Ocean biogeochemistry and low-level ice-cloud occurrence over the southern oceans.

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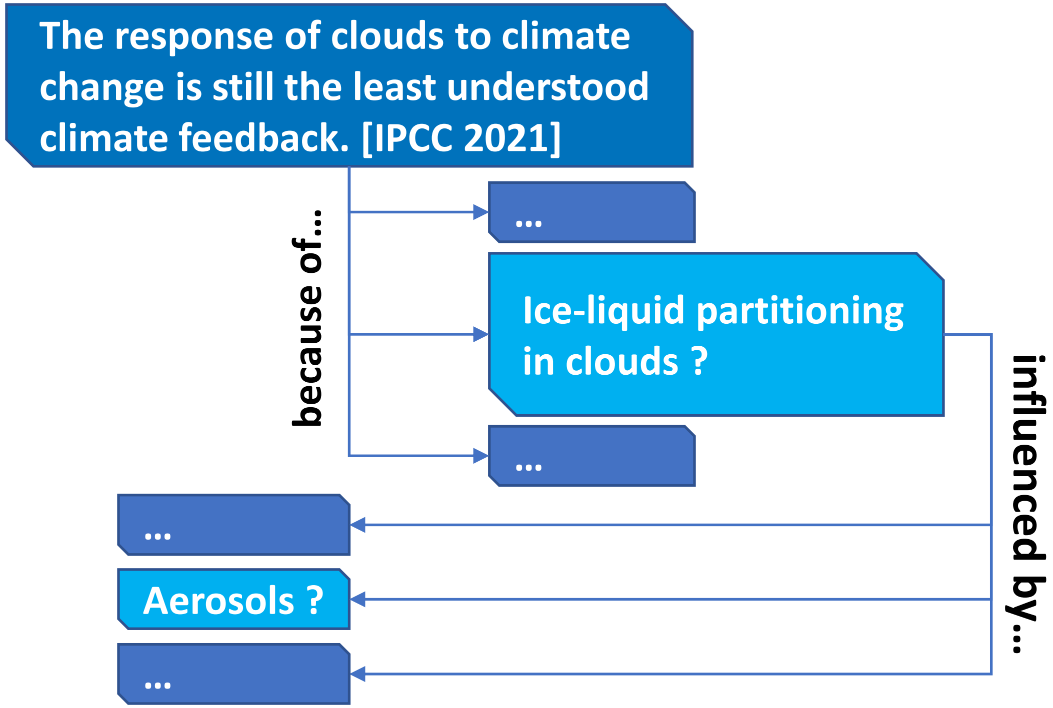
Scientific context



- Influence of sea-spray emissions, from marine microorganisms, on cloud droplet size/concentration. *[1-5]*
- Southern oceans (40°S-60°S) : remote area with a maximum of natural aerosols. *[6]*

[1] Lana et al. (2012), [2] Meskhidze and Nenes (2006),
[3] McCoy et al. (2015), [4] Wilson et al. (2015),
[5] McCoy et al. (2021), [6] McCoy et al. (2020)

Methodology

Strategy

- Segregating low-level ice-containing clouds and liquid clouds (DARDAR-MASK).
- Regionalisation of the studied area.
- Investigation with several biological indicators.

Datasets

- DARDAR-MASK products, based on satellite liDAR-raDAR synergy.
- MODIS-derived products from ocean color, for chlorophyll-a (Chl-a), particulate organic carbon (POC), and nanophytoplankton.

