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The influence of dissolved organic matter on the marine production of carbonyl sulfide (OCS) and carbon disulfide (CS_2) in the Eastern Tropical South Pacific

r [1] M r [2] [1] r r [1]
r [5] r [6] r [78] r d rr [8] d r r [9]
r [1]rMrd [1]

[1] Mrrr r rr 2 02105r
[2] r r rd r 7 r5 2 2 5
r
rr r dr1 5 1811 9
rd r rrr dMr r d 1227570 rr
r
[5] rrrrd rr 9 9 0 0 0 d r
[6] MMr rMr r r r 2 8 5 9 rr
[7] r d d rrd 27568rr
[8] r rr2 8rr
[9] r2 1502r
rdr M r rrdr dr

Correspondence to r r dr

Abstract. r rr ddr d d2r
rr r rdr rrdrrrd
rdr ddr rr d r r r r
rrr rr r d rd d rr M
d rd d rrrrMdrd d r
r M rr rr r d r d
rdd r d rrdd rrrrdrd
d M rr2 r d d
rrrrddd
rd d d r d r d d drd d
r r rd r rddd ddd r r dd r
rrdr dr d

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1 Introduction

d r r dr rr d
d rd d $_2$ d 1 99 rr 2 016 d r
r d $_2$ rrrr d rrdr $_2$
d rr rrrr r2 012 r
1976 r r dr d 1961 rr
2016 r r r d r rrrrr rr d
2008 M2 007 r r2 01 r dr
r d rrr r r2 01 2015
r2 015 2 015 *In-situ* rrr r d
rr d 0 0 6 0 0 r [1] r d
r 2 017 r d r 5 0 rr
2016 2 018 d r rrdrr r r
dd r r r d rrd rd d
r dr
M*in* -*situ* rd $_2$ r r r rd rdd d
r rrr 2018 rr r r rrrr
rrd r rrr r
rdr d r r r
d dr rMdrrMrd
rM r rrrdr r
r d d $_2$ 1998 1997 rd dr1997 r
rrrdrM d rdd rr
r d rrrdrrr d r d rr r rdr
d
rrMMrrdr d
rrdrr drr 2 007 rMr
rM rd dr
r r rrM
drd 2007 Mr2 0 1 rd d d d r rr d
d r r2008 drr r r
r 0 d d r rrr rd
drr Md M 2 018

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
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Ocean Science
Discussions

rddr r r d M r ddr1 997 r
rr drdddrr dr r r d
rd r d 1998 drd d
r d d d d Md rr r rr r r
d dr1 99 1 997 r r M r50
a_{350}r rrr r d rr rr r r
r d rd r d rd d a_{350} 200 rdr r r
r d d d d a $_{50}$r drdd
r 2 017 rr r r d r rrrrr
d rrM M rr d
r ddr d d ddr r d
drrd ddr1 996 2001 d r
r drd $_2$ r 1 998 1997 ddr1 996
dr rd rrr r r drd Knęry and Cutter, 1994 r
rdr r d d r rd$a$ $_{350}$ drdrd d d
Md r r 2001 rrrrd
r rrd r d d drd $_2$ d drd $_2$rd
r d ddrd rd r r rr rdd
rrrdr dr rr 1989 d rd
d r d Knęry and Cutter, 1994 r d d rd r
200 d r 2 017 r 200
r d 2015 d r r r r r
rr d d1 r d
rd d r r $_2$ rr ddd
r d $_2$ r dd rr d r d
r r dr d 1 998 r rrr*in*-*situ* rd r
r r r r d dd rr rdr
d r r d rd 1 999 d r $_2$
r d r d rrr r $_2$
dr 2 000 $_2$ drd d d d $_2$ $_2$rrdr
r rr 1 990 dd d drd
d 2000 r d rdr r d r
r dd rrr rrr rdr

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
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d rdr r d r rrd rr
rd r dr dr dd
rd r d r d d $_2$ r
r

2 Material and Methods

2.1 Study area

r Mrd d r 0 5 1 0 20 1 5 d r d
2 2 1020 1 5 1 rd rr r5 d 1 7
drrdr d d rr d r d r r 2 016 r
rrr rd r 2008 r
dd 1 00d900 r r d r
rr r 2008 r r d r r rr r
22 271 6 d rd r2 0 r7 18
rrd r rdd 15 18rdd r r1 5
1 8

2.2 Measurement of trace gases

r drr dr d rd rr
d rr r 2 017 rrd
2 [1] r rdrr5 r rr
d rrr d r r 0 2 ddrd drr r rr
r r r d rr
rrdrrd r d r d r
rdrdrr M rr r rd rdr r
dr rr d rd 2011 r
1 5 d d 1 8 0 r rd [1] 2 0 d dd d r
r rd M r 1998 d 2009 rd 2 dr
dr dr drrd rd rr
r d r 2017 r2 [1] Mr dr r rrd r r
r 1 0 rrd 5 rr
r r

d r rd d d r r rr d 1 d rr2 r [1] d d r 1 0 15rr 6 d d rr $_2$ rd rdrd rrdrr M 78905 975rM r d rr d r 2 017 5 0 r1 r rrd rrr r r r1 5 70 [1] rd rd rd rr r rdrd d r rrr rdr d $_2$ M r r $_2$ $\frac{m}{z}$=767 89d d r rd d rr r rd d $_2$ d rd thylene glycol. During purging, 500 µL gaseous deuterated DMS (d3 Mdr d 5 rr d dd r dr drd rr d 1 [1] r rd rr d rr r d d $_2$ rrdrr r d d rdrr r r rd $_2$ rr2 2 2

2.3 Chromophoric dissolved organic matter (CDOM)

rrM a_{50} d r d rd rr rdr r rrdrrdr d 0 2 rM rrr r r d r r d Mrd rrddr 2 5 Mr2 002 rrr r d dr 2 7 0 700 2 rr rrdrdr r r dr r r r rrd r d rd d r r d rrd r r 2 01 7 rd

