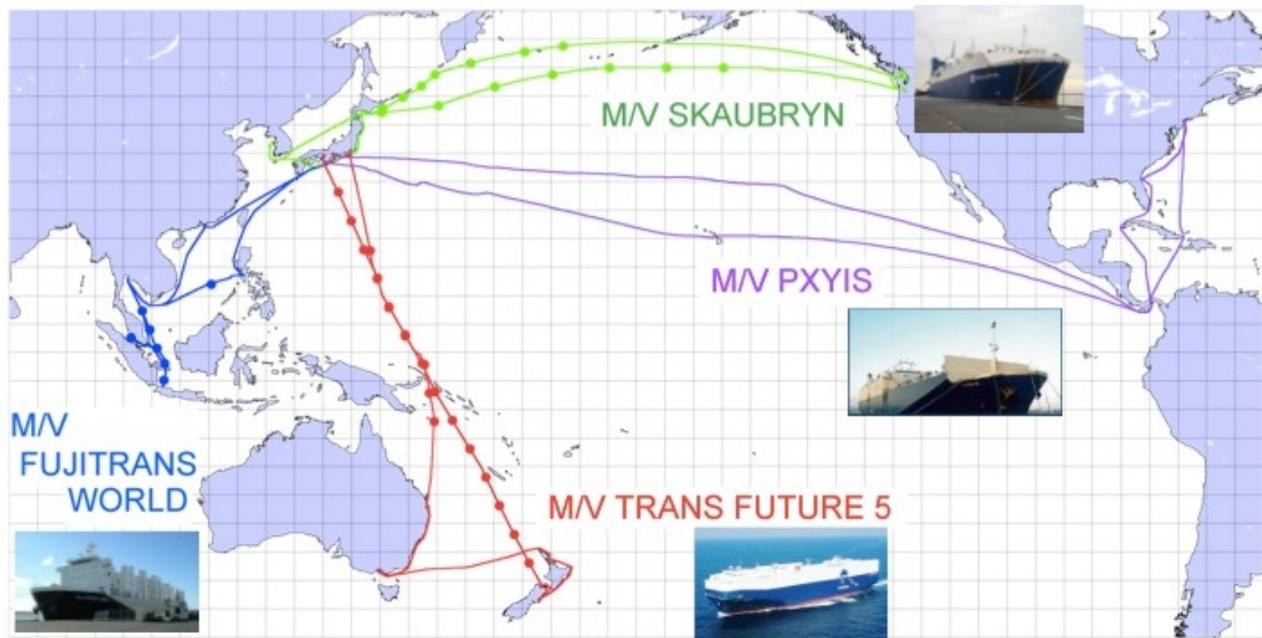


## Long-term Monitoring of Long-lived Greenhouse Gases (GHGs) and Short-lived Climate Pollutants in Asia and Oceania Using Voluntary Observing Ships

H. Tanimoto, H. Nara, F. Kondo, H. Mukai, Y. Nojiri, Y. Tohjima, T. Machida and S. Hashimoto

National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba-City, Ibaraki, Japan; +81 (29) 850-2930, E-mail: [tanimoto@nies.go.jp](mailto:tanimoto@nies.go.jp)

The National Institute for Environmental Studies (NIES) has been operating a long-term program for monitoring trace gases of atmospheric importance over the Pacific Ocean since 1995. The NIES Voluntary Observing Ships (VOS) program currently makes use of four commercial cargo vessels that are in regular operation in constant routes for long periods and sail over a wide area between various ports (e.g., between Japan and the United States, between Japan and Australia/New Zealand, and between Japan and southeast Asia). These routine platforms offer the advantage of systematic measurements of trace gases and aerosols, providing long-term datasets for pristine background air over the Pacific Ocean and regionally polluted air around east Asia. Ambient measurements are made by a combination of continuous instruments onboard ships and flask sampling apparatus followed by laboratory analysis. We observe both long-lived GHGs (e.g., carbon dioxide, methane, nitrous oxide, etc.) and short-lived climate pollutants (e.g., tropospheric ozone, black carbon, halocarbons) on a continuous basis. Flask samples are analyzed for carbon dioxide, methane, nitrous oxide, halocarbons, and carbon monoxide by using gas chromatographic techniques. In addition, cavity ringdown spectrometers were installed for high-resolution measurement of methane and carbon dioxide to capture their highly variable features in regionally polluted air around southeast Asia, which is now thought to be a large source due to expanding socioeconomic activities as well as biomass burnings. Comparison between *in situ* measurements and flask analyses enabled us to check data quality and thus improve accuracy and precision of overall measurements. Contrasting the Japan-Australia/New Zealand and Japan-southeast Asia cruises revealed remarkable characteristics of spatial and temporal variations that reflect regional characteristics of emissions, suggesting additional sources for methane, nitrous oxides, and carbon monoxide in this tropical Asian region. We will overview long-term trends and interannual variations of multiple species at different latitudinal bands and different geographic regions.



**Figure 1.** Typical routes of the NIES - VOS Program in the Pacific.