π in the sky

Soperman unveils a new web app for instant tracklog analysis and objective glider comparison.

I landed after 5 hours and 120 km feeling pretty chuffed, the longest flight of the season so far for me in terms of both duration and distance. The last 20 km had been a bonus, drifting along with some kites under a fading sky, so I was confident of having milked what I could from the day. Activating Telegram to try and cadge a lift out of this remote pocket of Wales, I discovered that the lead PG gaggle had another 30 km on my full carbon, racing spec HG. It came as no surprise, since the PGs have been cranking out big flights all year, a well-oiled machine when it comes to XC planning, flying together and retrieving, compounded by their overwhelming numerical advantage; whereas I'm lucky if I see another hangie on the hill, let alone in the sky.

Yet surely our supposedly aerodynamically superior craft should count for something? My own shortcomings as a pilot couldn't explain why far better hangies than I are also regularly being outflown by floppies on the same day. I couldn't dispel the niggling feeling that perhaps the gulf in performance between HGs and PGs isn't as wide as assumed. So I went home, downloaded some tracklogs and bashed out some code. Initial findings were noisy and inconclusive, but as the algorithms were refined and more data was processed, its potential use to the wider free flying community became obvious. The result is the web app www.xc-buddy.com.

Overview

XCBuddy analyses .igc cross-country gliding tracklog files, instantaneously generating numerical and graphical flight reports on glide and climb performance. As greater numbers of glides and thermals are collated over multiple flights, glide polars and corresponding speed to fly curves emerge from the averages, useful for comparing different gliders quantitatively. Multiple same-day flights can be used to compare competition tactics, whilst sufficient numbers of flights over time can detect performance deterioration due to wing aging, or gains thanks to improvements in technique.

Capabilities

- *Pilots*: upload your tracklogs to find out what your personal glide polar looks like. Add wind and lift/sink to determine your speed to fly in all conditions. Selling your wing? Brandish your polar to show how good it is!
- *Aspiring skygods*: what are the skygods' secrets? Upload their tracks and spot the differences.

- *Skygods*: maintain your supremacy by ensuring you have the best gear available. Is your wing past its best? See beyond the marketing bluster and base your next wing purchase on unbiased data.
- *Team captains*: struggling to decide who to pick for the next comp? Let the data guide your hand. Not only can you identify who has the all-out best glide and climb performance, you can also spot talent where it's perhaps held back by a sub-par wing; for instance, those who thermal well yet don't even know it because they're still sinking faster than the rest of the field thanks to their antiquated kit.
- *Manufacturers*: evaluate the effects of that latest design change without having to wait for consistent flight test conditions. In fact, use your customers as an extended pool of test pilots by uploading their tracklogs, and keep an eye on the competition too.

Analysis

Analysis results are summarised in a table and illustrated in 3 graphs, the first of which is the glide polar. This is the bread & butter standard graph for gliding. Your scattered points may not be as neat and ordered as the textbook smooth curve, but they ought to confirm your suspicions that as you fly faster, you sink faster. It probably won't show the hook at the top as you're unlikely to be gliding close to the stall. Fig. 1 charts my glide performance on the aforementioned flight from Malvern to Carmarthenshire on a Moyes Litespeed RS hang glider alongside that of Tim Pentreath on his Advance Omega X-Alps 3 paraglider. Though we did not see each other in the air, we flew similar tracks with similar numbers of climbs and glides in a similar time in the same conditions on the same day, so a fair comparison can be made.

Each small blob represents a glide, the large blobs are the medians and the curves are the trendlines, in this case representing the polar curves of the system comprising glider and pilot. I would recommend grouping at least 10 flights of around 10 glides each before using the resulting polar to program flight computers, but even with fewer, it gives a feel for ballpark glide performance. At 60 $km.h^{-1}$, I was gliding on average 58% faster (through the air) than Tim's 38 $km.h^{-1}$, but sinking 49% faster too (1.95 vs 1.31 $m.s^{-1}$). This equates to a still air glide ratio γ of 8.57 for me and only marginally less for Tim at 7.59. Moyes claims a max glide for the Litespeed RS (now a 15 year old model) of 15 at 48 $km.h^{-1}$.[a] Advance (shrewdly) no longer make performance claims about their gliders, but 15 years ago they claimed a glide of 10 for an earlier model in the Omega range.[b] There are plenty of caveats about harness choice, flying posture etc., but having now analysed thousands of tracklogs, including those of world champions, I have yet to find a single pilot on any glider who consistently achieves anything close to spec.

