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STATISTICS OF TERRAIN EMISSION AT 35 AND 94 GHZ

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1 INTRODUCTION

The 35 and 94 GHz atmospheric window frequencies are the primary channels used for making millimeter-wave radiometric observations of terrain. This report describes the operation of a computer code called SOTE (Statistics of Terrain Emission) which generates a statistical distribution function (SDF) for the brightness temperature T_B for any of ten types of terrain categories. The program is designed to incorporate the attenuation and emission effects of the atmosphere including cloudy and rainy conditions. The emission properties of terrain are based on a data base comprised of experimental observations reported in the literature.

2 ATMOSPHERIC PARAMETERS

The program can deal with any one of the four situations illustrated in Figure 1. In all cases, the atmosphere is considered to consist of only the first 30 km above the terrain surface, thereby ignoring the insignificant contributions of the upper atmosphere. The four conditions will be refereed to as:

$\boldsymbol{i = 1}$, atmospheric condition 1: clear sky

$\boldsymbol{i = 2}$, atmospheric condition 2: cloudy

$\boldsymbol{i = 3}$, atmospheric condition 3: rainy

$\boldsymbol{i = 4}$, atmospheric condition 4: rain and cloud layers

2.1 Gaseous Absorption Coefficient

The required input parameters are:

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$\boldsymbol{T_0}$: surface air temperature, K.
$\boldsymbol{P_0}$: surface air pressure, mbars
$\boldsymbol{\rho_0}$: surface water vapor density, g/m^3

The program uses the U.S. Standard Atmosphere model to calculate the vertical profiles of temperature $T(z)$, pressure $P(z)$, and water vapor density $\rho(z)$ in 50 m increments over the height z from 0 to 30 km. Then using, expressions for absorption and emission by oxygen and water vapor, the program calculates the following quantities at the specified frequency band (35 or 94 GHz):

(a) $\boldsymbol{\kappa_{O_2}}$: Oxygen absorption coefficient (NP/km) as a function of height z in 50 m intervals over the range 0 to 30 km.

(b) $\boldsymbol{\kappa_{H_2O}(z)}$: Water vapor absorption coefficient (NP/km) as a function of height z in 50 m intervals over the range 0 to 30 km.

(c) $\boldsymbol{\kappa_g(z)} = \kappa_{0_2}(z) + \kappa_{H_2O}(z)$: gaseous absorption coefficient, NP/km.

2.2 Cloud Absorption Coefficient

When a cloud layer is present, the following input parameters are required:

$\boldsymbol{H_2}$: Height of cloud base (km)
$\boldsymbol{H_3}$: Height of cloud top (km)
$\boldsymbol{m_v}$: Cloud liquid water content (g/m^3)

The program computes:

$\boldsymbol{\kappa_c(z)}$: Cloud absorption coefficient (NP/km) at height z (at the specified frequency band) for all 50 m-thick strata in the range H_2 to H_3. For strata at heights below H_2 or above H_3, $\kappa_c(z)$ is set equal to zero.

The expression used for computing $\kappa_c(z)$ is:

$$\kappa_c(z) = 2\pi f m_v \left|\text{Im } \{-K\}\right| \times 10^{-2} \quad (1)$$

where f is the frequency,

$$K = \frac{\epsilon - 1}{\epsilon + 2}\ , \tag{2}$$

and ϵ is the complex dielectric constant of water, which is a function of frequency and temperture $T(z)$. Complete expressions for the real and imaginary parts of $\epsilon = \epsilon_1 - j\epsilon_2$ are given later in Section 4.3.

2.3 Rain Absorption and Extinction Coefficients

When rain is present, the following input parameters are required:

$\boldsymbol{H_4}$: Height of top of rain layer (km)

$\boldsymbol{R}$: Rain rate (mm/hr)

The program computes:

(a) $\boldsymbol{\kappa_{re}(z)}$: Extinction coefficient (which includes both scattering and absorption losses) of the rain layer (NP/km) at height z for all 50 m-thick strata between the surface and height H_4. For strata above H_4, $\kappa_{re}(z)$ is set equal to zero.

(b) $\boldsymbol{\omega(z)}$: Scattering albedo of the rain layer for all strata below H_4.

