

The Soaring Climatology: A Meteorological Aid to Pilots and Forecasters

By Peter F. Lester, Environmental Sciences Centre (Kananaskis), The University of Calgary, Calgary, Alberta, Canada

Submitted to the 15th OSTIV Conference, Räyskälä, Finland (1976)

Abstract

A "soaring" climatology is defined as the documentation of the average and extreme soaring conditions for a given soaring area. Procedures for the compilation and presentation of the soaring climatology are given, as well as examples for three widely separated areas: Pincher Creek, Alberta; Oahu, Hawaii, and San Francisco, California. It is recommended that gliding clubs make an effort to produce local soaring climatologies as aids in pilot training, forecasting and contest planning.

1. Introduction

A soaring climatology is defined as the documentation of the average and extreme soaring conditions for a given soaring area. Its purpose is to aid forecasters in the preparation of gliding forecasts, to aid pilots in the practical application of their meteorological knowledge to the local area, to help instructors in the teaching of soaring techniques for different weather conditions, and finally, to facilitate contest planning. In the present paper, the contents of the soaring climatology are detailed, data sources are described and three examples are given.

2. Contents of the Soaring Climatology and Data Sources

A suggested table of contents for the soaring climatology is presented in table 1. Items 1 and 2 in that table are brief narratives which can be prepared from general climatic summaries and aviation climatologies with the aid of a suitable topographic map. Since the narratives are slanted towards gliding, it has been found that the separation of

Table 1
Recommended Outline for a Soaring Climatology

1. Regional and local climatology
2. Description of local terrain
3. Climatology of lift-producing phenomena
 - a. type of lift
 - b. area(s) of occurrence
 - c. favored season
 - d. frequency of occurrence
 - e. best macroscale conditions
 - f. remarks (qualifications, warnings, etc.)

the climatological year into soaring seasons (e. g., thermal, wave, no-lift periods) will facilitate the presentation. Also, the combination of items 1 and 2 may be more convenient for discussion purposes.

Item 3 in table 1 is the focus of the soaring climatology. Information sources are mainly experienced pilots and forecasters familiar with the area of interest. Information is most conveniently acquired via a formal questionnaire designed on the basis of table 1. Item 3 may also be enhanced by special meteorological studies carried out particularly for soaring needs. For example, the correlation of large scale meteorological data with local soaring conditions as deduced from pilot debriefings or from theory.

4. Examples

The soaring climatology should be as complete and as concise as possible. To these ends, a good topographic chart and tabular summaries are useful. To illustrate different approaches which may be taken both in acquiring data

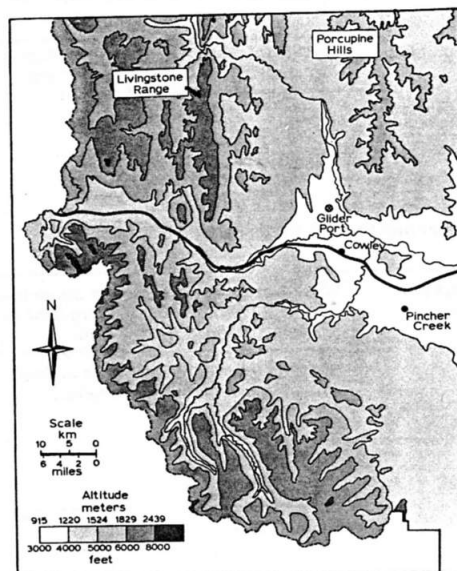


Figure 1
Topographical chart of area around Pincher Creek, Alberta, Canada. Dashed line to the west is the Continental Divide. Solid east-west line is Highway 3 (Lester, 1976a).

and in presenting the climatology, three cases will be considered.