2.4 Fluorescent dissolved organic matter (FDOM)

rd d rr Mr rdd MrM rr2700rrd r0 2 200 r r rrd r rdr d r220 5 50 r 1 0 r rr d d r250 5 5 0 1 r0 0 r8 00 d dd r r1 0 2 015rd rrr 50 r dr rd 0 9991d0 9971r Mr rd drd

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

Mr2 0 1 r r rd r r r
rr d d r M Mr2 0 1 d d r2008 r
r d d r rrMMrr r rd r
rrd 0 5 0 d 0 256r
r r d d r Mr2 0 1 dr r
rd rr

2.5 Solid-phase extractable dissolved organic sulfur (DOS_{SPE})

d rd rr rrr d r drd
r r d r5 0 r 5 2 0 0 rrr r5 0
r d r dd 2drrdrrM r rd rdr
2008 1 M dr drd 20r rr r rdr
d 5 rM r ddd
r r 7 0 0 rr1 0 0 rrd $_2$ d
rdd1 r d 1 Mdd dM r1 r 2 ^{1} d dd
rd rdr d d 1 820 r d 1 Md d dM r
d r r d rd rr rd r1000 ^{1} r d rd
r rd r d 5r r dr dd
d r r r rdr 5rd 2 01 rrd
r2 7 2 2 8 ^{1} r r d d rd
r drdr d 2 6 5 1 6 ^{1} r rd 0 015 ^{1} rr
r rr 8 9

2.6 Shortwave radiation in the water column

dr r rr d d rd rrd rd r r
rd r M rr rr r 1 8 9 5 0
r drr0 M rr d r
d d rd8 d rrr d d
r dr rdd rrrr MM7 r
rr drdrr dr6 d
rrrr*a* dr r r Mr 200
d rrd r rr rd r d d d
rrd r rd rr r rMrrd r
d r r d d r r 1

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

rrrr r d r r r rr rr rd rrd dr r dr d d r r 2 5 r 2 d2 25rrr rrd rrd K $_d$ λ $z$rr rr K_d λ $z$rrrd E $_d^-$ λ0 r rd r rE $_d$ λ zr d r rr dr d d r d d rr E_d^- λr λ 1 8 98 d r λ 0 0 700 r1rd r rd rd r rd E_d^- λrd d d r *in* *-situ* r1 d r 0 0 1 0

2.7 Determination of gas diffusivity with microstructure profiles

d d dd dr d rrd r r rdrr2 5 7 d1 8d l diffusive flux of a compound, φ$_d$ 2 1 d

$$\Phi_{dia} \approx \rho \cdot K_\rho \cdot \frac{\partial c}{\partial z} \quad (1)$$

r $\frac{\partial c}{\partial z}$ 1 1 r rd rr r drd d K_ρ 2 1] is the diapycnal turbulent diffusivity, and ρ [kg m r d d rd r r d drrdd r r drrrrdrM rrr d drd dr d Mr Mrr5 1 5 M 2 0 1 201rr rdr M d d r d r d r d 05 rr d r r d r d 2 0 1 d r d K_ρ d rrd r rr rd rr r rrr rrrr dr d rr M 9 0 d d d drrrr r d rrd r 201 d d201 d r dd r d r dr ddd r d dd r r rd r d r rrrr dd d rr dr r d r d

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Discussion started: 1 March 2019

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r d r rrrrr r
d r K_p r r d dr d rrr
r drr rrrrd dd
dr r rr rd d r rd d d r
rrd

2.8 Determination of OCS dark production rates

r rdr r d r d rrd r rrd
rd rd d rd rd r 2017 r d
d r rdr d rd rr d rr r
r d rr d d drr r 2001
d r rrd r rd$P$ $_D$ [1] [1] dr$L$ [1]
[1] r rdd r [1]dr k [1] rd
2

$$P_D = L_H = [OCS] \cdot k_h \quad (2)$$

r rdr [1] d rd1989 d

$$k_h = e^{\left(24.3 - \frac{10450}{T}\right)} + e^{\left(22.8 - \frac{6040}{T}\right)} \cdot \frac{K_w}{a[H^+]}$$

$$-log_{10}K_w = \frac{3046.7}{T} + 3.7685 + 0.0035486 \cdot \sqrt{S}$$

rr$T$ S, $a[H]^+$ rd K_w rdr d 1979
r rd dr r P_D d rd rr rr
5 rdr

$$\ln\left(\frac{P_D}{a_{350}}\right) = \frac{a}{T} + b \quad 5$$

a_{350} r M 50 [1] T r rd$a$ d b
dr r rd dr rdr P_D rd a_{350} 2001
rr a d b 5 r d r d r 5 rr rrrd r
rdr r rrd$a$ 50

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

2.9 Surface box models to estimate photoproduction rate constants

r drrd d r 2017 r d r dr r rrrdr 1 989 d rr d 2001 r d r 2017 dr 2000 *In-situ* rrdr r r d dr r d d r d 6

$$\frac{dc_{photo}}{dt} = \int_{MLD}^{0} UV \cdot a_{350} \cdot p \qquad 6$$

$\frac{dc_{photo}}{dt}$ rd r d 1 1 rrd r 2 $a_{5\,0}$ r M5 0 1 d r d r p 1 d r drd r r $\left(\frac{dc}{dt}\right)$ rdr p d rd rd 1 00 2 00 r Mr r d rM r 2015 Mr r p rrrrd d 200 d d d r $_2$drr d rd d rdr r rr r rddrddd M r rdrr r dr r

2.10 1D water column modules for OCS and CS_2

rr r M d Md d 1 r d rd d 2 0 1 dr d rr 2 5 7 d 1 8 Mr d rr d d d rr rrr rrddrdrdr d r r r M dM1 rdd rdd r drr d r d rrd 2005 Md rr rr d *In-situ* rr drrM drr r rd d r r r ddrr rrrr dd rddrrrrr dr5 d rd r rd2 1d r $_2$ dr rr r r d rd rdr 1 r d r d $_2$ Mrdd rd r 0 0

