

Summary and Conclusions of the EUFAR workshop of experts in Atmospheric Remote Sensing (ARS) held in Paris on May 3rd, 2002.

The main points addressed during the workshop have been:

- the presentation of the activities in ARS in the different groups represented, highlighting existing instruments and future developments
- a starting discussion on the definition of recommendations of the ARS expert working group about the improvement of existing systems, and the identification of needs.

The presentations of the experts will be made available on the EUFAR web site as a proceedings of the workshop.

Jean-Louis Brenguier (CNRM, France, administrator of the EUFAR programme) also presented the objectives of the EUFAR action and the role of the expert working groups (EWG).

A. Role the ARS expert working group

The EWG has to:

- 1) Provide information on all existing systems (airborne, or considered to be airborne in the near future).
- 2) Provide a list of references (publications in scientific journals) about the instruments and applications.
- 3) Prepare the future: improve the accessibility to airborne ARS systems to a larger community through the creation of instrument operational services (similar to the aircraft operational services), including existing large scale facilities (e.g., DLR) and new small-scale facilities certified by EUFAR; avoid the duplication of systems through an improved coordination between groups. This latter point is motivated by the possibility to propose new developments in joint RTD projects to be funded by the ESF.

The EWG is expected to draw recommendations:

- 4) to operators (on how to host standard ARS instruments)
- 5) to users (on how to design experiments with the proposed ARS instruments)
- 6) to the institutions and to the EC (on which reference or standard instruments should be supported).

The timetable is:

- 7) 12th June 2002: management meeting: the EUFAR needs recommendations from the EWGs.
- 8) End of August 2002: a scientific report is requested from the EWG (including results from the workshop)
- 9) End of year 2002: a proposal of RTD project on the development of a few standard ARS instruments that would be operational on different platforms.

A questionnaire has been provided by the EWG coordinator (Olivier.Bock@aero.jussieu.fr) to document points 1 and 2, which was filled in by the different groups involved. This questionnaire highlighted how the systems are operated (attended or unattended, qualified personal...), how they are calibrated (identifying existing calibration facilities which might serve to other instruments) and how the data are processed and corrected for biases. It has been asked to the experts to be ready to provide this information to the EUFAR web site (Back office access).

It is important that the references be related to the specific EWG, so that they appear when instruments or applications belonging to this EWG are selected.

The coordinator will check the completeness of the information.

B. Review of measurement needs

During the discussion, the needs for measurements using active remote sensing and the use of existing instruments or the development of new instruments providing these measurements have been reviewed. An attempt has been made to identify standards in each field and to state on the existence or need for developing such standard instruments.

1. Meteorological applications: need measurement of pressure, temperature, humidity and wind profiling.

1.1 Pressure

It might be obtained on the vertical with enough precision from numerical weather prediction models. Potential need of good accuracy surface pressure (better than 0.5 hPa). Not an issue for ARS.

1.2 Temperature

The needed accuracy is better than 0.2 K. It is extremely difficult to obtain using ARS. It might be obtained with enough precision from standard measurements, passive remote sensing and numerical weather prediction models.

1.3 Humidity

Need of profiling with good accuracy. Differential absorption lidars (DIAL) in near IR or IR, or Raman lidars (in visible or UV region) can be used. Existing airborne systems in Europe are DIAL systems at DLR in Germany and IPSL in France. These are research systems.

1.4 Wind

Wind can be measured by Doppler lidars in clear air or Doppler radars in clouds (some radars may be used in clear air). Existing lidars are based either on CO₂ lasers, which however are no longer manufactured, or on near IR laser (2 μm , e.g. manufactured by CTI, USA). The existing systems (in Europe) are research systems and might not in present state be considered as unattended systems. New near IR lasers are recommended for eye-safety reasons, and for the possibility to use small size solid-state systems (1.55 μm laser sources, manufactured in Japan, might be considered).

2. Chemistry

2.1 Minor constituents:

- O₃, SO₂...: mostly UV lidars are operational, though not as unattended systems. Existing at IPSL.
- CH₄, CO, OH... : no operational techniques yet. Some measurements have been done. Measurements in the infrared are possible for CH₄ and CO, in the UV for OH.

2.2 No other species can be easily measured in non-polluted conditions.

3. Climate

3.1 Species:

- CO₂: lidars at 1.5, 2 and 10 μm are possible. Only prototypes exist yet.

3.2 Aerosols:

can be sensed by lidars. Aerosol structure (layer height) is easily measured by backscattering lidar. Commercial systems are available. Optical and microphysical parameters: can be measured but systems are complex. Retrieval provides qualitative results: type of particle: spherical / non-spherical particles (through depolarization measurements), extinction profiles (through HSRL systems). Existing systems are research instruments (except for visibility measurements, e.g. at airports).

3.3 Clouds:

can be measured by lidar and radar. Optical and microphysical parameters: can be measured by lidar and radar. Radar systems are mostly research instruments. Some commercial systems are

available from Degreane company, France. Lidar systems are the same as those used for aerosol sensing. Combined systems (radar + lidar) have been demonstrated.

There is a need for having systems for identifying icing conditions (airports).

4. Surface: hydrology and biosphere

4.1 surface characterization (land / ocean):

roughness (ocean), canopy and surface analysis can be measured with lidar and radar (measurement of surface reflectivity)

4.2 ocean and surface waves:

can be measured with combined systems

4.3 river flow:

can be possibly measured with Doppler lidars.

C. Recommendations

Three types of systems can be distinguished: standard / research / development.

In order that a wider community of users can use existing research systems, a series of standard instruments should be finalized with associated data processing softwares delivering standard products. Standard systems can be considered for backscattering, water vapor and ozone measurements. Such systems should be either ruggedized systems, already existing or new ones developed as industrial systems on the basis of existing systems.

Real-time processing should be considered, which is required in order to conduct coordinated experiments with multiple aircrafts (e.g., a high altitude profiling instrument guiding an in-situ equipped aircraft). Processing, analysis and coordination might be done at a ground-based facility in real-time.

New research systems should be developed for CO₂ and cloud measurements. Proposals should be addressed to institutions.

D. Future work for the ARS-EWG

A table (Table A) is required to summarise the needs (to be done by O. Bock beginning of June from the discussion). Identify the uniqueness of research systems to meet measurement needs.

A table (Table B) is required to summarise the status of the instruments (to be done by O. Bock beginning of June from the presentations and questionnaires). Identify the existing equipment and a/c requirements: which a/c, versatility, certification issue, transportability (e.g. pods).

Main actions for the short-term:

- Complete questionnaire on existing systems from which table B can be derived (to be done by the experts)
- Complete recommendations for the 12th June management meeting
- Conduct reflection on how to improve the service (delivery date : 2004)
- Define the need and objectives for a next meeting (possible with another EWG).

Document written by O. Bock and J. Pelon, Paris, 25 May 2002.