Qualitative and quantitative evaluation of MODIS satellite sensor data for regional and urban scale air quality

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Abstract

Advances in satellite sensors have provided new datasets for monitoring air quality at urban and regional scales. Qualitative true color images and quantitative aerosol optical depth data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor on the Terra satellite were compared with ground-based particulate matter data from US Environmental Protection Agency (EPA) monitoring networks covering the period from 1 April to 30 September, 2002. Using both imagery and statistical analysis, satellite data enabled the determination of the regional sources of air pollution events, the general type of pollutant (smoke, haze, dust), the intensity of the events, and their motion. Very high and very low aerosol optical depths were found to be eliminated by the algorithm used to calculate the MODIS aerosol optical depth data. Correlations of MODIS aerosol optical depth with ground-based particulate matter were better in the eastern and Midwest portion of the United States (east of 100°W). Data were patchy and had poorer correlations in the western US, although the correlation was dependent on location. This variability is likely due to a combination of the differences between ground-based and column average datasets, regression artifacts, variability of terrain, and MODIS cloud mask and aerosol optical depth algorithms. Preliminary analysis of the algorithms indicated that aerosol optical depth measurements calculated from the sulfate-rich aerosol model may be more useful in predicting ground-based particulate matter levels, but further analysis would be required to verify the effect of the model on correlations. Overall, the use of satellite sensor data such as from MODIS has significant potential to enhance air quality monitoring over synoptic and regional scales.

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1. Introduction and background

Monitoring urban air quality with satellite sensors, both current and future, is an area for applied research with national policy and environmental health implications. In the last 5 years, the capabilities of National Aeronautics and Space Administration (NASA) earth observing satellites and the technological tools to share and use these images have advanced sufficiently to enable the use of satellite imagery in conjunction with ground-based data for air quality monitoring. Satellite data can add synoptic information, visualization, and validation to ground-based air quality data modeling. Satellite data are particularly suited for monitoring the transport of particulate matter since satellite sensors can measure changes in aerosol optical depth over large