Dimethylsulphide (DMS) emissions from the West Pacific Ocean: a potential marine source for stratospheric sulphur?

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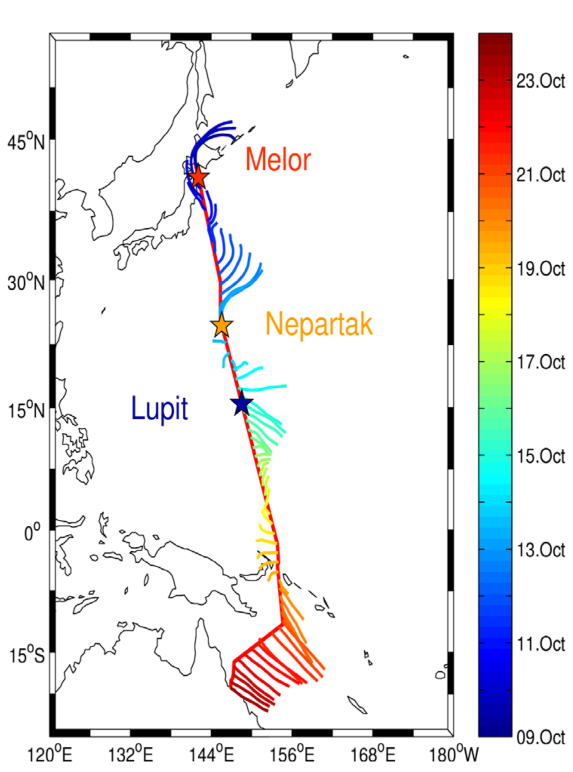
Introduction

- Underestimation of the radiative effect of the persistent stratospheric layer can lead to an overestimation of global warming and since 2000 there has been an increase in the aerosol backscatter above the tropopause.
- The importance of naturally occurring sulphur containing trace gases as a source to the stratosphere is currently debated and should be investigated.
- Dimethylsulphide (DMS) is rapidly oxidised when emitted from the ocean to the atmosphere and oxidation products thought to be transported above the TTL – DMS itself never investigated.
- It is still difficult to parameterise surface ocean DMS concentrations and there is a considerable lack of high spatial and temporal resolution data for oceanic DMS. The influence of DMS hotspots and high wind speed events, such as typhoons and tropical storms, on the DMS flux is hard to determine.

Conclusions

- Air-sea DMS fluxes, between 0 and 30 µmol m^{-2} d^{-1}, peaked during tropical storm systems and atmospheric variability was related to atmospheric transport processes.
- Good agreement between DMS profiles computed using the Langrangian dispersion model FLEXPART and those from aircraft data from the HIPPO2 campaign over the tropical West Pacific ocean.
- The model projected that up to 30 g S per month in the form of DMS can be transported above 17 km in this region, which is surprisingly large and disproportionate to the regional extent of the cruise track, mainly due to high convective activity in this region.
- The tropical West Pacific Ocean can be an important source of sulphur as DMS to the stratospheric persistent sulphur layer, which has not been considered as yet.

