Transport of bromoform from the Indian Ocean to the stratosphere during Asian summer monsoon

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Why is the Asian monsoon important?

Bromoform and other halogenated very short-lived substances (VSLS, atmospheric lifetime less than half a year) are naturally produced in the ocean and emitted to the atmosphere. If transported to the stratosphere, they take part in ozone depletion. The Asian summer monsoon transport of bromoform from the Indian Ocean to the stratosphere may provide an efficient pathway for compounds from the Indian Ocean. How much is transported? How fast is it transported? Where is it transported to? How much is emitted? Conclusions

The tropical tropopause layer (TTL) reaches the stratosphere above 17 km from OASIS-SONNE. Generally, high stratospheric bromine mixing ratios above the Asian monsoon anticyclone result from high bromoform emissions from the Bay of Bengal, Arabian Sea and tropical Indian Ocean.

Trajectory calculations with FLEXPART and ERA-Interim fields

Bromoform emissions on the OASIS-SONNE cruise in July and August 2014

Three transport regimes are discerned:
- Subtropical westerlies, the summer monsoon circulation toward India and Bay of Bengal, and tropical convection.

Monsoonal anticyclone source regions from trajectories released at 17 km (backward)

48% of boundary layer air masses originate from the ocean, 52% from land. Entrainment from Bay of Bengal and tropical West Pacific is even larger than from West Indian Ocean.

Conclusions

The tropical Indian Ocean is a strong source region for bromoform and other VSLS. Bromoform emissions were measured south of Madagascar and between 5°S and 15°S. Air masses from the Central East Indian Ocean surface are mainly entrained in the eastern flank of the Asian monsoon anticyclone.