SOARING WEATHER AT THE TOP OF THE WORLD

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Summary

City College and Tribhuvan University scientists studying air pollution transport in the Himalaya encountered unusual soaring weather. A frequent, stationary line of cumulus clouds formed during the afternoons in the Kathmandu valley of Nepal. The subcloud updrafts vacuumed the valley of the overnight accumulation of air pollutants. In Tibet, dust devils formed at 4300 m MSL Old Tingri which is 70 km north of 8848 m MSL Mt. Everest. Meteorological measurements confirmed observations of cumulus forming with bases of 8000 m MSL between Old Tingri and Everest. Further, lenticular clouds with associated rotor clouds were observed over the Rongbuk valley indicating mountain wave activity on the north side of Everest. These observations suggest awesome soaring possibilities for gliders launched from Old Tingri over the nearby Himalayas once the significant diplomatic and logistical obstacles are overcome.

Introduction

During the author's sabbatical, he led a meteorological expedition to Mt. Everest in the fall of 1995 and the spring of 1996. The expedition, conducted by City College of New Yak (CCNY) and Tribhuvan University (TU, Kathmandu, Nepal) researchers, studied air pollution transport in the Himalayas as described by Hindman and Upadhyay (1). During the studies, unusual soaring weather was observed: an atmospheric "chimney" in the Kathmandu valley, diurnal convection in the nearby Himalaya and 8000 m MSL cumulus cloud bases in Tibet. In this paper these observations are detailed and possible soaring opportunities are discussed, one of which may lead to the summit of Mt. Everest. Hindman and Engber (2) have studied soaring opportunities of Everest from Nepal and concluded a soaring ascent is feasible. In this paper, a more likely ascent from Tibet is detailed.

Kathmandu valley

Soaring birds were a common sight in the Kathmandu valley during the author's stay between September 1995 and June 1996. For example, those wonderful creatures were observed making lazy, ascending orbits in the weak morning thermals which bubbled up the slopes of a hilltop temple which overlooks the west side of the valley. While reading the "Kathmandu Post" in the warm, morning sun, the author often observed the young eagles who lived in the tall trees across the street learning to soar under the developing cumulus clouds. How, he envied them!

There were no sailplanes in the Kathmandu valley to explore the convection. So, an instrumented STEMME S-10VT motorglider was being prepared in Germany to join the expedition in Kathmandu in the fall of 1995. Permission was obtained to bring the aircraft into Nepal, but the necessary turbo-charging of the craft was only recently completed. The instrumented S-10VT is expected to begin flights in the fall of 1998.

The author brought his newly acquired radio-controlled (R/C) glider to Kathmandu to explore convection near the ground. But, he was unable to master the art of R/C soaring in the brief time available; he found it was easier to learn to fly full-size gliders. Thus, he had to rely on observations of the soaring birds to identify connective updrafts.

Kathmandu is at about 25N latitude, so the sun is high in the sky even in the winter. As a result, convective clouds were observed to form almost daily. Due to Kathmandu's elevation of 1400 m MSL (4600 feet), its inland location and the high-elevation Himalayas and Tibetan plateau immediately to the north blocking the arctic air, it has a "gentle climate": a moist, warm summer and a dry, cool winter. The author arrived at the end of the wet, summer monsoon in early September 1995.

The author made many trips to the rooftop patio of his apartment attempting to get glimpses of the Himalaya

Figure 1.. Kathmandu "chimney" cloud, 1645 NST, 10 September 1995, photographed from the Nepal Research Center.

Figure 2. A sequence of up-valley photographs on 25 November 1995 from the Hotel Everest View (HEV), Khumbu Himalaya, Nepal at (a) 0900 NST, (b) 1200 NST and (c) 1500 NST illustrating simultaneous development of cumulus at low and high elevations along the valley sidewalls.

through the post-monsoon clouds that obscured the range to the north. As a result, he observed a frequent, stationary line of cumulus clouds to form during the afternoons (Figure 1). This cloud line also was clearly visible from space as detected by an USA polar-orbiting meteorological satellite. The cloud line was distinct from the cloud covered Himalaya to the north and the cumulus forming along the foothills of the valley to the south. The line formed in the center of the valley because the valley is sufficiently wide to permit rising air. In a narrower valley, like those in the nearby Himalaya, air sinks in the center of the valley suppressing cloud formation (Figures 2 and 3).

The subcloud updrafts vacuumed the valley of the overnight accumulation of air pollutants: the pollution was lowest in the early morning when, it seemed, everybody was sleeping and the pollution was lowest at noon when, it seemed, everybody was driving a vehicle belching black

Figure 3. The companion sequence of down-valley photos from the HEV on 25 November 1995 at (a) 0900 NST, (b) 1200 NST and (c) 1500 NST showing haze drawn into the valley (c) and how clouds from on the slopes receiving direct sun.

