The power of a hurricane: An example of reckless driving on the information superhighway

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One of the more problematic tasks of the research scientist is to convey to the public in an accurate but stimulating way the power and beauty of natural phenomena. The World Wide Web provides a new means to do this, and increasingly is used as a resource for scientific information by everyone from school children to professional scientists. How accurate is the information that is available on the Web? Is most of the information traceable to its source? As a very small experiment designed to address these issues, the author asked students in his tropical meteorology class to investigate how the power of a hurricane is being conveyed to the public via the Web. This article describes the surprising result.

Of bombs and storms

A quick search turned up nine sites that refer to the power or energy of a hurricane. Of these, five state that a single hurricane over the course of one day releases an amount of energy equivalent to 400 20-megaton bombs. (A sixth states that this amount of energy is released in one *minute.* Presumably, this is a misquotation of another source.) As one megaton is equivalent to 4.2×10^{15} joules, the quoted power amounts to about 4×10^{14} watts. Only one of these five sites quotes a source - a popular book on hurricanes (Lee 1993). The sites range from the Web page of a high-school science teacher to the home page of a former director of the US National Hurricane Center. Two further sites, one from a small college and the other from an advanced placement high-school physics course, quote a power output of 2×10^{13} watts, but do not give sources. A final site states that the energy content of a hurricane is about 10^{15} joules, but does not define what that pertains to.

A simple estimate

In a popular textbook, Anthes *et al.* (1978) estimate that the latent-heat release in an average hurricane amounts to 10^{14} watts. This is not perhaps a meaningful quantity, however, since most of the latent heat is used to raise the potential energy of air. (For example, the flow of moist, stable air over a mountain actually requires work to be done on the air, but large quantities of latent heat are released.) A more meaningful quantity is the rate of generation of kinetic energy, which in a steady hurricane also equals the rate of dissipation of kinetic energy. Bister and Emanuel (1998) showed that in a hurricane dissipation occurs mostly in the atmospheric surface layer, and that the corresponding dissipation rate per unit area, *D,* is given by:

$$D = \rho C_D V^3,$$

where ρ is the air density, V is a characteristic wind speed at low levels and C_D is the surface drag coefficient. Thus, integrated over the surface area covered by a circularly symmetric hurricane, the total power dissipated by the storm, *P,* is:

$$P = 2\pi \int_0^{r_o} \rho C_D V^3 r dr, \qquad (1)$$

where r is the radius and r_o is some characteristic outer radius encompassing the storm. To evaluate Eq. (1) I shall assume that the velocity varies linearly with radius inside the radius of maximum winds, r_m, and that it has a profile outside of r_m similar to those used by Holland (1980) and Emanuel (1986). I also take the average sea-level air density to be $1\,kgm^{-3}$ and use a drag coefficient of 2×10^{-3}. With these values, an average Atlantic hurricane with maximum winds of $50\,ms^{-1}$ and a radius of maximum winds of $30\,km$ dissipates 3×10^{12} watts. At the extreme end, a Pacific supertyphoon with a maximum wind speed of $80\,ms^{-1}$ and a radius of maximum winds of $50\,km$ dissipates 3×10^{13} watts. Thus the values quoted by most of the World Wide Web sites are too high by one to two orders of magnitude. Values quoted by two educational institutions were consistent with power dissipated in large Pacific supertyphoons.

Summary

While the World Wide Web can serve as a valuable source of information, it is clearly susceptible to the rapid propagation of misinformation, as demonstrated by this very small example. Problems of the kind illustrated here would be mitigated by careful referencing to source material, as is standard practice in printed publications. While a realistic estimate of power dissipation in an average hurricane is two orders of magnitude less than most values found on the Web, it is still an impressive quantity, equivalent to the world-wide electrical generation capacity as of 1 January 1996, as reported by the US Department of Energy.

References

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