ROMIC THREAT project

Dimethylsulphide (DMS): A potential marine source for stratospheric sulphur?

S. Tegtmeier[1]

K. Krüger[2], C. A. Marandino[1], P. Patra[3], E. L. Atlas[4], C. Schlundt[1]

[1)] GEOMAR, Kiel, Germany

[2)] University of Oslo, Norway

[3)]Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan

[4)]Rosenstiel School of Marine and Atmospheric Science, University of Miami, USA

Motivation and Outline

What is the DMS flux into stratosphere?

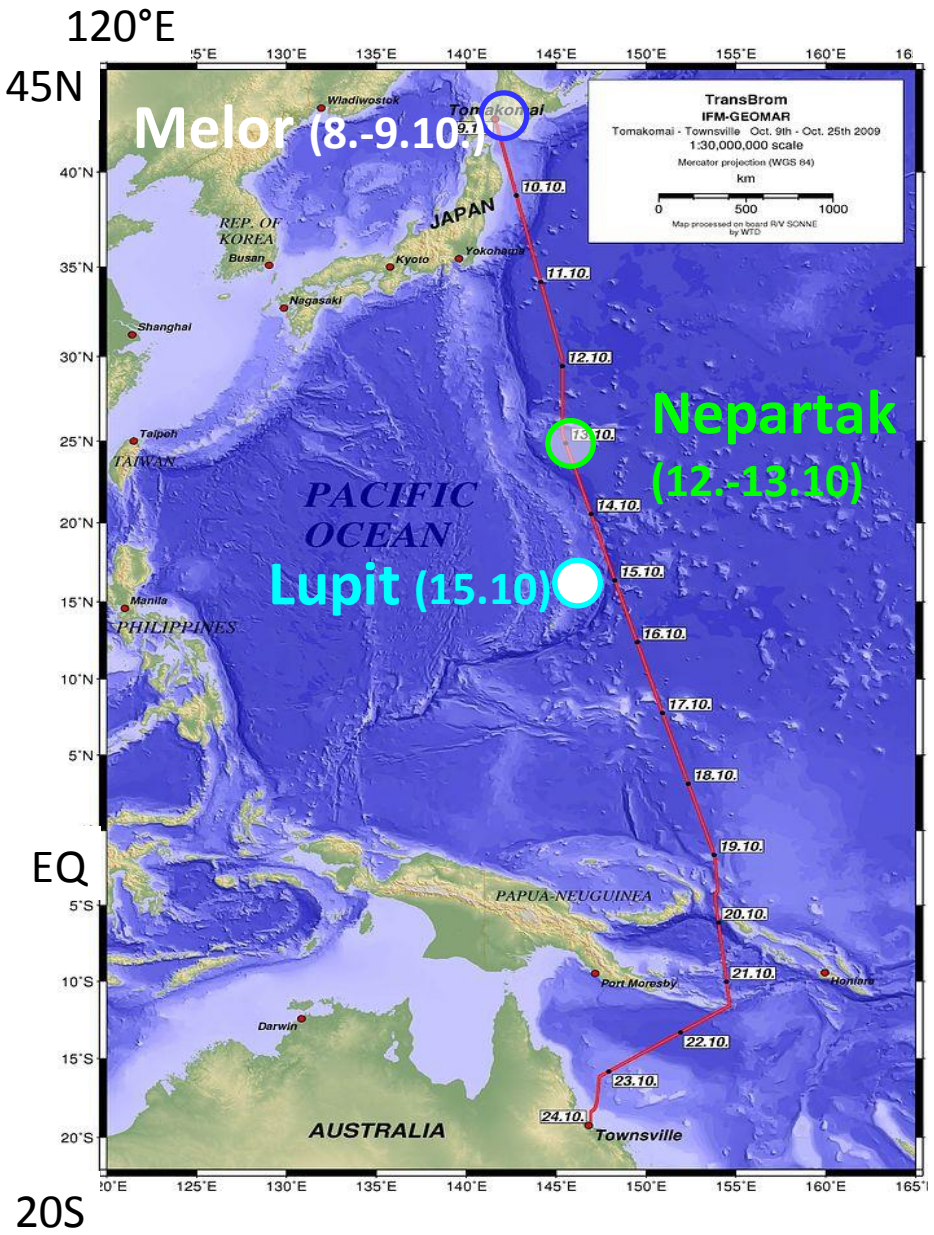
1. **Oceanic DMS emissions from ship campaign**
   → Lagrangian transport simulations
2. **DMS measurements in TTL from aircraft**

} ***Regional information in upper TTL***

3. **Global DMS simulations**
   CTM and Lagrangian transport simulations
   Sensitivity studies → uncertainties

