Supplement of Atmos. Chem. Phys., 25, 8355–8405, 2025
https://doi.org/10.5194/acp-25-8355-2025-supplement

Atmospheric Chemistry and Physics
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Supplement of

Modelling Arctic lower-tropospheric ozone: processes controlling seasonal variations

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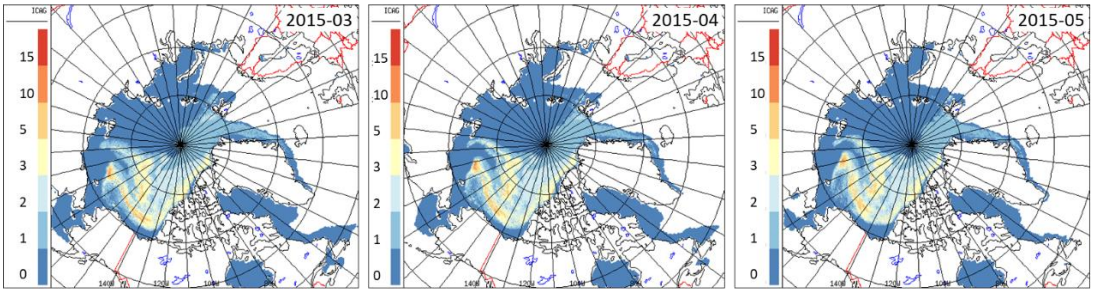
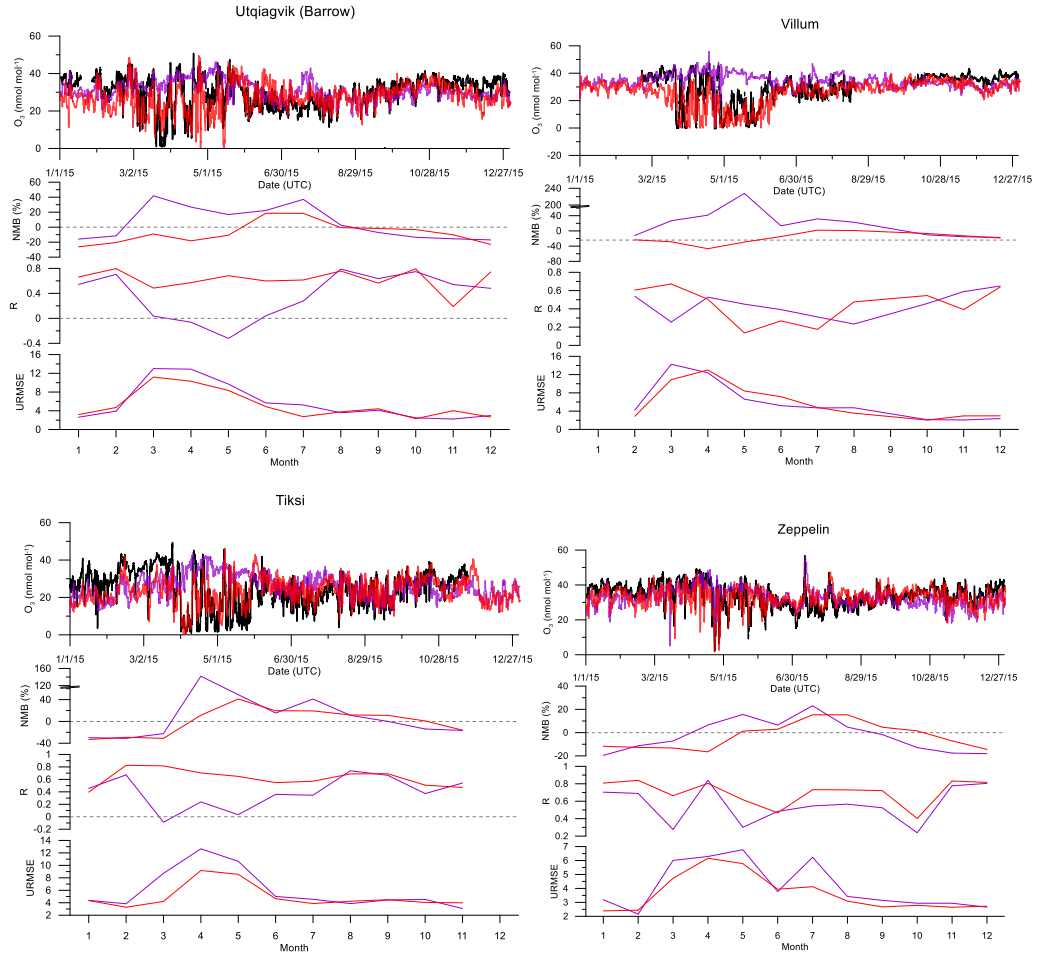


Figure S1. Monthly mean sea ice age (year), for March, April, and May 2015, from the EASE-Grid Sea Ice Age Version 4 dataset used by GEM-MACH.



