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Differences in the nocturnal heat budget of an Alpine valley in pooling and draining configurations

Gabriele Arduini (1,2), Charles Chemel (1,3), and Chantal Staquet (2)

(1) University of Hertfordshire, Hatfield, United Kingdom, (2) Laboratoire des Ecoulements Géophysiques et Industriels, UJF/CNRS/G-INP, Grenoble, France, (3) National Centre for Atmospheric Science, University of Hertfordshire, Hatfield, United Kingdom (c.chemel@herts.ac.uk)

A numerical model is used to quantify differences in the nocturnal heat budget of an idealised Alpine valley, with uniform surface properties and decoupled from the atmosphere above, in pooling and draining configurations. The pooling case corresponds to the valley opening on a narrower valley and the draining case to the valley opening on a wider valley. An isolated valley opening on a plain is used as a reference case. The down-valley winds are weaker for both the draining and pooling cases than for the reference case. Interestingly, after a transient stage, associated with the development of the down-valley winds, a quasi steady state is reached in all valleys, with almost the same valley-averaged instantaneous cooling rate. The details of the transient and steady states are different between the pooling and draining cases. Cooling in the draining case is similar to that of the reference case for both the transient and steady states, with only minor differences in the advection contribution due to the weaker down-valley winds. In contrast, cooling in the pooling case is 50% larger than in the reference case during the transient stage because of large differences in the advection contribution. This finding is discussed using volume arguments. When the steady state is reached, the dynamical contribution (i.e. the sum of the advection and the sensible heat flux contributions) to cooling is almost identical to that of the reference case. After the down-valley winds are fully developed, the cooling rate hardly varies along the valley axis for both the pooling and draining cases.