(c) $\boldsymbol{\kappa_{ra}(z)}$: Absorption coefficient (NP/m) of the rain layer for all strata below H_4. This quantity is related to the preceding two by:

$$\kappa_{ra}(z) = [1\ -\ \omega(z)]\ \kappa_{re}(z) \tag{3}$$

The expressions used for computing $\kappa_{re}(z)$ and $\omega(z)$ are based on numerical fits to data generated by computing the Mie extinction and scattering cross sections of spherical particles with size distributions governed by the rainfall rate R. These are:

$$\kappa_{re}(z) = \begin{cases} 0.0529R, & @35 \text{ GHz} \\ 0.2257R\ 0.76, & @94 \text{ GHz} \end{cases} \tag{4}$$

$$\omega(z) = \begin{cases} 0.37 - 0.05/R + 0.001R, & @35 \text{ GHz} \\ 0.47 - 0.03/R + 0.0002R, & @94 \text{ GHz} \end{cases} \tag{5}$$

2.4 Atmospheric Transmissivity

The transmissivity $\Upsilon_i(\theta, H_1)$ is the transmissivity of the atmospheric layer extending between the surface (z=0) and the radiometer platform (at z = H_1) along the observation direction specified by θ for atmospheric condition i, where $i = 1, 2, \cdots, 4$ as defined previously. The expression for $\Upsilon_i(\theta, H_1)$ is given by:

$$\Upsilon_i(\theta, H_1) = \exp\left[-\sec\theta\ \tau_i(0, H_1)\right] \tag{6}$$

where:

$$\tau_1(0, H_1) = \int_0^{H_1} \kappa_g(z)\ dz \qquad \text{(clear sky)} \tag{7}$$

$$\tau_2(0, H_1) = \int_0^{H_1} [\kappa_g(z) + \kappa_c(z)]\, dz, \qquad \text{(cloudy)} \tag{8}$$

$$\tau_3(0, H_1) = \int_0^{H_1} [\kappa_g(z) + \kappa_{re}(z)]\, dz, \qquad \text{(rainy)} \tag{9}$$

$$\tau_4(0, H_1) = \int_0^{H_1} [\kappa_g(z) + \kappa_c(z) + \kappa_{re}(z)]\, dz, \qquad \text{(rainy and cloudy)} \tag{10}$$

The quantity $\tau(0, H_1)$ is the optical thickness of the layer between the surface and the radiometer antenna along the zenith direction.

It should be noted that $\kappa_c(z)$ is zero outside the range $z = H_2$ to $z = H_3$ and $\kappa_{re}(z)$ is zero when $z > H_4$.

2.5 Downward and Upward Emitted Atmospheric Tempertures

The optical thickness for any layer extending between heights z_1, and z_2 is given by:

$$\tau_i(z_1, z_2) = \int_{z_1}^{z_2} \kappa_e(z) dz \tag{11}$$

where $\kappa_e(z)$ is the total extinction coefficient:

$$\kappa_e(z) = \kappa_g(z) + \kappa_c(z) + \kappa_{re}(z)\ , \tag{12}$$

where it is understood that $\kappa_c(z)$ is non-zero only for conditions $i = 2$ (cloudy) and $i = 4$ (rainy and cloudy) and only in the height range H_2

to H_3; and similarly, $\kappa_{re}(z)$ is non-zero only for conditions 3 and 4 and only in the height range 0 to H_4.

Similarly, the total absorption coefficient is given by:

$$\kappa_a(z) = \kappa_g(z) + \kappa_c(z) + \kappa_{ra}(z) \tag{13}$$

The downward-emitted atmospheric temperature $T_{di}(\theta)$, representing the enery arriving at the surface along the direction θ due to emission by the entire atmosphere (Figure 2) for atmospheric condition i, is given by:

$$T_{di}(\theta) = \sec\theta \int_0^{30\text{km}} \kappa_a(z)\ T(z)\ \exp\left[-\sec\theta\ \tau_i(0,z)\right] dz \tag{14}$$

The upward-emitted atmospheric temperture $T_{ui}(\theta, H_1)$, representing the energy arriving at the radiometer along the direction θ due to emission by the atmospheric layer extending between the surface and the radiometer antenna at height H_1, is given by:

$$T_{ui}(\theta, H_1) = \sec\theta \int_0^{H_1} \kappa_a(z)\ T(z)\ \exp\left[-\sec\theta\ \tau_i(z, H_1)\right] dz \tag{15}$$

