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# The dynamics of buoyant jets in a linearly stratified ambient cross-flow: Implications for the interaction between volcanic plumes and wind

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Volcanic plumes produced by explosive eruptions commonly interact with atmospheric wind causing plume bending and a reduction of its maximum rise height. It is well known that the maximum height reached by a buoyant plume rising in a cross-flow with uniform velocity is controlled by the plume buoyancy flux at the source, the strength of the initial environmental density stratification, the wind velocity and the efficiency of turbulent entrainment. Although numerous studies have been carried out to understand the effects of variations of environmental and source conditions on the plume maximum height, turbulent entrainment has not been taken into account with the same level of detailed analysis. Here, we present new laboratory experiments aimed at better understanding the contribution of the turbulent entrainment to determining the plume maximum height. The experiments consist in injecting downward fresh water in a tank containing an aqueous NaCl solution with linear density stratification. The jet source is towed at a constant speed through the stationary fluid in order to produce a cross-flow. According to the range of source and environmental conditions, the buoyant jet is distorted or bent-over and its maximum rise height is reduced up to a factor of 2 when wind speed is high. We quantify the efficiency of turbulent entrainment due to wind in our experiments and we show that the dynamical regime strongly depends on the ratio of the horizontal wind speed and the vertical plume velocity, and on the Richardson number defined at the source. Our results provide a robust framework to characterize the entrainment coefficient due to wind in a 1D model of turbulent jet rising in a linearly stratified ambient cross-flow, and hence can be used for the assessment of the impact of atmospheric winds on the dynamics of explosive volcanic plumes.