流体中における動物のナビゲーション能力を解明する：
対地速度ベクトルから対気速度ベクトルと風ベクトルを推定する新手法

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A new method to reveal animal orientation in flow: estimating air velocity and wind velocity only from tracking data

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Organisms flying above ocean to reach their distant destinations are often subjected to the effect of wind even though they are under poor visual cues environment. Investigating how organisms adjust their heading (animal moving direction relative to wind) responding to wind to reach the goals will shed light on their navigation capacities. In previous studies, animal heading was derived from subtracting wind velocity from ground velocity (similarly, for swimming animals, self-propelled swim vector was derived by subtracting currents from ground velocity). In this approach, satellite tracking (recorded with several days intervals) and atmospheric model output data with low spatial (tens to hundreds of kilometers) and temporal (several hours) resolution were used. Although this method has been applied long-term migratory movements, the coarse resolution of available tracking and wind data limited the understanding for the orientation of animals in short term (from several hours to a few day) movements, such as central place foragers' homing from their foraging sites.

We developed a new method that enables to estimate the animal heading and the wind velocity animal encountered only using ground velocity data, relatively higher resolution (minute) data recorded by GPS loggers. The main idea of our method is to take account in the fluctuation of animal movement that has been generally observed and modeling the animal movement in wind using probability densities. We applied this method to the tracks of streaked shearwaters homing from foraging sites distant from their colony more than 200 km and investigated how they adjusted their heading responding to cross wind. Streaked shearwaters adjusted its heading to compensate the drift by lateral wind relative to their colony direction so that moving towards the goal direction and the variation of moved direction between individuals were not affected by lateral wind. Our results suggest that, even though streaked shearwaters are above ocean distant enough from land, they can recognize the direction of their colony, detect how much they will be drifted by wind and respond to it. For pelagic seabirds that routinely exploit ocean environment, this ability should crucially effect on their breeding success and fitness. The wind compensation of birds flying above ocean intending to reach destinations have been reported only in their migration movement and this is, to our knowledge, the first report of wind compensation in dairy homing movement of birds above ocean. Our method can be applied to any species that can be tracked with sufficient time resolution. According to our numerical simulations, if 50 positions of an organism are recorded in the area where flow can be regarded constant, its mean heading and encountered flow velocities of the track can be estimated. Thus, we expect this method will contribute for understanding the orientation in flow of various species.