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CLOUD RADIATIVE FORCING OVER SOUTH AMERICA: COMPARISON OF CPTEC/COLA AGCM OUTPUT WITH SRB DATA

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1. INTRODUCTION

Recent comparisons between the solar radiative fluxes simulated at the Earth's surface by atmospheric general circulation models (AGCM) and observations indicate that models tend to overestimate incoming solar fluxes (Wild et al., 1995). In this study, the results of a simulation experiment using CPTEC/COLA spectral GCM are analyzed by comparing its surface radiative flux output with the data provided by the Surface Radiative Budget (SRB) project based on the satellite radiation measurements.

2. 10-YEAR RUN OF CPTEC/COLA AGCM

The CPTEC/COLA AGCM is a modified version of the Center for Ocean, Land and Atmosphere Studies (COLA) model (Kinter et al., 1997). It was run with the Kuo convection scheme, at T42L18 resolution. The shortwave radiation code employed by the model is based on the method of Lacis and Hansen (1974) taking into account Rayleigh scattering, water vapor and ozone absorption as well as scattering and absorption by cloudiness. The cloud cover scheme uses the parameterizations of Slingo (1987).

The model was integrated for 11 years, from September 1985 to December 1995, using NCEP initial conditions of 15 September 1985. Monthly observed Sea Surface Temperatures (SST) are used as forcing boundary conditions. Other boundary conditions as soil humidity and albedo are introduced as initial climatological conditions which are adjusted during the integration.

3. SURFACE RADIATIVE BUDGET (SRB) PROJECT DATA

Surface solar radiative fluxes in the SRB project database are available for the period from March 1985 to December 1988 (Whitlock et al., 1993). The results from the International Satellite Cloud Climatology Project (ISCCP) and the Earth Radiation Budget Experiment (ERBE) were used as inputs into the two radiative transfer codes in order to compute the fluxes. In this study, we utilize data obtained with the method of Pinker and Laszlo (1992), which is the physical radiative transfer model based on the delta-Eddington approximation. It takes into account all main absorbing and scattering atmospheric substances.

4. RESULTS OF THE COMPARISON

The comparison was performed for the South America region for 3 years from 1986 to 1988. In order to study the impact of cloudiness, we compared separately the all-sky and clear-sky surface fluxes as well as Cloud Radiative Forcing (CRF) and Cloud Radiative Forcing Ratio (CRFR). By its definition, CRF is the difference between the net fluxes in the all-sky and clear-sky conditions, and CRFR is the ratio between the incoming fluxes with and without cloudiness. The magnitude of CRFR depends on the cloud amount and cloud optical depth mainly while CRF depends on the cloud amount, cloud optical depth, cosine of solar zenith angle and magnitude of the surface albedo.

We compared the monthly mean values of surface-solar radiative fluxes for January and July averaged over the period from 1986 to 1988. The fluxes were also averaged over the latitude for the continental regions of South America excluding coastal zones. Figures 1-2 show the result of the comparison. One can see that simulated all-sky fluxes are larger than SRB data in almost all latitudes. This is related mainly to the clear-sky flux overestimation which, in turn, can be explained by the model underestimation of the water vapor absorption and neglect of the aerosol effects. The modeled absolute values of the CRF shown in Figure 3 are larger (smaller) than the SRB data in the tropical (extratropical) region. This diversity is related mainly to the cloud cover scheme employed by the model.

Figure 4 shows that there are similar diversities between the CRFR values. Nevertheless, the model reproduces well the main features of zonal variations of cloudiness over South America.

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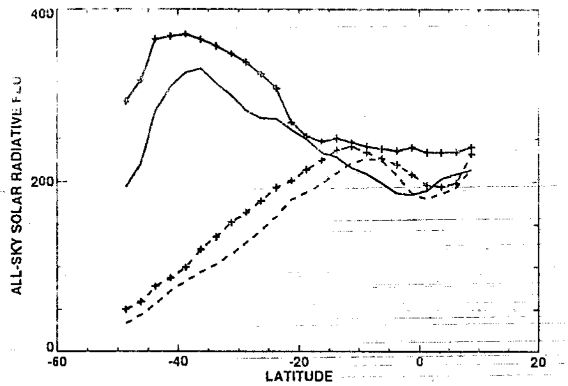

Figure 1: Monthly mean incoming solar radiative flux at the surface averaged over the South America latitudes for January (solid) and July (dashed) (3-year averages: 1986-1988). Plusses denote the model outputs, curves without marks show SRB data.

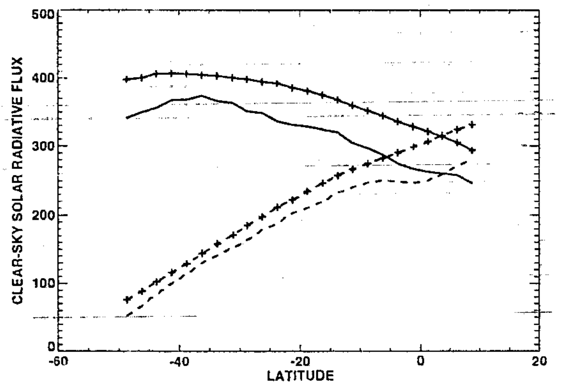

Figure 2: The same as in Figure 1 but for the clear-sky flux.

Thus, in the tropical region it simulates the smaller cloudiness impact on the incoming solar flux at the surface in July (dry season) and larger effect in January (wet season). On the contrary, in the extratropical region the effect of clouds is larger in July in the winter than in January in the summer.

5. REFERENCES

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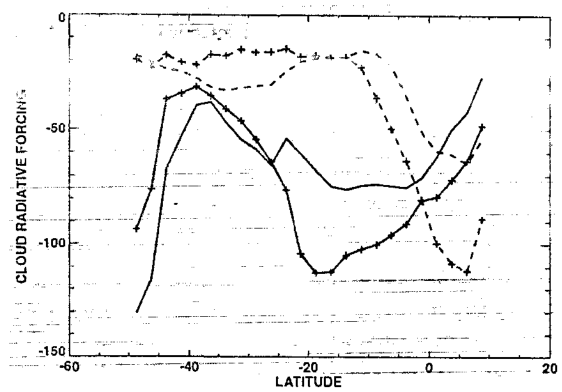

Figure 3: The same as in Figure 1 but for the cloud radiative forcing.

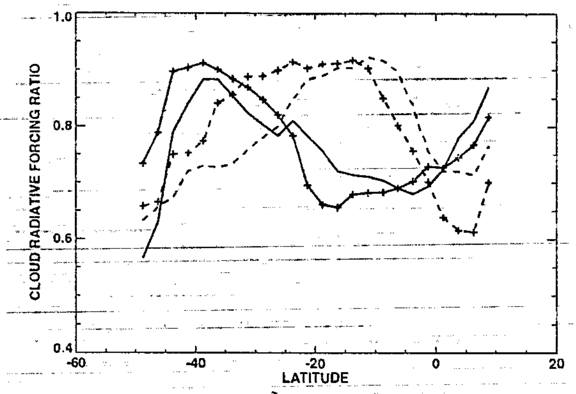

Figure 4: The same as in Figure 1 but for the cloud radiative forcing ratio.

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