Case I. A Soaring climatology for Pincher Creek, Alberta

Pincher Creek lies immediately east of the Continental Divide in southwestern Alberta and the surrounding area is one of the most prolific producers of lee waves in Canada (figure 1). The presence of a weather station in the area

has resulted in a unique source of information pertinent to a soaring climatology, i.e., records of wave cloud observations. More than 10 000 hourly wave cloud observations from a twelve year period have been processed to describe the annual, monthly and diurnal variations of wave cloud activity in that area (figures 2-4). The overall study is still in progress and the wave cloud information will subsequently be combined with data from standard climatologies, pilot debriefings, formal questionnaires and interviews (Lester, 1976b) to produce a detailed soaring climatology for Pincher Creek.

Case II. A Soaring climatology for the Island of Oahu, Hawaii

Lester and Dalbec (1975) considered only a single type of lift (wave) in this case. Because lee wave activity is much less frequent than ridge and thermal lift on Oahu, it had not been documented

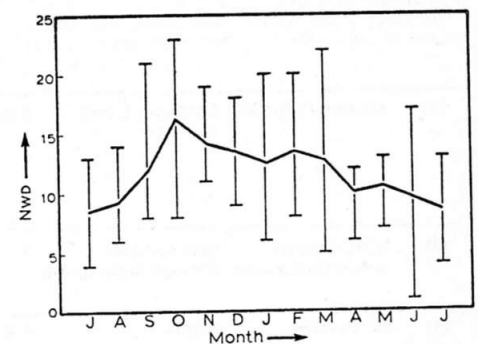


Figure 3
Heavy solid line is the mean monthly number of wave days (NWD) at Pincher Creek, Alberta. The vertical lines are ranges. Based on twelve years of data (Lester, 1976a).

Table 2
Climatology of a Lift Producing Phenomenon for Oahu, Hawaii (from Lester and Dalbec, 1976)

Lift type
Koolau wave (northeasterly flow)
Kona wave (southwesterly flow)

Areas of occurrence
Koolau wave: up to a distance of 10 km southwest of the ridge of the Koolau Mountain Range along its entire length and immediately southwest of the Wainae Range.
Kona wave: northeast of the Wainae Range.

Favored season
Winter, early spring

Frequency of occurrence
Koolau wave: 40 days per year
Kona wave: 4-5 days per year

Best macroscale weather conditions
Koolau wave: approach of an easterly wave or the passage of a weak cold front.
Kona wave: development of a Kona storm.

Remarks:
minimum frequency of wave occurrence in early fall
critical northeasterly wind speed for Koolau wave: 16 knots at mountain top.
Koolau wave is weak with typical wave lengths of 3-5 km, climb rates of 1-2 ms⁻¹ and maximum altitudes of 4-5 km.
Occasionally deep-northeasterly flow will produce maximum altitudes of 6-7 km.
Kona wave offers significantly higher climb rates although maximum altitude may be reduced by heavy cloud.
The Koolau wave is often "dry", lacking the characteristic lenticular clouds at higher levels.

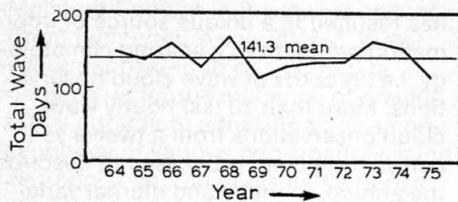


Figure 2
Annual number of wave days from 12 years of data at Pincher Creek, Alberta. A wave day is a daylight period during which wave clouds were observed for at least one hour (Lester, 1976a).

to any great extent, especially with respect to the associated meteorological conditions. The resulting "wave climatology" was based on the documentation of 40 wave soaring flights

over a four year period, macroscale meteorological data and theory. The results of the study are summarized in table 2.

Case III. A Soaring climatology for the San Francisco Bay region of California

Lester (1975) utilized general and aviation climatologies and pilot interviews to produce a documentation of all lift types for the area. The order of presentation followed the outline in table 1. Item 3 of that outline was accomplished with the map and tabular presentation shown in figure 5 and table 3, respectively.