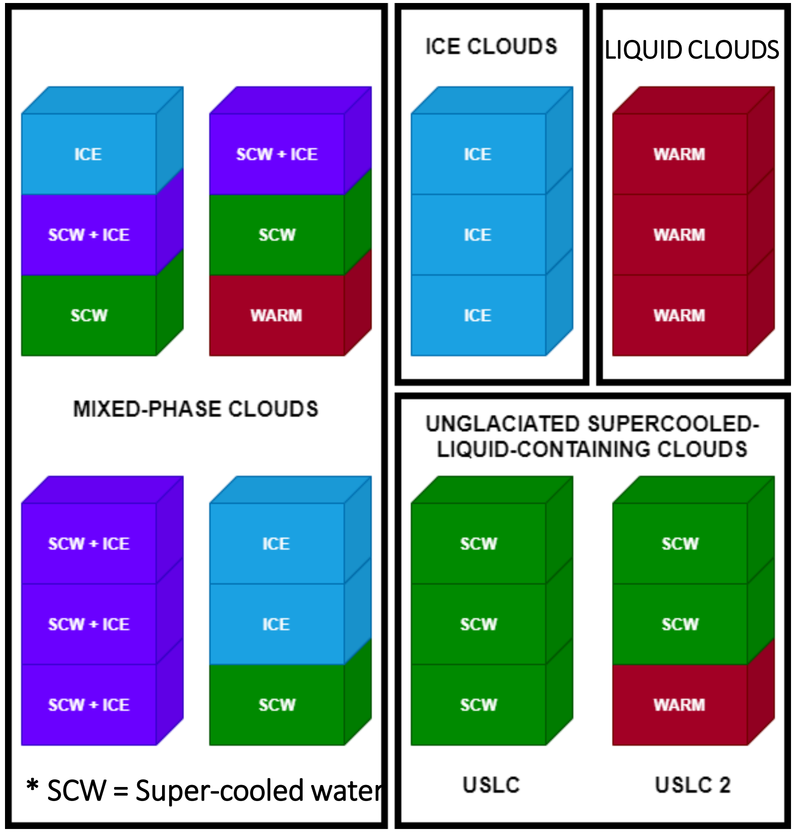


Fig. 1. Examples of clouds.

Geographical and temporal distributions

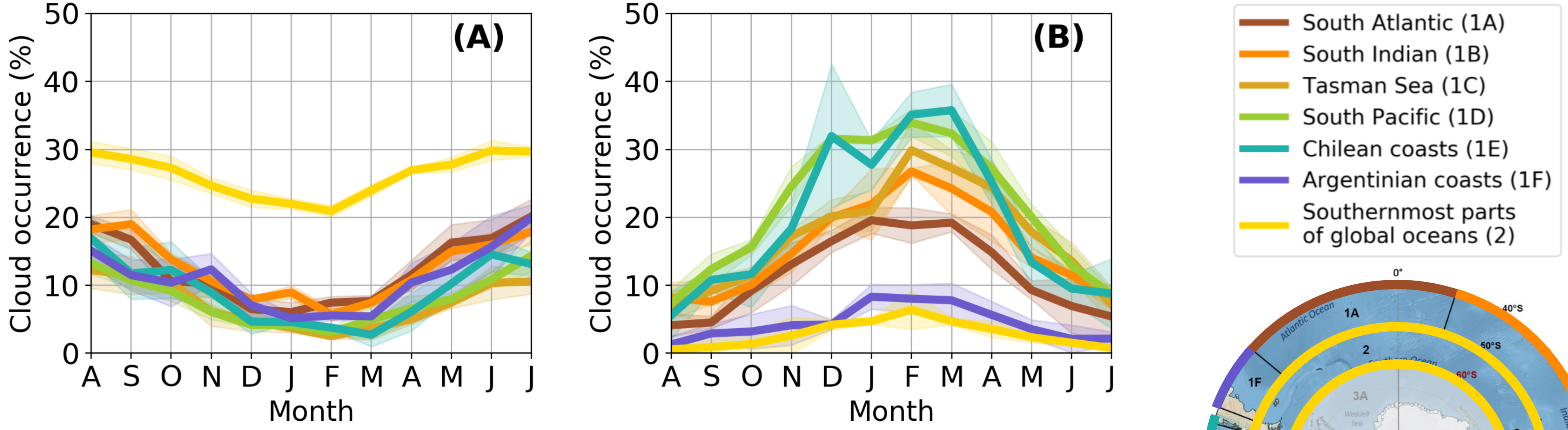


Fig. 2. Annual cycle of ice-cloud (A) and liquid-cloud (B) occurrence.

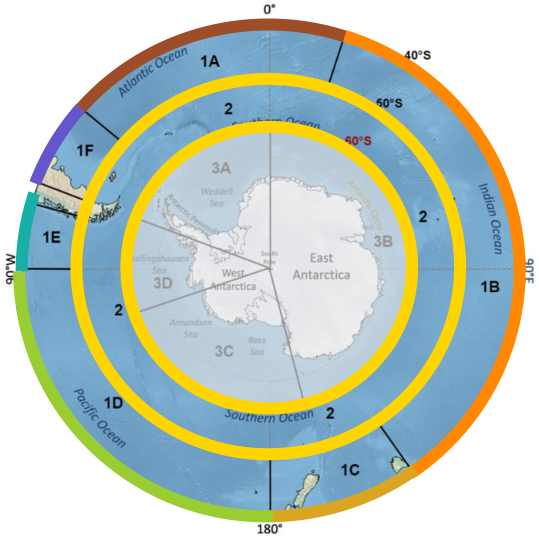


Fig. 3. Map of the studied area.

