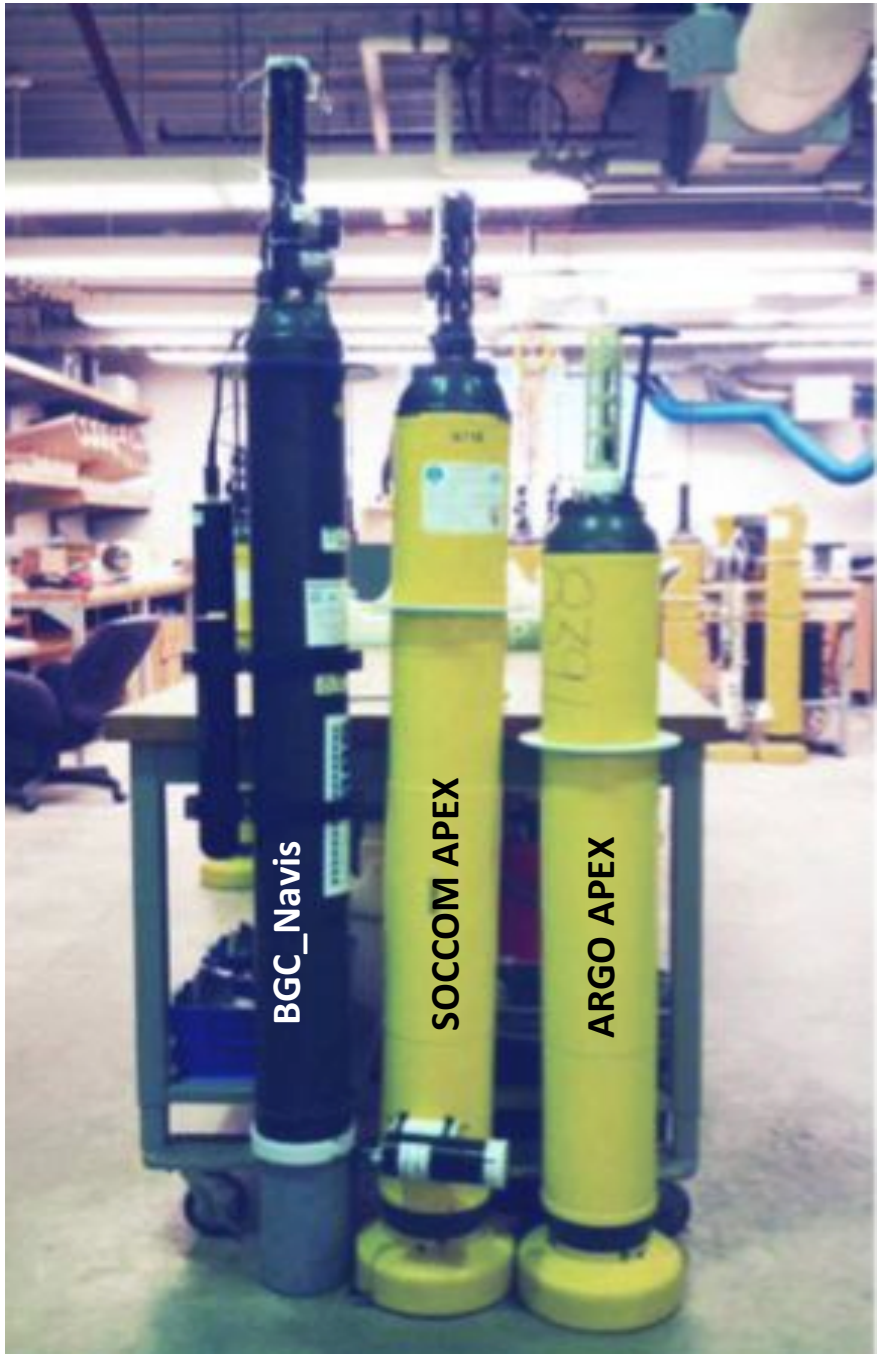
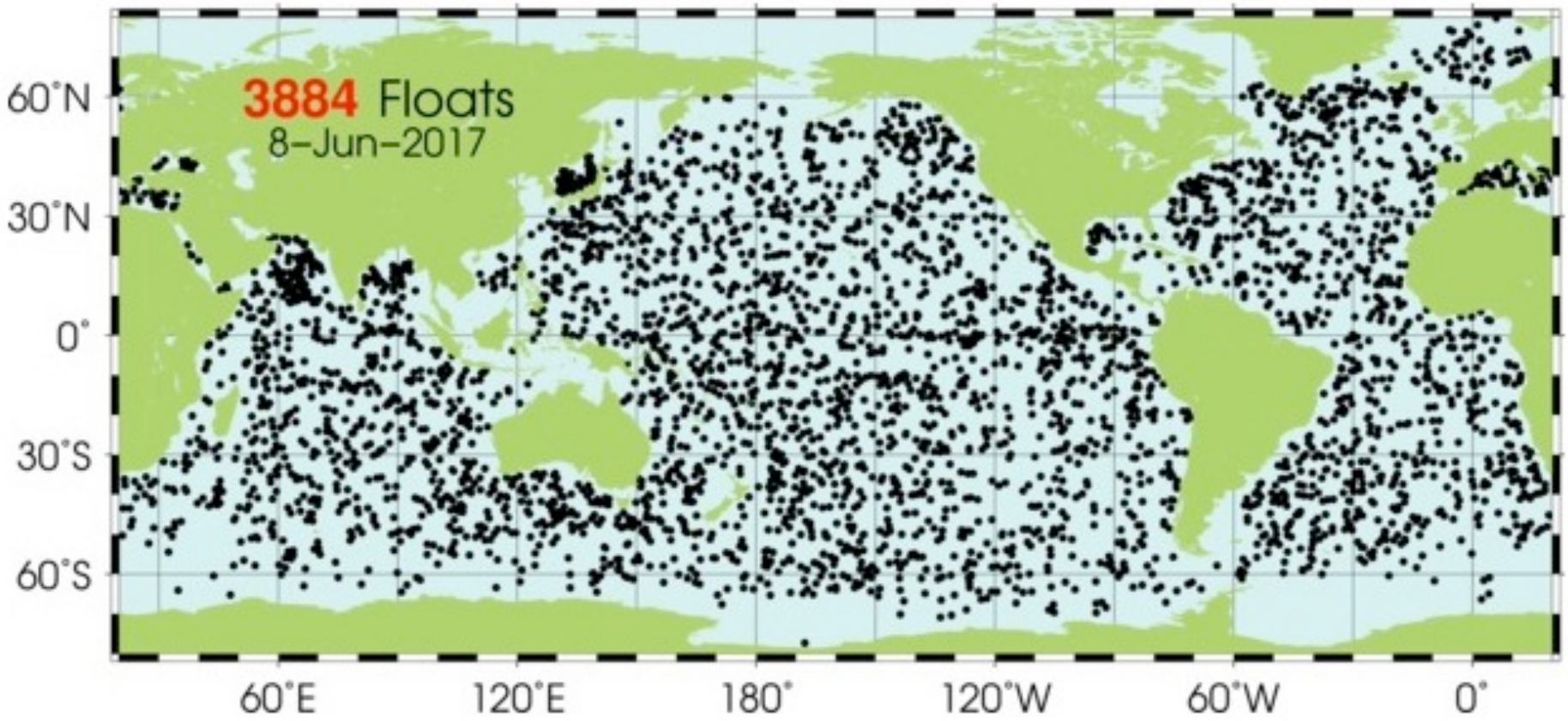


