


Supplement of Atmos. Chem. Phys., 17, 385–402, 2017  
<http://www.atmos-chem-phys.net/17/385/2017/>  
doi:10.5194/acp-17-385-2017-supplement  
© Author(s) 2017. CC Attribution 3.0 License.



Atmospheric  
Chemistry  
and Physics  
Open Access  


*Supplement of*

## **Direct oceanic emissions unlikely to account for the missing source of atmospheric carbonyl sulfide**

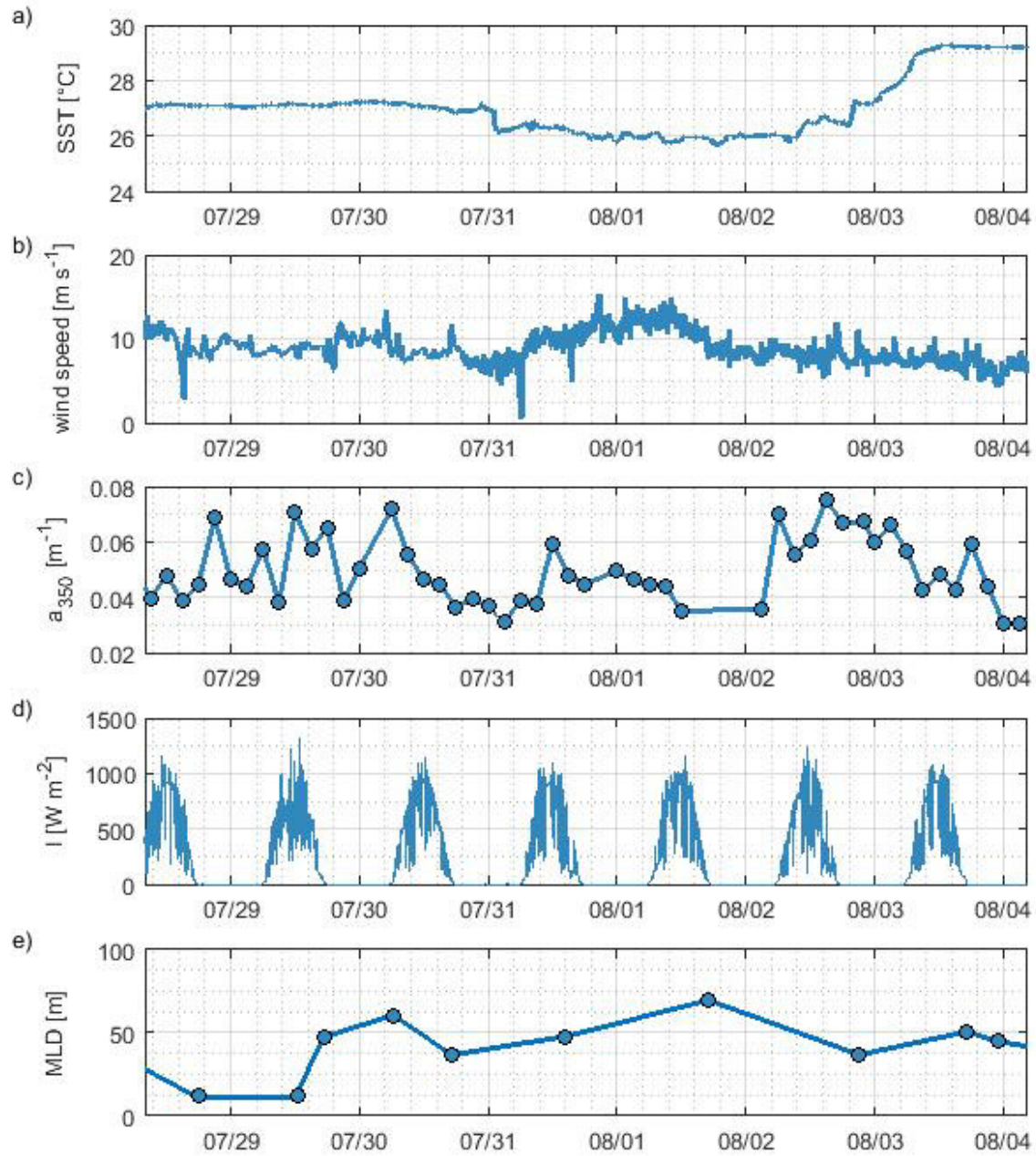
**Sinikka T. Lennartz et al.**

*Correspondence to:* Sinikka T. Lennartz ([slennartz@geomar.de](mailto:slennartz@geomar.de))

The copyright of individual parts of the supplement might differ from the CC-BY 3.0 licence.