3 BRIGHTNESS TEMPERATURE

For a radiometer at height H_1 observing the terrain at the angle θ, the j-polarized brightness temperature observed by the radiometer, where $j = v$ for vertical polarization or $j = h$ for horizontal polarization, is given by:

$$T^j_{i,k}(\theta, H_1) = \Upsilon_i(\theta, H_1) \left[e^j_k(\theta)T_0 + T^j_{sk}(\theta)\right] + T_{ui}(\theta) \tag{16}$$

where

$\boldsymbol{\Upsilon_i(\theta,H_1)}$ = atmospheric transmissivity defined by (6),

$\boldsymbol{T_{ui}(\theta)}$ = upward-emitted atmospheric temperature defined by (15),

$\boldsymbol{e^j_k(\theta)}$ = j – polarized emissivity of terrain category k,

$\boldsymbol{T_0}$ = surface temperature of terrain,

$\boldsymbol{j}$ = v or h polarization,

$\boldsymbol{k}$ = terrain category index; $k = 1, 2, \ldots, 10$,

as defined in Section 4,

$\boldsymbol{i}$ = atmospheric condition index; $i = 1, 2, \ldots, 4$,

and $T^j_{sk}(\theta)$ represents the energy scattered by the terrain surface, due to the downward-emitted energy $T_{di}(\theta)$. In the absence of information about the scattering properties of the terrain, the following standard approximation is used:

$$T^j_{sk}(\theta) = \left[1 - e^j_k(\theta)\right] T_{di}(\theta) \ , \tag{17}$$

which, when used in (16), leads to:

$$T^j_{i,k}(\theta, H_1) = \Upsilon_i(\theta, H_1) \left\{e^j_k(\theta)T_0 + \left[1 - e^j_k(\theta)\right] T_{di}(\theta)\right\} + T_{ui}(\theta) \tag{18}$$

All the atmospheric-related quantities have been defined in Section 2. The terrain emissivity is discussed in the next section.

