THERMALS AT CENTRAL ANATOLIA

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Summary

By employing the measurements obtained during the flight of a glider which is well equipped with meteorological sensors, some information was obtained about the lower troposphere and in particular about the atmospheric boundary layer which may be extended up to 1500 meters due to thermal instability. Since these measurements were obtained in clear sky as well as in thermals and in the vicinity of clouds, it was possible to investigate the vertical and horizontal components of air velocity, relative humidity and temperature corrected for space and temporal variations. The influence of the development of convection have also been evaluated. The computed height profiles of the mixing ratio and the vertical component for the air velocity have shown a marked similarity. In addition, since it is essential to find thermals in the air in order for gliders to be soared a knowledge of the temporal variation of relative humidity can be used as a thermal indicator.

1. Introduction

This research, which was begun in June 1983, includes only the test measurements and first results. The purpose of this study is to improve the measurement techniques, to investigate the correlation between the vertical air velocity and specific humidity and to identify the thermal segments. Thermals transport heat, momentum, moisture and turbulent energy from near the surface up into the overlying mixed layer as they rise (5, 6).

2. Description of the experiment

The measurements were made during four glider flights. The first two flights were made August 4, 1983, when warm air was existing at 850 mb level (**Figure 1(a)**).

The mean horizontal velocity was slight and occasionally moderate from southwest. The last two flights were made in cooler air in August 25, 1983 (**Figure 1(b)**). The mean velocity was moderate from north in the morning and from northwest in the afternoon.

During the first flight, a few fair weather cumulus with bases at 4000 feet were observed. These clouds became broken during the afternoon because of stable stratification.

Two pilot balloon observations were also made for comparison with corrected wind velocity (**Figure 3**).

3. Defining a thermal

To define a thermal segment some meteorological parameters have to be measured in thermals and some in the environment (1,2,3). Thermals were identified by requiring that humidity be equal to or greater than a threshold value (4). The thermal threshold criteria were chosen as one quarter of the standard deviations of specific humidity, relative humidity and potential temperature of temporal variations (**Figure 4**).

Standard deviation of specific humidity was calculated from two different sections whose flight paths are 27 km and 36.6 km long, the flight altitudes being 1140 m and 2100 m (above mean sea level). Figure 4 shows that relative humidity is the best indicator of thermals.

If we choose a threshold value of $\sigma RH/4$, data points be-

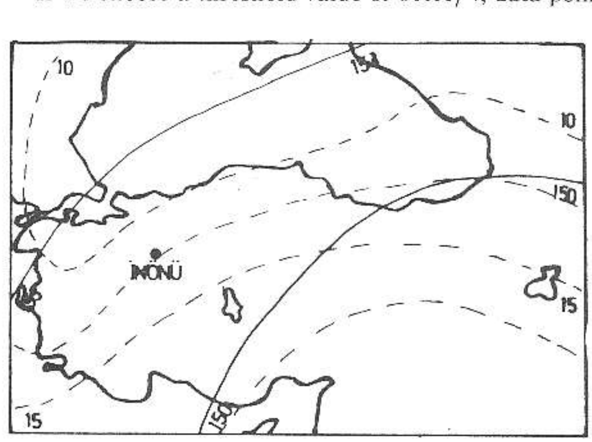

Figure 1(a). 850 mb level August 25, 1983, 0000 GMT.

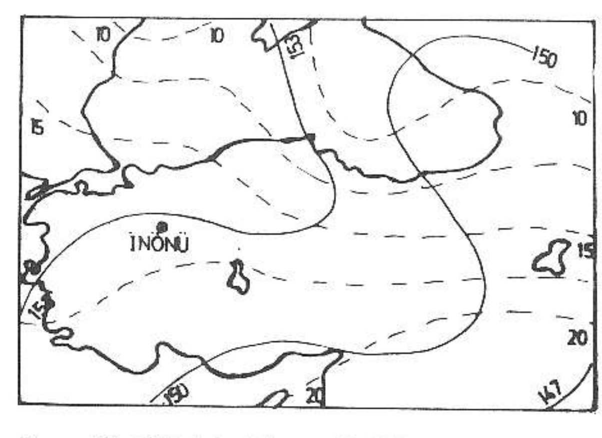

Figure 1(b). 850 mb level August 25, 1983, 1200 GMT.

tween 13 and 17 are thermal segments. According to the threshold value of RH, data points between 12 and 19 are thermal segments. By using $0{,}5\sigma q$ as the threshold value of humidity, some sections may have been incorrectly classified as thermal (**Figures 5 and 6**). Similarly, in other sections of the time series thermals were probably classified as non-thermals because of large scale variations.