5. Summary

The cases presented in the last section have demonstrated that there are many

approaches to the compilation of a soaring climatology. The resulting document may be either quantitatively detailed or a brief qualitative summary, depending on the information available. These differences are not a problem but serve as indicators of areas for investigation by pilots and forecasters. More importantly they emphasize that the soaring climatology is an open-ended document to be updated and improved with experience and as data become available.

6. Conclusions

The soaring climatology is a straightforward documentation of the meteorological conditions favorable and unfavorable for soaring. It is a useful tool for training, forecasting and contest plan-

Table 3
Climatology of Lift-Producing Phenomena for the San Francisco Bay Area, California (from Lester, 1975)

| Area | Lift Type | Favored Season | Frequency | Best Macroscale Conditions | Remarks |
|------|----------------------------------|----------------------------------|--|---|--|
| (1) | Thermal | Late winter, early spring | 8 days per month | Post-frontal | May occur over the entire area, but hills, especially sun-facing slopes, are favored. Stronger in convergence zones (see 10). May exist two to three days after frontal passage (but see 4). Not shown on the map because of the wide area of occurrence. |
| (2) | Mission Ridge lift | Late spring and summer | 6 days per month | Strong onshore flow - i.e., strong Pacific high with strong thermal low in San Joaquin valley. | Requires a perpendicular wind component at the level of the ridge greater than 15 knots. May be enhanced with thermal/upslope activity. When wind speed (irrespective of direction) reaches about 35 knots, flow becomes too turbulent. |
| (3) | Niles Canyon convergence zone | Late summer through early spring | ? | Slightly higher sea level pressure in San Joaquin/Livermore valleys, weak flow aloft. | Has been observed to occur when stratus burns off earlier in the Bay area than in interior valleys. May be enhanced by weak thermal activity. |
| (4) | North wave | Winter | 4-6 days per month | Post-frontal when a lobe of the Pacific high builds into Oregon, Idaho, and Montana. Strong N-NE flow aloft. | A variation on post frontal thermal activity due to strong ridging aloft just off the coast. If low level winds are too strong, flow is very chaotic - wave is ill-defined. If flow shifts to NW aloft, wave will be cut off. The air is dry so the characteristic clouds are not present. It is suspected that these waves also exist offshore, SW of the Santa Cruz range. |
| (5) | South wave | Winter, early spring | 5 days per month | Pre-frontal, strong SW flow aloft. | May be inaccessible due to heavy cloudiness in moist SW flow. |
| (6) | Summer wave | Late spring, early summer | 2-3 days per month | Weak trough approaching in upper levels flow (SW flow), strong onshore flow in lower levels, deep marine layer. | Limited vertical extent to waves. Variations due to thermal activity (when stratus does not exist) and local convergence zones. |
| (7) | Crystal Springs wave | Spring, early summer | ? | Same as (6) except it is better defined when the inversion base is below 2000 feet ASL. | Never flown, but it definitely exists. Max. lift is probably only weak to moderate below 2000' ASL. Located along NW-SE line over intersection of Highway 92 and Crystal Springs Reservoir. Associated cloud forms indicate turbulence west and east of narrow zone of maximum lift. |
| (8) | Crystal Springs convergence zone | Spring, early summer | ? | Same as (7) | Exists simultaneously with Crystal Springs wave (7). One E-W zone has been observed 1-2 miles south of Highway 92 - very likely a "twin" can be found (i.e., no documentation yet) to the north. Never flown. |
| (9) | Sea breeze front | Late spring, early summer | Daily Midday plus/minus 2 hours | Same as (2) | Not much information here from the soaring point of view, but records from SFO and Alameda indicate occurrence of the front which typically surges south-eastward from the area indicated to San Jose. Probably stronger on the east side of the Bay. |
| (10) | Morgan Hill convergence zone | Late winter, early spring | ? | Strong onshore flow following a frontal passage. | Convergence enhances thermal activity in this region. |
| (11) | Los Gatos convergence zone | Spring-summer | ? | Same as (6) | Not flown yet, but well-defined NE limit to strong gusty winds suggest narrow, strong lift zone over the valley at levels below 3000' ASL. |
| (12) | Upstream waves | Late spring, early summer | Daily with great variations of wave length and amplitude | Same as (2) but add strong inversion and strong wind variation (shear) through inversion. | Has not been flown in sailplanes. Meteorological conditions usually promote dense stratus layer with tops at base of marine inversion. Best waving in the inversion. These are "shearing-gravity" waves and are much shorter than lee waves. |

