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For Immediate Release

Scientists Study Turbulence Over Rocky Mountains

High winds and turbulence over mountainous terrain spell trouble for aircraft, and pilots usually do everything they can to avoid flying into such conditions. But the pilots of six aircraft, ranging in size from a two-place glider to a trio of four-engine jet bombers converted into research aircraft, are going to spend the next six weeks looking for that kind of trouble. They will be flying missions over the rugged Front Range of the Colorado Rockies on days when the weather forecast calls for strong winds and violent turbulence.

The flight crews and observers who man these aircraft are participating in the 1970 Colorado Lee Wave Experiment, a cooperative effort involving about 100 scientists, engineers, technicians, and other researchers from universities, government agencies and private organizations. The project is headed by two Boulder scientists, Douglas K. Lilly, of the National Center for Atmospheric Research (NCAR), and Joachim P. Kuettner, of the Environmental Science Services Administration (ESSA). Lilly is head of the NCAR turbulent interactions group, and Kuettner is in charge of advanced research projects at the ESSA Research Laboratories. Other participating organizations include the United States Air Force, the Canadian Aeronautical Establishment, and the Lockheed Aircraft Company. NCAR's participation in the Lee Wave Experiment, like its other research programs, is supported by the National Science Foundation.

The experiment, which will run from February 10 through March 20, is designed to probe the structure of lee waves that form on the downwind side of mountain ranges such as the Rockies. These lee waves

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resemble the standing wave, or series of stationary ripples, that appears in the moving water downstream from a rock in a streambed.

Both Lilly and Kuettner believe that lee waves are responsible for clear air turbulence (CAT) that is frequently encountered by aircraft flying over the Front Range, as well as for the strong surface winds that often occur in the winter in areas along the base of the eastern slope of the mountains. Clear air turbulence, they believe, occurs at the top of the wave, while the high surface winds occur where the wave dips down to ground level.

The Boulder area, where the Continental Divide reaches its easternmost point in North America and the mountains drop abruptly down to the plains, is a natural laboratory for studying lee waves. Pilots of commercial jet airliners have long been familiar with clear air turbulence over the Front Range. And violent and unpredictable surface winds, with sustained velocities of 50 miles per hour and more, and gusts that reach well over 100 miles per hour, are a well-known winter phenomenon along the foothills and the edge of the plains.

According to Dr. Lilly, the 1970 Colorado Lee Wave Experiment has several goals. Among these are:

1. To test some theories about the conditions under which clear air turbulence is generated by air flowing over mountain topography. CAT is a problem at present jet aircraft speeds and operating levels, but it may be even more serious for the supersonic transport (SST), that is now on the drawing boards. Lee waves over the Front Range appear to cause CAT at altitudes up to the planned operating levels of the SST--70 to 80,000 feet. Wide variations in air temperature that occur in the vicinity of CAT are also expected to be a problem for supersonic jets.

2. To observe and study the destructive downslope winds that frequently occur in the Boulder area during the winter. Lilly says that "Boulder's ground level windstorms are related to upper

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2. To observe and study the destructive downslope winds that frequently occur in the Boulder area during the winter. Lilly says that "Boulder's ground level windstorms are related to upper

air phenomena. They are basically caused by the response of the entire atmosphere as it passes over the mountain range." Thus an understanding of the causes of Boulder's high winter winds, and the possibility of developing techniques for forecasting them, depend on gaining an understanding of the lee-wave conditions that apparently cause them.

3. To study the way in which the energies involved in lee waves affect the large-scale behavior of the atmosphere. Lee waves appear to play an important role in the changes that occur in large-scale weather systems as they pass through mountain regions. An understanding of this role is an important factor in developing techniques for long-range weather forecasting on a large scale.