Figure 4.. Scene to the south from Old Tingri, Tibet on 19 April 1996 at 1500 NST.

rising air on the south-facing, snow-free, sun-warmed slopes of 6402 m Tawechie. Everest pokes over the Nuptse wall and Lhotse, to the right at the head of the wall, remained cloud free as did 6400 m Ama Dablam at the right in the figure. The nighttime down-valley winds from the cold snow have ceased and the up-valley wind has just be-

smoke. The large pollution peaks at the morning and evening rush periods were expected but not the cleanest air at noon! The clean air was due to dispersal by the significant convection. The author called the convection the "Kathmandu atmospheric chimney" and encouraged his Nepalese colleagues to burn their trash at noon to take advantage of the "chimney" and not in the evening and early morning as was their custom.

The "chimney" cloud may be explored with the instrumented S-10VT following careful air-traffic control procedures. Such explorations would map out the dispersal of the pollutants by the cloud. Further, the "chimney" cloud may serve as a jumping off point for exploration of soaring in the nearby Himalayas.

Between September 1995 and the author's departure in June 1996, he observed an average of 78% of the days in the Kathmandu valley to be soarable, ranging from 100% in October and December to 62% in June. A soarable day was one with high-based cumulus forming in the afternoon, good visibility and no precipitation. The maximum cloud base (H, m AGL) was estimated from the maximum air temperature (T, C) and corresponding dew point (Td, C), assuming a dry adiabatic ascent, using the following expression:

$$H = 125\,(T - Td) \qquad (l)$$

Between 18 and 23 October l995, the maximum T and minimum Td values were 28C and 6C producing a maximum cloud base value of 2750 m AGL. Likewise, between 4 and 6 April 1996, the T and Td values were 28C and -lC producing a maximum cloud base of 3,625 m AGL. These bases are certainly high enough to conduct soaring flights in the Kathmandu valley. The spring may be the best time because of the highest cloud bases but regional haze reduces the visibility to 8 to 12 km at this time (1).

Khumbu Himalaya

In November 1995, an almost daily convective cycle was observed from the 3876 m MSL Hotel Everest View (HEV) located 28 km south of 8848 m MSL Mt. Everest near Namche Bazar (Figure 7). At 0900 Nepal Standard Time (NST), as seen in Figure 2a, the first cumulus formed in the

Figure 5. 28 April 1996 Everest cumulus photos from Rongbuk Monastery, Tibet: (a) 0600 NST, (b) 0900 NST, (c) 1200 NST, (d) 1500 NST and (e) 1800 NST.

Figure 6. 23 April 1996 wave cloud photos looking north from Rongbuk monastery: (a) 0600 NST, (b) 0900 NST, (c) 1200 NST, (d) 1500 NST and (e) 1800 NST.

gun transporting both moisture and pollutants into the valley in response to the air rising up the warm slopes. At 1200 NST, as seen in Figure 2b, Tawechie continued to have the warmest slopes and its cloud grew larger. The up-valley wind was now blowing 10 knots. At 1500 NST, as seen in Figure 2c, the maximum solar heating had occurred and the clouds reached their maximum development. The slopes of Ama Dablam were now warm causing clouds to form. Looking south from the HEV down the Dudh Kosi valley, the companion sequence of photos (Figures 3a, 3b and 3c) shows clouds formed on the warm, east-facing slopes in the morning, both faces at noon and the warm, west-facing slopes in the afternoon. A temperature inversion caused the cloud tops to be flat. The clear center of the valley was caused by the sinking air.

The Syangboche airstrip, near the HEV, is a possible operations base for a rugged, powerful motorglider. Two ultra-light aircraft expeditions have flown from the strip as documented by Hindman and Engber (2). Also, the strip is a location to explore thermals with an instrumented R/C glider in the strong morning upslope flow and afternoon up-valley flow. Such R/C soaring flights may pave the way for motorglider flights from the strip. The flights will have to be coordinated with the Platus turbo-Porter and the Russian helicopters which fly daily to the strip. Further, the flights will have to cease by early afternoon to avoid the clouds that often fill the valley.

Cloud bases in the region were estimated using T and Td measurements with Equation 1. Between 29 October and 27 November 1995, the maximum T and minimum Td values were 13 and -23C producing a maximum cloud base of 4500 m AGL. Between 21 April and 9 May 1996, the T and Td values were 12C and -5C producing a maximum base of 2125 m AGL. It appears the fall is the best time for soaring flight due to the highest cloud bases.