Biogeochemical Measurements Under Antarctic Sea Ice: Observations from Profiling Floats

Stephen Riser
University of Washington

OASIIS Workshop
Bremerhaven, Germany 14-16 June 2017



The Argo profiling float array: quasi- global coverage at 300 km resolution

<u>Canonical Argo mission</u>

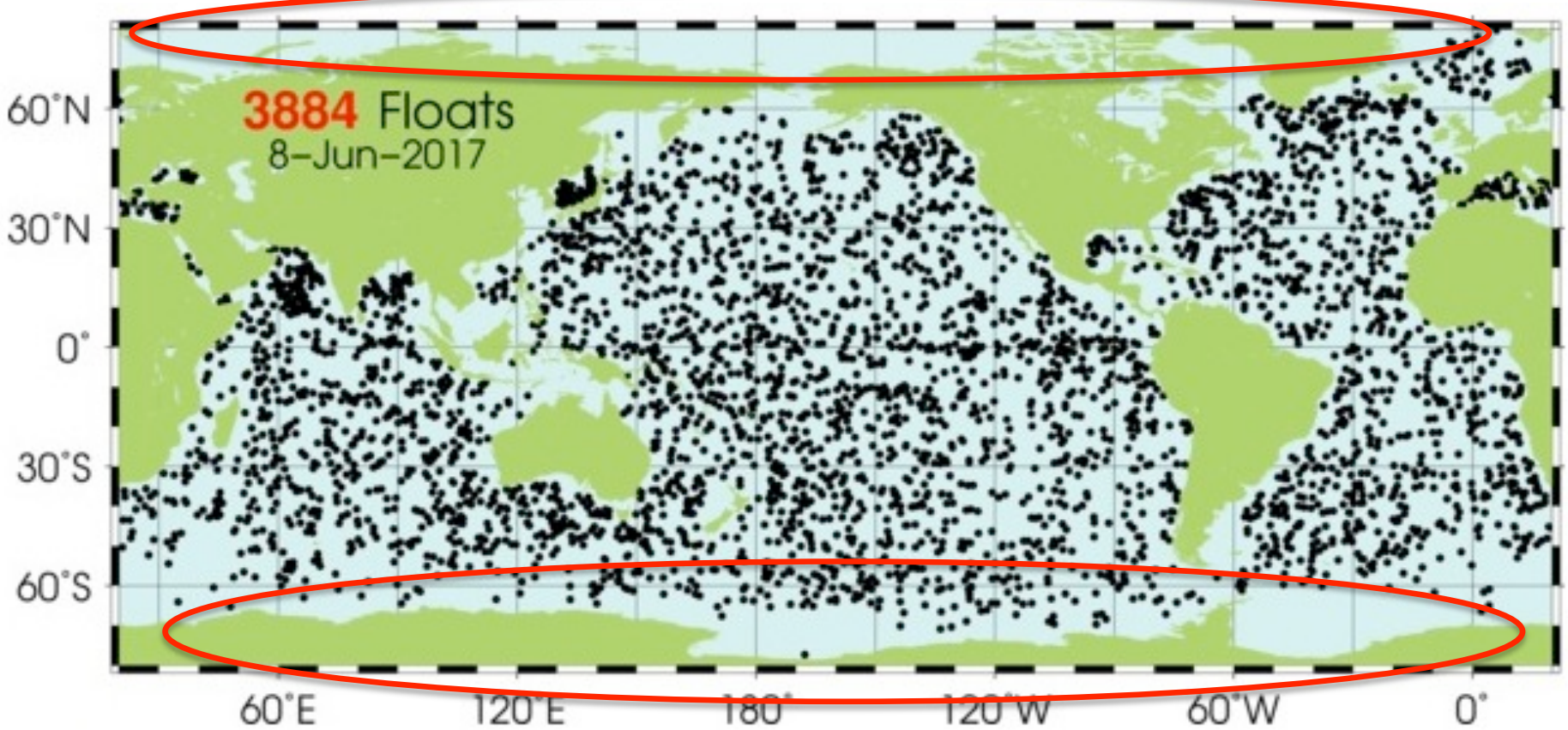
0-2000 m; *T*, *S*, *p* **(0.005 °C; 0.01 PSU ; 2.5 dbar)**

