Supplement: Large-Scale Variability of Physical and Biological Sea-Ice Properties in Polar Oceans

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Handling data gaps

Sensor malfunction

Gaps in the data occurred due to sensor failure or damage during hauls. During PS81 low temperatures caused battery failure of the CTD during some of the hauls. Gaps for salinity and temperature have been filled by linear regression with the sensors mounted on the ship (*David et al., 2017*). This was the case of stations 557_1 and 560_2. During PS89 stations 62_1, 70_2, and 71_1 the altimeter did not work, so draft has been calculated using equation (2) from the main article:

$$d = h_w - (h_a - h_{CTD}),$$

were depth h_w given by the pressure sensor of the CTD, h_{CTD} is the distance between CTD and altimeter and the value of h_a = 0.33 m is given by the altimeter mode retrieved from the other stations. During PS92 station 32_12 (not used in the present analysis) the SUIT ran into a big ridge and the ADCP was damaged. For the following stations, the ADCP was replaced with an older version of the same sensor that has no pitch and roll information. To retrieve the ice draft we used equation (2) from the main article, where h_a is the altimeter mode (h_a = 0.36 m) calculated from the altimeter values of all the PS92 profiles.

Radiation values

During September 2012 (PS80) the sensor mounted on the crow's nest did not measure, so we do not have incoming irradiance data for the calculation of transmittance. To fill this data gap, we used short-wave downward (GLOBAL) radiation measured with the ship sensors (artificially ventilated pyranometer), which is also placed at the level of the crow's nest. To assess the accuracy of the ship sensors we compared the transmittance calculated in August from the crown nest with this new data set and found an excellent agreement between both (r^2 = 0.94). We thus used the ships data for further calculation of transmittance as the ratio between under-ice and incoming radiation.

Supplementary table

Table S1. Summary of the measured and derived variables.

Variable	Units	Description	Sensor	Sampling interval	Final spatial resolution
T	°C	Under-ice temperature	CTD	0.1 s	0.5 m
S		Under-ice salinity	CTD	0.1 s	0.5 m
chl a_w	mg chl *a* m^{-2}	Under-ice chlorophyll *a*	Fluorometer mounted on the CTD	0.1 s	0.5 m
H_i	m	Total thickness (ice + snow)	Combined CTD and ADCP information	1 s (ADCP)	0.5 m
H_s	cm	Snow depth	Visual observation	-	-
TR		Transmittance	RAMSES spectral radiometers	11 s	~20* m
S_i	mol photons m^{-2} d^{-1}	Insolation	Combined transmittance and modelled downwelling radiation	11 s	~20* m
In-ice chl *a*	mg chl *a* m^{-2}	In-ice chlorophyll *a*	Retrieved from under-ice irradiance or radiance	11 s	~20* m

