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Fog Formula II

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Abstract
In Zakharova (1972) on page 9, we see Eqs. (1), (3) - (5), (7a), (8) and (16a) become closed for describing a nonstationary regime of radiation for fog. According to Brown and Roach (1976) [2] this included "all the physical effects which appear to be important" but Zakharova offered no solution. In this paper, the author will attempt to get the unknowns and try to simplify toward a solution. Another model is that of Zdunkowski and Nielsen (1969) [3], which Brown and Roach say is a realistic model.

Keywords: Fog , Math Model, Moisture Content, Droplet Concentration, Computer Model

Introduction

Here we introduce the equations announced in the ABSTRACT.

$$\partial u / \partial t = f\, v + \partial/\partial z\; k\, \partial u/\partial z \text{ and } \partial v / \partial t = -\, f\,(u - G) + \partial/\partial z\; k\, \partial v/\partial z \quad (1)$$

$$\partial b^2 / \partial t = k\,((\partial u / \partial z)^2 + (\partial v / \partial z)^2) - g\, k_x / T\, \partial \Theta / \partial z + \partial/\partial z\; k_b\, \partial b^2 / \partial z - e \quad (3a)$$

$$b^2 = \tfrac{1}{2}\,(< u\ '>^2 + < v\ '>^2 + < w\ '>^2) \quad (3b)$$

$$k = c_o\, l\, b,\ k_x = a_x\, k,\ k_b = a_b\, k,\ e = c_1\, b^3 / l \quad (4)$$

$$l = -\, x\,(b/l) / \partial/\partial z\,(b/l) \quad (5)$$

$$\partial S / \partial t = \partial/\partial z\; k_x\, \partial S / \partial z + \partial(\delta < v >)/\partial z \quad (7a)$$

$$\partial \Pi / \partial t = \partial/\partial z\; k_x\, \partial \Pi / \partial z + R(z, t)/c_p\, \rho \quad (8)$$

$$\partial N / \partial t = \partial/\partial z\; k_x\, \partial N / \partial z + 2/7\; \partial(N < v >)/\partial z \quad (16a)$$

The object of this paper is to solve these twelve equations after finding the twelve unknowns. It appears that obtaining N, the concentration of droplets, is the desired quantity in (16a). The problem of fog has received much attention from Russian scientists over the years.

Nomenclature (in order of appearance)
u projection of wind velocity on x axis
v projection of wind velocity on y axis
w projection of wind velocity on z axis
f Coriolis constant
k coefficient of turbulent mixing
G velocity modulus of geostrophic wind
x axis of wind parallel to the surface
y perpendicular to x at the surface
z goes in and out of the ground with z = 0 at ground surface

b kinetic energy of turbulence
t time.

Θ potential temperature
$k = c_o\, l\, b$
$c_o^4 = c_1^{4/3} = c = 0.046$
$a_b = 0.73$
g acceleration of gravity
L specific heat of condensation
$l = x\, z_o$ scale of turbulence, asynptotically expressed as a linear function of height
z_o unknown
$T = \Theta - \gamma_a z$
γ_a unknown
$k_x = a_x\, k$
$k_b = a_b\, k$ diffusion coefficient for turbulent energy
$a_b = 0.73$
$a_x = k_x / k = 0.8$
$x = 0.4$
$e = c_1\, b^3 / l$ rate of dissipation of the turbulent energy into heat energy
$T(0,z) = T(0,0) - \gamma_p z$
S specific moisture content
δ specific water content
c_p specific heat of dry air
q specific humidity
$\Pi(z,t) = \Theta(z,t) + (L/c_p)\, q(z,t)$
R (z,t) radiative heat flux through a unit of volume per unit of time
N total number of droplets in 1 cm^3 of cloudy air
< v > weighted mean velocity of the falling droplets

Results

The attempt in this paper is for the author to deal with the algebra and simplify and clarify getting N, the concentration of water droplets, from the twelve equations mentioned in INTRODUCTION after getting the twelve unknowns. Zakharova mentions on page 6 that the system of Eqs. (1), (3) – (5), (7) and (8) are ten equations with twelve unknowns. This gives a clue on getting the unknowns.

Equation (7a) is (7) rewritten. At first glance it seems that the twelve unknowns are: u, v, w, k, T, S, Π, N, δ, <v>, t and z. So, in order to get at N, some algebra is necessary.

Discussion

To get S in (7a) one can follow Zakharova's mathematics as presented by Jennings (2024). Then, the object is to find N in (16a), the culmination of the other eleven equations. N gives the concentration of droplets in the fog cloud. A computer is needed, as a closed-form equation is not available.

Acknowledgments

Here I proclaim that salvation is universal for all peoples through the death and resurrection of Christ. Here is a quote from TIMOTHY proving that: "Prayer of this kind is good, and God our savior is pleased with it, for he wants all men to be saved and come to know the truth."
(I TIMOTHY 2:3-4) New American Bible

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