Observations

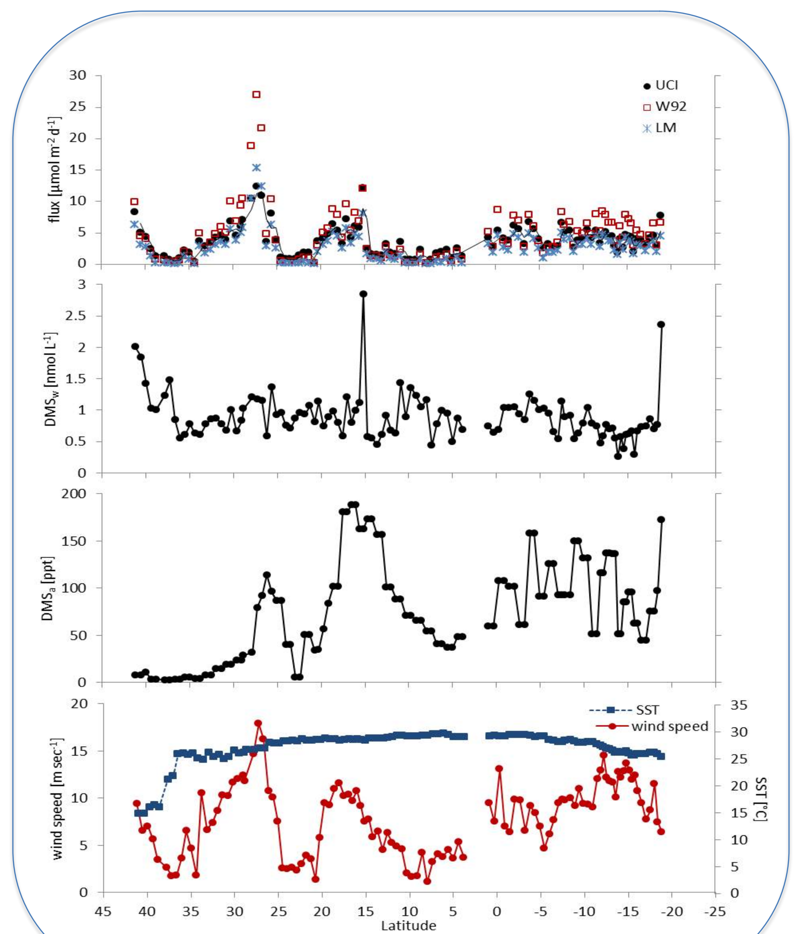


TransBrom cruise track from Japan to Australia in Oct 2009 (Krüger and Quack, 2013 *ACP special issue*). Colored lines indicate one day back trajectories for each day shown in the colorbar. Dots on the cruise track indicate the three tropical storm events that occurred during the cruise.

Days shown in blue – air masses influenced by Asian continent

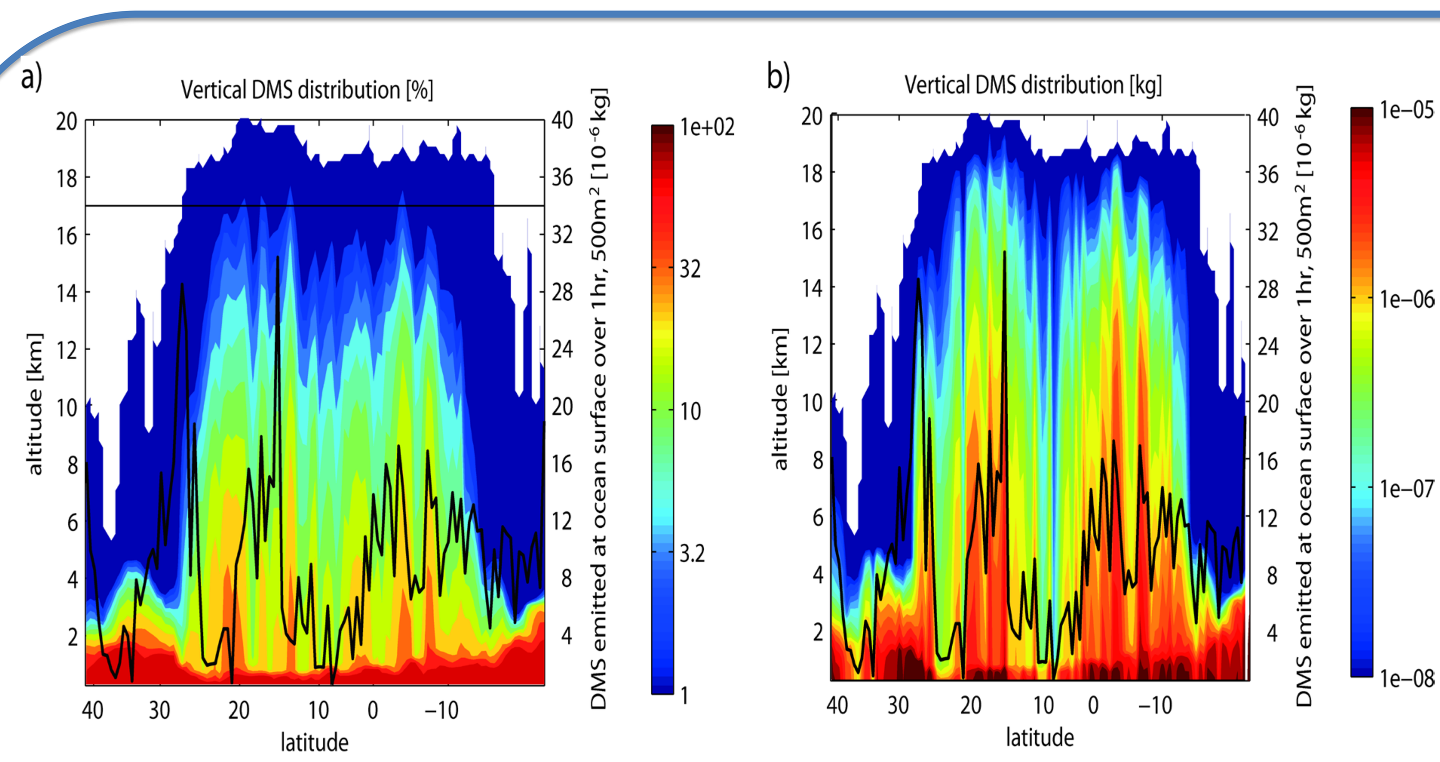
Days shown in green and yellow – air masses influenced by open ocean

