



*Supplement of*

## **Langmuir turbulence in the Arctic Ocean: insights from a coupled sea ice–wave model**

**Aikaterini Tavri et al.**

*Correspondence to:* Aikaterini Tavri ([aikaterini\\_tavri@brown.edu](mailto:aikaterini_tavri@brown.edu))

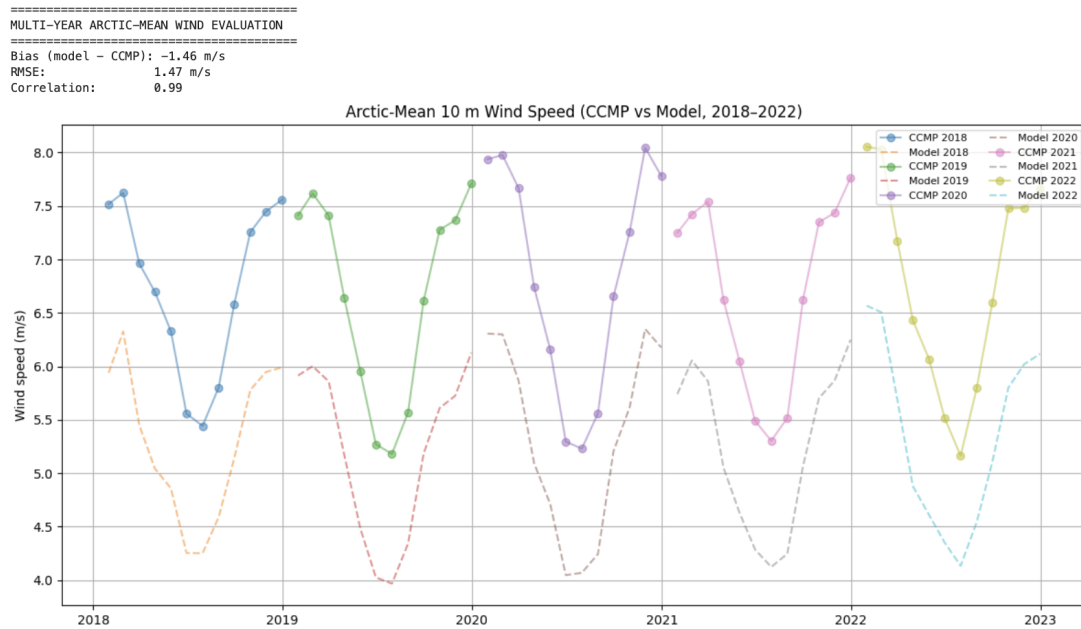
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## S1 Model variables and parameters

