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Analysis of the Interaction and Transport of Aerosols with Cloud or Fog during DRAGON Campaigns in Asia from AERONET and Satellite Remote Sensing

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Ground-based remote sensing observations from Aerosol Robotic Network (AERONET) sun-sky radiometers have recently shown several instances where cloud-aerosol interaction had resulted in modification of aerosol properties and/or in difficulty identifying some major pollution transport events due to aerosols being imbedded in cloud systems. AERONET has established Distributed Regional Aerosol Gridded Observation Networks (DRAGON) during field campaigns that are short-term ($\sim$2-3 months) relatively dense spatial networks of $\sim$15 to 45 sun and sky scanning photometers. Major DRAGON field campaigns in Japan and South Korea during Spring of 2012 have yielded observations of aerosol transport associated with clouds and/or aerosol properties modification as a result of fog interaction. Analysis of data from the Korean and Japan DRAGON campaigns shows that major fine-mode aerosol transport events are sometimes associated with extensive cloud cover and that cloud-screening of observations often filter out significant pollution aerosol transport events. The Spectral De-convolution Algorithm (SDA) algorithm was utilized to isolate and analyze the fine-mode aerosol optical depth (AOD) signal from AERONET data for these cases of persistent and extensive cloud cover. Satellite retrievals of AOD from MODIS sensors (from both dark target and MAIAC algorithms) were also investigated to assess the issue of detectability of high AOD events associated with high cloud fraction. Cloud properties retrieved from MODIS are also investigated in relation to the AERONET and satellite measurements of AOD. Underestimation of AOD by the Navy Aerosol Analysis and Prediction System (NAAPS) model at very high AOD at sites in China and Korea was observed, especially for observations that are cloud screened by AERONET (L2 data). Additionally, extensive fog that was coincident with aerosol layer height on some days in Korea resulted in large increases in fine mode aerosol radius, with a mode of cloud-processed or residual aerosol of radius $\sim$0.4-0.5 micron sometimes observed. Cloud processed aerosol may occur much more frequently than AERONET data suggest due to inherent difficulty in observing aerosol properties near clouds from remote sensing observations. These biases of aerosols associated with clouds are even greater for passive satellite remote sensing retrievals of aerosol properties near clouds due to sub-pixel cloud contamination and 3-D radiation scattering effects.