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Delay in convection in nocturnal boundary layer due to aerosol-induced cooling DHIRAJ KUMAR SINGH, V.K. PONNULAKSHMI, G. SUBRAMANIAN, K.R. SREENIVAS, EMU (JNCASR) — Heat transfer processes in the nocturnal boundary layer (NBL) influence the surface energy budget, and play an important role in many micro-meteorological processes including the formation of inversion layers, radiation fog, and in the control of air-quality near the ground. Under calm clear-sky conditions, radiation dominates over other transport processes, and as a result, the air layers just above ground cool the fastest after sunset. This leads to an anomalous post-sunset temperature profile characterized by a minimum a few decimeters above ground (Lifted temperature minimum). We have designed a laboratory experimental setup to simulate LTM, involving an enclosed layer of ambient air, and wherein the boundary condition for radiation is decoupled from those for conduction and convection. The results from experiments involving both ambient and filtered air indicate that the high cooling rates observed are due to the presence of aerosols. Calculated Rayleigh number of LTM-type profiles is of the order 10^5-10^7 in the field and of order 10^3-10^5 in the laboratory. In the LTM region, there is convective motion when the Rayleigh number is greater than 10^4 rather than the critical Rayleigh number ($\mathrm{Ra}_c = 1709$). The diameter of convection rolls is a function of height of minimum of LTM-type profiles. The results obtained should help in the parameterization of transport process in the nocturnal boundary layer, and highlight the need to accounting the effects of aerosols and ground emissivity in climate models.

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