Analogue experiment of rain

Yutong Cui, Benoît Semin, Philippe Claudin

PMMH, CNRS, ESPCI Paris, Université PSL, Sorbonne Université, Université Paris Cité, F-75005, Paris, France
yutong.cui@espci.fr

Rain plays a major role in the climate system. A key ingredient of the rain process is the coupling between flow and phase change. We have set up an analogue experiment, where the air in the atmosphere is replaced by water in a tank, and the phase change between rain droplets and water vapor is replaced by salt particles dissolving in water.

To mimic the rain, a certain amount of salt is injected into the water tank. It dissolves when it falls down, forming a plume (Fig. 1a and 1d). Non-dissolving particles are also used as a reference, like sand or plastic beads. The particle concentration is measured by light absorption. In the reference case with plastic beads, the particle concentration shows a Gaussian shape (Fig. 1b), whose width increases linearly with height (Fig. 1a). The plume particle flux is measured by integration of the local concentration along the horizontal direction. It is roughly constant for plastic beads plume, but decrease for salt plume due to dissolution (Fig. 1c and 1f).

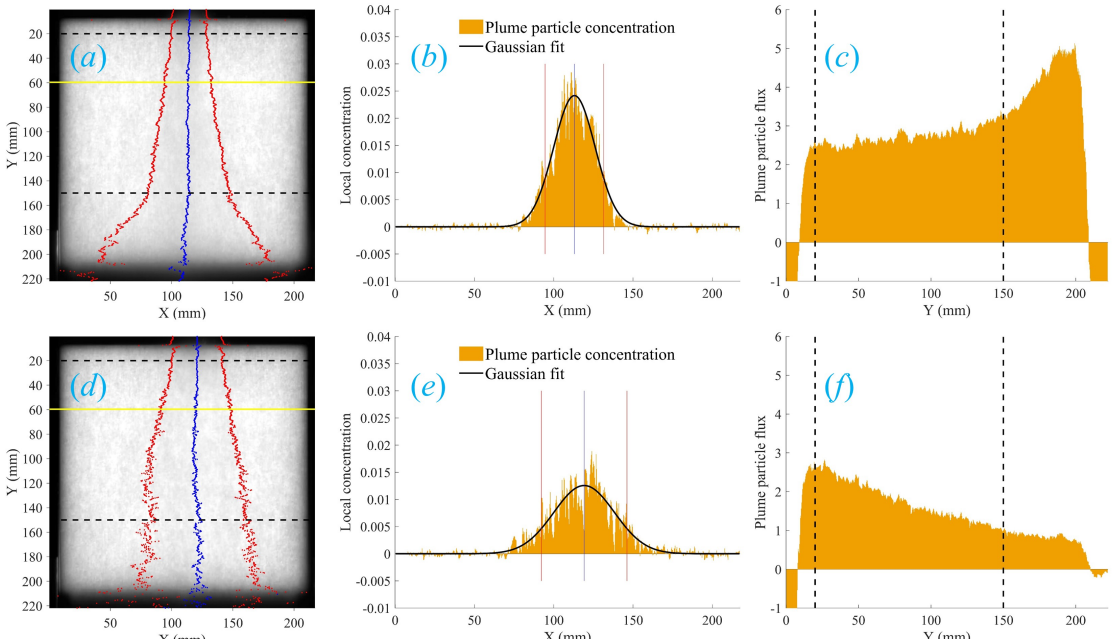

Figure 1. Plume particle concentration measurement, working zone between dash lines. First row, plastic beads, second row, salt, (*a*) and (*d*) Plume particle middle line and half width, (*b*) and (*e*) Plume particle profile fit for the yellow line, the red and blue line represent what shows in (*a*) and (*d*), (*c*) and (*f*) Plume particle flux change along vertical direction.

In real rain, the water droplets cool down the air around them due to evaporation, which enhances the downdraft velocity. To mimic this, we are using a salt with a large dissolution latent heat. By measuring velocity field with PIV and temperature with thermocouples, we will investigate the hydrodynamic and thermal behaviors of the plume.