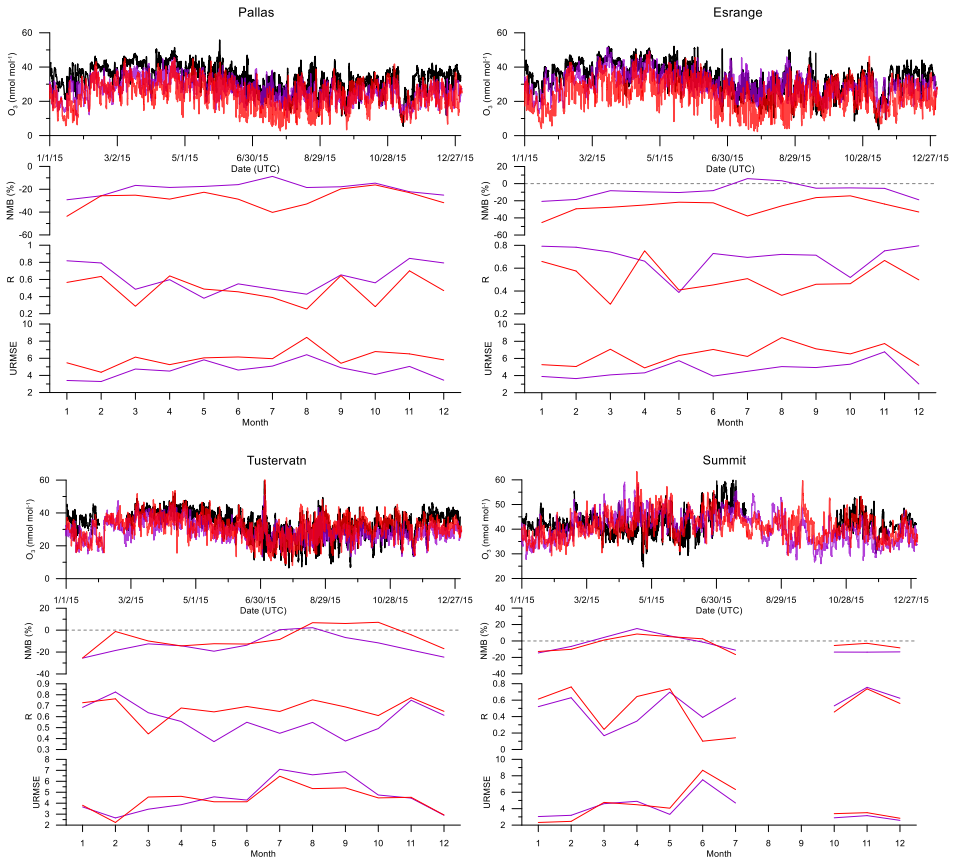
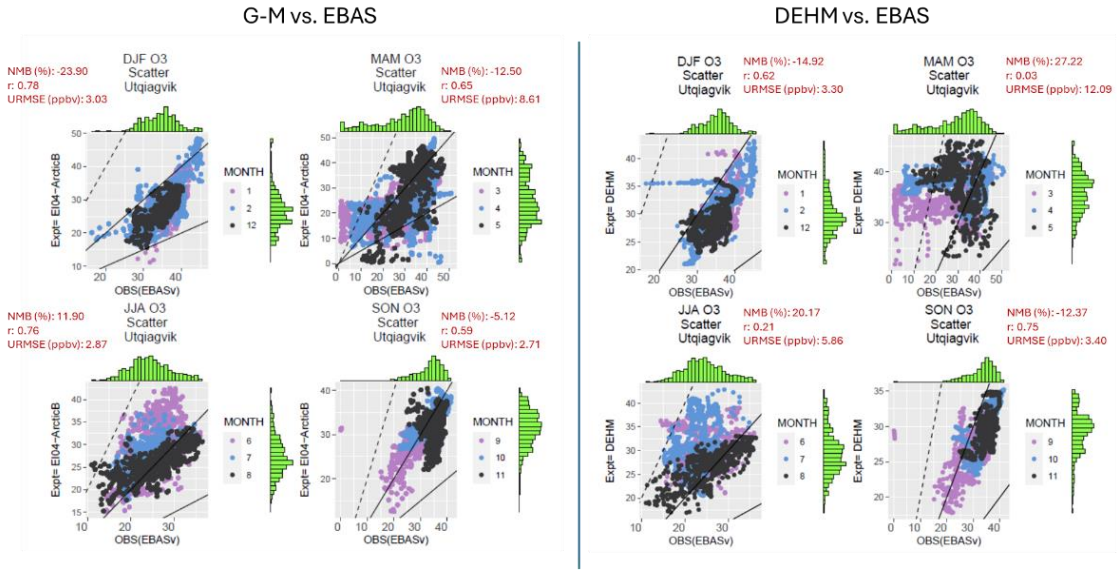
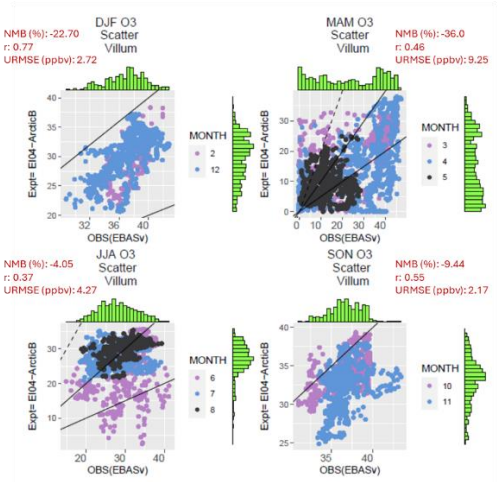


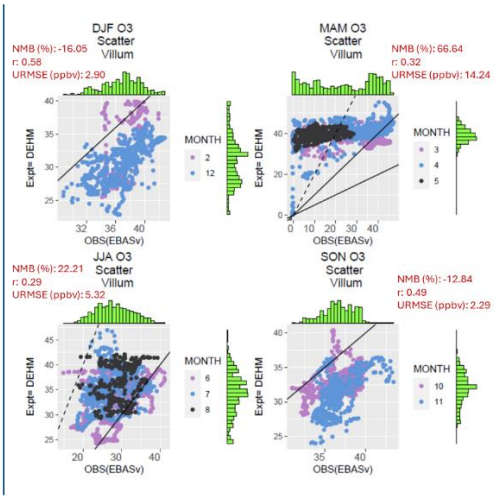
Figure S2. O_3 time series comparisons between models (GEM-MACH and DEHM) and observations at Arctic surface sites accompanied by monthly evaluation statistical metrics (NMB, R, URMSE).



G-M vs. EBAS



DEHM vs. EBAS



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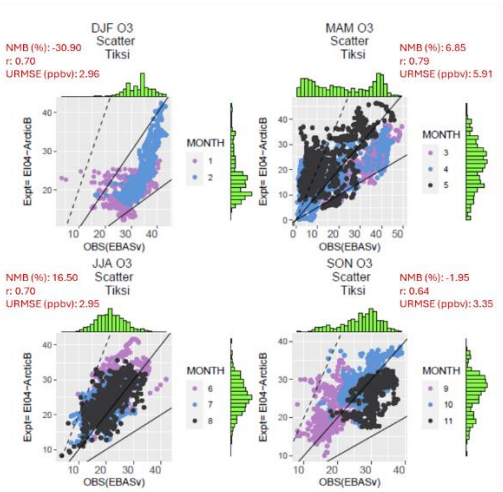
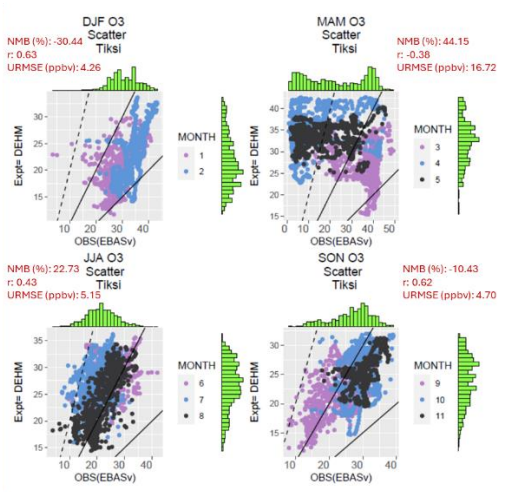
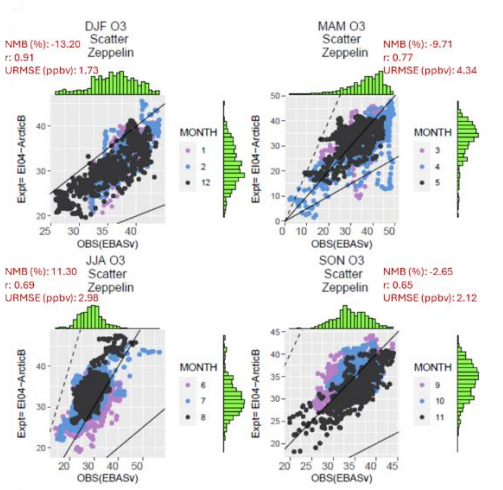


