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Hydrology and Earth System Sciences Discussions

Interactive comment on "Comment on "Biotic pump of atmospheric moisture as driver of the hydrological cycle on land" by A. M. Makarieva and V. G. Gorshkov, Hydrol. Earth Syst. Sci., 11, 1013–1033, 2007" *by* A. G. C. A. Meesters et al.

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In this comment we provide a checklist of major issues of atmospheric physics as treated by the biotic pump theory (BPT) and in the discussion paper (DP). This checklist is based on our two previous comments (Makarieva and Gorshkov HESSD 6: S1; HESSD 6: S11, 2009) and might be useful for the DP authors if they decide to undertake a revison of their critique. This comment is written by A. Makarieva and V. Gorshkov (vigorshk@thd.pnpi.spb.ru).

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 401, 2009.

Table 1. Major issues of atmospheric physics as treated by the biotic pump theory (BPT) and in the discussion paper by Meesters, Dolman and Bruijnzeel (MDB)

Issue	Biotic pump theory (BPT)	MDB
1. Presence/absence of hydrostatic disequilibrium and of the associated air updrafts and downdrafts	Due to the non-equilibrium distribution of water vapor and the existence of the evaporative force, the atmosphere is ubiquitously out of hydrostatic equilibrium. The associated vertical air flows maintain the observed approximately constant mixing ratio of dry air everywhere on Earth.	No coherent statement.
2. The degree of deviation from the hydrostatic equilibrium	$(p_v/p)h/L$, where p_v is water vapor partial pressure, p is atmospheric pressure, h and L are the minimum and maximum linear scales of the considered circulation pattern (height and length).	Not quantified; hydrostatic equilibrium is verbally defined as valid to a "good approximation".
3. Fluxes produced by the aerostatic disequilibrium (= component-disequilibrium of MDB) of non-condensable air components in the open atmosphere	Eddy diffusion fluxes. These are **quantified by BPT** to be insufficiently intense compared to the dynamic air fluxes to restore the aerostatic equilibrium of non-condensable air constiuents.	Molecular diffusion fluxes. This statement of MDB contradicts all the preceding literature on the subject.
4. Fluxes produced by the aerostatic disequilibrium of atmospheric water vapor	Change of phase volume during water vapor condensation creates a disequilibrium pressure shortage in agreement with Dalton's law and initiates **dynamic air motions**. These dynamic air motions sustain eddy diffusion mixing of the atmosphere.	Molecular diffusion fluxes, see above. **Condensation of water vapor is ignored.**

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Table 1. Major issues of atmospheric physics as treated by BPT and MDB (continued)

Issue	Biotic pump theory (BPT)	MDB
5. Nature of constant mixing ratio for dry air	BPT quantifies that the dynamic fluxes initiated by water vapor condensation and the evaporative force (that treat dry air components equally) are stronger than the eddy diffusion fluxes of these components that tend to restore their aerostatic equilibrium. BPT therefore provides **the first quantitative theoretical explanation** of the mixing ratio of dry air and of the precision to which it can be expected to hold.	Constant mixing ratio of dry air is qualitatively attributed to "mixing" (of unspecified nature). No quantitative statements.
6. Value of the scale height of atmospheric water vapor	**Predicted** by the BPT to be approximately 2 km, in agreement with observations.	No mentioning.
7. Role of vertical temperature lapse rate for generation of dynamic air flows	Critical for the BPT. Condensation of water vapor, its non-equilibrium aerostatic distribution and the resulting circulation patterns occur when the lapse rate exceeds the critical value of 1.2 $\mathrm{K\,km^{-1}}$.	Not discussed.
8. Continuity equation for atmospheric circulation	Distributes the non-equilibrium pressure difference $\Delta p \sim p_v$ over the entire streamline. The integral continuity equation between the vertical (w) and horizontal (u) velocities is $uh = wL$.	Ignored.

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Table 1. Major issues of atmospheric physics as treated by BPT and MDB (continued)

Issue	Biotic pump theory (BPT)	MDB
9. Friction forces	BPT quantifies that for stationary large-scale circulation like the one in forested river basins, surface friction forces reduce the stationary value of horizontal velocity (to a few meters per second) as compared to compact circulation events like hurricanes and tornadoes.	Ignored.
10. Nature of pressure difference observed in cyclones	Coincidence of this magnitude with partial pressure p_v of atmospheric water vapor is not random, but indicates a pervasive importance of the evaporative force for all atmospheric circulation phenomena.	Not discussed.

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