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12 Years of European Wake Vortex Research – An Overview

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With growing commercial air traffic, civil aviation community is increasingly concerned by the limitation of today's airspace and airport capacities. Both airline industry and airport authorities are vitally interested in methods to accommodate the growing air traffic, without degrading the high standards of safety. One approach for increasing airport capacity is to reduce the separation distances of airplanes flying in-rail. Separation distances are presently based on aircraft Maximum Take-Off Weight alone and stretch from 3 to 6 nautical miles. Established in the seventies, these standards increasingly limit the full exploitation airport capabilities. A revision, therefore, becomes mandatory. Not only do wake vortices pose a safety hazard for aircrafts flying closely behind one another, but the strict separation rules have a direct economic impact, as the imposed distances limit the number of take-offs and landings.

The aircraft industry was attempting to obtain physical explanations for the "wake vortex" phenomena. Indeed, the forceful but invisible whoosh of air that trails out from behind an airplane representing a major challenge to the aviation community, research projects were launched by Airbus. These dedicated programmes addressed typical wake-related effects of realistic models representing all existing Airbus aircraft types. Insight gained from wind tunnel investigations was tremendous, but it became clear that the limitations of the classical wind tunnels were a major obstacle to obtaining knowledge of the full lifetime of the wake.

This situation was recognised early by the European Commission when launching the Eurowake project in 1994 in the starting phase of the 4th Framework Programme. The Eurowake programme, which was executed as a modest 6-nations programme, addressed the near field of the wake. It was complemented by the European Wavenc project, which primarily addressed wake encounter topics. The justification of this project resulted from air traffic incidences where following aircraft on the approach encountered vortex wakes from preceding aircraft. A third FP4 project was Mflame completed by ETWIRL (incident reports).

As outcome of these initial FP4 projects several programmes have been initiated and financed through the 5th Framework Programme. Three Critical Technological Projects were launched: investigation of the physical aspects of vortex flows through wake characterisation (C-Wake), verification what level of safety has been achieved (S-Wake) and wake vortex instrumentation and detection (I-Wake). In particular the ambitious C-Wake program aimed at further improving the physical understanding of the wake formation and decay behind the aircraft.

The industrial objective behind these European projects was to obtain a set of validated data that describes typical wake characteristics of transport aircraft, to develop means by which vortices with less hazardous characteristics can be created and which promote their earlier decay, and, to lead to application guidelines for the European aircraft industry by dealing with wake control.

In order to cluster these projects and to gain added value through synergy effects, the thematic network WakeNet was launched in 1998, which was addressed to the entire aviation community, from research scientists to pilots, from aircraft manufacturers to law- and decision makers.

The follow-on wake vortex research activities financed through FP5 were concentrated in the AWIATOR project. Launched in 2003, AWIATOR is an ongoing ambitious European Technology Platform project that aims to integrate advanced technologies into novel fixed-wing configurations with two goals in mind: to create lighter, but stronger, wings and to reduce as much as possible the hazardous wake vortex. The four-year project performed numerous challenging tests in Europe's biggest wind tunnels, water towing-tank, catapult facilities complete by two important flight test campaigns.

Wake vortex research is pursued in the running 6th Framework Programme. Here the project FAR-Wake (2005-2008) represents an upstream research initiative driven by universities and research centres. Within FAR-Wake emphasis is put on the study of generic vortex configurations to gain the missing physical understanding, thus complementing the existing, mostly empirical knowledge. Use is made of results and data from previous projects or available data bases on aircraft wake turbulence, whose analysis is far from being complete. The assessment of the impact of the new results on practical applications and realistic situations is an integral part of the project.

The four papers of this dedicated wake vortex session result from the above mentioned projects and very nicely cover the wide range of applied and upstream research carried out in Europe.