Supporting Information for "Evaluation of a Coupled Wave-Ice Model in the Western Arctic"

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1. Figures S1 to S3

References

Meylan, M. H., Bennetts, L. G., & Kohout, A. L. (2014). In situ measurements and analysis of ocean waves in the Antarctic marginal ice zone. *Geophysical Research Letters*, *41*(14). doi: 10.1002/2014GL060809

Meylan, M. H., Horvat, C., Bitz, C. M., & Bennetts, L. G. (2021, 5). A floe size dependent scattering model in two- and three-dimensions for wave attenuation by ice floes. *Ocean Modelling*, *161*, 101779. Retrieved from `https://linkinghub.elsevier.com/retrieve/pii/S1463500321000299` doi: 10.1016/j.ocemod.2021.101779

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Roach, L. A., Bitz, C. M., Horvat, C., & Dean, S. M. (2019). Advances in Modeling Interactions Between Sea Ice and Ocean Surface Waves. *Journal of Advances in Modeling Earth Systems*. doi: 10.1029/2019MS001836

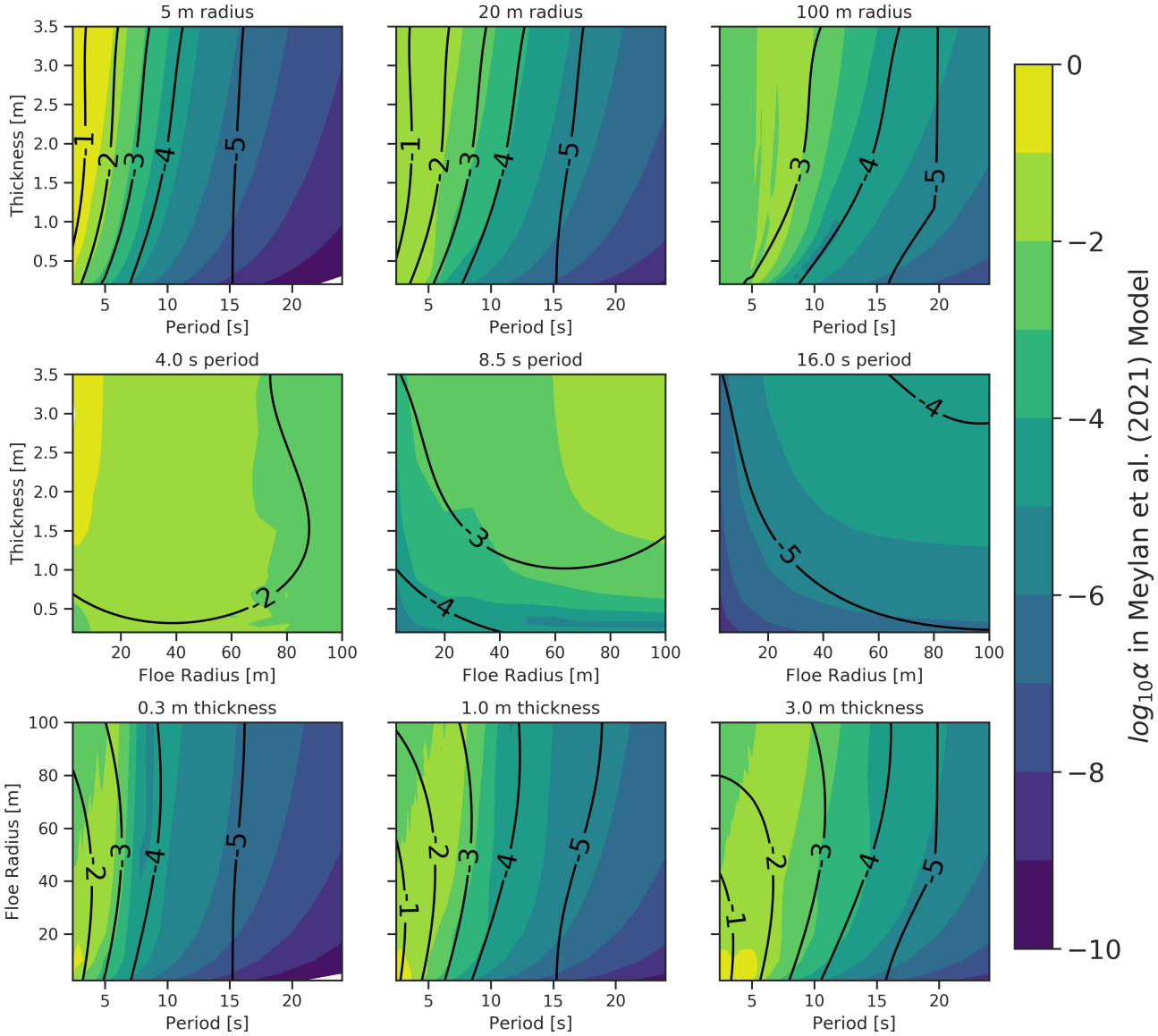

Figure S1. See caption on following page.

