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## How does the rain fall?

### Studying rain at the Vaisala Rain Laboratory

It has been known for over a century that raindrops are not shaped like teardrops. High-speed photographs taken in the first decades of the 20th century revealed that small raindrops falling through the air are spherical, larger ones exhibit a shape more like that of a hamburger bun.

The most important physical factors affecting the shape of raindrops are surface tension, hydrostatic pressures and external aerodynamic pressure. For cloud drops, drizzle and even small drops, the surface tension dominates, contracting the drop into a sphere where the surface to volume ratio is at its minimum. When

the drop size gets bigger, other factors than surface energy start to contribute to the total energy of the drop and the minimum total energy is not maintained without the perfectly spherical shape anymore. The drop becomes flattened at the bottom and will gradually break up when the pressure differential caused by the drag-force is much larger than the surface tension forces.

The speed of a falling drop increases until the gravitation and drag forces acting on the drop are balanced and cause the speed to remain constant. This constant speed is called terminal velocity

Figure 1. Schematic diagram of the Vaisala Rain Laboratory.

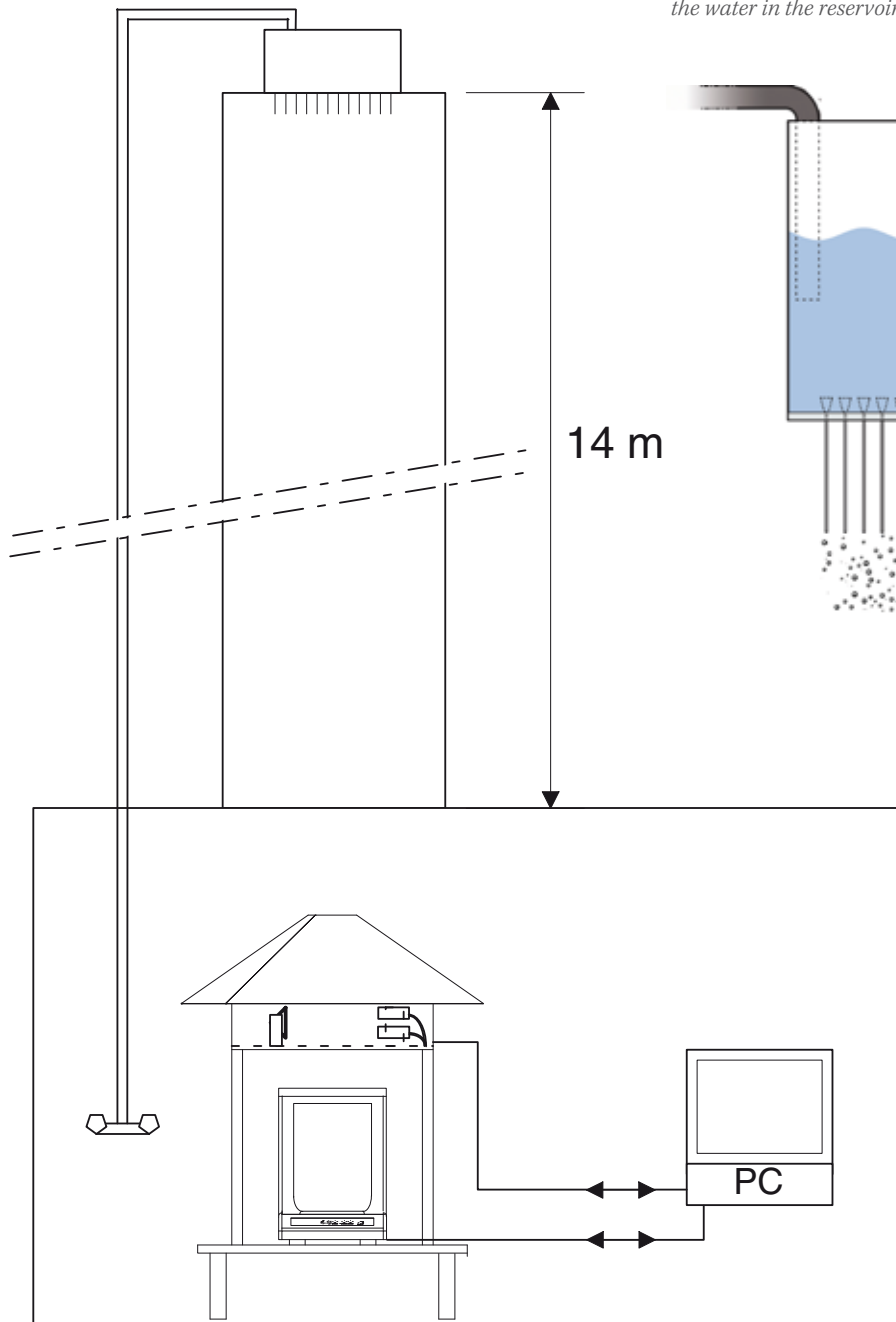


Figure 2. The water reservoir, at the top of the rain laboratory shaft, with a set of syringe needles as the source of raindrops. The intensity of the rain is relative to the depth of the water in the reservoir.

of the drop. Since some parameters in the equation of motion cannot be expressed in a simple formula, no analytical solutions exist to solve terminal velocity of the raindrop as a function of the drop size. Present knowledge is mainly based on experimental investigation.

### Simulating real-life conditions

During the product development of the Vaisala Weather Transmitter WXT510, we had the possibility to construct a laboratory for calibrating and testing the Vaisala RAINCAP® rain sensor used in the WXT510. Since the function of the sensor

is based on the measurement of vertical force produced by individual raindrops, it was necessary for the raindrops to reach their terminal velocity and final shape. A construction based on a shaft with a diameter of 1m and height of 14m, accessible at the top and bottom was created. A schematic diagram of the constructed Vaisala Rain Laboratory is shown in Figure 1. The drop generator (Figure 2) is located at the top of the shaft. The intensity of simulated rain is controlled by the depth of the water in the reservoir. The water drops are produced by

syringe needles that pierce the base of the reservoir.

In the past few years, the laboratory has been a facility for further development of the Vaisala RAINCAP® rain sensor and provided a great environment for research in the dynamics of raindrops. In October 2007, Salmi and Elomaa presented a study of the terminal velocity and shape of falling raindrops at the 7th EMS Annual Meeting. ■