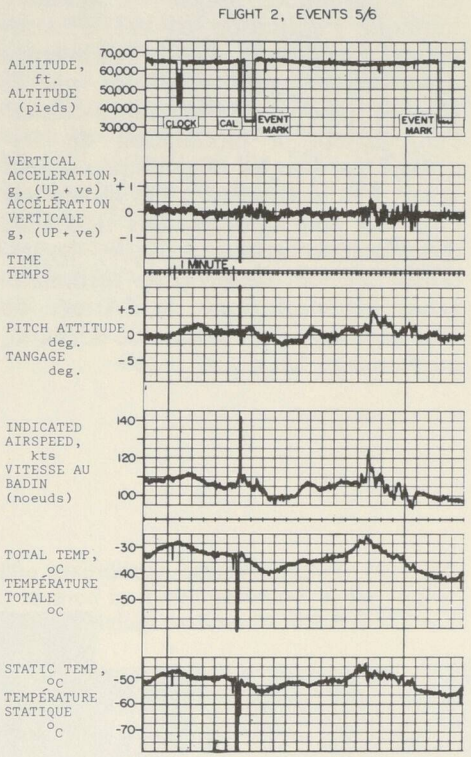
operation "coldscan"

"The aims of the project are to study each encounter with high-altitude turbulence with regard to future civil aircraft operations, to relate the nature and severity of the turbulence to geographical position and meteorological conditions, and to investigate the correlation between turbulence and temperature changes encountered by an aircraft in its flight path," according to J. E. MacPherson and K. Lum of the Flight Research Section.

The disadvantage of most airborne systems that record turbulence encountered on routine flights is that they record continuously and many hours of flight data must be scanned to reveal a single incident. The memory recorder installed on the RB-57F aircraft overcomes this disadvantage by virtue of a "memory storage" capability.

The recorder has two tapes – one in the form of a loop with a two-minute period, and the other a five-hour tape reel to make a permanent record of special incidents. As the aircraft climbs through 40,000 feet, an altitude detector automatically turns on the loop which then continuously records aircraft altitude, pitch and roll attitude, vertical acceleration, airspeed, and outside air temperature. The last three measured signals are simultaneously scanned by exceedance detectors for parameter fluctuations exceeding present levels. When an exceedance does occur, the control logics actuate the tape reels to transfer the data from the loop to the storage tape, giving a permanent record of the exceedance plus the two minutes of flight data before and after it. This occurs whenever a vertical acceleration increment exceeds 0.35g (35 per cent of the acceleration of gravity), when the rate of change of indicated airspeed is equal to or greater than five knots a second, or when the change in total temperature is equal to or greater than either 2.5 degrees Centigrade in 30 seconds or 1.25 degrees Centigrade in one second.

Every stored event or incident on the permanent record tape is identified by a coded digital clock time superimposed on one of the recorded signals. For each exceedance the aircraft's navigator logs the digital clock time along with geographical position, aircraft weight, doppler winds, and his comments on autopilot mode, severity



Results of the second Coldscan flight

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of turbulence, and local weather conditions. Completed tapes with the navigator's data logs and route maps are sent to NAE for analysis. Events with significant turbulence or large temperature changes along the flight path are selected for more detailed study, including an analysis of meteorological conditions by Graeme Morrissey, a research meteorologist with the Atmospheric Research Section, Meteorological Service of Canada.

Between January 31st and July 9th, 1969, the first 19 "Coldscan missions" were flown on routine operational and training routes over the central and western United States. The aircraft flew more than 30,000 miles during 88.5 hours of flight, 75.2 of which were above 40,000 feet.

During the cruise portions of the 19 flights, there were 26 events with recorded turbulence and 25 events with temperature changes exceeding 2.5 degrees Centigrade in 30 seconds (i.e. about ¾ °C per nautical mile). Seventy-four minutes of turbulence was encountered at altitudes above 40,000 feet, representing 1.6 per cent of the flight time at these altitudes.

Most of the turbulence and larger rates of change of temperature encountered in these winter and spring flights were the result of mountain waves, strong disturbances created when high winds blow normal to mountain ranges during certain conditions of atmospheric stability. A significant and surprising finding has been the magnitude of these disturbances in the stratosphere, even at altitudes above 60,000 feet, that is, at over five times the height of the generating mountains. One incident reveals a 22 nautical mile wave in the temperature data and a true longitudinal gust of over 80 feet per second on the indicated airspeed trace. Other encounters with mountain waves have given temperature changes of five degrees Centigrade in two-thirds of a mile at 63,000 feet, and 12 degrees Centigrade in five miles at 40,000 feet. The strongest turbulence has been found to occur usually in the troughs of the mountain waves, that is, where the measured temperature is above the local average.

In September, the instrumented RB-57F was flown from its base in Albuquerque, New Mexico, to the Flight Research Section at Uplands for instrumentation modifications, adjustments, and recalibration. While in Ottawa, two three-hour test flights were made to check the operation of the recorder and instrumentation, and to cross-check measured temperature and wind data with that recorded by the NAE T-33. After a week in Ottawa, the aircraft returned to its base in New Mexico to resume the measurement of turbulence and temperature changes encountered on its routine operational and training flights over western North America.

Mr. MacPherson says the tests to date show that the instrument package built for the "Coldscan" program is ideally suited for this type of research. □