0 0 d rd 6 d d d rd r r r d *in-situ*
rd r d d rrd rr *in* *-situ* rd M
r d r d rd r d
rd 1995 r d 1998 r $_2$dd
r d r *p* 6 d d r M2
ddd
ddrrrdrr rr d d r r $_2$ r
d rrd d d r d r d
rrr rrd d r r r rrr
dr1 r $_2$ r d rdrr9898d
9 8 d 2 r $_2$ rdr d r
9 8 2 d rd r r rr
$_2$ rd d r d rrd rr
rr $_2$ drdr rdrd d rr
dd rd r r $_2$ rrrdd
rr d rd r rdr1 0 2 5 9 8 d
25 5 0 d 98d rr rd rd drr
5 rrdrdrrr
d r r rrdr *p*
r r r r 1 rd r1998
d r2 rr rd rd2 r r *p*
d rdr6 dr
ddr r d r
rd rd 1 r r d r d d
rr 2

3 Results

3.1 CDOM, FDOM and DOS_{SPE}

Mdr rM r dMrM
r r50 r *a* $_{350}$0 1500 r r
dd d r 1 7 202 d
r d 2 0 1 r d 1

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

rd r Mr rrr rr d ddd

1drr r M

1 r r r rdrd r 2007 2 d

rr MM rrr d r r

d rd r rrrd r 2

2 1

r drr rrr0 1 6 0 05 1

r rr d1 6rd d

rr2 r rd rd d d

r dr 2 016

3.2 Carbonyl Sulfide (OCS)

3.2.1 Horizontal and vertical distribution

rr rr d r6 1 1 1 r0 5 1 rd r

dr d r 2017 rrr d r d ddr

rr8 1 2dd rr d1 62 rr

d rd d 2 7 d 1 8 10 1 rr d

r7d18r d d rrd d

r rd d rrr5 d r d rrr

r d d 7 5 dr rrr rdd

d 1 6

3.2.2 Dark production

d r rdr rr d 0 8 6 d 1 8 1 1 1 rr r r r

d 0 1 6 d 0 8 1 1 1 rd r 5 0 rr r rd d

d rd rrdr r rrr5 6 6 10 10 r

r d r dd r r d rd rr

$$P_D = a_{350} \cdot \exp\left(-\frac{15182}{T} + 53.1\right) \quad (7)$$

rr d r d M r 2 d a_{350} 5dr

rdr 5 0d1 6r r r rd d rr rda_{350} r

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

rrr d rr d r d d r rdr rr

Md r rdr 2001 d d d rdd d

d r 8

$$P_D = a_{350} \cdot \exp\left(-\frac{16692}{T} + 58.5\right) \quad 8$$

3.2.3 Diapycnal fluxes

d r r d r d rrd rdd r

rdd rdd rdrr dr

rrrrdrdr r 25 d 7 d

8 2 1 0 2 1 0 d 8 1 0 1 2 1 8 rd 0 8 1

2 r r 1 0 1 2

3.2.4 Photoproduction

r d r rd6r rd r d rrdd

rd d d r 2017 rd rrrM 7 8 9 10 1 16

r2015 r rr d r d M2r

0 0 1 0 8 1 5r d r9

$$p = 85.8 \cdot [\text{FDOM C2}] + 828.76 \quad 9$$

rdr *p* 1 d rM2

rr *a₃₅₀* d r 0 01

r rrdddr MM

1995 dd rrr 6 rd r

1 7 rd rd d

rr r d d dd d r rdr ddr rr

M 2d*p* 5 9 221 8rrr d r

r d rrr r d 5 r

rr5 5d1 6r d r rdd d r d

rd 9 5 d rd 17 1 9 rr d r

r d drd r

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

3.3 Carbon Disulfide (CS_2)

3.3.1 Horizontal and vertical distribution

r r $_2$ dr Mrrr r1 78 8 9 [1] dd d d r 7 2015r dr rr r d rd r rrr $_2$ dd r r r2 d2 rr $_2$ d d d r d r r r rrd r rrd r2 5 d1 8r $_2$ r d 200 d rr rd d r1 1 20 [1] rd rrrr1 5 1 8 1 0 [1] d r rr r r d r r d rr rd rr

3.3.2 Diapycnal fluxes

d $_2$ r r d rdrr1 8 r $_2$ r d rd d rd *in* *-situ* 2 7 d1 8 d *in* *-situ* r drrd 2 d 1 8 r rr rd r dr dr d M r 7 6 1 0 1 0 1 9 1 0 d 0 9 8 [1] [2] 2 5 7 d 1 8 d 1 r d rd rr1 8 d M dr r rd 0 9 8 d 1 0 [1] [2] r

3.3.3 Photoproduction of CS_2

r d r r $_2$ r d r d r rd d rd d r r d rr rdr r5 7 0 rr d d r M0 05rd d d r 0 08 rr 0 8 5 rdrrd d rrM1 M $_2$ rr d d r r 2 r d rd 1 rdr2 5d 7 r dr 1998 d dr 6r r d 98 d r dr d 98dd98rrdr d rr r 98 2 5 [1] 6rrr

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

d rrdd98dd98rrd
r rd d d r d rr d
rr d1 982 dd
199 8 d r2 $_2$ r drd2d
rrdr r d r 6 d rd r
r rd d rdr r00 0 0 9 8 2 d r r d
rr dr r r rdr d
6

4 Discussion

4.1 Carbonyl Sulfide

rr 2 5 7 d 18r r rrr d d
r d rrd r d r
r d d d r r5 r d rd
rrd d dr d r drrd r 2 016
r d r5 5
rr d r 1 8 1 [1] [1] rdr r dr rr rd r
2001 r1995 r1996 d dr1996
1999 rrM r r 1999 r r r
rdrr r r rr d rr d d
a $_{350}$ ddr r r15 18r rd dd r rd
7 d 8 rrd 2001 rrdM d r r
rrdr r d r r d d
rdr r rd*a* $_{350}$ rrrr r r
2001 rd dr r r 2 017 d rr d r
rdr rr r d r rr
rdrdd drrr d
r d rr d d d r d rrr
a $_{5\,0}$ d d d d $_2$r r r M
rd d d d r r rd r r rd
1998 rr d d d r
r5 rddd drr r r
d d rd r