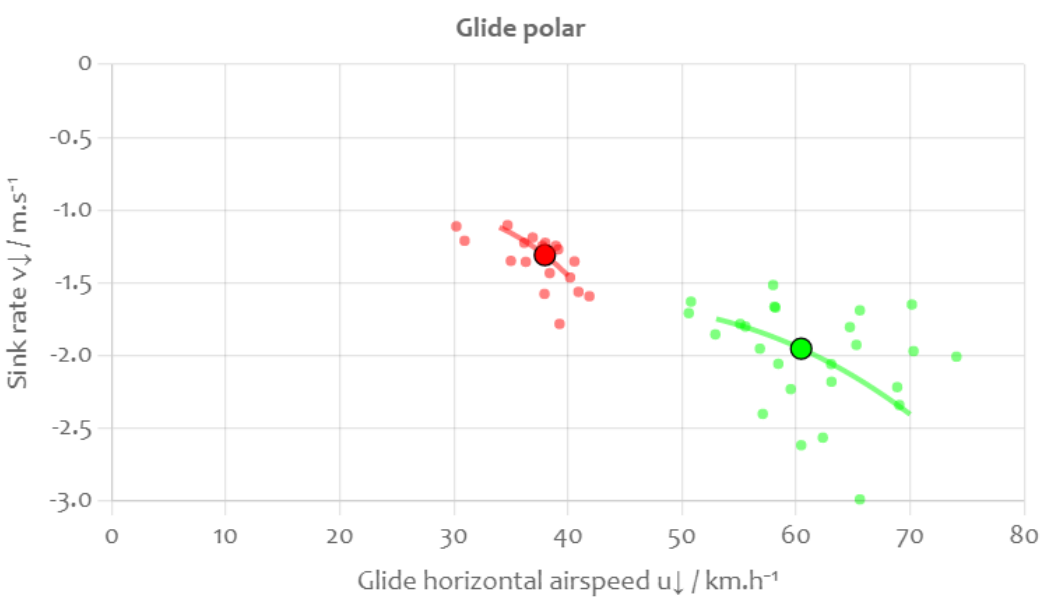

Fig. 1: Glide polar 2021/04/15 Malvern to Carmarthenshire, Soperman - HG Moyes Litespeed RS (green) vs Tim Pentreath - PG Advance Omega X-Alps 3 (red), still air performance

At this point it's worth mentioning that my aim is not to make myself universally unpopular. Instead, XCBuddy aims to promote a culture of transparency and integrity in free flying. Having built and somehow survived test flying a hang glider of my own design, I appreciate that glider development is far from trivial. Pressure to deliver a measurable improvement in max glide with each new competition-centric model has, I believe, led to considerable glide inflation over the years, conceptualised in fig. 2. Manufacturers have "gotten away with it" for so long because of the lack of accountability in the prior absence of an objective means of comparison. By the time a new model is released, its predecessors have likely deteriorated through age and use and furthermore, the most competitive pilots are usually the first in line for new gear, so it's no surprise that competition results tend to favour the latest model. XCBuddy is committed to providing an impartial review of glider performance, and as such is neither sponsored by nor in cahoots with any particular manufacturer or dealer.