Indeed for classifying the time series into thermal and non-thermal section it is necessary to have at least one data point for every 25 metres according to Lenschow (4). We did not have the new data recording system, and we could only record nine parameters every 350 metres. Estimation of the thermal characteristics may be possible by analyzing data on thermals. We observed thermals between 500 and 1000 metres during the third and fourth flights (Figure 4). Indeed the edge effects of thermals are important; the entrainment causes decrease of humidity. For this reason we can estimate the smaller thermal, and the segment which is passed can be in the middle or the edge of the thermal.

4. Observational results

The parameters were taken over the low-lying Inonu Region during four glider flights(1). Hills have altitudes of 260

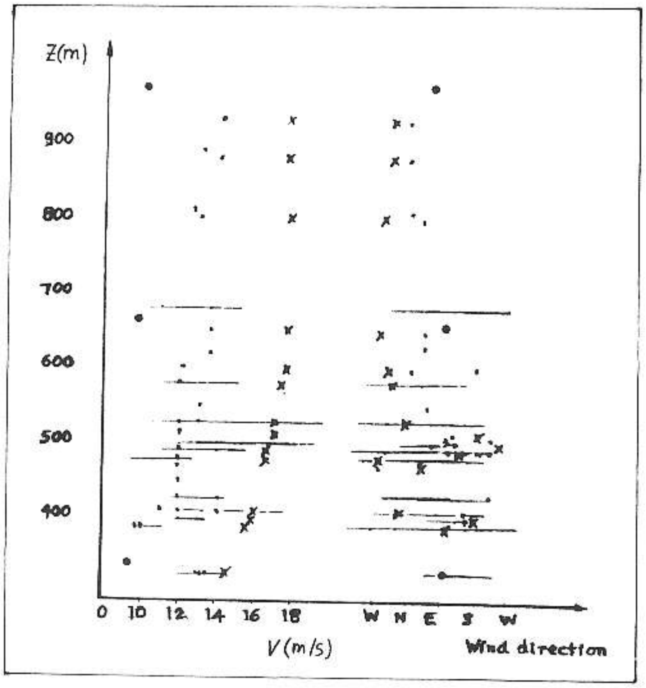

Figure 3. The variation with altitude of horizontal air velocity, August 25, 1983, 11:42–12:07 a.m.
. = according to measurements
x = according to Ekman Spiral
• = according to pilot baloon observation.

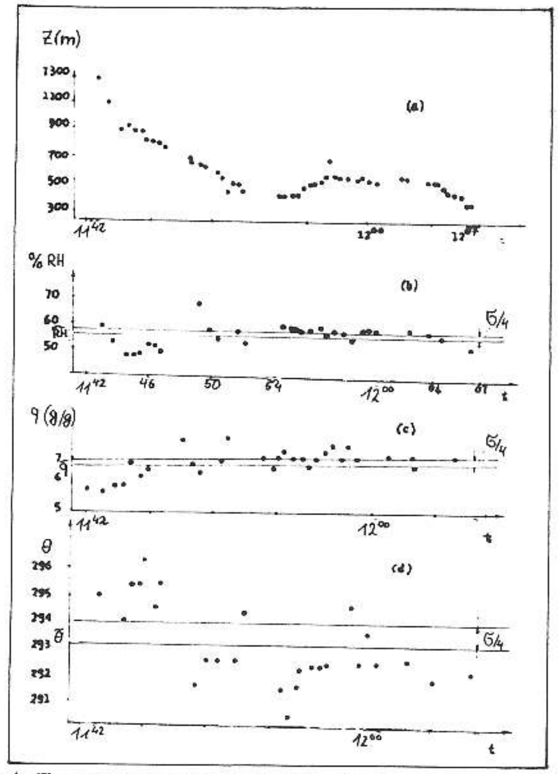

Figure 4. Temporal variations of flight altitude, relative humidity, specific humidity and potential temperature. August 25, 1983.

