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Propagation of acoustic-gravity waves in arctic zones with elastic ice-sheets

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We present an analytical solution of the boundary value problem of propagating acoustic-gravity waves generated in the ocean by earthquakes or ice-quakes in arctic zones. At the surface, we assume elastic ice-sheets of a variable thickness, and show that the propagating acoustic-gravity modes have different mode shape than originally derived by Ref. [1] for a rigid ice-sheet settings. Computationally, we couple the ice-sheet problem with the free surface model by Ref. [2] representing shrinking ice blocks in realistic sea state, where the randomly oriented ice-sheets cause inter modal transition at the edges and multidirectional reflections. We then derive a depth-integrated equation valid for spatially slowly varying thickness of ice-sheet and water depth. Surprisingly, and unlike the free-surface setting, here it is found that the higher acoustic-gravity modes exhibit a larger contribution. These modes travel at the speed of sound in water carrying information on their source, e.g. ice-sheet motion or submarine earthquake, providing various implications for ocean monitoring and detection of quakes. In addition, we found that the propagating acoustic-gravity modes can result in orbital displacements of fluid parcels sufficiently high that may contribute to deep ocean currents and circulation, as postulated by Refs. [1, 3].

References

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