} ***Total flux into stratosphere***

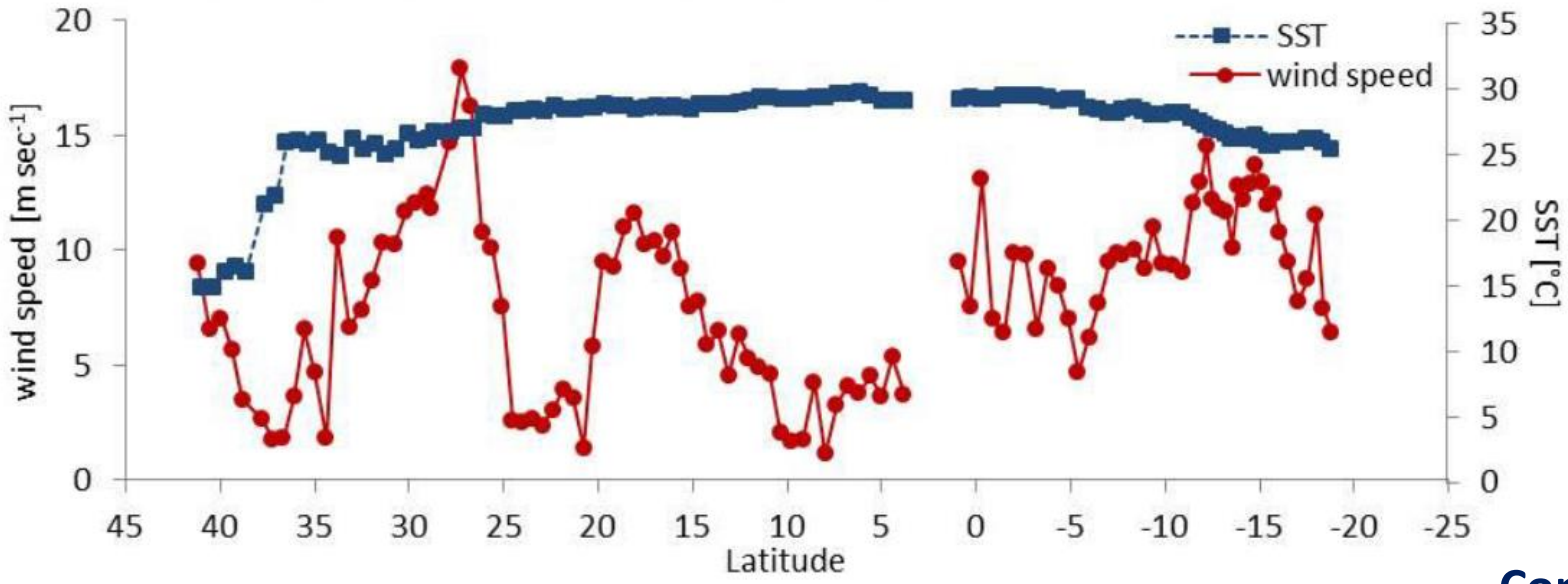
TransBrom SONNE cruise



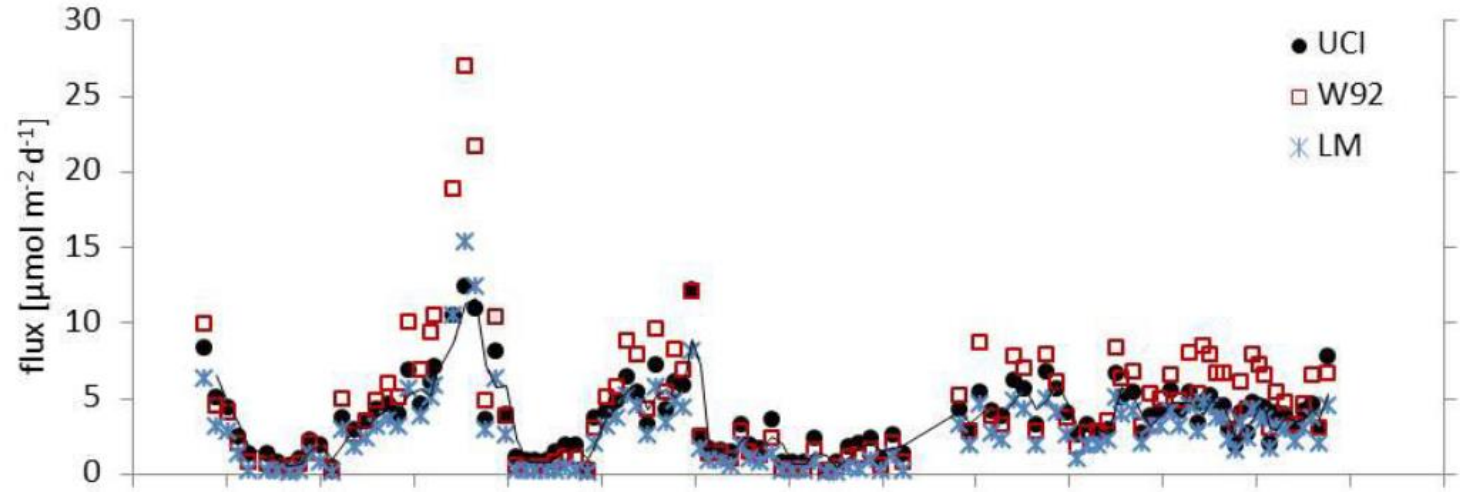
- October 2009
- West Pacific
- Three typhoons/tropical depressions

RV Sonne Townsville harbor Oct 2009

DMS fluxes during TransBrom SONNE



SST
Wind speed



Computed DMS fluxes using the

- UCI *k*
- Wanninkhof, 1992 (W92)
- Liss and Merlivat, 1986 (LM)

