雲模式在局部天氣預報上之應用

LOCAL WEATHER PREDICTION BY USING A CLOUD MODEL

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一 簡介

以雲模式作降水預報分析之研究很多，大部分之模式為一度無時序之雲模式。此種模式可以算出粗略之最大垂直速度，降水量及雲厚。比起以探空曲線估計可降水量可靠得多。可是此種模式缺時間因素，因此，降水於何時發生無法計算。一度有時序雲模式，可以看出時空分佈，雲之成長，成熟及消滅各階段之雲水，雨水，降水量都有計算，因此，作為預報工具時，比上述無時序雲模式多了一些資料。

一度有時序雲模式有很多種，大致上可分為兩類：一類是只有逸入(Entrain-ment)之雲，如 Winser ct al (1972)，另一類則考慮逸入及逸出(Detrainment) 例如：Asai and Kasabara (1967) Wang (1973) 等。第二類模式可以和兩度軸對稱雲比較，一般一度有時序雲模式皆未考慮空氣運動而引起之氣壓波動(Pressure Perturbation)，因此和二度以上雲模式作為比較時，往

往往發現垂直風速之高度分佈與後者不同。

本文使用之一度有時序雲模式為上述第二類模式。考慮之區域有二；內圈為活躍區（Active Regin），其中雲可以成長。外圈為邊界區（Enivronment）此區無雲，有垂直運動。兩區以亂流，逸出逸入混合。和王氏（1973）之模式相似。此模式包括一個氣壓波動診斷方程式（Pressure Perturbation Diagnostic Equation），用以計算氣壓波動，以便加入垂直運動方程式中之氣壓梯度力項。此項，可使垂直速度之高度分佈曲線接近拋物線形，即接近二度以上雲模式中之垂直速度分佈。

二、控制方程式

此模式使用之方程式之推導已列入 Chen（1976）之報告，在此不加詳述僅將重要之控制方程式列之如下；符號之意義列在附錄中；

（一）活躍區之方程式

1. 推算方程式（Prognotic Equation）

ABSTRACT

In the realm of numerical weather prediction, the large scale prediction model is proved to be one of the most important tools for the daily weather forecast. It elucidates the movement and development of pressure systems, and the associated weather phenomenon can be grossly predicted. However, in the local weather prediction, the large scale model fails to provide the necessary weather details such as shine or rain, duration and amount of rain. It is almost impossible, at the present stage, to include such a fine, detailed description of weather in the large scale model. Thus, the failure due to the large scale model prediction is often cited.

The small scale model study is needed for bridging the gaps between the large and the local scale phenomena. Hence, a simple, yet realistic, cloud model for studying the cloud and the precipitation on a daily basis is proposed here. In this model, the Asai-Kasahara (1967) dynamic framework is adopted, which consists of two concentric air columns: an inner column corresponding to the cloud region and an outer concentric annular column corresponding to the environment. The physical quantities are averaged in the cloud and the environment regions. The mixing of the cloud and the environment is simulated by using the mixing length theory. The mixing consists of two parts: the lateral eddy mixing term, which is proportional to the vertical gradient of the physical quantity, and the dynamic entrainment term, which is proportional to the horizontal gradient scaled by the cloud radius. The microphysical processes are adopted from the model developed by Wisner et. al. (1972). The interactions and formation of water substances, i.e., water vapor, cloud water, rainwater, and hail are simulated by the bulk parameterization.

The model provides the following information: 1. Whether a cloud is to develop to a precipitating or a non-precipitating cloud; 2. How strong is the updraft; 3. How tall is the cloud; 4. The time-height distribution of water substances, etc. The model is basically useful for the prediction of the cloud evolution in a convective unstable day. However, in the event of a frontal passage the model may be used to study isolated cumulus. This type of model is proved to be adequate in the tropical region and the continental U.S. where the convective activity is very frequent in the summer days.

The model has been tested by Chen (1976) in studying clouds in the St. Louis area. A few cases have been studied. The model predicts updraft velocity, cloud base, cloud top and precipitation, which are in good agreement with the detailed observation data.