* Depending on the speed of the SUIT

Supplementary Figures

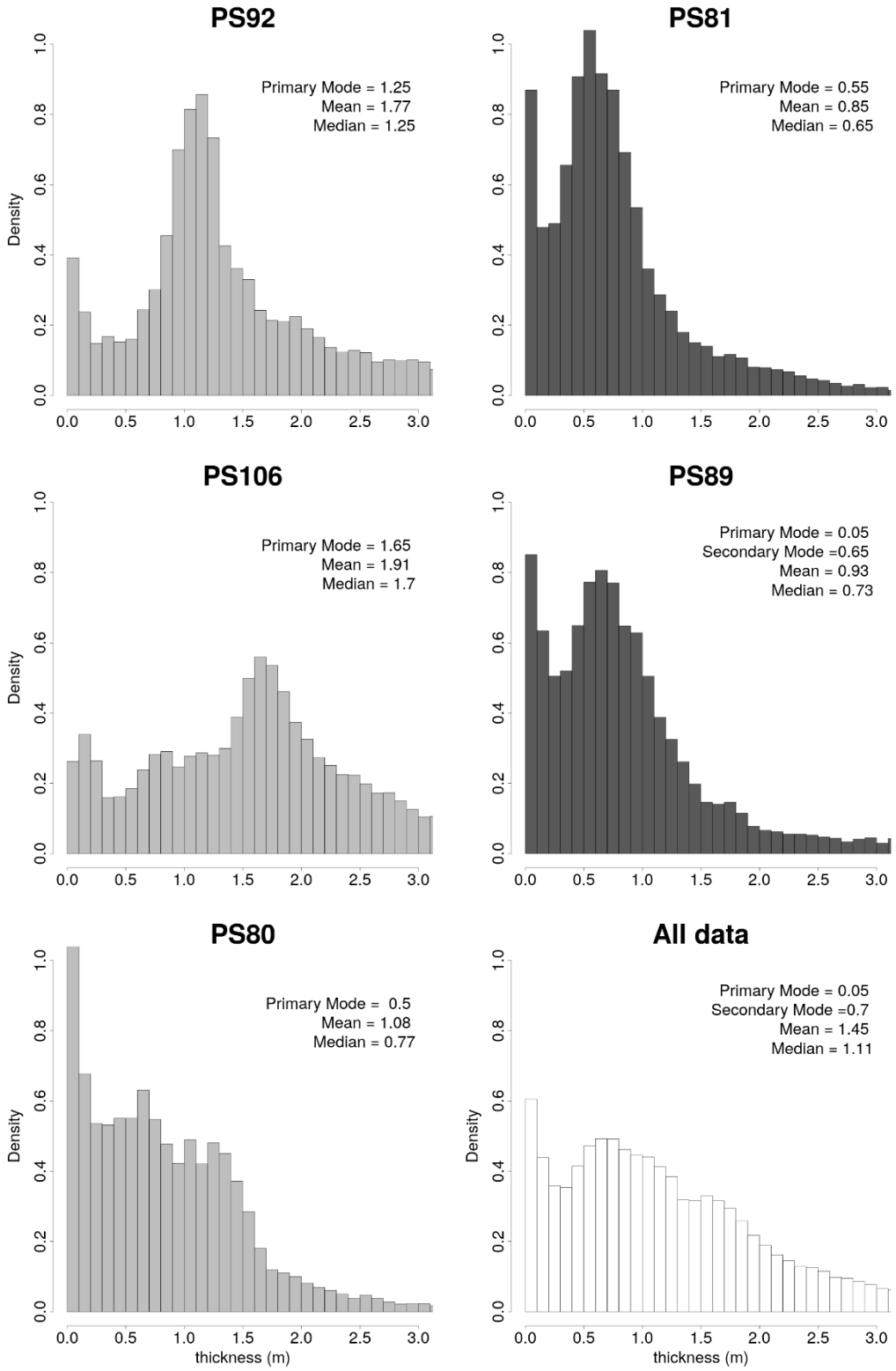

Figure S1. Histograms of ice thickness retrieved from the SUIT sensors array for all the expeditions. Data are filtered for open water. Histogram bins at 0.1 m. Arctic expeditions are highlighted with light grey bars and Antarctic expeditions with dark grey bars.

