Panel Discussion

Chairman :

Prof. J. Askne (JA)

Panel Members :

Dr. D. Massonnet (DM)
Prof. D. Nüesch (DN)
Prof. G. Petrie (GP)
Prof. G. Konecny (GK)

JA: **Seed Questions for the discussion**:

What is the need for topography from space?

Are there any special (geographical) areas of specific importance?
What are the requirements?
What are the demands on the satellite systems?
What can be achieved with present and planned systems?
What can be achieved with future systems?
What are the major obstacles to solve?
What useful by-products may we obtain in the work to determine topography?

GK: We have seen that there are possibilities as well as difficulties in producing topographic maps by using different techniques. We should not separate topographic mapping from general mapping – it is a huge amount of money that goes into mapping, about 0.1% of the world's GNP. Large areas of the world are mapped, but there is always a need for updated products since the maps we have are too old. Two areas of great importance are the environment and global change: Antarctica and the great ice sheets are not mapped at all. Monitoring of the Antarctic is an open question – no topographic maps exist.

GP: Topography from space is mainly for tackling remote areas, deserts and ice sheets. For most of the Earth a map revision is required. It is becoming more and more important for developing countries. Mapping from space, either from radar or from optical sensors, is very interesting since data acquisition is often the big problem. It would be interesting to have more evidence from national mapping agencies that they think that it is worthwhile. A real survey of mapping agencies needs to be seen.

DN: I feel ashamed that we have better maps of Venus than of the Earth. But I do not think that we should try to come up with new sensors for new things. We already have good tools to do a better job than we have done before. We are research scientists, excited about specific results, but what about economic justification? Politicians speak a different language and there is a gap between us and them. Funding is difficult. So we should try to justify the systems we have and persuade politicians to grant funding to do even better.

JA: What about the ERS-1/2 tandem mission? Guy Duchussois is interested in our opinion on this question. The funding for the mission is to be decided in September, 1994.

DN: We have not only ERS-1 and -2, we also have SPOT and new systems are planned.

JA: What accuracy can we achieve with INSAR systems?

DM: Processing with large orbital separation, e.g. an altitude of ambiguity of around 10m, would produce a DEM of about 1 m altitude resolution, at least over flat areas or areas with small relief. But the accuracy depends on what area we are mapping. The advantage of data already acquired with ERS-1 is that it offers a flexibility of choice between baselines. A flexibility that a fixed system like the ERS-1/2 tandem mission cannot offer. We prefer 100 m baseline for complicated topography but 800 m baseline for rather flat topography. I do not know which area is the most important.

JA: ESA discusses 50 m and 150 m baselines for the tandem mission. Do you think that such baselines are reasonable?

DM: This needs careful consideration depending on the type of surface. For mountainous areas a baseline of 50 m is best, but what is the usefulness of working in mountainous regions rather than deserts and ice caps, which are rather flat? The baseline is a critical aspect.

DN: It depends on requirements. Height extraction requires longer baselines, differential interferometry requires short baselines. We also need to consider the operational aspects of the satellite. How do we get small baselines over California and longer over Africa? It is difficult, we cannot get it all. A compromise is necessary, pick something between 50 and 800 m.

JA: What about other sensors and satellite systems?

GK: What can be done with satellites? Satellites are always technology driven and not user-demand driven. Therefore the sensors are not adapted to the science. We are trying to adapt our science to the sensors that are available. There is a gap between the demand from the users and the scientist that needs to be bridged. In the optical case, we are getting close to what we need with the increase in resolution and satellites that give global coverage.

Is not aircraft radar better designed for land applications than satellite radar?

There is a need to combine sensors – data fusion is important.

Calibration of a remote sensing system is disturbed by atmosphere, slope angle etc.

One third of the settled area of the Earth has a DEM of some kind. However, a 1 m geoid may be available in France and Scandinavia, but globally it is not. A reference system with an accuracy better than 5 m may be lacking in the rest of the world.

JA: What about future optical systems?

GP: 20 years have been wasted. Many parameters were defined 20 years ago, but we have never got what we wanted. Large Format Cameras (LFC) etc. have been available in the west but never deployed. Now with MOMS, ATSR and Russian photography, we are getting the systems that we need, with proper base, height ratios, resolution, etc.

(Floor) Dr. Sharov: New Russian spaceborne images are available. There are advantages and disadvantages compared with scanner data. We invite you to use both optical and radar image data together. We will start a new programme of topographic mapping on the 1:200.000 scale. Please assist us to produce a good example of what can be done with the new technology.

JA: Obstacles: Money is always a problem, but we must also present our views to the space agencies and make them work according to what we need. Are there any other major obstacles than money, technical etc?

GK: Why money, there is money around but it is around for different purposes. Too little emphasis has been put on the evaluation of what we really want to do, a demonstration of what we can do is considered enough. Space ministries believe that operational needs should be looked after by ministries of economics or environment etc. But they are not convinced. In all agencies, whether national, European or international, we are talking to science-oriented groups but not to the operational community. To demonstrate a technique costs a certain amount of money, but to put it into use is ten times more expensive. This is our big dilemma.

DN: Regarding the money, if there is money around where should it go? In new sensors – No. There are sensors around that are not well used. Generation of DEM is still too expensive for civil engineers or environmental planners. As long as a map sheet of 1:25000 scale costs 5000 $US, it will not be used.