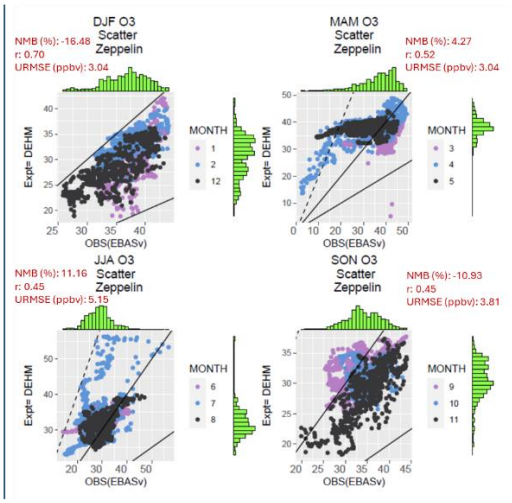
DEHM vs. EBAS



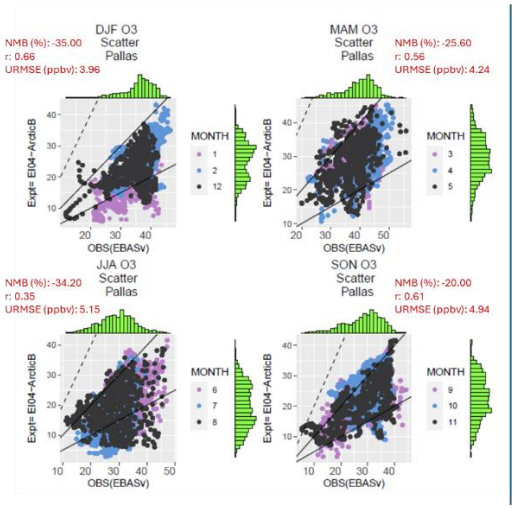
G-M vs. EBAS



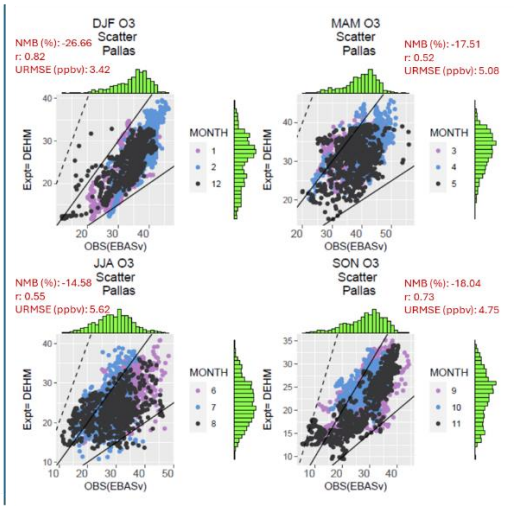
DEHM vs. EBAS



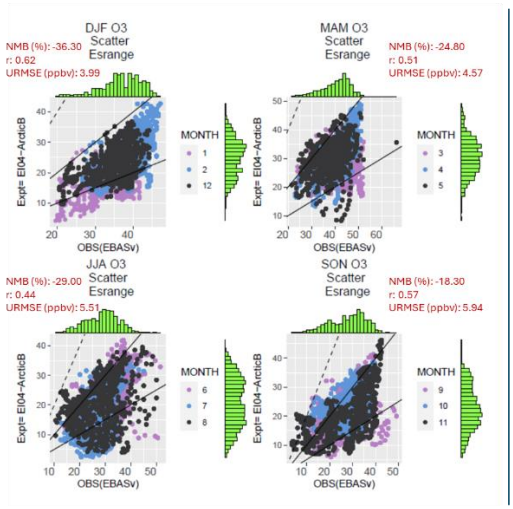
G-M vs. EBAS



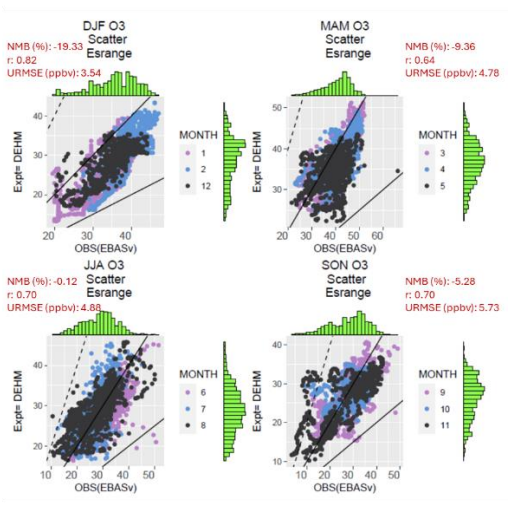
DEHM vs. EBAS



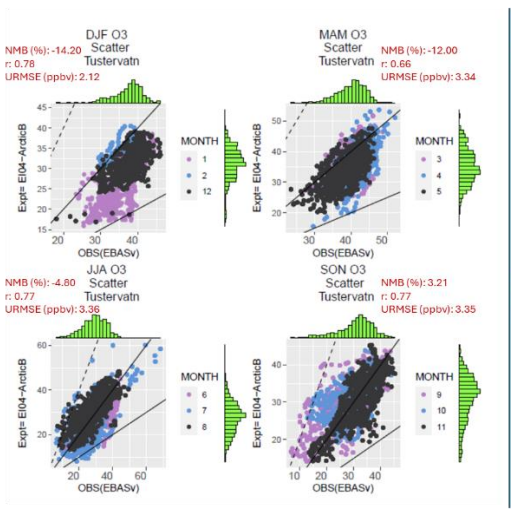
G-M vs. EBAS



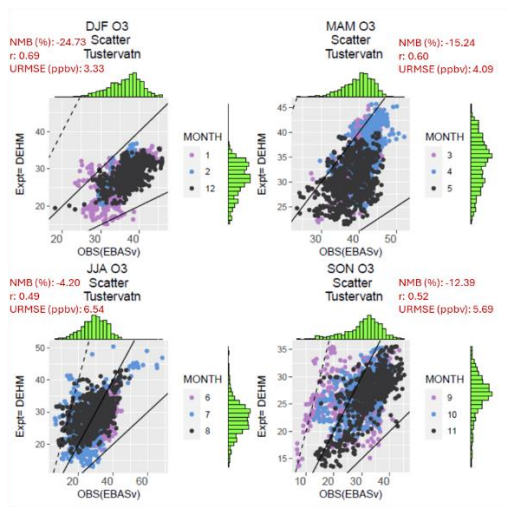
DEHM vs. EBAS



G-M vs. EBAS



DEHM vs. EBAS



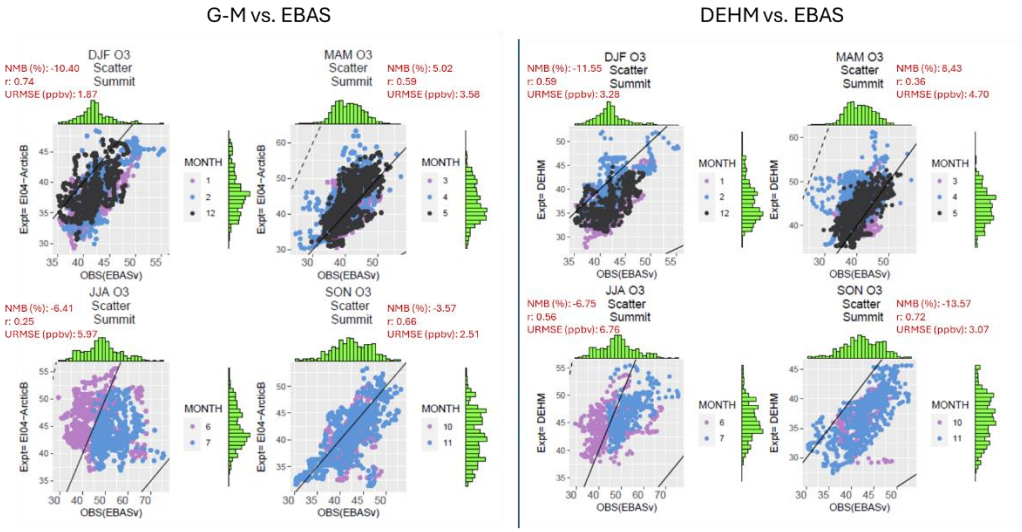
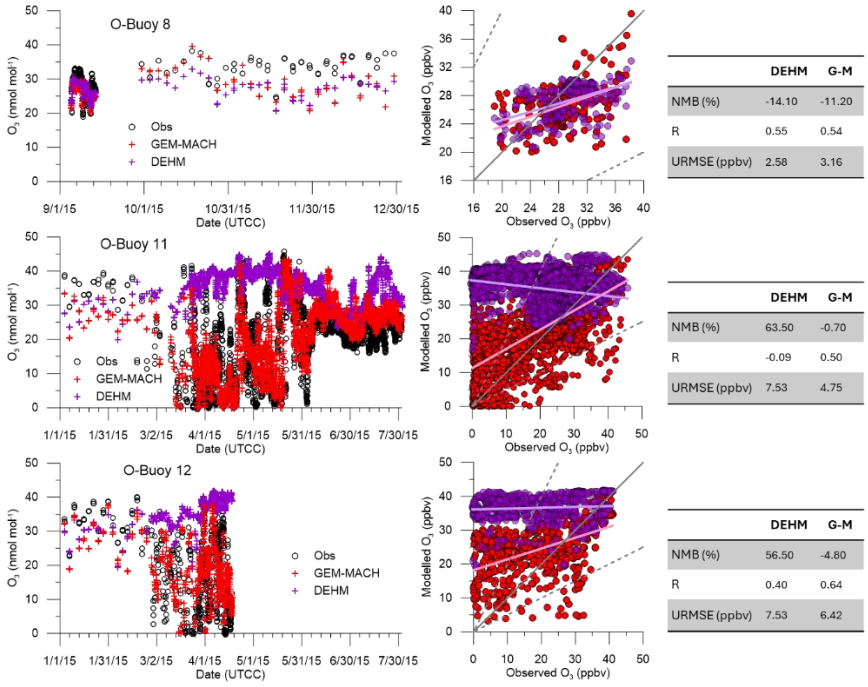


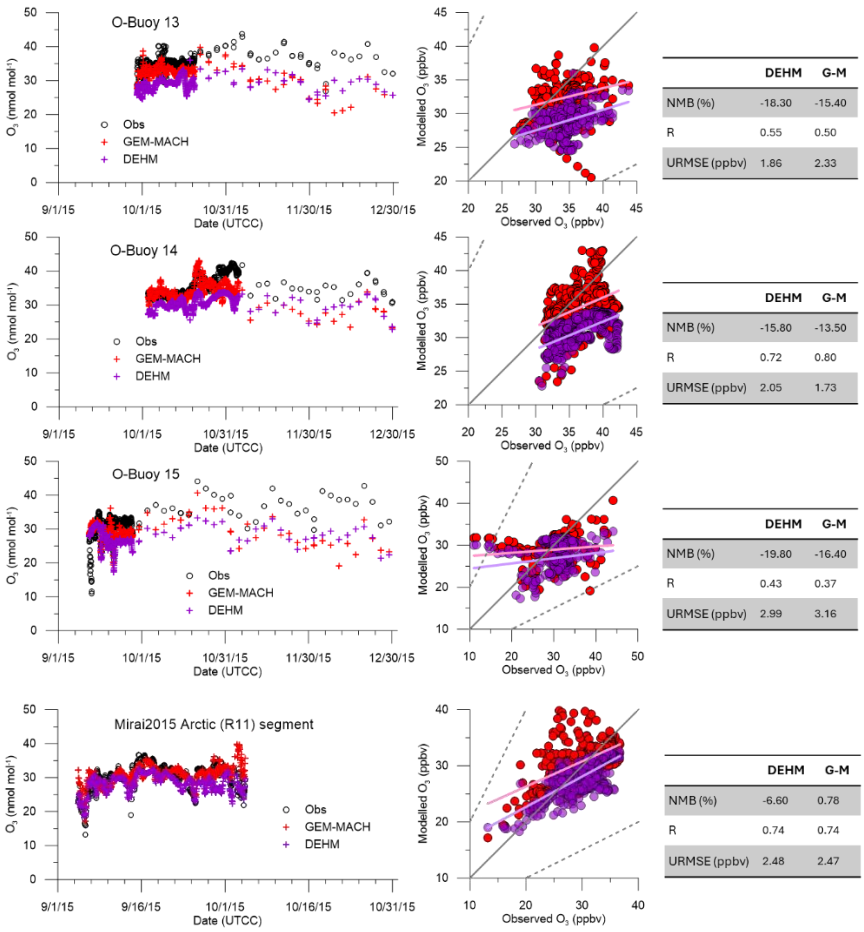
