

Long-range transport of particulate matter over Northeast Asia: an analysis using chemistry-transport modeling results and geostationary COMS/GOCI-retrieved products

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ABSTRACT

The aerosol optical depth (AOD), as a proxy to surface-level particulate matter (PM), combined chemistry-transport modeling (CTM) results with geostationary COMS/GOCI-retrieved outputs was used to quantitatively assess the long-range transport (LRT) characteristics of atmospheric PM over Northeast Asia. For a period of 1 April to 31 May, 2011, CMAQ modeling was conducted over Northeast Asia including Central East China (CEC), the Korean peninsula, and Japan. Hourly GOCI-retrieved AOD products were obtained during a daytime through an aerosol retrieval algorithm created by Yonsei university. The CMAQ-calculated AOD was then improved by integrating hourly GOCI-retrieved AOD via a data assimilation technique for the purpose of producing more accurate AOD products over Northeast Asia. From these results, the LRT events of AOD from China to the Korean peninsula were clearly shown. The average AOD increase by LRT events was found to be 0.41 above the background AOD value of 0.27 (approximately 150% of average AOD) at five AERONET sites.

INTRODUCTION

The long-range transport (LRT) events of particulate matter (PM) have been raised as issues among countries or continents. Many researches have been conducted to investigate the characteristics for the LRT of atmospheric pollutants, using mainly chemistry-transport modeling (CTM) outcomes with Low Earth Orbit (LEO) satellite sensor monitoring data. However, modeling studies have several uncertainties in emission fluxes of atmospheric pollutants and in the model itself. The LEO satellites also have a limitation in continuously monitoring aerosol optical properties, because they only pass over the region of interest once a day (or several days). In order to overcome the temporal limitation of the Low Earth Orbit (LEO) satellites and reduce the uncertainties related to model simulations, AOD data retrieved from Geostationary Ocean Color Imager (GOCI) on board Communication, Ocean, and Meteorological Satellite (COMS), a Korean geostationary satellite, were used with a data assimilation technique in this study.

METHODS

CMAQ modeling was carried out for a period of 1 April to 31 May, 2011, in order to assess the impacts of the LRT events on the PM concentrations. The GOCI-retrieved AOD products were obtained with Yonsei aerosol retrieval algorithm. For the

purpose of producing more accurate AOD products over Northeast Asia, the CMAQ-calculated AOD was then improved by integrating hourly GOCI-retrieved AOD via the data assimilation with optimal interpolation. AERONET AOD observed at five sites over the Korean peninsula and Japan was also applied to verify all AOD results above mentioned.

RESULTS

The assimilated AOD clearly showed the several LRT events of the small- and large-scale AOD plumes from Central East China (CEC) to the Korean peninsula (Fig. 1). Statistical analysis of the assimilated AOD for the LRT and non-LRT events at five AERONET sites was assessed. The average AOD increase by the LRT events was found to be 0.41 above the background AOD value of 0.27. It is further analysed that the effects for the LRT events of PM from CEC region to the three sub-regions of the Korean peninsula. The average AOD increases by LRT events from CEC region were found to be 108%, 118%, and 102% over northern Korea, central Korea, and southern Korea, respectively. The overall AOD increase in the Korean peninsula by the LRT events was shown as 111% comparing with non-LRT periods.

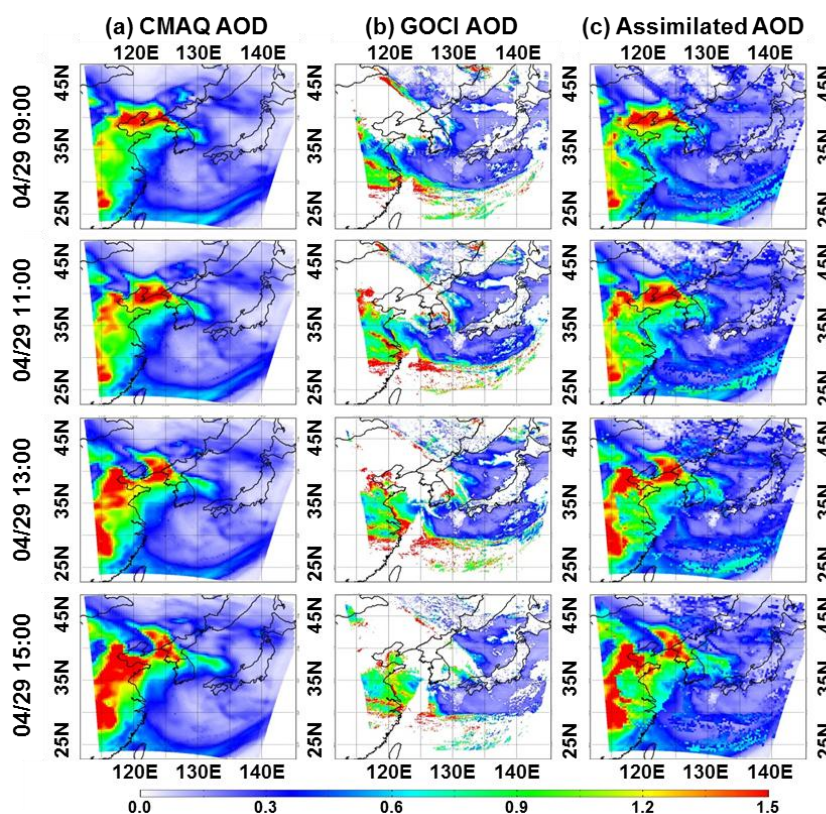


Fig. 1. Spatial and temporal distributions of (a) CMAQ-simulated AOD, (b) GOCI-retrieved AOD, and (c) assimilated AOD over Northeast Asia on 29 April, 2011.

CONCLUSIONS

The characteristics for the LRT events of PM from CEC to the Korean peninsula and Japan over Northeast Asia were investigated in this research. Hourly assimilated AOD results obviously indicated the LRT events of AOD plumes over Northeast Asia. Also, the average AOD increase by LRT events at five AERONET sites accounted for

approximately 150% of AOD during the non-LRT periods. Ultimately, it is expected that this study will also be useful for the applications of the data from the GOCI-2 and Geostationary Environmental Monitoring Spectrometer (GEMS) sensors, both of which will be launched in the year 2018 to monitor the air quality over the Asian regions including entire China, Korea, Japan, Southeast Asia, and parts of India and Central Asia.

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