turbulence in the surface boundary layer; turbulent fluxes of momentum, heat and moisture; radiation and surface energy balance; and temperature and humidity microstructure. A major program was carried out to investigate the interaction of the atmosphere and Lake Ontario by measuring the evaporation and heat flux from or onto the lake and the wind drag on the lake surface. A highly instrumented jet aircraft was used to extend the level of observations up to 1,000 ft and over the whole lake. The results will be useful in incorporating the lake effects into forecasting models.

Meteorological services research. A rapidly expanding program of applied research, including some more fundamental aspects where necessary, is grouped together in the Meteorological Services Research Branch in order to provide support for the expansion and improvement of forecast services of the AES.

Centralized aspects of the forecast system, carried out at the Canadian Meteorological Centre, receive support through a program of research and development in numerical-dynamical weather prediction using a very large computer to simulate atmospheric behaviour. Improvements are being made based on advances in dynamic, computational and occasionally quasi-empirical techniques. International effort in this area is being strongly influenced by the Canadian program.

Research and development to improve and automate the regional and local operations of the forecasting system is being intensively pursued. New forecasting operations are being investigated including systems for predicting air pollution potential, ice in navigable waters, forest fire hazards, avalanches and wind-waves.

Observational systems and data problems relating to improvement of the forecast system are continually being studied and evaluated. The work in this area touches on many basic questions that the Service must answer which means that a high degree of co-ordinated effort is necessary. For example, in one area, remote sensing satellite meteorology will have a very strong impact on the whole question of the quality and make-up of the atmospheric data base which, in turn, is related directly to the efficiency and effectiveness of the forecasting system.

Instrument research and development. The gathering of quantitative atmospheric data is a basic requirement for knowledge of the past and present, and prediction of the future weather. To accomplish this, instrumental measurements of the atmospheric variables are taken at 2,500 representative surface locations in Canada and the vertical structure of the atmosphere is probed to 100,000 ft at a network of 36 stations by means of rawinsonde balloon ascents. In all, approximately 50 different types of instruments and instrument systems are used in operational measurements and a number of other types in specialized investigations.

Continuing research and development is directed at improving existing measurements as well as in testing instruments to meet new needs. Some of the more noticeable areas where effort is expended are described here.

A family of automatic weather stations designed for great flexibility of application has been developed. These stations are now being used in a network of teletype reporting stations, in mountain stations for use in hydrological measurements, for reporting coastal winds by radio and on an experiment as recording stations for remote operation in the deep Arctic. The Earth Resources Technology satellite (ERTS) is also being used experimentally as a communication channel for one of these stations.

The development of ancillary processing equipment for use with weather radar is well advanced. The equipment under test involves a system controlled by a mini-computer which accepts the input from a C-Band weather radar. This radar is programmed to scan a horizontal volume of air of approximately 10,000 sq miles in area centred on the station to a depth of 30,000 ft above the surface. The computer sorts out the returns from the radar and issues a quantitative cross-sectional map of precipitation intensity of four levels from 5,000 to 30,000 ft superimposed on an area map. This information may be transmitted in approximately real time by telephone circuits for the information of a variety of users such as weather forecasters, hydrologists, etc.

Experimental prototypes of an acoustic radar have been successfully tested and further development toward operational equipment is started. This equipment, termed SODAR, transmits a pulse of acoustic energy upward and the sonic back-scatter from small temperature irregularities in the atmosphere is detected and graphically depicted. The ultimate use which is visualized for this equipment is to provide a continuous indication of the stability structure of