Characteristics of atmospheric environment over Korean peninsula for the optical remote sensing

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Abstract

In this study, we investigate the atmospheric environment changes in the aspect of optical remote sensing using surface observation data from 1971 to 2000 of Korea Meteorological Administration. Visibility, spatially averaged over Korean peninsula, is systematically reduced from about 28km to 18km during the last 30 years. It means that atmospheric conditions for the optical remote sensing over Korean peninsula are growing worse and worse due to the degradation of air quality. The 30-year average of cloud amount shows a strong seasonal variation, maximum(75%) in summer and minimum (35%) in autumn. Precipitation also shows a very similar variation pattern with cloud. The temperature and sea level pressure show a opposite seasonal change pattern, maximum(minimum in SLP) in summer and minimum(maximum in SLP) in winter, respectively. Relative humidiy(RH) is one of the variables mostly affected by urbanization or urban heat island. As a results, annual mean RH is decreased from 73% to 68% during last 30 years. When we take into account the favorable and unfavorable factors all together, summer and autumn are the worst and the best season for optical remote sensing in Korea.

1. Introduction

Atmospheric components including air molecules, clouds, water vapor and aerosols acts as a noise for the optical remote sensing of ground from space throuh a scattering and absorption. So, it is necessary to correct for the atmospheric effects in the quantative studies using a multi-temporal data, *such as change detection or retrieval of* physical parameters. There are many methods for the correction of atmsopheric effects from a simple bulk correction to a complicate radiative transfer model(e.g., Kaufuman and Sendra, 1988; Liu and Vermonte, 1998). Forsters(1984) developed a intermidiate methods using radiative transfer model and surface observation data for the correction of atmospheric effects. Cloud, aerosols and water vapor are one of the most effective atmospheric factors in the optical remote sensing.

The rapid growth of economy and urbanization of Korea impact not only on the air quality but also on the local climate. There are many studies about the recent degradation of air quality and climate change occurred in Korean peninsula, especially in the urban area(e.g., Ryoo et al., 1993; Oh and Yoon, 1996; Um et al., 1997). These studies are mainly focused on the temporal changes of the selected variables(e.g., temperature, relative humidity, visibility) by the urbanization.

The changes of air quality and local climate should be considered in the remote sensing of the land/ocean surface from space using optical sensor. In this study, we investigate the statistical characteristics of atmospheric conditions, such as cloud amount and visibility, over the Korean peninsula using surface observation data of Korea Meteorological Administration from 1971 to 2000.

2. Data

We used 30-year(1971-2000) surface observation data of KMA. We selected the variables which effect the scattering and absorption through a direct or indirect way. The analysis varaibles are sea level pressure, cloud amount, temperature, visibility, relative humidity, and precipitation. The sea level pressure and visibility can be used for the calculation of Rayleigh scattering by air molecules and Mie scattering by aerosols, respectively. The temporal frequency of observation is 1-hour(some variables are 3-hour). And we used the only 23 observation sites where observation history is longer than 30 years.

3. Results and Discussions

1) Results

o Visibility

Visibility is mainly controlled by scattering and absorption intensity of atmospheric aerosols and gases. Visibility can be used for the estimation of aerosol amounts since that is mostly effected by the scattering and absorption of aerosols. Fig. 1 shows a time series of visibility(15LST) averaged over Korean peninsula. Visibility is systematically reduced from about 28km to 18km during last 30 years. It means that atmospheric conditions for the optical remote sensing over Korean peninsula are growing worse and worse due to the degradation of air quality. And the visibility is worst in summer and best in autumn regardless of the year. However, recent visibility of large cities, such as Seoul and Pusan are farily consistent.

o Cloud and precipitation

Cloud is a critical obstacles for the optical remote sensing of Earth's surface from space. The quality of surface observed cloud amount can be controversial because the limitation of viewing area and subjectivity. Suh and Lee(1999) showed that the observed cloud amounts are systematically less about 1 - 2% than the cloud amounts retrieved from NOAA/AVHRR(Advanced

