Numerical Atmospheric Model Findings relevant to Solar Terrestrial Energy System and Global Climate

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1. Introduction

The interaction of the physical processes in the atmospheric environment is complex in nature. Proper representation of the physical processes in the numerical models forms the essential aspect of the prediction studies, especially in the tropics. The tropical systems are largely driven by the convective processes, because they act as an energy source by way of latent heat supply. The convective processes provide the mechanism of vertical transport of heat, moisture and momentum which have considerable effect on synoptic weather systems. The interaction of clouds and aerosols also play a major role in the total radiative forcings and vertical distribution of radiative fluxes within the atmosphere. The I-STEP is the 'International Solar-Terrestrial Energy Programme', which combines resources on an International level determining the flow of mass, momentum and energy in the solar system. Its main objective is to assess the impact of sulfate and other continental aerosols on global energy balance and radiative forcings (Ramanathan, V. 1987). The observations under the above-mentioned programme not only improves our understanding, but it also helps to improve the representation of these processes in our 'Modified' Atmospheric General Circulation Model as discussed in the following.

2. The Modified Atmospheric General Circulation Model (AGCM-M)

The Global Atmospheric Model T-80 /L-18 (Kanamitsu, 1989) is originally adapted from NCEP (NMC, USA) with an intermittent data assimilation scheme. We have modified the above model by including scattering and absorption of the incident solar radiation (direct effect) as well as the microphysical and optical properties of clouds (indirect effect). This modified model is being referred here as AGCM-M. The details of the modified model are given elsewhere by George and Begum, 1997; Begum, Z.N. 1998; and Begum, Z.N. 2017. The aerosols and chemicals are transported in the atmospheric environment by the model cumulus convection and through the model semi-Lagrangian advection process. Thus they are globally distributed along with the wind flow. The increase of concentration of the green house gases and aerosols in the tropics may affect the energy transfer in the earth-atmospheric system. Whether the planet loses or gains energy, the overall effect will be a re-distributed absorbed radiation energy within the system. The solar radiation suffers depletion due to absorption, scattering and reflection by the atmospheric constituents. This gives an overall assessment of the impact of different physical processes and the interactions with the atmospheric constituents on the energy transfer over the globe. The increase of infrared absorbing trace gases enhances the atmospheric heating effect and thus the surface air temperature.

3. Results and Discussion

In order to validate the modified model results, the model was integrated for many cases in the medium range time scale and a few long runs were also taken to see the time evolution of some physical parameters. The same results have been compared with the observations shown in. The global energy budget is displayed in Table 1, which shows the impact of the changes in the

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physical parameterization scheme of the modified model (Begum, Z.N. 1998, 2003, 2017; Georg J.P. and Begum, Z.N.(1997).

Table 1: Global Energy Balance for the month of June 1997

Types of Radiative F	Global annual mean condition flux (C) (in W/m^{-2})m (Ref. [1-5])	Modified Atmospheric Global Circulatiom Model (in W/$^{m-2}$) Present Work
Incoming Solar Radiation Reflected solar radiation	343 106	343 107
Outgoing long-wave radiation (OLR)	237	238
Atmospheric absorption of solar radiation by various constituents	68	70
Latent heat (LH)	90	91
Sensible heat (SH)	16	16
Surface absorption of solar radiation	169	170
Downward long-wave emission	327	329
Upward long-wave emission by the surface	390	392

From these findings we conclude that due to increase in aerosol and greenhouses gas concentrations there is more absorption of radiation in the lower atmosphere as a result of which the global temperature rises gradually.

References

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