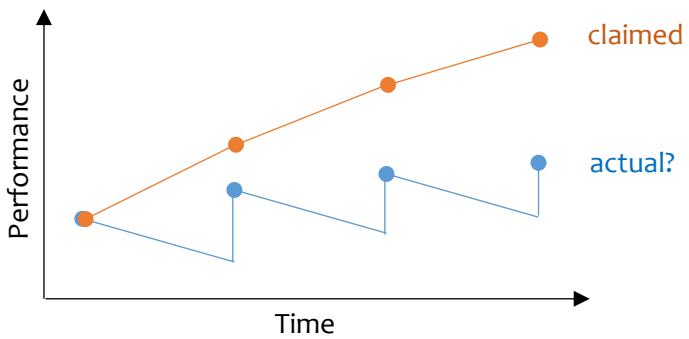

Fig. 2: Sawtoothed glider development

Returning to the case study: my advantage over Tim in nil wind is clearly a lot less pronounced than I would have liked to believe. What about in the actual conditions of the day itself? Imposing the 10 km.h^{-1} average tailwind that was blowing us across Wales, the numbers swing firmly in Tim's favour. The second graph, speed to fly (fig. 3), shows the glide ratio achieved over the ground against glide slant airspeed in the specified conditions (head/tail wind and sink/lift), with the triangles marking the best mean values. Tim's best mean glide over the ground was 10.9 to my 10.1. If you fly with a speed indicator, it would be worth memorising your speeds to fly for a few common sets of conditions. If not, you can still resolve to fly faster or slower to get closer to your best mean.

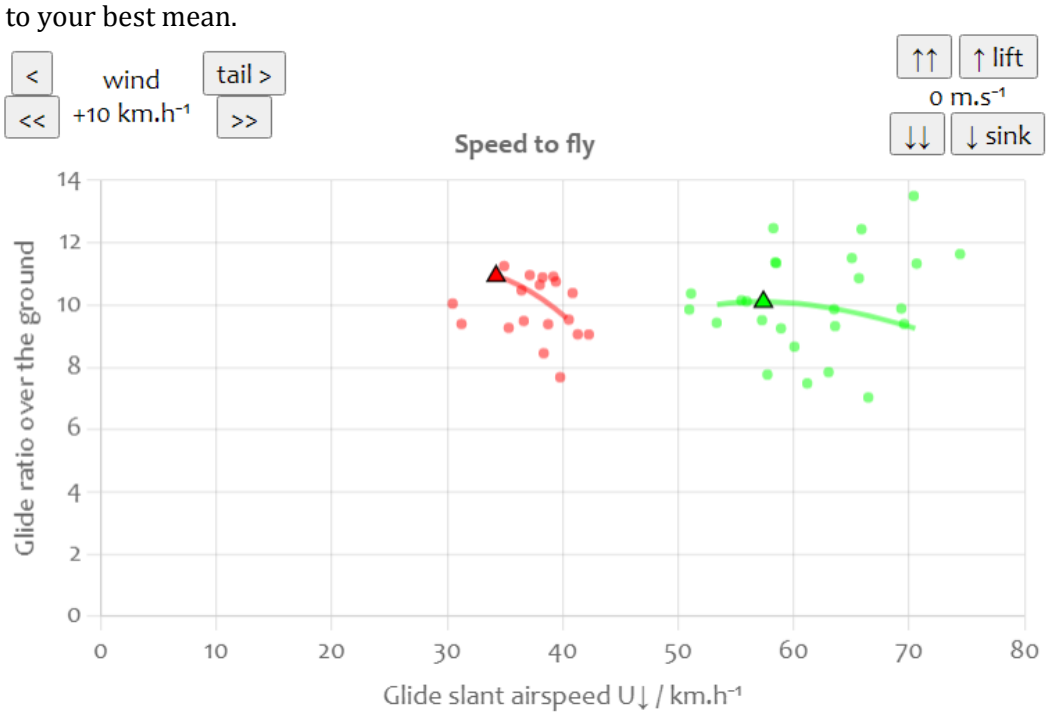

Fig. 3: Speed to fly 2021/04/15, Soperman vs Tim Pentreath, wind effects restored

The third graph on XCBuddy's analysis page offers two datasets on climb performance: climb rate vs thermalling period (time per revolution) on the left and climb rate vs thermalling diameter on the right. Fig. 4 immediately reveals that Tim and I have the same median period of 26 s but he is turning much tighter, with a diameter of 68 m to my 118 m. His 38% faster climb rate explains why, despite my faster glides, we have almost the same overall average groundspeed. Given my 0.56 m.s^{-1} greater sink rate at thermalling speed $u\uparrow$, it's also apparent that the slowest 1/6 of Tim's thermals would be inaccessible to me as I would not achieve a positive climb rate in them.

