

Press Releases



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JAMSTEC

Satellite-based Observations May Be Underestimating Tropospheric NO₂ Vertical Column Density (TropoNO₂VCD) ~ Light Scattering Effects of Co-existing PM_{2.5} Aerosols ~

1. Overview

International Research Team led by Dr. Yugo Kanaya, Deputy Director, Department of Environmental Geochemical Cycle Research, Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) found that satellite observation data of Nitrogen Dioxide (NO₂), which is one of air pollutants, had low biases up to 30%~50%. Based on the examination of satellite data using ground-based MAX-DOAS^{*1} network observations in Japan, China, Korea, and Russia, it is possibly related to the shielding effect caused by co-existing aerosols such as PM_{2.5}^{*2}, which obscure detection of NO₂ near the earth's surface by scattering sunlight serving as probe light for satellite observation.

This result means that it is necessary to revise upwards the emission rates of nitrogen oxides that have been estimated based on satellite data and also environmental impacts of human activity can be even greater than expected. In addition, the observational results suggest for the first time that it is necessary to consider the light-scattering effect caused by aerosol particles such as PM_{2.5} in accurately retrieving the amount of NO₂ from satellite observation.

We will continue NO₂ observations with the ground-based network and also extend the scope of analysis including other molecules, seeking similar impacts of aerosols.

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These research results have been published in an Interactive Open Access Journal of the European Geosciences Union, Atmospheric Chemistry and Physics on August 11.

Title: Long-term MAX-DOAS network observations of NO₂ in Russia and Asia (MADRAS) during 2007-2012: instrumentation, elucidation of climatology, and comparisons with OMI satellite observations and global model simulations

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*1 MAX-DOAS (Multi-Axis Differential Optical Absorption Spectroscopy) is a remote sensing measurement of atmospheric gases and aerosols in the air. It is based on a technique measuring UV/Visible hyperspectra of scattered sunlight at several low elevation angles.

*2 An aerosol is a colloidal system of solid or liquid particles suspended in the atmosphere. PM_{2.5} particles are the fine fraction of those particles, with diameters of 2.5 micrometers or smaller. They significantly interact with the ultraviolet and visible solar radiation.

