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C A S C

HIGH PERFORMANCE COMPUTING IMPROVES OUR UNDERSTANDING OF SEVERE WEATHER CONDITIONS AND GLOBAL CLIMATE CHANGE

Each year thousands of Americans are injured, die or suffer serious financial losses from catastrophic weather conditions such as lightning, flash floods, drought, wind storms, blizzards, hurricanes and tornadoes. When these phenomena occur with little or no advance warning, the loss of life, property and productivity is even more profound:

- Annually, over 6,000 fatalities on U.S. highways and 800 deaths in aviation accidents are weather related.

- Half of all airline flight delays are attributable to weather uncertainties, with wind prediction alone estimated to add over $250 million dollars to the national aviation fuel bill.

- More than half a billion dollars per year is spent preparing for predicted snowstorms that don't occur.

- The shipping industry suffers significant losses due to route changes based on inaccurate marine weather forecasts.

- Farmers sustain billions of dollars in weather-related crop losses each year.

Environmental changes stemming from human activity, such as deforestation and the use of aerosols, are resulting in confusing and often severe weather patterns. Pollution from fossil fuels, industrial waste, agricultural chemicals and auto exhaust is playing havoc with regional and global climates, causing ozone depletion, global warming and other large-scale processes that endanger water supplies, and threaten plant and animal life.

Several federal agencies support research to develop more accurate weather forecasting tools and research on regional and global change that rely on the power and speed of high performance computing. Here are a few examples:

WEATHER FORECASTING -- In 1989 the National Science Foundation's Center for Analysis and Prediction of Storms created its "Advanced Regional Prediction System," a computational model for forecasting and

tracking severe storms via high performance computing. In the Midwest floods of 1993, high performance computers were used to predict where floods would crest each day, helping to guide evacuation plans.

Since the spring of 1994 this system has been used in daily weather reporting on an experimental basis by the National Oceanic and Atmospheric Administration (NOAA).

TORNADO WARNINGS -- The National Center for Supercomputing Applications (NCSA), with the Department of Atmospheric Science, University of Illinois, Urbana-Champaign, pioneered the use of parallel processing to visualize the internal dynamics of severe thunderstorms and simulate the development of tornadoes embedded within larger storm supercells. This work has not only improved tornado prediction, but also has had worldwide impact on the adoption of scientific visualization as an important tool of computational science.

AVIATION SAFETY -- The National Center for Atmospheric Research (NCAR) has developed an early warning system using "virtual reality" to identify "micro-bursts" -- invisible weather events that threaten airplane safety. Micro-bursts cannot be detected with normal instrumentation, but air traffic controllers can capture the atmospheric circumstances that create these events as they occur and relay the information to pilots.

AIR POLLUTION CONTROL -- In 1989 applied researchers at MIT and Carnegie Mellon University developed the most comprehensive model ever available of chemical processes involved in smog formation. This has led to better tools for predicting and controlling air pollution and provided the underpinnings for state and federal air quality management plans.

For example, high performance computer-assisted modeling of the Los Angeles Basin has enabled scientists, engineers, and policy makers to reduce exposure to dangerous pollution levels by 50% in the past five years.

CLIMATIC CHANGE PREDICTION -- Scientists and researchers at the San Diego Supercomputer Center (SDSC) are using high performance computing technologies to increase understanding of climatic and atmospheric change.

"Project Sequoia," is a multi-disciplinary collaboration among scientists from SDSC, UCLA and Digital Equipment Corporation (DEC), aimed at building a technological infrastructure that supports global climate research. The goal is developing the tools to sort, manipulate, transfer, analyze and visualize an increasing volume of data needed to understand and address the processes and the problems involved in environmental change.

SDSC is also building complex numerical models to study interactions between the atmosphere and oceans, which play a key role in determining climate and weather. Such models are being used by atmospheric scientists to better understand and better predict climatic extremes -- El Niño for example.

Such research also helps policy makers to achieve appropriate regulatory balance in environmental concerns.