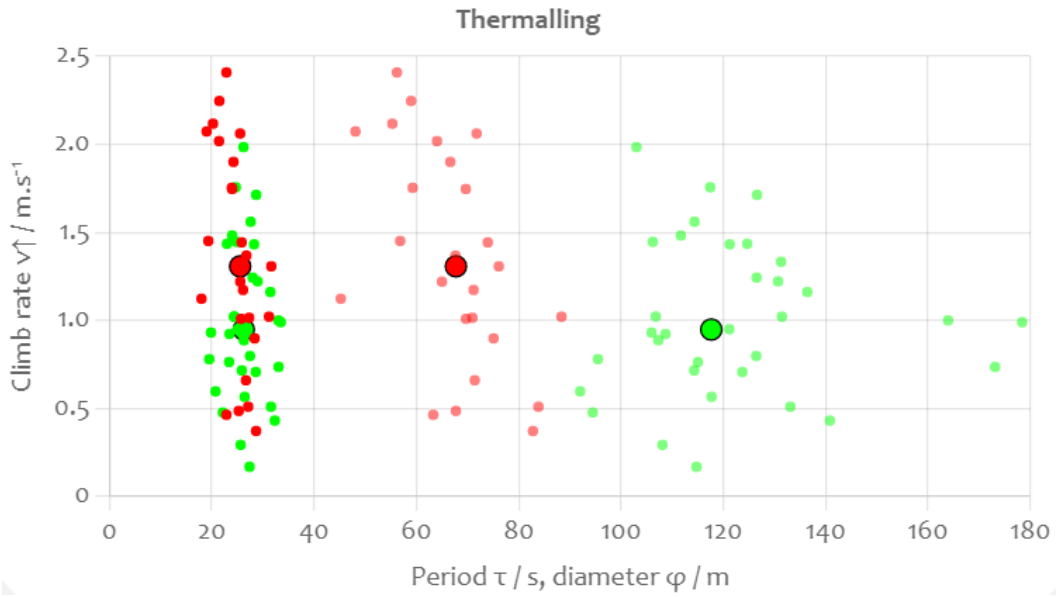

Fig. 4: Thermalling 2021/04/15, Soperman vs Tim Pentreath

Median values are tabulated in fig. 5 with the same colours, units and symbols as the above graphs. For a single analysis, the results table shows best means too. Specific datapoints can be scrutinised on the graphs in the app by hovering your cursor over them. Detailed instructions are on the website.

Results	Glides			Climbs			
	γ	v↓	U↓	v↑	φ	τ	u↑
Medians	7.59	-1.31	38	1.31	68	26	30
	8.57	-1.95	60	0.95	118	26	51

Fig. 5: Table of results 2021/04/15, Soperman vs Tim Pentreath

Sources of bias

- The better the day is, the more data collected. For instance, widespread convergence would reduce sink rates, extending glides, improving chances of finding further climbs, leading to longer flights featuring more glides. This overestimates the performance of all wings in completely flat air, but seeing as we are usually seeking non-flat, lifting air on cross-country flights, it is a useful bias.
- More competitive pilots, who pick liftier lines on glide and core thermals more proficiently, tend to fly higher performance wings. This will widen the apparent performance gap between high and low performance wings.

Further functionality

Besides the basic functionality of analysing and comparing up to 6 individual flights, XCBuddy allows you to group multiple flights as one, useful for comparing your flights this season to last season, for example.

"Publishing" one of your flights, i.e. making it available to all other users, earns you 1 point, which could be exchanged for another published flight, or saved up to purchase a glider polar.

These are estimates of what pilots around the world achieve on average on a given glider, and are automatically updated as more data becomes available. At last: a quantitative measure of performance to assist with your next gear investment, rather than relying on hearsay and marketing spiel. Fig. 6 samples the polars of 4 contemporary topless hang gliders – can you guess which?