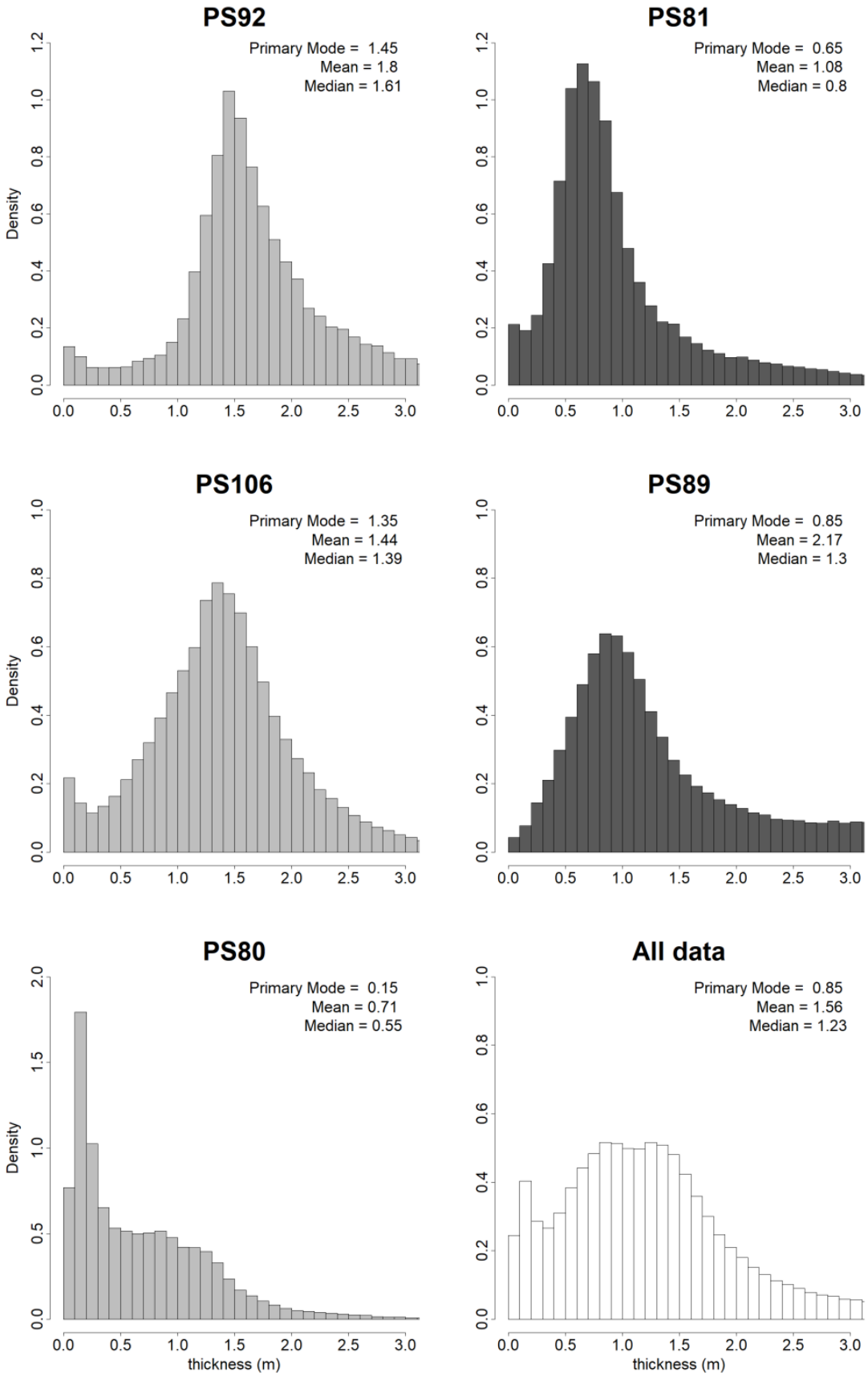

Figure S2. Histograms of ice thickness retrieved from the EM-bird measurements. Histogram bins at 0.1 m. Arctic expeditions are highlighted with light grey bars and Antarctic expeditions with dark grey bars.