2 zones, 2 regimes

Ice-cloud occurrence variations show a strong zonal variability.
Liquid-cloud occurrence variations highlight significant regional differences.

Cloud occurrence / POC correlations

	All clouds	CLOUD SEGREGATION
All Reg.	-0.24	
REGIONALISATION		CLOUD SEGREGATION + REGIONALISATION

Table 1. Correlation coefficients (R^2), with sign of the linear regression, between the cloud occurrence and POC concentration, for p-value < 0.05.

Global analysis **does not** lead to significant results.

Cloud occurrence / POC correlations

	All clouds	Liquid	Ice-only	MPC	USLC
All Reg.	-0.24		-0.11	-0.4	-0.03

REGIONALISATION

CLOUD SEGREGATION
+
REGIONALISATION

Table 1. Correlation coefficients (R^2), with sign of the linear regression, between the cloud occurrence and POC concentration, for p-value < 0.05.

Cloud segregation brings new information.

POC seems to inhibit cloud formation.

Cloud occurrence / POC correlations

	All clouds	Liquid	Ice-only	MPC	USLC
All Reg.	-0.24		-0.11	-0.4	-0.03
1A	-0.56				
1B	-0.14				
1C	-0.26				
1D	-0.48				
1E	-0.15				
1F	-0.17				
2	-0.29				

CLOUD SEGREGATION
+
REGIONALISATION

Table 1. Correlation coefficients (R^2), with sign of the linear regression, between the cloud occurrence and POC concentration, for p-value < 0.05.

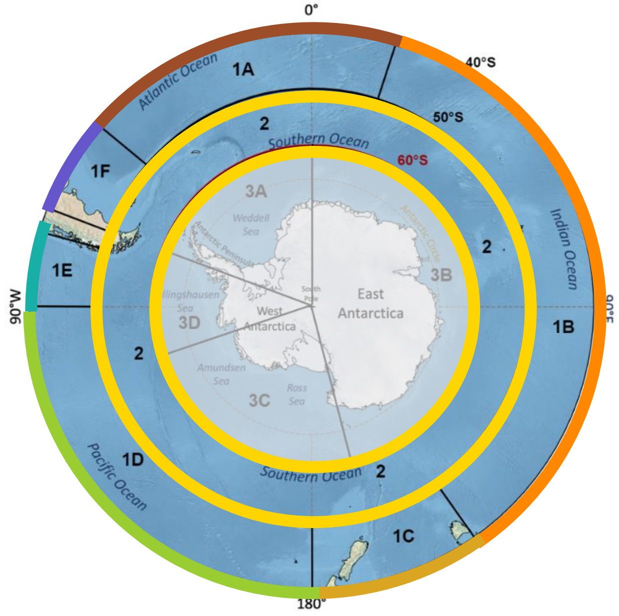


Fig. 3. Map of the studied area.

Better correlations at the local scale, with the regionalisation.

But the influence of biology on cloud still looks limited.

Cloud occurrence / POC correlations

	All clouds	Liquid	Ice-only	MPC	USLC
All Reg.	-0.24		-0.11	-0.4	-0.03
1A	-0.56	0.6	-0.8	-0.72	
1B	-0.14	0.55	-0.76	-0.58	
1C	-0.26	0.45	-0.62	-0.6	-0.22
1D	-0.48	0.49	-0.6	-0.73	-0.17
1E	-0.15	0.29	-0.28	-0.42	
1F	-0.17	0.13	-0.16		-0.24
2	-0.29	0.47	-0.76	-0.17	0.3

Table 1. Correlation coefficients (R^2), with sign of the linear regression, between the cloud occurrence and POC concentration, for p-value < 0.05.

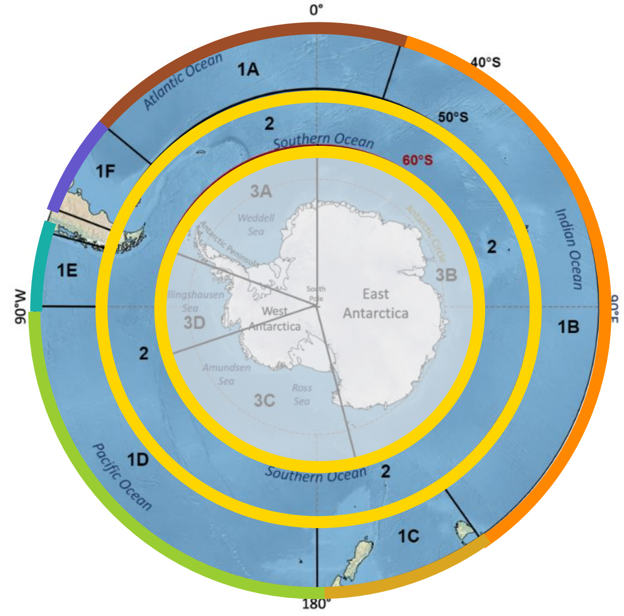


Fig. 3. Map of the studied area.

