

CHAPTER 3

Summer Cumulus Cloud Lifetime—Importance to Static Mode Seeding

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ABSTRACT

Any observing program studying summer cumulus clouds should attempt to measure cloud lifetime. This parameter is important for determining whether a cloud will last long enough for precipitation to form by either natural or artificially stimulated mechanisms. When reporting cloud lifetime, the definition used and the method of calculation should be clearly specified. In North America, after a summer cumulus cloud has been identified and selected, lifetimes, at temperatures below -5°C , of approximately 10 to 12 min are being reported. This lifetime must be considered marginal for static mode seeding to produce precipitation by artificial ice nucleants.

3.1. Introduction

Cloud lifetime is a useful parameter for describing the physical character of a summer cumulus cloud. For example, the lifetime can indicate whether a cloud will last long enough for a cold or warm rain process to develop by either natural or artificial means. However, recent textbooks on clouds physics such as those by Mason (1971), Pruppacher and Klett (1978), Rogers (1979), Ludlam (1980) and Dennis (1980) do not discuss cloud lifetime in detail, and they report few lifetime observations describing any cloud type. This should not be taken as indicating the unimportance of cloud lifetime. Houghton (1968) discusses the relevance of this parameter using the earlier work of Braham (1964) and Saunders (1965). He concluded that "simple single cell clouds have effective lifetimes about equal to the time required to grow raindrops." That time was estimated to be approximately 25–30 min. Houghton (1968) stressed that this conclusion implied that the precipitation process must start near cloud base at an early stage of cloud development. He also stated that more direct measurements of cloud lifetime in a variety of convective situations were desirable.

There are many possible ways of defining cloud lifetime and a few are given in Table 3.1. Although Definition 1, the time from initial condensation to total dissipation, is the most logical definition, it is difficult to measure in the real atmosphere. Definitions 6 and 7 have been used in weather radar and cloud photography studies (e.g., Braham, 1958; Knight et al., 1983; Warner, 1976; Johnson and Dungey, 1978; Ludlam, 1980), but they have a limited usefulness in weather modification studies, especially for static mode seeding. This type of seeding is generally performed within nonprecipitating clouds. Consequently, the lifetime of precipitation cells, as would be observed by radar, is not very useful.

Definition 4 is perhaps the best for static mode seeding. Braham (1960), Schemenauer and Isaac (1984), Cooper and Lawson (1984) and Kochtubajda and Rogers (1984) have all used Definition 4 or a variation of it to describe summer cumuli, most of which were nonprecipitating at selection. However, they were only able to calculate the lifetime after the cloud was selected. This might considerably underestimate the total lifetime. Schemenauer and Isaac (1984) used the term cloud "top" lifetime to help describe some of their assumptions. At the Weather Modification Workshop, Dennis suggested that the word lifetime might be replaced by "life expectancy." Although the words "cloud lifetime" often convey a false meaning to the reader, especially when the definition is not specified, in order to avoid confusion with past work, a more descriptive term has not been adopted for this paper.

The purpose of this paper is to emphasize the importance of cloud lifetime and to describe a few of the measurements that have been made. Although there are many different types of cumuli, the discussion will be restricted to fair-weather summer cumulus clouds, which are usually isolated from each other and not precipitating. This cloud type has been studied extensively and is regarded as one of the simplest cloud types. Certainly, it is relatively easy to make observations within and near such clouds. Discussion will also be limited to points relevant to the companion review paper by Silverman (1986) on static mode seeding.

3.2. Importance

Figure 3.1 shows some of the major cloud physics processes that might occur during the total lifetime (Definition 1) of a typical cumulus. Although the times quoted are used by the weather modification community, they must be considered as approximate and without firm theoretical

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Radar and Atmospheric Science Roger Wakimoto, 2015-03-30 This book is a tribute to one of the leading scientists in meteorology Dr David Atlas It was written by a group of specialists and presented at a symposium to honor Dr Atlas life and career as meteorologist It serves as a comprehensive resource for scientists and educators and also as an inspiring historical record of scientific research and important discoveries in the field of meteorology **Synoptic-Dynamic Meteorology and Weather Analysis and Forecasting** Lance Bosart, Howard Bluestein, 2013-01-06 This long anticipated monograph honoring

scientist and teacher Fred Sanders includes 16 articles by various authors as well as dozens of unique photographs evoking Fred's character and the vitality of the scientific community he helped develop through his work. Editors Lance F. Bosart, University at Albany SUNY and Howard B. Bluestein, University of Oklahoma at Norman, have brought together contributions from luminary authors including Kerry Emanuel, Robert Burpee, Edward Kessler, and Louis Uccellini to honor Fred's work in the fields of forecasting, weather analysis, synoptic meteorology, and climatology. The result is a significant volume of work that represents a lasting record of Fred Sanders' influence on atmospheric science and legacy of teaching.

Second International Conference on Southern Hemisphere Meteorology, 1986

The Representation of Cumulus Convection in Numerical Models Kerry Emanuel, 2015-03-30. This book presents descriptions of numerical models for testing cumulus in cloud fields. It is divided into six parts. Part I provides an overview of the problem, including descriptions of cumulus clouds and the effects of ensembles of cumulus clouds on mass, momentum, and vorticity distributions. A review of closure assumptions is also provided. A review of classical convection schemes in widespread use is provided in Part II. The special problems associated with the representation of convection in mesoscale models are discussed in Part III, along with descriptions of some of the commonly used mesoscale schemes. Part IV covers some of the problems associated with the representation of convection in climate models, while the parameterization of slantwise convection is the subject of Part V.

Third International Conference on the Aviation Weather System, 1988

Fourth Conference, Meteorology and Oceanography of the Coastal Zone, 1988

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