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The Math of Rainfall and Snowfall and Scripture on Precipitation

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Abstract

Consider a rain cloud when it is near the dew point, at which droplets appear from the water vapor. In that situation, the equation this author previously derived for nucleation of a polymer in solution may be thought of as applying in reverse: water vapor becomes water droplets in the cloud. In this construct, the solution containing the polymer corresponds to the air phase with water vapor mixed with the constituents of the atmosphere, and the nucleated solvent corresponds to the pure water droplet. This paper explains the transformation of the polymer nucleation equation to apply to the cloud dew point situation just described. Since the author is unable to supply the unknowns that pertain to the rain-producing cloud (T, To, n2/n) in Equation (5), it is hoped that atmospheric chemists having access to proper data from altostratus and nimbostratus clouds will use the equation to better predict when clouds will nucleate. Actually, the author was able to eliminate n2/n to get Equation (9), which has all measurable quantities. It is hoped that a plane capable of cloud-seeding will be able to determine the appropriate clouds to seed by solving for To in Equation (9). When T is sufficiently near To, the cloud can be seeded. The author maintains that snowfall can be had from clouds through cloud-seeding. Snow and rain are mentioned in the Bible relating to God's action and providence.

1. Introduction

In ISAIAH 55:10-11 there is "For just as from the heavens the rain and snow come down and do not return there … my word shall not return to me void." Man has seen that a great evil is drought, so chemistry has even devised cloud seeding with various agents, most particularly Silver Iodide. In a IAJER.COM paper, the author came up with Equation (9) as a method to identify clouds to apply cloud seeding. In this paper, we examine this process as applied to snow. Further, we see in the New Testament, "Be patient therefore brethren, unto the coming of the Lord. Behold, the husbandman waiteth for the precious fruit of the earth, and hath long patience for it, until he receives the early and latter rain." JAMES 5:7

There is mathematics applying to rain and snow formation in clouds, "Using the classical approach, the energy of ice-germ formation in supercooled water is obtained following the same line of reasoning that applies to a water germ." Pruppacher and Klett (1997) [2] This appears to be similar to boiling point elevation as opposed to freezing point depression.

2. Results

Jennings (IAJER, 2021) [1] derived (5) and (9) for rainfall and they dictate when the cloud is ready to give rain. In that case, a particular cloud can be measured and the other variables can be calculated to get To. A computer program has to be used as some variables depend on T and others on To with an iterative method. Here are Eqs. (5) and (9) from Jennings (IAJER, 2021) [1].

$$T - To = (3kTo^2/\sigma_o a_o)(n_2/n) \tag{5}$$

$$T - To = (3kTo^2/\sigma_o a_o)(P^*_{H2O}/P_{air})RH \tag{9}$$

As mentioned, there is a correspondence between rain and snow formation and we will attempt to outline it here. For boiling point elevation/freezing point depression, the enthalpy is either vaporization or melting, respectively, as is well known. The correspondence between rain and snow is the surface tension σ of the water-vapor interface or ice-water interface respectively, as (A) and (B) respectively bear out. Pruppacher and Klett (1997) [2], pages 198(A), 207(B).

$$\Delta Fg = (\sigma_{w/v} \, \Omega g)/3 \tag{A}$$

$$\Delta Fg = (\sigma_{i/w} \, \Omega g)/3 \tag{B}$$

For formation of rain the proper equation appears to be Pruppacher and Klett (1997) [2], page 202(C), for homogeneous nucleation rate of rain embryos.

$$J = \alpha_c/\rho_w \; ((2N_A{}^3 M_w \, \sigma_{w/v})/\pi)^{1/2}(e_{sat,w}/RT)^2 \; S_{v,w} \; \exp(-\Delta Fg/kT) \tag{C}$$

In like manner, we have, for homogeneous nucleation of ice embryos, Khvorostyanov and Sassen (1998) [3] corresponding to (C), page 1813(D).

$$J_{hom} = (N_l kT/h) \exp[-(\Delta Gcr + \Delta Fact)/kT] \tag{D}$$

The point I'm making is that Khvorostyanov and Sassen (1998) [2] maintain that (D) comes from Pruppacher and Klett (1978) [4], so I'm identifying ΔFg in (B) with ΔFact in (D), and saying they're both the activation energy of forming ice embryos.

It appears that the quote at the end of the Introduction is borne out by these equations. I leave Nomenclature out and the author is not equal to supplying the mathematical steps involved.

3. Discussion
Obviously rain and snow are necessary for life on earth and the Old and New Testaments say rain and snow are God-given. Classical nucleation theory is a human effort at explaining phase change. In boiling point elevation and freezing point depression, the enthalpy appears, but for rain and snow, the surface tension appears in like manner.

In Isaiah and James as quoted above compare the life-giving precipitation with the providential action of God Almighty. The authors' research on rainfall in Jennings (IAJER, 2021) [1] goes back to the published data of bubble nucleation in polymer solutions in Jennings and Middleman Macromolecules (1985) [5] and the first theoretical paper Jennings (2012).

4. Acknowledgments
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5. References
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