

Supplementary material

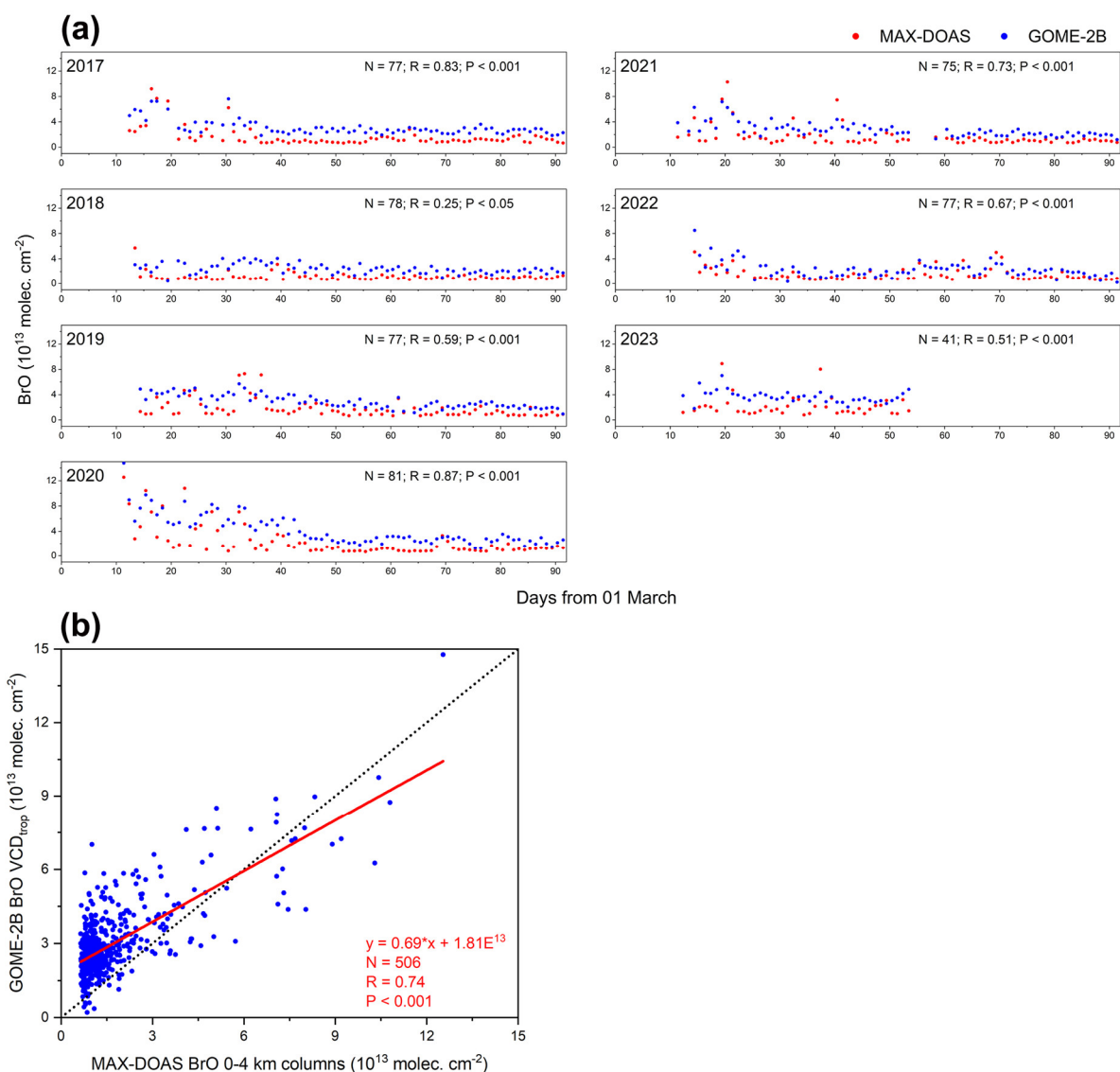


Figure S1. Daily time series of MAX-DOAS BrO partial columns (red symbols) in Ny-Ålesund and GOME-2B tropospheric BrO columns (blue symbols) within 45 km of Ny-Ålesund from March to May between 2017 and 2023 (a), and their correlation over the entire period (b). Note: Daily averages are calculated using only the hours with valid GOME-2B data, along with the corresponding MAX-DOAS observations for those hours.

