

## Achievement of CEReS Research Projects

<b>Project 3</b>
<b>Subject:</b> Evaluation of radiation budget on the basis of satellite data and ground observation network, and study of long-term changes in atmospheric parameters
<b>Members:</b> Tamio Takamura and Hiroaki Kuze
<b>Objective of the project:</b> The satellite evaluation of radiation budget in the Earth's surface system provides basic quantities required for the study of the global climate change including model studies. The accurate understanding of radiation budget is indispensable for studying dynamic behavior of vegetation, hydrology, and ocean environment. The purpose of this project is to investigate the long-term changes in the radiation budget of the East Asia region and related atmospheric parameters in a comprehensive manner, employing both the satellite data and ground-network data.
<b>Summary of Achievement</b> New algorithms have been developed and tested for extracting various atmospheric parameters from satellite data. Simultaneous observations with ground instruments, including a network observation called SKYNET, are used for validation as well as improvement of the algorithms. Regional and seasonal variations of aerosol, cloud, and radiation amounts have been studied.
<b>Details of Achievement</b> <b>Achievement 1: Variations of atmospheric parameters and long-term radiation budget using remote sensing data</b> <b>1-1 Algorithm development for radiation budget studies<sup>1),2)</sup></b> Land surface albedo is a key parameter in radiation budget and climate modeling studies. An empirical anisotropy correction model for estimating land surface albedo has been developed for snow free land surfaces under clear sky conditions. The proposed model can be used for direct estimation of surface albedo from a single BRF observation. <sup>1)</sup> The cloud optical thickness (COT) derived from the GMS-5/SVSSR is examined to estimate short-wave radiation budget. By comparing with MODIS COT, the GMS-5-retrieved COT has been corrected. <sup>2)</sup> <b>1-2 Measurement of time-integral of photosynthesis for NPP estimation in Mongolia<sup>3)</sup></b> We applied the monthly mean PAR for vegetation photosynthesis to estimate the NPP from Landsat ETM+ data for a semi-arid area of Mongolia. The estimated NPP results were compared with ground measurement data. <b>1-3 Long-term characterization of seasonal variation of tropospheric aerosols in Chiba<sup>4)</sup></b> Seasonal variations of tropospheric aerosol properties in Chiba, Japan, are investigated by means of sun-photometer measurement (1999–2005), ground sampling (1998–2004), and wind data. The influence of anthropogenic particles from local sources as well as that of Asian dust particles have been detected and discussed. The seasonal variation is remarkable also in the chemical analysis data. <b>1-4 Estimation of shortwave radiation budget using ADEOS II/GLI data<sup>5)</sup></b> The downward and upward solar radiation at the surface and at the top of the atmosphere are estimated using GLI aerosol and cloud products. The ground-observed data using <i>i</i> -sky radiometer are used for evaluating the satellite-derived aerosol and cloud products.
<b>Achievement 2: Collection of ground-validation data and improvement in satellite data analysis</b> <b>2-1 Dual-site lidar observations and satellite data analysis for regional cloud characterization<sup>6)</sup></b> Lidar data observed by two continuously operated portable automated lidar (PAL) systems and images from the visible and thermal infrared channels of AVHRR sensor onboard NOAA16 satellite are employed for the characterization of cloud heights and cloud types. <b>2-2 Influence of inhomogeneous cloud fields on satellite observations<sup>7)</sup></b> GMS-5/SVSSR-retrieved cloud optical depth (COD) appeared mostly lower than that of Terra-MODIS. The major factors causing such COD differences are the satellite viewing and solar conditions, the cloud thermodynamic phase differentiation and particle effective radius, and the cloud inhomogeneity. Here the emphasis is put on the examination of the cloud inhomogeneity effect. <b>2-3 A high-efficiency aerosol scatterometer for the calibration of multi-wavelength lidar data<sup>8)</sup></b> A scatterometer was developed to measure the aerosol scattering coefficient at the ground level, on the basis of an integrating sphere, cw lasers, and a controlled flow of the ambient air, including aerosol particles. <b>2-4 Aerosol mass extinction efficiency studied by continuous lidar measurements<sup>9)</sup></b> Continuous data of the atmosphere monitored using a portable automated lidar are correlated with the concentration of ground-measured suspended particulate matter (SPM). When the boundary layer is well mixed, high correlation makes it possible to calculate the mass extinction efficiency of the aerosols in the atmosphere.

## 2-5 The influence of ambient humidity on the aerosol mass concentration measurements<sup>10)</sup>

The influence of humidity is considered on the concentration of the suspended particulate matter measured with a  $\beta$ -ray counter. For the monthly data taken in September 2005, the difference in relative humidity between inside the instrument (48%) and outside the laboratory (78%) resulted in approximately 53% larger aerosol mass concentration after the correction, also affecting the mass extinction efficiency.

## Achievement 3: Analysis of atmospheric environment based on ground-network observations

### 3-1 Intercomparison between lidar and airborne measurements near Tokyo during ACE-Asia<sup>11)</sup>

In April 2001 during the ACE-Asia campaign, intercomparison studies were carried out near Tokyo using ground-based lidar networks as well as aircraft observations. Modest concentrations of Asian dust in the free troposphere was found to extend up to an altitude of 8 km.

### 3-2 Study of atmospheric brown cloud and its radiative effect<sup>12), 13)</sup>

Simultaneously measured sky-radiation and surface solar-flux data are used to retrieve aerosol optical properties. Data sets from several SKYNET sites suggest that Asian dusts become blackened during the movement because of mixing with soot particles produced over the industrial/urban area of China.<sup>12)</sup> In a campaign conducted on Cheju Island, the values of aerosol radiative forcing suggest that the aerosols might consist of more or less yellow sand in comparison with the results simulated using typical aerosol models.<sup>13)</sup>

### 3-3 Aircraft and ground-based observations of boundary layer CO<sub>2</sub> concentration<sup>14)</sup>

Concentrations of atmospheric CO<sub>2</sub> and aerosol were measured in a field campaign conducted in winter 2006 around Mt. Tsukuba, Japan using ground-based CO<sub>2</sub> analyzers, a lidar, and sky radiometers as well as CO<sub>2</sub> analyzers onboard an aircraft. A sudden increase of downward winds, due to the approach of an anticyclonic synoptic flow, resulted in a rapid decrease in both the CO<sub>2</sub> and aerosol concentrations in the boundary layer.

## Publications

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