# Chapter III

# Ability of the CCSR/NIES Atmospheric General Circulation Model in the Stratosphere

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# 1 Introduction

A quantitative evaluation of climate change such as global warming is impossible without a high-quality numerical model which describes the dynamics of the climate system and the circulation of energy and materials. The Center for Climate Research / National Institute for Environmental Studies (CCSR/NIES) atmospheric general circulation model (hereafter, GCM for a general circulation model) has been developed to obtain such a high-quality model. The emphasis of the development has been laid on the troposphere and the lower stratosphere below about 30 km altitude. This is natural because human beings live on the Earth's surface and the condition of the lower atmosphere directly affects human life. However, the stratosphere and the upper atmosphere beyond it have recently been the focus even in investigations of climate change, because they are relevant to many issues which relate closely to tropospheric climate change, such as the ozone hole, material exchange between the stratosphere and the troposphere, and physical interaction between the stratosphere and troposphere. This study extended the region of the CCSR/NIES GCM to the lower mesosphere (about 70 km from the surface). This is our first attempt to investigate this GCM's climatology in the upper atmosphere, although some studies for QBO in the middle and lower stratosphere had been done with the GCM.

# 2 Description of Calculations

The CCSR/NIES GCM and the numerical procedures of this study are described in brief in this section. The governing equations are transformed spectrally with the Gaussian grid in the horizontal direction and are differentiated in a $\sigma$ grid (Arakawa and Suarez, 1983) in the vertical direction. The physical parameterization includes a sophisticated radiation scheme with the 2-stream k-distribution method, a simplified Arakawa-Schubert cumulus parameterization (Arakawa and Schubert 1974), an estimation of cloud liquid water by prognostics of the total water content, the Mellor-Yamada level 2 turbulence scheme, a bulk scheme for surface fluxes (Louis, 1979), and an orographic gravity-wave drag scheme (McFarlane, 1987). Further general descriptions of this GCM are presented in another chapter of this monograph (see Chapter 1).

All integrations are done with climatological sea surface temperature as the boundary condition. After a preliminary integration for 4 years, a 2 year integration is performed as a control run. Results are shown as 3 month averages for winter and summer. Then, some parameter studies were made under the same conditions as above.