Hydrol. Earth Syst. Sci. Discuss., 12, C5338–C5341, 2015
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Hydrology and Earth System Sciences Discussions
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Interactive comment on "Experimental evidence of condensation-driven airflow" *by* P. Bunyard et al.

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Received and published: 2 December 2015

Brief reply to Kleidon: Thank you for your review and you make it clear that the experimental set-up results in a downward flow of air rather than upwards as occurs in the atmosphere at large.

As revealed by another reviewer the equation for specific humidity, kg moisture/kg moist air was incorrectly described in the original submitted manuscript, even though as we explained, the correct formulation had been used in the experiments. Other errors have also been dealt with.

As indicated in our general reply of 2nd December, we have carried out more experiments during which we have artificially heated the air in the right-hand column with a 150 Watt halogen lamp. That heating caused a counter-clockwise airflow which was therefore in the diametrically opposite direction to the observed flow on switching on

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the refrigeration. Even though the air density of the total air in the left-hand column was greater than that of the right-hand column, including the cold air formed at the cooling coils, the air circulation changed direction once condensation had been initiated (see graphs attached to the general reply).

Latent heat release would tend to cause upward flow by warming the air in the near vicinity of the cooling coils and therefore cannot be responsible in the experimental set-up for the downward flow. Meanwhile, simple calculations indicate that the volume change associated with the condensation of water vapour is nigh equivalent in energetic terms (rate of change of partial pressure in hPa/s converted to Watt.s) to the latent heat release from the quantity of vapour transformed to liquid and ice (see graph). Calculations of the cumulative partial pressure change of water vapour indicate how much condensate to expect. The precipitation of rain at the end of the experiment matches closely the theoretical expectation.

The total energy involved in the partial pressure rate of change is considerably more than would be required to move the air mass in the columns at the observed windspeed of approximately 0.2 m/s. As one reviewer pointed out, to move the 25 kg of air in the enclosed structure would require some 0.5 W.s. During cooling, the energy involved in condensation in the experiment of 20th November, 2015, amounted to 2.145 W.s, therefore more than enough by a factor of 4.

Nevertheless, condensation has largely been ignored as a mechanism for moving airflow in a determined direction simply because of the notion that the resulting implosion will be from all directions simultaneously and so dissipate any energies involved. The fit of the condensation curve to that of airflow cannot be ignored and the correlation is highly significant. From the recent experiments it goes against the 'flow' to invoke differential air densities as being the cause of the observed airflow during cooling. Simple warming of the air by latent heat release has also to be ruled out. That leaves the volume change at the point of condensation as being the major contender.

But what if there were some tendency which distorted the movement of air such that implosion did lead to uni-directional flow? In the experiment that bias could come from the chilled air sinking away and downwards from the coils, until arrested in its flow by the counter-flow from the higher air density of the left-hand column compared to the right. That downward flow would distort the multi-directional implosion of air as condensation takes place. Equally, in the atmosphere at large, the latent heat release could act in a comparable way by generating a tendency for upward flow. Of course, the latent heat release associated with cloud-forming necessitates a source of water vapour which the rainforest provides, through evapotranspiration.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 10921, 2015.

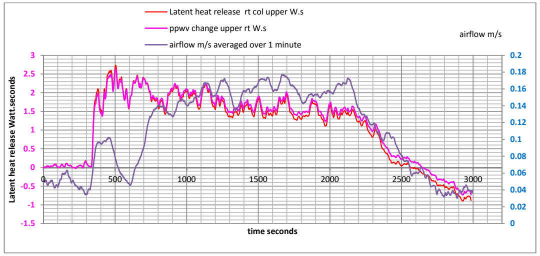

Figure 1. Experiment of 20th November, 2015, showing the latent heat release in W.s from condensation (ochre) compared to the energy associated with partial pressure change (vermillion). The two curves match each other closely. The airflow is shown (blue). During the entire period of the experiment the air in the right hand column was heated with a 150 Watt halogen lamp. Without the cooling, the air flowed in a counter-clockwise direction.

Fig. 1. Latent heat and precipitation energy

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