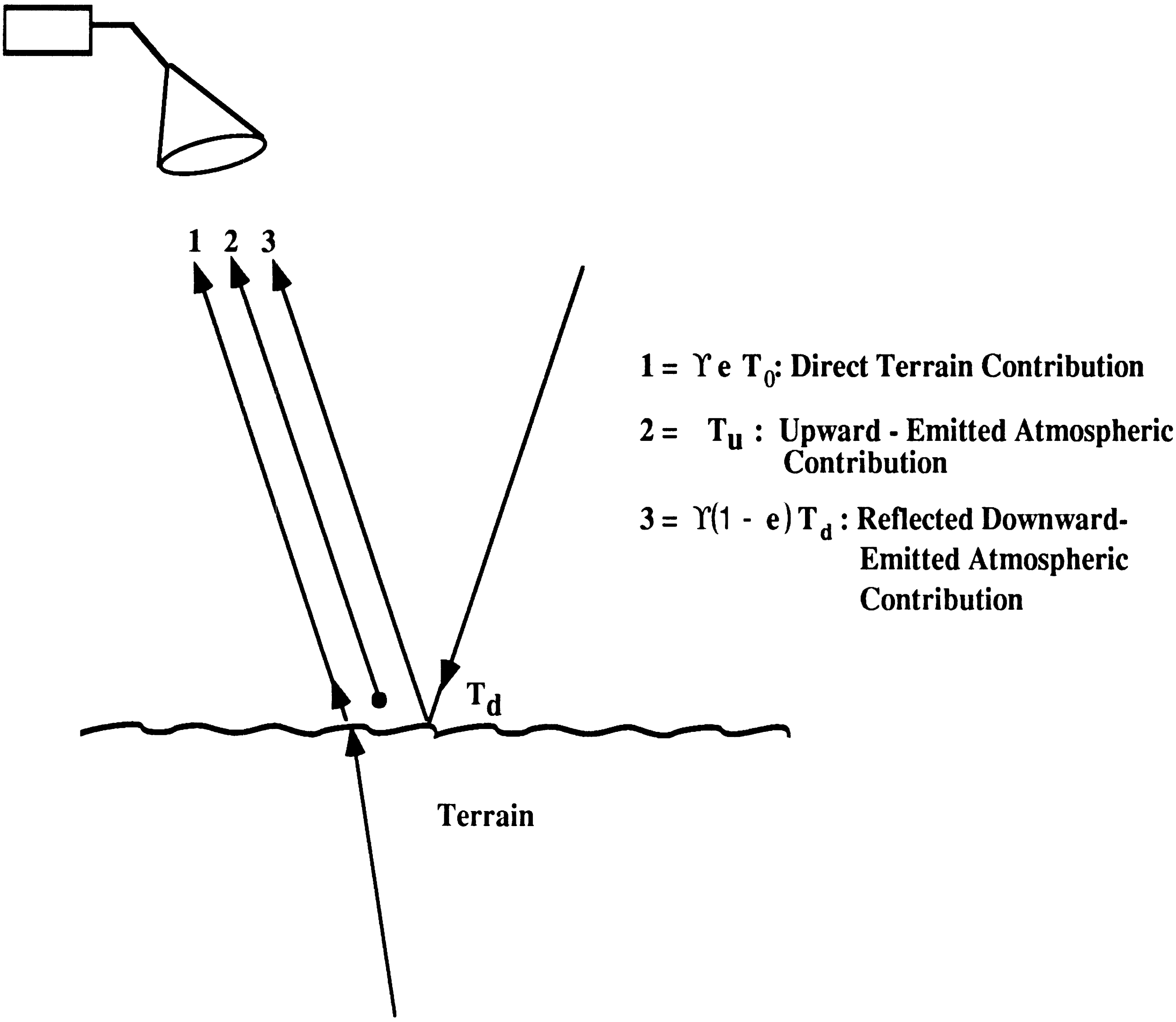

Figure 2. Components of the total brightness temperature observed by the radiometer.

4 TERRAIN EMISSIVITY

Terrain emissivity is a function of three variables: (a) radiometer polarization $j(v$ or $h)$, (b) observation angle θ, and (c) terrain type. Using radiometric observations reported in the literature at 35 and 94 GHz, a data base was generated for ten terrain categories:

k = 1: Vegetation (farmland, rangeland, forest)

k = 2: Bare-Soil (soil, rocky terrain, desert) - Dry Condition,

moisture content $\sim 0-10\%$

k = 3: Bare-Soil (soil, rocky terrain, desert) - Medium Wet Condition,

moisture content $\sim 11-20\%$

k = 4: Bare-Soil (soil, rocky terrain, desert) - Wet Condition,

moisture content $> 20\%$

k = 5: Highway Surfaces (concrete, asphalt) - Dry

k = 6: Highway Surfaces (concrete, asphalt) - Wet

k = 7: Dry Snow

k = 8: Wet Snow

k = 9: Water Surface (lakes, ponds, standing water)

k = 10: Residential and Commercial Areas

Tables 1 and 2 contain entries for $(\bar{e}, \sigma) \times 100$ for seven of the above terrain categories. The quantity $\bar{e}$ is the mean emissivity for the specified terrain category, observation angle θ, and polarization $j(v$ or $h)$, and σ is the asso-

Table 1

35 GHZ Terrain Emissivity

$(\bar{e}, \sigma) \times 100$

CAT	Name	Pol	0-10	20	30	40	50	60	70
1	Vegetation	V	93, 2.4	93, 2.3	93, 2.3	94, 2.1	94, 2.3	94, 2.0	94, 2.2
1	Vegetation	H	93, 2.3	93, 2.3	93, 2.3	94, 2.2	94, 2.2	94, 2.1	94, 2.1
2	Soil, Dry	V	93, 2.1	93, 2.3	94, 2.2	94, 2.4	95, 2.2	95, 3.0	96, 2.1
2	Soil, Dry	H	93, 2.3	92, 2.4	91, 2.0	90, 2.5	89, 2.6	87, 2.6	85, 2.4
3	Soil, Med	V	85, 3.5	86, 3.8	88, 3.9	89, 3.6	90, 3.0	91, 3.6	93, 4.0
3	Soil, Med	H	85, 4.1	84, 5.0	83, 4.2	82, 4.1	80, 4.1	77, 5.1	73, 5.3
4	Soil, Wet	V	78, 4.1	80, 3.5	82, 4.2	86, 3.3	90, 3.7	91, 2.2	93, 2.9
4	Soil, Wet	H	77, 3.7	76, 3.8	75, 5.1	74, 4.1	71, 3.0	68, 4.8	65, 3.9
5	Highway, Dry	V	93, 2.1	93, 2.3	94, 2.2	95, 3.0	96, 2.0	98, 1.7	96, 2.0
5	Highway, Dry	H	93, 2.2	92, 2.6	90, 3.3	87, 3.9	83, 4.0	77, 3.9	70, 4.1
6	Highway, Wet	V	78, 4.1	80, 3.9	82, 3.3	84, 3.1	88, 2.9	92, 2.6	96, 2.3
6	Highway, Wet	H	78, 3.9	76, 4.2	73, 3.7	70, 4.2	64, 5.0	58, 5.2	53, 5.1
7	Dry Snow	V	see text						
7	Dry Snow	H	see text						
8	Wet Snow	V	95, 3	95, 3	95, 3	95, 3	95, 3	95, 3	95, 3
8	Wet Snow	H	95, 3	95, 3	94, 3	93, 3	91, 3	88, 4	84, 5
9	Water	V	see text						
9	Water	H	see text						
10	Residential	V	see text						
10	Residential	H	see text						