Figure S3. Seasonal statistical evaluation (NMB, R, URMSE) based on 2015 hourly model and observational O_3 data at Arctic surface sites for GEM-MACH and DEHM, respectively.



	DEHM	G-M
NMB (%)	-14.10	-11.20
R	0.55	0.54
URMSE (ppbv)	2.58	3.16

	DEHM	G-M
NMB (%)	63.50	-0.70
R	-0.09	0.50
URMSE (ppbv)	7.53	4.75

	DEHM	G-M
NMB (%)	56.50	-4.80
R	0.40	0.64
URMSE (ppbv)	7.53	6.42



	DEHM	G-M
NMB (%)	-18.30	-15.40
R	0.55	0.50
URMSE (ppbv)	1.86	2.33

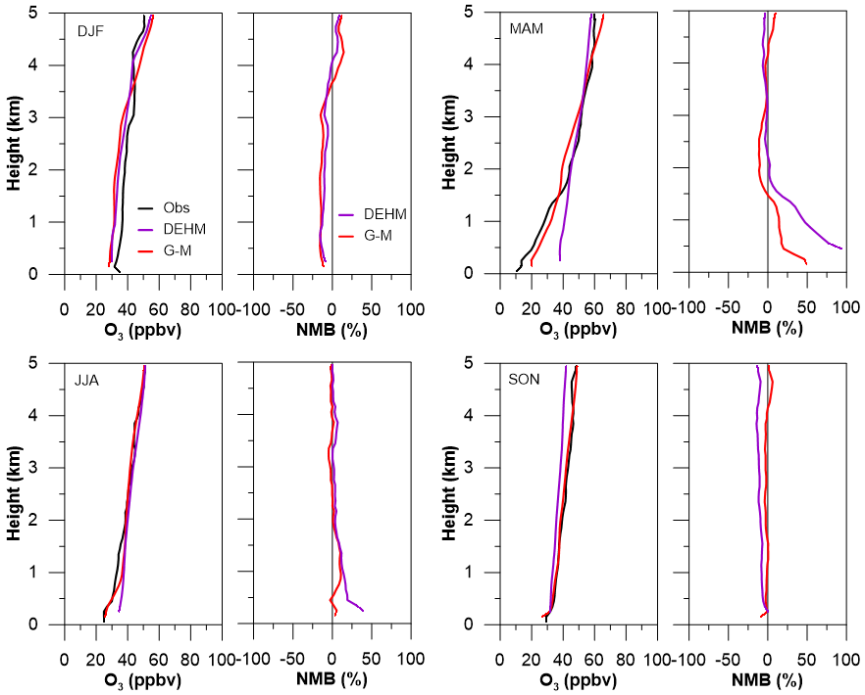
	DEHM	G-M
NMB (%)	-15.80	-13.50
R	0.72	0.80
URMSE (ppbv)	2.05	1.73