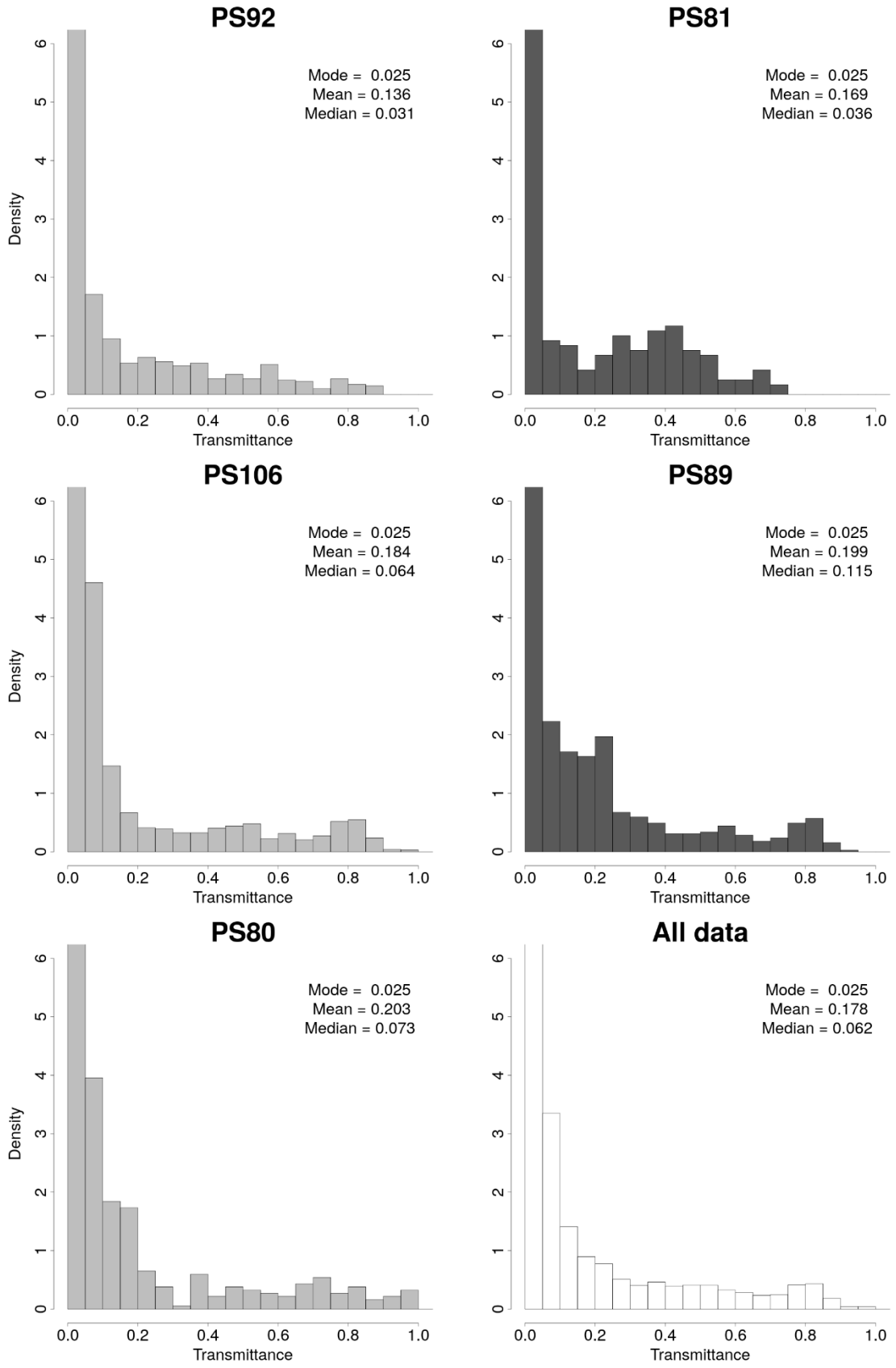

Figure S3. Histograms of ice transmittance. Histogram bins set at 0.05. Arctic expeditions are highlighted with light grey bars and Antarctic expeditions with dark grey bars.

