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A Physical Experiment to determine the Impact of Atmospheric Condensation of Water Vapour on Surface Air Movement

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A physical experiment, in which atmospheric air is enclosed in two interconnecting 4.8-metre high insulated PVC columns, consistently gives results showing that the condensation of water vapor, precipitated by means of refrigeration coils, gives rise to detectable air movements, with air speeds of up to 0.1 m/s. Once the compressor, sited well away from the two columns, is shut down, heavy drops of precipitated water are obtained which funnel into a flask for collection and measurement. The results in kg.m-2 (mm) from the 20 m3 volume of enclosed air accord well (>90%) with the physical calculations based on water vapour as an ideal gas. Air flow, resulting from the highly localized condensation, is measured through the movement of light-weight gauzes and an anemometer. It has a circulation time of some two minutes, such that both columns show cooling and a significant reduction in specific humidity from 0.01 to 0.005 (kg water vapour to kg dry air, r) with a drop in relative humidity of up to 40 per cent. Air flow is minimal during the control, non-refrigeration period of the experiment but becomes substantial within a minute of the compressor being switched on. The negative partial pressure change peaks at as much as 0.4 Pa/s during the first 30 minutes but reduces to approx.0.08 Pa/s during the latter part of the 110 minute-long experiment. Airflow displays an inverse relationship to the partial pressure change, initially rising rapidly and then reducing before returning to zero once refrigeration has been switched off. Inverse correlations of up to 0.8 or higher between the partial pressure reduction and the airflow are obtained routinely. Semi-aquatic vegetation from the nearby marshland enhances precipitation, suggesting that evapotranspiration adds significantly to humidity. Without vegetation the condensation rate is 0.06 to 0.07 millimol.m-3.s-1 on average compared with 0.11 when vegetation is present. Cooling, by some 2°C, combined with a reduction in water vapor, by 6 grams/m3during the course of the experiment, leads to differential increases in air density. The latent heat released during condensation tends to warm the air in the immediate vicinity of the coolant coils and as such would tend to counter the air clockwise air-circulation, the assumption being that the highly localized partial pressure reduction on condensation is the overriding force. The experimental data accords well with data from Costa Rica, where, for the past three years, daily meteorological data have been collected from two OTS sites, namely La Selva and Palo Verde, the former in particular displaying relatively high rates of evapotranspiration. Statistically high correlations are found between the calculated evaporative/condensation force fE, and corresponding surface wind movements. Those findings, combined with the experimental data, suggest that a high rate of condensation and the consequent partial pressure reduction at the scale of the lower trophosphere leads to horizontal surface airflows of the order of 1 m.s-1.