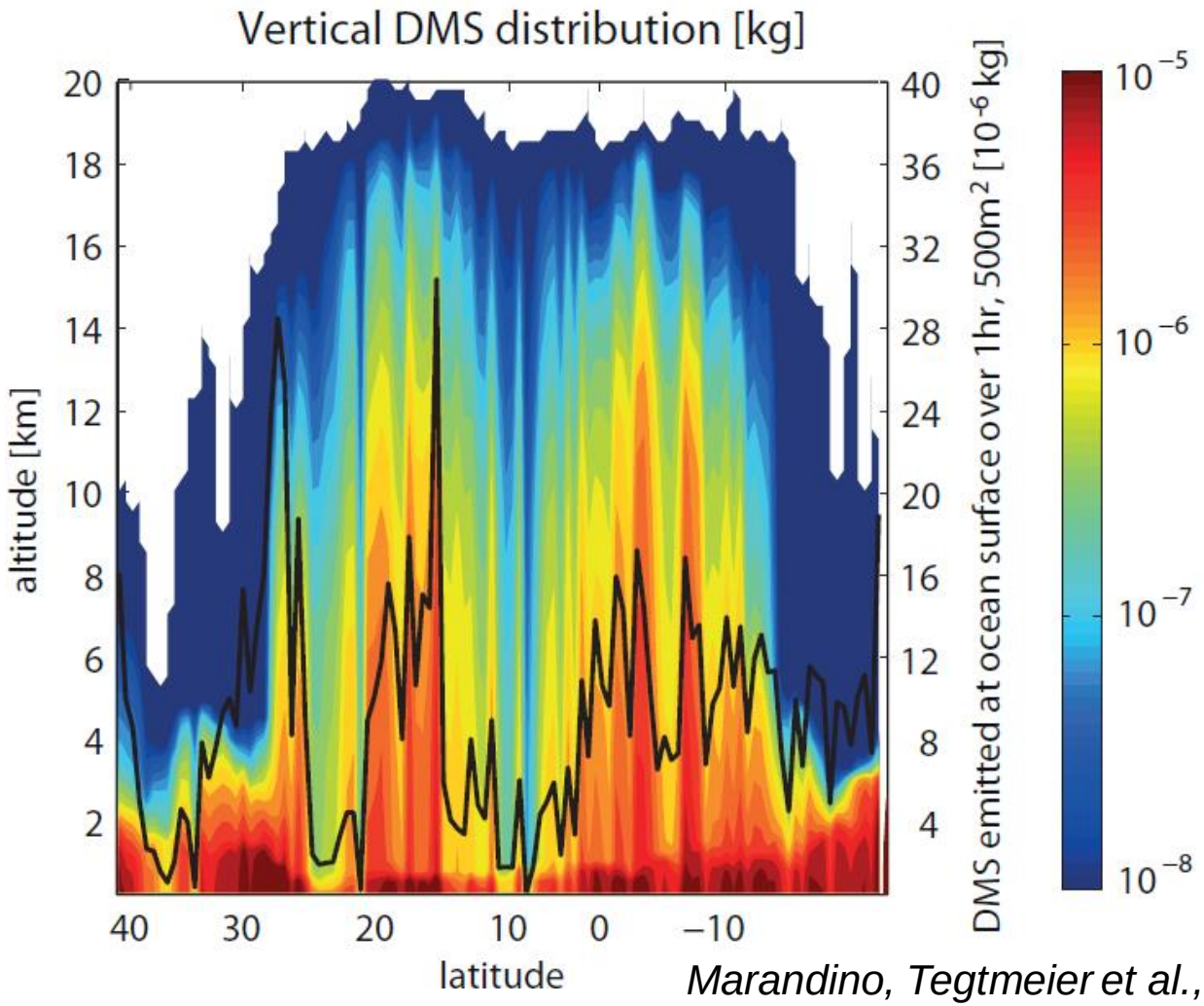
parameterization.

Marandino, Tegtmeier et al., 2013

DMS FLEXPART simulations (TransBrom 2009)

Regional importance of tropical West Pacific:

disproportionally large DMS transport into the stratosphere



FLEXPART

- *Lagrangian particle dispersion model (Stohl et al., 2005)*
- *Large scale and convective transport*
- *Driven by ERA-Interim*

