

Multiple equilibrium states of Venusian atmospheric general circulation simulated by AGCM

Atushige Kido[1]; Yoshinobu Wakata[2]

[1] Department of Earth System Science and Technology, Kyushu Univ; [2] RIAM, Kyushu Univ

Introduction

Venus rotates so slowly and the period of the rotation is 243 days, but the zonal wind with a velocity of about 100m/s exists at an altitude of about 70km and it is called super-rotation. The velocity is about 60 times faster than that of the solid surface rotation. At present, there is not definitive answer about how to make and maintain the super-rotation. But there are some scenarios that generate it, and this is called Gierasch mechanism (Gierasch, 1975). Furthermore, Matsuda (1980,1982) examined this Gierasch mechanism, and suggested the presence of the multiple equilibrium states in Venusian atmospheric general circulation. The alternative state is so utterly different, which has a strong meridional circulation with a slight zonal wind. This can also exist as a stable solution. In this study, we tried to simulate the multiple equilibrium states using a modified General Circulation Model(CCSR/NIES AGCM5.4) for Venusian atmosphere.

Model

The horizontal resolution is T21, and the vertical domain between 0 and 100 km has 60 layers. The physical parameters such as the rotation period and gravity acceleration are changed to Venus's values. Since the radiation process in Venus atmosphere is unknown, we assumed two types of the heatings: the first is a heating relative to the cloud solar absorption unvaried in zonal but varied in meridional, and the second is a heating relaxing the temperature to the horizontally homogeneous reference value by Newtonian cooling as referring to Yamamoto and Takahashi (2003). The first heating rate is just about same as Yamamoto and Takahashi in cloud layer, but smaller in lower layer. The unknown physical processes, i.e. clouds, precipitation etc., are omitted and the topography on the surface are not considered. We make up two initial conditions to reproduce the multiple equilibrium states. One is motionless state, and the other is a state with an appropriate wind speed like super-rotation.

Summary

In this study, we obtain two different circulations. One has slight zonal winds with strong meridional circulation, and the other has strong zonal winds with a weak meridional circulation. In fact, these two different circulations have character suggested by Matsuda(1980,1982).