Tibet

In the spring of 1996, the author traveled from Kathmandu to the north side of Everest via the Friendship highway to study trans-Himalayan pollution transport with his CCNY and TU colleagues stationed on the south side of Everest at the HEV and the Italian Pyramid station at 5000 m MSL near the base of Everest. The air in Tibet was found to be cleaner than the air at the same elevation in the Khumbu Himal. This was most likely due to fewer pollution sources in Tibet. Also, significant dilution of air pollutants advected into Tibet from Nepal in the afternoon trans-Himalayan air flow occurred in the extremely deep afternoon

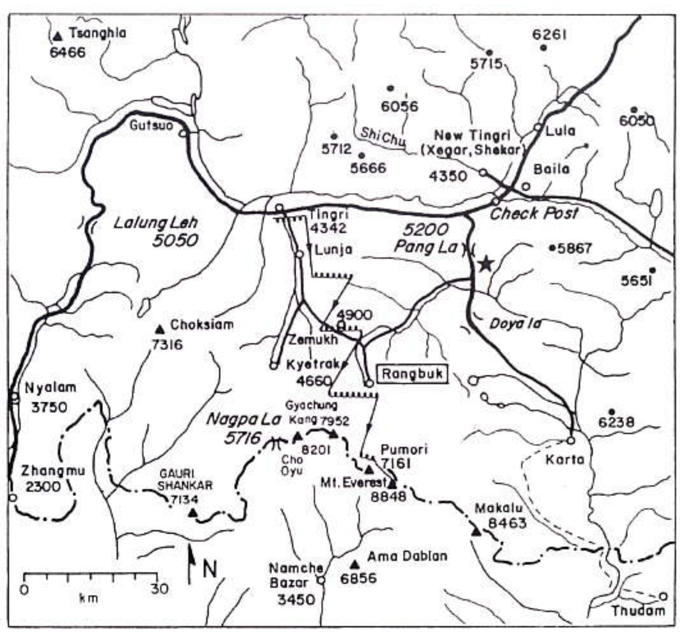

Figure 7. Possible flight track (plan-view) from Old Tingri to Mt. Everest. All elevations are in meters MSL.

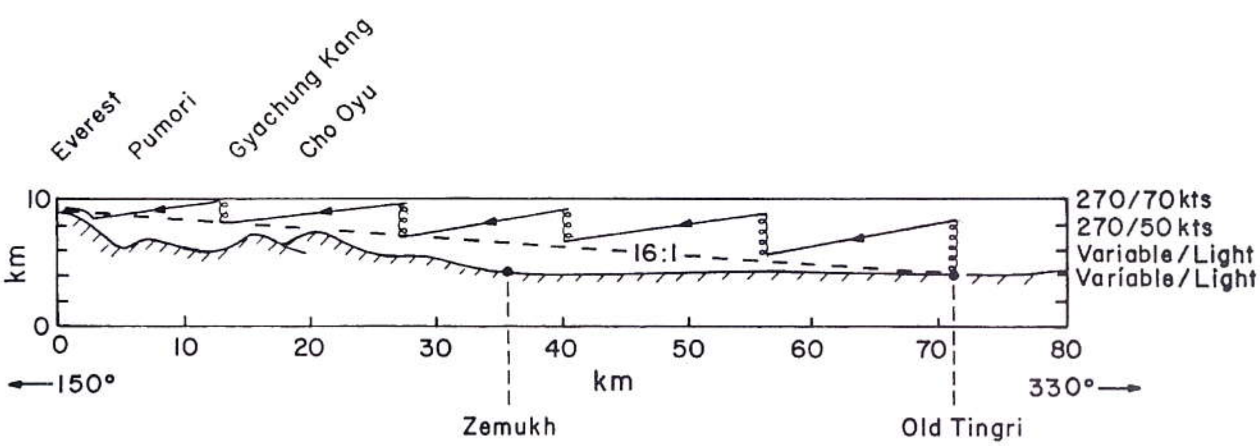

Figure 8. Possible flight track (cross-section view) from Old Tingri to Mt. Everest.

Tibetan convective boundary layer.

During the author's 18-19 April 1996 acclimatization period at 4300 m MSL Old Tingri (Figure 7), he observed dust devils forming each afternoon in the strong westerly surface air flow. The Tibetan villages were compounds surrounded by high walls to diminish these winds. Using surface T and Td measurements and Equation 1, a reasonable assumption according to Tao et al. (3), the cloud base was estimated to be 2400 m AGL. A possible flying location at Old Tingri is illustrated in Figure 4. It may be possible to construct a basic air strip and shelter for a motorglider, such as the S-10VT, on the flats visible in the foreground of the figure and to conduct exploratory flights to the awesome Himalaya looming in the background: 8848 m MSL Everest is to the left with a dust devil rising from the valley in the foreground and 8200 m MSL Cho Oyu is to the right with the Choughs slope-soaring in the strong afternoon breeze on the slope in the foreground. As described by Hindman (4), Choughs have ascended to near the summit of Everest in soaring flight.

