concentrations of these items than does the environmental air.

(b) Space charge can be detected from a distance; the other items are only measured at the sensor.

(c) Space charge, conductivity, nuclei, and chemical constituants can vary in time due to other factors than dilution with environmental air, which complicates their use as "identifiers."

Forecasting without Measurements

Consideration of topography, wind direction, stability and the whole synoptic weather situation and forecast can give clues as to the specific areas where thermals are most likely. This subject, which is beyond the scope of this article, is touched on in many articles in sailplane publications, for example References 1, 2, 3 and 4. In general, in non-flat land the high elevations provide earlier and higher thermals. Good source regions tend to produce upcurrents regularly — so a good spot to try is one where clouds have shown thermals earlier or experience has shown thermals on similar previous days.

Because of the regular production of thermals by good source retions, and because of the tendency for upcurrents to line up along the wind when there is a pronounced wind shear, it is often best to hunt for thermals straight upwind or downwind from where you are already using one.

Forecasting with Measurements

Since the primary cause of thermals is the heating of air as it blows over the ground, exact knowledge of the surface temperature will help immeasurably in the locating of thermals. The temperature depends on the past history of radiation at that point, reflectivity, evaporation, heat conductivity, specific heat, and surface structure — so trying to guess at the temperature variations is usually impractical. However, the recent developments in infrared radiation equipment imply that a radiometer may be worth considering. Portable equipment is available to measure temperature remotely, but at present costs more than a sailplane. Using wavelengths in which the radiation from the air itself causes no problem, the instrument reads essentially temperature of the ground (or cloud) at which it points (say with a 2° beamwidth). For sailplane use, relative temperatures, are adequate, which can greatly simplify the apparatus. The instrument would be pointed ahead and down; it could be programmed to sweep laterally or longitudinally, or could be rigid in the sailplane and the sailplane maneuvered as required.

The Standard Austria sailplane, winner of the OSTIV Prize in 1960 and now being manufactured in West Germany by Schempp-Hirth OHG. Of all-wood construction, it features a multi-stringered lamiar wing and has an L/D of 34 to 1.

With absolute accuracy, and with prior knowledge of the temperature lapse rate of their mass, the ground temperature unit can even show whether or not any thermals would be expected over a broad region. Relative measurements would permit determining the most likely local source region.

This subject of infrared measurements is reviewed in the Proceedings of the IRE, September, 1959. Reference 5 describes a portable instrument and various maufacturers, such as Barnes Engineering and Servo Corp. of America have developments along this line.

Locating Thermals from a Distance

Ascertaining the definitive existence of an upcurrent while still a distance away from it requires a measurement based on radiant energy field of some type. Passive measurements would be (1) visible light; the appearance of a cloud after it has formed or optical effects associated with the nuclei or contaminants in the rising air, (2) radiation in the infrared spectrum, from air which has a different temperature, water vapor, carbon dioxide, or ozone content, (3) acoustic radiation, or (4) the electrostatic field due to electric charge in the thermal. A non-passive measurement would be by radar where the energy source is at the sailplane — the echo would come from the radio refractive index fluctuation due to turbulent mixing in the presence of a gradient of water vapor. The radar and infrared techniques may offer real promise, but are beyond the scope of the average sailplane enthusiast to pursue and so will not be considered here. Infrared equipment for finding ground temperatures is more simple and practical. Acoustic methods do not appear operationally fruitful.

The visual use of cumulus clouds as thermal indicators is the main thermal locating technique. The cloud simply marks the top of a thermal. The detailed appearance of the cloud gives clues as to the upcurrent characteristics; large size, firm edges, and a dark, well-defined base usually mean a strong thermal. The most accurate way of getting thermal information from cloud appearance is to watch the shape and size change over a period of a few minutes.

When no cloud is visible, there may still be other things which show visually that a thermal is present. Sometimes condensation nuclei will become visible in an "almost cloud," when a true cloud does not quite form but the air does show a foglike character. Soaring birds or other sailplanes can mark a thermal. Dust and foreign objects swept up from the ground can also make it visible. A dust devil is an extreme example. Certain shades of dark glasses or polaroid glasses can apparently make "dusty" thermals more readily observable (and distant cumulus clouds too).

Even in fair weather there tends to be a weak net positive charge in the air near the ground (residing on ions collected on condensation nuclei. Thus a thermal may have a charge in it, of between 1 and 1000 elementary charges per cubic centimeter. By conductivity about half of the charge will leak away in 20 minutes, near sea level (in just a few minutes at 3000 meters), so the charges from "old" thermals slowly disappear and only new thermals are charged. Theoretically, at least, this charge should