4. To learn more about probing the atmosphere indirectly with radar. While the research aircraft are flying into lee waves to make direct measurements of their horizontal and vertical motions, ground-based radar will track fine metal chaff that has been dropped into the path of the winds blowing over the mountains. One unique radar system will apply a new technique developed by Roger Lhermitte, a physicist at the ESSA Research Laboratories. It uses a pair of doppler radars, designed and built by Lhermitte and his colleagues, which can measure the velocity of targets moving toward or away from the radar antenna. Using two doppler radars, pointed into the turbulent area at different angles, Lhermitte can build up a three-dimensional picture of the dynamic structure of the atmosphere in the target area. By participating in the Lee Wave Experiment, Lhermitte can test his radar data against the measurements made by the instruments in the aircraft. Thus he will add invaluable observational data to the experiment, and at the same time will have an opportunity to evaluate and refine his techniques of doppler radar probing.

Field program manager for the Lee Wave Experiment is Cleon Biter of the NCAR Research Aviation Facility. The six research aircraft to be used in the experiment are:

1) A de Havilland Buffalo from the NCAR Research Aviation Facility. Equipped with a highly sophisticated inertial navigation system for measuring turbulence, this twin-engine turboprop aircraft will probe horizontal and vertical motions at altitudes from 12,000 to 30,000 feet.

2) A North American Sabreliner, also supplied by NCAR. This twin-jet research aircraft will probe the structure of lee waves at 25,000 to 45,000 feet.

3) A B-57A from the ESSA Research Flight Facility in Miami, Florida. This converted jet bomber will operate interchangably with NCAR's Sabreliner at 25,000 to 45,000 feet.

4) An Explorer sailplane. This highly-instrumented Schweizer 2-32 glider, which was given to the ESSA Research Laboratories by the Explorers Research Corporation, will investigate lenticular clouds, the ovoid-shaped clouds that often form in connection with lee waves.

5) An RB-57F. This Air Force jet bomber, converted into a high-performance research aircraft for the Air Weather Service, will operate from Kirtland Air Force Base in Albuquerque, New Mexico. Equipped with special instrumentation supplied by the Canadian Aeronautical Establishment, it will measure lee-wave motions in the stratosphere at altitudes of 45,000 to 63,000 feet and even higher.

6) A B-57B. Operating from Hill Air Force Base, Utah, this Air Force jet will release fine metallized chaff for wind-field tracking by the ground-based radars.

In addition to the aircraft measurements and the ESSA doppler radar, upper-air data will be collected with an M-33 radar operated by the NCAR Field Observing Facility at a site near Boulder, and by weather balloon soundings made by NCAR and by an Air Force team stationed at Kremmling, Colorado, west of the Front Range. Ground-based anemometers, located in

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a network reaching from the Continental Divide to southeast Boulder, will provide records of surface winds.

Planning for each day's operations will start on the morning of the previous day, with a weather forecast and briefing in the Lee Wave Experiment operations center in the NCAR Mesa Laboratory. Two forecasters, Ellis Burton of ESSA's Weather Bureau office in Kansas City and F. A. Mitchell of the Lockheed Aircraft Company, will conduct these briefings. If the forecast indicates that the chances are good for lee wave conditions the next day, the scientific director, Dr. Lilly, will decide what the scientific objectives will be. An operations request will then be issued, specifying the mission of each of the aircraft and other units in the next day's operations. If the weather continues to cooperate, operations will begin in the early morning hours and will continue, under radio direction from the operations center, until the day's objectives have been met.

Like most large-scale field projects in atmospheric research, the 1970 Colorado Lee Wave Experiment is not guaranteed to provide any "breakthrough" in man's knowledge of the atmosphere, or even any quick and simple answers to the problems that it is attacking. First, the data from the airborne instruments and the radar and other atmospheric probes must be reduced and organized, which is no small task. Then the data must be subjected to intensive and rigorous analysis, from which certain patterns and conclusions should emerge. Finally, months or even years after the conclusion of the field operations phase of the 1970 Colorado Lee Wave Experiment, the results of the experiment may add a significant increment to man's knowledge of the complex behavior of the ocean of air that surrounds the planet on which we live.