Days shown in orange and red – air masses influenced by Tasmin sea and islands



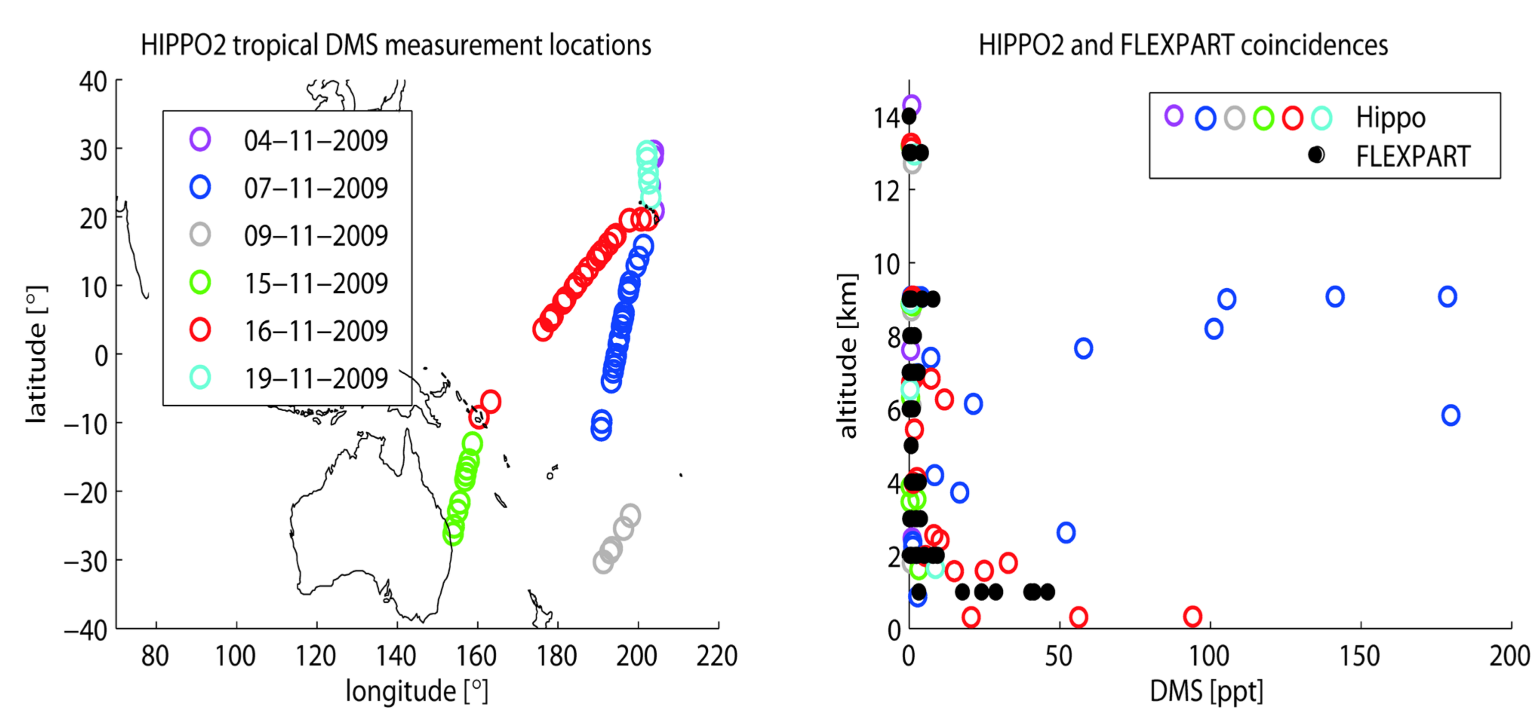
Shipboard measurements and subsequent flux calculations over the TransBrom cruise track (by latitude), from top: panel 1) computed DMS fluxes using the UCI k, the Wanninkhof (1992), and the Liss and Merlivat (1986) parameterisations; panel 2) measured seawater DMS concentrations from Zindler et al. (2013 *BG*); panel 3) measured atmospheric DMS mixing ratios; panel 4) measured horizontal wind speed and sea surface temperature.

