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Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the validity of representing hurricanes as Carnot heat engine" *by* A. M. Makarieva et al.

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The novel hurricane physics

In the present discussion paper [1], the authors give a critique of the presently existing hurricane model and describe a new physical mechanism, which consistently explains

the origin of high wind velocities observed in hurricanes and tornadoes. From my point of view, the authors have provided a crucial explanation already in the discussion paper, where they have indicated [see Eq. (5)] that the addition of work A to the heat input Q_s leads to violation of the fundamental law of the energy conservation. Note that, if one accepts $T_s = 300$ K and $T_0 = 200$ K, then ε in Eq. (5) should be equal to $1/3$, but not $2/3$ as currently stated. This is clearly a misprint.

The Carnot cycle is not stationary one in terms of energy (which accumulates in environment in the form of work), but is stationary in terms of entropy (which does not change). For this reason, the dissipative heat engine based on the Carnot cycle that requires the stationarity of both entropy and energy contradicts either the first or the second laws of thermodynamics. The authors explained this exhaustively in their first response [2] on pp. S7329-S7332. Surprisingly, it appears that the Review of Referee 1 completely ignores the first response of the authors [2], so the authors have had to repeat literally the same arguments in their second response [3].

It is also strange enough that the Referee 1 pays no attention to the novel concept of hurricane physics proposed in work [1], which is alternative to that based on the Carnot cycle (see work [4] and references there). I have also read the discussion of previous paper by the authors [5], where the basic physics of the present approach has been first introduced. It is highly surprising, but I could not find any reaction from the meteorological community there either. The existing problems of the environment and climate are far from being resolved. People have not got protected from hurricanes and other climate extremes. Accordingly, the meteorological science cannot simply ignore new ideas and scientific results. There is much more of a duty rather than of an option for scientists to follow the novel trends closely, in order to incorporate them into their own research. This is especially important for the environmental science, challenged by the climate change.

In work [1], it has been explained the nature of potential energy that accumulates in the atmosphere during evaporation of water vapor and is further available for conversion to

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kinetic energy of moving air masses due to condensation of water vapor. The amount of this potential energy per unit air volume turns out to be equal to the partial pressure of the atmospheric water vapor. The dimension of pressure (Pa) coincides with the dimension of the potential energy stored in unit volume, because 1 Pa = 1 N/m^2 = 1 (N m)/m^3 = 1 J/m^3. It is interesting to estimate the available potential energy for the Earth's atmosphere. At standard air pressure $p = 10^5$ Pa, relative amount of saturated water vapor $\gamma = 0.05$ at 30°C and air density $\rho = 1.3$ kg/m^3, the maximum store potential energy available for hurricane and tornado formation is of the order of $\gamma p/\rho \sim 4$ kJ/kg.

In comment [6], the authors explain the physical origin of this potential energy, indicating that this is the energy of "latent work" rather than the heat of vaporization, which converts to the kinetic energy within the hurricane or tornado during "a reverse explosion". Obviously, both hurricanes and tornadoes can be described now on the same physical basis.

In conclusion, I am very impressed by the beauty of explanation of hurricane dynamics suggested in work [1], which is physically clear and consistent. I am looking forward to see further discussions on this topic.

References

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