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Interactive Comment

Interactive comment on "Experimental evidence of condensation-driven airflow" *by* P. Bunyard et al.

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Again, many thanks to Reviewer #1 for taking the time to study the results of the experiments to determine whether the partial pressure change of water vapour undergoing condensation can and does lead to net uni-directional airflow.

First and foremost we have shown that refrigeration (1 kW compressor) of a small parcel of air, with volume of 0.05 cubic metres and therefore less than 0.25 per cent of the entire volume of enclosed air, does lead to uni-directional airflow. The great majority of experiments carried out to date show air flow, correlating well with the rate of condensation, passing downwards from the cooling tubes and hence in a clockwise fashion when facing the right-hand column from the laboratory. However, at the suggestion of the reviewer, and taking into account that significant correlations do not necessarily imply causality, we recently applied heating at the base of the right-hand column in order to test whether the resulting airflow in a counter-clockwise direction could be explained purely by air density considerations.

As we showed in our last communication, the airflow, with the heating and refrigeration on at the same time, leads conspicuously to a substantial increase in the counter-clockwise airflow. That increase in airflow occurs despite cold, dense air forming at the cooling coils and presumably flowing against the counter-clockwise flow induced by the heating. We have since repeated the experiments with simultaneous heating and refrigeration. We obtained similar results: the findings are robust.

If no other factor were involved we would have expected the counter-clockwise flow induced by floor mat heating to reduce on account of the streaming down of cold air from the cooling coils. That simply does not happen.

The reviewer mentions latent heat. However, we have shown from the experimental data that the per second reduction in the partial pressure of water vapour must absorb the bulk of latent heat release as the air flows into the region where condensation is occurring. That leaves condensation as the prime and, we would claim, only contender for the increase in airflow in the counter clockwise direction.

The reviewer brushes aside our reference to the Newcomen atmospheric condensing steam engine, remarking that both heating and cooling are independently involved. The heating generates the steam, which then passes through valve action into the cylinder, where it cools and condenses, thus providing the motive force for the piston. We fail to see why the process occurring in the Newcomen condensing engine is so different from what we have found with our experimentation. We have warm air rising and then abruptly cooling. Moreover, because such a small proportion of the total air passes over the cooling coils at any one moment, the rest of the air supplies the moisture, thus keeping the process of condensation going throughout the period of experimentation. The difference, if you like, is that whereas the Newcomen process involves strong heating and inefficient condensation, we have weak heating and sharp

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condensation.

Without question, of the potential energy available in condensation, only a small proportion is required to generate the airflow which we observe in the experiments. In terms of the atmosphere at large, that inefficiency is a boon in that it saves the surface from what would otherwise be powerful and destructive winds.

In conclusion, we have not suggested that air density differences play no role in airflow and the processes of convection. Of course, they do, and, as shown in previous replies, we can calculate the kinetic energy of the air in each column and, as a result, determine whether the air (with the refrigeration off) would be moving in a clockwise or counter-clockwise direction. Even, without checking the anemometer, it is clear from the suspended gauzes which way the wind is blowing. We can therefore verify that the anemometer readings are representative of columnar airflow and not just of a limited airstream close to the cooling coils.

The point is that whatever the airflow when the refrigeration is off, it increases conspicuously once the refrigeration is on. Depending on the initial conditions, i.e. whether the heating in the right hand column is on or off, the demonstrable increase in airflow can be either clockwise or counter-clockwise. When counter-clockwise, the increase in airflow stands out against the heat-induced airflow and the cold, dense air forming at the cooling coils.

In effect, we are grateful of the critiques, inasmuch as they have enabled us to modify experimental conditions and therefore to verify, even against our expectations that the process of refrigeration leads to an observed upward flow of air.

The reviewer suggests that the biotic pump theory of theoretical physicists, Anastassia Makarieva and Victor Gorshkov, is full of vague imprecisions. That is simply not the case. Their published papers in respectable international, peer reviewed journals, offer detailed, theoretical analyses of the biotic pump theory. Moreover, there is a growing body of evidence that the theory makes intelligible certain remarkable phenomena such as the Chocó low-level westerly jet stream which hits the Colombian Pacific Coast 4° N and brings bounteous rain (up to 12 metres per year) to what is one of the wettest rainforests in the world. It has to be appreciated that the jet stream breaks off from the Pacific Trade winds a few hundred kilometres from the coast and suddenly and diametrically reverses direction.

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