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# Low-frequency wave coupling in the ocean – Ross Ice Shelf – atmosphere system

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A part of the Southern Ocean, the Ross Sea, together with the Ross Ice Shelf and the atmosphere over the region represent a coupled system with respect to the low-frequency (with the periods longer than 1 hour) wave processes observed in the three media. We study interconnections between them using a unique combination of geophysical sensors: hydrophones measuring pressure variations on the bottom of the open ocean, seismographs measuring vertical displacements of the surface of the Ross Ice Shelf, and the Jang Bogo Dynasonde system measuring wave parameters at the altitudes of the lower thermosphere. Analysis of a year-long data sets from Ross Ice Shelf-based instruments reveals presence in their average power spectra of the peaks in the 2-11 hours period range that may be associated with the low-order resonance vibrations of the system. More harmonics of the 24 hour tide (seven) are detected by the RIS seismographs compared to the sea floor sensor (where only two are clearly visible). This may be a consequence of the RIS resonance-related broadband amplification effect predicted by our model. There are several peaks in the RIS vibration spectrum (T = 8.37, 8.23, 6.3 and 6.12 hours) that are not detected by the hydrophone and may be directly related to RIS resonances. The prominent T = 25.81 hour peak is a likely candidate for the sub-inertial RIS resonance. The periods of lower RIS resonance modes predicted by our simple model and the observed spectral peaks are in the same general band. This is the first direct observation of the resonance effects in vibrations of the Ross Ice Shelf. Our results demonstrate the key role of the resonances of the Ross Ice Shelf in maintaining the wave activity in the entire coupled system. We suggest that the ocean tide is a major source of excitation of the Ross Ice Shelf's resonances. The ice shelf vibrations may also be supported by the energy transfer from wind, swell, and infragravity wave energy that couples with the ice shelf. Overlapping 6-month-long data sets reveal a significant linear correlation between the spectra of the vertical shifts of the Ross Ice Shelf and of the thermospheric waves with the periods of about 2.1, 3.7, and 11.1 hours. This result corroborates earlier lidar observations of persistent atmospheric wave activity over McMurdo. We propose a theory that quantifies the nexus between the ocean tide and the resonance vibrations of the Ross Ice Shelf. It complements the theoretical model of the process of generating the atmospheric waves by the resonance vibrations of the Ross Ice Shelf published by us earlier.