New constraints on the source of the hum based on its observation in horizontal component seismic data

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The recently discovered torsional hum (Kurrle and Widmer-Schnidrig, GRL, 2008) consists of fundamental toroidal modes in the band 3-7 mHz. It is persistently detectable in times devoid of large earthquakes and has an acceleration amplitude of approximately 0.3 nGal per multiplet which is comparable to the spheroidal hum.

Since the torsional hum signal is dominated by fundamental modes, its excitation should preferentially occur near the Earth's surface, where this mode branch has the largest amplitude. This same argument was previously invoked for the source of the spheroidal hum by Kobayashi and Nishida (Science, 1998).

The most intriguing aspect of the torsional hum is that its amplitude more or less equals the spheroidal hum.

The currently favored models for the excitation of the spheroidal hum all involve normal stresses exerted on the Earths surface either by turbulence in the atmosphere or infragravity waves in the oceans. We can see three mechanisms by which such pressure fields could lead to an excitation of toroidal modes: (1) by the horizontal component of normal stresses on a surface with topography (e.g. mountain torque), (2) by spheroidal-toroidal mode coupling through heterogeneous Earth structure or (3) Coriolis coupling. In all three cases the torsional hum should be at least an order of magnitude smaller than the spheroidal hum. Since this is not the case, new physical mechanisms are called for.

A new mechanism that might go a long way to explain the torsional hum amplitude involves shear stresses exerted on the Earth's surface either by winds over the continents or by currents along the sea floor. If in the mHz-band these vector fields should turn out to have much larger toroidal (divergence free) than poloidal (curl free) horizontal components, they could preferentially excite toroidal over spheroidal modes and selectively excite the torsional hum.

Alternatively, we recall case studies which show that the primary marine microseisms can consist of Love and Rayleigh waves of equal amplitudes (Friedrich at al., J. of Seismology, 1998). While these observations also still lack a physical explanation they show that efficient Love wave excitation in the oceans is not all unusual.