

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

**A. Meesters**

antoon.meesters@falw.vu.nl

Received and published: 12 November 2008

This is likely to be my last contribution to the discussion. It contains responses to S8931 by Dr. Makarieva, preceded by some remarks about the dissipative heat engine.

### **about the dissipative heat engine**

I was urged to have a look at this subject too, though it has been considered already by others. I have find no time to look at the hurricane literature, and little time for reading the previous comments, so I will concentrate on S8193 by Dr. Makarieva which is short and self-contained, and seems to be the last part of the (undecided) discussion with Referee 1. There the discussion concentrates on the two equations

S9060

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



$$\Delta Q_s - \Delta Q_0 = 0$$

$$\Delta Q_s/T_s - \Delta Q_0/T_0 + \Delta Q_A/T_s = 0$$

These two equations are accepted by all, as far as I can see, as properly describing the budgets of the later generation of hurricane papers. Another generally accepted point is that a perpetual motion machine of the second kind cannot exist (this is a machine that works cyclically for an indefinite time, performing work while taking the required heat from a surrounding which has one single temperature).

Now the point is that Dr. Makarieva denies that the two equations can be satisfied simultaneously. This is said to be an “absolutely general statement”. Unfortunately I cannot follow the accompanying arguments.

I must say that if I try to imagine the energy- and entropy-budget of any prototypical dissipative heat engine (with the special assumption that dissipation occurs at temperature  $T_s$ ), I always end up with these two equations. If I am well, denying the possibility of the equations would imply that a dissipative heat engine cannot exist as such. This would seem the implication of the statement in S8193 that “the dissipative heat engine is a perpetual motion machine of the second kind”. The reference to the 2<sup>nd</sup> kind PMM is strange, as the two equations clearly describe a machine working in surroundings with two different temperatures. Even stranger is the apparent denial that any dissipative heat engine cannot exist. In daily life we are surrounded by installations containing dissipative heat engines of some kind, but maybe the denial pertains only to machines obeying the two equations.

The consequence of the equations that  $A/\Delta Q_s = (T_s - T_0)/T_0$ , implying that  $A/\Delta Q_s > 1$  if  $T_0$  is low enough (which will not occur for the hurricane), is indeed remarkable. I

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



would like to know if there is any literature on this phenomenon, which is new to me. However, as yet I do not see why it would conflict with the laws of thermodynamics. The argument in the Discussion Paper to show this has appeared to be wrong.

*the remainder of this short comment contains answers to S8931*

### section 3.1

It was indeed a stupid error of mine to estimate the wind speed term as I did. I also see now that the contribution of the wind speed to the concerned budget is substantial, and I do not understand why it was tacitly neglected in eq. 15 in Emanuel (1991). Still I do not understand why so much noise is made about this neglecting (The Discussion Paper claims that “it can be concluded that hurricane cannot exist”, S17428).

### section 3.3

I agree that production and dissipation need not be equal simultaneously. This was already admitted in my comment where I stated that they “must be equal (in the long run)”. But since small eddies have a short lifetime, the consequences should not be exaggerated. The dissipation as calculated in the criticized papers may be inexact, but this is in the nature of their approach: there is still no good reason to assume that the (variable) correction factor would differ strongly from one.

However, in the Discussion Paper a correction factor of  $10^{-8}$  was claimed to be necessary, based on a clearly erroneous argument.

---

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 17423, 2008.

S9062

**ACPD**

8, S9060–S9062, 2008

---

Interactive  
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

