FactSheet

National Aeronautics and
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FIRE: Understanding Connections between Clouds and Climate

Cloud systems play a crucial role in the Earth's climate (long-term weather). Clouds impact the cooling or warming of the Earth by influencing the amount of solar radiation (energy from the sun) that reaches or leaves the Earth's surface. This interaction between solar radiation and clouds partly determines how cloud systems affect climate. But details of this complex system are not fully understood, making the study of cloud processes very important.

These uncertainties also affect the accuracy of climate models. Climate models are mathematical representations of natural processes developed to understand the behavior of and make predictions about climate. Cloud processes are important for an accurate representation of Earth's climate. More detailed information about clouds therefore will enhance climate models.

To learn more about climatically important cloud systems around the world, scientists participate in FIRE (**F**irst **I**nternational Satellite Cloud Climatiology Project **R**egional **E**xperiment). The goals of FIRE are to gain a better understanding of the radiative and physical processes of cloud systems and of the interactions between clouds and solar radiation, atmospheric moisture, and other enviornmental factors. FIRE data will also help improve climate models and satellite monitoring of clouds.

International cooperation

Atmospheric scientists, under the sponsorship of federal agencies, founded FIRE in 1984 as an international research project designed to investigate connections between clouds and climate. NASA Langley Research Center manages FIRE for the Radiation Sciences Program, Office of Earth Science, NASA Headquarters. The National Science Foundation, the Office of Naval Research, the Department of Energy, and the National Oceanic and Atmospheric Administration as well as other federal agencies are a part of FIRE. In addition, scientists from the United Kingdom Meteorological Office, the Centre de la Recherche Scientifique in France, the European Centre for Medium Range Weather Forecasting, the Institute for Marine and Atmospheric Research of the University of Utrecht in The Netherlands, and several other international organizations have participated in FIRE.

Field experiments

FIRE scientists conduct their experiments in three overlapping ways: modeling, field measurements, and analysis. Each technique is necessary for an accurate understanding of cloud systems and, by extension, climatic processes. In preparation for a field experiment, researchers examine existing models to determine what new data to collect. Field measurements are either *in situ*—taken from inside the cloud system—or sensed remotely from outside the cloud system. Radar and lidar are two of the remote sensing instruments that scientists use. (Lidar is similar to radar in operation, but lidar sends short pulses of laser light instead of radio waves to collect measurements.)

Instrument platforms, such as ground-based stations, ships, airplanes, and satellites, obtain intensive *in-situ* and remotely-sensed data on cloud systems within a research area (Fig. 1). Data can consist of information like how much of the water in a cloud is either ice or liquid and can indicate the size distribution and the composition of aerosols (airborne particles). After conducting field measurements, scientists evaluate the new data for incorporation into climate models. Analysis of this data increases the understanding of clouds and, consequently, improves the representation of clouds in climate models.

Fig. 1 FIRE Project Scientists use instruments on aircraft, like the DC-8 shown above, ships, balloons, ground stations, and buoys to sample the atmosphere. Researchers use the DC-8 for mid-altitude atmospheric sampling.

FIRE missions

Scientists conducted the first two phases of FIRE from 1984 to1989 and from 1989 to1994. These missions focused on the development, maintenance, and break up of marine stratus clouds in the eastern Pacific Ocean and on continental clouds over the central United States. FIRE III (1994-present) scientists are investigating Arctic cloud systems off the north coast of Alaska. Researchers share their results with the scientific community and the public through special sessions at national and international meetings, papers, public Web sites, and special issues of scientific journals. Information from these field experiments helps update the comprehensive data base on clouds and cloud processes.

The next major phase will be CRYSTAL (**C**irrus **R**egional **S**tudy of **T**ropical **A**nvils and **L**ayers), with research to begin in late 2001. CRYSTAL will address questions about tropical cirrus cloud systems and their roles in regional and global climates. This phase consists of two field campaigns: one in south Florida in 2002 and another in the tropical western Pacific in 2004. During 2004 there will be several satellites in orbit to provide wide-view measurements of cloud systems that will aid CRYSTAL researchers. NASA Headquarters expects to issue separate NASA Research Announcements (NRA) for each of the two campaigns. Each NRA will include modeling, field measurements, and analysis opportunities.

For more FIRE information, please contact:
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Or see the FIRE Home Page for additional information:

http://asd-www.larc.nasa.gov/fire