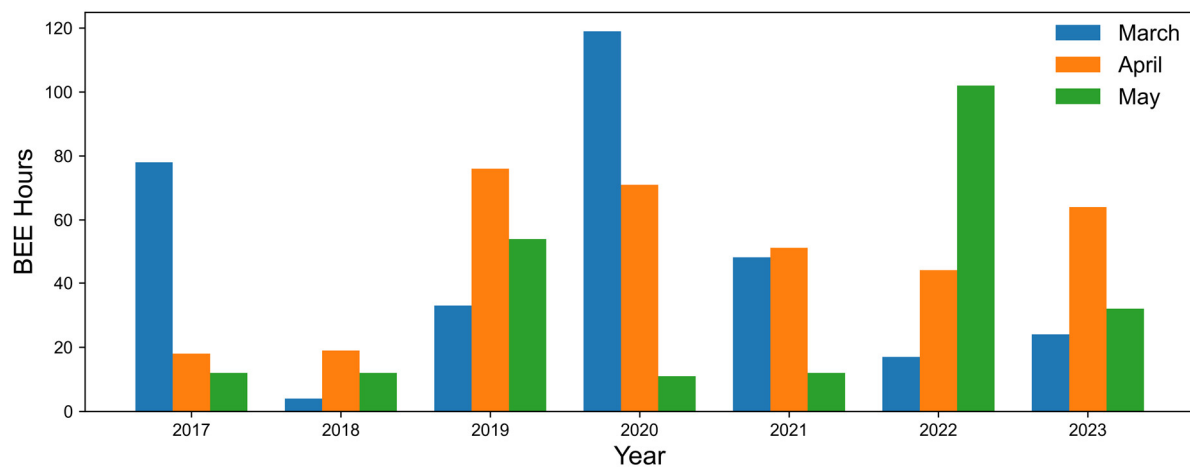


Figure S2. Monthly total hours of BEEs in Ny-Ålesund from March to May during 2017–2023. A BEE is defined as any hour during which BrO VMR exceeds 12 pptv at any altitude between 0 and 3 km.

Table S1. Percentage of air mass contact time (along the 5-d trajectories) with the free troposphere, land, sea ice, and open ocean for all BEEs that occurred in March, April and May during 2017–2023. N in the bracket represents the cumulative total of hours for air masses in each 200 m altitude interval within the 0–3 km range. Note that the boundary layer height is set to 500 m.

Percentage of Contact Time during BEEs				
	March (N=879)	April (N=835)	May (N=445)	Total (N=2159)
Free	35.69%	32.82%	36.98%	34.85%
Land	6.21%	7.95%	3.50%	6.32%
Sea ice	54.74%	50.88%	48.75%	52.01%
Ocean	3.36%	8.35%	10.77%	6.82%

Table S2. The same as Table S1, but with the boundary layer height set to 1000 m.

Percentage of Contact Time during BEEs				
	March (N=879)	April (N=835)	May (N=445)	Total (N=2159)
Free	14.30%	13.54%	15.47%	14.25%
Land	10.91%	14.15%	6.28%	11.21%
Sea ice	70.25%	61.99%	64.74%	65.92%
Ocean	4.54%	10.32%	13.51%	8.62%

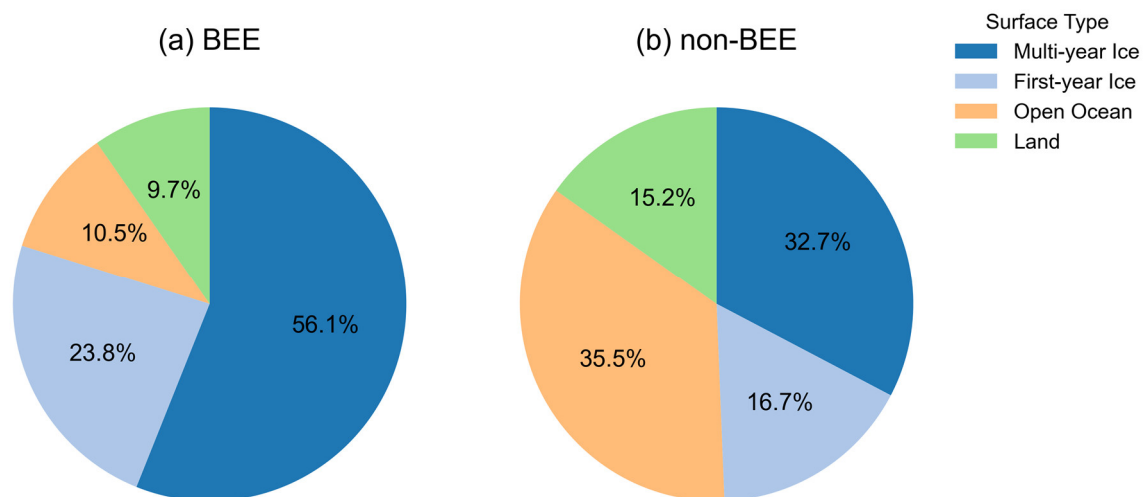


Figure S3. Percentages of air masses associated with (a) BEE and (b) non-BEE events that contact with different surface types (< 500 m) during March–May in 2017–2023. Note that the free troposphere is excluded.

