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Wave attenuation across 400 km of an Arctic Marginal Ice Zone: measuring wave heights with Sentinel 1 and numerical modeling

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The combination of various processes that affect ocean surface gravity waves in sea ice may lead to attenuation rates that vary with both wave frequency and amplitude. We take advantage of data collected in the marginal ice zone of the Beaufort Sea in 2015. These include the first kilometer-scale map of wave heights provided by Sentinel-1 SAR imagery, up to 400 km into the ice, and in situ sensors deployed as "Wave Array 3". We particularly test the possible effects of basal friction, scattering by ice floes, and the dissipation in the ice layer due to dislocations that appear when the ice flexes. We find that at an ice edge dominated by pancake ice, the viscous friction at the base of an ice layer may give a dissipation rate that is too large. Further into the ice, where ice floes are much larger, basal friction is not enough to explain the dissipation occurring at larger scale. We thus propose a reduction of basal friction based on pancakes or floe size distribution, and its combination with a dissipation due to ice flexure. This combination gives acceptable wave height gradients for the waves with periods around 10 s that were observed on October 12, 2015. These waves are associated with a 100 to 200 km wide region over which the ice should be broken by waves. Evidence for ice break-up in the IW mode SAR imagery is further discussed.