RESEARCH IN ATMOSPHERIC FLOW

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This field, which is that of aerology, is of utmost importance to the safety of air transportation.

With the exception of a few measurements made with kites, sounding balloons, and free balloons, it is entirely the result of numerous soaring flights that the laws of air mass movement over natural obstacles, such as mountains, were established.

By knowing the forward speed of the glider as well as its sinking speed, one can determine with a sufficient degree of accuracy the vertical components of the air flow around a terrestrial contour. Whether for the purpose of soaring flights or the safety and economy of aerial transport, it is important to know the zones of downdrafts. Definition and measurement of their downward velocity is of special importance to the safety of flight. A number of accidents entirely caused by the pilot's ignorance of fundamentals of aerology can easily be cited as examples. Today a pilot will not venture on a long cross country flight without requesting a complete meteorological coverage of the route. Nevertheless, much too often, he will make local flights without bothering about meteorological conditions.

Research concerning free air flow is of even greater importance. This deals with the flow influenced by the heating and cooling of the atmosphere, otherwise vertical thermal movements.

Our knowledge of it is the result of the latest and most important meteorological research, conducted in the last twenty years, and its development is completely parallel with the development of soaring flight.

The measurements of vertical velocities of 10 to 30 m/s in the cumulo-nimbus clouds did not only help the sport of soaring in the attainment of high altitude performances, but are also the basis for calculating gust loads of aircraft.

Hydrodynamic and aerodynamic research in atmospheric flow was too long neglected due to lack of means for measurement. The sailplane has provided these.

For example, the well-known phenomenon of standing waves, which generally form behind obstacles in a hydrodynamic canal, was not discovered until recently in the atmosphere. Soaring flight brought it to light.

Wave soaring finds its origin in waves which form as a rule in the air flow in the presence of an obstacle. These waves can, under certain conditions, become stationary in relationship to the obstacle, and it is this that explains the considerable amplitude which they then attain.

In an incompressible medium, these waves have been known a long time, having been studied in hydrodynamics. According to theory, the waves are produced on the upper surface of an isolated fluid, or on the surface of internal separation of several fluids resulting from the collision of the bottom wave with an obstacle, the impulse of which propagates in height. These bottom waves have a velocity of propagation which depends on the length of the wave. When the velocity of the flow approximates the velocity of propagation, the wave becomes stationary in relationship to the obstacle. The amplitude of the forced wave grows progressively due to the impetus which is continually furnished to it, and attains a value much greater than the height of the generating obstacle. Waves of considerable magnitude, therefore, can be produced without the application of external energy inasmuch as energy is derived from the flow itself, and the impulsive force of the obstacle. In a compressible medium, such as air in motion, these waves are produced in the same manner as in an incompressible one; the ability to compress and expand does not introduce important changes. Beginning with the fundamental relationship of hydro and thermo-dynamics, G. Lyra (ZAMM, March 1943) established the equation for waves in stable air and traced the theoretical field of lift.

Observations confirm this general theory of atmospheric waves. Nevertheless, there still remain many questions to be answered.

During "foehn" weather (dry hot winds below mountain winds) stationary foehn waves, often used for soaring flights, occur regularly. These waves are frequently marked by lenticular clouds at approximately 8,000 to 13,000 meters of altitude. At the time of Klockner's flight these clouds extended up to 14,000 meters.

However, the wave movement must extend even higher than that. Certain types of clouds (nacreous clouds), the height of which is estimated to be 20 to 30 km, and which are observed only in the undulatory flow of the foehn, must be related to the ascendance of the wave. This proves that foehn waves extend to altitudes of 20,000 meters or more.

Wave soaring flight will not be limited to mountainous regions alone, because the ground acts only as a releasing agent of the basic wave. Other waves can be produced on flat terrain by disturbing the air flow. Such an originating agent can be, for example, the difference in surface roughness between the ocean and the continent. Such waves were already observed several times in Paris, particularly on March 13, 1947; the proximity of the sea especially favors this condition. A thunderstorm front could also play this role. However, the study and practical application of these waves is still in the future.

A sailplane having a sinking speed of 2 meters per second at an altitude of 15-16 km and a forward speed of 100 km/h could, without much difficulty, reach an altitude of 15 km in the foehn waves of the Alps (and undoubtedly even higher). It is possible that wave flights from plains could be made to altitudes of 8-10 km. or even higher. In the absence of actual flights

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