



Analysis of mixing in the stable atmosphere of an idealized alpine valley

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Atmospheric circulation over complex terrain is governed by both synoptic forcing and thermal circulation induced by radiative heating or cooling of the ground surface. At night or in winter, when the synoptic forcing is weak enough, the dynamics of the atmospheric boundary layer in a deep valley is dominated by katabatic (downslope) winds.

As predicted theoretically and shown by in situ measurements, temporal oscillations in katabatic winds occur along the slope. When the atmosphere is stably-stratified, the frequency of these oscillations is proportional to the local Brunt-Väisälä frequency N and to the sine of the slope angle, as is well-known. Such an unsteady katabatic wind in a stably-stratified atmosphere must generate internal gravity waves. Numerical investigation of the dynamics of the stably-stratified atmosphere in an idealized valley using the ARPS code has shown that large scale waves are emitted, with frequency equal to about $0.8N$ whatever the value of N and the angle of the slope. Physical arguments have been provided to account for this behavior (Chemel et al., *Meteo. Atm. Physics*, 2008; Llargeron et al., in preparation).

The aim of the present paper is to analyze the turbulent properties of this flow, in terms of induced fluid mixing. Two sources of turbulence are expected, which are associated with the katabatic wind and with the internal gravity waves, when breaking. To quantify mixing, we have implemented an analysis of mixing based upon the work of Winters & D'Asaro (*J. Fluid Mechanics*, 1996), which enables one to compute exactly the turbulent heat flux associated with mixing. Results will be presented in terms of a local turbulent diffusivity, whereof spatial and temporal variability will be discussed.