

FORECASTING AIR QUALITY BY INTEGRATION OF SATELLITE DATA AND HYSPLIT TRAJECTORY MODEL

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Abstract:

Public awareness of local air quality is growing rapidly. Accurate air quality forecast is helpful for advance planning and decision making, which can offer significant societal and economic benefits. Air quality monitoring at urban and regional scales has traditionally been performed using a network of ground monitoring stations. As a complement to ground measurements for air quality monitoring, the satellite sensors can provide a broad view of urban haze and help determine when there is impact on urban air quality by local fires, dust storms, or transboundary transport of pollutants from more distant sources [1]-[4]. These sensors also can potentially be used to monitor air quality in rural or remote regions with no ground-based monitoring network. Satellite sensors provide comprehensive geospatial information on air quality with both qualitative imagery and quantitative data, such as aerosol optical depth (AOD), which has been described in many prior publications [5]-[7].

This paper describes a case study of satellite data integrated with hysplit forward-trajectory modeling to forecasting air quality in regional scale. During mid-October 2009, the eastern China experienced a significant haze event. Figure 1 (a) shows an image from the MODIS sensor (on the Terra satellite platform) from October 20th, 2009. Three regions with high AOD values in Hebei province (38.6°N, 115.5°E), Hubei province (31.1°N, 115.1°E) and Guangdong province (24.9°N, 115.7°E), where the haze occurred, can be seen clearly from Figure 1(a). With the help of HYSPLIT Trajectory Model (www.arl.noaa.gov/ready/hysplit4.html), a 24-hr, 48-hr and 72-hr forward

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trajectory from three regions mentioned above were created, starting at 0000 UTC on October 20th, 2009. To apply the integrate method, forward trajectories were mapped on geospatial MODIS Terra AOD data, as shown in Figure 1, Figure 2(a) and Figure 3(a). From Figure 1 to Figure 3, we can see that the spread direction described by trajectory lines matches the AOD maps quite well. Haze from Hebei province rapidly spread to Shangdong province, then spread to Bohai Bay. Haze from Hubei province rapidly spread to the Anhui province, then spread to Jiangsu province, and finally spread to Yellow Sea. Haze from Guangdong province spread to southwest just as the trajectory lines show.

This integrated satellite data with forward trajectory analysis is a promising technique for improving air quality forecasts. However, air quality of a city depends not only on long-range spread of pollution, but also on the local air pollution and atmospheric conditions. With the help of atmospheric chemical transport models, the long-range transport impacts on urban air quality could be assessed quantitatively. Moreover, the method described in this paper is only useful for the particulate matter forecasting. Further studies with other trace gases such as NO₂ and ozone forecasting could be performed along this way.

Key Words: Air quality; hysplit trajectory model; MODIS; Aerosol Optical Depth; Forecast

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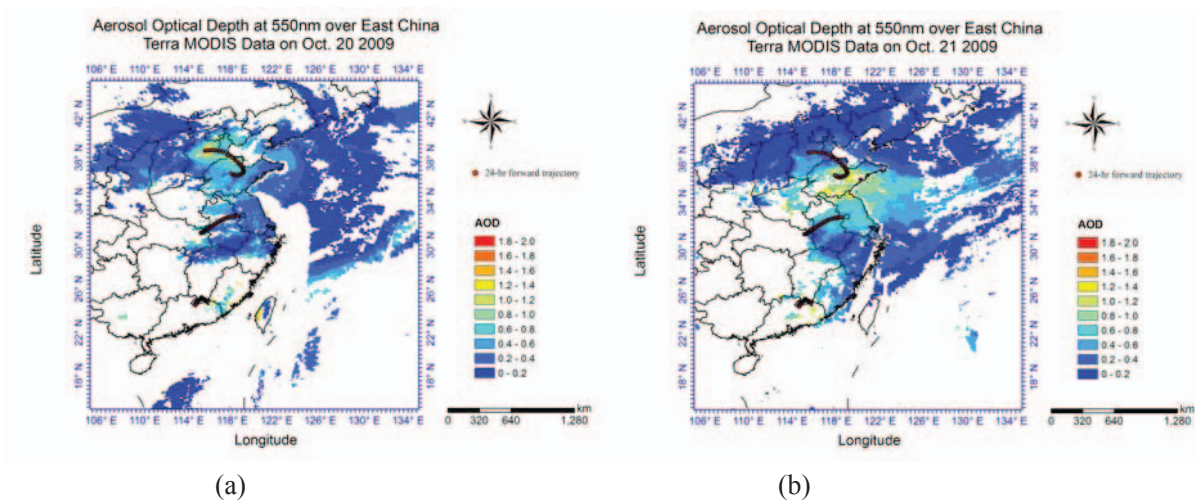


Figure 1. AOD maps derived from Terra MODIS data on (a) October 20th, 2009 and (b) 2009 October 21st, 2009 with 24-hr HYSPLIT-4 forward trajectory analysis results beginning from Hebei province (38.6°N, 115.5°E), Hubei province (31.1°N, 115.1°E) and Guangdong province (24.9°N, 115.7°E) at 0000 UTC on October 20th, 2009.

