

Press Release

InfraTec GmbH Infrarotsensorik und Messtechnik

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Thermography Reveals Ice Formation Processes in Freezing Drizzle Droplets Karlsruhe Institute of Technology Investigates Mechanisms of Secondary Ice Formation

How do ice crystals form in mixed-phase clouds? And what role do freezing drizzle droplets play in this process? Scientists at the Karlsruhe Institute of Technology (KIT) have investigated these questions through experimental studies. The focus was on the precise measurement of temperature profiles on the surface of freezing water droplets. A high-resolution MWIR thermographic camera, the ImageIR® 7340 from InfraTec, was used for this purpose. The investigations were intended to help better understand the processes by which freezing, drizzle-sized cloud droplets break apart and release ice fragments. These fragments, in turn, can trigger the freezing of additional droplets – a process known as secondary ice formation, which is of great importance for the formation of ice and precipitation in mixed-phase clouds.

Precise Temperature Measurement at the Outermost Layer of the Droplets

The experiments took place in a so-called electrodynamic trap. Within this trap, water droplets could be studied while suspended under controlled conditions – at defined temperatures, humidity levels, and airflow rates. Ice formation was stimulated by the targeted introduction of fine ice particles.

For the thermographic measurements, the researchers used an ImageIR® 7340 with a 50 mm lens, a close-up attachment, and extension rings for 2x magnification. In the temperature range from -30 °C to +30 °C, the system achieved an accuracy of ± 1 K at a frame rate of 287 frames per second. Since water and ice are not ideal black bodies in the relevant spectral range and the shape of the droplet can influence the measurement, the analysis focused on the central region of the droplet. The thermographic images were synchronized with high-speed video recordings to precisely correlate changes in temperature and shape.

The thermal images revealed three clearly distinguishable phases of the freezing process: Immediately after ice nucleation, the droplet warms to approximately 0 °C due to the heat of crystallization released. During the subsequent crystallization, the temperature initially remains nearly constant. Once the liquid water has completely solidified the droplet cools exponentially to ambient temperature.

Thermography Detects More Pressure Release Events

Particularly revealing were so-called pressure release events, or PREs for short. These are pressure-induced events such as cracking, shattering, or bubble formation in freezing droplets. In the measurements, they were accompanied by a slow drop in temperature followed by a sudden rise in temperature. The researchers attribute this to a pressure-induced lowering of the freezing point and a rapid drop in pressure caused by cracking in the ice shell.

Here, a decisive advantage of thermography became apparent: The thermal imaging camera detected three to nine times more pressure release events than the high-speed video technology used in parallel. In free fall, such events also occurred about three times more frequently than in still air. This is likely due to the freezing process being accelerated by airflow, which leads to increased internal pressure within the droplet.

The study thus demonstrates that thermography not only visualizes precise temperature profiles in freezing droplets, but is also well-suited for detecting short-term pressure-related events with high sensitivity. It thus provides important data for a better understanding of ice formation in the atmosphere and the processes that contribute to the formation of secondary ice crystals.

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The underlying study was published in the **Journal of the Atmospheric Sciences**:

Kleinheins, J., Kiselev, A., Keinert, A., Kind, M., and Leisner, T. (2021): *Thermal Imaging of Freezing Drizzle Droplets: Pressure Release Events as a Source of Secondary Ice Particles*.

Note: You can find the full case study on our website at

<https://www.infratec.eu/thermography/case-study-thermal-images-of-freezing-drizzle-droplets/>

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About InfraTec

The InfraTec infrared sensor and measurement technology company was founded in 1991 and has its headquarters in Dresden, Germany. The privately held company employs more than 240 employees and has its own design, manufacturing and distribution capabilities.

With its infrared measurement business unit, InfraTec is one of the leading suppliers of commercial thermal imaging technology. In addition to the high-end camera series ImageIR® and the camera series TaxisIR® and VarioCAM® High Definition, InfraTec offers turnkey thermographic automation solutions e.g. for industry processes, non-destructive testing and fire detection and prevention.

The Infrared Sensor division produces custom-made components – especially pyroelectrical infrared detectors – for clients worldwide. The product range includes analogue single and multi-channel detectors as well as digital multi-channel detectors (PyriQ®) and high-performance detectors (PYRONEER®) for analytical instruments. The detectors are used in gas analysis, fire and flame sensors and spectroscopy.

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