Positive correlations with liquid-cloud occurrence.

Negative correlations with ice-cloud occurrence.

Influence of surface forcing

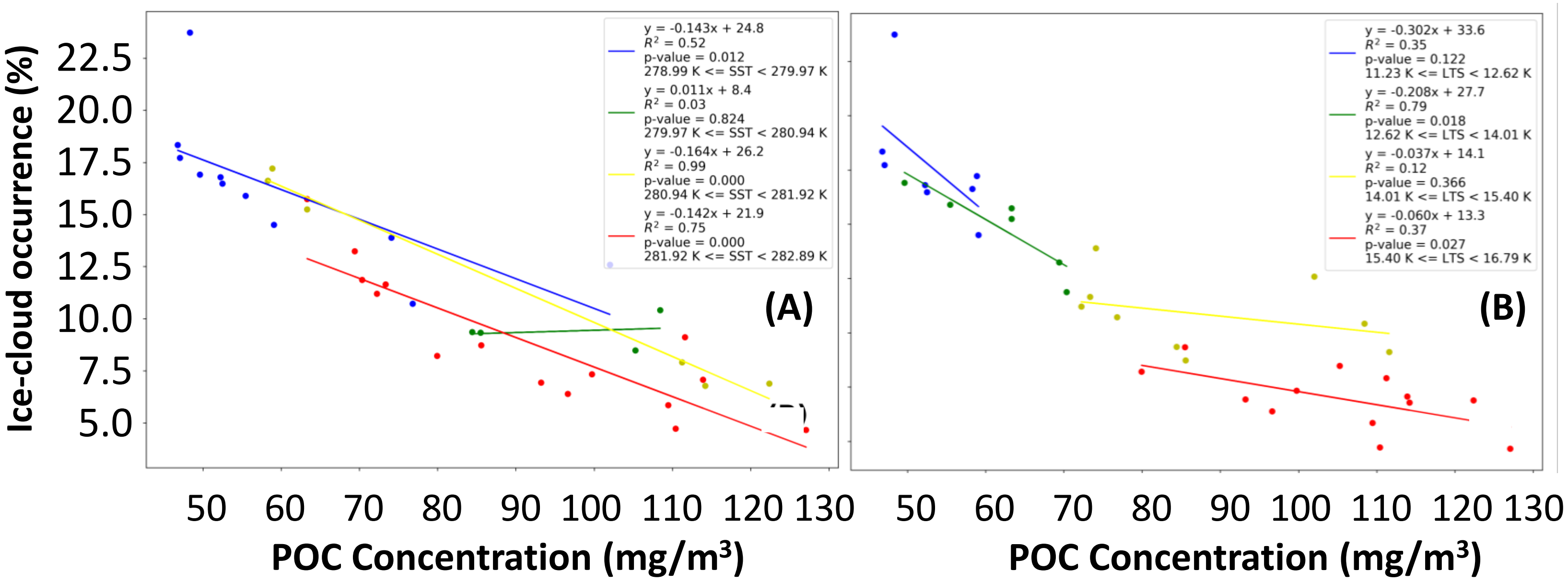


Fig. 4. Correlations between ice-cloud occurrence and POC concentration, for Region 1A (South Atlantic), at pseudo-constant SSTs (A) and LTSs (B).

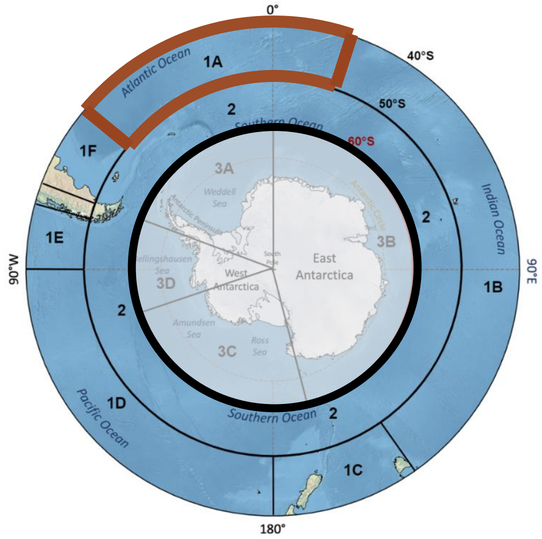


Fig. 3. Map of the studied area.

