Experiment and Discussion on Formation of Hurricanes / Ocean Currents by Cold and Heat Convection

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Abstract: As a student hailing from Southeast China and residing in the New England region of the Northeastern United States, I have personally witnessed the impact of both large and small hurricanes throughout my life. This firsthand experience has sparked my curiosity about the fundamental processes underlying the formation of these destructive weather phenomena. While existing literature attributes the primary energy source of hurricanes to water vapor and fluid flow generated by tropical oceans, the specific cause of their development remains elusive. This scientific report presents the rationale behind conducting an experiment to simulate the energy transfer in convection and its influence on fluid motion, with the goal of enhancing our understanding of hurricane formation and improving disaster prevention strategies.

Keywords: Convection; Energy Conversion; the Influence of Fluid Motion

Preface

I have designed an experiment to simulate convection and explore its role in energy transfer and fluid motion. By conducting this research, we aim to gain a deeper understanding of hurricanes, thus enabling more efficient disaster prevention measures. Additionally, during the course of the experiment, an unexpected observation was made: coldness was found to induce water flow at a comparable rate to heat-induced flow. This finding prompted further investigation into the energy dynamics associated with this phenomenon. It is hypothesized that the energy flow in the water arises from the heat absorbed by the center of the icicle, suggesting a previously unrecognized mechanism for the generation of ocean currents.

Rationale: energy transfer in convection and its influence on fluid motion, mechanism for the generation of ocean currents and hurricane formation.

Hypothesis

If the formation of a hurricane is related to how the airflow creates wind vortexes, then we can observe the formation of the wind vortex/hurricane by simulating the central heat convection of the hurricane.

If temperatures were been altered in the fluid, then we could understand the influence of temperature on the velocity and direction of water flow by observing the flow of pigments in the fluid.

If the surrounding air and the water vapor's center have different temperatures and flow patterns, then the airflow around the two will be different by measuring the thermal centers generated by the two.

Procedure

Safety

When executing experiments 2, 3, and 4, goggles, gloves, and closed-toe shoes should be worn when heating water using the gas stove. While holding the ruler to measure the water height in the iron kettles, leave at least 10cm between your hand and the surface of the boiling water to avoid burning.

Experimentation with Set-ups

Experiment - Height vs. Expansion Time

1.Have a plastic container with water. Settle the plastic container for 5 minutes to still the water.

2.Measure the water's height from the plastic container's bottom center to the water level and record the data.

3.Fill the plastic tube with hot water.

4.Place the plastic tubes in the center of the container.

5.Drops two drops of food coloring in the water and start the timer immediately after dropping. Observing the food coloring spread to the edge of the plastic container. Once it touches the border, stop the timer and record the time.

6.Repeat the above steps using the same plastic container. Each trail increases the height by 0.5-5cm.

7.Repeat the above steps; however, in step 3, fill the plastic tube with ice.

Result

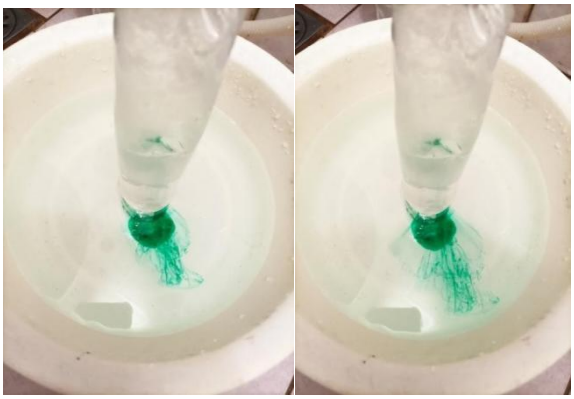
Experiment - Just some observations, no data

1. As the effect of the hot plastic container (bottle), the pigment in the lower part of the water moved and concentrated around the container, and the pigment on the surface of the water radiates outward.