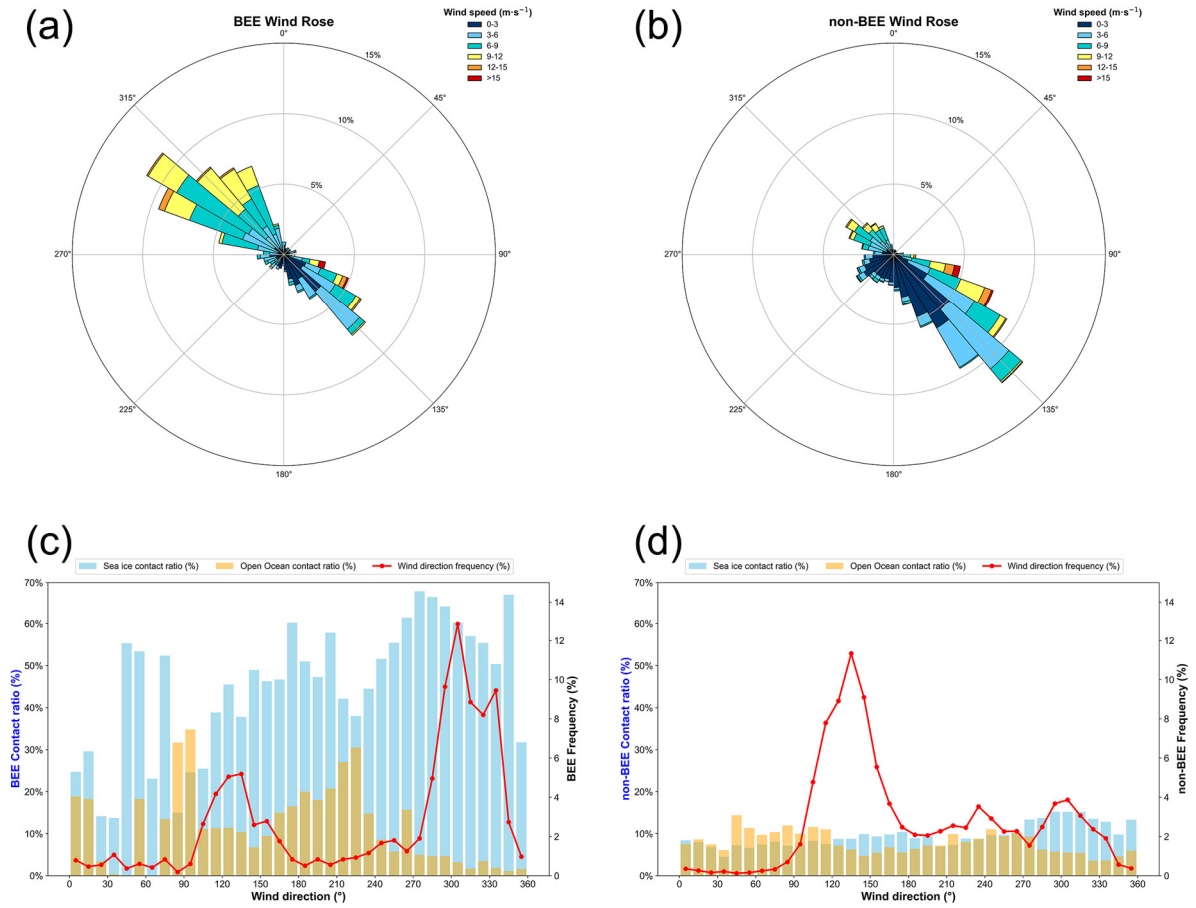


Figure S4. Wind rose diagrams for BEE (a) and non-BEE (b) during March–May, based on wind speed and direction measured in Ny-Ålesund from 2017 to 2023. Panels (c) and (d) present, for BEE and non-BEE periods respectively, the wind direction frequency (red line) along with the mean 5-day back-trajectory contact ratios with sea ice (blue bars) and open ocean (yellow bars) for each wind sector.