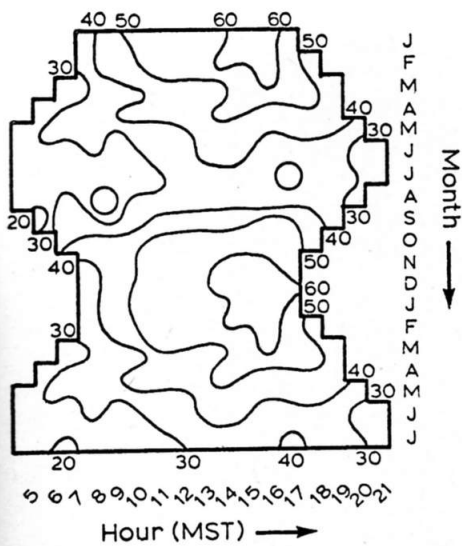


Figure 4
Frequency of occurrence of hourly wave observations on a wave day as a function of month and time of day (Lester, 1976a). Isoleth interval is 10%. Months of January through July are repeated for continuity. Sunrise and sunset frequency minima are probably due to observational difficulties. Theory implies wave frequency maxima at those times.

ing. Furthermore, the soaring climatology reduces the need for new pilotes

and forecasters to relearn (and occasionally rediscover!) the mesoscale soaring characteristics of a given area. It is recommended that glider clubs, encouraged by their national organizations, make an effort to document their own local soaring climatologies.

7. Acknowledgements

The author wishes to express his thanks to Emil Kissel, Carl Herold, Stan Dalbec, Dick Mamini, Julien Audette, George Blunden and the many other sailplane pilots who have contributed to the Soaring Climatology. Della Patton typed the manuscript. Her help and encouragement in the preparation of this paper is greatly appreciated.

8. References

- Lester, P.F., 1975: «Met Watch» – a soaring climatology of the San Francisco Bay Area. *West Wind*, January, 12–17. Reprinted in *Soaring*, 39, 34–37.
 Lester, P.F., 1976a: A lee wave cloud climatology for Pincher Creek, Alberta. Environmental Sciences Centre (Kananaskis), The University of Calgary, 29 pp.
 Lester, P.F., 1976b: The characteristics and soaring potential of long lee waves in southern Alberta.

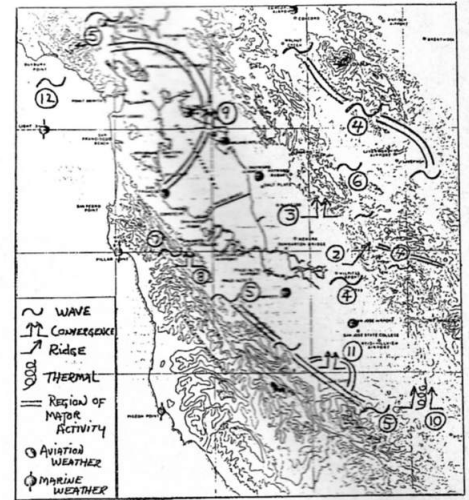


Figure 5
Lift areas and types in the San Francisco Bay Area. Numbered regions are described in table 3 (Lester, 1975).

OSTIV Publication XIV (1976)

- Lester, P.F., and S. Dalbec, 1975: A preliminary climatology of lee waves for the Island of Oahu, Hawaii. *West Wind*, April, 3–8. Reprinted in *Soaring*, 40, 16–20.