Table 2

94 GHZ Terrain Emissivity

$(\bar{e}, \sigma) \times 100$

CAT	Name	Pol	0-10	20	30	40	50	60	70
1	Vegetation	V	see text						
1	Vegetation	H	see text						
2	Soil, Dry	V	94, 2	94, 2	94, 2	95, 2	96, 2	96, 2	96, 2
2	Soil, Dry	H	94, 2	94, 2	94, 2	93, 2	93, 2	91, 2	90, 2
3	Soil, Med	V	88, 2	88, 2	89, 2	90, 2	92, 2	93, 2	94, 2
3	Soil, Med	H	88, 2	88, 2	87, 2	85, 2	84, 2	83, 2	82, 2
4	Soil, Wet	V	84, 2	84, 2	85, 2	86, 2	90, 2	92, 2	94, 2
4	Soil, Wet	H	84, 2	84, 2	83, 2	82, 2	80, 2	79, 2	78, 2
5	Highway, Dry	V	94, 2	94, 2	94, 2	95, 2	96, 2	96, 2	96, 2
5	Highway, Dry	H	94, 2	94, 2	94, 2	93, 2	93, 2	91, 2	90, 2
6	Highway, Wet	V	84, 2	84, 2	86, 2	88, 2	91, 2	93, 2	95, 2
6	Highway, Wet	H	84, 2	84, 2	82, 2	79, 2	76, 2	73, 2	70, 2
7	Dry Snow	V	see text						
7	Dry Snow	H	see text						
8	Wet Snow	V	97, 3	97, 3	97, 3	97, 3	97, 3	97, 3	97, 3
8	Wet Snow	H	97, 3	97, 3	97, 3	95, 3	94, 3	94, 3	92, 3
9	Water	V	see text						
9	Water	H	see text						
10	Residential	V	see text						
10	Residential	H	see text						

ciated standard derivation. Both quantities were computed on the basis of the measured data contained in the data base. For categories 1, 7, 8, and 10, other considerations apply, as discussed next.

4.1 Vegetation

The 35-GHz data given in Table I for vegetation (Category I) is based on experimental data, but at 94 GHz insufficient data are available from which to estimate $\bar{e}$ and σ. Hence, the emissivity values available at 35 GHz will be assumed to be reasonable estimates for the emissivity at 94 GHz also.

4.2 Dry Snow

The required input parameters are:

d: Snow Depth (m)
State of Underlying Soils Surface: Dry, Medium Wet, or Wet

For the specified observation angle θ, the program computes the refraction angle θ' from:

$$\theta' = \cos^{-1}\left[\frac{\sqrt{1.75 - \sin^2\theta}}{\sqrt{1.75}}\right] \tag{19}$$

which is based on an average snow density of $\simeq 0.4$ g/cm^3. For deep snow ($d > 2$m at 35 GHz and $d > 0.8$m at 94 GHz), the mean emissivity is given by:

$$\bar{e}_s(\theta) = A(\cos\theta)^x \ , \tag{20}$$

with

$$A = \begin{cases} 0.74 & @\ 35\ \text{GHz} \\ 0.68 & @\ 94\ \text{GHz} \end{cases} \tag{21}$$

$$x = \begin{cases} 0.125 & \text{for } v \text{ polarization} \\ 0.167 & \text{for } h \text{ polarization} \end{cases} \tag{22}$$

