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THE ENERGY OF HURRICANES

A most interesting calculation of the energy released by hurricanes was published as a "Frequently Asked Question at

http://www.aoml.noaa.gov/hrd/tcfaq/D7.html

Subject: D7) How much energy does a hurricane release?

Contributed by Chris Landsea

Hurricanes can be thought of, to a first approximation, as a heat engine; obtaining its heat input from the warm, humid air over the tropical ocean, and releasing this heat through the condensation of water vapor into water droplets in deep thunderstorms of the eyewall and rainbands, then giving off a cold exhaust in the upper levels of the troposphere (~12 km/8 mi up).

One can look at the energetics of a hurricane in two ways:

1. the total amount of energy released by the condensation of water droplets or ...
2. the amount of kinetic energy generated to maintain the strong swirling winds of the hurricane (Emanuel 1999).

It turns out that the vast majority of the heat released in the condensation process is used to cause rising motions in the thunderstorms and only a small portion drives the storm's horizontal winds.

- **Method 1) - Total energy released through cloud/rain formation:**

  An average hurricane produces 1.5 cm/day (0.6 inches/day) of rain inside a circle of radius 665 km (360 n.mi) (Gray 1981). (More rain falls in the inner portion of hurricane around the eyewall, less in the outer rainbands.) Converting this to a volume of rain gives 2.1×10^{16} cm3/day. A cubic cm of rain weighs 1 gm. Using the latent heat of condensation, this amount of rain produced gives

  $$5.2 \times 10^{19} \text{ Joules/day or}$$
  $$6.0 \times 10^{14} \text{ Watts.}$$

  This is equivalent to 200 times the world-wide electrical generating capacity - an incredible amount of energy produced!

- **Method 2) - Total kinetic energy (wind energy) generated:**

  For a mature hurricane, the amount of kinetic energy generated is equal to that being dissipated due to friction. The dissipation rate per unit area is air density times the drag coefficient times the windspeed cubed (See Emanuel 1999 for details). One could either integrate a typical wind profile over a range of radii from the hurricane's center to the outer radius encompassing the storm, or assume an average windspeed for the inner core of the hurricane. Doing the latter and using 40 m/s (90 mph) winds on a scale of radius 60 km (40 n.mi.), one gets a wind dissipation rate (wind generation rate) of

$$1.3 \times 10^{17} \text{ Joules/day or}$$
$$1.5 \times 10^{12} \text{ Watts.}$$

This is equivalent to about half the world-wide electrical generating capacity - also an amazing amount of energy being produced!

Either method is an enormous amount energy being generated by hurricanes. However, one can see that the amount of energy released in a hurricane (by creating clouds/rain) that actually goes to maintaining the hurricane's spiraling winds is a huge ratio of 400 to 1.

A single hurricane could provide convective cooling of 1.5x 10^{14} Watts per day and latent heat transfer of 6x 10^{14} watts per day

If you take 5x $10^{14}m^2$.as the area of the earth and the duration of a hurricane as one week, this means an average energy loss, over the entire surface, of $2.1Wm^{-2}$ from convection and $8.4Wm^{-2}$ of latent heat loss for a single hurricane. There are 11 hurricanes per year on average, giving 23.1 Wm^{-2} for convection loss and $92.4Wm^{-2}$ for latent heat loss per year. This should be compared with the $1.5Wm^{-2}$ claimed to have been supplied by the greenhouse effect since 1750[59]. And this was only hurricanes. There are 180 thunderstorms each year plus normal convection and evaporation.

These enormous amounts of energy are removed in one place and deposited elsewhere, partly in the oceans, partly reducing cooling at night and partly, as Landsea says, radiated to space., Their behaviour, dependent on the chaotic properties of fluid flow, is unpredictable. They conceal any possible much smaller effects of greenhouse gases which could never be identified. The models are not only wrong. They are irrelevant.

Cheers

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