	DEHM	G-M
NMB (%)	-19.80	-16.40
R	0.43	0.37
URMSE (ppbv)	2.99	3.16

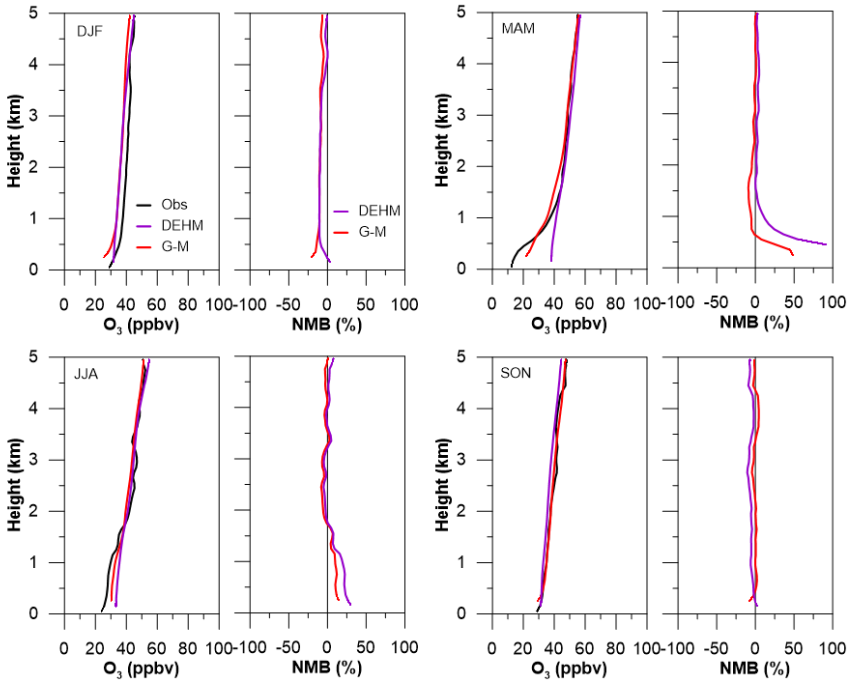
	DEHM	G-M
NMB (%)	-6.60	0.78
R	0.74	0.74
URMSE (ppbv)	2.48	2.47

Figure S4. O_3 time series comparison between model and observation for individual O-buoy deployment and Mirai cruise during 2015.