Δt = 10 days

5 years/200-250 profiles

33 countries; 700 floats per year

***Arctic*: few floats; the future?**



***Antarctic*: progress towards building an float-based observing system (SOCCOM)**

The Argo profiling float array: quasi- global coverage at 300 km resolution

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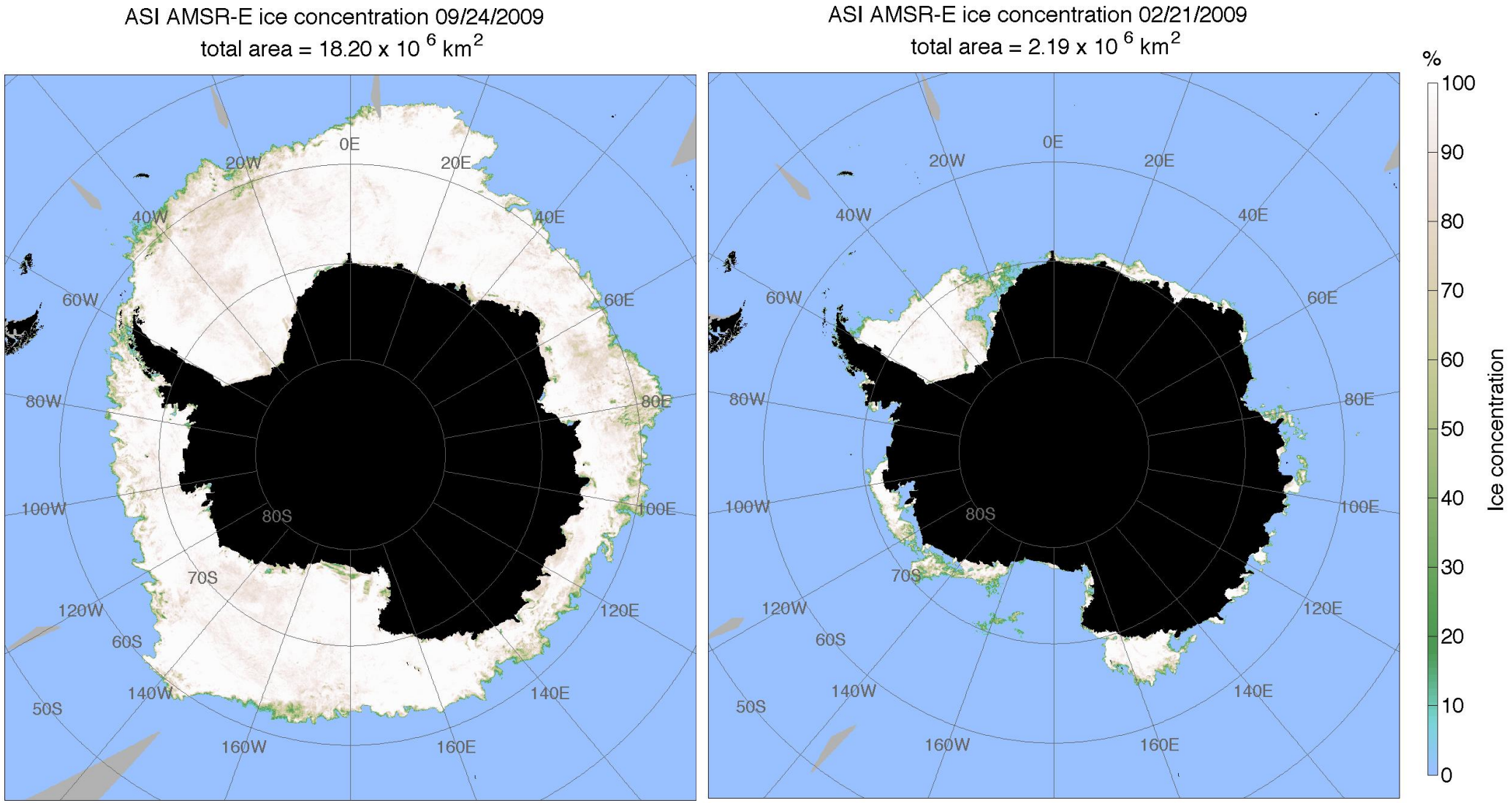
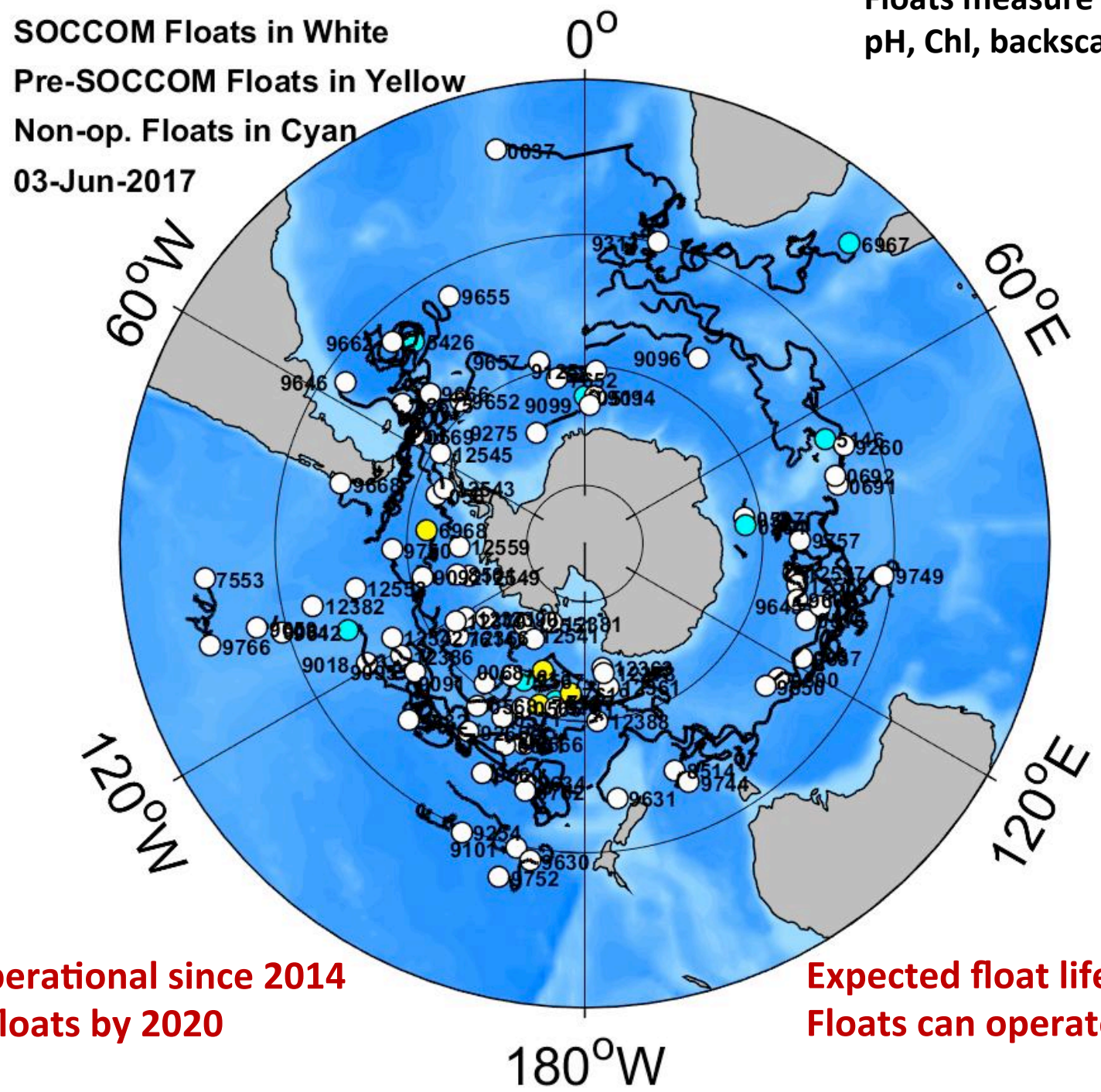