24 **Supplementary figures**

25

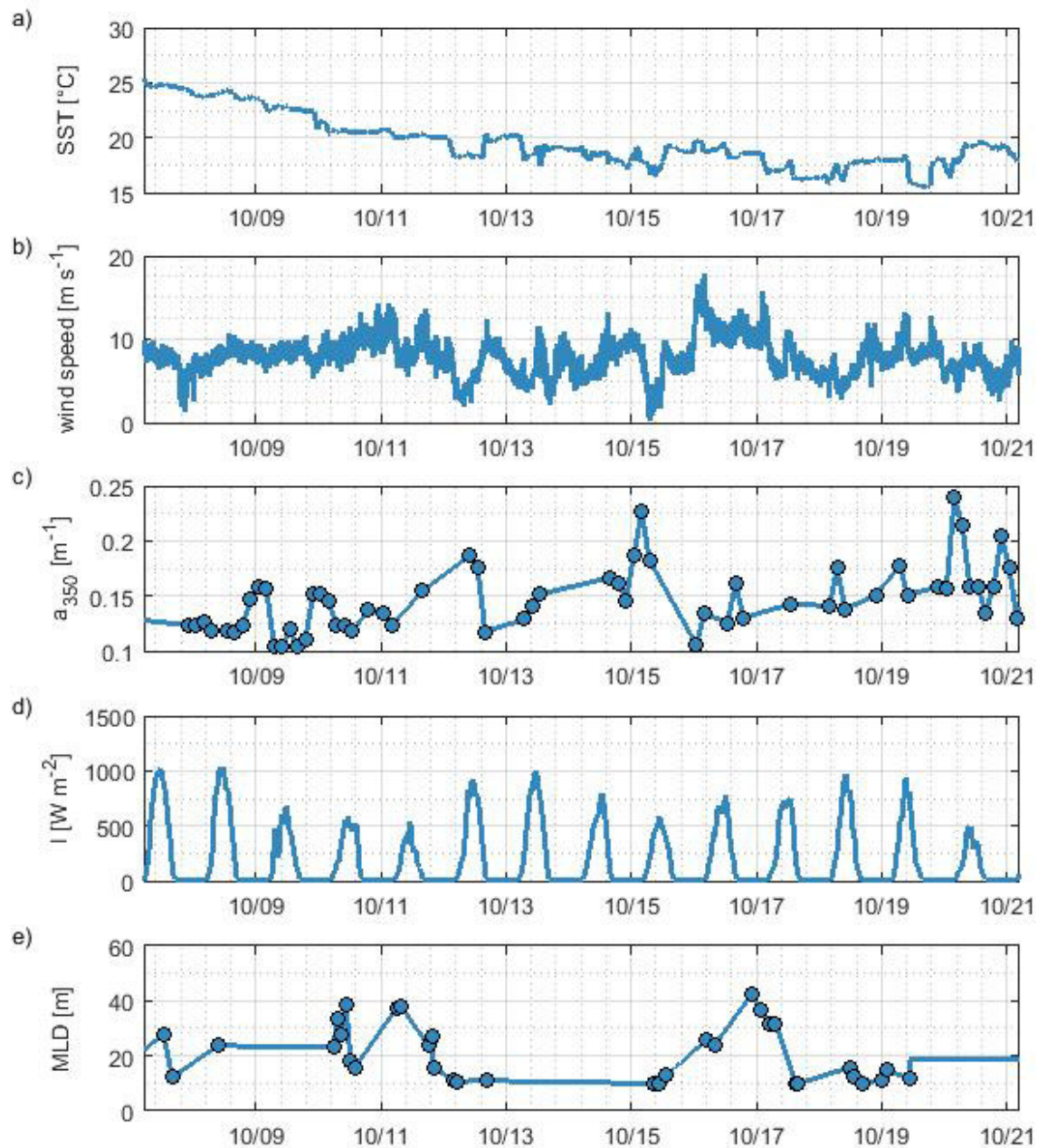


26

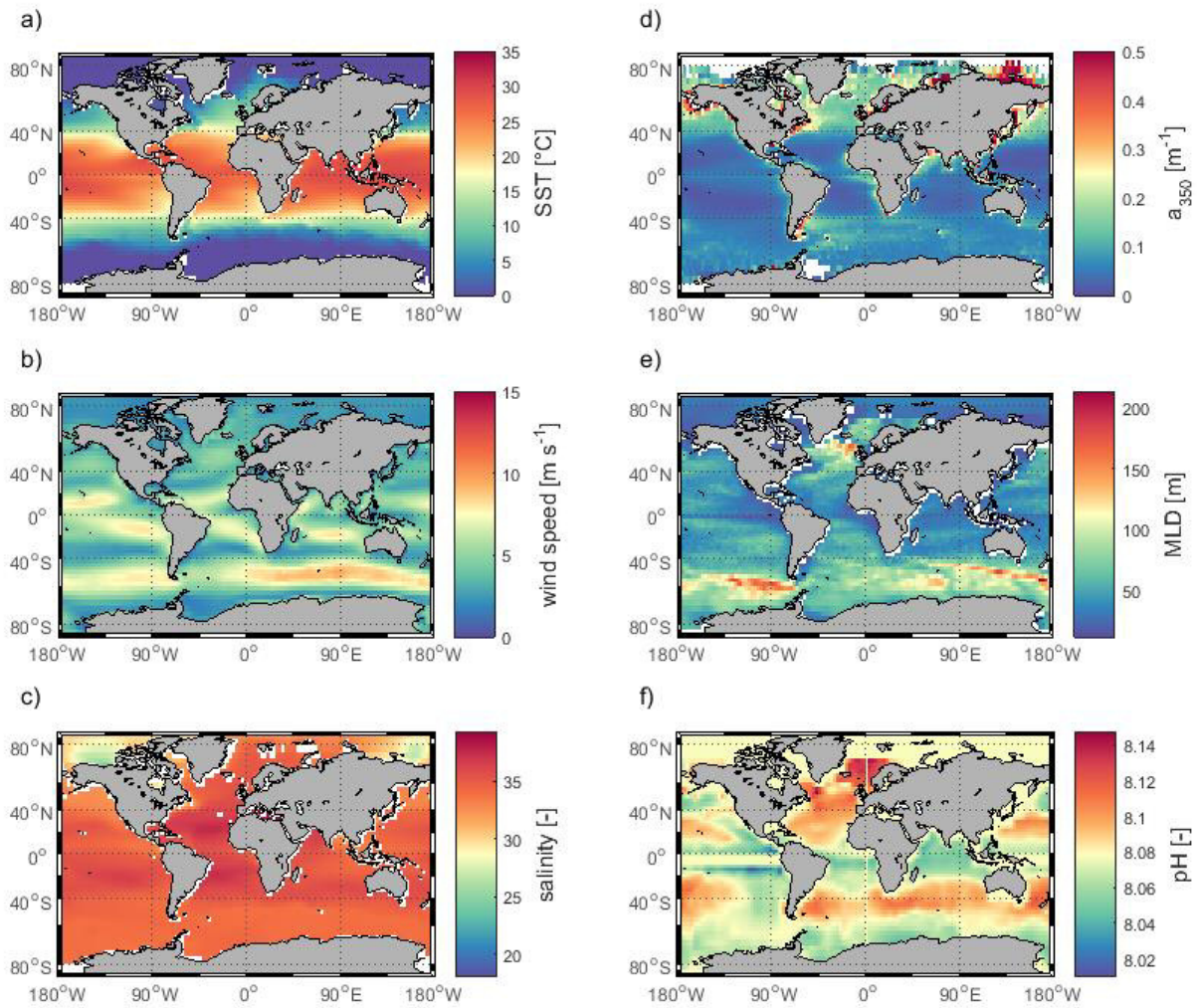
27 S-Fig 1: Input parameters for case study box model simulation for the OASIS cruise to the Indian Ocean

28 for a) SST, b) wind speed corrected to 10 m height, c) absorption at 350 nm, d) global radiation, e) mixed

29 layer depth; all measured directly onboard RV SONNE I in 2014.