The mean emissivity for any depth d is given by:

$$\bar{e}(\theta) = \bar{e}_s(\theta) + [\bar{e}_g(\theta') - \bar{e}_s(\theta)]\ \exp\left(-\alpha d \sec\theta'\right) \tag{23}$$

where $\bar{e}_g(\theta')$ is the emissivity of the underlying soil surface at the refraction angle θ' given by (19) for the specified wetness condition, and α is an attenuation factor given by:

$$\alpha = \begin{cases} 1.5 & @ \ 35 \text{ GHz} \\ 3.5 & @ \ 94 \text{ GHz} \end{cases} \tag{24}$$

Based on the observed variability of experimental data, the standard deviation is set at $\sigma = 0.05$ for all observation angles, at both frequency bands, and for both polarization configurations.

4.3 Water Surface

The emissivity of a calm water surface is given by:

$$e^v(\theta) = \frac{4p\cos\theta\,(\epsilon_1\cos\phi + \epsilon_2\sin\phi)}{(\epsilon_1\cos\theta + p\cos\phi)^2 + (\epsilon_2\cos\theta + p\sin\phi)^2} \tag{25}$$

$$e^h(\theta) = \frac{4p\cos\theta\cos\phi}{(\cos\theta + p\cos\phi)^2 + p^2\sin^2\phi} \tag{26}$$

where

$$p = \left[\left(\epsilon_1 - \sin^2\theta\right)^2 + \epsilon_2^2\right]^{\frac{1}{4}} , \tag{27}$$

$$\phi = \frac{1}{2}\tan^{-1}\left(\frac{\epsilon_2}{\epsilon_1 - \sin^2\theta}\right) , \tag{28}$$

and ϵ_1 and ϵ_2 are the real and imaginary parts of the complex relative dielectric constant of water:

$$\epsilon_1 = 4.9 + \frac{(\epsilon_a - 4.9)}{1 + b^2f^2} , \tag{29}$$

$$\epsilon_2 = \frac{bf\,(\epsilon_a - 4.9)}{1 + b^2f^2} \tag{30}$$

with:

$$b = 0.111 - 3.82 \times 10^{-3} T_c + 6.94 \times 10^{-5} T_c^2 - 5.1 \times 10^{-7} T_c^3 \,, \tag{31}$$

$$\epsilon_a = 88.05 - 0.415 T_c + 6.30 \times 10^{-4} T_c^2 + 1.08 \times 10^{-5} T_c^3 \tag{32}$$

In the above expressions, f is the frequency in GHz and T_c is the water temperature in $°C$, $(T_c = T - 273)$.

The emissivity of a water surface is also influenced by its surface roughness, caused by wind action. The change in emissivity can be accounted for by the approximate relation:

$$\bar{e}^v(\theta, u) = e^v(\theta) + \frac{1}{300}\left(1 - \frac{5\theta}{400}\right) u \tag{33}$$

$$\bar{e}^h(\theta, u) = e^h(\theta) + \frac{1}{300}\left(1 + \frac{5\theta}{400}\right) u \tag{34}$$

where θ is the observation angle in degrees and u is the mean wind speed in m/s.

The standard deviation proposed for the water emissivity is equal to one-half of the increase caused by roughness. Thus,

$$\sigma^v = \frac{1}{600}\left(1 - \frac{5\theta}{300}\right) u \,, \tag{35}$$

$$\sigma^h = \frac{1}{600}\left(1 + \frac{5\theta}{300}\right) u \,. \tag{36}$$

If σ^v (or σ^h) according to (35) (or (36)) is less than 0.01, it is assigned the value 0.01 (to account for the range of variations usually observed for calm water).

4.4 Residential and Commercial Areas

Emissivity is difficult to characterize for this category. The following ranges have been observed on 35 GHz imagery, for both V and H polarizations. Because similar data are not available at 94 GHz, the same set of values are suggested for use at both frequencies.

	Land Use	Dominant Features	Equivalent Emissivity
(a)	Industrial	Metal roofs, large buildings	0.2-0.5
(b)	Central Business District	Concrete with Little Vegetation, dense	0.4-0.7
(c)	Residential	Composite roofing, lawns, shrubs, trees	0.65-0.8
(d)	Parks	Vegetation	0.8-0.95

The user needs to specify the mean emissivity $\bar{e}$ and standard deviation σ (suggested value is 0.1).

