OIF: geochemical / atmospheric consequences

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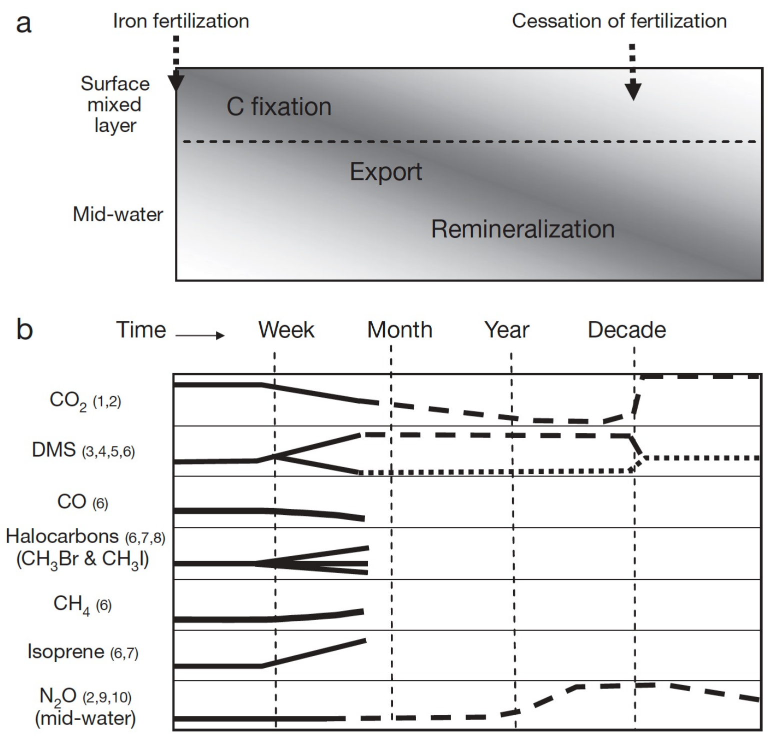
Ocean/atmosphere exchange processes influenced by OIF

- Rapid vs. delayed response

- Long term vs short term effects

- Positive or negative feedbacks on CDR

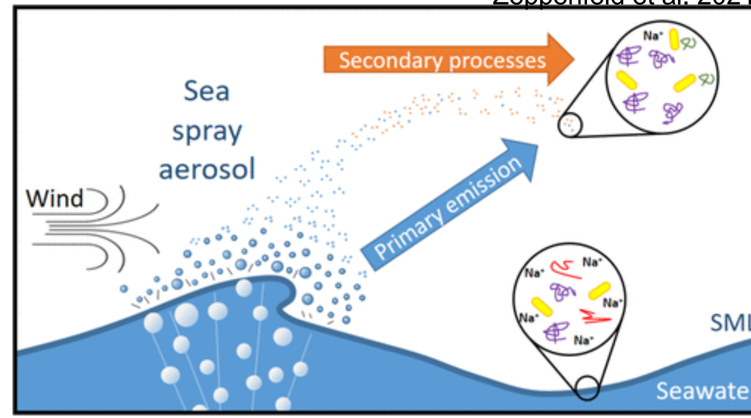


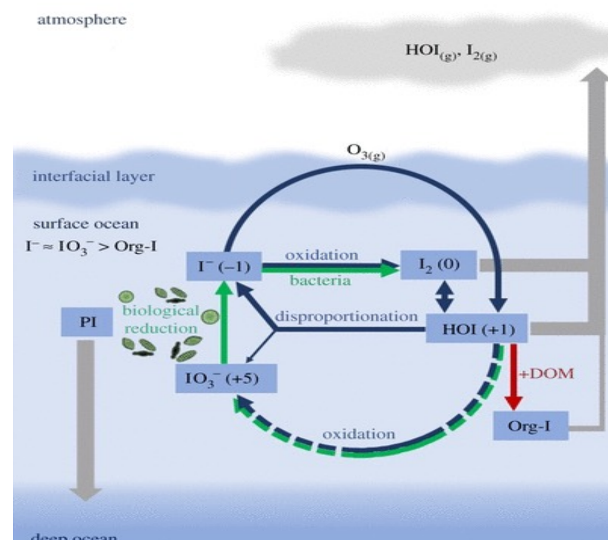
Law 2008

Additional ocean/atmosphere exchange processes potentially influenced by OIF

- Other potentially important trace gases: e.g. methylamines / ammonia
- Biological contributions to primary aerosols
- Surface chemical reactions: O_3 and Iodine cycle