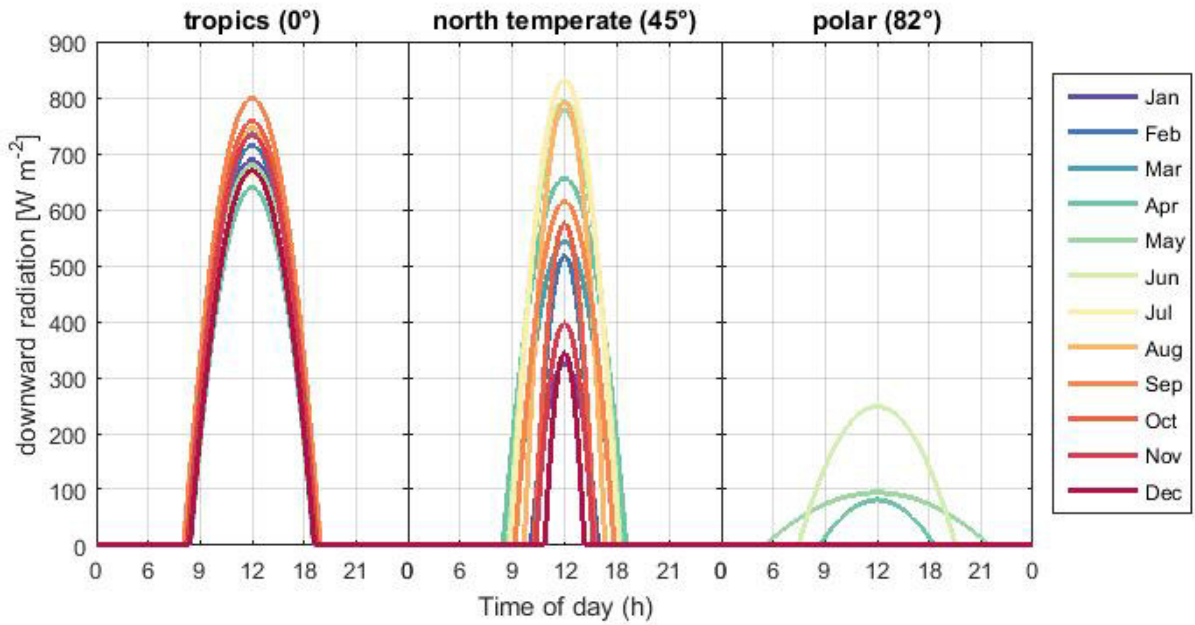
31  
 32 S-Fig 2: Input parameters for case study box model simulation for the ASTRA-OMZ cruise to the eastern  
 33 Pacific Ocean for a) SST, b) wind speed corrected to 10 m height, c) absorption at 350 nm, d) global  
 34 radiation, e) mixed layer depth; all measured directly onboard RV SONNE II in 2015.



35 S-Fig 3: Annual mean for input parameters of a) sea surface temperature SST, b) wind speed, c) salinity,  
 36 d) absorption of CDOM at 350 nm  $a_{350}$ , e) mixed layer depth, and f) pH. Details on data sources can be  
 37 found in S-Tab. 4.  
 38

39  
 40  
 41  
 42  
 43  
 44  
 45  
 46  
 47  
 48  
 49  
 50





52

53

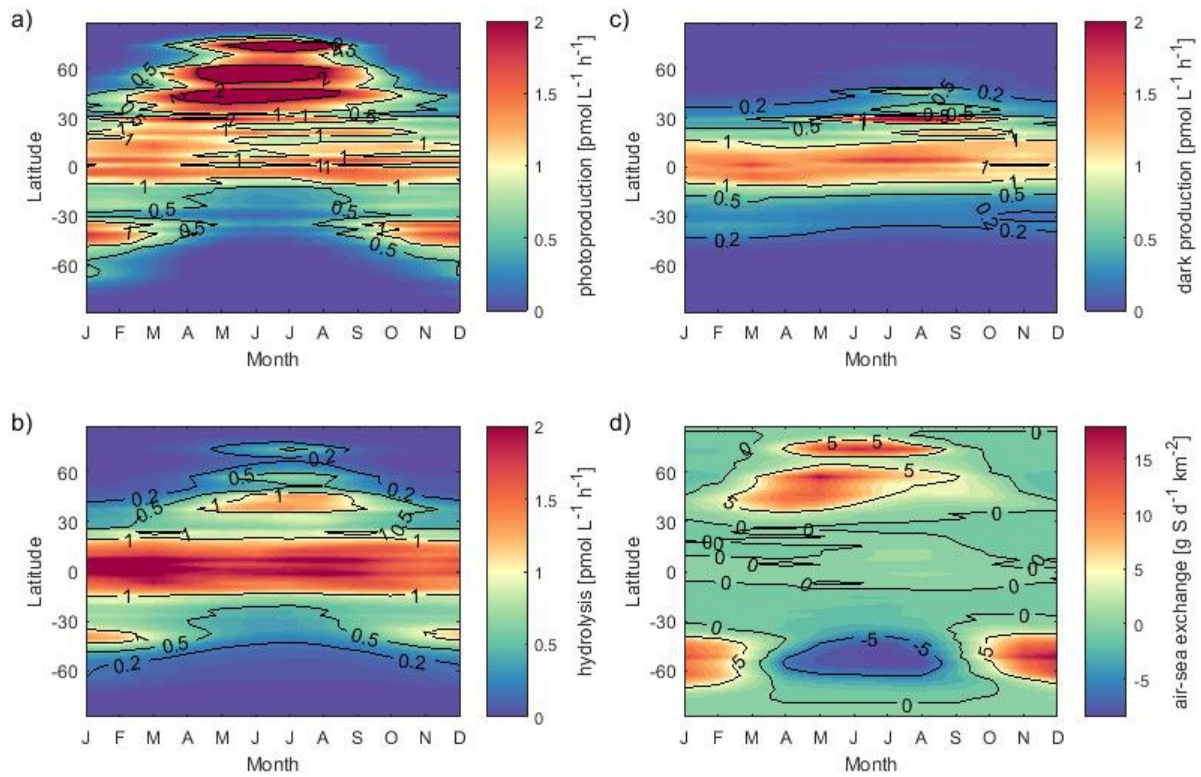
54 S-Fig. 4: Diurnal cycles of downward radiation from the tropics, north temperate and polar regions