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
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Ocean Science
Discussions

1 6 rr rr rd r r
r200 dd d r rdd r r
2 5 7 d 1 8 d d rd rr rrd r
r r r rdr dr r r1 8r
rdd r d d r
rrdd r r rr r r
d r dr dd d r
dd r d rdr
d d r rr
rd rr r d r *p* M2
M r d rdr r r rr
r r r d r r d rrr M
2d rrr 2 015 r2 011
2012 d rr r 2011 rM d
d 2 015 r rr2r rr
d rddr r d r2011 rr r r
r d r r r d r r*a* $_{350}$ r
r rd M d
M a_{350} rrrr r r r*p* d a_{350} rd
Mr
r d d rrr r rd r rd
r r r r0 [1] r r r2 00 d
ddr rdd r r ddd
rr*p* dr r
dd rdrrr r r r r r dd
rrr 1998 dr d r dr d rr r rr
rddr rddrr d d
rr d d drrr r *p* d r
r d 1998 r r d d drdr
rrdr d r1 999 d drdrdr
rrd d rr 7 rrr drr d d
r d r Mr M2
r d d drd rd d r d r rd 7 d
r drrd d r r Mrd d rd d

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

r d 7 5 8 [1] drr d rrr d r dr8 5 8 [1] d rd rd d dr7 r drdd r d d r d dd r r rd rr rrd d rd rrd dr drrr

d dd rrrr r r d0 d d rd r d d 1 d d d rr dr d r d d r r r rrdr r 2017 r d r d rd 9 5 d rd rd rrrdd d r r d rdrrr201717d d rrrr ddd rr d r d *p* M2d19ddr rd d d rd r r5 d r d d r d r rdr 18 rrd 5 0 d rd rrd d rd d r1 rrr rrrr r r r rdr r rdr d Mdrr1 d 20 0 rr dd r r dr rdrddr

4.2 Carbon Disulfide

$_2$ rrd r rr d d rr 2001r1 0 9 1 7 dr1 [1] d 1 6 [1] d Mr 1999 r r rd rr rr r 2 017 r $_2$ dddrr r r d rd 1999 d r r $_2$ r drdrr r $_2$ 0 9 7 2 r rr rd 8 r1 2 r dr r d r d rr r rd d rd rrrr rr r r $_2$ r r r r rr r rr dr rr r drd rrrr

rdd r r d r $_2$ rd
r r d d r r *p* drr r
d rd r d d r r r
rr r d r $_2$ r d
r r rrr rr rd r $_2$ rr
rr r dd rr r d r
dr r r rrr d r d d r rr
r r $_2$ d r r r d d r rd
dr r rrrr $_2$ r 1 998 rr
r r r r r 2 016 rrr d
r $_2$ rdd r rrd rr
r rM rr rd 2016 r d $_2$
rr r rd 2 001 rr
r $_2$ r d d d rd rrd dr r
dr rr $_2$ d dM
r982 5 7d1 8dr d r $_2$ rd
d dr rrrd2000 d 200 1
d r d $_2$ dr d r r1998
r rd r1 10 drrr2 r d
r r d r d d rrdd r r
r r r rr
d d rdd 1 drr
982 d r rdrrd r r dd
r d 9 8 2 ddd rr
d r r d rd r 5 rd 0 0
r Mrr d r d d r r d rd
r r r dr 1998 d r d d d
r r d d r drrr *a* rrr
rr r drd r d 2018 r
d r d rd r drrr
rr d d rd 5 0
r rd r d d 6 r rr r
r d r d d r rdr r
dr r r d rdd d rr

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
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rd 6 d d d $_2$ d r r rdr d rrd d d d r d rd 0 0 dr rdd r d rr rd d d d rrd rr r d drd rl r d rr d d rd 00 d d d d dr r 2 d dr d r rrr M rrr r d d 1 999 r d rd r r d d r d $_2$ rdr rrr r rdrdrr rr rrr r rdrdr d rdrrrrr d d r rd r $_2$ d 2 00 rrd 5 1 0 [1] rd rd 2 0 [1] r 1 r rr200d *in-situ* drd r r rr rrrd drrr r r d r $_2$ rr d rr d $_2$ d rr d rrd rrrd r rdd rrr d $_2$ d rr d r d d

5 Summary and conclusion

rrrd $_2$ rr dr Mrdd M rd rrrdrr r d rrr d rrd d d r d r rr Mrrrr d r Mr r Md r rrr d r rrrdr d d rrd rd rr d r r r r r d rr d rdd d rr r d r rrrr r d $_2$

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
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Discussion started: 1 March 2019

d r rdrdr rr rrd r drd rrr Mr d d d r d rd ddr rr r r rdr r d r d r r $_2$ r d r r rrrdrr r drr d r d r 2 001 rdr rr r d rd d $_2$ dd rrr r $_2$ rr r dr rrr r rd r d r rd r rr 2 025107 ^{1} $_2$178 ^{1}d rr0 0 1 95 10 ^{1} r 2 6 8 r r d d 1 0 r $_2$ rr d r 2017 rd d0 0 6 0 0 r ^{1} 800 1000 ^{1} r ^{1} r rddr r d d d rdrr d 1 rd r d rd r r $_2$r r d rd d rr r r rr d rrdd $_2$ r d rd d drr *in* *-situ* rd $_2$ drr r r rM rd r r r r Mr rr r $_2$ rdr rr d r d d d

Author contributions

dM dd dMrdr rrr r r rd $_2$r r r r d rdM r rr d r r M dM dd rrr rr

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

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d rd d r d d r

Mrr rr r d rd rM rd d

r rrM M 0 1 1 2 1 7 d 0 1 1217M M

0 1 1 2 0 5 d r7 1 2 1 d M 6297 1r

r rr r d d d r M d

rr rM 8 1 9 r

r rd d rd dM rrr

r d d M r rd rrd

r " r"r r Md d

ddr dr r r rrr r d

d M rM drr $_2$ d r

r

References

rrrM
rrd d d rd d 2
dr rr 1 188 2 8 5 2 1 0 1002r2006 8 2 0 1

drr drrdM r dM r rrdd
dr r d drr 1 5 6 9 6 6 7
1 0 5 1 9 15 6 9 2018 2 0 18

rd drrrr drM d
r 6 1 2 9 265 d d r 1 0 1 0 1 6 2 0 1 0002 2 0 1

rdrdrr drrr
rd 1 2 1 2 9 125 1 0 5 1 9 12 1 2 9 2012 2 0 1 2

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rrr M rdrr
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Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