Figure S1. Illustrative frequency-dependent wave attenuation coefficients based on varying floe size, ice thickness, and wave period applied in the Roach et al. (2019) model (black contours). Computing S_{ice}, the source term for wave-ice interactions, involves multiplying the wave spectral energy by a wave attenuation coefficient α, which represents the exponential rate of attenuation over distance travelled in ice (see Meylan et al. (2021) for full discussion). When α is relatively large, the ice causes strong attenuation. Contour labels and color contours indicate $\log_{10}\alpha$; the zero contour represents maximum attenuation while negative values represent weaker attenuation. Top row shows attenuation coefficients for fixed floe sizes, middle row for fixed wave periods, and bottom row for fixed ice thickness values. Scattering model from Meylan et al. (2021) shown as color-shading contours. Attenuation rates from the Roach et al. (2019) model are shown as black contour lines with labels. In Roach et al. (2019), a cubic polynomial fit to the Meylan et al. (2021) scattering model is used to approximate the scattering component of wave attenuation. Total attenuation in the Roach et al. (2019) model comes not only from the fit to the scattering model but also from an additional contribution for relatively long periods based on measurements reported in Meylan et al. (2014). This additional contribution based on the wave period T is $\alpha = c_1 T^{-2} + c_2 T^{-4}$, where $c_1 = 2.12 \times 10^{-3}$ s^{2}m^{-1} and $c_2 = 4.59 \times 10^{-2}$ s^{4}m^{-1}. In Roach et al. (2019), for periods less than 5 s, α is purely based on the fit to the scattering model. For periods between 5 and 20 s, α is the sum of the fit to the scattering model and the additional contribution from the period T. Beyond 20 s, α is entirely determined by the T terms.

