

An Extensive Wave System above a Convective Layer

A routine thermal soaring flight evolved into an unusual wave flight. The waves lay over a rather deep convective layer, above terrain unlikely to produce lee waves. Little change in wind direction with height was present between convective and laminar flow layers, and the waves apparently extended above 500 mb. They were easy to find and use once the transition from thermals to wave had been made. The pilot's description is supplemented by meteorological data.

J. M. Firth

Soaring Association of Canada

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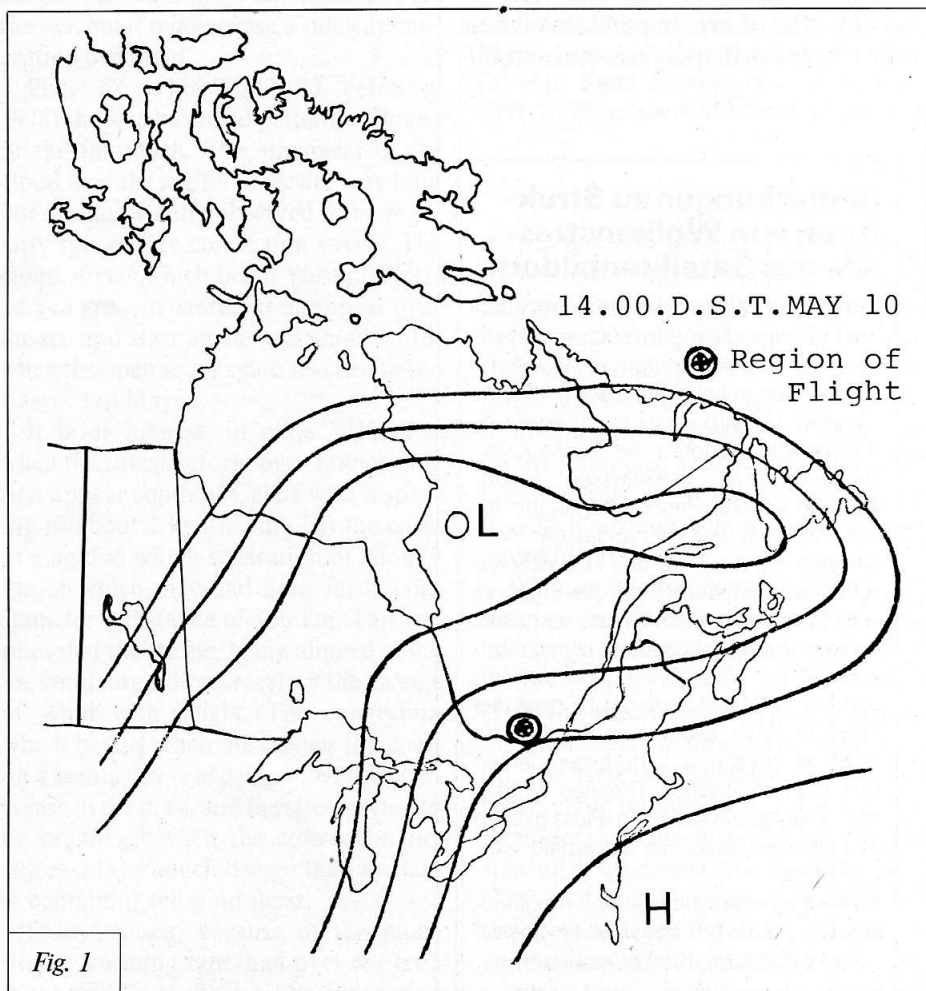
May 10th, 1980 promised to be a typical good Spring soaring day in Eastern Canada. Early morning cumulus with base about 1500 m in a moderate westerly wind, matured by midday into extensive cloud streets with lift of 2 to 3 m/s. A sortie upwind appeared to be a straightforward proposition, and proved so, until at 1500 EST, 140 km away, the streets broke up. The clouds reorganised across wind and began to suggest wave activity. After two failures to connect with thermals under good looking clouds, I reassessed the situation and searched further upwind, and was relieved to hit good lift at 500 m, which carried me back to cloud base. Now convinced that there was an overlying wave system, I moved slowly north across wind in zero sink, looking for a connection into the waves. Though there were large areas of smooth, but very weak lift, none persisted long enough for a climb above 2200 m. To the N.W., solid overcast suggested increasing humidity; at Deep River, 50 km upwind, the local club did little soaring that day.