5 STATISTICAL DISTRIBUTION OF BRIGHTNESS TEMPERATURE

For a given combination of frequency band, observation angle, antenna polarization, and terrain category, the terrain emissivity is characterized by a mean emissivity $\bar{e}$ and a standard deviation σ, where $\bar{e}$ represents the most likely condition for that terrain category and σ accounts for variations associated with that category. For vegetation, for example, σ accounts for variations in emissivity due to tree type, density, height, etc.

Once the user has specified all the input parameters associated with the sensor (frequency band, polarization, platform height, and observation angle), the atmosphere, and the terrain, SOTE generates a Gaussian distribution $p(e)$ for the emissivity e, with $\bar{e}$ as its mean and σ as its standard deviation, and then proceeds to compute the corresponding brightness temperature distribution $p(T_B)$ for the range $(\bar{e} - 3\sigma)$ to $(\bar{e} + 3\sigma)$. The range is divided into 40 intervals, noting that the upper end of the range may not exceed $e = 0.99$. The results can then be displayed in the form of a plot of $p(T_B)$ *versus* T_B. A sample plot is shown in Figure 3.

6 Using SOTE on your computer

SOTE has been configured for use on several computer platforms, including Macintosh computers, MS-DOS computers (IBM PC and compatibles), and

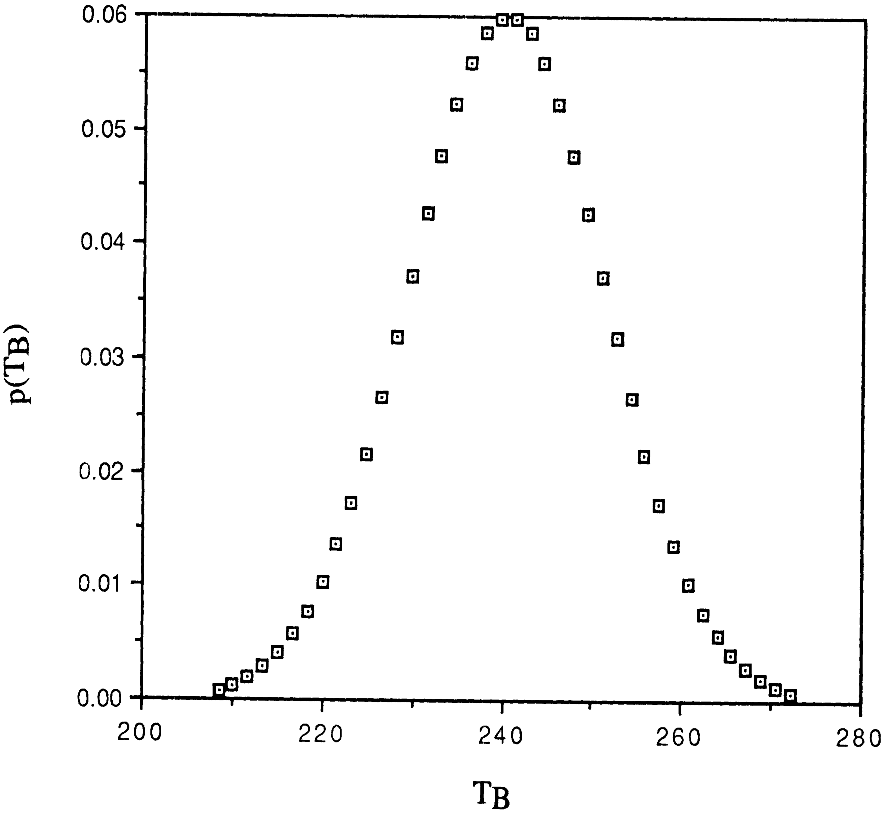

Figure 3. Normalized probability density function for the brightness temperature of wet soil at 35 GHz, observed by a nadir-viewing radiometer at 30 km altitude through clear-sky conditions,

Unix workstations (Sun, Apollo, IBM). This section contains instructions for using SOTE on each of these types of computer.

6.1 Macintosh

SOTE was compiled on the Macintosh using the Absoft MacFortran II compiler, version 3.1. This compiler produces code which requires a 68020, 68030, or 68040 CPU and a 68881 or 68882 FPU (math co-processor). Macintosh models which have these processors as standard equipment include the Macintosh II, IIx, IIcx, IIci, IIfx, SE/30, PowerBook 170, and all Macintosh Quadra models. SOTE will run under either System 6 or System 7. It requires only 384 K of RAM.