**Table S1.** Definitions and descriptions of parameters used from the neXtSIM and WAVEWATCH III models.

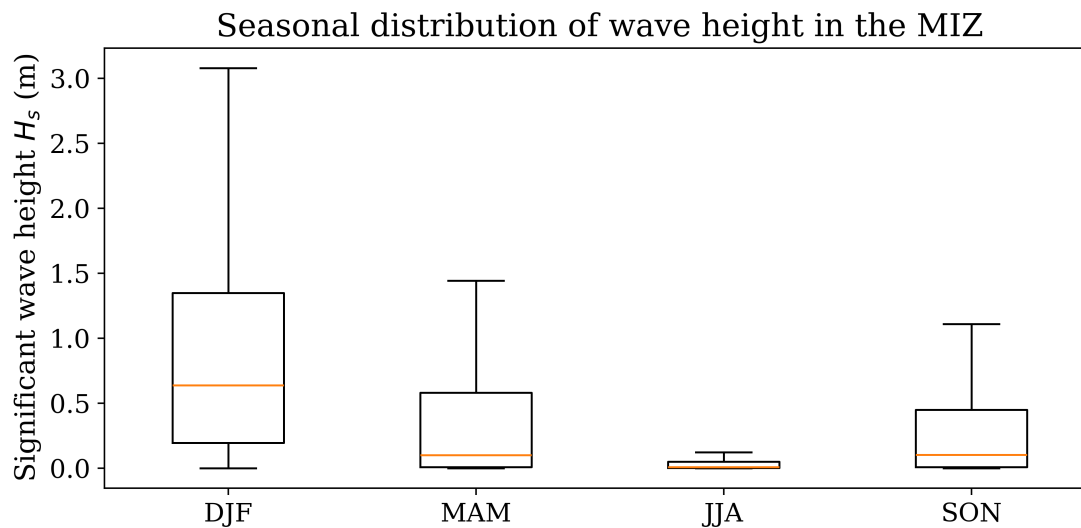
<b>Parameter</b>	<b>Description</b>	<b>Units</b>
<b>neXtSIM Model Parameters</b>		
$\tau_x$	Eastward stress at ocean surface	Pa
$\tau_y$	Northward stress at ocean surface	Pa
$u_{ice}$	Sea ice x velocity	$\text{ms}^{-1}$
$v_{ice}$	Sea ice y velocity	$\text{ms}^{-1}$
$SIC$	Sea ice concentration	–
$SIC_{young}$	Young ice concentration	–
$SIT_{young}$	Young ice thickness	m
$SIT$	Sea ice thickness	m
$SNT$	Surface snow thickness	m
$D_{max}$	Maximum floe size	m
$D_{mean}$	Mean floe size	m
$SSS$	Sea surface salinity	PSU
$SST$	Sea surface temperature	$^{\circ}\text{C}$
$T_{2m}$	2-m air temperature	$^{\circ}\text{C}$
<b>WW3 Model Parameters</b>		
$dir$	Wave direction	degrees
$d_p$	Peak wave direction	degrees
$f_p$	Peak wave frequency	Hz
$H_s$	Significant wave height	m
$ic1$	Ice thickness	m
$ic3$	Average ice floe diameter	m
$ice$	Sea ice area fraction	–
$t_{02}$	Mean wave period (second moment)	s
$tus$	Northward Stokes transport	–
$us$	Northward surface Stokes drift	–
$wnd$	Wind speed	$\text{ms}^{-1}$

## S2 Evaluation of surface wind forcing



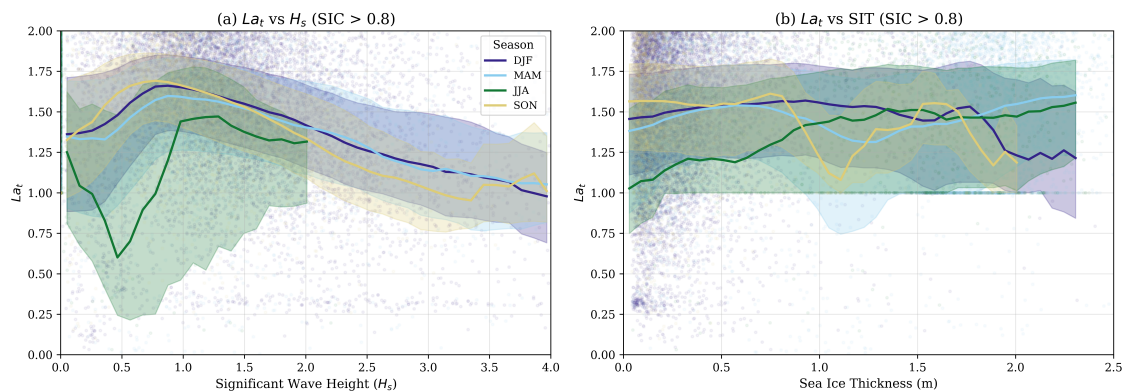
**Figure S1.** Arctic-mean monthly 10-m wind speed from CCMP (solid) and ERA5-forced model winds (dashed) for 2018–2022. The model captures the seasonal cycle and interannual variability ( $r = 0.99$ ) but exhibits a systematic low bias relative to CCMP.

### S3 Evaluation of significant wave height



**Figure S2.** Seasonal distribution of significant wave height in the marginal ice zone (MIZ). Boxplots show the distribution of significant wave height  $H_s$  over MIZ grid cells ( $0.15 \leq \text{SIC} \leq 0.8$ ) for winter (DJF), spring (MAM), summer (JJA), and fall (SON).

### S4 Parametric plots for Langmuir Number and model parameters



**Figure S3.** Seasonal dependence of  $La_t$  under compact ice conditions ( $\text{SIC} > 0.8$ ). (a)  $La_t$  as a function of significant wave height ( $h_s$ ), and (b)  $La_t$  as a function of sea ice thickness (SIT). Colored lines denote seasonal medians (DJF, MAM, JJA, SON), with shaded regions indicating variability (interquartile range). Background scatter points represent individual grid-cell values.