Geophysical Research Abstracts
Vol. 16, EGU2014-14728, 2014
EGU General Assembly 2014

Global stability of internal gravity wave

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Internal gravity waves are important in the ocean, they transfer energy to turbulence contributing to the deep ocean mixing and so influencing the thermohaline circulation.
Gravity waves are generated by different mechanisms, interaction of currents or tides with topography, or coupling with waves at the thermocline.
Plane internal wave of small amplitude are known to be unstable through triadic resonance (Phillips 1966), leading at small scale to the so-called parametric subharmonic instability (PSI).
Larger amplitude wave have also been shown to be unstable using linear Floquet analysis (Lombard & Riley 1996).
The subharmonic instability has been observed experimentally by Benielli & Sommeria (1998) and its nonlinear evolution studied numerically Koudella & Staquet (2005) showing that PSI indeed leads to turbulence.
Very recently Bourget et al. (2013) used a novel camshaft wave generator producing a finite size propagating internal wave in a still fluid and observed the appearance of a global instability that they identify being due to the triadic instability. Amazingly Sutherland (Aguilar et al. 2006) generates a wave of similar extend, amplitude, Reynolds and Froude numbers towing a rigid sinusoidal topography and observed no instabilities.

In the present work we set a numerical simulation that, by varying both the mean advection velocity and the frequency imposed at the upper wall by a penalization method allows us to compute the stability of a family of flow where the frequency in the fluid frame stay constant for all simulation. When the mean velocity is nil the simulation reproduces the tidal flow and the result of Bourget et al. are recovered whereas when the forcing frequency is zero the simulation corresponds to the lee wave flow of a sinusoidal mountain.
We show that the global stability properties of these different flows differ strongly with the mean advection.
All the flows have the same lateral confinement of the primary beam and correspond to the same unstable wave in the middle of the beam but the flows are globally unstable for small value of the mean advection in the tidal régime but globally stable for intermediate values of the advection and become again unstable for large values of the advection velocity in the lee régime.

The tidal and the lee unstable domain of the advection velocity involve two different instability modes, involving small scales in the tidal régime and large scales in the lee régime.
We show that this two global instability modes correspond to two different branches of the triadic resonance respectively larger and smaller wave vectors than the base flow wave vector.
We propose that this change in the global stability property with respect solely to the advection velocity is linked to changes from absolute to convective local instability. In the lee wave unstable domain the small scale local PSI branch is convectively unstable but the large scale triadic instability branch is absolute whereas in the tidal domain this is the other way around. In the stable domain for intermediate advection velocities both local instabilities are convective.