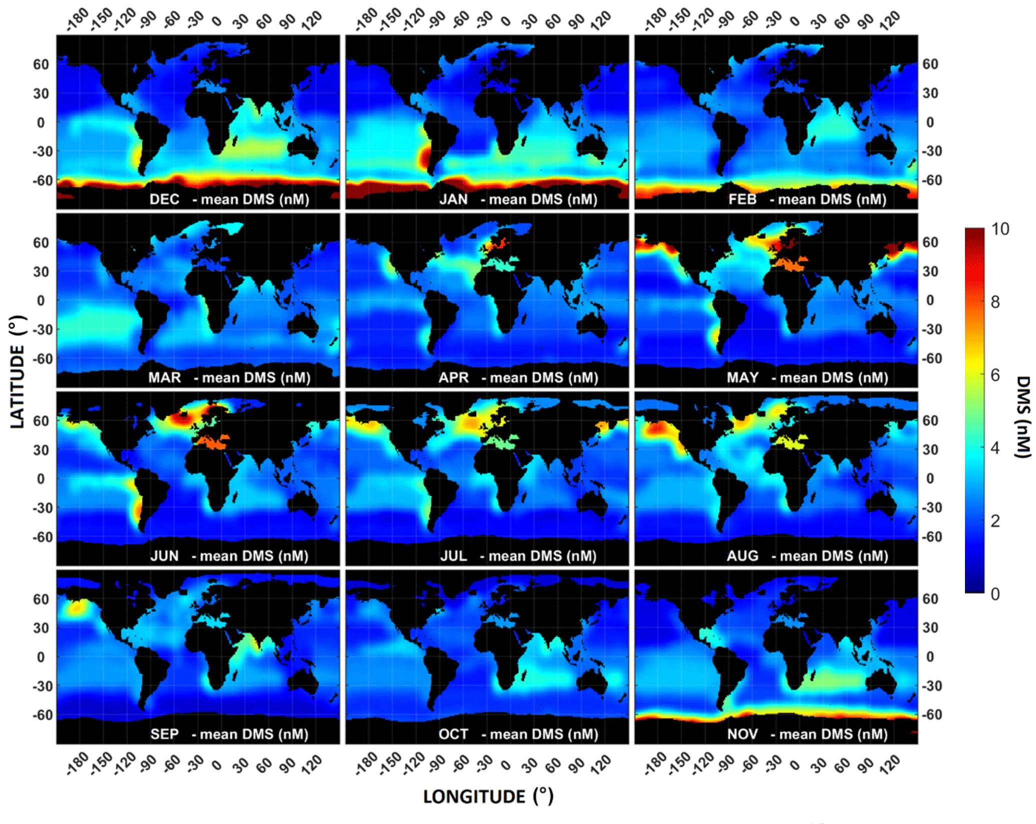
Zeppenfeld et al. 2021





Carpenter et al. 2021

Global distributions of surface water DMS: particularly important in the SO



Hulswar et al. 2022

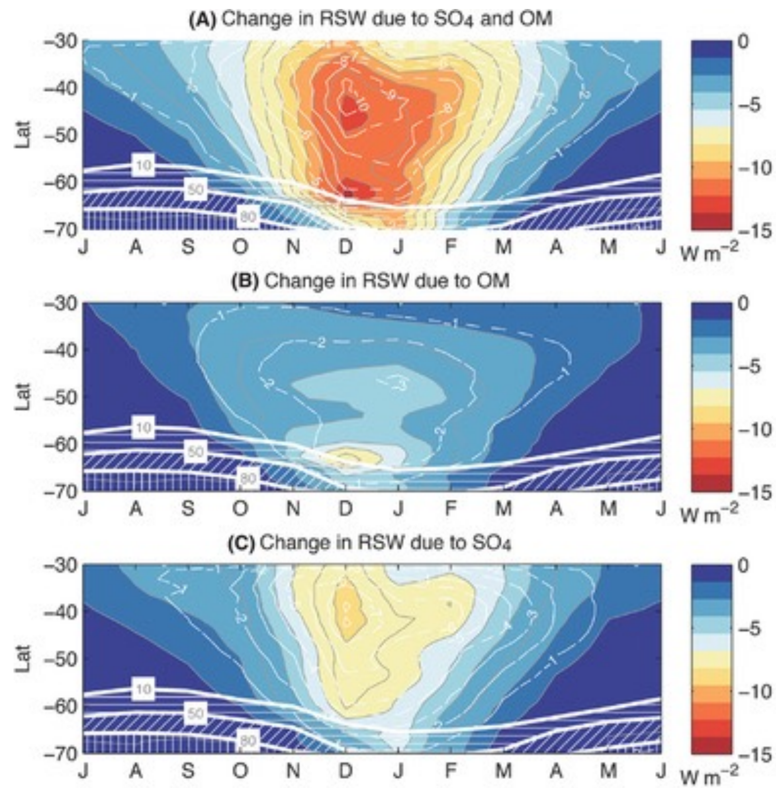
Radiative impact of biogenic SO_4 and primary aerosols