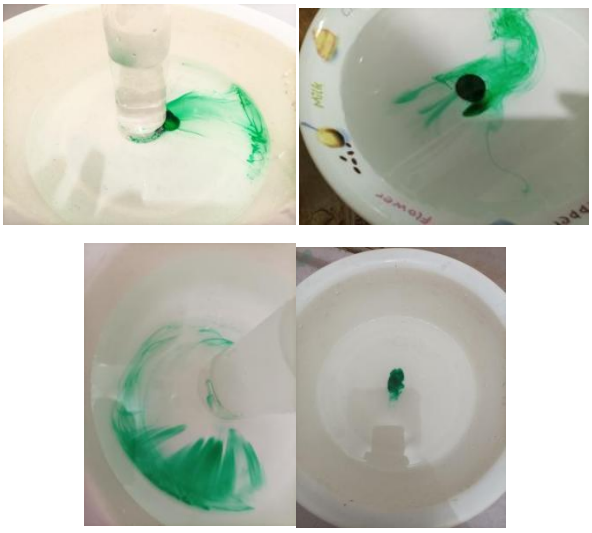
2. The cold plastic container (bottle) caused the pigment in the bottom part of the water radiates outward; while the pigment on the surface of the water centered around the plastic container (bottle)

3. Surface level Pigment with the hot plastic container formed a vortex when radiate outward; similarly, the bottom level pigment with the cold plastic container formed vortiex when radiate outward.

The cold plastic container (bottle) caused the pigment in the bottom part of the water radiates outward; while the pigment on the surface of the water centered around the plastic container (bottle)



Opposite to that of the cold bottle. The hot plastic container (bottle) caused the pigment on the surface part of the water radiates outward; while the pigment in the bottom of the water centered around the plastic container (bottle)



Color dye in both scenario forms vortex.

This is water in room temperature, with no vortex forming.

Discussion of Data

Experiment

The hot water bottle increases the temperature in the center of the container, so that the density of the surrounding water becomes smaller and rises. Vice versa, the ice water bottle decreased the central temperature, causing the density of the surrounding water to become larger and decrease. Convection does not happen only because of motion of high heat fluid. If there's a temeprature difference that cuases a different in density of water, there will be vertical flow of water.

This method is used to test the occurrence of radiant points of different temperatures in the water that could cause the surrounding water flow.

The reason that pigment in the bottom of the container concentrated around the hot water bottle is due to the inward water flow(towards the center), which prevent the expansion of the pigment in the bottom. On the other hand, in the container with cold water bottle, the phenomenon of the bottom pigment expanded, surface pigment slightly centered around the edge of bottle is because the downward flow of water, making the pigment flowing upward hard to center around the bottle.

Conclusion

We here disclosed our conclusions:

1. Convection occurs whenever a temperature difference exists in the center of fluid.

(1) Fluid flux moving upwards and outwards at the surface when the center of fluid has an elevated temperature.

(2) Fluid flux moving downwards and outwards at the bottom when the center of fluid has lower temperature.

2. Outwards movement of the fluid caused by convection occurs in a vortex fashion.

3. When a heat flux exists in the center of fluid, convection generates fluid current moving upwards. From the perspective of fluid dynamics, higher velocity at the fluid center resulting in lower pressure forcing the peripheral fluid moving towards the center. Greater heat flux resulting in higher horizontal velocity of the current moving towards the center.

4. The mists produced by boiling water are small water droplets condensed from water vapor. At the center of the vapor flow, gaseous water condensed into droplets and settled down. The sedimentation of the droplets cancelled out the upwards vapor flow, and due to gravity, the closer the droplets are to the water surface, the faster the sedimentation, resulting in decreased vapor flow measured by anemometer and even a reversed flow near the water surface. Out off a specific range from the water surface, the condensation process slows down leading to faster measured vapor flow. However, at a certain distance, the vapor flow decreased again. Overall, the vapor flow exhibits as a parabolic distribution upwards from the water surface. We proposed that at the center of the vapor flow, the air moved upwards due to convection. These airs contain great amount of vapor and prone to condensation. When most vapor condensed into droplets, the number of molecules in the air decreased greatly forming a low-pressure center. However, the anemometer failed to distinguish between air flow and droplets (liquid water) flow. We suggest that the downwards droplet flux outweigh the influence of the upwards air flow therefore a flux pointing down towards the water surface was measured.

References

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