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Waterfalls in space, and other problems of 'underwater' acoustics on a small planet

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Whilst extraterrestrial liquids do occur in the Solar System, today's acoustical oceanographers have fewer sites to which they can apply their experience of Earth's oceans than perhaps they would have had in the early Solar System, with its magma oceans. Possible sites are Saturn's moons Titan and Enceladus, and Jupiter's moon Europa. The ability to transfer our understanding of Earth's acoustical oceanography to other moons and planets is particularly valuable, given that current understanding is sufficient to undertake complex inversions to estimate Earth's ocean environmental parameters from relatively sparse, or even naturally-occurring, acoustical signals. However such transference should be done with care, as terms familiar in Earth's acoustical oceanography may not be correct on other worlds. For example, in a deep ocean on a small world (such as Europa), the hydrostatic pressure will not equal the product of the density, the depth, and the surface value of the acceleration due to gravity, since the latter can vary with depth, and because vertical lines are not parallel on a small planet. This paper explores two cases of transferring our terrestrial experience off world, to the ice seas of Europa, and to the methane lakes and waterfalls of Titan.