- Satellite obs. chlorophyll, cloud droplet number (MODIS)

- Modelled aerosol formation processes:

- biogenic SO_4 (DMS)
- sea surface organic matter

- Allow total Reflected Shortwave radiation (RSW) to be apportioned



Highest biogenic contributions occur in the summer (> 10 Wm^{-2})

Match highest anthropogenic sources in the Northern Hemisphere

McCoy et al. 2015

Scales of response: OIF experiments Southern Ocean: DMS(P)

IronEx II

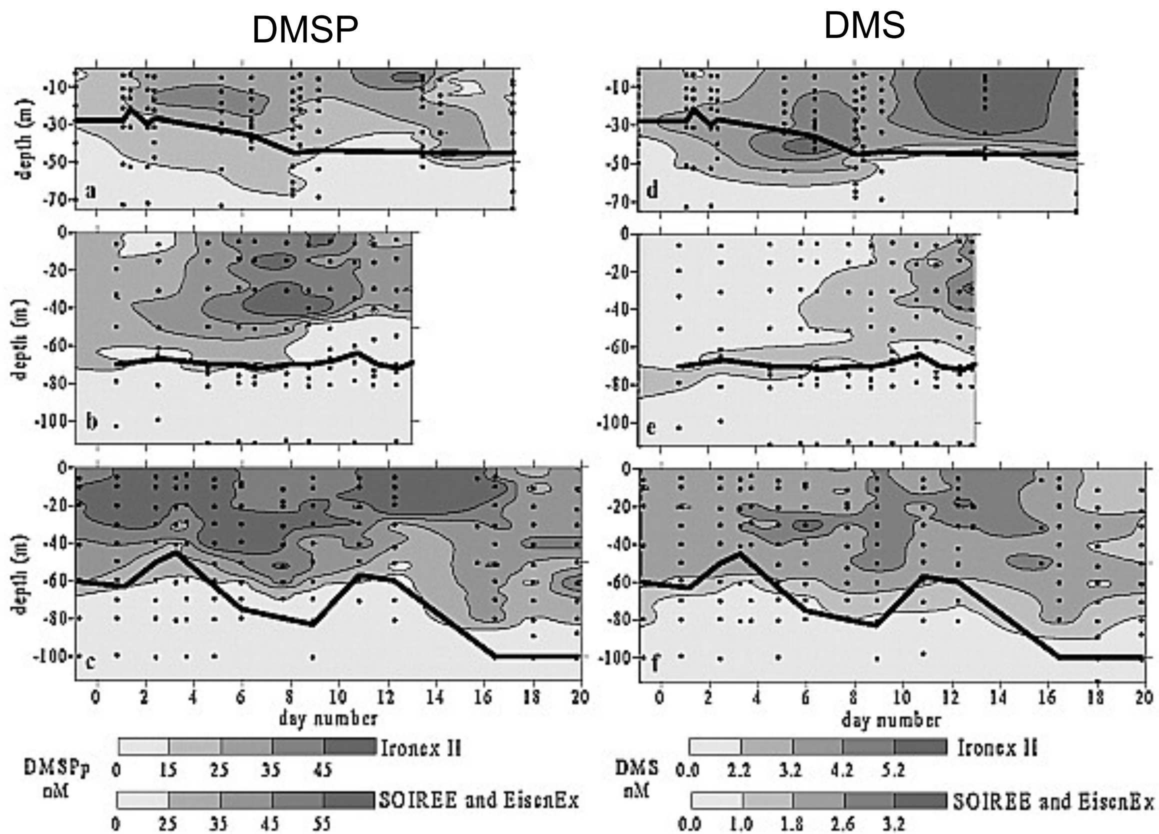
	DMS (nM)
Start:	2.5
In:	4.2 (t17)
Out:	2.4

