Weather on a Lab Bench

by Ann Ewing

Miniature tornadoes and hurricanes, as well as the same kinds of weather patterns swirling around the earth, are being created in laboratories to reproduce more and more realistically their counterparts in the real atmosphere.

Such laboratory models of the weather were once made in "dishpans" that showed only the large-scale features. Now scientists have so refined their methods of duplicating on a small scale the interactions occurring in the actual atmosphere that they can, at will, simulate a tornado or a hurricane, or details of the planetary jet stream sweeping around the world.

They use liquids, rather than the atmospheric gases in the real world. But the same principles of fluid mechanics apply.

One meteorologist has worked out an ingenious scheme for making "tornadoes" on a record player, using a soda bottle. Place a bottle of clear soda water, minus the label and the top few inches of liquid, on the center of the turntable, then rotate the record player until the soda reaches the same speed. Drop in a pinch of sugar; although any other solid particles will do, sugar is recommended if you want to drink the soda later.

Bubbles of gas from the sugar produce an inflow and, therefore, a tight vortex forms. The twisting funnel, very similar to that of a tornado, forms suddenly, Dr. J. S. Turner of the Commonwealth Scientific and Industrial Organization in Sydney, Australia, has found in his experiments with the "do-it-yourself" tornado.

Even more realistic models of tornadoes, as well as of hurricanes, are being made in laboratories. Scientists at Florida State University are now harnessing a simple chemical reaction to mimic the tremendous surge of energy powering a hurricane.

They have produced in the laboratory a rotating wall of fluid that looks and acts like the eye wall of a fully developed tropical storm. The twirling winds are produced in miniature by the heat released when acid and alkaline solutions are mixed, corresponding to the energy provided to hurricanes through the latent heat released by the condensation of water.

To create the simulated hurricanes, Florida's Ronald K. Hadlock uses a metal platform rotating at a rate equivalent to the earth's spinning. That platform supports a cylindrical chamber some 13 inches in diameter within which the miniature hurricane is produced, visible as a convection ring extending almost to the surface of the clear liquid into which the dye-carrying solution is introduced.

The ring has "geometric, kinematic and dynamic similarities to a prototype hurricane," Mr. Hadlock says. It has a "circular, counterclockwise motion around a hollow center, comparable in speed and direction to the circular winds around the eye of a hurricane."

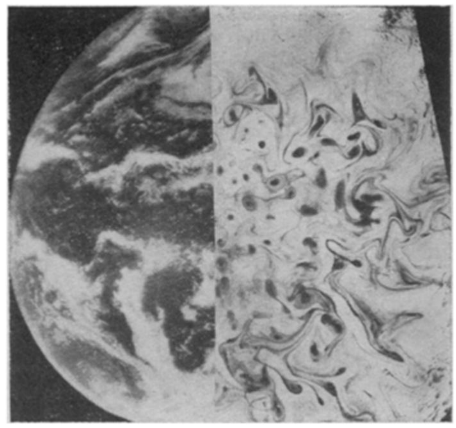
Previous attempts to produce small-scale hurricanes in the laboratory have reproduced gross wind structure but nothing corresponding to the eye wall that in typical hurricanes rises to a height of 12 or more miles and spreads out to a diameter of 25 miles as the hurricane gains momentum over tropical waters.

Not so clear to a non-meteorologists' eye, but possibly more important in learning about what causes worldwide weather changes, are the models of hemispheric wind patterns being simulated.

In these planet-wide models, scientists are now able to measure temperature and fluid flow—the equivalent of wind speed—at 48 different points, and they can do so with instruments so delicate that the liquid is not affected by their presence. The patterns thus produced are small-scale equivalents of the planet-circling jet stream, the high-altitude band of air that governs earth's surface weather.

In one of these laboratory experiments, at the University of Florida, meteorologists have photographed in miniature the worldwide circulation pattern that results in abnormally cold or abnormally warm surface weather. This usually results from what is called a "blocking" or "high index" circulation.

Dr. Dave Fultz at the University of Chicago was one of the first to demonstrate that his "dishpan" models of planet-wide weather patterns, such as seen in photographs from satellites, could be duplicated on a small scale. He is still doing this, but with much improved equipment that also reproduces the same kind of patterns resulting from a high index circulation.



NASA, University of Chicago

Weather from a satellite; in the lab.

Blocking results when some disturbance occurs in the atmosphere. Whether these disturbances—such as an abnormally large snow-covered area—start at the earth's surface and propagate upward, or result from some triggering of the earth's high atmosphere that propagates downward is not known.

Although the laboratory experiments are not likely to solve the problem, which meteorologists have been debating for some 20 years, they do help scientists figure out how heat input, such as the sun furnishes to the atmosphere, and cooling affect atmospheric circulation.

In order to find out how heat input and cooling change weather patterns, meteorologists now have to use the entire earth as their laboratory "model." They have plans to do just that during the World Weather Watch, in which observations of wind, temperature and humidity and other factors will be measured on a far larger scale and much more frequently than today.

However, even before the beginning of the World Weather Watch, now scheduled for 1968, weathermen are following a small portion of earth's global circulation by tracking balloons launched from the Southern Hemisphere. The wandering paths these constant-altitude balloons take show the meandering wind patterns of the high atmosphere in the latitudes of Australia.

By correlating these planetary meanderings with surface weather and with the patterns found in laboratory experiments, meteorologists hope to find the key to making weather forecasts more accurate for more of the world—and for a longer time range than now possible.

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