



Study on Atmospheric Water Cycle , Cloud Water Resource and Precipitation Efficiency

Yuquan Zhou, Miao Cai, Zhijin Hu, and Jietai Mao

Chinese academy of meteorological science, weather modification center, China (zhouyq05@163.com)

Atmospheric water cycle and water balance plays an important part of the climate system. Water substance includes water vapor and hydrometeors, and the water cycle is the process of phase transition of water substances. Liquid or solid water in the earth's surface becomes water vapor in the atmosphere only by phase transition, meanwhile, atmosphere's water vapor turns into hydrometeors by lifting and condensation, which is the second phase transition process. After that, the hydrometeors grow larger through cloud physical processes and then precipitate to ground, and became the only resource of available fresh water .Therefore, it's far from enough to only focus on the amount of water vapor in the atmosphere, more attention should be transfered to the hydrometeors (cloud water resources) which is formed by the process of phase transition including lifting and condensation. The core task of rainfall enhancement is to develop the cloud water resources and raise the precipitation efficiency by proper technological measures.

The original concept and quantitative assessment method of cloud water resource and its related physical parameters are proposed based on the atmospheric water circulation and precipitation enhancement. A diagnosis method of the three-dimensional (3-D) cloud and cloud water field are proposed , based on cloud observation and atmospheric reanalysis data. Furthermore, using analysis data and precipitation products, Chinese cloud water resources in 2000-2017 are assessed preliminarily. The results show that:

1. Comparing with the water vapor, the hydrometeor content is much smaller. Besides, the horizontal delivery amount also shows two orders of magnitude lower than water vapor. But the update cycle is faster and the precipitation efficiency is higher. The amount of cloud water resources in the atmosphere is determined by the instantaneous quantity, the advection transport, condensation and precipitation from the water balance.
 2. The cloud water resources vary a lot in different regions. In southeast China, hydrometeor has the fastest renewal cycle and the highest precipitation efficiency. The total amount of hydrometeor in the northwest China is relatively small, but it still has some development potential due to the low precipitation efficiency.
 3. More important, the accuracy of the assessment results can be improved and the estimation error can be reduced by using higher-resolution reanalysis data or combining of observational diagnosis and numerical model.
- Generally, it is necessary to further study the effective cloud water resources which are available to the technological development and economic use.