



The Forecast

TECHNOLOGY IS ADVANCING THE ABILITY TO PREDICT THE WEATHER AND ITS FAR-REACHING BUSINESS EFFECTS



Far more than just a polite conversational topic, the weather affects nearly one-third, or \$3 trillion, of the U.S. gross domestic product, according to the National Oceanic and Atmospheric Administration (NOAA), a division of the U.S. Department of Commerce. Research shows industries as diverse as agriculture, energy, entertainment, insurance, retail and travel all rely on accurate weather predictions to help manage risk. To better predict and respond to conditions, companies are developing technologies that more efficiently track and analyze the weather.

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Harris Corp. (HRS) reports it is testing an automated forecast system for airports that predicts ceiling and visibility conditions as many as eight hours ahead. Tom Hicks, Harris Weather Systems' independent research and development manager, says that the system updates forecasts every five minutes. This, he explains, saves air carriers and transportation companies time and money. NOAA reports tally the costs of air delays, 70 percent of which are attributed to weather, at \$6 billion a year.

NOAA says it is collaborating with the U.S. Navy, among others, to reconfigure the Navy's SPY-1 radar, developed by **Lockheed Martin Corp.** (LMT), to collect storm data and track tornadoes better. "The system's computer can command the antenna position programmer to move the radar beam every 800 microseconds and collect information about six times faster than it does today," explains Doug Forsyth, head of radar research at NOAA's National Severe Storms Laboratory. With faster data collection, Forsyth says he believes the radar could eventually double tornado warning lead times from 11 minutes to 22 minutes, which Lockheed Martin says could save potential damage costs to businesses, as well as lives.

The Boeing Co. (BA), **ITT Industries Inc.** (ITT) and Lockheed Martin, among others, build satellites that collect weather data from space. Boeing says it is building the next generation of weather satellites for the National Aeronautics and Space Administration (NASA) and NOAA, the first of which, NASA reports, will be launched later this

year. Boeing reports it is also designing conical microwave sensors that take "vertical pictures" of the atmosphere to gauge different altitude temperatures. These measurements can be added to surface weather data to create a more complete model for forecasters.

Once all the data is collected, supercomputers, such as those designed by **Hewlett-Packard Co.** (HPQ), **IBM Corp.** (IBM) and **Silicon Graphics Inc.** (SGI), take over. Weather models run on these supercomputers, which consist of several individual computers, each with hundreds of processors connected by a high-speed network over which they share calculations, explains Lloyd Treinish, head of the Deep Thunder weather modeling project at IBM, which supplies supercomputers, workstations, servers and storage systems to NOAA.

Treinish says that, in practice, detailed weather models are accurate for a five- to 10-mile geographic range. With more powerful computers, predicts Bob Bishop, CEO of Silicon Graphics, which makes supercomputers and software to graphically display data forecasts, "you could have one-square-mile micro-forecasts."

Rockwell Collins Inc. (COL) says it is developing enhanced vision systems and synthetic vision systems that allow pilots to land in low visibility. Raj Aggarwal, Ph.D., vice president of Rockwell Collins' Advanced Technology Center, says the enhanced vision system uses radar to collect weather data and detect runway obstructions, and the synthetic vision system shows power lines, mountains and other possible dangers.

Beyond technology, companies report deploying financial products to manage risk, such as swaps, collars, caps and floors. The Weather Risk Management Association (WRMA) was developed in 1999 to help companies handle how weather affects their revenues. WRMA's most recent survey of the \$16 billion weather risk-management industry shows that such weather contracts tripled from 2002 to 2003. WRMA members include **ABN AMRO Holding N.V.** (ABN), **AXA** (AXA), **Chicago Mercantile Exchange Holdings Inc.** (CME), **Constellation Energy Group Inc.** (CEG), **Hitachi Ltd.** (HIT), **Kinder Morgan Inc.** (KMI), **PartnerRe Ltd.** (PRE), **Statoil ASA** (STO), **Westpac Banking Corp.** (WBK), **Willis Group Holdings Ltd.** (WSH), **XL Capital Ltd.** (XL) and divisions of **Ennergy Corp.** (ETR), **Mitsubishi Tokyo Financial Group Inc.** (MTF) and **Suez S.A.** (SZE).