SOIREE

	DMS (nM)
Start:	0.5
In:	3.4 (t13)
Out:	0.5

EisenEx

	DMS (nM)
Start:	1.9
In:	3.1 (t12)
Out:	1.8

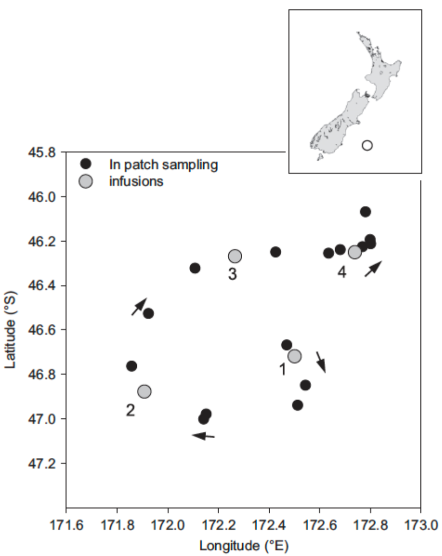


Turner et al. 2004

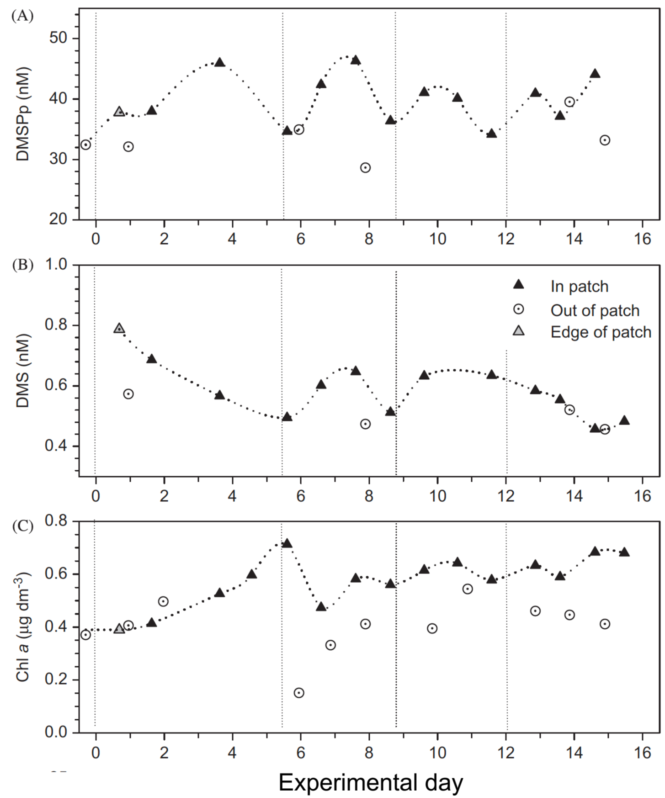
Scales of response: OIF experiments Southern Ocean: DMS(P)

SAGE

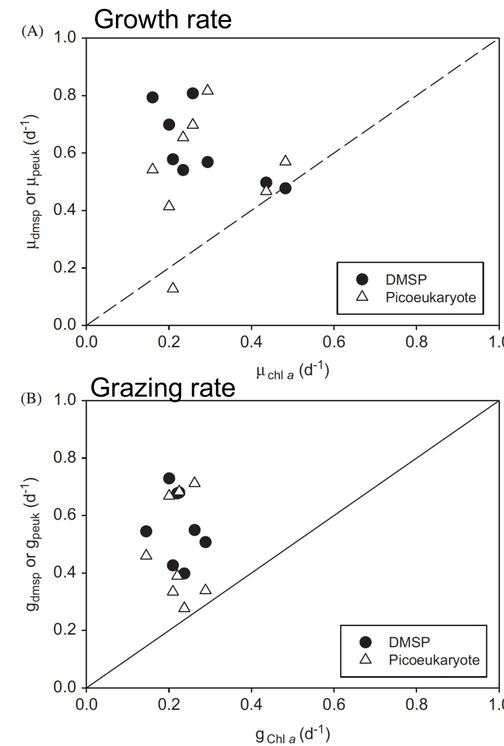
	DMS (nM)
Start:	0.7
In:	0.5 (t16)
Out:	0.5



Temporal dynamics: DMS(P) and Chl.



