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Interactive Comment

Interactive comment on "Biotic pump of atmospheric moisture as driver of the hydrological cycle on land" *by* A. M. Makarieva and V. G. Gorshkov

Y. Dovgaluk

dovgaluk@main.mgo.rssi.ru

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I have read the paper with great interest; the authors aim to build a coherent picture of atmospheric circulation based on the so-called evaporative force that they introduce. I confess I could not find any faults in their presentation. Still when I try to analyze the authors' propositions at the background of the conventional meteorological principles I feel somewhat puzzled. The authors do touch upon on how their new physical approach relates to some basic meteorological notions (pp. 2637-2638), but in my view this point deserves a much more detailed discussion.

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1. In meteorology fluxes of sensible heat are related to convective instability of air masses; this instability arises under conditions of the observed air temperature lapse rate Γ_{ob} = 6.5 K km^{-1}. If there occasionally appears an air parcel with positive buoyancy (i.e. more heated and less heavy than equal volumes of the surrounding atmosphere), this volume starts to rise acted upon by the Archimedes force. As is well-known, temperature of the adiabatically ascending air parcel decreases with height at a rate of 9.8 K km^{-1} (and about 6 K km^{-1} for moist air due to heat release after condensation of water vapor). Since the observed lapse rate 6.5 K km^{-1} is greater than the moist adiabatic lapse rate, the ascending air volume will always remain warmer and less heavy than the surrounding air and, since, will infinitely continue its movement. Similarly, air parcels of higher volume density (negative buoyancy) will infinitely move downward until they reach the Earth's surface. Ascent and descent of such air masses create atmospheric turbulence, which is responsible for the observed vertical fluxes of the sensible and latent heat. These fluxes uniformly mix the atmosphere, and this is why in the troposphere the mixing ratio of gases in dry air is uniform and height-independent. These very fluxes maintain clouds.

2. It is widely accepted in meteorology that under the condition of turbulent mixing of moist air, the latter is in hydrostatic equilibrium. Hydrostatic equilibrium of moist air is one of the fundamentals in all models of atmospheric circulation. Air density in hydrostatic equilibrium is determined by the scale height $h = RT/Mg$ (p. 2634, eq. (8)), which, in its turn, depends on surface temperature (p. 2634, lines 10-11). As far as the annual mean surface temperature decreases from equator to the poles, the vertical distribution of air masses changes with latitude as well. This leads to the appearance of the horizontal pressure gradient for atmospheric air, dp/dx, which drives horizontal air movements. Its relative magnitude, $\frac{1}{p}\frac{dp}{dx}$, coincides by the order of magnitude with the relative magnitude of the latitudinal

temperature gradient $\frac{1}{T}\frac{dT}{dx}$. The latter is of the order of 10^{-3} (100 km)$^{-1}$. This gives an estimate of $dp/dx \sim p \times 10^{-3} (100\,\mathrm{km})^{-1} \sim$ 1 mbar (100 km)$^{-1}$, and this agrees well with observations.

In the view of the above I was used to think that both vertical and horizontal movements of air masses all have their consistent explanation in meteorology. If the authors propose an alternative or modified picture, they would, in my view, greatly enhance their impact (perhaps with a follow-up paper), if they explicitly discussed the edges at which their approach meets the conventional and well-known meteorological viewpoint that I have attempted to outline above.

I also add that I would support the authors' claim which they made in response to the comment of Dr. Savenije, namely that the intriguing precipitation patterns that they report have a self-contained value independent of the proposed underlying physical principle (the evaporative force).

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 3, 2621, 2006.