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Interactive Comment

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

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Alex Kleidon and reviewer #1 have made the assumption that the inflow of air where condensation is occurring will be from all quarters and as such will cancel out any net, uni-directional flow. We have maintained that such perfect cancelling out is unlikely to occur because of distortions of energy flows in both the experimental situation and in the atmosphere at large. Whereas, condensation may lead on a tiny scale to zero net kinetic energy, on a larger scale, for example in a convective cell, where condensation is occurring at a high rate and within a zone, perhaps 1 km in diameter, the associated pressure reduction will lead to airflow.

In fact, a reduction in pressure from condensation was the principle behind the original Newcomen "atmospheric" steam engine, where the motive power was created by the condensation of the steam in the cylinder. Initially, Boulton and Watt used the same

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principle. Later steam engines were driven by true steam pressure, but the early engines were not.

As we have already pointed out, we followed the suggestion of reviewer #1 to heat the air in the lower part of the right-hand column, which bears the cooling coils in the upper three quarters of its 4.8 metre length. We produced evidence that, when the air was heated with a 100 Watt halogen lamp, the overall kinetic energy from the air density in the right hand column was less than that of the left hand column. Yet, with the refrigeration on, the air still circulated in a clockwise fashion. Moreover, the correlation between the rate of condensation, measured in Watt.seconds and the airflow gave a coefficient of 0.95.

The reply from both Kleidon and reviewer #1 was that correlations, even good correlations, do not necessarily indicate cause and effect. In the light of the experiments which we have since carried out (see below), we would like to know what alternative explanation the reviewers have for such finely tuned correlation.

They also argued that, because the flow of air was downwards from the cooling coils, we had in effect disproved the biotic pump theory of Anastassia Makarieva and Victor Gorshkov, who postulate that surface air is drawn upwards from the forested surface because of cloud condensation, not downwards.

Since receiving those replies, we have persisted with experimentation and replaced the halogen lamp with a heating mat which covered the floor of the right hand column, giving out 500 Watts of heat. On switching on the heating, the air flow, even though turbulent, was demonstrably counter-clockwise, as observed from both the anemometer readings and the movement of strategically placed gauzes. The air therefore passed upwards in the right hand column. The airflow caused the gauze, suspended at the junction between the upper tunnel and left-hand column, to move with a directionality of approximately 360°, hence counter-clockwise, while that suspended at the junction between the lower tunnel and the right-hand column to move with a directionality of

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180°.

After 5 minutes of beginning the experiment and logging the data, we switched on the refrigeration. Within 30 seconds the counter-clockwise air became both stronger and more intense (see attached graph). Therefore, despite cold air being formed at the cooling coils and passing against the airflow, we observed increased counter-clockwise flow.

In the experiment of 15 December, 2015, we carried out seven distinct 5-minute periods of refrigeration, followed by 5-minute periods when the refrigeration was switched off. The heating remained on during the entire length of the experiment. During the experiment, the air at the base of the right-hand column had a mean temperature of 17°C and a relative humidity of 90 per cent.

In effect, we observed that the airflow during the period of refrigeration increased in intensity, always counter-clockwise, and died away, though not completely because of the continued heating, during the period of no-refrigeration. The only factor which could bring about that increase, with air rising against the cold air formed by refrigeration, would have to be condensation, a mini-form, if you like, of the Newcomen atmospheric condensation steam engine. That being so, condensation had led to airflow against both air density considerations and gravitational pull.

Rather than having disproved the fundamental physics underlying the biotic pump theory, as Kleidon and reviewer #1 say we have, it would appear that we have provided strong experimental support for the theory (See attached graphs). Consequently, the smooth correlations obtained when the airflow is downwards from the cooling coils and the more turbulent correlations associated with airflow upwards from the coils, would appear not just to be coincidental, but actually an integral component of causality.

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

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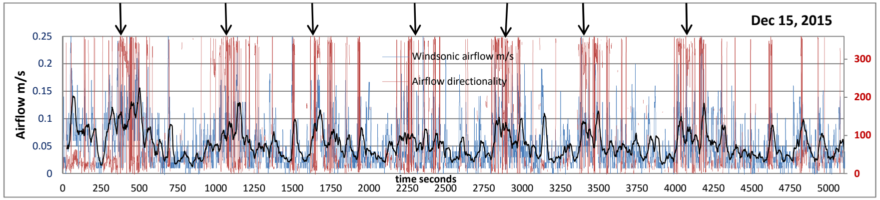

Figure 1. Experiment of 15 December, 2015. A heating mat at the base of the right-hand column provides 500 Watts of heat, thus causing a counter-clockwise convective flow of air up the column. The refrigeration cooling coils, three-quarters up the right-hand column, with a surface area of 0.96 square metres and distance from top to bottom of 0.05 metres, are switched on for five minutes and then off for a further 5 minutes, with seven such cycles in all during the course of the experiment. The directionality (red) shows counter-clockwise flow (close to either 0° or 360°) throughout the experiment. The airflow (blue) rises in intensity when the refrigeration is on and dies away when the refrigeration is switched off. The black arrows indicate periods of refrigeration.

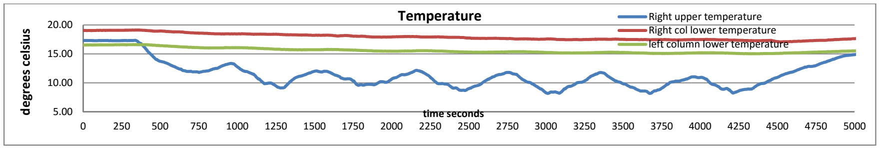

Figure 2. The temperature close to the cooling coils indicates the periods of refrigeration (blue). Below (red) the condensation rate and (blue) the airflow.

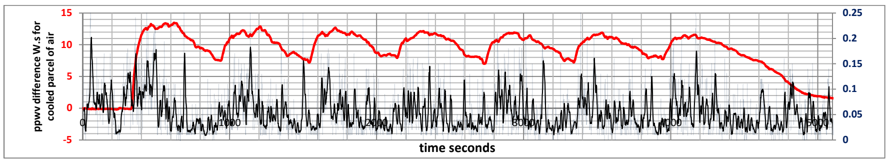

Fig. 1. upwards directed airflow from condensation

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