Picoeukaryotes, DMSP vs Chl

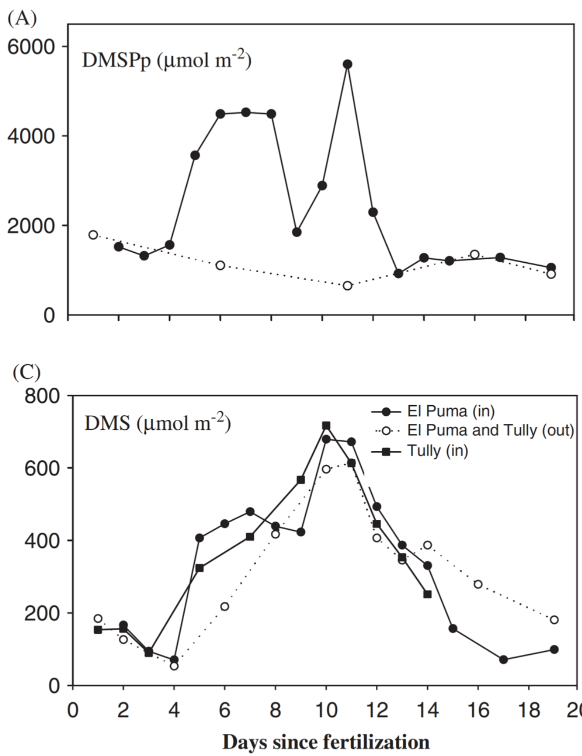


Archer et al. 2011

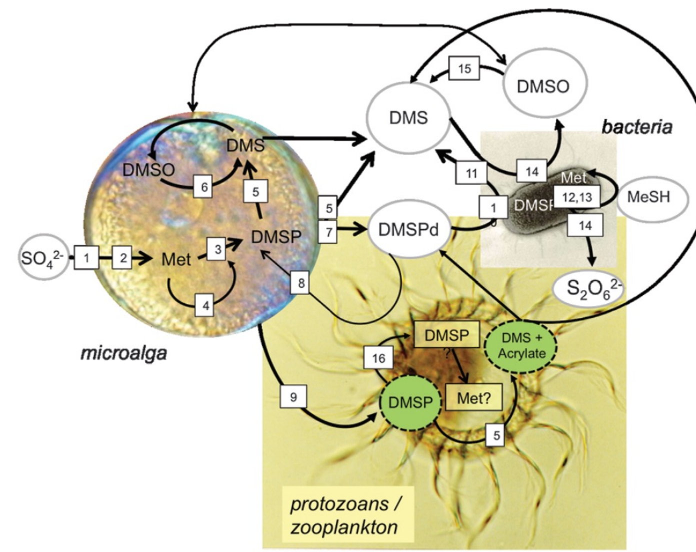
Scales of response: OIF experiments NW Pacific: DMS

SERIES

	DMS (nM)
Start:	16
In:	26 (t10)
Out:	26



- In patch: ~6-fold increase in DMSP vs. outside
- But equally high rates of DMS production inside and outside
- Net DMS production complex balance of production and loss processes