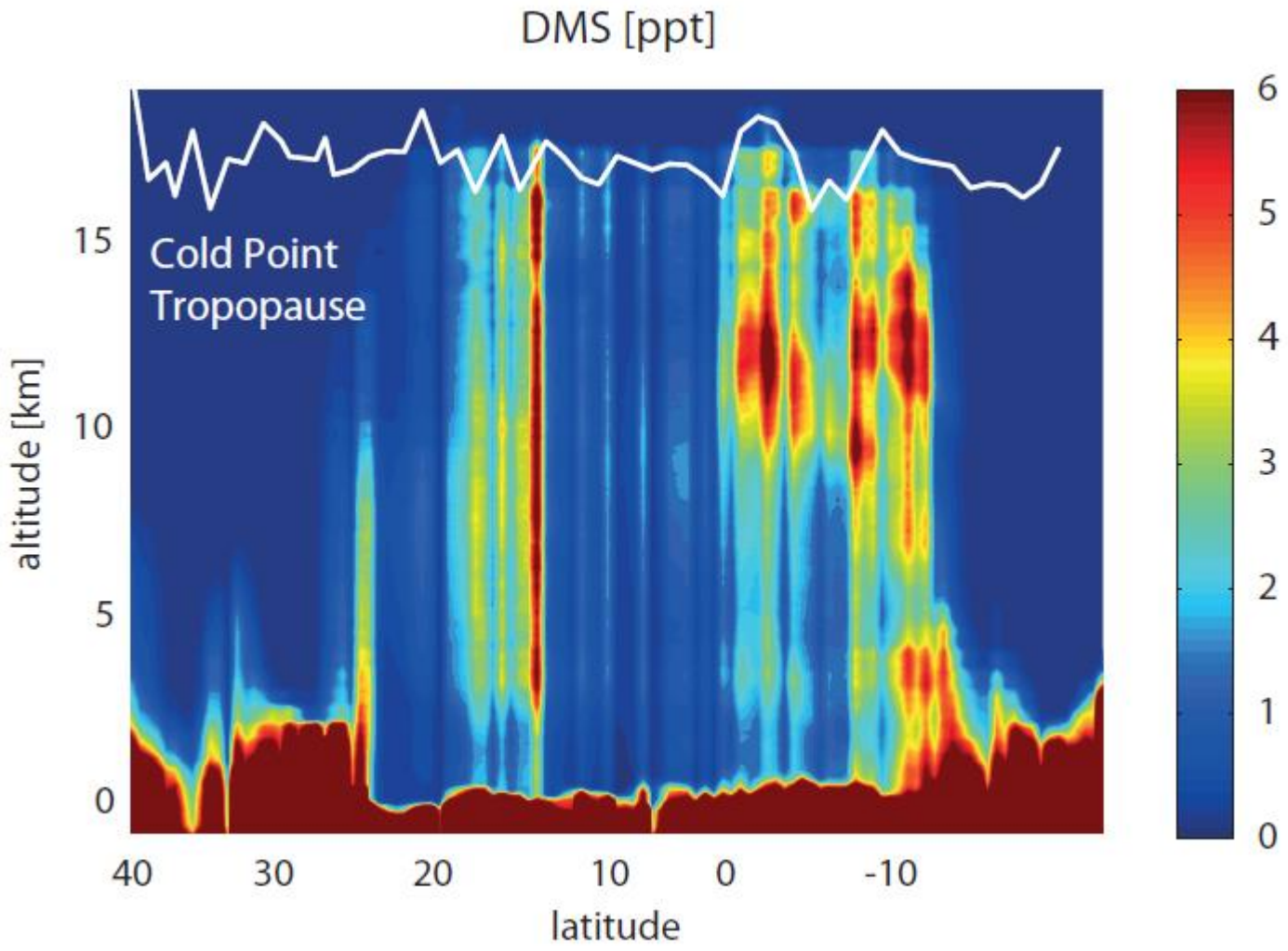
DMS Lifetime

- *24 hours*

Marandino, Tegtmeier et al., 2013

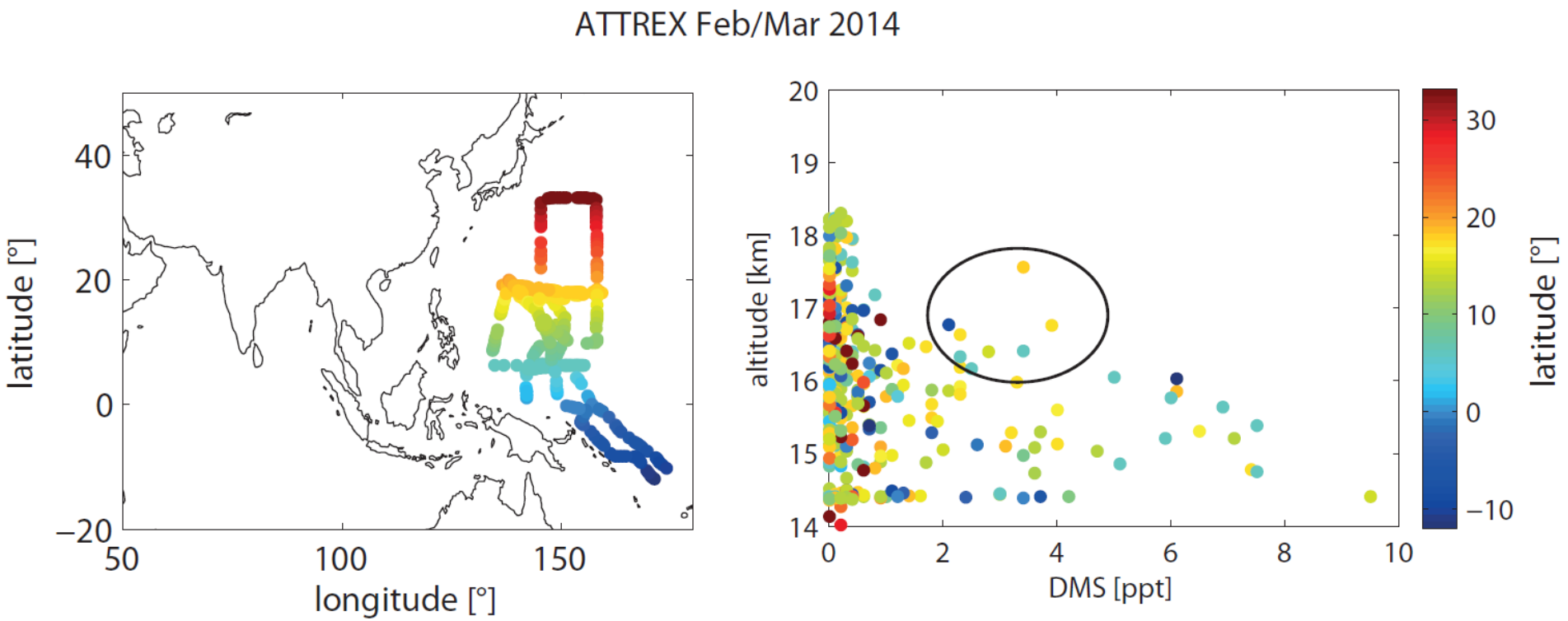
DMS FLEXPART simulations (TransBrom 2009)

Mixing ratios > 1 ppt at the CPT for individual events



ATTREX campaign 2014

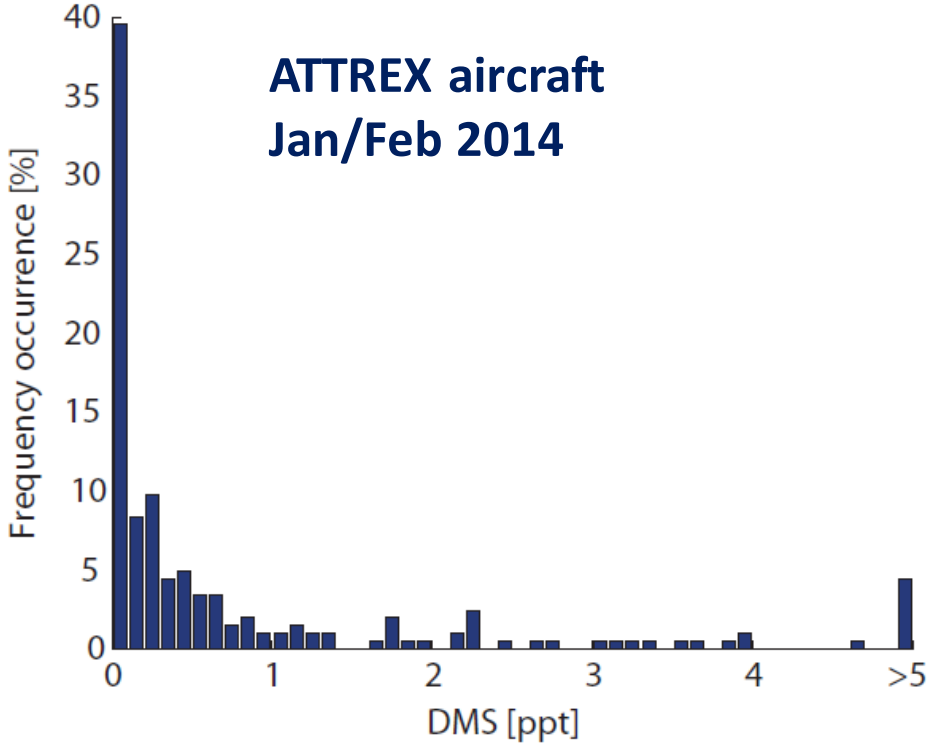
Mixing ratios > 1 ppt at the CPT for individual events



