



## A stochastic model for making artificial rain using aerosols

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### HIGHLIGHTS

- A deterministic model along with its stochastic version for artificial rain is proposed and analyzed.
- Multiplicative noise is introduced in the system to study effect of environmental fluctuations.
- Dispersion of variables depends on intensity of white noise.
- It is found that for small noise, system shows stationary distribution.
- Analytical results are supported by numerical simulation.

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### ABSTRACT

In this paper, a nonlinear deterministic mathematical model along with its stochastic version for artificial rain is proposed and analyzed. We have considered three dynamical variables in the modeling process; namely (i) density of cloud droplets, (ii) density of raindrops, and (iii) concentration of mixture of conductive aerosols. It is assumed that the cloud droplets are continuously formed in the atmosphere at a constant rate but its conversion into raindrops does not take place in the same proportion. The artificially introduced aerosols increase the rate of formation of raindrops from cloud droplets. These aerosols are introduced in the regional atmosphere at a rate proportional to the density of cloud droplets. The proposed model is analyzed using stability theory of differential equations in deterministic as well as stochastic environment. Numerical simulation is performed to see the effect of important parameters on the process leading to rainfall.

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### 1. Introduction

The shortage of water is a major cause of concern not only in India but all over the world. Several states of India, like Uttar Pradesh, Chhattisgarh, Maharashtra, Karnataka are much affected due to the shortage of water. The poor rainfall has created draught like situation in several parts of these states and the groundwater level has also fallen down. Simultaneously, this has also affected the other sources of water, like ponds, lakes, rivers, etc., as these sources are recharged during the rainfall. Most of the farmers in these states depend on rainfall to irrigate their agricultural farms. In the last few decades, due to inadequate rainfall, less production of grains, vegetables, fruits, etc., is observed and this has directly affected the income of farmers. It is reported that some farmers have committed suicide because of the reduced production from agricultural land. Thus, the inadequate rainfall leads to less grain production and affects not only the economic position of the farmers but also the country. To resolve the shortage of water, in the recent past some experimental and theoretical studies have been conducted to make artificial rain using aerosols in the local region.

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