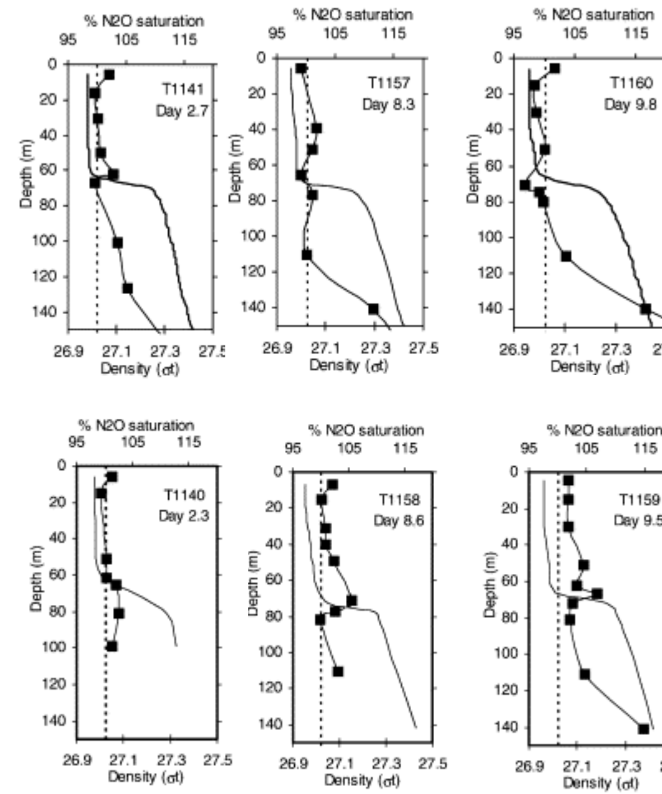


Observations during OIF experiments: Rapid N_2O response

Measured during SOIREE and EIFEX, and SERIES

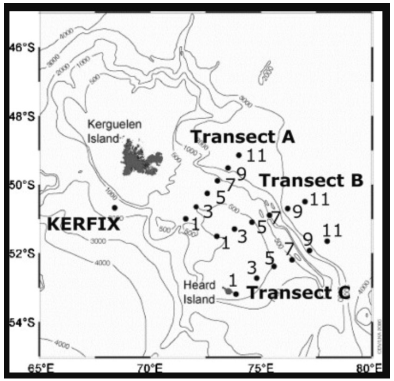
- No significant differences in ML concentrations
- Evidence of ~ 10% increase in N_2O saturation in pycnocline
- Differences possibly related to rates of export