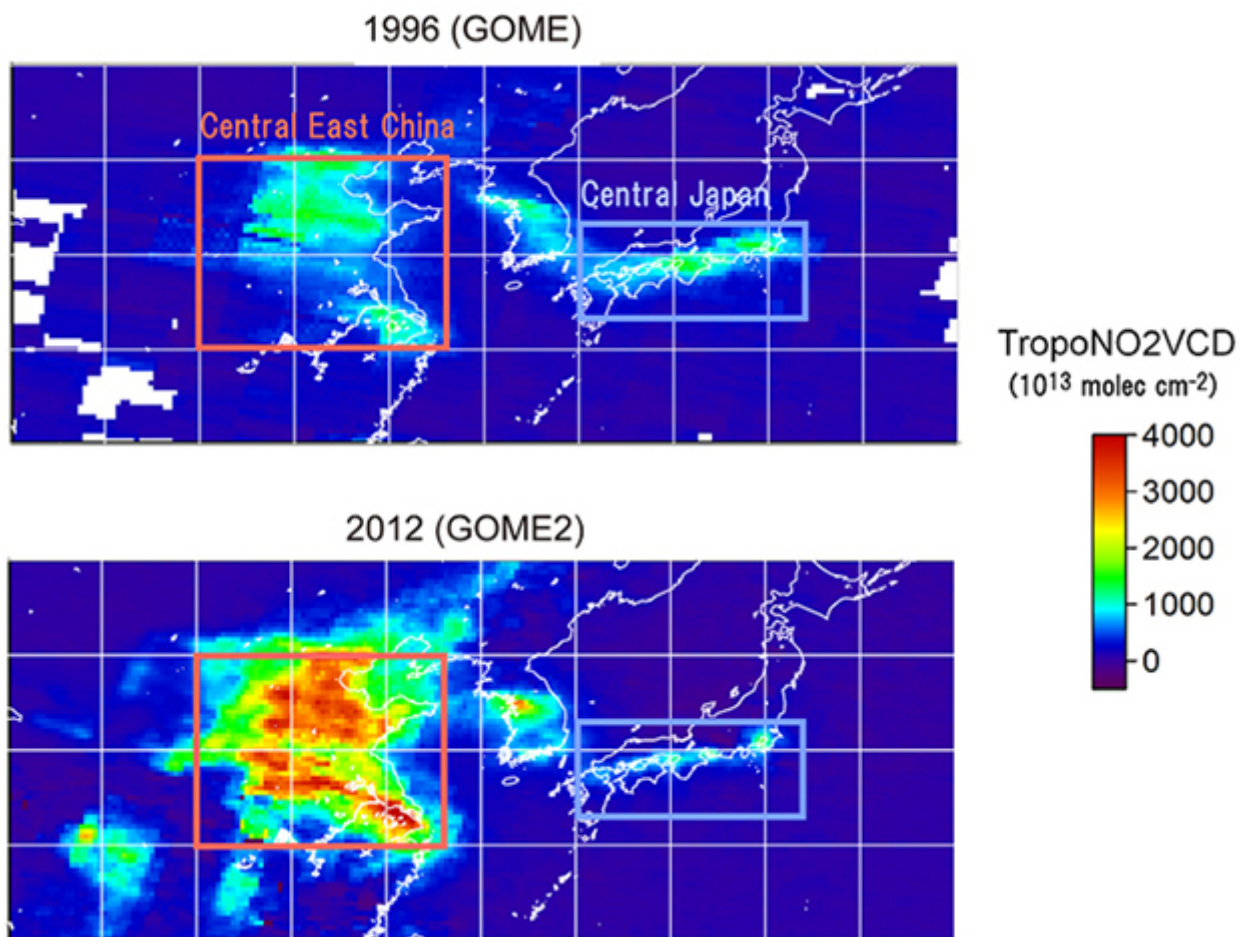


Figure 1: Change in tropospheric NO₂ vertical column density (TropoNO₂VCD) in Eastern Asia based on satellite observation. It has tripled over China in the last 15 years. However, the absolute value has remained highly uncertain.