A sequence of photographs is shown in Figure 5 shot from the 5,000 m MSL Rongbuk monastery located 28 km north of Everest. The photos illustrate 8,000 m MSL based cumulus forming just upwind of Everest between 0600 and 1800 NST on 28 April 1996. The surface T and Td measurements confirmed the bases of 3,000 m AGL (8,000 m MSL). Additionally, on 23 April 1996, lenticular clouds with associated rotor clouds were observed to form north of the monastery indicating mountain wave activity (Figures 6d and 6e).

Simultaneous T and Td measurements were made at Rongbuk and at the same elevation on the south side of Everest at the Pyramid station between 21 April and 9 May 1996. Using Equation 1 and the maximum T and minimum Td va1ues at Rongbuk of 13C and -18C produces a maximum convective cloud base of 387S m AGL (8875 m MSL). The corresponding values at the Pyramid station were 7C and -20C producing a cloud base of 3,375 m. Thus, convective cloud bases were higher in Tibet than in the Khumbu Himal in the spring of 1996.

These observations indicate awesome soaring possibilities for motorgliders launched from 0ld Tingri over the nearby Himalayas once the significant diplomatic and logistical obstacles are overcome. Between 18 April and 9 May 1996, 73% of the days were observed to be soarable at Rongbuk.

A first-approximation flight path between Old Tingri and Everest (Figure 7) was calculated using the author's HP-14T sailplane polar, as described by Hindman and Clark (5), and meteorological conditions measured and observed. Rawindsonde measurements made by Gao (6) at the base of Everest were used for upper-air winds. The author's dust devil observations were used for thermal spacing and updraft strength was assumed to be a conservative 5 m/s. This updraft estimate can be refined using standard rawindsondes from New Tingri with the cloud model of Liechti and Lorenzen (7). The assumed 70-knot westerly winds at 8,000 m cause the significant eastward drift visible in the figure during thermal ascents.

A minimum of five thermals plus slope soaring the last few hundred meters of the Everest pyramid, may be required to summit Everest as illustrated in Figure 8. The strong upper air winds from the west require that at least two thermals be used to return to Old Tingri. Hence, the flight appears to be a cross-country flight. If operations could be conducted from Zemukh and a higher performance sailplane were used, the flight would be local and increase the possibilities of ascending Everest. The glideslope from the summit to Old Tingri is 16:1.

Conclusions

It appears possible to conduct soaring flights in the Kathmandu valley of Nepal in the fall, winter and spring and possibly into the nearby high Himalaya before afternoon clouds fill the valleys. The best soaring opportunities may exist just over the Khumbu Himalaya in Tibet. Once the significant diplomatic and logistical problems are overcome, soaring flights to Everest from Old Tingri in Tibet may be possible. This is an exciting prospect!

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References

1. Hindman, E. E., and B. P. Upadhyay, Air pollution transport in the Himalayas of Nepal and Tibet. *J. Indian Meteor. Soc.*, submitted (1998)
2. Hindman, E. E., and M. A. Engber, Air motions in the Khumbu Himal and possible soaring flights. *Technical Soaring*, 1911, 3~ (1995).
3. Tao, S., S. Luo and H. Zhang, The Qinghai-Xizang Plateau Meteorological Experiment (QXPMEX), May-August 1979. In "Proc. Intl. Symp. Qinghai-Xizang Plateau and Mt. Meteor.", Science Press, Beijing and Am. Meteor. Soc., Boston, 3-13 (1986).
4. Hindman, E. E., Soaring birds of Mt. Everest. *Technical Soaring*, 18/1, 2-6 (1994).
5. Hindman, E. E., and T. L. Clark, Numerical simulations of soaring flights in lee-waves. In "Proc. 4th Intl. Symp. Sci. and Tech. of Low Speed and Motorless Flight", Soar. Soc. Am., Hobbs, NMUSA, 166-171 (1984).
6. Gao, D., Clouds on Mt. Everest. In "The report of the scientific expedition on Mt. Everest", Science Press, Beijing, 88-104 (1980).
7. Liechti, O., and E. Lorenzen, A new approach to the climatology of convective activity. *Technical Soaring*, 2212, 36-40 (1998).
8. Gao, D., Explorative studies of meso- and micro-scale systems of waves over Qomolangma Feng (Mt. Everest). In "Ppts. 2nd. Conf. Mt. Meteor.", Am. Meteor. Soc., Boston, 24-27(1981).
9. Hindman, E. E., Ascending Mt. Everest through soaring flight. *Technical Soaring*, 10/3, 44-52(1986).