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Tide-modulated seismicity in the vicinity of a calving front (Bowdoin Glacier, Greenland)

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For cryogenic microseismicity to be used as an indicator of climate-induced dynamic change, it must have a clear connection with glacier dynamics (including calving, basal sliding, strain, and melt). There is currently much speculation and disagreement about these connections, particularly, with respect to the relationship between tide-modulated seismicity and dynamics of calving glaciers. Here we analyze records from an on-ice seismometer placed 250 m from the calving front of Bowdoin Glacier, northwestern Greenland. We find that the overall micro-seismic activity of this glacier is at least an order of magnitude larger than previously reported (more than 100,000 events within 2 weeks and up to 600 events per hour) and that it is positively correlated with falling tide velocity. Using high-resolution surface displacement measurements, we show for the first time that the correlation is relayed through strain-rate variations. The strain-rate corresponds with longitudinal stretching of the glacial surface, in response to higher melt rates and falling tide, both of which accelerate glacier movement and enhance the stretching flow regime. Previous proposals to use icequakes as a proxy for grounding line migration need to be reconsidered because Bowdoin Glacier is grounded, with no tide-induced vertical bending of the near-floating tongue, which always exhibits microseismic activity due to continuous longitudinal stretching.