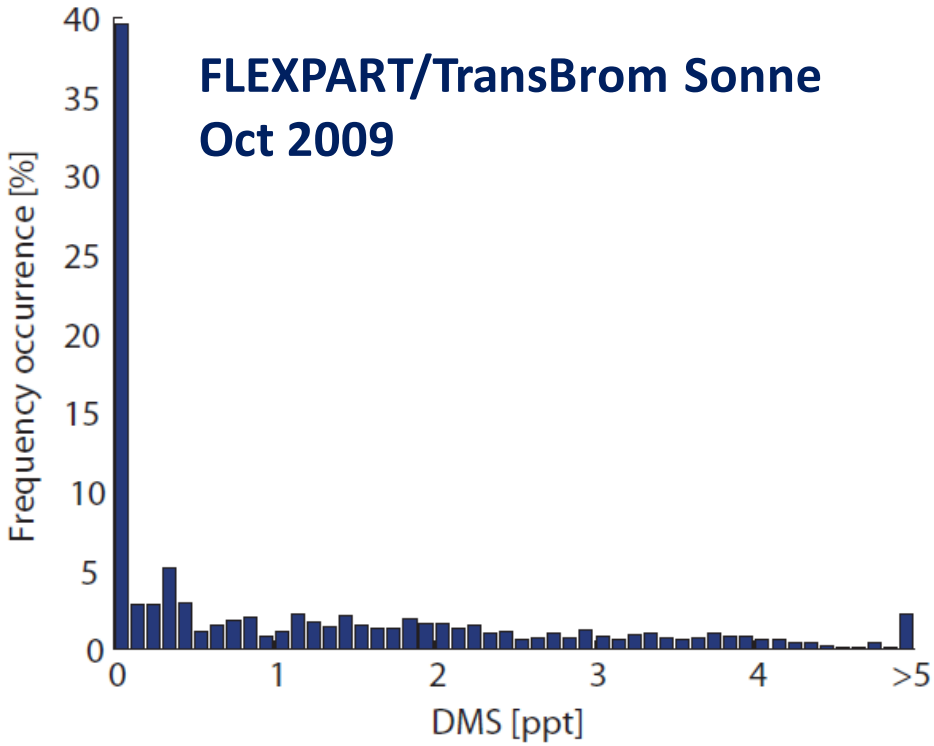
ATTREX vs FLEXPART (TransBrom)

