Concept and project objectives

Unique research aircraft platform

COPAL has the objective of providing the European scientific community in the field of environmental and Geo-sciences, with a unique research aircraft platform, capable of reaching and operating in any remote area in the world. It will offer an unprecedented opportunity to countries that are not yet operating research aircraft to develop expertise in airborne measurements and participate to international multidisciplinary experiments.

Multidisciplinary studies at a global scale

Parallel with the development of Earth simulators in numerical modeling, experimental research in environmental and Geo-sciences is evolving towards multidisciplinary studies of the atmospheric and climate systems at the global scale. Consequently, the on-board instrument configuration must now include in-situ measurements of turbulence, atmospheric state parameters, and cloud microphysics, sampling inlets for on board gas and aerosol analysis, and a combination of passive and active remote sensing systems. The endurance must be sufficient for long range studies over remote area such as the oceans, the Polar Regions and continental areas with limited ground infrastructures, such as the Sahara desert or the Amazon. Even with the UK BAE-146, offering the largest payload of 4.5 tones in the European fleet of instrumented aircraft, investigators have to accept compromises because the complete panoply of instruments available in Europe cannot be integrated, without significantly reducing the endurance of the aircraft. Moreover, all the aircraft of the European fleet are presently limited to an endurance of 5 hours. With a payload of 6 tones or more and an endurance of 12 hours, a heavy-payload, long endurance (HPLE) aircraft will more than double the capabilities offered to European scientists.

From the national to the pan-European approach

The objective is thus to move from the national approach in the development of airborne research infrastructures, that led to duplication and inefficient use of the facilities, to a pan-European approach that will allow to construct a facility that does not exist yet in Europe and operate it at the most efficient level by attracting a much broader community of users. In order to reach an agreement and financial commitments from potential shareholders, the COPAL consortium will analyze possible models for a joint management of a research infrastructure, that are adapted to the context of airborne operation, will precisely estimate the costs for the construction, modification for research, maintenance and operation of a HPLE aircraft, and will propose a governance model for the selection of scientific proposals and allocation of access at the European level.

The first 20 months of the project will be dedicated to the analysis of possible models and the estimation of the costs, that will be presented to the Governing Board of national

representatives. During the following 20 months of the project, the Governing Board will examine models and select solutions for the project consortium to elaborate on the most suited models of management and governance and refine the cost estimation. During the last 8 months of the project, an agreement will be submitted for signature to the member organizations, with comprehensive information on the legal and governance structures, accurate estimation of the costs and a work plan to proceed with the construction and scientific operation of the new airborne infrastructure.

COPAL aircraft in EUFAR Fleet

The requirement for COPAL is derived from work of the EUFAR FP6 I3, that aims at coordinating the activities of the European Fleet for Airborne Research in environmental and Geo-sciences. After evaluating the activities and performance of the European fleet of instrumented aircraft, to identify gaps in available infrastructures, the EUFAR Consortium concluded that the first priority in term of development of the fleet was the construction of a HPLE turboprop aircraft. EUFAR also develops standards protocols and good practice between all the operators of research aircraft in Europe, for the collected data to be more largely used, especially within the frame of GMES. These activities will directly benefit to the COPAL facility, when it will become part of the European fleet.

COPAL will provide the European community of researchers in environmental and Geo-sciences, with a unique facility for multidisciplinary tropospheric research. All the scientists however are not focused on tropospheric or multidisciplinary large scale experiments. COPAL, that will enter the EUFAR fleet, shall therefore also be the opportunity for the shareholders to get access for their national community of researchers to the other aircraft of the European fleet, either for stratospheric research on jets, or using well targeted small and low cost aircraft when a big facility is not necessary. This issue will be carefully examined when building the governance structure for the management of COPAL, and it will be the main concern of the coordination with the EUFAR I3. COPAL with EUFAR will thus build the groundwork of a European distributed infrastructure for airborne research in environmental and Geo-sciences for each European scientist to get access at equal terms to the airborne facility the most suited to his scientific objectives, irrespective of his origin and of where the facility is operated.

Progress beyond the state of the art

National management of research aircraft in Europe has resulted in a diverse fleet of small to large size aircraft. The 25 EUFAR members operate 30 instrumented aircraft, with sampling speeds ranging from 30 to 200 m/s, payloads from 80 kg to 4.5 tones, and ceilings from the boundary layer up to 13 km. At present all aircraft are limited to an endurance of 5 hours, hence preventing long-range experiments over the ocean, polar regions and remote continental areas. Germany has recently purchased and is equipping a large-payload (up to 3 tones) and long-endurance (up to 14 hours) jet, which will be available to the European scientific community in 2009, for research in the upper troposphere/lower stratosphere. In

contrast, the US scientific community has access to 4 heavy-payload (10 tones), and long-endurance (14 hours) jets and to 7 heavy-payload (15 tones) and long-endurance (12 hours) turboprops.

The construction of a heavy-payload, long endurance (HPLE) turboprop aircraft was therefore selected by the EUFAR Consortium as the first priority for the development of the fleet. The decision was also influenced by the fact that the UK Met. Office operated a HPLE aircraft for 27 years, but abandoned the activity in 2001 due to constraints associated with operating a military aircraft in civilian environments, the high expense to the UK alone, and the inability to secure sufficient funding from other EU countries. However, operational experience in the UK and US has shown that with its heavy payload and large cabin volume, such an aircraft is well-suited for multidisciplinary experiments mobilizing up to 15 research teams on board. Therefore, optimized use of such a facility (up to 600 flight hours per year) can relatively easily be achieved if access is offered to a large community of scientific users at the European level.

In order to evaluate the scientific impact of airborne activities, more than 1600 peer-reviewed scientific articles from European and international authors have been compiled by EUFAR. Of the 1220 articles published by European first authors, over the past 20 years, when the UK C130 was in operation, 334 rely on data collected with this aircraft (i.e. 27 % of the total), while the balance relate to the other 22 instrumented aircraft operated in Europe over this period. In terms of citations to date, these papers generate 4204 citations, i.e. 38 % of the total number of citations for the 1220 papers. The cost of access to the UK C130 of 12860 € per flight hour was similar to that of the medium payload and medium endurance aircraft of the EC trans-national access programs CAATER in FP5 and EUFAR in FP6. This remarkable scientific impact to costs ratio demonstrates the high relevance of a HPLE aircraft to environmental research.

Such environmental research has evolved from specific process studies, for which smaller aircraft with targeted instrumentation are adequate, to multidisciplinary studies of complex atmospheric and climate systems in which dynamics, microphysics, radiation and chemistry are tightly coupled. This is reflected by the fact that most of the medium and small specialized aircraft are operated at a level of about 200 hours per year, while the HPLE C130 operated by the NSF in the USA has operated at full capacity (~600 hours/y), with a considerable degree of overbooking.

Because of space and weight limitation on existing European aircraft the integration of new, user-provided instrumentation is often difficult and in some cases never completed. For an HPLE aircraft, payload and space are no longer a constraint, and it is feasible to mobilize the full Pan-European community of academic laboratories and SMEs for development of innovative instruments. This capability will be of particular relevance to European countries which do not have direct access to large airborne platforms, but which have the technical capacity for development of new and novel techniques.