Introduction to EUFAR

EUropean Fleet for Airborne Research

www.eufar.net
EUFAR is an Integrated Infrastructure Initiative (I3) of the European Commission. EUFAR aims at coordinating the operations of the European fleet of instrumented aircraft in the field of environmental research in the atmospheric, marine, terrestrial and Earth sciences.

### Networking Activities

- N1. ESF Scientific Advisory Committee (N1ESF-SAC)
- N2. Transnational Access Coordination (N2TAC)
- N3. Future of the Fleet (N3FF)
- N4. Expert Working Groups (N4EWG)
- N5. Education and Training (N5ET)
- N6. E-Communication (N6EC)

### Transnational Activities (TA)

### Joint Research Activities (JRA)

- AARP. Airborne Aerosol Reference Pod
Network activities: N1ESF-SAC (Scientific Advisory Committee)

**Tasks:**
- to assess the scientific demand in terms of airborne infrastructures and services,
- to evaluate the activities of the EUFAR I3 with regard to the demand,
- to provide National Research Funding Institutions with guidance for establishing multi-lateral agreements on TA, instrumental developments and the long term evolution of the fleet.

**Deliverables:**
- Survey questionnaire to the scientific community on user needs,
- Organisation of a forum on ETCA between research funding institutions, scientific users and aircraft operators

**Coordinator:**
- European Science Foundation

24 partners from 12 countries:

- Météo-France
- ESF
- DLR
- NLR
- Enviscope
- INSU - CNRS
- MetOffice
- NERC (ARSF/BGS)
- INTA
- TAU
- GTK
- TU-BS
- FUB

- METAIR
- CNR-ISAFoM
- FZK
- MISU
- MPI-C
- NUIG
- UNIMAN
- IFT
- ANM
- AWI
- Geophysica
- EEIG
Networking activities: N3FF (Future of the Fleet)

**Tasks:**
- Identify obstacles and find technical solutions to a unified management of Transnational Access (Transnational Access at Equal Terms through national funding)
- Evaluate existing fleet capabilities
- Elaborate on possible enhancements of the fleet following user’s needs (Large Scale Facility...)

**Deliverables:**
- Report on past activities of the fleet
- Report on technical obstacles to Trans-national Access, and solutions to facilitate ETTA
- (new) Report on the scientific impact of airborne research
- Operators views on gaps in the European fleet
- Proposal to ESFRI for the construction of a new pan-European infrastructure.

**Coordinator:**
- Météo-France

Networking activities: N4EWG (Expert Working-Groups)

**Objective: Improve cost/effectiveness of airborne research by:**
- Reducing duplication of new developments
- Sharing expertise
- Harmonizing procedures for instrument calibration, airborne measurements and data processing

**Deliverables:**
- Expert workshops
- Reports with advices to Researchers, Operators, Funding agencies
- Instrumentation and calibration database

**Coordinator:**
- MetOffice, UK
Networking activities: N4EWG
Achieved/Planned on March 2007
(Month 30/48)

- Certification and Operations
- Aerosols
- Gaz phase chemistry
- Imaging remote sensing
- Microphysics
- Radiation
- Thermodynamics
- Turbulence
- Data processing
- Active remote sensing
- Solid-Earth Geophysics
- (new) Instrumentation design and integration

Networking activities: N5ET
(Education and training)

- Objectives:
  - Promotion of airborne research in European academic community, especially dedicated to young scientists

- Deliverables:
  - Two opportunities are offered to students through EUFAR Education&Training:
    1. Get 100% funding for flight hours, including scientific and engineering support for integration of instruments, data analysis, etc
    2. Join researchers in existing field campaigns (benefit of training by the host research group and participation to research flights and data analysis).
  - (new) Organisation of two summer schools on airborne measurements:

- Coordinator:
  - National Administration of Meteorology (ANM), Romania
Networking activities: N5ET
Achieved on March 2007
(Month 30/48)

E&T : Join a field experiment

<table>
<thead>
<tr>
<th>Application status</th>
<th>On March 12, 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received</td>
<td>15</td>
</tr>
<tr>
<td>Not Eligible</td>
<td>0</td>
</tr>
<tr>
<td>Selected by UGSP</td>
<td>14</td>
</tr>
<tr>
<td>Rejected by UGSP</td>
<td>0</td>
</tr>
<tr>
<td>In Evaluation</td>
<td>1</td>
</tr>
<tr>
<td>Achieved</td>
<td>13</td>
</tr>
</tbody>
</table>

Networking activities: N6EC
(E-Communication)

Tasks:
- Upgrades / maintenance of the EUFAR website
- Online Transnational Access and Education&Training projects selection procedures
- Database: aircraft, instrumentation, publications
- EUFAR fleet planning
- Expert Working Groups mailing-lists

Coordinator:
- Meteo-France
Access is offered through EUFAR TA activity to 24 instrumented aircraft, ranging from low and slow flying small single engine aircraft to 4 engine turbo-jet aircraft carrying several tons of instrumentation payload.

