Variability of Aerosol Optical Properties at Mauna Loa and its Characteristics According to Source Regions

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Mauna Loa Observatory (MLO) is one of the NOAA Atmospheric Baseline Observatories, located far from major anthropogenic sources and at very high altitude (3397 m asl). These geographical conditions enable observations at MLO to be representative of Free-Tropospheric (F.T.) background conditions over the Pacific Ocean. However, MLO is suspected to be influenced by aerosols originating from remote continents and local sources. Global scale meteorological patterns and distinct diurnal radiation wind fields are known to be the reason, respectively, estranging MLO from obtaining free-tropospheric background aerosol optical properties (AOPs) (Bodhaine et al., 1981; Perry et al., 1999; Sheridan et al., 2017).

In this study, we investigated diurnal and seasonal variability of AOPs using long-term data (1974–2015). The aerosol scattering coefficient (σ_{sp}) showed distinct diurnal variation with peaks in the afternoon and minimum in the morning throughout the year. On the other hand, the aerosol absorption coefficient (σ_{ap}) didn't show a significant diurnal pattern. Based on a diurnal minimum of Radon-222 concentration in the morning, we defined the time period with the least local influence (LLI time period of 8:00–11:00 LST) to separate local influence and F.T. conditions (Chambers et al., 2013). Single scattering albedo (ω_0) was relatively high in the afternoon and in summer, which is when local radiation wind develops the most, showing that aerosols from local sources are scattering dominant. σ_{sp} and σ_{ap} under F.T. conditions showed a noticeable springtime peak, inferring that the free troposphere over the Pacific Basin shows higher aerosol concentrations during boreal spring than any other times of the year.

The HYSPLIT model was used to calculate backward trajectories to identify F.T. aerosol source regions. The most popular source regions were East Asia and South East Asia, which accounted for 25% and 13% in frequency, respectively. The frequency of Asian influence was greatest during the winter, but its normalized contribution with respect to measured σ_{sp} and σ_{ap} was greatest in spring. The systematic relationship between AOPs was analyzed to examine characteristics of aerosols according to respective source regions. Moreover, a significant increasing trend was found with σ_{sp} (1.85 %/yr), and a probable trend with σ_{ap} (6.59 %/yr). The positive trend on σ_{sp} and σ_{ap} was distinct in spring. East Asian influence is the most likely cause since its contribution increases as its average σ_{sp} increases.

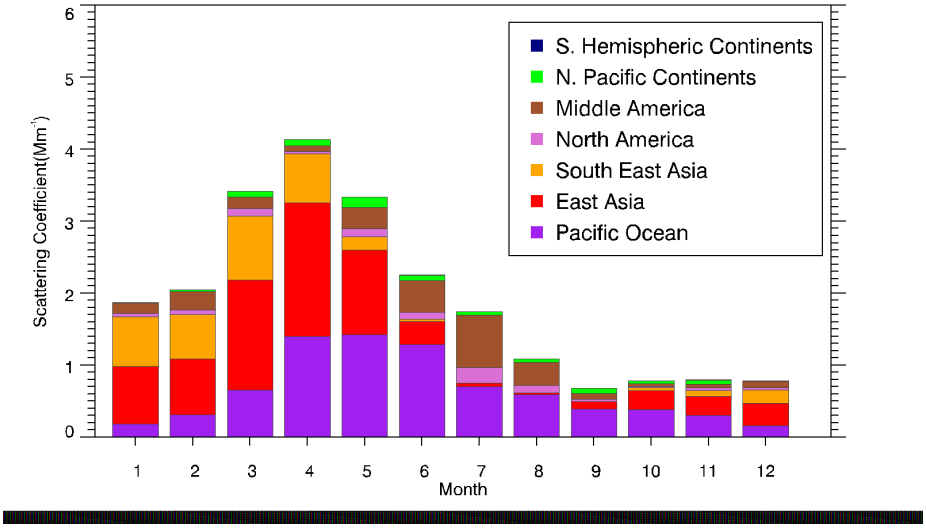

Figure 1. Monthly variation of contribution on aerosol scattering coefficient by each source region. Contribution was calculated using frequency and a measured aerosol scattering coefficient at collocated time.