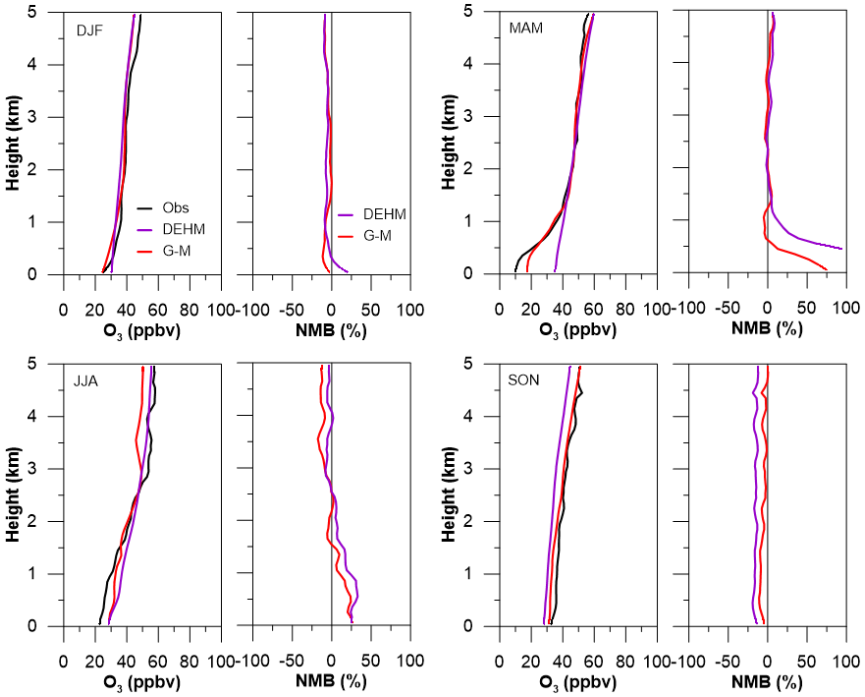
Alert



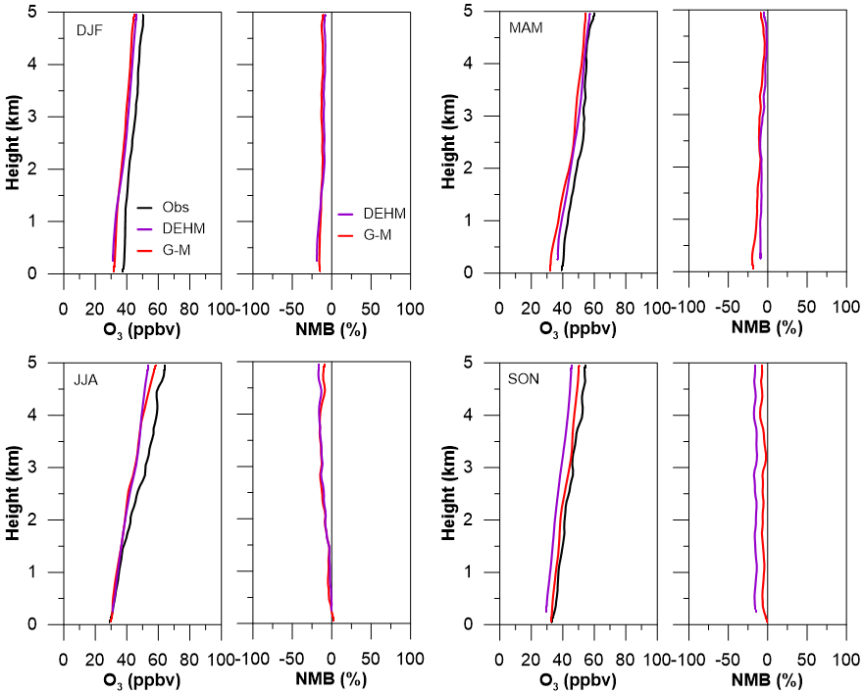
Eureka



Resolute



Ny Alesund



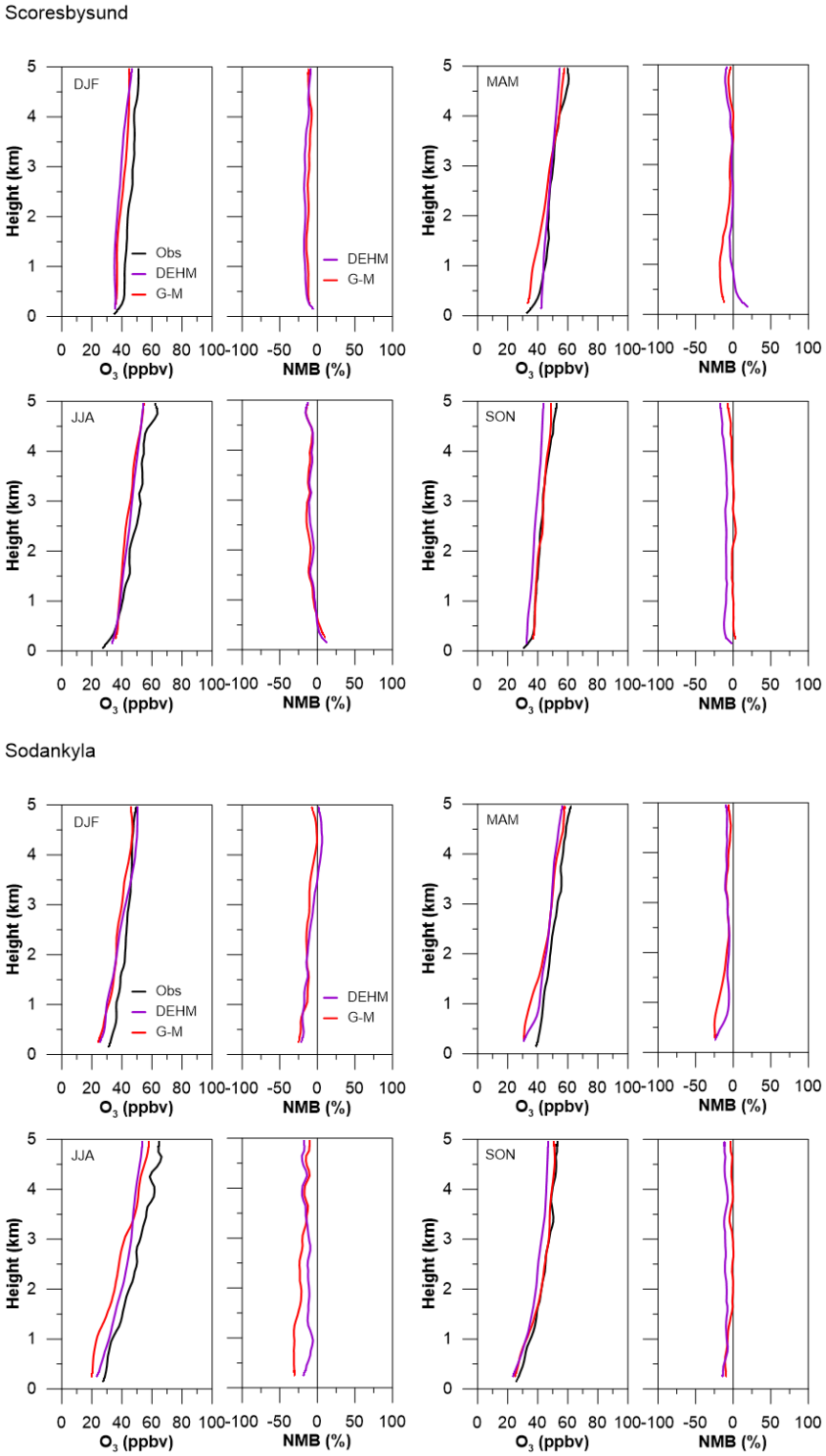


Figure S5. Comparison of modelled and observed O_3 profiles (seasonal averaged) over the lowest 5 km of the atmosphere at 6 Arctic ozonesonde sites: Alert, Eureka, Resolute, Ny Ålesund, Scoresbysund, and Sodankylä. Both measurement and modelled profiles are interpolated at 10-m resolution and binned to 100-m intervals.

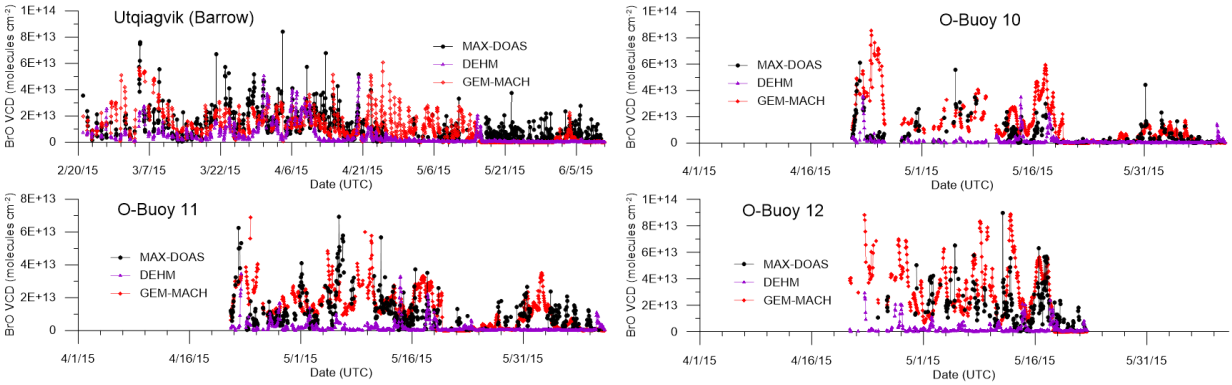


Figure S6. Comparison of modelled BrO (GEM-MACH in red, DEHM in purple) against MAX-DOAS observations (black) at Utqiaġvik and on O-buoys during 2015.

