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How many raindrops to fill the Atlantic Ocean?

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Abstract
The Atlantic Ocean is the second largest ocean on planet Earth. Through the use of multiple equations, this paper explores how many raindrops would be required to refill it if one day all of the water in it vanished. Further investigations are carried out to determine how long it would take the largest recorded storm to fill the Atlantic Ocean.

Keywords: *Statistics; Meteorology; Ocean; Atlantic Ocean; Storms*

Introduction
The Atlantic Ocean is the 2nd largest ocean in the world [1]. Comprising the gap separating the Americas from Europe and Africa, it is a gargantuan body of water composed of over 300 billion cubic meters. Imagine that for some reason, one day, all the water in the Atlantic Ocean vanished. This paper determines how many raindrops would be required to refill the Ocean and how long it would take the largest storm on global record.

Assumptions
The calculations in this paper are made using three assumptions. The first being that whilst raindrops are rarely true spheres, the raindrops are assumed to be of the same uniform size of 6 mm in diameter to calculate the volume per drop. The second assumption is that the shape of the storm forms a perfect circle when calculating the total area of the storm. Whilst storms often form a circular shape, they are not usually a perfect circle. The third assumption is that the storm constantly has the highest hourly precipitation rate ever recorded, this is the amount of rain per hour. This is so that the time taken for the largest storm to fill the Atlantic at its most heavy rainfall can be calculated.

How many raindrops?
According to the CIA, the Atlantic Ocean has a total volume of $3.10410900 \times 10^{17}\text{m}^3$ [2]. A variety of factors affect the size of a raindrop, such as weather conditions, but NASA determined that in heavy rainfall raindrop size can reach a maximum of 6 mm in diameter [3]. The equation to calculate the volume of a sphere can be used to calculate the volume of a raindrop with a diameter of 6 mm.

$$V = \frac{4}{3}\pi r^3$$

To calculate the volume in terms of meters, the diameter must first be converted into metres from millimetres:

$$6\,mm = 0.006\,m$$

Using the equation above, inputting this value can calculate the volume of a raindrop of this size:

$$V = \frac{4}{3}\pi \times 0.003^3$$
$$V = 1.131 \times 10^{-7} m^3$$

Now both the values of the volume of the Atlantic Ocean and the volume of a raindrop are obtained, by dividing the former by the latter the number of raindrops needed to fill the Atlantic can be calculated.

$$N = \frac{3.10410900 \times 10^{17} m^3}{1.131 \times 10^{-7} m^3}$$

$$N = 2.745 \times 10^{24}$$

From the calculation above, it becomes apparent that filling the Atlantic Ocean will require 2.745×10^{24} raindrops with a diameter of 6 mm.

How long for the Largest Storm?

Now that the number of raindrops to fill the Atlantic Ocean is known, how long would it take the largest storm ever recorded to fill the Ocean?

The largest storm ever recorded was *Typhoon Tip*. This colossal typhoon had a diameter of 2220 km^2 [4]. The highest hourly precipitation rate on record is 305 mm [5]. First, the area of the storm needs to be calculated.

$$A = \pi r^2$$
$$A = \pi \times 1110^2 = 3.871 \times 10^6\ km^2$$

The values of 3.871×10^6 km^2 and 305 mm should be converted into m^2 and m respectively.

$$1\ km^2 = 1 \times 10^6\ m^2$$
$$3.871 \times 10^6\ km^2 = 3.871 \times 10^{12}\ m^2$$
$$1\ mm\ of\ rain = 0.001\ m$$
$$305\ mm = 0.305\ m$$

This means that 0.305 m^3 of rainwater is deposited per m^2. Using these values, the hourly volume of rainwater deposited by the storm can be calculated.

$$(3.871 \times 10^{12}) \times 0.305 = 1.181 \times 10^{12}\ m^3 hr^{-1}$$

Dividing the total volume of the Atlantic Ocean by this volume will yield the total number of hours it would take Typhoon Tip to fill the Atlantic.

$$H = \frac{3.10410900 \times 10^{17}}{1.181 \times 10^{12}} = 2.629 \times 10^5\ hr$$

This value equates to 10,955 thousand days or just over 30 years.

Conclusion

This paper has calculated that it would take 2.745×10^{24} raindrops with a diameter of 6 mm to fill the Atlantic Ocean and the largest storm ever recorded over 30 years at the largest hourly precipitation rate on record. Multiple assumptions have been made which will affect the true value of these results. Most notably, not every raindrop will be the same size, the storm is unlikely to be a perfect circle, and the precipitation rate is likely to vary throughout the duration of the storm. This variety in raindrop size means it would take many more raindrops as many will be smaller than 6 mm. A varying precipitation rate means that it would take a much longer time for this largest storm to fill the Atlantic Ocean because there will be periods of time with less heavy rainfall.

References

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