Model simulations

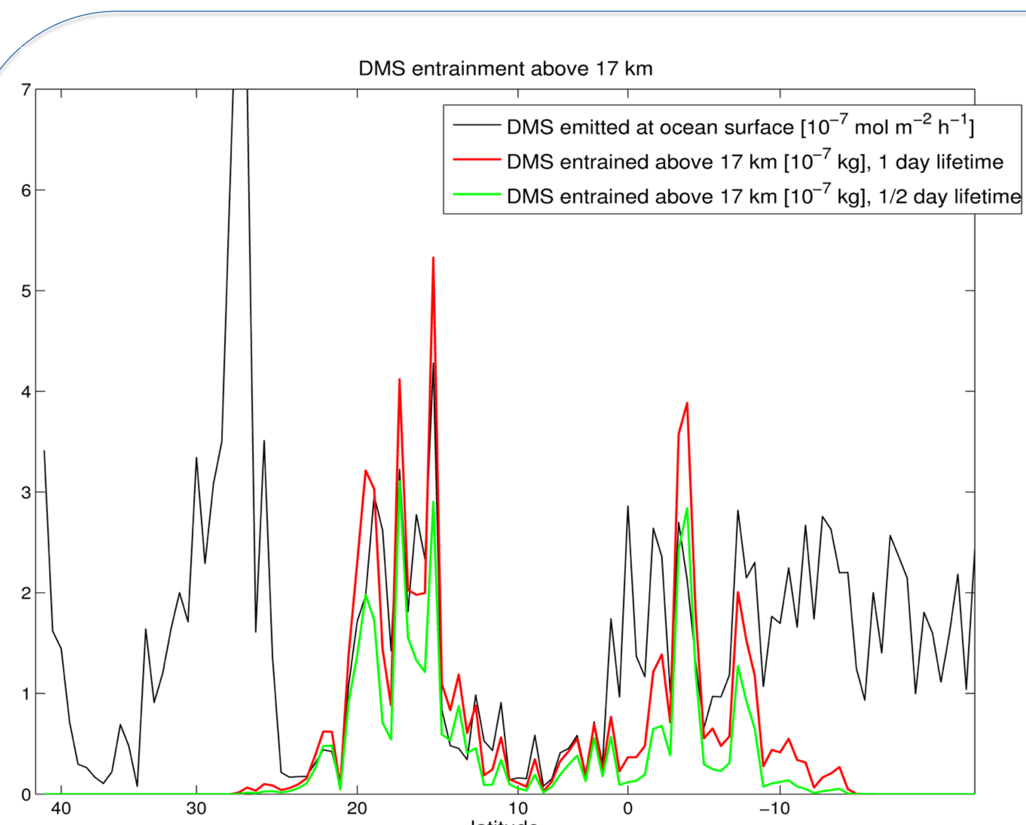


Atmospheric vertical DMS distribution computed along the TransBrom cruise track given as a) amount relative to DMS emission from the sea surface [%] and b) total amount [kg]. Atmospheric DMS distribution is based on FLEXPART simulations with a 1/2 day atmospheric lifetime. DMS emission at the ocean surface over 500 m^2 and one hour is given as the black line corresponding to the right y-axis