Typical seasonal sea ice concentration in the Antarctic

Southern Ocean Carbon and Climate Observations and Models (SOCCOM)

Floats measure *T*, *S*, *p*, O_2, NO_3, pH, Chl, backscatter 0-2000 m



80 floats operational since 2014
Goal: 200 floats by 2020

Expected float lifetime: 5-6 years
Floats can operate under sea ice

Chl/backscatter (FLBB) sensor

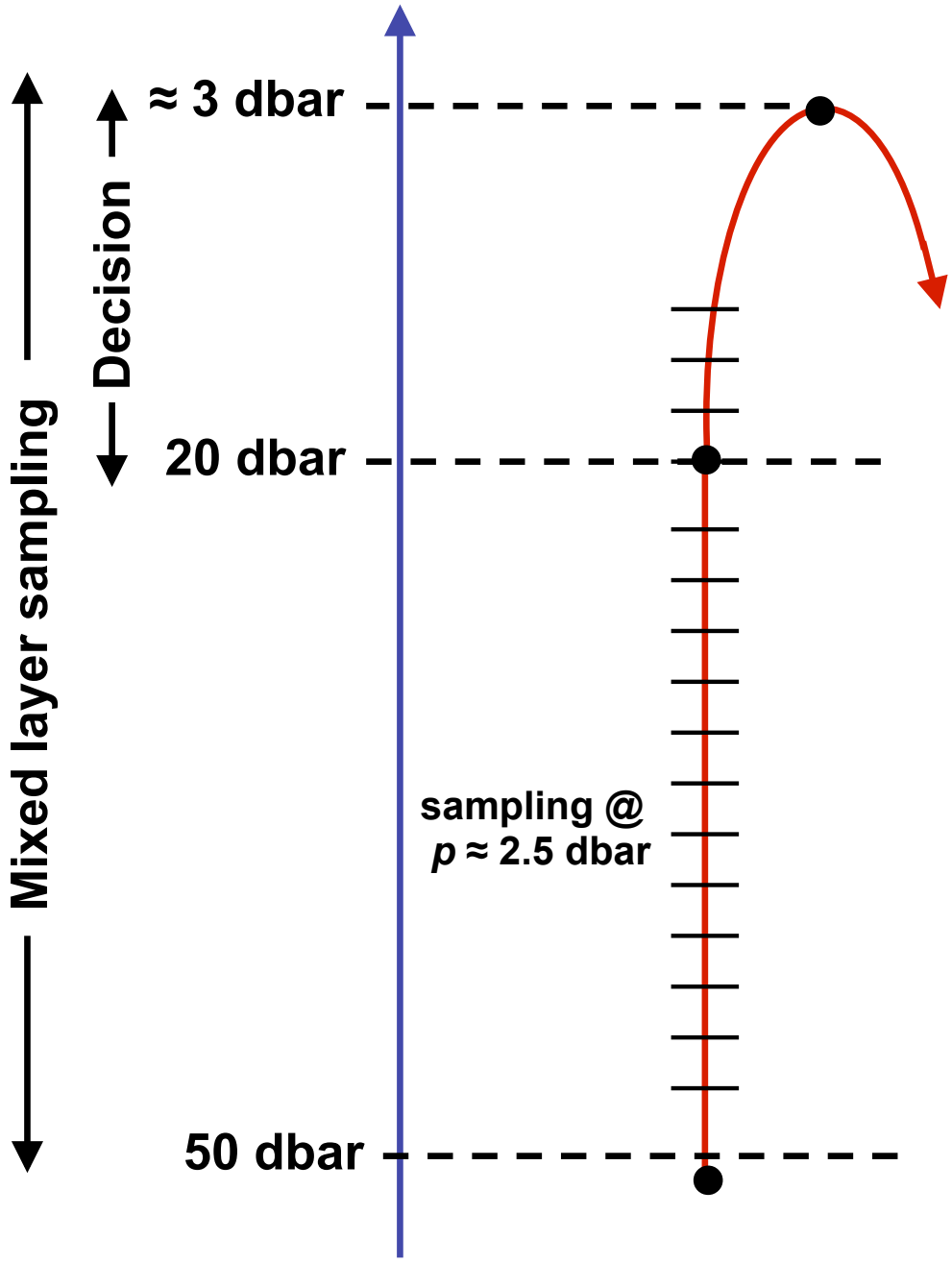
Nearly all of the floats used in SOCCOM are Teledyne/Apex floats built at the University of Washington, with NO_3 and pH sensors supplied by MBARI

