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Long-period oscillations in rotating oceans

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Oscillatory motions on a rotating Earth can be loosely classified into motions of two classes. Class I motions correspond to "normal" waves modified by the Earth's rotation. Class II motions approximate current systems rendered periodic by the Earth's rotation. Three situations are considered: the first two deal with class II, the last with class I.

The first situation is that of a train of planetary (class II) waves incident on a step change in depth. It is found that, even for quite small depth changes, very little energy is transmitted (agreeing with work by Rhines [2]). Thus, planetary waves will tend to be isolated within regions having very little depth variation.

The second and third problems are analysed by means of the collocation, or point-matching, technique. The success of the method is also investigated in each case.

The second situation is that of planetary wave resonance in a rectangular basin with a step change in depth. The motions found are quite insensitive to the position of the step, but are highly dependent on the depth variation. They can be classified into three kinds. If the depth change is quite small, motions are similar to the uniform basin case, with some vorticity at the ends of the step. For medium to large depth changes, motions correspond to "double Kelvin" waves, investigated recently by several authors. Velocities far from the step are quite small. In these two cases, collocation is found to work quite well. The third case is that of roughly self-contained motions in each basin section, with a

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corresponding disturbance at the step. Here, collocation is less satisfactory, and only general features can be discerned.

The third situation concerns the reflection of Kelvin (class I) waves from the closed end of a semi-infinite canal. This problem was originally discussed by Taylor [3] in 1920, and by Defant [1, pp. 202-219] in 1925, but the treatment was unsatisfactory in some ways. Of primary interest is the case of partial Kelvin wave reflection. It is found that the physical situation changes rapidly and dramatically near the critical period, total Kelvin wave reflection changing to almost total Poincaré reflection over a very small period range. The collocation method works remarkably well in both cases.

References

[1] Albert Defant, *Physical oceanography*, Vol. 2 (Pergamon Press, Oxford, London, New York, Paris, 1961).

[2] P.B. Rhines, "Slow oscillations in an ocean of varying depth. Part I. Abrupt topography", *J. Fluid Mech.* 37 (1969), 161-189.

[3] G.I. Taylor, "Tidal oscillations in gulfs and rectangular basins", *Proc. London Math. Soc.* (2) 20 (1921), 148-181.

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