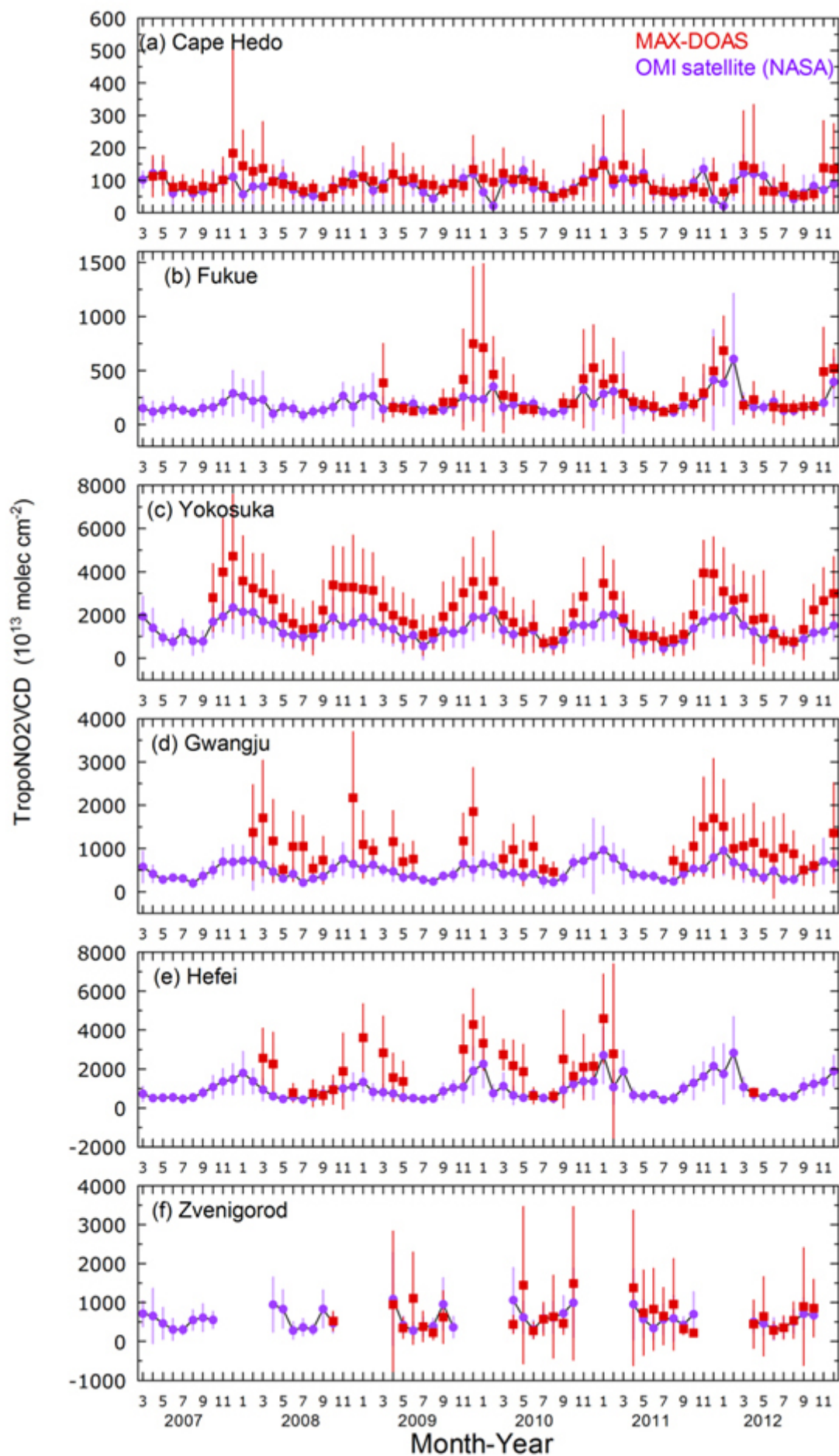


Figure 2: Time series of monthly averages of MAX-DOAS (shown in red) and satellite observations of TropoNO₂VCD (shown in purple) at six locations. The satellite observations tend to show lower values.

