5.10 Tropospheric aerosol and gas observations by MAX-DOAS and auxiliary techniques

(1) Personnel

Hisahiro TAKASHIMA	(PI, JAMSTEC/RIGC, not on board)
Fumikazu TAKETANI	(JAMSTEC/RIGC, not on board)
Hitoshi IRIE	(JAMSTEC/RIGC, not on board)
Yugo KANAYA	(JAMSTEC/RIGC, not on board)

(2) Objectives

- To quantify typical background values of atmospheric aerosol and gas over the ocean
- To clarify transport processes from source over Asia to the ocean (and also clarify the gas emission from the ocean (including organic gas))
- To validate satellite measurements as well as chemical transport model
- To clarify aerosol/gas variation associated with equatorial waves/ISO/MJO.

(3) Methods

(3-1) MAX-DOAS

Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) is a passive remote sensing technique designed for atmospheric aerosol and gas profile measurements using scattered visible and ultraviolet (UV) solar radiation at several elevation angles. Our MAX-DOAS instrument for R/V *Mirai* consists of two main parts: an outdoor telescope unit and an indoor spectrometer (Acton SP-2358 with Princeton Instruments PIXIS-400B). These two parts are connected by a 14-m bundle cable that consists of 12 cores with 100-mm radii. On the roof top of the anti-rolling system of R/V *Mirai*, the telescope unit was installed on a gimbal mount, which compensates for the pitch and roll of the ship. A sensor measuring pitch and roll of the telescope unit (10Hz) is used together to measure an offset of elevation angle due to incomplete compensation by the active-type gimbal. The line of sight was in directions of the starboard and portside of the vessel.

The MAX-DOAS system records spectra of scattered solar radiation every 0.2-0.4 second. Measurements were made at several elevation angles of 0, 1.5, 3, 5, 10, 20, 30, 70, 110, 150, 160, 170, 175, 177 and 178.5 degrees using a movable mirror, which repeated the same sequence of elevation angles every 30-min. The UV/visible spectra range was changed every minute (284-423 nm and 391-528 nm).

For the spectral analysis, spectra data were selected with a criterion for the elevation angle to be within ±0.2° of the target. For those spectra, DOAS spectral fitting was performed to quantify the slant column density (SCD), defined as the concentration integrated along the light path, for each elevation angle. In this analysis, SCDs of NO_2 (and other gases) and O_4 (O_2-O_2, collision complex of oxygen) were obtained together. Next, O_4 SCDs were converted to the aerosol optical depth (AOD) and the vertical profile of aerosol extinction coefficient (AEC) at a wavelength of 476 nm using an optimal estimation inversion method with a radiative transfer model. Using derived aerosol information, another inversion is performed to retrieve the tropospheric vertical column/profile of NO_2 and other gases.

(3-2) CO, O_3, and aerosol size distribution

Carbon monoxide (CO) and ozone (O_3) measurements were also continually conducted during the cruise. For CO and O_3 measurements, ambient air was continually sampled on the compass deck and drawn through ~20-m-long Teflon tubes connected to gas filter correlation CO analyzer (Model 48C, Thermo Fisher Scientific) and UV photometric based ozone analyzer (Model 49C, Thermo Fisher

Scientific) in the *Research Information Center*. Aerosol size distribution measurements by optical particle counter (KR-12A, Rion) were not conducted due to instrument problems during the cruise.

(4) Preliminary results

These data for the whole cruise period will be analyzed.

(5) Data archives

The data will be submitted to the Marine-Earth Data and Information Department (MEDID) of JAMSTEC after the full analysis of the raw spectrum data is completed, which will be <2 years after the end of the cruise.