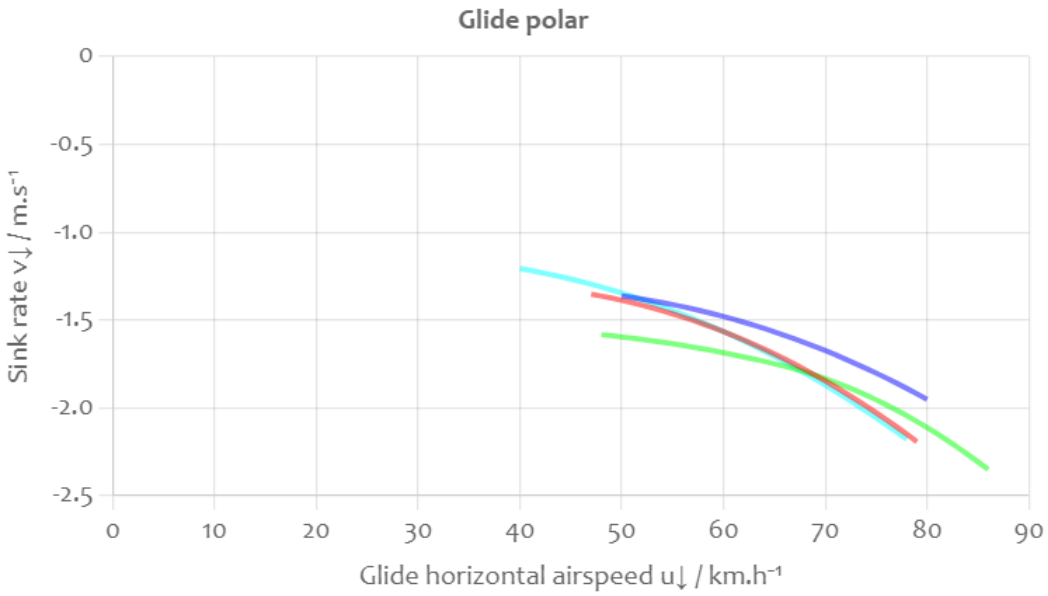

Fig. 6: Measured polars of 4 contemporary topless hang gliders

Additionally, anyone can join up to 3 teams of up to 7 members, with whom your uploaded flights can be shared freely and vice versa, fostering a sense of community in XC flying and facilitating daily objective feedback for team management at competitions.

Discussion

Although our case study examined only 2 flights on 1 day, analysis of a considerably greater corpus of data draws much the same conclusions. PG development, driven by a much larger customer base and correspondingly bigger R&D budgets, has naturally made great strides in closing the gap with HG performance. Where maximum distance downwind is the aim, the craft that can stay up in the sky the longest, i.e. the one with the slowest sink rate, will generally prevail, able to exploit weaker climbs in the early morning and late evening. At the time of writing, Sebastien Kayrouz has just broken 600 km for PGs;[c] how much longer can Dustin Martin's 2012 record of 764 km retain the lead for HGs?[d] Without a step advance in HG design (and I sincerely hope Avian et al. have just such an innovation up their sleeves), I believe the tipping point is imminent. But am I tempted to exchange my flexie for a floppy? Not at all. One thing XCBuddy cannot quantify is the pure exhilaration of flying like a bird.

Disclaimer

Anything that may be construed as an opinion in this article is that of the author. XCBuddy itself is merely a tool for meaningfully extracting the information embedded within .igc tracks, and does not assert that one wing is "better" than any other (those sorts of subjective conclusions must be made by the user, accounting for handling, cost, aftersales support etc). To paraphrase Tom Lehrer, XCBuddy "is like a sewer – what you get out of it depends on what you put into it." So get out there and chase some thermals in the footless halls of air. When you're back on terra firma, upload some tracklogs to XCBuddy, and maybe your friend in high places can help you achieve your flying goals!

[a] https://www.moyes.com.au/products/glider-archive/litespeed-rs/specifications
[b] https://web.archive.org/web/20061106165945/http://www.advance.ch/Technical_details.320.0.html
[c] https://xcmag.com/news/sebastien-kayrouz-flies-600km-in-texas/
[d] https://www.fai.org/record/16577