Investigation of Radiative Effects of Atmospheric and Dust Aerosols Using a Modified Global Spectral Model and Its Impact on the Atmospheric Environment and Climate

Z.N. Begum

Ex-Scientist 'G'/Advisor, Department of Science and Technology, New Delhi, India and OWSD Full member, Trieste, Italy

(Email: begumzn@hotmail.com)

Abstract

The 'Atmospheric Global Spectral Model' with modified physical parameterization considering atmospheric and dust aerosols is used to predict radiative fluxes over the deserts and adjoining region of the Indian subcontinent and the Arabian Peninsula. The background field of sand soil and dust aerosol particles are considered in the arid and semi-arid regions over the globe. Using the modified model, the radiative fluxes and change in the global temperature has been computed. The radiative heating due to atmospheric and dust aerosols contribute major energy source on the radiative forcings and global energy balance. It is found that the model-derived values for change in temperature over the globe increases gradually year after year which may lead to global climate change.

Keywords: Radiative forcings , Aerosols, Modified AGCM, Environment and Climate

1. Introduction

The dry hot desert and the summer meteorological conditions provide ideal conditions creating dust storms. Heat waves, generally known as 'loo' in India, are frequent in the months of May-June, before the onset of monsoon. The dust outbreak is one of the major phenomena that occurs over the desert of Saudi Arabia during the summer, which influences the nearby areas of Arabian peninsula and the Arabian sea. The 'shamal', a strong northwesterly wind-flow causes the major dust storm over Saudi Arabia. The aerosols and dust absorb a part of the incoming shortwave radiation and reflect/scatter the remaining portion of the radiation. The radiative effect and climate impact of aerosols is one of the major uncertainties in the radiative forcing of climate change.

2. Modeling Aspects

The details of the Atmospheric Global Spectral Model (also known as 'Atmospheric Global Circulation Model'AGCM-O is originally adapted from NMC, U.S.A. The details of the model are discussed by Kanamitsu (1989). However, in the modified model AGCM-M, we have implemented the modified parameterization scheme (Begum (2003), (1998), (2017); Begum and George (1999)) where atmospheric aerosols including dust aerosols have been considered. For the identification of desert, semi-desert and short-grass regions, the land cover data, as reported by Ackerman et al. (1989) are used in this work.

The surface radiation balance can be expressed in the form of budget equation composed of different terms, each representing a radiation transport or conversion process,

$$QNET = QSW + QLW$$

where QNET is the net all wave radiation, QSW represents the net short wave radiation (incoming and outgoing), and QLW is the net long wave radiation.

3. Results and discussion

The change of temperature derived from the present modified model AGCM-M for the years 1995 - 2002 is depicted in Fig.1 and is validated with the results of Hansen et al. (2000a, 2000b) using AGCM-O. Both the results show a gradual increase in temperature change over the said years, which contribute to global warming.

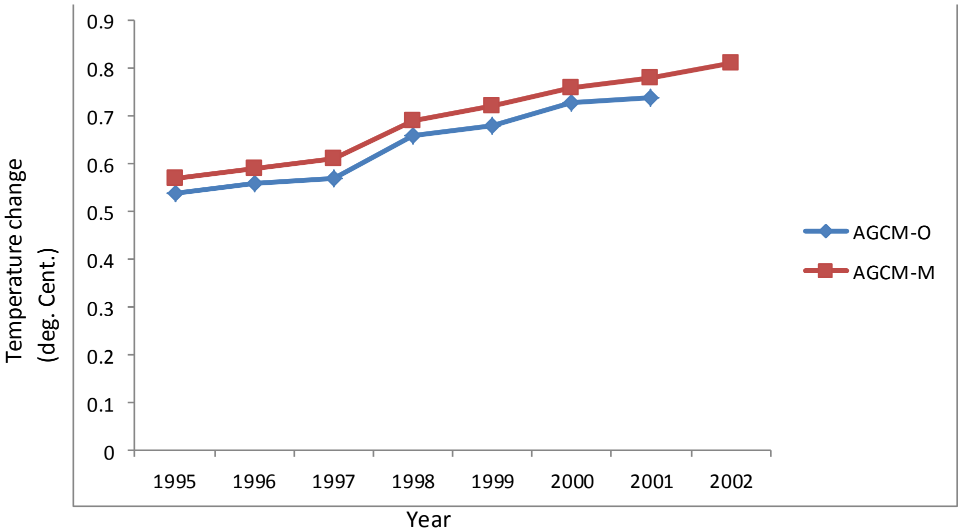

Fig.1. Plot of the change of temperature derived from the present modified model (AGCM-M) for the years 1995-2002 and its validation with AGCM-O.

4. Conclusions

The radiative effect and the climate impact of the atmospheric and dust aerosols is one of the main uncertainties in the radiative forcing of climate change. To minimize such uncertainties, our modified global circulation model (AGCM-M) incorporates more realistic physical parameterization, which successfully explains the radiative fluxes and rise in the global temperature.

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