Very High Resolution Radiometer). So, we can use the surface data for the analysis of long term change of cloud amount. Fig. 2 shows a temporal profile of three 10-year averages of cloud amount for spatially averaged over Korean peninsula. The climate of Korean peninsula is characterized by strong seasonal changes of precipitation(cloud) and temperature associated with the seasonal marches of east Asian monsoon system. The 30-year average of cloud amount varies from about 38%(autumn) to 75%(summer). Cloud amount is clearly decreased in early-Feburary and and mid-March during the last 10 years(1991-2000). It is interesting to see the strong variation of precipitation in summer without corresponding changes of cloud amounts(Fig. 3). It indicates the change of precipitation pattern, such as precipitation intensity. The cloud amount shows a strong interannual variation and slightly decreasing trends.

o T, SLP and RH

The temperature over Korean peninsula shows a slight warming trends especially in winter and spring season as shown in many studies(e.g., Ryoo et al., 1993). The sea level pressure(SLP) also shows a strong seasonal changes with high in winter and low in summer. The seasonal change pattern of SLP is exactly opposite to that of temperature. Relative humidiy(RH) is one of the variables mostly affected by urbanization or urban heat island. Annual mean RH is greatly decreased from 73% to 68% during last 30 years(Fig. 4). It is caused by opposite change of temperature(warming) and water vapor amount(decrease of moisture source). The decrease of RH is most pronounced in spring season.

2) Discussions

The atmospheric conditions over Korean peninsula greatly changed during the lsat 30 years. The largest changes are occurred at the visibility in summer and relative humidity in spring over the urban area. The systematic decrease of visibility during 30 years indicates the atmospheric environments for the optical remote sensing from space are growing worse and worse although that is partly compensated by the decrease of RH. When we take into account the strong wavelength dependency of visible band in scattering, correction of atmospheric effects using a simple methods (e.g., Forster, 1984) should be performed especially in the analysis of multi-temporal or multi-band data over urban environments. When we take into account the favorable(e.g., decreasing of cloud amount) and unfavorable factors(e.g., decreasing of visibility) all together, summer and autumn are the worst and the best season for optical remote sensing in Korea.

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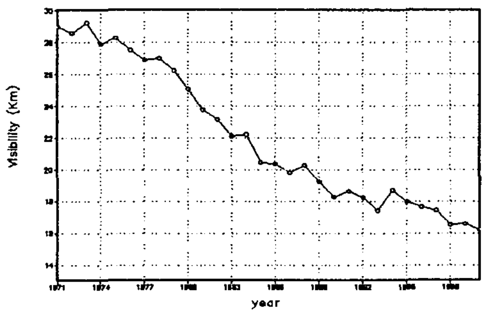

Fig. 1. Time series of visibility(km) spatially averaged over Korean peninsula.

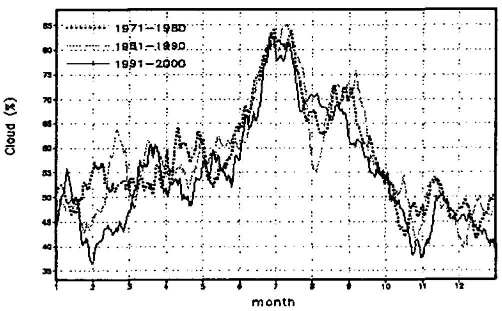

Fig. 2. Temporal profile of three selected 10-year mean cloud amount(%) over Korean peninsula.

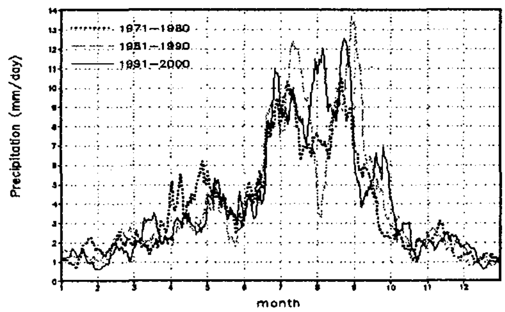

Fig. 3. Same as in Fig. 2 except for the precipitation(mm/day).

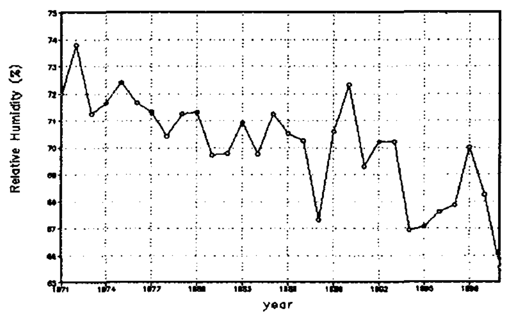

Fig. 4. Time series of relative humidity(%) spatially averaged over Korean peninsula.