17th biennial conference on the biology of marine mammals
Capetown, South Africa 29th Nov. -3rd Dec.

oral presentation abstract

numerical simulations of the flow around a humpback whale's pectoral fin

This paper is dedicated to the understanding of the flow around a humpback whale's pectoral fin.

The humpback whale (*megaptera novaeangliae*) is known to be a very versatile swimmer despite of it's size (average length: 13 meters, average weight: 30 tons). Biologists see the reason in the whale's unusually long pectoral fins (flippers), which can grow to 1/3 of the humpbacks overall body length. The flippers, aside from their length possess another peculiarity: Their leading edge is not smooth but covered with so called tubercles, which give the flipper a rather craggy look.

The idea that these tubercles play an important role in the hydrodynamic properties of the flippers seems obvious, especially considering that humpbacks are born that way and do not acquire the tubercles later in life.

In order to get some insights into the flow around the humpback's flippers, a virtual flipper was created for later use with CFD. As the whale operates a very wide range of different flow fields (e.g. hunting, long-distance swimming, cold and warm waters) chosen „operating points“ had to be specified for the numerical simulations.

For comparison a second flipper was created without tubercles. Both flippers were examined numerically in water at different angles of attack and a typical swimming speed of the whale. The flipper with tubercles was then scaled via the Reynolds number and also simulated in air.

Results show that the flipper with tubercles provides a much higher lift at high angles of attack, while losses remain the same compared to the smooth flipper. Apparently the tubercles generate a vortex pattern which re-energises and stabilises the boundary layer. This way stall is delayed and a higher lift achieved.

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