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Testing of a new dense gas approach in the Lagrangian Dispersion Model SPRAY.

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A new original method for the dispersion of a positively and negatively buoyant plume is proposed.
The buoyant pollutant movement is treated introducing a fictitious scalar inside the Lagrangian Stochastic Particle Model SPRAY. The method is based on the same idea of Alessandrini and Ferrero (Phys. A 388:1375-1387, 2009) for the treatment of a background substance entrainment into the plume. In this application, the fictitious scalar is the density and momentum difference between the plume portions and the environment air that naturally takes into account the interaction between the plume and the environment. As a consequence, no more particles than those inside the plume have to be released to simulate the entrainment of the background air temperature. In this way the entrainment is properly simulated and the plume sink is calculated from the local property of the flow. This new approach is wholly Lagrangian in the sense that the Eulerian grid is only used to compute the propriety of a portion of the plume from the particles contained in every cell. No equation of the bulk plume is solved on a fixed grid.
To thoroughly test the turbulent velocity field calculated by the model, the latter is compared with a water tank experiment carried out in the TURLAB laboratory in Turin (Italy). A vertical density driven current was created releasing a saline solution (salt and water) in a water tank with no mean flow. The experiment reproduces in physical similarity, based on the density Froud number, the release of a dense gas in the planetary boundary layer and the Particle Image Velocimetry technique has been used to analyze the buoyancy generated velocity field. The high temporal and spatial resolution of the measurements gives a deep insight to the problems of the bouncing of the dense gas and of the creation of the outflow velocity at the ground.