Priority to new inexperienced users and researchers from countries which do not operate similar infrastructures.

Fast and effective online selection procedure. Applications to be submitted at www.eufar.net.

**Figures:**
- 3M€ available for experiments
- 44 research projects to be funded (450 flight hours)
- 24 aircraft

**Coordinator:**
- MetOffice, UK

**TOTAL AIRCRAFT:** 24

<table>
<thead>
<tr>
<th>OPERATORS</th>
<th>CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geophysica</td>
<td>Geophysica</td>
</tr>
<tr>
<td>DLR</td>
<td>F-20</td>
</tr>
<tr>
<td>UoE</td>
<td>Learjet</td>
</tr>
<tr>
<td>ENVISOPE</td>
<td>ATR-42</td>
</tr>
<tr>
<td>GEOSCH</td>
<td>Bae-146</td>
</tr>
<tr>
<td>NRAC</td>
<td>Do-228</td>
</tr>
<tr>
<td>INFA</td>
<td>Casa 312</td>
</tr>
<tr>
<td>TAU</td>
<td>King Air 200</td>
</tr>
<tr>
<td>GTK</td>
<td>Flamingo</td>
</tr>
<tr>
<td>TU-SW</td>
<td>Caravan</td>
</tr>
<tr>
<td>TUB</td>
<td>Do-228</td>
</tr>
<tr>
<td>METAIR</td>
<td>Centro 207</td>
</tr>
<tr>
<td>ISAFoM</td>
<td>TMG-ASK-16</td>
</tr>
<tr>
<td>FZK</td>
<td>My-Aircraft</td>
</tr>
<tr>
<td>IMA</td>
<td>Microlight</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>
Transnational Access Activity
User Group Selection Process

Organization:
• 1 Overall User Group Selection Panel
• 6 Category User Group Selection Panels
  • Stratospheric aircraft
  • High Level Jets
  • Large Aircraft
  • Medium Size Aircraft
  • Low Level Aircraft

Online selection procedure:

---

Transnational Access Activity
Achieved/Planned on March 2007
(Month 30/48)

44 research projects to be funded (450 flight hours)
24 aircraft

<table>
<thead>
<tr>
<th>Application status</th>
<th>On March 12, 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received</td>
<td>47 (of which 5 E&amp;T)</td>
</tr>
<tr>
<td>Not Eligible</td>
<td>5 (of which 1 E&amp;T)</td>
</tr>
<tr>
<td>Selected by UGSP</td>
<td>20 (of which 1 E&amp;T)</td>
</tr>
<tr>
<td>Rejected by UGSP</td>
<td>5</td>
</tr>
</tbody>
</table>
| In Evaluation              | 17 (of which 3 E&T) | 39 %
| Achieved                   | 14 projects, 115 Fl hours, 10 aircraft | 32 % , 26 % , 42 % |
Joint Research Activity: Description

- **Design of an Aerosol Reference Pod (under-wing container)**
  - Fits on more than 50% of EUFAR aircraft
  - Used for inter-calibrations

- **Suite of instruments:**
  - Concentration (condensation particle counters - CPCs)
  - Ambient size distributions (X-probe)
  - Dry size distributions (differential mobility analysers + CPCs, optical particle counter)
  - Optical properties (nephelometer, soot photometer)
  - Thermal volatility (heated/unheated ADENA CPC)
  - Chemical composition (cascade impactor, filters)

- **Coordinator:**
  - UNIMAN, UK

---

**Joint Research Activity: Partners + Agenda**

- **6 partners:**
  - **Name of institution**
  - **Task**
    - UNIMAN, UK
      - Coordinator
      - Aerosol optical properties
    - Enviscope, Germany
      - Instrument, Inlet, Distribution line manufacture
    - Météo-France
      - X-Probe (ambient sizing)
      - Pod survey
    - NUI, Ireland
      - Calibration
    - IFR, Germany
      - Flow/particle modeling
      - Pod survey
    - MPIC, Germany
      - Aerosol optical properties

