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Foreword

The exploration of space and the utilisation of space-based platforms has progressed spectacularly over the past 40 years, since the launch of Sputnik. During this time, Europe has developed an enviable capacity by working together in both space science and technology.

The European Space Science Committee (ESSC) established soon after the European Science Foundation itself has developed an important role in providing a voice for the scientific community in Europe in all matters concerning space and in representing science in the various administrative and political structures which exist in Europe

In this ESF policy briefing, the European Space Science Committee takes the opportunity to set out its views on the future of space-based research in Europe. The recommendations presented here integrate two previous sets of ESSC recommendations first published in May 1999.

The first position paper ^(ref.1) was drafted in preparation of the Council of Ministers of the European Space Agency which took place in Brussels on 11-12 May 1999. The second set of recommendations ^(ref.2) was circulated to executives within the European Union and addressed the issue of the role of the European Union in defining and implementing a global European space policy.

It is the Committee's hope that by integrating these recommendations in this current policy briefing they will serve as a useful contribution to the definition of a European space policy by the various actors involved.

Enric Banda
 ESF Secretary General

Introduction

Europe occupies a world-leading position in science. A first class science base is essential to promote the common interests of Europe and to maintain its leading role on the international stage. Different aspects contribute to the region's preeminent position including cultural excellence, the maintenance of a high technology industrial base and the motivation of young people to engage in wealth creation. Since the start of the space-age in 1957, European institutions have adapted and evolved their practices to include the use of space-based techniques as an essential component of the continent's broadly based position of scientific leadership. The role of ESA is certainly crucial to maintaining this leadership.

However, during the past 20 years, new actors have appeared alongside ESA on the European space scene.

First, the European Union, by means of the European Commission now provides an additional component to the existing European space research programmes with a focus on the exploitation of Earth observation, telecommunications and navigation systems and for the support of a European space-based market.

Secondly, the establishment in 1986 of EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites) constituted a new and important factor for the operational uses of Earth observation, which will become particularly apparent in the implementation of future missions such as METOP (Meteorological operational polar orbiting satellites of the EUMETSAT Polar System – EPS) or the ESA / Earth Watch series in which EUMETSAT may become involved.

Such activities together with the increased willingness of the European Parliament to play an active and strategic role in this domain have now reached a level that they challenge the traditional division of responsibilities concerning space in Europe. ESA is no longer the sole player in charge of establishing European strategies in this domain.

Towards a European space policy

The primary function of the ESSC is to represent the position of the scientific community in relation to European needs and priorities in space science and technology. We aim to focus our efforts on this fundamental mission, by providing an independent voice on European space science policy.

As indicated above, establishing such a policy was the traditional purview of the European Space Agency. However, the task has become an increasingly difficult one as Europe's space arena has increased in complexity. The involvement of additional actors constitutes an important additional component to existing European space research programmes (ESA's and national programmes).

The current situation calls for the definition of a long-term plan in Europe for space research in order to reduce duplication and maximise the return on investment. We believe that the ESSC-ESF can act as a catalyst to facilitate the necessary discussions between all the interested parties and ensure that the strategies defined take basic scientific research into account. To achieve this, a close interaction with existing initiatives of the European Commission such as the Baveno group ^(ref.3) is necessary.

The aim of the European Union to acquire an important position in defining such a policy for Europe in space has made necessary a redefinition of the respective roles of the various European actors. How this should be best achieved has already been discussed

and emphasised at a European Parliament Space Forum ^(ref.4). A good illustration of the emerging new order has been provided by the process led by the Space Advisory Group of the European Commission to implement a European policy for Earth Observation from space ^(ref.5). Although the main line of the proposed research and development policy for the European Union aims at developing a market for space applications and having this market drive the development of Earth observation ^(ref.6), the ESSC insisted on the need to maintain a strong reference to space research *per se* in the rationale for this policy along two directions by improving:

- our knowledge on the planet Earth, and
- our know-how in applying the Earth sciences data to respond to the users' needs.

