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Seasonal and spatial comparisons between aerosol and cloud microphysical properties derived from satellite remote sensing in Northeast Asia

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Mainly MODIS/Terra level 3 and NCEP/NCAR Reanalysis long-term (2001-2008) daily data have been analyzed for the understanding aerosol-cloud interactions in Northeast Asia, such as aerosol optical depth (τ_a), liquid-phase cloud optical depth (τ_c), liquid-phase cloud effective radius (r_e), cloud fraction (CF), cloud top pressure (CTP), cloud top temperature (CTT), potential temperature (θ), vertical velocity (w) etc. The analysis region is divided into 4 regions such as A1 (118-121E & 35-38N), A2 (122-125E & 35-38N), A3 (126-129E & 35-38N), and A4 (130-133E & 35-38N). Horizontal distributions and box plots of τ_a for the different region showed the substantial horizontal gradient from China to Korea, especially with the strong difference between A1$\sim$A2 and A3$\sim$A4, which could represent the evidence of the anthropogenic influence downstream of China in the perspective of seasonal average. Specifically the relationship of τ_a to r_e on the monthly-average basis has been examined, which showed the negative correlations, only in summer and rather significant associations over the Yellow Sea (A2), but mostly ambiguous signals in the other seasons and/or regions. Relative variability (RV) is defined as normalized interquartile range being indicative of cloud inherent variability. Relative variability in τ_c (RVτ_c) is overall lowest whereas RVτ_a is higher in summer, such that the cloud variability in summer tends to be relatively suppressed. Especially, the highest ratio of RVτ_a/ RVτ_c in summer might represent the favorable condition for the efficient aerosol-cloud interaction in terms of the long-term spatial & temporal average. Also vertical gradient of the potential temperature ($\Delta\theta$) between 700 and 1000hPa is higher in summer. This might be associated with the location of subsidence zone of Hadley cell. Interestingly, relationship between $\tau_a$and CF over each region with the different seasons on low level (CTP$>$700hPa) liquid-phase (CTT$>$273K) clouds showed the positive correlation, more over the A2 region, which are consistent with the 2^{nd} indirect effect.