

THE EARSEC PROGRAMME IN RELATION TO THE 1991 MAC-EUROPE CAMPAIGN

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1. INTRODUCTION

The Joint Research Centre (JRC) of the European Commission and the European Space Agency (ESA) have initiated airborne remote sensing activities through a multi-year experiment plan. The project is called: EARSEC (European Airborne Remote Sensing Capabilities). The key-element within EARSEC is the establishment of an operational airborne system which includes:

- a fully polarized high spatial resolution C-and L-band SAR system;
- a multi-channel high spectral resolution imaging spectrometer.

The objectives are:

- to test and verify these highly innovative system types with respect to data processing, calibration and data interpretation;
- to test and verify the SAR system and the imaging spectrometer in support of (operational) projects (e.g. monitoring of agricultural production and tropical biomass burning);
- to complement and support ERS-1 pilot projects over European test sites.

2. EARSEC 1991 PROGRAMME

In 1990 JRC sent out a Call for Proposals for:

- the acquisition of remotely sensed data;
- campaign management;
- the improvement in existing airborne imaging spectrometers and airborne imaging radars;
- the improvement in existing imaging spectrometry and imaging radar data processors;
- collaborative contributions.

In 1991 EARSEC undertook the following activities:

- an airborne campaign using the GER II imaging spectrometer, flown by the German Aerospace Research Establishment (DLR), the CAESAR multispectral scanner (Ccd Airborne Experimental Scanner for Applications in Remote Sensing), flown by the Dutch National

Aerospace Laboratory (NLR). The campaign included aerial photography and ground measurements;

- improvement of the GER II imaging spectrometer to a new generation;
- state-of-art sensor called DAIS-7915;
- improvement to full polarization of the single polarized C-band SAR owned by the Technical University of Denmark.

2.1. EARSEC AIRBORNE CAMPAIGN 1991

The EARSEC airborne campaign took place simultaneously with the MAC Europe campaign to make use of the acquired AIRSAR data and AVIRIS and TMS data for intercalibration. Two test sites are of specific interest:

- The Villingen-Schwenningen area, near Freiburg, in the German Black Forest, where major research is conducted with respect to the effects on restabilisation measures and atmospheric deposition on N- and S-cycling of the eco- and hydrosphere;
- The Ardeche area, in France, where basic research is conducted with respect to the identification of basic soil types, estimation of canopy biochemistry of mediterranean woods and detection of relative amounts of vegetation and soils present in a ground resolution cell.

This paper only discusses the Villingen-Schwenningen area.

An extensive ground-truth measurement campaign was set up to accommodate both the airborne measurements acquired within the framework of the MAC-Europe and EARSEC campaigns.

The main objectives for the optical data analysis of the campaign are:

- to assess the data quality and calibration of the different sensors in terms of Signal-to-Noise ratio (SNR) and Noise-Equivalent-Radiance (NER), to gain experience of importance for the improvement of an European imaging spectrometer;
- to assess CAESAR's bidirectional reflectance properties for canopy structure evaluation by studying the sun-target interaction, validating physically based bidirectional reflectance models for homogeneous and inhomogeneous surfaces, and by retrieving biological parameters;
- to assess the capabilities of the imaging spectrometer for the extraction of biochemical components in vegetated areas.

2.2. IMPROVEMENT OF THE GER II IMAGING SPECTROMETER

The new European sensor will be a significant improvement of the GER II imaging spectrometer. It will consist of 79 channels covering the spectral range from 0.4 to 12.3 μm in semicontiguous intervals. The absolute calibration accuracy of the system is guaranteed to be less than 5 percent. Results from the 1991 campaigns will be used to steer the improvement with respect to data quality and data processing.

3. DATA COLLECTION

During July 1991 the following airborne data were acquired:

Date	Sensor
July 5	AVIRIS, TMS, ER-2 aerial photography

July 18	CAESAR
July 22	AVIRIS, TMS, ER-2 aerial photography
July 23	GER II
July 29	AVIRIS, TMS, ER-2 aerial photography
August 21	Aerial photography

Ground-truth measurements were collected from 7 to 22 June and from 7 to 22 July.

4. DATA ANALYSIS

Preliminary results regarding the three research objectives are shown below. As far as the data quality is concerned: the SNR and NER [$\mu\text{W cm}^{-2}\text{sr}^{-1}\mu\text{m}^{-1}$] were calculated for three sensors, AVIRIS (only July 5), GER II and CAESAR using a high reflectance calibration target, a homogeneous sandy sports field.

sensor	λ [nm]	SNR	NER	resolution [m]
AVIRIS	548.6	68	0.104	20
GER II	549.5	137	0.028	10
CAESAR	550	38	0.098	1.25
AVIRIS	667.5	30	20	
GER II	669	73	0.053	10
CAESAR	670	63	0.086	1.25
AVIRIS	872	70	0.108	20
GER II	860	66	0.064	10
CAESAR	870	73	0.074	1.25
AVIRIS	2030	5	0.136	20
GER II	2030	17	0.033	10
AVIRIS	2209	7.4	0.088	20
GER II	2212	22	0.033	10
AVIRIS	2406	0.79	0.229	20
GER II	2412	6.5	0.634	10

More detailed results will be presented during the workshop.

5. CONCLUSIONS

The current data set allows only for a study of data quality and calibration aspects. However, for that purpose, we consider this data set to be of importance. Especially with regard to the improvement of the GER imaging spectrometer, useful conclusions can be drawn to further improve the capabilities of the European spectrometer. The SNR's and NER's need to be improved in order to achieve the design goals of SNR's higher than 150 for the VIS/NIR region and higher than 80 for the SWIR/MIR/TIR region.

The data set also allows for a study of bidirectional information. Research in this area contributes to the development of MODIS-T and MISR.

The extraction of biochemical components in vegetated areas can be achieved by using the high spectral resolution of the AVIRIS. Research should be conducted into the area of atmospheric modelling, to fully explore the benefits of the AVIRIS data.

At present, the final results are not yet available. Major research in the area is established by a program exchange with U.S. scientists, this summer. By that time, all the ground truth data will be available.