SO305-Organic halogen cycling

The biogeochemical cycling of halogenated methanes in and over the Bay of Bengal

Participation in a research cruise with RV SONNE SO305: Colombo-Singapore: 10 April -22 May 2024: Analysis of water and air on board with GC/MS and interpretation of data

Halogenated very short-lived substances (VSLS, with lifetimes of less than 6 months) from the ocean, such as bromoform ($CHBr_3$), the largest organic bromine source for the atmosphere, dibromomethane (CH_2Br_2) and methyl iodide (CH_3I), contribute to atmospheric halogens and ozone depletion in the troposphere and stratosphere (Fig 1). Despite their short lifetimes, VSLS can be rapidly lifted to the stratosphere by tropical deep convection. Shipboard observations have shown that emissions are often higher near the coast and in upwelling areas than in the open ocean, due to natural sources as phytoplankton and macroalgae. Meanwhile coastal anthropogenic sources must also be taken into account (Mehlmann et al., 2020), as e.g. $CHBr_3$ is produced in large quantities during the disinfection of seawater and transported to the upper troposphere (Jia et al., 2023). Chlorinated very short-lived substances are identified as present major ozone-depleting VSLS due to increasing anthropogenic emissions (Villamayor et al., 2023). Dichloromethane (CH_2Cl_2) is the most abundant, with the fastest increasing emissions at present, especially from Asia, although emissions of chloroform ($CHCl_3$) have also grown rapidly. Measurements of VSLS in and above the world's oceans are sparse and data show great variability. Little is known about the emission strengths or the uptake into the seawater and biogeochemical cycling of VSLS from the Indian Ocean. A single measurement campaign in the Bay of Bengal suggests that the Bay of Bengal may be a significant source of bromine and iodine to the atmosphere, as concentrations of the compounds were generally higher than data reported for the open ocean at mid- and high-latitudes (Ziska et al., 2013).

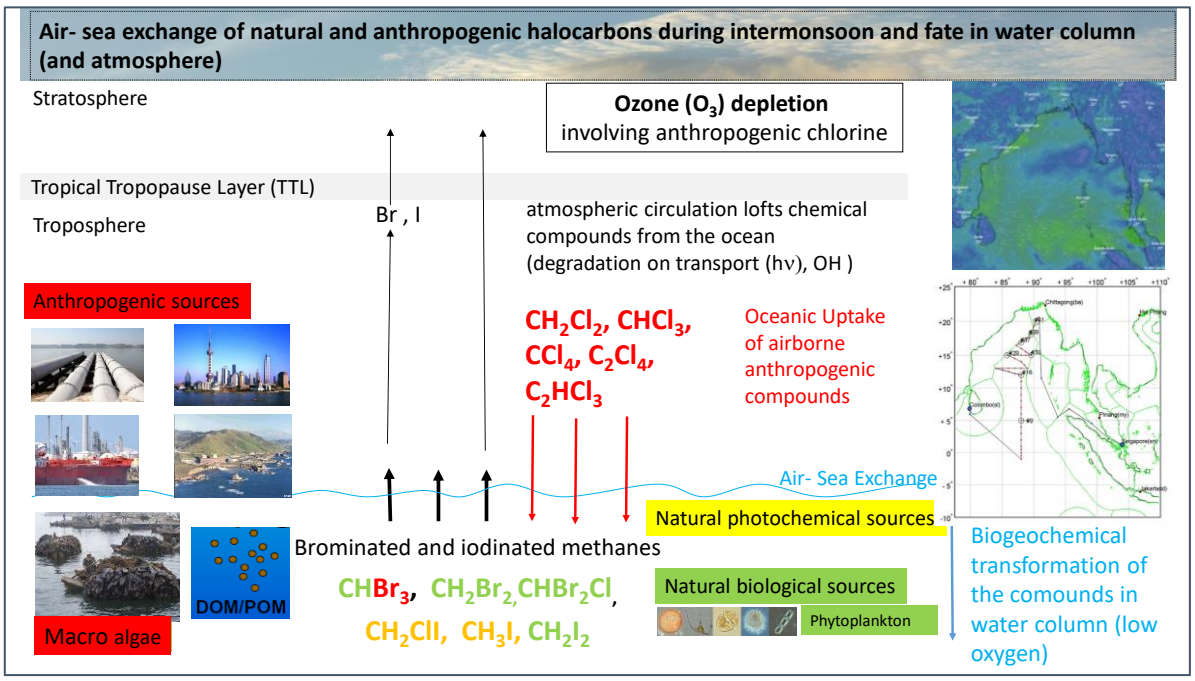

Fig 1: Halogenated very short-lived substances (VSLS, with a lifetime of less than 6 months) from the ocean, such as bromoform ($CHBr_3$) and methyl iodide (CH_3I), as well as anthropogenic e.g. chlorinated short-lived trace gases contribute to atmospheric halogens and ozone depletion.

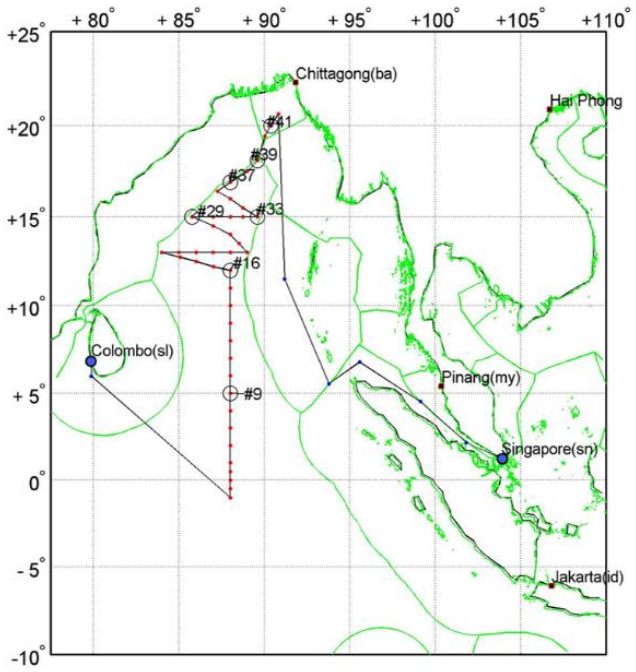

Fig 2: Planned route of RV Sonne during SO305 (Colombo -Singapore: 10 April-22 May 2024).

The research cruise SO305 (Fig 2) offers great opportunities to understand how biological production and chemical degradation, photochemistry and transport determine the compounds in ocean and atmosphere of the understudied region. We expect anthropogenic pollutants in the northern Bay of Bengal and lower atmospheric mixing ratios and oceanic concentrations in its central and southern part, influenced by the open ocean environment. Different sources, the exchange between air and sea and the reactivity of the compounds will lead to interesting distributions and gradients and help interpreting water and air masses and their fate.

Water and air samples will be taken on board and analysed with gas chromatography and mass spectrometry (GC/MS) for several halogenated methanes. A student helper, a master student and me will take part in the cruise, perform on board analyses and interpretation of the data. We will learn a lot about many different components of the Earth System. Chemical and physical oceanographers support the interpretation and the analyses of the chemical signals.

If you are interested, please contact Birgit Quack, GEOMAR: bquack@geomar.de

References

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