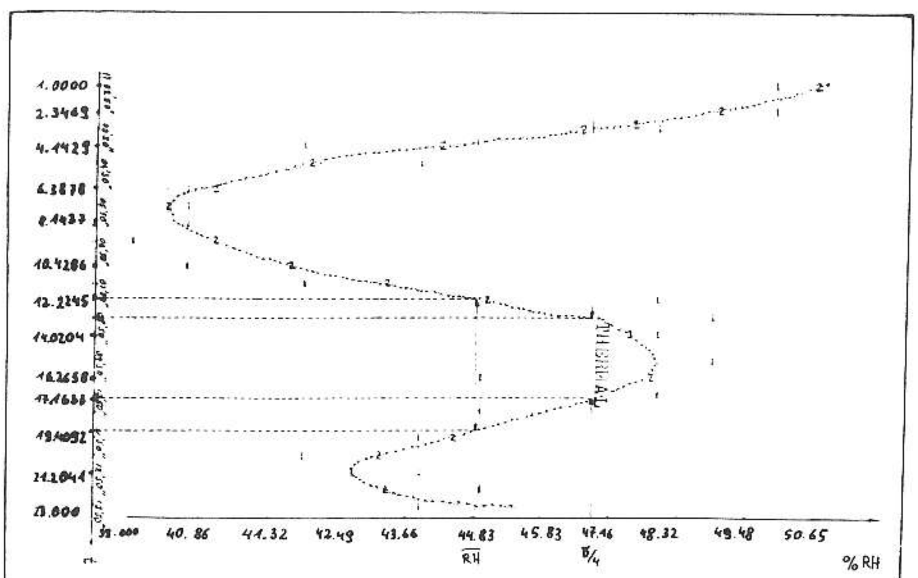

Figure 5. Temporal variation of relative humidity; August 25, 1983.
(1) data recorded, (2) 7th degree polynom.

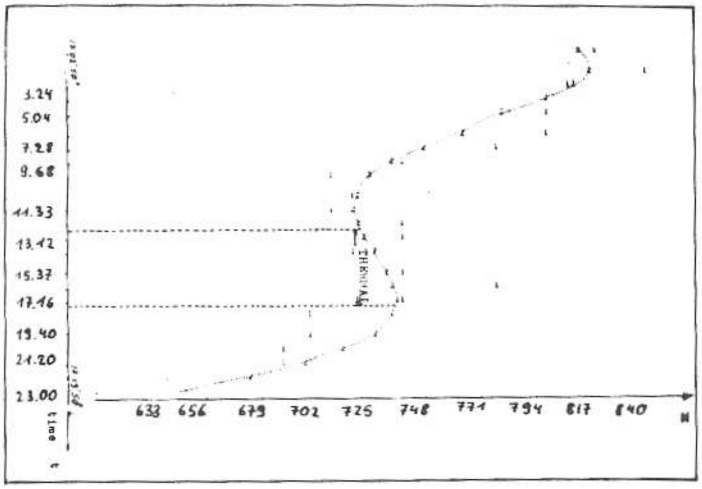

Figure 6. Temporal varation of flight altitude; August 25, 1983 (4th flight). (1) data recorded, (2) 7th degree polynom.

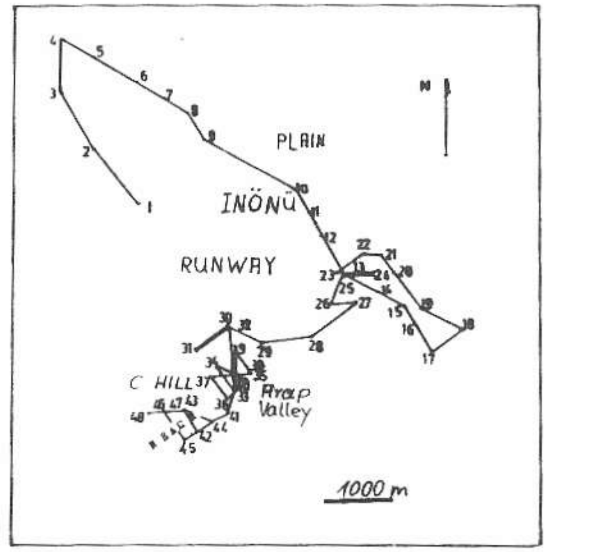

Figure 2. Flight path, August 25, 1983.