Using lines of zero sink, I was able to move N. of the local airway in anticipation of success. To the East, the cloud rolls had the characteristic smooth lenti-

cular appearance, so I set off towards them, and sampled two lines without success, although at this stage, I was well below cloud base. Finally a 2 m/s thermal lifted me to the base of the cloud, weakening as it rose into the centre of the next roll cloud. A move upwind in zero sink produced a slow climb; 0.2 m/s then 0.5 and 1 m/s carried me slowly up through the wave window above cloud tops at 3500 m, while drifting to the East.

"By now, well over an hour had gone by, and the increasing moisture was causing complete cloud cover, so I set off north along the wave till it weakened, and then turned downwind, finding open windows again, as expected, with successive waves easy to locate and use.

This was a totally unexpected and novel situation; a sea of waves extended north and south as far as could be seen from 5000 m, which was as high as I wanted to go, being dressed only for thermal flying. To the S.W., far away, a much higher solitary lenticular showed wave persisting possibly as high as 8000 m. Wave-length estimated by flying downwind at 60 kts adding 20 kts (10 m/s) for wind, gave about 8 km spacing. The next two hours were spent confirming the widespread usability of the wave system. Best lift found was over 2 m/s at 4000 m, and was still over 1 m/s at 5000 m. As I descended, while moving towards home, speeds up to 100 kts could be used without loss of height. The edge of the cloud marked waves was now at Carleton Place, about 70 km downwind of first encounter, and weak waves persisted for several wavelengths in clear air below 3000 m. At the club site, thermal soaring had ceased an hour earlier."



Ein extensives Wellensystem über einer konvektiven Schicht

(Zusammenfassung)

Ein thermischer Routine-Segelflug entwickelte sich zu einem unüblichen Wellenflug. Die Wellen lagen über einer ziemlich dicken konvektiven Schicht und über einem Gelände, über dem das Auftreten von Lee-Wellen unwahrscheinlich war. Es gab nur eine geringe Änderung der Windrichtung mit der Höhe zwischen den Schichten mit konvektiver und laminarer Strömung. Die Wellen breiteten sich sichtbar oberhalb 500 mb aus. Sie waren leicht zu finden, und um sie zu benutzen, würde einmal der Übergang von der thermischen Schicht zu den Wellen durchgeführt. Die Beschreibung des Piloten ist mit meteorologischen Daten vervollständigt worden.

Discussion

Synoptic Situation, Figure 1. The flight took place in a situation well known for the occurrence of waves; a complex low centred 1000 km to the N. was complemented by a high over the E. coast of the U.S.A. Though low level winds were moderate, winds above 600 mb increased steadily, while the wind direction through out the major layer varied only from 270 to 290 degrees. Hence the synoptic situation favoured formation of high level waves, though there was no strongly stable layer overlying the convection, which in any case, was unusually deep for a lee wave situation. The wave system extended perhaps 150 km from N. to S., and was not stationary over the ground. This alone seemed to suggest that the wave system was not of topographic origin; wooded hills rise to 500 m in places, but no isolated ridges exist in a suitable orientation.

On several occasions I have encountered thermal wave overlying a well established cloud street, but in those cases the upper wind was at a large angle to the streets. Here there was little change in direction with height.

Well defined cloud streets existed before the wave system was encountered, but were nearly parallel to the upper

