Title: **Acoustic Gravity Waves Generated by an Oscillating Ice Sheet in Arctic Zone**

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We investigate the formation of acoustic-gravity waves due to oscillations of large ice blocks, possibly triggered by atmospheric and ocean currents, ice block shrinkage or storms and ice-quakes within the framework of weakly compressible ocean. For the idealized case of a homogeneous water column bounded at the surface by moving ice sheet and a rigid bottom, the description of the infinite family of acoustic modes is characterized by the local water depth (h) and angular frequency of oscillating ice sheet (ω); i.e. the acoustic wave field is governed by the leading mode given by:

\[ N_{\text{max}} = \left\lfloor \frac{\omega h}{\pi c} \right\rfloor \]  

(1)

where \( c \) is the sound speed in water and the special brackets represent the floor function (Figure 1). Unlike the free-surface setting, the higher acoustic modes might exhibit a larger contribution and therefore all progressive acoustic modes have to be considered.

![Figure 1: Snapshots of dynamic pressure given by an oscillating ice sheet; \( h = 4500 \text{ m}, \ c = 1500 \text{ m/s}, \ \text{semi-length} \ b = 104 \text{ m}, \ \zeta_0 = 1 \text{ m}, \ \omega = \pi \text{ rad/s} \) and \( N_{\text{max}} = 3 \).](image)

This study focuses on the characteristics of acoustic-gravity waves generated by an oscillating elastic ice sheet in a weakly compressible fluid coupled with a free surface model [Abdolali et al. 2015] representing shrinking ice blocks in realistic sea state, where the randomly oriented ice sheets cause inter modal transition at the edges and multidirectional reflections. A theoretical
solution and a three dimensional numerical model have been developed for the study purposes. The model is first validated against the theoretical solution [Kadri, 2016]. To overcome the computational difficulties of three-dimensional models, we then derive a depth-integrated equation valid for spatially slowly varying thickness of ice sheet and water depth. We show that the generated acoustic-gravity waves contribute significantly to deep ocean currents compared to other mechanisms. In addition, these waves travel at the speed of sound in water carrying information on ice sheet motion, providing various implications for ocean monitoring and detection of ice-quakes.

References
