Energetics of Deep Alpine Valleys in Pooling and Draining Configurations

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Abstract

A numerical model is used to investigate the nocturnal atmospheric boundary layer in a valley that opens either on a wider valley (draining configuration) or on a narrower valley (pooling configuration), under decoupled conditions with the free troposphere. One draining case and weak to moderate pooling cases are considered. Numerical results show that the structure of the nocturnal boundary layer is substantially different for the draining and pooling configurations. The greater the pooling, the deeper and colder is the boundary layer. Down-valley winds are weaker for pooling and draining configurations than in an equivalent valley opening directly on a plain, because of the reduction of the along-valley pressure gradient due to the presence of the neighbouring valley. For the moderate pooling case, an up-valley wind develops from the narrower to the wider valley during the evening transition, affecting the mass budget during that period.

Considering the heat budget of the valley system, the contribution of the diabatic processes, when appropriately weighted, hardly varies along the valley axis. Conversely, the contribution of advection with respect to the diabatic processes, varies along the valley axis depending on the configuration: it decreases for a pooling configuration, and increases for a draining configuration. Consequently, for a pooling configuration, the heat transfer between the valley and the plain is reduced, thereby increasing the temperature difference between them. For the moderate pooling case, this temperature difference can be explained by the topographic amplification factor during the early night. This causality holds in a valley when the 'extra' heat loss within the valley due to the surface sensible heat flux balances the heat input due to advection.

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