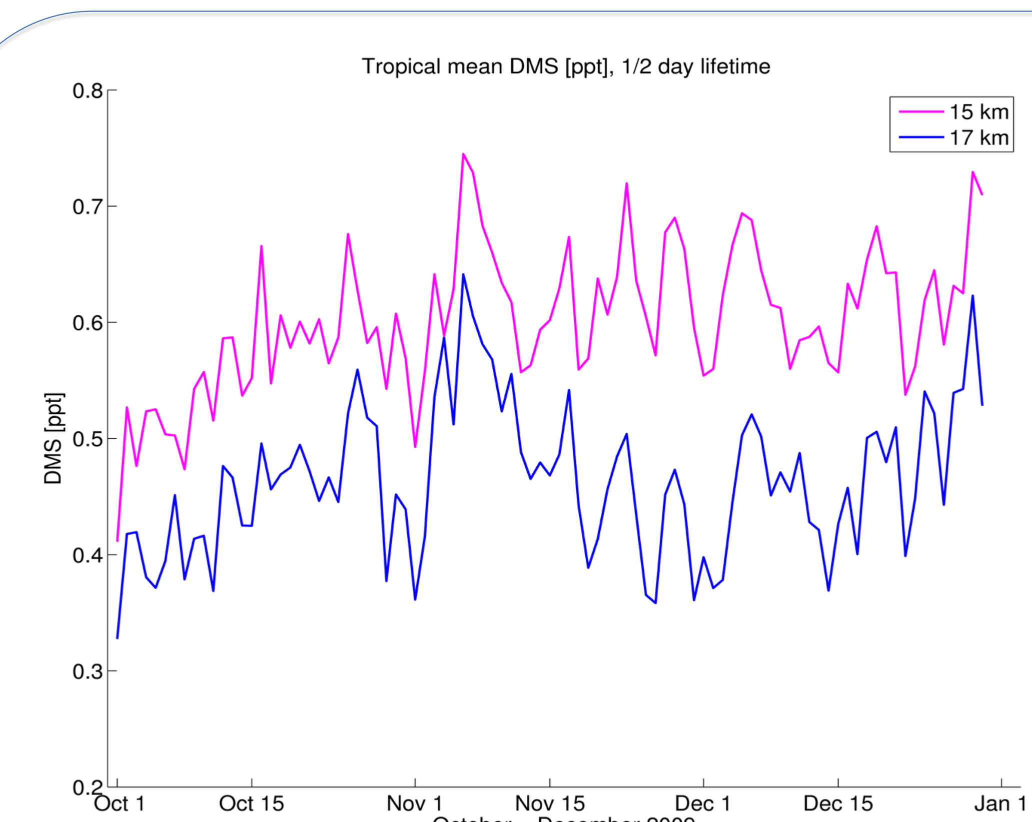
Comparison between HIPPO2 atmospheric DMS observations and FLEXPART DMS simulations (1/2 day atmospheric lifetime for DMS), using average TransBrom emissions (figure to the left) for the tropical oceans. Measurement locations for HIPPO2 (left panel) and comparison between HIPPO2 and FLEXPART coincidences (right panel) are shown.



Strat. contribution ?



Observed emissions of DMS at the ocean surface (black line), and total amount of DMS entrained above 17 km based on FLEXPART model simulations with 1 day (red line) and ½ day (green line) atmospheric lifetimes are shown.



Time series of tropical mean DMS volume mixing ratio at 17 km and 15 km for October to December 2009. The time series is based on FLEXPART model simulations using TransBrom average emissions for the tropical oceans and ½ day atmospheric lifetime for DMS.

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