Chapter 1

Summary of *CReSS*

CReSS(Cloud Resolving Storm Simulator) is the non-hydrostatic meteorological model to resolving cloud developed to the purpose to simulate meteorological phenomena from cloud scale to meso scale highly.

Clouds, especially cumulonimbus cloud, giving heavy precipitation, and organized cumulonimbus clouds, have very complex system and the processes of their development are determined by the flow field and the very complex non-liner interaction. It is important that to simulate such precipitation system for numerical model is to calculate the process of cloud physics in detail with the process of flow field.

CReSSis made to be able to calculate for massive parallel calculator effectively and time developing simulation of cloud in detail can do by massive parallel calculator.

In this chapter, we explain Progress of development of ***CReSS***and Outline of model.

1.1 Progress of development

CReSS(Cloud Resolving Storm Simulator) is developed by Kazuhisa Tsuboki, Hydrospheric Atmospheric Research Center, the University of Nagoya, and Atsushi Sakakibara, Research Organization for Information Science and Technology, for one of 'Study for Advanced Simulation of Down Burst Phenomenon' for Special Coordination Funds for Promoting Science and Technology, 'to develop parallel software for large-scale simulation that enables us to predict the global climate change with high resolution' and under the guidance by Prof. Nobuhiko Kamiya, Aichi Gakusen University.

In the plans of this work, It is the purposes that we develop the numerical model which can do the numerical simulation of down burst and micro burst by parallel computers and investigate the incidence and the behavior of descending flow and diverging flow by it.

Down burst rise from much developing cumulonimbus, which formation relates to the proses of cloud physics. The model which simulates them sufficiently should be able to describe in detail to phenomenon for cumulonimbus in dynamical and cloud physics. In the climate model, it is important for cloud to be the source of drive of atmosphere. But the model which simulates such as down burst is expected to utilization to make a model of the constitute of cloud with time variation and to appear the parameter of cloud for a climate model. It is necessary for the simulation of micro burst, which is the down burst below 4km in diameter, to be the model which can resolve cloud because the phenomena of micro burst has the scale in individual cumulonimbus. The generation of negative buoyancy occurring descending flow occurs that atmospheric cooling by the phase change of precipitation particle and weight by precipitation particle drag down atmosphere. For the simulation of generation of micro burst, it is necessary to simulate exactly how precipitation particles are formed cumulonimbus and how they behave cumulonimbus(fig.1.1).

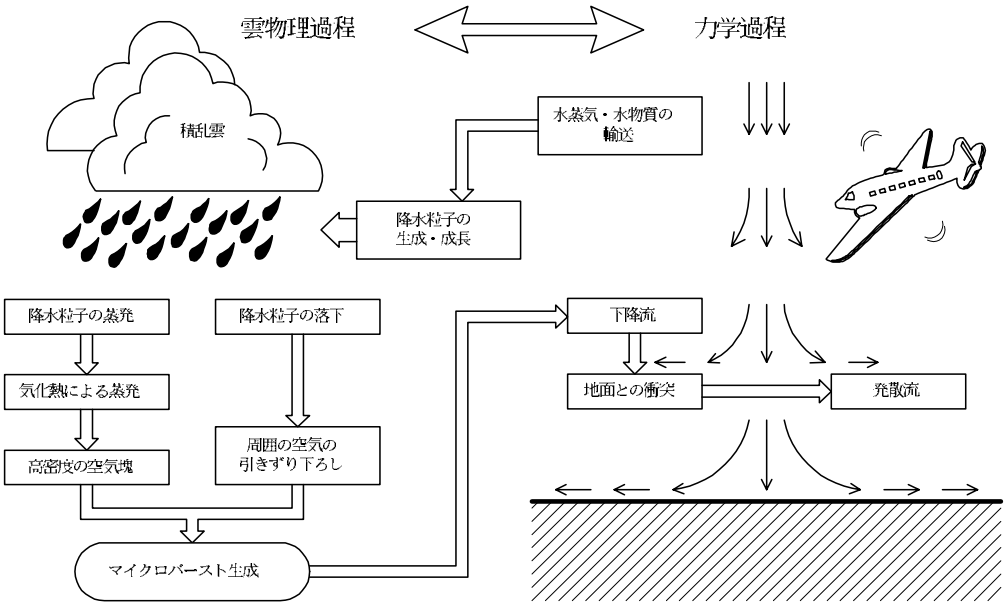

Figure 1.1. Conceptual model of the simulation model of micro burst.

It is the purpose that, to develop ***CReSS***, we can simulate such environment and the behavior of precipitation particles and can practice the model best by parallel computers.

1.2 Outline of model

CReSSis the model of cloud resolution which can simulate down burst and micro burst, which has the field of calculation in meso-scale.

The characters of ***CReSS***are given below.

- ***CReSS***is designed for parallel computers, so it can be performed massive calculation. On the other hand, it has the version for one processor element, so it can also be performed by PC-UNIX.
- ***CReSS***is the cloud model included in possible detail the processes of cloud physics. On the other hand, it is also possible to perform the intimate fluid field for dry model.
- ***CReSS***is designed not only for the experiment of cloud simulation separately but also for the experiment to forecast, giving ***CReSS***realistic terrain, initiation and boundary condition developing in time.
- ***CReSS***is written by the coda of FORTRAN77, but using the extended function, so you can decode easily and can perform in almost computers.

Next, the concrete functions equipped with ***CReSS***are given below.

- The basic equations of the process of dynamics are non-hydrostatic and compressible and performed in the field of three dimensional grid beside terrain.
- The dependent various values of the process of dynamics are the three components of velocity, the deviation of potential temperature, the deviation of pressure and the energy of turbulence.
- The processes of cloud physics introduce the bulk parametrization of warm rain and the bulk parametrization with ice phase
- The dependent various values of the process of cloud physics are the mixing ratio of water vapor, cloud water and rain water. In addition, in the bulk parametrization with ice phase, they are added the mixing ratio and numerical density of cloud ice, snow and graupel.
- Difference method is utilized to the method of differential of space and you can use the explicit method for both horizontal and vertical grids(HE-VE) or the explicit method for horizontal grid and the implicit method for vertical grid(HE-VI).
- The time differential method which divides the term related to the sound of wave and the other terms is utilized to the method of time integration. The method of leap frog is utilized to the integration with using Asselin filter together except the term related to the sound of wave.
- The parameterizations of the first order closure by Smagorinsky or the 1.5 order closure used the energy of turbulence are utilized to turbulence.
- The central difference having fourth or second order precision using fourth or second order numerical viscosity together is utilized to the calculation of advection.
- In the initialized condition, the first dimensional profile by upper-air observation and so on is given to the model horizontally and uniformly, or ,for the nesting to wide area model, the three dimensional unequal data compensating the output values is given to the model.
- The condition of fixed boundary (mirror boundary), the condition of periodic boundary, the condition of zero-inclination and the condition of radial boundary are utilized to the boundary conditions.
- The sponge layer can be utilized to upper layer.
- MPI(Message Passing Interface) is utilized to parallel computers, so the model can do parallel calculation by the two dimensional deviation of rectangular field.

By this User's Guide, you can appear the detail of the functions(dynamical and physical processes) given and the method of equipment of program for parallel computers and can see the concrete method of practice of model and the result of inspecting experiment in order.