The EC Fifth Framework Programme is now in place. Although it includes many different space components, it does not address space and space research *per se*. The ESSC endeavours therefore to convince decision-makers that the European Union should identify a programmatic and financial niche where space science research in general could be dealt with. This obviously is not the task of the ESSC alone, but a joint effort of all components of the ESF.

The ESSC was given observer status to attend the last ESA Council of Ministers and was able to present its recommendations to the Ministers present.

On the following pages, opportunities and difficulties are outlined briefly for each of the disciplinary fields falling within the remit of the Committee, taking into account decisions on missions and activities which have already been taken by Ministers.

Microgravity research and life sciences

At the November 1995 Council of Ministers of ESA Member States held in Toulouse, France, European Ministers agreed to participate and make a significant investment in the International Space Station (ISS) programme. Special emphasis was put on the use of the ISS by European industry. The ISS is now becoming a reality. In view of this large investment for the participating European countries, a strong utilisation programme must be established in order to exploit fully the important opportunities for research. The development of such a medium- and long-term programme in microgravity research and life sciences requires the definition of a reliable flight strategy for scientific experiments.

If the already strong position of the European community in both these fields is to be further enhanced, a clear recognition of the distinction between basic and applied research is required and activities need to be developed in parallel with adequate financing. However, current obstacles to such progress include the relatively low level of ESA Member States' support for the provision of experiments within the ESA *optional* programme, as distinct from the "mandatory" programme subscribed to by its Member States.

- Support needs to be provided at a sufficient level to enable the scientific and technical exploitation of the ISS planned in ESA's EMIR-2 (European Microgravity Research Programme) extension programme.
- The EMIR-2 extension programme which was agreed at the ESA Council of Ministers in Brussels has only achieved a level of subscription of € 48 M at 1998 cost levels. An appropriate level of national funding for flight experiments is thus needed at an early enough stage to allow for the preparation of approved experiments in a reliable and cost-effective manner.

The European Space Agency is providing some of the facilities to be

installed on board the ISS. However, in order to optimise the scientific and technical return upon this investment, as well as to secure the basis for the commercial use of the ISS by European industry, an efficient preparatory programme must be implemented on a European-wide basis.

This clearly falls within the remits of both ESA and the European Commission. It is important therefore that ESA and the EU find an equitable way to share the funding of the ground-based research required to underpin and maximise the scientific return of space missions.

Finally, while ESA and NASA have made every effort to provide more flight opportunities, it is clear that the only remaining platform in the future will be the ISS. Consequently, there remains a significant time gap without microgravity flights in the period before the ISS becomes fully available for scientific applications. This interval may be extended further by ISS schedule delays.

Therefore we recommend that:

- (1) there is access to and resources for at least one flight per year for a microgravity dedicated mission of the Columbia shuttle;**
- (2) ESA develops and uses a retrievable free-flying platform** ^(ref.1), **e.g. of the improved FOTON (Russian automated and retrievable capsule for life and microgravity sciences) type;**
- (3) the European Commission recognises the ISS as a "Large Research Facility" and consequently supports its access by European users, through Framework Programmes;**
- (4) the utilisation of the ground segment of the ISS (the so-called USOCs and UHBs¹) be co-funded by the European Union, with the aim of developing simulation experiments by the users and stimulating dissemination of the data;**

¹ USOC = User Support Operation Centre;
UHB = User Home Base.

- (5) Framework Programmes should encourage proposals from industry on the basis of integrated research teams, in order to encourage the use of the ISS by European industries and so increase their competitiveness. Such teams, networks, “clusters” or “virtual institutes” for applied research are now being advocated by various actors in Europe ^(ref.7);
- (6) that cosmo(exo)-biology, a newly emerging discipline, be supported and included by ESA and Member States in science missions such as planetary exploration. ESF-ESSC is willing to work with ESA in developing this multi-disciplinary topic at the European level.

Earth observation

Environmental science is evolving rapidly towards the prediction of changes in the natural environment. Regional and global change in our environment represents a challenge for the scientific community because of the necessity to understand and predict any changes and assess their significance and, where necessary, to help mitigate the effects of such changes. New observations are essential for meeting this challenge including Earth observations (EO) from space. Satellites also have an important role in monitoring and detecting changes, and assessing the significance of possible changes.