Correlations are maintained at pseudo-constant sea-surface temperatures (SSTs) and lower-tropospheric stability (LTSs), for samples with enough data.

Conclusions

Ice-cloud occurrence / POC relationship can be observed.

Induce **precipitation** and **reduce** cloud lifetime.

This hypothesis is consolidated by **positive correlations** between precipitations and POC concentration.

References used in this presentation

- **[1]** A. Lana, R. Simó, S. M. Vallina, J. Dachs, Potential for a biogenic influence on cloud microphysics over the ocean: a correlation study with satellite-derived data. *Atmospheric Chemistry and Physics*. **12**, 7977–7993 (2012).
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Influence of surface forcing (Liquid clouds)

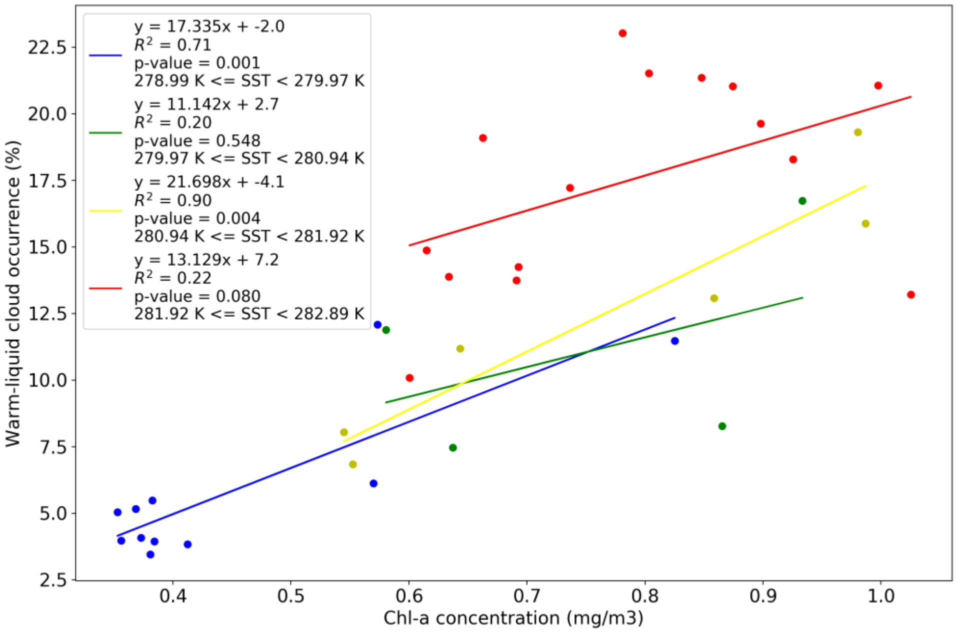

Fig. S1. Correlations between liquid-cloud occurrence and Chl-a concentration, for Region 1A (South Atlantic), at pseudo-constant SSTs.

Chl-a is **more abundant** at highest SST, which is coherent with seasonal variations of Chl-a.

However, **correlations are maintained** at pseudo-constant SSTs.

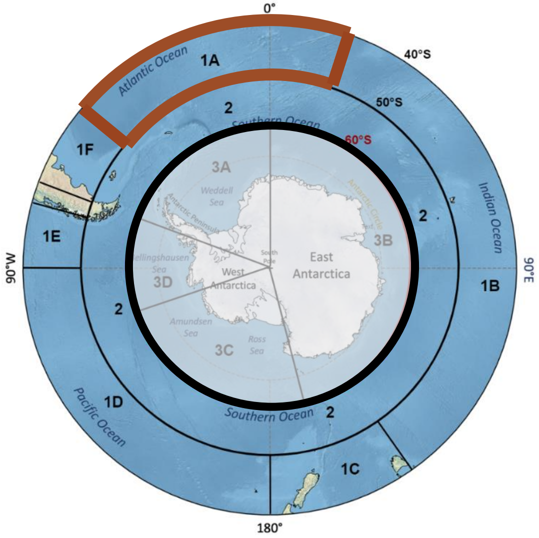

Fig. 3. Map of the studied area.