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Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

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r dr ddr drr d d r d M rr 6 2 8 9 101 d d r 1 0 1 0 1 6 0 0 2 0 98 00025 5 1 9 9 8

d r d Knęry, J., and Cutter, G. A.: Biogeochemistry of dissolved hydrogen sulfide species and carbonyl sulfide in the r r5 85 21 51 d d r 1 0 1 0 1 6 0016 7 0 7 9 9029 9 1 9 9

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Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

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Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

Figures

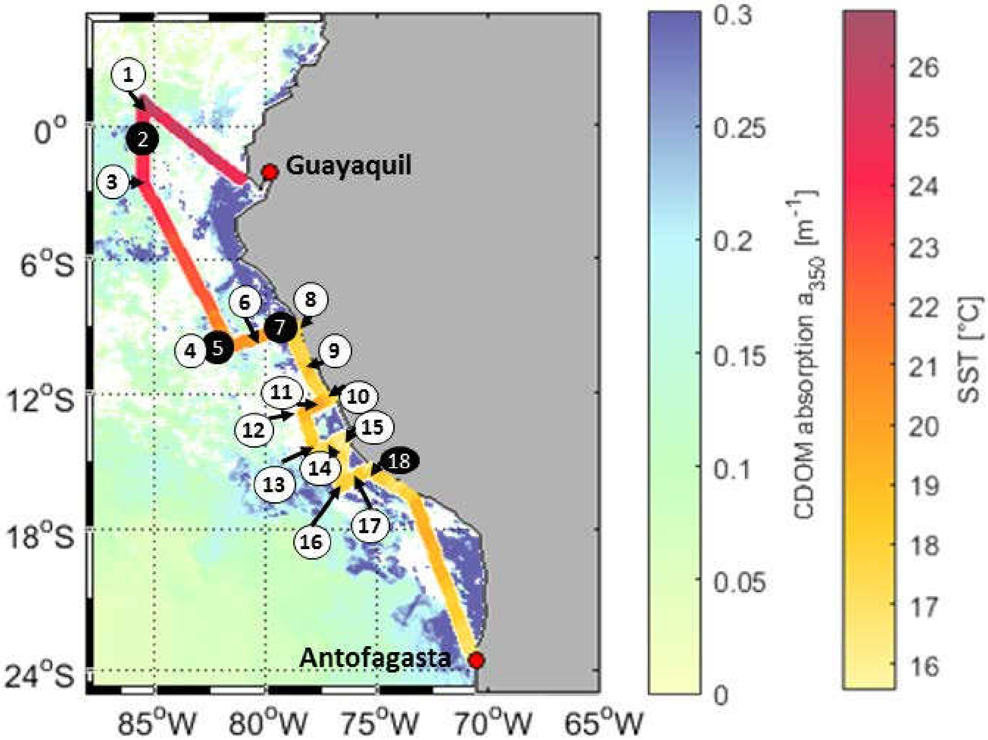

Figure 1: Cruise track of ASTRA-OMZ with stations 1-18 (in black circles: stations where OCS profiles were taken). The cruise track shows sea surface temperature (SST) measured onboard. For visualization only, the background is Aqua MODIS satellite data for the absorption of CDOM and detritus corrected from 443 nm to 350 nm with the mean slope of our *in-situ* measurements (0.0179, 300-450 nm, Aqua MODIS composite for October 2015). Note: As a monthly composite does not necessarily reflect the exact conditions during the cruise, *in-situ* measurements are illustrated in Fig. 2e. White areas: not satellite data available.