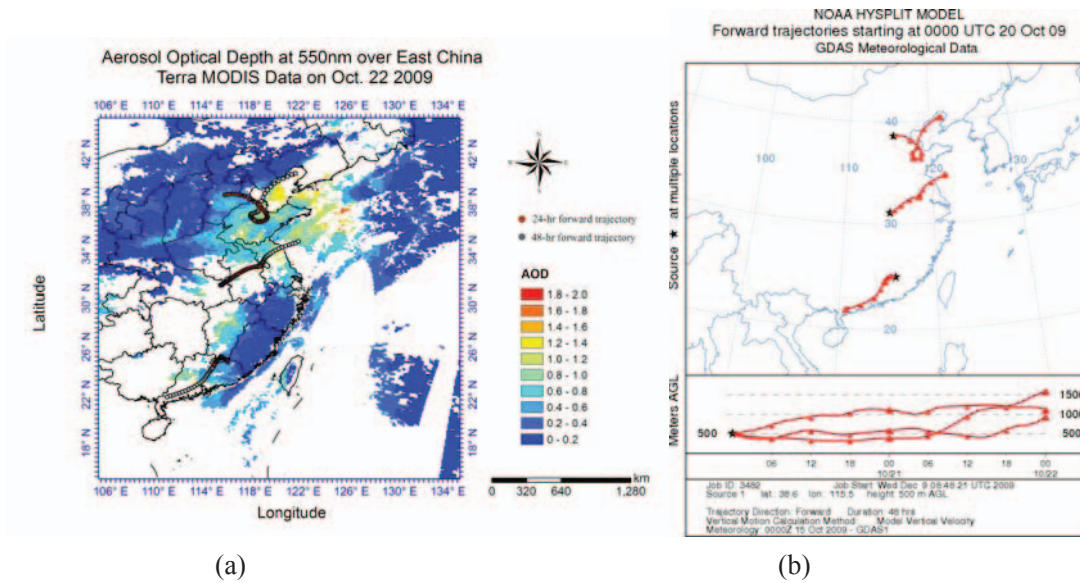


Figure 2. (a) AOD maps derived from Terra MODIS data on October 22nd, 2009 with 48-hr HYSPLIT-4 forward trajectory analysis results. (b) 48-hr HYSPLIT-4 forward trajectory analysis results beginning from Hebei province (38.6°N, 115.5°E), Hubei province (31.1°N, 115.1°E) and Guangdong province (24.9°N, 115.7°E) at 0000 UTC on October 20th, 2009. Pentacle denote the starting position of the trajectory lines and the interval is the location of the air mass every 6 h.

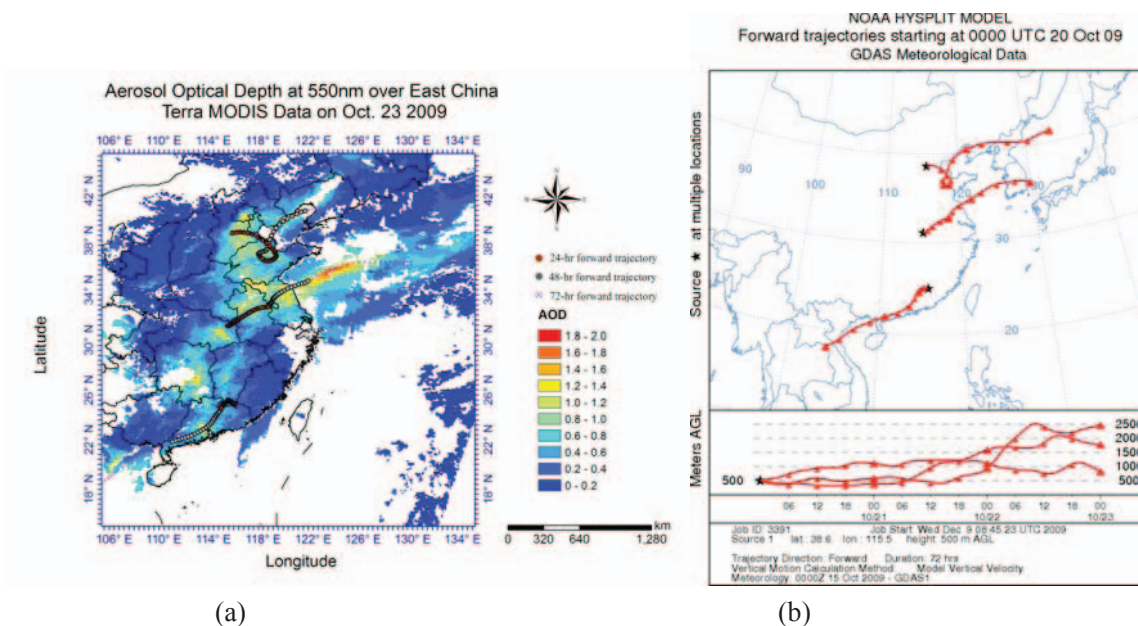


Figure 3. (a) AOD maps derived from Terra MODIS data on October 23nd, 2009 with 72-hr HYSPLIT-4 forward trajectory analysis results. (b) 72-hr HYSPLIT-4 forward trajectory analysis results beginning from Hebei province (38.6°N, 115.5°E), Hubei province (31.1°N, 115.1°E) and Guangdong province (24.9°N, 115.7°E) at 0000 UTC on October 20th, 2009. Pentacle denote the starting position of the trajectory lines and the interval is the location of the air mass every 6 h.