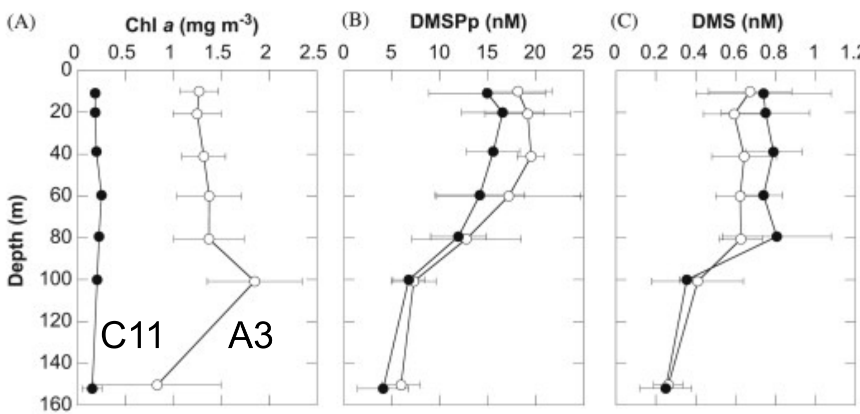
SOIREE: N_2O

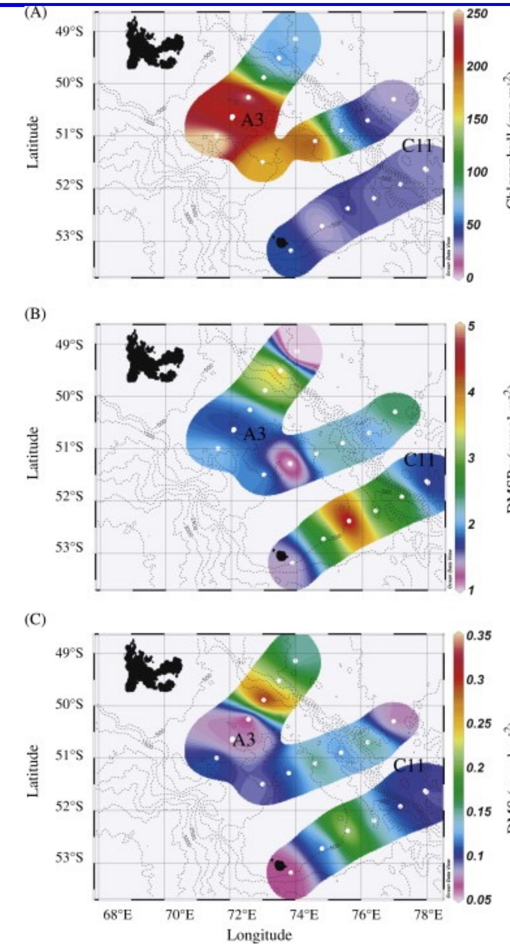


Law and Ling 2001

Longer term iron additions on DMS: KEOPS 2005







Belviso et al. 2008

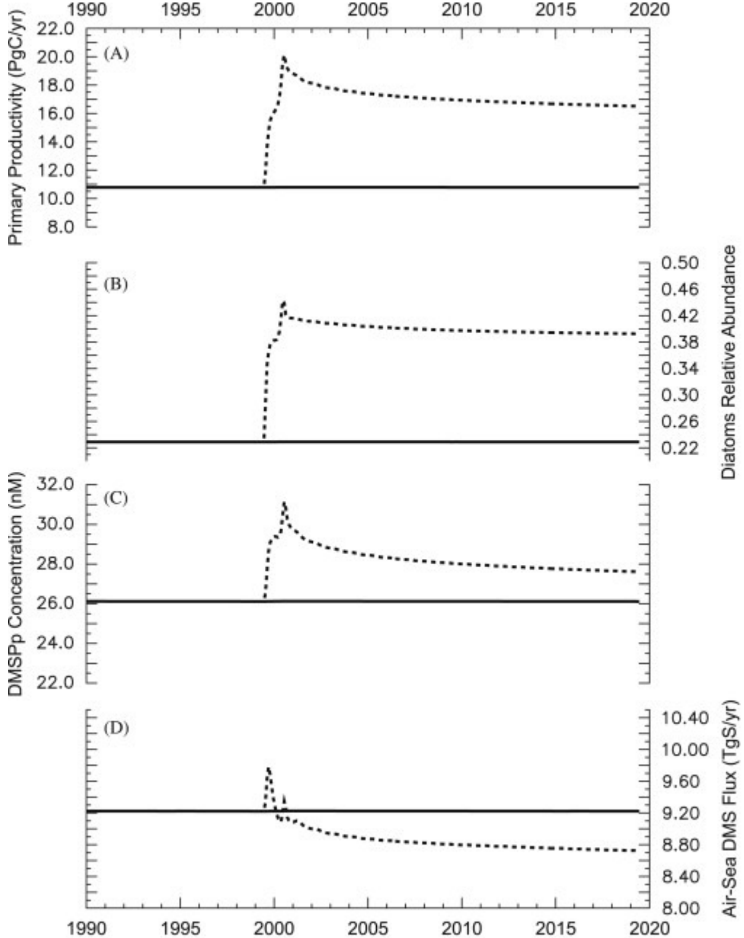
Longer term iron additions on DMS: Modelling

PISCES Model

- 20-year long-term iron-fertilization
- 2 nM dFe added
- for the SO south 40^{o}S

When diatoms are abundant:

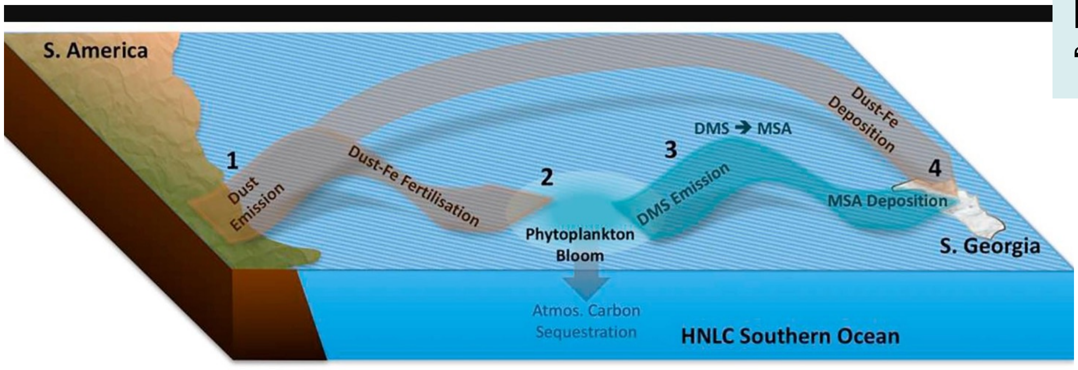
1. Low S/C cell quotas
2. Low efficiency % DMSP to DMS
3. High bacterial DMS consumption

