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The effect of the blocking of impact ocean waves by the crevasse-ridden ice shelf

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The propagation of high-frequency elastic-flexural waves through an ice shelf was modeled by a full 3-D elastic model, which also takes into account sub-ice seawater flow. The sea water flow is described by the wave equation. Numerical experiments were undertaken both for an intact ice shelf free of crevasses, which has idealized rectangular geometry, and for a crevasse-ridden ice shelf. The crevasses were modeled as triangle/rectangular notches into the ice shelf. The obtained dispersion spectra (the dispersion curves describing the wavenumber/periodicity relation) are not continuous. The spectra reveal gaps that provide the transition from n-th mode to (n+1)-th mode. These gaps are observed both for an intact ice shelf free of crevasses and for a crevasse-ridden ice shelf. They are aligned with the minimums in the amplitude spectrum. That is the ice shelf essentially blocks the impact wave at this transition. However, the dispersion spectrum obtained for a crevasse-ridden ice shelf, has a qualitatively difference from that obtained for an intact ice shelf free of crevasses. Moreover, the dispersion spectrum obtained for a crevasse-ridden ice shelf reveals the band gap – the zone there no eigenmodes exist (Freed-Brown and others, 2012). The numerical experiments with the crevasse-ridden ice tongue that is 16 km in longitudinal extent, 0.8km width and 100m thick, were undertaken for a wide range of the periodicities of the incident wave: from 5 s to 250 s. The obtained dispersion spectra reveal two band gaps in this range: the first band gap at about 20 s and the second band gap at about 7 s for 1km spatial periodicity of the crevasses. The width of the band gap significantly increases when the crevasses depth increases too. Respectively, the amplitude spectra reveal significantly increasing area of periodicities/frequencies where the ice shelf blocks the impact wave.

References

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