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The contribution of oceanic halocarbons to marine and free tropospheric air over the tropical West Pacific

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Supplement

Convective energy and precipitation

Intense solar insolation and high sea surface temperatures (SST) favour the South China and Sulu Seas for high convective activity. To indicate atmospheric instabilities that can lead to convective events the convective available potential energy ($CAPE$) (Margules, 1905; Moncrieff and Miller, 1976) is calculated. $CAPE$ is defined as the cumulative buoyant energy of an air parcel from the level of free convection (LFC), the level where the environmental temperature decreases faster than the moist adiabatic lapse rate of a saturated air parcel at the same level, and the equilibrium level (EL), the height at which the air parcel has the same temperature as the environment. $CAPE$ is computed after S-Eq. 1, with g as the gravitational constant, $T_{v,p}$ as the virtual temperature of an adiabatic ascending air parcel at geometric height z, $T_{v,e}$ as the virtual temperature of the environment at z, z_{LFC} as the height of the level of free convection and z_{EL} as the height of the equilibrium level. $CAPE$ can range from 0 to more than 3 kJ/kg for very intense thunderstorms (Thompson and Edwards, 2000).

$$CAPE = \int_{z_{LFC}}^{z_{EL}} g \cdot \left(\frac{T_{v,p} - T_{v,e}}{T_{v,e}}\right) dz \qquad \text{(S-Eq. 1)}$$

The mean CAPE computed from the radiosonde data is 998 ± 630 Jkg^{-1} and typically elevated for tropical regions (S-Figure 1). Highest CAPE during the cruise was observed on November 16, 2011 at 12 UTC in the southern South China Sea and exceeded 2.9 $kJkg^{-1}$, revealing developing convection. ERA-Interim mean CAPE during the cruise was 825 ± 488 Jkg^{-1} and about 170 Jkg^{-1} lower than observed by the radiosondes.

Precipitation measurements by the optical disdrometer ODM-470 are shown in S-Figure 1. Besides a number of small rain events during the cruise, three major convective rain events are evident on November 16, 21 and 24, 2011. The total amount of accumulated rain during the cruise was 52.3 mm. The most intense rain rate of 16.3 mmh^{-1} was observed on November 16, 2011 in the southwest South China Sea. The relatively low total precipitation during the cruise is reflected by negative precipitation anomalies in November 2011 compared to the long term climate mean along the northern coast of Borneo (Climate Diagnostics Bulletin, November 2011, Climate Prediction Center).

R/V SONNE – R/A FALCON: Identifying observations of the same air mass

To investigate if the same air masses were observed on R/V SONNE and on R/A FALCON a perfluorocarbon tracer was released on R/V SONNE on November 21, 2011, which was indeed detected 25 hours later on R/A FALCON (Ren et al., 2014). With the trajectory calculations it can be determined which fraction of the air masses investigated on R/V SONNE could subsequently be investigated on R/A FALCON. Within a horizontal distance of ± 20 km and a maximum vertical distance of ± 1 km around the position of the aircraft, as well as a time frame of ± 3 hrs of the VSLS air measurements on R/A FALCON, 15 % of all launched 80 x 10,000 surface trajectories, marking the air masses on R/V SONNE, passed the R/A FALCON flight track during the cruise. The amount of trajectories passing the flight track of R/A FALCON increases to 77 ± 29 % between November 16 and December 11, 2011 within a time frame of up to 10 days.

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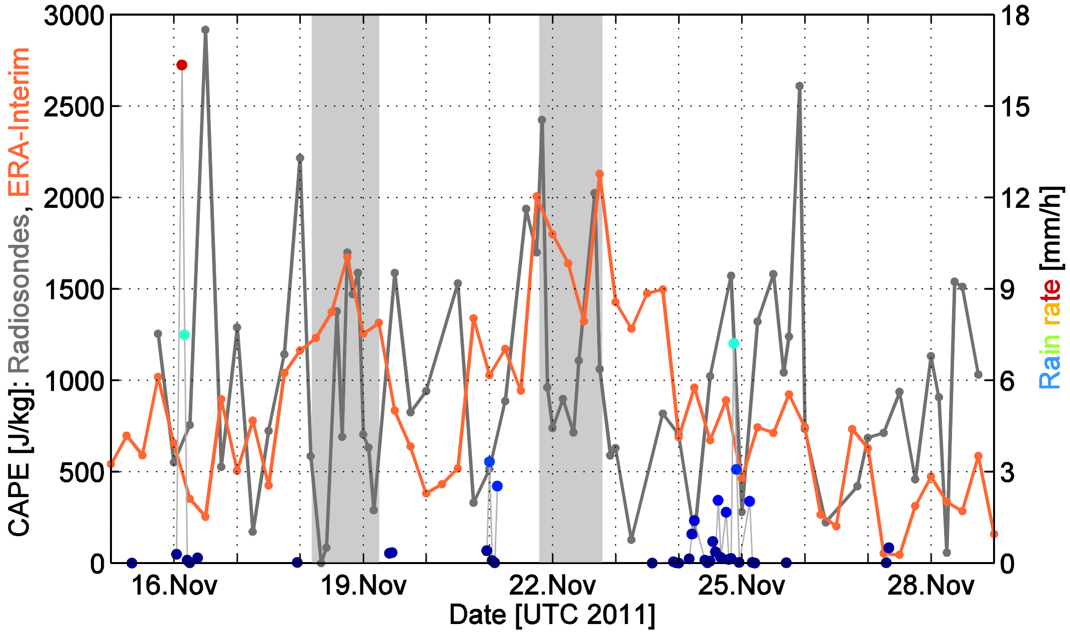

S-Figure 1: Left scale: convective available potential energy (CAPE) from radiosondes on R/V SONNE (grey) and ERA-Interim (orange). Right scale: Rain rate (colored dots) during the cruise, observed by an optical disdrometer (ODM 470) on R/V SONNE. The two shaded areas (light grey) in the background show the 24 h stations.

S-Table 1: As Table 3 and Table 4 using ERA-Interim MABL height.

	OD [% day^{-1}]	COL [% day^{-1}]	CL [% day^{-1}]	AD [% day^{-1}]	ODR	CLR	ADR	VMR_{ODR} [ppt]	VMR_{CLR} [ppt]	VMR_{ADR} [ppt]	MABL-FT Flux [pmol m^{-2} hr^{1}]
$CHBr_3$	87.0 ± 124.5	-224.9 ± 70.7	-7.1	144.9 ± 143.1	0.43 ± 0.56	-0.03 ± 0.01	0.60 ± 0.55	0.88 ± 1.18	-0.07 ± 0.04	1.22 ± 1.20	4251 ± 1907
CH_2Br_2	39.3 ± 40.3	-224.9 ± 70.7	-1.2	186.7 ± 83.2	0.20 ± 0.21	-0.01 ± 0.00	0.80 ± 0.21	0.24 ± 0.26	-0.01 ± 0.00	0.93 ± 0.27	2456 ± 921
CH_3I	135.2 ± 195.0	-224.9 ± 70.7	-24.0	113.8 ± 220.8	0.73 ± 1.06	-0.12 ± 0.05	0.39 ± 1.04	0.28 ± 0.39	-0.05 ± 0.02	0.14 ± 0.37	799 ± 356