OUTSIDE JEB

Secrets of the albatross's soaring success

Ever since humanity first gazed up enviously at the birds above our heads, we have marvelled at their mastery of the skies. This mastery has taken many diverse forms to match the lifestyles of different birds and their environmental niches, but no other bird has quite mastered the art of oceanic sky-surfing like the wandering albatross (*Diomedea exulans*). These marine travellers spend the majority of their life in flight, capable of flying over 600 miles in a single day, and they manage to do so using remarkably few wingbeats. Instead, they rely on their impressive 3.5 m wingspan to efficiently glide over the ocean surface using an energetically cheap flight strategy known as 'dynamic soaring'. Wandering albatrosses most commonly utilise dynamic soaring by flying in a crosscurrent direction to the wind just above the ocean waves, alternating between ascending and descending flights that cross a gradient of wind speeds, including a transitionary 'shear layer', where wind speed quickly increases from the calm ocean surface up to the blustery air around cresting waves. This manoeuvre allows the albatross to harvest energy from the wind gradient and replace the energy lost overcoming aerodynamic drag, meaning that it can repeat this pattern almost indefinitely.

Lord Rayleigh first attempted to calculate the aerodynamics of dynamic soaring over 130 years ago and assumed that albatrosses would turn during this manoeuvre with a 180 deg change in trajectory, as U-turns provided a simplified way to connect the up and down flights across the wind gradient. His equations are still used when discussing dynamic soaring today, but recently published observations of wild albatross flights suggest that albatrosses don't actually fly as Rayleigh suggested. So what's the real secret to the albatross' soaring success? This is the question that Gabriel Bousquet and a team of engineers from the Massachusetts Institute of Technology set out to answer by simulating the optimal flight trajectories for wandering albatrosses. By analysing GPS data recorded from real albatross flights and incorporating various bird turning angles and shear layer thicknesses into their simulation, the team successfully crafted a more detailed examination of this phenomenon.

The results of their study, recently published in the *Journal of the Royal Society Interface*, provide new and significant insights into how these creatures traverse the ocean skies so effectively. They discovered that although flight through thick shear layers requires big zig-zag trajectories with turning angles similar to the 180 deg turns suggested by Rayleigh, thinner shear layers allow for trajectories with much less horizontal movement and more acute turning angles of 50–70 deg. These shorter, sharper turns prove to be much more efficient than those suggested by Rayleigh's original calculations, reducing the wind required for dynamic soaring by over 35%. Moreover, these flight trajectories reliably match the GPS data from actual albatross flights, providing confidence that their new simulation is considerably more representative of wild albatrosses than previous attempts.

These results help to bolster our understanding of seabird aerodynamics and energetics, and the authors also enthusiastically describe the potential of their new approach for bio-inspired engineering applications. By utilising the albatross's recently revealed flight strategies, the authors hope to design wind-powered robotic drones that could soar great distances over the ocean waves without needing to recharge their batteries. These drones would have incredible endurance and a seemingly limitless flight range, making them ideal candidates for gathering atmospheric data in order to anticipate hurricanes or monitor the effects of climate change across the sea surface, or even as useful search and rescue tools. Whatever the eventual application of this work, as long as robo-albatrosses are involved, I'm on board.

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