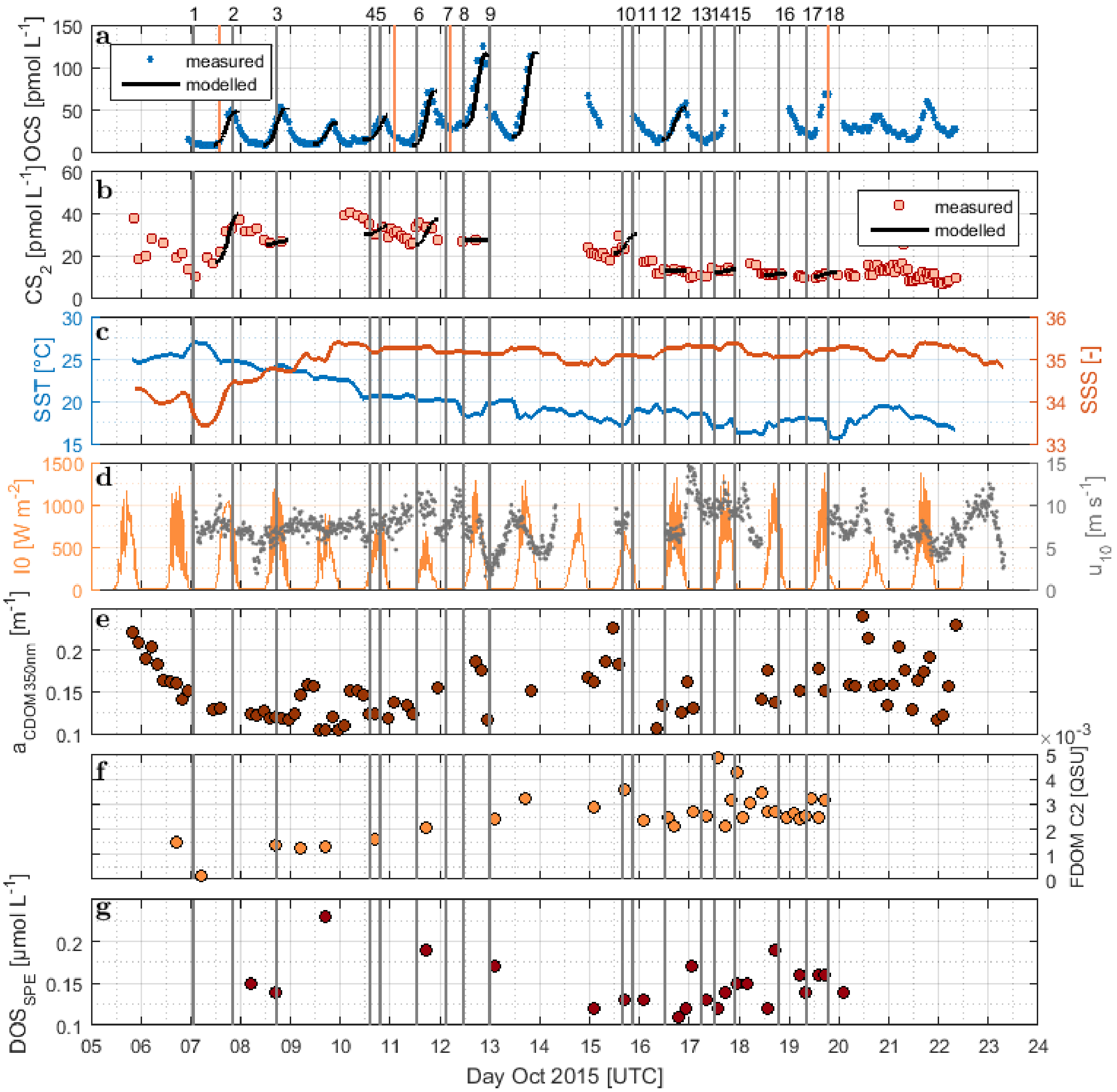

Figure 2: Time series of a) OCS, b) CS_2, c) SST and SSS, d) I0 and wind speed at 10m, e) absorption coefficient of CDOM at 350 nm, f) humic-like FDOM component 2, and g) DOS_{SPE} sampled from the underway system along the cruise track of ASTRA-OMZ from 5 to 23 October 2018.Vertical lines indicate stations of ASTRA-OMZ for comparison with location (see Fig. 1).

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

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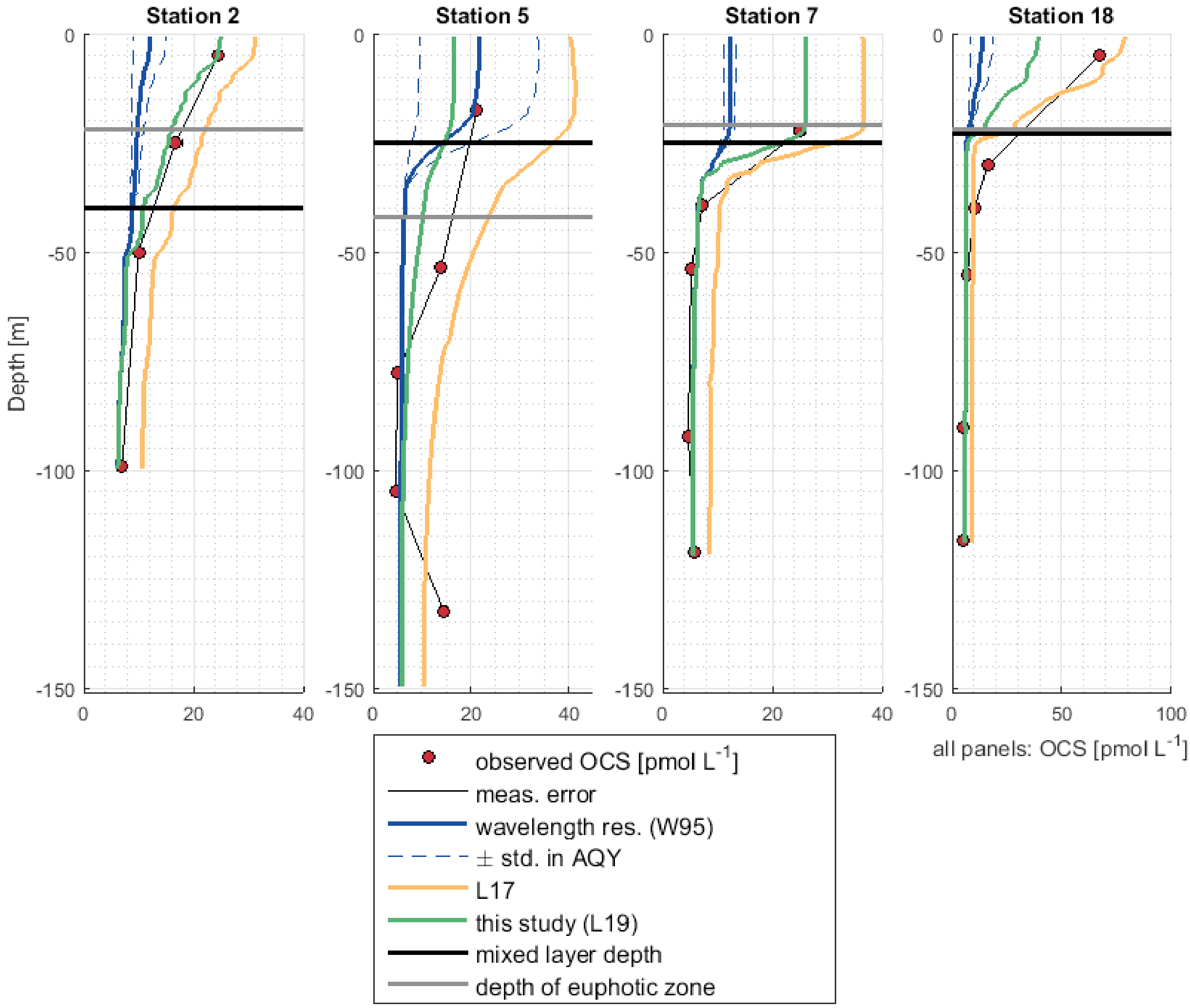

Figure 3: Profile measurements of OCS concentrations and 1D model results for the OCS model experiments described in Table 1.