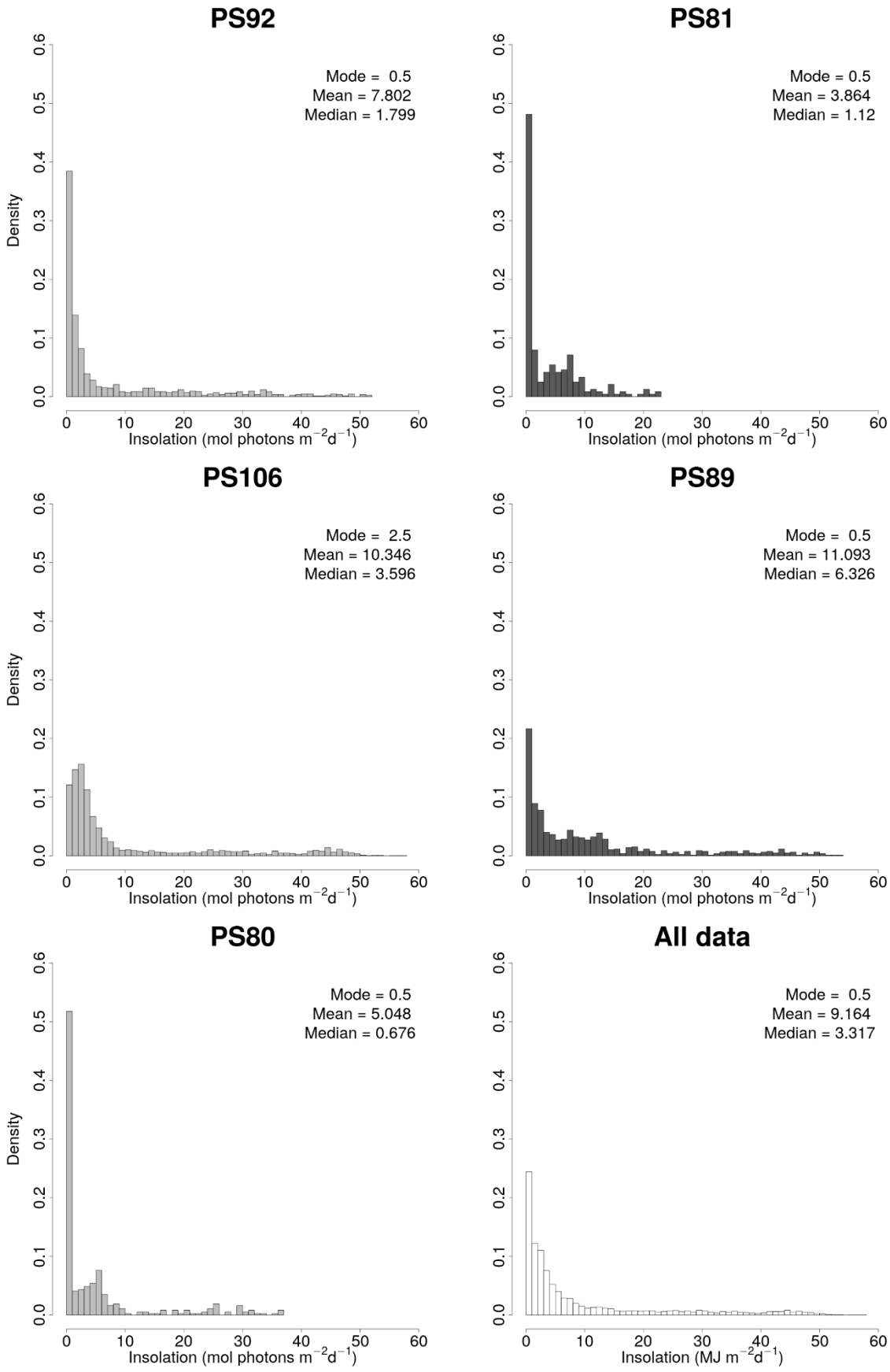

Figure S4. Histograms of under-ice insolation. Histogram bins set at 1. Arctic expeditions are highlighted with light grey bars and Antarctic expeditions with dark grey bars.