55 resulting from fitting a parable to the sunshine duration and downwelling radiance from ERAInterim (Eq.

56 13, S-Tab. 4). Color coding refers to mean monthly diurnal cycles.

57

58



59 S-Fig. 5: Rates of a) photoproduction (average of the mixed layer), b) hydrolysis, c) dark production and  
 60  
 61 d) air sea exchange in the mixed layer for each month and latitude from the box model simulation.

62

63

64

65

66

67

68

69

70

71

72

73

74

75

76

77

78

79

80

81

82

83 **Supplementary tables**

84 S-Tab. 1: Input parameter for the box model for the OASIS cruise (Indian Ocean). Measurements were  
 85 linearly interpolated to a time grid of 2 minute resolution.

86

<b>Parameter</b>	<b>Data source</b>
global radiation	shipboard meteorological equipment, 10 minute mean
CDOM absorption spectrum	measured onboard, ca. 3-hour resolution, LWCC setup(Miller et al., 2002)
sea surface temperature	continuously (every minute) measured at seawater intake for underway system, Seabird MicroCat SBE41
sea surface salinity	continuously (every minute) measured at seawater intake for underway system, Seabird MicroCat SBE41
pH	calculated from dissolved inorganic carbon and alkalinity sampled at seawater intake from underway system, ca. 3-hourly resolution
wind speed	measured onboard, corrected to 10 m height, 10 minute averages
atm. volume mixing ratio of OCS	sampled onboard, ca. 3-hourly resolution, air canister samples analysed at RSMAS(Schauffler et al., 1998; de Gouw et al., 2009)
mixed layer depth	obtained from CTD profiles, using the Lorbacher(Lorbacher et al., 2006) criterion, 1-2 times per day
sea level air pressure	measured onboard, 10 minute averages

87

88

89 S-Tab. 2: Input parameter for the box model for the ASTRA-OMZ cruise (Pacific Ocean). Measurements  
 90 were linearly interpolated to a time grid of 2 minute resolution.

91

<b>Parameter</b>	<b>Data source</b>
global radiation	shipboard meteorological equipment, 10 minute mean
CDOM absorption spectrum	measured onboard, ca. 3-hour resolution, LWCC setup(Miller et al., 2002)
sea surface temperature	continuously (every minute) measured at seawater intake for underway system, Seabird MicroCat SBE41
sea surface salinity	continuously (every minute) measured at seawater intake for underway system, Seabird MicroCat SBE41
pH	mean value of 8.1 assumed (minor sensitivity to pH confirmed in sensitivity tests)
wind speed	measured onboard, corrected to 10 m height, 10 minute averages
atm. volume mixing ratio of OCS	sampled onboard, ca. 3-hourly resolution, air canister samples analysed at RSMAS(Schauffler et al., 1998; de Gouw et al., 2009)
mixed layer depth	obtained from CTD profiles, using the Lorbacher(Lorbacher et al., 2006) criterion, 0-4 times per day
sea level air pressure	measured onboard, 10 minute averages

92

93

94



95 S.-Tab 3: Input parameter for the global box model. Data was linearly interpolated to a time grid of 2 h  
 96 resolution.