- **Agenda:**
  - **Selection of Pod / Instrumentation**
    - Year 1: Instrument, Inlet, Distribution line manufacture
    - Year 2
    - Year 3
    - Year 4: Tests and calibration
  - **Acquisition software + Certification**
Trans-national Access at Equal Terms

- Most airborne facilities (all the big ones) are subsidized;
- Airborne operation (real) costs are high (~6 to 12000 € / hour
- Much higher than what is provisioned in National thematic funding programs
- (subsidized) access to a national facility is easy
- (real cost) access to a foreign aircraft is impossible, except as part of a European project, or as invited scientist

It follows that
- In each country, science is driven by availability of the infrastructures
- Field experiments not always performed with the most suited aircraft (when the one available at the national level is "almost" suited)
- Airborne research in not developed in countries which are not operating aircraft
The Community actions should also stimulate the coordinated development and networking of these infrastructures, and foster the emergence of new research infrastructures of pan-European interest within a medium to long term vision.

Integrating Activities: to ensure that European researchers may have access to the best research infrastructures to conduct their research by supporting the integrated provision of infrastructure related services to the research community at a European level and at international level when appropriate. Integrating activities should also aim at structuring better, on a European scale, the way research infrastructures operate, and at fostering their joint development in terms of capacity and performance. Emphasis should be given to the efficient and coordinated implementation of transnational access and service activities.
www.eufar.net: aircraft planning update

1. Local System + Link to the EUFAR server
2. EUFAR central server + terminals
The EUFAR initiative has been submitted to ESFRI via the French delegate and it is presented to EMEG by Meteo-France, EUFAR co-ordinator, on behalf of the EUFAR I3.

This initiative shall therefore not be regarded as a French proposal, but as the proposal of a European Consortium.

**Scientific Research Fields supported by Airborne Research**

The following statistics summarize the activities of the whole EUFAR fleet over the period 1997-2005 per scientific field.

A total of 26598 hours flown over the period 1997-2005.

An annual average of 2955 flight hours.
Consequences of the national fragmentation in the construction of airborne infrastructures

The M55, for stratospheric research (CAT1), belongs to a Russian company and it is operated for research in Europe by the Geophysica EEIG. The long term sustainability of this aircraft however is not presently secured.

For tropospheric research, there is presently no heavy-payload and long-endurance aircraft in the European fleet. Germany has recently succeeded to purchase and equip a heavy-payload and long-endurance (12-16 h) jet, «HALO». This aircraft, a Gulfstream 550, is the most performing aircraft available today on the CAT2 market. It will be equipped and become operational for research in 2009.
With its endurance of 5.5 hours, the UK BAe146 is limited to a few hours of scientific work over remote (oceanic or polar) areas.

The concept of flying laboratory

This concept has been developed since many years by the National Center for Atmospheric Research of the US-NSF (NCAR). More than 20 scientists, from USA and Europe, have been collecting data together on board the NCAR C130 during the RICO campaign.
This graph shows the evolution, from 1994 to 2003, of the number of publications in refereed journals for the three aircraft separately, as well as the total number of articles per year.

The smaller publication rates from 1994 to 1998 may reflect a bias due to the internet reference search engine because some data bases are not yet completed for these years. This bias will be corrected in the final report, after confirmation and additions by the authors.

The following statistics measure the scientific impact in terms of annual publication rate, citation rate per article, # of published paper per flight hour and per euro spent.

<table>
<thead>
<tr>
<th>From 1994 to 2003</th>
<th>ARAT-F27</th>
<th>DLR-F20</th>
<th>UK-C130</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of papers</td>
<td>48</td>
<td>117</td>
<td>197</td>
</tr>
<tr>
<td>Total number of citations/ # of articles documented*</td>
<td>370/46</td>
<td>871/71</td>
<td>2379/152</td>
</tr>
<tr>
<td>Citation rate/article</td>
<td>8.0</td>
<td>12.3</td>
<td>15.7</td>
</tr>
<tr>
<td>Average flight hours / year</td>
<td>157</td>
<td>307</td>
<td>307</td>
</tr>
<tr>
<td># papers / FH *100</td>
<td>31</td>
<td>38</td>
<td>64</td>
</tr>
<tr>
<td>Flight hour cost (CAATER)</td>
<td>7440</td>
<td>10238</td>
<td>12860</td>
</tr>
<tr>
<td>Annual k€ spent</td>
<td>1168</td>
<td>3143</td>
<td>3948</td>
</tr>
<tr>
<td># papers / C spent * 10^6</td>
<td>4.1</td>
<td>3.7</td>
<td>5.0</td>
</tr>
</tbody>
</table>

