Long-term seasonal changes in tropospheric ozone over Japan

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Tropospheric O_3 is the primary source of OH radicals in the troposphere that contribute to the oxidation capacity of the atmosphere. According to the seasonal cycles of surface O_3, different behaviors at the remote and metropolitan areas in northern midlatitude have been pointed out (Parrish et al., 2013; Cooper et al., 2014; McGlynn et al., 2018; Jung et al., 2018). For example, European, American and Asian continental remote sites indicated that the seasonal cycle in the present decade had earlier annual maximum peaks than the maximum in the past decades. On the other hand, delayed maximum peaks appeared in urban locations. In spite of lots of monitoring stations, research for changes in seasonal O_3 cycles in Japan is still unclear. In this study, we investigate the seasonal cycle changes by using long-term continuous O_3 monitoring data at 265 ambient sites.
First, to clarify the annual O_3 maximum, sine function fitting examined by Parrish et al. (2013) was applied to monitoring data between the 1980s and 2010s. Regarding the spatial distribution of seasonal shifting between the 1980s and 2010s, most monitoring sites showed changes in a delayed shift. In particular, the stations with more than 0.2 days/decade delay belong to eastern and southwestern parts of Japan. Next, sine function was fitted to 5-years moving average over the entire data record to acquire the long-term trends of seasonal maximum in each region. All monitoring station were classified based on the 35-years averaged NOx concentration: urban, suburban and rural (Kurokawa et al., 2009). Results in all classifications showed delayed trends over analysis periods. In rural sites, O_3 mixing ratio reached the annual maximum in 5-days earlier than urban and suburban sites. In future work, we will conduct long-term air quality simulation and investigate the mechanism of seasonal cycle delaying.

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