6.1.1 Installation

Insert the disk "SOTE disk" in the floppy disk drive. Using the mouse, double-click the SOTE disk icon to open it. Drag the SOTE, TE35, and TE94 icons onto the hard disk icon or into a folder on the hard disk. The program is now ready to run.

6.1.2 Running SOTE

Double-click on the SOTE icon to start the program. You will first be asked if the results should be written to a file. Enter "1" (yes) if you wish to review the results later or create a plot of the brightness temperature distribution. You will then need to supply a filename of up to 7 characters.

SOTE will then ask the user to specify the sensor height, observation angle (measured from nadir), polarization, frequency, and atmospheric condition. If cloud or rain atmospheric conditions are selected, the user will be asked to specify heights of the cloud and/or rain layers. Surface temperature, pressure, and water vapor density are then requested. Finally, the user is asked to select a surface terrain category. Depending on the choice, additional parameters may be requested.

SOTE then calculates various brightness temperatures, the distribution of emissivity, and the distribution of brightness temperatures. These quantities are printed on the screen and written to a file if that option was selected. The program exits when the user presses the Return key.

To abort the program at any time, select "Quit" from the File menu or press Command-.(period).

The output file created by SOTE is a text file which may be viewed or edited using any Macintosh editor or word processing application such as Microsoft Word, WriteNow, MacWrite, Alpha, etc. We suggest that, instead of opening the file by double-clicking, you first open your chosen word processor, then open the file using the "Open..." command in the File menu[1].

6.1.3 Plotting $p(T_B)$ using Cricket Graph

The output file created by SOTE may be used to create a plot of the brightness temperature distribution using the Cricket Graph application. The steps are as follows (these instructions are for Cricket Graph 1.3):

1. Open the output file using any word processing application as described above.

2. Find the line which consists of an asterisk ("*") in the first column only. (This line is a few lines below the label "Probability Density Function Table:".) Delete all lines above the asterisk so that the line containing the asterisk is the first line of the modified file.

3. Save the file as a "plain text" or "text only" file.

4. Double-click the Cricket Graph icon to open the application.

5. Select "Open..." from the File menu, and click on the check box which says "Show all TEXT files". Open the file which was saved in step 3.

[1]The creator field of the text file is set to "MPS ", which indicates that the file was "created" by the MPW Shell, which is the environment within which Absoft MacFortran II operates. As a result, double-clicking the output file will open the MPW Shell application, if present on the computer. If the MPW Shell is not present and you are running System 7, the Macintosh will ask if you want to open the file using TeachText. If the MPW Shell is not present and you are running System 6, the Macintosh will complain that the file cannot be opened because the application that created it is busy or missing. The file is not damaged; this problem can be avoided by opening the file from within a word processing application.

6. Cricket Graph will open a new window showing three columns of data which were imported from the text file. To make a graph of the brightness temperature distribution, select "Scatter" or "Line" from the Graph menu, then select "TB(em)" for the horizontal axis, select "Normalized p(TBem)" for the vertical axis, and click the "New Plot" button.

7. Cricket Graph will open a new window showing a graph of the brightness temperature distribution which may be edited or printed.

6.1.4 Plotting $p(T_B)$ using Igor

Use the following steps to create a plot of the brightness temperature distribution using Igor:

1. Open the output file using any word processing application as described above.

2. Find the line which consists of an asterisk ("*") in the first column only. (This line is a few lines below the label "Probability Density Function Table:".) Delete this line and all lines above the asterisk so that the line which begins "Mid-Value(em)" is the first line of the modified file.

3. Save the file as a "plain text" or "text only" file.

4. Double-click the Igor icon to open the application. Select "Load Waves: Load General Text..." from the File menu. Open the file which was saved in step 3.

5. Igor will display the column headings from the text file and ask you to name each column (Igor calls each column a "wave"). Delete the "wave0" from the first box since we do not need the first column of data. Type "TB" in the second box and "pTB" in the third box, or use any names you prefer (wave names may consist of letters, numbers, and the underscore character only). Click the "Load" button.

6. Select "Display Waves" from the Waves menu. Select "pTB" as the Y wave, "TB" as the X wave, and click "Do It".

7. Igor will create a graph of the brightness temperature distribution which may be edited or printed.