GP: We had an "Operationalisation of Remote Sensing" symposium 20 years after the launch of Landsat, just to have a conference on that demonstrated what is wrong. Now 20 years later, operationalisation is being considered. Not only data acquisition, but also availability of all data should be considered. The JPL proposal about the global mapping mission should foresee how users can be involved at an early stage. An organisation has to be set up to do the processing and make data available to the users. Far more detailed studies of a system are necessary if we want to make a system operational.

DM: To produce a DEM on a global scale is not a great problem as regards data. We have data from SPOT and ERS-1. In my department we have processed data from about 1% of the Earth surface, we are limited by the amount of work not the amount of data. It is still very costly to produce a DEM, but comparing the costs to produce a DEM and the costs to put up a new satellite, existing data should be used.

DISCUSSION ON ERS-1/2 TANDEM MISSION

JA: **Seed Questions for the discussion**:

How should new data be analysed? Now or later?

Can a tandem solve any problems?

Can a tandem mission give any unique contributions?

What is our best estimate of the achievable accuracy of DEMs obtained by means of INSAR?

What are the most important areas to cover in order to obtain DEMs?

What is the best procedure to make use of a tandem INSAR results?

How do we obtain operational products?

Test sites?

Is the cost justified?

(Floor) C. Prati: At the moment a tandem mission can be considered a unique occasion – the added value is a repetition of the orbit every day – improvement of coherence and altitude accuracy over certain areas. Every 35 days we get an interferometric image couple that can be used to generate a DEM. Images that also can be used for differential interferometry, perhaps in combination with old ERS-1 data.

What is the best test site? We need to decide about that. This community should strongly recommend to ESA to have a tandem mission. It would be crazy to switch off ERS-1.

DM: We should not wear out ERS-1, but keep it to be able to take over if the ERS-2 mission fails in the future. ERS-1 data is a memory of the Earth. The real cost of the tandem mission is not only the money but also the potential loss of ERS-1/2 lifetime.

GK: We should not play the role of accountant. Radarsat or JERS-1 can take over. There may be an ERS-3. The added capability is worth the experimentation. Topography of Antarctica cannot be obtained by optical means. Anything we can get is better than what we have today, it should be tried.

DM: I am concerned about the total lifetime of the two missions. We can probably produce a DEM over Antarctica with data existing today. The cost/benefit ratio should be considered. What do we add with the combined mission versus the cost of a reduced life-time?

JA: Would it be possible to have coherence over the Antarctic or over glacier ice with the present system in a 35 days repeat cycle? Is not a one day repeat necessary?

DM: It is good to have data to allow things to be done but that does not mean that things will be done. We are not limited by data but we do not have the money to get things done.

GK: The EU could perhaps strengthen the use of the data in a similar way that SPOT Image does in France.

Other systems like the MOMS and the Russian systems are poorly marketed.

(Floor) A. Moccia: It might be problematic to get suitable baselines over the Antarctic with the tandem mission, due to the high latitudes.

(Floor) S. Madsen: On the other hand we will have much more data over the Antarctic so that we can average more and make up for the problem with small baselines. Decorrelation is a problem over the Antarctic. R. Goldstein (JPL) has studied glacier dynamics and he had to look through many data sets to find something useful. Weather is a serious problem in Arctic regions. Cutting the interval between passes to one day would be a great assistance.

DN: Additional comment to the lifetime of ERS-1: We have to take into account that nobody would ask for a continuous tandem mission. We would like to promote at least 2 to maximum 6 cycles, where 1 cycle is 35 days, which would take half a year, maximum, to a cost of 5 MAUs. Another problem with ERS-1 is the TWT, we are already running the backup system.

JA: A limited number of cycles is desirable but by how long will that shorten the life of the satellite is of course difficult to say.

DM: ERS-1 will be the only operational satellite during the ERS-2 commissioning phase. That gives us the opportunity to test the possibilities to do combined ERS-1/2 measurements.

The panel agrees that a number of cycles during the commissioning phase could be very useful for testing the possibilities of a tandem mission.

JA: There is a need for using the data – we have no organisation that takes care of this, but individual efforts only.

What are the possibilities of producing large numbers of DEMs from INSAR?

How do we organise the work?

(Floor) C. Prati: Milan University does not have the possibility of producing many maps. We are testing a semi-operational system using ERS-1 together with ESA/ESRIN – a software that should become available in the public domain.

JA: Are there similar ideas in the CNES group?

DM: Today we are able to generate interferometric products (not DEMs) covering about 6 or 7 million km²/year. The software can be used by people who are not necessarily experts. It can be proposed to industry, but there are no definite plans yet.

DN: We all agree that the big problem is personnel. A robust algorithm for fringe generation could be distributed to organisations who would take care of the generation of DEMs.

GK: My experience from the mapping industry is that the biggest problems are not technical but institutional. In the UK the government has to show cost/benefit ratio. If there is a production job then the industry can do it. DEMs are interesting for the telecommunications industry in developing countries, etc. and they might spend some money. Technical cooperation ministries in advanced countries may help.
We do not know if INSAR can work as an operational system. We know that SPOT data can, also aerial photography, at least within certain limitations – there is no need to concentrate on one system alone, cooperation is necessary.

FINAL COMMENTS

JA: A great deal is happening in the field. We are seeing new prospects. One question is: will more operational results be available than before? There is at least a fast development trend. Airborne systems are going to be used in specific areas. New optical systems such as MOMS, may be the most important for some of us while SAR interferometry may be more important for others in the years to come. We have many scientific challenges, but the biggest challenge is to work for operational products.