COMPARISON OF JPL-AIRSAR AND DLR E-SAR IMAGES FROM THE MAC EUROPE '91 CAMPAIGN OVER TESTSITE OBERPFAFFENHOFEN: FREQUENCY AND POLARIZATION DEPENDENT BACKSCATTER VARIATIONS FROM AGRICULTURAL FIELDS

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1. INTRODUCTION

On July 12, the MAC Europe'91 (Multi-Sensor Airborne Campaign) took place over test site Oberpfaffenhofen. The DLR Institute of Radio-Frequency Technology participated with its C-VV, X-VV,and X-HH Experimental SAR (E-SAR). The high resolution E-SAR images with a pixel size between 1 and 2 m and the polarimetric AIRSAR images were analyzed. Using both sensors in combination is a unique opportunity to evaluate SAR images in a frequency range from P- to X-band and to investigate polarimetric information.

2. EXPERIMENT AND DATA DESCRIPTION

The JPL AIRSAR was flown over testsite Oberpfaffenhofen on July 12, 1991 at noon. The DLR E-SAR was flown on different daytimes between July 8 and 12. The E-SAR data were processed at the DLR facility with the Motion Compensation SAR Processor [*Moreira 1990*]. The pixel resolution for the 8-look images (slant range presentation) is 1.8 x 1.2 m. The antenna pattern was corrected using a multiplicative polynomial correction function. The image digital numbers correspond to 16 bit amplitude values.

Ground truth consisted in mapping of landuse and the phenological situation, and intensive soil sampling on large, flat agricultural fields belonging to three different soil types: a loessy soil, drained turfy material, and a gravel-rich glacial terrace. Biomass and leaf area index were measured on several corn fields.

3. IMAGE INTERPRETATION

Digital image processing was performed on an EASI/PACE system (PCI Inc.) using a DECstation 5000/200. Since the E--SAR samples one frequency-polarization combination at a time, the image channels of the test site had to be geometrically rectified to each other. Figure 1 shows a color composite of three E-SAR images illustrating different backscattering mechanisms for C- and X-band but, furthermore, also for X-HH and -VV polarization. These differences are due to varying states of crop maturity. The wetness, mainly in the crop's ears, causes absorption losses of the VV-polarized signals.

This finding is in agreement with measurements of the absorption loss factor of wheat stalks [*Allen and Ulaby 1984*] and negative correlations between biomass and C-VV backscatter for corn fields and potato fields, see figure 2. For vertical polarization the loss factor increases with plant volumetric moisture (ie. the backscattered power decreases), and for horizontal polarization the loss factor decreases with wetness. Hence, the HH-polarized returns penetrate the crop's ear layer somewhat and backscattering occurs on lower parts of the plants where the different state of maturity does not cause, at this time of the year (July 8), differences in water content.

Figure 3 shows an unsupervised Migrating-Means (or K-Cluster) approach to classify an agricultural area close to the DLR. Only the E-SAR C-VV and X-VV channels were used. Image processing techniques such as post-classification filtering or a combination with image segmentation algorithms [*Rignot et al. 1991*] can improve the classification results.

4. CONCLUSION AND OUTLOOK

The VV-polarized C- and X-band scattering is dependent on the different degrees of maturity in the barley fields. HH-polarized X-band signals have a larger penetration depth and the backscattering intensity is not dependent on the water content of the uppermost vegetation layer. SAR images of one week later do not show these backscattering variations since the crops had been ripening in that time period.

JPL polarimetric AIRSAR data from this test site is being analysed with special regard to the polarization-dependent backscatter phenomena, since it could be shown that a combination of a different frequency plus a different polarization gives best statistical separability. Future campaigns such as CLEOPATRA 1992 will include additional ground truth measurements that are regarded to be of importance and have been missing in the MAC Europe '91 Campaign, such as plant geometry.

5. REFERENCES

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Fig. 1

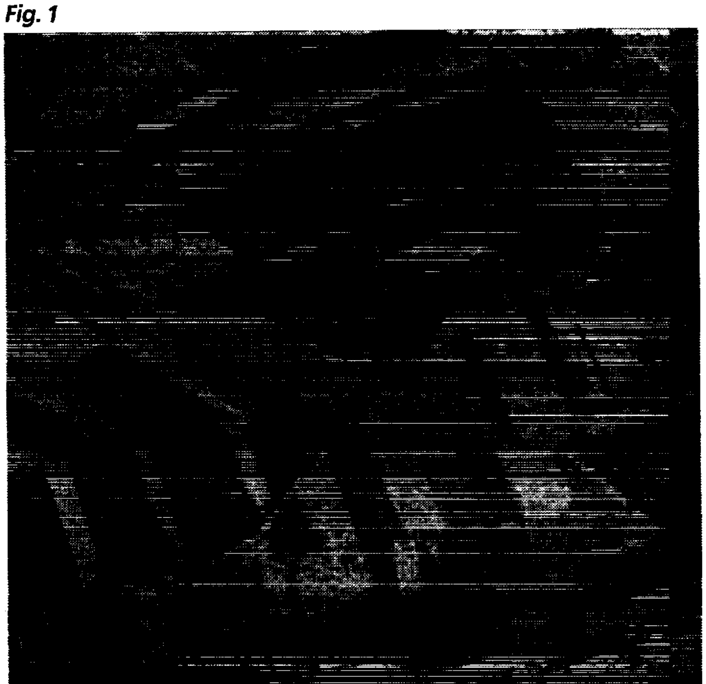

Fig. 3

Fig. 1
Color composite of a three channel image (red: C-VV, green: X-VV, blue: X-HH, MAC Europe '91).

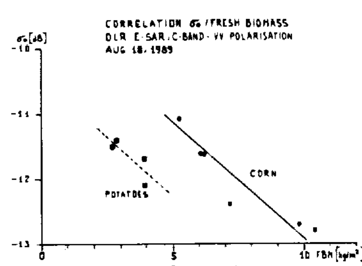

Fig. 2 Correlations of σo (derived from the mean grey value per field) with the fresh biomass of corn and potatoes (C-band image, Aug. 1989).

Fig. 3:
Non-supervised classification of a two frequency image (X-band, C-band both VV-polarisation, MAC Europe '91).

Legend:

Blue:	water
yellow + green:	Summer cereals
Green: (+ little orange)	Gras
Orange: (+ little green)	Oats
light blue:	not cultivated
Margenta:	Winter barley
Red/Violett:	Corn + potatoes
Red/Brown:	Rape