.A. Varnava, A.B. Karasev, V.V. Sapunov
and O.B. Fedichev
Moscow Physical-Technical Institute,
USSR Academy of Sciences

2.3 Method for the "Rapid" Temperature Correction of a Transmission in an Inhomogeneous Atmosphere /2*

In accordance with Point 2.3 of the Program of joint Soviet-American research on the improvement of methods of temperature sounding of the atmosphere by satellites, the Moscow Physical-Technical Institute has developed a method for the "rapid" temperature correction of the transmission function in an inhomogeneous atmosphere.

Consider the model of an inhomogeneous atmosphere of N layers. Let f_n be the averaged transmission function within a certain frequency interval between the upper bound of the atmosphere and the lower bound of the n^{th} layer (numbering the layers from the top down). Then the change of the transmission function from the temperature profile can be written in the form:

$$\Delta f_n = f_n(T_1^{cp} + \Delta T_1, T_2^{cp} + \Delta T_2, \ldots, T_n^{cp} + \Delta T_n) - f_n(T_1^{cp}, T_2^{cp}, \ldots T_n^{cp}), \quad (1)$$

where T_n^{cp} is the average climatic value of the temperature of the n^{th} layer, and ΔT_n is the deviation of temperature from the average.

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* Numbers in the margin refer to pagination in the foreign text.

In order to determine the value of Δf_n, let us assume the following recurrent relation:

$$\Delta f_n = \Delta f_{n-1} \cdot \alpha_n + \Delta T_n \cdot \beta_n + (\Delta T_n)^2 \gamma_n \qquad (2)$$

employing the constant coefficients α_n, β_n, γ_n in accordance with the given character of averaging over the frequency interval under consideration.

The values of these coefficients in the n^{th} layer are determined from the solution of the linear algebraic equation (3) by the method of least squares.

$$\Delta f_n^i = \Delta f_{n-1}^i \cdot \alpha_n + \Delta T_n^i \cdot \beta_n + (\Delta T_n^i)^2 \gamma_n \;, \quad i = 1,2,\ldots,M \qquad (3) \qquad /3$$

where the index i designates the given type of temperature profile and M > 3.

In particular, we have used the eleven following temperature profiles in calculations:

T_n^{φ} — climatic average

$T_n^{\varphi} + 45$ — climatic average plus 45°K

$T_n^{\varphi} - 45$ — climatic average minus 45°K

T_n^{Ap} — arctic

$T_n^{Ap} + 45$ — arctic plus 45°K

$T_n^{Ap} - 45$ — arctic minus 45°K

T_n^{Tp} — tropical

$T_n^{Tp} + 45$ — tropical plus 45°K

$T_n^{Tp}-45$ — tropical minus 45°K

T_n^{us} — isothermal at a temperature of 250°K

$T_n^{us}+50$ — isothermal at a temperature of 300°K

The functions $\Delta f_n{}^i$ were calculated for these profiles by the method of multiple straight lines.

Evaluation of this proposed arrangement of interpolation has shown that the addition of new equations to equation (3) corresponding to temperature profiles different from the given ones does not significantly alter the coefficients α, β, γ.

The absolute errors in the transmission arrived at by the use of equation (2) do not exceed 0.005 in the channels of a Soviet radiometer. The exact values of the transmission function were calculated from the results of the multiple straight-line /4 method.

Tables 1 and 2 present the absolute errors of the transmission function for some typical temperature profiles as a function of the level of pressure. The 730 cm^{-1} and 760 cm^{-1} frequency bands were selected as the ones with the greatest variation.

TABLE 1.

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THE ABSOLUTE VALUES OF THE ERRORS OF THE METHOD OF RAPID CORRECTION OF THE CALCULATION OF THE TRANSMISSION FUNCTION FOR CHARACTERISTIC TEMPERATURE PROFILES
(Channel center = 730 cm^{-1})

P (mbar)	C Av. + 45°	C Av. - 45°	Arct.	Trop.	Isoth.
I000.0	0.0004	0.0003	0.00II	0.00I4	0.0005
800.0	0.0005	0.0005	0.00I8	0.00I9	0.0009
650.0	0.0004	0.0002	0.00I8	0.00I3	0.00I0
500.0	0.0005	0.0006	0.0027	0.00I0	0.00I4
400.0	0.00I0	0.0005	0.0033	0.0005	0.0022
200.0	0.0003	0.0003	0.00I0	0.002I	0.0002
I00.0	0.0000	0.0000	0.000I	0.000I	0.0002
50.0	0.0000	0.0000	0.0000	0.0000	0.0000
25.0	0.0000	0.0000	0.0000	0.0000	0.0000
I3.0	0.0000	0.0000	0.0000	0.0000	0.0000
6.5	0.0000	0.0000	0.0000	0.0000	0.0000
3.0	0.0000	0.0000	0.0000	0.0000	0.0000
I.6	0.0000	0.0000	0.0000	0.0000	0.0000
0.6	0.0000	0.0000	0.0000	0.0000	0.0000
0.0	0.0000	0.0000	0.0000	0.0000	0.0000

TABLE 2. /6

THE ABSOLUTE VALUES OF THE ERRORS OF THE METHOD OF RAPID CORRECTION OF THE CALCULATION OF THE TRANSMISSION FUNCTION FOR CHARACTERISTIC TEMPERATURE PROFILES
(Channel center = 760 cm^{-1})

P (mbar)	C Av +45°	C Av -45°	Arct.	Trop.	Isoth.
1000.0	0.0014	0.0012	0.0044	0.0050	0.0020
800.0	0.0012	0.0008	0.0030	0.0047	0.0017
650.0	0.0008	0.0007	0.0019	0.0035	0.0014
500.0	0.0006	0.0005	0.0015	0.0023	0.0012
400.0	0.0008	0.0004	0.0013	0.0014	0.0017
200.0	0.0000	0.0001	0.0000	0.0009	0.0001
100.0	0.0000	0.0000	0.0000	0.0000	0.0000
50.0	0.0000	0.0000	0.0000	0.0000	0.0000
25.0	0.0000	0.0000	0.0000	0.0000	0.0000
13.0	0.0000	0.0000	0.0000	0.0000	0.0000
6.5	0.0000	0.0000	0.0000	0.0000	0.0000
330	0.0000	0.0000	0.0000	0.0000	0.0000
1,6	0.0000	0.0000	0.0000	0.0000	0.0000
0.6	0.0000	0.0000	0.0000	0.0000	0.0000
0.0	0.0000	0.0000	0.0000	0.0000	0.0000