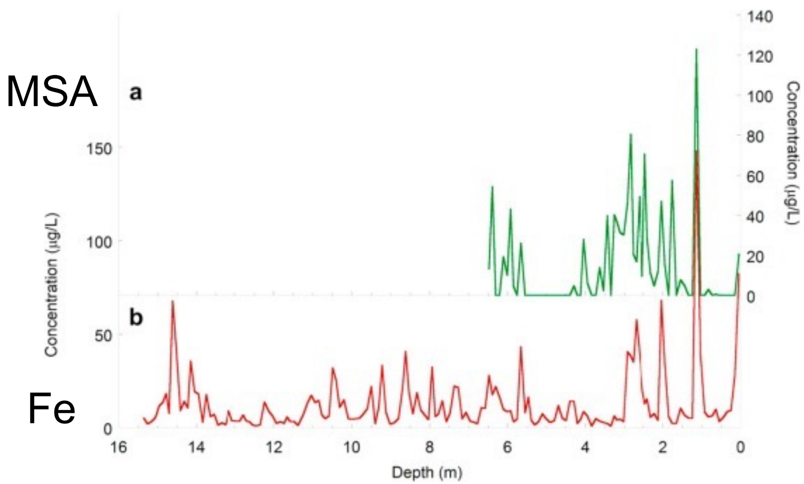


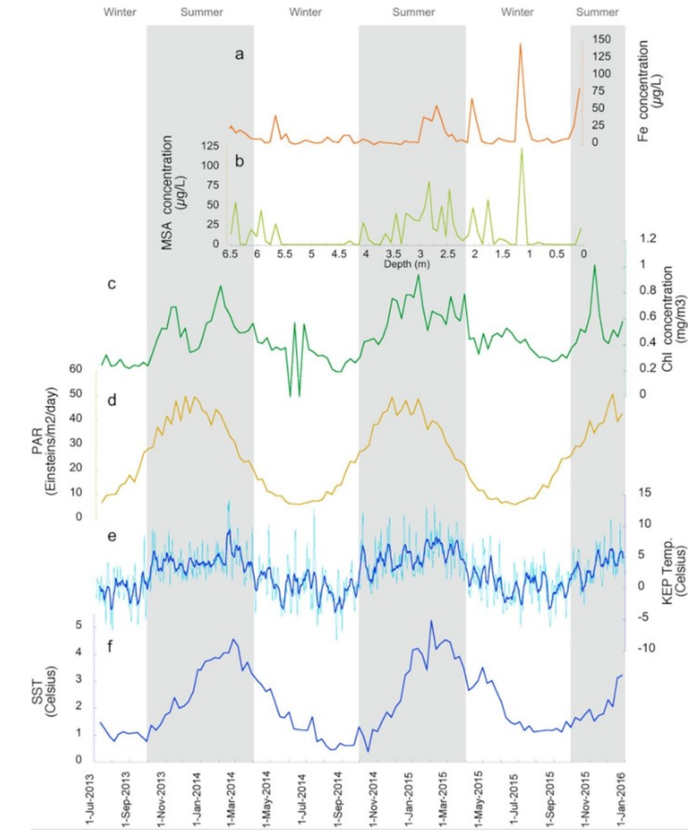
Bopp et al. 2008

Natural proxies: ice core records of MSA and dust deposition

In this case – interesting because of ‘daily’ resolution.







Hooper et al. 2019

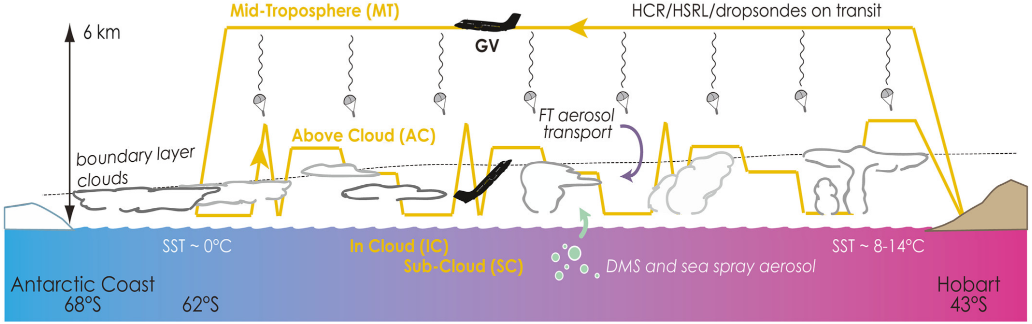
We have some advantages compared to 10+ years ago:

- Improved understanding of ocean and atmospheric processes
  - workshop series, reassess 'unintended' consequences?
  – which processes may really cause significant feedbacks?

- Make use of increasingly good atmosphere/ocean coupled models

- Improvements to analytical capabilities – e.g. higher resolution and sensitivity of trace gas measurements

- Design experiments that incorporate relevant atmospheric /sateliite obs



2018 SOCRATES aircraft campaign