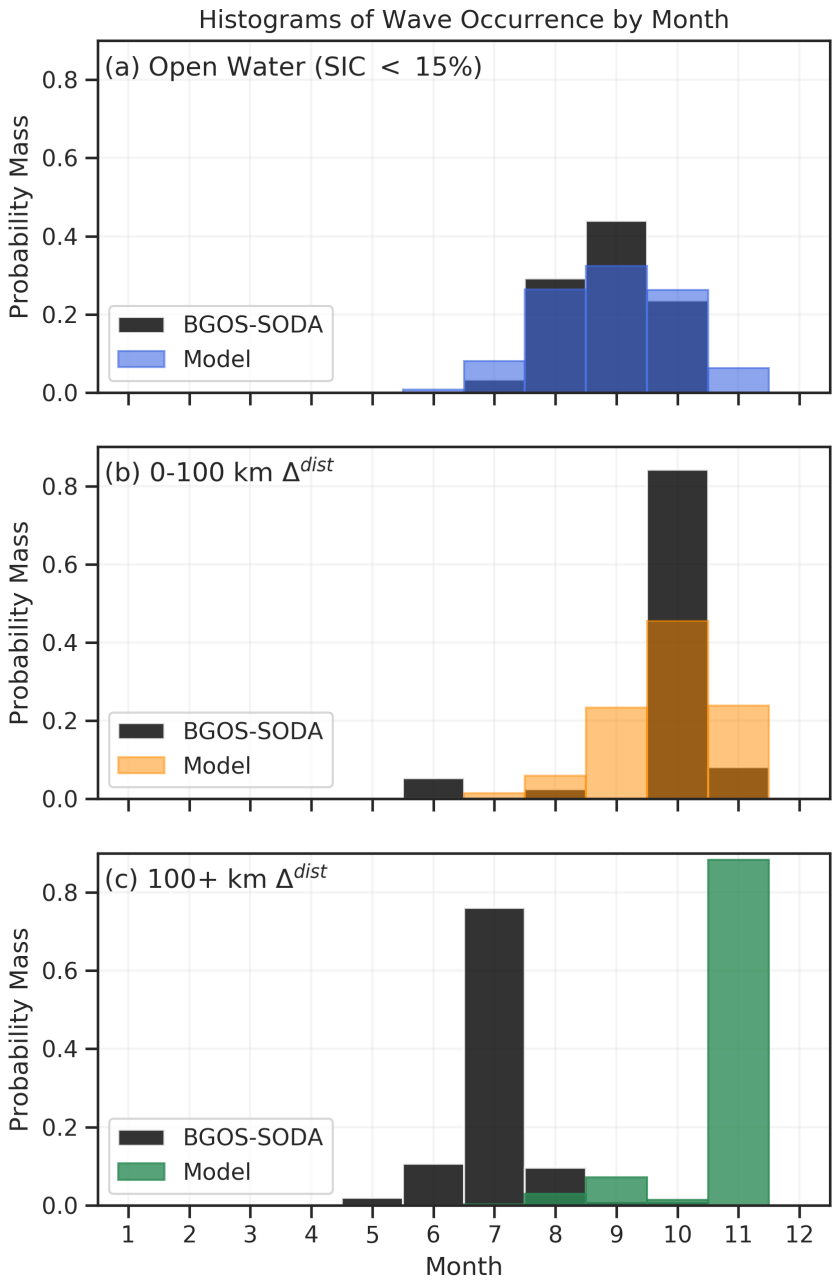

Figure S2. Histogram of wave occurrence by month for significant wave height > 0.3 m, spanning 2012-2019 and grouped by Δ^{dist}. Observations (black) represent combined BGOS and SODA datasets. Model (colors) represents results from Roach et al. (2019), aggregating grid cells in the central Beaufort region surrounding observations.

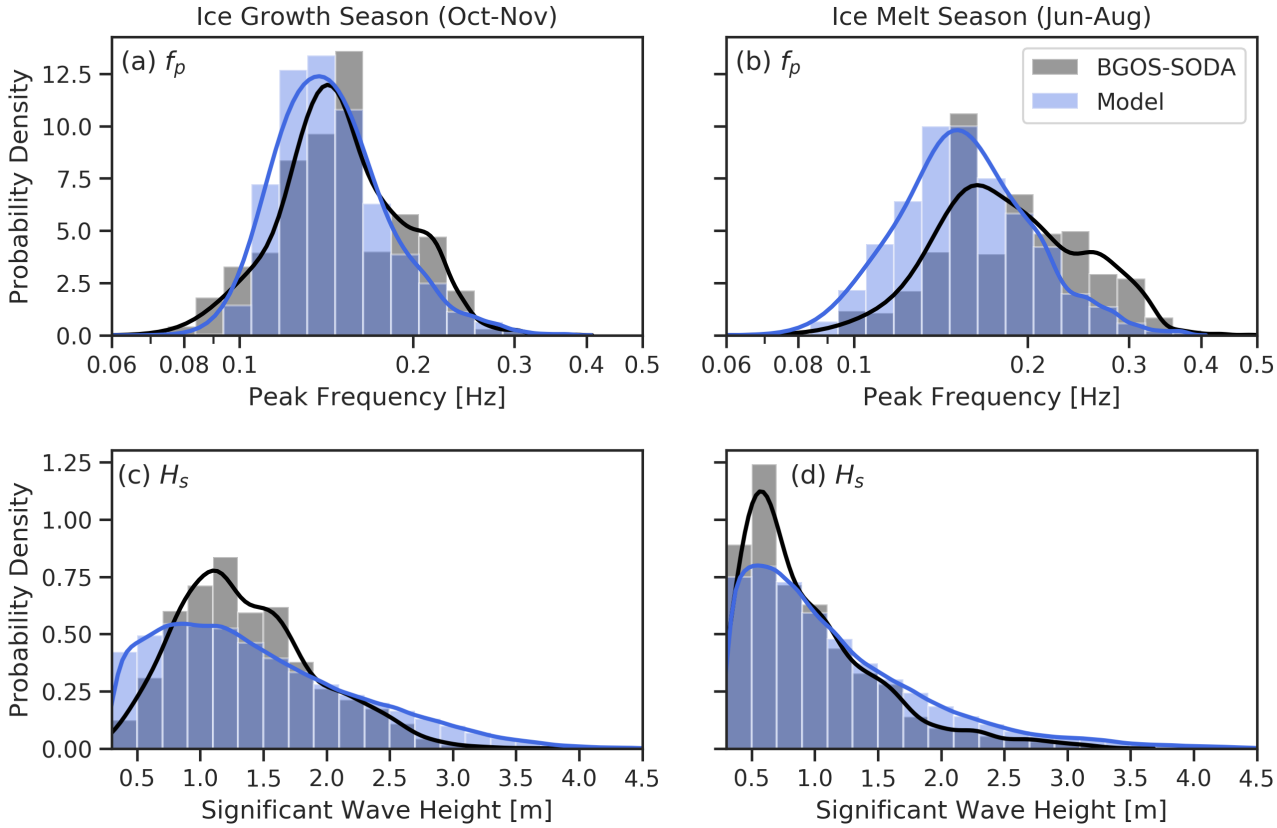

Figure S3. Histogram of (top row) peak frequency and (bottom row) significant wave height for spectra with $H_s > 0.3$ m in open water (SIC $< 15\%$), spanning 2012-2019, during the months of (left column) October and November when new ice is forming and (right column) June through August when the sea ice edge is retreating. Observations (black) represent combined BGOS-SODA dataset. Model (blue) represents results from Roach et al. (2019), aggregating grid cells in the Beaufort region surrounding observations. Note that swell occurs in the model during the ice growth season, panels (a,c).