* All published papers have not yet been documented in terms of citations
### Technical solutions

Three aircraft models have already been identified that fulfil EUFAR requirements:

<table>
<thead>
<tr>
<th>Designation</th>
<th>Loocked C130</th>
<th>CASA C295</th>
<th>AIRBUS 400M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft cost</td>
<td>10 M€</td>
<td>23 M€</td>
<td>70+ M€</td>
</tr>
<tr>
<td>New avionics</td>
<td>10 M€</td>
<td>included</td>
<td>included</td>
</tr>
<tr>
<td>Modif. for Res.</td>
<td>10 M€</td>
<td>Not quoted</td>
<td>Not quoted</td>
</tr>
<tr>
<td>Payload at 10h</td>
<td>10 T</td>
<td>3.5 T</td>
<td>10 T</td>
</tr>
<tr>
<td>Produced A/C</td>
<td>~1000</td>
<td>&lt;40</td>
<td>Launched 2009</td>
</tr>
<tr>
<td>Past exp.</td>
<td>UXMO, NASA, NCAR</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Ann. op. costs</td>
<td>&lt;1 M€</td>
<td>&lt;1 M€</td>
<td>&lt;1 M€</td>
</tr>
<tr>
<td>+ +</td>
<td>Best perf/cost ratio</td>
<td>Modern A/C</td>
<td>Modern A/C</td>
</tr>
<tr>
<td>--</td>
<td>old A/C (30 y)</td>
<td>Only 2 props Lim. security</td>
<td>No exp. on struct. modif.</td>
</tr>
<tr>
<td>Total cost</td>
<td>40-60 M€</td>
<td>40-65 M€</td>
<td>90-110 M€</td>
</tr>
</tbody>
</table>

### Design & Construction : Agenda

From Year 0, the project will progress according to the following agenda:

- Year 0 (t0): Definition of aircraft and instr. requirements
- Year 1: Call for tender & selection
- Year 2: Design review
- Year 3: Realisation of the aircraft modifications
- Year 4: Flight tests & certification
- Year 5:
- Year 6:

Timeline:
- 2007: DCP
- 2013: OP
The activities of the OP Group during the 6 years of the DCP amount to:

Personnel : 2.6 M€
Functionning : 1 M€

i.e. an average of 0.6 M€ annualy

<table>
<thead>
<tr>
<th>Level</th>
<th>Cost per year [k€]</th>
<th>Total Man-Month</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project leader</td>
<td>Senior engineer</td>
<td>60</td>
<td>61</td>
</tr>
<tr>
<td>Secretary</td>
<td>Bilingual secretary</td>
<td>20</td>
<td>64</td>
</tr>
<tr>
<td>Administrative and legal</td>
<td>Engineer</td>
<td>50</td>
<td>64</td>
</tr>
<tr>
<td>Engineer for scientific modification</td>
<td>Senior engineer</td>
<td>73</td>
<td>64</td>
</tr>
<tr>
<td>Engineer for scientific electric power</td>
<td>Engineer</td>
<td>66</td>
<td>46</td>
</tr>
<tr>
<td>Aeronautical engine: certification</td>
<td>Engineer</td>
<td>66</td>
<td>26</td>
</tr>
<tr>
<td>Engineer for Data acquisition</td>
<td>Engineer</td>
<td>66</td>
<td>35</td>
</tr>
<tr>
<td>Engineer for numerical simulation</td>
<td>Senior engineer</td>
<td>73</td>
<td>12</td>
</tr>
<tr>
<td>Designer</td>
<td>Technician</td>
<td>43</td>
<td>38</td>
</tr>
<tr>
<td>Aircraft mechanics engineer</td>
<td>Engineer</td>
<td>66</td>
<td>46</td>
</tr>
<tr>
<td>Pilot</td>
<td>Senior engineer</td>
<td>73</td>
<td>13</td>
</tr>
<tr>
<td>Scientific instruments technician 1</td>
<td>Technician</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>Scientific instruments technician 2</td>
<td>Technician</td>
<td>44</td>
<td>40</td>
</tr>
<tr>
<td>Technician: Documentation quality</td>
<td>Technician</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>Engineer for numerical simulation</td>
<td>Senior engineer</td>
<td>73</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>2577</td>
</tr>
</tbody>
</table>