Energy Considerations for BGC Floats [UW Apex]

Number of Lithium Battery Packs: 4
Energy per Pack: 1300 KJ
Total Energy Available: 5200 KJ
Energy per Profile: 19.82 KJ
Estimated Number of Profiles Possible: 262

System	Energy Required (KJ)	Per Cent of Total
Buoyancy pump	6.42	32.4
ISUS/NO_3	3.62	18.3
SBE 41CP	3.04	15.3
Iridium-GPS	2.50	12.6
APF9i	1.99	10.0
Durafet/pH	1.28	6.5
FLBB	0.16	1.3
Optode/O_2	0.10	0.5
Self-discharge	0.70	3.5
TOTAL	19.82	100

[BGC sensors → only 26% of the total energy]



TEMPERATURE-BASED CRITERIA

Test 1: Between 50 and 20 dbar compute the median temperature T_{ml}.

If T_{ml} is greater than a threshold temperature T_{th} for 2 successive profiles, continue ascent to the surface.

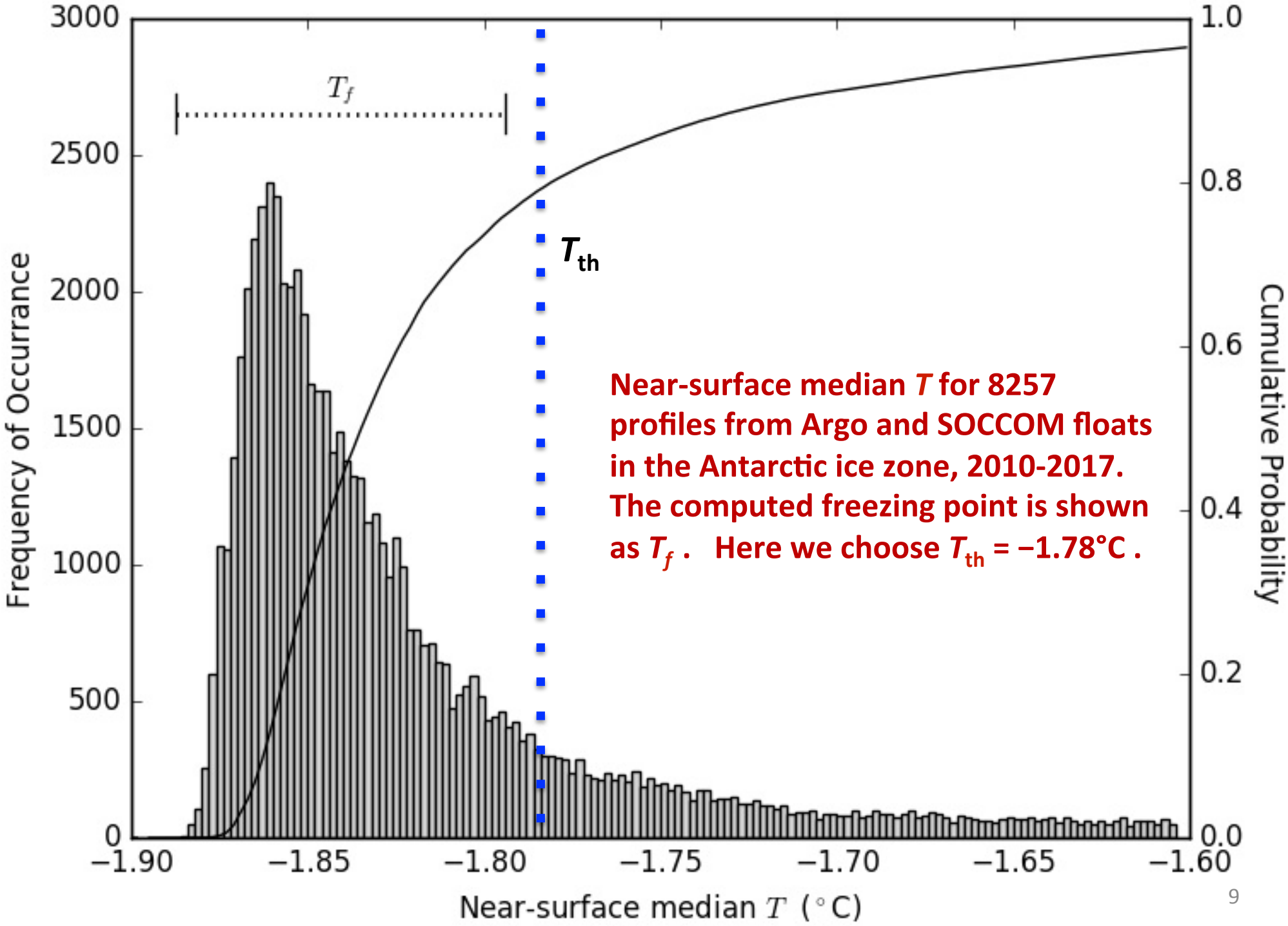
If not 2 successive profiles or if $T_{ml} < T_{th}$, then store the profile and descend.

