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Evolution of the daytime atmospheric boundary layer in deep alpine valleys

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Valley wind system and mixing depth evolutions are key processes of the pollution set of problems in deep valleys. Therefore diagnosing the convective boundary layer (CBL) structure and its evolution is decisive for understanding the dispersion and transport of pollutants such as ozone and its precursors. The main objective of this study aims at depicting the local mixed layer structure and its evolution in the Chamonix and the Maurienne valleys (France). A peculiar emphasis was put on transition period to give a better understanding of the formation of the CBL.

Wind profiler and tethered ballon were operated to probe the vertical structure of the atmosphere and its evolution during the last POVA (Alpine Valley POllution) field campaigns in summer 2003. The maximum backscatter intensity method coupled with the determination of the vertical velocity variance σ_w^2 correctly estimated the CBL depth when vertical mixing due to solar heating was significant and the vertical gradient of both virtual potential temperature and mixing ratio in the entrainment zone was strong enough. The tethersonde-derived mixing depths were especially useful to document the reversal of the down-valley wind system during the morning transition since proceeding from ground surface to upper layers.

At least during this summer field campaign, both valleys exhibit similar behavior with a wind reversal twice a day and a mixed layer up to approximately the altitude of the surrounding mountains. Hodographs are proposed as a characterization of changes in the valley wind typology. Complex orography makes each valley to develop specific features. The wind reversal is found to be much more sudden in the Maurienne valley than in the Chamonix valley. The topographic amplication factor (TAF) variability is identified as explaining the differences between the atmospheric dynamics in the two

valleys. The TAF may be regarded as a large scale geometry factor letting small-scale effects develop by themselves. Sensible heat flux generates the development of a CBL over the surface which grows up to an afternoon depth of about 1500 m above ground level. In the Chamonix valley convergence effects intensify the stable descending flow and delay the erosion of the stable core by the growing CBL. This interaction produces a complex boundary layer structure during morning and evening transition periods.