EO data has a number of different scientific uses, from curiosity-driven investigations for understanding the Earth system to vital economic applications (e.g. weather forecasting, natural hazard prediction and crop prediction and monitoring). Skill and competence in EO are especially important for ensuring compliance with environmental legislation and in particular for securing the implementation of international agreements such as that made at Kyoto on greenhouse gas emissions. An independent European capability in these areas is essential to underpin future negotiations and policy decisions. These issues were debated during the Fourth SAI² Annual User’s Seminar held in Baveno, Italy, on 18-19 May 1999. A good number of presentations, including the ESSC’s comments, stressed the need for effective coordination between European space agencies and the European Commission, which were deemed important for carrying out the programmes.

The ESA proposals for a continued programme in EO and the approval by the Ministers meeting in Brussels of an envelope programme to support underpinning research are very welcome and fully in line with earlier ESSC recommendations. The excellence of the science proposed by ESA has emerged from the highly effective peer-review process used in selection. As a

² The Space Applications Institute of the European Commission Joint Research Centre

result, all four of the Core Earth Explorer missions (evaluated by the scientific community during ESA's workshop held in Granada on 12-14 October 1999) currently proposed by ESA have generated very strong interest among the scientific communities of the Member States. The development of the Earth Explorer Opportunity Missions is also very welcome.

However, to retain the support of these communities, missions must be timely and cost effective when proposed and must remain so. They must deliver observations sufficiently quickly so as to remain relevant within the normal cycle for the evolution of scientific ideas. This usually means that they should be launched within three years of being proposed. Missions should be focused to address specific questions. This usually implies that they will be small missions.

We agree with ESA that it is essential to involve practising scientists in conjunction with industry throughout the development of scientific EO missions to ensure that they meet their scientific goals in a cost-effective manner. The interaction between scientists and industry in proposing and developing new missions should be strengthened. The technology development programme plays a vital role and must be directed at developing the new technologies required to answer the highest priority scientific challenges in environmental sciences. External peer-review and advisory committee mechanisms will help to ensure this direction.

The changed EO programme of ESA has implications for national agencies and other European bodies. Effective exploitation requires trained environmental scientists who are able to use the new observations and who can interact with the aerospace industry. This implies the training both of established scientists in a range of disciplines and of new scientists. Rigorous interdisciplinary training is not always easy in existing educational structures and needs to be addressed within the

ESA Member States. New research and development programmes will be required to effectively exploit the new observatories in Member States and European organisations.

There must be adequate support of the preparation for scientific missions in Member States so as to ensure that they are well-focused and that the observations will be used effectively. Support of appropriate distribution and archiving of data is also essential if the observations are to be easily accessible by the scientific community. The overall ESA and other European programmes must encompass such long-term possibilities. Space data often represent very valuable and unique resources, but for a number of reasons, there are barriers to the best use of these observations. Programmes within the EC Fifth Framework Programme should address these problems in the context of the scientific use of the data.

EO data are often used scientifically in conjunction with numerical models in order to predict and understand possible changes. The observations are used to provide the models with initial and boundary conditions, to validate these models, improve their parameterisation, and to detect and monitor changes. Specific sets of observations are often used in conjunction with other sets of observations. A powerful technique, often called "assimilation", may be used to blend the observations constrained by our models, to provide an estimate of the observed environment.

