An overview of the GAME Radiation Activities

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1. Introduction

Game Radiation Activities have started in 1996 when GAME (GEWEX Asian Monsoon Experiment) has been initiated under the GEWEX Project. The main objectives of the Activities are as follows:

- To understand the surface radiation budget distribution over Asia on continental scale.
- To understand the role of clouds, aerosols, and water vapor for determining the radiation budget regime of the earth-atmosphere system.
- To establish satellite remote sensing techniques for estimating surface radiation budget.

In this paper, I like to overview the recent activities and scientific achievement of the Radiation Activities.

2. Recent activities and scientific achievement

In the last several years, the Activities have made effort to establish the GAME high precision radiation sites at Sri-Samrong and Shou-Xian/Hefei. At these sites, full set of solar radiation and thermal radiation flux radiometers have been set with accompanying instruments to measure geophysical parameters for determining the radiative properties of the atmosphere. Especially the Sri-Samrong site has grown into a full-scale observatory and has been administrated by the Chulalongkorn University since 2000 with support of NRCT, TMD, IRD and Department of Agriculture. The site is now equipped with pyranometers, pyrheliometer, pyrgeometers, sky radiometer, MPL lidar, microwave radiometer, GPS, and AWS. Data from the observatory is electronically transferred to the archivers automatically and are under analysis for depicting the radiation budget regime at the site. Especially the relation between the radiation budget

and optical properties of clouds and aerosols has been intensively analyzed.

The SKYNET network, that is an Asian network of skyradiometers similar to NASA/AERONET network, is also being formed under tight collaboration with the GAME Radiation Activities. The GAME high precision radiation sites now serve as super sites of SKYNET. The SKYNET includes Chiba, Yinchuan, Duanhuan, and Mandalgovi sites equipped with a skyradiometer and a pynanometer. Korean sites at Anmyondo and Kosan, established by KMA, are also equipped with instruments similar to those of the GAME high precision radiation sites. Data from these Asian sites are being analyzed at UT/CCSR and Chiba U./CeRES. The analysis shows that downward radiative flux can be successfully synthesized by aerosol parameters derived from skyradiometer (Kim et al., 2001).

Several new algorithms have been developed for aerosol remote sensing (Higurashi et al., 2000), cloud remote sensing (Kawamoto et al., 2001), and earth's radiation budget estimation (Okada et al., 2001). Surface radiation budget has been retrieved by the satellite algorithm with GMS satellite data, and has been compared with ground-based flux and skyradiometer data at SKYNET sites (Okada et al., 2001). It is found that disgreement is related with the value of the aerosol optical thickness. It is, therefore, suggested that aerosol distribution, as well as cloud distribution, is important to be estimated for full understanding of the surface radiation budget formation. The radiative forcing of indirect aerosol effect, which is defined as the cloud radiative forcing caused by anthropogenic aerosols, is estimated as large as -0.8 W/m^2 as the globally averaged value from the remote sensing results of aerosols and clouds (Sekiguchi et al., 2001). It is interesting to see the Asian contribution to this global mean is smaller than that of other significant regions over east Pacific Ocean and around South America and South Africa.

Modeling the radiation budget is also an important activity of the GAME Radiation Activities. For this purpose an aerosol-chemical transport model coupled with the CCSR/NIES Atmospheric GCM model has been developed (Takemura et al., 2000). Modeled aerosol optical thicknesses are now under comparison with SKYNET data. Similar comparison with AERONET shows a promising agreement between modeled and ground-based measurement values. Resulted radiative forcing of the direct aerosol effect is -0.20 W/m^2 in total with contribution of -0.24 W/m^2 from organic carbon, -0.32 W/m^2 from sulfate and +0.36 W/m^2 from black carbon aerosol forcing (Takemura et al.,

2001). Carbonaceous aerosol contribution is large in the Asian region, as observed in the Indonesian forest fire event in 1997 (Nakajima et al., 1999; Narukawa et al., 1999; Ru et al., 2000).

3. Conclusion and Future work

The GAME Radiation Activities start producing interesting scientific results. The role of clouds and aerosols are about to be depicted from integrated effort of ground-based measurements, satellite remote sensing, and climate modeling. The near future important task is aerosol remote sensing over land by which radiative forcing over land region can be evaluated. The other task is to improve the SKYNET performance by establishing the efficient routine protocol of maintenance of the instruments, which is not an easy task over the wide area of Asia. Collaboration between SKYNET and AERONET projects is one of efforts to overcome this difficulty. Understanding the precipitation mechanism from cloud microphysical approach is one of new projects in the Activities.

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