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Publication date
2019

Document Version
Final published version

Citation (APA)
Izett, J., van de Wiel, B., Schilperoort, B., Coenders-Gerrits, M., Baas, P., & Bosveld, F. C. (2019). *Missed Fog: Understanding the Growth of Fog from the Ground Up*. Poster session presented at 8th International Conference on Fog, Fog Collection, and Dew, Taipei, Taiwan.

8th International Conference on Fog, Fog Collection and Dew
Taipei, Taiwan, 14–19 July 2019
IFDA2019-62

Missed Fog: Understanding the Growth of Fog from the Ground Up.

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Conventional in situ observations of visibility and other meteorological variables are restricted to a limited number of heights near the surface, with the lowest observation often made above 1 m. This can result in missed observations of shallow fog as well as the initial growth stage of thicker fog layers. At the same time, numerical experiments have demonstrated the need for high vertical grid resolution in the near-surface layer to accurately simulate the onset of fog; this requires correspondingly high-resolution observational data for validation.

In November 2017, a field experiment was conducted at the Cabauw Experimental Site for Atmospheric Research (CESAR) in the Netherlands with the aim of observing the growth of shallow fog from the ground up, assessing the applicability of emerging high-resolution methods for observing shallow fog. Two innovative, high-resolution techniques were employed: distributed temperature sensing (DTS), providing temperature and relative humidity observations at vertical resolutions as fine as 1 cm, and a novel camera-LED method to observe near-surface visibility below the conventional sensor height of 2.0 m. These observations were supplemented by the existing observations at the site, including those along a 200-m tall tower.

Comparison between the high-resolution observations and their conventional counterparts shows the errors to be small, giving confidence to the reliability of the techniques. The high resolution of the observations subsequently allows for detailed investigations of near surface processes. The growth of fog layers from the ground up was observed with very strong temperature inversions in the lowest metre (up to 5 K), and corresponding region of (super)saturation where the fog formed and grew. Throughout the two-week observation period, fog was observed twice at the conventional sensor height of 2.0 m, but up to four times in the lowest 0-0.5 m using the camera estimates, with the shallow fog also forming up to two hours before it was observed by the conventional sensor.

The observations are supplemented by high-resolution numerical simulations of the experimental period, highlighting the sensitivity of the fog layer to surface properties and ambient conditions, providing greater insight into what drives the growth of a very shallow fog layer (i.e. < 1 m) into a deeper, and therefore more dangerous, layer.