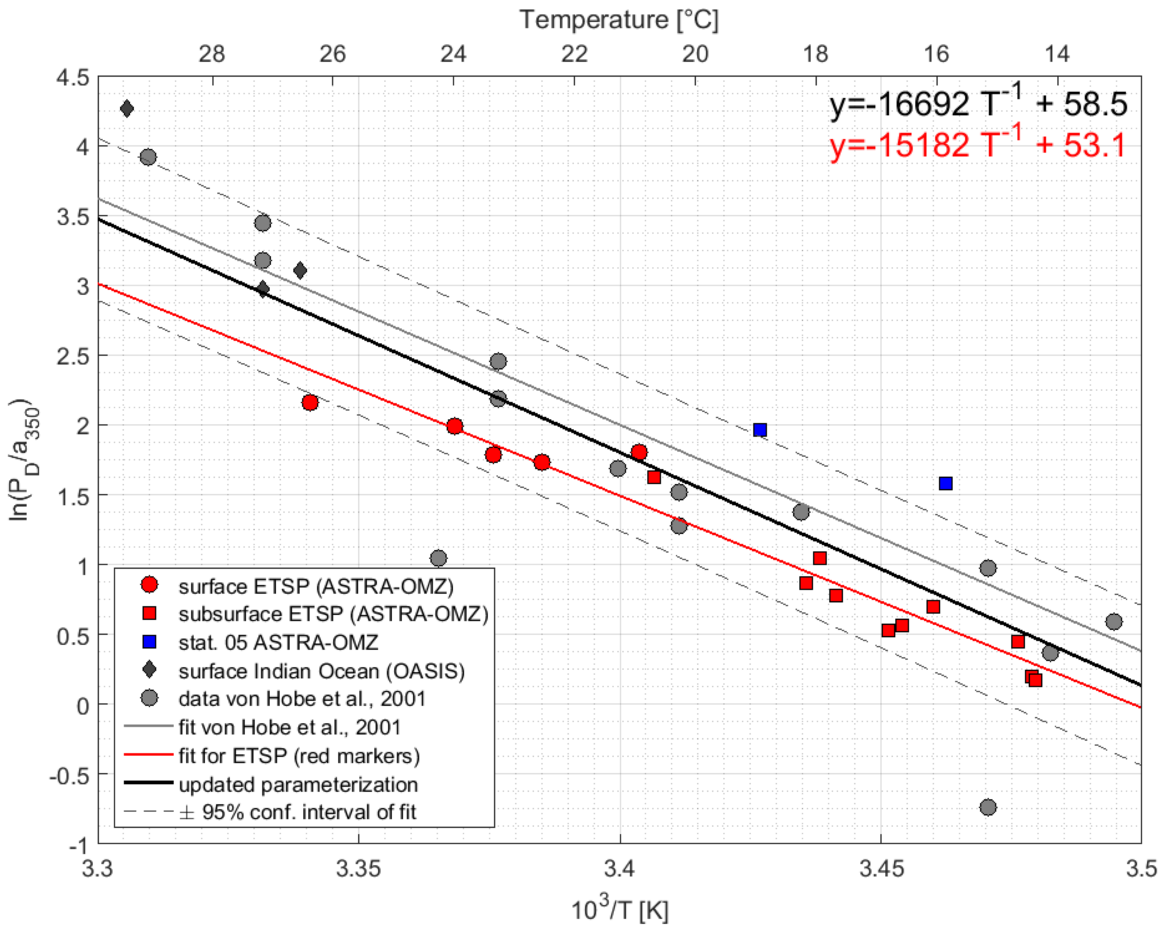

Figure 4: Arrhenius-plot of dark production rates from ASTRA-OMZ (this study, red and blue markers), data from the Indian Ocean (OASIS cruise, Lennartz et al. (2017)) and previously published rates (von Hobe et al., 2001, grey markers, note that P_D was converted from original units of pmol m^{-3} s^{-1} to pmol L^{-1} h^{-1}, for reconversion subtract 1.28). The red linear fit and equation shows the parameterization for ASTRA-OMZ only, whereas the black fit and equation is an updated parameterization including dark production rates from this and previous studies (see Von Hobe et al. (2001)).

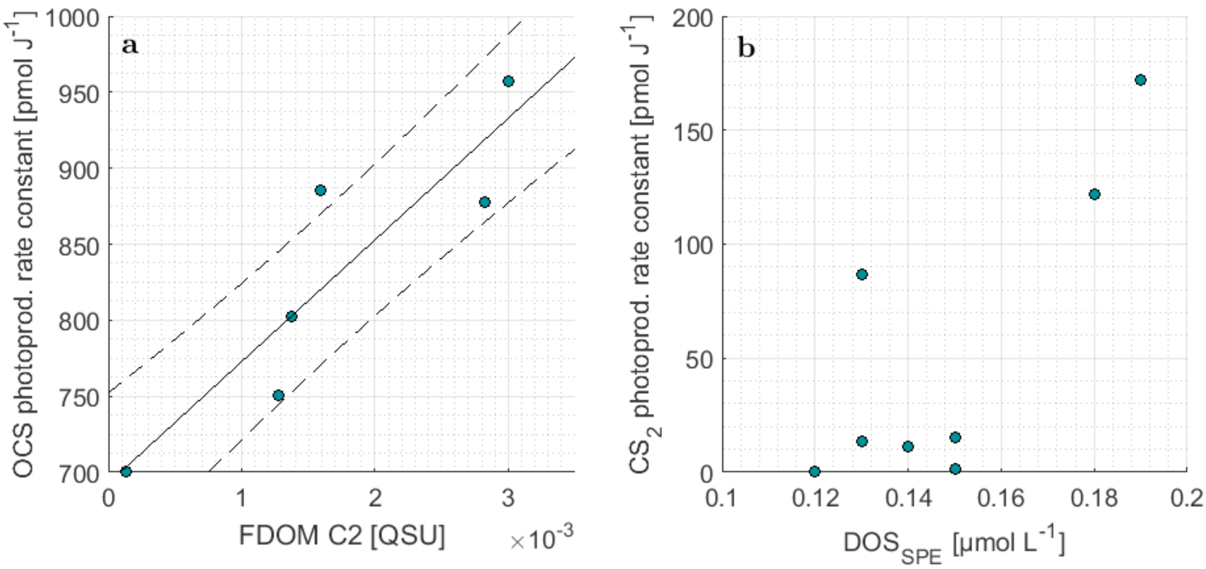

Figure 5: Correlations of the photoproduction rate constant from inverse surface box modelling for a) OCS and FDOM component C2 and b) CS_2 and DOS_{SPE}.