97

<b>Parameter</b>	<b>Input</b>
Global radiation	Diurnal cycle fitted to downwards radiation and sunshine duration from 2014 ERAInterim reanalysis data (ECMWF)
CDOM absorption 350 nm	MODIS Aqua satellite data “absorption due to gelbstoff and detritus 443 nm”, GIOP model, corrected to 350nm assuming an exponential spectrum, climatological monthly mean 2002-2014(NASA, 2014)
sea surface temperature	ERAInterim reanalysis, climatology from 2002-2014 synoptic monthly means(Dee et al., 2011)
sea surface salinity	World Ocean Atlas climatology(Antonov et al., 2010)
pH	Takahashi climatology(Takahashi et al., 2014)
wind speed	ERAInterim reanalysis, climatology from 2002-2014 synoptic monthly means
atm. volume mixing ratio for OCS	assumed 550 ppt
mixed layer depth	MIMOC climatology(Schmidtko et al., 2013)
sea level air pressure	ERAInterim reanalysis, climatology from 2000-2014 synoptic monthly means
initial condition	8 pmol L <sup>-1</sup>
spin-up until stable global mean	2 years

98

99

100

## References

- Antonov, J. I., Seidov, D., Boyer, T. P., Locarnini, R. A., Mishonov, A. V., Garcia, H. E., Baranova, O. K., Zweng, M. M., and Johnson, D. R.: World ocean atlas 2009, volume 2: Salinity, in, edited by: Levitus, S., Government Printing Office, Washington, D.C., NOAA Atlas NESDIS 69, 184, 2010.
- de Gouw, J. A., Warneke, C., Montzka, S. A., Holloway, J. S., Parrish, D. D., Fehsenfeld, F. C., Atlas, E. L., Weber, R. J., and Flocke, F. M.: Carbonyl sulfide as an inverse tracer for biogenic organic carbon in gas and aerosol phases, *Geophysical Research Letters*, 36, n/a-n/a, 10.1029/2008gl036910, 2009.
- Dee, D. P., Uppala, S. M., Simmons, A. J., Berrisford, P., Poli, P., Kobayashi, S., Andrae, U., Balmaseda, M. A., Balsamo, G., Bauer, P., Bechtold, P., Beljaars, A. C. M., van de Berg, L., Bidlot, J., Bormann, N., Delsol, C., Dragani, R., Fuentes, M., Geer, A. J., Haimberger, L., Healy, S. B., Hersbach, H., Hólm, E. V., Isaksen, I., Kållberg, P., Köhler, M., Matricardi, M., McNally, A. P., Monge-Sanz, B. M., Morcrette, J. J., Park, B. K., Peubey, C., de Rosnay, P., Tavolato, C., Thépaut, J. N., and Vitart, F.: The era-interim reanalysis: Configuration and performance of the data assimilation system, *Quarterly Journal of the Royal Meteorological Society*, 137, 553-597, 10.1002/qj.828, 2011.
- Lorbacher, K., Dommenges, D., Niiler, P. P., and Köhl, A.: Ocean mixed layer depth: A subsurface proxy of ocean-atmosphere variability, *Journal of Geophysical Research: Oceans*, 111, n/a-n/a, 10.1029/2003jc002157, 2006.
- Miller, R. L., Belz, M., Del Castillo, C., and Trzaska, R.: Determining cdom absorption spectra in diverse coastal environments using a multiple pathlength, liquid core waveguide system, *Continental Shelf Research*, 22, 1301-1310, 10.1016/s0278-4343(02)00009-2, 2002.
- Modis-aqua ocean color data, 2014.
- Schauffler, S. M., Atlas, E. L., Flocke, F., Lueb, R. A., Stroud, V., and Travnicek, W.: Measurements of bromine containing organic compounds at the tropical tropopause, *Geophysical Research Letters*, 25, 317-320, 10.1029/98gl00040, 1998.
- Schmidtko, S., Johnson, G. C., and Lyman, J. M.: Mimoc: A global monthly isopycnal upper-ocean climatology with mixed layers, *Journal of Geophysical Research-Oceans*, 118, 1658-1672, 10.1002/jgrc.20122, 2013.
- Takahashi, T., Sutherland, S. C., Chipman, D. W., Goddard, J. G., Ho, C., Newberger, T., Sweeney, C., and Munro, D. R.: Climatological distributions of ph, pco<sub>2</sub>, total co<sub>2</sub>, alkalinity, and caco<sub>3</sub> saturation in the global surface ocean, and temporal changes at selected locations, *Marine Chemistry*, 164, 95-125, 10.1016/j.marchem.2014.06.004, 2014.