[$T_{th} = -1.78°C$]

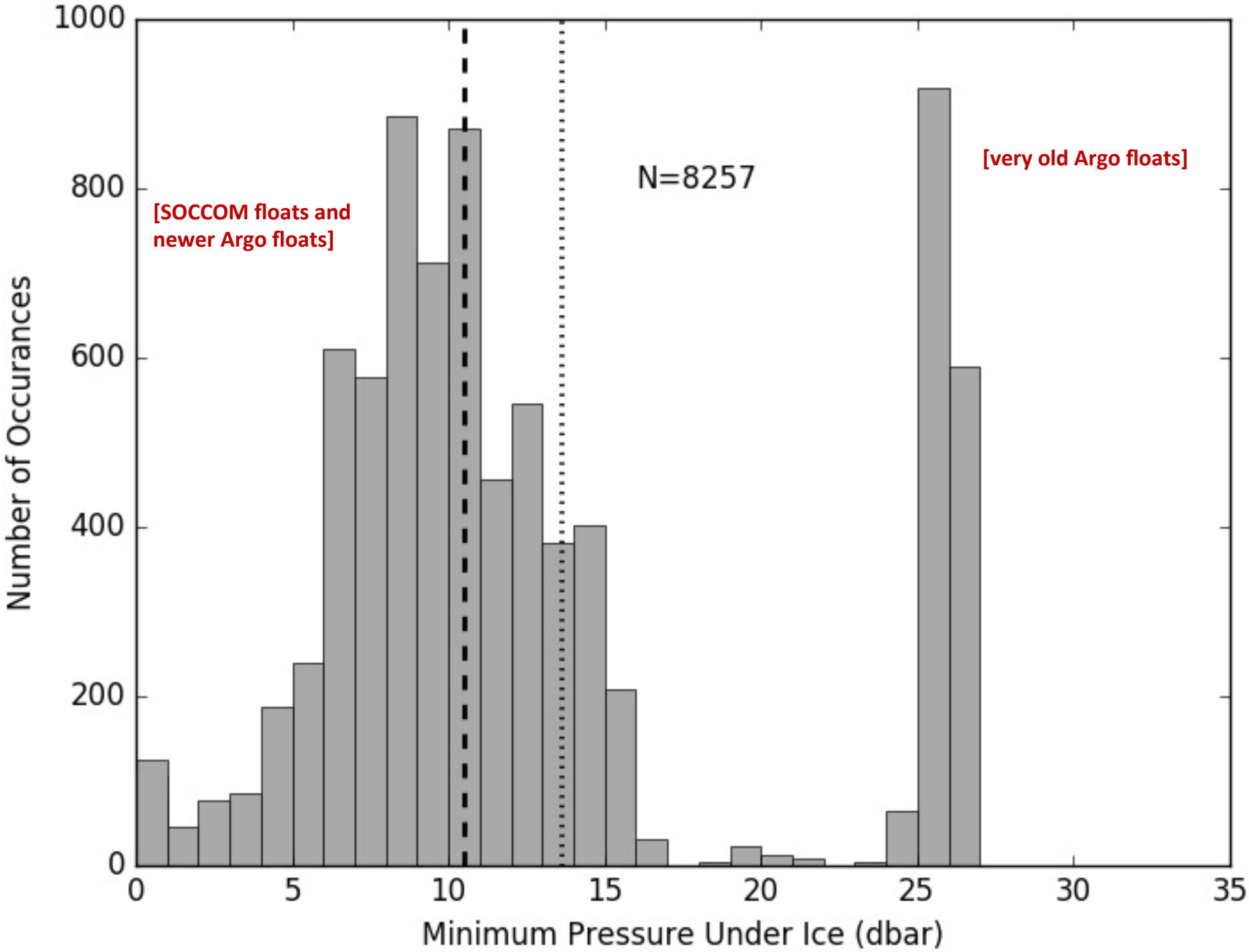
Test 2 (continue ascent):
(a) No ice; transmit the profile.
(b) The float hits the bottom of the ice; if no contact with a satellite in 2 hours, store the profile and descend.

Test 3 (on or off test): In designated summer months, turn off Tests 1-2.

