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High resolution climatology
- towards climate change services

Mechanisms of along-valley winds and heat exchange over mountainous terrain

J. Schmidli

ETH, Institut for Atmospheric and Climate Science, Zürich, Switzerland (juerg.schmidli@env.ethz.ch)

The physical mechanisms leading to the formation of diurnal along-valley winds are investigated over idealized three-dimensional topography. A diagnostic equation for the along-valley pressure gradient is developed and used in combination with numerical model simulations to clarify the relative role of various forcing mechanisms such as the valley volume effect, subsidence heating, and surface sensible-heat-flux effects. The full diurnal cycle is simulated using comprehensive model physics including radiation transfer, land-surface processes, and dynamic surface-atmosphere interactions. It is found that the basic assumption of the valley volume argument of no heat exchange with the free atmosphere seldom holds. Typically, advective and turbulent heat transport reduce the heating of the valley during the day and the cooling of the valley during the night. To gain further insight into the dynamics of the valley wind system and the role of advective heat transport we turn to simulations driven by a constant surface forcing and investigate the scaling of the steady state. The analysis confirms the importance of the valley volume effect for the formation of the diurnal along-valley winds, but also clarifies its limitations. In summary, the analysis brings together different ideas of the valley wind into a unified picture.