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*Supplement of*

## **The impact of synoptic meteorology on observed surface heat fluxes over the Southern Ocean**

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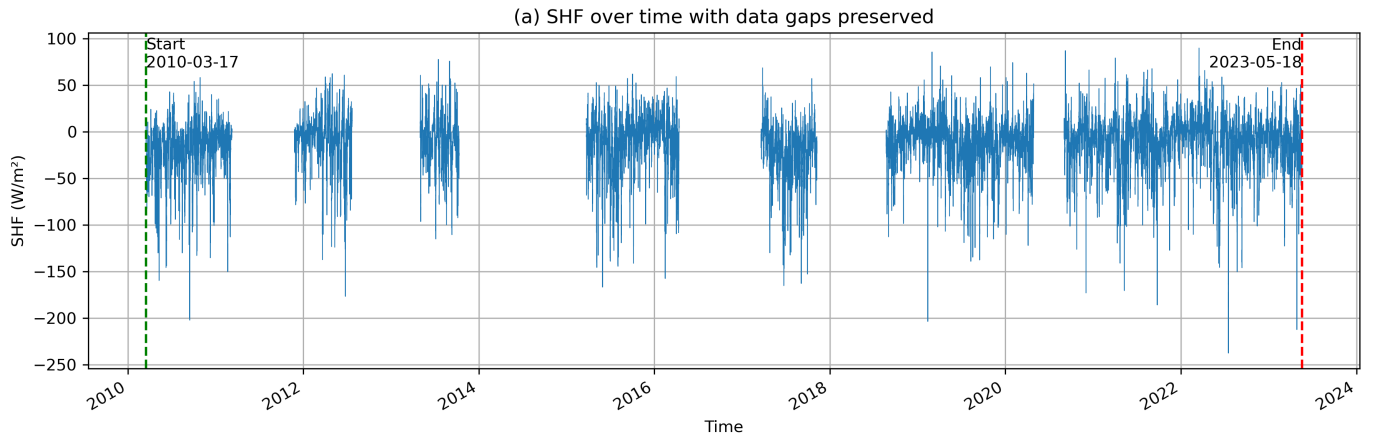


Figure S1: Time series of SHF derived from SOFS mooring data, with gaps indicating missing time steps in the dataset.

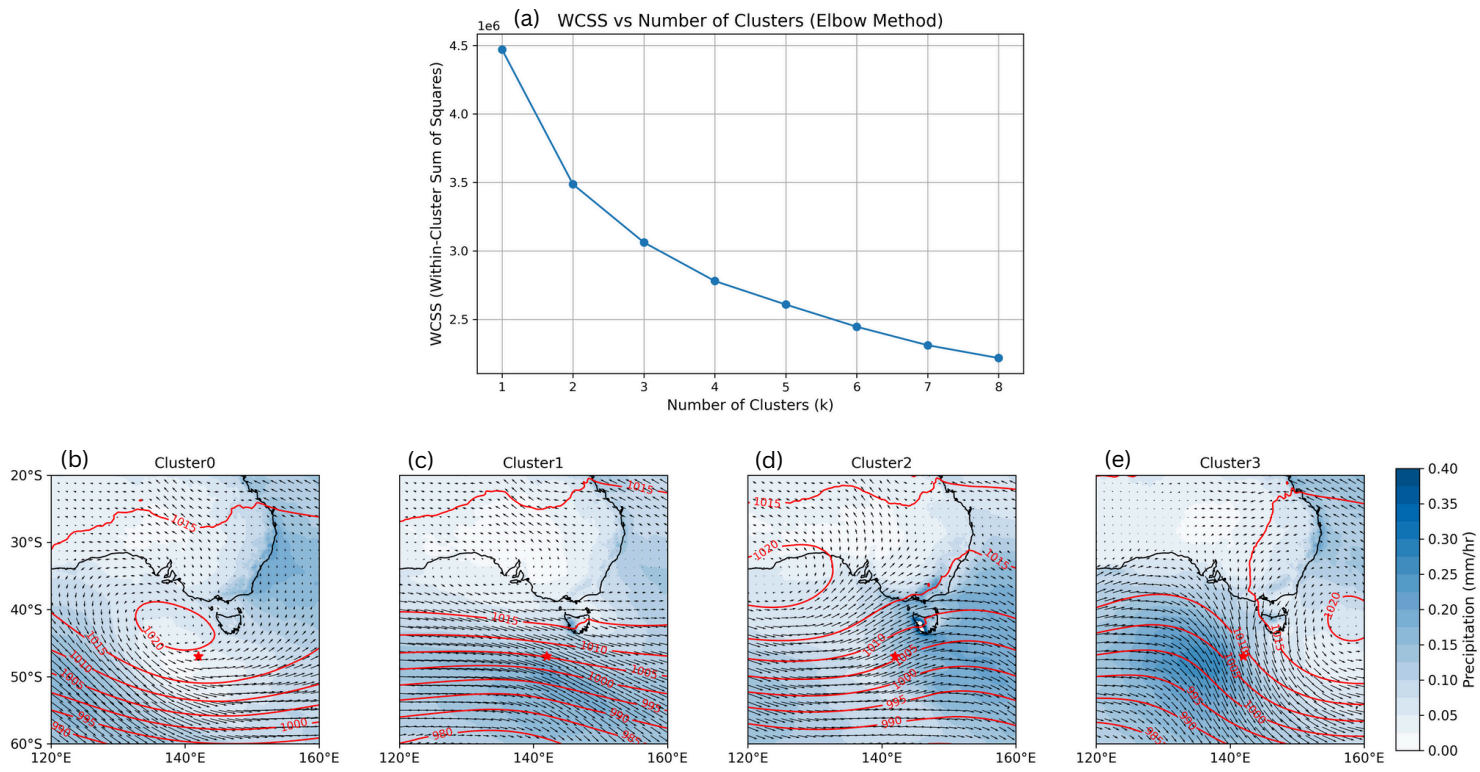


Figure S2: (a) Elbow method showing how the within-cluster sum of squares (WCSS) varies with the number of clusters. (b–e) Spatial distributions of mean sea-level pressure (contours; hPa), surface precipitation (shading; mm/hr), and 975-hPa winds (vectors) for the  $k = 4$  clustering at SOFS. The red marker denotes the SOFS buoy location.