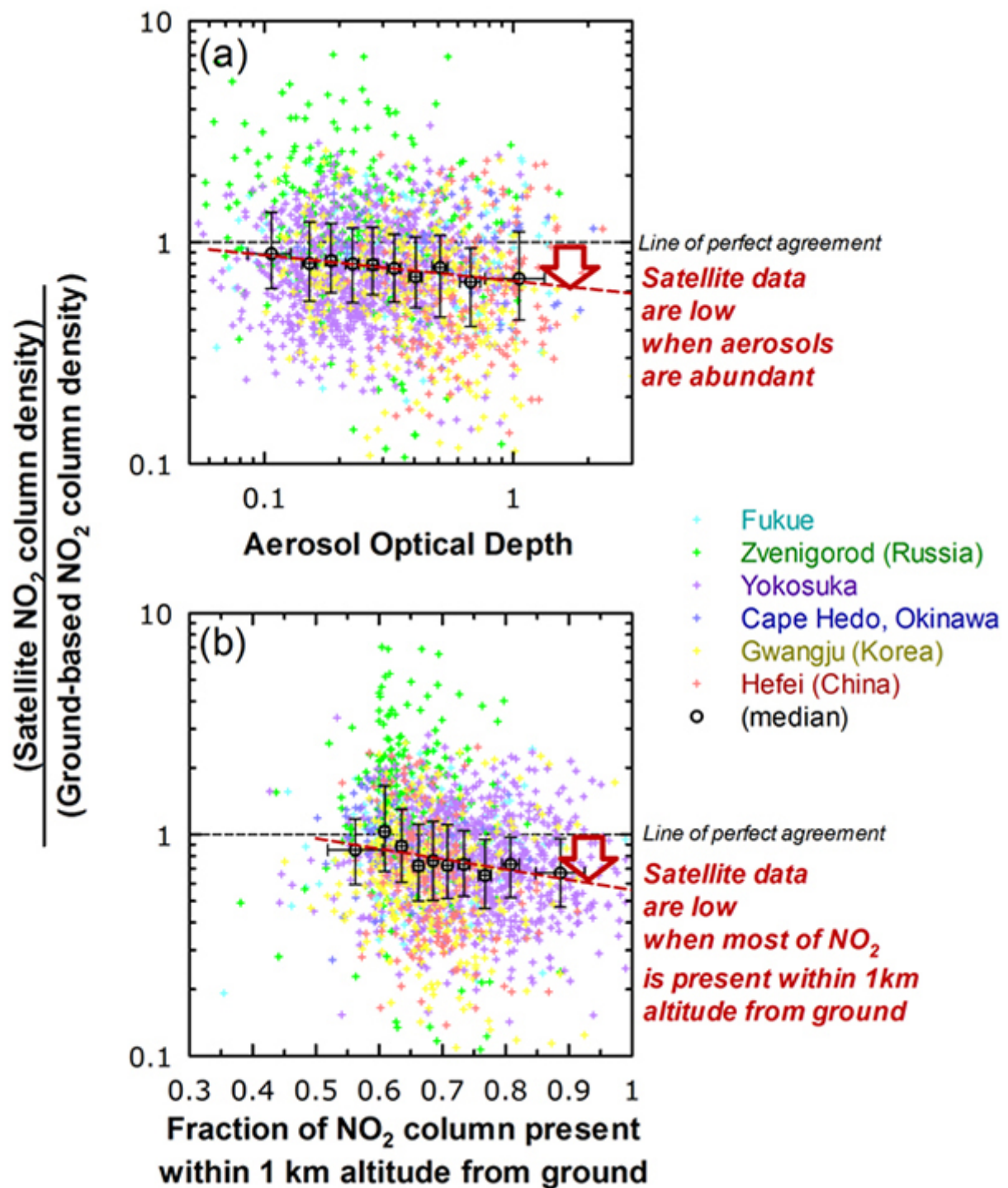


Figure 3: It was found that OMI satellite data have low biases compared to those from ground observations (shown with red allow) when aerosol optical depth is larger (the figure a) and when NO₂ is abundantly present near the Earth's surface (the figure b).