DMS (15-17 km) shows a similar distribution

ATTREX aircraft
Jan/Feb 2014

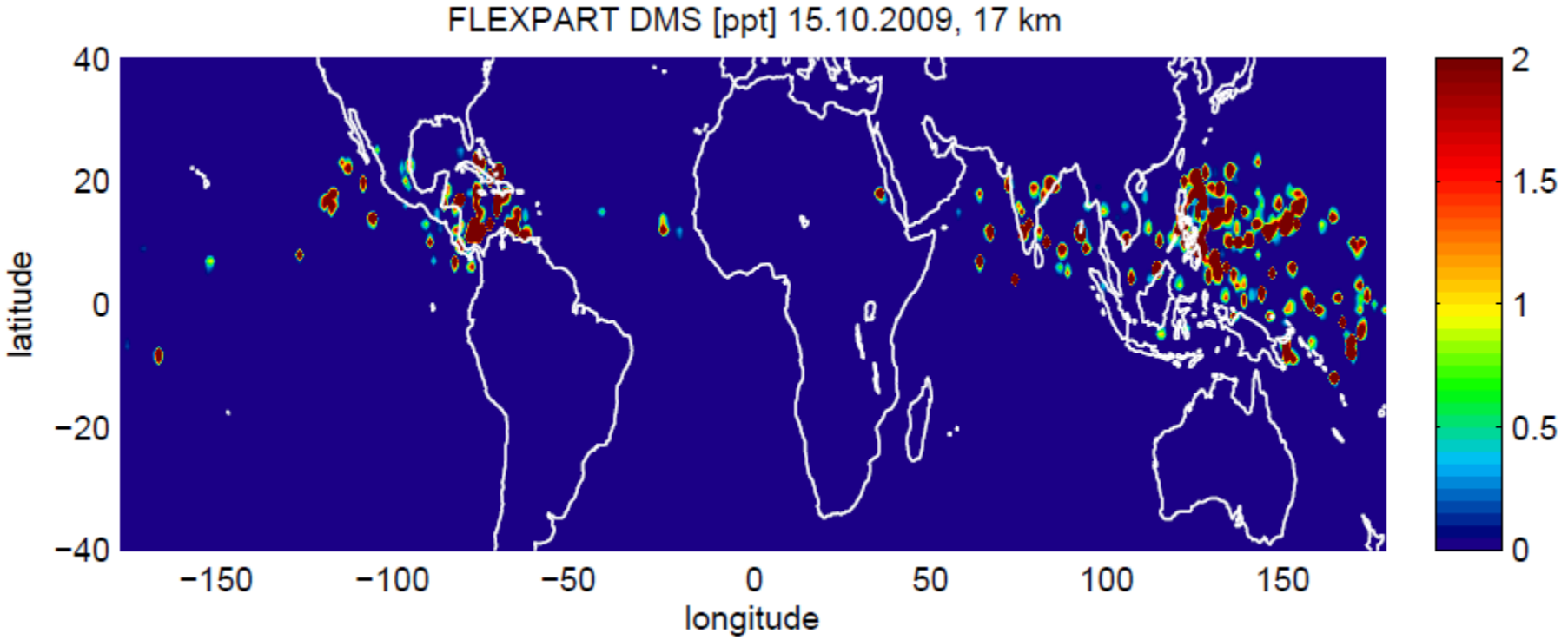


FLEXPART/TransBrom Sonne
Oct 2009



Global impact of DMS entrainment

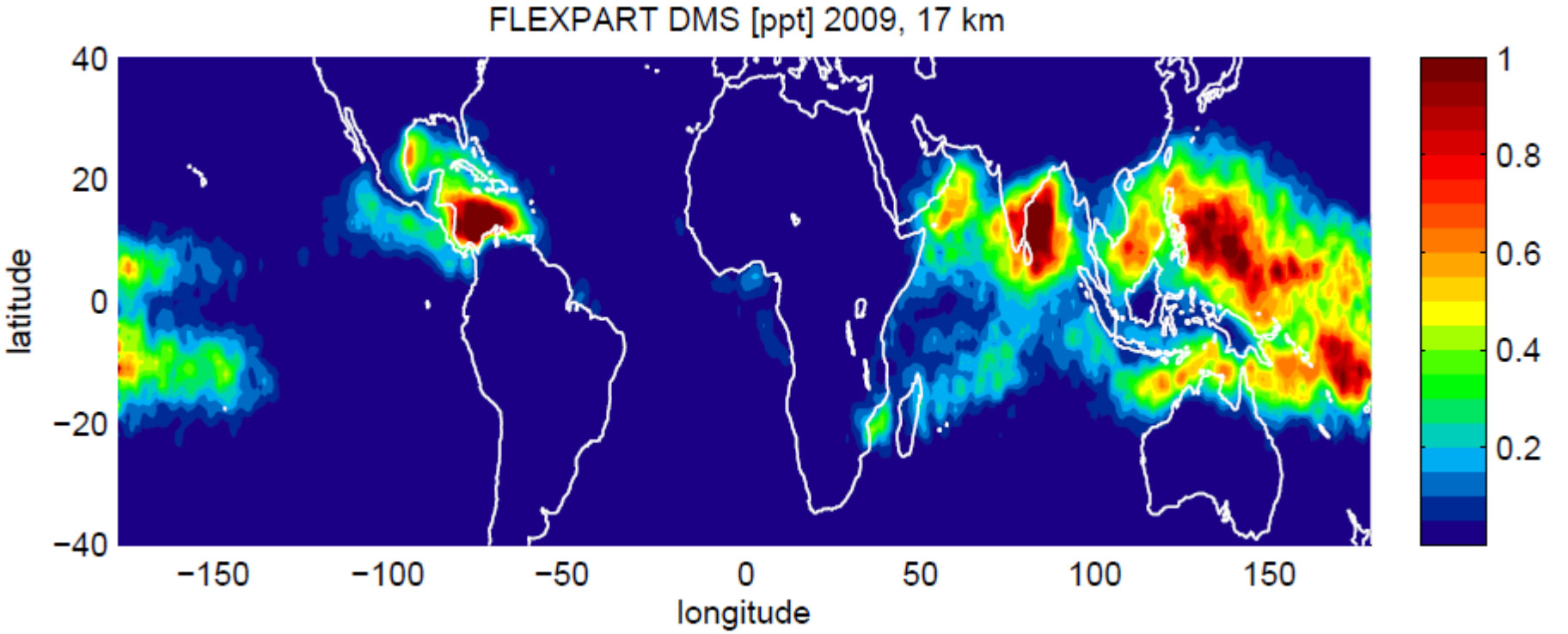
Daily mean values show isolated DMS events in the upper TTL



Emissions based on climatological sea surface DMS concentrations, (Lana et al., 2011).

Global impact of DMS entrainment

Annual mean values show a smooth field as a result of averaging

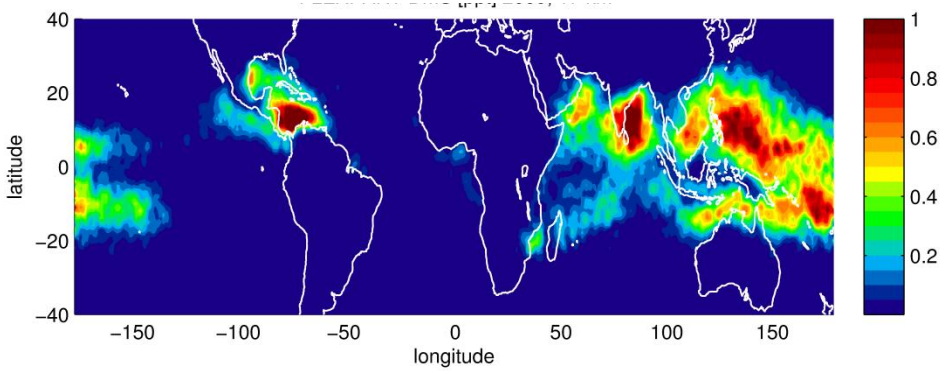


Emissions based on climatological sea surface DMS concentrations (Lana et al., 2011).