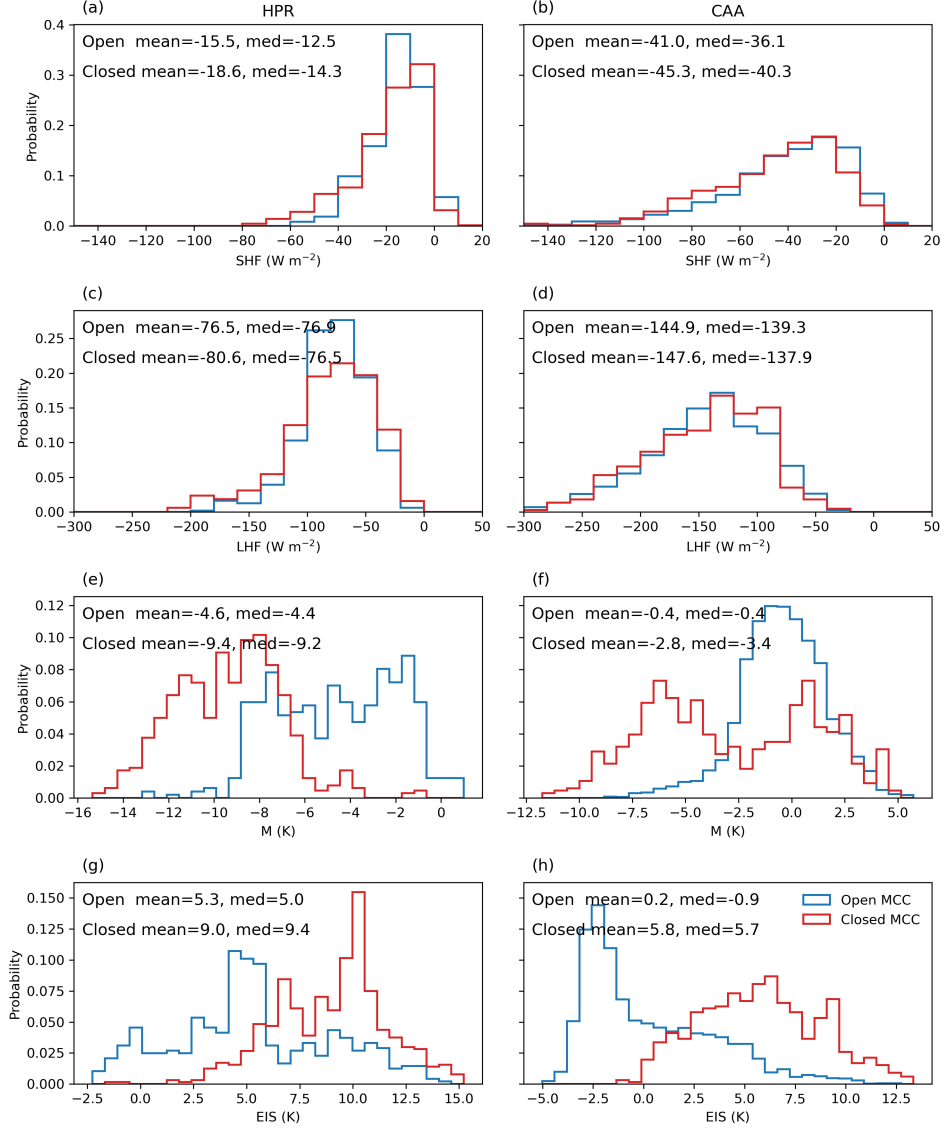


Figure S3: Probability distributions of (a, b) SHF ( $\text{Wm}^{-2}$ ), (c, d) LHF ( $\text{Wm}^{-2}$ ), (e, f) M-index (K), and (g, h) EIS (K) for HPR and CAA regimes when open and closed MCC are present. The left column shows HPR; the right column shows CAA. Solid blue lines denote open-MCC events, and solid red lines denote closed-MCC events at SOFS.

Regime / Condition	EIS < 0	$0 \leq \text{EIS} \leq 5$	EIS > 5	Total
<b>Weather Regimes</b>				
HPR	550	4,162	8,582	13,294
TBH	74	1,659	5,172	6,905
Zonal	3,545	8,114	4,817	16,476
Frontal	2,304	5,451	1,190	8,945
CAA	5,528	5,220	3,202	13,950
<b>Total (Regimes)</b>	<b>12,001</b>	<b>24,606</b>	<b>22,963</b>	<b>59,570</b>
<b>MCC Conditions</b>				
Open MCC	2,541	1,558	649	4,748
Closed MCC	9	377	1,257	1,643

Table S1: Number of occurrences of weather regimes and open and closed MCC cases within each EIS category at SOFS.