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► To cite this version:

François Lott, Riwal Plougonven, Jacques Vanneste. Gravity waves produced by potential vorticity anomalies. Symposium OGOA, May 2013, Lyon, France. hal-00840922

HAL Id: hal-00840922

<https://hal.science/hal-00840922>

Submitted on 11 Jul 2013

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Gravity Waves Produced by Potential Vorticity Anomalies

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The gravity waves (GWs) produced by potential vorticity (PV) anomalies in a vertical wind shear are evaluated for an unbounded rotating stratified flow. In this set-up, the disturbances have two inertial layers, one on each side of the PV anomaly that produces them. Between these layers the disturbance is well predicted by the quasi-geostrophic theory, beyond these layers it corresponds to propagating GWs.

This GW signal is predicted analytically using a Green's function method. The Green's functions used belong to the continuum of solutions of the non-geostrophic Eady problem of baroclinic instability. We find that the non-dimensional EP-flux of the GWs in the far field is approximately $\exp(-\pi N/Uz)/8$, where N is the Brunt-Vaisala frequency and Uz the wind shear. Between the two inertial layers the EP-flux is twice that outside of them, which means that substantial wave-flow interactions occur in the inertial layers. This formula is found to be useful for a large range of PV distribution, is easy to translate in dimensional form and from the large scale flow characteristics. The case of a PV disturbance with amplitude 1PVU and depth 1km is then analysed. When this disturbance enters in the troposphere, the EP-fluxes are between 0.1mPa and 100mPa when the Richardson number $J=N/Uz$ is between 1 and 10. These values compare with those observed in the low stratosphere, which suggests that we have identified a substantial GW source, and that this source can be parameterized in GCMs.

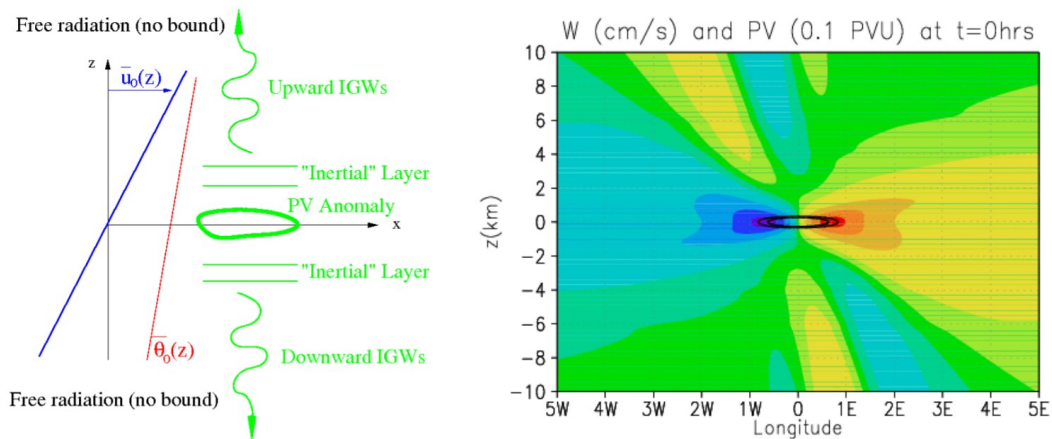


Figure 1: L'anomalie de tourbillon potentiel (en traits noirs) produit un champ de vitesse verticale, qui loins des niveaux critiques inertiels devient un champ d'ondes de gravité.

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2. Lott, F., R. Plougonven, and R. Vanneste, 2012: Gravity waves generated by sheared three dimensional potential vorticity anomalies, 69, 2134–2151. doi: <http://dx.doi.org/10.1175/JAS-D-11-0296.1>