and 1000 metres (above mean sea level). They lie from northeast and southeast and become a barrier for air flow. When the flow is perpendicular to the hills (when it is from northwest), the slope updraft is good for soaring. If we consider the dominant wind direction during the active period of the Air Club at Inonu (between April and October), according to the statistical results of 41 years, this region is very good for slope updraft as much as thermal updraft. During the third flight, measurements were taken in both parallel flights to hills (northeaster to southwester) and perpendicular flights to hills (wester) between 340 and 1300 metres. We began to record the measurements at 11.42 a. The data points between 1 and 27 were over Inonu Plain, between 29 and 41 were over Arap Valley and between 28 and 48 were over the hills (Figure 2). During the third flight, potential temperature lapse-rates at the point of 19th and 32nd and 39th are given in Table 1.

We observed the hill and valley potential temperature difference to be 0,52°C/100m. **Figure 7** shows the vertical variations of temperature, relative humidity, vertical air velocity, mixing ratio, pressure and density.

The data refer to parallel or traverse flights over the north side of the hills. After the sun rose convection activity developed. At first horizontal visibility was 6 or 8 km, but then it increased to 10 km. Relative humidity of air over the hills changed between 48% and 68%. After 1 p.m., clouds were broken and no clouds were observed after 2 p.m.

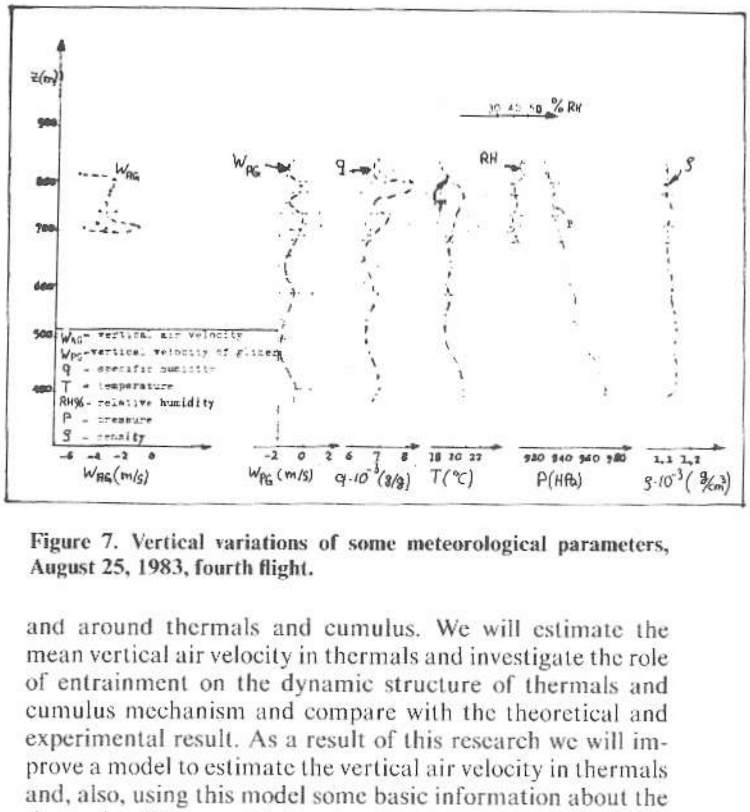

Figure 7. Vertical variations of some meteorological parameters, August 25, 1983, fourth flight.

5. Results

In this study, it was concluded that we can prefer relative humidity time series as an indicator of thermals. According to our results, the variations of the mixing ratio and vertical air velocity with altitude are also very similar.

We planned to take more data with greater accuracy in and around thermals and cumulus. We will estimate the mean vertical air velocity in thermals and investigate the role of entrainment on the dynamic structure of thermals and cumulus mechanism and compare with the theoretical and experimental result. As a result of this research we will improve a model to estimate the vertical air velocity in thermals and, also, using this model some basic information about the thermals will be provided to the Glider School.

Table 1. Potential temperature lapse rates for different data points (third flight).

data point	flight altitude (metre)	potential temperature (C°)	lapse-rate (°C/100m)
19 (Inönö Plain)	490	294.5	0.47
32 (Arap Valley)	540	294.7	0.46
39 (Hill)	510	291.9	-0.06

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