Sensitivities of DMS simulations

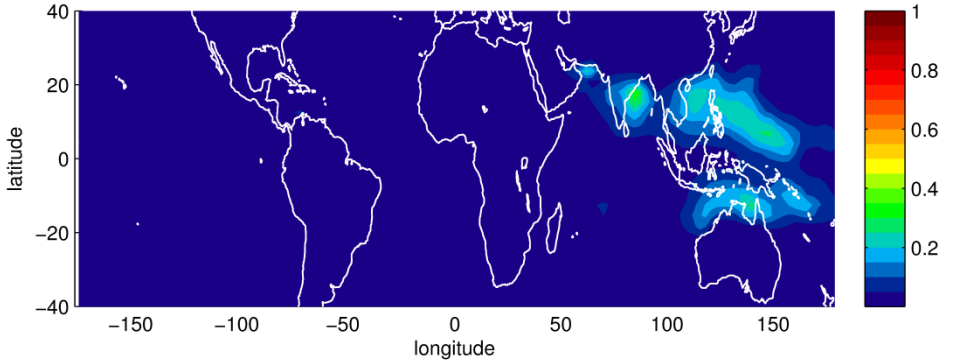
DMS @ 17 km, FLEXPART 2009

- monthly emissions (Lana et al., 2011)
- ERA-Interim



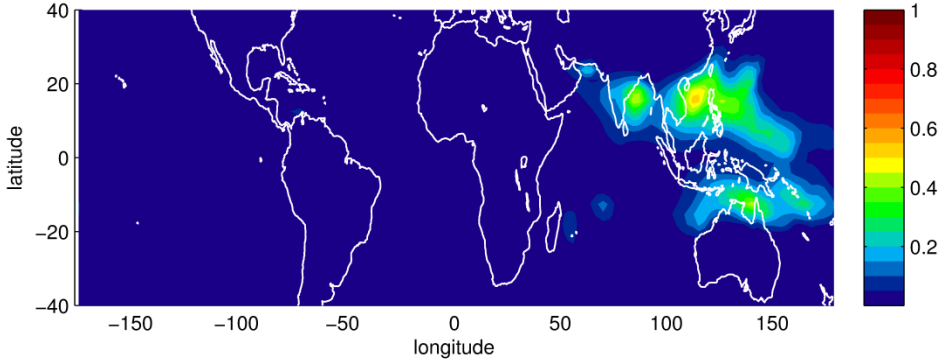
DMS @ 17 km, JAMSTEC ACTM 2009

- monthly emissions (Lana et al., 2011)
- ERA-Interim



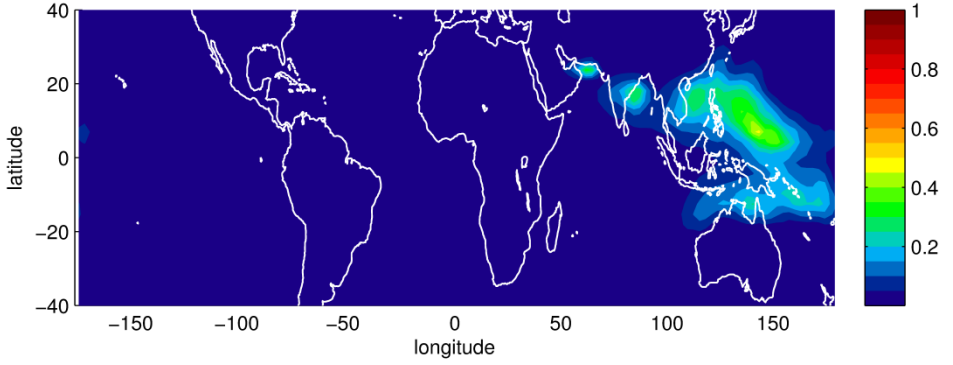
DMS @ 17 km, JAMSTEC ACTM 2009

- 6 hourly emissions (Lana et al., 2011)
- ERA-Interim



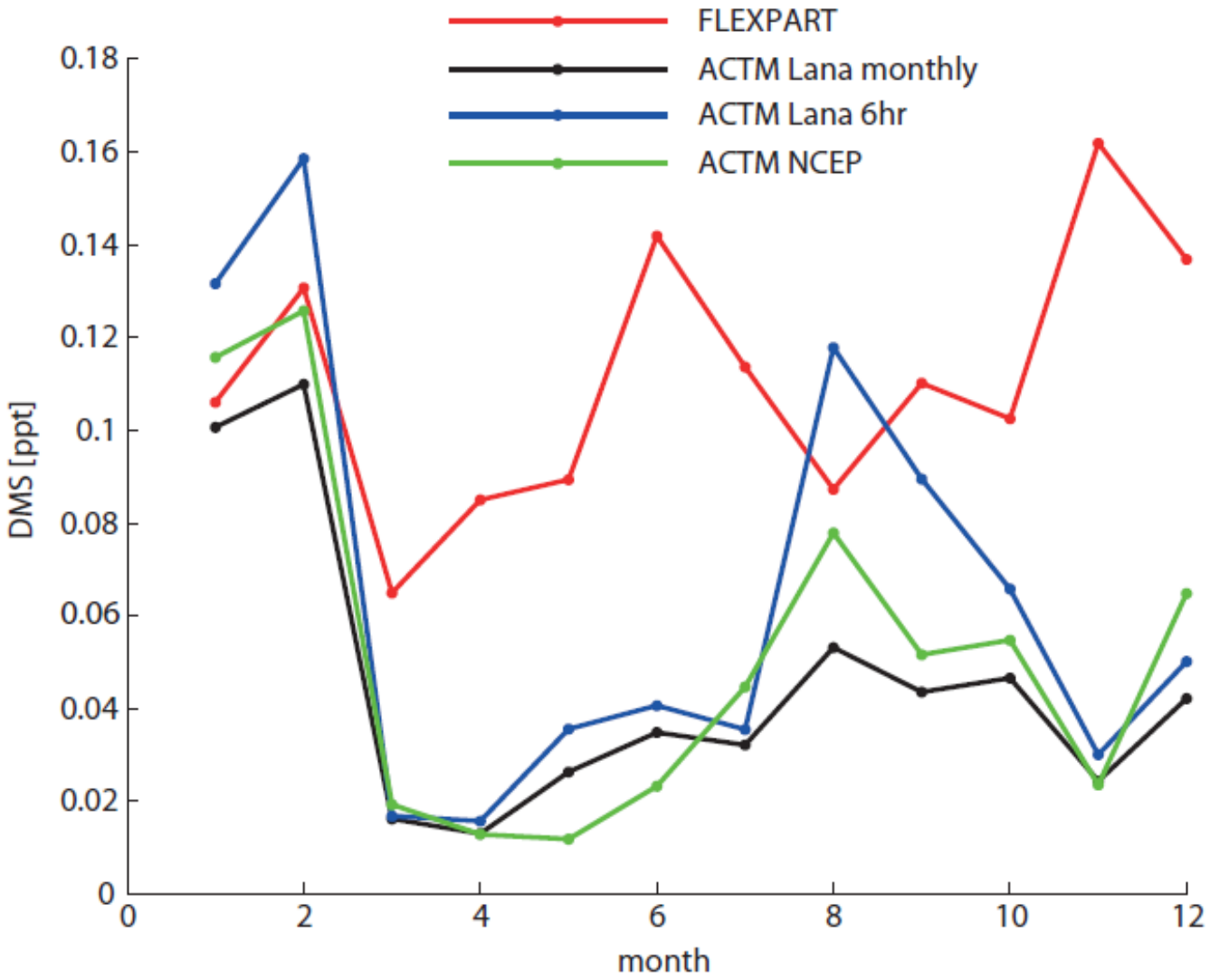
DMS @ 17 km, JAMSTEC ACTM 2009

- monthly emissions (Lana et al., 2011)
- NCEP R2



Sensitivities of DMS simulations

DMS seasonal cycle, 30°S - 30°N, 17 km, 2009



Global impact of DMS entrainment

DMS flux through the tropopause:

SOCOL-AER (Sheng et al., 2015)

Coupled aerosol-chemistry-climate model — **4.4 Gg S/year**

FLEXPART