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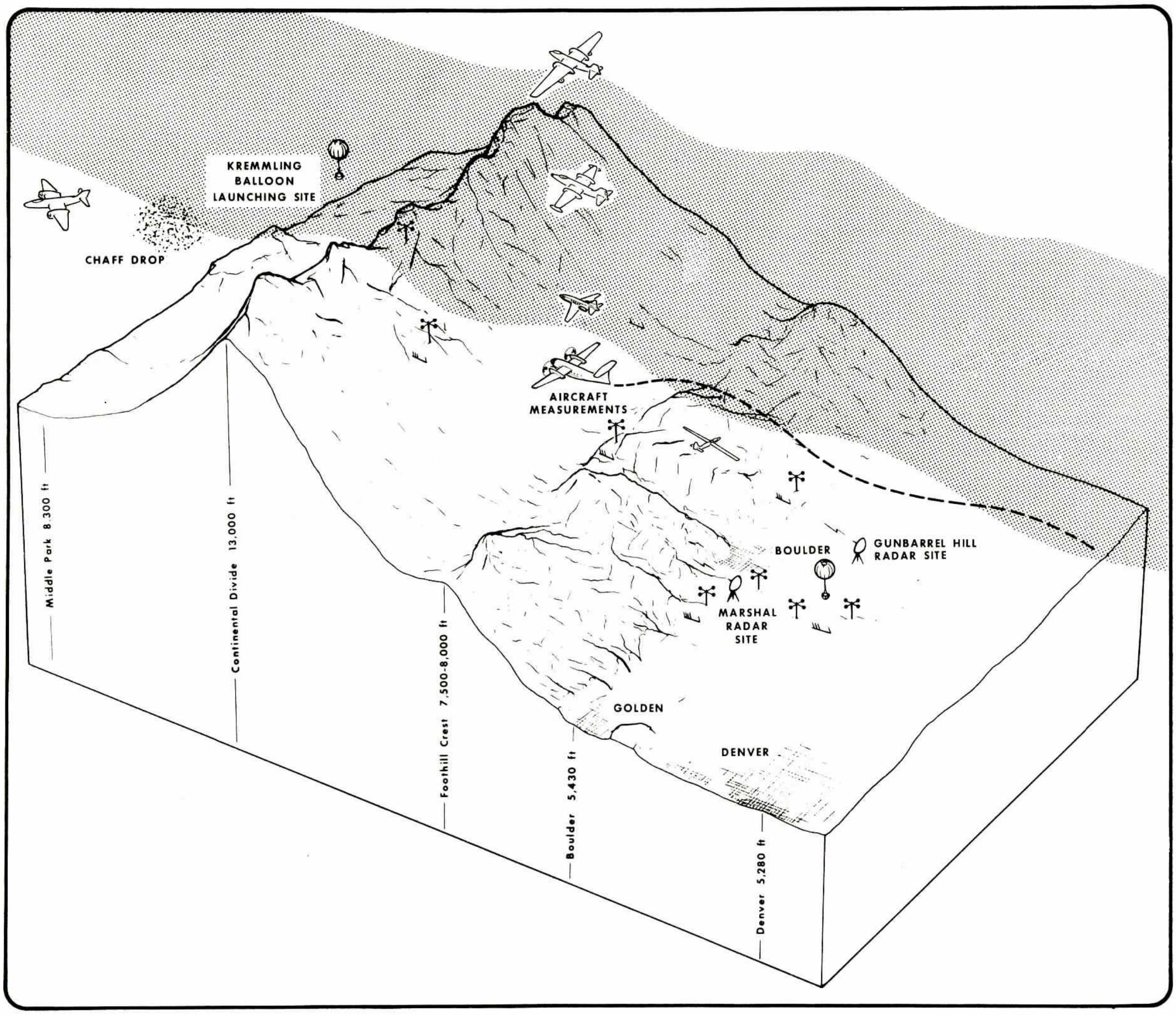

This diagram of the topographic structure of the Front Range west of Boulder shows the observing network that will be used to collect data on the structure of atmospheric motions during the 1970 Colorado Lee Wave Experiment (NCAR Drawing)