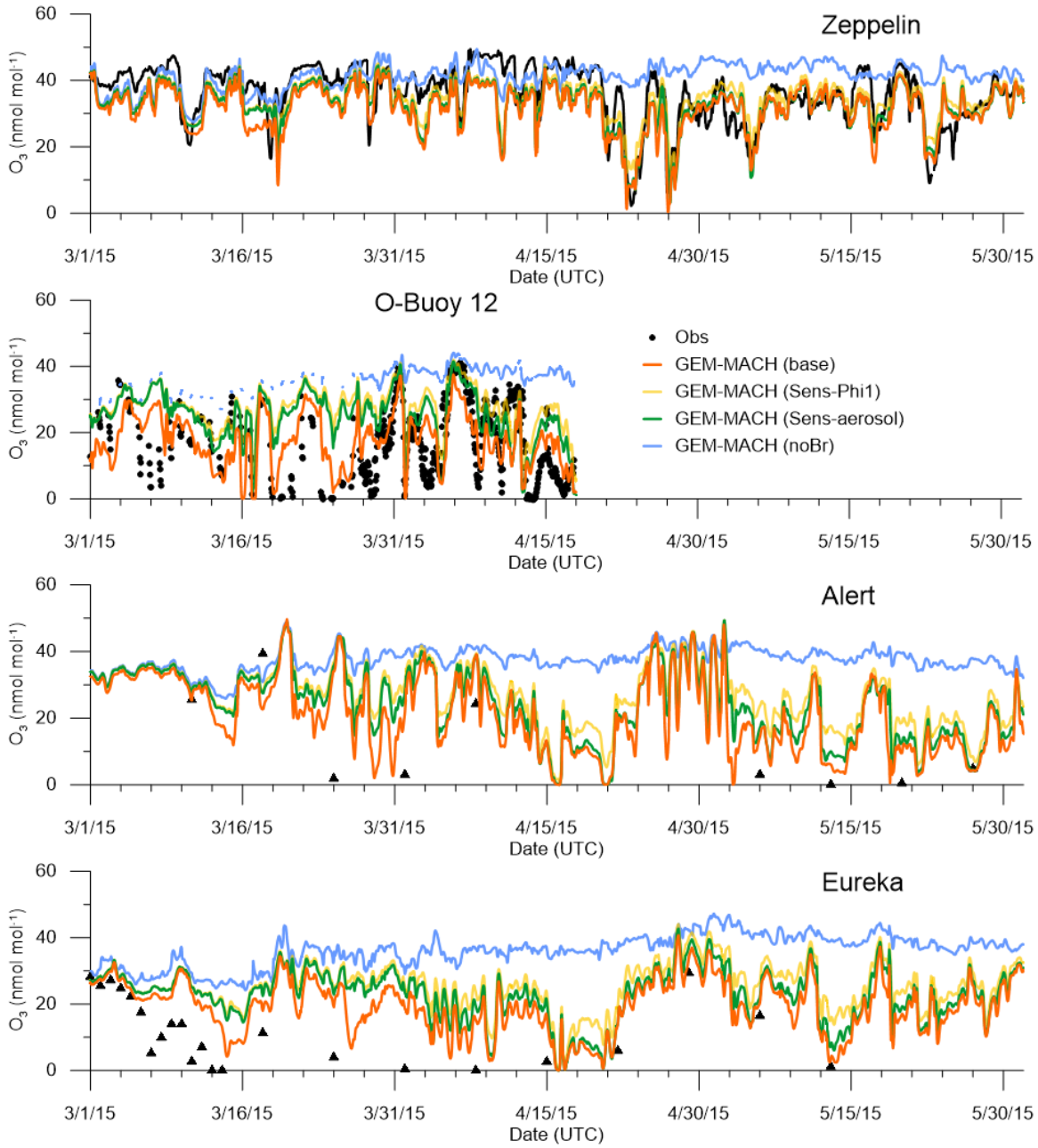


Figure S7. GEM-MACH simulated O_3 time series from the base (red) and sensitivity runs, Sens-Phi1 (turquoise) and Sens-aerosol (green), compared with observations (black) over Beaufort Sea (O-Buoy 12) and at coastal sites: Zeppelin, Alert, and Eureka. Also plotted are the modelled O_3 timeseries from the No-bromine run (blue).

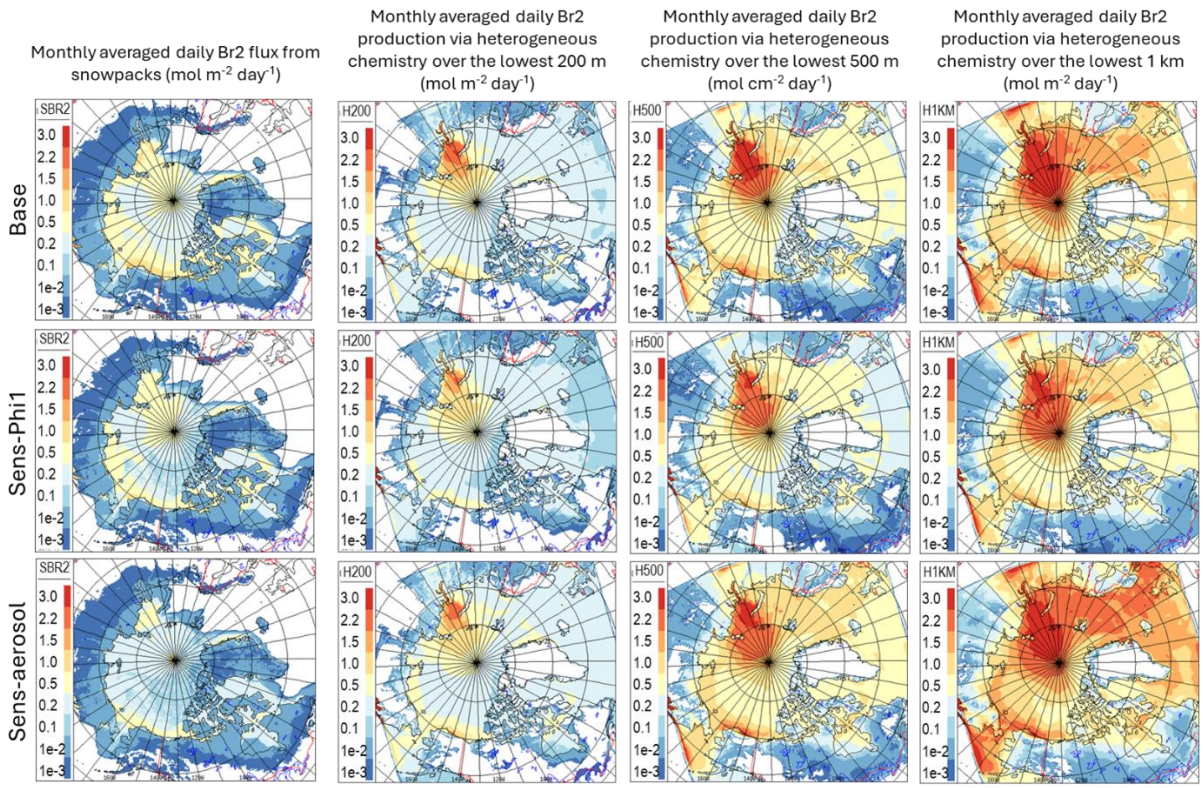


Figure S8. GEM-MACH modelled monthly mean (2015 April) Br_2 daily flux from snowpacks (leftmost column) and Br_2 daily production from aerosol heterogeneous reaction over the lowest 200 m (2nd column from left), the lowest 500 m (3rd column from left), and the lowest 1 km (rightmost column), all in moles m^{-2}, from the base (top), Sens-Phi1 (middle), and Sens-aerosol runs (bottom).