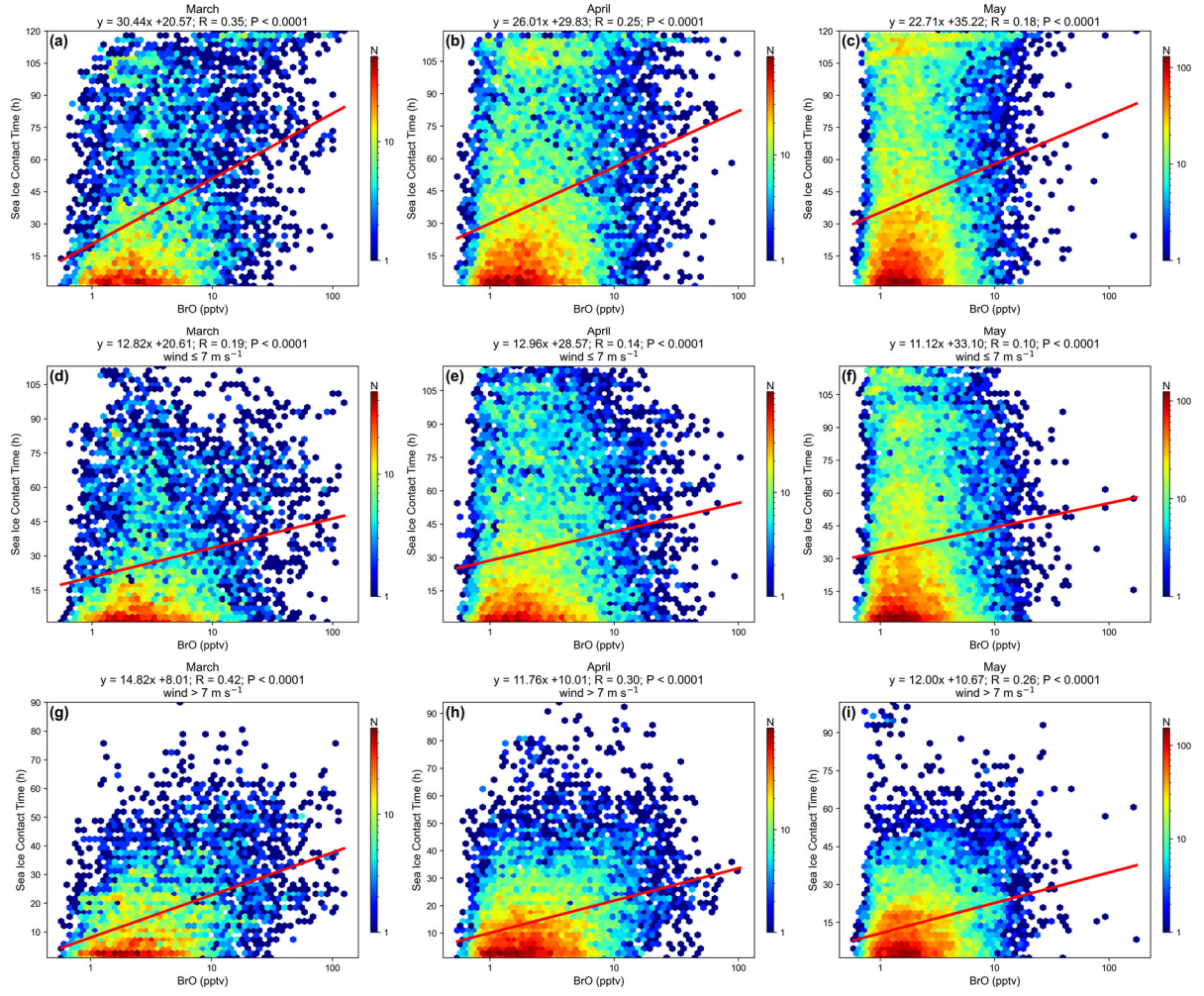


Figure S5. Correlation analysis of BrO with sea ice contact time from March to May during 2017–2023. (a–c) Correlations between BrO and overall sea ice contact time; (d–f) Correlations between BrO and sea ice contact time during low wind speed conditions ($\text{wind} \leq 7 \text{ m/s}$); (g–i) Correlations between BrO and sea ice contact time during high wind speed conditions ($\text{wind} > 7 \text{ m/s}$).