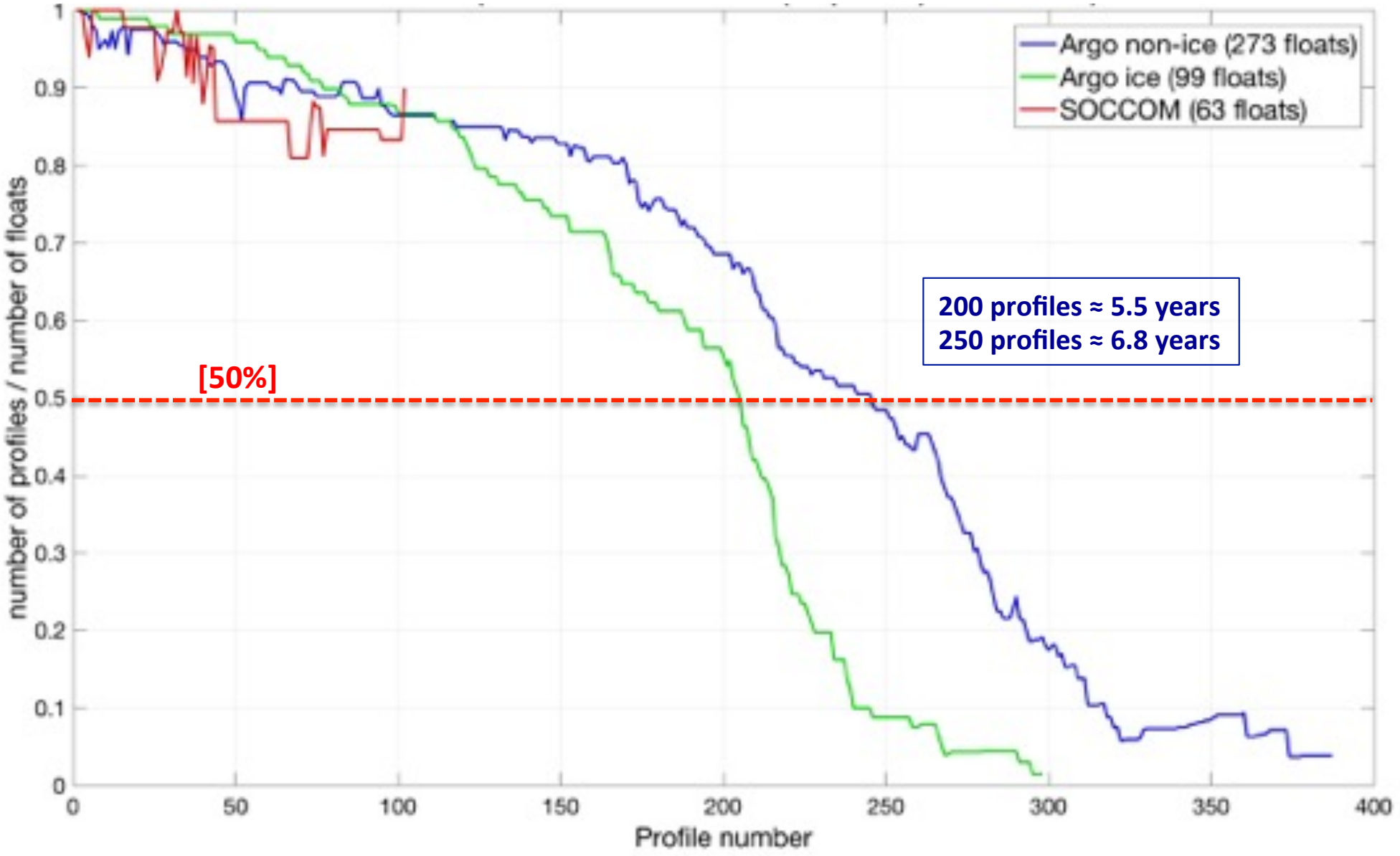
Schematic of the under-ice sampling algorithm (modified from Klatt et al., 2007)



Near-surface median *T* for 8257 profiles from Argo and SOCCOM floats in the Antarctic ice zone, 2010-2017. The computed freezing point is shown as T_f . Here we choose T_{th} = −1.78°C .

