2C1) Physico-chemical, Optical, and Radiative Properties of Asian Aerosols and Their Impacts on Regional Atmospheric Environment and Climate

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In site measurements at Gosan, Korea and onboard C-130 aircraft during the ACE-Asia 2001 field campaign were analyzed to investigate the influence of the aerosol hygroscopic growth on aerosol optical properties and radiative forcing. Investigation of the relationship between the transport pathways and the synoptic-scale circulation patterns and the characterization of the aerosol microphysical and optical properties in terms of transport regimes were carried out. The transport pathways of all air masses were classified as four continental clusters and one maritime cluster. The pathways were associated with the spatial distribution of migratory anticyclones and cyclones and synoptic-scale circulation pattern. High Rn-222 and condensation nuclei (CN) concentrations appeared in air masses with high Asian dust and pollution aerosols. The scattering and absorption coefficients of fine and coarse aerosols were highest in air masses accompanying Asian dust and pollution. The relative large concentration of Rn-222 and aerosol microphysical and optical properties for marine air mass in spring suggests that the marine air masses are somewhat mixed and aged with continental outflows.

The influence of relative humidity on the light scattering of Asian aerosols and the controlling factors were investigated. In the springtime Asian aerosols were hygroscopic in the visible wavelengths. The highest f(RH) appeared for the pollution aerosol from Chinese sectors (2.75±0.38) due to the high mass fraction of sulfate component. The smallest f(RH) appeared for the smoke period (1.60±0.20). f(RH) for the Asian dust period (2.00±0.27) was somewhat hygroscopic. During the Asian dust period, sp and ap were remarkably elevated with means and standard deviations of 238.6±55.3 Mm^{-1} and 24.2±10.9 Mm^{-1}, respectively. Mean f(RH) for pollution aerosols from Chinese sectors (2.75±0.38) in this study is much higher than for anthropogenic aerosols in Europe during ACE-2 (1.46±0.10) as well as for urban/industrial aerosols onthe east coast of the United States during TARFOX (1.81±0.37~2.30±0.24). The mean f(RH) during the smoke period (1.60±0.20) is comparable to that during INDOEX (1.58±0.21), and higher than that for SCAR-B in Brazil (1.16). There was a negative correlation (r=0.81) between f(RH) and the OC concentration. In spite of the high mass fractions of water-soluble organic carbon in organic carbon (61.7%) and total carbon (49.8%) at the site during ACE-Asia, this negative correlation suggests that organic aerosols have a strong influence on the smoke aerosol hygroscopicity. Results from this study show that the hygroscopic properties of Asian aerosols in spring are highly variable. This result may be explained by the presence of the ubiquitous hygroscopic pollution (e.g., sulfate) and organic aerosols and their complex mixing processes.

Chemical apportionment of light extinction, optical depth, and surface radiative forcing due to several key aerosol types was estimated. The calculated scattering, absorption, and extinction coefficients for Dp<10 μm aerosols coincided well with the measured scattering, absorption, and extinction coefficients with r^2 = 0.92, 0.93, and 0.93, respectively and RMSEs of 23.6, 3.0, 23.2 Mm^{-1}, respectively. Most of the daily calculated scattering, absorption, and extinction coefficients were

distributed within 1 standard deviation from the diurnal means of the measured scattering, absorption, and extinction coefficients, respectively. The chemical apportionment of measured AOD was estimated under the assumption of a vertically uniform distribution of aerosol chemical composition. A radiative transfer model was employed to estimate the diurnal variation of aerosol radiative forcing at the surface. The calculated direct and diffuse fluxes at the surface generally coincided well with the measured direct and diffuse fluxes. A large fraction of the 24-hr averaged aerosol radiative forcing at the surface is attributable to mineral dust, water-soluble components, and elemental carbon.

From the aerosol optical and radiative transfer modeling studies, Ifound that the extinction and scattering coefficients are greatly enhanced with RH if wavelength of solar light is shorter. Single scattering albedo with RH is also sensitively changed in the longer wavelength. Asymmetry parameter (g) is gradually increased with RH although g decreases with wavelength at a given RH. Diurnal-averaged aerosol radiative forcings for surface, TOA, and atmosphere were greatly increased with RH because AOD was increased with RH due to hygroscopic growth of aerosol particles. However, the diurnal-averaged radiative forcing efficiencies at the surface, TOA, and atmosphere were decreased with increasing RH. The results imply that the hygroscopic growth due to water-soluble or hydrophilic particles in the lower troposphere may significantly modify the magnitude of aerosol radiative forcing both at the surface and TOA.