ATMOSPHERIC SCIENCE

NASA Launches a 5-Year Plan to Clone Drones

In these days of the Space Shuttle, an aircraft with an 80-horsepower engine and a 60-foot wingspan that can't even carry a pilot sounds pitiable. But to many atmospheric researchers, this craft, named for the Greek demigod Perseus, and robot aircraft like it are the best way to get a front-row seat on global-change processes such as ozone depletion and greenhouse warming. For years, the Perseus program existed on a shoestring, as researchers' pleas for unmanned aircraft, which can linger high in the atmosphere for longer, with less risk, and at lower cost than any other craft, made little headway at the National Aeronautics and Space Administration (NASA) and other agencies. But, starting next year, atmospheric scientists may get the drones of their dreams.

Drones have caught the imagination of NASA administrator Daniel Goldin, because they fit in so well with his slogan for the new NASA: "Better, faster, and cheaper." Last December, Goldin was invited to the rollout of the first Perseus at Aurora Flight Sciences Corp. of Manassas, Virginia. As Goldin told *Science*, he "was overwhelmed by the possibilities, and also overwhelmed by how NASA had gotten so far out of balance" in its emphasis on studying global change using satellites. Goldin has learned what the research community has been arguing for years: that drones are ideal for directly measuring the chemistry and dynamics of the upper troposphere and stratosphere. The result of his consciousness-raising: The Administration's budget request for NASA includes what Goldin calls a "significant funding wedge"—$90 million over 5 years, according to NASA sources—for building and flying drones.

The new program marks a victory for Bob Watson, who heads NASA's research and analysis program and has been boosting drones for years. For sampling the upper atmosphere, he says, unmanned aircraft have certain capacities "that cannot be matched any other way." Balloons are at the mercy of the winds and can fly only in the daylight. The limitations of manned aircraft became clear in 1987 and 1988 during airborne studies of ozone-depleting chemistry. The two programs, in the Arctic and Antarctic, relied on NASA's workhorse platforms for atmospheric experiments, a DC-8 (a retired jetliner purchased used from Alitalia) and an ER-2 (one of NASA's two converted U-2 spy planes).

"The ER-2 did a great job," says Adrian Tuck of the National Oceanic and Atmospheric Administration, who was the chief scientist for both expeditions. But flying it was costly and risky. "Asking people to fly single engine planes over Antarctica is inviting the same kind of investigation if something goes wrong that you had with the Challenger disaster," says atmospheric scientist Sherwood Rowland of the University of California, Irvine. In addition, much of the action in ozone depletion takes place 30 kilometers up, adds atmospheric chemist Jim Anderson of Harvard University, and the ER-2 has a ceiling of only 20 kilometers. While that's high enough for greenhouse studies of how the atmosphere absorbs and reradiates solar energy, the ER-2 can't meet another requirement of those studies: the ability to stay aloft for a complete day-night cycle.

AURORA FLIGHT SCIENCES CORP.

Off the ground. A fleet of drones like Perseus may soon take wing.

Perseus was hatched in answer to those needs: a low-cost vehicle that would supply "flight opportunities for a community profoundly starved for access to the most crucial regions of the earth's atmosphere," says Anderson. In the summer of 1988, Anderson, fresh off the Antarctic ozone expedition, met with John Langford. Langford, then of the Massachusetts Institute of Technology, had just led the successful Daedalus project, which designed and flew a human-powered aircraft 115 kilometers from Crete to Santorini. With Anderson as visionary, Langford founded a company, Aurora Flight Sciences, and designed two models of Perseus. Perseus A, to be used for ozone studies, would carry a tank of liquid oxygen to supply the engine in the thin air of the stratosphere. It would be capable of climbing to 30 kilometers and staying there for 2 hours before running out of oxygen and coasting home. Perseus B, designed for studying greenhouse effects, would have a ceiling of only 20 kilometers and, not needing liquid oxygen, would be able to stay aloft for 72 hours. Once in production, either Perseus would cost approximately $1.5 million.

In the age of satellites costing $100 million and more, that may have sounded like a bargain-basement price tag, but there were few takers. Langford and Anderson's Perseus development project was forced to survive on private funding and a small National Science Foundation grant for 2 years. Finally, NASA stepped in in 1991, when the high-speed research division, which is studying the environmental impact of a future supersonic transport, came up with $3.5 million to fund the development and purchase of two of the drones by late 1993. Meanwhile, Watson tried without success to get funding for a more extensive and directed drone program. As Watson explains it, Congress had instructed NASA to focus on satellite monitoring of the global climate, and other agencies were left to concentrate on direct measurements of the upper atmosphere.

The only prospect for filling the breach was the Department of Energy (DOE), which was eyeing drones as a tool for its Atmospheric Radiation Measurement (ARM) Program, an effort to measure greenhouse variables. But DOE's $5 million budget for drones came with the proviso that it be used not for new vehicles but only to develop lightweight monitoring instruments. The idea, according to Ari Patrinos, chief of DOE's environmental sciences division, was to prompt DOE to find ways to use one of the several drones developed in the 1980s for classified military programs. None of those military drones, however, fit the bill for atmospheric research.

Researchers may be spared such compromises, now that Goldin has caught drone fever. In the near term, the NASA budget request should support the purchase and operation of a fleet of Perseuses; eventually, Goldin expects to add other drones. The money would also fund instrument development —what Goldin calls "a new generation of low-cost, low-price sensors that give you more for less." Carried by drones, the sensors should produce data complementary to space- and ground-based measurements on everything from the catalytic processes that destroy ozone and the microphysics of clouds to the temperature and circulation of the stratosphere.

Goldin says the expanded drone program will survive the budget process because NASA will tell Congress that the vehicles are a top priority. "There wasn't a commitment in the past," he says. "Now we are committed. We view it as among our highest priorities."

–**Gary Taubes**