Buoyancy Wave Interaction with Critical Levels in the Atmosphere

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General non-linear internal buoyancy wave equation (BWE) is developed, which has the second (differential) order in space but the third order in time. The wave operator splitting method is then applied to the stationary BWE to get the orographically generated buoyancy waves in the thermally stratified atmosphere for altitude-variable wind conditions. The splitting method is further generalized to a critical level (CL) containing atmosphere.

The CLs, which appear in the atmosphere (including the planetary boundary layer) if the wind weakens and changes direction or rotates with the altitude, will provide a break-up of the atmosphere to the regular (for BWE) layers separated by singular critical levels at which the differential order of the BWE is lowered. This lowering will cause either partial or full reflection of waves, though in the special fast wind altering case, the CL can prove transparent, too.

The wave modelling examples for different CLs are provided. Classification of the wind situations with respect to the various reflection-transparency types of CL is vital for wave stress (vertical flux of mean horizontal momentum) and upper-level wave breaking study.

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