Migratory birds need less time to travel longer routes when they optimize for wind support

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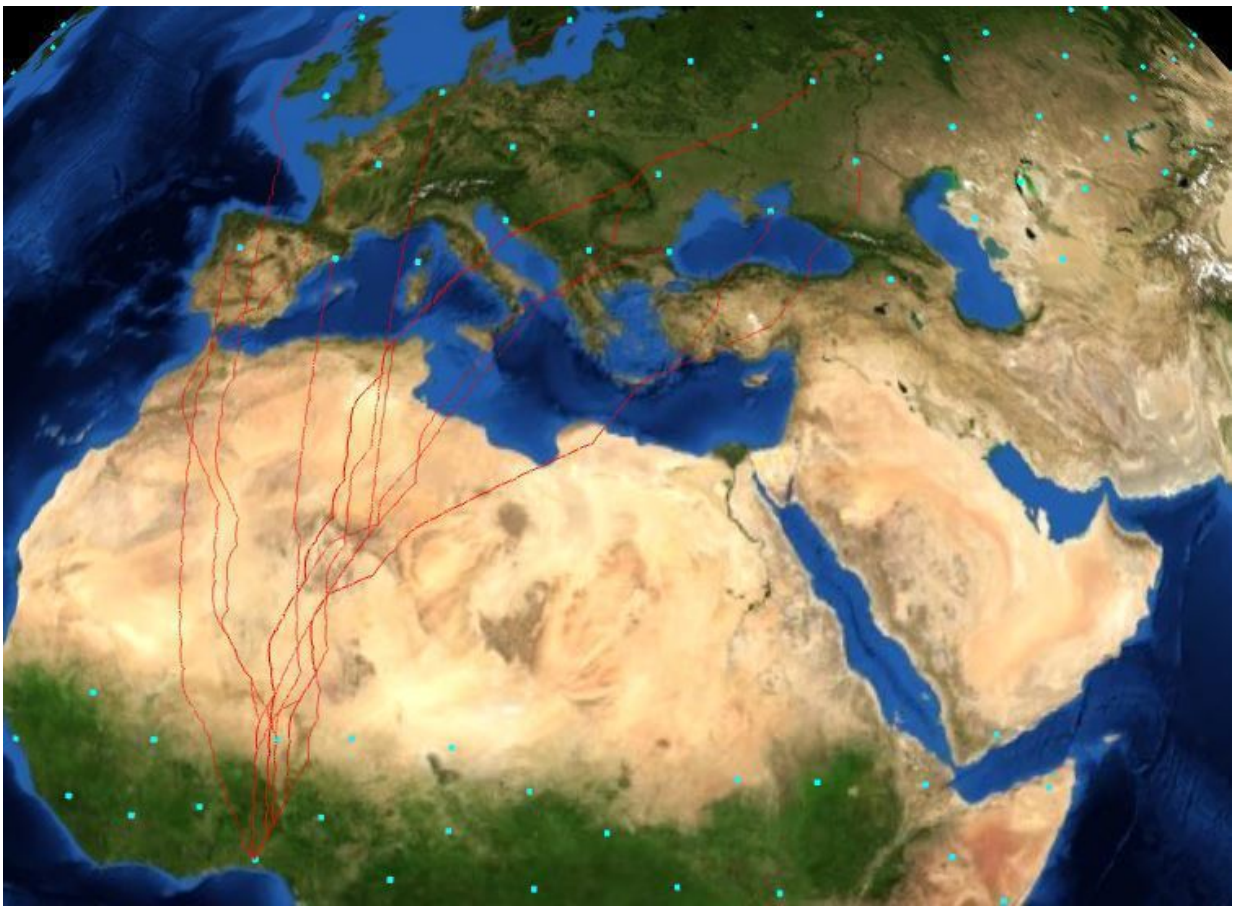

Based on the global weather data from the past 21 years, researchers have developed a model that allows them to calculate the optimal migration routes of migratory birds. It shows that the shortest flight time is not necessarily the result of the shortest route. The model also takes into account spatial and temporal changes in wind conditions. Credit: NASA

Each year migratory birds travel over thousands of kilometres. In spring and autumn, billions of individuals move from colder and less productive areas across vast distances to warmer and more productive places. To do so, however, it seems that the shortest route does not necessarily grant the fastest journey. Birds can save energy and time if they use wind support. Researchers at the Max Planck Institute for Ornithology in Radolfzell Germany have calculated optimal routes in respect to wind support globally. Their research shows that birds using optimal wind conditions can save up to a quarter of travel time. Thus birds optimising on wind support should arrive earlier and in better conditions and have higher chances of survival and reproduction. The knowledge about such optimal flyways could spread over generations in migratory species.

On their migratory journey, birds cross oceans, the highest mountains, and deserts. The arctic tern, for example, holds the world record in annual avian travel distance, where it moves between its breeding grounds in the Arctic to winter in the Antarctic. Using satellite based technology, scientists are just on the verge of unravelling these phenomena.

Scientists, led by Kamran Safi at the Max Planck Institute for Ornithology have now calculated that the route with the shortest distance between two points on the globe almost never represents the fastest option. They propose that it is beneficial for migratory birds to take detours, thereby using wind support on their journeys. "Of course the birds cannot forecast weather," says Bart Kranstauber, first author of the study. "But through natural selection or learning, it is possible that knowledge about the optimal route can spread in a species over time." This, however, only works because there are predictable patterns in the wind conditions over years.

Tailwind saves energy

"Quite a few of the routes we calculated match what we know some birds actually do," explains Safi. And the models suggest that it is energetically cheaper to fly south to Africa in the autumn using a more easterly detour and to return to Europe on a westerly route, giving rise to a so-called "loop migration". This pattern matches what is known from the common cuckoo.

The birds can save up to a quarter of their time if they choose to optimise their route in respect to wind instead of simple distance. Thus, they probably would be less fatigued and have a head start when it is comes to occupying good nesting sites. This in turn can decrease mortality, reduce recovery times and overall increase reproductive output of those individuals taking the optimal routes. Travelling along optimal routes can therefore become the winning strategy through natural selection or tradition.

More than wind

Safi and his group use weather data collected from 1990 until 2010 and calculated the most efficient routes in respect to wind support for 102 departure and arrival locations in the northern hemisphere connecting to 65 locations in the southern hemisphere. And although the programme ignores all other important factors in bird migration, the results are a striking match for some known flyways.

Based on this model, the researchers want to investigate when and where bird migration deviates from the simple assumptions, adding more complexity to better understand the importance of additional factors for bird migration. "We now want to know where the model fails and why, which will help us to derive a better understanding of what actually

shapes the fascinating phenomenon."

One of the still unresolved issues in bird migration is how birds navigate over such vast distances and can potentially master the task of following an optimal route.

More information: B. Kranstauber et al. Global aerial flyways allow efficient travelling, *Ecology Letters* (2015). DOI: 10.1111/ele.12528

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