The Effect of Radiative Forcings of Various Constituents of the Earth-Atmosphere on the Global Energy Transfer

Z.N. Begum*

**Ex-Scientist 'G'/Advisor, DST, New Delhi; India ;OWSD Full Member , Trieste, Italy.*

(Email: begumzn@hotmail.com)

Chemical tracers and aerosols are micro-particles with mean radii of 10^{-4} to 10^{-6} m. They include gases like CH_4, NO, N_2O, SO_2, NH_3, CO, CO_2, HNO_3, CFC and O_3. Aerosols and the greenhouse gases are essentially important elements of the world climate system. They affect both, the present-day climate as well as the future climate change. Aerosol source gases directly scatter and absorb radiation in cloud-free and cloudy conditions [1]. On the other hand, they indirectly play the role as cloud condensation nuclei (CCN) and modify optical properties of clouds.

The absorption of solar radiation by the aerosol layer increases the radiative heating of the atmosphere, while the fraction of scattering that leaves the atmosphere decreases the total amount of energy available to the earth-atmospheric system [2,3]. The composition of the atmosphere controls the climate to a large extent. In particular, the greenhouse gases in the atmosphere play a crucial role in determining the earth's climate. Thus the different constituents of the earth's atmosphere may interact in complex ways on different space and time.

Significant scattering, including multiple scattering and absorption of radiation can occur in the same part of the atmosphere due to the presence of aerosols and gases (Begum, 1998). The numerical global atmospheric models with comprehensive model physics are the tool for simulation and proper understanding of the feedback mechanism and the radiative forcings. The model used in these experiments is an 'Atmospheric Global Circulation Model' (AGCM) [4], with modified radiation scheme (M-AGCM) [1-3]. In order to compute the global energy balance, radiative transfer processes and their spectral dependence must be treated adequately as the continental aerosols and gases modify the atmospheric physical environment significantly. The magnitude of heating and cooling has changed considerably due to the physical processes and their interaction with the constituents present in the earth-atmospheric system.

Based on the M-AGCM, the optical properties of aerosols and gases are computed. The results of the global energy balance are given in the following Table, which are compared with the radiation budget data collected by the Earth Radiation Budget Experiment (ERBE) on global annual mean basis [5-7].

Table - Global Energy Balance for the month of June 1997

Types of Radiative Fluxes	Global annual mean condition flux (C) (in W/m^{-2}) (Ref. [5-7])	Modified Atmospheric Global Circulation Model (M-AGCM) (in W/m^{-2}) Present work
Incoming solar radiation	343	343
Reflected solar radiation	106	105
Outgoing long-wave radiation (OLR)	237	238
Atmospheric absorption of solar radiation by various constituents	68	70
Latent heat (LH)	90	89
Sensible heat (SH)	16	16
Surface absorption of solar radiation	169	168
Downward long-wave emission	327	325
Upward long-wave emission by the surface	390	388

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.

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