IMPROVING THERMAL SOARING FLIGHT TECHNIQUES

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Introduction

Locating and utilizing thermals are obviously vital factors in efficient soaring, and yet it seems that rather little attention is being paid to the subject. When one considers the tremendous investment in time and money throughout the world devoted to improving the breed of sailplanes it does seem odd that much greater effective performance benefits obtainable through improving flight techniques are neglected. Perhaps it is really not surprising, for aerodynamics and structures constitute scientific fields in which accurate calculations can be made, while the subject of "thermals" is a vague thing based at present on incomplete physical understanding and is a field in which accurate equations cannot apply to a specific case.

Finding and using thermals in an efficient manner can be thought of as involving a system approach based on (1) knowledge of the characteristics of thermals, (2) developments in instrumentation, and (3) intelligent use of the knowledge and equipment. This article investigates these factors in hopes that it may help stimulate some enthusiasts to help develop this field in a logical fashion. Various of these techniques can easily and inexpensively be utilized by, and improved by, the average sailplane pilot.

Thermal Factors

General — In brief, the thermals can be considered simply as rising volumes of air which carry aloft some air from near the ground while mixing somewhat with the environment. Thus a thermal has value to a sailplane because it represents a vertical velocity; for locating and using it, one can consider this vertical velocity, the factors causing it, plus other characteristics of air flow and symptoms of its origin near the ground. All these items must be considered in their relation to the surrounding environment and in their variations in the thermal throughout time and space. Obviously there are too many variables and interrelationships to permit detailed investigations, but some features stand out.

Many of the points to consider stem from the fact that the initial roots of the thermal core are near the ground where the source of heat lies. There the thermal acquires characteristics associated with the ground air — higher temperatures, and more water vapor, space charge dust, turbulence, etc. Later on and higher up, that air parcel, although getting somewhat mixed with the environment, will be distinguishable from the environment because the environment does not have those items in the same concentrations.

ABOUT THE AUTHOR

Paul MacCready, Jr., is eminently qualified to discourse on the subject of this paper. He was U. S. Soaring Champion three times, in 1948, 1949 and 1953, and World Soaring Champion in 1956, for which the F.A.I. awarded him the Lilienthal Medal. In the last five years he has done only occasional soaring but retains his interest and finds that everything he learned in soaring aids him in the various meterological research projects with which he is involved. He is president of his own company, Meterology Research, Inc., which performs basic studies in atmospheric physics (particularly cloud physics), weather control, turbulence and diffusion. These are primarily government-sponsored programs but the company also develops and manufactures various types of instruments for meterological purposes.

Paul is 36 and holds three degrees: a Bachelor's in physics from Yale, a Master's in physics from Cal. Tech., and a Ph.D. in aeronautics from Cal. Tech. in 1952. He is married to the former Judy Leonard and has one son, Parker, named for his grandfather, a former president of SSA.

Some of his numerous papers on thermals and soaring instruments are referenced at the end of this paper.

Buoyancy Factors — Temperature and Water Vapor.

(a) The buoyancy which powers the thermal depends both on the temperature and water vapor content, at all elevations; therefore measurements of temperature plus measurements or assumptions about water vapor can give information on buoyancy and on the future actions of the thermal.

(b) Near the ground the temperature excess is large, and the water vapor excess generally small. High up in the thermal, the water vapor excess often becomes large relative to the drier air outside the thermal, and the temperature excess may be small (or even reversed). These characteristics have direct bearing on the use of thermal detector devices.

(c) The air temperature in the root layer is closely related to ground temperatures — so predictions of ground temperature as it varies with ground cover, cloud shadow and topography and actual measurements of ground temperature will aid thermal seeking.

Flow Factors — Vertical Velocity; Lateral Velocity; Turbulence.

(a) Vertical velocity constitutes the payoff for the glider pilot and so is the most important thermal factor and warrants the best possible instrumentation.

(b) Lateral velocity of inflow can help locate the thermal, especially the inflow in the root region. Knowledge of rotational velocity and lateral velocity within the thermal may assist the pilot in finding the optimum spiral.

(c) Near the ground there is a lot of energy in small size turbulent eddies, so this turbulence could be deemed a thermal symptom. The situation is complicated because this initial turbulence decays and simultaneously turbulence develops from the thermal motions. Turbulence therefore may be of little value for locating thermals, but the way it affects other factors should be understood.

Root Symptom Factors — Dust; Foreign Bodies; Smells; Ions and Space Charge; Conductivity; Condensation Nuclei.

(a) Since the source of many vapors and particles is at the ground the thermal core can contain higher