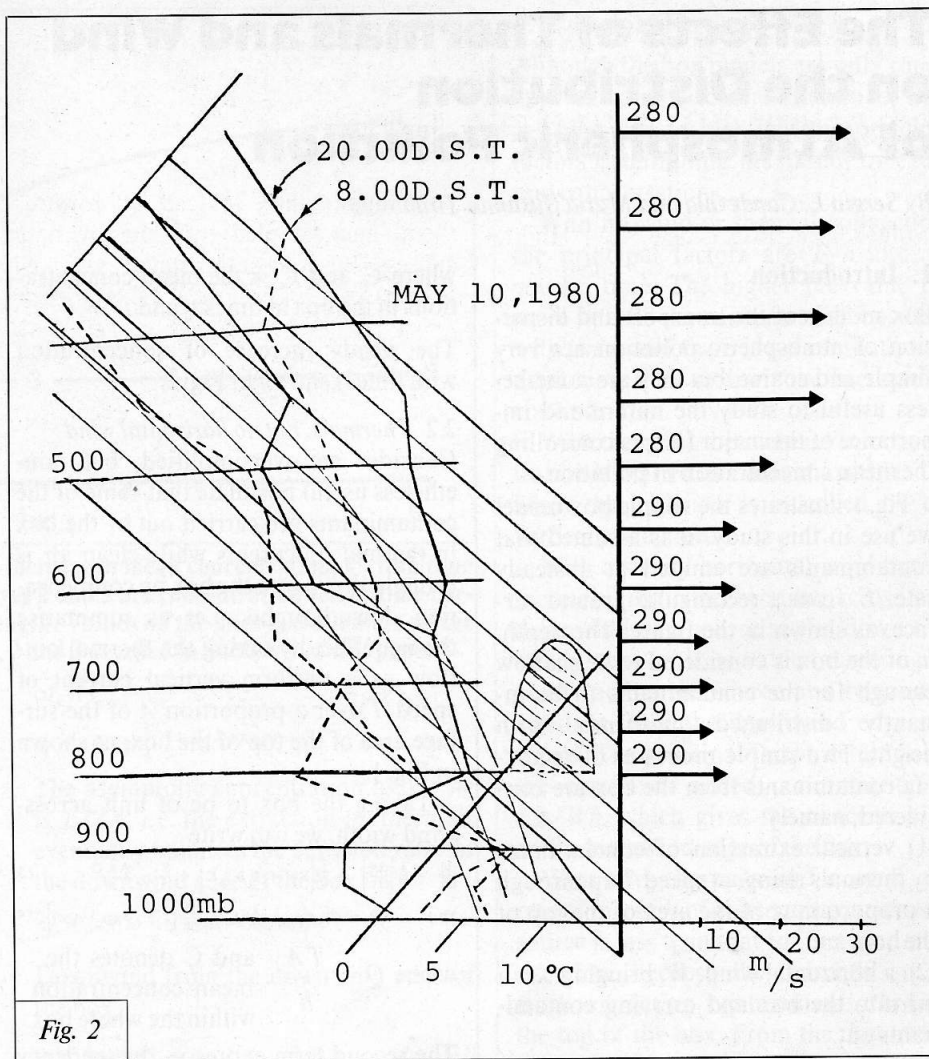


Fig. 2

winds, and broke up during the transition into the wave system. The high level lenticular suggests that the waves persisted, well above 500 mb in some locations, and possibly up to the tropopause. Climb rates and wavelengths were used to compute an amplitude of 300 m; this however, according to the data from the 20.00 D.S.T. Maniwaki radio-sonde, 50 km East (Fig. 2), was insufficient to cause condensation above 4000 m. However, rapidly increasing humidity injected by the low to the N. may not have shown on the radio-sonde.

The wave system was easily usable above 3000 m, but the transition from convective to wave lift was difficult. Reliable prediction of this situation could allow record breaking flights. The 20.00 EDT tephigram shows an unusually large depth of SALR, though the layer is apparently slightly stable, and this sug-

gests that the readings taken in this layer were made in the peak of one of the waves. Perhaps this deep but stable SALR layer is a clue to the development of the deep, persistent and extensive wave system.

Calculated wavelength at 4000 m, from the standard formula,

$$\lambda = 2\pi U \frac{T}{g(9T/9h - \Gamma)}$$

gives approximately 10 km. This is in reasonable agreement with the observed wavelength of 8 km.

References

- Jaekisch, Synoptic Conditions for Formation of Waves above Convective Streets. OSTIV Publication XII.
- Lindemann, Thermal Waves. OSTIV Publication XII.
- Wallington, Prediction of Lee Wave Factors. OSTIV Publication XV.