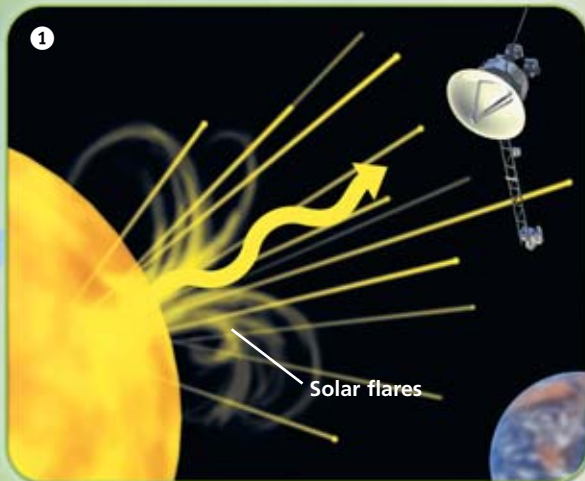
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Storm Chasers

From watching solar flares to tracking air pollutants, researchers are monitoring a variety of weather effects for safety and efficiency planning.

1 SPACE WEATHER

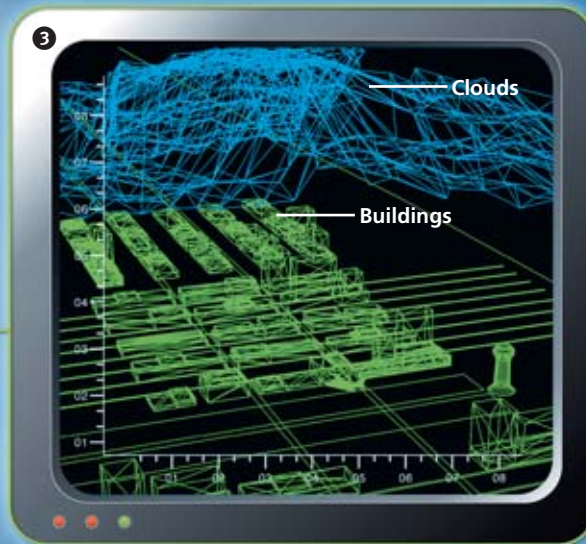
Satellites are vulnerable to radiation damage during solar flares, when the sun ejects plasma and particles that fly toward the earth, explains **Lockheed Martin Corp.** (LMT). The company reports it is developing a solar X-ray imager for NASA that will watch these solar eruptions. And **The Boeing Co.** (BA) says it has worked with **IBM Corp.** (IBM) to design integrated circuits that can withstand solar radiation. The resulting processor is so powerful that the computing power equivalent to thousands of desktop computers is housed in a unit the size of a kitchen table, states Boeing.



2 SATELLITES

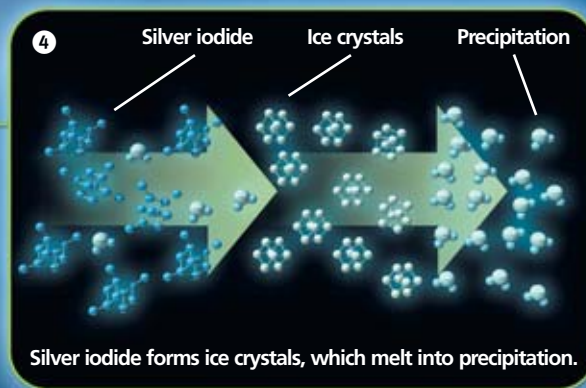
Divisions of Boeing, **General Dynamics Corp.** (GD), **ITT Industries Inc.** (ITT), **Lockheed Martin**, **Orbital Sciences Corp.** (ORB), **Raytheon Co.** (RTN) and **Unisys Corp.** (UIS) report that they have each developed spacecraft and/or instruments for NOAA's weather satellite program. **Northrop Grumman Corp.** (NOC) says it processes weather satellite data for the U.S. Air Force Weather Agency. The newest satellites will collect one terabyte of information — 10 to 100 times more than a typical home computer can store on its hard drive — each day, Lockheed Martin explains. As researchers add sensors to the satellites to collect even more data, payloads will soon be double the current 300 to 350 pounds, making platform stability even more crucial, according to Boeing.