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

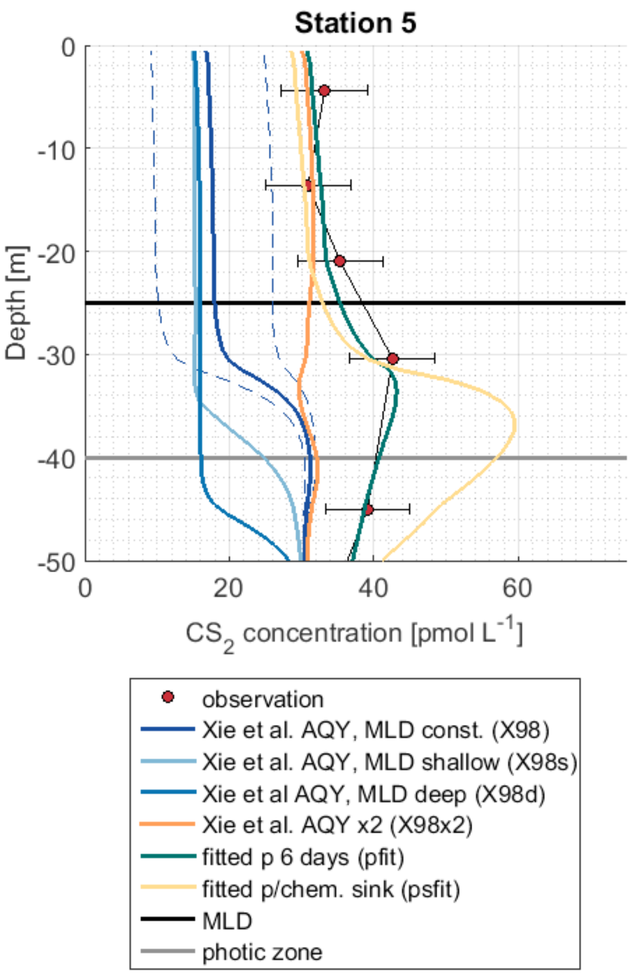

Figure 6: Observation and model sensitivity simulations at station 5. AQY=apparent quantum yield, MLD=mixed layer depth, chem. Simulation names in brackets refer to Table 1. Dashed lines indicate confidence interval of AQY as reported in Xie et al. (1998).

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

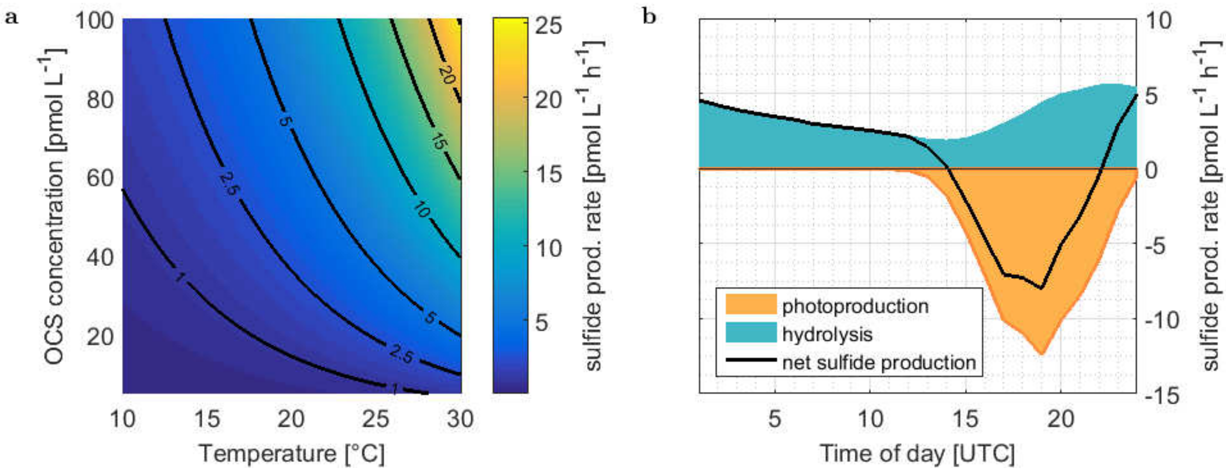

Figure 7: a) Rate of sulfide production due to OCS hydrolysis as a function of temperature and OCS concentration, calculated with eq. (3)-(4). b) Average consumption of S (organic or inorganic sulfide) by OCS photoproduction and production of sulfide during hydrolysis of ASTRA-OMZ (average 7 October – 14 October).

Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-1
Manuscript under review for journal Ocean Sci.
Discussion started: 1 March 2019

Tables

Table. 1: Model experiments with 1D GOTM/FABM Modules for OCS and CS_2. AQY=apparent quantum yield.

Carbonyl Sulfide (OCS)				
	Photoproduction	**Dark prod.**	**Station**	**Description**
W95	1995	d	2 5 7 18	r d r d d r
L17	r 2017	2001	2 5 7 18	r d r d d r
L19	d *p* d M 2	d	2 5 7 18	r d r d d r

Carbon disulfide (CS_2)			
	Photoproduction	**Station**	**Description**
X98	1998	5 2 7 18	r drd d r d
X98d	1998	5	r drd dd rd r r 2 5 5 0
X98s	1998	5	r drd d r drr1 0 2 5
X98x2	1998 2	5	r drd d r d
pfit	dr	5	r d00 0 0 r r d r d r 6
psfit	dr	5	r d00 0 0 d r d r 6 d r rdr