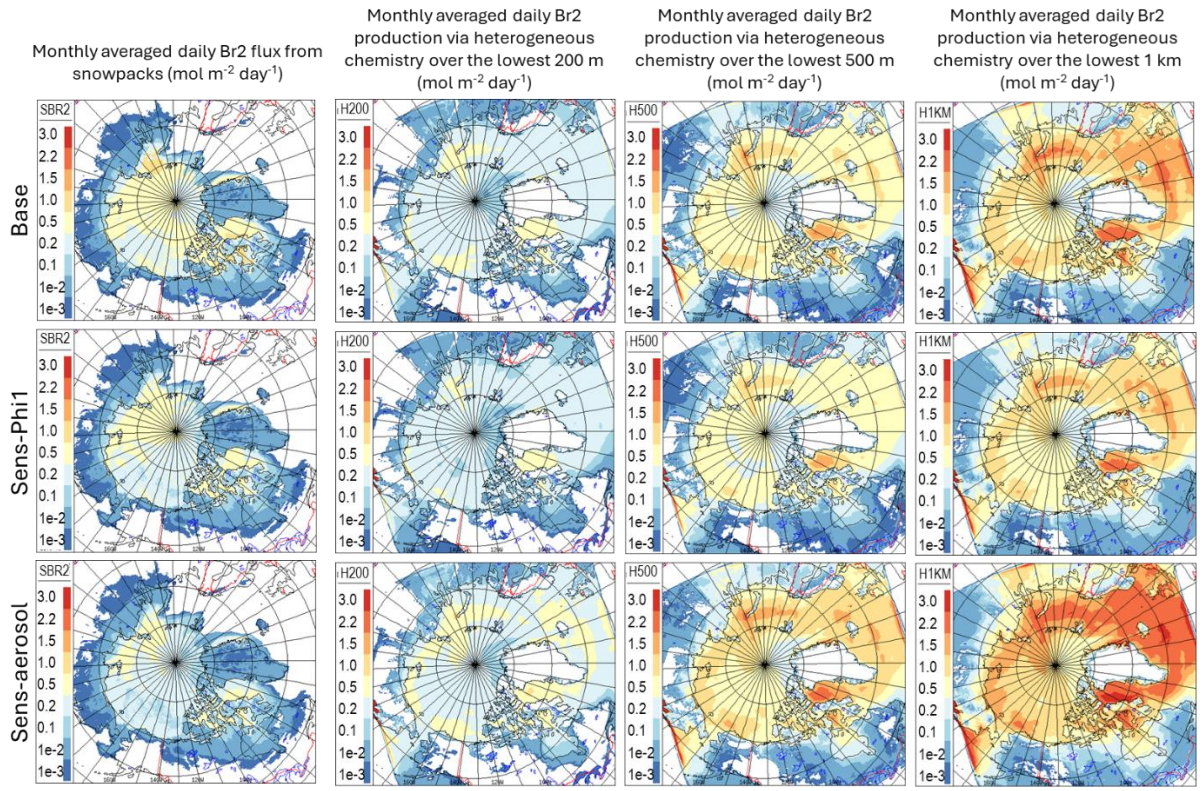


Figure S9. Same as SF.8 but for 2015 May.

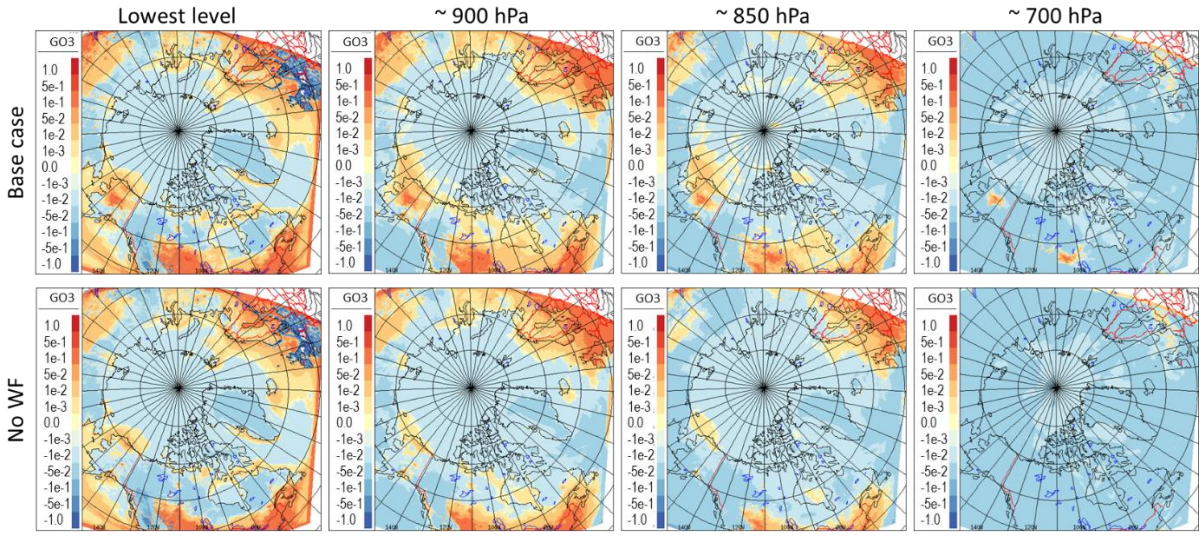


Figure S10. July monthly net O_3 chemical tendency (in µg/kg/900s) at model levels (from left to right): lowest surface level, ~ 900 hPa, ~850 hPa, and ~ 700 hPa, from the GEM-MACH base annual simulation (with wildfires) (top row) and the GEM-MACH simulation without the wildfire emissions in the model LAM domain (bottom row).

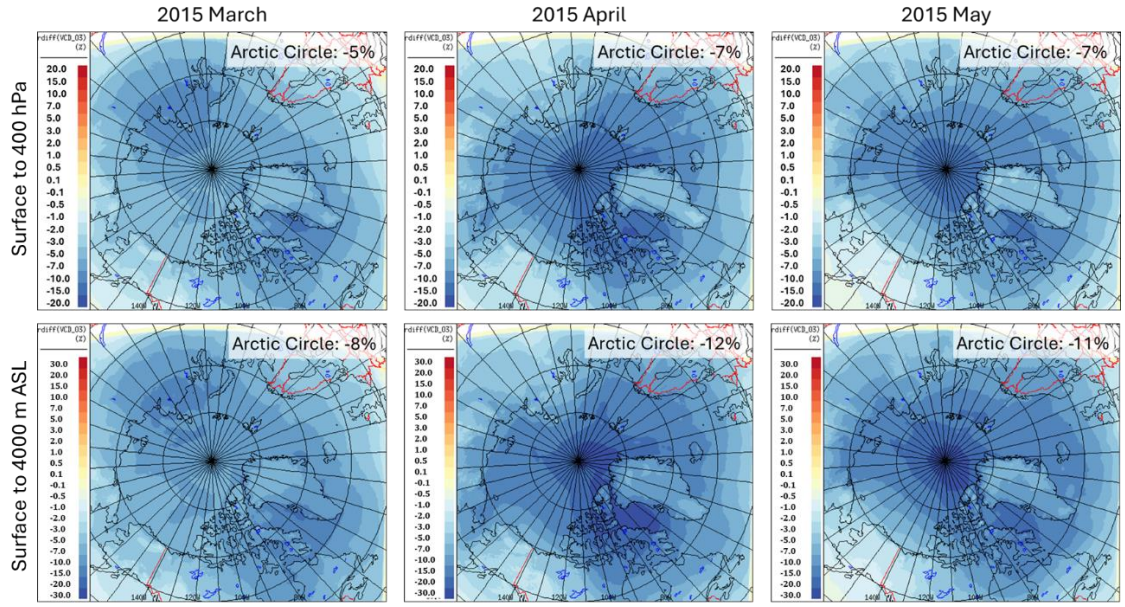


Figure S11. Reduction in monthly mean O_3 partial columns due to snowpack bromine in GEM-MACH, surface to 400 hPa (top row) and surface to 4000 m ASL (bottom row), shown in relative difference (%): (Base-noBr)/noBr*100. The corresponding reductions in pan-Arctic (> 66.5°N; "Arctic Circle") integrated monthly mean O_3 partial columns due to snowpack bromine are indicated in each plot.