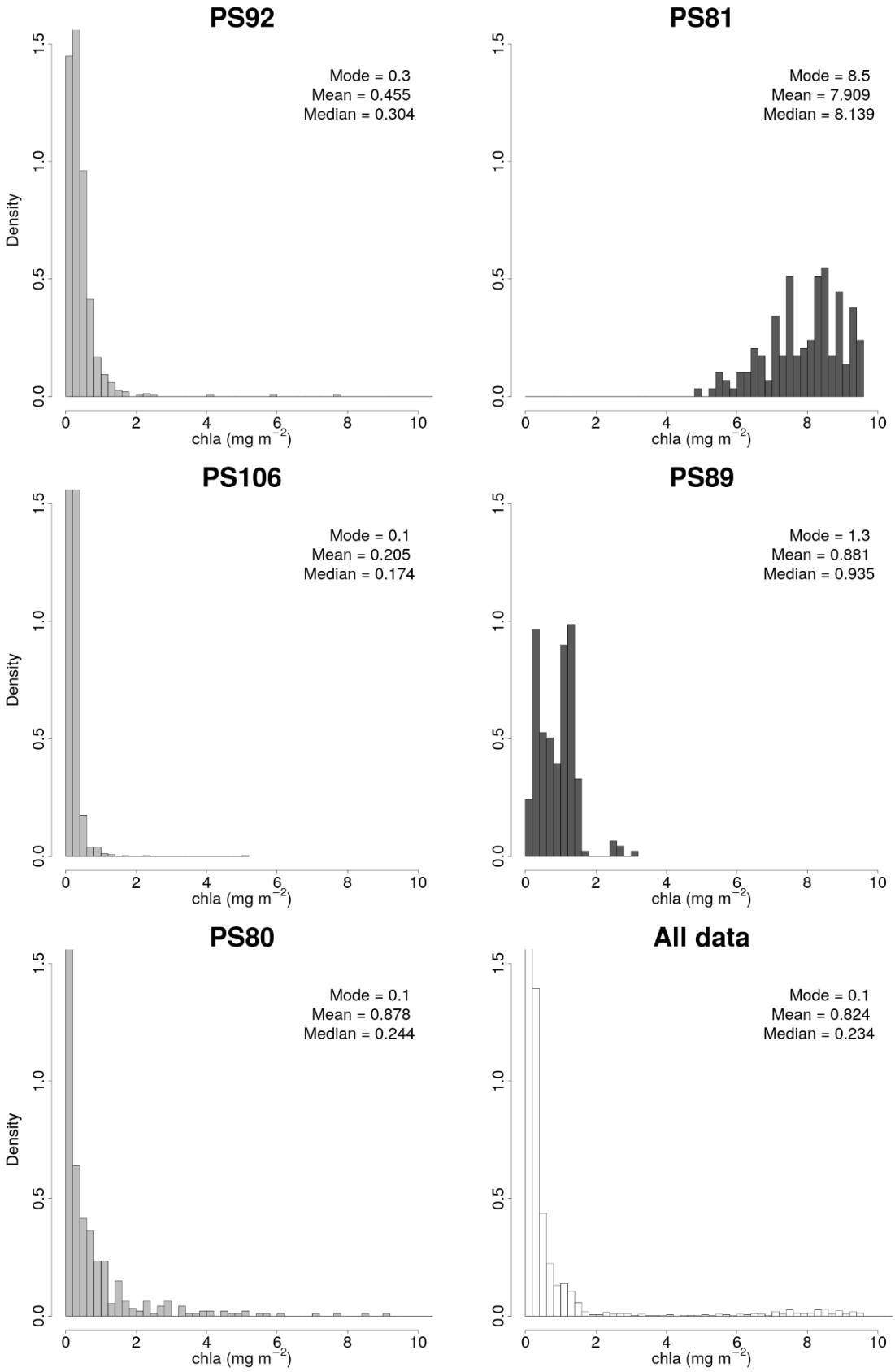

Figure S5. Histograms of in-ice chl *a* for all the expeditions retrieved by applying the algorithms listed in Table 2. Histogram bins set at 0.2 mg chl *a* m^{-2}. Arctic expeditions are highlighted with light grey bars and Antarctic expeditions with dark grey bars.