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Pollutant dispersion in a developing valley cold-air pool

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Pollutants are trapped and accumulate within cold-air pools (CAPs), thereby affecting air quality. A numerical model is used to quantify the role of cold-air-pooling processes in the dispersion of air pollution in a developing valley cold-air pool under decoupled stable conditions. Results indicate that the negatively buoyant downslope flows transport and mix pollutants into the valley to depths that depend on the temperature deficit of the flow and the ambient temperature structure inside the valley. Along the slopes, pollutants are generally entrained above the cold-air pool and detrained within the cold-air pool above the ground-based inversion layer. The ability of the cold-air pool to dilute pollutants is quantified. The analysis shows that the downslope flows fill the valley with air from above, which is then trapped within the CAP, and that dilution depends on where the pollutants are emitted with respect to the positions of the top of the ground-based inversion layer and cold-air pool, and on the speed of the slope winds. Over the lower part of the slopes, the cold-air-pool-averaged concentrations are proportional to the speed of the slope winds where the pollutants are emitted, which diminish as the cold-air pool deepens. Pollutants emitted within the ground-based inversion layer are largely trapped there. Pollutants emitted farther up the slopes detrain within the cold-air pool above the ground-based inversion layer, although some fraction, increasing with distance from the top of the slopes, penetrates into it. Hence, dilution within the cold-air pool increases with distance from the top of the slopes, for pollutants emitted along the slopes within the cold-air pool.