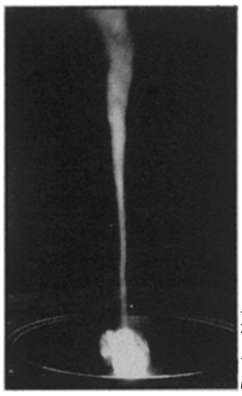
METEOROLOGY

Homegrown tornadoes


Purdue Univ.

What better way to study a tornado than to make one of your own? Judging from the work of three Purdue University researchers, it's the only way. Pictured is a miniature tornado whipped up by Ernest M. Agee, Christopher R. Church and John T. Snow in their aptly named Purdue Tornado Vortex Simulator. Besides being safer to study and more easily scheduled than tornadoes in the wild, these homemade twisters allow a close-up look at such characteristics as the distribution of air speeds and pressures inside the whirling air vortex.

Fashioned after a tornado-simulator designed by the late National Severe Storms Laboratory researcher Neil Ward, the Purdue simulator reproduces some of the wind conditions that seem most conducive to a tornado. "One way of looking at a tornado is as a small manifestation of a much larger thunderstorm," says Snow. "We are creating a small part of a thunderstorm."

The cylindrical chamber containing the tempest is 23 feet tall and 13 feet in diameter. By drawing air through a rotating screen into the chamber, which has a variable size hole in the bottom, the simulator mimics the three components that in nature appear most likely to spawn a tornado — resistance against a horizontal air flow, air swirling around a large radius and a rapid updraft. The simulated tornadoes reach a maximum height of about 4 and a half feet and winds of 30 to 60 feet per second.

When they put the 3-year-old machine through its paces, Snow and his co-workers can examine the whole spectrum of tornado behavior, from the very strongest conditions that spawn multiple funnels to the very weak events that nevertheless produce the greatest, and most destructive, pressure flows. Apparently because it is the most faithful to nature, the Ward-type apparatus (there are only four in the United States and Purdue's is the largest) is the only tornado simulator that can reproduce a twister's entire repertoire, including the rarely documented but highly destructive multiple funnels, says Snow. The Purdue team has found, among other things, that the highest air speeds are near the ground. They plan studies of the boundary layer of the cone and of the smaller turbulence within the storm.

Rain-making oil refineries

Despite what you may think, all polluted clouds are not the same. For instance, researchers from the National Oceanic and Atmospheric Administration in Boulder, Colo., have found that oil-refinery-polluted clouds probably produce rain more quickly than do smog-polluted clouds. In a study of Los Angeles, funded by the Environmental Protection Agency, NOAA's Earl W. Barrett, Farn Parungo and Rudolf F. Pueschel studied the size, composition and chemistry of particles in the air from areas that were unpolluted, smog-polluted and polluted by oil refineries.

Samples from the smog-polluted areas contained an excess of small droplets, not very favorable to coalescence and rain formation. But oil-refinery-polluted air, like unpolluted air, contained many large droplets, which are more likely to lead to rain. The difference, says Barrett, is that the larger particles produced by the oil refineries are better condensation nuclei than the small smog particles and that the nitrate and nitric acid refinery particles collect more water at a lower humidity than do the sulfate smog particles. The good news is that the effluent from oil refineries might increase the chances of rain over the city; the bad news, says Barrett, is that the rain will be acidic.

PHYSICAL SCIENCES

Stable hadron search

According to traditional particle physics the only stable subatomic particles are the proton and the electron (except for those that have no mass). All the others decay into others that decay in their turn until they reach stable particles.

In physics, traditions are made to be broken, and the current ferment in particle physics has raised the suggestion that there may be heavy, stable members of the particle class called hadrons of which heretofore the proton has been considered the only stable member. In the August 6 PHYSICAL REVIEW LETTERS R. Middleton, R. W. Zurmühle, J. Klein and R. V. Kollarits report on a search for a hypothetical stable hadron that would have about 10 times the proton's mass.

If such a stable, heavy hadron existed, it might get bound into an atomic nucleus in place of the ordinary proton or neutron. The theory says it won't bind to a single proton to form an anomalously heavy hydrogen isotope, so a heavier atom must be investigated. For a number of reasons oxygen seemed good to the University of Pennsylvania investigators.

The oxygen was put through a tandem accelerator, which in this case performs as a highly sensitive spectrometer to separate the ordinary isotopes of oxygen from the supposed extra-heavy one by their mass. The cosmological particle physics that had led to the prediction of the heavy stable hadron proposes that there should be one of these heavy things for every ten billion (10^{10}) or 100 billion (10^{11}) ordinary neutrons and protons. The experiment found nothing definite and set an upper limit between one in 10^{18} and one in 10^{16}. The experimenters are not enthusiastic about the prospects of a repeat experiment finding anything.

Putting in the plug

The way to prevent things from coming out the ends of an open tube is to put plugs in the ends. For decades plasma physicists have resisted this bit of folk wisdom, because they worried about contamination of the plasma by material in the plugs. Fusion experiments using this type of geometry were designed so that magnetic fields at the ends of the tube would send the ions and electrons of the plasma back to the center of the tube.

Magnetic plugging has never worked very well. Lately, at the Los Alamos Scientific Laboratory, experimenters have been using solid plugs and find that they work surprisingly well. The type of device involved is a linear theta pinch. It is a long tube in which the plasma is held by a magnetic field running parallel to its axis. The idea is to squeeze and heat the plasma by a sudden sharp increase in the field strength. Naturally the stuff flies out the ends.

A couple of years ago the suggestion was made that the ends be plugged with quartz. Resistance to the suggestion was based on the quite reasonable belief that cold material abraded from the plug would contaminate and cool the plasma. A cold plasma is useless for thermonuclear fusion experiments. It turned out it didn't quite work that way. The quartz plugs helped. That stimulated a search for optimum plug materials.

In the August 6 PHYSICAL REVIEW LETTERS R. J. Commisso, R. R. Bartsch, C. A. Ekdahl, K. F. McKenna and R. E. Siemon report that plugs made of lithium deuteride work very well. A series of shots with the theta pinch shows that the plasma is held three times as long with lithium deuteride plugs as with open-ended tubes. The reason, they think, is that lithium and deuterium are light atoms, and when they are abraded from the plugs and floating around the plasma chamber, they will bounce a hot heavy ion from the plasma back toward the middle of the tube with little loss of energy to the hot ion.