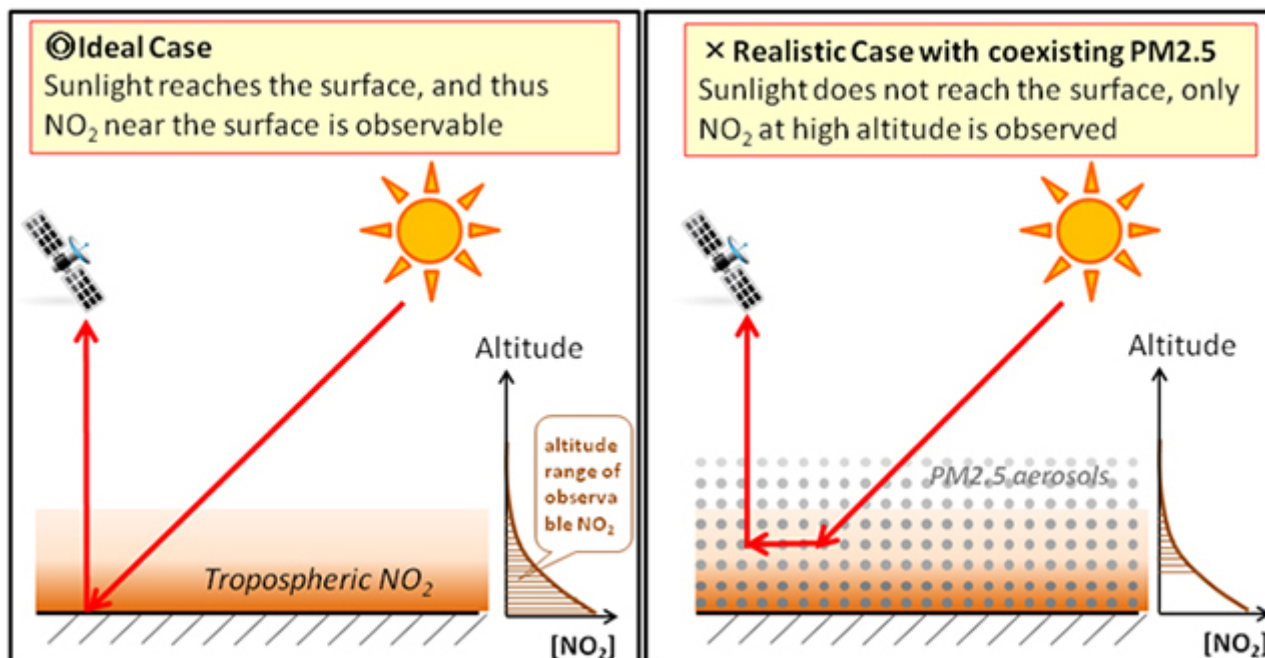
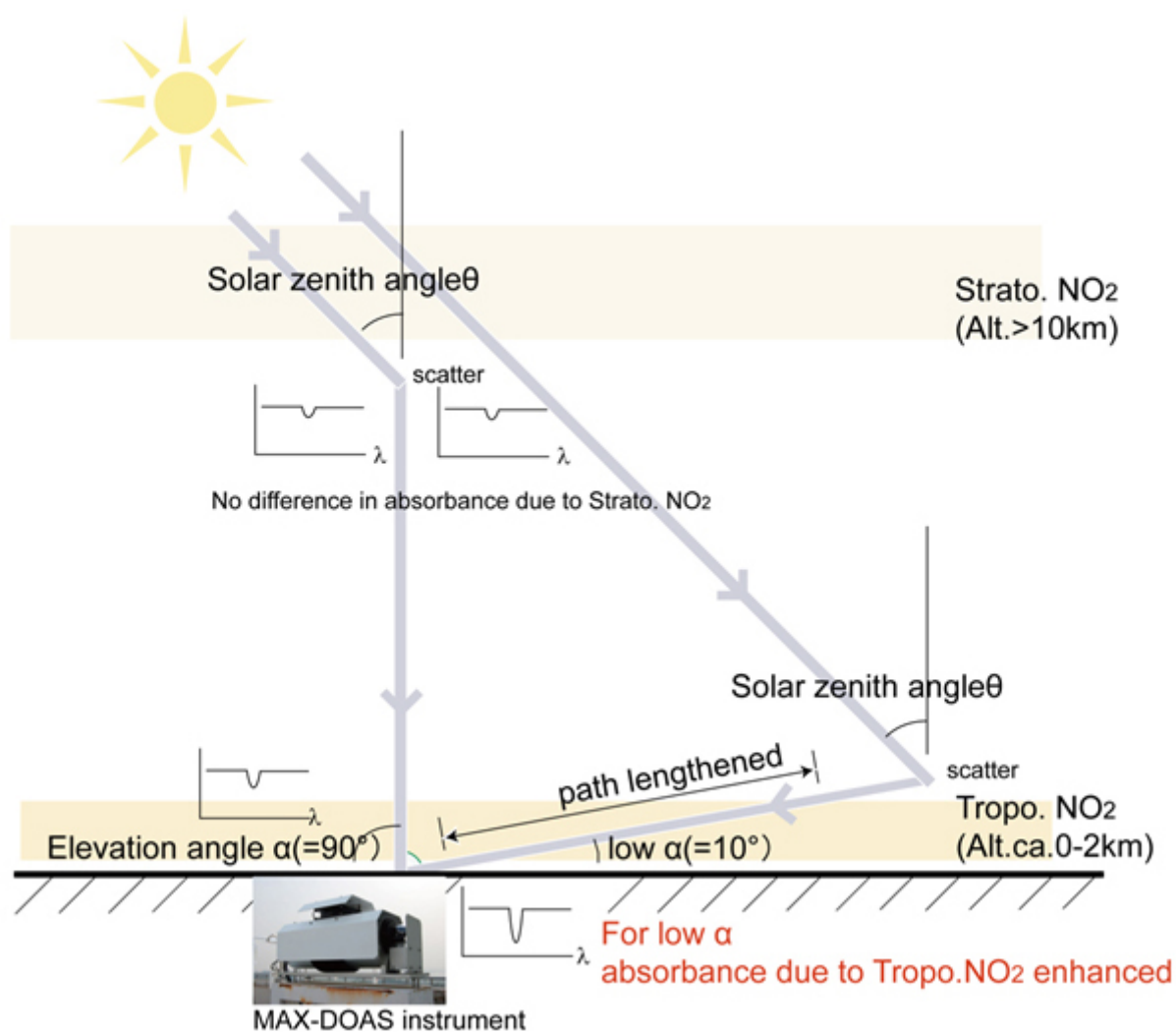
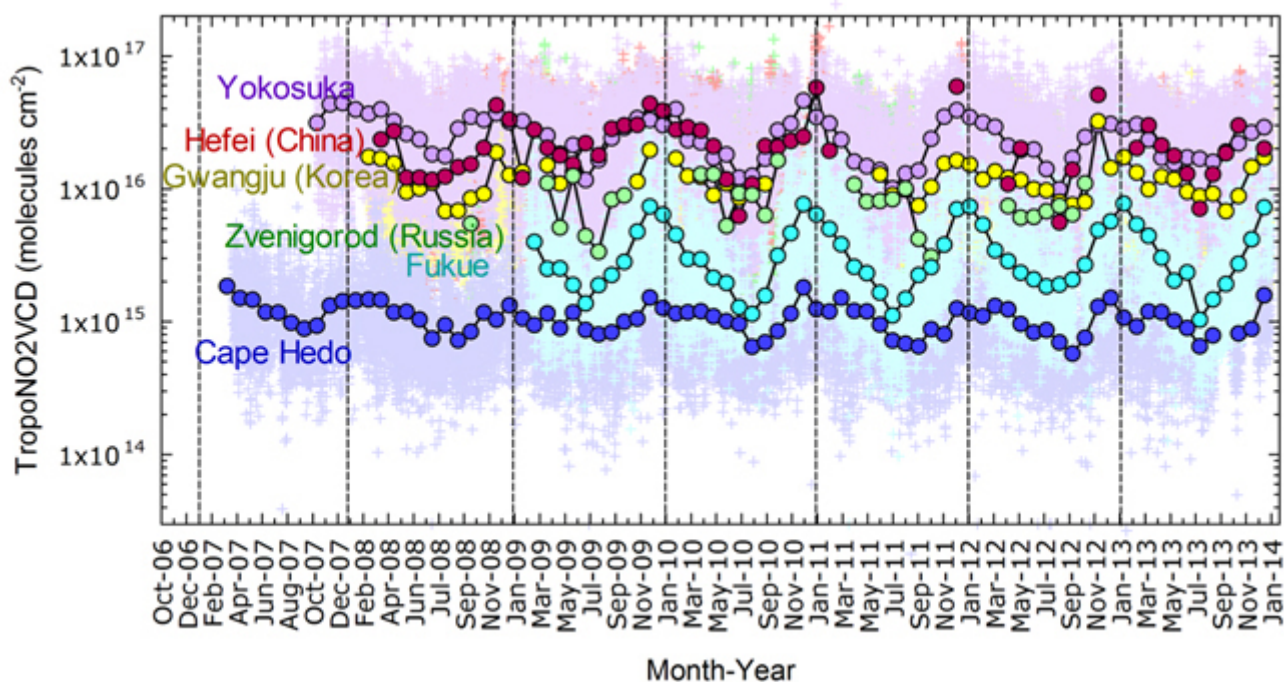
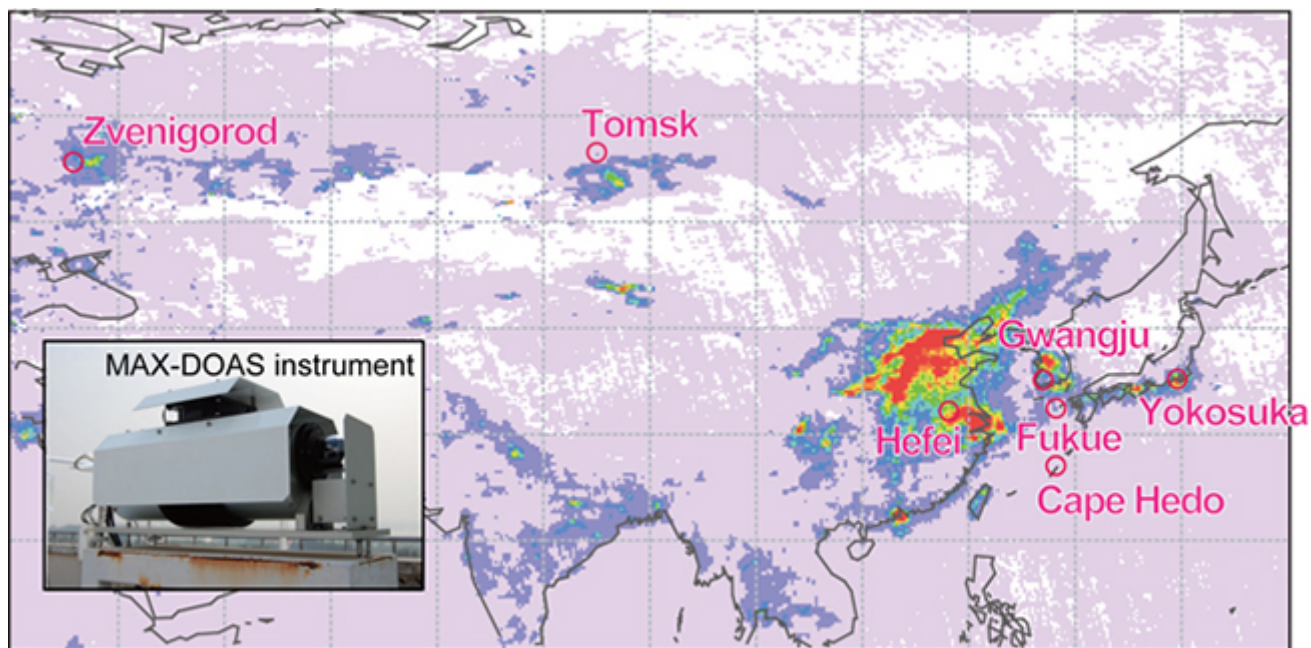


Figure 4: Conceptual diagram of shielding effect caused by co-existing PM2.5 aerosols. Co-existing PM2.5 aerosols prevent sunlight from reaching the earth's surface. As a result, satellite observation fails to detect NO_2 near the Earth's surface.



Reference 1: Principle of ground-based remote sensing based on the MAX-DOAS technique.



Reference 2:

(The diagram above) Locations of MAX-DOAS network observations

(The diagram below) Time series of all individual observations of TropoNO₂VCD

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