

Halocarbons in Southeast Asia

Regional ocean and atmosphere modelling of anthropogenic halocarbons

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In Short

- Oceanic Very Short-Lived Halocarbons (VSLH) are expected to increase due to anthropogenic activities
- Regional ocean and atmosphere modelling (CROCO and FLEXPART) of the Southeast Asia and China region
- Quantifying the impact of VSLH from various natural and anthropogenic sources on the ozone layer

The stratospheric ozone layer protects the Earth from most of the sun's harmful ultraviolet (UV) radiation. The depletion of stratospheric ozone in response to anthropogenic emissions of long-lived chlorofluorocarbons (CFCs), used as refrigerants or aerosol spray propellants, has been one of the major environmental issues of the last decades. Emissions of CFCs have been strongly reduced following the Montreal Protocol of 1987. As a consequence, their atmospheric abundance will decline during the 21st century and a gradual recovery of the ozone layer over the next decades is expected [1].

Emissions of Very Short-Lived Halocarbons (VSLH), which also have the potential to destroy ozone, are, on the other hand, expected to increase due to new technologies. In particular, increasing aquaculture in form of macroalgae farming [2] is suspected to drastically enhance the production of VSLH. The potential of large-scale macroalgae farms to artificially enhance the blue carbon sequestration processes or to reduce methane emissions from cattle is currently analysed. Such farms would release large amounts of VSLH that have a damaging effect on the stratospheric ozone layer. In addition, they will impact the radiative forcing and the oxidizing capacity of the atmosphere, i.e. the capacity of the atmosphere to ultimately remove many species emitted from natural and anthropogenic sources.

While anthropogenic activities such as large-scale macroalgae farming threaten to multiply the current natural oceanic production, it is currently unclear how far the man-made VSLH will be distributed into the open ocean and how they will change natural VSLH distribution and emissions. Southeast Asia and the coastline of China already show a particularly high density of widespread macroalgae farms

and will be a centre of anthropogenic VSLH production. Existing VSLH emission estimates for this region are highly uncertain and do not take anthropogenic sources into account [4]. High-resolution modelling of the transport and degradation of anthropogenic VSLH in sea water is necessary to capture the locally confined processes and to derive realistic estimates of the release of anthropogenic VSLH into the atmosphere.

The present work aims at quantifying the current and future impact of anthropogenic forcing on the oceanic VSLH budget. Based on prescribed sources of anthropogenic VSLH from seaweed farming activities, VSLH transport and degradation in coastal and marine water will be investigated with the Coastal and Regional Ocean COmmunity model (CROCO) [5] Macroalgae biomass and related bromoform production rates are prescribed based on a coastal classification scheme as well as biomass estimates and VSLH production rates from field campaigns and incubation studies.

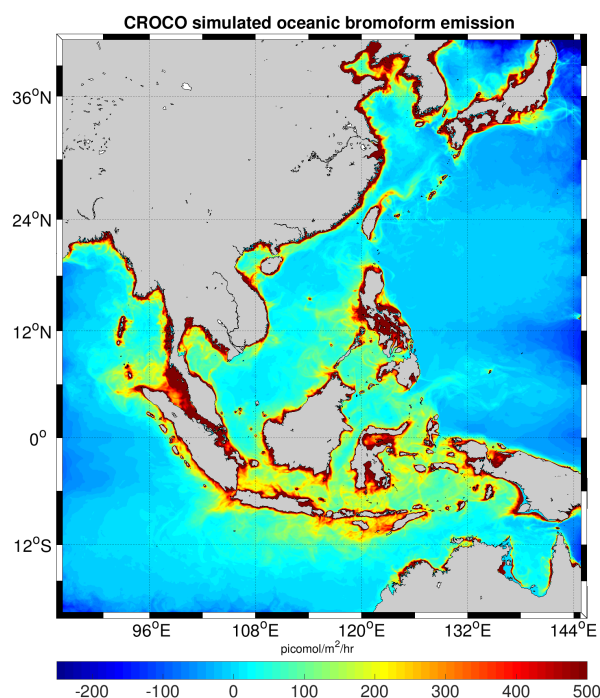


Figure 1: Example of oceanic bromoform emission simulated by CROCO model for Southeast Asia.

A high resolution CROCO configuration of Southeast Asia, the Philippine Sea, East China Sea, Yellow Sea and parts of the Indian Ocean and North-west Pacific Ocean has been implemented (see Figure 1 for exact model domain). First estimates of

oceanic VSLH distributions and their emissions into the atmosphere show high coastal values (Figure 1). This approach allows us to quantify the full VSLH emissions into the atmosphere, but to also separate coastal from open ocean as well as anthropogenic from natural sources. Potential scenarios of future large-scale farms of the macroalgae *Asparagopsis taxiformis* in South-East Asia, currently discussed as a measure of reducing methane emissions from cattle, will be investigated. Results from this study will feed into the research conducted within the DFG Emmy Noether group AVeSH, which combines oceanic and atmospheric modelling in order to quantify the impact of anthropogenic VSLH on the stratospheric ozone.

More Information

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- [4] Hossaini, R., et al.: Evaluating global emission inventories of biogenic bromocarbons, *Atmos. Chem. Phys.*, **13**, 11819-11838, 2013. doi: 10.5194/acp-13-11819-2013
- [5] Francis Auclair, Rachid Benshila, Laurent Debreu, Nicolas Ducouso, Franck Dumas, et al.. Some Recent Developments around the CROCO Initiative for Complex Regional to Coastal Modeling., *COMOD 2018 - Workshop on Coastal Ocean Modelling*, Feb 2018, Hamburg, Germany. pp.1-47. hal-01947670

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