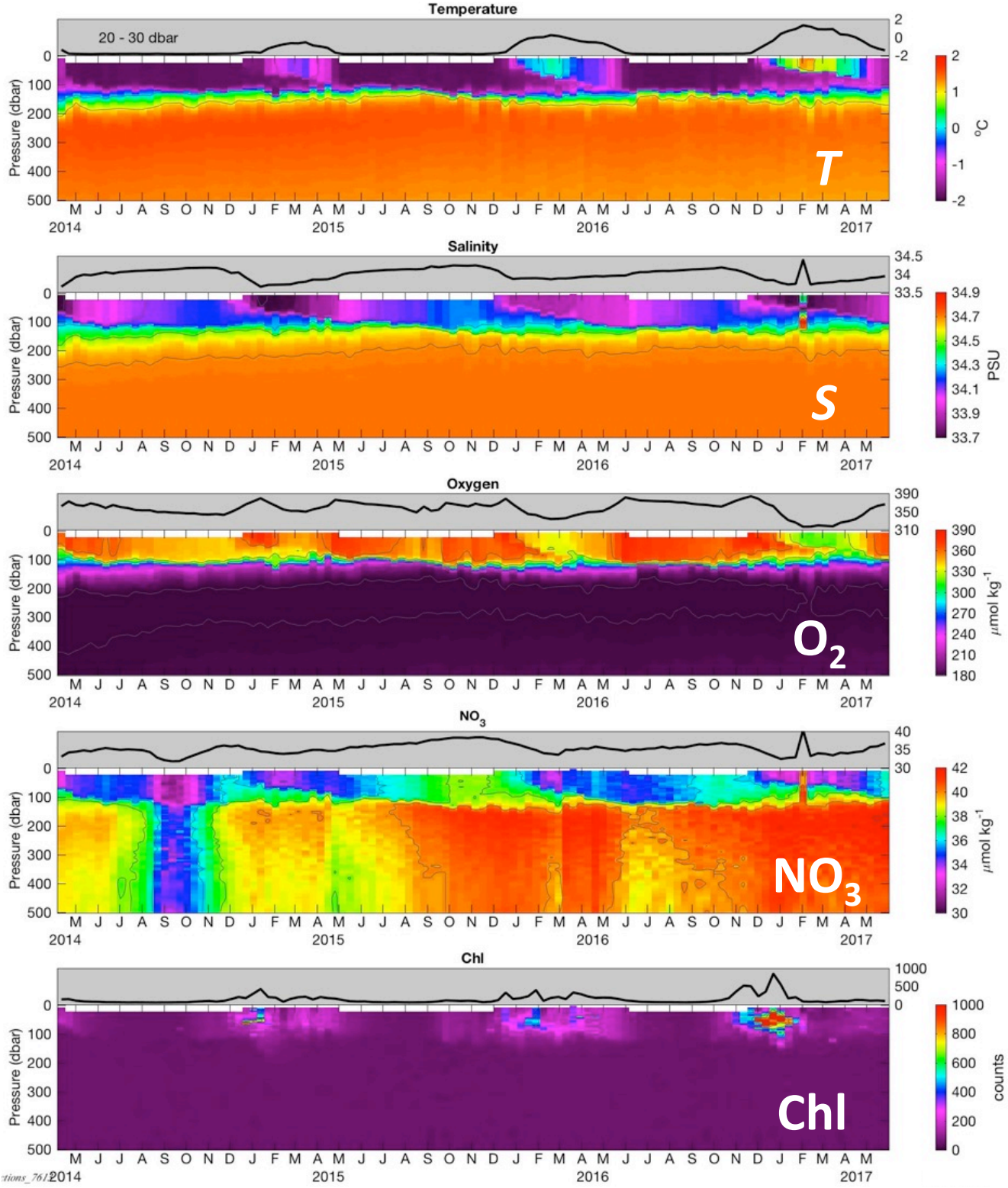

1000
800
600
400
200
0
Number of Occurances
0
5
10
15
20
25
30
35
Minimum Pressure Under Ice (dbar)
N=8257
[SOCCOM floats and newer Argo floats]
[very old Argo floats]

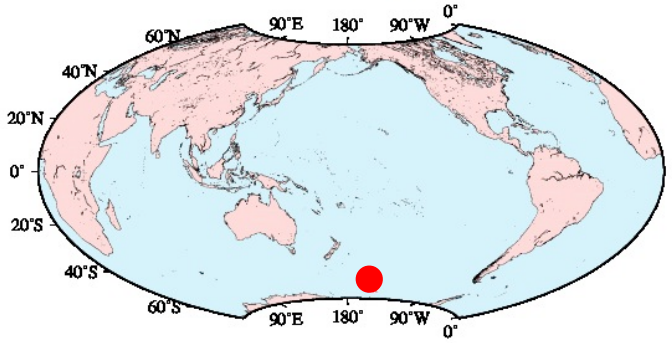
A summary and comparison of SOCCOM float performance

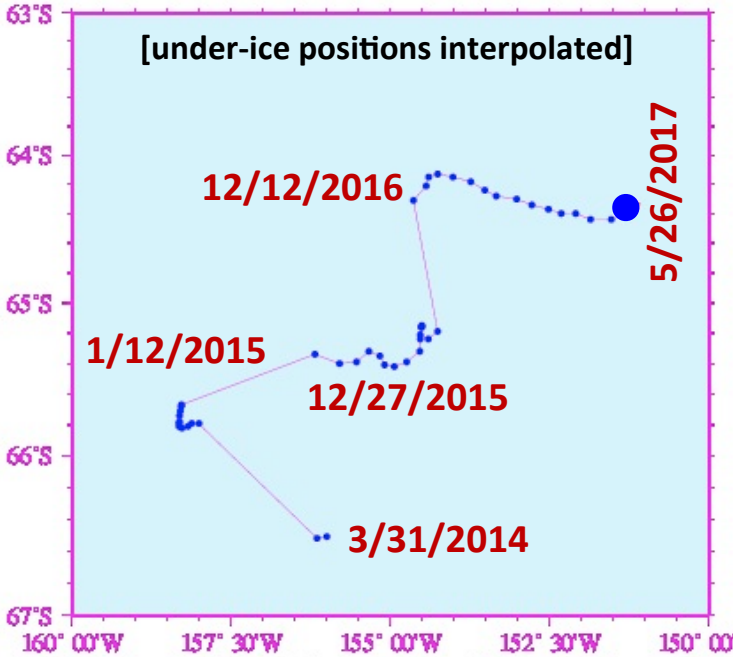


[Argo float performance data from 1/1/10 through 1/31/17]

[SOCCOM float performance data from 5/10/14 through 1/31/17]







Summer and winter under-ice data from UW SOCCOM float 7613, extending over 4 austral winters. Generally most of the seasonal variability occurs at depths above 200 m.

Summary and Additional Information

- **A detailed description of SOCCOM activities can be found at *http://soccom.princeton.edu* .**
- **All SOCCOM float data are freely-available in near real-time at the MBARI site *http://www.mbari.org/science/upper-ocean-systems/chemical-sensor-group/soccomviz/*.**
- **The SOCCOM float data have been used or referenced in 34 refereed publications so far. A special volume of *JGR-Oceans* with 21 SOCCOM-related papers is in preparation.**
- **In the future it is possible that sensors for Total Alkalinity, Irradiance, and pCO_2 could be added to the floats.**
- **At present, carbon-system parameters such as pCO_2 and Dissolved Inorganic Carbon are estimated from the float data by using multiple linear regression procedures as described in Williams et al. (2015 and 2017).**