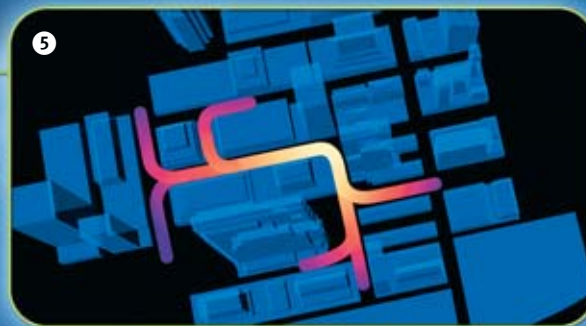
3 SENSORS AND AVIATION DISPLAYS

Enhanced vision systems (EVS) use infrared radar sensors that employ radiated energy, rather than reflected light, to help pilots see in low visibility, explains **Honeywell International Inc. (HON)**. The company says it is developing a liquid crystal display that combines infrared images with flight data. For its EVS and synthetic vision systems, **Rockwell Collins Inc. (COL)** is testing infrared sensors that view an area five- to 10-miles wide and a few thousand feet high, the manufacturer reports. Currently pilots must check two different cockpit displays, one for ground radar information and the other for data collected by the plane's radar antenna, but Rockwell Collins announces it is developing a single display to show both. **Boeing, DRS Technologies Inc. (DRS), Goodrich Corp. (GR), Griffon Corp. (GFF), Harris Corp. (HRS)** and **L-3 Communication Holdings Inc. (LLL)** report they are each developing weather-tracking systems and sensors for the aviation industry.



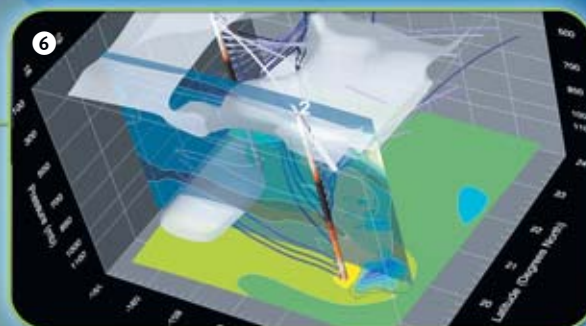
4 CLOUD SEEDING

In 2002 the U.S. incurred more than \$11 billion in economic losses due to drought, according to the National Drought Mitigation Center. A 2003 federal study concluded that the U.S. should initiate new research into weather modification, which includes cloud seeding. The study cites researchers who believe they can ease droughts and water shortages by treating clouds with silver iodide to form ice crystals, thus producing rain. Researchers at **Hewlett-Packard Co. (HPQ)** say multiple supercomputer simulations must be run first. The study also asserts that a highly sensitive millimeter-wave cloud radar is necessary to see clouds and rainfall in high detail.



5 MODELING AIR POLLUTANTS

Silicon Graphics Inc. (SGI) reports its high-performance computing systems and visualization software are currently used for weather forecasting and air-pollutant transport predictions. As the computing power and forecast resolution grow, Silicon Graphics says it hopes to develop a system that uses real-time weather data to model how nuclear, chemical or biological weapons would disperse through a city, street by street, it says. The company says elements of a more powerful model it is planning take into account street color, building reflectivity, cloud cover, heating effect of the road surface and wind tunnel effect.



6 SUPERCOMPUTERS

Between them, Hewlett-Packard, IBM and Silicon Graphics report installing more than 300 of the world's 500 fastest supercomputers. IBM reports its Deep Thunder consists of 56 Power3 central processing units (CPUs) organized into a cluster with a high-speed network. In the future, the company says, 20 1.7 GHz Power4 CPUs and two 1.5 GHz Power4 CPUs will make up the cluster with a high-speed network. Hewlett-Packard researchers say meteorologists will eventually use decentralized, grid-computing systems to share weather models among centers and to speed forecast calculations. That is good news for utility companies, which find good data hard to come by, making it difficult to predict demand, says Greg Darnell, the fleet operations manager for Generation Energy Marketing at **Southern Co. (SO)**.