It is therefore the feeling of the members of the ESSC that a European Union programme related to Earth observation needs to be constituted of several key elements:

- (1) the European Commission should support the technological research needed to develop an approach for space-based observations, for the development of appropriate detectors and of software and data processing techniques, in close co-operation with ESA;**

- (2) the implementation of operational systems to answer European needs must also be supported;**
- (3) validation of the programmes, including the use of ground- and air-borne observations, should be a sine qua non;**
- (4) the European Commission should provide the means to ensure that there is a clear understanding of the observations, including radiative transfer modelling and assimilation into environmental models;**
- (5) training of scientists for working with satellite observations must be developed, e.g., through the Fifth Framework Programme Horizontal Programme on "Confirming the International Role of Community Research";**
- (6) archiving and distribution of results and transfer of proven successful methods to the community at large, should be supported.**

In order to implement such working procedures and to ensure that responsibilities are efficiently shared, the various partners in the European space arena (European Union and Commission, ESA, Eumetsat, etc) should meet to discuss this specific issue. The ESF considers that the ESSC could serve as the link between these bodies to facilitate the organisation of such an event. As stated previously, already existing co-ordinating initiatives such as the 'Baveno group' have an important role to play here. In particular, the need for long-term climate monitoring has been assessed by most European partners and will need to be dealt with in a concerted way.

To discuss this specific issue, the ESSC wishes to organise in 2000 a European gathering (scientists, agencies, end-users, etc) for which the support of the European Commission will be sought.

Space science

Classical space science is more the purview of ESA and is not a priority for the European Commission's Framework Programmes.

The ESA scientific programme is community-defined and driven. It shows balance and coherence in the range of science topics that are pursued and has resulted in European world leadership in many scientific areas. The programme has evolved significantly since 1995 in response to the reduced purchasing power agreed at the Toulouse Ministerial Conference so as to preserve programme integrity and aims. Given the outstanding success of the mandatory ESA Horizon 2000 programme, the scientific excellence of the ESA science programme was reaffirmed and continued approval agreed at Toulouse in 1995.

The Brussels Ministerial Conference also praised the science programme of ESA but approved continued support only until 2001. Significant reductions in financial resources compared to the situation envisaged at the time the Horizon 2000 programme was established may render its implementation more difficult in the coming years. Flexibility has been introduced in the programme, with the advantage of quicker adaptation possibilities, but also with the danger of losing (i) the capability to establish a truly long-term mandatory programme, and (ii) some of our areas of leadership *vis-à-vis* other international space agencies.

Specific developments in this programme include:

- (i)** substitution of the "medium-class" missions by scientifically more focused missions at much reduced cost;
- (ii)** introduction of technology demonstration missions as precursors of "cornerstones", with substantial scientific potential';
- (iii)** improved project implementation procedures resulting in significant cost savings.

Thus the scientific breadth and competitiveness of the programme has been safeguarded although with very little room for new initiatives and with increased programme risk. In addition, following the reduction in purchasing power, the prospects for European independence in future space science missions has been reduced and the programme is now in a critical situation with respect to coherence and balance.

Europe is involved in a very vital branch of science, which attracts a high oversubscription, leading to fierce competition ensuring the highest standards of scientific, intellectual and technological excellence. This involvement is crucial to European industrial competitiveness and cultural vigour.

Any further decline in financial support (i.e. purchasing power) would endanger this perspective since:

- (1) if coherence is lost, the programme will disintegrate and the major players will leave the field, reducing our ability to respond adequately to new developments in space science;**
- (2) Europe would again become much more dependent on non-European mission opportunities and cease to be a main player on the world scene in space science;**
- (3) space science is a large-scale, supranational, interdisciplinary activity and the loss of the ESA programme would be particularly damaging for the smaller countries in Europe, as they would no longer be able to participate in these endeavours on a national scale;**
- (4) space science would no longer be available as a key catalyst in the inspiration and training of young Europeans.**

Loss of European autonomy in space would be a prelude to a more general loss of European scientific, technological and industrial competitiveness.

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European Science Foundation

The European Science Foundation (ESF) is a non-governmental association of 65 leading national science funding agencies and other organisations that carry out and promote research from 22 European countries. The role of ESF is wide ranging and is based on advancing cooperation in research in Europe, examining research issues from a strategic viewpoint and providing advice on science policy matters.

European Space Science Committee (ESSC)

The ESF European Space Science Committee (ESSC) provides Europe's scientific expert committee on space research related issues.

Established in 1975, ESSC covers space physical science, earth observation and microgravity. It investigates and presents the views of the scientific community in Europe and provides an independent voice on European space science policy.

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