monthly emissions (Lana et al., 2011), ERA-Interim) — **16.1 Gg S/year**

ACTM

monthly/6hr emissions (Lana et al., 2011), ERA-Interim/NCEP — **6.5 – 9.7 Gg S /year**

See also Wærsted and Krueger, poster.

Summary

- **First observational evidence of DMS in the upper TTL confirmed FLEXPART model simulations**

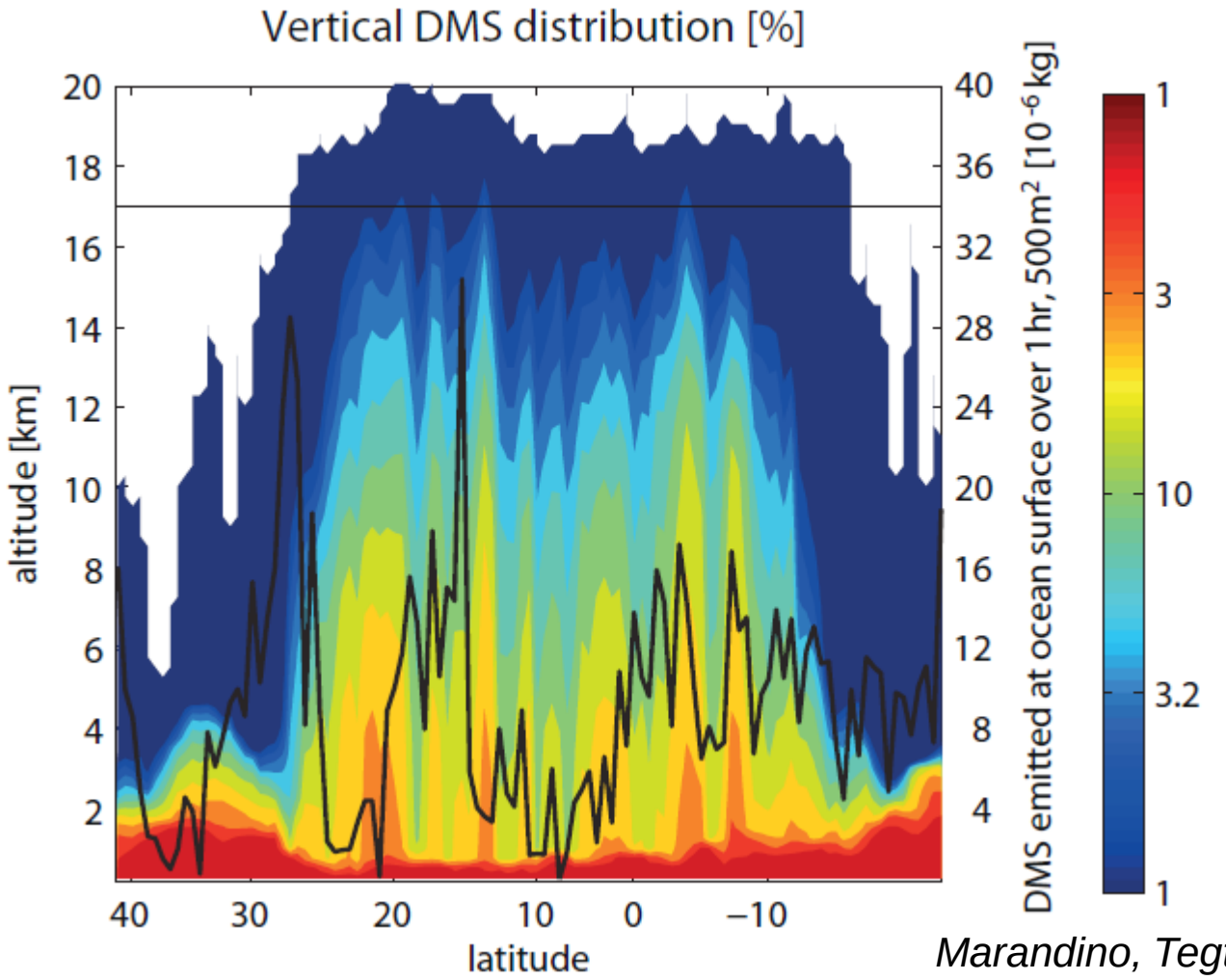
- **Simulations of global DMS flux through the tropopause suggest that direct entrainment is not negligible**
  - **6.5 and 16.1 Gg S/year**
  - **Well constrained oceanic emissions**
  - **Large sensitivities with respect to chemical decay and convection schemes**

Funded by BMBF project ROMIC THREAT (01LG1217A).

DMS FLEXPART simulations (TransBrom SONNE)

Regional importance of tropical West Pacific:

disproportionally large DMS transport into the stratosphere!



Marandino, Tegtmeier et al., 2013